

TAMPEEL Remedial Investigation Report

Volume I

***Project No. 802873 May 2005
(REV 2009)***



**TAMPEEL
REMEDIAL INVESTIGATION AND
SUPPLEMENTAL REMEDIAL INVESTIGATION
FORMER LORDSTOWN ORDNANCE DEPOT
LORDSTOWN, OHIO**

**PREPARED FOR
U.S. Army Corps of Engineers
Louisville District**

**PREPARED BY
IT Corporation
11499 Chester Road
Cincinnati, Ohio 45246
(513) 782-4700**

**Project No. 802873
Contract No. DACA27-99-D-0022, Delivery Order 0006**

May 2005

Table of Contents

List of Tables	vii
List of Figures	x
List of Appendices	xii
List of Acronyms	xiii
Executive Summary	ES-1
1.0 Introduction	1-1
1.1 Purpose of Investigation	1-1
1.2 Site Background	1-2
1.2.1 Site Description	1-2
1.2.2 Site History	1-3
1.2.2.1 Past Use of TAMPEEL Area	1-4
1.2.3 Previous Investigations	1-5
2.0 Site Investigation Activities (RI and SRI)	2-1
2.1 Geophysical Investigation	2-1
2.2 Subsurface Soil Samples	2-2
2.2.1 RI Activities	2-2
2.2.2 SRI Activities	2-4
2.3 Surface Soil Samples	2-4
2.3.1 RI Activities	2-4
2.3.1.1 Landfill Perimeter Samples	2-4
2.3.1.2 Children's Activity Areas	2-5
2.3.1.3 Depressed Areas	2-5
2.3.2 SRI Surface Soil Sampling	2-6
2.4 Surface Water and Sediment Sampling	2-6
2.4.1 RI Activity	2-6
2.4.1.1 Study pond and Beaver Pond	2-6
2.4.1.2 Aspen Creek	2-8
2.4.1.3 TAMPEEL Spring	2-8
2.4.2 SRI Activities	2-8
2.4.2.1 Aspen Creek	2-8
2.4.2.2 TAMPEEL Spring	2-9
2.4.2.3 Beaver Creek	2-9
2.5 Monitoring Well Installation	2-9
2.5.1 Well Drilling	2-10

Table of Contents (continued)

2.5.2	Well Installation	2-11
2.5.3	Well Development	2-12
2.6	Groundwater Sampling	2-13
2.7	Groundwater Level Measurements	2-14
2.8	Slug Tests	2-15
2.9	Surveying	2-15
2.10	Field Quality Assurance Samples	2-16
2.11	Equipment Decontamination	2-16
2.12	Investigation Derived Waste	2-18
3.0	Physical Characteristics of the Study Area	3-1
3.1	Surface Features	3-1
3.2	Meteorology	3-1
3.3	Surface Water Hydrology	3-2
3.4	Geology	3-3
3.5	Soils	3-4
3.6	Hydrogeology	3-4
3.7	Demography and Land Use	3-5
3.8	Ecological Characterization	3-7
4.0	Nature and Extent of Contamination	4-1
4.1	Determination of Background	4-3
4.2	TAMPEEL Subsurface Soil	4-8
4.3	Surface Soil Investigation	4-9
4.4	Surface Water and Sediment Sampling	4-15
4.4.1	Aspen Creek and TAMPEEL Spring	4-16
4.4.2	Study Pond Surface Water and Sediment Sampling	4-18
4.4.3	Beaver Pond Surface Water and Sediment Sampling	4-19
4.4.4	Beaver Creek Surface Water and Sediment Sampling	4-20
4.5	Nature and Extent of Groundwater Contamination	4-22
4.5.1	RI Sampling Results	4-22
4.5.2	SRI Sampling Activity	4-23
4.6	Summary of Analytical Results	4-24
5.0	Contaminant Fate and Transport	5-1
5.1	Potential Routes of Migration	5-1

Table of Contents (continued)

5.1.1	Air Emissions	5-2
5.1.2	Soil	5-3
5.1.3	Surface Water and Sediment	5-4
5.1.4	Groundwater	5-5
5.2	Contaminant Persistence and Mobility	5-6
5.2.1	Chemical and Physical Properties	5-6
5.2.2	Volatile Organic Compounds	5-9
5.2.2.1	Soil	5-11
5.2.2.2	Surface Water and Sediment	5-12
5.2.2.3	Groundwater	5-13
5.2.3	Semivolatile Organic Compounds	5-14
5.2.3.1	Soil	5-15
5.2.3.2	Surface Water	5-15
5.2.3.3	Sediments	5-16
5.2.3.4	Groundwater	5-16
5.2.4	Chlorinated Pesticides and PCBs	5-16
5.2.5	Dioxins Furans	5-17
5.2.6	Metals	5-17
5.2.6.1	Soils	5-26
5.2.6.2	Surface Water	5-26
5.2.6.3	Sediment	5-27
5.2.6.4	Groundwater	5-27
5.3	Contaminant Migration	5-28
6.0	Baseline Risk Assessment	6-1
6.1	Human Health Risk Assessment	6-1
6.1.1	Conceptual Site Model	6-2
6.1.2	Determination of Chemicals of Potential Concern	6-5
6.1.2.1	Data Compilation	6-5
6.1.2.2	Comparison of Site-Related Data to Background Data	6-5
6.1.2.3	Comparison of Site-Related Data to Screening Criteria	6-6
6.1.2.4	Detection Frequency	6-6
6.1.3	Exposure Point Concentrations	6-7
6.1.3.1	Calculation of Concentration Term for Soils and Sediment	6-7

Table of Contents (continued)

6.1.3.2	Determination of Groundwater Exposure Point Concentrations	6-8
6.1.3.3	Determination of Surface Water Exposure Point Concentrations	6-9
6.1.4	Quantification of Intake	6-9
6.1.4.1	Soil and Sediment Exposures	6-9
6.1.4.1.1	Incidental Ingestion	6-9
6.1.4.1.2	Inhalation of Volatiles	6-10
6.1.4.1.3	Inhalation of Particulates	6-11
6.1.4.1.4	Dermal Contact	6-12
6.1.4.2	Groundwater and Surface Water Exposures	6-12
6.1.4.2.1	Water Ingestion	6-13
6.1.4.2.2	Inhalation of Volatiles Released by Showering and Other Household Water Uses	6-13
6.1.4.2.3	Dermal Contact While Bathing or Wading	6-14
6.1.4.2.4	Vegetable and Fruit Ingestion	6-15
6.1.5	Toxicity Assessment	6-17
6.1.5.1	Toxicity Assessment for Carcinogenic Effects	6-17
6.1.5.2	Toxicity Assessment for Noncarcinogenic Effects	6-17
6.1.5.3	Chemical-Specific Issues	6-18
6.1.6	Risk Characterization	6-18
6.1.6.1	Calculation of Carcinogenic Risk	6-18
6.1.6.2	Calculation of Noncancer Risk	6-19
6.1.7	Human Health Risk Assessment Results	6-21
6.1.7.1	Soil	6-21
6.1.7.2	Surface Water and Sediment	6-23
6.1.7.2.1	Aspen Creek/TEMPEEL Spring	6-23
6.1.7.2.2	Beaver Pond	6-25
6.1.7.2.3	Study Pond	6-27
6.1.7.3	Groundwater	6-29
6.1.7.4	Cumulative Risk and Hazard Across All Media	6-29
6.1.8	Uncertainties Associated with the Human Health Risk Assessment	6-31

Table of Contents (continued)

	6.1.8.1	Methodological Uncertainty	6-31
	6.1.8.2	Site-Specific Uncertainties	6-34
6.2		Ecological Risk Assessment	6-35
	6.2.1	Introduction	6-35
	6.2.2	Problem Formulation	6-36
	6.2.2.1	Determination of COPECs	6-36
	6.2.2.2	Ecological Characterization	6-39
	6.2.2.3	Selection of Assessment and Measurement Endpoints	6-42
	6.2.2.4	Identification of Representative Ecological Receptors	6-45
	6.2.2.5	Presentation of Conceptual Site Model	6-47
	6.2.2.6	Problem Formulation Summary	6-48
	6.2.3	Exposure Assessment	6-48
	6.2.3.1	Exposure Pathways	6-54
	6.2.3.2	Receptor Profiles	6-55
	6.2.4	Ecological Effects Characterization	6-59
	6.2.4.1	Endpoint Selection	6-59
	6.2.4.2	Toxicity Reference Values	6-59
	6.2.5	Risk Characterization	6-61
	6.2.5.1	Terrestrial Risk Characterization	6-61
	6.2.5.2	Aquatic Risk Characterization	6-62
	6.2.6	Uncertainties Associated With the Ecological Risk Assessment	6-65
6.3		Conclusions	6-69
7.0		Summary and Conclusions	7-1
	7.1	Summary	7-1
	7.1.1	Soil Investigation	7-1
	7.1.2	Surface Water and Sediment Investigation	7-4
	7.1.2.1	Aspen Creek and TAMPEEL Spring	7-4
	7.1.2.2	Beaver Pond	7-7
	7.1.2.3	Study Pond	7-9
	7.1.3	Groundwater Investigation	7-11
	7.2	Conclusions	7-12
8.0		References	8-1

List of Tables

2-1	Sampling Location Rationale
2-2	Soil and Sediment Samples Analytical Summary
2-3	Study Pond and Beaver pond Surface Water field Parameter Readings
2-4	Study Pond and Beaver Pond Sediment GPS and Organic Vapor Readings
2-5	Monitoring Well Construction Summary
2-6	Monitoring Well Development Parameters
2-7	Water Samples Analytical Summary
2-8	Monitoring Well Water Level Elevations
2-9	Survey Data
2-10	QA/QC Samples
3-1	Adjacent Groundwater Wells
3-2	Slug Test Analysis Results
3-3	Vegetative Communities
3-4	Mammals Observed Onsite and Likely to be Found in Trumbull County, Ohio
3-5	Birds Observed Onsite and Likely to be Found in Trumbull County, Ohio
3-6	Reptiles Observed Onsite and Likely to be Found in Northeast Ohio
3-7	Amphibians Observed Onsite and Likely to be Found in Trumbull County, Ohio
4-1	Background Concentrations for Total Soil and Groundwater
4-2	Subsurface Soil Samples, Analytical Results Summary – Detected Compounds Only
4-3	Surface Soil Samples, Analytical Results Summary – Detected Compounds Only
4-4	Surface Water Samples, Analytical Results Summary – Detected Compounds Only
4-5	Sediment Samples, Analytical Results Summary – Detected Compounds Only
4-6	Groundwater Samples, Analytical Results Summary – Detected Compounds Only
5-1	Pathways for Potential Chemical Migration
5-2	VOCs Detected by Media
5-3	SVOCs Detected by Media
5-4	Pesticides/PCBs Detected by Media
5-5	Metals Detected Above Background Concentrations
5-6	Physical and Chemical Properties of VOCs Detected
5-7	Physical and Chemical Properties of SVOCs Detected
5-8	Physical and Chemical Properties of Pesticides Detected
6-1	Parameters Used to Estimate Potential Exposure for Soil and Sediment Receptors
6-2	Parameters used to Estimate Potential Exposure for Groundwater Receptors

List of Tables (continued)

6-3	Parameters Used to Estimate Potential Exposure for Surface Water Receptors
6-4	Chemical-Specific Dermal Absorption Factors
6-5	Fruit/Vegetable Uptake Model Parameters
6-6	Toxicity Data for Chemicals of Potential Concern
6-7	Chemical-Specific Oral Absorption Factors
6-8	Selection of Contaminants of Potential Concern, Surface Soil
6-9	Selection of Contaminants of Potential Concern, Total Soil
6-10	TAMPEEL Soil Cancer Risk Estimates
6-11	TAMPEEL Soil Non-Cancer Hazard Estimates
6-12	Selection of Contaminants of Potential Concern, Surface Water From Aspen Creek
6-13	Selection of Contaminants of Potential Concern, Surface Water from Beaver Pond
6-14	Selection of Contaminants of Potential Concern, Surface Water from the Study Pond
6-15	Selection of Contaminants of Potential Concern, Sediment From Aspen Creek
6-16	Selection of Contaminants of Potential Concern, Sediment from Beaver Pond
6-17	Selection of Contaminants of Potential Concern, Sediment from the Study Pond
6-18	Surface Water Cancer Risk Estimates
6-19	Surface Water Non-Cancer Hazard Estimates
6-20	Sediment Cancer Risk Estimates
6-21	Sediment Non-Cancer Hazard Estimates
6-22	Selection of Contaminants of Potential Concern, Groundwater
6-23	Groundwater Cancer Risk Estimates
6-24	Groundwater Non-Cancer Hazard Estimates
6-25	Cumulative Cancer Risk and Non-Cancer Hazard Estimates
6-26	Chemicals Evaluated as Beneficial Nutrients
6-27	Selection of Contaminants of Potential Ecological Concern, Surface Water from Study Pond
6-28	Selection of Contaminants of Potential Ecological Concern, Surface Water from Beaver Pond
6-29	Selection of Contaminants of Potential Ecological Concern, Aspen Creek Surface Water
6-30	Selection of Contaminants of Potential Ecological Concern, Sediment from Study Pond
6-31	Selection of Contaminants of Potential Ecological Concern, Sediment from Beaver Pond
6-32	Selection of Contaminants of Potential Ecological Concern, Aspen Creek Sediment
6-33	Selection of Contaminants of Potential Ecological Concern, Surface Soil
6-34	Vegetative Communities

List of Tables (continued)

- 6-35 Mammals Observed On-Site and Likely to be Found in Trumbull County, Ohio
- 6-36 Birds Observed On-Site and Likely to be Found in Trumbull County, Ohio
- 6-37 Reptiles Observed On-Site and Likely to be Found in Northeast Ohio
- 6-38 Amphibians Observed On-Site and Likely to be Found in Trumbull County, Ohio
- 6-39 Assessment and Measurement Endpoints and Exposure Delineation
- 6-40 Chemicals for Which Alternative Foraging Factors Were Used
- 6-41 Data Used to Model Exposure in the Indicator Wildlife Species
- 6-42 Soil and Sediment Transfer Factors for Chemicals of Potential Ecological Concern
- 6-43 Surface Water Transfer Factors for Chemicals of Potential Ecological Concern
- 6-44 No Observed Adverse Effects Levels (NOAEL) Used to Derive Wildlife Toxicity
Benchmarks for Chemicals of Potential Ecological Concern
- 6-45 Chemicals of Potential Ecological Concern for Which Insufficient Toxicological Data
Could be Found to Estimate NOAELs
- 6-46 COPEC Soil Benchmark Concentrations for Plants and Soil Invertebrates
- 6-47 Terrestrial Receptors Hazard Index (HI) Summary
- 6-48 Aquatic Receptors hazard Index (HI) Summary
- 6-49 Surface Water Quality
- 6-50 Sediment Quality
- 6-51 Terrestrial Receptors Hazard Index (HI) Summary with the Exclusion of Aluminum in
Soil
- 6-52 Predominant Chemicals of Potential Concern (Risk Drivers) for the Human Health Risk
Assessment

List of Figures

- 1-1 Site Location Map
- 1-2 Site Vicinity Map
- 1-3 Facility Layout Map
- 1-4 TAMPEEL Investigation Site Map
- 2-1 Magnetic Field Upper Sensor Geophysics Results of TAMPEEL Area Site Map
- 2-2 TAMPEEL RI Sampling Locations
- 2-3 TAMPEEL SRI Sampling Locations
- 3-1 TAMPEEL Area Topographic Map
- 3-2 TAMPEEL Bedrock Surface Contour Map
- 3-3 Cross Section Location Map
- 3-4 Geologic Cross-Section A-A'
- 3-5 Geologic Cross-Section B-B'
- 3-6 Geologic Cross-Section C-C'
- 3-7 Geologic Cross-Section D-D'
- 3-8 Geologic Cross-Section E-E'
- 3-9 Supply Well Locations
- 3-10 Potentiometric Surface Map – April 21, 1999
- 3-11 Potentiometric Surface Map – June 12, 2001
- 4-1 Background Sampling Locations
- 4-2 Subsurface Soil Sample Locations
- 4-3 TAMPEEL Subsurface Soil Boring Analytical Results
- 4-4 TAMPEEL Investigation Surface Soil Sample Locations
- 4-5 TAMPEEL Surface Soil Total BTEX Analytical Results
- 4-6 TAMPEEL Surface Soil Total PAH Analytical Results
- 4-7 TAMPEEL Surface Soil Total Pesticides/PCBs Analytical Results
- 4-8 TAMPEEL Surface Soil Total Metals Above Background
- 4-9 TAMPEEL Investigations Surface Water/Sediment Sampling Locations
- 4-10 TAMPEEL Investigations Surface Water and Sediment Analytical Results
- 4-11 TAMPEEL Investigations Beaver Pond Surface Water and Sediment Analytical Results
- 4-12 TAMPEEL Investigations Groundwater Analytical Results
- 5-1 Degradation Pathway for Selected Chlorinated Hydrocarbons

List of Figures (continued)

- 6-1 Conceptual Site Model for TAMPEEL
- 6-2 TAMPEEL Vegetative Communities
- 6-3 Simplified Terrestrial Food Web Conceptual Site Model
- 6-4 Simplified Aquatic Food Web Conceptual Site Model
- 6-5 Ecological Conceptual Site Model

List of Appendices

Appendix A	Geophysical Investigation Report
Appendix B	Soil Boring Logs
Appendix C	Soil Sample Collection Logs
Appendix D	Rock Coring/Well Construction Logs
Appendix E	Well Development Logs
Appendix F	Groundwater Sample Collection Logs
Appendix G	Groundwater Elevation Logs
Appendix H	Slug Test Plot Data
Appendix I	Analytical Data Tables and Chains-of Custody
Appendix J	Data Validation Summary Reports
Appendix K	Human Health Risk Assessment Spreadsheets
Appendix L	Ecological Risk Assessment Spreadsheets

List of Acronyms

AOC	area of concern
ASTM	American Standards for Testing Materials
BAF	bioaccumulation factors
BCF	bioconcentration factors
Bgs	below ground surface
BSAF	bioata-sediment accumulation factor
BTEX	Benzene, Toluene, Xylene, and Ethylbenzene
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
COPCs	chemicals of potential concern
COPEC	contaminants of potential ecological concern
CPSS	chemicals present in site samples
CSM	conceptual site model
CT	central tendency
DERP/FUDS	Defense Environmental Restoration Program/Formerly Used Defense Site
DEV	disturbed areas
DNAPL	dense nonaqueous phase liquid
DoD	Department of Defense
DOT	Department of Transportation
DQO	data quality objective
ERA	Ecological Risk Assessment
ET	Ecological Threshold
FCM	Food chain multipliers
FLOD	Former Lordstown Ordnance Depot
FRM	moderate forest
FS	Feasibility Study
GPS	global positioning system
GSA	General Services Administration
HEAST	Health Effects Assessment Summary Tables
HHRA	Human Health Risk Assessment
HI	hazard index
HQ	Hazard Quotient
HSA	hollow stem auger
HSP	Health and Safety Plan
IDW	investigation derived waste
IRIS	Integrated Risk Information System
IT	IT Corporation
K	Hydraulic Conductivity
kg	Kilogram
L	Liter
LNAPL	light nonaqueous phase liquid
LOAEL	lowest observed adverse effect levels
LOD	Lordstown Ordnance Depot
NCP	National Contingency Plan
NOAA	National Oceanic and Atmospheric Administration

List of Acronyms (continued)

NOAEL	no observed adverse effect levels
NTU	nepheometric turbidity unit
NWI	National Wetland Inventory
OAC	Ohio Administrative Code
OCC	Ohio Commerce Center
ODNR	Ohio Department of Natural Resources
OERR	Office of Remedial Response
OFM	moderate old field
OhioEPA	Ohio Environmental Protection Agency
OME	Ontario Ministry of the Environment
OW	open water
PA	preliminary assessment
PAH	polycyclic aromatic hydrocarbons
PCBs	polychlorinated biphenyls
PFO	palustrine forested wetland
PID	photoionization detector
PPE	personal protective equipment
PRG	Preliminary Remediation Goal
PSS	palustrine scrub/shrub
PVC	Polyvinyl Chloride
QA/QC	quality assurance/quality control
RAAD	Risk Assessment Assumptions Document
RBSC	risk-based screening concentrations
RfD	Reference dose
RI	Remedial Investigation
RME	reasonable maximum exposure
SI	Site Investigation
SIR	Site Investigation Report
SQL	sample quantitation limit
SRI	Supplemental Remedial Investigation
SSWP	Site Specific Work Plan
STP	standard temperature and pressure
SVOC	semivolatile organic compound
TAL	target analyte list
TAMPEEL	Trumbull Area Multi Purpose Environmental Education Laboratory
TEF	toxicity equivalence factors
TOC	total organic carbon
UCL	upper confidence limit
USACE	United States Army Corps of Engineers
USEPA	United States Environmental Protection Agency
UTL	upper 95-percent tolerance limit
VOC	volatile organic compound
µg	Micrograms

Executive Summary

1.0 Introduction

This Executive Summary presents the results of the Trumbull Area Multi Purpose Environmental Education Laboratory (TAMPEEL) Remedial Investigations (RI) conducted at the Former Lordstown Ordnance Depot (FLOD) in Lordstown, Ohio, between 2000 and 2005.

Investigations included in this report include a remedial investigation (RI) and supplemental remedial investigation (SRI). This report was originally prepared for the U.S. Army Corps of Engineers (USACE) by Shaw Environmental Inc., and submitted to Ohio Environmental Protection (Ohio EPA) in May 2005. The Ohio EPA reviewed the report and provided comments to the report on October 18, 2005. Between 2006 and 2009, USACE undertook additional investigation activities recommended in the Conclusions (Section 7.2). These included a year of quarterly monitoring of the groundwater, the TAMPEEL Spring, and Aspen Creek for one year. Landfill gas was also monitored for one year. Additional investigation of the landfill was conducted and included a geophysical survey with confirmation using trenches.

Minimal revisions have been made to this report and are limited to addressing specific comments and recommendations identified in the Ohio EPA letter dated October 18, 2005. These changes are summarized in the “USACE Response to Ohio EPA October 18, 2005 Comments and Recommendations Table”. Revised pages are identified in the header of each page (May 2005(Rev 2009)).

Additional activities for TAMPEEL were conducted in general accordance with the TAMPEEL Landfill and 3 Areas of Concern Investigation Work Plan dated July 2007. The results and discussion of the additional investigation activities between 2007 and 2009 will be presented in a report entitled “TAMPEEL Remedial Investigation Report Addendum” scheduled to be completed in May 2010.

TAMPEEL is a 39 acre fenced facility that includes the following locations that combined will be referred to as TAMPEEL:

- Children’s Activity Areas
- TAMPEEL Spring

- Beaver Creek
- Study Pond and Beaver Pond
- Aspen Creek
- Landfill
- Area Containing Depressions

The TAMPEEL RI was undertaken to characterize the nature and extent of environmental contamination, to assess risks to human health and the environment, and to provide data to develop, evaluate, and select appropriate remedial actions to mitigate adverse effects, if required. The TAMPEEL RI was conducted by IT Corporation (precursor organization to Shaw Environmental, Inc.) under contract to the United States Army Corps of Engineers (USACE), Louisville District.

The FLOD is a Defense Environmental Restoration Program/Formerly Used Defense Site (DERP/FUDS) facility that is currently owned by the Ohio Commerce Center (OCC) and the Trumbull County Board of Education. The site is located just west of Ohio State Route 45 in Lordstown Township, approximately four miles south of Warren, Ohio in Trumbull County.

Previous investigations include: the Level I Environmental Site Assessment of the Ohio Commerce Center (R&R, 1990), an additional site assessment conducted in 1994 (CH2M Hill, 1994), a Site Investigation (SI) (Maxim, 1997), and an OCC RI conducted in 1998 (IT Corporation). An Ordnance and Explosives Archives Search Report for FLOD was published by the USACE, Rock Island District in 1998 (USACE, 1998). Results of the research indicate that no unexploded ordnance were handled or stored at the site.

2.0 Remedial Site Investigation

This TAMPEEL RI was undertaken to characterize the nature and extent of environmental contamination, to evaluate contaminant fate and transport, conduct a baseline risk assessment, and to develop preliminary remedial action objectives, if required. Field activities, procedures, and methods used to conduct this RI were performed in accordance with the Work Plan for the Remedial Investigation at the Former Lordstown Ordnance Depot (IT, 1997) and the Work Plan Addendum for the Remedial Investigation, Firing Range and TAMPEEL, at the Former Lordstown Ordnance Depot (IT, 1999). The TAMPEEL RI was conducted by IT Corporation

under contract to the USACE, Louisville District. Remedial Investigation activities were as follows:

- Geophysical survey to help delineate the suspected landfill;
- Installation/sampling/analyses of 20 soil borings around the landfill perimeter;
- Collection/analyses of 9 surface soil samples in the Children's Activity Areas at TAMPEEL;
- Collection/analyses of 4 soil samples from two representative depressions to the south of TAMPEEL;
- Collection/analyses of 2 surface water samples and 2 sediment samples from Aspen Creek;
- Collection/analyses of 3 surface water and 3 sediment samples from the Study Pond;
- Collection/analyses of 4 surface water and 4 sediment samples from the Beaver Pond;
- Installation of 4 monitoring wells around the landfill;
- Resampling/analyses of the TAMPEEL spring; and
- Resampling/analyses of 11 monitoring wells installed as part of the previous RI at the Ohio Commerce Center (OCC).

The soil borings and monitoring wells were generally installed in the locations proposed in the work plan. However, several of the proposed sample locations for the Children's Activity Areas were changed by mutual agreement between the USACE Project Engineer, the Ohio Environmental Protection Agency (Ohio EPA) Site Coordinator, the TAMPEEL Director and the IT Project Manager. The sample locations were moved to coincide with the student activity areas.

Following assessment of the RI results, additional investigations were deemed necessary. These supplemental remedial investigations were conducted by IT Corporation in 2000 and 2001. SRI activities included:

- Installation of one additional monitoring well to provide a well more directly down gradient of the southern half of the landfill. See figure 3-11.
- Collection of groundwater samples from four existing wells and the one new well;
- Collection of 18 surface soil samples were collected from student activity areas to provide contaminant distribution data;
- Collection of sediment and surface water samples at five locations;
- Completing slug tests at five wells (4 existing and one new); and
- Analysis of all samples for the presence of volatile organic compounds (VOCs), semi volatile organic compounds (SVOCs), pesticides, polychlorinated biphenyls (PCBs), and target analyte list (TAL) metals.

3.0 Physical Characteristics of the Study Area

The site is located within an area generally characterized as containing irregular plains as the predominant land-surface form and as having a dominant natural vegetation of beech/maple and northern hardwoods (such as maple, birch, beech, and hemlock) in undisturbed areas. The site itself has little topographic relief, with a land surface elevation that varies from approximately 918 feet at the north to 946 feet at the south, National Geodetic Vertical Datum (NGVD).

Surface water features in the vicinity of the FLOD investigation area consist of the Beaver Pond and the Study Pond, Aspen Creek, and Beaver Creek running south to north into and out of the Beaver Pond which eventually is a tributary to Duck Creek. Runoff from the investigation area and vicinity drains into that tributary. A small spring is located at TAMPEEL, approximately 200 feet south-southwest of the Study Pond. This spring is the headwaters for a small creek that flows north to the Duck Creek drainage.

The bedrock formation directly below the unconsolidated materials is Mississippian sandstone and shale of the Berea Formation (Maxim, 1997). The sandstone was typically comprised of fine to medium grained sand, thinly bedded, and broken to a depth of approximately 10 feet, becoming slightly broken to a depth of approximately 14 feet, and becoming massive to a depth of approximately 20 feet. Two monitoring wells installed to the north of the landfill encountered shale bedrock, while all other monitoring wells encountered sandstone. However, all monitoring wells are believed to be installed in the same aquifer.

According to the map of Glacial Geology of Trumbull County (White, 1971), the unconsolidated materials which comprise the soils of the investigation site are known as the Hiram Till. The Hiram Till is at the surface in most of the western half of Trumbull County. This till is clay rich with few coarse-grained materials. It is rarely over 10 feet thick and at many places less than 5 feet thick.

According to the Groundwater Resources Map of Trumbull County (Haiker, 1996), groundwater at the investigation area is obtained from Mississippian and Pennsylvanian sandstone and sandy shale bedrock. Although occasional well yields of up to 75 gallons per minute are possible, maximum sustained yields are typically closer to 25 gallons per minute. During well development and sampling, all monitoring wells produced adequately with the exception of well MW105, which repeatedly went dry.

Water supplies for Lordstown Township are derived from Meander Lake, which is located approximately 17,000 feet to the southeast of the FLOD. FLOD is not in the Meander Lake drainage basin. The Lordstown Water Commissioner indicated that all residents in the area of FLOD are supplied with city water. However, Ohio Department of Natural Resources (ODNR) records indicate that 17 wells are present in the immediate vicinity of the site (within ½ mile). These wells are completed at depths ranging from 50 to 152 feet and have tested yields of 1.5 to 50 gpm. The potentiometric surface at the site indicates that downgradient is northwest for the wells in the vicinity of the Waste Oil Pit and to the northeast for wells around the landfill.

4.0 Nature and Extent of Contamination

Objectives of the TAMPEEL RI related to defining the nature and extent of contamination are to:

- Delineate the presence of leachate at the landfill perimeter;
- Investigate the nature of surface soils in the Children's Activity Areas;
- Investigate soil in the depressions south of the landfill;
- Investigate surface water and sediment in Aspen Creek;

- Investigate surface water and sediment quality at the Beaver Pond and Study Pond;
- Investigate groundwater quality upgradient and downgradient of the landfill; and
- Resample the monitoring wells installed as part of the OCC RI at the Ohio Commerce Center.

To characterize the nature and extent of contamination at TAMPEEL, some data from the OCC RI (1998) and the FLOD Site Investigation (Maxim, 1997) were included.

4.1 Determination of Background

Background samples for metals were collected during the OCC RI (1998). The samples were collected from three soil borings for soils background and two monitoring wells for groundwater background values. Since there are not any surface water or sediment background values, surface water samples are compared to Water Quality Criteria developed for the protection of aquatic life (OAC 3745-1). Sediment samples are compared to surface soil background values in Section 4.0, but only for the purposes of providing points of reference. In the risk assessment (Section 6.0), these background values are not used to define chemicals of potential concern (COPCs) in surface water and sediment. Only aluminum, arsenic, iron, magnesium, manganese, sodium and zinc were detected in the background groundwater samples.

4.2 Nature and Extent of Contamination at TAMPEEL

During the TAMPEEL RI, 20 soil borings (20 samples) were drilled around the perimeter of the landfill, 9 surface soil samples were collected in the Children's Activity Areas, 4 soil samples were collected in the depressed areas, 8 surface water and sediment samples were collected at the Study and Beaver Ponds, 2 surface water and sediment samples were collected in Aspen Creek, and four monitoring wells were installed around the landfill. All samples were analyzed for volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), pesticides/polychlorinated biphenyls (PCBs), and Target Analyte List (TAL) metals. Additionally, dioxins, furans and explosives were analyzed for in the soil samples from the depressed areas.

In samples collected from the soil borings drilled around the landfill, detected VOCs consisted of acetone and methylene chloride. VOCs were detected in 9 of 20 samples, with the highest concentration being an acetone detection of 810 µg/kg. The highest concentration of methylene

chloride detected was 15 µg/kg. No SVOCs were detected in any of the 20 samples. Pesticides were detected in only one sample at low levels. Metals above background consisted of arsenic, barium, iron, manganese, nickel, and zinc. Metals above background were detected in 11 out of the 20 samples collected.

In the 9 surface soil samples collected at the Children's Activity Areas, VOCs were detected in 7 of them. Detected analytes consisted of acetone, methylene chloride, and 1, 1, 1-trichloroethene. The highest concentration detected was a methylene chloride detection of 39 µg/kg. SVOCs were detected in all 9 of the samples with the highest total PAH concentration 30,710 µg/kg. Pesticides were detected in 4 of the 9 samples at low concentrations and one PCB was detected in one sample. Metals detected above background included: arsenic, barium, calcium, chromium, iron, copper, lead, manganese, mercury, and zinc.

The four depressed area samples each had VOC detections. The highest VOC detection was acetone at 110 µg/kg. No SVOCs, pesticides, PCBs, or explosives were detected in any of the 4 samples. Dioxins and furans were detected in all 4 samples at low concentrations. Metals were not detected above the established background levels for any of the 4 samples.

For surface soil samples collected during the SRI, VOCs were detected in 15 of 19 samples. The highest VOC concentration detected was a total xylene detection of 5,900 µg/kg in sample SS203. Detected VOCs consisted only of petroleum hydrocarbons (BTEX compounds). SVOCs were detected in 8 of the 91 samples. Detected SVOCs consisted primarily of PAHs. Total PAH concentrations in samples ranged from 454 µg/kg to 194,200 µg/kg. Metals were detected above background in every surface soil sample collected during the SRI activities. Metals detected above background included: aluminum, arsenic, barium, beryllium, cadmium, calcium, chromium, cobalt, copper, iron, lead, magnesium, manganese, mercury, nickel, potassium, selenium, sodium, vanadium, and zinc.

A total of eight surface water and sediment samples were collected at the Study and Beaver Ponds, two sediment samples were collected from Beaver Creek during the SI (Maxim, 1997), two surface water and sediment samples were collected in the Aspen Creek, and one surface water and sediment sample was collected (during the OCC RI) from the TAMPEEL Spring. In the Study Pond and Beaver Pond surface water samples, no VOCs, SVOCs, pesticides, or PCBs

were detected. The metals detected above the groundwater background values were aluminum, iron, lead, magnesium, manganese, and potassium. The sediment samples from the ponds showed VOC detections in one out of three samples in the Study Pond (acetone 100 µg/kg) and two out of four samples in the Beaver Pond, with only acetone detected at a maximum value of 69 µg/kg. Acetone was also detected in one sample from Beaver Creek. The only SVOCs detected in the sediment samples at either pond were fluoranthene and pyrene in one sample in the Study Pond. Eleven SVOCs, primarily PAHs, were detected in the Beaver Creek sediment samples. No pesticides or PCBs were detected in any of the pond samples. Metals that exceeded surface soil background levels in the sediment samples included: aluminum, barium, chromium, cobalt, copper, iron, lead, magnesium, manganese, nickel, potassium, selenium, vanadium, and zinc.

In Aspen Creek, surface water VOC samples detected included methylene chloride and cis-1, 2-dichloroethene at low concentrations. Cis-1, 2-dichloroethene was detected in the TAMPEEL Spring. SVOCs, pesticides, and PCBs were not detected in the surface water samples for either the creek or the spring. Metals detected above groundwater background values for surface water in the creek and spring included: aluminum, calcium, iron, magnesium, manganese and sodium. In Aspen Creek and TAMPEEL Springs sediment samples, three VOCs (acetone, carbon disulfide, methylene chloride) were detected in low concentrations. In Aspen Creek, the following SVOCs were detected: benzo (b) fluoranthene, fluoranthene and pyrene. Nine SVOCs, primarily PAHs, were detected in the TAMPEEL Spring sediment sample. No PCBs were detected in creek or spring samples. Pesticides were detected in both creek and spring sediment samples. Metals detected in sediment above soil background included barium, cobalt, copper, lead, manganese, and zinc.

During the SRI three surface water and three sediment samples were collected from Aspen Creek, one surface water and two sediment samples were collected from Beaver Creek. One VOC (cis-1,2DCE) was detected in the surface water sample from Aspen Creek. Chlorinated VOCs and carbon disulfide were detected in the SRI sediment samples collected from Aspen Creek. In Beaver Creek samples collected during the SRI SVOCs were detected in a sediment sample (SD205) as were several metals present above background levels.

In the four monitoring wells, methylene chloride was the only VOC detected. It was detected in only one sample at 1.7 µg/L (a duplicate sample). No SVOCs, pesticides or PCBs were detected

in any of the four monitoring well samples. Metals exceeding background for groundwater included: aluminum, calcium, chromium, iron, lead, magnesium, potassium, sodium and vanadium.

For groundwater samples collected during the SRI, VOCs, SVOCs, PCBs, and pesticides were all below the analytical detection limits. Calcium, iron, lead, magnesium, potassium, sodium, and thallium were detected in excess of background.

5.0 Contaminant Fate and Transport

Since only low concentrations of contaminants were detected in the surface water and sediment samples collected at TAMPEEL, there does not appear to be any significant transport of contaminants by soil erosion. DDT, DDE, and DDD were detected at the highest concentrations in the sediment sample from the TAMPEEL spring. No detections occurred in the surface water sample in the same location or in any other surface water sampling location. The persistence of the pesticides at the spring is probably due to the low flow rates, which are insufficient to transport the spring sediment.

No VOC's were detected in the monitoring wells installed around the landfill. However, the low concentrations of cis-1, 2-dichloroethene detected in the surface water samples from the spring and Aspen Creek might indicate contaminated groundwater is discharging in these areas.

6.0 Risk Assessment Summary and Conclusions

Soil, sediment, surface water and groundwater data were assessed to establish the level of risk associated with exposure to these media. In addition the ecological impact was also assessed. Both the human health risk assessment and the ecological risk assessment are intended to reflect appropriate guidance provided by USEPA and Ohio EPA.

Results of the HHRA assessment of media with constituents contributing to human health risk and hazard above the target risk range are listed below. The primary constituents contributing risk and hazard above the target are presented in Section 6.0. The following is a summary:

- Soil – The cancer risks for RME exposures to soil exceed the USEPA point of departure of 1×10^{-6} for the adult resident (1.9×10^{-5}), child resident (4.0×10^{-5}), TAMPEEL caretaker (1.3×10^{-5}), construction worker (2.3×10^{-6}), and industrial worker

(6.8×10^{-6}) scenarios. The greatest contributions to these risks are from arsenic, benzo (a) pyrene, and dibenz (a, h) anthracene. The noncancer hazards for RME exposure to soil exceed the limit of 1 for the child resident (4.2) exposure scenario. The greatest contributions to this hazard are iron and manganese. It should be noted that when compared to the Recommended Daily Allowance, iron and manganese EPCs are below these values.

- Surface Water – All cancer risks and noncancer hazards are below USEPA limits for surface water.
- Sediment – The cancer risks for RME exposures to Aspen Creek/TAMPEEL Spring, Beaver Pond, and Study Pond sediment exceed the USEPA departure point of 1×10^{-6} for the adult resident (2.7×10^{-6} , 6.0×10^{-6} , and 1.5×10^{-6}), child resident (3.0×10^{-6} , 6.7×10^{-6} , and 1.7×10^{-6}), and TAMPEEL caretaker (2.5×10^{-6} , 5.5×10^{-6} , and 1.4×10^{-6}), respectively. The greatest contribution to risk is from arsenic. Noncancer hazards are below USEPA limits for sediment.
- Groundwater – All cancer risks are below the USEPA departure point of 1×10^{-6} . The noncancer hazard for RME exposures to groundwater exceeds the limit of 1 for the adult resident (5.9) and the child resident (22) exposure scenarios. The greatest contributors to this hazard are thallium, iron, and aluminum.

An Ecological Risk Assessment (ERA) was conducted in addition to the HHRA. A summary of the ERA is as follows:

- Based on the findings of the ERA, risks are generally acceptable for fish and wildlife potentially exposed to site surface water. Potential risks from exposure to site sediments and soil, however, are generally predicted to be unacceptable. Surface soils are predicted to be the most significant ecological concern, especially for sensitive insectivorous receptors such as the shrew (and to a lesser extent the deer mouse, cottontail, robin, and red fox) due to elevated levels of aluminum, barium, arsenic, zinc, DDT, and chromium and the potential bioaccumulation in earthworms and/or plants. Also at risk is the American robin, due to DDT in soil (however, the levels of DDT detected on site have been found to be consistent with agricultural levels, and may not be associated with inappropriate waste practices [ATSDR, 1994b]).

7.0 Summary and Conclusions

While arsenic in soil is the primary risk driver, the representative concentration calculated in the risk assessment is actually below the calculated background concentration. The primary risk drivers in groundwater are thallium and iron. However, the results driving the risk were only detected in one well, one time, in both cases. Cis-1,2-DCE was detected in the TAMPEEL

spring, but at concentrations below the MCL and DCE was not detected in any of the monitoring wells.

The following additional investigation activities are recommended for the TAMPEEL Landfill Remedial Investigation:

- Four quarters of surface water sampling for VOCs from the TAMPEEL Spring and Aspen Creek to confirm only low levels of DCE are present.
- Four quarters of groundwater monitoring.
- Four quarters of landfill gas monitoring.
- Additional investigation to delineate the extent of the TAMPEEL Landfill.

The results of the additional investigation will be presented in a Remedial Investigation Addendum.

1.0 Introduction

This document presents the results of a Remedial Investigation (RI) and a Supplemental Remedial Investigation (SRI) conducted at the Trumbull Area Multi Purpose Environmental Education Laboratory (TAMPEEL) portion of the Former Lordstown Ordnance Depot (FLOD) in Lordstown, Ohio. Results presented in this report are from these investigations, conducted in 1999 and 2000. TAMPEEL was operated by and currently owned by the Trumbull County Board of Education and consists of the following locations:

- Children's Activity Areas
- TAMPEEL Compound (facility structures and parking areas)
- TAMPEEL Spring
- Study Pond and Beaver Pond
- Aspen Creek
- Beaver Creek
- Landfill
- Depressed Areas.

Figures 1-1, 1-2, and 1-3 show the site location, site vicinity, and facility layout, respectively. These locations will, for the remainder of this document, be referred to as the TAMPEEL. The TAMPEEL is a 39-acre parcel that is completely fenced as shown on Figure 1-3. Investigations were conducted on all the above-listed locations with the exception of the TAMPEEL Compound structures.

1.1 Purpose of Investigation

This RI was undertaken to characterize the nature and extent of environmental contamination, to evaluate contaminant fate and transport, conduct a baseline risk assessment, and to develop preliminary remedial action objectives, if required. Field activities, procedures, and methods used to conduct this RI were performed in accordance with the Work Plan for the Remedial Investigation at the Former Lordstown Ordnance Depot (IT, 1997), the Work Plan Addendum for the Remedial Investigation, Firing Range and TAMPEEL, at the Former Lordstown Ordnance Depot (IT, 1998a) and the Work Plan Addendum for the Remedial Investigation/Feasibility Study, Former Lordstown Ordnance Depot (IT, 2000). The investigations were conducted by IT Corporation (IT) under contract to the United States Army Corps of Engineers (USACE), Louisville District.

Two phases of investigations were conducted. The initial phase is referred to as the RI and the follow up investigation is referred to as the SRI. As part of the RI portion of the investigation, an additional round of groundwater samples were collected from monitoring wells on an adjacent portion of the FLOD owned and operated by the Ohio Commerce Center (OCC). Work was performed at the Waste Oil Pit the results of which are presented in a separate RI for the OCC.

The SRI was performed at the FLOD in accordance with the Defense Environmental Restoration Program/Formerly Used Defense Site (DERP/FUDS) program. The SRI was conducted to further delineate the nature and extent of contamination defined during the RI. In accordance with DERP/FUDS program, past activities at TAMPEEL include activities conducted during the operation period (1943 to 1963), but not the activities of subsequent landowners. To achieve the investigation objectives, the field activities were conducted in accordance with the Site Specific Work Plan (SSWP) developed for the FLOD RI conducted in accordance with the (IT, 1997) and subsequent work plan addendums (IT, 1997 and 2000b). The results of the field activities are described in detail in this report.

1.2 Site Background

Site background data was initially compiled in the Level I Environmental Assessment of the OCC (R&R International (R&R), 1990); Site Assessment, Industrial Park in Warren, Ohio (CH2M Hill, 1994); and the Site Investigation, Former Lordstown Ordnance Depot (Maxim, 1997). The following sections summarize some of the findings of these reports.

1.2.1 Site Description

The FLOD is a DERP/FUDS facility that is currently owned by the OCC and the Trumbull County Board of Education. The site is located just west of Ohio State Route 45 in Lordstown Township, approximately four miles south of Warren, Ohio in Trumbull County. The original property that comprised the Depot is rectangular in shape and occupied approximately 565 acres. Approximately 45 acres along the far western boundary are currently occupied by a variety of landowners. The majority of the property (approximately 480 acres) is occupied by the OCC. Another portion of the property (approximately 39 acres) to the west of the OCC is occupied by TAMPEEL, and is owned by the Trumbull County Board of Education.

Water supplies for Lordstown Township are derived from Meander Lake, which is located approximately 17,000 feet to the southeast of the FLOD. FLOD is not in the Meander Lake drainage basin. The Lordstown Water Commissioner indicated that all residents in the area of FLOD are supplied with city water. However, Ohio Department of Natural Resources (ODNR) 1990 records indicate that 17 wells are present in the immediate vicinity of the site (within ½ mile) (R&R, 1990). The Lordstown Water Commissioner was contacted during the SI, but did not have any additional records concerning well logs or groundwater usage in Lordstown Township (Maxim, 1997).

Local topography generally slopes gently from south to north. Much of the former Lordstown Ordnance Depot was composed of wetlands before being filled and graded prior to construction of the Depot. Small ponds are present north of the investigation area. Drainage is towards a tributary to Duck Creek (Beaver Creek), which runs south to north along the western boundary of the OCC and the eastern boundary of TAMPEEL.

1.2.2 Site History

The FLOD is a former quartermaster depot, which has been known by many names including the Lordstown Military Reservation, Lordstown Holding and Reconsignment Point, Warren War Aid Depot, and Lordstown Quartermaster Depot.

The Department of Defense (DoD) acquired the site property in 1942 and during the period of 1943 - 1945 it was used for the transportation, storage, reconditioning and disposal of military combat-related equipment, material and supplies. After World War II the site continued to be used for the storage, repair and maintenance of industrial and military equipment and vehicles. In 1945, approximately 45 acres at the extreme western end of the facility, along Ellsworth Bailey Road, were declared surplus and were disposed of by the General Services Administration. In 1956, ordnance missions were terminated and the property was assigned administrative and logistical support for the regional Nike Anti-Aircraft Activities, as well as repair and support for the Army Reserve. In 1963, the Depot was placed on inactive status and in 1967; the majority of the property was transferred to the Community Improvement Corporation of Warren and Trumbull County. TAMPEEL was established in 1973. A portion of the property was deeded to the OCC (formerly known as Space Center Ohio) in 1976, but has been an industrial park since 1967 (Twin City Testing, 1995).

1.2.2.1 Past Use of TAMPEEL Area

The approximate locations of the study areas for this investigation, the landfill, the Children's Activity Areas, the depressed areas, the Study Pond, the Beaver Pond, Aspen Creek, and the monitoring wells are shown on Figure 1-4. The information presented below on past site use is summarized from the Scope of Work for Remedial Investigation at TAMPEEL (June 7, 1998)

Aerial photographs of the FLOD indicate that the extensive excavation activities occurred in the area of the landfill in the 1950s. Concrete, automotive parts, rusted/crushed 55-gallon drums, smaller containers and other debris visible at the ground surface in this vicinity indicate that this area was likely used for landfilling of such debris.

Prior to construction of the TAMPEEL instructional building, a construction bulldozer uncovered construction debris at what was to be the site of the building. Upon this discovery the board agreed to move the building approximately 200 feet away from what they recognized as a burial area for construction debris. This information is based on personal communication between Dr. David Brancato, USACE, and Mr. Norm Peterson, the former director of TAMPEEL, in the spring of 1998.

The TAMPEEL Landfill area is located on property formerly used as an environmental laboratory for school children during the school year. As part of the activities at the lab, the students would dig in soil or observe wildlife in specified areas around the landfill (Figure 1-4). Surface soil samples were collected from the area of the landfill, and soil, groundwater, surface water, and sediment samples were collected from areas around the landfill during RI and SRI activities.

A number of circular to oblong depressed areas have been noted in the area south of the TAMPEEL Landfill (Figure 1-4). The depressed areas are generally less than 20 feet across, with some being generally circular (uniform) and some being non-uniform. Most of the depressed areas are less than 3 feet deep. It has been reported that these depressions may have occurred when large trees were removed. Four soil samples were collected from two of these depressions during RI activities.

1.2.3 Previous Investigations

Environmental response actions at DERP/ FUDS conform to the requirements of the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) and the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) under 40 CFR Part 300. The DERP/FUDS program has three major stages: inventory, study, and removal/remediation. All program activities related to hazardous substances are executed consistent with the CERCLA process, which involves the performance of preliminary assessments (PA), Site Investigation (SI), Remedial Investigation and Feasibility Study (RI/FS) for a remedial project.

The initial phase of investigation at the FLOD was conducted in the Level I Environmental Site Assessment of the OCC (R&R, 1990). This PA was a limited-scope investigation to collect readily available information and conduct a site and environs reconnaissance. The PA is designed to distinguish between sites that pose little or no threat to human health and the environment and sites that require further investigation. The initial PA was supplemented by an additional site assessment conducted in 1994 (CH2M Hill, 1994). Some of the results from these investigations were incorporated into the SI and subsequently into the site background information for this report.

In accordance with the requirements of CERCLA, USACE-Nashville conducted a SI at the FLOD (Maxim, 1997). The primary objectives of the SI were to:

- Identify potential environmental concerns related to DoD activities,
- Determine through a records search the type of materials disposed of at the Burn Area and Waste Oil Pit (Reported in a separate RI Report), and;
- Collect environmental samples to confirm if contamination is present and being released into the environment.

Conclusions from the SI indicated that contaminants are present at the site at concentrations that exceed the preliminary risk screening criteria.

An RI was conducted at the FLOD in 1997 by IT. The investigation included sampling in both the TAMPEEL and OCC areas. The purpose of the investigation was to determine the source, nature, and extent of contamination in groundwater, surface soils and downgradient surface water and

sediments resulting from past activities at the site. In accordance with the DERP/FUDS program, past activities include activities conducted during the operational period (1943 to 1963), but not the activities of subsequent landowners. To achieve the investigation objectives, field activities were conducted in accordance with the requirements of the SSWP developed for the FLOD RI (IT, 1997).

Based on the findings of the RI activities it was determined that additional data were needed to complete the characterization. Therefore an SRI was conducted at the FLOD to fill in the data gaps. The SRI included investigations at both TAMPEEL and the Commerce Center. Details of the investigations and from both the TAMPEEL RI and SRI activities are reported in this report. The results of the investigations for the Commerce Center are provided in a separate report.

In 1998, an Ordnance and Explosives Archives Search Report for FLOD was prepared by the USACE, Rock Island District (USACE, 1998). A search of historical records for FLOD indicates no evidence that any explosive ordnance was handled or stored at the site.

2.0 Site Investigation Activities (RI and SRI)

The primary objective of this Site Investigations or (SI) was to characterize the nature of soil, groundwater, surface water, and sediment at TAMPEEL. Investigative activities at TAMPEEL included a geophysical survey, geoprobe borings, surface soil sampling in the children's' activity areas and the depressed areas, surface water and sediment sampling in the Study Pond, Beaver Creek, TAMPEEL Spring, Beaver Pond, and Aspen Creek, and monitoring well installation and sampling. The scope of each of these activities is described below. In addition to describing the nature and extent of contamination in various media the data collected was used for human health and ecological risk assessment. This section outlines the investigative activities conducted in each of these areas. A summary of the location and rationale for sampling activities conducted to evaluate the nature of these media is presented in Table 2-1.

2.1 Geophysical Investigation

To support evaluation of the extent of buried material in the landfill, a geophysical survey was conducted across the TAMPEEL Landfill area using a G-858G metal detector and an EM31ground conductivity meter. The instruments have maximum depth ranges of approximately 18 feet. The survey was conducted using approximately 25 foot grid spacings, with allowances made for foliage and other physical constraints. Based on survey line spacing the estimated horizontal accuracy of the interpreted extent of the landfill material is +/- 50 feet. The geophysical instruments used cannot indicate the depth of buried material or the thickness of soil cover.

Preliminary data generated by both geophysical techniques was contoured in the field to identify data gaps or areas requiring increased data density. Additional data was collected until gaps were filled. The magnetic field-upper sensor geophysics results are presented in Figure 2-1. A detailed discussion of the methods and results of the geophysical investigation are presented in Appendix A.

The results from the geophysical investigation were used to estimate a boundary of the landfill. The boundary should not be considered absolute, but an estimate with an accuracy of +/- 50 feet. The results of all three surveys (magnetic, EM Conductivity, and EM In-Phase) performed were used to estimate the extent of the landfill. Some EM Conductivity anomalies in the northeast

area of the survey were not confirmed by the other surveys. Variations in EM Conductivity can be due to changes in soil type and moisture content and might not be indicative of landfill materials.

2.2 Subsurface Soil Samples

Subsurface soil samples were collected during RI and SRI activities. During the RI subsurface soil samples were collected from a series of borings located based on the findings of the geophysical surveys. Subsurface soil samples were collected during the SRI during installation of MW116.

2.2.1 RI Activities

Based on the estimated extent of the landfill developed from the geophysical survey 20 soil borings were placed along the perimeter. During the drilling of the soil borings no landfill material was encountered. This section includes a description of the methods used during completion of the soil borings. Based on sample selection protocol (described below) some of samples selected for analysis were collected from the upper two feet of soil. The results from these sampling efforts are included in the discussion of surface samples.

Geoprobe (direct push) sampling methods were utilized to collect soil samples at 20 locations outside the boundary of the TAMPEEL Landfill, as determined by the geophysical survey. The objective of the geoprobe activities was to check for contaminants leaching out of the landfill. The boring locations were spaced as evenly as practical around the perimeter of the landfill. Locations were adjusted based on physical obstructions. The locations of the 20 soil borings (SB131 – SB150) are presented on Figure 2-2. No soil borings were placed in the landfill due to the Ohio Solid Waste Regulations that prohibit drilling through a landfill.

Direct push samples were collected continuously from the ground surface (0 feet) to either refusal or to a maximum depth of nine feet below ground surface (bgs). Samples were collected using 1.5-inch inside diameter Geoprobe® sampler. All soils were described and classified in accordance with the Unified Soil Classification System. Parameters described included particle size, moisture content, color, consistency, and soil type classification. Soil classification logs are presented in Appendix B. No groundwater was encountered in the soil borings.

Soil samples from each borehole were submitted for off-site analysis based on the results of the

soil core field screening using a photoionization detector (PID). Field screening was conducted by placing a portion of the collected soil core in a clean container and sealing it with aluminum foil. The sample was allowed to volatilize for approximately 10 minutes in a warm area, then a head space reading was taken by piercing the foil with the detector probe tip. If the outside air temperature was less than approximately 60°F, the samples were placed in a vehicle with the heater running. The 2-foot interval with the highest head space reading was submitted for laboratory analysis. PID readings from each soil sample are shown on the boring logs in Appendix B. In addition to field instrument readings, odors, staining or other indicators were used to select the appropriate depth interval to sample.

One sample from each probe location (20 samples total) was selected for laboratory analysis. A headspace sample and a sample for potential volatile organic compound (VOC) analysis were collected from each 2-foot interval. The sample from the 2-foot interval with the highest PID readings and/or visual contamination was analyzed. If none of the samples had elevated PID readings or visual contamination, the sample from the two-foot interval directly above bedrock was analyzed. Samples not turned into the lab were disposed. The samples were analyzed for VOCs, semivolatile organic compounds (SVOCs), pesticides/polychlorinated biphenyls (PCBs), and target analyte list (TAL) metals.

Soil samples for volatile organic analysis were collected immediately along with the headspace samples by placing one or more representative portions of the soil core into the sample container until no head space remained and the container was sealed. The VOC samples were immediately placed on ice. The remaining soil from the selected interval was placed in a stainless steel mixing bowl, homogenized, and placed in the appropriate sample containers. Containers were filled in the order of parameter volatility (i.e., VOCs, SVOCs, pesticides/PCBs, metals, etc.) in accordance with the Technical Guidance Manual for Hydrogeologic Investigations and Ground Water Monitoring (Ohio EPA, 1995). Soil Sample Collection Logs were completed for each sample and are presented in Appendix C. A soil sample analytical summary is presented on Table 2-2.

Small diameter boreholes remaining after the completion of direct-push sampling were backfilled with granular bentonite. All abandoned boreholes were checked 24 to 48 hours after bentonite pellet emplacement to determine whether curing had caused significant settling. If so, a sufficient amount of bentonite was added to attain its initial level.

2.2.2 SRI Activities

One subsurface soil sample was collected during SRI activities; specifically it was collected during installation of MW116. A soil core (MW116) was collected on October 10, 2000. The description and classification of the collected soil core was logged in accordance with the Unified Soil Classification System. Physical parameters recorded include: particle size, moisture content, color, plasticity and consistency, and soil type classification. The soil boring log is presented in Appendix B.

The borehole for monitoring well installation and soil sampling was advanced using hollow stem auger (HSA) drilling. Drilling was conducted by Frontz Drilling Inc., Wooster, Ohio, using a CME 550-X ATV. The HSAs used has an inside diameter of 4-1/4 inches with a resultant borehole diameter of approximately 8-1/4 inches.

During the advancement of the borehole, the unconsolidated material was continuously sampled using a two-foot stainless steel, split-spoon sampler. While advancing the split spoon sampler, the number of blows required to drive the sampler each 6-inch depth interval was recorded on the boring log (Appendix B).

2.3 Surface Soil Samples

2.3.1 RI Activities

Surface soil sampling locations selected for the RI were collected from several locations around the landfill identified by the geophysical investigation and based on locations of the various Children's activity areas and the location of several surface depressions noted during site assessment activities.

2.3.1.1 Landfill Perimeter Samples

As discussed in the section describing the subsurface sampling, a series of Geoprobe® borings were advanced around the perimeter of the suspected landfill. Based on sample selection protocol described above some of samples selected for analysis were collected from the upper two feet of soil. Locations of the sampling locations are shown on Figure 2-2. Surface soil samples were collected from SB133, SB135, SB138, SB139, SB141, SB142, SB143, SB144, SB146, SB147, and SB148.

2.3.1.2 Children's Activity Areas

During the RI, a total of nine surficial soil samples were collected from the areas of the landfill where children's classes are held (Figure 2-2). The nine samples were collected in the following areas:

- The Children's Dig Area (SS185SO01, SS186SO01, SS187SO01)
- The Bird Watching Area (SS188SO01, SS189SO01)
- The Insect Viewing Area (SS190SO01, SS191SO01)
- The Woodchuck Dig Area (SS192SO01)
- The Spring (SS193SO01)

The purpose of this sampling was to characterize the soils with which the children have the most contact. The samples were collected from the upper 12 inches of soil using a hand auger. The samples were analyzed for VOCs, SVOCs, pesticides/PCBs, and TAL metals. Table 2-2 presents a soil sample analytical summary.

Soil samples to be analyzed for volatile constituents were collected as grab VOC samples. Pre-cleaned stainless steel spoons or trowels were used to remove the soil from the hand auger. The collected soil was placed into laboratory pre-cleaned glass sample jars with Teflon lined lids, labeled, sealed, and immediately placed on ice. Samples for non-volatile constituents were collected after compositing the soils of the designated interval in a stainless steel bowl.

All samples were shipped to the analytical laboratory in properly packed and iced coolers in accordance with U.S. Department of Transportation (DOT) regulations via courier. Samples were shipped daily or on alternate days in order to meet parameter holding times.

Decontamination of sampling equipment, including stainless steel bowls and spoons, was performed in accordance with the methods described in Section 2.11.

2.3.1.3 Depressed Areas

During the RI, a total of four surface soil samples (SS194SO01, SS195SO01, SS196SO01 and SS197SO01) were collected from two depressions in the area south of the landfill. The general locations of the depressed areas are shown on Figure 2-2. The depressed areas are generally less than 20 feet across, with some being generally circular (uniform) and some being non-uniform. Most of the depressed areas are less than 3 feet deep. The soil samples were collected from 0 to 12 inches bgs, with two samples collected from a uniform depression and two from a non-

uniform depression. Soil sampling was performed using a decontaminated hand auger and stainless steel bowl. The samples were analyzed for VOCs, SVOCs, pesticides/PCBs, TAL metals, dioxins/dibenzofurans, and explosives. Table 2-2 presents a soil sample analytical summary.

2.3.2 SRI Surface Soil Sampling

Surface soil samples (SS201-SS218, and MW11601) were collected on October 4-5, 2000 and October 13, 2000 from the locations depicted on Figure 2-3. The soil sample collection logs are presented in Appendix C. Surface soil sampling locations SS201-SS218 were selected based on a 100-ft triangular grid as detailed in the Work Plan Addendum, April 2000.

In accordance with the work plan three soil samples from the 0- to -2-foot depth interval were submitted for analysis to characterize the surface soil contamination. All samples were analyzed for the following parameters: VOCs, SVOCs, pesticides/PCBs and TAL metals. Table 2-2 presents a summary of the parameters analyzed for each soil sample.

2.4 Surface Water and Sediment Sampling

Surface water and sediment samples were collected from surface water bodies in the TAMPEEL area. Samples were collected from the Study Pond, Beaver Pond, Aspen Creek, TAMPEEL Spring, and Beaver Creek. Sampling activity completed during the RI and SRI are discussed below.

2.4.1 RI Activity

Samples were collected from the Study and Beaver ponds, Aspen Creek and the TAMPEEL spring during RI activities.

2.4.1.1 Study Pond and Beaver Pond

During the RI, a total of three surface water samples (SW102, SW103 and SW104) and sediment samples (SD102, SD103 and SD104) were collected from the Study Pond (Figure 2-2). Four surface water (SW105, SW106, SW107 and SW108)/sediment samples (SD105, SD106, SD107 and SD108) were also collected from the Beaver Pond (Figure 2-2). The samples were collected from the edge of the ponds as well as from the bottom of the pond at locations accessed using a row boat or canoe. The purpose of this sampling was to check for groundwater discharge from the Waste Oil Pit as well as evaluate the impact of TAMPEEL landfill activities on the

surrounding surface water and sediment. The samples were analyzed for VOCs, SVOCs, pesticides/PCBs, TAL metals, hardness, grain size and total organic carbon (TOC). Table 2-3 presents a surface water sample location and field parameter summary and Table 2-4 presents a pond sediment sample location and PID reading summary.

During the SI (Maxim, 1997), one original and one duplicate sediment sample (SD03) were collected upgradient of the Burn Area and one sample (SD04) was collected downgradient of the Burn Area. Both samples were analyzed for VOCs, SVOCs, pesticides/PCBs and TAL metals. Analytical data is presented in Appendix I.

Prior to sampling, equipment was decontaminated in accordance with Section 2.11. Surface water and sediment samples were collected at the same location. The surface water sample was collected first to avoid collecting suspended sediments that might have resulted if the sediment sample was collected first. In deep water, surface water samples were collected using a row boat in the Study Pond and a canoe in the Beaver Pond. Teflon®-lined tubing was lowered to within approximately 1 to 2 feet of the bottom using the anchor. The water samples were collected through this tubing using a peristaltic pump. Along the edges of the ponds, samples were collected by gently dipping a transfer container in the water and then filling the sample bottles. The surface water sample was collected by first filling the VOC sample vials. The remaining sample containers were then filled. VOC vials were prepreserved from the laboratory; the remaining containers were preserved after filling as required. The pH of preserved samples was verified by pouring a small amount of sample onto pH paper. The paper was not allowed to touch the sample inside the container. The pH of the prepreserved VOC samples was not checked.

Field parameter measurements collected for the surface water samples included pH, temperature, specific conductance, and turbidity. The locations of the surface water and sediment samples were documented with a Trimble Pro XRS global positioning system (GPS) unit, with Omni Star satellite error correction, capable of determining horizontal coordinates in Ohio State Plane Coordinates (NAD 27) with an accuracy of approximately 1 meter. The sample location coordinates as well as the field parameter readings are presented in Table 2-3.

Sediment samples were collected from the bottom of the pond using a decontaminated Eckman Dredge. The VOC container was filled first by transferring the sediment directly from the dredge

to the container with a decontaminated stainless steel spoon. Volatile organics were monitored during sample collection using a PID and the readings were recorded in the logbook. The remaining sediment was then transferred into a stainless steel mixing bowl. The sediment was then homogenized and transferred into the remaining containers for each parameter. Table 2-4 presents a pond sediment sample location and PID summary.

All samples were delivered directly to the analytical laboratory in properly packed and iced coolers in accordance with DOT regulations.

2.4.1.2 Aspen Creek

During the RI, two surface water (SW109 and SW110) and two sediment samples (SD109 and SD110) were collected from Aspen Creek (Figure 2-2). The purpose of this sampling was to evaluate if landfill activities have impacted the creek. One sample location (SD109/SW109) was at the creek immediately adjacent to the landfill. The second location (SD110/WS110) was down stream from the landfill. Since Aspen Creek begins at the landfill, there was no location available for background samples. The samples were analyzed for VOCs, SVOCs, pesticides/PCBs, TOCs, grain size and TAL metals. Sample methods used are as described in the previous section. Table 2-2 presents a soil sample analytical summary.

2.4.1.3 TAMPEEL Spring

During the RI activity, one sediment and one surface water sample (SW101/SD101) were collected at the TAMPEEL Spring located north of the landfill. The sediment sample was analyzed for VOCs, SVOCs, pesticides/PCBs, TAL metals, and TOC. The surface water sample was analyzed for VOCs, SVOCs, pesticides/PCBs and total and dissolved TAL metals. Analytical data is presented in Appendix H.

2.4.2 SRI Activities

During the SRI activities surface water and sediment samples were collected from Aspen Creek, TAMPEEL Spring and Beaver Creek. No samples were collected from the Study Pond and Beaver Pond during the SRI.

2.4.2.1 Aspen Creek

During the SRI, two surface water (SW202 and SW203) and two sediment samples (SD202 and SD203) were collected from the Aspen Creek. The purpose of the additional samples was to

further investigate surface water and sediment quality. The samples were analyzed for VOCs, SVOCs, pesticides/PCBs and TAL metals. Sampling methods used were the same as those used during the RI and are described in the previous section.

2.4.2.2 TAMPEEL Spring

During the SRI, one sediment and one surface water sample (SW201/SD201) were collected from TAMPEEL Spring and submitted for laboratory analysis. The sediment and surface water samples were analyzed for VOCs, SVOCs, pesticides/PCBs, and TAL metals. Sampling methods used were the same as those used during the RI and are described in the previous section.

2.4.2.3 Beaver Creek

During the SRI, two sediment (SD204 and SD205) and one surface water sample (SW204) were collected from Beaver Creek and submitted for laboratory analysis. The sediment and surface water samples were analyzed for VOCs, SVOCs, pesticides/PCBs, and TAL metals. Sampling methods used were the same as those used during the RI and are described in the previous section.

2.5 Monitoring Well Installation

Five Monitoring wells (MW112 to MW116) were installed during the RI and SRI activities. Well locations were selected to provide wells both up and down gradient of the former landfill.

During the RI, four groundwater monitoring wells were installed near the perimeter of the landfill to monitor groundwater conditions (Figure 2-1). Three of the wells (MW113, MW114 and MW115) were installed around the interpreted downgradient end, northwest, north, and northeast of the landfill. The fourth well (MW112) was installed upgradient of the landfill. All well locations were as described in the work plan with the exception of MW-115 (northeast corner of the landfill) which had to be relocated to the east of the TAMPEEL perimeter fence due to lack of drilling access.

During the SRI, one additional monitoring well was installed (MW116) on October 10, 2000. During installation, augers were incrementally lifted out of the borehole as well materials were added to prevent potentially contaminated soil from entering the rock borehole.

The following provides a description of the drilling and well installation methods used during the RI and SRI.

2.5.1 Well Drilling

Boreholes for monitoring well installation were advanced using hollow stem auger drilling. The hollow stem augers had an inside diameter of 4 1/4 inches with a resultant borehole diameter of approximately 8 1/4 inches. Drilling depth through the unconsolidated overburden to the top of bedrock ranged from 5.5 ft to 13.5 ft in thickness. Soils were continuously monitored with a PID during the drilling process and the associated readings were recorded on the boring log. All soil overburden were described and classified in accordance with Unified Soil Classification System. Parameters described included particle size, moisture content, color, plasticity and consistency, and soil type classification. Soil classification logs are presented in Appendix B.

Upon auguring down to the top of bedrock, borehole advancement continued with rotary drilling and NW-size coring. The rock coring and reaming were completed through the hollow-stem augers. The augers were left in place until the well was set and grouted to prevent potentially contaminated soil from entering the rock borehole.

The coring continued until the uppermost saturated zone was encountered. The rock core was examined for evidence of saturation, such as dissolution features and mineral deposits along fractures. Rock cores were placed in core boxes constructed of wood for protection and storage as per American Standards for Testing Materials (ASTM) D2113. All core boxes contained longitudinal separators and recovered cores were laid out as a book would read, from left to right and top to bottom. The beginning of the core was placed in the upper left-hand corner of the hinged core box with the hinge on the far side and the box right-side up. Spacer blocks or plugs were marked and inserted into the core column within the separators to indicate the beginning of each coring run. All hinged core boxes were permanently marked on the outside to indicate the top and the bottom, additionally, all core boxes were permanently marked internally to indicate the upper-left corner of the bottom with the letters "UL."

Rock core characteristics were described by a field geologist on rock classification logs. The logs documented the run number, depth, percent recovery, and rock quality designation for the run. The rock classification logs are presented in Appendix D.

After completion of the NW-sized coring through the bedrock, the borehole was reamed to a minimum diameter of four inches using air rotary drilling. To prevent introducing hydrocarbon-related contaminants into the borehole during the air rotary drilling process, the air compressor was equipped with an in-line organic filter system to filter the air coming from the compressor. The organic filter system was regularly inspected to ensure that the system was functioning properly.

2.5.2 Well Installation

The monitoring wells were installed in accordance with EM 1110-1-40000 and the “Technical Guidance Manual for Hydrogeologic Investigations and Ground Water Monitoring” (OEPA, 1995). Monitoring well installation began within 48 hours of borehole completion. Installation of each monitoring well was performed by using cleaned and decontaminated equipment and supplies per procedures outlined in Section 2.11. Potable water used during the drilling and construction of the monitoring wells (for grout mixing, bentonite pellet hydration, and decontamination) was obtained from an onsite source. A monitoring well construction diagram was completed for each well and is presented on the associated rock classification log for each monitoring well in Appendix D. Table 2-5 presents a monitoring well construction summary.

The monitoring wells were constructed using flush-threaded two-inch diameter Schedule 40 Polyvinyl Chloride (PVC) casing and screen. The well screen was 0.010-inch continuous-slotted PVC, placed to screen the upper most saturated zone. The bottom of the screen was capped with a six-inch PVC end cap. Based on hydrogeologic conditions encountered at each well location the screen lengths were all 10 feet. The annular space was filled with clean #7 silica sand to a minimum of three feet above the top of the screen. The screen slot size is based on the use of a No. 7 silica sand filter pack. The filter pack size (No. 7) was selected because it is relatively fine-grained but coarse enough to settle readily through the water column during well construction. Since the wells were screened in rock, soil grain size was not a consideration in the selection of the filter pack. Following verification of the top of the sand pack (3 feet above screen) a bentonite pellet seal was placed. A minimum of 3 feet of pellets was placed immediately above the filter pack. The bentonite seal was placed in 12-inch lifts and hydrated with 5 gallons of water for 15 minutes between lifts.

Aboveground surface completions were installed at all four monitoring well locations, with well casings extending 2 to 3 feet above land surface. A 4-inch diameter steel protective casing with a

lockable hinged cap was placed over the PVC casing with a spacer placed on the top of the PVC casing to allow easy access to the well head. The protective casing was set in neat cement, with the bottom approximately 2.5 foot below grade. A circular cement pad (2.5 diameter) was placed around the base of the protective casing. The wells are protected by four 3-inch diameter concrete-filled steel guard posts 5 feet in total length, set 3 feet below ground, around the well to protect the casing (with the exception of MW-115 which only has three). The guard posts were set in neat cement, and were placed outside the concrete pad. The well identification was permanently marked on the casing cap and the protective casing. A permanent notch in the top of the inner casing was marked as a measuring point for water levels.

2.5.3 Well Development

Development of the newly installed wells began no sooner than 48 hours after installation. Development was accomplished using a submersible pump, surge block, and bailers. During development, discharge (pumping) rates were measured using a graduated container (i.e., plastic bucket) prior to containerization.

A minimum of five well volumes were removed from the monitoring wells during development. The well volume is defined as the volume of submerged casing, screen, and filter pack, minus the estimated volume of the sand in the filter pack. Purge volume calculation forms were completed for each well and the volumes calculated were used as a basis for the minimum groundwater volume to be removed.

Development continued until the turbidity is ≤ 5 nephelometric turbidity unit (NTU), and when the stabilization of pH, temperature and specific conductance had occurred. Stabilization is defined as when pH is within " 0.1 units, temperature is within 1°C, and specific conductance is within $\pm 10\%$ over at least three successive well volumes. A groundwater development/purge log and a groundwater sample collection log were completed during development and are presented in Appendix E and Appendix F, respectively. Final monitoring well purge volumes, depths to water and water quality measurements are presented on Table 2-6.

No detergents, soaps, acids, bleaches, or other additives were used to develop the wells. All development equipment was decontaminated according to the specifications documented in Section 2.11.

2.6 Groundwater Sampling

Groundwater samples were collected during both the RI and SRI activities. During the RI activities, groundwater samples were collected from MW112 through MW 115. During the SRI activities, groundwater samples were collected from MW112 through MW116.

Purging and sampling of monitoring wells was performed using a decontaminated, stainless steel submersible pump (Grundfos Redi-Flo®) in accordance with Section 3.3.4 of the SSWP (IT, 1997). The pump was equipped with a positive bottom check valve to prevent evacuated water from flowing back into the well. Disposable, Teflon lined polyethylene tubing was attached to the pump head and was used for the transference of groundwater from the well. Clean plastic sheeting was placed around the well pad prior to sampling.

Prior to groundwater sampling from a well, a disposable clear polyethylene bailer was slowly lowered half way into the top of the water and removed to check for light nonaqueous phase liquids (LNAPLs). The bailer was then emptied and then slowly lowered to the bottom of the well and retrieved to check for dense nonaqueous phase liquids (DNAPLs). No LNAPL or DNAPL was observed in any of the wells.

Potential vapors in wells were monitored at the well head upon removing the well cap. Screening was performed using a calibrated PID held at the open well head for measurement. In addition, the breathing zone was monitored for potential organic vapor exposures to the sampling personnel. This information was recorded in the sampling log used to determine levels of protection in accordance with the Health and Safety Plan (HSP).

The sampling pump was placed at the top of the water column in the well and lowered as required by drawdown. This ensured any standing water in the well was removed and replaced by formation water. Low flow pumping rates were maintained to minimize agitation of suspended solids in the well. The pump was decontaminated between wells per procedures outlined in Section 2.11. Groundwater samples were not collected within 48 hours of monitoring well development.

A minimum of three well volumes was removed from each well prior to sampling. Pumping rates were measured using a graduated container (i.e., plastic bucket) prior to containerization. The well volume is defined as the volume of submerged casing, screen, and filter pack, minus the

estimated volume of the sand in the filter pack. Purge volume calculation forms were completed and the volumes calculated for each well were used as the minimum volume to be removed.

The temperature, pH, specific conductance, and turbidity of the purge water was measured and recorded after removing each well bore volume during purging. All wells were purged a minimum of three well volumes as well as temperature, pH, turbidity, and specific conductance had reached stabilization as presented in Section 3.3.1 of the work plan (IT, 1997).

A groundwater development/purge log and a groundwater sample collection log were completed during purging and are presented in Appendix E and Appendix F, respectively. Final monitoring well purge volumes, depths to water and water quality measurements are presented on Table 2-6.

The wells were sampled for VOCs, SVOCs, pesticides/PCBs, and TAL metals. Groundwater samples were collected directly from the disposable Teflon lined polyethylene tubing. Samples were collected in the following order: VOC, SVOC, Pesticides/PCBs, and TAL metals. When collecting VOC samples, the pumping rate was lowered to minimize turbulence and aeration of the sample. VOA bottles were filled until a positive meniscus was achieved above the rim of the sample bottle. The bottles were immediately capped and then gently tapped to verify that no air bubbles are present in the sample. If bubbles were detected, the bottle was discarded and a new sample container was filled. Collected samples were capped, labeled, and immediately placed on ice. Table 2-7 presents the water sample analytical summary.

Metals samples were preserved in the field with sample containers provided by the analytical laboratory. The pH of preserved samples was checked in the field by pouring a small amount of sample onto pH paper. The paper was not allowed to touch the sample inside the container. The pH of the prepreserved VOC samples was not checked.

2.7 Groundwater Level Measurements

Groundwater levels at each newly installed well and all previously installed wells were measured prior to development/purging and prior to sampling of the well. A water level indicator was used to measure water level to the nearest 0.01 foot. Complete rounds of water levels were measured on April 21, 1999 and June 12, 2001, and the data are shown on Table 2-8.

Groundwater elevations were logged on the well development and groundwater sampling purge logs for each well (Appendix E). The groundwater elevation logs for the measurements collected on 4/21/99 and 6/12/01 are presented in Appendix G.

After a water level measurement was taken, the portion of the water level indicator cable that entered the well casing was decontaminated by wiping the cable with paper towels soaked with laboratory-grade detergent followed by paper towels soaked with deionized water as it was retrieved from the well.

2.8 Slug Tests

Rising head and falling head slug tests were performed on the five monitoring wells at TAMPEEL to allow the hydraulic conductivity to be estimated. Slug test data were analyzed using the Bouwer and Rice method (Bouwer and Rice, 1976) and the Hvorslev Method (Hvorslev, 1951). Both of these methods can be used to estimate the hydraulic conductivity around a partially or fully penetrating well in an unconfined aquifer by measuring the rise or fall of water level in the well, initially at equilibrium conditions, after a volume of water is quickly removed or injected. The methods are based on assumptions that the aquifer, bounded below by an aquiclude, is homogeneous, isotropic, and incompressible, of uniform thickness and of infinite radial extent. When the known volume (slug) is instantaneously removed or injected, the head losses through the well screen and filter material are assumed to be negligible and the subsequent build-up of the water table is small in comparison to the saturated thickness (i.e., the water table is assumed to be a constant head boundary). The flow to the wells is in steady state, with radial flow combined with the vertical flow from the constant boundary. Groundwater density and viscosity are assumed constant.

2.9 Surveying

The horizontal and vertical coordinates of each well installed during this investigation were surveyed. The survey determined horizontal coordinates to within 0.5 feet and vertical coordinates to within 0.01 feet. Horizontal coordinates were determined and provided in Ohio State Plane Coordinates (in NAD83). Vertical datum for all elevations was 1929 (NGVD). Table 2-9 presents a summary of the survey data.

The locations of the surface water and sediment samples were documented with a Trimble Pro XRS global positioning system (GPS) unit, with Omni Star satellite error correction, capable of

determining horizontal coordinates in Ohio State Plane Coordinates (NAD 27) with an accuracy of approximately 1 meter.

2.10 Field Quality Assurance Samples

Quality control samples were collected and analyzed to provide an indication of the representativeness of the data. These samples were in addition to internal quality control samples analyzed by the contract laboratory as part of their standard operating procedures. Table 2-10 presents a summary of the quality assurance/quality control (QA/QC) samples collected.

Field Duplicates

Field duplicates were collected and analyzed at a rate of one per every 10 environmental samples analyzed. A separate set of bottles was collected for each duplicate sample.

Matrix Spike/Matrix Spike Duplicates

For every 20 environmental samples collected, two additional sets of sample containers were collected for use by the contract laboratory in performing matrix spike and matrix spike duplicate analyses. These samples were analyzed for VOCs, SVOCs, pesticides, PCBs, and TAL metals.

Trip Blanks

One trip blank was shipped with each sample cooler containing aqueous samples for VOC analysis. The sample was analyzed for VOCs.

Potable Water Sample

One sample was collected from the potable water source used for drilling operations and decontamination of the sampling equipment. This procedure was done to verify that the water source was contaminant-free. The sample was analyzed for VOCs, SVOCs, pesticides, PCBs, and TAL metals.

2.11 Equipment Decontamination

The following section describes the procedures that were used to decontaminate sampling equipment. Prior to commencement of field activities, a decontamination area was established at a suitable area determined by the USACE representative. All sampling equipment that might directly or indirectly contact samples was decontaminated before use. Sampling equipment (i.e.,

stainless steel bowls, and trowels or spoons, core barrels, split spoons etc.) was decontaminated in the following sequential steps:

- Washed and scrubbed equipment with a solution of potable water and laboratory-grade nonphosphate detergent.
- Rinsed several times with potable water.
- Rinsed with 10% hydrochloric acid solution.
- Rinsed with ASTM Type II water.
- Rinsed with pesticide-grade isopropanol.
- Rinsed with ASTM Type II water.
- Allowed equipment to air dry.
- Wrapped in aluminum foil.

Drilling equipment was steam cleaned prior to drilling each boring, installation of each monitoring well, and before leaving the site. Monitoring well casing material that arrived on-site sealed in factory-supplied packaging was not decontaminated prior to using in the well. Any casing material or well screen that was not sealed when it arrived at the wellhead was steam cleaned and allowed to air dry prior to use in the monitoring well.

Potable water used during the field investigation was obtained from an onsite source. One potable water sample was collected for offsite chemical analysis.

All decontamination solutions was stored and dispensed in proper containers. All fluids generated during decontamination activities were placed in 55-gallon steel closed top drums. All drums were properly labeled as to content and were staged in a central location designated by the USACE representative for temporary storage pending removal and disposal.

2.12 Investigation Derived Waste

All investigation derived waste (IDW) generated from the RI/SRI activities was disposed of by the end of the field activities. Overall guidance for disposition of IDW was according to *Management of Investigation-Derived Wastes During Site Inspections*, U.S. Environmental Protection Agency (USEPA) Office of Remedial Response (OERR) Directive 9345.3-02, and May 1991. IDW included:

- Soil cuttings
- Groundwater from well development or purging,
- Personal protective equipment (PPE), and disposable sampling equipment,
- Cleaning/decontamination fluids

All IDW was properly handled, labeled (type, amount, and source), and secured until its disposition was determined. The above listed types of IDW were kept separate from each other. The IDW was disposed of in accordance with all applicable State and Federal regulations.

Prior to demobilization from the site, the waste was sampled for disposal characterization. International Technology (IT) Corporation personnel collected one composite soil and one composite water sample for analysis. The samples were analyzed for hazardous characteristics by the Toxicity Characteristic Leaching Procedure methods and analytes, corrosivity, cyanide and sulfide reactivity. The soil samples were also tested for ignitability, and the paint filter test. The water samples were also tested for flashpoint and total solids. Following receipt of analytical results, IT personnel arranged for transportation and disposal of the waste. All necessary paperwork, including manifests, was prepared by IT for approval by USACE. The drums were removed from the site on September 15, 1999, and disposed of by Perma-Fix of Dayton, Ohio.

3.0 Physical Characteristics of the Study Area

3.1 Surface Features

The TAMPEEL area is comprised of 39 acres of predominately flat land with surface elevations that vary from approximately 918 to 946 feet, NGVD. The dominant vegetation in the area is forested areas containing primarily beech, maple, birch, hemlock, and white pine. The TAMPEEL area contains several surface water bodies including two ponds (Study and Beaver Pond), Beaver Creek, Aspen Creek, and TAMPEEL Spring.

The entire TAMPEEL area is fenced with the entrance located on the south end of the area. Road access to the TAMPEEL area is via a crushed gravel road, which leads past the TAMPEEL compound and through to the north end of the area. The TAMPEEL compound is located roughly in the center of the 39 acre area. The compound consists of one main building, which serves as the TAMPEEL schoolhouse, three outbuildings which contain tools and supplies for the classes and a building with composting toilets. There is also a trailer which serves as a birdseed storage area. The buildings surround a large parking area which contains gravel, slag and small coal pieces which are inter-mixed with crushed gravel.

3.2 Meteorology

The closest National Oceanic and Atmospheric Administration (NOAA) weather station to TAMPEEL is located at the Youngstown Municipal Airport. The airport is located approximately 8 miles north of the city of Youngstown, OH and approximately 12 miles northeast of the FLOD. The airport is at an elevation of 1178 feet, which is approximately 234 feet higher than the FLOD investigation site.

The average growing season for the region is 156 days (NOAA, 1975). The last frost of spring usually occurs early in May and the first in the fall is usually early in October.

Wintertime mean temperatures in January range from a minimum of 16.4°F to a maximum of 30.7°F. Summertime mean temperatures in July range from a minimum of 59.2°F to a maximum of 81.3°F. Precipitation for the region has a January mean of 2.1 inches and a July mean of 4.1 inches (NOAA, 1998). Normal precipitation for the year is approximately 38 inches.

3.3 Surface Water Hydrology

Surface water features in the vicinity of the TAMPEEL investigation area consist of Aspen Creek, two ponds, the Beaver Pond and the Study Pond, and TAMPEEL Spring (Figure 1-4). Aspen Creek originates just north of the landfill and drains to the north/northeast to Beaver Creek. Water contained in the creek is presumably from runoff from TAMPEEL and potentially from groundwater. Two sediment samples (SD109/SD110) were collected and submitted for grain size analysis from the creek. One sample (SD109) was collected close to the northern edge of the TAMPEEL Landfill and the second sample (SD110) was collected from approximately 150 yards to the north. Geotechnical results indicate that the sediment consists predominantly of silts and clays (70%) and fine sands (25%). The fine gravel, coarse and medium sand fraction comprised less than 5% of the total sample.

The Beaver Pond is located to the southeast of the TAMPEEL compound area. Beaver currently use this pond and there is a large beaver lodge located in the pond. The edge of the Beaver Pond contains a flooded forest margin, likely due to recent enlargement of the pond resulting from beaver dam building activity that has restricted outflow. Water from the pond flows into Beaver Creek which flows out of the northern end of the pond and continues north for approximately 1.5 miles until it flows into Duck Creek. Duck Creek continues to flow north another two miles before discharging into the Mahoning River.

A second pond (the Study Pond) is located on the northern portion of the TAMPEEL property. This pond was used by TAMPEEL school groups to conduct experiments during field trips. The Study Pond was formed after a borrow pit was created for building the adjacent roadway around 1985. This pond is presumed to be recharged by groundwater and has no outlet. The Study Pond is approximately 20 feet deep and is bordered on the east and west sides by white pine.

A small spring (TAMPEEL Spring) is located on TAMPEEL property approximately 200 feet south-southwest of the Study Pond. This spring is the headwaters for a small drainage that flows to the northeast. This surface water drains to the unnamed tributary that flows north to Duck Creek. One sediment sample was collected from the center of the small pond that receives the spring water as part of the previous RI for geotechnical analysis. Geotechnical results indicate that the sediment consists predominantly of silts and clays (60%) and fine sands (23%). The remainders of the sample particles are comprised of fine gravel, and coarse and medium sand (17% total).

The large forested areas that comprise the majority of the TAMPEEL site tend to impede runoff from the area. Precipitation at the TAMPEEL area infiltrates the ground until the upper topsoil is saturated. After saturation occurs, runoff flows topographically downgradient toward the northern portion of the TAMPEEL area. Figure 3-1 presents the topography of the TAMPEEL site.

When acquired at the beginning of World War II, the FLOD land was described as “badly eroded and poorly drained land, approximately 50% of the area was in a swampy condition” (Maxim, 1997). From the 1940 wetlands map reproduced in the SI, it does not appear that these wetlands were part of the RI study area.

3.4 Geology

Figure 3-2 presents bedrock surface elevations for the TAMPEEL area. Figure 3-3 shows the location of geologic cross-section lines A-A', B-B', C-C', D-D', and E-E'. The actual cross-sections are presented on Figures 3-4, 3-5, 3-6, 3-7, and 3-8, respectively. These cross-section profiles present the geology and geologic trends across the TAMPEEL area.

As seen in Figure 3-2 and the cross-sections, bedrock at the TAMPEEL area occurs at shallow depths averaging 8.2 feet. Average bedrock surface elevations are 924.6 feet at the TAMPEEL area and 939.7 feet at the Waste Oil Pit Area. Figure 3-2 illustrates the bedrock surface elevations as determined from auger refusal. The highest bedrock elevation from the previous RI investigation in the Waste Oil Pit Area exists in the vicinity of monitoring well MW110 at an elevation of 941.74 feet. The highest bedrock elevation for the RI investigation was at SB-146, at 930.6 feet. As seen in Figure 3-4, a bedrock high for the investigation area exists in the vicinity of SB146 at an elevation of 930.6 feet. The lowest bedrock surface elevation from the 1997 RI investigation occurred at soil boring SB118, at an elevation of approximately 932 feet. The lowest bedrock surface elevation for the investigation activity detailed in this RI Report was observed in the vicinity of MW114 and MW115 at an elevation of approximately 918 feet. The bedrock surface generally dips to the north of the site. Geologic cross-section A-A' (Figure 3-4) illustrates how the bedrock in the TAMPEEL area slopes down from the south to the north.

The bedrock formation directly below the unconsolidated materials is Mississippian sandstone of the Berea Formation (Maxim, 1997). The sandstone was typically comprised of fine to medium grained sand, thinly bedded, and broken to a depth of approximately 10 feet, becoming slightly broken to a depth of approximately 14 feet, becoming massive to a depth of approximately 20

feet. Boring MW116, according to the log, was completed in the Mississippian shale, which is of the Berea Formation and is dark gray in color, soft, broken, with some clay in the fractures. In two locations (MW114 and MW115) the sandstone unit was not encountered in the drilling interval. Monitoring wells MW114 and MW115 were drilled to a total depth of 23 feet and 20 feet, respectively. At both of those locations the bedrock consisted of soft, broken, bluish-gray shale. As was the case in the previous RI investigation the shale was likely interbedded with soft claystone. But due to poor recovery as a result of the softness of the material, thicknesses of the units could not be determined. The Mississippian shale is also part of the Berea Formation (Maxim, 1997).

3.5 Soils

According to the map of Glacial Geology of Trumbull County (White, 1971) the unconsolidated materials which comprise the soils of the investigation site are known as the Hiram Till. The Hiram Till is at the surface in most of the western half of Trumbull County. This till is clay rich with few coarse-grained materials. It is rarely over 10 feet thick and at many places less than 5 feet thick. The specific Unified Soil Classification System descriptions for each soil boring and monitoring well are presented in Appendix B.

Generally, the upper four feet of soils encountered at TAMPEEL consisted of a silty-clay/clayey-silt that was mottled yellow/gray, dry to moist, low plasticity and stiff. Below a depth of 4 feet, the overburden had consisted largely of the same material with the exception of intermittent sand lenses (none of which held appreciable water content). The sand lenses that were encountered in this interval consisted of fine to medium grained subrounded sand with intermittent iron staining. The soil at the surface of the landfill appears to be native soil that was reworked during the time of the active landfill.

3.6 Hydrogeology

According to the Groundwater Resources Map of Trumbull County (Haiker, 1996), groundwater at the investigation area is obtained from Mississippian and Pennsylvanian sandstone and sandy shale bedrock. Although occasional well yields of up to 75 gallons per minute are possible, maximum sustained yields are typically closer to 25 gallons per minute. During well development and sampling, all monitoring wells produced adequately with the exception of well MW105, which repeatedly went dry.

Water supplies for Lordstown Township are derived from Meander Lake, which is located approximately 17,000 feet to the southeast of the FLOD. FLOD is not in the Meander Lake drainage basin. The Lordstown Water Commissioner indicated that all residents in the area are of FLOD are supplied with city water. However, Ohio Department of Natural Resources records indicate that 17 wells are present in the immediate vicinity of the site (within ½ mile). Figure 3-9 shows the locations of these wells, and the information compiled from the boring logs is presented on Table 3-1. These wells are completed at depths ranging from 50 to 152 feet and have tested yields of 1.5 to 50 gpm. The potentiometric surface at the site indicates that downgradient is northwest for the wells in the vicinity of the Waste Oil Pit and to the northeast for wells in the vicinity of the TAMPEEL area (Figure 3-10 and 3-11).

At the TAMPEEL and Ohio Commerce Center areas, groundwater occurs in a confined water-bearing zone just below the unconsolidated material, in the fractures of the weathered bedrock. The highest groundwater measurement was collected from MW112 (933.14 ft, MSL April 21, 1999) and the lowest measurement collected was from MW115 (926.04 ft, MSL April 21, 1999). The potentiometric surface in monitoring wells at TAMPEEL averaged 1.3 feet below ground surface, flowing from southwest to northeast. The potentiometric surface in the monitoring wells at the Ohio Commerce Center averaged approximately 2.3 feet below ground surface.

Slug tests were completed on the five wells at TAMPEEL. Of the five wells, useable data were obtained from three of the wells tested. Tests that generated unusable data sets showed that the aquifer response was too rapid to achieve a curve with sufficient data points to calculate realistic K values or a three-segmented curve to the data was present. The hydraulic conductivity for the three useable data sets ranged from 0.70 feet/day to 4.2 feet/day using the Bouwer and Rice Method and from 0.98 feet/day to 6.0 feet/day using the Hvorslev Method. The wide range in K values is likely attributed to the degree of fracturing in the upper zone of the sandstone bedrock in relation to the top of the water column. Table 3-2 presents the results of the slug-test analysis. Plots for wells MW112 through MW116 are provided in Appendix H.

3.7 Demography and Land Use

The following discussion summarizes demography and land use information presented in the FLOD Site Investigation Report (Maxim, 1997).

Land for the Lordstown Ordnance Depot (LOD) was acquired in 1942 from owners of several small farms; land use was classified as agricultural. Construction of the LOD was completed January 14, 1943.

The facility included 31 miles of railroad track, classification yards with a capacity of 106 rail cars, and holding yards with a capacity of 446 rail cars. Nine warehouses had a combined enclosed storage capacity of 1,400,000 square feet and eight outdoor sheds had an additional capacity of more than 1,000,000 square feet. The warehouses and sheds were used for storage of ordnance material and associated ordnance transport and combat materiel. Other buildings at the facility included sentry boxes, a gas station, motor repair building, blacksmith, fire station, electrical distribution systems, dispensary, repair shops, vehicle processing shop, photo lab, field offices, officers' quarters, pistol range, and concrete water reservoir.

During World War II the LOD was contractor-operated by Sears Roebuck & Co. After the war, the facility was designated as a Government operated sub-depot of the Rossford Ordnance Depot, Toledo, OH. In August 1946, 45.11 acres at the extreme western end of the facility were declared surplus and disposed by the General Services Administration (GSA). This portion of the property is currently occupied by residential landowners.

Records from March 1955 indicated that the remaining 526 acres of the depot were used for the following purposes:

- Administrative - 9 acres
- Utilities - 52 acres
- Industrial and Maintenance - 7 acres
- Covered Storage - 135 acres
- Open Storage - 122 acres
- Housing - 25 acres
- Burning Area - 1 acre
- Training Area - 30 Acres
- Unallocated - 145 acres

In 1956, the facility's ordnance mission was terminated. The facility was reassigned to provide administrative and logistical support for the Nike activities and also to provide repair, utility service, transportation service, signal communications, and field maintenance support to Army Reserve and Reserve Officer Training Corps units.

The LOD was placed on inactive status in 1963 and, by 1967; 524 acres had been reported excess to the GSA. By 1976, ownership of portions of the property was transferred to several entities, with the majority of the FLOD being transferred to the Community Improvement Corporation of Warren and Trumbull County Ohio. This property was deeded to an industrial park, the Ohio Commerce Center, on November 3, 1976.

Currently, the 480 acres encompassed by the Ohio Commerce Center is zoned commercial. Approximately 40% of the property is used for storage while the remaining 60% is used for light manufacturing or assembly. Approximately 25 tenants utilize space through leases of one month or longer; others lease parking spots on a temporary or month-to-month basis.

The FLOD is bounded to the east by Ohio State Route 45 and to the south by the Baltimore and Ohio Railroads. Tracts near the southwest are zoned commercial and are occupied by trucking/transportation companies. A portion of the northwest corner (39 acres) is owned by the Trumbull County Board of Education and is occupied by the TAMPEEL environmental laboratory.

The 2000 census statistics indicate Trumbull County had a population of 225,116. The Village of Lordstown where FLOD is located had a population of 3,633. The City of Warren, located 4 miles north of FLOD, is the county seat and had a population of 46,832.

3.8 Ecological Characterization

The ecological characterization section includes a general discussion of site background and areas of concern (AOCs), surface water resources, wetlands, vegetative communities, a species inventory, and a discussion on threatened and endangered species.

General Site Background. The entire FLOD site is approximately 514 acres in size, is located within the Glaciated Plateau physiographic region of the western Erie/Ontario Lake Plain Ecoregion (Lafferty 1979; Omernik, 1986) which is generally characterized as containing irregular plains as the predominant land-surface form and as having a dominant natural vegetation of beech/maple and northern hardwoods (such as maple, birch, beech, and hemlock) in undisturbed areas. The rolling terrain of the Glaciated Plateau has made it amenable to agriculture and urban development and as a result the natural habitats in this region are more

modified than those found in other areas of northeastern Ohio. Forty-one percent of Trumbull County, the county in which the site is located, is forest covered (Dennis and Birch, 1981), although the site itself has much less forest cover than this due to development activities associated with its historic and current industrial use. The forest communities in the Glaciated Plateau are characterized by numerous isolated woodlands of varying size, rather than the more extensive forests of the unglaciated region to the south. In this area of the Plateau, beech-sugar maple communities are expected to predominate on the better drained uplands, while hemlock-beech communities are more common on the steeper bluffs (Lafferty, 1979). Site soils are poorly drained Mitiwanga and Wadsworth silt loams, with bedrock encountered 2 to 15 feet below the surface.

Surface Water. Beaver Creek originates at the railroad tracks that run east-west on the southern edge of the FLOD site and flows north south into and out off the Beaver Pond which is adjacent to the TAMPEEL Landfill. The Beaver Pond area is actively used by beaver and there is a large beaver lodge located in the pond. The area immediately south of the Beaver Pond contains a flooded forest margin, likely due to recent enlargement of the Beaver Pond resulting from beaver dam building activity that has restricted outflow. Red maple and green ash have been recorded near the Beaver Pond. The Beaver Pond has been stocked with bluegill, bass, and killifish in the past, according to TAMPEEL personnel. The creek flows out of the northern end of Beaver Pond, continues approximately 1.5 miles north until it flows into Duck Creek, and Duck Creek continues another two miles to the north before discharging into the Mahoning River.

The Study Pond is located at the northern portion of the TAMPEEL property and was formed after a borrow pit was created around 1985. The Study Pond is approximately 3/4 of an acre in size. This pond is recharged by groundwater and surface runoff, but has no outlet. The Study Pond is approximately 20 feet deep and is bordered on the east and west sides by stands of white pine.

TAMPEEL Spring is located to the south of the Study Pond in the northern section of the TAMPEEL area. The spring drains to the north-northeast into an area that contains substantial surface water during the spring and winter months. The area drains into the Beaver Creek, which runs south to north, east of TAMPEEL.

Aspen Creek forms to the north of the landfill. The creek originates at the northern edge of the landfill and runs into the same surface water drainage area as discussed above for the spring water. A sheen was noted in this creek during an initial site walk of the area. The sheen fails to coalesce after being mechanically disturbed. The sheen is thought to be naturally occurring due to the presence of iron or sulfur bacteria, which can produce sheen similar to petroleum sheen in appearance.

Wetlands. According to the National Wetland Inventory (NWI) Map for the area (USFWS, 1977), the Beaver Pond is classified as a palustrine emergent/open water wetland, while the spring-feed creek on TAMPEEL property is classified as a palustrine forested shrub/scrub wetland. As the Study Pond was created around 1985, it is not shown on the NWI map. About ¼- to ½-mile northwest of the ordnance site is a palustrine forested shrub/scrub wetland of approximately 8 acres in size (USFWS, 1977).

Vegetative Communities. Vegetative communities at the site were classified during the site reconnaissance trip using the 15 possible community types presented in Table 3-3. The three largest community types observed were moderate old field (OFM), moderate forest (FRM), and palustrine scrub/shrub and forested wetland (PSS/PFO). This general habitat figure presents the type and extent of biological communities present within the immediate vicinity of each AOC. Developed and disturbed areas (DEV) were associated with the sheds located north of the site AOCs. The Beaver Pond was characterized as PFO and open water (OW), whereas the Study Pond was primarily an OW community. Beaver Creek was characterized as PSS. Each of these habitat types, with the exception of DEV, 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, areas were examined for vegetative stress, including plants displaying stunted growth, poor foliage growth, tissue discoloration, and a loss of leaf coverage. No vegetative stress was observed at any of the AOC. It should be noted, however, that the time of year (November) may have limited the accuracy of this visual evaluation of vegetative stress.

Species Inventory. Based on information collected during the site reconnaissance, species lists were prepared for mammals, birds, reptiles and amphibians (Tables 3-4 through 3-7).

Information on species presence/absence was recorded by IT field scientists and was supplemented by information provided by TAMPEEL personnel that have been recording species information at TAMPEEL area since 1975. The TAMPEEL nature center is located immediately to the west of the site and provides environmental education to elementary school children of Trumbull County. Common trees and shrubs in the TAMPEEL area, according to TAMPEEL personnel, include elm, red maple, ash, red oak, white oak, dogwood, cherry, hawthorn, beech, quaking aspen, autumn and Russian olive, and golden rod.

Of the 46 species of mammals that may be found in the region based on species range maps, 22 species (48 percent) have been observed onsite (Table 3-4), including opossum, moles, bats, rabbits, woodchuck, squirrel, chipmunk, shrew, beaver, mice, muskrat, raccoon, skunk, weasel, fox, and deer. There is an active beaver lodge situated in the Beaver Pond and considerable evidence of recent beaver activity, in the form of gnawed tree stumps and wood chips around the pond, was observed during the site reconnaissance.

Of the 125 species of birds that may be found in the region based on species range maps, 64 species (51 percent) have been observed onsite (Table 3-5), including heron, duck, geese, hawks, vultures, quail, pheasant, grouse, rail, killdeer, woodcock, dove, owl, swift, hummingbird, kingfisher, flicker, woodpecker, sapsucker, waxwing, creeper, crow, jay, cardinal, goldfinch, junco, sparrow, bunting, grosbeak, towhee, martin, swallow, blackbird, oriole, cowbird, grackle, catbird, thrasher, chickadee, titmouse, warblers, nuthatch, starling, tanager, wren, thrush, bluebird, and robin. Some of these species are migratory and would only be expected to be at the site during spring and fall migrations. In the Glaciated Plateau, in which the site is located, a combination of woodlands, successional, edge and wetland habitats interspersed with farmlands and urban areas produces the greatest diversity of habitats for breeding birds in the state of Ohio (Peterjohn and Rice, 1991). It should be noted that TAMPEEL personnel mentioned the presence of a large great blue heron rookery within several miles of the site (at the Lordstown General Motors Fabrication Plant) that contains approximately 200 nests.

Of the 27 species of reptile that may be found in the region based on species range maps, six species (22 percent) have been observed onsite (Table 3-6), including turtles and snakes.

Of the 23 species of amphibians that may be found in the region based on species range maps, seven species (30 percent) have been observed at the site (Table 3-7), including salamanders, toads, and frogs.

Threatened and Endangered Species Information. According to an Ohio Division of Natural Areas & Preserves review of their Natural Heritage maps and files (ODNR, 1997), there are no records of rare or endangered species in the Lordstown Ordnance Depot project area, including a mile radius of the site. There are also no existing or proposed state nature preserves or scenic rivers within one mile of the project site, and Ohio Department of Natural Resources (ODNR) is unaware of any unique ecological sites, geological features, breeding or nonbreeding animal concentrations, champion trees, or state parks, forests or wildlife areas.

4.0 Nature and Extent of Contamination

Remedial Investigations were conducted in several phases. The initial phase conducted is referred to herein as the RI. The second phase, referred to as the SRI, was conducted to provide additional data in support of the findings of the RI and to provide data for consideration of remedial alternatives in a FS.

Objectives of the RI field investigation related to defining the nature and extent of contamination were:

- Determine if leachate is present at the landfill perimeter.
- Investigate the nature of surface soils in the Children's Activity Areas.
- Investigate soil in the depressions south of the landfill.
- Investigate surface water and sediment in Aspen Creek and the TAMPEEL Spring.
- Investigate surface water and sediment quality at the Beaver Pond and Beaver Creek.
- Investigate surface water and sediment quality at the Study Pond.
- Investigate groundwater quality upgradient and downgradient of the landfill.
- Resample the monitoring wells installed as part of the RI at the Ohio Commerce Center.

Objectives of the SRI related to defining the nature and extent of contamination were:

- Delineate the nature and extent of soil contamination for development of remedial options.
- Provide additional groundwater quality data in support of the RI.
- Provide additional surface water and sediment data in support of the RI.

Data used to characterize the nature and extent of contamination were obtained from the SRI, the RI and the FLOD Site Investigation (Maxim, 1997). Laboratory generated data from all the investigations were developed using standard methods consistent with data quality objectives

(DQO) Level III or IV criteria and may be used with confidence in assessing the nature and extent of contamination and risk assessment.

Section 4.0 reports levels of detected chemicals in soil, surface water, sediment and groundwater at TAMPEEL. It is important to recognize that the mere detection of a chemical does not imply that a hazardous situation exists. The potential for a chemical exposure to result in an adverse health effect is dependent upon the nature of the chemical itself and the dose (or level of exposure). Some chemicals are highly toxic (such as benzidene). Small doses of this kind of chemical can potentially cause harm. Other chemicals (such as zinc or iron) are not very toxic at all. Humans can be exposed to relatively high levels of these chemicals for long periods of time without adverse health effects.

Chemicals can also be described according to whether their presence is due to naturally occurring levels of the chemical or other non-site-related activities. Naturally occurring levels are associated with ambient concentrations in the environment that have not been influence by humans (also called naturally occurring background levels). Anthropogenic levels of chemicals are those concentrations that are in the environment due to human-made, non-site sources (for example, lead and polyaromatic hydrocarbons from automobile exhaust).

This section lists those chemicals that have been detected at TAMPEEL. For detected metals, those detections that are within naturally occurring background levels have been identified. Section 6 will discuss estimates of potential cancer risk and noncancer hazard associated with potential exposures to those detected chemicals.

The laboratory generated data is presented and summarized in the sections of this chapter as follows:

- Section 4.1 describes background soil and groundwater data used for comparison with data collected for this RI.
- Section 4.2 describes subsurface soil sample chemical data for the 20 soil borings around the perimeter of the landfill and a sample collected during installation of MW116.
- Section 4.3 describes surface soil chemical data from the Children's Activity Areas.

- Section 4.4 describes surface water and sediment chemical data.
- Section 4.5 describes groundwater chemical data for the monitoring wells installed as part of the previous RI at the Ohio Commerce Center and the four newly installed wells at the TAMPEEL Landfill area.

For reference, the complete listing of all analytical data is presented in Appendix I, and the Data Validation Summary Reports are presented in Appendix J.

4.1 Determination of Background

Background samples for metals were collected during the SI and the RI at the Ohio Commerce Center. The samples were collected from seven soil borings for soils background and three monitoring wells for groundwater background values. Groundwater background values are used in Section 4.0 as a point of comparison to detected constituents in groundwater samples. Likewise, soil background values are used in Section 4.0 as a point of comparison for detected constituents in soil samples. Since there sediment background values have not been established, sediment samples are compared to surface soil background values in Section 4.0, but only for the purposes of providing points of reference. This is appropriate as the sediment found in the streams and creeks is primarily due to surface runoff of soil. The results of analysis of surface water samples were compared to Ohio Surface Water Standards (OAC 3745-1) developed for the protection of aquatic life. Criteria developed for the protection of human health were not used as the surface water body is not used as a drinking water source.

Constituents present in soil or groundwater in excess of background are identified as chemical of potential concern (COPCs) presented in Section 6 (Baseline Risk Assessment). In the risk assessment, soil background values are not used to define COPCs in sediment. Surface water background values have also not been established; therefore, background values are not used to define COPCs in surface water.

Table 4-1 presents the background values for soil, and groundwater. Background soil and groundwater sample locations are depicted on Figure 4-1.

Determination of background concentrations were determined by the following:

In the case of soil, background data were first evaluated by depth and underlying geology. Soil data were segregated into four groups that include surface and subsurface soil underlain by sandstone and surface and subsurface soil underlain by shale. The Student's t test and the F-test were used to determine if there is a statistically significant difference ($\alpha = 0.05$) between soil data sets. If no difference between groups is determined, the data sets were combined. The Student's t test and the F-test methodologies are given below:

The T-test is conducted to test whether there is no difference between two population means with equal variances from a combined data set that is normally distributed. The null hypothesis to be tested is:

H_0 : The populations have equal means
versus

The alternative hypothesis

Rejection Region for a Level 0.05 Test

$$H_A: \mu_1 > \mu_2$$

$$T_{\text{test}} \geq T_{0.95, n_1 + n_2 - 2}$$

$$H_A: \mu_1 < \mu_2$$

$$T_{\text{test}} \leq -T_{0.95, n_1 + n_2 - 2}$$

$$H_A: \mu_1 \neq \mu_2 \quad \text{either}$$

$$T_{\text{test}} \geq T_{0.975, n_1 + n_2 - 2} \quad \text{or}$$

$$T_{\text{test}} \leq -T_{0.975, n_1 + n_2 - 2}$$

The sample means and the sample variance of the two groups are calculated, followed by the calculation of the estimated pooled standard deviation:

$$s = \left[\frac{(n_1 - 1)s_1^2 + (n_2 - 1)s_2^2}{n_1 + n_2 - 2} \right]^{0.5}$$

The test statistic is then calculated:

$$T_{\text{test}} = \frac{\bar{x}_1 - \bar{x}_2}{s \sqrt{\frac{1}{n_1} + \frac{1}{n_2}}}$$

The critical values (T_{critical}) are determined from a T-test table and the T_{test} values are compared to the T_{critical} values. Based on the rejection table, when the T_{test} statistic is between the two critical values, there is insufficient information to conclude that the means are from two different population.

The F-test is conducted to test whether there is no difference between two population variances from a combined data set that is normally distributed. The null hypothesis to be tested is:

$$H_0: \quad \text{The populations have equivalent variances } (\sigma_1^2 = \sigma_2^2)$$

versus

The alternative hypothesis

Rejection Region for a Level 0.05 Test

$$H_A: \quad \sigma_1^2 > \sigma_2^2$$

$$F_{\text{test}} \geq F_{0.05, n1-1, n2-1}$$

$$H_A: \quad \sigma_1^2 < \sigma_2^2$$

$$F_{\text{test}} \leq F_{0.95, n1-1, n2-1}$$

$$H_A: \quad \sigma_1^2 \neq \sigma_2^2$$

either

$$F_{\text{test}} \geq F_{0.025, n1-1, n2-1} \text{ or}$$

$$F_{\text{test}} \leq F_{0.975, n1-1, n2-1}$$

The sample variances of the two groups are calculated and the test statistic is calculated:

$$F_{\text{test}} = \frac{s_1^2}{s_2^2}$$

The two F_{critical} values are determined from an F table, and the F_{test} value is compared to the F_{critical} values. Based on the rejection table, when F_{test} is between the two F_{critical} values, there is insufficient information to conclude that the sample variances are from two different populations.

The soil background data sets were then evaluated to determine whether they are distributed normally. The W test developed by Shapiro and Wilk (Gilbert, 1987; Equations 12.3 and 12.4) were used to determine whether or not a data set has been drawn from a population which is normally distributed for sample size of 50 or less. By conducting this test on the natural logarithm of each data value, the W test is used to determine whether or not the sample was drawn from an underlying lognormal distribution. The null hypothesis tested is:

H_0 : The population has a normal (lognormal when the data is transformed) distribution.

versus

H_A : The population does not have a normal (i.e., lognormal when the data is transformed) distribution.

If H_0 is rejected, then H_A is accepted.

The equation for calculating W is:

$$W = \frac{1}{d} \left[\sum_{i=1}^k a_i (x_{[n-i+1]} - x_{[i]}) \right]^2$$

where:

$$d = \sum_{i=1}^n x_i^2 - \frac{1}{n} \left(\sum_{i=1}^n x_i \right)^2$$

$$k = \frac{n}{2} \text{ if } n \text{ is even}$$

$$= \frac{n-1}{2} \text{ if } n \text{ is odd}$$

a_i = Shapiro-Wilk coefficient (Gilbert, 1987; Table A-6)
 x_i = i^{th} data value in the ordered data set
 x_i^2 = square of the i^{th} data value in the ordered data set
 n = number of data points
 W = Shapiro-Wilk test statistic (Gilbert, 1987; Table A-7)

H_0 is rejected at the α significance level if W is less than the quantile given in Table A-7.

To test the null hypothesis that the population has a lognormal distribution, the observed data, y_1, y_2, \dots, y_n where $y_i = \ln x_i$, is transformed.

Once the data have been transformed, the following calculations were used to determine if on-site constituent concentrations are statistically greater than background. This step is accomplished by calculating the upper 95 percent tolerance limit (UTL) (Gilbert, 1987).

For normally distributed data:

The upper 95 percent tolerance limit ($UTL_{0.95}$) is actually the upper 95 percent confidence limit for the 95th quantile. Its purpose is to define that concentration of a constituent below which, with 95 percent certainty, all values in a population will fall. The $UTL_{0.95}$ is calculated using the following equation:

$$UTL_{0.95} = \bar{x} + sK_{0.95,0.95}$$

where:

\bar{x}	=	mean of background concentration
s	=	relative standard deviation
$K_{0.95,0.95}$	=	factor for estimating the 95 percent confidence limit for the 95th quantile (Gilbert, 1987; Table A-3)

For lognormally distributed data:

The upper 95 percent tolerance limit for data with an underlying lognormal distribution is calculated by:

$$UTL_{0.95} = \exp[\bar{y} + sK_{(0.95,0.95)}]$$

where:

\bar{y}	=	$\Sigma y/n$ = sample arithmetic mean of the log-transformed data, $y = \ln x$
s	=	relative standard deviation
$K_{0.95,0.95}$	=	factor for estimating the 95 percent confidence limit for the 95th quantile (Gilbert, 1987, Table A-3)

The statistical tests that are described in this section are parametric procedures and are intended for use in cases where the percentage of non-detects in a particular data set is less than 50 percent. In the event that the percentage of non-detects for a particular chemical is greater than 50 percent, non-parametric procedures were applied as appropriate. Procedures for evaluating and applying non-parametric statistics are described in the guidance document *Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities, Addendum to Interim Final Guidance* (USEPA, 1992a).

The statistical evaluation of soil types and depths indicated that no statistical difference exists between the four background groups. Therefore, background was summarized as one unit.

If the calculated UTL for a specific constituent was greater than the maximum detected concentration, then maximum detected concentration was used for that particular constituent. In the case of groundwater background, only three background wells were identified for the data set. Since the data set was small, UTLs could not be calculated. Therefore, maximum concentrations of inorganics detected in the background groundwater wells were used to characterize background groundwater.

Summaries of calculated background values used to characterize soil and groundwater are presented in Table 4-1. Only metals exceeding background are presented on figures referenced in this section.

4.2 TAMPEEL Subsurface Soil

During the RI, subsurface soil samples were collected from 10 soil borings which were located around the perimeter of the TAMPEEL Landfill. During the SRI, subsurface sampling consisted of only one subsurface sample (greater than 2 feet bgs). The sample was collected from the soil boring of MW116.

Soil boring locations are shown on Figure 4-2 and a summary of detected chemicals are depicted in Figure 4-3. Soil samples were analyzed for VOCs, SVOCs, Pesticides/PCBs and total TAL metals. A summary of detected compounds is presented in Table 4-2. The following discusses results for each analyte group

The following discusses results for each analyte group.

VOCs

For subsurface soil samples collected during the RI, VOCs were not detected in SB-131, SB-132, SB-136, SB-137, SB-140, SB-145 and SB-149. Acetone was detected in two samples with concentrations ranging up to 810 µg/kg (SB-134).

The subsurface soil sample collected from MW116 during the SRI showed VOCs to be below analytical detection limits.

SVOCs

SVOCs were not detected in any subsurface soil boring samples for the RI or SRI.

Pesticides/PCBs

Pesticides and PCBs were not detected in any subsurface samples collected during the RI and SRI.

Metals

For samples collected during the RI iron was detected above background in SB132 (38,400 mg/kg); manganese was detected above background in three samples (SB134, SB149, and SB150), with the maximum of 589 mg/kg in SB; nickel was detected above background in SB150 (32.5 mg/kg); and zinc was detected above background in SB131 (107 mg/kg).

For the sample collected during the SRI, copper was detected above background (32.6 mg/kg).

4.3 Surface Soil Investigation

During the RI, 11 surface soil samples were collected around the perimeter of the TAMPEEL landfill, and nine surface soil samples were collected in the Children's Activity Areas. Samples were collected at the following locations: TAMPEEL Landfill (SB133, SB135, SB138, SB139, SB141, SB142, SB143, SB144, SB146, SB147, and SB148), Children's dig area (SS-185, SS-186 and SS-187), Bird watching area (SS-188 and SS-189), Insect viewing area (SS-190 and SS-191), Woodchuck area (SS-192), and Spring area (SS-193). Surface soil samples were analyzed for VOCs, SVOCs, Pesticides/PCBs and total TAL metals. In addition, four samples (SS-194 and SS-197) were collected in the areas containing suspect depressions. Two samples were collected from a circular depression and two samples were collected from an irregular shaped depression. Depression area samples were analyzed for VOCs, SVOCs, Pesticides, PCBs, dioxins, furans, explosives, and total TAL metals.

During the SRI, 19 surface soil samples were collected from 18 surface soil borings and from one monitoring well location, (SS201 through SS218 and MW116). Samples were analyzed for VOCs, SVOCs, pesticides/PCBs and TAL metals.

Sample locations for surface samples collected during the RI and SRI are shown on Figure 4-4. Summaries of analytical results are presented in Table 4-3 and shown on Figures 4-5 through 4-8. The following discusses results for each analyte group.

VOCs

A summary of VOC detections is shown on Figure 4-5.

Landfill Area

For surface soil samples collected during the RI, acetone was detected in six soil samples, with a maximum detection of 680 µg/kg (SB143). Methylene chloride was detected in three soil samples, with a maximum detection of 15 µg/kg.

Children's Dig Area

For samples collected during the RI, methylene chloride (32 µg/kg) was detected at SS-187.

Bird Watching Area

For samples collected during the RI, methylene chloride was detected at SS-188 (23 µg/kg) and SS-189 (1.9 µg/kg) .

Insect Viewing Area

For samples collected during the RI, 1,1,1-Trichloroethane (2.1 µg/kg) was detected at SS-190. Methylene chloride (39 µg/kg) and Acetone (10 µg/kg) were detected at SS-191.

Woodchuck Area

For samples collected during the RI, methylene chloride (1.6 µg/kg) was detected at SS-192.

Spring Sample Area

For samples collected during the RI, methylene chloride was detected at SS-193 (13 µg/kg) and in the duplicate sample from this location (4.8 µg/kg) .

Depressed Areas

For samples collected during the RI, VOCs were detected in all the depressed areas samples and duplicates. The VOCS, followed by maximum detections of those analytes, were acetone (110 µg/kg), 2-butanone (5.9 mg/kg), and toluene (1.6 µg/kg).

SRI Surface Soil

For samples collected during the SRI, VOCs were detected in 15 of the 19 samples. The highest VOC concentration detected was a total xylene detection of 5,900 µg/kg in sample SS203. VOCs were not detected in surface soil samples from MW116, SS202, SS207, and SS216. Detected VOCs consisted of ethylbenzene, toluene, and xylenes (total), which are all part of the common petroleum hydrocarbon grouping {benzene, toluene, xylene, and ethylbenzene (BTEX)}.

SVOCs

A summary of SVOC detections from samples collected during the RI and SRI activities are shown on Figure 4-6.

Landfill Area

For surface soil samples collected during the RI no SVOCs were detected.

Children's Dig Area

For samples collected during the RI, total SVOC concentrations in the samples ranged up to 12,502 µg/kg (SS-185), while polycyclic aromatic hydrocarbons (PAH) concentrations ranged up to 12,242 µg/kg (SS-185).

Bird Watching Area

For samples collected during the RI, total SVOC concentrations in the samples ranged up to 2,490 µg/kg (SS-188), while PAH concentrations ranged up to 2,380 µg/kg (SS-188).

Insect Viewing Area

For samples collected during the RI, total SVOC concentrations in the samples ranged up to 31,540 µg/kg (SS-191), while PAH concentrations ranged up to 30,710 µg/kg (SS-191).

Woodchuck Area

For samples collected during the RI, total SVOC concentrations in the sample totaled 863 µg/kg (SS-192), while PAH concentrations totaled 783 µg/kg (SS-192).

Spring Sample Area

Total SVOC concentrations in the RI sample totaled 7,158 µg/kg (SS-193), while PAH concentrations totaled 6,830 µg/kg (SS-193).

Depressed Areas

For samples collected during the RI, no SVOCs were detected in any of the four samples or the duplicate sample collected at the depressed areas.

SRI Samples

For samples collected during the SRI, SVOCs were detected in samples from SS201, SS204, SS205, SS206, SS208, SS209, SS213, and SS214. All other surface soil samples were below detection limits. Detected SVOCs consisted primarily of PAHs. Total PAH concentrations in samples ranged from 454 µg/kg to 194,200 µg/kg.

Pesticides/PCBs

A summary of pesticides /PCBs detections from samples collected during the RI and SRI activities are shown on Figure 4-7.

Landfill Area

For surface soil samples collected during the RI pesticides were detected in one sample. 4-4'DDE and 4-4'DDT were detected in SB135.

Children's Dig Area

For samples collected during the RI, pesticides and PCBs were not detected in the surface soil samples.

Bird Watching Area

For samples collected during the RI, the following chemicals followed by the maximum concentrations were detected in the samples SS-188 and SS-189, 4,4'DDE (6 µg/kg) and 4,4'DDT (6.1 µg/kg).

Insect Viewing Area

For samples collected during the RI, the following chemicals followed by the maximum concentrations were detected in the samples SS-190 and SS-191, beta-BHC (56 µg/kg). In the soil sample SS-190, 4,4'DDE (6.4 µg/kg) and 4,4'DDT (6.9 µg/kg) were detected and in SS-191, Aroclor 1260 (97 µg/kg) was detected.

Woodchuck Area

For samples collected during the RI, pesticides and PCBs were not detected in the surface soil samples.

Spring Sample Area

For samples collected during the RI, no SVOCs were detected in the Spring sample area or in its duplicate.

Depressed Areas

For samples collected during the RI, no pesticide or PCBs were detected in any of the four samples collected at the depressed areas.

SRI Samples

For surface soil samples collected during the SRI, pesticides were detected in samples from 4 locations. PCBs were detected in 1 sample. The chemicals 4,4'-DDE and 4,4'-DDT were each detected in SS206, SS208, SS214, and SS216 at concentrations ranging from 94 µg/kg to 160 µg/kg. Aroclor 1254 was detected in SS206 at a concentration of 55 µg/kg.

Explosives

Explosives were only analyzed for in the depressed area samples. None were detected.

Dioxins

Dioxins were only analyzed for in the depressed area samples. 1,2,3,4,6,7,8-HxCDD was detected in both samples of the circular depressed areas at a maximum concentration of 3.1 pg/g. OCDD was detected in all five samples at a maximum concentration of 420 pg/g, also from one of the samples from the circular depressions. Total HPCDD was in the circular depression samples, with a maximum concentration of 6.8 pg/g. Total HXCCD was in one of the irregular depressions at 0.19 pg/g. Total PeCDF was detected in both of the irregular shaped depression

samples with a maximum detection of 1.0 pg/g. Total TCDF was also detected in both samples from the irregular depression with a maximum concentration of 1.7 pg/g.

Metals

A summary of metal detections from samples collected during the RI and SRI activities that exceeded background are shown on Figure 4-8.

Landfill Area

For samples collected during the RI in the vicinity of the TAMPEEL Landfill, metals were detected above background in 7 of the 11 samples. The following metals, followed by their maximum detected concentration, were detected above background in at least one sample: Arsenic (48.2 mg/kg), Barium (184 mg/kg), and manganese (1,580 mg/kg).

Children's Dig Area

For samples collected during the RI, metals were detected above background in samples from SS-185, SS-186 and SS-187. Lead was detected above background in all three samples with the maximum concentration (80.5 mg/kg) occurring in sample SS-185. Barium was detected above background in all three samples with the maximum concentration (227 mg/kg) occurring in sample SS-187. Zinc was detected above background in samples SS-185 and SS-187 at a maximum concentration of 159 mg/kg. Manganese was also present above background in SS-185 at 627 mg/kg.

Bird Watching Area

For samples collected during the RI, the following metals, followed by the maximum detected concentration, were detected above background in SS-188 and SS-189: barium (107 mg/kg) and lead (41.9 mg/kg). Manganese was detected above background in SS-188 (678 mg/kg).

Insect Viewing Area

For samples collected during the RI, the following metals, followed by the maximum detected concentration, were detected above background in SS-190 and SS-191: barium (222 mg/kg), manganese (864 mg/kg), lead (105 mg/kg), and zinc (154 mg/kg). Copper (41.6 mg/kg), iron (37,400 mg/kg), arsenic (27.1 mg/kg), calcium (13,700 mg/kg), and mercury (0.13 mg/kg) were detected above background in SS-191.

Woodchuck Area

For samples collected during the RI, the following metals, followed by the maximum detected concentration, were detected above background in sample SS-192: barium (212 mg/kg), manganese (1,250 mg/kg), lead (126 mg/kg), zinc (216 mg/kg), chromium (27.5 mg/kg), copper (31.8 mg/kg), and mercury (0.14 mg/kg).

Spring Sample Area

For samples collected during the RI, the following metals, followed by the maximum detected concentration, were detected above background in sample SS-193 or its duplicate: barium (117 mg/kg), calcium (11,200 mg/kg), manganese (1,730 mg/kg), lead (72.1 mg/kg), chromium (45.3 mg/kg) and zinc (117 mg/kg).

Depressed Areas

For samples collected during the RI, no TAL metals were detected above surface soil background concentrations in any of the four samples collected at the depressed areas.

SRI Samples

For samples collected during the SRI, metals were detected above background in 15 of the 18 samples. The following metals, followed by their maximum detected concentration, were detected above background in at least one sample: Aluminum (21,200 mg/kg), arsenic (69.8 mg/kg), barium (11,000 mg/kg), beryllium (2.6 mg/kg), calcium (86,100 mg/kg), chromium (286 mg/kg), copper (230 mg/kg), iron (151,000 mg/kg), lead (9,820 mg/kg), magnesium (14,300 mg/kg) manganese (12,900 mg/kg), mercury (0.71 mg/kg), nickel (164 mg/kg), potassium selenium (8.1 mg/kg), sodium (2,030 mg/kg), vanadium (118 mg/kg), and zinc (24,300 mg/kg).

4.4 Surface Water and Sediment Sampling

Surface water and sediment samples were collected during the RI and SRI activities. Sampling locations are shown on Figure 4-9 and the analytical results are presented in Tables 4-4 and 4-5. During the RI, a total of 10 surface water samples and 12 sediment samples were collected from the TAMPEEL (including samples from the OCC RI and SI). Two surface water and two sediment samples were collected from Aspen Creek. One surface water and one sediment sample were collected from the TAMPEEL Spring. Three surface water and three sediment samples were collected from the Study Pond (north of the landfill) and four surface water and

sediment samples were collected from the Beaver Pond (south of the landfill). Two sediment samples were collected from Beaver Creek.

During the SRI, three surface water and three sediment samples were collected from Aspen Creek. One surface water and two sediment samples were collected from Beaver Creek. The following summarizes the sample results from the RI and the SRI:

4.4.1 Aspen Creek and TAMPEEL Spring

During the RI, two samples were collected from the surface water and sediments in Aspen Creek. Samples SW109 and SD109 were collected, along with the duplicate surface water sample, at the source of the creek which is located just north of the landfill. Samples SW110 and SD110, were collected in the creek approximately 150 yards further downgradient. During the OCC RI, one sediment (SD101) and one surface water (SW101) sample were collected at the TAMPEEL Spring, located to the west of samples SW110 and SD110. Surface water and sediment samples were analyzed for VOCs, SVOCs and pesticides/PCBs. Sediment samples were also analyzed for total TAL metals.

During the SRI, three samples were collected from the surface water and sediments in Aspen Creek. Samples SW201 and SD201 were collected at the TAMPEEL Spring. Samples SW202 and SD202 were collected at the source of the creek. Samples SW203 and SD203 were collected in the creek approximately 150 yards further downgradient.

Table 4-4 (surface water) and Table 4-5 (sediment) and Figure 4-10 summarize the chemical detects. The following discusses results for each group.

VOCs

VOCs were detected in all four surface water samples (the three original samples and the duplicate). Methylene chloride was detected in SW110 at 1 µg/L. Cis-1,2-dichloroethene was detected in all the samples with the highest concentration at 2.2 µg/L in SW101.

For surface water samples collected during the SRI, VOCs were not detected in samples from SW202, and SW203. Detected VOC consisted of cis-1,2-dichloroethene (4.9 µg/kg) in SW201 and the duplicate.

In sediment samples SD109 and SD110, detected chemicals, followed by the maximum concentrations, were acetone (41 µg/kg) and methylene chloride (10 µg/kg). In sediment sample SD101, carbon disulfide was detected at an estimated concentration of 2.5 µg/kg.

The following VOCs, followed by their maximum detected concentration, were detected in at least one SRI sediment sample: 2-Butanone (39 µg/kg), acetone (120 µg/kg), carbon disulfide (1.7 µg/kg), toluene (2.2 µg/kg), methylene chloride (4.0 µg/kg) and cis-1,2-Dichloroethene (2.7 µg/kg).

SVOCs

For samples collected during the RI, SVOCs were not detected in the surface water samples. The following SVOCs, followed by the maximum concentration, were detected in SD109 and SD101, phenanthrene (450 µg/kg), fluoranthene (440 µg/kg), pyrene (400 µg/kg), benzo(a)anthracene (250 µg/kg), chrysene (220 µg/kg), anthracene (170 µg/kg), benzo(b)fluoranthene (190 µg/kg), benzo(a)pyrene (160 µg/L), and bis(2-ethylhexyl)phthalate (100 µg/kg).

For samples collected during the SRI, SVOCs were not detected in any of the surface water samples collected. SVOCs were detected in SD202. SVOCs detected include anthracene (830 µg/kg), benzo(a)anthracene (980 µg/kg), benzo(a)pyrene (690 µg/kg), benzo(b)fluoranthene (840 µg/kg), chrysene (830 µg/kg), fluoranthene (1,800 µg/kg), phenanthrene (2,300 µg/kg), and pyrene (1,500 µg/kg).

Pesticides/PCBs

For samples collected during the RI, pesticides/PCBs were not detected in the surface water samples.

Pesticides were detected in sediment samples SD101, SD109, and SD110. The maximum concentration were all found in SD101: 4,4'-DDD (1,400 µg/kg), 4,4'-DDE (220 µg/kg) and 4,4'-DDT (900 µg/kg).

For samples collected during the SRI, no pesticides or PCBs were detected in any surface water samples. 4,4'-DDD (270 µg/kg) was detected in sediment sample SD202.

Metals

No metals were detected in excess of Ohio Water Quality Criteria (OAC 3745-1) for the protection of aquatic life in surface water samples collected from TAMPEEL spring and Aspen Creek collected during the RI. Lead, nickel, and zinc were detected in excess of Ohio Water Quality Criteria (OAC 3745-1) for the protection of aquatic life in the surface water sample SW 202 (Aspen Creek).

Metals detected above soil background in one or more of the sediment samples collected during the RI, followed by the maximum concentration, included: barium (120 mg/kg), manganese (1,250 mg/kg), copper (223 mg/kg), lead (53.2 mg/kg), and zinc (117 mg/kg).

Metals detected above soil background in one or more of the sediment samples collected during the SRI, followed by the maximum concentration, included barium (742 mg/kg), calcium (11,200 mg/kg), manganese (5,910 mg/kg), lead (77.4 mg/kg), nickel (282), and zinc (2,060) mg/kg.

4.4.2 Study Pond Surface Water and Sediment Sampling

Sediment and surface water samples were collected from three sites (SD102-SD104 and SW102-SW104) at the Study Pond. Duplicate samples (SD103D and SW103D) were also collected at this time. Site sampling locations are shown on Figure 4-9 and a summary of detected chemicals for the Study Pond is depicted in Figure 4-10. All samples were analyzed for VOCs, SVOCs, pesticides/PCBs and total TAL metals. Water samples were also analyzed for hardness and sediment samples for TOC. A summary of detected compounds is presented in Table 4-4 (surface water) and Table 4-5 (sediment). No additional samples were taken at the Study Pond for the SRI. The following discusses the RI results for each analyte group.

VOCs

VOCs were not detected in the surface water samples.

Acetone was detected in the sediment sample SD102 at a concentration of 100 µg/kg. No other VOCs were detected in the Study Pond sediment samples.

SVOCs

SVOCs were not detected in the surface water samples.

SVOCs were detected in sediment sample SD104. Detected chemicals were fluoranthene (480 µg/kg) and pyrene (450 µg/kg).

Pesticides/PCBs

Pesticides and PCBs were not detected in surface water or sediment samples.

Metals

No metals in excess of Ohio Water Quality Criteria (OAC 3745-1) for the protection of aquatic life were detected in the Study Pond surface water samples.

The following metals, followed by the maximum detected concentration, were detected above background in samples SD102, SD103, and SD503 (Duplicate of SD103): aluminum (23,000 mg/kg), manganese (1,190 mg/kg), barium (134 mg/kg), chromium (31.1 mg/kg), copper (29.4 mg/kg), iron (41,300 mg/kg), zinc (128 mg/kg), vanadium (41.5 mg/kg), lead (29.1 mg/kg), and selenium (2.8 mg/kg). The maximum detected concentration for each metal occurred in sediment sample SD102.

Hardness

Surface water samples SW102, SW103 and SW104 were measured for hardness (as CaCO₃) and results were 110 mg/L, 100 mg/L and 100 mg/L, respectively.

TOC

TOC was measured in all of the sediment samples from the Study Pond. Results are as follows: SD102 8,300 mg/kg, SD103 8,900 mg/kg, and SD104 5,000 mg/kg.

4.4.3 Beaver Pond Surface Water and Sediment Sampling

Sediment and surface water samples were collected from four sites (SD105-SD108 and SW105-SW108) at the Beaver Pond. Sampling locations are shown on Figure 4-9 and a summary of detected chemicals for the Beaver Pond and Beaver Creek are depicted in Figure 4-10. All samples were analyzed for VOCs, SVOCs, pesticides/PCBs and total TAL metals. Water samples were also analyzed for hardness and sediment samples for TOC. A summary of detected compounds is presented in Table 4-4 (surface water) and Table 4-5 (sediment). No additional samples were taken at the Study Pond for the SRI. The following discusses the RI results for each analyte group.

VOCs

VOCs were not detected in the surface water samples.

Acetone was detected in sediment samples SD106, SD107, and SD03 with concentrations ranging up to 69 µg/kg (SD107).

SVOCs

SVOCs were not detected in the surface water or sediment from the Beaver Pond.

Pesticides/PCBs

Pesticides/PCBs were not detected in the surface water and sediment samples.

Metals

Lead was the only metal detected in a Beaver Pond sample (SW107 - 0.0071 mg/L) in excess of Ohio Water Quality Criteria (OAC 3745-1) for the protection of aquatic life.

Sediment samples SD105 and SD108 that did not contain metals above the surface soil background values. The metals, followed by the maximum concentration, were detected in at least one of the other sediment samples above background: lead (40.6 mg/kg), selenium (1.5 mg/kg), and zinc (111 mg/kg).

Hardness

Surface water samples SW105, SW106, SW107, and SW108 were measured for hardness (as CaCO₃) and results were 140 mg/L, 140 mg/L, 150 mg/L, and 140 mg/L, respectively.

TOC

TOC was measured in all of the sediment samples from the Beaver Pond. Results are as follows: SD105 (4,700 mg/kg), SD106 (35,000 mg/kg), SD107 (24,000 mg/kg) and SD108 (1,400 mg/kg).

4.4.4 Beaver Creek Surface Water and Sediment Sampling

During the SI (Maxim, 1997), one original (SD03-001) and one duplicate (SD03-002-D) sediment sample was collected from Beaver Creek upgradient of the Burn Area and one sample (SD04-001) was collected downgradient of the Burn Area. During SRI Activities one surface

water sample (SW204) was collected downstream of the TAMPEEL site and two sediment samples (SD204 and SD205) were collected (one upstream of FLOD and one down stream). All samples were analyzed for VOCs, SVOCs, pesticides/PCBs and total TAL metals. A summary of detected compounds is presented in Table 4-4 (surface water) and Table 4-5 (sediment) and on Figure 4-11.

VOCs

VOCs were not detected in the surface water samples.

Acetone was detected in SD03 (36 µg/kg).

SVOCs

SVOCs detected in the sediment sample from SD03 and SD03D included, followed by the maximum detected concentration: 2-methylnaphthalene (420 µg/kg), benzo(a)anthracene (220 µg/kg), benzo(a)pyrene (580 µg/kg), benzo(b)fluoranthene (1,100 µg/kg), benzo(g,h,i)perylene (320 mg/kg), chrysene (370 µg/kg), di-n-butylphthalate (440 µg/kg), dibenzofuran (140 µg/kg), diethyl phthalate (140 µg/kg), fluoranthene (560 µg/kg), indeno (1,2,3-cd) pyrene (310 µg/kg), naphthalene (310 µg/kg), phenanthrene (510 µg/kg), and pyrene (520 µg/kg). The presence of SVOCs in SD03 and SD03D was expected due to the proximity of the sample location to a railroad. In sediment sample SD04, di-n-butylphthalate was the only SVOC detected (89 µg/kg). This result was qualified to indicate that the chemical was also detected in an associated blank sample. In SD205 SVOCs detected included fluoranthene (1,300 µg/kg), phenanthrene (930 µg/kg) and pyrene (900 µg/kg).

Pesticides/PCBs

Pesticides/PCBs were not detected in the surface water samples.

In the sediment samples SD03 and SD03D, detected chemicals, followed by the maximum concentration, were 4,4'-DDD (100 µg/kg), 4,4'-DDE (200 µg/kg), and 4,4'-DDT (440 µg/kg). In sediment sample SD205 detected chemicals, followed by the maximum concentration, were 4,4'-DDD (91 µg/kg), 4,4'-DDE (160 µg/kg), and 4,4'-DDT (170 µg/kg).

Metals

No metals were detected in surface water sample SW204 in excess of Ohio Water Quality Criteria (OAC 3745-1) for the protection of aquatic life.

The following metals, followed by the maximum detected concentration, were detected in at least one sediment sample above background in SD03, SD204, and SD205: antimony (4.7 mg/kg), arsenic (67.3 mg/kg), barium (130 mg/kg), beryllium (1.3 mg/kg), cadmium (3.7 mg/kg), copper (48.8 mg/kg), iron (40,300 mg/kg), lead (66.6 mg/kg), manganese (770 mg/kg), mercury (0.17 mg/kg), selenium (3.7 mg/kg), and zinc (1,270 mg/kg)

4.5 Nature and Extent of Groundwater Contamination

The following describes the nature and extent of contamination observed in groundwater in the monitoring wells installed as part of the RI and SRI activities conducted at the TAMPEEL. Groundwater samples were collected during RI activities (April 1999) and during SRI activities (October 2000). Each sample was analyzed for VOCs, SVOCs, pesticides/PCBs and TAL metals. A summary of detected compounds is presented in Table 4-6. Monitoring well locations are presented on Figure 4-12. The following discusses results for each analyte group.

4.5.1 RI Sampling Results

During the RI, groundwater samples were collected from four monitoring wells installed around the TAMPEEL Landfill (MW-112 – MW-115). Well locations and a summary of detected chemicals are depicted in Figure 4-12. Groundwater samples were analyzed for VOCs, SVOCs, Pesticides/PCBs and TAL metals. A summary of detected compounds is presented in Table 4-6. The following discusses results for each analyte group.

VOCs

In groundwater samples collected during the RI, VOCs were not detected in samples from MW-112, MW-114 and MW-115. Methylene Chloride (1.7 µg/L) was detected only in the duplicate sample from MW-113.

SVOCs

SVOCs were not detected in the groundwater samples.

Pesticides/PCBs

Pesticides/PCBs were not detected in the groundwater samples.

Metals

In groundwater samples collected during the RI, the following metals, followed by their maximum concentration, were detected above background in at least one sample: aluminum (21.9 mg/L), chromium (0.031 mg/L), iron (21.6 mg/L), lead (0.0097 mg/L), magnesium (35.3 mg/L), potassium (10.8 mg/L), sodium (102 mg/L), and vanadium (0.057 mg/L).

4.5.2 SRI Sampling Activity

During the SRI, groundwater samples were collected from MW112 through MW116. Well locations and a summary of detected chemicals are depicted in Figure 4-12. Groundwater samples were analyzed for VOCs, SVOCs, Pesticides/PCBs and TAL metals. A summary of detected compounds is presented in Table 4-6. The following discusses results for each analyte group.

VOCs

In samples collected during the SRI, no VOCs were quantified above analytical detection limits in the groundwater samples collected from MW112, MW113, MW114, MW115, and MW116.

SVOCs

In samples collected during the SRI, no SVOCs were quantified above analytical detection limits in the groundwater samples collected from MW112, MW113, MW114, MW115, and MW116.

Pesticides/PCBs

In samples collected during the SRI, no pesticides or PCBs were quantified above analytical detection limits in the groundwater samples collected from MW112, MW113, MW114, MW115, and MW116.

Metals

In samples collected during the SRI sampling, the following nine metals, followed by the maximum detected concentration, were detected above background (Table 4-6) in at least one groundwater sample; aluminum (5.5 mg/L), calcium (195 mg/l), iron (10.5 mg/l), lead (0.0030 mg/l), magnesium (81.0 mg/l), potassium (6.5 mg/l), sodium (111 mg/l), and thallium (0.010 mg/l).

4.6 Summary of Analytical Results

In surface soil samples, detected VOCs consisted of acetone, 2-butanone, ethylbenzene, methylene chloride, 1,1,1-trichloroethane, toluene, and xylenes. Acetone and methylene chloride were the VOCs detected at the highest frequency. VOCs were detected in 32 of 43 samples and in one duplicate sample, with the highest concentration being a xylene detection of 5,900 µg/kg. All four samples collected from the depressed area had VOC detections.

Acetone was the only VOC detected in subsurface samples, with a maximum concentration of 810 µg/kg. In sediment samples collected from Aspen Creek, the following VOCs were detected: acetone, carbon disulfide, cis-1,2-dichloroethene, and methylene chloride. The sediment samples from the ponds showed VOC detections in 1 out of 4 samples in the Study Pond (acetone 100 µg/kg) and 2 out of 4 samples in the Beaver Pond, with only acetone detected at a maximum value of 69 µg/kg. In the Aspen Creek surface water samples, the VOCs methylene chloride and cis-1,2-dichloroethene were detected at low concentrations. No VOCs were detected in surface water from either the Study Pond or Beaver Pond. Only one detection of VOCs occurred in the TAMPEEL wells (methylene chloride 1.7 µg/L).

SVOCs detected in the samples during this investigation were primarily detected in the surface soils. Detections were further limited to the surface soil samples collected in the Children's Activity Areas samples. No detections of SVOCs were found in any of the subsurface soil samples. A number of SVOCs (9) were detected in sediment from Aspen Creek, Beaver Creek, and TAMPEEL Spring. The only SVOCs detected in the sediment samples at either pond were fluoranthene and pyrene in one sample from the Study Pond. No SVOCs were detected in any of the pond or the Aspen Creek and TAMPEEL Spring surface water samples. No SVOCs were detected in groundwater samples collected from the TAMPEEL wells.

PCBs/pesticides were not detected in the depressed area, surface water, Study Pond sediment, or the groundwater samples. Pesticides were detected at low concentrations in the surface soil samples in the insect viewing and bird viewing area samples. The PCB Aroclor 1260 was also detected in the insect viewing area. Pesticide detections were primarily found in the TAMPEEL spring sediment sample, with concentrations up to 1,400 µg/L. Pesticides were also detected in Aspen Creek sediment and Beaver Pond sediment at lower levels.

Dioxins, furans, and explosives were tested for only in the Depressed Area soil samples. Analytical results showed low concentrations of dioxins and furans in all four of those samples. No explosives were detected.

Metals detected above background for soil and sediment samples were: arsenic, barium, cadmium, calcium, chromium, cobalt, copper, iron, lead, magnesium, manganese, mercury, nickel, selenium, and zinc. Sediment samples were compared to surface soil background values because no background values exist for sediment. However the comparison of sediment to soil background was not used to screen this data out of the risk assessment.

Metals detected above background for groundwater were: aluminum, calcium, chromium, iron, lead, magnesium, potassium, sodium, and vanadium. Surface water samples detected two metal (lead and nickel) that exceed Ohio water quality criteria for the protection of aquatic life.

5.0 Contaminant Fate and Transport

In previous sections, physical characteristics of the study area and distributions of contaminants in each medium were presented. In this section, that information is used to discuss the fate and transport of contaminants in each medium. The section consists of three parts:

- Potential routes of migration are discussed for each medium (Section 5.1), including an overview of potential source areas and a synopsis of possible exposure pathways. This discussion is expanded upon in Section 6.0.
- Contaminant persistence in soils, groundwater, surface water and sediment, is considered (Section 5.2). For each class of compounds, the general fate and transport characteristics of the relevant contaminants are summarized since their chemical and physical properties affect contaminant migration and fate.
- Contaminant migration is presented (Section 5.3) with an overview of factors affecting contaminant migration.

5.1 *Potential Routes of Migration*

This section delineates the potential routes of migration for contaminants both within the TAMPEEL area and from the TAMPEEL area. Potential migration pathways in the TAMPEEL area are considered for each of the four available media:

- Air emissions, specifically the dispersion of VOCs from soil and surface water bodies (Section 5.1.1).
- Soil, primarily the potential leaching of contaminants from soil to underlying groundwater and nearby surface water, and the potential erosion of surface soil into adjacent surface water (Section 5.1.2).
- Surface water and sediment, including transport of surface water and sediment downstream, and the potential transport of contaminants to groundwater via infiltration from surface water bodies (Section 5.1.3).
- Groundwater and potential transport of contaminants to surface water via discharge of groundwater to surface water (Section 5.1.4).

These pathways are considered in the discussion below, within each medium and among the different media. Although migration via direct contact or biouptake by plants and animals are also

potential pathways, these potential exposure scenarios are considered in Section 6.0 and are not discussed herein as they do not pertain to contaminant transport issues.

Primary and secondary sources of contaminants and release mechanisms for chemical migration are presented in Table 5-1. Primary sources and release mechanisms are noted for soil, surface water/sediment, and groundwater. Secondary sources are noted for potential migration from a primary source to a second primary source before potential exposures may occur. A potential exposure medium is noted for each pathway. VOCs, SVOCs, pesticides/PCBs, and metals detected in each media are presented in Tables 5-2, 5-3, 5-4, and 5-5, respectively.

5.1.1 Air Emissions

Volatile chemicals in near-surface soil and surface water have the potential for migration to the air by volatilization. Individual chemical rates of volatilization are a function of their vapor pressure, Henry's Law Constant, relative concentration in the two media, temperature, and other factors such as wind conditions. As discussed in more detail later in this section, VOCs, relative to other classes of chemicals, have a tendency to volatilize to the atmosphere because of their relatively high vapor pressures and air/water partitioning.

During the RI field investigation, a total of nine surface soil samples and one duplicate were collected from the Children's Activity Areas from a depth of 0 to 1 foot bgs. The soils were monitored with a PID during sampling. None of the PID readings from the Children's Activity Areas measured above 2 ppm. Background readings during the investigation were also in the range of 0 to 2 ppm. Laboratory analysis of the ten samples showed VOC detections in eight samples. In six of the eight samples, methylene chloride was the only VOC detected. The maximum methylene chloride detection in any sample was 39 µg/kg in sample SS191SO01. The maximum total VOC concentration in the nine samples was 49 µg/kg, also in sample SS191SO01.

Additionally, 20 soil borings were drilled around the anticipated perimeter of the landfill and sample intervals were determined by headspace screening using a PID. Headspace screening of the 0- to 2-foot depth interval samples indicated that concentrations of organic vapors were detected above 5 ppm in 2 of the 20 borings (SB143 at 7.4 ppm and SB144 at 8.4 ppm). Of the 20 soil borings, 12 of the samples and one duplicate were collected from the 0 to 2 foot interval. Of those 13 samples, VOCs were detected in 7 of the samples and the duplicate. The only VOCs detected in those samples and the associated maximum detections were acetone (680 µg/kg) and methylene

chloride (6.7 µg/kg). As follow up, to provide addition data to support a feasibility study, 21 additional surface soil samples were collected during the SRI activity.

Air monitoring was conducted at each boring location during soil boring and well installation work using a PID. No significant concentrations of organic vapors were detected during the field investigation program. Because of the generally low levels of air measurements at FLOD field area, the air emissions pathway is not considered further in this discussion of contaminant fate and transport. Since migration of contaminants via volatilization could occur under varying conditions and could be a potential pathway, potential exposure scenarios via volatilization and subsequent inhalation are considered in Chapter 6.0.

5.1.2 Soil

Potential contaminant AOCs in the vadose zone have been previously summarized (Section 4), and include:

- Landfill - In general, surface (0 to 2 feet) and subsurface soils contain the following: VOCs including methylene chloride and acetone. Arsenic, barium, and manganese were detected above background. No SVOCs were detected in any of the 20 soil borings. There are some locations with low concentrations of pesticides.
- Children's Activity Areas – as discussed previously, contain low concentrations of VOCs, contain SVOCs which were predominantly PAHs, low concentrations of pesticides and PCBs and also contain TAL metals which included arsenic, barium, calcium, chromium, copper, iron, lead, manganese, mercury, and zinc above the established background levels.
- Soil sample results for the Depressed Areas indicated that VOCs were present at low concentrations at all four sample locations. Low concentrations of dioxins and furans were also present in all four of the samples. No SVOCs, pesticides, or PCBs were detected. No metals were detected above background.
- A total of 21 surface soil samples were collected during the SRI. The new SVOC detected in a surface soil sample (SS21301) collected was butyl benzene phthalate. Two new VOCs were detected; ethylbenzene was detected in four surface soil samples and xylenes (total) were detected in nine samples. Three new metals were detected above background in samples: beryllium was detected in eight samples, cadmium was detected in SS20901 and sodium was detected in SS20601. The PCB Aroclor 1254 was detected in SS20601.

- During the SRI, only one subsurface soil sample was collected. One new metal, beryllium, was detected above background in the subsurface soil sample MW11602.

Contaminants found in surface and subsurface soils at the TAMPEEL area may be released to the environment by one of the following three potential pathways listed in Table 5-1:

Volatilization

As indicated in Section 5.1.1, volatilization from surface soils is discussed in Section 6.0.

Erosion and Surface Runoff

Contaminants could be transported by erosion of surficial materials during precipitation events to the creek adjacent to the landfill. During periods of extensive precipitation, eroded soil and runoff could also be expected to reach the Study Pond and Beaver Pond.

Leaching

The principal processes that control contaminant migration by leaching are sorption and solubility. Leaching of soil contaminants into groundwater can occur from any depth in the vadose zone.

5.1.3 Surface Water and Sediment

The primary surface water bodies and courses located near the landfill are discussed in Section 3.3. Surface water features include Aspen Creek, adjacent to the landfill, the Beaver and Study Ponds, and the TAMPEEL Spring. Surface water samples were collected from each of these areas. Sediment samples were collected from Aspen Creek, the Study and Beaver Ponds, and the spring. In general, contaminants found at the sampling locations include:

- Surface water samples from Aspen Creek and the TAMPEEL Spring had VOCs at low concentrations, no SVOC detections and no pesticide or PCB detections. Three metals, lead, nickel, and zinc, was detected in a surface water samples (Aspen Creek (Pb, Ni, and Zn) in excess of Ohio water quality criteria. Sediment samples from the creek and spring had low concentrations of VOCs. SVOCs and pesticides were also found in the sediment. Metals detected in the sediment above soil background included: barium, calcium, copper, lead, nickel, manganese, and nickel.
- Surface water sample results from the Study and Beaver ponds showed no detections of VOCs, SVOCs, pesticides or PCBs.

- VOCs were detected in three of the seven sediment samples collected from the Beaver and Study Ponds. Acetone was the only VOC found in the sediment samples, with a maximum concentration of 100 µg/kg. SVOCs were detected at low concentrations in one sediment sample (SD104 from the Study Pond). PCBs were not found in any of the pond sediment samples. No pesticides were detected in samples from the Beaver Pond or Study Pond. Metals detected above soil background in four of the Study Pond and Beaver Pond sediment samples, included barium, chromium, copper, lead, selenium, vanadium, and zinc.

Migration pathways from the surface water and sediment at TAMPEEL include:

- Volatilization from the surface water in each water body or watercourse.
- Transport of sediment within the creek adjacent to the landfill via surface water movement to Beaver Creek and possibly Duck Creek. Transport of sediment from TAMPEEL Spring is not apparent due to the low flow rate.

The low concentrations of VOCs found in surface water and sediments at FLOD do not support volatilization to air as a medium of exposure. Potential exposure scenarios via volatilization and subsequent inhalation are considered in Section 6.0. The potential fate and migration of the noted contaminants via the identified pathways is discussed in detail in Section 5.3.

5.1.4 Groundwater

Analysis of groundwater collected at TAMPEEL showed the presence of methylene chloride in one sample at low levels and a number of metals in excess of background. The distribution of contamination, as defined in Section 4.0 includes:

- The only detection in the groundwater wells at TAMPEEL was a methylene chloride detection of 1.7 ug/L in a groundwater sample collected from well MW113 in the sample collected April 21, 1999.
- Metals detected above background in at least one sample included aluminum, calcium, chromium, iron, lead, magnesium, manganese, potassium, sodium, thallium, vanadium, and zinc.

Potential pathways for migration of contaminants from groundwater are:

- Groundwater flow into surface water in Aspen Creek, the Study Pond, the Beaver Pond, and TAMPEEL Spring.

The potential fate and migration of contaminants via the identified pathways is discussed in detail in Section 5.3.

5.2 Contaminant Persistence and Mobility

Persistence is a measure of how long a given chemical will exist in a specific medium. Mobility describes the relative potential of a chemical to be transported in environmental media.

Contaminant persistence and mobility in environmental media is a function of physical and chemical properties of a given class of compounds, the specific chemicals within each class found in the environment, and properties of the media of concern (including tendencies of each class of compounds to transfer among available media).

Persistence and mobility of compounds detected above background in FLOD soil, groundwater, surface water, and sediment is discussed below by compound class. For purposes of this discussion, relevant classes of compounds are VOCs, SVOCs, inorganics, pesticides, PCBs, dioxins and furans.

5.2.1 Chemical and Physical Properties

The persistence, transport, and fate of chemicals in the environment depend on individual chemical and physical properties. Relevant physical and chemical properties for the VOCs, SVOCs, and pesticides/PCBs detected in the investigation areas are presented in Tables 5-6, 5-7, and 5-8, respectively. A brief discussion of the listed properties is provided in the following paragraphs, along with a description of the significance of each property to volatilization, sorption, diffusion, dispersion, biodegradation, and other attenuation processes.

Chemical and physical properties relevant to evaluation of transport and fate of organic compounds detected above background include water solubility, vapor pressure, Henry's Law Constant, specific gravity, organic carbon partition coefficient, Eh and pH, and half life. Water solubility and adsorption coefficient are also properties of interest for inorganic compounds detected above background. After each property is introduced, impact on each of the relevant classes of compounds is discussed.

Water Solubility

The solubility of a chemical in water is the maximum amount of the chemical that will dissolve in pure water at a specified temperature. Chemicals with high solubility are relatively mobile in

water and are likely to leach from wastes and soils. When dissolved in water, these chemicals tend to have low volatilization potential and are generally biodegradable. Conversely, chemicals with low solubility tend to adsorb on soils and sediments and are not readily biodegraded. They also have a greater tendency to volatilize (see vapor pressure and Henry's Law discussions).

Vapor Pressure

Vapor pressure is a measure of the tendency of a substance to pass from a solid or a liquid to a vapor state. It is measured as the pressure of the gas in equilibrium with the pure liquid or solid at a given temperature. From dry soils, the vapor pressure indicates the volatilization potential of a given chemical to the atmosphere. From surface waters and moist soils, volatilization is dependent on vapor pressure and the Henry's Law Constant (see discussion below). A chemical with a vapor pressure less than 10^{-6} millimeters of mercury (mm Hg) tends to associate with particulate matter; a chemical with a higher vapor pressure tends to associate with the vapor phase. Highly water-soluble compounds generally show little volatilization from water or moist soils unless they also have a high vapor pressure.

Henry's Law Constant

The Henry's Law Constant describes a linear relation between vapor pressure and water solubility, providing a measure of a chemical's ability to move from water or moist soils to air. Compounds with Henry's Law Constants greater than 10^{-3} atmospheres-cubic meter per mole ($\text{atm}\cdot\text{m}^3/\text{mole}$) can be expected to readily volatilize from water. Compounds with values ranging from 10^{-3} to 10^{-5} $\text{atm}\cdot\text{m}^3/\text{mole}$ exhibit moderate volatilization. Compounds with values less than 10^{-5} $\text{atm}\cdot\text{m}^3/\text{mole}$ show limited ability to volatilize from water or moist soils.

Specific Gravity

The specific gravity of a substance is defined as the ratio of the weight of a given volume of that substance to the weight of the same volume of water. The water weight is usually measured at 4°C ; the other substance is often measured at some other temperature, typically 20°C . If the specific gravity of a substance is less than 1.0, that substance will float on water; if specific gravity is greater than 1.0, the substance will sink in water. The specific gravity can sometimes be used to predict the vertical distribution of the immiscible or insoluble portion of a chemical within an aquifer or other body of water.

Organic Carbon Adsorption Coefficient

The organic carbon adsorption coefficient (K_{oc}) is a measure of the degree to which an organic substance will preferentially dissolve in water or adsorb to organic carbon in soil or sediment. The typical range of K_{oc} values is from 1 to 10^7 milliliters per gram (mL/g), with higher values indicating a greater tendency to remain sorbed. Organic chemicals moving through the subsurface will alternately adsorb or desorb from available organic matter in soil matrix. The higher the K_{oc} values, the greater the tendency of a chemical to be attracted to the organic fraction of the soil and the lower its mobility in the subsurface environment.

Distribution Coefficient

The distribution coefficient, K_d , is a measure of the concentration of a chemical sorbed onto a solid relative to the concentration of the same chemical in the associated liquid phase. The K_d is the slope of a linear sorption isotherm relating the concentrations in the two media. The larger the K_d , the greater sorption to the solid phase and the less in solution for a given solute. As with K_{oc} , the distribution coefficient measures the relative mobility of a chemical in the environment; a larger K_d corresponds to a lower mobility. A K_d value may be estimated from the K_{oc} of the chemical in question and the fraction of organic carbon in the soil.

Eh and pH

Eh is referred to as the redox potential and is a measure of the oxidizing potential of water. Elevated Eh levels tend to facilitate dissolution of inorganic compounds. Additionally, the presence of oxidizing or reducing conditions will influence the microorganism population in the subsurface; which will affect the processes and rates governing biodegradation of organic compounds. The effects of Eh on biodegradation are compound, media, and site specific. The parameter pH is a measure of the hydrogen ion activity in water. Values of pH below the neutral value of 7 indicate acidic conditions. Water with low pH values would promote dissolution of inorganic compounds.

Half-Life

A half-life is the time required for the concentration of a substance to decrease from its initial level to one-half its initial level. Various processes including biodegradation, reactions with other substances, or mass removal from the media in question may cause the apparent decrease. The half-life values listed in Tables 5-6 and 5-7 are empirical and are presented as estimated ranges for groundwater. The conditions under which the half-life ranges shown in Tables 5-6

and 5-7 were determined may not be representative of conditions in the subsurface at FLOD. Additional discussion of half-life of chlorinated VOCs is presented below.

5.2.2 Volatile Organic Compounds

Relative to other organic compounds, VOCs can be expected to be mobile in the environment, with potential to volatilize to the atmosphere, leach to groundwater, and to move with surface water and groundwater. VOCs have relatively low molecular weight and high water solubility, vapor pressure, and Henry's Law Constant, along with a corresponding low K_{oc} . These properties all enhance the potential for degradability of VOCs. Many VOCs also tend to have relatively short half-lives in groundwater and surface water, on the order of days to months.

VOCs have a limited tendency to adsorb to solids and can be expected to be moderately to highly mobile in the environment. Especially in near surface soils, VOCs can migrate via diffusion through soil-air pore spaces to the ground surface, where they can be transported by wind.

VOCs were found in soil, surface water, sediment, and groundwater at FLOD. VOCs detected at FLOD are listed in Table 5-2. These compounds fall into four general VOC classes: aromatic hydrocarbons, halogenated hydrocarbons, ketones, and others. The relevant physical and chemical properties of each of these general VOC classes is discussed below.

Halogenated Hydrocarbons

Halogenated hydrocarbons detected during this investigation include, acetone, 2-butanone, 1,1-dichloroethene, ethylbenzene, methylene chloride, toluene, 1,1,1-trichloroethane, and xylene. Many of these compounds are used in industrial settings as solvents or as raw products in manufacturing. All are liquids at standard temperature and pressure (STP). A summary of the physical and chemical properties of these hydrocarbons is provided in Table 5-6.

Relative to the other aromatic hydrocarbons, the halogenated hydrocarbons have high solubilities and little tendency to partition onto organic carbon or other soil solids. They have relatively high vapor pressures and high Henry's Law Constants. Therefore, volatilization from soils, groundwater, and surface water is a significant mobility process for most halogenated hydrocarbons. The high specific gravity of these compounds causes them to tend to sink when present as a phase-separate liquid.

Halogenated hydrocarbons are subject to degradation under both aerobic and anaerobic conditions. Under aerobic conditions, a cometabolite such as methane, propane, toluene or cresol is required to induce the degradation. Most halogenated hydrocarbons are, however, highly oxidized compounds and are resistant to degradation by this mechanism. In general, more reduced daughter products (dichlorinated and single chloride compounds) are easier to degrade under aerobic conditions than the trichlorinated and tetrachlorinated compounds (Murray, 1993).

Halogenated compounds can also be degraded under anaerobic conditions. There are several mechanisms involved, including reductive dehalogenation and dehydrohalogenation (Sims, 1990). Reduction of halogenated hydrocarbons via biological mediated reductive dehalogenation generally requires the presence of a methanogenic (bacteria that produce methane), sulfate reducing, or nitrate reducing bacterial population. This type of bacterial population is encouraged by the presence of an anaerobic environment with a low or negative Eh. Because the bacterial population involved in this process does not typically use halogenated hydrocarbons as a carbon or energy sources, degradation is more rapid if a substrate such as acetate, formate, glucose or methanol is provided (Freedman, 1989).

The presence of transition metal complexes (iron, cobalt, nickel) can act as catalyst in the biodegradation of halogenated hydrocarbons as these complexes serve as electron donors during the reduction process. The use of transition metals alone can also induce abiotic (non-biological) reductive dehalogenation.

The classic reductive halogenated hydrocarbon degradation pathway is provided in Figure 5-1 (Dragun, 1988). This pathway follows the reduction from the most halogenated compounds (1,1,1-TCA and PCE) to chloroethane. In general, PCE can undergo reductive dehalogenation and form TCE. Dehalogenation of TCE can form 1,1-DCE and/or the cis- and trans-1,2-DCE isomers. TCE can undergo reductive dehalogenation and form 1,1-DCE and the cis- and trans-1,2-DCE isomers. These three compounds can also undergo reductive dehalogenation and form vinyl chloride; or the carbon-carbon double bond can be reduced to form 1,1-DCA and 1,2-DCA, respectively. 1,1-DCA and 1,2-DCA can undergo reductive dehalogenation and form chloroethane, or dehydrohalogenation and form vinyl chloride. Vinyl chloride can undergo reductive dehalogenation and form ethylene, or the carbon-carbon double bond in vinyl chloride can be reduced to form chloromethane.

In general, the greater the degree of halogenation, the greater the likelihood that a compound will be reduced, rather than oxidized and vice versa. The complete reduction of PCE and TCE to ethylene, which requires the reductive dehalogenation of vinyl chloride to ethylene, is fairly uncommon in natural settings.

Aromatic Hydrocarbons

Aromatic hydrocarbons detected during this investigation were benzene and xylenes.

Discussions of the persistence and mobility of these follow.

Benzene and xylenes are used extensively in chemical manufacturing, and are found in percent concentrations in gasolines. Benzene and xylene have solubilities of 1,750 mg/l and 198 mg/L respectively (Table 5-6). Relative to other VOC classes, they have relatively low vapor pressures and high affinity to partition onto soils. Based on these properties, they are typically less mobile than halogenated hydrocarbons or ketones.

Because of the relatively simple molecular structure of these compounds, they are relatively easily degraded in an aerobic environment. Published BTEX half-lives are typically short, in the range of 10 to 720 days (Table 5-6). Although degradation under anaerobic conditions can occur, degradation under aerobic conditions is much more prevalent.

Ketones

The only ketone detected during this investigation was acetone. Ketones are used as high quality solvents and as carriers in chemical manufacturing. They have relatively high vapor pressures and tend to volatilize quickly at standard temperature and pressure. Ketones are very highly soluble (acetone is miscible) and have relatively low Henry's Law Constants. Because of these properties, once dissolved they tend not to volatilize easily. They have very low partitioning coefficients and tend to be very mobile in groundwater. Relative to halogenated organics, ketones are amenable to biologic and abiotic decay.

5.2.2.1 Soil

Five VOCs were detected in the soil samples collected at TAMPEEL during the RI. Soil sampling at TAMPEEL included 20 soil borings around the landfill and nine surface soil samples in the Children's Activity Areas. Two of the VOCs were halogenated hydrocarbons, two were

ketones (acetone and 2-butanone), and one was an aromatic compound (toluene). Only one VOC (acetone) was detected in subsurface soil samples collected during the RI.

During the SRI, a total of 21 surface soil samples were collected. Two new VOCs were detected, ethylbenzene was detected in four surface soil samples and xylenes (total) were detected in eight samples. No VOCs were detected in the one subsurface sample collected during the SRI. A summary of the VOCs detected in soil samples from TAMPEEL is provided in Table 5-2.

Migration of VOCs from soils is typically limited to volatilization to the atmosphere and leaching to groundwater. The high vapor pressure of many VOCs detected at TAMPEEL would cause near-surface VOCs in soils to vaporize quickly. VOCs in deeper soils would be less likely to vaporize. The relatively high solubility of VOCs would cause them to readily leach to water percolating through the unsaturated zone. The rate of leaching is likely limited by the rate of recharge through the low permeability tills.

Additionally, four soil samples were collected from the Depressed Areas and acetone, 2-butanone, and toluene were detected in the depressed area samples.

5.2.2.2 Surface Water and Sediment

A total of ten surface water samples and ten sediment were collected from the TAMPEEL area. Two surface water and two sediment samples were collected from Aspen Creek, three surface water and three sediment samples were collected from the Study Pond, and four surface water and four sediment samples were collected from the Beaver Pond. Only cis-1,2-dichloro-ethene and methylene chloride were detected in surface water samples collected from Aspen Creek. No VOCs were detected at the Study Pond or the Beaver Pond surface water samples. Three VOCs (acetone, carbon disulfide, and methylene chloride) were detected in sediment samples collected during the RI.

During the SI, two sediment samples were collected from Beaver Creek. Acetone (36 µg/L) was the only VOC detected.

During the SRI, a total of five surface water samples were collected. No new VOCs were detected in surface water. A total of six sediment samples were collected, only three new VOCs were detected: 2-butanone - SD20201 and SD20301, toluene was detected in SD 20151

(duplicate) but not in the original sample SD20101 and cis-1,2-dichloroethene was detected in SD20101 and SD20201.

VOCs in surface water and sediments can come either from topographically upgradient in a flowing surface water body, from soil erosion occurring up gradient of the surface water body, or from inflow of groundwater where the water table intersects the ground surface.

One likely source of the VOC detected in the TAMPEEL surface water and sediments is from soil erosion occurring upgradient of the surface water body. Although the concentrations of VOCs in TAMPEEL are low, they are likely to persist if their source is from contaminated soils, since an ongoing flux of the contaminant will be available. Another source of the VOC detected in the TAMPEEL surface water is groundwater discharge from upgradient contamination sources which could also prove to be persistent.

5.2.2.3 Groundwater

One VOCs was detected (methylene chloride) in groundwater in samples collected during RI activity.

During the SRI, a total of five groundwater samples were collected and there were no VOC compounds were detected. A summary of the VOCs detected in groundwater at FLOD is provided in Table 5-2.

Degradation and migration of contaminants primarily govern the persistence of primary VOC contaminants in groundwater at FLOD. The extent of contaminant migration via groundwater to the tributary is unknown. The presence of several daughter products from reduction of PCE and TCE (TCE, cis- and trans-1,2-DCE, and vinyl chloride) indicate that some degradation of higher end halogenated hydrocarbons may have occurred, although these daughter products can be present as contaminants in the PCE or TCE solvent.

Sufficient data are not available at FLOD to predict the site-specific half-life of VOCs in groundwater. Table 5-6 lists the various ranges of half-lives found in literature for site-related VOCs. Based on these half-life ranges and the concentrations of most VOCs detected at the FLOD, most VOCs detected at FLOD would persist in groundwater for over ten years using

average half-life values. A continued source of VOCs (i.e., leaching from soils) could extend their persistence in groundwater.

5.2.3 Semivolatile Organic Compounds

SVOCs are of generally larger molecular weight and, as the name implies, less volatile compounds (with respect to VOCs). Because of their lower solubilities, vapor pressures, and Henry's Law Constants, the mobility of SVOCs is generally poor and they tend to adsorb to solids within the environment. The preferential mode of transport is through suspension with the solids to which they are adsorbed rather than dissolution into the aqueous media. These characteristics tend toward low mobility and moderate to extensive persistence within the environment.

SVOCs were generally determined by SW-846 Method 8270, which provides two fractions (classes) of SVOCs: acids (phenol and substituted phenolic compounds) and base/neutrals. The detected compounds present were of the base/neutral fraction. The base/neutral compounds detected consist of four major categories: PAHs, phthalates (bis(2-ethylhexyl)phthalate), chlorinated hydrocarbons and general SVOCs. Table 5-3 lists the SVOCs detected at during this investigation for each media. Table 5-7 presents a summary of their physical and chemical properties.

SVOCs were detected in surface soils, and sediment. Of the detected SVOCs, the majority belong to the PAH group (Table 5-3). The remaining groups of SVOCs only had two or three compounds detected.

In general, PAHs are associated with the combustion of fuels (coal/petroleum/wood), runoff or leaching from asphalt-bitumen, or separation from coal-tar products (Kirk-Othmer). PAHs as a class portray low solubility in water and therefore tend not to leach from solids to which they are adsorbed. The higher the carbon content of the soil, the stronger the affinity to the soil. The persistence of PAHs in the environment is enhanced by their low volatility in part due to the high molecular weight. Generally, only the PAHs anthracene, naphthalene, benzo(a)anthracene, and benz(a)pyrene are considered to be found in asphalt or bitumen products. The remaining PAHs, in addition to the previously mentioned compounds, are present within the exhaust condensate of engines and combustion products of coal, wood, etc., (Handbook of Environmental Data on Organic Chemicals).

The phthalates (dicarboxylic acid esters) are generally more soluble than the PAHs and are somewhat ubiquitous within the natural environment due to their use in the manufacture of plastics. Bis (2-ethylhexyl)phthalate (BEHP) is used in the manufacture of plastics to maintain softness and flexibility. Plasticizers, such as BEHP and the other phthalates, do not become a permanent part of the plastic and can find their way in the air, water, and soil. Although not very soluble in water, they are highly soluble in fats.

The chlorinated SVOCs group exhibit moderate solubility's in water and vapor pressures and Henry's Law Constants, which indicate greater association with the vapor phase, thus comparatively, higher volatilities.

The General SVOC category consists of compounds that are more soluble and possess higher vapor pressures than compounds from the three preceding categories. These characteristics tend to allow more avenues of mobility through both dissolution and volatilization (moderate Henry's Law Constants).

5.2.3.1 Soil

SVOCs detected in the surface soil samples collected at TAMPEEL were almost entirely PAHs. PAHs were present in almost all surface samples collected.

SVOCs were not detected in the 20 soil samples collected from the perimeter of the landfill. Samples collected in the soil borings ranged from two feet to nine feet below ground surface.

During the SRI, 21 surface and one subsurface soil sample was collected. The new SVOC detected in a surface soil sample (SS21301) collected was butyl benzyl phthalate. No new SVOCs were detected in the subsurface soil sample.

5.2.3.2 Surface Water

SVOCs were not detected in the ten surface water samples collected from Aspen Creek, the TAMPEEL Spring, the Study Pond, or the Beaver Pond. No SVOCs were detected in the samples collected during the SRI.

5.2.3.3 Sediments

SVOCs were detected in three of the ten sediment samples collected at TAMPEEL. All three of the detections were PAHs. Fluoranthene and pyrene were detected in one Study Pond sample at 480 µg/kg and 450 µg/kg, respectively. Benzo(b)fluoranthene, fluoranthene and pyrene were detected in one Aspen Creek sample at 56, 67, and 57 µg/kg, respectively. PAHs were not detected in sediment samples collected from the Beaver Pond.

During the OCC RI, the only SVOCs detected in the sediment sample from TAMPEEL Spring were PAHs and phthalates. PAHs were also detected in the SI sediment sampling location in Beaver Creek, upgradient of the Burn Area. This location is adjacent to the railroad tracks and may have been impacted by railroad activities. PAHs were not detected in the downgradient sample.

During the SRI sampling, SVOCs were only detected in samples from SD201 (duplicate) and SD205. Detected SVOCs consisted solely of PAHs. Total SVOC concentrations in samples ranged from 3,130 µg/kg to 9,770 µg/kg.

5.2.3.4 Groundwater

During the RI, no SVOCs were detected in groundwater samples collected from MW112, MW113, MW114, and MW115

During the SRI, no SVOCs were quantified above analytical detection limits in the samples collected from MW112, MW113, MW114, MW115 and MW116.

5.2.4 Chlorinated Pesticides and PCBs

Chlorinated pesticides were the principal class of pesticides determined by Method 8080 in SW-846 during the analytical program at TAMPEEL. The complete list of pesticides detected in each media during this program is found in Table 5-4. The only PCB detected in any media during this investigation was Aroclor 1260. Table 5-8 presents a summary of selected physical and chemical properties. As a group, pesticides are intended to kill insects, plants, weeds, molds, and rodents. DDT and other chlorinated hydrocarbons like lindane (gamma-BHC), aldrin/dieldrin, and heptachlor have gained notoriety because of their persistence in the environment, their tendency to accumulate in living tissue, and their adverse effects upon non-target species. Their

chemical stability prevents their breakdown within the environment and promotes accumulation within animal or plant tissue.

DDT is nearly immobile in soils and the hydrophobic nature of the molecule results in evaporation with water at a much greater rate than its vapor pressure would predict. DDT persistence in soils and sediments extends years after application. Microbial metabolism and photodecomposition can cause degradation of DDT. However, the processes are poorly understood. Dehydrohalogenation to DDE can be accomplished by resistant strains of insects and catalytically by iron. Pesticides were not detected in groundwater or surface water samples. DDE and DDT were detected in surface soils and in sediments.

Generally, the pesticides at TAMPEEL are of low water solubility. These compounds exhibit low to moderate volatilization according to the Henry's Law constants. Additionally, DDE and DDT report vapor pressures of 10^{-6} mm Hg, indicative of the tendency to associate with particulate matter.

5.2.5 Dioxins Furans

In soil, sediment, water columns, and probably air, dioxins/furans are primarily associated with particulate and organic matter because of their high lipophilicity and low water solubility. They exhibit little potential for significant leaching or volatilization once sorbed to particulate matter. Available evidence indicates that dioxins/furans, particularly the tetra- and higher chlorinated congeners, are extremely stable compounds under most environmental conditions, with environmental persistence measured in decades. The only environmentally significant transformation process for these congeners is believed to be photodegradation of chemicals not bound to particles in the gaseous phase or at the soil- water- air interface. Dioxins/Furans samples were collected in the four depressed areas samples. Dioxins/furans were detected in each sample collected. However, due to the surface soil being contained within a depressed area the mobility of those constituents will be limited.

5.2.6 Metals

Unlike organic compounds, inorganic chemicals do not degrade in the environment, but they may change chemical form or speciation. They are generally considered to be indefinitely persistent. Dissolved inorganic metals in groundwater may interact with soil or other solids through sorption processes (i.e., ion-exchange, adsorption, and precipitation), through complexation, and can act

as catalysts in biodegradation processes. These physical and chemical processes are sensitive to pH, groundwater composition, reduction-oxidation (redox) conditions, and the type and amount of organic matter, clay minerals, and oxyhydroxide minerals. In general, the solubility of metal compounds (amorphous solids or minerals) in potable groundwater is low (e.g., oxide and hydroxide minerals) to moderate. Table 5-5 presents a list of metals detected above background at TAMPEEL for each media. Since there were not sediment or surface water background samples, the results were screened against surface soil and groundwater background values in Section 4.0, but only for the purposes of providing points of reference. In the risk assessment (Section 6.0), these background values are not used to define COPCs in surface water and sediment. However, all detections in the sediment and surface water are carried through to the risk assessment and all the metals are discussed below.

Given the limited solubility of most metals under ambient conditions and their affinity for ion-exchange and adsorption reactions, most metal compounds have low mobility in the environment. However, groundwater containing elevated levels of chloride, bicarbonate, sulfate, or phosphate can enhance the solubility and mobility of metal compounds by the formation of aqueous complexes (e.g., PbCl^+ , MnSO_4^0 , etc). Additionally, extreme pH and Eh (i.e., the redox potential) conditions can significantly increase the solubility and mobility of metals in the environment. Therefore, the quantity of the metal in the source, metal compound solubilities, the composition of groundwater, and the adsorption capacity of the soils determine the migration potential of the metal element in the environment. Relevant physical and chemical properties of the site-related inorganics and their persistence in the environment are discussed below.

Additional information can be found in *Eh -pH Diagrams for Geochemistry* (Brookins, 1988).

Aluminum (Al) is an abundant, naturally occurring element that is found in hundreds of aluminosilicate and oxyhydroxide minerals. It is the most abundant metal in the earth's crust, but is never found in the native state as Al metal. Bauxite, an impure oxide ore of Al, is the chief commercial deposit exploited for Al, with the pure metal recovered by electrolysis. Aluminum is extensively used for kitchen utensils, building materials, in the canning industry, and in thousands of industrial applications where a strong, light, easily constructed material is needed. Pure aluminum is soft and lacks strength, but it is alloyed with small amounts of copper, magnesium, silicon, manganese, and other elements to impart useful properties of vital importance in the construction of aircraft and rockets. Aluminum has excellent corrosion resistance, due to the formation of a nearly insoluble thin protective oxide layer on the metal.

In the natural environment, Al is not redox sensitive, as it exists solely in the +3 valence state. The concentration of dissolved Al in most surface and ground waters (i.e., pH of 4 to 10) is commonly on the order of parts per billion (ppb) or less. Dissolved Al concentrations on the order of ppb or less are generally controlled by the dissolution of aluminosilicate minerals (mainly clay minerals) and/or the precipitation of $\text{Al}(\text{OH})_3$ (gibbsite), whereas Al concentrations above about 10 ppb generally indicate the presence of colloidal Al species. Under acidic conditions (pH less than 4), Al is solubilized as the Al^{+3} or $\text{Al}(\text{OH})_2^+$ ions, while above pH 10 it is mobilized by the formation of the AlO_2^- species. In general, Al has very limited mobility under the near neutral pH conditions of potable groundwater.

Arsenic (As) is a naturally occurring element that forms several common minerals. The metal is sometimes found in its elemental form, which is either a yellow or metallic-gray modification. It is also found in sulfides such as realgar (AsS) and orpiment (As_2S_3), as the oxide, arsenates and arsenides, and sulfoarsenides of heavy metals. Arsenopyrite (FeAsS) is the most ubiquitous mineral found in nature, and upon heating, sublimes to ferrous sulfide. Arsenic is used in agricultural insecticides, poisoning agents, pyrotechny, bronzing and for hardening and rounding lead shot. High purity arsenic is also used as a doping agent in solid-state devices such as transistors. Arsenic is released to the environment through the burning of coal and the smelting of ores. Arsenic and its compounds are highly toxic.

Arsenic is a multivalent element with -3, 0, +3 and +5 valence states. In natural groundwater, however, arsenic exists in the +3 and +5 oxidation states and forms a variety of species. The As(V) species H_3AsO_4^0 , H_2AsO_4^- , HAsO_4^{2-} , and AsO_4^{3-} dominate in oxidizing conditions. The As(III) species H_3AsO_3^0 , H_2AsO_3^- , HAsO_3^{2-} , and AsO_3^{3-} dominate under strongly reducing conditions. At neutral pH, in the presence of sulfur, the oxidation of As(III) to As(V) occurs at Eh values above about -110 millivolts (mV). Arsenic species are generally present in the aqueous environment in low concentrations (a few ppb), and correlate strongly with iron, which scavenges most of the available arsenic in the system. Under oxidizing conditions, the neutral and negatively charged As(V) species are quite mobile. Arsenic complexes have a strong affinity for iron/manganese oxyhydroxide minerals. Arsenic is also attenuated in groundwater through coprecipitation and scavenging by metal sulfides.

Barium (Ba) is a naturally occurring element that exists chiefly in the sulfate (barite) or carbonate (witherite) form. It is ubiquitous trace element in carbonate rocks and Portland cement, substituting for calcium in the calcite and lime mineral structures. Barite is used in paint, X-ray imaging work, glassmaking, and extensively as a weighting agent in oil well drilling muds. Witherite has found some commercial application as a rat poison.

Barium is not redox sensitive in the natural environment, and it occurs only in the +2 valence state. The concentration of dissolved Ba in surface and ground waters is generally kept below 100 ppb, and is controlled by the solubility of barite and adsorption of the Ba^{2+} ion on clay mineral surfaces. The formation of witherite ($BaCO_3$) becomes important above a pH of 10, and Ba can be mobilized as the Ba^{2+} ion below a pH of about 2. Barium does not form strong aqueous complexes with bicarbonate, sulfate, nitrate, or phosphate ions. This characteristic, along with the low solubility of barite and high adsorption affinity of Ba^{2+} , results in limited mobility of Ba under the near neutral pH conditions of potable groundwater.

Cadmium (Cd) is a naturally occurring element that most often occurs in trace quantities with zinc ores, such as sphalerite (ZnS). Almost all Cd is recovered as a by-product during the processing of zinc, copper, and lead ores. Cadmium is used most extensively in the electroplating industry, and also finds use in solder, batteries, and as a barrier to control fission reactions. Silver solder contains Cd, and workers using this material must exercise caution to avoid exposure to dangerous fumes. Cadmium and solutions of its compounds (e.g., $CdSO_4$) are toxic.

Cadmium is not redox sensitive in the natural environment, and it occurs only in the +2 valence state. The concentration of dissolved Cd in surface and ground waters is generally kept below 10 ppb, and is controlled by the substitution of Cd for zinc and/or lead in carbonate and sulfide minerals and by the adsorption of the Cd^{2+} ion on clay mineral surfaces. Under oxidizing conditions, the formation of otavite ($CdCO_3$) is possible above a pH of 8 and $Cd(OH)_2$ above a pH of 11. In the presence of sulfide (reducing conditions), greenockite (CdS) may form. However, the substitution of Cd for zinc and/or lead in carbonate and sulfide minerals generally prevents the formation of pure otavite or greenockite. Cadmium does not form strong aqueous complexes with bicarbonate, sulfate, nitrate, or phosphate ions. This characteristic, along with the partitioning of Cd into zinc and lead minerals and the high adsorption affinity of Cd^{2+} , results in limited mobility of Cd under the near neutral pH conditions of potable groundwater.

Calcium (Ca) is the fifth most abundant metal in the earth's crust. It is an essential constituent for plant and animal life forms and is found in leaves, bones, teeth, and shells. The pure metal is never found in nature, as Ca readily combines with carbonate, sulfate, fluoride, or phosphate to form calcite (CaCO_3), gypsum ($\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$), fluorite (CaF_2), or apatite ($\text{Ca}_5[\text{PO}_4]_3\text{F}$, $\text{Ca}_5[\text{PO}_4]_3\text{Cl}$, or $\text{Ca}_5[\text{PO}_4]_3\text{OH}$). At higher temperature, Ca combines with aluminum and silicon to form hundreds of minerals (e.g., pyroxene, feldspar, and clay phases). Calcium finds wide use and application as lime (CaO) and Portland cement.

Calcium exists solely in the +2 valence state in nature. The ubiquitous distribution of Ca in limestone, shale, and granite ensures that Ca will be present in groundwater. The solubility of limestone in water containing carbon dioxide (e.g., rain) creates distinct groundwater compositions that can be identified by their pH (near neutral) and elevated Ca and carbonate concentrations (i.e., FLOD groundwater's). Once in solution, the Ca^{2+} ion is the most important aqueous specie, with carbonate and sulfate complexes forming in the presence of these ligands.

Chromium, Total (Cr) is a naturally occurring element that mainly occurs in the oxide state, principally as chromite (FeCr_2O_4). Chromium metal is usually produced by reducing the oxide with aluminum. Chromium is used in the manufacturing of stainless steel and other alloys, and as a catalyst in many chemical processes. All chromium compounds are colored; the most important being sodium chromate (Na_2CrO_4) and potassium chromate (K_2CrO_4), the dichromates (e.g., $\text{K}_2\text{Cr}_2\text{O}_7$), and the chrome alums (e.g., $\text{KCr}(\text{SO}_4)_2 \cdot 12\text{H}_2\text{O}$). Dichromates are used as oxidizing agents in quantitative analysis and in the tanning industry.

Chromium exists in the +3 and +6 valence states in nature. The oxidation of Cr (III) to Cr (VI) occurs at Eh values above 500 mV at a pH of approximately 7. Cr (III) forms sparingly soluble oxide and hydroxide minerals under moderate to low redox conditions over the pH interval of 5 to 12. However, Cr (VI) is quite mobile under oxidizing conditions, primarily as the CrO_4^{2-} specie above a pH of 6, and Cr(VI) species are known carcinogens. Negatively-charged chromium complexes (e.g., CrO_4^{2-} , CrO_2^-) can effectively adsorb onto iron and manganese oxyhydroxide minerals.

Copper (Cu) is a naturally occurring element that can occur in native form, but is chiefly found and extracted from cuprite (Cu_2O), malachite ($\text{Cu}_2\text{CO}_3[\text{OH}]_2$), azurite ($\text{Cu}_3[\text{CO}_3]_2[\text{OH}]_2$), chalcopyrite (CuFeS_2), and bornite (Cu_5FeS_4). The discovery of Cu dates back to prehistoric

times, and it remains one of our most important metals. Copper is obtained by smelting, leaching, and electrolysis. The most important application of the metal is in the electrical industry, with numerous other applications employed for its alloys, brass and bronze.

Copper may exist in nature with a valence of 0, +1, or +2. Under reducing conditions, native Cu is the stable form in the absence of sulfide, with Cu sulfide minerals becoming important as sulfur is added to the system. Above neutral pH and under oxidizing conditions, native copper and Cu sulfides are oxidized to cuprite and, at high Eh, tenorite (CuO). In the presence of carbonate and above a pH of 7, malachite and azurite are the stable Cu minerals. Below a pH of 6 and under oxidizing conditions, Cu minerals oxidize to form cupric ion (Cu^{2+}) and hydroxide species. In carbonate groundwaters, Cu carbonate species will be the dominant aqueous form.

Iron (Fe) is the fourth most abundant metal, by weight, in the earth's crust, and it is the most abundant, useful, and important metal. It is a vital constituent of plant and animal life, the most notable component being hemoglobin. The most common ore is hematite (Fe_2O_3), which is reduced with carbon to produce the metal. Iron is also found widely distributed in minerals such as magnetite (Fe_3O_4), goethite (FeOOH), hydroxide phases (e.g., $\text{Fe}[\text{OH}]_3$), siderite (FeCO_3), and pyrite (FeS). Nearly all Fe is used to produce carbon steel and special alloy steels that contain nickel, chromium, vanadium, and tungsten.

Iron occurs in the +2 and +3 valence states under ambient conditions. Under reducing conditions and below a pH of 8, Fe can be mobilized as the Fe^{2+} specie in the absence of carbonate. Addition of carbonate to the system results in the stabilization of siderite between a pH of about 5 and 9. Under oxidizing conditions, $\text{Fe}(\text{OH})_3$ is stable above a pH of 4 and dissolved Fe concentrations are driven very low (e.g., 50 ppb or less) as the pH rises above 7. In the presence of oxygen, precipitation of $\text{Fe}(\text{OH})_3$ is followed by aging of the hydroxide to goethite and eventually hematite (although the kinetics for this aging are very slow under ambient temperature). Dissolved Fe readily complexes with hydroxide, carbonate, and chloride ions when available.

Lead (Pb) is a naturally occurring element that rarely occurs in elemental form. Lead is obtained chiefly from galena (PbS) through roasting. Other common minerals that contain lead in appreciable quantities are anglesite (PbSO_4), cerrusite (PbCO_3) and minim (Pb_3O_4). Lead is a poor conductor, is a bluish-white metal of bright luster, is very resistant to corrosion, and is very soft, malleable, and ductile. The metal is used as a shield against radiation and sound vibration

and in a variety of manufacturing processes, which includes the production of plumbing pipes, ammunition, and cable coverings. Lead has been introduced into the environment in large quantities through prior use of leaded gasoline, and Pb arsenide salts have been used in insecticides in the past. As Pb is cumulative toxin, it is of significant environmental concern.

Lead is a multivalent element with 0, +2 and +4 valence states. In natural environments, lead exists primarily as Pb (II) and rarely as native lead. Pb (IV) only exists in extremely oxidizing conditions generally not found in the environment. The dominant aqueous species are Pb^{2+} under acidic conditions, and Pb^{2+} -carbonate complexes under alkaline conditions. When chloride ion is present in appreciable concentration (e.g., 100 ppm or greater), Pb chloride complexes become important. Cerrusite and anglesite are the solubility controlling phases in carbonate systems containing sulfur (e.g., FLOD groundwaters). At a pH of approximately 7 and in the presence of carbonate, Pb concentrations in natural groundwater are typically below 30 $\mu\text{g/L}$. Both adsorption/desorption and ion-exchange reactions also serve to lower aqueous Pb concentrations.

Magnesium (Mg) is the eighth most abundant metal in the earth's crust. It is an essential constituent for plant and animal life. The pure metal is never found in nature, as Mg readily combines with carbonate and sulfate to form dolomite ($\text{MgCa}[\text{CO}_3]_2$), magnesite (MgCO_3), kieserite ($\text{MgSO}_4 \cdot \text{H}_2\text{O}$), and epsomite ($\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$). At higher temperature, Mg combines with aluminum and silicon to form hundreds of minerals (e.g., pyroxenes, zeolites, and clay phases). Magnesium is used in flashlight photography, flares, pyrotechnics, and aluminum alloys. Its hydroxide, chloride, sulfate, and citrate compounds are used in medicine.

Magnesium exists solely in the +2 valence state in nature. The ubiquitous distribution of Mg in dolomite, shale, metamorphic, and igneous rocks ensures that Mg will be present in groundwater. The solubility of dolomite in water containing carbon dioxide (e.g., rain) creates distinct groundwater compositions that can be identified by their pH (near neutral) and elevated Mg and carbonate concentrations (i.e., FLOD groundwaters). Once in solution, the Mg^{2+} ion is the most important aqueous specie, with carbonate and sulfate complexes forming in the presence of these ligands.

Manganese (Mn) is a ubiquitous naturally occurring element that is an essential nutrient in animals for utilization of vitamin B₁. It is found in a variety of minerals including oxides, sulfides, silicate and carbonates, with pyrolusite (MnO_2) and rhodochrosite (MnCO_3) being the

most common Mn-bearing minerals. Manganese substitutes for iron, magnesium, and calcium in mineral structures. The metal is obtained by electrolysis, or by reduction of the oxide in the presence of sodium, magnesium, and aluminum. Manganese is chemically reactive, and decomposes in cold water at a slow rate. It is used in the manufacturing of several steel alloys. Pyrolusite is used as a depolarizer in dry cells, and to "decolorize" glass tinted by iron impurities. Permanganate is a strong oxidizing agent used widely in quantitative analysis and in medicine. Manganese oxyhydroxide compounds can form in low temperature systems, and act as strong adsorbing agents for inorganic ions and ligands.

Manganese is a multivalent element with +2, +3, +4 and +7 oxidation states. All oxidation states except the +7 state form environmentally important solid phases. Mn(II) is the stable and dominant oxidation state in most natural waters below pH of 8. Its oxides and hydroxides form under basic conditions (pH greater than 8) or at neutral pH under high oxidizing conditions. In natural groundwaters, Mn concentrations are typically about 50 times less than those for dissolved iron. Iron/manganese oxyhydroxide particles in unfiltered groundwater samples typically inflate the total Mn concentrations up to several orders of magnitude above dissolved values.

Potassium (K) is the seventh most abundant metal in the earth's crust and it is an essential nutrient for plant life. The metal is obtained by electrolysis of the hydroxide (KOH), which is produced from the mining of the evaporite minerals sylvite (KCl), carnallite ($\text{KMgCl}_3 \cdot 6\text{H}_2\text{O}$), langbeinite ($\text{K}_2\text{Mg}_2[\text{SO}_4]_3$), and polyhalite ($\text{K}_2\text{Ca}_2\text{Mg}[\text{SO}_4]_4 \cdot 2\text{H}_2\text{O}$). At high temperature, K combines with oxygen, aluminum, and silicon to form hundreds of minerals (e.g., feldspars, micas, and clay minerals). The chief use of K is as a fertilizer, with numerous other uses provided by its hydroxide, nitrate, chloride, bromide, cyanide, chromate, and dichromate salts.

Potassium exists in nature only in the +1 valence state. The K^+ ion is the only specie found in most groundwaters. Most K concentrations in groundwater are controlled by ion-exchange reactions with clay minerals. Potassium concentrations in groundwater are generally less than 10 mg/l, unless evaporite deposits with soluble K salts are present.

Selenium (Se) is a naturally occurring element that is found in a few scarce minerals, such as crooksite and clausthalite. It is recovered from the flue dusts remaining from processing copper ores or the anode muds from electrolytic copper refineries. Selenium is a member of the sulfur family and resembles sulfur both in its various forms and compounds. It is used in the produc-

tion of photocells, solar cells, and solid-state devices. Elemental Se is practically nontoxic, but its compounds are extremely toxic and resemble arsenic in their physiological reactions.

Selenium can exist in the -2, 0, +4 or +6 valence states under natural conditions. Under strong reducing conditions, Se can substitute for sulfur in sulfide minerals (e.g., FeSe, ferroselite), while mild reducing to oxidizing conditions can produce native Se, especially at low pH. Oxidized forms of Se are not stable as solids, and a variety of Se (IV) and Se (VI) aqueous species are formed. The aqueous Se species are especially important, as they have been linked to adverse health effects.

Sodium (Na) is the sixth most abundant element in the earth's crust. It is never found as the free metal, and the most common sodium compound is halite (NaCl), a salt that is important to animal nutrition. Sodium metal is obtained commercially by electrolysis of dry, fused NaCl. The compounds most important to industry are common salt (NaCl), soda ash (Na₂CO₃), baking soda (NaHCO₃), caustic soda (NaOH), Chile saltpeter (NaNO₃), di- and tri-sodium phosphates, sodium thiosulfate (Na₂S₂O₃•5H₂O), and borax (Na₂B₄O₇•10H₂O). Sodium compounds are important to the paper, glass, soap, textile, petroleum, chemical, and metal industries.

Sodium occurs in nature only in the +1 valence state. The Na⁺ ion is the only specie found in most groundwaters. Most Na concentrations in groundwater are controlled by ion-exchange reactions with clay minerals. Sodium concentrations in groundwater are generally less than 30 mg/l, unless evaporite deposits with soluble Na salts are present.

Vanadium (V) is a naturally occurring element that is found in over 65 minerals, the most important sources for the metal being carnotite (K₂[UO₂]₂[VO₄]₂•3H₂O), roscoelite (KV₂AlSi₃O₁₀[OH]₂), vanadinite (Pb₅[VO₄]₃Cl), and patronite (VS₄). About 80 percent of the V produced is used as ferrovanadium or as a steel additive, with the remainder finding application in dyeing, printing, and superconductor industries. Vanadium and its compounds are considered to be mild toxins.

Vanadium can occur in the +2, +3, +4, and +5 valence states, although the +2 state is uncommon. Under mild oxidizing to reducing conditions and neutral pH of common groundwaters, V is immobilized as the solid phases V₂O₄ and V₂O₃. However, where groundwaters move across redox fronts in mineralized regions of the earth's crust, V will be immobilized as carnotite, vanadinite,

and patronite. Under oxidizing conditions, V is mobilized as VO^{2+} below a pH of 5, H_2VO_4^- between a pH of about 5 and 8, and as HVO_4^{2-} above a pH of 8. Where a source of V exists and oxidizing conditions prevail, V tends to be a mobile constituent in groundwater environments.

Zinc (Zn) is a naturally occurring element that is an essential nutrient for the growth of humans and animals. Its principal ores are sphalerite (ZnS), smithsonite (ZnCO_3), calamine ($\text{Zn}_4\text{Si}_2\text{O}_7[\text{OH}] \cdot \text{H}_2\text{O}$), and franklinite (ZnFeMnO_4). Zinc metal is obtained by roasting the ores to the oxide and reducing the oxide with coal or carbon. The metal is used to form a number of alloys, the most important being brass, nickel silver, bronze, German silver, soft solder, and aluminum solder. Zinc is also used extensively to galvanize other metals such as iron to prevent corrosion. Zinc is not considered toxic, but the freshly formed oxide (ZnO) is known to cause the Aoxide shakes when inhaled.

Zinc occurs in the natural environment solely in the +2 oxidation state. Under reducing conditions and the presence of sulfide, Zn is immobilized as sphalerite. Under oxidizing conditions, Zn is mobile below a pH of 7 and immobile above a pH of 9 as ZnO . Between a pH of 7 and 9, smithsonite is stable when carbonate groundwater is present (e.g., FLOD groundwaters). Zn concentrations in groundwater are generally kept below 50 ppb when carbonate minerals are present in the groundwater/soil system.

5.2.6.1 Soils

At the TAMPEEL area, metals detected above background included the following: arsenic, aluminum, barium, beryllium, calcium, chromium, copper, iron, lead, magnesium, manganese, mercury, nickel, selenium, sodium, vanadium, and zinc. The elevated levels of metals relative to background are assumed to have two causes: 1) human activity (e.g. coal handling), and 2) varying geochemical composition between background and TAMPEEL soils.

The metals are expected to be persistent over time in the environment, with possible migration related to sediment transport in streams, windborn transport of surface particulates, leaching and dissolution of source materials, or desorption of metals into the liquid phase.

5.2.6.2 Surface Water

During the RI, the only lead in a Beaver pond Sample (SW107) exceeded the water quality criterion established for the protection of aquatic habitat. For samples collected during the SRI lead

nickel, and zinc were at concentrations exceeding water quality criteria established for the protection of aquatic habitat. The pH and Eh conditions present in the surface water/sediment system (i.e., near neutral pH and oxidizing) indicate that dissolved metals will tend to sorb onto sediment particles. The inorganics will therefore, tend to persist in and migrate with the sediment. The generally low concentrations of metals detected in surface water indicate that low mineral solubilities and/or adsorption is limiting the mobility of the metals in the aqueous environment.

5.2.6.3 Sediment

The metals aluminum, arsenic, barium, chromium, copper, iron, lead, manganese, potassium, selenium, vanadium, and zinc were detected at concentration that exceeded surface soil background values. As mentioned in the previous section metals in a water/sediment system will tend to sorb onto sediment particles. The inorganic concentrations detected in the sediment samples are very close to or below the background values for surface soils.

SRI metals were detected above background in every sample. The following metals were detected above background in at least one sample: arsenic, barium, beryllium, cadmium, calcium, copper, lead, manganese, nickel, selenium, and zinc.

5.2.6.4 Groundwater

The following metals were detected above background in groundwater samples collected during the RI: aluminum, chromium, iron, lead, magnesium, potassium, sodium, and vanadium. Background numbers for the FLOD groundwater (Section 4.1) exist for the following constituents: aluminum, arsenic, calcium, iron, magnesium, manganese, sodium and zinc. All other TAL metals analyzed for were not detected. Calcium, magnesium, and sodium are essential nutrients for which there are no known toxic effects at the observed concentrations. Chapter 6.0 discusses these compounds.

Aluminum hydroxides are common structural components of clay minerals which are the dominant soil type encountered at FLOD. In general, the solubility of aluminum hydroxides is low particularly in the near neutral pH range, and solubility decreases with aging. Consequently, aluminum hydroxides tend to sorb onto colloids and will persist in, and migrate with, suspended particles.

In groundwater samples collected during the SRI sampling, the following nine metals were detected above background (Table 4-1) in at least one groundwater sample; aluminum, calcium, chromium, iron, lead, magnesium, potassium, sodium, and thallium.

5.3 Contaminant Migration

In the following section the potential contaminant migration scenarios are described for contaminants present at the TAMPEEL.

Primary potential routes of contaminant migration at the TAMPEEL area include the following:

- Erosion of surface soil to sediment and surface water.
- Movement of contaminants through the soil column into groundwater.
- Discharge of groundwater to surface water
- Movement of groundwater northeastward off site.

Potential erosion of surface soil to sediment and surface water at the TAMPEEL area is not showing a significant impact based upon samples collected during this investigation. Surface water samples collected at the Study Pond, Beaver Pond, and creek adjacent to the landfill indicate little evidence of impact due to erosion of contaminated soil. DDT, DDE, and DDD were detected at the highest concentrations in the sediment sample from the TAMPEEL Spring. No detections occurred in the surface water sample in the same location or in any other surface water sampling location. The persistence of the pesticides at the spring is probably due to the low flow rates, which are insufficient to transport the spring sediment.

One low concentration detection of methylene chloride was the only VOC observed in the monitoring wells installed at TAMPEEL. However, the low concentrations of 1,2-DCE detected in the surface water samples from the TAMPEEL Spring and Aspen Creek might indicate contaminated groundwater is discharging in these areas.

6.0 Baseline Risk Assessment

This section presents methodologies and findings of the Baseline Risk Assessment for TAMPEEL. The Baseline Risk Assessment is presented in two parts: the Human Health Risk Assessment (HHRA) and the Ecological Risk Assessment (ERA). Both the HHRA and the ERA are intended to reflect appropriate guidance provided by USEPA and Ohio EPA. The relevant guidance and approved approaches for the risk assessment negotiated between the USACE and Ohio EPA have been presented in the Draft Risk Assessment Assumptions Document (RAAD) for Former Lordstown Ordnance Depot, Part 1 - Human Health Risk and Part 2 - Ecological Risk (IT, 1997). Elements of the RAAD are included in this section of the RI to provide a complete description of the methodologies employed in this risk assessment.

The objectives of the human health and ecological risk assessment process are to:

- provide an analysis of baseline risks and help determine the need for remedial action at TAMPEEL;
- provide a basis for determining levels of chemicals that can remain onsite and still be adequately protective of public health and the environment;
- provide a basis for comparing potential health and environmental impacts of various remedial alternatives;
- provide a consistent process for evaluating and documenting public health and environmental threats at TAMPEEL.

6.1 Human Health Risk Assessment

The HHRA as defined by USEPA (USEPA, 1989a) includes the exposure assessment, toxicity assessment, and risk characterization. This HHRA includes the evaluation of soil, surface water and sediment for Aspen Creek (including the TAMPEEL Spring), the Study Pond, and the Beaver Pond, and groundwater. Section 6.1.1 defines the Conceptual Site Model. Section 6.1.2 describes the methods used to define the COPCs for the HHRA. Section 6.1.3 describes the basis for the exposure point concentrations in each media. Section 6.1.4 describes methods used to quantify intake. Section 6.1.5 identifies data sources used in the toxicity assessment, and Section 6.1.6 describes the risk characterization procedures. Section 6.1.7 summarizes the results of the COPC selection process and exposure point concentrations, and the estimation of intake and risk

for each media and receptor. Section 6.1.8 identifies uncertainties associated with the risk assessment.

6.1.1 Conceptual Site Model

The conceptual model for the risk assessment has been developed to provide the basis for identifying and evaluating the potential risks to human health in the baseline risk assessment.

The conceptual model facilitates consistent and comprehensive evaluation of risks by creating a framework for identifying the paths by which humans and the environment may be impacted by contaminants at TAMPEEL.

The elements necessary to construct a complete exposure pathway and develop the conceptual site model (CSM) include:

- Sources and COPCs
- Release mechanisms
- Transport pathways
- Exposure pathway scenarios
- Receptors

The exposure setting for TAMPEEL can be generally described as a recreational area, however, since no deed restriction is in place at this time, the potential exists for future residential use of the property. TAMPEEL is part of the FLOD, which is a former quartermaster depot, now a privately owned industrial park operated under the name Ohio Commerce Center. The site is located just west of Ohio State Route 45 in Lordstown Township, approximately four miles south of Warren, Ohio in Trumbull County. The property is rectangular in shape and occupies approximately 514 acres, however, this investigation involves a 39-acre portion of the total property. Much of the FLOD was composed of wetlands before being filled and graded prior to its construction. Small ponds are present north of the site. Drainage is towards a tributary to Duck Creek, which runs south to north along the eastern boundary of the property.

Figure 6-1 presents the CSM for potential human and environmental exposures to the soils, sediment, surface water, and groundwater of TAMPEEL. Details of ecological receptor exposure scenarios are discussed in Section 6.2. The human health receptor exposure scenarios included in the TAMPEEL conceptual model include:

- Onsite Industrial Worker - This exposure scenario is based on the assumption that a worker is present on the property. The worker conducts activities in the TAMPEEL area and is exposed to surface soil. Occupational exposures to surface soil may include more traditional 8 hour, 250 day/year exposures. Municipal water is supplied to the facility; therefore, onsite exposure to groundwater is not a complete pathway. Exposure routes for this receptor include:
 - Incidental ingestion of surface soil
 - Inhalation of fugitive dusts and volatile organics in the surface soil
 - Dermal contact with chemicals in the surface soil
- Onsite Construction Worker - This exposure scenario is based on the assumption that a construction worker is present on the property and conducts activities in the TAMPEEL area and is exposed to total soil. Construction worker exposures to total soil were evaluated in the HHRA because construction worker exposures would involve both surface and subsurface soil (i.e., total soil) that would be mixed during construction/excavation activities. Construction worker exposures to total soil include traditional 8 hour, 250 day/year exposures, but for a limited exposure duration (i.e., less than one year). During construction activities, it is assumed that the construction worker may come into contact with groundwater, and conducts activities near surface water bodies. Exposure routes for this receptor include:
 - Incidental ingestion of soil, sediment, and surface water
 - Inhalation of fugitive dusts and volatile organics in the soil
 - Dermal contact with chemicals in the soil, sediment, and surface water
 - Incidental ingestion of groundwater
 - Inhalation of volatiles in groundwater
 - Dermal contact with chemicals in groundwater
- TAMPEEL Caretaker - This exposure scenario is based on the assumption that a caretaker is present on the TAMPEEL property and conducts activities in the area and in the surface water bodies at TAMPEEL and is exposed to surface soil on the property. Exposures to soil were assumed to include 8 hr, 250 days per year exposures. TAMPEEL caretaker exposures to surface water and sediment were assumed to be short term, intermittent exposures. This receptor is not currently exposed to the groundwater. Exposure routes for this receptor include:
 - Incidental ingestion of soil, sediment and surface water
 - Inhalation of fugitive dusts and volatile organics in the soil
 - Dermal contact with chemicals in the soil, sediment and surface water
- TAMPEEL Student - This exposure scenario is based on the assumption that a student is present on the TAMPEEL property and conducts activities in the area

and in the surface water bodies at TAMPEEL. The student is assumed to be 9 to 10 years old. TAMPEEL student exposures to surface soil, surface water and sediment include short term, intermittent exposures. This receptor is not currently exposed to the groundwater. Exposure routes for this receptor include:

- Incidental ingestion of soil, sediment and surface water
 - Inhalation of fugitive dusts and volatile organics in the soil
 - Dermal contact with chemicals in the soil, sediment and surface water
- Future Onsite Resident – This exposure scenario is based on the assumption that the receptors, both adults and children, are present on the property some time in the future, conduct activities in the surface water bodies at TAMPEEL, and obtain all household water from private wells on the site. The residential exposures to soil include traditional 24 hour, 350 day/year exposures. Both surface soil and total soil exposures are evaluated for this receptor. Resident exposures to total soil are evaluated in the HHRA because it was assumed that both surface and subsurface soil (i.e., total soil) might have become mixed during construction/excavation activities for the future development area. Exposure routes for this receptor include:
 - Incidental ingestion of soil, sediment and surface water
 - Inhalation of fugitive dusts and volatile organics in the soil
 - Dermal contact with chemicals in the soil, sediment and surface water
 - Ingestion of groundwater
 - Inhalation of volatiles from groundwater
 - Dermal contact with chemicals in the groundwater
 - Ingestion of home-produced foodstuffs including fruits and vegetables
- Onsite Trespasser - This exposure scenario is based on the assumption that the receptor (i.e., a young adult) visits an area intermittently. This receptor is not currently exposed to the groundwater. However, this receptor is potentially exposed to surface soil, sediment and surface water. The trespasser was assumed to be a teenager between the ages of 13 through 18. The exposure routes for this receptor include:
 - Incidental ingestion of soil, sediment and surface water
 - Inhalation of fugitive dusts and volatile organics in soil
 - Dermal contact with chemicals in soil, sediment and surface water

All receptors are evaluated for the reasonable maximum exposure (RME) and, where appropriate, central tendency (CT) exposure. Details concerning the assumptions and parameters used to estimate the RME and CT are provided in Section 6.1.4. Potential future exposure of

onsite (industrial) workers to groundwater was not evaluated but is encompassed by the residential risk assessment since the residential exposures are greater.

6.1.2 Determination of Chemicals of Potential Concern

The objective for selecting COPCs is to identify a set of chemicals that are likely to be site-related and reported concentrations that are of acceptable quality for use in the quantitative risk assessment (USEPA, 1989a and USACE, 1996). The process for selecting COPCs for TAMPEEL is described in the following sections.

6.1.2.1 Data Compilation

The data set for TAMPEEL consists of surface water and sediment data summarized in the Site Investigation Report (SIR) (Maxim, 1997) and surface water, sediment, soil, and groundwater data collected for the RI and the SRI. A summary of the available data is discussed in Section 4.0. These data constitute the data set considered in the selection of COPCs. For the purpose of the risk assessment, soil samples were divided into surface soil and total soil groups. Surface soil is defined by sampling intervals that do not exceed 2 feet below ground surface (bgs); total soil is defined by all sampling intervals (i.e., 0 to 9 feet bgs).

6.1.2.2 Comparison of Site-Related Data to Background Data

Once the sampling data had been grouped and summarized, a statistical comparison of site-related data to background metals data was conducted. This comparison is made by determining whether the distribution of site-related data statistically deviates from the distribution of background data. Determination of background data was described in Section 4.1. Background samples were collected for soil and groundwater. No surface water or sediment background data were collected. Summaries of calculated background values used to characterize soil and groundwater are presented in Table 4-1.

Inorganic chemicals detected in soil and groundwater were compared to background values to assess whether these chemicals were present at concentrations below naturally occurring levels. Constituents present in soil and groundwater below background were eliminated as COPCs. As described above, background data was not collected for surface water or sediment. Therefore, background comparisons were not conducted for these media.

6.1.2.3 Comparison of Site-Related Data to Screening Criteria

After eliminating chemicals as COPCs on the basis of background, the remaining chemicals are evaluated using a risk-based concentration screen developed by USEPA (USEPA, 1993a). The purpose of this screen is to make the baseline risk assessment process more efficient by focusing on the dominant chemicals and routes of exposure at the earliest feasible stage. These criteria are applied for evaluating COPCs for the human health risk assessment. These criteria are not applied for evaluation of contaminants of potential ecological concern (COPECs).

The risk-based concentration screen was used as follows:

- The maximum concentration was identified for each chemical detected in each medium.
- The maximum concentration was compared to the risk-based concentration for that medium. The risk-based concentrations consist of USEPA Region 9 Preliminary Remediation Goals (PRGs) (USEPA, 2002), which have been adjusted by a factor of 0.1. Region 9 PRGs are used because they account for oral, inhalation, and dermal soil exposures and oral and inhalation groundwater exposures. A factor of 0.1 is applied to add a ten-fold measure of safety (i.e., to ensure that compounds that could come to result in an HI greater than 1 or a risk greater than 1×10^{-6} were not eliminated from the assessment). Also, a residential scenario is assumed for soil, surface water, sediment, and groundwater exposures.
- If a specific chemical exceeded the risk-based concentration for that medium, the chemical was retained for the risk assessment for all routes of exposure involving that medium.
- If a specific chemical did not exceed its risk-based concentration for any medium, the chemical was eliminated from the COPC list.

6.1.2.4 Detection Frequency

In accordance with USEPA guidance (USEPA, 1989a), consideration of detection frequency can be applied in the selection of COPCs. Chemicals that are detected infrequently (i.e., in less than or equal to 5 percent of the samples) at less than five times the method detection limit were eliminated from the COPC list. Exceptions were made for Class A carcinogens, which remain on the COPC list. However, as a conservative approach, any chemical that would have been eliminated as a COPC based solely on detection frequency was retained. Three chemicals in soil

would have been eliminated solely on the basis of frequency of detection: Aroclor 1254, Aroclor 1260, and beta-BHC. These will be included as COPCs for all soil exposure pathways.

6.1.3 Exposure Point Concentrations

The exposure point concentration is the concentration of a contaminant in an exposure medium that would be contacted by an actual or hypothetical receptor. Determination of the exposure point concentration depends on factors such as:

- Availability of data
- Amount of data available to perform statistical analysis
- Location of the potential receptor

In most cases, analyte concentrations are below the applicable detection limit in each sample. Non-detected results are reported as less than the sample quantitation limit (SQL). The chemical may be present at the concentration just below the reported quantitation limit, or it may not be present in the sample at all. For media in which a chemical has been otherwise detected, non-detected results for that chemical will be treated as one-half the SQL as a proxy concentration for purposes of statistical calculations. This standard conservative approach is used to determine the concentrations most representative of potential exposures.

As a conservative estimate of sample contamination, field and laboratory duplicate samples were reduced to one sample value by choosing the greater value for each analyte pair. This value was used in the risk assessment as the representative analyte value.

For purposes of the baseline risk assessment, exposure point concentrations were calculated for all COPCs. Chemical toxicants pose risks at threshold levels; therefore, total intakes must be compared to the intake level associated with toxic levels.

6.1.3.1 Calculation of Concentration Term for Soils and Sediment

In Superfund risk assessments, the concentration term in the intake equation is an estimate of the arithmetic average concentration for a contaminant based on a set of site sampling results (USEPA, 1989a and 1992d). Because of the uncertainty associated with estimating the true average concentration at a site, the 95 percent upper confidence limit (UCL) of the arithmetic mean should be used for this variable. The UCL provides reasonable confidence that the true site average will not be underestimated.

USEPA has determined that most large environmental contaminant data sets from soil sampling are lognormally distributed rather than normally distributed (USEPA, 1992d). The W-test (Gilbert, 1987) was used to determine the appropriate distribution describing each data set. The equation used to calculate the UCL for the lognormal distribution is shown below:

$$UCL = e^{\bar{x} + 0.5s^2 + sH / \sqrt{n-1}}$$

where:

UCL	=	95 percent upper confidence limit
e	=	constant (base of the natural log, equal to 2.718)
\bar{x}	=	arithmetic mean of transformed data
s	=	standard deviation of the transformed data
H	=	H-statistic (Gilbert, 1987)
n	=	number of samples

The equation used to calculate the UCL for the normal distribution is:

$$UCL = \bar{x} + t(s / \sqrt{n})$$

where:

UCL	=	95 percent upper confidence limit
\bar{x}	=	arithmetic mean of the untransformed data
s	=	standard deviation of the untransformed data
t	=	Student-t statistic (Gilbert, 1987)
n	=	number of samples

The statistical tests that are described in this section are parametric procedures and are intended for use in cases where the percentage of non-detects in a particular data set is less than 50 percent. In the event that the percentage of non-detects for a particular chemical is greater than 50 percent, non-parametric procedures were applied as appropriate. Procedures for evaluating and applying non-parametric statistics are described in the guidance document *Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities, Addendum to Interim Final Guidance* (USEPA, 1992a).

6.1.3.2 Determination of Groundwater Exposure Point Concentrations

Groundwater exposure point estimates were determined using guidance established by Region V (USEPA, 1991a). In this risk assessment, groundwater exposure point concentrations were

established as the maximum detected concentration from the data set described in Section 6.1.2.1.

6.1.3.3 Determination of Surface Water Exposure Point Concentrations

Exposure point concentrations for surface water were calculated based on the UCL (as described in Section 6.1.3.1).

6.1.4 Quantification of Intake

This section describes the method used to quantify chronic exposures for exposure pathways identified in the CSM for TAMPEEL; exposures are estimated to characterize the RME and CT. The RME is the maximum exposure reasonably expected to occur at the site (USEPA, 1989a). The CT is used to approximate the average estimate of exposure and can be derived by using average values for exposure variables. Exposure parameters used to estimate the RME and CT are provided in Tables 6-1, 6-2, and 6-3 for soil/sediment, groundwater and surface water pathways, respectively.

6.1.4.1 Soil and Sediment Exposures

Surface soil exposures were evaluated for industrial worker, adult resident, child resident, trespasser, TAMPEEL caretaker, and student scenarios. Total soil exposures were evaluated for construction exposure scenarios and for adults and children in residential scenarios. Exposures to sediment were evaluated for adult resident, child resident, trespasser, TAMPEEL caretaker, and student scenarios. Sediment exposures were also evaluated for a construction worker.

6.1.4.1.1 Incidental Ingestion

The estimation of intake of contaminants in soils or sediment is determined using the concentration in the soil or sediment at the location of interest (USEPA, 1989a).

$$I_s = \frac{C_s \cdot IR \cdot CF \cdot FI \cdot EF \cdot ED}{BW \cdot AT}$$

where:

I_s	=	intake from soil or sediment for contaminant (mg/kg-day)
C_s	=	concentration of contaminant in soil or sediment (mg/kg)
IR	=	ingestion rate (mg/day)
CF	=	conversion factor (10^{-6} kg/mg)
FI	=	fraction ingested from contaminated source (unitless)

EF	=	exposure frequency (days/year)
ED	=	exposure duration (years)
BW	=	body weight (kg)
AT	=	averaging time (days); for noncarcinogens, AT equals [(ED)(365 days/year)]; for chemical carcinogens, AT equals [(70 years)(365 days/year)]

Specific values for these exposure parameters are listed in Table 6-1.

6.1.4.1.2 Inhalation of Volatiles

Intake for inhalation of volatile contaminants in soils as a result of outdoor activities by industrial worker, construction worker, TAMPEEL caretaker, trespasser, TAMPEEL student, and residential receptors were estimated using the following equation (USEPA, 1991b):

$$I_s = \frac{C_s \cdot (1/VF) \cdot IR \cdot FI \cdot EF \cdot ED}{BW \cdot AT}$$

where:

I_s	=	intake from soil for contaminant (mg/kg-day)
C_s	=	concentration of contaminant in soil (mg/kg)
VF	=	volatilization factor (m^3/kg)
IR	=	inhalation rate (m^3/day)
FI	=	fraction inhaled from contaminated source (unitless)
EF	=	exposure frequency (days/year)
ED	=	exposure duration (years)
BW	=	body weight (kg)
AT	=	averaging time (days); for noncarcinogens, AT equals [(ED)(365 days/year)]; for chemical carcinogens, AT equals [(70 years)(365 days/year)]

and where:

$$VF = (Q/C) \times \frac{[3.14 \cdot a \cdot T]^{1/2}}{2 \cdot D_{ei} \cdot K_{as} \cdot \theta_a} \times 10^{-4} \text{ m}^2 / \text{cm}^2$$

and:

$$\alpha = \frac{D_{ei} \cdot \theta_a}{\theta_a + (p_s \cdot 1 - \theta_a) / K_{as}}$$

where:

Q/C	=	inverse of the mean concentration at the center of a 0.5-acre source (g/m^2 -s per kg/m^3)
-----	---	--

T	=	exposure interval (7.9×10^8 s)
D_{ei}	=	effective diffusivity (cm^2/s); equal to $[(D_i)(E^{0.33})]$, where D_i is the chemical specific molecular diffusivity (cm^2/s)
θ_a	=	air filled porosity (L_{air}/L_{soil})
D_i	=	diffusivity in air (cm^2/s)
p_s	=	soil or particulate density (2.65 g/cm^3)
E	=	default soil porosity (0.35)(unitless)
K_{as}	=	soil to air partition coefficient ($\text{g soil/cm}^3 \text{ air}$); equal to $[(\{\text{chemical specific Henry's law constant (atm-m}^3/\text{mol})/ K_d (\text{chemical specific soil to water partition coefficient) (unitless})\})(41)]$. K_d can be estimated as K_{oc} [(organic carbon partition coefficient)(OC){soil organic carbon content}] estimated at 0.02.

Specific values for these exposure parameters are listed in Table 6-1.

6.1.4.1.3 Inhalation of Particulates

Intake for inhalation of particulates from soils as a result of outdoor activities by an industrial worker, construction worker, TAMPEEL caretaker, trespasser, TAMPEEL student, or residential receptor were estimated using the following equations.

$$I_s = \frac{C_s \cdot IR \cdot RF \cdot CF \cdot EF \cdot ED}{BW \cdot AT \cdot TCF \cdot PEF}$$

where:

I_s	=	intake from soil from contaminant (mg/kg-day)
C_s	=	concentration of contaminant in soil (mg/kg)
IR	=	inhalation rate (m^3/day)
RF	=	respirable fraction (unitless)
CF	=	conversion factor (10^{-6} kg/mg)
EF	=	exposure frequency (days/year)
ED	=	exposure duration (years)
BW	=	body weight (kg)
AT	=	averaging time (days); for non-carcinogens AT equals $[(ED)(365 \text{ days/year})]$; for chemical carcinogens, AT equals $[(70 \text{ years})(365 \text{ days/year})]$
TCF	=	time conversion factor (days/year)
PEF	=	particulate emission factor (m^3/kg) [4.63×10^9 (USEPA, 1991b)]

Specific values for these parameters are listed in Table 6-1.

6.1.4.1.4 Dermal Contact

The estimation of intake of organic contaminants in soil and sediment via absorption through the skin was determined using the concentration in the soil or sediment at the location evaluated and the following equation (USEPA, 1991c):

$$AB_s = \frac{C_s \cdot CF \cdot SA \cdot AF \cdot ABS \cdot EF \cdot ED}{BW \cdot AT}$$

where:

AB_s	=	amount of constituent absorbed during contact with soil or sediment (mg/kg-day)
C_s	=	concentration of constituent in soil or sediment (mg/kg)
SA	=	skin surface area available for contact (cm ² /event)
AF	=	skin adherence factor (mg/cm ²)
ABS	=	absorption factor (unitless)
CF	=	conversion factor (10 ⁻⁶ kg/mg)
EF	=	exposure frequency (events/year)
ED	=	exposure duration (years)
BW	=	body weight (kg)
AT	=	averaging time (days); for noncarcinogens, AT equals [(ED)(365 days/year)]; for chemical carcinogens, AT equals [(70 years)(365 days/year)]

Specific values for these exposure parameters, with the exception of ABS, are listed in Table 6-1. Values proposed for ABS are provided in Table 6-4. Activity (or receptor)-specific adherence factors are referenced from USEPA (1998) and are listed in Table 6-1.

6.1.4.2 Groundwater and Surface Water Exposures

The potential for future residential exposure assumes that the residential receptor obtains all household water from private wells hypothetically located on TAMPEEL property. Groundwater exposures were also evaluated for a construction worker, assuming limited exposure to groundwater during construction activities.

Surface water exposure scenarios include incidental ingestion of surface water and dermal contact with surface water. These exposures can occur as a function of intermittent exposures to the adult resident, child resident, construction worker, TAMPEEL caretaker, student and a trespasser. The evaluation of these exposures is also included below.

6.1.4.2.1 Water Ingestion

A receptor can ingest water by deliberately drinking it, or by accidentally swallowing water while wading. An estimate of intake from ingesting water was calculated as follows (USEPA, 1989a):

$$I_w = \frac{C_w \cdot IR \cdot FI \cdot ED \cdot EF}{BW \cdot AT}$$

where:

I_w	=	intake of contaminant from drinking water (mg/kg-day)
C_w	=	concentration of contaminant in water (mg/L)
IR	=	ingestion rate (L/day)
FI	=	fraction ingested from contaminated source (unitless)
EF	=	exposure frequency (days/year)
ED	=	exposure duration (years)
BW	=	body weight (kg)
AT	=	averaging time (days); for noncarcinogens, AT equals [(ED)(365 days/year)]; for chemical carcinogens, AT equals [(70 years)(365 days/year)]

Specific values for these exposure parameters are listed in Tables 6-2 and 6-3 for groundwater and surface water, respectively.

6.1.4.2.2 Inhalation of Volatiles Released by Showering and Other Household Water Uses

The amount of a chemical taken into the body via exposure to volatilization of chemicals from showering was evaluated using the concentration of a chemical in the water source (USEPA, 1991b). Intake from the volatilization of chemicals in household water was calculated using the Andelman model (USEPA, 1991b):

$$I_w = \frac{C_w \cdot K \cdot IR_i \cdot EF \cdot ED}{BW \cdot AT}$$

where:

I_w	=	intake of volatile in water from inhalation (mg/kg-day)
C_w	=	concentration of contaminant in water (mg/L)
K	=	volatilization factor (0.5 L/m ³)
IR_i	=	inhalation rate (m ³ /day)
EF	=	exposure frequency (days/year)
ED	=	exposure duration (years)
BW	=	body weight (kg)

AT = averaging time (days); for noncarcinogens, AT equals [(ED)(365 days/year)]; for chemical carcinogens, AT equals [(70 years)(365 days/year)]

For volatile compounds, volatilization from groundwater can be an important exposure pathway from showering and other household uses of groundwater. However, for most heavy metals volatilization is not a significant pathway because they do not vaporize at room temperature or temperatures associated with showering scenarios. Therefore, this exposure pathway was only evaluated for organic chemicals with a Henry's Law constant greater than 1×10^{-5} atm-m³/mol and with a molecular weight of 200 g/mole or less (USEPA, 1991b). Specific values for these exposure parameters are listed in Table 6-2.

6.1.4.2.3 Dermal Contact While Bathing or Wading

The estimate of intake of contaminants in water via absorption through the skin is determined using the concentration of a chemical in the water source evaluated. Evaluation of the dermal absorption pathway was performed for both adults and children. The amount of a chemical taken into the body upon exposure via dermal contact is referred to as an absorbed dose. The absorbed dose was calculated using the dermal guidance contained in USEPA 1989b, 1992b, and 1992c;

$$I_w = \frac{D_{event} \cdot SA \cdot EF \cdot ED}{BW \cdot AT}$$

where:

I_w = intake through skin from showering or wading (mg/kg-day)
 D_{event} = absorbed dose per event (mg/cm²-event)
 SA = skin surface area (cm²)
 EF = exposure frequency (days/year)
 ED = exposure duration (years)
 BW = body weight (kg)
 AT = averaging time (days); for noncarcinogens, AT equals [(ED)(365 days/year)]; for chemical carcinogens, AT equals [(70 years)(365 days/year)]

Specific values for these exposure parameters are listed in Tables 6-2 and 6-3 for groundwater and surface water, respectively. D_{event} was calculated as:

$$D_{event} = C_v \cdot 2 \cdot K_p \cdot CF [(6 \cdot TAO \cdot ET) / \pi]^{+0.5} \text{ if } ET < t^*,$$

or

$$D_{event} = C_v \cdot K_p \cdot CF [ET + (2 \cdot TAO \cdot (1 + 3B))] / (1 + B) \text{ if } ET > t^*$$

where:

C_v	=	concentration in the vehicle (mg/L)
K_p	=	permeability constant (cm/hour; chemical-specific, USEPA, 1992b)
TAO	=	lag time (hour; chemical-specific, USEPA, 1992b)
B	=	partitioning coefficient (unitless; chemical-specific, USEPA, 1992b)
ET	=	exposure time (hours)
π	=	Pi (3.14)
t^*	=	time to equilibrium conditions (hours; chemical-specific, USEPA, 1992b)
CF	=	conversion factor (0.001 L/cm ³)

The vehicle is domestic water for showering; the vehicle is surface water for wading. In either case, C_v equals the concentration in the water (C_w). For most metals, dermal absorption is not a significant pathway because penetration through the skin is minimal.

6.1.4.2.4 Vegetable and Fruit Ingestion

The amount of a contaminant a receptor takes in as a result of consuming vegetables and fruit is determined using the concentration of a chemical in the edible portions of the plants. USEPA has determined that sufficient data exists for only arsenic, cadmium, mercury, nickel, selenium, and zinc (USEPA, 1996a). If any of these six inorganics are found to be COPCs in the groundwater associated with a site, estimates of exposure for those inorganic COPCs should be calculated and included in the total estimate of exposure. However, none of these inorganics were found to be COPCs in the groundwater at TAMPEEL. The concentration in vegetables and fruit attributed to contaminant irrigation water can be estimated by (NCR, 1977):

$$C_{wv} = d_w \left[\frac{r_w (1 - e^{-\lambda_w t})}{Y \cdot \lambda_w} + \frac{f_w \cdot B_{iv} (1 - e^{-\lambda_d t_{bw}})}{\rho \cdot \lambda_d} \right] e^{-\lambda_d t_h}$$

where:

C_{wv}	=	concentration of contaminant in plants as a result of irrigating plants with contaminated water (mg/kg)
λ_w	=	effective depletion constant of contaminant on the plant surface also known as the weathering removal rate (hour ⁻¹)
λ	=	chemical decay constant of contaminant (hour ⁻¹)
λ_d	=	soil depletion constant (hour ⁻¹)
B_{iv}	=	dry soil to wet plant partitioning coefficient of contaminant (unitless)
d_w	=	irrigation deposition rate (mg/m ² -hour)

f_w	=	fraction of year plant is irrigated (unitless)
ρ	=	effective dry surface density of the soil (kg/m ²)
r_w	=	fraction of water borne material retained on plant surface (unitless)
t	=	growing season (hours)
t_{bw}	=	duration of irrigation use (hours)
t_h	=	duration of period between harvest and consumption (hours)
Y	=	agricultural yield (kg/m ²)

And d_w was calculated as:

$$d_w = C_w \cdot I$$

where:

C_w	=	concentration of contaminant in irrigation water (mg/L)
I	=	irrigation rate (L/m ² /hour)

The soil depletion coefficient was calculated by:

$$\lambda_d = \lambda + \lambda_L$$

And where the leaching coefficient (λ_L) was calculated using the relationship (Baes et al., 1984):

$$\lambda_L = \frac{V_w}{z \cdot \delta \left[1 + \frac{K_d}{\theta} \right]}$$

where:

λ_L	=	leach rate (hour ⁻¹)
V_w	=	percolation rate (0.0044 cm/hour)
z	=	depth of surface soil (15 cm)
δ	=	density of soil in root zone (nominally 1.5 g/cm ²)
K_d	=	water to soil partitioning coefficient (cm ³ /g)
θ	=	moisture fraction of surface soil (measured at 0.17)

$$I_{f/v} = \frac{C_{wv} \cdot IR \cdot FI \cdot EF \cdot ED}{BW \cdot AT}$$

where:

$I_{f/v}$	=	intake of fruits or vegetables (mg/kg-day)
C_{wv}	=	concentration of contaminant in plants (fruits or vegetables) as a result of irrigating plants with contaminated water (mg/kg)
IR	=	ingestion rate of fruits or vegetables (g/day)
FI	=	fraction ingested from contaminated source (unitless)

EF	=	exposure frequency (days/year)
ED	=	exposure duration (years)
BW	=	body weight (kg)
AT	=	averaging time (days); for non-carcinogens, AT equal [(ED) (365 days/year)]; for chemical carcinogens, AT equals [(70 years) (365 days/year)]

Specific values for exposure parameters are listed in Table 6-2. The parameter values for the uptake model are found in Table 6-5.

6.1.5 Toxicity Assessment

Toxicity values used in this risk assessment are provided in Table 6-6. Data sources and guidance used in the selection of toxicity values are discussed below.

6.1.5.1 Toxicity Assessment for Carcinogenic Effects

Slope factors (SFs) were obtained from the Integrated Risk Information System (IRIS) (USEPA, 2003a), an on-line data base updated monthly, and Health Effects Assessment Summary Tables (HEAST) and supplements (USEPA, 1997a), a compilation of non-verified toxicity data, as well as other USEPA sources.

Toxicity values were chosen on the basis of the route of exposure. Because there are no SFs for dermal exposure, oral values are frequently used to assess risks from dermal exposure. It was necessary to adjust oral SFs for use in calculations for dermal risk. This adjustment was made using the following equation (USEPA, 1989a):

$$\text{Oral SF} / \text{Oral Absorption Factor} = \text{Adjusted SF}$$

Values proposed for oral absorption factors (OAFs) are provided in Table 6-7.

6.1.5.2 Toxicity Assessment for Noncarcinogenic Effects

Reference doses (RfDs) will also be obtained from IRIS (USEPA, 2003a), and HEAST (USEPA, 1997a). It was necessary to adjust the oral RfD for use in calculations for dermal hazard. The adjustment was made using the following equation (USEPA, 1989a):

$$\text{Oral RfD} \cdot \text{Oral Absorption Factor} = \text{Adjusted RfD}$$

Values used for oral absorption factors (OAFs) are provided in Table 6-7.

6.1.5.3 Chemical-Specific Issues

Lead. There is no RfD for lead. For residential exposure scenarios, the evaluation of risk from exposure to lead is typically evaluated using the Lead Uptake/Biokinetic Model (USEPA, 1994a). The model utilizes data from soil and drinking water to estimate total exposure to a population of children for an estimate of blood lead concentration. This estimate of blood lead is then compared to an acceptable blood lead level for children of 10 µg/dL.

For industrial, commercial, TAMPEEL caretaker, and trespasser exposures, lead in soil was compared with the adult screening level of 1,414 mg/kg (USEPA, 1995a), while residential exposures were compared with the USEPA soil screening level of 400 mg/kg (USEPA, 1994a). Lead in groundwater and surface water was qualitatively compared to the federal and state action levels for lead of 0.015 mg/L.

PAHs. Polycyclic aromatic hydrocarbon (PAH) toxicity was evaluated using the relative potency approach for oral exposures to PAHs (USEPA, 1993b). The toxicity of benzo(a)pyrene is used as a surrogate for other carcinogenic PAHs. The slope factor of benzo(a)pyrene is scaled using factors of 1, 0.1, 0.01 and 0.001 to estimate slope factors for other PAHs.

Dioxins and Furans. The toxicity of individual dioxins and furans was assessed using toxicity equivalence factors (TEFs) (USEPA, 1989a, 1994b). The toxicity of 2,3,7,8-TCDD is used as a surrogate for other dioxins and furans. The slope factor of 2,3,7,8-TCDD is scaled using factors of 1, 0.5, 0.1, 0.05, 0.01, 0.001, and 0 to estimate slope factors for other dioxins and furans.

6.1.6 Risk Characterization

The purpose of the risk characterization step is to integrate the exposure and toxicity assessments to generate quantitative expressions of risk. The risk characterization was performed in accordance with USEPA risk assessment guidelines (USEPA, 1989a). Quantitative estimates of carcinogenic and noncarcinogenic risk were calculated for exposures from soil, sediment, surface water and groundwater. The exceptions are lead exposures, which were discussed in Section 6.1.5.3.

6.1.6.1 Calculation of Carcinogenic Risk

Cancer risk was compared with USEPA's 1×10^{-6} point of departure.

Cancer risk from exposures to a chemical contaminant were estimated using the equation:

$$Cancer\ Risk_i = I_i \cdot SF_i$$

where:

$$\begin{aligned} Cancer\ Risk_i &= \text{lifetime cancer risk (unitless) from chemical contaminant } i \text{ (} i=1\dots n \text{)} \\ I_i &= \text{total daily intake of contaminant } i \text{ (} i=1\dots n \text{) from indirect exposures (mg/kg-day)} \\ SF_i &= \text{slope factor } ([\text{mg/kg-day}]^{-1}) \text{ for chemical contaminant } i \text{ (} i=1\dots n \text{)} \end{aligned}$$

Cancer risk from exposure to multiple chemicals in each pathway (e.g., ingestion of soil) was estimated using the equation:

$$Pathway\ Cancer\ Risk_i = \sum CancerRisk_i$$

where:

$$\begin{aligned} Pathway\ Cancer\ Risk_i &= \text{Total lifetime cancer risk from all chemicals (unitless) in the } i \text{ th pathway} \\ Cancer\ Risk &= \text{Lifetime cancer risk for the } i \text{ th chemical} \end{aligned}$$

Total cancer risk from all exposures was summed:

$$Total\ Exposure\ Cancer\ Risk = \sum Pathway\ Cancer\ Risk_i$$

where:

$$\begin{aligned} Total\ Exposure\ Cancer\ Risk &= \text{Total lifetime cancer risk from exposures to all chemicals (unitless)} \\ Pathway\ Cancer\ Risk_i &= \text{Lifetime cancer risk from exposure pathway } i \text{ (} i=1\dots n \text{) (unitless)} \end{aligned}$$

6.1.6.2 Calculation of Noncancer Risk

The Hazard Quotient (HQ) is used to evaluate noncancer toxicity of chemical contaminants. The HQ represents the ratio of the dose received by the exposed individual to the dose that is associated with no adverse effects (i.e., the threshold or reference dose).

The HQ for exposures to a chemical contaminant that has noncancer health effects was estimated using the equation below:

$$HQ = \frac{I}{RfD}$$

where:

HQ = hazard quotient for chemical (unitless)
I = total daily intake from exposures to chemical contaminant (mg/kg-day)
RfD = reference dose for chemical (mg/kg-day)

The hazard index (HI) from exposure to multiple chemicals in each pathway (e.g., ingestion of soil) was estimated using the equation:

$$HI = \sum \frac{I_i}{RfD_i}$$

where:

HI = hazard index for all chemicals (unitless) in the i th pathway
 I_i = total daily intake from exposure to chemical i ($i = 1...n$)
 RfD_i = reference dose for chemical i ($i = 1...n$) (mg/kg-day)

Total hazard index from all exposures was summed:

$$Total\ Exposure\ HI = \sum HI_i$$

where:

Total Exposure HI = total hazard index from exposures to all chemicals (unitless)
 HI_i = hazard index for exposure pathway i ($i = 1...n$)

In the event that the HI for multiple chemicals exceeded unity, HQs were calculated for groups of chemicals that affect the same target organ (or have a similar mechanism for toxicity). HQs that represent the same target organ (i.e., liver, kidney, etc.) were summed to obtain a HI for an individual target organ. The HI was estimated using the equation:

$$HI_k = \sum HQ_{ik}$$

where:

HI_k = hazard index for individual target organ k ($k=1...h$) (unitless)
 HQ_{ik} = hazard quotient for chemical i ($i=1...n$) with effects in target organ k ($k=1...h$) (unitless)

In cases where a chemical may have multiple effects (i.e., a chemical may have more than one target organ), all of the target organs that may apply were considered. However, the toxicity data were evaluated to determine whether the target organ effects are dose-related.

The total noncancer HI for a target organ from all exposure pathways was estimated using the equation:

$$Total\ HI_k = \sum HI_k$$

where:

Total HI_k = total hazard index for individual target organ k ($k=1...h$) (unitless)
 ΣHI_k = sum of all hazard indices with effects in target organ k ($k=1...h$) (unitless)

6.1.7 Human Health Risk Assessment Results

This section summarizes the results of the human health risk assessment. Each subsection discusses an individual medium. The discussion includes the selection of COPCs for each medium and the quantitative risk estimates associated with those COPCs. The summary of the quantitative risk estimates (presented in a series of tables and text discussion) include cancer risk and noncancer hazard summed for all COPCs in each pathway. Total risk for each receptor is also presented. Where applicable (i.e., when RME risk estimates exceed 1×10^{-6} or hazard estimates exceed 1), CT values are presented in the summary tables for comparison.

Generally, excess cancer risk estimates below 1×10^{-6} are considered negligible (USEPA, 1990). A cancer risk of 1×10^{-6} is considered a point of departure, above which concern rises. Risk is discussed relative to the 1×10^{-6} point of departure. An HI below 1.0 is considered acceptable; above 1.0 indicates concern about the occurrence of adverse noncancer effects (USEPA, 1989a). The reader is directed to Appendix K for a complete representation of individual chemical risk for each pathway and receptor presented in individual spreadsheets.

6.1.7.1 Soil

Tables 6-8 and 6-9 summarize selected COPCs for surface soil and total soil associated with the TAMPEEL. Metals, SVOCs, pesticides, and dioxins/furans comprise selected COPCs for both surface and total soil. Cancer risk and hazard (non-cancer) results for each receptor are presented in Tables 6-10 and 6-11, respectively. Where applicable, central tendency values are given in parentheses in the tables. These values, however, are not discussed in the text below.

Adult Resident. At 1.9×10^{-5} , the total cancer risk for the RME adult resident exposed to surface soil is above the departure point of 1×10^{-6} . Carcinogenic risk is primarily driven by arsenic through ingestion and dermal absorption, with a cancer risk of 1.5×10^{-5} and 2.1×10^{-6} , respectively. The total noncancer hazard (0.51) for exposures to surface soil is below the limit of 1.

At 1.9×10^{-5} , the total cancer risk for the RME adult resident exposed to total soil is above the departure point of 1×10^{-6} . Carcinogenic risk is primarily driven by arsenic through ingestion, with a cancer risk of 1.4×10^{-5} . Also contributing to risk is arsenic through dermal absorption (2.0×10^{-6}) and benzo(a)pyrene (total risk = 1.2×10^{-6}). The total noncancer hazard (0.47) for exposures to surface soil is below the limit of 1.

Child Resident. At 4.0×10^{-5} , the total cancer risk for the RME child resident exposed to surface soil exceeds the departure point of 1×10^{-6} . Carcinogenic risk is primarily driven by arsenic through ingestion, with a cancer risk of 3.5×10^{-5} . Also contributing to risk is arsenic through dermal absorption (2.8×10^{-6}) and dibenz(a,h)anthracene (total risk = 1.3×10^{-6}). The total noncancer hazard (4.2) for exposures to surface soil exceeds the limit of 1. The greatest contribution to this hazard is from iron through ingestion, with an HQ of 1.4 and from manganese with a total HI of 1.0.

At 4.0×10^{-5} , the total cancer risk for the RME child resident exposed to total soil exceeds departure point of 1×10^{-6} . Carcinogenic risk is primarily driven by arsenic through ingestion, with a cancer risk of 3.3×10^{-5} . Also contributing to risk is arsenic through dermal absorption (2.7×10^{-6}), benzo(a)pyrene through ingestion (1.7×10^{-6}), and dibenz(a,h)anthracene (total risk = 1.3×10^{-6}). The total noncancer hazard (3.9) for exposures to surface soil exceeds the limit of 1. The greatest contribution to this hazard is from iron through ingestion, with an HQ of 1.3.

Trespasser. The total cancer risk (3.0×10^{-7}) for the trespasser exposed to surface soil is below the 1×10^{-6} point of departure. The total noncancer hazard (0.031) for exposures to surface soil is below the acceptable limit of 1.

TAMPEEL Caretaker. At 1.3×10^{-5} , the total cancer risk for the RME TAMPEEL caretaker exposed to surface soil exceeds the departure point of 1×10^{-6} . Carcinogenic risk is primarily driven by arsenic through ingestion, with a cancer risk of 1.1×10^{-5} . The cumulative noncancer hazard (0.31) for exposures to surface soil is below the limit of 1.

TAMPEEL Student. The total cancer risk (1.3×10^{-7}) for the RME TAMPEEL student exposed to surface soil is below the 1×10^{-6} point of departure. The cumulative noncancer hazard (0.053) for exposures to surface soil is below the limit of 1.

Construction Worker. At 2.3×10^{-6} , the total cancer risk for the RME construction worker exposed to total soil exceeds the departure point of 1×10^{-6} . Carcinogenic risk is primarily driven by arsenic through ingestion, with a cancer risk of 2.0×10^{-6} . The total noncancer hazard (1.3) for exposures to total soil slightly exceeds the target of 1. No individual chemical HQ was above 1.

Industrial Worker. At 6.8×10^{-6} , the total cancer risk for the RME industrial worker exposed to surface soil exceeds the departure point of 1×10^{-6} . Carcinogenic risk is primarily driven by arsenic through ingestion, with a cancer risk of 5.5×10^{-6} . The cumulative noncancer hazard (0.18) for exposures to surface soil is below the acceptable limit of 1.

Exposure to Soil Lead. The representative concentrations of lead in surface soil (140 mg/kg) and total soil (93 mg/kg) were below the residential (400 mg/kg) and industrial (1,414 mg/kg) screening levels, respectively.

6.1.7.2 Surface Water and Sediment

Surface water and sediment exposures were evaluated for three areas of concern: Aspen Creek/TAMPEEL Spring, the Beaver Pond, and the Study Pond. It should be noted that a spring is also located in the TAMPEEL area between the Beaver Pond and Study Pond. Tables 6-12 through 6-17 summarize selected COPCs for surface water and sediment associated with the site. Metals and VOCs comprise selected COPCs for surface water; metals and SVOCs comprise selected COPCs for sediment. Since there were no detected carcinogenic constituents in the surface water of the Beaver Pond and Study Pond, carcinogenic risk is, by default, within acceptable limits for these areas.

Cancer risk and hazard (non-cancer) results for each receptor for surface water and sediment are presented in Tables 6-18 through 6-21. The lead soil screening levels (400 mg/kg in residential soil and 1,414 mg/kg in industrial soil) were used to evaluate lead in sediment; the action level for lead in groundwater (0.015 mg/L) was used to evaluate lead exposures in surface water.

6.1.7.2.1 Aspen Creek/TAMPEEL Spring

Adult Resident. At 3.6×10^{-10} , the cancer risk for the RME adult resident exposed to Aspen Creek/TAMPEEL Spring surface water is below the USEPA point of departure of 1×10^{-6} . The

noncancer hazard for exposures to Aspen Creek/TAMPEEL Spring (0.082) surface water is below the limit of 1.

The cancer risk for the RME adult resident exposed to Aspen Creek/TAMPEEL Spring sediment (2.7×10^{-6}) exceeded the USEPA point of departure of 1×10^{-6} . Risk is primarily driven by arsenic through ingestion, with a cancer risk of 2.1×10^{-6} . The noncancer hazard for exposure to Aspen Creek/TAMPEEL Spring sediment (0.16) is below the limit of 1.

Child Resident. At 1.3×10^{-10} , the cancer risk for the RME child resident exposed to Aspen Creek/TAMPEEL Spring surface water is below the USEPA point of departure of 1×10^{-6} . The noncancer hazard for exposures to Aspen Creek/TAMPEEL Spring surface water (0.14) is below the limit of 1.

The cancer risk for the RME child resident exposed to Aspen Creek/TAMPEEL Spring sediment (3.0×10^{-6}) exceeded the USEPA point of departure of 1×10^{-6} . Risk is primarily driven by arsenic through ingestion, with a cancer risk of 2.4×10^{-6} . The noncancer hazard for exposure to Aspen Creek/TAMPEEL Spring sediment (0.69) is below the limit of 1.

Trespasser. The total cancer risk (7.3×10^{-11}) for the RME trespasser exposed to Aspen Creek/TAMPEEL Spring surface water is below the 1×10^{-6} point of departure. The total noncancer hazard (0.084) for exposures to surface water is below the acceptable limit of 1.

The total cancer risk (3.9×10^{-7}) for the RME trespasser exposed to sediment is below the departure point of 1×10^{-6} . The total noncancer hazard (8.9×10^{-2}) for exposures to sediment is below the acceptable limit of 1.

TAMPEEL Caretaker. The total cancer risk (2.6×10^{-10}) for the RME TAMPEEL caretaker exposed to Aspen Creek/TAMPEEL Spring surface water is below the 1×10^{-6} point of departure. The total noncancer hazard (0.074) for exposures to surface water is below the acceptable limit of 1.

The total cancer risk (2.5×10^{-6}) for the RME TAMPEEL caretaker exposed to sediment exceeds the departure point of 1×10^{-6} . Risk is primarily driven by arsenic through ingestion, with a

cancer risk of 2.1×10^{-6} . The total noncancer hazard (0.13) for exposures to sediment is below the acceptable limit of 1.

TAMPEEL Student. The total cancer risk (1.2×10^{-11}) for the RME TAMPEEL student exposed to Aspen Creek/TAMPEEL Spring surface water is below the 1×10^{-6} point of departure. The total noncancer hazard (0.043) for exposures to surface water is below the acceptable limit of 1.

The total cancer risk (1.6×10^{-7}) for the RME TAMPEEL student exposed to sediment is below the 1×10^{-6} point of departure. In addition, the noncancer hazard for student sediment exposures (0.12) is also below the acceptable limit of 1.

Construction Worker. At 1.0×10^{-11} , the cancer risk for the RME construction worker exposed to Aspen Creek/TAMPEEL Spring surface water is below the USEPA point of departure of 1×10^{-6} . The noncancer hazard for exposures to Aspen Creek/TAMPEEL Spring surface water (0.075) is below the limit of 1.

The cancer risks for the RME construction worker exposed to Aspen Creek/TAMPEEL Spring sediment (1.1×10^{-7}) is below the USEPA point of departure of 1×10^{-6} . The noncancer hazard for exposure to Aspen Creek/TAMPEEL Spring sediment (0.15) is below the limit of 1.

Lead. Lead in Aspen Creek/TAMPEEL Spring surface water is estimated at 0.015 mg/L, which is equal to the drinking water action level. Lead in sediment is estimated at 77 mg/kg, which is below the residential (400 mg/kg) and industrial (1,414 mg/kg) screening levels.

6.1.7.2.2 Beaver Pond

Adult Resident. There are no carcinogenic COPCs for Beaver Pond surface water. The noncancer hazard for exposures to Beaver Pond surface water (0.017) is below the limit of 1.

The cancer risk for the RME adult resident exposed to Beaver Pond sediment (6.0×10^{-6}) exceeds the USEPA point of departure of 1×10^{-6} . Risk is primarily driven by arsenic through ingestion, with a risk of 5.3×10^{-6} . The noncancer hazard for exposure to Beaver Pond sediment (0.067) is below the limit of 1.

Child Resident. There are no carcinogenic COPCs for Beaver Pond surface water. The noncancer hazard for exposures to Beaver Pond surface water (0.027) is below the limit of 1.

The cancer risk for the RME child resident exposed to Beaver Pond sediment (6.7×10^{-6}) exceeds the USEPA point of departure of 1×10^{-6} . Risk is primarily driven by arsenic through ingestion, with a risk of 6.0×10^{-6} . The noncancer hazard for exposure to Beaver Pond sediment (0.30) is below the limit of 1.

Trespasser. There are no carcinogenic COPCs for Beaver Pond surface water. The total noncancer hazard (0.017) for the RME trespasser exposed to surface water at the Beaver Pond is below the acceptable limit of 1.

The total cancer risk (8.6×10^{-7}) for the RME trespasser exposed to sediment is below the departure point of 1×10^{-6} . The total noncancer hazard (0.038) for exposures to sediment is below the acceptable limit of 1.

TAMPEEL Caretaker. There are no carcinogenic COPCs for Beaver Pond surface water. The total noncancer hazard (0.015) for the RME TAMPEEL caretaker exposed to surface water is below the acceptable limit.

The total cancer risk (5.5×10^{-6}) for the RME TAMPEEL caretaker exposed to sediment is above the departure point of 1×10^{-6} . Risk is primarily driven by arsenic through ingestion, with a risk of 5.1×10^{-6} . The total noncancer hazard (0.059) for exposures to sediment is below the acceptable limit of 1.

TAMPEEL Student. There are no carcinogenic COPCs for Beaver Pond surface water. The total noncancer hazard (0.0086) for the RME TAMPEEL student exposed to surface water is below the acceptable limit of 1.

The total cancer risk (3.4×10^{-7}) for the RME TAMPEEL student exposed to sediment is below the 1×10^{-6} point of departure. The noncancer hazard for student sediment exposures (0.046) is below the acceptable limit of 1.

Construction Worker. There are no carcinogenic COPCs for Beaver Pond surface water. The noncancer hazard for exposures to Beaver Pond surface water (0.015) is below the limit of 1.

The cancer risk for the RME construction worker exposed to Beaver Pond sediment (2.3×10^{-7}) is below the USEPA point of departure of 1×10^{-6} . The noncancer hazard for exposure to Beaver Pond sediment (0.063) is below the limit of 1.

Lead. Lead in the Beaver Pond surface water is estimated at 0.007 mg/L, which is below the drinking water action level of 0.015 mg/L. Lead in sediment is estimated at 67 mg/kg, which is below the residential (400 mg/kg) and industrial (1,414 mg/kg) screening levels.

6.1.7.2.3 Study Pond

Adult Resident. There are no carcinogenic COPCs for Study Pond surface water. The noncancer hazard for exposures to Study Pond surface water (0.01) is below the limit of 1.

The cancer risk for the RME adult resident exposed to Study Pond sediment (1.5×10^{-6}) exceeds the USEPA point of departure of 1×10^{-6} . Risk is primarily driven by arsenic through ingestion, with a risk of 1.4×10^{-6} . The noncancer hazard for exposure to Study Pond sediment (0.048) is below the limit of 1.

Child Resident. There are no carcinogenic COPCs for Study Pond surface water. The noncancer hazard for exposures to Study Pond surface water (0.016) is below the limit of 1.

The cancer risk for the RME child resident exposed to Study Pond sediment (1.7×10^{-6}) exceeds the USEPA point of departure of 1×10^{-6} . Risk is primarily driven by arsenic through ingestion, with a risk of 1.6×10^{-6} . The noncancer hazard for exposure to Study Pond sediment (0.21) is below the limit of 1.

Trespasser. There are no carcinogenic COPCs for Study Pond surface water. The total noncancer hazard (0.01) for the RME trespasser exposed to surface water is below the acceptable limit of 1.

The total cancer risk (2.2×10^{-7}) for the RME trespasser exposed to sediment is below the departure point of 1×10^{-6} . The total noncancer hazard (0.027) for exposures to sediment is below the acceptable limit of 1.

TAMPEEL Caretaker. There are no carcinogenic COPCs for Study Pond surface water. The total noncancer hazard (0.0093) for the RME TAMPEEL caretaker exposed to surface water is below the acceptable limit.

The total cancer risk (1.4×10^{-6}) for the RME TAMPEEL caretaker exposed to sediment is above the departure point of 1×10^{-6} . Risk is primarily driven by arsenic through ingestion, with a risk of 1.4×10^{-6} . The total noncancer hazard (0.042) for exposures to sediment is below the acceptable limit of 1.

TAMPEEL Student. There are no carcinogenic COPCs for Study Pond surface water. The total noncancer hazard (0.0053) for the RME TAMPEEL student exposed to surface water is below the acceptable limit of 1.

The total cancer risk (8.3×10^{-8}) for the RME TAMPEEL student exposed to sediment is below the 1×10^{-6} point of departure. The noncancer hazard for student sediment exposures (0.034) is below the acceptable limit of 1.

Construction Worker. There are no carcinogenic COPCs for Study Pond surface water. The noncancer hazard for exposures to Study Pond surface water (0.057) is below the limit of 1.

The cancer risk for the RME construction worker exposed to Study Pond sediment (5.9×10^{-8}) is below the USEPA point of departure of 1×10^{-6} . The noncancer hazard for exposure to Study Pond sediment (0.046) is below the limit of 1.

Lead. Lead was not detected in Study Pond water. Lead in Study Pond sediment is estimated at 29 mg/kg, which is below the residential (400 mg/kg) and industrial (1,414 mg/kg) screening levels.

6.1.7.3 Groundwater

Table 6-22 summarizes selected COPCs for groundwater associated with the site. Metals and VOCs comprise selected COPCs. Cancer risk and hazard (non-cancer) results for each receptor are presented in Tables 6-23 and 6-24, respectively.

Adult Resident. The total cancer risk (2.2×10^{-7}) for the RME adult resident exposed to groundwater is below the departure point of 1×10^{-6} . The total noncancer hazard of 5.9 for exposures to groundwater is above the limit of 1. The greatest contribution to this hazard is from thallium and iron through ingestion exposure, with HQs of 3.3 and 1.6, respectively.

Child Resident. The total cancer risk (1.8×10^{-7}) for the RME child resident exposed to groundwater is below the 1×10^{-6} point of departure. The total noncancer hazard (22) for exposures to groundwater exceeds the limit of 1. The greatest contribution to this hazard is from thallium and iron through ingestion exposures, with HQs of 13 and 6, respectively. Also contributing to the hazard is aluminum through ingestion, with an HQ of 1.8.

Construction Worker. The total cancer risk (3.8×10^{-10}) for the RME construction worker exposed to groundwater is below the 1×10^{-6} point of departure. The total noncancer hazard (0.0071) for exposures to groundwater is below the limit of 1.

Lead in Groundwater. The maximum detected concentration of lead in groundwater is 0.0097 mg/L, which is less than the 0.015 mg/L action level.

6.1.7.4 Cumulative Risk and Hazard Across All Media

Receptors may be exposed to a combination of media such as soil, surface water, sediment, and groundwater. Therefore, the cumulative risks for plausible multiple media exposures are provided in Table 6-25 and are discussed below. In addition, the risk drivers for each media and the percent contribution of each are identified in Table 6-25.

Adult Resident. The cumulative cancer risk for the RME adult resident exposed to surface soil, surface water, sediment, and groundwater was 2.9×10^{-5} , which is above the departure point of 1×10^{-6} . The cumulative risk using values for total soil in place of surface soil are not given; however, the total risk for total soil is provided in Table 6-25. Exposure to surface soil and sediment are the greatest contributors to cumulative risk, primarily due to arsenic. The

cumulative noncancer hazard for the RME adult resident exposures to surface soil, surface water, sediment, and groundwater was 6.8, which is above the limit of 1. Exposure to groundwater is the greatest contribution to cumulative hazard, primarily due to iron and thallium.

Child Resident. The cumulative cancer risk for the RME child resident exposed to surface soil, surface water, sediment, and groundwater was 5.1×10^{-5} , which is above the departure point of 1×10^{-6} . Exposure to surface soil and sediment are the greatest contribution to cumulative risk, primarily due to arsenic and dibenz(a,h)anthracene. The cumulative noncancer hazard for the RME child resident exposures to surface soil, surface water, sediment, and groundwater was 28, which is above the limit of 1. Exposures to groundwater and surface soil are the greatest contribution to cumulative hazard, primarily due to aluminum, iron, and thallium.

Trespasser. The cumulative cancer risk for the RME trespasser exposed to surface soil, surface water, and sediment was 1.8×10^{-6} , which is above the departure point of 1×10^{-6} . Exposure to sediment is the greatest contribution to cumulative risk. No individual chemical exceeded 1×10^{-6} . The cumulative noncancer hazard for the RME trespasser exposures to surface soil, surface water, and sediment was 0.29, which is below the limit of 1.

TAMPEEL Caretaker. The cumulative cancer risk for the RME TAMPEEL caretaker exposed to surface soil, surface water and sediment was 2.2×10^{-5} , which is above the departure point of 1×10^{-6} . Exposure to surface soil and sediment are the greatest contribution to cumulative risk, primarily due to arsenic. The cumulative noncancer hazard for the RME TAMPEEL caretaker exposures to surface soil, surface water, sediment, and groundwater was 0.64, which is below the limit of 1.

TAMPEEL Student. The cumulative cancer risk for the RME TAMPEEL student exposed to surface soil, surface water, and sediment was 7.1×10^{-7} , which is below the departure point of 1×10^{-6} . The cumulative noncancer hazard for the TAMPEEL student exposures to surface soil, surface water, and sediment was 0.31, which is below the limit of 1.

Construction Worker. The cumulative cancer risk for the RME construction worker exposed to surface soil, surface water, sediment, and groundwater was 2.7×10^{-6} , which is above the departure point of 1×10^{-6} . Exposure to surface soil is the greatest contributor to cumulative risk, primarily due to arsenic. The cumulative noncancer hazard for the RME construction worker

exposures to surface soil, surface water, sediment, and groundwater was 1.6, which is above to the limit of 1. No individual chemical or medium HI was above 1.

Industrial Worker. The industrial worker exposure scenario only evaluated exposure to surface soil. At 6.8×10^{-6} , the cancer risk for the RME industrial worker exposed to surface soil exceeds the USEPA point of departure of 1×10^{-6} , primarily due to arsenic. The noncancer hazard (0.17) for exposures to surface soil is below the limit of 1.

6.1.8 Uncertainties Associated With the Human Health Risk Assessment

Calculated risk estimates are subject to varying degrees of uncertainty from a variety of sources. Areas of uncertainty in a risk assessment can be categorized as: generic or methodological and site-specific. Methodological uncertainties are those that are inherent to the methods or procedures used for risk assessments (i.e., policy decisions made to reflect USEPA's desire to err on the side of conservatism). Site-specific areas of uncertainty are those characteristics of the site or the investigation of the site that could result in overestimates or underestimates of risk. The most significant sources of uncertainty in the risk assessment are itemized and evaluated qualitatively for their potential to contribute to either the over- or underestimation of risk. Specific areas of uncertainty are discussed in following sections.

6.1.8.1 Methodological Uncertainty

There are four major areas of methodological uncertainty: uncertainty in the estimation of contaminant concentration, uncertainty in the estimation of exposure, and uncertainty in the estimation of toxicity, and uncertainty in the estimation of risk.

Contaminant Concentration. It is not possible to completely characterize the nature and extent of contamination at any site. In selecting COPCs, and in estimating concentrations, uncertainties arise from limits on the number and locations of environmental samples that can be collected to characterize a site and from eliminating constituents that are infrequently detected. These limitations may tend to over- or underestimate risk. However, when evaluating constituents with low detection frequencies, the use of the maximum detected concentration, in some instances, overestimates average exposures by an order of magnitude or more. Since exposures to any medium can be more accurately reflected by evaluating media concentrations over some area rather than by a single point, exposure estimates using maximum detected values overestimate the exposure for most exposed individuals. For instance, some COPCs in

groundwater were only detected once. In particular, thallium was a risk driver in groundwater, but was only detected in 1 of 9 samples. Methylene chloride, the only VOC detected in groundwater, had a frequency of detect of 1 of 6.

Exposure Assessment Standard assumptions for population characteristics, such as body weight or life expectancy, and exposure characteristics, such as frequency, duration, amount of intake or contact may not represent actual exposure conditions. Standard exposure assumptions are used to characterize residential groundwater exposures. The assumption that a population receives all of their liquid intake from one source is generally recognized as an overestimation of exposure.

An attempt is made to reflect site-specific exposure estimates in the characterization of soil exposures while maintaining a level of conservatism. Therefore, the magnitude of over- or underestimation of risk from soil exposures is expected to be minimal. As an example, the exposure parameters for the TAMPEEL student were very conservative. Students were known to attend only one class for two days; however, 20 days was used as the exposure frequency and two years was used as the exposure duration.

Toxicity Assessment The principal uncertainties associated with the toxicity assessment are:

- Extrapolation of toxic effects observed at the high doses necessary to conduct animal studies to effects that might occur at much lower, “real-world” doses; and
- Extrapolation from toxic effects in animals to toxic effects in man.

For noncancer effects, these uncertainties are given numerical value by using an uncertainty factor, which is actually a product of as many as five separate factors, each intended to account for one type of uncertainty (USEPA, 2002). For cancer effects, the uncertainty is addressed by estimating the 95 percent upper bound on the slope of the dose-response curve (USEPA, 2002). Utilizing the guidance of the USEPA will minimize uncertainties by using USEPA-derived toxicity values (USEPA, 2002 and 1997a) to evaluate the risks posed by constituents. The basis of USEPA policy in the derivation of toxicity values is to err on the side of conservatism, which may tend to overestimate risk. However, uncertainties associated with the lack of published toxicity data on many constituents would tend to balance any overestimation of risk by tending to underestimate risk from these constituents.

For chemicals without IRIS or HEAST toxicity criteria, provisional toxicity criteria were used if available (aluminum, iron, and beta-BHC, Table 6-6). Provisional toxicity criteria present a source of uncertainty, since USEPA has evaluated the compound, but consensus has not been established on the toxicity criteria. For this assessment, use of provisional toxicity criteria was preferable to not evaluating the chemical in order to limit data gaps. However, because the toxicity criteria have not been formally accepted by USEPA, there is uncertainty with these values and, therefore, with the risks calculated using these toxicity criteria.

The essential nutrients iron and manganese exceeded the PRG screening levels and were, therefore, carried through in the risk assessment. These two constituents were identified as risk drivers for soil and iron was identified as a risk driver for groundwater. When compared to the Recommended Dietary Allowance, however, concentrations of iron and manganese in soil are below these levels (Table 6-26). Therefore, iron and manganese in soil are not considered to be of concern for soil.

Risk Characterization. The adjustment of SFs and RfDs for use in calculations for dermal risk may present some uncertainty although it is expected that the adjustment would result in a conservative estimate. Risk is assumed to be additive for chemicals with similar sites of toxicological action. In the event that any combinations of these chemicals result in multiplicative effects, risk may be underestimated.

USEPA (1992b) guidance on risk assessment urges risk assessors to address or provide descriptions of individual risk to include the "high end" portions and "central tendency" of the risk distribution. Therefore, if either cancer or noncancer risk exceed generally acceptable limits (cancer risk greater than 1×10^{-6} (USEPA, 1990) or target organ-specific HI greater than 1 (USEPA, 1989a), the risk calculations were re-computed using CT values for as many intake model variables as possible. In contrast to the RME evaluation, which prevails in USEPA risk assessments, and uses upper-end values for intake or contact rates, exposure frequency and exposure duration, the CT evaluation chooses average or mid-range values for these variables (USEPA, 1991a). The intent is to present a quantified risk/hazard estimate more typical for the receptor of interest.

The CT exposure evaluation, however, falls short of its stated intent for several reasons. First, the same source-term concentration is usually used for the CT evaluation as is used for the RME

evaluation. USEPA (1993b) considers that the UCL or maximum detected concentration selected as a conservative estimate of average for the RME is appropriate for the CT estimates. Second, there is little information available as to what constitutes a reliable CT estimate for most exposure variables (USEPA, 1993b), with the possible exception of a simple on-site residential scenario. Hence, RME values are still used. Third, no CT toxicity values are available, so the uncertainty about the toxicity assessment is not included. A CT evaluation, therefore, usually provides little relief, compared with the RME, particularly for exposure scenarios such as the trespasser and construction worker, for which no reliable estimation of most exposure variable values can be made. CT risk and hazard calculation spreadsheets for each pathway and receptor are presented in Appendix K.

In Section 6.1.7.4, total cumulative risk and hazards were presented. As a conservative measure, exposure to all three surface water bodies (i.e., surface water and sediment) was included in the total risk and hazard estimates to represent the possible maximum exposure. An approach to prevent overestimation of cancer risk and hazard estimates, however, would have been to include the surface water or sediment grouping with the highest risk and/or hazard. For example, cancer risk estimates for sediment exposures to the three water bodies for the adult resident were 2.7×10^{-6} , 6.0×10^{-6} , and 1.5×10^{-6} . The total cumulative risk for all exposures to water bodies (see Table 6-25) for the adult resident is 2.9×10^{-5} . When using only the highest cancer risk value for all sediment exposures (6.0×10^{-6} , Beaver Pond) the total cumulative risk is estimated to be 2.5×10^{-5} .

6.1.8.2 Site-Specific Uncertainties

Site-specific uncertainties can be categorized into two major areas: analytical methodology and background. Each of these areas will be discussed in the context of the impact on risk assessment.

- **Analytical Methodology:** Some uncertainty may be introduced by combining the data sets from multiple investigations because there are differences in the compounds that have been analyzed.
- **Background:** Characterization of background involves some uncertainty due to the presence of other anthropogenic sources of organics and inorganics in the vicinity of TAMPEEL. In addition, background constituent concentrations were calculated differently for human health receptors than for ecological receptors. No background data are available for surface water and sediment; therefore, the selection of COPCs

and COPECs is a conservative estimate of site-related contamination. Groundwater wells used for the groundwater background characterization were in the Ohio Commerce Center area of the FLOD. The presence of shale in two TAMPEEL wells may have an effect on naturally occurring constituent concentrations in TAMPEEL groundwater.

The solubilities of iron and aluminum in neutral-pH are both below 1 mg/L. Measured concentrations of aluminum and iron in excess of ~1mg/L indicates the presence of suspended particulates (iron oxides in the case of iron and clay minerals in the case of aluminum). These groundwater samples were not filtered (following EPA and Ohio EPA sampling protocols). Therefore, the high levels of both aluminum and iron point to turbid samples rather than contaminated samples. In addition, the analytical data imply that the TAMPEEL groundwater samples reflect turbid samples rather than contaminated samples and do not exceed MCLs.

A risk assessment of a site is ultimately an integrated evaluation of historical, chemical, analytical, environmental, demographic, and toxicological data that are as site-specific as possible. To minimize the possibility of underestimating risk, each step was biased toward health-protective estimations. Because each step builds on the previous one, this biased approach mathematically compounds, and should more than compensate for risk assessment uncertainties that underestimate true risk. In addition, these calculations do not represent currently existing or expected future exposure or health risks. Rather, they are estimates of potential risk only if all of the conservative exposure assumptions are realized. This risk assessment does not represent a worst-case scenario; therefore, the potential for underestimating some risks to some receptors, however unlikely, does exist.

6.2 Ecological Risk Assessment

6.2.1 Introduction

An ERA is a process that can be used to estimate the risk or probability of adverse effects to biota. Estimates of risk to biota based on this ERA will be used to determine if risks are acceptable or if further assessment is necessary.

Ecological risk assessment is a qualitative and/or quantitative appraisal of the actual or potential effects of chemical or physical stressors on plants and animals other than people and domesticated species. The objective of this ecological risk assessment is to determine whether or not there are any potential adverse ecological effects that may be caused by exposure to potential

contaminants at the FLOD. The ERA focuses on four separate AOCs: (1) soil at the TAMPEEL Nature Center area (2) surface water and sediment at the Study Pond; (3) surface water and sediment at the Beaver Pond; and (4) surface water and sediment at Aspen Creek (including TAMPEEL Spring). The primary objective of the ERA is to determine whether unacceptable adverse risks are posed to ecological receptors as a result of the hazardous substance releases. This objective is met by characterizing the ecological communities in the vicinity of the AOCs, determining the particular hazardous substances being released from the AOCs, identifying pathways for receptor exposure, and determining the extent to which response actions are necessary. The ERA addresses the potential for adverse effects to the vegetation, wildlife, terrestrial invertebrates, aquatic life (including both fish and aquatic macro-invertebrates), endangered and threatened species, and wetlands or other sensitive habitats associated with the AOCs.

The ERA has been conducted in accordance with guidelines set forth in the *Tri-Service Procedural Guidelines for Ecological Risk Assessments* (Wentsel et al., 1996). Additional guidance sources include: *Framework for Ecological Risk Assessment* (USEPA, 1992e), *Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments* (USEPA, 1997b), and *Risk Assessment Handbook, Volume II: Environmental Evaluation* (USACE, 1996).

6.2.2 Problem Formulation

This section presents the problem formulation that establishes the goals, breadth, and focus of the ERA through an evaluation of COPECs, a characterization of the ecological communities, a selection of assessment and measurement endpoints, an identification of ecological receptors, and a presentation of an ecological conceptual site model.

6.2.2.1 Determination of COPECs

Soil, water, and sediment concentrations have been measured for a variety of organic and inorganic constituents at the site. A screening assessment was performed to focus the ERA on those constituents that are above background and above readily available screening concentrations published by EPA Region 5 and others, and are found with a frequency of detection greater than 5 percent. Four constituents (calcium, magnesium, potassium, and sodium) are essential nutrients in biological systems and were not considered as COPECs due to their very low potentials for producing toxic effects. Results of the background, frequency, and risk-based screening concentration screening assessments (using maximum detected site

concentrations), are presented in Tables 6-27 through 6-33 for each AOC. Note: few surface water and sediment samples were collected during the investigation, however, no surface water or sediment background data are available.

COPECs have been selected based on the list of chemicals present in site samples (CPSS). All chemicals detected in site media are considered CPSS. From the list of CPSS, COPECs have been selected using appropriate screening methodology as follows:

- The data for each chemical have been sorted by medium. For ecological impacts, soil from 0 to 2 feet has been considered. Available background data for soil have been used.
- Tables have been prepared for AOC soils, surface water, and sediment with the following information:
 - Chemical name
 - Frequency of detection
 - Range of detected concentrations
 - Range of detection limits
 - Statistical data distribution
 - Ninety-five percent UCL on the concentration mean
 - Available background concentrations
 - Appropriate risk-based screening concentration (RBSC)
 - Selection as COPEC (yes or no)
 - Exposure concentration.

Footnotes in the tables document the reason that the chemical was selected or rejected as a COPEC.

Methods for calculating the UCL are presented in Section 6.1. UCLs have been calculated for transformed (lognormal distribution) and nontransformed (normal distribution) data. Selection of the UCL value for the ERA have been based on the following criteria, based on the following procedure presented in the ERA Work Plan (IT, 1998b):

- If one of the two calculated UCLs exceeds the maximum concentration in the potential COPEC data set, then the other UCL has been used, unless it was less than 80% of the maximum concentration, in which case the maximum has been used as the UCL value.

- If both UCLs are below the maximum concentration in the potential COPEC data set, then the greater UCL has been used if greater than the 80% of the maximum concentration. If both UCLs are less than 80% of the maximum, the UCL is set at the default concentration of 80% of the maximum.
- If both UCLs exceed the maximum concentration in the potential COPEC data set, then both UCLs have been eliminated and the maximum concentration has been used as the UCL value.
- Chemicals that are detected infrequently (less than 5 percent) may be artifacts in the data that may not reflect site-related activity or disposal practices. These chemicals are not included in the risk evaluation. Based on qualitative evaluation of the data (Tables 6-27 through 6-33), no chemicals were detected infrequently at elevated concentrations that suggested the existence of “hot spots.”
- A comparison has been made between MDCs of chemicals in media and risk-based screening values for ecological endpoints following recommendations in USEPA Region 5 *BTAG Eco Risk Assessment Bulletin No. 1* (USEPA, 1996c). Chemicals that exceeded the risk-based value, or for which no risk-based value was available, have been retained as COPECs. The following risk-based screening values have been used for the ecological evaluation:
 - **Soil.** Soil screening values from USEPA Region 5 Ecological Screening Levels (USEPA, 2003) and if not available, from USEPA Region 3 *BTAG Screening Levels* (USEPA, 1995d).
 - **Surface Water.** USEPA Ecological Threshold (ET) screening values for freshwater (USEPA, 1996d), Ohio EPA Water Quality Criteria (Ohio River Basin Water Quality Criteria [OEPA, 1997] for outside mixing zone average and errata dated 12/10/97), and USEPA Region 3 BTAG Screening Levels (USEPA, 1995d) have been used.
 - **Sediment.** USEPA ET values for freshwater sediment and sediment criteria from the Ontario Ministry of the Environment [OME] (Persaud et al., 1992) have been used, as recommended per USEPA Region 5 guidance (USEPA, 1996c). If no values were available from this document, USEPA Region 3 BTAG Screening Levels were used (USEPA, 1995c).

An evaluation of all of the CPSS that were eliminated as COPECs was performed to determine whether any should be reinstated as COPECs due to other considerations. Based on an evaluation of potential break-down products, and chemicals with detection limits greater than the RBC screening values, no additional CPSS need to be reinstated as COPECs. However, several

chemicals known to be important bioaccumulative constituents (USEPA, 2000) were retained as COPECs.

Chemicals not eliminated using the screening processes are considered COPECs and have been quantitatively evaluated in the ERA.

6.2.2.2 Ecological Characterization

The ecological characterization section includes a general discussion of site background and AOCs, surface water resources, wetlands, vegetative communities, a species inventory, and a discussion on threatened and endangered species.

General Site Background. The site, approximately 514 acres in size, is located within the Glaciated Plateau physiographic region of the western Erie/Ontario Lake Plain Ecoregion (Lafferty 1979; Omernik, 1986), which is generally characterized as containing irregular plains as the predominant land-surface form and as having a dominant natural vegetation of beech/maple and northern hardwoods (such as maple, birch, beech, and hemlock) in undisturbed areas. The rolling terrain of the Glaciated Plateau has made it amenable to agriculture and urban development and as a result the natural habitats in this region are more modified than those found in other areas of northeastern Ohio. Forty one percent of Trumbull County, the county in which the site is located, is forest covered (Dennis and Birch, 1981), although the site itself has much less forest cover than this due to development activities associated with its historic and current industrial use. Numerous isolated woodlands of varying size, rather than the more extensive forests of the unglaciated region to the south, characterize the forest communities in the Glaciated Plateau. In this area of the Plateau, beech-sugar maple communities are expected to predominate on the better drained uplands, while hemlock-beech communities are more common on the steeper bluffs (Lafferty 1979). Site soils are poorly drained Mitiwanga and Wadsworth silt loams, with bedrock encountered 2 to 15 feet below the surface.

Site Areas of Concern. AOCs at the site include the landfill at the TAMPEEL compound area, surface water bodies such as the Study Pond, Beaver Pond, and Aspen Creek that originates from the north end of the landfill area, and area wetlands. Based on a site reconnaissance performed by IT Corporation on November 24, 1997, these areas are discussed in more detail below.

Surface Water. Aspen creek originates at the north end of the landfill and flows approximately 200 feet to the north before infiltrating into the ground during dry periods, or flows northeast to the unnamed tributary to Duck Creek. The Beaver Pond is approximately 1 to 2 acres in size, based on an aerial photograph taken in March 1992. During the site visit floating macrophytes (duck weed) were observed in the creek and emergent macrophytes were recorded along the southern edge of the Beaver Pond. The Beaver Pond has been stocked with bluegill, bass, and killifish in the past, according to TAMPEEL personnel. Beaver actively use the Beaver Pond area, which includes a large beaver lodge. The area immediately south of the Beaver Pond contains a flooded forest margin, likely due to recent enlargement of the Beaver Pond resulting from beaver dam building activity that has restricted outflow. Red maple and green ash have been recorded near the Beaver Pond. A creek flows out of the northern end of Beaver Pond, continues approximately 1.5 miles north until it flows into Duck Creek, and Duck Creek continues another two miles to the north before discharging into the Mahoning River.

The Study Pond is located northwest of the site on TAMPEEL Nature Center property and was formed after a borrow pit was created around 1985. The Study Pond is approximately 3/4 of an acre in size. This pond is recharged by groundwater and has no outlet. The Study Pond is approximately 20 feet deep and is bordered on the east and west sides by stands of white pine. A small spring is located west of Aspen Creek and this spring is the headwaters for another small creek that flows east to Beaver Creek.

Wetlands. According to the National Wetland Inventory (NWI) Map for the area (USFWS, 1977), the Beaver Pond is classified as a palustrine emergent/open water wetland, while the spring-feed creek is classified as a palustrine forested shrub/scrub wetland. As the Study Pond was created around 1985, it is not shown on the NWI map. Aspen Creek is not shown on the NWI map, but is most likely a palustrine forested shrub/scrub wetland. About 2- to 3-miles northwest of the ordnance site is a palustrine forested shrub/scrub wetland of approximately 8 acres in size (USFWS, 1977).

Vegetative Communities. Vegetative communities at the site were classified during the site reconnaissance trip using the 15 possible community types presented in Table 6-34. The three largest community types observed were moderate old field (OFM), moderate forest (FRM), and palustrine scrub/shrub and forested wetland (PSS/PFO) as shown in Figure 6-2. This general habitat figure presents the type and extent of biological communities present within the

immediate vicinity of each AOC. Developed and disturbed areas (DEV) were associated with the sheds located north of the site AOCs. The Beaver Pond was characterized as palustrine forested wetlands (PFO) and open water (OW), whereas the Study Pond was primarily an OW community. Aspen Creek is most likely a palustrine scrub/shrub wetland (PSS). Each of these habitat types, with the exception of DEV, 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, areas were examined for vegetative stress, including plants displaying stunted growth, poor foliage growth, tissue discoloration, and a loss of leaf coverage. No vegetative stress was observed at any of the AOCs. However, Aspen Creek was not evaluated. It should be noted, however, that the time of year (November) may have limited the accuracy of this visual evaluation of vegetative stress.

Species Inventory. Based on information collected during the site reconnaissance, species lists were prepared for mammals, birds, reptiles and amphibians (Tables 6-35 through 6-38). Information on species presence/absence was recorded by IT field scientists and was supplemented by information provided by TAMPEEL personnel that have been recording species information at the site since 1975. The TAMPEEL nature center is located immediately to the west of the site and provides environmental education to elementary school children of Trumbull County. Common trees and shrubs in the TAMPEEL area, according to TAMPEEL personnel, include elm, red maple, ash, red oak, white oak, dogwood, cherry, hawthorn, beech, quaking aspen, autumn and Russian olive, and golden rod. Additional plant species information has been presented previously.

Of the 46 species of mammals that may be found in the region based on species range maps, 22 species (48 percent) have been observed onsite (Table 6-35), including opossum, moles, bats, rabbits, woodchuck, squirrel, chipmunk, shrew, beaver, mice, muskrat, raccoon, skunk, weasel, fox, and deer. There is an active beaver lodge situated in the Beaver pond and considerable evidence of recent beaver activity, in the form of gnawed tree stumps and wood chips around the pond, was observed during the site reconnaissance.

Of the 125 species of birds that may be found in the region based on species range maps, 64 species (51 percent) have been observed onsite (Table 6-36), including heron, duck, geese, hawks, vultures, quail, pheasant, grouse, rail, killdeer, woodcock, dove, owl, swift, hummingbird, kingfisher, flicker, woodpecker, sapsucker, waxwing, creeper, crow, jay, cardinal, goldfinch, junco, sparrow, bunting, grosbeak, towhee, martin, swallow, blackbird, oriole, cowbird, grackle, catbird, thrasher, chickadee, titmouse, warblers, nuthatch, starling, tanager, wren, thrush, bluebird, and robin. Some of these species are migratory and would only be expected to be at the site during spring and fall migrations. In the Glaciated Plateau, in which the site is located, a combination of woodlands, successional, edge and wetland habitats interspersed with farmlands and urban areas produces the greatest diversity of habitats for breeding birds in the state of Ohio (Peterjohn and Rice, 1991). It should be noted that TAMPEEL personnel mentioned the presence of a large great blue heron rookery within several miles of the site (at the Lordstown General Motors Fabrication Plant) that contains approximately 200 nests.

Of the 27 species of reptile that may be found in the region based on species range maps, six species (22 percent) have been observed onsite (Table 6-37), including turtles and snakes.

Of the 23 species of amphibians that may be found in the region based on species range maps, seven species (30 percent) have been observed at the FLOD (Table 6-38), including salamanders, toads, and frogs.

Threatened and Endangered Species Information. According to an Ohio Division of Natural Areas & Preserves review of their Natural Heritage maps and files (ODNR, 1997) [Appendix ECO-NEW]), there are no records of rare or endangered species in the FLOD project area, including a mile radius of the site. There are also no existing or proposed state nature preserves or scenic rivers within one mile of the project site, and ODNR is unaware of any unique ecological sites, geological features, breeding or non-breeding animal concentrations, champion trees, or state parks, forests or wildlife areas.

6.2.2.3 Selection of Assessment and Measurement Endpoints

The protection of ecological resources, such as habitats and species of plants and animals, is a principal motivation for conducting an ERA. 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.

An ecological endpoint is a characteristic of an ecological component that may be affected by exposure to a chemical stressor. Assessment endpoints represent environmental values to be protected and generally refer to characteristics of populations and ecosystems (Suter, 1993). Unlike the human health risk assessment process, which focuses on individual receptors, the ERA focuses on populations or groups of interbreeding nonhuman, non-domesticated receptors. In the ERA process, the risks to individuals are assessed only if they are protected under the Endangered Species Act, as well as species that are candidates for protection and those 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 were considered in selecting assessment endpoints suitable for this ecological risk assessment were: (1) ecological relevance, (2) susceptibility to the contaminant(s), (3) accessibility to prediction and/or measurement, (4) societal relevance, and (5) definable in clear, operational terms (Suter, 1993).

Information gained during the site reconnaissance was used to select 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 ERA (Table 6-39).

Assessment Endpoints. The assessment endpoints for FLOD are stated as the protection of long-term survival and reproductive capabilities for terrestrial invertebrates, small herbivorous mammals, small omnivorous mammals, small carnivorous mammals, large carnivorous mammals, omnivorous birds, carnivorous birds, benthic invertebrates, aquatic vertebrates (fin fish), herbivorous aquatic mammals, and piscivorous aquatic birds. The corresponding null hypothesis (H_0) for each of the assessment endpoints is stated as: the presence of site contaminants within surface soil, surface water, sediment, vegetation, and prey will have no effect on the survival or reproductive capabilities of terrestrial invertebrates, small herbivorous

mammals, small omnivorous mammals, small carnivorous mammals, large carnivorous mammals, omnivorous birds, carnivorous birds, benthic invertebrates, aquatic vertebrates (fin fish), herbivorous aquatic mammals, and piscivorous aquatic birds.

Assessment receptor species were selected based on the likelihood of finding the species at FLOD. Historical information, the site reconnaissance (performed November 24, 1997), and the availability of toxicological data were used to select terrestrial and aquatic receptor species. These receptors species are depicted in a food web model. 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, surrogate species have been selected to represent broad classes, or guilds, in these food web models.

A terrestrial food web conceptual site model (Figure 6-3) and an aquatic food web conceptual site model (Figure 6-4) were developed to illustrate how the selected terrestrial and aquatic species, respectively, are ecologically linked within food webs. One species was used to represent each of the 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 vertebrates 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. 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 FLOD receptor species are provided in Section 6.2.3.2.

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 finfish fulfill the role of aquatic herbivorous (feeding on aquatic plants and suspended detritus) and predatory vertebrates (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 great blue heron was included in the aquatic food web as a top trophic-level piscivore 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.

Measurement Endpoints. Measurement endpoints are defined as a measurable ecological characteristic that is related to the valued characteristic chosen as the assessment endpoint (USEPA, 1992e). 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 survey of existing impacts (USEPA, 1994b).

For this assessment measurable responses to stressors include lowest observed adverse effect levels (LOAEL), no observed adverse effect levels (NOAEL), LC₅₀s (lethal concentration to 50 percent of the test population), or LD₅₀s (lethal dose to 50 percent of the test population). The most appropriate measurement endpoint(s) were chosen based on exposure pathways as well as ecotoxicity of the contaminant.

6.2.2.4 Identification of Representative Ecological Receptors

This section presents the selection and rationale for representative terrestrial and aquatic ecological receptors at the site.

Terrestrial. Six representative receptor species that have been documented in the area of the FLOD (Section 6.2.2.2) 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. The six 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), red fox (*Vulpes vulpes*) (medium-sized carnivorous mammal), American robin (*Turdus migratorius*) (small omnivorous bird), and red-tailed hawk (*Buteo jamaicensis*) (large, carnivorous bird).

The deer mouse, Eastern cottontail, and shrew, represent the prey base for the large predators of the area (represented by the red fox and red-tailed hawk). A terrestrial food web is presented in Figure 6-3. Many of these species have limited home ranges, particularly the deer mouse, cottontail, shrew, and American robin, 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* (USEPA, 1993c).

Larger mammal species, such as white-tailed deer, were not selected as sensitive receptors due to their large home ranges, however, the far-ranging red-tailed hawk and red fox were retained due to their unique role as top predators in the food chain. Smaller birds were generally not included because most are migratory, although it should be noted that the robin is a migratory species, but has been assumed to be non-migratory for the ERA. 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.

Aquatic. The aquatic habitats at or adjacent to the site include the Beaver and Study ponds, the unnamed creek that flows into the Beaver pond, the TAMPEEL spring, the TAMPEEL stream, and the palustrine forested shrub/scrub wetlands along the riparian systems and located northwest of the site (Section 6.2.2.2). Exposure to aquatic organisms within the water bodies is assumed to occur via direct exposure to contaminants in the water column and via ingestion of benthic invertebrates and pelagic prey exposed to contaminants in surface water and sediment. Potential effects to fish, macroinvertebrates, and phytoplankton (algae) were assessed using available surface water and sediment quality criteria for the protection of aquatic life. Potential uptake through the food chain was evaluated for three representative receptors, including the bluegill (*Lepomis macrochirus*) (a representative medium-sized benthic/pelagic omnivore that serves as a prey item for great blue heron), the great blue heron itself (*Ardea herodias*) (large-sized aquatic predator) and the beaver (*Castor canadensis*) (large-sized semi-aquatic herbivore). It should be noted that a large great blue heron rookery is located within a few miles of the site and an active beaver lodge is situated within the Beaver Pond.

Fish and other aquatic organisms represent the prey base for aquatic predators (represented by the great blue heron). An aquatic food web is presented in Figure 6-4. The selected receptor species have relatively small home ranges, which makes them particularly vulnerable to exposure to site contaminants. Foraging factors were conservatively set to 100 percent for all of the aquatic receptors evaluated in this ERA. All of the selected aquatic receptor species have been documented on site (Section 6.2.2.2), 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, the selected species have readily available exposure data, as summarized in the *Wildlife Exposure Factors Handbook* (USEPA, 1993c) (for the heron) and, for the beaver, in *A Guide to the Mammals of Ohio* (Gottschang, 1981).

Other water fowl were not included as representative receptors because they are migratory, although it should be noted that the great blue heron is a migratory species, but has been assumed to be non-migratory for the ERA. The potential risk to migratory avian species will be included within the predicted risks to the selected aquatic indicator receptors.

6.2.2.5 Presentation of Conceptual Site Model

A conceptual site model (Figure 6-5) presents potential exposure pathways and receptors evaluated in the ecological risk assessment. The food webs depicted in this conceptual site model 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, surrogate species have been selected to represent broad classes, or guilds, in the food webs and conceptual site model.

The conceptual site model (Figure 6-5), along with the terrestrial and aquatic food webs (Figures 6-3 and 6-4), were developed to illustrate how the selected terrestrial and aquatic species, respectively, are ecologically linked within food webs.

6.2.2.6 Problem Formulation Summary

Based on the information presented previously for the Problem Formulation (Sections 6.2.2.1 through 6.2.2.5), a Phase I ERA is warranted for the site given the following:

- Forty-four COPECs were selected for site soils, 31 COPECs were selected for site sediments, and seven COPEC was selected for site surface water,
- Sensitive ecological features exist at the site, such as surface water, wetlands, and wildlife habitat,
- Numerous species of mammals, birds, reptiles, amphibians, and finfish either have been documented at the site, or are expected given the available habitat, although no threatened or endangered species have been documented,
- Appropriate assessment and measurement endpoints may be selected for the site, and
- Appropriate representative receptor species may be selected for the site.

6.2.3 Exposure Assessment

Exposure characterization is critical in further evaluating the risk of compounds identified as COPECs during the screening process. The exposure assessment characterizes the magnitude (concentration) and distribution (locations) of the constituents detected in the media sampled during the investigation, evaluates pathways by which chemicals may be transported through the environment, and determines the points at which organisms found in the study areas may contact constituents. The ecological conceptual site models (discussed previously) presented the ecological receptors at the site that are potentially exposed to hazardous substances in media across several pathways.

Ecological exposure pathways for biota may be direct or through the food web by consuming contaminated organisms. Direct exposure pathways 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.

Food web exposure pathways for biota can occur when terrestrial or aquatic fauna consume previously impacted biota. Examples of food web exposure include animals at higher trophic levels consuming plants or animals that bioaccumulate contaminants.

Uptake of biota could result from exposure to one or more COPECs. 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 is a function of several physical and chemical environmental factors.

Exposure pathways consist of four components: source and mechanism of contaminant release, transport medium, potential receptors, and exposure route. If any of these components are not complete, then constituents in those media do not constitute an environmental risk at that specific site.

The concepts of bioconcentration, bioaccumulation, and biomagnification have been used throughout this ERA. The following definitions describe their application in this assessment approach.

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. Bioaccumulation refers to the uptake and retention of a substance by an aquatic organism from its surrounding medium and food (USEPA, 1993c). Biomagnification refers to the process by which tissue concentrations of bioaccumulated toxic substances increase as the substances pass up through two or more trophic levels (Suter, 1993).

For this approach, definitions for these terms for terrestrial and aquatic organisms are similar. As aquatic bioconcentration focuses on the organism-level uptake and retention of constituents, terrestrial bioconcentration focuses on uptake and retention of constituents from the surrounding medium on the organism level (as by the earthworm, for example). Terrestrial bioaccumulation, as with aquatic bioaccumulation, is defined as an organism's uptake and retention of a substance from its surrounding medium and food. Similarly, terrestrial biomagnification retains the same definition as that for aquatic organisms.

Exposures to COPECs in the indicator wildlife species were estimated from the measured soil, sediment, and surface water concentrations using the methods described in the EPA's "Wildlife Exposure Factors Handbook" (USEPA, 1993c). It should be noted that concentrations in surface soil (0-2 foot depth) were used in the ERA. Results from subsurface soil (2-6 foot depth) were not used per a stipulation from the OEPA. Groundwater was not evaluated as an exposure medium in the ERA as results were available from surface water and to date it has not been demonstrated that impacted groundwater is discharging to surface water. For soil, sediment, and surface water, only the dietary exposure pathway was considered. The inhalation and dermal contact pathways were not considered to be significant pathways for COPECs in soil. Although both of these pathways may lead to additional absorption of the COPECs, both are also linked to ingestion by the ingestion of soil particles that have been entrapped in the mucus lining of the nasal cavity and throat and the ingestion of soil through grooming. The absorption of COPECs from soil particles directly through the lungs or skin is expected to be insignificant compared with the daily dietary intake of soil.

Exposures for the mouse, shrew, rabbit, beaver, American robin, and great blue heron were based on the conservative assumption that 100 percent of the receptor's home range is impacted, regardless of the potential size of the species' home range. For the fox and hawk a very conservative foraging factor of 100 percent was initially used in the assessment. However, if needed, a more realistic foraging factor could be estimated based on the size of each AOC and published home range data. A more realistic foraging factor for both the fox and hawk could be set at 0.01, suggesting that these two receptors would spend one one-hundredth of their time foraging at the site for prey items. The use of a foraging factor of 0.01 would be realistically conservative as the home ranges for the fox and hawk average 2,565 and 2,081 acres, respectively (USEPA, 1993c), while the landfill at TAMPEEL is approximately two acres. Note: as summarized in Table 6-40, the use of fox and hawk foraging factors of 0.01 was completed (Appendix L) for specific chemicals at each AOC, as initial hazard estimates for both of these receptors were greater than 1.0 (Section 6.2.5.1).

The basic equation for estimating dose through the dietary pathway is:

$$D_p = \sum_{k=1}^m (C_k \bullet F_k \bullet I_k) / W$$

where:

- D_p = the potential average daily dose (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).

Table 6-41 presents the natural history data used in modeling the exposure in each of these species, including the average or midpoint body weight, the total ingestion rate, and the fraction of the diet composed of various food types. Data presented in this table is from the Receptor Parameter Assumptions Table (Appendix L). Because the calculation of C_k is based on the measured soil concentration, food items of a particular type are considered to be equally contaminated throughout the entire home range of the receptor and, therefore, F_k is 1, although a foraging factor of 0.01 could be used for the hawk and the fox receptors. Estimated home range sizes for the indicator species are also presented in Table 6-41.

The COPEC concentration in ingested soil was taken to be the upperbound concentration calculated from the measured soil concentration, as discussed in Section 6.2.2.1. For plants and soil invertebrates, soil-to-organism transfer factors were used to estimate the COPEC concentrations in their tissues on a dry weight basis. For organic COPECs in plants, the regression equation developed by Travis and Arms (1988) was used to derive the soil-to-plant transfer factor from the logarithm of the octanol/water partition coefficient (log K_{ow}) value of the compound. Soil-to-plant transfer factors for inorganics are from IAEA (1994)(uptake specific to grasses), Arthur and Gates (1988), and Baes et al. (1984). The latter is based on unspecified agricultural plants.

For organic COPECs in soil invertebrates, the transfer factor was derived from the equation developed by Connell and Markwell (1990) for bioaccumulation in earthworms:

$$BF = \frac{y_L \bullet K_{ow}^{b-a}}{x \bullet f_{oc}}$$

where:

- BF = 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 (0.07 – OEPA recommended value) 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).

The fraction of organic carbon in the soil was estimated to be the same as that measured in site sediment (2.6 percent, IT, 1998b), as site-specific soil f_{oc} data were not available. This is a reasonable assumption as the sediment in the creek and ponds is expected to be derived from soil runoff in the immediate watershed. Except where literature-derived values are available, the soil-to-invertebrate transfer factors for inorganics were assumed to be 1. Table 6-42 presents the soil/sediment-to-plant and soil/sediment-to-invertebrate transfer factors estimated for the organic and inorganic COPECs, respectively. The COPECs in these tables are limited to those that were not dropped during the screening assessment (Section 6.2.2.1). As use of the organic soil/sediment-to-invertebrate TFs results in invertebrate wet weight COPEC concentration, they were subsequently converted to dry weight concentrations using a value of 61 percent water content in beetles (USEPA, 1993c), as follows:

$$\frac{\text{Wet weight concentration}}{(1 - 0.61)} = \text{Dry weight concentration}$$

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 IAEA (1994) and Baes et al. (1984). A weighted average of the concentrations of all food items (including ingested soil or sediment) was then used in the calculation of tissue concentrations in prey species and the dietary exposure rate in all indicator species, as follows:

$$\frac{\text{Total intake of soil, water, plants, and invertebrates (in mg COPEC/day)} \times \text{Food-to-Tissue TF}}{0.32 \times \text{Total food and soil intake (in kg mass/day)}}$$

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, passerine birds, and fish is reported to be 68 percent (Table 4-1 in USEPA, 1993c).

Adjustments have been made for the potential biomagnification of contaminants through aquatic trophic levels. Food chain multipliers (FCM), derived by USEPA (1995f), have been used to assess the possibility of contaminant magnification through site receptors. The FCMs are multiplied by chemical-specific bioconcentration factors (BCF) to obtain bioaccumulation factors (BAF). The ERA has used laboratory-measured BCF values obtained from the scientific literature.

Per USEPA (1995f) guidance, aquatic BAFs have been estimated by one of four methods (in order of preference):

- A measured BAF for an inorganic or organic chemical derived from a field study
- A predicted BAF for an organic chemical derived from a field-measured biota-sediment accumulation factor (BSAF)
- A predicted BAF for an inorganic or organic chemical derived from a laboratory-measured BCF and a FCM
- A predicted BAF for an organic chemical derived from a K_{ow} and a FCM.

The USEPA guidance notes, however, that for chemicals for which no K_{ow} is available, and for which no BCF is calculable, a default FCM of 1.0 should be used. Thus, for inorganics not thought to biomagnify and/or which no literature value is available, a value of 1.0 has been used at each trophic level. FCMs are presented in Table 6-43 for surface water COPECs.

6.2.3.1 Exposure Pathways

Exposure pathways evaluated in this ERA include soil, sediment, surface water and groundwater. A conceptual site model is presented in Figure 6-5.

Soil Exposure Pathway. Soil exposure pathways are potentially important for terrestrial plants and animals at the site. The vast majority of exposure to soil contaminants is in surface rather than deeper soil. For animal exposure, soil samples obtained from a depth of 0 to 2 feet has been considered, as this would be the point of exposure for both above ground exposure and below ground burrowing animals. For plant exposure, soil samples taken from 0 to 2 feet have also been considered.

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. For aluminum, soil pH greater than 5.5 generally limit this inorganics bioavailability (USEPA, 2000a). Literature values for soil-to-plant transfer rates for inorganic and organic soil contaminants and for organic soil contaminants have been used unless contaminant-specific information is available.

Sediment Exposure Pathway. Sediment consists of materials precipitated or settled out of suspension in surface water. 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 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, including PCBs 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 the 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. Water hardness, pH, and total suspended solids control chemical bioavailability of some metals and other chemicals.

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. Contaminant transport along the shallow groundwater pathway maybe an exposure route to aquatic life, wetlands, and some wildlife where the groundwater discharges to surface water. The potential impact of groundwater to surface water has been examined though direct sampling and evaluation of surface water.

6.2.3.2 Receptor Profiles

This section presents brief receptor profiles for the representative receptors selected for the site.

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 Northwest 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 (USEPA, 1993c). Home range is 0.5 to 3 acres

(Burt and Grossenheider, 1980). Density of populations is 4 to 12 mice per acre, and average life span is two 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 grayish to reddish-brown with a white belly, with a distinctly short-haired, bicolor tail (Whitaker, 1995). Weight range is 14.8 (USEPA, 1993) to 33 grams (Whitaker, 1995).

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. (USEPA, 1993c). 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 (USEPA, 1993c). Open grassy areas are generally used for grazing at night, whereas dense, heavy cover typically is used for shelter during the day (USEPA, 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) (USEPA, 1993c). 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 (USEPA, 1993c).

Short-tailed Shrew (Blarina brevicauda)

This shrew is the largest found in North America. It is solid gray 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 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 (USEPA, 1993c). Their home range varies from 0.5 to 1 acre (Burt and Grossenheider, 1980). Longevity is typically around 20 months (USEPA, 1993c), with 5 to 8 young born to each of 2 to 3 litters (Burt and Grossenheider, 1980).

American Robin (Turdus migratorius)

The omnivorous American robin commands a vast range across North America. Its breeding range extends from Alaska east across the continent to Newfoundland, and south to California, Texas, Arkansas, and South Carolina. The robin winters north to British Columbia and Newfoundland (Bull and Farrand, 1995). The preferred habitat of the robin includes towns, gardens, open woodlands, bogs and swamps, and agricultural land (Bull and Farrand, 1995). Access to fresh water, protected nesting sites, and productive foraging areas are important requirements for breeding robins (Speirs, 1953). The American robin consumes a combination of fruits and terrestrial invertebrates. On average, over the course of the seasons, its dietary fraction is 52 percent fruits (plums, dogwood, sumac, hackberries, blackberries, cherries, greenbriers, and raspberries) and 48 percent invertebrates (earthworms, beetles, caterpillars, moths, grasshoppers, spiders, and millipedes) (USEPA, 1993c). Foraging range is approximately two acres (Weatherhead and McRae, 1990) and territory size is approximately 0.37 acres (Howell, 1942). Average weight is 77.3 g (Clench and Leberman, 1978), and life span averages 1.35 years (Farner, 1949).

Red-Tailed Hawk (Buteo jamaicensis)

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 stream-side 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). Breeding population density is one nest per 0.009 acre or one individual per 0.004 acre. Body weight for male red-tails is 957 to 1,204 grams, and for females 1,154 to 1,235 grams (USEPA, 1993c). They typically mate for life or until one of the pair dies, with pairs clinging to territories year after year (Austing, 1964).

Red Fox (Vulpes vulpes)

Red foxes are present throughout the United States and Canada except for much of the west coast; southwest (southern California, northern Nevada, and Arizona); southern Alberta and southwestern Saskatchewan to southwestern Oklahoma; northwestern Texas and the southeastern United States (coastal North Carolina to peninsular Florida) (Whitaker, 1995). This fox is most active at night, early morning, and late evening, but is often active in the day. A mixture of forest and open country is the preferred habitat of the fox. Omnivorous, it preys extensively on mice and voles, but also feeds on other small mammals, insects, hares, game birds, poultry, and occasionally seeds, berries, and fruits (Burt and Grossenheider, 1980). Foxes do not hibernate in the winter, and are active all year round (Whitaker, 1995). Home territory size can range from 2,590 to 5,180 acres (Burt and Grossenheider, 1980), and one red fox family per 247 to 2,471 acres is typical (USEPA, 1993c). The dog-sized fox has a body approximately 56 to 63 centimeters in length, with a 35 to 41 centimeter tail. They weigh from 3 to 7 kilograms, with the males usually outweighing the females by about one kilogram (USEPA, 1993c).

Beaver (Castor canadensis)

The beaver is found in most of Canada and the United States except for most of Florida, much of Nevada, and southern California (Burt and Grossenheider, 1980). Preferred habitat includes lakes, ponds, rivers, and streams, which it often alters to form a pond. Beavers living along a river make burrows with an underwater entrance in the riverbank; those in streams, lakes, and ponds usually build dams that generally incorporate a lodge (Burt and Grossenheider, 1980). Their preferred diet consists of aspen, poplar, birch, maple, willow, and alder bark, as well as twigs. Branches and small sections of logs are stored underwater near the lodge for later feeding or use (Whitaker, 1995). Home range of the beaver is around 100 meters from the lodge (Gottschang, 1981). Young are born once a year, between April and July, and the litter typically consists of 2 to 4 kits. The average life span in the wild is 11 years (Burt and Grossenheider, 1980). Beaver body weight ranges from 18 kilograms (Gottschang, 1981) to 27 kilograms (Whitaker, 1995).

Great Blue Heron (Ardea herodias)

The great blue heron is the largest member of its group in North America (99 to 132 centimeters) (USEPA, 1993c; Bull and Farrand, 1995). It ranges from coastal Alaska, and Nova Scotia south to Mexico (Bull and Farrand, 1995). Habitat of this heron includes both fresh and marine waters, including freshwater lakes and rivers, brackish marshes, lagoons, mangroves, and coastal

wetlands, particularly where small fish are plentiful (USEPA, 1993c). Great blues tend to nest in dense colonies, or heronries. The location of the heronry is generally close to foraging grounds, and tall trees are preferred over shorter trees or bushes for nest sites. There is a heronry several miles from the FLOD (Section 6.2.2.2). Fish are the preferred prey, but the heron will also eat crustaceans, amphibians, reptiles, insects, birds, and mammals. Foraging home range may be as great as 24 kilometers, and population densities along streams and rivers range from 2.3 to 3.6 birds per kilometer (USEPA, 1993c). Once a year the female will lay 2 to 7 eggs (Bull and Farrand, 1995), and the first year mortality rate is approximately 64 percent (USEPA, 1993c).

6.2.4 Ecological Effects Characterization

The ecological effects characterization (toxicity assessment) includes an endpoint selection and determination of toxicity reference values used in the ERA.

6.2.4.1 Endpoint Selection

As discussed in Section 6.2.2.3, measurement endpoints are defined as a measurable ecological characteristic that is related to the valued characteristic chosen as the assessment endpoint (USEPA, 1992e). 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 survey of existing impacts (USEPA, 1994b).

For this assessment, measurable responses to stressors include toxicity reference values such as LOAEL, NOAEL, LC₅₀s, or LD₅₀s,. The most appropriate measurement endpoint(s) have been chosen based on exposure pathways as well as ecotoxicity of the contaminant.

6.2.4.2 Toxicity Reference Values

NOAELs for chronic oral exposure were used as benchmarks for toxic effects to wildlife. Because the NOAELs for the indicator wildlife species are based on NOAELs from test species, the latter were converted to NOAELs specific to indicator species using a power function of the ratio of body weights, as described by Sample et al. (1996). Thus:

$$NOAEL_W = NOAEL_T \left(\frac{BW_T}{BW_W} \right)^s$$

where:

- NOAEL_W = the No Observed Adverse Effect Level for the wildlife indicator species (mg/kg-day)
 NOAEL_T = the No 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 COPECs (Table 6-45) are contained in the ecological spreadsheets presented in Appendix L.

When only subchronic oral NOAEL_T values were available, these were converted to chronic NOAEL_T values by applying an uncertainty factor of 0.2 (Sample et al., 1996). When NOAELs were not available for test species in the same class as the indicator wildlife species (i.e., mammal or bird), no interclass extrapolations were performed, as per recommendations from OEPA. In cases where only an acute toxicity value was available for a specific COPEC (e.g., a lethal dose to 50 percent of the test population [LD₅₀]), but both a NOAEL and LD₅₀ value were available for a closely related compound in the same test species, then the NOAEL_T for the COPEC was estimated using the relationship from Sample et al. (1996):

$$NOAEL_{TX} = LD_{50TX} \left(\frac{NOAEL_{TY}}{LD_{50TY}} \right)$$

where:

- NOAEL_{TX} = the No Observed Adverse Effect Level for COPEC X in test species T (mg/kg-day)
 LD_{50TX} = the acute lethal dose to 50 percent of the test population of test species T for COPEC X (mg/kg)
 NOAEL_{TY} = the No Observed Adverse Effect Level for compound Y (closely related to COPEC X) in test species T (mg/kg-day)

LD_{50TY} = the acute lethal dose to 50 percent of the test population of test species T for compound Y

Table 6-44 presents the $NOAEL_T$ values used to determine the $NOAEL_W$ values for the indicator wildlife species at the TAMPEEL site. Insufficient toxicity information could be found to estimate the $NOAEL_W$ values for a few of the COPECs. Those COPECs for which sufficient toxicity data could not be found are listed in Table 6-45. This data gap is discussed in the uncertainties section (Section 6.2.6).

Soil benchmark concentrations for toxicity to terrestrial plants and soil invertebrates were available for several of the COPECs at the site (Will and Suter, 1995a and b). These are shown in Table 6-46 for organic and inorganic COPECs, respectively.

6.2.5 Risk Characterization

This section presented results of the terrestrial and aquatic risk characterization.

6.2.5.1 Terrestrial Risk Characterization

The HQ, which is the ratio of the modeled exposure to the NOAEL of the indicator species, determines potential risk to the indicator wildlife species. HQs greater than 1.0 indicate a potential risk of adverse toxic effect to individuals of that species at the point of maximum exposure. HQs were summed to obtain a HI for each receptor. This is a conservative health-protective approach as not all COPECs have the same toxicity endpoint; HQs may be segregated and summed separately for those that affect the same organ systems. Terrestrial HIs are summarized in Table 6-47 by AOC and media, with details presented in the risk characterization spreadsheets presented in Appendix J. HIs were estimated to be above 1,000 for the shrew; between 1,000 and 100 for the deer mouse, cottontail, and robin; between 100 and 10 for the fox, and less than 10 for the hawk. The most important soil risk driver for the deer mouse, cottontail, shrew, and fox was aluminum, whereas the primary risk driver for the robin and hawk were zinc and barium, respectively. A summary of soil risk drivers that contributed approximately 50 percent of the total hazard, is presented below (from Table 6-47):

Mouse	Cottontail	Shrew	Robin	Fox	Hawk
Aluminum	Aluminum	Aluminum	Zinc	Aluminum	Barium
					Chromium

Ingestion of water from all three water bodies resulted in HQ values less than 1.0 for all terrestrial receptors (Table 6-47). For aquatic receptor surface water exposure (i.e., drinking water or consuming prey that are exposed to surface water), zinc in Aspen Creek was the primary risk driver (Tables 6-47 and 6-48). Toxicity profiles for these risk drivers are presented in Appendix M.

Potential toxicity to plants was indicated by elevated surface soil concentrations of 12 inorganics (aluminum, arsenic, barium, chromium, copper, lead, manganese, mercury, nickel, selenium, vanadium, and zinc) (Table 6-46). It should be noted that many organic COPECs did not have any available benchmarks and no conclusions could be made as to whether or not these COPEC concentrations were potentially detrimental to terrestrial plants. However, those COPEC that did have plant benchmarks (Aroclor 1254, Aroclor 1260, and acenaphthene), exhibited HQs less than 1.0.

Potentially adverse effects to soil invertebrates were also indicated by surface soil concentrations of chromium, copper, lead, mercury, and zinc (Table 6-46). It should be noted that many COPECs did not have any available benchmarks and no conclusions could be made as to whether or not these COPEC concentrations were potentially detrimental to soil macroinvertebrates.

6.2.5.2 Aquatic Risk Characterization

This aquatic assessment presents an exposure assessment, a risk characterization for semi-aquatic mammals and birds, a risk characterization for aquatic life, and a risk characterization for benthic biota.

Exposure Assessment. The aquatic sites of concern, as discussed in IT (1998b), with regard to the aquatic risk assessment are Aspen Creek (including TAMPEEL Spring) the Study Pond, and the Beaver Pond. Exposure to pelagic aquatic organisms within these areas was assumed to occur via direct exposure to contaminants in the water column and to benthic invertebrates via direct exposure to contaminants in sediment. Exposure to semi-aquatic mammals and birds was assumed to occur via consumption of potentially contaminated fish and aquatic invertebrates (by the heron) and via ingestion of potentially contaminated tree bark (by the beaver), as well as via the direct consumption of impacted surface water and sediment. It should be noted that although the beaver's consumption of potentially impacted bark is derived from the potential uptake of

COPECs from surface soil (not sediment), this hazard is discussed herein (i.e., in the aquatic risk characterization section) as the beaver is considered a semi-aquatic mammal for purposes of this ERA. Measured concentrations in surface water (total concentration) and sediment from the site were used as exposure point concentrations or as the starting point for modeling tissue concentrations.

Semi-Aquatic Mammals and Birds. Aquatic HIs are summarized in Table 6-48 by AOC and media. HIs were estimated to be as high as 50 for aluminum exposure to the beaver (sediment), and as high as 90 for DDD, DDE, and DDT exposure the great blue heron from ingestion of benthic invertebrates.

For surface water exposure, only the great blue heron had an HI that exceeded 1.0 (i.e., a great blue heron HI of 30 for creek surface water exposure due to modeled intake of zinc bioaccumulated in fish and a great blue heron Beaver Pond HI of 1.5 for surface water exposure due to modeled intake of aluminum bioaccumulated in fish). Both receptors would be expected to have elevated HIs from potential exposure to sediment or sediment-impacted macroinvertebrates. Sediment HIs ranged from 90 for the heron to 50 for the beaver from exposure to sediment at Aspen Creek and the Study Pond, respectively. Risk drivers included DDD, DDT, and DDE for the heron (primarily from modeled intake of sediment-associated aquatic invertebrates), and aluminum for the beaver (primarily from estimated sediment intake; Table 6-48). Toxicity profiles for these risk drivers are presented in Appendix M.

If the beaver consumed tree bark from trees grown in area soils, an HI of 35 was predicted, primarily from ingestion of trees contaminated with zinc, manganese, and barium (Table 6-48).

Aquatic Life. The measured concentration of each surface water COPEC was compared to published water quality criteria for acute and chronic exposure. It should be noted that surface water COPECs were previously selected by screening MDCs with OEPA water quality criteria, EcoTox Threshold values, and USEPA Region 3 BTAG values (Section 6.2.2 and Tables 6-27 through 6-29). Sources used for this second evaluation are listed below:

- Tier II values reported in Suter and Mabrey (1994)
- Federal Ambient Water Quality Criteria (1986)
- USEPA Region 4 Water Quality Criteria (1995g)

When criteria were unavailable from these sources, the lowest lethal concentration for 50 percent of the test species (LC₅₀) value reported in the literature for freshwater fish was converted to a lowest chronic value (CV) using the equation below (Suter and Mabrey, 1994) for nonmetallic constituents:

$$\log CV = 1.07 \log LC_{50} - 1.51$$

If no LC₅₀ data could be found, the lowest effect concentration (LEC) was used. Risk to aquatic life was predicted when a criterion was exceeded by the 95 percent UCL surface water concentration at the site AOCs.

As shown in Table 6-49, the Study Pond had a manganese concentration that exceeded the Tier II benchmarks and the lowest chronic effect value for aquatic organisms, however, as no federal AWQC exists for manganese, the AWQC was not exceeded. The Beaver Pond had aluminum, iron, lead, and manganese concentrations that exceeded some, or all, of the available benchmarks. Aspen Creek had aluminum, barium, iron, lead, manganese, nickel, and zinc concentrations that exceeded some, or all, of the available benchmarks.

Based on these analyses, aquatic populations within either Beaver Pond or Aspen Creek are predicted to be at some potential risk from exposure to constituents in surface water. It should be noted that it is unknown if significant populations actually reside in Aspen Creek, as it is relatively isolated from other surface water bodies. Residents of the Study Pond are also predicted to have elevated risk from exposure to manganese, however, there is considerable uncertainty associated with the Tier II manganese benchmarks.

Benthic Biota. Measured concentrations of each COPEC in sediment were compared to published sediment quality criteria for chronic exposure. It should be noted that sediment COPECs were previously selected by screening MDCs with OME and EcoTox thresholds (and USEPA Region 3 BTAG values, if necessary) (Section 6.2.2 and Tables 6-30 through 6-32). Sources used for this second evaluation are listed below:

- NOAA Effect Range values for low and median effects (Long and Morgan, 1990; updated by Long et al., 1995; and summarized by Jones et al., 1996)
- Florida Department of Environmental Protection (FDEP) threshold effect level and potential effect level values (TELs and PELs, respectively) (MacDonald, 1994).

It should be noted that the NOAA and FDEP criteria are primarily based on marine data and may not be appropriate for freshwater ecosystems. The NOAA ER-L and ER-M values, and the FDEP TEL and PEL values, however, are expected to provide general indications of risk to aquatic biota.

Risk to sediment-associated biota such as macroinvertebrates was predicted when a criterion was exceeded by the measured sediment concentration at the site. As shown in Table 6-50, three COPECs (DDD, DDT, and zinc) in the Beaver Pond and five COPECs (DDD, DDT, phenanthrene, nickel, and zinc) in Aspen Creek had chemical concentrations that exceeded both the ER-M and PEL, suggesting the most significant adverse effects to sediment-dwelling biota. Nine sediment COPECs (2-methylnaphthalene, DDE, anthracene, benzo[a]anthracene, fluoranthene, phenanthrene, pyrene, arsenic, and copper) had a concentration that exceeded either the ER-M or PEL in the Beaver Pond or Aspen Creek, also suggesting significant adverse effects to sediment-dwelling biota.

Six sediment COPECs (benzo[a]pyrene, chrysene, antimony, chromium, lead, and mercury) had concentrations that were between the ER-L and ER-M and/or TEL and PEL values, suggesting possible adverse effects, but less significant than the COPECs listed previously. It should also be noted that many of these COPECs exceeded initial sediment screening criteria presented in Section 6.2.2.1 and Tables 6-30 through 6-32. Based on these analyses, benthic populations within the surface water bodies at the site (primarily the Beaver Pond and Aspen Creek, and to a lesser extent the Study Pond) are potentially at risk from exposure to many constituents (noted above) in sediment.

6.2.6 Uncertainties Associated With the Ecological Risk Assessment

A wide variety of factors contribute to the uncertainty associated with this ecological risk assessment. These factors are related to the exposure assessment, characterization of ecological effects, and the characterization of risk. The quantitative modeling of exposures to wildlife receptors incorporates a large number of parameters which are highly stochastic in nature or for which very limited quantitative information is available in the literature. In general, the values used in the exposure models were selected to result in a conservative estimation of risk. That is, the values for uncertain or stochastic parameters were generally biased toward those that would more likely overestimate the actual exposure rather than underestimate it.

The COPEC concentrations used in all exposure models were the 95 percent UCL or maximum measured concentrations, thereby allowing for the overestimation of the probable concentration at this point. As a result of recommendations from the USACE, the exposure concentration was conservative set at 80 percent of the maximum if calculated 95 percent UCLs were below this concentration (TAMPEEL RI Report). Further, this concentration was assumed to be uniform throughout the receptor's home range, allowing for the probable overestimation of exposure to the larger of the receptor species. The expected result of these factors is an overestimation of exposure and a conservative estimation of risk estimated by either HQs or by comparison with the soil benchmark values.

The soil-to-plant transfer factors for organic COPECs were derived from the $\log K_{ow}$ values using the geometric mean regression equation of Travis and Arms (1988). This equation was derived from data gleaned from several published studies for 29 organic compounds with $\log K_{ow}$ values ranging from 1.15 to 9.35. The correlation coefficient ($r = 0.73$) indicates a reasonable predictive power for this equation. Soil-to-plant transfer factors for several of the inorganic COPECs were taken from various sources used in radionuclide modeling. Because these values are derived from measurements in various agricultural situations, their applicability to natural plant communities is uncertain. Furthermore, these values are presented without indication of stochastic error. Therefore, no statements can be made with regard to the whether these values will over- or underestimate the actual plant tissue concentrations.

Soil-to-insect transfer factors for organic COPECs were based on the bioaccumulation factors for earthworms derived by Connell and Markwell (1990). These earthworm-derived BAFs are based on K_{ow} values rather than being chemical-specific. The application of earthworm-based BAFs to model soil insects is expected to be conservative because of the differences in integument and mode of feeding. The lipid content of the insect is based on measurements from a single species of beetle and the stochastic nature of this parameter with regard to other insects is not known. A nonlinearity constant of 0.07 was used, based on an OEPA recommendation for the Connell and Markwell (1990) equation. The soil-to-insect transfer factors for organic COPECs are inversely dependent upon the soil organic carbon content (f_{oc}). This parameter value for soil was assumed to be equal to the site-measured f_{oc} for sediment and may over- or underestimate the average soil f_{oc} value for the site. The soil-to-insect transfer factors for several of the inorganic COPECs were taken from published sources when available. The default value of 1.0 is considered to be reasonable and probably conservative for the other inorganic COPECs.

Wildlife exposure factors included body weight, daily food consumption, and dietary composition. In general, these were selected as average or mid-range values, to model exposure to an "average" individual of the modeled species. Body weights were taken as averages or the midpoint of ranges and the food and water consumption rates were estimated by allometric equations based on body weight when empirical data were not available. Because most animals feed opportunistically, dietary composition is also highly variable between individuals. The dietary compositions selected for the key receptor species were generalized from published literature. This will lead to the overestimation of exposure to some individuals and the underestimation of others.

The soil depth of interest for the ecological receptors was 0-2 feet. Although some burrowing wildlife (e.g., the red fox) may actually burrow to depths greater than two feet, their prey items would be primarily associated with surface soil, and incidental contact by the fox with deeper soil is expected to be insignificant compared to exposures associated with soil in the 0-2 ft depth range.

Exposure pathways were limited to ingestion. Although the exclusion of inhalation and dermal contact may result in an underestimation of exposure, this is probably compensated by conservatism in the dietary exposure modeling.

The use of NOAELs is conservative and may over estimate the hazards that will actually occur. The wildlife NOAELs are extrapolated from test species that are different from the target wildlife receptor species. When the test species was in a different class (e.g., a mammal species compared with a bird species), no extrapolation was performed as the target class may be either more or less sensitive to the chemical than the test species class. This results in a toxicity benchmark data gap for several of the avian COPECs.

The lack of toxicity data for carbazole, dibenzofuran, iron, and six chlorinated dibenzo dioxins and/or dibenzofurans (Table 6-45) may result in the underestimation of receptor hazards. However, these constituents are not believed to be overly toxic to the selected receptors and it is unlikely hazard indices and overall ERA conclusions would change significantly if toxicity data were included for these COPECs. Similarly, the lack of plant and soil invertebrate toxicity benchmarks for many COPECs may result in the underestimation of hazards to area plants and soil invertebrates.

DDT, a risk driver in this assessment, was detected at concentrations ranging from 0.0052 to 0.16 mg/kg, along with DDT byproducts. Much of FLOD is surrounded by agricultural land. ATSDR reports typical agricultural soil levels to range between 0.2 to 6 mg/kg (ATSDR, 1994b). This was substantiated in a study reported by Ohio State University (Willett et al., 1994) where levels averaging 2 mg/kg DDT in surface soil were observed in land previously farmed. The researchers found this level of DDT despite the occurrence of plowing of these fields since the last DDT application. These data support the conclusion that DDT detections may be a result of former use and normal application of DDT, and not a result of a spill, disposal, or release. Soil DDT and its byproducts (DDD and DDE) could therefore, be considered anthropogenic constituents. According to USEPA in Risk Assessment Guidance for Superfund (1989a):

“There are two types of background levels of chemicals: (1) naturally occurring levels, which are ambient concentrations of chemicals present in the environment that have not been influenced by humans (e.g., aluminum, manganese)); and (2) anthropogenic levels, which are concentrations of chemicals that are present in the environment due to human-made, non-site sources (e.g., industry, automobiles).

Background can range from localized to ubiquitous. For example, pesticides – most of which are not naturally occurring (anthropogenic) – may be ubiquitous in certain areas (e.g., agricultural areas); salt runoff from roads during periods of snow may contribute high ubiquitous levels of sodium. Polycyclic aromatic hydrocarbons (PAHs) and lead are other examples of anthropogenic, ubiquitous chemicals, although these chemicals also may be present at naturally occurring levels in the environment due to natural sources (e.g., forest fires may be a source of PAHs, and lead is a natural component of soils in some areas).”

The statement comparing soil levels at TAMPEEL with measured soil concentrations in other areas of Ohio points to the fact that DDT was used ubiquitously as a pesticide all over the United States until it was banned in 1972.

No background data are available for sediment and surface water, therefore, the characterization of exposures to surface water and sediment were a conservative estimate and may have overestimated true risk from site-related constituents.

In conclusion, many factors contribute to the uncertainty associated with these predicted risk results. Several of the factors can be ascribed to either leading to probable overestimations of risk or underestimations. It is expected that, in this assessment, most factors were overestimated.

6.3 Conclusions

Human Health Risk Assessment

Results of media with carcinogenic or noncarcinogenic constituents contributing to human health risk and hazard above the target risk range are listed below. The primary contaminants contributing risk and hazard above the target are presented in Table 6-52.

- Soil – The cancer risks for RME exposures to soil exceed the USEPA point of departure of 1×10^{-6} for the adult resident (1.9×10^{-5}), child resident (4.0×10^{-5}), TAMPEEL caretaker (1.3×10^{-5}), construction worker (2.3×10^{-6}), and industrial worker (6.8×10^{-6}) scenarios. The greatest contributions to these risks are from arsenic, benzo(a)pyrene, and dibenz(a,h)anthracene. The noncancer hazards for RME exposure to soil exceed the limit of 1 for the child resident (4.2) exposure scenario. The greatest contributions to this hazard are iron and manganese. It should be noted that when compared to the Recommended Daily Allowance, iron and manganese EPCs are below these values.
- Surface Water – All cancer risks and noncancer hazards are below USEPA limits for surface water.
- Sediment – The cancer risks for RME exposures to Aspen Creek/TAMPEEL Spring, Beaver Pond, and Study Pond sediment exceed the USEPA departure point of 1×10^{-6} for the adult resident (2.7×10^{-6} , 6.0×10^{-6} , and 1.5×10^{-6}), child resident (3.0×10^{-6} , 6.7×10^{-6} , and 1.7×10^{-6}), and TAMPEEL caretaker (2.5×10^{-6} , 5.5×10^{-6} , and 1.4×10^{-6}), respectively. The greatest contribution to risk is from arsenic. Noncancer hazards are below USEPA limits for sediment.
- Groundwater – All cancer risks are below the USEPA departure point of 1×10^{-6} . The noncancer hazard for RME exposures to groundwater exceeds the limit of 1 for the adult resident (5.9) and the child resident (22) exposure scenarios. The greatest contributors to this hazard are thallium, iron, and aluminum.

Ecological Risk Assessment

Based on the findings of the ERA, risks are generally acceptable for fish and wildlife potentially exposed to site surface water. However, surface water HI values greater than 1.0 were identified for the Great Blue Heron due to elevated levels of zinc in Aspen Creek (HI = 30) and aluminum in Beaver Pond (HI = 1.46). Potential risks from exposure to site sediments and soil, however, are generally predicted to be unacceptable. Surface soils are predicted to be the most significant ecological concern, especially for sensitive insectivorous receptors such as the shrew (and to a lesser extent the deer mouse, cottontail, robin, and red fox) due to elevated

levels of aluminum, barium, arsenic, zinc, DDT, and chromium and the potential bioaccumulation in earthworms and/or plants. Also at risk is the American robin, due to DDT in soil (however, the levels of DDT detected on site have been found to be consistent with agricultural levels, and may not be associated with inappropriate waste practices [ATSDR, 1994b]).

If it can be demonstrated that the soil pH is greater than 5.5, it could be confidently stated that aluminum would not be bioavailable (USEPA, 2000a), and thus would not constitute an ecological risk at the TAMPEEL site. It should be noted that pH ranges of 4.5 to 6.5 and 3.6 to 7.3 are documented (SCS, 1992) for the two soil types at the site (Mitiwanga and Wadsworth silt loams [Section 6.2.2.2]). If aluminum were dropped as a COPEC in soil, the estimated ecological hazard for the shrew (the most impacted receptor) would drop from 3,390 to approximately 870, with barium then contributing 29% of the hazard, arsenic contributing 15% of the hazard and benzo(b)fluoranthene contributing 10% of the hazard. Table 6-51 presents a summary of terrestrial HIs with the exclusion of aluminum.

Sediments are predicted to be a significant ecological concern for the great blue heron and the beaver, due to the estimated intake of DDT, its metabolites, aluminum, and to a lesser extent, arsenic. There were no sediment background data available for this investigation and soil background data were used to evaluate sediment concentrations. The maximum concentration of aluminum in Beaver Pond sediment (14,000 mg/kg) does not exceed the aluminum soil background concentration (19,000 mg/kg). The maximum concentration of aluminum in Aspen Creek sediment (15,000 mg/kg) does not exceed the aluminum soil background concentration (19,000 mg/kg). One of three sediment samples from the Study Pond (concentrations of 4,030 mg/kg; 12,000 mg/kg; and 23,000 mg/kg, respectively), exceeded the aluminum soil background concentration by 21 percent (i.e., 23,000 mg/kg for Study Pond maximum sediment detection versus 19,000 mg/kg for aluminum soil background).

Aluminum in sediment at these water bodies (Beaver Pond, Aspen Creek, and Study Pond) is within or similar to soil background concentrations. In addition, if soil pH is greater than 5.5, the aluminum would not be bioavailable and therefore would not constitute an ecological risk. Sediment sample pH values were not obtained for this investigation; however the associated pH values for co-located surface water samples for Beaver Pond (pH values of 7.18, 7.57, 8.67, and 8.62) all exceeded the soil pH criteria of 5.5. Likewise the surface water pH values

for the Study Pond (pH values of 7.40, 8.28, and 8.95) also exceeded the soil pH criteria of 5.5. The above information supports consideration of eliminating aluminum in sediment as a COPEC for the ecological risk assessment. Also, field observations have not noted any overt signs of toxicity in the habitats in and around TAMPEEL.

A risk assessment of a site is ultimately an integrated evaluation of historical, chemical, analytical, environmental, demographic, and toxicological data that are as site-specific as possible. To minimize the possibility of underestimating risk, each step is biased toward health-protective estimations. Because each step builds on the previous one, this biased approach mathematically compounds the estimated hazard, and should more than compensate for risk assessment uncertainties that may cause an underestimation of true risk.

7.0 Summary and Conclusions

This section presents a summary of the contaminants detected in each sampled media and summary of the human health and ecological risk assessments. Media sampled included surface soil, subsurface soil, surface water, sediment, and groundwater. The sampling activities were completed in two rounds. The initial round was the remedial investigation (RI) and the second round the supplemental remedial investigation (SRI). Sampling locations for the SRI were established based on the findings of the RI. The results of both the RI and SRI and subsequent assessment of the results are combined in this single RI Report.

7.1 Summary

All environmental samples were analyzed for VOCs, SVOCs, pesticides/PCBs, and TAL metals. Additionally, dioxins/furans and explosives were analyzed for in the depressed area soil samples.

7.1.1 Soil Investigation

During the RI activity twenty soil borings (20 samples) were drilled around the perimeter of the landfill, nine surface soil samples were collected in the Children's Activity Areas, four soil samples were collected in the depressed areas. Nine subsurface samples and 20 surface soil samples were collected from the soil borings. During the SRI activity, one subsurface soil sample was collected during the installation of MW116 and 18 surface soil samples were collected in the Children's Activities Areas. The following discussion combines the results of the both the RI and SRI activities.

In the subsurface soil samples, acetone was the only VOC detected (2 of 10 samples). No SVOCs and pesticides were detected in any of the subsurface samples. Metals above background were detected in six out of the 10 samples collected. Metals above background included copper, iron, nickel, manganese, and zinc.

In the 27 surface soil samples collected at the Children's Activity Areas, VOCs were detected in 22 samples. Detected analytes consisted of acetone, 2-butanone, ethylbenzene, methylene chloride, 1,1,1-trichloroethane, toluene, and xylene. The highest VOC concentration detected was a xylene detection of 5,900 µg/kg. SVOCs were detected in 16 of the 21 samples with the highest total PAH concentration of 207,200 µg/kg (SS206). Pesticides were detected at low

concentrations in 8 of the 27 samples and PCBs were detected in only two samples. Metals detected above background included: aluminum, arsenic, barium, beryllium, calcium, chromium, copper, iron, copper, lead, magnesium, manganese, mercury, nickel, selenium, sodium, vanadium, and zinc.

The four samples collected from representative depressions south of the landfill, all had VOC detections. The highest VOC detection was acetone (110 µg/kg). No SVOCs, pesticides, PCBs, or explosives were detected in any of the 4 samples. Dioxins/furans were detected in all 4 samples, with maximum value of 420 pg/g (OCDD). Metals were not detected above the established background levels for any of the 4 samples.

Human health and ecological risk assessments were completed to evaluate the potential risks due to the presence of detected contaminants in the soil. A summary of the results follow:

Adult Resident. At 1.9×10^{-5} , the total cancer risk for the RME adult resident exposed to surface soil is above the departure point of 1×10^{-6} . Carcinogenic risk is primarily driven by arsenic through ingestion and dermal absorption, with a cancer risk of 1.5×10^{-5} and 2.1×10^{-6} , respectively. The total noncancer hazard (0.51) for exposures to surface soil is below the limit of 1.

At 1.9×10^{-5} , the total cancer risk for the RME adult resident exposed to total soil is above the departure point of 1×10^{-6} . Carcinogenic risk is primarily driven by arsenic through ingestion, with a cancer risk of 1.4×10^{-5} . Also contributing to risk is arsenic through dermal absorption (2.0×10^{-6}) and benzo(a)pyrene (total risk = 1.2×10^{-6}). The total noncancer hazard (0.47) for exposures to surface soil is below the limit of 1.

Child Resident. At 4.0×10^{-5} , the total cancer risk for the RME child resident exposed to surface soil exceeds the departure point of 1×10^{-6} . Carcinogenic risk is primarily driven by arsenic through ingestion, with a cancer risk of 3.5×10^{-5} . Also contributing to risk is arsenic through dermal absorption (2.8×10^{-6}) and dibenz(a,h)anthracene (total risk = 1.3×10^{-6}). The total noncancer hazard (4.2) for exposures to surface soil exceeds the limit of 1. The greatest contribution to this hazard is from iron through ingestion, with an HQ of 1.4 and from manganese with a total HI of 1.0.

At 4.0×10^{-5} , the total cancer risk for the RME child resident exposed to total soil exceeds departure point of 1×10^{-6} . Carcinogenic risk is primarily driven by arsenic through ingestion, with a cancer risk of 3.3×10^{-5} . Also contributing to risk is arsenic through dermal absorption (2.7×10^{-6}), benzo(a)pyrene through ingestion (1.7×10^{-6}), and dibenz(a,h)anthracene (total risk = 1.3×10^{-6}). The total noncancer hazard (3.9) for exposures to surface soil exceeds the limit of 1. The greatest contribution to this hazard is from iron through ingestion, with an HQ of 1.3.

Trespasser. The total cancer risk (3.0×10^{-7}) for the trespasser exposed to surface soil is below the 1×10^{-6} point of departure. The total noncancer hazard (3.1×10^{-2}) for exposures to surface soil is below the acceptable limit of 1.

TAMPEEL Caretaker. At 1.3×10^{-5} , the total cancer risk for the RME TAMPEEL caretaker exposed to surface soil exceeds the departure point of 1×10^{-6} . Carcinogenic risk is primarily driven by arsenic through ingestion, with a cancer risk of 1.1×10^{-5} . The cumulative noncancer hazard (0.31) for exposures to surface soil is below the limit of 1.

TAMPEEL Student. The total cancer risk (1.3×10^{-7}) for the RME TAMPEEL student exposed to surface soil is below the 1×10^{-6} point of departure. The cumulative noncancer hazard (5.3×10^{-2}) for exposures to surface soil is below the limit of 1.

Construction Worker. At 2.3×10^{-6} , the total cancer risk for the RME construction worker exposed to total soil exceeds the departure point of 1×10^{-6} . Carcinogenic risk is primarily driven by arsenic through ingestion, with a cancer risk of 2.0×10^{-6} . The total noncancer hazard (1.3) for exposures to total soil slightly exceeds the target of 1. No individual chemical HQ was above 1.

Industrial Worker. At 6.8×10^{-6} , the total cancer risk for the RME industrial worker exposed to surface soil exceeds the departure point of 1×10^{-6} . Carcinogenic risk is primarily driven by arsenic through ingestion, with a cancer risk of 5.5×10^{-6} . The cumulative noncancer hazard (0.18) for exposures to surface soil is below the acceptable limit of 1.

Exposure to Soil Lead. The representative concentration of lead in surface and total soil is 140 mg/kg, which is below the residential (400 mg/kg) and industrial (1,414 mg/kg) screening levels.

Ecological Risk of Surface Soil. . Surface soils are predicted to be the most significant ecological concern, especially for sensitive insectivorous receptors such as the shrew (and to a lesser extent the deer mouse, cottontail, robin, and red fox) due to elevated levels of aluminum, barium, arsenic, zinc, and chromium and the potential bioaccumulation in earthworms and/or plants.

7.1.2 Surface Water and Sediment Investigation

A total of 15 surface water samples and 18 sediment samples were collected at TAMPEEL during the RI and SRI activities. Samples were collected from Aspen Creek (five surface water and five sediment), TAMPEEL Spring (two surface water and two sediment), the Beaver Pond (four surface water and four sediment), the Study Pond (three surface water and three sediment), and Beaver Creek (one surface water and four sediment).

7.1.2.1 Aspen Creek and TAMPEEL Spring

VOCs were detected in four of the five surface water samples collected during the RI and SRI from Aspen Creek and the TAMPEEL Spring. VOCs detected include cis-1,2-dichloroethane and methylene chloride. No SVOCs were detected in any of the surface water samples. Zinc was detected in excess of the Ohio Water Quality Criteria in the surface water sample collected during the SRI.

VOCs were detected in five of the five sediment samples collected during the RI and SRI from Aspen Creek and the TAMPEEL Spring. VOCs detected in the include acetone, 2-butanone, carbon disulfide, cis-1,2-dichloroethane, and methylene chloride. SVOCs were detected in the sediment sample collected from Aspen Creek during the RI and in one of the samples collected from the TAMPEEL spring collected during the SRI. Metals detected in the sediment in excess of soil background include barium, calcium, copper, manganese, lead, nickel, and zinc.

Human health risk assessments and ecological risk assessments showed the following:

Adult Resident. At 3.6×10^{-10} , the cancer risk for the RME adult resident exposed to Aspen Creek/TAMPEEL Spring surface water is below the USEPA point of departure of 1×10^{-6} . The noncancer hazard for exposures to Aspen Creek/TAMPEEL Spring (0.082) surface water is below the limit of 1.

The cancer risk for the RME adult resident exposed to Aspen Creek/TAMPEEL Spring sediment (2.7×10^{-6}) exceeded the USEPA point of departure of 1×10^{-6} . Risk is primarily driven by arsenic through ingestion, with a cancer risk of 2.1×10^{-6} . The noncancer hazard for exposure to Aspen Creek/TAMPEEL Spring sediment (0.16) is below the limit of 1.

Child Resident. At 1.3×10^{-10} , the cancer risk for the RME child resident exposed to Aspen Creek/TAMPEEL Spring surface water is below the USEPA point of departure of 1×10^{-6} . The noncancer hazard for exposures to Aspen Creek/TAMPEEL Spring surface water (0.14) is below the limit of 1.

The cancer risk for the RME child resident exposed to Aspen Creek/TAMPEEL Spring sediment (3.0×10^{-6}) exceeded the USEPA point of departure of 1×10^{-6} . Risk is primarily driven by arsenic through ingestion, with a cancer risk of 2.4×10^{-6} . The noncancer hazard for exposure to Aspen Creek/TAMPEEL Spring sediment (0.69) is below the limit of 1.

Trespasser. The total cancer risk (7.3×10^{-11}) for the RME trespasser exposed to Aspen Creek/TAMPEEL Spring surface water is below the 1×10^{-6} point of departure. The total noncancer hazard (8.4×10^{-2}) for exposures to surface water is below the acceptable limit of 1.

The total cancer risk (3.9×10^{-7}) for the RME trespasser exposed to sediment is below the departure point of 1×10^{-6} . The total noncancer hazard (8.9×10^{-2}) for exposures to sediment is below the acceptable limit of 1.

TAMPEEL Caretaker. The total cancer risk (2.6×10^{-10}) for the RME TAMPEEL caretaker exposed to Aspen Creek/TAMPEEL Spring surface water is below the 1×10^{-6} point of departure. The total noncancer hazard (7.4×10^{-2}) for exposures to surface water is below the acceptable limit of 1.

The total cancer risk (2.5×10^{-6}) for the RME TAMPEEL caretaker exposed to sediment exceeds the departure point of 1×10^{-6} . Risk is primarily driven by arsenic through ingestion, with a cancer risk of 2.1×10^{-6} . The total noncancer hazard (1.3×10^{-1}) for exposures to sediment is below the acceptable limit of 1.

TAMPEEL Student. The total cancer risk (1.2×10^{-11}) for the RME TAMPEEL student exposed to Aspen Creek/TAMPEEL Spring surface water is below the 1×10^{-6} point of departure. The total noncancer hazard (4.3×10^{-2}) for exposures to surface water is below the acceptable limit of 1. The total cancer risk (1.6×10^{-7}) for the RME TAMPEEL student exposed to sediment is below the 1×10^{-6} point of departure. In addition, the noncancer hazard for student sediment exposures (1.2×10^{-1}) is also below the acceptable limit of 1.

Construction Worker. At 1.0×10^{-11} , the cancer risk for the RME construction worker exposed to Aspen Creek/TAMPEEL Spring surface water is below the USEPA point of departure of 1×10^{-6} . The noncancer hazard for exposures to Aspen Creek/TAMPEEL Spring surface water (0.075) is below the limit of 1. The cancer risks for the RME construction worker exposed to Aspen Creek/TAMPEEL Spring sediment (1.1×10^{-7}) is below the USEPA point of departure of 1×10^{-6} . The noncancer hazard for exposure to Aspen Creek/TAMPEEL Spring sediment (0.15) is below the limit of 1.

Lead. Lead in Aspen Creek/TAMPEEL Spring surface water is estimated at 0.015 mg/L, which is equal to the drinking water action level. Lead in sediment is estimated at 77 mg/kg, which is below the residential (400 mg/kg) and industrial (1,414 mg/kg) screening levels.

Ecological Risk. No significant risk is associated with aquatic life exposure to surface water or sediment at Aspen Creek. Ingestion of water resulted in HI values less than 1.0 for all terrestrial receptors. For aquatic receptor surface water/sediment exposure, zinc in Aspen Creek surface water and DDD and DDT in Aspen Creek sediment resulted in HI values greater than 1.0 for the Great Blue Heron. Likewise, aluminum in Aspen Creek sediment resulted in HI values greater than 1.0 for the Beaver. However the following qualifications to these eco-risk results are appropriate: Initial indications are that the aluminum in sediment is not readily bioavailable and would not constitute an ecological risk based on pH values that range from 3.6 to 7.3 for two soil types reported for the site (SCS, 1992; USEPA, 2000a). It appears that arsenic in soil/sediment may represent naturally occurring levels (Table 4-1). The levels of DDD and DDT in sediment at TAMPEEL appear consistent with agricultural levels (ATSDR, 1994b).

7.1.2.2 Beaver Pond

Four surface water and four sediment samples were collected from the Beaver Pond during the RI. No additional samples were collected from the Beaver Pond during the SRI activities.

No VOCs or SVOCs were detected in any of the surface water samples collected from the Beaver Pond. No metals were detected in surface water samples from the Beaver Pond in excess of the Ohio Water Quality Criteria. Acetone was detected in two of the sediment samples collected from the Beaver Pond. No SVOCs were detected in sediment samples collected from the Beaver Pond. Metals were detected in Beaver Pond sediment in excess of soil background levels include lead, selenium, and zinc.

Human health risk assessments and ecological risk assessments showed the following:

Adult Resident. There are no carcinogenic COPCs for Beaver Pond surface water. The noncancer hazard for exposures to Beaver Pond surface water (0.017) is below the limit of 1.

The cancer risk for the RME adult resident exposed to Beaver Pond sediment (6.0×10^{-6}) exceeds the USEPA point of departure of 1×10^{-6} . Risk is primarily driven by arsenic through ingestion, with a risk of 5.3×10^{-6} . The noncancer hazard for exposure to Beaver Pond sediment (0.067) is below the limit of 1.

Child Resident. There are no carcinogenic COPCs for Beaver Pond surface water. The noncancer hazard for exposures to Beaver Pond surface water (0.027) is below the limit of 1.

The cancer risk for the RME child resident exposed to Beaver Pond sediment (6.7×10^{-6}) exceeds the USEPA point of departure of 1×10^{-6} . Risk is primarily driven by arsenic through ingestion, with a risk of 6.0×10^{-6} . The noncancer hazard for exposure to Beaver Pond sediment (0.30) is below the limit of 1.

Trespasser. There are no carcinogenic COPCs for Beaver Pond surface water. The total noncancer hazard (1.7×10^{-2}) for the RME trespasser exposed to surface water at the Beaver Pond is below the acceptable limit of 1.

The total cancer risk (8.6×10^{-7}) for the RME trespasser exposed to sediment is below the departure point of 1×10^{-6} . The total noncancer hazard (3.8×10^{-2}) for exposures to sediment is below the acceptable limit of 1.

TAMPEEL Caretaker. There are no carcinogenic COPCs for Beaver Pond surface water. The total noncancer hazard (1.5×10^{-2}) for the RME TAMPEEL caretaker exposed to surface water is below the acceptable limit.

The total cancer risk (5.5×10^{-6}) for the RME TAMPEEL caretaker exposed to sediment is above the departure point of 1×10^{-6} . Risk is primarily driven by arsenic through ingestion, with a risk of 5.1×10^{-6} . The total noncancer hazard (5.9×10^{-2}) for exposures to sediment is below the acceptable limit of 1.

TAMPEEL Student. There are no carcinogenic COPCs for Beaver Pond surface water. The total noncancer hazard (8.6×10^{-3}) for the RME TAMPEEL student exposed to surface water is below the acceptable limit of 1.

The total cancer risk (3.4×10^{-7}) for the RME TAMPEEL student exposed to sediment is below the 1×10^{-6} point of departure. The noncancer hazard for student sediment exposures (4.6×10^{-2}) is below the acceptable limit of 1.

Construction Worker. There are no carcinogenic COPCs for Beaver Pond surface water. The noncancer hazard for exposures to Beaver Pond surface water (0.015) is below the limit of 1.

The cancer risk for the RME construction worker exposed to Beaver Pond sediment (2.3×10^{-7}) is below the USEPA point of departure of 1×10^{-6} . The noncancer hazard for exposure to Beaver Pond sediment (0.063) is below the limit of 1.

Lead. Lead in the Beaver Pond surface water is estimated at 0.007 mg/L, which is below the drinking water action level of 0.015 mg/L. Lead in sediment is estimated at 67 mg/kg, which is below the residential (400 mg/kg) and industrial (1,414 mg/kg) screening levels.

Ecological Risk. No significant risk is associated with aquatic life exposure to surface water or sediment at the Beaver Pond. Ingestion of water resulted in HI values less than 1.0 for all terrestrial receptors. For aquatic receptor surface water/sediment exposure, aluminum in surface water and DDD and DDE in Beaver Pond sediment resulted in HI values greater than 1.0 for the Great Blue Heron. Likewise, aluminum and arsenic in Beaver Pond sediment resulted in HI values greater than 1.0 for the Beaver. However the following qualifications to these eco-risk results are appropriate: Initial indications are that the aluminum in sediment is not readily bioavailable and would not constitute an ecological risk based on pH values that range from 3.6 to 7.3 for two soil types reported for the site (SCS, 1992; USEPA, 2000a). It appears that arsenic in soil/sediment may represent naturally occurring levels (Table 4-1). The levels of DDD and DDT in sediment at TAMPEEL appear consistent with agricultural levels (ATSDR, 1994b).

7.1.2.3 Study Pond

Three surface water and three sediment samples were collected during RI activities. No surface water or sediment samples were collected during SRI activities.

No VOCs or SVOCs were detected in Study Pond Surface water. In addition no metals were detected in the Study Pond surface water in excess of Ohio Water Quality Criteria.

One VOC, acetone, was detected in the Study Pond sediment. Two SVOCs (fluoranthene and pyrene) were detected in Study Pond sediment. Ten metals (aluminum, barium, chromium, copper, iron, lead, manganese, selenium, vanadium, and zinc), were detected in the Study Pond sediment in excess of the soil background levels.

Human health risk assessments and ecological risk assessments showed the following:

Adult Resident. There are no carcinogenic COPCs for Study Pond surface water. The noncancer hazard for exposures to Study Pond surface water (0.01) is below the limit of 1.

The cancer risk for the RME adult resident exposed to Study Pond sediment (1.5×10^{-6}) exceeds the USEPA point of departure of 1×10^{-6} . Risk is primarily driven by arsenic through ingestion, with a risk of 1.4×10^{-6} . The noncancer hazard for exposure to Study Pond sediment (0.048) is below the limit of 1.

Child Resident. There are no carcinogenic COPCs for Study Pond surface water. The noncancer hazard for exposures to Study Pond surface water (0.016) is below the limit of 1.

The cancer risk for the RME child resident exposed to Study Pond sediment (1.7×10^{-6}) exceeds the USEPA point of departure of 1×10^{-6} . Risk is primarily driven by arsenic through ingestion, with a risk of 1.6×10^{-6} . The noncancer hazard for exposure to Study Pond sediment (0.21) is below the limit of 1.

Trespasser. There are no carcinogenic COPCs for Study Pond surface water. The total noncancer hazard (1.0×10^{-2}) for the RME trespasser exposed to surface water is below the acceptable limit of 1.

The total cancer risk (2.2×10^{-7}) for the RME trespasser exposed to sediment is below the departure point of 1×10^{-6} . The total noncancer hazard (2.7×10^{-2}) for exposures to sediment is below the acceptable limit of 1.

TAMPEEL Caretaker. There are no carcinogenic COPCs for Study Pond surface water. The total noncancer hazard (9.3×10^{-3}) for the RME TAMPEEL caretaker exposed to surface water is below the acceptable limit.

The total cancer risk (1.4×10^{-6}) for the RME TAMPEEL caretaker exposed to sediment is above the departure point of 1×10^{-6} . Risk is primarily driven by arsenic through ingestion, with a risk of 1.4×10^{-6} . The total noncancer hazard (4.2×10^{-2}) for exposures to sediment is below the acceptable limit of 1.

TAMPEEL Student. There are no carcinogenic COPCs for Study Pond surface water. The total noncancer hazard (5.3×10^{-3}) for the RME TAMPEEL student exposed to surface water is below the acceptable limit of 1.

The total cancer risk (8.3×10^{-8}) for the RME TAMPEEL student exposed to sediment is below the 1×10^{-6} point of departure. The noncancer hazard for student sediment exposures (3.4×10^{-2}) is below the acceptable limit of 1.

Construction Worker. There are no carcinogenic COPCs for Study Pond surface water. The noncancer hazard for exposures to Study Pond surface water (0.057) is below the limit of 1.

The cancer risk for the RME construction worker exposed to Study Pond sediment (5.9×10^{-8}) is below the USEPA point of departure of 1×10^{-6} . The noncancer hazard for exposure to Study Pond sediment (0.046) is below the limit of 1.

Lead. Lead was not detected in Study Pond water. Lead in Study Pond sediment is estimated at 29 mg/kg, which is below the residential (400 mg/kg) and industrial (1,414 mg/kg) screening levels.

Ecological Risk. No significant risk is associated with aquatic life exposure to surface water or sediment at the Study Pond. Ingestion of water resulted in HI values less than 1.0 for all terrestrial receptors. For aquatic receptor surface water/sediment exposure, aluminum in sediment resulted in HI values greater than 1.0 for the Great Blue Heron and the Beaver. However the following qualifications to these eco-risk results are appropriate: Initial indications are the aluminum in sediment is not readily bioavailable and would not constitute an ecological risk.

7.1.3 Groundwater Investigation

Five monitoring wells were installed during RI and SRI activities, four during the RI and one during the SRI. VOC analysis showed that methylene chloride was the only VOC detected. It was detected in one sample at 1.7 µg/L (duplicate sample only) collected during the RI sampling activity. No SVOCs, pesticides or PCBs were detected in any of the groundwater samples collected during the RI and SRI. Metals exceeding background for groundwater included: aluminum, calcium, chromium, iron, lead, magnesium, potassium, sodium, thallium, and vanadium.

Adult Resident. The total cancer risk (2.2×10^{-7}) for the RME adult resident exposed to groundwater is below the departure point of 1×10^{-6} . The total noncancer hazard of 5.9 for exposures to groundwater is above the limit of 1. The greatest contribution to this hazard is from thallium and iron through ingestion exposure, with HQs of 3.3 and 1.6, respectively.

Child Resident. The total cancer risk (1.8×10^{-7}) for the RME child resident exposed to groundwater is below the 1×10^{-6} point of departure. The total noncancer hazard (22) for exposures to groundwater exceeds the limit of 1. The greatest contribution to this hazard is from thallium and iron through ingestion exposures, with HQs of 13 and 6, respectively. Also contributing to the hazard is aluminum through ingestion, with an HQ of 1.8.

Construction Worker. The total cancer risk (3.8×10^{-10}) for the RME construction worker exposed to groundwater is below the 1×10^{-6} point of departure. The total noncancer hazard (7.1×10^{-3}) for exposures to groundwater is below the limit of 1.

Lead in Groundwater. The maximum detected concentration of lead in groundwater is 0.0097 mg/L, which is less than the 0.015 mg/L action level.

Ecological Risk. There are no ecological receptors for groundwater.

7.2 Conclusions

While arsenic in soil is the primary risk driver, the representative concentration calculated in the risk assessment is actually below the calculated background concentration. The primary risk drivers in groundwater are thallium and iron. However, the results driving the risk were only detected in one well, one time, in both cases. Cis-1,2-DCE was detected in the TAMPEEL spring, but at concentrations below the MCL and DCE was not detected in any of the monitoring wells.

The following additional investigation activities are recommended for the TAMPEEL Landfill Remedial Investigation:

- Four quarters of surface water sampling for VOCs from the TAMPEEL Spring and Aspen Creek to confirm only low levels of VOCs were present.
- Four quarters of groundwater monitoring.
- Four quarters of landfill gas monitoring.
- Additional investigation to delineate the extent of the TAMPEEL Landfill.

The results of the additional investigation will be presented in a Remedial Investigation Addendum.

8.0 References

Adamcik, R. S., A. W. Todd, and L. B. Keith, 1979, Demographic and Dietary Responses of Red-Tailed Hawks During a Snowshoe Hare Fluctuation, *Canadian Field Naturalist*, Vol. 93, pp. 16-27.

Agency for Toxic Substances and Disease Registry (ATSDR), 1994, Toxicological Profile for DDT, DDE, and DDD, U.S. Public Health Service.

Arthur, J., and R.J. Gates, 1988, Trace element intake via soil ingestion in pronghorns and in black-tailed jackrabbits, *Journal of Range Management*, Vol. 41, No. 2, March, pp. 162-166.

Austing, G. R., 1964, *The World of the Red-Tailed Hawk*, J. B. Lippincott Co., Philadelphia.

Baes, C.F., R.D. Sharp, A.L. Sjoreen, and R.W. Shor, 1984, A Review and Analysis of Parameters for Assessing Transport of Environmentally Released Radionuclides Through Agriculture. Oak Ridge National Laboratory, Oak Ridge, TN, ORNL-5786.

Bouwer, H. and R.C. Rice, 1976, A Slug Test for Determining Hydraulic Conductivity of Unconfined Aquifers With Completely or Partially Penetrating Wells, *Water Resources Res.* Vol. 12, pp. 423-428.

Brookins, D. G., 1988, *Eh-pH Diagrams for Geochemistry*, Springer-Verlag, New York, New York.

Brown, L. and D. Amadon, 1968, *Eagles, Hawks, and Falcons of the World*, Vol. 1, McGraw-Hill Book Company, New York.

Bull, J. and J. Farrand, Jr., 1995, *The Audubon Society Field Guide to North American Birds*, Alfred A. Knopf, Inc., New York.

Burt, W. H. and R. P. Grossenheider, 1980, *A Field Guide to Mammals*, Peterson Field Guide Series, Houghton Mifflin Co., Boston.

CH2MHILL, 1994, *Assessment, Industrial Park in Warren, Ohio*

Clench, M. H. and R. C. Leberman, 1978, Weights of 151 Species of Pennsylvania Birds Analyzed by Month, Age, and Sex, *Bulletin of the Carnegie Museum of Natural History*, 5.

Conant, R. and J. T. Collins, 1991, *Reptiles and Amphibians, Eastern/Central North America*, Peterson Field Guide, Third Edition, Houghton Mifflin Company, Boston.

Connell, D. W., and R. D. Markwell, 1990, Bioaccumulation in the Soil to Earthworm System, *Chemosphere*, Vol. 20, Nos. 1-2, pp. 91-100.

Dennis, D.F. and T.W. Birch, 1981, Forest Statistics for Ohio-1979, Broomall, Pennsylvania: Northeast Forest Experimental Station, USDA Forest Service Resource Bulletin, NE-68.

Dragun, J., 1988, The Soil Chemistry of Hazardous Material, Hazardous Materials Control Research Institute, Silver Spring, MD.

Ehrlich, P. R., D. S. Dobkin, and D. Wheye, 1988, The Birder's Handbook: A Field Guide to the Natural History of North American Birds, Simon and Shuster, Inc., New York.

Engineering and Design, April 1996, ER 1110-1-263, Chemical Quality Management for Hazardous, Toxic, and Radioactive Waste Remedial Activities.

Farner, D. S., 1949, Age Groups and Longevity in the American Robin: Comments, Further Discussion, and Certain Revisions, *Wilson Bulletin*, 61:68-81.

Freedman, D. L. and J. M. Gossett, 1989, Biological Reductive Dehalogenation of Tetrachloroethylene and Trichloroethylene to Ethylene Under Methanogenic Conditions. *Appl. Environmental Microbiology*, 55:2144-2151.

Gilbert, R.O., 1987, Statistical Methods for Environmental Pollution Monitoring, Van Nostrand Reinhold, New York, NY.

Gottschang, J. L., 1981, A Guide to the Mammals of Ohio, Ohio State University Press. Howell, J. C., 1942, Notes on the Nesting Habitats of the American Robin (*Turdus migratorius*), *Am. Midl. Nat.*, 28:529-603.

Haiker, 1996, Ground Water Resources of Trumbull County, Published by the Ohio Department of Natural Resources.

Howell, J. C., 1942, Notes on the Nesting Habitats of the American Robin (*Turdus migratorius*), *Am. Midl. Nat.*, 28:529-603.

Hvorslev, M. J., 1951, time Lag and Soil Permeability in Groundwater Observations, U. S. Army Corps of Engineers, Waterways Exp. Sta. Bull. 36, Vicksburg, Miss.

Industrial Park in Warren, Ohio Site Assessment Volume 1 of 3 Submitted to Doeppen, Keevican, Weiss, Medved, Attorneys, by CH2M Hill dated May 1994.

International Atomic Energy Agency (IAEA), 1994, Handbook of Parameter Values for the Prediction of Radionuclide Transfer in Temperate Environments, Technical Reports Series No. 364, Vienna, Austria.

International Technology Corp (IT), 1997, Draft Risk Assumptions Document (RAAD) for Former Lordstown Ordnance Depot, Part 1 – Human Health Risk and Part 2 – Ecological Risk.

International Technology Corp (IT), 1998a, Time Critical Removal Action, Remedial Investigation, Former Lordstown Ordnance Depot, January.

International Technology Corporation (IT), 1998b, Work Plan Addendum for the Remedial Investigation, Firing Range and TAMPEEL, at the Former Lordstown Ordnance Depot, September.

International Technology Corp (IT), 2000, Work Plan Addendum for the Remedial Investigation/Feasibility Study, Former Lordstown Ordnance Depot (IT, 2000).

Janes, S. W., 1984, Influences of Territory Composition and Interspecific Competition on Red-Tailed Hawk Reproductive Success, *Ecology*, 65:862-870.

Jones, D. S., R. N. Hall, and E. W. Sutter, 1996, Toxicological Benchmarks or Screening Contaminants of Potential Concern for Effects on Sediment-Associated Biota, prepared by the Risk Assessment Program, Health Sciences Research Division, Oak Ridge, TN, for Lockheed Martin Energy Systems, ES/ER/TM-95/R2, June.

Kao, J.K., F. K. Patterson, and J. Hall, 1985, Skin Penetration and Metabolism of Topically Applied Chemicals in Six Mammalian Species, Including Man: An *In Vitro* Study with Benzo(a)pyrene and Testosterone, *Toxicology and Applied Pharmacology*, Vol 81:502-516.

Kirk-Othmer, Encyclopedia of Chemical Technology, Vol 1 (Air Pollution), Wiley Interscience, 3rd Edition.

Lafferty, M.B., 1979, Ohio's Natural Heritage, The Ohio Academy of Sciences, Columbus, Ohio.

Landrum, P.F., and J.A. Robbins, 1990, "Bioavailability of Sediment-Associated Contaminants to Benthic Invertebrates," in *Sediments: Chemistry and Toxicity of In-Place Pollutants*, R. Baudo, J. P. Giesy and II, Muntau Eds., Chelsea, Michigan: Lewis, 1990, pp. 237-263.

Leo, A., C. Hansch, and D. Elkins, 1971, Partition Coefficients and Their Uses, *Chemical Reviews*, Vol. 71, No. 6, December, pp. 525-617.

Level I Environmental Site Assessment of the Space Center Ohio, Warren, Ohio prepared by R&R International, Inc. dated December 31, 1990.

Long, E. R., and L. G. Morgan, 1990, The Potential for Biological Effects of Sediment-Sorbed Contaminants Tested in the National Status and Trends Program, Technical Memorandum NOS OMA 52, National Oceanic and Atmospheric Administration, Seattle, Washington.

Long, E. R., D. D. MacDonald, S. L. Smith, and F. D. Calder, 1995, Incidence of Adverse Biological Effects Within Ranges of Chemical Concentrations in Marine and Estuarine Sediments, *Environmental Management* 19(1):81-97.

Ma, W. C., 1982, The Influence of Soil Properties and Worm-related Factors on the Concentration of Heavy Metals in Earthworms, *Pedobiologia*, Vol. 24, pp. 109-119.

MacDonald D. D., 1994, Approach to the Assessment of Sediment Quality in Florida Coastal Waters, Florida Department of Environmental Protection, Tallahassee, Florida.

Maxim, 1997, Final Site Investigation Report for Former Lordstown Ordnance Depot, Ohio.

MMEDE Database, 1994, Multimedia Environmental Database.

Montgomery, J.H., 1996, Groundwater Chemicals Desk Reference, 2nd Edition, Lewis Publishers, Boca Raton, 1345 pgs.

Murray, W., Richardson, M., 1993, Progress Toward the Biological Treatment of C1 and C2 Halogenated Hydrocarbons, *Critical Reviews in Environmental Science and Technology*, 23(3):195-217.

National Academy of Science, 1989, Recommended Daily Allowances, 10th ed.

National Council on Radiation Protection and Measurements (NCRP), 1989, Screening Techniques for Determining Compliance with Environmental Standards: Releases of Radionuclides to the Atmosphere, NCRP Commentary No. 3, Revision of January 1989, National Council on Radiation Protection and Measurements, Bethesda, Maryland.

National Oceanic and Atmospheric Administration (NOAA), 1998, Climatic Diagnostics Center (<http://www.cdc.noaa.gov/>), Daily Mean Temperatures and Precipitation, Youngstown, Ohio.

National Oceanic and Atmospheric Administration (NOAA), 1975, Local Climatological Data, Youngstown, Ohio.

Ohio Department of Natural Resources (ODNR), Division of Natural Areas & Preserves, 1997, letter from Ms. Debbie Woischke - Ecological Analyst to Mr. Mark Weisberg - IT Corporation, November 12.

Ohio Department of Natural Resources (ODNR), U.S. Department of Agriculture, Soil Conservation Service, 1992, Soil Survey of Trumbull County, Ohio.

Ohio Environmental Protection Agency (OEPA), 1997, Water Quality Criteria for the Protection of Aquatic Life, OAC 3745-1-34.

Ohio Environmental Protection Agency (OEPA), 1995, Technical Guidance Manual for Hydrogeologic Investigations and Ground Water Monitoring.

Ohio Environmental Protection Agency (OEPA), 1993, Closure Review Guidance for RCRA Facilities: Interim Final, Appendix G: Oral Absorption Factors, Division of Hazardous Waste Management.

Omernik, J.M., 1986, Ecoregions of the United States, Corvallis Environmental research Laboratory, U.S. EPA.

Persaud, D., R. Jaagumagi, and A. Hayton, 1992, Guidelines for the Protection and Management of Aquatic Sediment in Ontario, Ontario Ministry of the Environment (OME), OSBN 0-7729-9248-7.

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.

Peterson, R. T., 1947, A Field Guide to the Birds, sponsored by the National Audubon Society, Houghton Mifflin Company, Boston, Massachusetts.

R&R International, 1990, Level I Environmental Assessment of the OCC.

Risk Analysis Information System (RAIS), 2003, On-Line.

Ryan, E.A., E.T. Hawkins, et al., 1987, Assessing Risk from Dermal Exposure at Hazardous Waste Sites. In: Bennett, G. and J. Bennett, eds. Superfund '87: Proceedings of the Eighth National Conference; November 16-18; Washington, D.C., The Hazardous Materials Control Research Institute, pp.166-168.

Sample, B. E., D. M. Opresko, and G. W. Suter II, 1996, Toxicological Benchmarks for Wildlife: 1996 Revision, ES/ER/TM-86/R3, Risk Assessment Program, Health Sciences Research Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee.

SCS, 1992, Soil Conservation Service, Soil Survey for Trumbull County, Ohio, published by the U.S. Department of Agriculture..

Sims, J. L., J. M. Suflita, and H. H. Russell, 1990, Reductive Dehalogenation: A Subsurface Bioremediation Process, Remediation, 1:75-93.

Skowronski, G.A., R. M. Turkall, and M.S. Abdel-Rahman, 1988, Soil Adsorption Alters Bioavailability of Benzene in Dermal Exposed Male Rats. American Industrial Hygiene Association Journal, Vol 49(10):506-511.

Speirs, J. M., 1953, Winter Distribution of Robins East of the Rocky Mountains, Wilson Bulletin, 65:175-183.

Stafford, E. A., J. W. Simmers, R. G. Rhett, and C. P. Brown, 1991, Interim Report: Collation and Interpretation of Data for Times Beach Confined Disposal Facility, Buffalo, New York, Miscellaneous Paper D-91-17, U.S. Army Corps of Engineers, Buffalo, New York.

Suter, II, G. W., 1993, Ecological Risk Assessment, Lewis Publishers, Chelsea, Michigan.

Suter II, G. W., and J. B. Mabrey, 1994, Toxicological benchmarks for Screening Potential Contaminants of Concern for Effects on Aquatic Biota, ES/ER/TM-96/R1, Oak Ridge National Laboratory, Oak Ridge, Tennessee.

Taylor, R. L., 1975, Butterflies in My Stomach, Woodbridge Press Publishing Company, Santa Barbara, California.

Travis, C. C., and A. D. Arms, 1988, Bioconcentration of Organics in Beef, Milk, and Vegetation, Environmental Science & Technology, Vol. 22, No. 3, pp. 271-274.

Twin City Testing (TCT), February 1995, Summary of Findings at Lordstown.

U.S. Army Corps of Engineers (USACE), 1998, Ordnance and Explosives Archives Search Report for the FLOD, Rock Island District.

U.S. Army Corps of Engineers (USACE), 1996, Risk Assessment Handbook, Volume II: Environmental Evaluation, EM 200-1-4

U.S. Army Corps of Engineers (USACE), 1995, Risk Assessment Handbook, Human Health Evaluation, Volume I: Human Health Evaluation, EM 200-1-4.

U.S. Department of Agriculture (USDA), 1979, Soil Survey of Hamilton County, Ohio, USDA, Soil Conservation Service.

U.S. Department of Agriculture (USDA), 1970, Ohio Irrigation Guide. Soil Conservation Service and Agricultural Research Service, USDA, Washington, DC.

U.S. Environmental Protection Agency (USEPA), 2003a, Integrated Risk Information System (IRIS). Office of Health and Environmental Assessment, Washington, DC., <http://www.EPA.Gov/iris>.

U.S. Environmental Protection Agency (USEPA), 2003b, Revised Region 5 Ecological Screening Levels (ESLs), July.

U.S. Environmental Protection Agency (USEPA), 2002, Region IX Preliminary Remediation Goals (PRGs), USEPA Region IX, Waste Programs, San Francisco, CA. November 2002.

U.S. Environmental Protection Agency (USEPA), 2000a, Amended Guidance on Ecological Risk Assessment at Military Bases: Process Considerations, Timing of Activities, and Inclusion of Stakeholders, EPA Region 4, Atlanta, Georgia.

U.S. Environmental Protection Agency (USEPA), 2000b, Bioaccumulation Testing and Interpretation for the Purpose of Sediment Quality Assessment – Status and Needs, Office of Solid Waste, EPA 823-R-00-001, Washington, D.C.

U.S. Environmental Protection Agency (USEPA), 1998, Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual, Supplemental Guidance, Dermal Risk Assessment. Office of Emergency and Remedial Response, Washington, DC. NCEA-W-0364.

U.S. Environmental Protection Agency (USEPA), 1997a, Health Effects Assessment Summary Tables (HEAST). Office of Emergency and Remedial Response, Washington, DC. EPA/540/R-97/036.

U.S. Environmental Protection Agency (USEPA), 1997b, Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments, Interim Final, Office of Solid Waste and Emergency Response, EPA 540-R-97-006, Washington, D.C.

U.S. Environmental Protection Agency (USEPA), 1996a, Soil Screening Guidance: Technical Background Document, EPA/540/R-95/128.

U.S. Environmental Protection Agency (USEPA), 1996b, Exposure Factors Handbook, Office of Health and Environmental Assessment, Washington, DC. EPA/600/P-95/002A.

U.S. Environmental Protection Agency (USEPA) 1996c, Region 5 BTAG Ecological Risk Assessment Bulletin No. 1 (April 18, 1996).

U.S. Environmental Protection Agency (USEPA), 1996d, ECO Update, Publication 9345.0-12FSI, Office of Solid Waste and Emergency Response, U.S. Environmental Protection Agency, Washington, DC.

U.S. Environmental Protection Agency (USEPA), 1995a, Screening Level Soil Concentrations for Workers and Recreational Site Visitors Exposed to Lead and Arsenic, USEPA Region VIII, Denver, CO.

U.S. Environmental Protection Agency (USEPA) 1995b, Review of a Methodology for Establishing Risk-Based Soil Remediation Goals for Commercial Areas of the California Gulch Site, Technical Review Workgroup for Lead, October 26, 1995.

U.S. Environmental Protection Agency (USEPA), 1995c, Region III Technical Guidance Manual: Assessing Dermal Exposure from Soil. Office of Superfund Programs, Hazardous Waste Management Division. EPA/903/K/95/003.

U.S. Environmental Protection Agency, (USEPA), 1995d, Revised Region III BTAG Screening Levels, Memorandum from R.S. Davis to Users, August.

U.S. Environmental Protection Agency (USEPA), 1995e, Land Use in the CERCLA Remedy Selection process. OSWER Directive # 9355.7-04.

U.S. Environmental Protection Agency (USEPA), 1995f, Great Lakes Water Quality Initiative, 40 CFR Part 132, Appendix B.

U.S. Environmental Protection Agency (USEPA), 1995fg Ecological Screening Values, Ecological Risk Assessment Bulletin No. 2, Waste Management Division, U.S. Environmental Protection Agency Region IV, Atlanta, Georgia.

U.S. Environmental Protection Agency (USEPA), 1994a, Revised Interim Soil Lead Guidance for CERCLA Sites and RCRA Corrective Action Facilities, Office of Solid Waste and Emergency Response, Washington, DC. (OSWER Directive #9355.4-12) EPA/540/F-94/043.

U.S. Environmental Protection Agency (USEPA), 1994b, Estimating Exposure to Dioxin-Like Compounds, Volume 1: Executive Summary. EPA/600/9-88/005Ca.

U.S. Environmental Protection Agency (USEPA), 1994b, Ecological Risk Assessment for Superfund: Process for Designing and Conducting Ecological Risk Assessments, EPA Environmental Response Team, Edison, New Jersey, Review Draft, September 26, 1994.

U.S. Environmental Protection Agency (USEPA), 1993a, Selecting Exposure Routes and Contaminants of Concern by Risk-Based Screening, Hazardous Waste Management Division, Office of Superfund, Region III, Philadelphia, PA. EPA/903/R-93/001.

U.S. Environmental Protection Agency (USEPA), 1993b, Provisional Guidance for Quantitative Risk Assessment of Polycyclic Aromatic Hydrocarbons, Office of Research and Development, Washington, DC. EPA/600/R-93/089.

U.S. Environmental Protection Agency (USEPA), 1993d, Wildlife Exposure Factors Handbook, Volume I of II, EPA/600/R-93/187a, Office of Research and Development, United States Environmental Protection Agency, Washington, D.C.

U.S. Environmental Protection Agency (USEPA), 1992a, Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities, Addendum to Interim Final Guidance, Office of Solid Waste Management Division, Washington, D.C.

U.S. Environmental Protection Agency (USEPA), 1992b, Dermal Exposure Assessment: Principles and Applications, Office of Research and Development, Washington, DC. EPA/600/8-91/011B.

U.S. Environmental Protection Agency (USEPA), 1992c, Risk Assessment Guidance for Superfund, Volume 1: Human Health Evaluation Manual, Supplemental Guidance, Dermal Risk Assessment, Interim Guidance, Office of Emergency and Remedial Response, Washington, DC. August 18.

U.S. Environmental Protection Agency (USEPA), 1992d, Supplemental Guidance to RAGS: Calculating the Concentration Term, Office of Emergency and Remedial Response, Washington, DC. Publication #9285.7-081.

U.S. Environmental Protection Agency (USEPA), 1992e, Framework for Ecological Risk Assessment, Risk Assessment Forum, Washington, D.C., EPA/630/R-92/001.

U.S. Environmental Protection Agency (USEPA), 1991a, Future Residential Land Use Ground Water Exposure Point Concentrations for the Baseline Risk Assessment. Memo from John Kelley (May 10, 1991), Remedial and Enforcement Response Branch, Region 5, Chicago, IL.

U.S. Environmental Protection Agency (USEPA), 1991b, Risk Assessment Guidance for Superfund, Vol. I: Human Health Evaluation Manual, Part B, Development of Risk-Based Preliminary Remediation Goals. Office of Emergency and Remedial Response, Washington, DC.

U.S. Environmental Protection Agency (USEPA), 1991c, Risk Assessment Guidance for Superfund, Vol. I: Human Health Evaluation Manual, Supplemental Guidance: Dermal Risk Assessment Interim Guidance, Office of Emergency and Remedial Response, Washington, DC.

U.S. Environmental Protection Agency (USEPA), 1991d, Risk Assessment Guidance for Superfund, Vol. I: Human Health Evaluation Manual, Supplemental Guidance: Standard Default Exposure Factors, Office of Emergency and Remedial Response, Washington, D.C., OSWER Directive 9285.6-03.

U.S. Environmental Protection Agency (USEPA), 1991e, Role of the Baseline Risk Assessment in Superfund Remedy Selection Decisions. Office of Solid Waste and Emergency Response, Washington, DC. OSWER Directive #9355.-30.

U.S. Environmental Protection Agency (USEPA), 1990, National Oil and Hazardous Substances Pollution Contingency Plan, Final Rule, 40 CFR Part 300, March 8.

U.S. Environmental Protection Agency (USEPA), 1989a, Risk Assessment Guidance for Superfund, Vol. 1: Human Health Evaluation Manual, Part A, Office of Emergency and Remedial Response, Washington, DC. EPA/540/1-89/002.

ES/ER/TM-126/R1, Environmental Restoration Risk Assessment Program, Oak Ridge National Laboratory, Oak Ridge, Tennessee.

Willet, L.B., A.F. O'Donnell, H.I. Durst, and M.M. Kurz, 1994, Intensive Grazing/Seasonal Dairing: The Mahoning County Dairy Program, Chapter 11: Soil Pesticides. Ed. D.L. Zartman. April

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.

Table 2-1
Sampling Location Rationale
TAMPEEL
Former Lordstown Ordnance Depot, Ohio
Page 1 of 2

Location	Boring/Well/Sample ID	Sample Type	Rationale
TAMPEEL Landfill	SB131 to SB150	Soil	Investigate the presence of leachate at landfill perimeter
TAMPEEL Landfill	SS185 to SS193	Soil	Investigate the nature of surface soils in areas that the students visit
TAMPEEL Landfill	SS201 to SS218	Soil	Delineate extent of soil contamination in support of a Feasibility Study
Two depressions areas, one uniform and one non-uniform, located south of the TAMPEEL Landfill	SS194 to SS197	Soil	Investigate the concentrations of possible contaminants in surface soils in the area containing depressions
Study Pond	SW102 to SW104 SD102 to SD104	Surface Water and Sediment	Investigate the concentrations of possible contaminants in the pond downgradient of the landfill
Beaver Pond	SW105-SW108 SD105-SD108	Surface Water and Sediment	Investigate the concentrations of possible contaminants in the surface water and sediment downgradient of the Waste Oil Disposal Pit
Spring Area	SW101 and SW201 SD101 and SD201	Surface Water and Sediment	Investigate the concentrations of possible contaminants in the spring adjacent to and down stream from the landfill

U.S. Environmental Protection Agency (USEPA), 1989b, Exposure Factors Handbook. Office of Health and Environmental Assessment, Washington, DC. EPA/600/8-89/043.

U.S. Environmental Protection Agency (USEPA), 1989c, Assessing Human Health Risks from Chemically Contaminated Fish and Shellfish: A Guidance Manual, Office of Marine and Estuarine Protection, Washington, D.C., EPA 503/8-89-002.

U.S. Environmental Protection Agency (USEPA), 1986, Quality Criteria for Water, Office of Water Regulations and Standards, EPA 440/5-86-001.

United States Fish and Wildlife Service (USFWS), 1977, National Wetland Inventory Map, based on aerial photography on 4/77, Newton Falls, Ohio quadrangle.

U.S. Nuclear Regulatory Commission (NRC), 1977, Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10CFR Part 50, Appendix I, Regulatory Guide 1.109, NRC, Office of Standards Development, Washington, DC.

Weatherhead, P. J. and S. B. McRae, 1990, Brood Care in American Robins: Implications for Mixed Reproductive Strategies for Females, *Animal Behavior*, 39:1179-1188.

Wentsel, R.S., T.W. LaPoint, M. Simini, R.T. Checkai, D. Ludwig, and L.W. Brewer, 1996, Tri-Service Procedural Guidelines for Ecological Risk Assessments, Volume 1, prepared by the U.S. Army Edgewood Research, Development, and Engineering Center, Aberdeen Proving Ground, Maryland.

Wester, R.C., H.I. Maibach, and L. Sedik, 1993c, Percutaneous Absorption of PCBs from Soil: *In Vivo* Rhesus Monkey, *In Vitro* Human Skin, and Binding to Powdered Human Stratum Corneum. *J. Tox. Env. Health*. Vol. 39(3):375.

Whitaker Jr., J. O., 1995, The Audubon Society Field Guide to North American Mammals, Alfred A. Knopf, Inc., New York.

White, 1971, Glacial Geology of Trumbull County, Ohio, Ohio Division of Geologic Survey, Report of Investigations No. 80.

Will, M. E., and G. W. Suter II, 1995a, Toxicological Benchmarks for Screening Potential Contaminants of Concern for Effects on Terrestrial Plants: 1995 Revision, ES/ER/TM-85/R2, Environmental Restoration Risk Assessment Program, Oak Ridge National Laboratory, Oak Ridge, Tennessee.

Will, M. E., and G. W. Suter, 1995b, Toxicological Benchmarks for Screening Potential Contaminants of Concern for Effects on Soil and Litter Invertebrates and Heterotrophic Process,

Table 2-1
Sampling Location Rationale
TAMPEEL
Former Lordstown Ordnance Depot, Ohio
Page 2 of 2

Location	Boring/Well/Sample ID	Sample Type	Rationale
Aspen Creek. One sample location immediately adjacent to Landfill, one location downstream from Landfill	SW109 and SW110 SW201 and SW202 SD109 and SD110 SD201 to SD202	Surface Water and Sediment	Investigate the concentrations of possible contaminants in the creek adjacent to and down stream from the landfill
Beaver Creek	SW204 SD204 and SD205	Surface Water and Sediment	Investigate the concentrations of possible contaminants in Beaver Creek, adjacent to the landfill
Upgradient of TAMPEEL Landfill – south to southeast of waste area	MW112	Groundwater	Monitor groundwater quality upgradient of the landfill
Downgradient of TAMPEEL Landfill, north and northwest of waste	MW113, MW114, MW115, & MW116	Groundwater	Monitoring groundwater quality downgradient of the landfill

Table 2-2
Soil and Sediment Samples Analytical Summary
TAMPEEL
Former Lordstown Ordnance Depot, Ohio
Page 1 of 3

RI Report
FLOD - TAMPEEL
Section 2
May 2005

Sample Location	Date Sampled	Depth Interval (ft,bgs)	Analysis								QA/QC	
			VOCs	SVOCs	Pesticides/ PCBs	TAL Metals	Dioxin/ Furans	Explosives	TOC	Grain Size	Duplicate	Matrix Spike/ MS Duplicate
TAMPEEL Landfill												
SB131SO004	3/16/1999	6 to 7	1	1	1	1	0	0	0	0	1	1
SB132SO002	3/16/1999	2 to 4	1	1	1	1	0	0	0	0		
SB133SO001	3/16/1999	0 to 2	1	1	1	1	0	0	0	0		
SB134SO003	3/16/1999	6 to 7	1	1	1	1	0	0	0	0		
SB135SO001	3/16/1999	0 to 2	1	1	1	1	0	0	0	0		
SB136SO003	3/16/1999	4 to 6	1	1	1	1	0	0	0	0		
SB137SO004	3/16/1999	6 to 8	1	1	1	1	0	0	0	0		
SB138SO001	3/17/1999	0 to 2	1	1	1	1	0	0	0	0		
SB139SO001	3/17/1999	0 to 2	1	1	1	1	0	0	0	0		
SB140SO002	3/17/1999	2 to 4	1	1	1	1	0	0	0	0		
SB141SO001	3/17/1999	0 to 2	1	1	1	1	0	0	0	0		
SB142SO001	3/17/1999	0 to 2	1	1	1	1	0	0	0	0		
SB143SO001	3/17/1999	0 to 2	1	1	1	1	0	0	0	0		
SB144SO001	3/17/1999	0 to 2	1	1	1	1	0	0	0	0		
SB145SO002	3/17/1999	2 to 4	1	1	1	1	0	0	0	0		
SB146SO002	3/17/1999	0 to 2	1	1	1	1	0	0	0	0		
SB147SO001	3/17/1999	0 to 2	1	1	1	1	0	0	0	0		
SB148SO001	3/17/1999	0 to 2	1	1	1	1	0	0	0	0		
SB149SO002	3/17/1999	2 to 4	1	1	1	1	0	0	0	0		
SB150SO005	3/17/1999	8 to 9	1	1	1	1	0	0	0	0		
SS20101	10/4/2000	0 to 0.5'	1	1	1	1	0	0	0	0	1	1
SS20201	10/4/2000	0 to 0.5'	1	1	1	1	0	0	0	0		
SS20301	10/4/2000	0 to 0.5'	1	1	1	1	0	0	0	0		
SS20401	10/5/2000	0 to 0.5'	1	1	1	1	0	0	0	0		
SS20501	10/5/2000	0 to 0.5'	1	1	1	1	0	0	0	0		
SS20701	10/5/2000	0 to 0.5'	1	1	1	1	0	0	0	0		
SS20801	10/5/2000	0 to 0.5'	1	1	1	1	0	0	0	0		
SS20901	10/5/2000	0 to 0.5'	1	1	1	1	0	0	0	0		
SS21001	10/5/2000	0 to 0.5'	1	1	1	1	0	0	0	0		
SS21101	10/5/2000	0 to 0.5'	1	1	1	1	0	0	0	0		
SS21301	10/5/2000	0 to 0.5'	1	1	1	1	0	0	0	0		
SS21701	10/5/2000	0 to 0.5'	1	1	1	1	0	0	0	0		
SS21801	10/5/2000	0 to 0.5'	1	1	1	1	0	0	0	0		
MW11601	10/13/2000	0 to 2	1	1	1	1	0	0	0	0		
MW11602	10/13/2000	2 to 4	1	1	1	1	0	0	0	0		
Subtotal:			35	35	35	35	0	0	0	0	4	2
Childrens Dig Area												
SS185SO01	3/18/1999	0 to 1	1	1	1	1	0	0	0	0		
SS186SO01	3/18/1999	0 to 1	1	1	1	1	0	0	0	0		
SS187SO01	3/18/1999	0 to 1	1	1	1	1	0	0	0	0		
SS21201	10/5/2000	0 to 0.5'	1	1	1	1	0	0	0	0		
SS21501	10/5/2000	0 to 0.5'	1	1	1	1	0	0	0	0		

Table 2-2
Soil and Sediment Samples Analytical Summary
TAMPEEL
Former Lordstown Ordnance Depot, Ohio
Page 2 of 3

RI Report
FLOD - TAMPEEL
Section 2
May 2005

Sample Location	Date Sampled	Depth Interval (ft,bgs)	Analysis								QA/QC	
			VOCs	SVOCs	Pesticides/ PCBs	TAL Metals	Dioxin/ Furans	Explosives	TOC	Grain Size	Duplicate	Matrix Spike/ MS Duplicate
SS21601	10/5/2000	0 to 0.5'	1	1	1	1	0	0	0	0	0	0
Subtotal:			6	6	6	6	0	0	0	0	0	0
Bird Watching Area												
SS188SO01	3/18/1999	0 to 1	1	1	1	1	0	0	0	0		
SS189SO01	3/18/1999	0 to 1	1	1	1	1	0	0	0	0		
SS21401	10/5/2000	0 to 0.5'	1	1	1	1	0	0	0	0		
Subtotal:			3	3	3	3	0	0	0	0	0	0
Insect Viewing Area												
SS190SO01	3/18/1999	0 to 1	1	1	1	1	0	0	0	0		
SS191SO01	3/18/1999	0 to 1	1	1	1	1	0	0	0	0		
SS20601	10/5/2000	0 to 0.5'	1	1	1	1	0	0	0	0		
Subtotal:			3	3	3	3	0	0	0	0	0	0
Woodchuck Area												
SS192SO01	3/18/1999	0 to 1	1	1	1	1	0	0	0	0		1
Subtotal:			1	1	1	1	0	0	0	0	0	1
Spring Area												
SS193SO01	3/18/1999	0 to 1	1	1	1	1	0	0	0	0	1	
SD20101	10/13/2000	0 to 0.5'	1	1	1	1	0	0	0	0	1	
Subtotal:			2	2	2	2	0	0	0	0	2	0
Representative Depression												
SS194SO01	3/29/1999	0 to 1	1	1	1	1	1	1	0	0		
SS195SO01	3/29/1999	0 to 1	1	1	1	1	1	1	0	0	1	
SS196SO01	3/29/1999	0 to 1	1	1	1	1	1	1	0	0		
SS197SO01	3/29/1999	0 to 1	1	1	1	1	1	1	0	0		
Subtotal:			4	4	4	4	4	4	0	0	1	0
Study Pond												
SD102	8/11/1998	pond bottom	1	1	1	1	0	0	1	1		
SD103	8/11/1998	pond bottom	1	1	1	1	0	0	1	1	1	1
SD104	8/12/1998	pond bottom	1	1	1	1	0	0	1	1		
Subtotal:			3	3	3	3	0	0	3	3	1	1
Beaver Pond												
SD105	8/12/1998	pond bottom	1	1	1	1	0	0	1	1		
SD106	8/12/1998	pond bottom	1	1	1	1	0	0	1	1		
SD107	8/12/1998	pond bottom	1	1	1	1	0	0	1	1		
SD108	8/12/1998	pond bottom	1	1	1	1	0	0	1	1		
Subtotal:			4	4	4	4	0	0	4	4	0	0

Table 2-2
Soil and Sediment Samples Analytical Summary
TAMPEEL
Former Lordstown Ordnance Depot, Ohio
Page 3 of 3

RI Report
FLOD - TAMPEEL
Section 2
May 2005

Sample Location	Date Sampled	Depth Interval (ft,bgs)	Analysis								QA/QC	
			VOCs	SVOCs	Pesticides/ PCBs	TAL Metals	Dioxin/ Furans	Explosives	TOC	Grain Size	Duplicate	Matrix Spike/ MS Duplicate
Aspen Creek												
SD109SO01	3/19/1999	0 to 1	1	1	1	1	0	0	1	1		
SD110SO01	3/19/1999	0 to 1	1	1	1	1	0	0	1	1		
SD20201	10/12/2000	0 to 0.5'	1	1	1	1	0	0	0	0		
SD20301	10/12/2000	0 to 0.5'	1	1	1	1	0	0	0	0		
Subtotal:			4	4	4	4	0	0	2	2	0	0
Beaver Creek												
SD20401	10/12/2000	0 to 0.5'	1	1	1	1	0	0	0	0	1	
SD20501	10/10/2000	0 to 0.5'	1	1	1	1	0	0	0	0		
Subtotal:			2	2	2	2	0	0	0	0	0	1
Totals:			67	67	67	67	4	4	9	9	8	5

Table 2-3
Study Pond and Beaver Pond
Surface Water Field Parameter Readings
TAMPEEL
Former Lordstown Ordnance Depot, Ohio

Location	Date	Sample Time	GPS Reading		Field Parameter Readings			
			North (Feet)	East (Feet)	Temperature (°C)	PH (pH units)	Conductivity (ms/cm)	Turbidity (NTU)
Study Pond								
SW102	8/11/98	1212	558072	2414117	26.1	7.40	0.309	185
SW103	8/11/98	1715	557831	2414215	26.7	8.28	0.207	0
SW104	8/12/98	1545	557875	2414049	29.6	8.95	0.215	7
Beaver Pond								
SW105	8/12/98	1058	556935	2414247	25.4	7.18	0.286	5
SW106	8/12/98	1350	556823	2414394	25.9	7.57	0.287	114
SW107	8/12/98	1810	556581	2414650	26.9	8.67	0.289	171
SW108	8/12/98	1850	556504	2414536	28.2	8.62	0.285	5

Table 2-4
Study Pond and Beaver Pond Sediment
GPS and Organic Vapor Readings
TAMPEEL
Former Lordstown Ordnance Depot, Ohio

Location	Date	Sample Time	GPS Reading		Organic Vapor Reading	
			North (Feet)	East (Feet)	Headspace (ppm)	Background (ppm)
Study Pond						
SD102	8/11/98	1231	558070	2414406	2.2	2.2
SD103	8/11/98	1753	557957	2414100		
SD104	8/12/98	1550	557875	2414049	2.4	2.4
Beaver Pond						
SD105	8/12/98	1103	556935	2414247		
SD106	8/12/98	1430	556823	2414394	0.5	1.5
SD107	8/12/98	1820	556581	2414650	2.8	2.2
SD108	8/12/98	1900	556504	2414536	2.2	2.0

Table 2-5
Monitoring Well Construction Summary
TAMPEEL
Former Lordstown Ordnance Depot, Ohio

RI Report
FLOD - TAMPEEL
Section 2
May 2005

Well Location	Installation Date	Ground Surface Elev. (ft, MSL)	Top of Casing (TOC) Elev. (ft, MSL)	TOC Above Ground Surface (ft)	Well Depth (ft, BGS)	Borehole Diameter (in.)	Screen Length (ft)	Screened Interval (ft, MSL)	Depth to Sand Pack (ft)	Sand Pack Thickness (ft)	Depth to Seal (ft)	Seal Thickness (ft)
MW112	3/24/1999	935.80	938.00	2.20	20.5	4	10	10 to 20	7.0	13.5	4.0	3
MW113	3/24/1999	931.70	933.87	2.17	18.5	4	10	8 to 18	5.0	13.5	3.0	3
MW114	4/21/1999	931.80	934.13	2.33	23.5	4	10	13 to 23	10.0	13.5	7.0	3
MW115	4/20/1999	926.40	928.64	2.24	20.0	4	10	9.5 to 19.5	6.5	13.5	3.5	3
MW116	10/10/2000	930.4	932.5	2.10	18	4	10	8 to 18	6	12	0*	6

Notes: MSL = Mean Sea Level, TOC = Top of inner casing, BGS = Below ground surface.

Table 2-6
Monitoring Well Development Parameters
TAMPEEL
Former Lordstown Ordnance Depot, Ohio

RI Report
FLOD - TAMPEEL
Section 2
May 2005

Monitoring Well ID	Date Purged	Volume Purged (gals)	Depth to Water (ft, BGS)	Temp (°C)	pH (SU)	Conductivity (us/cm)	Turbidity (NTU)	Comments
MW112	4/21/1999	60	4.76	9.2	7.32	0.34	5	
MW113	4/21/1999	60	0.00	10.0	7.36	0.39	5	
MW114	4/22/1999	65	4.15	10.5	7.48	0.72	3	
MW115	4/21/1999	60	2.36	10.6	7.36	0.70	2	
MW116	10/23/2000	45.5	5.15	13.1	6.9	166	723	

Table 2-7
Water Samples Analytical Summary
TAMPEEL
Former Lordstown Ordnance Depot, Ohio

Sample Location	Date Sampled	Analysis					QA/QC	
		VOCs	SVOCs	Pesticides/ PCBs	TAL Metals	Hardness	Duplicate	Matrix Spike/ MS Duplicate
Monitoring Wells								
MW112-GW01	4/21/1999	1	1	1	1	0		
MW112GW01	10/4/2000	1	1	1	1	0		
MW113-GW01	4/21/1999	1	1	1	1	0		
MW113GW01	10/4/2000	1	1	1	1	0		
MW114-GW01	4/22/1999	1	1	1	1	0		
MW114GW01	10/6/2000	1	1	1	1	0		
MW115-GW01	4/21/1999	1	1	1	1	0		
MW115GW01	10/9/2000	1	1	1	1	0		
MW116GW01	10/26/2000	1	1	1	1	0		
Subtotal:		7	7	7	7	0	0	0
Surface Water								
SW101	8/11/1998	1	1	1	1	1	1	1
SW102	8/11/1998	1	1	1	1	1		
SW103	8/11/1998	1	1	1	1	1		
SW104	8/12/1999	1	1	1	1	1		
SW105	8/12/1999	1	1	1	1	1		
SW106	8/12/1999	1	1	1	1	1		
SW107	8/12/1999	1	1	1	1	1		
SW108	8/12/1999	1	1	1	1	1		
SW109SW01	3/19/1999	1	1	1	1	1		
SW110SW01	3/19/1999	1	1	1	1	1	1	
SW20101	10/13/2000	1	1	1	1	0	1	
SW20201	10/12/2000	1	1	1	1	0		
SW20301	10/12/2000	1	1	1	1	0		
SW20401	10/12/2000	1	1	1	1	0		1
Subtotal:		14	14	14	14	10	3	2
Totals:		21	21	21	21	10	3	2

Table 2-8
Monitoring Well Water Level Elevations
TAMPEEL
Former Lordstown Ordnance Depot, Ohio

RI Report
FLOD - TAMPEEL
Section 2
May 2005

Date	Well	Time	Ground Surface Elev. (ft, MSL)	Top of Casing (TOC) Elev. (ft, MSL)	TOC Above Ground Surface (ft)	Depth to Water (ft, BTOC)	Depth to Water (ft, BGS)	Groundwater Elevation (ft, MSL)
April 21, 1999								
	MW112	1630	935.80	938.00	2.20	4.86	2.66	933.14
	MW113	1640	931.70	933.87	2.17	2.17	0.00	931.70
	MW114	1650	931.80	934.13	2.33	4.08	1.75	930.05
	MW115	1700	926.40	928.64	2.24	2.60	0.36	926.04
June 12, 2001								
	MW112		935.80	938.00	2.20	5.55	3.35	932.45
	MW113		931.70	933.87	2.17	2.52	0.35	931.35
	MW114		931.80	934.13	2.33	5.26	2.93	928.87
	MW115		926.40	928.64	2.24	2.47	0.23	926.17
	MW116		930.40	932.50	2.10	3.65	1.55	928.85

Notes: MSL = Mean Sea Level, TOC = Top of inner casing, BTOC = Below top of casing, BGS = Below ground surface.

Table 2-9

RI Report
FLOD - TAMPEEL
Revision 0
May 2005

**Survey Data
TAMPEEL
Former Lordstown Ordnance Depot
Page 1 of 2**

Area of Concern	State Plane Coordinates ¹		Ground Surface Elevation ² (ft, MSL)	Top of PVC Casing Elevation ² (ft, MSL)
	Northing	Easting		
TAMPEEL				
Existing Monitoring Wells				
MW112	556988	2445350	935.80	938.00
MW113	557340	2445349	931.70	933.87
MW114	557480	2445473	931.80	934.13
MW115	557617	2445675	926.40	928.64
MW116	557334	2445768	930.40	932.50
Surface Soil Samples				
SB131	557095	2445262	935.10	NA
SB132	557164	2445257	933.50	NA
SB133	557229	2445257	932.90	NA
SB134	557293	2445279	932.40	NA
SB135	557341	2445345	931.90	NA
SB136	557393	2445382	931.20	NA
SB137	557442	2445425	931.90	NA
SB138	557036	2445485	933.60	NA
SB139	557469	2445478	931.80	NA
SB140	557458	2445562	930.00	NA
SB141	557420	2445584	929.60	NA
SB142	557358	2445584	930.70	NA
SB143	557275	2445612	932.20	NA
SB144	557222	2445612	932.90	NA
SB145	557160	2445587	933.90	NA
SB146	557099	2445579	933.10	NA
SB147	557033	2445540	933.60	NA
SB148	557034	2445422	934.20	NA
SB149	557035	2445334	935.30	NA
SB150	557057	2445297	935.20	NA
SS185	557099	2445152	935.50	NA
SS186	557092	2445147	935.50	NA
SS187	557094	2445158	935.90	NA
SS188	557085	2445512	936.20	NA
SS189	557087	2445492	936.70	NA
SS190	557242	2445433	934.50	NA
SS191	557245	2445450	934.80	NA
SS192	557394	2445454	931.70	NA
SS193	557641	2445464	929.30	NA
SS194	556801	2445429	936.10	NA
SS195	556804	2445419	937.20	NA
SS196	556744	2445547	937.50	NA
SS197	556741	2445554	936.00	NA

Table 2-9

RI Report
FLOD - TAMPEEL
Revision 0
May 2005

**Survey Data
TAMPEEL
Former Lordstown Ordnance Depot
Page 2 of 2**

Area of Concern	State Plane Coordinates ¹		Ground Surface Elevation ² (ft, MSL)	Top of PVC Casing Elevation ² (ft, MSL)
	Northing	Easting		
SS201	557393	2445409	931.50	NA
SS202	557388	2445508	932.10	NA
SS203	557311	2445258	931.70	NA
SS204	557298	2445359	931.90	NA
SS205	557305	2445455	933.60	NA
SS206	557265	2445560	933.70	NA
SS207	557199	2445300	933.20	NA
SS208	557210	2445406	934.70	NA
SS209	557201	2445504	935.70	NA
SS210	557120	2445147	935.50	NA
SS211	557127	2445256	933.70	NA
SS212	557129	2445355	934.40	NA
SS213	557130	2445457	936.30	NA
SS214	557104	2445514	936.70	NA
SS215	557044	2445121	935.80	NA
SS216	557048	2445200	935.50	NA
SS217	557045	2445305	935.20	NA
SS218	556966	2445446	934.70	NA
Surface Water/ Sediment Samples				
SD01	555872	2446204	943.70	NA
SD03	555691	2445494	942.90	NA
SD04	556286	2445787	938.00	NA
SW/SD109	557462	2445521	927.60	NA
SW/SD110	557639	2445472	928.60	NA
SW/SD201	557638	2445470	928.70	NA
SW/SD202	557461	2445522	927.60	NA
SW/SD203	557645	2445509	927.60	NA
SW/SD204	558377	2446423	917.10	NA
SW/SD205	555693	2445482	939.60	NA

¹ North American Datum of 1927

² National Geodetic Vertical Datum 1929

Table 2-10
QA/QC Samples
TAMPEEL
Former Lordstown Ordnance Depot, Ohio

Field Duplicates

Field Duplicate Number	Date Sampled	matrix	Analysis							
			VOCs	SVOCs	Pesticides/ PCBs	TAL Metals	Dioxin/ Furans	Explosives	TOC	Hardness
SD503	8/11/1998	sediment	1	1	1	1			1	
SW503	8/11/1998	surface water	1	1	1	1				1
SB138SOD01	3/17/1999	0 to 2' soil	1	1	1	1				
SB149SOD2	3/17/1999	2 to 4' soil	1	1	1	1				
SS193SOD01	3/18/1999	surface soil	1	1	1	1				
SW109SWD01	3/19/1999	surface water	1	1	1	1				1
SS195S5101	3/29/1999	surface soil	1	1	1	1	1	1		
SS21101	10/5/2000	surface soil	1	1	1	1				
SS21801	10/5/2000	surface soil	1	1	1	1				
SD20101	10/13/2000	sediment	1	1	1	1				
Totals:			10	10	10	10	1	1	1	2

**Matrix Spikes/
MS Duplicates**

Sample Location	Date Sampled	Depth Interval (ft,bgs)	Analysis			
			VOCs	SVOCs	Pesticides/ PCBs	TAL Metals
SD103MS/MSD	8/11/1998	sediment	1	1	1	1
SD103MS/MSD	8/11/1998	sediment	1	1	1	1
SW103MS/MSD	8/11/1998	sediment	1	1	1	1
SB139SOMS/MSD1	3/17/1999	0 to 2' soil	1	1	1	1
SS192SOMS/MSD01	3/18/1999	0 to 1' soil	1	1	1	1
SS21701	10/5/2000	surface soil	1	1	1	1
SD20401	10/12/2000	sediment	1	1	1	1
Totals:			7	7	7	7

Table 3-1
Adjacent Groundwater Wells
TAMPEEL
Former Lordstown Ordnance Depot, Ohio
Page 1 of 2

SI Well Number	Ohio Well Number	Approximate Surface Elevation	Well Depth (ft)	Strata Depth	Strata Material	Rock Elevation	Depth Water Encountered	Test Flow (gpm)	Static Depth	Water Elevation
3	375979	907	60	0-15	Yellow clay	892		1.5	6	901
				15-60	Shale					
4	423973	913	50	0-10	Yellow clay	896		4	9	904
				10-17	Clay & gravel					
				17-50	Shale					
5	399243	915	59	0-10	Yellow clay	900		10	15	900
				10-15	Blue clay					
				15-59	Shale					
7	405105	966	95	0-8	Sand	958		2	11	955
				8-20	Sand rock					
				20-95	Shale					
8	410995	948	58	0-8	Yellow clay	940		10	20	928
				8-58	Sand rock					
17	323366	918	118	0-24	Yellow clay	894	36	50	10	908
				24-40	Sand rock					
				40-118	Blue shale					
24	316060	934	152	0-7	Clay	926		4	7	927
				7-152	Shale					
26	347885	956	70	0-4	Yellow clay	952	66	10	30	926
				4-66	Sand rock					
				66-70	White sand rock					
30	169537	937	64	0-4		933		30	5	932
				4-53	Brown sand rock					
				53-64	White sand rock					
31	118986	950	50	0-20	Yellow clay	922		5	22	928
				20-28	Blue clay					
				28-50	Grey sandstone					
32	93467	923	48	0-14	Clay	909	35	10	1	922
				14-48	Sandstone					

Table 3-1
Adjacent Groundwater Wells
TAMPEEL
Former Lordstown Ordnance Depot, Ohio
Page 2 of 2

SI Well Number	Ohio Well Number	Approximate Surface Elevation	Well Depth (ft)	Strata Depth	Strata Material	Rock Elevation	Depth Water Encountered	Test Flow (gpm)	Static Depth	Water Elevation
36	362086	945	100	0-14	Clay	926		12	15	930
				14-19	Sand, gravel, shale					
				19-32	Grey rock					
				32-74	Grey shale					
				74-88	Black shale					
				88-100	Grey rock					
37	303197	947	116	0-6	Yellow clay	933	110	7	11	936
				6-14	Blue clay					
				14-116	Shale rock					
38	318924	944	100	0-5	Clay	939	22	5	5	939
				5-17	Grey shale					
				17-23	Grey rock					
				23-76	Shale					
				76-100	Grey rock shale					
39	302798	941	65	0-12	Clay	923	30	8	4	937
				12-18	Sand, gravel, shale					
				18-30	Grey rock					
				30-48	Grey shale					
				48-65	Grey rock shale					
58	37561	921	60	0-8	Yellow clay	913		4	7	914
				8-60	Shale					
59	375954	920	60	0-10	Yellow clay	910		5	20	900
				10-60	Shale					

Table 3-2
Slug Test Analysis Results

Well	Hydraulic Conductivity (ft/day)		Comments
	Hvorslev	Bower-Rice	
MW112	6.0000	4.2100	Acceptable Data
MW113	-	-	Unacceptable Data
MW114	3.2900	2.3400	Acceptable Data
MW115	0.9820	0.7010	Acceptable Data
MW116	-	-	Three-segment curve

Table 3-3
Vegetative Communities
TAMPEEL
Former Lordstown Ordnance Depot, Ohio

Community Type	Definition
AGRI	Agricultural areas including crop fields, pastures, and fallow fields
DEV	Developed and disturbed areas including residential, commercial, industrial
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 3-4
Mammals Observed Onsite
and Likely to be Found in Trumbull County, Ohio
TAMPEEL
Former Lordstown Ordnance Depot, Ohio

Family Name	Scientific Name	Common Name	Observed On-site
Didelphidae	<i>Didelphis virginiana</i>	Virginia opossum	1, 2
Talpidae	<i>Condylura cristata</i>	star-nosed mole	2
	<i>Parascalops breweri</i>	hairy-tailed mole	
	<i>Scalopus aquaticus</i>	Eastern mole	
Vespertilionidae	<i>Myotis keenii</i>	Keen's bat	
	<i>M. lucifugus</i>	little brown bat	2
	<i>M. sodalis</i>	Indiana bat	
	<i>Eptesicus fuscus</i>	big brown bat	
	<i>Lasiurus noctivagans</i>	silver-haired bat	
	<i>Lasiurus borealis</i>	red bat	
	<i>L. cinereus</i>	hoary bat	
	<i>Nycticeius humeralis</i>	evening bat	
	<i>Pipistrellus subflavus</i>	Eastern pipistrelle	
Leporidae	<i>Sylvilagus floridanus</i>	cottontail rabbit	1, 2
Scluridae	<i>Glaucomys volans</i>	Southern flying squirrel	
	<i>Marmota monax</i>	woodchuck	1, 2
	<i>Sciurus carolinensis</i>	gray squirrel	
	<i>S. niger</i>	fox squirrel	1, 2
	<i>Tamias striatus</i>	Eastern chipmunk	1, 2
	<i>Tamiasciurus hudsonicus</i>	red squirrel	1, 2
	<i>Blarina brevicauda</i>	short-tailed shrew	1, 2
	<i>Cryptotis parva</i>	least shrew	2
	<i>Sorex cinereus</i>	masked shrew	
	<i>S. fumeus</i>	smoky shrew	
Castoridae	<i>Castor canadensis</i>	beaver	1, 2, 3
Cricetidae	<i>Microtus ochrogaster</i>	prairie vole	
	<i>M. pennsylvanicus</i>	meadow vole	
	<i>M. pinetorum</i>	woodland vole	
	<i>Mus musculus</i>	house mouse	1
	<i>Napaeozapus insignis</i>	woodland jumping mouse	2
	<i>Ondatra zibethicus</i>	muskrat	1, 2
	<i>Peromyscus leucopus</i>	white-footed mouse	
	<i>P. maniculatus</i>	deer mouse	1
	<i>Rattus norvegicus</i>	Norway rat	
	<i>Synaptomys cooperi</i>	Southern bog lemming	
	<i>Zapus hudsonius</i>	meadow jumping mouse	
Procyonidae	<i>Procyon lotor</i>	raccoon	1, 2
Mustelidae	<i>Mephitis mephitis</i>	striped skunk	1, 2
	<i>Mustela frenata</i>	long-tailed weasel	2
	<i>M. nivalis</i>	least weasel	2
	<i>M. vison</i>	mink	
	<i>Taxidea taxus</i>	badger	
Canidae	<i>Canis latrans</i>	coyote	
	<i>Urocyon cinereoargenteus</i>	gray fox	2
	<i>Vulpes vulpes</i>	red fox	1
Cervidae	<i>Odocoileus virginianus</i>	white-tailed deer	1, 2

Mammals likely to be found in Trumbull County based on information presented in:
Gottschang, J. L., 1981, A Guide to the Mammals of Ohio, Ohio State University Press, 176 pages.
Reference for on-site observation:

- (1) Brice Harris, Tampeel, Aug. 1996 - Dec. 1997
- (2) Norm Downing, Tampeel, 1975 - 1996
- (3) IT reconnaissance, Nov. 24, 1997

Table 3-5
Birds Observed Onsite and Likely to be Found
in Trumbull County, Ohio
TAMPEEL
Former Lordstown Ordnance Depot, Ohio
Page 1 of 3

Family Name ^a	Scientific Name ^b	Common Name	Observed On-site
Ardeidae	<i>Ardea herodias</i>	great blue heron	1, 2
	<i>Butorides striatus</i>	green-backed heron	2
	<i>Casmerodius albus egretta</i>	American egret	
Anatinae	<i>Aix sponsa</i>	Wood duck	1, 2
	<i>Anas discors</i>	blue-winged teal	
	<i>A. platyrhynchos</i>	mallard	1, 2, 3
Anserinae	<i>Branta canadensis</i>	Canada goose	1, 2
Accipitrinae	<i>Accipiter cooperii</i>	Cooper's hawk	1, 2
	<i>A. striatus</i>	sharp-shinned hawk	
Buteoninae	<i>Buteo jamaicensis</i>	red-tailed hawk	1, 2
	<i>B. lineatus</i>	red-shouldered hawk	2
	<i>B. platypterus</i>	broad-winged hawk	
Cathartidae	<i>Cathartes aura</i>	turkey vulture	1, 2
Circinae	<i>Circus cyaneus</i>	marsh hawk	2
Falconinae	<i>Falco sparverius</i>	American kestrel	
Phasianidae	<i>Colinus virginianus</i>	Northern bobwhite quail	2
	<i>Phasianus colchicus</i>	ring-necked pheasant	1, 2
Tetraonidae	<i>Bonasa umbellus</i>	ruffed grouse	1, 2
Rallidae	<i>Rallus limicola</i>	Virginia rail	1
Charadriidae	<i>Charadrius vociferus</i>	killdeer	1, 2
Scolopacidae	<i>Actitis macularia</i>	spotted sandpiper	
	<i>Ereunetes pusillus</i>	semipalmated plover	
	<i>Scolopax minor</i>	American woodcock	2
Columbidae	<i>Columba livia</i>	rock dove	2
	<i>Zenaida macroura</i>	mourning dove	1, 2
Cuculidae	<i>Coccyzus americanus</i>	yellow-billed cuckoo	
	<i>C. erythrophthalmus</i>	black-billed cuckoo	
Tytonidae	<i>Bubo virginianus</i>	great horned owl	2
	<i>Otus asio</i>	Eastern screech-owl	
	<i>Strix varia</i>	barred owl	
Caprimulgidae	<i>Caprimulgus vociferus</i>	whip-poor-will	
	<i>Chordeiles minor</i>	common nighthawk	2
Apodidae	<i>Chaetura pelagica</i>	chimney swift	2
Trochilidae	<i>Archilochus colubris</i>	ruby-throated hummingbird	1, 2
Alcedinidae	<i>Ceryle alcyon</i>	belted kingfisher	1, 2
Picidae	<i>Colaptes auratus</i>	Northern flicker	1, 2
	<i>Dryocopus pileatus</i>	pileated woodpecker	2
	<i>Melanerpes carolinus</i>	red-bellied woodpecker	1, 2
	<i>M. erythrocephalus</i>	red-headed woodpecker	
	<i>Picoides pubescens</i>	downy woodpecker	1, 2
	<i>P. villosus</i>	hairy woodpecker	1, 2
	<i>Sphyrapicus varius</i>	yellow-bellied sapsucker	2
	<i>Eremophila alpestris</i>	horned lark	
Bombycillidae	<i>Bombycilla cedrorum</i>	cedar waxwing	1, 2
Certhiidae	<i>Certhia americana</i>	brown creeper	1
Corvidae	<i>Corvus brachyrhynchos</i>	American crow	1, 2
	<i>Cyanocitta cristata</i>	blue jay	1, 2
Fringillidae	<i>A. henslowii</i>	Henslow's sparrow	
	<i>A. savannarum</i>	grasshopper sparrow	
	<i>Cardinalis cardinalis</i>	Northern cardinal	1, 2
	<i>Carduelis tristis</i>	American goldfinch	1, 2

Table 3-5
Birds Observed Onsite and Likely to be Found
In Trumbull County, Ohio
TAMPEEL
Former Lordstown Ordnance Depot, Ohio
Page 2 of 3

Family Name ^a	Scientific Name ^b	Common Name	Observed On-site
Hirundinidae	<i>Carpodacus mexicanus</i>	house finch	1, 2
	<i>C. purpureus</i>	purple finch	
	<i>Junco hyemalis</i>	dark-eyed junco	2
	<i>Melospiza georgiana</i>	swamp sparrow	
	<i>M. melodia</i>	song sparrow	1, 2
	<i>Passerculus sandwichensis</i>	Savannah sparrow	
	<i>Passerina cyanea</i>	indigo bunting	1, 2
	<i>Pheucticus ludovicianus</i>	rose-breasted grosbeak	1, 2
	<i>Pipilo erythrophthalmus</i>	rufous-sided towhee	1, 2
	<i>Poocetes gramineus</i>	vesper sparrow	
	<i>Spizella passerina</i>	chipping sparrow	
	<i>S. pusilla</i>	field sparrow	1
	<i>Hirundo pyrrhonota</i>	cliff swallow	
	<i>H. rustica</i>	barn swallow	1, 2
	<i>Progne subis</i>	purple martin	1
Icteridae	<i>Riparia riparia</i>	bank swallow	
	<i>Stelgidopteryx serripennis</i>	Northern rough-winged swallow	
	<i>Tachycineta bicolor</i>	tree swallow	2
	<i>Agelaius phoeniceus</i>	red-winged blackbird	1, 2
	<i>Dolichonyx oryzivorus</i>	bobolink	
Mimidae	<i>Icterus galbula</i>	Northern oriole	1, 2
	<i>I. spurius</i>	orchard oriole	
	<i>Molothrus ater</i>	brown-headed cowbird	1, 2
	<i>Quiscalus quiscula</i>	common grackle	2
	<i>Sturnella magna</i>	Eastern meadowlark	
Paridae	<i>S. neglecta</i>	Western meadowlark	
	<i>Dumetella carolinensis</i>	gray catbird	1, 2
	<i>Mimus polyglottos</i>	Northern mockingbird	
Parulidae	<i>Toxostoma rufum</i>	brown thrasher	2
	<i>Parus atricapillus</i>	black-capped chickadee	1, 2
	<i>P. bicolor</i>	tufted titmouse	1, 2
Sittidae	<i>P. carolinensis</i>	Carolina chickadee	
	<i>Dendroica cerulea</i>	cerulean warbler	
	<i>D. discolor</i>	prairie warbler	
	<i>D. dominica</i>	yellow-throated warbler	
	<i>D. pensylvanica</i>	chestnut-sided warbler	
	<i>D. petechia</i>	yellow warbler	1, 2
	<i>Geothlypis trichas</i>	common yellowthroat	
	<i>Icteria virens</i>	yellow-breasted chat	
	<i>Mniotilta varia</i>	black and white warbler	
	<i>Oporornis formosus</i>	Kentucky warbler	
	<i>O. philadelphia</i>	mourning warbler	
	<i>Protonotaria citrea</i>	prothonotary warbler	
	<i>Seiurus aurocapillus</i>	overbird	
	<i>Setophaga ruticilla</i>	American redstart	
	<i>Vermivora pinus</i>	blue-winged warbler	
Sturnidae	<i>Wilsonia citrina</i>	hooded warbler	1
	<i>Passer domesticus</i>	house sparrow	1, 2
	<i>Sitta canadensis</i>	red-breasted nuthatch	1, 2
Sylviidae	<i>S. carolinensis</i>	white-breasted nuthatch	1, 2
	<i>Sturnus vulgaris</i>	European starling	1, 2
	<i>Polioptila caerulea</i>	blue-gray gnatcatcher	

Table 3-5
Birds Observed Onsite and Likely to be Found
In Trumbull County, Ohio
TAMPEEL
Former Lordstown Ordnance Depot, Ohio
Page 3 of 3

Family Name ^a	Scientific Name ^b	Common Name	Observed On-site
Thraupidae	<i>Piranga olivacea</i>	scarlet tanager	1, 2
Troglodytidae	<i>Cistothorus palustris</i>	marsh wren	
	<i>C. platensis</i>	sedge wren	
	<i>Thryothorus ludovicianus</i>	Carolina wren	
	<i>Troglodytes aedon</i>	house wren	1, 2
Turdidae	<i>Catharus fuscescens</i>	veery	
	<i>Hylocichla mustelina</i>	wood thrush	1
	<i>Sialia sialis</i>	Eastern bluebird	1, 2
	<i>Turdus migratorius</i>	American robin	1, 2
Tyrannidae	<i>Contopus virens</i>	Eastern wood-pewee	
	<i>Empidonax alnorum</i>	alder flycatcher	
	<i>E. minimus</i>	least flycatcher	
	<i>E. traillii</i>	willow flycatcher	
	<i>E. virescens</i>	Acadian flycatcher	
	<i>Myiarchus crinitus</i>	crested flycatcher	
	<i>Sayornis phoebe</i>	Eastern phoebe	
	<i>Tyrannus tyrannus</i>	Eastern kingbird	
	<i>Vireo bellii</i>	Bell's vireo	
Vireonidae	<i>V. flavifrons</i>	yellow-throated vireo	
	<i>V. gilvus</i>	warbling vireo	
	<i>V. griseus</i>	white-eyed vireo	
	<i>V. olivaceus</i>	red-eyed vireo	

^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.

Reference for on-site observation:

- (1) Brice Harris, Tampeel, Aug. 1996 - Dec. 1997
- (2) Norm Downing, Tampeel, 1975 - 1996
- (3) IT reconnaissance, Nov. 24, 1997

Table 3-6
Reptiles Observed On-site and Likely to be Found in Northeast Ohio
TAMPEEL
Former Lordstown Ordnance Depot, Ohio

Family Name	Scientific Name	Common Name	Observed On-site
Crotalidae	<i>Ancistrodon contortrix mokeson</i>	copperhead	
	<i>Grotalus h. horridus</i>	timber rattlesnake	
	<i>Sistrurus catenatus catenatus</i>	Eastern massasauga	
Chelydridae	<i>Chelydra serpentina</i>	snapping turtle	1, 2
Kinosternidae	<i>Sternotherus odoratus</i>	musk turtle	
Emydidae	<i>Chrysemys picta</i>	painted turtle	1, 2
	<i>Clemmys guttata</i>	spotted turtle	
	<i>Graptemys geographica</i>	map turtle	
	<i>Terrapene carolina</i>	box turtle	2
Trionychidae	<i>Apalone spinifera</i>	Spiny softshell	
Colubridae	<i>Coluber constrictor constrictor</i>	black racer	
	<i>C. constrictor foxi</i>	blue racer	
	<i>C. constrictor flaviventris</i>	yellow bellied racer	
	<i>Diadophis punctatus edwardsi</i>	Eastern ring-necked snake	2
	<i>Elaphe obsoleta obsoleta</i>	pilot black snake	
	<i>Heterodon platyrhinos platyrhinos</i>	hog-nosed snake	
	<i>Lampropeltis dolia triangularis</i>	milk snake	1, 2
	<i>Natrix erythrogaster neglecta</i>	Northern copper belly	
	<i>N. kirtlandi</i>	Kirtland's water snake	
	<i>N. septemvittata</i>	queen snake	
	<i>N. sipedon sipedon</i>	water snake	
	<i>Opheodrys vernalis vernalis</i>	green snake	
	<i>Storeria dekayi dekayi</i>	Dekay's snake	
	<i>S. dekayi wrightorum</i>	Central brown snake	
	<i>S. occipitomaculata occipitomaculata</i>	red-bellied snake	
	<i>Thamnophis sauritus sauritus</i>	ribbon snake	
	<i>T. s. sirtalis</i>	common garter snake	1, 2

Sources: 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) Brice Harris, Tampeel, Aug. 1996 - Dec. 1997
- (2) Norm Downing, Tampeel, 1975 - 1996
- (3) IT reconnaissance, Nov. 24, 1997

Table 3-7
Amphibians Observed On-site and Likely to be Found
in Trumbull County, Ohio
TAMPEEL
Former Lordstown Ordnance Depot, Ohio

Family Name	Scientific Name	Common Name	Observed On-site
Scincidae	<i>Eumeces fasciatus</i>	five-lined skink	
Ambystomatidae	<i>Ambystoma jeffersonianum</i>	Jefferson salamander	
	<i>A. maculatum</i>	spotted salamander	
	<i>A. texanum</i>	smallmouth salamander	
	<i>A. tigrinum</i>	tiger salamander	
Proteidae	<i>Necturus maculosus</i>	mudpuppy	
Salamandridae	<i>Notophthalmus viridescens</i>	Eastern newt	
Plethodontidae	<i>Desmognathus fuscus</i>	dusky salamander	
	<i>Eurycea bislineata</i>	two-lined salamander	
	<i>E. longicauda</i>	longtail salamander	
	<i>Plethodon cinereus</i>	redback salamander	1
	<i>P. glutinosus</i>	slimy salamander	
Bufonidae	<i>P. richmondi</i>	ravine salamander	
	<i>Bufo americanus</i>	American toad	1, 2
	<i>B. woodhousii</i>	Fowler's toad	
Hylidae	<i>Hyla versicolor</i>	gray treefrog	2
	<i>Pseudacris crucifer</i>	spring peeper	1, 2
	<i>P. triseriata</i>	chorus frog	
Ranidae	<i>Rana catesbeiana</i>	bullfrog	1, 2
	<i>R. clamitans</i>	green frog	1, 2
	<i>R. palustris</i>	pickerel frog	
	<i>R. pipiens</i>	Northern leopard frog	
	<i>R. sylvatica</i>	wood frog	1

Sources: 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) Brice Harris, Tampeel, Aug. 1996 - Dec. 1997
- (2) Norm Downing, Tampeel, 1975 - 1996
- (3) IT reconnaissance, Nov. 24, 1997

Table 4-1

**Background Concentrations for Total Soil and Groundwater
TAMPEEL
Former Lordstown Ordnance Depot
Lordstown, Ohio**

Chemical	Total Soil ¹ mg/kg	Groundwater ² mg/L
ALUMINUM	18,600	3.5
ANTIMONY	ND	ND
ARSENIC	24	0.014
BARIUM	79.7	ND
BERYLLIUM	1.1	ND
CADMIUM	1.9	ND
CALCIUM	9,800	91
CHROMIUM ³	25.3	ND
COBALT	18.7	ND
COPPER	26.2	ND
IRON	35,700	3.2
LEAD	24.1	ND
MAGNESIUM	5,626	30.2
MANGANESE	469	2.4
MERCURY	0.12	ND
NICKEL	32	ND
POTASSIUM	4,059	ND
SELENIUM	1.4	ND
SILVER	0.16	ND
SODIUM	75.6	13.8
THALLIUM	ND	ND
VANADIUM	36.5	ND
ZINC	103	0.47

¹ Total soil background is 95% UTL of SB21, SB39, SB128A, SB129, SB130, MW-103, and MW-110. If the 95% UTL is greater than the maximum detected value, the maximum detected value was used.

² Groundwater background is the maximum value of MW-103, MW-109, and MW-110.

³ Chromium not speciated - Assumed to be Cr VI
ND - Not Detected.

Table 4-2
Subsurface Soil Samples
Analytical Results Summary - Detected Compounds Only
TAMPEEL
Former Lordstown Ordnance Depot
Page 1 of 2

Sample Number	MW11602	SB131SO004	SB132SO002	SB134SO003	SB136SO003	SB137SO004	SB140SO002	SB145SO002
Sample Date	10/13/2000	3/16/1999	3/16/1999	3/16/1999	3/16/1999	3/16/1999	3/17/1999	3/17/1999
Depth:	2.00-4.00	6.00-7.00	2.00-4.00	6.00-7.00	4.00-6.00	6.00-8.00	2.00-4.00	2.00-4.00

VOCS

Acetone	(ug/kg)	--	--	--	810 J	--	--	--	--
METALS									
Aluminum	(mg/kg)	13800 =	6490 =	13600 =	11500 =	9510 =	1520 =	12300 =	8650 =
Arsenic	(mg/kg)	21.1 =	10.8 =	23 =	9.2 =	5.2 =	--	18.2 =	10.8 =
Barium	(mg/kg)	62.5 =	22.8 =	75.8 =	41.5 =	74.3 =	--	54.1 =	65.3 =
Beryllium	(mg/kg)	0.62 =	--	--	--	--	--	--	--
Calcium	(mg/kg)	4130 =	1040 =	1350 =	1570 =	1260 =	987 =	9750 =	829 =
Chromium	(mg/kg)	18.7 =	10.9 =	18.1 =	15.7 =	14.1 =	3.7 =	17 =	12.3 =
Cobalt	(mg/kg)	11.4 =	8.1 J	7.6 J	8.4 J	9.4 J	--	11.1 J	7.7 J
Copper	(mg/kg)	[32.6] =	20.3 J	20.2 J	24 J	15.3 J	--	20.9 J	14.7 J
Iron	(mg/kg)	32800 =	21600 =	[38400] =	28700 =	29500 =	3180 =	30100 =	24400 =
Lead	(mg/kg)	20.8 =	10.7 =	14.3 =	14.2 =	10.6 =	3.2 =	11.7 =	9.7 =
Magnesium	(mg/kg)	4320 =	2100 J	3200 J	3050 J	3120 J	615 J	4980 J	2210 J
Manganese	(mg/kg)	377 =	223 =	191 =	[589] =	195 =	52.3 =	292 =	378 =
Nickel	(mg/kg)	27.7 =	21.1 =	24.8 =	24 =	25.6 =	--	29.9 =	20.5 =
Potassium	(mg/kg)	2020 =	1140 =	1610 =	2470 =	1800 =	--	1830 =	1640 =
Vanadium	(mg/kg)	21.7 =	11 =	22.1 =	20.6 =	14.5 =	--	18.1 =	13.8 =
Zinc	(mg/kg)	74.9 =	[107] J	75.6 J	60.6 J	55.8 J	10.7 J	65.3 J	46.3 J

Table 4-2
Subsurface Soil Samples
Analytical Results Summary - Detected Compounds Only
TAMPEEL
Former Lordstown Ordnance Depot
Page 2 of 2

Sample Number	SB149SO002	SB149SO0D2	SB150SO005
Sample Date	3/17/1999	3/17/1999	3/17/1999
Depth:	2.00-4.00	2.00-4.00	8.00-9.00

VOCS

Acetone	(ug/kg)	--	--	370 J
---------	---------	----	----	-------

METALS

Aluminum	(mg/kg)	11200 =	11900 =	10800 =
Arsenic	(mg/kg)	23.2 =	20.4 =	14.7 =
Barium	(mg/kg)	51.3 =	57.8 =	70.5 =
Beryllium	(mg/kg)	--	--	--
Calcium	(mg/kg)	2120 =	2130 =	2080 =
Chromium	(mg/kg)	18.1 =	18.1 =	17.4 =
Cobalt	(mg/kg)	11.2 J	14.1 J	13 J
Copper	(mg/kg)	25.4 J	22.3 J	21 J
Iron	(mg/kg)	28400 =	30100 =	25300 =
Lead	(mg/kg)	16.7 =	14.7 =	12.9 =
Magnesium	(mg/kg)	2850 J	3170 J	3330 J
Manganese	(mg/kg)	358 J	[496] J	[514] =
Nickel	(mg/kg)	29.7 =	30.7 =	[32.5] =
Potassium	(mg/kg)	2050 =	2050 =	1910 =
Vanadium	(mg/kg)	17.8 =	18.7 =	16.5 =
Zinc	(mg/kg)	77.1 J	80.4 J	65.8 J

NOTES:

-- = Not Detected

[] = Metal Concentration Exceeds Background Value

Blank = Not Analyzed

DATA QUALIFIERS

= - The analyte of concern was detected at the concentration level reported.

J = The analyte of concern was detected but should be considered as an estimated value.

B = Qualifier indicates the presence of the qualified target compound in the method or procedure blank.

Table 4-3
Surface Soil Samples
Analytical Results Summary - Detected Compounds Only
TAMPEEL
Former Lordstown Ordnance Depot
Page 1 of 15

Sample Number		MW11601	SB133SO001	SB135SO001	SB138SO001	SB138SO01 Dup	SB139SO001	SB141SO001
Sample Date		10/13/2000	3/16/1999	3/16/1999	3/17/1999	3/17/1999	3/17/1999	3/17/1999
VOCS								
1,1,1-trichloroethane	(ug/kg)	--	--	--	--	--	--	--
2-butanone	(ug/kg)	--	--	--	--	--	--	--
Acetone	(ug/kg)	--	--	--	--	24 J	--	--
Ethylbenzene	(ug/kg)	--	--	--	--	--	--	--
Methylene Chloride	(ug/kg)	--	--	--	5.7 =	--	15 =	--
Toluene	(ug/kg)	--	--	--	--	--	--	--
Xylenes (total)	(ug/kg)	--	--	--	--	--	--	--
SVOCS								
2-methylnaphthalene	(ug/kg)	--	--	--	--	--	--	--
Acenaphthene	(ug/kg)	--	--	--	--	--	--	--
Acenaphthylene	(ug/kg)	--	--	--	--	--	--	--
Anthracene	(ug/kg)	--	--	--	--	--	--	--
Benzo(a)anthracene	(ug/kg)	--	--	--	--	--	--	--
Benzo(a)pyrene	(ug/kg)	--	--	--	--	--	--	--
Benzo(b)fluoranthene	(ug/kg)	--	--	--	--	--	--	--
Benzo(g,h,i)perylene	(ug/kg)	--	--	--	--	--	--	--
Benzo(ghi)perylene	(ug/kg)	--	--	--	--	--	--	--
Benzo(k)fluoranthene	(ug/kg)	--	--	--	--	--	--	--
Bis(2-ethylhexyl) Phthalate	(ug/kg)	--	--	--	--	--	--	--
Butyl Benzyl Phthalate	(ug/kg)	--	--	--	--	--	--	--
Carbazole	(ug/kg)	--	--	--	--	--	--	--
Chrysene	(ug/kg)	--	--	--	--	--	--	--
Dibenz(a,h)anthracene	(ug/kg)	--	--	--	--	--	--	--
Dibenzofuran	(ug/kg)	--	--	--	--	--	--	--
Fluoranthene	(ug/kg)	--	--	--	--	--	--	--
Fluorene	(ug/kg)	--	--	--	--	--	--	--
Indeno(1,2,3-cd)pyrene	(ug/kg)	--	--	--	--	--	--	--
Naphthalene	(ug/kg)	--	--	--	--	--	--	--
Phenanthrene	(ug/kg)	--	--	--	--	--	--	--
Pyrene	(ug/kg)	--	--	--	--	--	--	--

Table 4-3
Surface Soil Samples
Analytical Results Summary - Detected Compounds Only
TAMPEEL
Former Lordstown Ordnance Depot
Page 2 of 15

Sample Number		MW11601	SB133SO001	SB135SO001	SB138SO001	SB138SO001 Dup	SB139SO001	SB141SO001
Sample Date		10/13/2000	3/16/1999	3/16/1999	3/17/1999	3/17/1999	3/17/1999	3/17/1999
PESTICIDES								
4,4'-DDE	(ug/kg)	--	--	10 =	--	--	--	--
4,4'-DDT	(ug/kg)	--	--	5.2 =	--	--	--	--
Beta-BHC	(ug/kg)	--	--	--	--	--	--	--
PCBS								
Aroclor 1254	(ug/kg)	--	--	--	--	--	--	--
Aroclor 1260	(ug/kg)	--	--	--	--	--	--	--
DIOXINS/FURANS								
1,2,3,4,6,7,8-HPCDD	(pg/g)							
OCDD	(pg/g)							
Total HPCDD	(pg/g)							
Total HXCDD	(pg/g)							
Total PECDF	(pg/g)							
Total TCDF	(pg/g)							
METALS								
Aluminum	(mg/kg)	14600 =	15900 =	12300 =	6380 =	6600 =	14200 =	15100 =
Arsenic	(mg/kg)	[24.2] =	8.1 =	17.1 =	[48.2] J	10.3 J	13.7 =	18.1 =
Barium	(mg/kg)	35.5 =	[184] =	[109] =	27.3 J	41.5 J	[165] =	64.8 =
Beryllium	(mg/kg)	--	--	--	--	--	--	--
Cadmium	(mg/kg)	--	--	--	--	--	--	--
Calcium	(mg/kg)	929 =	2040 =	1980 =	--	--	4160 =	891 =
Chromium	(mg/kg)	19.4 =	19.6 =	17.6 =	9.8 =	8.2 =	18.9 =	19.9 =
Cobalt	(mg/kg)	8 =	11.9 J	9.2J	--	--	10.7 J	--
Copper	(mg/kg)	24.2 =	22.6 J	19J	8 J	9.2 J	17 J	13.5 J
Iron	(mg/kg)	[41500] =	28800 =	32000 =	21300 J	12100 J	26700 =	31500 =
Lead	(mg/kg)	15.8 =	12.6 =	11.2 =	6.9 =	6.2 =	14.3 =	11.5 =
Magnesium	(mg/kg)	3200 =	3460 J	3700 J	935 J	990 J	3210 J	2790 J
Manganese	(mg/kg)	186 =	[963] =	338 =	173 J	331 J	[1580] =	277 =
Mercury	(mg/kg)	--	--	--	--	--	--	--
Nickel	(mg/kg)	22.1 =	26.7 =	29.1 =	10.5 =	9.1 =	26.9 =	18.2 =
Potassium	(mg/kg)	1310 =	1480 =	1590 =	581 =	597 =	1930 =	1260 =
Selenium	(mg/kg)	0.65 =	--	--	--	--	--	--
Sodium	(mg/kg)	--	--	--	--	--	--	--
Vanadium	(mg/kg)	22.2	23.1 =	17.1 =	9.6 =	10.8 =	25.1 =	26.5 =
Zinc	(mg/kg)	58.9	74.3 J	66.8 J	49.6 J	36.6 J	66.5 J	59.8 J

Table 4-3
Surface Soil Samples
Analytical Results Summary - Detected Compounds Only
TAMPEEL
Former Lordstown Ordnance Depot
Page 3 of 15

Sample Number		SB142SO001	SB143SO001	SB144SO001	SB146SO002	SB147SO001	SB148SO002	SS185SO01
Sample Date		3/17/1999	3/17/1999	3/17/1999	3/17/1999	3/17/1999	3/17/1999	3/18/1999
VOCS								
1,1,1-trichloroethane	(ug/kg)	--	--	--	--	--	--	--
2-butanone	(ug/kg)	--	--	--	--	--	--	--
Acetone	(ug/kg)	220 J	680 J	--	32 =	60 =	470 J	--
Ethylbenzene	(ug/kg)	--	--	--	--	--	--	--
Methylene Chloride	(ug/kg)	6.7 =	--	--	--	--	--	--
Toluene	(ug/kg)	--	--	--	--	--	--	--
Xylenes (total)	(ug/kg)	--	--	--	--	--	--	--
SVOCS								
2-methylnaphthalene	(ug/kg)	--	--	--	--	--	--	--
Acenaphthene	(ug/kg)	--	--	--	--	--	--	--
Acenaphthylene	(ug/kg)	--	--	--	--	--	--	--
Anthracene	(ug/kg)	--	--	--	--	--	--	340 =
Benzo(a)anthracene	(ug/kg)	--	--	--	--	--	--	1100 =
Benzo(a)pyrene	(ug/kg)	--	--	--	--	--	--	890 =
Benzo(b)fluoranthene	(ug/kg)	--	--	--	--	--	--	1300 =
Benzo(g,h,i)perylene	(ug/kg)	--	--	--	--	--	--	350 =
Benzo(ghi)perylene	(ug/kg)	--	--	--	--	--	--	350 =
Benzo(k)fluoranthene	(ug/kg)	--	--	--	--	--	--	520 =
Bis(2-ethylhexyl) Phthalate	(ug/kg)	--	--	--	--	--	--	120 =
Butyl Benzyl Phthalate	(ug/kg)	--	--	--	--	--	--	--
Carbazole	(ug/kg)	--	--	--	--	--	--	140 =
Chrysene	(ug/kg)	--	--	--	--	--	--	1100 =
Dibenz(a,h)anthracene	(ug/kg)	--	--	--	--	--	--	120 =
Dibenzofuran	(ug/kg)	--	--	--	--	--	--	--
Fluoranthene	(ug/kg)	--	--	--	--	--	--	2700 =
Fluorene	(ug/kg)	--	--	--	--	--	--	62 =
Indeno(1,2,3-cd)pyrene	(ug/kg)	--	--	--	--	--	--	460 =
Naphthalene	(ug/kg)	--	--	--	--	--	--	--
Phenanthrene	(ug/kg)	--	--	--	--	--	--	1400 =
Pyrene	(ug/kg)	--	--	--	--	--	--	1900 =

Table 4-3
Surface Soil Samples
Analytical Results Summary - Detected Compounds Only
TAMPEEL
Former Lordstown Ordnance Depot
Page 4 of 15

Sample Number		SB142SO001	SB143SO001	SB144SO001	SB146SO002	SB147SO001	SB148SO002	SS185SO01
Sample Date		3/17/1999	3/17/1999	3/17/1999	3/17/1999	3/17/1999	3/17/1999	3/18/1999
PESTICIDES								
4,4'-DDE	(ug/kg)	--	--	--	--	--	--	--
4,4'-DDT	(ug/kg)	--	--	--	--	--	--	--
Beta-BHC	(ug/kg)	--	--	--	--	--	--	--
PCBS								
Aroclor 1254	(ug/kg)	--	--	--	--	--	--	--
Aroclor 1260	(ug/kg)	--	--	--	--	--	--	--
DIOXINS/FURANS								
1,2,3,4,6,7,8-HPCDD	(pg/g)							
OCDD	(pg/g)							
Total HPCDD	(pg/g)							
Total HXCDD	(pg/g)							
Total PECDF	(pg/g)							
Total TCDF	(pg/g)							
METALS								
Aluminum	(mg/kg)	11500 =	12300 =	12800 =	9800 =	11200 =	14400 =	6160 =
Arsenic	(mg/kg)	14.5 =	14.1 =	17.3 =	5.8 =	16.1 =	12.8 =	7.3 =
Barium	(mg/kg)	49.8 =	52.6 =	[87.1] =	38.5 =	[83.4] =	[90.8] =	[226] J
Beryllium	(mg/kg)	--	--	--	--	--	--	--
Cadmium	(mg/kg)	--	--	--	--	--	--	--
Calcium	(mg/kg)	896 =	726 =	1290 =	--	732 =	764 =	4490 J
Chromium	(mg/kg)	14.9 =	15.7 =	16.6 =	12.8 =	16 =	18.2 =	8.2 J
Cobalt	(mg/kg)	--	--	7.8 J	--	9.2 J	9.4 J	--
Copper	(mg/kg)	13.3 J	11.4 J	15.8 J	7.3 J	18.5 J	16 J	12 J
Iron	(mg/kg)	25500 =	25700 =	29900 =	17500 =	31300 =	25800 =	11100 =
Lead	(mg/kg)	9.5 =	9.4 =	10.9 =	7.1 =	12.1 =	8.8 =	[80.5] J
Magnesium	(mg/kg)	2190 J	2210 J	2820 J	1520 J	2220 J	3620 J	1080 J
Manganese	(mg/kg)	119 =	143 =	[523] =	81.4 =	[739] =	436 =	[627] =
Mercury	(mg/kg)	--	--	--	--	--	--	--
Nickel	(mg/kg)	15.4 =	15.4 =	22.9 =	10.6 =	27.7 =	27.9 =	6.4 J
Potassium	(mg/kg)	689 =	736 =	1650 =	1080 =	1180 =	1920 =	--
Selenium	(mg/kg)	--	--	--	--	--	--	0.88 =
Sodium	(mg/kg)	--	--	--	--	--	--	--
Vanadium	(mg/kg)	20.7 =	20.7 =	21.3 =	16.9 =	19 =	18.2 =	11.8 J
Zinc	(mg/kg)	45.8 J	48.3 J	56.3 J	33.4 J	58.4 J	63.7 J	[159] J

Table 4-3
Surface Soil Samples
Analytical Results Summary - Detected Compounds Only
TAMPEEL
Former Lordstown Ordnance Depot
Page 5 of 15

Sample Number		SS186SO01	SS187SO01	SS188SO01	SS189SO01	SS190SO01	SS191SO01	SS192SO01
Sample Date		3/18/1999	3/18/1999	3/18/1999	3/18/1999	3/18/1999	3/18/1999	3/18/1999
VOCS								
1,1,1-trichloroethane	(ug/kg)	--	--	--	--	2.1 =	--	--
2-butanone	(ug/kg)	--	--	--	--	--	--	--
Acetone	(ug/kg)	--	--	--	--	--	10 =	--
Ethylbenzene	(ug/kg)	--	--	--	--	--	--	--
Methylene Chloride	(ug/kg)	--	32 =	23 J	1.9 =	--	39 =	1.6 =
Toluene	(ug/kg)	--	--	--	--	--	--	--
Xylenes (total)	(ug/kg)	--	--	--	--	--	--	--
SVOCS								
2-methylnaphthalene	(ug/kg)	--	--	--	--	300 =	170 =	--
Acenaphthene	(ug/kg)	--	--	--	--	--	--	--
Acenaphthylene	(ug/kg)	--	--	--	--	--	150 =	--
Anthracene	(ug/kg)	--	--	--	--	--	560 =	--
Benzo(a)anthracene	(ug/kg)	150 =	54 =	220 =	110 =	190 =	2800 =	82 =
Benzo(a)pyrene	(ug/kg)	170 =	61 =	210 =	120 =	180 =	2500 =	66 =
Benzo(b)fluoranthene	(ug/kg)	340 =	110 =	300 =	160 =	270 =	3600 =	98 =
Benzo(g,h,i)perylene	(ug/kg)	94 =	--	100 =	--	98 =	1100 =	--
Benzo(ghi)perylene	(ug/kg)	94 =	--	100 =	--	98 =	1100 =	--
Benzo(k)fluoranthene	(ug/kg)	110 =	--	110 =	55 =	93 =	1300 =	--
Bis(2-ethylhexyl) Phthalate	(ug/kg)	100 =	160 =	110 =	80 =	81 =	160 =	80 =
Butyl Benzyl Phthalate	(ug/kg)	--	--	--	--	--	--	--
Carbazole	(ug/kg)	--	--	--	--	--	220 =	--
Chrysene	(ug/kg)	210 =	72 =	240 =	130 =	230 =	2900 =	87 =
Dibenz(a,h)anthracene	(ug/kg)	--	--	--	--	--	350 =	--
Dibenzofuran	(ug/kg)	--	--	--	--	94 =	140 =	--
Fluoranthene	(ug/kg)	170 =	87 =	510 =	230 =	360 =	6700 =	180 =
Fluorene	(ug/kg)	--	--	--	--	--	250 =	--
Indeno(1,2,3-cd)pyrene	(ug/kg)	110 =	--	120 =	71 =	110 =	1300 =	--
Naphthalene	(ug/kg)	--	--	--	--	180 =	140 =	--
Phenanthrene	(ug/kg)	67 =	--	240 =	120 =	320 =	2500 =	140 =
Pyrene	(ug/kg)	170 =	70 =	330 =	170 =	280 =	4700 =	130 =

Table 4-3
Surface Soil Samples
Analytical Results Summary - Detected Compounds Only
TAMPEEL
Former Lordstown Ordnance Depot
Page 6 of 15

Sample Number		SS186SO01	SS187SO01	SS188SO01	SS189SO01	SS190SO01	SS191SO01	SS192SO01
Sample Date		3/18/1999	3/18/1999	3/18/1999	3/18/1999	3/18/1999	3/18/1999	3/18/1999
PESTICIDES								
4,4'-DDE	(ug/kg)	--	--	6 J	5.8 J	6.4 J	--	--
4,4'-DDT	(ug/kg)	--	--	5.2 J	6.1 J	6.9 J	--	--
Beta-BHC	(ug/kg)	--	--	--	--	5.7 =	56 J	--
PCBS								
Aroclor 1254	(ug/kg)	--	--	--	--	--	--	--
Aroclor 1260	(ug/kg)	--	--	--	--	--	97 =	--
DIOXINS/FURANS								
1,2,3,4,6,7,8-HPCCD	(pg/g)							
OCDD	(pg/g)							
Total HPCDD	(pg/g)							
Total HXCDD	(pg/g)							
Total PECDF	(pg/g)							
Total TCDF	(pg/g)							
METALS								
Aluminum	(mg/kg)	5590 =	5050 =	7440 =	12300 =	9200 =	9440 =	15600 =
Arsenic	(mg/kg)	7.1 =	4.3 =	10.5 =	16.9 =	17 =	[27.1] =	12.7 =
Barium	(mg/kg)	[80.9] J	[227] J	[88.7] J	[107] J	[167] J	[222] J	[212] J
Beryllium	(mg/kg)	--	--	--	--	--	--	--
Cadmium	(mg/kg)	--	--	--	--	--	--	--
Calcium	(mg/kg)	709 J	2260 J	8400 J	2720 J	4900 J	[13700] J	9070 J
Chromium	(mg/kg)	6.8 J	6.5 J	12.8 J	16.6 J	15.1 J	24.4 J	[27.5] J
Cobalt	(mg/kg)	--	--	--	--	--	8.3 J	8.1 J
Copper	(mg/kg)	7.3 J	11.7 J	19.7 J	25.1 J	21.5 J	[41.6] J	[31.8] J
Iron	(mg/kg)	11000 =	6460 =	15300 =	20900 =	19500 =	[37400] =	28400 =
Lead	(mg/kg)	[39.2] J	[74.3] J	[41.9] J	[36.9] J	[56.1] J	[105] J	[126] J
Magnesium	(mg/kg)	--	--	2110 J	1800 J	1830 J	2690 J	3140 J
Manganese	(mg/kg)	320 =	373 =	[678] =	410 =	[745] =	[864] =	[1250] =
Mercury	(mg/kg)	--	--	--	--	--	[0.13] =	[0.14] =
Nickel	(mg/kg)	--	--	24.6 J	18.2 J	17.2 J	18.6 J	24.2 J
Potassium	(mg/kg)	--	1180 J	1040 J	1680 J	1650 J	1300 J	2580 J
Selenium	(mg/kg)	--	0.72 =	--	--	--	0.7 =	--
Sodium	(mg/kg)	--	--	--	--	--	--	--
Vanadium	(mg/kg)	11.9 J	7.9 J	13.7 J	22.2 J	17.7 J	19 J	23.6 J
Zinc	(mg/kg)	35.6 J	[129] J	92.2 J	97.5 J	[116] J	[154] J	[216] J

Table 4-3
Surface Soil Samples
Analytical Results Summary - Detected Compounds Only
TAMPEEL
Former Lordstown Ordnance Depot
Page 7 of 15

Sample Number		SS193SO01	SS193SO01 Dup	SS194SO01	SS195SO01	SS195SO01 Dup	SS196SO01	SS197SO01
Sample Date		3/18/1999	3/18/1999	3/29/1999	3/29/1999	3/29/1999	3/29/1999	3/29/1999
VOCS								
1,1,1-trichloroethane	(ug/kg)	--	--	--	--	--	--	--
2-butanone	(ug/kg)	--	--	--	5.9 =	--	--	--
Acetone	(ug/kg)	--	--	4.7 =	21 =	35 =	110 =	87 =
Ethylbenzene	(ug/kg)	--	--	--	--	--	--	--
Methylene Chloride	(ug/kg)	13 J	4.8 J	--	--	--	--	--
Toluene	(ug/kg)	--	--	--	1.5 =	0.6 J	1.6 =	--
Xylenes (total)	(ug/kg)	--	--	--	--	--	--	--
SVOCS								
2-methylnaphthalene	(ug/kg)	--	--	--	--	--	--	--
Acenaphthene	(ug/kg)	--	140 J	--	--	--	--	--
Acenaphthylene	(ug/kg)	--	--	--	--	--	--	--
Anthracene	(ug/kg)	66 J	350 J	--	--	--	--	--
Benzo(a)anthracene	(ug/kg)	170 J	620 J	--	--	--	--	--
Benzo(a)pyrene	(ug/kg)	130 J	440 J	--	--	--	--	--
Benzo(b)fluoranthene	(ug/kg)	170 J	540 J	--	--	--	--	--
Benzo(g,h,i)perylene	(ug/kg)	--	160 J	--	--	--	--	--
Benzo(ghi)perylene	(ug/kg)	--	160 J	--	--	--	--	--
Benzo(k)fluoranthene	(ug/kg)	74 J	240 J	--	--	--	--	--
Bis(2-ethylhexyl) Phthalate	(ug/kg)	100 =	92 =	--	--	--	--	--
Butyl Benzyl Phthalate	(ug/kg)	--	--	--	--	--	--	--
Carbazole	(ug/kg)	--	170 J	--	--	--	--	--
Chrysene	(ug/kg)	150 J	530 J	--	--	--	--	--
Dibenz(a,h)anthracene	(ug/kg)	--	--	--	--	--	--	--
Dibenzofuran	(ug/kg)	--	66 J	--	--	--	--	--
Fluoranthene	(ug/kg)	340 J	1300 J	--	--	--	--	--
Fluorene	(ug/kg)	--	160 J	--	--	--	--	--
Indeno(1,2,3-cd)pyrene	(ug/kg)	66 =	200 J	--	--	--	--	--
Naphthalene	(ug/kg)	--	--	--	--	--	--	--
Phenanthrene	(ug/kg)	250 J	1200 J	--	--	--	--	--
Pyrene	(ug/kg)	250 J	950 J	--	--	--	--	--

Table 4-3
Surface Soil Samples
Analytical Results Summary - Detected Compounds Only
TAMPEEL
Former Lordstown Ordnance Depot
Page 8 of 15

Sample Number Sample Date		SS193SO01 3/18/1999	SS193SO01 Dup 3/18/1999	SS194SO01 3/29/1999	SS195SO01 3/29/1999	SS195SO01 Dup 3/29/1999	SS196SO01 3/29/1999	SS197SO01 3/29/1999
PESTICIDES								
4,4'-DDE	(ug/kg)	--	--	--	--	--	--	--
4,4'-DDT	(ug/kg)	--	--	--	--	--	--	--
Beta-BHC	(ug/kg)	--	--	--	--	--	--	--
PCBS								
Aroclor 1254	(ug/kg)	--	--	--	--	--	--	--
Aroclor 1260	(ug/kg)	--	--	--	--	--	--	--
DIOXINS/FURANS								
1,2,3,4,6,7,8-HPCDD	(pg/g)			3.1 =	--	1.4 J	--	--
OCDD	(pg/g)			420 J	53 J	150 J	9.5 J	21 J
Total HPCDD	(pg/g)			6.8 =	--	2.8 J	--	--
Total HXCDD	(pg/g)			--	--	--	--	0.19 J
Total PECDF	(pg/g)			--	--	--	0.37 J	1 J
Total TCDF	(pg/g)			--	--	--	1 J	1.7 J
METALS								
Aluminum	(mg/kg)	13000 =	13000 =	11000 =	8240 J	5430 J	12100 =	6360 =
Arsenic	(mg/kg)	10.6 =	11.4 =	11.3 =	6.2 J	4.9 J	10.3 =	7.5 =
Barium	(mg/kg)	[108] J	[117] J	57 J	32.3 J	--	43.3 J	32.9 J
Beryllium	(mg/kg)	--	--	--	--	--	--	--
Cadmium	(mg/kg)	--	--	--	--	--	--	--
Calcium	(mg/kg)	9620 J	[11200] J	--	--	--	--	678 =
Chromium	(mg/kg)	[30.4] J	[45.3] J	14.5 =	11.9 J	8.2 J	14.6 =	8.4 =
Cobalt	(mg/kg)	--	--	--	--	--	--	--
Copper	(mg/kg)	19.5 J	19.3 J	10 =	5.7 =	3.8 =	8.1 =	7.1 =
Iron	(mg/kg)	23100 =	23800 =	21200 =	15000 J	8860 J	18600 =	12900 =
Lead	(mg/kg)	[55.6] J	[72.1] J	10.9 =	6.7 J	4.8 J	10.1 =	9.7 =
Magnesium	(mg/kg)	2820 J	3030 J	1580 =	1120 =	779 =	1540 =	1010 =
Manganese	(mg/kg)	[1230] J	[1730] J	90.4 =	107 =	88.4 =	58.6 =	37.5 =
Mercury	(mg/kg)	--	--	--	--	--	--	--
Nickel	(mg/kg)	18.2 J	18.3 J	11 =	9.2 =	7.3 =	11 =	8.1 =
Potassium	(mg/kg)	1830 J	1670 J	691 J	784 J	--	1220 J	--
Selenium	(mg/kg)	--	--	0.83 =	--	--	0.79 =	--
Sodium	(mg/kg)	--	--	--	--	--	--	--
Vanadium	(mg/kg)	25.7 J	31 J	22.6 =	17.1 =	10.7 =	24.9 =	13.6 =
Zinc	(mg/kg)	[117] J	[113] J	51.1 =	35.8 J	26.5 J	66.4 =	43.8 =

Table 4-3
Surface Soil Samples
Analytical Results Summary - Detected Compounds Only
TAMPEEL
Former Lordstown Ordnance Depot
Page 9 of 15

Sample Number		SS20101	SS20201	SS20301	SS20401	SS20501	SS20601	SS20701
Sample Date		10/4/2000	10/4/2000	10/4/2000	10/5/2000	10/5/2000	10/5/2000	10/5/2000
VOCS								
1,1,1-trichloroethane	(ug/kg)	--	--	--	--	--	--	--
2-butanone	(ug/kg)	--	--	--	--	--	--	--
Acetone	(ug/kg)	--	--	--	--	--	--	--
Ethylbenzene	(ug/kg)	12 =	--	830 =	--	--	--	--
Methylene Chloride	(ug/kg)	--	--	--	--	--	--	--
Toluene	(ug/kg)	--	--	--	2.6 =	8.9 J	32 =	--
Xylenes (total)	(ug/kg)	110 =	--	5900 =	7.5 =	--	--	--
SVOCs								
2-methylnaphthalene	(ug/kg)	--	--	--	--	460 =	--	--
Acenaphthene	(ug/kg)	--	--	--	--	--	--	--
Acenaphthylene	(ug/kg)	--	--	--	--	--	--	--
Anthracene	(ug/kg)	480 =	--	--	--	--	--	--
Benzo(a)anthracene	(ug/kg)	670 =	--	--	--	--	21000 =	--
Benzo(a)pyrene	(ug/kg)	470 =	--	--	--	--	22000 =	--
Benzo(b)fluoranthene	(ug/kg)	650 =	--	--	760 =	--	33000 =	--
Benzo(g,h,i)perylene	(ug/kg)	--	--	--	--	--	13000 =	--
Benzo(ghi)perylene	(ug/kg)	--	--	--	--	--	13000 =	--
Benzo(k)fluoranthene	(ug/kg)	--	--	--	--	--	11000 =	--
Bis(2-ethylhexyl) Phthalate	(ug/kg)	--	--	--	--	--	--	--
Butyl Benzyl Phthalate	(ug/kg)	--	--	--	--	--	--	--
Carbazole	(ug/kg)	--	--	--	--	--	--	--
Chrysene	(ug/kg)	550 =	--	--	840 =	--	23000 =	--
Dibenz(a,h)anthracene	(ug/kg)	--	--	--	--	--	--	--
Dibenzofuran	(ug/kg)	--	--	--	--	--	--	--
Fluoranthene	(ug/kg)	1500 =	--	--	3900 =	--	27000 =	--
Fluorene	(ug/kg)	--	--	--	--	--	--	--
Indeno(1,2,3-cd)pyrene	(ug/kg)	--	--	--	--	--	13000 =	--
Naphthalene	(ug/kg)	--	--	--	--	--	--	--
Phenanthrene	(ug/kg)	1500 =	--	--	2400 =	--	8200 =	--
Pyrene	(ug/kg)	1000 =	--	--	2200 =	--	23000 =	--

Table 4-3
Surface Soil Samples
Analytical Results Summary - Detected Compounds Only
TAMPEEL
Former Lordstown Ordnance Depot
Page 10 of 15

Sample Number Sample Date		SS20101 10/4/2000	SS20201 10/4/2000	SS20301 10/4/2000	SS20401 10/5/2000	SS20501 10/5/2000	SS20601 10/5/2000	SS20701 10/5/2000
PESTICIDES								
4,4'-DDE	(ug/kg)	--	--	--	--	--	26 J	--
4,4'-DDT	(ug/kg)	--	--	--	--	--	47 J	--
Beta-BHC	(ug/kg)	--	--	--	--	--	--	--
PCBS								
Aroclor 1254	(ug/kg)	--	--	--	--	--	55 =	--
Aroclor 1260	(ug/kg)	--	--	--	--	--	--	--
DIOXINS/FURANS								
1,2,3,4,6,7,8-HPCDD	(pg/g)							
OCDD	(pg/g)							
Total HPCDD	(pg/g)							
Total HXCDD	(pg/g)							
Total PECDF	(pg/g)							
Total TCDF	(pg/g)							
METALS								
Aluminum	(mg/kg)	12700 =	10600 =	17800 =	13600 =	8310 =	14300 =	12600 =
Arsenic	(mg/kg)	21.8 =	14.8 =	7.4 =	12.1 =	17.2 =	[37.7] =	18 =
Barium	(mg/kg)	[228] J	[111] J	[233] J	[134] J	[115] =	[11000] J	[89.9] J
Beryllium	(mg/kg)	0.76 =	--	0.78 =	--	0.62 =	--	--
Cadmium	(mg/kg)	--	--	--	--	--	--	--
Calcium	(mg/kg)	4830 =	6140 =	1460 =	[53700] =	2820 =	[26100] =	991 =
Chromium	(mg/kg)	17.1 J	14.9 J	22.4 J	[286] J	13.6 =	[133] J	16.8 J
Cobalt	(mg/kg)	7.3 J	9.8 J	--	9.7 J	7.2 =	11 J	7.5 J
Copper	(mg/kg)	16.4 =	16.1 =	17.5 =	[32.9] =	18 =	[230] =	8.7 =
Iron	(mg/kg)	32900 =	24900 =	16500 =	[68100] =	23100 =	[151000] =	27800 =
Lead	(mg/kg)	[37.5] =	21.7 =	[38.7] =	[52.0] =	23.1 =	[9820] =	22.1 =
Magnesium	(mg/kg)	2710 =	2670 =	2580 =	[12100] =	1920 =	[14300] =	1900 =
Manganese	(mg/kg)	[1490] =	[767] =	163 =	[12900] =	[681] =	[1280] =	[1400] =
Mercury	(mg/kg)	--	--	[0.14] =	--	--	[0.14] =	--
Nickel	(mg/kg)	19.4 =	20.6 =	19.2 =	21.7 =	17.4 =	[164] =	13.2 =
Potassium	(mg/kg)	1450 =	1450 =	1490 =	2160 =	1560 =	937 =	980 =
Selenium	(mg/kg)	--	--	--	--	--	[8.1] =	--
Sodium	(mg/kg)	--	--	--	--	--	[2030] =	--
Vanadium	(mg/kg)	20.9 =	17.1 =	26.2 =	[118] =	17.1 =	--	27.4 =
Zinc	(mg/kg)	87.1 =	83.5 =	[104] =	[124] =	[137] =	[24300] =	77.9 =

Table 4-3
Surface Soil Samples
Analytical Results Summary - Detected Compounds Only
TAMPEEL
Former Lordstown Ordnance Depot
Page 11 of 15

Sample Number		SS20801	SS20901	SS21001	SS21101	SS21101 Dup	SS21201	SS21301
Sample Date		10/5/2000	10/5/2000	10/5/2000	10/5/2000	10/5/2000	10/5/2000	10/5/2000
VOCS								
1,1,1-trichloroethane	(ug/kg)	--	--	--	--	--	--	--
2-butanone	(ug/kg)	--	--	--	--	--	--	--
Acetone	(ug/kg)	--	--	--	--	--	--	--
Ethylbenzene	(ug/kg)	--	--	--	--	--	--	1.7 J
Methylene Chloride	(ug/kg)	--	--	--	--	--	--	--
Toluene	(ug/kg)	6.1 =	11 =	1.2 J	--	--	1.1 =	77 J
Xylenes (total)	(ug/kg)	--	--	4.2 J	2.8 =	5.5 =	--	3.9 J
SVOCS								
2-methylnaphthalene	(ug/kg)	--	1900 =	--	--	--	--	--
Acenaphthene	(ug/kg)	--	--	--	--	--	--	--
Acenaphthylene	(ug/kg)	--	--	--	--	--	--	--
Anthracene	(ug/kg)	--	--	--	--	--	--	--
Benzo(a)anthracene	(ug/kg)	--	1200 =	--	--	--	--	--
Benzo(a)pyrene	(ug/kg)	--	2300 =	--	--	--	--	--
Benzo(b)fluoranthene	(ug/kg)	--	3800 =	--	--	--	--	--
Benzo(g,h,i)perylene	(ug/kg)	--	2600 =	--	--	--	--	--
Benzo(ghi)perylene	(ug/kg)	--	2600 =	--	--	--	--	--
Benzo(k)fluoranthene	(ug/kg)	--	1100 =	--	--	--	--	--
Bis(2-ethylhexyl) Phthalate	(ug/kg)	--	--	--	--	--	--	--
Butyl Benzyl Phthalate	(ug/kg)	--	--	--	--	--	--	890 =
Carbazole	(ug/kg)	--	--	--	--	--	--	--
Chrysene	(ug/kg)	--	1600 =	--	--	--	--	--
Dibenz(a,h)anthracene	(ug/kg)	--	720 =	--	--	--	--	--
Dibenzofuran	(ug/kg)	--	530 =	--	--	--	--	--
Fluoranthene	(ug/kg)	440 =	1400 =	--	--	--	--	--
Fluorene	(ug/kg)	--	--	--	--	--	--	--
Indeno(1,2,3-cd)pyrene	(ug/kg)	--	2500 =	--	--	--	--	--
Naphthalene	(ug/kg)	--	1200 =	--	--	--	--	--
Phenanthrene	(ug/kg)	430 =	1700 =	--	--	--	--	--
Pyrene	(ug/kg)	--	1200 =	--	--	--	--	--

Table 4-3
Surface Soil Samples
Analytical Results Summary - Detected Compounds Only
TAMPEEL
Former Lordstown Ordnance Depot
Page 12 of 15

Sample Number		SS20801	SS20901	SS21001	SS21101	SS21101 Dup	SS21201	SS21301
Sample Date		10/5/2000	10/5/2000	10/5/2000	10/5/2000	10/5/2000	10/5/2000	10/5/2000
PESTICIDES								
4,4'-DDE	(ug/kg)	94 =	--	--	--	--	--	--
4,4'-DDT	(ug/kg)	160 =	--	--	--	--	--	--
Beta-BHC	(ug/kg)	--	--	--	--	--	--	--
PCBS								
Aroclor 1254	(ug/kg)	--	--	--	--	--	--	--
Aroclor 1260	(ug/kg)	--	--	--	--	--	--	--
DIOXINS/FURANS								
1,2,3,4,6,7,8-HPCDD	(pg/g)							
OCDD	(pg/g)							
Total HPCDD	(pg/g)							
Total HXCDD	(pg/g)							
Total PECDF	(pg/g)							
Total TCDF	(pg/g)							
METALS								
Aluminum	(mg/kg)	10200 =	8970 =	7560 =	9730 =	11700 =	7790 =	5260 =
Arsenic	(mg/kg)	22.4 =	[69.8] =	5.8 =	10.8 =	12.7 =	12.9 =	[26.6] =
Barium	(mg/kg)	[150] J	[8000] J	60 J	[87.6] J	[89.3] J	[93.1] J	[154] J
Beryllium	(mg/kg)	1.1 =	[1.2] =	--	--	0.64 =	--	[1.6] =
Cadmium	(mg/kg)	--	1.8 =	--	--	--	--	--
Calcium	(mg/kg)	6970 =	[17000] =	--	957 =	895 =	2900 =	5600 =
Chromium	(mg/kg)	16.8 J	[52.4] J	9.5 J	12.5 J	15.2 J	10.3 J	14 J
Cobalt	(mg/kg)	8.8 J	--	--	9.4 J	--	--	--
Copper	(mg/kg)	19.3 =	[111] =	9 =	13 =	13.2 =	12.6 =	[35] =
Iron	(mg/kg)	26400 =	[52400] =	8920 =	17300 =	23000 =	18800 =	11700 =
Lead	(mg/kg)	[43.1] =	[1770] =	[35.2] =	[38.5] =	[37.4] =	[30.8] =	[31.2] =
Magnesium	(mg/kg)	2370 =	4010 =	647 =	1190 =	1350 =	1190 =	--
Manganese	(mg/kg)	[1120] =	[762] =	313 =	[900] J	419 J	[831] =	[620] =
Mercury	(mg/kg)	[0.71] =	[0.20] =	--	--	--	--	--
Nickel	(mg/kg)	22.7 =	30.3 =	6.4 =	10.1 =	10.4 =	12.2 =	11.5 =
Potassium	(mg/kg)	1110 =	1260 =	--	--	677 =	--	--
Selenium	(mg/kg)	--	[4.8] =	--	--	0.68 =	--	1.1 =
Sodium	(mg/kg)	--	--	--	--	--	--	--
Vanadium	(mg/kg)	19.6 =	24.1 =	12.8 =	19.3 =	22.3 =	15.2 =	26.1 =
Zinc	(mg/kg)	67 =	[5170] =	52.6 =	65 =	71.9 =	58.3 =	48.4 =

Table 4-3
Surface Soil Samples
Analytical Results Summary - Detected Compounds Only
TAMPEEL
Former Lordstown Ordnance Depot
Page 13 of 15

Sample Number		SS21401	SS21501	SS21601	SS21701	SS21801	SS21801 Dup
Sample Date		10/5/2000	10/5/2000	10/5/2000	10/5/2000	10/5/2000	10/5/2000
VOCS							
1,1,1-trichloroethane	(ug/kg)	--	--	--	--	--	--
2-butanone	(ug/kg)	--	--	--	--	--	--
Acetone	(ug/kg)	--	--	--	--	--	--
Ethylbenzene	(ug/kg)	--	--	--	1.1 J	--	--
Methylene Chloride	(ug/kg)	--	--	--	--	--	--
Toluene	(ug/kg)	7.6 =	--	--	12 J	2.9 J	12 J
Xylenes (total)	(ug/kg)	--	36 J	--	3.4 J	--	--
SVOCS							
2-methylnaphthalene	(ug/kg)	--	--	--	--	--	--
Acenaphthene	(ug/kg)	--	--	--	--	--	--
Acenaphthylene	(ug/kg)	--	--	--	--	--	--
Anthracene	(ug/kg)	--	--	--	--	--	--
Benzo(a)anthracene	(ug/kg)	850 =	--	--	--	--	--
Benzo(a)pyrene	(ug/kg)	860 =	--	--	--	--	--
Benzo(b)fluoranthene	(ug/kg)	1200 =	--	--	--	--	--
Benzo(g,h,i)perylene	(ug/kg)	420 =	--	--	--	--	--
Benzo(ghi)perylene	(ug/kg)	420 =	--	--	--	--	--
Benzo(k)fluoranthene	(ug/kg)	440 =	--	--	--	--	--
Bis(2-ethylhexyl) Phthalate	(ug/kg)	--	--	--	--	--	--
Butyl Benzyl Phthalate	(ug/kg)	--	--	--	--	--	--
Carbazole	(ug/kg)	--	--	--	--	--	--
Chrysene	(ug/kg)	910 =	--	--	--	--	--
Dibenz(a,h)anthracene	(ug/kg)	--	--	--	--	--	--
Dibenzofuran	(ug/kg)	--	--	--	--	--	--
Fluoranthene	(ug/kg)	1900 =	--	--	--	--	--
Fluorene	(ug/kg)	--	--	--	--	--	--
Indeno(1,2,3-cd)pyrene	(ug/kg)	470 =	--	--	--	--	--
Naphthalene	(ug/kg)	--	--	--	--	--	--
Phenanthrene	(ug/kg)	1100 =	--	--	--	--	--
Pyrene	(ug/kg)	1400 =	--	--	--	--	--

Table 4-3
Surface Soil Samples
Analytical Results Summary - Detected Compounds Only
TAMPEEL
Former Lordstown Ordnance Depot
Page 14 of 15

Sample Number		SS21401	SS21501	SS21601	SS21701	SS21801	SS21801 Dup
Sample Date		10/5/2000	10/5/2000	10/5/2000	10/5/2000	10/5/2000	10/5/2000
PESTICIDES							
4,4'-DDE	(ug/kg)	33 J	--	9.9 =	--	--	--
4,4'-DDT	(ug/kg)	66 =	--	11 =	--	--	--
Beta-BHC	(ug/kg)	--	--	--	--	--	--
PCBS							
Aroclor 1254	(ug/kg)	--	--	--	--	--	--
Aroclor 1260	(ug/kg)	--	--	--	--	--	--
DIOXINS/FURANS							
1,2,3,4,6,7,8-HPCCD	(pg/g)						
OCDD	(pg/g)						
Total HPCDD	(pg/g)						
Total HXCDD	(pg/g)						
Total PECDF	(pg/g)						
Total TCDF	(pg/g)						
METALS							
Aluminum	(mg/kg)	[21200] =	15700 =	10800 =	14400 =	11000 =	11000 =
Arsenic	(mg/kg)	10.9 =	8 =	8.5 =	12.9 =	13.6 =	14.6 =
Barium	(mg/kg)	[233] J	[106] J	46.9 J	70.5 J	40.5 =	35.4 =
Beryllium	(mg/kg)	[2.6] =	--	--	--	--	--
Cadmium	(mg/kg)	--	--	--	--	--	--
Calcium	(mg/kg)	[86100] =	--	--	2760 =	--	--
Chromium	(mg/kg)	12.9 J	16.6 J	13.8 J	19.4 J	14.3 =	14.7 =
Cobalt	(mg/kg)	10.4 J	--	--	6.6 J	7.6 =	9.1 =
Copper	(mg/kg)	13.6 =	8 =	6.2 =	12.4 =	12.7 =	16.7 =
Iron	(mg/kg)	17100 =	17700 =	16100 =	23500 =	26200 =	28600 =
Lead	(mg/kg)	[68.1] =	23.7 =	14 =	18 =	15.6 =	12.7 =
Magnesium	(mg/kg)	[11800] =	1430 =	1410 =	2370 =	1890 =	2160 =
Manganese	(mg/kg)	[2680] =	355 =	224 =	391 =	298 =	239 =
Mercury	(mg/kg)	--	--	--	--	--	--
Nickel	(mg/kg)	9.9 =	11.5 =	9.3 =	13.6 =	13.2 =	16.8 =
Potassium	(mg/kg)	1610 =	1030 =	715 =	1590 =	954 =	871 =
Selenium	(mg/kg)	--	--	--	--	--	--
Sodium	(mg/kg)	--	--	--	--	--	--
Vanadium	(mg/kg)	17.7 =	26.3 =	22 =	26.9 =	19.5 =	19.4 =
Zinc	(mg/kg)	99.5 =	69.3 =	48.5 =	60.2 =	49.8 =	52.1 =

Table 4-3
Surface Soil Samples
Analytical Results Summary - Detected Compounds Only
TAMPEEL
Former Lordstown Ordnance Depot
Page 15 of 15

Sample Number	SS21401	SS21501	SS21601	SS21701	SS21801	SS21801 Dup
Sample Date	10/5/2000	10/5/2000	10/5/2000	10/5/2000	10/5/2000	10/5/2000

NOTES:

-- = Not Detected
[] = Metal Concentration Exceeds Background Value
Blank = Not Analyzed

DATA QUALIFIERS

= - The analyte of concern was detected at the concentration level reported.
J = The analyte of concern was detected but should be considered as an estimated value.
B = Qualifier indicates the presence of the qualified target compound in the method or procedure blank.

Table 4-4
Surface Water Samples
Analytical Results Summary - Detected Compounds Only
TAMPEEL
Former Lordstown Ordnance Depot
Page 1 of 2

Sample Number		SW101 Dup	SW102	SW103	SW103 Dup	SW104	SW105	SW106	SW107	SW108
Sample Date		10/30/1997	8/11/1998	8/11/1998	8/11/1998	8/12/1998	8/12/1998	8/12/1998	8/12/1998	8/12/1998
VOCS										
Cis-1,2-dichloroethene	(ug/l)	2.2 =	--	--	--	--	--	--	--	--
Methylene Chloride	(ug/l)	--	--	--	--	--	--	--	--	--
METALS										
Aluminum	(mg/l)	--	--	--	--	--	--	--	1.7 =	0.32 =
Barium	(mg/l)	--	--	--	--	--	--	--	--	--
Calcium	(mg/l)	50.9 J	23.7 =	20.9 =	19.9 =	20.2 =	36.4 =	37.5 =	39.6 =	37.6 =
Iron	(mg/l)	0.47 J	0.3 =	0.16 =	0.12 =	0.22 =	1.2 =	2.9 =	5.1 =	2.8 =
Lead	(mg/l)	--	--	--	--	--	--	--	[0.0071] =	--
Magnesium	(mg/l)	20.5 J	12 =	13.2 =	13 =	11.2 =	9.2 =	10 =	8.3 =	9 =
Manganese	(mg/l)	0.59 J	1.7 =	0.14 =	0.14 =	0.097 =	1.7 =	2.5 =	1.2 =	1.2 =
Nickel	(mg/l)	--	--	--	--	--	--	--	--	--
Potassium	(mg/l)	--	--	--	--	--	5.5 =	6 =	5.3 =	5.8 =
Sodium	(mg/l)	8.9 =	--	--	--	--	--	--	--	--
Zinc	(mg/l)	--	--	--	--	--	--	--	--	--

Table 4-4
Surface Water Samples
Analytical Results Summary - Detected Compounds Only
TAMPEEL
Former Lordstown Ordnance Depot
Page 2 of 2

Sample Number		SW109SW01	SW109SWD01	SW110SW01	SW20101	SW20101 Dup	SW20201	SW20301	SW20401
Sample Date		3/19/1999	3/19/1999	3/19/1999	10/13/2000	10/13/2000	10/12/2000	10/12/2000	10/12/2000
VOCS									
Cis-1,2-dichloroethene	(ug/l)	1.3 =	1.1 =	1.8 =	4.9 =	4.9 =	--	--	--
Methylene Chloride	(ug/l)	--	--	1 =	--	--	--	--	--
METALS									
Aluminum	(mg/l)	--	--	0.8 J	--	0.28 J	2.3 J	--	1.2 J
Barium	(mg/l)	--	--	--	--	--	0.37 =	--	--
Calcium	(mg/l)	88.6 J	96.4 J	46.1 J	59 =	57.5 =	76.1 =	57.7 =	72.9 =
Iron	(mg/l)	3.1 J	5.9 J	2.9 J	1.5 =	2 =	71.8 =	1.1 =	1.4 =
Lead	(mg/l)	--	--	--	--	--	[0.015] =	--	--
Magnesium	(mg/l)	25.5 =	28 =	16.3 =	24.3 =	23.8 =	23.7 =	22.4 =	12.8 =
Manganese	(mg/l)	0.82 J	1.3 J	1 =	0.78 =	0.76 =	10 =	0.83 =	0.52 =
Nickel	(mg/l)	--	--	--	--	--	[0.085] =	--	--
Potassium	(mg/l)	--	--	--	--	--	--	--	--
Sodium	(mg/l)	12 =	10.4 =	8 =	9.9 =	9.8 =	10.7 =	8.9 =	5.7 =
Zinc	(mg/l)	0.1 J	0.11 J	--	--	--	[0.68] =	--	--

NOTES:

-- = Not Detected

[] = Metal Concentration Exceeds the warm water aquatic habitat water quality standard OAC 3745-1-25

Blank = Not Analyzed

DATA QUALIFIERS

= - The analyte of concern was detected at the concentration level reported.

J = The analyte of concern was detected but should be considered as an estimated value.

B = Qualifier indicates the presence of the qualified target compound in the method or procedure blank.

Table 4-5
Sediment Samples
Analytical Results Summary - Detected Compounds Only
TAMPEEL
Former Lordstown Ordnance Depot
Page 1 of 6

Sample Number		SD03001	SD03001 Dup	SD04001	SD101	SD101 Dup	SD102	SD103	SD103 Dup	SD104
Sample Date		9/18/1996	9/18/1996	9/18/1996	10/30/1997	10/30/1997	8/11/1998	8/11/1998	8/11/1998	8/12/1998
VOCS										
2-butanone	(ug/kg)	--	--	--	--	--	--	--	--	--
Acetone	(ug/kg)	36 =	--	--	--	--	100 J	--	--	--
Carbon Disulfide	(ug/kg)	--	--	--	2.5 J	--	--	--	--	--
Cis-1,2-dichloroethene	(ug/kg)	--	--	--	--	--	--	--	--	--
Methylene Chloride	(ug/kg)	--	--	--	--	--	--	--	--	--
Toluene	(ug/kg)	--	--	--	--	--	--	--	--	--
SVOCS										
2-methylnaphthalene	(ug/kg)	250 J	420 J	--	--	--	--	--	--	--
Anthracene	(ug/kg)	--	--	--	170 J	--	--	--	--	--
Benzo(a)anthracene	(ug/kg)	150 J	220 J	--	250 J	--	--	--	--	--
Benzo(a)pyrene	(ug/kg)	--	580 J	--	160 J	--	--	--	--	--
Benzo(b)fluoranthene	(ug/kg)	630 J	1100 =	--	190 J	--	--	--	--	--
Benzo(g,h,i)perylene	(ug/kg)	200 J	320 J	--	--	--	--	--	--	--
Bis(2-ethylhexyl) Phthalate	(ug/kg)	--	--	--	100 J	--	--	--	--	--
Chrysene	(ug/kg)	230 J	370 J	--	220 J	--	--	--	--	--
Di-n-butyl Phthalate	(ug/kg)	220 BJ	440 BJ	89 BJ	--	--	--	--	--	--
Dibenzofuran	(ug/kg)	--	140 J	--	--	--	--	--	--	--
Diethyl Phthalate	(ug/kg)	--	140 J	--	--	--	--	--	--	--
Fluoranthene	(ug/kg)	370 J	560 J	--	440 J	--	--	--	--	480 =
Indeno(1,2,3-cd)pyrene	(ug/kg)	170 J	310 J	--	--	--	--	--	--	--
Naphthalene	(ug/kg)	190 J	310 J	--	--	--	--	--	--	--
Phenanthrene	(ug/kg)	310 J	510 J	--	450 J	--	--	--	--	--
Pyrene	(ug/kg)	290 J	520 J	--	400 J	--	--	--	--	450 =
PESTICIDES										
4,4'-DDD	(ug/kg)	64 =	100 =	--	--	1400 J	--	--	--	--
4,4'-DDE	(ug/kg)	130 =	200 =	--	--	220 J	--	--	--	--
4,4'-DDT	(ug/kg)	47 =	440 =	--	--	900 J	--	--	--	--
METALS										
Aluminum	(mg/kg)	7530 =	9980 =	4530 =	11500 =	--	[23000] =	12000 =	15100 =	4030 =
Antimony	(mg/kg)	[2.7] BN	[2.3] BN	[4.7] BN	--	--	--	--	--	--
Arsenic	(mg/kg)	[67.3] =	[64.3] =	6.1 =	12.7 =	--	18.4 =	9.7 =	16.8 =	5.9 =
Barium	(mg/kg)	[82.4] =	[89.7] =	76.1 =	[120] =	--	[134] =	42.4 =	[119] =	--
Beryllium	(mg/kg)	0.98 B	0.98 B	0.37 B	--	--	--	0.64 =	--	--
Cadmium	(mg/kg)	[3.3] =	[3.7] =	[1.9] =	--	--	--	--	--	--
Calcium	(mg/kg)	8020 E*	8970 E*	2420 E*	4910 =	--	3500 =	1390 =	3750 =	6400 =

Table 4-5
Sediment Samples
Analytical Results Summary - Detected Compounds Only
TAMPEEL
Former Lordstown Ordnance Depot
Page 2 of 6

Sample Number		SD03001	SD03001 Dup	SD04001	SD101	SD101 Dup	SD102	SD103	SD103 Dup	SD104
Sample Date		9/18/1996	9/18/1996	9/18/1996	10/30/1997	10/30/1997	8/11/1998	8/11/1998	8/11/1998	8/12/1998
Chromium	(mg/kg)	14.4 =	16.6 =	7.2 =	24.1 =	--	[31.1] =	18.5 =	23.1 =	7 =
Cobalt	(mg/kg)	6.3 B	7.1 B	3.7 B	--	--	--	11.9 =	--	--
Copper	(mg/kg)	[48.8] =	[45.6] =	15.3 =	[223] =	--	[29.4] =	20.8 =	25.6 =	12.4 =
Cyanide	(mg/kg)	10.7 =	7.6 B	4.9 B	--	--	--	--	--	--
Iron	(mg/kg)	33800 +	[40300] =	7360 =	30100 =	--	[41300] =	23300 =	33200 =	12500 =
Lead	(mg/kg)	[61.9] E*	[66.6] E*	[26.9] E*	[53.2] =	--	[29.1] =	12 =	24 =	8.9 =
Magnesium	(mg/kg)	1140 B	1560 =	627 B	2940 =	--	5460 =	3720 =	4530 =	1930 =
Manganese	(mg/kg)	215 E*	258 E*	67.9 E*	734 =	--	1190 =	261 =	766 =	315 =
Mercury	(mg/kg)	[0.14] *	[0.17] *	0.09 *	--	--	--	--	--	--
Nickel	(mg/kg)	17.8 =	18 =	9.3 =	21.1 =	--	34.7 =	26.3 =	30.8 =	10.3 =
Potassium	(mg/kg)	510 BN	843 BN	390 BN	1400 =	--	3120 =	2490 =	1970 =	--
Selenium	(mg/kg)	[3.5] *	[3.7] *	--	--	--	[2.8] =	1.3 =	--	--
Sodium	(mg/kg)	40.8 B	73 B	38.5 B	--	--	--	--	--	--
Vanadium	(mg/kg)	16.4 =	17.5 =	12.1 =	28.5 =	--	[41.5] =	25.3 =	28.4 =	7.1 =
Zinc	(mg/kg)	[1270] =	[1270] =	67.2 =	[117] =	--	[128] =	58.7 =	103 =	42.6 =

Table 4-5
Sediment Samples
Analytical Results Summary - Detected Compounds Only
TAMPEEL
Former Lordstown Ordnance Depot
Page 3 of 6

Sample Number		SD105	SD106	SD107	SD108	SD109SO01	SD110SO01	SD20101	SD20101 Dup	SD20201
Sample Date		8/12/1998	8/12/1998	8/12/1998	8/12/1998	3/19/1999	3/19/1999	10/13/2000	10/13/2000	10/12/2000
VOCS										
2-butanone	(ug/kg)	--	--	--	--	--	--	--	--	20 J
Acetone	(ug/kg)	--	61 J	69 J	--	41 J	30 J	--	--	53 J
Carbon Disulfide	(ug/kg)	--	--	--	--	--	--	--	--	--
Cis-1,2-dichloroethene	(ug/kg)	--	--	--	--	--	--	2.7 =	--	2.1 =
Methylene Chloride	(ug/kg)	--	--	--	--	3.3 =	10 =	--	--	--
Toluene	(ug/kg)	--	--	--	--	--	--	--	2.2 =	--
SVOCS										
2-methylnaphthalene	(ug/kg)	--	--	--	--	--	--	--	--	--
Anthracene	(ug/kg)	--	--	--	--	--	--	--	830 J	--
Benzo(a)anthracene	(ug/kg)	--	--	--	--	--	--	--	980 J	--
Benzo(a)pyrene	(ug/kg)	--	--	--	--	--	--	--	690 J	--
Benzo(b)fluoranthene	(ug/kg)	--	--	--	--	56 =	--	--	840 J	--
Benzo(g,h,i)perylene	(ug/kg)	--	--	--	--	--	--	--	--	--
Bis(2-ethylhexyl) Phthalate	(ug/kg)	--	--	--	--	--	--	--	--	--
Chrysene	(ug/kg)	--	--	--	--	--	--	--	830 J	--
Di-n-butyl Phthalate	(ug/kg)	--	--	--	--	--	--	--	--	--
Dibenzofuran	(ug/kg)	--	--	--	--	--	--	--	--	--
Diethyl Phthalate	(ug/kg)	--	--	--	--	--	--	--	--	--
Fluoranthene	(ug/kg)	--	--	--	--	67 =	--	--	1800 J	--
Indeno(1,2,3-cd)pyrene	(ug/kg)	--	--	--	--	--	--	--	--	--
Naphthalene	(ug/kg)	--	--	--	--	--	--	--	--	--
Phenanthrene	(ug/kg)	--	--	--	--	--	--	--	2300 J	--
Pyrene	(ug/kg)	--	--	--	--	57 =	--	--	1500 J	--
PESTICIDES										
4,4'-DDD	(ug/kg)	--	--	--	--	--	--	--	270 J	--
4,4'-DDE	(ug/kg)	--	--	--	--	5.6 =	7.4 =	--	--	--
4,4'-DDT	(ug/kg)	--	--	--	--	--	6.6 J	--	--	--
METALS										
Aluminum	(mg/kg)	3780 =	12400 =	11200 =	5580 =	15100 =	14000 =	9720 =	8430 =	13800 =
Antimony	(mg/kg)	--	--	--	--	--	--	--	--	--
Arsenic	(mg/kg)	6 =	4.2 =	13.9 =	10.5 =	19.3 =	14.7 =	12.6 J	8.6 J	[33.9] =
Barium	(mg/kg)	--	138 =	79.1 =	29.3 =	[97.6] J	74.2 J	[99.8] =	[103] =	[742] =
Beryllium	(mg/kg)	--	--	--	--	--	--	--	--	--
Cadmium	(mg/kg)	--	--	--	--	--	--	--	--	[2.8] =
Calcium	(mg/kg)	865 =	1880 =	1700 =	--	2800 J	1760 J	[11200] =	8800 =	[9830] =

Table 4-5
Sediment Samples
Analytical Results Summary - Detected Compounds Only
TAMPEEL
Former Lordstown Ordnance Depot
Page 4 of 6

Sample Number		SD105	SD106	SD107	SD108	SD109SO01	SD110SO01	SD20101	SD20101 Dup	SD20201
Sample Date		8/12/1998	8/12/1998	8/12/1998	8/12/1998	3/19/1999	3/19/1999	10/13/2000	10/13/2000	10/12/2000
Chromium	(mg/kg)	7 =	14.3 =	16.6 =	8.1 =	18.5 J	18.2 J	16 J	[84] J	[26.1] =
Cobalt	(mg/kg)	--	--	12.9 =	--	13.4 J	9.1 J	8.7 =	--	--
Copper	(mg/kg)	10.6 =	14.2 =	13.8 =	8.4 =	13.6 J	17 J	16 =	19.6 =	[34] =
Cyanide	(mg/kg)	--	--	--	--	--	--	--	--	--
Iron	(mg/kg)	11500 =	15300 =	23500 =	18600 =	30100 =	27700 =	26500 =	23500 =	[171000] =
Lead	(mg/kg)	10.8 =	19.7 =	[40.6] =	7.7 =	22.2 J	16.2 J	[31.4] =	[35.5] =	[77.4] =
Magnesium	(mg/kg)	1180 =	1440 =	1570 =	915 =	2870 J	3120 J	2090 =	2550 =	3330 =
Manganese	(mg/kg)	165 =	221 =	987 =	535 =	[1250] =	[483] =	[719] J	[1380] J	[5910] =
Mercury	(mg/kg)	--	--	--	--	--	--	--	--	--
Nickel	(mg/kg)	10.2 =	16.6 =	11.9 =	9.1 =	18.9 J	24.6 J	14.9 =	13.1 =	[282] =
Potassium	(mg/kg)	848 =	--	--	--	1610 J	1880 J	999 =	--	2190 =
Selenium	(mg/kg)	--	--	[1.5] =	1.2 =	--	--	--	--	--
Sodium	(mg/kg)	--	--	--	--	--	--	--	--	--
Vanadium	(mg/kg)	7.3 =	21 =	24.3 =	12.3 =	28.9 J	23.5 J	19.5 =	33.4 =	24.9 =
Zinc	(mg/kg)	33.5 =	[111] =	84.4 =	71.3 =	63.6 J	66.9 J	74.3 J	69.7 J	[2060] J

Table 4-5
Sediment Samples
Analytical Results Summary - Detected Compounds Only
TAMPEEL
Former Lordstown Ordnance Depot
Page 5 of 6

Sample Number		SD20301	SD20401	SD20501
Sample Date		10/12/2000	10/12/2000	10/10/2000
VOCS				
2-butanone	(ug/kg)	39 J	--	--
Acetone	(ug/kg)	120 J	17 J	--
Carbon Disulfide	(ug/kg)	1.7 =	--	--
Cis-1,2-dichloroethene	(ug/kg)	--	--	--
Methylene Chloride	(ug/kg)	4 =	--	--
Toluene	(ug/kg)	--	--	--
SVOCS				
2-methylnaphthalene	(ug/kg)	--	--	--
Anthracene	(ug/kg)	--	--	--
Benzo(a)anthracene	(ug/kg)	--	--	--
Benzo(a)pyrene	(ug/kg)	--	--	--
Benzo(b)fluoranthene	(ug/kg)	--	--	--
Benzo(g,h,i)perylene	(ug/kg)	--	--	--
Bis(2-ethylhexyl) Phthalate	(ug/kg)	--	--	--
Chrysene	(ug/kg)	--	--	--
Di-n-butyl Phthalate	(ug/kg)	--	--	--
Dibenzofuran	(ug/kg)	--	--	--
Diethyl Phthalate	(ug/kg)	--	--	--
Fluoranthene	(ug/kg)	--	--	1300 =
Indeno(1,2,3-cd)pyrene	(ug/kg)	--	--	--
Naphthalene	(ug/kg)	--	--	--
Phenanthrene	(ug/kg)	--	--	930 =
Pyrene	(ug/kg)	--	--	900 =
PESTICIDES				
4,4'-DDD	(ug/kg)	--	--	91 =
4,4'-DDE	(ug/kg)	--	--	160 =
4,4'-DDT	(ug/kg)	--	--	170 =
METALS				
Aluminum	(mg/kg)	11400 =	13100 =	14000 =
Antimony	(mg/kg)	--	--	--
Arsenic	(mg/kg)	11.7 =	5.2 =	[38.8] =
Barium	(mg/kg)	[103] =	[106] =	[130] =
Beryllium	(mg/kg)	--	0.74 =	[1.3] =
Cadmium	(mg/kg)	--	--	1.7 =
Calcium	(mg/kg)	1330 =	2320 =	[31100] =

Table 4-5
Sediment Samples
Analytical Results Summary - Detected Compounds Only
TAMPEEL
Former Lordstown Ordnance Depot
Page 6 of 6

Sample Number		SD20301	SD20401	SD20501
Sample Date		10/12/2000	10/12/2000	10/10/2000
Chromium	(mg/kg)	17.4 =	14.6 =	15.1 =
Cobalt	(mg/kg)	13.6 =	--	--
Copper	(mg/kg)	7.6 =	9.3 =	[37.1] =
Cyanide	(mg/kg)	--	--	--
Iron	(mg/kg)	24400 =	15000 =	24600 =
Lead	(mg/kg)	20.7 =	9.7 =	[39.9] =
Magnesium	(mg/kg)	2300 =	1730 =	4030 =
Manganese	(mg/kg)	[535] =	326 =	[770] =
Mercury	(mg/kg)	--	--	--
Nickel	(mg/kg)	16.5 =	19 =	16.2 =
Potassium	(mg/kg)	1310 =	1030 =	1190 =
Selenium	(mg/kg)	--	--	[1.8] =
Sodium	(mg/kg)	--	--	--
Vanadium	(mg/kg)	24.8 =	16.2 =	18.5 =
Zinc	(mg/kg)	72.5 J	75.9 J	[1030] =

NOTES:

-- = Not Detected

[] = Metal Concentration Exceeds Background Value

Blank = Not Analyzed

DATA QUALIFIERS

= - The analyte of concern was detected at the concentration level reported.

J = The analyte of concern was detected but should be considered as an estimated value.

B = Qualifier indicates the presence of the qualified target compound in the method or procedure blank.

E = Estimated value due to chemical or spectral interference.

N = Laboratory has presumptive evidence of the presence of the identified compound

* = Duplicate not within 35% of original result.

Table 4-6
Ground Water Samples
Analytical Results Summary - Detected Compounds Only
TAMPEEL
Former Lordstown Ordnance Depot
Page 1 of 2

Sample Number		MW112GW01	MW112GW01	MW113GW01	MW113GW01	MW113GW01 Dup	MW114GW01	MW114GW01	MW115GW01
Sample Date		10/4/2000	4/21/1999	10/4/2000	4/21/1999	4/21/1999	10/6/2000	4/22/1999	10/9/2000
VOCS									
Methylene Chloride	(ug/l)	--	--	--	--	1.7 =	--	--	--
METALS									
Aluminum	(mg/l)	--	0.83 =	--	1 =	0.37 =	0.34 J	0.35 =	2.1 J
Calcium	(mg/l)	39.6 =	38.9 =	49.7 =	42.9 =	45.2 =	[98.4] =	84.2 =	14.2 =
Chromium	(mg/l)	--	--	--	--	--	--	--	--
Iron	(mg/l)	[7.3] =	[6.2] =	[6.1] =	[7.7] =	[7.6] =	[4.4] =	2.9 =	[7.3] =
Lead	(mg/l)	--	--	--	--	--	--	--	[0.0030] =
Magnesium	(mg/l)	16.1 =	16.6 =	19.6 =	17.2 =	18.2 =	[41.1] =	[35.3] =	7.2 =
Manganese	(mg/l)	0.7 =	0.62 =	0.65 =	0.63 =	0.67 =	0.57 =	0.47 =	0.1 =
Potassium	(mg/l)	--	--	--	--	--	--	--	--
Sodium	(mg/l)	6.2 =	5.8 =	8.6 =	7.2 =	7.8 =	[19.7] J	[14.4] =	[111] J
Thallium	(mg/l)	--	--	--	--	--	[0.010] =	--	--
Vanadium	(mg/l)	--	--	--	--	--	--	--	--
Zinc	(mg/l)	--	--	--	--	--	--	--	--

Table 4-6
Ground Water Samples
Analytical Results Summary - Detected Compounds Only
TAMPEEL
Former Lordstown Ordnance Depot
Page 2 of 2

Sample Number	MW115GW01	MW116GW01
Sample Date	4/22/1999	10/26/2000

VOCS

Methylene Chloride	(ug/l)	--	--
--------------------	--------	----	----

METALS

Aluminum	(mg/l)	[21.9] =	[5.5] =
Calcium	(mg/l)	19.3 =	[195] =
Chromium	(mg/l)	[0.031] =	--
Iron	(mg/l)	[21.6] =	[10.5] =
Lead	(mg/l)	[0.0097] =	--
Magnesium	(mg/l)	14.4 =	[81.0] =
Manganese	(mg/l)	0.13 =	0.95 =
Potassium	(mg/l)	[10.8] =	[6.5] =
Sodium	(mg/l)	[102] =	[73.2] =
Thallium	(mg/l)	--	--
Vanadium	(mg/l)	[0.057] =	--
Zinc	(mg/l)	0.059 =	--

NOTES:

-- = Not Detected

[] = Metal Concentration Exceeds Background Value

Blank = Not Analyzed

DATA QUALIFIERS

= - The analyte of concern was detected at the concentration level reported.

J = The analyte of concern was detected but should be considered as an estimated value.

B = Qualifier indicates the presence of the qualified target compound in the method or procedure blank.

Table 5-1

**Pathways for Potential Chemical Migration
TAMPEEL
Former Lordstown Ordnance Depot, Ohio**

Primary		Secondary (if applicable)		
Source	Release Mechanism	Source	Release Mechanism	Potential Exposure Medium
Surface and Subsurface Soil	Volatilization/ Fugitive Dust	-	-	Air
Surface Soil	Erosion/Surface Runoff	Surface Water/ Sediment	Surface Water Transport	Surface Water/ Sediment
Surface and Subsurface Soil	Leaching	-	-	Groundwater
Surface Water/Sediment	Surface Water Transport	-	-	Downstream Surface Water/ Sediment
Surface Water/Sediment	Volatilization	-	-	Air
Surface Water/Sediment	Influent Flow	Groundwater	Groundwater Transport	Groundwater
Groundwater	Effluent flow	Surface Water/ Sediment	Surface Water Transport	Surface Water/ Sediment
Groundwater	Advective Flow	-	-	Downgradient Groundwater

Table 5-2
VOCs Detected by Media
TAMPEEL
Former Lordstown Ordnance Depot, Ohio

Compound	Surface Soil	Subsurface Soil	Groundwater	Surface Water	Sediments
Aromatic Hydrocarbons					
Ethylbenzene	X				
Toluene	X				X
Xylene (Total)	X				
General Hydrocarbons					
Carbon Disulfide					X
Halogenated Hydrocarbons					
1,1,1-Trichloroethane	X				
Cis-1,2-Dichloroethene				X	X
1,2-Dichloropropane					
Methylene Chloride	X	X	X	X	X
Ketones					
Acetone	X	X			X
2-Butanone	X				X

Table 5-3
SVOCs Detected by Media
TAMPEEL
Former Lordstown Ordnance Depot, Ohio

Compound	Surface Soil	Subsurface Soil	Groundwater	Surface Water	Sediment
General SVOCs					
Carbazole	X				
Dibenzofuran	X				X
Chlorinated SVOCs					
1,2-Dichlorobenzene					
PAHs					
2-methylnaphthelene	X				
Acenaphthene	X				X
Acenaphthylene	X				
Anthracene	X				X
Benzo(a)anthracene	X				X
Benzo(a)pyrene	X				X
Benzo(b)fluoranthene	X				X
Benzo(g,h,i)perylene	X				X
Benzo(k)fluoranthene	X				
Chrysene	X				X
Dibenz(a,h)anthracene	X				
Fluoranthene	X				X
Fluorene	X				
Indeno(1,2,3-cd)pyrene	X				X
Naphthalene	X				X
Phenanthrene	X				X
Pyrene	X				X
Phthalates					
Bis(2-ethylhexyl)phthalate	X				X
Di-N-butylphthalate					X
Diethyl phthalate					X
Buthyl benzyl phthalate	X				

Table 5-4
Pesticides/PCBs Detected by Media
TAMPEEL
Former Lordstown Ordnance Depot, Ohio

Compound	Surface Soil	Subsurface Soil	Groundwater	Surface Water	Sediments
Pesticides					
Aroclor 1260	X				
Aroclor 1254	X				
4,4'-DDE	X	X			X
4,4'-DDD					X
4,4'-DDT	X	X			X
beta-BHC	X				
Endrin	X				

Table 5-5
Metals Detected
Above Background Concentrations
TAMPEEL
Former Lordstown Ordnance Depot, Ohio

Inorganic Compound	Surface Soil	Subsurface Soil	Groundwater	Surface Water	Sediments
Aluminum			X	X	X
Arsenic	X	X			X
Barium	X	X		X	X
Beryllium	X	X			
Cadmium	X				X
Calcium	X		X	X	
Chromium, Total	X		X		X
Cobalt					X
Copper	X				X
Iron	X	X	X	X	X
Lead	X		X	X	X
Magnesium			X	X	X
Manganese	X	X	X	X	X
Mercury	X				
Nickel		X		X	X
Potassium			X	X	
Selenium					X
Sodium			X	X	
Vanadium			X		
Zinc	X	X	X		X

Table 5-6

**Physical and Chemical Properties of VOCs Detected
TAMPEEL
Former Lordstown Ordnance Depot, Ohio**

Compound	Solubility in water at 25°C ⁽¹⁾ (mg/L)	Vapor at 25°C Pressure ⁽¹⁾ (mm Hg)	Henry's Law ⁽¹⁾ K (atm-m ³ /mol)	Specific Gravity ⁽²⁾ (g/cm ³)	K _{oc} ⁽¹⁾ (ml/g)	Half-Life ⁽³⁾ (days)
Aromatic Hydrocarbons						
Ethyl Benzene	152	7	6.43E-03	0.86	1,100	6 - 228
Toluene	535	28.1	6.73E-03	0.87	300	
Xylene (Total)	198	10	7.04E-03	0.87	240	14 - 360
General Hydrocarbons						
Carbon disulfide	2,940	360	1.23E-02	1.26	54	NA
Halogenated Hydrocarbons						
1,1,1-Trichloroethane	1,200	1.60E-01	1.90E-02	1.34	270	140 - 546
Cis-1,2-Dichloroethene	6,300	324	6.60E-03	1.26	59	56 - 2,875
1,2-Dichloropropane						
Methylene Chloride	6,500	4,310	4.40E-02	1.33	35	7-28
Ketones						
Acetone	1,000,000	270	2.06E-05	0.79	2.2	2-14
2-Butanone	268,000	77.5	2.75E-05	0.8	4.5	NA

⁽¹⁾ Superfund Public Health Evaluation Manual, EPA 540/1 - 86/060.

⁽²⁾ Groundwater Chemicals Desk Reference, J. H. Montgomery and L. M. Welkom, Lewis Publishers, 1990, Chelsea, Michigan.

⁽³⁾ Handbook of Environmental Degradation Rates, P. H. Howard, R. S. Boethling, W. F. Jarvis, W. M. Meylan, E. M. Michalenko, Lewis Publishers, 1991, Chelsea, Michigan.

Table 5-7

**Physical and Chemical Properties of SVOCs Detected
TAMPEEL
Former Lordstown Ordnance Depot, Ohio**

Compound	Solubility ⁽¹⁾ (mg/L)	Vapor Pressure ⁽¹⁾ (mm Hg)	Henry's Law K ⁽¹⁾ (atm-m ³ /mol)	Specific Gravity ⁽²⁾ (g/cm ³)	K _{oc} ⁽¹⁾ (mL/g)	Half-Life ⁽³⁾ (days)
General SVOCs						
Carbazole	NA	NA	NA	1.10	NA	-
Dibenzofuran	1.00E+01	2.63E-03	5.82E-05	1.0886	10000	7-28
Chlorinated SVOCs						
1,2-Dichlorobenzene	1.00E+02	1.00E+00	1.93E-03	1.30	1700	-
Bis(2-chloroethyl)ether	1.02E+04	7.10E-01	1.31E-05	NA	13.9	-
PAHs						
2-Methylnaphthelene	2.54E+01	5.10E-02	3.18E-04	1.0058	9000	-
Acenaphthene	3.42E+00	1.55E-03	9.2E-05	1.0242	4600	12-102
Acenaphthylene	3.93E+00	2.90E-02	1.80E-03	0.90	2500	42-60
Anthracene	4.50E-02	1.95E-04	1.02E-03	1.283	14000	100-920
Benzo(a)anthracene	5.70E-03	2.20E-08	1.16E-06	1.274	1380000	204-1362
Benzo(a)pyrene	1.20E-03	5.60E-09	1.55E-06	1.351	5500000	114-1060
Benzo(b)fluoranthene	1.40E-02	5.00E-07	1.19E-05	NA	550000	720-1220
Benzo(g,h,i)perylene	7.00E-04	1.03E-10	5.34E-08	NA	1600000	590-650
Benzo(k)fluoranthene	4.30E-03	5.10E-07	3.94E-05	NA	550000	910-2140
Chrysene	1.80E-03	6.30E-09	1.06E-06	1.274	200000	371-1000
Dibenz(a,h)anthracene	5.00E-04	1.00E-10	7.33E-08	1.282	3300000	361-940
Fluoranthene	2.60E-01	5.00E-06	6.46E-06	1.252	38000	140-440
Flourene	1.69E+00	7.10E-04	6.42E-05	1.203	7300	32-60
Indeno(1,2,3-cd)pyrene	5.30E-04	1.00E-10	6.86E-08	NA	1600000	600-730
Naphthalene	3.10E+01	1.20E-04	4.80E-04	1.162	2000	1-258
Phenanthrene	1.00E+00	6.80E-04	1.59E-04	1.179	14000	16-200
Pyrene	1.32E-01	2.50E-06	5.04E-06	1.271	38000	210-1900
Phthalates						
Bis(2-ethylhexyl)phthalate	4.00E+00	8.5E-09	8.3E-06	0.985	15000000	10-389
Butyl benzol phthalate						
Di-n-butyl phthalate	1.30E+01	1.00E-05	2.82E-07	1.042	170000	-
Diethyl phthalate	8.96E+02	3.50E-03	1.14E-06	1.175	142	-

(1) Superfund Public Health Evaluation Manual, EPA 540/1 - 86/060.

(2) Groundwater Chemicals Desk Reference, J. H. Montgomery and L. M. Welkom, Lewis Publishers, 1990, Chelsea, Michigan.

(3) Handbook of Environmental Degradation Rates, P. H. Howard, R. S. Boethling, W. F. Jarvis, W. M. Meylan, E. M. Michalenko, Lewis Publishers, 1991, Chelsea, Michigan.

Table 5-8

**Physical and Chemical Properties of Pesticides Detected
TAMPEEL
Former Lordstown Ordnance Depot, Ohio**

Compound	Solubility in water at 25°C ⁽¹⁾ (mg/L)	Vapor at 25°C Pressure ⁽¹⁾ (mm Hg)	Henry's Law ⁽¹⁾ K (atm-m ³ /mol)	Specific Gravity ⁽²⁾ (g/cm ³)	K _{oc} ⁽¹⁾ (ml/g)	Half-Life ⁽³⁾ (days)
Pesticides						
4,4'-DDE	4.00E-02	6.50E-06	6.80E-05	NA	4,400,000	730
4,4'-DDD	1.00E-01	1.89E-06	7.96E-06	1.47	770,000	NA
4,4'-DDT	5.00E-03	5.50E-06	5.13E-04	1.56	243,000	5833
Beta-BHC						
Endrin	2.50E-01	7.70E-10	1.20E-06	NA	94,000	NA

(1) Superfund Public Health Evaluation Manual, EPA 540/1 - 86/060.

(2) Groundwater Chemicals Desk Reference, J. H. Montgomery and L. M. Welkom, Lewis Publishers, 1990, Chelsea, Michigan.

(3) Handbook of Environmental Degradation Rates, P. H. Howard, R. S. Boethling, W. F. Jarvis, W. M. Meylan, E. M. Michalenko, Lewis Publishers, 1991, Chelsea, Michigan.

Table 6-1
Parameters Used to Estimate Potential Exposure
For Soil and Sediment Receptors^{a,b}
Page 1 of 2

Pathway Parameter	Adult Resident	Child Resident	Trespasser	TAMPEEL Caretaker	TAMPEEL Student	Construction Worker	Industrial Worker
Ingestion Rate (mg/day)	100 (50 Soil) (10 Sediment)	200 (100 Soil) (10 Sediment)	50	100 (50 Soil) (10 Sediment)	100 (50)	480	50
Fraction Ingested (unitless)	1 (0.5)	1 (0.5)	1 (0.5)	1(0.5)	1 (0.5)	1 (0.5)	1 (0.5)
Soil Exposure Frequency (day/yr)	350	350	39	250	20 (5)	250	250
Sediment Exposure Frequency (day/yr)	39	19	39 ^c	36 ^c	20 (5) ^c	36	--
Exposure Duration (years)	24 (9)	6 (2)	6 (3) ^c	25 (7) ^c	2 ^c	1 (0.5) ^c	25 (7) ^c
Body Weight (kg)	70	15	59	70	59	70	70
Averaging Time-Noncancer (days)	8,760	2,190	2,190 (1,095) ^d	9,125 (2,880) ^d	730 ^d	365 (182) ^d	9,125 (2,550) ^d
Averaging Time-Cancer (days)	25,500	25,500	25,550 ^e	25,550 ^e	25,550 ^e	25,550 ^e	25,550 ^e
Inhalation Rate (m ³ /day)	15	15	20	20	20	30 (20)	20
Skin Surface Area (cm ²) (Soil)	5,800 (5,000)	1,800	4,525 (3,675) ^f	5,800 (5000) ^f	4,525	5,800 (5000) ^f	5,800 (5000) ^f
Skin Surface Area (cm ²) (sediment)	2,570	980	1,800	2,570	1,800	2,570	NA
Skin Adherence Factor (mg/cm ²) ^g	0.08	0.3	0.035	0.035	0.3	0.1	0.035

Table 6-1
Parameters Used to Estimate Potential Exposure
For Soil and Sediment Receptors^{a,b}
Page 2 of 2

Pathway Parameter	Adult Resident	Child Resident	Trespasser	TAMPEEL Caretaker	TAMPEEL Student	Construction Worker	Industrial Worker
Absorption Factor (unitless)	Chemical-specific ^g	Chemical-specific ^g	Chemical-specific ^g	Chemical-specific ^g	Chemical-specific ^g	Chemical-specific ^g	Chemical-specific ^g

^a Parameter values are intended to characterize the RME; values in parenthesis represent an estimate of the CT.

^b Parameter values obtained from Risk Assessment Guidance for Superfund, Volume 1: Human Health Evaluation Manual, Supplemental Guidance: "Standard Default Exposure Factors." OSWER Directive 9285.6-03, March 25, 1991 (USEPA, 1991d), unless otherwise noted.

^c Best professional judgment.

Fraction Ingested: For RME, it is assumed that 100 percent of the soil ingested on days that the site is visited is attributable to the site. The CT value is 50 percent, half of the RME amount.

Exposure Frequency: Assumes that the trespasser visits the site one day a week for 9 months of the year. Sediment exposure frequencies for trespasser based on surface water exposure assumptions. It is assumed that the TAMPEEL Caretaker works at TAMPEEL during the school year and is exposed to the surface water and sediment once a week. Students visiting TAMPEEL are known to attend a class once for 2 days; 20 days is used as the EF to overestimate exposure.

Exposure Duration: It is assumed that the trespasser is 13 to 18 years of age. The RME is based on a 6-year period representing that age range; the CT is half of the RME value. The construction worker scenario assumes that the construction project will have a duration of 1 year; the CT value is half of the RME value. The industrial worker and caretaker scenarios are based on 25 years of employment at Lordstown or TAMPEEL and performance of the same job. The CT value assumes that the worker will remain in the same job for 7 years. The student is assumed to be 9 to 10 years of age. Students visiting TAMPEEL are known to attend a class one; 2 years is used as the ED to overestimate exposure.

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

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

^f Exposure Factors Handbook. EPA/600/P-95/002A (USEPA, 1996b).

^g Risk Assessment Guidance for Superfund, Volume 1: Human Health Evaluation Manual, Supplemental Guidance, Dermal Risk Assessment (USEPA, 1998).

Table 6-2
Parameters Used to Estimate Potential Exposure
For Groundwater Receptors^{a,b}
Page 1 of 2

Pathway Parameter	Resident Adult	Resident Child	Construction worker
<i>Ingestion of Groundwater</i>			
Ingestion Rate (L/day)	2 (1.4) ^c	1.3 (0.7) ^c	1.0 ^c
Exposure Frequency (days/year)	350	350	20
Exposure Duration (years)	30 (9) ^c	6 ^c	1 ^c
Body Weight (kg)	70	15	70
Averaging Time-Noncancer (days)	10,950 (3,285) ^e	2,190 ^e	365 ^e
Averaging Time-Cancer (days)	25,550 ^f	25,550 ^f	25,550 ^f
<i>Inhalation of Volatiles from Groundwater</i>			
Inhalation Rate (m ³ /day)	15	11(5) ^c	15
Exposure Frequency (days/year)	350	350	20
Event time (hours/day)	0.25 ^c	0.25 ^c	1 ^c
Exposure Duration (years)	30 (9) ^c	6 ^c	1 ^c
Body Weight (kg)	70	15	70
Averaging Time-Noncancer (days)	10,950 (3,285) ^e	2,190 ^e	365 ^e
Averaging Time-Cancer (days)	25,550 ^f	25,550 ^f	25,550 ^f
<i>Dermal Exposures</i>			
Skin Surface Area (cm ²)	23,000 (20,000) ^g	8,450(7,310)	4,300
Exposure Frequency (days/year)	350	350	20
Event Time (hours/event)	0.25 ^d	0.25 ^d	1 ^d
Exposure Duration (years)	30 (9) ^c	6 ^c	1 ^c
Body Weight (kg)	70	15	70
Averaging Time-Noncancer (days)	10,950 (3,285) ^e	2,190 ^e	365 ^e
Averaging Time-Cancer (days)	25,550 ^f	25,550 ^f	25,550 ^f
<i>Ingestion of Fruits and Vegetables</i>			
IR (fruit) (g/day)	42 (28) ^c	28 ^c	--
FI (fruit) (unitless)	0.2 ^d	0.2 ^d	--
IR (vegetable) (g/day)	80 (50) ^c	24.9 ^c	--
FI (vegetable) (unitless)	0.5 ^d	0.5 ^d	--

Table 6-2
Parameters Used to Estimate Potential Exposure
For Groundwater Receptors^{a,b}
Page 2 of 2

Pathway Parameter	Resident Adult	Resident Child	Construction worker
EF (days/year)	350 (73) ^c	350	--
ED (years)	30 (9) ^c	6 ^c	--
BW (kg)	70	15	--
Averaging Time-Noncancer (days)	10,950 (3,285) ^e	2,190 ^e	--
Averaging Time-Cancer (days)	25,550 ^f	25,550 ^f	--

- ^a Parameter values are intended to characterize the RME; values in parenthesis represent an estimate of the CT.
^b Parameter values obtained from Risk Assessment Guidance for Superfund, Volume 1: Human Health Evaluation Manual, Supplemental Guidance: "Standard Default Exposure Factors." OSWER Directive 9285.6-03, March 25, 1991 (USEPA, 1991d), unless otherwise noted.
^c Exposure Factors Handbook. EPA/600/P-95/002A (USEPA, 1996b).
^d Best professional judgement.

Event Time: In the scenario for inhalation of volatiles released by showering and other household uses, the event time is based on a 15 minute shower.

Fraction Ingested for Fruits and Vegetables: Assumes that 20 percent of the fruit consumed on a daily basis is grown in the vicinity of Lordstown. The value for vegetables is approximately twice that amount because homegrown produce is likely to consist of a greater percentage of vegetables.

- ^e Calculated as the product of ED (years) x 365 days/year.
^f Calculated as the product of 70 years (assumed lifetime) x 365 days/year.
^g Risk Assessment Guidance for Superfund, Volume 1, Human Health Evaluation Manual, Supplemental Guidance: "Interim Dermal Risk Assessment Guidance" September, 1992 (USEPA, 1992c).

Table 6-3
Parameters Used to Estimate Potential Exposure
For Surface Water Receptors^{a,b}
Page 1 of 2

Pathway Parameter	Adult	Child	Trespasser	TAMPEEL Caretaker	TAMPEEL Student	Construction Worker
<i>Ingestion of Surface Water</i>						
Ingestion Rate (L/day)	0.05 ^c	0.05 ^c	0.05 ^c	0.05 ^c	0.05 ^c	0.05 ^c
Exposure Frequency (days/year)	39 ^d	19 ^d	39 ^d	36 ^d	20 ^d	36 ^d
Exposure Duration (years)	30 ^e	6 ^c	6 (3) ^d	25 (7) ^d	2 ^d	1 ^d
Body Weight (kg)	70	15	59	70	59	70
Averaging Time- Noncancer (days)	10,950 ^e	2,190 ^e	2,190 (1,095) ^e	9,125 (2,880) ^e	730 ^e	365 ^e
Averaging Time- Cancer (days)	25,550 ^f	25,550 ^f	25,550 ^f	25,500 ^f	25,550 ^f	25,500 ^f
<i>Dermal Exposures to Surface Water</i>						
Skin Surface Area (cm ²)	2,570	980	1,800	2,570	1,800	2,570
Exposure Frequency (days/year)	39 ^d	19 ^d	39 ^d	36 ^d	20 ^d	36 ^d
Exposure Duration (years)	30 ^d	6 ^d	6 (3) ^d	25 (7) ^d	2 ^d	1 ^d
Body Weight (kg)	70	15	70 59	70	59	70

Table 6-3
Parameters Used to Estimate Potential Exposure
For Surface Water Receptors^{a,b}
Page 2 of 2

Pathway Parameter	Adult	Child	Trespasser	TAMPEEL Caretaker	TAMPEEL Student	Construction Worker
Averaging Time- Noncancer (days)	10,950 ^e	2,190 ^e	2,190 (1,095) ^e	9,125 (2,880) ^a	730 ^e	365 ^a
Averaging Time- Cancer (days)	25,500 ^f	25,500 ^f	25,550 ^f	25,550 ^f	25,550 ^f	25,500 ^f

^a Parameter values are intended to characterize the RME; values in parenthesis represent an estimate of the CT.

^b Parameter values obtained from Risk Assessment Guidance for Superfund, Volume 1: Human Health Evaluation Manual, Supplemental Guidance: "Standard Default Exposure Factors." OSWER Directive 9285.6-03, March 25, 1991 (USEPA, 1991d), unless otherwise noted.

^c Exposure Factors Handbook. EPA/600/P-95/002A (USEPA, 1996b).

^d Best professional judgement.

Exposure frequency for surface water exposures for the trespasser assumes visits to the stream one day a week during summer months; frequency for the caretaker assumes one exposure each week during the school year. Students visiting TAMPEEL are known to attend a class once for 2 days; 20 days is used as the EF to overestimate exposures.

^e Calculated as the product of ED (years) x 365 days/year.

^f Calculated as the product of 70 years (assumed lifetime) x 365 days/year.

Table 6-4
Chemical-Specific Dermal Absorption Factors

Chemical	Percent Absorption	Reference
<i>Inorganics</i>		
Arsenic	3	USEPA, 1995c
Cadmium	1.0	EPA, 1992b
Other Metals	1.0	Ryan et al., 1987
<i>Volatile Organics</i>		
Xylene	3.0	USEPA, 1995c
VOCs with vapor pressure \geq benzene	0.05	USEPA, 1995c
VOCs with vapor pressure $<$ benzene	3.0	USEPA, 1995c
<i>Semivolatile Organics</i>		
PAHs	15	USEPA, 1995c
Polychlorinated biphenyls	20	Wester et al., 1993c
Other SVOCs	10	USEPA, 1995c
<i>Pesticides</i>		
DDT	5	USEPA, 1995c
Other pesticides	10	USEPA, 1995c
<i>Dioxins/Furans</i>		
<10% organic soil	0.03	USEPA, 1992b
>10% organic soil	0.001	USEPA, 1992b

Table 6-5
Fruit/Vegetable Uptake Model Parameters

Parameter	Value
Irrigation rate (I) ($L/m^2/hour$)	0.081 ^a
Fraction of irrigation deposits retained on crops (r_w) (unitless)	0.20 ^b
Removal rate by weathering (λ_w) ($hour^{-1}$)	0.0021 ^b
Growing season for crops (t) (hour)	1440 ^b
Agricultural yield of food crops (Y) (kg/m^2)	1.5 ^c
Fraction of year plants are irrigated (f_w) (unitless)	1.0 ^b
Period soil is exposed to contaminated water (t_{bw})	613200 ^d
Effective surface soil density (r) (kg/m^2)	150 ^e
Delay between harvest and consumption of vegetables (t_h) (hour)	24 ^b
Delay between harvest and consumption of fruit (t_h) (hour)	720 ^d

^a USDA, 1970.

^b NRC, 1977.

^c USDA, 1979.

^d Best professional judgement.

^e Corresponds to a density of 1.5 g/cm^3 and a depth of 10 cm. Moist bulk densities of surface soil range from 1.4 to 1.55 g/cm^3 in Ohio.

Table 6-6
Toxicity Data for Chemicals of Potential Concern
Page 1 of 3

Chemical	Reference Dose			Cancer Slope Factor		Weight of Evidence and Target Organ
	Oral Exposure (mg/kg/day)	Inhalation Exposure (mg/kg/day)	Noncancer Target Organ (Oral/Inhalation)	Oral Exposure (mg/kg/day) ⁻¹	Inhalation Exposure (mg/kg/day) ⁻¹	
Inorganics						
Aluminum	1.0x10 ⁰ (P ^a)	1.4x10 ⁻³ (P)	CNS/NA	NA ^b	NA	NA
Antimony	4.0x10 ⁻⁴ (I ^c)	NA	Blood glucose/NA	NA	NA	D/NA
Arsenic	3.0x10 ⁻⁴ (I)	NA	Skin/NA	1.5x10 ⁰ (I)	1.5x10 ¹ (I)	A ^d /Skin, Lung
Barium	7.0x10 ⁻² (I)	1.4x10 ⁻⁴ (H)	Blood pressure	NA	NA	D/NA
Chromium VI	3.0x10 ⁻³ (I)	2.2x10 ⁻⁶ (I)	NOAEL/Respiratory System	NA	2.9x10 ² (I)	A/Lung
Iron	3.0x10 ⁻¹ (P)	NA	GI Irritation	NA	NA	NA
Lead	NA	NA	NA	NA	NA	B2/Kidney
Manganese	2.4x10 ⁻² (I)	1.4x10 ⁻⁵ (I)	CNS/CNS	NA	NA	D/NA
Nickel	2.0x10 ⁻² (I)	NA	Decreased Body Weight/NA	NA	NA	NA
Thallium	6.6x10 ⁻⁵ (I)	NA	Blood Chemistry/NA	NA	NA	NA
Vanadium	7.0x10 ⁻³ (H ^e)	NA	NA	NA	NA	D/NA
Zinc	3.0x10 ⁻¹ (I)	NA	Erythrocytes/NA	NA	NA	NA
Volatile Organics						
Methylene Chloride	6.0x10 ⁻² (I)	8.6x10 ⁻¹ (H)	Liver/Liver	7.5x10 ⁻³ (I)	1.6x10 ⁻³ (I)	B2/Liver, Lung
Semivolatile Organics						
Benzo(a)anthracene	NA	NA	NA	7.3x10 ⁻¹ (T ^f)	NA	B2/Lung

Table 6-6
Toxicity Data for Chemicals of Potential Concern
Page 2 of 3

Chemical	Reference Dose			Cancer Slope Factor		Weight of Evidence and Target Organ
	Oral Exposure (mg/kg/day)	Inhalation Exposure (mg/kg/day)	Noncancer Target Organ (Oral/Inhalation)	Oral Exposure (mg/kg/day) ⁻¹	Inhalation Exposure (mg/kg/day) ⁻¹	
Benzo(a)pyrene	NA	NA	NA	7.3×10^0 (T)	NA	B2/Lung
Benzo(b)fluoranthene	NA	NA	NA	7.3×10^{-1} (T)	NA	B2/Lung
Benzo(ghi)perylene	NA	NA	NA	NA	NA	D/NA
Benzo(k)fluoranthene	NA	NA	NA	7.3×10^{-2} (T)	NA	B2/Lung
Chrysene	NA	NA	NA	7.3×10^{-3} (T)	NA	B2/Lung
Dibenzo(a,h)anthracene	NA	NA	NA	7.3×10^0 (T)	NA	B2/Lung
Indeno(1,2,3-cd)pyrene	NA	NA	NA	7.3×10^{-1} (T)	NA	B2/Lung
Pesticides/PCBs						
Aroclor 1254	2.0×10^{-5} (I)	NA	Eyes, Immune System/NA	2.0×10^0 (I)	2.0×10^0 (I)	B2/Liver
Aroclor 1260	NA	NA	NA	2.0×10^0 (I)	2.0×10^0 (I)	B2/Liver
Beta-BHC	2.0×10^{-4} (P)	NA	NA	1.8×10^0 (I)	1.8×10^0 (I)	C/Liver
DDD	NA	NA	NA	2.4×10^{-1} (I)	NA	B2/Lung
DDE	NA	NA	NA	3.4×10^{-1} (I)	NA	B2/Liver
DDT	5.0×10^{-4} (I)	NA	Liver/NA	3.4×10^{-1} (I)	3.4×10^{-1} (I)	B2/Liver
Dioxins/Furans						
1,2,3,4,6,7,8-HpCDD	NA	NA	NA	NA	NA	NA
Total PeCDF	NA	NA	NA	7.5×10^4 (D ⁹)	7.5×10^4 (D)	NA
OCDD	NA	NA	NA	1.5×10^2 (D)	1.5×10^2 (D)	NA

Table 6-6
Toxicity Data for Chemicals of Potential Concern
Page 3 of 3

- a P - provisional toxicity value (USEPA, 2002)
- b NA - not available
- c I - value found in Integrated Risk Information System (USEPA, 2003)
- d EPA Carcinogen Classification:
 - Group A = Sufficient evidence for carcinogenicity in humans.
 - Group B = Probable human carcinogen (B1 - limited evidence of carcinogenicity in humans; B2 - sufficient evidence of carcinogenicity in animals with inadequate evidence in humans.)
 - Group C = Possible human carcinogen.
 - Group D = Not classifiable as to human carcinogenicity.
 - Group E = Evidence for noncarcinogenicity in humans.
- e H - Value found in the Health Effects Assessment Summary Tables (USEPA, 1997a).
- f T - value derived from Toxicity Equivalency Factors for PAHs (USEPA, 1993b).
- g D - value derived from the Toxicity Equivalency Factors for Dioxins (USEPA, 1994b).

Table 6-7
Chemical-Specific Oral Absorption Factors^a
Page 1 of 2

Chemical	Percent OAF
<i>Volatile Organics</i>	
Acetone	100
Bromomethane	100
Chloroform	100
Chloromethane	100
1,2-Dichloroethene (total)	100
2-Hexanone	100
Methylene Chloride	100
Trichloroethene	100
Vinyl Chloride	100
Xylene	100
<i>Semivolatile Organics</i>	
Benzo(a)pyrene	100
Bis(2-chloroethyl)ether	100
Bis(2-ethyl hexyl)phthalate	100
Chrysene	100
2-Methylnaphthalene	100
Naphthalene	100
Polycyclic Aromatic Hydrocarbons (except B(a)P)	100
Polychlorinated Biphenyls	100
<i>Inorganics</i>	
Aluminum	100
Antimony	15
Arsenic	100
Barium	7
Beryllium	1
Cadmium	5
Calcium	100
Cobalt	100
Chromium III	1
Chromium VI	2
Copper	100
Iron	100
Lead	100
Magnesium	100
Manganese	6
Mercury	6
Nickel	4
Potassium	100
Selenium	100
Silver	4
Sodium	100
Vanadium	3
Zinc	100
<i>Pesticides</i>	
4,4'-DDD	100

Table 6-7
Chemical-Specific Oral Absorption Factors^a
Page 2 of 2

Chemical	Percent OAF
4,4 ¹ -DDE	100
4,4-DDT	100
Beta-BHC	100
Endosulfan Sulfate	100
Heptachlor	100
<i>Dioxins/Furans</i>	
1,2,3,4,6,7,8-HPCDD	100
OCDD	100
Total PECDF	100

^aUSEPA, 1998

Table 6-8

Selection of Contaminants of Potential Concern, Surface Soil ^a
Page 1 of 2

RI Report
TAMPEEL
Section 6
May 2005

Chemical	Frequency of Detection	Range of values, mg/kg		Statistical Distribution ^b	95% UCL mg/kg ^c	Background mg/kg ^d	Screening Criteria mg/kg ^e	Exclusion Rationale ^f	COPC? ^g	Representative Concentration mg/kg ^h
		Detected	Nondetected							
INORGANICS										
ALUMINUM	44/44(100)	1.5E+03 - 2.1E+04	NA	N	1.2E+04	1.9E+04	7.6E+03	--	Y	1.2E+04
ARSENIC	43/44(98)	4.3E+00 - 7.0E+01	1.1E+00	U	2.1E+01	2.4E+01	3.9E-02	--	Y	2.1E+01
BARIUM	43/44(98)	3.2E+01 - 1.1E+04	2.3E+01	U	3.5E+02	8.0E+01	5.4E+02	--	Y	3.5E+02
BERYLLIUM	8/44(18)	6.2E-01 - 2.6E+00	5.6E-01 - 7.5E-01	NP	6.2E-01	1.1E+00	1.5E+01	C	N	--
CADMIUM	1/44(2)	1.8E+00	5.6E-01 - 6.9E+00	NP	1.8E+00	1.9E+00	3.7E+00	A,B,C	N	--
CALCIUM	35/44(80)	6.8E+02 - 8.6E+04	5.6E+02 - 6.9E+02	L	1.1E+04	9.8E+03	NA	D	N	--
CHROMIUM	44/44(100)	3.7E+00 - 2.9E+02	NA	U	2.7E+01	2.5E+01	3.0E+00	--	Y	2.7E+01
COBALT	20/44(45)	6.6E+00 - 1.2E+01	5.6E+00 - 7.5E+00	NP	7.5E+00	1.9E+01	9.0E+01	A,C	N	--
COPPER	43/44(98)	5.7E+00 - 2.3E+02	2.8E+00	L	2.7E+01	2.6E+01	3.1E+02	C	N	--
IRON	44/44(100)	3.2E+03 - 1.5E+05	NA	L	3.2E+04	3.6E+04	2.3E+03	--	Y	3.2E+04
LEAD	44/44(100)	3.2E+00 - 9.8E+03	NA	U	1.4E+02	2.4E+01	4.0E+01 ¹	--	Y	1.4E+02
MAGNESIUM	41/44(93)	6.2E+02 - 1.4E+04	6.7E+02 - 7.0E+02	L	3.6E+03	5.6E+03	NA	D	N	--
MANGANESE	44/44(100)	3.8E+01 - 1.3E+04	NA	L	1.3E+03	4.7E+02	1.8E+02	--	Y	1.3E+03
MERCURY	6/44(14)	1.3E-01 - 7.1E-01	1.1E-01 - 1.5E-01	NP	1.3E-01	1.2E-01	2.3E+00	C	N	--
NICKEL	41/44(93)	6.4E+00 - 1.6E+02	4.5E+00 - 5.6E+00	L	2.4E+01	3.2E+01	1.6E+02	--	Y	2.4E+01
POTASSIUM	37/44(84)	6.0E+02 - 2.6E+03	5.7E+02 - 6.8E+02	N	1.3E+03	4.1E+03	NA	A,D	N	--
SELENIUM	10/44(23)	6.5E-01 - 8.1E+00	5.6E-01 - 2.5E+00	NP	6.5E-01	1.4E+00	3.9E+01	C	N	--
SODIUM	1/44(2)	2.0E+03	5.6E+02 - 7.5E+02	NP	2.0E+03	7.6E+01	NA	B,D	N	--
VANADIUM	42/44(95)	7.9E+00 - 1.2E+02	5.7E+00 - 6.9E+01	U	2.5E+01	3.7E+01	5.5E+01	--	Y	2.5E+01
ZINC	44/44(100)	1.1E+01 - 2.4E+04	NA	U	2.8E+02	1.0E+02	2.3E+03	--	Y	2.8E+02
VOLATILE ORGANIC COMPOUNDS										
1,1,1-TRICHLOROETHANE	1/44(2)	2.1E-03	5.6E-03 - 6.6E-02	NP	2.1E-03	NA	1.2E+02	B,C	N	--
1,1-DICHLOROETHANE	1/44(2)	6.0E-03	5.6E-03 - 6.6E-02	NP	6.0E-03	NA	5.1E+01	B,C	N	--
2-BUTANONE	1/44(2)	5.9E-03	2.2E-02 - 2.6E-01	NP	5.9E-03	NA	7.3E+02	B,C	N	--
ACETONE	11/44(25)	4.7E-03 - 6.8E-01	2.2E-02 - 2.6E-01	NP	4.7E-03	NA	1.6E+02	C	N	--
ETHYLBENZENE	4/44(9)	1.1E-03 - 8.3E-01	5.6E-03 - 6.1E-02	NP	1.1E-03	NA	8.9E-01	C	N	--
METHYLENE CHLORIDE	9/44(20)	1.6E-03 - 3.9E-02	5.6E-03 - 6.6E-02	NP	1.6E-03	NA	9.1E-01	C	N	--
TOLUENE	13/44(30)	1.1E-03 - 7.7E-02	5.6E-03 - 6.6E-02	NP	1.1E-03	NA	5.2E+01	C	N	--
XYLENE, TOTAL	8/44(18)	3.4E-03 - 5.9E+00	5.6E-03 - 6.1E-02	NP	3.4E-03	NA	2.7E+01	C	N	--
SEMI-VOLATILE ORGANIC COMPOUNDS										
2-METHYLNAPHTHALENE	4/44(9)	1.7E-01 - 1.9E+00	3.7E-01 - 5.7E+00	NP	1.7E-01	NA	5.6E+00	C	N	--
ACENAPHTHENE	1/44(2)	1.4E-01	3.7E-01 - 5.7E+00	NP	1.4E-01	NA	3.7E+02	B,C	N	--
ACENAPHTHYLENE	1/44(2)	1.5E-01	3.7E-01 - 5.7E+00	NP	1.5E-01	NA	2.3E+02	B,C	N	--
ANTHRACENE	4/44(9)	3.4E-01 - 5.6E-01	3.7E-01 - 5.7E+00	NP	3.4E-01	NA	2.2E+03	C	N	--
BENZO(A)ANTHRACENE	13/44(30)	5.4E-02 - 2.1E+01	3.7E-01 - 5.4E-01	NP	5.4E-02	NA	6.2E-02	--	Y	5.4E-02
BENZO(A)PYRENE	13/44(30)	6.1E-02 - 2.2E+01	3.7E-01 - 5.4E-01	NP	6.1E-02	NA	6.2E-03	--	Y	6.1E-02
BENZO(B)FLUORANTHENE	14/44(32)	9.8E-02 - 3.3E+01	3.7E-01 - 4.6E-01	NP	9.8E-02	NA	6.2E-02	--	Y	9.8E-02
BENZO(GH)PERYLENE	9/44(20)	9.4E-02 - 1.3E+01	3.7E-01 - 5.4E-01	NP	9.4E-02	NA	2.3E+02	C	N	--
BENZO(K)FLUORANTHENE	10/44(23)	5.5E-02 - 1.1E+01	3.7E-01 - 5.4E-01	NP	5.5E-02	NA	6.2E-01	--	Y	5.5E-02
BIS(2-ETHYLHEXYL)PHTHALATE	9/44(20)	8.0E-02 - 1.6E-01	3.7E-01 - 5.7E+00	NP	8.0E-02	NA	3.5E+00	C	N	--
BUTYL BENZYL PHTHALATE	1/44(2)	8.9E-01	3.7E-01 - 5.7E+00	NP	8.9E-01	NA	1.2E+03	B,C	N	--
CARBAZOLE	3/44(7)	1.4E-01 - 2.2E-01	3.7E-01 - 5.7E+00	NP	1.4E-01	NA	2.4E+00	C	N	--
CHRYSENE	14/44(32)	7.2E-02 - 2.3E+01	3.7E-01 - 4.6E-01	NP	7.2E-02	NA	6.2E+00	--	Y	7.2E-02
DIBENZ(A,H)ANTHRACENE	3/44(7)	1.2E-01 - 7.2E-01	3.7E-01 - 5.7E+00	NP	1.2E-01	NA	6.2E-03	--	Y	1.2E-01
DIBENZOFURAN	4/44(9)	6.6E-02 - 5.3E-01	3.7E-01 - 5.7E+00	NP	6.6E-02	NA	2.9E+01	C	N	--

Table 6-8

Selection of Contaminants of Potential Concern, Surface Soil ^a
Page 2 of 2

RI Report
TAMPEEL
Section 6
May 2005

Chemical	Frequency of Detection	Range of values, mg/kg		Statistical Distribution ^b	95% UCL mg/kg ^c	Background mg/kg ^d	Screening Criteria mg/kg ^e	Exclusion Rationale ^f	COPC? ^g	Representative Concentration mg/kg ^h
		Detected	Nondetected							
FLUORANTHENE	15/44(34)	8.7E-02 - 2.7E+01	3.7E-01 - 4.6E-01	NP	8.7E-02	NA	2.3E+02	C	N	--
FLUORENE	3/44(7)	6.2E-02 - 2.5E-01	3.7E-01 - 5.7E+00	NP	6.2E-02	NA	2.7E+02	C	N	--
INDENO(1,2,3-CD)PYRENE	10/44(23)	7.1E-02 - 1.3E+01	3.7E-01 - 5.4E-01	NP	7.1E-02	NA	6.2E-02	--	Y	7.1E-02
NAPHTHALENE	3/44(7)	1.4E-01 - 1.2E+00	3.7E-01 - 5.7E+00	NP	1.4E-01	NA	5.6E+00	C	N	--
PHENANTHRENE	14/44(32)	6.7E-02 - 8.2E+00	3.7E-01 - 4.6E-01	NP	6.7E-02	NA	2.3E+02	C	N	--
PYRENE	14/44(32)	7.0E-02 - 2.3E+01	3.7E-01 - 4.6E-01	NP	7.0E-02	NA	2.3E+02	C	N	--
PESTICIDES/PCBS										
4,4'-DDE	8/44(18)	5.8E-03 - 9.4E-02	3.7E-03 - 9.1E-02	NP	1.0E-02	NA	1.7E-01	C	N	--
4,4'-DDT	8/44(18)	5.2E-03 - 1.6E-01	3.7E-03 - 9.1E-02	NP	5.2E-03	NA	1.7E-01	C	N	--
AROCLOR 1254	1/44(2)	5.5E-02	3.7E-02 - 5.0E-02	NP	5.5E-02	NA	2.2E-02	B	Y	5.5E-02
AROCLOR 1260	1/44(2)	9.7E-02	3.7E-02 - 5.0E-02	NP	9.7E-02	NA	2.2E-02	B	Y	9.7E-02
BETA-BHC	2/44(5)	5.7E-03 - 5.6E-02	1.9E-03 - 4.7E-02	NP	5.7E-03	NA	3.2E-02	B	Y	5.7E-03
HERBICIDES										
No samples collected										
DIOXINS/FURANS										
1,2,3,4,6,7,8-HPCDD	2/4(50)	1.4E-06 - 3.1E-06	3.7E-07 - 5.5E-07	NA	NA	NA	NA	--	Y	3.1E-06
OCDD	4/4(100)	9.5E-06 - 4.2E-04	NA	NA	NA	NA	3.8E-04	--	Y	4.2E-04
TOTAL HPCDD	2/4(50)	2.8E-06 - 6.8E-06	7.1E-07 - 1.2E-06	NA	NA	NA	3.8E-05	C	N	--
TOTAL HXCDD	1/4(25)	1.9E-07	5.4E-07 - 7.2E-07	NA	NA	NA	3.8E-06	C	N	--
TOTAL PECDF	2/4(50)	3.7E-07 - 1.0E-06	6.2E-07 - 8.2E-07	NA	NA	NA	7.6E-07	--	Y	1.0E-06
TOTAL TCDF	2/4(50)	1.0E-06 - 1.7E-06	7.4E-07 - 8.8E-07	NA	NA	NA	3.8E-06	C	N	--

^a Surface soil is defined as the interval less than 2 feet below the ground surface. Soil samples were classified on the basis of the end depth of the sample.

^b Statistical Distribution: N = Normal distribution; L = Lognormal distribution; U = Undetermined distribution; NP = Nonparametric distribution for data sets with greater than 50% nondetects; NA = distribution not determined if sample size is less than 5.

^c 95% Upper Confidence Limit calculated for the indicated distribution. NA = sample size is less than 5 and distribution is not calculated.

^d Background concentrations for inorganic constituents are based on inorganic constituents detected in background soil samples defined in Section 4 (Table 4-1).

^e Toxicity/concentration screen based on USEPA Region 9 Preliminary Remediation Goals (PRGs) for residential soil, adjusted, if necessary, to reflect an incremental lifetime cancer risk of 1 E-7 and a hazard index of 0.1 (USEPA, 2002).

^f Rationale for exclusion of chemical as a contaminant of potential concern (COPC):

A = within background concentration.

B = detection frequency less than 5%.

C = maximum detection is less than screening criteria.

D = essential nutrient.

^g N = Chemical is not chosen as a COPC; Y = Chemical is chosen as COPC. Note: chemicals with only a less than 5% detection frequency (B) exclusion rationale were chosen as COPCs.

^h Concentration used in risk assessment equal to 95% UCL or maximum value, if maximum value is less than UCL or if no UCL is calculated.

ⁱ Screening criteria for lead based on the residential soil screening value of 400 mg/kg (USEPA, 1994a).

Table 6-9

Selection of Contaminants of Potential Concern, Total Soil ^a
Page 1 of 2

RI Report
TAMPEEL
Section 6
May 2005

Chemical	Frequency of Detection	Range of values, mg/kg		Statistical Distribution ^b	95% UCL mg/kg ^c	Background mg/kg ^d	Screening Criteria mg/kg ^e	Exclusion Rationale ^f	COPC? ^g	Representative Concentration mg/kg ^h
		Detected	Nondetected							
INORGANICS										
ALUMINUM	53/53(100)	1.5E+03 - 2.1E+04	NA	N	1.2E+04	1.9E+04	7.6E+03	--	Y	1.2E+04
ARSENIC	52/53(98)	4.3E+00 - 7.0E+01	1.1E+00	U	2.0E+01	2.4E+01	3.9E-02	--	Y	2.0E+01
BARIUM	52/53(98)	2.3E+01 - 1.1E+04	2.3E+01	U	2.7E+02	8.0E+01	5.4E+02	--	Y	2.7E+02
BERYLLIUM	9/53(17)	6.2E-01 - 2.6E+00	5.6E-01 - 7.5E-01	NP	6.2E-01	1.1E+00	1.5E+01	C	N	--
CADMIUM	1/53(2)	1.8E+00	5.6E-01 - 6.9E+00	NP	1.8E+00	1.9E+00	3.7E+00	A,B,C	N	--
CALCIUM	44/53(83)	6.8E+02 - 8.6E+04	5.6E+02 - 6.9E+02	L	8.6E+03	9.8E+03	NA	D	N	--
CHROMIUM	53/53(100)	3.7E+00 - 2.9E+02	NA	U	2.4E+01	2.5E+01	3.0E+00	--	Y	2.4E+01
COBALT	29/53(55)	6.6E+00 - 1.4E+01	5.6E+00 - 7.5E+00	U	7.6E+00	1.9E+01	9.0E+01	A,C	N	--
COPPER	52/53(98)	5.7E+00 - 2.3E+02	2.8E+00	U	2.6E+01	2.6E+01	3.1E+02	C	N	--
IRON	53/53(100)	3.2E+03 - 1.5E+05	NA	U	3.1E+04	3.6E+04	2.3E+03	--	Y	3.1E+04
LEAD	53/53(100)	3.2E+00 - 9.8E+03	NA	U	9.3E+01	2.4E+01	4.0E+01 ⁱ	--	Y	9.3E+01
MAGNESIUM	50/53(94)	6.2E+02 - 1.4E+04	6.7E+02 - 7.0E+02	L	3.6E+03	5.6E+03	NA	D	N	--
MANGANESE	53/53(100)	3.8E+01 - 1.3E+04	NA	L	1.1E+03	4.7E+02	1.8E+02	--	Y	1.1E+03
MERCURY	6/53(11)	1.3E-01 - 7.1E-01	1.1E-01 - 1.5E-01	NP	1.3E-01	1.2E-01	2.3E+00	C	N	--
NICKEL	50/53(94)	6.4E+00 - 1.6E+02	4.5E+00 - 5.6E+00	U	2.5E+01	3.2E+01	1.6E+02	--	Y	2.5E+01
POTASSIUM	46/53(87)	6.0E+02 - 2.6E+03	5.7E+02 - 6.8E+02	N	1.4E+03	4.1E+03	NA	A,D	N	--
SELENIUM	10/53(19)	6.5E-01 - 8.1E+00	5.6E-01 - 2.5E+00	NP	6.5E-01	1.4E+00	3.9E+01	C	N	--
SODIUM	1/53(2)	2.0E+03	5.6E+02 - 7.5E+02	NP	2.0E+03	7.6E+01	NA	B,D	N	--
VANADIUM	51/53(96)	7.9E+00 - 1.2E+02	5.7E+00 - 6.9E+01	U	2.4E+01	3.7E+01	5.5E+01	--	Y	2.4E+01
ZINC	53/53(100)	1.1E+01 - 2.4E+04	NA	U	2.2E+02	1.0E+02	2.3E+03	--	Y	2.2E+02
VOLATILE ORGANIC COMPOUNDS										
1,1,1-TRICHLOROETHANE	1/53(2)	2.1E-03	5.6E-03 - 6.6E-02	NP	2.1E-03	NA	1.2E+02	B,C	N	--
1,1-DICHLOROETHANE	1/53(2)	6.0E-03	5.6E-03 - 6.6E-02	NP	6.0E-03	NA	5.1E+01	B,C	N	--
2-BUTANONE	1/53(2)	5.9E-03	2.2E-02 - 2.6E-01	NP	5.9E-03	NA	7.3E+02	B,C	N	--
ACETONE	13/53(25)	4.7E-03 - 8.1E-01	2.2E-02 - 2.6E-01	NP	4.7E-03	NA	1.6E+02	C	N	--
ETHYLBENZENE	4/53(8)	1.1E-03 - 8.3E-01	5.6E-03 - 6.1E-02	NP	1.1E-03	NA	8.9E-01	C	N	--
METHYLENE CHLORIDE	9/53(17)	1.6E-03 - 3.9E-02	5.6E-03 - 6.6E-02	NP	1.6E-03	NA	9.1E-01	C	N	--
TOLUENE	13/53(25)	1.1E-03 - 7.7E-02	5.6E-03 - 6.6E-02	NP	1.1E-03	NA	5.2E+01	C	N	--
XYLENE, TOTAL	8/53(15)	3.4E-03 - 5.9E+00	5.6E-03 - 6.1E-02	NP	3.4E-03	NA	2.7E+01	C	N	--
SEMI-VOLATILE ORGANIC COMPOUNDS										
2-METHYLNAPHTHALENE	4/53(8)	1.7E-01 - 1.9E+00	3.7E-01 - 5.7E+00	NP	1.7E-01	NA	5.6E+00	C	N	--
ACENAPHTHENE	1/53(2)	1.4E-01	3.7E-01 - 5.7E+00	NP	1.4E-01	NA	3.7E+02	B,C	N	--
ACENAPHTHYLENE	1/53(2)	1.5E-01	3.7E-01 - 5.7E+00	NP	1.5E-01	NA	2.3E+02	B,C	N	--
ANTHRACENE	4/53(8)	3.4E-01 - 5.6E-01	3.7E-01 - 5.7E+00	NP	3.4E-01	NA	2.2E+03	C	N	--
BENZO(A)ANTHRACENE	13/53(25)	5.4E-02 - 2.1E+01	3.7E-01 - 5.4E-01	NP	5.4E-02	NA	6.2E-02	--	Y	5.4E-02
BENZO(A)PYRENE	13/53(25)	6.1E-02 - 2.2E+01	3.7E-01 - 5.4E-01	NP	2.1E-01	NA	6.2E-03	--	Y	2.1E-01
BENZO(B)FLUORANTHENE	14/53(26)	9.8E-02 - 3.3E+01	3.7E-01 - 4.6E-01	NP	9.8E-02	NA	6.2E-02	--	Y	9.8E-02
BENZO(GH)PERYLENE	9/53(17)	9.4E-02 - 1.3E+01	3.7E-01 - 5.4E-01	NP	9.4E-02	NA	2.3E+02	C	N	--
BENZO(K)FLUORANTHENE	10/53(19)	5.5E-02 - 1.1E+01	3.7E-01 - 5.4E-01	NP	5.5E-02	NA	6.2E-01	--	Y	5.5E-02
BIS(2-ETHYLHEXYL)PHTHALATE	9/53(17)	8.0E-02 - 1.6E-01	3.7E-01 - 5.7E+00	NP	8.0E-02	NA	3.5E+00	C	N	--
BUTYL BENZYL PHTHALATE	1/53(2)	8.9E-01	3.7E-01 - 5.7E+00	NP	8.9E-01	NA	1.2E+03	B,C	N	--
CARBAZOLE	3/53(6)	1.4E-01 - 2.2E-01	3.7E-01 - 5.7E+00	NP	1.4E-01	NA	2.4E+00	C	N	--
CHRYSENE	14/53(26)	7.2E-02 - 2.3E+01	3.7E-01 - 4.6E-01	NP	7.2E-02	NA	6.2E+00	--	Y	7.2E-02
DIBENZ(A,H)ANTHRACENE	3/53(6)	1.2E-01 - 7.2E-01	3.7E-01 - 5.7E+00	NP	1.2E-01	NA	6.2E-03	--	Y	1.2E-01
DIBENZOFURAN	4/53(8)	6.6E-02 - 5.3E-01	3.7E-01 - 5.7E+00	NP	6.6E-02	NA	2.9E+01	C	N	--

Table 6-9

Selection of Contaminants of Potential Concern, Total Soil ^a
Page 2 of 2

RI Report
TAMPEEL
Section 6
May 2005

Chemical	Frequency of Detection	Range of values, mg/kg		Statistical Distribution ^b	95% UCL mg/kg ^c	Background mg/kg ^d	Screening Criteria mg/kg ^e	Exclusion Rationale ^f	COPC? ^g	Representative Concentration mg/kg ^h
		Detected	Nondetected							
FLUORANTHENE	15/53(28)	8.7E-02 - 2.7E+01	3.7E-01 - 4.6E-01	NP	8.7E-02	NA	2.3E+02	C	N	--
FLUORENE	3/53(6)	6.2E-02 - 2.5E-01	3.7E-01 - 5.7E+00	NP	6.2E-02	NA	2.7E+02	C	N	--
INDENO(1,2,3-CD)PYRENE	10/53(19)	7.1E-02 - 1.3E+01	3.7E-01 - 5.4E-01	NP	7.1E-02	NA	6.2E-02	--	Y	7.1E-02
NAPHTHALENE	3/53(6)	1.4E-01 - 1.2E+00	3.7E-01 - 5.7E+00	NP	1.4E-01	NA	5.6E+00	C	N	--
PHENANTHRENE	14/53(26)	6.7E-02 - 8.2E+00	3.7E-01 - 4.6E-01	NP	6.7E-02	NA	2.3E+02	C	N	--
PYRENE	14/53(26)	7.0E-02 - 2.3E+01	3.7E-01 - 4.6E-01	NP	7.0E-02	NA	2.3E+02	C	N	--
PESTICIDES/PCBS										
4,4'-DDE	8/53(15)	5.8E-03 - 9.4E-02	3.7E-03 - 9.1E-02	NP	6.0E-03	NA	1.7E-01	C	N	--
4,4'-DDT	8/53(15)	5.2E-03 - 1.6E-01	3.7E-03 - 9.1E-02	NP	5.2E-03	NA	1.7E-01	C	N	--
AROCOR 1254	1/53(2)	5.5E-02	3.7E-02 - 5.0E-02	NP	5.5E-02	NA	2.2E-02	B	Y	5.5E-02
AROCOR 1260	1/53(2)	9.7E-02	3.7E-02 - 5.0E-02	NP	9.7E-02	NA	2.2E-02	B	Y	9.7E-02
BETA-BHC	2/53(4)	5.7E-03 - 5.6E-02	1.9E-03 - 4.7E-02	NP	5.7E-03	NA	3.2E-02	B	Y	5.7E-03
HERBICIDES										
No samples collected										
DIOXINS/FURANS										
1,2,3,4,6,7,8-HPCCD	2/4(50)	1.4E-06 - 3.1E-06	3.7E-07 - 5.5E-07	NA	NA	NA	NA	--	Y	3.1E-06
OCDD	4/4(100)	9.5E-06 - 4.2E-04	NA	NA	NA	NA	3.8E-04	--	Y	4.2E-04
TOTAL HPCDD	2/4(50)	2.8E-06 - 6.8E-06	7.1E-07 - 1.2E-06	NA	NA	NA	3.8E-05	C	N	--
TOTAL HXCDD	1/4(25)	1.9E-07	5.4E-07 - 7.2E-07	NA	NA	NA	3.8E-06	C	N	--
TOTAL PECDF	2/4(50)	3.7E-07 - 1.0E-06	6.2E-07 - 8.2E-07	NA	NA	NA	7.6E-07	--	Y	1.0E-06
TOTAL TCDF	2/4(50)	1.0E-06 - 1.7E-06	7.4E-07 - 8.8E-07	NA	NA	NA	3.8E-06	C	N	--

^a Total soil is defined as the interval greater than 0 feet below the ground surface. Soil samples were classified on the basis of the end depth of the sample.

^b Statistical Distribution: N = Normal distribution; L = Lognormal distribution; U = Undetermined distribution; NP = Nonparametric distribution for data sets with greater than 50% nondetects; NA = distribution not determined if sample size is less than 5.

^c 95% Upper Confidence Limit calculated for the indicated distribution. NA = sample size is less than 5 and distribution is not calculated.

^d Background concentrations for inorganic constituents are based on inorganic constituents detected in background soil samples defined in Section 4 (Table 4-1).

^e Toxicity/concentration screen based on USEPA Region 9 Preliminary Remediation Goals (PRGs) for residential soil, adjusted, if necessary, to reflect an incremental lifetime cancer risk of 1 E-7 and a hazard index of 0.1 (USEPA, 2002).

^f Rationale for exclusion of chemical as a contaminant of potential concern (COPC):

A = within background concentration.

B = detection frequency less than 5%.

C = maximum detection is less than screening criteria.

D = essential nutrient.

^g N = Chemical is not chosen as a COPC; Y = Chemical is chosen as COPC. Note: chemicals with only a less than 5% detection frequency (B) exclusion rationale were chosen as COPCs.

^h Concentration used in risk assessment equal to 95% UCL or maximum value, if maximum value is less than UCL or if no UCL is calculated.

ⁱ Screening criteria for lead based on the residential soil screening value of 400 mg/kg (USEPA, 1994a).

Table 6-10
TAMPEEL Soil Cancer Risk Estimates

Population/Pathway	Surface Soil	Total Soil
Adult Resident		
Ingestion	1.6×10^{-5} (1.5×10^{-6}) ^a	1.6×10^{-5} (1.5×10^{-6})
Volatile Inhalation	No COPCs ^b	No COPCs
Particulate Inhalation	1.2×10^{-7} (4.6×10^{-8})	1.1×10^{-7} (4.1×10^{-8})
Dermal	2.7×10^{-6} (8.7×10^{-7})	2.9×10^{-6} (9.5×10^{-7})
Total	1.9×10^{-5} (2.4×10^{-6})	1.9×10^{-5} (2.4×10^{-6})
Child Resident		
Ingestion	3.7×10^{-5} (3.1×10^{-6})	3.6×10^{-5} (3.0×10^{-6})
Volatile Inhalation	No COPCs	No COPCs
Particulate Inhalation	1.4×10^{-7} (4.8×10^{-8})	1.3×10^{-7} (4.3×10^{-8})
Dermal	3.6×10^{-6} (1.2×10^{-6})	4.0×10^{-6} (1.3×10^{-6})
Total	4.0×10^{-5} (4.3×10^{-6})	4.0×10^{-5} (4.4×10^{-6})
Trespasser		
Ingestion	2.6×10^{-7}	-- ^c
Volatile Inhalation	No COPCs	--
Particulate Inhalation	5.5×10^{-9}	--
Dermal	3.0×10^{-8}	--
Total	3.0×10^{-7}	--
TAMPEEL Caretaker		
Ingestion	1.2×10^{-5} (8.2×10^{-7})	--
Volatile Inhalation	No COPCs	--
Particulate Inhalation	1.2×10^{-7} (3.4×10^{-8})	--
Dermal	8.7×10^{-7} (2.1×10^{-7})	--
Total	1.3×10^{-5} (1.1×10^{-6})	--
TAMPEEL Student		
Ingestion	8.9×10^{-8}	--
Volatile Inhalation	No COPCs	--
Particulate Inhalation	9.3×10^{-10}	--
Dermal	4.4×10^{-8}	--
Total	1.3×10^{-7}	--
Construction Worker		
Ingestion	--	2.2×10^{-6} (5.5×10^{-7})
Volatile Inhalation	--	No COPCs
Particulate Inhalation	--	6.6×10^{-9} (3.3×10^{-9})
Dermal	--	1.1×10^{-7} (4.6×10^{-8})
Total	--	2.3×10^{-6} (6.0×10^{-7})
Industrial Worker		
Ingestion	5.8×10^{-6} (8.2×10^{-7})	--
Volatile Inhalation	No COPCs	--
Particulate Inhalation	1.2×10^{-7} (3.4×10^{-8})	--
Dermal	8.7×10^{-7} (2.1×10^{-7})	--
Total	6.8×10^{-6} (1.1×10^{-6})	--

^a Central Tendency values given in parentheses.

^b No volatile contaminants of potential concern (COPCs) for this pathway.

^c Pathway not calculated.

Table 6-11
TAMPEEL Soil Non-Cancer Hazard Estimates

Population/Pathway	Surface Soil	Total Soil
Adult Resident		
Ingestion	3.6×10^{-1}	3.4×10^{-1}
Volatile Inhalation	No COPCs ^a	No COPCs
Particulate Inhalation	5.2×10^{-3}	4.4×10^{-3}
Dermal	1.4×10^{-1}	1.2×10^{-1}
Total	5.1×10^{-1}	4.7×10^{-1}
Child Resident		
Ingestion	3.4×10^0 (8.5×10^{-1}) ^b	3.2×10^0 (7.9×10^{-1})
Volatile Inhalation	No COPCs	No COPCs
Particulate Inhalation	2.4×10^{-2} (2.4×10^{-2})	2.1×10^{-2} (2.1×10^{-2})
Dermal	7.6×10^{-1} (7.6×10^{-1})	6.8×10^{-1} (6.8×10^{-1})
Total	4.2×10^0 (1.6×10^0)	3.9×10^0 (1.5×10^0)
Trespasser		
Ingestion	2.4×10^{-2}	-- ^c
Volatile Inhalation	No COPCs	--
Particulate Inhalation	9.1×10^{-4}	--
Dermal	6.2×10^{-3}	--
Total	3.1×10^{-2}	--
TAMPEEL Caretaker		
Ingestion	2.6×10^{-1}	--
Volatile Inhalation	No COPCs	--
Particulate Inhalation	4.9×10^{-3}	--
Dermal	4.4×10^{-2}	--
Total	3.1×10^{-1}	--
TAMPEEL Student		
Ingestion	2.5×10^{-2}	--
Volatile Inhalation	No COPCs	--
Particulate Inhalation	4.7×10^{-4}	--
Dermal	2.8×10^{-2}	--
Total	5.3×10^{-2}	--
Construction Worker		
Ingestion	--	1.2×10^0
Volatile Inhalation	--	No COPCs
Particulate Inhalation	--	6.3×10^{-3}
Dermal	--	1.1×10^{-1}
Total	--	1.3×10^0
Industrial Worker		
Ingestion	1.3×10^{-1}	--
Volatile Inhalation	No COPCs	--
Particulate Inhalation	4.9×10^{-3}	--
Dermal	4.4×10^{-2}	--
Total	1.8×10^{-1}	--

^a No volatile contaminants of potential concern (COPCs) for this pathway.

^b Central Tendency values given in parentheses.

^c Pathway not calculated.

Table 6-12

Selection of Contaminants of Potential Concern, Surface Water From Aspen Creek^a

Chemical	Frequency of Detection	Range of values, mg/L		Statistical Distribution ^b	95% UCL mg/L ^c	Background mg/L ^d	Screening Criteria mg/L ^e	Exclusion Rationale ^f	COPC? ^g	Representative Concentration mg/L ^h
		Detected	Nondetected							
INORGANICS										
ALUMINUM	3/6(50)	2.8E-01 - 2.3E+00	2.0E-01 - 2.0E-01	L	1.2E+01	NA	3.6E+00	C	N	--
BARIUM	1/6(17)	3.7E-01	2.0E-01 - 2.0E-01	NP	3.7E-01	NA	2.6E-01	--	Y	3.7E-01
CALCIUM	6/6(100)	4.6E+01 - 9.6E+01	NA	L	8.4E+01	NA	NA	D	N	--
IRON	6/6(100)	4.7E-01 - 7.2E+01	NA	L	2.7E+03	NA	1.1E+00	--	Y	7.2E+01
LEAD	1/6(17)	1.5E-02	3.0E-03 - 3.0E-03	NP	1.5E-02	NA	NA	--	Y	1.5E-02
MAGNESIUM	6/6(100)	1.6E+01 - 2.8E+01	NA	N	2.6E+01	NA	NA	D	N	--
MANGANESE	6/6(100)	5.9E-01 - 1.0E+01	NA	U	1.0E+01	NA	8.8E-02	--	Y	1.0E+01
NICKEL	1/6(17)	8.5E-02	4.0E-02 - 4.0E-02	NP	8.5E-02	NA	7.3E-02	--	Y	8.5E-02
SODIUM	6/6(100)	8.0E+00 - 1.2E+01	NA	L	1.1E+01	NA	NA	D	N	--
ZINC	2/6(33)	1.1E-01 - 6.8E-01	5.0E-02 - 5.0E-02	NP	6.8E-01	NA	1.1E+00	C	N	--
VOLATILE ORGANIC COMPOUNDS										
CIS-1,2-DICHLOROETHENE	4/6(67)	1.3E-03 - 4.9E-03	5.0E-03 - 5.0E-03	L	4.2E-03	NA	6.1E-03	C	N	--
METHYLENE CHLORIDE	1/6(17)	1.0E-03	1.7E-03 - 5.0E-03	NP	1.0E-03	NA	4.3E-04	--	Y	1.0E-03
SEMI-VOLATILE ORGANIC COMPOUNDS										
No detected values										
PESTICIDES/PCBS										
No detected values										
HERBICIDES										
No samples collected										
DIOXINS/FURANS										
No samples collected										

^a Surface water represented by samples from Aspen Creek and TAMPEEL Springs.

^b Statistical Distribution: N = Normal distribution; L = Lognormal distribution; U = Undetermined distribution; NP = Nonparametric distribution for data sets with greater than 50% nondetects; NA = distribution not determined if sample size is less than 5.

^c 95% Upper Confidence Limit calculated for the indicated distribution. NA = sample size is less than 5 and distribution is not calculated.

^d No background samples were collected for surface water.

^e Toxicity/concentration screen based on USEPA Region 9 Preliminary Remediation Goals (PRGs) for residential tap water, adjusted, if necessary, to reflect an incremental lifetime cancer risk of 1 E-7 and a hazard index of 0.1 (USEPA, 2002).

^f Rationale for exclusion of chemical as a contaminant of potential concern (COPC):

A = within background concentration.

B = detection frequency less than 5%.

C = maximum detection is less than screening criteria.

D = essential nutrient.

^g N = Chemical is not chosen as a COPC; Y = Chemical is chosen as COPC. Note: chemicals with only a less than 5% detection frequency (B) exclusion rationale were chosen as COPCs.

^h Concentration used in risk assessment equals the maximum value.

Table 6-13

RI Report
TAMPEEL
Section 6
May 2005

Selection of Contaminants of Potential Concern, Surface Water from Beaver Pond ^a

Chemical	Frequency of Detection	Range of values, mg/L		Statistical Distribution ^b	95% UCL mg/L ^c	Background mg/L ^d	Screening Criteria mg/L ^e	Exclusion Rationale ^f	COPC? ^g	Representative Concentration mg/L ^h
		Detected	Nondetected							
INORGANICS										
ALUMINUM	3/5(60)	3.2E-01 - 1.7E+00	2.0E-01 - 2.0E-01	L	6.4E+01	NA	3.6E+00	C	N	--
CALCIUM	5/5(100)	3.6E+01 - 7.3E+01	NA	U	7.3E+01	NA	NA	D	N	--
IRON	5/5(100)	1.2E+00 - 5.1E+00	NA	L	7.3E+00	NA	1.1E+00	--	Y	5.1E+00
LEAD	1/5(20)	7.1E-03	3.0E-03 - 3.0E-03	NP	7.1E-03	NA	NA	--	Y	7.1E-03
MAGNESIUM	5/5(100)	8.3E+00 - 1.3E+01	NA	L	1.2E+01	NA	NA	D	N	--
MANGANESE	5/5(100)	5.2E-01 - 2.5E+00	NA	N	2.1E+00	NA	8.8E-02	--	Y	2.5E+00
POTASSIUM	4/5(80)	5.3E+00 - 6.0E+00	5.0E+00	N	6.4E+00	NA	NA	D	N	--
SODIUM	1/5(20)	5.7E+00	5.0E+00 - 5.0E+00	NP	5.7E+00	NA	NA	D	N	--
VOLATILE ORGANIC COMPOUNDS										
No detected values										
SEMI-VOLATILE ORGANIC COMPOUNDS										
No detected values										
PESTICIDES/PCBS										
No detected values										
HERBICIDES										
No samples collected										
DIOXINS/FURANS										
No samples collected										

^a Surface water represented by samples from Beaver Pond.

^b Statistical Distribution: N = Normal distribution; L = Lognormal distribution; U = Undetermined distribution; NP = Nonparametric distribution for data sets with greater than 50% nondetects; NA = distribution not determined if sample size is less than 5.

^c 95% Upper Confidence Limit calculated for the indicated distribution. NA = sample size is less than 5 and distribution is not calculated.

^d No background samples were collected for surface water.

^e Toxicity/concentration screen based on USEPA Region 9 Preliminary Remediation Goals (PRGs) for residential tap water, adjusted, if necessary, to reflect an incremental lifetime cancer risk of 1 E-7 and a hazard index of 0.1 (USEPA, 2002).

^f Rationale for exclusion of chemical as a contaminant of potential concern (COPC):

A = within background concentration.

B = detection frequency less than 5%.

C = maximum detection is less than screening criteria.

D = essential nutrient.

^g N = Chemical is not chosen as a COPC; Y = Chemical is chosen as COPC. Note: chemicals with only a less than 5% detection frequency (B) exclusion rationale were chosen as COPCs.

^h Concentration used in risk assessment equal to 95% UCL or maximum value, if maximum value is less than UCL or if no UCL is calculated.

Table 6-14

Selection of Contaminants of Potential Concern, Surface Water from the Study Pond ^a

Chemical	Frequency of Detection	Range of values, mg/L		Statistical Distribution ^b	95% UCL mg/L ^c	Background mg/L ^d	Screening Criteria mg/L ^e	Exclusion Rationale ^f	COPC? ^g	Representative Concentration mg/L ^h
		Detected	Nondetected							
INORGANICS										
CALCIUM	3/3(100)	2.0E+01 - 2.4E+01	NA	NA	NA	NA	NA	D	N	--
IRON	3/3(100)	1.6E-01 - 3.0E-01	NA	NA	NA	NA	1.1E+00	C	N	--
MAGNESIUM	3/3(100)	1.1E+01 - 1.3E+01	NA	NA	NA	NA	NA	D	N	--
MANGANESE	3/3(100)	9.7E-02 - 1.7E+00	NA	NA	NA	NA	8.8E-02	--	Y	1.7E+00
VOLATILE ORGANIC COMPOUNDS										
No detected values										
SEMI-VOLATILE ORGANIC COMPOUNDS										
No detected values										
PESTICIDES/PCBS										
No detected values										
HERBICIDES										
No samples collected										
DIOXINS/FURANS										
No samples collected										

^a Surface water represented by samples from the Study Pond.

^b Statistical Distribution: N = Normal distribution; L = Lognormal distribution; U = Undetermined distribution; NP = Nonparametric distribution for data sets with greater than 50% nondetects; NA = distribution not determined if sample size is less than 5.

^c 95% Upper Confidence Limit calculated for the indicated distribution. NA = sample size is less than 5 and distribution is not calculated.

^d No background samples were collected for surface water.

^e Toxicity/concentration screen based on USEPA Region 9 Preliminary Remediation Goals (PRGs) for residential tap water, adjusted, if necessary, to reflect an incremental lifetime cancer risk of 1 E-7 and a hazard index of 0.1 (USEPA, 2002).

^f Rationale for exclusion of chemical as a contaminant of potential concern (COPC):

A = within background concentration.

B = detection frequency less than 5%.

C = maximum detection is less than screening criteria.

D = essential nutrient.

^g N = Chemical is not chosen as a COPC; Y = Chemical is chosen as COPC. Note: chemicals with only a less than 5% detection frequency (B) exclusion rationale were chosen as COPCs.

^h Concentration used in risk assessment equals the maximum value.

Table 6-15

RI Report
TAMPEEL
Section 6
May 2005

Selection of Contaminants of Potential Concern, Sediment From Aspen Creek^a

Page 1 of 2

Chemical	Frequency of Detection	Range of values, mg/kg		Statistical Distribution ^b	95% UCL mg/kg ^c	Background mg/kg ^d	Screening Criteria mg/kg ^e	Exclusion Rationale ^f	COPC? ^g	Representative Concentration mg/kg ^h
		Detected	Nondetected							
INORGANICS										
ALUMINUM	6/6(100)	9.7E+03 - 1.5E+04	NA	N	1.4E+04	NA	7.6E+03	--	Y	1.4E+04
ARSENIC	6/6(100)	1.2E+01 - 3.4E+01	NA	L	2.7E+01	NA	3.9E-02	--	Y	2.7E+01
BARIUM	6/6(100)	7.4E+01 - 7.4E+02	NA	U	7.6E+02	NA	5.4E+02	--	Y	7.4E+02
CADMIUM	1/6(17)	2.8E+00	6.8E-01 - 1.3E+00	NP	2.8E+00	NA	3.7E+00	C	N	--
CALCIUM	6/6(100)	1.3E+03 - 1.1E+04	NA	L	2.6E+04	NA	NA	D	N	--
CHROMIUM	6/6(100)	1.7E+01 - 8.4E+01	NA	U	6.7E+01	NA	3.0E+00	--	Y	6.7E+01
COBALT	4/6(67)	8.7E+00 - 1.4E+01	1.3E+01 - 1.9E+01	L	1.3E+01	NA	9.0E+01	C	N	--
COPPER	6/6(100)	7.6E+00 - 2.2E+02	NA	L	5.0E+02	NA	3.1E+02	C	N	--
IRON	6/6(100)	2.4E+04 - 1.7E+05	NA	U	1.5E+05	NA	2.3E+03	--	Y	1.5E+05
LEAD	6/6(100)	1.6E+01 - 7.7E+01	NA	L	8.5E+01	NA	4.0E+01 ⁱ	--	Y	7.7E+01
MAGNESIUM	6/6(100)	2.3E+03 - 3.3E+03	NA	N	3.2E+03	NA	NA	D	N	--
MANGANESE	6/6(100)	4.8E+02 - 5.9E+03	NA	L	8.4E+03	NA	1.8E+02	--	Y	5.9E+03
NICKEL	6/6(100)	1.5E+01 - 2.8E+02	NA	U	4.7E+02	NA	1.6E+02	--	Y	2.8E+02
POTASSIUM	6/6(100)	1.0E+03 - 2.2E+03	NA	L	2.1E+03	NA	NA	D	N	--
VANADIUM	6/6(100)	2.4E+01 - 3.3E+01	NA	L	3.1E+01	NA	5.5E+01	C	N	--
ZINC	6/6(100)	6.4E+01 - 2.1E+03	NA	U	7.5E+03	NA	2.3E+03	C	N	--
VOLATILE ORGANIC COMPOUNDS										
1,1,2-TRICHLOROETHANE	1/6(17)	1.9E-02	6.8E-03 - 1.3E-02	NP	1.9E-02	NA	7.3E-02	C	N	--
2-BUTANONE	2/6(33)	2.0E-02 - 3.9E-02	2.7E-02 - 5.2E-02	NP	3.9E-02	NA	7.3E-02	C	N	--
ACETONE	4/6(67)	3.0E-02 - 1.2E-01	4.0E-02 - 5.2E-02	L	1.2E-01	NA	1.6E+02	C	N	--
CARBON DISULFIDE	2/6(33)	1.7E-03 - 2.5E-03	6.8E-03 - 1.9E-02	NP	2.5E-03	NA	3.6E+01	C	N	--
CIS-1,2-DICHLOROETHENE	2/6(33)	2.1E-03 - 2.7E-03	6.8E-03 - 1.3E-02	NP	2.7E-03	NA	4.3E+00	C	N	--
METHYLENE CHLORIDE	3/6(50)	3.3E-03 - 1.0E-02	1.0E-02 - 1.9E-02	L	1.1E-02	NA	9.1E-01	C	N	--
TOLUENE	1/6(17)	2.2E-03	6.8E-03 - 1.9E-02	NP	2.2E-03	NA	5.2E+01	C	N	--
SEMI-VOLATILE ORGANIC COMPOUNDS										
ANTHRACENE	2/6(33)	1.7E-01 - 8.3E-01	4.5E-01 - 1.2E+00	NP	8.3E-01	NA	2.2E+03	C	N	--
BENZO(A)ANTHRACENE	2/6(33)	2.5E-01 - 9.8E-01	4.5E-01 - 1.2E+00	NP	9.8E-01	NA	6.2E-02	--	Y	9.8E-01
BENZO(A)PYRENE	2/6(33)	1.6E-01 - 6.9E-01	4.5E-01 - 1.2E+00	NP	6.9E-01	NA	6.2E-03	--	Y	6.9E-01
BENZO(B)FLUORANTHENE	3/6(50)	5.6E-02 - 8.4E-01	4.5E-01 - 1.2E+00	L	2.2E+00	NA	6.2E-02	--	Y	8.4E-01
BIS(2-ETHYLHEXYL)PHTHALATE	1/6(17)	1.0E-01	4.5E-01 - 1.2E+00	NP	1.0E-01	NA	3.5E+00	C	N	--
CHRYSENE	2/6(33)	2.2E-01 - 8.3E-01	4.5E-01 - 1.2E+00	NP	8.3E-01	NA	6.2E+00	C	N	--
FLUORANTHENE	3/6(50)	6.7E-02 - 1.8E+00	4.5E-01 - 1.2E+00	L	5.2E+00	NA	2.3E+02	C	N	--
PHENANTHRENE	2/6(33)	4.5E-01 - 2.3E+00	4.5E-01 - 1.2E+00	NP	2.3E+00	NA	2.3E+02	C	N	--
PYRENE	3/6(50)	5.7E-02 - 1.5E+00	4.5E-01 - 1.2E+00	L	4.8E+00	NA	2.3E+02	C	N	--
PESTICIDES/PCBS										
4,4'-DDD	2/6(33)	2.7E-01 - 1.4E+00	4.5E-03 - 1.2E-02	NP	1.4E+00	NA	2.4E-01	--	Y	1.4E+00
4,4'-DDE	3/6(50)	5.6E-03 - 2.2E-01	5.1E-03 - 2.6E-01	L	3.6E+01	NA	1.7E-01	--	Y	2.2E-01
4,4'-DDT	2/6(33)	6.6E-03 - 9.0E-01	4.6E-03 - 2.6E-01	NP	9.0E-01	NA	1.7E-01	--	Y	9.0E-01

HERBICIDES

No samples collected

DIOXINS/FURANS

No samples collected

Table 6-15

Selection of Contaminants of Potential Concern, Sediment From Aspen Creek ^a
Page 2 of 2

Chemical	Frequency of Detection	Range of values, mg/kg		Statistical Distribution ^b	95% UCL mg/kg ^c	Background mg/kg ^d	Screening Criteria mg/kg ^e	Exclusion Rationale ^f	COPC? ^g	Representative Concentration mg/kg ^h
		Detected	Nondetected							
MISCELLANEOUS										
TOTAL ORGANIC CARBON	3/3(100)	1.5E+03 - 2.6E+04	NA	NA	NA	NA	NA	--	Y	2.6E+04

^a Sediments represents surficial samples from Aspen Creek and TAMPEEL Springs.

^b Statistical Distribution: N = Normal distribution; L = Lognormal distribution; U = Undetermined distribution; NP = Nonparametric distribution for data sets with greater than 50% nondetects; NA = distribution not determined if sample size is less than 5.

^c 95% Upper Confidence Limit calculated for the indicated distribution. NA = sample size is less than 5 and distribution is not calculated.

^d No background samples were collected for sediment.

^e Toxicity/concentration screen based on USEPA Region 9 Preliminary Remediation Goals (PRGs) for residential soil, adjusted, if necessary, to reflect an incremental lifetime cancer risk of 1 E-7 and a hazard index of 0.1 (USEPA, 2002).

^f Rationale for exclusion of chemical as a contaminant of potential concern (COPC):

A = within background concentration.

B = detection frequency less than 5%.

C = maximum detection is less than screening criteria.

D = essential nutrient.

^g N = Chemical is not chosen as a COPC; Y = Chemical is chosen as COPC. Note: chemicals with only a less than 5% detection frequency (B) exclusion rationale were chosen as COPCs.

^h Concentration used in risk assessment equal to 95% UCL or maximum value, if maximum value is less than UCL or if no UCL is calculated.

ⁱ Screening criteria for lead based on the residential soil screening value of 400 mg/kg (USEPA, 1994a).

Table 6-16

Selection of Contaminants of Potential Concern, Sediment from Beaver Pond ^a

Page 1 of 2

RI Report
TAMPEEL
Section 6
May 2005

Chemical	Frequency of Detection	Range of values, mg/kg		Statistical Distribution ^b	95% UCL mg/kg ^c	Background mg/kg ^d	Screening Criteria mg/kg ^e	Exclusion Rationale ^f	COPC? ^g	Representative Concentration mg/kg ^h
		Detected	Nondetected							
INORGANICS										
ALUMINUM	8/8(100)	3.8E+03 - 1.4E+04	NA	N	1.2E+04	NA	7.6E+03	--	Y	1.2E+04
ANTIMONY	2/8(25)	2.7E+00 - 4.7E+00	7.8E+00 - 1.5E+01	NP	4.7E+00	NA	3.1E+00	--	Y	4.7E+00
ARSENIC	8/8(100)	4.2E+00 - 6.7E+01	NA	L	7.1E+01	NA	3.9E-02	--	Y	6.7E+01
BARIUM	7/8(88)	2.9E+01 - 1.4E+02	2.8E+01	N	1.1E+02	NA	5.4E+02	C	N	--
BERYLLIUM	4/8(50)	3.7E-01 - 1.3E+00	6.5E-01 - 1.3E+00	L	1.0E+00	NA	1.5E+01	C	N	--
CADMIUM	3/8(38)	1.7E+00 - 3.7E+00	6.5E-01 - 1.3E+00	NP	3.7E+00	NA	3.7E+00	C	N	--
CALCIUM	7/8(88)	8.7E+02 - 3.1E+04	6.5E+02	L	6.7E+04	NA	NA	D	N	--
CHROMIUM	8/8(100)	7.0E+00 - 1.7E+01	NA	N	1.5E+01	NA	3.0E+00	--	Y	1.5E+01
COBALT	3/8(38)	3.7E+00 - 1.3E+01	6.5E+00 - 1.3E+01	NP	1.3E+01	NA	9.0E+01	C	N	--
COPPER	8/8(100)	8.4E+00 - 4.9E+01	NA	L	3.7E+01	NA	3.1E+02	C	N	--
CYANIDE, TOTAL	2/2(100)	4.9E+00 - 1.1E+01	NA	NA	NA	NA	1.2E+02	C	N	--
IRON	8/8(100)	7.4E+03 - 4.0E+04	NA	L	3.2E+04	NA	2.3E+03	--	Y	3.2E+04
LEAD	8/8(100)	7.7E+00 - 6.7E+01	NA	L	6.9E+01	NA	4.0E+01 ¹	--	Y	6.7E+01
MAGNESIUM	8/8(100)	6.3E+02 - 4.0E+03	NA	L	2.7E+03	NA	NA	D	N	--
MANGANESE	8/8(100)	6.8E+01 - 9.9E+02	NA	L	1.3E+03	NA	1.8E+02	--	Y	9.9E+02
MERCURY	2/8(25)	9.0E-02 - 1.7E-01	1.3E-01 - 2.6E-01	NP	1.7E-01	NA	2.3E+00	C	N	--
NICKEL	8/8(100)	9.1E+00 - 1.9E+01	NA	N	1.7E+01	NA	1.6E+02	C	N	--
POTASSIUM	5/8(63)	3.9E+02 - 1.2E+03	6.5E+02 - 1.3E+03	N	9.3E+02	NA	NA	D	N	--
SELENIUM	4/8(50)	1.2E+00 - 3.7E+00	7.0E-01 - 1.3E+00	L	3.5E+00	NA	3.9E+01	C	N	--
SODIUM	2/8(25)	3.9E+01 - 7.3E+01	6.5E+02 - 1.3E+03	NP	7.3E+01	NA	NA	D	N	--
VANADIUM	8/8(100)	7.3E+00 - 2.4E+01	NA	N	2.0E+01	NA	5.5E+01	C	N	--
ZINC	8/8(100)	3.4E+01 - 1.3E+03	NA	L	3.1E+03	NA	2.3E+03	C	N	--
VOLATILE ORGANIC COMPOUNDS										
ACETONE	4/8(50)	1.7E-02 - 6.9E+01	1.8E-02 - 4.8E-02	U	7.6E+04	NA	1.6E+02	C	N	--
SEMI-VOLATILE ORGANIC COMPOUNDS										
2-METHYLNAPHTHALENE	1/8(13)	4.2E-01	4.3E-01 - 8.5E-01	NP	4.2E-01	NA	5.6E+00	C	N	--
BENZO(A)ANTHRACENE	1/8(13)	2.2E-01	4.3E-01 - 8.5E-01	NP	2.2E-01	NA	6.2E-02	--	Y	2.2E-01
BENZO(A)PYRENE	1/8(13)	5.8E-01	4.3E-01 - 8.5E-01	NP	5.8E-01	NA	6.2E-03	--	Y	5.8E-01
BENZO(B)FLUORANTHENE	1/8(13)	1.1E+00	4.3E-01 - 8.5E-01	NP	1.1E+00	NA	6.2E-02	--	Y	1.1E+00
BENZO(GH)PERYLENE	1/8(13)	3.2E-01	4.3E-01 - 8.5E-01	NP	3.2E-01	NA	2.3E+02	C	N	--
CHRYSENE	1/8(13)	3.7E-01	4.3E-01 - 8.5E-01	NP	3.7E-01	NA	6.2E+00	C	N	--
DIBENZOFURAN	1/8(13)	1.4E-01	4.3E-01 - 8.5E-01	NP	1.4E-01	NA	2.9E+01	C	N	--
DIETHYL PHTHALATE	1/8(13)	1.4E-01	4.3E-01 - 8.5E-01	NP	1.4E-01	NA	4.9E+03	C	N	--
DI-N-BUTYL PHTHALATE	2/8(25)	8.9E-02 - 4.4E-01	4.3E-01 - 8.5E-01	NP	4.4E-01	NA	6.1E+02	C	N	--
FLUORANTHENE	2/8(25)	5.6E-01 - 1.3E+00	4.3E-01 - 8.5E-01	NP	1.3E+00	NA	2.3E+02	C	N	--
INDENO(1,2,3-CD)PYRENE	1/8(13)	3.1E-01	4.3E-01 - 8.5E-01	NP	3.1E-01	NA	6.2E-02	--	Y	3.1E-01
NAPHTHALENE	1/8(13)	3.1E-01	4.3E-01 - 8.5E-01	NP	3.1E-01	NA	5.6E+00	C	N	--
PHENANTHRENE	2/8(25)	5.1E-01 - 9.3E-01	4.3E-01 - 8.5E-01	NP	9.3E-01	NA	2.3E+02	C	N	--
PYRENE	2/8(25)	5.2E-01 - 9.0E-01	4.3E-01 - 8.5E-01	NP	9.0E-01	NA	2.3E+02	C	N	--

Table 6-16

RI Report
TAMPEEL
Section 6
May 2005

Selection of Contaminants of Potential Concern, Sediment from Beaver Pond ^a
Page 2 of 2

Chemical	Frequency of Detection	Range of values, mg/kg		Statistical Distribution ^b	95% UCL mg/kg ^c	Background mg/kg ^d	Screening Criteria mg/kg ^e	Exclusion Rationale ^f	COPC? ^g	Representative Concentration mg/kg ^h
		Detected	Nondetected							
PESTICIDES/PCBS										
4,4'-DDD	2/8(25)	9.1E-02 - 1.0E-01	4.3E-03 - 8.5E-03	NP	1.0E-01	NA	2.4E-01	C	N	--
4,4'-DDE	2/8(25)	1.6E-01 - 2.0E-01	4.3E-03 - 8.5E-03	NP	2.0E-01	NA	1.7E-01	--	Y	2.0E-01
4,4'-DDT	2/8(25)	1.7E-01 - 4.4E-01	4.3E-03 - 8.5E-03	NP	4.4E-01	NA	1.7E-01	--	Y	4.4E-01
HERBICIDES										
No samples collected										
DIOXINS/FURANS										
No samples collected										
MISCELLANEOUS										
TOTAL ORGANIC CARBON	4/4(100)	1.4E+03 - 3.5E+04	NA	NA	NA	NA	NA	--	Y	3.5E+04

^a Sediments represents surficial samples from Beaver Pond and Beaver Creek.

^b Statistical Distribution: N = Normal distribution; L = Lognormal distribution; U = Undetermined distribution; NP = Nonparametric distribution for data sets with greater than 50% nondetects; NA = distribution not determined if sample size is less than 5.

^c 95% Upper Confidence Limit calculated for the indicated distribution. NA = sample size is less than 5 and distribution is not calculated.

^d No background samples were collected for sediment.

^e Toxicity/concentration screen based on USEPA Region 9 Preliminary Remediation Goals (PRGs) for residential soil, adjusted, if necessary, to reflect an incremental lifetime cancer risk of 1 E-7 and a hazard index of 0.1 (USEPA, 2002).

^f Rationale for exclusion of chemical as a contaminant of potential concern (COPC):

A = within background concentration.

B = detection frequency less than 5%.

C = maximum detection is less than screening criteria.

D = essential nutrient.

^g N = Chemical is not chosen as a COPC; Y = Chemical is chosen as COPC. Note: chemicals with only a less than 5% detection frequency (B) exclusion rationale were chosen as COPCs.

^h Concentration used in risk assessment equal to 95% UCL or maximum value, if maximum value is less than UCL or if no UCL is calculated.

ⁱ Screening criteria for lead based on the residential soil screening value of 400 mg/kg (USEPA, 1994a).

Table 6-17

Selection of Contaminants of Potential Concern, Sediment from the Study Pond ^a

Chemical	Frequency of Detection	Range of values, mg/kg		Statistical Distribution ^b	95% UCL mg/kg ^c	Background mg/kg ^d	Screening Criteria mg/kg ^e	Exclusion Rationale ^f	COPC? ^g	Representative Concentration mg/kg ^h
		Detected	Nondetected							
INORGANICS										
ALUMINUM	3/3(100)	4.0E+03 - 2.3E+04	NA	NA	NA	NA	7.6E+03	--	Y	2.3E+04
ARSENIC	3/3(100)	5.9E+00 - 1.8E+01	NA	NA	NA	NA	3.9E-02	--	Y	1.8E+01
BARIUM	2/3(67)	1.2E+02 - 1.3E+02	2.8E+01	NA	NA	NA	5.4E+02	C	N	--
BERYLLIUM	1/3(33)	6.4E-01	6.9E-01 - 1.7E+00	NA	NA	NA	1.5E+01	C	N	--
CALCIUM	3/3(100)	3.5E+03 - 6.4E+03	NA	NA	NA	NA	NA	D	N	--
CHROMIUM	3/3(100)	7.0E+00 - 3.1E+01	NA	NA	NA	NA	3.0E+00	--	Y	3.1E+01
COBALT	1/3(33)	1.2E+01	6.9E+00 - 1.7E+01	NA	NA	NA	9.0E+01	C	N	--
COPPER	3/3(100)	1.2E+01 - 2.9E+01	NA	NA	NA	NA	3.1E+02	C	N	--
IRON	3/3(100)	1.3E+04 - 4.1E+04	NA	NA	NA	NA	2.3E+03	--	Y	4.1E+04
LEAD	3/3(100)	8.9E+00 - 2.9E+01	NA	NA	NA	NA	4.0E+01 ⁱ	C	N	--
MAGNESIUM	3/3(100)	1.9E+03 - 5.5E+03	NA	NA	NA	NA	NA	D	N	--
MANGANESE	3/3(100)	3.2E+02 - 1.2E+03	NA	NA	NA	NA	1.8E+02	--	Y	1.2E+03
NICKEL	3/3(100)	1.0E+01 - 3.5E+01	NA	NA	NA	NA	1.6E+02	C	N	--
POTASSIUM	2/3(67)	2.5E+03 - 3.1E+03	6.9E+02	NA	NA	NA	NA	D	N	--
SELENIUM	2/3(67)	1.3E+00 - 2.8E+00	6.9E-01	NA	NA	NA	3.9E+01	C	N	--
VANADIUM	3/3(100)	7.1E+00 - 4.2E+01	NA	NA	NA	NA	5.5E+01	C	N	--
ZINC	3/3(100)	4.3E+01 - 1.3E+02	NA	NA	NA	NA	2.3E+03	C	N	--
VOLATILE ORGANIC COMPOUNDS										
ACETONE	1/3(33)	1.0E-01	2.8E-02 - 6.9E-02	NA	NA	NA	1.6E+02	C	N	--
SEMI-VOLATILE ORGANIC COMPOUNDS										
FLUORANTHENE	1/3(33)	4.8E-01	1.1E+00 - 1.1E+00	NA	NA	NA	2.3E+02	C	N	--
PYRENE	1/3(33)	4.5E-01	1.1E+00 - 1.1E+00	NA	NA	NA	2.3E+02	C	N	--
PESTICIDES/PCBS										
No detected values										
HERBICIDES										
No samples collected										
DIOXINS/FURANS										
No samples collected										

Table 6-17

Selection of Contaminants of Potential Concern, Sediment from the Study Pond ^a

^a Sediments represents surficial samples from the Study pond.

^b Statistical Distribution: N = Normal distribution; L = Lognormal distribution; U = Undetermined distribution; NP = Nonparametric distribution for data sets with greater than 50% nondetects;
NA = distribution not determined if sample size is less than 5.

^c 95% Upper Confidence Limit calculated for the indicated distribution. NA = sample size is less than 5 and distribution is not calculated.

^d No background samples were collected for sediment.

^e Toxicity/concentration screen based on USEPA Region 9 Preliminary Remediation Goals (PRGs) for residential soil, adjusted, if necessary, to reflect an incremental lifetime cancer risk of 1 E-7 and a hazard index of 0.1 (USEPA, 2002).

^f Rationale for exclusion of chemical as a contaminant of potential concern (COPC):

A = within background concentration.

B = detection frequency less than 5%.

C = maximum detection is less than screening criteria.

D = essential nutrient.

^g N = Chemical is not chosen as a COPC; Y = Chemical is chosen as COPC. Note: chemicals with only a less than 5% detection frequency (B) exclusion rational were chosen as COPCs.

^h Concentration used in risk assessment equal to 95% UCL or maximum value, if maximum value is less than UCL or if no UCL is calculated.

ⁱ Screening criteria for lead based on the residential soil screening value of 400 mg/kg (USEPA, 1994a).

Table 6-18
Surface Water Cancer Risk Estimates

Population/Pathway	Creek Surface Water	Beaver Pond Surface Water	Study Pond Surface Water
<i>Adult Resident</i>			
Ingestion	2.5×10^{-10}	NTV ^b	NTV
Dermal	1.2×10^{-10}	NTV	NTV
Total	3.6×10^{-10}	NTV	NTV
<i>Child Resident</i>			
Ingestion	1.1×10^{-10}	NTV	NTV
Dermal	1.9×10^{-11}	NTV	NTV
Total	1.3×10^{-10}	NTV	NTV
<i>Trespasser</i>			
Ingestion	5.8×10^{-11}	NTV	NTV
Dermal	1.5×10^{-11}	NTV	NTV
Total	7.3×10^{-11}	NTV	NTV
<i>TAMPEEL Caretaker</i>			
Ingestion	1.9×10^{-10}	NTV	NTV
Dermal	6.8×10^{-11}	NTV	NTV
Total	2.6×10^{-10}	NTV	NTV
<i>TAMPEEL Student</i>			
Ingestion	1.0×10^{-11}	NTV	NTV
Dermal	2.5×10^{-12}	NTV	NTV
Total	1.2×10^{-11}	NTV	NTV
<i>Construction Worker</i>			
Ingestion	7.5×10^{-12}	NTV	NTV
Dermal	2.9×10^{-12}	NTV	NTV
Total	1.0×10^{-11}	NTV	NTV
<i>Industrial Worker</i>			
Ingestion	-- ^b	--	--
Dermal	--	--	--
Total	--	--	--

^a NTV – No toxicity values available for COPCs in this pathway.

^b Pathway not calculated.

Table 6-19
Surface Water Non-Cancer Hazard Estimates

Population/Pathway	Creek Surface Water	Beaver Pond Surface Water	Study Pond Surface Water
Adult Resident			
Ingestion	5.1×10^{-2}	9.2×10^{-3}	5.4×10^{-3}
Dermal	3.1×10^{-2}	7.4×10^{-3}	5.0×10^{-3}
Total	8.2×10^{-2}	1.7×10^{-2}	1.0×10^{-2}
Child Resident			
Ingestion	1.2×10^{-1}	2.1×10^{-2}	1.2×10^{-2}
Dermal	2.5×10^{-2}	6.0×10^{-3}	4.0×10^{-3}
Total	1.4×10^{-1}	2.7×10^{-2}	1.6×10^{-2}
Trespasser			
Ingestion	6.0×10^{-2}	1.1×10^{-2}	6.4×10^{-3}
Dermal	2.4×10^{-2}	5.7×10^{-3}	3.8×10^{-3}
Total	8.4×10^{-2}	1.7×10^{-2}	1.0×10^{-2}
TAMPEEL Caretaker			
Ingestion	4.7×10^{-2}	8.5×10^{-3}	5.0×10^{-3}
Dermal	2.7×10^{-2}	6.3×10^{-3}	4.3×10^{-3}
Total	7.4×10^{-2}	1.5×10^{-2}	9.3×10^{-3}
TAMPEEL Student			
Ingestion	3.1×10^{-2}	5.6×10^{-3}	3.3×10^{-3}
Dermal	1.2×10^{-2}	2.9×10^{-3}	2.0×10^{-3}
Total	4.3×10^{-2}	8.6×10^{-3}	5.3×10^{-3}
Construction Worker			
Ingestion	4.7×10^{-2}	8.5×10^{-3}	3.0×10^{-2}
Dermal	2.9×10^{-2}	6.8×10^{-3}	2.7×10^{-2}
Total	7.5×10^{-2}	1.5×10^{-2}	5.7×10^{-2}
Industrial Worker			
Ingestion	-- ^a	--	--
Dermal	--	--	--
Total	--	--	--

^a Pathway not calculated.

Table 6-20
Sediment Cancer Risk Estimates

Population/Pathway	Creek Sediment	Beaver Pond Sediment	Study Pond Sediment
Adult Resident			
Ingestion	2.5×10^{-6} (4.7×10^{-6}) ^a	5.6×10^{-6} (1.0×10^{-7})	1.4×10^{-6} (2.6×10^{-8})
Dermal	2.4×10^{-7} (8.9×10^{-8})	4.1×10^{-7} (1.5×10^{-7})	8.7×10^{-8} (3.3×10^{-8})
Total	2.7×10^{-6} (1.4×10^{-7})	6.0×10^{-6} (2.6×10^{-7})	1.5×10^{-6} (5.9×10^{-8})
Child Resident			
Ingestion	2.8×10^{-6} (4.7×10^{-8})	6.3×10^{-6} (1.1×10^{-7})	1.6×10^{-6} (2.7×10^{-8})
Dermal	1.9×10^{-7} (6.4×10^{-8})	3.4×10^{-7} (1.1×10^{-7})	7.1×10^{-8} (2.4×10^{-8})
Total	3.0×10^{-6} (1.1×10^{-7})	6.7×10^{-6} (2.2×10^{-7})	1.7×10^{-6} (5.0×10^{-8})
Trespasser			
Ingestion	3.7×10^{-7}	8.2×10^{-7}	2.1×10^{-7}
Dermal	2.2×10^{-8}	3.8×10^{-8}	7.9×10^{-9}
Total	3.9×10^{-7}	8.6×10^{-7}	2.2×10^{-7}
TAMPEEL Caretaker			
Ingestion	2.4×10^{-6} (3.4×10^{-8})	5.3×10^{-6} (7.5×10^{-8})	1.4×10^{-6} (1.9×10^{-8})
Dermal	1.0×10^{-7} (2.8×10^{-8})	1.7×10^{-7} (4.9×10^{-8})	3.7×10^{-8} (1.0×10^{-8})
Total	2.5×10^{-6} (6.1×10^{-8})	5.5×10^{-6} (1.2×10^{-7})	1.4×10^{-6} (2.9×10^{-8})
TAMPEEL Student			
Ingestion	1.3×10^{-7}	2.8×10^{-7}	7.2×10^{-8}
Dermal	3.2×10^{-8}	5.5×10^{-8}	1.2×10^{-8}
Total	1.6×10^{-7}	3.4×10^{-7}	8.3×10^{-8}
Construction Worker			
Ingestion	9.6×10^{-8}	2.1×10^{-7}	5.4×10^{-8}
Dermal	1.1×10^{-8}	2.0×10^{-8}	4.2×10^{-9}
Total	1.1×10^{-7}	2.3×10^{-7}	5.9×10^{-8}
Industrial Worker			
Ingestion	-- ^b	--	--
Dermal	--	--	--
Total	--	--	--

^a Central Tendency values are given in parentheses.

^b Pathway not calculated.

Table 6-21
Sediment Non-Cancer Hazard Estimates

Population/Pathway	Creek Sediment	Beaver Pond Sediment	Study Pond Sediment
<i>Adult Resident</i>			
Ingestion	1.4×10^{-1}	6.1×10^{-2}	4.3×10^{-2}
Dermal	2.0×10^{-2}	5.7×10^{-3}	5.3×10^{-3}
Total	1.6×10^{-1}	6.7×10^{-2}	4.8×10^{-2}
<i>Child Resident</i>			
Ingestion	6.2×10^{-1}	2.8×10^{-1}	1.9×10^{-1}
Dermal	6.6×10^{-2}	1.8×10^{-2}	1.7×10^{-2}
Total	6.9×10^{-1}	3.0×10^{-1}	2.1×10^{-1}
<i>Trespasser</i>			
Ingestion	8.1×10^{-2}	3.6×10^{-2}	2.5×10^{-2}
Dermal	7.4×10^{-3}	2.1×10^{-3}	1.9×10^{-3}
Total	8.9×10^{-2}	3.8×10^{-2}	2.7×10^{-2}
<i>TAMPEEL Caretaker</i>			
Ingestion	1.3×10^{-1}	5.6×10^{-2}	3.9×10^{-2}
Dermal	8.2×10^{-3}	2.3×10^{-3}	2.1×10^{-3}
Total	1.3×10^{-1}	5.9×10^{-2}	4.2×10^{-2}
<i>TAMPEEL Student</i>			
Ingestion	8.3×10^{-2}	3.7×10^{-2}	2.6×10^{-2}
Dermal	3.3×10^{-2}	9.1×10^{-3}	8.5×10^{-3}
Total	1.2×10^{-1}	4.6×10^{-2}	3.4×10^{-2}
<i>Construction Worker</i>			
Ingestion	1.3×10^{-1}	5.6×10^{-2}	3.9×10^{-2}
Dermal	2.4×10^{-2}	6.6×10^{-3}	6.1×10^{-3}
Total	1.5×10^{-1}	6.3×10^{-2}	4.6×10^{-2}
<i>Industrial Worker</i>			
Ingestion	-- ^a	--	--
Dermal	--	--	--
Total	--	--	--

^a Pathway not calculated.

Table 6-22

Selection of Contaminants of Potential Concern, Groundwater ^a

Chemical	Frequency of Detection	Range of values, mg/L		Statistical Distribution ^b	95% UCL mg/L ^c	Background mg/L ^d	Screening Criteria mg/L ^e	Exclusion Rationale ^f	COPC? ^g	Representative Concentration mg/L ^h
		Detected	Nondetected							
INORGANICS										
ALUMINUM	7/9(78)	3.4E-01 - 2.2E+01	2.2E-01 - 3.3E-01	L	7.9E+01	3.5E+00	3.6E+00	--	Y	2.2E+01
CALCIUM	9/9(100)	1.4E+01 - 2.0E+02	NA	L	1.5E+02	9.1E+01	NA	D	N	--
CHROMIUM	1/9(11)	3.1E-02	1.0E-02 - 1.0E-02	NP	3.1E-02	ND	1.1E-02	--	Y	3.1E-02
IRON	9/9(100)	2.9E+00 - 2.2E+01	NA	L	1.3E+01	3.2E+00	1.1E+00	--	Y	2.2E+01
LEAD	2/9(22)	3.0E-03 - 9.7E-03	3.0E-03 - 3.0E-03	NP	9.7E-03	ND	NA	--	Y	9.7E-03
MAGNESIUM	9/9(100)	7.2E+00 - 8.1E+01	NA	L	5.4E+01	3.0E+01	NA	D	N	--
MANGANESE	9/9(100)	1.0E-01 - 9.5E-01	NA	N	7.1E-01	2.4E+00	8.8E-02	A	N	--
POTASSIUM	2/9(22)	6.5E+00 - 1.1E+01	5.0E+00 - 5.0E+00	NP	1.1E+01	ND	NA	D	N	--
SODIUM	9/9(100)	5.8E+00 - 1.1E+02	NA	L	2.1E+02	1.4E+01	NA	D	N	--
THALLIUM	1/9(11)	1.0E-02	1.0E-02 - 1.0E-02	NP	1.0E-02	ND	2.4E-04	--	Y	1.0E-02
VANADIUM	1/9(11)	5.7E-02	5.0E-02 - 5.0E-02	NP	5.7E-02	ND	2.6E-02	--	Y	5.7E-02
ZINC	1/9(11)	5.9E-02	5.0E-02 - 5.0E-02	NP	5.9E-02	4.7E-01	1.1E+00	A,C	N	--
VOLATILE ORGANIC COMPOUNDS										
METHYLENE CHLORIDE	1/6(17)	1.7E-03	5.0E-03 - 5.0E-03	NP	1.7E-03	NA	4.3E-04	--	Y	1.7E-03
SEMI-VOLATILE ORGANIC COMPOUNDS										
No detected values										
PESTICIDES/PCBS										
No detected values										
HERBICIDES										
No samples collected										
DIOXINS/FURANS										
No samples collected										

^a Groundwater is defined the upper water bearing zone.

^b Statistical Distribution: N = Normal distribution; L = Lognormal distribution; U = Undetermined distribution; NP = Nonparametric distribution for data sets with greater than 50% nondetects; NA = distribution not determined if sample size is less than 5.

^c 95% Upper Confidence Limit calculated for the indicated distribution. NA = sample size is less than 5 and distribution is not calculated.

^d Background concentrations for inorganic constituents are based on inorganic constituents detected in background wells defined in Section 4 (Table 4-1). ND = not detected.

^e Toxicity/concentration screen based on USEPA Region 9 Preliminary Remediation Goals (PRGs) for residential tap water, adjusted, if necessary, to reflect an incremental lifetime cancer risk of 1 E-7 and a hazard index of 0.1 (USEPA, 2002).

^f Rationale for exclusion of chemical as a contaminant of potential concern (COPC):

A = within background concentration.

B = detection frequency less than 5%.

C = maximum detection is less than screening criteria.

D = essential nutrient.

^g N = Chemical is not chosen as a COPC; Y = Chemical is chosen as COPC. Note: chemicals with only a less than 5% detection frequency (B) exclusion rational were chosen as COPCs.

^h Concentration used in risk assessment equals the maximum value.

Table 6-23
Groundwater Cancer Risk Estimates

Population/Pathway	Groundwater
<i>Adult Resident</i>	
Ingestion	1.2×10^{-7}
Volatile Inhalation	9.6×10^{-8}
Dermal	5.7×10^{-9}
Fruits & Vegetables	No COPCs ^a
Total	2.2×10^{-7}
<i>Child Resident</i>	
Ingestion	9.1×10^{-8}
Volatile Inhalation	8.2×10^{-8}
Dermal	2.4×10^{-9}
Fruits & Vegetables	No COPCs
Total	1.8×10^{-7}
<i>Trespasser</i>	
Ingestion	-- ^b
Volatile Inhalation	--
Dermal	--
Total	--
<i>TAMPEEL Caretaker</i>	
Ingestion	--
Volatile Inhalation	--
Dermal	--
Total	--
<i>TAMPEEL Student</i>	
Ingestion	--
Volatile Inhalation	--
Dermal	--
Total	--
<i>Construction Worker</i>	
Ingestion	1.4×10^{-10}
Volatile Inhalation	2.3×10^{-10}
Dermal	5.4×10^{-12}
Total	3.8×10^{-10}
<i>Industrial Worker</i>	
Ingestion	--
Volatile Inhalation	--
Dermal	--
Total	--

^a No COPCs – No noncarcinogenic contaminants of potential concern for this pathway.

^b Pathway not calculated.

Table 6-24
Groundwater Non-Cancer Hazard Estimates

Population/Pathway	Groundwater
<i>Adult Resident</i>	
Ingestion	5.8×10^0 (5.1×10^0) ^a
Volatile Inhalation	1.6×10^{-4} (2.0×10^{-4})
Dermal	1.2×10^{-1} (1.3×10^{-1})
Fruits & Vegetables	No COPCs ^b
Total	5.9×10^0 (5.2×10^0)
<i>Child Resident</i>	
Ingestion	2.2×10^1 (1.2×10^1)
Volatile Inhalation	7.0×10^{-4} (3.2×10^{-4})
Dermal	2.6×10^{-1} (2.3×10^{-1})
Fruits & Vegetables	No COPCs
Total	2.2×10^1 (1.2×10^1)
<i>Trespasser</i>	
Ingestion	-- ^c
Volatile Inhalation	--
Dermal	--
Fruits & Vegetables	--
Total	--
<i>TAMPEEL Caretaker</i>	
Ingestion	--
Volatile Inhalation	--
Dermal	--
Total	--
<i>TAMPEEL Student</i>	
Ingestion	--
Volatile Inhalation	--
Dermal	--
Total	--
<i>Construction Worker</i>	
Ingestion	6.9×10^{-3}
Volatile Inhalation	3.9×10^{-7}
Dermal	2.2×10^{-4}
Total	7.1×10^{-3}
<i>Industrial Worker</i>	
Ingestion	--
Volatile Inhalation	--
Dermal	--
Total	--

^a Central Tendency values given in parentheses.

^b No COPCs – No noncarcinogenic contaminants of potential concern for this pathway.

^c Pathway not calculated.

Table 6-25
Cumulative Cancer Risk and Non-Cancer Hazard Estimates
Chemicals of Concern (Risk Drivers)
Page 1 of 2

Population/Media	RME Cancer Risk	RME Non-Cancer Hazard
Adult Resident		
Total Surface Soil	1.9×10^{-5} =>As-89%	5.1×10^{-1}
Total Soil ^a	1.9×10^{-5} =>As-84%; B(a)P-6%	4.7×10^{-1}
Total Surface Water ^b	3.6×10^{-10}	1.1×10^{-1}
Total Sediment ^c	1.0×10^{-5} =>As-91%	2.7×10^{-1}
Total Groundwater	2.2×10^{-7}	5.9×10^0 =>Fe-27%; TI-58%
Total Media Risk and Hazard	2.9×10^{-5} =>As-91%	6.8×10^0 =>Fe-24%; TI-50%
Child Resident		
Total Surface Soil	4.0×10^{-5} =>As-93%; Dibenz(a,h)anthracene-3%	4.2×10^0 =>Fe-33%; Mn-24%;
Total Soil ^a	4.0×10^{-5} =>As-90%; B(a)P-6%; Dibenz(a,h)anthracene-3%	3.9×10^0 =>Fe-36%
Total Surface Water ^b	1.3×10^{-10}	1.8×10^{-1}
Total Sediment ^c	1.1×10^{-5} =>As-94%	1.2×10^0
Total Groundwater	1.8×10^{-7}	2.2×10^1 =>TI-59%; Fe-27%; Al-8%
Total Media Risk and Hazard	5.1×10^{-5} =>As-92%	2.8×10^1 =>TI-47%; Fe-27%; Al-7%; Mn-4%
Trespasser		
Total Surface Soil	3.0×10^{-7}	3.1×10^{-2}
Total Surface Water ^b	7.3×10^{-11}	1.1×10^{-1}
Total Sediment ^c	1.5×10^{-6}	1.4×10^{-1}
Total Groundwater	-- ^d	--
Total Media Risk and Hazard	1.8×10^{-6}	2.9×10^{-1}
TAMPEEL Caretaker		
Total Surface Soil	1.3×10^{-5} =>As-92%	3.1×10^{-1}
Total Surface Water ^b	2.6×10^{-10}	9.8×10^{-2}
Total Sediment ^c	9.4×10^{-6} =>As-93%	2.3×10^{-1}
Total Groundwater	--	--
Total Media Risk and Hazard	2.2×10^{-5} =>As-94%	6.4×10^{-1}
TAMPEEL Student		
Total Surface Soil	1.3×10^{-7}	5.3×10^{-2}
Total Surface Water ^b	1.2×10^{-11}	5.7×10^{-2}
Total Sediment ^c	5.8×10^{-7}	2.0×10^{-1}
Total Groundwater	--	--
Total Media Risk and Hazard	7.1×10^{-7}	3.1×10^{-1}
Construction Worker		
Total Soil (Total)	2.3×10^{-6} =>As-91%	1.3×10^0
Total Surface Water ^b	1.0×10^{-11}	1.5×10^{-1}
Total Sediment ^c	4.0×10^{-7}	2.6×10^{-1}
Total Groundwater	3.8×10^{-10}	7.1×10^{-3}
Total Media Risk and Hazard	2.7×10^{-6} =>As-91%	1.7×10^0
Industrial Worker		
Total Surface Soil (Total Soil)	6.8×10^{-6} =>As-91%	1.8×10^{-1}
Total Surface Water	--	--
Total Sediment	--	--
Total Groundwater	--	--
Total Media Risk and Hazard	6.8×10^{-6} =>As-91%	1.8×10^{-1}

Table 6-25
Cumulative Cancer Risk and Non-Cancer Hazard Estimates
Chemicals of Concern (Risk Drivers)
Page 2 of 2

^a Although the values for Total Soil are presented in the table for the residents, only the values for Surface Soil (which were the higher of the two) were included in the Total Media Risk and Hazard value.

^b Total surface water values represent the sum of estimated values for the three surface water bodies (i.e., Aspen Creek, Beaver Pond, Study Pond).

^c Total sediment values represent the sum of estimated values for the three surface water bodies (i.e., Aspen Creek, Beaver Pond, Study Pond) where sediment was collected.

^d Pathway not calculated.

Note: For risk exceeding 1×10^{-6} , the percentage of risk due to the risk driver(s) is indicated: As = arsenic, Fe = iron, Tl = thallium, Mn = manganese, Al = aluminum, B(a)P = benzo(a)pyrene.

Table 6-26

Chemicals Evaluated as Beneficial Nutrients

Chemical	Conc in Soil (a) (mg/kg)	Daily Intake from Soil (b)	Conc. In Water (c)	Daily Intake from Water (d)	Total DI (mg/day)	RDA (e) mg/day	Ratio (DI/RDA)	Chemical of Concern
Iron	32000	3.20	22	44	47.20	10	5	Yes (f)
Manganese	1300	0.13	NA (g)	NA	0.13	5	0.0	No

(a) Exposure point concentration in surface soil.

(b) Assumed ingestion of 100 mg (1E-04 kg) soil/day.

(c) Exposure point concentration in groundwater.

(d) Assumed ingestion of 2 L/day.

(e) Recommended Dietary Allowance. National Academy of Science; 10th ed., 1989.

(f) Ratio of Daily Intake from soil (0.32) is below the level of one. Exceedence of the ratio of above 1 is due to iron concentrations in water.

(g) Ratio of manganese from water was not calculated because manganese was not identified as a risk driver in groundwater.

Table 6-27

Selection of Contaminants of Potential Ecological Concern, Surface Water from the Study Pond ^a

Table 1. Summary of Chemical Ecological Concentrations, Surface Water from the Study Pond												
Chemical	Frequency of Detection	Range of values, mg/L		Statistical Distribution ^b	95% UCL-N ^c	95% UCL-L ^d	80% of	Background mg/L ^e	Screening Criteria mg/L ^f	Exclusion Rationale ^g	COPEC? ^h	Representative Concentration mg/L ⁱ
		Detected	Nondetected		mg/L	mg/L	maximum					
INORGANICS												
CALCIUM	3/3(100)	2.0E+01 - 2.4E+01	NA	NA	2.5E+01	2.5E+01	1.9E+01	N/A	NA	D	N	--
IRON	3/3(100)	1.6E-01 - 3.0E-01	NA	NA	3.5E-01	6.0E-01	2.4E-01	N/A	1.0E+00	C	N	--
MAGNESIUM	3/3(100)	1.1E+01 - 1.3E+01	NA	NA	1.4E+01	1.4E+01	1.1E+01	N/A	NA	D	N	--
MANGANESE	3/3(100)	9.7E-02 - 1.7E+00	NA	NA	2.2E+00	5.3E+09	1.4E+00	N/A	8.0E-02	--	Y	1.7E+00
VOLATILE ORGANIC COMPOUNDS												
No detected values												
SEMI-VOLATILE ORGANIC COMPOUNDS												
No detected values												
PESTICIDES/PCBS												
No detected values												
HERBICIDES												
No samples collected												
DIOXIN												
No samples collected												

^a Surface water represented by samples from the Study Pond.

^b Statistical Distribution: N = Normal distribution; L = Lognormal distribution; U = Undetermined distribution; NP = Nonparametric distribution for data sets with greater than 50% nondetects; NA = distribution not determined if sample size is less than 5.

^c 95% Upper Confidence Limit calculated based on a normal distribution.

^d 95% Upper Confidence Limit calculated based on a lognormal distribution.

^e Background concentrations for inorganic constituents are provided in Table 4-1.

^f Screening criteria are based on Ohio EPA Water Quality Criteria (OEPA, 1997) and Ecotox Threshold Concentrations (USEPA, 1996d) for fresh water, unless noted.

^g Rationale for exclusion of chemical as a contaminant of potential ecological concern (COPEC):

A = within background concentration.

B = detection frequency less than 5%.

C = maximum detection is less than screening criteria.

D = essential nutrient.

^h N = Chemical is not chosen as a COPEC; Y = Chemical is chosen as COPEC.

ⁱ The representative concentration selection based on Ecological criteria which includes the following:

- 1) If one of the two calculated UCL's exceed the maximum concentration in the potential COPEC data set, then the other UCL will be used, unless it is less than 80% of the maximum concentration, in which case the maximum concentration will be used as the UCL value.
- 2) If both calculated UCL's are below the maximum concentration in the potential COPEC data set, then the greater UCL will be used if greater than 80% of the maximum concentration, otherwise, 80% of the maximum detected concentration will be used.
- 3) If both calculated UCL's exceed the maximum concentration in the potential COPEC data set, then both UCLs will be eliminated and the maximum concentration will be used as the UCL value.

Table 6-28

Selection of Contaminants of Potential Ecological Concern, Surface Water from Beaver Pond ^a

Chemical	Frequency of Detection	Range of values, mg/L		Statistical Distribution ^b	95% UCL-N ^c mg/L	95% UCL-L ^d mg/L	80% of maximum	Background mg/L ^e	Screening Criteria mg/L ^f	Exclusion Rationale ^g	COPEC? ^h	Representative Concentration mg/L ⁱ
		Detected	Nondetected									
INORGANICS												
ALUMINUM	3/5(60)	3.2E-01 - 1.7E+00	2.0E-01 - 2.0E-01	L	1.4E+00	6.4E+01	1.4E+00	N/A	4.6E-01 ^j	--	Y	1.4E+00
CALCIUM	5/5(100)	3.6E+01 - 7.3E+01	NA	U	6.0E+01	8.5E+01	5.8E+01	N/A	NA	D	N	--
IRON	5/5(100)	1.2E+00 - 5.1E+00	NA	L	4.2E+00	7.3E+00	4.1E+00	N/A	1.0E+00	--	Y	4.2E+00
LEAD	1/5(20)	7.1E-03	3.0E-03 - 3.0E-03	NP	5.0E-03	9.3E-03	5.7E-03	N/A	2.5E-03	--	Y	7.1E-03
MAGNESIUM	5/5(100)	8.3E+00 - 1.3E+01	NA	L	1.2E+01	1.2E+01	1.0E+01	N/A	NA	D	N	--
MANGANESE	5/5(100)	5.2E-01 - 2.5E+00	NA	N	2.1E+00	3.8E+00	2.0E+00	N/A	8.0E-02	--	Y	2.1E+00
POTASSIUM	4/5(80)	5.3E+00 - 6.0E+00	5.0E+00	N	6.4E+00	9.3E+00	4.8E+00	N/A	NA	D	N	--
SODIUM	1/5(20)	5.7E+00	5.0E+00 - 5.0E+00	NP	4.5E+00	5.7E+00	4.6E+00	N/A	NA	D	N	--
VOLATILE ORGANIC COMPOUNDS												
No detected values												
SEMI-VOLATILE ORGANIC COMPOUNDS												
No detected values												
PESTICIDES/PCBS												
No detected values												
HERBICIDES												
No samples collected												
DIOXIN												
No samples collected												

^a Surface water represented by samples from Beaver Pond.

^b Statistical Distribution: N = Normal distribution; L = Lognormal distribution; U = Undetermined distribution; NP = Nonparametric distribution for data sets with greater than 50% nondetects; NA = distribution not determined if sample size is less than 5.

^c 95% Upper Confidence Limit calculated based on a normal distribution.

^d 95% Upper Confidence Limit calculated based on a lognormal distribution.

^e Background concentrations for inorganic constituents are provided in Table 4-1.

^f Screening criteria are based on Ohio EPA Water Quality Criteria (OEPA, 1997) and Ecotox Threshold Concentrations (USEPA, 1996d) for fresh water, unless noted.

^g Rationale for exclusion of chemical as a contaminant of potential ecological concern (COPEC):

A = within background concentration.

B = detection frequency less than 5%.

C = maximum detection is less than screening criteria.

D = essential nutrient.

^h N = Chemical is not chosen as a COPEC; Y = Chemical is chosen as COPEC.

ⁱ The representative concentration selection based on Ecological criteria which includes the following:

1) If one of the two calculated UCL's exceed the maximum concentration in the potential COPEC data set, then the other UCL will be used, unless it is less than 80% of the maximum concentration, in which case the maximum concentration will be used as the UCL value.

2) If both calculated UCL's are below the maximum concentration in the potential COPEC data set, then the greater UCL will be used if greater than 80% of the maximum concentration, otherwise, 80% of the maximum detected concentration will be used.

3) If both calculated UCL's exceed the maximum concentration in the potential COPEC data set, then both UCLs will be eliminated and the maximum concentration will be used as the UCL value.

^j USEPA Region 3 BTAG Screening Level (1995d).

Table 6-29

Selection of Contaminants of Potential Ecological Concern, Aspen Creek Surface Water ^a

Chemical	Frequency of Detection	Range of values, mg/L		Statistical Distribution ^b	95% UCL-N ^c mg/L	95% UCL-L ^d mg/L	80% of maximum	Background mg/L ^e	Screening Criteria mg/L ^f	Exclusion Rationale ^g	COPEC? ^h	Representative Concentration mg/L ⁱ
		Detected	Nondetected									
INORGANICS												
ALUMINUM	3/6(50)	2.8E-01 - 2.3E+00	2.0E-01 - 2.0E-01	L	1.3E+00	1.2E+01	1.8E+00	N/A	4.6E-01	--	Y	2.3E+00
BARIUM	1/6(17)	3.7E-01	2.0E-01 - 2.0E-01	NP	2.4E-01	2.7E-01	3.0E-01	N/A	2.6E-01	--	Y	3.0E-01
CALCIUM	6/6(100)	4.6E+01 - 9.6E+01	NA	L	8.0E+01	8.4E+01	7.7E+01	N/A	NA	D	N	--
IRON	6/6(100)	4.7E-01 - 7.2E+01	NA	L	3.7E+01	2.7E+03	5.7E+01	N/A	1.0E+00	--	Y	7.2E+01
LEAD	1/6(17)	1.5E-02	3.0E-03 - 3.0E-03	NP	8.3E-03	1.8E-02	1.2E-02	N/A	4.0E-04	--	Y	1.5E-02
MAGNESIUM	6/6(100)	1.6E+01 - 2.8E+01	NA	N	2.6E+01	2.7E+01	2.2E+01	N/A	NA	D	N	--
MANGANESE	6/6(100)	5.9E-01 - 1.0E+01	NA	U	5.5E+00	1.5E+01	8.0E+00	N/A	8.0E-02	--	Y	1.0E+01
NICKEL	1/6(17)	8.5E-02	4.0E-02 - 4.0E-02	NP	5.3E-02	6.5E-02	6.8E-02	N/A	7.3E-02	--	Y	6.8E-02
SODIUM	6/6(100)	8.0E+00 - 1.2E+01	NA	L	1.1E+01	1.1E+01	9.6E+00	N/A	NA	D	N	--
ZINC	2/6(33)	1.1E-01 - 6.8E-01	5.0E-02 - 5.0E-02	NP	3.6E-01	3.2E+00	5.4E-01	N/A	1.2E-01	--	Y	6.8E-01
VOLATILE ORGANIC COMPOUNDS												
CIS-1,2-DICHLOROETHENE	4/6(67)	1.3E-03 - 4.9E-03	5.0E-03 - 5.0E-03	L	3.6E-03	4.2E-03	3.9E-03	NA	3.1E-01	C	N	--
METHYLENE CHLORIDE	1/6(17)	1.0E-03	1.7E-03 - 5.0E-03	NP	2.6E-03	3.8E-03	8.0E-04	NA	4.3E-01	C	N	--
SEMI-VOLATILE ORGANIC COMPOUNDS												
No detected values												
PESTICIDES/PCBS												
No detected values												
HERBICIDES												
No samples collected												
DIOXIN												
No samples collected												

^a Surface water represented by samples from Aspen Creek and TAMPEEL Springs.

^b Statistical Distribution: N = Normal distribution; L = Lognormal distribution; U = Undetermined distribution; NP = Nonparametric distribution for data sets with greater than 50% nondetects; NA = distribution not determined if sample size is less than 5.

^c 95% Upper Confidence Limit calculated based on a normal distribution.

^d 95% Upper Confidence Limit calculated based on a lognormal distribution.

^e Background concentrations for inorganic constituents are provided in Table 4-1.

^f Screening criteria are based on Ohio EPA Water Quality Criteria (OEPA, 1997) and Ecotox Threshold Concentrations (USEPA, 1996d) for fresh water, unless noted.

^g Rationale for exclusion of chemical as a contaminant of potential ecological concern (COPEC):

A = within background concentration.

B = detection frequency less than 5%.

C = maximum detection is less than screening criteria.

D = essential nutrient.

^h N = Chemical is not chosen as a COPEC; Y = Chemical is chosen as COPEC.

ⁱ The representative concentration selection based on Ecological criteria which includes the following:

- 1) If one of the two calculated UCL's exceed the maximum concentration in the potential COPEC data set, then the other UCL will be used, unless it is less than 80% of the maximum concentration, in which case the maximum concentration will be used as the UCL value.
- 2) If both calculated UCL's are below the maximum concentration in the potential COPEC data set, then the greater UCL will be used if greater than 80% of the maximum concentration, otherwise, 80% of the maximum detected concentration will be used.
- 3) If both calculated UCL's exceed the maximum concentration in the potential COPEC data set, then both UCLs will be eliminated and the maximum concentration will be used as the UCL value.

^j USEPA Region 3 BTAG Screening Level (1995d).

Table 6-30

Selection of Contaminants of Potential Ecological Concern, Sediment from Study Pond ^a

Chemical	Frequency of Detection	Range of values, mg/kg		Statistical Distribution ^b	95% UCL-N ^c (mg/kg)	95% UCL-L ^d (mg/kg)	80% of maximum	Background mg/kg ^e	Screening Criteria mg/kg ^f	Exclusion Rationale ^g	COPEC? ^h	Representative Concentration mg/kg ⁱ
		Detected	Nondetected									
INORGANICS												
ALUMINUM	3/3(100)	4.0E+03 - 2.3E+04	NA	NA	3.0E+04	3.4E+07	1.8E+04	NA	NA	--	Y	2.3E+04
ARSENIC	3/3(100)	5.9E+00 - 1.8E+01	NA	NA	2.5E+01	5.9E+02	1.5E+01	NA	6.0E+00	--	Y	1.8E+01
BARIUM	2/3(67)	1.2E+02 - 1.3E+02	2.8E+01	NA	2.0E+02	5.3E+08	1.1E+02	NA	NA	--	Y	1.3E+02
BERYLLIUM	1/3(33)	6.4E-01	6.9E-01 - 1.7E+00	NA	1.0E+00	4.5E+00	5.1E-01	NA	1.5E+01	C	N	--
CALCIUM	3/3(100)	3.5E+03 - 6.4E+03	NA	NA	7.3E+03	1.3E+04	5.1E+03	NA	NA	D	N	--
CHROMIUM	3/3(100)	7.0E+00 - 3.1E+01	NA	NA	4.1E+01	7.3E+03	2.5E+01	NA	2.6E+01	--	Y	3.1E+01
COBALT	1/3(33)	1.2E+01	6.9E+00 - 1.7E+01	NA	1.5E+01	3.6E+02	9.5E+00	NA	5.0E+01	C	N	--
COPPER	3/3(100)	1.2E+01 - 2.9E+01	NA	NA	3.8E+01	1.7E+02	2.4E+01	NA	1.6E+01	--	Y	2.9E+01
IRON	3/3(100)	1.3E+04 - 4.1E+04	NA	NA	5.4E+04	1.3E+06	3.3E+04	NA	2.0E+04	--	Y	4.1E+04
LEAD	3/3(100)	8.9E+00 - 2.9E+01	NA	NA	3.8E+01	9.3E+02	2.3E+01	NA	3.1E+01	C	Y*	2.9E+01
MAGNESIUM	3/3(100)	1.9E+03 - 5.5E+03	NA	NA	7.1E+03	7.1E+04	4.4E+03	NA	NA	D	N	--
MANGANESE	3/3(100)	3.2E+02 - 1.2E+03	NA	NA	1.5E+03	5.7E+04	9.5E+02	NA	4.6E+02	--	Y	1.2E+03
NICKEL	3/3(100)	1.0E+01 - 3.5E+01	NA	NA	4.7E+01	1.7E+03	2.8E+01	NA	1.6E+01	--	Y	3.5E+01
POTASSIUM	2/3(67)	2.5E+03 - 3.1E+03	6.9E+02	NA	4.4E+03	2.3E+09	2.5E+03	NA	NA	D	N	--
SELENIUM	2/3(67)	1.3E+00 - 2.8E+00	6.9E-01	NA	3.6E+00	6.0E+04	2.2E+00	NA	NA	--	Y	2.8E+00
VANADIUM	3/3(100)	7.1E+00 - 4.2E+01	NA	NA	5.5E+01	9.0E+04	3.3E+01	NA	NA	--	Y	4.2E+01
ZINC	3/3(100)	4.3E+01 - 1.3E+02	NA	NA	1.7E+02	2.2E+03	1.0E+02	NA	1.2E+02	--	Y	1.3E+02
VOLATILE ORGANIC COMPOUNDS												
ACETONE	1/3(33)	1.0E-01	2.8E-02 - 6.9E-02	NA	1.3E-01	4.5E+02	8.0E-02	NA	NA	--	Y	1.0E-01
SEMI-VOLATILE ORGANIC COMPOUNDS												
FLUORANTHENE	1/3(33)	4.8E-01	1.1E+00 - 1.1E+00	NA	5.9E-01	6.1E-01	3.8E-01	NA	2.9E+00	C	Y*	4.8E-01
PYRENE	1/3(33)	4.5E-01	1.1E+00 - 1.1E+00	NA	6.1E-01	6.5E-01	3.6E-01	NA	6.7E-01	C	Y*	4.5E-01
PESTICIDES/PCBS												
No detected values												
HERBICIDES												
No samples collected												
DIOXIN												
No samples collected												

^a Sediments represents surficial samples from fresh water areas.

^b Statistical Distribution: N = Normal distribution; L = Lognormal distribution; U = Undetermined distribution; NP = Nonparametric distribution for data sets with greater than 50% nondetects; NA = distribution not determined if sample size is less than 5.

^c 95% Upper Confidence Limit calculated based on a normal distribution.

^d 95% Upper Confidence Limit calculated based on a lognormal distribution.

^e Background concentrations for inorganic constituents are provided in Table 4-1.

^f Screening criteria are based on Ontario Ministry of the Environment Persaud et al., 1992) and Ecotox Threshold Concentrations (USEPA, 1996d) for fresh water sediment, unless noted.

^g Rationale for exclusion of chemical as a contaminant of potential ecological concern (COPEC):

- A = within background concentration.
- B = detection frequency less than 5%.
- C = maximum detection is less than screening criteria.
- D = essential nutrient.

^h N = Chemical is not chosen as a COPEC; Y = Chemical is chosen as COPEC.

ⁱ The representative concentration selection based on Ecological criteria which includes the following:

- 1) If one of the two calculated UCL's exceed the maximum concentration in the potential COPEC data set, then the other UCL will be used, unless it is less than 80% of the maximum concentration, in which case the maximum concentration will be used as the UCL value.
- 2) If both calculated UCL's are below the maximum concentration in the potential COPEC data set, then the greater UCL will be used if greater than 80% of the maximum concentration, otherwise, 80% of the maximum detected concentration will be used.
- 3) If both calculated UCL's exceed the maximum concentration in the potential COPEC data set, then both UCL's will be eliminated and the maximum concentration will be used as the UCL value.

^j USEPA Region III BTAG Screening Level (1995).

^k Chemical retained as COPEC due to high bioaccumulation potential (EPA, 2000b).

Table 6-31

Selection of Contaminants of Potential Ecological Concern, Sediment from Beaver Pond ^a

(1 of 2)

Chemical	Frequency of Detection	Range of values, mg/kg		Statistical Distribution ^b	95% UCL-N ^c mg/kg	95% UCL-L ^d mg/kg	80% of maximum	Background mg/kg ^e	Screening Criteria mg/kg ^f	Exclusion Rationale ^g	COPEC? ^h	Representative Concentration mg/kg ⁱ
		Detected	Nondetected									
INORGANICS												
ALUMINUM	8/8(100)	3.8E+03 - 1.4E+04	NA	N	1.2E+04	1.5E+04	1.1E+04	NA	NA	--	Y	1.2E+04
ANTIMONY	2/8(25)	2.7E+00 - 4.7E+00	7.8E+00 - 1.5E+01	NP	6.3E+00	6.9E+00	3.8E+00	NA	3.0E+00	--	Y	4.7E+00
ARSENIC	8/8(100)	4.2E+00 - 6.7E+01	NA	L	3.4E+01	7.1E+01	5.4E+01	NA	6.0E+00	--	Y ⁱ	6.7E+01
BARIUM	7/8(88)	2.9E+01 - 1.4E+02	2.8E+01	N	1.1E+02	2.2E+02	1.1E+02	NA	NA	--	Y	1.1E+02
BERYLLIUM	4/8(50)	3.7E-01 - 1.3E+00	6.5E-01 - 1.3E+00	L	8.9E-01	1.0E+00	1.0E+00	NA	1.5E+01	C	N	--
CADMIUM	3/8(38)	1.7E+00 - 3.7E+00	6.5E-01 - 1.3E+00	NP	2.0E+00	3.8E+00	3.0E+00	NA	3.7E+00	C	Y ⁱ	3.7E+00
CALCIUM	7/8(88)	8.7E+02 - 3.1E+04	6.5E+02	L	1.3E+04	6.7E+04	2.5E+04	NA	NA	D	N	--
CHROMIUM	8/8(100)	7.0E+00 - 1.7E+01	NA	N	1.5E+01	1.7E+01	1.3E+01	NA	2.6E+01	C	Y ⁱ	1.7E+01
COBALT	3/8(38)	3.7E+00 - 1.3E+01	6.5E+00 - 1.3E+01	NP	8.0E+00	8.9E+00	1.0E+01	NA	5.0E+01	C	N	--
COPPER	8/8(100)	8.4E+00 - 4.9E+01	NA	L	3.0E+01	3.7E+01	3.9E+01	NA	1.6E+01	--	Y	3.9E+01
CYANIDE, TOTAL	2/2(100)	4.9E+00 - 1.1E+01	NA	NA	2.6E+01	N/A	8.6E+00	NA	1.1E+02	C	N	--
IRON	8/8(100)	7.4E+03 - 4.0E+04	NA	L	2.6E+04	3.2E+04	3.2E+04	NA	2.0E+04	--	Y	3.2E+04
LEAD	8/8(100)	7.7E+00 - 6.7E+01	NA	L	4.1E+01	6.9E+01	5.3E+01	NA	3.1E+01	--	Y	6.7E+01
MAGNESIUM	8/8(100)	6.3E+02 - 4.0E+03	NA	L	2.3E+03	2.7E+03	3.2E+03	NA	NA	D	N	--
MANGANESE	8/8(100)	6.8E+01 - 9.9E+02	NA	L	6.3E+02	1.3E+03	7.9E+02	NA	4.6E+02	--	Y	9.9E+02
MERCURY	2/8(25)	9.0E-02 - 1.7E-01	1.3E-01 - 2.6E-01	NP	1.3E-01	1.4E-01	1.4E-01	NA	2.2E+00	C	Y ⁱ	1.4E-01
NICKEL	8/8(100)	9.1E+00 - 1.9E+01	NA	N	1.7E+01	1.8E+01	1.5E+01	NA	1.6E+01	--	Y	1.8E+01
POTASSIUM	5/8(63)	3.9E+02 - 1.2E+03	6.5E+02 - 1.3E+03	N	9.3E+02	1.1E+03	9.5E+02	NA	NA	D	N	--
SELENIUM	4/8(50)	1.2E+00 - 3.7E+00	7.0E-01 - 1.3E+00	L	2.0E+00	3.5E+00	3.0E+00	NA	NA	--	Y	3.5E+00
SODIUM	2/8(25)	3.9E+01 - 7.3E+01	6.5E+02 - 1.3E+03	NP	5.2E+02	1.8E+03	5.8E+01	NA	NA	D	N	--
VANADIUM	8/8(100)	7.3E+00 - 2.4E+01	NA	N	2.0E+01	2.2E+01	1.9E+01	NA	NA	--	Y	2.2E+01
ZINC	8/8(100)	3.4E+01 - 1.3E+03	NA	L	6.8E+02	3.1E+03	1.0E+03	NA	1.2E+02	--	Y	1.3E+03
VOLATILE ORGANIC COMPOUNDS												
ACETONE	4/8(50)	1.7E-02 - 6.9E+01	1.8E-02 - 4.8E-02	U	2.5E+01	7.6E+04	5.5E+01	NA	NA	--	Y	6.9E+01
SEMI-VOLATILE ORGANIC COMPOUNDS												
2-METHYLNAPHTHALENE	1/8(13)	4.2E-01	4.3E-01 - 8.5E-01	NP	3.8E-01	4.0E-01	3.4E-01	NA	NA	--	Y	4.0E-01
BENZO(A)ANTHRACENE	1/8(13)	2.2E-01	4.3E-01 - 8.5E-01	NP	3.5E-01	3.7E-01	1.8E-01	NA	5.6E-02	--	Y	2.2E-01
BENZO(A)PYRENE	1/8(13)	5.8E-01	4.3E-01 - 8.5E-01	NP	4.3E-01	4.6E-01	4.6E-01	NA	5.6E-03	--	Y	4.6E-01
BENZO(B)FLUORANTHENE	1/8(13)	1.1E+00	4.3E-01 - 8.5E-01	NP	6.0E-01	6.5E-01	8.8E-01	NA	5.6E-02	--	Y	8.8E-01
BENZO(GH)PERYLENE	1/8(13)	3.2E-01	4.3E-01 - 8.5E-01	NP	3.6E-01	3.8E-01	2.6E-01	NA	NA	--	Y	3.2E-01
CHRYSENE	1/8(13)	3.7E-01	4.3E-01 - 8.5E-01	NP	3.7E-01	3.9E-01	3.0E-01	NA	5.6E+00	C	Y ⁱ	3.7E-01
DIBENZOFURAN	1/8(13)	1.4E-01	4.3E-01 - 8.5E-01	NP	3.5E-01	3.9E-01	1.1E-01	NA	2.1E+01	C	N	--
DIETHYL PHTHALATE	1/8(13)	1.4E-01	4.3E-01 - 8.5E-01	NP	3.5E-01	3.9E-01	1.1E-01	NA	4.4E+03	C	N	--
DI-N-BUTYL PHTHALATE	2/8(25)	8.9E-02 - 4.4E-01	4.3E-01 - 8.5E-01	NP	3.8E-01	5.1E-01	3.5E-01	NA	5.5E+02	C	N	--
FLUORANTHENE	2/8(25)	5.6E-01 - 1.3E+00	4.3E-01 - 8.5E-01	NP	7.0E-01	8.0E-01	1.0E+00	NA	2.0E+02	C	Y ⁱ	1.0E+00
INDENO(1,2,3-CD)PYRENE	1/8(13)	3.1E-01	4.3E-01 - 8.5E-01	NP	3.6E-01	3.8E-01	2.5E-01	NA	5.6E-02	--	Y	3.1E-01
NAPHTHALENE	1/8(13)	3.1E-01	4.3E-01 - 8.5E-01	NP	3.6E-01	3.8E-01	2.5E-01	NA	5.5E+00	C	N	--
PHENANTHRENE	2/8(25)	5.1E-01 - 9.3E-01	4.3E-01 - 8.5E-01	NP	5.6E-01	6.2E-01	7.4E-01	NA	NA	--	Y	7.4E-01
PYRENE	2/8(25)	5.2E-01 - 9.0E-01	4.3E-01 - 8.5E-01	NP	5.5E-01	6.2E-01	7.2E-01	NA	1.5E+02	C	Y ⁱ	7.2E-01
PESTICIDES/PCBS												
4,4'-DDD	2/8(25)	9.1E-02 - 1.0E-01	4.3E-03 - 8.5E-03	NP	5.5E-02	6.4E-01	8.0E-02	NA	2.4E-01	C	Y ⁱ	1.0E-01
4,4'-DDE	2/8(25)	1.6E-01 - 2.0E-01	4.3E-03 - 8.5E-03	NP	1.0E-01	4.0E+00	1.6E-01	NA	1.7E-01	--	Y	2.0E-01
4,4'-DDT	2/8(25)	1.7E-01 - 4.4E-01	4.3E-03 - 8.5E-03	NP	1.8E-01	1.7E+01	3.5E-01	NA	1.7E-01	--	Y	4.4E-01
HERBICIDES												
No samples collected												
DIOXIN												
No samples collected												

Table 6-31

Selection of Contaminants of Potential Ecological Concern, Sediment from Beaver Pond ^a

(2 of 2)

Chemical	Frequency of Detection	Range of values, mg/kg		Statistical Distribution ^b	95% UCL-N ^c	95% UCL-L ^d	80% of maximum	Background mg/kg ^e	Screening Criteria mg/kg ^f	Exclusion Rationale ^g	COPEC? ^h	Representative Concentration mg/kg ⁱ
		Detected	Nondetected		mg/kg	mg/kg						

^a Sediments represents surficial samples from the Beaver Pond and Beaver Creek.

^b Statistical Distribution: N = Normal distribution; L = Lognormal distribution; U = Undetermined distribution; NP = Nonparametric distribution for data sets with greater than 50% nondetects; NA = distribution not determined if sample size is less than 5.

^c 95% Upper Confidence Limit calculated based on a normal distribution.

^d 95% Upper Confidence Limit calculated based on a lognormal distribution.

^e Background concentrations for inorganic constituents are provided in Table 4-1.

^f Screening criteria are based on Ontario Ministry of the Environment Persaud et al., 1992) and Ecotox Threshold Concentrations (USEPA, 1996d) for fresh water sediment, unless noted.

^g Rationale for exclusion of chemical as a contaminant of potential ecological concern (COPEC):

A = within background concentration.

B = detection frequency less than 5%.

C = maximum detection is less than screening criteria.

D = essential nutrient.

^h N = Chemical is not chosen as a COPEC; Y = Chemical is chosen as COPEC.

ⁱ The representative concentration selection based on Ecological criteria which includes the following:

1) If one of the two calculated UCL's exceed the maximum concentration in the potential COPEC data set, then the other UCL will be used, unless it is less than 80% of the maximum concentration, in which case the maximum concentration will be used as the UCL value.

2) If both calculated UCL's are below the maximum concentration in the potential COPEC data set, then the greater UCL will be used if greater than 80% of the maximum concentration, otherwise, 80% of the maximum detected concentration will be used.

3) If both calculated UCL's exceed the maximum concentration in the potential COPEC data set, then both UCLs will be eliminated and the maximum concentration will be used as the UCL value.

^j Chemical retained as COPEC due to high bioaccumulation potential (EPA, 2000b).

Table 6-32

Selection of Contaminants of Potential Ecological Concern, Aspen Creek Sediment ^a

Chemical	Frequency of Detection	Range of values, mg/kg		Statistical Distribution ^b	(1 of 2)		80% of maximum	Background mg/kg ^d	Screening Criteria mg/kg ⁱ	Exclusion Rationale ^g	COPEC? ^h	Representative Concentration mg/kg ⁱ
		Detected	Nondetected		95% UCL-N ^c (mg/kg)	95% UCL-L ^d (mg/kg)						
INORGANICS												
ALUMINUM	6/6(100)	9.7E+03 - 1.5E+04	NA	N	1.4E+04	1.5E+04	1.2E+04	NA	NA	--	Y	1.4E+04
ARSENIC	6/6(100)	1.2E+01 - 3.4E+01	NA	L	2.4E+01	2.7E+01	2.7E+01	NA	6.0E+00	--	Y	2.7E+01
BARIUM	6/6(100)	7.4E+01 - 7.4E+02	NA	U	4.2E+02	7.6E+02	5.9E+02	NA	NA	--	Y	7.4E+02
CADMIUM	1/6(17)	2.8E+00	6.8E-01 - 1.3E+00	NP	1.6E+00	2.8E+00	2.2E+00	NA	3.7E+00	C	Y ^k	2.8E+00
CALCIUM	6/6(100)	1.3E+03 - 1.1E+04	NA	L	8.8E+03	2.6E+04	9.0E+03	NA	NA	D	N	--
CHROMIUM	6/6(100)	1.7E+01 - 8.4E+01	NA	U	5.3E+01	6.7E+01	6.7E+01	NA	2.6E+01	--	Y	6.7E+01
COBALT	4/6(67)	8.7E+00 - 1.4E+01	1.3E+01 - 1.9E+01	L	1.2E+01	1.3E+01	1.1E+01	NA	5.0E+01	C	N	--
COPPER	6/6(100)	7.6E+00 - 2.2E+02	NA	L	1.2E+02	5.0E+02	1.8E+02	NA	1.6E+01	--	Y	2.2E+02
IRON	6/6(100)	2.4E+04 - 1.7E+05	NA	U	1.0E+05	1.5E+05	1.4E+05	NA	2.0E+04	--	Y	1.5E+05
LEAD	6/6(100)	1.6E+01 - 7.7E+01	NA	L	5.7E+01	8.5E+01	6.2E+01	NA	3.1E+01	--	Y	7.7E+01
MAGNESIUM	6/6(100)	2.3E+03 - 3.3E+03	NA	N	3.2E+03	3.2E+03	2.7E+03	NA	NA	D	N	--
MANGANESE	6/6(100)	4.8E+02 - 5.9E+03	NA	L	3.4E+03	8.4E+03	4.7E+03	NA	4.6E+02	--	Y	5.9E+03
NICKEL	6/6(100)	1.5E+01 - 2.8E+02	NA	U	1.5E+02	4.7E+02	2.3E+02	NA	1.6E+01	--	Y	2.8E+02
POTASSIUM	6/6(100)	1.0E+03 - 2.2E+03	NA	L	1.9E+03	2.1E+03	1.8E+03	NA	NA	D	N	--
VANADIUM	6/6(100)	2.4E+01 - 3.3E+01	NA	L	3.0E+01	3.1E+01	2.7E+01	NA	NA	--	Y	3.1E+01
ZINC	6/6(100)	6.4E+01 - 2.1E+03	NA	U	1.1E+03	7.5E+03	1.6E+03	NA	1.2E+02	--	Y	2.1E+03
VOLATILE ORGANIC COMPOUNDS												
1,1,2-TRICHLOROETHANE	1/6(17)	1.9E-02	6.8E-03 - 1.3E-02	NP	1.2E-02	1.7E-02	1.5E-02	NA	8.2E-02	C	N	--
2-BUTANONE	2/6(33)	2.0E-02 - 3.9E-02	2.7E-02 - 5.2E-02	NP	3.0E-02	3.4E-02	3.1E-02	NA	6.9E+02	C	N	--
ACETONE	4/6(67)	3.0E-02 - 1.2E-01	4.0E-02 - 5.2E-02	L	7.9E-02	1.2E-01	9.6E-02	NA	NA	--	Y	1.2E-01
CARBON DISULFIDE	2/6(33)	1.7E-03 - 2.5E-03	6.8E-03 - 1.9E-02	NP	6.6E-03	9.3E-03	2.0E-03	NA	3.5E+01	C	N	--
CIS-1,2-DICHLOROETHENE	2/6(33)	2.1E-03 - 2.7E-03	6.8E-03 - 1.3E-02	NP	4.9E-03	5.6E-03	2.2E-03	NA	4.2E+00	C	N	--
METHYLENE CHLORIDE	3/6(50)	3.3E-03 - 1.0E-02	1.0E-02 - 1.9E-02	L	8.7E-03	1.1E-02	8.0E-03	NA	NA	--	Y	8.7E-03
TOLUENE	1/6(17)	2.2E-03	6.8E-03 - 1.9E-02	NP	7.0E-03	9.2E-03	8.0E-03	NA	5.2E+01	C	N	--
SEMI-VOLATILE ORGANIC COMPOUNDS												
ANTHRACENE	2/6(33)	1.7E-01 - 8.3E-01	4.5E-01 - 1.2E+00	NP	6.0E-01	9.1E-01	6.6E-01	NA	1.4E+03	C	Y ^k	8.3E-01
BENZO(A)ANTHRACENE	2/6(33)	2.5E-01 - 9.8E-01	4.5E-01 - 1.2E+00	NP	6.8E-01	9.8E-01	7.8E-01	NA	5.6E-02	--	Y	9.8E-01
BENZO(A)PYRENE	2/6(33)	1.6E-01 - 6.9E-01	4.5E-01 - 1.2E+00	NP	5.4E-01	7.9E-01	5.5E-01	NA	5.6E-03	--	Y	6.9E-01
BENZO(B)FLUORANTHENE	3/6(50)	5.6E-02 - 8.4E-01	4.5E-01 - 1.2E+00	L	6.0E-01	2.2E+00	6.7E-01	NA	3.2E+00	C	Y ^k	8.4E-01
BIS(2-ETHYLHEXYL)PHTHALATE	1/6(17)	1.0E-01	4.5E-01 - 1.2E+00	NP	4.3E-01	6.3E-01	8.0E-02	NA	3.2E+00	C	N	--
CHRYSENE	2/6(33)	2.2E-01 - 8.3E-01	4.5E-01 - 1.2E+00	NP	6.1E-01	8.4E-01	6.6E-01	NA	5.6E+00	C	Y ^k	8.3E-01
FLUORANTHENE	3/6(50)	6.7E-02 - 1.8E+00	4.5E-01 - 1.2E+00	L	1.1E+00	5.2E+00	1.4E+00	NA	2.9E+00	C	Y ^k	1.8E+00
PHENANTHRENE	2/6(33)	4.5E-01 - 2.3E+00	4.5E-01 - 1.2E+00	NP	1.3E+00	3.0E+00	1.8E+00	NA	NA	--	Y	2.3E+00
PYRENE	3/6(50)	5.7E-02 - 1.5E+00	4.5E-01 - 1.2E+00	L	9.3E-01	4.8E+00	1.2E+00	NA	6.7E-01	j	Y	1.5E+00
PESTICIDES/PCBS												
4,4'-DDD	2/6(33)	2.7E-01 - 1.4E+00	4.5E-03 - 1.2E-02	NP	7.4E-01	7.4E+05	1.1E+00	NA	2.4E-01	--	Y	1.4E+00
4,4'-DDE	3/6(50)	5.6E-03 - 2.2E-01	5.1E-03 - 2.6E-01	L	1.4E-01	3.6E+01	1.8E-01	NA	5.0E-03	--	Y	2.2E-01
4,4'-DDT	2/6(33)	6.6E-03 - 9.0E-01	4.6E-03 - 2.6E-01	NP	4.7E-01	7.8E+03	7.2E-01	NA	8.0E-03	--	Y	9.0E-01
HERBICIDES												
No samples collected												
DIOXIN												
No samples collected												

Table 6-32

Selection of Contaminants of Potential Ecological Concern, Aspen Creek Sediment ^a
(2 of 2)

^a Sediments represents surficial samples from Aspen Creek and TAMPEEL Springs.

^b Statistical Distribution: N = Normal distribution; L = Lognormal distribution; U = Undetermined distribution; NP = Nonparametric distribution for data sets with greater than 50% nondetects;
NA = distribution not determined if sample size is less than 5.

^c 95% Upper Confidence Limit calculated based on a normal distribution.

^d 95% Upper Confidence Limit calculated based on a lognormal distribution.

^e Background concentrations for inorganic constituents are provided in Table 4-1.

^f Screening criteria are based on Ontario Ministry of the Environment Persaud et al., 1992) and Ecotox Threshold Concentrations (USEPA, 1996d) for fresh water sediment, unless noted.

^g Rationale for exclusion of chemical as a contaminant of potential ecological concern (COPEC):

A = within background concentration.

B = detection frequency less than 5%.

C = maximum detection is less than screening criteria.

D = essential nutrient.

^h N = Chemical is not chosen as a COPEC; Y = Chemical is chosen as COPEC.

ⁱ The representative concentration selection based on Ecological criteria which includes the following:

1) If one of the two calculated UCL's exceed the maximum concentration in the potential COPEC data set, then the other UCL will be used, unless it is less than 80% of the maximum concentration, in which case the maximum concentration will be used as the UCL value.

2) If both calculated UCL's are below the maximum concentration in the potential COPEC data set, then the greater UCL will be used if greater than 80% of the maximum concentration, otherwise, 80% of the maximum detected concentration will be used.

3) If both calculated UCL's exceed the maximum concentration in the potential COPEC data set, then both UCLs will be eliminated and the maximum concentration will be used as the UCL value.

^j USEPA Region III BTAG Screening Level (1995).

^k Chemical retained as COPEC due to high bioaccumulation potential (USEPA, 2000b).

Table 6-33

Selection of Contaminants of Potential Ecological Concern, Surface Soil ^a

(Page 1 of 2)

Chemical	Frequency of Detection	Range of values, mg/kg		Statistical Distribution ^b	95% UCL-N ^c	95% UCL-L ^d	80% of maximum	Background mg/kg ^e	Screening Criteria mg/kg ^f	Exclusion Rationale ^g	COPEC? ^h	Representative Concentration mg/kg ⁱ
		Detected	Nondetected		(mg/kg)	(mg/kg)						
INORGANICS												
ALUMINUM	44/44(100)	1.5E+03 - 2.1E+04	NA	N	1.2E+04	1.3E+04	1.7E+04	1.9E+04	1.0E+00	--	Y	1.7E+04
ARSENIC	43/44(98)	4.3E+00 - 7.0E+01	1.1E+00	U	1.9E+01	2.1E+01	5.6E+01	2.4E+01	5.7E+00	--	Y	5.6E+01
BARIUM	43/44(98)	3.2E+01 - 1.1E+04	2.3E+01	U	1.0E+03	3.5E+02	8.8E+03	8.0E+01	1.0E+00	--	Y	8.8E+03
BERYLLIUM	8/44(18)	6.2E-01 - 2.6E+00	5.6E-01 - 7.5E-01	NP	5.8E-01	5.2E-01	2.1E+00	1.1E+00	1.1E+00	--	Y	2.1E+00
CADMIUM	1/44(2)	1.8E+00	5.6E-01 - 6.9E+00	NP	5.5E-01	4.3E-01	1.4E+00	1.9E+00	2.2E-03	A,B	Y ^j	1.4E+00
CALCIUM	35/44(80)	6.8E+02 - 8.6E+04	5.6E+02 - 6.9E+02	L	1.1E+04	1.1E+04	6.9E+04	9.8E+03	NA	D	N	--
CHROMIUM	44/44(100)	3.7E+00 - 2.9E+02	NA	U	3.7E+01	2.7E+01	2.3E+02	2.5E+01	4.0E-01	--	Y	2.3E+02
COBALT	20/44(45)	6.6E+00 - 1.2E+01	5.6E+00 - 7.5E+00	NP	6.6E+00	6.8E+00	9.5E+00	1.9E+01	1.4E-01	A	N	--
COPPER	43/44(98)	5.7E+00 - 2.3E+02	2.8E+00	L	3.2E+01	2.7E+01	1.8E+02	2.6E+01	5.4E+00	--	Y	1.8E+02
IRON	44/44(100)	3.2E+03 - 1.5E+05	NA	L	3.2E+04	3.2E+04	1.2E+05	3.6E+04	1.2E+01	--	Y	1.2E+05
LEAD	44/44(100)	3.2E+00 - 9.8E+03	NA	U	6.7E+02	1.4E+02	7.9E+03	2.4E+01	5.4E-02	--	Y	7.9E+03
MAGNESIUM	41/44(93)	6.2E+02 - 1.4E+04	6.7E+02 - 7.0E+02	L	3.5E+03	3.6E+03	1.1E+04	5.6E+03	4.4E+03	D	N	--
MANGANESE	44/44(100)	3.8E+01 - 1.3E+04	NA	L	1.4E+03	1.3E+03	1.0E+04	4.7E+02	3.3E+02	--	Y	1.0E+04
MERCURY	6/44(14)	1.3E-01 - 7.1E-01	1.1E-01 - 1.5E-01	NP	1.1E-01	9.3E-02	5.7E-01	1.2E-01	1.0E-01	--	Y	5.7E-01
NICKEL	41/44(93)	6.4E+00 - 1.6E+02	4.5E+00 - 5.6E+00	L	2.5E+01	2.4E+01	1.3E+02	3.2E+01	1.4E+01	--	Y	1.3E+02
POTASSIUM	37/44(84)	6.0E+02 - 2.6E+03	5.7E+02 - 6.8E+02	N	1.3E+03	1.4E+03	2.1E+03	4.1E+03	NA	A,D	N	--
SELENIUM	10/44(23)	6.5E-01 - 8.1E+00	5.6E-01 - 2.5E+00	NP	1.0E+00	7.1E-01	6.5E+00	1.4E+00	2.8E-02	--	Y	6.5E+00
SODIUM	1/44(2)	2.0E+03	5.6E+02 - 7.5E+02	NP	4.2E+02	3.7E+02	1.6E+03	7.6E+01	NA	B,D	N	--
VANADIUM	42/44(95)	7.9E+00 - 1.2E+02	5.7E+00 - 6.9E+01	U	2.6E+01	2.5E+01	9.4E+01	3.7E+01	1.6E+00	--	Y	9.4E+01
ZINC	44/44(100)	1.1E+01 - 2.4E+04	NA	U	1.7E+03	2.8E+02	1.9E+04	1.0E+02	6.6E+00	--	Y	1.9E+04
VOLATILE ORGANIC COMPOUNDS												
1,1,1-TRICHLOROETHANE	1/44(2)	2.1E-03	5.6E-03 - 6.6E-02	NP	6.1E-03	4.7E-03	1.7E-03	NA	3.0E+01	B,C	N	--
1,1-DICHLOROETHANE	1/44(2)	6.0E-03	5.6E-03 - 6.6E-02	NP	6.2E-03	4.8E-03	4.8E-03	NA	2.0E+01	B,C	N	--
2-BUTANONE	1/44(2)	5.9E-03	2.2E-02 - 2.6E-01	NP	2.4E-02	1.9E-02	4.7E-03	NA	9.0E+01	B,C	N	--
ACETONE	11/44(25)	4.7E-03 - 6.8E-01	2.2E-02 - 2.6E-01	NP	8.3E-02	5.1E-02	5.4E-01	NA	2.5E+00	C	N	--
ETHYLBENZENE	4/44(9)	1.1E-03 - 8.3E-01	5.6E-03 - 6.1E-02	NP	5.4E-02	8.3E-03	6.6E-01	NA	5.2E+01	C	N	--
METHYLENE CHLORIDE	9/44(20)	1.6E-03 - 3.9E-02	5.6E-03 - 6.6E-02	NP	9.4E-03	8.0E-03	3.1E-02	NA	4.1E+01	C	N	--
TOLUENE	13/44(30)	1.1E-03 - 7.7E-02	5.6E-03 - 6.6E-02	NP	1.1E-02	8.6E-03	6.2E-02	NA	5.5E+00	C	N	--
XYLENE, TOTAL	8/44(18)	3.4E-03 - 5.9E+00	5.6E-03 - 6.1E-02	NP	3.7E-01	2.0E-02	4.7E+00	NA	1.0E+01	C	N	--
SEMI-VOLATILE ORGANIC COMPOUNDS												
2-METHYLNAPHTHALENE	4/44(9)	1.7E-01 - 1.9E+00	3.7E-01 - 5.7E+00	NP	4.3E-01	3.2E-01	1.5E+00	NA	3.2E+00	C	N	--
ACENAPHTHENE	1/44(2)	1.4E-01	3.7E-01 - 5.7E+00	NP	3.8E-01	2.8E-01	1.1E-01	NA	6.8E+02	B,C	Y ^j	1.4E-01
ACENAPHTHYLENE	1/44(2)	1.5E-01	3.7E-01 - 5.7E+00	NP	3.7E-01	2.7E-01	1.2E-01	NA	6.8E+02	B,C	Y ^j	1.5E-01
ANTHRACENE	4/44(9)	3.4E-01 - 5.6E-01	3.7E-01 - 5.7E+00	NP	3.9E-01	3.0E-01	4.5E-01	NA	1.5E+03	C	Y ^j	4.5E-01
BENZO(A)ANTHRACENE	13/44(30)	5.4E-02 - 2.1E+01	3.7E-01 - 5.4E-01	NP	1.6E+00	5.8E-01	1.7E+01	NA	5.2E+00	--	Y	1.7E+01
BENZO(A)PYRENE	13/44(30)	6.1E-02 - 2.2E+01	3.7E-01 - 5.4E-01	NP	1.7E+00	5.9E-01	1.8E+01	NA	1.5E+00	--	Y	1.8E+01
BENZO(B)FLUORANTHENE	14/44(32)	9.8E-02 - 3.3E+01	3.7E-01 - 4.6E-01	NP	2.4E+00	7.8E-01	2.6E+01	NA	6.0E+01	C	Y ^j	2.6E+01
BENZO(GHI)PERYLENE	9/44(20)	9.4E-02 - 1.3E+01	3.7E-01 - 5.4E-01	NP	1.1E+00	4.4E-01	1.0E+01	NA	1.2E+02	C	Y ^j	1.0E+01
BENZO(K)FLUORANTHENE	10/44(23)	5.5E-02 - 1.1E+01	3.7E-01 - 5.4E-01	NP	9.1E-01	4.1E-01	8.8E+00	NA	1.5E+02	C	Y ^j	8.8E+00
BIS(2-ETHYLHEXYL)PHTHALATE	9/44(20)	8.0E-02 - 1.6E-01	3.7E-01 - 5.7E+00	NP	3.5E-01	2.5E-01	1.3E-01	NA	9.3E-01	C	N	--
BUTYL BENZYL PHTHALATE	1/44(2)	8.9E-01	3.7E-01 - 5.7E+00	NP	4.0E-01	3.0E-01	7.1E-01	NA	2.4E-01	B	N	--
CARBAZOLE	3/44(7)	1.4E-01 - 2.2E-01	3.7E-01 - 5.7E+00	NP	3.7E-01	2.7E-01	1.8E-01	NA	NA	--	Y	2.2E-01
CHRYSENE	14/44(32)	7.2E-02 - 2.3E+01	3.7E-01 - 4.6E-01	NP	1.7E+00	6.3E-01	1.8E+01	NA	4.7E+00	--	Y	1.8E+01
DIBENZ(A,H)ANTHRACENE	3/44(7)	1.2E-01 - 7.2E-01	3.7E-01 - 5.7E+00	NP	3.9E-01	2.9E-01	5.8E-01	NA	1.8E+01	C	Y ^j	5.8E-01

Table 6-33

Selection of Contaminants of Potential Ecological Concern, Surface Soil ^a

(Page 2 of 2)

Chemical	Frequency of Detection	Range of values, mg/kg		Statistical Distribution ^b	95% UCL-N ^c (mg/kg)	95% UCL-L ^d (mg/kg)	80% of maximum	Background mg/kg ^e	Screening Criteria mg/kg ^f	Exclusion Rationale ^g	COPEC? ^h	Representative Concentration mg/kg ⁱ
		Detected	Nondetected									
DIBENZOFURAN	4/44(9)	6.6E-02 - 5.3E-01	3.7E-01 - 5.7E+00	NP	3.7E-01	2.8E-01	4.2E-01	NA	NA	—	Y	4.2E-01
FLUORANTHENE	15/44(34)	8.7E-02 - 2.7E+01	3.7E-01 - 4.6E-01	NP	2.3E+00	1.1E+00	2.2E+01	NA	1.2E+02	C	Y ^j	2.2E+01
FLUORENE	3/44(7)	6.2E-02 - 2.5E-01	3.7E-01 - 5.7E+00	NP	3.7E-01	2.7E-01	2.0E-01	NA	1.2E+02	C	Y ^j	2.5E-01
INDENO(1,2,3-CD)PYRENE	10/44(23)	7.1E-02 - 1.3E+01	3.7E-01 - 5.4E-01	NP	1.1E+00	4.5E-01	1.0E+01	NA	1.1E+02	C	Y ^j	1.1E+01
NAPHTHALENE	3/44(7)	1.4E-01 - 1.2E+00	3.7E-01 - 5.7E+00	NP	4.0E-01	2.9E-01	9.6E-01	NA	1.0E-01	—	Y	9.6E-01
PHENANTHRENE	14/44(32)	6.7E-02 - 8.2E+00	3.7E-01 - 4.6E-01	NP	9.6E-01	6.8E-01	6.6E+00	NA	4.6E+01	C	Y ^j	6.6E+00
PYRENE	14/44(32)	7.0E-02 - 2.3E+01	3.7E-01 - 4.6E-01	NP	1.9E+00	8.1E-01	1.8E+01	NA	7.9E+01	C	Y ^j	1.8E+01
PESTICIDES/PCBS												
4,4'-DDE	8/44(18)	5.8E-03 - 9.4E-02	3.7E-03 - 9.1E-02	NP	2.1E-02	2.8E-02	7.5E-02	NA	6.0E-01	C	Y ^j	7.5E-02
4,4'-DDT	8/44(18)	5.2E-03 - 1.6E-01	3.7E-03 - 9.1E-02	NP	2.5E-02	3.3E-02	1.3E-01	NA	3.5E-03	—	Y	1.3E-01
AROCLOR 1254	1/44(2)	5.5E-02	3.7E-02 - 5.0E-02	NP	2.3E-02	2.3E-02	4.4E-02	NA	3.3E-04	B	Y ^j	4.4E-02
AROCLOR 1260	1/44(2)	9.7E-02	3.7E-02 - 5.0E-02	NP	2.6E-02	2.4E-02	7.8E-02	NA	3.3E-04	B	Y ^j	7.8E-02
BETA-BHC	2/44(5)	5.7E-03 - 5.6E-02	1.9E-03 - 4.7E-02	NP	1.1E-02	1.4E-02	4.5E-02	NA	4.0E-03	B	Y ^j	4.5E-02
HERBICIDES												
No samples collected												
DIOXIN												
1,2,3,4,6,7,8-HPCDD	2/4(50)	1.4E-06 - 3.1E-06	3.7E-07 - 5.5E-07	NA	3.0E-06	1.5E-03	2.5E-06	NA	2.0E-07	—	Y	3.0E-06
OCDD	4/4(100)	9.5E-06 - 4.2E-04	NA	NA	3.8E-04	2.8E+01	3.4E-04	NA	2.0E-07	—	Y	3.8E-04
TOTAL HPCDD	2/4(50)	2.8E-06 - 6.8E-06	7.1E-07 - 1.2E-06	NA	6.0E-06	4.3E-03	5.4E-06	NA	2.0E-07	—	Y	6.0E-06
TOTAL HXCDD	1/4(25)	1.9E-07	5.4E-07 - 7.2E-07	NA	—	—	1.5E-07	NA	2.0E-07	C	Y ^j	1.9E-07
TOTAL PECDF	2/4(50)	3.7E-07 - 1.0E-06	6.2E-07 - 8.2E-07	NA	1.0E-06	2.0E-06	8.0E-07	NA	3.3E-05	C	Y ^j	1.0E-06
TOTAL TCDF	2/4(50)	1.0E-06 - 1.7E-06	7.4E-07 - 8.8E-07	NA	2.0E-06	7.0E-06	1.4E-06	NA	3.3E-05	C	Y ^j	1.7E-06

^a Surface soil is defined as the interval less than 2 feet below the ground surface. Soil samples were classified on the basis of the end depth of the sample.

^b Statistical Distribution: N = Normal distribution; L = Lognormal distribution; U = Undetermined distribution; NP = Nonparametric distribution for data sets with greater than 50% nondetects; NA = distribution not determined if sample size is less than 5.

^c 95% Upper Confidence Limit calculated based on a normal distribution.

^d 95% Upper Confidence Limit calculated based on a lognormal distribution.

^e Background concentrations for inorganic constituents are provided in Table 4-1.

^f Screening criteria are based on USEPA Region 5 (USEPA, 2003) ecological screening levels with the exception of aluminum, iron, magnesium, and manganese which were based on EPA Region 3 BTAG screening levels (USEPA, 1995d).

^g Rationale for exclusion of chemical as a contaminant of potential ecological concern (COPEC):

A = within background concentration.

B = detection frequency less than 5%.

C = maximum detection is less than screening criteria.

D = essential nutrient.

^h N = Chemical is not chosen as a COPEC; Y = Chemical is chosen as COPEC.

ⁱ The representative concentration selection based on Ecological criteria which includes the following:

1) If one of the two calculated UCL's exceed the maximum concentration in the potential COPEC data set, then the other UCL will be used, unless it is less than 80% of the maximum concentration, in which case the maximum concentration will be used as the UCL value.

2) If both calculated UCL's are below the maximum concentration in the potential COPEC data set, then the greater UCL will be used if greater than 80% of the maximum concentration, otherwise, 80% of the maximum detected concentration will be used.

3) If both calculated UCL's exceed the maximum concentration in the potential COPEC data set, then both UCLs will be eliminated and the maximum concentration will be used as the UCL value.

^j Chemical retained as COPEC due to high bioaccumulative potential (USEPA, 2000b).

Table 6-34
Vegetative Communities

Community Type	Definition
AGRI	Agricultural areas including crop fields, pastures, and fallow fields
DEV	Developed and disturbed areas including residential, commercial, industrial
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 6-35
Mammals Observed On-Site
and Likely to be Found in Trumbull County, Ohio

Family Name	Scientific Name	Common Name	Observed On-site
Didelphidae	<i>Didelphis virginiana</i>	Virginia opossum	1, 2
Talpidae	<i>Condylura cristata</i>	star-nosed mole	2
	<i>Parascalops breweri</i>	Hairy-tailed mole	
	<i>Scalopus aquaticus</i>	Eastern mole	
Vespertilionidae	<i>Myotis keenii</i>	Keen's bat	
	<i>M. lucifugus</i>	little brown bat	2
	<i>M. sodalis</i>	Indiana bat	
	<i>Eptesicus fuscus</i>	big brown bat	
	<i>Lasionycteris noctivagans</i>	Silver-haired bat	
	<i>Lasiurus borealis</i>	red bat	
	<i>L. cinereus</i>	Hoary bat	
	<i>Nycticeius humeralis</i>	Evening bat	
	<i>Pipistrellus subflavus</i>	Eastern pipistrelle	
Leporidae	<i>Sylvilagus floridanus</i>	Cottontail rabbit	1, 2
Sciuridae	<i>Glaucomys volans</i>	Southern flying squirrel	
	<i>Marmota monax</i>	Woodchuck	1, 2
	<i>Sciurus carolinensis</i>	gray squirrel	
	<i>S. niger</i>	fox squirrel	1, 2
	<i>Tamias striatus</i>	Eastern chipmunk	1, 2
	<i>Tamiasciurus hudsonicus</i>	red squirrel	1, 2
	<i>Blarina brevicauda</i>	short-tailed shrew	1, 2
	<i>Cryptotis parva</i>	least shrew	2
	<i>Sorex cinereus</i>	masked shrew	
	<i>S. fumeus</i>	smoky shrew	
Castoridae	<i>Castor canadensis</i>	beaver	1, 2, 3
Cricetidae	<i>Microtus ochrogaster</i>	prairie vole	
	<i>M. pennsylvanicus</i>	meadow vole	
	<i>M. pinetorum</i>	woodland vole	
	<i>Mus musculus</i>	house mouse	1
	<i>Napaeozapus insignis</i>	woodland jumping mouse	2
	<i>Ondatra zibethicus</i>	muskrat	1, 2
	<i>Peromyscus leucopus</i>	white-footed mouse	
	<i>P. maniculatus</i>	deer mouse	1
	<i>Rattus norvegicus</i>	Norway rat	
	<i>Synaptomys cooperi</i>	Southern bog lemming	
	<i>Zapus hudsonius</i>	meadow jumping mouse	
Procyonidae	<i>Procyon lotor</i>	raccoon	1, 2
Mustelidae	<i>Mephitis mephitis</i>	striped skunk	1, 2
	<i>Mustela frenata</i>	long-tailed weasel	2
	<i>M. nivalis</i>	least weasel	2
	<i>M. vison</i>	mink	
	<i>Taxidea taxus</i>	badger	
Canidae	<i>Canis latrans</i>	coyote	
	<i>Urocyon cinereoargenteus</i>	gray fox	2
	<i>Vulpes vulpes</i>	red fox	1
Cervidae	<i>Odocoileus virginianus</i>	white-tailed deer	1, 2

Mammals likely to be found in Trumbull County based on information presented in:
Gottschang, J. L., 1981, A Guide to the Mammals of Ohio, Ohio State University Press, 176 pages.
Reference for on-site observation:

- (1) Brice Harris, Tampeel, Aug. 1996 - Dec. 1997
- (2) Norm Downing, Tampeel, 1975 - 1996
- (3) IT reconnaissance, Nov. 24, 1997

Table 6-36

**Birds Observed On-Site and Likely to be Found
in Trumbull County, Ohio**

(Page 1 of 3)

Family Name ^a	Scientific Name ^b	Common Name	Observed On-site
Ardeidae	<i>Ardea herodias</i>	great blue heron	1, 2
	<i>Butorides striatus</i>	green-backed heron	2
	<i>Casmerodius albus egretta</i>	American egret	
Anatinae	<i>Aix sponsa</i>	Wood duck	1, 2
	<i>Anas discors</i>	blue-winged teal	
	<i>A. platyrhynchos</i>	mallard	1, 2, 3
Anserinae	<i>Branta canadensis</i>	Canada goose	1, 2
Accipitrinae	<i>Accipiter cooperii</i>	Cooper's hawk	1, 2
	<i>A. striatus</i>	sharp-shinned hawk	
Buteoninae	<i>Buteo jamaicensis</i>	red-tailed hawk	1, 2
	<i>B. lineatus</i>	red-shouldered hawk	2
	<i>B. platypterus</i>	broad-winged hawk	
Cathartidae	<i>Cathartes aura</i>	turkey vulture	1, 2
Circinae	<i>Circus cyaneus</i>	marsh hawk	2
Falconinae	<i>Falco sparverius</i>	American kestrel	
Phasianidae	<i>Colinus virginianus</i>	Northern bobwhite quail	2
	<i>Phasianus colchicus</i>	ring-necked pheasant	1, 2
Tetraonidae	<i>Bonasa umbellus</i>	ruffed grouse	1, 2
Rallidae	<i>Rallus limicola</i>	Virginia rail	1
Charadriidae	<i>Charadrius vociferus</i>	killdeer	1, 2
Scolopacidae	<i>Actitis macularia</i>	spotted sandpiper	
	<i>Ereunetes pusillus</i>	semipalmated plover	
	<i>Scolopax minor</i>	American woodcock	2
Columbidae	<i>Columba livia</i>	rock dove	2
	<i>Zenaida macroura</i>	mourning dove	1, 2
	<i>Coccyzus americanus</i>	yellow-billed cuckoo	
Cuculidae	<i>C. erythrophthalmus</i>	black-billed cuckoo	
	<i>Bubo virginianus</i>	great horned owl	2
	<i>Otus asio</i>	Eastern screech-owl	
Tytonidae	<i>Strix varia</i>	barred owl	
	<i>Caprimulgus vociferus</i>	whip-poor-will	
	<i>Chordeiles minor</i>	common nighthawk	2
Apodidae	<i>Chaetura pelagica</i>	chimney swift	2
Trochilidae	<i>Archilochus colubris</i>	ruby-throated hummingbird	1, 2
Alcedinidae	<i>Ceryle alcyon</i>	belted kingfisher	1, 2
Picidae	<i>Colaptes auratus</i>	Northern flicker	1, 2
	<i>Dryocopus pileatus</i>	pileated woodpecker	2
	<i>Melanerpes carolinus</i>	red-bellied woodpecker	1, 2
	<i>M. erythrocephalus</i>	red-headed woodpecker	
	<i>Picoides pubescens</i>	downy woodpecker	1, 2
	<i>P. villosus</i>	hairy woodpecker	1, 2
	<i>Sphyrapicus varius</i>	yellow-bellied sapsucker	2
	<i>Eremophila alpestris</i>	horned lark	
	<i>Bombycilla cedrorum</i>	cedar waxwing	1, 2
Bombycillidae	<i>Certhia americana</i>	brown creeper	1
Certhiidae	<i>Corvus brachyrhynchos</i>	American crow	1, 2
Corvidae	<i>Cyanocitta cristata</i>	blue jay	1, 2
	<i>A. henslowii</i>	Henslow's sparrow	
Fringillidae	<i>A. savannarum</i>	grasshopper sparrow	
	<i>Cardinalis cardinalis</i>	Northern cardinal	1, 2
	<i>Carduelis tristis</i>	American goldfinch	1, 2
	<i>Carpodacus mexicanus</i>	house finch	1, 2

Table 6-36

**Birds Observed On-Site and Likely to be Found
in Trumbull County, Ohio**

(Page 2 of 3)

Family Name ^a	Scientific Name ^b	Common Name	Observed On-site
Fringillidae (continued)	<i>C. purpureus</i>	purple finch	
	<i>Junco hyemalis</i>	dark-eyed junco	2
	<i>Melospiza georgiana</i>	swamp sparrow	
	<i>M. melodia</i>	song sparrow	1, 2
	<i>Passerculus sandwichensis</i>	Savannah sparrow	
	<i>Passerina cyanea</i>	indigo bunting	1, 2
	<i>Pheucticus ludovicianus</i>	rose-breasted grosbeak	1, 2
	<i>Pipilo erythrophthalmus</i>	rufous-sided towhee	1, 2
	<i>Pooecetes gramineus</i>	vesper sparrow	
	<i>Spizella passerina</i>	chipping sparrow	
Hirundinidae	<i>S. pusilla</i>	field sparrow	1
	<i>Hirundo pyrrhonota</i>	cliff swallow	
	<i>H. rustica</i>	barn swallow	1, 2
	<i>Progne subis</i>	purple martin	1
	<i>Riparia riparia</i>	bank swallow	
	<i>Stelgidopteryx serripennis</i>	Northern rough-winged swallow	
Icteridae	<i>Tachycineta bicolor</i>	tree swallow	2
	<i>Agelaius phoeniceus</i>	red-winged blackbird	1, 2
	<i>Dolichonyx oryzivorus</i>	bobolink	
	<i>Icterus galbula</i>	Northern oriole	1, 2
	<i>I. spurius</i>	orchard oriole	
	<i>Molothrus ater</i>	brown-headed cowbird	1, 2
Mimidae	<i>Quiscalus quiscula</i>	common grackle	2
	<i>Sturnella magna</i>	Eastern meadowlark	
	<i>S. neglecta</i>	Western meadowlark	
	<i>Dumetella carolinensis</i>	gray catbird	1, 2
	<i>Mimus polyglottos</i>	Northern mockingbird	
	<i>Toxostoma rufum</i>	brown thrasher	2
Paridae	<i>Parus atricapillus</i>	black-capped chickadee	1, 2
	<i>P. bicolor</i>	tufted titmouse	1, 2
Parulidae	<i>P. carolinensis</i>	Carolina chickadee	
	<i>Dendroica cerulea</i>	cerulean warbler	
	<i>D. discolor</i>	prairie warbler	
	<i>D. dominica</i>	yellow-throated warbler	
	<i>D. pensylvanica</i>	chestnut-sided warbler	
	<i>D. petechia</i>	yellow warbler	1, 2
	<i>Geothlypis trichas</i>	common yellowthroat	
	<i>Icteria virens</i>	yellow-breasted chat	
	<i>Mniotilta varia</i>	black and white warbler	
	<i>Oporornis formosus</i>	Kentucky warbler	
	<i>O. philadelphia</i>	mourning warbler	
	<i>Protonotaria citrea</i>	prothonotary warbler	
	<i>Seiurus aurocapillus</i>	overbird	
	<i>Setophaga ruticilla</i>	American redstart	
	<i>Vermivora pinus</i>	blue-winged warbler	
	<i>Wilsonia citrina</i>	hooded warbler	1
Ploceidae	<i>Passer domesticus</i>	house sparrow	1, 2
Sittidae	<i>Sitta canadensis</i>	red-breasted nuthatch	1, 2
	<i>S. carolinensis</i>	white-breasted nuthatch	1, 2
Sturnidae	<i>Sturnus vulgaris</i>	European starling	1, 2
Sylviidae	<i>Polioptila caerulea</i>	blue-gray gnatcatcher	
Thraupidae	<i>Piranga olivacea</i>	scarlet tanager	1, 2

Table 6-36

**Birds Observed On-Site and Likely to be Found
in Trumbull County, Ohio**

(Page 3 of 3)

Family Name ^a	Scientific Name ^b	Common Name	Observed On-site
Troglodytidae	<i>Cistothorus palustris</i>	marsh wren	
	<i>C. platensis</i>	sedge wren	
	<i>Thryothorus ludovicianus</i>	Carolina wren	
	<i>Troglodytes aedon</i>	house wren	1, 2
Turdidae	<i>Catharus fuscescens</i>	veery	
	<i>Hylocichla mustelina</i>	wood thrush	1
	<i>Sialia sialis</i>	Eastern bluebird	1, 2
	<i>Turdus migratorius</i>	American robin	1, 2
Tyrannidae	<i>Contopus virens</i>	Eastern wood-pewee	
	<i>Empidonax alnorum</i>	alder flycatcher	
	<i>E. minimus</i>	least flycatcher	
	<i>E. traillii</i>	willow flycatcher	
	<i>E. virens</i>	Acadian flycatcher	
	<i>Myiarchus crinitus</i>	crested flycatcher	
	<i>Sayornis phoebe</i>	Eastern phoebe	
	<i>Tyrannus tyrannus</i>	Eastern kingbird	
	<i>Vireo bellii</i>	Bell's vireo	
	<i>V. flavifrons</i>	yellow-throated vireo	
Vireonidae	<i>V. gilvus</i>	warbling vireo	
	<i>V. griseus</i>	white-eyed vireo	
	<i>V. olivaceus</i>	red-eyed vireo	

^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.

Reference for on-site observation:

- (1) Brice Harris, Tampeel, Aug. 1996 - Dec. 1997
- (2) Norm Downing, Tampeel, 1975 - 1996
- (3) IT reconnaissance, Nov. 24, 1997

Table 6-37

Reptiles Observed On-Site and Likely to be Found in Northeast Ohio

Family Name	Scientific Name	Common Name	Observed On-site
Crotalidae	<i>Ancistrodon contortrix mokeson</i>	copperhead	
	<i>Grotalus h. horridus</i>	timber rattlesnake	
	<i>Sistrurus catenatus catenatus</i>	Eastern massasauga	
Chelydridae	<i>Chelydra serpentina</i>	snapping turtle	1, 2
Kinosternidae	<i>Sternotherus odoratus</i>	musk turtle	
Emydidae	<i>Chrysemys picta</i>	painted turtle	1, 2
	<i>Clemmys guttata</i>	spotted turtle	
	<i>Graptemys geographica</i>	map turtle	
	<i>Terrapene carolina</i>	box turtle	2
Trionychidae	<i>Apalone spinifera</i>	Spiny softshell	
Colubridae	<i>Coluber constrictor constrictor</i>	black racer	
	<i>C. constrictor foxi</i>	blue racer	
	<i>C. constrictor flaviventris</i>	yellow bellied racer	
	<i>Diadophis punctatus edwardsi</i>	Eastern ring-necked snake	2
	<i>Elaphe obsoleta obsoleta</i>	pilot black snake	
	<i>Heterodon platyrhinos platyrhinos</i>	hog-nosed snake	
	<i>Lampropeltis doliaata triangulum</i>	milk snake	1, 2
	<i>Natrix etythrogaster neglecta</i>	Northern copper belly	
	<i>N. kirtlandi</i>	Kirtland's water snake	
	<i>N. septemvittata</i>	queen snake	
	<i>N. sipedon sipedon</i>	water snake	
	<i>Opheodrys vernalis vernalis</i>	green snake	
	<i>Storeria dekayi dekayi</i>	Dekay's snake	
	<i>S. dekayi wrightorum</i>	Central brown snake	
	<i>S. occipitomaculata occipitomaculata</i>	red-bellied snake	
	<i>Thamnophis sauritus sauritus</i>	ribbon snake	
	<i>T. s. sirtalis</i>	common garter snake	1, 2

Sources: 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) Brice Harris, Tampeel, Aug. 1996 - Dec. 1997
- (2) Norm Downing, Tampeel, 1975 - 1996
- (3) IT reconnaissance, Nov. 24, 1997

Table 6-38

**Amphibians Observed On-Site and Likely to be Found
in Trumbull County, Ohio**

Family Name	Scientific Name	Common Name	Observed On-site
Scincidae	<i>Eumeces fasciatus</i>	five-lined skink	
Ambystomatidae	<i>Ambystoma jeffersonianum</i>	Jefferson salamander	
	<i>A. maculatum</i>	spotted salamander	
	<i>A. texanum</i>	smallmouth salamander	
	<i>A. tigrinum</i>	tiger salamander	
Proteidae	<i>Necturus maculosus</i>	mudpuppy	
Salamandridae	<i>Notophthalmus viridescens</i>	Eastern newt	
Plethodontidae	<i>Desmognathus fuscus</i>	dusky salamander	
	<i>Eurycea bislineata</i>	two-lined salamander	
	<i>E. longicauda</i>	longtail salamander	
	<i>Plethodon cinereus</i>	redback salamander	1
	<i>P. glutinosus</i>	slimy salamander	
	<i>P. richmondi</i>	ravine salamander	
Bufonidae	<i>Bufo americanus</i>	American toad	1, 2
	<i>B. woodhousii</i>	Fowler's toad	
Hylidae	<i>Hyla versicolor</i>	gray treefrog	2
	<i>Pseudacris crucifer</i>	spring peeper	1, 2
	<i>P. triseriata</i>	chorus frog	
Ranidae	<i>Rana catesbeiana</i>	bullfrog	1, 2
	<i>R. clamitans</i>	green frog	1, 2
	<i>R. palustris</i>	pickerel frog	
	<i>R. pipiens</i>	Northern leopard frog	
	<i>R. sylvatica</i>	wood frog	1

Sources: 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) Brice Harris, Tampeel, Aug. 1996 - Dec. 1997
- (2) Norm Downing, Tampeel, 1975 - 1996
- (3) IT reconnaissance, Nov. 24, 1997

Table 6-39

Assessment and Measurement Endpoints and Exposure Delineation

(Page 1 of 3)

Assessment Goal	Assessment Endpoint	Null Hypothesis (H ₀)	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 surficial soils, surface water, and vegetation will have no adverse effect on survival and reproductive capabilities of herbivorous mammals.	eastern cottontail (<i>Sylvilagus floridanus</i>) 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 surficial soils, surface water, terrestrial invertebrates, and vegetation will have no adverse effect on survival and reproductive capabilities of omnivorous mammals.	deer mouse (<i>Peromyscus maniculatus</i>) 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 small carnivorous 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 carnivorous mammals.	short-tailed shrew (<i>Blarina brevicauda</i>) Ingestion of terrestrial invertebrates, water, and incidental soil	Comparison of total daily dose to species-specific TEVs.

Table 6-39

Assessment and Measurement Endpoints and Exposure Delineation

(Page 2 of 3)

Assessment Goal	Assessment Endpoint	Null Hypothesis (H ₀)	Selected Receptor and Exposure Routes	Measurement Endpoint
Protection of terrestrial ecosystem structure and function. (continued)	Protection of long-term survival and reproductive capabilities for omnivorous birds.	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 birds.	American robin (<i>Turdus migratorius</i>) 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 (<i>Buteo jamacensis</i>) 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 medium carnivorous mammals.	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 mammals.	red fox (<i>Vulpes vulpes</i>) ingestion of small mammals, birds, 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.

Table 6-39

Assessment and Measurement Endpoints and Exposure Delineation

(Page 3 of 3)

Assessment Goal	Assessment Endpoint	Null Hypothesis (H ₀)	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 vertebrates (fin fish).	The presence of site contaminants within surface water, benthic invertebrates, and plants will have no adverse effect on survival and reproductive capabilities of aquatic vertebrates.	aquatic vertebrates ingestion of benthic invertebrates, plants, and direct exposure to water	Comparison of surface water concentration to aquatic CEVs.
	Protection of long-term survival and reproductive capabilities for aquatic mammals.	The presence of site contaminants within surface water, and terrestrial plants will have no adverse effect on survival and reproductive capabilities of aquatic mammals.	beaver (<i>Castor canadensis</i>) ingestion of terrestrial plants, water and incidental sediment	Comparison of total daily dose to species-specific TEVs.
	Protection of long-term survival and reproductive capabilities for piscivorous birds.	The presence of site contaminants within aquatic vertebrates and benthic invertebrates will have no adverse effect on survival and reproductive capabilities of piscivorous birds.	great blue heron (<i>Ardea herodias</i>) ingestion of aquatic vertebrates, benthic invertebrates, and incidental sediment	Comparison of total daily dose to species-specific TEVs.

Table 6-40

Chemicals for which Alternative Foraging Factors were Used

Chemical	Fox	Hawk
Aspen Creek		
4,4'-DDE	--	X
4,4'-DDT	--	X
Aroclor 1260	X	X
Benzo(a)pyrene	X	NA
Benzo(b)fluoranthene	X	NA
Benzi(g,h,i)perylene	X	NA
Indeno(1,2,3-cd)pyrene	X	NA
Aluminum	X	X
Arsenic	X	--
Barium	X	--
Lead	X	X
Vanadium	X	--
Zinc	X	X
Beaver Pond		
4,4'-DDE	--	X
4,4'-DDT	--	X
Aroclor 1260	X	X
Benzo(a)pyrene	X	NA
Benzo(b)fluoranthene	X	NA
Benzi(g,h,i)perylene	X	NA
Indeno(1,2,3-cd)pyrene	X	NA
Aluminum	X	X
Arsenic	X	--
Barium	X	--
Lead	X	X
Vanadium	X	--
Zinc	X	X
Study Pond		
4,4'-DDE	--	X
4,4'-DDT	--	X
Aroclor 1260	X	--
Benzo(a)pyrene	X	NA
Benzo(b)fluoranthene	X	NA
Benzi(g,h,i)perylene	X	NA
Indeno(1,2,3-cd)pyrene	X	NA
Aluminum	X	X
Arsenic	X	--
Barium	X	--
Lead	X	X
Vanadium	X	--
Zinc	X	X

X = Foraging factor adjusted from 1.0 to 0.01.

-- = No adjustment required, as HQ is less than 1.

NA = Due to lack of toxicological data, no HQ could be estimated.

Table 6-41

Data Used to Model Exposure in the Indicator Wildlife Species

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)	Trophic Level	Dietary Composition ^a (percent)
Deer mouse (<i>Peromyscus maniculatus</i>)	Mammalia/ Rodentia	0.0148	0.062	0.0028	0.000057 (2.0%)	Omnivore	Inverts. : 39 Plants: 61
Eastern cottontail (<i>Sylvilagus floridanus</i>)	Mammalia/ Lagomorpha	1.132	3.1	0.096	0.006 (6.3%)	Herbivore	Plants: 100
Short-tailed shrew (<i>Blarina brevicauda</i>)	Mammalia/ Insectivora	0.015	0.39	0.008	0.00016 (2.0%)	Insectivore	Inverts.: 100
Red fox (<i>Vulpes vulpes</i>)	Mammalia/ Carnivora	3.94	1038	0.21	0.0059 (2.8%)	Carnivore	Birds: 10 Rabbits: 30 Shrews: 30 Mice: 30
American robin (<i>Turdus migratorius</i>)	Aves/ Passeriformes	0.0773	0.48	0.016	0.00032 (2.0%)	Omnivore	Plants: 52 Inverts.: 48
Red-tailed hawk (<i>Buteo jamaicensis</i>)	Aves/ Falconiformes	0.957	842	0.1	0.002 (2.0%)	Carnivore	Rabbits: 25.3 Shrews: 25.3 Mice: 25.3 Birds: 24
Great blue heron (<i>Ardea herodias</i>)	Aves/ Ciconiiformes	2.204	4.5	0.4	0.0079 (2.0%)	Omnivore	Fish: 96 Inverts.: 4
Beaver (<i>Castor canadensis</i>)	Mammalia/ Rodentia	18 ^b	3.14 ^b	0.74	0.0148 (2.0%)	Herbivore	Plants: 100

^aFrom USEPA (1993d), except as noted.

^bInformation is from *A Guide to the Mammals of Ohio* (Gottschang, 1981).

Table 6-42
Soil and Sediment
Transfer Factors for Chemicals of Potential Ecological Concern

(Page 1 of 3)

Chemical	CAS No.	Log K _{ow} ^a	Soil/ Sediment-to- Plant TF ^b	Soil/ Sediment- to-Insect TF ^c	Food-to- Muscle TF ^d
ORGANIC					
2-Methylnaphthalene	91576	3.86	2.27×10^{-1}	3.37×10^0	1.79×10^{-4}
4,4'-DDD	72548	6.2	1.01×10^{-2}	4.91×10^0	4.67×10^{-2}
4,4'-DDE	72559	7.0	3.48×10^{-3}	5.58×10^0	3.13×10^{-1}
4,4'-DDT	50293	6.19	1.02×10^{-2}	4.90×10^0	4.56×10^{-2}
Aroclor 1254	1197691	6.79 °	4.61×10^{-3}	5.39×10^0	1.90×10^{-1}
Aroclor 1260	11096825	8.27 °	6.43×10^{-4}	6.85×10^0	6.42×10^0
Acetone	67641	-0.24	$5.33 \times 10^{+1}$	1.74×10^0	1.04×10^{-8}
Acenaphthene	83329	3.92 °	2.10×10^{-1}	3.40×10^0	2.06×10^{-4}
Acenaphthylene	208968	3.94 °	2.04×10^{-1}	3.41×10^0	2.16×10^{-4}
Anthracene	120127	4.45	1.04×10^{-1}	3.70×10^0	7.28×10^{-4}
Benzo(a)anthracene	56553	5.6	2.24×10^{-2}	4.45×10^0	1.12×10^{-2}
Benzo(a)pyrene	50328	6.06	1.22×10^{-2}	4.8×10^0	3.35×10^{-2}
Benzo(b)fluoranthene	205992	6.06	1.22×10^{-2}	4.80×10^0	3.35×10^{-2}
Benzo(g,h,i)perylene	191242	7.23 ^g	2.56×10^{-3}	5.79×10^0	5.41×10^{-1}
Benzo(k)fluoranthene	207089	6.06	1.22×10^{-2}	4.80×10^0	3.35×10^{-2}
Beta-BHC	319857	4.5 ^f	9.71×10^{-2}	3.73×10^0	8.19×10^{-4}
Carbazole	86748	3.29 ^g	4.86×10^{-1}	3.07×10^0	4.61×10^{-5}
Chrysene	218019	5.61	2.22×10^{-2}	4.46×10^0	1.15×10^{-2}
Dibenzo(a,h)anthracene	53703	5.61	2.22×10^{-2}	4.46×10^0	1.15×10^{-2}
Dibenzofuran	132649	4.12 ^g	1.61×10^{-1}	3.51×10^0	3.32×10^{-4}
Fluoranthene	206440	4.9	5.70×10^{-2}	3.98×10^0	2.12×10^{-3}
Fluorene	86737	4.2	1.45×10^{-1}	3.56×10^0	4.01×10^{-4}
Indeno(1,2,3-cd)pyrene	193395	6.5	6.78×10^{-3}	5.15×10^0	9.54×10^{-2}
Methylene chloride	75092	1.3	6.86×10^0	2.23×10^0	4.05×10^{-7}
Naphthalene	91203	3.23	5.26×10^{-1}	3.04×10^0	4.00×10^{-5}
Phenanthrene	85018	4.46	1.02×10^{-1}	3.71×10^0	7.45×10^{-4}
Pyrene	129000	5.32	3.26×10^{-2}	4.26×10^0	5.76×10^{-3}
1,2,3,4,6,7,8-HpCDD	NA	7.02	3.39×10^{-3}	5.60×10^0	3.29×10^{-1}
OCDD	NA	7.02	3.39×10^{-3}	5.60×10^0	3.29×10^{-1}

Table 6-42
Soil and Sediment
Transfer Factors for Chemicals of Potential Ecological Concern

(Page 2 of 3)

Chemical	CAS No.	Log K_{ow} ^a	Soil/ Sediment-to- Plant TF ^b	Soil/ Sediment- to-Insect TF ^c	Food-to- Muscle TF ^d
Total HpCDD	NA	7.02	3.39×10^{-3}	5.60×10^0	3.29×10^{-1}
Total HxCDD	NA	7.02	3.39×10^{-3}	5.60×10^0	3.29×10^{-1}
Total PeCDF	NA	7.02	3.39×10^{-3}	5.60×10^0	3.29×10^{-1}
Total TCDF	NA	7.02	3.39×10^{-3}	5.60×10^0	3.29×10^{-1}
INORGANIC					
Aluminum	7429905	—	2.30×10^{-3h}	1.00×10^{0i}	1.00×10^{0i}
Antimony	7440360	—	5.6×10^{-4j}	1.00×10^{0i}	1.00×10^{-3h}
Arsenic	7440382	—	2.30×10^{-2h}	1.00×10^{0i}	2.00×10^{-3h}
Barium	7440393	—	3.00×10^{-2j}	1.00×10^{0i}	2.00×10^{-4j}
Beryllium	7440417	—	5.80×10^{-3h}	1.00×10^{0i}	1.00×10^{-3h}
Cadmium	7440439	—	3.50×10^{-1h}	8.00×10^{-1k}	5.50×10^{-4h}
Chromium	7440473	—	1.00×10^{-3j}	1.30×10^{-1l}	9.00×10^{-3j}
Copper	7440508	—	8.00×10^{-1j}	2.50×10^{-1k}	9.00×10^{-3j}
Iron	7439896	—	2.5×10^{-3h}	3.6×10^{-1l}	2.0×10^{-2h}
Lead	7439921	—	1.1×10^{-3j}	4.0×10^{-2m}	4.0×10^{-4j}
Manganese	7439965	—	6.8×10^{-1j}	3.9×10^{-1l}	5.0×10^{-4j}
Mercury	7439976	—	5.5×10^{-1h}	1.00×10^{0i}	2.5×10^{-1h}
Nickel	7440020	—	3.60×10^{-1n}	3.80×10^{-1l}	5.00×10^{-3j}
Selenium	7782492	—	2.50×10^{-2h}	1.00×10^{0i}	1.5×10^{-2h}
Vanadium	7440622	—	4.3×10^{-3h}	1.00×10^{0i}	2.50×10^{-3h}
Zinc	7440666	—	9.9×10^{-1j}	3.0×10^{-1k}	1.0×10^{-1j}

^a From MMEDE Database (1994), unless otherwise noted.

^b Based on the log K_{ow} (Travis and Arms, 1988): $\log TF_{\text{soil-to-plant}} = 1.588 - 0.578(\log K_{ow})$.

^c Based on the log K_{ow} (Connell and Markwell, 1990), see Section 6.2.3.

^d Based on food-to-beef transfer factor derived from the log K_{ow} (Travis and Arms, 1988): $\log TF_{\text{food-to-beef}} = -7.735 + 1.033(\log K_{ow})$.

^e From RREL Database.

^f From Ground Water Chemicals Desk Reference (Montgomery, 1996).

^g From Partition Coefficients and Their Uses, (Leo et al., 1971).

^h From Baes, et al. (1984); for soil-to-plant TFs average of vegetative and nonvegetative values used.

ⁱ Default value.

^j From IAEA (1994).

^k From Stafford, et al. (1991).

^l From Ma (1982).

^m NCRP (1989).

ⁿ Arthur and Gates (1988).

Table 6-42

Soil and Sediment

Transfer Factors for Chemicals of Potential Ecological Concern

(Page 3 of 3)

° From RAIS (2003).

Note: TFs are presented in terms of dry weight, except for the organic soil-to-insect TFs which are presented in terms of wet weight. Organic wet weight insect concentrations are converted to dry weight concentrations by multiplying by $1/(1-0.61)$, where 0.61 is the fractional water content in beetles (USEPA, 1993).

Surrogate: 2,3,7,8-TCDD for other chlorinated dioxin and furan congeners.

Table 6-43

**Surface Water
Transfer Factors for Chemicals of Potential Ecological Concern**

Chemical	CAS No.	Water-to-Fish BCF	Food Chain Multiplier (FCM) ^a	Water-to-Fish BAF
INORGANIC				
Aluminum	7429905	100 ^b	1.0	100
Barium	7440393	4 ^c	1.0	4
Iron	7439896	200 ^c	1.0	200
Lead	7439921	300 ^c	1.0	300
Manganese	7439965	400 ^c	1.0	400
Nickel	7440020	100 ^c	1.0	100
Zinc	7440666	1,000 ^c	1.0	1,000

^a Food chain multipliers (FCM) from EPA (1995f).

^b Conservative BCF of 100 used, based on 95% UCL for nonparametric distributions of 54 BCF values presented in IAEA (1994).

^c From IAEA (1994).

Note: TFs are presented in terms of dry weight.
BCF = bioconcentration factor
BAF = bioaccumulation factor
BCF x FCM = BAF (refer to text for discussion).

Table 6-44

**No Observed Adverse Effects Levels (NOAEL)
Used to Derive Wildlife Toxicity Benchmarks
For Chemicals of Potential Ecological Concern**

(Page 1 of 2)

Chemical	Mammals		Birds	
	NOAEL ^a (mg/kg-day)	Test Species	NOAEL ^a (mg/kg-day)	Test Species
ORGANIC				
2-Methylnaphthalene	1.0 ^c	Mouse	NA ^b	NA
4,4'-DDD	0.8 ^c	Rat	0.0028 ^c	Brown pelican
4,4'-DDE	0.8 ^c	Rat	0.0028 ^c	Brown pelican
4,4'-DDT	0.8	Rat	0.0028	Brown pelican
Aroclor 1254	0.068	Mouse	0.18	Pheasant
Aroclor 1260	0.068	Mouse	0.18	Pheasant
Acetone	10	Rat	NA	NA
Acenaphthene	1.0 ^c	Mouse	NA	NA
Acenaphthylene	1.0 ^c	Mouse	NA	NA
Anthracene	1.0 ^c	Mouse	NA	NA
Benzo(a)anthracene	1.0 ^c	Mouse	NA	NA
Benzo(a)pyrene	1.0	Mouse	NA	NA
Benzo(b)fluoranthene	1.0 ^c	Mouse	NA	NA
Benzo(g,h,i)perylene	1.0 ^c	Mouse	NA	NA
Benzo(k)fluoranthene	1.0 ^c	Mouse	NA	NA
Beta-BHC	0.4 ^c	Rat	2.0 ^c	Mallard duck
Carbazole	NA	NA	NA	NA
Chrysene	1.0 ^c	Mouse	NA	NA
Dibenzo(a,h)anthracene	1.0 ^c	Mouse	NA	NA
Dibenzofuran	NA	NA	NA	NA
Fluoranthene	125 ^d	Mouse	NA	NA
Fluorene	1.0 ^c	Mouse	NA	NA
Indeno(1,2,3-cd)pyrene	1.0 ^c	Mouse	NA	NA
Methylene chloride	5.85	Rat	NA	NA
Naphthalene	1.0 ^c	Mouse	NA	NA
Phenanthrene	65.6 ^e	Mouse	NA	NA
Pyrene	75 ^d	Mouse	NA	NA
1,2,3,4,6,7,8-HpCDD	NA	NA	NA	NA
OCDD	NA	NA	NA	NA
Total HpCDD	NA	NA	NA	NA
Total HxCDD	NA	NA	NA	NA
Total PeCDF	NA	NA	NA	NA

Table 6-44

**No Observed Adverse Effects Levels (NOAEL)
Used to Derive Wildlife Toxicity Benchmarks
For Chemicals of Potential Ecological Concern**

(Page 2 of 2)

Chemical	Mammals		Birds	
	NOAEL ^a (mg/kg-day)	Test Species	NOAEL ^a (mg/kg-day)	Test Species
Total TCDF	NA	NA	NA	NA
INORGANIC				
Aluminum	1.93	Mouse	109.7	Ringed dove
Antimony	0.125	Mouse	NA	NA
Arsenic	0.126	Mouse	2.46	Cowbird
Barium	5.1	Rat	20.8	Chick
Beryllium	0.66	Rat	NA	NA
Cadmium	1	Rat	1.45	Mallard duck
Chromium (III)	2,737	Rat	1.0	Black duck
Copper	11.7	Mink	47	Chick
Iron	NA	NA	NA	NA
Lead	8.0	Rat	3.85	American kestrel
Manganese	88	Rat	977	Japanese quail
Mercury	1.01	Mink	0.9	Japanese quail
Nickel	40	Rat	77.4	Mallard duck
Selenium	0.20	Rat	0.4	Mallard duck
Vanadium	0.21	Rat	11.4	Mallard duck
Zinc	160	Rat	14.5	Chickens

^aFrom Sample et al. (1996), unless otherwise noted.

^bNA indicates that the information is not available.

^cSurrogate values were utilized as follows:

1,2-DCE (total) for cis-1,2-DCE.

Benzo(a)pyrene for 2-Methylnaphthalene, Acenaphthene, Acenaphthylene, Anthracene, Benzo(a)anthracene, Benzo(b)fluoranthene, Benzo(g,h,i)perylene, Benzo(k)fluoranthene, Chrysene, Dibenzo(a,h)anthracene, Flourene, Indeno(1,2,3-cd)pyrene, and Naphthalene.

Aroclor 1254 for Aroclor 1260.

4,4'-DDT for 4,4'-DDD and 4,4'-DDE.

Gamma-BHC for Beta-BHC.

^dBased on data from IRIS Database (USEPA, 1998a).

^eBased on the NOAEL for pyrene using the ratio of LD₅₀ values.

Table 6-45
Chemicals of Potential Ecological Concern
For Which Insufficient Toxicological Data Could Be Found
To Estimate NOAELs

Chemical	Maximum Measured Water Concentration (mg/L)	Maximum Measured Sediment Concentration (mg/kg)	Maximum Measured Soil Concentration (mg/kg)
Carbazole	ND	ND	0.22
Dibenzofuran	ND	ND	0.53
1,2,3,4,6,7,8-HpCDD	ND	ND	0.0000031
OCDD	ND	ND	0.00042
Total HpCDD	ND	ND	0.0000068
Total HxCDD	ND	ND	0.00000019
Total PeCDF	ND	ND	0.000001
Total TCDF	ND	ND	0.0000017
Iron	72	170,000	150,000

^a ND indicates that the the constituent was not detected.

Table 6-46

COPEC Soil Benchmark Concentrations for Plants and Soil Invertebrates

(Page 1 of 3)

Constituent	Soil Concentration ^a (mg/kg)	Benchmark Concentrations (in mg/kg) for:		Benchmarks Exceeded?
		Plants ^b	Soil ^c Invertebrates	
Organics				
4,4'-DDE	0.075	NA	NA	NA
4,4'-DDT	0.13	NA	NA	NA
Aroclor 1254	0.044	40	NA	No
Aroclor 1260	0.078	40	NA	No
beta-BHC	0.045	NA	NA	NA
Acenaphthene	0.14	20	NA	No
Acenaphthylene	0.15	NA	NA	NA
Anthracene	0.45	NA	NA	NA
Benzo(a)anthracene	17.0	NA	NA	NA
Benzo(b)fluroanthene	26.0	NA	NA	NA
Benzo(a)pyrene	18.0	NA	NA	NA
Benzo(g,h,i)perylene	10	NA	NA	NA
Benzo(k)fluoranthene	8.8	NA	NA	NA
Carbazole	0.22	NA	NA	NA

Table 6-46

COPEC Soil Benchmark Concentrations for Plants and Soil Invertebrates

(Page 2 of 3)

Constituent	Soil Concentration ^a (mg/kg)	Benchmark Concentrations (in mg/kg) for:		Benchmarks Exceeded?
Chlorinated dioxins and/or furans	0.00000019-0.00038	NA	NA	NA
Chrysene	18.0	NA	NA	NA
Dibenzo(a,h)anthracene	0.58	NA	NA	NA
Dibenzofuran	0.42	NA	NA	NA
Fluoranthene	2.3	NA	NA	NA
Fluorene	0.25	NA	NA	NA
Indeno(1,2,3-cd)pyrene	10	NA	NA	NA
Naphthalene	0.96	NA	NA	NA
Phenanthrene	6.6	NA	NA	NA
Pyrene	18	NA	NA	NA
Inorganics				
Aluminum	17,000	50	NA	Yes (1 of 1)
Arsenic	56	10	60	Yes (1 of 2)
Barium	8,800	550	NA	Yes (1 of 1)
Beryllium	2.1	10	NA	No
Cadmium	1.4	4	20	No
Chromium	230	1.0	0.4	Yes (2 of 2)
Copper	180	100	50	Yes (2 of 2)

Table 6-46

COPEC Soil Benchmark Concentrations for Plants and Soil Invertebrates

(Page 3 of 3)

Constituent	Soil Concentration ^a (mg/kg)	Benchmark Concentrations (in mg/kg) for:		Benchmarks Exceeded?
Iron	120,000	NA	NA	NA
Lead	7,900	50	500	Yes (2 of 2)
Manganese	10,000	500	NA	Yes (1 of 1)
Mercury	0.57	0.3	0.1	Yes
Nickel	130	30	200	Yes (1 of 2)
Selenium	6.5	1.0	70	Yes (1 of 2)
Vanadium	94.0	2	NA	Yes (1 of 1)
Zinc	19,000	50	200	Yes (2 of 2)

^a 95 percent upper confidence limit concentrations presented for COPECs (from Table 6-34).

^b Will and Sutter (1995a)

^c Will and Sutter (1995b)

^d NA = not available.

Table 6-47

Terrestrial Receptors Hazard Index (HI) Summary^a

AOC/Media	Terrestrial Receptor					
	Deer Mouse	Cottontail	Shrew	Robin	Red Fox	Hawk
TAMPEEL Site Soil HI	786	102	3,390	371	29.1	2.68
Risk Drivers:	73% Aluminum (Insect intake)	66% Aluminum (Soil intake)	74% Aluminum (Insect intake)	50% Zinc (Plant intake)	85% Aluminum (Shrew intake)	33% Barium (Soil intake)
	8% Barium (Insect intake)	9% Barium (Soil intake)	7% Barium (Insect intake)	16% DDT (Insect intake)		20% Chromium (Soil intake)
	4% Arsenic (Insect intake)	8% Zinc (Plant intake)	4% Arsenic (Insect intake)	12% Barium (Insect intake)		
Aspen Creek Surface Water HI	0.16	0.17	0.1	0.014	0.032	0.0058
Risk Drivers:	93% Aluminum (Water intake)	92% Aluminum (Water intake)	92% Aluminum (Water intake)	48% Zinc (Water intake)	57% Manganese (Water intake)	48% Zinc (Water intake)
Beaver Pond Surface Water HI	0.092	0.10	0.06	0.002	0.22	<0.001
Risk Drivers:	99% Aluminum (Water intake)	99% Aluminum (Water intake)	99% Aluminum (Water intake)	99% Aluminum (Water intake)	98% Aluminum (Water intake)	85% Lead (Water intake)
Study Pond Surface Water HI	0.001	0.001	<0.001	<0.001	<0.001	<0.001
Risk Drivers:	100% Manganese (Water intake)	100% Manganese (Water intake)	100% Manganese (Water intake)	100% Manganese (Water intake)	100% Manganese (Water intake)	100% Manganese (Water intake)
Total Receptor HI	786 ^b	102 ^b	3,390 ^b	371 ^b	29.3 ^b	2.68 ^b

^a Details presented in ecological risk assessment spreadsheets in Appendix J.

^b Exposure to surface water from Aspen Creek was assumed to be 100% for all receptors since hazards were typically highest at this surface water body.

Table 6-48
Aquatic Receptors Hazard Index (HI) Summary^a

AOC/Media	Aquatic Receptor	
	Great Blue Heron	Beaver
TAMPEEL Site Soil HI	^b	35
Risk Drivers:		37% Zinc (Plant intake)
		24% Manganese (Plant intake)
		15% Barium (Plant intake)
Aspen Creek Surface Water HI	30	0.46
Risk Drivers:	86% Zinc (Fish intake)	93% Aluminum (Water intake)
Beaver Pond SW HI	1.46	0.264
Risk Drivers:	48% Aluminum (Fish intake)	98% Aluminum (Water intake)
Study Pond SW HI	0.4	0.004
Risk Drivers:	100% Manganese (Fish intake)	100% Manganese (Water intake)
Aspen Creek Sediment HI	90	31
Risk Drivers:	53% DDD (Aq. invertebrate intake)	94% Aluminum (Sediment intake)
	34% DDT (Aq. invertebrate intake)	
	9% DDE (Aq. invertebrate intake)	
Beaver Pond Sediment HI	28	28
Risk Drivers:	52% DDT (Aq. invertebrate intake)	90% Aluminum (Sediment intake)
	27% DDE (Aq. invertebrate intake)	8% Arsenic (Sediment intake)
Study Pond Sediment HI	2.8	50
Risk Drivers:	82% Aluminum (Aq. invert. intake)	98% Aluminum (Sediment intake)
Total Receptor HI^c	120 ^c	85 ^c

^aDetails presented in ecological risk assessment spreadsheets (Appendix J).

^bPathway incomplete; herons do not eat soil or soil-associated prey.

^cThe total receptor HIs for heron and beaver are based on exposure to surface water and sediment with the highest estimated hazards.

Note: Beaver HI also includes indirect soil exposure.

Table 6-49

Surface Water Quality

(Page 1 of 2)

COPEC	AOC Concentration (ug/L)			Assessment Benchmarks (ug/L)				Benchmarks Exceeded?		
	Study Pond	Beaver Pond	Aspen Creek	AWQC ^a	Tier II ^b	USEPA Region 4 ^c	Other ^d	Study Pond	Beaver Pond	Aspen Creek
Aluminum	-	1,400	2,300	750 (acute) 87 (chronic)	NA	same as AWQC	460	-	Yes (3/3)	Yes (3/3)
Barium	-	-	300	-	69.1 (acute) 3.8 (chronic)	-	5,800	-	-	Yes (2/3)
Iron	-	4,200	72,000	1,000 (chronic)	NA	same as AWQC	158	-	Yes (2/2)	Yes (2/2)
Lead	-	7.1	15	82 (acute) 3.2 (chronic)	NA	33.78 (acute) 1.32 (chronic)	12.26	-	Yes (2/5)	Yes (3/5)
Manganese	1,700	2,100	10,000	NA	1,470 (acute) 80.3 (chronic)	NA	<1,100	Yes (3/3)	Yes (3/3)	Yes (3/3)
Nickel	-	-	68	1,400 (acute) 160 (chronic)	-	78.9 (acute) 87.71 (chronic)	<5	-	-	Yes (1/5)
Zinc	-	-	680	120 (acute) 110 (chronic)	-	65.04 (acute) 58.91 (chronic)	30	-	-	Yes (5/5)

Table 6-49

Surface Water Quality
(Page 2 of 2)

NA = not available.

^a Ambient water quality criteria for the protection of aquatic life (USEPA, 1986).

^b Values calculated using Great Lakes Water Quality Initiative Tier II methodology, as summarized in Eco Update (EPA, 1996d).

^c Screening concentration from Supplemental Guidance to RAGS: USEPA Region 4 Bulletins - Ecological Risk (USEPA, 1995g)

^d Lowest chronic value for organisms (Suter and Mabrey, 1994).

Table 6-50
Sediment Quality
(Page 1 of 3)

COPEC	AOC Concentrations (mg/kg) ^a			Assessment Benchmarks (mg/kg)				Benchmarks Exceeded?		
	Study Pond	Beaver Pond	Aspen Creek	NOAA ER-L ^b	NOAA ER-M ^c	FDEP TEL ^d	FDEP PEL ^e	Study Pond	Beaver Pond	Aspen Creek
Organics										
2-methylnaphthalene	- ^f	0.4	-	0.070	0.67	0.0202	0.201	-	Yes (3/4)	-
4,4'-DDD	-	0.10	1.4	0.002	0.02	0.00122	0.00781	-	Yes (4/4)	Yes (4/4)
4,4'-DDE	-	0.20	0.22	0.0022	0.027	0.0021	0.374	-	Yes (3/4)	Yes (3/4)
4,4'-DDT	-	0.44	0.9	0.00158	0.0461	0.00389	0.0517	-	Yes (4/4)	Yes (4/4)
Acetone	0.1	69	0.12	NA	NA	NA	NA	No	No	No
Anthracene	-	-	0.83	0.0853	1.1	0.047	0.245	-	-	Yes (3/4)
Benzo(a)anthracene	-	0.22	0.98	0.261	1.6	0.0748	0.693	-	Yes (1/4)	Yes (3/4)
Benzo(a)pyrene	-	0.46	0.69	0.43	1.6	0.0888	0.763	-	Yes (2/4)	Yes (2/4)
Benzo(b)fluoranthene	-	0.88	0.84	NA	NA	NA	NA	-	No	No
Benzo(g,h,i)perylene	-	0.32	-	NA	NA	NA	NA	-	No	-
Chrysene	-	0.37	0.83	0.384	2.8	0.108	0.846	-	Yes (1/4)	Yes (2/4)
Fluoranthene	0.48	1.0	1.8	0.6	5.1	0.113	1.494	Yes (1/4)	Yes (2/4)	Yes (3/4)
Indeno(1,2,3-cd)pyrene	-	0.31	-	NA	NA	NA	NA	-	No	-
Methylene chloride	-	-	0.0087	NA	NA	NA	NA	-	-	No
Phenanthrene	-	0.74	2.3	0.24	1.5	0.0867	0.544	-	Yes (3/4)	Yes (4/4)
Pyrene	0.45	0.72	1.5	0.665	2.6	0.153	1.398	Yes (1/4)	Yes (2/4)	Yes (3/4)

Table 6-50
Sediment Quality
(Page 2 of 3)

COPEC	AOC Concentrations (mg/kg) ^a			Assessment Benchmarks (mg/kg)				Benchmarks Exceeded?		
	Study Pond	Beaver Pond	Aspen Creek	NOAA ER-L ^b	NOAA ER-M ^c	FDEP TEL ^d	FDEP PEL ^e	Study Pond	Beaver Pond	Aspen Creek
Inorganics										
Aluminum	23,000	12,000	14,000	NA	NA	NA	NA	No	No	No
Antimony	-	4.7	-	2	25	NA	NA	-	Yes (1/2)	-
Arsenic	18	67	27	8.2	70	7.24	41.6	Yes (2/4)	Yes (3/4)	Yes (2/4)
Barium	130	110	740	NA	NA	NA	NA	No	No	No
Cadmium	-	3.7	2.8	1.2	9.6	0.68	4.21	-	Yes (2/4)	Yes (2/4)
Chromium	31	17	67	81	370	52.3	160	No	No	Yes (2/4)
Copper	29	39	220	34	270	18.7	108	Yes (1/4)	Yes (2/4)	Yes (3/4)
Iron	41,000	32,000	150,000	NA	NA	NA	NA	No	No	No
Lead	29	67	77	46.7	218	30.2	112	-	Yes (2/4)	Yes (2/4)
Manganese	1,200	990	5,900	NA	NA	NA	NA	No	No	No
Mercury	-	0.14	-	0.015	0.71	0.13	0.7	-	Yes (2/4)	-
Nickel	35	18	280	20.9	51.6	15.9	42.8	Yes (2/4)	Yes (1/4)	Yes (4/4)
Selenium	2.8	3.5	-	NA	NA	NA	NA	No	No	-
Vanadium	42	22	31	NA	NA	NA	NA	No	No	No
Zinc	130	1,300	2,100	150	410	124	271	Yes (1/4)	Yes (4/4)	Yes (4/4)

Table 6-50

Sediment Quality
(Page 3 of 3)

- ^a 95 percent UCL concentrations presented for selected COPECs for each Area of Concern (AOC), from Tables 6-31, 6-32, and 6-33.
- ^b Effects Range - Low, developed by NOAA (Long and Morgan, 1990), updated by Long et al. (1995), and summarized in Jones, et al. (1996).
- ^c Effects Range - Medium, developed by NOAA (Long and Morgan, (1990), updated by Long et al. (1995), and summarized in Jones, et al. (1996).
- ^d Florida Dept. of Environmental Protection, threshold effects level, summarized in Jones et al. (1996).
- ^e Florida Dept. of Environmental Protection, probable effects level, summarized in Jones et al. (1996).
- ^f - indicates sediment constituent not selected as a COPEC for indicated Area of Concern.

Table 6-51

Terrestrial Receptors Hazard Index (HI) Summary with the Exclusion of Aluminum in Soil ^a

AOC/Media	Terrestrial Receptor					
	Deer Mouse	Cottontail	Shrew	Robin	Red Fox	Hawk
TAMPEEL Site Soil HI	211	35	870	355	4.4	2.4
Risk Drivers:	28% Barium (Insect intake)	27% Barium (Soil intake)	29% Barium (Insect intake)	52% Zinc (Plant intake)	22% Benzo(k)fluoranthene (Shrew intake)	34% Barium (Soil intake)
	14% Arsenic (Insect intake)	23% Zinc (Plant intake)	15% Arsenic (Insect intake)	16% DDT (Insect intake)	16% Chrysene (Shrew intake)	22% Chromium (Soil intake)
	9% Benzo(b)fluoranthene (Insect intake)	15% Manganese (Plant intake)	10% Benzo(b)fluoranthene (Insect intake)	11% Barium (Insect intake)	15% Benzo(a)anthracene (Shrew intake)	
Aspen Creek Surface Water HI	0.16	0.17	0.1	0.014	0.032	0.0058
Risk Drivers:	93% Aluminum (Water intake)	92% Aluminum (Water intake)	92% Aluminum (Water intake)	48% Zinc (Water intake)	57% Manganese (Water intake)	48% Zinc (Water intake)
Beaver Pond Surface Water HI	0.092	0.10	0.06	0.002	0.22	<0.001
Risk Drivers:	99% Aluminum (Water intake)	99% Aluminum (Water intake)	99% Aluminum (Water intake)	99% Aluminum (Water intake)	98% Aluminum (Water intake)	85% Aluminum (Water intake)
Study Pond Surface Water HI	0.001	0.001	<0.001	<0.001	<0.001	<0.001
Risk Drivers:	100% Manganese (Water intake)	100% Manganese (Water intake)	100% Manganese (Water intake)	100% Manganese (Water intake)	100% Manganese (Water intake)	100% Manganese (Water intake)
Total Receptor HI	211 ^b	35 ^b	870 ^b	355 ^b	4.7 ^b	2.4 ^b

^a Details presented in ecological risk assessment spreadsheets in Appendix J.

^b Exposure to surface water from Aspen Creek was assumed to be 100% for all receptors since hazards were typically highest at this surface water body.

Table 6-52
Predominant Chemicals of Potential Concern (Risk Drivers)
for the Human Health Risk Assessment

Risk Drivers ^a	Soil	Surface Water			Sediment			Groundwater
		Aspen Creek	Beaver Pond	Study Pond	Aspen Creek	Beaver Pond	Study Pond	
Inorganic								
Aluminum								X
Arsenic	X				X	X	X	
Iron	X							X
Manganese	X							
Thallium								X
VOCs								
No Risk Drivers								
SVOCs								
Benzo(a)pyrene	X							
Dibenz(a,h)anthracene	X							
Pesticides/PCBs								
No Risk Drivers								

^a Risk drivers = chemicals with cancer risk greater than 1×10^{-6} or hazard index greater than one.

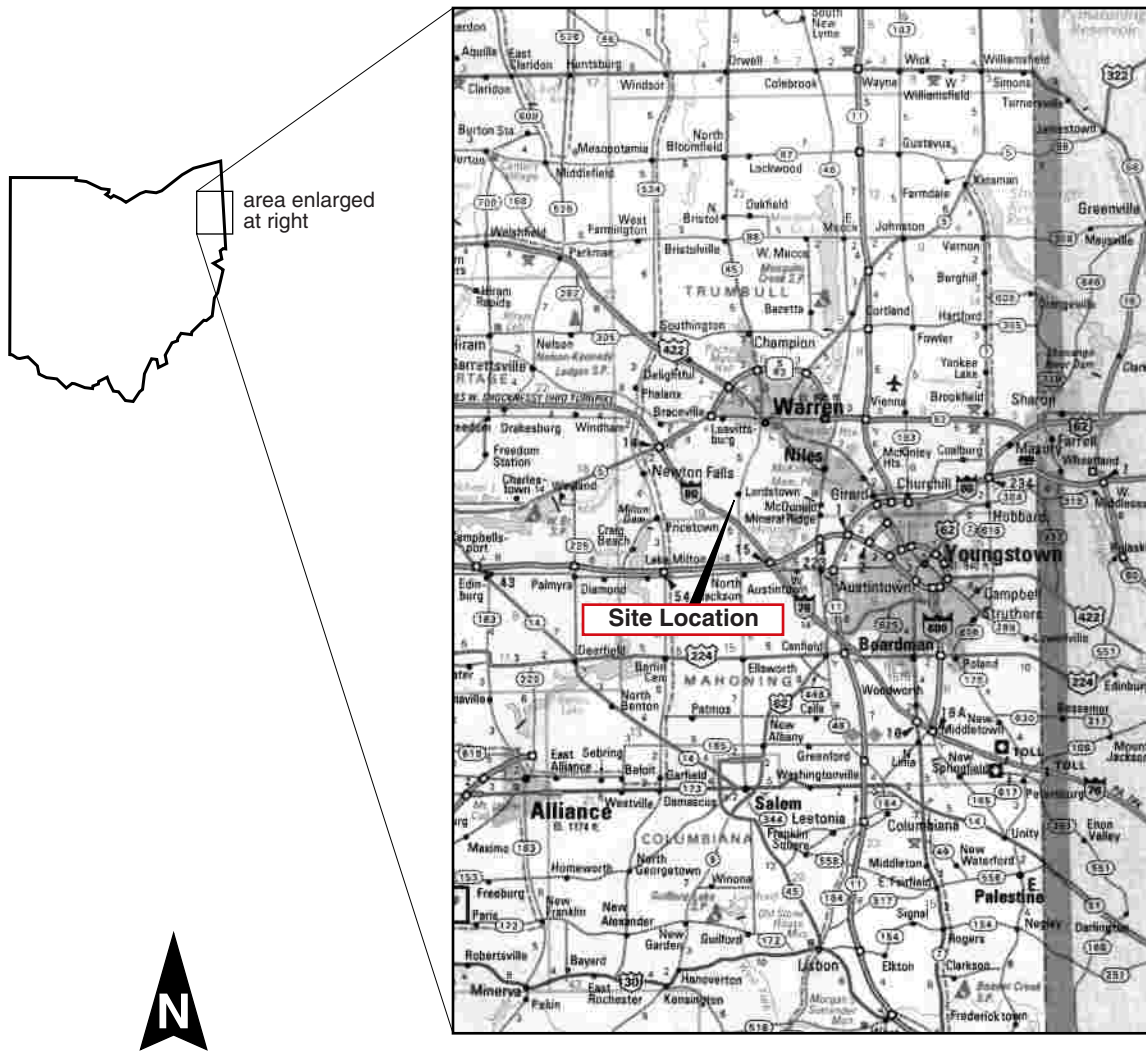
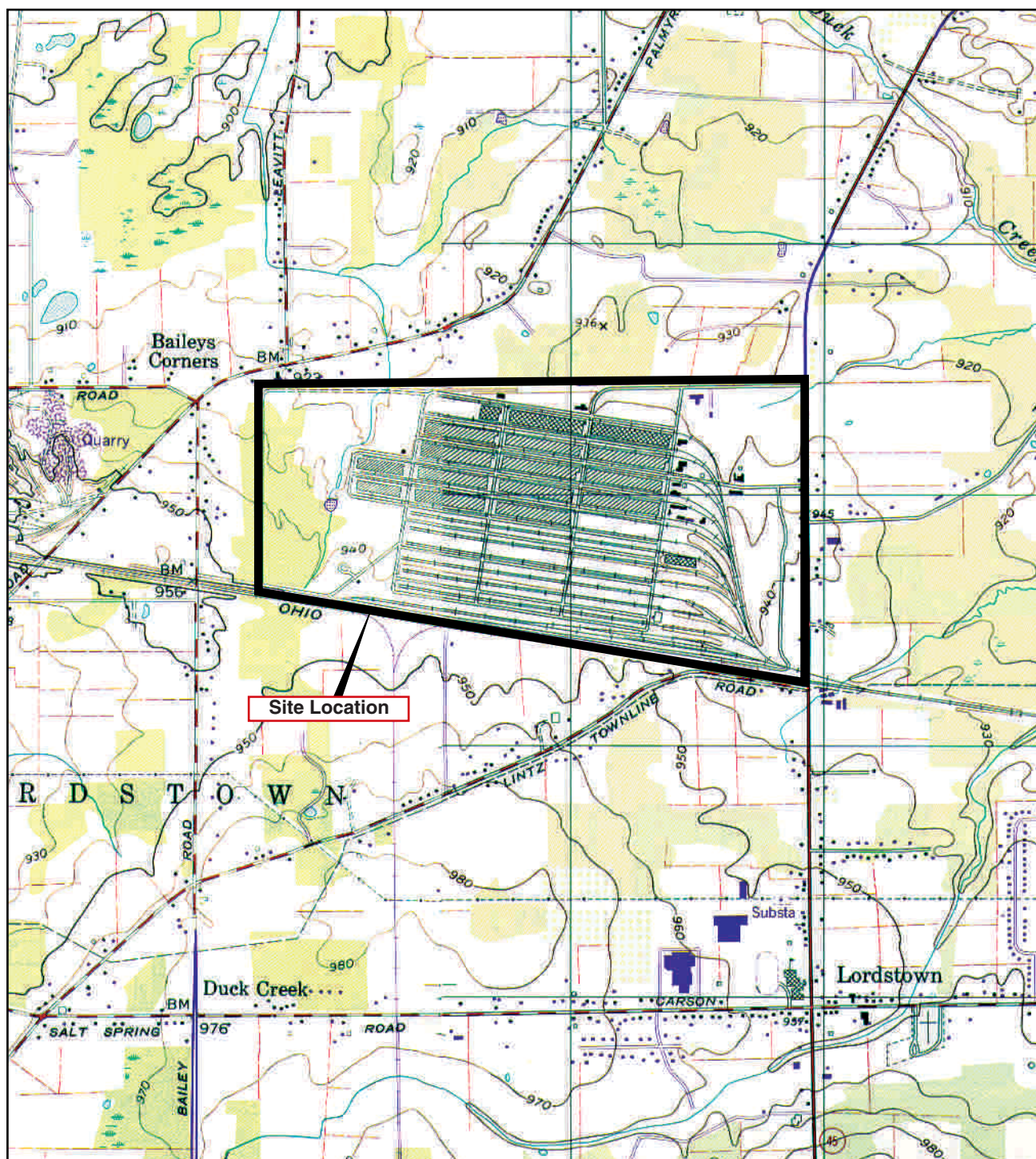


Figure 1-1. Site Location Map.



Site Location



0 1/4 1/2 1

Scale in Miles

Quadrangle Location

Ohio

Warren, Ohio & Newton Falls, Ohio
Quadrangles,
USGS 7.5 minute series

DRAWING NO.
K-802873-0500-6-99-1w

4/20/00	4/20/00
---------	---------

TC	KVK
----	-----

CHECKED BY
APPROVED BY

KMS
6/16/99

DRAWING
BY

Figure 1-2. Site Vicinity Map.

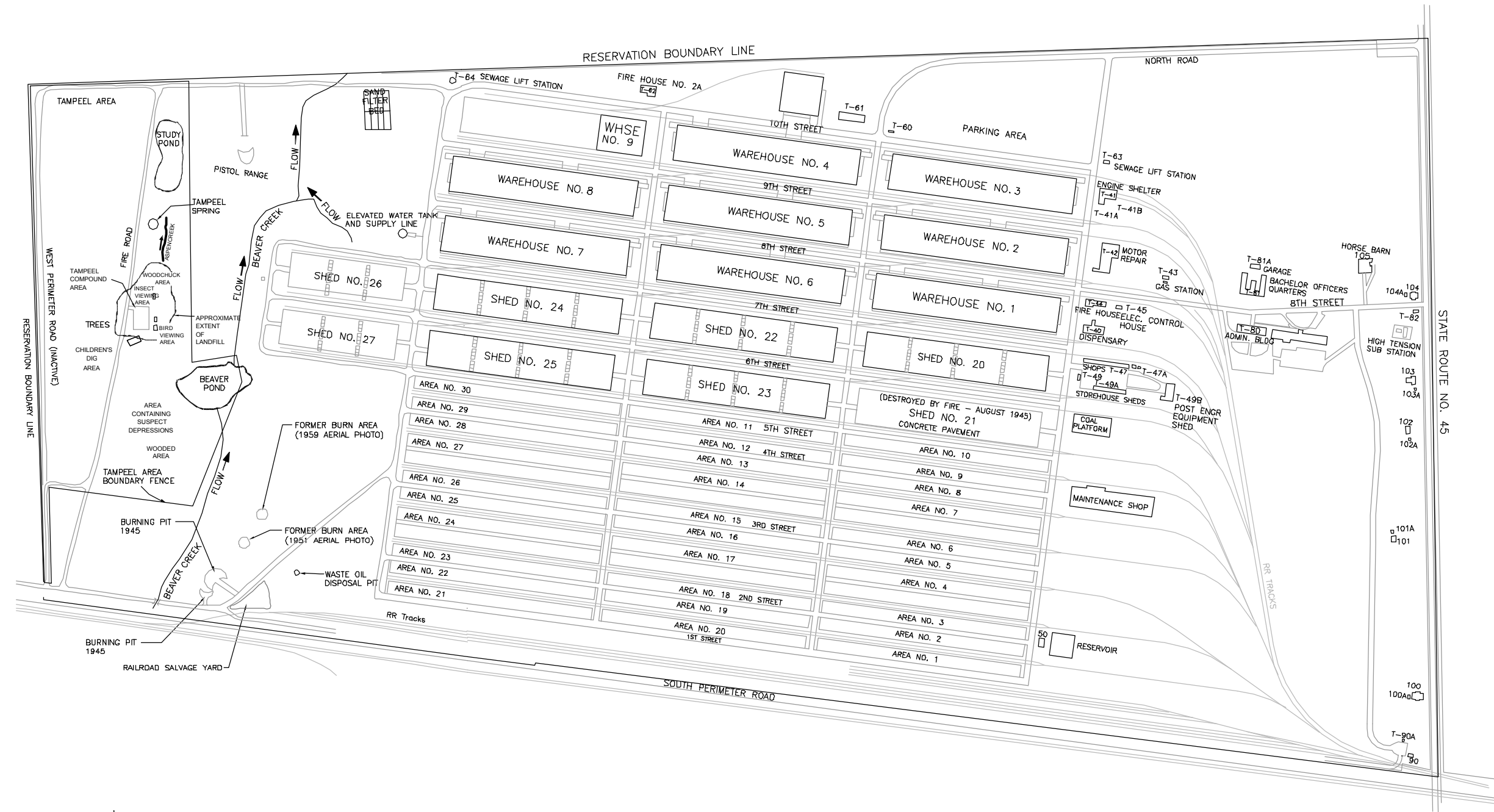
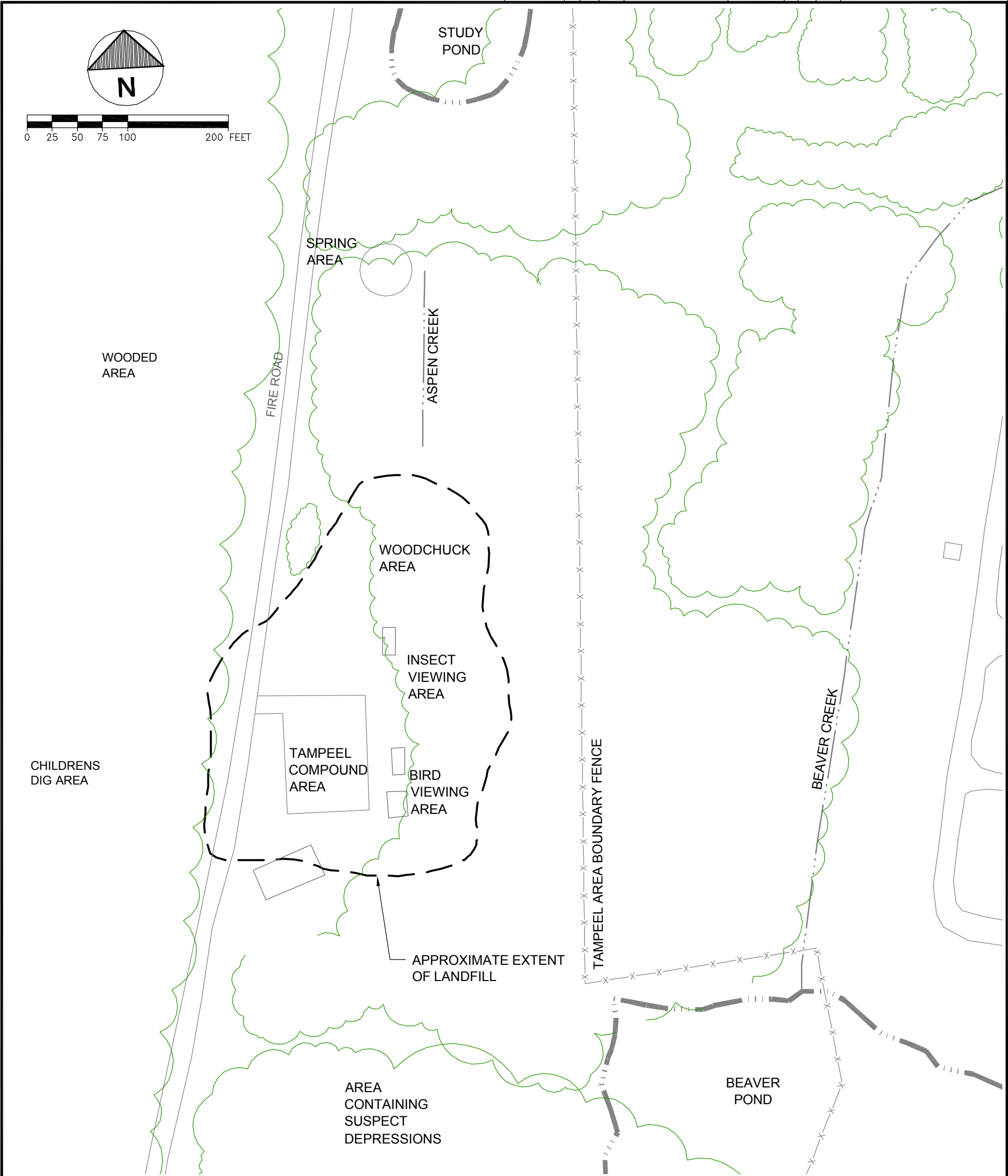


Figure 1-3
FACILITY LAYOUT MAP
 PREPARED FOR
FORMER LORDSTOWN
ORDNANCE DEPOT



DRAWN BY	KMS	CHECKED BY	LC	5/19/05	DRAWING NUMBER	2003 66-02.DWG
	4/11/01	APPROVED BY	KVK	5/19/05		

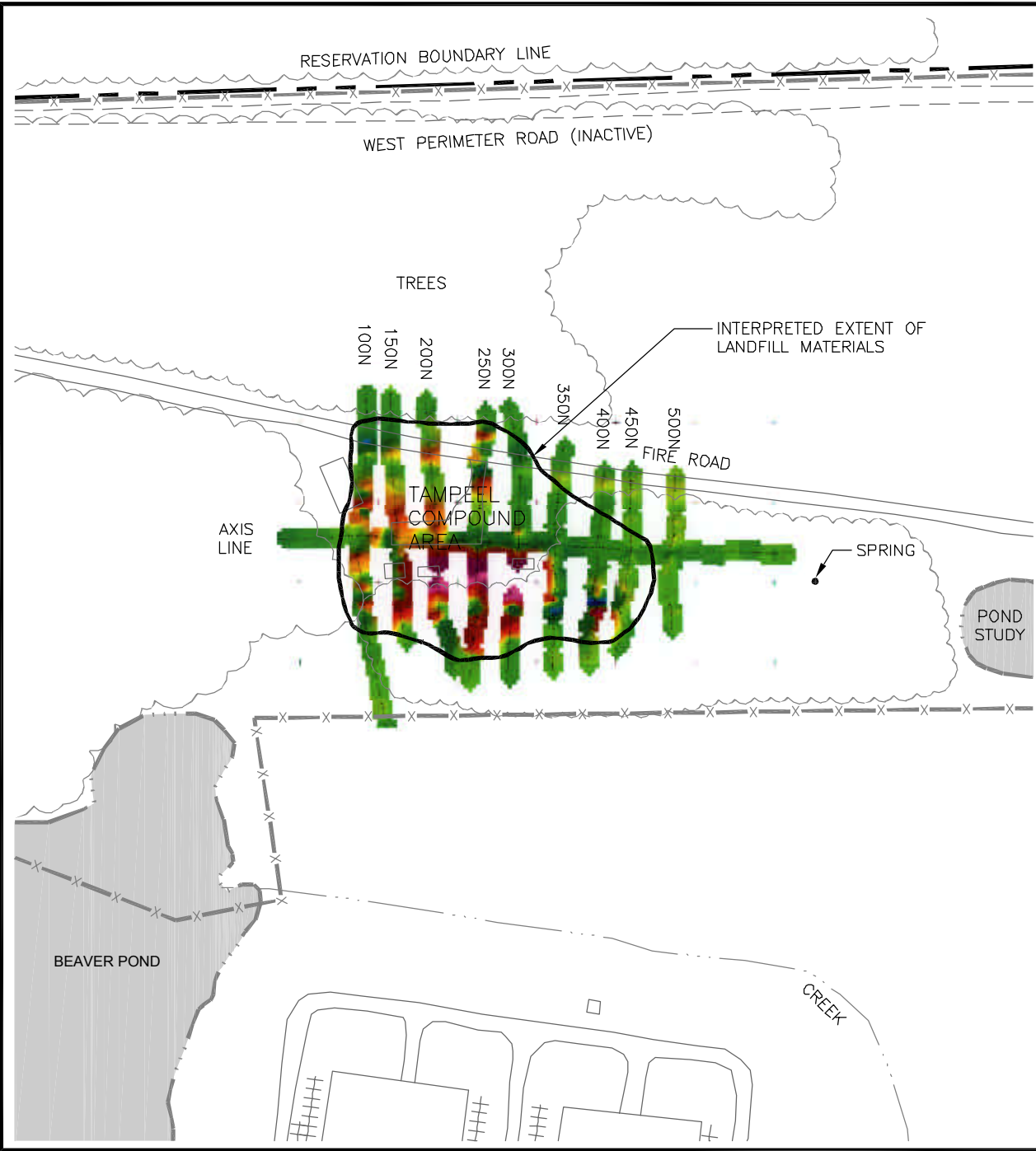


**Figure 1-4
TAMPEEL INVESTIGATION
SITE MAP**

PREPARED FOR

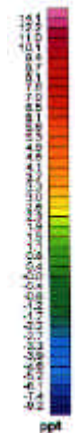
**REMEDIAL INVESTIGATION
FORMER LORDSTOWN
ORDNANCE DEPOT**





LEGEND:

- x— FENCE LINE
- ~~~~~ TREE LINE
- +++++ RAILROAD TRACKS



KEY

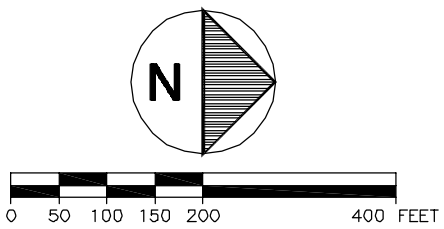


Figure 2-1
Magnetic Field-Upper Sensor
Geophysics Results of
Tampeel Area Site Map

PREPARED FOR

Former Lordstown
Ordnance Depot



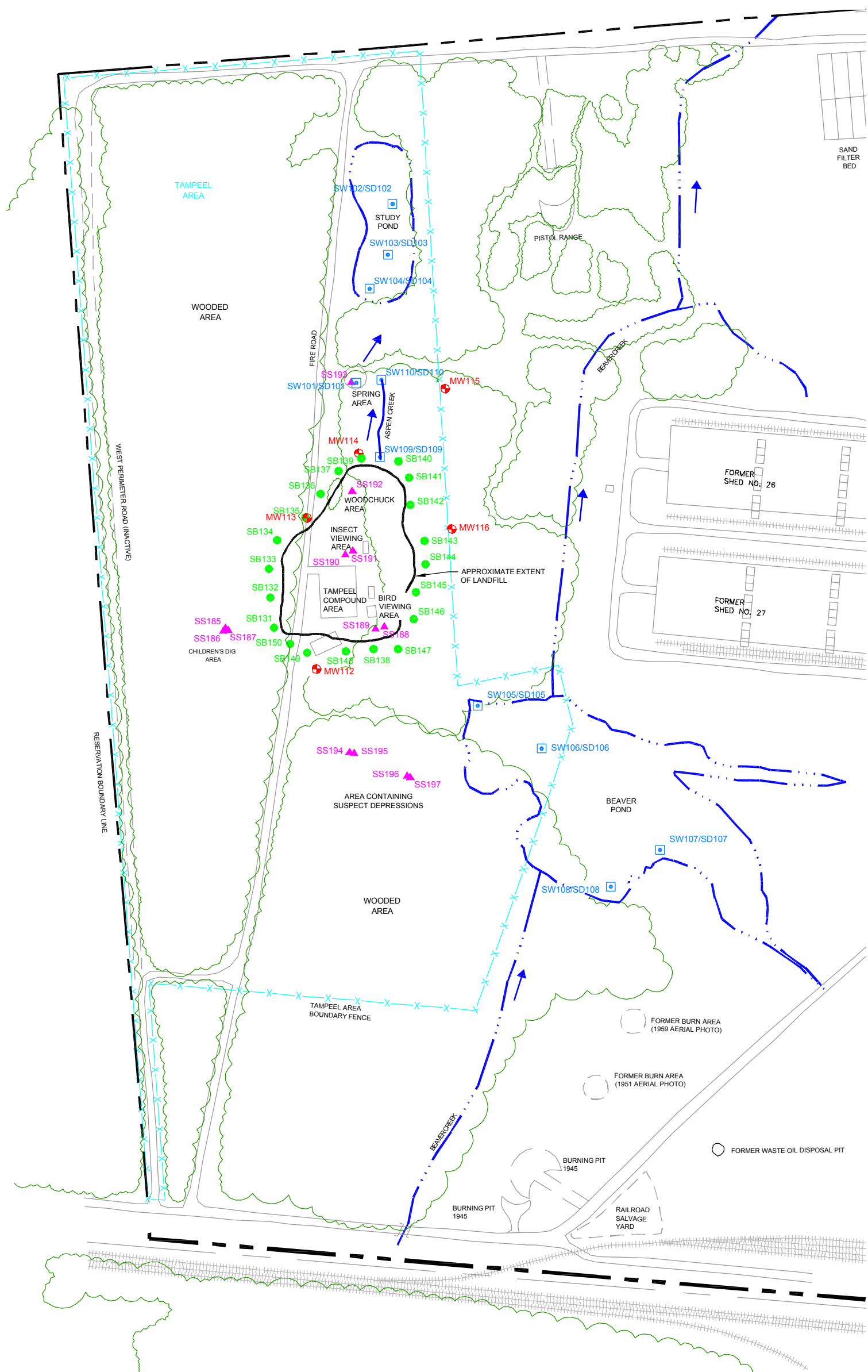


Figure 2-2
TAMPEEL INVESTIGATION
RI SAMPLING LOCATIONS

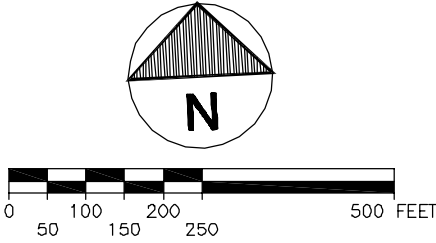
PREPARED FOR

FORMER LORDSTOWN
ORDNANCE DEPOT



LEGEND:

- MONITORING WELL LOCATION
- SOIL BORING LOCATIONS
- SURFACE WATER / SEDIMENT SAMPLES
- SURFACE SOIL SAMPLES



DRAWN BY	MSN	CHECKED BY	LC	5/19/05	DRAWING NUMBER	2003 66-05.DWG
	7/16/99	APPROVED BY	KVK	5/19/05		

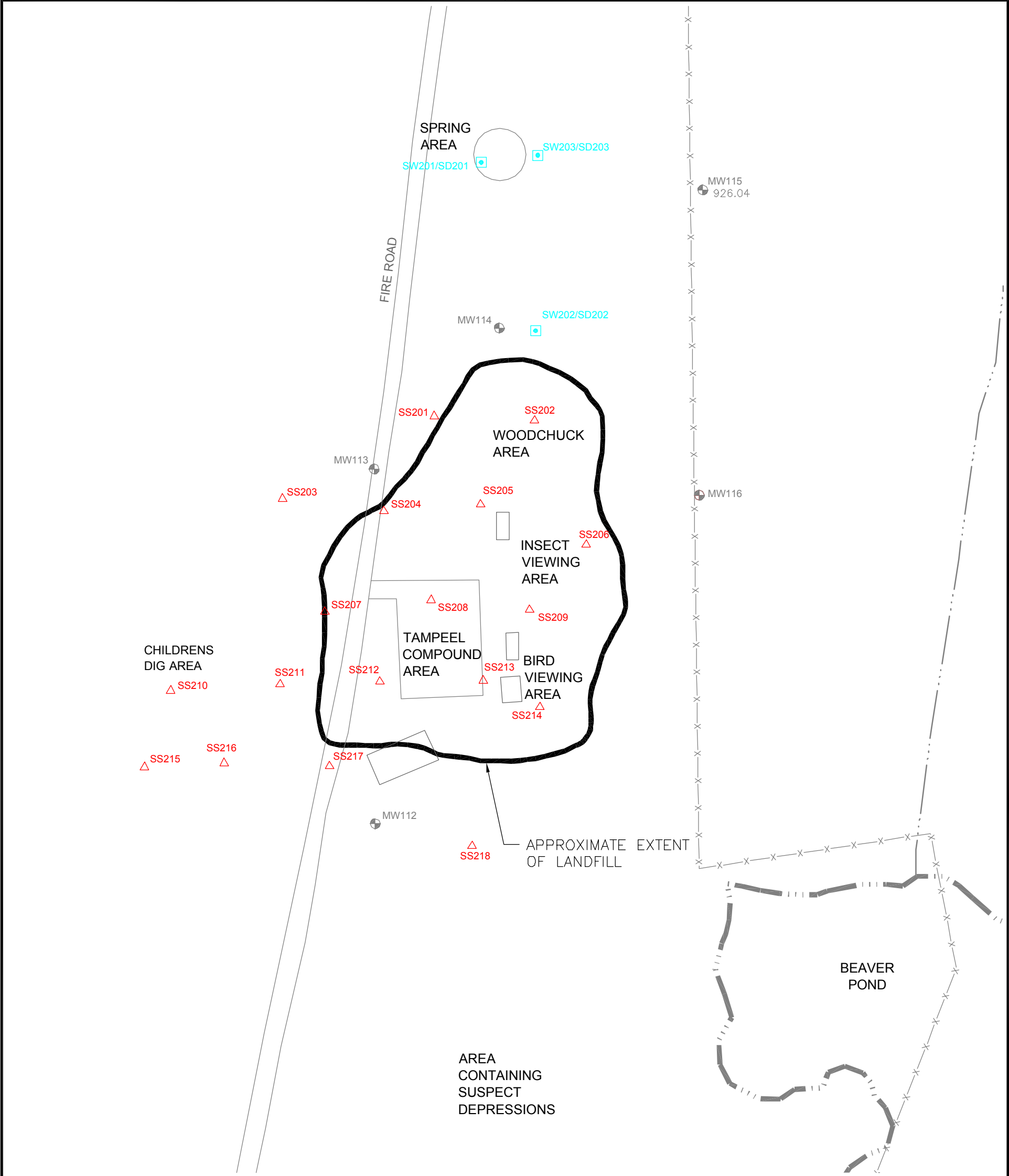


Figure 2-3

TAMPEEL INVESTIGATION
SRI SAMPLING LOCATIONS

PREPARED FOR

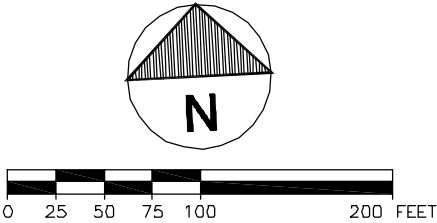
FORMER LORDSTOWN
ORDNANCE DEPOT



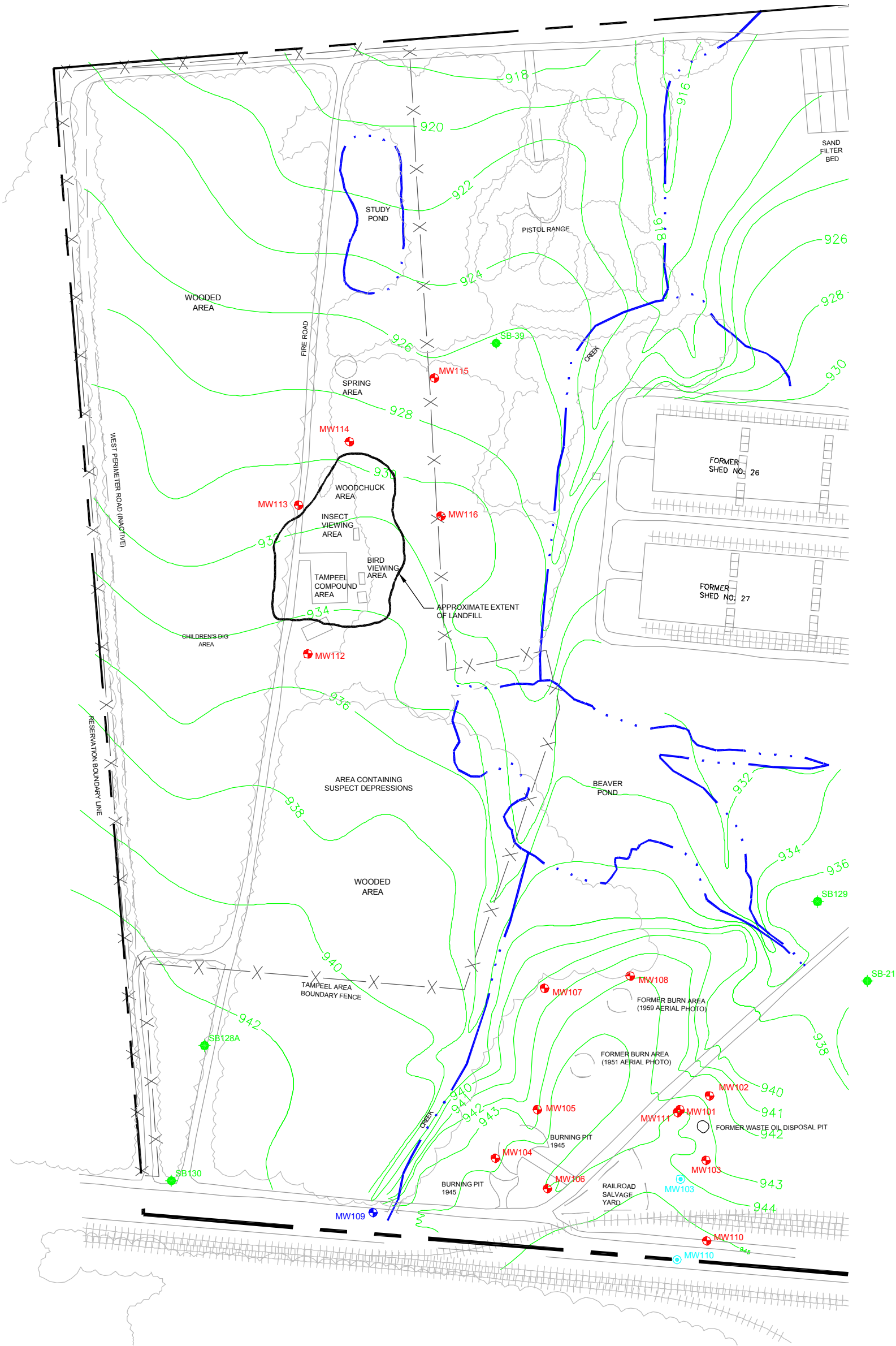
LEGEND:

- MW101 MONITORING WELL LOCATION
- SS201 SURFACE SOIL SAMPLE LOCATION
- SURFACE WATER / SEDIMENT SAMPLES

NOTE: SAMPLE LOCATIONS FOR SW204/SD204
AND SD205 NOT SHOWN.



DRAWN BY	MSN	CHECKED BY	CN	5/19/05	DRAWING NUMBER
	8/11/99	APPROVED BY	KVK	5/19/05	2003 66-06.DWG



LEGEND:

- MONITORING WELL LOCATIONS
- BACKGROUND SAMPLE LOCATION
- BACKGROUND GROUNDWATER AND SOIL SAMPLE LOCATION
- BACKGROUND GROUNDWATER SAMPLE LOCATION

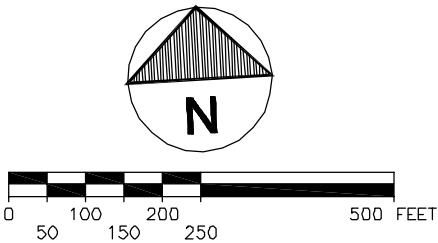


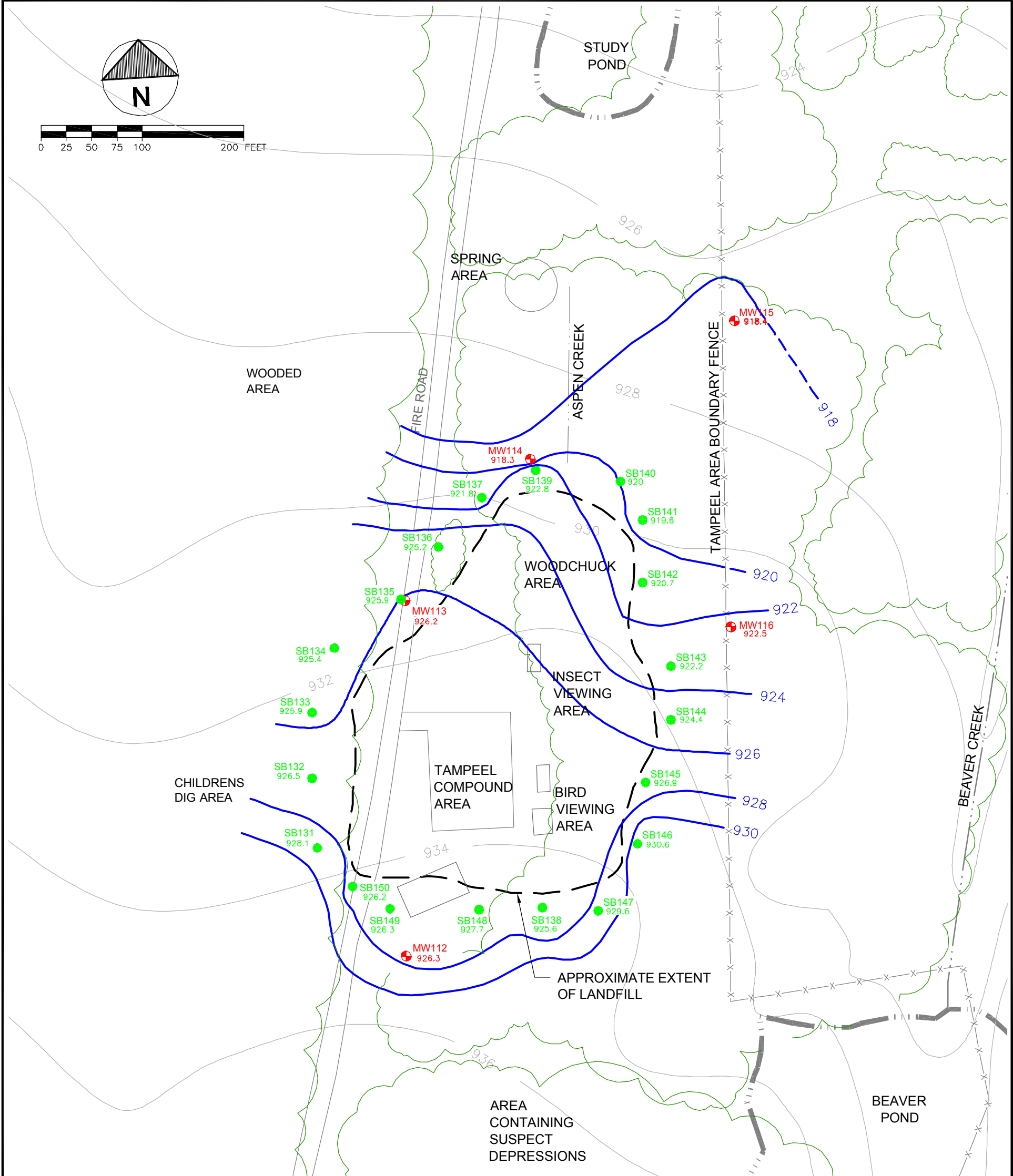
Figure 3-1
TAMPEEL AREA TOPOGRAPHIC MAP

PREPARED FOR

FORMER LORDSTOWN
ORDNANCE DEPOT



DRAWN BY	MSN	CHECKED BY	DR	5/19/05	DRAWING NUMBER	2003 66-07.DWG
	4/11/01	APPROVED BY	KVK	5/19/05		



**Figure 3-2
TAMPEEL BEDROCK SURFACE
CONTOUR MAP**

PREPARED FOR

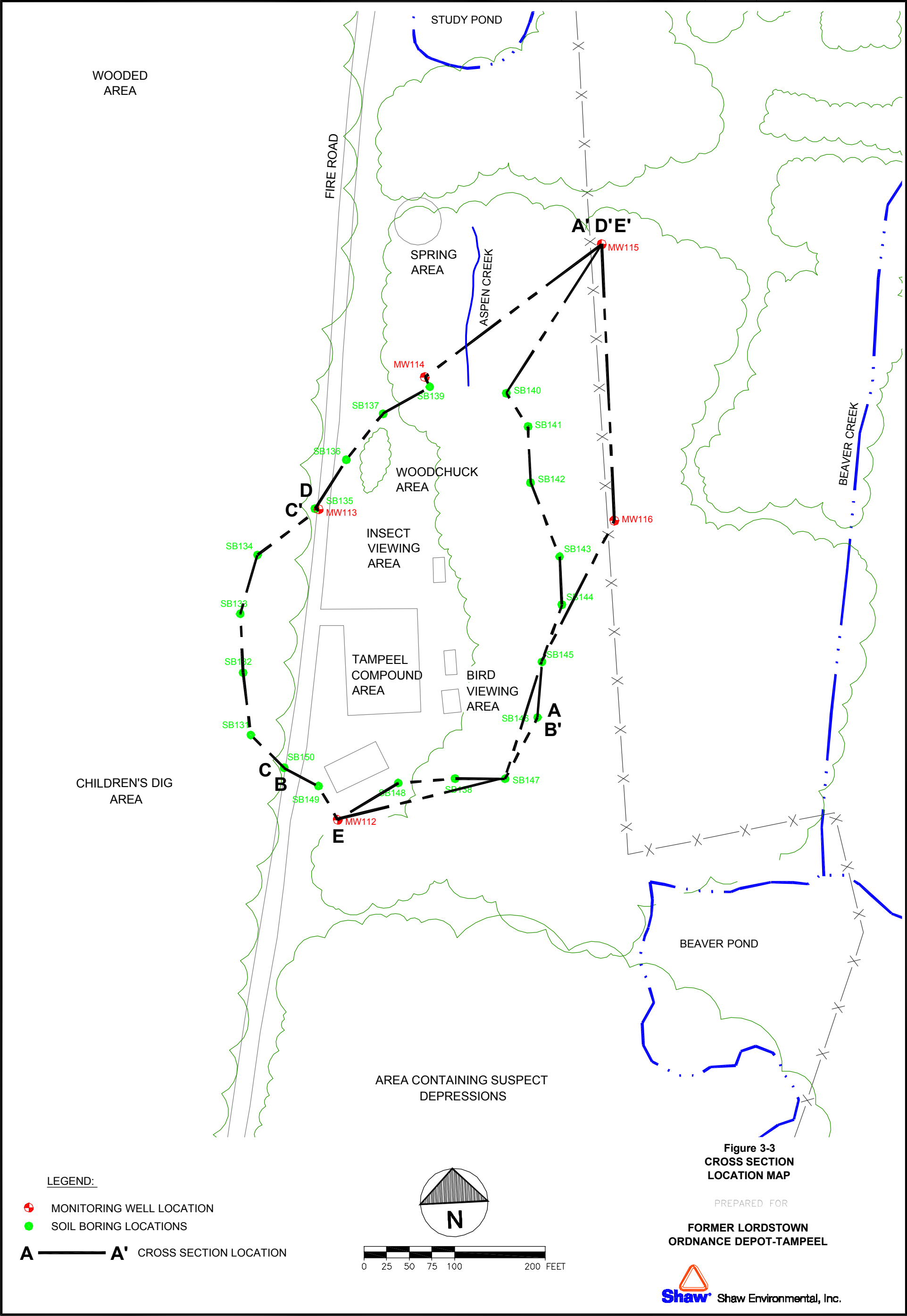
**FORMER LORDSTOWN
ORDNANCE DEPOT-TAMPEEL**

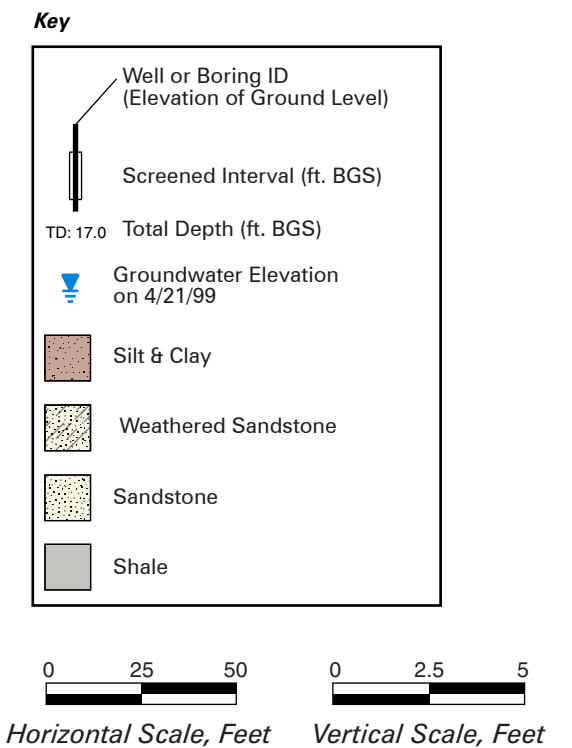
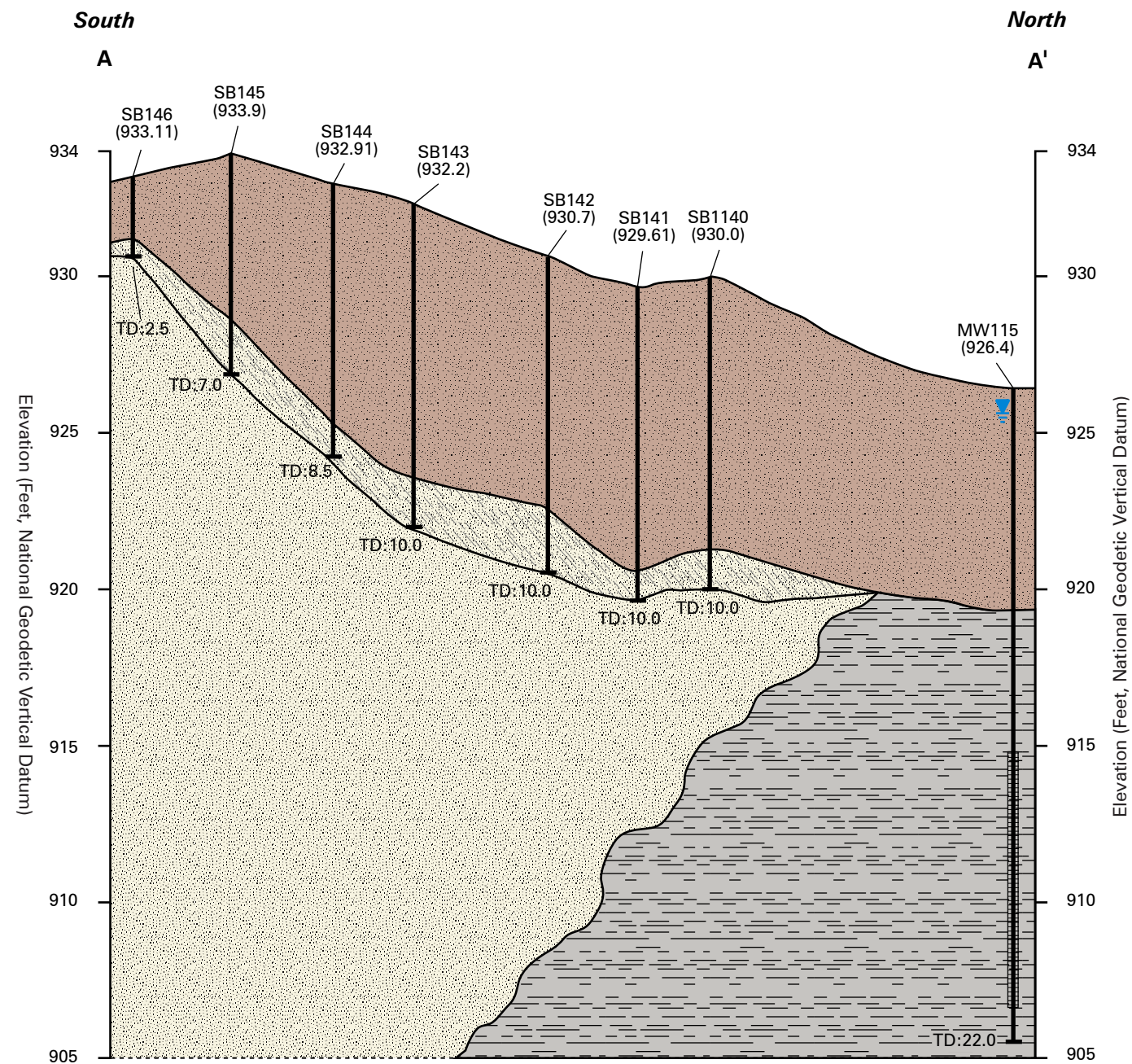


LEGEND:

- MW112 MONITORING WELL LOCATIONS
- SB150 SOIL BORING SAMPLE LOCATIONS (1999)
- 936 GROUND SURFACE CONTOUR
- 930 BEDROCK SURFACE CONTOUR

DRAWN BY	MSN	CHECKED BY	LC	5/19/05	DRAWING NUMBER	2003 66-08.DWG
	8/11/99	APPROVED BY	KVK	5/19/05		





**Figure 3-4.
GEOLOGICAL CROSS SECTION A'-A.**

PREPARED FOR
**FORMER LORDSTOWN
ORDNANCE DEPOT - TAMPEEL**

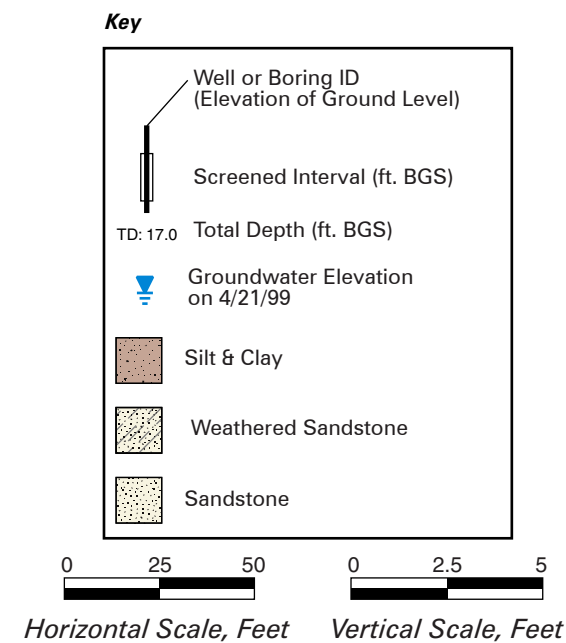
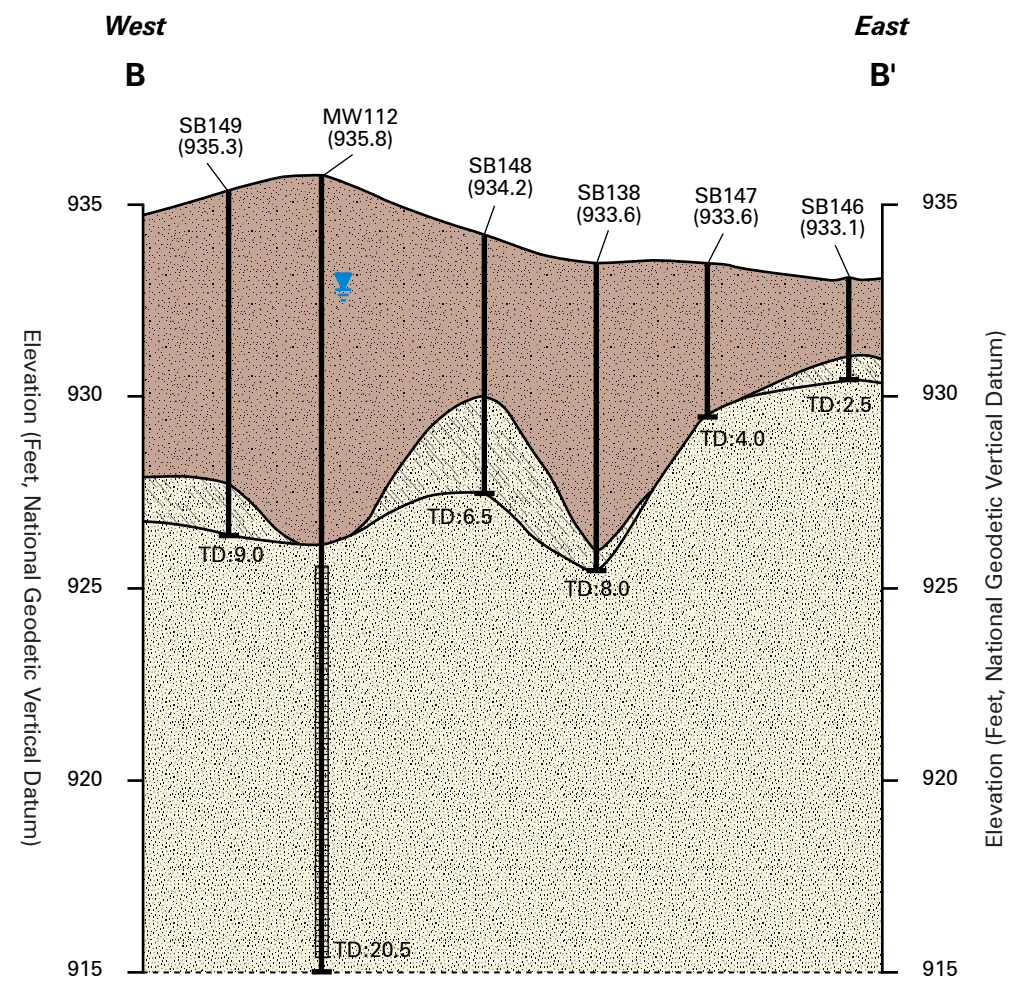


Figure 3-5.
GEOLOGICAL CROSS SECTION B'-B.

PREPARED FOR
**FORMER LORDSTOWN
ORDNANCE DEPOT - TAMPEEL**

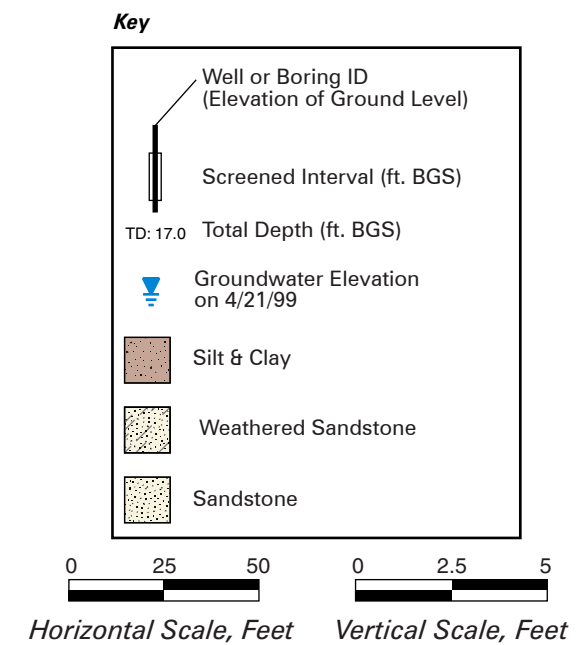
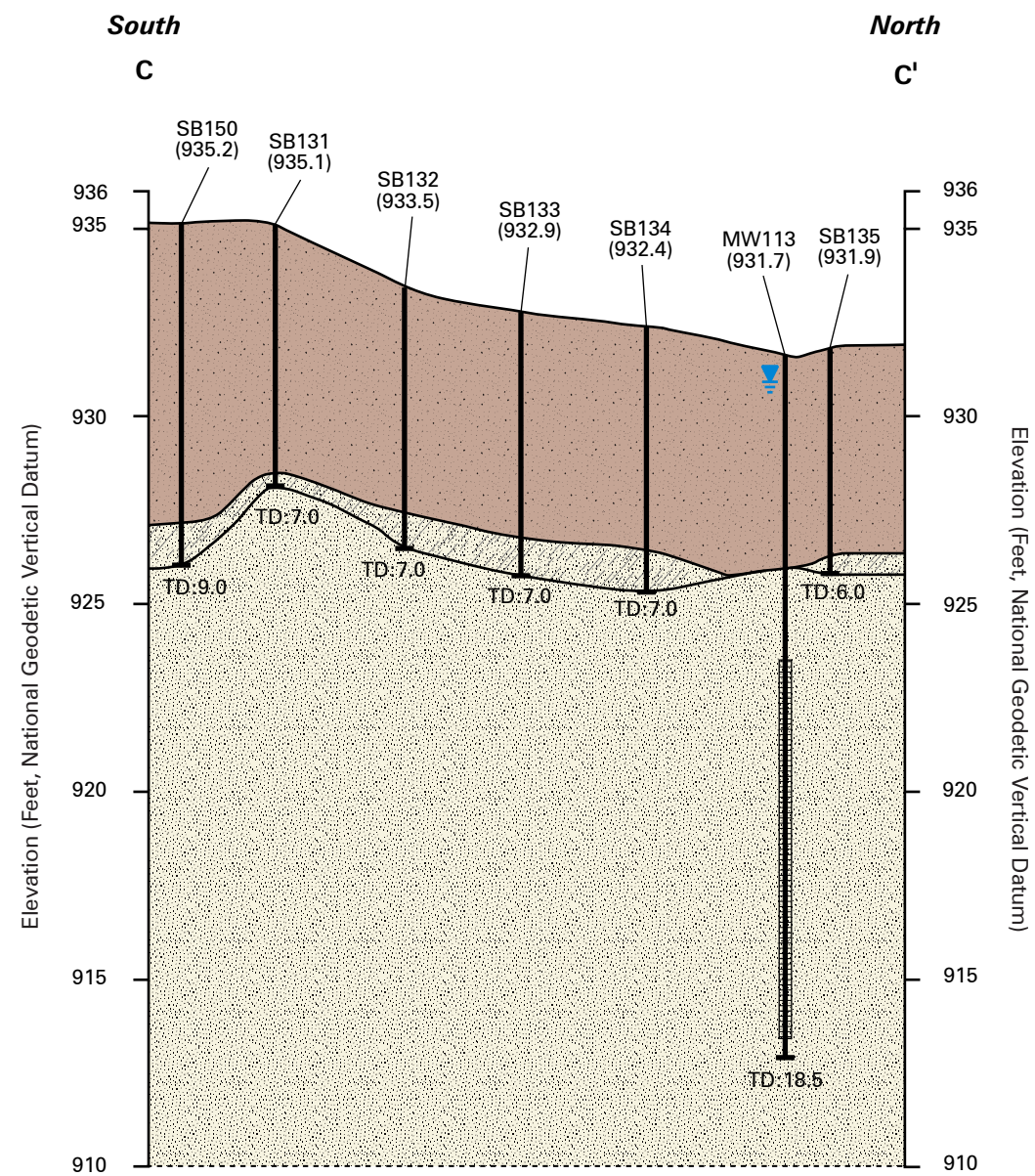


Figure 3-6.
GEOLOGICAL CROSS SECTION C'-C.

PREPARED FOR
**FORMER LORDSTOWN
ORDNANCE DEPOT - TAMPEEL**

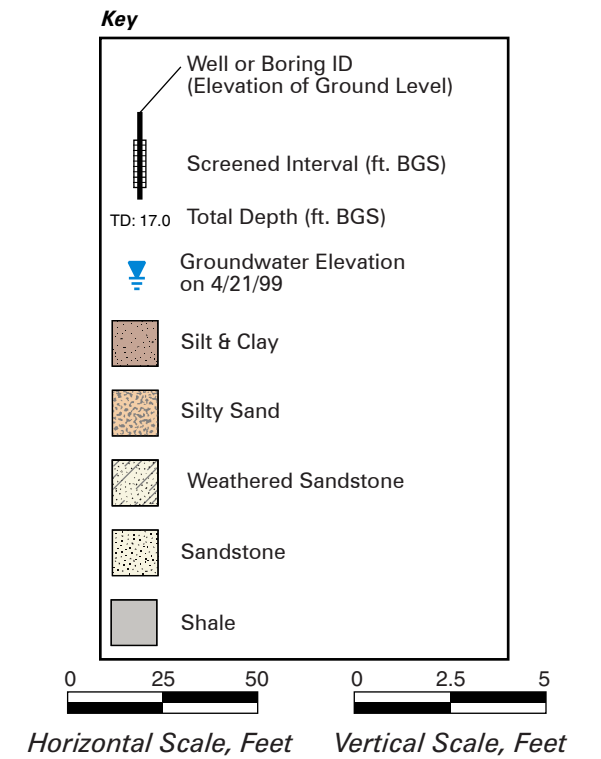
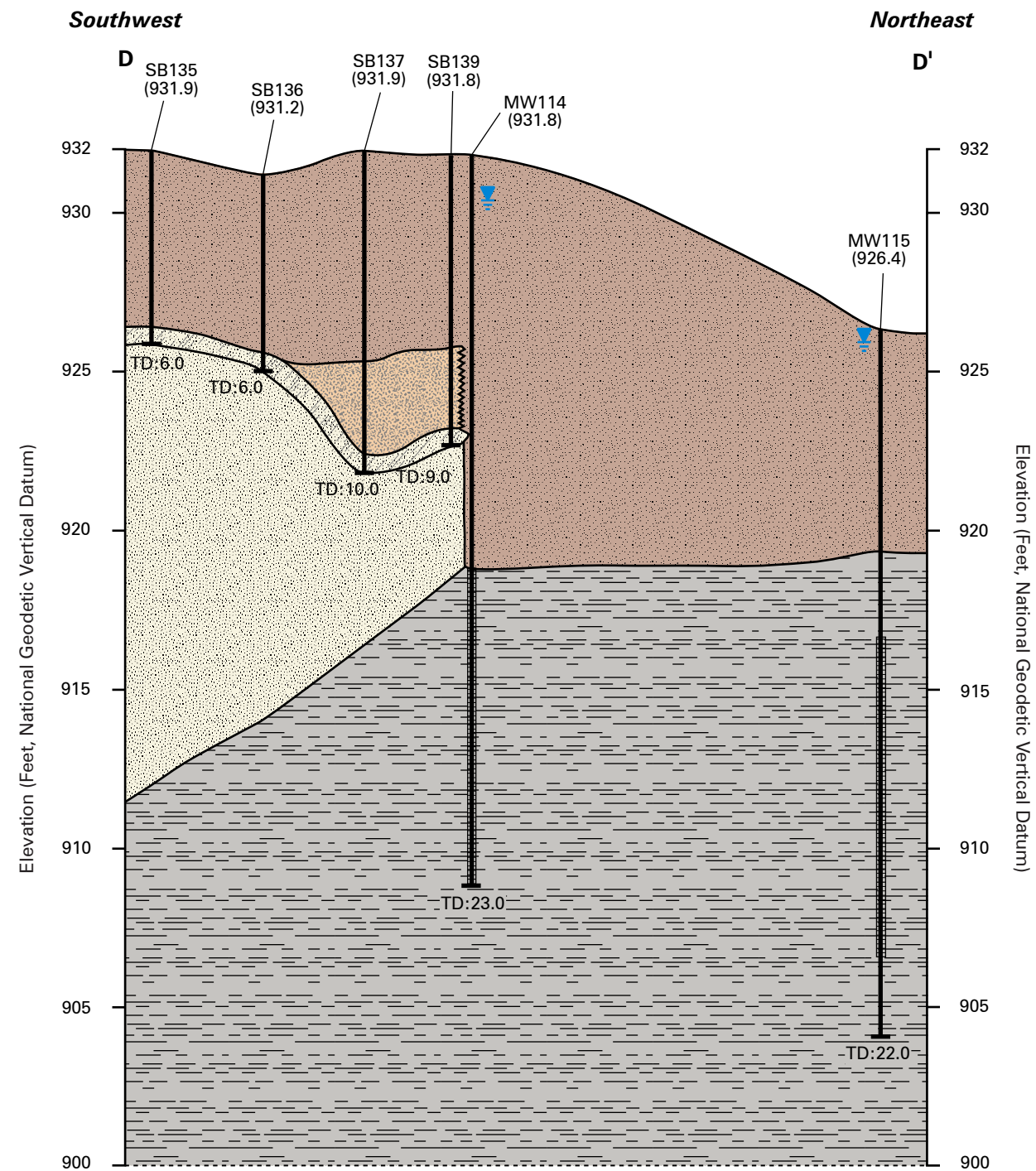


Figure 3-7.
GEOLOGICAL CROSS SECTION D'-D.

PREPARED FOR
**FORMER LORDSTOWN
ORDNANCE DEPOT - TAMPEEL**

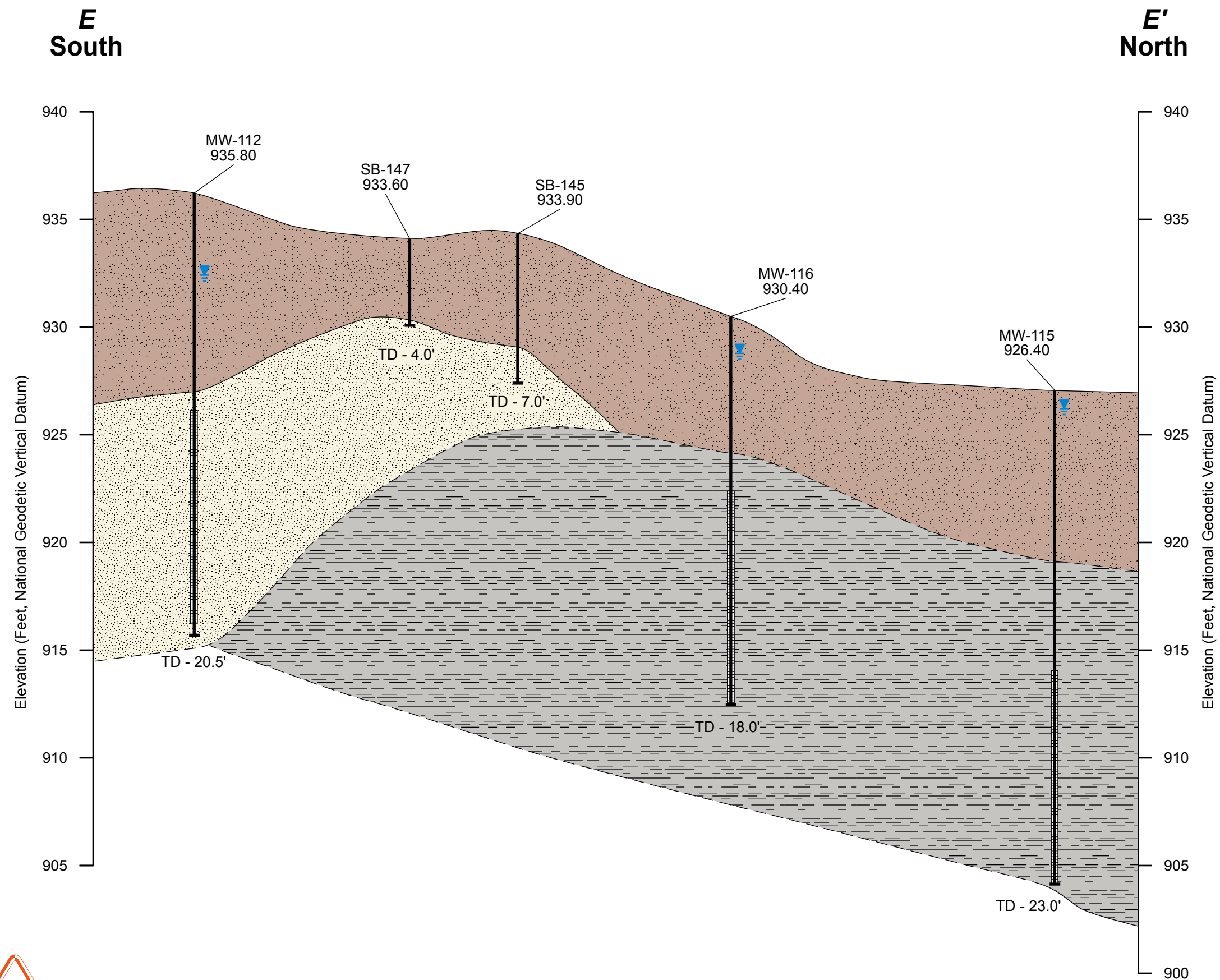
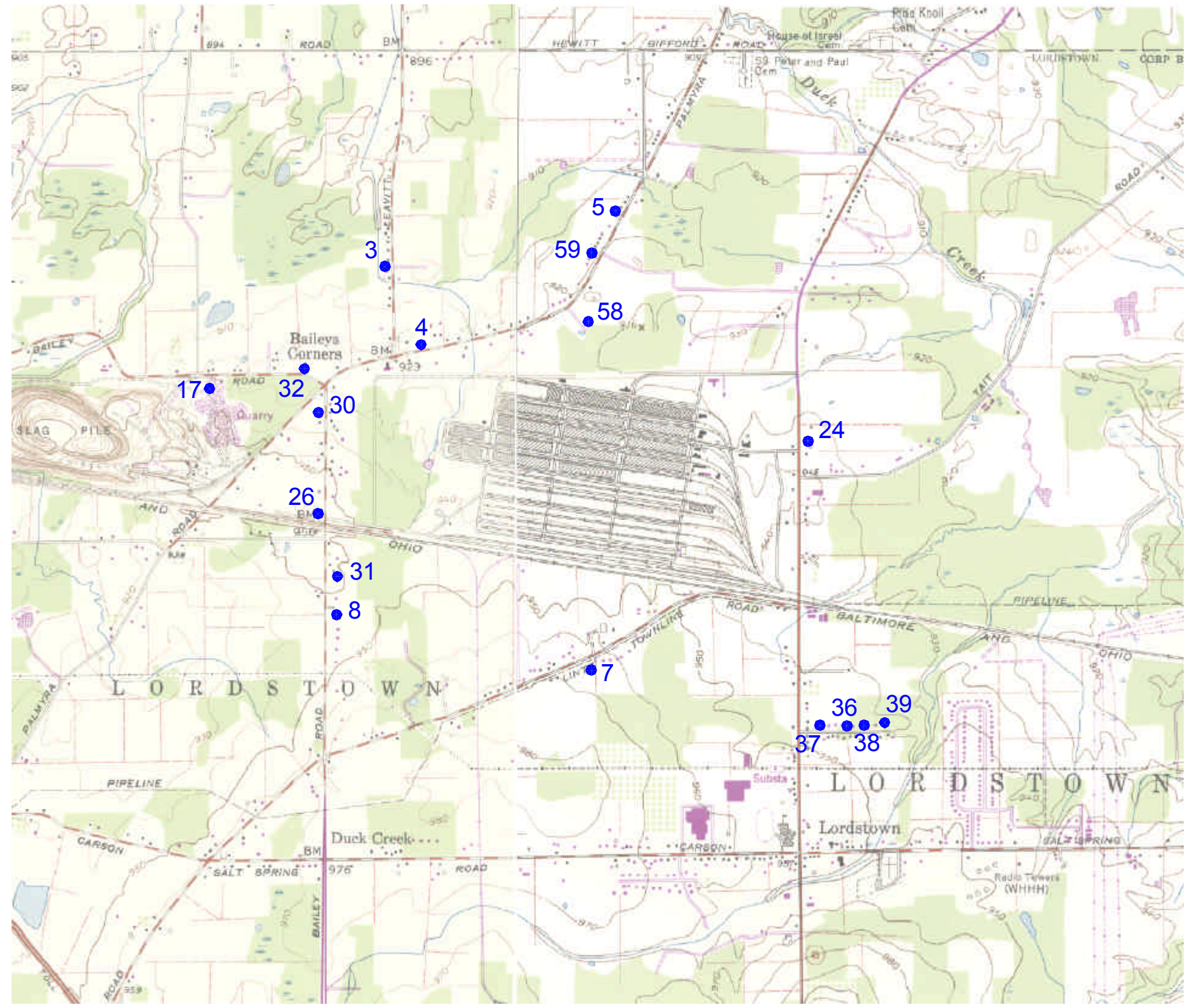


Figure 3-8.
GEOLOGICAL CROSS SECTION E'-E.

PREPARED FOR
**FORMER LORDSTOWN
ORDNANCE DEPOT - TAMPEEL**



LEGEND:
 ● SUPPLY WELL LOCATION

NOTE: SEE APPENDIX E OF THIS DOCUMENT FOR THE WELL LOGS

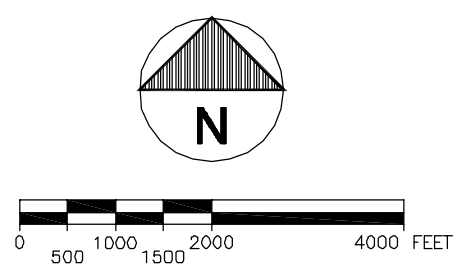
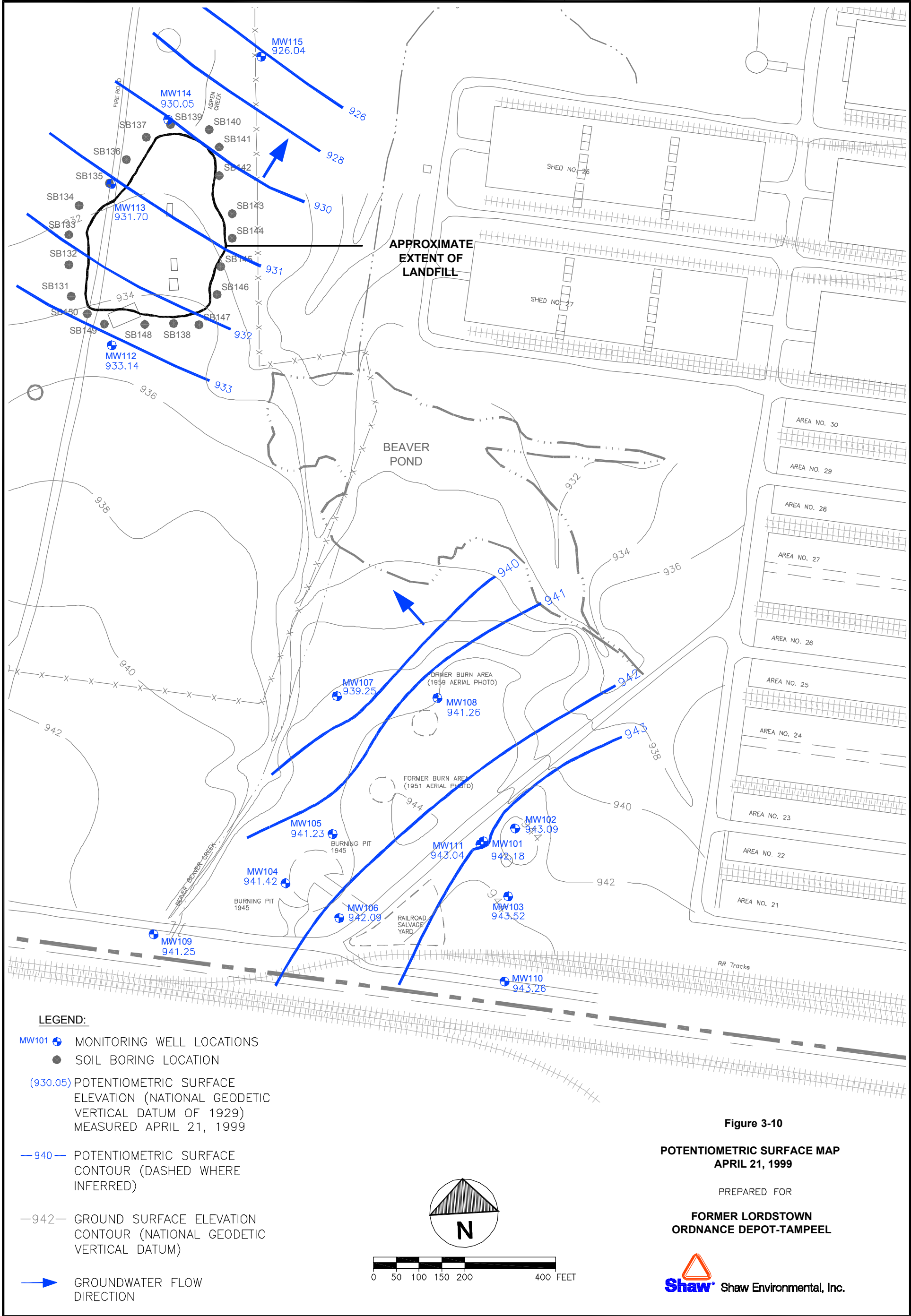


Figure 3-9
SUPPLY WELL LOCATIONS
 PREPARED FOR
FORMER LORDSTOWN
ORDNANCE DEPOT





DRAWN BY	KMS	CHECKED BY	LC	5/19/05	DRAWING NUMBER
	4/11/01	APPROVED BY	KVK	5/19/05	2003 66-11.DWG

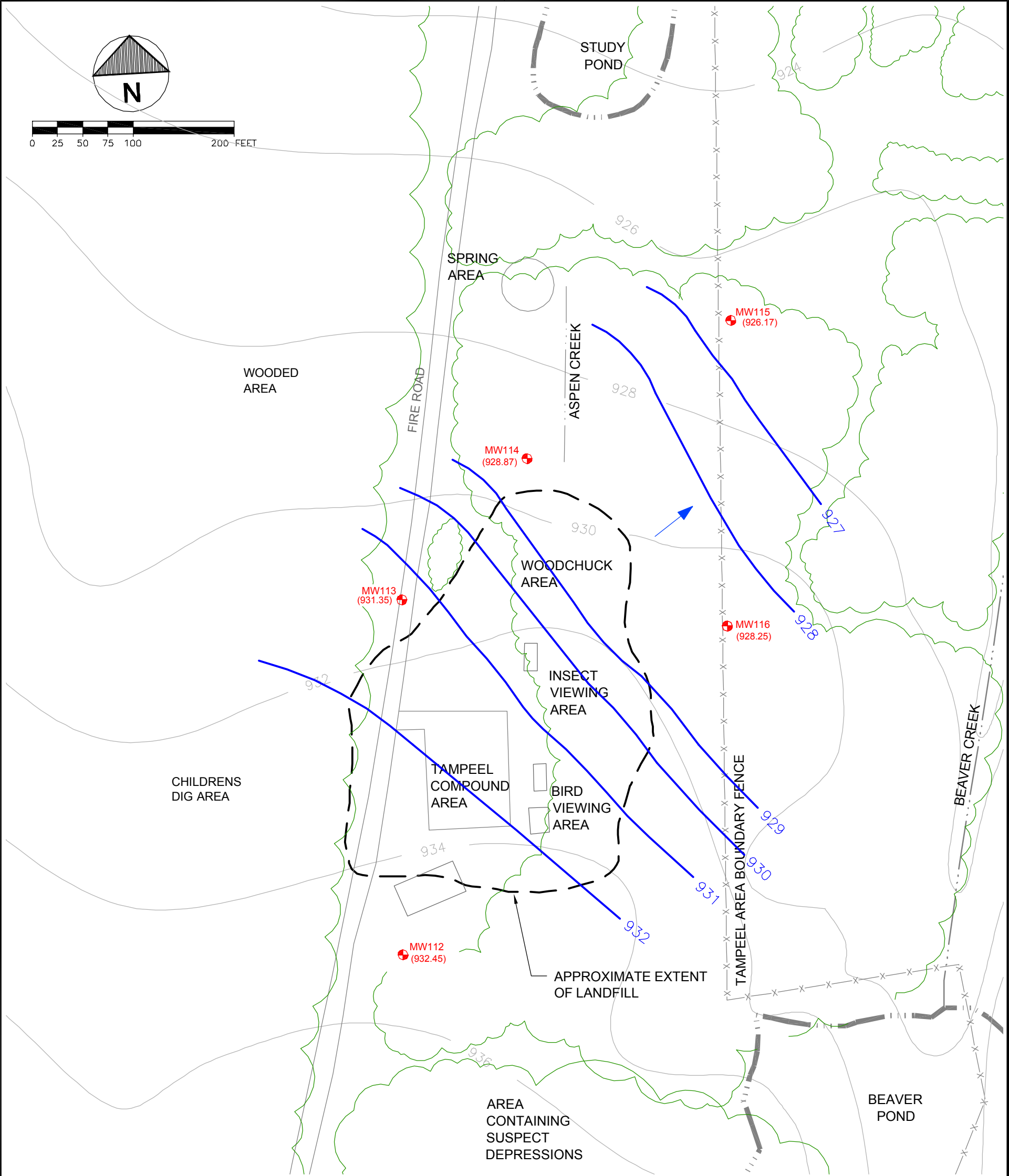


Figure 3-11
POTENTIOMETRIC SURFACE MAP
JUNE 12, 2001

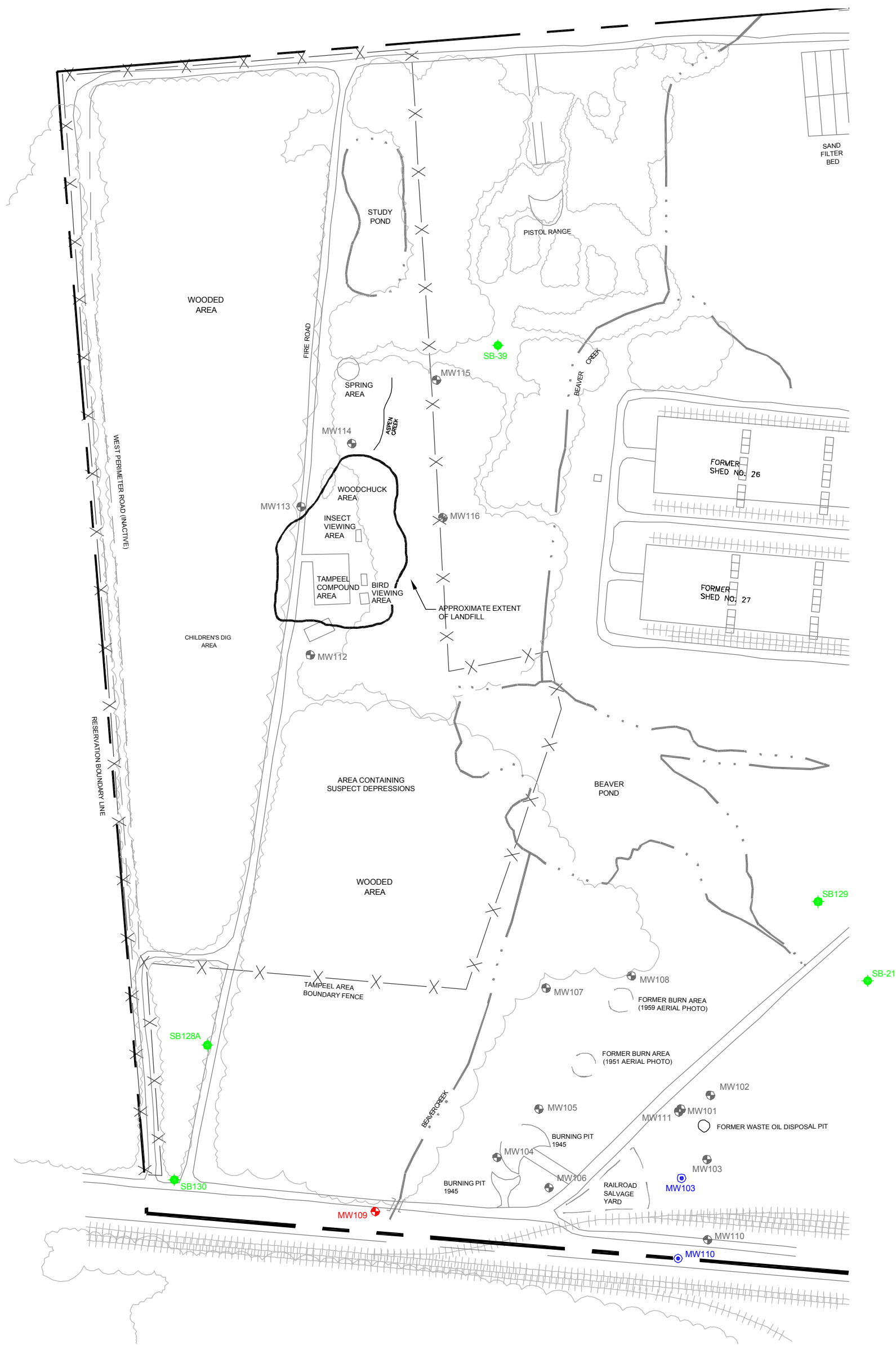
PREPARED FOR

FORMER LORDSTOWN
ORDNANCE DEPOT



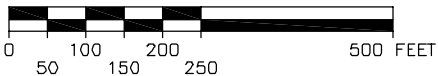
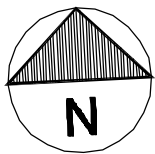
LEGEND:

- MW112 MONITORING WELL LOCATIONS
- (928.21) JUNE 12, 2001 GROUNDWATER ELEVATION (FT)
- 931 POTENTIOMETRIC SURFACE CONTOUR
- GROUNDWATER FLOW DIRECTION
- 936 GROUND SURFACE CONTOUR



LEGEND:

- MONITORING WELL LOCATIONS
- BACKGROUND SOIL SAMPLE LOCATION
- BACKGROUND GROUNDWATER AND SOIL SAMPLE LOCATION
- BACKGROUND GROUNDWATER SAMPLE LOCATION



**Figure 4-1
BACKGROUND SAMPLING
LOCATIONS**

PREPARED FOR

**FORMER LORDSTOWN
ORDNANCE DEPOT-TAMPEEL**



Shaw Environmental, Inc.

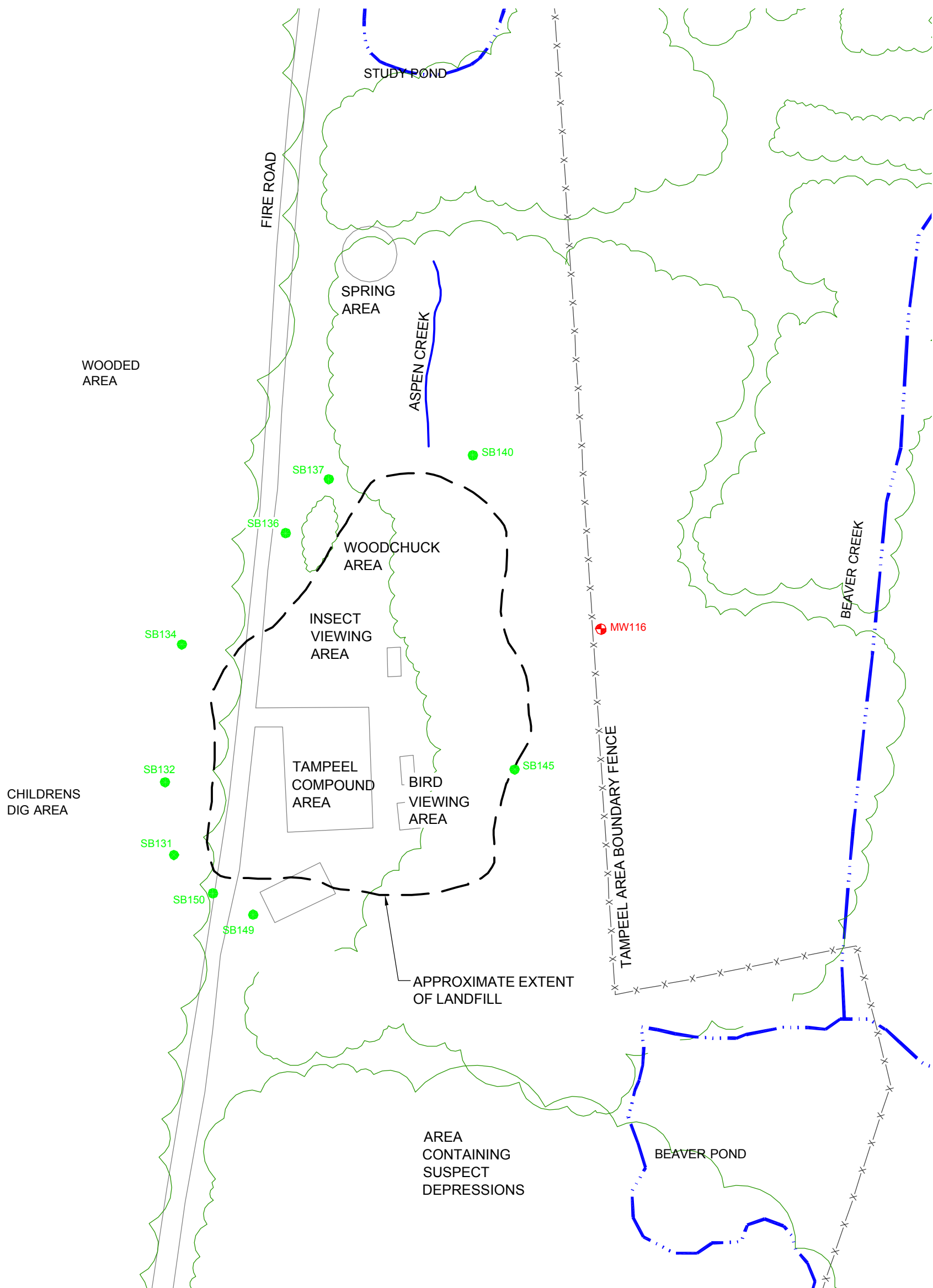




Figure 4-2

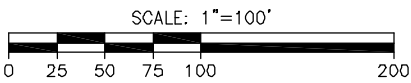
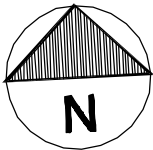
SUBSURFACE SOIL SAMPLE LOCATIONS

PREPARED FOR

FORMER LORDSTOWN
ORDNANCE DEPOT

LEGEND:

- MW#  MONITORING WELL LOCATION (2000)
SB#  SOIL BORING LOCATIONS (1999)



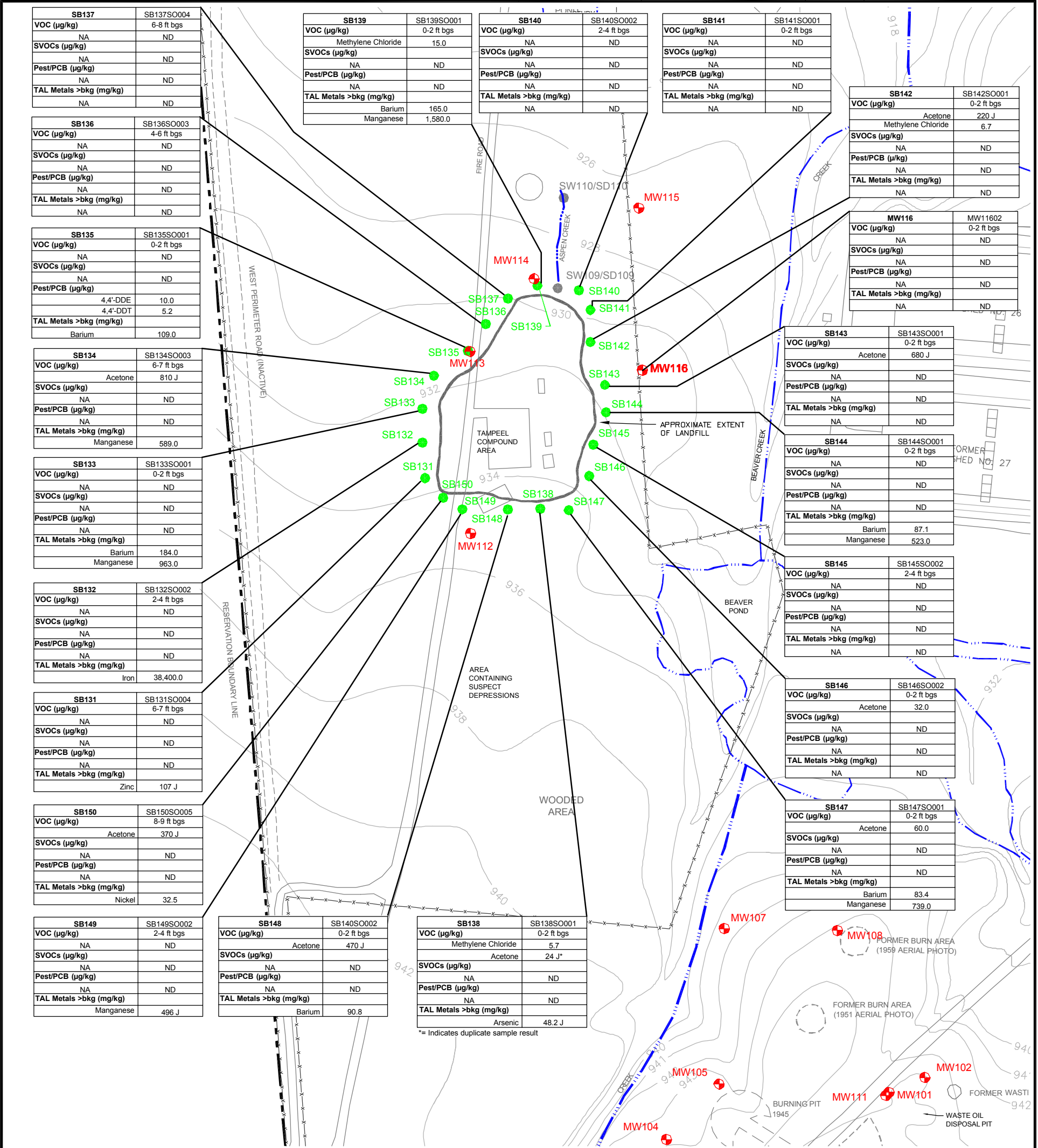


Figure 4-3

TAMPEEL SOIL BORING
ANALYTICAL RESULTS

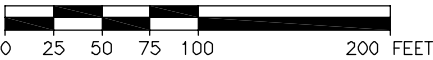
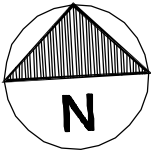
PREPARED FOR

FORMER LORDSTOWN
ORDNANCE DEPOT

LEGEND:

- MONITORING WELL LOCATIONS
- SOIL BORING LOCATION

—942— GROUND SURFACE ELEVATION
CONTOUR (NATIONAL GEODETIC
VERTICAL DATUM)



Shaw Environmental, Inc.

DRAWN BY	KMS	CHECKED BY	LC	5/19/05	DRAWING NUMBER	2003 66-15.DWG
	4/11/01	APPROVED BY	KVK	5/19/05		

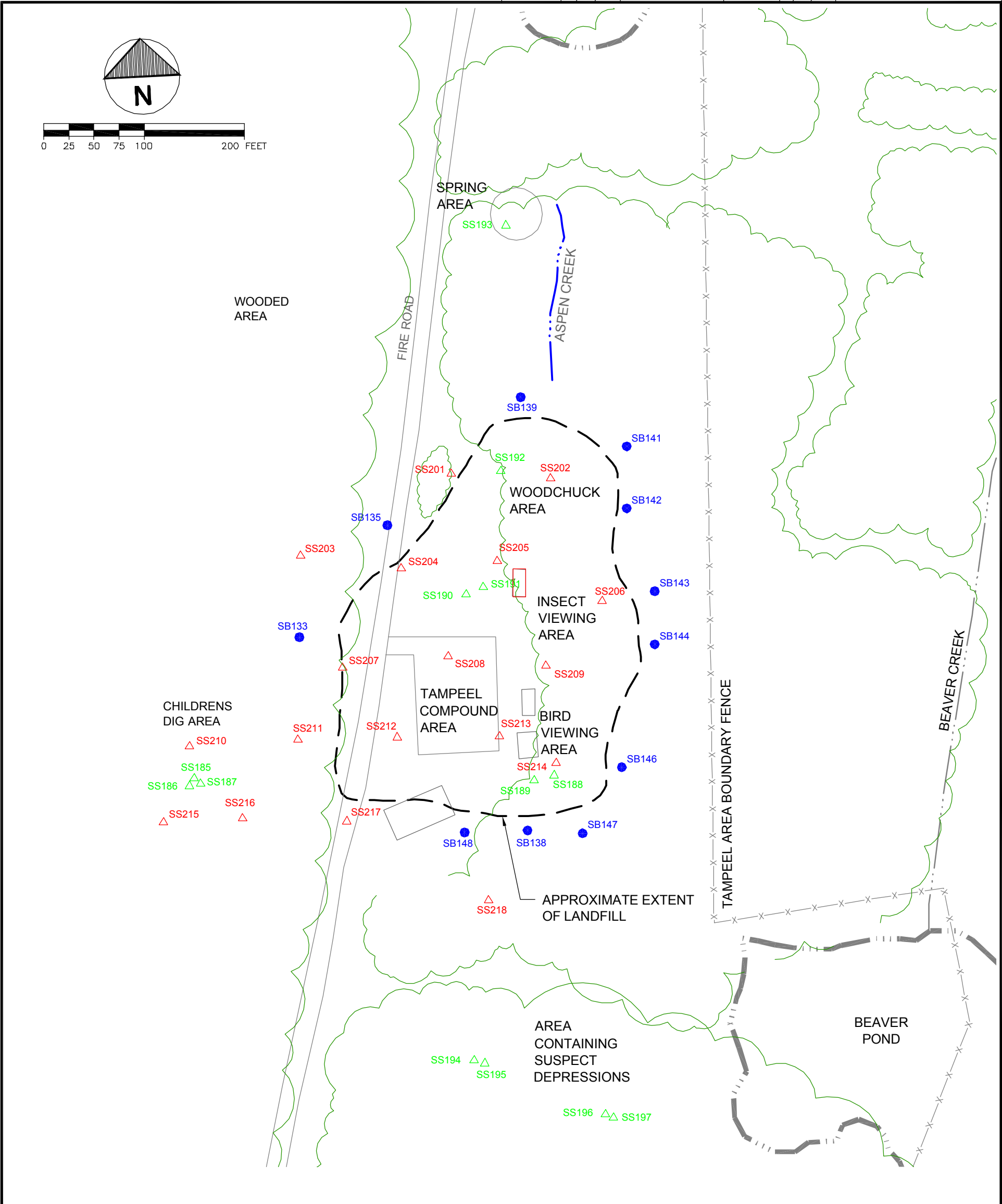


Figure 4-4
TAMPEEL INVESTIGATION
SURFACE SOIL SAMPLING LOCATIONS

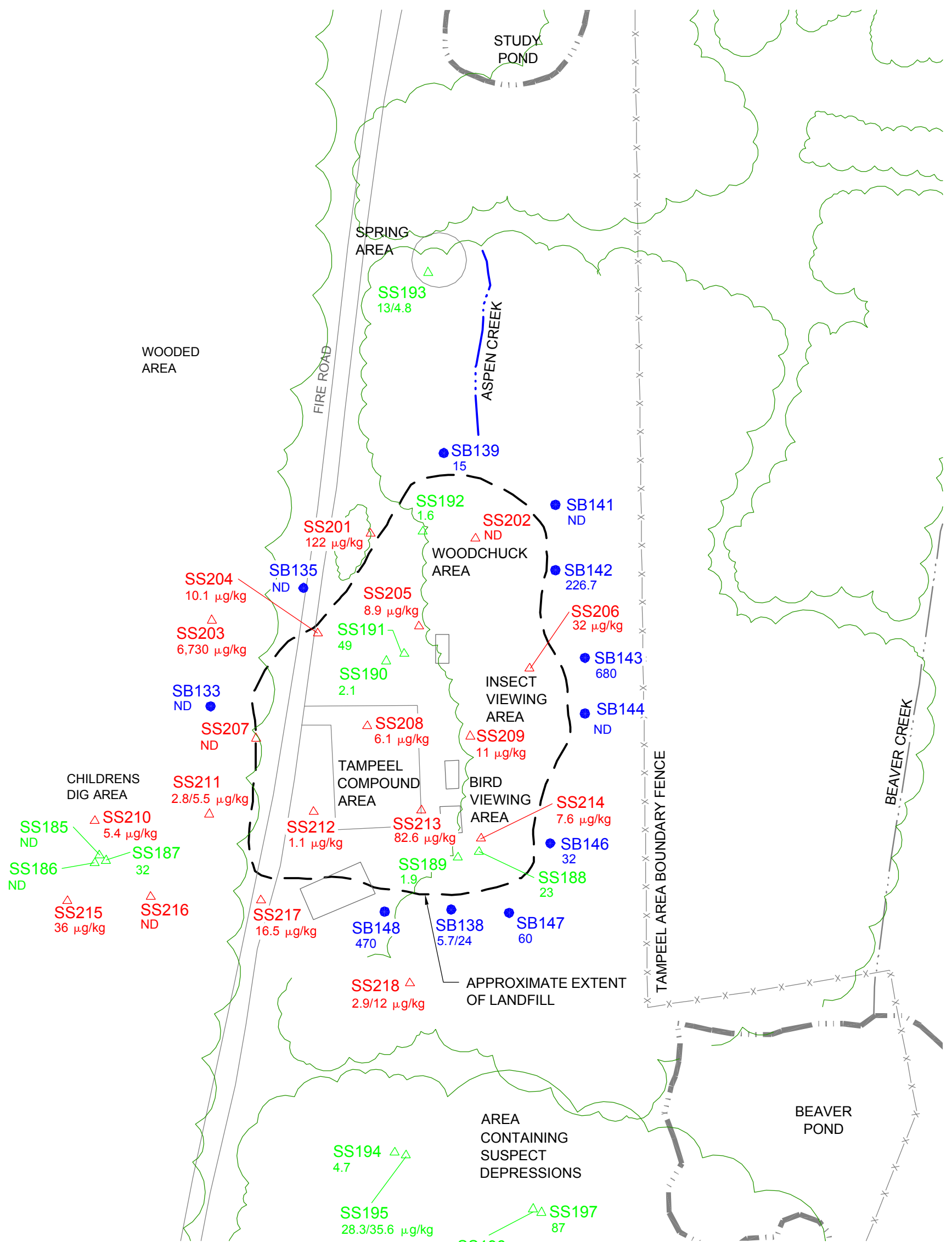
PREPARED FOR

FORMER LORDSTOWN
ORDNANCE DEPOT-TAMPEEL

LEGEND:

- SS201△ SRI SURFACE SOIL SAMPLE LOCATIONS (2000)
- SS185△ RI SURFACE SOIL SAMPLE LOCATIONS (1999)
- SB138● RI SOIL BORING SAMPLE LOCATIONS (0-2') (1999)





LEGEND:

- SS# △ SRI SURFACE SOIL SAMPLE LOCATIONS (2000)
- SS# △ RI SURFACE SOIL SAMPLE LOCATIONS (1999)
- SB# ● SOIL BORING SAMPLE LOCATIONS (0-2') (1999)
- ND NOT DETECTED



SCALE: 1"=100'

0 25 50 75 100 200

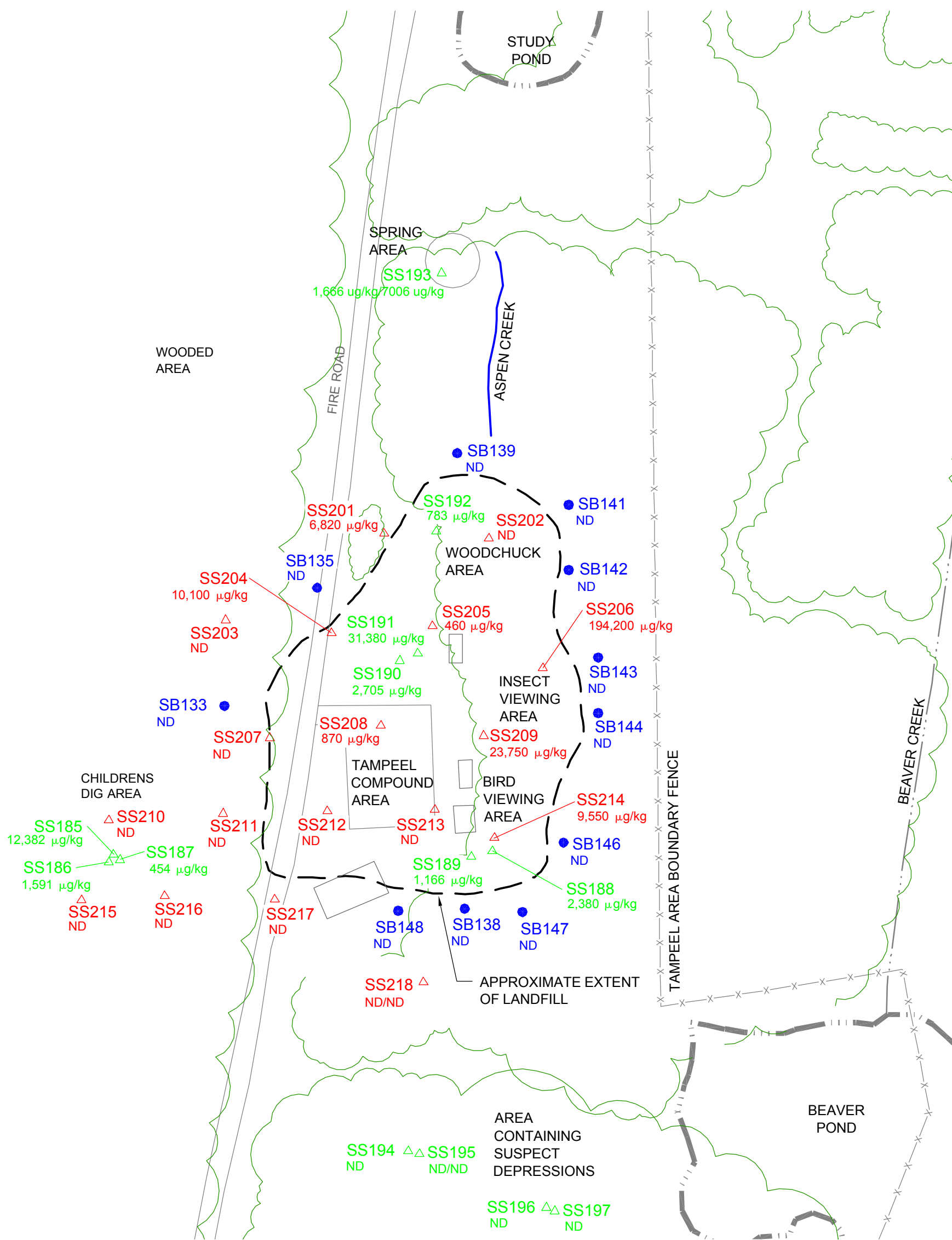
Figure 4-5

TAMPEEL SURFACE SOIL
TOTAL VOC ANALYTICAL RESULTS

PREPARED FOR

FORMER LORDSTOWN
ORDNANCE DEPOT





LEGEND:

- SS# △ SRI SURFACE SOIL SAMPLE LOCATIONS (2000)
- SS# △ RI SURFACE SOIL SAMPLE LOCATIONS (1999)
- SB# ● SOIL BORING SAMPLE LOCATIONS (0-2') (1999)
- ND NOT DETECTED

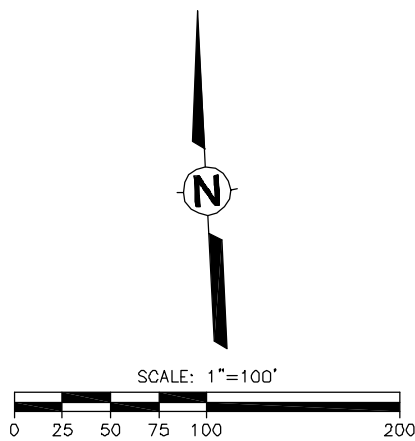


Figure 4-6
TAMPEEL SURFACE SOIL
TOTAL PAH ANALYTICAL RESULTS
PREPARED FOR
FORMER LORDSTOWN
ORDNANCE DEPOT

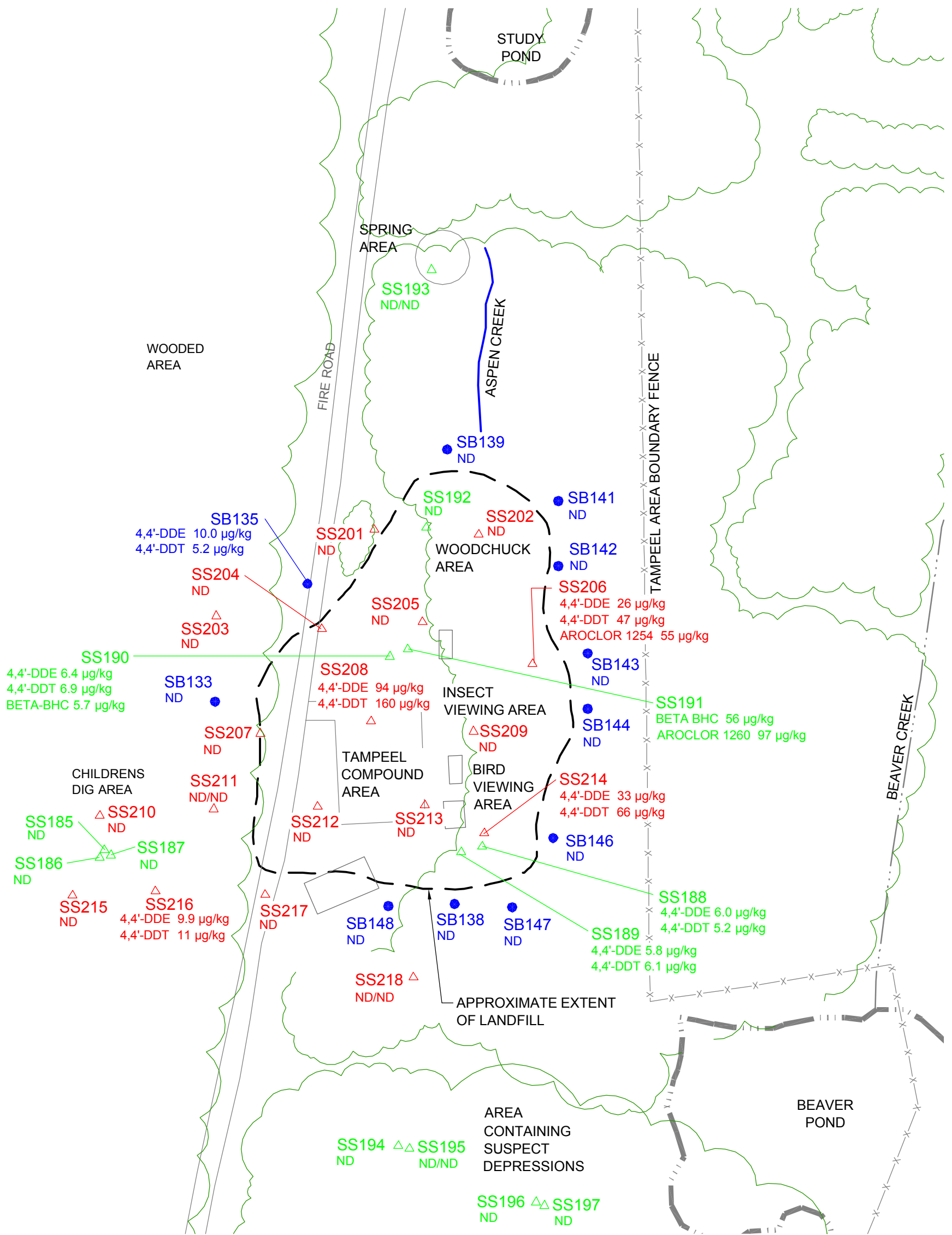


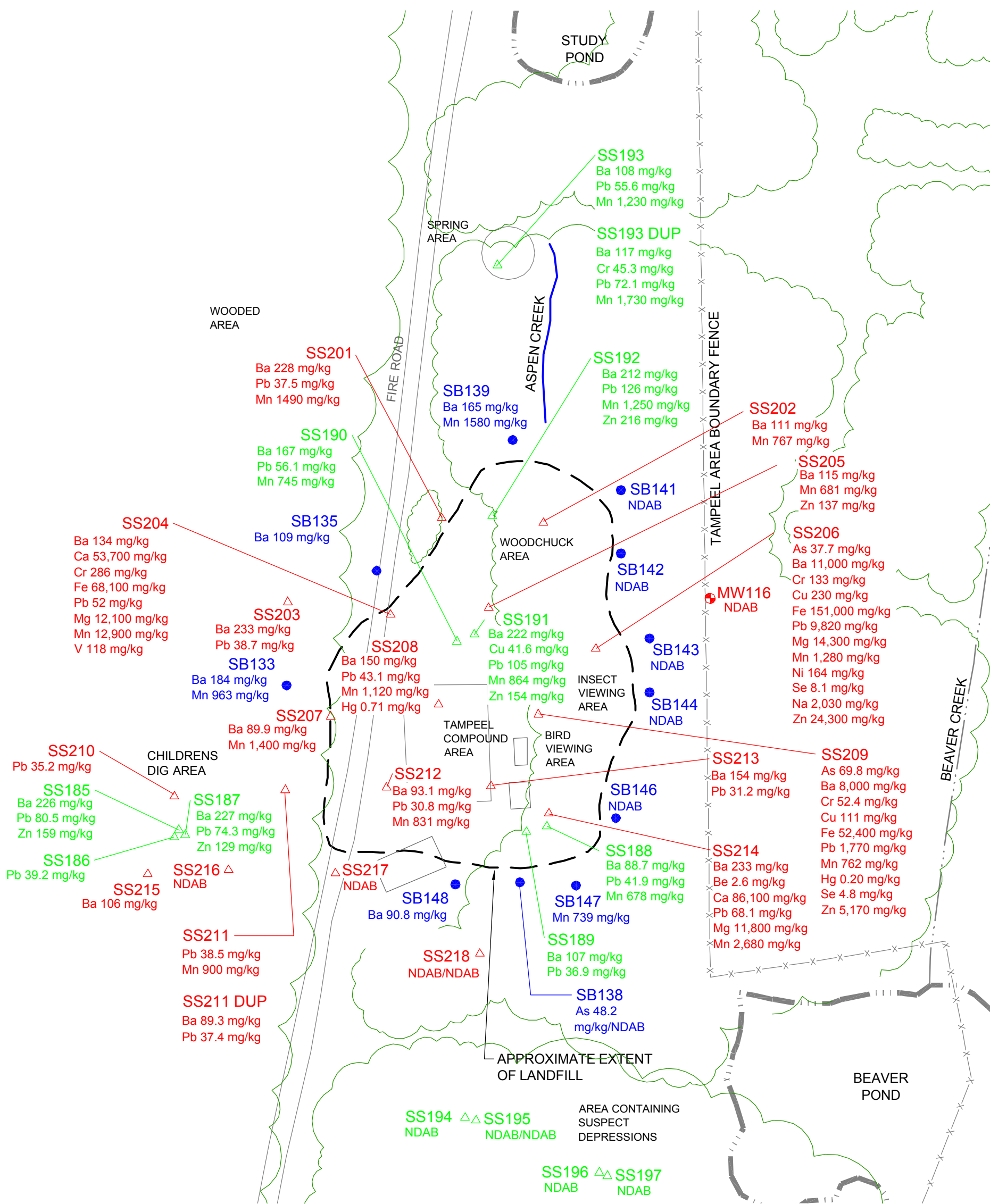
Figure 4-7

**TAMPEEL SURFACE SOIL
PESTICIDES/PCBs
ANALYTICAL RESULTS**

PREPARED FOR

**FORMER LORDSTOWN
ORDNANCE DEPOT**





LEGEND:

- MW# ● MONITORING WELL LOCATION
- SS# △ SRI SURFACE SOIL SAMPLE LOCATIONS (2000)
- SS# △ RI SURFACE SOIL SAMPLE LOCATIONS (1999)
- SB# ● SOIL BORING SAMPLE LOCATIONS (0-2') (1999)
- NDAB NOT DETECTED ABOVE BACKGROUND

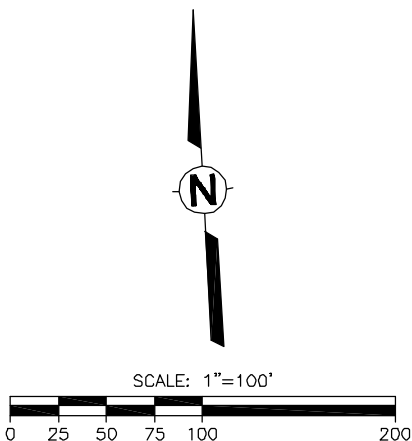


Figure 4-8

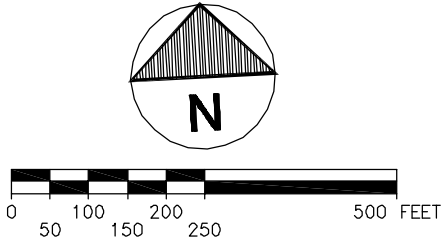
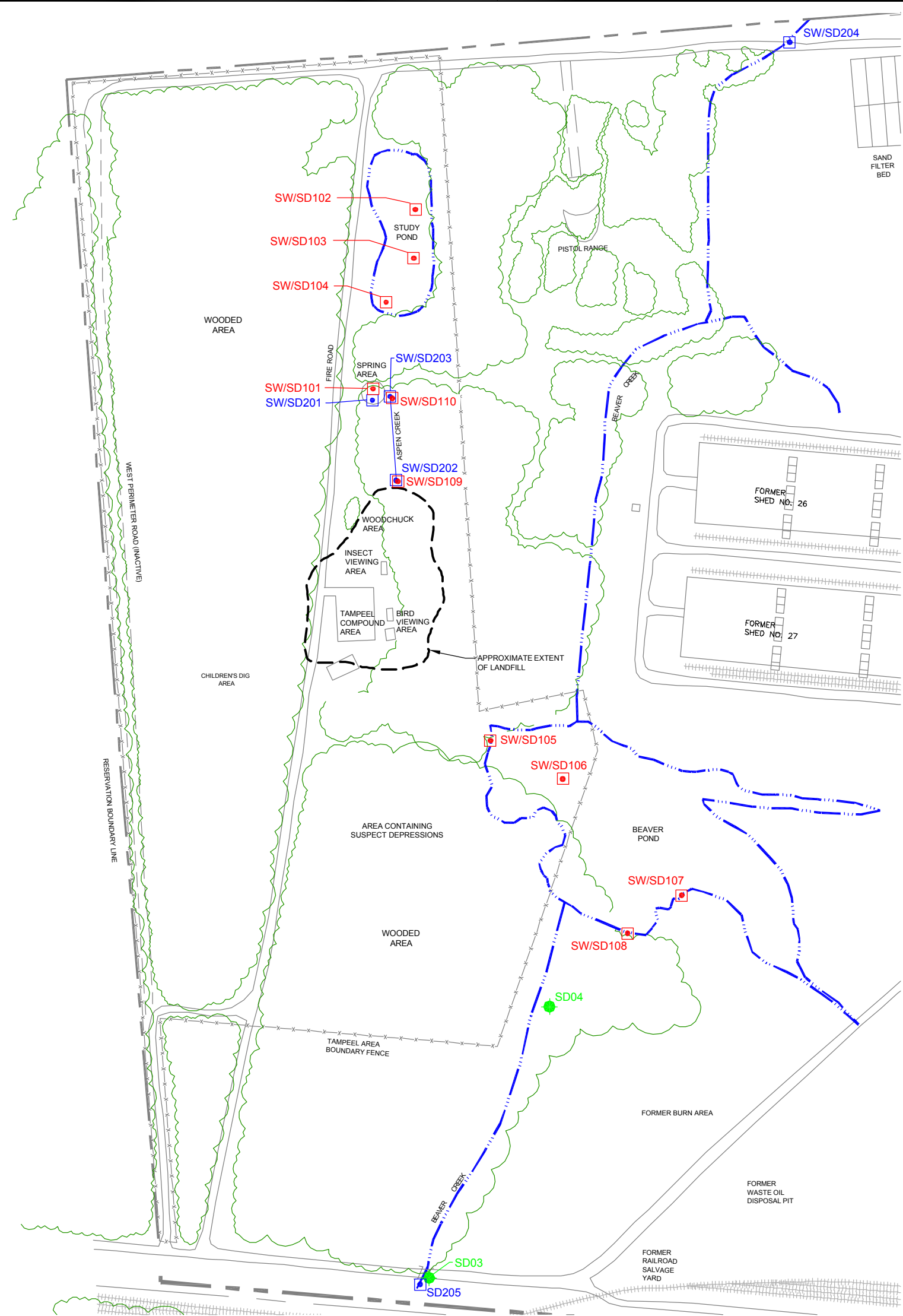
TAMPEEL SURFACE SOIL METALS ABOVE BACKGROUND

PREPARED FOR

FORMER LORDSTOWN ORDNANCE DEPOT

Shaw Shaw Environmental, Inc.

DRAWN BY	KMS	CHECKED BY	LC	5/19/05	DRAWING NUMBER	2003 66-20.DWG
	4/24/01	APPROVED BY	KVK	5/19/05		



LEGEND:

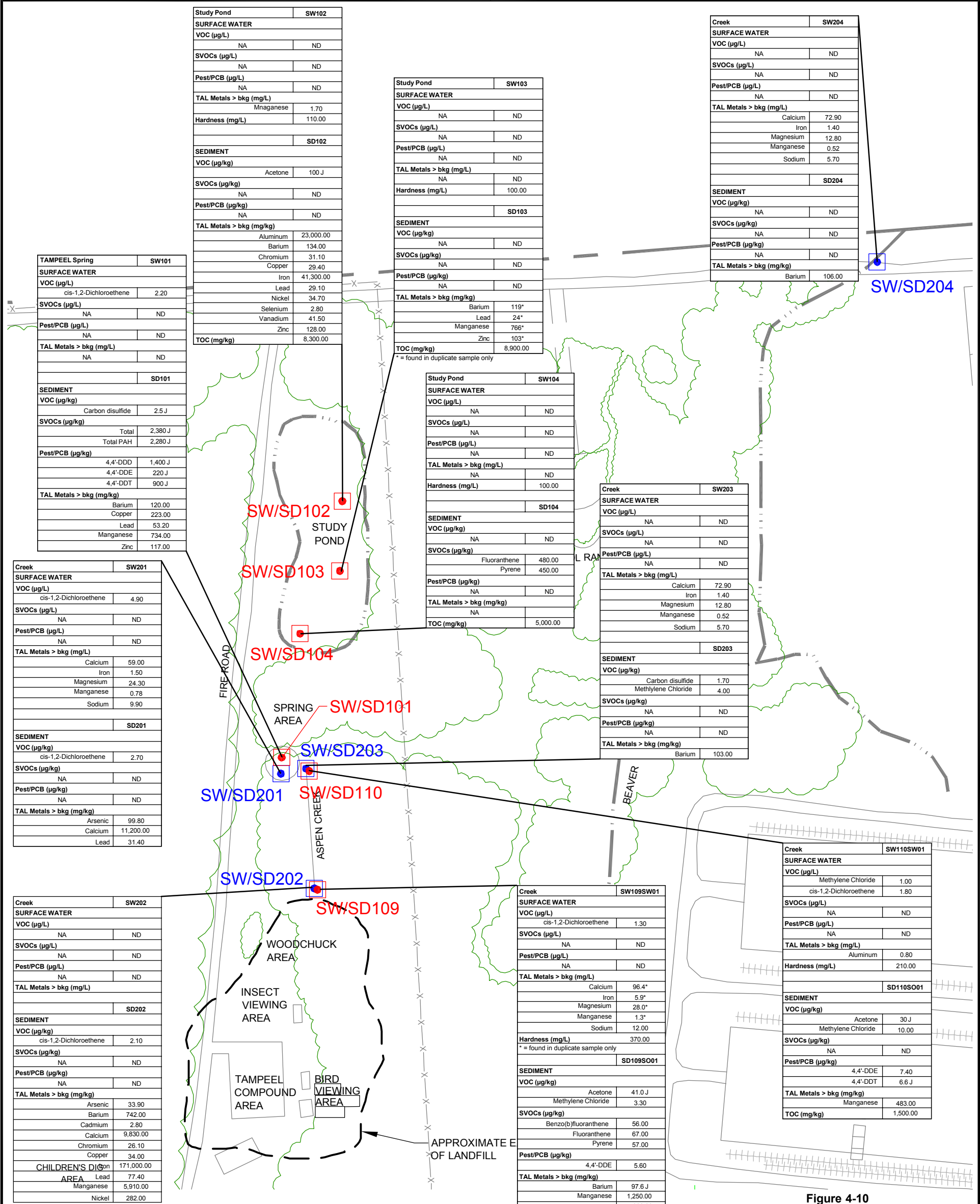
- SRI SURFACE WATER/SOIL SEDIMENT SAMPLES
- RI SURFACE WATER/SOIL SEDIMENT SAMPLES
- SI SEDIMENT SAMPLES

Figure 4-9
TAMPEEL INVESTIGATIONS
SURFACE WATER/SEDIMENT
SAMPLING LOCATIONS

PREPARED FOR

FORMER LORDSTOWN
ORDNANCE DEPOT-TAMPEEL





LEGEND:

- SRI SURFACE WATER/SOIL SEDIMENT SAMPLES
- RI SURFACE WATER/SOIL SEDIMENT SAMPLES
- SI SEDIMENT SAMPLES

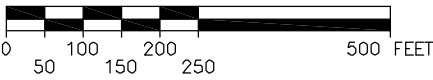
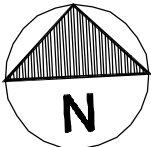
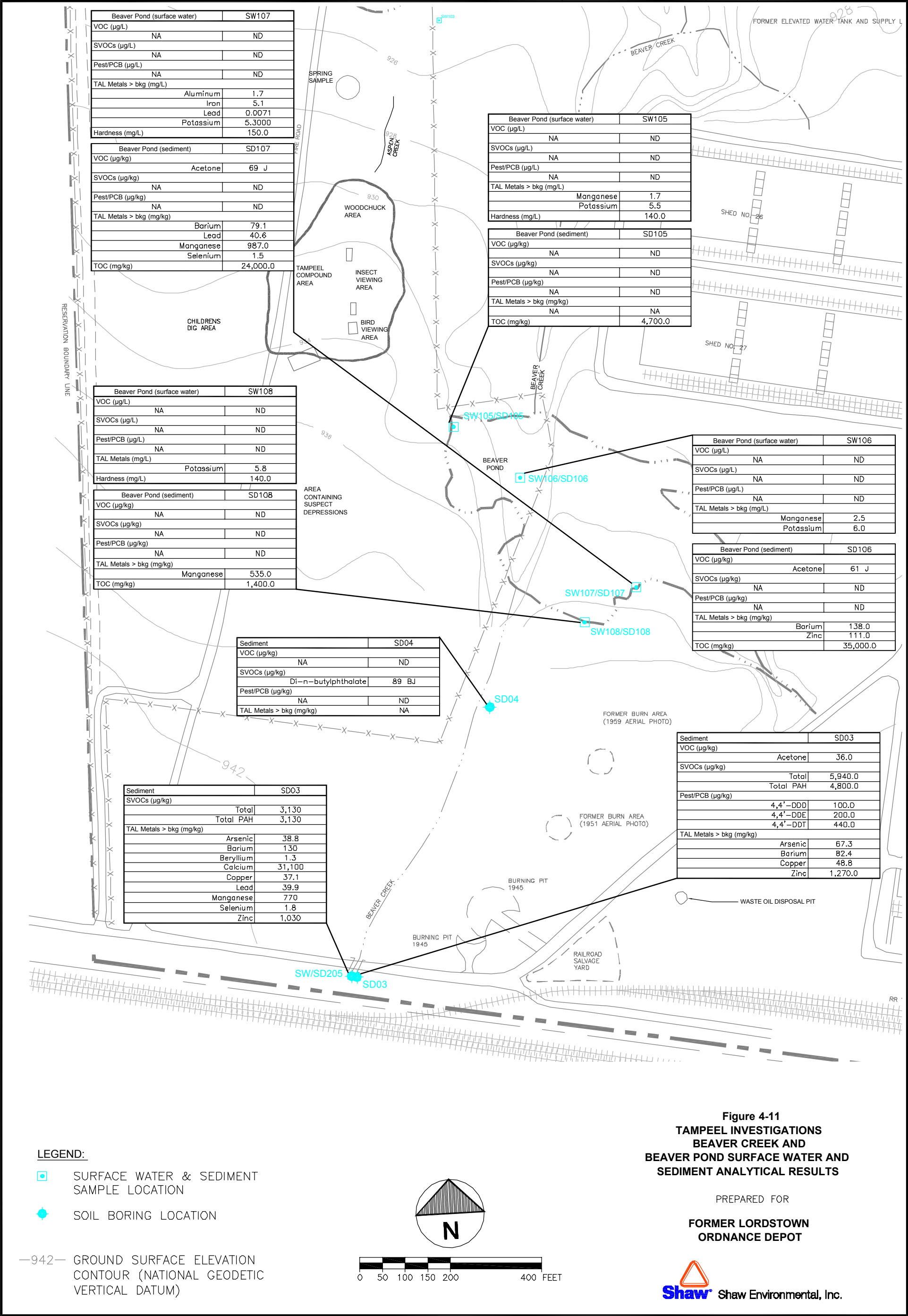


Figure 4-10
TAMPEEL
ASPEN CREEK, SPRING
AND STUDY POND
SURFACE WATER AND SEDIMENT
ANALYTICAL RESULTS

PREPARED FOR

FORMER LORDSTOWN
ORDNANCE DEPOT-TAMPEEL





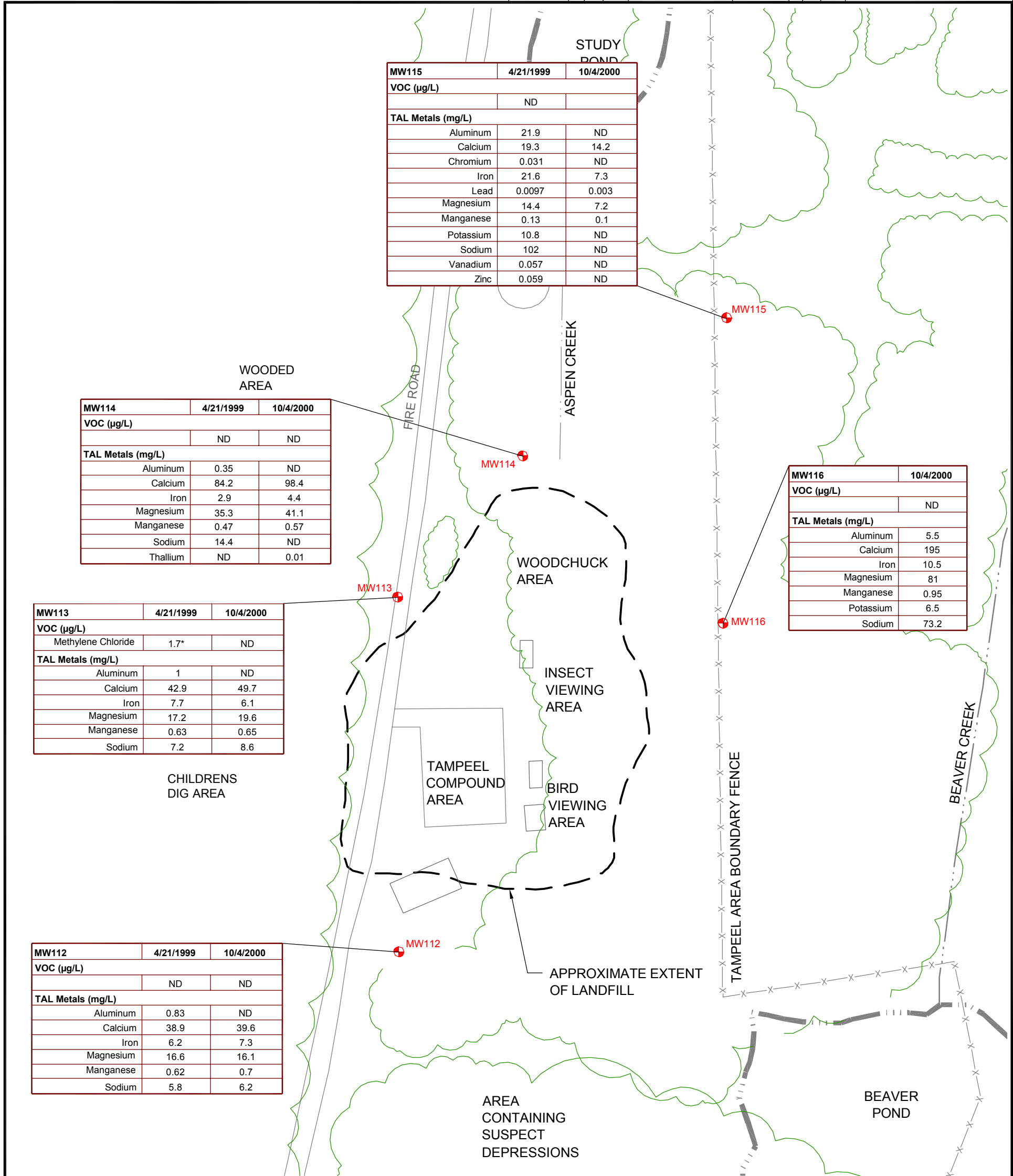


Figure 4-12
TAMPEEL INVESTIGATION
GROUNDWATER SAMPLING
ANALYTICAL RESULTS

PREPARED FOR

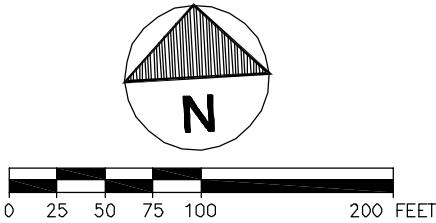
FORMER LORDSTOWN
ORDNANCE DEPOT-TAMPEEL

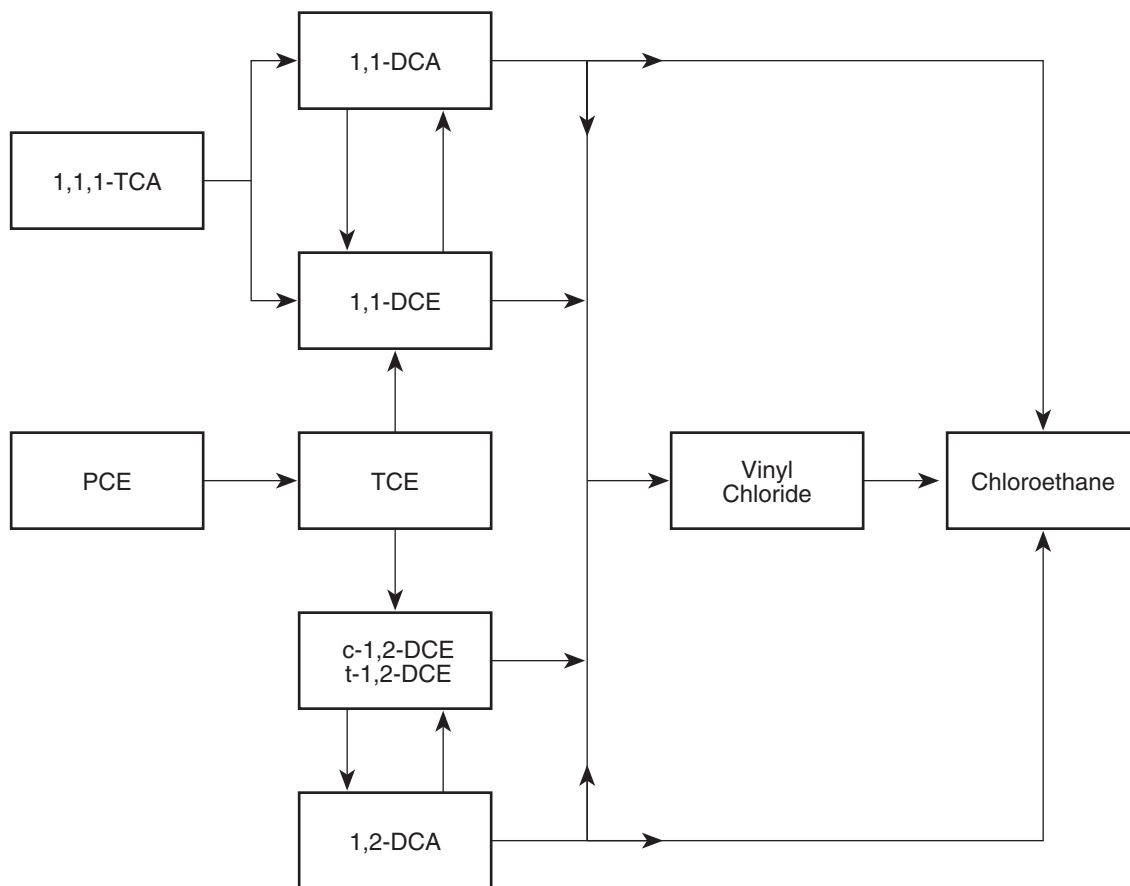
LEGEND:

MW112 MONITORING WELL LOCATIONS

ND: NOT DETECTED

NOTE: DATA SHOWN REPRESENTS DETECTED
CONSTITUENTS ONLY





PCE Tetrachloroethene
 TCE Trichloroethene
 1,1,1-TCA 1,1,1-Trichloroethane
 1,1-DCA 1,1-Dichloroethane
 1,1-DCE 1,1-Dichloroethene
 c-1,2-DCE CIS-1,2-Dichloroethene
 t-1,2-DCE TRANS-1,2-Dichloroethene
 1,2-DCA 1,2-Dichloroethane

Source:
 Dragun, J., 1988,
The Soil Chemistry of Hazardous Materials,
 Hazardous Materials Control Research Institute, Silver Spring, MD

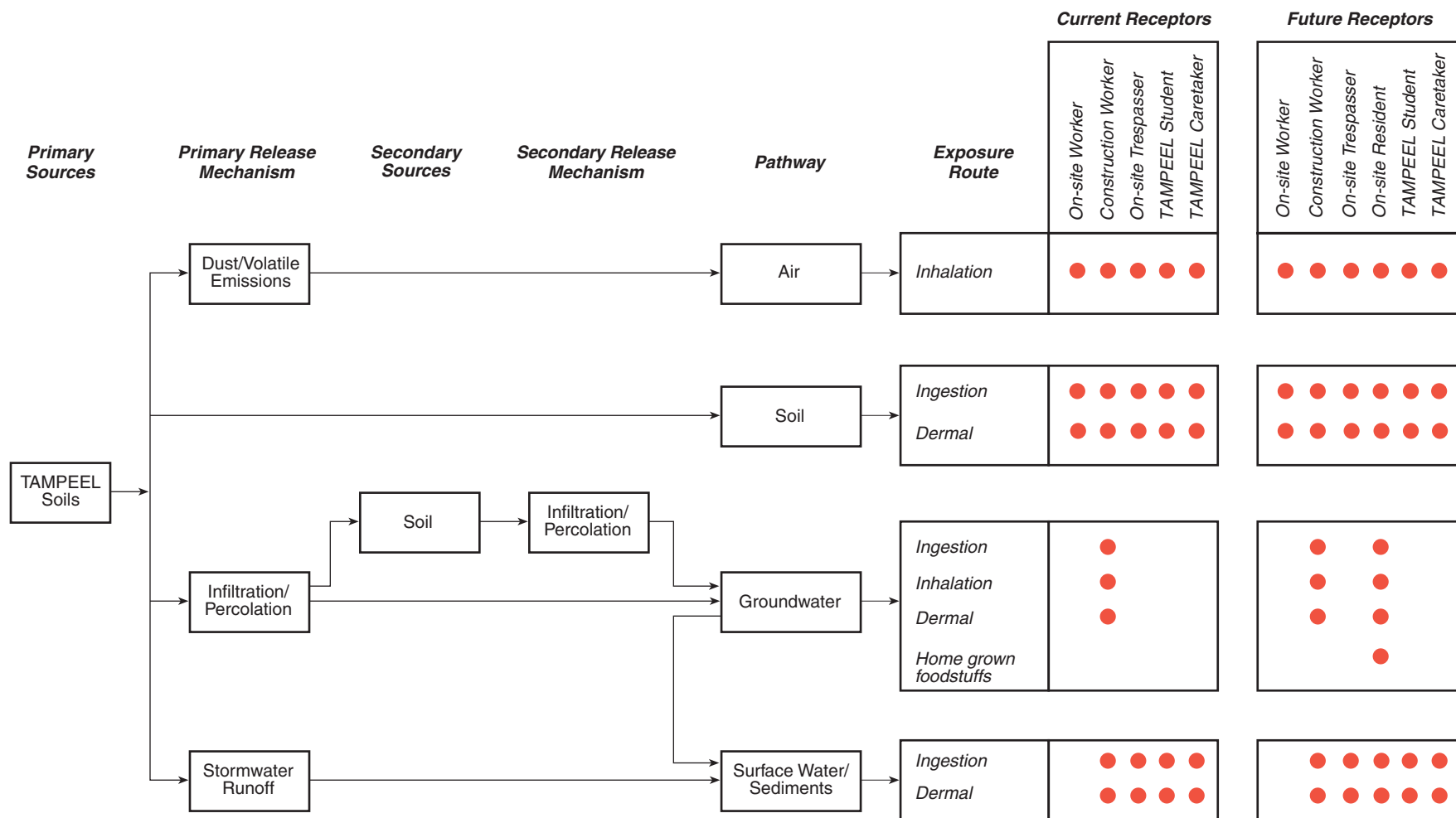
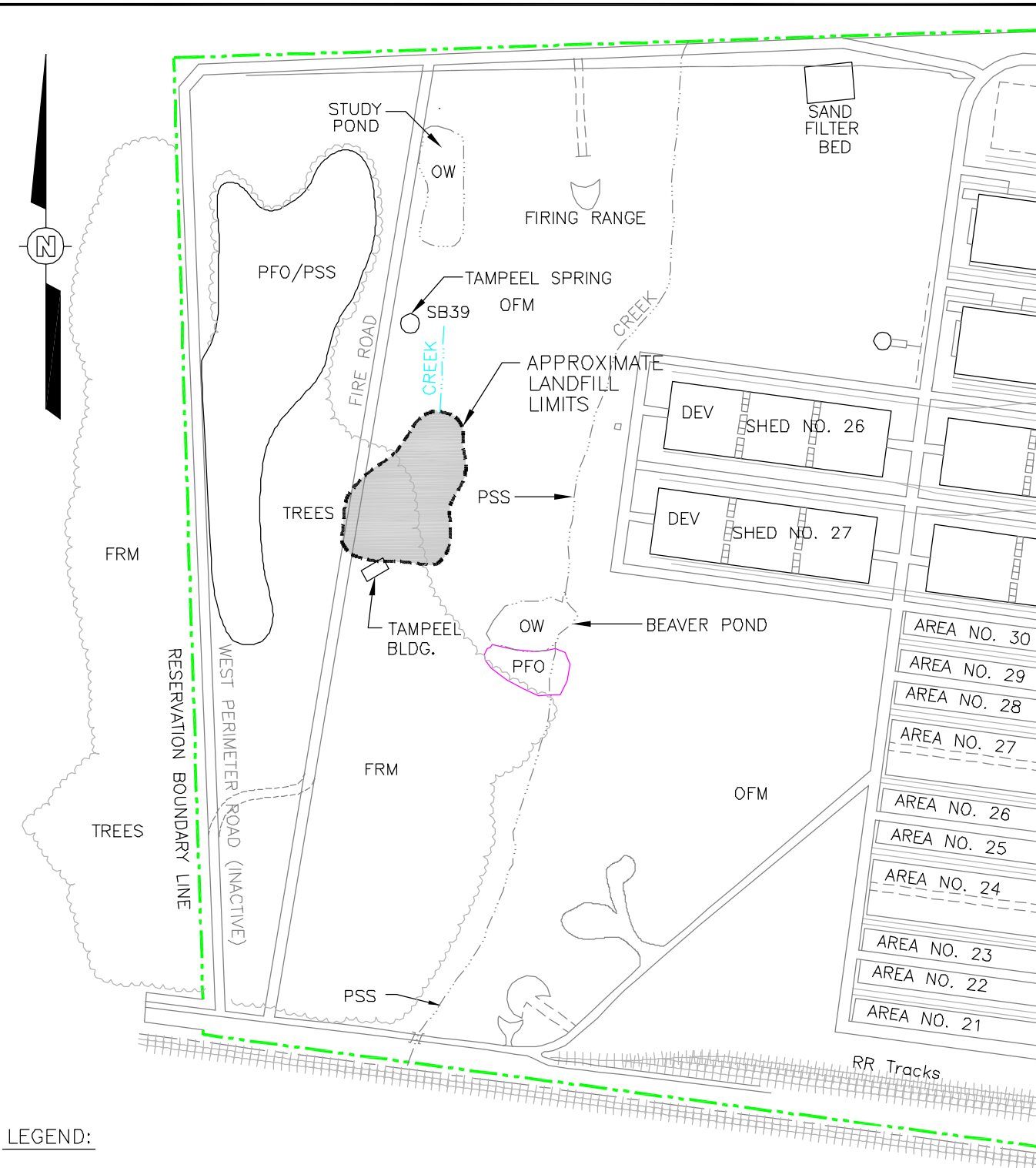


Figure 6-1. Conceptual Site Model for TAMPEEL

IMAGE	X-REF	OFFICE	DRAWN BY	CHECKED BY	APPROVED BY	DRAWING NUMBER
---	---	Pittsburgh, PA	M. Warrick	CN	KVK	775882-A1
			8/23/99	5/19/05	5/19/05	




LEGEND:

DEV	DEVELOPED AND DISTURBED AREAS
OFM	MODERATE OLD FIELD
FRM	MODERATE FOREST
OW	OPEN WATER
PSS	PALUSTRINE SCRUB/SHRUB WETLANDS
PFO	PALUSTRINE, FORESTED WETLANDS

NOTE:

LOCATION AND SIZE OF PONDS IS BASED ON AERIAL PHOTO DATED: MARCH 1992.



	FORMER LORDSTOWN ORDNANCE DEPOT
	<p>FIGURE 6-2</p> <p>VEGETATIVE COMMUNITIES</p> <p>ECOLOGICAL CHARACTERIZATION</p> <p>LORDSTOWN, OHIO</p>

DRAWING NO.	S-772528.05-5/98-5W	
CHECKED BY	JIS, III	
APPROVED BY	5/20/98	
DRAWING BY		

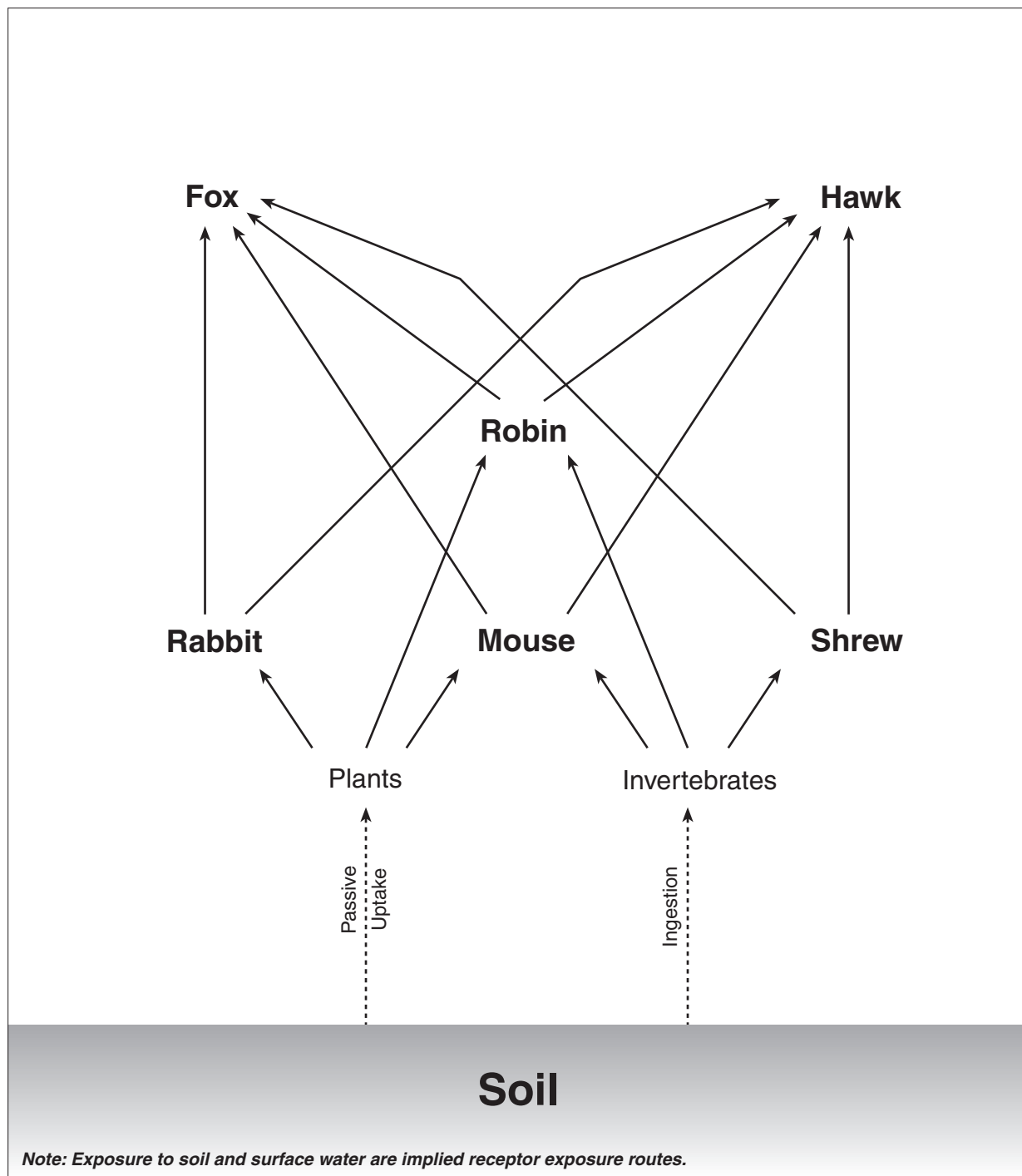


Figure 6-3.
Simplified Terrestrial Food Web Conceptual Site Model (CSM)
Former Lordstown Ordnance Depot, Ohio

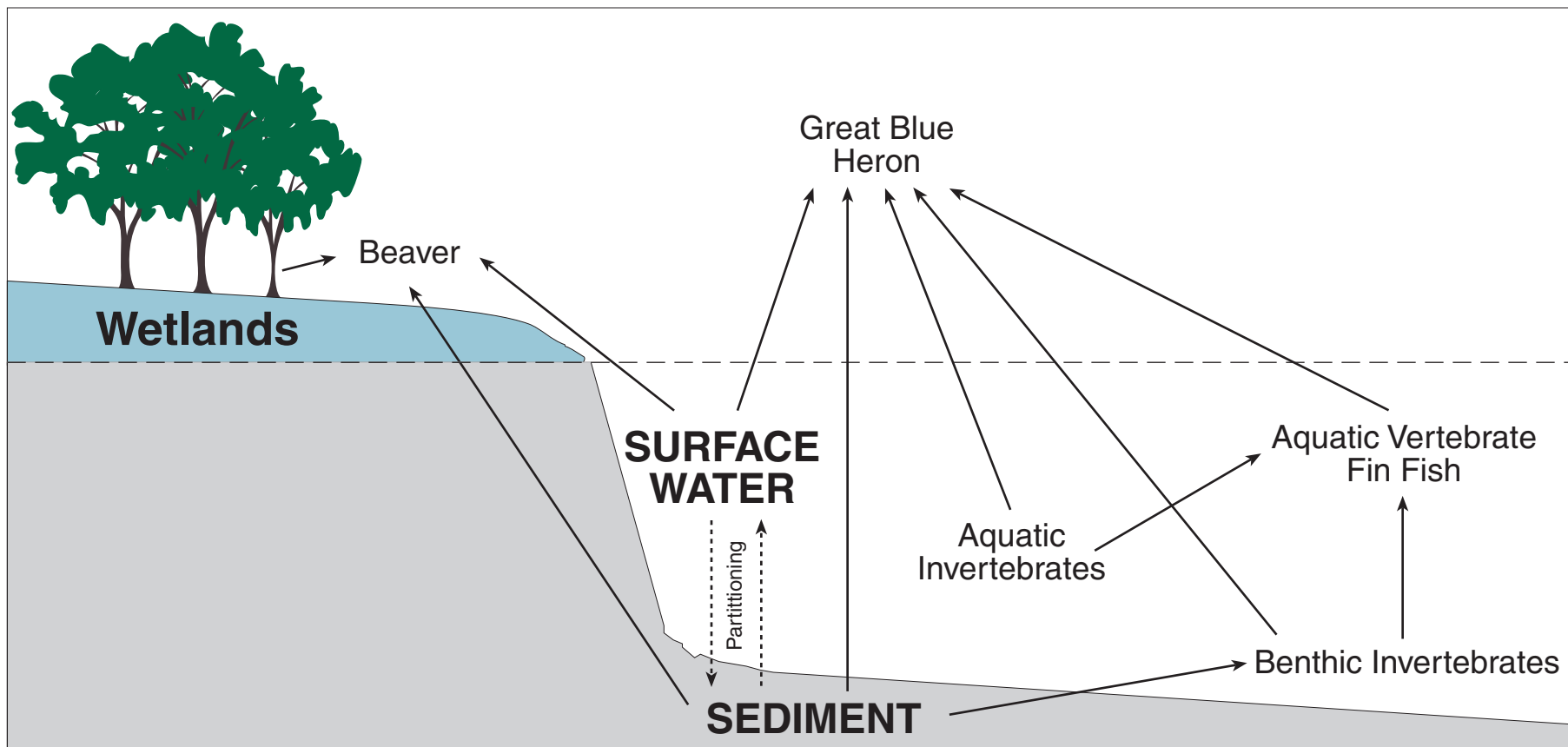
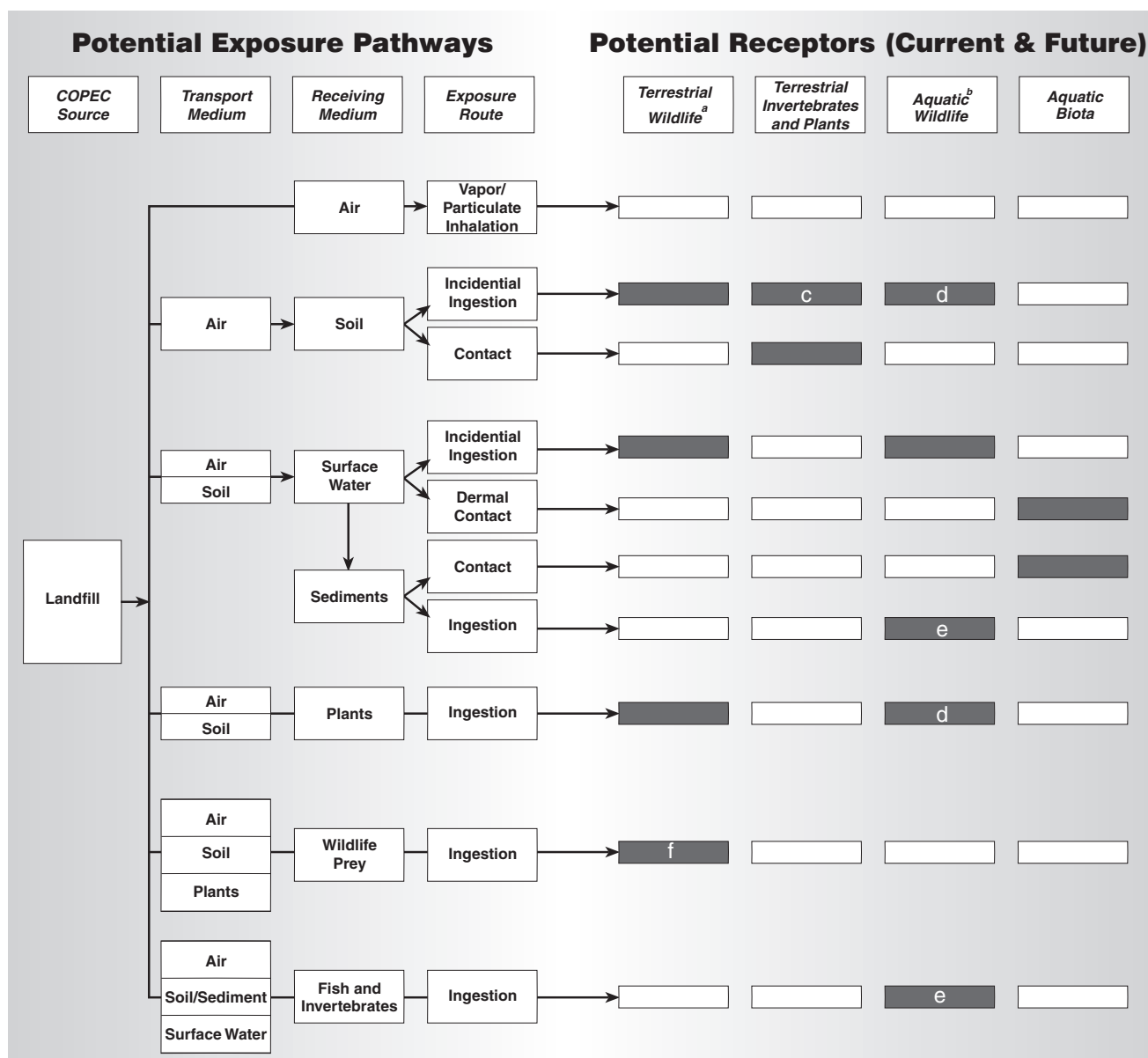


Figure 6-4.
Simplified Aquatic Food Web Conceptual Site Model (CSM)
Former Lordstown Ordnance Depot, Ohio

**Comments:**

- COPEC = Chemical of Potential Ecological Concern
- Surface Soil (0-2.0') Used

Footnotes:

- | | |
|---|----------------------|
| a. Deer Mouse; Eastern Cottontail; Short-Tailed Shrew; American Robin; Red-Tailed Hawk; Red Fox | c. Excluding Plants |
| b. Great Blue Heron; Beaver | d. Beaver Only |
| | e. Heron Only |
| | f. Hawk and Fox only |

Legend:

- Complete pathway which will be evaluated
- Pathway which will not be evaluated

Draft Final TAMPEEL Remedial Investigation Report
Dated May 2005
Former Lordstown Ordinance Depot
Comment Response Tables
Reviewed by Ohio EPA
October 18, 2005

Note: Ohio EPA reviewed a draft report entitled *TAMPEEL Remedial Investigation and Supplemental Investigation, Former Lordstown Ordinance Depot*, dated 2004, and provided comments to USACE in a document dated May 17, 2004. In June 2005, USACE submitted a revised report entitled *Final TAMPEEL Remedial Investigation*, dated May 2005, with a "Responses to Ohio EPA comments".

Ohio EPA reviewed and responded with comments in a letter dated October 18, 2005. This letter identified several comments that were not adequately addressed in the final report or USACE's "Response to Ohio EPA Comments". Although USACE has conducted additional investigative activities between 2006 and 2009, which will be presented in a RI Addendum, outstanding comments concerning the 2005 RI Report were never addressed. The following Comment Response Table summarizes the revisions proposed for the 2005 RI Report. The table includes responses to four General Comments and the three remaining unresolved Ohio EPA comments dated October 18, 2008 concerning the 2005 RI report.

Cmt #	Location	Ohio EPA Comment	Ohio EPA Recommendation	Response
General	1.	The USACE "Responses to Ohio EPA Comments" section is not dated.	A date should be added, as this section was located separately in the from binder pocket.	Agree. The date is included in the footer of the Response to Comments, but will also be added to the top of the page for clarity.
General	2.	Please verify how the additional investigative work results will be presented to Ohio EPA (addendum, another report, etc.) and frequency (after each sampling event, all in one report, etc.)		Agree. The Executive Summary of the report will be revised and will include an explanation that that additional RI activity has been conducted at the site and that results will be presented in a Remedial Investigation Report Addendum.

Cmt #	Location	Ohio EPA Comment	Ohio EPA Recommendation	Response
General	3.	The conclusion/recommendation section should be changed to a discussion of the additional investigative work that is being completed.		<p>Agree. The Conclusions section (Section 7.2, Page 7-12 will be revised as follows: "The following additional investigation activities are recommended for the TAMPEEL Landfill Remedial Investigation:</p> <ul style="list-style-type: none"> • Four quarters of surface water sampling for VOCs from the TAMPEEL Spring and Aspen Creek to confirm that only low levels of VOCs were present. • Four quarters of groundwater Monitoring. • Four quarters of landfill gas monitoring. • Additional investigation to delineate the extent of the TAMPEEL Landfill. <p>The results of the additional investigation will be presented in a Remedial Investigation Addendum."</p> <p>Agree. All premature conclusions in the Shaw document will be removed.</p>
General	4.	All premature conclusions in the "Responses to Ohio Comments" Section and with the Shaw document should be removed.		

Cmt #	Location	Ohio EPA Comment	Ohio EPA Recommendation	Response
2		This response is regarding a possible Presumptive Landfill Remedy that was suggested by the USACE to the Ohio EPA.	All remedy and discussions to "obtain Ohio EPA concurrence that a Feasibility Study (FS) is not warranted based on the RI results" should be deleted until the additional investigative work has been complete and analyzed. This includes the entire response to Item #2.	Agree. All references to presumptive remedies and statements that a feasibility study does not appear to be warranted will be deleted from the 2005 RI Report.
5		This response is regarding a Recommendations section to be added to the report. The USACE response discussing "that a FS is not warranted" should be deferred until additional investigative work has been completed and analyzed	The Recommendations section can merely state that additional investigative work should be completed at the site.	Agree. The Recommendations section will be revised as indicated in the response to General Comment 3.

Cmt #	Location	Ohio EPA Comment	Ohio EPA Recommendation	Response
7		<p>This response is regarding the Ecological Risk conclusions presented in Section 7.0. All conclusions/statements with empirical data or a citation to a study that supports conclusion statement must be supported. For example, the USACE response to comment #7, "Initial indications are the aluminum in sediment is not readily bioavailable and would not constitute an ecological risk" and "The levels of DDD and DDE in sediment at TAMPEEL appear consistent with agricultural applications" must be supported by site-specific data or a reference.</p>		<p>Agree. The discussions of Ecological Risk on Pages 7.6 and 7.9 of Section 7.0 will be revised as follows:</p> <p>"Initial indications are the aluminum in sediment is not readily bioavailable and would not constitute an ecological risk based on pH that range from 3.6 to 7.3 for two soil types reported for the site (SCS, 1992; USEPA, 2000a). It appears that arsenic in soil/sediment may represent naturally occurring levels (Table 4-1). The levels of DDD and DDT in sediment at TAMPEEL appear consistent with agricultural levels (ATSDR, 1994b)."</p>