

**Final
Remedial Investigation Report for the
Occidental Chemical Corporation Property
At Formerly Used Defense Site
Former Lake Ontario Ordnance Works (LOOW)
Niagara County, New York**

Volume One

April 2013

Prepared for:



**US Army Corps
of Engineers®**

BUILDING STRONG®

U.S. Army Corps of Engineers
Baltimore District

Contract W912QR-08-D-0012

Delivery Order 0008

FUDS Project No. C02NY0025

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COMPLETION OF SENIOR TECHNICAL REVIEW

This document has been produced within the framework of the ERT, Inc. (ERT) and EA Engineering, Science, and Technology, Inc. (EA) quality management system. As such, a senior technical review, as defined in the Quality Control Plan for this project, has been conducted. This included review of the overall design addressed within the document, proposed or utilized technologies and alternatives and their applications with respect to project objectives and framework of U.S. Army Corp of Engineers (USACE) regulatory constraints under the current Defense Environmental Restoration Program for Formerly Used Defense Sites (DERP-FUDS). No. C02NY0025 project, within which this work has been completed.

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COMPLETION OF INDEPENDENT TECHNICAL REVIEW

This document has been produced within the framework of ERT's total quality management system. As such, an independent technical review, appropriate to the level of risk and complexity inherent in the project as defined in the Quality Control Plan for this project, has been conducted. This included review of assumptions (methods, procedures, and material used in analyses), alternatives evaluated; the appropriateness of data used and level of data obtained; and reasonableness of the results, including whether the product meets the project objectives. Comments and concerns resulting from review of the document have been addressed and corrected as necessary.

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18 July 2012

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LIST OF ACRONYMS AND ABBREVIATIONS

A/E	Architecture/Engineering
AEC	U. S. Atomic Energy Commission
AOC	area of concern
AOI	area of interest
ARAR	applicable or relevant and appropriate requirement
ASTM	American Society for Testing and Materials
B	blank contamination
bgs	below ground surface
BRA	Baseline Risk Assessment
BTV	background threshold value
CDD	Central Drainage Ditch
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CLP	Contract Laboratory Program
COC	constituent of concern
COPC	constituent of potential concern
cpm	counts per minute
CWM	Chemical Waste Management, LLC
DAF	dilution attenuation factor
DERP	Defense Environmental Restoration Program
DNT	dinitrotoluene
DO	Delivery Order
DoD	Department of Defense
DPT	direct push technology
DQA	data quality assessment
DQI	data quality indicator
DQO	data quality objective
DUSR	Data Usability Summary Report
EA	EA Engineering, Science, and Technology, Inc.
EA/FWIA	Ecological Assessment/Fish and Wildlife Impact Analysis
ERDA	Energy Research and Development Administration
ERT	Earth Resources Technology, Inc.
EU	Exposure Unit
eV	electron-volt
FS	Feasibility Study
FSP	Field Sampling Plan
ft	feet
ft/day	feet per day
ft/yr	feet per year
FUDS	Formerly Used Defense Site
FUSRAP	Formerly Utilized Sites Remedial Action Program
g/cm ³	gram per cubic centimeter
GLC	glaciolacustrine clay
GPS	global positioning system

LIST OF ACRONYMS AND ABBREVIATIONS

GSA	General Services Administration
HHRA	human health risk assessment
HMX	cyclotetramethylenetetranitramine
HQ	hazard quotient
HSR	History Search Report
HTRW	Hazardous, Toxic, and Radioactive Waste
ID	identification
IDIQ	Indefinite Delivery/Indefinite Quantity
IEUBK	Integrated Exposure Uptake Biokinetic
J	estimated value
Koc	Soil organic carbon-water partition coefficient
kg	kilogram
kg/L	kilogram per liter
KOA	Kampground of America
L	liter
L/kg	liter per kilogram
L-P CSD	Lewiston-Porter Central School District
LOOW	Lake Ontario Ordnance Works
MCGI	Meridian Consultant Group, Inc.
MCL	Maximum Contaminant Level
mg	milligram
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
mm Hg	millimeter of mercury
MS/MSD	matrix spike/matrix spike duplicate
N	tentatively identified compound
NA	not applicable
NAD	North American Datum
ND	non-detect
NFA	no further action
NFSS	Niagara Falls Storage Site
NJDEP	New Jersey Department of Environmental Protection
nm	nanometers
NRAA	Niagara River Angler's Association
NSA	no screening level available
NYSDEC	New York State Department of Environmental Conservation
NYSDOP	New York Statewide Digital Orthoimagery Program
Occidental	Occidental Chemical Corporation
OCCP	Occidental Chemical Corporation Property
PAH	polycyclic aromatic hydrocarbon
PARCCS	precision, accuracy, representativeness, comparability, completeness and sensitivity
PCB	polychlorinated biphenyl
pCi/g	average picocuries per gram
PE	Performance Evaluation

LIST OF ACRONYMS AND ABBREVIATIONS

PID	photoionization detector
ppm	parts per million
QA/QC	quality assurance/quality control
QAPP	Quality Assurance Project Plan
R	Roentgen or rejected
RDX	Cyclotrimethylenetrinitramine
REI	Rust Environmental and Infrastructure
RI	Remedial Investigation
RME	reasonable maximum exposure
ROE	right-of-entry
RPD	relative percent difference
RSL	Regional Screening Levels
RSP	Radiation Safety Plan
SBC	small bermed clearing
SD	Sediment
SF	slope factor
SLERA	Screening Level Ecological Risk Assessment
Smith	Peter J. Smith & Company, Inc.
SOP	standard operating procedure
SQL	sample quantitation limits
SSHP	Site Safety and Health Plan
SSL	site-specific screening levels
SVOC	semi-volatile organic compound
SW	surface water
SWDD	Southwestern Drainage Ditch
TAL	Target Analyte List
TBC	to be considered
TCL	Target Compound List
TDS	total dissolved solids
TEC	threshold effect concentrations
TNT	Trinitrotoluene
TOGS	Technical and Operational Guidance Series
TOV	total organic vapor
TP	test pit
TRW	Technical Review Workgroup
U	analyte not detected above the method detection limit and limit of detection
UCT	upper clay till
UPL	upper prediction limit
USACE	U.S. Army Corps of Engineers
TEC	Topographic Engineering Center
USCB	U.S. Census Bureau
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
UXO	unexploded ordnance
VOC	volatile organic compound

LIST OF ACRONYMS AND ABBREVIATIONS

VP	Vicinity Properties
WMA	Wildlife Management Area
WWTP	Wastewater Treatment Plant
%R	percent recovery
µg/dL	microgram per deciliter
µg/kg	microgram per kilogram
µg/L	micrograms per liter
µR/hr	microRoentgens per hour
µrem/hr	microrem per hour

EXECUTIVE SUMMARY

This *Remedial Investigation Report for the Occidental Chemical Corporation Property* (hereinafter the “OCCP RI Report”) characterizes the nature and extent of contamination to environmental media (i.e., soil, surface water, sediment), evaluates potential impacts to groundwater from identified subsurface soil concentrations, evaluates the fate and transport of contaminants, and assesses potential risk to human health and the environment resulting from former Department of Defense (DoD) operations at the Occidental Chemical Corporation Property (OCCP) (hereinafter the “site”) at the former Lake Ontario Ordnance Works (LOOW), Niagara County, New York.

This investigation was completed under contract to the U.S. Army Corps of Engineers (USACE), Baltimore District under the Defense Environmental Restoration Program for Formerly Used Defense Sites (DERP-FUDS).

The primary objectives for the investigation were to evaluate impacts to environmental media (i.e., soils, groundwater, surface water, sediment) resulting from former DoD operations at the site as follows:

- Assess the presence and/or absence and map the extent of DoD-related contaminants in soil, surface water, and sediment at specific areas of concern (AOCs)
- Evaluate the fate and transport of contaminants attributed to previous DoD operations
- Evaluate potential impacts to human health and the environment from contaminants attributed to previous DoD operations

The scope of this investigation included non-intrusive and intrusive activities. Based on the *Examination of Historical Aerial Photography – Selected Sites, Former LOOW* (U.S. Army Topographic Engineering Center [U.S. Army TEC], 2002), 39 areas of interest (AOIs) were prioritized and preliminarily assessed. Following the assessment of each AOI for evidence of environmental impacts from former DoD operations, six AOCs were selected for investigation. These AOCs were labeled AOC 1 through AOC 6 and contained the following features:

- AOC 1 – Former dump area identified by U.S. Army TEC as a “presumed storage area (1944 aerial photograph) and “disturbed ground” (1951 aerial photograph)
- AOC 2 – Pond located in the eastern section of the site
- AOC 3 – Small dump area identified by USACE during site reconnaissance performed in 2010
- AOC 4 – Location of two buildings and a small structure that were identified by U.S. Army TEC (1944 aerial photograph)
- AOC 5 – Mounded material at the intersection of a dirt road and 30 inch outfall line that was identified by USACE during site reconnaissance performed in 2010
- AOC 6 – Pond located in the north central section of the site

Investigation activities were performed between 2001 and 2011 at AOC 1 through AOC 6 to characterize surface soil, subsurface soil, surface water, and sediment using field screening and sampling activities. Laboratory analysis was performed on 51 surface soil, 26 subsurface soil, 3 surface water, and 3 sediment samples. The samples were analyzed for some or all of the

following: Target Compound List (TCL) volatile organic compounds (VOCs), TCL semi-volatile organic compounds (SVOCs), pesticides, polychlorinated biphenyls (PCBs), explosives, Target Analyte List (TAL) metals, boron, lithium, and/or radionuclides. Following laboratory analysis the analytical data was validated and evaluated against established project screening criteria. Constituents that exceeded the project screening criteria were carried through to risk assessments for human health and ecological receptors:

Surface Soil

An SVOC, explosives, inorganics, and radionuclide measurements were detected in surface soil at concentrations greater than the project screening criteria. They included:

- One SVOC (i.e., benzo(a)pyrene)
- Eight explosives (i.e., 1,3-dinitrobenzene; 2,4,6-trinitrotoluene [TNT]; 2,4-dinitrotoluene [DNT]; 2,6-DNT; 2-amino-4,6-DNT, 2-nitrotoluene, 4-amino-2,6-DNT, and cyclotrimethylenetrinitramine [RDX])
- Sixteen metals (i.e., aluminum, antimony, arsenic, barium, cadmium, chromium [hexavalent], cobalt, copper, iron, lead, lithium, manganese, nickel, thallium, vanadium, and zinc)
- Radionuclide measurements (i.e., gross alpha and gross beta)

Subsurface Soil

Explosives and metals were detected in subsurface soil at concentrations greater than the project screening criteria. They included:

- One explosive (i.e., 2,4,6-TNT)
- Eight metals (i.e., aluminum, arsenic, chromium [hexavalent], cobalt, iron, lithium, manganese, and thallium)

Surface Water

An SVOC, explosives, and metals were detected in surface water at concentrations greater than project screening criteria. They included:

- One TCL SVOC (i.e., 4-methylphenol)
- Two explosives (i.e., 3-nitrotoluene and RDX)
- Sixteen metals (i.e., aluminum, arsenic, barium, beryllium, cadmium, cobalt, copper, iron, lead, lithium, manganese, nickel, potassium, silver, vanadium, and zinc)

Sediment

VOCs and metals were detected in sediment at concentrations greater than project screening criteria. They included:

- Two VOCs (i.e., 2-butanone and acetone)
- Sixteen metals (i.e., aluminum, arsenic, barium, beryllium, cadmium, cobalt, copper, iron, lead, lithium, manganese, nickel, potassium, silver, vanadium, and zinc)

Human Health Risk Assessment

For AOC 1 - exposure unit (EU) 8, cumulative carcinogenic risks did not exceed the USEPA acceptable risk range for the adult and adolescent trespasser, maintenance worker, commercial worker, and construction worker. Cumulative carcinogenic risks exceeded the USEPA acceptable risk range for the resident adult and child. Carcinogenic risks were driven by 2,4,6-TNT and hexavalent chromium in total soil.

All receptors had non-carcinogenic hazards above the threshold value of 1.0 for EU 8. Non-carcinogenic hazards were almost exclusively due to 2,4,6-TNT.

Lead in surface soil was identified as a potential concern for the resident child based upon use of a USEPA lead uptake model.

Hexavalent chromium in soil was analyzed using USEPA Method 7196A. However, significant uncertainty surrounded the results obtained using this colorimetric method. Based upon this uncertainty, it is recommended that a different analytical method be used to verify if hexavalent chromium is a constituent of concern (COC) in EU 8 soil. Additional sampling and analysis for hexavalent chromium is recommended prior to completion of a remedial feasibility study (FS) to indicate whether or not hexavalent chromium is retained as a COC.

Sediment and surface water at AOC 2 and AOC 6 were evaluated qualitatively and no risks for human contact were identified.

No further study of AOC 2, AOC 3, AOC 4, AOC 5, and AOC 6 is necessary with regard to human health risk.

Screening Level Ecological Risk Assessment

AOC 1 – EU 8 was found to have high concentrations of metals and explosives, to the extent that lower trophic level receptors (plants and invertebrates) and higher trophic level receptors (shrew, rabbit, robin, and hawk) are potentially at risk from this exposure. While no physical appearance of damaged vegetation was apparent at EU 8, this does not preclude impacts to other receptors or even plants. Colonization of the site by more resistant plant species could have occurred, resulting in the appearance of viable vegetation, when there have been changes to the system. Given the high hazard quotients exhibited at EU 8, continuation of the risk assessment process is recommended for this area.

No further study of AOC 2, AOC 3, AOC 4, AOC 5, and AOC 6 is necessary with regard to ecological risk.

Conclusions

Negligible risk was determined from exposure to constituents in soil, sediment, and surface water for any receptors at AOC 2, AOC 3, AOC 4, AOC 5, and AOC 6. No further environmental action or management is recommended for these AOCs.

Unacceptable additional risk associated with the contaminants detected at AOC 1 – EU 8 requires further environmental action and management. A remedial FS is recommended for soil, which should consider all fill materials and redistributed soil. Based on sampling completed during the RI, concentrations exceeding risk based criteria for human health extend to a depth of approximately 3 feet below ground surface. Risk outside of the acceptable range was identified

for the adult trespasser, adolescent trespasser, maintenance worker, commercial worker, construction worker, resident adult, and resident child (receptors) from exposure to 2,4,6-TNT in surface soil. Lead in surface soil is also a potential concern for the resident child.

Within AOC 1 – EU 8 the area of impacted soil is approximately 30,000 square feet and is located in the vicinity of deteriorated steel 55-gallon drums. The concentrations reported in subsurface soil do not suggest that there is an impact to groundwater. The total volume of soil exhibiting concentrations greater than USEPA RSLs is estimated to be 2,250 cubic yards.

1.0 INTRODUCTION

This *Remedial Investigation Report for the Occidental Chemical Corporation Property* (hereinafter the “OCCP RI Report”) was prepared by ERT, Inc. (ERT) in accordance with the Statement of Work for Delivery Order (DO) 0008 for Architectural/Engineering (A/E) Services at the former Lake Ontario Ordnance Works (LOOW), Niagara County, NY, under Indefinite Delivery/Indefinite Quantity (IDIQ) Contract No. W912QR-08-D-0012. This DO was issued for the Occidental Chemical Corporation Property (hereinafter “OCCP” or “the site”) by the U.S. Army Corps of Engineers (USACE), Baltimore District on August 17, 2011 under the Defense Environmental Restoration Program for Formerly Used Defense Sites (DERP-FUDS). The DERP-FUDS project number for the former LOOW is No. C02NY0025. Remedial investigation (RI) activities associated with the OCCP were conducted in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) as required by DERP-FUDS. **Figure 1-1** (Site Location) depicts the general locality and orientation of the site within the former LOOW. **Figure 1-2** (Site Layout) depicts the current ownership boundary for the former LOOW and the OCCP.

Approximately 6,583 acres of the former LOOW, including the OCCP, were transferred from DoD ownership prior to October 17, 1986 and fall under the definition of a FUDS. There is no evidence that this area exhibits any parameters that would exclude the property from FUDS restoration. Therefore, the USACE is responsible for the management and execution of the DERP FUDS program at this site in accordance with legislation, FUDs guidance, and DoD policy. The RI was performed as a Hazardous, Toxic, and Radioactive Waste (HTRW) project under the DERP-FUDS Installation Restoration Program (IRP) (USACE, 2012a).

1.1 Purpose, Scope, and Objective

The RI characterizes the nature and extent of contamination to environmental media (i.e., soils, surface water, sediment) resulting from former Department of Defense (DoD) operations at the site. The potential for impact to groundwater from contaminants in subsurface soil is also assessed.

The RI evaluates potential risks to human health and the environment posed by contaminants at the site. Based on the human health and environmental risks, each area of concern (AOC) is classified as either requiring no further action (NFA) or as an exposure unit (EU) that will be subjected to a feasibility study (FS) that will evaluate remedial alternatives.

The scope of this investigation included 39 areas of interest (AOIs) (**Figure 1-3**) that were previously identified from aerial photos documented in *Examination of Historical Aerial Photography – Selected Sites, Former LOOW* (U.S. Army Topographic Engineering Center [U.S. Army TEC], 2002) or identified during site reconnaissance conducted by USACE (USACE, 2004). These AOIs were prioritized and preliminarily assessed by USACE between 2002 and 2011. Based on analytical data collected from a subset of small bermed clearings (SBCs), USACE determined that these features do not present a potential risk and were recommended for no further environmental investigation (USACE, 2004). Each remaining AOI was assessed for evidence of environmental impacts attributed to former DoD operations. Six areas of concern (AOCs), labeled AOC 1 through AOC 6, were identified for further investigation (**Figure 1-4**):

- AOC 1 –Former dump area identified by U.S. Army TEC as a “presumed storage area” (1944 aerial photograph) and “disturbed ground” (1951 aerial photograph)
- AOC 2 –Pond located in the eastern section of the site
- AOC 3 – Small dump area identified by USACE during site reconnaissance performed in 2010
- AOC 4 – Location of two buildings and a small structure that were identified by U.S. Army TEC (1944 aerial photograph)
- AOC 5 – Mounded material at the intersection of a dirt road and 30 inch outfall line that was identified by USACE during site reconnaissance performed in 2010
- AOC 6 – Pond located in the north central section of the site

These AOCs were investigated to:

- Evaluate the presence or absence of contaminants in soil, surface water, and sediment resulting from past DoD operations
- Characterize the nature and extent of contamination in soil, surface water, and sediment
- Assess the potential for human health and ecological risk associated with the contaminants

1.2 Report Organization

This report documents background information, historical analytical data, investigation objectives, methodologies, field screening and analytical data, and provides an assessment of the data. Data collected during investigation activities between 2001 and 2011 are presented and evaluated.

Each report section, summarized below, provides information specific to the RI objectives.

- Section 1.0 contains an introduction, identifies the purpose, objectives, and scope of the investigation, and outlines the report structure
- Section 2.0 describes regional physical characteristics, the environmental setting and site characteristics
- Section 3.0 identifies chemical screening levels and background levels that were used as a first step in the data evaluation process
- Section 4.0 summarizes the investigation activities and methodologies
- Section 5.0 presents the investigation data and provides an assessment of the quality and usability of the data
- Section 6.0 summarizes the nature and extent of contamination
- Section 7.0 discusses the fate and transport of contaminants of potential concern
- Section 8.0 summarizes the human health risk assessment (HHRA)
- Section 9.0 summarizes the screening level ecological risk assessment (SLERA)
- Section 10.0 provides conclusions and recommendations

- Section 11.0 includes references.

1.3 Site Background

1.3.1 Former LOOW History

The former LOOW is a 7,500-acre parcel located in northwestern New York State within Niagara County (**Figures 1-1 and 1-2**). In 1942, the U.S. Department of War obtained a parcel proximal to both Lake Ontario and Niagara River in northwestern Niagara County for the construction of a trinitrotoluene (TNT) production facility designated LOOW. TNT production, product support, and storage occupied 2,500 acres of the eastern portion of LOOW. The remaining 5,000 acres were left undeveloped, acting as a buffer zone and allowing for the possible expansion of production. The site is located within the undeveloped buffer zone.

In 1943, after nine months of production, the LOOW was decommissioned due to excess TNT production at other DoD facilities. The eastern 2,500 acres, which was the production area, was subsequently used by various other agencies of the DoD, including the Air Force and Navy. The Air Force and Navy later used the area for manufacturing plants, such as Air Force Plant 68 and the Navy Interim Production Pilot Plant, for manufacturing of high-efficiency borane fuels. The Army subsequently used the acreage for the construction of a Nike Missile Base.

In the mid-1940s, 1,500 acres of the southern portion of the former LOOW were transferred to the USACE, Manhattan Engineer District which later gave rise to the U. S. Atomic Energy Commission (AEC). While under operation by the USACE, Manhattan Engineer District, radioactive materials were stored on portions of the 1,500 acres of the LOOW site. However, between the 1950s and 1980s, radioactive materials formerly housed on the acreage were consolidated, removed, and transferred to the current 191-acre Niagara Falls Storage Site (NFSS). During investigation and consolidation, the acreage surrounding the NFSS that was formerly used by the AEC and its predecessor was designated as “Vicinity Properties” (VP) to facilitate the cleanup and closure. The NFSS and remaining open VPs are currently being addressed under the Formerly Utilized Sites Remedial Action Program (FUSRAP).

1.3.2 Site History

The site is an approximately 304 acre parcel located within the former LOOW FUDS boundary (**Figure 1-2**). The site is bounded to the north by Balmer Road and to the east by the former LOOW wastewater treatment plant (WWTP). The OCCP is situated in the Buffer Zone of the former LOOW. The Buffer Zone, also referred to as the “undeveloped area” refers to that area of the former LOOW where no manufacturing took place. It is generally considered to consist of approximately 5,000 acres of the western, northern, and southern portion of LOOW. No significant former DoD structures are located in this area, with the exception of an open shed formerly used as part of the transportation area, and a fenced storage area. However, various types of disturbances of unknown origin are visible on aerial photographs of the buffer zone taken during the 1940s timeframe. The largely undeveloped buffer zone of the former LOOW (including the current OCCP) was transferred to the General Services Administration (GSA) in 1945 for disposal to private landowners (USACE, 2002). The Hooker Chemical and Plastics Corporations (Hooker) purchased the land from a private landowner in 1975 and later sold it to the current owner, the Occidental Chemical Corporation (Occidental) (USACE, 2012a).

The Developed Zone, also referred to as the “developed area” refers to that area of the former LOOW where manufacturing took place. It is generally considered to consist of approximately

2,500 acres of the eastern portion of LOOW, and is comprised of the former TNT storage bunkers (north of Balmer Road), the nitration area (north of M Street), the former WWTP (on property currently owned by the Town of Lewiston), the shops and acid concentration area (on property currently owned by the Department of Energy for the NFSS), and the administrative area (north of Pletcher Road, on property currently owned by Modern Disposal) (USACE, 2012b).

Prior to development of the LOOW, the OCCP was mixed agricultural land (e.g., forest, orchard, and farms with some farmsteads and farm ponds [AOC 2 and AOC6]). During development of the LOOW, a 30-inch diameter outfall line was installed across the southern portion of the site from the LOOW WWTP to the Niagara River. The 30-inch outfall line conveyed wastewater from the WWTP west to the Niagara River. Other than WWTP outfall line, former DoD operations at the OCCP are unknown.

1.4 Previous Investigation Activities

This report documents the fifth phase of an ongoing investigation at the former LOOW. Details of previous investigation activities at the former LOOW are available in the following documents:

- *Final Report of Results for the Phase I Remedial Investigation at the Lake Ontario Ordnance Works, Niagara County, New York* (USACE, 1999) – hereinafter the “LOOW Phase I RI Report.”
- *Final Report of Results for the Phase II Remedial Investigation at the Lake Ontario Ordnance Works, Niagara County, New York* (USACE, 2002) – hereinafter the “LOOW Phase II RI Report.”
- *Small-Bermed Clearing Supplemental Investigation Summary Report* (USACE, 2004) – hereinafter the “LOOW SBC Report.”
- *Final Report of Results for the Phase III Remedial Investigation at the Lake Ontario Ordnance Works, Niagara County, New York* (USACE, 2008a) – hereinafter the “LOOW Phase III RI Report.”
- *Final Remedial Investigation Report for Phase IV Remedial Investigation/Feasibility Study at Formerly Used Defense Site, The Lake Ontario Ordnance Works, Niagara County, New York* (USACE, 2011d) – hereinafter the “LOOW Phase IV RI Report.”

The following discussion provides a summary of historical investigation activities conducted at the site.

U.S. Army TEC Examination of Historical Aerial Photography

In 2002, the U.S. Army TEC completed an *Examination of Historical Aerial Photography – Selected Sites, Former LOOW*. During the examination, photographic anomalies at the OCCP were identified including ground scars, disturbed ground, small bermed clearings, and debris piles (U.S. Army TEC, 2002). The U.S. Army TEC studied photographs from 1938, 1942, 1944, 1951, 1956, 1958, 1960, 1963, 1972, 1978, 1981, 1985, 1990, 1995, and 1997, and the anomalies identified in the photographs from the timeframe of DoD ownership are considered areas of interest due to possible DoD activity (**Figure 1-3**). Review of historical aerial photographs taken between 1938 and 1956, identified an area in the southwest portion of the OCCP that appeared to

be fenced and showed indications of possible usage; with ground scarring and debris/mounded material evident on the historical aerial photographs. The area in question, AOC 1, was approximately 500 feet (ft) by 400 ft in size (**Figure 1-4**).

LOOW Phase II RI

During a review of historical aerial photographs from 1938, 1944, and 1956, an area of approximately 200,000 square ft appeared to be fenced and in use. Because of the timeframe coincided with DoD ownership, the OCCP was included for investigation during the Phase II RI (USACE, 2002).

In 2002, the USACE completed the investigation activities for the *LOOW Phase II RI* which included surface soil, subsurface soil, surface water, and sediment sample collection at AOC 1 and AOC 2. AOC 1 was evaluated as it contained various trash and debris as well as terra cotta piping, transite siding, ceramic electrical junctions, and approximately 6-8 deteriorated steel 55-gallon drums. A solid, caked, fibrous, brownish-black material was observed and was identified as possible former 55-gallon drum contents, based on the shape of material. Surface soil sampling (0 ft to 1 ft below ground surface [bgs]), and subsurface soil sampling (3 ft to 7 ft bgs) was conducted. AOC 2 was evaluated because it was a surface water body that may have been contaminated from historical operations. Surface water and sediment sampling was conducted at this location.

Following laboratory analysis of surface and subsurface soil samples from AOC 1 and surface water and sediment from AOC 2, analytes from AOC 1 were reported at concentrations greater than health-based or project screening criteria. The highest reported concentration(s) were from a fill area in AOC 1, near debris, drums, and fibrous/solidified drum contents. Contaminants were not detected above health-based or project screening criteria from AOC 2.

LOOW Phase III RI

Underground utilities formerly used by the DoD throughout LOOW were investigated during a Phase III RI conducted during 2005 to 2007. A 30-inch WWTP outfall line that traverses the OCCP was included in this investigation. Data collected from the outfall line and the ensuing risk assessment determined that there are no human health concerns associated with exposure to constituents within outfall. Therefore, the 30-inch outfall was not evaluated further during this RI.

Small-Bermed Clearings

In 2004, the USACE completed an investigation of SBCs identified in the U.S. Army TEC examination of historical aerial photography (USACE 2004). The USACE determined that the SBCs were created between April 1942 and March 1944, which is the time period corresponding to the construction, operation, and decommissioning of the former LOOW. The USACE sampled a subset of the SBCs (12 SBCs located on four properties) for 2,4,6- TNT, TNT breakdown products, and total petroleum hydrocarbons-diesel range organics (TPH-DRO). In addition, a subset of the samples was analyzed for full suite chemical analyses and analysis of some radiological compounds.

TNT was not detected in any of the samples; TPH-DRO was detected at low levels in the off-site laboratory samples but the report associated this with typical motor oil. Measured concentrations

of radioactivity were consistent with background/ambient levels, as were measured concentrations of metals, polycyclic aromatic hydrocarbons (PAHs), and pesticides.

The conclusions of the investigation were that the constituents found in the samples did not present an imminent or substantial danger to public health or the environment. In addition, because the TNT and TPH-DRO results suggest that the SBCs were not used by the DOD for burn pits, the USACE concluded that further evaluation of chemical contamination in the SBCs may not be authorized under DERP-FUDS (USACE, 2012a).

Lewiston-Porter Central School District Campus

Several environmental investigations of the adjacent Lewiston-Porter Central School District Campus have been conducted since 1999, which culminated in USACE investigations in 2010.

- Phase I RI (USACE, 1999)
- Surface soil sampling/analysis (Chopra Lee, 2001a, 2001b, and 2001c)
- Gamma walkover survey (USACE, 2002)
- Surface water sampling/analysis (Niagara County Department of Health, 2002)
- Soil sampling/analysis (Chopra-Lee, 2003)
- Soils investigation, University of Buffalo Environment and Society Institute (Gardella, et al, 2004)
- Soil sampling/analysis (Panamerican Environmental, Inc., 2004)
- Phase III RI (USACE, 2008)
- Final site inspection (USACE, 2011a)
- Investigation for radiological contaminants (USACE 2011b)

The final site inspection evaluated anomalies that were identified in historical aerial photographs, and surface water, sediment, and soil from the Southwest Drainage Ditch (SWDD). Investigation results indicated that the anomalies, where present, consisted of displaced native soils that were not contaminated by previous DoD activities. Field screening of surface water, sediment, and subsurface soils within the SWDD did not indicate the presence of contamination from previous DoD activities. PAHs and other semi-volatile organic compounds (SVOCs) in SWDD sediment were attributed to asphalt or petroleum combustion by-products. Metals within the surface water were determined to not pose unacceptable risks to individuals using or visiting the Lewiston-Porter Central School District property.

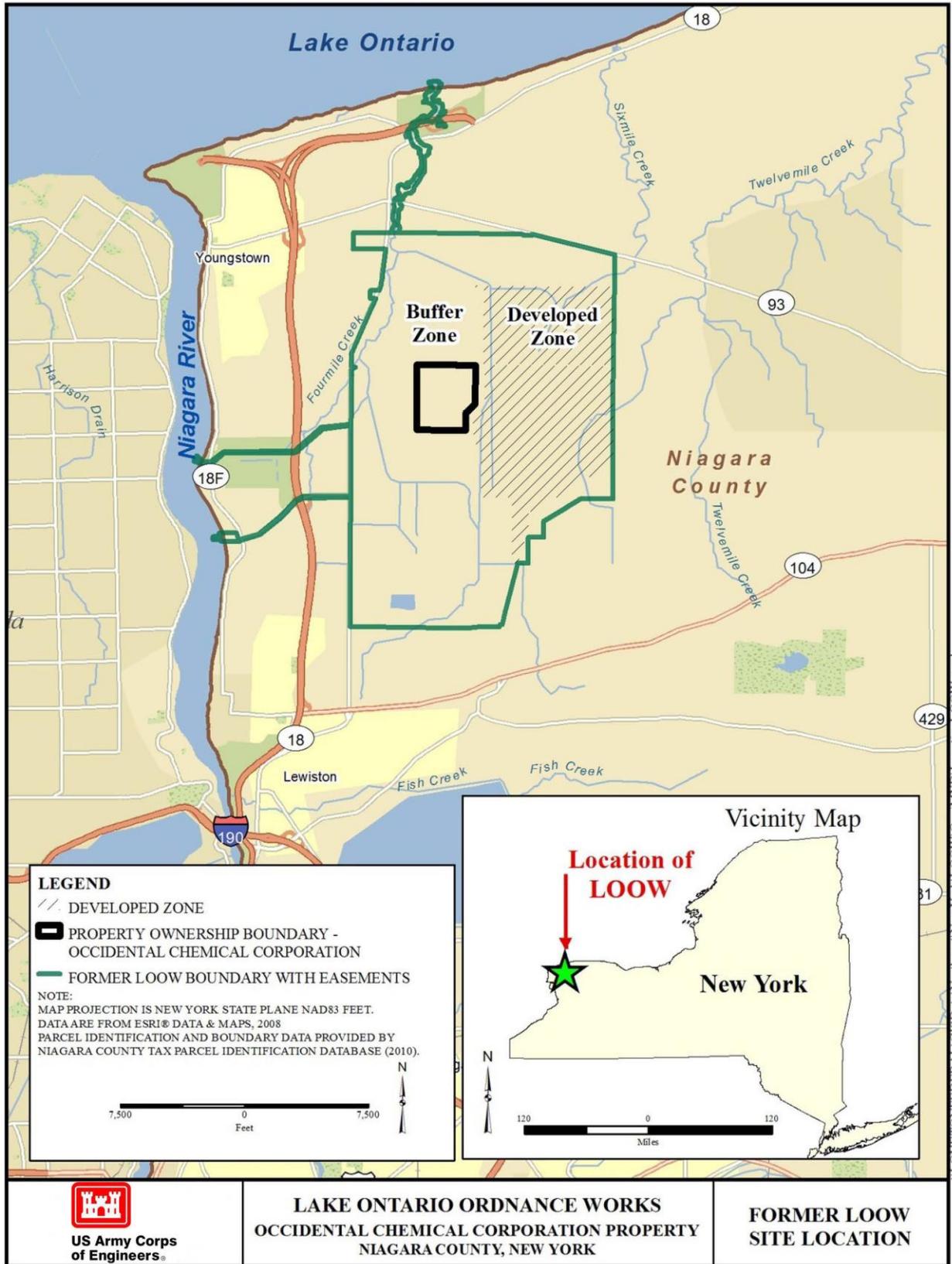


Figure 1-1. Former LOOW Site Location

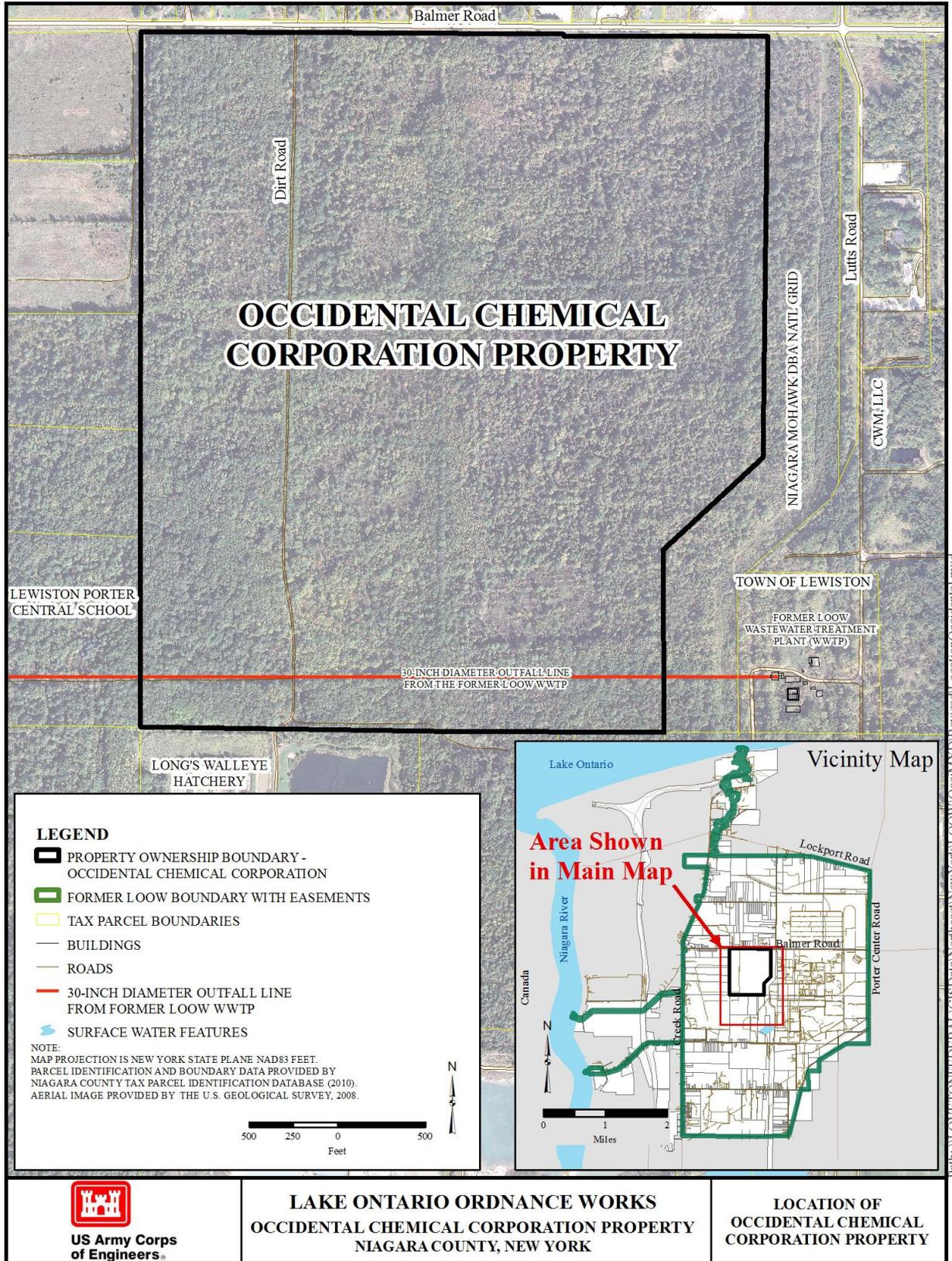


Figure 1-2. Location of Occidental Chemical Corporation Property

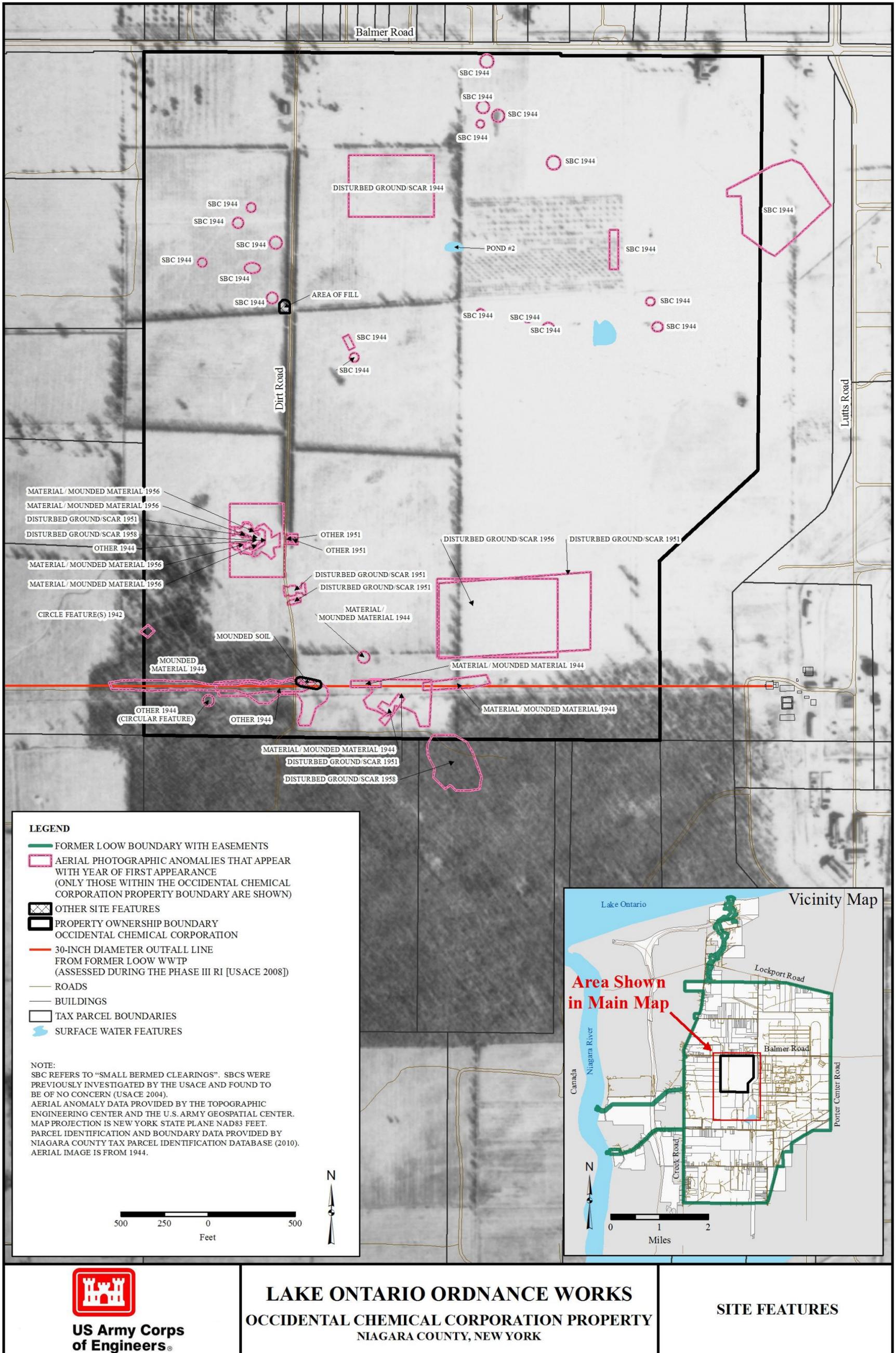
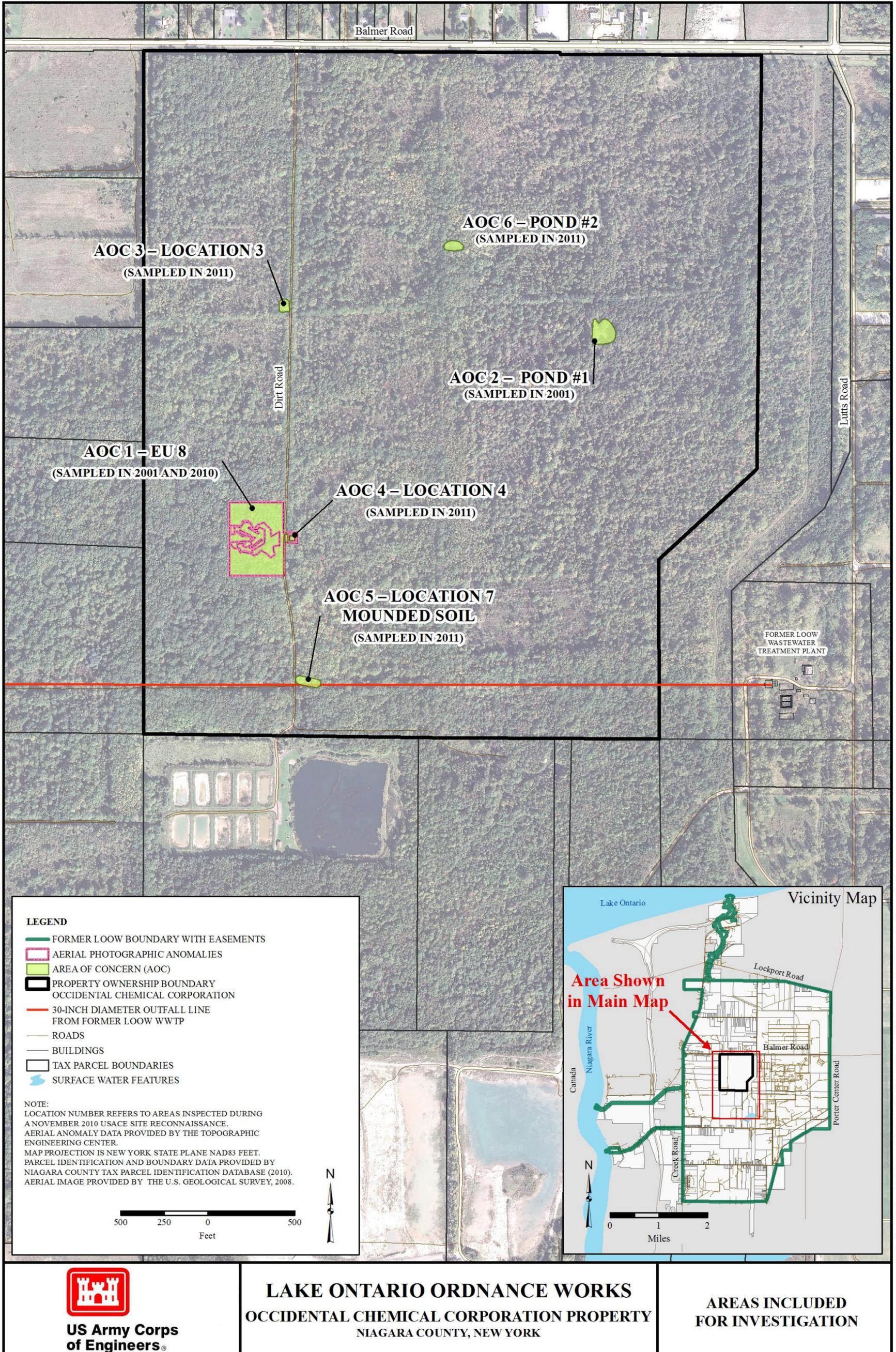


Figure 1-3. Site Features



Path: \LOVETON\FEDERAL\GISData\North east\New York\LOOW\OcciMXD\Revised\Investigation\Areas.mxd



**LAKE ONTARIO ORDNANCE WORKS
OCCIDENTAL CHEMICAL CORPORATION PROPERTY
NIAGARA COUNTY, NEW YORK**

**AREAS INCLUDED
FOR INVESTIGATION**

Figure 1-4. Areas Included for Investigation

2.0 PHYSICAL CHARACTERISTICS

2.1 Environmental Setting and Land Use

The site is owned by the Occidental Chemical Corporation, encompasses approximately 304 acres, and is undeveloped and heavily wooded (**Figure 1-2**). The site is abutted to the north by Balmer Road, to the south by a recreational area used by the Niagara River Angler's Association (NRAA), to the east by a National Grid utility easement, and to the west by the Lewiston-Porter School District Campus. The site is located west of a former LOOW TNT production area. The Chemical Waste Management, LLC (CWM) property and a former LOOW WWTP (currently owned by the Town of Lewiston) are located immediately east of the National Grid utility easement. Beyond the National Grid utility easement, southeast of the site, is the NFSS.

The land use defined in the Town Comprehensive Plan for the Town of Lewiston is described as undeveloped, however proposed future land use is industrial (Smith, 2004). The eastern half of the site is zoned general industrial and the western half is zoned agricultural and rural residential (Smith, 2004). Reconnaissance completed during field activities in August 2010 and October 2011 confirmed that the site is heavily wooded, undeveloped, and unused. Based on current ownership, land use (undeveloped), zoning (industrial or agricultural and rural residential), proposed future land use (industrial), and land uses of abutting properties (recreational, agricultural, and residential), recreational (i.e., hunting), commercial, and industrial activities are anticipated future land use options for the site. However, there are no restrictions preventing the sale of the site under current zoning for either agricultural or residential use.

Adjoining and surrounding properties are used for industrial, residential, recreational, commercial, and agricultural activities. These properties include a mobile home park, a campground, a religious destination, an industrial facility, a public school (Lewiston-Porter School District Campus) and several small farms. There are approximately 380 private residences within the original 7,500-acre land parcel of the former LOOW. Most are located along Creek Road, the western section of Cain Road, Balmer Road, and Pletcher Road in the 5,000-acre buffer zone of the former LOOW. The largest area of residential use is located along Balmer Road and includes a mobile home park designated as the Youngstown Mobile Park. The Youngstown Mobile Park consists of approximately 92 units on Balmer Road, northwest of the site. A Kampground of America (KOA) campground is opened seasonally from April through October. The campground is a 13-acre parcel with a centrally located sewage disposal area that is located on the south side of Pletcher Road in the south-central portion of the former LOOW. The Shrine of Fatima is located on the north side of Swann Road in the 5,000-acre buffer zone of the former LOOW. The shrine attracts thousands of visitors annually. The CWM property is a waste storage and disposal facility. The Lewiston-Porter School District Campus consists of a 372-acre campus that includes an elementary school, middle school, and high school. Several small farms are also located in the area (USACE, 2011d).

2.2 Surface Structures and Features

The site topography is relatively flat and the site is heavily wooded (**Figure 2-1**). Previous DoD activities are evident in features that consist of disturbed ground, small bermed clearings, and mounded material or debris piles. Evidence of buildings associated with former DoD operations was not identified during RI activities. Surface features also include a single unnamed dirt road that traverses south from Balmer Road to the NRAA wilderness preserve.

Mounded material and debris were observed to varying degrees across the site within some AOCs, most notably AOC 1 (**Figure 1-3**). This area contains evidence of municipal waste (e.g., beverage containers, asphalt shingles, and tires) and construction debris (e.g., terra cotta pipes, transite siding, ceramic electrical junctions, and deteriorated steel drums) (USACE, 2002).

The site contains a system of drainage ditches, ephemeral in nature, that consist of pre-existing agricultural ditches used to irrigate farmland and drainage ditches constructed during DoD development of the former LOOW. The system of drainage ditches is no longer maintained resulting in impeded flow, acute flash flooding and erosion of the banks during precipitation events. Small ponds at the site appear to be related to previous agricultural activities prior to DoD ownership.

Many of the surface structures and features documented in the *Examination of Historical Aerial Photography – Selected Sites, Former LOOW* (U.S. Army TEC, 2002), which are depicted in **Figure 1-3**, were not observed during the investigation.

2.3 Subsurface Structures and Features

Based on documents reviewed and visual surveys of the site, one subsurface structure associated with former DoD operations was identified; a 30-inch outfall line from the former LOOW WWTP. The 30-inch diameter outfall line was installed in 1942 across the southern portion of the site (**Figure 1-3**). The outfall line conveyed sewage from the former WWTP west to the Niagara River. This outfall line has been sealed and was investigated during the Phase III RI (USACE, 2008a).

No additional man-made subsurface structures or features, nor evidence of either, were identified at the site.

2.4 Geology

An extensive investigation of the site geology has been conducted on the former LOOW, which included more than 1,000 borings and test pits. Subsurface data obtained from multiple investigations indicates that the former LOOW is underlain by approximately 30 to 60 ft of unconsolidated glacial deposits that overlie shale bedrock of the Queenston Formation. Eight distinct stratigraphic units have been previously identified at the former LOOW; fill, alluvium, upper glacial till, middle silt till, glaciolacustrine clay (GLC), glaciolacustrine silt and sand, lodgment till and bedrock (USACE, 2011d).

Four geologic units encountered during the Phase I RI (USACE, 1999), Phase II RI (USACE, 2002), Phase III RI (USACE, 2008a), and Phase IV RI (USACE, 2011d) activities are described in descending order below.

2.4.1 Alluvium

Alluvium underlying the surface fill or surface soil is discontinuous and typically no greater than 5 ft in thickness. The alluvium layer varies in consistency and consists of fine sands, silt, and silty clay (USACE, 1999).

2.4.2 Upper Glacial Till Sequence

Glacial till underlies the alluvium, is typically between 15 ft to 20 ft in thickness, and consists of two distinct strata. The upper silt till overlies the upper clay till (UCT) and is composed of

compact to very dense, brown to purple-brown silt and fine sand with little fine gravel. This layer was observed at maximum thickness of 5 ft (USACE, 2011d).

The UCT is commonly composed of stiff to hard, moderate brown to purple-brown silty clay with fine to coarse sand and fine gravel. Occasional deposits of cobbles, discontinuous wet sand, gravel and silt layers less than 6 inches in thickness can be observed and tend to be thicker near the base of the geologic unit. The upper glacial till is typically dry with wet sand or gravel lenses at the lower strata (USACE, 2011d).

2.4.3 Middle Silt Till Unit

Along the western and northwestern areas of the current CWM property, the approximate location of the focus of the LOOW Phase IV RI Report (USACE, 2011d), a middle silt till layer has been identified which divides the GLC geologic unit. This unit is composed of a well graded, compact to very dense gray to gray brown silt and coarse to fine sand (USACE, 1999).

2.4.4 Glaciolacustrine Clay

Glaciolacustrine clay (GLC) underlies the upper glacial till sequence and is typically composed of very soft to firm, gray to gray brown silty clay with traces of fine sand (USACE, 1999). The unit is typically high in natural moisture content, averaging approximately 28 percent (USACE, 1999).

2.5 Hydrology

2.5.1 Regional Hydrogeology

The regional hydrogeology of the unconsolidated overburden across the former LOOW is determined by glacial deposits and fluvial deposits. Previous investigations indicate glacial deposits vary between 30 ft and 60 ft in thickness, vary in permeability from low within glacial lake deposits to high within sand and gravel outwashes (USACE, 1999). Groundwater flow within the unconsolidated deposits and surface water flow at the OCCP are generally influenced by local topography, trending north towards Lake Ontario and northwest towards the Niagara River (**Figure 2-1**).

Subsurface hydrostratigraphy at the site is divided into three units or zones (e.g., Zone 1, Zone 2, and Zone 3).

- Zone 1 consists of unconfined water-bearing zones within the upper silt till, clay till, alluvium and fill units. The UCT Unit comprises the Upper Water Bearing Zone and lacks a contiguous, dominant flow system. Where devoid of sand lenses, the hydraulic properties of the UCT are representative of an aquitard and thus the term ‘aquifer’ is not used (USACE, 2007a). Flow in the Upper Water Bearing Zone generally proceeds toward the northwest with localized and seasonal variations. Vertical gradients in the Upper Water Bearing Zone are typically downward, but vary depending on the season and localized lithologic variations. Low permeability of near-surface materials, abate recharge to the Upper Water Bearing Zone and result in a swampy landscape with poor surficial drainage.
- Zone 2 consists of moist, relatively impermeable material in the GLC unit. The GLC/Middle Silt Till Units form an aquitard and confine the Lower Water Bearing Zone. This aquitard is continuous across the former LOOW, saturated and of a homogeneous nature.

- Zone 3** consists of a confined water-bearing zone predominantly within the glaciolacustrine silt and sand unit. The Lower Water Bearing Zone consists of alluvial sand and gravel and Upper Queenston Formation. The Basal Red Till serves as a secondary, discontinuous aquitard which further confines localized zones of the Upper Queenston Formation. Flow in the Lower Water Bearing Zone is to the northwest, with localized deviations due to lithologic heterogeneities (USACE, 2007a). Seasonal influences do not have the pronounced impact on flow directions as is typical of flow in the Upper Water Bearing Zone (USACE, 2007a). The Lower Water Bearing Zone has a greater transmissivity than the Upper Water Bearing Zone. The Lower Water Bearing Zone is recharged by a combination of connate water from the Queenston Formation, recharge from regional sources and to a lesser degree, recharge through the overlying Zone 2 GLC. The hydraulic conductivities of each formation vary considerably with Zone 3 being the most permeable.

Table 2-1 summarizes vertical and horizontal hydraulic conductivity for each zone.

Table 2-1. Regional Hydraulic Conductivity			
Zone	Stratigraphic Unit	Hydraulic Conductivity (ft/day)	
		Vertical	Horizontal
1	Upper Clay Till	2×10^{-3}	6×10^{-3}
	Upper Silt Till	2×10^{-3}	6×10^{-3}
	Middle Silt Till	3×10^{-4}	9×10^{-3}
2	Glaciolacustrine Clay	6×10^{-5}	1×10^{-4}
3	Glaciolacustrine Silt and Sand	8.5×10^{-5}	
	• Stratified Coarse Sand		6×10^{-1}
	• Non-Stratified Silt and Fine Sand		9×10^{-2}
	• Stratified Silt and Fine Sand		3×10^{-2}
	• Interlayered Silt, Sand and Clay		9×10^{-3}
<p><i>Legend:</i> ft/day: feet per day <i>Source:</i> Hydrogeologic Characterization, Chemical Waste Management, Inc. (Golder, 1985) <i>Note:</i> Values presented in the table were derived from rising head tests following the bail-down of piezometers</p>			

Groundwater within the Queenston Formation is moderate to highly mineralized, with total dissolved solids (TDS) concentrations averaging 2,600 milligrams per liter (mg/L). High TDS concentrations are generally attributed to elevated levels of sodium, calcium and chloride in the connate water within the formation (Johnston, 1964). Connate water refers to water that was deposited simultaneously with the bedrock and became trapped in rock pore space. Essentially connate waters exhibit zero flow.

2.5.2 Surface Hydrology

During operation of the former LOOW, a system of drainage ditches was constructed and maintained in order to drain surface water runoff across the former LOOW to the Central Drainage Ditch (CDD). The system of drainage ditches, ephemeral in nature, consists of pre-existing agricultural ditches used to irrigate farmland, and drainage ditches constructed during DoD development of the former LOOW. The system of drainage ditches is no longer maintained resulting in impeded flow, acute flash flooding and erosion of the banks during heavy

precipitation events. The Southwestern Drainage Ditch (SWDD) is a receiving surface water body that hydrologically separates the OCCP from the Lewiston-Porter Central School District property. The SWDD ultimately discharges to Four Mile Creek north of Balmer Road.

Six Mile Creek, which originally flowed across the former LOOW was diverted to the CDD and ultimately discharges into Four Mile Creek. Six Mile Creek is described by the New York State Department of Environmental Conservation (NYSDEC) as a Class C fresh water source, indicating that it is suitable for fishing, and primary and secondary recreational use. Four Mile Creek is described by NYSDEC as a Class B water body from its mouth at Lake Ontario to approximately 0.9 miles upstream (located 0.3 miles southeast of the intersection of Lake Road and Creek Road) and the remaining upstream portion is classified as a Class C water body (USACE, 1999). Classification as a Class B water body indicates the water body is suitable for primary and secondary recreational use. It is not considered suitable as a potable water source (USACE, 2011d).

There are only two perennial surface water bodies associated with the OCCP, two unnamed ponds identified as AOC 2 and AOC 6.

2.6 Ecology

2.6.1 Sensitive Ecosystems

According to the U.S. Fish and Wildlife Service (USFWS) Critical Habitat for Threatened & Endangered Species, the site is not located within or abutting an established critical habitat for endangered and/or threatened species. There are 26 endangered and threatened species located in the state of New York, seven flora species and 19 fauna species. Seven of the 19 fauna species are fish or aquatic mammals and have no defined county-level habitat range. No threatened or endangered flora or fauna species are located at the site (USFWS, 2012a and USFWS, 2012b).

The site is located within an area freshwater forested/shrub wetland (USFWS, 2012c). Specifically, the freshwater wetland designated LE-18 is within the boundary of the site according to aerial imagery available at *New York State Orthos Online for Niagara County* (New York Statewide Digital Orthoimagery Program [NYSODP], 2012).

The site is not located within or abutting a refuge boundary. The closest refuge is the Iroquois National Wildlife Refuge located approximately 30 miles east of the site (USFWS, 2012d).

The site is not located within or adjacent to an established Wildlife Management Area (WMA). The only WMA in Niagara County is the Hartland Swamp WMA, located over 20 miles east of the site in Hartland, NY. However, the closest WMA is the Spicer Creek WMA located approximately 14 miles south of the site in Erie County (NYSDEC, 2012e).

The NRAA wilderness preserve is adjacent to the southern portion of the site. It is currently an outdoor recreational area for NRAA members (USACE, 2008b).

2.6.2 Local Flora

In 2004, reconnaissance to identify local flora species at the former LOOW was completed and presented in the *Final Screening-Level Ecological Risk Assessment at Selected Exposure Units within the former Lake Ontario Ordnance Works, Niagara County, New York* (USACE, 2008b) – hereinafter the “LOOW SLERA.” Reconnaissance completed at EU 1 through EU 6, identified that the site is generally overgrown with pasture-grass and northern shrub; second growth

wooded areas are dominated by maple, ash, and oak trees; and within drainage swales, cattail-marsh grass dominates. While the reconnaissance did not include the OCCP, the parcels within the former LOOW are sufficiently similar that the findings were determined applicable for the OCCP.

Subsequent inquiries and research conducted in accordance with ongoing investigation activities have identified no endangered flora species potentially inhabiting the former LOOW. Review of the most recent *Federally Listed Threatened and Endangered Species and Candidate Species in Niagara County*, current as of June 2012, indicates that the eastern prairie fringed orchid (historic) is known to occur in Niagara County. The eastern prairie fringed orchid is a threatened species identified to potentially inhabit ecosystems within one-half mile of the former LOOW (USFWS, 2012b).

Table 2-2 summarizes the local flora species observed during the reconnaissance activities in 2004.

Table 2-2. Flora Species Observed at the former LOOW		
Herbs	Shrubs and Vines	Trees
Birdsfoot trefoil	Canada honeysuckle	Basswood
Cinquefoil	Gray-stemmed dogwood	Black locust
Daisy fleabane	Hawthorn	Black willow
Goldenrod	Highbush blueberry	Eastern cottonwood
Hemp	Poison ivy	Pig nut
Indian	Staghorn sumac	Quaking aspen
Oxeye daisy	Tartarian honeysuckle	Scarlet oak
Sedge	Virginia creeper	Slippery elm
Spikerush	Winter grape	White ash
Teasel	---	White oak
Yellow hawkweed	---	---
<i>Source(s): Final Screening-Level Ecological Risk Assessment at Selected Exposure Units within the former Lake Ontario Ordnance Works, Niagara County, New York (USACE, 2008b)</i>		

2.6.3 Local Fauna

In 1995, Rust Environmental and Infrastructure (REI) conducted an *Ecological Assessment/Fish and Wildlife Impact Analysis* (hereinafter EA/FWIA) as part of the *Site-Wide Corrective Measures Study for Specific Exposure Units* (REI, 1995) completed for CWM, located to the east of the site. The major findings of the EA/FWIA with respect to fish and wildlife are summarized below:

- According to the USFWS, NYSDEC Wildlife Resource Center, and NYSDEC Region 9 Office, there are no known occurrences of federally or state-listed endangered, threatened, or special concern wildlife species, rare plant, animals or natural communities within the boundary of the former LOOW (REI, 1995).
- A variety of mammals, amphibians, reptiles, fish and bird species utilize the area within a one-half mile radius of the former LOOW. These species include the Black-capped Chickadee, Northern Cardinal, American Crow, Red-tailed Hawk, Great Blue Heron,

Blue Jay, Canada Goose, Mallard, Red-winged Blackbird, Woodchuck, and White-tailed Deer (REI, 1995).

- Species, including those of a sensitive status, could potentially inhabit areas within one-half mile of the former LOOW (REI, 1995).

Subsequent inquiries and research conducted in accordance with the ongoing investigation activities have identified no threatened or endangered fauna species potentially inhabiting the former LOOW.

In addition to the EA/FWIA, reconnaissance to identify local fauna species at the former LOOW was completed at EU 1 through EU 6 in 2004 and presented in the LOOW SLERA (USACE, 2008b). While reconnaissance was not completed at the site as part of the 2004 activities, each parcel at the former LOOW is sufficiently similar. The following identified fauna species were determined applicable for the OCCP. **Table 2-3** summarizes the local fauna species observed during the reconnaissance activities in 2004.

Table 2-3. Fauna Species Observed at the former LOOW		
Birds	Mammals	Reptiles
American crow	Eastern gray squirrel	American toad
Song sparrow	White-tailed deer	Snake (unidentified)
Yellow warbler	---	Tadpole
<i>Source(s): Final Screening-Level Ecological Risk Assessment at Selected Exposure Units within the former Lake Ontario Ordnance Works, Niagara County, New York (USACE, 2008b)</i>		

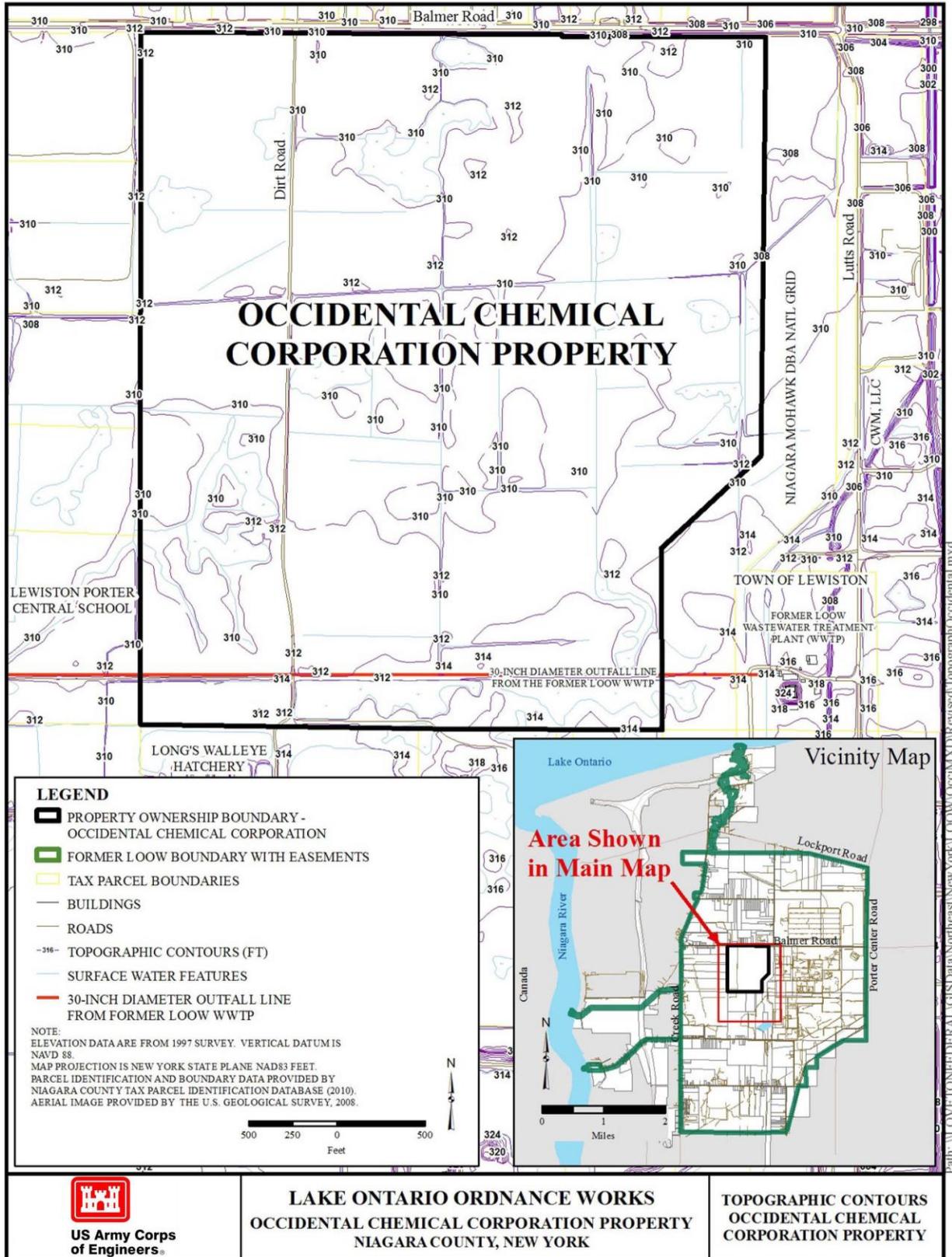


Figure 2-1. Topographic Contours of Occidental Chemical Corporation Property

3.0 DATA COMPARISON METHODOLOGY

3.1 Regulatory Criteria

The RI was performed in accordance with U.S. Environmental Protection Agency (USEPA) CERCLA guidance, USACE guidance, and the DERP-FUDS program. The NYSDEC has provided regulatory oversight for this and other environmental projects at the former LOOW. Sections 3.1.1 through 3.1.3 identify the regulatory criteria applicable to soil, surface water, and sediment at the site. These sections echo the methodology and data quality objectives (DQOs) outlined in the OCCP Data Gap QAPP Addendum (USACE, 2010b) and OCCP/WWTP Data Gap QAPP Addendum (USACE, 2011b).

Similar to previous investigations performed at the former LOOW, to account for circumstances where multiple constituents were reported and to reduce the likelihood that a constituent that should have been retained for further consideration is dropped, data for non-carcinogenic analytes were compared to $1/10^{\text{th}}$ of the applicable USEPA Regional Screening Levels (RSLs) (with the exception of lead) to determine if a constituent should be further evaluated in the risk assessment.

3.1.1 Soil

The RI evaluated analytical data and reported chemical concentration against risk-based criteria for protection of human health and the environment, as well as background concentrations. Soil analytical data were initially screened conservatively against the chemical-specific RSLs for Residential Soil (USEPA, 2011a) and $1/10^{\text{th}}$ the USEPA RSL for Residential Soil for non-carcinogens (except for lead) to determine constituents that require further evaluation in the risk assessment.

Site-specific screening levels (SSLs) for the protection of groundwater that were developed during the Phase IV RI Report (USACE, 2011d) based on the *Guidance for Developing Soil Screening Levels for Superfund Sites* (USEPA, 1996) and the *Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites* (USEPA, 2002b). These SSLs were compared to subsurface soil constituent concentrations obtained from this RI. The potential for contaminant migration from soil to groundwater was evaluated using the following the equation (USEPA, 2002b):

$$C_t = C_w [(K_d) + \theta_w + \theta_a H' / \rho_b]$$

Where:

C_t = screening level in soil (milligrams per kilogram [mg/kg])

C_w = target leachate concentration (milligrams per liter [mg/L])

K_d = soil-water partition coefficient (liter per kilogram [L/kg])

θ_w = water-filled soil porosity ($L_{\text{water}}/L_{\text{soil}}$)

θ_a = air-filled soil porosity ($L_{\text{air}}/L_{\text{soil}}$)

H' = dimensionless Henry's law constant

ρ_b = soil bulk density (kg/L)

The soil partition coefficient (K_d) is established based on the equation:

$$K_d = (K_{oc} * f_{oc})$$

Where:

K_{oc} = soil organic carbon-water partition coefficient (L/kg)

f_{oc} = organic carbon content of soil (mg/mg)

A dilution attenuation factor (DAF) is typically utilized to account for natural attenuation and constituent mass reduction. In order to be as conservative as possible and evaluate the potential worst-case scenario, a DAF of one (negligible) was used for the calculation of SSLs. This is consistent with methodology utilized through previous RIs within the former LOOW property. Additionally, chemical specific parameters utilized in the equations were obtained from the USEPA soil screening guidance (USEPA, 2002b).

For the target leachate concentration, C_w , the New York State Technical and Operational Guidance Series (TOGS) 1.1.1 Ambient Water Quality Standards and Guidance Values for Class GA, type Health (Water Source) for protection of groundwater as a potentially potable drinking water source (which includes the Part 703.5 standards) were used.

For consistency in reporting, SSLs were developed in accordance with methodology and target leachate concentrations used during previous phases of investigation at the former LOOW. The parameters used for the calculation of site-specific SSLs are presented in **Table 3-1**.

Table 3-1. Parameters Used for Calculating Site-Specific Soil Screening Levels		
Parameter	Value	Units
Dilution Attenuation Factor ^a (conservative assumption)	DAF = 1	unitless
Fraction of Organic Content in Soil ^b	$f_{oc} = 0.005$	mg/mg
Water-filled soil porosity ^c	$\theta_w = 0.15$	L_{water}/L_{soil}
Air-filled soil porosity ^d	$\theta_a = 0.25$	L_{air}/L_{soil}
Total soil porosity ^e	$\theta = 0.4$	L_{pore}/L_{soil}
Dry soil bulk density ^f	$\rho_b = 1.4$	kg/L
<p><i>Legend:</i> DAF = dilution attenuation factor f_{oc} = organic carbon content of soil (mg/mg) θ = soil porosity (L/L) ρ_b = soil bulk density (kg/L) mg = milligram kg = kilogram L = liter</p> <p><i>Source(s):</i> ^a = Guidance for Developing Soil Screening Levels for Superfund Sites (USEPA, 1996) ^b = Site-specific ^c = Final Report: RCRA Facility Investigation Report CWM Chemical Services, Model City Facility, Model City, New York (Golder, 1993) ^d = Calculated (total minus water-filled) ^e = Hydrology for Engineers (Linsley, 1982) ^f = The Soil Chemistry of Hazardous Materials (Dragum, 1998)</p>		

Based on the methodology and parameters presented above, chemical-specific parameters and site-specific SSLs were developed for the site. **Table 3-2**, presented at the end of Section 3, includes selected chemical-specific and site-specific screening values for soil at the site.

3.1.2 Surface Water

The RI evaluated analytical data and reported chemical concentration against three criteria. Surface water analytical data were initially screened conservatively against the chemical-specific USEPA RSLs for Tapwater (USEPA, 2011a) and 1/10th the USEPA RSL for Tapwater for non-carcinogens (except for lead) to determine constituents that require further evaluation in the risk assessment. During the risk assessment, summarized in Sections 8 and 9, surface water data was further screened against 10X the USEPA RSLs for Tapwater (USEPA, 2011a) (with the exception of lead) to account for the expected reduced exposure to surface water.

Site-specific ecological screening values and background threshold values (BTV) for surface water at the former LOOW were originally prepared for the *Baseline Risk Assessment Report for the Niagara Fall Storage Site* (USACE, 2007c) – hereinafter the “NFSS BRA Report.” Surface water analytical data were evaluated against site-specific ecological screening values (NFSS Surface Water Eco Values and NFSS BTV (NFSS BTV) presented in the NFSS BRA Report (USACE, 2007c). **Table 3-3**, presented at the end of Section 3.0, includes selected chemical-specific and site-specific screening values for surface water at the site.

3.1.3 Sediment

The RI evaluated analytical data and reported chemical concentration against three criteria. Sediment analytical data were initially screened conservatively against the chemical-specific USEPA RSLs for Residential Soil (USEPA, 2011a), a USEPA Sediment Threshold Effect Concentrations (TEC) from the *Guidance Manual to Support the Assessment of Contaminated Sediments in Freshwater Ecosystems Volume III - Interpretation of the Results of Sediment Quality Investigations* (USEPA, 2002a), and 1/10th the USEPA RSL for Residential Soil for non-carcinogens (except for lead). This conservative screening process was used to determine constituents that require further evaluation in the risk assessment.

Site-specific BTVs for sediment at the former LOOW were originally prepared for the NFSS BRA Report (USACE, 2007c). Sediment analytical data were evaluated against site-specific BTV, NFSS BTV, presented in the NFSS BRA Report (USACE, 2007c). **Table 3-4**, presented at the end of Section 3.0, includes selected chemical-specific and site-specific screening values for sediment at the site.

3.2 Background Data

3.2.1 Data Sources

A site-specific background evaluation was performed to establish comparable background concentration levels for Target Analyte List (TAL) metals in surface soil and subsurface soil. The background soil samples were obtained from various locations (several properties) within the undeveloped portion of the 7,500-acre former LOOW, as indicated on Figure 4.1 of the Phase II RI Report (USACE, 2002). Additionally, background surface water and sediment data were obtained from the NFSS RI Report (USACE, 2007b). **Appendix A** includes the background data and evaluation.

3.2.2 Comparison of Data to Background Concentrations

Inorganic constituents detected in soil from AOC 1 underwent a background screening using hypothesis testing, employing the quantile test in conjunction with the Wilcoxon Rank Sum test. Both tests were conducted with the null hypothesis that site concentrations are less than or equal

to background. If the null hypothesis was rejected for either the quantile test or Wilcoxon Rank Sum tests at the 95 percent significance level, then it was concluded that the site data exceeded background. All statistical computations were conducted using ProUCL version 4.4 (USEPA, 2011b). **Appendix A** includes the complete background evaluation.

3.3 Laboratory Data Evaluation

The laboratory data validation was completed as defined and in accordance with the approved OCCP/WWTP Data Gap QAPP Addendum (USACE, 2011b). Laboratory qualifiers, laboratory reports and Quality Assurance/Quality Control (QA/QC) data were qualitatively evaluated in conjunction with the data reduction and reporting process. These data were used to evaluate whether the data quality indicators (DQIs) for precision, accuracy, representativeness, comparability, completeness and sensitivity (PARCCS) satisfied the established DQOs.

Table 3-2. OCCP Screening Levels for Soil

ANALYTE	C _w	H'	k _{oc}	k _d	SSL	USEPA RSL	
	µg/L		L/kg	L/kg	mg/kg	µg/kg	
1,1,1-Trichloroethane	55	7.1	140	0.693	4.63	870,000	*
1,1,2,2-Tetrachloroethane	55	0.014	79	0.39	2.5	560	
1,1,2-Trichloroethane	11	0.037	75	0.37	0.485	160	*
1,1-Dichloroethane	55	0.23	53	0.26	2.05	3,300	
1,1-Dichloroethene	5	1.1	65	0.32	3.13	24,000	*
1,2,4-Trichlorobenzene	55	0.0581	717.6	3.55	18.3	6,200	*
1,2,4-Trimethylbenzene	5	0.252	614	NA	16	6,200	*
1,2-Dichlorobenzene	33	0.0785	443.1	2.19	6.9	190,000	*
1,2-Dichloroethane	0.6	0.04	38	0.19	0.18	430	
1,3-Dichlorobenzene	33	0.108	434	2.15	6.8	610	*
1,4-Dichlorobenzene	33	0.0985	434	2.15	6.8	2,400	
1-Methylnaphthalene	2.3	0	0	0	0.246	22,000	
2,4,6-Trinitrotoluene	5	18,700	1,800	9.1	45.9	3,600	*
2,4-Dimethylphenol	730	0.000039	717.6	3.55	2,671	120,000	*
2,4-Dinitrotoluene	5	0.000022	363.8	1.8	9.5	1,600	
2-Amino-4,6-dinitrotoluene	73	6.6E-09	100.5	0.5	44	15,000	*
2-Butanone	50	0.0011	4.5	0.022	6.48	2,800,000	*
2-Chlorophenol	180	0.00046	443.1	2.2	414	39,000	*
2-Methylnaphthalene	10	0.021	2976	14.7	148	31,000	*
2-Methylphenol	1,800	0.000049	443.1	2.2	4,140	310,000	*
4,4'-DDD	0.3	0.00016	4,470,000	22,100	6,600	2,000	
4,4'-DDE	0.2	0.00086	2,630,000	13,000	2,600	1,400	
4,4'-DDT	0.2	0.00033	65	0.32	0.086	1,700	
4-Amino-2,6-dinitrotoluene	73	0.00098	65	0.64	31.3	15,000	*
4-Chloro-3-methylphenol	None	0.0001	718	0.4	NA		
4-Methyl-2-pentanone	2,000	0.0053	130	0.64	1,500	530,000	*
4-Methylphenol	180	0.000029	81	0.4	91	31,000	*
4-Nitrotoluene	55	0.00023	309	1.53	8.2	24,000	*
Acenaphthene	20	0.0064	0.004.9	24	487	340,000	*
Acenaphthylene	20	0.0047	2000	9.9	200	3,600	
Acetone	50	0.0016	0.58	0.0029	5.51	6,100,000	*
Aldrin	0.004	0.007	2,450,000	12,000	48.5	29	
Alpha-BHC	0.01	0.0048	1,230	6.1	0.062	77	
Alpha-chlordane	0.05	0.002	120,000	594	29.7	1,600	

Table 3-2. OCCP Screening Levels for Soil

ANALYTE	C _w	H'	k _{oc}	k _d	SSL	USEPA RSL	
	µg/L		L/kg	L/kg	mg/kg	µg/kg	
Aluminum	37,000	0	0	1,500	55,500,000	7,700,000	*
Anthracene	50	0.0027	24,000	118.8	5,945	1,700,000	*
Antimony	3	0	0	45	135	3,100	*
Aroclor 1232	0.9	0.00932	10,300	51	46	140	
Aroclor 1242	0.9	0.014	44,800	222	200	220	
Aroclor 1248	0.9	0.018	43,900	217	196	220	
Aroclor 1254	0.9	0.0116	75,600	370	337	110	*
Aroclor 1260	0.9	0.0137	207,000	1,025	922	220	
Arsenic	25	0	0	200	5,000	390	
Barium	1,000	0	0	41	41,100	1,500,000	*
Benz[a]anthracene	0.002	0.00014	398,000	1970	3.94	150	
Benzene	1	0.23	62	0.31	0.46	1,100	
Benzo[a]pyrene	None	0.000046	1,020,000	5,049	NA		
Benzo[b]fluoranthene	0.002	0.00455	1,230,000	6090	12.2	150	
Benzo[g,h,i]perylene	None	0.0000058	3860000	19107	NA		
Benzo[k]fluoranthene	0.002	0.000034	1,230,000	6090	12.2	1,500	
Benzyl Butyl phthalate	50	0.000052	57,500	285	14,200	260,000	
Beryllium	3	0	0	790	2,370	16,000	*
Beta-BHC	0.04	0.0048	1,260	6.2	0.25	270	
Bis(2-Ethylhexyl) phthalate	55	0.0000042	15,100,000	74,750	375,000	35,000	
Boron	1,000	0	0	3	3,100	1,600,000	*
Cadmium	5	0	0	75	376	7,000	*
Calcium	None	0	3,390	0	NA		
Carbazole	None	0.00000063	46	0.23	NA		
Carbon disulfide	60	1.2	46	0.23	33	82,000	*
Carbon tetrachloride	5	1.2	150	0.74	5.3	610	
Carbon, total organic	None	0	0	0	NA		
Chlorobenzene	5	0.127	268	0	7.28	29,000	*
Chloroform	7	0.15	53	0.26	2.8	290	
Chloromethane	5	0.98	35	0.17	2.3	12,000	*
Chromium	50	0	0	1,800,000	90,000,000	120,0001	
Chromium (hexavalent)					NA	290	
Chrysene	0.002	0.0039	400,000	1980	3.96	15,000	
Cis-1,2-dichloroethene	5	0.17	36	0.18	1.58	16,000	*
Cobalt	11	0	0	45	496	2,300	*
Copper	200	0	0	428	85,600	310,000	*
Cyanide, total	200	0	0	9.9	2,000	160,000	*
Cyclohexane	13,000	6.13	146	NA	25,000	700,000	*
Delta-BHC	0.04	0.0048	11,700	58	2.33	77	
Dibenz[a,h]anthracene	0.0029	0.0000006	3,800,000	18,800	55	15	
Dibenzofuran	37	0.00053	7,800	39	1,400	7,800	*
Dieldrin	0.004	0.00062	21,400	106	0.42	30	
Diethyl phthalate	29,000	0.000025	105	NA	18,200	4,900,000	*
Di-N-butyl phthalate	50	0.0000019	33,900	168	8,400	610,000	*
Di-N-octyl phthalate	50	0.0000019	2,400	11.8	596	610,000	*
Endosulfan I	220	0.00046	2,140	10.6	2,350	37,000	*
Endosulfan II	220	0.00046	2,140	10.6	2,350	37,000	*

Table 3-2. OCCP Screening Levels for Soil

ANALYTE	C _w	H'	k _{oc}	k _d	SSL	USEPA RSL	
	µg/L		L/kg	L/kg	mg/kg	µg /kg	
Endosulfan sulfate	220	0.00046	2,140	10.6	2,350	37,000	*
Endrin	11	0.00031	12,300	61	671	1,800	*
Endrin aldehyde	5	0.00031	12,300	61	305	1,800	*
Endrin ketone	5	0.00031	12,300	61	305	1,800	*
Ethylbenzene	5	0.32	200	0.99	5.8	5,400	
Fluoranthene	50	0.00066	107,000	530	26,500	230,000	*
Fluorene	50	0.0032	7,900	39	1,960	230,000	*
Gamma-BHC	0.05	0.0048	1,070	5.3	0.27	520	
Gamma-chlordane	0.05	0.002	120,000	594	29.7	NSA	
Heptachlor	0.04	0.045	1,410,000	7,000	279	110	
Heptachlor Epoxide	0.03	0.00039	83,200	411	12.4	53	
Hexachlorobenzene	0.04	0.054	55,000	270	11	300	
Hexachlorobutadiene	0.5	0.33	54,000	266	133	6,100	*
Hexachlorocyclopentadiene	5	1.1	1,670	8.3	42.8	37,000	*
Hexachloroethane	5	0.16	1,780	8.8	45	4,300	*
HMX	1,800	0.000000036	1,850	9.2	16,700	380,000	*
Indeno[1,2,3-Cd]pyrene	0.002	0.0000066	3,470,000	17,200	34	150	
Iron	300	0	0	25	7,500	5,500,000	*
Isophorone	71	0.00027	58	0.29	28	510,000	
Isopropylbenzene	5	0.47	820	4	21	210,000	*
Lead	25	0	0	900	22,500	400,000	
Lithium	73	0	0	300	NSA	NSA	
Magnesium	35,000	0	0	4.5	NSA	NSA	
Manganese	300	0	0	65	19,500	180,000	*
Mercury	0.7	0.47	0	52	36.5	780	*
Methcyclohexane	None	0	0	NA	NSA	NSA	
Methoxychlor	35	0.00065	97,700	484	16,900	31,000	*
Methyl acetate	37,000	0.0047	3.1	NA	4,560	NSA	
Methylene chloride	5	0.09	10	0.05	0.87	11,000	
Molybdenum	180	0	0	20	3,620	NSA	
Naphthalene	10	0.02	1,200	5.9	61	NSA	
Nickel	100	0	1,200	5.9	605	150,000	*
Nitrobenzene	0.4	0.00098	190	0.94	0.42	4,800	
Percent solids	None	0	0	65	NSA	NSA	
Phenanthrene	50	0.00096	4,800	24	1,200	1,700,000	*
Phenol	1	0.000016	29	0.14	0.25	1,800,000	*
Potassium	None	0	0	0	NSA	NSA	
Pyrene	50	0.00045	68,000	340	16,800	170,000	*
RDX	0.61	0	0	0.04	NSA	NSA	
Sec-butylbenzene	5	0.72	1,330	NA	34	NSA	
Selenium	10	0	0	300	3,000	39,000	*
Silver	50	0	0	8.3	420	39,000	*
Sodium	20,000	0	0	100	NSA	NSA	
Styrene	5	0.11	520	2.6	13	630,000	*
Tert-butylbenzene	55	0.54	3.39	NA	1.1	NSA	
Tetrachloroethylene	5	0.75	270	1.3	7.9	550	
Tetryl	150	0	0	0	NSA	NSA	
Thallium	0.5	0	0	1,500	750	78	*

Table 3-2. OCCP Screening Levels for Soil

ANALYTE	C _w	H'	k _{oc}	k _d	SSL	USEPA RSL	
	µg/L		L/kg	L/kg	mg/kg	µg/kg	
Toluene	5	0.27	140	0.7	4.2	500,000	*
Trans-1,2-dichloroethene	5	0.38	38	0.19	1.8	15,000	*
Trichloroethylene	5	0.42	94	0.47	3.2	440	*
Vanadium	180	0	0	1,000	180,000	39,000	*
Vinyl chloride	2	1.1	19	0.094	0.795	60	
Xylenes (Total)	5	0.3	200	0.99	5.75	63,000	*
Zinc	2000	0	0	62	124,000	2,300,000	*

Legend:

USEPA RSL = USEPA Residential Soil Regional Screening Level, November 2011.

* = A non-carcinogen; the screening level has been divided by 10 to achieve a hazard index of 0.1.

SSL = Site-specific screening levels for the protection of groundwater.

NA = Not applicable

NSA = No screening level available

C_w values are H(W) GA values (meaning source of drinking water - ground water, in µg/L) from the TOGS 1.1.1 dated June 1998, with the exception of carbon disulfide, which was from an addendum dated April 2000.

USEPA RSLs for Tapwater (USEPA, 2011a) values are listed if there were no value in TOGS, ; "none" means that there is no criterion listed in TOGS or USEPA RSLs for Tapwater (USEPA, 2011a) .

H' = Henry's Law Constant (Dimensionless)

K_{oc} = Soil organic carbon - water partition coefficient

K_d = Soil - water partition coefficient

µg/L = microgram per liter

L/kg = liter per kilogram

µg/kg = microgram per kilogram

mg/kg = milligram per kilogram

¹ = USEPA RSL is for chromium (III)

Source of chemical parameters: the chemical parameters utilized during initial development of the SSLs during the LOOW Phase II RI Report (USACE, 2002). The original 2001 source was the ORNL toxicity database:

<http://rais.ornl.gov/index.shtml> published on line in June 2001, which utilized data from multiple sources including Table C out of the USEPA SSL guidance (USEPA, 2002b) and USEPA program WATER8. For chemicals for which SSLs were not previously developed (s-butybenze, t-butybenzene, cyclohexane, diethylphthalate, and 1,2,4-trimethylbenzene) parameters currently (as of 27 September 2010) listed on the <http://rais.ornl.gov/website> (as of 27 September 2010) were utilized.

Table 3-3. OCCP Screening Levels for Surface Water ¹

ANALYTE	USEPA RSL		NFSS SW BTV	NFSS SW Eco
TCL VOCs (µg/L)				
1,1,1,2-Tetrachloroethane	0.5		NSA	NSA
1,1,1-Trichloroethane	750	*	0.34 ^a	11
1,1,2,2-Tetrachloroethane	0.066		0.49 ^a	NSA
1,1,2-Trichloro-1,2,2-trifluoroethane	5300	*	NSA	NSA
1,1,2-Trichloroethane	0.041	*	0.44 ^a	NSA
1,1-Dichloroethane	2.4		0.41 ^a	NSA
1,1-Dichloroethene	26	*	0.41 ^a	303
1,1-Dichloropropene	NSA		NSA	NSA
1,2,3-Trichlorobenzene	0.52	*	NSA	NSA
1,2,3-Trichloropropane	0.00065		NSA	NSA
1,2,4-Trichlorobenzene	0.39	*	0.71 ^a	NSA
1,2,4-Trimethylbenzene	1.5	*	NSA	NSA
1,2-Dibromo-3-chloropropane	0.00032		NSA	NSA
1,2-Dibromoethane	0.0065		NSA	NSA
1,2-Dichlorobenzene	28	*	0.41 ^a	NSA
1,2-Dichloroethane	0.15		0.29 ^a	910
1,2-Dichloroethene	13	*	1.72 ^a	NSA
1,2-Dichloropropane	0.38		1.72	NSA
1,3,5-Trimethylbenzene	8.7	*	NSA	NSA
1,3-Dichlorobenzene	0.42		0.41 ^a	NSA
1,3-Dichloropropane	29	*	NSA	NSA
1,4-Dichlorobenzene	0.42		0.31 ^a	11.2
2,2-Dichloropropane	NSA		NSA	NSA
2-Butanone	490	*	15.8	14000
2-Chlorotoluene	18	*	NSA	NSA
2-Hexanone	3.4	*	1.45 ^a	990
4-Chlorotoluene	19	*	NSA	NSA
4-Isopropyltoluene	NSA		NSA	NSA
4-Methyl-2-pentanone	100	*	1.78 ^a	170
Acetone	1200	*	16.4	1500
Benzene	0.39		0.33 ^a	210
Bromobenzene	5.4	*	NSA	NSA
Bromochloromethane	8.3	*	NSA	NSA
Bromodichloromethane	0.12		3.25	NSA
Bromoform	7.9		0.5 ^a	NSA
Bromomethane	0.7	*	0.5 ^a	NSA
Carbon disulfide	72	*	1.91 ^a	0.92
Carbon tetrachloride	0.39		0.29 ^a	NSA
Chlorobenzene	7.2	*	0.32 ^a	NSA

Table 3-3. OCCP Screening Levels for Surface Water ¹

ANALYTE	USEPA RSL		NFSS SW BTV	NFSS SW Eco
Chloroethane	2100	*	0.5 ^a	NSA
Chloroform	0.19		5.3	28
Chloromethane	19	*	0.5 ^a	NSA
Cis-1,2-dichloroethene	2.8	*	0.3 ^a	NSA
Cis-1,3-dichloropropene	0.41		0.3 ^a	NSA
Cyclohexane	1300	*	NSA	NSA
Dibromochloromethane	0.15		1.59	NSA
Dibromomethane	0.79	*	NSA	NSA
Dichlorodifluoromethane	19	*	NSA	NSA
Ethylbenzene	1.3		0.21 ^a	17
Hexachloro-1,3-butadiene	0.26		0.32 ^a	NSA
Isopropylbenzene	39	*	NSA	NSA
m,p-Xylene	190	*	NSA	NSA
Methyl tert-butyl ether	12		NSA	NSA
Methylcyclohexane	1,300	*	NSA	NSA
Methylene Chloride	4.7		1.9 ^a	1,930
n-Butylbenzene	78	*	NSA	NSA
n-Propylbenzene	53	*	NSA	NSA
o-Xylene	19	*	NSA	NSA
Sec-butylbenzene	NSA		NSA	NSA
Styrene	110	*	0.25 ^a	NSA
Tert-butylbenzene	NSA		NSA	NSA
Tetrachloroethylene	0.072		0.554	84
Toluene	86	*	0.39 ^a	100
Trans-1,2-dichloroethene	8.6	*	0.37 ^a	1,350
Trans-1,3-dichloropropene	0.41		0.29 ^a	NSA
Trichloroethylene	0.26	*	0.36 ^a	47
Trichlorofluoromethane	110	*	NSA	NSA
Vinyl chloride	0.015		0.55 ^a	3,880
Xylenes, Total	19	*	0.25 ^a	65
TCL SVOC (µg/L)				
1,1-Biphenyl	0.083	*	NSA	NSA
2,2-Oxybis(1-chloropropane)	0.31		NSA	NSA
2,4,5-Trichlorophenol	89	*	0.97 ^a	NSA
2,4,6-Trichlorophenol	0.9	*	0.39 ^a	NSA
2,4-Dichlorophenol	3.5	*	0.47 ^a	NSA
2,4-Dimethylphenol	27	*	0.47 ^a	NSA
2,4-Dinitrophenol	3	*	5 ^a	NSA
2-Chloronaphthalene	55	*	0.4 ^a	NSA
2-Chlorophenol	7.1	*	0.41 ^a	43.8
2-Methyl-4,6-dinitrophenol	0.12	*	1 ^a	NSA

Table 3-3. OCCP Screening Levels for Surface Water ¹

ANALYTE	USEPA RSL		NFSS SW BTV	NFSS SW Eco
2-Methylnaphthalene	2.7	*	0.5 ^a	4.7
2-Methylphenol	72	*	NSA	13
2-Nitroaniline	15	*	0.64 ^a	NSA
2-Nitrophenol	0.27		0.59 ^a	NSA
3,3-Dichlorobenzidine	0.11		0.51 ^a	NSA
3-Nitroaniline	0.13	*	1 ^a	NSA
4-Bromophenyl phenyl ether	NSA		1.22 ^a	NSA
4-Chloro-3-methylphenol	110	*	0.69 ^a	NSA
4-Chloroaniline	0.32		1.1 ^a	NSA
4-Chlorophenyl phenyl ether	NSA		0.84 ^a	NSA
4-Methylphenol	7.2	*	NSA	NSA
4-Nitroaniline	3.3		0.67 ^a	NSA
4-Nitrophenol	3.7		5 ^a	NSA
Acenaphthene	40	*	0.151 ^a	17
Acenaphthylene	0.14		0.153 ^a	5.3
Acetophenone	150	*	NSA	NSA
Anthracene	130	*	0.194 ^a	3.8
Atrazine	0.26		NSA	NSA
Benzaldehyde	150	*	NSA	NSA
Benzo[a]anthracene	0.029		0.108	0.03
Benzo[a]pyrene	0.0029		0.025 ^a	0.014
Benzo[b]fluoranthene	0.029		0.485 ^a	0.027
Benzo[g,h,i]perylene	8.7	*	0.485 ^a	NSA
Benzo[k]fluoranthene	0.29		0.485 ^a	0.027
Benzyl butyl phthalate	14		NSA	3
Bis(2-chloroethoxy) methane	4.7	*	0.48 ^a	NSA
Bis(2-chloroethyl) ether	0.012		1.37 ^a	NSA
Bis(2-ethylhexyl) phthalate	0.071		1.3 ^a	0.6
Caprolactam	770	*	NSA	NSA
Carbazole	NSA		0.5 ^a	NSA
Chrysene	2.9		0.151	0.027
Dibenz[a,h]anthracene	0.0029		0.022 ^a	0.027
Dibenzofuran	0.58	*	0.42 ^a	3.7
Diethyl phthalate	1,100	*	0.89 ^a	210
Dimethyl phthalate	NSA		0.53 ^a	NSA
Di-n-butyl phthalate	67	*	1 ^a	3
Di-n-octyl phthalate	67	*	0.87 ^a	3
Fluoranthene	63	*	0.522 ^a	6.16
Fluorene	22	*	0.158 ^a	0.54
Hexachloro-1,3-butadiene	0.26		0.32 ^a	NSA
Hexachlorobenzene	0.042		0.65 ^a	NSA

Table 3-3. OCCP Screening Levels for Surface Water ¹

ANALYTE	USEPA RSL		NFSS SW BTV	NFSS SW Eco
Hexachlorocyclopentadiene	2.2	*	1 ^a	NSA
Hexachloroethane	0.51	*	0.43 ^a	NSA
Indeno[1,2,3-c,d]pyrene	0.029		0.0265 ^a	0.027
Isophorone	67		NSA	1,170
Naphthalene	0.14		0.11 ^a	13
n-Nitrosodi-n-propylamine	0.0093		0.75 ^a	NSA
n-Nitrosodiphenylamine	10		0.79 ^a	NSA
Pentachlorophenol	0.17		5 ^a	0.4
Phenanthrene	130	*	0.223	5
Phenol	450	*	0.3 ^a	5
Pyrene	8.7	*	0.302	4.6
PCB (µg/L)				
Aroclor 1016	0.11 ²	*	0.051 ^a	NSA
Aroclor 1221	0.0043 ²		0.085 ^a	NSA
Aroclor 1232	0.0043 ²		0.051 ^a	NSA
Aroclor 1242	0.034 ²		0.0612 ^a	NSA
Aroclor 1248	0.034 ²		0.051 ^a	NSA
Aroclor 1254	0.031 ²	*	0.051 ^a	0.0142
Aroclor 1260	0.034 ²		0.051 ^a	0.0142
EXPLOSIVES (µg/L)				
1,3,5-Trinitrobenzene	46	*	0.0249	NSA
1,3-Dinitrobenzene	0.15	*	0.033	NSA
2,4,6-Trinitrotoluene	0.76	*	0.0779	NSA
2,4-Dinitrotoluene	0.2		0.0349	23
2,6-Dinitrotoluene	1.5	*	0.0501	60
2-Amino-4,6-dinitrotoluene	3	*	0.0779	NSA
2-Nitrotoluene	0.27		0.064	NSA
3-Nitrotoluene	0.13	*	0.064	NSA
4-Amino-2,6-dinitrotoluene	3	*	0.0409	NSA
4-Nitrotoluene	3.7		0.064	NSA
HMX	78	*	0.0779	NSA
Nitrobenzene	0.12		0.0131	NSA
RDX	0.61		0.053	NSA
Tetryl	6.3	*	0.032	NSA
TAL METALS (mg/L)				
Aluminum	1,600	*	5,030	100
Antimony	0.6	*	2.33	30
Arsenic	0.045		6.33	150
Barium	290	*	117	4
Beryllium	1.6	*	0.253	1,100
Boron	310	*	244	10,000

Table 3-3. OCCP Screening Levels for Surface Water ¹

ANALYTE	USEPA RSL		NFSS SW BTV	NFSS SW Eco
Cadmium	0.69	*	0.00081 ^a	2.09
Calcium	NSA		141,000	116,400
Chromium ^b	1.6	*	7.52	74.11
Cobalt	0.47	*	1.08	5
Copper	62	*	15	8.96
Iron	1,100	*	4,740	300
Lead	15		11.1	3.78
Lithium	3.1	*	13.2	14
Magnesium	NSA		30,200	82,000
Manganese	32	*	951	120
Mercury	0.16	*	0.000095 ^a	1.3
Nickel	30	*	7.74	52
Potassium	NSA		9,540	53,000
Selenium	7.8	*	4.24	4.6
Silver	7.1	*	0.03	0.1
Sodium	NSA		179,000	680,000
Thallium	0.016	*	0.026	8
Vanadium	7.8	*	8.52	14
Zinc	470	*	70.5	58.91

Legend:
NSA = No screening level available
TCL = Target Compound List
NFSS SW Eco = Surface water values from the NFSS Baseline Risk Assessment: Science Applications International Corporation. 2007. Baseline Risk Assessment Report for the NFSS. December.
NFSS SW BTV = Surface water background threshold values from the NFSS RI: Science Applications International Corporation. 2007. Remedial Investigation Report for the NFSS. December.
USEPA RSL = USEPA Tapwater Regional Screening Level (USEPA, 2011a).
¹ USEPA Regional Screening Levels for Tapwater (USEPA, 2011a). In the absence of a USEPA RSL, the NYSDEC Groundwater TOGS value was used.
² = Screening value is based on total PCBs.
* = A non-carcinogen; the screening level has been divided by 10 to achieve a hazard index of 0.1.
a = No screening level available; presented value is maximum detection limit of all background samples collected for analyte and matrix. Hereafter, BTV value is presented as "NSA."
b = USEPA RSL for trivalent chromium

Table 3-4. OCCP Screening Levels for Sediment

ANALYTE	USEPA RSL		NFSS SD BTV	USEPA SD TEC
TCL VOCs (µg/kg)				
1,1,1,2-Tetrachloroethane	1,900		NSA	NSA
1,1,1-Trichloroethane	870,000	*	1.58 ^a	NSA
1,1,2,2-Tetrachloroethane	560		2.72 ^a	NSA
1,1,2-Trichloro-1,2,2-trifluoroethane	4,300,000	*	NSA	NSA
1,1,2-Trichloroethane	160	*	1.61 ^a	NSA
1,1-Dichloroethane	3,300		1.41 ^a	NSA
1,1-Dichloroethene	24,000	*	3.46	NSA
1,2,3-Trichlorobenzene	4,900	*	NSA	NSA
1,2,3-Trichloropropane	5		NSA	NSA
1,2,4-Trichlorobenzene	6,200	*	57.9 ^a	NSA
1,2,4-Trimethylbenzene	6,200	*	NSA	NSA
1,2-Dibromo-3-chloropropane	5.4		NSA	NSA
1,2-Dibromoethane	34		NSA	NSA
1,2-Dichlorobenzene	190,000	*	45.7 ^a	NSA
1,2-Dichloroethane	430		1.29 ^a	NSA
1,2-Dichloroethene	70,000	*	NSA	NSA
1,2-Dichloropropane	940		1.44 ^a	NSA
1,3,5-Trimethylbenzene	78,000	*	NSA	NSA
1,3-Dichlorobenzene	610	*	51.8 ^a	NSA
1,3-Dichloropropane	160,000	*	NSA	NSA
1,4-Dichlorobenzene	2,400		71.6 ^a	NSA
2,2-Dichloropropane	NSA		NSA	NSA
2-Butanone	2,800,000	*	49.3	NSA
2-Chlorotoluene	160,000	*	NSA	NSA
2-Hexanone	21,000	*	11.3 ^a	NSA
4-Chlorotoluene	160,000	*	NSA	NSA
4-Isopropyltoluene	NSA		NSA	NSA
4-Methyl-2-pentanone	530,000	*	12.1 ^a	NSA
Acetone	6,100,000	*	206	NSA
Benzene	1,100		1.35 ^a	NSA
Bromobenzene	30,000	*	NSA	NSA
Bromochloromethane	16,000	*	NSA	NSA
Bromodichloromethane	270		1.47 ^a	NSA
Bromoform	62,000		1.47 ^a	NSA
Bromomethane	730	*	1.5 ^a	NSA
Carbon disulfide	82,000	*	7.06 ^a	NSA

Table 3-4. OCCP Screening Levels for Sediment

ANALYTE	USEPA RSL		NFSS SD BTV	USEPA SD TEC
Carbon tetrachloride	610		1.47 ^a	NSA
Chlorobenzene	29,000	*	1.23 ^a	NSA
Chloroethane	1,500,000	*	2.42 ^a	NSA
Chloroform	290		1.55 ^a	NSA
Chloromethane	12,000	*	1.11 ^a	NSA
Cis-1,2-dichloroethene	16,000	*	1.41 ^a	NSA
Cis-1,3-dichloropropene	160,000	*	1.29 ^a	NSA
Cyclohexane	700,000	*	NSA	NSA
Dibromochloromethane	680		1.5 ^a	NSA
Dibromomethane	2,500	*	NSA	NSA
Dichlorodifluoromethane	9,400	*	NSA	NSA
Ethylbenzene	5,400		1.14 ^a	NSA
Hexachloro-1,3-butadiene	6,100	*	57.9 ^a	NSA
Isopropylbenzene	210,000	*	NSA	NSA
m,p-Xylene	63,000	*	NSA	NSA
Methyl tert-butyl ether	43,000		NSA	NSA
Methylcyclohexane	700,000	*	NSA	NSA
Methylene Chloride	11,000		4.04 ^a	NSA
n-Butylbenzene	390,000	*	NSA	NSA
n-Propylbenzene	340,000	*	NSA	NSA
o-Xylene	69,000	*	NSA	NSA
Sec-butylbenzene	NSA		NSA	NSA
Styrene	630,000	*	1.17 ^a	NSA
Tert-butylbenzene	NSA		NSA	NSA
Tetrachloroethylene	550		1.14 ^a	NSA
Toluene	500,000	*	8.89	NSA
Trans-1,2-dichloroethene	15,000	*	1.58 ^a	NSA
Trans-1,3-dichloropropene	1,700		0.748 ^a	NSA
Trichloroethylene	440	*	1.35 ^a	NSA
Trichlorofluoromethane	79,000	*	NSA	NSA
Vinyl chloride	60		1.67 ^a	NSA
Xylenes, Total	63,000	*	1.17 ^a	NSA
TCL SVOCs (µg/kg)				
1,1-Biphenyl	5,100	*	NSA	NSA
2,2-Oxybis(1-chloropropane)	4,600		NSA	NSA
2,4,5-Trichlorophenol	610,000	*	79.2 ^a	NSA
2,4,6-Trichlorophenol	6,100	*	125 ^a	NSA

Table 3-4. OCCP Screening Levels for Sediment

ANALYTE	USEPA RSL		NFSS SD BTV	USEPA SD TEC
2,4-Dichlorophenol	18,000	*	94.5 ^a	NSA
2,4-Dimethylphenol	120,000	*	762 ^a	NSA
2,4-Dinitrophenol	12,000	*	762 ^a	NSA
2-Chloronaphthalene	630,000	*	62.5 ^a	NSA
2-Chlorophenol	39,000	*	70.1 ^a	NSA
2-Methyl-4,6-dinitrophenol	490	*	762 ^a	NSA
2-Methylnaphthalene	31,000	*	76.2 ^a	NSA
2-Methylphenol	310,000	*	NSA	NSA
2-Nitroaniline	61,000	*	762 ^a	NSA
2-Nitrophenol	2,900		77.7 ^a	NSA
3,3-Dichlorobenzidine	1,100		762 ^a	NSA
3-Nitroaniline	610	*	762 ^a	NSA
4-Bromophenyl phenyl ether	NSA		155 ^a	NSA
4-Chloro-3-methylphenol	610,000	*	762 ^a	NSA
4-Chloroaniline	2,400		762 ^a	NSA
4-Chlorophenyl phenyl ether	NSA		89.9 ^a	NSA
4-Methylphenol	31,000	*	NSA	NSA
4-Nitroaniline	24,000		169 ^a	NSA
4-Nitrophenol	24,000	*	762 ^a	NSA
Acenaphthene	340,000	*	20.8 ^a	NSA
Acenaphthylene	3,600		134	NSA
Acetophenone	780,000	*	134 ^a	NSA
Anthracene	1,700,000	*	13 ^a	57.2
Atrazine	2,100		NSA	NSA
Benzaldehyde	780,000	*	NSA	NSA
Benzo[a]anthracene	150		399	108
Benzo[a]pyrene	15		618	150
Benzo[b]fluoranthene	150		1,090	NSA
Benzo[g,h,i]perylene	17,000	*	179	NSA
Benzo[k]fluoranthene	1,500		381	NSA
Benzyl butyl phthalate	260,000		NSA	NSA
Bis(2-chloroethoxy) methane	18,000	*	56.4 ^a	NSA
Bis(2-chloroethyl) ether	210		171 ^a	NSA
Bis(2-ethylhexyl) phthalate	35,000		31,300	NSA
Caprolactam	3,100,000	*	NSA	NSA
Carbazole	NSA		76.2 ^a	NSA
Chrysene	15,000		470	166

Table 3-4. OCCP Screening Levels for Sediment

ANALYTE	USEPA RSL		NFSS SD BTV	USEPA SD TEC
Dibenz[a,h]anthracene	15		3.26 ^a	33
Dibenzofuran	7,800	*	77.7 ^a	NSA
Diethyl phthalate	4,900,000	*	80.8 ^a	NSA
Dimethyl phthalate	NSA		83.8 ^a	NSA
Di-n-butyl phthalate	610,000	*	110 ^a	NSA
Di-n-octyl phthalate	610,000	*	139 ^a	NSA
Fluoranthene	230,000	*	696	423
Fluorene	230,000	*	14.5 ^a	77.4
Hexachloro-1,3-butadiene	6,100	*	57.9 ^a	NSA
Hexachlorobenzene	300		91.4 ^a	NSA
Hexachlorocyclopentadiene	37,000	*	762 ^a	NSA
Hexachloroethane	4,300	*	101 ^a	NSA
Indeno[1,2,3-c,d]pyrene	150		265	NSA
Isophorone	510,000		73.1 ^a	NSA
Naphthalene	3,600		2.76 ^a	176
n-Nitrosodi-n-propylamine	69		104 ^a	NSA
n-Nitrosodiphenylamine	99,000		102 ^a	NSA
Pentachlorophenol	890		762 ^a	NSA
Phenanthrene	1,700,000	*	169	204
Phenol	1,800,000	*	57.9 ^a	NSA
Pyrene	170,000	*	1,000	195
PCBs (µg/kg)				
Aroclor 1016	390 ¹	*	22.9 ^a	59.81
Aroclor 1221	140 ¹		64.5 ^a	59.81
Aroclor 1232	140 ¹		38.1 ^a	59.81
Aroclor 1242	220 ¹		66.3	59.81
Aroclor 1248	220 ¹		22.9 ^a	59.81
Aroclor 1254	110 ¹	*	58.3	59.81
Aroclor 1260	220 ¹		21.7	59.81
EXPLOSIVES (µg/kg)				
1,3,5-Trinitrobenzene	220,000	*	29 ^a	NSA
1,3-Dinitrobenzene	610	*	NSA	NSA
2,4,6-Trinitrotoluene	3,600	*	48 ^a	NSA
2,4-Dinitrotoluene	1,600		55 ^a	NSA
2,6-Dinitrotoluene	6,100	*	48 ^a	NSA
2-Amino-4,6-dinitrotoluene	15,000	*	18.1 ^a	NSA
2-Nitrotoluene	2,900		24 ^a	NSA

Table 3-4. OCCP Screening Levels for Sediment

ANALYTE	USEPA RSL		NFSS SD BTV	USEPA SD TEC
3-Nitrotoluene	610	*	24 ^a	NSA
4-Amino-2,6-dinitrotoluene	15,000	*	34.1 ^a	NSA
4-Nitrotoluene	24,000	*	24 ^a	NSA
HMX	380,000	*	99.6	NSA
Nitrobenzene	4,800		48 ^a	NSA
RDX	5,600		48 ^a	NSA
Tetryl	24,000	*	22.1 ^a	NSA
TAL METALS (mg/kg)				
Aluminum	7,700	*	30,400	NSA
Antimony	3.1	*	5.03	NSA
Arsenic	0.39		7.14	9.79
Barium	1,500	*	246	NSA
Beryllium	16	*	1.44	NSA
Boron	1,600	*	31.4	NSA
Cadmium	7	*	1.89	0.99
Calcium	NSA		59,400	NSA
Chromium	12,000 ^b	*	472	43.4
Cobalt	2.3	*	21.3	NSA
Copper	310	*	184	31.6
Iron	5,500	*	37,800	NSA
Lead	400	*	121	35.8
Lithium	16	*	47	NSA
Magnesium	NSA		27,300	NSA
Manganese	180	*	814	NSA
Mercury	0.78	*	0.47	0.18
Nickel	150	*	51.9	22.7
Potassium	NSA		5,070	NSA
Selenium	39	*	1.87	NSA
Silver	39	*	0.742	NSA
Sodium	NSA		679	NSA
Thallium	0.078	*	0.356	NSA
Vanadium	39	*	60.6	NSA
Zinc	2,300	*	405	121
<p><i>Legend:</i> NFSS = Niagara Falls Storage Site NSA = No screening level available TCL = Target Compound List USEPA RSL = USEPA Residential Soil Regional Screening Level (USEPA, 2011a). SD = sediment</p>				

Table 3-4. OCCP Screening Levels for Sediment

ANALYTE	USEPA RSL	NFSS SD BTV	USEPA SD TEC
<p><i>BTV = background threshold values</i> <i>USEPA SD TEC = Consensus-based threshold effect concentrations from the USEPA Guidance Manual to Support the Assessment of Contaminated Sediments in Freshwater Ecosystems Volume III - Interpretation of the Results of Sediment Quality Investigations (USEPA, 2002a). EPA-905-B02-001-C United States Great Lakes National Program Office.</i> <i>NFSS SD BTV = Remedial Investigation report for the Niagara Falls Storage Site (USACE, 2007b)</i> ¹ = Screening value is based on total PCBs. * = A non-carcinogen; the screening level has been divided by 10 to achieve a hazard index of 0.1. ^a = No screening level available; presented value is maximum detection limit of all background samples collected for analyte and matrix. Hereafter, BTV value is presented as “NSA.” b = USEPA RSL for trivalent chromium</p>			

4.0 SITE CHARACTERIZATION ACTIVITIES

The methodology and design of the investigation activities were outlined in sampling plans that are listed below. The investigations were completed in accordance with approved sampling plans and conducted during multiple field efforts between 2001 and 2011.

- *Final Radiation Safety Plan Addendum for Phase IV Remedial Investigation/Feasibility Study at the Former Lake Ontario Ordnance Works, Niagara County, New York (USACE, 2009a) – hereinafter the “LOOW Phase IV RI/FS RSP Addendum.”*
- *Final Field Sampling Plan Addendum for Occidental Chemical Corporation Property Data Gap and Lewiston-Porter Central School District Investigations at the Former Lake Ontario Ordnance Works, Niagara County, New York (USACE, 2010a) – hereinafter the “OCCP Data Gap FSP Addendum.”*
- *Final Quality Assurance Project Plan Addendum for Occidental Chemical Corporation Property Data Gap and Lewiston-Porter Central School District Investigations Former Lake Ontario Ordnance Works, Niagara County, New York (USACE, 2010b) – hereinafter the “OCCP Data Gap QAPP Addendum.”*
- *Final Site Safety and Health Plan Addendum for Occidental Chemical Corporation Property Data Gap and Lewiston-Porter Central School District Investigations at the Former Lake Ontario Ordnance Works, Niagara County, New York (USACE, 2010c) – hereinafter the “OCCP Data Gap SSHP Addendum.”*
- *Final Field Sampling Plan Addendum for Occidental Chemical Corporation Property and Wastewater Treatment Plant Data Gap Investigations at the Former Lake Ontario Ordnance Works, Niagara County, New York (USACE, 2011a) – hereinafter the “OCCP/WWTP Data Gap FSP Addendum.”*
- *Final Quality Assurance Project Plan Addendum for Occidental Chemical Corporation and Wastewater Treatment Plant Data Gap Investigations at the Former Lake Ontario Ordnance Works, Niagara County, New York (USACE, 2011b) – hereinafter the “OCCP/WWTP Data Gap QAPP Addendum.”*
- *Final Site Safety and Health Plan Addendum for Occidental Chemical Corporation Property and Wastewater Treatment Plant Data Gap Investigations at the Former Lake Ontario Ordnance Works, Niagara County, New York (USACE, 2011c) – hereinafter the “OCCP/WWTP Data Gap SSHP Addendum.”*

4.1 Pre-Investigation

Prior to each field effort, pre-investigation activities were performed to ensure the health and safety of field personnel and obtain authorized access to all proposed investigation areas. The pre-investigation activities included securing access to the site through an executed right-of-entry (ROE) agreement with the site owner. In addition, utility clearance was performed to identify, if present, both municipal and private utility features that service and/or intersect the site.

4.1.1 Rights of Entry

Prior to accessing the site, authorization was provided through an executed ROE agreement. A valid ROE was secured and requirements were adhered to during field investigation activities. The status of the ROE was revalidated prior to each mobilization. In addition, field efforts were scheduled and coordinated with the property owner and project stakeholders to ensure

cooperation among all stakeholders and communication of potential restrictions resulting from planned activities at the site.

4.1.2 Utility Clearance

Prior to commencing intrusive investigation activities, a utility clearance was performed to identify municipal and/or private utility features that service and/or intersect the site. According to OCCP records, no private utilities have been installed on the property. As per the OCCP Data Gap FSP Addendum (USACE, 2010a) and the OCCP/WWTP Data Gap FSP Addendum (USACE, 2011a), New York One Call was contacted to perform a site-wide utility clearance and provide utility mark outs prior to commencing intrusive investigation activities at the site. A site-wide utility clearance was confirmed during field efforts and referenced during intrusive activities at the site.

4.2 Field Screening

Field screening of soil and sediment samples was performed during each field investigation. Samples were field screened for organic vapors, radiological, and explosive properties. Field screening of soil and sediment samples for organic vapors was performed to assist in determining potential organic compound concentrations. Field screening of sample locations and samples for radiological properties was performed to ensure the health and safety of field personnel and subcontractors based on historical operations at the former LOOW, specifically those associated with NFSS. Field screening of biased and systematic samples for explosive properties was performed in conjunction with laboratory analysis for delineating potential explosives constituents.

4.2.1 Total Organic Vapor Screening

During each field effort, soil and sediment samples were screened for total organic vapors (TOV) with a portable photoionization detector (PID). Based on historical operations and constituents of concern (COC) for other parcels (e.g., polycyclic aromatic hydrocarbons [PAHs]) at the former LOOW, a PID with an 11.7 eV (electron volt) lamp was selected for field screening. However, a PID with an 11.7 eV lamp is more fragile and prone to malfunction.

The weather conditions encountered (e.g., humidity and/or precipitation) during investigation activities also affected the PID by causing intermittent malfunctioning and an inability to consistently field screen samples for the presence of organic vapors. However, these equipment issues did not interfere with the collection of environment samples for laboratory analysis. Field activities were accomplished during each field effort.

Section 5.2.1 presents the results of the TOV screening activities. **Appendix B** includes the TOV screening results as recording on the soil boring collection records.

4.2.2 Radiological Screening

During each field effort, radiological screening was conducted at sample locations. Radiological screening was performed solely as a prudent health and safety measure for field personnel due to historical activities at the LOOW.

During investigation activities, a background exposure rate level was established with a Ludlum Model 19 or Bicron MicroRem, a background direct count was established via a Ludlum 2221 meter coupled to a Ludlum Model 44-10 probe (2 inch by 2 inch sodium iodide detector). The background exposure rate (7.7 microRoentgens per hour [$\mu\text{R/hr}$] or microrem per hour

[µrem/hr]) and direct count level (8,000 counts per minute [cpm]) were determined at a selected background location, presumed to be free of potential radiological impacts, and in accordance with the approved LOOW Phase IV RI/FS RSP Addendum (USACE, 2009a).

Prior to intrusive activities and/or environmental sampling, radiological screening was conducted with both instruments. Each environmental sample collected for laboratory analysis was field screened for radiological properties. In addition, radiological screening was performed on filled sample containers, equipment employed during investigations activities, and vehicles prior to egress from the site to ensure the health and safety of field personnel and subcontractors. One sample, C2-OXY-SO-Y20 from location C10-GS2-Y20, was submitted for laboratory analysis of radionuclide constituents.

Section 5.2.2 presents the results of the radiological screening activities. **Appendix C** includes the radiological screening results.

4.2.3 Explosives Screening

During the 2010 field effort, explosives screening was performed at the site. Screening of soil samples for explosives was performed utilizing a DropEx[®] brand explosives detection field test kit. DropEx is a non-aerosol test kit designed to determine the presence or absence of nitroaromatics (i.e., 2,4,6- TNT) to a sensitivity of 20 nanograms. Soil samples from both biased and systematic sampling locations were screened for explosives at AOC 1.

Between 23 and 27 August 2010, screening of soil samples for explosives was performed at 63 locations within AOC 1. From the 63 locations, 91 individual soil samples were screened for explosives (79 regular samples and 12 duplicate samples). Approximately one half of the soils samples screened for explosives (38 soil samples from 19 locations) were also submitted for laboratory analysis. **Figure 4-1** presents the explosive screening and soil sample locations at AOC 1.

Section 5.2.3 presents the results of the explosives screening activities. **Appendix D** includes the explosives screening results.

4.2.4 Area of Debris Delineation at AOC 1

A reconnaissance and geophysical investigation were conducted in 2010 to:

- Determine the content of the slightly elevated portions of the area of debris
- Determine the horizontal and vertical extent of the area of debris
- Further investigate any potential remnants of munitions items identified during the initial sampling

A Schonstedt assisted visual survey was completed at AOC 1 to determine the horizontal extent of the area of debris. A qualified unexploded ordnance (UXO) technician utilized a Schonstedt GA-52Cx to verify the presence or absence of ferrous metals signatures within the area of debris.

Manual excavation was completed at AOC 1 to further delineate the horizontal and vertical extent of the area of debris. Eleven test pits were manually excavated at AOC 1 to verify the horizontal extent of the area of debris. The test pits were located at the perimeter of slightly elevated areas which exhibited ferrous metal signatures. Test pits were also excavated within mounded areas to determine the vertical profile across the area of debris.

In addition, the horizontal extent of the area of debris and location of each test pit were georeferenced using an Archer Longbow global positioning system (GPS). **Figure 4-2** presents the approximate extent of the area of debris and test pit locations at AOC 1. **Appendix E** includes the test pit photographic log.

4.3 Field Sampling

Surface soil and subsurface soil samples were collected at four of the AOCs and surface water and sediment samples were collected from the other two AOCs, which were ponds. Sample locations for the six AOC were determined based on field observations during each field effort at the site. Coordinates for each sample location were recorded with a handheld GPS in North American Datum (NAD) 1983 State Plane, New York West or georeferenced from two control points located at the site.

Samples collected during investigation activities were submitted for laboratory analysis of some or all of the following: volatile organic compounds (VOCs), SVOCs, pesticides, PCBs, explosives, metals, cyanide, hexavalent chromium, and radionuclides. **Table 4-1** summarizes investigation samples (e.g., regular and duplicate) collected and submitted for laboratory analysis between 2001 and 2011. **Appendix F** includes laboratory analytical data reports and summary tables.

Sample Matrix Type	TCL VOC	TCL SVOC	Pesticides	PCB	Explosives	TAL Metals	Boron	Cyanide	Lithium	Hexavalent Chromium	Radionuclide
Surface Soil	21	21	12	21	50	49	49	12	49	32	1
Subsurface Soil	16	16	9	16	25	26	26	9	26	13	---
Surface Water	2	2	---	2	3	2	2	---	2	---	1
Sediment	2	2	---	2	3	2	2	---	2	---	1

Legend:
 --- = no sample submitted for analysis
 PCB = polychlorinated biphenyl
 SVOC = semi-volatile organic compound
 VOC = volatile organic compound

The following sections provide a summary of surface soil, subsurface soil, surface water, and sediment samples collected during investigation activities at the site between 2001 and 2011. **Table 4-2** identifies soil sampled collected between 2001 and 2011 that were included in this RI.

Location ID	Matrix Type	Date	Sample ID	Sample Depth (ft bgs)
C10-GS2-1	Surface	5/9/2001	C10-GS2-SO-1-1	0 - 1
	Subsurface	5/9/2001	C10-GS2-SO-1-7	6 - 7
C10-GS2-2	Surface	5/9/2001	C10-GS2-SO-2-1	0 - 1
	Subsurface	5/9/2001	C10-GS2-SO-2-7	6 - 7
C10-GS2-3	Surface	5/10/2001	C10-GS2-SO-3-1	0 - 1
	Subsurface	5/10/2001	C10-GS2-SO-3-5	4 - 5
C10-GS2-4	Surface	5/9/2001	C10-GS2-SO-4-1	0 - 1
	Subsurface	5/9/2001	C10-GS2-SO-4-5	4 - 5
C10-GS2-5	Surface	5/10/2001	C10-GS2-SO-5-1	0 - 1
	Subsurface	5/10/2001	C10-GS2-SO-5-7	6 - 7
C10-GS2-6	Surface	5/10/2001	C10-GS2-SO-6-1	0 - 1
	Subsurface	5/10/2001	C10-GS2-SO-6-25	24 - 25
C10-GS2-7	Surface	5/10/2001	C10-GS2-SO-7-1	0 - 1
	Subsurface	5/10/2001	C10-GS2-SO-7-13	12 - 13
C10-GS2-8	Surface	5/10/2001	C10-GS2-SO-8-1	0 - 1
	Subsurface	5/10/2001	C10-GS2-SO-8-12	11 - 12
C10-GS2-9	Surface	5/10/2001	C10-GS2-SO-9-1	0 - 1
	Subsurface	5/10/2001	C10-GS2-SO-9-6	5 - 6
C10-GS2-10	Surface	5/10/2001	C10-GS2-SO-10-0.5	0 - 0.5
	Surface	6/13/2001	C10-GS2-SO-10A-0.5	0 - 0.5

Table 4-2. Soil Samples Collected During RI Activities (between 2001 and 2011)				
Location ID	Matrix Type	Date	Sample ID	Sample Depth (ft bgs)
C10-GS2-2	Subsurface	8/25/2010	C2-OXY-SO-S02-7	6.5 - 7
C10-GS2-DET	Surface	8/27/2010	C2-OXY-DET-0.5	0 - 0.5
C10-GS2-DET	Surface	8/27/2010	C2-OXY-DET-1	0.5 - 1
C10-GS2-HE	Surface	8/23/2010	C2-OXY-HE-0.5	0 - 0.5
C10-GS2-HE	Surface	8/23/2010	C2-OXY-HE-1	1 - 1.5
C10-GS2-HN	Surface	8/23/2010	C2-OXY-HN-0.5	0 - 0.5
C10-GS2-HN	Surface	8/23/2010	C2-OXY-HN-1	1 - 1.5
C10-GS2-HS	Surface	8/23/2010	C2-OXY-HS-0.5	0 - 0.5
C10-GS2-HS	Surface	8/23/2010	C2-OXY-HS-1	1 - 1.5
C10-GS2-HW	Surface	8/23/2010	C2-OXY-HW-0.5	0 - 0.5
C10-GS2-HW	Surface	8/23/2010	C2-OXY-HW-1	1 - 1.5
C10-GS2-P21	Surface	8/27/2010	C2-OXY-SO-P21-1	1 - 1.5
	Subsurface	8/27/2010	C2-OXY-SO-P21-3	2.5 - 3
C10-GS2-P22	Surface	8/27/2010	C2-OXY-SO-P22-2	1.5 - 2
	Subsurface	8/27/2010	C2-OXY-SO-P22-3	2.5 - 3
C10-GS2-P23	Surface	8/27/2010	C2-OXY-SO-P23-1	0.5 - 1
	Subsurface	8/27/2010	C2-OXY-SO-P23-3	2.5 - 3
C10-GS2-P24	Surface	8/27/2010	C2-OXY-SO-P24-1	0.5 - 1
	Subsurface	8/27/2010	C2-OXY-SO-P24-3	2.5 - 3
C10-GS2-PE	Surface	8/23/2010	C2-OXY-SO-PE-0.5	0 - 0.5
C10-GS2-PE	Surface	8/23/2010	C2-OXY-SO-PE-1	1 - 1.5
C10-GS2-PN	Surface	8/23/2010	C2-OXY-SO-PN-0.5	0 - 0.5
C10-GS2-PN	Surface	8/23/2010	C2-OXY-SO-PN-1	1 - 1.5
C10-GS2-PS	Surface	8/23/2010	C2-OXY-SO-PS-0.5	0 - 0.5
C10-GS2-PS	Surface	8/23/2010	C2-OXY-SO-PS-1	1 - 1.5
C10-GS2-PW	Surface	8/23/2010	C2-OXY-SO-PW-0.5	0 - 0.5
C10-GS2-PW	Surface	8/23/2010	C2-OXY-SO-PW-1	1 - 1.5
C10-GS2-SIN	Surface	8/27/2010	C2-OXY-SO-SIN-1	0.5 - 1
	Subsurface	8/27/2010	C2-OXY-SO-SIN-3	2.5 - 3
C10-GS2-SIS	Surface	8/27/2010	C2-OXY-SO-SIS-1	0.5 - 1
	Subsurface	8/27/2010	C2-OXY-SO-SIS-3	2.5 - 3
C10-GS2-SIW	Surface	8/27/2010	C2-OXY-SO-SIW-1	0.5 - 1
	Subsurface	8/27/2010	C2-OXY-SO-SIW-3	2.5 - 3
C10-GS2-SOE	Surface	8/27/2010	C2-OXY-SO-SOE-1	0.5 - 1
	Subsurface	8/27/2010	C2-OXY-SO-SOE-3	2.5 - 3
C10-GS2-Y20	Surface	8/27/2010	C2-OXY-SO-Y20	0 - 0.5
C10-AA03-BP01	Surface Soil	10/12/2011	C10-AA03-SO-01-0.5	0 - 0.5
	Subsurface Soil	10/12/2011	C10-AA03-SO-01-4.0	3.5 - 4
C10-AA03-BP02	Surface Soil	10/12/2011	C10-AA03-SO-02-0.5	0 - 0.5
	Subsurface Soil	10/12/2011	C10-AA03-SO-02-4.0	3.5 - 4
C10-AA04-BP01	Surface Soil	10/12/2011	C10-AA04-SO-01-0.5	0 - 0.5

Table 4-2. Soil Samples Collected During RI Activities (between 2001 and 2011)				
Location ID	Matrix Type	Date	Sample ID	Sample Depth (ft bgs)
	Subsurface Soil	10/12/2011	C10-AA04-SO-01-4.0	3.5 - 4
C10-AA04-BP02	Surface Soil	10/12/2011	C10-AA04-SO-02-0.5	0 - 0.5
	Subsurface Soil	10/12/2011	C10-AA04-SO-02-4.0	3.5 - 4
C10-AA04-BP03	Surface Soil	10/12/2011	C10-AA04-SO-03-0.5	0 - 0.5
	Subsurface Soil	10/12/2011	C10-AA04-SO-03-4.0	3.5 - 4
C10-AA07-BP01	Surface Soil	10/12/2011	C10-AA07-SO-01-0.5	0 - 0.5
	Subsurface Soil	10/12/2011	C10-AA07-SO-01-4.0	3.5 - 4
C10-AA07-BP02	Surface Soil	10/12/2011	C10-AA07-SO-02-0.5	0 - 0.5
	Subsurface Soil	10/12/2011	C10-AA07-SO-02-4.0	3.5 - 4
C10-GS2-BP1	Subsurface	5/10/2001	C10-GS2-BP1	0.0
<p><i>Legend:</i> Surface and subsurface soil samples collected in 2001 were submitted for VOC, SVOC, PAH, pesticides, PCB, explosives, metals, and cyanide laboratory analysis. Surface and subsurface soil samples collected in 2010 were submitted for explosives, metals, and hexavalent chromium laboratory analysis. Surface and subsurface soil samples collected in 2011 were submitted for VOC, SVOC, PAH, PCB, explosives, metals, and hexavalent chromium laboratory analysis. Source = Report of Results for the Phase II Remedial Investigation at the Former Lake Ontario Ordnance Works (LOOW), Niagara County, New York (USACE, 2002)</p>				

4.3.1 Surface Soil

Surface soil samples were collected from four of the six AOCs (AOC 1, AOC 3, AOC 4, and AOC 5) during multiple field events conducted between 2001 and 2011. The surface soil samples were collected using disposable (e.g., single use polyethylene trowels and aluminum pans) and non-disposable (e.g., direct push technology [DPT] and hand auger drilling methods) sampling equipment.

Fifty-one surface soil samples (46 regular samples and 5 duplicate samples) were collected from 32 locations. Each surface soil sample was collected from two distinct intervals; 0.0 – 1.0 ft bgs or 1.0 – 2.0 ft bgs. Forty surface soil samples were collected from the 0.0 – 1.0 ft bgs interval (36 regular samples and 4 duplicate samples) and 11 surface soil samples were collected from the 1.0 – 2.0 ft bgs interval (10 regular samples and 1 duplicate sample). The surface soil sample interval at each location ranged from 0.5 – 1.0 ft. Surface soil was considered to be the upper two feet due to the presence of debris and soil in this interval. Surface soil samples from 26 locations were collocated with subsurface soil samples.

Each surface soil sample was located using professional judgment and did not utilize random or systematic sampling patterns. Biased sample locations were selected to target potentially impacted areas identified during the examination of historical aerial photography (U.S. Army TEC, 2002) and focus on historical operations at the former LOOW. Section 5.3.1 evaluates the laboratory analytical results for surface soil samples.

AOC 1

Surface and subsurface soil at AOC 1 was investigated in May and June 2001 and August 2010. AOC 1 has been historically referred to as the “possible storage area” or “debris field” in

previous reports (i.e., LOOW Phase I RI Report, LOOW Phase II RI Report). **Figures 4-1, 4-3, and 4-4** depict the surface soil sample locations at AOC 1.

Forty-two surface soil samples (39 regular samples and 3 duplicate samples) were collected for laboratory analysis. Each surface soil sample was located on the basis of visual observations (i.e., a debris field, drums, incendiary rings, an assumed burn area, and an area of terra cotta pipes). One sample (C10-GS2-BP1) from location C10-GS2-SO-BP1 targeted caked and fibrous material that appeared to be the contents of a former drum and the suspected source of contamination.

AOC 3 – Location 3, AOC 4 – Location 4, and AOC 5 – Location 7

Surface and subsurface soil at AOC 3, AOC 4, and AOC 5 was investigated in October 2011. Nine surface soil samples (7 regular samples and 2 duplicate samples) were collected for laboratory analysis (**Figure 4-3**). Each surface soil sample was located on the basis of visual observations (i.e., vehicle tires, asphalt shingles, metal and glass beverage containers).

4.3.2 Subsurface Soil

Subsurface soil samples (greater than 2 ft bgs) were collected from AOC 1, AOC 3, AOC 4, and AOC 5) during multiple field efforts between 2001 and 2011. Subsurface soil samples were collected using non-disposable (e.g., DPT and hand auger drilling methods) sampling equipment.

Twenty-six subsurface soil samples (25 regular samples and 1 duplicate sample) were collected from 21 locations. Each subsurface soil sample was collected from depths of 2.0 – 25 ft bgs. Subsurface soil samples from 26 locations were collocated with surface soil samples. All subsurface soil samples were located on the basis of visual observations. Section 5.3.2 presents a detailed evaluation of the laboratory analytical results for subsurface soil samples.

AOC 1

Collocated surface and subsurface soils were collected in May and June 2001 and in August 2010. **Figures 4-1, 4-2, and 4-4** depict the subsurface soil sample locations at AOC 1, which show that 19 subsurface soil samples (18 regular samples and 1 duplicate sample) were collected for laboratory analysis. Each subsurface soil sample was collected based on visual observations (i.e., a debris field, drums, incendiary rings, an assumed burn area, an area of terra cotta pipes).

AOC 3 – Location 3, AOC 4 – Location 4, and AOC 5 – Location 7

Collocated surface and subsurface soil samples were collected from AOC3, AOC4, and AOC 5 in October 2011. **Figure 4-3** depicts these sample locations.

Seven subsurface soil samples (all regular samples) were collected for laboratory analysis. Each subsurface soil sample was collected based on visual observations (i.e., vehicle tires, asphalt shingles, metal and glass beverage containers).

4.3.3 Surface Water

Surface water samples were collected from AOC 2 in May 2001 and from AOC 6 in October 2011. AOC 2 is an unnamed pond located in the eastern half of the site. AOC 6 is an unnamed pond located in the northern half of the site. **Figure 4-3** depicts the surface water sample locations.

The surface water samples were collocated with sediment samples. Three surface water samples (2 regular samples and 1 duplicate sample) were collected from the two locations. Each sample was selected using a biased strategy. The surface water samples were collected using disposable (e.g., single use polyethylene bailers and laboratory provided glassware) sampling equipment.

Table 4-3 identifies the regular surface water samples. One duplicate sample was also collected.

Table 4-3. Surface Water Collected During RI Activities (between 2001 and 2011)			
Location ID	Matrix Type	Date	Sample ID
C10-POND-SW	Surface Water	5/11/2001	C10-POND-SW-1
C10-AA02-BP01	Surface Water	10/11/2011	C10-AA02-SW-01-0.0
<i>Legend:</i> NA = Not Applicable			

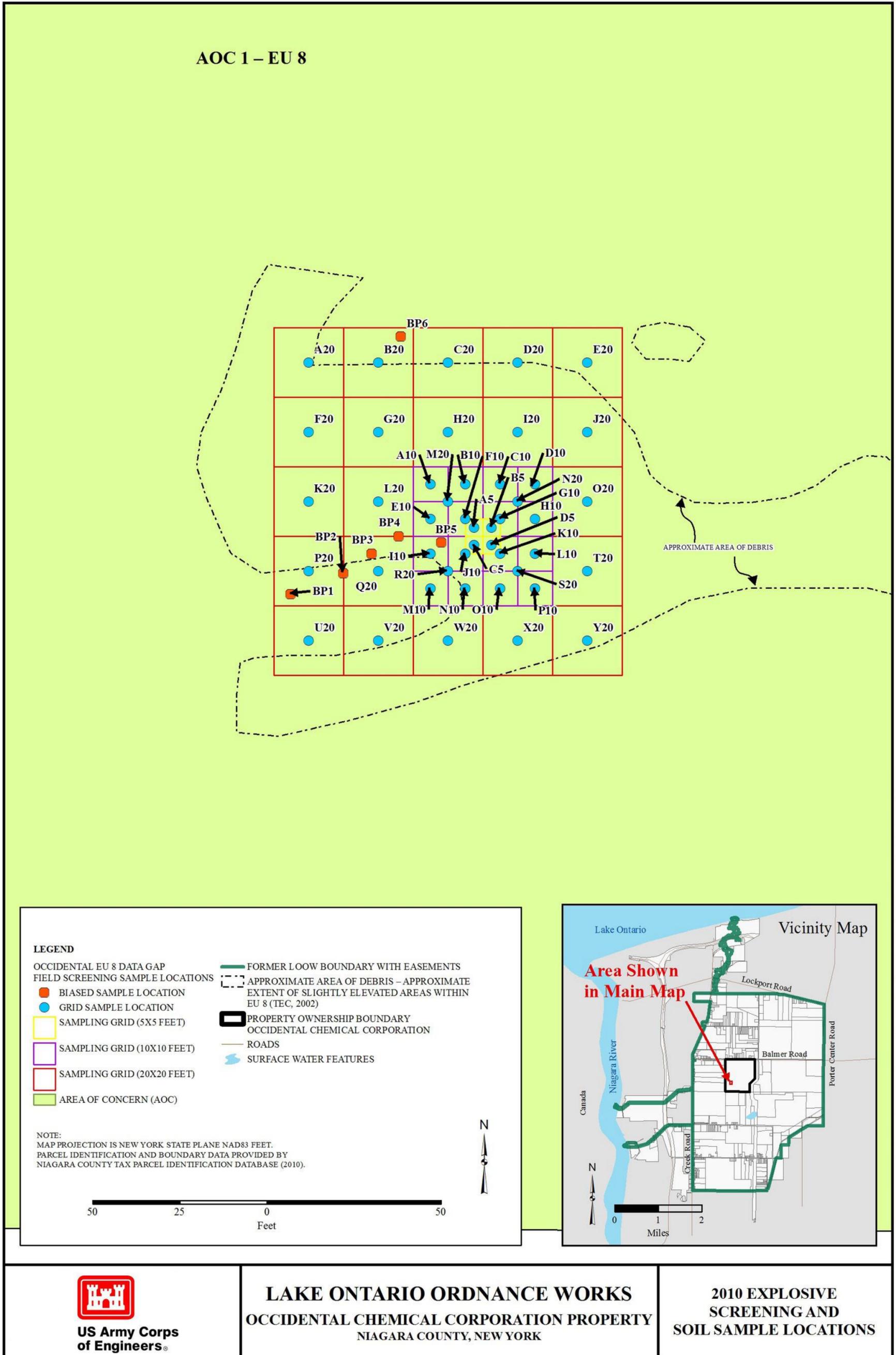
The samples were submitted for laboratory analysis of VOCs, SVOCs, PCBs, explosives, metals. Analytical results are discussed in Section 5.3.3.

4.3.4 Sediment

Sediment samples were collected from AOC 2 in May 2001 and AOC 6 in October 2011 using disposable (e.g., laboratory provided glassware) sampling equipment. **Table 4-4** identifies the regular sediment samples. One duplicate sample was also collected.

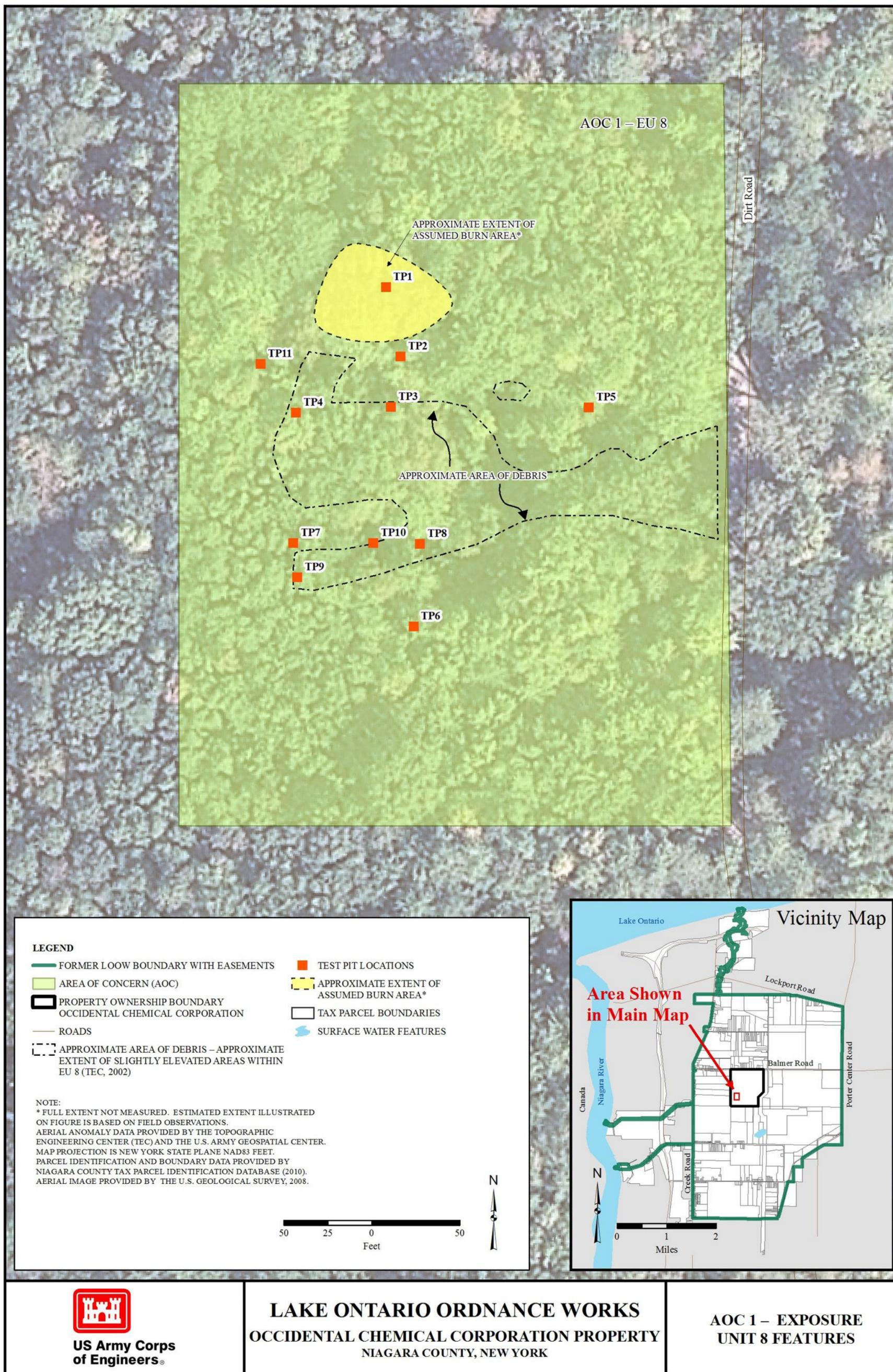
Table 4-4. Sediment Samples Collected During RI Activities (between 2001 and 2011)				
Location ID	Matrix Type	Date	Sample ID	Sample Depth (ft bgs)
C10-POND-SD	Sediment	5/11/2001	C10-POND-SED-1	0.5
C10-AA02-BP01	Sediment	10/11/2011	C10-AA02-SD-01-0.5	0.5
<i>Legend:</i> NA = Not Applicable				

Figure 4-3 depicts the sediment sample locations, which were submitted for laboratory analysis of VOCs, SVOCs, PCBs, explosives, metals. Analytical results are discussed in Section 5.3.4.



Path: \\LOVETON\FEDERAL\GISData\Northeast\NewYork\LOOW\Occid\Revised\OccidentalFieldScreening.mxd

Figure 4-1. 2010 Explosive Screening and Soil Sample Locations



Path: \\LOVETON\FEDERAL\GISData\NorthEast\NewYork\LOOW\OcciMXD\Revised\EU8\Features.mxd

Figure 4-2. AOC 1 - Site Observations and Test Pits (2010)

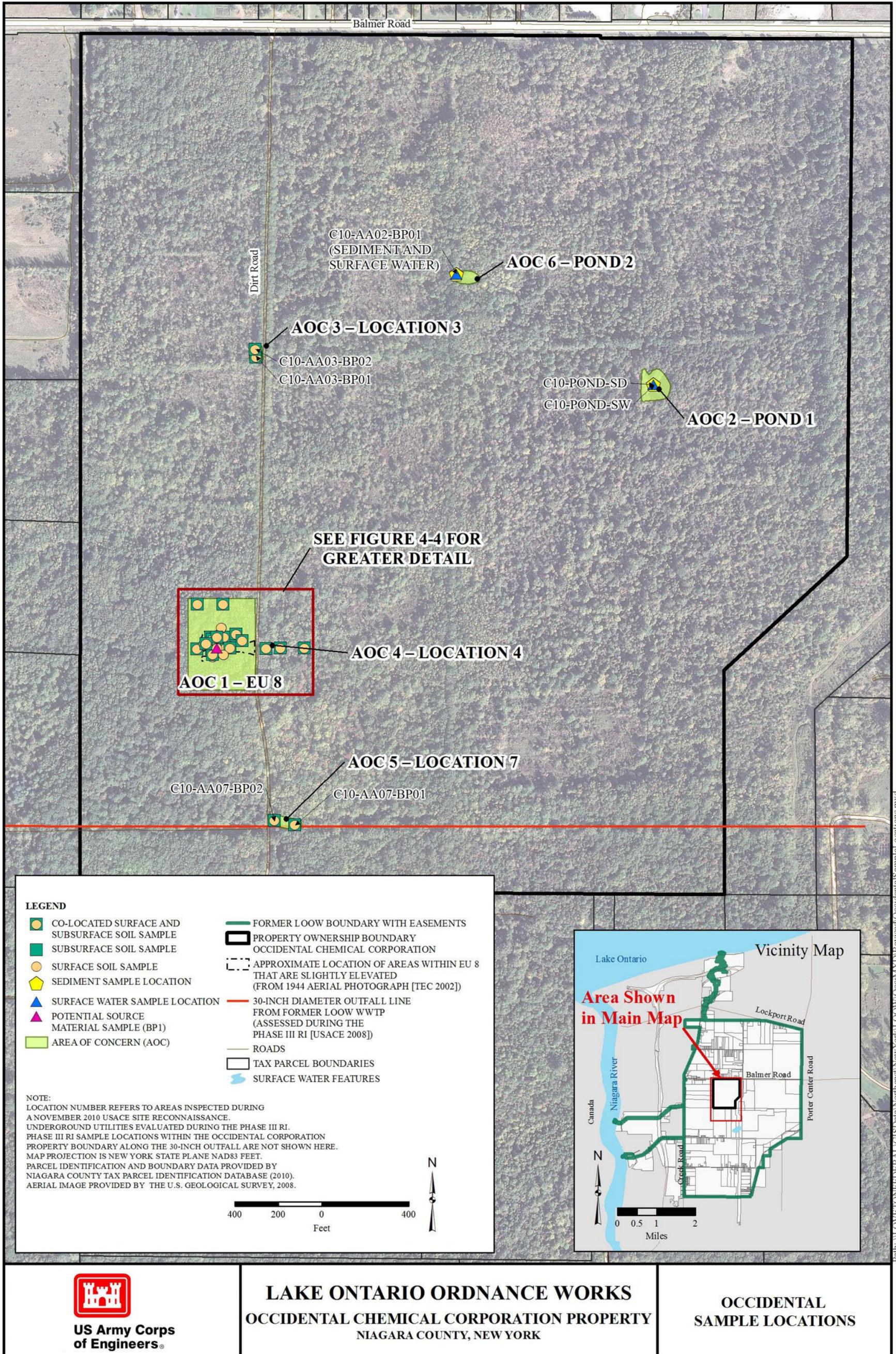


Figure 4-3. Occidental Sample Locations

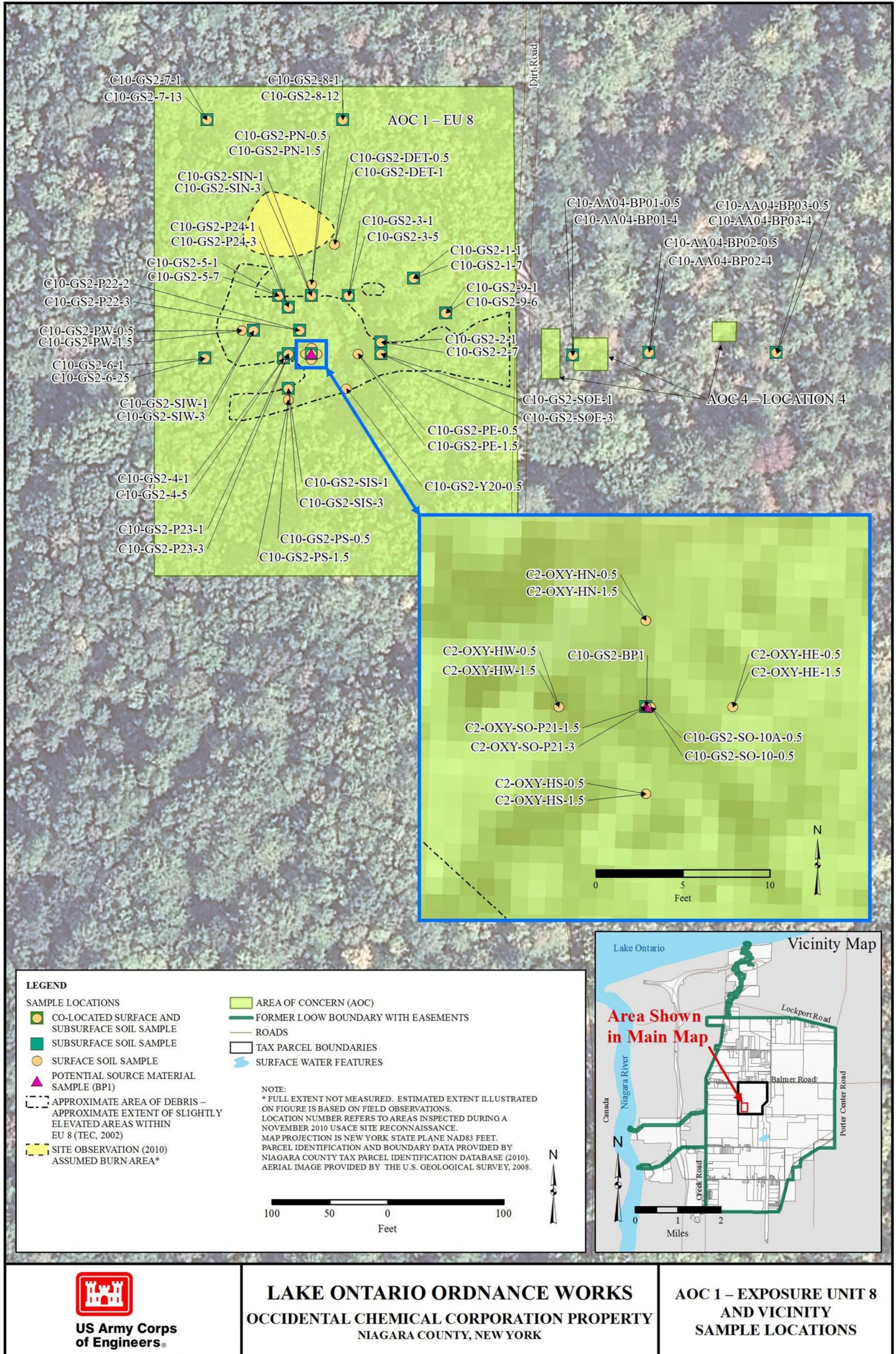


Figure 4-4. AOC 1 - EU 8 and Vicinity Sample Locations

5.0 SITE INVESTIGATION RESULTS

This section presents site investigation results and evaluates data quality. The following subsections detail the results of a data quality assessment (DQA), field screening activities, and laboratory analytical data for surface soil, subsurface soil, surface water, and sediment samples; specifically those samples exceeding screening criteria that warranted additional evaluation within a risk assessment.

Appendix G includes the Data Usability Summary Reports (DUSRs). **Appendix H** includes the DQA evaluation tables.

5.1 Data Quality Assessment

This project utilized both field and analytical laboratory QC measures to meet the data DQOs presented in the OCCP Data Gap QAPP Addendum (USACE, 2010b) and OCCP/WWTP Data Gap QAPP Addendum (USACE, 2011b). The sampling program consisted of 71 field soil samples, 2 field surface water samples, and 2 field sediment samples collected during the investigation activities. Laboratories were provided with all field samples and the following field QC samples: three rinsate blanks, six trip blanks, eight field duplicates, and six MS/MSD pairs.

This DQA describes the evaluation of DQIs that were used to assess the overall quality of the analytical data collected during investigation activities and presented in the OCCP RI Report. The DQIs (PARCCS) are assessed with respect to the DQOs. Project DQOs establish the data end uses and end users and provide objective criteria by which the data quality can be measured. More importantly, the DQO process identifies the up-front protocols, processes, procedures, and methods by which the DQOs can be met. With the appropriate planning for project DQOs, their achievement provides the basis for concluding that the acquired investigation data is scientifically sound, legally defensible, and adequate for their intended use. The specific DQIs for PARCCS were established in the project-planning phase. DQIs may be qualitative statements, while others set quantitative criteria or goals. Both are evaluated in this DQA.

During investigation activities, sampling and analysis was conducted using the QC requirements and QA objectives as outlined in the OCCP Data Gap QAPP Addendum (USACE, 2010b) and OCCP/WWTP Data Gap QAPP Addendum (USACE, 2011b). Samples were analyzed for TCL VOCs, TCL SVOCs plus PAHs, explosives, pesticides, PCBs, TAL metals, lithium, boron, cyanide, and/or radionuclides.

5.1.1 Environmental Analytical Laboratories

Environmental and field QC samples were submitted for chemical analysis to National Environmental Laboratory Accreditation Program accredited analytical laboratories. The laboratory analyzed all environmental samples (i.e., solid and aqueous) and field QC samples (i.e., trip blanks, equipment rinsate blanks, and field duplicates) using accepted laboratory standard operating procedures (SOPs) based on the *SW-846 Test Methods for Evaluating Solid Waste, Physical/Chemical Methods* (USEPA, 2008), and previous versions.

5.1.2 Analytical Data Validation

Analytical data were independently validated for adherence to method QA/ QC criteria by Meridian Consultant Group, Inc. (MCGI) and Environmental Data Services, Inc. using

specifications established in the approved OCCP Data Gap QAPP Addendum (USACE, 2010c) and OCCP/WWTP Data Gap QAPP Addendum (USACE, 2011b), and the guidelines described in the USEPA Contract Laboratory Program (CLP) National Functional Guidelines for Organic Data Review (USEPA, 1999b) and USEPA CLP National Functional Guidelines for Inorganic Data Review (USEPA, 2002c), modified to accommodate the criteria in the analytical methods used in this program, and Region II SOPs for data validation, including:

- *USEPA Region II SOP HW-24, Revision 1, June 1999: Validating Volatile Organic Compounds by SW-846 Method 8260B (USEPA, 1999a)*
- *USEPA Region II SOP No. HW-2, Revision 11, January 1992, for Evaluation of Metals Data for the Contract Laboratory Program (USEPA, 1992)*
- *USEPA Region II SOP No. HW-22, Revision 2, June 2001: Validating Semivolatile Organic Compounds by SW846 Method 8270C (USEPA, 2001)*
- *USEPA Region II SOP, Revision 1.3, September 1994: Validating Explosive Residues by HPLC(USEPA, 1994) and the USEPA Region II SOP No. HW-22, Revision 2, June 2001: Validating Semivolatile Organic Compounds by SW846 Method 8270C (USEPA, 2001)*
- *USEPA Region II SOP No. HW-23, Revision 0, April 1995: Validating Pesticide/PCB Compounds by SW-846 Method 8080A (USEPA, 1995)*

Data received from the laboratories were subjected to an initial review to ensure that all Level IV CLP elements were submitted. The validators were responsible for the following:

- Reviewing laboratory data packages and applying required control limits
- Using professional judgment where specific limits were not specified
- Qualifying affected data points on the applicable result forms
- Preparing a DUSR for actions taken.

5.1.3 Data Bias Assessment

The DQA was conducted using the OCCP QC data (by matrix and by parameter) and the data validation results. The QC data were evaluated for the number of results observed within the set acceptance criteria. When the data are observed as being lower or higher than the acceptance criteria, a bias existed. However, for the purpose of this project and based on the Data Validation Guidelines used, bias has been considered as estimated, indicated by a “J” data qualifier.

Hexavalent chromium in soil was analyzed using USEPA Method 7196A, which is a colorimetric method. The reaction of hexavalent chromium with diphenylcarbazide in an acid solution produces a red-violet product that is measured photometrically at an absorbance of 540 nanometers (nm).

Section 3.0 of Method 7196A states:

“The chromium reaction with diphenylcarbazide is usually free from interferences. However, certain substances may interfere if the chromium concentration is relatively low. Vanadium interferes strongly, but concentrations up to 10 times that of chromium will not cause trouble. Iron in concentrations greater than 1 mg/L may produce a yellow color, but the ferric iron color is not strong and difficulty is not normally encountered if

the absorbance is measured photometrically at the appropriate wavelength (USEPA, 1992)."

The laboratory's case narrative documented matrix interferences associated with the most elevated hexavalent chromium results:

"For hexavalent chromium results by Method 3060A/7196A, samples C2-OXY-SO-DUP1, C2-OXY-HN-0.5, C2-OXY-HS-0.5, C2-OXY-HE-0.5 and C2-OXY-HW-0.5 in batch 0242094 were analyzed at 10x dilution due to their extremely dark color which showed absorbances >> 1.0 when analyzed without dilution. The diluted samples also exhibited fine reddish-brown suspended material after the color reagent was added and the samples were mixed. This material appeared to interfere with the absorbency measurements of these samples, resulting in elevated absorbencies and associated high hexavalent chromium concentrations. These matrix interference effects, while also observed, were less severe in the same samples analyzed in batch 0242082."

An evaluation was performed to determine whether the presence of interfering substances, such as vanadium and iron, may have affected the hexavalent chromium results. In addition, the hexavalent chromium results were compared to their respective total chromium result. 2,4,6-TNT, the risk driver at the site, was also evaluated since its reddish-brown color while in solution may have contributed to the matrix interference. **Table 5-1** summarizes hexavalent chromium, total chromium, vanadium, iron, and 2,4,6-TNT results for the five samples mentioned above that exhibited matrix interferences.

Two of the highest hexavalent chromium concentrations reported for this project (C2-OXY-HW-0.5 and C2-OXY-HN-0.5 with 170 and 22.4 mg/kg, respectively) come from this group of five samples, as do the fifth and six highest concentrations (C2-OXY-HS-0.5 and C2-OXY-SO-DUP1 with 11.8 and 3.3 mg/kg, respectively). Samples C2-OXY-SO-PS-0.5 and C2-OXY-SO-PS-1, also analyzed in batch 0242082, had hexavalent chromium results of 12.7 and 12.4 mg/kg, respectively. Also note that the parent sample for C2-OXY-SO-DUP1 (C2-OXY-HN-1) had a non-detectable concentration of hexavalent chromium.

Table 5-1. Hexavalent Chromium Results with Potentially Interfering Substances

Sample Name:		C2-OXY-SO-DUP1		C2-OXY-HN-0.5		C2-OXY-HS-0.5		C2-OXY-HE-0.5		C2-OXY-HW-0.5	
Analyte	USEPA RSL	Batch 0242084 Results	Batch 0242082 Results								
Chromium (hexavalent)	0.29	4.4 J	4.4 U	22.4	4.6 U	11.8	4.5 U	3.6 U	3.6 U	170	4.7 U
Chromium (total)	12,000	214 J		111 J		46.8 J		33.9 J		92.2 J	
Vanadium	39	18.5		13.3		10.5 U		5.6		4 J	
Iron	5,500	18,200		14,000		51,300		10,900		8,500	
2,4,6-Trinitrotoluene	3.6	8.8		9.6		0.280 U		0.220 U		3 J	

Legend:
 Sample results and USEPA RSL values are presented as milligrams per kilogram (mg/kg)
 J = Estimated value
 U = the analyte was analyzed for but was not detected above the method detection limit and the value presented is the limit of detection.
 USEPA RSL = USEPA Residential Soil Regional Screening Level (USEPA, 2011a)
 Gray shading = detected concentration is > the USEPA RSL.

Based upon results in **Table 5-1**, the following was concluded:

- Hexavalent chromium results from batch 0242082 for the five samples presented in **Table 5-1** were non-detect
- The most elevated hexavalent chromium result (170 mg/kg for sample C2-OXY-HW-0.5) was greater than its respective total chromium result (92.2 mg/kg)
- Interference from iron and vanadium was unlikely
- No correlation between hexavalent chromium and 2,4,6-TNT is apparent

Although the source of the matrix interference was not readily apparent from this evaluation, it was clear that significant uncertainty surrounded these results.

The higher results (i.e. from batch 0242084) were conservatively identified by the data validator as the result to be reported from these five samples for the purposes of establishing nature and extent of contamination for this Remedial Investigation. These higher detected reported results were also used to calculate the exposure point concentration in the HHRA. Hexavalent chromium was identified as a COC for an adult and child resident in the HHRA. If the hexavalent chromium results from batch 0242082 (which were subject to less interference and all below detection limits) were used instead, risks from exposure to hexavalent chromium would be much lower, and may result in elimination of hexavalent chromium as a COC.

Based upon the assessment above concerning the uncertainty with the aforementioned hexavalent chromium data, it is recommended that more defensible hexavalent chromium data be obtained to verify if it is indeed a COC in EU8 soil. Additional sampling and analysis for hexavalent chromium will need to be completed prior to completion of the remedial FS to indicate whether or not hexavalent chromium is retained as a COC.

5.1.4 Quality Data Management

Analytical data were incorporated into one database. Following an initial review to ensure that all Level IV CLP elements were received from the laboratory, hard copy data packages were submitted to the data validator for validation. The qualifiers applied to estimated or rejected data points were incorporated into the database once the DUSRs were received and reviewed. In certain cases, data were selected for incorporation into or exclusion from the database (e.g., two results from the same sampling point). The selection processes are described below.

- Data points qualified with "R" (rejected) were marked to prevent incorporation into the usable data population.
- All laboratory and field QC (e.g., blanks and spikes) results were marked to prevent incorporation into the usable data population.
- All duplicate values (same sample location) were identified with a unique sample identification (ID) to identify them for appropriate incorporation into the usable data population.
- All dilution results were evaluated for best value and detection limit using the following procedure:
 - The diluted sample results were selected for all compounds that exceeded the analytical calibration range in the original data set,

- The non-diluted sample results were selected for all target compounds reported within the calibration range, and
 - The most sensitive detection limit (the non-diluted or original sample) was selected for undetected compounds.
- All reanalysis results were evaluated for best value, based on QC results, established criteria, detection limit, and professional judgment.

5.1.5 Data Quality Objectives

The project DQOs were developed and updated using the *USEPA Guidance on Systematic Planning Using the DQO Process* (USEPA, 2006). The USEPA DQO process focuses on the need/decision/action evaluation for a site. Quality assurance objectives were developed to support the project DQOs. The primary goal of the quality assurance objectives is to ensure that the collected data, supporting the conclusions of the RI, are defensible.

There were several project DQOs established for the OCCP RI, and each concerned the collection of sufficient defensible data. The DQOs included:

- Collecting data of sufficient quality and quantity to identify potential health risks posed by the former activities at the site,
- Determining if constituents of potential concern (COPCs) are present,
- Determining if COPCs represent a risk to human health and the environment, and
- Determining the extent of COPCs.

The required inputs for making informed decisions include analytical results from surface and subsurface soil, surface water and sediment. Additional required inputs were chemical-specific applicable or relevant and appropriate requirements (ARARs) and risk-based “to be considered” (TBC) criteria; and sample location, type, and depth. The DQOs also specified that investigation activities would be confined to the site; where previously reported explosives and chromium concentrations exceeded screening criteria.

Performance and acceptance criteria were developed in order to minimize the potential for study error rates. Quantitative project specific objectives for the DQIs of precision, accuracy, completeness and sensitivity were developed in order to define acceptable measurement error and to assess the overall quality of the analytical data presented in the OCCP RI Report.

Numerical DQOs, calculated for accuracy, precision, and completeness, provide the main point of reference for an assessment of the analytical data presented in the OCCP RI Report. A more defined assessment of the data quality results, including statistical evaluations, is presented in Section 5.3. A summary of the project DQIs (PARCCS) is provided below.

Accuracy and Precision:

Laboratory accuracy and precision assessment and sample matrix effect evaluation were conducted using matrix spike/matrix spike duplicate (MS/MSD) samples. Accuracy and precision were expressed as the percent recovery (%R) (based on analytical recovery) and relative percent difference (RPD) of the spike compounds or elements, respectively. For samples collected and analyzed as field duplicates, precision was expressed as the percent difference of the concentration of analytes detected in the sample and associated duplicate. The field duplicate

data served as indications of the matrix sampled and precision in the analytical system. Rinsate blanks and trip blanks were collected to also serve to identify contamination effects. An MS/MSD or a spike and analytical duplicate analysis were required for every 20 samples of a similar matrix. Field duplicates were collected at a 10 percent frequency by matrix. Rinsate blanks were collected once per sampling day that included non-disposable sampling equipment.

Accuracy is defined as the extent of agreement between a measured or calculated value and the true value. Accuracy was determined using spike %R data from MS/MSD samples. Several VOCs, SVOCs, explosives, and TAL metals were qualified as estimated in several samples due to high or low MS/MSD %R values.

Precision is defined as the reproducibility, or degree of agreement, among replicate measurements of the same compound or element analyzed under identical conditions. Precision is expressed as RPD between the two results.

Rinsate Blanks:

Equipment rinsate blanks were collected to evaluate the decontamination technique used for non-dedicated or non-disposable sampling equipment. Equipment rinsate blanks were collected by pouring American Society for Testing and Materials (ASTM) Type II reagent water through a recently decontaminated piece of equipment into a prepared sample container appropriate for the required analysis.

In total, three rinsate blank QC samples were collected during the investigation activities; one rinsate blank was collected per each field effort that environmental samples were collected with non-dedicated or non-disposable equipment, and was submitted for laboratory analysis of the full suite of project target compounds and analytes as the samples for that sample date. Constituent concentrations detected associated with the collected rinsate blanks are presented in **Tables H-1 and H-2** in **Appendix H**.

Trip Blanks:

Trip blanks monitor for VOC contamination during sample transport and storage. Trip blanks were prepared by the laboratory with ASTM Type II water, stored and transported with the unused sample bottles, and returned to the laboratory with each cooler containing VOC samples. Constituent concentrations detected associated with trip blanks are presented in **Table H-3** of **Appendix H**.

Matrix Spikes:

MS/MSD samples collected during investigation activities were analyzed at the correct frequency, and the accuracy control limits used to evaluate the data were taken from the OCCP Data Gap QAPP Addendum (USACE, 2010b) and OCCP/WWTP Data Gap QAPP Addendum (USACE, 2011b). The MS/MSD %R results and the MS/MSD RPD results that were outside of established control limits are presented in detail in the DUSR. Percent recovery was outside of the control limits for hexavalent chromium in the MS and MSD samples associated with sample C2-OXY-HW-0.5. Established QA/QC procedures indicate that variability in sample matrices (e.g. insufficient blending of the sample volume) results in significant bias of hexavalent chromium, and it is recommended that only those hexavalent chromium results within the spike recoveries are utilized without qualification (NJDEP, 2005).

Hexavalent chromium (170J µg/L) was detected at a greater concentration than the result for total chromium (92.2J µg/L) in C2-OXY-HW-0.5. Theoretically, hexavalent chromium concentrations cannot be greater than total chromium concentrations and are considered to be significantly biased high for this sample. **Appendix G** includes the DUSR.

Field Duplicates:

Duplicate environmental field samples were collected at selected locations to evaluate the precision of the sampling techniques. The RPD value of each detected analyte was reviewed to assess the sample collection reproducibility and matrix variability. Where good field techniques are consistently implemented and matrix effects are minimal, the RPDs are expected to be low. Eighty-three percent of the field duplicate RPDs for surface soil results were within acceptance criteria; this percentage is low, and mostly attributed to exceeded acceptance criteria for duplicate PAHs, metals, and explosives results. Sixty-five percent of the field duplicate RPDs for subsurface soil results were within acceptance criteria; this percentage is low, and mostly attributed to exceeded acceptance criteria for duplicate metals and explosives results. Ninety-five percent of the field duplicate RPDs for surface water results were within acceptance criteria. Eighty-six percent of the field duplicate RPDs for sediment results were within acceptance criteria; this percentage is low, and mostly attributed to exceeded acceptance criteria for duplicate metals results.

As previously discussed, established analytical procedures indicate that variability in sample matrices (e.g. insufficient blending of the sample volume) results in significant bias of hexavalent chromium (NJDEP, 2005). Low precision between regular and field duplicate sample results may result from variability in sample matrices. Low precision, therefore, could be attributed to variability in the sample matrix itself. Additionally, empirical data have indicated that transformation of chromium species may occur in certain soil types both in the environment and during sample analysis. Chromium (III) can be oxidized to hexavalent chromium during the digestion step of analysis where conditions are thermodynamically favorable and may occur simultaneously with the reduction of hexavalent chromium in certain instances (Vitale et al. 1994). As an example, there was no detection (0.27 mg/kg U) of hexavalent chromium in the regular sample collected from SO-P-23-1; its field duplicate, collected adjacent to the regular sample, had a measurable concentration (3.3 mg/kg) which yielded a RPD of 170%. **Tables H-4 through H-7** in **Appendix H** summarize the RPD values that were outside the acceptance criteria.

Completeness:

Completeness refers to the fraction of valid (i.e., not rejected) data obtained compared to that which was planned, calculated as follows:

$$\text{Completeness (\%)} = \frac{\text{Number of Valid Measurements Made}}{\text{Number of Measurements Planned}}$$

Completeness determinations were made separately for samples obtained from the field collection effort and data obtained from the analytical measurement system. The completeness goal for this investigation was 95 percent. Percent completeness was dependent upon the number of data that were rejected within each matrix and analyte group; VOCs had the highest number of rejections (73) of the matrices, with surface soil being the matrix with the most rejected results overall (107). The higher number of rejected data associated with VOCs is due

to the higher number of failed laboratory QC measures with this method. Failed QC measures included, but are not limited to, low initial calibration values and low MS/MSD recoveries. Percent completeness (84.1 percent) for pesticides in surface soil was low due to results for two samples being rejected for low surrogate recoveries.

Rejected Data:

As a result of data quality being outside objectives limits, some data were rejected according to project-specific validation guidelines. **Tables H-12 through H-15** in **Appendix H** summarize the rejected data. Data were rejected due to issues including, but not limited to low initial calibration values and low MS/MSD recoveries. **Appendix G** includes DUSR, which provide a complete explanation for all rejected data.

Representativeness:

Representativeness, in part, was accomplished by the consistent use of approved sampling techniques, environmental sample collection methods, equipment, decontamination methods, and sample containers for the field work according to the guidelines and specifications described in the OCCP Data Gap QAPP Addendum (USACE, 2010b) and OCCP/WWTP Data Gap QAPP Addendum (USACE, 2011b). The data are considered representative of site conditions for the purpose of this OCCP RI Report. Representativeness was also assessed by evaluating the RPD values calculated from the field duplicate samples, duplicate concentration values reported from redundant analyses, and the concentrations of contaminants detected in the field and laboratory QC blanks. The reproducibility of a representative set of samples reflects the degree of homogeneity of the sampled medium.

All samples were prepared and analyzed within the holding time required for the respective analyses. Equipment rinsate blanks, method blanks, and trip blanks were found to be mostly free of target analytes. **Tables H-1 and H-2** in **Appendix H** present analytes in equipment rinsate blanks having concentrations greater than project screening criteria, and **Table H-3** in **Appendix H** presents analytes in trip blanks having concentrations greater than project screening criteria.

Comparability:

Comparability refers to the confidence with which one data set can be compared to another. The project planning, including laboratory selection, incorporated various appropriate USEPA and USACE guidance documents, as well as direct input from USACE on field and laboratory issues, to ensure the comparability of the data.

The RI was conducted over a 10-year period, and in order to improve data comparability, the data set used for the OCCP RI was generated by employing approved analytical methods. Each analysis was performed by an accredited laboratory, with minor variations to the analytical methods employed. For example, 2001 PAHs analyses were conducted via USEPA Method 8310, and 2010 and 2011 PAHs analyses were conducted via USEPA Method 8270. In addition, metals analyses were conducted by a mixture of USEPA Methods 6010 and 6020. Explosives analyses over the 10-year RI period also included a combination of methods.

Standardized data validation guidelines were employed, with minor variations to the professional judgment involved therein by the data validators. For example, data validation guidelines recommend a “U” qualifier for blank contamination. MCGI, who validated 2010 data, qualify

data from blank contamination with a “B” qualifier, under the premise that a “U” qualifier confuses the data user with the normal “U” qualifier definition of “non-detect.”

Definitions of the qualifiers that were incorporated in the data sets are included in the legend of each data table and the DUSR. **Appendix G** includes the DUSRs.

Sensitivity:

Sensitivity was evaluated as a function of the laboratory limits of detection with respect to potential chemical specific ARARs and risk-based TBC criteria, and the screening level benchmarks. Typically, limits of detection should be less than the screening levels, but this does not always occur (i.e., because of dilutions). The analytical methods and the resultant limits of detection resulted in several limits of detection being greater than the screening level benchmarks.

In general, quantitation limits should be lower than the screening level benchmarks. The analytical methods and the resultant quantitation limits reported resulted in some sample quantitation limits (SQL) being greater than project screening criteria. SQLs above the respective screening levels are identified in **Tables H-8 through H-11** in **Appendix H**.

Additionally, the laboratories participated in the analysis of Performance Evaluation (PE) samples for organics and inorganics. The laboratory performance throughout the duration analytical testing for the investigation activities indicates their ability to generate accurate results over time.

5.1.6 Data Quality Summary

Data collected as part of this investigation were evaluated to determine whether the DQIs for PARCCS satisfied the established DQOs. Based on the evaluation of DQIs, the data is considered sufficient to satisfy the DQOs established for this investigation. Data collected for this investigation is of sufficient quality and quantity to identify potential health risks posed by former DoD operations, to determine if COPCs are present, to determine if COPCs present a risk to human health and the environment, and to determine the extent of COPCs.

Accuracy:

Data validation indicated that, although not all specific recoveries for specific compounds met the DQO for recovery, the number and magnitude of failures were within acceptable validation guidelines such that all data was usable, but some were qualified, as appropriate.

Precision:

The overall percentage of field duplicate RPDs within a 20 percent RPD control limit was 85.1 percent. Few RPDs from MS/MSD analyses were outside of control limits; no qualifying action was required.

Completeness:

Field completeness was 100 percent, indicating that the project DQOs for field completeness were met. Analytical completeness for each matrix and analytical group were as follows in **Table 5-2**.

Table 5-2. Analytical Completeness				
Analytical Group	Matrix			
	Surface Soil	Subsurface Soil	Sediment	Surface Water
	Percentage of Analytical Completeness			
VOCs	94.4	98.8	91.2	98.6
SVOCs	98.8	99.3	100	100
Pesticides	84.1	100	NA	NA
PCBs	100	100	100	100
Explosives	100	100	100	97.9
Metals	100	100	100	100
<i>Legend:</i> NA = not applicable PCB = polychlorinated biphenyl SVOC = semi-volatile organic compound VOC = volatile organic compound				

Representativeness:

Data collected and presented is considered representative of the site conditions.

Comparability:

Data collected from the various field activities over a span of approximately 10 years is considered comparable due to strict adherence to the approved project work plans and USEPA analytical methods and validation methodologies.

Sensitivity:

The analytical methods and resultant limits of detection resulted in several limits of detection being greater than the screening level benchmarks.

5.2 Field Screening Results

During the performance of investigation activities at the site, field screening of soil and sediment to determine the presence or absence of organic vapors, radiological, and/or explosive impacts potentially resulting from former DoD operations was performed. Field screening activities completed by ERT adhered to the methodology and design outlined in the OCCP Data Gap FSP Addendum (USACE, 2010a), OCCP/WWTP Data Gap FSP Addendum (USACE, 2011a), and additional plans listed in Section 4.0. The following subsections present the field screening results for investigation activities completed during multiple field efforts between 2001 and 2011.

5.2.1 Total Organic Vapor Screening Results

Surface and subsurface soil samples were screened in the field with a PID for TOV. The resulting measurements were zero parts per million (ppm) or non-detect (ND) for the majority of soil screened, except for CO-OXY-P33-3, which had a measurement of 1.8 ppm, similar to background calibration for the PID. **Appendix B** includes the TOV screening results on the soil boring collection records.

5.2.2 Radiological Screening Results

One elevated radiological reading was reported near sample location C10-GS2. Although the reading did not exceed two times the background level (i.e., 16,000 cpm), the threshold for requiring laboratory analysis specified in LOOW Phase IV RI/FS RSP Addendum (USACE, 2009a) and OCCP Data Gap FSP Addendum (USACE, 2010a) was triggered and one sample was collected for laboratory analysis of radionuclides as directed by the USACE. Surface soil sample C2-OXY-SO-Y20 was submitted for analysis as a prudent health and safety measure to ensure the health and safety of field personnel during future field activities. **Appendix C** includes the radiological screening results.

5.2.3 Explosives Screening Results

None of the 91 soil samples (representing 63 locations) from EU 8 reacted positively for the presence of explosives constituents. **Appendix D** includes the explosives screening results.

5.2.4 Area of Debris Delineation Results

During a field effort in 2010 to refine the known horizontal and vertical extent of the area of debris identified at AOC 1, debris was observed that appeared to be related to former DoD operations (e.g., detonator caps and fuzes) and likely from other site uses (e.g. municipal trash and shot gun shells). The results of the reconnaissance identified two distinct areas within AOC 1, an elevated area and an assumed burn area. Five heavily corroded 55-gallon drums were observed between both distinct areas. The slightly elevated area measured approximately 225 ft in length from west to east and 125 ft in width from north to south. Within the slightly elevated area, the remains of heavily corroded 55-gallon drums, old tires, beverage containers, and miscellaneous trash were observed. The assumed burn area measured approximately 75 ft in length from west to east and 35 ft in width from north to south. Within the assumed burn area, multiple ring adaptors, igniter container lids for incendiary devices, a 2-inch munitions ring clamp, and a 4-pound incendiary device fuze (potentially an M 54 series or M 126 device) were identified. Further reconnaissance revealed evidence of burning, including a metallic residue identified within approximately 0.0 ft to 1.0 ft bgs; directly underlain by undisturbed native soil. **Figure 4-2** presents the approximate extent of the area of debris and test pit locations at AOC 1.

Test pit locations were selected based on reconnaissance and geophysical observations at AOC 1. Eleven test pits were dug to investigate the horizontal and vertical extent of impacts within the slightly elevated area and the assumed burn area. Test pit locations were located at the perimeter of the elevated area and in the center of the assumed burn area. **Table 5-3** presents test pit observations and **Appendix E** includes the photographic log for each test pit.

Table 5-3. Test Pit Observations (2010)	
Test Pit ID	Description
TP1	0-1 inch: Dark brown silty loam. 1-13 inch: Slag, melted metals, and soil burn scaring. 13 inch: End of boring, native soil encountered.
TP2	0-1 inch: Brown silty loam. 1-8 inch: Slag, metallics, and soil burn scaring. 8 inch: End of boring, native soil encountered.
TP3	0-1 inch: Brown silty loam. 1-11 inch: Slag, metallics, and some glass. 11 inch: End of boring, native soil encountered.
TP4	0-6 inch: All native soil. Total depth 6 inch.
TP5	0-6 inch: All native soil. Total depth 6 inch.
TP6	0-6 inch: All native soil. Total depth 6 inch.
TP7	0-1 inch: Dark brown silty loam 1-6 inch: Slag, melted metals, soil burn scaring. 6 inch: End of boring detonator ring found.
TP8	0-1 inch: Brown silty loam. 1-8 inch: Slag, metallics, soil burn scaring. 8 inch: End of boring
TP9	0-6 inch: All native soil. Total depth 6 inch.
TP10	0-6 inch: All native soil. Total depth 6 inch.
TP11	0-6 inch: All native soil. Total depth 6 inch.
<i>Legend:</i> TP = test pit	

5.3 Field Sampling Results

The following subsections provide a discussion of field sampling results by matrix. Section 6 provides a discussion of constituent concentrations above the project screening criteria by AOC and illustrates the extent of potential contamination at each AOC. Complete analytical data packages are provided in **Appendix F**.

5.3.1 Surface Soil Analytical Results

Between 2001 and 2011, 51 surface soil samples (46 regular samples and 5 duplicate samples) were collected from 37 locations at AOC 1, AOC 3, AOC 4, and AOC 5 and submitted for laboratory analysis of VOCs, SVOCs, pesticides, PCBs, explosives, metals (including boron, lithium, cyanide, and hexavalent chromium). One sample was analyzed for radionuclides. As per the OCCP Data Gap QAPP Addendum (USACE, 2010b) and OCCP/WWTP Data Gap

QAPP Addendum (USACE, 2011b), surface soil samples were screened against the following project screening criteria:

- *USEPA Residential Soil Regional Screening Levels* (USEPA, 2011a) – hereinafter “USEPA RSL”
- Radionuclide screening values outlined in the *Quality Assurance Project Plan Addendum for Phase IV Remedial Investigation/Feasibility Studies at the Former Lake Ontario Ordnance Works (LOOW), Niagara County, New York* (USACE, 2009c) – hereinafter “LOOW Phase IV RI/FS QAPP Addendum”

Surface soil samples exhibited concentrations greater than project screening criteria for SVOC, explosives, metals, and radionuclide measurements. VOCs, pesticides, and PCBs were not detected above the project screening criteria in surface soil samples. The following summarizes constituents detected at concentrations above project screening criteria for surface soil samples.

TCL SVOC

One SVOC (i.e., benzo(a)pyrene) was detected in three regular and one duplicate surface soil samples at concentrations greater than the project screening level. These four samples were collected from AOC 1, AOC 3 and AOC 5.

Explosives

Eight explosives (i.e., 1,3-dinitrobenzene; 2,4,6-TNT; 2,4-dinitrotoluene (DNT); 2,6-DNT; 2-amino-4,6-DNT, 2-nitrotoluene, 4-amino-2,6-DNT, and RDX) were detected in 11 regular samples and one duplicate at concentrations greater than their respective project screening levels. These 12 samples were collected from AOC 1.

TAL metals

Fifteen metals (i.e., aluminum, antimony, arsenic, barium, cadmium, chromium [hexavalent], cobalt, copper, iron, lead, lithium, manganese, nickel, thallium, and zinc) were detected in 44 regular and 5 duplicate surface soil samples at concentrations greater than the project screening levels. These 49 samples were collected from AOC 1, AOC 3, AOC 4, and AOC 5.

Thirteen metals were detected at concentrations greater than background levels. Zinc and lead were detected at all four AOCs at concentrations greater than the background levels. Cadmium was detected at AOC 1, AOC 3, and AOC 4 at concentrations greater than the background levels. Selenium was detected at AOC 3, 4 and 5 at concentrations greater than the background levels. Copper was each detected at AOC1 and AOC 4 at concentrations greater than the background levels. Seven metals (i.e. barium, beryllium, boron, chromium [total], magnesium, nickel, and silver) were detected at a single AOC at concentrations greater than the background levels (**Table 5-4**).

Table 5-4. Metals in Surface Soil Greater Than Background Levels			
AOC 1	AOC 3	AOC 4	AOC 5
Barium Boron Cadmium Chromium Copper Lead Magnesium Nickel Zinc	Cadmium Lead Selenium Silver Zinc	Beryllium Cadmium Copper Lead Selenium Zinc	Lead Selenium Zinc
<p><i>Legend:</i> BKGD = concentration detected above background levels or background upper prediction limits AOC = area of concern None = no samples were reported at concentrations greater than background levels or background UPLs</p>			

Surface soil background levels and background upper prediction limits (UPLs) for the OCCP background evaluation data sets are presented in **Appendix A**.

Table 5-5. Surface Soil Concentrations Greater Than Project Screening Criteria

Sample Location:	C10-AA03-BP01	C10-AA03-BP01	C10-AA03-BP02	C10-AA04-BP01	C10-AA04-BP02	C10-AA04-BP03	C10-AA07-BP01	C10-AA07-BP02	C10-AA07-BP02	C10-GS2-1	
Sample Name:	C10-AA03-SO-01-0.5	C10-AA03-SO-DUP2	C10-AA03-SO-02-0.5	C10-AA04-SO-01-0.5	C10-AA04-SO-02-0.5	C10-AA04-SO-03-0.5	C10-AA07-SO-01-0.5	C10-AA07-SO-02-0.5	C10-AA07-SO-DUP1	C10-GS2-SO-1-1	
Sample Date:	10/12/2011	10/12/2011	10/12/2011	10/12/2011	10/12/2011	10/12/2011	10/12/2011	10/12/2011	10/12/2011	5/9/2001	
Parent Sample:		C10-AA03-SO-01-0.5							C10-AA07-SO-02-0.5		
Sample Depth (ft bgs):	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0 - 1	
Area of Concern:	AOC 3	AOC 3	AOC 3	AOC 4	AOC 4	AOC 4	AOC 5	AOC 5	AOC 5	AOC 1	
Analyte	USEPA RSL										
SVOCs (SW8270, 2001 PAHs by SW8310) (µg/kg)											
Benzo[a]pyrene	15	2.6 J	6.5 J	20	84 U	4.3 J	4.3 J	1.5 U	35	25	80 U
Explosives (SW8321, SW8330 unless otherwise noted) (µg/kg)											
1,3-Dinitrobenzene	610	* 36 U	36 U	37 U	37 U	39 U	37 U	37 U	39 U	39 U	500 U
2,4,6-Trinitrotoluene	3600	* 36 U	36 U	37 U	37 U	39 U	37 U	37 U	39 U	39 U	500 U
2,4-Dinitrotoluene	1600	36 U	36 U	37 U	37 U	39 U	37 U	37 U	39 U	39 U	500 U
2,6-Dinitrotoluene	6100	* 36 U	36 U	37 U	37 U	39 U	37 U	37 U	39 U	39 U	500 U
2-Amino-4,6-dinitrotoluene	15000	* 60 U	61 U	62 U	62 U	65 U	62 U	61 U	65 U	65 U	500 U
2-Nitrotoluene	2900	120 U	120 U	120 U	120 U	130 U	120 U	120 U	130 U	130 U	500 U
4-Amino-2,6-dinitrotoluene	15000	* 60 U	61 U	62 U	62 U	65 U	62 U	61 U	65 U	65 U	500 U
RDX	5600	120 U	120 U	120 U	120 U	130 U	120 U	120 U	130 U	130 U	500 U
Inorganics (SW6020 or SW6010B, unless otherwise noted) (mg/kg)											
Aluminum	7700	* 10500 J	9560 J	7950 J	10400 J	10400 J	13300 J	7870 J	10900 J	12500 J	13700
Antimony	3.1	* 0.6 UJ	0.6 UJ	0.6 UJ	0.6 UJ	0.6 UJ	0.6 UJ	0.6 UJ	0.6 UJ	0.6 UJ	0.56 UJ
Arsenic	0.39	2.5	2.5	3.4	3.5	3.2	2.4	2.9	4.5	4.6	3.3 J
Barium	1500	* 110	104	87	154	113	204	76.5	94.7	108	90.1 J
Cadmium	7	* 0.082	0.092	0.59	0.84	0.18	0.36	0.2	0.45	0.48 J	0.56 U
Chromium (hexavalent) (SW7196A)	0.29	0.27 J	0.24 U	0.25 U	b	b	0.25 U	b	b	b	b
Cobalt	2.3	* 4.8	4.3	3.6	6	5.1	5.3	5.8	7.4	8.4	6.9
Copper	310	* 15.9	13.2	22.7	42.7	17.8	47.8	29.3	24.8	26.5	24.8
Iron	5500	* 15100	14400	13800	21800	16100	12700	16000	20100	20700	20400
Lead	400	* 9.2	9.9	49.9	98.3	18.2	12.1	11.4	39.3	41.5 J	3.5 J
Lithium	16	* 16.8	15.8	13.3	19.8	22.7	20.4	15	17.1	19.7	17.8 J
Manganese	180	* 242 J	228 J	123 J	260 J	133 J	89 J	546 J	644 J	696 J	262
Nickel	150	* 11.2	9.9	10.2	23	14.2	18.1	12.3	17.6	19.5	14.9 J
Thallium	0.078	* 0.16 J	0.14 J	0.14 J	0.15 U	0.19 J	0.17 J	0.14 J	0.16 J	0.16 J	0.64
Vanadium	39	* 20.6	19.6	16	19.4	20.6	28.1	16.7	24.6	27.1	27
Zinc	2300	* 31.6 J	30.2 J	158 J	377 J	50.9 J	46.1 J	57.1 J	90.5 J	121 J	34.8 J

Legend presented at the end of the table (pg 71)

Table 5-5. Surface Soil Concentrations Greater Than Project Screening Criteria (continued)

Sample Location:	C10-GS2-10	C10-GS2-10	C10-GS2-2	C10-GS2-3	C10-GS2-3	C10-GS2-3	C10-GS2-4	C10-GS2-5	C10-GS2-6	C10-GS2-7	C10-GS2-8
Sample Name:	C10-GS2-SO-10-0.5	C10-GS2-SO-10A-0.5	C10-GS2-SO-2-1	C10-GS2-SO-3-1	FIELD DUPLICATE	C10-GS2-SO-4-1	C10-GS2-SO-5-1	C10-GS2-SO-6-1	C10-GS2-SO-7-1	C10-GS2-SO-8-1	
Sample Date:	5/10/2001	6/13/2001	5/9/2001	5/10/2001	5/10/2001	5/9/2001	5/10/2001	5/10/2001	5/10/2001	5/10/2001	
Parent Sample:					C10-GS2-SO-3-1						
Sample Depth (ft bgs):	0 - 0.5	0.5	0 - 1	0 - 1	0 - 1	0 - 1	0 - 1	0 - 1	0 - 1	0 - 1	
Area of Concern:	AOC 1	AOC 1	AOC 1	AOC 1	AOC 1	AOC 1	AOC 1	AOC 1	AOC 1	AOC 1	
Analyte	USEPA RSL										
SVOCs (SW8270, 2001 PAHs by SW8310) (µg/kg)											
Benzo[a]pyrene	15	179	b	82 U	84 U	83 U	86 U	81 U	78 U	86 U	82 U
Explosives (SW8321, SW8330 unless otherwise noted) (µg/kg)											
1,3-Dinitrobenzene	610	* 500 U	500 U	500 U	500 U	500 U	500 U	500 U	500 U	500 U	500 U
2,4,6-Trinitrotoluene	3600	* 22400 J	4350 J	500 U	672 J	500 UJ	500 U	1840	500 U	500 U	500 U
2,4-Dinitrotoluene	1600	1310 J	350 J	500 U	582 J	500 UJ	500 U	1830	500 U	500 U	500 U
2,6-Dinitrotoluene	6100	* 5530 J	3590 J	500 U	500 U	500 U	500 U	882	500 U	500 U	500 U
2-Amino-4,6-dinitrotoluene	15000	* 59200 J	17000	500 U	207 J	500 U	500 U	322 J	500 U	500 U	500 U
2-Nitrotoluene	2900	500 U	500 U	500 U	500 U	500 U	500 U	126 J	500 U	500 U	500 U
4-Amino-2,6-dinitrotoluene	15000	* 49800 J	14800	500 U	430 J	500 U	500 U	326 J	500 U	500 U	500 U
RDX	5600	500 U	500 U	500 U	500 U	500 U	500 U	500 U	500 U	500 U	500 U
Inorganics (SW6020 or SW6010B, unless otherwise noted) (mg/kg)											
Aluminum	7700	* 3000 J	b	32800	11400 J	13700 J	14500	14400 J	16700 J	14600 J	14400 J
Antimony	3.1	* 1.8 UJ	b	0.59 UJ	0.6 UJ	0.56 UJ	0.57 UJ	0.55 UJ	0.53 UJ	0.55 UJ	0.58 UJ
Arsenic	0.39	10.5 J	b	2.5 J	3.2 J	1.4 J	1.9 J	3.2 J	2 J	2.3 J	1.8 J
Barium	1500	* 1650 J	b	430 J	309 J	164 J	310 J	126 J	94.5 J	133 J	125 J
Cadmium	7	* 184 J	b	0.59 U	0.6 UJ	0.56 UJ	1.5	0.55 UJ	0.53 UJ	0.55 UJ	0.58 UJ
Chromium (hexavalent) (SW7196A)	0.29	b	b	b	b	b	b	b	b	b	b
Cobalt	2.3	* 43.3	b	2.9 U	6.4	7	5	11.7	10.9	7	6.2
Copper	310	* 311	b	6.3	55.1 J	23.3 J	154	28.7	30.5	28.6	33.5
Iron	5500	* 74400	b	4480	19100	13300	10500	29300	23100	16400	13300
Lead	400	* 2760 J	b	0.99 J	41.8 J	6.1 J	82.6 J	5.5 J	5.1 J	7.4 J	6.3 J
Lithium	16	* 1.8 U	b	16.3 J	19.4 J	27 J	36.3 J	27.6 J	26.3 J	27.4 J	28 J
Manganese	180	* 604 J	b	1390	220 J	102 J	162	161 J	304 J	132 J	82.6 J
Nickel	150	* 49.4 J	b	2.4 U	13.3 J	12 J	21.8 J	17.8 J	21.3 J	15.3 J	14.1 J
Thallium	0.078	* 1.8 UJ	b	0.59 U	0.6 UJ	0.56 UJ	0.57 U	0.55 UJ	0.53 UJ	0.55 UJ	0.58 UJ
Vanadium	39	* 11.6 J	b	7.7	16.7 J	19 J	18.1	26.5 J	27.6 J	23.8 J	18.9 J
Zinc	2300	* 5490 J	b	9.3 J	10600 J	449 J	3180 J	43.3 J	60.3 J	60.1 J	55.3 J

Legend presented at the end of the table (pg 71)

Table 5-5. Surface Soil Concentrations Greater Than Project Screening Criteria (continued)

Sample Location:	C10-GS2-9	C10-GS2-DET	C10-GS2-DET	C10-GS2-HE	C10-GS2-HE	C10-GS2-HN	C10-GS2-HN	C10-GS2-HN	C10-GS2-HS	C10-GS2-HS		
Sample Name:	C10-GS2-SO-9-1	C2-OXY-DET-0.5	C2-OXY-DET-1	C2-OXY-HE-0.5	C2-OXY-HE-1	C2-OXY-HN-0.5	C2-OXY-HN-1	C2-OXY-SO-DUP1	C2-OXY-HS-0.5	C2-OXY-HS-1		
Sample Date:	5/10/2001	8/27/2010	8/27/2010	8/23/2010	8/23/2010	8/23/2010	8/23/2010	8/23/2010	8/23/2010	8/23/2010		
Parent Sample:								C2-OXY-HN-1				
Sample Depth (ft bgs):	0 - 1	0 - 0.5	0.5 - 1	0 - 0.5	1 - 1.5	0 - 0.5	1 - 1.5	1 - 1.5	0 - 0.5	1 - 1.5		
Area of Concern:	AOC 1	AOC 1	AOC 1	AOC 1	AOC 1	AOC 1	AOC 1	AOC 1	AOC 1	AOC 1		
Analyte	USEPA RSL											
SVOCs (SW8270, 2001 PAHs by SW8310) (µg/kg)												
Benzo[a]pyrene	15		80 U	b	b	b	b	b	b	b	b	
Explosives (SW8321, SW8330 unless otherwise noted) (µg/kg)												
1,3-Dinitrobenzene	610	*	500 U	390 J	140 U	220 U	170 U	1400 U	190 U	1300 U	280 U	810
2,4,6-Trinitrotoluene	3600	*	500 U	220 U	140 U	220 U	50000	9600	400	8800	280 U	780 NJ
2,4-Dinitrotoluene	1600		500 U	970	140 U	770	390	5600	410	2800	830	960
2,6-Dinitrotoluene	6100	*	500 U	1200	140 U	580 NJ	330 J	3300	190 U	2900 NJ	370 NJ	2100
2-Amino-4,6-dinitrotoluene	15000	*	500 U	750	140 U	220 U	8300	98000	7000	85000	280 U	440
2-Nitrotoluene	2900		500 U	220 U	140 U	220 U	170 U	14000 NJ	190 U	1300 U	280 U	180 U
4-Amino-2,6-dinitrotoluene	15000	*	500 U	2100	140 U	220 U	4900	130000	8400	130000	280 U	380 J
RDX	5600		500 U	220 U	140 U	220 U	320 J	1400 U	190 U	1300 NJ	280 U	270 NJ
Inorganics (SW6020 or SW6010B, unless otherwise noted) (mg/kg)												
Aluminum	7700	*	11100 J	6720	12000	6420	10400	21900	11800	17600	1310	7200
Antimony	3.1	*	0.52 UJ	15 U	1.2 U	1 J	0.93 J	1.3 J	3 UJ	1.6 J	1.6 J	4.2 J
Arsenic	0.39		2.2 J	15 U	2.9	4.6 J	16	3.3 J	4.9 J	3.2 J	6	10.1
Barium	1500	*	88.3 J	4840	134	463	1750	465	293	804	2890	3910
Cadmium	7	*	0.52 UJ	0.75 U	0.11	17.4	23.6	35.9	5.6	38.3	7.7	23.3
Chromium (hexavalent) (SW7196A)	0.29		b	1.3	0.24 U	3.6 UJ	0.59 J	22.4 J	0.65 J	4.4 J	11.8 J	0.71 J
Cobalt	2.3	*	6	5.4	9.6	2.9	6	6.7	9.3	11.4	5.5	6.2
Copper	310	*	22.3	239	26.6	259	407	1310	85.2	1170	97.9	389
Iron	5500	*	15500	99900	22800	10900	13000	14000	49700	18200	51300	29300
Lead	400		4.1 J	59.3	5.3	1960	1160	2110	234	2750	1040	1660
Lithium	16	*	24 J	4.8 J	18.5	1.8 J	3.6 J	3.1 J	19.6	3.9 J	0.53 J	3.2 J
Manganese	180	*	83.5 J	625 J	147 J	225	535	131	287	198	415	352
Nickel	150	*	11.3 J	22.2	21.6	19.1 J	75.2 J	40.7 J	27.5 J	63.5 J	25.8 J	53.6 J
Thallium	0.078	*	0.52 UJ	3.75 U	0.3 U	0.75 U	0.75 U	0.75 U	0.75 U	0.75 U	0.75 U	0.75 U
Vanadium	39	*	24.5 J	52.5 U	30.3	5.6	6.7	13.3	21.7	18.5	10.5 U	6.7
Zinc	2300	*	33.4 J	17100 J	42.4 J	9450 J	52300 J	12900 J	1220 J	13700 J	6930 J	35900 J

Legend presented at the end of the table (pg 71)

Table 5-5. Surface Soil Concentrations Greater Than Project Screening Criteria (continued)

Sample Location:	C10-GS2-HW	C10-GS2-HW	C10-GS2-P21	C10-GS2-P22	C10-GS2-P23	C10-GS2-P23	C10-GS2-P24	C10-GS2-PE	C10-GS2-PE	C10-GS2-PN	
Sample Name:	C2-OXY-HW-0.5	C2-OXY-HW-1	C2-OXY-SO-P21-1	C2-OXY-SO-P22-2	C2-OXY-SO-P23-1	C2-OXY-SO-DUP1	C2-OXY-SO-P24-1	C2-OXY-SO-PE-0.5	C2-OXY-SO-PE-1	C2-OXY-SO-PN-0.5	
Sample Date:	8/23/2010	8/23/2010	8/27/2010	8/27/2010	8/27/2010	8/27/2010	8/27/2010	8/23/2010	8/23/2010	8/23/2010	
Parent Sample:						C2-OXY-SO-P23-1					
Sample Depth (ft bgs):	0 - 0.5	1 - 1.5	1 - 1.5	1.5 - 2	0.5 - 1	0.5 - 1	0.5 - 1	0 - 0.5	1 - 1.5	0 - 0.5	
Area of Concern:	AOC 1	AOC 1	AOC 1	AOC 1	AOC 1	AOC 1	AOC 1	AOC 1	AOC 1	AOC 1	
Analyte	USEPA RSL										
SVOCs (SW8270, 2001 PAHs by SW8310) (µg/kg)											
Benzo[a]pyrene	15	b	b	b	b	b	b	b	b	b	
Explosives (SW8321, SW8330 unless otherwise noted) (µg/kg)											
1,3-Dinitrobenzene	610	* 1600	3300	170 U	180 UJ	160 U	310 U	140 U	780	180 J	160 U
2,4,6-Trinitrotoluene	3600	* 3000 J	5200000	790	19000000 J	160 U	1400	140 U	4200	760 J	160 U
2,4-Dinitrotoluene	1600	1900	16000	270 J	26000 J	160 U	760	140 U	3300	280 NJ	160 U
2,6-Dinitrotoluene	6100	* 7200	11000 J	180 J	22000 J	160 U	310 J	140 U	1600	950 NJ	160 U
2-Amino-4,6-dinitrotoluene	15000	* 5300	54000	2300	170000 J	160 U	3400	140 U	1000	190 NJ	160 U
2-Nitrotoluene	2900	270 NJ	230 U	170 U	180 UJ	160 U	430 J	140 U	150 U	150 U	160 U
4-Amino-2,6-dinitrotoluene	15000	* 8500	230 U	2300	180 UJ	160 U	2200	140 U	150 U	150 U	160 U
RDX	5600	280 U	6300 J	170 U	180 UJ	160 U	310 U	140 U	270 J	150 U	160 U
Inorganics (SW6020 or SW6010B, unless otherwise noted) (mg/kg)											
Aluminum	7700	* 5430	10600	21000	7850	10600	9350	9870	2190	1840	9550
Antimony	3.1	* 1.9 J	2.3 J	10.1	0.36	3 U	6 U	1.2 U	0.93 J	3 UJ	1.2 J
Arsenic	0.39	2.4 J	3.4 J	18.4	1.8 J	1.1 J	6 U	1.4 J	7.4	5.4	6.1
Barium	1500	* 1970	9710	651 J	559 J	114 J	182	131 J	648	62.8	4860
Cadmium	7	* 12.2	5.7	15.1	0.26	0.53	0.87	0.37	1.3	0.14 J	0.82
Chromium (hexavalent) (SW7196A)	0.29	170 J	2.7 J	1.8	0.91	0.27 U	3.3	0.42 J	1.1 J	0.65 J	1.9 J
Cobalt	2.3	* 2	10.1	13.4	4.6	4.7	5.4	4.7	2.6	3.5	4.9
Copper	310	* 414	1240	4790	85	33.2	46.1	27.2	60.3	19.9	167
Iron	5500	* 8500	73300	153000	10500	9130	11500	9430	13800	11700	22200
Lead	400	* 201	122	2160	232	6.6	19.4	43.9	292	37.7	145
Lithium	16	* 1 J	2.7 J	5.5	7.3	16.4	18.6	17.7	2.1 J	1.6 J	7
Manganese	180	* 235	434	870 J	308 J	78.5 J	108 J	78.6 J	77.6	18.5	171
Nickel	150	* 23.6 J	198 J	87.7	29.9	15.6	20.7	14.5	9.3 J	6.8 J	21.8 J
Thallium	0.078	* 0.75 U	0.75 U	1.8 J	0.3 U	0.75 U	1.5 U	0.3 U	0.75 U	0.75 U	0.75 U
Vanadium	39	* 4 J	11.7	10.1	11.8	14.6	11.2	14.8	7.1	8.7	11.9
Zinc	2300	* 20000 J	17400 J	8570 J	508 J	3510 J	8310 J	222 J	2340 J	103 J	39200 J

Legend presented at the end of the table (pg 71)

Table 5-5. Surface Soil Concentrations Greater Than Project Screening Criteria (continued)

Sample Location:	C10-GS2-PN	C10-GS2-PS	C10-GS2-PS	C10-GS2-PW	C10-GS2-PW	C10-GS2-SIN	C10-GS2-SIS	C10-GS2-SIW	C10-GS2-SOE	C10-GS2-BP1	
Sample Name:	C2-OXY-SO-PN-1	C2-OXY-SO-PS-0.5	C2-OXY-SO-PS-1	C2-OXY-SO-PW-0.5	C2-OXY-SO-PW-1	C2-OXY-SO-SIN-1	C2-OXY-SO-SIS-1	C2-OXY-SO-SIW-1	C2-OXY-SO-SOE-1	C10-GS2-SO-BP1	
Sample Date:	8/23/2010	8/23/2010	8/23/2010	8/23/2010	8/23/2010	8/27/2010	8/27/2010	8/27/2010	8/27/2010	5/10/2001	
Parent Sample:											
Sample Depth (ft bgs):	1 - 1.5	0 - 0.5	1 - 1.5	0 - 0.5	1 - 1.5	0.5 - 1	0.5 - 1	0.5 - 1	0.5 - 1	z	
Area of Concern:	AOC 1	AOC 1	AOC 1	AOC 1	AOC 1	AOC 1	AOC 1	AOC 1	AOC 1	AOC 1	
Analyte	USEPA RSL										
SVOCs (SW8270, 2001 PAHs by SW8310) (µg/kg)											
Benzo[a]pyrene	15	b	b	b	b	b	b	b	b	12000 U	
Explosives (SW8321, SW8330 unless otherwise noted) (µg/kg)											
1,3-Dinitrobenzene	610	* 150 U	200 U	170 U	170 U	170 U	190 U	150 U	160 U	130 J	500 U
2,4,6-Trinitrotoluene	3600	* 150 U	200 U	170 U	170 U	170 U	330 J	150 U	250 J	1000	500 U
2,4-Dinitrotoluene	1600	150 U	220 NJ	170 U	170 U	170 U	320 J	3400	160 U	1100	2500 U
2,6-Dinitrotoluene	6100	* 150 U	200 U	170 U	170 U	170 U	150 J	670	160 U	390 J	2500 U
2-Amino-4,6-dinitrotoluene	15000	* 150 U	300 J	68 NJ	170 U	170 U	120 J	150 U	160 U	260 J	500 U
2-Nitrotoluene	2900	150 U	200 U	170 U	170 U	170 U	190 U	100 J	160 U	150 U	500 U
4-Amino-2,6-dinitrotoluene	15000	* 150 U	410 J	200 NJ	170 U	170 U	190 U	150 U	200 J	150 U	500 U
RDX	5600	150 U	200 U	170 U	170 U	170 U	190 U	150 U	160 U	150 U	500 U
Inorganics (SW6020 or SW6010B, unless otherwise noted) (mg/kg)											
Aluminum	7700	* 5110	8570	9400	6850	6760	6170	11500	5960	3550	1960 J
Antimony	3.1	* 3.7 J	1.2 J	3 UJ	3 UJ	3 UJ	6 U	15 U	0.6 U	6 U	0.62 J
Arsenic	0.39	27.1	2.6 J	1.5 J	1.7 J	1.7 J	3.7 J	8.8 J	2.8	18.7	1.3 J
Barium	1500	* 3840	3920	414	98.3	99.6	3850	858	88.8	369	5.4 J
Cadmium	7	* 1.1	0.52	0.31	0.43	0.28 J	5.7	49.2	0.29	0.85	0.47 UJ
Chromium (hexavalent) (SW7196A)	0.29	1.6 J	12.7 J	12.4 J	0.29 UJ	0.67 J	5.8	0.43 J	0.27 U	0.26 U	b
Cobalt	2.3	* 12.7	4.3	4.9	2.9	2.8	18.1	6	2.5	5.2	33.4
Copper	310	* 301	188	38.3	20.4	20.6	164	1600	19.2	52.6	3.3
Iron	5500	* 182000	21000	9760	5960	6280	21600	21100	6970	26600	17400
Lead	400	* 75.6	76.7	10.8	8.6	8.6	673	1460	21.5	365	4.6 J
Lithium	16	* 2.4 J	11.2	17.3	10.1	9.8	4.7 J	3.8 J	9.6	6.1 J	0.47 U
Manganese	180	* 667	167	85.1	56.5	59.3	395 J	183 J	72.7 J	320 J	262 J
Nickel	150	* 104 J	23.2 J	14 J	9 J	9.1 J	306	111	9	18	699 J
Thallium	0.078	* 0.75 U	0.75 U	0.75 U	1 J	0.31 J	1.5 U	3.75 U	0.063 B	1.5 U	0.47 UJ
Vanadium	39	7.1	8.6	12.3	10.6	11	14.9	52.5	11.2	11.4	220 J
Zinc	2300	* 35900 J	3780 J	324 J	33.4 J	34 J	5510 J	14000 J	41.9 J	689 J	0.94 U

Legend presented at the end of the table (pg 71)

Table 5-5. Surface Soil Concentrations Greater Than Project Screening Criteria (continued)

Legend:
USEPA RSL = USEPA Residential Soil Regional Screening Level (USEPA, 2011a),(unless otherwise noted).
* = A non-carcinogen; the screening level has been divided by 10 to achieve a hazard index of 0.1.
+ = Radionuclide screening values from the Quality Assurance Project Plan Addendum for Phase IV Remedial Investigation/Feasibility Studies at the Former Lake Ontario Ordnance Works (LOOW), Niagara County, New York, June (USACE, 2009c).
NSA = No screening level available.
PE = Performance Evaluation
RDX = cyclotrimethylenetrinitramine
a = Result was rejected for use by the data validator.
b = Analyte was not analyzed for.
z = Considered as potential source material
ft bgs = feet below ground surface
B = Blank contamination
J = Estimated value
N = Tentatively identified compound
U (2011 data) = Either a) the analyte was analyzed for but was not detected above the method detection limit and the value presented is the limit of detection, or b) blank contamination existed and the value presented is the reported concentration (see Data Usability Summary Reports for explanation).
U (2010 data) = the analyte was analyzed for but was not detected above the method detection limit and the value presented is the limit of detection.
U (2001 data) = the analyte was analyzed for but was not detected above the method detection limit. The value presented is the sample quantitation limit.
Gray shading = detected concentration is > the USEPA RSL.
Bold font = detected at concentrations above background at one or more AOC

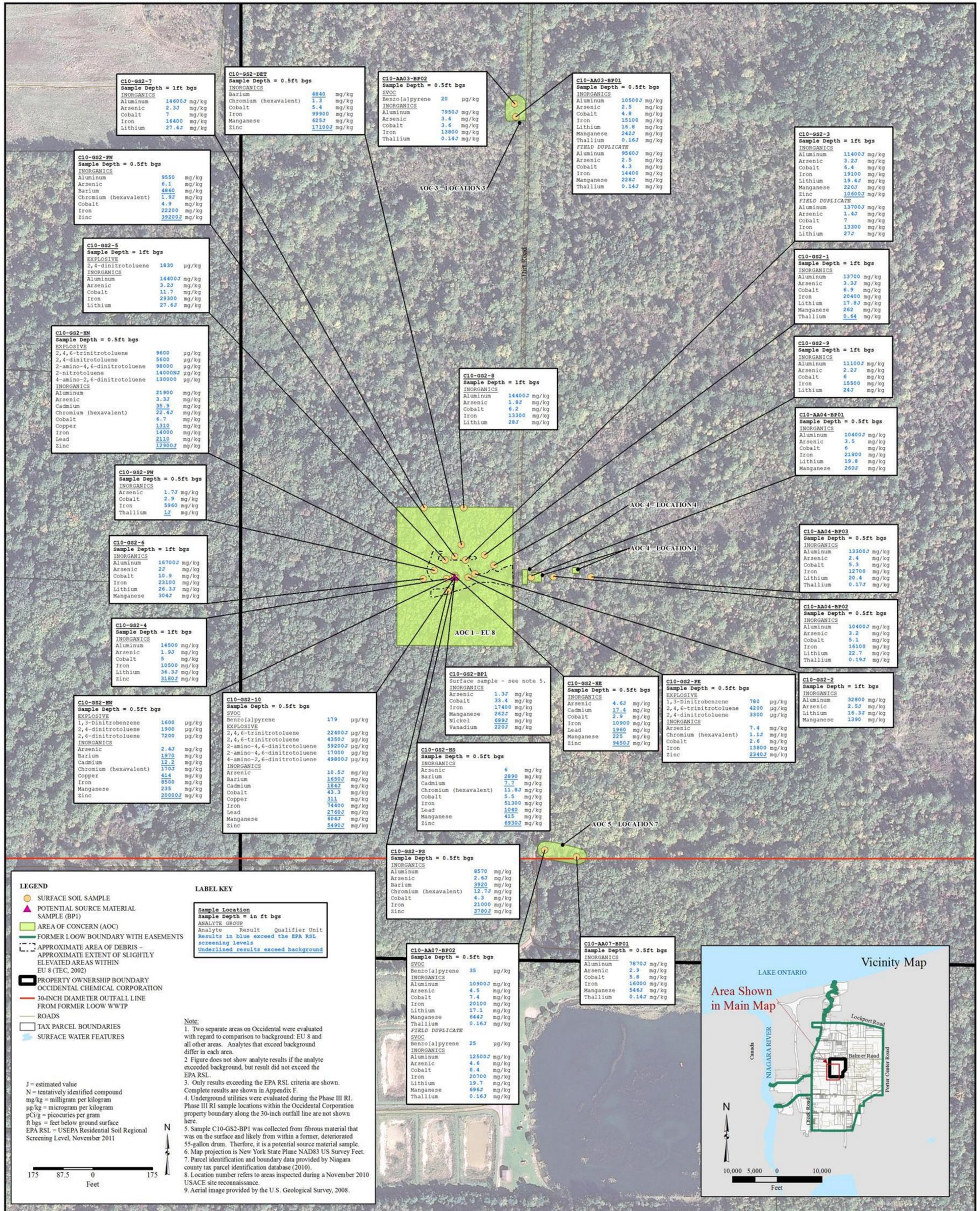


Figure 5-1. Occidental RI Surface Soil Sample Results Exceeding Screening Criteria for Sample Depths Between 0.0 and 1.0 ft bgs.

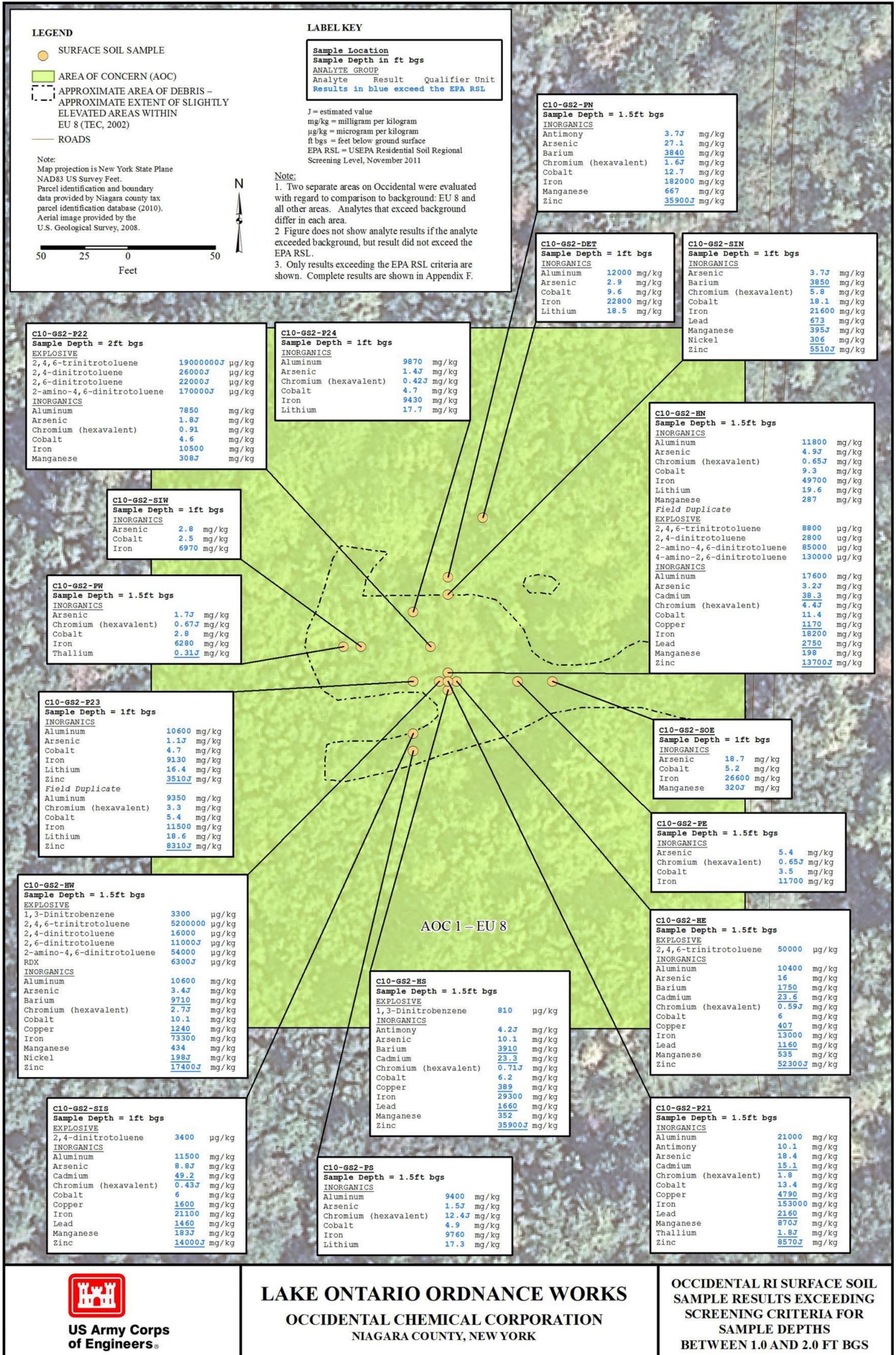


Figure 5-2. Occidental RI Surface Soil Sample Results Exceeding Screening Criteria for Sample Depths Between 1.0 and 2.0 ft bgs.

5.3.2 Subsurface Soil Analytical Results

Twenty-six subsurface soil samples (25 regular samples and 1 duplicate sample) were collected from 24 locations at AOC 1, AOC 3, AOC 4, and AOC 5 and submitted for laboratory analysis of VOCs, SVOCs, pesticides, PCBs, explosives, and metals (including boron, lithium, cyanide, and hexavalent chromium). Explosives and metals were detected at concentrations greater than project screening criteria. VOCs, SVOCs, pesticides, and PCBs were not detected at concentrations greater than project screening criteria.

Explosives

One explosive (i.e., 2,4,6-TNT) was detected in two subsurface soil samples from AOC 1 at concentrations greater than the project screening level.

TAL Metals

Eight metals (i.e., aluminum, arsenic, chromium [hexavalent], cobalt, iron, lithium, manganese, and thallium) were detected in 25 regular samples and one duplicate soil sample at concentrations greater than the project screening levels.

Six metals were detected at concentrations greater than the background levels (**Table 5-6**).

Table 5-6. Metals in Subsurface Soil Greater Than Background Levels			
AOC 1	AOC 3	AOC 4	AOC 5
Boron Chromium Potassium Selenium	Selenium	Arsenic Boron Cobalt Selenium	Selenium
<i>Legend:</i> BKGD = concentrations detected greater than background levels or background upper prediction limits AOC = area of concern			

Subsurface soil background levels and background UPLs for the OCCP background evaluation data sets are presented in **Appendix A**.

Table 5-7 presents subsurface soil sample results for constituents above the screening levels. **Figure 5-3** and **Figure 5-4** illustrate subsurface soil concentrations greater than USEPA RSLs and site-specific SSLs for the protection of groundwater, respectively. Complete data summary tables are presented as **Table F-2** in **Appendix F**.

Table 5-7. Subsurface Soil Concentrations Greater Than Project Screening Criteria

Sample Location:	C10-AA03-BP01	C10-AA03-BP02	C10-AA04-BP01	C10-AA04-BP02	C10-AA04-BP03	C10-AA07-BP01	C10-AA07-BP02	C10-GS2-1	C10-GS2-2			
Sample Name:	C10-AA03-SO-01-4.0	C10-AA03-SO-02-4.0	C10-AA04-SO-01-4.0	C10-AA04-SO-02-4.0	C10-AA04-SO-03-4.0	C10-AA07-SO-01-4.0	C10-AA07-SO-02-4.0	C10-GS2-SO-1-7	C10-GS2-SO-2-7			
Sample Date:	10/12/2011	10/12/2011	10/12/2011	10/12/2011	10/12/2011	10/12/2011	10/12/2011	5/9/2001	5/9/2001			
Parent Sample:												
Sample Depth (ft bgs):	3.5 - 4	3.5 - 4	3.5 - 4	3.5 - 4	3.5 - 4	3.5 - 4	3.5 - 4	6 - 7	6 - 7			
Area of Concern	AOC 3	AOC 3	AOC 4	AOC 4	AOC 4	AOC 5	AOC 5	AOC 1	AOC 1			
Analyte	USEPA RSL	SSL										
Explosives (SW8321, SW8330 unless otherwise noted) (µg/kg)												
2,4,6-TNT	3600	*	45900	32 U	33 U	33 U	34 U	34 U	34 U	32 U	500 U	500 U
Inorganics (SW6020 or SW6010B, unless otherwise noted) (mg/kg)												
Aluminum	7700	*	55500000	8990 J	6730 J	12100 J	11500 J	11400 J	4250 J	6610 J	15900	16500
Arsenic	0.39		5000	3.7	3.3	2.4	8	5.6	3.3	3.5	4.4 J	3.8 J
Chromium (hexavalent) (by SW7196A)	0.29		NSA	0.14 J	0.19 J	a	a	0.25 J	a	a	a	a
Cobalt	2.3	*	496	7.6	6.3	7.5	17.7	10.1	5.2	7	10.8	9.6
Iron	5500	*	7500	<u>19100</u>	<u>15400</u>	<u>16200</u>	<u>30900</u>	<u>30600</u>	<u>13000</u>	<u>16300</u>	<u>27000</u>	<u>26200</u>
Lithium	16	*	NSA	17.9	15.8	24.6	25.1	23.6	8.7	10.2	21.4 J	22.6 J
Manganese	180	*	19500	823 J	727 J	156 J	942 J	793 J	816 J	700 J	870	712
Thallium	0.078	*	750	0.11 J	0.15 U	0.19 J	0.16 J	0.11 J	0.15 U	0.15 U	0.59	0.67

Legend:
 USEPA RSL = USEPA Residential Soil Regional Screening Level (USEPA, 2011a).
 * = A non-carcinogen; the screening level has been divided by 10 to achieve a hazard index of 0.1.
 SSL = Site-specific protection of groundwater soil screening level.
 NSA = No screening level available.
 a = Analyte was not analyzed for.
 ft bgs = feet below ground surface
 B = Blank contamination
 J = Estimated value
 U (2011 data) = Either a) the analyte was analyzed for but was not detected above the method detection limit and the value presented is the limit of detection, or b) blank contamination existed and the value presented is the reported concentration (see Data Usability Summary Reports for explanation).
 U (2010 data) = the analyte was analyzed for but was not detected above the method detection limit and the value presented is the limit of detection.
 U (2001 data) = the analyte was analyzed for but was not detected above the method detection limit. The value presented is the sample quantitation limit.
 Gray shading = detected concentration is > the USEPA RSL.
 Underlined font = detected concentration is > the SSL
 Bold font = detected at concentrations above background at one or more AOC

Table 5-7. Subsurface Soil Concentrations Greater Than Project Screening Criteria (continued)

Sample Location:	C10-GS2-2	C10-GS2-3	C10-GS2-4	C10-GS2-5	C10-GS2-6	C10-GS2-7	C10-GS2-8	C10-GS2-9
Sample Name:	C2-OXY-SO-S02-7	C10-GS2-SO-3-5	C10-GS2-SO-4-5	C10-GS2-SO-5-7	C10-GS2-SO-6-25	C10-GS2-SO-7-13	C10-GS2-SO-8-12	C10-GS2-SO-9-6
Sample Date:	8/25/2010	5/10/2001	5/9/2001	5/10/2001	5/10/2001	5/10/2001	5/10/2001	5/10/2001
Parent Sample:								
Sample Depth (ft bgs):	6.5 - 7	4 - 5	4 - 5	6 - 7	24 - 25	12 - 13	11 - 12	5 - 6
Area of Concern	AOC 1	AOC 1	AOC 1	AOC 1	AOC 1	AOC 1	AOC 1	AOC 1
Analyte	USEPA RSL	SSL						
Explosives (SW8321, SW8330 unless otherwise noted) (µg/kg)								
2,4,6-TNT	3600	* 45900	b	500 U	124 J	500 U	500 U	500 U
Inorganics (SW6020 or SW6010B, unless otherwise noted) (mg/kg)								
Aluminum	7700	* 55500000	7800	12200 J	17700	12700 J	6000 J	10800 J
Arsenic	0.39	5000	3.1	3.5 J	3.9 J	4.2 J	2.3 J	3.4 J
Chromium (hexavalent) (by SW7196A)	0.29	NSA	0.23 UJ	a	a	a	a	a
Cobalt	2.3	* 496	8.5	8.7	11.2	12.9	6	8.4
Iron	5500	* 7500	19800	<u>27700</u>	<u>26100</u>	<u>29500</u>	<u>16600</u>	<u>24800</u>
Lithium	16	* NSA	19.1	18.7 J	23.3 J	22.6 J	12.4 J	19.8 J
Manganese	180	* 19500	992 J	877 J	844	871 J	821 J	858 J
Thallium	0.078	* 750	0.11 B	0.53 UJ	0.61	0.5 UJ	0.5 UJ	0.51 UJ
<p><i>Legend:</i> USEPA RSL = USEPA Residential Soil Regional Screening Level (USEPA, 2011a). * = A non-carcinogen; the screening level has been divided by 10 to achieve a hazard index of 0.1. SSL = Site-specific protection of groundwater soil screening level. NSA = No screening level available. a = Analyte was not analyzed for. ft bgs = feet below ground surface B = Blank contamination J = Estimated value U (2011 data) = Either a) the analyte was analyzed for but was not detected above the method detection limit and the value presented is the limit of detection, or b) blank contamination existed and the value presented is the reported concentration (see Data Usability Summary Reports for explanation). U (2010 data) = the analyte was analyzed for but was not detected above the method detection limit and the value presented is the limit of detection. U (2001 data) = the analyte was analyzed for but was not detected above the method detection limit. The value presented is the sample quantitation limit. Gray shading = detected concentration is > the USEPA RSL. Underlined font = detected concentration is > the SSL Bold font = detected at concentrations above background at one or more AOC</p>								

Table 5-7. Subsurface Soil Concentrations Greater Than Project Screening Criteria (continued)

Sample Location:		C10-GS2-P21	C10-GS2-P22	C10-GS2-P23	C10-GS2-P23	C10-GS2-P24	C10-GS2-SIN	C10-GS2-SIS	C10-GS2-SIW	C10-GS2-SOE		
Sample Name:		C2-OXY-SO-P21-3	C2-OXY-SO-P22-3	C2-OXY-SO-P23-3	C2-OXY-SO-P2-03-DUP	C2-OXY-SO-P24-3	C2-OXY-SO-SIN-3	C2-OXY-SO-SIS-3	C2-OXY-SO-SIW-3	C2-OXY-SO-SOE-3		
Sample Date:		8/27/2010	8/27/2010	8/27/2010	8/27/2010	8/27/2010	8/27/2010	8/27/2010	8/27/2010	8/27/2010		
Parent Sample:					C2-OXY-SO-P23-3							
Sample Depth (ft bgs):		2.5 - 3	2.5 - 3	2.5 - 3	2.5 - 3	2.5 - 3	2.5 - 3	2.5 - 3	2.5 - 3	2.5 - 3		
Area of Concern		AOC 1	AOC 1	AOC 1	AOC 1	AOC 1	AOC 1	AOC 1	AOC 1	AOC 1		
Analyte	USEPA RSL	SSL										
Explosives (SW8321, SW8330 unless otherwise noted) (µg/kg)												
2,4,6-TNT	3600	*	45900	140 U	23000	140 U	240 J	140 U	70 J	4500	150 U	140 J
Inorganics (SW6020 or SW6010B, unless otherwise noted) (mg/kg)												
Aluminum	7700	*	55500000	9800	8010	10600	9260	10800	11500	11200	5160	8700
Arsenic	0.39		5000	1.8	1	5.6	4.4	5.2	2.9	4.5	3.8 J	2.4
Chromium (hexavalent) (by SW7196A)	0.29		NSA	0.23 U	0.17 J	0.23 U	0.24 U	0.23 U	0.24 U	0.25 U	0.25 U	0.61
Cobalt	2.3	*	496	7.9	4.5	10.3	8.4	9.9	12.3	10.2	6.5	3.7
Iron	5500	*	7500	<u>14900</u>	<u>7830</u>	<u>25500</u>	<u>23400</u>	<u>25000</u>	<u>22600</u>	<u>25900</u>	<u>14600</u>	<u>9540</u>
Lithium	16	*	NSA	22.2	15.1	17.9	16.9	18.6	18.5	17.6	10.5	15.2
Manganese	180	*	19500	215 J	74 J	874 J	527 J	1150 J	263 J	198 J	1790 J	83.1 J
Thallium	0.078	*	750	0.12 B	0.064 B	0.3 U	0.3 U	0.39 B	0.3 U	0.3 U	0.75 U	0.1 J
<i>Legend:</i>												
USEPA RSL = USEPA Residential Soil Regional Screening Level (USEPA, 2011a).												
* = A non-carcinogen; the screening level has been divided by 10 to achieve a hazard index of 0.1.												
AOC = Area of Concern												
SSL = Site-specific protection of groundwater soil screening level.												
NSA = No screening level available.												
a = Analyte was not analyzed for.												
ft bgs = feet below ground surface												
B = Blank contamination												
J = Estimated value												
U (2011 data) = Either a) the analyte was analyzed for but was not detected above the method detection limit and the value presented is the limit of detection, or b) blank contamination existed and the value presented is the reported concentration (see Data Usability Summary Reports for explanation).												
U (2010 data) = the analyte was analyzed for but was not detected above the method detection limit and the value presented is the limit of detection.												
U (2001 data) = the analyte was analyzed for but was not detected above the method detection limit. The value presented is the sample quantitation limit.												
Gray shading = detected concentration is > the USEPA RSL.												
Underlined font = detected concentration is > the SSL												
Bold font = detected at concentrations above background at one or more AOC												

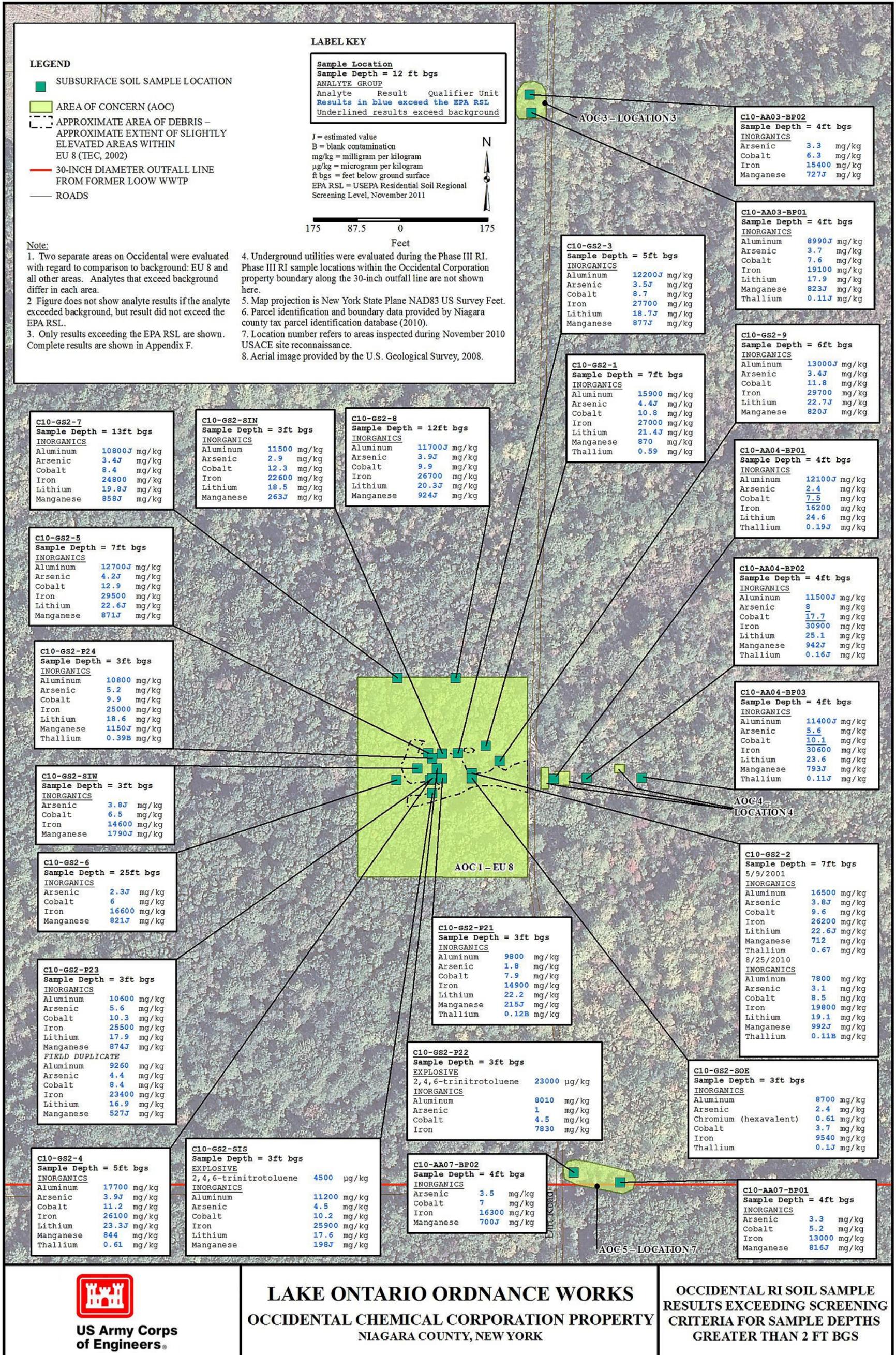


Figure 5-3. Occidental RI Soil Sample Results Exceeding Screening Criteria for Sample Depths Greater Than 2.0 ft bgs.

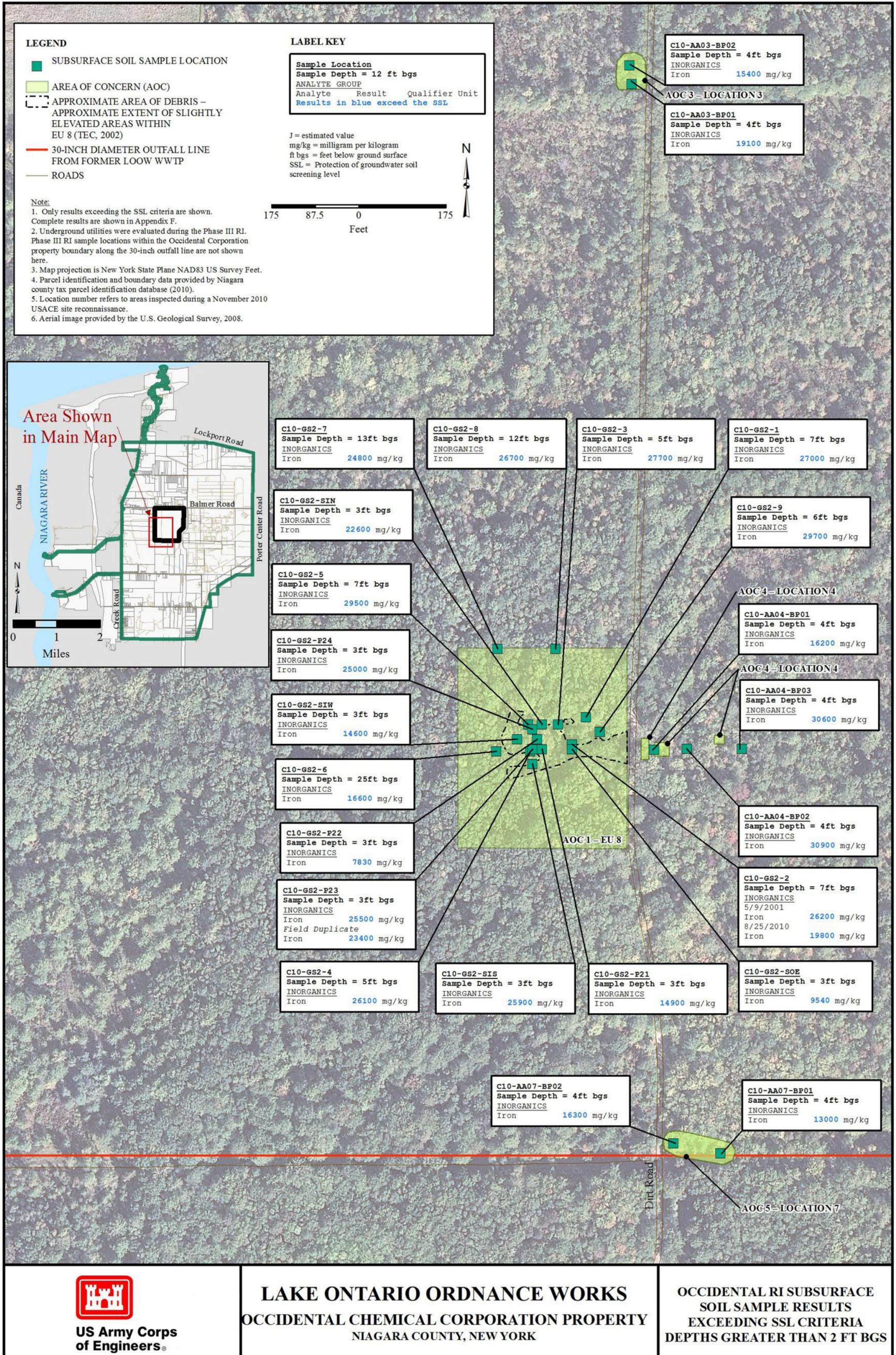


Figure 5-4. Occidental RI Subsurface Soil Sample Results Exceeding SSL Criteria for Sample Depths Greater Than 2.0 ft bgs.

5.3.3 Surface Water Analytical Results

Three surface water samples (i.e., two regular samples and one duplicate sample) from AOC 2 and AOC 6 and were analyzed for VOCs, SVOCs, PCBs, explosives, and metals (including boron and lithium). The surface water sample from AOC 6 (and associated duplicate) contained SVOCs, explosives, and metals at concentrations greater than the screening criteria. VOCs and PCBs were not detected above the project screening criteria.

TCL SVOC

One SVOC (i.e., 4-methylphenol) was detected in a surface water sample from AOC 6 above the project screening level.

Explosives

Two explosives (i.e., 3-nitrotoluene and RDX) were detected in from AOC 6 at concentrations greater than the project screening levels.

TAL Metals

Eleven metals (i.e., aluminum, arsenic, barium, , cobalt, copper, iron, lead, lithium, silver, vanadium, and zinc) were detected from AOC 6 at concentrations greater than the project screening criteria.

Fourteen metals (i.e., aluminum, arsenic, barium, beryllium, cobalt, copper, iron, lead, lithium, nickel, potassium, silver, vanadium, and zinc) were detected above the NFSS background threshold values for surface water. Eleven metals (i.e., aluminum, arsenic, barium, cobalt, copper, iron, lead, lithium, silver, vanadium, and zinc) were detected in surface water samples above both project screening criteria and NFSS background threshold values.

Project screening criteria and NFSS background threshold values for surface water were established for LOOW in the NFSS RI (USACE, 2007b). Surface water background threshold values are presented in **Appendix A**.

Table 5-8 presents surface water sample results for constituents above the project screening levels. **Figure 5-5** illustrates surface water analytical results that exceeded the USEPA RSLs, NFSS SW BTV, and NFSS SW Eco. Complete data summary tables presented as **Table F-3** in **Appendix F**.

Table 5-8. Surface Water Concentrations Greater Than Project Screening Criteria

Sample Location:		C10-AA02-BP01		C10-AA02-BP01	
Sample Name:		C10-AA02-SW-01-0.0		C10-AA02-SW-DUP1	
Sample Date:		10/11/2011		10/11/2011	
Parent Sample:				C10-AA02-SW-01-0.0	
Area of Concern		AOC 6		AOC 6	
Analyte	NFSS SW BTV	USEPA RSL	NFSS SW Eco		
SVOCs (8270 DoD) (µg/L)					
4-Methylphenol	NSA	7.2	* NSA	0.62 J	12 J
Explosives (SW8330, CHPPM_AMINO3.1, CHPPM_MUS3.1) (µg/L)					
3-Nitrotoluene	0.064	0.13	* NSA	0.2 U	<u>2.8 J</u>
RDX	0.053	0.61	NSA	<u>1.9 J</u>	<u>1.2 J</u>
Total Metals (SW6020A, SW7470) (µg/L)					
Aluminum	5,030	1,600	* 100	<u>21,400 J</u>	<u>17,600 J</u>
Arsenic	6.33	0.045	150	<u>11.7 J</u>	<u>11.4 J</u>
Barium	117	290	* 4	<u>224</u>	<u>203</u>
Beryllium	0.253	1.6	* 1,100	<u>1.1</u>	<u>1.2</u>
Cadmium	NSA	0.69	* 2.09	1.3	1.1
Cobalt	1.08	0.47	* 5	<u>11.3</u>	<u>10.2</u>
Copper	15	62	* 8.96	<u>56.1</u>	<u>51</u>
Iron	4740	1100	* 300	<u>25,500</u>	<u>23,000</u>
Lead	11.1	15	+ 3.78	<u>41.4</u>	<u>44.1</u>
Lithium	13.2	3.1	* 14	<u>24.2</u>	<u>20.3</u>
Manganese	951	32	* 120	<u>612</u>	<u>689</u>
Nickel	7.74	30	* 52	<u>28.2</u>	<u>25.4</u>
Potassium	9,540	NSA	53,000	<u>10,500 J</u>	<u>11,800 J</u>
Silver	0.03	7.1	* 0.1	<u>0.13 J</u>	<u>0.13 J</u>
Vanadium	8.52	7.8	* 14	<u>34.4</u>	<u>29.4</u>
Zinc	70.5	470	* 58.91	<u>161</u>	<u>146</u>
<i>Legend:</i>					
USEPA RSL = USEPA Tapwater Regional Screening Level (USEPA, 2011a) (unless otherwise noted).					
* = A non-carcinogen; the screening level has been divided by 10 to achieve a hazard index of 0.1.					
+ = USEPA Maximum contaminant level for lead					
NFSS SW Eco = Surface water values from the NFSS Baseline Risk Assessment: (USACE, 2007b)					
NFSS SW BTV = Surface water background threshold values from the NFSS RI (USACE, 2007b).					
NSA = No screening level available.					
J = Estimated value					
Gray shading = detected concentration is greater than the EPA RSL					
Bold font = detected concentration is greater than the NFSS SW Eco					
Underlined font = detected concentration is greater than the NFSS SW BTV					

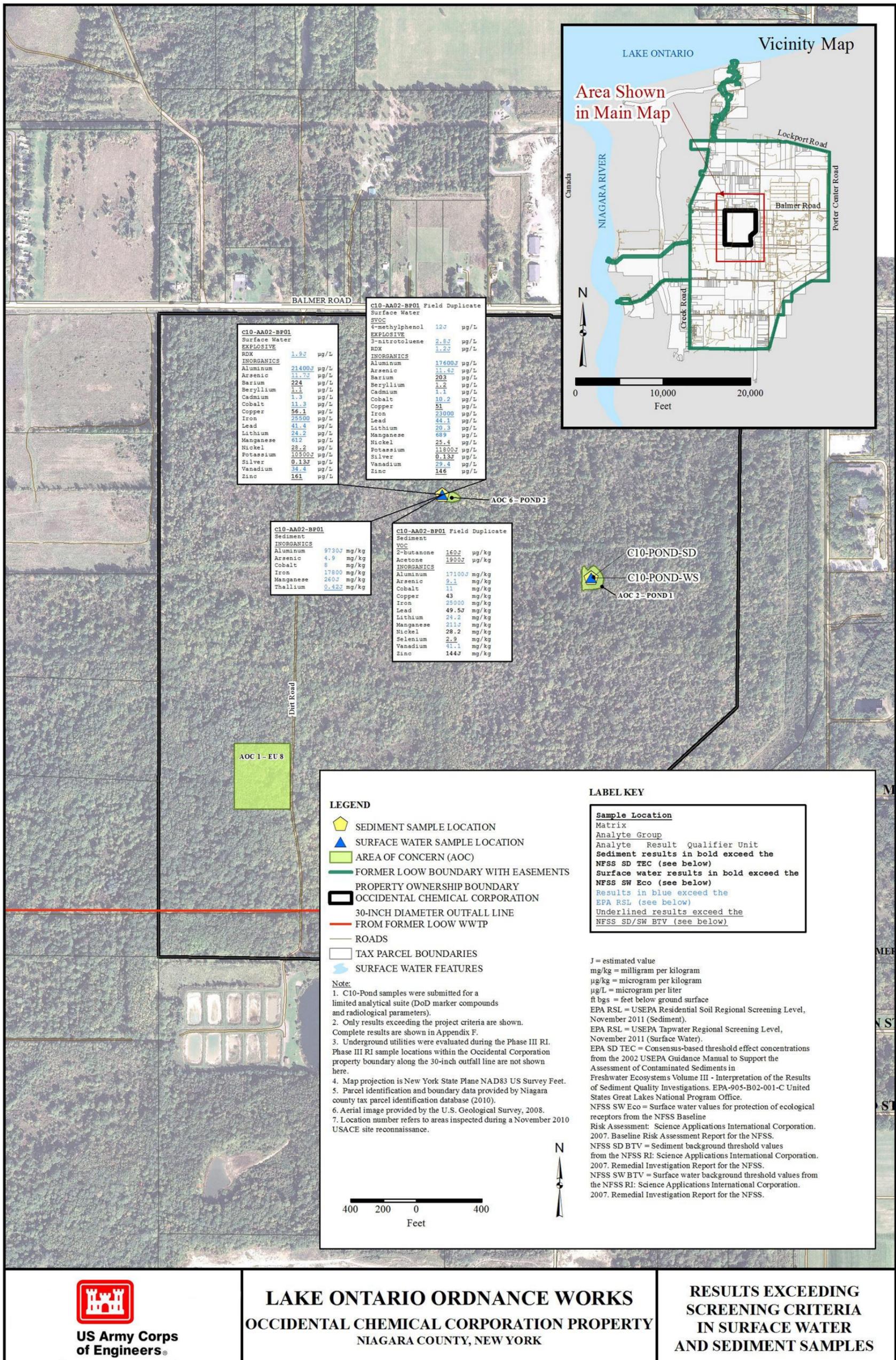


Figure 5-5. Results Exceeding Screening Criteria in Surface Water and Sediment Samples

5.3.4 Sediment Analytical Results

Three sediment samples (two regular samples and one duplicate sample) from AOC 2 and AOC 6 were analyzed for VOCs, SVOCs, PCBs, explosives, and TAL metals (including boron and lithium). VOCs and metals were detected at concentrations greater than the project screening criteria. SVOCs, explosives and PCBs were not detected above the project screening criteria.

VOCs

Two VOCs (2-butanone and acetone) were detected at concentrations exceeding the project screening criteria at AOC 2.

TAL Metals

Two metals (i.e., arsenic and thallium) were detected in the sediment sample (or associated duplicate) from AOC 6 at concentrations greater than the project screening criteria.

Three metals (i.e., arsenic, selenium, and thallium) were detected above the NFSS background threshold values for sediment. Project screening criteria and NFSS background threshold values for sediment were established for LOOW in the NFSS RI (USACE, 2007b). Sediment background threshold values are presented in **Appendix A**.

Table 5-9 presents sediment sample results for constituents above the project screening levels. **Figure 5-5** illustrates sediment concentrations greater than USEPA RSLs, USEPA SD TEC, and NFSS SD BTV. Complete data summary tables for the OCCP RI are presented as **Table F-4** in **Appendix F**.

Table 5-9. Sediment Concentrations Greater Than Project Screening Criteria						
Sample Location:			C10-AA02-BP01		C10-AA02-BP01	
Sample Name:			C10-AA02-SD-01-0.5		C10-AA02-SD-DUP1	
Sample Date:			10/11/2011		10/11/2011	
Sample Depth (ft bgs):			0.5		0.5	
Parent Sample:					C10-AA02-SD-01-0.5	
Area of Concern			AOC 6		AOC 6	
Analyte	USEPA RSL	USEPA SD TEC	NFSS SD BTV			
VOCs (SW8260B) (µg/kg)						
2-Butanone	2,800,000	* NSA	49.3	11 J		<u>160 J</u>
Acetone	6,100,000	* NSA	206	a		<u>1,900 J</u>
Metals (SW6020A, SW7471) (mg/kg)						
Aluminum	7,700	* NSA	30,400	9,730 J		17,100 J
Arsenic	0.39	9.79	7.14	4.9		<u>9.1</u>
Cobalt	2.3	* NSA	21.3	8		11
Copper	310	* 31.6	184	24.5		43
Iron	5,500	* NSA	37,800	17,800		25,000
Lead	400	* 35.8	121	16.1 J		49.5 J
Lithium	16	* NSA	47	14.6		24.2
Manganese	180	* NSA	814	260 J		211 J
Nickel	150	* 22.7	51.9	18.2		28.2
Selenium	39	* NSA	1.87	1.1		<u>2.9</u>
Thallium	0.078	* NSA	0.356	0.42 J		0.15 U
Vanadium	39	* NSA	60.6	23.4		41.1
Zinc	2,300	* 121	405	48 J		144 J
<i>Legend:</i>						
USEPA RSL = USEPA Residential Soil Regional Screening Level (USEPA, 2011a).						
* = A non-carcinogen; the screening level has been divided by 10 to achieve a hazard index of 0.1.						
USEPA SD TEC = Consensus-based threshold effect concentrations from the 2002 USEPA Guidance Manual to Support the Assessment of Contaminated Sediments in Freshwater Ecosystems Volume III - Interpretation of the Results of Sediment Quality Investigations. USEPA-905-B02-001-C United States Great Lakes National Program Office.						
NFSS SD BTV = Sediment background threshold values from the NFSS RI: SAIC, 2007. Remedial Investigation Report for the NFSS. December.						
NSA = No screening level available.						
ft bgs = feet below ground surface						
a = Result was rejected for use by the data validator.						
J = Estimated value						
U (2011 data) = Either a) the analyte was analyzed for but was not detected above the method detection limit and the value presented is the limit of detection, or b) blank contamination existed and the value presented is the reported concentration (see Data Usability Summary Reports for explanation).						
Gray shading = detected concentration is > the EPA RSL						
Bold font = detected concentration is greater than the NFSS SD TEC						
Underlined font = detected concentration is greater than the NFSS SD BTV						

5.4 Summary of Results

This section provides a summary of the field sampling results by matrix and AOC. Complete analytical data packages and summary reports are provided in **Appendix F**.

Surface Soil Sample Results

Fifty-one surface soil samples from 37 sample locations were submitted for laboratory analysis. Explosives, SVOCs, metals, and radionuclide measurements were detected above the project screening criteria.

- AOC 1
 - One SVOC (i.e., benzo(a)pyrene)
 - Eight explosives (i.e., 1,3-dinitrobenzene; 2,4,6-TNT ; 2,4-DNT; 2,6-DNT; 2-amino-4,6-DNT, 2-nitrotoluene, 4-amino-2,6-DNT, and RDX)
 - Nine metals (i.e., aluminum, antimony, arsenic, chromium [hexavalent], cobalt, iron, lithium, manganese, thallium, and vanadium)
 - Two radionuclide measurements (i.e., gross alpha and gross beta)
- AOC 3
 - One SVOC (i.e., benzo(a)pyrene)
 - Seven metals (i.e., aluminum, arsenic, cobalt, iron, lithium, manganese, and thallium)
- AOC 4
 - Seven metals (i.e., aluminum, arsenic, cobalt, iron, lithium, manganese, and thallium)
- AOC 5
 - One SVOC (i.e., benzo(a)pyrene)
 - Seven metals (i.e., aluminum, arsenic, cobalt, iron, lithium, manganese, and thallium)

Subsurface Soil Sample Results

26 subsurface soil samples from 24 sample locations were submitted for laboratory analysis. Explosives and TAL metal in subsurface soil were detected at concentrations greater than the project screening criteria.

- AOC 1
 - One explosive (i.e., 2,4,6-TNT)
 - Eight metals (i.e., aluminum, arsenic, chromium [hexavalent], cobalt, iron, lithium, manganese, and thallium)
- AOC 3

- Seven metals (i.e., aluminum, arsenic, cobalt, iron, lithium, manganese, and thallium)
- AOC 4
 - Five metals (i.e., aluminum, iron, lithium, manganese, and thallium)
- AOC 5
 - Four metals (i.e., arsenic, cobalt, iron, and manganese)

Surface Water Results

Surface water samples from the two ponds (AOC 2 and AOC 6) contained TCL SVOCs, explosives, and metals at concentrations greater than project screening criteria.

- AOC 2
 - None
- AOC 6
 - One SVOC (i.e., 4-methylphenol)
 - Two explosives (i.e., 3-nitrotoluene and RDX)
 - Eleven metals (i.e., aluminum, arsenic, barium, cobalt, copper, iron, lead, lithium, silver, vanadium, and zinc)

Sediment Results

The sediment samples each pond (AOC 2 and AOC 6) contained VOCs and metals at concentrations greater than project screening criteria.

- AOC 2
 - Two VOCs (i.e., 2-butanone and acetone)
 - Two metals (i.e., arsenic and thallium)

6.0 NATURE AND EXTENT

An objective of the investigation was to characterize the nature and extent of contamination based on statistically valid data. Determining the nature and extent of contamination involves evaluating potential source areas, analytical data, fate and transport properties and physical site characteristics to determine the likely location of contaminants and their extent.

The nature and extent of contamination at the site is discussed separately for the surface soil, subsurface soil, surface water, and sediment.

6.1 Surface Soil

The nature and extent of contamination in surface soil was assessed using the data collected during investigation activities for this RI. SVOCs, explosives, and metals in surface soil were detected at concentrations greater than the project screening criteria. **Figures 5-1 and 5-2** summarize the laboratory results for these analytes in surface soil.

TCL SVOCs

One SVOC (i.e., benzo[a]pyrene) is present at concentrations greater than project screening levels in three samples. No additional SVOCs were reported in surface soil at concentrations greater than project screening levels. The surface soil sample exhibiting the greatest concentration of benzo[a]pyrene was collected from AOC 1. Sample C10-GS2-10 (179 µg/kg) was collected near deteriorated steel 55-gallon drums at AOC 1. Samples C10-AA03-BP02 (20 µg/kg) and C10-AA07-BP02 (35 µg/kg) were collected from the mounded soils of AOC 3 and AOC 5; approximately 1,200 ft north and approximately 625 ft south of AOC 1, respectively. Although the maximum detected concentration of benzo(a)pyrene was greater than the 95 percent UPL for Next Observation (ProUCL 4.1) background data distribution, it was less than the maximum detected concentrations of benzo(a)pyrene contained within the background data set (240 µg/kg) (**Appendix A**).

There is no commercial production or known use for benzo(a)pyrene; it is a byproduct of incomplete combustion (e.g., burning of plant and coal, and operation of motor vehicles). The largest emissions of benzo(a)pyrene occur from the residential energy production in coal and wood furnaces. The presence of benzo[a]pyrene may be potentially attributed to fossil fuels, coal tar, diesel fuels, asphalt, asphalt shingles, and numerous other petroleum based products; all readily available products employed by various regional industries (e.g., agriculture, construction, defense, etc.). Additionally, deposition of benzo(a)pyrene during may be the result of natural process such as the decomposition of organic matter and precipitation events.

Benzo(a)pyrene is expected to have very low to no mobility based upon measured Koc values ranging from 930 to 6,300 L/kg. The persistence of benzo(a)pyrene in soil is expected to vary depending upon the nature of compounds accompanying it and the nature and previous history of the soil; biodegradation half-lives of 309 and 229 days were observed in sandy loam soils, respectively. If released into water, benzo(a)pyrene is expected to adsorb to suspended solids and sediment based upon measured soil Koc values (National Institute of Health, 2012).

Explosives

The data indicates that eight explosives are present within AOC 1 at concentrations greater than the project screening levels. The samples were located near deteriorated 55-gallon drums and collected from 2.5 to 3 ft bgs.

The presence of explosives in surface soil samples may be attributed to former DoD operations/activities at the site.

TAL Metals

Various metals (i.e. barium, cadmium, chromium, copper, lead, nickel and zinc) are present at AOC 1 at concentrations above background and the project screening criteria. Metals were not detected above background and the project screening criteria outside of AOC 1. Similar to the SVOCs and explosives, the greatest concentrations of metals occurred near the deteriorated steel 55-gallon drums.

Metals in surface soil at AOC 1, AOC 3, AOC 4, and AOC 5 may be attributed to natural occurrence, historical operations (e.g., agricultural, industrial) within the region, and former site uses. Localized elevated metal concentrations in surface soil near the deteriorated 55-gallon drums at AOC 1 may also be attributed to former DoD operations/activities.

6.2 Subsurface Soil

The nature and extent of contamination in subsurface soil was assessed using the data collected during the RI. Explosives and metals in subsurface soil were detected at concentrations greater than the project screening criteria, which are illustrated in **Figures 5-3 and 5-4**.

Explosives

One explosive (i.e., 2,4,6-TNT) is present at two locations within AOC 1 at concentrations greater than the screening levels. The samples were located near deteriorated 55-gallon drums and were collected from 2.5 to 3 ft bgs.

The presence of 2,4,6-TNT may be potentially attributed to former DoD operations/activities at the site.

TAL Metals

Two metals (i.e. arsenic and cobalt) are present at AOC 4 at concentrations greater than the project screening levels and background, and one metal (i.e. hexavalent chromium) at AOC 1 is present at concentrations greater than the project screening criteria and background. None of the metals that exceeded the background and project screening criteria were also present above the SSL. One metal (i.e., iron) was detected above the SSL but less than background. Similar to the SVOCs and explosives, the greatest concentrations of metals were observed near deteriorated steel 55-gallon drums at AOC 1. In addition, the metals concentrations generally decreased with depth in subsurface soil.

The presence of metals may be potentially attributed to natural occurrence, historical operations (e.g., agricultural, industrial) within the region, and former site uses. At AOC 1, these constituents may also be potentially attributed to former DoD operations/activities.

Of particular interest due to its acute toxicity, hexavalent chromium was detected in subsurface soil. Chromium is a naturally occurring element that is released into the environment from

natural and anthropogenic sources. The largest industrial contribution to chromium release to the environment includes metal processing, tannery facilities, chromate production, and stainless steel welding. None of these activities were performed at the former LOOW or OCCP at high capacity. Due to the proximity of elevated concentrations near a deteriorated steel 55-gallon drum, it is possible that the chromium observed is the result of former DoD operations at the site. However, due to uncertainties associated with the analytical method (discussed in Section 5.1.3) reanalysis for hexavalent chromium is recommended using a different analytical method.

6.3 Surface Water

The nature and extent of contamination in surface water was assessed using data collected for this RI. An SVOC, explosives, and metals are present at concentrations greater than the project screening criteria, which are illustrated in **Figures 5-5**.

TCL SVOC

One SVOC (i.e., 4-methylphenol) was reported at concentrations greater than the project screening levels. 4-Methylphenol was observed in surface water from AOC 6, but based on physical properties associated with the constituent and other natural and anthropogenic sources of 4-methylphenol, it is unlikely that DoD use of the area over 60 years prior is the result of the observed concentrations.

The presence of 4-methylphenol may be potentially attributed to fuel combustion, refinement and use of coal tars, sewage effluents, solvents and disinfectants, the production of synthetic resins, and the use of motor vehicles; all readily available products employed by various regional industries (e.g., agriculture, construction, defense, etc.). Additionally, cresols, including 4-methylphenol, are formed naturally as metabolites of microbial activity and in various plant lipid constituents; and excreted in the urine of mammals. Deposition of 4-methylphenol during may also be the result of natural process such as the decomposition of organic matter and precipitation events.

If released to soil, 4-methylphenol is expected to have moderate to high mobility based upon log Koc values of 1.69-2.81 L/kg. Volatilization from moist soil surfaces is expected to occur based upon a Henry's Law constant of 1×10^{-6} atmospheric liters per molar concentration (atm L mol⁻¹). 4-Methylphenol is not expected to volatilize from dry soil surfaces based upon its extrapolated vapor pressure. This compound is expected to biodegrade rapidly based upon half-lives of 1 and 0.5 days in 2 agricultural soils. If released into water, 4-methylphenol is not expected to adsorb to suspended solids and sediment in the water column based upon the log Koc values. 4-Methylphenol is expected to biodegrade quickly in water under aerobic conditions based on complete degradation of p-cresol within 4 and 6 days (National Institute of Health, 2012).

Explosives

Two explosives (i.e., 3-nitrotoluene and RDX) were reported at concentrations greater than the project screening levels in surface water collected at AOC 6. Based on physical properties associated with these constituents and other natural and anthropogenic sources of 3-nitrotoluene, it is unlikely that DoD use of the area over 60 years prior is the result of the observed concentrations. Additionally, although RDX is typically attributable to former DoD activities,

physical properties of the compound make it unlikely that the compound existed in the environment over the last 60 years.

The presence of 3-nitrotoluene may be potentially attributed to the manufacture of chemicals for the dye, explosives, and pesticide industries. The biodegradation of 3-nitrotoluene in soils has not been studied extensively; one study indicated that it persists for greater than 64 days using a silt loam soil inoculum. In anaerobic soils, 3-nitrotoluene has been observed to be degraded to toluidine, with little additional degradation. If released into water, 3-nitrotoluene is expected to adsorb to suspended solids and sediment based upon its estimated Koc (3 L/kg). Nitrotoluene has been observed to be partially or completely degraded in aqueous sewage treatment systems, and completely degraded in aquifers, and in rivers or streams. Half lives for degradation in the studied aquatic environments ranged from 12 hours to greater than 64 days (National Institute of Health, 2012).

RDX is an explosive used in military munitions. If released to soil, it is expected to have high to moderate mobility based upon a Koc range of 42-167 L/kg. Volatilization from moist soil surfaces is not expected to be an important fate process based upon an estimated Henry's Law constant of 2.0×10^{-11} atm L mol⁻¹. RDX will biodegrade under anaerobic conditions in soil with complete degradation reported in 24 days; it is expected to be resistant to biodegradation in soil under aerobic conditions. If released into water, cyclonite may adsorb to suspended solids and sediment based upon the Koc range. Aerobic biodegradation in aquatic environments is unlikely to occur; however, anaerobic degradation (e.g., phototransformation) under the proper conditions in lakes, ponds, and groundwater may occur (National Institute of Health, 2012).

TAL Metals

Eleven metals (i.e., aluminum, arsenic, barium, cobalt, copper, iron, lead, lithium, silver, vanadium, and zinc) from AOC 6 are present at concentrations greater than the project screening levels. The presence of metals may be potentially attributed to natural occurrence, historical operations (e.g., agricultural, industrial) within the region, and former site uses.

6.4 Sediment

The nature and extent of contamination in sediment was assessed using the data collected during investigation activities for this RI. TCL VOCs and metals are present at concentrations greater than the project screening criteria. **Figure 5-5** summarizes the laboratory results for TCL VOC and metals in sediment.

VOCs

Two TCL VOCs (2-butanone and acetone) are present at AOC 6 at concentrations greater than the project screening levels.

The presence of these VOCs may be potentially attributed to the use of petroleum-based fuels and solvents; all readily available products employed by various industries (e.g., agriculture, construction, defense, etc.). Acetone is one of the least hazardous industrial solvents, but is highly volatile. It is commonly used as a solvent for fats, oils, resins, waxes and rubbers. Nearly 90 percent of acetone production is via cumene where acetone is coproduced with phenol. Additionally, acetone occurs naturally as a metabolic byproduct of plants and animals and is emitted into the atmosphere by volcanoes and forest fires. Acetone also undergoes photodecomposition by sunlight with an estimated half-life of about 80 days. Acetone is

expected to have very high mobility in soils based upon an estimated Koc value of 1 L/kg. Volatilization from dry soil surfaces is expected based upon the vapor pressure of this compound. Acetone is expected to biodegrade under aerobic and anaerobic conditions based upon the results of numerous screening tests. If released into water, acetone is not expected to adsorb to suspended solids or sediment based upon its estimated Koc value. Volatilization from water surfaces is expected to be an important environmental fate process with an estimated volatilization half-lives for a model river and model lake are 38 and 333 hours, respectively. The volatilization half-life of acetone applied to the surface of a shallow stream was in the range of 8-18 hours (National Institute of Health, 2012).

2-Butanone is manufactured by the dehydration of 2-butanol and by catalytic oxidation of n-butenes. It is commonly used as a solvent for lubricants, resins, adhesives, rubbers and acrylic. Additionally, 2-butanol occurs naturally as a metabolic byproduct of plants and animals and is released into the atmosphere by volcanoes and forest fires. If released to soil, 2-butanol is expected to have very high mobility. Volatilization from moist soil surfaces is expected to be an important fate process. The volatilization half-life of 2-butanol from silt and sandy loams was measured as 4.9 days. This compound is expected to biodegrade under aerobic and anaerobic conditions in soil. If released into water, 2-butanol is not expected to adsorb to suspended solids and sediment based upon the Koc values. Methyl ethyl ketone was shown to biodegrade 89 percent in 20 days in fresh water and 69 percent in 20 days in salt water. Volatilization from water surfaces is expected to be an important fate process. Estimated volatilization half-lives for a model river and model lake are 16 hours and 7.3 days, respectively (National Institute of Health, 2012).

TAL Metals

Two metals (i.e., arsenic and thallium) are present at AOC 6 at concentrations greater than the project screening levels. The presence of these metals may be potentially attributed to natural processes and historical operations (e.g., agricultural, industrial, DoD) within the area

6.5 Conclusions

Based on the variety of constituents detected and the variability of their concentrations within the AOCs, most organic constituents are not believed to be the result of isolated operations; limited in both duration and extent.

Due to the localized nature and extent and proximity to anomalies observed in aerial photographs from 1944 during DoD ownership of the site, these constituents may be attributed to former DoD operations/activities at AOC 1. In addition, due to the cessation of federal ownership at the site in 1975, these constituents reported at concentrations greater the project screening levels do not represent an uncontrolled, continued, and/or potential release to the environment.

AOC 1 exhibits evidence of recent and historic municipal waste disposal circa 1950. All constituents detected above the project screening criteria, except for explosives, are readily available, and may be found at similar municipal waste disposal sites dating back to the early 1950's.

Within AOC 1 - EU 8 the area of surface soil impacted by risk drivers exceeding screening criteria is approximately 30,000 square ft and is located in the vicinity to the deteriorated steel 55-gallon drums. Based on sampling completed during this RI, concentrations exceeding risk

based criteria for human health extend into subsurface soil to a depth of 2 ft bgs. However, concentrations reported in subsurface soil do not suggest there is an impact to groundwater. The total volume of soil exhibiting concentrations greater than USEPA RSLs is estimated to be 2,250 cubic yards.

7.0 FATE AND TRANSPORT

The environmental fate and transport of identified COPCs are evaluated to characterize in this section. Included is a discussion of the fate and transport mechanisms potentially affecting releases and the distribution of COPCs at the site and evidence is examined for how these mechanisms are affecting migration of the constituents.

The discussion identifies potential routes of COPC transport; estimates the persistence of identified COPCs based on physical, chemical and biological factors affecting fate and transport; and predicts migration routes of the COPCs.

7.1 Description of Fate and Transport Mechanisms

7.1.1 Airborne Transport Process

Movement of COPCs absorbed to surface soil via atmospheric wind is a potential transportation pathway. Airborne transport is generally limited due to particle size, wind speed, and other site-specific conditions. COPC migration via airborne transport at the site is not considered a concern due to mature vegetation and ground cover throughout the site.

7.1.2 Aqueous Transport Process

Aqueous transport can be accomplished by one of two potential migration pathways or transport mechanisms, unsaturated gravitational flow of surface water or saturated advective flow of groundwater.

7.1.2.1 Surface Water

Site conditions enable some movement of surface water flow towards drainage ditches and two ponds (AOC 2 and AOC 6). Surface water provides a potential critical pathway for chemical constituents to migrate from a source area. Based on the typical topography of the site, characterized by relatively level grade surface, during heavy rain events, sheet flow or overland flow of surface water may result in surface water flowing into drainage ditch and ponds. Construction of various drainage ditches associated with the former LOOW may have at one time directed stormwater flow into local streams and ponds. Direct infiltration of surface water to the shallow groundwater can contribute to the migration of constituents; however, the low permeability of site soils severely impacts static groundwater conditions and does not allow for uniform groundwater presence. The near homogeneous existence of fine-grained silt/sands and shallow UCT layer inhibits surface water infiltration into the shallow groundwater. In addition, vegetation typically inhibits the erosion of soil particles and very few areas at the site are devoid of ground surface grass and brush vegetation.

7.1.2.2 Groundwater

Groundwater recharge at the site occurs primarily from precipitation and snowmelt infiltration. As water filters through the surface soil and overburden and then into the soil pores, constituents can be transported via groundwater flow from areas of high hydraulic head to areas of low hydraulic head. Hydraulic head is the water level pressure at a point in an aquifer which is determined by measuring the height of the water in a groundwater well and converting it to a water level height above a geodetic datum. In order to completely evaluate the groundwater

migration; horizontal groundwater flow, vertical groundwater flow and residence time must be investigated.

Generally, groundwater flow at the site occurs within unconsolidated deposits and conforms to the local topography. Locally, groundwater at the site flows through low permeability subsurface material to the series of surface drainage ditches and streams associated with the former LOOW. Regional groundwater flow is towards Lake Ontario to the north and the Niagara River to the northwest.

Due to local geology, perched groundwater is also present in intermittent lenses of saturated alluvium, fill or silt and sand, particularly around surface water bodies. Lateral groundwater flow is severely restricted due to the discontinuous nature of the saturated lenses and low groundwater flow rate, which was previously calculated at 0.11 feet per year (ft/yr) (Golder, 1993).

Groundwater may also migrate downward to the lower saturated layers, although downward recharge is expected to be minimal due to the low vertical permeability of the local strata. Groundwater presents a potential migration pathway of concern because all necessary migratory components are present at the site; infiltration, leaching, vertical flow, and advective flow.

Only iron was detected in subsurface soil at concentrations above the SSL. Iron is a naturally occurring element, typically associated with glacial deposits common to western New York. Iron concentrations exceeding the USEPA RSL for Tapwater (11,000 µg/L) may cause characteristic red staining or other aesthetically displeasing characteristics (e.g. foul odor and taste). Iron does not have an established USEPA MCL and is not considered a national drinking water contaminant. TNT and other metals detected in subsurface soil where present at concentrations above the SSL and therefore should not negatively impact groundwater.

7.2 Fate Processes

Acid-base reactions, volatilization, precipitation, complexation, sorption, oxidation-reduction, hydrolysis and isotopic reactions all affect constituent fate processes.

Sorption of organic compounds to soil or sediment is quantified by a partitioning coefficient, K_d , which is defined as:

$$K_d = C_s/C_w$$

Where:

C_s = concentration of a constituent sorbed to a specific weight of soil

C_w = concentration of the same constituent dissolved in an equal weight of water (Olson et al., 1982)

The sorption coefficient is commonly expressed on an organic carbon basis and defined as:

$$K_{oc} = K_d/f_{oc}$$

Where:

f_{oc} = fractional mass of organic carbon in the matrix

The sorption coefficient provides an indication of the tendency of a chemical to partition between particles containing organic carbon content and water. The greater the K_{oc} , the less likely the constituent will partition from soil to water.

The distribution coefficient, K_d , for a given solute is directly proportional to the organic content of a soil or sediment. The greater the organic carbon content, the greater the value of K_d (Karckhoff et al, 1979). This approach for estimating K_d is applicable only to soil typically containing organic matter greater than 0.1 percent. In soil that contains lower than 0.1 percent organic carbon, sorption of neutral organics onto the mineral phase can cause erroneous K_d estimates (Chiou, 2002). For subsurface soil at the OCCP, the average total organic carbon concentration (including surface and subsurface soil) is 16,500 mg/kg or 1.65 percent.

Organic compounds under naturally occurring environmental conditions will ultimately revert to elemental forms due to exposure to the air, water, bacteria, sunlight, soil or a combination of these factors. The persistence of organic constituents in the environment is directly related to its specific resistance to degradation. Utilizing published data, the organic constituents that were reported above the screening criteria were evaluated to assess applicable rates of degradation (Table 7-1).

Table 7-1. Estimated Properties for Organic and Explosive Analytes in Soil and Water							
Analyte	Media	Half-Life Range ^a	K_{oc} (L/kg)	K_d (L/kg)	Retarded Migration Rate (ft/yr)	Solubility ^c (mg/L)	Vapor Pressure ^c (mm Hg)
VOCs							
2-Butanone	SD	4.9 days for soil ^a	1.93E+00 ^b	8.0E-02 ^b	5.19E-02	2.23E+05	9.06E+01
Acetone	SD	24-168 hours for soil ^a	5.8E-01 ^b	2.0E-02 ^b	8.59E-02	1.00E+06	2.32E+02
SVOCs							
Benzo[a]pyrene	SO	0.2-1.5 years ^a	9.69E+05 ^b	1.6E+05 ^b	1.3E-06	4.0E-03	5.49E-09
4-Methylphenol	SW	12 hours ^a	7.38E+01 ^b	5.53E+00 ^b	NA	2.15E+04	1.10E-01
Explosives							
1,3-Dinitrobenzene	SO	672 – 4,320 hours ^a	2.98E+01 ^b	4.4E+00 ^b	1.76E-03	5.33E+02	9.0E-04
2,4-Dinitrotoluene	SO	672 – 4,320 hours ^a	8.84E+01 ^b	8.8E-01 ^b	8.26E-03	2.00E+02	1.47E-04
2,6-Dinitrotoluene	SO	672 – 4,320 hours ^a	4.91E+01 ^b	4.9E-01 ^b	1.40E-02	1.82E+02	5.67E-04
2,4,6-Trinitrotoluene	SO	672 – 4,320 hours ^a	3.74E+01 ^b	3.7E-01 ^b	1.78E-02	1.15E+02	8.02E-06
2-Amino-4,6-dinitrotoluene	SO	672 – 4,320 hours ^a	2.83E+02 ^c	2.83E+00 ^e	2.71E-03	3.19E+02	3.33E-06

Table 7-1. Estimated Properties for Organic and Explosive Analytes in Soil and Water

Analyte	Media	Half-Life Range ^a	K _{oc} (L/kg)	K _{d_s} (L/kg)	Retarded Migration Rate (ft/yr)	Solubility ^c (mg/L)	Vapor Pressure ^c (mm Hg)
2-Nitrotoluene	SO	672 – 4,320 hours ^a	3.71E+02 ^c	3.71E+00 ^e	2.08E-03	6.50E+02	1.88E-01
3-Nitrotoluene	SW	672 – 4,320 hours ^a	3.16E+02 ^c	2.37E+01 ^e	NA	5.0E+02	2.05E-01
4-Amino-2,6-dinitrotoluene	SO	672 – 4,320 hours ^a	2.83E+02 ^c	2.83E+00 ^e	2.71E-03	3.19E+02	3.65E-06
RDX	SO	672 – 4,320 hours ^a	8.91E+01 ^c	8.91E-01 ^e	8.16E-03	5.97E+01	4.10E-09
	SW	672 – 4,320 hours ^a	8.91E+01 ^c	6.68E+00 ^e	NA	5.97E+01	4.10E-09

Legend:

^a – Mackay (1992a, 1992b, 1993, 1995)

^b – USEPA Region 6, 2005. Hazardous Waste Combustion Facility Guidance and HHRAP Companion Database.

http://www.epa.gov/earth1r6/6pd/rcra_c/protocol/protocol.htm

^c – University of Tennessee, 2009. – Risk Assessment Information System (RAIS). <http://rais.ornl.gov/>

^d – USEPA, 2011b. Estimation Program Interface (EPI) Suite. EPI Suite Version 4.10. January.

<http://www.epa.gov/opptintr/exposure/pubs/episuitedl.htm>

^e – K_d values not directly available in the preferred sources were calculated using the following fraction organic carbon (foc) correlation equations provided in U.S. EPA Review Draft Addendum to the Methodology for Assessing Health Risks Associated with Indirect Exposure to Combustor Emissions. Office of Health and Environmental Assessment. Office of Research and Development. EPA-600-AP-93-003. November 10. (USEPA, 1993)

^f – USEPA, 1996. Guidance for Developing Soil Screening Levels for Superfund Sites. June.

<http://www.epa.gov/superfund/health/conmedia/soil/index.htm>

SO – surface and subsurface soil

SW – surface water

SD – sediment

K_{oc} – Soil organic carbon-water partition coefficient

K_{d_s} – Soil-water partition coefficient

L/kg – liters per kilogram

ft/yr – ft per year

mg/L – milligrams per liter

mm Hg – millimeters of mercury

Rate of degradation is presented in half-lives; or the amount of time necessary to effectively reduce a given constituent quantity in half. Half-lives are based on the highest and lowest degradation rates associated with the dominant degradation process within a particular media.

Surface soil and subsurface soil constituents are typically degraded due to biodegradation and hydrolysis. Most hydrolysis half-lives in soil are based upon rate data determined in water, since hydrolysis data in soil were rare to find (Howard, 1993). Surface soil and subsurface soil half-lives provide an estimate of the natural in-situ attenuation of the target compound.

Half-lives presented, are based on estimated times of degradation from available and trusted resources. Surface soil and subsurface soil concentration were considered to be unaffected by additional source loading.

Although groundwater data is unavailable for the site, the migration rate of organic compounds relative to groundwater flow considering adsorption to organic matter can be estimated by calculating the retardation factor, based on K_d as follows:

$$R = 1 + K_d \times \rho_b/n$$

Where:

ρ_b – soil bulk density (estimated at 1.4 grams per centimeter cubed [g/cm^3] [USACE, 2002])

n = effective porosity (estimated at 0.1 [USACE, 2002])

The retarded plume velocity is approximated by:

$$V_c = V/R$$

Where:

V_c = plume velocity

V = average groundwater flow velocity (estimated as 0.11 ft/yr for UCT [Golder, 1993])

The estimated groundwater plume retardation velocities based on this analysis for the various COPCs are listed in **Table 6-1**. A bulk density of $1.4 \text{ g}/\text{cm}^3$ and F_{oc} of 1.65 percent is assumed. These estimated velocities do not include other transport and retardation factors. Lower retardation velocities calculated indicate limited constituent transport via groundwater.

7.2.1 Natural Attenuation of Organic Compounds

Natural attenuation of organic compounds refers to the reduction of contaminant mass due to naturally occurring environmental processes, including; physical, chemical, and biological processes. Physical and chemical sorption processes result in a decrease of concentration and mobility, but do not reduce the total contaminant mass. Contaminant mass may be reduced only through abiotic chemical and biological processes.

The reduction of organic compounds is the result of electron transfers between a donor and an acceptor, which occurs within an aerobic reducing environment. These chemical reactions are generally defined as biologically mediated redox reactions (Chiou, 2002) and are typically facilitated by naturally occurring microorganism populations. Naturally, microbial degradation is most effective on low to moderate organic constituent concentrations (USEPA, 1998a). Normally, microorganism populations capable of effectively degrading organic compounds, flourish in a potential of hydrogen (pH) range of between 5 and 9 (USEPA, 1998a). Carbon dioxide is a by-product of the oxidation of organic compounds, which in forming carbonic acid in groundwater effectively reduces the groundwater pH.

Microbial degradation of organic compounds typically results in an aerobic environment transforming into an anaerobic environment as electron acceptors are systematically depleted. With the introduction of organic compounds, oxygen, favored by microbial populations is depleted. Upon transitioning to an anaerobic environment, microbial populations begin to

sequentially utilize other components for respiration including nitrate, manganese oxide, ferrous oxide and sulfate.

Typical organic compound plumes exhibit aerobic degradation along the outer limits of the plume and anaerobic degradation within the center of the plume. It is not uncommon for contaminant plumes to have differing zones of reduction that are supported by specific components. Anaerobic degradation may be assisted by the occurrence compounds such as ferrous iron and manganese oxide.

Natural attenuation is generally confirmed via a series of evidence supporting the overall degradation process. Primary evidence for natural attenuation is evaluated by the accumulation of historical analytical data. Groundwater samples were not collected at the debris field; therefore evidence of natural attenuation is not available.

7.2.2 Metals

Metals are present in sediment, surface water, surface and subsurface soil above background concentrations and project screening levels. Metals are generally treated as infinitely persistent in the environment and unaffected by naturally occurring degradation. The potential for transport of metal analytes is based upon analyte specific affinity to sediment, surface water, and soil. Factors affecting transport dynamics include soil-water chemistry and charge deficiency on adsorbent surfaces, such as soil and sediment. In order to neutralize the surface charge, an accumulation of ions near the soil-groundwater interface is required. Factors including soil texture, soil chemistry, pH and redox potential also enhance or diminish the mobility of a particular metal analyte. Typically, the solubility of metals tends to increase proportional to increased acidity, and conversely under alkaline conditions.

There are numerous natural materials that strongly interact with water. Metal sorption is affected primarily by physical and chemical processes. Generally, the sorption coefficient for a metal is indicative of the relative affinity of a metal to soil, and ultimately the immobility of the metal. Physical adsorption is due to surface charges which attract ionic specie of the opposite charge. Hydrous oxides may also promote the sorption of metals. Metal ions sorbed to these surfaces become precipitated with the hydrous oxides. Chemical processes for adsorption include ion exchanges, precipitation, solid-state diffusion and isomorphic substitution. Organic matter may also result in metals sorbing to soil and sediment making them insoluble in groundwater.

Iron was the only constituent detected in subsurface soil samples at concentrations above the SSL. The fate of iron in groundwater depends on the form of iron present. Under reducing conditions, ferrous iron (FeII or Fe⁺²) occurs. Under oxidizing conditions, ferric iron (FeIII or Fe⁺³) dominates. Concentrations of ferrous iron in ground or surface water may be more than 1 mg/L (part per million). Ferric iron, although relatively insoluble, forms complexes with other chemicals or with suspended material. Most iron in groundwater occurs naturally, although industrial applications include the use of machinery and structural materials. However, despite potentially high concentrations, iron will likely only leach into groundwater in minimal amounts due to a high affinity to soil.

The fate of chromium in soil is greatly dependent upon the speciation of chromium, which is a function of redox potential and the pH of the soil. In most soils, chromium will be present predominantly in the chromium (III) state. In deeper soil where anaerobic conditions exist, hexavalent chromium will be reduced to chromium (III) by S⁻² and Fe⁺² present in soil. The

reduction of hexavalent chromium to chromium is possible in aerobic soils that contain appropriate organic energy sources to carry out the redox reaction, with the reduction of hexavalent chromium to chromium (III) facilitated by low pH (Cary 1982; EPA 1990b; Saleh et al. 1989).

The oxidation of chromium (III) to hexavalent chromium in soil is facilitated by the presence of organic substances, oxygen, manganese dioxide, moisture, and the elevated temperatures in surface soil that result from brush fires (Calder 1988; Cary 1982). Organic forms of chromium (III) (e.g., humic acid complexes) are more easily oxidized than insoluble oxides. However, oxidation of chromium (III) to hexavalent chromium was not observed in soil under conditions of maximum aeration and a maximum pH of 7.3 (Bartlett and Kimble 1976). It was later reported that soluble chromium (III) in soil can be partly oxidized to hexavalent chromium by manganese dioxide in soil, and the process is enhanced at pH values >6 (Bartlett 1991). Because most chromium (III) in soil is immobilized due to adsorption and complexation with soil materials, the barrier to this oxidation process is the lack of availability of mobile chromium (III) to immobile manganese dioxide in soil surfaces. Due to this lack of availability of mobile chromium (III) to manganese dioxide surfaces, a large portion of chromium in soil will not be oxidized to hexavalent chromium, even in the presence of manganese dioxide and favorable pH conditions (Bartlett 1991; James et al. 1997).

7.2.3 Potential Routes of Constituent Migration

Fate and transport mechanisms and characteristics of chemicals were used to evaluate site-specific analytical data in order to identify constituents reported above the screening levels that have the potential to persist or migrate along potential transport pathways. Two potential routes of migration were evaluated; airborne transport and surface water transport. Due to the lack of groundwater analytical data and concentrations in soil that present risk to groundwater, the groundwater route of is no longer considered.

Airborne Transport

Airborne transport of impacted surface soil is possible, but considered unlikely due to the minimal amount of exposed soil at the site and the heavy vegetation enclosing the site. The heavy and mature vegetation at the site will significantly reduce the likelihood of airborne transport of contaminated soil to onsite and/or offsite receptors. It is possible that the deposition of constituents such as benzo(a)pyrene and 4-methylphenol, may be the result of natural process such as precipitation events of contaminated rain, and manufacturing processes such as the combustion of fuels.

Migration of constituents via soil and/or sediment erosion in exposed areas is possible; however migration is laterally limited due to the heavy vegetation at the site. As a result of heavy and mature vegetation at the site, soil and/or sediment is root bound and significantly reduced from transport via erosion.

Subsurface soil is not susceptible to airborne or surface water transport. The fate and transport of subsurface soil is further limited by the UCT confining layer which retards surface water and groundwater leaching of constituents in subsurface soil. Barring subsurface soil disturbance activities at AOC 1, potential receptors will not interact with identified constituents in surface soil. Due to the lack of increasing or persistent constituent concentrations with depth, the migration of constituents in subsurface soil is minimal.

In contrast to SVOCs and explosives, metals are generally treated as infinitely persistent in the environment and unaffected by naturally occurring degradation. Metals that adhere to surface soils may be transported via surface water runoff. The absence of metals outside of AOC 1 at equal or greater concentrations suggests that airborne transport of contaminated surface soil at the site is not significant.

Surface Water Transport

Surface water transport of contaminated soil is possible, but laterally limited by heavy vegetation and the extensive drainage ditch system. The fate of identified constituents in surface water is inversely affected by degradation via natural attenuation and accumulation via overland flow in drainage ditches. There are no potential transport mechanisms that would cause impacted surface water to migrate from AOC 6. Overland flow may have transported COPCs in surface soil via surface drainage pathways to AOC 6.

8.0 HUMAN HEALTH RISK ASSESSMENT

The following provides a summary of the HHRA which is included in **Appendix I** of this report.

8.1 Objective

The objective of HHRA is to evaluate potential human health risk under current and potential future conditions at the OCCP. Specific objectives include:

- Outlining the regulatory basis and guidance for conducting the HHRA
- Outlining the methods for determining COPCs for the HHRA and identify COPCs for human receptors
- Developing a conceptual site model that characterizes relevant contaminant pathways and receptors of concern
- Calculating potential carcinogenic and non-carcinogenic risk to receptors of concern (e.g., any human contact at the site under present or future scenarios)
- Identifying areas or media that pose no unacceptable risks to human health and require no further action
- Determining COCs that contribute significantly to overall site risks, which will be used to determine risk-based preliminary remediation goals in the FS
- Providing baseline risks for the no action alternative in the FS that are used to evaluate risk reduction for each proposed alternative

Following USEPA Risk Assessment Guidance for Superfund (USEPA, 1989), the HHRA methodology involves a four-step process: data evaluation and hazard identification, exposure assessment, toxicity assessment, and risk characterization.

8.2 Methodology

The purpose of the HHRA is to evaluate potential human health concerns for exposure to environmental media within the OCCP affected by past activities related to the former LOOW. To determine human health concerns, the HHRA evaluates potential sources of contamination and routes of migration based on current and potential future site uses. The HHRA results are based upon potential exposure pathways that can occur or are reasonably likely to occur in the future within the OCCP. Risks determined in the HHRA are considered baseline risks associated with exposure to the OCCP site media. The baseline risk assumes no remedial actions or other means of exposure reduction (i.e., the use of personal protective equipment, digging restrictions, etc.). The HHRA evaluates the reasonable maximum exposure (RME) that has the potential to occur at the site. Therefore, HHRA results are considered potential and should be used as a guideline in making risk management decisions.

The HHRA followed the technical protocols presented in the *Technical Memorandum No. 1, Occidental Chemical Corporation Property – Human Health Risk Assessment Work Plan Addendum* (USACE, 2012b), which is an addendum to the *Final Human Health Risk Assessment Work Plan For Phase IV Remedial Investigation/Feasibility Study At The Former Lake Ontario Ordnance Works, Niagara County, New York* (USACE, 2009e).

Following USEPA guidance (1989), the HHRA methodology involves a four-step process: data evaluation and hazard assessment, exposure assessment, toxicity assessment, and risk characterization.

8.2.1 Data Evaluation and Hazard Assessment

In the data evaluation and hazard assessment, all available environmental data for the site are compiled and reviewed. The site environmental data are analyzed for data quality and compared to risk-based screening values and background concentrations. Through this comparison, COPCs are identified for evaluation in the HHRA. COPCs for human health were identified within surface soil, subsurface soil, and total soil within AOC 1. No COPCs were identified above background concentrations for AOC 3, AOC 4, and AOC 5, with the exception of arsenic in subsurface soil at AOC 4. However, due to the limited data set (three samples), and because only one of the reported arsenic concentrations was above the background UPL, arsenic was not carried through as a COPC. Furthermore, the maximum concentration of arsenic in AOC 4 is less than the NFSS BTV of 8.73 mg/kg in soil. In addition, COPCs were identified in a surface water and sediment sample collected from AOC 6 (Pond 2). No COPCs for human health were identified in AOC 2 (Pond 1). Therefore, two exposure areas were carried forward for evaluation of risk: AOC 1 (EU 8); and AOC 6 (Pond 2) which was qualitatively evaluated.

8.2.2 Exposure Assessment

In the exposure assessment, the receptors of concern and potential exposure pathways are identified. The COPCs in site environmental media are converted into systemic doses, taking into account contaminant concentrations, rates of contact (e.g., ingestion rates), and absorption rates of different COPCs. The magnitude, frequency, and duration of these exposures are then integrated to obtain estimates of daily doses over a specified period of time (e.g., lifetime, activity-specific duration). Receptors identified for the OCCP include adolescent and adult trespasser, maintenance worker, commercial worker, construction worker, and resident adult and child. Media of concern included surface soil, total soil (surface and subsurface soil combined), surface water, and sediment. Soil exposure pathways evaluated in the HHRA included incidental ingestion, dermal contact with, and inhalation of air particulates from soil, ingestion of home grown produce, and ingestion of game (deer) meat. Surface water and sediment were evaluated qualitatively for potential incidental ingestion and dermal contact.

8.2.3 Toxicity Assessment

The toxicity assessment considers the types of potential adverse health effects associated with exposures to COPCs, the relationship between the magnitude of exposure and potential adverse effects, and related uncertainties, such as the weight of evidence of a particular COPC's carcinogenicity in humans. Both non-carcinogenic and carcinogenic effects were considered in the HHRA.

8.2.4 Risk Characterization

In this step, the toxicity values from the toxicity assessment are combined with the calculated chemical intakes from the exposure assessment for receptor populations to quantitatively estimate both carcinogenic and non-carcinogenic risks. Risks were calculated for each receptor of concern identified for the OCCP. Carcinogenic risks and non-carcinogenic hazards are evaluated for each receptor on a cumulative basis across all pathways and media. Carcinogenic risk results are compared to the USEPA carcinogenic "acceptable risk range" of 10^{-4} to 10^{-6} . For

non-carcinogens, a threshold of 1.0 is utilized. Unacceptable risks for potential receptors are identified when cumulative carcinogenic risks exceed the upper bound of the “acceptable risk range” (i.e., 10^{-4}) or cumulative non-carcinogenic hazards exceed 1.0, based upon a target organ breakdown.

8.3 Results for EU 8 (AOC 1)

Calculations for EU 8 (AOC 1) are presented by receptor in **Tables I-7.1 through I-7.7** of the HHRA (**Appendix I**). **Table I-7.8** in **Appendix I** presents the estimation of air concentrations of particulates from soil. **Table I-7.9** in **Appendix I** presents the estimation of contaminant concentrations in home-grown produce. **Table I-7.10** in **Appendix I** presents the estimation of contaminant concentrations in game meat.

For EU 8, estimates of cumulative risks across all pathways for non-carcinogenic and carcinogenic effects for all receptors are presented in **Tables I-9.1 through I-9.6** of the HHRA (**Appendix I**). **Tables I-9.1 through I-9.6** in **Appendix I** also present a summary of non-carcinogenic risk for target organs across all media evaluated. A summary of significant contributors to risk is presented in **Tables I-10.1 through I-10.6** in **Appendix I**. COCs for human health are only identified on **Tables I-10.1 through I-10.6** in **Appendix I** if cumulative carcinogenic risks are greater than the target risk range of 10^{-6} to 10^{-4} or cumulative non-carcinogenic risks are greater than 1.0. Significant contributors to risk are identified as COCs with carcinogenic risks greater than 10^{-6} or non-carcinogenic risks greater than 0.1.

Lead

Lead is considered a COPC in both surface and total soil within EU 8. Lead was evaluated through the use of blood-lead modeling. The USEPA software program, Integrated Exposure Uptake Biokinetic (IEUBK) Lead Model, was used for predicting blood lead levels in resident children 0-7 years of age. The model output is a probability distribution function describing the percentage of children predicted to have blood-lead levels exceeding 10 micrograms per deciliter ($\mu\text{g}/\text{dL}$). To achieve a specific level of protectiveness, the USEPA has established that no more than a 5 percent probability of children exposed to lead would exceed a blood lead level of 10 $\mu\text{g}/\text{dL}$ (USEPA, 1994). The IEUBK Lead Model was used to evaluate the resident and trespasser exposure to lead in soil at the site.

For estimating blood-lead levels in site workers, the USEPA Technical Review Workgroup (TRW) for Lead developed a model to predict blood-lead levels in adult workers and their potential children (USEPA, 2003 and USEPA, 2009). This model is run to assess potential workers under a commercial setting. The TRW adult lead model was used to evaluate all potential worker exposure to the OCCP, which includes commercial, maintenance, and construction workers.

8.4 Surface Water and Sediment

Surface water and sediment were evaluated qualitatively through a comparison to the USEPA RSLs because only one sample results was available. Additionally, 10 out of 37 surface soil samples had detected concentrations of lead above 400 mg/kg. Sediment and surface water at the OCCP was evaluated qualitatively. The qualitative evaluation found no risks for human contact with surface water and sediment.

8.5 Conclusions

For EU 8, cumulative carcinogenic risks do not exceed the USEPA acceptable risk range for the adult and adolescent trespasser, maintenance worker, commercial worker, and construction worker. The cumulative carcinogenic risks exceed the USEPA acceptable risk range at EU 8 for the resident adult and child. Carcinogenic risks are driven by 2,4,6-TNT and hexavalent chromium in surface and subsurface soil (i.e., total soil).

All receptors have non-carcinogenic hazards above the threshold of 1.0 for EU 8. Non-carcinogenic hazards are almost exclusively due to 2,4,6-TNT.

2,4,6-TNT was detected in 23 out of 54 soil samples. The calculated risks for 2,4,6-TNT are skewed due to the maximum detected concentration of 19,000 mg/kg (sample location C2-OXY-SO-P22-2).

As noted in the HHRA (**Appendix I**), there are numerous uncertainties involved in the HHRA process. Uncertainties are associated with each of the 4-steps in the HHRA methodology: data evaluation and hazard assessment, exposure assessment, toxicity assessment, and risk characterization. These uncertainties and potential effects on the HHRA results are discussed further in **Appendix I**, Section 4. Most of the uncertainties are considered minimal and do not have an effect on the HHRA conclusions. However, there are significant uncertainties associated with the toxicity assessment for hexavalent chromium.

For carcinogenic risks associated with hexavalent chromium, there are potential uncertainties with the oral slope factor and the assumption of a mutagenic mode of action. The oral slope factor and mutagenic mode of action were derived from two Tier 3 sources, the New Jersey Department of Environmental Protection (NJDEP) and the USEPA Office of Pesticides Programs, respectively. A recent USEPA peer-review of the hexavalent chromium oral SF and mutagenic mode of action found significant uncertainty in the derivation of the oral slope factor and the finding that hexavalent chromium has a mutagenic mode of action (USEPA, 2012). The USEPA has undertaken a revision of the oral slope factor and analysis of the mutagenicity of hexavalent chromium (USEPA, 2012). However, the final results of the hexavalent chromium revision will not be available until 2015 (USEPA, 2012). It is estimated that the carcinogenic risk results for hexavalent chromium are most likely overestimated based upon the application of a mutagenic mode of action alone. The effects of the oral slope factor on the overall carcinogenic risk results cannot be determined at this time.

These uncertainties associated with hexavalent chromium toxicity are in addition to the potential high-bias in reporting hexavalent chromium concentrations identified in Section 5.1.3 of this report.

In addition to the above findings, lead in both surface soil and total soil were evaluated through the use of a USEPA model for evaluating risks from exposure to lead for a hypothetical resident child. The resident child exposure is assumed to contact total soil; however, an evaluation of surface soil was also completed because all lead detections above the USEPA CERCLA and RCRA lead soil guidance levels of 400 ppm are within surface soil. This evaluation indicated that lead in surface soil in EU 8 is a potential concern for human health. The maximum detected concentration of lead, 2,760 mg/kg, was detected in sample location C10-GS2-SO-10-0.5.

Table 8-1 summarizes the overall risks and preliminary COCs for EU 8 (pending further confirmation of the presence of hexavalent chromium at the site). Analytical results for these COCs (2,4,6-TNT, hexavalent chromium, and lead) are presented in **Figure 8-1**.

Table 8-1. Summary of HHRA Results for EU 8				
Receptor	HHRA Results		Exposure Media Contributing to Risk	COCs Contributing Significantly to the Results
Adult Trespasser	Cancer Risk	2×10^{-5}	N/A	N/A
	Non-Cancer Hazard Index	2	soil	2,4,6-trinitrotoluene
Adolescent Trespasser	Cancer Risk	2×10^{-5}	N/A	N/A
	Non-Cancer Hazard Index	7	soil	2,4,6-trinitrotoluene
Adult Maintenance Worker	Cancer Risk	6×10^{-5}	N/A	N/A
	Non-Cancer Hazard Index	9	soil	2,4,6-trinitrotoluene
Adult Commercial Worker	Cancer Risk	4×10^{-5}	N/A	N/A
	Non-Cancer Hazard Index	7	soil	2,4,6-trinitrotoluene
Adult Construction Worker	Cancer Risk	1×10^{-5}	N/A	N/A
	Non-Cancer Hazard Index	45	soil	2,4,6-trinitrotoluene
Child Resident ¹	Cancer Risk	5×10^{-4}	soil	2,4,6-trinitrotoluene hexavalent chromium
	Non-Cancer Hazard Index	141	soil	2,4,6-trinitrotoluene
	Lead Exposure	---	soil	lead
Adult Resident ¹	Cancer Risk	5×10^{-4}	soil	2,4,6-trinitrotoluene hexavalent chromium
	Non-Cancer Hazard Index	14	soil	2,4,6-trinitrotoluene
Legend:				
N/A – Not applicable				
1 – Cancer risk for the resident adult and child are presented as a total lifetime cancer risk				

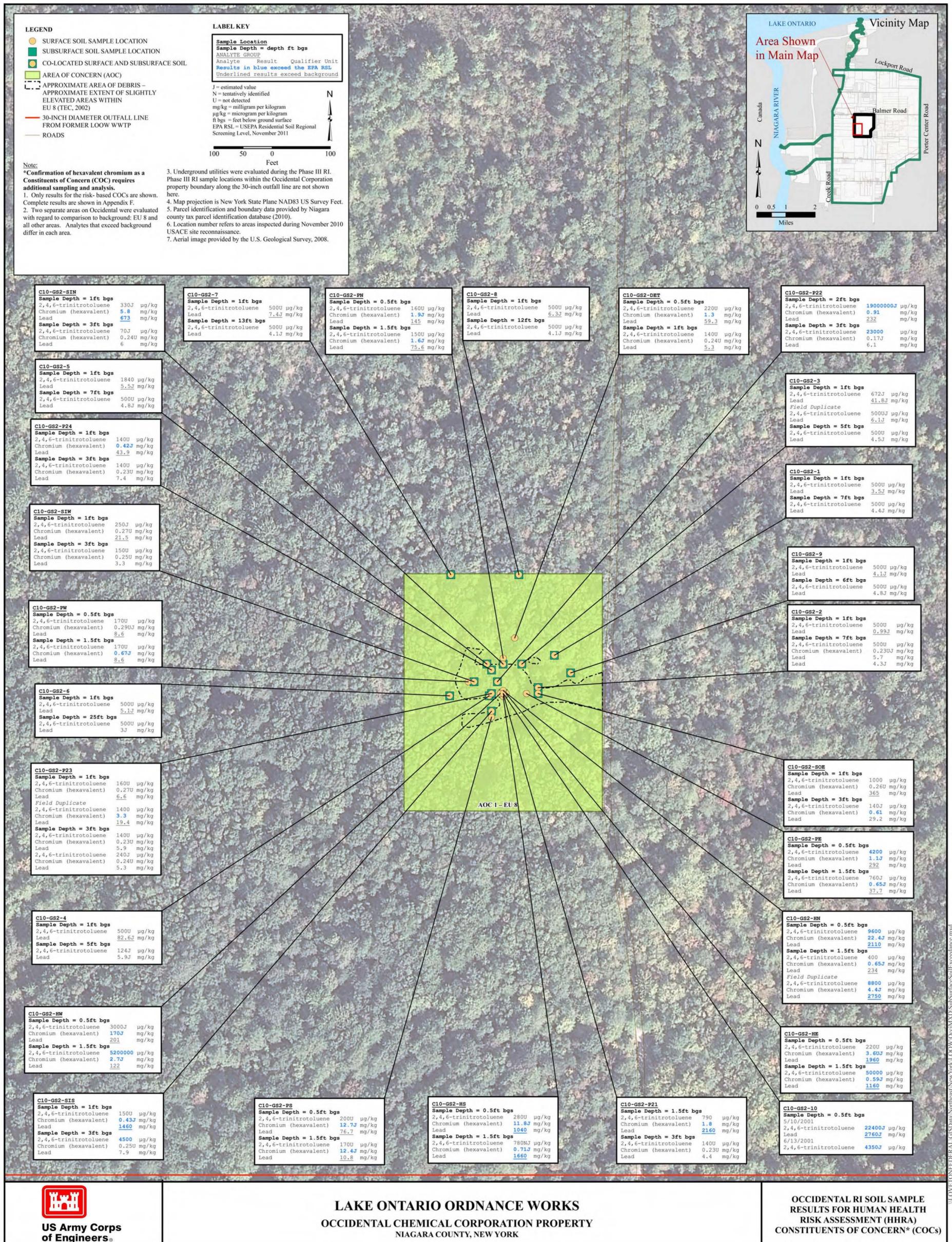


Figure 8-1. Summary of HHRA Results for EU 8

9.0 SCREENING LEVEL ECOLOGICAL RISK ASSESSMENT

The following provides a summary of the SLERA included as **Appendix J** in this OCCP RI report.

9.1 Objective

The objective of this SLERA is to determine whether a more detailed, site-specific assessment is warranted, or whether no further consideration is required. As an initial evaluation, this screening level assessment is very precautionary. For example, maximum or other upper bound chemical concentrations are used as exposure concentrations, rather than the average. Also, the lowest available toxicological benchmarks are often used. These and other conservative decisions serve to minimize removal of chemicals from the assessment when in fact they pose risk. Conversely, the most conservative screening assessments result in carrying forward many chemicals that do not actually pose risk.

Surface soil (0 to 2 ft bgs) is the primary exposure medium addressed herein. There are former farm ponds (AOC 2 and AOC 6) that provide aquatic habitat within the OCCP and are evaluated in this assessment; therefore surface water and sediment are pertinent exposure media. Subsurface soil is not addressed because there are no significant complete pathways to ecological receptors.

In accordance with the Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments (USEPA, 1997) and Risk Assessment Handbook Volume II: Environmental Evaluation (USACE, 1996), the SLERA follows established protocols by implementing a very conservative “screening” of chemical concentrations at a site during the beginning of assessing potential risk.

9.2 Methodology

The areas included for investigation were evaluated based on potential exposure for ecological receptors. Unlike a human health risk assessment, protection of ecological receptors is based on protection of the population, rather than individual organisms. Previous SLERAs for the former LOOW defined potential exposure areas based upon area proximity, contaminant type and distribution, history. AOC 1 – EU 8 was identified for initial investigation in 2001, as a separate exposure area due to high concentrations of constituents and suspected site history. AOC 3 and AOC 5 were similar in the type and concentrations of reported constituents. Area of interest AOC 4 generally had higher concentrations of constituents than AOC 3 and AOC 5, but concentrations were much lower than those reported in AOC 1. Therefore, two exposure areas were evaluated in this SLERA: AOC1 (EU 8), and the combined AOC 3, AOC 4, and AOC 5. A screening process is typically employed to identify chemical constituents that may pose risk at a site. The screening process described below was performed for the two exposure areas: EU 8 and the combined AOC 3, AOC 4, and AOC 5. In addition, AOC 2 and AOC 6 (Pond 1 and 2, respectively) were also evaluated. The risk-based screen consisted of dividing the maximum chemical concentration by the screening benchmark shown in **Table 5-1** in **Appendix J** for surface soil and **Table 5-2** in **Appendix J** for surface water and sediment to produce a hazard quotient (HQ):

$$HQ = \frac{\text{Maximum Concentration}}{\text{Screening Benchmark}}$$

If the concentration is less than the benchmark, the HQ will be less than 1, and negligible risk is inferred. If the concentration exceeds the benchmark, the HQ will be greater than 1, suggesting the potential for risk; therefore that chemical constituent is designated as a COPC.

Bioaccumulative DDT and metabolites have been identified as COPCs even though they do not exceed the risk screening values. Soil benchmarks represent the lowest available screening value provided by USEPA Eco SSLs; where these were not available, precautionary benchmarks were derived from other sources (**Table 5-1 in Appendix J**). Surface water and sediment benchmarks represent water quality criteria and sediment screening values from appropriate sources respectively (**Table 5-2 in Appendix J**).

9.3 Results

If a given chemical constituent was not detected at all, it was not carried through the risk assessment screening. Chemical constituents represent a source of uncertainty only if the detection limit is greater than the screening value (see Chapter 8 in **Appendix J**). The results of the risk-based screening of detected chemical constituents for the areas of interest in OCCP and EU 8 are presented in **Tables 5-3 through 5-8 in Appendix J** and are summarized below. As indicated in the tables, a number of chemicals were identified as COPCs for ecological receptors because there were no available screening ecotoxicity values. It is conventional to carry such chemicals forward in a risk assessment on the assumption of potential risk. Because of the absence of screening values, risks to lower trophic level terrestrial plants and soil invertebrates cannot be assessed; however, food-web based ecotoxicity data exist for many of those chemicals. Therefore they are maintained as COPCs for ecological receptors at least through the food-web exposure assessment.

9.3.1 COPCs for EU 8 (AOC 1)

Shown in **Table 5-3 in Appendix J**, the final list of COPCs for ecological receptors in EU 8 surface soil includes 13 explosives (i.e., 1,3,5-trinitrobenzene, 1,3-dinitrobenzene, 2,4,6-TNT, 2,4-DNT, 2,6-DNT, 2-amino-4,6-dinitrotoluene, 2-nitrotoluene, 3-nitrotoluene, 4-amino-2,6-dinitrotoluene, 4-nitrotoluene, cyclotetramethylenetetranitramine [HMX], RDX, and tetryl), 17 metals (i.e., antimony, arsenic, barium, boron, cadmium, chromium [hexavalent], cobalt, copper, lead, lithium, manganese, mercury, nickel, selenium, thallium, vanadium and zinc), one pesticide (i.e., DDT and metabolites), and three VOCs (i.e., 2-butanone, acetone, and styrene). Of the 17 metals identified as COPCs for AOC 1 - EU8, seven (arsenic, cobalt, lithium, manganese, mercury, selenium, and vanadium) were similar to background metal concentrations.

9.3.2 COPCs for AOC 2, AOC 3, AOC 4, AOC 5, and AOC 6

Surface soil COPCs at AOC 3, AOC 4, and AOC 5 are identified in **Table 5-4 in Appendix J**, and include eight metals (i.e., cadmium, copper, lead, lithium, manganese, selenium, vanadium, and zinc), and due to the absence of screening values 12 VOCs (i.e., 1,4-dichlorobenzene, 2-butanone, 4-isopropyltoluene, acetone, ethyl benzene, methyl acetate, methylene chloride, m,p-xylene, o-xylene, tert-butylbenzene, toluene, total xylenes) and one SVOC (i.e., carbazole). Of the eight metals listed above, three (lithium, manganese, and vanadium) concentrations were similar to background.

COPCs for ecological receptors in sediment and surface water at AOC 6 are shown in **Tables 5-5 and 5-6** respectively in **Appendix J**. Only copper and nickel were identified as COPC in sediment (**Table 5-5** in **Appendix J**), showing very slight exceedances of the risk screening value. In surface water the surface water concentration of 11 metals (i.e., aluminum, barium, cobalt, copper, iron, lead, lithium, manganese, silver, vanadium, and zinc) exceeded risk screening values. However, as noted, these represented total metals, and risk screening values for metals in surface water are best represented by dissolved metals. Because only one sample of this surface water was taken, and sediment did not show significant numbers of COPCs, it is not known if this extensive metal list of COPC in AOC 6 is significant.

AOC 2 was sampled in 2001, and analyzed for explosives, boron, lithium and radionuclide constituents (**Table 5-7** and **Table 5-8** in **Appendix J** for sediment and surface water, respectively). Radionuclides were detected. The screening values used in the SLERA for the radionuclides represent background, not risk screening values (**Table 5-2** in **Appendix J**). No radionuclide constituents in sediment or surface water exceeded the background values, and AOC 2 can no longer be located, apparently having filled in by natural processes.

9.4 Conclusions

EU 8 was found to have high concentrations of metals and explosives, to the extent that lower trophic level receptors (e.g., plants and invertebrates) and higher trophic level receptors (e.g., shrew, rabbit, robin, and hawk) are potentially at risk from this exposure. While no physical appearance of damaged vegetation was apparent at EU 8, this does not preclude impacts to other receptors or even plants. Colonization of the site by more resistant plant species could have occurred, resulting in the appearance of viable vegetation, when there have been changes to the system. Given the high HQs exhibited at EU 8, continuation of the risk assessment process is recommended for this area.

As discussed in the risk assessments, potential risk to both human health and ecological receptors was found at EU8. Therefore, it is recommended that remedial action objectives for EU8 be based on protection of human health. It is expected that compliance with waste management regulations and human health standards will require remediation of elevated concentrations of COCs at EU8. Reduction of these concentrations will concurrently decrease risks to ecological receptors, and any residual risks to ecological receptors will be re-assessed and documented based on post-remediation confirmation samples.

Alternatively, negligible risk was found from exposure to chemicals in soil, sediment, and surface water for any ecological receptors at AOC 2, AOC 3, AOC 4, AOC 5, and AOC 6. AOC 3 and AOC 5 exhibited the lowest concentrations. AOC 4, adjacent to EU 8, had the highest concentrations. No further study of AOC 2, AOC 3, AOC 4, AOC 5, and AOC 6 with regard to ecological risk should be necessary.

10.0 SUMMARY AND CONCLUSIONS

10.1 Summary

Risk-based screening criteria for surface soil, subsurface soil, sediment and surface water were utilized as conservative screening values to evaluate constituents detected in environmental samples collected during the comprehensive OCCP RI. In addition, site-specific soil screening values for the protection of groundwater and a statistical comparison of background concentrations were used to further evaluate detected constituent concentrations.

RI sampling was performed during 2001 (Phase II RI), 2010, and 2011 field activities. Surface soil, subsurface soil, and/or surface water and sediment samples were collected from six AOCs at the site (**Figure 4-3**). Sample locations were initially established using a biased sampling approach and were selected based on historical site data and site reconnaissance. Additional field screening for explosives was performed in a systematic manner.

10.1.1 Field Screening Results

Field screening of samples was performed prior to submittal for laboratory analysis. Results of field screening with a PID indicated a single detectable concentration of TOV. During 2010 RI activities, 96 surface sample locations were field screened via a DropEx[®], a non-aerosol explosives detection kit. None of the 96 individual surface samples screened in AOC 1 reacted positively, which would have indicated the presence explosives.

10.1.2 Field Sampling Results

Fifty-one surface soil samples were collected from 37 locations and submitted for laboratory analysis. An SVOC, explosives, metals and radionuclide measurements were detected greater than the project screening criteria. The following presents a summary of COPC concentrations greater than project screening criteria by AOC:

- AOC 1
 - One SVOC (i.e., benzo(a)pyrene)
 - Eight explosives (i.e., 1,3-dinitrobenzene; 2,4,6- TNT; 2,4-DNT; 2,6-DNT; 2-amino-4,6-DNT, 2-nitrotoluene, 4-amino-2,6-DNT, and RDX)
 - Sixteen metals (i.e., aluminum, antimony, arsenic, barium, cadmium, chromium [hexavalent], cobalt, copper, iron, lead, lithium, manganese, nickel, thallium, vanadium, and zinc)
 - Radionuclide measurements (i.e., gross alpha and gross beta)
- AOC 3
 - One SVOC (i.e., benzo(a)pyrene)
 - Seven metals (i.e., aluminum, arsenic, cobalt, iron, lithium, manganese, and thallium)
- AOC 4
 - Seven metals (i.e., aluminum, arsenic, cobalt, iron, lithium, manganese, and thallium)

- AOC 5
 - One SVOC (i.e., benzo(a)pyrene)
 - Seven metals (i.e., aluminum, arsenic, cobalt, iron, lithium, manganese, and thallium)

Subsurface Soil Sample Results

Twenty-six subsurface soil samples were collected from 24 locations at the OCCP and submitted for laboratory analysis. Explosives and TAL metals in subsurface soil were detected at concentrations greater than the project screening criteria. The following presents a summary of COPC concentrations greater than project screening criteria by AOC:

- AOC 1
 - One explosive (i.e., 2,4,6-TNT)
 - Eight metals (i.e., aluminum, arsenic, chromium [hexavalent], cobalt, iron, lithium, manganese, and thallium)
- AOC 3
 - Seven metals (i.e., aluminum, arsenic, cobalt, iron, lithium, manganese, and thallium)
- AOC 4
 - Seven metals (i.e., aluminum, arsenic, cobalt, iron, lithium, manganese, and thallium)
- AOC 5
 - Four metals (i.e., arsenic, cobalt, iron, and manganese)

Surface Water Results

One surface water sample was collected from each of two ponds (AOC 2 and AOC 6). A TCL SVOC, explosives, and metal analytes in surface water were detected at concentrations greater than project screening criteria. The following presents a summary of COPC concentrations greater than project screening criteria by AOC:

- AOC 2
 - None
- AOC 6
 - One SVOC (i.e., 4-methylphenol)
 - Two explosives (i.e., 3-nitrotoluene and RDX)
 - Seventeen metals (i.e., aluminum, arsenic, barium, beryllium, cadmium, chromium, cobalt, copper, iron, lead, lithium, manganese, nickel, potassium, silver, vanadium, and zinc)

Sediment Results

One sediment sample was collected from each of two ponds (AOC 2 and AOC 6). TCL VOCs and metals were detected at concentrations greater than project screening criteria. The following presents a summary of COPC concentrations greater than project screening criteria by AOC:

- AOC 2
 - None
- AOC 6
 - Two VOCs (i.e., 2-butanone and acetone)
 - Seventeen metals (i.e., aluminum, arsenic, barium, beryllium, cadmium, chromium, cobalt, copper, iron, lead, lithium, manganese, nickel, potassium, silver, vanadium, and zinc)

Potential Impact to Groundwater

Iron was detected above the site-specific protection of groundwater values in each of the 26 subsurface soil samples collected. Iron is a naturally occurring element, typically associated with glacial deposits common to western New York. Iron concentrations exceeding the USEPA RSL for Tapwater (11,000 µg/L) may cause characteristic red staining or other aesthetically displeasing characteristics (e.g. foul odor and taste). Iron does not have an established USEPA MCL and is not considered a national drinking water contaminant and is not considered for further reevaluation in regards to potential impacts to groundwater.

No other constituent was detected at concentrations above the site-specific protection of groundwater values. Therefore, based on the data presented in this OCCP RI Report, there are no potential impacts to groundwater considerations that should be addressed further.

10.1.3 Risk Assessment Results

HHRA

Results of the HHRA indicate that no parameters exceeded the carcinogenic or non-carcinogenic risk thresholds for any receptors at AOC 3, AOC 4, or AOC 5. At AOC 1 – EU 8, no parameters exceeded the carcinogenic risk thresholds for the adult and adolescent trespasser, maintenance worker, commercial worker, and construction worker. Cumulative carcinogenic risks exceeded the USEPA acceptable risk range for the resident adult and child. These risks were driven by 2,4,6-TNT in total soil. Potential carcinogenic risk was also determined for resident exposure to hexavalent chromium in surface and subsurface soil (i.e., total soil). However, there is uncertainty about both the hexavalent chromium oral SF and the mutagenic mode of action. Hexavalent chromium in soil was analyzed using USEPA Method 7196A, which is a colorimetric method, and significant uncertainty surrounded the results obtained. Based upon these uncertainties, it is expected that hexavalent chromium carcinogenic risks are overestimated. These uncertainties and expected overestimation are in addition to the potential high-bias identified for non-detects and low reported concentrations of hexavalent chromium. More defensible hexavalent chromium data should be obtained to verify if it is indeed a COC in EU8 soil. Additional sampling and analysis for hexavalent chromium should be completed prior to completion of a remedial FS to establish whether or not hexavalent chromium is retained as a COC.

All receptors at AOC 1 – EU 8 had potential risk above the non-carcinogenic threshold of 1.0, which was almost exclusively due to 2,4,6-TNT.

In addition to the above findings, the lead evaluation for AOC 1 – EU 8 surface soil found a mean blood lead level of 5.25 µg/dL in surface soil with 8.5 percent exceeding the 10 µg/dL blood for a resident child. This indicates that lead is a potential concern for surface soil. Lead in both surface soil and total soil were evaluated through the use of the IEUBK model for the resident child. The resident child exposure is assumed to contact total soil; however, an evaluation of surface soil was also completed because all lead detections above the USEPA RSL are within surface soil.

SLERA

Sediment and surface water at AOC 2 and AOC 6 were evaluated qualitatively. The qualitative evaluation found no concerns for human contact with surface water and sediment.

The results of the SLERA found that AOC 1 – EU 8 at the OCCP has high concentrations of metals and explosives, to the extent that lower trophic level receptors (plants and invertebrates) as well as higher trophic level receptors (shrew, rabbit, robin, and hawk) are potentially at risk from this exposure. While no physical appearance of damaged vegetation was apparent at AOC 1 – EU 8, this does not preclude impacts to other receptors or even plants. Colonization of the site by more resistant plant species could have occurred, resulting in the appearance of viable vegetation, when there have been changes to the system. Given the high HQs exhibited at AOC 1 – EU 8, continuation of the risk assessment process is recommended for this area.

10.2 Conclusions

Negligible risk was determined from exposure to constituents in soil, sediment, and surface water for any receptors at AOC 2, AOC 3, AOC 4, AOC 5, and AOC 6. No further environmental action or management is recommended for these AOCs.

Unacceptable additional risk associated with constituent concentrations detected at AOC 1 – EU 8 requires further environmental action and management. A remedial FS is recommended for total soil, and should also consider all fill material and redistributed soil. Based on sampling completed during this RI, concentrations exceeding risk based criteria for human health extend to a depth of 3 ft bgs. Risk outside of the acceptable range were identified for the adult trespasser, adolescent trespasser, maintenance worker, commercial worker, construction worker, resident adult, and resident child (receptors) from exposure to 2,4,6-TNT in surface soil. Non-carcinogenic hazards are almost exclusively due to 2,4,6-TNT. Carcinogenic risks were driven by 2,4,6-TNT and hexavalent chromium in surface and subsurface soil. Although carcinogenic risk is associated with hexavalent chromium, results for hexavalent chromium are considered subjective due to potential analytical method interference, DoD operations at the OCCP did not include activities considered a source of hexavalent chromium, and the most probable fate of hexavalent chromium in the environment for over 65 years (time period since the last DoD operations at the former LOOW) being trivalent chromium. Hexavalent chromium may be reduced and immobilized in the subsurface as a result of interaction with naturally existing reductants.

Recommendations for future action are summarized in Table 10-1.

Table 10-1. Recommendations for Future Action

AOC	Matrix	Recommendation
AOC 1 – EU 8	surface soil	Remedial FS
	subsurface soil	Remedial FS
AOC 2	surface water	NFA
	sediment	NFA
AOC 3	surface soil	NFA
	subsurface soil	NFA
AOC 4	surface soil	NFA
	subsurface soil	NFA
AOC 5	surface soil	NFA
	subsurface soil	NFA
AOC 6	surface water	NFA
	sediment	NFA
<p><i>Legend:</i> AOC = area of concern EU = exposure unit FS = feasibility study NFA = no further action</p>		

Within EU 8 the area of soil impacted by risk drivers exceeding screening criteria is approximately 30,000 square ft and is located in the vicinity of deteriorated steel 55-gallon drums. Based on sampling completed during this RI, concentrations exceeding risk based criteria for human health extend to a depth of 3 ft bgs. The concentrations reported in subsurface soil do not suggest there is an impact to groundwater. The total volume of soil exhibiting concentrations greater than USEPA RSLs is estimated to be 2,250 cubic yards.

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