LMS/FER/S13683

Fourth Five-Year Review Report for the Fernald Preserve

August 2016 – Final

U.S. DEPARTMENT OF ENERGY | Legacy Management

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Five-Year Review Report

Fourth Five-Year Review Report

for the

Fernald Preserve

Butler and Hamilton Counties, Ohio

Final August 2016

PREPARED BY:

U.S. Department of Energy
Office of Legacy Management

Approved by:

Susan Smiley

Susan Smiley
Fernald Preserve Manager
DOE-LM-20.1

Date:

8/25/2016

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Abbreviations

ARAR	applicable or relevant and appropriate requirement
BRSR	Baseline Remedial Strategy Report
BTV	benchmark toxicity value
CAWWT	Converted Advanced Wastewater Treatment
CCC	criterion continuous concentration
CDI	chronic daily intake
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	*Code of Federal Regulations*
CMC	criterion maximum concentration
COPEC	contaminant of potential ecological concern
CRARE	Comprehensive Response Action Risk Evaluation
CSF	cancer slope factor
D&D	decontamination and dismantling
DOE	U.S. Department of Energy
dpm	disintegration units per minute
ECOC	ecological constituent of concern
Eco-SSL	ecological soil screening level
EM	(DOE) Office of Environmental Management
EPA	U.S. Environmental Protection Agency
ERA	ecological risk assessment
ESD	Explanation of Significant Differences
ESL	Ecological Screening Level
FFCA	Federal Facility Compliance Agreement
FMPC	Feed Materials Production Center
FRL	Final Remediation Level
FS	Feasibility Study
FY	fiscal year
GMA	Great Miami Aquifer
gpad	gallons per acre per day
gpm	gallons per minute
HI	Hazard Index
HTW	horizontal till well

HQ	hazard quotient
HWMU	hazardous waste management unit
ILCR	Incremental Lifetime Cancer Risk
IRIS	Integrated Risk Information System
IROD	Record of Decision for Interim Action
IRRA	Interim Residual Risk Assessment
LCS	leachate collection system
LCV	lowest chronic value
LDS	leak detection system
LM	(DOE) Office of Legacy Management
LMICP	*Comprehensive Legacy Management and Institutional Controls Plan*
M gal	million gallons
MCL	maximum contaminant level
µg/L	micrograms per liter
mg/L	milligrams per liter
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
NRWQC	National Recommended Water Quality Criteria
NTS	Nevada Test Site (renamed Nevada National Security Site in 2010)
O&M	operations and maintenance
Ohio EPA	Ohio Environmental Protection Agency
OMZM	outside mixing zone maximum
ORNL	Oak Ridge National Laboratory
OSDF	On-Site Disposal Facility
OSWER	EPA Office of Solid Waste and Emergency Response
OU	operable unit
PCB	polychlorinated biphenyl
pCi/g	picocuries per gram
PFOA	perfluorooctanoic acid
PFOS	perfluorooctane sulfonate
RAIS	Risk Assessment Information System
RCRA	Resource Conservation Recovery Act
RfD	reference dose

RI	Remedial Investigation
RI/FS	Remedial Investigation/Feasibility Study
ROD	Record of Decision
SAV	secondary acute value
SCV	secondary chronic value
SDWA	Safe Drinking Water Act
SEP	Sitewide Excavation Plan
SER	Site Environmental Report
SQuiRTs	Screening Quick Reference Tables
TCLP	Toxicity Characteristic Leaching Procedure
WAC	Waste Acceptance Criteria

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Executive Summary

This fourth five-year review is the second review to be conducted after physical completion of remedial actions at the Fernald Preserve in Harrison, Ohio, on October 29, 2006. At that time, remedial actions for Operable Units (OUs) 1 through 4 were complete, and the groundwater remedy being implemented under OU5 was determined operational and functional. OUs 1 through 4 were considered source OUs, and OU5 addressed the contaminated media affected by past site operations and waste disposal practices. The OUs were defined as follows:

- **OU1, Waste Pit Area:** Waste Pits 1 through 6, Clearwell, Burn Pit, berms, liners, and affected soil within the OU boundary.
- **OU2, Other Waste Units:** The Active and Inactive Flyash Piles, the South Field disposal area, north and south Lime Sludge Ponds, the Solid Waste Landfill, and the berms, liners, and affected soil within the OU boundary.
- **OU3, Former Production Area:** Former production and production-associated facilities and equipment, including all above- and below-grade improvements.
- **OU4, Silos 1 through 4:** Contents of Silos 1, 2, 3 (Silo 4 has remained empty); the silo structures, berms, decant sump tank system, and affected soil within the OU boundary.
- **OU5, Environmental Media:** Groundwater, surface water, all soil not included in the definitions of OUs 1 through 4, sediment, and flora and fauna.

The focus of this five-year review is to ensure that the remedies completed for OUs 1 through 4 remain protective of human health and the environment, the performance of the On-Site Disposal Facility meets design criteria, the ongoing groundwater remedy is performing to design expectations, and the required institutional controls are being implemented and are effective. A review of all available operational data, environmental monitoring data, and site inspection reports since November 2011 is the basis for the following conclusions:

- The remedies completed for OUs 1, 2, 3, and 4 continue to be protective of human health and the environment.
- The groundwater remedy conducted under OU5 is currently protective of human health and the environment. However, in order for the remedy to be protective in the long term following completion of the groundwater remedy, an investigation of the site will be performed to evaluate the potential for releases of perfluorinated compounds (PFCs), primarily perfluorooctane sulfonate (PFOS) and perfluorooctanoic acid (PFOA).

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Five-Year Review Summary Form

SITE IDENTIFICATION		
Site Name: Feed Materials Production Center		
EPA ID: OH6890008976		
Region: 5	State: OH	City/County: Hamilton and Harrison/Butler and Hamilton

SITE STATUS	
NPL Status: Final	
Multiple OUs? Yes	Has the site achieved construction completion? Yes

REVIEW STATUS
Lead agency: Other Federal Agency If "Other Federal Agency" was selected above, enter Agency name: U.S. Department of Energy
Author name (Federal or State Project Manager): Susan Smiley
Author affiliation: U.S. Department of Energy Office of Legacy Management
Review period: September 16, 2015–December 31, 2015
Date of site inspection: March 12, 2015; June 3, 2015; September 3, 2015; December 8, 2015
Type of review: Statutory
Review number: 4
Triggering action date: 9/13/2011
Due date (five years after triggering action date): 9/13/2016

Five-Year Review Summary Form (continued)

The table below is for the purpose of the summary form and associated data entry and does not replace the two tables required in Section VIII and IX by the FYR guidance. Instead, data entry in this section should match information in Section VII and IX of the FYR report.

Issues/Recommendations

OU(s) without Issues/Recommendations Identified in the Five-Year Review:
1, 2, 3, and 4

Issues and Recommendations Identified in the Five-Year Review:

OU(s): 5	**Issue Category: Monitoring**			
	Issue: Presence or absence of perfluorinated compounds (PFCs) including perfluorooctane sulfate (PFOS) or perfluorooctanoic acid (PFOA) due to the use of fire fighting suppression is unknown.			
OU(s): 5	**Recommendation:** 1) Submit for regulator review, a PFC (PFOA and PFOS) groundwater screening sampling plan to include a schedule for sampling and reporting. 2) Submit a comprehensive PFC investigation plan for regulator review.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
No	Yes	Federal Facility	EPA/State	1) December 31, 2016 2) March 31, 2018.

Issues and Recommendations Identified in the Five-Year Review:

OU(s): 5	**Issue Category: Operations and Maintenance**			
	Issue: Soils sitewide have been certified to meet FRLs established in the OU5 ROD, with the exception of the infrastructure footprint that supports aquifer restoration.			
OU(s): 5	**Recommendation:** Certify soil following removal of aquifer infrastructure including subgrade utility corridors and associated buildings.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
No	Yes	Federal Facility	EPA/State	2040

To add additional issues/recommendations here, copy and paste the above table as many times as necessary to document all issues/recommendations identified in the FYR report.

Five-Year Review Summary Form (continued)

Protectiveness Statement(s)
Include each individual OU protectiveness determination and statement. If you need to add more protectiveness determinations and statements for additional OUs, copy and paste the table below as many times as necessary to complete for each OU evaluated in the FYR report.

Operable Unit: 1	*Protectiveness Determination:* Protective
Protectiveness Statement: The remedy at OU1 is protective of human health and the environment. All known waste materials have been removed and disposed of permanently. The underlying soils have been certified to meet established final remediation levels (FRLs) pursuant to the OU5 ROD. Institutional Controls are specified in Section 6.1.6 and access controls are in place and effective in ensuring that the footprint of OU1 is used in accordance with the land use objectives and FRLs supporting those land use objectives.	

Operable Unit: 2	*Protectiveness Determination:* Protective
Protectiveness Statement: The remedy at OU2 is protective of human health and the environment. All waste materials have been removed and disposed of permanently. The underlying soils have been certified to meet established FRLs pursuant to the OU5 ROD. Institutional controls and access controls are in place and effective in ensuring that the footprint of OU2 is used in accordance with the land use objectives and FRLs supporting those land use objectives. The cap and liner systems of the On-Site Disposal Facility (OSDF) are functioning as designed and are successfully isolating the waste materials. The volume of leachate generated from the OSDF is continuing to decline, and the leachate is being effectively collected and treated to minimize impacts to human health and the environment.	

Operable Unit: 3	*Protectiveness Determination:* Protective
Protectiveness Statement: The remedy at OU3 is protective of human health and the environment. All waste materials and building debris have been removed and disposed of permanently. The underlying soils have been certified to meet established FRLs pursuant to the OU5 ROD. Institutional controls and access controls are in place and effective in ensuring that the footprint of OU3 is used in accordance with the land use objectives and FRLs supporting those land use objectives.	

Five-Year Review Summary Form (continued)

Operable Unit: 4	*Protectiveness Determination:* Protective
Protectiveness Statement: The remedy at OU4 is protective of human health and the environment. All waste materials have been removed and disposed of permanently. The underlying soils have been certified to meet established FRLs pursuant to the OU5 ROD. Institutional controls and access controls are in place and effective in ensuring that the footprint of OU4 is used in accordance with the land use objectives and FRLs supporting those land use objectives.	

Operable Unit: 5	*Protectiveness Determination:* Short-term Protective
Protectiveness Statement: The remedy at OU5 is currently protective of human health and the environment because exposure pathways that could result in unacceptable risks are being managed. Soils sitewide have been certified to meet FRLs established in the OU5 ROD, with the exception of the infrastructure footprint that supports aquifer restoration. Current groundwater monitoring data indicate that the groundwater remedy is functioning as required to achieve groundwater FRLs. The cap and liner systems of the On-Site Disposal Facility (OSDF) are functioning as designed and are successfully isolating the waste materials. The volume of leachate generated from the OSDF is continuing to decline, and the leachate is being effectively collected and treated to minimize impacts to human health and the environment. Institutional controls as specified in Section 6.1.6 and access controls are in place and effective in ensuring that the footprint of OU5 is used in accordance with the land use objectives and FRLs supporting those land use objectives. However, in order for the remedy to be protective in the long-term, the following actions need to be taken to ensure protectiveness: 1) perform an investigation of the site to evaluate the potential for releases of PFCs and 2) certify soils associated with the aquifer restoration infrastructure footprint.	

Sitewide Protectiveness Statement
Protectiveness Determination: Short-term Protective
Protectiveness Statement: The remedy at the Fernald Preserve site is currently protective of human health and the environment because exposure pathways that could result in unacceptable risks are being managed. All waste materials generated during remediation have been removed and disposed of permanently. The underlying soils have been certified to meet established FRLs except soils beneath two facilities (Converted Advanced Wastewater Treatment facility and South Field Valve House) and subgrade utility corridors needed to support the ongoing groundwater remedy. Institutional controls and access controls are in place and effective in ensuring that the footprint of OUs 1, 2, 3, 4, and 5 are used in accordance with the established land use objectives and the FRLs that support those land use objectives. In addition, for OU5, current groundwater monitoring data indicate the groundwater remedy is functioning as required to achieve groundwater FRLs. The cap and liner systems of the OSDF are functioning as designed and are successfully containing waste materials. The volume of leachate generated from the OSDF is continuing to decline, and the leachate is being effectively collected and treated to minimize impacts to human health and the environment. Institutional controls as specified in Section 6.1.6 and access controls are in place and effective in ensuring that the footprint of OU5 is used in accordance with the land use objectives and FRLs supporting those land use objectives. However, in order for the remedy to be protective in the long-term, the following actions need to be taken to ensure protectiveness: 1) perform an investigation of the site to evaluate the potential for releases of PFCs and 2) certify soils associated with the aquifer restoration infrastructure footprint.

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1.0 Introduction

Section 121(c) of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) requires that selected National Priorities List (NPL) sites conduct a five-year review of remedial actions. The five-year review is a statutory requirement for NPL sites, such as the Fernald Preserve, that will result in hazardous substances, pollutants, or contaminants remaining at the site above levels that allow for unlimited use and unrestricted exposure. For sites where the U.S. Department of Energy (DOE) is the lead agency, and where a statutory review is required, DOE is responsible for conducting the review every 5 years after the selected remedial action begins. The findings are documented in Five-Year Review Reports to the U.S. Environmental Protection Agency (EPA), as cited in CERCLA (Sections 120 and 121).

The purpose of five-year reviews is to determine whether the remedy at a site is protective of human health and the environment. The methods, findings, and conclusions of reviews are documented in Five-Year Review Reports. In addition, Five-Year Review Reports identify issues found during the review, if any, and recommendations to address them.

DOE ensures that the remedy at the Fernald Preserve remains protective of human health and the environment through the continued implementation of the *Comprehensive Legacy Management and Institutional Controls Plan* (LMICP) (DOE 2016). The LMICP documents the requirements for the long-term care and maintenance of the Fernald Preserve. The plan outlines the institutional controls, including routine inspections, permits, continuing groundwater remedial activities, routine maintenance and monitoring, ecological restoration, and leachate management practices.

DOE is responsible for conducting the five-year review at sites under its jurisdiction, while EPA is responsible for concurrence with the review. DOE and its contractor, Navarro Research and Engineering, Inc. (Navarro), conducted the five-year review of the remedy implemented at the Fernald Preserve. This review was conducted for the entire site from September 2015 through December 2015. This report documents the results of the review.

This is the fourth five-year review for the Fernald Preserve. The report documents the status of the remedial actions implemented for each of the five operable units (OUs) at the Fernald Preserve. For sites with multiple OUs, the five-year review due date is triggered by the onset of construction for the first OU remedial action that will result in hazardous substances, pollutants, or contaminants remaining at the site above levels that allow for unlimited use and unrestricted exposure. Of all the OUs, the site preparation construction to support the Waste Pit Remedial Action Project under the OU1 Record of Decision (DOE 1995c) was the first such action. This construction began on April 1, 1996; consequently, the first five-year review report had a due date of April 1, 2001. According to EPA guidance, the trigger date for subsequent five-year reviews is the signature date of the previous Five-Year Review Report. For reviews led by other federal agencies (e.g., DOE) where EPA has a concurrence role, the trigger for subsequent reviews corresponds to EPA’s concurrence signature date of the preceding Five-Year Review Report. The EPA concurrence date for the previous Five-Year Review Report was September 13, 2011. Therefore, the due date for the current Five-Year Review Report is September 13, 2016.

2.0 Site Chronology

Table 1. Chronology of Site Events

Event	Date
Initial discovery of problem or contamination	March 1985
NPL listing	November 1989
Record of Decision (ROD) signature	OU1 – March 1995 OU2 – June 1995 OU3 – August 1996 OU4 – December 1994 OU5 – January 1996
ROD amendments or Explanation of Significant Differences (ESD)	OU1 – ESD (September 2002) (DOE 2002); Amendment (November 2003) (DOE 2003a) OU2 – None OU3 – None OU4 – ESD (Silo 3, March 1998) (DOE 1998a); Amendment (Silo 1 & 2, July 2000) (DOE 2000); Amendment (Silo 3, September 2003) (DOE 2003b); ESD (Silos 1 & 2, November 2003) (DOE 2003c); ESD (Silos 1, 2, & 3; January 2005) (DOE 2005a) OU5 – ESD (November 2001) (DOE 2001b)
Enforcement documents	Federal Facility Compliance Agreement (EPA) – July 1986 Consent Decree (Ohio) – December 1988 Consent Agreement (EPA) – April 1990 Amended Consent Agreement (EPA) – September 1991 Amended Consent Decree (Ohio) – November 2008
Remedial design start	March 1995 (OU3 Remedial Design Work Plan) (DOE 1995a)
Remedial design complete	February 2004 (OU4 Silo 3 Remedial Design Package)
Actual remedial action start	April 1996 (OU1 Site Preparation)
Construction completion date	December 20, 2006
Remedial Action Reports	OU1 Final Remedial Action Report – August 2006 OU2 Final Remedial Action Report – September 2006 OU3 Final Remedial Action Report – February 2007 OU4 Final Remedial Action Report – September 2006 OU5 Interim Remedial Action Report – August 2008
Preliminary Close-Out Report	December 21, 2006
Previous five-year reviews	April 2001 (DOE 2001a) April 2006 (DOE 2006e) September 2011 (DOE 2011)

3.0 Background

3.1 Physical Characteristics

The Fernald Preserve is a 1,050-acre government-owned, contractor-operated facility located in southwestern Ohio approximately 18 miles northwest of downtown Cincinnati. The site is located just north of Fernald, Ohio, a small farming community, and lies on the boundary between Hamilton and Butler counties. It is located approximately one mile west of the Great Miami River (see Attachment 1). Of the total site area, approximately 850 acres are in Crosby Township in Hamilton County and 200 acres are in Ross and Morgan Townships in Butler County. Approximately 15,900 people live within 5 miles of the site.

3.2 Land and Resource Use

The Fernald Preserve is located on the site of the former Feed Materials Production Center (FMPC), which operated between 1951 and 1989. The primary historical mission of the facility during its 37 years of operation was the processing of uranium feed materials to produce high purity uranium metal. These high purity uranium metals were then shipped to other DOE or U.S. Department of Defense facilities for use in the nation's nuclear weapons program.

The CERCLA Remedial Investigation/Feasibility Study (RI/FS) process began under the Fernald Environmental Management Project in 1986, in accordance with a Federal Facility Compliance Agreement (FFCA) between DOE and EPA to cover environmental impacts associated with the facility. The FFCA was intended to ensure that environmental impacts associated with production activities at the facility would be thoroughly and adequately addressed. Production operations at the facility were suspended in 1989, and the facility was placed on the NPL. The FFCA was amended in April 1990 by a Consent Agreement (under Sections 120 and 106(a) of CERCLA) that revised the milestone dates for the RI/FS and provided for implementation of removal actions. The Consent Agreement was amended in September 1991 (EPA 1991) to revise schedules for completing the RI/FS process. This amended Consent Agreement provided for implementation of the OU concept. The Fernald facility was partitioned into five OUs to promote a more structured and expeditious cleanup. The schedule for preparation of a remedial investigation report and feasibility study report for each OU was included in the amended Consent Agreement.

Remediation activities generally occurred between 1986 and October 29, 2006. These activities included 31 removal actions implemented between 1991 and 1997, 14 Resource Conservation and Recovery Act (RCRA) closures between 1988 and 1995, and 33 RCRA closures through the RCRA/CERCLA integrated process.

As of October 29, 2006, when remediation activities were completed, the site's mission became to serve as an undeveloped park, with an emphasis on wildlife, consistent with stakeholder land use recommendations. The DOE Office of Environmental Management (EM) was responsible for the remediation of the Fernald site. Post-remediation responsibilities transitioned to the DOE Office of Legacy Management (LM) in January 2007. The site was opened to the public in August 2008 with a series of trails and a Visitors Center. Attachment 2 shows the current site configuration.

The current land use for the surrounding area is primarily for crop farming and gravel pit excavation operations. A private water utility company is located approximately 1 mile northeast of the Fernald Preserve that pumps groundwater primarily for industrial use.

The portion of the Great Miami Aquifer (GMA) underlying the site is currently not used as a drinking water source. The dominant groundwater flow direction is from west to east beneath the site then to the south and southeast toward the Great Miami River.

3.3 History of Contamination

Uranium metal products manufacturing generally occurred in seven of the more than 50 production, storage, and support buildings that composed what was known as the 140-acre Production Area. During the 37 years of production operations, the facility produced nearly 500 million pounds of uranium metal products. The site also served as the nation’s key federal repository for thorium-related nuclear products, and it recycled uranium used in the reactors at the Hanford site in the state of Washington. These recycled reactor returns were the source of technetium-99, a radiological contaminant that was prevalent at the Fernald site.

Liquid and solid wastes were generated by the various operations between 1952 and 1989. Before 1984, solid and slurried processing wastes were deposited in the on-property Waste Storage Area. This area, located west of the former Production Area, included six low-level radioactive waste storage pits; two earthen-bermed concrete silos containing K-65 residues (radioactive mill residues from very high grade uranium ore); one concrete silo containing metal oxides; one unused concrete silo; two lime sludge ponds; a burn pit; a clearwell; the Solid Waste Landfill; and a lagoon known as the bio-surge lagoon to treat wastewater. After 1984, wastes produced from operations were containerized for offsite disposal. Contaminants from material processing and related activities were released into the environment through air emissions, wastewater discharges, storm water runoff, leaks, and spills.

3.4 Initial Response

On March 9, 1985, EPA issued a Notice of Noncompliance to DOE, identifying concerns about environmental impacts associated with Fernald’s past and ongoing operations. The Ohio Environmental Protection Agency (Ohio EPA) sued DOE and National Lead of Ohio for violations of hazardous waste and water pollution laws in 1986. In response, DOE initiated the CERCLA process that same year. This process was used to characterize the nature and extent of contamination at the site (at that time called the FMPC), establish risk-based cleanup standards, and select the appropriate remediation technologies to achieve those standards. In November 1989, EPA placed the Fernald site on the NPL. By 1991, the site mission had officially changed from uranium production to environmental remediation and site restoration under CERCLA.

There were 31 removal actions implemented between 1991 and 1997, 14 Resource Conservation and Recovery Act (RCRA) closures between 1988 and 1995, and 33 RCRA closures through the RCRA/CERCLA integrated process to stabilize site operations and address imminent or ongoing releases of hazardous substances.

3.5 Basis for Taking Action

The sources of contamination within each of the source OUs represented a continuing release of hazardous substances. The resultant contamination of the soils, groundwater, surface water, sediments, and air emissions presented an unacceptable risk to human health and the environment as well as to ecological receptors.

Extensive sampling of soil, groundwater, surface water, sediment, and air was conducted during the remedial investigation to characterize the nature and extent of contamination resulting from past operations. Findings included the following:

- Data from the OU5 Remedial Investigation (RI) (DOE 1995b) indicated that uranium contamination of soil was widespread on Fernald property, including both surface soils and subsurface soils. Radium-226 and thorium contaminants were predominant. The extent of the uranium contamination boundaries generally included all other contaminants, including inorganic and organic contaminants. The predominant inorganic contaminants were cadmium and beryllium, but other heavy metals were found as well. The primary organic contaminants included volatile organic compounds (related to chlorinated solvents), semivolatile organic compounds, and polychlorinated biphenyls (PCBs). Off-property uranium contamination was also found above background levels due to air emissions from plant stacks.
- Contamination of the groundwater had resulted from infiltration through the bed of Paddys Run, the Storm Sewer Outfall Ditch, and the Pilot Plant Drainage Ditch. In portions of these drainages, the glacial overburden was eroded, and the sand and gravel of the GMA was in direct contact with uranium-contaminated surface water from the site. To a lesser degree, groundwater contamination also resulted where past excavations (such as the waste pits) or deep building foundations removed some of the protective clay in the glacial overburden and exposed the aquifer to contamination.
- Uranium contamination was in the uppermost portions of the GMA as well as in perched groundwater zones throughout the former Production Area. As with soil, the uranium contamination boundary generally included all other contaminants detected above background. Predominant contaminants in perched groundwater included uranium, technetium, heavy metals, and volatile organics. Predominant contamination in the aquifer included uranium, technetium, and heavy metals. Groundwater contamination was found offsite to the south of the Fernald property. At the time of the RI, approximately 172 acres of the GMA had uranium contamination above 20 parts per billion.
- Elevated levels of uranium were in the primary uncontrolled site surface water drainage channels, including the Storm Sewer Outfall Ditch and the Pilot Plant Drainage Ditch. Concentrations of uranium in the Great Miami River were detected above background but quickly diminished downstream of the outfall line. On-property sediment sampling predominantly detected uranium and radium along with some volatile and semivolatile organics. Only uranium contamination was found in off-property sediment sampling.

4.0 Remedial Actions

4.1 Remedy Selection

For purposes of investigation and study, the remedial issues and concerns that were similar in location, history, type/level of contamination, and inherent characteristics were grouped into OUs under the 1991 Amended Consent Agreement (EPA 1991). Specifically, the site was divided into five OUs. Four of the OUs (1 through 4) are considered contaminant "source" OUs, as they represent the physical sources of contamination that have affected the site's environmental media. The fifth operable unit (OU5) is considered the "environmental media" OU, as it represents the environmental media affected by (1) past production operations and waste disposal practices (i.e., beyond the contaminant "source" OU boundaries) and (2) the pathways of contaminant migration at the site. The four contaminant "source" OUs and the fifth environmental media OU are described below:

- **OU1, Waste Pit Area:** Waste Pits 1 through 6, a clearwell, a burn pit, berms, liners, and affected soil within the OU boundary.
- **OU2, Other Waste Units:** Fly ash piles, other South Field disposal areas, lime sludge ponds, the Solid Waste Landfill, berms, liners, and affected soil within the OU boundary.
- **OU3, Former Production Area:** Former production and production-associated facilities and equipment (including all above- and below-grade improvements), including, but not limited to, all structures, equipment, utilities, drums, tanks, solid waste, waste product, thorium, effluent lines, a portion of the K-65 transfer line, wastewater treatment facilities, fire training facilities, scrap metal piles, feedstocks, and a coal pile. All affected soil beneath the facilities falls within OU5.
- **OU4, Silos 1 through 4:** Contents of Silos 1, 2, 3 (Silo 4 had remained empty); the silo structures, berms, decant sump tank system, and affected soil within the OU boundary.
- **OU5, Environmental Media:** Affected groundwater; surface water; soil not included in the definitions of OUs 1, 2, and 4; sediment, and flora, and fauna.

During the time period 1994 to 1996, DOE and EPA signed the final Records of Decision (RODs) for each OU, in cooperation with the Ohio EPA and the Fernald Citizen's Advisory Board. The RODs specified the major cleanup requirements and approaches that collectively define the Fernald cleanup. The RODs employed a combination of offsite and onsite disposal, under which an estimated 77 percent of the remedial waste volume (the site's lower-concentration, higher-volume materials) was to be disposed of in the engineered On-Site Disposal Facility (OSDF), while approximately 23 percent of the waste volume (the site's higher-concentration, lower-volume materials) was to be sent offsite for disposal, primarily at permitted facilities in Utah, Nevada, and Texas.

At the time the RI/FS activities were completed and the RODs put in place, an estimated 31 million pounds of uranium products, 2.5 billion pounds of waste, 255 buildings and structures, and 2.75 million cubic yards of contaminated soil and debris were identified as requiring action. In addition, a 223-acre portion of the GMA was found to be contaminated at levels above radiological drinking water standards. Under the sitewide approach, the final remedial actions contained in the OU RODs were:

- Production and support facility decontamination and dismantling (D&D).
- Onsite disposal of the quantities of contaminated soil, above- and below-grade debris, and OU2 waste unit materials that could be disposed of in accordance with OSDF waste acceptance criteria (WAC).
- Offsite disposal of the contents of the silos, waste pit materials, nuclear product inventories, containerized low-level and mixed waste inventories, and the quantities of soil and debris that did not meet OSDF WAC.
- Extraction and treatment of contaminated groundwater to restore the contaminated portions of the GMA to meet Safe Drinking Water Act (SDWA) requirements.

At completion, approximately 975 acres of the 1,050-acre property were to be restored for use as an undeveloped park (i.e., the target land use selected in the OU5 ROD), and approximately 98 acres were to be dedicated to the footprint of the OSDF. The GMA was to be restored to drinking water standards, with long-term stewardship actions and requisite institutional controls consistent with the target land use.

Taken together, the individual RODs for the OUs provided a sitewide cleanup approach that encompassed all contaminant source areas and all affected environmental media at the site. Collectively, the RODs provided a natural link between the remediation of the sources of contamination and the media affected. Each ROD progressively built on the decisions of the earlier RODs, yielding a cohesive and comprehensive remedy for Fernald. The ROD signature dates and progressive sequence of decisions adopted under the RODs (including ROD amendments and explanation of significant differences [ESD]) are described below:

- **OU3 ROD for Interim Remedial Action (July 22, 1994):** Provided accelerated approval for the D&D of Fernald’s buildings and structures (DOE 1994a).
- **OU4 ROD for Final Remedial Action (December 7, 1994):** Provided for the remediation of Silos 1 through 4, affected soil within the OU boundary, and other sources of contamination within the boundary. The D&D of all remedial facilities constructed for the OU4 remedial action are to be addressed as part of OU3 (DOE 1994b). There were five post-ROD decision changes for OU 4:
    - *Explanation of Significant Differences for Operable Unit 4 Silo 3 Remediation Action* (DOE 1998a), signed and effective March 27, 1998, modified the treatment component of the Silo 3 remedy to onsite or offsite treatment by chemical stabilization or polymer encapsulation, and allowed the option for disposal at a permitted commercial disposal facility in addition to the Nevada Test Site (NTS; renamed the Nevada National Security Site in 2010).
    - *Final Record of Decision Amendment for Operable Unit 4 Silos 1 and 2 Remedial Actions* (DOE 2000), signed and effective on July 13, 2000, modified the treatment component of the Silos 1 and 2 remedy to onsite treatment by chemical stabilization.

- *Final Record of Decision Amendment for Operable Unit 4 Silo 3 Remedial Action* (DOE 2003b), signed and effective on September 24, 2003, modified the treatment component of the Silo 3 remedy to treatment, to the degree reasonably implementable, to address material dispersability and metals mobility.
- *Explanation of Significant Differences for Operable Unit 4 Silos 1 and 2 Remedial Action* (DOE 2003c), signed and effective November 24, 2003, removed the RCRA Toxicity Characteristic Leaching Procedure (TCLP) test as a performance standard for the chemical stabilization process (maintaining the requirement to treat by chemical stabilization to meet disposal facility WAC), and allowed the option for disposal at a permitted commercial disposal facility in addition to disposal at the NTS.
- *Explanation of Significant Differences for Operable Unit 4* (DOE 2005a), signed and effective January 18, 2005, allowed the option for temporary offsite storage of treated Silos 1, 2, and 3 materials prior to permanent offsite disposal.

- **OU1 ROD for Final Remedial Action (March 1, 1995):** Provided for the remediation of the waste pit contents, caps, and liners, affected soil within the OU boundary, and other sources of contamination within the boundary. The D&D of all remedial facilities constructed for the OU1 remedial action were to be addressed as part of OU3 (DOE 1995c). There were two post-ROD decision changes for OU1:
  - An ESD was prepared to document the cost effectiveness and safety advantages associated with using the OU1 remedial infrastructure to process for disposal, other waste streams originating outside of OU1. The Final ESD for OU1 was approved in September 2002 (DOE 2002).
  - Amendment to the OU1 ROD was prepared to address the following changes:
    - Align the surface and subsurface soil Final Remediation Levels (FRLs) in the OU1 ROD with the approved FRLs for soil in the OU5 ROD.
    - Place Pit 4 soil cover materials meeting onsite WAC into the OSDF for permanent disposal.
    - Align the final cover design for the waste pit area as originally designated in the OU1 Feasibility Study and ROD, with the current design from the July 1998 Draft Final Natural Resource Impact Assessment and Natural Resource Restoration Plan for the site.
    - Provide clarification to terminology.

  The *Final Record of Decision Amendment for Operable Unit 1 Remedial Actions*, reflecting the above, was signed in November 2003 (DOE 2003a).

- **OU2 ROD for Final Remedial Action (June 8, 1995):** Provided for the remediation of the active and inactive fly ash piles, the South Field disposal area, lime sludge ponds, the Solid Waste Landfill, affected soil within the OU boundary, and other sources of contamination within the boundary. This decision set in motion the approval of onsite disposal at Fernald and construction of the OSDF. However, at the time it was formally limited to disposal of the OU2 wastes, since the OU5 and OU3 decisions related to waste disposal (onsite or offsite) were not yet final (DOE 1995d).

- **OU5 ROD for Final Remedial Action (January 31, 1996):** Provided for the remediation of Fernald's onsite and offsite environmental media. This ROD addressed the cleanup of the GMA at all locations, and the remediation of affected sitewide soil and sediment outside the source OU boundaries. It also addressed the monitoring of air, surface water, groundwater, sediment, and biota. The OU5 ROD finalized the concept of a sitewide OSDF and further incorporated the "balanced approach" concept into Fernald onsite and offsite waste disposal decisions. The D&D of all remedial facilities constructed to support the OU5 groundwater remedial action were to be addressed as part of OU3 (DOE 1996a).
  - There was one post-ROD change for OU5. The ESD changed the groundwater FRL for uranium from 20 micrograms per liter (µg/L) to 30 µg/L and revised the performance-based monthly average concentration limit for discharge to the Great Miami River from 20 µg/L to 30 µg/L (DOE 2001b). The original OU5 ROD had adopted the proposed SDWA maximum contaminant level (MCL) for uranium of 20 µg/L. In December 2000, EPA adopted 30 µg/L as the final MCL, prompting the change in the groundwater FRL for uranium.
- **OU3 ROD for Final Remedial Action (September 24, 1996):** Provided a final disposal decision for the D&D materials generated through the Interim Remedial Action ROD. Consistent with the OU5 decision, this final decision document adopted onsite disposal as the selected remedy for disposal of the D&D debris. It also adopted earlier decisions as part of the "balanced approach" to send Fernald's containerized waste inventories and nuclear materials offsite. The ROD also acknowledged that the D&D of new remedial facilities constructed at the site would be addressed as part of OU3 (DOE 1996b).

4.2 Remedy Implementation

The following provides a brief description of the remedial actions undertaken under each of the five RODs. Interim and Final Remedial Action Reports, as appropriate, have been completed for each OU in accordance with the EPA Office of Solid Waste and Emergency Response (OSWER) Directive 9320.2-09A-P, *Closeout Procedures for National Priorities List Sites*.

4.2.1 OU1 Remedial Actions

The OU1 remedy as identified in the OU1 ROD was removal, treatment, and offsite disposal of the waste pit material at a permitted commercial disposal facility. Remedial actions began in April 1996. The following components describe the approach used for remediation of OU1.

- Construction of waste processing and loading facilities and equipment.
- Removal of water from open waste pits for treatment at the site's wastewater treatment facility.
- Removal of waste pit contents, caps, and liners, and excavation of surrounding contaminated soil.
- Preparation (e.g., sorting, crushing, shredding) of waste.
- Treatment of the waste by thermal drying as required to meet Envirocare WAC. Envirocare in Clive, Utah, was the selected offsite disposal facility. It has since been purchased by EnergySolutions, Inc.

- Waste sampling and analysis prior to shipment to ensure that the offsite disposal facility WAC are met.
- Offsite shipment of waste for disposal at Envirocare.
- Decommissioning and removal of the drying treatment unit and associated facilities, as well as miscellaneous structures and facilities within the OU.
- Disposal of remaining OU1 residual contaminated soils in the OSDF, consistent with the selected remedy for contaminated process area soils as documented in the OU5 ROD.

The Final Remedial Action Report for OU1 (DOE 2006a) provides a complete history of the remedial action undertaken.

4.2.2 OU2 Remedial Actions

As identified in the OU2 ROD, key components of the selected remedy for OU2 are listed below. Remedial actions began in June 1997.

- Construction of the engineered OSDF.
- Excavation of the OU2 subunits to the required depth established by the OU2 RI and FS Reports to remove materials with contaminant concentrations above the cleanup levels.
- Verification sampling and testing in the excavated area to confirm that materials with contaminant concentrations above the cleanup levels have been removed.
- Segregation of debris (e.g., concrete, steel, pallets) from OU2 subunits and processing for size reduction, as necessary, before disposal in the OSDF.
- Collection and treatment of water from the OU2 subunits and OSDF construction areas.
- Transportation and onsite disposal of excavated material with a concentration at or below 346 picocuries per gram (pCi/g) of uranium-238 or 1,030 milligrams per kilogram (mg/kg) of total uranium.
- Transportation and offsite disposal of approximately 3,100 cubic yards of excavated material with concentrations above 346 pCi/g of uranium-238 or 1,030 mg/kg of total uranium.
- Excavation, treatment, and offsite disposal of approximately 300 cubic yards of lead-containing soil from the South Field firing range (handled as mixed waste).
- Restoration (including grading, seeding, fencing, and installation of monitoring wells) of OU2 subunits after excavation and verification sampling and testing.
- Implementation of access restrictions (fencing) and groundwater monitoring at the OU2 subunits and OSDF.
- Maintenance of OU2 subunits after restoration, and maintenance and monitoring of the OSDF for at least 30 years following closure of the OSDF.

The OU2 ROD preceded the RODs for OU5 and OU3 by nearly a year. As a result, the costs, waste volumes, size, and configuration of the OSDF represented in the OU2 ROD are specific to OU2 materials only, since the onsite disposal decisions for OU5 and OU3 had not yet been formally made. Ultimately, once the OUs 5 and 3 onsite disposal decisions were finalized, the

OSDF was sized and designed to accommodate all three OUs, resulting in a greater economy of scale and a combined sitewide design, siting, and implementation approach.

The Final Remedial Action Report for OU2 (DOE 2006b) provides a complete history of the remedial actions undertaken.

4.2.3 OU3 Remedial Actions

At the time that uranium production operations ceased at Fernald, the former production buildings were at or beyond their design lives, and no viable future mission existed for the aging buildings and structures. As a result, DOE and EPA officially decided that all of Fernald's buildings and structures would be dismantled and that the resulting debris would be placed in interim storage. The initial dismantlement and interim storage decision was formally documented in the July 1994 OU3 ROD for Interim Action (IROD). The IROD also provided that a subsequent final remedial action ROD would establish the final disposal strategy and locations for the materials generated by the interim remedial action. The first-step remedial activities approved through the IROD are listed below. Remedial action began in August 1995.

- Surface decontamination of the buildings and structures by removing/fixing loose contamination.
- Dismantlement of the above-grade buildings and structures.
- Removal of foundations, storage pads, ponds, basins, and underground utilities and other at- and below-grade structures.
- Offsite disposal, of up to 10 percent by volume, of the nonrecoverable waste and debris generated from structural D&D, pending issuance of the final remedial action ROD.
- Interim storage of the remaining waste and debris until a final disposal decision is identified in the final remedial action ROD.

The final remedial action ROD adopted the remedy of selected material treatment, on-property disposal, and offsite disposal of the OU3 materials. The key components of the selected remedy for final remedial action are listed below in two categories.

Adoption of Previous OU3 Decisions

- Incorporation of the facility and structural D&D decisions contained in the IROD so as to provide for an integrated implementation of the interim and final decisions.
- Adoption of the procedures and offsite disposal decisions (primarily Removal Actions 9 and 12) to continue the offsite disposal of the containerized wastes, products, residues, and nuclear materials generated during historical site operations.
- Adoption of the prior procedures and decisions for the management of safe shutdown (Removal Action 12), management of asbestos abatement (Removal Action 26), and management of debris (Removal Action 17).
- Approval of alternatives to disposal, which included permitting the restricted/unrestricted release of materials, as economically feasible, for recycling or reuse.
- Treatment of OU3 materials, which permitted the treatment of materials to meet the OSDF WAC or offsite disposal facility WAC.

- Offsite disposal of materials above the OSDF WAC.
- Requiring the offsite disposal of process residues, product materials, and process-related metals generated during D&D activities.
- Requiring offsite disposal of acid-resistant brick, lead sheeting, and concrete from four designated locations to further minimize the total quantity of materials with technetium-99 contamination (including the top inch of concrete from two areas in Plant 9, an area in Plant 8, and an area in the Pilot Plant) placed in the OSDF, and any other materials exceeding the OSDF physical and numerical WAC.

On-Property Disposal—Materials Eligible for Placement in the OSDF

- Determining whether the remaining quantities of OU3 D&D materials are eligible for disposal in the OSDF, and requiring that the materials pass visual inspections for the presence of process residues during implementation.
- Recognizing the need for institutional controls at the completion of the remedy (consistent with OU5).
- Recognizing the need for long-term monitoring and maintenance of the OSDF and operation of a groundwater monitoring network to evaluate performance of the OSDF consistent with OU5. (**Note:** The scope for the long-term monitoring and maintenance of the OSDF, and the implementation of the site's institutional controls, are part of Fernald's post-closure long-term stewardship program and are not part of OU3.)

The Final Remedial Action Report for OU3 (DOE 2007a) provides a complete history of the remedial actions undertaken.

4.2.4 OU4 Remedial Actions

The final remedy implemented for OU4 defined by the OU4 ROD and its subsequent modifications consisted of the components listed below.

- Removal of the contents of Silos 1 and 2 and the decant sump tank system sludge from the silos. Transfer to the transfer tank area for storage pending subsequent transfer to the Silos 1 and 2 remediation facility for treatment using chemical stabilization to attain the disposal facility WAC.
- Removal of material from Silo 3 by pneumatic or mechanical processes, followed by treatment to the extent practicable by addition of a chemical stabilization reagent and a reagent to reduce dispersability, then offsite disposal at NTS (now called the Nevada National Security Site) or a permitted commercial disposal facility.
- Offsite shipment and disposal of the treated Silos 1 and 2 materials at NTS or an appropriately permitted commercial disposal facility; or, temporary offsite storage for a maximum of 2 years from the initiation of storage activities, if required, prior to permanent offsite disposal.
- Gross decontamination, demolition, size reduction, and packaging of the Silos 1, 2, and 3 structures and remediation facilities in accordance with the OU3 ROD.
- Shipment of the concrete from the Silos 1 and 2 structures for offsite disposal at the NTS or an appropriately permitted commercial disposal facility.

- Disposal of contaminated soil and debris, excluding concrete from Silos 1 and 2 structures, either (1) onsite in accordance with Fernald OSDF WAC, or (2) at an appropriate offsite disposal facility, such as the NTS or a permitted commercial disposal facility.
- Removal of the earthen berms and excavation of the contaminated soils within the OU4 boundary to achieve the soil remediation levels outlined in the OU5 ROD.
- Appropriate treatment and disposal of all secondary wastes at either the NTS or an appropriately permitted commercial disposal facility.
- Collection of perched water encountered during remedial activities for treatment in onsite treatment facilities installed under OU5.

Silo 3 materials have been disposed of at the EnergySolutions (formerly Envirocare) facility in Clive, Utah. The final permanent disposal of Silos 1 and 2 treated waste material began on October 7, 2009, at Waste Control Specialists, LLC, in Andrews, Texas. The last container was placed on November 2, 2009. The Final Remedial Action Report for OU4 (DOE 2006c) provides a complete history of the remedial actions undertaken.

4.2.5 OU5 Remedial Actions

The remedial strategy adopted for OU5 was necessarily a multifaceted approach to protect existing and future human and environmental receptors through implementing extensive soils excavations, excavating contaminated sediments and perched water zones containing concentrations above established FRLs, on-property disposal of excavated material in the OSDF (in compliance with established OSDF WAC), and restoration of the GMA through pump-and-treat technologies. In addition, the remedy required treatment of collected storm water and process wastewater throughout remedial activities.

Key components of the OU5 remedy related to groundwater restoration included the following:

Perched Water

- Excavation of perched water zones necessary to ensure the continued protection of the regional groundwater aquifer.
- Disposal of the soils generated during the removal of the impacted perched water zones in a manner consistent with the methods defined for soils.
- Treatment, as required, of contaminated perched water and storm water collected during excavation operations. The treatment envisioned was via the Advanced Wastewater Treatment facility. For zones contaminated by volatile organic compounds, the water was to be treated through activated carbon absorption.

Great Miami Aquifer Restoration

- Extraction of contaminated groundwater until such time as FRLs are attained at all points in the impacted areas of the GMA. The basis of the groundwater FRLs and the associated selection process was to use the SDWA-established MCLs, proposed MCLs, or nonzero maximum contaminant level goals. When these standards were not available for a specific contaminant, other criteria were used to establish the necessary FRL (e.g., 1×10^{-5} incremental lifetime cancer risk [ILCR] for carcinogens; 0.2 Hazard Quotient for noncarcinogens) via the drinking water pathway for a resident farmer (DOE 1996).

- Performance of an engineering study to examine the economic and technical viability of applying reinjection techniques to enhance containment recovery from the aquifer system and to enhance groundwater restoration activities.
- Collection of recovered groundwater for treatment (as necessary) and discharge to the Great Miami River or reinjection (if deemed appropriate).

Treatment of Discharges

- Treatment of collected storm water, wastewater, and recovered groundwater before discharge to the Great Miami River to the extent necessary to not exceed FRLs for surface water in the Great Miami River.
- Treatment of wastewater, storm water, and groundwater to the extent necessary to ensure that the maximum annual mass discharge of uranium to the Great Miami River from the effluent does not exceed 600 pounds. (The 600 pounds-per-year limit was effective upon issuance of the OU5 ROD in January 1996.)
- Treatment of the necessary wastewater, storm water, and groundwater to the extent necessary to ensure that the maximum concentration of total uranium in the blended effluent discharged to the Great Miami River does not exceed 20 µg/L, based on a monthly average concentration. (This standard was later revised to 30 µg/L per the 2001 OU5 ESD.)
- Expansion of the Advanced Wastewater Treatment facility within the confines of the existing Building 51 to provide a minimum additional design capacity of 1,800 gallons per minute (gpm).
- Disposal of treatment sludges generated from the treatment of wastewater, storm water, and groundwater in the OSDF if established WAC can be attained; otherwise, disposal of the sludges at an appropriate offsite disposal facility.

Recognizing the ongoing implementation of the groundwater remedy and the required long-term monitoring of the OSDF required by the OU2 ROD, DOE prepared an Interim Remedial Action Report for OU5.

4.2.6 Sitewide Remedial Actions

Sitewide Soil and Sediment

Key components of the selected remedy for sitewide soil and sediment included the following:

- Excavation, using conventional construction equipment, of contaminated soil and sediment to the extent necessary to establish statistically, with reasonable certainty, that the concentrations of contaminants at the entire site are below FRLs.
- Excavation, using conventional construction equipment, of contaminated soil containing perched water that presents an unacceptable risk of contaminant migration to the underlying aquifer.

- Placement of contaminated soil and sediment that do not exceed concentration-based WAC in an on-property disposal facility. Soil containing nonradiological contaminant concentrations exceeding the WAC (e.g., soil contaminated with organic constituents) would be treated before placement in the on-property disposal facility or shipped offsite for disposal at an appropriate commercial or federal disposal facility. Soil with radiological contaminant concentrations exceeding the WAC would be shipped offsite for disposal. Soil from six designated areas where a reasonable potential existed for the presence of characteristic waste (as defined by RCRA) would be treated, as needed, before disposal.
- Sitewide restoration of impacted areas following excavation and certification sampling. Restoration would include regrading (to blend with the surrounding topography and to promote positive drainage), seeding, fencing, and reestablishment of wetlands, as required.
- Application of institutional controls (Section 6.1.6) during and after remedial activities to minimize the potential for human exposure to site-introduced contaminants and ensure the continued protection of human health. Implementation of a long-term environmental monitoring program and a maintenance program to ensure the continued protectiveness of the remedy, including the integrity of the OSDF.

Onsite Disposal

As identified in the OU2 ROD, the OU5 ROD, and the OU3 ROD for Final Remedial Action, key components of the onsite disposal selected remedy included the following:

- Construction of the engineered OSDF.
- Establishment of maximum WAC for the OSDF.
- Onsite disposal of materials from OUs 2, 3, and 5 that meet the OSDF WAC (including RCRA-regulated materials using the Corrective Action Management Unit mechanism).
- Selected onsite disposal of soils from OUs 1 and 4.
- Implementation of access restrictions (fencing) and groundwater monitoring at the OSDF for at least 30 years following closure.
- Maintenance of the OSDF, including the final cover system and leachate collection system. Because this remedy results in contaminants remaining onsite in an engineered disposal facility, a review will be conducted no less often than every 5 years after the initiation of remedial action in accordance with CERCLA Section 121(c) to ensure that the remedy continues to provide adequate protection of human health and the environment. This review will continue until determined that it is no longer needed to maintain protectiveness of the disposal facility.
- To construct the OSDF over a sole-source aquifer capable of sustaining a yield of 100 gallons per minute, DOE needed an Ohio EPA exemption or an EPA CERCLA waiver from the State of Ohio siting prohibitions. It was determined that a CERCLA waiver was the appropriate regulatory strategy. The waiver request was based on the ability of the selected remedial action to attain a standard of performance that is equivalent to that required by the applicable or relevant and appropriate requirements (ARARs). The criteria in determining a CERCLA ARAR waiver based on equivalent standard of performance were degree of protection, level of performance, reliability into the future, and time required to achieve

remedial action objectives (Title 40 *Code of Federal Regulations* [CFR] Part 300.430 (f)(1)(ii)(C)(4)). CERCLA waivers were requested, justified, and granted through the approval of the OU2, OU3, and OU5 RODs. Therefore, EPA granted three CERCLA waivers to allow construction of the OSDF at Fernald and onsite disposal of materials from OUs 2, 3, and 5 (and selected materials from OUs 1 and 4).

In general, application of the WAC allowed certain materials from each of the OUs to be disposed of in the OSDF as described below:

OU1

- Waste Pit 4 cover material
- Impacted soils below or outside the waste pits that otherwise meet the OSDF WAC

OU2

- Waste materials meeting the OSDF WAC from the north and south lime sludge ponds, the Solid Waste Landfill, the inactive fly ash pile, the active fly ash pile, and the South Field area

OU3

- D&D debris meeting the OSDF WAC and not otherwise prohibited

OU4

- Impacted soils and debris not containing silo materials that otherwise meet the OSDF WAC
- D&D debris from Silo 4

OU5

- Sitewide impacted soils, sediments, and debris meeting the OSDF WAC and not otherwise prohibited

4.2.7 Site-wide Remedial Action Closeout Strategy

As stated in the *Interim Remedial Action Report for Operable Unit 5* (DOE 2008), EPA and DOE issued a fact sheet in the spring of 2005 (DOE 2005b) describing the coordination approach across the OUs. Where affected media (primarily soil within an OU boundary) was a part of a source-control OU remedy (i.e., OU1, OU2, and OU4), it was determined to be appropriate to accommodate the documentation of the remediation of that soil under the OU5 closeout report. Therefore, only the source waste material would be addressed in the other source OU Final Remedial Action Reports, while the contaminated media within the other source OU boundaries would be addressed under OU5. Figure 4-4, *Location of Potential Sources of Contamination*, from the OU5 Remedial Investigation Report (DOE 1995b) is reproduced in Attachment 4. The 2005 fact sheet documented the following strategy for the remaining scope following formal closeout of each OU:

- Following removal and offsite disposition of the waste pit contents and liners, the remaining OU1 scope (soil remediation with OU1 boundary and D&D of the OU1 remediation facilities) would be documented in the closeout reports for OU5 and OU3, respectively.

- Following removal and offsite or onsite disposition of the waste materials from the Solid Waste Landfill, the two Lime Sludge Ponds, Active and Inactive Flyash Piles, and the South Field area, the remaining OU2 scope (soil remediation within the OU2 waste unit boundaries) would be documented in the closeout report for OU5.
- Following offsite disposition of Silos 1&2 and Silo 3 contents, the remaining OU4 scope (soil remediation within the OU4 boundary and D&D of the OU4 remediation facilities and the empty silo structures) would be documented in the closeout reports for OU5 and OU3, respectively.

The interim Remedial Action Report for OU5 recognized that the Great Miami Aquifer restoration activities would continue and addressed completion of soil remediation activities (including those within the OU 1, 2, and 4 boundaries) and closure of the OSDF, but also recognized the ongoing aquifer restoration activities, future D&D of the groundwater infrastructure, and final soil remediation (as necessary beneath the groundwater infrastructure) remain to be completed once groundwater remediation is complete.

4.3 System Operation

System operation includes operation and maintenance (O&M) of the groundwater remediation system (including the extraction wells, pipeline and associated infrastructure and the Converted Advanced Wastewater Treatment [CAWWT] facility), OSDF leachate management or conveyance and treatment, and the OSDF cap. Staff are onsite daily conducting O&M activities and periodic inspections. System operation costs are provided below (Tables 2, 3, and 4), reported as operation and maintenance costs combined. Costs are presented on a fiscal year basis (October through September). Costs presented below for the groundwater remediation system include all site utilities, but the groundwater remediation system is the predominant utility user. Table 5 presents annual Fernald site total project costs. Actual costs continue to be significantly less than estimated at the time of transition to LM. O&M costs are reviewed annually as part of LM lifecycle baseline estimating.

Table 2. Annual Groundwater System O&M Costs

Dates		Total Cost (Rounded to Nearest $1,000)
From	To	
October 2010	September 2011	$2,591,000
October 2011	September 2012	$2,197,000
October 2012	September 2013	$2,645,000
October 2013	September 2014	$3,206,000
October 2014	September 2015	$3,182,000

Table 3. Annual OSDF Leachate System O&M Costs

Dates		Total Cost
From	To	
October 2010	September 2011	$171,00
October 2011	September 2012	$64,000
October 2012	September 2013	$62,000
October 2013	September 2014	$65,000
October 2014	September 2015	$110,000

Table 4. Annual OSDF Cap System O&M Costs

Dates		Total Cost
From	To	
October 2010	September 2011	$67,000
October 2011	September 2012	$61,000
October 2012	September 2013	$55,000
October 2013	September 2014	$78,000
October 2014	September 2015	$109,000

Table 5. Annual Fernald Site Total Project Costs

Dates		Total Cost (Rounded to Nearest $1,000)
From	To	
October 2010	September 2011	$7,898,000
October 2011	September 2012	$7,983,000
October 2012	September 2013	$8,717,000
October 2013	September 2014	$9,053,000
October 2014	September 2015	$9,798,000

5.0 Five-Year Review Process

5.1 Community Notification and Involvement

The five-year review community involvement process was initiated on September 26, 2015, when notices of the review and a questionnaire were distributed electronically to the stakeholder mailing list. Hardcopies of this information were also mailed on that date to stakeholders who reside adjacent to the Fernald Preserve and property owners who have monitoring wells located on their properties. Attachment 4 shows the electronic notice and the letter distributed to stakeholders. A public meeting was held at the Fernald Preserve on October 6, 2015. The questionnaire was distributed at the public meeting and, following the public meeting, was made available at the Visitor Center and on the Fernald Preserve website (http://www.lm.doe.gov/fernald/Sites.aspx) through November 16, 2015.

Four questionnaires were received from the public. These individuals were reached during the public meeting, the direct mailing to adjacent properties owners, and the questionnaires that were made available at the Visitor Center. No questionnaire responses were received electronically. Interviews were held with two individuals who requested to be contacted through the questionnaire process. The responses were positive and indicated that stakeholders remain engaged in the site status and activities. Attachment 5 contains the completed questionnaires and a summary of each interview.

5.2 Document Review

The following documents were reviewed and evaluated during the preparation of this Five-Year Review Report:

- LMICP, Revision 8, January 2015
- Annual Site Environmental Reports (SERs) for 2011 (DOE 2012), 2012 (DOE 2013), 2013 (DOE 2014a), and 2014 (DOE 2015b)
- Quarterly OSDF Inspection Reports for inspections conducted 2011 through 2015
- Quarterly Site Inspection Reports for inspections conducted 2011 through 2015
- OU5 ROD
- Interim Residual Risk Assessment (DOE 2007b)

The OU5 ROD includes all pertinent cleanup levels (i.e., FRLs). Analytical data collected and reviewed have been compared to these FRLs.

5.3 Data Review

In the first half of each year, all monitoring data collected in the previous year are reviewed, evaluated, and reported as part of the annual SER. OSDF performance data and environmental data (groundwater, surface water, and sediment) for the years 2011 thru 2014 are included in this Five-Year Review Report. OSDF performance data and environmental monitoring data for 2015 are not available in time to include in this report. Groundwater remedy operational data and Site and OSDF Inspection Data for 2015 are included in this report. Below is a summary of the data reviewed for this report.

5.3.1 OSDF Performance Monitoring

The OSDF consists of eight individual disposal cells. Performance monitoring is conducted for each cell to: (1) track the quantity of liquid produced within the leachate collection system (LCS) and leak detection system (LDS) over time to determine if the facility is performing as designed, and (2) track the water quality of the LCS and LDS liquid, the perched groundwater, and groundwater in the GMA. The controlling document for OSDF performance monitoring is the Groundwater/Leak Detection and Leachate Monitoring Plan (Attachment C of the LMICP [DOE 2015a]).

Flow volumes in the LDS of each cell are tracked against an initial response leakage rate of 20 gallons per acre per day (gpad). The initial response leakage rate indicates that hydraulic conditions are one-tenth of the action leakage rate. The action leakage rate is the maximum design flow rate that the LDS can remove without the fluid head on the bottom liner exceeding 1 foot (40 CFR 264.302). If flow in the LDS of any cell reaches the initial response leakage rate of 20 gpad, DOE will begin the process of determining if the cell is no longer functioning as designed.

Water quality in the LCS, LDS, horizontal till well (HTW), and GMA wells of each cell is routinely monitored. Sampling frequencies were quarterly, with a more comprehensive suite of analytes collected on an annual basis through 2013, depending upon the monitoring horizon and the cell. In 2014, with EPA and Ohio EPA concurrence, sampling frequencies were changed to semiannual, and the more comprehensive suite of analytes will continue annually. Data are reviewed throughout the year and reported annually in the SERs. Water quality assessment tools include control charts, concentration trend plots, and bivariate plots.

5.3.2 Groundwater Monitoring and Groundwater Remedy Operational Data

Groundwater monitoring was conducted during the past 5 years as prescribed in the Integrated Environmental Monitoring Plan (Attachment D of the LMICP) as part of the pump-and-treat stage of the groundwater certification process presented in the *Fernald Groundwater Certification Plan* (DOE 2006d).

Data from 140 wells are used to assess water quality, and 178 wells are used to measure groundwater elevations. In addition, each year a selected number of direct-push samples are collected to supplement data collected at the fixed well sampling locations.

An integrated data evaluation process is used to review and analyze data collected from the wells and direct-push sampling locations to determine:

- Capture and restoration of the uranium plume.
- Capture and restoration of non-uranium FRL constituents.
- If there is a need to modify the remedy.

In addition to the above, data are analyzed to determine what impact, if any, the groundwater remedy is having on a separate groundwater restoration effort south of the uranium plume (i.e., the Paddys Run Road site plume). This separate plume, which is unrelated to the Fernald Preserve, resulted from industrial activities south of the Fernald Preserve along Paddys Run Road. Data and evaluation of the results are reported annually in the SERs. This evaluation indicates that the Fernald groundwater remedy is not impacting the Paddys Run Road site plume.

5.3.3 Surface Water Monitoring

Data from 23 surface water sampling locations are used to fulfill surveillance and compliance monitoring functions. The data are routinely evaluated to identify any unacceptable trends and to trigger corrective actions when needed to ensure protection of these critical environmental pathways. Appendix B of the Site Environmental Report provides data associated with these locations. Since the last five-year review (2011 through 2014):

- There was one instance of National Pollutant Discharge Elimination System (NPDES) noncompliance at the Parshall Flume (PF 4001) in 2014. The daily load limit for total suspended solids was exceeded on August 5, 2014, as a result of the operational changes implemented in July 2014. These changes resulted in increased flow rates that were higher than the design flow rate established in the NPDES permit. While the concentration limit was not exceeded, the daily load limit was exceeded. A change to the 2013 NPDES permit application was submitted to increase the flow rate, concentrations, and loading limits for three parameters: carbonaceous biochemical oxygen demand, oil and grease, and total suspended solids. The new permit (1IO0004*ID), took effect on March 1, 2015, and reflected these increases.
- Results of samples collected from two locations west of the former Waste Storage Area have been exceeding the surface water FRL for uranium (530 µg/L) since monitoring began in 2007. Uranium concentrations at these two locations are trending downward from a maximum of 1,900 parts per billion total uranium. None of the other 21 sampling locations have had a surface water FRL exceedance for uranium.
- Samples are collected at eight locations to monitor the cross-media impact of surface water infiltrating into the aquifer. The results of these samples are compared to the groundwater FRLs. Five of the eight locations periodically exceed the groundwater FRL for uranium (30 µg/L). One of the cross-media impact locations in the Waste Storage Area exceeded the groundwater FRL for thorium-232 (270 picocuries per liter) in 2012 and 2013. The thorium-232 groundwater FRL was not exceeded in 2014.

Based on an initial review of the surface water results since the last five-year review, it may be appropriate to stop monitoring several locations where FRLs have not been exceeded during the 5-year period. This review, which will take into account the cross-media impact issues, will be finalized and documented in the 2015 SER.

5.3.4 Sediment Monitoring

Sediment samples are collected in the Great Miami River from two sampling locations once every 5 years. One location is upstream of the Fernald Preserve treated effluent discharge line and the other is located downstream. Sediment sampling results have been indiscernible from background. Based on an initial review of the sediment results, it may be appropriate to eliminate sediment sampling. This review will be completed and documented in the 2015 SER.

5.4 Site Inspection

Site inspections are conducted quarterly at the Fernald Preserve, in accordance with the LMICP. A separate inspection process is outlined for both the site and the OSDF. Site inspections involve annual field walkdowns and quarterly inspection of institutional controls. From 2011 to 2014, a portion of the site was walked down every 3 months. This site inspection process was revised in 2015 so that field walkdowns are now conducted in the winter months, when access and visibility are optimal. The site is divided into four quadrants, which are inspected between November and April. Attachment 6 shows the location of field walkdown quadrants. For OSDF inspections, a complete cap walkdown is conducted annually, and a perimeter walkdown takes place quarterly. Inspection findings are reported quarterly to EPA and Ohio EPA.

The site and OSDF are inspected for the effectiveness of activity and use limitations and the need for repairs. The OSDF cap is also evaluated to ensure integrity of the design. Ecologically restored areas are evaluated for the condition of vegetation and soil stabilization. The most recent site and OSDF inspections were conducted in December 2015. Inspections are led by DOE, with participation from state regulators, including Ohio EPA and the Ohio Department of Health.

Annual inspection photographs are also taken across the site. The most recent inspection photographs were taken in August 2015. A representative set of these photographs and a figure showing the location of the photographs is provided in Attachment 7. All annual inspection photographs taken at the Fernald Preserve are available on LM's Geospatial Environmental Mapping System at http://gems.lm.doe.gov. All inspection documents are made available to the public on the Fernald Preserve website (http://www.lm.doe.gov/land/sites/oh/fernald/fernald.htm). In addition, an annual summary of inspection findings, beginning with the 2014 *Fernald Preserve Site Environmental Report* (DOE 2015b), is included annually in the SER.

Inspections in 2015 demonstrated activity and use limitations at the Fernald Preserve are functioning as intended. Very few instances of prohibited activities have been observed. Instances of prohibited activities include isolated incidents of deer hunting and the occasional hiker wandering off trail. Fences, barricades, and signs are in place and properly maintained. If the frequency of prohibited activities increases, further evaluation will be necessary. OSDF findings are mostly related to the presence of invasive herbaceous and woody vegetation on the cap and the need for minor fence repairs. These items are addressed as part of routine maintenance of the site.

One consistent finding in portions of the site is the presence of remediation-related debris. Frost heave and surface erosion have uncovered a variety of items that have the potential for fixed radiological contamination. Suspect debris includes concrete, glazed tile, brick, asphalt and metal. Most debris is small in size and is easily removed by hand without the use of heavy equipment. Equipment has been needed to remove larger items on several occasions, including pipes that have appeared to have historically been reused as culverts.

Debris consists mostly of construction rubble (i.e., small chunks of broken building materials). Occasionally, pieces of metal such as bolts and plates are found that appear to have come from the heavy equipment used during the site remediation prior to 2006. Three pieces of graphite, which was used as to construct molds during the production processes, have been found since 2011 in the former Waste Storage Area. These pieces of graphite have had the highest activities of any radiological debris to date at 60,000 to 720,000 disintegrations per minute per 100 centimeters squared (dpm/100 cm^2).

Most debris is not contaminated and is disposed of in a commercial landfill. Less than 2 percent of the debris has had fixed radiological contamination. This debris is removed from the field and placed in a radiological materials storage area pending permanent disposal at a licensed low-level waste disposal facility. The volume of radiologically-contaminated debris collected at the site since 2007 is estimated to be less than 100 cubic feet. Since the last CERCLA five-year review, 3,342 pieces of debris have been found at the site, 45 of which had fixed radiological contamination. Activity levels of these 45 pieces of debris with fixed radiological contamination ranged from less than 5,000 dpm/100 cm^2 to 60,000 dpm/100 cm^2. The breakdown of the type of debris for these 45 pieces is as follows:

- concrete-16
- metal -11
- glazed tile -9
- brick 4
- graphite -3
- rebar -1
- asphalt - 1

Of the debris found since the last CERCLA five-year review listed above, 35 of the 45 pieces were found in the Former Production Area and former Waste Pit Area. This pattern is consistent with findings in 2007, when debris locations were mapped to determine the extent of the issue. Attachment 8 includes an updated map of debris findings from site inspections performed in 2011 through 2015. Site inspections are one way of identifying debris in the field, along with monitoring for debris during construction activities and casual observations. Debris identified during construction activities or casual observations are not currently mapped. The figure in Attachment 8 shows that debris found during site inspections from 2011 to 2015 continues to be concentrated in the remediated portions of the site. Trail design and activity and use limitations are effective in preventing the public from encountering contaminated debris. Additional detail regarding protective measures is included in Section 6.1.5.9.

Ecological restoration of the site is progressing well. The quarterly site inspections, along with additional monitoring specific to restored areas, demonstrate continued establishment of prairie communities, created wetlands and open-water habitats, and expansion of the forested areas located along the Paddys Run riparian corridor and in northern portions of the site. Sitewide ecological restoration and associated monitoring activities were set forth in the Natural Resource Restoration Plan.

Challenges for ecological restoration have mostly shifted from vegetation establishment to invasive species control. Resources are required to reduce the spread of several non-native herbaceous and woody plants, including Canada thistle, bush honeysuckle, reed canary grass, and callery pear.

6.0 Technical Assessment

6.1 Question A: Remedy Function

Question A: Is the remedy functioning as intended by the decision documents?

6.1.1 OU1: Waste Pits

Remedial actions involved the excavation, drying as necessary, transportation by rail, and disposal of waste pit materials at the EnergySolutions (formerly Envirocare) facility in Clive, Utah. Remedial actions for OU1 involving the excavation and shipment of waste pit materials were completed in June 2005. The D&D of remedial action infrastructure was completed in October 2005. The Final Remedial Action Report, which documents completion of remedial actions under OU1, was approved in August 2006. The puddles in the western portion of OU1 (with elevated uranium concentrations) will continue to be monitored, and access restrictions will continue to be implemented to prevent direct human exposure in this area. The remedial actions for OU1 are complete as intended by the OU1 ROD.

6.1.2 OU2: Other Waste Units

Remedial actions involved the excavation, treatment as necessary, and disposal of waste materials contained within the Other Waste Units as defined in the OU2 ROD. Remedial actions were completed in November 2003. The Final Remedial Action Report, which documents completion of remedial actions under OU2, was approved in September 2006. The remedial actions for OU2 are complete as intended by the OU2 ROD.

6.1.3 OU3: Production Area Facilities

Remedial actions involved the D&D of all production facilities, remedial action facilities, and all appurtenant facilities and infrastructure as well as the disposal of all D&D material, nuclear materials, and legacy wastes. Remedial actions were completed in October 2006. The Final Remedial Action Report, which documents completion of remedial actions under OU3, was approved in February 2007. The remedial actions for OU3 are complete as intended by the OU3 ROD.

6.1.4 OU4: Silos

Remedial actions involved the removal, stabilization, and offsite disposal of waste materials within Silos 1, 2, and 3 as well as the offsite disposal of the silo structures. Offsite disposal was to be in an appropriately licensed facility. Remedial actions related to Silo 3 were completed in April 2006 with the final disposal of Silo 3 materials at the EnergySolutions (formerly Envirocare) facility in Clive, Utah. Remedial actions related to Silos 1 and 2 were completed in May 2006 with the final shipment, and materials were temporarily stored at the Waste Control Specialists facility in Andrews, Texas. Final disposal of Silos 1 and 2 materials occurred in July 2010. D&D of the OU4 remediation facilities was completed in August 2006. The Final Remedial Action Report, which documents completion of remedial actions under OU4, was approved in September 2006. The remedial actions for OU4 are complete as intended by the OU4 ROD.

6.1.5 OU5: Groundwater, OSDF, Soils, and Sediments

The groundwater remedial action is performing to design expectations. Current operating procedures (i.e., Operations and Maintenance Master Plan and standard operating procedures) are adequate and are maintaining a high degree of operational performance. Although there are not large variances in O&M costs to date, well field maintenance may become an issue due to iron fouling resulting in increased maintenance costs.

The amount of groundwater that needs to be treated to achieve discharge limits has decreased dramatically since the start of the remedy. Except as noted below, for the past 5 years the aquifer remedy was able to achieve discharge limits (a monthly average uranium discharge limit of 30 µg/L and an annual limit of 600 pounds) without groundwater treatment. With implementation of higher pumping rates in July 2014, a short period of groundwater treatment (July 2015 through mid-November 2015) was needed to achieve outfall limits.

6.1.5.1 Status of the Groundwater Remediation

The status of the groundwater remediation is reported annually in the SER. Contamination sources were removed during soil remediation, which was completed in October 2006. Uranium is the principal contaminant of concern for the aquifer. A dissolved uranium plume in the GMA is being addressed by a pump-and-treat remedy. Since treatment of pumped groundwater is no longer needed to meet discharge limits at the Great Miami River, the operation now is essentially pumping.

The groundwater remedy was optimized in July 2014. The decision to optimize was based on discovering that (1) more uranium was present in portions of the aquifer than originally modeled for back in 2005, (2) data indicating that the 2005 model predictions were not being realized, and (3) performance metrics (i.e., data regressions) being used to track remedy progress indicated that the pumping operation was becoming less effective over time (an observation that is common to pumping remedies). A modeling report that provides background for the optimization decision and the outcome was issued in 2014: *Operational Adjustment-1 WSA Phase-II Groundwater Remediation Design, Fernald Preserve* (DOE 2014b).

The optimization resulted in a new pumping design that shut down three extraction wells pumping water with low uranium concentrations. These three wells were turned off because they were no longer providing benefit to the cleanup. The available pumping budget that resulted from shutting down these three wells was re-allocated to extraction wells located in areas of the plume with higher uranium concentrations. The previous aquifer design (DOE 2005c) consisted of pumping 23 wells for the life of the remedy. The new, optimized design focuses the pumping in areas where the pumping can be most productive. As the remedy progresses, the number of pumping wells will decrease; however, for the first 8 years of the new optimized design, the overall system pumping rate is more aggressive than the 2005 design, increasing from 4,775 gpm to 5,075 gpm.

Performance metrics are used to track remedy progress. From 1993 through December 2015, a net total of 39.7 billion gallons of water have been pumped from the GMA, and 12,819 pounds of uranium have been removed from the aquifer. Table 6 provides summaries of gallons pumped, total uranium removed, and uranium removal indices for 2015 and for August 1993 through December 2015.

Table 6. Aquifer Restoration System Operational Summary Sheet

Module	Reporting Period					
	January 2015 through December 2015			August 1993 through December 2015		
	Gallons Pumped/ Reinjected (M gal)	Total Uranium Removed/ Reinjected (lbs)	Uranium Removal Index (lbs/M gal)	Gallons Pumped/ Reinjected (M gal)	Total Uranium Removed/ Reinjected (lbs)	Uranium Removal Index (lbs/M gal)
South Field Module[a]	1,395.54	341.59	0.24	20,126.421	7,785	0.39
Waste Storage Area Module[b]	505.54	87.89	0.17	6,192.004	2,048	0.33
South Plume Module[c]	522.52	89.77	0.17	15,354.800	3,061	0.20
Reinjection Module[d]	0	0	NA	1,936.478	76	NA
Aquifer Restoration Systems Totals						
Extraction Wells	2,423.60	519.25	0.21	41,673.226	12,896	0.31
(Reinjection Wells)	0	0	NA	(1,936.478)	(76)	NA
Net	2,423.60	519.25	NA	39,736.748	12,820	NA

Abbreviations:
M gal = million gallons
NA = not applicable
lbs = pounds

Notes:
[a] South Field Module Start-up: 1998
[b] Waste Storage Area Module Start-up: 2002
[c] South Plume Module Start-up: 1993
[d] Reinjection module was shut down in September 2004

Routine groundwater monitoring is conducted using a system of monitoring wells and direct-push groundwater sampling techniques to track the boundary of the 30 µg/L maximum uranium plume and to monitor increasing and decreasing trends in total uranium contamination.

The boundary of the maximum uranium plume is determined semiannually and reported annually in the SER. The boundary interpretation is conservative and represents a worst-case scenario in that uranium contamination measured at any depth in the aquifer is projected onto a single horizontal plane of reference.

The area of the aquifer targeted for remediation is defined in the *Fernald Groundwater Certification Plan* (DOE 2006d) as the aquifer remediation footprint, which is approximately 312.7 acres in size. In consultation with the Ohio EPA, the name was changed to the target certification footprint (LMICP 2009). The groundwater cleanup goal for uranium in the target certification footprint is 30 µg/L. Good progress is being made in reducing the size of the maximum uranium plume that remains inside of the target certification footprint. Attachment 9 shows the size of the maximum uranium plume footprint at the end of 2014 compared to the target certification footprint. The maximum uranium plume at the end of 2014 was 110.9 acres, which is 201.8 acres (64.5 percent) smaller than the target certification footprint. As shown below, the 30 µg/L maximum uranium plume footprint has decreased by 78.4 acres (41.4 percent) since 2006.

Year	Remaining size (acres) of the maximum uranium plume within the target certification footprint
2006	189.3
2007	186.0
2008	186.9
2009	186.0
2010	184.0
2011	144.3
2012	130.3
2013	127.3
2014	110.9

Attachment 10 illustrates the maximum uranium plume footprint as of the end of 2014. The figure indicates that uranium concentrations within the maximum uranium plume footprint are decreasing in most of the wells as a result of pumping operations. Because sources of uranium contamination have been remediated, the uranium concentration increase in some wells within the plume is attributed to the movement of pre-existing uranium contamination toward extraction wells.

Non-uranium constituents are also monitored to evaluate aquifer concentrations relative to FRLs established in the ROD. Forty-nine non-uranium constituents were evaluated through a detailed selection process presented in Appendix A of the Integrated Environmental Monitoring Plan (Attachment D of the LMICP). Currently, 35 of 50 chemical constituents have never exceeded their FRL, and one constituent has had a single exceedance. As documented in the *Fernald Groundwater Certification Plan*, these 36 parameters will be monitored during groundwater certification to determine if they remain below their FRLs. The remaining 14 constituents are currently monitored semiannually, and concentrations are reported annually in the SER.

Most of the locations where non-uranium constituents are present at concentrations above their FRLs lie within the 10-year, uranium-based restoration footprint. However, sporadic FRL exceedances have been detected outside of the 10-year, uranium-based restoration footprint (e.g., zinc, manganese). Monitoring results for the last 19 years have failed to identify a plume outside of the restoration footprint. In many instances, FRL exceedances detected one year are well below the FRL the next year. Exceedances for zinc and manganese in the aquifer could be the result of natural conditions within the aquifer, or caused by biofouling around the monitoring wells being sampled.

Continued monitoring and evaluation of non-uranium constituents is reported annually in Appendix A of the SERs. Monitoring results indicate that no changes to the uranium-based aquifer remedy are necessary to address sporadic non-uranium FRL exceedances outside of the defined restoration footprint for the aquifer remediation.

Review of groundwater remedy progress reported annually in the SER reveals that the remedy remains on track to be protective of human health and the environment. Specifically:

- Institutional controls, as specified in Section 6.1.6, remain in place and prevent exposure.
- A high degree of operational efficiency is being maintained.
- Capture of the uranium plume is being maintained.
- The size of the uranium plume, and uranium concentrations within the plume, continue to decrease. Pumping continues to remove over 500 pounds of uranium each year.
- Groundwater treatment is no longer required to meet uranium discharge limits.

6.1.5.2 Operational Efficiency

Performance metrics provide insight into how efficiently the groundwater remediation is being managed. Performance metrics indicate that a high degree of operational efficiency is being maintained. Performance predictions for the finalized baseline strategy were presented in Section 5.3 of the Baseline Remedial Strategy Report (BRSR) (DOE 1997). The BRSR strategy predicted that the groundwater remediation schedule could be shortened from that presented in the Feasibility Study for OU5 (DOE 1995e) from 27 years to a period between 10 and 20 years. As aquifer restoration modules were installed, remediation design updates were issued based on more up-to-date aquifer data collected in the area where the modules were being installed. The additional data led to enhanced designs that slightly modified the design presented in the BRSR. At the beginning of this five-year review period, the groundwater remediation was operating to a design enhancement that was presented in the Waste Storage Area (Phase II) Design Report, issued in 2005 (DOE 2005c). The model-predicted cleanup date for the groundwater remedy under the 2005 design was 2023. In July 2014, the groundwater remediation began operating to a design presented in the *Operational Design Adjustments-1, WSA Phase II Groundwater Remediation Design Fernald Preserve* (DOE 2014b). The new model-predicted cleanup date for the 2014 operational design is 2035.

Predicted performance is compared to actual performance to assess how closely the two match. Attachment 11 provides a comparison of the actual versus predicted gallons of groundwater extracted from the GMA from fiscal year (FY) 1993 through FY 2014. Attachment 12 provides a comparison of the actual versus predicted pounds of uranium extracted from the GMA from FY 1993 through FY 2015. As shown in Attachment 11, actual versus predicted gallons of groundwater removed from the GMA match fairly well. This is due to an aggressive well maintenance and operational program. As shown in Attachment 12, more uranium has been removed from the aquifer than was predicted by the groundwater model since FY 2010. This observation is consistent with less uranium being loaded initially into the groundwater model in 2005 than was actually present in the aquifer. The 2014 optimization included reloading the groundwater model with more recent uranium concentration data, which provides a more realistic depiction of the current uranium mass in the aquifer.

6.1.5.3 Capture of the Uranium Plume

An important objective of the groundwater remediation is to maintain hydraulic control of the uranium plume. This is being accomplished through a combination of natural flow directions within the aquifer system coupled with the water level drawdown created by pumping the 20 extraction wells used in the pump-and-treat remedy.

Groundwater elevations in the aquifer are measured quarterly, and then water elevation maps for the aquifer are prepared and compared against the footprint of the uranium plume in the aquifer to verify that capture of the uranium plume is being maintained. Attachment 13 provides an example of a quarterly water level map. Quarterly water level maps and the associated plume capture analysis are published annually in the SERs.

Since pump-and-treat operations began, quarterly groundwater elevation maps have consistently shown that capture of the uranium plume has been maintained by pump-and-treat operations. There has also been good agreement between the modeled capture zone and the measured capture zone for the pump-and-treat remedy.

6.1.5.4 Uranium Concentration Predictions

A residual assessment of uranium concentrations (observed concentrations versus model-predicted concentrations) evaluates how reasonable the groundwater model concentration predictions remain over time. These assessments are completed every 5 years, provided groundwater modeling design operational changes have not been made. In July 2014, the groundwater design operational changes were made. Future uranium concentration predictions are now based on the groundwater modeling that used the new modeled pumping rates. Five years has not elapsed since the operational changes were implemented in July of 2014. The next 5-year uranium concentration prediction assessment is planned for 2019 and will be available for inclusion in the fifth CERCLA Five-Year Review Report scheduled for 2021.

6.1.5.5 Uranium Removal Predictions

Modeling provides predictions for the amount of uranium to be recovered from the aquifer to achieve concentration-based cleanup goals. Water samples are collected monthly from extraction wells and analyzed for total uranium. The total uranium concentrations are used to calculate the mass of uranium removed from the well. The actual pounds of uranium removed from the aquifer are compared with the total model-predicted pounds to be removed from the aquifer, and a percent remedy completion estimate is calculated. The results are presented in the annual SERs.

Attachment 12 is a plot showing the percent complete estimates from 2006 through 2014 based on pounds of uranium removed from the aquifer. As Attachment 12 shows, the actual pounds removed compares closely to the pounds predicted to be removed by the groundwater model. In 2014 a new operational design was implemented. Model predictions made using the new design indicate that extraction wells will need to be pumped longer, and that more uranium will be removed from the aquifer than previously predicted using the old design. The drop in percent complete, based on the pounds of uranium removed, reported for 2014 reflects this fact.

A logarithmic regression of the data collected prior to 2014 shows how the data were trending prior to the optimization change in 2014. The trend lines indicate that the efficiency of the pump-and-treat operation was decreasing. This situation is common to pump-and-treat remediations. Implementation of higher pumping rates in July 2014 will help counter this drop in efficiency.

6.1.5.6 Groundwater Treatment

As reported in the third CERCLA Five-year Review (DOE 2011), there is no longer a need to treat groundwater prior to discharge to the Great Miami River in order to meet uranium discharge limits. The aquifer remedy can achieve the uranium discharge limits (i.e., average monthly concentration of less than 30 µg/L and 600 pounds annually) established in the OU5 ROD, without groundwater treatment.

An exception to this occurred between July 2014 and mid November 2014 as a result of initiating higher pumping rates under the new 2014 operational design. As predicted by the groundwater model, groundwater treatment was needed for a brief period to meet discharge limits. Because pumped concentrations continue to decrease, the need for future treatment of groundwater is not expected; however, a reduced groundwater treatment capacity will be maintained. Following the implementation of operational changes to the aquifer remediation system in 2014, a condition assessment of the site's existing wastewater treatment facility, the CAWWT, was conducted. The CAWWT condition assessment, issued in March 2015 (Whitman, Requardt & Associates 2015), concluded that many components of the CAWWT were past their design life and in need of replacement. Additionally, the current treatment capacity of 500 to 600 gpm is significantly more than currently needed. Groundwater modeling predictions based on the new operational design predict that this higher treatment capacity will not be needed in the future. Discussions were completed in the spring and summer of 2015 with regulators and stakeholders to help ensure a common understanding of the issues related to wastewater treatment at the site. DOE, EPA, Ohio EPA, and the community have all reached agreement on replacing the CAWWT with a 50 gpm system, capable of expanding in the future if necessary. It is anticipated that the new system will be operational in 2018 and that the existing system will remain operational to address site wastewater treatment needs until the new system is commissioned and operational.

6.1.5.7 Status of OSDF Leachate/Leak Detection

The OSDF is a potential contamination source located above an area where soil was remediated to FRLs which are above background concentrations. These above-background concentrations in the soil make it difficult to determine (based on water quality alone) whether changing water quality conditions beneath the facility are caused by a leak from the facility or leaching from the soils. DOE has been working with EPA and Ohio EPA to select the interpretation techniques used to assess the nature and cause of changing water quality beneath the facility. Three techniques are currently being used: control charts, bivariate plots, and concentration trend plots. Leachate collection system and leak detection system flow and water quality data are evaluated and reported annually through the SER.

The primary means of demonstrating the absence of a leak from the facility is flow measurement through each cell's LDS in relation to an administrative action leakage rate of 20 gpad, which is one-tenth the design action leakage rate of 200 gpad. The importance of the design action leakage rate was discussed in Section 5.3.1. The LCS and LDS flow data collected over the past 5 years show that flows in both the LCS and the LDS continue to decline and that the engineered drainage features within the OSDF continue to perform as designed. In 2014, only three cells

(Cells 6, 7, and 8) had enough flow in the LDS to collect a water sample. From a sampling perspective, Cells 1 through 5 were dry the entire year. The highest LDS maximum accumulation rate recorded in 2014 was 0.06 gpad in Cell 6, which is 0.3 percent of the initial response leakage rate of 20 gpad, and 0.03 percent of the design Action Leakage rate. An accumulation rate of 0.06 gpad equates to a volumetric flow rate of 0.0015 milliliters per minute for the cell, or approximately 1 cup per acre each day.

Water quality of the leachate in the facility (i.e., LCS and LDS) as well as groundwater located beneath the facility (HTWs and GMA monitoring wells) are also sampled and measured. Existing contaminant concentrations (lower than the CERCLA cleanup levels but higher than background levels) in the groundwater beneath the facility complicates the interpretation of the water quality data. In 2014, increasing contaminant concentration trends were identified in the HTWs and the downgradient GMA wells of OSDF Cells 1–8. The low flow measurements recorded in the LDS indicate that there was not enough water present in the facility to reach the action leakage rate for the facility. The lack of flow from within the facility, coupled with the use of bivariate plots to illustrate that water chemistry of the LCS, LDS, and HTWs is distinct and different, results in a conclusion that the increasing concentration trends observed below the facility can be attributed to pre-existing conditions and not a leak from the facility.

6.1.5.8 Status of OSDF Cap

Quarterly inspections of the OSDF cap have demonstrated that the vegetated cover is stable and performing as designed. In the last 5 years, findings have generally shifted from minor erosion and vegetation establishment to the presence of woody vegetation and noxious weed control. One item of note from the inspection process was the presence of wetland vegetation along several locations within the west inner drainage channel. The appearance of wetland vegetation indicated that flow was restricted within the channel. At one location, the restriction was due to road-base aggregate that had washed into the riprap. The aggregate was removed and flow was restored. Investigation at a second area showed that a concrete culvert was not performing as designed. Water was draining through a misaligned seam rather than through the standpipe inlet. The culvert was repaired in 2014, and subsequent inspections have confirmed that proper drainage has been restored. An engineering evaluation of the west inner drainage confirmed that vegetation within the channel does not compromise function. The channel was designed with the assumption that the inner drainage channel would become vegetated over time (Geosyntec 2013).

6.1.5.9 Status of Soils and Sediments Remediation

As stated in Section 4, all soils and sediments at the Fernald Preserve, with the exception of groundwater restoration and treatment infrastructure, have been remediated and certified to ensure that area-specific contaminants of concern do not exceed soil FRLs specified in the relevant RODs. When groundwater remediation activities are complete (projected in the year 2035), the remediation infrastructure will be removed, and the soil beneath will be remediated (if necessary) and certified. Attachment 15 identifies the subgrade utility corridors and the two remaining uncertified areas.

The soils at the surface of the onsite utility corridors have been certified clean. In general, subgrade soils within the utility corridors are not likely to be contaminated above soil FRLs based on the fact that the contaminated water transported through the pipelines had uranium concentrations much lower than the soil FRL for uranium. The exception is the subsurface areas near former waste units where subsurface soil may be contaminated because the below-grade pipeline was installed on contaminated soil (e.g., utility corridors near the South Field Valve House). Additionally, due to operations in the CAWWT footprint, it is anticipated that soils within the area may be slightly above soil FRLs.

The potential for discovery of contaminated debris continues in portions of the site. Debris is identified during site inspections and during construction and maintenance activities. Fixed radiological contamination has been documented on approximately 2 percent of debris. No removable contamination has been associated with any of the debris. Because the site is open to the public, there is a remote possibility of exposure; however, DOE uses several protective measures to ensure that the potential for exposure is minimized.

First, trail design and construction were undertaken to avoid areas of heavy debris. Attachment 8 shows the location of trails in relation to debris findings across the site in 2011 to 2015. Trail locations were specifically designed to avoid areas of debris. Only one trail traverses the central portion of the site. Prior to construction, extensive debris identification and removal was undertaken in trail corridors. All debris identified from this effort was prior to trail construction.

Second, protective measures are in place to limit public access. The public is prohibited from traveling off of designated trails and public roads. Trail signage, barricades, fact sheets and brochures are used to inform the public of the areas of limited site access. A public brochure is available that specifically addresses the potential for debris discoveries. Additionally, site personnel are authorized to verbally advise visitors about the requirements and ask them to comply should they observe any stated prohibitions being violated.

Third, restored areas are maintained across the site to limit erosion and frost-heave that may expose debris. Wetland, prairie and forest restoration projects have resulted in the establishment of robust vegetation that helps to hold topsoil in place. Erosion issues are addressed upon discovery. The continued establishment of vegetation in remediated areas will reduce the likelihood of debris exposure over time.

Fourth, a process is in place to remove debris from the field once discovered. Field personnel are instructed how to handle debris discoveries during ground-disturbing activities prior to the initiation of fieldwork. A radiological control technician is on staff at the site so that debris discoveries can be addressed in a timely manner. Personnel prioritize removal of debris that is in or near areas accessible by the public.

Lastly, the public is kept informed of debris discoveries through a variety of means. Debris findings are reported in quarterly inspection reports, and as of 2014, an annual summary of inspection findings, including debris, is provided in the Site Environmental Report. Both the quarterly inspection reports and the Site Environmetnal Reports are available online at http://www.lm.doe.gov/Fernald/reports/.

The protective measures summarized above are sufficient in minimizing the potential for exposure to contaminated debris. These measures help to ensure that the remedy is functioning as intended.

6.1.6 Implementation of Institutional Controls and Other Measures

Access restrictions, use limitations, and institutional controls have been established at the Fernald Preserve as described below. These controls have been effective at ensuring remedy protection. There have been no instances where personnel have compromised site remediation or have been exposed to contaminants. The OSDF is fenced in, posted, and access gates remain locked unless authorized personnel are within the fenced area.

Evidence of prohibited activities is observed occasionally; however, these infractions by the public are generally minor, such as hiking with a pet or wandering off-trail. Since 2011, one instance of illegal dumping was documented, along with two instances of vandalism to the OSDF fence. The vandalism on one occasion appeared to be an attempt to steal heavy equipment parked within the south laydown area. Copper ground wire was stolen from an on-property electrical substation and well field power poles in 2014. Additionally, evidence of hunting activity onsite was discovered in 2014.

The well field is not contained within a fenced area, but individual extraction well controls are enclosed in locked well houses to prevent public access. All monitoring wells are kept locked. Consistent with the target land use objective for the on-property area (restricted use as an undeveloped park); institutional control and other measures have been implemented to prevent the use of the aquifer as an on-property drinking water supply. Institutional controls remain in place and consist of:

- Continued federal ownership of the Fernald Preserve. The entire Fernald property must remain in federal ownership, pursuant to the OU5 ROD.
- The Hamilton County water well permitting process. Drinking water wells cannot be installed until a permit has been obtained from the Hamilton County Health Department. DOE will ensure that the Health Department is aware of the off-property areas where groundwater contamination is greater than 30 µg/L of uranium. DOE has sent a letter and map documenting the contaminated area to the Hamilton County Health Department and requested that no permits be issued in this area, given the contamination and the ongoing aquifer remediation (Attachment 16). Additionally, the letter requests that DOE be notified of any proposed drilling activities in the vicinity of the plume. If DOE is made aware of any drilling activities in the area of the offsite plume, the regulators must be notified. This process was confirmed through a documented interview, which is included in Attachment 5. DOE will notify the Hamilton County Health Department when the off-property area is certified clean and the two private wells being sampled in the area are no longer needed.
- The Environmental Covenant, Appendix B of the Consent Decree between the State of Ohio and DOE. The Environmental Covenant establishes activity and use limitations for the Fernald site and restricts use of groundwater as a drinking water supply. The LMICP is referenced in the Environmental Covenant and is used to ensure compliance with the Environmental Covenant.
- Two off-property subgrade utility corridors. The corridors (Attachment 15) exist to support the aquifer remediation infrastructure, the outfall line from the eastern property boundary to the Great Miami River and South Plume utility corridor. As stated in Section 6.1.5.9, following removal of the aquifer infrastructure from these areas, the subgrade soils within the corridors will be remediated (if necessary) and certified. DOE has entered into

agreements with the property owners for these areas. These agreements provide for operation, maintenance, alteration, repair, and patrol of the areas.

6.2 Question B: Assumptions Validity

Question B: Are the exposure assumptions, toxicity data, cleanup levels, and remedial action objectives used at the time of remedy selection still valid?

The EPA five-year review guidance documents suggest the following evaluation:

> Evaluate those assumptions critical to the effectiveness of remedial measures on the protection of human health and the environment (made at the time of the remedial decision) to determine, given current information, whether these assumptions are still valid.

Risk assessment assumptions and calculations are reviewed as part of the five-year review process. In the second five-year review (DOE 2006e), the 2006 cancer slope factors (CSFs) and reference doses (RfDs) were obtained from the EPA website (radionuclide tables and Integrated Risk Information System [IRIS] database, www.epa.gov/IRIS) and were used in the risk calculations presented in Attachment IV of the Comprehensive Response Action Risk Evaluation (CRARE), which can be found in Appendix H of the Feasibility Study Report for OU5 (DOE 1995e). The exposure scenarios that were evaluated include the undeveloped-park user, off-property farm adult, and off-property farm child. All pathways were evaluated and summed to produce the results in Table 6-3 of the second five-year review, and the 2006 results indicated that the original risk assumptions upon which the Fernald remedy was based remain valid.

After the release of the 2006 five-year review, the Interim Residual Risk Assessment (IRRA) was prepared to assess the risk to human health and the environment from post-remediation contaminants in the air, soil, and surface water at the Fernald site. Groundwater remediation is ongoing, and a final risk assessment will be performed when the groundwater restoration goals have been achieved for the GMA. The IRRA calculations documented that the soil remedial actions at the Fernald site were adequate to reduce contaminant concentrations in soil and surface water to levels that are protective of human health and the environment.

The third five-year review in 2011 examined the 2010 CSFs and RfDs and compared them to values used in the 2007 IRRA to identify values that had changed and determine if those changed values had produced significant changes in human-health risk. In the 2007 IRRA, the highest risk was to the undeveloped-park user who recreates in Zone 5 of the Fernald Preserve (DOE 2007b). Therefore, risk calculations were performed with 2010 values for CSFs and RfDs and the same exposure scenario for the undeveloped-park user in Zone 5. Results presented in the third five-year review indicated a slight decrease in human-health risk relative to the IRRA, and the risk assumptions remained valid for the OU5 post-remedial conditions.

This five-year review proceeded in a manner similar to the third five-year review, where 2015 CSFs and RfDs were compiled and entered into the undeveloped-park user scenario in Zone 5 to calculate human-health risk and compare the results to values in the third five-year review. Additionally, EPA exposure factors were reviewed, and updated values for inhalation rate, surface-water ingestion rate, resident exposure duration, body weight and body surface area were entered into the risk calculations. In general, new CSFs and RfDs slightly increased the risk and the revised exposure factors decreased the risk, with the overall results slightly lower than those reported in the third Five-Year Review Report. Therefore, the risk assumptions remain valid for the OU5 post-remedial conditions. Attachment 17 provides additional detail regarding risk calculations using the updated CSFs, RfDs, and exposure factors.

6.2.1 Human Health Risks and Remedial Design

In the OU5 Baseline Risk Assessment (Appendix A of the OU5 RI Report), risk was calculated for a series of modeled human receptors representing a variety of possible land uses (DOE 1995b). The risk to the modeled receptor had to be less than 1×10^{-4} for the ILCR and less than 1 for the hazard index (HI) to ensure that the selected remedy was protective of human health and the environment. The OU5 Baseline Risk Assessment considered all radionuclides and chemicals that passed a preliminary screening for their presence or absence onsite (Tables A.4-1 and A.4-3 of the OU5 RI Report [DOE 1995b]).

In Appendix H of the FS Report for OU5, the CRARE was performed for the remedial alternatives to evaluate the risk imposed on target receptors from contaminants remaining under post-remediation conditions (DOE 1995e). The target receptors evaluated in the CRARE supported the OU5 selected remedies of (1) undeveloped-park user, (2) off-property farm adult, and (3) off-property farm child. Calculated post-remediation risks to these receptors were evaluated using projected residual concentrations of constituents of concern (the projected residual concentrations became the OU5 ROD FRLs for soil, sediment, surface water, and groundwater). The human health risk to these receptors met the CERCLA upper-bound limit of less than 1×10^{-4} for ILCR and less than 1 for HI.

After the 2006 completion of the OU5 soil remedy, the IRRA was prepared to assess the risk to onsite receptors by post-remediation (i.e., actual residual) contaminant concentrations in air, soil, and surface-water media within eight exposure zones that the Fernald site comprises (DOE 2007). Exposure pathways for the receptors included inhalation of air and particulates, dermal contact with soil and surface water, ingestion of soil and surface water, and external radiation. Receptors, exposure parameters, RfDs, and CSFs were updated relative to values presented in the CRARE. The IRRA report evaluated the receptor risk due to exposure to measured post-remediation contaminant concentrations in air, soil, and surface water on the site, whereas the CRARE evaluated risk using the OU5 Remedial Investigation data set, background data, and air models to estimate post-remediation contaminant concentrations in air, soil, and surface-water media. Target receptors in the CRARE were selected for the onsite undeveloped park and offsite farm land-use scenarios. However, the IRRA calculations presented only the receptors for the onsite undeveloped park, as groundwater remediation is ongoing, and the evaluation of the offsite farm scenario is dependent on the groundwater pathway for ingestion of water by humans and livestock and irrigation of crops. This condition remains valid for the site, and the offsite farm scenario is not evaluated in this report. Groundwater and food pathways for the offsite receptors will be covered in the final risk assessment report submitted to the regulatory agencies after aquifer remediation is complete.

6.2.2 Cancer Slope Factors (CSFs)

CSFs are published values that specify a cancer morbidity value (risk) to a receptor for a given quantity of contaminant intake, referred to as an ILCR. The resulting value determines whether post-remediation concentrations of contaminants will result in a cancer risk that is in compliance with CERCLA guidance (i.e., ILCR of less than 1×10^{-4}). EPA publishes CSFs for most radionuclides and some nonradionuclide chemicals that are proven or suspected carcinogens, and the Risk Assessment Information System ([RAIS] http://rais.ornl.gov) maintains an updated set of CSFs.

6.2.3 Chemical Reference Dose (RfDs)

Non-cancer health risks that are due to exposure to nonradiological chemicals are evaluated by application of RfDs for oral and inhalation exposure routes. Reference doses estimate the upper-bound chronic dose of a chemical that a human receptor can be exposed to without suffering ill effects. The contaminant intake for a receptor is divided by the appropriate RfD factor to yield the HI. If the HI is greater than 1, a negative health impact to the receptor is expected. The EPA's IRIS database and Oak Ridge National Laboratory’s RAIS database contain the RfD factors.

6.2.4 Changes in Slope Factors and Reference Doses

As the body of knowledge regarding radiological and chemical toxicity increases, EPA occasionally finds it necessary to change the CSFs and/or RfDs. For this five-year review, RAIS was queried to obtain the most recent CSFs and RfDs for each exposure pathway (inhalation, ingestion, dermal, and external radiation). Absorption factors and permeability factors for the dermal exposure pathway were also updated. This database is a comprehensive source for toxicity data compiled from the EPA IRIS, the EPA Health Effects Assessment Summary Tables (radionuclide table), and the EPA Provisional Peer Reviewed Toxicity Values. The RAIS toxicity values are reviewed monthly and updated as new values are added to the individual EPA source databases. The CSFs and RfDs used in this five-year review were extracted from RAIS on July 24, 2015. Attachment 17 shows a comparison of the October 2010 CSF and RfD values to the values used in the *Third Five-Year Review Report for the Fernald Preserve* (DOE 2011).

In the 2007 IRRA, the highest risk was to the undeveloped-park user who recreates in Zone 5 of the Fernald Preserve. Therefore, risk calculations were performed with (1) 2015 values for CSFs and RfDs, (2) updated EPA exposure factors, and (3) the same exposure scenario for the undeveloped-park user in Zone 5. Calculations and comprehensive results are provided in Attachment 17. All pathways tabulated in Attachment 17, Table 17-4 were evaluated and summed to produce the results in Table 7. Background risk is included with the reported results.

For the undeveloped-park user, the ILCR and HI for all pathways and contaminants of concern decreased slightly in 2015, relative to the 2011 Third Five-Year Review Report and 2007 IRRA values. The decrease in ILCR and HI is primarily due to the decrease that arises from the change in exposure factors, because the new CSF and RfD values increased the overall ILCR and HI values (Attachment 17).

Table 7. Comparison of IRRA (2007) and 2011 Five-Year Review to Current Risk for the Undeveloped Park User in Zone 5 of the Fernald Preserve

Receptor	ILCR	HI
Undeveloped-Park User (IRRA, Appendix E)	7.11×10^{-5}	8.15×10^{-2}
Undeveloped-Park User (DOE 2011)	3.49×10^{-5}	2.57×10^{-2}
Undeveloped-Park User (this report, Attachment 15)	2.57×10^{-5}	2.01×10^{-2}

As a result of this evaluation, the original risk assumptions upon which the Fernald remedy is based remain valid. Alteration of the planned remedial design is unnecessary because changes in the CSFs, RfDs, and exposure factors will not result in ILCR and HI values that exceed 1×10^{-4} and 1, respectively. Attachment 17 provides additional detail.

6.2.5 Ecological Risk

A screening-level ecological risk assessment was conducted as part of the OU5 RI. Both radiological and nonradiological risks were evaluated. For radiological risks, dose estimates were calculated for several ecological receptors at the Fernald Preserve. For nonradiological risks, media-specific contaminant concentrations were compared to literature-based benchmark toxicity values (BTVs). BTVs are concentrations that are considered protective of ecological receptors. They are also referred to as Ecological Screening Levels (ESLs) in current EPA guidance (EPA 1997).

The RI risk assessment concluded that several constituents warranted further investigation. Since the evaluation of nonradiological risks was a screening-level assessment only, the OU5 ROD did not commit to any cleanup based on risk to ecological receptors. Instead, potential ecological risks would be revisited following remedial activities. The *Site-Wide Excavation Plan* (SEP) (DOE 1998b) began implementing this approach by refining the nonradiological risk screening and by defining remediation areas where ecological risk might be a concern following excavation. These area-specific ecological constituents of concern were investigated as part of the certification process following soil remediation. Surface water and sediment constituents of concern were also monitored, along with an evaluation of cross-media impacts, with no resulting issues.

A review of the assumptions associated with receptor organisms, exposure pathways, calculation parameters, and the target level radiological dose indicated that these assumptions are still valid. Ecological dose continues to be evaluated annually and reported in the SER, with no issues identified. For nonradiological risk, a review of screening benchmarks was conducted as well. Since completion of the SEP, a number of updated ESLs have been published for a variety of ecological receptors and media.

Although a single BTV was listed in the SEP, and this approach was followed during an update of the BTV/ESL values in the 2011 Fernald CERCLA Five Year Review Report, it is generally recognized now that a broad comparison of site data to many literature sources for ESLs provides a better means for screening site-specific data when assessing whether an ecological risk assessment is warranted. Attachment 18 provides a current data set of media-specific ESLs that were considered for this review. The ESLs are presented in two tiers. Tier 1 ESLs are conservative values that serve as thresholds for adverse effects, based on survival, growth, and reproductive endpoints, under long-term or chronic exposures. If site ecological constituent of concern (ECOC) values exceed Tier 1 values, it may indicate a potential need for further investigation (e.g., as described in Step 3a of the ERA guidance for Superfund sites [EPA 1997]). Tier 2 ESLs are less conservative values more likely to be associated with measurable or more serious adverse effects such as reduced survival or impaired growth or reproduction. Media concentrations that exceed a Tier 2 ESL generally invoke additional evaluation of ecological habitat.

Attachment 18 Tables 18-1 and 18-2 show a summary of this effort for soil and surface water. The lowest above-background Tier 1 ESL from Attachment 18 was compared to the soil and surface water BTVs established in the OU5 RI and SEP. If a Tier 1 ESL was not available, then Tier 2 or other alternative ESLs were considered. Other than a comparison with background concentrations, no site-specific conditions were considered, such as adjustments due to pH, water hardness, and receptors. Total uranium was not included for further evaluation in the SEP because the BTV was higher than the sitewide FRL (DOE 1998b). It was added as part of this updated review, given that it is the primary contaminant of concern across the site.

Updated soil and surface water ESLs were then compared to zone-specific maximum and average concentrations from the IRRA. As Attachment 18 Tables 18-1 and 16-2 show, some maximum zone concentrations do exceed the new ESLs. However, a comparision of more representative average values for each zone demonstrates that soil and water concentrations across the site are generally protective of ecological receptors.

Field data from ecological surveys and wetland mitigation monitoring continue to show a diverse and growing ecosystem. No signs of toxicological stress have been observed during field activities. Therefore, at this time the prudent course of action is to reevaluate the literature during subsequent CERCLA five-year reviews. If it is determined that a full-scale ecological risk assessment is warranted, it will be conducted as part of the final Residual Risk Assessment, which will be prepared following completion of the groundwater remedy.

6.2.6 Review of Maximum Contaminant Levels (MCLs)

None of the 50 groundwater constituents of concern had changes in MCLs from the last five-year review.

6.3 Question C: New Information

Question C: Has any other information come to light that could call into question the protectiveness of the remedy?

Overall, there has been no information that has indicated either (1) the protectiveness of individual remedies has been compromised or (2) the assumptions underlying the remedies implemented have come into question. While updated human health CSFs and RfDs have been published, resulting risk calculations show that the remedy remains protective. In addition, there are no concerns in a comparison of updated ecological risk screening values to site soil and surface water concentrations. In addition, the ecological restoration that is proceeding has shown no toxicological stresses. There has been no observed natural phenomenon that has compromised the completed remedies or the ongoing operation of the groundwater remedy and care and maintenance of the OSDF. There has been no illegal or malicious behavior that has compromised site operations. As a site that is open to the public, visitor behavior is tracked and evaluated.

6.3.1 Emerging Contaminants: Perfluorooctane Sulfonate and Perfluorooctanoic Acid

EPA has identified perfluorooctane sulfonate (PFOS) and perfluorooctanoic acid (PFOA) as emerging contaminants (EPA 2014). An emerging contaminant is a chemical or material that is characterized by a perceived, potential, or real threat to human health or the environment or by lack of published health standards. These chemicals were used in a variety of products such as surfactants and fire supressent foams, and the main environmental impacts result from manufacturing the chemicals or tank and supply line leaks. PFOS and PFOA were not manufactured at the Fernald site, but fire suppression used at the former Fire Training Facility may have contained PFOS or PFOA.

Removal Action 28, Fire Training Facility which was completed in June 1995, involved the removal, decontamination, treatment and disposal of all structures, tanks, equipment, underground sump, and surface soils at the Fire Training Facility. A query of the environmental database failed to locate analytical results for PFOS and PFOA in any media. Because data are unavailable to support the contention that, if present, PFOS and PFOA residual levels are not a threat to human health and the environment after the extensive remediation of the Fire Training Facility, limited sampling and analysis will be conducted for PFOS and PFOA.

6.3.2 Vapor Intrusion

Vapor intrusion is the migration of hazardous vapors from any subsurface contaminant source, such as contaminated soil or groundwater, through the vadose zone and into the indoor air. The vapor usually intrudes overlying buildings through openings in the building foundation, through cracks in the slab or gaps around utility lines. Contaminants that may result in vapor intrusion include volatile organic compounds and other vapor-forming chemicals, such as semivolatile organic compounds, and elemental mercury. EPA defines vapor as a component of the gas phase that is generated from volatile chemicals. A chemical is considered to be volatile if its vapor pressure is greater than 1 millimeter of mercury or if it has a Henry's law constant that is greater than 10^{-5} atmosphere-meter cubed per mole at ambient temperature (EPA 2015).

A review of the conditions at the Fernald site was completed to evaluate whether a vapor intrusion pathway exists at the Fernald Preserve under the post soil-remediation conditions present today. As part of the remedy for OU5, all RCRA volatile chemicals found in soil during the OU5 remedial investigation and failing toxicity characteristic leaching procedure test were excavated and treated prior to disposal offsite or in the OSDF; therefore, all subsurface sources have been eliminated. Per EPA guidance (EPA 2015), if a subsurface source of hazardous vapor is absent in soil and groundwater, the vapor intrusion pathway is incomplete and no further assessment is warranted. Data collected and assessed during the IRRA evaluation show no potential exposure pathway exists because the:

1) maximum VOC soil concentrations in the remediated hazardous waste management units (HWMUs) are order of magnitude below the resident soil screening levels for the inhalation pathway (Table 8).
2) soil and groundwater below the two main buildings onsite, the Visitor Center and CAWWT, are not contaminated with VOCs so there is no source on the site capable of creating sufficient soil gas concentrations for migration to the footprints of these buildings.

Table 8. VOC Soil COCs at Remediated HWMUs

Compound	Maximum Soil Concentration (mg/kg)	Soil Screening Level (mg/kg)
Benzene	0.0012	1.3[a]
Methylene Chloride	0.0077	140[b]
Tetrachloroethylene	0.069	9.8[b]
Trichloroethane, 1,1,1-	0.012	860[b]
Toluene	0.0076	2200[b]
Xylene	0.030	60[b]

[a] Soil screening level from EPA Regional Screening Level Resident Soil Table (EPA 2016), elevated lifetime cancer risk of 1×10^{-6}.
[b] Soil screening level based on hazard index of 0.1.

6.3.3 Technical Assessment Summary

According to the data collected and reviewed, the inspections conducted, and the stakeholder feedback received, the remedies are functioning as intended by the five RODs. There have been no changes in the physical conditions of the site that would affect the protectiveness of the remedies. There have been no significant changes to the ARARs cited in the individual RODs. There have been no changes in the toxicity factors for the contaminants of concern or risk assessment methodologies that could affect the remedies. There is no new information or activities that call into question the protectiveness of the remedies.

The groundwater remedy is generally progressing as predicted through modeling. The system pumping optimization that was implemented in 2014 and the aggressive well maintenance program that continues are examples of current efforts to keep the efficiency of the cleanup as high as possible. The performance of the OSDF cap and liner systems have been well within the original design requirements. Implementation of the required institutional controls and the access and use restrictions of the site have been effective to ensure that land use is consistent with stakeholder expectations, established cleanup levels, and public use as an undeveloped park with an emphasis on wildlife.

7.0 Issues

Table 9. Issues

Issue number	Issues	Affects Current Protectiveness (Yes/No)	Affects Future Protectiveness (Yes/No)
1	Not achieving model-predicted aquifer remediation cleanup times	No	No
2	Elevated uranium concentrations in surface water west of former Waste Pit 3	No	No
3	Debris Management Program	No	No
4	Presence or absence of PFCs (PFOS or PFOA)	No	Yes
5	Uncertified Utility Corridors and Building Footprints	No	Yes

7.1 Issue 1 – Not Achieving Model-Predicted Aquifer Remediation Cleanup Times

Four conditions have been identified at the site that could extend the aquifer cleanup time beyond that predicted by the model:

- Sorbed uranium contamination in the vadose zone of the aquifer
- Stagnation zones within the uranium plume
- Preferential flushing pathways within the uranium plume
- Well field maintenance

7.1.1 Sorbed Uranium Contamination in the Vadose Zone

Uranium is bound to soils in the unsaturated zone of the GMA beneath former contamination source areas. This contamination will remain bound unless water levels in the aquifer rise and saturate the contaminated sediments, allowing the bound contamination to dissolve into the groundwater. Early indicators include rising uranium concentrations in groundwater beneath former source areas when water levels are high.

Planned annual well field shutdowns have been conducted since 2007 to allow water levels in the aquifer to rise as high as possible to saturate material that is normally unsaturated in an attempt to alleviate this condition. To achieve the highest water level rise possible, the well field shutdowns are planned to coincide with seasonal high water levels in the aquifer. Results are reported annually in the Site Environmental Report. Attachment 19 shows how water levels have fluctuated for one well over the past 9 years during the shutdowns. A review of data from monitoring wells located in or near the former source areas indicates that the well field shutdowns and resulting aquifer water level rebound are providing some benefit and will therefore be continued. However, in general, recent aquifer water levels continue to be lower than the historical water levels that occurred when contamination was actively leaching from the source areas to the aquifer. This leaves a potential for additional leaching of contaminants from the vadose zone should the water levels return to the historical levels.

7.1.2 Stagnation Zones within the Uranium Plume

Stagnation zones exist within the uranium plume. These stagnation zones are created by the competition of extraction wells for water within the aquifer. A stagnation zone between the South Plume extraction wells and the South Field extraction wells appears to be impacting the remediation of an off-property lobe of contamination just south of Willey Road. Attachment 20 is a map that shows the maximum uranium plume (as of December 2014) in relation to the time-of-travel remediation footprint predicted by the groundwater model for the new remedy design that was implemented in 2014. Groundwater modeling conducted to support the well field operational changes implemented in 2014 predicts that increasing the pumping rates in nearby extraction wells will attain FRLs by 2022. Additional operational time is required to determine if the modeling predictions will be achieved. Additional changes to the aquifer remedy may be needed to address this off-property lobe of contamination. Any change to the aquifer remedy to address this lobe of contamination will likely be complicated by landowner concerns, due to its off-property location.

7.1.3 Preferential Flushing Pathways within the Uranium Plume

The GMA is both heterogeneous and anisotropic. Groundwater flowing through the aquifer matrix seeks the pathway of least resistance to the extraction wells. The result is that coarser-grained aquifer material flushes contamination more effectively than the finer-grained aquifer material because more water is moving through the coarser material. Contamination sorbed to the finer-grained aquifer material slowly leaches out into the more active flow paths. Over time, this ineffective flushing of the finer-grained material results in reduced cleanup efficiency and prolonged cleanup times. The constant pumping rate being maintained at each extraction well may be contributing to this possible condition. Indirect evidence that preferential flow paths may have been established is the increasingly asymptotic nature of the decreasing uranium concentration trends of the extraction wells and the relatively stable extent of the boundary of the maximum uranium plume. The operational pumping changes that were implemented in 2014 should help to address this concern because the different pumping rates will help redirect flow paths within the aquifer matrix. Additional operational changes to the aquifer remedy may be needed to further address this issue. Operational changes could include changing the pumping rates of existing extraction wells, pulse-pumping the existing extraction wells, and installing additional extraction wells.

7.1.4 Well Field Maintenance

Increased individual well pumping rates under the optimized remedy design that was implemented in 2014 will likely result in the need for increased maintenance to the pumps, motors, and well screens due to iron fouling and plugging. The feasibility of the maintaining the wells at these higher pumping rates can only be determined through long-term operations. Should operational experience show that maintaining these higher pumping rates requires excessive maintenance and is not cost effective, individual well pumping rates may need to be reduced. Lower individual well pumping rates could result in increased cleanup time.

7.1.5 Summary

Because of the proactive management of the aquifer remediation by continuing annual well field shutdowns, adjusting the operation of the well field, and continuing the aggressive well maintenance program this issue does not affect current or future protectiveness of the remedy.

7.2 Issue 2: Elevated Uranium Concentrations in Surface Water West of Former Waste Pit 3

In late 2006, during the course of routine sampling of several surface water locations, Ohio EPA sample results were above the surface water FRL for uranium (530 μg/L). DOE confirmed these sampling results in early 2007.

The location in question is a series of small puddles and drainage ditches due west of the center of former Waste Pit 3, which drain generally south to a depression near the former cement pond. This area does not drain directly to Paddys Run. The area of impact at peak water retention is approximately one-half acre, and the actual surface water area is much less than that.

Even though the area in question underwent a rigorous soil certification process, and all certification samples from this area were well below the soil certification FRLs, DOE proposed a study to investigate the leachability of the residual uranium present in the surface soils in the area to gain a better understanding of the reason for the persistently elevated concentrations of uranium in the ponded surface waters. The results of this study confirmed that surface soil uranium concentrations in the area are below the prescribed soil FRL, but the uranium present is generally more leachable than in other areas at the Fernald site. Further, because of these differing leachability characteristics, it was concluded that the possibility of an unknown source of uranium contamination in the area is unlikely.

Although certification had been achieved, compliance with the OU5 ROD was established, and the area of elevated uranium concentrations posed no offsite impacts, DOE implemented a maintenance action as a good faith effort to address Ohio EPA concerns. The scope of the maintenance action was to remove approximately 6 inches of soil from the surface of the area. The removed material was (1) transported to a topographically higher location and distributed sufficiently to prevent extended contact time with ponding rain water (and thus reduce leaching of the residual uranium), (2) treated with high phosphorus content fertilizer to further reduce leachability, and (3) adequately revegetated to stop erosion and spread of this soil. The scraped area and nearby depressions were filled and graded (to reduce or eliminate future ponding) and reseeded. This maintenance action was completed in October 2007.

New surface water monitoring locations were established in this area in 2007 to track and trend uranium concentrations. It would appear, based on a review of these data, that the maintenance action undertaken has not achieved its goal of significantly reducing surface water uranium concentrations in this area. However, groundwater modeling indicates that a worst-case continued source of uranium from this area does not impact predicted cleanup times for the groundwater in this area. The pumping underway only addresses dissolved uranium; the aquifer remedy does not address uranium that is sorbed to soils above the water table. If surface water elevated uranium concentrations persist, additional action may be needed to address the puddles and the potential vadose zone contamination.

Site inspections revealed that Paddys Run was migrating toward one of the surface water puddles. From 2012 to 2014, the east bank of Paddys Run had eroded more than 13 feet to the east. In response, DOE began a streambank stabilization project in 2014. The project took place along a 475-foot reach of Paddys Run and involved relocation of the main channel 30 feet west; installation of a rock toe along the east bank; installation of two cross-vane in-stream grade-control structures; stabilization of a portion of the east bank using soil encapsulated lifts; and regrading, seeding, and planting within remaining disturbed areas. The project was completed in November 2015 and to date has been successful in stopping further bank erosion into the area of concern, thereby preventing off-site migration of the contaminated surface water via Paddys Run.

Because the surface water is intermittent in nature, does not migrate offsite, and the soils remaining in the area meet soil FRLs established in the OU5 ROD, the issue does not affect current or future protectiveness of the remedy.

7.3 Issue 3: Debris Management Program

During routine care and maintenance activities as well as routine inspections of the site, debris from remediation activities has been found. This debris typically consists of pieces of asphalt, concrete, brick, tile, and metal. As debris is found, it is flagged and undergoes a radiological scan to determine its disposal protocol. Debris with radiological scans measured above background is removed and placed in a radiological materials storage area. Controls are in place to mitigate the possibility of members of the public coming into contact with debris. To date, there is no evidence that members of the public have handled contaminated debris. The program to identify and remove debris will continue. Result of the debris management program are included in quarterly inspection reports and reported annually to the public in the SERs.

As discussed in Section 6.1.5, multiple controls are in place to manage debris and this issue does not affect the current or future protectiveness of the remedy.

7.4 Issue 4: Presence or Absence of PFCs (PFOS or PFOA)

The Fernald Preserve environmental database does not contain analytical data for PFCs (PFOS or PFOA). Because these chemicals may have been used in fire suppressant materials discharged at the former Fire Training Facility, a screening groundwater sampling plan will be submitted for regulator review. The sampling plan will include a schedule for sampling and reporting. Results will be compared to the EPA provisional health advisory (EPA 2014). Following this screening sampling event, a comprehensive investigation plan will be submitted for regulator review and approval.

This issue may affect future protectiveness of the remedy if PFCs are present above levels that present an unacceptable risk.

7.5 Issue 5: Uncertified Utility Corridors and Building Footprints

Because the active aquifer restoration continues, certification of the soil within the subgrade utility corridors and footprints of the CAWWT and South Field Valve House remains to be completed. Any soil or debris originating in the two uncertified areas and subsurface soil in the subgrade utility corridors cannot be moved to certified areas. The site inspection process ensures that uncertified soil is not disturbed.

Because the soils beneath the utility corridors and footprints of the CAWWT and South Field valve houses will be remediated (if necessary) and certified after removal of the infrastructure following completion of the groundwater remediation activities, projected in the year 2035, this issue does not affect current protectiveness. In order to be protective in the future, the soils must be certified to meet soil FRLs specified in the OU5 ROD following completion of the groundwater remediation activities.

8.0 Recommendations and Follow-Up Actions

Table 10. Recommendations and Follow-Up Actions

Issue	Recommendations and Follow-Up Actions	Party Responsible	Oversight Agency	Milestone Date	Affects Protectiveness (Y/N)	
					Current	Future
1	1.1 Continue annual well field shutdown to allow water levels to rebound.	DOE	EPA, Ohio EPA	Annual	N	N
	1.2 Determine need to change pump-and-treat configuration based on characterization data.	DOE	EPA, Ohio EPA	During routine aquifer remedy activities	N	N
	1.3 To address potentially ineffective plume flushing, determine what pumping rate changes may be beneficial.	DOE	EPA, Ohio EPA	During routine aquifer remedy activities	N	N
	1.4 Continue with aggressive well maintenance program and keep wells operating at design set points.	DOE	EPA, Ohio EPA	During routine aquifer remedy activities	N	N
2	Continue surface water sampling program with reductions.	DOE	EPA, Ohio EPA	During routine monitoring activities	N	N
3	Continue current debris management program.	DOE	EPA, Ohio EPA	Annual	N	N
4	4.1 Submit, for regulator review, a PFC (PFOA and PFOS) groundwater screening sampling plan to include a schedule for sampling and reporting.	DOE	EPA, Ohio EPA	December 31, 2016	N	Y
	4.2 Submit a comprehensive PFC (PFOA and PFOS) investigation plan for regulator review.	DOE	EPA, Ohio EPA	March 31, 2018	N	Y
5	Certify soil following removal of aquifer infrastructure including subgrade utility corridors and associated buildings.	DOE	EPA, Ohio EPA	2040	N	Y

9.0 Protectiveness Statement(s)

The remedy at OU1 is protective of human health and the environment. All known waste materials have been removed and disposed of permanently. The underlying soils have been certified to meet established FRLs pursuant to the OU5 ROD. Institutional controls as specified in Section 6.1.6 and access controls are in place and effective in ensuring that the footprint of OU1 is used in accordance with the land use objectives and FRLs supporting those land use objectives.

The remedy at OU2 is protective of human health and the environment. All waste materials have been removed and disposed of permanently. The underlying soils have been certified to meet established FRLs pursuant to the OU5 ROD. Institutional controls and access controls are in place and effective in ensuring that the footprint of OU2 is used in accordance with the land use objectives and FRLs supporting those land use objectives. The cap and liner systems of the OSDF are functioning as designed and are successfully isolating the waste materials. The volume of leachate generated from the OSDF is continuing to decline, and the leachate is being effectively collected and treated to minimize impacts to human health and the environment.

The remedy at OU3 is protective of human health and the environment. All waste materials and building debris have been removed and disposed of permanently. The underlying soils have been certified to meet established FRLs pursuant to the OU5 ROD. Institutional controls and access controls are in place and effective in ensuring that the footprint of OU3 is used in accordance with the land use objectives and FRLs supporting those land use objectives.

The remedy at OU4 is protective of human health and the environment. All waste materials have been removed and disposed of permanently. The underlying soils have been certified to meet established FRLs pursuant to the OU5 ROD. Institutional controls and access controls are in place and effective in ensuring that the footprint of OU4 is used in accordance with the land use objectives and FRLs supporting those land use objectives.

The remedy at OU5 is currently protective of human health and the environment because exposure pathways that could result in unacceptable risks are being managed. Soils sitewide have been certified to meet FRLs established in the OU5 ROD, with the exception of the infrastructure footprint that supports aquifer restoration. Current groundwater monitoring data indicate that the groundwater remedy is functioning as required to achieve groundwater FRLs. The cap and liner systems of the OSDF are functioning as designed and are successfully isolating the waste materials. The volume of leachate generated from the OSDF is continuing to decline, and the leachate is being effectively collected and treated to minimize impacts to human health and the environment. Institutional controls as specified in Section 6.1.6 and access controls are in place and effective in ensuring that the footprint of OU5 is used in accordance with the land use objectives and FRLs supporting those land use objectives. However, in order for the remedy to be protective in the long-term, the following actions need to be taken to ensure protectiveness: 1) perform an investigation of the site to evaluate the potential for releases of PFCs and 2) certify soils associated with the aquifer restoration infrastructure footprint.

The sitewide remedy at the Fernald Preserve site is currently protective of human health and the environment because exposure pathways that could result in unacceptable risks are being managed. All waste materials generated during remediation have been removed and disposed of permanently. The underlying soils have been certified to meet established FRLs except soils beneath two facilities (Converted Advanced Wastewater Treatment facility and South Field Valve House) and subgrade utility corridors needed to support the ongoing groundwater remedy. Institutional controls and access controls are in place and effective in ensuring that the footprint of OUs 1, 2, 3, 4, and 5 are used in accordance with the established land use objectives and the FRLs that support those land use objectives. In addition, for OU5, current groundwater monitoring data indicate the groundwater remedy is functioning as required to achieve groundwater FRLs. The cap and liner systems of the OSDF are functioning as designed and are successfully containing waste materials. The volume of leachate generated from the OSDF is continuing to decline, and the leachate is being effectively collected and treated to minimize impacts to human health and the environment. Institutional controls as specified in Section 6.1.6 and access controls are in place and effective in ensuring that the footprint of OU5 is used in accordance with the land use objectives and FRLs supporting those land use objectives. However, in order for the remedy to be protective in the long-term, the following actions need to be taken to ensure protectiveness: 1) perform an investigation of the site to evaluate the potential for releases of PFCs and 2) certify soils associated with the aquifer restoration infrastructure footprint.

10.0 Next Review

The next five-year review for the Fernald site is required in 2021, which is 5 years from the due date of this review.

The next five-year review report for the Fernald site is required to be completed by 5 years from EPA’s concurrence signature date on this review.

11.0 References

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Attachment 1

Fernald Preserve and Vicinity

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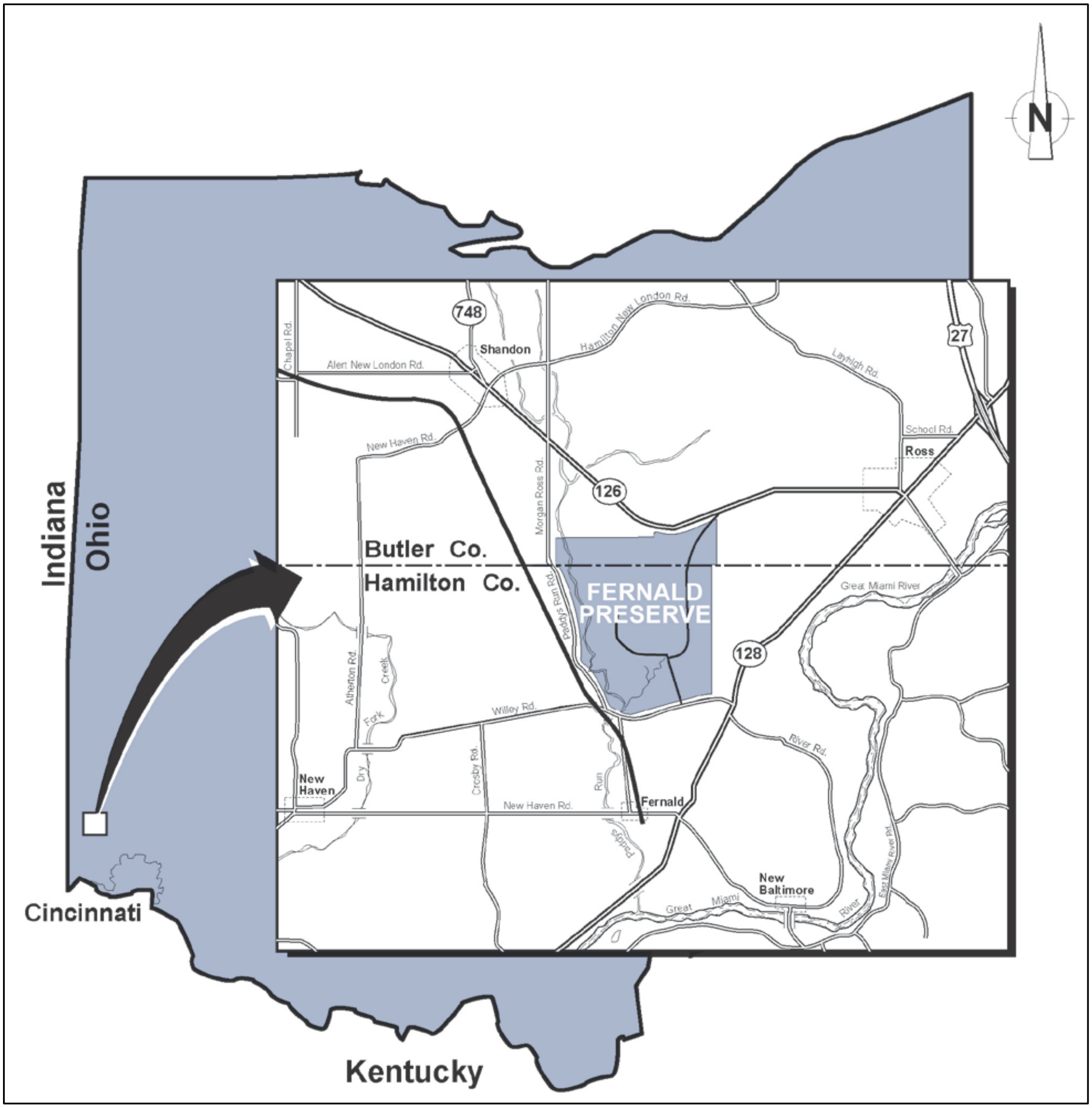

Note: The Fernald site covers about 1,050 acres (425 hectares).

Fernald Preserve and Vicinity

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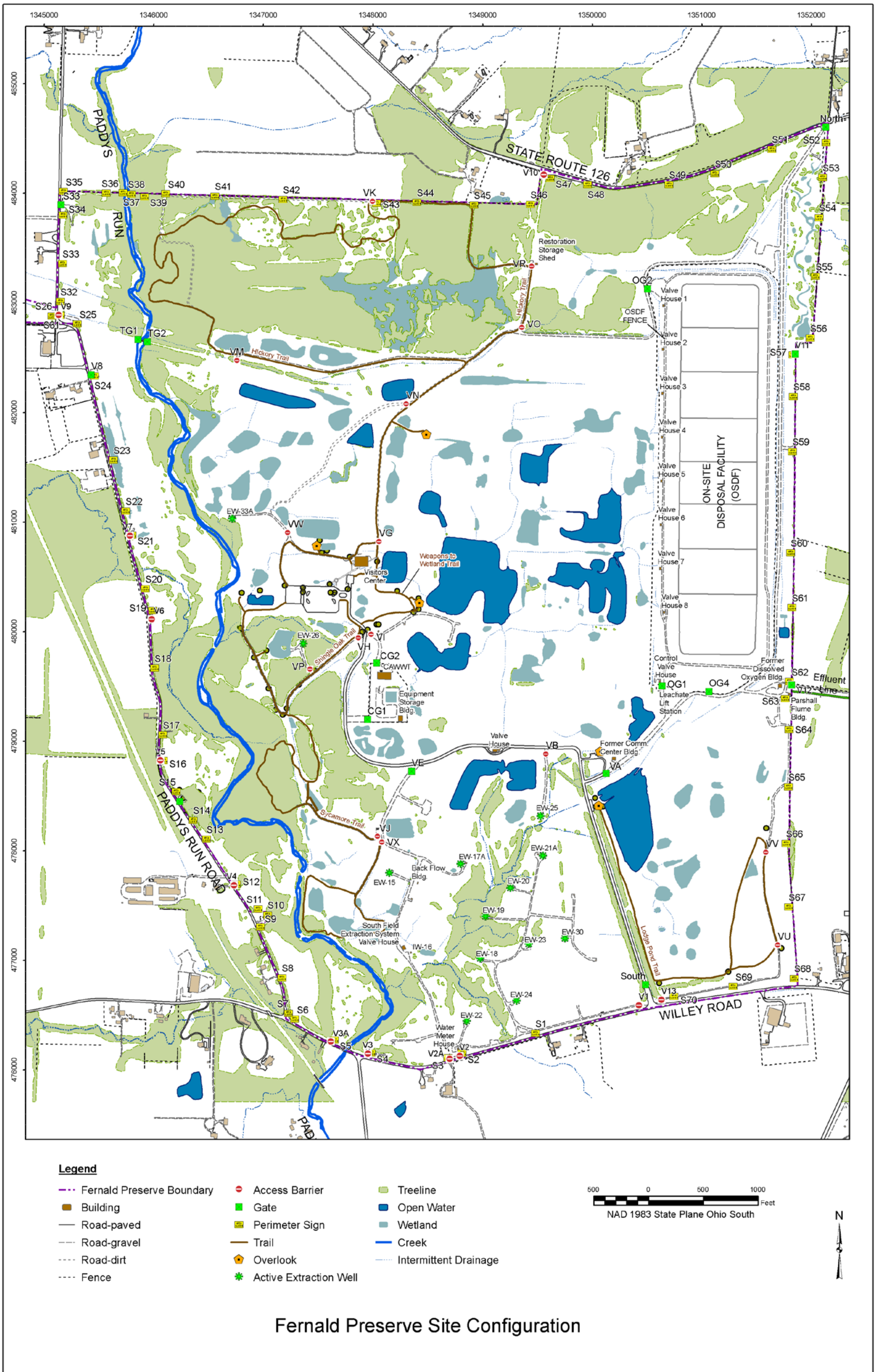
Attachment 2

Fernald Preserve Site Configuration



Fernald Preserve Site Configuration

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Attachment 3

Figure 4-4, Location of Potential Sources of Contamination, Operable Unit 5

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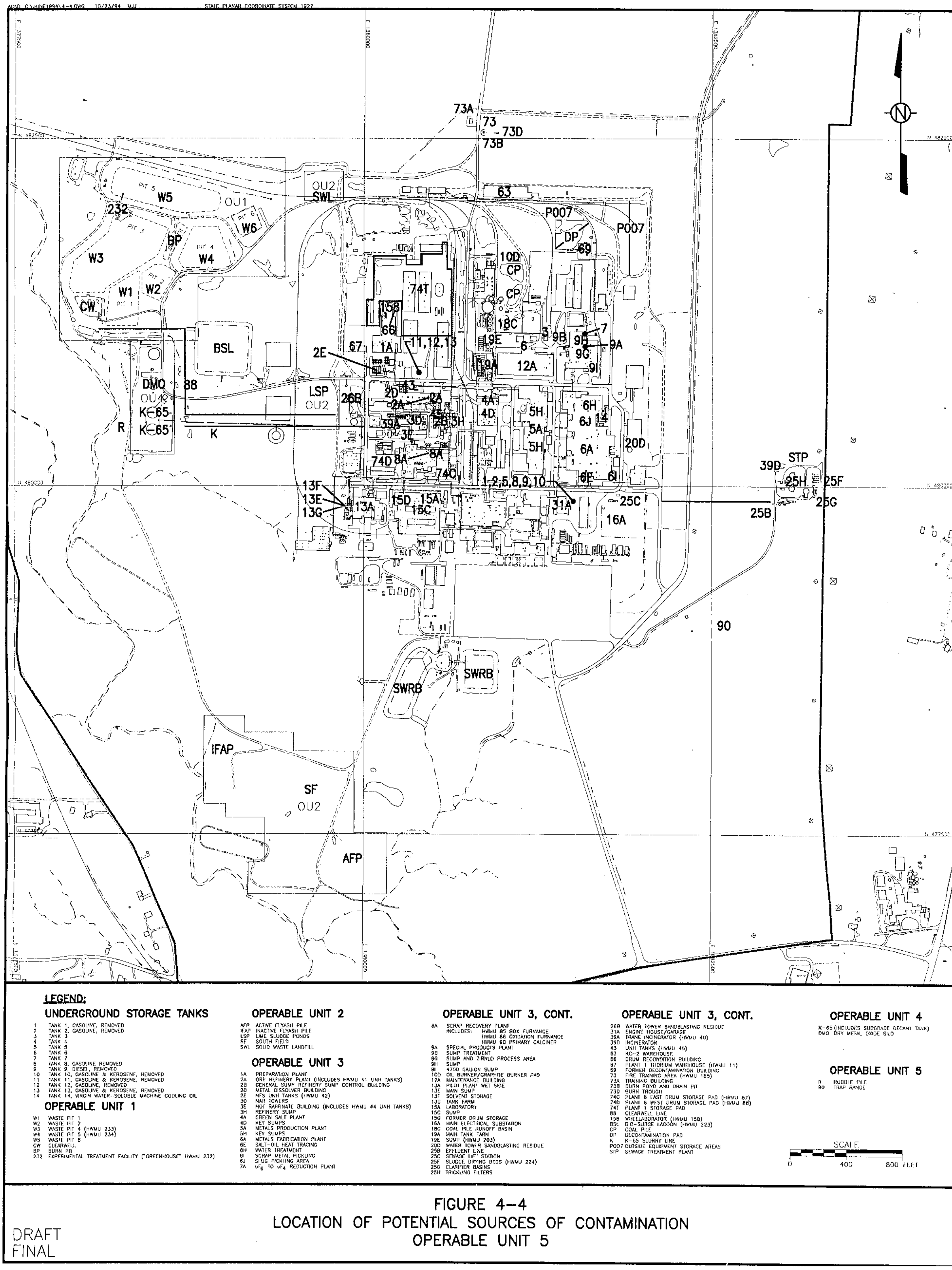

Figure 4-4, Location of Potential Sources of Contamination, Operable Unit 5

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Attachment 4

Initial Public Notice

Fernald Preserve

Annual Community Meeting

October 6, 2015

As a community asset, the Fernald Preserve fosters wildlife habitat and provides educational opportunities through environmental stewardship.

Community members are encouraged to attend the Fernald Preserve Annual Community Meeting.

Date: Tuesday, October 6, 2015

Time: 6:30 p.m.

Location: Fernald Preserve Visitors Center
7400 Willey Road
Hamilton, Ohio 45013

This year's meeting will focus on the recently released U.S. Department of Energy Office of Legacy Management Fernald Preserve *2014 Site Environmental Report*. Topics to be discussed include:

- Updated results of ongoing environmental and ecological monitoring
- CERCLA Five-Year Review
- Groundwater remedy status
- Latest information regarding onsite activities

For more information please call (513) 648-3330.

U.S. DEPARTMENT OF ENERGY | Legacy Management

Fernald Preserve

U.S. DEPARTMENT OF ENERGY | Legacy Management

The Fernald Preserve is managed by the U.S. Department of Energy Office of Legacy Management

September 28, 2015

Dear Fernald Preserve Stakeholder:

The U.S. Department of Energy is conducting the fourth Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Five-Year Review for the Fernald Preserve. This review is required by the U.S. Environmental Protection Agency to evaluate the implementation and performance of CERCLA cleanup remedies at sites that do not allow unrestricted use. The review will be initiated October 1, 2015, and will conclude with submission of the draft report to stakeholders April 1, 2016.

Community input is an important part of the CERCLA Five-Year Review process and the U.S. Department of Energy values comments you may have regarding the site's activities since 2011. You are invited to complete and return the enclosed questionnaire. Responses will be accepted through November 13, 2015.

The questionnaire is also available online at **http://www.lm.doe.gov/CERCLA_Five-Year_Review.pdf** where you may review the three previous CERCLA Five-Year Review reports. Additional hard copy questionnaires are available at the Visitors Center, located at 7400 Willey Rd., Hamilton, OH 45013; (513) 648-3330 (open Wednesday through Saturday, 9:00 a.m. to 5:00 p.m., or by appointment).

Please email me at **fernald@lm.doe.gov** or call me at (513) 648-3333 if you have any questions or would like to be interviewed as part of this CERCLA review process.

Sincerely,

Gwendolyn N. Hooten
2015.09.28 08:28:39 -06'00'

Gwendolyn Hooten
Fernald Preserve Site Manager
DOE LM 20.2

Enclosures

10995 Hamilton-Cleves Highway • Harrison, OH 45030 • Telephone (513) 648-7500 • FAX (513) 648-3252

Attachment 5

Public Questionnaires and Summary of Interviews

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CERCLA Five-Year Review Questionnaire

Fernald Preserve

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Fernald Preserve
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Office of Legacy Management
10995 Hamilton-Cleves Highway
Harrison, OH 45030-9728

CERCLA Five-Year Review Questionnaire

Fernald Preserve

The U.S. Department of Energy is currently conducting the fourth five-year review at the Fernald Preserve, as required by Section 121 of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA). This Act requires that remedial actions that result in any hazardous substances, pollutants, or contaminants remaining onsite at levels that do not allow for unlimited use and unrestricted exposure, be subject to a five-year review. The purpose of the five-year review is to ensure that the remedies implemented to cleanup the site continue to be protective of human health and the environment.

Community and regulatory involvement is an integral part of the Fernald Preserve mission and the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) five-year review process. The U.S. Department of Energy values and requests any input or comments you have regarding the site's activities since 2011. Completed questionnaires will be accepted through November 13, 2015.

U.S. DEPARTMENT OF ENERGY | Legacy Management

Fernald Preserve

CERCLA Five-Year Review Questionnaire

What is your overall impression of the Fernald Preserve?

Pretty bare - I do walk there anyway. It's close to my house. Wildlife that I have seen are rabbits, birds, Geese. I never see anything else.

What effects have site activities had on the surrounding community?

Do not know

Do you have any concerns regarding the Fernald Preserve or its operation and administration? If so, please describe your concerns in detail.

Yes. Attention administrators. Dogs should be allowed in the preserve. Dogs on a leash do not disturb wildlife.

U.S. DEPARTMENT OF ENERGY Legacy Management

Fernald Preserve

CERCLA Five-Year Review Questionnaire

Do you feel well informed about the Fernald Preserve's activities and progress?

☒ Yes ☐ No

If you do not feel well informed, how do you suggest the site keep the community adequately informed?

Please provide comments, suggestions, or recommendations regarding the site's management or operation.

Would you like to be contacted for additional discussion? Dog related ☒ Yes ☐ No

If yes, please provide your contact information.

Name: Dorothy Theman

Phone:

Email:

...ENT OF ...GY Legacy Management

OSWER No. 9355.7-03B-P

INTERVIEW RECORD

Site Name: Fernald Preserve		**EPA ID No.:**	
Subject: Cercla 5 yr Review		**Time:** 9:00 am	**Date:** 11/17/15
Type: ☒ Telephone ☐ Visit ☐ Other **Location of Visit:**		☐ Incoming ☐ Outgoing	

Contact Made By:

Name:	**Title:**	**Organization:**

Individual Contacted:

Name: Dorothy Nieman	**Title:**	**Organization:**
Telephone No: **Fax No:** **E-Mail Address:**	**Street Address:** **City, State, Zip:**	

Summary Of Conversation

Dorothy Nieman (D)/Gwen Hooten (G) /Penny Borgman (P)

G – presented summary of CERCLA 5-year process

D – stated that her farm borders the site in back, she doesn't really know much about the clean-up at this point

G – description of OSDF, groundwater remediation, eco-restoration

D – expressed concern over honeysuckle – discussion ensued about invasives mgt activities at the site

G – mentioned monthly programs

D – asked to be placed on event/program e-mailing list

D – stated that it seems like site is doing everything possible but bothered by no dogs rule, dogs will not disturb wildlife.

G – since the focus was on un-developed park with emphasis on wildlife, and we have no means by which to enforce a leash/pick-up policy, decision was made to prohibit dogs

D – I can understand that and has been here quite often when the place was very quiet/lonely

Concluded with thanks for participating and sharing your feedback

Page 1 of ____

CERCLA Five-Year Review Questionnaire

Fernald Preserve

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CERCLA Five-Year Review Questionnaire

Fernald Preserve

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Community and regulatory involvement is an integral part of the Fernald Preserve mission and the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) five-year review process. The U.S. Department of Energy values and requests any input or comments you have regarding the site's activities since 2011. Completed questionnaires will be accepted through November 13, 2015.

U.S. DEPARTMENT OF ENERGY | Legacy Management

CERCLA Five-Year Review Questionnaire

Fernald Preserve

We need Habitat ancors from Big Bone to Hueston Woods on west side to clean the air!

What is your overall impression of the Fernald Preserve?

I think it is an excellent (ancor + useful) area for wildlife + Biodiversity. It adds to the Great Miami River and Whitewater River nature corridors and also is a link from Rush Run-Hueston Woods area to Miami Whitewater - Shawnee Lookout - Mitchel Memorial areas with the Patty's Run + 3 Valley Trust support it is even more valuable to all of us.

What effects have site activities had on the surrounding community?

a positive - peaceful effect - Family + group activities help give us a sense of place and a connection to the past - the way it must have been. It's nice to see stars planets + the harvest moon!

Do you have any concerns regarding the Fernald Preserve or its operation and administration? If so, please describe your concerns in detail.

Continue to monitor sight and clean the water. acquifer.

Future wishes

1. Bike trail to Fernald Entrance from Miami Whitewater Forest.

Save Gravel Pit Lakes on St Rt 128 So you can view from Lodge Pond Lake trail - with an overlook for Bald Eagle viewing.

U.S. Department of Energy — Legacy Management

CERCLA Five-Year Review Questionnaire

Fernald Preserve

Do you feel well informed about the Fernald Preserve's activities and progress?

☐ Yes ☐ No

If you do not feel well informed, how do you suggest the site keep the community adequately informed?

Please provide comments, suggestions, or recommendations regarding the site's management or operation.

Get rid of the honey suckle plants - maybe honor prisoners could tackle it in groups of 10 with a group leader. It is still all of the forest areas

Would you like to be contacted for additional discussion? ☐ Yes ☒ No

If yes, please provide your contact information.

Name: Wes Wiemann

Phone:

Email:

U.S. Department of Energy — Legacy Management

CERCLA Five-Year Review Questionnaire

Fernald Preserve

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Lisa Crawford

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CERCLA Five-Year Review Questionnaire

Fernald Preserve

The U.S. Department of Energy is currently conducting the fourth five-year review at the Fernald Preserve, as required by Section 121 of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA). This Act requires that remedial actions that result in any hazardous substances, pollutants, or contaminants remaining onsite at levels that do not allow for unlimited use and unrestricted exposure, be subject to a five-year review. The purpose of the five-year review is to ensure that the remedies implemented to cleanup the site continue to be protective of human health and the environment.

Community and regulatory involvement is an integral part of the Fernald Preserve mission and the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) five-year review process. The U.S. Department of Energy values and requests any input or comments you have regarding the site's activities since 2011. Completed questionnaires will be accepted through November 13, 2015.

U.S. DEPARTMENT OF ENERGY | Legacy Management

CERCLA Five-Year Review Questionnaire

Fernald Preserve

What is your overall impression of the Fernald Preserve?

Just what we worked for! asked for! got!!

What effects have site activities had on the surrounding community?

Bad befor - now an assett!

Do you have any concerns regarding the Fernald Preserve or its operation and administration? If so, please describe your concerns in detail.

Some, want to make sure all remains as is ! nothig changes!

CERCLA Five-Year Review Questionnaire

Fernald Preserve

Do you feel well informed about the Fernald Preserve's activities and progress?

☒ Yes ☐ No

If you do not feel well informed, how do you suggest the site keep the community adequately informed?

Please provide comments, suggestions, or recommendations regarding the site's management or operation.

With new contractor - I don't want to see anythig change! Nothig!!

Would you like to be contacted for additional discussion? ☒ Yes ☐ No

If yes, please provide your contact information.

Name: Lisa Crawford

Phone:

Email:

U.S. Department of Energy Legacy Management

OSWER No. 9355.7-03B-P

INTERVIEW RECORD

Site Name: Fernald Preserve	**EPA ID No.:**	
Subject: Cercla 5yr Review	**Time:** 9:30am	**Date:** 11/17/15
Type: ☐ Telephone ☒ Visit ☐ Other **Location of Visit:** Fernald Preserve Visitors Center	☐ Incoming ☐ Outgoing	

Contact Made By:

Name:	**Title:**	**Organization:**

Individual Contacted:

Name: Lisa Crawford	**Title:**	**Organization:**
Telephone No: **Fax No:** **E-Mail Address:**	**Street Address:** **City, State, Zip:**	

Summary Of Conversation

Lisa Crawford (L) /Gwen Hooten (G) /Tom Schneider (T) /Penny Borgman (P)

L – has been communicating with many stakeholders at St. Louis site

G – asked if there were any concerns especially as it relates to groundwater/CAWWT

L – expressed concern about drawing the timeline for completion – wants to make sure site clean-up is not forgotten, water is a major issue. Mentioned story about community member who provided unsolicited positive feedback, she is grateful to be no longer hearing complaints. But people are still paying attention.

T – OEPA no longer gets questions from prospective land buyers in the area

L – has no issues or complaints, happy that DOE is open for comments, no major changes in last 5 years

T/G – discussion of 2006 change to ROD and 3 wells going off-line. Should be no surprises and continued improvement in eco-restoration, OSDF leachate amounts declining

L – views that as positive

Concluded with thanks for participating and sharing your feedback

Page 1 of ____

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Fernald Preserve

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CERCLA [illegible]-Year Review Ques[illegible]onnaire

Fernald Preserve

The U.S. Department of Energy is currently conducting the fourth five-year review at the Fernald Preserve, as required by Section 121 of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA). This Act requires that remedial actions that result in any hazardous substances, pollutants, or contaminants remaining onsite at levels [illegible] do not allow for unlimited use and unrestricted exposure, be subject to a five-year [illegible] purpose of the five-year review is to ensure that the remedies implemen[illegible] site continue to be protective of human health and the environment.

Community and regulatory involvement is an integral part of the Fern[illegible] and the Comprehensive Environmental Response, Compensation, and [illegible] five-year review process. The U.S. Department of Energy values and re[illegible] comments you have regarding the site's activities since 2011. Compl[illegible] be accepted through November 13, 2015.

U.S. DEPARTMENT OF ENERGY | Legacy Management

Fernald Preserve — CERCLA Five-Year Review Questionnaire

What is your overall impression of the Fernald Preserve?

Believe that happy cleaned up but still don't th[...] that our water, soil, & air are [...]ee from health issues for [...] Land is nice to visit, but [...] me nervous.

[...]n the surrounding community?

[...]g the Fernald Preserve or its operation and administration? [...]is in detail.

[...] mainly. We live right behind and have well water. We do not feel comfortable. Also worry about gardening in soil.

Legacy Management — U.S. Department of Energy

Fernald Preserve — CERCLA [...]e-Year Review Ques[...]ionnaire

Do you feel well informed about the Fernald Preserve's activities and progress?

☐ Yes ☑ No

If you do not feel well informed, how do you suggest the site keep the community adequ[...] [...]formed?

Mo. newsletters

Please provide comments, suggestions, or recommendations regarding t[...] or operation.

Would you like to be contacted for additional discussion? ☑ Yes ☐ No

If yes, please provide your contact information.

Name: Jesica Shane

Phone:

Email:

Legacy Management — U.S. Department of Energy

OSWER No. 9355.7-03B-P

INTERVIEW DOCUMENTATION FORM

The following is a list of individual interviewed for this five-year review. See the attached contact record(s) for a detailed summary of the interviews.

Name	Title/Position	Organization	Date
Lisa Crawford	FRESH		Nov. 17, 2015
Dorothy Nieman	Neighbor		Nov. 17, 2015
~~Jesica Shane~~	~~Neighbor~~ *Cancelled		~~Nov. 17, 2015~~

OSWER No. 9355.7-03B-P

INTERVIEW RECORD

Site Name: Fernald Preserve		**EPA ID No.:**	
Subject: CERCLA 5 yr. Review		**Time:**	**Date:** Apr. 14, 2015
Type: ☐ Telephone ☒ Visit ☐ Other **Location of Visit:** Hamilton Co. Public Health Office		☐ Incoming	☐ Outgoing

Contact Made By:

Name:	**Title:**	**Organization:**

Individual Contacted:

Name: Greg Cassiere	**Title:** Supervisor, Div. of Water Quality	**Organization:** Hamilton Co. Public Health
Telephone No: **Fax No:** **E-Mail Address:**	**Street Address:** **City, State, Zip:**	

Summary Of Conversation

Greg Cassiere (GC) /Gwen Hooten (GH) /Bill Hertel (BH)/ Karen Voisard (KV)

**this is a synopsis of a meeting that occurred for 4/14/15 for the purpose of discussing the process to ensure that groundwater is not used for domestic purposes within the area of the offsite plume.*

GC - summarized the domestic well permitting process. HCPHD uses CAGIS showing plume boundary and field verification to deny or approve. They do not regulate irrigation wells.
GH/BH/KV - agreed to provide more conservative certification footprint.
GC - are homeowners required to tie-in to alternate water supply?
BH - believes yes, and if they maintained private wells, backflow preventer must be used.
GC - when an owner hooks up to public water, ODNR requires they abandon existing well. Application and contractor required to meet standards.
ALL - it was agreed that Fernald will notify HCPHD when off property area is certified clean, suggested to add issue to 5-year review to ensure follow-up.

Page 1 of _____

Attachment 6

Field Walkdown Quadrants

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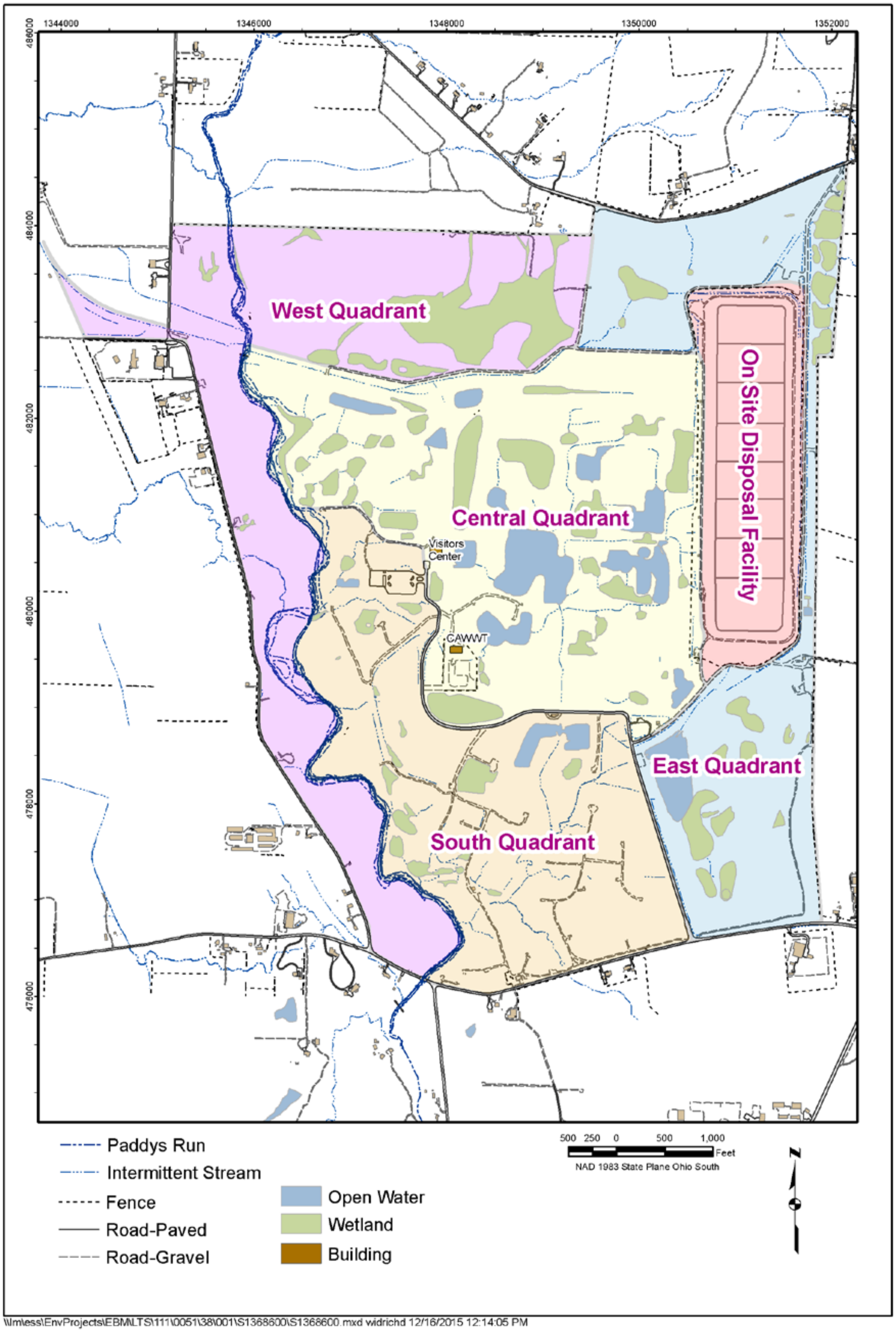

Field Walkdown Quadrants

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Attachment 7

Site Inspection Photographs from Selected Locations

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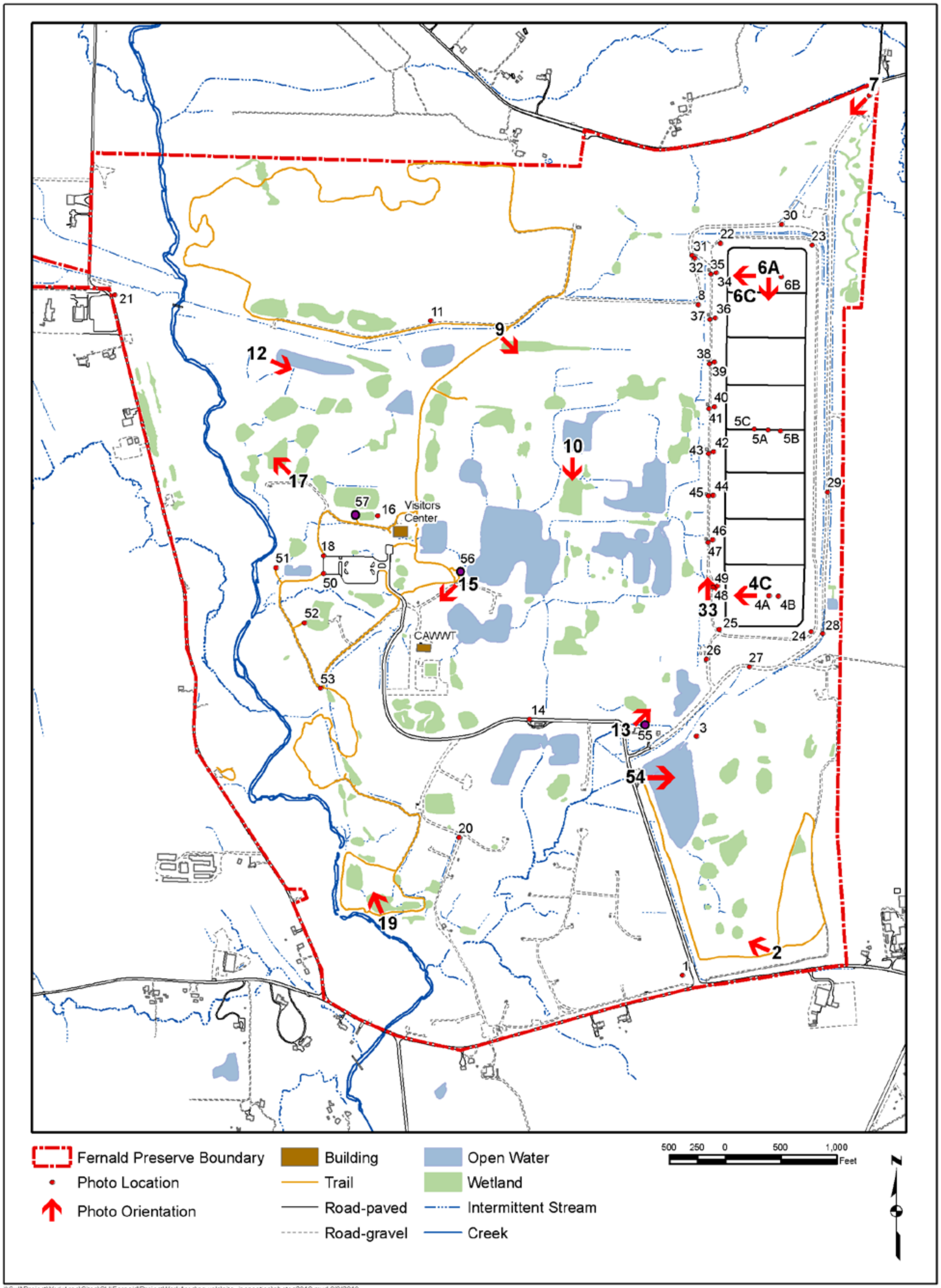

Site Inspection Photograph Locations

Photo Location 2 – West-Northwest Perspective

Photo Location 4C – West Perspective

Photo Location 6A – South Perspective

Photo Location 6C – West Perspective

Photo Location 7 – Southwest Perspective

Photo Location 9 – Southeast Perspective

Photo Location 10 – South Perspective

Photo Location 12 – Southeast Perspective

Photo Location 13 – Northeast Perspective

Photo Location 15 – Northwest Perspective

Photo Location 17 – Northwest Perspective

Photo Location 19 – North-Northwest Perspective

Photo Location 33 – North Perspective

Photo Location 54 – East Perspective

Attachment 8

Site Inspection Debris Findings (2011 to 2015)

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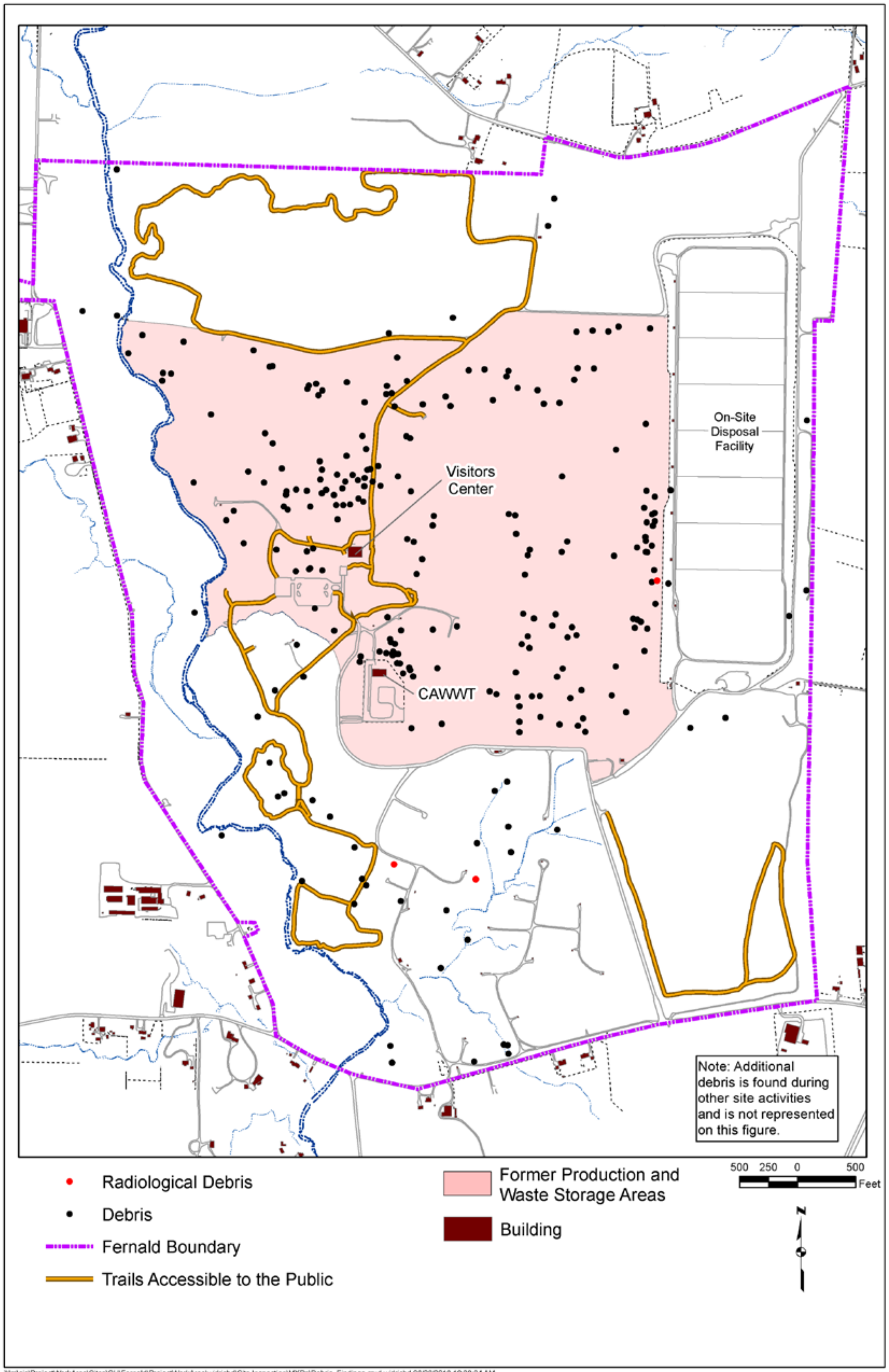

Site Inspection Debris Findings (2011 to 2015)

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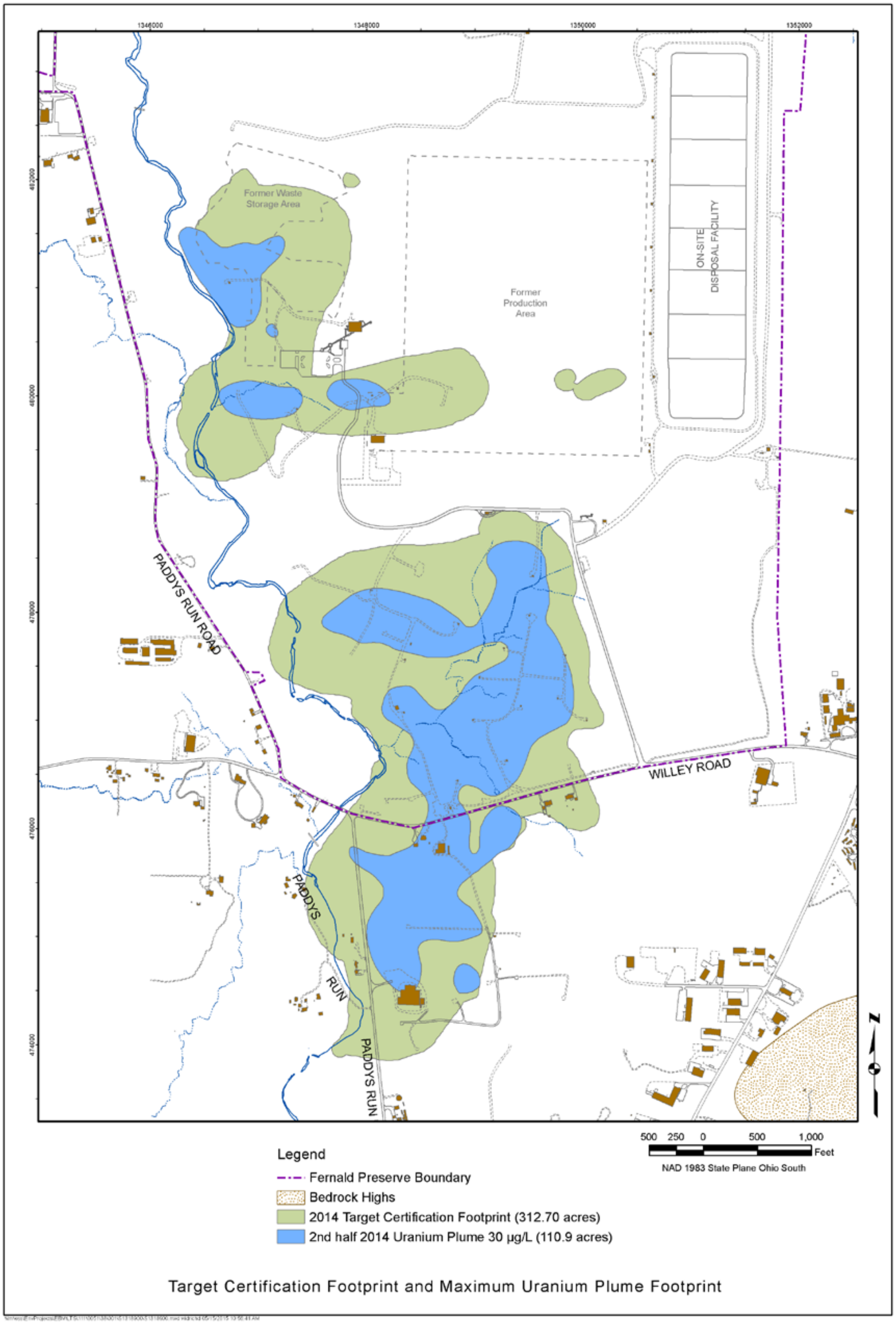
Attachment 9

Target Certification Footprint and Maximum Uranium Plume Footprint



Target Certification Footprint and Maximum Uranium Plume Footprint

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Attachment 10

Maximum Uranium Plume Footprint as of Second Half 2014

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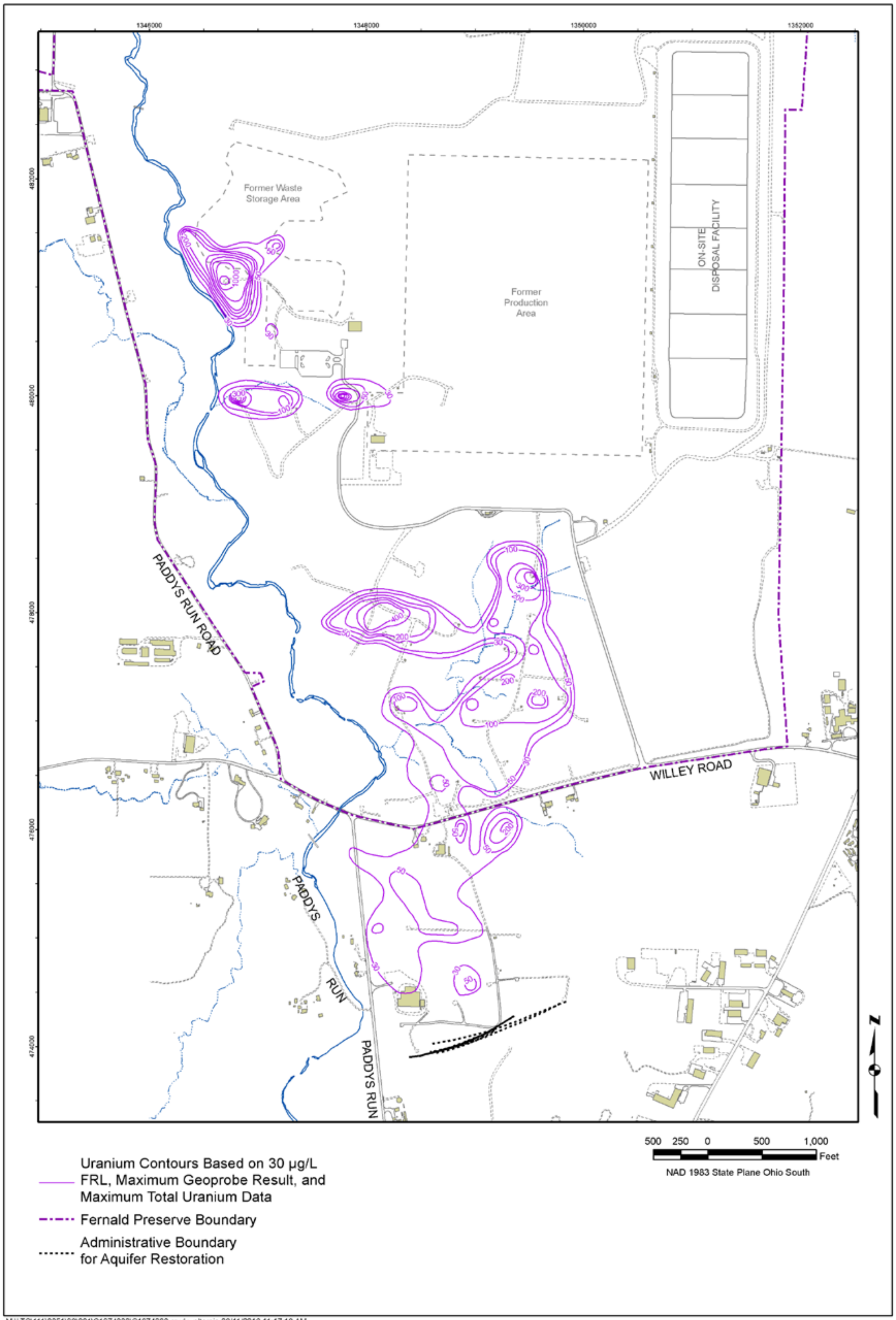

Maximum Uranium Plume Footprint as of Second Half 2014

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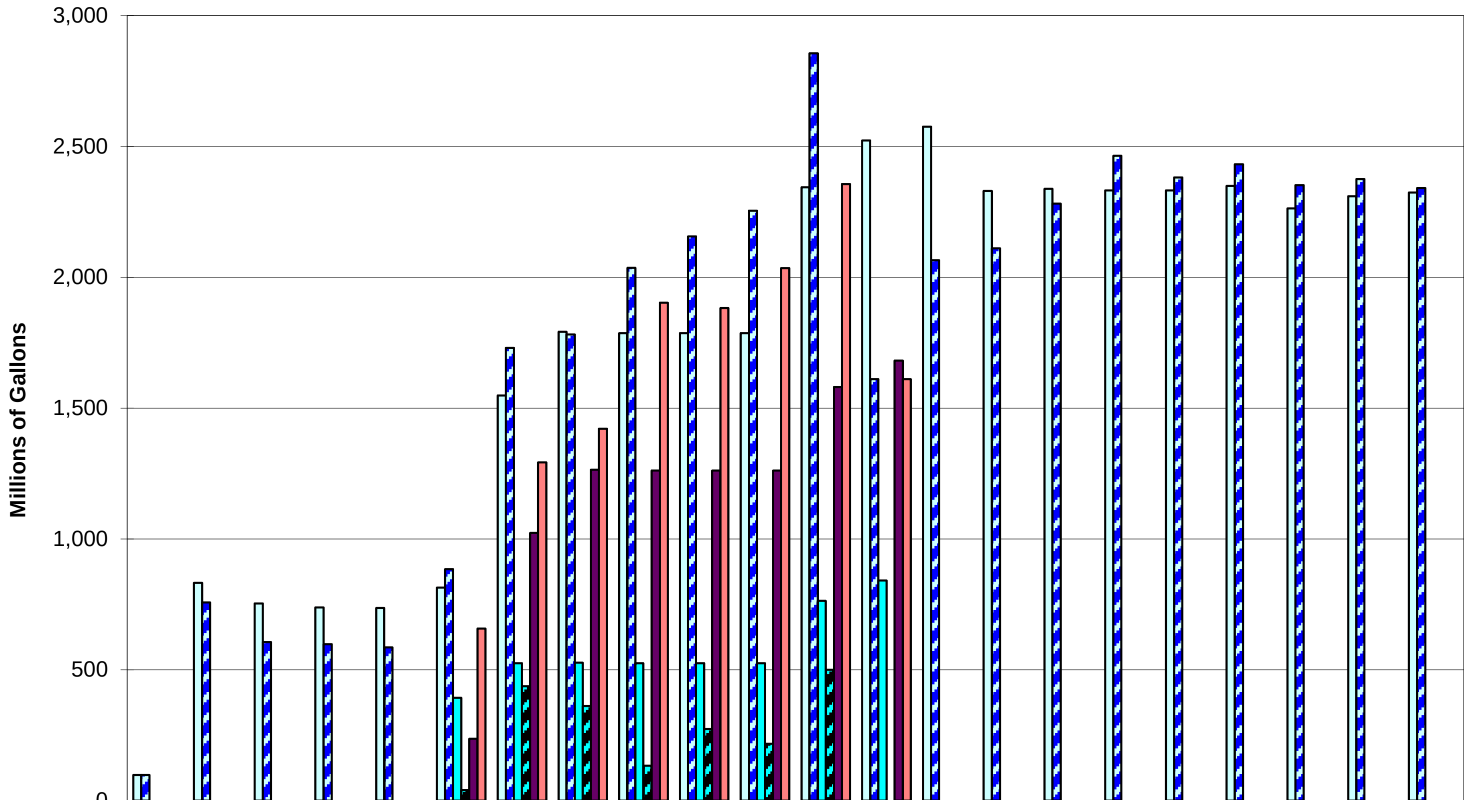
Attachment 11

Actual Versus Predicted Gallons Extracted (1993 to 2014)



	FY1993	FY1994	FY1995	FY1996	FY1997	FY1998	FY1999	FY2000	FY2001	FY2002	FY2003	FY2004	FY2005	FY2006	FY2007	FY2008	FY2009	FY2010	FY2011	FY2012	FY2013	FY2014
Planned Total GW Pumped (Mgal)	97.920	832.320	753.552	737.856	735.840	814.464	1548.576	1791.936	1787.040	1787.040	1787.040	2344.320	2522.880	2,575.11	2,330.17	2,338.02	2,332.29	2,332.29	2,349.48	2,262.89	2,309.40	2,324.28
Actual Total GW Pumped (Mgal)	97.183	756.976	605.541	597.200	585.123	883.804	1729.578	1781.524	2035.166	2155.971	2253.355	2855.224	1610.678	2064.370	2110.350	2281.350	2463.450	2380.590	2431.424	2351.213	2374.832	2340.479
Planned Injected GW (Mgal)	0.000	0.000	0.000	0.000	0.000	393.120	525.600	527.040	525.600	525.600	525.600	763.776	840.960									
Actual Injected GW (Mgal)	0.000	0.000	0.000	0.000	0.000	39.842	436.652	361.052	132.460	273.188	216.340	499.365	0.000									
Planned Net GW Extracted (Mgal)	0.000	0.000	0.000	0.000	0.000	235.872	1,022.97	1,264.89	1,261.44	1,261.44	1,261.44	1,580.54	1,681.92									
Actual Net GW Extracted (Mgal)	0.000	0.000	0.000	0.000	0.000	657.184	1,292.92	1,420.47	1,903.09	1,882.36	2,034.64	2,355.85	1,610.67									

Fiscal Year

Actual Versus Predicted Gallons Extracted (1993 to 2014)

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Attachment 12

Actual Versus Predicted Pounds of Uranium Removed (1993 to 2014)

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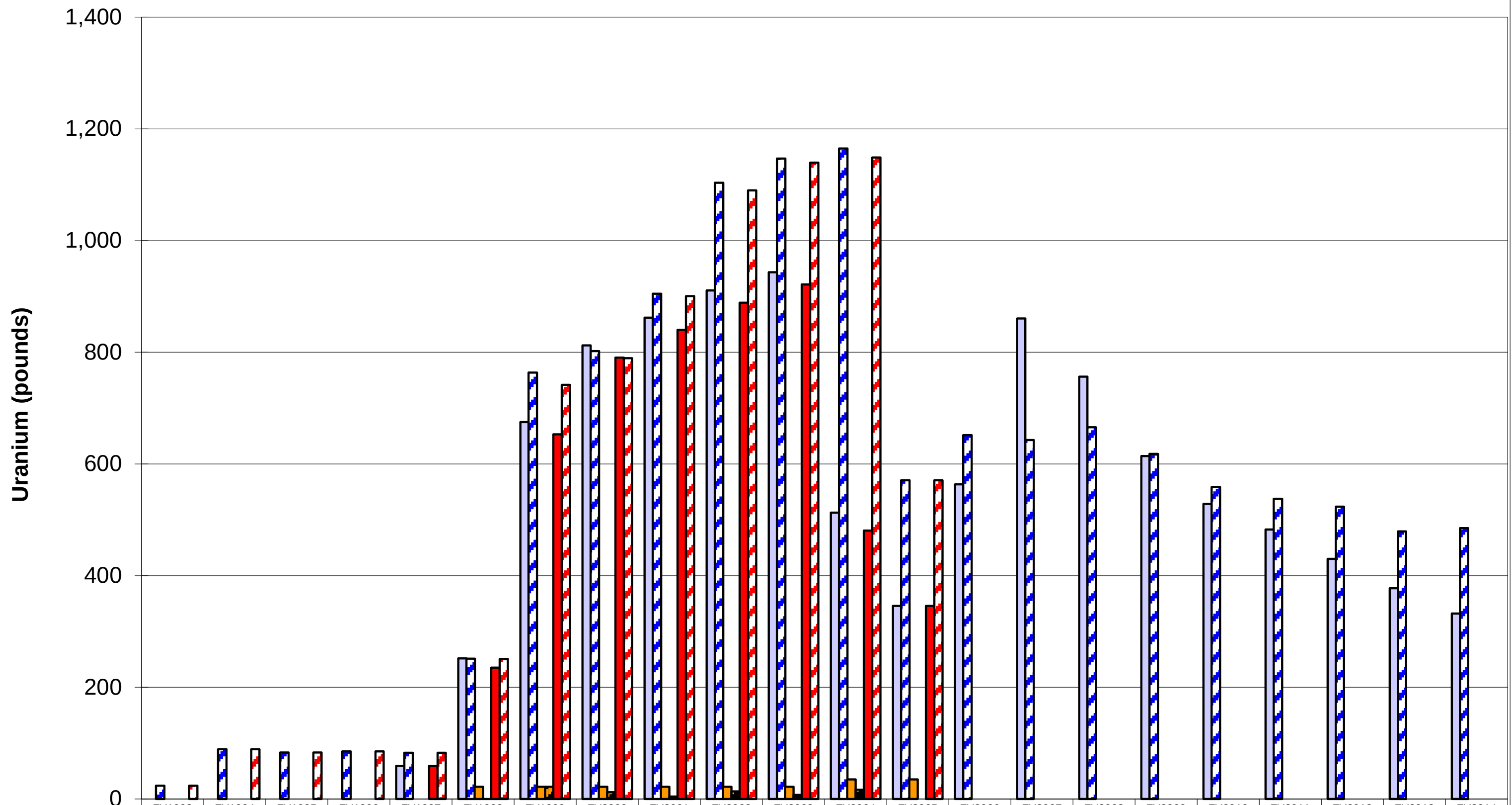

	FY1993	FY1994	FY1995	FY1996	FY1997	FY1998	FY1999	FY2000	FY2001	FY2002	FY2003
Planned Total U Extracted from GMA (lbs)	0.0	0.0	0.0	0.0	59.6	251.7	674.8	812.3	862.2	910.9	943.4
Actual Total U Extracted from GMA (lbs)	24.0	89.0	83.0	85.0	82.6	251.3	763.6	801.8	904.9	1,103.4	1,146.9
Planned Total U Injected (lbs)	0.0	0.0	0.0	0.0	0.0	21.9	21.9	21.9	21.9	21.9	21.9
Actual Total U Injected (lbs)	0.0	0.0	0.0	0.0	0.0	0.3	22.0	12.3	4.6	13.4	7.2
Planned Net Total U Removed from GMA (lbs)	0.0	0.0	0.0	0.0	59.6	235.3	652.9	790.4	840.3	889.0	921.5
Actual Net Total U Removed from GMA (lbs)	24.0	89.0	83.0	85.0	82.6	251.0	741.6	789.5	900.3	1090.0	1139.7

	FY2004	FY2005	FY2006	FY2007	FY2008	FY2009	FY2010	FY2011	FY2012	FY2013	FY2014
Planned Total U Extracted from GMA (lbs)	512.7	346.0	563.6	860.7	756.4	614.0	528.4	482.8	429.9	377.6	332.1
Actual Total U Extracted from GMA (lbs)	1,165.0	570.6	651.7	642.6	665.7	618.0	558.4	537.6	523.5	479.4	485.1
Planned Total U Injected (lbs)	35.0	35.0									
Actual Total U Injected (lbs)	16.4	0.0									
Planned Net Total U Removed from GMA (lbs)	480.9	346.0									
Actual Net Total U Removed from GMA (lbs)	1148.6	570.6									

Fiscal Year

Actual Versus Predicted Pounds of Uranium Removed (1993 to 2014)

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Attachment 13

Routine Groundwater Elevation Map, Fourth Quarter 2014
(November 10 through November 14, 2014)

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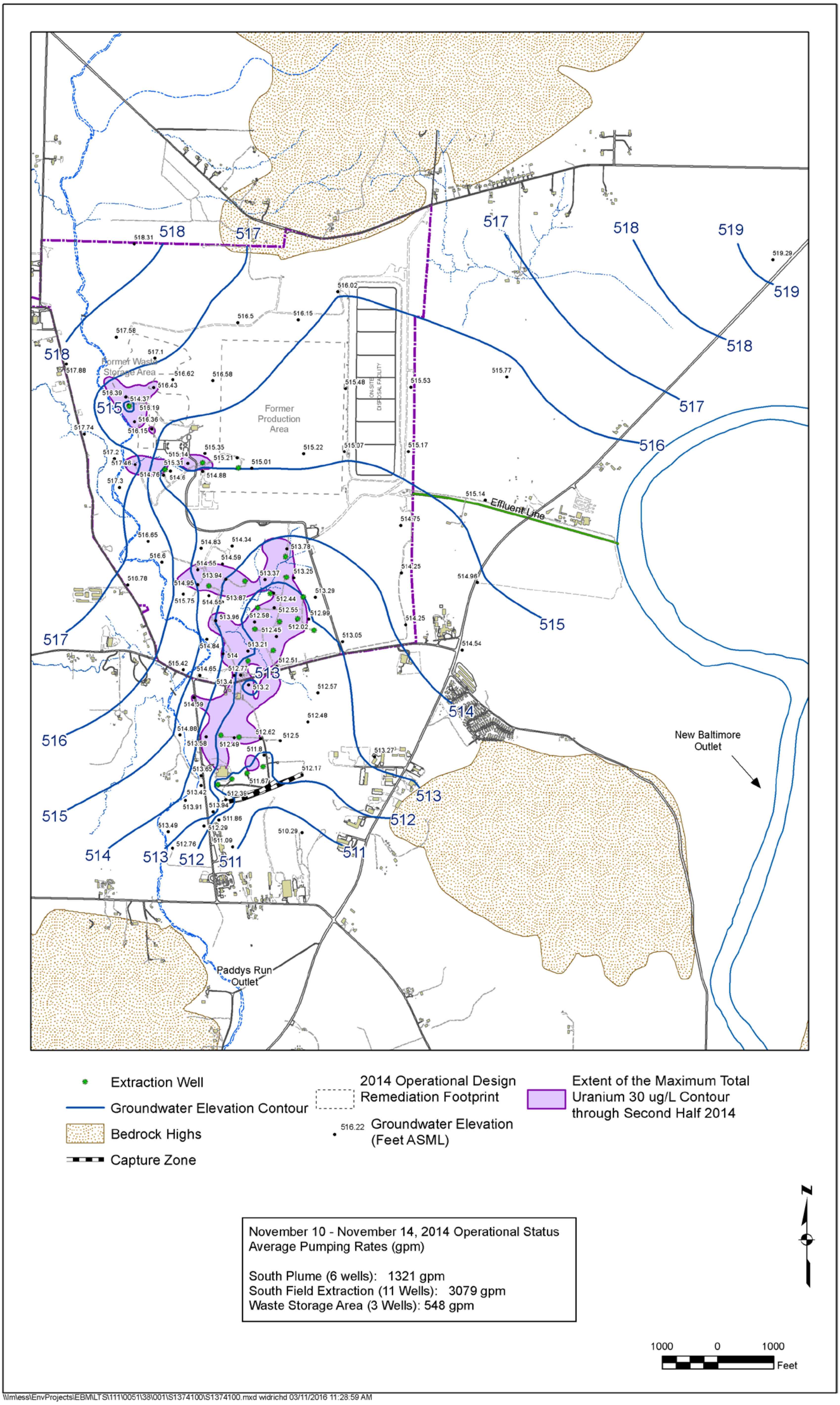

Routine Groundwater Elevation Map, Fourth Quarter 2014 (November 10 through November 14, 2014)

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Attachment 14

Percent Complete Estimate Based on Uranium Removal

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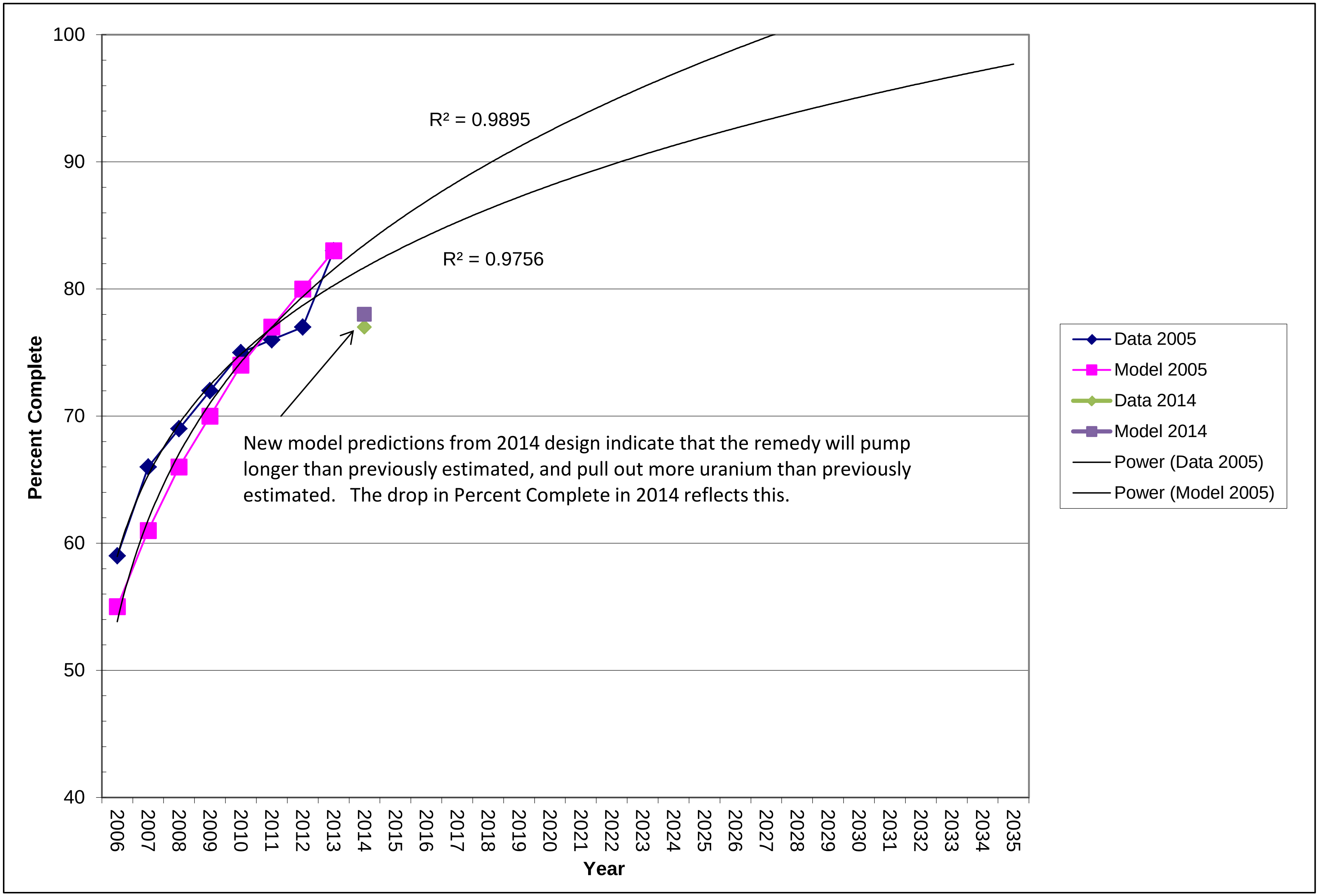

Percent Complete Estimate Based on Uranium Removal

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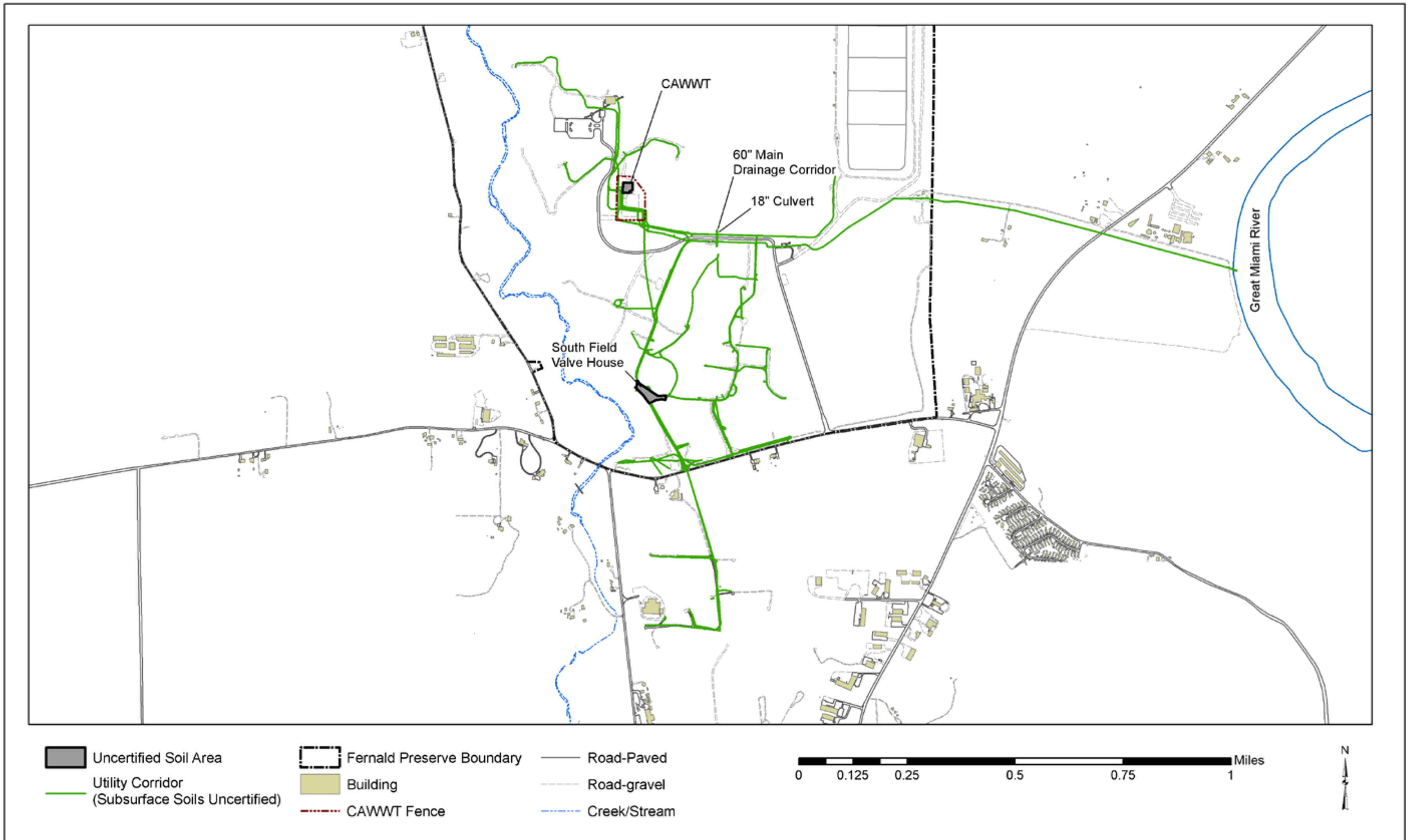
Attachment 15

Uncertified Areas and Subgrade Utility Corridors



Uncertified Areas and Subgrade Utility Corridors

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Attachment 16

Hamilton County Health Department Notification Letter

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Department of Energy

Ohio Field Office
Fernald Closure Project
175 Tri-County Parkway
Springdale, Ohio 45246

AUG 2 1 2006

Mr. Chris Griffith
RS: Director of Water Quality
Hamilton County General Health District
250 William Howard Taft, 2nd Floor
Cincinnati, Ohio 45219

DOE-0184-06

Dear Mr. Griffith:

The United States Department of Energy (DOE) is conducting groundwater remediation at the Fernald Site in Crosby Township. Based on groundwater modeling, the groundwater remediation activities are likely to continue for an additional 15 –20 years. The primary constituent of concern in the groundwater plume is uranium. The U.S. Environmental Protection Agency (EPA) approved drinking water standard for uranium is 30 parts per billion (ppb). As shown in the enclosed figure, the affected area where groundwater uranium concentrations are greater than 30 ppb (i.e., inside the 30 ppb contour line) extends to the south, beyond the DOE Fernald site property, approximately 2,400 feet.

The purpose of this letter is to help ensure that water supply wells are not installed in and around the area affected by the uranium plume. DOE requests that no well installation permits be approved in and around the area of the uranium plume where groundwater remediation is occurring. Additionally, DOE requests to be notified of any proposed drilling activities in the vicinity of the plume.

Per discussion between my Aquifer Restoration Contractor and Mr. Joe Leever, Crosby Township Sanitarian, the outline of the uranium plume can be provided to your staff in electronic format compatible with the Cagis System so that the plume can be overlain onto the aerial photo of the Fernald site area. My contractor will be in contact with Mr. Leever to coordinate transmittal of the electronic file containing the plume outline. As the groundwater remediation progresses at the Fernald site, the area of the off-property uranium plume will be reduced. We will periodically provide the Hamilton County General Health District with updated plume maps as necessary to reflect the changes in the area of the plume. We anticipate these updates will be provided every two to three years.

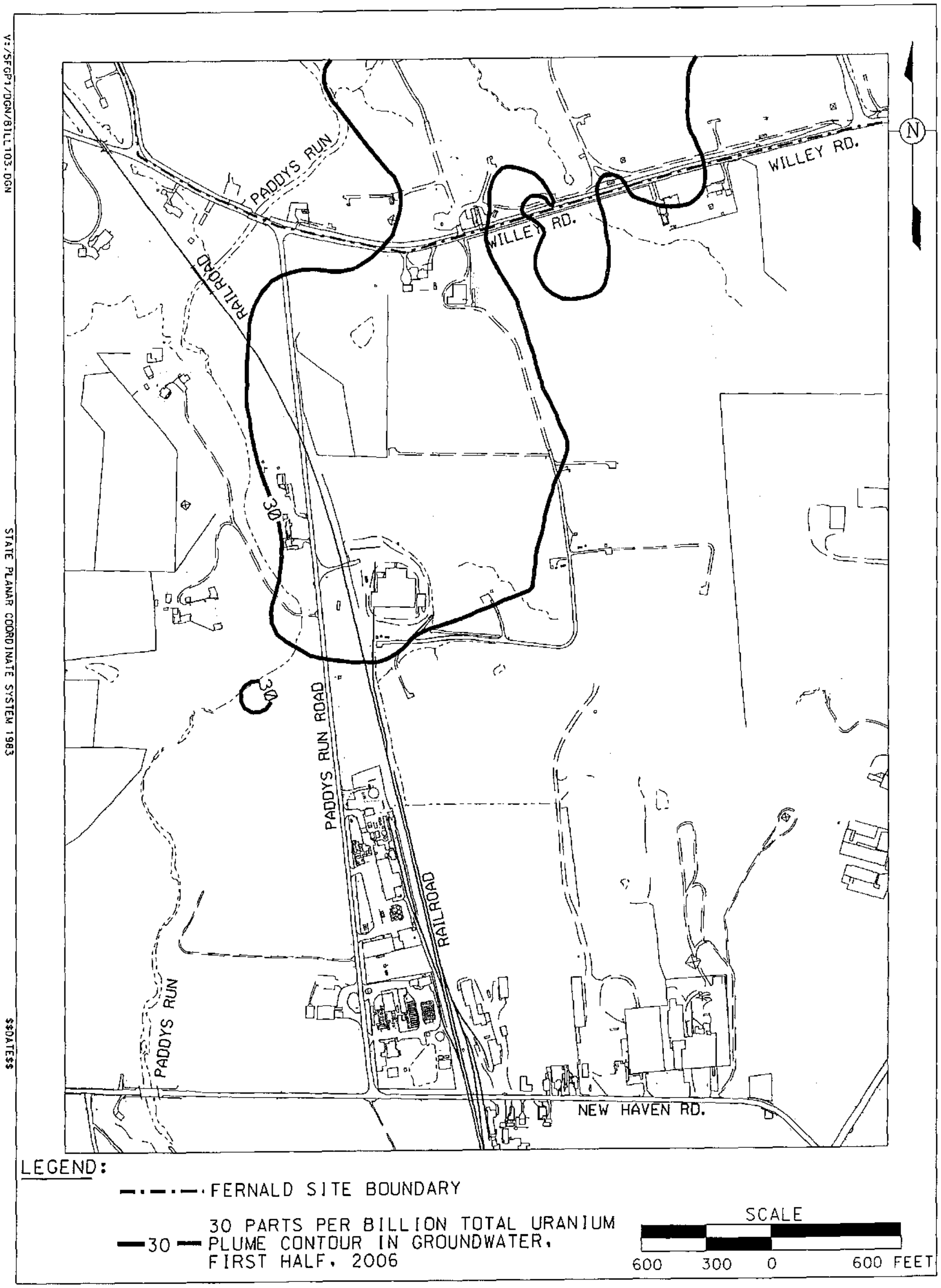
If you have any immediate questions regarding this please contact me at 513-648-3139 or Bill Hertel, Manager of Aquifer Restoration at 513-648-3894 (office) or 513-235-2325 (cell). In the future, please contact Ms. Jane Powell at (513) 648-3148.

Sincerely,

Johnny W. Reising
Director

Enclosure: As Stated
cc w/ enclosure:
G. Stegner, DOE-OH
M. Lutz, S.M. Stoller Corp.
S. Marutzky, S.M. Stoller Corp.
J. Powell, DOE-LM/FCP, MS2
M. Cullerton, Tetra Tech
S. Helmer, ODH
G. Jablonowski, USEPA-V, SR-6J
M. Miller, S.M. Stoller Corp., MS2
M. Murphy, USEPA-V, A-18J
J. Saric, USEPA
D. Sarno, FCAB
T. Schneider, OEPA
M. Shupe, HSI GeoTrans

cc w/o enclosure:
J. Chiou, Fluor Fernald, Inc., MS88
B. Hertel, Fluor Fernald, Inc., MS12
J. Homer, S.M. Stoller Corp., MS12
F. Johnston, Fluor Fernald, Inc., M12
L. McHenry, S.M. Stoller Corp., MS12
C. Murphy, Fluor Fernald, Inc., MS1
D. Sizemore, Fluor Fernald, Inc., MS1
M. Sucher, Fluor Fernald, Inc., MS90
C. Tabor, S.M. Stoller Corp., MS12
T. Terry, Fluor Fernald, Inc., MS1
S. Walpole, S.M. Stoller Corp., MS76



Fernald Off-Site Groundwater Total Uranium Plume Location

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Attachment 17

Human Health Risk Calculations

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Human health risk calculations have been conducted using the latest published cancer slope factors (CSFs), reference doses (RfDs), and exposure factors. As described in Section 6.2.1, the updated CSFs and RfDs were used in conjunction with post-remediation concentrations from the 2007 Interim Remedial Risk Assessment (IRRA). In the 2007 IRRA, the highest risk was to the undeveloped-park user who recreates in Zone 5 of the Fernald Preserve (DOE 2007b). Therefore, risk calculations were performed with 2015 values for CSFs and RfDs, soil concentrations reported in the IRRA for Zone 5 and the same exposure scenario for the undeveloped-park user in Zone 5.

The 2015 values were extracted from DOE Risk Assessment Information System (RAIS) on July 24, 2015, and compared to the values used in the *Third Five-Year Review Report for the Fernald Preserve* (DOE 2011). If a given CSF 2015/2010 ratio is greater than 1, the 2015 ILCR will increase relative to the 2010 value because risk is calculated by multiplying the chronic daily intake (CDI) by the CSF. For the RfD comparison, the 2010/2015 ratio is used because the HI is calculated by dividing the CDI by the RfD. Therefore, if the RfD decreases for 2015 (i.e., 2010/2015 > 1), the HI increases and there is a greater risk to the receptor in 2015 relative to the 2010 result. Values in Tables 17-1 through 17-3 that indicate a ratio greater or less than 1 are highlighted. Red-shaded cells contain values that are greater than 1, and these values correspond to an increase in the ILCR or HI for the given contaminant. Conversely, green-shaded cells hold values that are less than 1, which indicates that the ILCR or HI will decrease when the 2015 value is used in the risk calculations. Values of 1 indicate no change from results in the Third-Five Year Review Report. A cell with “NA” indicates that a 2010 or 2015 value was unavailable to calculate the ratio.

Table17-1. Comparison of Cancer Slope Factors (CSFs) for Chemicals

Chemical	Oral CSF 2015/2010[a]	Dermal CSF 2015/2010[a]	Inhale CSF 2015/2010[a]
Acetone	NA	NA	NA
Antimony (metallic)	NA	NA	NA
Aroclor 1254	1.00E+00	1.00E+00	1.00E+00
Aroclor 1260	1.00E+00	1.00E+00	1.00E+00
Arsenic, Inorganic	1.00E+00	1.00E+00	1.00E+00
Barium	NA	NA	NA
Benz[*a*]anthracene	1.00E+00	1.00E+00	1.00E+00
Benzene	1.00E+00	1.00E+00	1.00E+00
Benzo[*a*]pyrene	1.00E+00	1.00E+00	1.00E+00
Benzo[*b*]fluoranthene	1.00E+00	1.00E+00	1.00E+00
Benzo[*k*]fluoranthene	1.00E+00	1.00E+00	1.00E+00
Beryllium and compounds	NA	NA	1.00E+00
Bis(2-chloroethyl)ether	1.00E+00	1.00E+00	1.00E+00
Bis(2-ethylhexyl)phthalate	1.00E+00	1.00E+00	1.00E+00
Boron and Borates Only	NA	NA	NA
Bromodichloromethane	1.00E+00	1.00E+00	1.00E+00
Bromoform	1.00E+00	1.00E+00	1.00E+00
Bromomethane	NA	NA	NA
Cadmium (Diet)	NA	NA	1.00E+00

Table 17-1 (continued). Comparison of Cancer Slope Factors (CSF) for Chemicals

Chemical	Oral CSF 2015/2010[a]	Dermal CSF 2015/2010[a]	Inhale CSF 2015/2010[a]
Cadmium (Water)	NA	NA	1.00E+00
Carbazole	1.00E+00	1.00E+00	NA
Carbon Disulfide	NA	NA	NA
Carbon Tetrachloride	1.00E+00	1.00E+00	1.00E+00
Chlordane	NA	NA	NA
Chlorobenzene	NA	NA	NA
Chloroform	1.00E+00	1.00E+00	1.00E+00
Chromium(VI)	1.00E+00	1.00E+00	1.00E+00
Chrysene	1.00E+00	1.00E+00	1.00E+00
Cobalt	NA	NA	1.00E+00
Copper	NA	NA	NA
Cresol, p-	NA	NA	NA
Cyanide (CN^-)	NA	NA	NA
Cyclohexanone	NA	NA	NA
Dibenzo[*a,h*]anthracene	1.00E+00	1.00E+00	1.00E+00
Dichlorobenzidine, 3,3'-	1.00E+00	1.00E+00	1.00E+00
Dichloroethane, 1,2-	1.00E+00	1.00E+00	1.00E+00
Dichloroethylene, 1,1-	NA	NA	NA
Dieldrin	1.00E+00	1.00E+00	1.00E+00
Ethyl Ether	NA	NA	NA
Ethylbenzene	1.00E+00	1.00E+00	1.00E+00
Fluorine (Soluble Fluoride)	NA	NA	NA
HpCDD, 2,3,7,8-	1.00E+02	1.00E+02	1.00E+00
HpCDF, 2,3,7,8-	NA	NA	NA
HxCDF, 2,3,7,8-	NA	NA	NA
Indeno[1,2,3-*cd*]pyrene	1.00E+00	1.00E+00	1.00E+00
Lead and Compounds	1.00E+00	1.00E+00	1.00E+00
Manganese (Diet)	NA	NA	NA
Manganese (Water)	NA	NA	NA
Mercury, Inorganic Salts	NA	NA	NA
Methanol	NA	NA	NA
Methyl Ethyl Ketone (2-Butanone)	NA	NA	NA
Methyl Isobutyl Ketone (4-methyl-2-pentanone)	NA	NA	NA
Methylene Chloride	2.67E-01	2.67E-01	2.13E-02
Molybdenum	NA	NA	NA
Nickel Soluble Salts	NA	NA	1.00E+00
Nitroaniline, 4-	1.00E+00	1.00E+00	NA
Nitroso-di-N-propylamine, *N*-	1.00E+00	1.00E+00	1.00E+00
Nitrosodiphenylamine, *N*-	1.00E+00	1.00E+00	1.00E+00
OCDD	3.00E+00	3.00E+00	3.00E+00
OCDF	3.00E+00	3.00E+00	3.00E+00
Octyl Phthalate, di-*N*-	NA	NA	NA
PeCDD, 2,3,7,8-	NA	NA	NA
PeCDF, 2,3,4,7,8-	6.00E-01	6.00E-01	6.00E-01

Table 17-1 (continued). Comparison of Cancer Slope Factors (CSF) for Chemicals

Chemical	Oral CSF 2015/2010[a]	Dermal CSF 2015/2010[a]	Inhale CSF 2015/2010[a]
Pentachlorophenol	1.00E+00	1.00E+00	1.00E+00
Phenanthrene	NA	NA	NA
Selenium	NA	NA	NA
Silver	NA	NA	NA
TCDD, 2,3,7,8-	1.00E+00	1.00E+00	1.00E+00
TCDF, 2,3,7,8-	1.00E+00	1.00E+00	1.00E+00
Tetrachloroethylene	3.89E-03	3.89E-03	4.41E-02
Thallium (I) Nitrate	NA	NA	NA
Toluene	NA	NA	NA
Tributyl Phosphate	9.78E-01	9.78E-01	NA
Trichloroethane, 1,1,2-	1.00E+00	1.00E+00	1.00E+00
Trichloroethylene	7.80E+00	7.80E+00	2.05E+00
Trichlorofluoromethane	NA	NA	NA
Uranium (Soluble Salts)	NA	NA	NA
Vanadium, Metallic	NA	NA	NA
Vinyl Chloride	1.00E+00	1.00E+00	1.00E+00
Xylene, Mixture	NA	NA	NA
Zinc (Metallic)	NA	NA	NA

Table 17-2. Comparison of Cancer Slope Factor (CSF) for Radionuclides

ISOTOPE	Soil CSF 2015/2010[a]	Water CSF 2015/2010[a]	Inhale CSF 2015/2010[a]	External CSF 2015/2010[a]
Cesium-137+Daughters	9.84E-01	1.00E+00	9.41E+00	9.96E-01
Neptunium-237+Daughters	8.70E-01	1.02E+00	1.62E+00	1.07E+00
Lead-210	9.35E-01	1.00E+00	5.74E+00	1.05E+00
Plutonium-238	8.27E-01	1.00E+00	1.55E+00	9.57E-01
Plutonium-239	8.26E-01	1.00E+00	1.67E+00	1.05E+00
Plutonium-240	8.23E-01	1.00E+00	1.67E+00	1.02E+00
Radium-226+Daughters	9.27E-01	9.97E-01	2.43E+00	9.86E-01
Radium-228+Daughters	8.65E-01	1.00E+00	8.36E+00	3.28E-01
Radon-222+Daughters	NA	NA	1.78E+00	1.99E-04
Strontium-90+Daughters	9.38E-01	1.00E+00	3.83E+00	9.95E-01
Technetium-99	9.46E-01	1.00E+00	2.70E+00	1.02E+00
Thorium-228	8.41E-01	1.01E+00	1.00E+00	1.01E+00
Thorium-230	8.22E-01	1.00E+00	1.20E+00	1.03E+00
Thorium-232	7.97E-01	1.00E+00	1.00E+00	1.05E+00
Uranium-234	9.37E-01	1.00E+00	2.44E+00	1.00E+00
Uranium-235+Daughters	9.45E-01	1.00E+00	2.48E+00	NA
Uranium-238+Daughters	9.38E-01	9.99E-01	2.53E+00	1.04E+00

[a] NA = not applicable

Table 17-3. Comparison of Reference Dose (RfD) for Chemicals

CHEMICAL	Oral RfD 2010/2015[a]	Dermal RfD 2010/2015[a]	Inhale RfD 2010/2015[a]
Acetone	1.00E+00	1.00E+00	1.00E+00
Antimony (metallic)	1.00E+00	1.00E+00	NA
Aroclor 1254	1.00E+00	1.00E+00	NA
Aroclor 1260	NA	NA	NA
Arsenic, Inorganic	1.00E+00	1.00E+00	1.00E+00
Barium	1.00E+00	1.00E+00	1.00E+00
Benz[*a*]anthracene	NA	NA	NA
Benzene	1.00E+00	1.00E+00	1.00E+00
Benzo[*a*]pyrene	NA	NA	NA
Benzo[*b*]fluoranthene	NA	NA	NA
Benzo[*k*]fluoranthene	NA	NA	NA
Beryllium and compounds	1.00E+00	1.00E+00	1.00E+00
Bis(2-chloroethyl)ether	1.00E+00	1.00E+00	NA
Bis(2-ethylhexyl)phthalate	1.00E+00	1.00E+00	NA
Boron and Borates Only	1.00E+00	1.00E+00	1.00E+00
Bromodichloromethane	1.00E+00	1.00E+00	NA
Bromoform	1.00E+00	1.00E+00	NA
Bromomethane	1.00E+00	1.00E+00	1.00E+00
Cadmium (Diet)	1.00E+00	1.00E+00	1.00E+00
Cadmium (Water)	1.00E+00	1.00E+00	1.00E+00
Carbazole	NA	NA	NA
Carbon Disulfide	1.00E+00	1.00E+00	1.00E+00
Carbon Tetrachloride	1.00E+00	1.00E+00	1.00E+00
Chlordane	NA	NA	NA
Chlorobenzene	1.00E+00	1.00E+00	1.00E+00
Chloroform	1.00E+00	1.00E+00	1.00E+00
Chromium(VI)	1.00E+00	1.00E+00	1.00E+00
Chrysene	NA	NA	NA
Cobalt	1.00E+00	1.00E+00	1.00E+00
Copper	1.00E+00	1.00E+00	NA
Cresol, p-	5.00E-02	5.00E-02	1.00E+00
Cyanide (CN^-)	3.33E+01	3.33E+01	NA
Cyclohexanone	1.00E+00	1.00E+00	NA
Dibenzo[*a,h*]anthracene	NA	NA	NA
Dichlorobenzidine, 3,3'-	NA	NA	NA
Dichloroethane, 1,2-	3.33E+00	3.33E+00	3.47E+02
Dichloroethylene, 1,1-	1.00E+00	1.00E+00	1.00E+00
Dieldrin	1.00E+00	1.00E+00	NA
Ethyl Ether	1.00E+00	1.00E+00	NA
Ethylbenzene	1.00E+00	1.00E+00	1.00E+00
Fluorine (Soluble Fluoride)	1.00E+00	1.00E+00	1.00E+00
HpCDD, 2,3,7,8-	NA	NA	NA
HpCDF, 2,3,7,8-	NA	NA	NA

Table 17-3 (continued). Comparison of Reference Dose (RfD) for Chemicals

CHEMICAL	Oral RfD 2010/2015[a]	Dermal RfD 2010/2015[a]	Inhale RfD 2010/2015[a]
HxCDF, 2,3,7,8-	NA	NA	NA
Indeno[1,2,3-*cd*]pyrene	NA	NA	NA
Lead and Compounds	NA	NA	NA
Manganese (Diet)	1.00E+00	1.00E+00	1.00E+00
Manganese (Water)	1.96E+00	1.96E+00	1.00E+00
Mercury, Inorganic Salts	1.00E+00	1.00E+00	NA
Methanol	2.50E-01	2.50E-01	2.00E-01
Methyl Ethyl Ketone (2-Butanone)	1.00E+00	1.00E+00	1.00E+00
Methyl Isobutyl Ketone (4-methyl-2-pentanone)	1.00E+00	1.00E+00	1.00E+00
Methylene Chloride	1.00E+01	1.00E+01	1.73E+00
Molybdenum	1.00E+00	1.00E+00	NA
Nickel Soluble Salts	1.00E+00	1.00E+00	1.00E+00
Nitroaniline, 4-	1.00E+00	1.00E+00	1.00E+00
Nitroso-di-N-propylamine, *N*-	NA	NA	NA
Nitrosodiphenylamine, *N*-	NA	NA	NA
OCDD	4.29E-03	4.29E-03	3.01E-04
OCDF	4.29E-03	4.29E-03	3.01E-04
Octyl Phthalate, di-*N*-	4.00E+00	4.00E+00	NA
PeCDD, 2,3,7,8-	NA	NA	NA
PeCDF, 2,3,4,7,8-	4.29E+00	4.29E+00	3.01E-01
Pentachlorophenol	1.00E+00	1.00E+00	NA
Phenanthrene	NA	NA	NA
Selenium	1.00E+00	1.00E+00	1.00E+00
Silver	1.00E+00	1.00E+00	NA
TCDD, 2,3,7,8-	1.43E+00	1.43E+00	1.00E+00
TCDF, 2,3,7,8-	1.43E+00	1.43E+00	1.00E-01
Tetrachloroethylene	1.67E+00	1.67E+00	6.78E+00
Thallium (I) Nitrate	NA	NA	NA
Toluene	1.00E+00	1.00E+00	1.00E+00
Tributyl Phosphate	2.00E+01	2.00E+01	NA
Trichloroethane, 1,1,2-	1.00E+00	1.00E+00	NA
Trichloroethylene	NA	NA	3.00E+02
Trichlorofluoromethane	1.00E+00	1.00E+00	1.00E+00
Uranium (Soluble Salts)	1.00E+00	1.00E+00	7.50E+00
Vanadium, Metallic	1.39E-02	1.39E-02	1.00E+00
Vinyl Chloride	1.00E+00	1.00E+00	1.00E+00
Xylenes, Mixture	1.00E+00	1.00E+00	1.00E+00
Zinc (Metallic)	1.00E+00	1.00E+00	NA

[a] NA = not applicable

Updated EPA Exposure Factors

In 2011, shortly after the release of the Third Five-Year Review Report, EPA released its updated *Exposure Factors Handbook* (2011 Edition, EPA/600/R-09/052F) with new exposure values for inhalation rate, resident exposure duration, body weight, ingestion of surface water, and body surface area. The 2011 exposure values are used in this report.

Inhalation rate had been 1 cubic meter per hour (m^3/h) for all receptors, and this was lowered to 0.66 m^3/h for the child (6 to <11 years), 0.78 m^3/h for the youth (11 to <16 years) and 0.72 m^3/h for the adult (31 to 41 years) and senior (61 to 71 years). The decrease in the inhalation rate will decrease the risk values.

Resident exposure duration decreased from 30 to 26 years, with 6 years for the child and 20 years for the adult. The assumption for this report is the 20 adult years are spread as 6 youth, 7 adult, and 7 senior. Decreasing the resident exposure duration will decrease the risk values.

Body weight increased for the child (15 to 31.8 kilograms [kg]), youth (47 to 56.8 kg) and adult/senior (70 to 80 kg), using the same age ranges noted for the inhalation rate. Increasing body weight will decrease the risk values.

Surface water ingestion rates are slightly higher, with the child/youth value rising from 0.035 to 0.037 liters per day (L/day) and the adult/senior value changing from 0.015 to 0.016 L/day. An increase in surface water ingestion rate will increase the risk values.

Body surface area for soil and surface water contact (one-half of arms, hands, one-half of legs, and feet) increased for the child (2180 to 3550 square centimeters [cm^2]), youth (4470 to 5320 cm^2), and adult/senior (6070 to 6853 cm^2), using the same age ranges noted for the inhalation rate. Increasing body surface area increases the risk values.

2015 Risk Calculations for the Undeveloped-Park User

Tables 17-4 through 17-15 present the risk calculations for the undeveloped-park user who recreates in Zone 5 of the Fernald Preserve. The IRRA remediation zones are shown on Figure 18-1. Details on the exposure scenario can be found in the IRRA. Tabulated results presented here use 2015 data for CSFs and RfDs downloaded from RAIS and the updated exposure factors (EPA 2011) noted above. The presentation format for Tables 17-4 through 17-15 is identical to that used in the third five-year review and Table E.5.2 of the IRRA. Red-shaded cells indicate where the changes have been made to the calculations.

Table 17-4. Undeveloped Park User in Zone 5 – Summation of All Pathways

	HQ	ILCR	Rad Only ILCR
Inhale	1.19E-04	1.20E-05	1.20E-05
Dermal Soil	1.65E-03	2.45E-07	NA
Ingest Soil	1.14E-02	2.88E-06	8.60E-07
Dermal Surface Water	6.33E-03	8.27E-06	NA
Ingest Surface Water	6.07E-04	1.50E-07	4.87E-08
External Radiation	NA	2.17E-06	2.17E-06
SUM	**2.01E-02**	**2.57E-05**	**1.51E-05**

NA = not applicable

Table 17-5. Undeveloped Park User in Zone 5—Summation of All Pathways for Individual Nuclides

	Total ILCR[a]	Background ILCR[a]	Total – Bkgd ILCR[a]
Cesium-137 + D	2.84E-08	2.30E-08	5.43E-09
Lead-210	3.37E-07	2.47E-07	8.99E-08
Neptunium-237 + D	8.38E-10	6.53E-11	7.73E-10
Plutonium-238	9.02E-11	1.16E-11	7.87E-11
Plutonium-239/240	NA	3.43E-11	NA
Radium-226 + D	1.51E-06	1.84E-06	0.00E+00
Radium-228 + D	8.24E-07	9.34E-07	0.00E+00
Radon-222+ D	1.20E-05	1.45E-05	0.00E+00
Strontium-90 + D	NA	2.76E-10	NA
Technetium-99	1.30E-09	1.37E-10	1.16E-09
Thorium-228	3.25E-08	3.53E-08	0.00E+00
Thorium-230	3.99E-08	2.51E-08	1.48E-08
Thorium-232	2.22E-08	2.47E-08	0.00E+00
Uranium-234	8.27E-08	2.24E-08	6.03E-08
Uranium-235 + D	2.33E-08	6.51E-09	1.68E-08
Uranium-238 + D	1.91E-07	5.26E-08	1.38E-07
SUM	**1.51E-05**		**3.28E-07**

NA = not applicable
+ D = plus daughters

Note: Background ILCR cannot be summed and subtracted from the sum for Total ILCR because some background values are higher than Total ILCR values, and this would lower the sum for Total-Bkgd ILCR.

Table 17-6. Undeveloped Park User in Zone 5 – Summation of All Pathways for Individual Chemicals

	Total ILCR	Total HQ	Bkgd ILCR	Bkgd HQ	Tot-Bkd ILCR	Tot-Bkd HQ
Acetone	no CSFs	5.35E-08	no CSFs	0.00E+00	no CSFs	5.35E-08
Antimony	no CSFs	1.04E-03	no CSFs	1.33E-03	no CSFs	0.00E+00
Aroclor-1254	1.03E-07	6.90E-03	0.00E+00	0.00E+00	1.03E-07	6.90E-03
Aroclor-1260	1.15E-07	no RfDs	0.00E+00	no RfDs	1.15E-07	no RFDs
Arsenic	1.34E-06	8.04E-03	1.47E-06	8.80E-03	0.00E+00	0.00E+00
Barium	no CSFs	1.77E-04	no CSFs	2.40E-04	no CSFs	0.00E+00
Benzene	6.45E-10	7.90E-06	0.00E+00	0.00E+00	6.45E-10	7.90E-06
Benz[*a*]anthracene	2.40E-07	no RfDs	0.00E+00	no RfDs	2.40E-07	no RfDs
Benzo[*a*]pyrene	3.07E-06	no RfDs	0.00E+00	no RfDs	3.07E-06	no RfDs
Benzo[*b*]fluoranthene	1.88E-07	no RfDs	0.00E+00	no RfDs	1.88E-07	no RfDs
Benzo[*k*]fluoranthene	2.93E-08	no RfDs	0.00E+00	no RfDs	2.93E-08	no RfDs
Beryllium	NA	1.41E-04	2.36E-10	1.65E-04	NA	0.00E+00
Bis(2-chloroisopropyl)ether	4.82E-13	NA	6.74E-13	0.00E+00	0.00E+00	NA
Bis(2-ethylhexyl)phthalate	NA	NA	0.00E+00	0.00E+00	NA	NA
Boron	no CSFs	NA	no CSFs	3.93E-06	no CSFs	NA
Bromodichloromethane	3.42E-10	7.43E-07	0.00E+00	0.00E+00	3.42E-10	7.43E-07
Bromoform	NA	NA	0.00E+00	0.00E+00	NA	NA
Bromomethane	no CSFs	NA	no CSFs	0.00E+00	no CSFs	NA
Butanone, 2-	no CSFs	2.23E-13	no CSFs	0.00E+00	no CSFs	2.23E-13
Cadmium	NA	1.72E-04	1.21E-10	2.52E-04	NA	0.00E+00
Carbazole	NA	no RfDs	0.00E+00	no RfDs	NA	no RfDs
Carbon disulfide	no CSFs	2.24E-11	no CSFs	0.00E+00	no CSFs	2.24E-11
Carbon tetrachloride	8.77E-10	8.43E-06	0.00E+00	0.00E+00	8.77E-10	8.43E-06
Chlordane	no CSFs	no RfDs	no CSFs	no RfDs	no CSFs	no RfDs
Chlorobenzene	no CSFs	NA	no CSFs	0.00E+00	no CSFs	NA
Chloroform	NA	NA	0.00E+00	0.00E+00	NA	NA
Chromium(VI)	9.79E-07	1.76E-03	1.01E-06	1.61E-03	0.00E+00	1.48E-04
Chrysene	2.58E-09	no RfDs	0.00E+00	no RfDs	2.58E-09	no RfDs
Cobalt	NA	NA	0.00E+00	1.28E-02	NA	NA
Copper	no CSFs	NA	no CSFs	1.41E-04	no CSFs	NA
Cresol, *p*- (4-methylphenol)	no CSFs	5.51E-08	no CSFs	0.00E+00	no CSFs	5.51E-08
Cyanide	no CSFs	1.28E-10	no CSFs	0.00E+00	no CSFs	1.28E-10
Cyclohexanone	no CSFs	1.43E-13	no CSFs	0.00E+00	no CSFs	1.43E-13
Dibenz[*a,h*]anthracene	4.01E-06	no RfDs	0.00E+00	no RfDs	4.01E-06	no RfDs
Dichlorobenzidine, 3,3-	2.58E-10	no RfDs	0.00E+00	no RfDs	2.58E-10	no RfDs
Dichloroethane, 1,2-	5.13E-10	2.53E-06	0.00E+00	0.00E+00	5.13E-10	2.53E-06
Dichloroethylene, 1,1-	no CSFs	5.37E-07	no CSFs	0.00E+00	no CSFs	5.37E-07
Dieldrin	1.49E-08	5.01E-05	0.00E+00	0.00E+00	1.49E-08	5.01E-05
Di-n-octylphthalate	no CSFs	NA	no CSFs	0.00E+00	no CSFs	NA
Ethyl ether	no CSFs	NA	no CSFs	0.00E+00	no CSFs	NA
Ethylbenzene	3.45E-10	8.45E-07	5.21E-12	5.61E-09	3.40E-10	8.39E-07
Fluoride	no CSFs	1.49E-04	no CSFs	5.92E-05	no CSFs	8.94E-05
Heptachlorodibenzofuran	NA	NA	0.00E+00	0.00E+00	NA	NA

Table 17-6 (continued). Undeveloped Park User in Zone 5 – Summation of All Pathways for Individual Chemicals

	Total ILCR	Total HQ	Bkgd ILCR	Bkgd HQ	Tot-Bkd ILCR	Tot-Bkd HQ
Heptachlorodibenzo-*p*-dioxin	NA	NA	0.00E+00	0.00E+00	NA	NA
Hexachlorodibenzofuran	1.46E-08	2.60E-05	0.00E+00	0.00E+00	1.46E-08	2.60E-05
Hexachlorodibenzo-*p*-dioxin	no CSFs	no RfDs	no CSFs	no RfDs	no CSFs	no RfDs
Indeno[1,2,3-*c,d*]pyrene	5.24E-07	no RfDs	0.00E+00	no RfDs	5.24E-07	no RfDs
Lead	1.69E-08	no RfDs	1.74E-08	no RfDs	0.00E+00	no RfDs
Manganese	no CSFs	NA	no CSFs	1.70E-03	no CSFs	NA
Mercury	no CSFs	5.45E-05	no CSFs	5.41E-05	no CSFs	3.93E-07
Methanol	no CSFs	1.24E-14	no CSFs	0.00E+00	no CSFs	1.24E-14
Methyl Isobutyl Ketone (4-methyl-2-pentanone)	no CSFs	8.49E-07	no CSFs	0.00E+00	no CSFs	8.49E-07
Methylene chloride	5.25E-11	1.18E-05	0.00E+00	0.00E+00	5.25E-11	1.18E-05
Molybdenum	no CSFs	1.75E-04	no CSFs	1.92E-04	no CSFs	0.00E+00
Nickel	NA	NA	8.08E-10	5.05E-04	NA	NA
Nitroanaline, 4-	NA	4.21E-12	0.00E+00	0.00E+00	NA	4.21E-12
Nitroso-di-*N*-propylamine, N-	NA	no RfDs	0.00E+00	no RfDs	NA	no RfDs
Nitrosodiphenylamine, *N*-	NA	NA	0.00E+00	0.00E+00	NA	NA
Octachlorodibenzofuran	NA	NA	0.00E+00	0.00E+00	NA	NA
Octochlorodibenzo-p-dioxin	NA	NA	0.00E+00	0.00E+00	NA	NA
Pentachlorodibenzofuran	NA	NA	0.00E+00	0.00E+00	NA	NA
Pentachlorodibenzo-p-dioxin	NA	NA	0.00E+00	0.00E+00	NA	NA
Pentachlorophenol	4.33E-14	NA	0.00E+00	0.00E+00	4.33E-14	NA
Phenanthrene	no CSFs	no RfDs	no CSFs	no RfDs	no CSFs	no RfDs
Selenium	no CSFs	5.56E-05	no CSFs	5.29E-05	no CSFs	2.70E-06
Silver	no CSFs	2.86E-05	no CSFs	4.31E-05	no CSFs	0.00E+00
Tetrachlorodibenzofuran	NA	NA	0.00E+00	0.00E+00	NA	NA
Tetrachlorodibenzo-*p*-dioxin	2.41E-09	4.28E-06	0.00E+00	0.00E+00	2.41E-09	4.28E-06
Tetrachloroethylene	4.69E-11	1.00E-05	8.08E-14	2.10E-08	4.68E-11	1.00E-05
Thallium	no CSFs	NA	no CSFs	1.60E-02	no CSFs	NA
Toluene	no CSFs	7.07E-07	no CSFs	0.00E+00	no CSFs	7.07E-07
Tributyl phosphate	NA	NA	0.00E+00	0.00E+00	NA	NA
Trichloroethane, 1,1,2-	3.48E-10	4.12E-06	9.74E-11	8.20E-05	2.51E-10	0.00E+00
Trichloroethylene	4.54E-10	5.31E-05	0.00E+00	0.00E+00	4.54E-10	5.31E-05
Trifchlorofluoromethane	no CSFs	NA	no CSFs	0.00E+00	no CSFs	NA
Uranium	no CSFs	1.19E-03	no CSFs	3.05E-04	no CSFs	8.86E-04
Vanadium	no CSFs	NA	no CSFs	1.53E-03	no CSFs	NA
Vinyl chloride	NA	NA	0.00E+00	0.00E+00	NA	NA
Xylenes	no CSFs	4.29E-07	no CSFs	0.00E+00	no CSFs	4.29E-07
Zinc	no CSFs	NA	no CSFs	5.36E-05	no CSFs	NA
SUM	**1.07E-05**	**2.01E-02**			**8.31E-06**	**8.21E-03**

NA = not available. CSFs and RfDs are unavailable.
Note: Background ILCR cannot be summed and subtracted from the sum for Total ILCR because some background values are higher than Total ILCR values, and this would lower the sum for Total-Bkgd ILCR.

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Table 17-7. Undeveloped-Park User in Zone 5—Inhalation Pathway; Chemicals

Intake Equation:			UNITS	Assigned Values			
	CDI =	(CA*EF*ED*IR*ET)/(BW*AT)					
	CDI =	Chronic Daily Intake	mg/kgday	child	youth	adult	senior
	CA =	Concentration of chemical in air	mg/m^3	see table of COCs below			
	EF =	Exposure frequency	days/yr	20	40	20	40
	ED =	Exposure duration	yrs	6	6	7	7
	IR =	Inhalation rate	m^3/hr	0.66	0.78	0.72	0.72
	ET =	Exposure time	hrs/day	2	2	2	2
	BW =	Body weight	kg	31.8	56.8	80	80
	ATc =	Average time for carcinogens	days	25550	25550	25550	25550
	ATn =	Average time for non-carcinogens	days	2190	2190	2555	2555

				CHILD				YOUTH				ADULT				SENIOR				SUM			
COC	conc	RfDi	CSFi	CDI	HQ	CDI	ILCR	CDI	HQ	CDI	ILCR	CDI	HQ	CDI	ILCR	CDI	HQ	CDI	ILCR	CDI	HQ	CDI	ILCR
	mg/m^3	mg/kgday	kgday/mg	mg/kgday	CDI/RfD	mg/kgday	CDI*CSF	mg/kgday	CDI/RfD	mg/kgday	CDI*CSF	mg/kgday	CDI/RfD	mg/kgday	CDI*CSF	mg/kgday	CDI/RfD	mg/kgday	CDI*CSF	mg/kgday	CDI/RfD	mg/kgday	CDI*CSF
Acetone	2.24E-09	8.83E+00	NA	5.09E-12	5.76E-13	NA	NA	6.73E-12	7.62E-13	NA	NA	2.21E-12	2.50E-13	NA	NA	4.41E-12	5.00E-13	NA	NA	4.51E-12	5.11E-13	NA	NA
Antimony	2.26E-09	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Aroclor-1254	3.56E-09	NA	2.00E+00	NA	NA	6.94E-13	1.39E-12	NA	NA	9.18E-13	1.84E-12	NA	NA	3.51E-13	7.02E-13	NA	NA	7.02E-13	1.40E-12	NA	NA	2.67E-12	5.33E-12
Aroclor-1260	7.92E-10	NA	2.00E+00	NA	NA	1.54E-13	3.09E-13	NA	NA	2.04E-13	4.09E-13	NA	NA	7.82E-14	1.56E-13	NA	NA	1.56E-13	3.12E-13	NA	NA	5.93E-13	1.19E-12
Arsenic	3.05E-08	4.29E-06	1.51E+01	6.93E-11	1.62E-05	5.94E-12	8.94E-11	9.17E-11	2.14E-05	7.86E-12	1.18E-10	3.00E-11	7.01E-06	3.00E-12	4.52E-11	6.01E-11	1.40E-05	6.01E-12	9.04E-11	6.14E-11	1.43E-05	2.28E-11	3.43E-10
Barium	NA	1.43E-04	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benzene	NA	8.57E-03	2.73E-02	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benz(a)anthracene	NA	NA	3.85E-01	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benzo(a)pyrene	3.00E-12	NA	3.85E+00	NA	NA	5.84E-16	2.25E-15	NA	NA	7.73E-16	2.98E-15	NA	NA	2.96E-16	1.14E-15	NA	NA	5.91E-16	2.28E-15	NA	NA	2.24E-15	8.64E-15
Benzo(b)fluoranthene	NA	NA	3.85E-01	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benzo(k)fluoranthene	NA	NA	3.85E-01	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Beryllium	NA	5.71E-06	8.40E+00	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Bis(2-chloroisopropyl)ether	1.84E-08	NA	3.50E-02	NA	NA	3.59E-12	1.25E-13	NA	NA	4.74E-12	1.66E-13	NA	NA	1.81E-12	6.35E-14	NA	NA	3.63E-12	1.27E-13	NA	NA	1.38E-11	4.82E-13
Bis(2-ethylhexyl)phthalate	NA	NA	8.40E-03	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Boron	NA	5.71E-03	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Bromodichloromethane	3.53E-12	NA	1.30E-01	NA	NA	6.88E-16	8.91E-17	NA	NA	9.10E-16	1.18E-16	NA	NA	3.48E-16	4.51E-17	NA	NA	6.96E-16	9.01E-17	NA	NA	2.64E-15	3.42E-16
Bromoform	NA	NA	3.85E-03	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Bromomethane	NA	1.43E-03	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Butanone, 2-	1.58E-10	1.43E+00	NA	3.59E-13	2.51E-13	NA	NA	4.75E-13	3.33E-13	NA	NA	1.56E-13	1.09E-13	NA	NA	3.11E-13	2.18E-13	NA	NA	3.18E-13	2.23E-13	NA	NA
Cadmium	NA	2.86E-06	6.30E+00	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Carbazole	6.37E-07	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Carbon disulfide	2.22E-09	2.00E-01	NA	5.04E-12	2.52E-11	NA	NA	6.68E-12	3.34E-11	NA	NA	2.19E-12	1.09E-11	NA	NA	4.37E-12	2.19E-11	NA	NA	4.47E-12	2.24E-11	NA	NA
Carbon tetrachloride	NA	2.86E-02	2.10E-02	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chlordane	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chlorobenzene	NA	1.43E-02	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chloroform	NA	2.79E-02	8.05E-02	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chromium (VI)	NA	2.86E-05	2.94E+02	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chrysene	3.96E-10	NA	3.85E-02	NA	NA	7.73E-14	2.97E-15	NA	NA	1.02E-13	3.94E-15	NA	NA	3.91E-14	1.51E-15	NA	NA	7.82E-14	3.01E-15	NA	NA	2.97E-13	1.14E-14
Cobalt	NA	1.71E-06	3.15E+01	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Copper	7.19E-12	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Cresol, p- (4-methylphenol)	4.68E-06	1.71E-01	NA	1.06E-08	6.22E-08	NA	NA	1.41E-08	8.23E-08	NA	NA	4.61E-09	2.70E-08	NA	NA	9.22E-09	5.39E-08	NA	NA	9.43E-09	5.51E-08	NA	NA
Cyanide	1.45E-11	2.29E-04	NA	3.30E-14	1.44E-10	NA	NA	4.37E-14	1.91E-10	NA	NA	1.43E-14	6.25E-11	NA	NA	2.86E-14	1.25E-10	NA	NA	2.92E-14	1.28E-10	NA	NA
Cyclohexanone	1.42E-11	2.00E-01	NA	3.23E-14	1.61E-13	NA	NA	4.27E-14	2.14E-13	NA	NA	1.40E-14	7.00E-14	NA	NA	2.80E-14	1.40E-13	NA	NA	2.86E-14	1.43E-13	NA	NA
Dibenz(a,h)anthracene	NA	NA	4.20E+00	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dichlorobenzidine, 3,3-	2.90E-07	NA	1.19E+00	NA	NA	5.65E-11	6.72E-11	NA	NA	7.48E-11	8.90E-11	NA	NA	2.86E-11	3.40E-11	NA	NA	5.72E-11	6.80E-11	NA	NA	2.17E-10	2.58E-10
Dichloroethane, 1,2-	1.75E-09	2.00E-03	9.10E-02	3.99E-12	1.99E-09	3.42E-13	3.11E-14	5.28E-12	2.64E-09	4.53E-13	4.12E-14	1.73E-12	8.65E-10	1.73E-13	1.57E-14	3.46E-12	1.73E-09	3.46E-13	3.15E-14	3.54E-12	1.77E-09	1.31E-12	1.20E-13
Dichloroethylene, 1,1-	5.78E-08	5.71E-02	NA	1.31E-10	2.30E-09	NA	NA	1.74E-10	3.04E-09	NA	NA	5.70E-11	9.97E-10	NA	NA	1.14E-10	1.99E-09	NA	NA	1.16E-10	2.04E-09	NA	NA
Dieldrin	NA	NA	1.61E+01	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Di-n-octylphthalate	3.58E-12	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Ethyl ether	8.55E-08	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Table 17-7 (continued). Undeveloped-Park User in Zone 5—Inhalation Pathway; Chemicals

Intake Equation:			UNITS	Assigned Values			
	CDI =	(CA*EF*ED*IR*ET)/(BW*AT)					
	CDI =	Chronic Daily Intake	mg/kgday	child	youth	adult	senior
	CA =	Concentration of chemical in air	mg/m^3	see table of COCs below			
	EF =	Exposure frequency	days/yr	20	40	20	40
	ED =	Exposure duration	yrs	6	6	7	7
	IR =	Inhalation rate	m^3/hr	0.66	0.78	0.72	0.72
	ET =	Exposure time	hrs/day	2	2	2	2
	BW =	Body weight	kg	31.8	56.8	80	80
	ATc =	Average time for carcinogens	days	25550	25550	25550	25550
	ATn =	Average time for non-carcinogens	days	2190	2190	2555	2555

				CHILD				YOUTH				ADULT				SENIOR				SUM			
COC	conc	RfDi	CSFi	CDI	HQ	CDI	ILCR	CDI	HQ	CDI	ILCR	CDI	HQ	CDI	ILCR	CDI	HQ	CDI	ILCR	CDI	HQ	CDI	ILCR
	mg/m^3	mg/kgday	kgday/mg	mg/kgday	CDI/RfD	mg/kgday	CDI*CSF	mg/kgday	CDI/RfD	mg/kgday	CDI*CSF	mg/kgday	CDI/RfD	mg/kgday	CDI*CSF	mg/kgday	CDI/RfD	mg/kgday	CDI*CSF	mg/kgday	CDI/RfD	mg/kgday	CDI*CSF
Ethylbenzene	NA	2.86E-01	8.75E-03	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Fluoride	NA	3.71E-03	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Heptachlorodibenzofuran	NA	1.14E-06	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Heptachlorodibenzo-p-dioxin	NA	1.14E-06	1.33E+03	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Hexachlorodibenzofuran	1.47E-09	1.14E-07	1.33E+04	3.34E-12	2.93E-05	2.87E-13	3.81E-09	4.42E-12	3.88E-05	3.79E-13	5.04E-09	1.45E-12	1.27E-05	1.45E-13	1.93E-09	2.90E-12	2.54E-05	2.90E-13	3.86E-09	2.96E-12	2.60E-05	1.10E-12	1.46E-08
Hexachlorodibenzo-p-dioxin	7.70E-07	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Indeno(1,2,3-cd)pyrene	NA	NA	3.85E-01	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Lead	1.84E-09	NA	4.20E-02	NA	NA	3.58E-13	1.50E-14	NA	NA	4.74E-13	1.99E-14	NA	NA	1.81E-13	7.61E-15	NA	NA	3.62E-13	1.52E-14	NA	NA	1.38E-12	5.78E-14
Manganese	NA	1.43E-05	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Mercury	1.84E-11	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Methanol	3.52E-11	5.71E+00	NA	8.01E-14	1.40E-14	NA	NA	1.06E-13	1.86E-14	NA	NA	3.47E-14	6.08E-15	NA	NA	6.95E-14	1.22E-14	NA	NA	7.10E-14	1.24E-14	NA	NA
Methyl Isobutyl Ketone (4-methyl-2-pentanone)	1.03E-07	8.57E-01	NA	2.34E-10	2.73E-10	NA	NA	3.10E-10	3.62E-10	NA	NA	1.02E-10	1.19E-10	NA	NA	2.03E-10	2.37E-10	NA	NA	2.08E-10	2.42E-10	NA	NA
Methylene chloride	NA	1.71E-01	3.50E-05	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Molybdenum	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Nickel	NA	2.571E-05	9.10E-01	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Nitroanaline, 4-	3.58E-12	1.71E-03	NA	8.14E-15	4.75E-12	NA	NA	1.08E-14	6.28E-12	NA	NA	3.53E-15	2.06E-12	NA	NA	7.06E-15	4.12E-12	NA	NA	7.21E-15	4.21E-12	NA	NA
Nitroso-di-N-propylamine, N-	NA	NA	7.00E+00	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Nitrosodiphenylamine, N-	NA	NA	9.10E-03	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Octochlorodibenzofuran	NA	3.80E-05	3.99E+01	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Octochlorodibenzo-p-dioxin	NA	3.80E-05	3.99E+01	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Pentachlorodibenzofuran	NA	3.80E-08	3.99E+04	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Pentachlorodibenzo-p-dioxin	NA	1.14E-08	1.33E+05	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Pentachlorophenol	3.23E-09	NA	1.79E-02	NA	NA	6.30E-13	1.13E-14	NA	NA	8.34E-13	1.49E-14	NA	NA	3.19E-13	5.71E-15	NA	NA	6.37E-13	1.14E-14	NA	NA	2.42E-12	4.33E-14
Phenanthrene	3.29E-08	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Selenium	1.89E-08	5.71E-03	NA	4.30E-11	7.54E-09	NA	NA	5.69E-11	9.97E-09	NA	NA	1.87E-11	3.27E-09	NA	NA	3.73E-11	6.54E-09	NA	NA	3.81E-11	6.68E-09	NA	NA
Silver	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Tetrachlorodibenzofuran	NA	1.14E-07	1.33E+04	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Tetrachlorodibenzo-p-dioxin	2.42E-11	1.14E-08	1.33E+05	5.50E-14	4.82E-06	4.71E-15	6.27E-10	7.28E-14	6.38E-06	6.24E-15	8.30E-10	2.38E-14	2.09E-06	2.38E-15	3.17E-10	4.77E-14	4.18E-06	4.77E-15	6.34E-10	4.87E-14	4.28E-06	1.81E-14	2.41E-09
Tetrachloroethylene	NA	1.14E-02	9.10E-04	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Thallium	1.57E-11	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Toluene	NA	1.43E+00	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Tributyl phosphate	8.38E-12	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Trichloroethane, 1,1,2-	1.31E-10	5.71E-05	5.60E-02	2.98E-13	5.22E-09	2.56E-14	1.43E-15	3.95E-13	6.91E-09	3.38E-14	1.89E-15	1.29E-13	2.26E-09	1.29E-14	7.24E-16	2.59E-13	4.53E-09	2.59E-14	1.45E-15	2.64E-13	4.63E-09	9.82E-14	5.50E-15
Trichloroethylene	9.65E-12	5.71E-04	1.44E-02	2.20E-14	3.85E-11	1.88E-15	2.71E-17	2.91E-14	5.09E-11	2.49E-15	3.59E-17	9.52E-15	1.67E-11	9.52E-16	1.37E-17	1.90E-14	3.34E-11	1.90E-15	2.74E-17	1.95E-14	3.41E-11	7.23E-15	1.04E-16
Trifluorochloromethane	NA	2.00E-01	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Uranium	4.22E-07	1.14E-05	NA	9.61E-10	8.43E-05	NA	NA	1.27E-09	1.12E-04	NA	NA	4.17E-10	3.65E-05	NA	NA	8.33E-10	7.31E-05	NA	NA	8.52E-10	7.47E-05	NA	NA
Vanadium	NA	2.857E-05	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Vinyl chloride	NA	2.86E-02	1.54E-02	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Xylenes	3.43E-11	2.86E-02	NA	7.80E-14	2.73E-12	NA	NA	1.03E-13	3.61E-12	NA	NA	3.38E-14	1.18E-12	NA	NA	6.77E-14	2.37E-12	NA	NA	6.91E-14	2.42E-12	NA	NA
Zinc	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
																				total =	**1.19E-04**	total =	**1.77E-08**

Air concentration is derived using an air particulate value of 26 ug/m^3 (2005 SER background average from monitor AMS-12) multiplied by the soil concentration.

Table 17-8. Undeveloped-Park User in Zone 5—Dermal Soil Contact; Chemicals

Intake Equation:			UNITS	Assigned Values			
	CDI =	(CS*AB*SA*EF*ED*AF*CF)/(BW*AT)	mg/kgday	child	youth	adult	senior
	CDI =	Chronic Daily Intake					
	CS =	Concentration of chemical in soil	mg/kg	see table of COCs below			
	AB	Absorption factor	--	see table of COCs below			
	SA	Surface area of exposed skin	cm^2/day	3550	5320	6853	6853
	EF =	Exposure frequency	days/yr	20	40	20	40
	ED =	Exposure duration	yrs	6	6	7	7
	AF =	Adherence factor	mg/cm^2	0.2	0.2	0.07	0.07
	CF =	Conversion factor	kg/mg	1.00E-06	1.00E-06	1.00E-06	1.00E-06
	BW =	Body weight	kg	31.8	56.8	80	80
	ATc =	Average time for carcinogens	days	25550	25550	25550	25550
	ATn =	Average time for non-carcinogens	days	2190	2190	2555	2555

					CHILD				YOUTH				ADULT				SENIOR				SUM			
COC	conc	AB	RfDd	CSFd	CDI	HQ	CDI	ILCR	CDI	HQ	CDI	ILCR	CDI	HQ	CDI	ILCR	CDI	HQ	CDI	ILCR	CDI	HQ	CDI	ILCR
	mg/kg	unitless	mg/kgday	kgday/mg	mg/kgday	CDI/RfD	mg/kgday	CDI*CSF	mg/kgday	CDI/RfD	mg/kgday	CDI*CSF	mg/kgday	CDI/RfD	mg/kgday	CDI*CSF	mg/kgday	CDI/RfD	mg/kgday	CDI*CSF	mg/kgday	CDI/RfD	mg/kgday	CDI*CSF
Acetone	5.04E-03	NA	9.00E-01	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Antimony	2.22E+00	NA	6.00E-05	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Aroclor-1254	6.75E-02	1.40E-01	2.00E-05	2.00E+00	1.16E-08	5.78E-04	9.91E-10	1.98E-09	1.94E-08	9.70E-04	1.66E-09	3.32E-09	3.10E-09	1.55E-04	3.10E-10	6.21E-10	6.21E-09	3.10E-04	6.21E-10	1.24E-09	9.65E-09	4.82E-04	3.58E-09	7.17E-09
Aroclor-1260	6.07E-03	1.40E-01	NA	2.00E+00	NA	NA	8.91E-11	1.78E-10	NA	NA	1.50E-10	2.99E-10	NA	NA	2.79E-11	5.59E-11	NA	NA	5.59E-11	1.12E-10	NA	NA	3.23E-10	6.45E-10
Arsenic	1.11E+01	3.00E-02	3.00E-04	1.50E+00	4.09E-07	1.36E-03	3.51E-08	5.26E-08	6.86E-07	2.29E-03	5.88E-08	8.83E-08	1.10E-07	3.66E-04	1.10E-08	1.65E-08	2.20E-07	7.32E-04	2.20E-08	3.30E-08	3.42E-07	1.14E-03	1.27E-07	1.90E-07
Barium	1.80E+02	NA	1.40E-02	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benzene	1.38E-04	NA	4.00E-03	5.50E-02	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benz(a)anthracene	8.60E-02	1.30E-01	NA	7.30E-01	NA	NA	1.17E-09	8.56E-10	NA	NA	1.97E-09	1.44E-09	NA	NA	3.67E-10	2.68E-10	NA	NA	7.35E-10	5.36E-10	NA	NA	4.24E-09	3.10E-09
Benzo(a)pyrene	8.70E-02	1.30E-01	NA	7.30E+00	NA	NA	1.19E-09	8.65E-09	NA	NA	1.99E-09	1.45E-08	NA	NA	3.71E-10	2.71E-09	NA	NA	7.43E-10	5.42E-09	NA	NA	4.29E-09	3.13E-08
Benzo(b)fluoranthene	1.37E-01	1.30E-01	NA	7.30E-01	NA	NA	1.87E-09	1.36E-09	NA	NA	3.13E-09	2.29E-09	NA	NA	5.85E-10	4.27E-10	NA	NA	1.17E-09	8.54E-10	NA	NA	6.75E-09	4.93E-09
Benzo(k)fluoranthene	3.05E-02	1.30E-01	NA	7.30E-02	NA	NA	4.15E-10	3.03E-11	NA	NA	6.97E-10	5.09E-11	NA	NA	1.30E-10	9.50E-12	NA	NA	2.60E-10	1.90E-11	NA	NA	1.50E-09	1.10E-10
Beryllium	1.17E+00	NA	1.40E-05	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Bis(2-chloroisopropyl)ether	NA	NA	4.00E-02	7.00E-02	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Bis(2-ethylhexyl)phthalate	NA	1.00E-01	2.00E-02	1.40E-02	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Boron	NA	NA	2.00E-01	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Bromodichloromethane	1.15E-04	NA	2.00E-02	6.20E-02	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Bromoform	NA	NA	2.00E-02	7.90E-03	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Bromomethane	NA	NA	1.40E-03	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Butanone, 2-	NA	NA	6.00E-01	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Cadmium	7.07E-01	1.00E-03	2.50E-05	NA	8.65E-10	3.46E-05	NA	NA	1.45E-09	5.81E-05	NA	NA	2.32E-10	9.29E-06	NA	NA	4.65E-10	1.86E-05	NA	NA	7.22E-10	2.89E-05	NA	NA
Carbazole	NA	1.00E-01	NA	2.00E-02	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Carbon disulfide	NA	NA	1.00E-01	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Carbon tetrachloride	1.36E-04	NA	4.00E-03	7.00E-02	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chlordane	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chlorobenzene	NA	NA	2.00E-02	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chloroform	NA	NA	1.00E-02	3.10E-02	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chromium (VI)	2.45E+01	NA	7.50E-05	2.00E+01	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chrysene	8.53E-02	1.30E-01	NA	7.30E-03	NA	NA	1.16E-09	8.49E-12	NA	NA	1.95E-09	1.42E-11	NA	NA	3.64E-10	2.66E-12	NA	NA	7.29E-10	5.32E-12	NA	NA	4.21E-09	3.07E-11
Cobalt	NA	NA	3.00E-04	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Copper	NA	NA	4.00E-02	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Cresol, p- (4-methylphenol)	NA	1.00E-01	1.00E-01	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Cyanide	NA	NA	6.00E-04	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Cyclohexanone	NA	NA	5.00E+00	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dibenz(a,h)anthracene	1.52E-02	1.30E-01	NA	7.30E+00	NA	NA	2.08E-10	1.52E-09	NA	NA	3.49E-10	2.55E-09	NA	NA	6.51E-11	4.75E-10	NA	NA	1.30E-10	9.51E-10	NA	NA	7.52E-10	5.49E-09
Dichlorobenzidine, 3,3-	NA	1.00E-01	NA	4.50E-01	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dichloroethane, 1,2-	2.76E-04	NA	6.00E-03	9.10E-02	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dichloroethylene, 1,1-	5.58E-04	NA	5.00E-02	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dieldrin	5.46E-04	1.00E-01	5.00E-05	1.60E+01	6.68E-11	1.34E-06	5.72E-12	9.16E-11	1.12E-10	2.24E-06	9.60E-12	1.54E-10	1.79E-11	3.59E-07	1.79E-12	2.87E-11	3.59E-11	7.17E-07	3.59E-12	5.74E-11	5.57E-11	1.11E-06	2.07E-11	3.31E-10
Di-n-octylphthalate	NA	1.00E-01	1.00E-02	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Ethyl ether	NA	NA	2.00E-01	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Table 17-8 (continued). Undeveloped-Park User in Zone 5—Dermal Soil Contact; Chemicals

Intake Equation:			UNITS	Assigned Values			
	CDI =	(CS*AB*SA*EF*ED*AF*CF)/(BW*AT)	mg/kgday	child	youth	adult	senior
	CDI =	Chronic Daily Intake					
	CS =	Concentration of chemical in soil	mg/kg	see table of COCs below			
	AB	Absorption factor	--	see table of COCs below			
	SA	Surface area of exposed skin	cm^2/day	3550	5320	6853	6853
	EF =	Exposure frequency	days/yr	20	40	20	40
	ED =	Exposure duration	yrs	6	6	7	7
	AF =	Adherence factor	mg/cm^2	0.2	0.2	0.07	0.07
	CF =	Conversion factor	kg/mg	1.00E-06	1.00E-06	1.00E-06	1.00E-06
	BW =	Body weight	kg	31.8	56.8	80	80
	ATc =	Average time for carcinogens	days	25550	25550	25550	25550
	ATn =	Average time for non-carcinogens	days	2190	2190	2555	2555

					CHILD				YOUTH				ADULT				SENIOR				SUM			
COC	conc	AB	RfDd	CSFd	CDI	HQ	CDI	ILCR	CDI	HQ	CDI	ILCR	CDI	HQ	CDI	ILCR	CDI	HQ	CDI	ILCR	CDI	HQ	CDI	ILCR
	mg/kg	unitless	mg/kgday	kgday/mg	mg/kgday	CDI/RfD	mg/kgday	CDI*CSF	mg/kgday	CDI/RfD	mg/kgday	CDI*CSF	mg/kgday	CDI/RfD	mg/kgday	CDI*CSF	mg/kgday	CDI/RfD	mg/kgday	CDI*CSF	mg/kgday	CDI/RfD	mg/kgday	CDI*CSF
Ethylbenzene	1.38E-04	NA	1.00E-01	1.10E-02	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Fluoride	3.29E+00	NA	6.00E-02	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Heptachlorodibenzofuran	NA	3.00E-02	7.00E-08	1.30E+03	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Heptachlorodibenzo-p-dioxin	NA	3.00E-02	7.00E-08	1.30E+03	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Hexachlorodibenzofuran	NA	3.00E-02	7.00E-09	1.30E+04	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Hexachlorodibenzo-p-dioxin	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Indeno(1,2,3-cd)pyrene	5.65E-02	1.30E-01	NA	7.30E-01	NA	NA	7.71E-10	5.62E-10	NA	NA	1.29E-09	9.44E-10	NA	NA	2.41E-10	1.76E-10	NA	NA	4.83E-10	3.52E-10	NA	NA	2.79E-09	2.04E-09
Lead	2.96E+01	NA	NA	8.50E-03	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Manganese	NA	NA	9.60E-04	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Mercury	7.07E-02	NA	2.10E-05	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Methanol	NA	NA	2.00E+00	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Methyl Isobutyl Ketone (4-methyl-2-pentanone)	7.08E-04	NA	8.00E-02	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Methylene chloride	1.35E-03	NA	6.00E-03	2.00E-03	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Molybdenum	3.96E+00	NA	5.00E-03	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Nickel	NA	NA	8.00E-04	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Nitroanaline, 4-	NA	1.00E-01	4.00E-03	2.00E-02	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Nitroso-di-N-propylamine, N-	NA	1.00E-01	NA	7.00E+00	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Nitrosodiphenylamine, N-	NA	1.00E-01	2.00E-02	4.90E-03	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Octochlorodibenzofuran	NA	3.00E-02	2.33E-06	3.90E+01	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Octochlorodibenzo-p-dioxin	NA	3.00E-02	2.33E-06	3.90E+01	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Pentachlorodibenzofuran	NA	3.00E-02	2.33E-09	3.90E+04	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Pentachlorodibenzo-p-dioxin	NA	3.00E-02	7.00E-10	1.30E+05	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Pentachlorophenol	NA	2.50E-01	5.00E-03	4.00E-01	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Phenanthrene	1.24E-01	1.30E-01	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Selenium	1.27E+00	NA	5.00E-03	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Silver	7.28E-01	NA	2.00E-04	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Tetrachlorodibenzofuran	NA	3.00E-02	7.00E-09	1.30E+04	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Tetrachlorodibenzo-p-dioxin	NA	3.00E-02	7.00E-10	1.30E+05	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Tetrachloroethylene	9.30E-04	NA	6.00E-03	1.30E-03	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Thallium	NA	NA	7.00E-06	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Toluene	6.05E-04	NA	8.00E-02	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Tributyl phosphate	NA	1.00E-01	1.00E-02	9.00E-03	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Trichloroethane, 1,1,2-	3.22E-04	NA	4.00E-03	5.70E-02	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Trichloroethylene	3.71E-04	NA	5.00E-04	4.60E-02	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Trifluorochloromethane	NA	NA	3.00E-01	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Uranium	1.62E+01	NA	3.00E-03	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Vanadium	NA	NA	1.31E-04	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Vinyl chloride	NA	NA	3.00E-03	7.20E-01	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Xylenes	1.32E-03	NA	2.00E-01	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Zinc	NA	NA	3.00E-01	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
																					total =	**1.65E-03**	**total =**	**2.45E-07**

Table17-9. Undeveloped-Park User in Zone 5—Ingestion of Soil; Chemicals

Intake Equation:	CDI =	(CS*EF*ED*IR*FI*CF)/(BW*AT)	UNITS	Assigned Values			
	CDI =	Chronic Daily Intake	mg/kgday	child	youth	adult	senior
	CS =	Concentration of chemical in soil	mg/kg	see table of COCs below			
	EF =	Exposure frequency	days/yr	20	40	20	40
	ED =	Exposure duration	yrs	6	6	7	7
	IR =	Ingestion rate	mg/day	200	100	100	100
	FI =	Fraction of contaminated soil	unitless	1	1	1	1
	CF =	Conversion factor	kg/mg	1.00E-06	1.00E-06	1.00E-06	1.00E-06
	BW =	Body weight	kg	31.8	56.8	80	80
	ATc =	Average time for carcinogens	days	25550	25550	25550	25550
	ATn =	Average time for non-carcinogens	days	2190	2190	2555	2555

				CHILD				YOUTH				ADULT				SENIOR				SUM			
COC	conc	RfDo	CSFo	CDI	HQ	CDI	ILCR	CDI	HQ	CDI	ILCR	CDI	HQ	CDI	ILCR	CDI	HQ	CDI	ILCR	CDI	HQ	CDI	ILCR
	mg/kg	mg/kgday	kgday/mg	mg/kgday	CDI/RfD	mg/kgday	CDI*CSF	mg/kgday	CDI/RfD	mg/kgday	CDI*CSF	mg/kgday	CDI/RfD	mg/kgday	CDI*CSF	mg/kgday	CDI/RfD	mg/kgday	CDI*CSF	mg/kgday	CDI/RfD	mg/kgday	CDI*CSF
Acetone	5.04E-03	9.00E-01	NA	1.74E-09	1.93E-09	NA	NA	9.73E-10	1.08E-09	NA	NA	3.45E-10	3.84E-10	NA	NA	6.91E-10	7.67E-10	NA	NA	9.04E-10	1.00E-09	NA	NA
Antimony	2.22E+00	4.00E-04	NA	7.66E-07	1.91E-03	NA	NA	4.29E-07	1.07E-03	NA	NA	1.52E-07	3.80E-04	NA	NA	3.04E-07	7.61E-04	NA	NA	3.99E-07	9.96E-04	NA	NA
Aroclor-1254	6.75E-02	2.00E-05	2.00E+00	2.33E-08	1.16E-03	1.99E-09	3.99E-09	1.30E-08	6.51E-04	1.12E-09	2.23E-09	4.62E-09	2.31E-04	4.62E-10	9.24E-10	9.24E-09	4.62E-04	9.24E-10	1.85E-09	1.21E-08	6.05E-04	4.50E-09	8.99E-09
Aroclor-1260	6.07E-03	NA	2.00E+00	NA	NA	1.79E-10	3.59E-10	NA	NA	1.00E-10	2.01E-10	NA	NA	4.16E-11	8.32E-11	NA	NA	8.32E-11	1.66E-10	NA	NA	4.05E-10	8.09E-10
Arsenic	1.11E+01	3.00E-04	1.50E+00	3.84E-06	1.28E-02	3.29E-07	4.94E-07	2.15E-06	7.17E-03	1.84E-07	2.77E-07	7.63E-07	2.54E-03	7.63E-08	1.15E-07	1.53E-06	5.09E-03	1.53E-07	2.29E-07	2.00E-06	6.66E-03	7.43E-07	1.11E-06
Barium	1.80E+02	2.00E-01	NA	6.20E-05	3.10E-04	NA	NA	3.47E-05	1.73E-04	NA	NA	1.23E-05	6.16E-05	NA	NA	2.46E-05	1.23E-04	NA	NA	3.23E-05	1.61E-04	NA	NA
Benzene	1.38E-04	4.00E-03	5.50E-02	4.74E-11	1.19E-08	4.06E-12	2.24E-13	2.65E-11	6.64E-09	2.28E-12	1.25E-13	9.42E-12	2.36E-09	9.42E-13	5.18E-14	1.88E-11	4.71E-09	1.88E-12	1.04E-13	2.47E-11	6.17E-09	9.17E-12	5.04E-13
Benzo(a)anthracene	8.60E-02	NA	7.30E-01	NA	NA	2.54E-09	1.85E-09	NA	NA	1.42E-09	1.04E-09	NA	NA	5.89E-10	4.30E-10	NA	NA	1.18E-09	8.60E-10	NA	NA	5.73E-09	4.18E-09
Benzo(a)pyrene	8.70E-02	NA	7.30E+00	NA	NA	2.57E-09	1.87E-08	NA	NA	1.44E-09	1.05E-08	NA	NA	5.96E-10	4.35E-09	NA	NA	1.19E-09	8.70E-09	NA	NA	5.79E-09	4.23E-08
Benzo(b)fluoranthene	1.37E-01	NA	7.30E-01	NA	NA	4.04E-09	2.95E-09	NA	NA	2.26E-09	1.65E-09	NA	NA	9.38E-10	6.85E-10	NA	NA	1.88E-09	1.37E-09	NA	NA	9.12E-09	6.66E-09
Benzo(k)fluoranthene	3.05E-02	NA	7.30E-02	NA	NA	9.00E-10	6.57E-11	NA	NA	5.04E-10	3.68E-11	NA	NA	2.09E-10	1.52E-11	NA	NA	4.18E-10	3.05E-11	NA	NA	2.03E-09	1.48E-10
Beryllium	1.17E+00	2.00E-03	NA	4.04E-07	2.02E-04	NA	NA	2.26E-07	1.13E-04	NA	NA	8.02E-08	4.01E-05	NA	NA	1.60E-07	8.02E-05	NA	NA	2.10E-07	1.05E-04	NA	NA
Bis(2-chloroisopropyl)ether	NA	NA	1.10E+00	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Bis(2-ethylhexyl)phthalate	NA	2.00E-02	1.40E-02	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Boron	NA	2.00E-01	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Bromodichloromethane	1.15E-04	2.00E-02	6.20E-02	3.97E-11	1.99E-09	3.41E-12	2.11E-13	2.22E-11	1.11E-09	1.91E-12	1.18E-13	7.90E-12	3.95E-10	7.90E-13	4.90E-14	1.58E-11	7.90E-10	1.58E-12	9.79E-14	2.07E-11	1.03E-09	7.68E-12	4.76E-13
Bromoform	NA	2.00E-02	7.90E-03	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Bromomethane	NA	1.40E-03	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Butanone, 2-	NA	6.00E-01	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Cadmium	7.07E-01	1.00E-03	NA	2.44E-07	2.44E-04	NA	NA	1.36E-07	1.36E-04	NA	NA	4.84E-08	4.84E-05	NA	NA	9.69E-08	9.69E-05	NA	NA	1.27E-07	1.27E-04	NA	NA
Carbazole	NA	NA	2.00E-02	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Carbon disulfide	NA	1.00E-01	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Carbon tetrachloride	1.36E-04	4.00E-03	7.00E-02	4.68E-11	1.17E-08	4.01E-12	2.81E-13	2.62E-11	6.54E-09	2.24E-12	1.57E-13	9.29E-12	2.32E-09	9.29E-13	6.50E-14	1.86E-11	4.65E-09	1.86E-12	1.30E-13	2.43E-11	6.08E-09	9.04E-12	6.33E-13
Chlordane	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chlorobenzene	NA	2.00E-02	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chloroform	NA	1.00E-02	3.10E-02	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chromium (VI)	2.45E+01	3.00E-03	5.00E-01	8.45E-06	2.82E-03	7.24E-07	3.62E-07	4.73E-06	1.58E-03	4.05E-07	2.03E-07	1.68E-06	5.60E-04	1.68E-07	8.39E-08	3.36E-06	1.12E-03	3.36E-07	1.68E-07	4.40E-06	1.47E-03	1.63E-06	8.17E-07
Chrysene	8.53E-02	NA	7.30E-03	NA	NA	2.52E-09	1.84E-11	NA	NA	1.41E-09	1.03E-11	NA	NA	5.84E-10	4.27E-12	NA	NA	1.17E-09	8.53E-12	NA	NA	5.68E-09	4.15E-11
Cobalt	NA	3.00E-04	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Copper	NA	4.00E-02	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Cresol, p- (4-methylphenol)	NA	1.00E-01	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Cyanide	NA	6.00E-04	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Cyclohexanone	NA	5.00E+00	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dibenz(a,h)anthracene	1.52E-02	NA	7.30E+00	NA	NA	4.50E-10	3.29E-09	NA	NA	2.52E-10	1.84E-09	NA	NA	1.04E-10	7.62E-10	NA	NA	2.09E-10	1.52E-09	NA	NA	1.02E-09	7.41E-09
Dichlorobenzidine, 3,3-	NA	NA	4.50E-01	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dichloroethane, 1,2-	2.76E-04	6.00E-03	9.10E-02	9.53E-11	1.59E-08	8.17E-12	7.43E-13	5.33E-11	8.89E-09	4.57E-12	4.16E-13	1.89E-11	3.16E-09	1.89E-12	1.72E-13	3.79E-11	6.31E-09	3.79E-12	3.45E-13	4.96E-11	8.26E-09	1.84E-11	1.68E-12
Dichloroethylene, 1,1-	5.58E-04	5.00E-02	NA	1.92E-10	3.85E-09	NA	NA	1.08E-10	2.15E-09	NA	NA	3.82E-11	7.64E-10	NA	NA	7.64E-11	1.53E-09	NA	NA	1.00E-10	2.00E-09	NA	NA
Dieldrin	5.46E-04	5.00E-05	1.60E+01	1.88E-10	3.76E-06	1.61E-11	2.58E-10	1.05E-10	2.11E-06	9.03E-12	1.44E-10	3.74E-11	7.48E-07	3.74E-12	5.98E-11	7.48E-11	1.50E-06	7.48E-12	1.20E-10	9.79E-11	1.96E-06	3.64E-11	5.82E-10
Di-n-octylphthalate	NA	1.00E-02	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Ethyl ether	NA	2.00E-01	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Table 17-9 (continued). Undeveloped-Park User in Zone 5—Ingestion of Soil; Chemicals

Intake Equation:			UNITS	Assigned Values			
	CDI =	(CS*EF*ED*IR*FI*CF)/(BW*AT)					
	CDI =	Chronic Daily Intake	mg/kgday	child	youth	adult	senior
	CS =	Concentration of chemical in soil	mg/kg	see table of COCs below			
	EF =	Exposure frequency	days/yr	20	40	20	40
	ED =	Exposure duration	yrs	6	6	7	7
	IR =	Ingestion rate	mg/day	200	100	100	100
	FI =	Fraction of contaminated soil	unitless	1	1	1	1
	CF =	Conversion factor	kg/mg	1.00E-06	1.00E-06	1.00E-06	1.00E-06
	BW =	Body weight	kg	31.8	56.8	80	80
	ATc =	Average time for carcinogens	days	25550	25550	25550	25550
	ATn =	Average time for non-carcinogens	days	2190	2190	2555	2555

				CHILD				YOUTH				ADULT				SENIOR				SUM			
COC	conc	RfDo	CSFo	CDI	HQ	CDI	ILCR	CDI	HQ	CDI	ILCR	CDI	HQ	CDI	ILCR	CDI	HQ	CDI	ILCR	CDI	HQ	CDI	ILCR
	mg/kg	mg/kgday	kgday/mg	mg/kgday	CDI/RfD	mg/kgday	CDI*CSF	mg/kgday	CDI/RfD	mg/kgday	CDI*CSF	mg/kgday	CDI/RfD	mg/kgday	CDI*CSF	mg/kgday	CDI/RfD	mg/kgday	CDI*CSF	mg/kgday	CDI/RfD	mg/kgday	CDI*CSF
Ethylbenzene	1.38E-04	1.00E-01	1.10E-02	4.74E-11	4.74E-10	4.06E-12	4.47E-14	2.65E-11	2.65E-10	2.28E-12	2.50E-14	9.42E-12	9.42E-11	9.42E-13	1.04E-14	1.88E-11	1.88E-10	1.88E-12	2.07E-14	2.47E-11	2.47E-10	9.17E-12	1.01E-13
Fluoride	3.29E+00	6.00E-02	NA	1.13E-06	1.89E-05	NA	NA	6.35E-07	1.06E-05	NA	NA	2.25E-07	3.76E-06	NA	NA	4.51E-07	7.51E-06	NA	NA	5.90E-07	9.84E-06	NA	NA
Heptachlorodibenzofuran	NA	7.00E-08	1.30E+03	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Heptachlorodibenzo-p-dioxin	NA	7.00E-08	1.30E+03	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Hexachlorodibenzofuran	NA	7.00E-09	1.30E+04	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Hexachlorodibenzo-p-dioxin	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Indeno(1,2,3-cd)pyrene	5.65E-02	NA	7.30E-01	NA	NA	1.67E-09	1.22E-09	NA	NA	9.35E-10	6.82E-10	NA	NA	3.87E-10	2.83E-10	NA	NA	7.74E-10	5.65E-10	NA	NA	3.77E-09	2.75E-09
Lead	2.96E+01	NA	8.50E-03	NA	NA	8.75E-07	7.44E-09	NA	NA	4.90E-07	4.16E-09	NA	NA	2.03E-07	1.72E-09	NA	NA	4.06E-07	3.45E-09	NA	NA	1.97E-06	1.68E-08
Manganese	NA	1.40E-01	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Mercury	7.07E-02	3.00E-04	NA	2.43E-08	8.12E-05	NA	NA	1.36E-08	4.54E-05	NA	NA	4.84E-09	1.61E-05	NA	NA	9.68E-09	3.23E-05	NA	NA	1.27E-08	4.22E-05	NA	NA
Methanol	NA	2.00E+00	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Methyl Isobutyl Ketone (4-methyl-2-pentanone)	7.08E-04	8.00E-02	NA	2.44E-10	3.05E-09	NA	NA	1.37E-10	1.71E-09	NA	NA	4.85E-11	6.06E-10	NA	NA	9.70E-11	1.21E-09	NA	NA	1.27E-10	1.59E-09	NA	NA
Methylene chloride	1.35E-03	6.00E-03	2.00E-03	4.67E-10	7.78E-08	4.00E-11	8.00E-14	2.61E-10	4.35E-08	2.24E-11	4.48E-14	9.27E-11	1.55E-08	9.27E-12	1.85E-14	1.85E-10	3.09E-08	1.85E-11	3.71E-14	2.43E-10	4.05E-08	9.02E-11	1.80E-13
Molybdenum	3.96E+00	5.00E-03	NA	1.37E-06	2.73E-04	NA	NA	7.64E-07	1.53E-04	NA	NA	2.71E-07	5.43E-05	NA	NA	5.43E-07	1.09E-04	NA	NA	7.11E-07	1.42E-04	NA	NA
Nickel	NA	2.00E-02	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Nitroanaline, 4-	NA	4.00E-03	2.00E-02	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Nitroso-di-N-propylamine, N-	NA	NA	7.00E+00	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Nitrosodiphenylamine, N-	NA	2.00E-02	4.90E-03	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Octachlorodibenzofuran	NA	2.33E-06	3.90E+01	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Octochlorodibenzo-p-dioxin	NA	2.33E-06	3.90E+01	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Pentachlorodibenzofuran	NA	2.33E-09	3.90E+04	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Pentachlorodibenzo-p-dioxin	NA	7.00E-10	1.30E+05	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Pentachlorophenol	NA	5.00E-03	4.00E-01	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Phenanthrene	1.24E-01	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Selenium	1.27E+00	5.00E-03	NA	4.36E-07	8.72E-05	NA	NA	2.44E-07	4.88E-05	NA	NA	8.66E-08	1.73E-05	NA	NA	1.73E-07	3.47E-05	NA	NA	2.27E-07	4.54E-05	NA	NA
Silver	7.28E-01	5.00E-03	NA	2.51E-07	5.02E-05	NA	NA	1.40E-07	2.81E-05	NA	NA	4.98E-08	9.97E-06	NA	NA	9.97E-08	1.99E-05	NA	NA	1.31E-07	2.61E-05	NA	NA
Tetrachlorodibenzofuran	NA	7.00E-09	1.30E+04	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Tetrachlorodibenzo-p-dioxin	NA	7.00E-10	1.30E+05	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Tetrachloroethylene	9.30E-04	6.00E-03	2.10E-03	3.20E-10	5.34E-08	2.75E-11	5.77E-14	1.79E-10	2.99E-08	1.54E-11	3.23E-14	6.37E-11	1.06E-08	6.37E-12	1.34E-14	1.27E-10	2.12E-08	1.27E-11	2.68E-14	1.67E-10	2.78E-08	6.20E-11	1.30E-13
Thallium	NA	7.00E-06	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Toluene	6.05E-04	8.00E-02	NA	2.09E-10	2.61E-09	NA	NA	1.17E-10	1.46E-09	NA	NA	4.14E-11	5.18E-10	NA	NA	8.29E-11	1.04E-09	NA	NA	1.09E-10	1.36E-09	NA	NA
Tributyl phosphate	NA	1.00E-02	9.00E-03	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Trichloroethane, 1,1,2-	3.22E-04	4.00E-03	5.70E-02	1.11E-10	2.78E-08	9.52E-12	5.43E-13	6.22E-11	1.55E-08	5.33E-12	3.04E-13	2.21E-11	5.52E-09	2.21E-12	1.26E-13	4.41E-11	1.10E-08	4.41E-12	2.52E-13	5.78E-11	1.45E-08	2.15E-11	1.22E-12
Trichloroethylene	3.71E-04	5.00E-04	4.60E-02	1.28E-10	2.56E-07	1.10E-11	5.05E-13	7.16E-11	1.43E-07	6.14E-12	2.82E-13	2.54E-11	5.09E-08	2.54E-12	1.17E-13	5.09E-11	1.02E-07	5.09E-12	2.34E-13	6.66E-11	1.33E-07	2.47E-11	1.14E-12
Trifchlorofluoromethane	NA	3.00E-01	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Uranium	1.62E+01	3.00E-03	NA	5.60E-06	1.87E-03	NA	NA	3.13E-06	1.04E-03	NA	NA	1.11E-06	3.71E-04	NA	NA	2.23E-06	7.42E-04	NA	NA	2.91E-06	9.71E-04	NA	NA
Vanadium	NA	5.04E-03	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Vinyl chloride	NA	3.00E-03	7.20E-01	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Xylenes	1.32E-03	2.00E-01	NA	4.55E-10	2.27E-09	NA	NA	2.55E-10	1.27E-09	NA	NA	9.03E-11	4.52E-10	NA	NA	1.81E-10	9.03E-10	NA	NA	2.37E-10	1.18E-09	NA	NA
Zinc	NA	3.00E-01	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
																				total =	**1.14E-02**	total =	**2.02E-06**

Table17-10. Undeveloped-Park User in Zone 5—Dermal Surface Water Contact; Chemicals

			UNITS	Assigned Values: child	youth	adult	senior
Intake Equation:	CDI =	(DA*EF*ED*SA)/(BW*AT)					
	CDI =	Chronic Daily Intake	mg/kgday	calculated below			
	DA =	Dermal absorption dose	mg/cm^2day	see COC list below			
	EF =	Exposure frequency	days/yr	12	12	12	12
	ED =	Exposure duration	yrs	6	6	7	7
	SA =	Surface area of skin	cm^2	3550	5320	6853	6853
	BW =	Body weight	kg	31.8	56.8	80	80
	ATc =	Average time for carcinogens	days	25550	25550	25550	25550
	ATn =	Average time for non-carcinogens	days	2190	2190	2555	2555
where:	$DA = C_v*K_p*CF*ET$						
	C_v =	concentation of ith contaminant in surface water	mg/L	see COC list below			
	K_p =	permeability constant for ith contaminant	cm/hr	see COC list below			
	CF =	conversion factor	L/cm^3	0.001	0.001	0.001	0.001
	ET =	exposure time	hr/d	1	1	1	1

						CHILD				YOUTH				ADULT				SENIOR				SUM			
COC	C_v	K_p	DA	RfDd	CSFd	CDI	HQ	CDI	ILCR	CDI	HQ	CDI	ILCR	CDI	HQ	CDI	ILCR	CDI	HQ	CDI	ILCR	CDI	HQ	CDI	ILCR
	mg/L	cm/hr	mg/cm^2day	mg/kgday	kgday/mg	mg/kgday	CDI/RfD	mg/kgday	CDI*CSF	mg/kgday	CDI/RfD	mg/kgday	CDI*CSF	mg/kgday	CDI/RfD	mg/kgday	CDI*CSF	mg/kgday	CDI/RfD	mg/kgday	CDI*CSF	mg/kgday	CDI/RfD	mg/kgday	CDI*CSF
Acetone	2.50E-03	5.12E-04	1.28E-09	9.00E-01	NA	4.70E-09	5.22E-09	NA	NA	3.94E-09	4.38E-09	NA	NA	3.60E-09	4.01E-09	NA	NA	3.60E-09	4.01E-09	NA	NA	3.93E-09	4.37E-09	NA	NA
Antimony	5.00E-04	1.00E-03	5.00E-10	6.00E-05	NA	1.84E-09	3.06E-05	NA	NA	1.54E-09	2.57E-05	NA	NA	1.41E-09	2.35E-05	NA	NA	1.41E-09	2.35E-05	NA	NA	1.54E-09	2.56E-05	NA	NA
Aroclor-1254	5.00E-05	7.51E-01	3.76E-08	2.00E-05	2.00E+00	1.38E-07	6.89E-03	1.18E-08	2.36E-08	1.16E-07	5.78E-03	9.91E-09	1.98E-08	1.06E-07	5.29E-03	1.06E-08	2.11E-08	1.06E-07	5.29E-03	1.06E-08	2.11E-08	1.15E-07	5.77E-03	4.29E-08	8.57E-08
Aroclor-1260	5.00E-05	9.86E-01	4.93E-08	NA	2.00E+00	NA	NA	1.55E-08	3.10E-08	NA	NA	1.30E-08	2.60E-08	NA	NA	1.39E-08	2.78E-08	NA	NA	1.39E-08	2.78E-08	NA	NA	5.63E-08	1.13E-07
Arsenic	3.29E-03	1.00E-03	3.29E-09	3.00E-04	1.50E+00	1.21E-08	4.02E-05	1.03E-09	1.55E-09	1.01E-08	3.37E-05	8.68E-10	1.30E-09	9.26E-09	3.09E-05	9.26E-10	1.39E-09	9.26E-09	3.09E-05	9.26E-10	1.39E-09	1.01E-08	3.37E-05	3.75E-09	5.63E-09
Barium	5.26E-02	1.00E-03	5.26E-08	1.40E-02	NA	1.93E-07	1.38E-05	NA	NA	1.62E-07	1.16E-05	NA	NA	1.48E-07	1.06E-05	NA	NA	1.48E-07	1.06E-05	NA	NA	1.62E-07	1.16E-05	NA	NA
Benzene	5.00E-04	1.49E-02	7.45E-09	4.00E-03	5.50E-02	2.73E-08	6.84E-06	2.34E-09	1.29E-10	2.29E-08	5.74E-06	1.97E-09	1.08E-10	2.10E-08	5.24E-06	2.10E-09	1.15E-10	2.10E-08	5.24E-06	2.10E-09	1.15E-10	2.29E-08	5.73E-06	8.51E-09	4.68E-10
Benz(a)anthracene	5.00E-04	5.52E-01	2.76E-07	NA	7.30E-01	NA	NA	8.68E-08	6.34E-08	NA	NA	7.28E-08	5.32E-08	NA	NA	7.77E-08	5.67E-08	NA	NA	7.77E-08	5.67E-08	NA	NA	3.15E-07	2.30E-07
Benzo(a)pyrene	5.00E-04	7.13E-01	3.57E-07	NA	7.30E+00	NA	NA	1.12E-07	8.19E-07	NA	NA	9.41E-08	6.87E-07	NA	NA	1.00E-07	7.33E-07	NA	NA	1.00E-07	7.33E-07	NA	NA	4.07E-07	2.97E-06
Benzo(b)fluoranthene	5.00E-04	4.17E-01	2.09E-07	NA	7.30E-01	NA	NA	6.56E-08	4.79E-08	NA	NA	5.50E-08	4.02E-08	NA	NA	5.87E-08	4.29E-08	NA	NA	5.87E-08	4.29E-08	NA	NA	2.38E-07	1.74E-07
Benzo(k)fluoranthene	5.00E-04	6.91E-01	3.46E-07	NA	7.30E-02	NA	NA	1.09E-07	7.93E-09	NA	NA	9.12E-08	6.66E-09	NA	NA	9.73E-08	7.10E-09	NA	NA	9.73E-08	7.10E-09	NA	NA	3.94E-07	2.88E-08
Beryllium	1.58E-04	1.00E-03	1.58E-10	1.40E-05	NA	5.78E-10	4.13E-05	NA	NA	4.85E-10	3.46E-05	NA	NA	4.44E-10	3.17E-05	NA	NA	4.44E-10	3.17E-05	NA	NA	4.84E-10	3.46E-05	NA	NA
Bis(2-chloroisopropyl)ether	NA	7.64E-03	NA	4.00E-02	7.00E-02	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Bis(2-ethylhexyl)phthalate	NA	1.13E+00	NA	2.00E-02	1.40E-02	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Boron	NA	1.00E-03	NA	2.00E-01	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Bromodichloromethane	5.00E-04	4.02E-03	2.01E-09	2.00E-02	6.20E-02	7.38E-09	3.69E-07	6.32E-10	3.92E-11	6.19E-09	3.09E-07	5.31E-10	3.29E-11	5.66E-09	2.83E-07	5.66E-10	3.51E-11	5.66E-09	2.83E-07	5.66E-10	3.51E-11	6.18E-09	3.09E-07	2.29E-09	1.42E-10
Bromoform	NA	2.35E-03	NA	2.00E-02	7.90E-03	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Bromomethane	NA	2.84E-03	NA	1.40E-03	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Butanone, 2-	NA	9.62E-04	NA	6.00E-01	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Cadmium	1.00E-04	1.00E-03	1.00E-10	2.50E-05	NA	3.67E-10	1.47E-05	NA	NA	3.08E-10	1.23E-05	NA	NA	2.82E-10	1.13E-05	NA	NA	2.82E-10	1.13E-05	NA	NA	3.07E-10	1.23E-05	NA	NA
Carbazole	NA	5.36E-02	NA	NA	2.00E-02	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Carbon disulfide	NA	1.14E-02	NA	1.00E-01	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Carbon tetrachloride	5.00E-04	1.63E-02	8.15E-09	4.00E-03	7.00E-02	2.99E-08	7.48E-06	2.56E-09	1.79E-10	2.51E-08	6.27E-06	2.15E-09	1.51E-10	2.30E-08	5.74E-06	2.30E-09	1.61E-10	2.30E-08	5.74E-06	2.30E-09	1.61E-10	2.51E-08	6.26E-06	9.31E-09	6.51E-10
Chlordane	NA	1.07E-01	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chlorobenzene	NA	2.82E-02	NA	2.00E-02	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chloroform	NA	6.83E-03	NA	1.00E-02	3.10E-02	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chromium (VI)	3.33E-03	2.00E-03	6.66E-09	7.50E-05	2.00E+01	2.45E-08	3.26E-04	2.10E-09	4.19E-08	2.05E-08	2.74E-04	1.76E-09	3.52E-08	1.88E-08	2.50E-04	1.88E-09	3.75E-08	1.88E-08	2.50E-04	1.88E-09	3.75E-08	2.05E-08	2.73E-04	7.61E-09	1.52E-07
Chrysene	5.00E-04	5.96E-01	2.98E-07	NA	7.30E-03	NA	NA	9.37E-08	6.84E-10	NA	NA	7.87E-08	5.74E-10	NA	NA	8.39E-08	6.13E-10	NA	NA	8.39E-08	6.13E-10	NA	NA	3.40E-07	2.48E-09
Cobalt	NA	4.00E-04	NA	3.00E-04	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Copper	NA	1.00E-03	NA	4.00E-02	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Cresol, p- (4-methylphenol)	NA	7.54E-03	NA	1.00E-01	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Cyanide	NA	1.00E-03	NA	6.00E-04	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Cyclohexanone	NA	1.52E-03	NA	5.00E+00	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dibenz(a,h)anthracene	5.00E-04	9.53E-01	4.77E-07	NA	7.30E+00	NA	NA	1.50E-07	1.09E-06	NA	NA	1.26E-07	9.18E-07	NA	NA	1.34E-07	9.80E-07	NA	NA	1.34E-07	9.80E-07	NA	NA	5.44E-07	3.97E-06
Dichlorobenzidine, 3,3-	NA	1.28E-02	NA	NA	4.50E-01	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dichloroethane, 1,2-	5.00E-04	4.20E-03	2.10E-09	6.00E-03	9.10E-02	7.71E-09	1.28E-06	6.61E-10	6.01E-11	6.47E-09	1.08E-06	5.54E-10	5.04E-11	5.91E-09	9.86E-07	5.91E-10	5.38E-11	5.91E-09	9.86E-07	5.91E-10	5.38E-11	6.46E-09	1.08E-06	2.40E-09	2.18E-10
Dichloroethylene, 1,1-	5.00E-04	1.17E-02	5.85E-09	5.00E-02	NA	2.15E-08	4.29E-07	NA	NA	1.80E-08	3.60E-07	NA	NA	1.65E-08	3.29E-07	NA	NA	1.65E-08	3.29E-07	NA	NA	1.80E-08	3.60E-07	NA	NA
Dieldrin	2.00E-05	3.26E-02	6.52E-10	5.00E-05	1.60E+01	2.39E-09	4.79E-05	2.05E-10	3.28E-09	2.01E-09	4.02E-05	1.72E-10	2.75E-09	1.84E-09	3.67E-05	1.84E-10	2.94E-09	1.84E-09	3.67E-05	1.84E-10	2.94E-09	2.00E-09	4.01E-05	7.44E-10	1.19E-08
Di-n-octylphthalate	NA	2.43E+00	NA	1.00E-02	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Ethyl ether	NA	2.35E-03	NA	2.00E-01	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Table 17-10 (continued). Undeveloped-Park User in Zone 5—Dermal Surface Water Contact; Chemicals

				Assigned Values			
			UNITS	child	youth	adult	senior
Intake Equation:	CDI =	(DA*EF*ED*SA)/(BW*AT)					
	CDI =	Chronic Daily Intake	mg/kgday	calculated below			
	DA =	Dermal absorption dose	mg/cm^2day	see COC list below			
	EF =	Exposure frequency	days/yr	12	12	12	12
	ED =	Exposure duration	yrs	6	6	7	7
	SA =	Surface area of skin	cm^2	3550	5320	6853	6853
	BW =	Body weight	kg	31.8	56.8	80	80
	ATc =	Average time for carcinogens	days	25550	25550	25550	25550
	ATn =	Average time for non-carcinogens	days	2190	2190	2555	2555
where:	DA = C_v*K_p*CF*ET						
	C_v =	concentation of ith contaminant in surface water	mg/L	see COC list below			
	K_p =	permeability constant for ith contaminant	cm/hr	see COC list below			
	CF =	conversion factor	L/cm^3	0.001	0.001	0.001	0.001
	ET =	exposure time	hr/d	1	1	1	1

						CHILD				YOUTH				ADULT				SENIOR				SUM			
COC	C_v	K_p	DA	RfDd	CSFd	CDI	HQ	CDI	ILCR	CDI	HQ	CDI	ILCR	CDI	HQ	CDI	ILCR	CDI	HQ	CDI	ILCR	CDI	HQ	CDI	ILCR
	mg/L	cm/hr	mg/cm^2day	mg/kgday	kgday/mg	mg/kgday	CDI/RfD	mg/kgday	CDI*CSF	mg/kgday	CDI/RfD	mg/kgday	CDI*CSF	mg/kgday	CDI/RfD	mg/kgday	CDI*CSF	mg/kgday	CDI/RfD	mg/kgday	CDI*CSF	mg/kgday	CDI/RfD	mg/kgday	CDI*CSF
Ethylbenzene	5.00E-04	4.93E-02	2.47E-08	1.00E-01	1.10E-02	9.05E-08	9.05E-07	7.75E-09	8.53E-11	7.59E-08	7.59E-07	6.51E-09	7.16E-11	6.94E-08	6.94E-07	6.94E-09	7.64E-11	6.94E-08	6.94E-07	6.94E-09	7.64E-11	7.58E-08	7.58E-07	2.81E-08	3.10E-10
Fluoride	4.09E-01	1.00E-03	4.09E-07	6.00E-02	NA	1.50E-06	2.50E-05	NA	NA	1.26E-06	2.10E-05	NA	NA	1.15E-06	1.92E-05	NA	NA	1.15E-06	1.92E-05	NA	NA	1.26E-06	2.09E-05	NA	NA
Heptachlorodibenzofuran	NA	1.45E+00	NA	7.00E-08	1.30E+03	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Heptachlorodibenzo-p-dioxin	NA	1.33E+00	NA	7.00E-08	1.30E+03	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Hexachlorodibenzofuran	NA	1.35E+00	NA	7.00E-09	1.30E+04	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Hexachlorodibenzo-p-dioxin	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Indeno(1,2,3-cd)pyrene	5.00E-04	1.24E+00	6.20E-07	NA	7.30E-01	NA	NA	1.95E-07	1.42E-07	NA	NA	1.64E-07	1.19E-07	NA	NA	1.75E-07	1.27E-07	NA	NA	1.75E-07	1.27E-07	NA	NA	7.08E-07	5.17E-07
Lead	1.68E-03	1.00E-04	1.68E-10	NA	8.50E-03	NA	NA	5.29E-11	4.49E-13	NA	NA	4.43E-11	3.77E-13	NA	NA	4.73E-11	4.02E-13	NA	NA	4.73E-11	4.02E-13	NA	NA	1.92E-10	1.63E-12
Manganese	NA	1.00E-03	NA	1.40E-01	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Mercury	6.00E-05	1.00E-03	6.00E-11	2.10E-05	NA	2.20E-10	1.05E-05	NA	NA	1.85E-10	8.80E-06	NA	NA	1.69E-10	8.05E-06	NA	NA	1.69E-10	8.05E-06	NA	NA	1.84E-10	8.78E-06	NA	NA
Methanol	NA	3.19E-04	NA	2.00E+00	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Methyl Isobutyl Ketone (4-methyl-2-pentanone)	2.50E-03	3.19E-03	7.98E-09	8.00E-02	NA	2.93E-08	3.66E-07	NA	NA	2.46E-08	3.07E-07	NA	NA	2.25E-08	2.81E-07	NA	NA	2.25E-08	2.81E-07	NA	NA	2.45E-08	3.06E-07	NA	NA
Methylene chloride	2.50E-03	3.54E-03	8.85E-09	6.00E-03	2.00E-03	3.25E-08	5.41E-06	2.78E-09	5.57E-12	2.73E-08	4.54E-06	2.34E-09	4.67E-12	2.49E-08	4.15E-06	2.49E-09	4.98E-12	2.49E-08	4.15E-06	2.49E-09	4.98E-12	2.72E-08	4.53E-06	1.01E-08	2.02E-11
Molybdenum	8.03E-03	1.00E-03	8.03E-09	5.00E-03	NA	2.95E-08	5.89E-06	NA	NA	2.47E-08	4.94E-06	NA	NA	2.26E-08	4.52E-06	NA	NA	2.26E-08	4.52E-06	NA	NA	2.47E-08	4.93E-06	NA	NA
Nickel	NA	2.00E-04	NA	8.00E-04	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Nitroanaline, 4-	NA	2.21E-03	NA	4.00E-03	2.00E-02	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Nitroso-di-N-propylamine, N-	NA	2.33E-03	NA	NA	7.00E+00	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Nitrosodiphenylamine, N-	NA	1.45E-02	NA	2.00E-02	4.90E-03	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Octachlorodibenzofuran	NA	2.63E+00	NA	2.33E-06	3.90E+01	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Octochlorodibenzo-p-dioxin	NA	1.16E+00	NA	2.33E-06	3.90E+01	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Pentachlorodibenzofuran	NA	6.27E-01	NA	2.33E-09	3.90E+04	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Pentachlorodibenzo-p-dioxin	NA	2.41E-01	NA	7.00E-10	1.30E+05	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Pentachlorophenol	NA	1.27E-01	NA	5.00E-03	4.00E-01	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Phenanthrene	5.00E-04	1.44E-01	7.20E-08	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Selenium	2.50E-03	1.00E-03	2.50E-09	5.00E-03	NA	9.18E-09	1.84E-06	NA	NA	7.70E-09	1.54E-06	NA	NA	7.04E-09	1.41E-06	NA	NA	7.04E-09	1.41E-06	NA	NA	7.68E-09	1.54E-06	NA	NA
Silver	2.00E-04	6.00E-04	1.20E-10	2.00E-04	NA	4.40E-10	2.20E-06	NA	NA	3.70E-10	1.85E-06	NA	NA	3.38E-10	1.69E-06	NA	NA	3.38E-10	1.69E-06	NA	NA	3.69E-10	1.84E-06	NA	NA
Tetrachlorodibenzofuran	NA	6.57E-01	NA	7.00E-09	1.30E+04	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Tetrachlorodibenzo-p-dioxin	NA	8.08E-01	NA	7.00E-10	1.30E+05	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Tetrachloroethylene	5.00E-04	3.34E-02	1.67E-08	6.00E-03	2.10E-03	6.13E-08	1.02E-05	5.25E-09	1.10E-11	5.14E-08	8.57E-06	4.41E-09	9.26E-12	4.70E-08	7.84E-06	4.70E-09	9.88E-12	4.70E-08	7.84E-06	4.70E-09	9.88E-12	5.13E-08	8.56E-06	1.91E-08	4.00E-11
Thallium	NA	1.00E-03	NA	7.00E-06	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Toluene	5.00E-04	3.11E-02	1.56E-08	8.00E-02	NA	5.71E-08	7.13E-07	NA	NA	4.79E-08	5.99E-07	NA	NA	4.38E-08	5.47E-07	NA	NA	4.38E-08	5.47E-07	NA	NA	4.78E-08	5.97E-07	NA	NA
Tributyl phosphate	NA	2.28E-02	NA	1.00E-02	9.00E-03	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Trichloroethane, 1,1,2-	5.00E-04	5.04E-03	2.52E-09	4.00E-03	5.70E-02	9.25E-09	2.31E-06	7.93E-10	4.52E-11	7.76E-09	1.94E-06	6.65E-10	3.79E-11	7.10E-09	1.77E-06	7.10E-10	4.05E-11	7.10E-09	1.77E-06	7.10E-10	4.05E-11	7.75E-09	1.94E-06	2.88E-09	1.64E-10
Trichloroethylene	5.00E-04	1.16E-02	5.80E-09	5.00E-04	4.60E-02	2.13E-08	4.26E-05	1.82E-09	8.39E-11	1.79E-08	3.57E-05	1.53E-09	7.04E-11	1.63E-08	3.27E-05	1.63E-09	7.51E-11	1.63E-08	3.27E-05	1.63E-09	7.51E-11	1.78E-08	3.57E-05	6.62E-09	3.05E-10
Trifchlorofluoromethane	NA	1.27E-02	NA	3.00E-01	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Uranium	2.14E-02	1.00E-03	2.14E-08	3.00E-03	NA	7.84E-08	2.61E-05	NA	NA	6.58E-08	2.19E-05	NA	NA	6.01E-08	2.00E-05	NA	NA	6.01E-08	2.00E-05	NA	NA	6.56E-08	2.19E-05	NA	NA
Vanadium	NA	1.00E-03	NA	1.31E-04	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Vinyl chloride	NA	8.38E-03	NA	3.00E-03	7.20E-01	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Xylenes	5.00E-04	5.00E-02	2.50E-08	2.00E-01	NA	9.18E-08	4.59E-07	NA	NA	7.70E-08	3.85E-07	NA	NA	7.04E-08	3.52E-07	NA	NA	7.04E-08	3.52E-07	NA	NA	7.68E-08	3.84E-07	NA	NA
Zinc	NA	6.00E-04	NA	3.00E-01	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
																						total =	**6.33E-03**	**total =**	**8.27E-06**

Table 17-11. Undeveloped-Park User in Zone 5—Ingestion of Surface Water; Chemicals

			UNITS	Assigned Values			
Intake Equation:	CDI =	(CW*EF*ED*IR)/(BW*AT)					
	CDI =	Chronic Daily Intake	mg/kgday	child	youth	adult	senior
	CW =	Concentration of chemical in water	mg/L	see COC table below			
	EF =	Exposure frequency	days/yr	12	12	12	12
	ED =	Exposure duration	yrs	6	6	7	7
	IR =	Ingestion rate	L/day	0.037	0.037	0.016	0.016
	BW =	Body weight	kg	31.8	56.8	80	80
	ATc =	Average time for carcinogens	days	25550	25550	25550	25550
	ATn =	Average time for non-carcinogens	days	2190	2190	2555	2555

				CHILD				YOUTH				ADULT				SENIOR				SUM			
COC	CW	RfDo	CSFo	CDI	HQ	CDI	ILCR	CDI	HQ	CDI	ILCR	CDI	HQ	CDI	ILCR	CDI	HQ	CDI	ILCR	CDI	HQ	CDI	ILCR
	mg/L	mg/kgday	kgday/mg	mg/kgday	CDI/RfD	mg/kgday	CDI*CSF	mg/kgday	CDI/RfD	mg/kgday	CDI*CSF	mg/kgday	CDI/RfD	mg/kgday	CDI*CSF	mg/kgday	CDI/RfD	mg/kgday	CDI*CSF	mg/kgday	CDI/RfD	mg/kgday	CDI*CSF
Acetone	2.50E-03	9.00E-01	NA	9.56E-08	1.06E-07	NA	NA	5.35E-08	5.95E-08	NA	NA	1.64E-08	1.83E-08	NA	NA	1.64E-08	1.83E-08	NA	NA	4.33E-08	4.81E-08	NA	NA
Antimony	5.00E-04	4.00E-04	NA	1.91E-08	4.78E-05	NA	NA	1.07E-08	2.68E-05	NA	NA	3.29E-09	8.22E-06	NA	NA	3.29E-09	8.22E-06	NA	NA	8.66E-09	2.16E-05	NA	NA
Aroclor-1254	5.00E-05	2.00E-05	2.00E+00	1.91E-09	9.56E-05	1.64E-10	3.28E-10	1.07E-09	5.35E-05	9.18E-11	1.84E-10	3.29E-10	1.64E-05	3.29E-11	6.58E-11	3.29E-10	1.64E-05	3.29E-11	6.58E-11	8.66E-10	4.33E-05	3.21E-10	6.43E-10
Aroclor-1260	5.00E-05	NA	2.00E+00	NA	NA	1.64E-10	3.28E-10	NA	NA	9.18E-11	1.84E-10	NA	NA	3.29E-11	6.58E-11	NA	NA	3.29E-11	6.58E-11	NA	NA	3.21E-10	6.43E-10
Arsenic	3.29E-03	3.00E-04	1.50E+00	1.26E-07	4.19E-04	1.08E-08	1.62E-08	7.04E-08	2.35E-04	6.03E-09	9.05E-09	2.16E-08	7.21E-05	2.16E-09	3.24E-09	2.16E-08	7.21E-05	2.16E-09	3.24E-09	5.69E-08	1.90E-04	2.11E-08	3.17E-08
Barium	5.26E-02	2.00E-01	NA	2.01E-06	1.01E-05	NA	NA	1.13E-06	5.63E-06	NA	NA	3.46E-07	1.73E-06	NA	NA	3.46E-07	1.73E-06	NA	NA	9.11E-07	4.55E-06	NA	NA
Benzene	5.00E-04	4.00E-03	5.50E-02	1.91E-08	4.78E-06	1.64E-09	9.02E-11	1.07E-08	2.68E-06	9.18E-10	5.05E-11	3.29E-09	8.22E-07	3.29E-10	1.81E-11	3.29E-09	8.22E-07	3.29E-10	1.81E-11	8.66E-09	2.16E-06	3.21E-09	1.77E-10
Benz(a)anthracene	5.00E-04	NA	7.30E-01	NA	NA	1.64E-09	1.20E-09	NA	NA	9.18E-10	6.70E-10	NA	NA	3.29E-10	2.40E-10	NA	NA	3.29E-10	2.40E-10	NA	NA	3.21E-09	2.35E-09
Benzo(a)pyrene	5.00E-04	NA	7.30E+00	NA	NA	1.64E-09	1.20E-08	NA	NA	9.18E-10	6.70E-09	NA	NA	3.29E-10	2.40E-09	NA	NA	3.29E-10	2.40E-09	NA	NA	3.21E-09	2.35E-08
Benzo(b)fluoranthene	5.00E-04	NA	7.30E-01	NA	NA	1.64E-09	1.20E-09	NA	NA	9.18E-10	6.70E-10	NA	NA	3.29E-10	2.40E-10	NA	NA	3.29E-10	2.40E-10	NA	NA	3.21E-09	2.35E-09
Benzo(k)fluoranthene	5.00E-04	NA	7.30E-02	NA	NA	1.64E-09	1.20E-10	NA	NA	9.18E-10	6.70E-11	NA	NA	3.29E-10	2.40E-11	NA	NA	3.29E-10	2.40E-11	NA	NA	3.21E-09	2.35E-10
Beryllium	1.58E-04	2.00E-03	NA	6.02E-09	3.01E-06	NA	NA	3.37E-09	1.69E-06	NA	NA	1.04E-09	5.18E-07	NA	NA	1.04E-09	5.18E-07	NA	NA	2.73E-09	1.36E-06	NA	NA
Bis(2-chloroisopropyl)ether	NA	4.00E-02	7.00E-02	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Bis(2-ethylhexyl)phthalate	NA	2.00E-02	1.40E-02	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Boron	NA	2.00E-01	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Bromodichloromethane	5.00E-04	2.00E-02	6.20E-02	1.91E-08	9.56E-07	1.64E-09	1.02E-10	1.07E-08	5.35E-07	9.18E-10	5.69E-11	3.29E-09	1.64E-07	3.29E-10	2.04E-11	3.29E-09	1.64E-07	3.29E-10	2.04E-11	8.66E-09	4.33E-07	3.21E-09	1.99E-10
Bromoform	NA	2.00E-02	7.90E-03	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Bromomethane	NA	1.40E-03	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Butanone, 2-	NA	6.00E-01	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Cadmium	1.00E-04	5.00E-04	NA	3.83E-09	7.65E-06	NA	NA	2.14E-09	4.28E-06	NA	NA	6.58E-10	1.32E-06	NA	NA	6.58E-10	1.32E-06	NA	NA	1.73E-09	3.46E-06	NA	NA
Carbazole	NA	NA	2.00E-02	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Carbon disulfide	NA	1.00E-01	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Carbon tetrachloride	5.00E-04	4.00E-03	7.00E-02	1.91E-08	4.78E-06	1.64E-09	1.15E-10	1.07E-08	2.68E-06	9.18E-10	6.42E-11	3.29E-09	8.22E-07	3.29E-10	2.30E-11	3.29E-09	8.22E-07	3.29E-10	2.30E-11	8.66E-09	2.16E-06	3.21E-09	2.25E-10
Chlordane	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chlorobenzene	NA	2.00E-02	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chloroform	NA	1.00E-02	3.10E-02	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chromium (VI)	3.33E-03	3.00E-03	5.00E-01	1.27E-07	4.25E-05	1.09E-08	5.46E-09	7.13E-08	2.38E-05	6.12E-09	3.06E-09	2.19E-08	7.30E-06	2.19E-09	1.10E-09	2.19E-08	7.30E-06	2.19E-09	1.10E-09	5.77E-08	1.92E-05	2.14E-08	1.07E-08
Chrysene	5.00E-04	NA	7.30E-03	NA	NA	1.64E-09	1.20E-11	NA	NA	9.18E-10	6.70E-12	NA	NA	3.29E-10	2.40E-12	NA	NA	3.29E-10	2.40E-12	NA	NA	3.21E-09	2.35E-11
Cobalt	NA	3.00E-04	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Copper	NA	4.00E-02	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Cresol, p- (4-methylphenol)	NA	1.00E-01	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Cyanide	NA	6.00E-04	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Cyclohexanone	NA	5.00E+00	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dibenz(a,h)anthracene	5.00E-04	NA	7.30E+00	NA	NA	1.64E-09	1.20E-08	NA	NA	9.18E-10	6.70E-09	NA	NA	3.29E-10	2.40E-09	NA	NA	3.29E-10	2.40E-09	NA	NA	3.21E-09	2.35E-08
Dichlorobenzidine, 3,3-	NA	NA	4.50E-01	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dichloroethane, 1,2-	5.00E-04	6.00E-03	9.10E-02	1.91E-08	3.19E-06	1.64E-09	1.49E-10	1.07E-08	1.78E-06	9.18E-10	8.35E-11	3.29E-09	5.48E-07	3.29E-10	2.99E-11	3.29E-09	5.48E-07	3.29E-10	2.99E-11	8.66E-09	1.44E-06	3.21E-09	2.93E-10
Dichloroethylene, 1,1-	5.00E-04	5.00E-02	NA	1.91E-08	3.83E-07	NA	NA	1.07E-08	2.14E-07	NA	NA	3.29E-09	6.58E-08	NA	NA	3.29E-09	6.58E-08	NA	NA	8.66E-09	1.73E-07	NA	NA
Dieldrin	2.00E-05	5.00E-05	1.60E+01	7.65E-10	1.53E-05	6.56E-11	1.05E-09	4.28E-10	8.57E-06	3.67E-11	5.87E-10	1.32E-10	2.63E-06	1.32E-11	2.10E-10	1.32E-10	2.63E-06	1.32E-11	2.10E-10	3.46E-10	6.92E-06	1.29E-10	2.06E-09
Di-n-octylphthalate	NA	1.00E-02	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Ethyl ether	NA	2.00E-01	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Table 17-11 (continued). Undeveloped-Park User in Zone 5—Ingestion of Surface Water; Chemicals

Intake Equation:			UNITS	Assigned Values			
	CDI =	(CW*EF*ED*IR)/(BW*AT)					
	CDI =	Chronic Daily Intake	mg/kgday	child	youth	adult	senior
	CW =	Concentration of chemical in water	mg/L	see COC table below			
	EF =	Exposure frequency	days/yr	12	12	12	12
	ED =	Exposure duration	yrs	6	6	7	7
	IR =	Ingestion rate	L/day	0.037	0.037	0.016	0.016
	BW =	Body weight	kg	31.8	56.8	80	80
	ATc =	Average time for carcinogens	days	25550	25550	25550	25550
	ATn =	Average time for non-carcinogens	days	2190	2190	2555	2555

				CHILD				YOUTH				ADULT				SENIOR				SUM			
COC	CW	RfDo	CSFo	CDI	HQ	CDI	ILCR	CDI	HQ	CDI	ILCR	CDI	HQ	CDI	ILCR	CDI	HQ	CDI	ILCR	CDI	HQ	CDI	ILCR
	mg/L	mg/kgday	kgday/mg	mg/kgday	CDI/RfD	mg/kgday	CDI*CSF	mg/kgday	CDI/RfD	mg/kgday	CDI*CSF	mg/kgday	CDI/RfD	mg/kgday	CDI*CSF	mg/kgday	CDI/RfD	mg/kgday	CDI*CSF	mg/kgday	CDI/RfD	mg/kgday	CDI*CSF
Ethylbenzene	5.00E-04	1.00E-01	1.10E-02	1.91E-08	1.91E-07	1.64E-09	1.80E-11	1.07E-08	1.07E-07	9.18E-10	1.01E-11	3.29E-09	3.29E-08	3.29E-10	3.62E-12	3.29E-09	3.29E-08	3.29E-10	3.62E-12	8.66E-09	8.66E-08	3.21E-09	3.54E-11
Fluoride	4.09E-01	6.00E-02	NA	1.56E-05	2.60E-04	NA	NA	8.75E-06	1.46E-04	NA	NA	2.69E-06	4.48E-05	NA	NA	2.69E-06	4.48E-05	NA	NA	7.07E-06	1.18E-04	NA	NA
Heptachlorodibenzofuran	NA	7.00E-08	1.30E+03	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Heptachlorodibenzo-p-dioxin	NA	7.00E-08	1.30E+03	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Hexachlorodibenzofuran	NA	7.00E-09	1.30E+04	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Hexachlorodibenzo-p-dioxin	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Indeno(1,2,3-cd)pyrene	5.00E-04	NA	7.30E-01	NA	NA	1.64E-09	1.20E-09	NA	NA	9.18E-10	6.70E-10	NA	NA	3.29E-10	2.40E-10	NA	NA	3.29E-10	2.40E-10	NA	NA	3.21E-09	2.35E-09
Lead	1.68E-03	NA	8.50E-03	NA	NA	5.51E-09	4.68E-11	NA	NA	3.08E-09	2.62E-11	NA	NA	1.10E-09	9.39E-12	NA	NA	1.10E-09	9.39E-12	NA	NA	1.08E-08	9.18E-11
Manganese	NA	1.40E-01	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Mercury	6.00E-05	3.00E-04	NA	2.30E-09	7.65E-06	NA	NA	1.28E-09	4.28E-06	NA	NA	3.95E-10	1.32E-06	NA	NA	3.95E-10	1.32E-06	NA	NA	1.04E-09	3.46E-06	NA	NA
Methanol	NA	2.00E+00	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Methyl Isobutyl Ketone (4-methyl-2-pentanone)	2.50E-03	8.00E-02	NA	9.56E-08	1.20E-06	NA	NA	5.35E-08	6.69E-07	NA	NA	1.64E-08	2.05E-07	NA	NA	1.64E-08	2.05E-07	NA	NA	4.33E-08	5.41E-07	NA	NA
Methylene chloride	2.50E-03	6.00E-03	2.00E-03	9.56E-08	1.59E-05	8.20E-09	1.64E-11	5.35E-08	8.92E-06	4.59E-09	9.18E-12	1.64E-08	2.74E-06	1.64E-09	3.29E-12	1.64E-08	2.74E-06	1.64E-09	3.29E-12	4.33E-08	7.21E-06	1.61E-08	3.21E-11
Molybdenum	8.03E-03	5.00E-03	NA	3.07E-07	6.14E-05	NA	NA	1.72E-07	3.44E-05	NA	NA	5.28E-08	1.06E-05	NA	NA	5.28E-08	1.06E-05	NA	NA	1.39E-07	2.78E-05	NA	NA
Nickel	NA	2.00E-02	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Nitroanaline, 4-	NA	4.00E-03	2.00E-02	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Nitroso-di-N-propylamine, N-	NA	NA	7.00E+00	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Nitrosodiphenylamine, N-	NA	NA	4.90E-03	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Octachlorodibenzofuran	NA	2.33E-06	3.90E+01	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Octochlorodibenzo-p-dioxin	NA	2.33E-06	3.90E+01	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Pentachlorodibenzofuran	NA	2.33E-09	3.90E+04	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Pentachlorodibenzo-p-dioxin	NA	7.00E-10	1.30E+05	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Pentachlorophenol	NA	5.00E-03	4.00E-01	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Phenanthrene	5.00E-04	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Selenium	2.50E-03	5.00E-03	NA	9.56E-08	1.91E-05	NA	NA	5.35E-08	1.07E-05	NA	NA	1.64E-08	3.29E-06	NA	NA	1.64E-08	3.29E-06	NA	NA	4.33E-08	8.66E-06	NA	NA
Silver	2.00E-04	5.00E-03	NA	7.65E-09	1.53E-06	NA	NA	4.28E-09	8.57E-07	NA	NA	1.32E-09	2.63E-07	NA	NA	1.32E-09	2.63E-07	NA	NA	3.46E-09	6.92E-07	NA	NA
Tetrachlorodibenzofuran	NA	7.00E-09	1.30E+04	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Tetrachlorodibenzo-p-dioxin	NA	7.00E-10	1.30E+05	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Tetrachloroethylene	5.00E-04	6.00E-03	2.10E-03	1.91E-08	3.19E-06	1.64E-09	3.44E-12	1.07E-08	1.78E-06	9.18E-10	1.93E-12	3.29E-09	5.48E-07	3.29E-10	6.90E-13	3.29E-09	5.48E-07	3.29E-10	6.90E-13	8.66E-09	1.44E-06	3.21E-09	6.75E-12
Thallium	NA	7.00E-06	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Toluene	5.00E-04	8.00E-02	NA	1.91E-08	2.39E-07	NA	NA	1.07E-08	1.34E-07	NA	NA	3.29E-09	4.11E-08	NA	NA	3.29E-09	4.11E-08	NA	NA	8.66E-09	1.08E-07	NA	NA
Tributyl phosphate	NA	1.00E-02	9.00E-03	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Trichloroethane, 1,1,2-	5.00E-04	4.00E-03	5.70E-02	1.91E-08	4.78E-06	1.64E-09	9.34E-11	1.07E-08	2.68E-06	9.18E-10	5.23E-11	3.29E-09	8.22E-07	3.29E-10	1.87E-11	3.29E-09	8.22E-07	3.29E-10	1.87E-11	8.66E-09	2.16E-06	3.21E-09	1.83E-10
Trichloroethylene	5.00E-04	5.00E-04	4.60E-02	1.91E-08	3.83E-05	1.64E-09	7.54E-11	1.07E-08	2.14E-05	9.18E-10	4.22E-11	3.29E-09	6.58E-06	3.29E-10	1.51E-11	3.29E-09	6.58E-06	3.29E-10	1.51E-11	8.66E-09	1.73E-05	3.21E-09	1.48E-10
Trifchlorofluoromethane	NA	3.00E-01	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Uranium	2.14E-02	3.00E-03	NA	8.17E-07	2.72E-04	NA	NA	4.57E-07	1.52E-04	NA	NA	1.40E-07	4.68E-05	NA	NA	1.40E-07	4.68E-05	NA	NA	3.70E-07	1.23E-04	NA	NA
Vanadium	NA	5.04E-03	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Vinyl chloride	NA	3.00E-03	7.20E-01	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Xylenes	5.00E-04	2.00E-01	NA	1.91E-08	9.56E-08	NA	NA	1.07E-08	5.35E-08	NA	NA	3.29E-09	1.64E-08	NA	NA	3.29E-09	1.64E-08	NA	NA	8.66E-09	4.33E-08	NA	NA
Zinc	NA	3.00E-01	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
																				total =	**6.07E-04**	total =	**1.01E-07**

Table 17-12. Undeveloped-Park User in Zone 5—Inhalation Pathway; Radionuclides

Intake Equation:			UNITS	Assigned Values			
	CDI =	(CA*EF*ED*IR*ET)					
	CDI =	Chronic Daily Intake	pCi	child	youth	adult	senior
	CA =	Concentration of radionuclide in air	pCi/m^3	see table of COCs below			
	EF =	Exposure frequency	days/yr	20	40	20	40
	ED =	Exposure duration	yrs	6	6	7	7
	IR =	Inhalation rate	m^3/hr	0.66	0.78	0.72	0.72
	ET =	Exposure time	hrs/day	2	2	2	2

			CHILD		YOUTH		ADULT		SENIOR		SUM	
COC	conc	CSFi	CDI	ILCR	CDI	ILCR	CDI	ILCR	CDI	ILCR	CDI	ILCR
	pCi/m^3	1/pCi	pCi	CDI*CSF	pCi	CDI*CSF	pCi	CDI*CSF	pCi	CDI*CSF	pCi	CDI*CSF
Cesium-137 + D	2.12E-06	1.12E-10	3.36E-04	3.77E-14	7.95E-04	8.91E-14	4.28E-04	4.80E-14	8.56E-04	9.59E-14	2.42E-03	2.71E-13
Lead-210	5.55E-05	1.59E-08	8.79E-03	1.40E-10	2.08E-02	3.30E-10	1.12E-02	1.78E-10	2.24E-02	3.56E-10	6.31E-02	1.00E-09
Neptunium-237 + D	1.41E-07	2.87E-08	2.23E-05	6.40E-13	5.27E-05	1.51E-12	2.84E-05	8.15E-13	5.68E-05	1.63E-12	1.60E-04	4.60E-12
Plutonium-238	6.11E-08	5.22E-08	9.68E-06	5.05E-13	2.29E-05	1.19E-12	1.23E-05	6.43E-13	2.46E-05	1.29E-12	6.95E-05	3.63E-12
Plutonium-239/240	NA	5.55E-08	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Radium-226 + D	3.33E-05	2.82E-08	5.28E-03	1.49E-10	1.25E-02	3.52E-10	6.72E-03	1.90E-10	1.34E-02	3.79E-10	3.79E-02	1.07E-09
Radium-228 + D	2.88E-05	4.37E-08	4.57E-03	2.00E-10	1.08E-02	4.72E-10	5.81E-03	2.54E-10	1.16E-02	5.08E-10	3.28E-02	1.43E-09
Radon-222+ D	3.28E+02	3.20E-11	5.20E+04	1.66E-06	1.23E+05	3.93E-06	6.62E+04	2.12E-06	1.32E+05	4.24E-06	3.74E+05	1.20E-05
Strontium-90 + D	NA	4.33E-10	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Technetium-99	4.26E-05	3.81E-11	6.75E-03	2.57E-13	1.60E-02	6.08E-13	8.59E-03	3.27E-13	1.72E-02	6.55E-13	4.85E-02	1.85E-12
Thorium-228	2.93E-05	1.32E-07	4.64E-03	6.12E-10	1.10E-02	1.45E-09	5.90E-03	7.79E-10	1.18E-02	1.56E-09	3.33E-02	4.40E-09
Thorium-230	6.39E-05	3.41E-08	1.01E-02	3.45E-10	2.39E-02	8.16E-10	1.29E-02	4.39E-10	2.58E-02	8.79E-10	7.27E-02	2.48E-09
Thorium-232	2.85E-05	4.33E-08	4.52E-03	1.96E-10	1.07E-02	4.63E-10	5.75E-03	2.49E-10	1.15E-02	4.98E-10	3.25E-02	1.41E-09
Uranium-234	1.44E-04	2.78E-08	2.28E-02	6.35E-10	5.40E-02	1.50E-09	2.91E-02	8.08E-10	5.81E-02	1.62E-09	1.64E-01	4.56E-09
Uranium-235 + D	6.57E-06	2.50E-08	1.04E-03	2.60E-11	2.46E-03	6.15E-11	1.32E-03	3.31E-11	2.65E-03	6.62E-11	7.47E-03	1.87E-10
Uranium-238 + D	1.41E-04	2.37E-08	2.23E-02	5.29E-10	5.27E-02	1.25E-09	2.84E-02	6.73E-10	5.68E-02	1.35E-09	1.60E-01	3.80E-09
											total =	**1.20E-05**

Air concentration is derived using particulate value of 26 ug/m^3 (2005 SER background average from monitor AMS-12) multiplied by the soil concentration.

Rn-222 is derived by multiplying the soil Ra-226 value by 256 g/m^3. This conversion factor is based on Rn-222 air background and Ra-226 soil background (i.e., 400 pCi/m^3 divided by 1.56 pCi/g)

Lead-210+D and Th-228+D changed to Lead-210 and Th-228 because RAIS site no longer contains information for Lead-210+D and Th-228+D

NA = not applicable

Table17-13. Undeveloped Park-User in Zone 5—Ingestion of Soil; Radionuclides

Intake Equation:			UNITS	Assigned Values			
	CDI =	(CS*EF*ED*IR*FI)					
	CDI =	Chronic Daily Intake	pCi	child	youth	adult	senior
	CS =	Concentration of radionuclide in soil	pCi/g	see table of COCs below			
	EF =	Exposure frequency	days/yr	20	40	20	40
	ED =	Exposure duration	yrs	6	6	7	7
	IR =	Ingestion rate	g/day	0.2	0.1	0.1	0.1
	FI =	Fraction of contaminated soil	unitless	1	1	1	1

			CHILD		YOUTH		ADULT		SENIOR		SUM	
COC	conc	CSFos	CDI	ILCR	CDI	ILCR	CDI	ILCR	CDI	ILCR	CDI	ILCR
	pCi/g	1/pCi	pCi	CDI*CSF	pCi	CDI*CSF	pCi	CDI*CSF	pCi	CDI*CSF	pCi	CDI*CSF
Cesium-137 + D	8.17E-02	4.26E-11	1.96E+00	8.35E-11	1.96E+00	8.35E-11	1.14E+00	4.87E-11	2.29E+00	9.74E-11	7.35E+00	3.13E-10
Lead-210	2.13E+00	1.72E-09	5.12E+01	8.81E-08	5.12E+01	8.81E-08	2.99E+01	5.14E-08	5.98E+01	1.03E-07	1.92E+02	3.30E-07
Neptunium-237 + D	5.42E-03	1.41E-10	1.30E-01	1.83E-11	1.30E-01	1.83E-11	7.58E-02	1.07E-11	1.52E-01	2.14E-11	4.88E-01	6.88E-11
Plutonium-238	2.35E-03	2.25E-10	5.64E-02	1.27E-11	5.64E-02	1.27E-11	3.29E-02	7.40E-12	6.58E-02	1.48E-11	2.12E-01	4.76E-11
Plutonium-239/240	NA	2.28E-10	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Radium-226 + D	1.28E+00	6.77E-10	3.08E+01	2.08E-08	3.08E+01	2.08E-08	1.80E+01	1.22E-08	3.59E+01	2.43E-08	1.15E+02	7.81E-08
Radium-228 + D	1.11E+00	1.98E-09	2.66E+01	5.27E-08	2.66E+01	5.27E-08	1.55E+01	3.07E-08	3.10E+01	6.15E-08	9.98E+01	1.98E-07
Radon-222+ D	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Strontium-90 + D	NA	1.35E-10	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Technetium-99	1.64E+00	7.25E-12	3.93E+01	2.85E-10	3.93E+01	2.85E-10	2.30E+01	1.66E-10	4.59E+01	3.33E-10	1.48E+02	1.07E-09
Thorium-228	1.13E+00	2.43E-10	2.70E+01	6.57E-09	2.70E+01	6.57E-09	1.58E+01	3.83E-09	3.15E+01	7.66E-09	1.01E+02	2.46E-08
Thorium-230	2.46E+00	1.66E-10	5.90E+01	9.79E-09	5.90E+01	9.79E-09	3.44E+01	5.71E-09	6.88E+01	1.14E-08	2.21E+02	3.67E-08
Thorium-232	1.10E+00	1.84E-10	2.63E+01	4.85E-09	2.63E+01	4.85E-09	1.54E+01	2.83E-09	3.07E+01	5.65E-09	9.88E+01	1.82E-08
Uranium-234	5.55E+00	1.48E-10	1.33E+02	1.97E-08	1.33E+02	1.97E-08	7.76E+01	1.15E-08	1.55E+02	2.30E-08	4.99E+02	7.39E-08
Uranium-235 + D	2.53E-01	1.54E-10	6.06E+00	9.34E-10	6.06E+00	9.34E-10	3.54E+00	5.45E-10	7.07E+00	1.09E-09	2.27E+01	3.50E-09
Uranium-238 + D	5.42E+00	1.97E-10	1.30E+02	2.56E-08	1.30E+02	2.56E-08	7.58E+01	1.49E-08	1.52E+02	2.99E-08	4.87E+02	9.60E-08
											total =	**8.60E-07**

Lead-210+D and Th-228+D changed to Lead-210 and Th-228 because RAIS site no longer contains information for Lead-210+D and Th-228+D

NA = not applicable

Table 17-14. Undeveloped-Park User in Zone 5—Ingestion of Surface Water; Radionuclides

Intake Equation:			UNITS	Assigned Values			
	CDI =	(CW*EF*ED*IR)/(BW*AT)		child	youth	adult	senior
	CDI =	Chronic Daily Intake	pCi				
	CW =	Concentration of radionuclide in water	pCi/L	see COC table below			
	EF =	Exposure frequency	days/yr	12	12	12	12
	ED =	Exposure duration	yrs	6	6	7	7
	IR =	Ingestion rate	L/day	0.037	0.037	0.016	0.016

COC	conc	CSF	CHILD		YOUTH		ADULT		SENIOR		SUM	
			CDI	ILCR	CDI	ILCR	CDI	ILCR	CDI	ILCR	CDI	ILCR
	pCi/L	1/pCi	pCi	CDI*CSF	pCi	CDI*CSF	pCi	CDI*CSF	pCi	CDI*CSF	pCi	CDI*CSF
Cesium-137 + D	1.99E+00	3.05E-11	5.30E+00	1.62E-10	5.30E+00	1.62E-10	2.67E+00	8.16E-11	2.67E+00	8.16E-11	1.60E+01	4.87E-10
Lead-210	7.80E-01	8.84E-10	2.08E+00	1.84E-09	2.08E+00	1.84E-09	1.05E+00	9.26E-10	1.05E+00	9.26E-10	6.25E+00	5.53E-09
Neptunium-237 + D	2.66E-01	6.85E-11	7.10E-01	4.86E-11	7.10E-01	4.86E-11	3.58E-01	2.45E-11	3.58E-01	2.45E-11	2.13E+00	1.46E-10
Plutonium-238	3.71E-02	1.31E-10	9.89E-02	1.29E-11	9.89E-02	1.29E-11	4.99E-02	6.53E-12	4.99E-02	6.53E-12	2.97E-01	3.90E-11
Plutonium-239/240	NA	1.35E-10	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Radium-226 + D	3.01E-01	3.85E-10	8.02E-01	3.09E-10	8.02E-01	3.09E-10	4.05E-01	1.56E-10	4.05E-01	1.56E-10	2.41E+00	9.30E-10
Radium-228 + D	3.17E+00	1.04E-09	8.43E+00	8.77E-09	8.43E+00	8.77E-09	4.26E+00	4.43E-09	4.26E+00	4.43E-09	2.54E+01	2.64E-08
Radon-222+ D	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Strontium-90 + D	NA	7.40E-11	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Technetium-99	9.35E+00	2.75E-12	2.49E+01	6.85E-11	2.49E+01	6.85E-11	1.26E+01	3.45E-11	1.26E+01	3.45E-11	7.49E+01	2.06E-10
Thorium-228	3.07E+00	1.08E-10	8.18E+00	8.84E-10	8.18E+00	8.84E-10	4.13E+00	4.46E-10	4.13E+00	4.46E-10	2.46E+01	2.66E-09
Thorium-230	6.30E-01	9.14E-11	1.68E+00	1.53E-10	1.68E+00	1.53E-10	8.47E-01	7.74E-11	8.47E-01	7.74E-11	5.05E+00	4.62E-10
Thorium-232	3.17E+00	1.01E-10	8.43E+00	8.52E-10	8.43E+00	8.52E-10	4.26E+00	4.30E-10	4.26E+00	4.30E-10	2.54E+01	2.56E-09
Uranium-234	7.29E+00	7.07E-11	1.94E+01	1.37E-09	1.94E+01	1.37E-09	9.80E+00	6.93E-10	9.80E+00	6.93E-10	5.85E+01	4.13E-09
Uranium-235 + D	3.32E-01	7.18E-11	8.85E-01	6.35E-11	8.85E-01	6.35E-11	4.46E-01	3.21E-11	4.46E-01	3.21E-11	2.66E+00	1.91E-10
Uranium-238 + D	7.12E+00	8.70E-11	1.90E+01	1.65E-09	1.90E+01	1.65E-09	9.57E+00	8.33E-10	9.57E+00	8.33E-10	5.71E+01	4.97E-09
											total =	**4.87E-08**

Lead-210+D and Th-228+D changed to Lead-210 and Th-228 because RAIS site no longer contains information for Lead-210+D and Th-228+D

NA = not applicable

Table 17-15. Undeveloped−Park User in Zone 5—External Radiation; Radionuclides

Intake Equation:			UNITS	Assigned Values			
	CDI =	$(CS*EF*ED*ET_o*(1-SH_o))$		child	youth	adult	senior
	CDI =	Chronic Daily Intake	yr pCi/g				
	CS =	Concentration of radionuclide in soil	pCi/g	see table of COCs below			
	EF =	Fraction of year exposed to radiation	--	0.055	0.11	0.055	0.11
	ED =	Exposure duration	yrs	6	6	7	7
	ET_o =	Fraction of day spent outdoors	--	0.083	0.083	0.083	0.083
	ET_i =	Fraction of day spent indoors	--	NA	NA	NA	NA
	SH_o =	Shield factor outdoors	--	0.25	0.25	0.25	0.25
	SH_i =	Shield factor indoors	--	NA	NA	NA	NA

COC	conc	CSFx	CHILD		YOUTH		ADULT		SENIOR		SUM	
			CDI	ILCR	CDI	ILCR	CDI	ILCR	CDI	ILCR	CDI	ILCR
	pCi/g	g/pCi yr	yr pCi/g	CDI*CSF	yr pCi/g	CDI*CSF	yr pCi/g	CDI*CSF	yr pCi/g	CDI*CSF	yr pCi/g	CDI*CSF
Cesium-137 + D	8.17E-02	2.53E-06	1.68E-03	4.25E-09	3.36E-03	8.49E-09	1.96E-03	4.95E-09	3.92E-03	9.91E-09	1.09E-02	2.76E-08
Lead-210	2.13E+00	1.48E-09	4.39E-02	6.49E-11	8.77E-02	1.30E-10	5.12E-02	7.57E-11	1.02E-01	1.51E-10	2.85E-01	4.22E-10
Neptunium-237 + D	5.42E-03	8.55E-07	1.11E-04	9.52E-11	2.23E-04	1.90E-10	1.30E-04	1.11E-10	2.60E-04	2.22E-10	7.24E-04	6.19E-10
Plutonium-238	2.35E-03	6.91E-11	4.83E-05	3.34E-15	9.66E-05	6.67E-15	5.63E-05	3.89E-15	1.13E-04	7.79E-15	3.14E-04	2.17E-14
Plutonium-239/240	NA	2.09E-10	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Radium-226 + D	1.28E+00	8.37E-06	2.64E-02	2.21E-07	5.27E-02	4.41E-07	3.07E-02	2.57E-07	6.15E-02	5.15E-07	1.71E-01	1.43E-06
Radium-228 + D	1.11E+00	4.04E-06	2.28E-02	9.20E-08	4.56E-02	1.84E-07	2.66E-02	1.07E-07	5.32E-02	2.15E-07	1.48E-01	5.98E-07
Radon-222+ D	3.85E-01	1.69E-09	7.91E-03	1.34E-11	1.58E-02	2.67E-11	9.22E-03	1.56E-11	1.84E-02	3.12E-11	5.14E-02	8.69E-11
Strontium-90 + D	NA	1.95E-08	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Technetium-99	1.64E+00	8.28E-11	3.37E-02	2.79E-12	6.74E-02	5.58E-12	3.93E-02	3.25E-12	7.86E-02	6.51E-12	2.19E-01	1.81E-11
Thorium-228	1.13E+00	5.64E-09	2.31E-02	1.31E-10	4.63E-02	2.61E-10	2.70E-02	1.52E-10	5.40E-02	3.05E-10	1.50E-01	8.48E-10
Thorium-230	2.46E+00	8.45E-10	5.05E-02	4.27E-11	1.01E-01	8.53E-11	5.89E-02	4.98E-11	1.18E-01	9.96E-11	3.28E-01	2.77E-10
Thorium-232	1.10E+00	3.58E-10	2.25E-02	8.07E-12	4.51E-02	1.61E-11	2.63E-02	9.42E-12	5.26E-02	1.88E-11	1.47E-01	5.25E-11
Uranium-234	5.55E+00	2.53E-10	1.14E-01	2.88E-11	2.28E-01	5.77E-11	1.33E-01	3.36E-11	2.66E-01	6.73E-11	7.41E-01	1.87E-10
Uranium-235 + D	2.53E-01	5.76E-07	5.19E-03	2.99E-09	1.04E-02	5.98E-09	6.06E-03	3.49E-09	1.21E-02	6.98E-09	3.37E-02	1.94E-08
Uranium-238 + D	5.42E+00	1.19E-07	1.11E-01	1.32E-08	2.23E-01	2.65E-08	1.30E-01	1.54E-08	2.60E-01	3.09E-08	7.23E-01	8.61E-08
											total =	**2.17E-06**

Lead-210+D and Th-228+D changed to Lead-210 and Th-228 because RAIS site no longer contains information for Lead-210+D and Th-228+D
Rn-222+D soil value assumed to be 0.3 times Ra-226+D to account for the retention of 30% of the radon in the soil.

NA = not applicable

Attachment 18

Ecological Screening Levels

A screening-level ecological risk assessment was conducted as part of the OU5 RI. Both radiological and nonradiological risks were evaluated. For radiological risks, dose estimates were calculated for several ecological receptors at the Fernald Preserve, and the ecological dose continues to be evaluated annually and reported in the Sitewide Environmental Report (SER). For nonradiological risks, media-specific contaminant concentrations were compared to literature-based benchmark toxicity values (BTVs). Since the evaluation of nonradiological risks was a screening-level assessment only, the OU5 ROD committed to revisiting the screening-level assessment following soil remedial activities.

The Sitewide Excavation Plan (SEP) (DOE 1998b) initiated the implementation of this approach by listing BTV data for nonradiological risk screening and by defining areas where ecological risk might be a concern following excavation. After implementation of the SEP and completion of soil remediation activities, area-specific ecological constituents of concern (ECOCs) were investigated in the certification reports for each remediation area. For each remediation area, defined as Zones 1 through 8 in the Interim Remedial Risk Assessment (IRRA) Report (DOE 2007), data were compiled for each media type to list the maximum and average value for each constituent of concern. The nonradiological ECOCs in soil and surface water are shown in Tables 18-1 and 18-2, with the corresponding SEP BTV and maximum and average ECOC concentrations in each of the remediation zones. Figure 18-1 (Plate 1 in the IRRA) shows the IRRA remediation zones. Current practice refers to BTVs as ecological screening levels (ESLs). For this review, screening values listed in the SEP are referred to as BTVs, and updated screening values are referred to as ESLs.

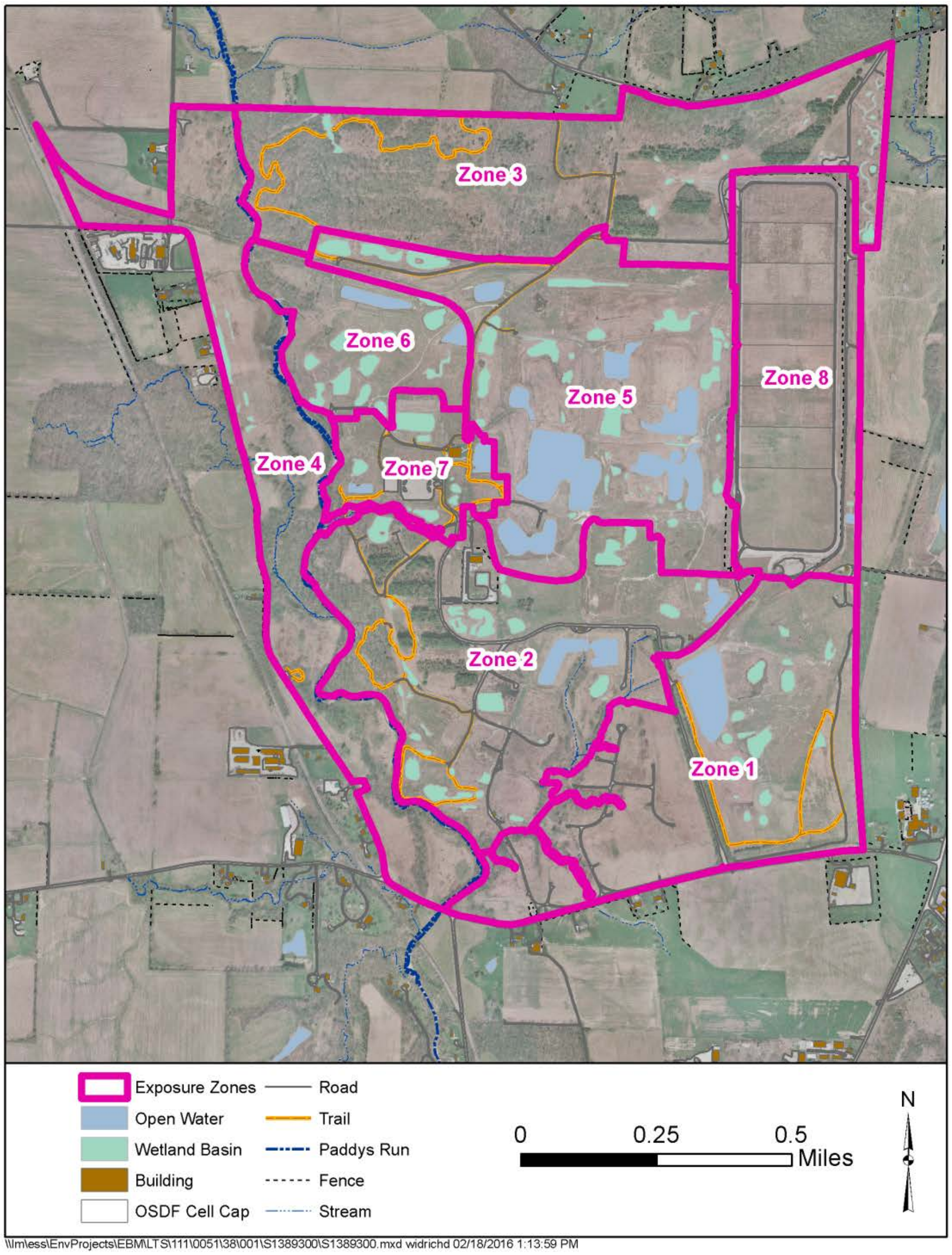

Figure 18-1. IRRA Remediation Zones

Although a single BTV was listed in the SEP, and this approach was followed for updating the BTV/ESL values in the 2011 Five-Year Review Report, it is generally now recognized that a broad comparison of site data to many literature sources for ESLs provides a better means for screening site-specific data when assessing whether an ecological risk assessment is warranted. Therefore, the Fernald Preserve data have been compared to ESLs for each exposure medium in a two-tiered fashion. Tier 1 ESLs are conservative values that serve as thresholds for adverse effects, based on survival, growth, and reproductive endpoints, under long-term or chronic exposures. If site ECOC values exceed Tier 1 values, it may indicate a need for further investigation (e.g., as described in Step 3a of the ERA guidance for Superfund sites (EPA 1997). Tier 2 ESLs are less conservative values more likely to be associated with measurable or more serious adverse effects such as reduced survival or impaired growth or reproduction. Media concentrations that exceed a Tier 2 ESL generally imply additional evaluation of ecological habitat.

Tier 1 and Tier 2 ESL sources and values are provided for soil and surface water in Tables 18-3 through 18-7 and are discussed below. Tier 2 values for soil are not provided because these are not readily available. Alternative ESLs are defined here as values that may be used when a Tier 1 ESL is unavailable or where an Alternative ESL better represents the site-specific needs at the screening level stage of the assessment. For this screening effort, the lowest Tier 1 above-background ESL is used to compare with the IRRA concentrations in Tables 18-1 and 18-2. If a Tier 1 ESL is not available, then the lowest above-background Tier 2 or Alternative ESL is used.

Soil

<u>Tier 1 ESLs</u>

Ecological Soil Screening Values (EPA 2008)

EPA derived ecological soil screening levels (Eco-SSLs) to be employed in the process of identifying contaminants of potential ecological concern (COPECs) and impacted geographical areas that need to be evaluated further in the risk assessment process. Eco-SSLs are intended to be protective of ecological receptors that are exposed to soil either by direct contact (Eco-SSLs for plants and invertebrates) or by ingesting organisms that live in or on the soil (Eco-SSLs for birds and mammals). These values may be employed to determine if there are ecological risks associated with onsite soil, which chemicals are associated with the risk and need to be included in the risk characterization, and which receptors are at greatest risk. Following a four step peer-reviewed process, EPA’s working group derived plant and invertebrate screening values after an evaluation of chronic toxicity data. The avian and mammalian values were back-calculated from a Hazard Index of 1, assuming food web transfer; therefore, these values consider bioaccumulation and are appropriate for screening potential hazards to upper trophic level receptors. Eco-SSLs are applicable for sites where soil parameters, such as pH and organic matter content, fall within specific (generally observed) ranges and where ecological receptors are exposed to contaminated site surface soil either directly or indirectly via ingestion. EPA Eco-SSLs were selected to be the primary source of ESLs for soil.

The Tier 1 ESLs for soil should be the lowest EPA Eco-SSL of those available for plants, invertebrates, birds, or mammals. Table 18-3 lists the Tier 1 soil ESLs for ECOCs.

<u>Alternative ESLs</u>

Toxicological Benchmarks for Screening Chemicals of Potential Concern for Effects on Terrestrial Plants: 1997 Revision (Efroymson et al. 1997a), Phytotoxicity Benchmarks.

This Oak Ridge National Laboratory (ORNL) document presents plant toxicity (phytotoxicity) data from multiple studies and derives from these studies a single benchmark concentration to be used as an ESL. This document also describes the confidence in the derived benchmark values, which helps interpret screening results based on these benchmarks. Finally, this document describes the method for deriving benchmarks. ORNL phytotoxicity benchmarks were selected as a secondary source of Tier 1 soil ESLs.

Toxicological Benchmarks for Screening Chemicals of Potential Concern for Effects on Soil and Litter Invertebrates and Heterotrophic Process: 1997 Revision (Efroymson et al. 1997b), Earthworm Benchmarks.

This ORNL document presents a review of the literature and provides a standard method for deriving benchmarks for assessing chemicals in soil with respect to their toxicity to earthworms, heterotrophic bacteria and fungi and their processes, and other invertebrates (soil and litter-dwelling invertebrates). The values are intended for use in chemical screening during the hazard identification (problem formulation) phase of ERAs (Step 1). ORNL earthworm benchmarks were selected to be a secondary source of Tier 1 ESLs for soil.

The ORNL (1997b) microbial benchmarks were selected as alternative soil ESLs for COPECs (Table 18-4).

Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health, Summary Table, Update 7.0 (CCME 2007b).

The CCME environmental soil quality guidelines are derived using toxicological data to determine the threshold level of effects for soil-associated ecological receptors. Direct soil contact is the primary exposure route considered in the derivation of these guidelines for residential/parkland, commercial, and industrial land uses. Another derivation procedure, based on soil and food ingestion, is also applied in the case of agricultural land use, with the lower of the two values considered as the environmental soil quality guideline for this land use (CCME 2007b). The CCME agriculture land use values for soil were selected as alternative soil ESLs for COPECs (Table 18-4). Of all the CCME soil values, the agriculture values are, almost without exception, the most conservative values.

Region 5 RCRA Screening Levels (EPA 2003).

EPA Region 5 has developed ESLs for various media, including soil. ESLs are initial screening levels to which site chemical concentrations can be compared; they are not meant to be used as cleanup values. Region 5 does not provide details regarding the derivation of these values, but available information indicates that ESLs are based on other studies, other recommended values, or on protection of a single, sensitive species. For example, many of the listed soil ESLs are based on protection of vermivorous small mammals (shrew), and thus consider bioaccumulation potential. In a few cases, the ESLs are based on the lowest laboratory detection limit that can commonly be attained. Region 5 ESLs were selected as alternative soil ESLs (Table 18-4).

Surface Water

<u>Tier 1 ESLs</u>

EPA National Recommended Water Quality Criteria—Chronic (CCC) (EPA 2009).

National Recommended Water Quality Criteria (NRWQC), most recently updated in 2009, were developed for both acute and chronic effects in aquatic biota (primarily fish and aquatic invertebrates, and in some cases aquatic plants [EPA 2009]). These criteria are often used to select ECOCs in surface water or for evaluating risks to aquatic organisms. For most chemicals, NRWQC include both a criterion maximum concentration (CMC; an acute criterion) and a criterion continuous concentration (CCC; a chronic criterion). The CMC is based on survival endpoints under short-term exposures, while the CCC is based on reduced survival or impaired growth or reproduction under long-term exposures. Both the CMC and CCC are intended to protect a diverse aquatic community consisting of freshwater fish, benthic and water column invertebrates, and in some cases aquatic plants and larval amphibians. Toxicity data used in the development of NRWQC are derived from laboratory experiments conducted over short (CMC) and long (CCC) duration exposures. NRWQC are intended to protect 95 percent of aquatic species most of the time. Therefore, maintaining exposure concentrations of chemicals in surface water below NRWQC CCC values should protect most species most of the time from sublethal effects. Freshwater CCC values were selected as the source of the Tier 1 ESLs for surface water (Table 18-5). If no NRWQC chronic values are available, the ORNL Tier II secondary chronic values (SCVs) should be considered.

Toxicological Benchmarks for Screening of Potential Contaminants of Concern for Effects on Aquatic Biota: 1996 Revision (Suter and Tsao 1996) (ORNL Tier II Secondary Chronic Values).

The Tier II method employed by ORNL is described in EPA's Water Quality Guidance for the Great Lakes System (EPA 1993). ORNL Tier II values were developed so that aquatic benchmarks could be established for those chemicals that did not meet the minimum data requirements for establishing NRWQC. The Tier II values are concentrations that would be expected to be higher than NRWQC in no more than 20 percent of cases. The Tier II values equivalent to the final acute value and final chronic value as defined by EPA are the secondary acute values (SAVs) and SCVs, respectively. SCVs are considered as Tier 1 ESLs and are included in Table 18-5. If no SCVs are available, then National Oceanic and Atmospheric Administration (NOAA) Screening Quick Reference Tables (SQuiRTs) chronic values should be considered.

NOAA SQuiRTs Chronic Values (Buchman 2008).

NOAA developed the NOAA SQuiRTs, which present toxicity values, including screening concentrations for inorganic and organic contaminants in various environmental media. The latest update of SQuiRTs was in 2008 (Buchman 2008). Preference for surface water screening values in the SQuiRTs tables is given to the EPA water quality criteria. This is generally followed by Tier II SCVs or available standards and guidelines from other regulatory agencies. Tier II SCVs are derived using a similar approach to that used to derive acute NRWQC, but allow for derivation using a more limited database. Lowest observable effect levels (LOELs), originally published by EPA in NRWQC documents, are included in the NOAA SQuiRTs tables when other benchmarks are unavailable. Acceptance of LOELs as appropriate screening values is based in part on their use as state standards in some cases (Buchman 2008). The NOAA chronic freshwater surface water values for COPECs are provided as Tier 1 ESLs in Table 18-5. If no NOAA SQuiRTs Chronic Values are available, then the Ohio EPA Water Quality Criteria should be considered.

Ohio EPA Water Quality Criteria (OMZM) (Ohio EPA 2009)

The Ohio Water Quality Criteria (*Ohio Administrative Code* [OAC] 3745-1) are state standards and are to be considered for ERA. These include a combination of both chemical and biological standards. Specific criteria considered are for the Ohio River Basin Aquatic Life contained in and developed pursuant to Chapter 3745-1 of the OAC (Ohio EPA 2009). The outside mixing zone maximum (OMZM) values are provided as Tier 1 ESLs in Table 18-5.

Tier 2 ESLs

EPA NRWQC (EPA 2009) Acute (CMC)

Freshwater CMC values (i.e., acute criteria) were selected as the preferred source of the Tier 2 ESLs for surface water (Table 18-6).

ORNL Tier II SAVs (Suter and Tsao 1996)

ORNL SAVs are considered as Tier 2 ESLs in cases where EPA NRWQC CMC have not been derived (Table 18-6). If no SCVs are available, then NOAA SQuiRTs Acute Values should be considered.

NOAA SQuiRTs Acute Values (Buchman 2008)

The NOAA SQuiRTs acute freshwater surface water values are provided as Tier 2 ESLs in Table 18-6. If no NOAA SQuiRTs Acute Values are available, then the Ohio EPA Water Quality Criteria should be considered.

Ohio EPA Water Quality Criteria (inside mixing zone maximum) (Ohio EPA 2009).

The Ohio EPA Water Quality Criteria inside mixing zone maximum values are provided as Tier 2 ESLs in Table 18-6.

Alternate Tier 1 ESLs

CCME Water: Aquatic Life, Freshwater (CCME 2007a)

CCME developed guidelines for the protection of aquatic life. Canadian water quality guidelines are intended to provide protection of freshwater and marine life from anthropogenic stressors, such as chemical inputs or changes to physical components (e.g., pH, temperature, and debris). Guidelines are numerical limits or narrative statements based on the most current, scientifically defensible toxicological data available for the parameter of interest. Guideline values are meant to protect all forms of aquatic life and all aspects of the aquatic life cycles, including the most sensitive life stage of the most sensitive species over the long term. Ambient water quality guidelines developed for the protection of aquatic life provide the science-based benchmark for a nationally consistent level of protection for aquatic life in Canada. Canadian water quality guidelines for aquatic life are not restricted to a particular species, but species-specific information is provided in the respective fact sheets, and more detailed information is available in the supporting documents, so that the water quality manager and other users may determine the appropriateness of the guideline for the protection and enhancement of local species. A consistent approach according to the nationally approved, scientifically defensible protocol for developing water quality guidelines (freshwater and marine) for the protection of aquatic life was maintained. The most current guidelines list values that either have been retained from the original Canadian Water Quality Guidelines (CCREM 1987) or have been revised or updated in 1991, 1999, 2001, 2002, 2003, 2005, 2006, and 2007 (CCME 2007a). The CCME freshwater values have been selected as alternative surface water ESLs and are provided in Table 18-7.

EPA Region 5 (EPA 2003)

If screening levels could not be obtained from the source described above, the freshwater ecological screening values established by EPA Region 5 were selected as a secondary source for surface water screening levels. A requirement of EPA's RCRA Corrective Action and Permit programs within Region 5 is that adverse risk to the environment be evaluated and controlled.

This risk is determined through an ERA, and the Region 5 RCRA ESLs are one of the initial tools employed. The ESLs represent protective levels for chemicals in freshwater, as well as other environmental media. ESLs were revised in 2003 using more recent information and were based on a variety of sources. The EPA Region 5 surface water values for COPECs are provided as alternative ESLs in Table 18-7.

ORNL Lowest Chronic Values for Fish, Daphnid and Non-Daphnid Invertebrates, and Aquatic Plants (Suter and Tsao 1996).

The LCVs for fish, daphnids, non-daphnid aquatic invertebrates, and aquatic plants reported in the literature are presented in this ORNL document and serve as potential screening-level benchmarks for these receptor groups. LCVs as reported by ORNL (Suter and Tsao 1996) may be lower than the chronic NRWQC. The ORNL LCVs for fish, daphnids, non-daphnid invertebrates, and aquatic plants have been selected as sources of alternative ESLs for surface water (Table 18-7).

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Table 18-1. Soil ECOCs

Soil Ecological Screening Values

SOIL

IRRA zone-specific maximum and average concentrations (DOE 2007)

Ecological Constituent of Concern (ECOC)	units	Benchmark Toxicity Value (BTV)[a]	Updated Ecological Screening Level (ESL)[a]	Background[a]	Zone 1		Zone 2		Zone 3		Zone 4		Zone 5		Zone 6		Zone 7		Zone 8	
					Maximum[a]	Average[a,b]	Maximum[a]	Average[a,b]	Maximum[a]	Average[a,b]	Maximum[a]	Average[a,b]	Maximum[a]	Average[a,b]	Maximum[a]	Average[a,b]	Maximum[a]	Average[a,b]	Maximum[a]	Average[a,b]
Acetone	ug/g	8.00E+03	**2.50E+00**	NV	NV	NV	2.48E-02	5.21E-04	NV	NV	NV	NV	2.29E-01	5.04E-03	NV	NV	NV	NV	6.94E-02	1.20E-03
Antimony	ug/g	1.00E+01	7.80E+01	2.87E+00	4.47E+00	2.90E+00	6.40E+00	2.94E+00	NV	NV	NV	NV	6.10E+00	2.22E+00	5.10E+00	1.39E+00	7.50E+00	1.98E+00	5.01E+00	2.81E+00
Aroclor-1254	ug/g	1.00E+00	**3.32E-04**	NV	NV	NV	3.96E-01	1.23E-02	4.90E-02	1.46E-03	NV	NV	8.60E+00	6.75E-02	3.30E-01	2.03E-02	1.18E-01	1.54E-02	6.54E-02	2.64E-03
Aroclor-1260	ug/g	1.00E+00	NV	NV	NV	NV	8.78E-02	6.12E-03	3.20E+01	6.29E-01	NV	NV	8.60E-02	6.07E-03	6.19E-02	7.28E-03	1.27E-01	6.34E-03	6.54E-02	4.02E-03
Arsenic	ug/g	3.00E+01	**1.80E+01**	1.24E+01	1.24E+01	9.59E+00	1.24E+01	9.49E+00	1.24E+01	1.10E+01	NV	NV	1.24E+01	1.11E+01	1.35E+01	1.02E+01	1.24E+01	1.03E+01	1.24E+01	9.06E+00
Barium	ug/g	5.00E+02	**3.30E+02**	1.87E+02	NV	NV	1.87E+02	1.85E+02	NV	NV	NV	NV	4.04E+02	1.80E+02	1.87E+02	1.84E+02	NV	NV	1.87E+02	1.86E+02
Benzene	ug/g	1.00E-01	**6.80E-03**	NV	NV	NV	1.40E-03	3.90E-05	NV	NV	NV	NV	2.60E-03	1.38E-04	NV	NV	NV	NV	1.30E-03	4.31E-05
Benzo(a)anthracene	ug/g	1.00E+00	1.10E+00	NV	NV	NV	4.08E-01	4.79E-03	4.40E+00	8.63E-02	NV	NV	3.73E+00	8.60E-02	1.43E-01	6.67E-03	2.49E+00	1.16E-01	4.22E-02	7.28E-04
Benzo(a)pyrene	ug/g	1.00E+00	1.10E+00	NV	NV	NV	4.50E-01	3.38E-02	4.10E-01	8.04E-03	NV	NV	1.40E+00	8.70E-02	2.83E-01	5.53E-02	3.02E-01	5.28E-02	9.39E-02	1.62E-03
Benzo(b)fluoranthene	ug/g	1.00E+00	1.10E+00	NV	NV	NV	4.00E-01	7.73E-03	6.20E+00	1.22E-01	NV	NV	4.27E+00	1.37E-01	4.45E-01	5.21E-02	3.91E+00	1.85E-01	1.44E-01	2.48E-03
Benzo(k)fluoranthene	ug/g	1.00E+00	1.10E+00	NV	NV	NV	5.15E-02	1.44E-03	4.00E+00	7.84E-02	NV	NV	1.33E+00	3.05E-02	7.44E-02	4.15E-03	7.30E-01	5.57E-02	4.22E-02	7.28E-04
Beryllium	ug/g	5.60E+01	**2.10E+01**	1.44E+00	1.46E+00	1.44E+00	1.48E+00	9.31E-01	1.44E+00	1.10E+00	NV	NV	1.49E+00	1.17E+00	1.44E+00	1.14E+00	1.44E+00	1.03E+00	1.44E+00	1.22E+00
Bromodichloromethane	ug/g	1.00E+01	**5.40E-01**	NV	NV	NV	5.18E-01	2.43E-02	NV	NV	NV	NV	1.60E-03	1.15E-04	6.00E-03	1.01E-03	NV	NV	1.30E-03	2.24E-05
Butanone-2	ug/g	NV	NV	NV	NV	NV	NV	NV	NV	NV	NV	NV	NV	NV	NV	NV	NV	NV	1.83E-02	3.16E-04
Cadmium	ug/g	5.00E+00	3.20E+01	9.89E-01	NV	NV	1.34E+00	9.69E-01	NV	NV	NV	NV	1.90E+00	7.07E-01	1.10E+00	4.89E-01	9.89E-01	6.74E-01	1.70E+00	1.00E+00
Carbon tetrachloride	ug/g	3.00E-01	2.98E+00	NV	NV	NV	1.40E-03	3.90E-05	NV	NV	NV	NV	2.60E-03	1.36E-04	NV	NV	NV	NV	2.10E-03	7.24E-05
Chromium (VI)	ug/g	NV	**1.30E+02**	2.47E+01	NV	NV	2.78E+01	2.46E+01	NV	NV	NV	NV	3.93E+01	2.45E+01	NV	NV	NV	NV	3.55E+01	2.49E+01
Chrysene	ug/g	1.00E+00	1.10E+00	NV	NV	NV	1.42E-01	2.05E-03	4.70E+00	9.22E-02	NV	NV	3.48E+00	8.53E-02	1.80E-01	1.00E-02	1.73E+01	6.27E-01	4.22E-02	7.28E-04
Dibenzo(a,h)anthracene	ug/g	8.80E-02	1.10E+00	NV	NV	NV	4.60E-01	8.27E-03	1.20E+00	2.35E-02	NV	NV	3.82E-01	1.52E-02	1.06E-01	2.02E-02	1.51E-01	2.88E-02	4.22E-02	7.28E-04
Dichloroethane-1,2	ug/g	8.70E+02	**1.00E-01**	NV	NV	NV	1.40E-03	3.90E-05	NV	NV	NV	NV	2.60E-03	2.76E-04	6.00E-03	9.80E-04	NV	NV	1.30E-03	2.24E-05
Dichloroethylene-1,1	ug/g	NV	**8.28E+00**	NV	NV	NV	5.31E-02	2.53E-03	NV	NV	NV	NV	7.20E-03	5.58E-04	7.40E-03	1.21E-03	NV	NV	1.90E-03	3.28E-05
Dieldrin	ug/g	4.00E-02	**4.90E-03**	NV	NV	NV	9.70E-03	3.20E-04	NV	NV	NV	NV	2.96E-02	5.46E-04	9.20E-03	1.83E-03	NV	NV	4.60E-03	1.09E-04
Ethylbenzene	ug/g	1.00E-01	**1.80E-02**	NV	NV	NV	1.40E-03	3.90E-05	NV	NV	NV	NV	2.60E-03	1.38E-04	NV	NV	NV	NV	2.70E-03	6.90E-05
Fluoride	ug/g	1.00E+00	NV	3.20E+00	NV	NV	NV	NV	NV	NV	NV	NV	7.75E+00	3.29E+00	3.30E+01	7.05E+00	NV	NV	NV	NV
Heptachlorodibenzo-p-dioxin	ug/g	NV	NV	NV	NV	NV	NV	NV	NV	NV	NV	NV	NV	NV	1.84E-04	1.68E-05	NV	NV	NV	NV
Indeno(1,2,3-cd)pyrene	ug/g	1.00E+00	1.10E+00	NV	NV	NV	4.50E-01	3.49E-02	4.20E+00	8.24E-02	NV	NV	1.27E+00	5.65E-02	1.96E-01	4.21E-02	3.87E+00	2.14E-01	6.40E-02	1.10E-03
Lead	ug/g	2.00E+02	**5.60E+01**	3.06E+01	3.17E+02	4.85E+01	4.97E+01	2.98E+01	5.63E+01	3.21E+01	NV	NV	1.10E+02	2.96E+01	NV	NV	NV	NV	1.88E+02	3.24E+01
Manganese	ug/g	1.50E+03	4.00E+03	1.33E+03	NV	NV	NV	NV	1.59E+03	1.31E+03	NV	NV	NV	NV	NV	NV	NV	NV	1.73E+03	1.33E+03
Mercury	ug/g	5.00E+00	**1.00E-01**	7.00E-02	NV	NV	7.00E-02	6.87E-02	NV	NV	NV	NV	4.09E-01	7.07E-02	NV	NV	NV	NV	7.00E-02	6.89E-02
Methyl-2-pentanone	ug/g	8.50E+01	4.43E+02	NV	NV	NV	6.90E-03	1.97E-04	NV	NV	NV	NV	1.28E-02	7.08E-04	NV	NV	NV	NV	6.20E-03	1.07E-04
Methylene chloride	ug/g	NV	**4.05E+00**	NV	NV	NV	6.90E-03	1.97E-04	NV	NV	NV	NV	1.28E-02	1.35E-03	NV	NV	NV	NV	6.20E-03	1.07E-04
Molybdenum	ug/g	1.00E+01	2.00E+02	5.24E+00	NV	NV	5.24E+00	4.89E+00	5.24E+00	4.00E+00	NV	NV	6.14E+00	3.96E+00	7.40E+00	4.89E+00	6.26E+00	3.97E+00	5.24E+00	4.33E+00
Octochlorodibenzo-p-dioxin	ug/g	NV	NV	NV	NV	NV	NV	NV	NV	NV	NV	NV	NV	NV	2.23E-03	2.59E-04	NV	NV	NV	NV
Phenanthrene	ug/g	5.00E+00	2.90E+01	NV	NV	NV	5.73E-02	1.57E-03	NV	NV	NV	NV	4.49E+00	1.24E-01	2.08E-01	7.37E-03	3.79E-01	6.02E-02	1.25E-01	2.16E-03
Selenium	ug/g	3.00E+00	**1.20E+00**	1.19E+00	NV	NV	3.81E+00	1.25E+00	NV	NV	NV	NV	3.52E+00	1.27E+00	NA	NA	NV	NV	3.09E+00	1.22E+00
Silver	ug/g	1.00E+01	**4.20E+00**	1.13E+00	NV	NV	5.58E+00	1.11E+00	NV	NV	NV	NV	2.40E+00	7.28E-01	1.62E+00	4.72E-01	8.21E+00	8.84E-01	1.13E+00	1.11E+00
Tetrachloroethylene	ug/g	2.50E+01	**1.00E-01**	NV	NV	NV	1.40E-03	3.90E-05	NV	NV	NV	NV	3.61E-02	9.30E-04	7.00E-03	1.13E-03	NV	NV	6.87E-02	1.76E-03
Toluene	ug/g	1.00E-01	**8.00E-02**	NV	NV	NV	6.30E-03	1.04E-04	NV	NV	NV	NV	4.62E-02	6.05E-04	NA	NA	NV	NV	2.40E-03	7.41E-05
Trichloroethane-1,1,2	ug/g	3.00E-01	**1.00E-01**	NV	NV	NV	1.40E-03	3.90E-05	NV	NV	NV	NV	2.60E-03	3.22E-04	1.20E-02	3.26E-04	NV	NV	2.10E-03	9.48E-05
Trichloroethylene	ug/g	5.80E+01	**1.00E-02**	NV	NV	NV	1.40E-03	3.90E-05	NV	NV	NV	NV	1.30E-02	3.71E-04	2.55E-02	1.83E-03	NV	NV	2.10E-03	9.48E-05
Uranium	ug/g	2.30E+02	**5.00E+00**	4.56E+00	3.04E+01	1.37E+01	8.17E+01	1.98E+01	5.30E+01	1.87E+01	7.01E+01	1.54E+01	7.28E+01	1.62E+01	8.06E+01	3.83E+01	4.95E+01	1.52E+01	7.26E+01	2.50E+01
Xylenes	ug/g	1.60E+05	**2.40E+00**	NV	NV	NV	1.90E-03	4.74E-05	NV	NV	NV	NV	3.00E-02	1.32E-03	NV	NV	NV	NV	1.46E-02	2.74E-04

Updated ESLs in **bold** are lower concentrations than the SEP BTV. Highlighted zone concentrations exceed ESLs.

[a] NV = No value is available. There is no BTV, ESL, and/or the ECOC is not applicable to the assesment of risk in a zone because it was not evaluated in the certification reports for the zone.

[b] If at least one CU in a zone has an analytical result for a given COC, the background value for the COC is used in the calculations for the CUs that have no reported analytical result to avoid a high bias for the COC in this zone.

Table 18-2. Surface Water ECOCs

Surface Water Ecological Screening Values

IRRA zone-specific maximum and average concentrations (DOE 2007)

Ecological Constituent of Concern (ECOC)	units	Benchmark Toxicity Value (BTV)[a]	Updated Ecological Screening Level (ESL)[a]	Background[a]	Zone 1 Maximum[a]	Zone 1 Average[a,b]	Zone 2 Maximum	Zone 2 Average[a,b]	Zone 3 Maximum	Zone 3 Average[a,b]	Zone 4 Maximum	Zone 4 Average[a,b]	Zone 5 Maximum	Zone 5 Average[a,b]	Zone 6 Maximum	Zone 6 Average[a,b]	Zone 7 Maximum	Zone 7 Average[a,b]	Zone 8 Maximum	Zone 8 Average[a,b]
Acetone	mg/L	NV	NV	NV	NV	NV	0.00E+00	0.00E+00	NV	NV	NV	NV	5.00E-03	2.50E-03	NV	NV	NV	NV	0.00E+00	NV
Aroclor-1254	mg/L	NV	**3.30E-05**	NV	NV	NV	0.00E+00	0.00E+00	0.00E+00	0.00E+00	NV	NV	1.00E-04	5.00E-05	1.00E-04	5.00E-05	0.00E+00	0.00E+00	0.00E+00	NV
Aroclor-1260	mg/L	NV	**9.40E-02**	NV	NV	NV	0.00E+00	0.00E+00	0.00E+00	0.00E+00	NV	NV	1.00E-04	5.00E-05	1.00E-04	5.00E-05	0.00E+00	0.00E+00	0.00E+00	NV
Arsenic	mg/L	1.90E-01	**3.10E-03**	1.50E-03	1.50E-03	NV	1.88E-02	4.93E-03	1.50E-03	1.50E-03	NV	NV	7.70E-03	3.29E-03	1.27E-02	5.76E-03	4.50E-03	3.00E-03	1.50E-03	NV
Barium	mg/L	1.45E-01	2.20E-01	1.31E-02	NV	NV	3.67E-01	9.92E-02	NV	NV	NV	NV	1.74E-01	5.26E-02	1.31E-01	6.90E-02	NV	NV	5.21E-02	NV
Benzene	mg/L	NV	**1.30E-01**	NV	NV	NV	0.00E+00	0.00E+00	NV	NV	NV	NV	1.00E-03	5.00E-04	NV	NV	NV	NV	0.00E+00	NV
Benzo(a)anthracene	mg/L	NV	NV	NV	NV	NV	0.00E+00	0.00E+00	0.00E+00	0.00E+00	NV	NV	1.00E-03	5.00E-04	1.00E-03	5.00E-04	0.00E+00	0.00E+00	NV	NV
Benzo(a)pyrene	mg/L	NV	**1.40E-05**	NV	NV	NV	0.00E+00	0.00E+00	0.00E+00	0.00E+00	NV	NV	1.00E-03	5.00E-04	1.00E-03	5.00E-04	0.00E+00	0.00E+00	NV	NV
Benzo(b)fluoranthene	mg/L	NV	**9.07E-03**	NV	NV	NV	0.00E+00	0.00E+00	0.00E+00	0.00E+00	NV	NV	1.00E-03	5.00E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	NV	NV
Benzo(k)fluoranthene	mg/L	NV	NV	NV	NV	NV	0.00E+00	0.00E+00	0.00E+00	0.00E+00	NV	NV	1.00E-03	5.00E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	NV	NV
Beryllium	mg/L	1.50E-01	**6.60E-04**	1.00E-04	1.90E-04	NV	3.60E-03	6.56E-04	1.00E-04	1.00E-04	NV	NV	1.00E-03	1.58E-04	7.30E-04	1.94E-04	2.10E-04	1.60E-04	1.30E-04	NV
Bromodichloromethane	mg/L	NV	**1.10E+01**	NV	NV	NV	0.00E+00	0.00E+00	NV	NV	NV	NV	1.00E-03	5.00E-04	1.00E-03	5.00E-04	NV	NV	0.00E+00	NV
Butanone, '2-	mg/L	NV	NV	NV	NV	NV	NV	NV	NV	NV	NV	NV	NV	NV	NV	NV	NV	NV	0.00E+00	NV
Cadmium	mg/L	3.50E-03	**2.50E-03**	1.00E-04	NV	NV	1.00E-04	1.00E-04	NV	NV	NV	NV	1.00E-04	1.00E-04	1.30E-04	1.08E-04	1.00E-04	1.00E-04	1.00E-04	NV
Carbon tetrachloride	mg/L	NV	**9.80E-03**	NV	NV	NV	0.00E+00	0.00E+00	NV	NV	NV	NV	1.00E-03	5.00E-04	NV	NV	NV	NV	0.00E+00	NV
Chromium (VI)	mg/L	NV	**1.10E-02**	1.00E-03	NV	NV	7.93E-02	1.49E-02	NV	NV	NV	NV	2.37E-02	3.33E-03	NV	NV	NV	NV	3.10E-03	NV
Chrysene	mg/L	NV	NV	NV	NV	NV	0.00E+00	0.00E+00	0.00E+00	0.00E+00	NV	NV	1.00E-03	5.00E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	NV
Dibenzo(a,h)anthracene	mg/L	NV	NV	NV	NV	NV	0.00E+00	0.00E+00	0.00E+00	0.00E+00	NV	NV	1.00E-03	5.00E-04	1.00E-03	5.00E-04	0.00E+00	0.00E+00	0.00E+00	NV
dichloroethane, 1,2-	mg/L	NV	**9.10E-01**	NV	NV	NV	0.00E+00	0.00E+00	NV	NV	NV	NV	1.00E-03	5.00E-04	1.00E-03	5.00E-04	NV	NV	0.00E+00	NV
Dichloroethylene, '1,1-	mg/L	NV	**2.50E-02**	NV	NV	NV	0.00E+00	0.00E+00	NV	NV	NV	NV	1.00E-03	5.00E-04	1.00E-03	5.00E-04	NV	NV	0.00E+00	NV
Dieldrin	mg/L	NV	**5.60E-05**	NV	NV	NV	0.00E+00	0.00E+00	NV	NV	NV	NV	4.00E-05	2.00E-05	4.00E-05	2.00E-05	NV	NV	0.00E+00	NV
Ethylbenzene	mg/L	NV	**7.30E-03**	NV	NV	NV	0.00E+00	0.00E+00	NV	NV	NV	NV	1.00E-03	5.00E-04	NV	NV	NV	NV	0.00E+00	NV
Fluoride	mg/L	9.80E-01	NV	1.46E-01	NV	NV	NV	NV	NV	NV	NV	NV	7.38E-01	4.09E-01	5.65E-01	4.73E-01	NV	NV	NV	NV
Heptachlorodibenzo-p-dioxin	mg/L	NV	NV	NV	NV	NV	NV	NV	NV	NV	NV	NV	NV	NV	0.00E+00	0.00E+00	NV	NV	NV	NV
Indeno(1,2,3-cd)pyrene	mg/L	NV	**4.31E-03**	NV	NV	NV	0.00E+00	0.00E+00	0.00E+00	0.00E+00	NV	NV	1.00E-03	5.00E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	NV
Lead	mg/L	3.00E-02	**2.50E-03**	5.00E-04	2.00E-03	NV	6.99E-02	1.16E-02	6.10E-04	5.55E-04	NV	NV	1.37E-02	1.68E-03	NV	NV	NV	NV	1.60E-03	NV
Manganese	mg/L	9.80E-02	**8.00E-02**	6.50E-03	NV	NV	NV	NV	2.01E-01	1.90E-01	NV	NV	NV	NV	NV	NV	NV	NV	6.83E-02	NV
Mercury	mg/L	2.00E-04	7.70E-04	6.00E-05	NV	NV	6.00E-05	6.00E-05	NV	NV	NV	NV	6.00E-05	6.00E-05	NV	NV	NV	NV	6.00E-05	NV
Methyl-2-pentanone	mg/L	NV	**1.70E-01**	NV	NV	NV	0.00E+00	0.00E+00	NV	NV	NV	NV	5.00E-03	2.50E-03	NV	NV	NV	NV	0.00E+00	NV
Methylene chloride	mg/L	NV	**2.20E+00**	NV	NV	NV	0.00E+00	0.00E+00	NV	NV	NV	NV	5.00E-03	2.50E-03	NV	NV	NV	NV	0.00E+00	NV
Molybdenum	mg/L	NV	**3.70E-01**	9.70E-04	NV	NV	8.60E-03	4.87E-03	1.60E-03	1.29E-03	NV	NV	1.59E-02	8.03E-03	1.45E-02	6.99E-03	1.06E-02	7.65E-03	1.50E-03	NV
Octochlorodibenzo-p-dioxin	mg/L	NV	NV	NV	NV	NV	NV	NV	NV	NV	NV	NV	NV	NV	0.00E+00	0.00E+00	NV	NV	NV	NV
Phenanthrene	mg/L	NV	**3.00E-02**	NV	NV	NV	0.00E+00	0.00E+00	NV	NV	NV	NV	1.00E-03	5.00E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	NV
Selenium	mg/L	NV	**5.00E-03**	2.50E-03	NV	NV	2.50E-03	2.50E-03	NV	NV	NV	NV	2.50E-03	2.50E-03	NV	NV	NV	NV	2.50E-03	NV
Silver	mg/L	1.30E-03	**3.60E-04**	2.00E-04	NV	NV	2.00E-04	2.00E-04	NV	NV	NV	NV	2.00E-04	2.00E-04	2.00E-04	2.00E-04	2.00E-04	2.00E-04	2.00E-04	NV
Tetrachloroethylene	mg/L	NV	**9.80E-02**	NV	NV	NV	0.00E+00	0.00E+00	NV	NV	NV	NV	1.00E-03	5.00E-04	1.00E-03	5.00E-04	NV	NV	0.00E+00	NV
Toluene	mg/L	NV	**9.80E-03**	NV	NV	NV	0.00E+00	0.00E+00	NV	NV	NV	NV	1.00E-03	5.00E-04	NV	NV	NV	NV	0.00E+00	NV
Trichloroethane, '1,1,2-	mg/L	NV	**1.20E+00**	NV	NV	NV	0.00E+00	0.00E+00	NV	NV	NV	NV	1.00E-03	5.00E-04	0.00E+00	0.00E+00	NV	NV	0.00E+00	NV
Trichloroethylene	mg/L	7.50E-02	**2.10E-02**	NV	NV	NV	0.00E+00	0.00E+00	NV	NV	NV	NV	1.00E-03	5.00E-04	1.00E-03	5.00E-04	NV	NV	0.00E+00	NV
Uranium	mg/L	8.90E-01	**2.60E-03**	1.70E-03	9.09E-03	NV	1.93E-02	1.26E-02	1.39E-02	1.01E-02	7.80E-03	4.75E-03	4.46E-02	2.14E-02	3.86E-02	2.42E-02	2.99E-02	1.94E-02	1.18E-02	NV
Vanadium	mg/L	NV	**2.00E-02**	2.00E-03	NV	NV	NV	NV	NV	NV	NV	NV	NV	NV	NV	NV	NV	NV	NV	NV
Xylenes	mg/L	NV	NV	NV	NV	NV	0.00E+00	0.00E+00	NV	NV	NV	NV	1.00E-03	5.00E-04	NV	NV	NV	NV	0.00E+00	NV
Zinc	mg/L	2.80E-01	**1.20E-01**	3.70E-03	NV	NV	NV	NV	NV	NV	NV	NV	NV	NV	NV	NV	NV	NV	NV	NV

Updated Screening Values in **bold** are lower concentrations than SEP BTV. Highlighted zone concentrations exceed ESLs.

[a]NV = No value is available. There is no BTV, ESL, and/or the ECOC is not applicable to the assesment of risk in a zone because it was not evaluated in the certification reports for the zone.

[b] If at least one CU in a zone has an analytical result for a given COC, the background value for the COC is used in the calculations for the CUs that have no reported analytical result to avoid a high bias for the COC in this zone.

Table 18-3. Tier 1 ESLs for Surface Soil

	TIER 1 ESLs			
SOIL COPCs in mg/kg[a]	**EPA Eco-SSL Plant [R1]**	**EPA Eco-SSL Invertebrate [R1]**	**EPA Eco-SSL Avian [R1]**	**EPA Eco-SSL Mammal [R1]**
Acetone	–	–	–	–
Antimony	–	7.80E+01	–	2.70E-01
Arsenic	1.80E+01	–	4.30E+01	4.60E+01
Barium	–	3.30E+02	–	2.00E+03
Benzene	–	–	–	-
Benzo(a)anthracene	–	1.80E+01 [c]	–	1.10E+00 [c]
Benzo(a)pyrene [b]	–	1.80E+01 [c]	–	1.10E+00 [c]
Benzo(b)fluoranthene	–	1.80E+01 [c]	–	1.10E+00 [c]
Benzo(k)fluoranthene	–	1.80E+01 [c]	–	1.10E+00 [c]
Beryllium	–	4.00E+01	–	2.10E+01
Bis(2-chloroethyl)ether	–	–	–	–
Bis(2-ethylhexyl)phthalate	–	–	–	–
Boron and Borates Only	5.00E-01	–	–	–
Bromodichloromethane	–	–	–	–
Bromoform	–	–	–	–
Bromomethane	–	–	–	–
Cadmium	3.20E+01	1.40E+02	7.70E-01	3.60E-01
Carbon Disulfide	–	–	–	–
Carbon Tetrachloride	–	–	–	–
Chlordane	–	–	–	–
Chlorobenzene	–	–	–	–
Chlorobenzenes (total)	–	–	–	–
Chloroform	–	–	–	–
Chromium (III) Insoluble Salts	–	–	2.60E+01	3.40E+01
Chromium (VI)	–	–	–	1.30E+02
Chromium, total	–	–	–	–
Chrysene	–	1.80E+01[c]	–	1.10E+00 [c]
Cobalt	1.30E+01	–	1.20E+02	2.30E+02
Copper	1.30E+01	–	1.20E+02	2.30E+02
Dibenz(a,h)anthracene	–	1.80E+01[c]	–	1.10E+00[c]
Dibenzofuran [b]	–	–	–	–
Dichlorobenzidine, 3,3'-	–	–	–	–
Dichloroethylene, 1,1-	–	–	–	–
Dichloroethane, 1,2-	–	–	–	–

Table 18-3 (continued). Tier 1 ESLs for Surface Soil

	TIER 1 ESLs			
SOIL COPCs in mg/kg[a]	**EPA Eco-SSL Plant [R1]**	**EPA Eco-SSL Invertebrate [R1]**	**EPA Eco-SSL Avian [R1]**	**EPA Eco-SSL Mammal [R1]**
Dieldrin	–	–	2.20E-02	4.90E-03
Ethylbenzene	–	–	–	–
Indeno(1,2.3-cd)pyrene	–	1.80E+01[c]	–	1.10E+00[c]
Lead	1.20E+02	1.70E+03	1.10E+01	5.60E+01
Manganese	2.20E+02	4.50E+02	4.30E+03	4.00E+03
Mercury	–	–	–	–
Methanol	–	–	–	–
Methyl-2-pentanone	–	–	–	–
Methylene Chloride	–	–	–	–
Molybdenum	–	–	–	–
Nickle Soluble Salts	3.80E+01	2.80E+02	2.10E+02	1.30E+02
Nitroaniline, 4-	–	–	–	–
Nitroso-di-N-propylamine, N-	–	–	–	–
Nitrosodiphenylamine, N-	–	–	–	–
PCB (Aroclor 1254)	–	–	–	–
Phenanthrene	–	2.90E+01[d]	–	1.00E+02[d]
Selenium	5.20E-01	1.40E+00	1.20E+00	6.30E-01
Silver	5.60E+02	-	4.20E+00	1.40E+01
Tetrachloroethylene	–	–	–	–
Thallium (Soluble Salts)	1.00E+00	–	–	–
Toluene	–	–	–	–
Trichloroethane, 1,1,2-	–	–	–	–
Trichloroethylene	–	–	–	–
Trichlorofluoromethane	–	–	–	–
Uranium (Soluble Salts)	–	–	–	–
Uranium, Insoluble Compounds	5.00E+00	–	–	–
Vanadium and Compounds	2.00E+00	–	7.80E+00	2.80E+02
Xylenes	–	–	–	–
Zinc (Metallic)	1.60E+02	1.20E+02	4.60E+01	7.90E+01

Notes:

[a] Tier 2 ESLs are not provided in this table. Recommended Tier 2 ESL sources include acute toxicity data from Efroymson 1997a and b (see References 2 and 3 below).

[b] Added after consideration of EPA's guidance from the Persistent Bioaccumulative and Toxic Chemical Program (EPA 2008)

[c] Value established for high molecular weight PAHs

[d] Value established for low molecular weight PAHs

References: R1 = EPA 2008

Table 18-4. Alternative ESLs for Surface Soil for the Fernald Preserve

SOIL COPCs in mg/kg [a]	ORNL Soil Phytotoxicity Benchmarks (1997) [R1]	ORNL Soil Earthworm Benchmarks (1997) [R2]	ORNL Soil Microbial Benchmarks (1997) [R2]	CCME (Agri.) (2007) [R3]	EPA Region 5 RCRA ESLs (2003) [R4]
Acetone	–	–	–	–	2.50E+00
Antimony	5.00E+00	–	–	2.00E+01	1.42E-01
Arsenic	1.00E+01	6.00E+01	1.00E+02	1.20E+01	5.70E+00
Barium	5.00E+02	–	3.00E+03	7.50E+02	1.04E+00
Benzene	–	–	–	6.80E-03	2.55E-01
Benzo[*a*]anthracene	–	–	–	5.00E-01	5.21E+00
Benzo[*a*]pyrene [b]	–	–	–	5.00E-01	1.52E+00
Benzo[*b*]fluoranthene	–	–	–	5.00E-01	5.98E+01
Benzo[*k*]fluoranthene	–	–	–	5.00E-01	1.48E+01
Beryllium	1.00E+01	–	–	4.00E+00	1.06E+00
Bis(2-chloroethyl)ether	–	–	–	–	2.37E+01
Bis(2-ethylhexyl)phthalate	–	–	–	–	9.25E-01
Boron and Borates Only	5.00E-01	–	2.00E+01	–	–
Bromodichloromethane	–	–	–	–	5.40E-01
Bromoform	–	–	–	–	1.59E+01
Bromomethane	–	–	–	–	2.35E-01
Cadmium	4.00E+00	2.00E+01	2.00E+01	1.40E+00	2.22E-03
Carbon Disulfide	–	–	–	–	9.41E-02
Carbon Tetrachloride	–	–	1.00E+03	–	2.98E+00
Chlordane	–	–	–	–	2.24E-01
Chlorobenzene	–	4.00E+01	–	–	1.31E+01
Chlorobenzenes (total)	–	–	–	–	1.31E+01
Chloroform	–	–	–	–	1.19E+00
Chromium(III) Insoluble Salts	–	–	–	–	–
Chromium(VI)	1.00E+00	4.00E-01	–	–	–
Chromium, total	1.00E+00	4.00E-01	1.00E+01	–	4.00E-01
Chrysene [b]	–	–	–	5.00E-01	4.73E+00
Cobalt	2.00E+01	–	1.00E+03	–	1.40E-01
Copper	1.00E+02	5.00E+01	1.00E+02	–	5.40E+00
Dibenz[*a*,*h*]anthracene	–	–	–	5.00E-01	1.84E+01
Dibenzofuran [b]	–	–	–	–	–
Dichlorobenzidine, 3,3'-	–	–	–	–	6.46E-01
Dichloroethane, 1,2-	–	–	–	1.00E-01	2.12E+01
Dichloroethylene, 1,1-	–	–	–	–	8.28E+00
Dieldrin	–	–	–	–	2.38E-03

Table 18-4 (continued). Alternative ESLs for Surface Soil for the Fernald Preserve

SOIL COPCs in mg/kg [a]	ORNL Soil Phytotoxicity Benchmarks (1997) [R1]	ORNL Soil Earthworm Benchmarks (1997) [R2]	ORNL Soil Microbial Benchmarks (1997) [R2]	CCME (Agri.) (2007) [R3]	EPA Region 5 RCRA ESLs (2003) [R4]
Ethylbenzene	–	–	–	1.80E-02	5.16E+00
Indeno(1,2.3-*cd*)pyrene	–	–	–	5.00E-01	1.09E+02
Lead	5.00E+01	5.00E+02	9.00E+02	7.00E+01	5.37E-02
Manganese	5.00E+02	–	1.00E+02	–	–
Mercury	3.00E-01	1.00E-01	3.00E+01	6.60E+00	1.00E-01
Methanol	–	–	–	–	–
Methyl-2-pentanone	–	–	–	–	4.43E+02
Methylene Chloride	–	–	–	–	4.05E+00
Molybdenum	2.00E+00	–	2.00E+02	5.00E+00	–
Nickle Soluble Salts	3.00E+01	2.00E+02	9.00E+01	–	1.36E+01
Nitroaniline, 4-	–	–	–	–	2.19E+01
Nitroso-di-*N*-propylamine, *N*-	–	–	–	–	5.44E-01
Nitrosodiphenylamine, N-	–	–	–	–	5.45E-01
PCB (Aroclor 1254)	4.00E+01[c]	–	–	5.00E-01[c]	3.32E-04[c]
Phenanthrene	–	–	–	5.00E-01	4.57E+01
Selenium	1.00E+00	7.00E+01	1.00E+02	1.00E+00	2.76E-02
Silver	2.00E+00	–	5.00E+01	2.00E+01	4.04E+00
Tetrachloroethylene	–	–	–	1.00E-01	9.92E+00
Thallium (Soluble Salts)	1.00E+00	–	–	–	5.69E-02
Toluene	2.00E+02	–	–	8.00E-02	5.45E+00
Trichloroethane, 1,1,2-	–	–	–	1.00E-01	2.86E+01
Trichloroethylene	–	–	–	1.00E-02	1.24E+01
Trichlorofluoromethane	–	–	–	–	1.64E+01
Uranium (Soluble Salts)	5.00E+00	–	–	–	–
Uranium, Insoluble Compounds	–	–	–	–	–
Vanadium and Compounds	2.00E+00	–	2.00E+01	–	1.59E+00
Xylenes	–	–	–	2.40E+00	1.00E+01
Zinc (Metallic)	5.00E+01	1.00E+02	1.00E+02	–	6.62E+00

Notes:

[a] Tier 2 ESLs are not provided in this table. Recommended Tier 2 ESL sources include acute toxicity data from Efroymson 1997a and b (see References 2 and 3 below).

[b] Added after consideration of EPA's guidance from the Persistent Bioaccumulative and Toxic Chemical Program (EPA 2008)

[c] Based on a Total PCB value used as a surrogate value

References [R]:

1. Efroymson et al. 1997a
2. Efroymson et al. 1997b
3. CCME 2007b
4. EPA 2003

Table 18-5. Tier 1 ESLs for Surface Water

	TIER 1 ESLs				
Surface Water ECOCs (mg/L) [a]	**EPA NRWQC (2009) Chronic (CCC) [R1]**	**ORNL Tier II Secondary Chronic Values (1996)** [d] **[R2]**	**NOAA SQuiRTs Chronic Values (2008) [R3]**	**Ohio EPA (2009) (OMZM) [R4]**	**Ohio EPA (2009) (OMZA) [R4]**
Aroclor 1254		3.30E-05			
Aroclor 1260		9.40E-02			
Arsenic(III)	1.50E-01 [c]	–	1.90E-01	3.40E-01	1.50E-01
Arsenic(V)	1.50E-01 [c]	3.10E-03	3.10E-03 [b]	3.40E-01	1.50E-01
Barium	–	–	3.90E-03	2.00E+00	2.20E-01
Barium (d)	–	4.00E-03	–	–	–
Benzene	–	1.30E-01	–	–	–
Benzo[*a*]pyrene	–	1.40E-05	–	–	–
Benzo[*b*]fluoranthene	–	–	–	–	–
Benzo[*k*]fluoranthene	–	–	–	–	–
Beryllium	–	6.60E-04	6.60E-04	9.30E-02 [b]	1.10E-02 [b]
Bis(2-chloroethyl)ether	–	–	–	–	–
Bis(2-ethelhexyl)phthalate	–	3.00E-03	–	–	–
Boron and Borates Only	–	1.60E-03	–	–	–
Bromodichloromethane	–	–	–	–	–
Bromoform	–	3.20E-01	–	–	–
Bromomethane	–	–	–	–	–
Butanone-2, 4-chloro-4,4-difluoro	–	–	–	–	–
Cadmium	2.50E-03	–	2.50E-03	See Table 7-9, Chapter 3745-1, OAC	See Table 7-9, Chapter 3745-1, OAC
Carbazole	–	–	–	–	–
Carbon Disulfide	–	9.20E-04	–	–	–
Carbon Tetrachloride	–	9.80E-03	–	–	–
Chlordane	–	–	–	–	–
Chlorobenzene	–	6.40E-02	–	–	–
Chloroform	–	2.80E-02	–	–	–
Chromium(III) Insoluble Salts	–	–	–	–	–
Chromium(VI)	1.10E-02	–	1.10E-02	1.60E-02	1.10E-02
Chromium, Total	7.40E-02	–	–	–	–
Cobalt	–	2.30E-02	–	–	–
Copper	9.00E-03	-	–	–	–
Chrysene	–	–	–	–	–
Cyanide (total complex)	–	–	–	–	–
Cyclohexane	–	–	–	–	–
Dibenz[*a*,*h*]anthracene	–	–	–	–	–
Dichlorobenzidine, 3,3'-	–	–	–	–	–

Table 18-5 (continued). Tier 1 ESLs for Surface Water

	TIER 1 ESLs				
Surface Water ECOCs (mg/L) [a]	**EPA NRWQC (2009) Chronic (CCC) [R1]**	**ORNL Tier II Secondary Chronic Values (1996)** [d] **[R2]**	**NOAA SQuiRTs Chronic Values (2008) [R3]**	**Ohio EPA (2009) (OMZM) [R4]**	**Ohio EPA (2009) (OMZA) [R4]**
Dichloroethane, 1,2-	–	9.10E-01	–	–	–
Dichloroethylene, 1,1-	–	2.50E-02	–	–	–
Dieldrin	5.60E-05	–	–	–	–
Ethylbenzene	–	7.30E-03	–	–	–
Fluoride	–	–	–	–	–
Indeno[1,2,3-*cd*]pyrene	–	–	–	–	–
Lead (d)	2.50E-03[b]	–	2.50E-03 [b]	See Table 7-9, Chapter 3745-1, OAC	See Table 7-9, Chapter 3745-1, OAC
Manganese (d)	–	1.20E-01	8.00E-02	–	–
Mercury (methyl)	–	2.80E-06	2.80E-06	–	–
Mercury (total/inorganic)	7.70E-4 (d)	1.30E-03	7.70E-04	0.0017 (T/R), 0.0014 (d)	0.00091 (T/R), 0.00077 (d)
Methyl Isobutyl Ketone (4-methyl-2-pentanone)	–	1.70E-01	–	–	–
Methylene Chloride	–	2.20E+00	–	–	–
Molybdenum	–	3.70E-01	–	–	–
Nickle Soluble Salts	5.20E-02	–	–	–	–
Phenanthrene	–	–	–	–	–
Selenium	5.00E-03	–	–	–	–
Silver (d)	–	3.60E-04	3.60E-04	-	1.40E-03
Tetrachloroetheylene	–	9.80E-02	–	–	–
Thallium (Soluble Salts)	–	1.20E-02	–	–	–
Toluene	–	9.80E-03	–	–	–
Trichloroethylene	–	4.70E-02	2.10E-02	2.00E+00	2.20E-01
Trichloroethane, 1,1,2-	–	1.20E+00	–	–	–
Uranium (Soluble Salts	–	2.60E-03	–	–	–
Uranium, Insoluble Compounds	–	–	–	–	–
Vanadium and Compounds	–	2.00E-02	–	–	–
Zinc (Metalic)	1.20E-01		–	–	–

Table 18-5 (continued). Tier 1 ESLs for Surface Water

Abbreviations:
(d) = dissolved
(T/R) = total recoverable
OAC = *Ohio Administrative Code*
OMZA = Outside Mixing Zone Average
OMZM = Outside Mixing Zone Maximum
SQuiRTs = Screening Quick Reference Tables (NOAA)
TRV = toxicity reference value

Notes
[a] Essential nutrients and electrolytes not typically associated with ecological risk are not shown in this table.
[b] Hardness dependent: value listed is based on a hardness value of 100; if hardness is not 100, see EPA 2009.
[c] The value for arsenic is for total arsenic.
[d] Refined Surface Water ESLs (i.e., TRVs) are found in Suter and Tsao (1996)

References [R]:
1. EPA 2009
2. Suter and Tsao 1996
3. Buchman 2008
4. Ohio EPA 2009 (standards that must be obtained, where no single value can exceed OMZM and a 30 day average of 3 or more samples cannot exceed the OMZA)

Table 18-6. Tier 2 ESLs for Surface Water

Surface Water ECOCs[a] (mg/L)	TIER 2 ESLs			
	EPA NRWQC (2009) Acute (CMC) [R1]	ORNL Tier II Secondary Acute Values (1996) [d] [R2]	NOAA SQuiRTs Acute Values (2008) [R3]	Ohio EPA (2009) IMZM [R4]
Aroclor 1254	–	6.00E-04	–	–
Aroclor 1260	–	1.70E+00	–	–
Arsenic(III)	3.40E-01 [c]	–	–	6.80E-01
Arsenic(V)	3.40E-01 [c]	6.60E-02	6.60E-02 [b]	6.80E-01
Barium	–	–	1.10E-01 [b]	4.00E+00
Barium (d)	–	1.10E-01	–	–
Benzene	–	2.30E+00	–	–
Benzo[*a*]pyrene	–	2.40E-04	–	–
Benzo[*b*]fluoranthene	–	–	–	–
Benzo[*k*]fluoranthene	–	–	–	–
Beryllium	–	3.50E-02	3.50E-02	-
Bis(2-chloroethyl)ether	–	–	–	–
Bis(2-ethelhexyl)phthalate	4.00E-01	2.70E-02	–	–
Boron and Borates Only	–	3.00E-02	–	–
Bromodichloromethane	1.10E+01	–	–	–
Bromoform	–	2.30E+00	–	–
Bromomethane	–	–	–	–
Butanone-2, 4-chloro-4,4-difluoro	–	–	–	–
Cadmium	2.00E-03	–	2.00E-03	See Table 7-9, Chapter 3745-1, OAC
Carbazole	–	–	–	–
Carbon Disulfide	–	1.70E-02	–	–
Carbon Tetrachloride	–	1.80E-01	–	–
Chlordane	–	–	–	–
Chlorobenzene	–	1.10E+00	–	–
Chloroform	–	4.90E-01	–	–
Chromium(III) Insoluble Salts	–	–	–	–
Chromium(VI)	1.60E-02	–	1.60E-02	3.10E-02
Chromium, Total	5.70E-01	–	–	–
Cobalt	–	1.50E+00	–	–
Copper	1.30E-02	–	–	–
Chrysene	–	–	–	–
Cyanide (total complex)	–	–	–	–
Cyclohexane	–	–	–	–
Dibenz[*a*,*h*]anthracene	–	–	–	–
Dichlorobenzidine, 3,3'-	–	–	–	–
Dichloroethane, 1,2-	–	8.80E+00	–	–

Table 18-6 (continued). Tier 2 ESLs for Surface Water

	TIER 2 ESLs			
Surface Water ECOCs[a] (mg/L)	**EPA NRWQC (2009) Acute (CMC) [R1]**	**ORNL Tier II Secondary Acute Values (1996) [d] [R2]**	**NOAA SQuiRTs Acute Values (2008) [R3]**	**Ohio EPA (2009) IMZM [R4]**
Dichloroethylene, 1,1-	–	4.50E-01	–	–
Dieldrin	2.40E-04	–	–	–
Ethylbenzene	–	1.30E-01	–	–
Fluoride	–	–	–	–
Indeno[1,2,3-*cd*]pyrene	–	–	–	–
Lead (d)	6.50E-02[b]	–	6.50E-02 [b]	See Table 7-9, Chapter 3745-1, OAC
Manganese (d)	–	2.30E+00	2.30E+00	–
Mercury (methyl)	–	9.90E-05	9.90E-05	–
Mercury (total/inorganic)	1.40E-03 (d)	–	1.40E-03	3.40E-03 (T/R), 2.90E-03 (d)
Methyl Isobutyl Ketone (4-methyl-2-pentanone)	–	2.20E+00	–	–
Methylene Chloride	–	2.60E+01	–	–
Molybdenum	–	1.60E+01	–	–
Nickle Soluble Salts	4.70E-01	–	–	–
Phenanthrene	3.00E-02	–	–	–
Selenium	–	–	–	–
Silver (d)	3.20E-03	–	1.60E-03 [b]	2.70E-03
Tetrachloroetheylene	–	8.30E-01	–	–
Thallium (Soluble Salts)	–	–	–	–
Toluene	–	1.20E-01	–	–
Trichloroethane, 1,1,2-	–	1.10E-01	–	–
Trichloroethylene	–	4.40E-01	–	4.00E+00
Uranium (Soluble Salts)	–	4.60E-02	–	–
Uranium, Insoluble Compounds	–	–	–	–
Vanadium and Compounds	–	2.80E-01	–	–
Zinc (Metalic)	1.20E-01	–	–	–

Table 18-6 (continued). Tier 2 ESLs for Surface Water

Notes:
[a] Essential nutrients and electrolytes not typically associated with ecological risk are not shown in this table
[b] Hardness dependent: value listed is based on a hardness value of 100; if hardness is not 100, please see EPA 2009
[c] The value for arsenic is for total arsenic
[d] Refined Surface Water ESLs (i.e., TRVs) are found in Suter and Tsao 1996

Abbreviations:
CMC = criterion maximum concentration
(d) = dissolved
IMZM = inside mixing zone maximum
OAC = Ohio Administrative Code
SQuiRTs = Screening Quick Reference Tables (NOAA)
(T/R) = total recoverable

References [R]:

1. EPA 2009
2. Suter and Tsao 1996
3. Buchman 2008
4. Ohio EPA 2009 (standards that must be obtained, where no single value can exceed outside mixing zone standard and a 30-day average of three or more samples cannot exceed the outside mixing zone average.

Table 18-7. Alternative Tier 1 ESLs for Surface Water

Surface Water ECOCs [a] (mg/L)	CCME Water: Aquatic Life, Freshwater (2007) [R1]	EPA Region 5 [R2]	ORNL Lowest Chronic Value (Fish) [R3]	ORNL Lowest Chronic Value (Daphnid Invertebrates) [R3]	ORNL Lowest Chronic Value (Non-Daphnid Invertebrates) [R3]	ORNL Lowest Chronic Value (Aquatic Plants) [R3]
Aroclor 1254	–	–	–	2.90E-3	–	1.00E-4
Aroclor 1260	–	–	1.30E-3	–	–	–
Arsenic(III)	5.00E-3 [b]	1.48E-1 [b]	2.96E+00	9.14E-1	–	2.32E+00
Arsenic(V)	5.00E-3 [b]	1.48E-1 [b]	8.92E-1	4.50E-1*	–	4.80E-2
Barium	–	–	–	–	–	–
Barium (d)	–	2.20E-1	–	–	–	–
Benzene	3.70E-01	1.14E-01	–	9.80E+01	–	5.25E+02
Benzo[*a*]pyrene	1.50E-05	1.40E-05	–	3.00E-04	–	–
Benzo[*b*]fluoranthene	–	9.07E-03	–	–	–	–
Benzo[*k*]fluoranthene	–	–	–	–	–	–
Beryllium	–	3.60E-03	5.70E-02	5.30E-03	–	1.00E+02
Bis(2-chloroethyl)ether	–	1.90E+00	–	–	–	–
Bis(2-ethelhexyl)phthalate	1.60E-02	3.00E-03	–	9.12E-01	–	–
Boron and Borates Only	1.50E+00	–	–	8.83E+00	–	–
Bromodichloromethane	–	1.60E-02	–	–	–	–
Bromoform	–	2.30E-01	–	–	–	–
Bromomethane	–	1.60E-02	–	–	–	–
Butanone-2, 4-chloro-4,4-difluoro	–	–	–	–	–	–
Cadmium	9.00E-05	1.50E-04	1.70E-03	1.50E-04	–	2.00E-03
Carbazole	–	–	–	–	–	–
Carbon Disulfide	–	1.50E-02	9.54E+00	2.44E-01	–	–
Carbon Tetrachloride	1.33E-02	2.40E-01	1.97E+00	5.58E+00	–	–
Chlordane	–	–	–	–	–	–
Chlorobenzene	1.30E-03	4.70E-02	1.20E+00	1.50E+01	–	2.24E+02
Chloroform	1.80E-03	1.40E-01	1.24E+00	4.48E+00	–	–
Chromium(III) Insoluble Salts	–	–	–	–	–	–
Chromium(VI)	1.00E-03	–	7.32E-02	6.13E-03	–	2.00E-03
Chromium, Total	8.90E-03	4.20E-02	6.86E-02	4.40E-02	–	3.97E-01
Cobalt	–	2.40E-02	2.90E-01	5.10E-03	–	–
Copper	2.00E-03	1.58E-03	3.80E-03	2.30E-04	6.07E-03	1.00E-03
Chrysene	–	–	–	–	–	–

Table 18-7 (continued). Alternative Tier 1 ESLs for Surface Water

Surface Water ECOCs [a] (mg/L)	CCME Water: Aquatic Life, Freshwater (2007) [R1]	EPA Region 5 [R2]	ORNL Lowest Chronic Value (Fish) [R3]	ORNL Lowest Chronic Value (Daphnid Invertebrates) [R3]	ORNL Lowest Chronic Value (Non-Daphnid Invertebrates) [R3]	ORNL Lowest Chronic Value (Aquatic Plants) [R3]
Cyanide (total complex)	–	–	–	–	–	–
Cyclohexane	–	–	–	–	–	–
Dibenz[*a*,*h*]anthracene	–	–	–	–	–	–
Dichlorobenzidine, 3,3'-	–	4.50E-03	–	–	–	–
Dichloroethane, 1,2-	1.00E-01	9.10E-01	4.14E+01	1.52E+01	–	–
Dichloroethylene, 1,1-	–	6.50E-02	2.80E+00	4.72E+00	–	7.98E+02
Dieldrin	–	7.10E-02	–	–	–	–
Ethylbenzene	9.00E-02	1.40E-02	4.40E-01	1.29E+01	–	4.38E+02
Fluoride	1.20E-01	–	–	–	–	–
Indeno[1,2,3-*cd*]pyrene	–	4.31E-03	–	–	–	–
Lead (d)	1.00E-03	1.17E-03	1.89E-02	1.23E-02	2.55E-02	5.00E-01
Manganese	–	–	1.79E+00	<1.10E+00	–	–
Mercury (methyl)	4.00E-06	2.46E-06	5.20E-04	<4.00E-05	–	8.00E-04 – 4.00E-03 [c]
Mercury (total/inorganic)	2.60E-05	1.30E-06	<2.30E-04	9.60E-04	–	5.00E-03
Methyl Isobutyl Ketone (4-methyl-2-pentanone)	–	1.70E-01	7.74E+01	–	–	–
Methylene Chloride	9.81E-02	9.40E-01	1.08E+02	4.27E+01	–	–
Molybdenum	7.30E-02	–	–	8.80E-01	–	–
Nickle Soluble Salts	6.50E-02	2.89E-02	3.50E-02	5.00E-03	1.28E-01	5.00E-03
Phenanthrene	4.00E-04	3.60E-03	–	2.00E-01	–	–
Selenium	1.00E-03	5.00E-03	8.83E-02	9.17E-02	–	1.00E-01
Silver	2.50E-04	1.20E-04	1.20E-04	2.60E-03	–	3.00E-02
Tetrachloroetheylene	1.10E-01	4.50E-02	8.40E-01	7.50E-01	–	8.16E+02
Thallium (Soluble Salts)	8.00E-04	1.00E-02	5.70E-02	1.30E-01	–	1.00E-01
Toluene	2.00E-03	2.53E-01	1.27E+00	2.52E+01	–	2.45E+02
Trichloroethane, 1,1,2-	2.10E-02	5.00E-01	9.40E+00	1.84E+01	–	–
Trichloroethylene	2.10E-02	4.70E-02	1.11E+01	7.26E+00	–	–
Uranium (Soluble Salts)	–	–	1.42E-01	–	–	–
Uranium, Insoluble Compounds	1.50E-02	–	–	–	–	–
Vanadium and Compounds	–	1.20E-02	8.00E-02	1.90E+00	–	–
Zinc (Metalic)	3.00E-02	6.57E-02	3.64E-02	–	5.24E+00	3.00E-02

Table 18-7 (continued). Alternative Tier 1 ESLs for Surface Water

Notes:
[a] Essential nutrients and electrolytes not typically associated with ecological risk are not shown in this table
[b] The value for arsenic is for total
[c] See Suter and Tsao 1996

Abbreviations:
* Estimated value
(d) = dissolved

References [R]:
1. CCME 2007a
2. EPA 2003
3. Suter and Tsao 1996 (EC_{20} values may be considered in lieu of Lowest Chronic Values)

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Attachment 19

Water Levels for 62433
(May 25, 2007, through January 4, 2016)

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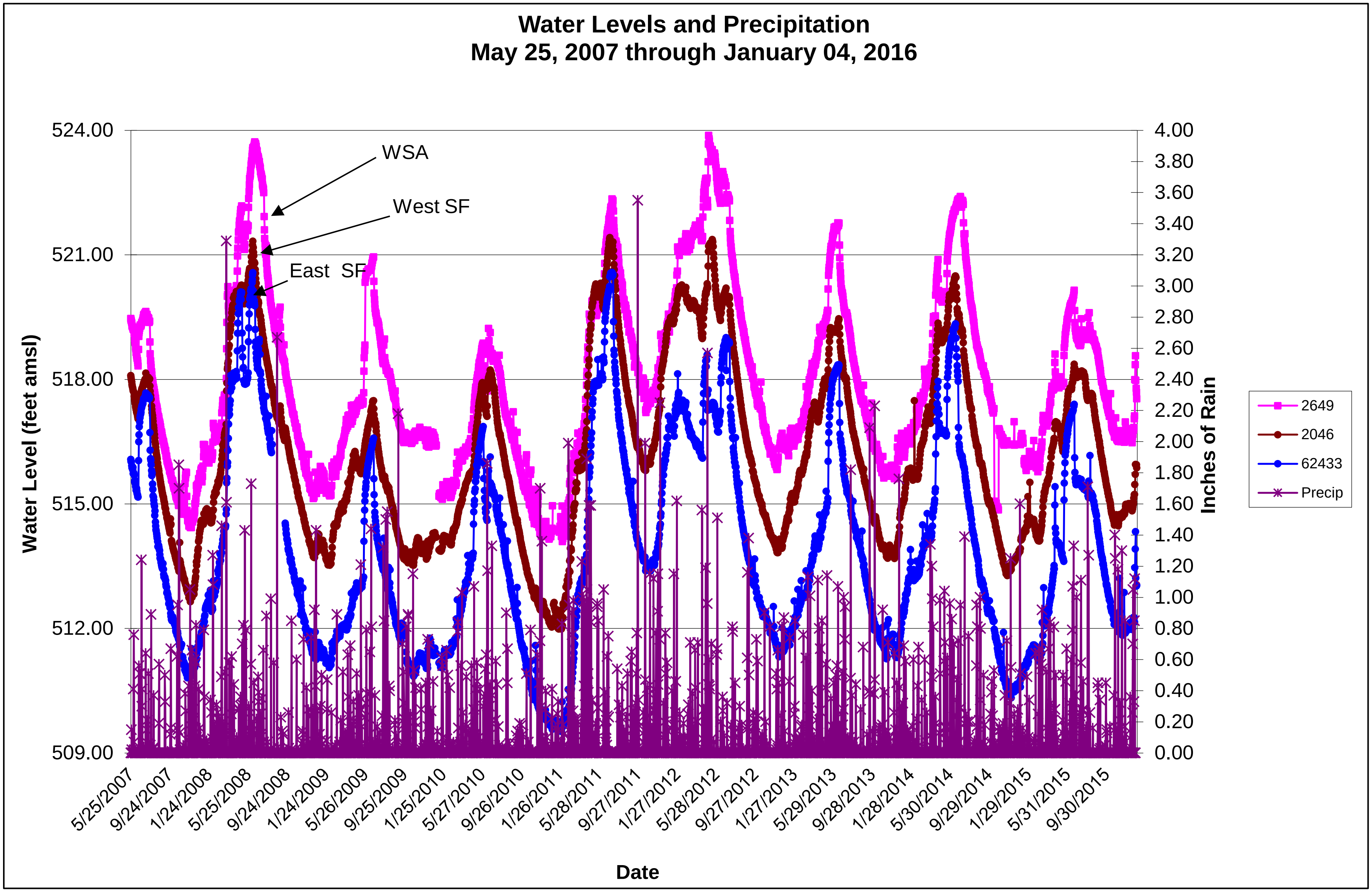

Water Levels for 62433 (May 25, 2007, through January 4, 2016)

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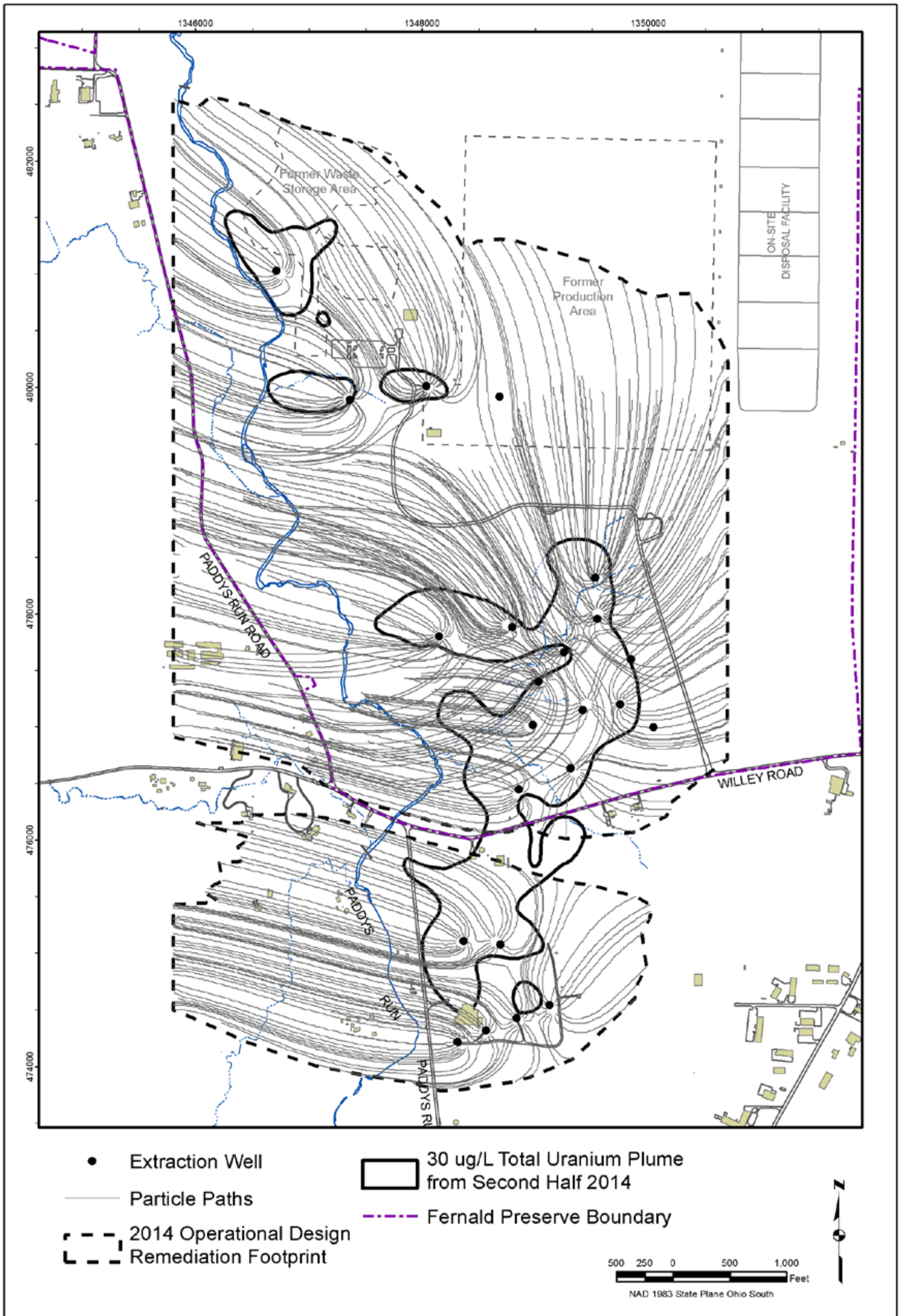
Attachment 20

Operational Design Adjustment-1
Remediation Footprint



Operational Design Adjustment-1 Remediation Footprint

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