LMS/FER/S33442

Final
Fifth Five-Year Review Report for the Fernald Preserve

September 2021

U.S. DEPARTMENT OF ENERGY | Legacy Management

LMS/FER/S33442

Final Fifth Five-Year Review Report

for the

Fernald Preserve

Butler and Hamilton Counties, Ohio

September 2021

Prepared by:

U.S. Department of Energy
Office of Legacy Management

Approved by: BRIAN ZIMMERMAN Digitally signed by BRIAN ZIMMERMAN Date: 2021.09.02 08:04:47 -04'00' Date:

Brian Zimmerman Fernald Preserve Manager
DOE-LM-20.1

This page intentionally left blank

Contents

Tables

Attachments

Abbreviations

ARAR	Applicable or Relevant and Appropriate Requirement
BRSR	Baseline Remedial Strategy Report
BTV	benchmark toxicity value
CAWWT	Converted Advanced Wastewater Treatment
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	*Code of Federal Regulations*
cm^2	square centimeters
CRARE	Comprehensive Response Action Risk Evaluation
CSF	cancer slope factor
D&D	decontamination and dismantling
DOE	United States Department of Energy
dpm	disintegration units per minute
EM	(DOE) Office of Environmental Management
EPA	United States Environmental Protection Agency
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
FTF	Fire Training Facility
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
IC	institutional control
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
LDS	leak detection system
LM	Office of Legacy Management
LMICP	*Comprehensive Legacy Management and Institutional Controls Plan*
M gal	million gallons
MCL	maximum contaminant level
mg/kg	milligrams per kilogram
µg/L	micrograms per liter
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
NTS	Nevada Test Site (renamed Nevada National Security Site in 2010)
Ohio EPA	Ohio Environmental Protection Agency
O&M	operations and maintenance
OSDF	On-Site Disposal Facility
OU	operable unit
PCB	polychlorinated biphenyl
pCi/g	picocuries per gram
PFAS	per- or polyfluorinated alkyl substance
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
SDWA	Safe Drinking Water Act
SEP	*Sitewide Excavation Plan*
TCLP	Toxicity Characteristic Leaching Procedure
UU/UE	unlimited use and unrestricted exposure
WAC	Waste Acceptance Criteria

This page intentionally left blank

Executive Summary

This fifth five-year review conducted by the United States Department of Energy for the Fernald Preserve in Harrison, Ohio, is the third review to be conducted after physical completion of remedial actions 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, and 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 and the ongoing OU5 remedy remain protective of human health and the environment. Specific items reviewed within these remedies include ensuring 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 (ICs) are being implemented and are effective. A review of all available operational data, environmental monitoring data, and site inspection reports since November 2016 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 because the pump and treat remedy maintains hydraulic capture of the groundwater plume and exposure pathways that could result in unacceptable risks are being managed and mitigated through institutional controls. However, groundwater must achieve Final Remediation Levels (FRLs) to be protective long-term.

This page intentionally left blank

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 when hazardous substances, pollutants, or contaminants remain above levels that allow for unlimited use and unrestricted exposure (UU/UE). Because the final land use for the Fernald Preserve was not remediated to UU/UE cleanup criteria, a five-year review is a statutory requirement. For sites where the United States Department of Energy (DOE) is the lead agency, DOE is responsible for conducting the review every 5 years after the first selected remedial action begins, while the United States Environmental Protection Agency (EPA) is responsible for concurrence with the review. The findings are documented in Five-Year Review Reports to EPA, as cited in CERCLA (Sections 120 and 121) and are available at https://www.energy.gov/lm/fernald-preserve-ohio-cercla-five-year-review.

The purpose of five-year reviews is to review all information over the last five years and 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 2019a). The LMICP documents the requirements for the long-term care and maintenance of the Fernald Preserve. The plan outlines the institutional controls (ICs), including routine inspections, permits, continuing groundwater remedial activities, routine maintenance and monitoring, ecological restoration, and leachate management practices.

This is the fifth five-year review conducted by DOE 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 (ROD) (DOE 1995d) 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 9, 2016. Therefore, the due date for the current Five-Year Review Report is September 9, 2021, and the report covers the period from November 2015 to November 2020. The site chronology is presented in Table 1.

Table 1. Chronology of Site Events

Event	Date
Initial discovery of problem or contamination	March 1985
NPL listing	November 1989
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 2003c) OU2 – None OU3 – None OU4 – ESD (Silo 3, March 1998) (DOE 1998a); Amendment (Silo 1 and 2, July 2000) (DOE 2000); Amendment (Silo 3, September 2003) (DOE 2003b); ESD (Silos 1 and 2, November 2003) (DOE 2003a); ESD (Silos 1, 2, and 3; January 2005) (DOE 2005a) OU5 – ESD (November 2001) (DOE 2001a)
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 1995b)
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 2001b) April 2006 (DOE 2006f) September 2011 (DOE 2011) September 2016 (DOE 2016c)

1.1 Site Background

1.1.1 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 1 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 21,000 people live within 5 miles of the site.

1.1.2 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 final 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. Residential use is increasing locally, especially north and west of the Fernald site (DOE 2019c). 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.

1.1.3 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.

1.2 Five-Year Review Summary Form

<table>
<tr><th colspan="3">SITE IDENTIFICATION</th></tr>
<tr><td colspan="3">Site Name: Feed Materials Production Center</td></tr>
<tr><td colspan="3">EPA ID: OH6890008976</td></tr>
<tr><td>Region: 5</td><td>State: Ohio</td><td>City/County: Hamilton and Harrison/Butler and Hamilton</td></tr>
<tr><th colspan="3">SITE STATUS</th></tr>
<tr><td colspan="3">NPL Status: Final</td></tr>
<tr><td>Multiple OUs?
Yes</td><td colspan="2">Has the site achieved construction completion?
Yes</td></tr>
<tr><th colspan="3">REVIEW STATUS</th></tr>
<tr><td colspan="3">Lead agency: Other Federal Agency
[If “Other Federal Agency”, enter Agency name]:</td></tr>
<tr><td colspan="3">Author name (Federal or State Project Manager): Brian Zimmerman</td></tr>
<tr><td colspan="3">Author affiliation: U. S. Department of Energy, Office of Legacy Management</td></tr>
<tr><td colspan="3">Review period: 9/1/2020 – 12/31/2020</td></tr>
<tr><td colspan="3">Dates of site inspection: January 10, 2020; February 14, 2020; March 13, 2020; June 3, 2020; September 1, 2020; December 8, 2020</td></tr>
<tr><td colspan="3">Type of review: Statutory</td></tr>
<tr><td colspan="3">Review number: 5</td></tr>
<tr><td colspan="3">Triggering action date: 9/9/2016</td></tr>
<tr><td colspan="3">Due date (five years after triggering action date): 9/9/2021</td></tr>
</table>

2.0 Response Action Summary

2.1 Initial Response

On March 9, 1985, EPA issued a Notice of Noncompliance to DOE, identifying concerns about environmental impacts associated with the 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 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.

2.2 Basis for Taking Action

The sources of contamination within each of the source OUs (OU1, OU2, OU3, and OU4) 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 1995e) 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), semi-volatile 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 238 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 semi-volatile organics. Only uranium contamination was found in off-property sediment sampling.
- A baseline risk assessment was conducted as part of the OU5 RI. A variety of exposure scenarios were investigated for both current conditions and expected future use and included groundwater, surface water, sediment, surface and subsurface soils, flora and fauna and crops and produce. This effort demonstrated that there was unacceptable risk to receptors on-property and off-property, under both current conditions and expected future use. Risks were primarily due to ingestion of uranium from groundwater as a source of drinking water.

2.3 Remedial Actions

2.3.1 Remedy Selection

For purposes of investigation and study, the remedial issues and concerns that were similar in location, history, type and 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 because 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 because 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 as follows:

- **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:** Flyash 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, and 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 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% 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% 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.

For the four source OUs (OU1, OU2, OU3, and OU4), remediation and certification of affected media within an operable unit boundary was to be performed under OU5. Therefore, these OUs focused only on the source waste material within the respective source operable units (e.g., building demolition, infrastructure removal, and wastes disposal activities), while the contaminated media within the source operable unit boundaries would be addressed under OU5. These materials were removed from the Fernald Preserve for proper off-site disposal or were placed in the OSDF if they met the waste acceptance criteria. The following summarizes the remedial action objectives and information pertaining to cleanup levels for each of the OUs:

- **OU1, Waste Pit Area:** The remedial action objectives for OU1 was to prevent unacceptable current or future exposure to the contaminated materials of OU1.
- **OU2, Other Waste Units:** The remedial action focus of OU2 was to prevent unacceptable current or future exposure to the contaminated materials of OU2. Cleanup levels for OU2 were selected for soils only and both contaminants of concern and cleanup levels were subunit specific per Table 9-1 of the OU2 ROD (DOE 1995c).
- **OU3, Former Production Area:** The remedial action objectives for OU3 stipulate for the decontamination and disposition of materials resulting from removal of contaminated structures and facilities, as well as disposition of legacy wastes in a manner that confines risk to human health and the environment to acceptable levels.
- **OU4, Silos 1 through 4:** Remedial action objectives for OU3 were developed for waste material, structural material and equipment, soil, and residual water to prevent direct contact through inhalation or ingestion, release and migration or exposure of contaminants to protect human health and the environment.
- **OU5, Environmental Media:** Remedial action objectives for OU5 include reducing or eliminating potential for human health or ecological receptors to come into contact with contaminated environmental media and prevent contaminants from migrating off site. Cleanup levels were developed to mitigate the potential adverse effects of site contaminants present in environmental media, which led to setting acceptable chemical-specific remediation levels for a range of human and ecological receptors under differing land uses. Four land use objectives were developed ranging from establishing a hypothetical family farm anywhere on the property to consolidating contaminated material and restricting access and future use of the property. Final remediation levels for

soil, sediment, Great Miami Aquifer groundwater, surface water in Paddys Run and the Great Miami River outside the mixing zone were developed to attain the post-remediation risk levels of a carcinogenic risk level of 10^{-5} and a hazard index of 1 to an off-property farmer, a carcinogenic risk level of 10^{-6} and an HI of 1 for recreational users of the site and a carcinogenic risk level of 10^{-6} and an HI of 1 for trespassers in the disposal facility area.

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 238-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 of the remedial actions, 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 dispersibility and metals mobility.
- *Explanation of Significant Differences for Operable Unit 4 Silos 1 and 2 Remedial Action* (DOE 2003a), 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 1995d). 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 2003c).

- **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, because the OU5 and OU3 decisions related to waste disposal (onsite or offsite) were not yet final (DOE 1995c).
- **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 1996b).
  - 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 2001a). 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 1996a). A *Non-Significant (or minor) Post-ROD Change* was documented via Fact Sheet in 2006 to communicate the decision to allow for beneficial use of identified clean buildings, critical structure, and construction materials under Legacy Management (DOE 2006a), which is consistent with the 1996 OU3 ROD.

2.3.2 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 Directive 9320.2-09A-P, *Closeout Procedures for National Priorities List Sites* (EPA 2000).

2.3.2.1 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 2006c) provides a complete history of the remedial action undertaken.

2.3.2.2 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 Feasibility Study (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 because 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 2006d) provides a complete history of the remedial actions undertaken.

2.3.2.3 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 or 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% 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 or 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. (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.

2.3.2.4 OU4 Remedial Actions

The final remedy implemented for OU4 defined by the OU4 ROD and its subsequent modifications consisted of the following components:

- 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 dispersibility, 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 2006) provides a complete history of the remedial actions undertaken.

2.3.2.5 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 [HQ] for noncarcinogens) via the drinking water pathway for a resident farmer (DOE 1996a).
- 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.

2.3.2.6 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 non-radiological 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 2.3.3) 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 (LCS). 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 gpm, 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 standards 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* Section 300.430 (f)(1)(ii)(C)(4) [40 CFR 300.430 (f)(1)(ii)(C)94)]). CERCLA waivers were requested, justified, and granted through the approval of the OU2, OU3, and OU5 RODs. Therefore, EPA granted three CERCLA waivers from the State of Ohio citing prohibitions 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 follows:

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

2.3.2.7 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) were 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 1995e) is reproduced in Attachment 3. 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 and 2 and Silo 3 contents, the remaining OU4 scope (i.e., 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 GMA 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 that 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.

2.3.3 Institutional Controls

DOE ensures that the remedy at the Fernald Preserve remains protective of human health and the environment through the continued implementation of the LMICP (DOE 2019a). The LMICP documents the requirements for the long-term care and maintenance of the Fernald Preserve. The plan outlines the ICs, including routine inspections, permits, continuing groundwater remedial activities, routine maintenance and monitoring, ecological restoration, and leachate management practices. Table 2 provides a summary of institutional controls.

Table 2. Summary of Institutional Controls

Media, Engineered Controls, and Areas that Do Not Support UU/UE Based on Current Conditions	ICs Needed	ICs Called for in the Decision Documents	Impacted Parcel(s)	IC Objective	Title of IC Instrument Implemented and Date (or planned)
Groundwater and surface water	Yes	Yes	Operable Unit 5	Continued federal ownership of the site.	Warranty Deed
				Restrict the use of groundwater as a drinking water source in off-property areas.	Hamilton County Well Permitting Process
				Activity and use limitations; restrict use of groundwater as a drinking water source onsite.	Environmental Covenant
Soil	Yes	Yes	Operable Unit 5	Continued federal ownership of the site.	Warranty Deed
		Yes	Operable Unit 5	Activity and use limitations.	Environmental Covenant
		No	Operable Unit 5, Offsite	Restrict access to uncertified subgrade utility corridors.	Off-property subgrade utility corridor agreements
On-site Disposal Facility	Yes	Yes	Operable Unit 5	Continued federal ownership of the site.	Warranty Deed
				Activity and use limitations.	Environmental Covenant

Access restrictions, use limitations, and institutional controls have been established at the Fernald Preserve as described above. Since portions of the site are open to the public, access restrictions and prohibited activities are prominently displayed via signage at site access points. Signs are posted along the site boundary as well. Limits to public access are clearly marked along trails and other public amenities. 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 and posted, and access gates remain locked unless authorized personnel are within the fenced area.

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), ICs and other measures have been implemented to prevent the use of the aquifer as an on-property drinking water supply. ICs remain in place and consist of the following:

- 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 Hamilton County 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 4). 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 in 2021. 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 being sampled as part of the routine monitoring program.

- The Environmental Covenant, Appendix B of the Consent Decree between the State of Ohio and DOE (State of Ohio 2008). The Environmental Covenant establishes activity and use limitations for the Fernald site, restricts use of groundwater as a drinking water supply, and use of the site for residential or agricultural purposes. 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 5) exist to support the aquifer remediation infrastructure, the outfall line from the eastern property boundary to the Great Miami River, and the South Plume utility corridor. As stated in Section 5.1.5.9, 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.

2.4 Systems Operations/Operation & Maintenance

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 in Tables 3, 4, and 5, reported as operation and maintenance costs combined. Costs are presented on a fiscal year basis (i.e., October through September). Costs presented for the groundwater remediation system include all site utilities, but the groundwater remediation system is the predominant utility user. Table 6 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's life-cycle baseline budgetary planning process.

As presented in the *Fernald Preserve 2015 Site Environmental Report* (DOE 2016b), the CAWWT system had become oversized and reached the end of its useful life. Additionally, equipment corrosion and corrective maintenance had become ongoing issues for facility operations. In March 2015, a CAWWT Condition Assessment Report was finalized (Whitman, Requardt & Associates 2015) confirming that many of the treatment system components were at or nearing the end of their useful life. A decision was made to replace the CAWWT treatment system with a 50 gpm system inside the CAWWT building. The project was initiated in 2016 and became operational on April 3, 2018.

Replacement of the nearby backwash basin occurred in 2019. The backwash basin is used to temporarily store wastewater originating from a variety of sources (i.e., well rehabilitation, CAWWT backwash, OSDF leachate, groundwater sampling, CAWWT laboratory, and CAWWT storm water drainage). Construction began in late summer of 2019 and was completed in December 2019.

Minor disruptions related to the O&M of the groundwater remediation system occurred during the reporting period and consisted of the following:

- Maintenance activities at the CAWWT backwash basin resulted in an unplanned release of wastewater until repairs could be made in late 2017. A leak occurred during installation of a blind flange on the CAWWT facility backwash basin exit pipe. The blind flange was being installed because portions of the old backwash basin exit piping and the pumps had been recently removed to make way for the new piping and pumps to be installed as part of the CAWWT construction project. Surface water samples were collected to assess the impact of the temporary leak, and analytical results indicated the release did not adversely impact the surface water quality. Additional detail is provided in the 2017 Site Environmental Report (DOE 2018b).
- In addition to the planned annual month-long wellfield shutdown, additional wellfield shutdowns of the entire wellfield occurred during the five-year period. These temporary well field shutdowns have not had a negative impact on remediation progress and could be beneficial from a rebound perspective.
  - In 2016, the wellfield was shut down for an unplanned outage due to an electrical breaker failure to the site power system. The wellfield was shut down for an additional 79 days. The shutdown is further discussed in Appendix A.1 of the 2016 Site Environmental Report (DOE 2017).
  - In addition to the annual planned well field shutdown, the well field is shut down whenever the Great Miami River reaches a river stage of 14 feet at the U.S. Geological Survey measurement gauge at Miamitown, Ohio, approximately 7 miles south of the site. When flow in the river reaches this level, gravity flow from the site discharge pipe is affected. The well field remains off until the river stage falls below 14 feet. This approach was discussed with the regulators during the March 14, 2018, regulatory meeting and incorporated into the LMICP. In 2018, the entire well field was off for a combined 10 days and in 2019, the entire well field was off for a combined 7 days.
- Extraction wells are treated with a chemical solution when operational parameters indicate that cleaning is warranted. The number of chemical treatments has increased as a result of pumping at higher rates; however, during 2016, 2018 and 2019, the number of treatments was down for the following reasons:
  - In 2016, the unplanned wellfield shutdown discussed above affected the number of treatments completed.
  - In 2018, the CAWWT construction project affected the availability of the backwash basin for wastewater generated by well treatment for 33 days.
  - In 2019, replacement of the CAWWT backwash basin affected the availability of the backwash basin for wastewater generated by well treatments for 112 days.

Any individual well shutdown of greater than 24 hours is documented in Attachment A.1 of the Site Environmental Report.

Table 3. Annual Groundwater System O&M Costs

Dates		Total Cost (Rounded to Nearest $1,000)
From	To	
October 2015	September 2016	$3,278,000
October 2016	September 2017	$4,155,000
October 2017	September 2018	$2,825,000
October 2018	September 2019	$3,922,000
October 2019	September 2020	$3,478,000

Table 4. Annual OSDF Leachate System O&M Costs

Dates		Total Cost (Rounded to Nearest $1,000)
From	To	
October 2015	September 2016	$47,000
October 2016	September 2017	$43,000
October 2017	September 2018	$53,000
October 2018	September 2019	$59,000
October 2019	September 2020	$53,000

Table 5. Annual OSDF Cap System O&M Costs

Dates		Total Cost (Rounded to Nearest $1,000)
From	**To**	
October 2015	September 2016	$60,000
October 2016	September 2017	$84,000
October 2017	September 2018	$62,000
October 2018	September 2019	$77,000
October 2019	September 2020	$113,000

Table 6. Annual Fernald Site Total Project Costs

Dates		Total Cost (Rounded to Nearest $1,000)
From	**To**	
October 2015	September 2016	$7,286,000
October 2016	September 2017	$10,637,000
October 2017	September 2018	$12,473,000
October 2018	September 2019	$10,001,000
October 2019	September 2020	$9,124,000

3.0 Progress Since the Last Review

This section includes the protectiveness determinations and statements from the last Five-Year Review Report (Table 7) as well as the recommendations from the last Five-Year Review Report and the current status of those recommendations (Table 8).

Table 7. Protectiveness Determinations/Statements from the Fourth CERCLA Five-Year Review Report (DOE 2016c)

OU #	Protectiveness Determination	Protectiveness Statement
1	Protective	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.
2	Protective	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.
3	Protective	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.
4	Protective	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.

Table 7. Protectiveness Determinations/Statements from the Fourth CERCLA Five-Year Review Report (DOE 2016c) (continued)

OU #	Protectiveness Determination	Protectiveness Statement
5	Short-Term Protective	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 of the Fourth CERCLA Five-Year Review Report 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	Short-Term Protective	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 of the Fourth CERCLA Five-Year Review Report 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.

Table 8. Status of Recommendations from the Fourth CERCLA Five-Year Review Report (DOE 2016c)

OU #	Issue	Recommendations	Current Status	Current Implementation Status Description	Completion Date (if applicable)
5	Presence or absence of perfluorinated compounds (PFCs) including perfluorooctane sulfate (PFOS) or perfluorooctanoic acid (PFOA) (now referred to as PFAS) due to the use of firefighting suppression is unknown.	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.	Completed	Recommendation 1 was submitted on December 28, 2016 and Recommendation 2 was submitted on March 18, 2018. Based on the extremely low volumes of aqueous foam firefighting used at the site, the deliverables recommend addressing the issue in future five-year reviews as more information becomes available.	March 18, 2018
5	Soils sitewide have been certified to meet FRLs established in the OU5 ROD, with the exception of the infrastructure footprint that supports aquifer restoration.	Certify soil following removal of aquifer infrastructure including subgrade utility corridors and associated buildings.	Ongoing	Soil will be certified after removal of aquifer infrastructure which is currently predicted to occur in late 2030s.	December 31, 2040

4.0 Five-Year Review Process

4.1 Community Notification, Involvement & Site Interviews

The five-year review community involvement process was initiated on October 5, 2020, when notices of the review were distributed electronically to the stakeholder mailing list of approximately 2,000 stakeholders. A link to the questionnaire was included in the electronic distribution. Hardcopies of this information were also mailed to stakeholders who reside adjacent to the Fernald Preserve and property owners who have monitoring wells located on their properties. Attachment 6 shows the electronic notice and the questionnaire distributed to stakeholders. A virtual public meeting was held at the Fernald Preserve on October 13, 2020. The availability of the questionnaire was promoted at the public meeting and was made available on the Fernald Preserve website (https://www.energy.gov/lm/fernald-preserve-ohio-cercla-five-year-review) October 1, 2020, through November 13, 2020. A letter of explanation, and an invitation and a link to complete a questionnaire was emailed to state and local government officials on October 15, 2020.

Six questionnaires were received from the public, and one was received as a result of the state and local government officials mailing. Individuals who responded were reached via the electronic email distribution, the public meeting, and by direct mailing. Questionnaire responses were received electronically and by mail. 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 7 contains the completed questionnaires and a summary of both interviews.

The results of the review and the Final CERCLA Fifth Five-Year Review Report will be made available on the Fernald Preserve, Oh, Site webpage (https://www.energy.gov/lm/fernald-preserve-ohio-cercla-five-year-review), which also includes links to the previous five-year review reports. The results of the review will also be discussed at the annual public meeting which is scheduled for the fall of 2021.

4.2 Document Review

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

- LMICP, Revision 12, January 2019 (DOE 2019a)
- Annual Site Environmental Reports for 2016 (DOE 2017), 2017 (DOE 2018b), 2018 (DOE 2019b), and 2019 (DOE 2020)
- Quarterly OSDF Inspection Reports for inspections conducted 2016 through 2020
- Quarterly Site Inspection Reports for inspections conducted 2016 through 2020
- OU5 ROD
- *Interim Residual Risk Assessment for the Fernald Closure Project* (DOE 2007b)
- *Draft Perfluorinated Compound Groundwater Screening Sampling and Analysis Plan* (DOE 2016a)
- *Draft Perfluorinated Alkyl Substances (PFASs) Investigation Plan for the Fernald Preserve* (DOE 2018a)

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

4.3 Data Review

This five-year review consisted of a review of relevant site-specific data for the years (2015 through 2019). 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, environmental data (groundwater, surface water, and sediment), groundwater remedy operational data, and site inspection data for the years 2015 through 2019 are included in this Five-Year Review Report. Below is a summary of the data reviewed for this report.

4.3.1 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 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 below the OSDF. The controlling document for OSDF performance monitoring is the Groundwater/Leak Detection and Leachate Monitoring Plan (Attachment C of the LMICP

[DOE 2019a]). Appendix A.5 of the Site Environmental Report provides OSDF monitoring data and an interpretation of that data. Since the last five-year review (2015 through 2019), the data indicate that the OSDF continues to operate as designed.

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 in accordance with 40 CFR 264.302. The action leakage rate is 200 gallons per acre per day (gpad). Flow from the LDS has never reached the action leakage rate. In fact, flow from the LDS has been well below the action leakage rate. As the flow has decreased over time as expected due to the impermeable cap, DOE has established two OSDF administrative action levels for leakage rates. The first is the initial response leakage rate of 20 gpad, and the second is the low flow rate of 2 gpad. If flow in the LDS of any cell reaches the low flow rate of 2 gpad (one-hundredth of the action leakage rate), 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, in 2017, the number of parameters sampled was reduced from 24 to 13. 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.

4.3.2 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 2006b). Appendix A.1 through A.4 of the Site Environmental Report provides groundwater monitoring data and an interpretation of that data. Since the last five-year review (2015 through 2019), the data indicate that the capture of the uranium plume has been maintained and that the groundwater remedy continues to operate as designed to remove dissolved uranium contamination from the aquifer. The area of the aquifer targeted for remediation is defined in the *Fernald Groundwater Certification Plan* as the aquifer remediation footprint, which is approximately 312.7 acres in size, as of December 2019. In consultation with Ohio EPA, the name was changed to the target certification footprint (DOE 2019a). 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. Further discussion is provided in Section 5.1.5.1.

Data from 90 wells are used to assess water quality, and 172 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 optimize the existing 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.

4.3.3 Surface Water and Effluent Monitoring

Data from 23 surface water and effluent 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 (2015 through 2019):

- There were no instances of National Pollutant Discharge Elimination System (NPDES) noncompliance at the Parshall Flume (PF 4001) during the reporting period.
- Samples collected from two locations west of the former Waste Storage Area (SWD-05 and SWD-09) 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 2,087 parts per billion total uranium which was measured at SWD-09 in 2016. None of the other 21 sampling locations have had a surface water FRL exceedance for uranium. Further discussion of this anomaly is presented in Section 6.3.2.
- Samples are collected at six 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. Two of the six locations periodically exceeded the groundwater FRL for uranium (30 µg/L) during the review period. One of the cross-media impact locations in the Waste Storage Area exceeded the groundwater FRL for thorium-232 (1.2 picocuries per liter) in 2019.

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 discussed in the 2021 SER.

4.4 Site Inspections

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. Field walkdowns are conducted in the winter months when vegetation is dormant, allowing increased access and visibility. The site is divided into four quadrants, which are inspected between November and April. Attachment 8 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. Inspections are also conducted following prescribed burns. The burns remove vegetation and exposes the ground surface, allowing for increased visibility of potential findings such as debris. A post-prescribed burn inspection occurred in 2019. A prescribed burn and post-burn inspection of the OSDF were planned for 2020, but the prescribed burn was postponed due to the response to the COVID-19 pandemic.

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 2020. Inspections are led by DOE, with participation from state regulators, including Ohio EPA and the Ohio Department of Health. The LMICP identifies the inspection process for the site and the OSDF. Inspections are conducted quarterly with participation from the regulators; however, regulators were not able to participate in person in most 2020 inspections due to the response to the COVID-19 pandemic. DOE instead worked with Ohio EPA to implement a virtual inspection process, using livestream video to allow for participation in the 2020 inspections.

Annual inspection photographs are also taken across the site. The most recent inspection photographs were taken in September 2020. The entire set of annual inspection photographs are included in the annual Site Environmental Report. 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 *Fernald Preserve 2014 Site Environmental Report* (DOE 2015), is included annually in the Site Environmental Report. Representative photographs of remedy components are provided in Attachment 9.

Inspections in 2020 demonstrated activity and use limitations at the Fernald Preserve are functioning as intended. Fences, barricades, and signs are in place and properly maintained. Occasional instances of prohibited activities have been observed. These generally involve members of the public walking off trail. There have been isolated instances of trespass and unauthorized use, such as hunting and dumping along the site perimeter. These issues are reported to local law enforcement as necessary. If the frequency of prohibited activities increases, further evaluation will be necessary. The greatest number of findings identified during site inspections were related to invasive herbaceous and woody vegetation, debris, and damage to deer exclosure fencing used to protect ecologically restored planting areas while they become established. OSDF findings are mostly related to the presence of invasive herbaceous and woody vegetation on the cap and in the perimeter drainages. Vegetation and minor fence repairs are addressed as part of routine maintenance of the site.

One consistent finding in portions of the site, predominantly in the Former Production Area and former Waste Storage Area, 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. Debris is discovered through the site inspection process as well as during construction activities, site maintenance, and casual observation. It is often the case that when one piece of debris is observed during an inspection, additional debris is discovered nearby when returning to remove the debris. 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 items such as larger pieces of concrete that are too heavy for personnel to move by hand.

Debris consists mostly of construction rubble (i.e., small chunks of broken building materials). A representative photo of the construction debris found at the site is provided in Attachment 10. 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 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 (dpm) per 100 square centimeters (cm^2).

Most debris is not contaminated and is disposed of in a commercial landfill. Less than 1% 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. Debris findings are summarized in Table 9.

Table 9. Summary of Debris Findings (2011 to 2020)

Time Period	Total Number of Pieces of Debris Removed	Number of Radiologically Contaminated Debris Removed	Range of Radiologically Contaminated Debris (dpm/cm^2)[a]	Type of Radiologically-Contaminated Debris (number of pieces)
2011 to 2015	3,387[b]	45	5,000–60,000	concrete (16) metal (1) glazed tile (9) brick (4) graphite (3) rebar (1) asphalt (1)
2016 to 2020	2,311	16	5,000–20,075	concrete (14) metal (1) brick (1)

Notes:

[a] dpm/cm^2 = disintegrations per minute per centimeter squared

[b] The total number of pieces of debris removed that was reported in the *Fourth CERCLA Five-Year Review Report* (DOE 2016b) did not include the radiologically-contaminated debris; the value presented is the corrected value.

Of the radiologically contaminated debris removed since the last CERCLA five-year review, 13 of the 16 pieces were found in the Former Production Area and former Waste Pit Area. The remaining three were found immediately adjacent to those areas. This pattern is consistent with previous locations, as reported in the 2011 and 2016 CERCLA five-year review reports.

Attachment 10 contains a map of debris findings from site inspections performed in 2016 through 2020 and a map of the debris findings from site inspections from 2011 to 2020. 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 10 shows that debris found during site inspections continued to be more heavily concentrated in the remediated portions of the site. Many of the debris findings in the former production area and adjacent to the Visitor Center were identified during a post-prescribed burn site inspection that occurred in

2019. Trail design and activity and use limitations are effective in preventing the public from encountering contaminated debris. A brochure is provided in the Fernald Preserve Visitor Center to educate the public about the debris, reminding the public to stay on marked trails and to inform staff if debris is found so it can be safely and properly disposed. Additional detail regarding protective measures is included in Section 5.1.5.9.

Ecological restoration of the site continues to progress, with several restored areas well established. The quarterly site inspections, along with additional monitoring specific to restored areas, demonstrate continued establishment of prairie communities, creation of wetlands and open water habitats, and expansion of the forested areas 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 (State of Ohio 2008). As restored areas have matured, the focus of ecosystem management has shifted from vegetation establishment to invasive species control. LM has worked with the Fernald Natural Resource Trustees to update the approach for maintenance and evaluation of ecologically restored areas at the site. A site Natural Resource Management Plan has been drafted that is intended as a replacement for the existing *Restored Area Maintenance Plan* (DOE 2012). The Natural Resource Management Plan ensures continued management of restored areas at the Fernald site, consistent with community vision as documented in the *Fernald Preserve, Ohio, Site Master Plan* (DOE 2019c) and OU 5 Record of Decision (DOE 1996b).

5.0 Technical Assessment

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

<u>Question A Summary:</u>

A summary of ROD amendments and ESDs for each OU is provided in Table 1 and Section 2.3.

5.1.1 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 (DOE 2006c). 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.

5.1.2 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 (DOE 2006d). The remedial actions for OU2 are complete as intended by the OU2 ROD.

5.1.3 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 (DOE 2007a). The remedial actions for OU3 are complete as intended by the OU3 ROD.

5.1.4 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 at the Waste Control Specialists facility in Texas. 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 (DOE 2006e). The remedial actions for OU4 are complete as intended by the OU4 ROD.

5.1.5 OU5: Groundwater, OSDF, Soils, and Sediments

DOE ensures that the remedy at the Fernald Preserve remains protective of human health and the environment through the continued implementation of LMICP (DOE 2019a). The LMICP documents the requirements for the long-term care and maintenance of the Fernald Preserve. The plan outlines the ICs, including routine inspections, permits, continuing groundwater remedial activities, routine maintenance and monitoring, ecological restoration, and leachate management practices.

The groundwater remedial action is performing to design expectations. Current operating procedures (i.e., Operations and Maintenance Master Plan, Attachment A of the LMICP, 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 is 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, since 2010 (including the current reporting period) 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 routine groundwater treatment. With implementation of higher pumping rates in July 2014, a short period of nonroutine groundwater treatment (July 2015 through mid-November 2015) was needed to achieve outfall limits.

5.1.5.1 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. Groundwater is pumped and treated as necessary to meet discharge limits at the Great Miami River.

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 2014).

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 reallocated to extraction wells 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 uses 20 wells and 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 2019, a net total of 48.7 billion gallons of water have been pumped from the GMA, and 14,645 pounds of uranium have been removed from the aquifer. Table 10 provides summaries of gallons pumped, total uranium removed, and uranium removal indices for 2019 and for August 1993 through December 2019.

Table 10. Aquifer Restoration System Operational Summary Sheet

Module	Reporting Period: January 2019 through December 2019 — Gallons Pumped/ Reinjected (M gal)	Total Uranium Removed/ Reinjected (lb)	Uranium Removal Index (lbs/M gal)	Reporting Period: August 1993 through December 2019 — Gallons Pumped/ Reinjected (M gal)	Total Uranium Removed/ Reinjected (lbs)	Uranium Removal Index (lbs/M gal)
South Field Module[a]	1,350.18	290.62	0.19	25,242.39	8,947.91	0.35
Waste Storage Area Module[b]	376.37	76.96	0.17	7,746.15	2,353.39	0.30
South Plume Module[c]	567.74	85.99	0.14	17,686.99	3,419.63	0.19
Reinjection Module[d]	0	0	NA	1,936.478	76.27	NA
Aquifer Restoration Systems Totals						
Extraction Wells	2,294.28	453.57	0.17	50,675.53	14,720.93	0.30
(Reinjection Wells)	0	0	NA	(1,936.478)	(76)	NA
Net	2,294.28	453.57	NA	48,739.05	14,644.66	NA

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.

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

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 2006b) as the aquifer remediation footprint, which is approximately 312.7 acres in size, as of December 2019. In consultation with Ohio EPA, the name was changed to the target certification footprint (DOE 2019). 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 11 shows the size of the maximum uranium plume footprint at the end of 2014 and at the end of 2019 compared to the target certification footprint. The maximum uranium plume at the end of 2019 was 86.5 acres, which is 226.2 acres (72.3%) smaller than the target certification footprint. As shown in Table 11, the 30 µg/L maximum uranium plume footprint has decreased by 102.8 acres (54.3%) since 2006.

Table 11. Decreasing Uranium Plume Footprint

Year	Remaining Size of Maximum Uranium Plume Within Target Certification Footprint (acres)
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
2015	109.5
2016	105.0
2017	94.4
2018	89.3
2019	86.5

Attachment 12 illustrates the maximum uranium plume footprint as of the end of 2019. 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 monitoring wells within the plume is attributed to the movement of dissolved uranium contamination toward the 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). The current sampling program defined in the Integrated Environmental Monitoring Plan only focuses on the routine sampling of 14 of the 50 chemical constituents because 35 of 50 chemical constituents have never exceeded their FRL, and one constituent has only had a single exceedance. Even though these constituents have not had persistent exceedances, these 36 parameters will be monitored during groundwater certification to determine if they remain below their FRLs as documented in the *Fernald Groundwater Certification Plan* (DOE 2006b). The remaining 14 constituents are currently monitored semiannually, and concentrations are reported annually in the Site Environmental Report.

As discussed in the annual Site Environmental Reports, most of the locations where non-uranium constituents are present at concentrations above their FRLs lie within the model predicted 10-year, uranium-based restoration plume footprint. However, sporadic FRL exceedances have been detected outside of the model predicted 10-year, uranium-based restoration footprint (e.g., zinc, manganese). Monitoring results for the last 24 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. Past exceedances for zinc and manganese in the aquifer outside the uranium-based restoration footprint 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 Site Environmental Reports. Monitoring results indicate that no changes to the uranium-based aquifer remedy are necessary to address sporadic nonuranium FRL exceedances outside of the defined restoration footprint for the aquifer remediation.

Review of groundwater remedy progress reported annually in the Site Environmental Report reveals that the remedy continues to be protective of human health and the environment. Specifically:

- ICs, as specified in Section 2.3.3, 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 450 pounds of uranium each year.
- Groundwater treatment is no longer routinely required to meet uranium discharge limits.

Review of groundwater remedy progress reported annually in the SER also reveals that the efficiency of the remedy continues to decrease over time, which is common for pump-and-treat operations. As reported in the 2019 SER, in the first 26 years of pumping, 48.7 billion gallons of water have been pumped, and 14,645 pounds of uranium have been removed from the aquifer. Current modeling predictions call for an additional 14 years of pumping to remove 24.3 more billion gallons of water and 1,521 additional pounds of uranium. The remaining 14 years of pumping will, therefore, be much less efficient than the first 26 years, which is common for pumping operations. DOE remains committed to further optimizing the pumping operation and exploring ways to apply innovative technologies to the remedy in efforts to increase the effectiveness of the remedy. A DOE National Lab Collaboration workshop on the Fernald groundwater remedy is scheduled for 2021, with the objective of providing recommendations to improve the existing well field maintenance program and improve the efficiency of the overall groundwater remedy to achieve concentration-based remediation goals.

5.1.5.2 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, Remedial Design for Aquifer Restoration* (DOE 1997), hereafter referred to as the Baseline Remedial Strategy Report (BRSR). The BRSR strategy predicted that the groundwater remediation schedule could be shortened from that presented in the *Feasibility Study for Operable Unit 5* (DOE 1995a) 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. 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 2014). The 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 13 provides a comparison of the actual versus predicted gallons of groundwater extracted from the GMA from fiscal year (FY) 1993 through FY 2019. As shown in Attachment 13, actual versus predicted gallons of groundwater extracted from the GMA match fairly well. This is due to an aggressive well maintenance and operational program. It should be noted in 2016 extraction was lower than planned due to an unplanned well field shutdown caused by a damaged transformer. It should also be noted that extraction in 2018 and 2019 was lower than planned due to the impact of CAWWT construction projects.

Attachment 14 is a plot showing the actual versus model predicted pounds of uranium to be removed from the aquifer from 1993 to 2019. The 2005 remedy design was optimized in 2014 by eliminating three wells that were no longer providing benefit to the remediation and by strategically increasing the pumping rate in areas of the plume where remaining uranium concentrations were higher. This operational optimization is reflected in Attachment 14 by the increases shown in uranium pounds (both actual and planned) from 2014 to 2019. The actual increase in pounds removed in 2014 and 2015 gradual decreases from 2015 to 2019 but not as fast as the model predicted it would. This indicates that pumping is still effective in removing uranium from the aquifer, but that there is a growing disconnect between the amount of uranium that the model predicts will be removed and the actual amount being removed. The data trend from 2015 to 2019 indicates that the efficiency of the pump-and-treat operation was decreasing. This situation is common to pump-and-treat remediations and indicates that another operational optimization should be considered in the near future. DOE remains committed to evaluating ways to improve the remedy as the remedy progresses. The DOE National Laboratory Collaboration planned for 2021 is an example of the proactive action DOE is taking to seek out and find innovative ways to improve the groundwater remedy.

As shown in Attachment 14, more uranium has been removed from the aquifer than was predicted by the groundwater model since FY 2010.

5.1.5.3 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 groundwater remedy.

Groundwater elevations in the aquifer are measured quarterly, and 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 15 provides an example of a quarterly water level map. Quarterly water level maps and the associated plume capture analysis are published annually in the Site Environmental Reports.

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.

5.1.5.4 Uranium Concentration Predictions

An assessment of uranium concentrations (observed concentrations versus model-predicted concentrations) evaluates how reasonable the groundwater model uranium concentration predictions remain over time. Two such assessments are provided annually in the Site Environmental Report. From 2015 through 2019, a comparison has been reported of model predicted total uranium concentrations in the extraction wells versus actual measured average concentrations in the extraction wells and, from 2017 through 2019, a comparison has been reported of model predicted average total uranium concentration from select monitoring wells versus model predicted average uranium concentration from those wells. Table 12 shows the differences between predicted and actual uranium concentrations.

Table 12. Comparison of Predicted to Actual Uranium Concentrations in Extraction and Monitoring Wells

Year	Model-Predicted Average Total Uranium Concentrations from Extraction Wells (µg/L)	Actual Average Total Uranium Concentration from Extraction Wells (µg/L)
2015	23.1	22.6
2016	20.5	23.5
2017	18.5	22.0
2018	16.8	21.1
2019	15.3	19.9

Year	Model-Predicted Average Total Uranium Concentration from Select Monitoring Wells (µg/L)	Actual Average Total Uranium Concentration from Select Monitoring Wells (µg/L)
2017	33.9	42.0
2018	30.2	38.5
2019	27.4	40.8

As the data in Table 12 show, the actual concentrations being measured result in yearly averages that are higher than the model predicted yearly averages (with one exception in 2015 for the extraction wells). This indicates that more uranium is being removed from the aquifer than was predicted to be removed by the model.

5.1.5.5 Uranium Removal Predictions

Modeling provides predictions for the amount of uranium to be recovered from the aquifer to achieve concentration-based cleanup goals assuming pumping continues to the model predicted end date. Water samples are collected monthly from extraction wells and analyzed for total uranium as a means of checking how close actual conditions are matching model predictions. The monthly average total uranium concentrations are used to calculate the mass of uranium removed from the well. Each year, new uranium concentration data is added to the data set for each extraction well, and the data sets are trended using Excel software to determine the total pounds of uranium to be removed by the well if pumping continues to the model predicted end date. Using this procedure, the total number of predicted pounds to be removed changes slightly each year. Because the majority of the data sets are trailing asymptotic, the predicted total number of pounds to be removed slightly increases each year. This is further discussed below.

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 Site Environmental Reports. For the past 5 years, the percent complete has been reported as shown in Table 13.

Table 13. Comparison of Percent Complete of Actual to Predicted Pounds of Uranium

Year	Percent Complete Based on Actual Pounds of Uranium Removed	Percent Complete Based on Model Predictions
2015	79%	81%
2016	84%	84%
2017	86%	87%
2018	87%	89%
2019	86%	91%

As shown above, for the past 5 years the percent complete based on actual data has not kept pace with the steady rise in percent complete predicted by the model. As discussed above, this is because the total predicted pounds of uranium to be removed slightly increases each year due to the asymptotic nature of the uranium concentration trends. The model prediction does not change each year but the percent complete steadily increases from year to year. The percent complete based on the actual concentration data is not a steady increase because the predicted total amount of pounds to be removed changes slightly each year based on the trend of the actual data. Attachment 16 illustrates percent complete model predictions versus measured concentrations from 2006 through 2033. The break in trend results from the new modeling predictions obtained from the 2014 optimization. The new model predictions from 2014 indicate that the remedy will pump longer to achieve cleanup goals than previously estimated.

5.1.5.6 Groundwater Treatment

As reported in the Third CERCLA Five-year Review Report (DOE 2011), there is no longer a need to routinely treat groundwater prior to discharge to the Great Miami River in order to meet uranium discharge limits. Since 2010, the aquifer remedy has been able 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 routine 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.

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 treatment capacity of 500 to 600 gpm was significantly more than was needed. Groundwater modeling predictions predicted that this high of a treatment capacity would 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 all reached agreement on replacing the CAWWT with a 50 gpm system, capable of expanding in the future if necessary. The project was initiated in 2016, and the new system became operational on April 3, 2018. In 2019, the backwash basin, which is used to hold wastewater from the site before being treated, was refurbished.

5.1.5.7 Status of OSDF Leachate and Leak Detection

The OSDF is a potential contamination source above an area where soil was remediated to FRLs that 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. LCS and LDS 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 low flow rate of 2 gpad, which is one-hundredth the design action leakage rate of 200 gpad. The importance of the design action leakage rate was discussed in Section 4.3.1. 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 2019, only three cells (Cells 4, 6, and 8) had enough flow in the LDS to collect a water sample. From a sampling perspective, Cells 1, 2, 3, 5, and 7 were dry the entire year. The highest LDS maximum accumulation rate recorded in 2019 was 0.32 gpad in Cell 6, which is 16% of the low-flow response leakage rate of 2 gpad and 0.16% of the design action leakage rate.

As presented annually in Attachment A.5 in the Site Environmental Report, water quality of the leachate in the facility (i.e., LCS and LDS) as well as groundwater beneath the facility (HTWs and GMA monitoring wells) are sampled. 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. 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 any increasing concentration trend observed below the facility can be attributed to pre-existing conditions and not to a leak from the facility.

5.1.5.8 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, inspection findings were predominantly the presence of woody vegetation and noxious weeds. The woody vegetation and noxious weeds are addressed as part of regular site maintenance activities using a combination of methods, including prescribed burning, herbicide application, and physical removal. Water drainage repairs made in 2014 at two locations in the west inner drainage channel and reported in the Fourth CERCLA Five-Year Review Report (DOE 2016c) continue to allow proper drainage.

The LMICP identifies the inspection process for the site and the OSDF. Inspections are conducted quarterly with participation from the regulators; however, regulators were not able to participate in person in most 2020 inspections due to the response to the COVID-19 pandemic. DOE instead worked with Ohio EPA to implement a virtual inspection process, using livestream video to allow for participation in the 2020 inspections. This inspection process satisfies the 5-year inspection requirement. EPA was not able to participate due to the COVID-19 pandemic.

5.1.5.9 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 pumping activities are complete (projected in the year 2035) and the last portion of the aquifer has been certified clean (projected in the year 2039), 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% of debris from 2016 through 2020. No removable contamination has been associated with any of the debris. Because portions of the site are 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 10 shows the location of trails in relation to debris findings across the site during inspections in 2016 through 2020. Trail locations were specifically designed to avoid areas where debris might be located. Only one trail traverses the central portion of the site. Prior to construction, extensive debris identification and removal was undertaken in trail corridors.

Second, protective measures are in place to limit public access. The public is prohibited from traveling off 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. In recent years, most debris findings are discovered following prescribed burns, when vegetation is cleared to expose the ground surface.

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. Quarterly inspection reports and the Site Environmental Reports are available online at https://www.energy.gov/lm/fernald-preserve-ohio-site; select the documents link to locate the site-related reports. Attachment 10 contains a map of debris findings from site inspections performed in 2016 through 2020 and a map of the debris findings from site inspections from 2011 to 2020.

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.

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

Yes. Based on the evaluation presented below and Attachment 17, 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 cancer slope factors (CSFs), reference doses (RfDs), and exposure factors do not result in ILCR and Hazard Index (HI) values that exceed 1×10^{-4} and 1, respectively. However, the presented results only address a site worker and recreational user for the onsite undeveloped park; as groundwater remediation is ongoing and evaluation of the offsite farm scenario (i.e., groundwater pathway for ingestion of water by humans and livestock and irrigation of crops) will be part of the final risk assessment that will be prepared after groundwater restoration goals are met.

<u>Question B Summary:</u>

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 2006f), the 2006 CSFs and 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 for Operable Unit 5* (DOE 1995a). 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.

The Interim Residual Risk Assessment (IRRA) was prepared to assess the risk to human health for a recreational user in an undeveloped park that was exposed to post-remediation contaminants in the air, soil, and surface water at the Fernald site (DOE 2007b). Groundwater remediation is ongoing, and a final risk assessment will be performed to evaluate the offsite farm scenario after 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, the Former Production Area (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 because ILCR and HI values did not exceed 1×10^{-4} and 1, respectively.

The fourth five-year review (DOE 2016) proceeded in a manner similar to the third five-year review, where 2015 CSFs and RfDs were compiled, compared to values used in the 2011 five-year review, and entered into the undeveloped-park user scenario in Zone 5 to calculate human-health risk. 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.

This five-year review compiled 2020 CSF and RfD values, compared them to 2015 values, and calculated risk for the recreational user in an undeveloped park, as was done for previous five-year reviews. EPA exposure factors were reviewed and found to be identical to those used in the fourth five-year review (DOE 2016c). In general, the new CSF values slightly decreased the ILCR and new RfDs slightly increased the HI. However, ILCR and HI values did not exceed

1×10^{-4} and 1, respectively, and risk assumptions remain valid for the OU5 post-remedial recreational user at an undeveloped park. Attachment 17 provides additional detail regarding risk calculations using the updated CSFs and RfDs.

5.2.1 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 1995e). The risk to the modeled receptor had to be less than 1×10^{-4} for the ILCR and less than 1 for the 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 1995e]).

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 1995a). 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 indicating that the risk was below the cleanup standards.

After the 2006 completion of the OU5 soil remedy, the IRRA was prepared to assess the risk to onsite recreational users by post-remediation (i.e., actual residual) contaminant concentrations in air, soil, and surface water media within eight exposure zones on the Fernald site (DOE 2007b). Exposure pathways for the recreational users 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 RI 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.

5.2.2 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.

5.2.3 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.

5.2.4 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 or RfDs. For this five-year review, RAIS was queried to obtain the most recent CSFs and RfDs for each exposure pathway (i.e., inhalation, ingestion, dermal, and external radiation). Absorption factors and permeability factors for the dermal exposure pathway were also reviewed to ensure the most recent values were incorporated into the updated calculations. 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 generally 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 December 23 and 26, 2020. Attachment 17 shows a comparison of the December 2020 CSF and RfD values to the values used in the *Fourth Five-Year Review Report for the Fernald Preserve* (DOE 2016c). 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) EPA exposure factors identical to the 2015 values (no new exposure factors reported), 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 16-4, were evaluated and summed to produce the results in Table 14. 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 and increased slightly in 2020, relative to the 2016 Fourth Five-Year Review Report. The decrease in ILCR is primarily due to the decrease in oral CSF for all radionuclides. The increase in HI is due to a new reported RfD for benzo(a)pyrene (no RfD was available in 2016) and a decrease in the RfD for uranium (which increased the uranium HQ) (Attachment 17).

Table 14. Comparison of IRRA (2007) and Previous Five-Year Reviews 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 (DOE 2016c)	2.57×10^{-5}	2.01×10^{-2}
Undeveloped Park User (this report, Attachment 17)	1.84×10^{-5}	3.94×10^{-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 CSF and RfDs do not result in ILCR and HI values that exceed 1×10^{-4} and 1, respectively. Attachment 17 provides additional detail.

5.2.5 Ecological Risk

Ecological risk assumptions and processes are evaluated as part of the five-year review. This section provides background and a review of the assessment documented in the 2016 Fourth CERCLA Five-Year Review Report (DOE 2016c). This review shows that this previous assessment is still valid and that the remedy remains protective of ecological receptors.

5.2.5.1 Ecological Risk Background

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.

As part of the screening update in the SEP, a review of the assumptions associated with receptor organisms, exposure pathways, calculation parameters, and the target level radiological dose indicated that these assumptions remained valid. 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 (DOE 2011), 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 in the 2016 Fourth CERCLA Five-Year Review Report (DOE 2016c) provided a data set of media-specific ESLs that were considered for this review. The ESLs were presented in two tiers. Tier 1 ESLs were 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 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.

Updated soil and surface water ESLs were compared to zone-specific maximum and average concentrations from the IRRA. Some maximum zone concentrations exceeded the ESLs. However, a comparison of more representative average values for each zone demonstrates that soil and water concentrations across the site are generally protective of ecological receptors.

5.2.5.2 2020 Ecological Risk Review

A review of current published ESLs showed that the 2016 evaluation is still valid. No significant changes in Tier I or Tier II were observed. In addition, field data from ecological surveys and wetland mitigation monitoring continue to show diverse and growing ecosystems. No signs of toxicological stress have been observed during field activities.

A review of ESLs will be completed in subsequent CERCLA five-year reviews, and, 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.

5.2.6 Review of Maximum Contaminant Levels (MCLs)

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

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

No. 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. Previous assessments concerning emerging contaminants, specifically per- or polyfluorinated alkyl substances (PFASs), remain valid; however, because the PFAS issue continues to evolve in terms of known sources, DOE will further evaluate this concern based on current understanding of PFASs. Further discussion is provided in Section 5.3.1.1.

5.3.1 Emerging Contaminants

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. EPA has identified the contaminants listed (https://www.epa.gov/fedfac/emerging-contaminants-and-federal-facility-contaminants-concern). A brief evaluation of each emerging contaminant is presented in Table 15.

5.3.1.1 Perfluorooctane Sulfonate and Perfluorooctanoic Acid

EPA has identified perfluorooctane sulfonate (PFOS) and perfluorooctanoic acid (PFOA) as emerging contaminants (EPA 2014). These chemicals were used in a variety of products, such as surfactants and fire suppressant 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.

To address this issue, DOE submitted two deliverables: (1) *Draft Perfluorinated Compound Groundwater Screening Sampling and Analysis Plan* (DOE 2016a) and (2) *Draft Polyfluorinated Alkyl Substances Investigation Plan for the Fernald Preserve* (DOE 2018a). EPA now refers to the perfluorinated compounds as PFASs.

Table 15. Summary of Emerging Contaminants

Emerging Contaminant	Use	Occurrence	Potential Site Use
1,2,3 Trichloropropane	Manmade chlorinated hydrocarbon, often found at sites contaminated by other chlorinated solvents (EPA 2017a).	Most likely to occur near hazardous waste sites where chemical was improperly stored or disposed. May remain in groundwater for long periods.	Further discussion below. Chlorinated solvents used at the site, but minimal solvent contamination is present.
1,4-Dioxane	Manmade chlorinated hydrocarbon, often found at sites contaminated by other chlorinated solvents (EPA 2017b). Radiological laboratory equipment (i.e., liquid scintillation counters) contained the chemical.	Typically found at some solvent release sites, especially sites with 1,1,1,-trichloroethane contamination.	Further discussion below. Chlorinated solvents used at the site, but minimal chlorinated solvent contamination is present. Liquid scintillation counters were utilized in the onsite laboratory.
2,4,6-Trinitrotoluene	Widely used military explosive (EPA 2017c).	Released through spills at manufacturing and munitions processing facilities.	None
Dinitrotoluene	Widely used military explosive (EPA 2017d).	Released through spills at manufacturing and munitions processing facilities.	None
Hexahydro-1,3,5-trinitro-1,3,5-triazine	Widely used military explosive (EPA 2017e).	Released through spills at manufacturing and munitions processing facilities.	None
Nanomaterials	Diverse class of substances released mainly through industrial and environmental applications, improper handling or consumer waste. Releases through production of nanoparticles and medical and consumer uses (EPA 2017f).	Largely dependent on the material released.	None
N-Nitroso-dimethylamine	Found in the production of rocket fuel, antioxidants, and softener for copolymers. Currently used only for research purposes (EPA 2017g).	Released through spills at manufacturing and processing facilities.	None
Perchlorate	Contamination found at sites involved in the manufacture, maintenance, use, and disposal of ammunition and rocket fuel (EPA 2017h).	Released through spills or improper disposal at manufacturing and processing facilities.	None
Perfluorooctane Sulfonate (PFOS) and Perfluorooctanoic Acid (PFOA)	Used in a variety of industrial and consumer products such as carpet and clothing treatments and firefighting foams (EPA 2017i). These chemicals are also used as anti--corrosives in uranium enrichment and metal plating.	Released through spills or improper disposal at manufacturing sites and at sites with firefighting training activities.	Further discussion below. Fire Training facility used very small volumes of aqueous foam firefighting liquids as documented in the Fourth CERCLA Five-Year Review Report (DOE 2016c). Uranium enrichment and metal plating were not operations conducted at Fernald. Highly corrosive UF_6 was used at the site.
Polybrominated Biphenyls	Used as a fire retardant in electrical equipment, electronic devices, etc. (EPA 2017j).	Not produced in the United States since 1976 and no longer in use.	None
Polybrominated Diphenyl Ethers	Used as flame retardants for electrical equipment, electronic devise, furniture, textiles and other household products (EPA 2017k).	Widely used in many consumer products in the United States since the 1970s.	None
Tungsten	Naturally occurring element, used in welding, oil drilling, electrical, and aerospace industries. Introduced in the mid-1990s as a replacement for lead ammunition (EPA 2017l).	Contamination found at military sites after replacement of lead bullets with tungsten bullets.	None. Shooting ranges existed historically at the site, but all were discontinued when the site mission changed to clean up in the early 1990s.

The investigation plan (DOE 2018a) provided the informational summary of the issue:

- Fernald used a very small volume of aqueous film-forming foam (i.e., less than 25 gallons) from 1976 to 1990. This is orders of magnitude lower than volumes used at military bases or produced by aqueous film-forming foam manufacturing facilities.
- PFAS use at the Fernald site was exclusively for fire training purposes and occurred in just one area of the site, the Fire Training Facility (FTF).
- Extensive soil remediation of the entire Fernald site was completed in 2006, with over 13,000 cubic yards of impacted soil removed from the FTF area alone. This equates to over 800 16-cubic-yard truckloads. Given that the geochemical properties of PFAS are similar to the organic contaminants present at the FTF, it is reasonable to assume the soil remediation effort removed potential residual sources of PFAS as part of the sitewide CERCLA cleanup.
- On the basis of the site geology (25–35 feet of surficial clay-rich glacial overburden deposits), hydrogeology, and PFAS transport properties, the potential pathway for PFAS contaminants to reach the GMA is the same pathway that uranium contamination would have taken to reach the GMA via surface water to areas where the surface waters come into direct contact with the underlying permeable GMA sand and gravel (i.e., areas where the low-permeability glacial overburden is absent).
- Since the late 1990s, the uranium plume in the GMA has been undergoing active remediation. Through 2017, this effort has resulted in the extraction of more than 46 billion gallons of groundwater. Through 2020, 52 billion gallons of groundwater have been extracted. This volume of water equates to a column of water nearly 140 feet deep over the entire Fernald Preserve.
- In the unlikely event that significant concentrations of PFAS contaminants from the FTF found their way to the GMA prior to remediation of the FTF area, the PFAS have been and are being contained and removed from the aquifer along with the uranium plume since 1996.
- A public water supply funded in part by DOE has been in place since 1996 in the off-property areas affected by the uranium plume in the GMA.
- Groundwater as a drinking water source is restricted in areas affected by the Fernald Preserve uranium plume, with ICs in place to ensure this restriction.

Based on this information, PFASs are not a widespread issue at the Fernald Preserve. Additional potential industrial uses of PFAS have been recently identified. An evaluation of these newly identified general industrial uses at Fernald will be completed to determine if they were used at Fernald. Additional discussion is provided in Section 6.0.

5.3.1.2 Chlorinated Solvents (1,2,3-Trichloropropane and 1,4-Dioxane)

The emerging contaminants 1,2,3-trichloropropane and 1,4-dioxane are synthetic industrial chemicals that may be found in groundwater at sites contaminated with certain chlorinated solvents because of their persistence and widespread use as a stabilizer for chlorinated solvents (particularly 1,4-dioxane). The chemicals are likely human carcinogens. 1,2,3-trichloropropane is used as an industrial solvent and as a cleaning and degreasing agent (EPA 2017a). 1,4-dioxane is a byproduct present in many consumer goods including paint strippers, dyes, greases, antifreeze, deodorant, shampoos, and cosmetics. It is also present in some food supplements, or food containing residues from packaging adhesives, or on food crops treated with pesticides that contain 1,4-dioxane. Synonyms for 1,4-dioxane include dioxane, dioxan, p-dioxane, diethylene dioxide, diethylene oxide, diethylene ether, and glycol ethylene ether (EPA 2017b).

1,4-dioxane was used during radiological analysis in the onsite laboratory using liquid scintillation counting. Liquid scintillation is used to quantify radioisotopes and requires a specific cocktail to absorb the energy into detectable light pulses. Approximately 10 milliliters of a mixture of organic solvents (including 1,4-dioxane), detergents, and fluorescence is used and consumed during analysis. Prior to the RCRA disposal requirements, the waste would have been disposed with all other liquid laboratory waste in the General Sump. Disposal following enactment of the RCRA in 1976 was containerization of the waste with disposal offsite under the RCRA waste disposal requirements.

While sampling and analysis for these chlorinated solvents has not been conducted at the site, sampling for many other chlorinated solvents has occurred in the past. As stated above, these two contaminants are generally found at sites contaminated with chlorinated solvents. Only one chlorinated solvent, trichloroethene, has exceeded the groundwater FRL of 0.0050 milligrams per liter. Of the over 1,500 samples collected and analyzed for trichloroethene since 1997, only 2.6% have exceeded the FRL. These exceedances are isolated exceedances at two locations in the former Waste Storage Area and are within capture of the groundwater extraction system. Based on this isolated nature of chlorinated solvent groundwater contamination at the Fernald Preserve, it is unlikely that 1,2,3-trichloropropane or 1,4-dioxane are present.

5.3.2 Climate Change

Climate change is a complex topic to address due to both regional and seasonal variations (EPA 2016). During the next century, EPA predicts that Ohio is expected to have increased precipitation and more severe summer and fall droughts. Increasing humidity, higher average rainfall, and more frequent heavy rainstorms will potentially lead to increased flood episodes. The site's remedy has been designed to addresses several potential climate change effects.

The OSDF was designed to withstand a 2,000-year flood, and drainage features associated with the OSDF are regularly inspected and maintained. The vegetative cover on the OSDF consists of native warm-season grasses and forbs. These species were selected partly due to drought tolerance once established. The cap is regularly inspected and maintained with prescribed fire, which is recognized as the preferred approach for native grassland management.

Sitewide ecological restoration provides several benefits to ensure climate resiliency. First, as with the OSDF cap, use of native vegetation for soil stabilization helps protect against damage from flooding and drought. Native grasses, forbs, and woody plants are well-adapted to withstand the weather and temperature changes that are anticipated in the coming decades. Second, restoration along the Paddys Run corridor was intended to increase floodplain where possible. The site has limited infrastructure along the corridor, which allows for expansion of floodplain on-property and subsequent mitigation of flood impacts both upstream and downstream of the site. Third, maintenance of restored areas uses adaptive management to adjust area-specific goals and objectives. This has occurred at several areas in recent years due to increased beaver activity. Beaver dams have expanded wetlands and open water in some portions of the site. For these instances and when there is increased flooding along Paddys Run, DOE intervenes only when infrastructure is threatened. An example of this is the maintenance activity to address increasing erosion along Paddys Run that was completed in 2014. Details of this project are presented in Section 6.2.2.

DOE has an established well field and treatment system maintenance program that prepares the site's instrumentation and controls systems for operational disruptions during power outages. In addition to formal preventive maintenance activities, several routine system checks are performed by operations personnel between scheduled preventive maintenance activities to ensure equipment is functioning properly. Many of the site's electrical lines are buried, which protects some of the power lines from weather-related damage and resulting power outages. Isolated power failures still periodically occur, mainly due to minor surges from external influences or lightning strikes. DOE plans for these outages and has calculated that the site's well field can be nonoperational for 1,080 days without contaminated groundwater exceeding the southern extent of the well field capture.

DOE has conservatively planned for these climate factors throughout the remedial design for the Fernald Preserve and will continue to assess these factors and effects of extreme weather on the site's remedies as additional information becomes available.

5.3.3 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 last 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. DOE remains committed to further optimizing the pumping operation and exploring ways to apply innovative technologies to the remedy in efforts to increase the effectiveness of the remedy. A DOE National Lab Collaboration workshop on the Fernald groundwater remedy is scheduled for 2021, with the objective of providing recommendations to improve the existing well field maintenance program and improve the efficiency of the overall groundwater remedy to achieve concentration-based remediation goals.

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.

6.0 Issues/Recommendations

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: Operations and Maintenance**			
	Issue: Groundwater must achieve FRLs. Sitewide soils 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:** Groundwater must achieve FRLs and soils must be certified following removal of aquifer infrastructure including subgrade utility corridors and associated buildings. A draft soil certification report will be submitted for regulatory review.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
No	Yes	Federal Facility	EPA/State	December 31, 2040
OU(s): 5	**Issue Category: Changed Site Conditions**			
	Issue: Presence or absence of PFAS aquifer contamination due to potential uses in historical site processes (e.g., uranium enrichment and metal plating).			
OU(s): 5	**Recommendation:** Submit for regulatory review, an evaluation report for uses of PFAS in historical processes.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
No	Yes	Federal Facility	EPA/State	September 9, 2022

6.1 Issue 1: Achievement of Groundwater FRLs and Soil Certification of Aquifer Restoration Infrastructure 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.

Soils beneath the utility corridors and aquifer remediation building footprints remains to be remediated (if necessary) and certified after removal of the aquifer remediation infrastructure. This will occur following completion of the groundwater remediation pumping activities and groundwater certification, projected in the year 2035 and 2040, respectively. Therefore, this issue does not affect current protectiveness. In order to be protective in the future, groundwater as well as soils beneath the aquifer remediation infrastructure must be certified to meet FRLs specified in the OU5 ROD. A draft soil certification report will be submitted for regulatory review by December 31, 2040.

6.2 Issue 2: Presence or Absence of PFAS Aquifer Contamination

Additional potential industrial uses of PFAS have been recently identified. An evaluation of these newly identified general industrial uses will be conducted to determine if they were historically used at Fernald. An evaluation will be completed and submitted within one year of five-year review report approval.

6.3 Other Findings

Table 16. Findings

Finding Number	Findings	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

6.3.1 Finding 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

6.3.1.1 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 18 shows how water levels have fluctuated for one well over the past 13 years during the shutdowns (2007–2019). A review of data from monitoring wells 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 reported in the OU5 RI (DOE 1995e) 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 higher levels.

6.3.1.2 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 19 is a map that shows the maximum uranium plume (as of December 2019) 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.

Direct push sampling between 2014 and 2019 within this off-property lobe of the plume indicates that the total uranium concentration has decreased from 253 µg/L to 49.1 µg/L. Additional operational time is required to determine if the modeling predictions for this lobe of the plume 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.

6.3.1.3 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 pore spaces of 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 to help optimize performance may have helped to address this concern as evidenced by the larger amount of uranium that was removed from the aquifer between 2014 and 2019. 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.

6.3.1.4 Well Field Maintenance

As the extraction system has aged, well field maintenance has become more challenging. Optimizing the system in 2014 through increased pumping has only contributed to the challenge. Current methods for maintaining the pumps, motors, and well screens due to iron fouling and plugging are becoming less effective. DOE is continuing to explore better ways to maintain the wells to keep the groundwater remedy operational. The issue of well maintenance will be discussed in a DOE National Laboratory Collaboration occurring in 2021.

6.3.1.5 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, these issues do not affect current or future protectiveness of the remedy. These issues could affect the timing for remedy completion. DOE continues to look for innovative ways to improve upon the efficiency of the groundwater remedy. The DOE National Lab Collaboration planned for 2021 is an example of the proactive action DOE is taking to seek out and find innovative ways to improve the groundwater remedy.

As stated in Section 5.1.5.2, the data trend from 2015 to 2019 indicates that the efficiency of the pump-and-treat operation was decreasing. This situation is common to pump-and-treat remediations and indicates that another operational optimization should be considered in the near future.

6.3.2 Finding 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 in the former Waste Pits Area, Ohio EPA sample results were above the surface water FRL for uranium (530 µg/L). DOE confirmed these sampling results in early 2007. Routine sampling has been conducted in this area at both locations since 2007, and results are reported each year in Appendix B of the annual Site Environmental Report. Between January 2007 and December 2019, SWD-05 has been sampled 228 times, and SWD-09 has been sampled 387 times. Data indicate that the concentrations display a cycle of high to low each year. Fifteen of the 228 samples collected at SWD-05 (6.6%) and 242 of the 387 samples collected at SWD-09 (63%) have exceeded the total uranium surface water FRL. There were no surface water FRL exceedances for uranium at SWD-05 in 2019. The highest concentration measured in SWD-09 in 2019 was 1,255 µg/L. An historical high of 2,087 µg/L was measured at SWD-09 in 2016. The overall statistical trend calculated in 2019 (Mann-Kendall with a 95% confidence interval) for FRL exceedances at SWD-09 was "Down."

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 rainwater (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 in the vadose zone. 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 continues to be 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. Total uranium concentrations at both locations continue to statistically trend downward. It should also be noted that any surface water infiltrating down into the aquifer is captured by nearby downgradient wells that are pumping as part of the aquifer remedy.

6.3.3 Finding 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 that is not accessible to the public. To date, there is no evidence that members of the public have handled contaminated debris. The program to identify and remove debris will continue. Results of the debris management program are included in quarterly inspection reports and reported annually to the public in the Site Environmental Report.

As discussed in Section 5.1.5, multiple controls are in place to manage debris, and this issue does not affect the current or future protectiveness of the remedy.

6.4 Findings and Follow-Up Actions

Table 17. Findings and Follow-Up Actions

Finding	Findings and Follow-Up Actions	Affects Protectiveness (Y/N)	
		Current	Future
1	1.1 Continue annual well field shutdown to allow water levels to rebound.	N	N
	1.2 Determine need to change pump-and-treat configuration based on characterization data.	N	N
	1.3 To address potentially ineffective plume flushing, determine what pumping rate changes may be beneficial.	N	N
	1.4 Continue with aggressive well maintenance program and keep wells operating at design set points.	N	N
2	Continue surface water sampling program.	N	N
3	Continue current debris management program.	N	N

7.0 Protectiveness Statement

Protectiveness Statement(s)

Operable Unit:	*Protectiveness Determination:*
1	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 2.3.3, 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:	*Protectiveness Determination:*
2	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:	*Protectiveness Determination:*
3	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.

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 in progress at OU5 is currently protective of human health and the environment because the pump and treat remedy maintains hydraulic capture of the groundwater plume and exposure pathways that could result in unacceptable risks are being managed and mitigated through institutional controls. However, groundwater must achieve Final Remediation Levels (FRLs) to be protective long-term. 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 2.3.3 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) groundwater must achieve FRLs and soils associated with the aquifer restoration infrastructure footprint will need to be certified; and (2) a PFAS evaluation of historical uses to determine the potential for releases which may have resulted in unacceptable environmental impacts will need to be completed.	

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 and mitigated through institutional controls. 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) groundwater must achieve FRLs and soils associated with the aquifer restoration infrastructure footprint will need to be certified; and (2) a PFAS evaluation of historical uses to determine the potential for releases of PFAS will need to be completed.

8.0 Next 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.

9.0 References

40 CFR 264.302. "Action Leakage Rate," *Code of Federal Regulations*.

40 CFR 300.430. "Remedial Investigation/Feasibility Study and Selection of Remedy," *Code of Federal Regulations*.

DOE (U.S. Department of Energy), 1994a. *Interim Record of Decision for Remedial Action at Operable Unit 3*, Final, Fernald Environmental Management Project, Fernald Area Office, Cincinnati, Ohio.

DOE (U.S. Department of Energy), 1994b. *Record of Decision for Remedial Actions at Operable Unit 4*, Final, Fernald Environmental Management Project, Fernald Area Office, Cincinnati, Ohio.

DOE (U.S. Department of Energy), 1995a. *Feasibility Study for Operable Unit 5*, Final, Fernald Environmental Management Project, Fernald Area Office, Cincinnati, Ohio.

DOE (U.S. Department of Energy), 1995b. *Operable Unit 3 Remedial Design/Remedial Action Work Plan for Interim and Final Remedial Actions*, Final, Fernald Environmental Management Project, Fernald Area Office, Cincinnati, Ohio.

DOE (U.S. Department of Energy), 1995c. *Record of Decision for Remedial Actions at Operable Unit 2*, Final, Fernald Environmental Management Project, Fernald Area Office, Cincinnati, Ohio.

DOE (U.S. Department of Energy), 1995d. *Record of Decision for Remedial Actions for Operable Unit 1*, Final, Fernald Environmental Management Project, Fernald Area Office, Cincinnati, Ohio.

DOE (U.S. Department of Energy), 1995e. *Remedial Investigation Report for Operable Unit 5*, Final, Fernald Environmental Management Project, Fernald Area Office, Cincinnati, Ohio.

DOE (U.S. Department of Energy), 1996a. *Operable Unit 3 Record of Decision for Final Remedial Action*, Final, Fernald Environmental Management Project, Fernald Area Office, Cincinnati, Ohio.

DOE (U.S. Department of Energy), 1996b. *Record of Decision for Remedial Actions at Operable Unit 5*, Final, Fernald Environmental Management Project, Fernald Area Office, Cincinnati, Ohio.

DOE (U.S. Department of Energy), 1997. *Baseline Remedial Strategy Report, Remedial Design for Aquifer Restoration*, Final, Fernald Environmental Management Project, Fernald Area Office, Cincinnati, Ohio, June.

DOE (U.S. Department of Energy), 1998a. *Explanation of Significant Differences for Operable Unit 4 Silo 3 Remediation Action*, Final, Fernald Environmental Management Project, Fernald Area Office, Cincinnati, Ohio.

DOE (U.S. Department of Energy), 1998b. *Sitewide Excavation Plan,* Final, Fernald Environmental Management Project, Fernald Area Office, Cincinnati, Ohio.

DOE (U.S. Department of Energy), 2000. *Final Record of Decision Amendment for Operable Unit 4 Silos 1 and 2 Remedial Actions*, Revised, Fernald Environmental Management Project, Fernald Area Office, Cincinnati, Ohio.

DOE (U.S. Department of Energy), 2001a. *Explanation for Non-Significant Differences for Operable Unit 5 Record of Decision*, Final, Fernald Environmental Management Project, Fernald Area Office, Cincinnati, Ohio.

DOE (U.S. Department of Energy), 2001b. *First Five-Year Review Report for the Fernald Closure Project*, Final, Fernald Environmental Management Project, Fernald Area Office, Cincinnati, Ohio.

DOE (U.S. Department of Energy), 2002. *Explanation of Significant Differences for Operable Unit 1*, Final, Fernald Closure Project, Fernald Area Office, Cincinnati, Ohio.

DOE (U.S. Department of Energy), 2003a. *Explanation of Significant Differences for Operable Unit 4 Silos 1 and 2 Remedial Action*, Final, Fernald Closure Project, Fernald Area Office, Cincinnati, Ohio.

DOE (U.S. Department of Energy), 2003b. *Final Record of Decision Amendment for Operable Unit 4 Silo 3 Remedial Action*, Final, Fernald Closure Project, Fernald Area Office, Cincinnati, Ohio.

DOE (U.S. Department of Energy), 2003c. *Record of Decision Amendment for Operable Unit 1 Remedial Actions*, Final, Fernald Closure Project, Fernald Area Office, Cincinnati, Ohio.

DOE (U.S. Department of Energy), 2005a. *Explanation of Significant Differences for Operable Unit 4*, Final, Fernald Closure Project, Fernald Area Office, Cincinnati, Ohio.

DOE (U.S. Department of Energy), 2005b. *Fact Sheet: Development of CERCLA Remedial Action Closeout Reports for the Fernald Closure Project*, Fernald Area Office, Cincinnati, Ohio, April.

DOE (U.S. Department of Energy), 2005c. *Waste Storage Area (Phase II) Design Report*, 52424 RP 0004, Revision A, Draft Final, Fernald Closure Project, Cincinnati, Ohio, June.

DOE (U.S. Department of Energy), 2006a. *Fernald Closure Project, Fact Sheet, The Fernald Closure Project Identifies Clean Buildings, Critical Structures, and Construction Materials for Beneficial Reuse Under Legacy Management,* Fernald Closure Project, Cincinnati, Ohio, December.

DOE (U.S. Department of Energy), 2006b. *Fernald Groundwater Certification Plan*, 51900-PL-0002, Revision 2, Final, Fluor Fernald, Cincinnati, Ohio, August.

DOE (U.S. Department of Energy), 2006c. *Final Remedial Action Report for Operable Unit 1—Waste Pits Remedial Action Project*, Fernald Closure Project, Cincinnati, Ohio, August.

DOE (U.S. Department of Energy), 2006d. *Final Remedial Action Report for Operable Unit 2—Other Waste Units*, Fernald Closure Project, Cincinnati, Ohio, September.

DOE (U.S. Department of Energy), 2006e. *Final Remedial Action Report for Operable Unit 4—Silos 1 through 4*, Fernald Closure Project, Cincinnati, Ohio, September.

DOE (U.S. Department of Energy), 2006f. *Second Five-Year Review Report for the FCP*, 2500-RP-0004, Revision A, Draft, Fluor Fernald, Fernald Area Office, Cincinnati, Ohio, April.

DOE (U.S. Department of Energy), 2007a. *Final Remedial Action Report For Operable Unit 3 at the Fernald Closure Project*, Fernald Closure Project, Cincinnati, Ohio, February.

DOE (U.S. Department of Energy), 2007b. *Interim Residual Risk Assessment for the Fernald Closure Project*, 50000-RP-0012, Rev 1, Fernald Closure Project, Fernald, Ohio, July.

DOE (U.S. Department of Energy), 2008. *Interim Remedial Action Report for Operable Unit 5*, Fernald Closure Project, Fernald, Ohio, August.

DOE (U.S. Department of Energy), 2011. *Third Five-Year Review Report for the Fernald Preserve*, LMS/FER/S07045, Office of Legacy Management, September.

DOE (U.S. Department of Energy), 2012. *Fernald Preserve, Ohio, Restored Area Maintenance Plan,* LMS/FER/S05080, Office of Legacy Management, January.

DOE (U.S. Department of Energy), 2014. *Operational Adjustment-1 WSA Phase-II Groundwater Remediation Design, Fernald Preserve*, LMS/FER/S10798, Office of Legacy Management, March.

DOE (U.S. Department of Energy), 2015. *Fernald Preserve 2014 Site Environmental Report*, LMS/FER/S12455, Office of Legacy Management, May.

DOE (U.S. Department of Energy), 2016a. *Draft Perfluorinated Compound Groundwater Screening Sampling and Analysis Plan,* LMS/FER/S15292, Office of Legacy Management, Cincinnati Ohio, December.

DOE (U.S. Department of Energy), 2016b. *Fernald Preserve 2015 Site Environmental Report*, LMS/FER/S13591, Office of Legacy Management, May.

DOE (U.S. Department of Energy), 2016c. *Fourth Five-Year Review Report for the Fernald Preserve*, LMS/FER/S13683, Office of Legacy Management, August.

DOE (U.S. Department of Energy), 2017. *Fernald Preserve 2016 Site Environmental Report*, LMS/FER/S15232, Office of Legacy Management, May.

DOE (U.S. Department of Energy), 2018a. *Draft Perfluorinated Alkyl Substances (PFASs) Investigation Plan for the Fernald Preserve,* LMS/FER/S18662, Office of Legacy Management, Cincinnati Ohio, March.

DOE (U.S. Department of Energy), 2018b. *Fernald Preserve 2017 Site Environmental Report,* LMS/FER/S17983, Office of Legacy Management, May.

DOE (U.S. Department of Energy), 2019a. *Comprehensive Legacy Management and Institutional Controls Plan*, LMS/FER/S03496, Revision 12, Office of Legacy Management, January.

DOE (U.S. Department of Energy), 2019b. *Fernald Preserve 2018 Site Environmental Report,* LMS/FER/S28948, Office of Legacy Management, May.

DOE (U.S. Department of Energy), 2019c. *Fernald Preserve, Ohio, Site Master Plan*, LMS/FER/S19953, Fernald Area Office, Cincinnati, Ohio, April.

DOE (U.S. Department of Energy), 2020. *Fernald Preserve 2019 Site Environmental Report*, LMS/FER/S23329, Office of Legacy Management, May.

EPA (U.S. Environmental Protection Agency), 1991. Consent Agreement as Amended under CERCLA Section 120 and 106 (a) in the matter of U.S. Department of Energy, Fernald Materials Production Center, Fernald, Ohio, U.S. EPA Region 5.

EPA (U.S. Environmental Protection Agency), 1997. *Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments, Interim Final,* EPA/540/R-97/006, Office of Solid Waste and Emergency Response 9285, June.

EPA (U.S. Environmental Protection Agency), 2000. *Close Out Procedures for national Priorities List Sites*, Office of Solid Waste and Emergency Response Directive 9320.2-09A-P, January.

EPA (U.S. Environmental Protection Agency), 2014. *Emerging Contaminants—Perfluorooctane Sulfonate (PFOS) and Perfluorooctanoic Acid (PFOA)*, EPA 505-F-14-001, Fact Sheet, Federal Facilities Restoration and Reuse Office, Office of Solid Waste and Emergency Response (5106P), March.

EPA (U.S. Environmental Protection Agency), 2016. *What Climate Changes Means for Ohio*, EPA 430-F-16-037, August.

EPA (U.S. Environmental Protection Agency), 2017a. *Technical Fact Sheet- 1,2,3 Trichloropropane (TCP),* EPA 505-F-17-007, Office of Land and Emergency Management, November.

EPA (U.S. Environmental Protection Agency), 2017b. *Technical Fact Sheet- 1,4-Dioxane,* EPA 505-F-17-011, Office of Land and Emergency Management, November.

EPA (U.S. Environmental Protection Agency), 2017c. *Technical Fact Sheet- 2,4,6-Triniotrotoluene (TNT),* EPA 505-F-17-009, Office of Land and Emergency Management, November.

EPA (U.S. Environmental Protection Agency), 2017d. *Technical Fact Sheet- Diniotrotoluene (DNT),* EPA 505-F-17-010, Office of Land and Emergency Management, November.

EPA (U.S. Environmental Protection Agency), 2017e. *Technical Fact Sheet-Hexahydro-1,3,5-trinitro-1,3,5-triazine*, EPA 505-F-17-008, Office of Land and Emergency Management, November.

EPA (U.S. Environmental Protection Agency), 2017f. *Technical Fact Sheet-Nanomaterials,* EPA 505-F-17-002, Office of Land and Emergency Management, November.

EPA (U.S. Environmental Protection Agency), 2017g. *Technical Fact Sheet-N-Nitroso-dimethylamine,* EPA 505-F-17-005, Office of Land and Emergency Management, November.

EPA (U.S. Environmental Protection Agency), 2017h. *Technical Fact Sheet-Perchlorate*, EPA 505-F-17-003, Office of Land and Emergency Management, November.

EPA (U.S. Environmental Protection Agency), 2017i. *Technical Fact Sheet-Perfluorooctane Sulfonate (PFOS) and Perfluorooctanoic Acid (PFOA)*, EPA 505-F-17-001, Office of Land and Emergency Management, November.

EPA (U.S. Environmental Protection Agency), 2017j. *Technical Fact Sheet-Polybromated Biphenyls (PBB)*, EPA 505-F-17-001, Office of Land and Emergency Management, November.

EPA (U.S. Environmental Protection Agency), 2017k. *Technical Fact Sheet-Polybrominated Diphenyl Ethers (PBDEs) and Polybrominated Biphenyls (PBBs)*, EPA 505-F-17-015, Office of Land and Emergency Management, November.

EPA (U.S. Environmental Protection Agency), 2017l. *Technical Fact Sheet-Tungsten*, EPA 505-F-17-004, Office of Land and Emergency Management, November.

State of Ohio (OEPA), 2008, *Consent Decree between the State of Ohio and DOE Fernald Settlement*, CASE NO. C-I-86-0217, November.

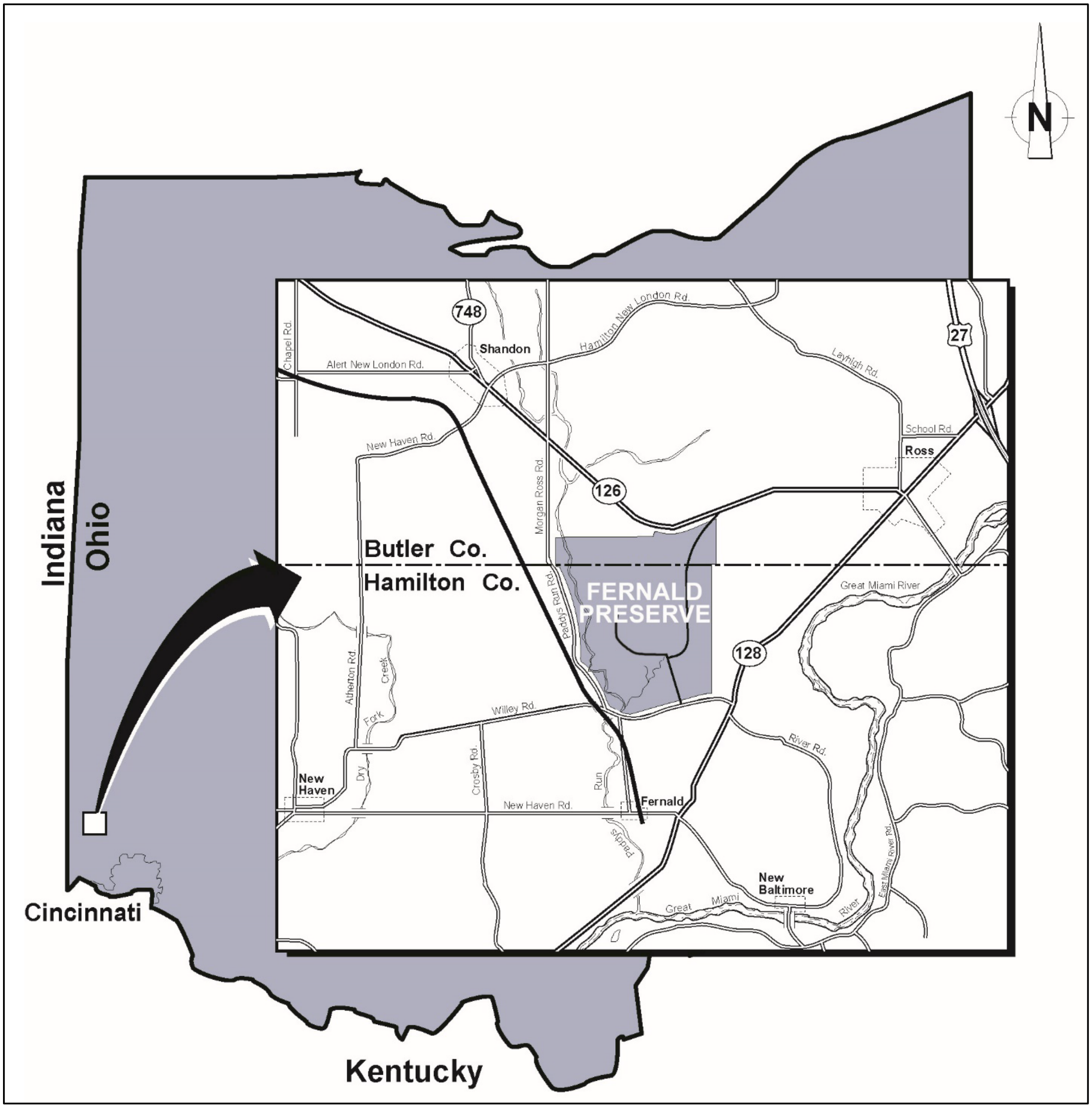
Whitman, Requardt & Associates LLP, 2015. *Fernald Preserve Site Converted Advanced Wastewater Treatment Current Condition Assessment Report*, Final, March.

This page intentionally left blank

Attachment 1

Fernald Preserve and Vicinity

This page intentionally left blank



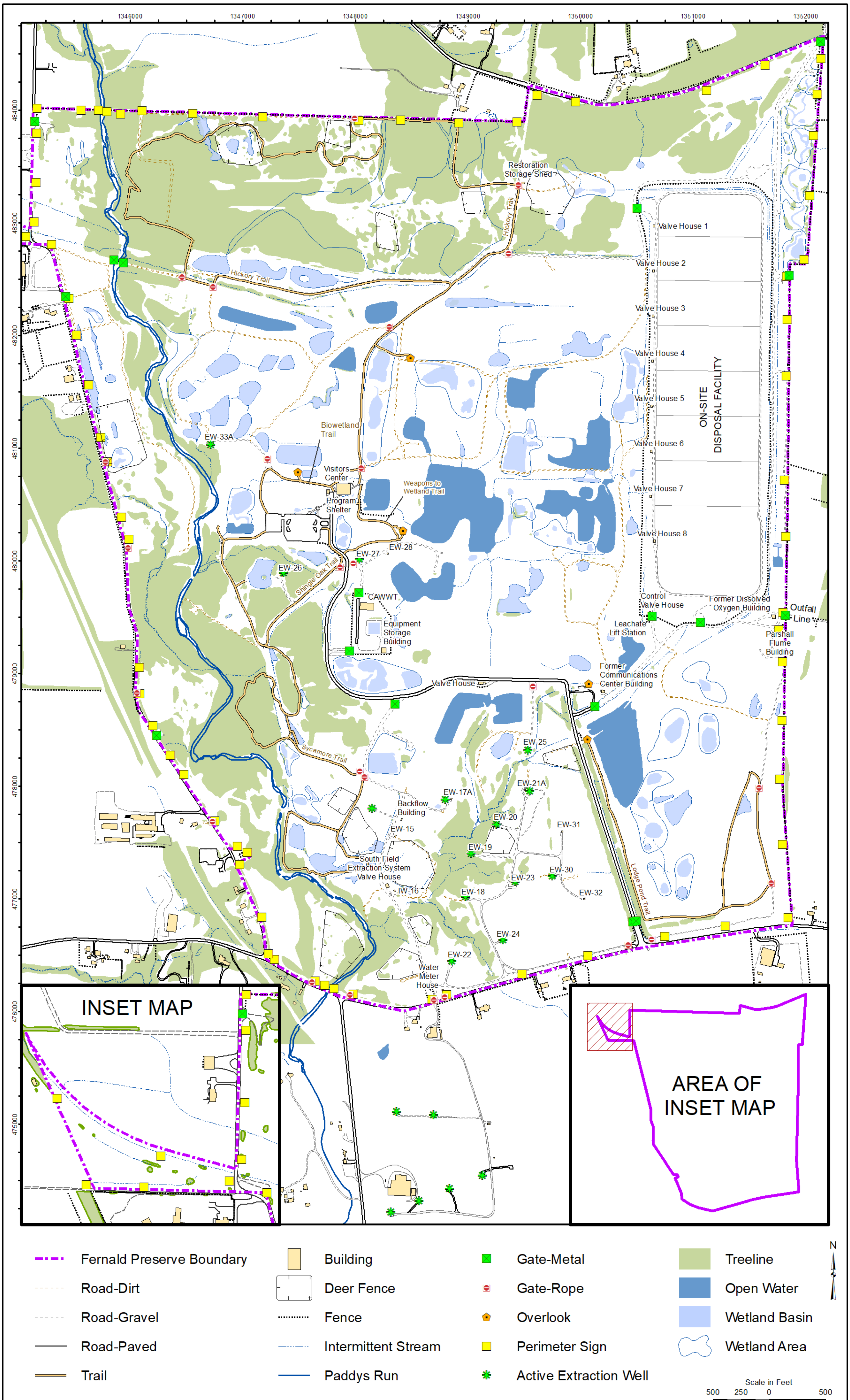
Note:
The Fernald site covers about 1,050 acres (425 hectares).

Fernald Preserve and Vicinity

This page intentionally left blank

Attachment 2

Fernald Preserve Site Configuration



S3215800 03/25/2021 11:15:40 AM

Fernald Preserve Site Configuration

This page intentionally left blank

Attachment 3

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

This page intentionally left blank

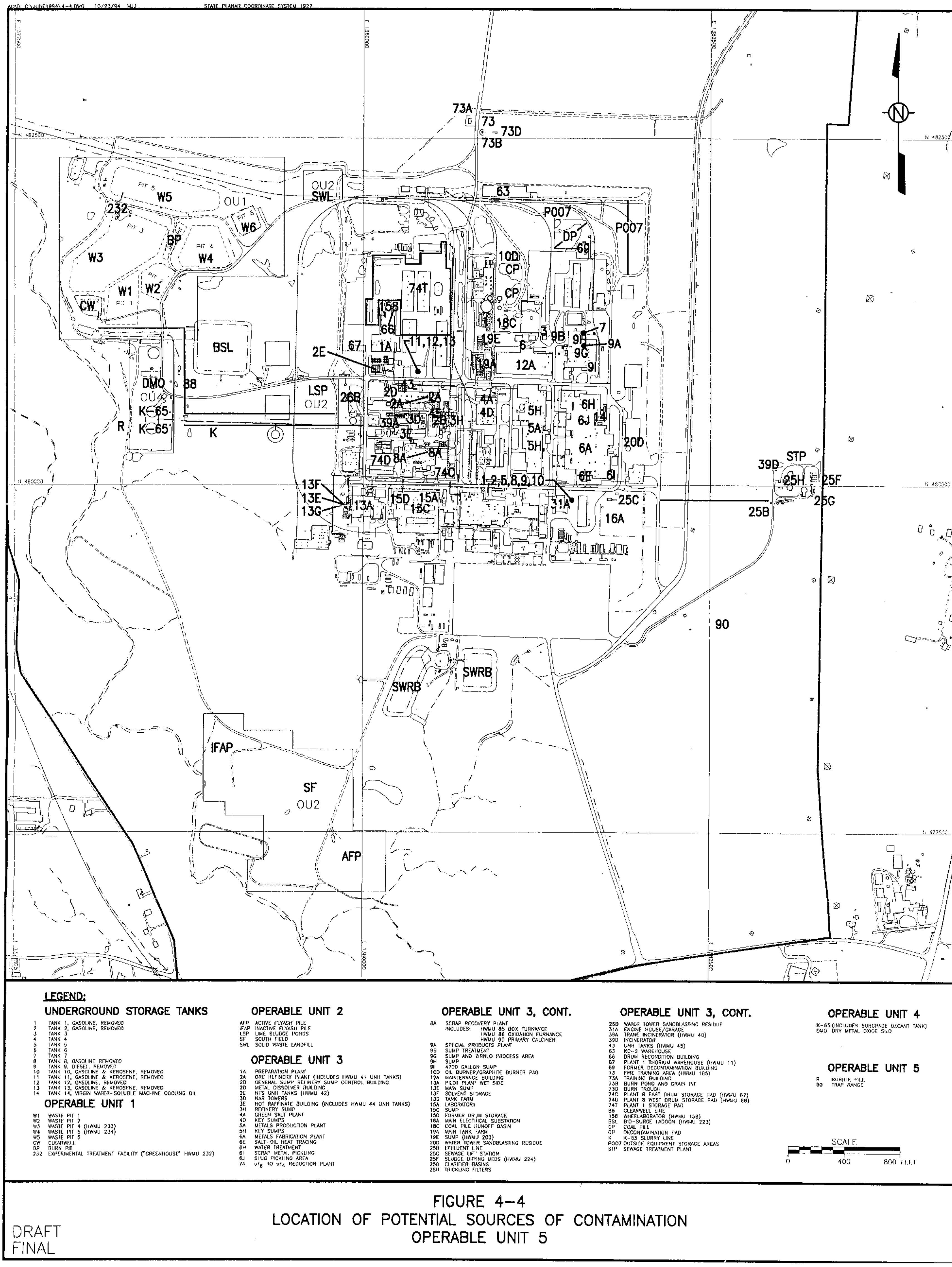


Figure 4-4, Location of Potential Sources of Contamination, Operable Unit 5

This page intentionally left blank

Attachment 4

Hamilton County Health Department Notification Letter, August 21, 2006

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.

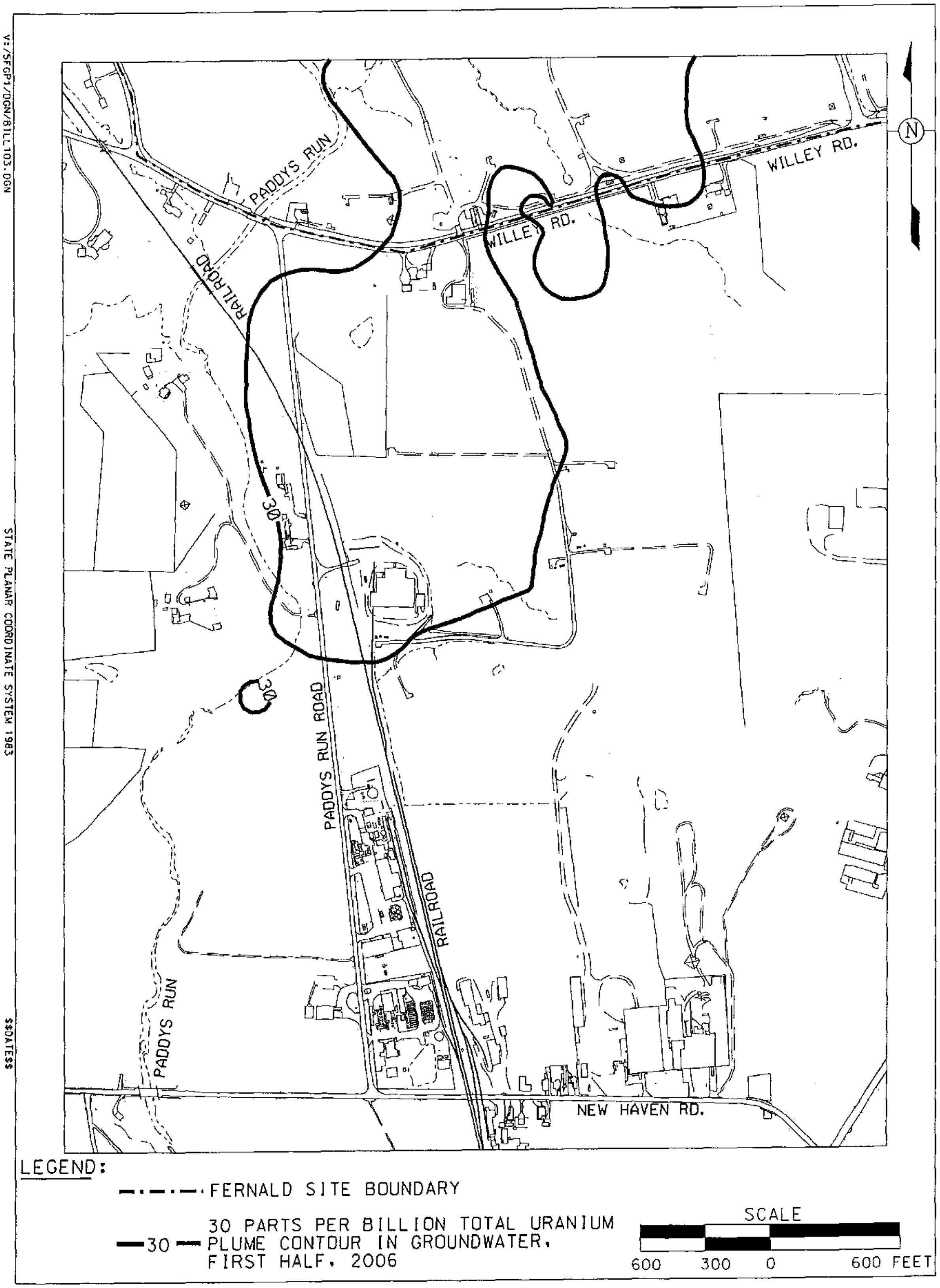
Sincerely,

Johnny Reising

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

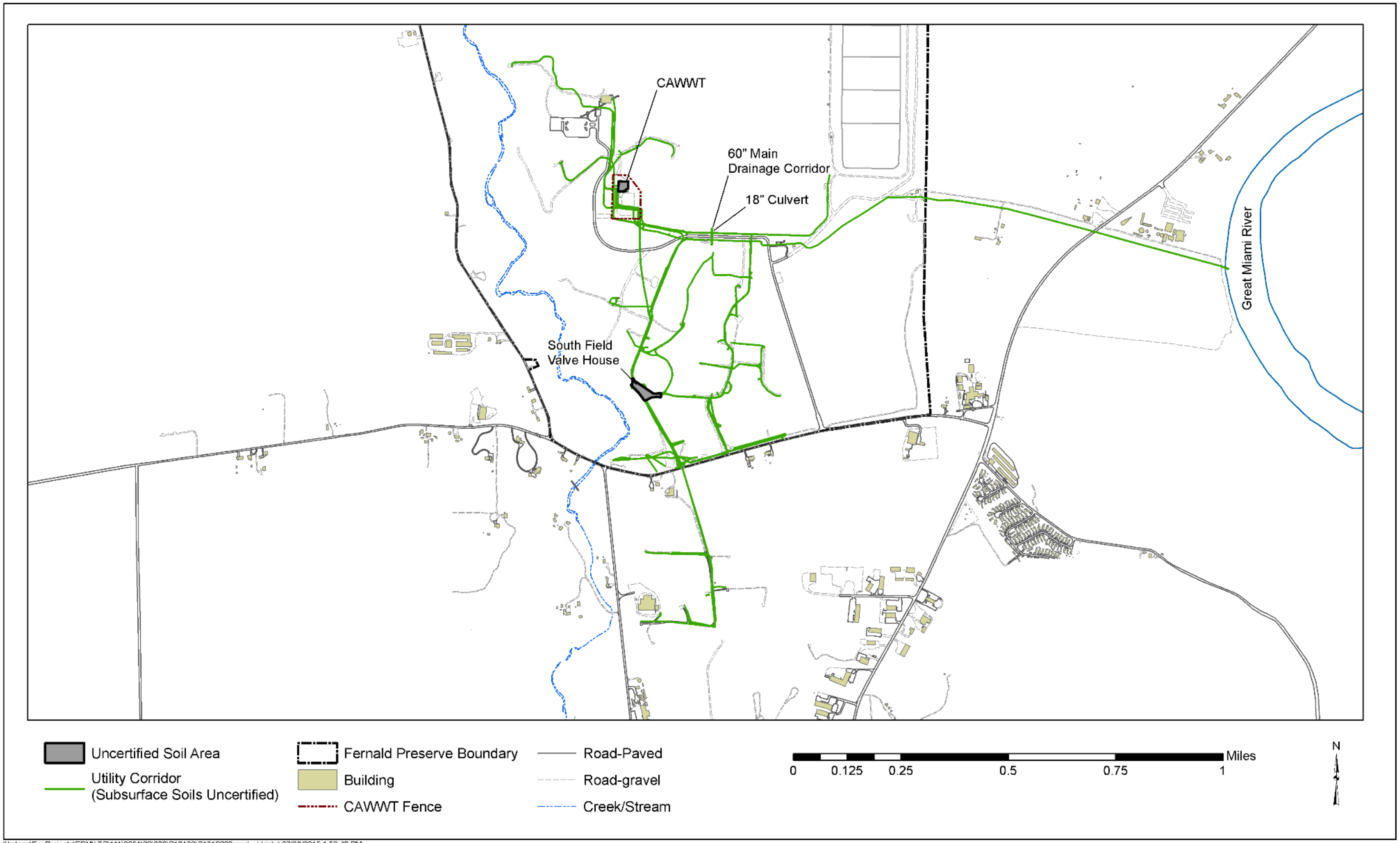


Fernald Off-Site Groundwater Total Uranium Plume Location

This page intentionally left blank

Attachment 5

Uncertified Areas and Subgrade Utility Corridors



\\lm\ess\EnvProjects\EBM\LTS\111\0051\20\008\S13192\S1319200.mxd widrichd 07/28/2015 1:50:49 PM

Uncertified Areas and Subgrade Utility Corridors

This page intentionally left blank

Attachment 6

Initial Public Notice

This page intentionally left blank

Fernald Preserve

Annual Community Meeting

October 13, 2020

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

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

Date: Tuesday, October 13, 2020

Time: 6:30 p.m.

Click here for remote connection details:
https://www.energy.gov/lm/articles/2020-fernald-preserve-community-meeting

This year's meeting will focus on the *Fernald Preserve 2019 Site Environmental Report* issued by the U.S. Department of Energy Office of Legacy Management (https://www.lm.doe.gov/Fernald/Reports/ASER.aspx#2019). Meeting topics will include:

- Environmental and ecological monitoring.
- Groundwater remedy status.
- On-Site Disposal Facility monitoring.
- Other site activities.
- Initiation of CERCLA Five-Year Review

Email fernald@lm.doe.gov
or call (513) 648-3330 for more information.

U.S. DEPARTMENT OF ENERGY | Legacy Management

This page intentionally left blank

Attachment 7

Questionnaires and Summary of Interviews

This page intentionally left blank

CERCLA Five-Year Review Questionnaire

Fernald Preserve

Fold at line, tape, apply first class postage, and mail.

CINCINNATI OH 452

12 NOV 2020 PM 4 L

FOREVER / USA

Fernald Preserve

U.S. Department of Energy

Office of Legacy Management

10995 Hamilton-Cleves Highway

Harrison, OH 45030-9728

45030-923795

CERCLA Five-Year Review Questionnaire

Fernald Preserve

Thank you for participating in the CERCLA five-year review. Please use this form to evaluate your experience with the Fernald Preserve. Your feedback will help shape and improve the quality of future activities.

What is your overall impression of the Fernald Preserve?

It is well run with high quality programming with a focus on conservation.

What effects have site activities had on the surrounding community?

The restoration has provided a greenspace for the community to enjoy. Likewise, the programming provides educational opportunities and fosters connections in the community.

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

Personally no. Have heard others with concerns about contamination of groundwater, streams and drinking water which would be worth addressing

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

☑ Yes ☐ No

U.S. DEPARTMENT OF ENERGY Legacy Management

CERCLA Five-Year Review Questionnaire

Fernald Preserve

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

There is always room for improvement, so maybe an open house or free webinar to answer questions from the public and summarize activities

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

No comments at this time.

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

If yes, please provide your contact information.

Name:

Phone:

Email:

Your feedback supporting this Fernald Preserve CERCLA five-year review is greatly appreciated.

To submit this form:
Fold, tape, and mail to the address panel on the back.

U.S. DEPARTMENT OF ENERGY | Legacy Management

CERCLA Five-Year Review Questionnaire

Fernald Preserve

↓ Fold at line, tape, apply first class postage, and mail. ↓

Lisa Crawford
[redacted]

CINCINNATI OH 452
5 OCT 2020 PM 4 L

Energy Awareness Month
FOREVER / USA

Fernald Preserve
U.S. Department of Energy
Office of Legacy Management
10995 Hamilton-Cleves Highway
Harrison, OH 45030-9728

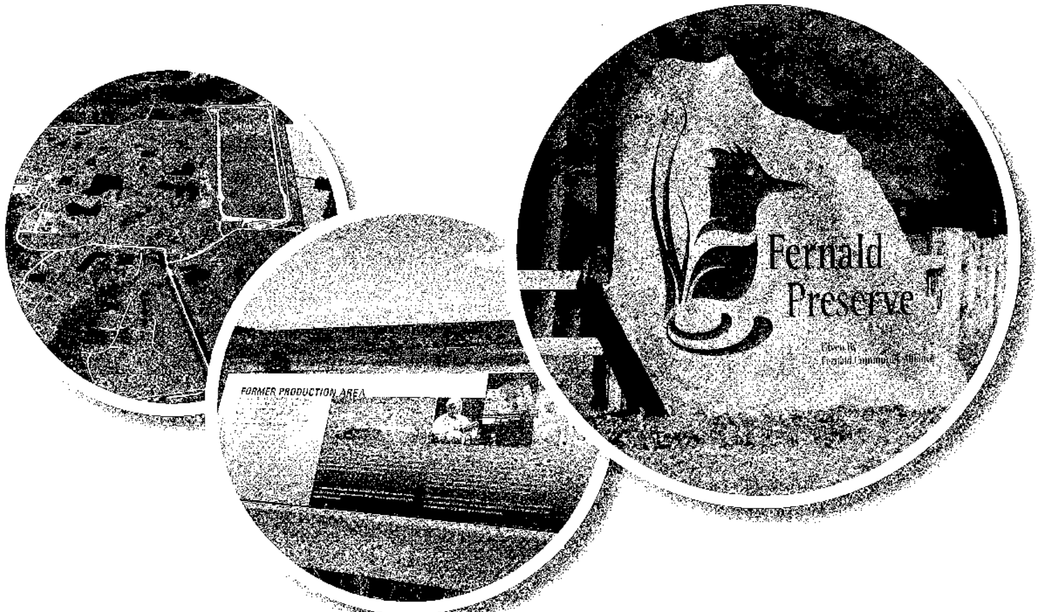
45030-923795

CERCLA Five-Year Review Questionnaire

Fernald Preserve

The U.S. Department of Energy (DOE) is currently conducting the fifth 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). CERCLA requires a five-year review for remedial actions that result in any hazardous substances, pollutants, or contaminants remaining on-site at levels that do not allow for unlimited use and unrestricted exposure. The purpose of the five-year review is to ensure that the remedies implemented to clean up 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 CERCLA five-year review process. DOE values and requests any input or comments you have regarding the site's activities since stakeholder feedback was collected for the last CERCLA five-year review in 2015. Completed questionnaires will be accepted through November 13, 2020.



U.S. DEPARTMENT OF ENERGY Legacy Management

CERCLA Five-Year Review Questionnaire

Fernald Preserve

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

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

Keep up the good work! Openness & public involvement are the best tools!

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

If yes, please provide your contact information.

Name: Lisa Crawford

Phone: [redacted]

Email: [redacted]

Your feedback supporting this Fernald Preserve CERCLA five-year review is greatly appreciated.

To submit this form:
Fold, tape, and mail to the address panel on the back.

U.S. DEPARTMENT OF ENERGY Legacy Management

CERCLA Five-Year Review Questionnaire

Fernald Preserve

Thank you for participating in the CERCLA five-year review. Please use this form to evaluate your experience with the Fernald Preserve. Your feedback will help shape and improve the quality of future activities.

What is your overall impression of the Fernald Preserve?

So much better now - renewing itself. Watch closely & pay attention.

What effects have site activities had on the surrounding community?

Long better - still a concern regarding the aquifer!

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

No!

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

☑ Yes ☐ No

U.S. Department of Energy Legacy Management

Fernald Preserve

CE Five-Year Review Questionnaire

Fold at line, tape, apply first class postage, and mail.

CINCINNATI OH 452

9 OCT 2020 PM 4 L

Energy Awareness Month

FOREVER / USA

Hardy and Barbara Eshbaugh

[redacted]

Fernald Preserve

U.S. Department of Energy

Office of Legacy Management

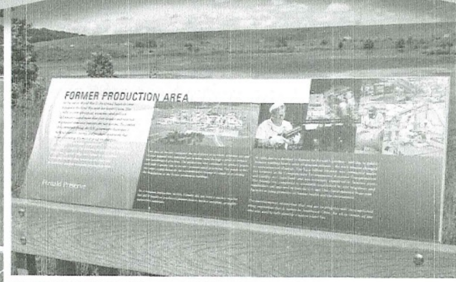
10995 Hamilton-Cleves Highway

Harrison, OH 45030-9728

45030-923795

CERCLA Five-Year Review Questionnaire

Fernald Preserve



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

The U.S. Department of Energy (DOE) is conducting the fifth five-year review at the Fernald Preserve. The review is 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. The purpose of the review is to ensure that cleanup remedies remain protective of human health and the environment.

Community involvement is integral to the mission of the Fernald Preserve and the CERCLA five-year review process. DOE values and requests feedback you may have regarding the site's activities for the last five years.

The questionnaire is located at https://www.energy.gov/lm/fernald-preserve-ohio-cercla-five-year-review. For questions or to request a hard copy of the questionnaire, please call (513) 648-3330, or email Fernald@lm.doe.gov.

Completed questionnaires will be accepted through November 13, 2020.

Sincerely,
Sue Smiley
DOE Office of Legacy Management
(513) 648-3330 Sue.Smiley@lm.doe.gov

U.S. DEPARTMENT OF ENERGY | Legacy Management

CERCLA Five-Year Review Questionnaire

Fernald Preserve

THIS DOCUMENT MUST BE SAVED TO YOUR COMPUTER BEFORE COMPLETING

Thank you for participating in the CERCLA five-year review. Please use this form to evaluate your experience with the Fernald Preserve. Your feedback will help shape and improve the quality of future activities.

What is your overall impression of the Fernald Preserve?

This is one of the best nature viewing sites in all of southwest Ohio with excellent event options offered each month not with standing the Covid19 shutdown.

What effects have site activities had on the surrounding community?

It has brought together people with similar interests that now represent and advocacy voice for the preserve.

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

I wish that more of the preserve could be open to the public if at all possible

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

● Yes ○ No

U.S. DEPARTMENT OF ENERGY | Legacy Management

CERCLA Five-Year Review Questionnaire

Fernald Preserve

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

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

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

If yes, please provide your contact information.

Name:

Phone:

Email:

Your feedback supporting this Fernald Preserve CERCLA five-year review is greatly appreciated.

To submit this form:

1. **By email:** Turn in completed forms to fernald@lm.doe.gov by clicking the submit button or emailing directly. Click the "**SUBMIT**" button, and your form will be uploaded as an attachment to your default email browser with an auto-populated email address (fernald@lm.doe.gov). Attach any additional materials and send the email.
2. **By mail:** Print, fold, tape, and apply first class postage to the address panel on the back.

SUBMIT

U.S. DEPARTMENT OF ENERGY | Legacy Management

CERCLA Five-Year Review Questionnaire

Fernald Preserve

↓ Fold at line, tape, apply first class postage, and mail. ↓

Fernald Preserve

U.S. Department of Energy
Office of Legacy Management
10995 Hamilton-Cleves Highway
Harrison, OH 45030-9728

CERCLA Five-Year Review Questionnaire

Fernald Preserve

THIS DOCUMENT MUST BE SAVED TO YOUR COMPUTER BEFORE COMPLETING

The U.S. Department of Energy (DOE) is currently conducting the fifth 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). CERCLA requires a five-year review for remedial actions that result in any hazardous substances, pollutants, or contaminants remaining on-site at levels that do not allow for unlimited use and unrestricted exposure. The purpose of the five-year review is to ensure that the remedies implemented to clean up 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 CERCLA five-year review process. DOE values and requests any input or comments you have regarding the site's activities since stakeholder feedback was collected for the last CERCLA five-year review in 2015. Completed questionnaires will be accepted through November 13, 2020.

U.S. DEPARTMENT OF ENERGY | Legacy Management

CERCLA Five-Year Review Questionnaire

Fernald Preserve

THIS DOCUMENT MUST BE SAVED TO YOUR COMPUTER BEFORE COMPLETING

Thank you for participating in the CERCLA five-year review. Please use this form to evaluate your experience with the Fernald Preserve. Your feedback will help shape and improve the quality of future activities.

What is your overall impression of the Fernald Preserve?

I have a very positive overall impression of Fernald. I have witnessed the evolution of this site from 1993 through now. From ever improving adjustments in outreach to cleanup technologies, Fernald staff have remained committed to excellence.

What effects have site activities had on the surrounding community?

Fernald has transformed from being a community liability into a community asset. The programming and resources available to the public pre-pandemic were well used and respected. Even during the pandemic, the outdoor resources have provided a great service to birders, hikers, photographers, etc.

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

DOE's presence and programming at the site not only serves as an asset to the community, but also helps to ensure that institutional controls are maintained, thus ensuring the cleanup remedy. While not anticipated, it is concerning that this model could fail in the very distant future (even if not in my lifetime).

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

● Yes ○ No

U.S. DEPARTMENT OF ENERGY | Legacy Management

CERCLA Five-Year Review Questionnaire

Fernald Preserve

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

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

Keep up the great work and hopefully the site can get back to full programming once it is safe.

Would you like to be contacted for additional discussion? ◉ Yes ● No

If yes, please provide your contact information.

Name: Laura Hafer

Phone:

Email:

Your feedback supporting this Fernald Preserve CERCLA five-year review is greatly appreciated.

To submit this form:

1. **By email:** Turn in completed forms to fernald@lm.doe.gov by clicking the submit button or emailing directly. Click the "**SUBMIT**" button, and your form will be uploaded as an attachment to your default email browser with an auto-populated email address (fernald@lm.doe.gov). Attach any additional materials and send the email.
2. **By mail:** Print, fold, tape, and apply first class postage to the address panel on the back.

SUBMIT

U.S. Department of Energy | Legacy Management

CERCLA Five-Year Review Questionnaire

Fold at line, tape, apply first class postage, and mail.

Fernald Preserve
U.S. Department of Energy
Office of Legacy Management
10995 Hamilton-Cleves Highway
Harrison, OH 45030-9728

CERCLA Five-Year Review Questionnaire

Fernald Preserve

THIS DOCUMENT MUST SAVED TO YOUR COMPUTER BEFORE COMPLETING

The U.S. Department of Energy (DOE) is currently conducting the fifth 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). CERCLA requires a five-year review for remedial actions that result in any hazardous substances, pollutants, or contaminants remaining on-site at levels that do not allow for unlimited use and unrestricted exposure. The purpose of the five-year review is to ensure that the remedies implemented to clean up 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 CERCLA five-year review process. DOE values and requests any input or comments you have regarding the site's activities since stakeholder feedback was collected for the last CERCLA five-year review in 2015. Completed questionnaires will be accepted through November 13, 2020.

U.S. DEPARTMENT OF ENERGY | Legacy Management

CERCLA Five-Year Review Questionnaire

Fernald Preserve

THIS DOCUMENT MUST BE SAVED TO YOUR COMPUTER BEFORE COMPLETING

Thank you for participating in the CERCLA five-year review. Please use this form to evaluate your experience with the Fernald Preserve. Your feedback will help shape and improve the quality of future activities.

What is your overall impression of the Fernald Preserve?

The Fernald preserve is one of my favorite hiking and nature watching locations in the Cincinnati area. Prior to COVID, I attended 6 programs during the last two years. These programs were informative and entertaining. The staff naturalists are well-informed and personable.

What effects have site activities had on the surrounding community?

I do not live in the immediate locale of the Fernald preserve, so I am unsure.

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

None.

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

● Yes ○ No

U.S. DEPARTMENT OF ENERGY | Legacy Management

CERCLA Five-Year Review Questionnaire

Fernald Preserve

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

NA

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

It is difficult to make suggestions due to recent disruptions to Fernald Preserve operations from COVID restrictions.

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

If yes, please provide your contact information.

Name:

Phone:

Email:

Your feedback supporting this Fernald Preserve CERCLA five-year review is greatly appreciated.

To submit this form:

1. **By email:** Turn in completed forms to fernald@lm.doe.gov by clicking the submit button or emailing directly. Click the "**SUBMIT**" button, and your form will be uploaded as an attachment to your default email browser with an auto-populated email address (fernald@lm.doe.gov). Attach any additional materials and send the email.
2. **By mail:** Print, fold, tape, and apply first class postage to the address panel on the back.

SUBMIT

U.S. DEPARTMENT OF ENERGY | Legacy Management

CERCLA Five-Year Review Questionnaire

Fernald Preserve

↓ Fold at line, tape, apply first class postage, and mail. ↓

Graham & Sharon Mitchell
[redacted]

CINCINNATI OH 452
7 OCT 2020 PM 6 L

Energy Awareness Month
FOREVER USA

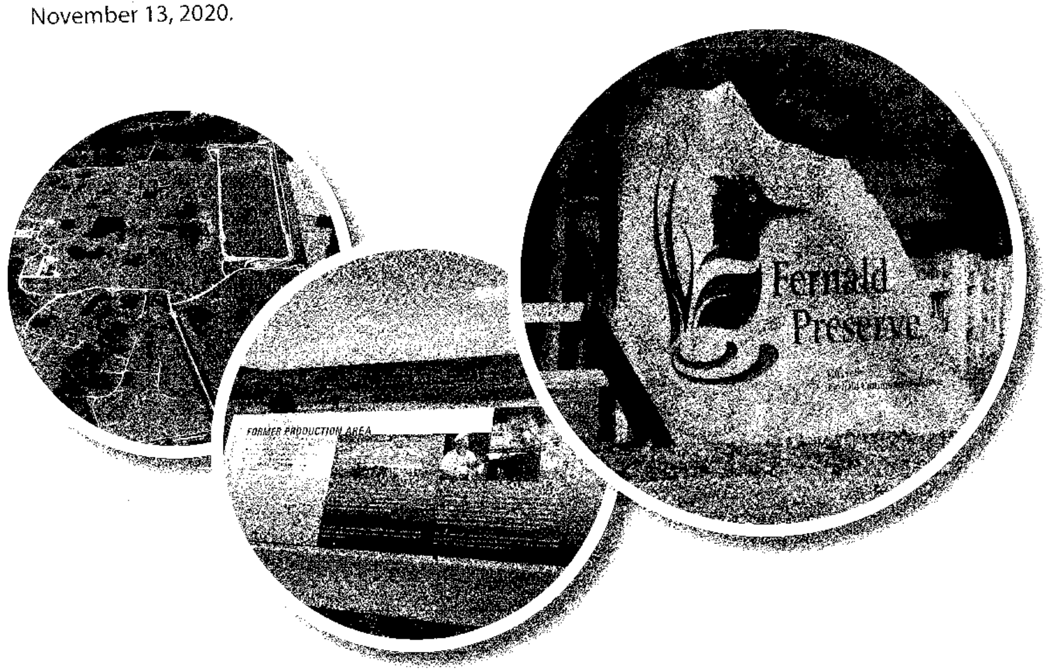
Fernald Preserve
U.S. Department of Energy
Office of Legacy Management
10995 Hamilton-Cleves Highway
Harrison, OH 45030-9728

CERCLA Five-Year Review Questionnaire

Fernald Preserve

The U.S. Department of Energy (DOE) is currently conducting the fifth 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). CERCLA requires a five-year review for remedial actions that result in any hazardous substances, pollutants, or contaminants remaining on-site at levels that do not allow for unlimited use and unrestricted exposure. The purpose of the five-year review is to ensure that the remedies implemented to clean up 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 CERCLA five-year review process. DOE values and requests any input or comments you have regarding the site's activities since stakeholder feedback was collected for the last CERCLA five-year review in 2015. Completed questionnaires will be accepted through November 13, 2020.



U.S. DEPARTMENT OF ENERGY Legacy Management

CERCLA Five-Year Review Questionnaire

Fernald Preserve

Thank you for participating in the CERCLA five-year review. Please use this form to evaluate your experience with the Fernald Preserve. Your feedback will help shape and improve the quality of future activities.

What is your overall impression of the Fernald Preserve?

VERY POSITIVE, BEAUTIFUL SITE, EXCELLENT CLEANUP + RESTORATION

What effects have site activities had on the surrounding community?

POSITIVE EFFECTS - GIVING BACK TO THE COMMUNITY WITH EDUCATION + RECREATION

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

FCA WOULD LIKE TO WORK WITH DOE AND CONTRACTORS TO FIGURE OUT A WAY FOR DOE TO OFFICIALLY PARTNER WITH A NON PROFIT LIKE FCA. WE WOULD LIKE TO SEE A PATH FORWARD WHERE DOE COULD ACCEPT DONATED FUNDS FOR THINGS LIKE THE COLD WAR GARDEN UPKEEP AND OTHER PROJECTS.

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

☒ Yes ☐ No

U.S. DEPARTMENT OF ENERGY Legacy Management

CERCLA Five-Year Review Questionnaire

Fernald Preserve

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

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

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

If yes, please provide your contact information.

Name: GRAHAM MITCHELL, PRESIDENT FCA

Phone: [redacted]

Email: [redacted]

Your feedback supporting this Fernald Preserve CERCLA five-year review is greatly appreciated.

To submit this form:
Fold, tape, and mail to the address panel on the back.

U.S. DEPARTMENT OF ENERGY Legacy Management

INTERVIEW RECORD

Site Name: Fernald Preserve			**EPA ID No:** OH6890008976		
Subject: CERCLA Five Year Review			**Time:** **11:00am**	**Date:11/18/2020**	
Type: Telephone ☒ **Location of Visit: Remote due to COVID19**	**Visit** ☐	**Other**☐	**Incoming** ☐	**Outgoing** ☐	
Contact Made By:					
Name:	**Title**		**Organization:**		
Individual Contacted:					
Name: Graham Mitchell	**Title: FCA, retired OEPA**		**Organization:**		
Telephone Number:[redacted] **Fax Number:** **E-Mail Address:**[redacted]		**Street Address:**[redacted] **City, State, Zip Code:**[redacted]			
Summary of Conversation					

CERCLA 5YR Review – Requested stakeholder interview:
Graham Mitchell, 11/18/2020, 11:00am

Graham Mitchell (G)
Sue Smiley (S)
John Homer (J)
Penny Borgman (P)

S – Welcome, good morning, we want to address any questions you may have.

G – Can the DOE-LM/Fernald Community Alliance (FCA) relationship be more formalized? Looking to future needs, i.e. commemorative brick garden, etc. The National Park Service has associated 501c3 'official partners', such as Rocky Mountain Conservancy supporting Rocky Mountain National Park.

S – Agreed to look into potential options, noted that it may take some time. LM appreciates suggestion to look into arrangement between above mentioned parties or similar arrangements for federal agency/non-profit partnerships. There is a process for private parties to donate tangible items to LM, such as items that may be useful for display. Unclear if process exists within U.S. DOE to accept cash donations.

G – FCA would like to facilitate easier management, collaboration, utilization of funds donated to/collected by FCA, etc. And ensure that funds remain accessible into the future for intended purpose.

J – There is a possible opportunity to collaborate on a bluebird box nesting trail, monitor and record box activity, donate replacements for aging and damaged boxes, etc. Perhaps this could attract potential new FCA members.

G – Staff are doing an amazing job, appreciates work maintaining site. Thx for quick response to brick installation, FCA will continue maintenance and offering of bricks for brick garden.

S – Any feedback on the Annual Community Meeting?

G – Appreciated the content, pleased to be able to attend, even remotely.

J – Any feedback on the typical updates provided at routine FCA meetings?

G – It has been sufficient and appropriate; do not change.

S – Thx for taking the time to participate today.

After OSWER No. 9355.7-03B-P Page _2__ of __2__

CERCLA Five-Year Review State and Local Government Questionnaire

Fernald Preserve

THIS DOCUMENT MUST BE SAVED TO YOUR COMPUTER BEFORE COMPLETING

The U.S. Department of Energy (DOE) is currently conducting the fifth 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). CERCLA requires a five-year review for remedial actions that result in any hazardous substances, pollutants, or contaminants remaining on-site at levels that do not allow for unlimited use and unrestricted exposure. The purpose of the five-year review is to ensure that the remedies implemented to clean up 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 CERCLA five-year review process. DOE values and requests any input or comments you have regarding the site's activities since stakeholder feedback was collected for the last CERCLA five-year review in 2015. Completed questionnaires will be accepted through November 13, 2020.

U.S. DEPARTMENT OF ENERGY | Legacy Management

CERCLA Five-Year Review State and Local Government Questionnaire

Fernald Preserve

THIS DOCUMENT MUST BE SAVED TO YOUR COMPUTER BEFORE COMPLETING

Thank you for participating in the CERCLA five-year review. Please use this form to evaluate your experience with the Fernald Preserve. Your feedback will help shape and improve the quality of future activities.

What is your overall impression of the Fernald Preserve?

I have a very positive overall impression of Fernald. I have witnessed the evolution of this site from 1993 through now. From ever improving adjustments in outreach to cleanup technologies, Fernald staff have remained committed to excellence.

Have there been routine communications or activities (site visits, inspections, reporting activities, etc.) conducted by your office regarding the site? If so, please state the purpose and results.

Fernald has transformed from being a community liability into a community asset. The programming and resources available to the public pre-pandemic were well used and respected. Even during the pandemic, the outdoor resources have provided a great service to birders, hikers, photographers, etc.

Have there been any complaints, violations, or other incidents related to the site requiring response by your office? If so, please give details of the events and results of the responses.

DOE's presence and programming at the site not only serves as an asset to the community, but also helps to ensure that institutional controls are maintained, thus ensuring the cleanup remedy. While not anticipated, it is concerning that this model could fail in the very distant future (even if not in my lifetime).

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

● Yes ● No

U.S. DEPARTMENT OF ENERGY | Legacy Management

CERCLA Five-Year Review State and Local Government Questionnaire

Fernald Preserve

If you do not feel well informed, how do you suggest the site keep state and local officials better informed?

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

Keep up the great work and hopefully the site can get back to full programming once it is safe.

Would you like to be contacted for additional discussion? ◉ Yes ● No

If yes, please provide your contact information.

Name: Laura Hafer

Phone:

Email:

Your feedback supporting this Fernald Preserve CERCLA five-year review is greatly appreciated.

Turn in completed forms to fernald@lm.doe.gov by clicking the **"SUBMIT"** button or emailing directly.

To submit this form:
Click the **"SUBMIT"** button, and your form will be uploaded as an attachment to your default email browser with an auto-populated email address (fernald@lm.doe.gov). Attach any additional materials and send the email.

SUBMIT

U.S. DEPARTMENT OF ENERGY | Legacy Management

INTERVIEW RECORD

Site Name: Fernald Preserve		**EPA ID No:** OH6890008976	
Subject: CERCLA Five Year Review		**Time:** **10:00am**	**Date:** **11/30/2020**
Type: Telephone ☒ **Visit** ☐ **Other**☐ **Location of Visit: Remote due to COVID19**		**Incoming** ☐	**Outgoing** ☐
Contact Made By:			
Name:	**Title**	**Organization:**	
Individual Contacted:			
Name: Laura Hafer	**Title: Regulator**	**Organization: OH EPA**	
Telephone Number:[redacted] **Fax Number:** **E-Mail Address**[redacted]		**Street Address:** **City, State, Zip Code:**	
Summary of Conversation			

CERCLA 5YR Review – Requested stakeholder interview:
Laura Hafer, 11/30/2020, 10:00am

Laura Hafer (L)
Sue Smiley (S)
John Homer (J)
Penny Borgman (P)

S – Welcome, good morning, thank-you for participating and we want to address any concerns/questions you may have.

L – No specific issues to bring up, FP has been a good example of responsive customer and communications. Had concern about site closure in March, 2020 due to COVID and glad to see the trails open again. Important to continue communications and relationship with community to ensure people don't forget site history and current status. Understands why VC remains closed and interpretive service programs are on hold until COVID restrictions are relaxed.

J/S/P – Description of open/close decision factors including DOE and state mandates. Port-o-let is sanitized daily to serve visitors. Brief discussion about dogs on site, visible site personnel give unspoken message.

S – Do you have any feedback on routine FCA meetings?

L – Appreciates the updates, seems to work well, keep "moment of nature", members like it. How was the feedback on the CERCLA 5YR notice?

J – Covered responses, 7 questionnaires, 2 interviews, during one interview a more formal relationship between DOE LM and FCA was discussed in terms of volunteer opportunities.

P – And ensuring that FCA funds get directed to the site as intended (eg, if current FCA membership wanes; need ways to keep FCA active and engaged). Potential volunteer opportunities are currently tabled until the VC re-opens.

S – This could perhaps increase FCA participation.

L – Volunteer opportunity is a good angle, should be prepared in advance with activities for VC re-opening and staff returning as people will be ready to participate.

S – Do you have any feedback on the quarterly regulator meetings?

L – Timing is good, perhaps send agenda, reminders to regulators earlier.

S – Communications during COVID have been working well. If USEPA requires an in-person CERCLA 5YR inspection, OEPA will be notified as soon as possible.

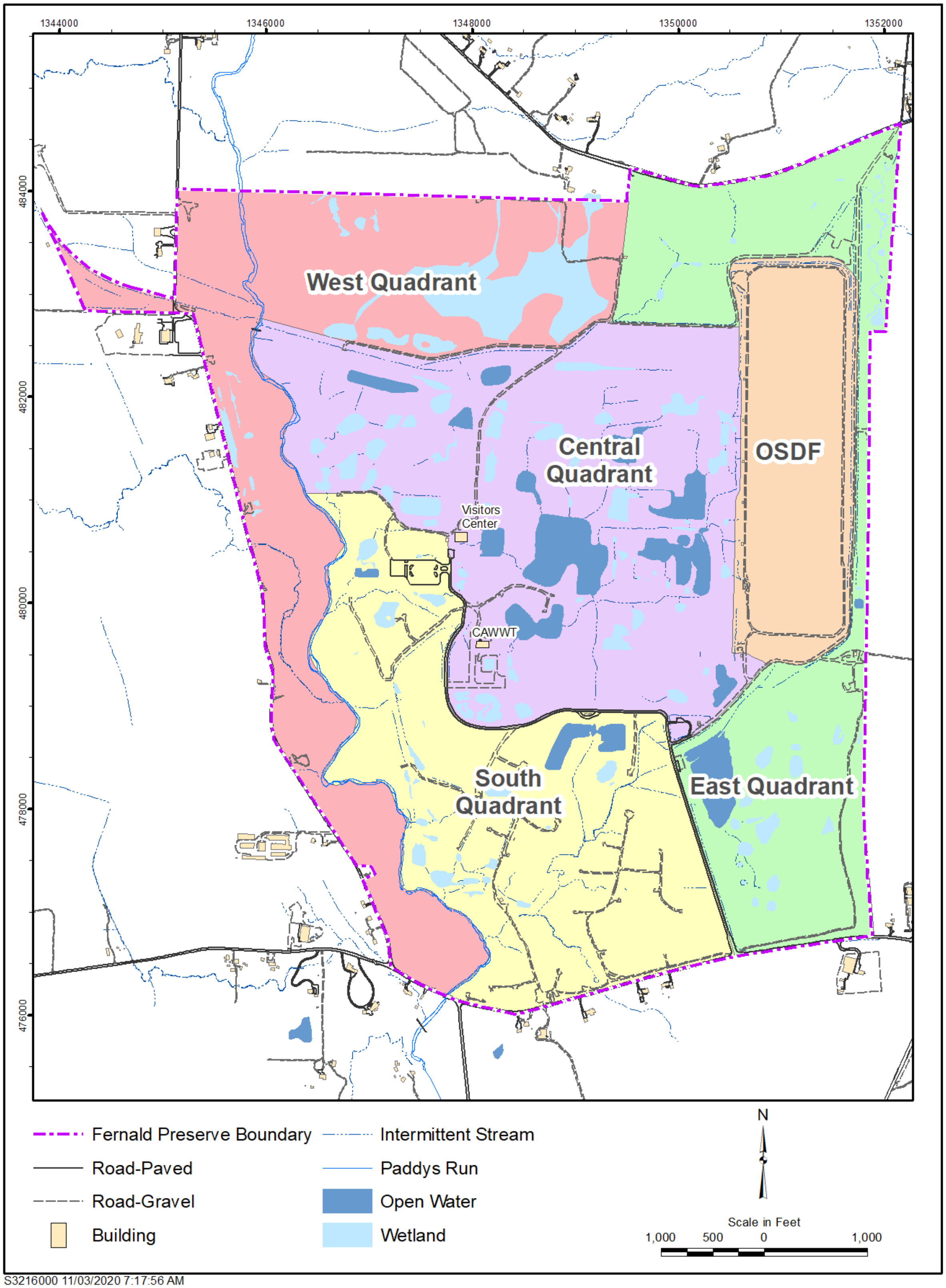
J – Has shared information about virtual inspections done collaboratively with OEPA with other LM sites.

After OSWER No. 9355.7-03B-P Page _2__ of __2__

Attachment 8

Field Walkdown Quadrants

This page intentionally left blank



Field Walkdown Quadrants

This page intentionally left blank

Attachment 9

Site Photographs

This page intentionally left blank

OSDF Valve Houses, North Perspective

OSDF Northwest Gate, North-Northeast Perspective

OSDF Southwest Gate, North-Northeast Perspective

OSDF South Gate, North-Northeast Perspective

Converted Advanced Wastewater Treatment Facility (CAWWT)

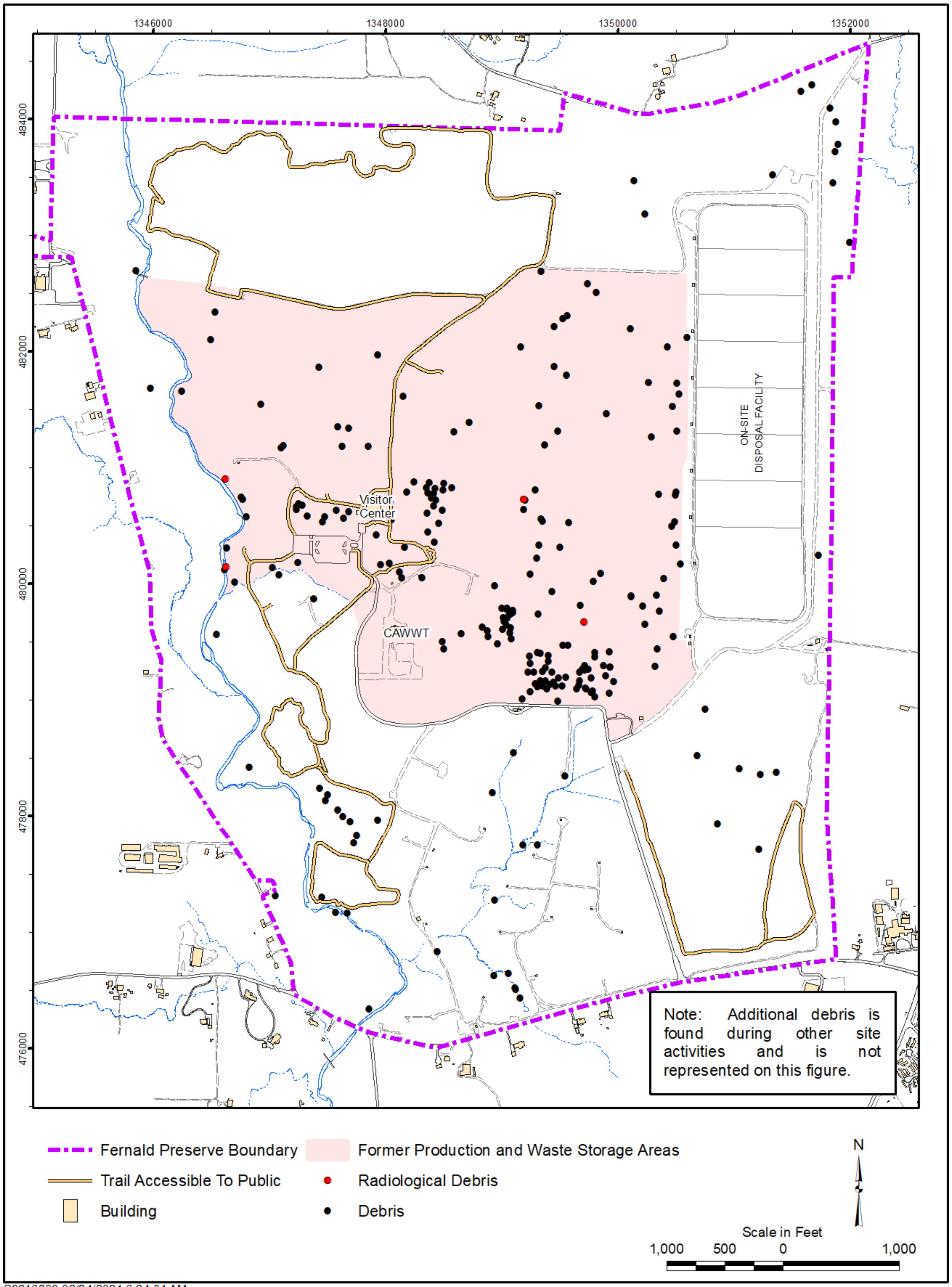
Effluent Discharge at the Great Miami River, NPDES Location PF4001

This page intentionally left blank

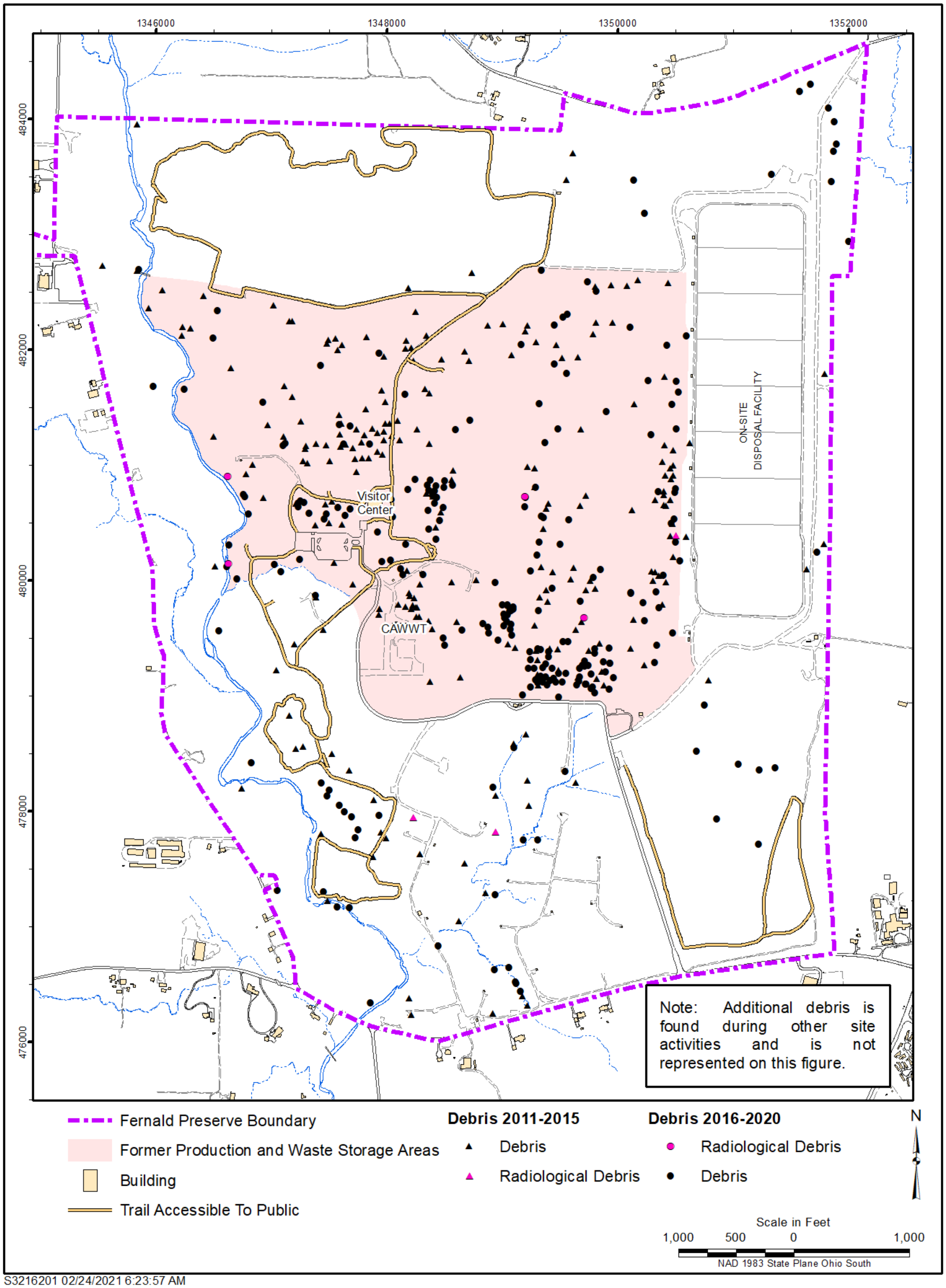
Attachment 10

Site Inspection Debris Findings

This page intentionally left blank



Site Inspection Debris Findings (2016-2020)



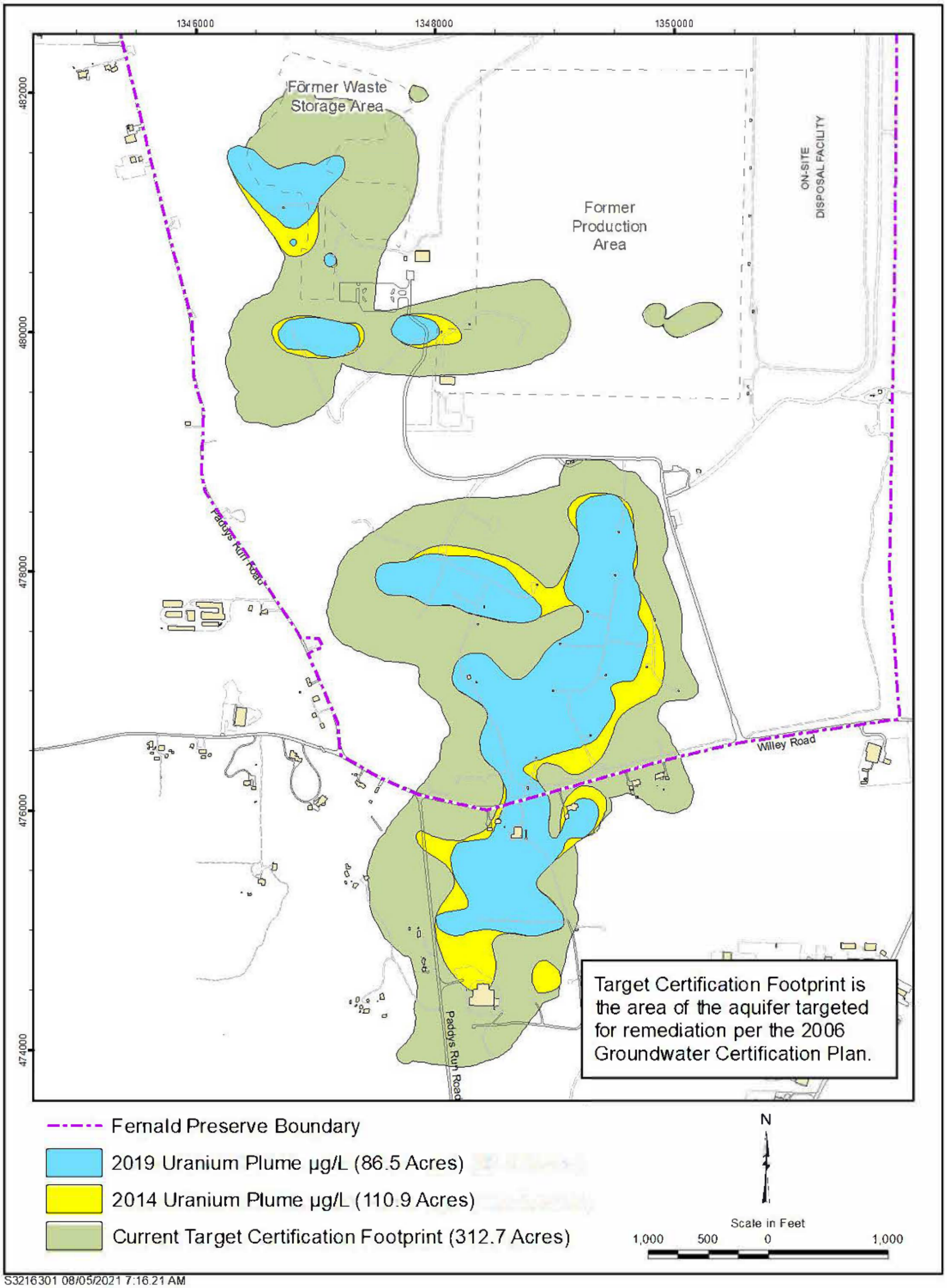
Site Inspection Debris Findings (2011-2020)

Representative construction debris identified during a post-prescribed burn inspection.

This page intentionally left blank

Attachment 11

Target Certification Footprint and Maximum Uranium Plume Footprint



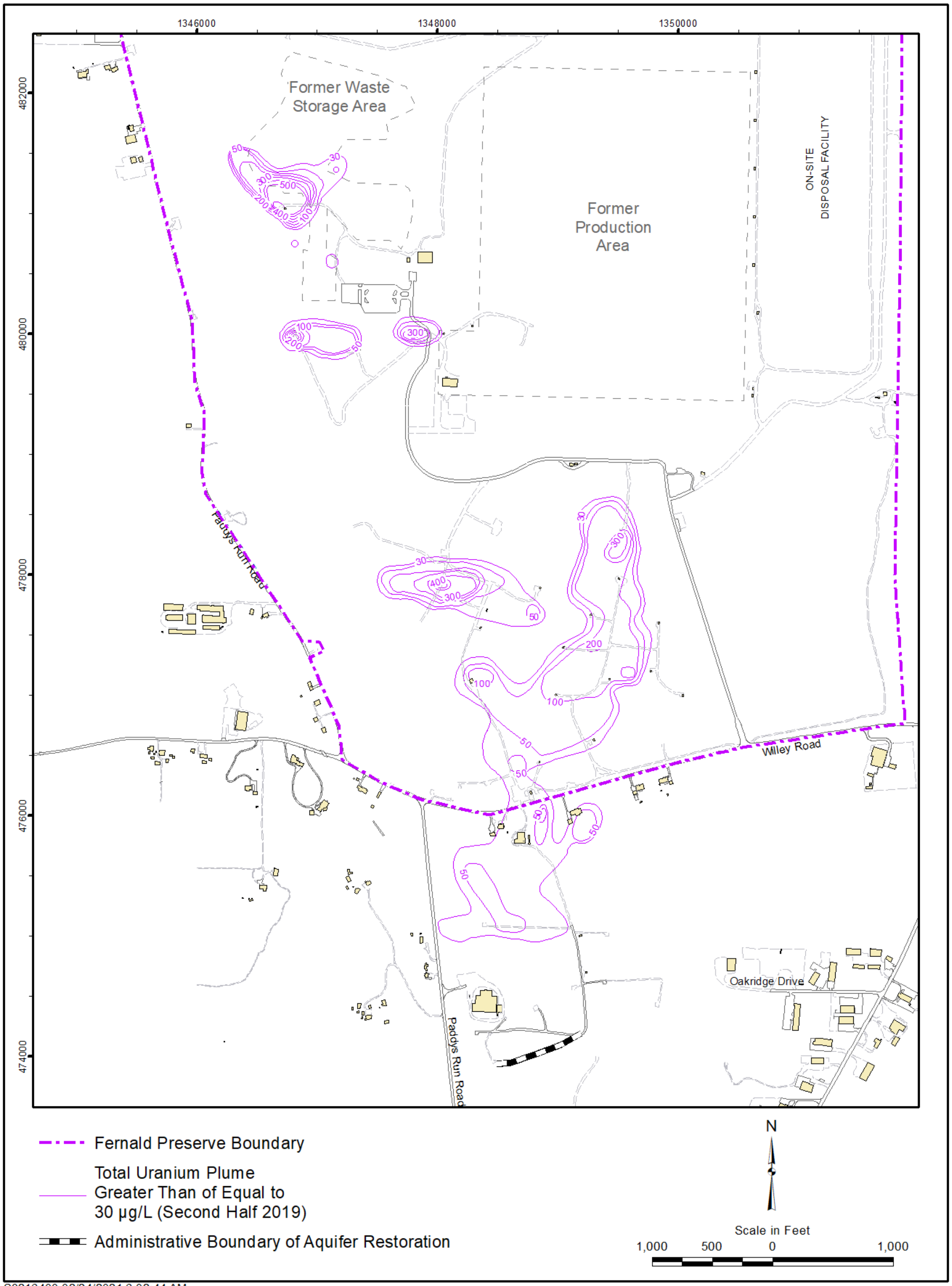
Target Certification Footprint and Maximum Uranium Plume Footprints in 2014 and 2019

This page intentionally left blank

Attachment 12

Maximum Uranium Plume Footprint as of Second Half 2019

This page intentionally left blank



S3216400 02/24/2021 6:02:44 AM

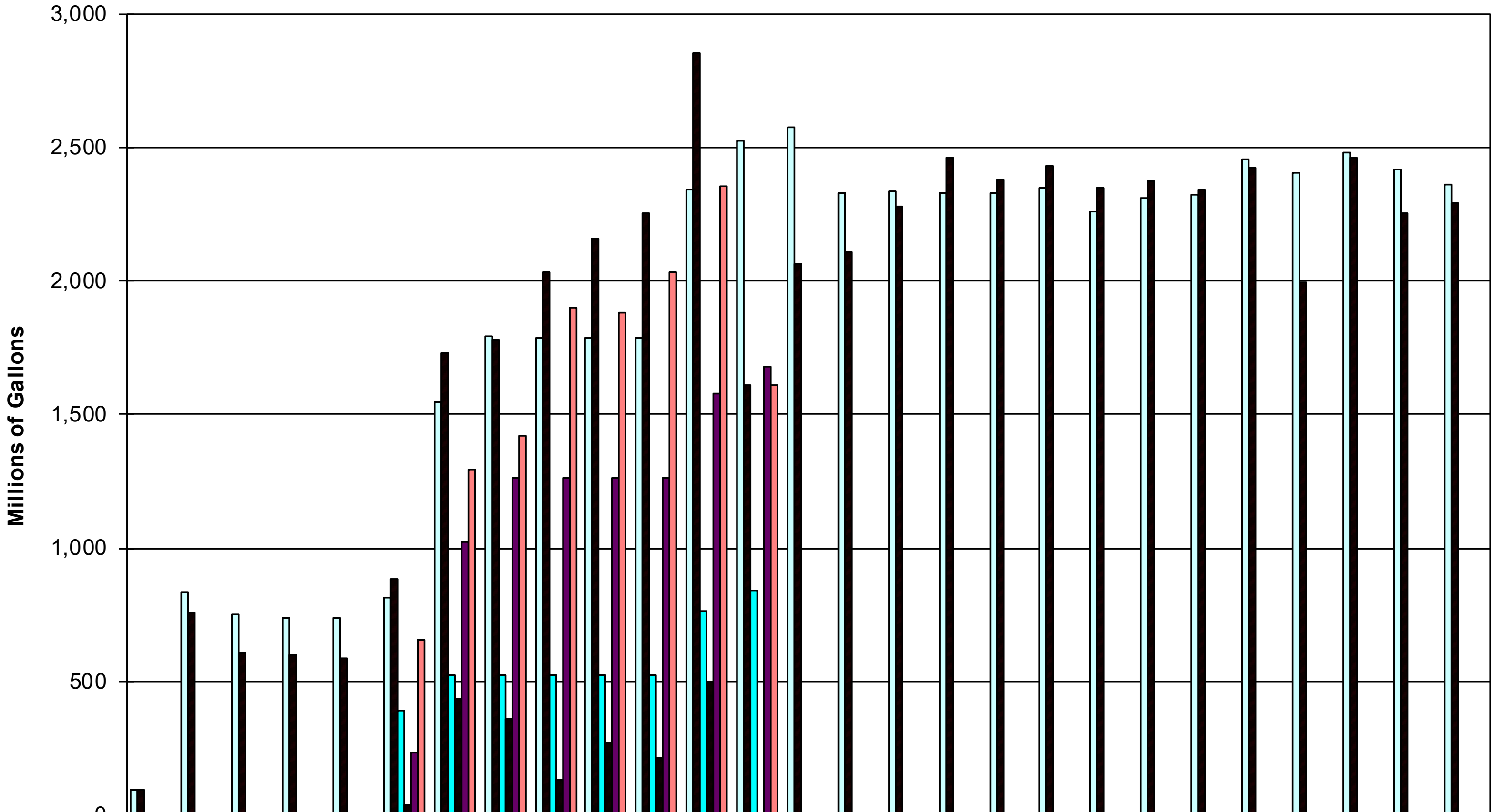
Maximum Uranium Plume Footprint as of Second Half 2019

This page intentionally left blank

Attachment 13

Actual Versus Predicted Gallons Extracted (1993 to 2019)

This page intentionally left blank



	FY1993	FY1994	FY1995	FY1996	FY1997	FY1998	FY1999	FY2000	FY2001	FY2002	FY2003	FY2004	FY2005
Planned Total GW Pumped (Mgal)	97.920	832.320	753.552	737.856	735.840	814.464	1548.57	1791.93	1787.04	1787.04	1787.04	2344.32	2522.88
Actual Total GW Pumped (Mgal)	97.183	756.976	605.541	597.200	585.123	883.804	1729.57	1781.52	2035.16	2155.97	2253.35	2855.22	1610.67
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	1,022.9	1,264.8	1,261.4	1,261.4	1,261.4	1,580.5	1,681.9
Actual Net GW Extracted (Mgal)	0.000	0.000	0.000	0.000	0.000	657.184	1,292.9	1,420.4	1,903.0	1,882.3	2,034.6	2,355.8	1,610.6

	FY2006	FY2007	FY2008	FY2009	FY2010	FY2011	FY2012	FY2013	FY2014	FY2015	FY2016	FY2017	FY2018	FY2019
Planned Total GW Pumped (Mgal)	2,575.1	2,330.1	2,338.0	2,332.2	2,332.2	2,349.4	2,262.8	2,309.4	2,324.2	2,456.9	2,404.2	2,482.7	2,420.6	2,362.3
Actual Total GW Pumped (Mgal)	2064.37	2110.35	2281.35	2463.45	2380.59	2431.42	2351.21	2374.83	2340.47	2423.60	1992.87	2461.57	2253.57	2294.28
Planned Injected GW (Mgal)														
Actual Injected GW (Mgal)														
Planned Net GW Extracted (Mgal)														
Actual Net GW Extracted (Mgal)														

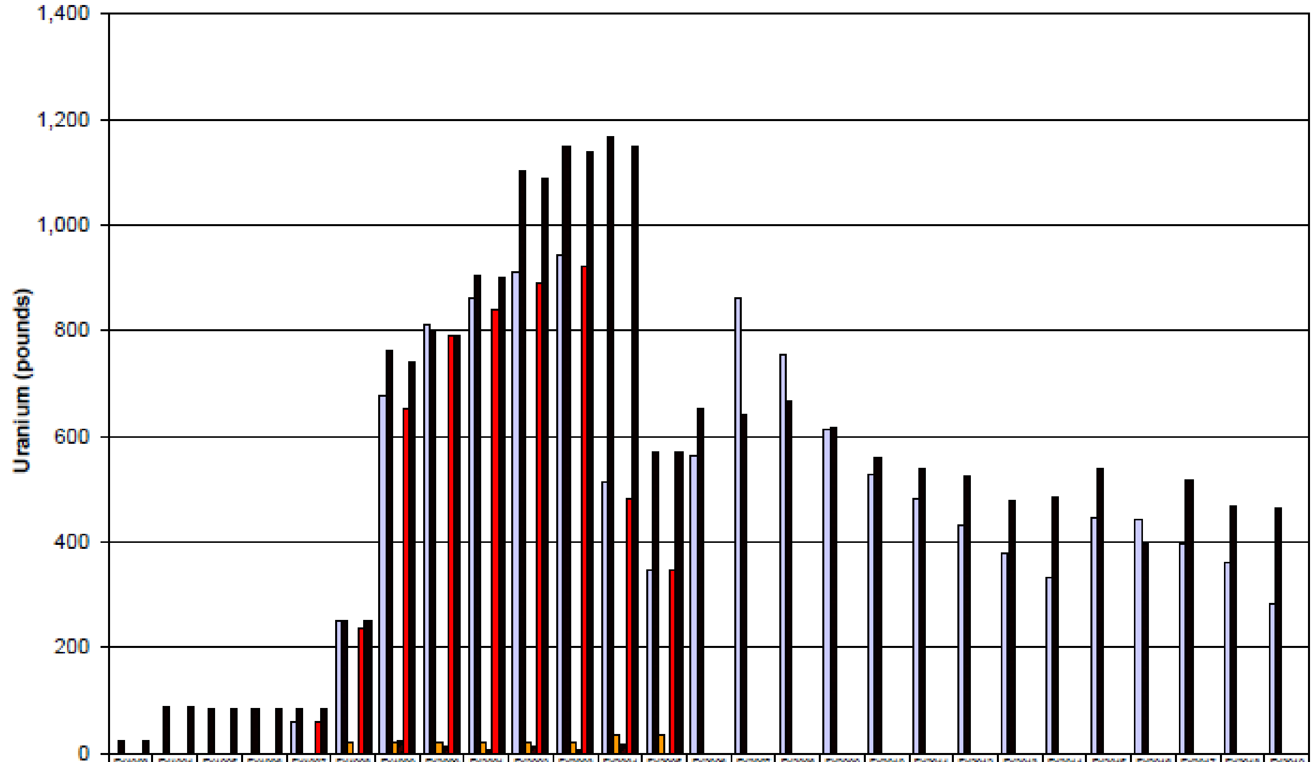
Actual Versus Predicted Gallons Extracted (1993 to 2019)

This page intentionally left blank

Attachment 14

Actual Versus Predicted Pounds of Uranium Removed (1993 to 2019)

This page intentionally left blank



	FY1993	FY1994	FY1995	FY1996	FY1997	FY1998	FY1999	FY2000	FY2001	FY2002	FY2003	FY2004	FY2005	FY2006	FY2007	FY2008	FY2009	FY2010	FY2011	FY2012	FY2013	FY2014	FY2015	FY2016	FY2017	FY2018	FY2019
Planned Total U Extracted from GMA (lbs)	0.0	0.0	0.0	0.0	59.6	251.7	674.6	812.3	862.2	910.9	943.4	512.7	346.0	563.6	860.7	756.4	614.0	528.4	482.6	429.9	377.6	332.1	445.2	444.4	397.1	359.8	284.4
Actual Total U Extracted from GMA (lbs)	24.0	89.0	83.0	85.0	82.6	251.3	763.6	801.6	904.9	1,103.4	1,146.9	1,165.0	570.6	651.7	642.6	665.7	616.0	558.4	537.6	523.5	479.4	485.1	538.6	397.7	516.3	465.8	462.6
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	35.0	35.0														
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	16.4	0.0														
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	480.9	346.0														
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	1148.6	570.6														

Fiscal Year

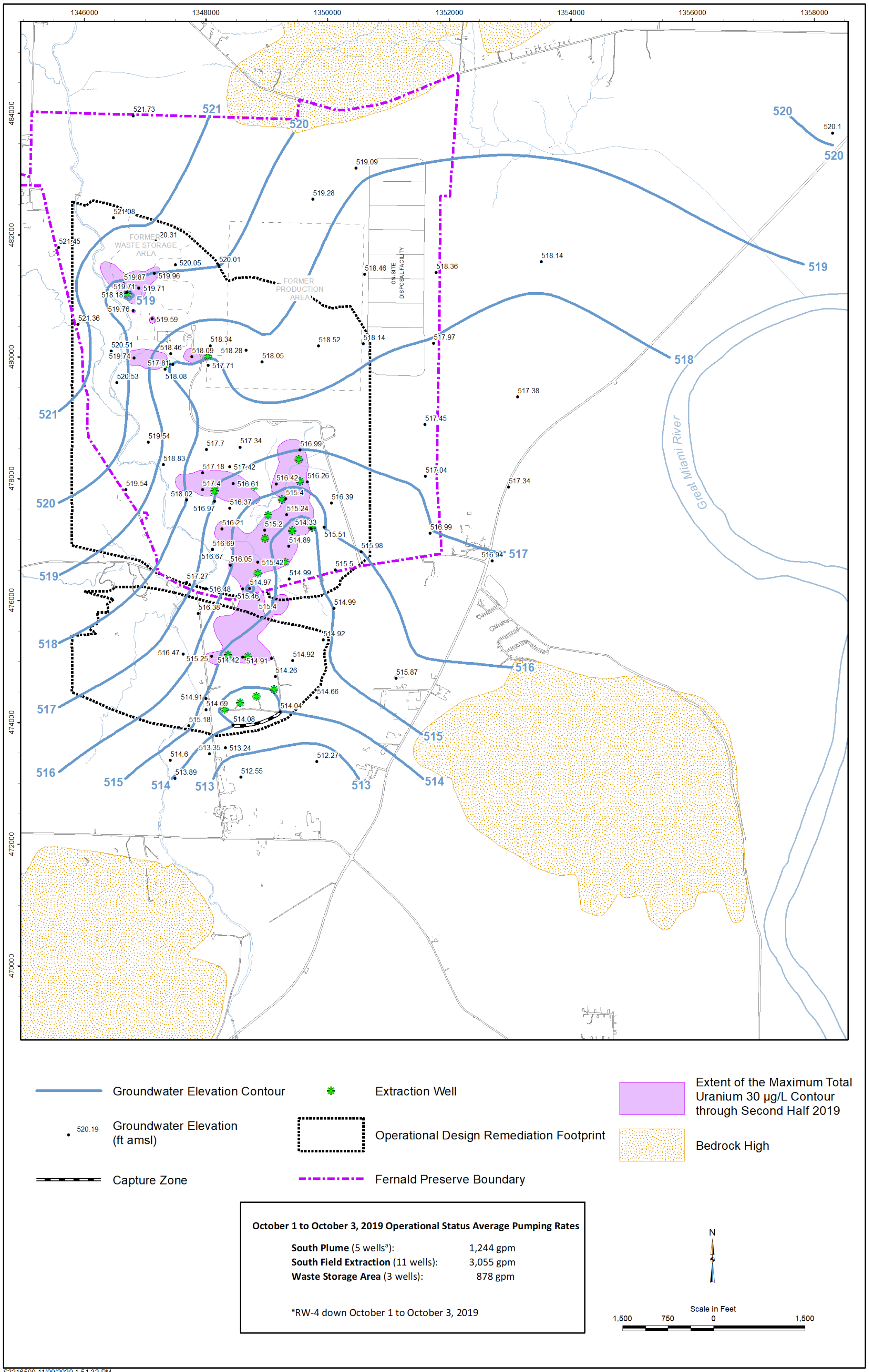
Actual Versus Predicted Pounds of Uranium Removed (1993 to 2019)

This page intentionally left blank

Attachment 15

Routine Groundwater Elevation Map, Fourth Quarter 2019 (October 1 through October 3, 2019)

This page intentionally left blank

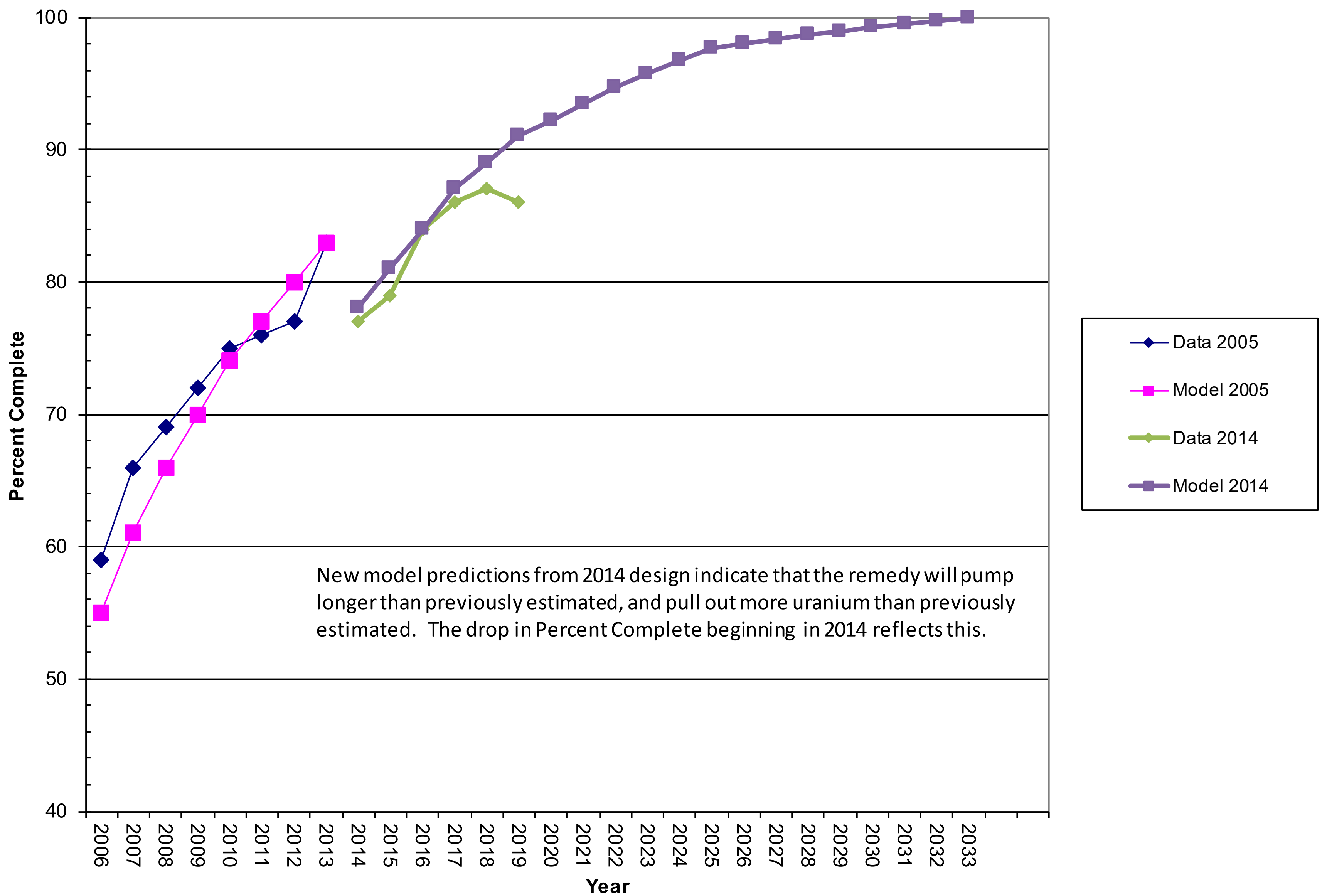


Routine Groundwater Elevation Map, Fourth Quarter 2019

This page intentionally left blank

Attachment 16

Percent Complete Estimate Based on Uranium Removal



Percent Complete Estimate Based on Uranium Removal

This page intentionally left blank

Attachment 17

Human Health Risk Calculations

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 2020 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 2020 CSF and RfD values were extracted from DOE Risk Assessment Information System (RAIS) on, respectively, December 23 and 26, 2020. The 2020 values were compared to the values used in the *Fourth Five-Year Review Report for the Fernald Preserve* (DOE 2016). If a given CSF 2020/2015 ratio is greater than 1, the 2020 ILCR will increase relative to the 2015 value because risk is calculated by multiplying the chronic daily intake (CDI) by the CSF. For the RfD comparison, the 2015/2020 ratio is used because the HI is calculated by dividing the CDI by the RfD. Therefore, if the RfD decreases for 2020 (i.e., 2015/2020 > 1), the HI increases and there is a greater risk to the receptor in 2020 relative to the 2015 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 2020 value is used in the risk calculations. Values of 1 indicate no change from results in the Fourth-Five Year Review Report. A cell with “NA” indicates that a 2015 or 2020 value was unavailable to calculate the ratio.

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

CHEMICAL	Oral CSF 2020/2015[a]	Dermal CSF 2020/2015[a]	Inhale CSF 2020/2015[a]
Acetone	NA	NA	NA
Antimony (metallic)	NA	NA	NA
Aroclor-1254	1.00	1.00	1.00
Aroclor-1260	1.00	1.00	1.00
Arsenic (inorganic)	1.00	1.00	1.00
Barium	NA	NA	NA
Benzene	1.00	1.00	1.00
Benz(a)anthracene	0.14	0.14	0.55
Benzo(a)pyrene	0.14	0.14	0.55
Benzo(b)fluoranthene	0.14	0.14	0.55
Benzo(k)fluoranthene	0.14	0.14	0.05
Beryllium and compounds	NA	NA	1.00
Bis(2-chloroisopropyl)ether	NA	NA	NA
Bis(2-ethylhexyl)phthalate	1.00	1.00	1.00
Boron and borates only	NA	NA	NA
Bromodichloromethane	1.00	1.00	1.00
Bromoform	1.00	1.00	1.00
Bromomethane	NA	NA	NA
Butanone, 2-	NA	NA	NA
Cadmium	NA	NA	1.00

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

CHEMICAL	Oral CSF 2020/2015[a]	Dermal CSF 2020/2015[a]	Inhale CSF 2020/2015[a]
Carbazole	1.00	1.00	NA
Carbon disulfide	NA	NA	NA
Carbon tetrachloride	1.00	1.00	1.00
Chlordane	NA	NA	NA
Chlorobenzene	NA	NA	NA
Chloroform	1.00	1.00	1.00
Chromium (VI)	1.00	0.03	1.00
Chrysene	0.14	0.14	0.05
Cobalt	NA	NA	1.00
Copper	NA	NA	NA
Cresol, p- (4-methylphenol)	NA	NA	NA
Cyanide	NA	NA	NA
Cyclohexanone	NA	NA	NA
Dibenz(a,h)anthracene	0.14	0.14	0.50
Dichlorobenzidine, 3,3-	1.00	1.00	1.00
Dichloroethane, 1,2-	1.00	1.00	1.00
Dichloroethylene, 1,1-	NA	NA	NA
Dieldrin	1.00	1.00	1.00
Di-n-octylphthalate	NA	NA	NA
Ethyl ether	NA	NA	NA
Ethylbenzene	1.00	1.00	1.00
Fluoride	NA	NA	NA
Heptachlorodibenzofuran	1.00	1.00	NA
Heptachlorodibenzo-p-dioxin	NA	NA	NA
Hexachlorodibenzofuran	1.00	1.00	1.00
Hexachlorodibenzo-p-dioxin	NA	NA	NA
Indeno(1,2,3-cd)pyrene	0.14	0.14	0.55
Lead and compounds	1.00	1.00	1.00
Manganese (diet)	NA	NA	NA
Mercury (elemental)	NA	NA	NA
Methanol	NA	NA	NA
Methyl Isobutyl Ketone (4-methyl-2-pentanone)	NA	NA	NA
Methylene chloride	1.00	1.00	1.00
Molybdenum	NA	NA	NA
Nickel (soluble salts)	NA	NA	1.00
Nitroanaline, 4-	5.00	5.00	NA
Nitroso-di-N-propylamine, N-	1.00	1.00	1.00
Nitrosodiphenylamine, N-	1.00	1.00	1.00
Octochlorodibenzofuran	1.00	1.00	1.00
Octochlorodibenzo-p-dioxin	1.00	1.00	1.00
Pentachlorodibenzofuran	NA	NA	NA
Pentachlorodibenzo-p-dioxin	1.00	1.00	1.00
Pentachlorophenol	1.00	1.00	1.00
Phenanthrene	NA	NA	NA
Selenium	NA	NA	NA

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

CHEMICAL	Oral CSF 2020/2015[a]	Dermal CSF 2020/2015[a]	Inhale CSF 2020/2015[a]
Silver	NA	NA	NA
Tetrachlorodibenzofuran	1.00	1.00	1.00
Tetrachlorodibenzo-p-dioxin	1.00	1.00	1.00
Tetrachloroethylene	1.00	1.62	1.00
Thallium (soluble salts)	NA	NA	NA
Toluene	NA	NA	NA
Tributyl phosphate	1.00	1.00	NA
Trichloroethane, 1,1,2-	1.00	1.00	1.00
Trichloroethylene	1.00	1.00	1.00
Trichlorofluoromethane	NA	NA	NA
Uranium (soluble salts)	NA	NA	NA
Vanadium	NA	NA	NA
Vinyl chloride	1.00	1.00	1.00
Xylenes	NA	NA	NA
Zinc and compounds	NA	NA	NA

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

ISOTOPE	Soil CSF 2020/2015[a]	Water CSF 2020/2015[a]	Inhale CSF 2020/2015[a]	External CSF 2020/2015[a]
Cesium-137 + D	1.00	1.00	1.00	0.90
Lead-210	1.00	1.00	1.00	1.00
Neptunium-237 + D	1.00	1.00	1.00	0.95
Plutonium-238	1.00	1.00	1.00	0.99
Plutonium-239/240	1.00	1.00	1.00	0.96
Radium-226 + D	1.00	1.00	1.00	0.85
Radium-228 + D	1.00	1.00	1.00	0.87
Radon-222+ D	NA	NA	1.00	0.91
Strontium-90 + D	1.00	1.00	1.00	0.94
Technetium-99	1.00	1.00	1.00	1.00
Thorium-228	1.00	1.00	1.00	0.98
Thorium-230	1.00	1.00	1.00	0.99
Thorium-232	1.00	1.00	1.00	1.00
Uranium-234	1.00	1.00	1.00	1.00
Uranium-235 + D	1.00	1.00	1.00	0.97
Uranium-238 + D	1.00	1.00	1.00	0.89

[a] NA = not applicable

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

CHEMICAL	Oral RfD 2015/2020[a]	Dermal RfD 2015/2020[a]	Inhale RfD 2015/2020[a]
Acetone	1.00	1.00	1.00
Antimony (metallic)	1.00	0.15	NA
Aroclor-1254	1.00	1.00	NA
Aroclor-1260	NA	NA	NA
Arsenic (inorganic)	1.00	1.00	1.00
Barium	1.00	0.07	1.00
Benzene	1.00	1.00	1.00
Benz(a)anthracene	NA	NA	NA
Benzo(a)pyrene	NA	NA	NA
Benzo(b)fluoranthene	NA	NA	NA
Benzo(k)fluoranthene	NA	NA	NA
Beryllium and compounds	1.00	0.01	1.00
Bis(2-chloroisopropyl)ether	NA	NA	NA
Bis(2-ethylhexyl)phthalate	1.00	1.00	NA
Boron and borates only	1.00	1.00	1.00
Bromodichloromethane	1.00	1.00	NA
Bromoform	1.00	1.00	NA
Bromomethane	1.00	1.00	1.00
Butanone, 2-	NA	NA	NA
Cadmium	1.00	0.03	1.00
Carbazole	NA	NA	NA
Carbon disulfide	1.00	1.00	1.00
Carbon tetrachloride	1.00	1.00	1.00
Chlordane	NA	NA	NA
Chlorobenzene	1.00	1.00	1.00
Chloroform	1.00	1.00	1.00
Chromium (VI)	1.00	0.03	1.00
Chrysene	NA	NA	NA
Cobalt	1.00	1.00	1.00
Copper	1.00	1.00	NA
Cresol, p- (4-methylphenol)	1.00	1.00	1.00
Cyanide	1.00	1.00	1.00
Cyclohexanone	1.00	1.00	1.00
Dibenz(a,h)anthracene	NA	NA	NA
Dichlorobenzidine, 3,3-	NA	NA	NA
Dichloroethane, 1,2-	1.00	1.00	1.00
Dichloroethylene, 1,1-	1.00	1.00	1.00
Dieldrin	1.00	1.00	NA
Di-n-octylphthalate	0.98	0.98	NA
Ethyl ether	1.00	1.00	NA
Ethylbenzene	1.00	1.00	1.00
Fluoride	1.50	1.50	1.00

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

CHEMICAL	Oral RfD 2015/2020[a]	Dermal RfD 2015/2020[a]	Inhale RfD 2015/2020[a]
Heptachlorodibenzofuran	1.00	1.00	1.00
Heptachlorodibenzo-p-dioxin	NA	NA	NA
Hexachlorodibenzofuran	1.00	1.00	1.00
Hexachlorodibenzo-p-dioxin	NA	NA	NA
Indeno(1,2,3-cd)pyrene	NA	NA	NA
Lead and compounds	NA	NA	NA
Manganese (diet)	1.00	0.01	1.00
Mercury (elemental)	1.00	0.07	NA
Methanol	1.00	1.00	1.00
Methyl Isobutyl Ketone (4-methyl-2-pentanone)	1.00	1.00	1.00
Methylene chloride	1.00	1.00	1.00
Molybdenum	1.00	1.00	NA
Nickel (soluble salts)	1.00	0.04	1.00
Nitroanaline, 4-	1.00	1.00	1.00
Nitroso-di-N-propylamine, N-	NA	NA	NA
Nitrosodiphenylamine, N-	NA	NA	NA
Octochlorodibenzofuran	1.00	1.00	1.00
Octochlorodibenzo-p-dioxin	1.00	1.00	1.00
Pentachlorodibenzofuran	NA	NA	NA
Pentachlorodibenzo-p-dioxin	1.00	1.00	1.00
Pentachlorophenol	1.00	1.00	NA
Phenanthrene	NA	NA	NA
Selenium	1.00	1.00	1.00
Silver	1.00	0.04	NA
Tetrachlorodibenzofuran	NA	NA	1.00
Tetrachlorodibenzo-p-dioxin	1.00	1.00	1.00
Tetrachloroethylene	1.00	1.00	1.00
Thallium (soluble salts)	0.70	0.70	NA
Toluene	1.00	1.00	1.00
Tributyl phosphate	1.00	1.00	NA
Trichloroethane, 1,1,2-	1.00	1.00	NA
Trichloroethylene	1.00	1.00	1.00
Trichlorofluoromethane	1.00	1.00	1.00
Uranium (soluble salts)	15.00	15.00	1.00
Vanadium	1.00	0.03	NA
Vinyl chloride	1.00	1.00	1.00
Xylenes	1.00	1.00	1.00
Zinc and compounds	1.00	1.00	NA

[a] NA = not applicable

Updated EPA Exposure Factors

In 2011, 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 were used in the 2016 FYR report and, as there have been no changes to the exposure factors, the exposure factors used in this report are identical to those used in the 2016 report.

Inhalation rate, cubic meter per hour (m^3/h), is 0.66 m^3/h for the child (5 to 11 years), 0.78 m^3/h for the youth (11 to 17 years) and 0.72 m^3/h for the adult (31 to 38 years) and senior (64 to 71 years).

Resident exposure includes 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 (as noted above for the inhalation rates).

Body weight 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.

Surface water ingestion rates are: child/youth, 0.035 to 0.037 liters per day (L/day); and adult/senior, 0.015 to 0.016 L/day.

Body surface area for soil and surface water contact (one-half of arms, hands, one-half of legs, and feet) are as follows: 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.

2020 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 2020 data for CSFs and RfDs downloaded from RAIS (December 2020) and the exposure factors (EPA 2011) noted above. The presentation format for Tables 17-4 through 17-15 is identical to that used in the fourth 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	3.55E-04	1.21E-05	1.20E-05
Dermal Soil	1.66E-03	2.05E-07	NA
Ingest Soil	2.50E-02	2.83E-06	8.60E-07
Dermal Surface Water	9.94E-03	1.30E-06	NA
Ingest Surface Water	2.42E-03	1.03E-07	4.87E-08
External Radiation	NA	1.86E-06	1.86E-06
SUM	**3.94E-02**	**1.84E-05**	**1.47E-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	2.56E-08	2.30E-08	2.60E-09
Lead-210	3.37E-07	2.47E-07	8.99E-08
Neptunium-237 + D	8.07E-10	6.53E-11	7.42E-10
Plutonium-238	9.02E-11	1.16E-11	7.87E-11
Plutonium-239/240	NC	NC	NC
Radium-226 + D	1.30E-06	1.84E-06	0.00E+00
Radium-228 + D	7.44E-07	9.34E-07	0.00E+00
Radon-222+ D	1.20E-05	1.45E-05	0.00E+00
Strontium-90 + D	NC	NC	NC
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	2.28E-08	6.51E-09	1.63E-08
Uranium-238 + D	1.81E-07	5.26E-08	1.29E-07
SUM	**1.47E-05**	**---**	**3.15E-07**

NC = soil and water concentrations are unavailable for Pu-239/240 and Sr-90
+ 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

CHEMICAL	Total ILCR	Total HQ	Bkgd ILCR	Bkgd HQ	Tot-Bkd ILCR	Tot-Bkd HQ
Acetone	no CSFs	5.35E-08	0.00E+00	0.00E+00	no CSFs	5.35E-08
Antimony (metallic)	no CSFs	1.02E-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	0.00E+00	1.15E-07	no RFDs
Arsenic (inorganic)	1.34E-06	8.16E-03	1.47E-06	8.80E-03	0.00E+00	0.00E+00
Barium	no CSFs	2.33E-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	3.28E-08	no RfDs	0.00E+00	0.00E+00	3.28E-08	no RfDs
Benzo[*a*]pyrene	4.20E-07	3.78E-03	0.00E+00	0.00E+00	4.20E-07	3.78E-03
Benzo[*b*]fluoranthene	2.57E-08	no RfDs	0.00E+00	0.00E+00	2.57E-08	no RfDs
Benzo[*k*]fluoranthene	4.01E-09	no RfDs	0.00E+00	0.00E+00	4.01E-09	no RfDs
Beryllium and compounds	no CSFs	1.17E-04	no CSFs	1.65E-04	no CSFs	0.00E+00
Bis(2-chloroisopropyl)ether	no CSFs	no RfDs	0.00E+00	0.00E+00	no CSFs	no RfDs
Bis(2-ethylhexyl)phthalate	NC	NC	0.00E+00	0.00E+00	NC	NC
Boron and borates	no CSFs	NC	no CSFs	3.93E-06	no CSFs	NC
Bromodichloromethane	3.42E-10	7.43E-07	0.00E+00	0.00E+00	3.42E-10	7.43E-07
Bromoform	NC	NC	0.00E+00	0.00E+00	NC	NC
Bromomethane	no CSFs	NC	0.00E+00	0.00E+00	no CSFs	NC
Butanone, 2-	no CSFs	no RfDs	0.00E+00	0.00E+00	no CSFs	no RfDs
Cadmium	no CSFs	1.43E-04	no CSFs	2.52E-04	no CSFs	0.00E+00
Carbazole	NC	no RfDs	0.00E+00	0.00E+00	NC	no RfDs
Carbon disulfide	no CSFs	NC	0.00E+00	0.00E+00	no CSFs	NC
Carbon tetrachloride	8.77E-10	8.43E-06	0.00E+00	0.00E+00	8.77E-10	8.43E-06
Chlordane	NC	NC	0.00	0.00	NC	NC
Chlorobenzene	no CSFs	NC	0.00E+00	0.00E+00	no CSFs	NC
Chloroform	NC	NC	0.00E+00	0.00E+00	NC	NC
Chromium(VI)	9.71E-07	1.54E-03	1.01E-06	1.61E-03	0.00E+00	0.00E+00
Chrysene	3.53E-10	no RfDs	0.00E+00	0.00E+00	3.53E-10	no RfDs
Cobalt	NC	NC	no CSFs	1.28E-02	NC	NC
Copper	no CSFs	NC	no CSFs	1.41E-04	no CSFs	NC
Cresol, *p*- (4-methylphenol)	no CSFs	NC	0.00E+00	0.00E+00	no CSFs	NC
Cyanide	no CSFs	NC	0.00E+00	0.00E+00	no CSFs	NC
Cyclohexanone	no CSFs	NC	0.00E+00	0.00E+00	no CSFs	NC
Dibenz[*a,h*]anthracene	5.49E-07	no RfDs	0.00E+00	0.00E+00	5.49E-07	no RfDs
Dichlorobenzidine, 3,3-	NC	no RfDs	0.00E+00	0.00E+00	NC	no RfDs
Dichloroethane, 1,2-	5.12E-10	2.53E-06	0.00E+00	0.00E+00	5.12E-10	2.53E-06
Dichloroethylene, 1,1-	no CSFs	5.35E-07	0.00E+00	0.00E+00	no CSFs	5.35E-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	NC	0.00E+00	0.00E+00	no CSFs	NC
Ethyl ether	no CSFs	NC	0.00E+00	0.00E+00	no CSFs	NC
Ethylbenzene	3.45E-10	8.45E-07	0.00E+00	0.00E+00	3.40E-10	8.39E-07
Fluoride	no CSFs	2.23E-04	no CSFs	5.92E-05	no CSFs	1.64E-04
Heptachlorodibenzofuran	NC	NC	0.00E+00	0.00E+00	NC	NC

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

CHEMICAL	Total ILCR	Total HQ	Bkgd ILCR	Bkgd HQ	Tot-Bkd ILCR	Tot-Bkd HQ
Heptachlorodibenzo-*p*-dioxin	NC	NC	0.00E+00	0.00E+00	NC	NC
Hexachlorodibenzofuran	NC	NC	0.00E+00	0.00E+00	NC	NC
Hexachlorodibenzo-*p*-dioxin	no CSFs	no RfDs	0.00E+00	0.00E+00	no CSFs	no RfDs
Indeno[1,2,3-*c,d*]pyrene	7.18E-08	no RfDs	0.00E+00	0.00E+00	7.18E-08	no RfDs
Lead and compounds	1.69E-08	no RfDs	1.74E-08	no RfDs	0.00E+00	no RfDs
Manganese (diet)	no CSFs	NC	no CSFs	1.70E-03	no CSFs	NC
Mercury (elemental)	no CSFs	4.64E-05	no CSFs	5.41E-05	no CSFs	0.00E+00
Methanol	no CSFs	NC	0.00E+00	0.00E+00	no CSFs	NC
Methyl Isobutyl Ketone (4-methyl-2-pentanone)	no CSFs	8.49E-07	0.00E+00	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 (soluble salts)	NC	NC	8.08E-10	5.05E-04	NC	NC
Nitroanaline, 4-	NC	NC	0.00E+00	0.00E+00	NC	NC
Nitroso-di-*N*-propylamine, N-	NC	no RfDs	0.00E+00	0.00E+00	NC	no RfDs
Nitrosodiphenylamine, *N*-	NC	NC	0.00E+00	0.00E+00	NC	NC
Octachlorodibenzofuran	NC	NC	0.00E+00	0.00E+00	NC	NC
Octochlorodibenzo-p-dioxin	NC	NC	0.00E+00	0.00E+00	NC	NC
Pentachlorodibenzofuran	NC	NC	0.00E+00	0.00E+00	NC	NC
Pentachlorodibenzo-p-dioxin	NC	NC	0.00E+00	0.00E+00	NC	NC
Pentachlorophenol	NC	NC	0.00E+00	0.00E+00	NC	NC
Phenanthrene	no CSFs	no RfDs	0.00E+00	0.00E+00	no CSFs	no RfDs
Selenium	no CSFs	5.56E-05	no CSFs	5.29E-05	no CSFs	2.70E-06
Silver	no CSFs	2.69E-05	no CSFs	4.31E-05	no CSFs	0.00E+00
Tetrachlorodibenzofuran	NC	NC	0.00E+00	0.00E+00	NC	NC
Tetrachlorodibenzo-*p*-dioxin	NC	NC	0.00E+00	0.00E+00	NC	NC
Tetrachloroethylene	4.69E-11	1.00E-05	0.00E+00	0.00E+00	4.68E-11	1.00E-05
Thallium (soluble salts)	no CSFs	NC	no CSFs	1.60E-02	no CSFs	NC
Toluene	no CSFs	7.07E-07	0.00E+00	0.00E+00	no CSFs	7.07E-07
Tributyl phosphate	NC	NC	0.00E+00	0.00E+00	NC	NC
Trichloroethane, 1,1,2-	3.48E-10	4.11E-06	0.00E+00	0.00E+00	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	NC	0.00E+00	0.00E+00	no CSFs	NC
Uranium (soluble salts)	no CSFs	1.68E-02	no CSFs	3.05E-04	no CSFs	1.65E-02
Vanadium	no CSFs	NC	no CSFs	1.53E-03	no CSFs	NC
Vinyl chloride	NC	NC	0.00E+00	0.00E+00	NC	NC
Xylenes	no CSFs	4.29E-07	0.00E+00	0.00E+00	no CSFs	4.29E-07
Zinc and compounds	no CSFs	NC	no CSFs	5.36E-05	no CSFs	NC
SUM	**3.67E-06**	**3.94E-02**	---	---	**1.34E-06**	**2.75E-02**

NC = CSF or RfD available, but no soil and/or water concentrations.
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 17-7. 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/m³	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	m³/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
	RfDi =	RfC*20m³/day/70kg					
	CSFi	IUR*1000ug/mg*70kg/20m³/day					

NOTE: Corrected error found in calculation of air concentration (Formula misaligned callout for COC soil concentration reported in Table 17-8)

NOTE: RAIS now reports RfC and IUR values. RfDi and CSDi calculated as indicated above.

COC	conc	RfC	RfDi	IUR	CSFi	CHILD				YOUTH			
						CDI	HQ	CDI	ILCR	CDI	HQ	CDI	ILCR
	mg/m³	mg/m³	mg/kgday	m³/ug	kgday/mg	mg/kgday	CDI/RfD	mg/kgday	CDI*CSF	mg/kgday	CDI/RfD	mg/kgday	CDI*CSF
Acetone	1.31E-10	3.09E+01	8.83E+00	NA	NA	2.98E-13	3.38E-14	NA	NA	3.95E-13	4.47E-14	NA	NA
Antimony (metallic)	5.78E-08	3.00E-04	8.57E-05	NA	NA	1.31E-10	1.53E-06	NA	NA	1.74E-10	2.03E-06	NA	NA
Aroclor-1254	1.75E-09	NA	NA	5.71E-04	2.00E+00	NA	NA	3.42E-13	6.84E-13	NA	NA	4.53E-13	9.05E-13
Aroclor-1260	1.58E-10	NA	NA	5.71E-04	2.00E+00	NA	NA	3.08E-14	6.16E-14	NA	NA	4.07E-14	8.15E-14
Arsenic (inorganic)	2.90E-07	1.50E-05	4.29E-06	4.30E-03	1.51E+01	6.59E-10	1.54E-04	5.65E-11	8.50E-10	8.72E-10	2.04E-04	7.48E-11	1.13E-09
Barium	4.68E-06	5.00E-04	1.43E-04	NA	NA	1.06E-08	7.44E-05	NA	NA	1.41E-08	9.85E-05	NA	NA
Benzene	3.58E-12	3.00E-02	8.57E-03	7.80E-06	2.73E-02	8.14E-15	9.49E-13	6.97E-16	1.90E-17	1.08E-14	1.26E-12	9.23E-16	2.52E-17
Benz(a)anthracene	2.24E-09	NA	NA	6.00E-05	2.10E-01	NA	NA	4.36E-13	9.15E-14	NA	NA	5.77E-13	1.21E-13
Benzo(a)pyrene	2.26E-09	2.00E-06	5.71E-07	6.00E-04	2.10E+00	5.14E-12	9.00E-06	4.41E-13	9.26E-13	6.80E-12	1.19E-05	5.83E-13	1.22E-12
Benzo(b)fluoranthene	3.56E-09	NA	NA	6.00E-05	2.10E-01	NA	NA	6.94E-13	1.46E-13	NA	NA	9.18E-13	1.93E-13
Benzo(k)fluoranthene	7.92E-10	NA	NA	6.00E-06	2.10E-02	NA	NA	1.54E-13	3.24E-15	NA	NA	2.04E-13	4.29E-15
Beryllium and compounds	3.05E-08	2.00E-05	5.71E-06	2.40E-03	8.40E+00	6.93E-11	1.21E-05	5.94E-12	4.99E-11	9.17E-11	1.60E-05	7.86E-12	6.60E-11
Bis(2-chloroisopropyl)ether	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Bis(2-ethylhexyl)phthalate	NA	NA	NA	2.40E-06	8.40E-03	NA	NA	NA	NA	NA	NA	NA	NA
Boron and borates only	NA	2.00E-02	5.71E-03	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Bromodichloromethane	3.00E-12	NA	NA	3.70E-05	1.30E-01	NA	NA	5.84E-16	7.57E-17	NA	NA	7.73E-16	1.00E-16
Bromoform	NA	NA	NA	1.10E-06	3.85E-03	NA	NA	NA	NA	NA	NA	NA	NA
Bromomethane	NA	5.00E-03	1.43E-03	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Butanone, 2-	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Cadmium	1.84E-08	1.00E-05	2.86E-06	1.80E-03	6.30E+00	4.18E-11	1.46E-05	3.59E-12	2.26E-11	5.53E-11	1.94E-05	4.74E-12	2.99E-11
Carbazole	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Carbon disulfide	NA	7.00E-01	2.00E-01	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Carbon tetrachloride	3.53E-12	1.00E-01	2.86E-02	6.00E-06	2.10E-02	8.02E-15	2.81E-13	6.88E-16	1.44E-17	1.06E-14	3.72E-13	9.10E-16	1.91E-17
Chlordane	NA	NA	NA	3.40E-04	1.19E+00	NA	NA	NA	NA	NA	NA	NA	NA
Chlorobenzene	NA	5.00E-02	1.43E-02	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chloroform	NA	9.77E-02	2.79E-02	2.30E-05	8.05E-02	NA	NA	NA	NA	NA	NA	NA	NA
Chromium (VI)	6.37E-07	1.00E-04	2.86E-05	8.40E-02	2.94E+02	1.45E-09	5.07E-05	1.24E-10	3.65E-08	1.92E-09	6.71E-05	1.64E-10	4.83E-08
Chrysene	2.22E-09	NA	NA	6.00E-07	2.10E-03	NA	NA	4.32E-13	9.08E-16	NA	NA	5.72E-13	1.20E-15
Cobalt	NA	6.00E-06	1.71E-06	9.00E-03	3.15E+01	NA	NA	NA	NA	NA	NA	NA	NA
Copper	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Cresol, p- (4-methylphenol)	NA	6.00E-01	1.71E-01	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Cyanide	NA	8.00E-04	2.29E-04	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Cyclohexanone	NA	7.00E-01	2.00E-01	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dibenz(a,h)anthracene	3.96E-10	NA	NA	6.00E-04	2.10E+00	NA	NA	7.73E-14	1.62E-13	NA	NA	1.02E-13	2.15E-13
Dichlorobenzidine, 3,3-	NA	NA	NA	3.40E-04	1.19E+00	NA	NA	NA	NA	NA	NA	NA	NA
Dichloroethane, 1,2-	7.19E-12	7.00E-03	2.00E-03	2.60E-05	9.10E-02	1.63E-14	8.17E-12	1.40E-15	1.28E-16	2.16E-14	1.08E-11	1.85E-15	1.69E-16
Dichloroethylene, 1,1-	1.45E-11	2.00E-01	5.71E-02	NA	NA	3.30E-14	5.77E-13	NA	NA	4.37E-14	7.64E-13	NA	NA
Dieldrin	1.42E-11	NA	NA	4.60E-03	1.61E+01	NA	NA	2.77E-15	4.45E-14	NA	NA	3.66E-15	5.89E-14
Di-n-octylphthalate	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Ethyl ether	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

COC	ADULT				SENIOR				SUM			
	CDI	HQ	CDI	ILCR	CDI	HQ	CDI	ILCR	CDI	HQ	CDI	ILCR
	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	1.29E-13	1.46E-14	NA	NA	2.59E-13	2.93E-14	NA	NA	2.64E-13	2.99E-14	NA	NA
Antimony (metallic)	5.70E-11	6.65E-07	NA	NA	1.14E-10	1.33E-06	NA	NA	1.16E-10	1.36E-06	NA	NA
Aroclor-1254	NA	NA	1.73E-13	3.46E-13	NA	NA	3.46E-13	6.92E-13	NA	NA	1.31E-12	2.63E-12
Aroclor-1260	NA	NA	1.56E-14	3.11E-14	NA	NA	3.11E-14	6.23E-14	NA	NA	1.18E-13	2.36E-13
Arsenic (inorganic)	2.86E-10	6.67E-05	2.86E-11	4.30E-10	5.72E-10	1.33E-04	5.72E-11	8.60E-10	5.84E-10	1.36E-04	2.17E-10	3.27E-09
Barium	4.61E-09	3.23E-05	NA	NA	9.22E-09	6.46E-05	NA	NA	9.43E-09	6.60E-05	NA	NA
Benzene	3.53E-15	4.12E-13	3.53E-16	9.63E-18	7.06E-15	8.23E-13	7.06E-16	1.93E-17	7.21E-15	8.41E-13	2.68E-15	7.31E-17
Benz(a)anthracene	NA	NA	2.21E-13	4.63E-14	NA	NA	4.41E-13	9.26E-14	NA	NA	1.67E-12	3.52E-13
Benzo(a)pyrene	2.23E-12	3.90E-06	2.23E-13	4.68E-13	4.46E-12	7.80E-06	4.46E-13	9.37E-13	4.56E-12	7.98E-06	1.69E-12	3.56E-12
Benzo(b)fluoranthene	NA	NA	3.51E-13	7.37E-14	NA	NA	7.02E-13	1.47E-13	NA	NA	2.67E-12	5.60E-13
Benzo(k)fluoranthene	NA	NA	7.82E-14	1.64E-15	NA	NA	1.56E-13	3.28E-15	NA	NA	5.93E-13	1.25E-14
Beryllium and compounds	3.00E-11	5.26E-06	3.00E-12	2.52E-11	6.01E-11	1.05E-05	6.01E-12	5.05E-11	6.14E-11	1.07E-05	2.28E-11	1.92E-10
Bis(2-chloroisopropyl)ether	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Bis(2-ethylhexyl)phthalate	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Boron and borates only	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Bromodichloromethane	NA	NA	2.96E-16	3.83E-17	NA	NA	5.91E-16	7.66E-17	NA	NA	2.24E-15	2.91E-16
Bromoform	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Bromomethane	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Butanone, 2-	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Cadmium	1.81E-11	6.35E-06	1.81E-12	1.14E-11	3.63E-11	1.27E-05	3.63E-12	2.29E-11	3.71E-11	1.30E-05	1.38E-11	8.68E-11
Carbazole	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Carbon disulfide	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Carbon tetrachloride	3.48E-15	1.22E-13	3.48E-16	7.31E-18	6.96E-15	2.44E-13	6.96E-16	1.46E-17	7.11E-15	2.49E-13	2.64E-15	5.55E-17
Chlordane	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chlorobenzene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chloroform	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chromium (VI)	6.29E-10	2.20E-05	6.29E-11	1.85E-08	1.26E-09	4.40E-05	1.26E-10	3.70E-08	1.28E-09	4.50E-05	4.77E-10	1.40E-07
Chrysene	NA	NA	2.19E-13	4.59E-16	NA	NA	4.37E-13	9.19E-16	NA	NA	1.66E-12	3.49E-15
Cobalt	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Copper	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Cresol, p- (4-methylphenol)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Cyanide	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Cyclohexanone	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dibenz(a,h)anthracene	NA	NA	3.91E-14	8.21E-14	NA	NA	7.82E-14	1.64E-13	NA	NA	2.97E-13	6.23E-13
Dichlorobenzidine, 3,3-	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dichloroethane, 1,2-	7.09E-15	3.54E-12	7.09E-16	6.45E-17	1.42E-14	7.09E-12	1.42E-15	1.29E-16	1.45E-14	7.25E-12	5.38E-15	4.90E-16
Dichloroethylene, 1,1-	1.43E-14	2.50E-13	NA	NA	2.86E-14	5.01E-13	NA	NA	2.92E-14	5.12E-13	NA	NA
Dieldrin	NA	NA	1.40E-15	2.25E-14	NA	NA	2.80E-15	4.51E-14	NA	NA	1.06E-14	1.71E-13
Di-n-octylphthalate	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Ethyl ether	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

NA = not applicable because concentration data are unavailable.

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

Intake Equation:			UNITS	Assigned Values			
			mg/kgday	child	youth	adult	senior
	CDI =	(CA*EF*ED*IR*ET)/(BW*AT)					
	CDI =	Chronic Daily Intake	mg/kgday				
	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
	RfDi =	RfC*20m³/day/70kg					
	CSFi	IUR*1000ug/mg*70kg/20m³/day					

NOTE: Corrected error found in calculation of air concentration (Formula misaligned callout for COC soil concentration reported in Table 17-8)

NOTE: RAIS now reports RfC and IUR values. RfDi and CSDi calculated as indicated above.

COC	conc	RfC	RfDi	IUR	CSFi	CHILD				YOUTH				ADULT				SENIOR				SUM			
						CDI	HQ	CDI	ILCR	CDI	HQ	CDI	ILCR	CDI	HQ	CDI	ILCR	CDI	HQ	CDI	ILCR	CDI	HQ	CDI	ILCR
	mg/m^3	mg/m^3	mg/kgday	m^3/ug	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	3.58E-12	1.00E+00	2.86E-01	2.50E-06	8.75E-03	8.14E-15	2.85E-14	6.97E-16	6.10E-18	1.08E-14	3.77E-14	9.23E-16	8.07E-18	3.53E-15	1.23E-14	3.53E-16	3.09E-18	7.06E-15	2.47E-14	7.06E-16	6.17E-18	7.21E-15	2.52E-14	2.68E-15	2.34E-17
Fluoride	8.55E-08	1.30E-02	3.71E-03	NA	NA	1.95E-10	5.24E-08	NA	NA	2.57E-10	6.93E-08	NA	NA	8.44E-11	2.27E-08	NA	NA	1.69E-10	4.54E-08	NA	NA	1.72E-10	4.64E-08	NA	NA
Heptachlorodibenzofuran	NA	4.00E-06	1.14E-06	3.80E-01	1.33E+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	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Hexachlorodibenzofuran	NA	4.00E-07	1.14E-07	3.80E+00	1.33E+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	1.47E-09	NA	NA	6.00E-05	2.10E-01	NA	NA	2.87E-13	6.02E-14	NA	NA	3.79E-13	7.96E-14	NA	NA	1.45E-13	3.04E-14	NA	NA	2.90E-13	6.09E-14	NA	NA	1.10E-12	2.31E-13
Lead and compounds	7.70E-07	NA	NA	1.20E-05	4.20E-02	NA	NA	1.50E-10	6.30E-12	NA	NA	1.99E-10	8.34E-12	NA	NA	7.59E-11	3.19E-12	NA	NA	1.52E-10	6.38E-12	NA	NA	5.77E-10	2.42E-11
Manganese (diet)	NA	5.00E-05	1.43E-05	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Mercury (elemental)	1.84E-09	3.00E-04	8.57E-05	NA	NA	4.18E-12	4.87E-08	NA	NA	5.53E-12	6.45E-08	NA	NA	1.81E-12	2.11E-08	NA	NA	3.62E-12	4.23E-08	NA	NA	3.70E-12	4.32E-08	NA	NA
Methanol	NA	2.00E+01	5.71E+00	NA	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)	1.84E-11	3.00E+00	8.57E-01	NA	NA	4.19E-14	4.89E-14	NA	NA	5.54E-14	6.47E-14	NA	NA	1.82E-14	2.12E-14	NA	NA	3.63E-14	4.24E-14	NA	NA	3.71E-14	4.33E-14	NA	NA
Methylene chloride	3.52E-11	6.00E-01	1.71E-01	1.00E-08	3.50E-05	8.01E-14	4.67E-13	6.86E-15	2.40E-19	1.06E-13	6.18E-13	9.08E-15	3.18E-19	3.47E-14	2.03E-13	3.47E-15	1.22E-19	6.95E-14	4.05E-13	6.95E-15	2.43E-19	7.10E-14	4.14E-13	2.64E-14	9.23E-19
Molybdenum	1.03E-07	2.00E-03	5.71E-04	NA	NA	2.34E-10	4.10E-07	NA	NA	3.10E-10	5.43E-07	NA	NA	1.02E-10	1.78E-07	NA	NA	2.03E-10	3.56E-07	NA	NA	2.08E-10	3.63E-07	NA	NA
Nickel (soluble salts)	NA	9.00E-05	2.57E-05	2.60E-04	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-	NA	6.00E-03	1.71E-03	NA	NA	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	NA	2.00E-03	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	NA	2.60E-06	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	1.33E-04	3.81E-05	1.14E-02	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	1.33E-04	3.81E-05	1.14E-02	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	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Pentachlorodibenzo-p-dioxin	NA	4.00E-08	1.14E-08	3.80E+01	1.33E+05	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Pentachlorophenol	NA	NA	NA	5.10E-06	1.79E-02	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Phenanthrene	3.23E-09	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Selenium	3.29E-08	2.00E-02	5.71E-03	NA	NA	7.48E-11	1.31E-08	NA	NA	9.90E-11	1.73E-08	NA	NA	3.24E-11	5.68E-09	NA	NA	6.49E-11	1.14E-08	NA	NA	6.63E-11	1.16E-08	NA	NA
Silver	1.89E-08	NA	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	4.00E-07	1.14E-07	3.80E+00	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	NA	4.00E-08	1.14E-08	3.80E+01	1.33E+05	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Tetrachloroethylene	2.42E-11	4.00E-02	1.14E-02	2.60E-07	9.10E-04	5.50E-14	4.81E-12	4.71E-15	4.29E-18	7.28E-14	6.37E-12	6.24E-15	5.68E-18	2.38E-14	2.09E-12	2.38E-15	2.17E-18	4.77E-14	4.17E-12	4.77E-15	4.34E-18	4.87E-14	4.27E-12	1.81E-14	1.65E-17
Thallium (soluble salts)	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
Toluene	1.57E-11	5.00E+00	1.43E+00	NA	NA	3.58E-14	2.50E-14	NA	NA	4.74E-14	3.31E-14	NA	NA	1.55E-14	1.09E-14	NA	NA	3.10E-14	2.17E-14	NA	NA	3.17E-14	2.22E-14	NA	NA
Tributyl phosphate	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
Trichloroethane, 1,1,2-	8.38E-12	NA	NA	1.60E-05	5.60E-02	NA	NA	1.63E-15	9.15E-17	NA	NA	2.16E-15	1.21E-16	NA	NA	8.26E-16	4.63E-17	NA	NA	1.65E-15	9.26E-17	NA	NA	6.27E-15	3.51E-16
Trichloroethylene	9.65E-12	2.00E-03	5.71E-04	4.10E-06	1.44E-02	2.20E-14	3.84E-11	1.88E-15	2.70E-17	2.91E-14	5.09E-11	2.49E-15	3.57E-17	9.52E-15	1.67E-11	9.52E-16	1.37E-17	1.90E-14	3.33E-11	1.90E-15	2.73E-17	1.95E-14	3.41E-11	7.23E-15	1.04E-16
Trichlorofluoromethane	NA	7.00E-01	2.00E-01	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Uranium (soluble salts)	4.22E-07	4.00E-05	1.14E-05	NA	NA	9.61E-10	8.41E-05	NA	NA	1.27E-09	1.11E-04	NA	NA	4.17E-10	3.65E-05	NA	NA	8.33E-10	7.29E-05	NA	NA	8.52E-10	7.45E-05	NA	NA
Vanadium	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
Vinyl chloride	NA	1.00E-01	2.86E-02	4.40E-06	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	1.00E-01	2.86E-02	NA	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 and compounds	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
																						total =	**3.55E-04**	**total =**	**1.44E-07**

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 in Table 17-8.

NA = not applicable because concentration data are unavailable.

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)					
	CDI =	Chronic Daily Intake	mg/kgday	child	youth	adult	senior
	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 (metallic)	2.22E+00	NA	4.00E-04	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 (inorganic)	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	2.00E-01	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	1.00E-01	NA	NA	1.17E-09	1.17E-10	NA	NA	1.97E-09	1.97E-10	NA	NA	3.67E-10	3.67E-11	NA	NA	7.35E-10	7.35E-11	NA	NA	4.24E-09	4.24E-10
Benzo(a)pyrene	8.70E-02	1.30E-01	3.00E-04	1.00E+00	1.38E-08	4.61E-05	1.19E-09	1.19E-09	2.32E-08	7.74E-05	1.99E-09	1.99E-09	3.71E-09	1.24E-05	3.71E-10	3.71E-10	7.43E-09	2.48E-05	7.43E-10	7.43E-10	1.15E-08	3.85E-05	4.29E-09	4.29E-09
Benzo(b)fluoranthene	1.37E-01	1.30E-01	NA	1.00E-01	NA	NA	1.87E-09	1.87E-10	NA	NA	3.13E-09	3.13E-10	NA	NA	5.85E-10	5.85E-11	NA	NA	1.17E-09	1.17E-10	NA	NA	6.75E-09	6.75E-10
Benzo(k)fluoranthene	3.05E-02	1.30E-01	NA	1.00E-02	NA	NA	4.15E-10	4.15E-12	NA	NA	6.97E-10	6.97E-12	NA	NA	1.30E-10	1.30E-12	NA	NA	2.60E-10	2.60E-12	NA	NA	1.50E-09	1.50E-11
Beryllium and compounds	1.17E+00	NA	2.00E-03	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	NA	NA	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	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 and borates only	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	NA	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	1.00E-03	NA	8.65E-10	8.65E-07	NA	NA	1.45E-09	1.45E-06	NA	NA	2.32E-10	2.32E-07	NA	NA	4.65E-10	4.65E-07	NA	NA	7.22E-10	7.22E-07	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	4.00E-02	5.00E-04	3.50E-01	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	3.00E-03	5.00E-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	1.00E-03	NA	NA	1.16E-09	1.16E-12	NA	NA	1.95E-09	1.95E-12	NA	NA	3.64E-10	3.64E-13	NA	NA	7.29E-10	7.29E-13	NA	NA	4.21E-09	4.21E-12
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	1.00E+00	NA	NA	2.08E-10	2.08E-10	NA	NA	3.49E-10	3.49E-10	NA	NA	6.51E-11	6.51E-11	NA	NA	1.30E-10	1.30E-10	NA	NA	7.52E-10	7.52E-10
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	1.02E-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

NA = not applicable because concentration data are unavailable.

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

Intake Equation:			UNITS	Assigned Values			
	CDI =	(CS*AB*SA*EF*ED*AF*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			
	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	4.00E-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	NA	NA	NA	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	1.00E-01	NA	NA	7.71E-10	7.71E-11	NA	NA	1.29E-09	1.29E-10	NA	NA	2.41E-10	2.41E-11	NA	NA	4.83E-10	4.83E-11	NA	NA	2.79E-09	2.79E-10
Lead and compounds	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 (diet)	NA	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 (elemental)	7.07E-02	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
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 (soluble salts)	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
Nitroanaline, 4-	NA	1.00E-01	4.00E-03	1.00E-01	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	NA	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	NA	NA	NA	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	NA	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	5.00E-03	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	NA	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	2.10E-03	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Thallium (soluble salts)	NA	NA	1.00E-05	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
Trichlorofluoromethane	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 (soluble salts)	1.62E+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
Vanadium	NA	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	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 and compounds	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 =	**1.66E-03**	total =	**2.05E-07**

NA = not applicable because concentration data are unavailable.

Table17-9. 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
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 (metallic)	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 (inorganic)	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
Benz(a)anthracene	8.60E-02	NA	1.00E-01	NA	NA	2.54E-09	2.54E-10	NA	NA	1.42E-09	1.42E-10	NA	NA	5.89E-10	5.89E-11	NA	NA	1.18E-09	1.18E-10	NA	NA	5.73E-09	5.73E-10
Benzo(a)pyrene	8.70E-02	3.00E-04	1.00E+00	3.00E-08	9.99E-05	2.57E-09	2.57E-09	1.68E-08	5.59E-05	1.44E-09	1.44E-09	5.96E-09	1.99E-05	5.96E-10	5.96E-10	1.19E-08	3.97E-05	1.19E-09	1.19E-09	1.56E-08	5.20E-05	5.79E-09	5.79E-09
Benzo(b)fluoranthene	1.37E-01	NA	1.00E-01	NA	NA	4.04E-09	4.04E-10	NA	NA	2.26E-09	2.26E-10	NA	NA	9.38E-10	9.38E-11	NA	NA	1.88E-09	1.88E-10	NA	NA	9.12E-09	9.12E-10
Benzo(k)fluoranthene	3.05E-02	NA	1.00E-02	NA	NA	9.00E-10	9.00E-12	NA	NA	5.04E-10	5.04E-12	NA	NA	2.09E-10	2.09E-12	NA	NA	4.18E-10	4.18E-12	NA	NA	2.03E-09	2.03E-11
Beryllium and compounds	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	NA	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 and borates only	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	NA	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	5.00E-04	3.50E-01	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	1.00E-03	NA	NA	2.52E-09	2.52E-12	NA	NA	1.41E-09	1.41E-12	NA	NA	5.84E-10	5.84E-13	NA	NA	1.17E-09	1.17E-12	NA	NA	5.68E-09	5.68E-12
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	1.00E+00	NA	NA	4.50E-10	4.50E-10	NA	NA	2.52E-10	2.52E-10	NA	NA	1.04E-10	1.04E-10	NA	NA	2.09E-10	2.09E-10	NA	NA	1.02E-09	1.02E-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	1.02E-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

NA = not applicable because concentration data are unavailable.

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

Intake Equation:			UNITS	Assigned Values			
	CDI =	(CS*EF*ED*IR*FI*CF)/(BW*AT)	UNITS	child	youth	adult	senior
	CDI =	Chronic Daily Intake	mg/kgday				
	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	4.00E-02	NA	1.13E-06	2.83E-05	NA	NA	6.35E-07	1.59E-05	NA	NA	2.25E-07	5.63E-06	NA	NA	4.51E-07	1.13E-05	NA	NA	5.90E-07	1.48E-05	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	NA	NA	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	1.00E-01	NA	NA	1.67E-09	1.67E-10	NA	NA	9.35E-10	9.35E-11	NA	NA	3.87E-10	3.87E-11	NA	NA	7.74E-10	7.74E-11	NA	NA	3.77E-09	3.77E-10
Lead and compounds	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 (diet)	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 (elemental)	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 (soluble salts)	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	1.00E-01	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
Octochlorodibenzofuran	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	NA	NA	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	NA	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 (soluble salts)	NA	1.00E-05	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
Trichlorofluoromethane	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 (soluble salts)	1.62E+01	2.00E-04	NA	5.60E-06	2.80E-02	NA	NA	3.13E-06	1.57E-02	NA	NA	1.11E-06	5.56E-03	NA	NA	2.23E-06	1.11E-02	NA	NA	2.91E-06	1.46E-02	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 and compounds	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 =	**2.50E-02**	**total =**	**1.97E-06**

NA = not applicable because concentration data are unavailable.

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

			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^{2}day	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^{2}day	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 (metallic)	5.00E-04	1.00E-03	5.00E-10	4.00E-04	NA	1.84E-09	4.59E-06	NA	NA	1.54E-09	3.85E-06	NA	NA	1.41E-09	3.52E-06	NA	NA	1.41E-09	3.52E-06	NA	NA	1.54E-09	3.84E-06	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 (inorganic)	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	2.00E-01	NA	1.93E-07	9.66E-07	NA	NA	1.62E-07	8.10E-07	NA	NA	1.48E-07	7.41E-07	NA	NA	1.48E-07	7.41E-07	NA	NA	1.62E-07	8.09E-07	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	1.00E-01	NA	NA	8.68E-08	8.68E-09	NA	NA	7.28E-08	7.28E-09	NA	NA	7.77E-08	7.77E-09	NA	NA	7.77E-08	7.77E-09	NA	NA	3.15E-07	3.15E-08
Benzo(a)pyrene	5.00E-04	7.13E-01	3.57E-07	3.00E-04	1.00E+00	1.31E-06	4.36E-03	1.12E-07	1.12E-07	1.10E-06	3.66E-03	9.41E-08	9.41E-08	1.00E-06	3.35E-03	1.00E-07	1.00E-07	1.00E-06	3.35E-03	1.00E-07	1.00E-07	1.10E-06	3.65E-03	4.07E-07	4.07E-07
Benzo(b)fluoranthene	5.00E-04	4.17E-01	2.09E-07	NA	1.00E-01	NA	NA	6.56E-08	6.56E-09	NA	NA	5.50E-08	5.50E-09	NA	NA	5.87E-08	5.87E-09	NA	NA	5.87E-08	5.87E-09	NA	NA	2.38E-07	2.38E-08
Benzo(k)fluoranthene	5.00E-04	6.91E-01	3.46E-07	NA	1.00E-02	NA	NA	1.09E-07	1.09E-09	NA	NA	9.12E-08	9.12E-10	NA	NA	9.73E-08	9.73E-10	NA	NA	9.73E-08	9.73E-10	NA	NA	3.94E-07	3.94E-09
Beryllium and compounds	1.58E-04	1.00E-03	1.58E-10	2.00E-03	NA	5.78E-10	2.89E-07	NA	NA	4.85E-10	2.42E-07	NA	NA	4.44E-10	2.22E-07	NA	NA	4.44E-10	2.22E-07	NA	NA	4.84E-10	2.42E-07	NA	NA
Bis(2-chloroisopropyl)ether	NA	7.64E-03	NA	NA	NA	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 and borates only	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	NA	NA	NA	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	1.00E-03	NA	3.67E-10	3.67E-07	NA	NA	3.08E-10	3.08E-07	NA	NA	2.82E-10	2.82E-07	NA	NA	2.82E-10	2.82E-07	NA	NA	3.07E-10	3.07E-07	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	5.00E-04	3.50E-01	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	3.00E-03	5.00E-01	2.45E-08	8.15E-06	2.10E-09	1.05E-09	2.05E-08	6.84E-06	1.76E-09	8.79E-10	1.88E-08	6.25E-06	1.88E-09	9.38E-10	1.88E-08	6.25E-06	1.88E-09	9.38E-10	2.05E-08	6.83E-06	7.61E-09	3.80E-09
Chrysene	5.00E-04	5.96E-01	2.98E-07	NA	1.00E-03	NA	NA	9.37E-08	9.37E-11	NA	NA	7.87E-08	7.87E-11	NA	NA	8.39E-08	8.39E-11	NA	NA	8.39E-08	8.39E-11	NA	NA	3.40E-07	3.40E-10
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	1.00E+00	NA	NA	1.50E-07	1.50E-07	NA	NA	1.26E-07	1.26E-07	NA	NA	1.34E-07	1.34E-07	NA	NA	1.34E-07	1.34E-07	NA	NA	5.44E-07	5.44E-07
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	1.02E-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

NA = not applicable because concentration data are unavailable.

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

			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^{2}day	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^{2}day	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	4.00E-02	NA	1.50E-06	3.75E-05	NA	NA	1.26E-06	3.14E-05	NA	NA	1.15E-06	2.88E-05	NA	NA	1.15E-06	2.88E-05	NA	NA	1.26E-06	3.14E-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	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Hexachlorodibenzofuran	NA	2.25E+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	1.00E-01	NA	NA	1.95E-07	1.95E-08	NA	NA	1.64E-07	1.64E-08	NA	NA	1.75E-07	1.75E-08	NA	NA	1.75E-07	1.75E-08	NA	NA	7.08E-07	7.08E-08
Lead and compounds	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 (diet)	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 (elemental)	6.00E-05	1.00E-03	6.00E-11	3.00E-04	NA	2.20E-10	7.34E-07	NA	NA	1.85E-10	6.16E-07	NA	NA	1.69E-10	5.63E-07	NA	NA	1.69E-10	5.63E-07	NA	NA	1.84E-10	6.15E-07	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 (soluble salts)	NA	2.00E-04	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	2.21E-03	NA	4.00E-03	1.00E-01	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	NA	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	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	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Pentachlorodibenzo-p-dioxin	NA	4.05E-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	5.00E-03	NA	4.40E-10	8.81E-08	NA	NA	3.70E-10	7.39E-08	NA	NA	3.38E-10	6.76E-08	NA	NA	3.38E-10	6.76E-08	NA	NA	3.69E-10	7.38E-08	NA	NA
Tetrachlorodibenzofuran	NA	6.57E-01	NA	NA	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 (soluble salts)	NA	1.00E-03	NA	1.00E-05	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
Trichlorofluoromethane	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 (soluble salts)	2.14E-02	1.00E-03	2.14E-08	2.00E-04	NA	7.84E-08	3.92E-04	NA	NA	6.58E-08	3.29E-04	NA	NA	6.01E-08	3.01E-04	NA	NA	6.01E-08	3.01E-04	NA	NA	6.56E-08	3.28E-04	NA	NA
Vanadium	NA	1.00E-03	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	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 and compounds	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 =	**9.94E-03**	**total =**	**1.30E-06**

NA = not applicable because concentration data are unavailable.

Table 17-11. 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

COC	CW	RfDo	CSFo	CHILD				YOUTH				ADULT				SENIOR				SUM			
				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 (metallic)	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 (inorganic)	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	1.00E-01	NA	NA	1.64E-09	1.64E-10	NA	NA	9.18E-10	9.18E-11	NA	NA	3.29E-10	3.29E-11	NA	NA	3.29E-10	3.29E-11	NA	NA	3.21E-09	3.21E-10
Benzo(a)pyrene	5.00E-04	3.00E-04	1.00E+00	1.91E-08	6.38E-05	1.64E-09	1.64E-09	1.07E-08	3.57E-05	9.18E-10	9.18E-10	3.29E-09	1.10E-05	3.29E-10	3.29E-10	3.29E-09	1.10E-05	3.29E-10	3.29E-10	8.66E-09	2.89E-05	3.21E-09	3.21E-09
Benzo(b)fluoranthene	5.00E-04	NA	1.00E-01	NA	NA	1.64E-09	1.64E-10	NA	NA	9.18E-10	9.18E-11	NA	NA	3.29E-10	3.29E-11	NA	NA	3.29E-10	3.29E-11	NA	NA	3.21E-09	3.21E-10
Benzo(k)fluoranthene	5.00E-04	NA	1.00E-02	NA	NA	1.64E-09	1.64E-11	NA	NA	9.18E-10	9.18E-12	NA	NA	3.29E-10	3.29E-12	NA	NA	3.29E-10	3.29E-12	NA	NA	3.21E-09	3.21E-11
Beryllium and compounds	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	NA	NA	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 and borates only	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	NA	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	NA	3.83E-09	3.83E-06	NA	NA	2.14E-09	2.14E-06	NA	NA	6.58E-10	6.58E-07	NA	NA	6.58E-10	6.58E-07	NA	NA	1.73E-09	1.73E-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	5.00E-04	3.50E-01	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	1.00E-03	NA	NA	1.64E-09	1.64E-12	NA	NA	9.18E-10	9.18E-13	NA	NA	3.29E-10	3.29E-13	NA	NA	3.29E-10	3.29E-13	NA	NA	3.21E-09	3.21E-12
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	1.00E+00	NA	NA	1.64E-09	1.64E-09	NA	NA	9.18E-10	9.18E-10	NA	NA	3.29E-10	3.29E-10	NA	NA	3.29E-10	3.29E-10	NA	NA	3.21E-09	3.21E-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-	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	1.02E-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

NA = not applicable because concentration data are unavailable.

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

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	4.00E-02	NA	1.56E-05	3.91E-04	NA	NA	8.75E-06	2.19E-04	NA	NA	2.69E-06	6.72E-05	NA	NA	2.69E-06	6.72E-05	NA	NA	7.07E-06	1.77E-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	NA	NA	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	1.00E-01	NA	NA	1.64E-09	1.64E-10	NA	NA	9.18E-10	9.18E-11	NA	NA	3.29E-10	3.29E-11	NA	NA	3.29E-10	3.29E-11	NA	NA	3.21E-09	3.21E-10
Lead and compounds	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 (diet)	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 (elemental)	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 (soluble salts)	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	1.00E-01	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
Octochlorodibenzofuran	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	NA	NA	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	NA	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 (soluble salts)	NA	1.00E-05	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
Trichlorofluoromethane	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 (soluble salts)	2.14E-02	2.00E-04	NA	8.17E-07	4.08E-03	NA	NA	4.57E-07	2.29E-03	NA	NA	1.40E-07	7.02E-04	NA	NA	1.40E-07	7.02E-04	NA	NA	3.70E-07	1.85E-03	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 and compounds	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 =	2.42E-03	total =	5.46E-08

NA = not applicable because concentration data are unavailable.

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

COC	conc	CSFi	CHILD		YOUTH		ADULT		SENIOR		SUM	
			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)

NA = not applicable because concentration data are unavailable.

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**

NA = not applicable because concentration data are unavailable

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

Intake Equation:			UNITS	Assigned Values			
				child	youth	adult	senior
	CDI =	(CW*EF*ED*IR)/(BW*AT)					
	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**

NA = not applicable because concentration data are unavailable

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

Intake Equation:			UNITS	Assigned Values			
				child	youth	adult	senior
	CDI =	$(CS*EF*ED*ET_o*(1-SH_o))$					
	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	2.27E-06	1.68E-03	3.81E-09	3.36E-03	7.62E-09	1.96E-03	4.45E-09	3.92E-03	8.89E-09	1.09E-02	2.48E-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	8.12E-07	1.11E-04	9.04E-11	2.23E-04	1.81E-10	1.30E-04	1.05E-10	2.60E-04	2.11E-10	7.24E-04	5.88E-10
Plutonium-238	2.35E-03	6.87E-11	4.83E-05	3.32E-15	9.66E-05	6.64E-15	5.63E-05	3.87E-15	1.13E-04	7.74E-15	3.14E-04	2.16E-14
Plutonium-239/240	NA	2.01E-10	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Radium-226 + D	1.28E+00	7.10E-06	2.64E-02	1.87E-07	5.27E-02	3.74E-07	3.07E-02	2.18E-07	6.15E-02	4.37E-07	1.71E-01	1.22E-06
Radium-228 + D	1.11E+00	3.50E-06	2.28E-02	7.97E-08	4.56E-02	1.59E-07	2.66E-02	9.30E-08	5.32E-02	1.86E-07	1.48E-01	5.18E-07
Radon-222+ D	3.85E-01	1.54E-09	7.91E-03	1.22E-11	1.58E-02	2.44E-11	9.22E-03	1.42E-11	1.84E-02	2.84E-11	5.14E-02	7.91E-11
Strontium-90 + D	NA	1.84E-08	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Technetium-99	1.64E+00	8.24E-11	3.37E-02	2.78E-12	6.74E-02	5.55E-12	3.93E-02	3.24E-12	7.86E-02	6.48E-12	2.19E-01	1.80E-11
Thorium-228	1.13E+00	5.55E-09	2.31E-02	1.28E-10	4.63E-02	2.57E-10	2.70E-02	1.50E-10	5.40E-02	3.00E-10	1.50E-01	8.35E-10
Thorium-230	2.46E+00	8.35E-10	5.05E-02	4.22E-11	1.01E-01	8.43E-11	5.89E-02	4.92E-11	1.18E-01	9.84E-11	3.28E-01	2.74E-10
Thorium-232	1.10E+00	3.57E-10	2.25E-02	8.05E-12	4.51E-02	1.61E-11	2.63E-02	9.39E-12	5.26E-02	1.88E-11	1.47E-01	5.23E-11
Uranium-234	5.55E+00	2.52E-10	1.14E-01	2.87E-11	2.28E-01	5.74E-11	1.33E-01	3.35E-11	2.66E-01	6.70E-11	7.41E-01	1.87E-10
Uranium-235 + D	2.53E-01	5.60E-07	5.19E-03	2.91E-09	1.04E-02	5.81E-09	6.06E-03	3.39E-09	1.21E-02	6.78E-09	3.37E-02	1.89E-08
Uranium-238 + D	5.42E+00	1.06E-07	1.11E-01	1.18E-08	2.23E-01	2.36E-08	1.30E-01	1.38E-08	2.60E-01	2.75E-08	7.23E-01	7.67E-08
											total =	**1.86E-06**

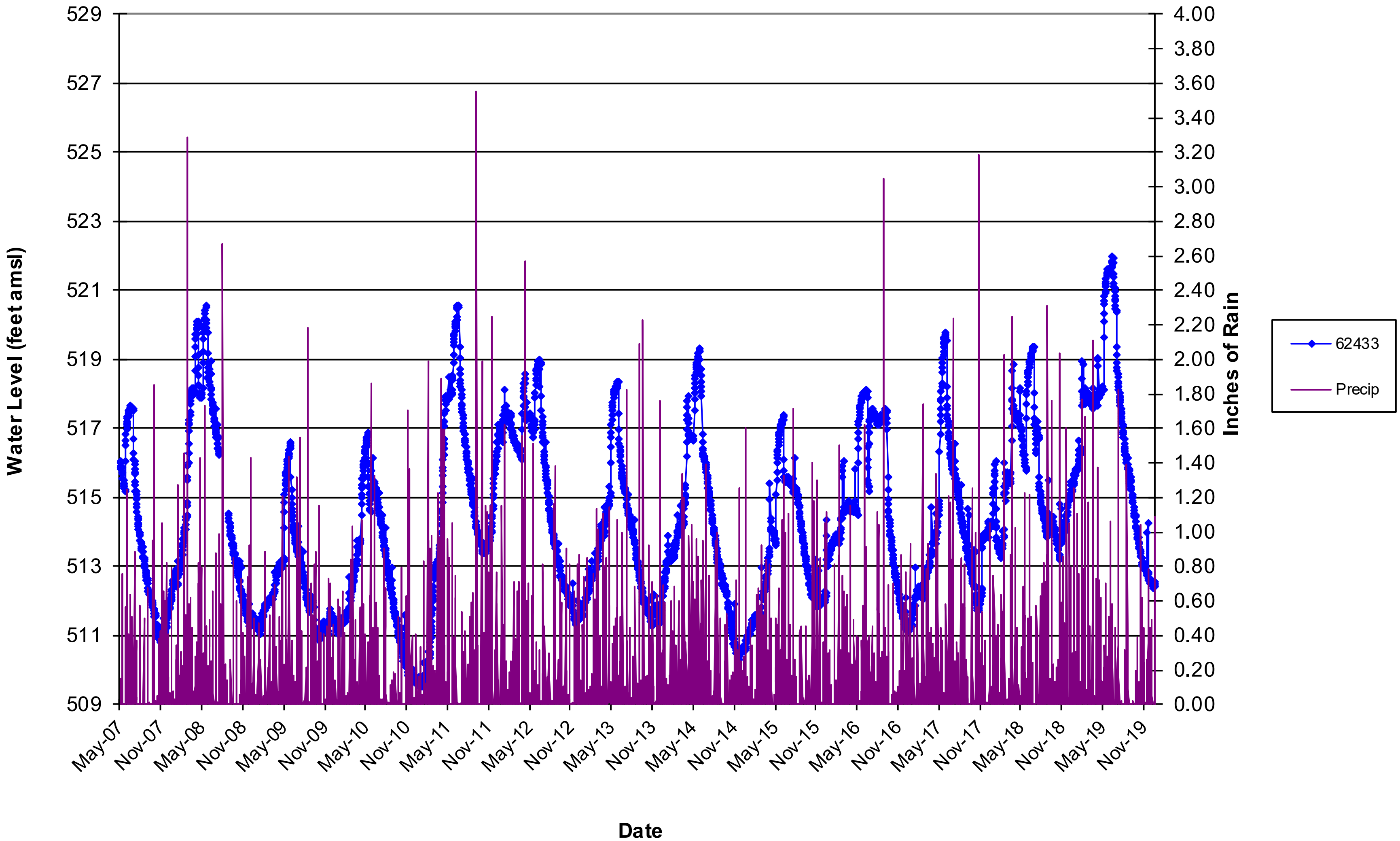
Rn-222+D soil value assumed to be 0.3 times Ra-226+D to account for the retention of 30% of the radon in the soil.

NA = not applicable because concentration data are unavailable

Attachment 18

Water Levels for 62433
(May 25, 2007, through December 31, 2020)

This page intentionally left blank



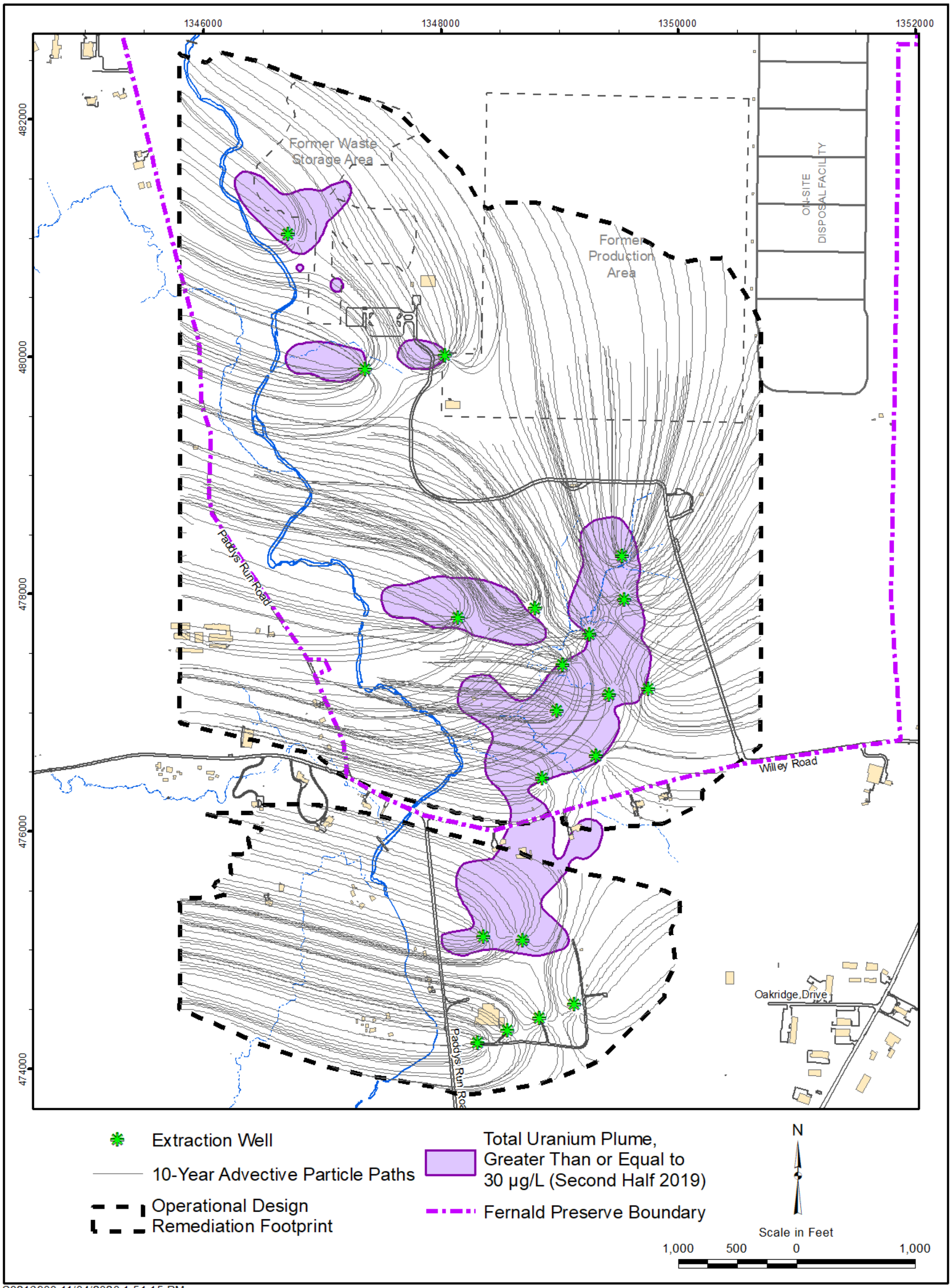
Water Levels for 62433 (May 25, 2007, through December 31, 2020)

This page intentionally left blank

Attachment 19

Operational Design Adjustment-1
Remediation Footprint

This page intentionally left blank



WSA (Phase-II) Design Remediation Footprint

This page intentionally left blank