UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION I
5 POST OFFICE SQUARE, SUITE 100
BOSTON, MA 02109-3912

September 25, 2019

Mr. Roger Walton
AFCEC/CIBE
2261 Hughes Ave, Ste 155
JBSA Lackland, TX 78236-9853

Re: **Fifth Five-Year Review Report for the Pease Air Force Base NPL Site, NH**

Dear Mr. Walton:

This office is in receipt of the U.S. Air Force's Fifth Five-Year Review Report for the Pease AFB NPL Site dated September 2019. Upon review of this report, EPA concurs with the findings that all CERCLA remedies selected for the Site have been implemented and are currently protective of human health and the environment. EPA also concurs that important follow-up actions identified in the Five-Year Review that are necessary to maintain long-term protectiveness at the Site will be implemented by the U.S. Air Force. EPA will continue to work collaboratively with the U.S. Air Force and NHDES to ensure that all the Pease AFB remedies continue to remain protective and eventually meet their cleanup objectives.

The U.S. Air Force is currently evaluating the presence and nature of per- and poly-fluoroalkyl substances (PFAS) in the environment on the Pease-Newington Peninsula. The results of these evaluations will guide the scope of future studies that will confirm the nature and extent of this contamination as well as evaluate potential health risks posed by these contaminants through completion of baseline environmental risk assessments, in accordance with CERCLA. As this important work continues, threats posed by these contaminants to public and private ground water supplies are being addressed by two operating ground water extraction and treatment systems as well a new public water supply treatment system currently under construction.

For purposes of future planning, EPA must concur on the completed sixth Five-Year Review for Pease AFB no later than September 25, 2024.

Sincerely,

Bryan Olson, Director
Superfund & Emergency Management Division

cc: Steve Termaath, AFCEC
Val de la Fuente, AFCEC
Peter Sandin, NHDES
Cayleigh Eckhardt, EPA
Anni Loughlin, EPA
Mike Daly, EPA

SEMS Doc ID 100012290

Final
Five-Year Review Report (2014–2019)
Former Pease Air Force Base
Portsmouth, New Hampshire

Contract No. FA8903-09-D-8580, Task Order No. 0010
Project No. 143279
Revision 0
September 2019

Final
Five-Year Review Report (2014–2019)
Former Pease Air Force Base
Portsmouth, New Hampshire

Performance-Based Remediation
Contract No. FA8903-09-D-8580
Task Order No. 0010

APTIM-PL-00952

Revision 0
September 2019

Submitted to:

Air Force Civil Engineer Center
2261 Hughes Avenue, Suite 155
JBSA Lackland, Texas 78236-9853

Submitted by:

Aptim Federal Services, LLC
150 Royall Street
Canton, Massachusetts 02021

Declaration Statement

Based upon the results of this Five-Year Review for the former Pease Air Force Base completed in September 2019, it is concluded that the remedies for all the sites are currently protective of human health and the environment, as prescribed by the decision documents in place at the time of this review. All in-place decision document remedies are functioning and meeting their intended requirements, protecting human health and the environment.

23 September 2019

STEPHEN G. TERMAATH, GS-15, DAF
Chief, BRAC Program Management Div
Installations Directorate

Date

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Acronyms and Abbreviations

%	percent
µg/L	micrograms per liter
AFB	Air Force Base
AFCEC	Air Force Civil Engineer Center
AIMS	Airfield Interim Mitigation System
AMEC	Amec Foster Wheeler Environment & Infrastructure
AO	Administrative Order
APTIM	Aptim Federal Services, LLC
ARAR	Applicable or Relevant and Appropriate Requirement
AS	air sparge
ASN	Area of Special Notice
BA	Burn Area
Bechtel	Bechtel Environmental, Inc.
BEHP	bis(2-ethylhexyl)phthalate
BFSA	Bulk Fuel Storage Area
bgs	below ground surface
BTEX	benzene, toluene, ethylbenzene, and xylenes
CB&I	CB&I Federal Services LLC
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CG	cleanup goal
COC	contaminant of concern
CRD	Construction Rubble Dump
DCA	dichloroethane
DCE	dichloroethene
DDD	dichlorodiphenyldichloroethane
DNAPL	dense nonaqueous phase liquid
DOI	U.S. Department of the Interior
EPA	U.S. Environmental Protection Agency
EPC	exposure point concentration
ESD	Explanation of Significant Differences
FDTA	Fire Department Training Area
Fe^0	zerovalent iron
FFA	Federal Facility Agreement
FS	feasibility study
FYR	Five-Year Review
GAC	granular activated carbon
GMZ	Groundwater Management Zone
GWETS	groundwater extraction and treatment system
GWTP	Groundwater Treatment Plant
HA	Health Advisory
HMSA	Hazardous Material Storage Area
HSDB	Hazardous Substances Data Base

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Acronyms and Abbreviations (continued)

IBA	intrinsic bioremediation area
IR	intrinsic remediation
IRM	Interim Remedial Measure
IRP	Installation Restoration Program
ISCO	in situ chemical oxidation
ISEB	in situ enhanced bioremediation
JETC	Jet Engine Test Cell
JP-4	jet propulsion fuel No. 4
LF	landfill
LFTS	Leaded Fuel Tank Storage
LHA	Lifetime Health Advisory
LNAPL	light nonaqueous phase liquid
LTM	long-term monitoring
LTMP	Long-Term Monitoring Plan
LUC	land use control
MCL	Maximum Contaminant Level
mg/kg	milligrams per kilogram
mg/kg-day	milligrams per kilogram per day
MNA	monitored natural attenuation
MRDDA	McIntyre Road Drum Disposal Area
MWH	MWH Americas, Inc.
N	No
NA	not applicable
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NFA	No Further Action
NHAGQS	New Hampshire Ambient Groundwater Quality Standards
NHANG	New Hampshire Air National Guard
NHDES	New Hampshire Department of Environmental Services
NHDPHS	New Hampshire Department of Health and Human Services
NHSRS	New Hampshire Soil Remediation Standards
O&M	operations and maintenance
OJETS	Old Jet Engine Test Stand
OSWER	Office of Solid Waste and Emergency Response
OU	operable unit
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
PCE	tetrachloroethene
PCMMP	Postclosure Maintenance and Monitoring Plan
PDA	Pease Development Authority
PFBS	perfluorobutane sulfonate
PFOA	perfluorooctanoic acid
PFOS	perfluorooctanesulfonic acid

Acronyms and Abbreviations (continued)

PHA	Provisional Health Advisory
PPRTV	Provisional Peer Reviewed Toxicity Value
PRB	permeable reactive barrier
RAO	remedial action objective
RCRA	Resource Conservation and Recovery Act
RfD	reference dose
RI	remedial investigation
ROD	Record of Decision
RSL	Regional Screening Level
RTE	Refuse-to-Energy Plant
SDWA	Safe Drinking Water Act
SEB	sulfate-enhanced bioremediation
Shaw	Shaw Environmental & Infrastructure, Inc.
SVE	soil vapor extraction
SVOC	semivolatile organic compound
TBC	to be considered
TCE	trichloroethene
TCRA	Time-Critical Removal Action
TI	Technical Impracticability
TMB	trimethylbenzene
U.S.	United States
URS	URS Group, Inc.
URZ	Use Restriction Zone
UST	underground storage tank
VC	vinyl chloride
Versar	Versar, Inc.
VOC	volatile organic compound
Weston	Roy F. Weston, Inc.
Y	Yes
yd^3	cubic yard

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EXECUTIVE SUMMARY

The Air Force Civil Engineer Center (AFCEC) has initiated a Five-Year Review for the former Pease Air Force Base (AFB) in Portsmouth, New Hampshire. The review was conducted under AFCEC Contract No. FA8903-09-D-8580, Task Order No. 0010. The United States Air Force is preparing this Five-Year Review pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act Section 121 and the National Oil and Hazardous Substances Pollution Contingency Plan. A Five-Year Review is required for the former Pease AFB because the implemented remedies have resulted in hazardous substances remaining on site at concentrations that do not allow for unlimited use and unrestricted exposure. This document represents the fifth Five-Year Review for the former Pease AFB and encompasses the period from 2014 through 2019. The available data relied on to complete this Pease Five-Year Review ranged in date from January 2014 to December 2018.

The overall purpose of this Five-Year Review is to determine if selected remedies are functioning as intended and are protective of human health and the environment. Methods, findings, and conclusions are documented in this Five-Year Review Report, which also identifies remaining issues and makes recommendations to attain or maintain protectiveness.

Based on the review, remedies at most sites were found to be functioning as intended by the decision documents. Several changes were noted in Applicable or Relevant and Appropriate Requirements used to develop cleanup goals (CGs), as noted in the subsections of this Five-Year Review Report. Since the last Five-Year Review, various guidance documents have been issued regarding changes to methodologies for human health and ecological risk assessments, and there have been changes to toxicity values; however, these changes should not significantly impact the protectiveness of the remedies, since most Record of Decision (ROD) CGs were based on regulatory standards rather than risk-based numbers.

During the course of this Five-Year Review period, the United States (U.S.) Environmental Protection Agency (EPA) issued final lifetime drinking water health advisories for perfluorooctanoic acid (PFOA) and perfluorooctanesulfonic acid (PFOS). EPA's Office of Water established final lifetime drinking water health advisories of 70 parts per trillion for PFOS and PFOA separately or combined. Also in 2016, the New Hampshire Department of Environmental Services, under its Contaminated Site Management Rules (Env Or-600), established New Hampshire Ambient Groundwater Quality Standards (NHAGQS) for PFOS and PFOA separately and combined at the same concentrations as EPA. In July 2019, New Hampshire adopted Maximum Contaminant Levels (MCLs)/drinking water standards and Ambient Groundwater Quality Standards for four per- and polyfluoroalkyl substances (PFOA, PFOS, perfluorononanoic acid, and perfluorohexanesulfonic acid), which will become

effective September 30, 2019. While not yet effective, these MCLs and NHAGQS may be relevant for future investigations and actions.

In response to impacts from PFOS and PFOA on the Pease and private drinking water supplies and the potential human health threats posed by consuming this contaminated groundwater, EPA issued an Administrative Order (AO) under the Safe Drinking Water Act (SDWA) in July 2015. The SDWA AO requires the U.S. Air Force to address the PFOS and PFOA contamination in groundwater at the Pease site. The AO requires that Site 8 groundwater be restored to levels less than the health advisories for PFOA and PFOS.

The U.S. Air Force has conducted extensive investigation of the former Pease AFB to determine the presence of PFOS and PFOA and has identified actions to address drinking water health concerns with these compounds. In particular, the presence of PFOS/PFOA at Site 8 affects the long-term protectiveness of the remedy.

Several issues were identified during the Five-Year Review process. The follow-up actions listed in **Table ES-1** cannot be addressed as part of routine site monitoring, data evaluation, and reporting activities. The actions in **Table ES-1** will be taken to verify current and future protectiveness.

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Table ES-1
Summary of Site Issues Identified and Recommended Actions

Category/Zone/Site	Identified Issue	Recommended Action(s)	Milestone Date
Zone 3, Site 39	Potential for new Exposure Pathway (Vapor Intrusion)	Finalize draft ROD Amendment and implement actions to address this future pathway	December 31, 2020
Zone 5, Site 8	Identification of Emerging Contaminants (PFOS and PFOA)	Prepare a new ESD to revise the GMZ	December 31, 2020

ESD denotes Explanation of Significant Differences.
GMZ denotes Groundwater Management Zone.
PFOA denotes perfluorooctanoic acid.
PFOS denotes perfluorooctanesulfonic acid.
ROD denotes Record of Decision.

Additional findings/issues were identified that do not affect the protectiveness of the remedy as follows:

- Long-term monitoring should continue for each Zone/site.
- Benzene concentrations remain elevated in Site 10 groundwater, despite the sulfate-enhanced bioremediation pilot study completed in 2016 with performance

monitoring conducted from November 2016 to June 2018. Long-term monitoring should continue in Zone 2 to evaluate additional progress.

- Performance monitoring should continue in Zone 3 (Sites 32, 36, and 49) to evaluate pilot study efforts. These data should be reviewed to identify ways to further optimize remedial activities.
- An Explanation of Significant Differences or ROD Amendment should be prepared to document the elimination of groundwater extraction and treatment as a component of the remedy at Zone 3, Sites 32/36.
- The effect of extraction and reinjection of groundwater within Zone 3 for perfluorooctanesulfonic acid/perfluorooctanoic acid treatment should be evaluated for Zone 3 long-term monitoring sites (Sites 32, 36, 39, 49, 73, and Zone 5/Site 8).
- A modification to the Zone 3 ROD should be prepared to address all site contaminants, including the newly discovered PFOS/PFOA, through the operation of the Airfield Interim Mitigation System.
- A modification to the relevant RODs should be prepared to change the groundwater CGs for arsenic to the Pease background concentration at Landfill 5, Sites 10/22, Landfill 6, and Site 8; for manganese to the Pease background concentration at Site 8 and Site 45; and for vanadium to 86 micrograms per liter based on risk for Zone 3.

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1.0 INTRODUCTION

The purpose of a Five-Year Review (FYR) is to evaluate the implementation and performance of a remedy in order to determine if the remedy is and will continue to be protective of human health and the environment. The methods, findings, and conclusions of reviews are documented in FYR reports such as this one. In addition, FYR reports identify issues found during the review, if any, and document recommendations to address them.

The United States (U.S.) Air Force is preparing this FYR pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Section 121, consistent with the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) (40 Code of Federal Regulations Section 300.430(f)(4)(ii)), and considering U.S. Environmental Protection Agency (EPA) policy.

Consistent with Executive Order 12580, the Secretary of Defense is responsible for ensuring that FYRs are conducted at federal facility sites under jurisdiction, custody, or control of the U.S. Department of Defense. The U.S. Air Force is the lead agency responsible for this FYR under the Pease Air Force Base Federal Facilities Agreement (FFA) effective April 24, 1991.

This is the fifth FYR for the Former Pease Air Force Base (AFB) Superfund Site. The triggering action for this statutory review is the remedial action start date for Landfill (LF) 5, which was September 30, 1999. The FYR has been prepared due to the fact that hazardous substances, pollutants, or contaminants remain at the site above levels that allow for unlimited use and unrestricted exposure.

This FYR was led by Roger Walton, Air Force Base Realignment and Closure Environmental Coordinator. Participants included Mike Quinlan, Aptim Federal Services, LLC (APTIM) Project Manager; Joanne Perwak of APTIM; and Benjamin Porter, APTIM Site Engineer. The fifth FYR began on 10/22/2018.

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1.1 Facility Background

The former Pease AFB is located in the towns of Newington and Greenland and the city of Portsmouth in Rockingham County, New Hampshire. As shown on **Figure 1-1**, the former Pease AFB occupies approximately 4,365 acres and is located on a peninsula in southeastern New Hampshire. The peninsula is bounded on the west and southwest by Great Bay, on the northwest by Little Bay, and on the north and northeast by the Piscataqua River.

At the onset of World War II, an airport at the former Pease AFB location was used by the U.S. Navy. The U.S. Air Force assumed control of the site in 1951, and construction of the former Pease AFB was completed in 1956. Under U.S. Air Force command, the former Pease

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AFB served to maintain a combat-ready force capable of long-range bombardment operations. Over time, various quantities of fuels, oils, lubricants, solvents, and protective coatings were used to support the mission, and contaminants from these substances were released into the environment.

In December 1988, the former Pease AFB was selected as 1 of 86 military installations to be closed by the Secretary of Defense's Commission on Base Realignment and Closure. The former Pease AFB was closed as an active installation in March 1991. The U.S. Air Force has transferred most of the former Pease AFB to the Pease Development Authority (PDA) via quitclaim deed (also known as the Pease Deed). The airfield is now a fully operational commercial airport. Other property is currently being used or developed for light commercial and industrial facilities. A portion of the former Pease AFB was transferred to the U.S. Department of the Interior (DOI) for use as a national wildlife refuge, and the U.S. Air Force retained 229 acres of the former Pease AFB for use by the New Hampshire Air National Guard (NHANG).

Modification 1 to the FFA (effective September 8, 1993) established eight Installation Restoration Program (IRP) zones (operable units [OUs]) at the former Pease AFB (refer to **Figure 2-1**). Zones 6 and 8 are located in the western portion of the former Pease AFB, within Parcels L and M, which is the area established by the DOI as the Great Bay National Wildlife Refuge. Zones 6 and 8 do not require FYRs. The IRP zones and the sites included in this FYR Report are shown in **Table 1-1**:

Table 1-1
IRP Zones and Sites Included in this FYR

OU	Site Number	Site Name	Current Status	Included in this FYR? (Y/N)
Active Operable Units				
Zone 1	5	Landfill 5	LTM	Y
	NA	Railway Ditch	LTM discontinued	Y
	23	Pauls Brook	LTM discontinued	Y
	26	Flagstone Brook	LTM discontinued	Y

Table 1-1 (continued)
IRP Zones and Sites Included in this FYR

OU	Site Number	Site Name	Current Status	Included in this FYR? (Y/N)
Zone 2	22	Burn Area 1	LTM	Y
	10	Leaded Fuel Tank Sludge Area	LTM	Y
	24	Peverly Ponds and Bass Pond	LTM discontinued	Y
	37	Burn Area 2	Closure evaluation sampling	Y
Zone 3	20	Upper Grafton Ditch	LTM discontinued	N
	21	McIntyre Brook	LTM discontinued	N
	32	Building 113	LTM	Y
	33	Building 229	CGs met, LTM discontinued	Y
	34	Building 222	CGs met, LTM discontinued	Y
	35	Building 226	CGs met, LTM discontinued	Y
	36	Building 119	LTM	Y
	38	Building 120	CGs met, LTM discontinued	Y
	39	Building 227	ROD Amendment in preparation	Y
	49	Former Building 22	LTM	Y
	73	Building 234	LTM	Y
Zone 4	6	Landfill 6	LTM	Y
	20	Grafton Ditch	LTM discontinued	Y
Zone 5	8	Fire Department Training Area 2	Original remedial system dismantled; ESD completed specifying actions to address PFOS/ PFOA in groundwater	Y
	NA	Knights Brook and Pickering Brook	LTM discontinued	Y

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Table 1-1 (continued)
IRP Zones and Sites Included in this FYR

OU	Site Number	Site Name	Current Status	Included in this FYR? (Y/N)
Zone 7	45	Old Jet Engine Test Stand	LTM	Y
Inactive Operable Units/Sites				
Zone 1	2	Landfill 2	NFA	N
	3	Landfill 3	NFA	N
	4	Landfill 4	NFA	N
	46	Railroad Tracks Herbicide Area	NFA	N
	13	Bulk Fuel Storage Area	non-CERCLA action	N
Zone 2	1	Landfill 1	non-CERCLA action	N
	7	Fire Department Training Area 1	NFA	N
	43	McIntyre Road Drum Disposal Area	NFA	N
	16	Building 410 PCB spill site	non-CERCLA action closure evaluation investigation pending	N
Zone 3	19	Newfields Ditch	NFA	Y
	31	Building 244	NFA	N
	42	Building 123	NFA	N
	65	Building 213	NFA	N
Zone 4	17	Construction Rubble Dump 2	NFA under CERCLA	N
	40	Auto Hobby Shop	NFA	N

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Table 1-1 (continued)
IRP Zones and Sites Included in this FYR

OU	Site Number	Site Name	Current Status	Included in this FYR? (Y/N)
Zone 5	9	Construction Rubble Dump 1	NFA under CERCLA	N
	11	Fuel Maintenance Squadron Cleaning Site	NFA	N
Zone 7	41	Golf Course Maintenance Area	NFA	N
	47	Golf Course Pesticide Storage and Mixing Area	NFA	N

CERCLA denotes Comprehensive Environmental Response, Compensation, and Liability Act.
CG denotes cleanup goal.
ESD denotes Explanation of Significant Differences.
FYR denotes Five-Year Review.
LTM denotes long-term monitoring.
N denotes No.
NA denotes not applicable.
NFA denotes No Further Action.
OU denotes operable unit.
PCB denotes polychlorinated biphenyl.
PFOA denotes perfluorooctanoic acid.
PFOS denotes perfluorooctanesulfonic acid.
ROD denotes Record of Decision.
Y denotes Yes.

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Various terms for cleanup goals have been used in controlling documents for the former Pease AFB Superfund Site, including Restoration Goals, Remedial Goals, and Cleanup Goals. For the sake of consistency in this FYR Report, the term, "cleanup goal" (CG) is used throughout to refer to these values.

1.2 Five-Year Review Summary Form

SITE IDENTIFICATION		
Site Name: Pease Air Force Base		
EPA ID: NH7570024847		
Region: 1	**State:** NH	**City/County:** Portsmouth, Newington, Greenland; Rockingham County
SITE STATUS		
NPL Status: Final		
Multiple OUs? Yes	**Has the site achieved construction completion?** Yes	
REVIEW STATUS		
Lead Agency: Other Federal Agency **If "Other Federal Agency" was selected above, enter Agency name:** U.S. Air Force		
Author Name (Federal or State Project Manager): Roger Walton		
Author Affiliation: Air Force Civil Engineer Center		
Review Period: 09/30/2014–09/30/2019		
Date of Site Inspection: N/A (see report)		
Type of Review: Statutory		
Review Number: 5		
Triggering Action Date: 09/30/2014		
Due Date *(5 years after Triggering Action Date)*: 09/30/2019		

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1.3 Report Organization

This FYR Report generally follows EPA (2001) guidance and the report template developed by EPA (2016). However, because of the number of sites involved in the review, certain modifications were made to make the data more accessible to the reader. Certain general information is presented in introductory sections, and detailed technical review of each site is presented in separate sections. Tables are included in the text. References are provided in **Appendix A**. This FYR Report is organized as follows:

- Section 1.0: Introduction—This section introduces the FYR Report and describes the facility background and the organization of the report.

- Section 2.0: Methodology—This section describes the overall process followed for the FYR, including community involvement.
- Section 3.0: Operable Unit Evaluations—This section provides information on sites in Zones 1 through 7 consisting of brief site descriptions, response actions taken and status, progress since the last FYR Report (CB&I Federal Services LLC [CB&I], 2014), technical assessments for individual sites, issues and recommendations, and protectiveness statements. Drainage areas in these zones are considered separately in Section 4.0.
- Section 4.0: Pease Drainage Areas—This section provides summary information on site drainage areas.
- Section 5.0: Issues/Recommendations—This section identifies issues and makes recommendations based on the content of this FYR Report. This section also identifies other findings of note that do not affect the current or future protectiveness of the remedies.
- Section 6.0: Protectiveness Statement—This section provides the sitewide protectiveness statement.
- Section 7.0 Next Review—This section identifies the date of the next FYR.

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2.0 METHODOLOGY

2.1 Applicable Guidance

The *Comprehensive Five-Year Review Guidance* (EPA, 2001) was the primary guidance used to prepare this fifth FYR Report for the former Pease AFB. This guidance provides an overview of the review process and describes roles and responsibilities, components of the FYR process, and procedures for assessing the protectiveness of remedies. In addition, the following guidance documents were considered:

- *Five-Year Reviews, Frequently Asked Questions (FAQs) and Answers* (EPA, 2009)
- *Recommended Evaluation of Institutional Controls: Supplement to the "Comprehensive Five-Year Review Guidance"* (EPA, 2011)
- *Clarifying the Use of Protectiveness Determinations for the Comprehensive Environmental Response, Compensation and Liability Act Five-Year Reviews* (EPA, 2012a)
- *Assessing Protectiveness at Sites for Vapor Intrusion, Supplement to the Comprehensive Five-Year Review Guidance* (EPA, 2012b)
- *FYR Recommended Template* (EPA, 2016)
- *V. Technical Assessment, Region 1, Supplemental Template* (EPA, 2019)

2.2 Document Review

Numerous documents were reviewed for each site during the process of the FYR. These documents are cited as references within each section and included in **Appendix A**, which is organized by section. These documents, as well as many other relevant documents, are maintained in the Pease AFB Administrative Record. The U.S. Air Force's Administrative Record database is accessible via the following web link: http://afcec.publicadmin-record.us.af.mil/Search.aspx. The Information Repository for the former Pease AFB is located at the APTIM Field Office at 20 Short Street, Newington, New Hampshire.

2.3 Interviews and Site Inspections

Site interviews and inspections were not performed specifically for this FYR Report. All sites included in the FYR are routinely inspected and subject to ongoing monitoring and maintenance by the U.S. Air Force and its consultants. EPA and the New Hampshire Department of Environmental Services (NHDES) also inspect Pease AFB sites as part of their cleanup oversight responsibilities. Inspection logs included in annual reports, contractor and U.S. Air Force personnel responsible for individual sites, and the on-site Operations and

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Maintenance (O&M) manager were consulted for specific information relative to the performance of individual remedies during preparation of this FYR Report.

2.4 Community Involvement

The Information Repository for the former Pease AFB IRP is currently maintained at the APTIM Field Office at 20 Short Street, Newington, New Hampshire.

A public notice was published by the U.S. Air Force announcing the commencement of the FYR and seeking public input. The final fifth FYR Report will be placed in the Administrative Record and the Information Repository for the former Pease AFB and made available for public review. A public notice will be published announcing the completion of the FYR Report and its availability at the Administrative Record and the Information Repository.

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2.5 Technical Assessments

Each of the sites included in this FYR has a remedy in place. **Figure 2-1** shows the zones, sites, and parcels. Therefore, technical assessments, as required under *Comprehensive Five-Year Review Guidance* (EPA, 2001), were made for each of the sites. These assessments consisted of answering the following questions:

- Question A: Is the remedy functioning as intended by the decision documents?
- 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?
- Question C: Has any other information come to light that could call into question the protectiveness of the remedy?

Section 4.0 of the *Comprehensive Five-Year Review Guidance* (EPA, 2001), the technical template provided by Region 1 (EPA, 2019), and other relevant guidance were used to develop appropriate responses to these questions. In general, the response to Question A was developed based on review of the RAOs set forth in the applicable Records of Decision (RODs), followed by assessment of current remedy performance data and progress toward CGs, which are provided in **Appendix B** for all sites included in this FYR Report. Question B was answered through an assessment of significant changes in standards and assumptions that were used at the time of remedy selection. Where risk-based values were established as the CGs, the underlying toxicity data were also reviewed. Other information, such as potential changes in land use that could affect the protectiveness of the remedy, was considered in responding to Question C.

Investigations are continuing at the former Pease AFB to document the nature and extent of perfluorooctanesulfonic acid (PFOS)/perfluorooctanoic acid (PFOA) contamination. The

results of these investigations may affect the protectiveness of site remedies in the future, which will be evaluated in future FYR reports. Site 8 is the only site identified in this FYR Report for which the protectiveness is impacted by the presence of PFOS/PFOA.

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3.0 OPERABLE UNIT EVALUATIONS

3.1 Zone 1, Landfill 5

3.1.1 Site Description

LF-5 (Site 5) is located in Zone 1, in the northeastern portion of the former Pease AFB, as shown on **Figure 2-1**. The original LF consisted of approximately 23 acres; consolidation of wastes during remedial action resulted in a capped area of approximately 18.5 acres. As shown on **Figure 3-1**, LF-5 is bordered by Arboretum Drive on the north, the Railway Ditch paralleling an abandoned railway bed on the east, Flagstone Brook to the west, the Paint Can Disposal Area (Site 44) on the south, and the Bulk Fuel Storage Area (BFSA) (Site 13) to the southeast.

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LF-5 reportedly was used between 1964 and 1975 as the primary base LF, although some disposal occurred as late as 1979. Most of the material placed in the LF consisted of municipal-type solid wastes generated from on-base housing, barracks, offices, dining facilities, etc. Industrial wastes were also reported to be disposed of in the LF, including an unspecified quantity of waste oils, solvents, paints, paint strippers and thinners, pesticide containers, empty cans and drums, and sludge from the industrial waste treatment and base wastewater treatment facilities. LF operations reportedly included trench and fill methods involving excavation of overburden soils such that wastes were buried in direct contact with the underlying bedrock (Bechtel Environmental, Inc. [Bechtel], 1999).

3.1.2 Initial Response

The LF-5 remedial investigation (RI) was conducted in three stages from 1986 through 1990 (Roy F. Weston, Inc. [Weston], 1992). A drum disposal area was identified in the southeastern portion of the LF area during the Stage 2 field effort. As a result, a drum removal operation was implemented as an Interim Remedial Measure (IRM). This operation resulted in the excavation of an approximately 1.1-acre area, with more than 1,000 intact, crushed, and partially crushed 55-gallon drums and 5-gallon cans being removed. Additionally, seven tanks ranging in size from 250 to 5,000 gallons were removed (Weston, 1992).

3.1.3 Basis for Taking Action

Action was taken at LF-5 because the contaminated soil, debris, and sediment posed a threat to human health and the environment. In addition, action was taken to remedy the threat to human health, welfare, or the environment posed by the migration of contaminated groundwater from the LF-5 source area. Contaminants of concern (COCs) identified in LF soil included metals, polychlorinated biphenyls, chlorinated pesticides, and polycyclic aromatic hydrocarbons (PAHs). COCs identified in groundwater included arsenic, lead, and thallium,

as well as several volatile organic compounds (VOCs) (benzene, trichloroethene [TCE], and tetrachloroethene [PCE]). COCs in sediment included metals, PAHs, and chlorinated pesticides.

3.1.4 Response Actions

The response actions required at LF-5 were specified in the LF-5 ROD (Weston, 1993a) and the Zone 1 ROD (Weston, 1995). The LF-5 ROD addressed only source control measures. Source materials identified were LF soil and solid waste and sediment in the Railway Ditch and associated wetlands. The Zone 1 ROD addressed management of migration from source materials through groundwater and surface water.

3.1.4.1 Remedial Action Objectives

The following RAOs were identified in the LF-5 ROD (Weston, 1993a):

- Prevent or minimize risks to ecological receptors resulting from exposure to contaminated sediment in the Railway Ditch and associated wetlands or to contaminated soil and debris associated with LF-5.
- Prevent or minimize risks to humans resulting from exposure to contaminated soil or debris associated with LF-5.
- Minimize further migration of contaminants from the LF-5 source area into the groundwater or surface water.

The RAOs identified in the Zone 1 ROD (Weston, 1995) include the following:

- Prevent off-base migration of contaminated groundwater.
- Protect human receptors from exposure to contaminated groundwater that may present unacceptable health risks.
- Comply with chemical-specific Applicable or Relevant and Appropriate Requirements (ARARs) and/or attain background levels for specific contaminants in groundwater. The LF-5 and Zone 1 CGs are provided in **Appendix B**.

3.1.4.2 Remedy Description

The LF-5 ROD (Weston, 1993a) specified a source control remedy having the following components:

- Excavating Railway Ditch sediments that contained contaminants at concentrations exceeding site-specific CGs with consolidation/disposal into LF-5
- Excavating soil and debris from LF-2 and LF-4 with consolidation/disposal into LF-5

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- Excavating soil and LF debris from LF-5 that would be in contact with groundwater
- Regrading and capping of LF-5 with a composite barrier cap designed to meet the Resource Conservation and Recovery Act (RCRA) Subtitle C cap performance standards
- Conducting long-term monitoring (LTM) (including FYRs) and placement of land use controls (LUCs) (deed restrictions) to restrict future activities on the capped area

The Zone 1 ROD (Weston, 1995) specified a management of migration remedy to address dissolved-phase contamination at LF-5, including contamination within the LF-5 boundary, which had migrated beyond its footprint. Specific components of the action included the following:

- Natural attenuation and biodegradation of contaminated groundwater in Zone 1.
- Placement of deed restrictions on future use of groundwater in Zone 1 in the vicinity of the LF-5 source area.
- Establishment of a Groundwater Management Zone (GMZ) in Zone 1 in the vicinity of the LF-5 source area.
- Long-term environmental monitoring in the zone to allow the continued evaluation of the magnitude of contamination including groundwater, surface water, and sediment sampling and analysis. Groundwater CGs for LF-5 were established and are provided in **Appendix B**.

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3.1.5 Status of Implementation

3.1.5.1 Response Action Status

Excavation and relocation of LF debris, soils, and sediments from LF-2, LF-4, and LF-5 and the adjacent Railway Ditch to LF-5 were performed between December 1993 and June 1995. Additionally, a lined sedimentation basin was constructed to receive groundwater, site runoff, and water pumped from the excavation. Relocated waste was consolidated above the predicted seasonal high groundwater level. An intermediate cap was constructed to cover debris as a precursor to Phase II cap construction (IT, 1995).

During the second phase of the LF-5 remedial action, additional debris and waste soils from LF-6, the Underground Storage Tank (UST) flight line area, Site 34, and UST Site 72 were consolidated into LF-5. Following consolidation, LF-5 was capped with a composite-barrier-type final cover system to minimize water infiltration and prevent contact between LF debris and either human or ecological receptors. After completion of capping, piezometers, LF gas monitoring probes and vents, and survey monuments were installed as specified in the design. This work was completed between May 1995 and July 1996 (Bechtel, 1999).

3.1.5.2 Land Use Controls

LUCs implemented for LF-5 are identified in **Appendix C** and consist of the delineation of a GMZ and Use Restriction Zone (URZ).

3.1.5.3 LTM

Inspections and groundwater LTM are ongoing components of the LF-5 remedy in accordance with the 2003 Postclosure Maintenance and Monitoring Plan (PCMMP), Revision 3 (MWH, 2003). Sampling and inspections in accordance with the PCMMP (MWH Americas, Inc. [MWH], 2003) were conducted at LF-5 in 2014 and 2015 (CB&I, 2016a, 2016b).

In 2016, the PCMMP was revised to include the various LF and Construction Rubble Dump (CRD) sites at the former Pease AFB, including LF-5 (CB&I, 2016c). This revision eliminated monitoring of five interior wells at LF-5 and decreased the frequency of the monitoring of the perimeter wells from annual to triennial. Analyses for the triennial sampling are to include the full list of VOCs and target metals. LF gas and ambient air sampling is also to be conducted triennially. LF inspections were reduced from a frequency of semiannual to annual. Reporting was also changed from annual to triennial. However, a brief report describing the LF maintenance and inspection activities is submitted annually. A monitoring report was submitted under the 2016 PCMMP for sampling conducted in 2018 (APTIM, 2019).

Results from the sampling and inspections during this period are summarized as follows:

- All VOC analytical results for the 2014 and 2015 annual sampling were less than Zone 1 ROD CGs and the New Hampshire Ambient Groundwater Quality Standards (NHAGQS). VOCs were not detected in the 2018 LF-5 groundwater samples.
- Analyses conducted for metals in LF-5 groundwater samples collected in 2018 and previous years have documented the widespread occurrence of inorganic constituents, most of which are naturally occurring in the soils, sediment, and bedrock at the former Pease AFB. During this period, concentrations of arsenic and manganese were greater than the Zone 1 ROD CG and background or NHAGQS.
- Results from visual inspections indicate that the LF cover was both properly designed and constructed. All components of the closure action continue to function as intended. The site and surrounding areas have stabilized, and vegetation is well established following the extensive earthwork associated with LF-5's closure.
- The semiannual (and now annual) visual inspections performed as part of the LTM at LF-5 also serve to verify that the LUCs have not been violated; inspection results are documented in the LFs and CRDs Annual Reports. The Area of Special Notice (ASN) and PDA dig permit review processes, both requiring U.S. Air Force review and

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approval, also aid in LUC enforcement. The ongoing use of the property conforms to the restrictions of the URZ, and this use is not expected to change. A small portion of the LF-5 GMZ falls on NHANG property; the U.S. Air Force coordinates enforcement of the LUCs on this property with the NHANG environmental staff. The LUCs remain protective; no deficiencies and no violations have been identified.

3.1.6 Progress since Last Five-Year Review

This section includes the protectiveness determinations and statements from the last FYR as well as the recommendations from the last FYR and the status of those recommendations.

In the 2014 FYR, no issues were identified for LF-5 and the remedy was determined to be protective of human health and the environment (see **Appendix D**). As a result, no recommendations were made that were necessary to address the protectiveness of the remedy.

Other findings identified in the 2014 FYR were: (1) the annual evaluation of environmental monitoring data should continue; and (2) data analysis of monitoring results should include identification of opportunities to streamline monitoring and reporting. Both recommendations have been implemented at LF-5. LTM was performed in 2014 (CB&I, 2016a) and 2015 (CB&I, 2016b). In 2016, the PCMMP was revised to streamline monitoring and reporting (CB&I, 2016c). Triennial LTM has been performed since 2015.

3.1.7 Technical Assessment

The technical assessment component of the FYR consists of evaluating the protectiveness of the remedy. The technical assessment was performed based on guidance provided in Section 4.0 of the *Comprehensive Five-Year Review Guidance* (EPA, 2001) and the Region 1 guidance (EPA, 2019a).

3.1.7.1 Question A

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

A review of documents, ARARs, risk assumptions, and the results of annual monitoring and inspections indicates that the remedy is functioning as intended. The cover is maintained and is functioning as designed, based on groundwater elevations and decreasing trends in groundwater contaminant concentrations.

Remedial Action Performance:

- The LF cover continues to operate and function as designed. The excavation and capping have served to isolate LF wastes and reduce infiltration. The most recent groundwater sampling data from LF-5 (APTIM, 2019) indicate that VOCs were not detected and have been below their respective CGs and NHAGQS since 2002 in all

monitored locations. Concentrations of arsenic and manganese, however, exceeded their background concentrations, CG, and/or NHAGQS at one or two locations in 2014 and 2015. In 2018, arsenic exceeded its background concentration at one of the perimeter locations (bedrock well 05-6003) at a concentration of 72.7 micrograms per liter (µg/L), higher that detected in previous sampling rounds. This difference was attributed to high turbidity observed in this sample. This location is downgradient of the Site 13 BFSA and is thought to be affected by that site rather than LF-5 based on arsenic concentrations observed in perimeter locations (CB&I, 2016d). Hence, the GMZ boundary is still considered protective for LF-5. The gas vents are functioning as designed to collect and discharge LF gases, and ambient air quality is not being adversely impacted by LF gas discharge.

Implementation of Land Use Controls and Other Measures:

- LUCs have been implemented as described in Section 3.1.5.2 and **Appendix C**, and have been effective as described in Section 3.1.5.3.

3.1.7.2 Question B

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

The RAOs used at the time of the remedy selection are still valid. While some of the exposure assumptions, toxicity data, and cleanup levels were based on information that has changed over time, these changes do not affect the protectiveness of the remedy as discussed in the following paragraphs.

Changes in Standards and TBCs

CGs adopted for sites at the former Pease AFB are summarized in **Appendix B**, along with their basis. In order to expedite review of changes to standards, **Appendix B** also shows the current EPA Maximum Contaminant Levels (MCLs; EPA, 2019b) and NHAGQS (New Hampshire Department of Environmental Services [NHDES], 2018a), and identifies if there was a change from those adopted in the Site RODs.

The LF-5 ROD identified CGs for soil and solid waste. However, the remedy provided for source control and reduction of exposure to site contaminants via containment, as described in Section 3.1.5.1. LF debris that was predicted to be saturated after capping was excavated and consolidated in LF-5. Since the remedy relied on prevention of exposure and not reduction in concentrations, the CGs were not used in remedy implementation. In addition, the soil CGs are not used in postclosure care of the LF, since the LF is capped. Postclosure care of LF-5 is discussed in Section 3.1.5.3. As a result, the soil CGs established for LF-5 are not discussed here.

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Groundwater CGs at LF-5 were identified in the Zone 1 ROD (**Appendix B**). As shown in **Appendix B**, the LF-5 ROD CGs are consistent with current standards unless the CGs are based on background (manganese), with the following exceptions:

- **Arsenic**—As shown in **Appendix B**, the current MCL and NHAGQS for arsenic are less than the Zone 1 ROD CG. Definitions in New Hampshire Code of Administrative Rules Chapters Env-Or 602.07 and Env-Or 602.23 exempt naturally occurring substances at naturally occurring or background levels. Background concentrations of arsenic at the former Pease AFB have been documented as 23 µg/L (Weston, 1993b), which is greater than the arsenic NHAGQS value. Therefore, the background concentration is used in the evaluation site data from LF-5 and the evaluation of protectiveness in this FYR. A ROD modification should be completed adopting the Pease background concentration for arsenic as the groundwater CG for LF-5.
- **1,1-Dichloroethane (DCA)**—The Zone 1 ROD identifies a risk-based CG of 8.1 µg/L for 1,1-DCA. The current NHAGQS is 81 µg/L. As a result, the existing CG is still protective and no change is needed.

There have been no other changes in groundwater standards that would affect the protectiveness of the remedy.

Changes in Toxicity and Other Contaminant Characteristics

As discussed in the *Comprehensive Five-Year Review Guidance* (EPA, 2001), changes in toxicity should be evaluated for risk-based cleanup levels to determine whether they are still protective. For the most part, the ARARs and background values were used to establish groundwater CGs in the Zone 1 ROD (see **Appendix B**). The ROD indicated that the 1,1-DCA CG was risk based. However, review of the feasibility study (FS; Weston, 1993c) showed that the value (8.1 µg/L) was a regulatory goal (the ARAR from the New Hampshire Department of Health and Human Services [NHDPHS] in 1993). Therefore, this value was not actually risk based, but was an ARAR. As discussed previously, the current NHAGQS for 1,1-DCA is 81 µg/L, higher than the ROD CG. Therefore, changes in toxicity values or other contaminant characteristics do not affect the protectiveness of the remedy for LF-5, Zone 1.

Changes in Risk Assessment Methods

The original human health risk assessments were conducted following then-current EPA and EPA Region 1 guidance. The health protectiveness of the original CGs would not be expected to change because the groundwater CGs were established primarily using ARARs and background values.

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Risk assessments are performed somewhat differently now than they were at the time of the last FYR and especially since the time of the LF-5 and Zone 1 RODs. Guidance documents/risk assessment tools that have been issued since completion of the last FYR include the following:

- Office of Solid Waste and Emergency Response (OSWER) Directive 9200.1-120: *Human Health Evaluation Manual, Supplemental Guidance: Update of Standard Default Exposure Factors* (EPA, 2014a). In 2014, EPA finalized a directive to update standard default exposure factors and frequently asked questions associated with these updates. Many of these exposure factors differ from those used in the risk assessment(s) supporting the ROD(s). These changes in general would result in a slight decrease of the risk estimates for most chemicals.
- OSWER Directive 9283.1-42: *Determining Groundwater Exposure Point Concentrations* (EPA, 2014b). In 2014, EPA finalized a directive to determine groundwater exposure point concentrations (EPCs). This directive provides recommendations to develop groundwater EPCs. The recommendations to calculate the 95 percent (%) upper confidence limit of the arithmetic mean concentration for each contaminant from wells within the core/center of the plume, using the statistical software ProUCL, could result in lower groundwater EPCs than the maximum concentrations routinely used for EPCs as past practice in risk assessment, leading to changes in groundwater risk screening and evaluation. In general, this approach could result in slightly lower risk or higher screening levels.
- EPA Regional Screening Levels (RSLs), updated twice a year (current version is November 2018) (EPA, 2018a).
- EPA toxicity data base (Integrated Risk Information System; EPA, 2018b).
- NHDES Method 1 Groundwater Standards, *NHDES Risk Characterization and Management Policy*, Section 7.3 (4) (NHDES, 2018b).

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Of the cleanup levels for LF-5, the only one based on calculated risk is 1,1-DCA, which remains protective, as discussed previously. As a result, changes in risk assessment methods do not affect the protectiveness of the remedy at LF-5.

Changes in Exposure Pathways

The LF-5 cover is in place, functions as designed, and is inspected annually. There have been no changes in physical conditions or land use that would affect the protectiveness of the remedy.

Expected Progress towards Meeting RAOs

Implementation of the remedy at LF-5 is currently achieving most of the RAOs specified in the applicable LF-5 and Zone 1 RODs. As discussed in Section 3.1.4.1, the Zone 1 RAOs for LF-5 specify protection of human receptors from ingestion of contaminated groundwater that may result in an unacceptable risk. It also specifies the compliance with chemical-specific ARARs for groundwater and/or established background levels. Human health is protected as a result of the deed restrictions preventing groundwater use with in the LF-5 GMZ. However, background levels have not been achieved for arsenic and manganese in some locations.

3.1.7.3 Question C

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

No other information has been identified that would call into question the protectiveness of the remedy.

3.1.8 Issues/Recommendations

Remedial measures at LF-5 remain protective of human health and the environment. A ROD modification is recommended for LF-5 adopting the Pease background concentration for arsenic as the groundwater CG for LF-5. No other issues or recommendations are identified.

3.1.9 Protectiveness Statement

Protectiveness Statement(s)		
Operable Unit: Zone 1 – Landfill 5	*Protectiveness Determination:* Protective	*Planned Addendum Completion Date:*
Protectiveness Statement: The remedy at Zone 1, LF-5 is protective of human health and the environment.		

3.2 Zone 2

3.2.1 Site Description

Zone 2 is located in the northwestern portion of the former Pease AFB, as shown on **Figure 2-1**. Zone 2 contains six sites investigated under the U.S. Air Force's IRP. The sites include LF-1, Site 7 (Fire Department Training Area [FDTA] 1), Site 10 (Leaded Fuel Tank Sludge Area), Site 22 (Burn Area [BA] 1), Site 37 (BA-2), and Site 43 (McIntyre Road Drum Disposal Area). **Figure 3-2** illustrates the location of each site in Zone 2. Site 24, Peverly Ponds and Bass Pond (also known as Stubbs Pond), is also in Zone 2, but is discussed with the other former Pease AFB drainage areas in Section 4.0.

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As shown in **Table 1-1**, LF-1, Site 7, and Site 43 are not addressed in this FYR Report; however, for context, each is briefly described below. The Zone 2 Long-Term Monitoring Plan (LTMP), Revision 2 (MWH, 2002), and the Revision 3 LTMP (CB&I, 2016a) address the LTM associated with Sites 10, 22, and 37. A description of each site is provided below.

3.2.1.1 Landfill 1

LF-1 is a fan-shaped landform located approximately 100 feet east of Upper Peverly Pond and north of Nottingham Road in the northwestern corner of Zone 2. LF-1 served as the original base landfill and was operated from 1953 to 1961.

3.2.1.2 Site 7—Fire Department Training Area 1

FDTA-1, Site 7 is located north of Nottingham Road, west of the flightline, and east of McIntyre Road. FDTA-1 is a relatively flat area approximately 300 feet in diameter. FDTA-1 served as the main fire training site between 1956 and 1961, after which fire training moved to FDTA-2 (Site 8) in Zone 5.

3.2.1.3 Site 10

Site 10 consists of two separate areas on the eastern and western sides of Nottingham Road, both within approximately 300 feet of Site 22 (**Figure 3-2**). From the late 1950s to 1978, Site 10 was used for disposal of sludge obtained from leaded aviation gasoline tank cleaning operations conducted at the on-base BFSA. An estimated 350 gallons of sludge containing water, rust, residual fuels, fuel sludge, and residue from sand-blasting tank interiors were generated during the approximately 20-year disposal period. Historical aerial photographs indicated that drum disposal may have also occurred at Site 10 to the south–southeast of the current site boundaries (MWH, 2004).

3.2.1.4 Site 22

Site 22 is located in the central portion of Zone 2 and is the main source of contamination in Zone 2. It is reported that Site 22 was used as a fire training area and a site for burning spent fuel and solvents between 1954 and 1976. The primary contaminant source was found to consist of two circular areas characterized by blackened or stained surface soil with little or no vegetation (MWH, 2004).

3.2.1.5 Site 37

Site 37 is located southwest of Site 10, adjacent to the eastern side of McIntyre Road. Site 37 covers approximately 3.4 wooded acres surrounding roughly circular areas characterized by blackened surface soil with little or no vegetation. Site 37 is a suspected former fire training area or waste solvent BA. Although the exact period of use is not certain, based on aerial photographs, it is estimated that fire training or waste solvent burn activities commenced between 1954 and 1960 and ended before 1976 (MWH, 2004).

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3.2.1.6 Site 43—McIntyre Road Drum Disposal Area

The McIntyre Road Drum Disposal Area (MRDDA) is located west of McIntyre Road and south of Nottingham Road in Zone 2. Little information is available concerning the history and use of MRDDA. When first in discovered during the IRP Stage 2 effort, MRDDA showed signs of past earthmoving activities. An elongated ridge, approximately 4 feet high and approximately 50 feet by 425 feet in size, was parallel to McIntyre Road.

3.2.2 Initial Response

At the MRDDA site, a cluster of 55-gallon drums and 5-gallon cans was partially exposed at the surface of the ridge parallel to McIntyre Road. Consequently, the ridge and adjacent areas were suspected to be locations of historical subsurface disposal. The buried drums were suspected to have been associated either with disposal from other sites within the zone or with the construction of McIntyre Road in 1972. As part of site investigation activities, an intensive test pit operation was conducted in 1992 at the MRDDA. Approximately 23 crushed drums and 5-gallon containers and a small amount of impacted soil were removed in 1992.

3.2.3 Basis for Taking Action

The basis for taking action at Zone 2 was to address the principal threat posed by leaching of contaminants to groundwater at Site 22 and to address potential risks associated with contaminant plumes at Site 10, Site 22, and Site 37 (Weston, 1995).

3.2.4 Response Actions

The Zone 2 ROD (Weston, 1995) documented the selection of a remedy that included soil vapor extraction (SVE)/air sparge (AS) (Site 22 only), LTM, natural attenuation, and LUCs.

3.2.4.1 Remedial Action Objectives

The Zone 2 ROD identified RAOs that defined the scope and purpose of the cleanup action needed to mitigate the potential threats to human health and the environment identified in the Baseline Risk Assessment. The following site-specific RAOs were developed for Zone 2 (Bechtel, 1999):

- Soils:
  - LF-1 (solid waste and inert debris)—Comply with State of New Hampshire Solid Waste Rules concerning closure of solid waste facilities. (No further action under CERCLA.)
  - Site 7—No RAOs were established for soils because the risk assessment identified no unacceptable risks to human health or the environment.

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  - Site 10—No RAOs were established for soils because the risk assessment identified no unacceptable risks.
  - Site 22—Remove light nonaqueous phase liquid (LNAPL) and residual product from Site 22 soil.
  - Site 37—No RAOs were established for soil because the extent of contamination was limited.
  - Site 43—No RAOs were established for soils because the risk assessment identified no unacceptable risks to human health or the environment.
- Overburden and Bedrock Groundwater:
  - No RAOs were necessary for Site 7
  - Protect human receptors from contaminated groundwater that may present an unacceptable health risk (total cancer risk greater than 10^{-4} or a Hazard Index of greater than 1) (Leaded Fuel Tank Storage [LFTS]/BA-1/MRDDA and BA-2 groundwater).
  - Comply with chemical-specific, regulatory-based remedial objectives (LFTS/BA-1/MRDDA, and BA-2 groundwater).
  - Prevent contaminated groundwater from affecting surface water quality (LFTS/BA-1/MRDDA, BA-2, and LF-1).
  - Protect against potential leaching of soil contaminants from Site 22 soils to groundwater at levels that could cause exceedances of groundwater remedial objectives.
  - Monitor surface water and sediment quality over time in Upper and Lower Peverly and Bass Ponds (drainage areas are discussed in Section 4.0 of this FYR Report.).

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3.2.4.2 Remedy Description

The remedial alternative selected by the Zone 2 ROD (Weston, 1995) included the following:

- In situ SVE/AS treatment of Site 22 source area LNAPL and residual LNAPL (enhanced by injection of air below the water table into the marine clay silt)
- Treatment of extracted soil vapor for removal of VOCs
- Establishment of LUCs restricting the future use of Zone 2 groundwater, including a GMZ and performance of GMZ LTM
- Natural attenuation (which may include natural biodegradation) of residual bedrock groundwater contamination after excavation, AS, and SVE

- Monitoring of groundwater, surface water, sediment, and fish tissue

The CGs for Zone 2 overburden and bedrock groundwater were specified in the Zone 2 ROD (Weston, 1995). These CGs are provided in **Appendix B**. No specific CGs were established for soil.

3.2.5 Status of Implementation

3.2.5.1 Response Action Status

The Site 22 remedial system for source soils was constructed in late 1996 and early 1997 and began operation in May 1997. The system was divided into two areas: (1) the primary area that included the western portion of the site and (2) the expansion area that included the eastern portion of the site. The original design called for treatment in the primary area only. Subsequent investigations indicated that soil remediation was necessary in additional areas, and the system was expanded to meet this need. However, AS was limited in the expansion area and SVE was the primary form of treatment in the expansion area.

In situ SVE/AS of the source area for removal of LNAPL and residual product from the soil and treatment of extracted soil vapor for removal of VOCs was the active remedy for Site 22 from May 1997 through 2000 (except for the winter months) and for portions of 2002.

3.2.5.2 Land Use Controls

The LUCs implemented for Zone 2 are identified in **Appendix C** and consist of establishment of a GMZ and a URZ.

3.2.5.3 Current Status of Remedial Actions

Site 22

The SVE/AS system was shut down on October 23, 2003, and was not restarted after that date. LNAPL and residual product were no longer observed in Site 22 soils following system shutdown, and no rebound of soil vapor concentrations was observed in monitoring data collected since system shutdown (MWH, 2005).

The LTM groundwater sampling results together with the 2005 SVE groundwater results and the 2002 and 2003 soil sampling results indicated that the SVE/AS system had met its objectives for Site 22 soils and that natural attenuation is the appropriate technology for the downgradient plume (URS Group, Inc. [URS], 2008). A Site 22 SVE/AS System Closeout Report was included in the Zone 2 2006 Annual Report (URS, 2008). The Zone 2 2012 Annual Report likewise recommended that the wells/piezometers associated with the system (i.e., pressure monitoring points, SVE, and AS) be decommissioned. A December 2012 notification of intent letter to abandon the SVE wells, AS wells, pressure monitoring points, and recovery vent wells was submitted to EPA and the NHDES and received agency approval.

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Decommissioning of the SVE wells and a limited number of the AS wells, pressure monitoring points, and recovery well vents was conducted in October and November 2014 (CB&I, 2016b).

Detected concentrations for the certain VOCs (1,2,4-trimethylbenzene [TMB], 1,3,5-TMB, ethylbenzene, 2-methylbenzene, and naphthalene) in the upper sand unit exceeded the NHAGQS (APTIM, 2019a). In order to address this residual contamination, a pilot study was conducted to determine the feasibility of in situ chemical oxidation (ISCO) in reducing alkylbenzene VOC concentrations in groundwater at Site 22 (APTIM, 2019a).

Pilot study ISCO injections were conducted between July 11 and July 22, 2016, at 37 injection wells. A total of 25,900 gallons of 8% hydrogen peroxide solution, 3,700 gallons of flush water, and 25,900 gallons of 20% sodium persulfate were injected at Site 22.

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The conclusion of the Pilot Study Completion Report (APTIM, 2019a) was that the ISCO injections were effective in reducing 1,2,4-TMB, naphthalene, and ethylbenzene concentrations in groundwater, although elevated concentrations remain at monitoring wells 22-5065 and 22-5124. An elevated sulfate concentration was still present in monitoring well 22-5124 in the last performance monitoring event, and bioremediation of alkylbenzenes may continue. Continued monitoring was recommended and will occur in 2019 with the Zone 2 biennial sampling.

Site 10

A supplemental site investigation was conducted in 2013–2015 to further assess residual contamination remaining at Sites 10 and 22 (CB&I, 2014, 2016c). The primary objective of these investigations was to determine the source of benzene in monitoring well 10-5112. Since 2000, benzene concentrations in this well have ranged from 530 to 1,700 µg/L (APTIM, 2018a). The results of the investigation suggested that the Sites 10 and 22 plumes are located in different geologic units and are not connected. Site 10 has a benzene plume in the lower sand unit traveling to the northwest. Site 22 has an alkylbenzenes plume in the upper sand unit traveling north-northeast. Both plumes overlap at the northern edge of Site 10, but do not appear to commingle. The investigation concluded that alkylbenzenes observed at Site 22 are likely residual groundwater contamination that was not treated by the SVE/AS system previously operated at Site 22.

A pilot study to determine the feasibility of sulfate-enhanced bioremediation (SEB) in reducing residual benzene concentrations in groundwater at Site 10 was initiated in August 2016 (APTIM, 2019b). This approach uses sulfate to provide a respiratory substrate for existing microorganisms to enhance contaminant degradation. The conclusions of the Pilot Study Completion Report (APTIM, 2019b) were that significant concentrations of benzene remained in the Site 10 plume area. Sulfate concentrations also remain elevated at a number of the site

wells, although they are expected to decrease over time. Continued monitoring was recommended and will occur in 2019 with the Zone 2 biennial sampling.

3.2.5.4 LTM

The Zone 2 LTMP, Revision 2 (MWH, 2002) required that 32 locations be sampled. Parameters to be monitored include Zone 2 COCs and intrinsic remediation (IR) parameters, as necessary. Additionally, the collection of water levels was also required on a semiannual basis to assess groundwater elevations and flow directions. Monitoring in 2014 and 2015 was conducted in accordance with this LTMP. The Zone 2 LTMP, Revision 3 (CB&I, 2016a) reduced the frequency of LTM sampling, water level measurement, and reporting to biennial; discontinued monitoring at certain locations; and eliminated parameters for analysis at some locations. Monitoring in 2017 (APTIM, 2018a) was conducted in accordance with the Revision 3 LTMP.

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Key findings of the 2017 sampling are as follows:

- COC concentrations in the Sites 10 and 22 point-of-compliance wells were all below the CGs during the 2017 sampling event.
- Benzene was detected at monitoring well 10-5112 at 1,500 µg/L, greater than the CG, but similar to concentrations reported in this well historically. Benzene was not detected at any other LTM wells at concentrations greater than the CG.
- Manganese concentrations were greater than the CG and background at both Site 10 and 22 wells. Manganese concentrations at some Site 10 wells were substantially greater than those detected at these wells historically. The 2017 Biennial and Performance Monitoring Report (APTIM, 2018a) attributes the higher concentrations to mobilization of manganese and other metals due to SEB injections (Section 3.2.5.3). **Figure 3-3** shows detections in groundwater at Zone 2 sites greater than CGs or NHAGQS.
- The 2017 analytical results for well 22-5124 are consistent with historical results and indicate exceedances of CGs and/or the NHAGQS for 1,2,4-TMB, ethylbenzene, isopropylbenzene, naphthalene, *sec*-butylbenzene, arsenic, and manganese.
- Results from the two monitoring wells at Site 37 (37-5125 and 37-5108) show that VOCs and semivolatile organic compounds (SVOCs) were not detected at concentrations greater than their CGs or NHAGQS in samples collected in 2010 through 2013. In October 2014, however, bis(2-ethylhexyl)phthalate (BEHP) was detected at 34.1 µg/L, greater than the NHAGQS and the CG of 6 µg/L at monitoring well 37-5125. This was the only SVOC detected at this location in this sampling round. BEHP had not been detected at a concentration greater than the CG since 2004

(APTIM, 2018b). A closure sampling plan was initiated in the fall of 2018 consisting of two seasonal rounds of sampling to verify groundwater at the site has achieved CGs (APTIM, 2018c).

- No COCs were detected at concentrations above the CGs in the 2014 or 2015 bedrock well sampling. In 2017 (APTIM, 2018a), bedrock monitoring well 10-6113 was sampled instead of 43-6114 in error. All VOCs at 10-6113 were nondetect, and arsenic was detected above background at well 01-6106 at a concentration of 33.4 µg/L.
- Benzene concentrations in bedrock well 43-6114 have shown a decreasing trend over time (since 1999) and have been below the NHAGQS since 2013.
- The IR parameter monitoring in previous sampling rounds and decreasing trends in contaminant concentrations demonstrate that natural attenuation reactions are occurring across Zone 2 (APTIM, 2018a).

Observations are made during the performance of the LTM activities in Zone 2 to ensure that the LUCs have not been violated; these observations are documented in the Zone 2 Annual/Biennial Reports, most recently in 2017 (APTIM, 2018a). The ASN and PDA dig permit review processes, both requiring U.S. Air Force review and approval, also aid in LUC enforcement. It should also be noted that access to Zone 2 is generally restricted (i.e., fences and locked gates), and redevelopment activities will not be permitted in the Great Bay National Wildlife Refuge. The western portion of Zone 2 is within the National Wildlife Refuge; however, Sites 10, 22, and 37 are not within the Refuge. The ongoing use of the property conforms to the restrictions of the URZ, and property use is not expected to change. The LUCs remain protective, and no deficiencies have been identified.

3.2.6 Progress since Last Five-Year Review

This section includes the protectiveness determinations and statements from the last FYR as well as the recommendations from the last FYR and the current status of those recommendations.

In the 2014 FYR, no issues were identified for Zone 2 and the remedy was determined to be protective of human health and the environment (see **Appendix D**). As a result, no recommendations were made that were necessary to address the protectiveness of the remedy.

Other findings identified in the 2014 FYR were: routine monitoring should continue, additional delineation of benzene contamination in vicinity of monitoring well 10-5112 should be completed, and opportunities optimize remedial activities to improve progress towards Zone 2 RAOs should be considered. As discussed in Section 3.2.5.3, all of these recommendations have been implemented. Optimization of LTM was also completed during this FYR period, resulting in a Revision 3 of the LTMP (CB&I, 2016a).

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In EPA's review of the draft 2014 FYR, the agency disagreed with the protectiveness statement for Zone 2. EPA indicated that the presence or absence of PFOS/PFOA in Zone 2 groundwater associated with FDTA 1 (Site 7), BA-1 (Site 22), and BA-2 (Site 37) needed to be determined. EPA indicated that the protectiveness determination for Zone 2 should be deferred until this work has been completed. The U.S. Air Force did not agree with the deferred protectiveness determination for Zone 2.

Since the 2014 FYR, the U.S. Air Force has conducted extensive work related to the nature and extent of PFOS/PFOA at the former Pease AFB, including Zone 2. This work is not described in detail here, but is discussed in the *Final Basewide Investigation Report* (Amec Foster Wheeler Environment & Infrastructure [AMEC], 2017). The conclusion of this report was that PFOS/PFOA were not detected at concentrations greater than the 2009 Provisional Health Advisories (PHAs) in groundwater from the upper sand aquifer in monitoring wells in Zone 2. Concentrations in these areas were also less than the EPA Lifetime Health Advisories (LHAs) for PFOS/PFOA. However, these compounds were detected in groundwater at concentrations exceeding PHAs (and the LHAs) in the lower sand and bedrock aquifers. It was concluded that the detected concentrations in Zone 2 could be from upgradient sources such as Site 8 or undocumented releases of PFOS/PFOA-containing firefighting aqueous film-forming foam that may have historically occurred on the flightline.

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3.2.7 Technical Assessment

The technical assessment component of the FYR consists of evaluating the protectiveness of the remedy. The technical assessment was performed based on guidance provided in Section 4.0 of the *Comprehensive Five-Year Review Guidance* (EPA, 2001).

3.2.7.1 Question A

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

A review of documents, ARARs, risk assumptions, and the results of annual system and groundwater monitoring indicates that the remedy is functioning as intended.

Remedial Action Performance

- LNAPL is generally no longer observed in Site 22 monitoring wells.
- Natural attenuation of contamination in overburden and bedrock groundwater is occurring, and progress is being monitored.
- Additional measures are being evaluated to enhance reduction in groundwater concentrations in localized areas of Sites 10 (SEB) and 22 (ISCO).

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Implementation of Land Use Controls and Other Measures

- LUCs have been implemented as described in Section 3.2.5.2 and **Appendix C**, and have been effective as described in Section 3.2.5.3.

3.2.7.2 Question B

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

The RAOs used at the time of the remedy selection are still valid. While some of the exposure assumptions, toxicity data, and cleanup levels were based on information that has changed over time, these changes do not affect the protectiveness of the remedy as discussed in the following paragraphs.

Changes in Standards and TBCs

As discussed in the Zone 2 ROD (Weston, 1995), no CGs were established for soil at Site 10, 22, or 37.

As shown in **Appendix B**, groundwater CGs were established for 2-methylnaphthalene, naphthalene, 1,2,4-TMB, *sec*-butylbenzene, isopropylbenzene, and methyl isobutyl ketone either based on risk or NHAGQS. The current version of the NHAGQS (NHDES, 2018) includes values for all of these compounds that are higher than the CGs established in the ROD. As a result, the CGs are still protective and no changes are needed.

The only chemical with a CG based on an MCL that has changed is arsenic, as discussed in Section 3.1.7.2. While current ARARs are less than the CG established in the ROD, the current ARARs as well as background concentrations are used to evaluate progress in Zone 2 LTM results. A ROD modification for Sites 10/22 in Zone 2 should be completed to adopt the Pease background as the CG for arsenic.

While there have been changes in standards, as described previously, such changes do not affect the protectiveness of the remedy, since most of the changes have resulted in higher ARAR concentrations and LUCs have been established to prevent groundwater use, as discussed in Section 3.2.5.2 and **Appendix C**.

Changes in Toxicity and Other Contaminant Characteristics

Groundwater COCs with risk-based CGs in the Zone 2 ROD included 1,2,4-TMB, 2-methylnaphthalene, *sec*-butylbenzene, and isopropylbenzene. Some of the toxicity values used to establish these CGs have changed since the ROD was completed; however, these changes are reflected in the revised NHAGQS (NHDES, 2018). Based on the changes in toxicity values, the NHAGQS values established as shown in **Appendix B** are all greater than

the ROD CGs established for these chemicals. As a result, none of these changes affects the protectiveness of the Zone 2 remedy.

On May 19, 2016, EPA issued LHAs for PFOA and PFOS, which identified chronic oral reference dose (RfD) values of 2E-05 milligrams per kilogram per day (mg/kg-day) for both. These RfD values should be used when evaluating potential risks from ingestion of contaminated groundwater at CERCLA sites where PFOA and PFOS are present. Potential estimated health risks from PFOA and PFOS could increase total site risks due to groundwater exposure. Further evaluation of potential risks from exposure to PFOA and PFOS in other media at the Site might be needed based on site conditions and may also affect total site risk. Perfluorobutane sulfonate (PFBS) has a chronic oral RfD of 2E-02 mg/kg-day based on an EPA Provisional Peer Reviewed Toxicity Value (PPRTV). This RfD value should be used when evaluating potential risks from ingestion of contaminated groundwater at CERCLA sites where PFBS is present.

Changes in Risk Assessment Methods

As discussed in Section 3.1.7.2, numerous changes have occurred in risk assessment methods since the date of the Pease ROD completed in the 1990s. However, NHAGQS have now been established for all Zone 2 COCs, and relevant changes in risk assessment methods have been incorporated in these values. As a result, changes in risk assessment methods do not affect the protectiveness of the remedy.

Changes in Exposure Pathways

There have been no changes in physical conditions or land use that would affect the protectiveness of the remedy.

Expected Progress toward Meeting RAOs

LNAPL and residual product are generally no longer observed in Site 22 monitoring wells. Human receptors are protected from groundwater as a result of the LUCs implemented as described in Section 3.2.5.2 and **Appendix C**. At Site 22, concentrations of VOCs in all source area wells/piezometers were below the CGs as of the 2017 sampling event. Only concentrations of manganese remain above the CG. Elevated VOC concentrations (primarily ethylbenzene, naphthalene, and 1,2,4-TMB) are still present in the treatment area located to the east of the historical source area. Significant concentrations of benzene remain in the Site 10 plume area, accompanied by manganese exceedances in a number of locations. The COC concentrations in Site 10 and 22 point-of-compliance wells continue to be below the CGs. Well 37-5125 (located in the Site 37 groundwater source area) has generally shown decreasing trends since 1999, with most COCs detected at concentrations less than their CGs since 2010. BEHP was the only chemical detected since that time at a concentration greater

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than the CG, although this result is not consistent with historical results. Closure sampling to verify attainment of CGs was initiated in the fall of 2018 and will be completed in 2019.

3.2.7.3 Question C

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

No other information has been identified that would call into question the protectiveness of the remedy as it was implemented for regulated contaminants directed by the decision document. As discussed in Section 3.2.6, Zone 2 sites have been evaluated for the presence of PFOS/PFOA, and concentrations greater than EPA LHAs have been detected in lower sand and bedrock groundwater. However, the presence of these compounds does not affect the protectiveness of the remedy given the LUCs in place (Section 3.2.5.2).

3.2.8 Issues/Recommendations

No issues were identified in Zone 2 that affect the protectiveness of the remedy. A ROD modification is recommended for Sites 10/22 in Zone 2 adopting the Pease background concentration for arsenic as the groundwater CG.

Other findings were that benzene concentrations remain elevated in Site 10 groundwater, despite the SEB pilot study completed in 2016 with performance monitoring conducted in November 2016, May 2017, October 2017, and June 2018. LTM should continue in Zone 2.

3.2.9 Protectiveness Statement

Protectiveness Statement(s)		
Operable Unit: Zone 2	*Protectiveness Determination:* Protective	*Planned Addendum Completion Date:*
Protectiveness Statement: The remedy at Zone 2 is protective of human health and the environment.		

3.3 Zone 3

3.3.1 Site Description

Zone 3 is located in the central portion of the former Pease AFB and occupies approximately 440 acres (refer to **Figure 2-1**). The zone contains numerous buildings with adjacent paved parking areas, a network of roads, and the flight line area. A large section of Zone 3 covers the flight line area of the former Pease AFB, which includes portions of the runway, aircraft parking apron, and the grassy infield between the aircraft parking apron and the runway. The aircraft parking apron is a major feature of the former Pease AFB, covering nearly one-third of the zone. Zone 3 encompasses 12 individual IRP sites including Site 31 (Building 244),

Site 32 (Building 113), Site 33 (Building 229), Site 34 (Building 222), Site 35 (Building 226), Site 36 (Building 119), Site 38 (Building 120), Site 39 (Building 227), Site 42 (Building 123), Site 49 (Building 222), Site 65 (Building 213), and Site 73 (**Figure 2-1**). As shown in **Table 1-1**, Site 31, Site 42, and Site 65 are not addressed in this FYR Report; however, for context, each site is briefly described in the following subsections.

Site 73 was originally investigated under the UST program at the former Pease AFB. Because of the presence of chlorinated VOC compounds in groundwater, the site was transferred to the IRP. Site 73 was under investigation at the time of the Zone 3 ROD (Weston, 1995a). Remedial actions at Site 49 and 73 were later documented in the Zone 3 ROD Amendment (MWH, 2003).

3.3.1.1 Site 31

Building 244 is located east of the aircraft parking apron and was known as the Consolidated Aircraft Maintenance Squadron building. The site was used for jet engine maintenance and repair from 1955 to 1965. The primary area of interest is a former 1,200-gallon concrete UST located adjacent to the building that received discharge from the building floor drains. The tank, which was removed in 1991, held waste solvents (predominantly TCE) that were used as degreasers for aircraft engine parts.

3.3.1.2 Sites 32/36

Sites 32 and 36 are discussed together due to their close proximity. Buildings 113 (Site 32) and 119 (Site 36) are located in the center of the former Pease AFB in the area known as the Industrial Shop/Parking Area (refer to **Figure 3-4**). Newfields Ditch, a storm water drainage swale, passes between Buildings 113 and 119.

Building 113 (Site 32) was used between 1955 and 1991 primarily for aircraft munitions systems and avionics maintenance, including some vapor degreasing operations. A 1,200-gallon concrete UST that received waste TCE from degreasing was located near the northeastern corner of Building 113. The soil and groundwater contamination at this site is believed to be primarily a result of the historical use of the TCE tank and associated overflow pipe.

Jet engine and engine accessory maintenance was performed in Building 119 (Site 36) between 1956 and 1990. Prior to 1971, waste generated in the building, including fuel and TCE, was disposed of at a fire training area (Site 8). From 1971 to 1990, these wastes were either drummed and stored in a designated drum storage area on site for contractor removal or were piped to Building 226 (Site 35, industrial waste treatment plant) for treatment. During the early stages of investigations at Building 119, soil surrounding the drum storage area and oil rack behind the building was observed to be visibly stained, apparently from former waste spills.

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An underground sewer line located along Dover Avenue transported wastes from Building 119 to Building 226 (Site 35, Building 226 was removed in 1992/1993). A break in the line between the two buildings may have resulted in a release of contaminants.

3.3.1.3 Site 33

Site 33 consists of the Aircraft Maintenance Squadron hangar (Building 229) (refer to **Figure 3-4**). Operations in the building included cleaning and repairing aircraft fuel systems and tanks. In 1964, an oil-water separator was installed to receive wastes from the building floor drains. Activities of concern at the site include the past use of TCE and a possible fuel/oil spill near the building. The principal area of concern is the former location of the oil-water separator and associated sump in the southwestern corner of the building; these structures were removed in October 1991.

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3.3.1.4 Site 34

The Jet Engine Test Cell (JETC) was used to test the performance of jet engines (refer to **Figure 3-4**). Liquid generated from activities at the JETC potentially contained PAHs, fuel, hydraulic fluid, and solvents. Before 1989, waste liquid from Building 222 drained directly to the Test Cell Ditch, which forms the uppermost section of Grafton Ditch. In 1989, the test cell was modified to reduce discharge to the Test Cell Ditch. Other sources of contamination at Site 34 are the former locations of the 5,000-gallon UST that was used to store jet fuel, an oil-water separator, and two No. 2 heating fuel USTs.

3.3.1.5 Site 35

Building 226, referred to as the Industrial Wastewater Treatment Plant, was built in 1956 to house a dissolved air flotation water treatment system (refer to **Figure 3-4**). The system operated from 1956 to 1975, processing aircraft wash water and wastewater from Buildings 119 and 227. During this period, treated water was discharged to the sanitary sewer system. In 1973, an oil-water separator was installed next to Building 226 to replace the dissolved air flotation system. Beginning in 1974, wastewater that passed through the oil-water separator was discharged into the storm sewer system. In 1989, the oil-water separator discharge was rerouted to the base sanitary sewer system. Building 226 was removed in 1992, and the building foundation was removed in the spring of 1993 and then paved over.

In addition to the oil-water separator, areas of concern at Site 35 include the former 15,000-gallon UST and the Hazardous Material Storage Area (HMSA). The UST was used to store solvents and was located next to the oil-water separator between Buildings 226 and 227. The UST and the oil-water separator were removed in October 1991. The HMSA was used for temporary drum storage between 1982 and 1990 and was located on the asphalt area between Building 226 and Dover Avenue.

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3.3.1.6 Site 38

Site 38 consists of several maintenance shops (Building 120) that were used for a variety of purposes when the former Pease AFB was in operation (refer to **Figure 3-4**). The shops include a sheet metal shop, paint shop, welding shop, battery shop, and a nondestructive testing area. The sources of contamination at Site 38 were the drum storage area and the floor drain pipeline adjacent to the eastern corner of the building.

3.3.1.7 Site 39

Site 39 (Building 227 Area) (refer to **Figure 3-4**) includes the largest hangar at the former Pease AFB and served as a major maintenance area for aircraft. The hangar was historically used for a variety of general maintenance activities, including degreasing, paint stripping, and minor repairs, and to wash down aircraft. The northern quarter of the hangar housed a wash rack area and a container storage area for hazardous waste. The floor drains in that area were connected to the Building 226 Industrial Wastewater Treatment Plant (Site 35) (1956 to 1974) and later to the oil-water separator (1974 to 1991). From 1956 to 1974, the floor drains for the other sections of the building (along with the roof drains) connected directly into the flight line storm water sewer system, which crosses the flight line before discharging into McIntyre Brook. In 1974, a low-flow bypass line was constructed to connect these drains with the Building 226 oil-water separator. Between 1974 and 1991, wastewater from the Building 227 floor drains emptied into the flight line storm sewers only during rainstorms when the wastewater was highly diluted.

The soil and groundwater adjacent to and underneath the building have been the primary areas of concern. Sources of contamination in groundwater are suspected to be solvent, oil, and fuel spills on the floors or outside the building and wastewater discharged to the flight line storm sewers.

3.3.1.8 Site 42

Building 123 (Refuse-to-Energy Plant [RTE]) was constructed in 1981 by the City of Portsmouth and was operated at the base from July 1982 to April 1987 incinerating refuse collected from the City of Portsmouth, Pease AFB, the Portsmouth Naval Shipyard, and several surrounding communities and private companies. The heat generated at the RTE was used to generate steam for the heating system at the base. Of interest at Site 42 was a petroleum UST, the incinerator ash storage area, and an oil-water separator. A 20,000-gallon fuel oil UST was removed by the City of Portsmouth in August 1991.

3.3.1.9 Site 49

Site 49 is approximately 5 acres in size and is located at the intersection of Pease Boulevard and International Drive. **Figure 2-1** shows the location of Site 49. Site 49 is located outside of the Zone 3 boundary but was included as part of the 2003 Zone 3 ROD Amendment

(MWH, 2003). The site was formerly occupied by Building 22 (a former communications building) and consists of the location of the former building, surrounding driveways and grassy areas, and downgradient areas associated with the groundwater contaminant plume. Building 22 has been demolished, and the site has been redeveloped with a privately-owned office building.

U.S. Air Force records for Site 49 indicate that PCE and TCE were used as solvents and degreasers at Building 22. Cleaning and degreasing operations were conducted in the vicinity of the south wing area of Building 22, with discharges to the environment apparently occurring in the form of minor spills or on-site disposal associated with the normal daily operations. These discharges resulted in releases of TCE and PCE to the soils and groundwater in the vicinity of the building.

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3.3.1.10 Site 65

Site 65 consists of Building 213, which served as a maintenance facility for aircraft ground equipment. Releases of hazardous substances to soil and groundwater were associated with a former HMSA and a former oil-water separator, and aircraft parking equipment area. The oil-water separator at Building 213 served as part of the aircraft ground equipment maintenance activities and regularly received wastewater along with fuels, lubricants, and solvents through a single floor drain in a wash rack area. The 1,700-gallon separator reclaimed product and returned it to a storage tank inside the building. The oil-water separator was removed in 1992 by the U.S. Air Force as part of UST compliance activities. USTs associated with the building were removed in 1993. A soil removal action was performed at the HMSA during 1992.

3.3.1.11 Site 73

Site 73 is located in Zone 3 in the central portion of the former Pease AFB (refer to **Figure 2-1**). Building 234 was constructed in 1959 and was originally used as a liquid oxygen plant. In 1978, it was converted to house a water demineralization plant. U.S. Air Force records for Site 73 indicate that PCE and TCE were used as solvents and degreasers at Building 234. Cleaning and degreasing operations were conducted in the vicinity of the concrete area northeast of Building 234, with discharges to the environment apparently occurring in the form of minor spills or runoff associated with these operations (Weston, 1996).

3.3.1.12 Zone-Wide Geological, Hydrogeological, and Groundwater Flow Descriptions

The shallow subsurface beneath Zone 3 generally consists of five stratigraphic units. Unconsolidated strata include the upper sand, marine clay silt, lower sand, and glacial till. The bedrock underlying these units is either the Kittery or Eliot Formation. The thickness of the overlying unconsolidated units varies across the site. In addition, the elevation of the bedrock

surface is highly variable, likely a result of the region's glacial history. Although not located within the defined limits of Zone 3, the subsurface geology at Site 49 is similar to that of Zone 3.

Regional groundwater flow is to the south–southeast within Zone 3 under static conditions (i.e., when the Haven Well is not being used). Depending upon the season, localized flow vectors may also exist at each of the sites. A more detailed description of the geologic, hydrogeological, and hydrologic characteristics of Zone 3 can be found within the Zone 3 ROD (Weston, 1995a). Local overburden and bedrock groundwater generally flows west to east across Site 49.

3.3.2 Initial Response

Initial response actions were taken at some of the sites in Zone 3, mostly to remove USTs and/or contaminated soil, as described in **Table 3-1**.

Table 3-1
Initial Response Actions at Zone 3 Sites

Zone 3 Site	Initial Response Action
31	1991—UST and 22 tons of contaminated soils excavated.
32	1990—Overflow pipe and contaminated soil near waste TCE UST excavated. 1991—Pilot groundwater extraction and treatment system installed.
33	1991—Oil-water separator and associated sump removed.
34	1991—Pilot groundwater extraction and treatment system installed. 1992—UST removed. Sediment removal from portion of Test Cell Ditch. Operation of pilot groundwater extraction and treatment system.
35	1991—Oil-water separator removed. 1991—300 yd^3 of contaminated soil removed.
36	None
38	None
39	1991—Building floor drain system cleaned and sealed. 1992—Pilot SVE treatment system installed.
42	1991—UST removed.
49	1997—Approximately 880 yd^3 contaminated soil removed. 1998—Crushed drum and 3 yd^3 removed.

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Table 3-1 (continued)
Initial Response Actions at Zone 3 Sites

Zone 3 Site	Initial Response Action
65	1992—Oil-water separator removed. 1992—Contaminated soil removal. 1993—USTs removed.
73	1989, 1991—Two 1,000-gallon fuel oil tanks removed under UST program. 150 tons of contaminated soil also removed.

Sources: Weston, 1995a and Bechtel, 1999.
SVE denotes soil vapor extraction.
TCE denotes trichloroethene.
UST denotes underground storage tank.
yd^3 denotes cubic yard.

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3.3.3 Basis for Taking Action

The basis for taking action at Zone 3 was to address leaching of contaminants in soil and sediment to groundwater; reduce contamination concentrations in source area groundwater; and control the flow of contaminant plumes to prevent them from migrating outside the zone (Weston, 1995a).

3.3.4 Response Actions

The controlling documents that present the selected remedies for Zone 3 include the following:

- Zone 3 ROD (1995): The Zone 3 ROD addressed Sites 32, 33, 34, 35, 36, 39, and 42, as well as the site drainage ways (see Section 4.0) (Weston, 1995a). No further action was recommended for Site 42.
- Site 34 ROD (1993): The U.S. Air Force's selected alternative at Site 34, as stated in the Site 34 ROD, was for a Source Area Remedial Action (Weston, 1993a) involving excavation and off-base disposal of contaminated soils.
- Explanation of Significant Differences (ESD) for Remedial Action at Site 34 (1995): The U.S. Air Force issued an ESD in May of 1995 outlining a change to the method of soil disposal from off-site treatment and disposal to on-site disposal at LF-5 (U.S. Air Force, 1995).
- Sites 32/36 ROD (1995): The U.S. Air Force's selected alternative for remediation as stated in the Sites 32/36 ROD (Weston, 1995b) involved containment of the source area both physically and hydraulically.
- Zone 3 ROD Amendment (2003): The Zone 3 ROD Amendment (MWH, 2003) presented a modified Zone 3 cleanup approach to improve the long-term effectiveness

of the remedy and document cleanup actions for sites that were not addressed in the 1995 Zone 3 ROD (Sites 49 and 73).

- Site 73 ESD: This ESD adds anaerobic in situ enhanced bioremediation (ISEB) as a supplemental remedial action for Site 73 to enhance the performance of the existing permeable reactive barrier (PRB) and monitored natural attenuation (MNA) (U.S. Air Force, 2012).
- Site 49 ESD: This ESD adds anaerobic ISEB as a supplemental remedial action for Site 49 to eliminate the residual TCE in certain groundwater areas (U.S. Air Force, 2013).
- Zone 3 ROD Amendment in preparation: A Zone 3 ROD Amendment is in preparation to address potential vapor intrusion issues at Site 39 (Building 227). This is discussed in more detail in Section 3.3.5.5.

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3.3.4.1 Remedial Action Objectives

The Zone 3 ROD (Weston 1995a), the Zone 3 ROD Amendment (MWH, 2003), and other site-specific RODs established RAOs for each specific site in Zone 3 as follows.

The following RAOs were established in the Zone 3 ROD (Weston, 1995a) applicable to the dissolved-phase portion of IRP Sites 32, 34, 35, 36, 38, and 39 overburden and shallow bedrock groundwater:

- Protect human receptors from ingestion of or direct contact with contaminated groundwater that may present an unacceptable health risk.
- Comply with chemical-specific ARARs and/or established background levels for specific contaminants in groundwater, as appropriate.
- Prevent discharge of contaminated groundwater to surface water bodies where such discharges may cause unacceptable risks to human health and the environment.
- Prevent contaminant migration toward the Haven Well.

An additional RAO was established in the Zone 3 ROD for Sites 33, 38, and 39 to address the potential for leaching:

- Minimize leaching of contaminants from soil to groundwater or surface water that would result in groundwater or surface water contamination concentrations that may present an unacceptable health risk, given the site-specific exposure scenarios.

In the Sites 32/36 ROD (Weston, 1995b), the following source control RAO was specified:

- Reduce the migration of contaminants from Sites 32 and 36 source area soil and groundwater such that groundwater outside the Technical Impracticability (TI) zone will attain all chemical-specific groundwater standards within the 30-year reasonable timeframe for groundwater restoration (Weston, 1995b).

The Site 34 ROD (Weston, 1993a) included a source control RAO as follows:

- Minimize the leaching of contamination from the source area soils into groundwater or surface water, thereby reducing the potential for the public to ingest or directly contact contaminated groundwater or surface that presents a health risk.

Contamination in Upper Newfields Ditch and Upper Grafton Ditch was addressed by the following RAO (drainage areas are discussed in Section 4.0):

- Protect ecological receptors from direct contact with, or ingestion of, sediment containing contaminants at concentrations that may present a potential unacceptable risk.

The Zone 3 ROD Amendment (MWH, 2003) effected a change in the RAOs. The first three RAOs for overburden and bedrock groundwater were unchanged in the amendment and extended to Site 49 and 73; however, the fourth RAO was revised to allow for increased demand for water from the Haven Well as follows:

- Minimize contaminant migration toward the Haven Well should increased water demand require pumping the Haven Well at the maximum safe yield.

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3.3.4.2 Remedy Description

Sites 32/36 ROD

Specifically, the selected remedy for Sites 32/36 included the following remedial action components:

- Containment of the source area or dense nonaqueous phase liquid (DNAPL) zone at Site 32 using a vertical barrier (installed in November 1996) and hydraulic control through groundwater extraction and treatment (operational February 1997 through October 2014) (CB&I, 2015a)
- Excavation and off-site disposal of Site 36 VOC- and metals-contaminated soil (completed in 1996 [Bechtel, 1998])

Site 34 ROD

The selected remedy for Site 34 was excavation of soils with contaminant concentrations exceeding site-specific CGs (see **Appendix B**). Groundwater was to be extracted as part of the excavation and treated, and excavated soil was to be transported to an off-site treatment/disposal location.

Zone 3 ROD

The remedy identified in the Zone 3 ROD (Weston, 1995a) included the following components:

- No further action at Sites 31 and 42.
- Excavation and removal of sediment exceeding CGs from Upper Newfields and Upper Grafton Ditches (see Section 4.0).
- Excavation and removal of soil exceeding cleanup goals at Sites 33, 38, and 39. The Zone 3 ROD identified that if Building 227 (Site 39) was ever removed, remediation of underlying soils would be required.
- Natural attenuation and biodegradation of the dissolved-phase contaminant plume emanating from the Sites 32 and 36 source area outside the TI containment zone.
- Management of the Zone 3 groundwater implemented through a GMZ using New Hampshire regulations. LUCs to restrict future use of groundwater.
- Long-term environmental performance monitoring in Zone 3, consisting of groundwater sampling (including water level measurement) and analysis, GMZ maintenance, groundwater extraction system performance monitoring, and process monitoring at groundwater treatment facilities.

Zone 3 ROD Amendment

As noted earlier, the Zone 3 ROD was amended (MWH, 2003); the modified cleanup approach was designed to improve the long-term effectiveness of the remedy and document cleanup actions for sites that were not addressed in the Zone 3 ROD (Weston, 1995a). Major components of the amended remedy include the following:

- No further action at Site 65
- Construction of a contingency wellhead treatment system for the Haven Well
- Optimization of the Site 39 source area groundwater extraction system with monitored natural attenuation of the downgradient plume

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- Termination of groundwater extraction to control contaminant migration southwest of Sites 34 and 39
- Modification of the Zone 3 LTM program to measure the performance of the selected remedy (MWH, 2004a), which includes monitoring of Haven sentry wells to ascertain if migration of potentially contaminated groundwater will impact the Haven Well
- Ongoing treatment of Site 49 and Site 73 source area groundwater contamination with PRBs
- Implementation of LUCs that protect human receptors from exposure to contaminants in soils and groundwater at sites in Zone 3

The groundwater CGs for the Zone 3 were modified by the Zone 3 ROD Amendment (MWH, 2003), in addition to including specific CGs for Site 49 and 73 groundwater (**Appendix B)**.

Site 49 ESD

The Site 49 ESD adds anaerobic ISEB as a supplemental remedial action for Site 49 to eliminate the residual TCE in certain groundwater areas (U.S. Air Force, 2013).

Site 73 ESD

The Site 73 ESD adds anaerobic ISEB as a supplemental remedial action for Site 73 to enhance the performance of the existing PRB and MNA (U.S. Air Force, 2012).

3.3.5 Status of Implementation

3.3.5.1 Soil and Sediment Remedial Action

The U.S. Air Force excavated and disposed off base 235 tons of soil from Site 33 that exceeded soil remediation goals for arsenic and 418 tons of soil from Site 38 that exceeded remediation goals for PAHs (Bechtel, 1998).

A soil removal action for contaminated overburden soils was performed at Site 34 under the Site 34 ROD (Weston, 1993a) in July 1994, and approximately 10,700 tons of contaminated soils were excavated from the site. The Site 34 excavated soils were used as fill material on LF-5 at the former Pease AFB prior to its closure with an RCRA hazardous waste cap.

The selected remedy for Site 36 specified the removal of metals- and organics-contaminated soil. A total of 1,403 tons of contaminated soil was removed from Site 36 in 1996 (Bechtel, 1998).

Remedial activities at Site 38 took place in April 1996, removing a total of approximately 418 tons of contaminated soil.

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In August 1996, 181.15 tons of contaminated soil were removed from two areas at the southwest corner of Building 227 (Site 39) (Bechtel, 1998). However, waste characterization sampling of the removed soils did not clearly indicate that the source of the TCE contamination detected in groundwater had been located (Bechtel, 1998). No compounds were detected at or above applicable cleanup standards. Nevertheless, the excavated soil was removed from Site 39 and disposed of off site (Bechtel, 1998).

3.3.5.2 Groundwater Remedial Action

Sites 32 and 36

The selected remedy for Sites 32 and 36, as noted previously, required containment of the Site 32 source area through installation of a physical barrier and hydraulic control through extraction and treatment of groundwater. Installation of sheet piling was completed in November 1996, and pumping of groundwater at Site 32 commenced in February 1997.

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Sites 33, 34, 35, 38, and 39

To achieve Zone 3 ROD groundwater RAOs, initial activities included installation or reconfiguration of 11 wells to extract groundwater for treatment at one of the two groundwater treatment systems constructed under the Sites 32/36 and Zone 3 remedies. Three of these wells were to be used for extraction at the Site 39 source area, one well was to be used for extraction at the Site 35 source area, two wells were for extraction at the Site 34 source area, and five wells were for hydraulic control of groundwater flow southwest of Sites 34 and 39. As part of the remedial design process, the pumping strategy was determined based on numerical groundwater flow modeling for optimization of groundwater extraction.

Site 49

In June to July of 2000, the U.S. Air Force installed the PRB at Site 49 with both a shallow and deep component. The PRB component installations are summarized in the following paragraphs and detailed in the *Shallow and Deep PRB Construction Installation Report* (Versar, Inc. [Versar], 2000).

The shallow PRB was placed in the overburden at a location downgradient of the highest VOC groundwater concentrations. Upon completion, the shallow PRB measured approximately 150 feet in length and had an average depth and thickness of 15 feet and 2.5 feet, respectively. The wall was installed approximately 200 feet downgradient of the suspected source area and along the western edge of the present office building (Versar, 2000).

The deep PRB consists of 40 shallow bedrock borings, 6 inches in diameter, spaced at 5-foot intervals and backfilled with 100-percent zerovalent iron (Fe^0) within the zone of interest, approximately 15 to 30 feet below ground surface (bgs). The deep PRB portion of the wall

was placed parallel to the shallow portion and at a 75-degree angle to the groundwater flow direction in order to maintain optimal plume/PRB contact area.

The Zone 3 ROD Amendment (MWH, 2003) was finalized in December 2003 and included Site 49 to formally document the implemented remedy, consistent with CERCLA and the NCP.

Site 73

Construction of the PRB at Site 73 was completed in August 1999. A 150-foot-long by 2.5-foot-wide PRB containing Fe^0 was constructed approximately 125 feet downgradient of the source area. The PRB was constructed to a depth of approximately 34 feet bgs (overburden/weathered bedrock interface) (Bechtel, 1999). The Zone 3 ROD Amendment (MWH, 2003) also included Site 73 to formally document the implemented remedy.

3.3.5.3 Land Use Controls

LUCs implemented for Zone 3 are identified in **Appendix C** and consist of the delineation of a GMZ and URZ.

3.3.5.4 Current Status of Remedial Actions

Sites 32 and 36

Ongoing operation of the containment system at Site 32 continued through 2014 when the extraction system was dismantled in order to excavate contaminated soils (CB&I, 2015b). LTM continues at both Site 32 and 36.

The ROD remedy for Site 32 has been successful at containing the source area and reducing the TCE plume by groundwater extraction and treatment; however, given new technologies available and the U.S. Air Force's desire to restore the site to unlimited use, additional remedial actions have been considered for soil and groundwater at Site 32. Additional investigation activities, pilot studies, and response actions have been conducted to that end.

Additional subsurface soil investigations were conducted in 2013 at Site 32. The primary goals of this work were to (1) determine the approximate extent of Site 32 overburden soil requiring excavation, (2) evaluate the current extent of inferred DNAPL in both overburden and bedrock, and (3) provide site-specific design and baseline information needed to finalize the revised remedy for the site (Shaw Environmental & Infrastructure, Inc. [Shaw], 2012). The results of the subsurface soil and sub-slab investigations indicated that potential DNAPL-contaminated soil was located in two areas: (1) the saturated zone near the northeast corner of Building 113 and (2) at the end of the former overflow pipe (CB&I, 2014a). The recommendations in the Action Memorandum for Time-Critical Removal Action (TCRA) included the removal of the source area soils at Site 32 where there was the potential for DNAPL.

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The Site 32 soil removal action was conducted between October and December 2014 in accordance with the recommendations made in the Action Memorandum for TCRA (CB&I, 2014a). A portion of Building 113 was removed, and approximately 2,800 cubic yards of VOC-contaminated soils were excavated during the removal action (CB&I, 2015b; APTIM, 2018a). Quarterly (April, July/August, and October/November 2015 and January 2016) post-removal action groundwater sampling and analysis were conducted. Data collected from these groundwater sampling events were reported in quarterly monitoring reports (CB&I 2015c, 2015d, 2016a, 2016b). The results of the post-removal monitoring showed significant decreases in VOCs within the sheet pile enclosure area; however, it was also evident that residual contamination remained in the deep overburden and/or shallow bedrock groundwater at the former source areas (APTIM, 2018a).

In 2016, ISEB pilot study injections were performed to evaluate the technology in treating chlorinated VOCs at Site 32. However, problems with distribution of the emulsified vegetable oil occurred, resulting in well fouling. The pilot study status and results are discussed in the 2017 Biennial and Performance Monitoring Report for Zone 3 (APTIM, 2018a). A work plan for additional investigation was submitted in 2018 (APTIM, 2018b) to allow better delineation of the current plume extent, further evaluate the performance of the previous ISEB study, and help identify the best remedial strategy for reaching site closure.

Additional investigations were conducted at Site 36 in 2014 and 2015 to further delineate the extent of soil and groundwater contamination at the site (CB&I, 2015e). A pilot study was initiated to assess ISCO to treat VOCs in groundwater and saturated soil at Site 36 (CB&I, 2017a). The pilot study injections were cut short due to NHDES concerns over residual amendment byproducts that were discharging into Newfield Ditch (APTIM, 2019a). Initial performance monitoring results showed that ISCO injections were effective in reducing concentrations of TCE and daughter products. Benzene and chlorobenzene concentrations were reduced in some locations. The presence of elevated sulfate concentrations at some locations indicated bioremediation may continue, and continuing performance monitoring was recommended through 2019 (APTIM, 2019a).

Sites 33, 34, 35, 38, and 39

The groundwater treatment system implemented under the Zone 3 ROD initially was intended to extract groundwater from Sites 34, 35, and 39. Groundwater extraction from Site 34 was discontinued in 2002 and from Site 35 in 2001 (APTIM, 2018a). Based on data obtained during routine LTM, groundwater cleanup objectives had been met at Sites 34, 35, and 38; therefore, monitoring at these three sites is no longer necessary (CB&I, 2014b). Groundwater extraction continued at Site 39 until the extraction system was shut down on June 24, 2015, in preparation for an ISEB pilot study that was conducted to assess the technology in treating residual chlorinated VOCs in lower sand and shallow bedrock groundwater at the site (CB&I, 2015f).

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Site 49

As of 2017 (APTIM, 2018c), chlorinated VOC contamination remains in both the deep overburden and shallow bedrock zones. A small residual DNAPL zone still appears to be present in the vicinity of monitoring well 49-MW027 (deep overburden). ISEB injections conducted in 2013 and 2016 in accordance with the Site 49 ESD (U.S. Air Force, 2013) have yielded significant reductions in chlorinated VOC concentrations. The implementation of the 2013 supplemental remedial action is presented in the *In Situ Bioremediation Injection Report* (CB&I, 2014c). Additional ISEB injections were conducted in May 2016 and focused on the areas within and immediately downgradient of the historical excavation area, which is upgradient of the PRB, and the ISEB treatment area that was completed in November 2013. The details of the 2016 injections can be found in the *Supplemental In Situ Enhanced Bioremediation Injection Report* (CB&I, 2016c).

Site 73

As of 2011, chlorinated VOCs were still present in excess of the Zone 3 ROD Amendment CGs in Site 73 shallow overburden, deep overburden, and shallow bedrock, upgradient and immediately downgradient of the PRB. Although the PRB was successful in reducing the extent of the chlorinated VOC plume, VOC exceedances persisted immediately upgradient and downgradient of the PRB. As a result, ISEB was proposed in the Site 73 ESD to complement existing remedial action (U.S. Air Force 2012). ISEB at Site 73 was implemented between October 16 and December 3, 2012. The Draft Site 73 *In Situ Bioremediation Injection Report* provides a summary of the ISEB implementation field activities (Shaw, 2013a). Site LTM and changes in groundwater conditions since that time are discussed in Section 3.3.5.6.

Haven Well

A key component of the Zone 3 remedy is the protection of the Haven Well, as required by the Zone 3 ROD (Weston, 1995a) and ROD Amendment (MWH, 2003). However, due to the presence of PFOS at concentrations greater than the EPA PHA concentration of 0.2 µg/L, the Haven Well was shut down on May 13, 2014. In addition, the City of Portsmouth decommissioned the 2003 Zone ROD Amendment–required Haven Well VOC Treatment System in 2014. The U.S. Air Force installed a groundwater mitigation system on the airfield (Airfield Interim Mitigation System [AIMS]) as part of the response to the Safe Drinking Water Act (SDWA) Administrative Order (AO) to treat PFOS/PFOA-contaminated groundwater upgradient from the Haven Well. The AIMS began operations on April 1, 2019. The City is currently constructing a new treatment system to treat PFOS/PFOA from the Haven, Smith, and Harrison public water supply wells.

3.3.5.5 Vapor Intrusion

The evaluation for potential vapor intrusion migration was performed at the former Pease AFB between 2009 and 2013 (URS, 2009, 2012; and Shaw, 2013b). Both the 2013 nonheating

season results and the 2011 heating season results identified evidence of a potentially complete vapor intrusion pathway at Building 227. Based on these results, additional investigations were conducted, including additional soil, soil gas, and groundwater sampling as well as an SVE pilot study (CB&I, 2014d, 2016d; and Air Force Civil Engineer Center [AFCEC], 2017, 2018). The results of these investigations have been incorporated into a Proposed Plan for Vapor Intrusion (AFCEC, 2019) that specifically addresses Building 227 (Site 39) in Zone 3. The proposed remedial alternative in this Proposed Plan is building mitigation, including sealing floor cracks and openings to the extent feasible; installation and operation of an SVE system under Building 227; treatment of shallow groundwater using ISEB; and performance monitoring and LTM. No additional LUCs are needed. Once the public meeting has been held and comments addressed, a Zone 3 ROD Amendment will be issued. Since this amendment is not yet in effect, further evaluation of this remedy will be deferred to the next FYR. Additional vapor intrusion assessments are planned for the buildings immediately downgradient of both Sites 32 and 49 following implementation of pilot studies at each site and follow-on groundwater treatment actions.

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3.3.5.6 LTM

The LTM for most sites in Zone 3 has been performed during this period in accordance with the Zone 3 LTMP, Revision 3 (URS, 2011). In February 2015, the LTMP was revised to suspend the monthly Haven Well sampling and quarterly sentry well (AFCEC, 2015). A Revision 5 to the LTMP was completed in 2016 (CB&I, 2016e) that reduced the frequency of LTM events and associated reporting, eliminated wells from the LTM program, and instituted less-costly passive sampling techniques. LTM of Sites 33, 34, 35, and 38 was eliminated. Groundwater monitoring conducted in 2017 was conducted in accordance with the Revision 5 LTMP.

Performance monitoring at Site 49 was previously conducted in accordance with the *Site 49 Performance and Long-Term Monitoring, Sampling and Analysis Plan, Revision 3* (URS, 2010). Since 2016, groundwater monitoring at Site 49 was conducted to meet the performance monitoring objectives defined in Revision 4 of the Performance and Long-Term Monitoring Sampling and Analysis Plan (CB&I, 2016f).

Groundwater monitoring activities were conducted at Site 73 until 2016 in accordance with the Site 73 LTMP (MWH, 2004b). The LTMP was revised in 2016 (CB&I, 2016g). LTM activities were conducted in 2017 in accordance with CB&I (2016g) and consisted of the collection of groundwater elevation and analytical data from monitoring points upgradient, side gradient, and downgradient of the PRB.

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Evaluation of these monitoring results is presented in the following documents:

- Zone 3 2013 Annual Report (CB&I, 2014b)
- Zone 3 2014 Annual Report (CB&I, 2015a)
- Zone 3 2015 Annual Report (CB&I, 2016h)
- Zone 3 2017 Biennial and Performance Monitoring Report (APTIM, 2018a)
- Site 49 2013 Annual Report (CB&I, 2014e)
- Site 49 2014 Annual Report (CB&I, 2015g)
- Site 49 2015 Annual Report (CB&I, 2016i)
- Site 49 2016 Annual Report (CB&I, 2017b)
- Site 49 2017 Annual Report (APTIM, 2018c)
- Site 73 2013 Annual Report (CB&I, 2014f)
- Site 73 2014 Annual Report (CB&I, 2015h)
- Site 73 2015 Annual Report (CB&I, 2016j)
- Site 73 2016 Annual Report (APTIM, 2017)
- Site 73 2017 Annual Report (APTIM, 2018d)
- Site 73 2018 Annual Report (APTIM, 2019b)

LUCs specified for Zone 3 are identified in Section 3.3.5.3 and **Appendix C**. All Zone 3 property has been transferred by the U.S. Air Force to the PDA via quitclaim deed (Rockingham County Registry of Deeds 2003, 2005). Observations are made during the performance of the LTM activities in Zone 3 to ensure that the LUCs have not been violated; these observations are documented in the Zone 3 Annual/Biennial Reports, as well as the Site 49 and 73 Annual Reports. The ASN and PDA dig permit review processes, both requiring U.S. Air Force review and approval, also aid in LUC enforcement. The ongoing use of the property conforms with the restrictions of the URZ, and land use is not expected to change. The LUCs remain protective; no deficiencies have been identified.

Observations and conclusions from the most recent periodic monitoring reports (APTIM, 2018a, 2018c, 2019b), including LTM and performance monitoring, are provided in the following subsections for the Zone 3 sites. **Figure 3-5** shows the Zone 3 LTM groundwater exceedances from the 2017 Zone 3 Biennial and Performance Monitoring Report (APTIM, 2018a).

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Sites 32 and 36

The contaminant plume associated with Sites 32 and 36 contains significantly higher concentrations of TCE and its degradation byproducts when compared with the rest of Zone 3. However, Sites 32 and 36 contaminant concentrations are trending downward, and the extent of contamination has decreased since the implementation of the remedy.

- Site 32 source area wells could not be sampled in 2017 due to fouling that occurred from the 2016 pilot study injections, although sampling of two source area monitoring wells in 2015 showed TCE concentrations less than the CG.
- TCE breakdown products *cis*-1,2-dichloroethene (DCE) and vinyl chloride (VC) are present in both the deep overburden and shallow bedrock at wells both within and outside the sheet pile enclosure at Site 32, indicating that continued dechlorination of TCE is occurring. The highest concentrations of *cis*-1,2-DCE and VC were detected at well 32-5225 in September 2017 at concentrations of 1,100 and 2,400 µg/L, respectively.
- At Site 36, decreases in TCE concentrations have occurred as a result of the injections. The highest baseline concentration (September 2016) of TCE was 2,800 µg/L at well 36-5633. The highest baseline concentrations of *cis*-1,2-DCE, *trans*-1,2-DCE, 1,1-DCE, and VC (2,200, 840, 11.9, and 560 µg/L, respectively) were also above CGs in this well. In addition, benzene and chlorobenzene were detected above CGs in the baseline sampling round.

Sites 33, 34, 35, 38, and 39

As noted previously, groundwater sampling of Sites 33, 34, 35, and 38 is no longer being conducted. Regarding Site 39, the following conclusions were drawn in the 2017 Biennial and Performance Monitoring Report (APTIM, 2018a):

- ISEB injections appear to have had little effect on *cis*-1,2-DCE and VC concentrations at Site 39. During the baseline sampling event, *cis*-1,2-DCE (110 µg/L) exceeded the CG at one well (39-MWE2D), and VC (46.3 and 14.7 µg/L) exceeded the CG at two wells (39-MWE2D and 39-MWE7, respectively). In addition, arsenic and manganese exceeded background concentrations at some locations.
- TCE concentrations did not exceed the CG during pre-injection baseline or post-injection performance monitoring.
- *Cis*-1,2-DCE and VC concentrations have increased at well 39-MWRE3S since shutdown of the groundwater extraction system and may be evidence of increased biological degradation of TCE in the shallow groundwater.

- The elevated concentrations of PCE and TCE discovered in the shallow groundwater under the building may be contributing to continued daughter products in downgradient lower sand wells (U.S. Air Force, 2018).

Site 49

Groundwater monitoring was conducted in 2017 (APTIM, 2018c) in accordance with Revision 4 of the Performance and Long-Term Monitoring Sampling and Analysis Plan (CB&I, 2016f). Groundwater sampling locations are shown on **Figure 3-6**. The spring 2017 event was limited to performance monitoring wells, while the fall 2017 included both LTM and performance monitoring wells. The following conclusions were drawn in the 2017 Annual Report (APTIM, 2018c):

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- Chlorinated VOC contamination remains in both the deep overburden and shallow bedrock zones, but TCE exceedances are restricted to the area west of the office building with a single exception (49-MW-3 [shallow bedrock]):
  - Deep Overburden: TCE exceedances are all located west of the PRB. TCE concentrations at source area well 49-MW027 (deep overburden) were 13,200 and 24,000 µg/L in the spring and fall events, respectively, indicating that DNAPL is still present at this location. However, baseline monitoring completed in December 2018 at this location showed a lower concentration of TCE (4,100 µg/L) (APTIM, 2019c).
  - Shallow Bedrock: TCE exceedances are located west of the office building. The TCE concentration at 49-PZ003 (shallow bedrock), while still high (61.2 µg/L in fall 2017), has decreased significantly in the last 2 years. Elevated concentrations in this well suggest migration of contamination over time in the shallow bedrock in this area.
  - Shallow Overburden: A single TCE exceedance (7.1 µg/L) was detected at 49-MW-3 (shallow overburden) located approximately 400 feet downgradient of the PRB near the southeast corner of the building at 2 International Drive.
- Natural attenuation is occurring downgradient of the PRB, which is still largely functioning as intended.
- Chlorinated VOC–contaminated groundwater is not migrating beyond the GMZ boundary or to the detention pond from the former Building 22 source area.
- Manganese was detected above background concentrations at GMZ boundary well 49-MW009 (deep overburden) at a concentration of 1,480 µg/L. Manganese was also detected in 2016 when metals were analyzed at this location, but the concentration was much higher (4,250 µg/L). Manganese concentrations are likely high at this location

due to the supplemental injections and are anticipated to decrease as impact from the injections dissipates.

Site 73

Monitoring activities performed at Site 73 during 2018 consisted of LTM of groundwater for wells on an annual sampling schedule, in accordance with the latest LTMP (CB&I, 2016g). The conclusions of the most recent results (APTIM, 2019b) are as follows:

- Groundwater at Site 73 remains largely anaerobic.
- The 2018 analytical data suggest that the ISEB supplemental remedial action is increasing the rate of contaminant degradation at the site. Concentrations of chlorinated VOCs upgradient and downgradient of the PRB have been substantially reduced to levels below the Site 73 CGs. VC exceedances were detected at 3 of the 10 locations sampled, 2 of which are collocated upgradient of the PRB near the source area with a maximum concentration of 21.9 µg/L and 1 of which is located approximately 700 feet downgradient at Site 81 (81-7480). All wells with VC exceedances are located in the overburden.
- Arsenic and manganese were present groundwater at concentrations greater than background at numerous site locations.

3.3.6 Progress since Last Five-Year Review

This section includes the protectiveness determinations and statements from the last FYR as well as the recommendations from the last FYR and the current status of those recommendations.

In the 2014 FYR, no issues were identified for Zone 3, Sites 32, 33, 34, 35, 36, 38, 39, and 49. Remedies for these sites were determined to be protective of human health and the environment (see **Appendix D**). As a result, no recommendations were made that were necessary to address the protectiveness of the remedy. In EPA's review of the draft 2014 FYR Report, the agency disagreed with the protectiveness statement for Zone 3. In mid-2014, PFOS and PFOA were confirmed in three operating municipal water supply wells at the former base (Haven, Smith and Harrison), resulting in the shutdown of one production well located within Zone 3 (Haven Well) that exceeded EPA's PHA for PFOS. EPA indicated that the protectiveness determination for Zone 3 should be deferred until further investigations were completed to identify sources of contamination that had impacted or threaten to impact these supply wells. The U.S. Air Force did not agree with the deferred protectiveness determination for Zone 3.

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Since the 2014 FYR, the U.S. Air Force has conducted extensive work related to the nature and extent of PFOS/PFOA at the former Pease AFB, including Zone 3. This work will not be described in detail here but is discussed in the *Final Basewide Investigation Report* (AMEC, 2017). The U.S. Air Force has installed a groundwater mitigation system on the airfield (AIMS) to intercept and treat PFOS/PFOA-contaminated groundwater upgradient of the Haven Well as part of the response to the SDWA AO. The U.S. Air Force also conducts routine PFOS/PFOA monitoring of the Smith, Harrison, Collins, and Portsmouth #1 municipal supply wells as well as a network of sentry monitoring wells upgradient of these water supplies to identify PFOS/PFOA groundwater contamination that may threaten future drinking water quality. The City of Portsmouth is also constructing a new drinking water supply treatment system at an existing water facility on Pease to treat PFOS/PFOA from the Haven, Smith, and Harrison Wells.

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While the Site 73 remedy was determined to be protective of human health and the environment (see **Appendix D**), the issue shown in **Table 3-2** was identified for this site.

Table 3-2
Status of Recommendations for Zone 3 from the 2014 FYR

OU	Issue	Recommendations	Current Status	Current Implementation Status Description	Completion Date (if applicable)
Zone 3, Site 73	Mobilization of arsenic and manganese at Site 73 by ISEB injections	Conduct further evaluation of mobilization and migration of arsenic and manganese in Site 73 groundwater to determine potential to migrate beyond Site 73 GMZ	Completed	Monitoring conducted since the ISEB injections (2012) has showed that groundwater flow is to the southeast, and concentrations of arsenic and manganese concentrations greater than background are located immediately upgradient of the PRB and downgradient of the PRB (APTIM, 2018d), all of which are within the Zone 3 GMZ (there is no specific Site 73 GMZ). There is no potential for these concentrations to migrate beyond the Zone 3 GMZ. Annual monitoring and reporting are ongoing.	12/31/2018

APTIM denotes Aptim Federal Services, LLC.
GMZ denotes Groundwater Management Zone.
ISEB denotes in situ enhanced bioremediation.
PRB denotes permeable reactive barrier.

Other findings identified in the 2014 FYR were: routine monitoring should continue, the performance of the Site 32 extraction system should be assessed to optimize remedial activities, the performance of the Site 39 extraction should be assessed, and opportunities for optimizing remedial activities to improve progress towards Zone 3 RAOs should be considered. As discussed in Section 3.3.5.4, all of these recommendations have been implemented.

Optimization of LTM was also completed during this FYR period, resulting in Revision 5 of the LTMP for Zone 3 (CB&I, 2016e), Revision 4 of the Performance and Long-Term Monitoring Sampling and Analysis Plan (CB&I, 2016f), and Revision 1 of the LTMP for Site 73 (CB&I, 2016g).

3.3.7 Technical Assessment

The technical assessment component of the FYR consists of evaluating the protectiveness of the remedy. The technical assessment was performed based on guidance provided in Section 4.0 of the *Comprehensive Five-Year Review Guidance* (EPA, 2001).

3.3.7.1 Question A

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

A review of documents, ARARs, risk assumptions, and the results of annual system and groundwater monitoring indicates that the remedy is functioning as intended.

Remedial Action Performance

- **Sites 32 and 36:** The Site 32 hydraulic containment has been effective at containing the source area within the TI zone and coupled with natural attenuation downgradient, concentrations have significantly decreased since implementation of the groundwater extraction/treatment system. Additional measures to improve groundwater quality at Sites 32 and 36 were conducted, including the removal of contaminated soil from Site 32, an ISEB pilot study at Site 32, and an ISCO pilot study at Site 36. These pilot studies are ongoing.
- **Sites 33, 34, 35, 38, and 39:** Soil excavation was conducted at Site 39, and the groundwater treatment system at Sites 32 and 36 originally included extraction of groundwater from Sites 34, 35, and 39. As conditions improved, extraction of groundwater from Sites 34 and 35 was eliminated. Groundwater cleanup objectives have been met at Sites 33, 34, 35, and 38, and groundwater concentrations have decreased at Site 39. ISEB and SVE pilot studies were conducted at Site 39 in order to address shallow groundwater and VOC-impacted soil under the building. These efforts are ongoing.

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- **Site 49:** The PRB was installed and has performed as intended. However, upgradient of the PRB, chlorinated VOC contamination remains in both the deep overburden and shallow bedrock zones, and a small residual DNAPL zone still appears to be present in the vicinity of monitoring well 49-MW027. A supplemental remedial action was conducted at Site 49 using ISEB upgradient of the PRB. Significant reductions in chlorinated VOC concentrations have been observed in this area.
- **Site 73:** The PRB was installed and has performed as intended. However, chlorinated VOCs at concentrations greater than CGs are present in shallow overburden, deep overburden, and shallow bedrock, upgradient and immediately downgradient of the PRB. An ISEB pilot study was conducted in these areas, and the results show substantial reduction in concentrations.

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Implementation of Land Use Controls and Other Measures

LUCs have been implemented as described in Section 3.3.5.3 and **Appendix C**, and have been effective as described in Section 3.3.5.4.

3.3.7.2 Question B

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

The RAOs used at the time of the remedy selection are still valid. While some of the exposure assumptions, toxicity data, and cleanup levels were based on information that has changed over time, these changes do not affect the protectiveness of the remedy as discussed in the next paragraphs. However, the potential for a significant vapor intrusion exposure pathway to occur in the future has been identified at Site 39. Existing RAOs and CGs did not specifically address this pathway. A Proposed Plan and Zone 3 ROD Amendment are being prepared to address this issue.

Changes in Standards and TBCs

Soil CGs were established for Sites 36, 38, and 39 in Zone 3, as shown in **Appendix B**. These CGs were established for use in excavation activities proposed for these sites. As shown in **Appendix B**, the CGs for metals were based on background and are not affected by changes in standards and "to be considered" TBC criteria. All CGs for organic compounds (naphthalene, phenathrene, phenol, *cis*-1,2-DCE, TCE, and VC) were based on consideration of leaching, and were derived using site-specific modeling (Weston, 1995a, 1995b). The groundwater basis of the modeling was a groundwater risk-based concentration or ARAR. In all cases, a current groundwater ARAR is available for these chemicals, and it is the same or greater than that use in the CG derivation. As a result, these soil CGs remain protective.

As shown in **Appendix B**, groundwater CGs were established for vanadium, carbon disulfide (Site 49), 2-methylnaphthalene, naphthalene (Zone 3 and Site 49), 2-butanone (Site 49), dibromochloromethane (Site 49), and 1,1-DCA (Sites 49 and 73) based on risk or NHAGQS. The current version of NHAGQS (NHDES, 2018) includes values for all of these substances except vanadium. The revised NHAGQS are the same or higher than the CGs established in the RODs or ROD Amendment.

The CG for vanadium was based on the risk assessment completed in the remedial investigation for Zone 3 (MWH, 2003). No ARAR is available for vanadium. As a result, the risk basis for the vanadium CG is discussed in the next subsection.

MCLs for all chemicals with a CG based on an MCL have not changed. CGs for arsenic and manganese are based on background. As a result, these CGs are still protective.

There have been no changes in standards that would affect the protectiveness of the remedy.

Changes in Toxicity and Other Contaminant Characteristics

Groundwater COCs with risk-based CGs in Zone 3 included vanadium, carbon disulfide, 2-methylnaphthalene, naphthalene, 2-butanone, dibromochloromethane, and 1,1-DCA, as identified above and in **Appendix B**. The toxicity values used to establish some of these CGs have changed since the ROD was completed; however, these changes are reflected in the revised NHAGQS discussed previously. Based on the changes in toxicity values, the NHAGQS values established as shown in **Appendix B** are all greater than the ROD CGs established for these chemicals. Therefore, no changes are needed to the CGs.

As noted previously, no NHAGQS or other ARAR has been developed for vanadium. The vanadium oral RfD used to derive the risk-based ROD CG of 256 µg/L was 0.007 mg/kg-day from EPA (1993) Health Effects Summary Tables. This was not a verified RfD, but was based on results from a specific study apparently using elemental vanadium, which is unlikely to be present in groundwater. According to Hazardous Substances Data Base (HSDB; 2019), vanadium in water is generally found in the ionic form and is strongly sorbed to particulates. There is no current verified toxicity value for vanadium, with the exception of vanadium pentoxide, which is a compound used in the steel industry, and also as a catalyst in other manufacturing operations (HSDB, 2019). In order to develop a screening concentration for vanadium, EPA (2018) derived an oral RfD for vanadium for vanadium pentoxide by factoring out the molecular weight of the oxide ion, resulting in a derived oral RfD of 0.005 mg/kg-day. The RSL developed using this toxicity value is 86 µg/L at a Hazard Index of 1. A change to the Zone 3 groundwater CG for vanadium to 86 µg/L is recommended despite the uncertainties regarding available toxicity values.

On May 19, 2016, EPA issued LHAs for PFOA and PFOS, which identified chronic oral RfD values of 2E-05 mg/kg-day. These RfD values should be used when evaluating potential risks from ingestion of contaminated groundwater at CERCLA sites where PFOA and PFOS are present. Potential estimated health risks from PFOA and PFOS would increase total site risks due to groundwater exposure. Further evaluation of potential risks from exposure to PFOA and PFOS in other media at the Site might be needed based on site conditions and may also affect total site risk. PFBS has a chronic oral RfD of 2E-02 mg/kg-day based on an EPA PPRTV. This RfD value should be used when evaluating potential risks from ingestion of contaminated groundwater at CERCLA sites where PFBS is present. As discussed in Section 3.3.6, the U.S. Air Force has conducted extensive work related to the nature and extent of PFOS/PFOA at the former Pease AFB, including Zone 3, and has installed a groundwater mitigation system on the airfield (AIMS) to intercept and treat PFOS/PFOA-contaminated groundwater upgradient of the Haven Well. Since these compounds were not identified in the Zone 3 ROD, the U.S. Air Force will prepare an ESD to document the change in Zone 3 remedy to address all site contaminants, including the newly discovered PFOS/PFOA, through the operation of the AIMS groundwater treatment system.

Changes in Risk Assessment Methods

As discussed in Section 3.1.7.2, numerous changes have occurred in risk assessment methods since the date of the Pease ROD completed in the 1990s. However, NHAGQS have now been established for all Zone 3 COCs (see **Appendix B**), with the exception of vanadium, and relevant changes in risk assessment methods have been incorporated in these values. As a result, changes in risk assessment methods do not affect the protectiveness of the remedy.

Changes in Exposure Pathways

There have been no changes in physical conditions or land use that would affect the protectiveness of the remedy. However, as discussed in Section 3.3.5.5, a potential future indoor air pathway has been identified for Building 227 (Site 39). This potential exposure pathway was not addressed in the current remedy for Site 39. As discussed in Section 3.3.5.5, a ROD Amendment is underway to address future exposures due to vapor intrusion in Building 227 (Site 39), which were not addressed in the original Zone 3 remedy. In addition, investigations are underway to evaluate the potential for vapor intrusion at sites downgradient of Sites 32 and 49.

Expected Progress towards Meeting RAOs

The Sites 32 and 36 remedy is achieving the stated RAO of source control. Reductions in groundwater COC concentrations outside the TI zone indicate that natural attenuation is reducing concentrations, indicating progress toward Zone 3 CGs. Pilot studies have been conducted to improve the rate of progress towards CGs.

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Zone 3 remedial groundwater cleanup objectives have been met at Sites 33, 34, 35, and 38, and groundwater concentrations have decreased at Site 39. ISEB and SVE pilot studies were conducted at Site 39 in order to further decrease VOC concentrations in shallow groundwater and VOC-impacted soil under the building. These efforts are ongoing.

At both Sites 49 and 73, the PRBs are performing as intended by reducing groundwater concentrations downgradient to CGs. Since these remedies effected source control, groundwater concentrations upgradient of the PRBs remain elevated, and residual DNAPL is suspected at Site 49. Pilot studies have been conducted at both sites to address upgradient areas, as discussed in Sections 3.3.5.4 and 3.3.5.6. These efforts are ongoing.

3.3.7.3 Question C

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

No other information has come to light that would call into question the protectiveness of the remedy.

3.3.8 Issues/Recommendations

The response actions for Zone 3 are protective in the short term. The only issue identified for Zone 3 that prevents the response actions from being protective of human health or the environment in the long term is the potential future indoor air exposures at Site 39. This issue is being addressed through the implementation of a ROD Amendment to implement SVE beneath the building and ISEB to address shallow groundwater.

Other findings for Zone 3 include the following:

- Routine LTM should continue throughout Zone 3.
- Performance monitoring should also continue where necessary to evaluate pilot study efforts. These data should be reviewed to identify ways to further optimize remedial activities.
- Modifications to the Sites 32/36 Source Area and Zone 3 RODs should be prepared to revise the groundwater remedial strategy for Sites 32/36. As part of the 2014 Site 32 soil removal action, portions of the groundwater extraction and treatment system were dismantled, and the system is currently not operable as long-term groundwater monitoring continues to assess site contaminant concentration trends.
- The effect of extraction and reinjection of groundwater within Zone 3 for PFOS/PFOA treatment should be evaluated for Zone 3 LTM sites

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- A modification to the Zone 3 ROD should be prepared to address all site contaminants, including the newly discovered PFOS/PFOA, through the operation of the AIMS groundwater treatment system.
- A modification to the Zone 3 ROD should be prepared to change the groundwater CG for vanadium to 86 µg/L.

3.3.9 Protectiveness Statement

Protectiveness Statement(s)		
Operable Unit: Zone 3, Sites 32, 33, 34, 36, 38, 49, and 73	*Protectiveness Determination:* Protective	*Planned Addendum Completion Date:*
Protectiveness Statement: The remedies at Sites 32, 33, 34, 36, 38, 49, and 73 in Zone 3 are protective of human health and the environment.		

Protectiveness Statement(s)		
Operable Unit: Zone 3, Site 39	*Protectiveness Determination:* Short-term Protective	*Planned Addendum Completion Date:* 12/31/2020
Protectiveness Statement: The remedy at Site 39 in Zone 3 is currently protective of human health and the environment, as groundwater actions have been taken and LUCs have been implemented to prevent exposure to groundwater. There are no current indoor air exposures, as Building 227 is unoccupied. However, in order to be protective of indoor air exposures in the long-term, the following actions need to be conducted: (1) implementation of an SVE system under Building 227 to minimize intrusion of vapors into the building and (2) treatment of soil that may be acting as a vapor source. Treatment of shallow groundwater is also recommended to reduce concentrations that may be acting as a vapor source.		

3.4 Zone 4, Landfill 6

3.4.1 Site Description

LF-6 is a former LF that covered approximately 3 acres on the southeastern margin of the former Pease AFB (**Figure 2-1**). The site of the former LF is bordered by Grafton Ditch and associated wetlands to the north, woodlands and CRD-2 to the east, and wetlands and woodlands to the west and south (**Figure 3-7**).

LF-6 reportedly received domestic and industrial solid wastes during the 1970s. These wastes may have also included spent paint thinners and solvents as well as medical waste from the former Pease AFB clinic. The primary contaminants identified at LF-6 were aromatic hydrocarbons (benzene, toluene, ethylbenzene, and xylenes [BTEX] and dichlorobenzene), PAHs, total petroleum hydrocarbons, and metals (Weston, 1995). The refuse was buried in the LF using trench and fill methods (Weston, 1993).

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Groundwater flow in the overburden and bedrock at LF-6 is generally toward the east, northeast.

3.4.2 Initial Response

No remedial action was performed at LF-6 prior to the finalization of the Zone 4 ROD (Weston, 1995).

3.4.3 Basis for Taking Action

The RI found that contamination was widespread within the LF. In general, it was found that the eastern portion of the LF contained more industrial solid waste and that the western portion contained more organic contaminants with some medical waste (Weston, 1993). The basis of taking action is to protect human health and the environment through remediation of LF soil, solid waste, and groundwater.

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3.4.4 Response Actions

The controlling document that presents the selected remedy for Zone 4, LF-6 is the Zone 4 ROD (Weston, 1995).

3.4.4.1 Remedial Action Objectives

The Zone 4 ROD (Weston, 1995) identified the following RAOs for LF-6:

- Protection of ecological receptors from direct contact with LF soils/wastes at concentrations that could pose an unacceptable risk
- Isolation of contaminated LF soil and solid waste to prevent leaching to surface water and groundwater that could pose an unacceptable risk
- Compliance with the ARARs and background levels, as appropriate, for soil and groundwater
- Protection of human receptors from ingestion of contaminated groundwater that could pose an unacceptable risk

3.4.4.2 Remedy Description

The remedy selected in the Zone 4 ROD (Weston, 1995) included the following:

- Excavation and removal of all LF soil and solid waste from LF-6 and disposal of excavated soil and solid waste in LF-5 prior to final closure of LF-5 with a RCRA cap. Excavated materials classified as hazardous would be disposed of off site at an appropriate facility.

- Dewatering of the LF-6 excavation area, as necessary, during the excavation process and treatment of extracted groundwater in an on-zone mobile treatment unit to meet site-specific groundwater treatment objectives.
- Creation, reestablishment, and enhancement of wetland within the footprint of LF-6 on completion of excavation activities.
- Natural attenuation and biodegradation of residual contaminated groundwater. Contaminant transport modeling performed for LF-6 groundwater estimated approximately 10 years for contaminant concentrations to achieve the CG, using benzene as a predictor of the attenuation rates for LF-6 groundwater contaminants.
- Management of the Zone 4 groundwater release in accordance with the New Hampshire regulations contained in Chapter Env-Ws 410 (now Chapter Env-Or 600).
- Placement of deed restrictions on the use of groundwater at LF-6.
- Long-term environmental monitoring in the zone, including groundwater, surface water, and sediment sampling and analysis.

Groundwater CGs established for LF-6 are summarized in **Appendix B**. Grafton Ditch is discussed in Section 4.0.

3.4.5 Status of Implementation

3.4.5.1 Landfill 6 Actions

Remedial activities associated with the IRP for LF-6 were initiated in March of 1995 and completed in August of 1996. The remedial action included excavation and the removal of all LF soil and solid waste from LF-6 and disposal of the nonhazardous portion of the excavated material in LF-5 before the LF was closed. The hazardous portion of the excavated material was disposed off base at an appropriate treatment/disposal facility.

Wetlands were created within the footprint of LF-6 to offset wetland impacts that occurred with the construction of the cap at LF-5. (MWH, 2002).

3.4.5.2 Land Use Controls

LUCs implemented for LF-6 are identified in **Appendix C** and consist of the delineation of a GMZ.

3.4.5.3 Current Status of Response Actions

The status of the response action at LF-6 has not changed since the original response action conducted in 1995 and 1996 (see Section 3.4.5.1).

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3.4.5.4 LTM

Annual monitoring and reporting were conducted at LF-6 until 2015, most recently in accordance with the LF-6 LTMP, Revision 2 (MWH, 2003). Since removal of the contaminant source was completed in 1995, the frequency of the CG exceedances at overburden and bedrock wells for both the organic and inorganic COCs has decreased. LTM data show that the removal of the contaminated soil and LF debris appears to have eliminated any further releases of contamination into groundwater, resulting in a significant beneficial effect on groundwater quality beneath the LF and elsewhere in Zone 4. These data also provide supporting evidence that natural attenuation processes are actively reducing the concentrations of groundwater contamination that previously migrated from LF-6.

A PCMMP for Pease LFs and CRDs, including LF-6, was prepared in 2016 (CB&I, 2016). This document consolidated and updated various plans, including the LF-6 LTMP, Revision 2 (MWH, 2003). This PCMMP increased the frequency of inspections from biennial to annual at LF-6 to identify any issues requiring maintenance and to verify that the LUCs have not been violated. Groundwater monitoring requirements at LF-6 were changed from a combination of annual, biannual, and triennial sampling to triennial for all locations (see **Figure 3-7**).

This PCMMP was implemented in 2018 (APTIM, 2019). The visual inspection of LF-6 showed no deficiencies and no need for corrective actions. No new drinking wells or damage/alternation to LF-6 were noted during the 2018 or prior 2016 visual inspections.

In 2018, benzene was the only VOC detected at a concentration greater than the ROD CG of 5 µg/L at well 06-0552 (5.5 µg/L), similar to the concentration detected in the previous sampling round in 2015. Metals analyses are performed on the interior wells at LF-6. In 2018, arsenic was detected above the site background concentration of 23 µg/L in three of these wells, with a maximum detected concentration of 537 µg/L at monitoring well 06-5553 (see **Figure 3-7**). No other metals were detected above the ROD CGs or NHAGQS. Reducing conditions (negative oxidation potential) and low dissolved oxygen were present in most of the LF-6 monitoring wells.

Groundwater samples were collected from 14 monitoring wells at LF-6 from November 30 to December 7, 2017, in support of a geochemical evaluation for arsenic. Sampling was conducted in accordance with the *Geochemical Evaluation Work Plan* for LF-6 (APTIM, 2018), which included collection of dissolved and total data for arsenic, and the reference elements aluminum, iron, and manganese. Field readings including conductivity, oxidation-reduction potential, dissolved oxygen, pH, temperature, and turbidity were also collected. The primary purpose of the evaluation was to determine if arsenic is naturally occurring at LF-6. The report (provided in Appendix B of APTIM, 2019) concludes that some of the arsenic at LF-6 is naturally occurring; its presence at elevated concentrations in some

locations appears to be the result of reductive dissolution or dissipation due to a decrease in oxidation state. The report also noted that while elevated arsenic concentrations are present beyond the former LF footprint, they do not extend beyond the GMZ boundary. Historical data indicate that arsenic concentrations have been stable or decreasing at these locations.

3.4.6 Progress since Last Five-Year Review

This section includes the protectiveness determinations and statements from the last FYR as well as the recommendations from the last FYR and the current status of those recommendations.

In the 2014 FYR, no issues were identified for LF-6 and the remedy was determined to be protective of human health and the environment (see **Appendix D**). As a result, no recommendations were made that were necessary to address the protectiveness of the remedy.

Other findings were that routine monitoring should continue, and that evaluation of environmental monitoring results should continue, with data analysis including identification of opportunities to streamline monitoring and reporting. These recommendations have been implemented with the continuation of monitoring and the evaluation and streamlining of monitoring and reporting completed with the 2016 PCMMP (CB&I, 2016).

3.4.7 Technical Assessment

3.4.7.1 Question A

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

A review of documents, ARARs, risk assumptions, and the results of annual system and groundwater monitoring indicates that the LF-6 remedy is functioning as intended.

Remedial Action Performance

Soil and waste material have been removed from LF-6. Annual inspections are performed, and maintenance is performed as needed. The LUCs are maintained, including a GMZ, to prevent potential exposures. The LTM analytical results indicate that concentrations of only one organic COC (benzene) in groundwater remain above the CGs in the former source area. In 2016, costs of monitoring and reporting were reduced by reducing the groundwater sampling and reporting to triennial. Arsenic is the only inorganic COC that is still present at concentrations above the CGs. No organic or inorganic COCs are present at concentrations greater than the CGs at the GMZ boundary.

Implementation of Land Use Controls and Other Measures

LUCs have been implemented as described in Section 3.4.5.2 and **Appendix C**, and have been effective as described in Section 3.4.5.4.

3.4.7.2 Question B

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

The RAOs used at the time of the remedy selection are still valid. While some of the exposure assumptions, toxicity data, and cleanup levels were based on information that has changed over time, these changes do not affect the protectiveness of the remedy as discussed in the following subsections.

Changes in Standards and TBCs

As shown in **Appendix B**, ARARs were used for the establishment of groundwater CGs at LF-6 for most COCs. Risk-based CGs were established only for 1,2,4-TMB.

As shown in **Appendix B**, CGs were established for boron, 4-methylphenol, and 2-butanone based on the NHAGQS. The current version of the NHAGQS (NHDES, 2018) includes values for all of these compounds. Current NHAGQS are higher for boron and 2-butanone than CGs established in the ROD. As a result, the ROD CGs are still protective. In addition, a NHAGQS has been established for 1,2,4-TMB that is higher than the risk-based CG established in the ROD. As a result, the CGs for these chemicals are still protective.

The current NHAGQS for 4-methylphenol (40 µg/L) is lower than the ARAR-based CG established in the ROD (350 µg/L). However, the ROD CG does not pose a non-cancer hazard of greater than 1 based on estimates completed using default assumptions for tap water in the RSL calculator. Therefore, no change to the CG is recommended for 4-methylphenol.

The only chemical with a CG based on an MCL that has changed is arsenic, as discussed in Section 3.1.7.2. Thus, while current ARARs are less than the CG established in the ROD, the current ARARs as well as background concentrations are used to evaluate progress in LTM results. A ROD modification should be completed to adopt the Pease background concentration as the groundwater CG for arsenic.

Changes in Toxicity and Other Contaminant Characteristics

The only groundwater COC with risk-based CG in the LF-6 ROD was 1,2,4-TMB. The toxicity values used to establish this CGs has changed since the ROD was completed; however, these changes are reflected in the revised NHAGQS discussed previously. The NHAGQS for 1,2,4-TMB is greater than the risk-based CG. As a result, this change does not affect the protectiveness of the LF-6 remedy and no change is needed.

Changes in Risk Assessment Methods

As discussed in Section 3.1.7.2, numerous changes have occurred in risk assessment methods since the date of the Pease ROD completed in the 1990s. However, MCLs and/or NHAGQS

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have now been established for all LF-6 COCs (see **Appendix B**) and relevant changes in risk assessment methods have been incorporated in these values. As a result, changes in risk assessment methods do not affect the protectiveness of the LF-6 remedy.

Changes in Exposure Pathways

There have been no changes in physical conditions or land use that would affect the protectiveness of the remedy.

Expected Progress towards Meeting RAOs

Most of the RAOs identified in Section 3.4.4.1 were met with the completion of the LF-6 remedial action and the implementation of LUCs. However, groundwater ARARs have not been met for benzene, and background levels have not been achieved for arsenic. Concentrations of benzene were only slightly greater than the CG in 2015 and 2018 at one location (monitoring well 06-0552). This well is located within the site boundary and has exhibited a decreasing trend since 1997. Arsenic concentrations in the LF-6 former source area groundwater have not demonstrated downward trends, suggesting that the CG for arsenic will not be achieved in the near term. While elevated arsenic concentrations are present beyond the former LF footprint, they do not extend beyond the GMZ boundary based on data collected in 2018, and historical data indicate that arsenic concentrations have been stable or decreasing at locations with concentrations greater than background.

3.4.7.3 Question C

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

No other information has been identified that would call into question the protectiveness of the remedy.

3.4.8 Issues/Recommendations

No issues have been identified for LF-6 that prevent the response action from being protective of human health or the environment. A ROD modification is recommended for LF-6 adopting the Pease background concentration for arsenic as the groundwater CG. No other issues or recommendations are identified. Remedial measures at LF-6 remain protective of human health and the environment under current exposures. Routine LTM and evaluation of environmental monitoring results should continue, with data analysis including identification of opportunities to streamline monitoring and reporting.

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3.4.9 Protectiveness Statement

Protectiveness Statement(s)		
Operable Unit: Zone 4, Landfill 6	*Protectiveness Determination:* Protective	*Planned Addendum Completion Date:*
Protectiveness Statement: The remedy at Zone 4, Landfill 6 is protective of human health and the environment.		

3.5 Zone 5, Site 8

3.5.1 Site Description

Site 8, the former FDTA 2, is located in the northern portion of the former Pease AFB in the area designated as Zone 5 (**Figure 2-1**). Site 8 is bounded in the southeast by Site 11, the Field Maintenance Squadron Equipment Cleaning Area. Northwest of Site 8 is Site 9, CRD-1. (Sites 9 and 11 are not shown on **Figure 2-1** because they are not included in this FYR). The town of Newington Center is north of the site, and Taxiway D is located to the south. Undeveloped forested land, including the Newington Town Forest, is located along the eastern Site 8 boundary.

Site 8 was an active fire training area from 1961 to 1988. The majority of fire training exercises were performed in a large circular pit area located in the southeastern section of the site. Small and large aircraft crash fires were simulated using up to 1,000 gallons of jet propulsion fuel No. 4 (JP-4). Prior to 1971, mixed waste oils, solvents, and fuels were also disposed of at Site 8. The pit area was presaturated with water and then the waste oils, solvents, and fuels were poured on top of the water and onto a mock aircraft. The mixture was allowed to burn for 1 to 2 minutes before being extinguished. In the mid-1970s, the practice of mixing waste oils and solvents with fuel for training fires ceased and only JP-4 was used (Weston, 1994).

3.5.2 Initial Response

Several IRMs were implemented at Site 8 prior to the preparation and execution of the Site 8 ROD in 1994. In February and March of 1990, approximately 262 tons of contaminated soil were removed from the drainage ditch located in the northeastern corner of the site. This drainage ditch received surface runoff from the former main burn pit. The soil removal was performed to avoid migration of contaminants from this highly contaminated soil to deeper soil and to groundwater. In August of 1990, a pilot-scale groundwater extraction system was installed. The system was designed to mitigate off-site VOC migration and evaluate the pump and treat technique as a potential source control measure. Subsequent to the preparation of the FS in 1993 that evaluated potential remediation technologies, a pilot-scale SVE study was performed at Site 8 to evaluate the effectiveness of this technology to remediate site soils.

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Results were promising and were later used to establish design criteria for a full-scale system (Weston, 1994).

3.5.3 Basis for Taking Action

Potential risks to human health and the environment were identified at Site 8 for exposure to site soil and groundwater (Weston, 1994). In addition, leaching of contaminants in soil could pose an unacceptable health risk associated with groundwater use for drinking water. The basis for taking action at Site 8 was to address these risks.

3.5.4 Response Actions

The controlling document that presents the selected remedy for Zone 5, Site 8 is the Site 8 ROD (Weston, 1994). An ESD was completed for Site 8 (U.S. Air Force, 2018) to document the change in remedy at Site 8 to address all site contaminants, including the newly discovered PFOS/PFOA, through the operation of the groundwater extraction and treatment system (GWETS).

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3.5.4.1 Remedial Action Objectives

The RAOs were developed in the Site 8 ROD (Weston, 1994) to mitigate the existing and future potential threats to human health and the environment via source control (i.e., SVE and free product recovery) and management of migration of contaminated groundwater. The RAOs for Site 8 include the following:

- Protect ecological receptors from direct contact with or ingestion of soil containing contaminants in concentrations that may present an unacceptable risk.
- Prevent leaching of contaminants from soil to groundwater that would result in groundwater contamination that may present a health risk (total carcinogenic risk greater than 10^{-4} to 10^{-6} or a Hazard Index greater than 1).
- Protect human receptors from ingestion of contaminated groundwater that may present a health risk (total carcinogenic risk greater than 10^{-4} to 10^{-6} or a Hazard Index greater than 1).
- Prevent discharge of contaminated groundwater to surface water bodies where it may present increased risks to human health and the environment.

3.5.4.2 Remedy Description

The Site 8 remedy as described in the Site 8 ROD (Weston, 1994) included the following components:

- In situ SVE treatment of source area soil contaminated at concentrations exceeding the CGs and treatment of extracted soil vapor for removal of volatized organics.

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- Construction of an asphaltic concrete cap to minimize rainfall and snowmelt infiltration into the area of SVE treatment. The cap would help to minimize the moisture content of the soil to be treated by SVE.
- Recovery and off-site disposal of free-phase product floating on the water table in the source area.
- Management of migration in the downgradient overburden water-bearing zone. A groundwater recovery system was to be designed to capture overburden groundwater that is contaminated above the CGs to prevent migration into the bedrock water-bearing zone.
- Construction of an on-site Groundwater Treatment Plant (GWTP) for long-term treatment of recovered groundwater. Treated groundwater was to be discharged to subsurface recharge trenches.
- Environmental monitoring during remedial operations.
- Long-term environmental monitoring, including groundwater, surface water, and sediment sampling and analysis.
- LUCs in the form of restrictions on future land development and use of groundwater.

The associated 1994 Zone 5 ROD determined that no further action under CERCLA was needed for Site 9, CRD-1; and Site 11, Field Maintenance Squadron Equipment Cleaning Site.

A Site 8 ESD (U.S. Air Force, 2019) was issued to modify the remedy at Site 8 by implementing a new GWETS to specifically address PFOS and PFOA in addition to the contaminants of concern identified in the 1994 ROD. In addition, this ESD identified that private residences with drinking water wells exceeding the PFOS/PFOA LHAs would be connected to the City of Portsmouth municipal drinking water system.

3.5.5 Status of Implementation

3.5.5.1 Soil and Groundwater Actions

The start-up date for the Site 8 remediation facility was September 20, 1995 (pilot scale), with full-scale operation beginning on October 5, 1995. The initial Site 8 remedial action consisted of hydraulic containment with groundwater treatment and SVE. Both extraction remedies included aboveground treatment facilities. See **Figure 3-8** for the locations of the components of these facilities.

Soil sampling was performed in 2001 to characterize the current extent of soil contamination. The data suggested that the SVE system at Site 8 has successfully cleaned unsaturated soils and that residual contamination at Site 8 was associated with saturated soils and the smear zone

near the LNAPL plumes. Numerous system modifications and operational changes were made through the years to optimize recovery of contamination.

3.5.5.2 Land Use Controls

LUCs implemented for Site 8 are identified in **Appendix C** and consist of the delineation of a GMZ and URZ.

3.5.5.3 Current Status of Response Actions

In 2005, an Alternatives Analysis was developed to evaluate remedial measures to address residual source area contamination at Site 8 in groundwater, saturated soil, and as floating free product (MWH, 2005). The Alternatives Analysis recommended installation and operation of an AS system to supplement the SVE system by providing treatment of contaminated soils below the water table and reducing the amount of floating free product. Construction of the AS system began in February 2008; the system began operating in 2009 (URS, 2009). The SVE/AS systems were turned off in October 2013 due to limited recovery in recent years. In 2014 and 2015, investigation activities were completed at Site 8 (CB&I, 2015) to assess rebound in groundwater contamination and to assess areas of remaining soil contamination, respectively. Based on the results of the investigation activities, it was determined to keep the SVE/AS systems off (CB&I, 2015). From 1995 to 2012, combined treatment operations removed over 300,000 pounds of contamination from Site 8 (U.S. Air Force, 2019).

A work plan (URS, 2008) was developed to treat contaminated soil in the saturated zone and zone of water table fluctuation in areas that were not amenable to AS. Focused recovery of LNAPL and enhanced aerobic bioremediation of contaminated soil (i.e., oxygen-releasing compounds applied to existing wells and air supply vents) were proposed for three areas. Treatment of one of these areas (identified as Intrinsic Bioremediation Area (IBA) 3 took place in May 2009. Treatment of the other two areas did not occur, and LNAPL is no longer observed in IBA-2 and IBA-3 (APTIM, 2018). Investigation activities completed in 2014 and 2015 identified residual organic contamination in the overburden/shallow bedrock interface at the eastern side of IBA-2 and on the eastern side of IBA-3 (CB&I, 2015). These two areas were termed Hot Spot Areas 1 and 2. Based on these results, ISCO was selected as a remedial alternative to address the residual organic contamination in these areas. ISCO injections were implemented in October 2015. Details on the injection activities are provided in the Pilot Study Implementation Report (CB&I, 2016a).

The SVE/AS systems were shut off in October 2013 and remained off since there has been no rebound in groundwater concentrations at the site, indicating that RAOs have been attained. In June 2015, the U.S. Air Force shut down the GWTP based on the stated position that RAOs had been successfully achieved (U.S. Air Force, 2015). The GWTP was restarted in August 2015 with an additional granular activated carbon unit (GAC) to establish maximum

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hydraulic containment for source and plume migration of PFOS/PFOA in groundwater at Site 8. Restarting the Site 8 GWTP was required by a July 2015 SDWA AO issued by EPA to the U.S. Air Force in response to PFOS/PFOA contamination threatening public and private drinking water sources. With EPA approval, the GWTP was discontinued again on April 30, 2017, and the existing systems (GWTP, SVE, and AS) have been partially decommissioned and are no longer operable.

Groundwater investigations began at Site 8 to evaluate the presence of PFOS and PFOA. In 2014, sampling results showed that concentrations of these compounds exceeded the EPA 2009 PHAs for these contaminants. In addition, four private drinking water wells downgradient of Site 8 have been identified with PFOS/PFOA concentrations greater than the EPA LHAs. GAC treatment systems were installed in these homes (U.S. Air Force 2019).

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In response to these impacts and potential drinking water health threats and in accordance with the 2015 SDWA AO, a new GWETS was constructed to mitigate further expansion of PFOS/PFOA-contaminated groundwater away from Site 8 (U.S. Air Force, 2019). The system began operation in April 2018. An ESD has been completed to document the change in remedy at Site 8 to address all site contaminants, including the newly discovered PFOS/PFOA, through the operation of the GWETS. Treated groundwater from the GWETS meets EPA's LHAs and NHAGQS for PFOS and PFOA prior to discharge back into the aquifer. The ESD states that private residences with drinking water wells exceeding the PFOS/PFOA LHAs will be connected to the City of Portsmouth municipal drinking water system. The U.S. Air Force will propose a new ESD describing a new or modified GMZ once it has the data to delineate the groundwater plume. These data are being gathered as part of expanded site inspection activities.

3.5.5.4 LTM

Recently, LTM was conducted in accordance with the Site 8 LTMP, Revision 2 (MWH, 2003), which required annual sampling of 32 groundwater monitoring wells for VOCs and samples from 3 of those locations also analyzed for target metals. Sampling was semiannual at four locations. Surface water and sediment monitoring at Knights and Pickering Brooks are discussed in Section 4.0.

The Site 8 LTMP, Revision 3 (CB&I, 2016b) reduced the frequency of LTM sampling, water level measurement, and reporting to biennial; and discontinued monitoring at 22 locations. Monitoring in 2017 (APTIM, 2018) was conducted in accordance with the Revision 3 of the Site 8 LTMP. In addition, all site wells were evaluated for the presence of LNAPL in 2017. Trace LNAPL was observed in monitoring well 08-5520, but in rechecking 1 week later, no LNAPL was observed.

The results of the LTM groundwater sampling showed that 1,2,4-TMB, benzene, naphthalene, and VC were detected at one or two locations at concentrations slightly greater than the ROD CGs (**Figure 3-9**). However, concentrations of 1,2,3-TMB and naphthalene were less than the current NHAGQS (see **Appendix B**). The report (APTIM, 2018) showed that the concentrations of these contaminants have generally decreased since 1996 in overburden and bedrock groundwater.

Compliance with the Site 8 LUCs was assessed in conjunction with the groundwater monitoring activities. The assessment indicated the PDA has complied with the restrictions though 2017 (APTIM, 2018). Site visits and inspections completed during 2018 confirm continued compliance.

3.5.6 Progress since Last Five-Year Review

In the 2014 FYR, no issues were identified for Site 8 and the remedy was determined to be protective of human health and the environment (see **Appendix D**). As a result, no recommendations were made that were necessary to address the protectiveness of the remedy.

Findings reported in the 2014 FYR were identified and addressed, as shown in **Table 3-3**.

Table 3-3
Status of Findings for Site 8 from the 2014 FYR

OU	Issue	Recommendations	Current Status	Current Implementation Status Description	Completion Date (if applicable)
Zone 5, Site 8	O&M	Conduct O&M of the AS, GWTP, and SVE systems	Completed	O&M continued until systems were shut down.	4/30/2017
	Groundwater Quality in Areas Untreated by SVE/AS	Perform groundwater investigation in areas where AS system not installed	Completed	Investigation completed in 2014 and 2015 (CB&I, 2015).	6/2/2015
	Soil Quality in Source Areas	Perform sampling in unsaturated soil to determine if it has been remediated and evaluate options for source soils if needed	Completed	Investigation completed in 2014 and 2015 (CB&I, 2015).	6/2/2015
	LTM	Continue LTM, and optimize LTM activities	Ongoing	LTM continuing; last sampling conducted in 2017 (APTIM, 2018); LTMP revised in 2016 (CB&I, 2016b)	

Table 3-3 (continued)
Status of Findings for Site 8 from the 2014 FYR

APTIM denotes Aptim Federal Services, LLC.
AS denotes air sparge.
CB&I denotes CB&I Federal Services LLC.
GWTP denotes Groundwater Treatment Plant.
LTM denotes long-term monitoring.
LTMP denotes Long-Term Monitoring Plan.
O&M denotes operations and maintenance.
OU denotes operable unit.
SVE denotes soil vapor extraction.

In EPA's review of the draft 2014 FYR Report, the agency disagreed with the protectiveness statement for Site 8. EPA indicated that further delineation of PFOS/PFOA in Site 8 groundwater was needed. EPA indicated that the protectiveness determination for Site 8 should be deferred until this work has been completed.

This work has been completed, as discussed in Section 3.5.5.3. Since the 2014 FYR, the U.S. Air Force has conducted extensive work related to the nature and extent of PFOS/PFOA at the former Pease AFB, including Site 8. Groundwater investigations began at Site 8 to evaluate the presence of PFOS and PFOA in 2013. Investigations have shown that PFOS/PFOA are present in groundwater at concentrations greater than the EPA LHAs within and beyond the current GMZ boundary. GAC treatment systems have been installed in the four private drinking water wells downgradient of Site 8 with PFOS/PFOA concentrations greater than the EPA LHAs, and a GWETS was constructed and is operating to mitigate further expansion of PFOS/PFOA-contaminated groundwater away from Site 8 (U.S. Air Force, 2019).

3.5.7 Technical Assessment

3.5.7.1 Question A

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

A review of documents, ARARs, risk assumptions, and the results of system and groundwater monitoring indicates that the Site 8 is functioning as intended. As discussed in Section 3.5.5.3, an ESD has been completed to address PFOS/PFOA at Site 8. The GWETS was constructed and is operating in order to mitigate further expansion of PFOS/PFOA-contaminated groundwater away from Site 8. The ESD also indicates that households with private wells that are impacted by PFOS/PFOA will be connected to public water. These households currently have in-home treatment for PFOS/PFOA. Therefore, the remedy is functioning as intended.

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Remedial Action Performance

A review of performance and LTM data collected for Site 8 since the last FYR indicates that the components of the remedy at Site 8 functioned as intended; however, the Site 8 remedy did not address PFOS/PFOA. Groundwater concentrations of other contaminants have declined, and influent concentrations of both the SVE/AS and the GWTP declined substantially. Site 8 COCs were not detected beyond the boundaries of the Site 8 GMZ in 2017, although PFOS and PFOA were detected beyond these boundaries. The LUCs have restricted groundwater use within the Site 8 GMZ. The SVE/AS system successfully removed soil contamination and free product from the vadose zone at Site 8, and there has been substantial improvement in groundwater quality at the site. Groundwater data collected since the shutdown of the SVE/AS systems has not shown any noticeable rebound in concentrations of Site 8 COCs. The operation of the new GWETS was initiated in April 2018, and it is functioning as intended.

System Operations/O&M

As discussed in Section 3.5.5.3, the SVE/AS system was shut down in October 2013 and did not operate during this 5-year period. The GWTP operated until June 2015 and was restarted in August 2015 to establish maximum hydraulic containment for source of plume migration of PFOS/PFOA in groundwater at Site 8. It was shut down permanently in April 2017. During this period, O&M was conducted in accordance with the *Operation and Maintenance Plan for the Treatment of Perfluorinated Compounds in Groundwater* (CB&I, 2016c).

Since the former GWTP is no longer operating and is being dismantled, issues related to its effectiveness and cost are no longer relevant. As discussed in Section 3.5.5.3, a new GWETS was constructed and began operation in April 2018.

Implementation of Land Use Controls and Other Measures

LUCs have been implemented as described in Section 3.5.5.2 and **Appendix C**, and have been effective as described in Section 3.5.5.4. As discussed in the Site 8 ESD, the U.S. Air Force will delineate the extent of the PFOS/PFOA contamination and will modify the GMZ in another ESD if that is necessary to protect human health and the environment. Because existing private wells with concentrations greater than the LHAs are being treated, the current GMZ is protective in the short term.

3.5.7.2 Question B

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

The RAOs used at the time of the remedy selection are still valid. While some of the exposure assumptions, toxicity data, and cleanup levels were based on information that has changed

over time, these changes do not affect the protectiveness of the remedy for existing Site 8 COCs as discussed in the following subsections.

Changes in Standards and TBCs

As shown in **Appendix B**, ARARs were used for the establishment of CGs at Site 8 in most cases. Risk-based CGs were established for 2-methylnaphthalene, phenanthrene, 4,4'-dichlorodiphenyldichloroethane (DDD), *sec*-butylbenzene, 1,2-dibromomethane, isopropylbenzene, and 1,2,4-TMB. Since the time of the Site 8 ROD, ARARs have been established for all of these chemicals. In all cases, established ARARs (**Appendix B**) are greater than the CG. The only exception to this is for 4.4'-DDD. The ROD CG for this chemical was 0.177 µg/L, but the recent NHAGQS is 0.1 µg/L. However, the ROD CG does not pose a non-cancer hazard of greater than 1 based on estimates completed using default assumptions for tap water in the RSL calculator. As a result, no change to the CGs for these chemicals is recommended.

In terms of chemicals for which the CGs were based on New Hampshire ARARs and recent values are lower, manganese was based on a NHDPHS value of 1,500 µg/L. The current NHAGQS for manganese is 840 µg/L; however, site data are compared to the site background concentration of 942 µg/L. A ROD modification is recommended to change the groundwater CG for manganese at Site 8 to the current Pease background concentration.

The CG for 4-methylphenol was based on the NHAGQS of 350 µg/L, as opposed to the current NHAGQS of 40 µg/L. However, the ROD CG does not pose a non-cancer hazard of greater than 1 based on the estimates completed using default assumptions for tap water in the RSL calculator. Therefore, no change to the CG is recommended for 4-methylphenol.

The only chemical with a CG based on an MCL that has changed is arsenic as discussed in Section 3.1.7.2. While current ARARs are less than the CG established in the ROD, the current ARARs as well as background concentrations are used to evaluate progress in LTM results. A ROD modification is recommended to change the groundwater CG for arsenic at Site 8 to the Pease background concentration.

The Site 8 ROD soil CGs (see **Appendix B**) were largely based on leaching and are used to evaluate changes in site conditions. A leaching model specific to the former Pease AFB was used to develop these CGs, which are designed to be protective of groundwater use for drinking water. **Appendix B** shows the ROD CGs, the current soil ARAR (New Hampshire Soil Remediation Standards [NHSRS]; NHDES, 2018), the groundwater basis for the ROD leaching CGs, and the current groundwater ARAR. **Appendix B** shows that NHSRS based on leaching are consistently higher than the site-specific leaching values. In addition, the current groundwater ARAR is consistently higher than the groundwater concentration used in the

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development of the soil CG based on leaching. These comparisons indicate that the soil CGs based on leaching are still protective and no changes are needed.

The soil CGs for BTEX were based on an interim NHDES 1991 petroleum policy. **Appendix B** shows other potential ARARs, including current NHSRS (NHDES, 2018). All of these values are higher than values used in the ROD CG, with the exception of benzene. The NHSRS for this compound (0.3 milligrams per kilogram [mg/kg]) is based on leaching and is slightly lower than the ROD CG of 1 mg/kg. However, recent soil sampling conducted in potential residual source areas at Site 8 showed no detections of benzene (CB&I, 2015b), indicating that the remedy is protective for leaching of benzene. As a result, no changes are needed for these CGs.

Changes in Toxicity and Other Contaminant Characteristics

As discussed previously, a number of groundwater COCs had risk-based CG in the Site 8 ROD (see **Appendix B**). The toxicity values used to establish some of these CGs may have changed since the ROD was completed; however, these changes are reflected in the revised NHAGQS values discussed previously. As a result, changes in toxicity or other contaminant characteristics do not affect the protectiveness of the Site 8 remedy.

On May 19, 2016, EPA issued final lifetime drinking water health advisories for PFOA and PFOS, which identified chronic oral RfD values of 2E-05 mg/kg-day. These RfD values should be used when evaluating potential risks from ingestion of contaminated groundwater at CERCLA sites where PFOA and PFOS are present. Potential estimated health risks from PFOA and PFOS would increase total site risks due to groundwater exposure. Further evaluation of potential risks from exposure to PFOA and PFOS in other media at the Site might be needed based on site conditions and may also affect total site risk. PFBS has a chronic oral RfD of 2E-02 mg/kg-day based on an EPA PPRTV. This RfD value should be used when evaluating potential risks from ingestion of contaminated groundwater at Superfund sites where PFBS is present.

The discovery of PFOS/PFOA, however, does affect the long-term protectiveness of the remedy; an ESD was prepared that incorporates the GWETS to address PFOS/PFOA. This system is operating and adequately treating these compounds. In addition, groundwater LUCs remain in place.

Changes in Risk Assessment Methods

As discussed in Section 3.1.7.2, numerous changes have occurred in risk assessment methods since the date of the Pease ROD completed in the 1990s. However, MCLs and/or NHAGQS have now been established for all Site 8 COCs (see **Appendix B**) with the exception of vanadium for which background is used, and bromochloromethane, which was based on a

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LHA that has not changed (EPA, 2018). Relevant changes in risk assessment methods have been incorporated in these values. As a result, changes in risk assessment methods do not affect the protectiveness of the remedy.

Changes in Exposure Pathways

There have been no changes in physical conditions or land use that would affect the protectiveness of the remedy.

Expected Progress towards Meeting RAOs

RAOs are currently being at met at Site 8. LNAPL is no longer present at Site 8. Ingestion of groundwater is prohibited with the current Site 8 GMZ. A GWETS is operating to control further migration of PFOS/PFOA. Private wells (beyond the boundaries of the Site 8 GMZ) impacted with PFOS/PFOA are currently being treated and will be connected to public water.

3.5.7.3 Question C

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

The protectiveness of the Site 8 remedy remains intact; however, this protectiveness is short term. As discussed in previous sections, an ESD to amend the GMZ will be implemented (U.S. Air Force, 2019) to assure the protectiveness of the remedy in the long term.

3.5.8 Issues/Recommendations

As discussed above, issues related to PFOS/PFOA at Site 8 result in the remedy being protective in the short term.

Remedial measures at Site 8 are protective of human health and the environment under current conditions. Historical remedial systems implemented under the Site 8 ROD have been shut down, largely because they are no longer needed. However, the GWETS identified in the Site 8 ESD (U.S. Air Force, 2019) to prevent further migration of PFOS/PFOA has been constructed and is operating; residents have been provided alternate water supplies (in-home treatment). Future measures to address the appropriateness of the current GMZ boundaries will result in the remedy being protective in the long term.

A ROD modification is recommended for Site 8 adopting the Pease background concentrations for arsenic and manganese as the groundwater CGs. No other issues or recommendations are identified.

3.5.9 Protectiveness Statement

Protectiveness Statement(s)		
Operable Unit: Zone 5, Site 8	*Protectiveness Determination:* Short-term Protective	*Planned Addendum Completion Date:* 12/31/2020
Protectiveness Statement: The remedy at Zone 5, Site 8 is protective of human health and the environment in the short term. Remedial activities completed to date have adequately addressed all exposure pathways that could result in unacceptable risks in these areas. In order for the remedy to be protective in the long term, the revision of the Site 8 GMZ needs to be completed.		

3.6 Zone 7, Site 45

3.6.1 Site Description

The Old Jet Engine Test Stand (OJETS) (Site 45) was constructed (circa 1958) near the southwestern edge of the runway at the former Pease AFB (**Figure 2-1**). The OJETS encompasses approximately 0.6 acres and is located in IRP Zone 7 and the PDA natural resource protection zone. The facility consisted of a partially enclosed test stand, an engine control room, a transformer, an in-ground exhaust crib, and a 2,500-gallon fuel storage tank (**Figure 3-10**).

In the mid-1960s, the test stand operated at full capacity for the majority of the time. During testing, engine exhaust was directed out of the northern end of the containment structure toward the rock crib, which was designed to deflect the engine exhaust. Petroleum products, hydraulic fluids, and solvents were reportedly used extensively at the facility before the OJETS was taken out of service in 1976. After the OJETS was removed from service, the engine control room, aboveground fuel storage tank, and transformer were removed. In 1992, as part of the RI, the OJETS building, concrete pad, and rock crib were also removed.

Site 45 was included in the deeded transfer of Parcel E to the PDA in 2003 (**Figure 2-1**). Part of this land was used to expand the 18-hole Pease Golf Course to 27 holes. The nine-hole expansion impacted an area of approximately 100 acres, including Site 45. A newly constructed fairway adjacent to the site now covers the western portion of the Site 45 GMZ.

3.6.2 Initial Response

No remedial actions were performed at Site 45 prior to the finalization of the Site 45 ROD (Weston, 1995).

3.6.3 Basis for Taking Action

The basis for taking action was to remedy the threat to human health, welfare, or the environment posed by soil and groundwater contamination at the OJETS (Weston, 1995). Potential risks to human health and the environment were identified associated with leaching

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of contaminants from soil to groundwater at the OJETS source area. In addition, a potential threat to ecological receptors from ingestion of inorganic contaminants in the source area was identified (Weston, 1995).

3.6.4 Response Actions

The controlling document that presents the selected remedy is the Site 45 ROD (Weston, 1995).

3.6.4.1 Remedial Action Objectives

The RAOs identified in the Site 45 ROD (Weston, 1995) include the following:

- Minimize leaching of contaminants from soil to groundwater that would result in groundwater contamination that may exceed ARARs or present an unacceptable health risk.
- Protect ecological receptors from direct contact with or ingestion of surface soil or vegetation containing contaminants at concentrations that may present an unacceptable risk.
- Protect human receptors from ingestion of contaminated groundwater that may present an unacceptable health risk.
- Comply with location- and action-specific ARARs, TBC criteria, and/or established background levels for specific contaminants in soil and groundwater, as appropriate.

3.6.4.2 Remedy Description

In summary, the Site 45 remedy included the following actions:

- In situ AS of approximately 4,000 cubic yards of saturated contaminated soil to enhance volatilization and biodegradation of organic contaminants in soil and groundwater
- In situ SVE treatment of approximately 3,000 cubic yards of unsaturated contaminated soil to extract VOCs and to enhance biodegradation of organic contaminants
- Installation of a low-permeability membrane on the ground surface over the area to be treated by SVE/AS to minimize the potential for the intrusion of atmospheric air into the SVE vents
- Natural attenuation of residual contamination remaining in groundwater after excavation and in conjunction with SVE/AS treatment
- LUCs, including placement of security fence and access restriction signs until treatment is complete and units have been removed from the site

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- Monitoring of site groundwater until CGs have been attained

3.6.5 Status of Implementation

3.6.5.1 Soil and Groundwater Actions

Following completion of the treatability study, installation of a full-scale SVE/AS system commenced, but operation of the pilot-scale SVE/AS system was continued on an interim basis through May 1995. Full-scale system startup was initiated in August 1996. The remedial system operated for approximately 2 months before it was shut down in October 1996 due to high water table conditions. In July 1997, two soil borings were completed in the most highly contaminated areas of the site. Results from the analysis of those samples, as well as the results obtained during installation of the AS and SVE wells, indicated that soil RAOs had been attained.

The U.S. Air Force recommended the abandonment and dismantling of the SVE/AS remedial system in the *Site 45 1999 Status Report* (Bechtel, 2000). The NHDES and EPA concurred with this recommendation, and the SVE/AS remedial system was dismantled in September 2000. Details of the system abandonment and dismantling were presented in the *Site 45 Remedial System Closure Report* (Bechtel, 2001).

3.6.5.2 Land Use Controls

LUCs implemented for Site 45 are identified in **Appendix C** and consist of the delineation of a GMZ and URZ. Inclusion of a security fence for Site 45 was specified in the ROD (see Section 3.6.4.2). This LUC is no longer needed in accordance with the ROD, since the treatment is complete and the treatment units have been removed from the site.

3.6.5.3 LTM

LTM has been conducted at Site 45 since 2000 to evaluate the continued natural attenuation of contaminants in groundwater. Recently, LTM has been conducted in accordance with the Site 45 LTMP, Revision 2 (MWH, 2004), which required annual sampling of four groundwater monitoring wells for manganese and nine wells for water level measurements.

With a few exceptions, manganese is consistently detected at concentrations above the ROD CG of 1,500 µg/L as well as site background of 942 µg/L in the four Site 45 monitoring wells. In 2018, manganese concentrations were greater than these values in three of the four wells sampled (see **Figure 3-10**). In general, manganese concentrations have decreased in the source area wells, but have been more variable in the two downgradient wells (APTIM, 2019).

It has been generally accepted that the elevated manganese concentrations in groundwater are due to the reduced conditions in the aquifer resulting in the biological degradation of fuels. However, golf-course activities (fertilizing and irrigation) may also contribute to the anaerobic

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conditions (APTIM, 2019), especially at the downgradient locations where the water table is within 2 feet of the surface.

The 2018 Annual Report (APTIM, 2019) recommended the discontinuation of sampling at monitoring well 45-7628R due to results being less than the ROD CG since 2014, and to change sampling frequency to triennial at the three remaining wells.

3.6.6 Progress since Last Five-Year Review

This section includes the protectiveness determinations and statements from the last FYR as well as the recommendations from the last FYR and the current status of those recommendations.

In the 2014 FYR, no issues were identified for Site 45 and the remedy was determined to be protective of human health and the environment (see **Appendix D**). As a result, no recommendations were made that were necessary to address the protectiveness of the remedy.

Other findings were that routine monitoring should continue. This recommendation has been implemented with the continuation of LTM at Site 45.

3.6.7 Technical Assessment

The technical assessment portion of the FYR evaluates the protectiveness of the remedy. The following subsections address the specific questions outlined in the *Comprehensive Five-Year Review Guidance* (EPA, 2001).

3.6.7.1 Question A

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

Based on a review of documents, ARARs, and risk assumptions, the remedy at Site 45 is functioning as intended. Soil CGs were attained by the SVE/AS system (Bechtel, 2001). Organic constituents in groundwater have declined to concentrations below Site 45 ROD-specified CGs. Manganese concentrations in the source area remain above the Site 45 ROD-specified CG, with most wells exhibiting a downward trend. The LUCs, including a GMZ, are in place and maintained.

3.6.7.2 Question B

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

Changes in Standards and TBCs

Soil CGs adopted in the Site 45 ROD were based on background or ARARs (**Appendix B**). Since the RAOs did not include protection of human health for soil, these CGs were established

for the protection of ecological receptors and groundwater from leaching. NHDES (2018) soil ARARs are greater than ROD CGs with the exception of xylenes, for which the current ARAR is based on the ceiling concentration. Risk-based and leaching-based values are all greater than the ROD CG (NHDES, 2018). As a result, these changes do not affect the protectiveness of the remedy.

Groundwater CGs in the Site 45 ROD were based on the ARARs, except where ARARs were not available. Of the nine constituents for which CGs were established, ARARs were used for benzene, *cis*-1,2-DCE, naphthalene, lead, and manganese. Current ARARs (NHDES, 2018) (see **Appendix B**) are equal to or greater than the ROD CGs and do not affect the protectiveness of the remedy, with the exception of manganese. The current NHAGQS for manganese is 840 µg/L; however, site data are compared to the site background concentration of 942 µg/L. A ROD modification is recommended to change the groundwater CG for manganese to the current Pease background concentration.

Groundwater CGs based on risk are 2-methylnaphthalene, *sec*-butylbenzene, isopropylbenzene, 1,2,4-TMB. NHAGQS have now been established for all of these compounds (NHDES, 2018), all of which are greater than the risk-based CGs. As a result, the risk-based CGs are still protective and no changes are needed.

Changes in Toxicity and Other Contaminant Characteristics

1,2,4-TMB, *sec*-butylbenzene, 2-methylnaphthalene, and isopropylbenzene were the only groundwater COCs with risk-based CGs in the Site 45 ROD. As discussed previously, while the toxicity values for the COCs with risk-based CGs have changed, the Site 45 ROD risk-based CGs are more stringent than the available NHAGQS for these COCs. None of the toxicity changes affects the protectiveness of the Site 45 remedy.

Changes in Risk Assessment Methods

As discussed in Section 3.1.7.2, numerous changes have occurred in risk assessment methods since the date of the Pease ROD completed in the 1990s. However, MCLs and/or NHAGQS have now been established for all Site 45 COCs (see **Appendix B**). Relevant changes in risk assessment methods have been incorporated in these values. As a result, changes in risk assessment methods do not affect the protectiveness of the remedy.

Changes in Exposure Pathways

There have been no other changes in physical conditions or land use that would affect the protectiveness of the remedy.

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Expected Progress towards Meeting RAOs

The remedy has achieved the CGs in soil (Bechtel, 2001) and therefore, has achieved the RAOs associated with minimizing leaching and protecting ecological receptors. The remedy has currently achieved the CGs for organic constituents in groundwater. It is expected that over time, the remedy will attain the remaining inorganic CG for manganese in groundwater.

3.6.7.3 Question C

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

No other information has been identified that would call into question the protectiveness of the remedy.

3.6.8 Issues/Recommendations

No issues were identified for Site 45 that prevent the response action from being protective of human health or the environment. A ROD modification is recommended for Site 45 adopting the Pease background concentration for manganese as the groundwater CG. No other issues or recommendations are identified.

3.6.9 Protectiveness Statement

Protectiveness Statement(s)		
Operable Unit: Zone 7, Site 45	*Protectiveness Determination:* Protective	*Planned Addendum Completion Date:*
Protectiveness Statement: The remedy at Zone 7, Site 45 is protective of human health and the environment.		

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4.0 PEASE DRAINAGE AREAS

4.1 Site Description

Several of the sites and zones described in Section 3.0 include associated drainage areas. These areas have been described in detail in a recent evaluation that included site descriptions, controlling documents including RAOs (if any), CGs (if any), and recent and historical monitoring results (CB&I, 2016). The purpose of this evaluation was to provide a summary of current sampling plans, a summary of results over time, a comparison of results to CGs if specified in controlling documents or other relevant values, and recommendations as to whether continued sampling is warranted in the drainage areas. The Conclusions and Recommendations section of CB&I (2016) is included in this FYR Report as **Appendix E** for reference.

Given the detailed evaluation provided in this recent report (CB&I, 2016), only summary information is provided here. **Table 4-1** shows the controlling documents and the reporting documents. **Figure 4-1** shows the locations of the drainage areas associated with the former Pease AFB.

Table 4-1
Summary of Controlling Documents and Reporting for Surface Water and Sediment Areas

Site Area	Controlling Documents	Reporting
Pauls Brook (Drainage Area A)	Brooks and Ditches ROD (U.S. Air Force, 1997)	Landfill and CRD Annual Reports
Lower Grafton Ditch (Drainage Area E)	Zone 3 ROD (Weston, 1995a), Zone 4 ROD (Weston, 1995b)	
Peverly Drainage System (Drainage Area G)	Zone 2 ROD (Weston, 1995c)	
Railway Ditch and Flagstone Brook (Drainage Area J)	Landfill 5 ROD (Weston, 1993a), Zone 1 ROD (Weston, 1995d)	
Knights and Pickering Brooks (Drainage Areas H and I)	Site 8 ROD (Weston, 1994)	Site 8 Annual Reports

CRD denotes Construction Rubble Dump.
ROD denotes Record of Decision.
U.S. denotes United States.
Weston denotes Roy F. Weston, Inc.

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More information on these areas can be found in CB&I (2016) and the documents identified in **Table 4-1**.

4.2 Initial Response

The only immediate remedial measure in the former Pease AFB drainage areas was taken at the Site 8 drainage ditch in 1990, where 260 tons of contaminated sediment were removed in 1990 and disposed of off-site (Weston, 1994). No remedial actions were performed in the former Pease AFB drainage areas prior to the finalization of the RODs identified in **Table 4-1**.

4.3 Basis for Taking Action

Of the drainage areas identified in **Table 4-1**, actions were taken at Pauls Brook (U.S. Air Force, 1997). Upper Grafton Ditch (Weston, 1995a), and the Railway Ditch (Weston, 1993). Actions were taken in these three areas to prevent or minimize risks to ecological receptors resulting from exposure to sediment. RAOs for all other drainage areas were confined to LTM.

4.4 Response Actions

The response actions required at the former Pease AFB drainage areas are specified in the controlling documents identified in **Table 4-1**.

4.4.1 Remedial Action Objectives

The RAOs for Zone 1 (Railway Ditch) and Zone 3 (Upper Grafton Ditch) are described in Sections 3.1.4.1 and 3.3.4.1, respectively. The RAO for Pauls Brook sediment (U.S. Air Force, 1997) was similar, and is as follows:

- Protect ecological receptors from direct contact with, or ingestion of, sediment containing contaminants at concentrations that may present an unacceptable ecological risk.

4.4.2 Remedy Description

The selected remedy for the three drainage areas identified in Section 4.4.1 was to remove contaminated sediment to address the identified ecological risk. For these and the other drainage areas identified in **Table 4-1**, LTM was also specified. See further descriptions of remedies and required monitoring in CB&I (2016) and **Appendix E**.

4.5 Status of Implementation

4.5.1 Sediment Removals

As discussed in **Appendix E**, the removal of contaminated sediment from Pauls Brook was completed in 1997, the Railway Ditch excavation was performed between 1993 and 1995, and the Upper Grafton Ditch excavation was conducted in 1996.

4.5.2 Land Use Controls

No LUCs were implemented for former Pease AFB drainage areas.

4.5.3 LTM

LTM has been conducted in surface water and sediment in former Pease AFB drainage areas since the early to mid-1990s. Initially, surface water and sediment sampling was conducted at many locations; however, sampling has been reduced over the years, especially in surface water. CB&I (2016) described the historical and recent sampling conducted, including an evaluation of recent results. The conclusion of this report was that surface water and sediment sampling should be discontinued at the former Pease AFB in general because the RAOs have been met. Therefore, LTM in former Pease AFB drainage areas was discontinued in 2016.

4.6 Progress since Last Five-Year Review

The protectives determinations from the 2014 FYR for drainage areas are included in **Appendix D** with the relevant zones.

In EPA's review of the draft 2014 FYR Report, the agency disagreed with the protectiveness statement for Knights Brook and Pickering Brook in Zone 5. EPA indicated that further delineation of PFOS/PFOA in surface water in these areas was needed. EPA indicated that the protectiveness determination for these areas of Zone 5 should be deferred until this work has been completed.

This work has been completed. Since the 2014 FYR, the U.S. Air Force has conducted extensive work related to the nature and extent of PFOS/PFOA at the former Pease AFB, including surface water. The investigation results are detailed in the Site Investigation Report (AMEC, 2017) and the Exposure Assessment Report (Wood Environment & Infrastructure Solutions, Inc. [formerly AMEC], 2018). Pore water and surface water sampling was conducted to evaluate the migration of PFOS/PFOA from groundwater to surface water and concentrations present in surface water. This report concluded that PFOS/PFOA were entering Pickering Brook near the beginning of the wetland; however, concentrations in surface water decreased with distance from the point of entry. The report found similar results for Knights Brook with entry at the headwaters and decreasing surface water concentrations downstream. In November 2017, EPA provided human health screening levels for adult and child recreation in surface water that were used in the evaluation. Concentrations in Knights Brook and Pickering Brook exceeded the screening values for a child recreator (swimming) scenario, even though there was no indication of such use. The screening level is based on a Hazard Quotient of 0.1. The report concluded that there is no or negligible potential for PFOS/PFOA exposure for current recreational use in all Pease Drainage Areas sampled.

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4.7 Technical Assessment

The technical assessment portion of the FYR evaluates the protectiveness of the remedy. In the case of the drainage areas, remedial actions were conducted in three areas, and LTM has been conducted throughout the areas. Based on the evaluation provided in CB&I (2016), LTM has been discontinued since the RAOs have been met. As a result, further technical assessment is not provided here. A summary is provided in **Appendix E**, and the report is available in the Administrative Record (CB&I, 2016).

4.8 Issues/Recommendations

No issues were identified for the former Pease AFB drainage areas that prevent the response action from being protective of human health or the environment.

4.9 Protectiveness Statement

Protectiveness Statement(s)		
Operable Unit: Zone 1 Pauls Brook, Railway Ditch, and Flagstone Brook; Zone 2, Peverly Drainage System; Zone 4, Lower Grafton Ditch; Zone 5, Knights Brook and Pickering Brook	*Protectiveness Determination:* Protective	*Planned Addendum Completion Date:*
Protectiveness Statement: The remedies at the former Pease AFB drainage areas are protective of human health and the environment.		

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5.0 ISSUES/RECOMMENDATIONS

This section identifies OUs with no issues/recommendations in this FYR, as well as those with issues and recommendations identified.

<table>
<tr><th colspan="5">Issues/Recommendations</th></tr>
<tr><td colspan="5">OU(s) without Issues/Recommendations Identified in the Five-Year Review:</td></tr>
<tr><td colspan="5">Zone 1, Landfill 5; Zone 2; Zone 3, Sites 32, 33, 34, 35, 38, 49, and 73; Zone 4, Landfill 6; Zone 7, Site 45; Pease Drainage Areas</td></tr>
<tr><td colspan="5">Issues and Recommendations Identified in the Five-Year Review:</td></tr>
<tr><td rowspan="3">OU(s): Zone 3, Site 39</td><td colspan="4">Issue Category: Other
Potential for exposure pathways not anticipated in the Zone 3 ROD</td></tr>
<tr><td colspan="4">Issue:
Potential for unacceptable risk due to vapor intrusion in Building 39</td></tr>
<tr><td colspan="4">Recommendation:
Prepare ROD Amendment and implement measures to prevent future unacceptable risk</td></tr>
<tr><td>Affect Current Protectiveness</td><td>Affect Future Protectiveness</td><td>Party Responsible</td><td>Oversight Party</td><td>Milestone Date</td></tr>
<tr><td>No</td><td>Yes</td><td>Federal Facility</td><td>EPA/State</td><td>12/31/2020</td></tr>
<tr><td rowspan="3">OU(s): Zone 5, Site 8</td><td colspan="4">Issue Category: Changed Site Conditions</td></tr>
<tr><td colspan="4">Issue:
Current GMZ may not be protective in the long term</td></tr>
<tr><td colspan="4">Recommendation:
Complete a new ESD to revise the GMZ to achieve long-term protectiveness of human health and the environment</td></tr>
<tr><td>Affect Current Protectiveness</td><td>Affect Future Protectiveness</td><td>Party Responsible</td><td>Oversight Party</td><td>Milestone Date</td></tr>
<tr><td>No</td><td>Yes</td><td>Federal Facility</td><td>EPA/State</td><td>12/31/2020</td></tr>
</table>

In addition, the following are recommendations that were identified during the FYR and may improve performance of the remedy, reduce costs, improve management of O&M, accelerate site closeout, conserve energy, promote sustainability, etc., but do not affect current and/or future protectiveness:

- LTM should continue for each Zone/site.
- Benzene concentrations remain elevated in Site 10 groundwater, despite the SEB pilot study completed in 2016 with performance monitoring conducted from November 2016 to June 2018. LTM should continue in Zone 2 to evaluate additional progress.

- Performance monitoring should continue in Zone 3 where necessary to evaluate pilot study efforts. These data should be reviewed to identify ways to further optimize remedial activities.
- An ESD or ROD Amendment should be prepared to document the elimination of groundwater extraction and treatment as a component of the remedy at Zone 3, Sites 32/36.
- A modification to the Zone 3 ROD should be prepared to address all site contaminants, including the newly discovered PFOS/PFOA, through the operation of the AIMS groundwater treatment system.
- A modification to the relevant RODs should be prepared to change the groundwater CG for arsenic to the Pease background concentration for LF-5, Sites 10/22, LF-6, and Site 8; for manganese to the Pease background concentration at Site 8 and Site 45; and for vanadium to 86 µg/L for Zone 3 based on risk.

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6.0 PROTECTIVENESS STATEMENT

The protectiveness statements for each OU are provided in Sections 3.0 and 4.0. The Sitewide Protectiveness Statement is as follows:

Sitewide Protectiveness Statement	
Protectiveness Determination: Short-term Protective	*Planned ESD Completion Date:* 12/31/2020
Protectiveness Statement: The remedy at Zone 3, Site 39 is short-term protective and will be long-term protective of human health and the environment upon completion of the remedial activities in the Zone 3 ROD Amendment. The remedy at Zone 5, Site 8 is short-term protective and will be long-term protective of human health and the environment upon completion of an ESD revising the Site 8 GMZ. The remedies at all other Pease AFB zones/sites are protective of human health and the environment.	

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7.0 NEXT REVIEW

The next FYR Report for the former Pease AFB Superfund Site will need to be finalized by September 30, 2024.

For reference, the regulator comments (EPA and NHDES) and U.S. Air Force responses on the *Draft Five-Year Review Report (2014–2019)* are included as **Appendix F**.

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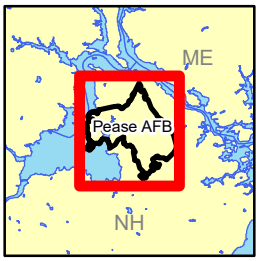
Figures

Former AFB Boundary



N

0 1,500 3,000 6,000 Feet

PROJECTION: NAD_1983_StatePlane_New_Hampshire_FIPS_2800_Feet

U.S. AIR FORCE

U.S. AIR FORCE

Five Year Review Report (2014 - 2019)

FIGURE NUMBER 1-1

LOCATION MAP
FORMER PEASE AIR FORCE BASE
PORTSMOUTH, NEW HAMPSHIRE

APTIM

APTIM
150 Royall Street
Canton, MA 02021

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Parcel ID	Owner ID
A	Pease Development Authority
B	Air Force Retained
C	Pease Development Authority
D	Pease Development Authority
E	Pease Development Authority
F	Pease Development Authority
G	Pease Development Authority
G1	Pease Development Authority
H	Pease Development Authority
I	Pease Development Authority
I1	Pease Development Authority
J	State of New Hampshire
K	Pease Development Authority
L	U.S. Fish and Wildlife Service
M	U.S. Fish and Wildlife Service
Park and Ride	Pease Development Authority

Legend

- Site Boundary
- Taxlot Parcel Boundary
- Zone Boundary

N

0 1,000 2,000 4,000 Feet

PROJECTION: NAD_1983_StatePlane_New_Hampshire_FIPS_2800_Feet

U.S. AIR FORCE

Five Year Review Report (2014 - 2019)

FIGURE NUMBER 2-1

PBR SITE LOCATIONS
FORMER PEASE AIR FORCE BASE
PORTSMOUTH, NEW HAMPSHIRE

APTIM
150 Royall Street
Canton, MA 02021

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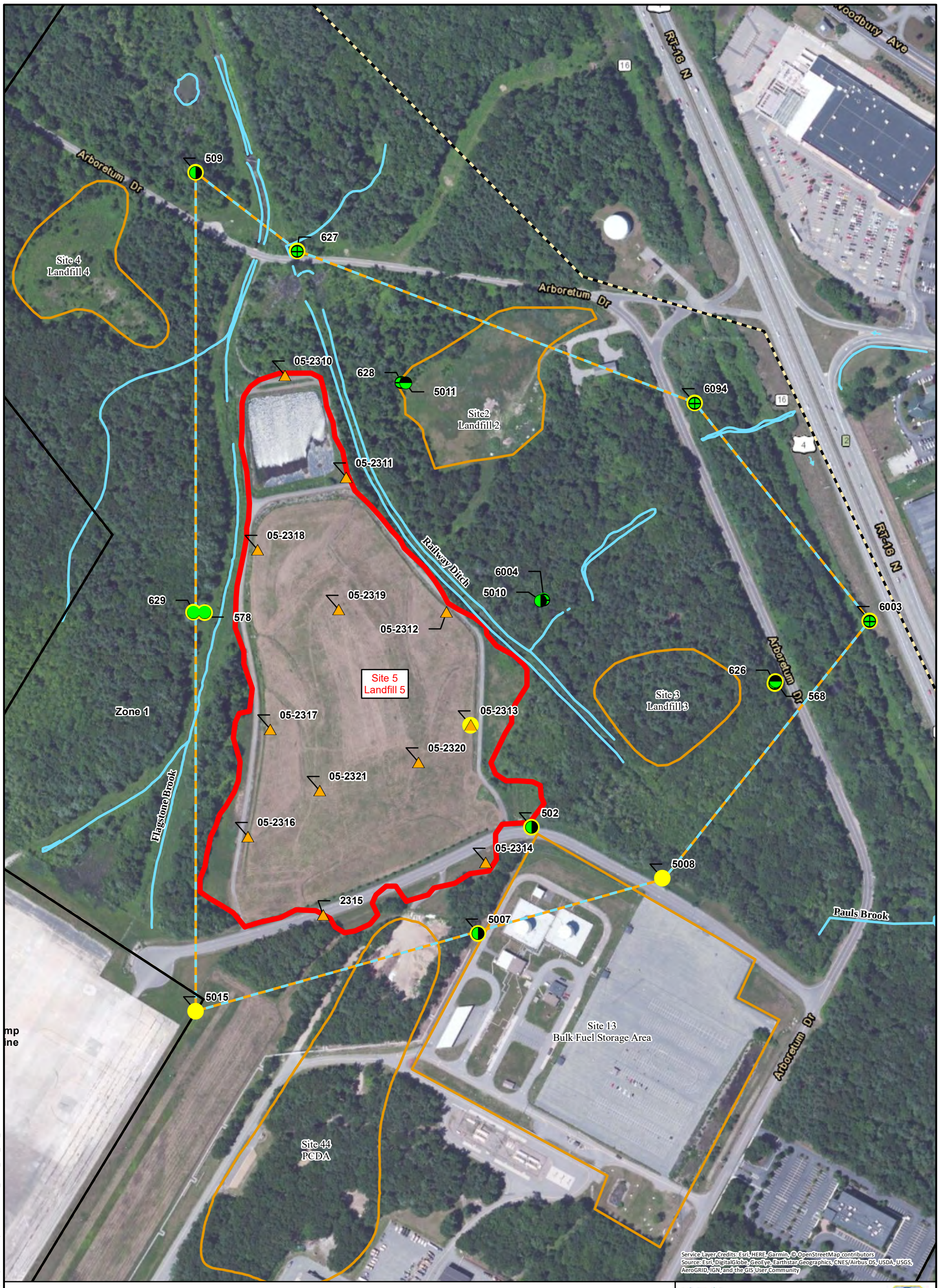

Legend

- Landfill 5 Boundary
- Neighboring Site
- Zone Boundary
- Landfill 5 GMZ Boundary
- Stream/Surface Water
- Upper Sand Overburden Piezometer
- Upper Sand Overburden Well
- Lower Sand Overburden Well
- Hybrid Well
- Bedrock Well
- Sampled in 2012

Notes:
1) GMZ = Groundwater Management Zone

N

0 150 300 600 Feet

PROJECTION: NAD_1983_StatePlane_New_Hampshire_FIPS_2800_Feet

U.S. AIR FORCE

Five Year Review Report (2014 - 2019)

FIGURE NUMBER 3-1

LANDFILL 5/ZONE 1 GROUNDWATER MONITORING LOCATIONS FORMER PEASE AIR FORCE BASE PORTSMOUTH, NEW HAMPSHIRE

APTIM
150 Royall Street
Canton, MA 02021

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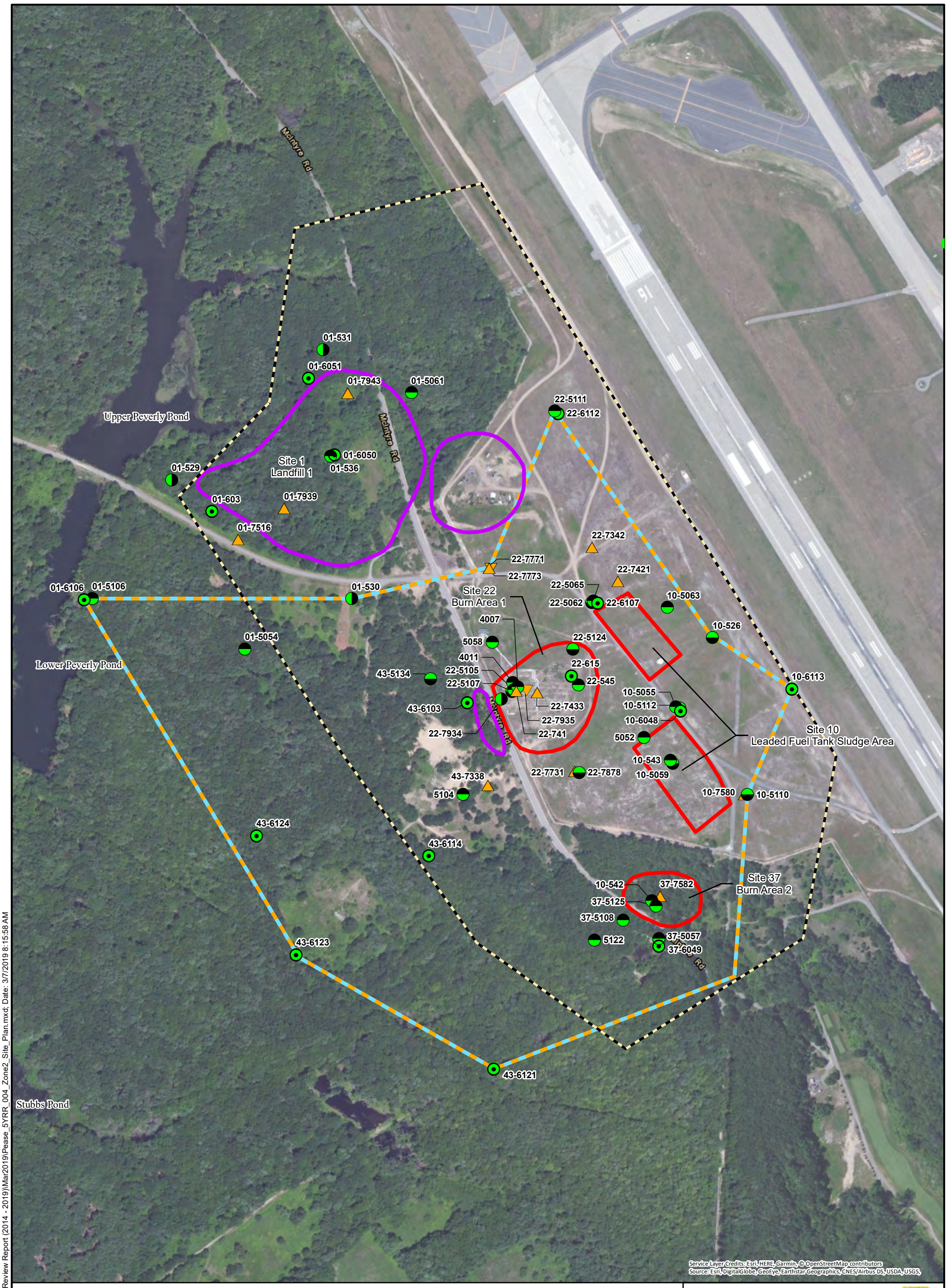

- Upper Sand Overburden Piezometer
- Lower Sand Overburden Piezometer
- Upper Sand Overburden Well
- Lower Sand Overburden Well
- Hybrid Well
- Shallow Bedrock Well
- Zone 2 GMZ Boundary
- Zone 2 Boundary
- Site Boundaries Included in Zone 2 LTMP
- Site Boundaries Not Included in Zone 2 LTMP

N

0 200 400 800 Feet

PROJECTION: NAD_1983_StatePlane_New_Hampshire_FIPS_2800_Feet

U.S. AIR FORCE

Five Year Review Report (2014 - 2019)

FIGURE NUMBER 3-2

SITE PLAN
ZONE 2
FORMER PEASE AIR FORCE BASE
PORTSMOUTH, NEW HAMPSHIRE

APTIM
150 Royall Street
Canton, MA 02021

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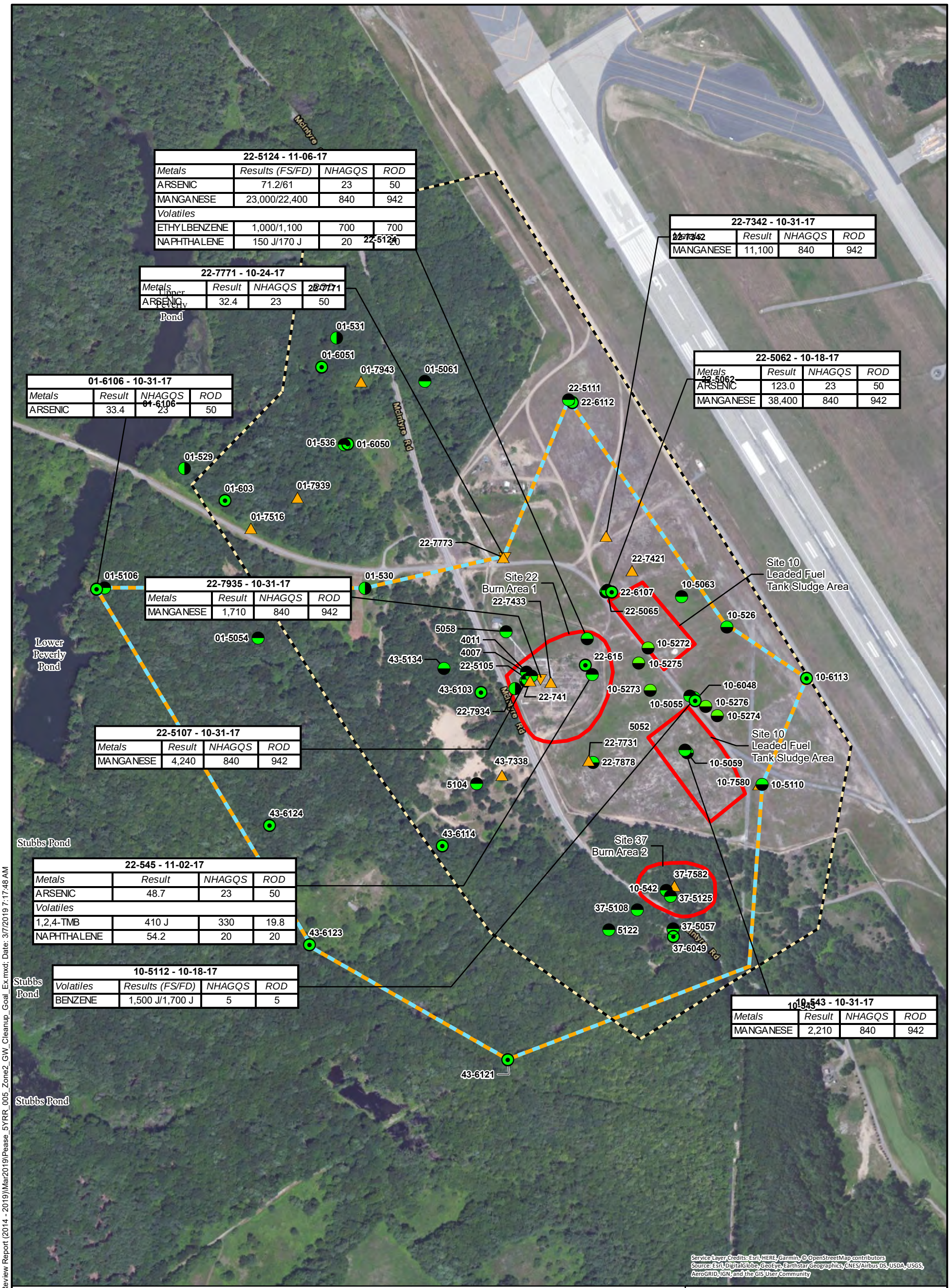
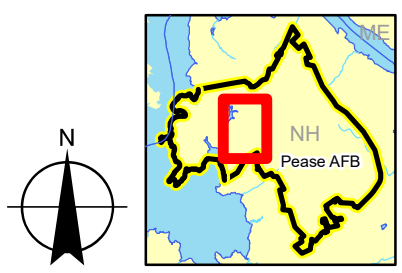


- Upper Sand Overburden Well
- Lower Sand Overburden Well
- Hybrid Well
- Shallow Bedrock Well
- Upper Sand Overburden Piezometer
- Lower Sand Overburden Piezometer
- Zone 2 Boundary
- Zone 2 GMZ Boundary
- Site Boundary

NOTES:
1) Results in micrograms per liter.
2) NHAGQS= New Hampshire Ambient Groundwater Quality Standard.
3) ROD = Record of Decision (Cleanup Goals) - Zone 2 Pease Air Force Base, New Hampshire (Weston, 1995)



N

0 200 400 800 Feet

PROJECTION: NAD_1983_StatePlane_New_Hampshire_FIPS_2800_Feet

U.S. AIR FORCE

Five Year Review Report (2014 - 2019)

FIGURE NUMBER 3-3

ZONE 2 LTM GROUNDWATER CLEANUP GOAL EXCEEDANCES FORMER PEASE AIR FORCE BASE PORTSMOUTH, NEW HAMPSHIRE

APTIM
150 Royall Street
Canton, MA 02021

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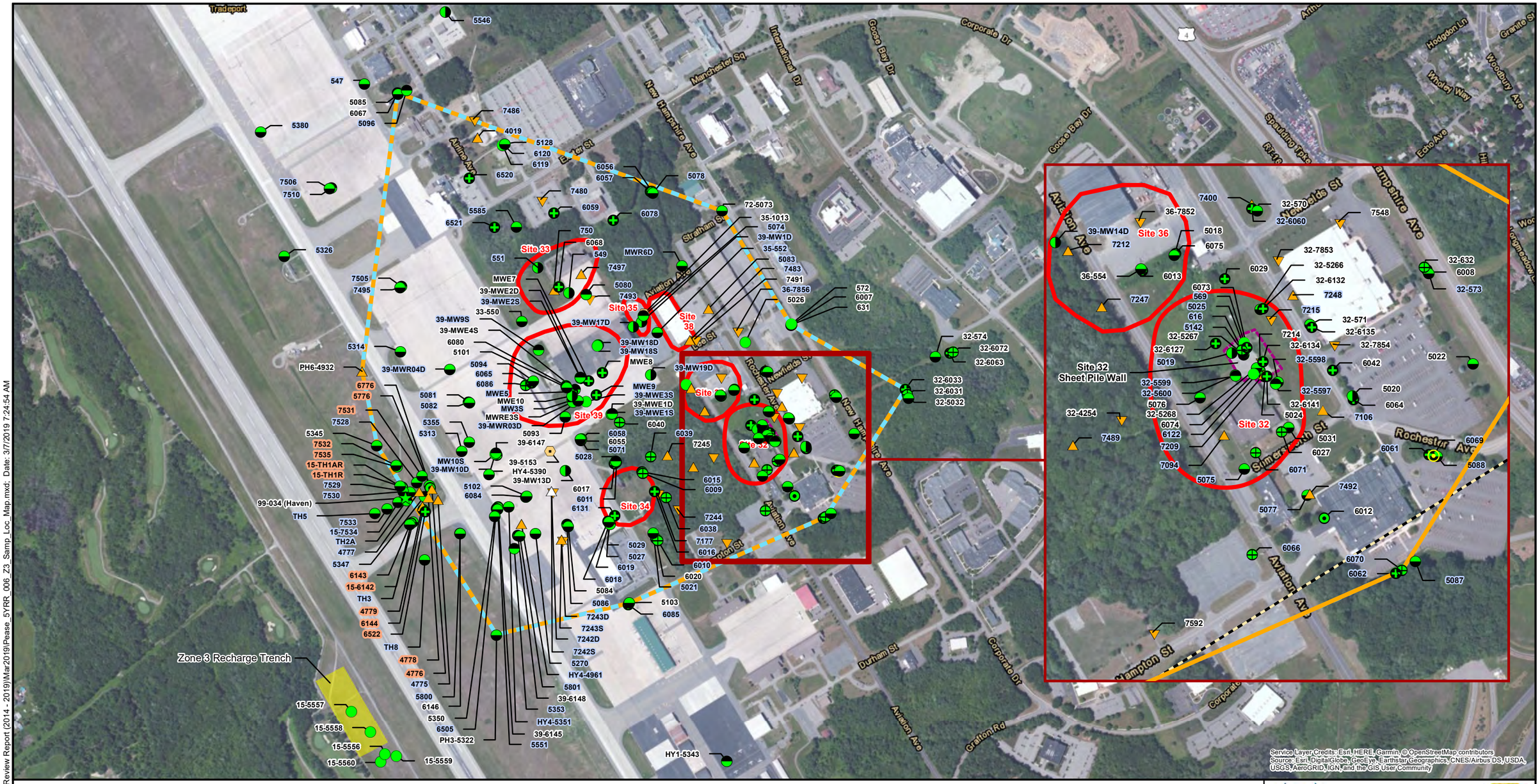

- Zone 3 GMZ Boundary
- Site Location
- Site 32 Sheet Pile Wall
- Zone 3 Recharge Trench
- Recovery Well
- Overburden Well
- Upper Sand Overburden Well
- Lower Sand Overburden Well
- Hybrid Well
- Bedrock Well
- Fractured Bedrock Well
- Shallow Bedrock Well
- Deep Bedrock Well
- Overburden Piezometer
- Upper Sand Overburden Piezometer
- Lower Sand Overburden Piezometer
- 5801 Water Levels Only
- 4772 Sentry Well

Notes:
1) GMZ = Groundwater Management Zone

N

0 300 600 1,200 Feet

PROJECTION: NAD_1983_StatePlane_New_Hampshire_FIPS_2800_Feet

ME
Pease AFB
NH

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Five Year Review Report (2014 - 2019)

FIGURE NUMBER 3-4

ZONE 3 SAMPLING LOCATION MAP FORMER PEASE AIR FORCE BASE PORTSMOUTH, NEW HAMPSHIRE

APTIM
150 Royall Street
Canton, MA 02021

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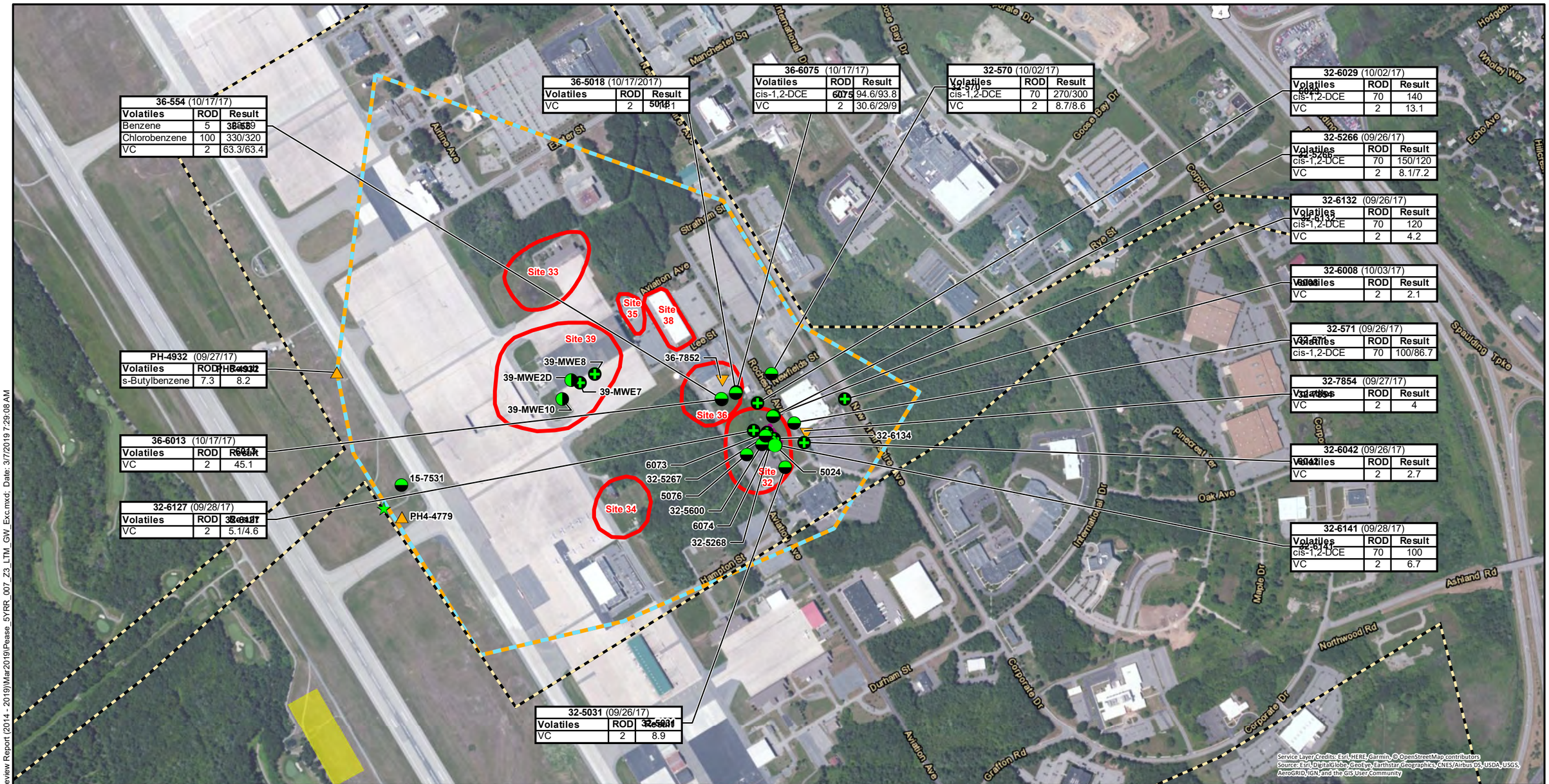
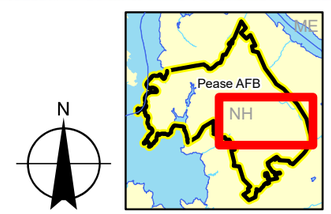


Zone 3 Boundary
Zone 3 GMZ Boundary
Site 32 Sheet Pile Wall
Site Location
Zone 3 Recharge Trench

Lower Sand Overburden Well
Hybrid Well
Fractured Bedrock Well
Upper Sand Overburden Piezometer
Lower Sand Overburden Piezometer

Notes:
1) All results are in micrograms per liter (µg/L).
2) Both sets of results presented for field duplicate pairs.
3) J qualifier indicates estimated value.

Acronyms:
DCE denotes dichloroethene.
GMZ denotes Groundwater Management Zone.
LTM denotes long-term monitoring.
ROD denotes Zone 3 Record of Decision Amendment.
VC denotes vinyl chloride.



0 350 700 1,400 Feet

PROJECTION: NAD_1983_StatePlane_New_Hampshire_FIPS_2800_Feet

U.S. AIR FORCE

Five Year Review Report (2014 - 2019)

FIGURE NUMBER 3-5

ZONE 3 LTM GROUNDWATER EXCEEDANCES FORMER PEASE AIR FORCE BASE PORTSMOUTH, NEW HAMPSHIRE

APTIM
150 Royall Street
Canton, MA 02021

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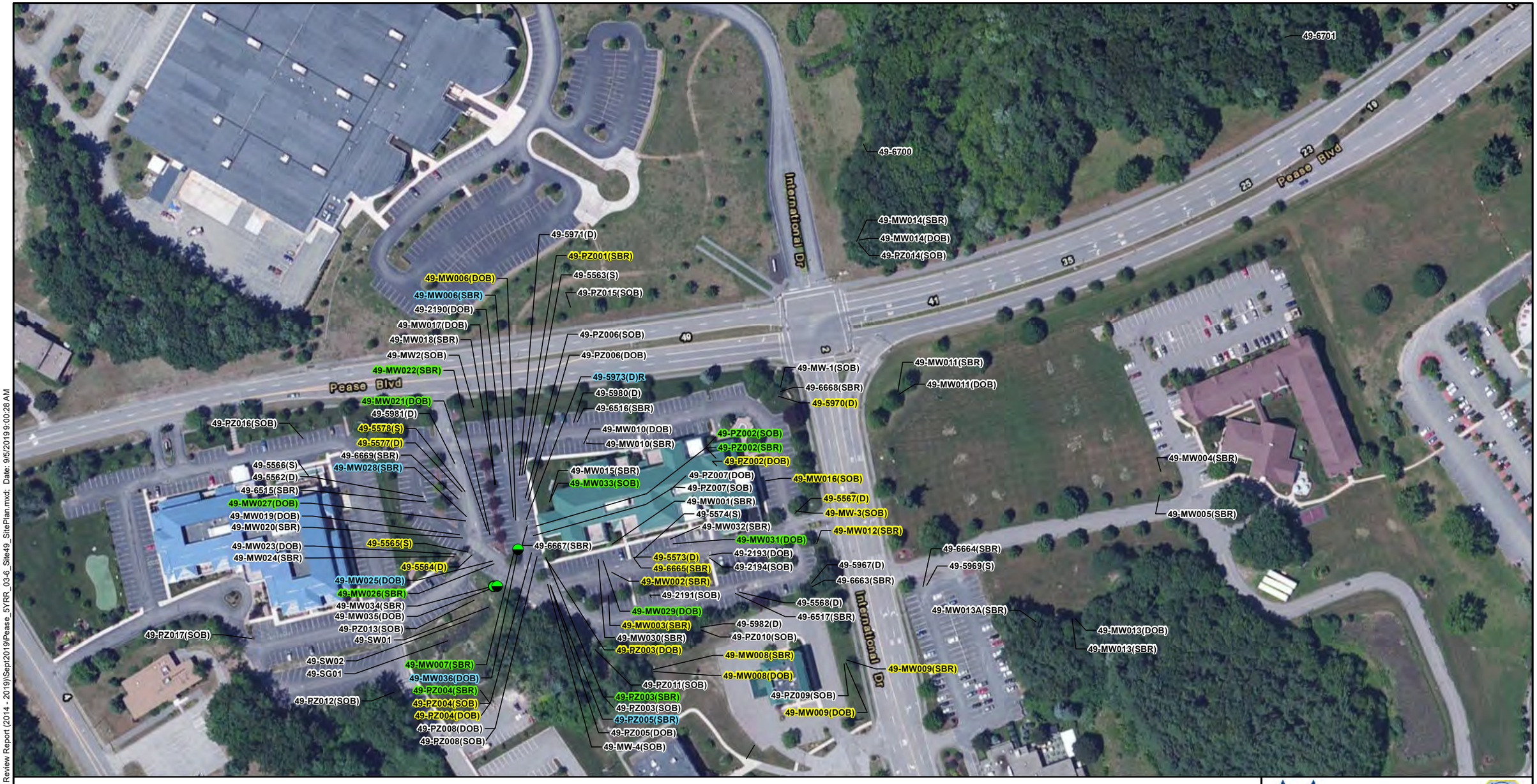

Former Building 22

GMZ Boundary

Permeable Reactive Barrier (Shallow)

Permeable Reactive Barrier (Deep)

Storm Water Basin

Well ID LTM Wells

Well ID PM Wells

Well ID LTM/PM Wells

Note:
GMZ = Groundwater Management Zone

N

0 150 300 Feet

Projection : NAD_1983_StatePlane_New_Hampshire_FIPS_2800_Feet

U.S. AIR FORCE

Five Year Review Report (2014 - 2019)

FIGURE NUMBER 3-6

SITE PLAN
SITE 49
FORMER PEASE AIR FORCE BASE
PORTSMOUTH, NEW HAMPSHIRE

APTIM
150 Royall Street
Canton, MA 02021

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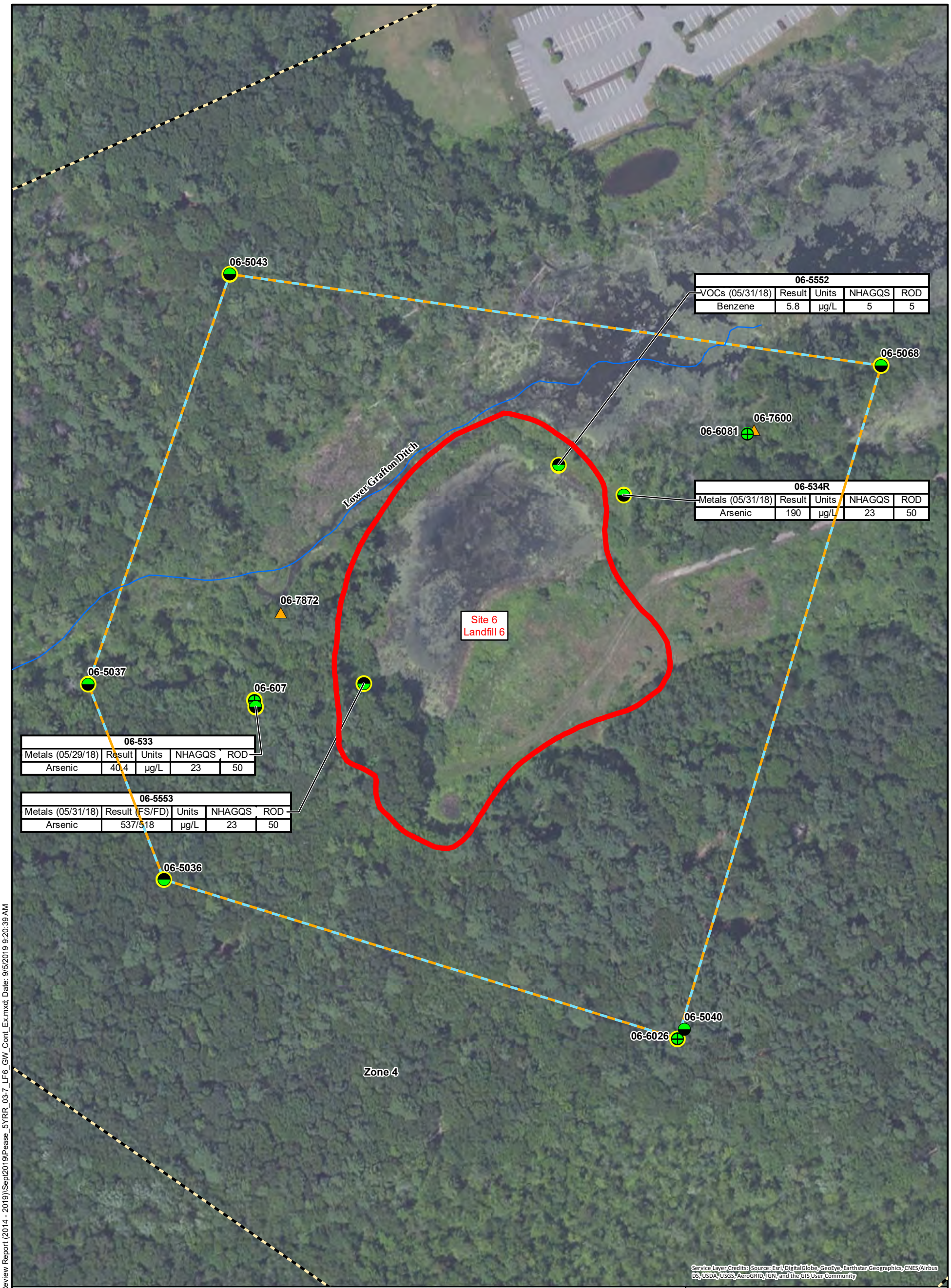


06-5552				
VOCs (05/31/18)	Result	Units	NHAGQS	ROD
Benzene	5.8	µg/L	5	5

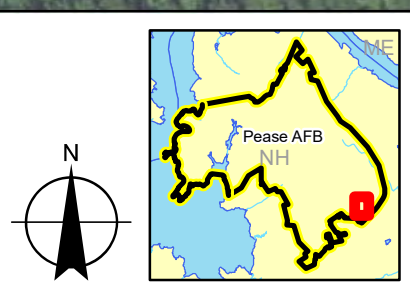
06-534R				
Metals (05/31/18)	Result	Units	NHAGQS	ROD
Arsenic	190	µg/L	23	50

06-533				
Metals (05/29/18)	Result	Units	NHAGQS	ROD
Arsenic	40.4	µg/L	23	50

06-5553				
Metals (05/31/18)	Result (FS/FD)	Units	NHAGQS	ROD
Arsenic	537/518	µg/L	23	50

Upper Sand Overburden Piezometer
Upper Sand Overburden Well
Lower Sand Overburden Well
Bedrock Well
Sampled in 2018
Site Boundary
Zone Boundary
GMZ Boundary
Stream/Surface Water

Notes:
1) GMZ = Groundwater Management Zone
2) NHAGQS = New Hampshire Ambient Groundwater Quality Standards
3) µg/L = micrograms per liter
4) ROD = Zone 2 Record of Decision Cleanup Goal



N

0 62.5 125 250 Feet

PROJECTION: NAD_1983_StatePlane_New_Hampshire_FIPS_2800_Feet

U.S. AIR FORCE

Five Year Review Report (2014 - 2019)

FIGURE NUMBER 3-7

LANDFILL 6/ZONE 4 GROUNDWATER CONTAMINANTS EXCEEDING NHAGQS AND ROD CGs IN 2018 FORMER PEASE AIR FORCE BASE PORTSMOUTH, NEW HAMPSHIRE

APTIM
150 Royall Street
Canton, MA 02021

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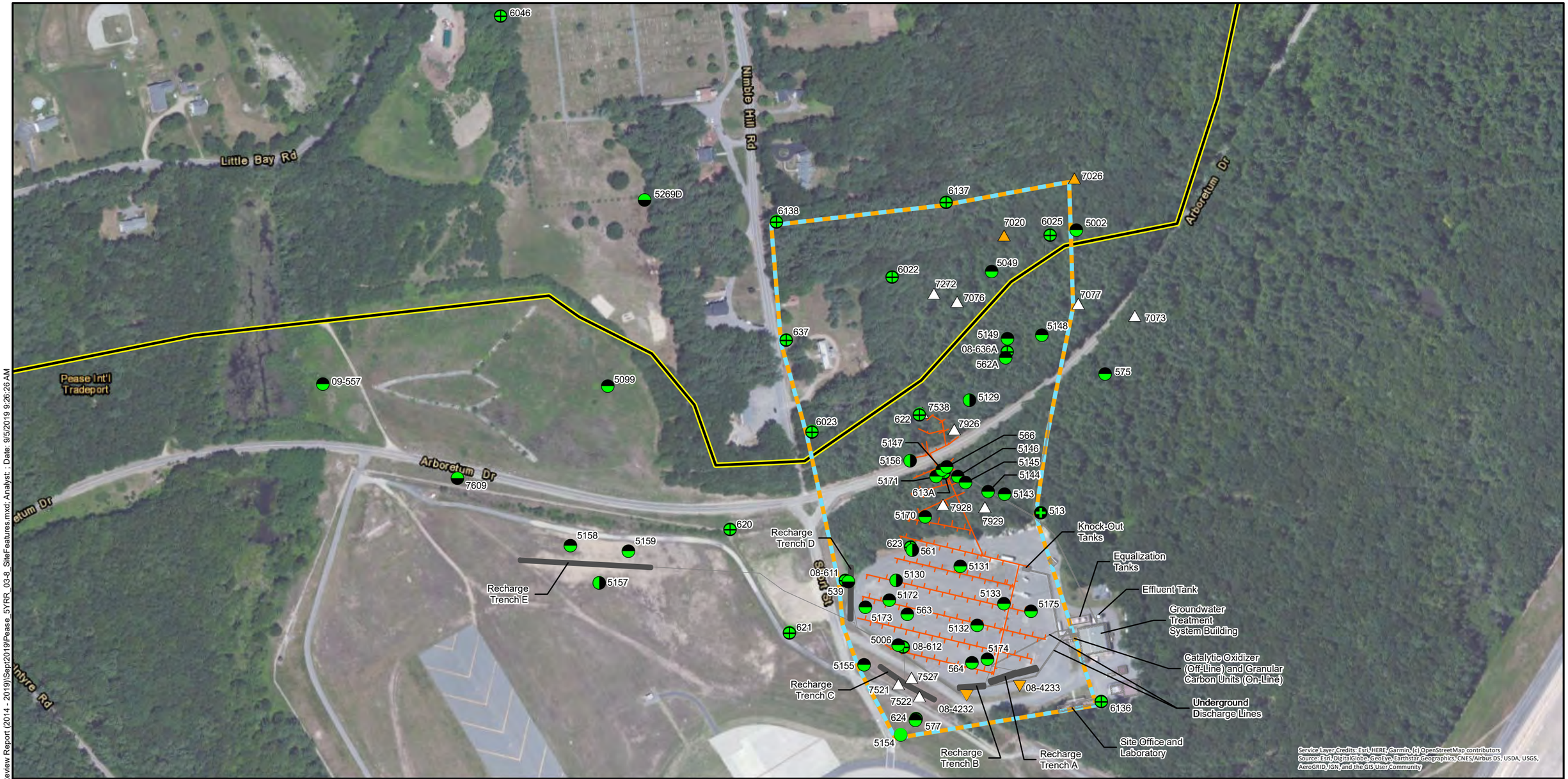

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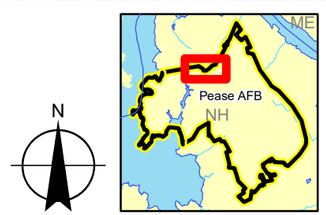
- Upper Sand Overburden Well
- Lower Sand Overburden Well
- Hybrid Well
- Bedrock Well
- Fractured Bedrock Well
- Overburden Piezometer
- Upper Sand Overburden Piezometer
- Lower Sand Overburden Piezometer

- Former Air Force Base Boundary
- Site 8 GMZ Boundary
- SVE System Piping

Notes:
1) GMZ = Groundwater Management Zone



N

0 300 600 Feet

PROJECTION: NAD_1983_StatePlane_New_Hampshire_FIPS_2800_Feet

U.S. AIR FORCE

Five Year Review Report (2014 - 2019)

FIGURE NUMBER 3-8

SITE FEATURES
SITE 8
FORMER PEASE AIR FORCE BASE
PORTSMOUTH, NEW HAMPSHIRE

APTIM
150 Royall Street
Canton, MA 02021

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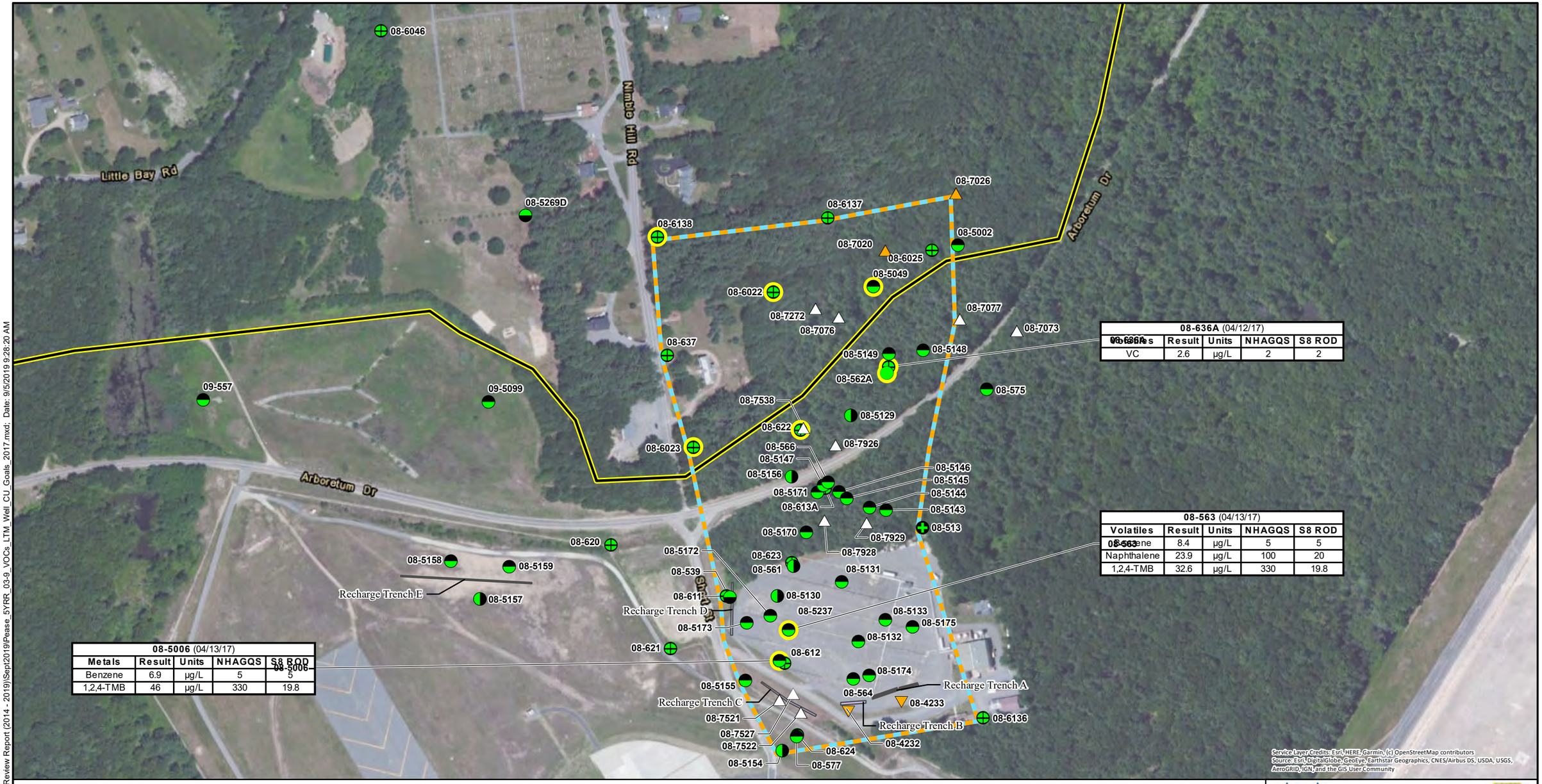

Upper Sand Overburden Well
Lower Sand Overburden Well
Hybrid Well
Bedrock Well
Fractured Bedrock Well
Overburden Piezometer
Upper Sand Overburden Piezometer
Lower Sand Overburden Piezometer

Sampled in 2017 - LTM Well
Former Air Force Base Boundary
Site 8 GMZ Boundary

N

0 150 300 600 Feet

PROJECTION: NAD_1983_StatePlane_New_Hampshire_FIPS_2800_Feet

U.S. AIR FORCE

Five Year Review Report (2014 - 2019)

FIGURE NUMBER 3-9

VOCs AT LTM WELLS EXCEEDING CLEANUP GOALS IN 2017
SITE 8
FORMER PEASE AIR FORCE BASE
PORTSMOUTH, NEW HAMPSHIRE

APTIM
150 Royall Street
Canton, MA 02021

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Overburden Well
Upper Sand Overburden Well
Lower Sand Overburden Well
Hybrid Well
Overburden Piezometer
Sampled in 2018
Long-Term Monitoring Well
GMZ Boundary

Former Building Location
Former Above Ground Storage Tank
Former Features

Notes:
1) GMZ = Groundwater Management Zone
2) ROD = Record of Decision; Site 45 (Weston, 1995)
3) µg/L = micrograms per liter
4) Manganese denotes total manganese

N

0 60 120
Feet

Projection : NAD_1983_StatePlane_New_Hampshire_FIPS_2800_Feet

U.S. AIR FORCE

U.S. AIR FORCE

Five Year Review Report (2014 - 2019)

FIGURE NUMBER 3-10

MANGANESE CONCENTRATIONS IN GROUNDWATER, JULY 2018
SITE 45
FORMER PEASE AIR FORCE BASE
PORTSMOUTH, NEW HAMPSHIRE

APTIM
150 Royall Street
Canton, MA 02021

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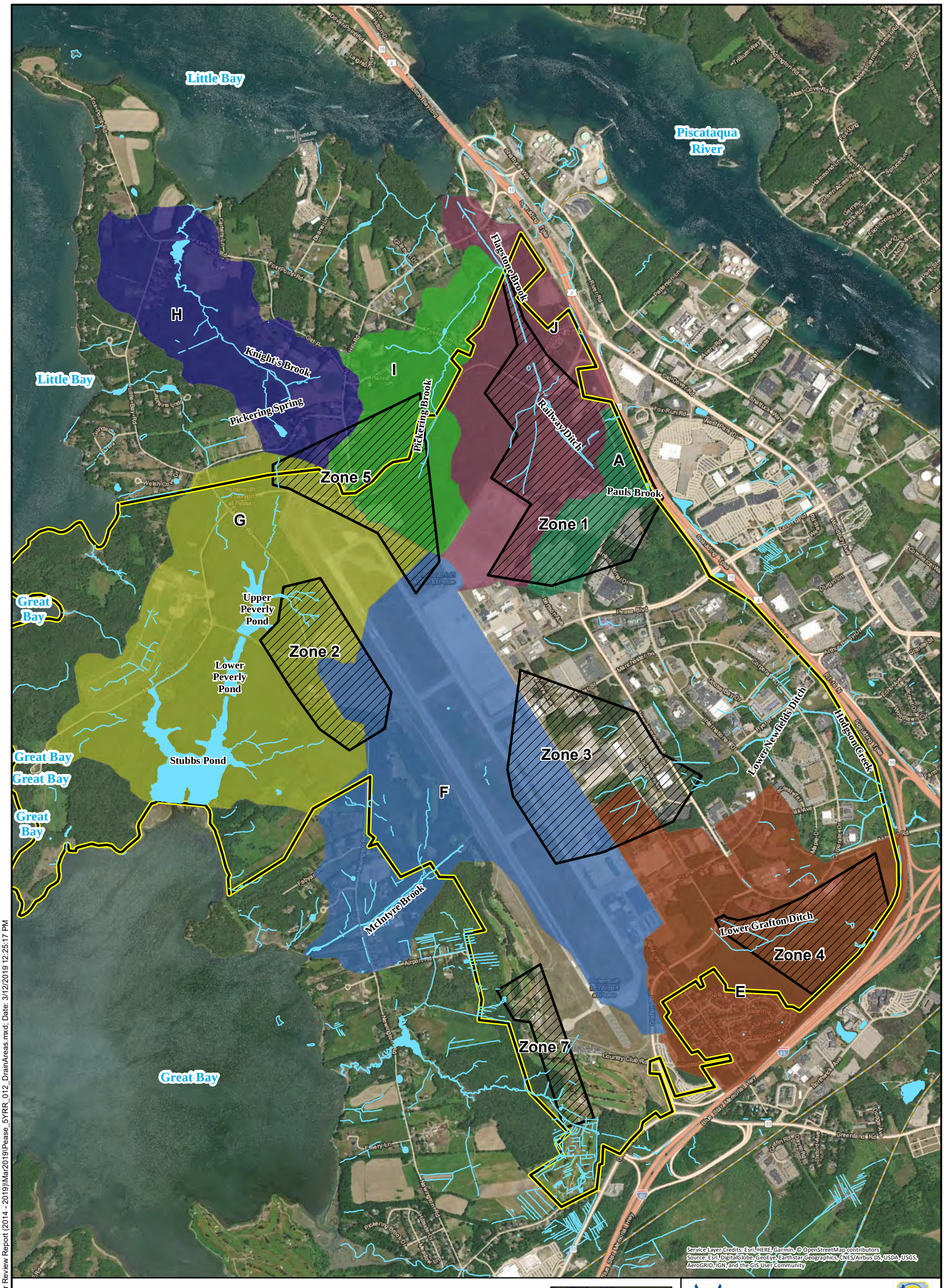

Drainage Area

- A
- E
- F
- G
- H
- I
- J

- Former Air Force Base Boundary
- Stream/Surface Water
- Zone Boundary

N

Pease AFB
NH
ME

0 1,000 2,000 4,000
Feet

PROJECTION: NAD_1983_StatePlane_New_Hampshire_FIPS_2800_Feet

U.S. AIR FORCE

Five Year Review Report (2014 - 2019)

FIGURE NUMBER 4-1

DRAINAGE AREAS
FORMER PEASE AIR FORCE BASE
PORTSMOUTH, NEW HAMPSHIRE

APTIM
150 Royall Street
Canton, MA 02021

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Appendix A
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Appendix B
Evaluation of Groundwater and Soil Cleanup Goals and ARARs

Appendix B-1
Evaluation of Groundwater Cleanup Goals and ARARs
Former Pease Air Force Base
Portsmouth, New Hampshire

Contaminant	Cleanup Goal (CG) (µg/L)	Basis	Current MCL (EPA, 2019)	Current NHAGQS (NHDES, 2018a)	Sites	Change to CG needed?
Inorganics						
Antimony	6	MCL	6	6	Site 8	No
Arsenic	50	MCL	10	10	LF-5 Water Table, Deep BR; Sites 10/22 OB; LF-6; Site 8	Yes, change to Pease background concentration of 23 µg/L recommended.
Arsenic	23	Background	10	10	Zone 3	No, Pease background concentration still appropriate.
Beryllium	4	MCL	4	4	Site 8	No
Boron	620	NHAGQS	None	620	LF-6	No
Cadmium	5	MCL	5	5	Site 10/22 OB; LF-6; Site 8	No
Chromium (total)	100	MCL	100	100	Site 8	No
Lead	15	MCL*	15	15	Site 10/22 OB; Zone 3; LF-6; Site 8; Site 45	No
Manganese	942	Background	None	840	LF-5 Water Table; Site 10/22 OB; Zone 3	No, Pease background concentration still appropriate.
Manganese	1500	NHDPHS	None	840	Site 8; Site 45	Yes, change to Pease background concentration of 942 µg/L recommended.
Nickel	100	MCL	None	100	Zone 4, Landfill 6; Site 8	No
Thallium	2	MCL	2	2	LF-5 Water Table; Site 8	No
Vanadium	50	Background (dissolved)	None	None	Site 8	No, no ARARs available.
Vanadium	256	Risk-based	None	None	Zone 3	Yes, current CG exceeds a Hazard Index of 1 for residential tap water; a change to CG of 86 µg/L is recommended, see Section 3.3.7.2.
SVOCs						
Bis(2-ethylhexyl) phthalate	6	MCL	6	6	LF-5 Water Table, Deep Bedrock; Sites 10/22/37 OB; Zone 3; Site 8	No
Carbon disulfide	7	NHAGQS	None	70	Site 49	No, revised ARAR is higher.
1,2-Dibromoethane	0.05	MCL	0.05	0.05	Sites 10/22 OB	No
2-Methylnaphthalene	13.4	Risk-based	None	280	Sites 10/22/37 OB; Site 8; Site 45	No, revised ARAR is higher.
2-Methylnaphthalene	280	NHAGQS	None	280	Zone 3	No

Appendix B-1 (continued)
Evaluation of Groundwater Cleanup Goals and ARARs
Former Pease Air Force Base
Portsmouth, New Hampshire

Contaminant	Cleanup Goal (CG) (µg/L)	Basis	Current MCL (EPA, 2019)	Current NHAGQS (NHDES, 2018a)	Sites	Change to CG needed?
4-Methylphenol	350	NHAGQS	None	40	LF-6, Site 8	No, current CG does not result in a non-cancer Hazard Index greater than 1 based on the default exposure factors for residential tap water in the RSL calculator.
Naphthalene	20	NHAGQS	None	100	Sites 10/22 OB; Zone 3; Site 49; Site 8; Site 45	No, revised ARAR is higher.
Phenanthrene	12.4	Risk-based	None	210	Site 8	No, revised ARAR is higher.
Pesticides/PCBs						
Aroclor-1260	0.5	MCL	0.5	0.5	LF-5 Water Table	No
gamma-BHC	0.2	MCL	0.2	0.2	Site 8	No
4,4'-DDD	0.177	Risk-based	None	0.1	Site 8	No, current CG does not result in a non-cancer Hazard Index greater than 1 based on the default exposure factors for residential tap water in the RSL calculator.
4,4'-DDT	0.1	NHDPHS	None	0.1	Site 8	No
Heptachlor	0.4	MCL	0.4	0.4	Site 8	No
VOCs						
Benzene	5	MCL	5	5	LF-5 Water Table, Deep Bedrock; Sites 10/22 OB, BR; Zone 3; LF-6; Site 8; Site 45	No
Bromochloromethane	90	Lifetime Health Advisory	None	None	Site 8	No
2-Butanone	170	NHAGQS	None	4,000	Site 49; LF-6	No, revised ARAR is higher.
sec-Butylbenzene	7.3	Risk-Based	None	260	Sites 10/22 OB; Zone 3; Site 8; Site 45	No, revised ARAR is higher.
Chlorobenzene	100	MCL	100	100	Zone 3; LF-6	No
Dibromochloromethane	0.3	NHAGQS	80 (for total trihalomethanes)	60	Site 49	No, revised ARAR is higher.
1,2-Dibromoethane	0.000993	Risk-Based	0.05	0.05	Site 8	No, revised ARAR is higher.
1,4-Dichlorobenzene	75	MCL	75	75	LF-6; Site 8	No
1,1-Dichloroethane	8.1	Risk	None	81	LF-5 Water Table, Deep Bedrock	No, revised ARAR is higher.
1,1-Dichloroethane	81	NHAGQS	None	81	Site 49; Site 73	No
1,1-Dichloroethene	7	MCL	7	7	Zone 3; Site 49; Site 73	No
1,2-Dichloroethane	5	MCL	5	5	Site 49; Site 8	No

Appendix B-1 (continued)
Evaluation of Groundwater Cleanup Goals and ARARs
Former Pease Air Force Base
Portsmouth, New Hampshire

Contaminant	Cleanup Goal (CG) (µg/L)	Basis	Current MCL (EPA, 2019)	Current NHAGQS (NHDES, 2018a)	Sites	Change to CG needed?
cis-1,2-Dichloroethene	70	MCL	70	70	Zone 3; Site 49; Site 73; Site 8; Site 45	No
trans-1,2-Dichloroethene	100	MCL	100	100	Zone 3; Site 49; Site 73; Site 8	No
Ethylbenzene	700	MCL	700	700	Sites 10/22 OB; Zone 3; Site 8	No
Isopropylbenzene	88.1	Risk-Based	None	800	Sites 10/22 OB; Site 45	No, revised ARAR is higher.
Isopropylbenzene	89.1	Risk-Based	None	800	Site 8	No, revised ARAR is higher.
Methylene chloride	5	MCL	5	5	Site 49; Site 8	No
Methyl isobutyl ketone	350	NHAGQS	None	2000	Sites 10/22 OB	No, revised ARAR is higher.
Tetrachloroethene	5	MCL	5	5	LF-5 Water Table, Deep Bedrock; Zone 3; Site 49; Site 73; Site 8	No
Toluene	1,000	MCL	1,000	1,000	Sites 10/22 OB; Zone 3; Site 8	No
Trichloroethene	5	MCL	5	5	LF-5 Water Table, Deep Bedrock; Sites 10/22/37 OB; Zone 3; Site 49; Site 73; LF-6; Site 8	No
1,2,4-Trimethylbenzene	19.8	Risk-based	None	330	Sites 10/22 OB; Zone 4, LF-6; Site 8; Site 45	No, revised ARAR is higher.
Vinyl chloride	2	MCL	2	2	LF-5 Water Table; Zone 3; Site 49; Site 73; LF-6; Site 8	No

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Appendix B-2
Evaluation of Soil Cleanup Goals and ARARs
Former Pease Air Force Base
Portsmouth, New Hampshire

Contaminant	Cleanup Goal (CG) (mg/kg)	Basis	Current Soil ARAR - NHSRS (NHDES, 2018a) (mg/kg)	Basis	Groundwater Concentration Basis of Leaching CG in ROD (µg/L)	Basis	Current Groundwater ARAR (µg/L)	Basis	Sites	Change to CG needed?
Inorganics										
Arsenic	15.25	Background	11	Background	NA	NA	NA	NA	Site 33; Site 36	No, CG based on Pease background.
Chromium (total)	37.5	Background	1000	Ceiling concentration	NA	NA	NA	NA	Site 36	No, revised ARAR is higher.
Lead	65.3	Background	400	Direct contact	NA	NA	NA	NA	Site 36; Site 45	No, revised ARAR is higher.
Zinc	92.3	Background	1000	Direct contact	NA	NA	NA	NA	Site 45	No, revised ARAR is higher.
Manganese	623	Background	1000	Ceiling concentration	NA	NA	NA	NA	Site 39	No, revised ARAR is higher.
SVOCs										
Butyl benzyl phthalate	1.5	Leaching	None	NA	100	Proposed MCL	None	NA	Site 8	NA
Chrysene	2.9	Leaching	120	Direct contact	0.2	Proposed MCL	5	NHAGQS	Site 8	No, revised ARAR is higher.
2-Methylnaphthalene	5.4	Leaching	96	Direct contact	12.4	Non-cancer hazard	280	NHAGQS	Site 8	No, revised ARAR is higher.
4-Methyl-2-pentanone	2.8	Leaching	29	Leaching	350	NHDPHS	2000	NHAGQS	Site 8	No, revised ARAR is higher.
Naphthalene	0.39	Leaching	28	Leaching	20	NHDPHS	100	NHAGQS	Site 38	No, revised ARAR is higher.
Naphthalene	1.4	Leaching	28	Leaching	20	NHDPHS	100	NHAGQS	Site 8	No, revised ARAR is higher.
Naphthalene	3	NHDES[b]	28	Leaching	NA	NA	100	NHAGQS	Site 45	No, revised ARAR is higher.
n-Nitrosodiphenylamine	0.36	Leaching	None	NA	7	Cancer risk	None	NA	Site 8	NA
Phenanthrene	4.6	Leaching	None	NA	13.4	Non-cancer hazard	210	NHAGQS	Site 38	NA
Phenol	0.45	Leaching	22	Leaching	4000	NHDPHS	4000	NHAGQS	Site 38	No, revised ARAR is higher.
Pesticides/PCBs										
Dieldrin	0.002	Leaching	0.06	Direct contact	0.002	NHDPHS	0.1	NHAGQS	Site 8	No, revised ARAR is higher.
VOCs										
Benzene	1	NHDES[a]	0.3	Leaching	NA	NA	NA	NA	Site 8	No, substantial reductions in groundwater concentrations of benzene have occurred due to soil removal and treatment, and concentrations in recent years have generally been below the MCL.
Benzene	0.2	NHDES[b]	0.3	Leaching	NA	NA	5	MCL	Site 45	No, revised ARAR is higher.
cis-1,2-Dichloroethene	4.7	Leaching	2	Leaching	70	MCL	70	MCL	Site 36	No, ROD CG is based on site-specific modeling.

Appendix B-2 (continued)
Evaluation of Soil Cleanup Goals and ARARs
Former Pease Air Force Base
Portsmouth, New Hampshire

Contaminant	Cleanup Goal (CG) (mg/kg)	Basis	Current Soil ARAR - NHSRS (NHDES, 2018a) (mg/kg)	Basis	Groundwater Concentration Basis of Leaching CG in ROD (µg/L)	Basis	Current Groundwater ARAR (µg/L)	Basis	Sites	Change to CG needed?
Ethylbenzene	1	NHDES[a]	120	Direct contact	NA	NA	NA	NA	Site 8	No, revised ARAR is higher.
Ethylbenzene	75	NHDES[b]	120	Direct contact	NA	NA	NA	NA	Site 45	No, revised ARAR is higher.
Toluene	75	NHDES[b]	100	Leaching	NA	NA	1000	NHAGQS	Site 45	No, revised ARAR is higher.
Trichloroethene	0.7	Leaching	0.8	Leaching	5	MCL	5	MCL	Site 36	No, revised ARAR is higher.
Trichloroethene	0.12	Leaching	0.8	Leaching	5	MCL	5	MCL	Site 39	No, revised ARAR is higher.
Trichloroethene	0.046	Leaching	0.8	Leaching	5	MCL	5	MCL	Site 8	No, revised ARAR is higher.
Vinyl chloride	0.02	Leaching	1	Direct contact	2	MCL	2	MCL	Site 36	No, revised ARAR is higher.
Xylenes	1	NHDES[a]	500	Ceiling concentration	NA	NA	NA	NA	Site 8	No, revised ARAR is higher.
Xylenes	750	NHDES[b]	500	Ceiling concentration	NA	NA	NA	NA	Site 45	No, revised ARAR is higher.

Appendix B-3
Notes for Appendices B-1 and B-2
Former Pease Air Force Base
Portsmouth, New Hampshire

** denotes Action Level.*

µg/L denotes micrograms per liter.

[a] denotes value for total benzene, toluene, ethylbenzene, and xylenes for NH Interim Policy for Petroleum-Contaminated Soils (NHDES, 1991).

ARAR denotes Applicable or Relevant and Appropriate Requirements.

[b] denotes based on NH Interim Policy for Petroleum-Contaminated Soils (NHDES, 1993).

BR denotes bedrock.

CG denotes cleanup goal.

DDD denotes dichlorodiphenyldichloroethane.

DDT denotes dichlorodiphenyltrichloroethane.

EPA denotes U.S. Environmental Protection Agency.

LF denotes landfill.

MCL denotes Maximum Contaminant Level.

mg/kg denotes milligrams per kilogram.

NA denotes not available or not applicable.

NH denotes New Hampshire.

NHAGQS denotes New Hampshire Ambient Groundwater Quality Standards.

NHDES denotes New Hampshire Department of Environmental Services.

NHDPHS denotes New Hampshire Department of Public Health Services.

NHSRS denotes New Hampshire Site Remediation Standards.

OB denotes overburden.

PCB denotes polychlorinated biphenyl.

RSL denotes Regional Screening Level.

SVOC denotes semivolatile organic compound.

VOC denotes volatile organic compound.

Sources for CGs:

MWH Americas, Inc. (MWH), 2003. Zone 3 Record of Decision Amendment, December.

Roy F. Weston (Weston), 1993. Record of Decision for a Source Area Remedial Action at Landfill 5, September.

Weston, 1994. Site 8 Record of Decision, Former Pease Air Force Base, Portsmouth, New Hampshire, September.

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Weston, 1995. Record of Decision, Zone 2, Pease Air Force Base, New Hampshire, September.

Weston, 1995. Record of Decision for Zone 3, September.

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Weston, 1995. Site 45 Record of Decision, Former Pease Air Force Base, Portsmouth, New Hampshire, August.

Sources for current ARARs:

EPA, 2019. National Primary Drinking Water Regulations <https://www.epa.gov/ground-water-and-drinking-water/national-primary-drinking-water-regulations>, March.

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Appendix C
Land Use Control Summary

Appendix C
Land Use Control Summary
Former Pease Air Force Base
Portsmouth, New Hampshire

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	Yes	Yes	Zone 1, Landfill 5; Zone 2; Zone 3; Zone 3, Site 49; Zone 4, Landfill 6; Zone 5, Site 8; Zone 7, Site 45	Delineation of a GMZ that prohibits installing a well within a GMZ except for the purpose of determining or monitoring groundwater quality or quantity. The Smith Well, the Harrison Well, and the Haven Well are excepted.	Transfer documents between Air Force and PDA (Rockingham County Registry of Deeds, 2003, 2005); Zone 2 - transfer documents between Air Force and Newington (McIntyre Road only) and the DOI
Soil	Yes	Yes	Zone 1, Landfill 5; Zone 2; Zone 3; Zone 3, Site 49; Zone 5, Site 8; Zone 7, Site 45	Delineation of a URZ that prohibits residential use, childcare centers, playgrounds, athletic fields, or elementary or secondary schools. URZ for Landfill 5 prohibits activities that lead to erosion or damage to the landfill cover system. URZs also identified as ASN requiring concurrence from Air Force for any development within the GMZ and URZ, and specifically prohibiting activities that disturb ongoing remedies.	Transfer documents between Air Force and PDA (Rockingham County Registry of Deeds, 2003, 2005); Zone 2 - transfer documents between Air Force and Newington (McIntyre Road only) and the DOI

ASN denotes Area of Special Notice.

DOI denotes Department of Interior.

IC denotes institutional control.

GMZ denotes Groundwater Management Zone.

URZ denotes Use Restriction Zone.

UU/UE denotes Unlimited Use/Unrestricted Exposure.

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Appendix D
Protectiveness Statements from the 2009–2014 Five-Year Review Report

Appendix D
Protectiveness Statements from the 2009–2014 Five-Year Review Report

Protectiveness Statement(s)
Include each individual OU protectiveness determination and statement.

Operable Unit:	*Protectiveness Determination:*	*Addendum Due Date (if applicable):*
Zone 1, Landfill 5	Protective	

Protectiveness Statement:
The remedy at LF-5 is protective of human health and the environment. LF-5 debris has been relocated above the seasonally high groundwater elevation, the installation of the composite barrier cap is complete, and the GMZ and other ICs have been established and maintained.

Operable Unit:	*Protectiveness Determination:*	*Addendum Due Date (if applicable):*
Zone 2	Protective	

Protectiveness Statement:
The remedy is functioning per the remedial action objectives specified in the Zone 2 ROD and is protective of human health and the environment. LNAPL and residual product are no longer observed in Zone 2 soils. Concentrations of organic and inorganic COCs in groundwater have steadily declined across the zone. The COCs were below the CGs in the point-of-compliance wells during the 2013 sampling event. The ICs, including a GMZ, are in place and maintained to prevent groundwater exposures to the regulated contaminants.

Operable Unit:	*Protectiveness Determination:*	*Addendum Due Date (if applicable):*
Zone 3, Sites 32 and 36	Protective	

Protectiveness Statement:
The remedy at Sites 32 and 36 is protective of human health and the environment. Limited soil excavations have removed contaminated source soil. Hydraulic control has successfully contained the source area within the TI zone. Concentrations of the COCs have significantly decreased outside the TI zone since implementation of the groundwater containment/treatment system. The LUCs/ICs have prevented groundwater use and limited human contact via establishment of a GMZ and URZ.

Five-Year Review Summary Form (continued)

Operable Unit:	*Protectiveness Determination:*	*Addendum Due Date (if applicable):*
Zone 3, Sites 33, 34, 35, 38, and 39	Protective	

Protectiveness Statement:
The remedy at Sites 33, 34, 35, 38, and 39 is protective of human health and the environment. Soil removal actions have been completed at Sites 33, 34, 38, and 39. Groundwater RGs have been met at Sites 33, 34, 35, and 38. The Site 39 extraction and treatment system is providing source area hydraulic control. There were no violations of the GMZ between 2009 and 2013. The LUCs/ICs have prevented groundwater use and limited human contact via establishment of a GMZ and URZ.

Operable Unit:	*Protectiveness Determination:*	*Addendum Due Date (if applicable):*
Zone 4, Landfill 6	Protective	

Protectiveness Statement:
The remedy at LF-6 is protective of human health and the environment. All landfill wastes have been excavated and consolidated within the LF-5 cap. Wetlands were created to offset wetland impacts that occurred during construction of the LF-5 cap. Natural attenuation is ongoing, and a GMZ and other ICs have been established and maintained.

Operable Unit:	*Protectiveness Determination:*	*Addendum Due Date (if applicable):*
Zone 5, Site 8	Protective	

Protectiveness Statement:
The current remedial action objectives specified in the Site 8 ROD, implemented per its decision document for specific contaminants, is protective of human health and the environment for those contaminants. The amount and extent of LNAPL continues to decrease. The AS/SVE system has reduced soil and groundwater contaminant concentrations. The LUCs/ICs have prevented groundwater use and limited human contact via establishment of a GMZ and URZ.

Five-Year Review Summary Form (continued)

Operable Unit:	*Protectiveness Determination:*	*Addendum Due Date (if applicable):*
Zone 7, Site 45	Protective	

Protectiveness Statement:
The remedy at Site 45 is protective of human health and the environment. The AS and SVE have reduced the groundwater organic contaminant concentrations below criteria. Manganese concentrations continue to exceed the RGs in long-term performance monitoring wells. The LUCs/ICs have prevented groundwater use and limited human contact via establishment of a GMZ and URZ.

Operable Unit:	*Protectiveness Determination:*	*Addendum Due Date (if applicable):*
Zone 3, Site 73	Protective	

Protectiveness Statement:
The remedy at Site 73 is protective of human health and the environment. The PRB at Site 73 is functioning as intended by successfully capturing and remediating a substantial portion of the remaining groundwater contaminant plume. The ISEB injections have been completed with the goal of accelerating restoration of Site 73 groundwater. However, arsenic and manganese groundwater concentrations have been mobilized in groundwater as a result of ISEB injections. Future performance monitoring will continue to be conducted in part to verify the anticipated abatement of the mobilized arsenic and manganese. Should the mobilization of arsenic and manganese continue and threaten to migrate beyond the Site 73 GMZ, supplemental remedial action(s) may be necessary to halt their migration. The LUCs/ICs are in place to prevent groundwater use and limit human contact via establishment of a GMZ and URZ.

Operable Unit:	*Protectiveness Determination:*	*Addendum Due Date (if applicable):*
Zone 3, Site 49	Protective	

Protectiveness Statement:
The remedy at Site 49 is protective of human health and the environment. The PRB is functioning to reduce groundwater VOC concentrations. Supplemental application of ISEB technology is being developed to speed the remediation time frame. The LUCs/ICs have prevented groundwater use and limited human contact via establishment of a GMZ and URZ.

Five-Year Review Summary Form (continued)

Operable Unit:	*Protectiveness Determination:*	*Addendum Due Date (if applicable):*
Zone 1, Pauls Brook	Protective	

Protectiveness Statement:
The remedy at Pauls Brook is protective of human health and the environment. Contaminated sediment has been excavated. Inorganic constituent concentrations have met the CGs.

Operable Unit:	*Protectiveness Determination:*	*Addendum Due Date (if applicable):*
Zone 1, Railway Ditch and Flagstone Brook	Protective	

Protectiveness Statement:
The remedy at Railway Ditch (including Flagstone Brook) is protective of human health and the environment. Contaminated sediment has been removed from Railway Ditch. Surface water and sediment LTM is ongoing.

Operable Unit:	*Protectiveness Determination:*	*Addendum Due Date (if applicable):*
Zone 2, Peverly Drainage System	Protective	

Protectiveness Statement:
The remedy at Peverly Brook is protective of human health and the environment. Surface water and sediment LTM is ongoing.

Operable Unit:	*Protectiveness Determination:*	*Addendum Due Date (if applicable):*
Zone 4, Lower Grafton Ditch	Protective	

Protectiveness Statement:
The remedy at Grafton Ditch is protective of human health and the environment. Excavation of contaminated sediment has been completed, while surface water and sediment LTM is ongoing.

Operable Unit:	*Protectiveness Determination:*	*Addendum Due Date (if applicable):*
Zone 5, Knights Brook and Pickering Brook	Protective	

Protectiveness Statement:
The current remedy at Knights Brook and Pickering Brook, implemented per its decision document for specific regulated contaminants, is protective of human health and the environment for those contaminants.

Five-Year Review Summary Form (continued)

Operable Unit:	*Protectiveness Determination:*	*Addendum Due Date (if applicable):*
Zones 1, 2, 3, 4, 5, and 7, Vapor Intrusion	Short-Term Protective	03/30/2015

Protectiveness Statement:
Base-wide screening and sampling efforts to evaluate the vapor intrusion pathway identified a potentially complete groundwater to indoor air pathway at unoccupied Building 227. A quantitative risk evaluation of the vapor intrusion pathway should be conducted at Building 227 to determine if an unacceptable risk exists in excess of the EPA's risk range of 1 x 10-4 to 1 x 10-6, a hazard index greater than 1, for future commercial/industrial workers.

Site-Wide Protectiveness Statement (if applicable)

For sites that have achieved construction completion, enter a site-wide protectiveness determination and statement.

Protectiveness Determination:	*Addendum Due Date (if applicable):*
Protectiveness Deferred	03/30/2015

Protectiveness Statement:
With one exception, the remedies at the former Pease AFB site, defined in various decision documents for specific regulated contaminants and addressed in the Five-Year Review, are protective of human health and the environment. Numerous remedies are in place, including soil excavation, debris relocation, wetlands creation, AS/SVE, PRBs, in situ enhanced bioremediation, and long-term monitoring. In addition, the LUCs/ICs prevent groundwater use and limit human contact via establishment of GMZs and URZs. The lone exception is the potentially complete vapor intrusion pathway identified at unoccupied Building 227. A quantitative risk evaluation of the vapor intrusion pathway should be conducted at Building 227 to determine if the remedy is protective.

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Appendix E
Conclusions and Recommendations from the Brooks and Ditches Long-Term Monitoring Evaluation

APPENDIX E
CONCLUSIONS AND RECOMMENDATIONS FROM THE BROOKS AND DITCHES LONG-TERM MONITORING EVALUATION (CB&I, 2016)[1]

4.0 CONCLUSIONS AND RECOMMENDATIONS

This evaluation presents available surface water and sediment data for the brooks and ditches at the former Pease AFB, considering locations and parameters that are included in the current LTMP (MWH, 1993a). Locations included are Pauls Brook in Drainage Area A, Lower Grafton Ditch in Drainage Area E, Peverly Brook and Upper Peverly Pond in Drainage Area G, Location 99-015 (groundwater seep) in Drainage Area H, Pickering Brook in Drainage Area I, and Flagstone Brook and Railway Ditch in Drainage area J. Some locations included sampling and analysis of VOCs and pesticides; however, these parameters have been rarely detected in recent years. These results are discussed briefly in the text. Metals results are presented in tabular and graphical form. While the tables include all historical data available for the metals and locations currently included in the LTMP, the figures include data from 2000 to 2014 or 2015. Over this period, sampling was conducted annually at all locations, unless surface water locations could not be sampled due to dry conditions. Earlier data were not included in the graphical presentations because remedial activities were occurring at many locations during the mid- to late 1990s, and these activities may have affected the sample results.

In considering the results, of particular importance were the RAOs specified in the relevant RODs, if any. In addition, the CGs were considered if specified in the ROD. Relevant criteria were also considered, including background concentrations for the former Pease AFB, NHWQC for surface water, and ER-L and ER-M values for consideration of the potential for ecological risk associated with sediment exposure. Field measurement results were also considered.

In general, the results for both surface water and sediment were variable. This is not unexpected in surface water and sediment sampling due to the number of factors that can influence the results, including flow conditions, turbidity, pH, and alkalinity for surface water; and dissolved oxygen, total organic carbon, and grain size for sediment. Concentrations of aluminum and iron varied over several orders of magnitude in surface water samples from Grafton Ditch and Peverly Brook. In some cases, the variability could be attributed to sampling conditions, such as turbidity. However, elevated turbidity measurements did not always correlate with elevated metals results, i.e., similar

[1] CB&I Federal Services LLC (CB&I), 2016, *Brooks and Ditches Long-Term Monitoring Evaluation, Former Pease Air Force Base, Portsmouth, New Hampshire*, Final, November. All tabular and graphical presentations referenced in the above text can be found in the referenced report.

metal results were seen in some instances where turbidity varied. These discrepancies may be due to sampling errors, the sequence of sample collection and turbidity measurements, or the influence of some other unidentified factor. However, such discrepancies were generally isolated and infrequent.

The overall conclusion of this evaluation is that continued sampling and analysis of surface water and sediment in the brooks and ditches at the former Pease AFB is no longer needed to evaluate the potential source areas. The long duration of sampling has shown that ROD objectives, when specified, have been met. In many cases, impacts of the potential source areas on surface water and sediment have not been demonstrated by the extensive sampling conducted, and continued sampling and analysis is unlikely to do so. The specific conclusions for each drainage area are discussed below.

4.1 Pauls Brook—Drainage Area A

A remedy was selected for Pauls Brook in the Brooks and Ditches ROD that consisted of removal of contaminated sediment to address identified ecological risk. This remedial action was completed in the fall of 1997. Excavation in the cleanup area proceeded until sediment concentrations were below the CGs. The ROD specified that surface water and sediment samples from Pauls Brook be collected and analyzed semiannually for the first 5 years following remediation and annually thereafter, to monitor conditions within the brook and to determine whether additional remedial actions were warranted. Currently, sediment monitoring for site-specific metals (arsenic, cadmium, chromium, copper, lead, nickel, and zinc) is conducted at three locations annually in the spring. No additional remedial actions have been recommended or conducted since monitoring was initiated.

Concentrations of target metals in Pauls Brook sediment have generally been stable since 2006. Concentrations have been below the CGs for the most part during this period. Arsenic and nickel have been above their CGs more recently, however only at the upstream location that may be impacted by road runoff. Cadmium has been detected above the CG, however infrequently since 2006. Cadmium was not detected above the ER-M during the period of monitoring. As a result, no additional sediment remediation is or has been recommended for Pauls Brook and the continued monitoring of sediment provides no further benefit. Therefore, the ROD objective for sediment sampling has been met and discontinuation of sediment monitoring in Pauls Brook is recommended.

4.2 Grafton Ditch—Drainage Area E

The Zone 4 ROD concluded that surface water and sediment in Lower Grafton Ditch did not pose unacceptable risks to human receptors and marginal risks identified to ecological receptors were determined not to be site related. The Zone 4 ROD specified no RAOs for surface water and

sediment sampling, and CGs were not established. Surface water and sediment sampling in Lower Grafton Ditch were specified in the LTMP as part of the LF-6 selected remedial alternative.

LTM data for Lower Grafton Ditch surface water samples from 1993 to 2014 indicate no occurrences of VOCs at concentrations exceeding the NHWQC or the NHAGQS. Surface water metals results indicated that most metals were nondetect or had concentrations less than the NHWQC. Concentrations of aluminum, cadmium, copper, iron, lead, and zinc were all affected by turbidity, and concentrations present in samples with low turbidity measurements do not indicate that LF-6 (from which waste material has been removed) or CRD-2 are impacting the surface water in the Lower Grafton Ditch. Therefore, discontinuation of surface water sampling in Lower Grafton Ditch is recommended.

4.3 Peverly Drainage System—Drainage Area G

The Zone 2 ROD evaluated potential risks to human and ecological receptors for surface water and sediment in the Peverly Drainage System. The results of this evaluation indicated that human health risks from surface water and sediment posed by the chemicals of concern were within the EPA range of acceptable risks. The Zone 2 ROD specified LTM of surface water and sediment in order to enhance the protectiveness of the implementation of the related Zone 2 alternatives by providing data to determine whether risks to potential human and ecological receptors are being reduced, or at least not increased. CGs were established for surface water and sediment.

The results indicate that surface water concentrations in Peverly Brook have been generally below CGs. Almost all surface water concentrations have been below CGs in recent years, with isolated occurrences of concentrations above CGs. The surface water results do not show evidence of ongoing impacts from LF-1 or Site 7, and the ROD objectives have been met, as risks to potential human and ecological receptors have been reduced, or at least not increased. Discontinuation of sampling of Peverly Brook surface water is recommended.

The results also indicate that sediment concentrations in Peverly Brook are generally below CGs. Almost all sediment concentrations have been below CGs in recent years, with isolated occurrences of concentrations above CGs. The exception to this is sampling location 24-8015, which appears to be located in a depositional area. Concentrations of all four metals are above CGs in numerous samples at this location. However, concentrations of the magnitude found at 24-8015 are not found at other locations, the variation observed is very consistent among the four metals, and no increasing trend has been demonstrated. Arsenic concentrations in sediment at sampling location 24-8018 have increased in recent years (2014 and 2015); however, these increases do not appear to be related to releases from LF-1 or Site 7 based on the low concentrations of arsenic in surface water at sampling this location and at sediment locations closer to the landfill. The sediment results show that ROD objectives have been met, as risks to potential human and ecological receptors related to releases from identified source areas have been reduced, or at least

not increased. Therefore, the discontinuation of sampling of Peverly Brook sediment is recommended.

4.4 Knights and Pickering Brooks—Drainage Areas H and I

The Site 8 ROD concluded that neither surface water nor sediment posed an unacceptable risk and that CGs were unnecessary for these media. No specific objective of the surface water or sediment monitoring was identified; however, one RAO is relevant:

- Prevent discharge of contaminated groundwater to surface water bodies where it may present increased risks to human health and the environment.

LTM has been conducted in Knights and Pickering Brooks since 1991. Surface water monitored within Knights Brook currently consists of annual VOC analysis at station 99-015 (Watering Spring) as a courtesy to the landowner. VOCs have rarely been detected at this location, with most detected concentrations less than 1 µg/L. No VOCs have been detected since 2006.

Two surface water and sediment locations within Pickering Brook are sampled annually in the spring for site-specific metals (lead, mercury, nickel, and zinc). Surface water results show that mercury, nickel, and zinc concentrations in Pickering Brook surface water have been less than their NHWQC. The three concentrations of lead above background were associated with elevated turbidity measurements. Therefore, there is no evidence of discharge to surface water from Site 8 that would result in increased risks to human health or the environment.

Metals concentrations in sediment have been consistent over time (with one anomalous event in May 2013). Lead, mercury, nickel, and zinc concentrations at location 27-8026 were consistently below the respective ER-Ls, and always below the ER-M values. Concentrations of these metals at location 27-8027 were generally higher than those at location 27-8026. Metals concentrations were above the ER-L for some events at location 27-8027, but were never above the ER-M (except in May 2013). In addition, all nickel concentrations were below background values for the former Pease AFB. Therefore, the Site 8 groundwater RAO to prevent groundwater discharge to surface water that results in increased risk to surface water bodies has been met and the discontinuation of sampling and analysis of metals in Pickering Brook surface water and sediment samples is recommended.

4.5 Flagstone Brook—Drainage Area J

The following RAO specific to Flagstone Brook was identified in the LF-5 ROD:

- Minimize further migration of contaminants from the LF-5 source area into the groundwater or surface water.

CGs were not specified for Flagstone Brook surface water; however, the LF-5 ROD identified sediment CGs for Flagstone Brook. LTM of surface water and sediment has been conducted in Flagstone Brook since 1991. Biennial analyses for VOCs and annual analyses for target metals (aluminum, arsenic, cadmium, copper, iron, lead, mercury, nickel, thallium, and zinc) is conducted for the three surface water and sediment sampling stations in Flagstone Brook.

VOCs have been very infrequently detected in Flagstone Brook surface water and have not been detected at any location since 2005. Results of surface water analysis of most metals were nondetect or had concentrations less than the NHWQC or background. The concentrations detected above background were generally found at locations upstream and upgradient of LF-5.

In Flagstone Brook sediment, cadmium, mercury, and thallium were rarely detected and copper and zinc were rarely detected above the ER-L. Aluminum and iron were detected above background in some samples, but were never detected above the sediment TELs. Nickel concentrations have been below background for the last four sampling rounds. Arsenic concentrations are generally above background; however, they have been below the ER-M since 2004. Lead concentrations have been relatively stable since 2005. Most lead concentrations are below background, and all concentrations are below the ER-M.

The RAO specified in the ROD has been met for Flagstone Brook surface water. No specific RAO was identified for sediment, although the above RAO could indirectly apply to sediment. In any case, LF-5 does not appear to be resulting in worsening conditions in surface water or sediment in Flagstone Brook. Therefore, the RAO for LF-5 has been met and discontinuation of surface water and sediment sampling in Flagstone Brook is recommended.

4.6 Railway Ditch—Drainage Area J

The following RAOs specific to Railway Ditch were identified in the LF-5 ROD:

- Prevent or minimize risks to ecological receptors resulting from exposure to contaminated sediment in the Railway Ditch and associated wetlands or to contaminated soil and debris associated with LF-5.
- Minimize further migration of contaminants from the LF-5 source area into the groundwater or surface water.

The LF-5 ROD specified surface water CGs for Railway Ditch. LTM data for Railway Ditch surface water samples show that VOCs have been very infrequently detected in Railway Ditch surface water and have not been detected at any location since 2005, with the exception of toluene detected at 1 µg/L in one sample on June 22, 2011. It has not been detected at any location in the two subsequent sampling rounds (2012 and 2014). This concentration is well below the MCL for

toluene of 1,000 µg/L and the NHWQC of 6.8 µg/L (protection of human health from water and fish ingestion).

Results of surface water analysis of most metals were nondetect or had concentrations less than the NHWQC or background. Cadmium, mercury, and thallium were rarely detected in surface water and were never detected above their current NHWQC, other than in the 2014 round at location 26-8119, which had a turbidity of 410 NTU. Nickel was rarely above NHWQC, and those rare events were typically associated with high turbidities. The analysis of total and dissolved metals in the 2011 and 2015 sampling events support the significance of turbidity in the results. Aluminum and iron were frequently detected at concentrations above background; however, turbidity was generally elevated during these events. Results for arsenic, iron, and zinc were occasionally above the current NHWQC, and these results were also generally related to associated turbidity.

Based on the monitoring results, LF-5 does not appear to be resulting in worsening conditions in surface water in Railway Ditch. Therefore, the RAOs for LF-5 have been met and discontinuation of surface water sampling in Railway Ditch is recommended.

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Appendix F
Comments and Responses on the *Draft Five-Year Review Report (2014–2019)*

Response to Comments on the Draft Five-Year Review Report (2014–2019), Former Pease Air Force Base, Portsmouth, New Hampshire, July 2019

Comments by: New Hampshire Department of Environmental Services (08/19/19)				
Comment No.	Page No.	Section, Figure, Table	Comments	Response/Discussion Points *(09/05/19)*
1	ES-2	Lines 20–26	1. Add to the first bullet a statement about the BCT's obligation to review LTM Plans under a follow-on contract. 2. Add as a second bullet a statement about the agreed-upon additional investigations to be conducted under a follow-on contract.	1. These bullets are the findings of the report, and inclusion of the additional text in the first bullet about activities to be conducted in the follow-on contracts is not appropriate here. Recommend no change to this bullet. 2. This bullet is also not a finding of this report. These things would be included in the sixth Five-Year Review (FYR) regardless of their identification in this FYR. Recommend not including this bullet.
2	NA	Figure 2-1	Please revise this and other figures to show Site 49 within Zone 3.	Site 49 is shown on Figure 2-1. It is not within the Zone 3 GMZ, but was included in the Zone 3 ROD. A separate figure will be added showing the relevant features of Site 49.
3	1-2 through 1-5	Table 1-1	1. Revise table to include missing sites (72, 81, 85 etc.). 2. Revise the status of Site 37 to "Closure *evaluation* sampling". 3. Admin Record now has OU 9 for PFAS. Does that need to be memorialized here (or recommended action to establish OU 9)? 4. Revise the status of Site 16 to include "*closure evaluation investigation pending*".	1. These sites are not CERCLA sites. As such, they don't belong in Table 1-1 as part of the FYR under CERCLA. 2. Concur. 3. While OU9 has been established on the Administrative Record, no such OU actually exists, nor has a ROD been issued. Therefore, OU9 should not be added to the FYR at this point. 4. Concur.
4	3-9	Section 3.1.7.3	Additional PFAS investigation is pending to determine if the remedy is protective for these contaminants. This should be an added caveat at all sites since all PFAS sources have not been delineated and therefore the existing remedies can't be evaluated for PFAS.	Instead of adding a discussion of this at each site, we recommend adding a discussion of this in Section 2.5 indicating that an investigation is ongoing and once the nature and extent is determined, changes to the remedial approach for other sites (besides Site 8) will be considered.

Comments by: New Hampshire Department of Environmental Services (08/19/19)				
Comment No.	Page No.	Section, Figure, Table	Comments	Response/Discussion Points *(09/05/19)*
5	3-36	Section 3.3.5.5	Add as the last sentence: "Due diligence VI assessments are pending for the buildings immediately downgradient of both Sites 32 and 49 following implementation of pilot studies at each site and pending follow-on groundwater treatment actions."	Concur with the replacement of "due diligence" with "additional" in this sentence.
6	3-40	Section 3.3.5.6 Site 49 Subheading Line 12	Although the text states CVOC-contaminated groundwater is not migrating beyond the GMZ, this may not be the case for 1,4-dioxane especially since AGQS lowered. More investigation/sampling needed.	The Air Force (AF) does not agree that additional investigation is needed. While the 2011 report on 1,4-dioxane showed its presence at Site 49, the concentrations are within the acceptable risk range. According to EPA FYR guidance, no additional action is required in such cases and the remedy remains protective.
7	3-44	Section 3.3.7.2	1. In response to Question B for Zone 3, include VI assessment summary conducted for 32 and 49, including pending follow-on due diligence monitoring to assess conditions following pilot studies/groundwater treatment. 2. The last sentence of the "Changes in Standards and TBCs" subheading states that there have been no changes to standards that would affect the protectiveness of the remedy; however, there's 1,4-dioxane at Site 49. Need to determine if GMZ is appropriate.	1. Concur. The efforts to evaluate VI in buildings adjacent to Sites 32 and 49 will be discussed in the section on Changes in Exposure Pathways. 2. See response to Comment No. 6.

Comments by: New Hampshire Department of Environmental Services (08/19/19)				
Comment No.	Page No.	Section, Figure, Table	Comments	Response/Discussion Points *(09/05/19)*
8	3-68	Section 3.6.5.2	Based on Mn concentrations at 45-5116 the GMZ may no longer be appropriate.	In the 2004 Annual Report, it was stated that all exceedances of manganese were at the four wells currently being monitoring and that manganese at concentrations greater than its cleanup goal were not found at any other wells or the GMZ boundary wells, with the exception of boundary well 5116 in 1996. As a result, the LTMP was revised in 2004 to limit the sampling to the four wells currently being sampled. The historical information on manganese in these four wells provided in the 2018 Annual Report indicates variable concentrations, but does not suggest significant differences that would affect the conclusions of the 2004 Annual Report. No changes to the text are recommended.
9	3-69	Section 3.6.7.1	Please add to the response to Question A for Site 45 that additional investigation is warranted downgradient of 45-5116 to evaluate whether GMZ needs expansion.	The AF does not concur with the need to investigate downgradient of location 45-5116 to evaluate the GMZ. See previous response.
10	NA	Appendix B	For the Evaluation of CGs and ARARs, consider the revised AGQS for 1,4-dioxane and other VOCs during this 5-yr period.	See response to Comment No. 6.

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Comments by: U.S. Environmental Protection Agency (07/29/19)				
Comment No.	Page No.	Section, Figure, Table	Comments	Response/Discussion Points *(09/05/19)*
1	NA	Declaration Statement	Update month of completion to September 2019.	Concur.
2	ES-1	First ¶, Line 11	Technically, this 5YR does not cover through the 2019 calendar year. Typically, a cutoff date for site data to consider in a 5YR is established late in the prior calendar year. It is recommended that a clarifying sentence be included in this paragraph that identifies the available data relied on to complete this Pease 5YR (e.g., 12/2013 to 12/2018).	Concur. A sentence will be added to indicate the date range of the available data (01/2014 to 12/2018).
3	ES-1	After Line 24	Add a paragraph about the PFOS/PFOA EPA HAs and NHAGQS.	Concur. Suggest deleting the reference to the RFDs in the Executive Summary (ES) and just refer to the EPA HAs and NHAGQS. Also suggest simplification of the two sentences discussing the HA as follows: The EPA's Office of Water established final lifetime health drinking water advisories of 70 ppt for PFOS and PFOA separately or combined. Also in 2016…established NHAGQS for PFOS and PFOA separately and combined at the same concentrations as EPA. These changes can be described in more detail in the body of the report.
4	ES-2	Line 1	Call out the federal and state PFOS/PFOA criteria.	Based on a comment from EPA to add information on the SDWA Administrative Order (AO) in the ES, this sentence has been changed slightly to refer to the AO.
5	ES-3	Fourth Bullet, Line 1	Add Site 49 to the list of sites in a PM sampling program.	Concur.
6	ES-3	Last Bullet, Line 9	Add Zone 5/Site 8 to the list of sites in Zone 3 to be evaluated for the effects of PFOS/PFOA treatment.	Concur.

Comments by: U.S. Environmental Protection Agency (07/29/19)

Comment No.	Page No.	Section, Figure, Table	Comments	Response/Discussion Points *(09/05/19)*
7	1-1	Section 1.0, Line 15 Line 25	1. Add "Pease Air Force Base" before "Federal Facilities Agreement". 2. Insert "fifth FYR" instead of "review".	Concur.
8	1-2	Table 1-1	Update LF-5 site number to "5".	Concur.
9	1-6	Section 1.2	Page 1-1 Line 22 states that 5YR was led by Joanne Perwak. Suggest modifying responsibilities so Author name is consistent.	Concur. Line 22 will be revised to indicate FYR was led by Roger Walton and Joanne Perwak was a contributor, as indicated on the Five-Year Summary Form.
10	2-1	Section 2.2, Line 22	Add "Pease AFB" before "Administrative Record".	Concur.
11	2-1	Section 2.3, Lines 29–31	Clarify the roles of the USAF, its contractors, EPA, and NHDES within the context of the ongoing monitoring and maintenance at the base.	Concur.
12	2-2	Section 2.4, Lines 6–7	Suggest minor clarifications to public comment period on this FYR.	Minor changes to the sentence were made so that it reads: "A public notice was published by the U.S. Air Force announcing the commencement of the FYR and seeking public input."
13	3-1	Section 3.1.1	Indicate that LF-5 is Site 5.	Concur.
14	3-4 & 3-5	Section 3.1.5.3, Lines 34 & 2	1. Line 34: Replace "are functioning" with "continue to function". 2. Line 2: Replace the word, "the" with "LF-5's".	Concur with both points.
15	3-8	Line 5	Replace "is a capped LF" with "cover is in place, functions as designed,".	Concur, with the addition of "The" in the beginning of the sentence and the correction of the spelling of functions.
16	3-10	Section 3.2.1, Line 8	Indicate Bass Pond is also known as Stubbs Pond.	Concur (with spelling correction).
17	3-10	Section 3.2.1	Add new subsections for LF-1 (Section 3.2.1.1) and Site 7 (Section 3.2.1.2).	Concur. A sentence has been added to this section indicating that LF-1. Site 7, and Site 43 are not addressed in this FYR Report; however, for context each is briefly described below.

Comments by: U.S. Environmental Protection Agency (07/29/19)				
Comment No.	Page No.	Section, Figure, Table	Comments	Response/Discussion Points *(09/05/19)*
18	3-11	Section 3.2.1	Add a new subsection (3.2.1.6) for the MRDDA.	Concur.
19	3-11	Section 3.2.2	Revise entire section to discuss discovery of drums and cans at the MRDDA site.	Concur.
20	3-12	Section 3.2.4.1	1. For **the "Soils" bullet**, add as the first and second sub-bullets RAOs for LF-1 and Site 7, respectively. Add as the last sub-bullet the RAO for Site 43. **2. For the "Groundwater" bullet**, change bullet to "Overburden and Bedrock Groundwater", then include a sub-bullet for the RAOs for Site 7. Further, for the RAOs starting with "Comply..." and "Prevent...", add the involved sites.	Concur with both points.
21	3-13	Section 3.2.4.2, Line 11 Line 12	1. Add "groundwater" to the list of media to be monitored. 2. Add "overburden and bedrock" before "groundwater."	1. Concur, although groundwater monitoring is identified in the third bullet. 2. Concur.
22	3-17	Section 3.2.6, Lines 23, 26, 31	Minor grammar changes as indicated in RLSO.	Concur.
23	3-18	Lines 5–6	Update sentence to include undocumented releases of AFFF.	Concur.

Comments by: U.S. Environmental Protection Agency (07/29/19)				
Comment No.	Page No.	Section, Figure, Table	Comments	Response/Discussion Points *(09/05/19)*
24	3-19	"Changes in Toxicity and Other Contaminant Character-istics" subheading	Add a paragraph about the PFOS/PFOA RfD values.	Concur with revisions. To end of first sentence, add "for both". In second sentence, change "would increase total site risks…" to "could increase total site risks...". The last sentence doesn't seem to apply in this case, since groundwater sampling has been conducted and PFBS is present in some locations. Therefore, recommend the last sentence in this paragraph be revised to "This RFD value should be used at sites where PFBS is present."
25	3-21	Section 3.3.1, Figure 3-4	Add missing Zone 3 site names (31, 42, Building 222, 65) to the text and to Figure 3-4.	Sites are added to the text. Sites will be added to Figure 2-1, not 3-4. A sentence has been added to the end of this paragraph indicating that these sites are not addressed in this FYR Report: however, for context, each site is briefly described in the following subsections.
26	3-21	Section 3.1.1	Add a new subsection (Section 3.3.1.1) for Site 31.	Concur.
27	3-22	Section 3.3.1.2, Lines 13–22	Revise the narrative about waste streams that came from Building 119.	Concur.
28	3-22	Section 3.3.1.3, Line 30	Change "items" to "structures".	Concur.
29	3-23	Section 3.3.1.4, Line 2	Change "the oil-water separator" to "an oil-water separator".	Concur.
30	3-24	Section 3.3.1	Add as Subsection 3.3.1.8 a paragraph regarding Site 42.	See above.
31	3-24	Section 3.3.1.9, Lines 19–21	Add a sentence to indicate Site 49 is outside the Zone 3 boundary but appears as part of that zone's ROD.	Concur.

Comments by: U.S. Environmental Protection Agency (07/29/19)				
Comment No.	Page No.	Section, Figure, Table	Comments	Response/Discussion Points *(09/05/19)*
32	3-24 thru 3-25	Section 3.3.1	Add as Subsection 3.3.1.10 a narrative of Site 65.	See above.
33	3-25	Section 3.3.1.12	1. Line 22: Add a sentence about Site 49 geology. 2. Line 29: Add a sentence about groundwater flow at Site 49.	Concur with both points.
34	3-26	Table 3-1	1. Add Sites 31, 42, and 65 to the table. 2. Revise Initial Response Actions for Sites 32, 33, 34, 35, and 39.	Concur with both points.
35	3-27	Section 3.3.4	After the Zone 3 bullet, add a new bullet summarizing the Site 73 ESD.	Concur with change of site reference from 49 to 73.
36	3-29	Section 3.3.4.2	1. In the Zone 3 ROD discussion, add as the first bullet a statement about NFA at Sites 31 & 42. 2. In the Zone 3 ROD Amendment discussion, add as the first bullet a statement about NFA at Site 65.	Concur with both points.
37	3-30	Section 3.3.4.2	Please add to Section 3.3.4.2 a summary of the ESDs for Site 73 & 49.	Concur. Additional subsections will be added for the Site 49 and Site 73 ESDs.
38	3-32	Section 3.3.5.2	1. For the Site 49 subsection, please include a paragraph on implementation of the Site 49 ESD. 2. For the Site 73 discussion, please include a paragraph on implementation of the Site 73 ESD.	1. This discussion is provided in Section 3.3.5.4. 2. This discussion is provided in Section 3.3.5.4.
39	3-34	Section 3.3.5.4, Lines 1–2	Revise description of byproducts entering Newfields Ditch and clarify the results of the initial PM.	Concur.
40	3-34	Section 3.3.5.4, Line 19	Describe the DNAPL at Site 49 as “a small residual DNAPL zone”.	Concur.

Comments by: U.S. Environmental Protection Agency (07/29/19)				
Comment No.	Page No.	Section, Figure, Table	Comments	Response/Discussion Points *(09/05/19)*
41	3-35	Section 3.3.5.4, Lines 8–13	Revise the Haven Well section to clarify the shut-down of the VOC Treatment System and start-up of the AIMS.	Concur.
42	3-40	Section 3.3.6, second ¶	Add multiple sentences regarding the PFOS/PFOA remediation work occurring in Zone 3.	Concur.
43	3-42	Section 3.3.7.1, Line 23	Describe the DNAPL as stated in Comment No. 40.	Concur.
44	3-42	Section 3.3.7.1, 3rd and 4th bullets	The 3rd and 4th bullets in this section indicate that VOCs at concentrations greater than cleanup goals are present upgradient and/or downgradient of the PRBs. Please discuss whether there is any potential for a complete vapor intrusion pathway at these sites, any plans for future VI sampling/evaluations, and whether any of these conditions affect protectiveness. As part of future planned supplemental ISEB treatment at Site 49, additional VI assessment will be completed as part of on-going performance monitoring.	In response to the State's Comment No. 7, a discussion of the VI evaluation to be completed will be included in Section 3.3.7.2 under Changes in Exposure Pathway. The response to Comment No. 7 should address this comment.
44	3-44	Section 3.3.7.2	Add as the last paragraph of the "Changes in Toxicity and Other Contaminant Characteristics" discussion a summary of the PFOS/PFOA RfD and the AIMS.	Concur.
45	3-45	Section 3.3.7.2	Start the second paragraph of the "Expected Progress towards Meeting RAOs" discussion with "Zone 3 remedial groundwater...".	Concur.
46	3-45	Section 3.3.7.2, Line 35	Please briefly discuss supplemental remedial actions completed as part of the Site 49 and Site 73 ESDs.	These actions are discussed in Sections 3.3.5.4 and 3.3.5.6. A brief summary will be included here, with reference to these other sections.

Comments by: U.S. Environmental Protection Agency (07/29/19)				
Comment No.	Page No.	Section, Figure, Table	Comments	Response/Discussion Points *(09/05/19)*
47	3-46	Section 3.3.8	1. Lines 20–24: Widen the discussion regarding Site 32/36 Source Area and Zone 3 RODs (not ESD). 2. Add as the final bullet a recommendation to revise the Zone 3 ROD to address PFOS/PFOA and the role of the AIMS.	1. Concur with a replacement of "A revision" with "A modification". 2. Concur, although this will be called a modification to the ROD.
48	3-56	Section 3.5.4.2	Add as the last bullet a summary of ROD actions for Sites 9 and 11.	Concur.
49	3-57 and 3-58	Section 3.5.5.3, 3rd and 5th ¶	Revise this portion of the section to discuss the shut-down and re-start of the Site 8 GWTP (3rd ¶) and the status of the new GWETS (5th ¶).	Concur, with removal of the second "shut down" in the sentence.
50	3-60	Section 3.5.6, Line 9	Change "they" to "the agency".	Concur.
51	3-63	Section 3.5.7.2	Add as a new second paragraph to the "Changes in Toxicity and Other Contaminant Characteristics" discussion a summary of the PFOS/PFOA RfD values.	Concur.
52	4-3	Section 4.6, Line 20	Change "they" to "the agency".	Concur.
53	5-2	Section 5.0	Add as the final bullet a recommendation to revise the Zone 3 ROD.	Concur, but this will be identified as a ROD modification.

Comments by: U.S. Environmental Protection Agency (07/29/19)

Comment No.	Page No.	Section, Figure, Table	Comments	Response/Discussion Points *(09/05/19)*
54	NA	Appendix B	1. Appendix B-1: In the appropriate section of text and/or in footnotes please identify any action for groundwater, such as an ESD or ROD amendment, that is needed for those chemical/site combinations where "yes" has been entered under the column entitled "Change?". Provide justification if an action is not needed (e.g. does not affect protectiveness, ARAR change does not affect protectiveness). Perhaps add a column that identifies the action (e.g. update cleanup goal based on revised NHAGQS, revise risk-based goal to reflect updated tapwater Regional Screening Level). With regard to vanadium, the risk-based goal of 256 ug/L in Zone 3 may not be protective because the tapwater Regional Screening Level (RSL) for vanadium and compounds is 86 ug/L representing a Hazard Quotient of 1. 2. Appendix B-2: In the appropriate section of text and/or footnotes, please identify any action for soil, such as an ESD or ROD amendment, that is needed for those chemical/site combinations where "yes" has been entered under the column entitled "Change?". Provide justification if an action is not needed (e.g. does not affect protectiveness, ARAR change does not affect protectiveness). Perhaps add a column that identifies the action (e.g. update leaching based cleanup goal to NHSRS). Explain in a footnote the meaning of "proposed MCL" as the basis for the changes for butyl benzyl phthalate and chrysene because EPA is unaware of any proposed MCLs for these chemicals.	1. All differences shown in Table B-1 are discussed in the text. A sentence or two will be added to each discussion as to whether a ROD modification is needed to address these changes. The last column of Table B-1 will be changed to read "CG needs to be Changed?". If the answer is "no", an additional comment will be added as to the reason. Regarding vanadium, there is a discussion of this metal and available information in Section 3.3.7.2. While the AF disputes the use of RSLs as CGs, since they are not ARARs and are intended for screening. Using the RfD derived by EPA, the ROD CG results in a Hazard Index (HI) of 3 using the default assumptions in the EPA RSL calculator for tap water. As a result, this section recommends a change to the vanadium RG to 86 µg/L based on an HI of 1. This is the HI basis used in the ROD for risk-based values based on non-cancer hazard. This change has no effect on protectiveness of the remedy, since vanadium concentrations have been less than the existing ROD CG and the proposed changed value. 2. The text will be revised for soil as discussed above. In addition, the last column of this table will be revised as described above for groundwater. The sixth column in Appendix B-2 is confused by the inclusion of the reference (NHDES, 2018b). This reference should not be included here. The values shown in this column are the groundwater basis of the original CG for those based on leaching. In the case of butylbenzyl phthalate and chrysene, MCLs were proposed in the early 1990s, but never adopted. The heading will be revised to read "Concentration Basis of Leaching CG in ROD" to make this clearer.

Comments by: U.S. Environmental Protection Agency (07/29/19)				
Comment No.	Page No.	Section, Figure, Table	Comments	Response/Discussion Points *(09/05/19)*
55	NA	Appendix E	Appendix E Section 4.0: It is stated in the first paragraph that metals results are presented in tabular and graphical form. Please include these presentations in this appendix.	Appendix E is taken verbatim from the "Conclusions" section of the Brooks and Ditches Report. It was intended to provide a brief summary of the information in the Brooks and Ditches Report. It was not intended to include all the figures and tables from that report, as they would be difficult to understand without the text and figures showing sampling locations, etc., provided in the Brooks and Ditches Report. Recommend expanding Note 1 on the first page to identify that all tabular and graphical presentations can be found in the Brooks and Ditches Report.

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Supplemental Comments by: U.S. Environmental Protection Agency (08/29/19)				
Comment No.	Page No.	Section, Figure, Table	Comments	Response/Discussion Points *(09/05/19)*
1	ES-1	Executive Summary & Section 1.0 Introduction	Due to the complex interaction between the 2014 SDWA Order and contamination addressed pursuant to CERCLA at the former Pease Air Force Base, EPA requests that additional background information be included to in this section to provide a brief explanation of the Order (what's covered and being done under the Order by Air Force and the City) and CERCLA actions related to PFAS (SI activities, etc.). Throughout the site-specific sections of the document, the line between these different CERCLA & A.O.-related work/accomplishments is confusing to a reader not well versed in the cleanup history of the Pease Site.	Concur. Background information regarding the AO and actions taken under the AO and CERCLA will be added to the ES after the paragraph regarding PFOS/PFOA standards/criteria, and in Section 3.3.6.

Supplemental Comments by: U.S. Environmental Protection Agency (08/29/19)				
Comment No.	Page No.	Section, Figure, Table	Comments	Response/Discussion Points *(09/05/19)*
2	ES-1	Executive Summary & Section 1.0 Introduction	The Air Force refers throughout the 5th 5YR EPA's Lifetime Health Advisories as well as NH's previous NHAGQS for PFAS. However, Air Force does not mention the recently promulgated NH MCLs for four PFAS. While EPA is neither suggesting that these standards be included as potential ARARs or TBCs nor that these standards implicate protectiveness of the remedies, EPA believes it is important to provide this new information concerning MCL development. These new MCLs will likely become important in future Pease Five Year Reviews with regard to future actions at the Site. EPA's suggestion is to simply acknowledge the new standards in language similar to the following: a. "In July 2019, New Hampshire established Maximum Contaminant Levels (MCLs)/drinking water standards and Ambient Groundwater Quality Standards (AGQS) for four per- and polyfluoroalkyl substances (PFAS): perfluorooctanoic acid (PFOA), perfluorooctanesulfonic acid (PFOS), perfluorononanoic acid (PFNA) and perfluorohexanesulfonic acid (PFHxS), which will become effective October 1, 2019. While not yet effective, these NH MCLs and NHAGQS may be relevant for future investigations and actions related to PFAS at Former Pease Air Force Base in the future."	The recommended paragraph will be added to the fourth paragraph of the ES and Section 2.5. Recommend change from "established" to "adopted", and to change the effective date to 9/30/19. Minor changes have been made to the last sentence to refer in general to future investigations and actions.
3	3-9	Line 15	Please clarify that the media discussed here is ground water.	This will be clarified by adding "groundwater" to the sentence ending on Line 15.
4	3-10	Line 15	Please correct spelling for Stubbs Pond (EPA mistake in previously provided edits).	Concur.

Supplemental Comments by: U.S. Environmental Protection Agency (08/29/19)				
Comment No.	Page No.	Section, Figure, Table	Comments	Response/Discussion Points *(09/05/19)*
5	3-20 and 3-21	Lines 25 and 4, respectively	Please clarify if the closure sampling has been completed.	The sentence will be revised to indicate that the closure sampling was conducted in the Fall of 2018. While closure sampling was also conducted in the Spring of 2019, the data range for this report is to December 2018.
6	3-36	Lines 4-14	Please clarify that the PFOS/PFOA NHAGQS standard referenced in this paragraph was the previous 2016 standard for these two PFAS. Also, please clarify that the AIMS & the City's new water treatment plant is being completed as part of the SDWA AO. In addition, further clarify that the City is completing the new drinking water plant through an environmental services cooperative agreement (ESCA).	The reference to the NHAGQS is incorrect in this sentence, as the NHAGQS for PFOS/PFOA were not adopted until 2016. The reference to NHAGQS will be removed, and the reference to EPA HA will be changed to EPA Provisional HA and the value will be changed to 0.2 µg/L. The sentence on the installation of the AIMS system will indicate it is being completed as part of the SDWA AO. The Air Force Does not concur that discussion of the ESCA is necessary for this report.
7	3-41	Lines 19-30 (EPA-Proposed text additions)	Please add that the AIMS & City's new water treatment plant is being completed as part of the SDWA AO. Also, further clarify that the City is completing the new drinking water plant through an ESCA.	The reference to SDWA AO will be added. The Air Force Does not concur that discussion of the ESCA is necessary for this report.
8	3-45	Line 21	Please clarify why this "slightly lower" value does not affect protectiveness of the remedy with regard to vanadium.	See response to EPA Comment No. 54. The protectiveness of the remedy is not affected, since concentrations have been below the ROD CG and the EPA RSL, even though this value is not an ARAR.
9	3-56	Line 26	The recently completed ESD should be mentioned in this section as it is a decision document identifying new components of the remedy.	Concur.
10	3-60	Line 11	Please verify LUC compliance since 2017.	A sentence will be added indicating that site visits and inspections conducted during 2018 confirm continued compliance.
11	3-61	Line 31	Please identify the public water connection component of ESD in description of remedy section. Please see comment #9 above.	Concur. The ESD will be described in Section 3.5.4.2.

Supplemental Comments by: U.S. Environmental Protection Agency (08/29/19)				
Comment No.	Page No.	Section, Figure, Table	Comments	Response/Discussion Points *(09/05/19)*
12	3-64	Lines 25-28	This paragraph is not clear. The Site 8 ESD modified the original remedy, so not considering PFOS/PFOA as a part of a protectiveness evaluation is not consistent. EPA suggests this paragraph include a brief discussion that the current protectiveness of the remedy is not affected as the GWETS is adequately treating PFOS/PFOA.	Concur. This sentence will be revised to indicate that the protectiveness of the remedy is not affected because the GWETS is treating PFOS/PFOA and groundwater LUCs are still in place.
13	3-70	Line 6	Does “current ARARs” mean all ARARs that have changed since the last Pease FYR? Please clarify.	Assume this is referring to Line 16 and Line 20 on page 3-70? Current ARARs for soil refer to NHDES soil remediation standards updated in 2018 (provided in Appendix A) and groundwater refer to NHAGQS, updated in 2018 (provided in Appendix B). This will be clarified in the text.

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