PRELIMINARY ASSESSMENT AND SITE INSPECTION OF PER- AND POLYFLUOROALKYL SUBSTANCES

Former Vint Hill Farms Station, Virginia

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EXECUTIVE SUMMARY

The United States Army (Army) is conducting preliminary assessments (PAs) and site inspections (SIs) on the potential historical use, storage, or disposal of per- and polyfluoroalkyl substances (PFAS), with a focus on perfluorooctane sulfonate (PFOS), perfluorooctanoic acid (PFOA), and perfluorobutanesulfonic acid (PFBS) at Former Vint Hill Farms Station (VHFS) in Warrenton, Virginia. The objective of a PA is to identify locations that are areas of potential interest (AOPIs) based on whether there was use, storage and/or disposal of PFAS-containing materials, in accordance with the 2018 Army Guidance for Addressing Releases of Per-and Polyfluoroalkyl Substances (Army 2018). Where necessary, the SI includes multi-media sampling at AOPIs to determine whether or not a release has occurred, and the PFOS, PFOA, and PFBS results in groundwater, surface water, soil, and/or sediment are compared to the Office of the Secretary of Defense (OSD) risk screening levels to determine whether further investigation is warranted. This report provides the PA/SI for VHFS and was completed in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA, 10 U.S.C. §9601 et. seq.) and The National Oil and Hazardous Substances Pollution Contingency Plan (NCP, 40 CFR Part 300), as well as the Defense Environmental Restoration Program (10 U.S.C. §2701 et seq., DoDM 4715.20).

While active, VHFS occupied approximately 701 acres near the town of Warrenton, Virginia in Fauquier County approximately 40 miles southwest of Washington, D.C. Between 1942 and 1997, VHFS and its facilities supported military intelligence and communications activities. VHFS is bordered by Virginia State Route 215 to the north, Lake Brittle and Lake Ashby to the west, residential areas to the south, and a mix of forest and agriculture land to the east. The southern portion of the former VHFS property has been redeveloped into commercial space, single-family homes, detached senior homes, and a park and recreation area (IT Corporation 1999). This PA/SI focuses on the buildings and areas operated by the U.S. Army within the confines of the former VHFS installation boundaries.

As a result of the PA at VHFS, 23 AOPIs, also referred to as areas requiring environmental evaluation (AREEs), have been identified. The names of the AOPIs and the associated use, storage, and/or disposal of PFAS-containing material types identified at VHFS are summarized in **Table ES-1**, below.

Based on the results of the PA at VHFS, an SI for PFOS, PFOA, and PFBS was conducted in accordance with CERCLA. SI sampling was completed at VHFS at all 23 AOPIs to evaluate presence or absence of PFOS, PFOA, and PFBS. All AOPIs except for AREE 28-9, AREE 29-3, AREE 29-4, and AREE 29-5 had positive detections of PFAS, PFOS, and/or PFBS in collected samples. OSD Residential Scenario Risk Levels for constituents of concern under investigation were 40 ppt PFOS (tap water) and 0.13 parts per million (ppm) PFOS (soil); 40 ppt PFOA (tap water) and 0.13 ppm PFOA (soil); and 600 ppt PFBS (tap water) and 1.9 ppm PFBS (soil). Below is a summary of the SI sampling event and results.

- **Overburden Groundwater:** Twenty-four samples were collected in association with 15 of the 23 AOPIs. The temporary or permanent wells ranged from approximately 4 feet below ground surface (bgs) to 62 feet bgs. PFAS were detected in temporary monitoring wells at 14 AOPIs and exceeded OSD risk screening levels in samples from six AOPIs. The maximum concentration of PFOS was observed at the AREE 1: Waste Disposal Area at a concentration of 1,100 nanograms per liter (ng/L); while the maximum concentration of PFOA was observed at AREE 13: Sludge

Disposal Area at a concentration of 1,300 DJ ng/L. The greatest PFBS concentration was also observed at AREE 13: Sludge Disposal Area at a concentration of 89 J ng/L. The data qualifier DJ and J indicate instances where the analyte was analyzed at dilution and the result is an estimated quantity, and where the analyte was positively identified; however, the associated numerical value is an estimated concentration only.

- **Bedrock Groundwater:** The interval sampling conducted on the production wells VNT-1B and VNT 3-B ranged from 28 feet bgs to 562 feet bgs. PFAS were detected in all intervals within the production wells at concentrations exceeding OSD risk screening levels (PFOS and/or PFOA). The maximum concentration was observed in VNT-3B between 88 and 110 feet bgs at a combined (PFOS and PFOA) concentration of 1,690 ng/L. The greatest concentration of PFBS, 70 ng/L, was also observed within this same interval as well as a deeper interval of VNT-3B that spanned 380 and 402 feet bgs.
- **Soil:** Forty samples were collected at 18 of the 23 AOPIs. PFAS were detected in soil samples at seven AOPIs; however, all concentrations were below the residential OSD risk screening levels. Maximum concentrations of PFOS and PFOA were observed at the AREE 16-2: Possible Fire Training Pit at concentrations of 0.0.0094 milligrams per kilogram (mg/kg); and 0.0011 mg/kg, respectively. PFBS was not detected in any soil sample.
- **Surface Water:** Five samples were collected upstream and downstream along both the South Run and Western South Run Tributary. PFAS were detected in all five surface water samples; however, all concentrations were below the residential OSD risk screening levels. Concentrations ranged from 5 ng/L to 33 ng/L of PFOS and 2.2 ng/L to 14 ng/L of PFOA. The greatest PFBS concentration was observed at AREE 10: Former Photographic Wastewater Lagoon at a concentration of 3.4 J ng/L.
- **Sediment:** Sediment sampling was not performed during the PA/SI phase at VHFS.

Following the SI sampling, 19 out of the 23 AOPIs with confirmed PFOS, PFOA, and/or PFBS presence were considered to have complete or potentially complete exposure pathways.

Complete exposure pathways include:

- Soil exposure pathways for on-installation site workers at AREE 17, AREE 29-6, the Helipad, AREE 2, AREE 16-2, AREE 10, and Building 271.
- Surface water exposure pathways for on-installation recreational users at AREE 29-2, AREE 2, AREE 16-1, and AREE 10.

Potentially complete exposure pathways include:

- Soil exposure pathways for on-installation site workers at AREE 1, Building 2470, the Automated Car Wash, and AREE 9.
- Groundwater exposure pathways for residents and site workers at AREE 29-2, AREE 17, AREE 29-6, the Helipad, AREE 2, AREE 5, AREE 7, AREE 11, AREE 8, AREE 26, AREE 13, AREE 16-1, AREE 1, Building 2740, the Automated Car Wash, AREE 9, AREE 16-2, Building 271, and AREE 10. Although there were positive detections of PFASs in groundwater samples,

exposure pathways were considered potentially complete because monitoring wells were sampled, not drinking water wells, and tap water/finished water samples were not collected.

- Surface water and sediment exposure pathways for on-installation recreational users at AREE 17, AREE 29-6, the Helipad, AREE 5, AREE 7, AREE 11, AREE 8, AREE 26, AREE 13, AREE 1, Building 2740, the Automated Car Wash, AREE 9, AREE 16-2, and Building 271.
- Surface Water exposure pathways for off-installation drinking water receptors and recreational users and sediment exposure pathways for off-installation recreational users at AREE 29-2, AREE 17, AREE 29-6, the Helipad, AREE 2, AREE 5, AREE 7, AREE 11, AREE 8, AREE 26, AREE 13, AREE 16-1, AREE 1, Building 2740, Automated Car Wash, AREE 9, AREE 16-2, Building 271, and AREE 10.
- Sediment exposure pathways for on-installation recreational users at AREE 29-2, AREE 2, AREE 16-1, and AREE 10.

Although the CSMs indicate complete or potentially complete exposure pathways may exist, the recommendation for remedial investigation is based on the comparison of analytical results for PFOS, PFOA, and PFBS to the OSD risk screening levels. Results from this PA/SI indicate further study in a remedial investigation for PFAS is warranted at 6 AOPIs and within the bedrock aquifer at VFHS in accordance with the guidance provided by the OSD. **Table ES-1** below summarizes the AOPIs identified during the Preliminary Assessment, PFOS, PFOA, and PFBS sampling at VHFS and rationale for recommendations for further study in a remedial investigation or no action at this time at each AOPI.

Table ES-1. Summary of AOPIs Identified During the Preliminary Assessment, PFOS, PFOA, and PFBS Sampling at VHFS and Recommendations

AOPI Name	PFOS, PFOA, and/or PFBS detected greater than OSD Risk Screening Levels?			Recommendation	Rationale
	GW	SO	SW		
AREE 16-1: Possible Fire Training Pit	N	N	N	No action at this time	No exceedances of 2019 OSD risk screening levels in GW and SO
AREE 17: Unlined Sludge Disposal Area	NA	N	NS	No action at this time	No exceedances of 2019 OSD risk screening levels in SO
AREE 29-3: Possible Disposal Area	NA	N	NS	No action at this time	No exceedances of 2019 OSD risk screening levels in SO
AREE 16-2: Possible Fire Training Pit	N	N	NS	No action at this time	No exceedances of 2019 OSD risk screening levels in GW and SO
AREE 29-2: Possible Sludge Disposal Area	NA	N	N	No action at this time	No exceedances of 2019 OSD risk screening levels in SO
Former Helipad	NS	N	NS	No action at this time	No exceedances of 2019 OSD risk screening levels in SO
Building 271 – Fire Station	N	N	NS	No action at this time	No exceedances of 2019 OSD risk screening levels in GW and SO
Building 2470 - Fire Department Storage Building	N	NS	NS	No action at this time	No exceedances of 2019 OSD risk screening levels in GW
AREE 5: Environmental Photographic Interpretation Center (EPIC) Building	Y	N	NS	Future study in a remedial investigation	Exceedances of 2019 OSD risk screening levels in GW (PFOS)
AREE 10: Former Photographic Wastewater Lagoon	Y	N	N	Future study in a remedial investigation	Exceedances of 2019 OSD risk screening levels in GW (PFOA)
AREE 11: Former Sewage Treatment Plant – Sludge Drying Beds and Sludge Piles	Y	N	NS	Future study in a remedial investigation	Exceedances of 2019 OSD risk screening levels in GW (PFOS/PFOA)
AREE 28-9: Sewage Lift Station	NA	N	NS	No action at this time	No exceedances of 2019 OSD risk screening levels in SO
AREE 7: Building 2400 – Electrical Equipment Facility and Pretreatment Tank	N	NS	NS	No action at this time	No exceedances of 2019 OSD risk screening levels in GW

AOPI Name	PFOS, PFOA, and/or PFBS detected greater than OSD Risk Screening Levels?			Recommendation	Rationale
	GW	SO	SW		
AREE 8: Building 2400 – Neutralization Pit	N	N	NS	No action at this time	No exceedances of 2019 OSD risk screening levels in GW and SO
AREE 29-4: Disposal Area	N	N	NS	No action at this time	No exceedances of 2019 OSD risk screening levels in GW and SO
AREE 29-5: Liquid Impoundment Area	NA	N	NS	No action at this time	No exceedances of 2019 OSD risk screening levels in SO
AREE 13: Sludge Disposal Area	Y	N	NS	Future study in a remedial investigation	Exceedances of 2019 OSD risk screening levels in GW (PFOS/PFOA)
AREE 29-6: Possible Burn Pile	NA	N	NS	No action at this time	No exceedances of 2019 OSD risk screening levels in SO
AREE 9: Vehicle Maintenance Buildings 288 and 290	N	NS	NS	No action at this time	No exceedances of 2019 OSD risk screening levels in GW
Automated Car Wash	Y	NS	NS	Future study in a remedial investigation	Exceedances of 2019 OSD risk screening levels in GW (PFOS)
AREE 26: Outdoor Wash Rack	N	N	NS	No action at this time	No exceedances of 2019 OSD risk screening levels in GW and SO
AREE 1: Waste Disposal Area	Y	NS	N	Future study in a remedial investigation	Exceedances of 2019 OSD risk screening levels in GW (PFOS/PFOA)
AREE 2: Active Sewage Treatment Plant – Former Sludge Drying Beds and Sludge Piles	NA	N	N	No action at this time	No exceedances of 2019 OSD risk screening levels in SO
Bedrock Aquifer (VNT 1B and 3B)	Y	NS	NS	Future study in a remedial investigation	Exceedances of 2019 OSD risk screening levels in GW (PFOS/PFOA)

Notes:
GW – groundwater
N – no
NS – not sampled
NA – not sampled because the media was not present (i.e., dry well)
SO – soil
SW – surface water
Y – yes

1 INTRODUCTION

The United States (U.S.) Army (Army) is performing a preliminary assessment (PA) and site inspection (SI) for the former Army installation Vint Hill Farms Station (VHFS), on the potential historical Army use of per- and polyfluoroalkyl substances (PFAS) with a focus on perfluorooctane sulfonate (PFOS), perfluorooctanoic acid (PFOA), and perfluorobutanesulfonic acid (PFBS). The Army is the lead agency under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) and Executive Order 12580 and is conducting the PA/SI consistent with its authority under CERCLA, 42 United States Code §§ 9601, et seq. (as amended), and the Defense Environmental Restoration Program, 10 United States Code §§ 2701, et seq. The PFAS PA/SI includes two distinct efforts. The PA identified locations that are areas of potential interest (AOPIs) at VHFS based on the use, storage and/or disposal of PFAS-containing materials, in accordance with the 2018 Army Guidance for Addressing Releases of Per-and Polyfluoroalkyl Substances (Army 2018). Where necessary, the PA was followed by an SI, which included multi-media sampling at AOPIs to determine whether or not a release has occurred. Additionally, the PFOS, PFOA, and PFBS results in groundwater, surface water, soil, and/or sediment were compared to the 2019 Office of the Secretary of Defense (OSD) PFOS, PFOA, and PFBS risk screening levels to determine whether further investigation is warranted. This report provides the PA/SI for VHFS and was completed in accordance with CERCLA and The National Oil and Hazardous Substances Pollution Contingency Plan.

1.1 Project Background

PFAS are a class of compounds that have been used in a wide range of industrial applications and commercial products due to their unique surface tension/leveling properties. Due to industry and regulatory concerns about the potential health effects and adverse environmental impacts, there has been a reduction in the manufacture and use of PFAS worldwide. In the U.S., significant reductions in the production, importation, and use of PFOS and PFOA (two individual compounds in the PFAS class) occurred between 2001 and 2015 (Interstate Technology Regulatory Council 2017). PFBS replaced PFOS in some applications and is currently used and manufactured in the U.S.

In 2016, the United States Environmental Protection Agency (USEPA) established a lifetime health advisory of 70 nanograms per liter (ng/L) in drinking water for PFOS or PFOA and for the sum of PFOS and PFOA when both are present (USEPA 2016). On 15 October 2019, the OSD provided guidance on the investigation of PFOS, PFOA, and PFBS at DoD restoration sites (OSD 2019). The 15 October 2019 Memorandum: Investigating Per- and Polyfluoroalkyl Substances within the Department of Defense Cleanup Program is provided for reference as Appendix A. The DoD guidance provides risk screening levels for PFOS, PFOA, and PFBS in groundwater (tap water) or soil, calculated using the USEPA's Regional Screening Level (RSL) calculator for residential and industrial/commercial worker receptor scenarios. Following the issuance of the 2019 OSD memo, on 08 April 2021, USEPA published an updated toxicity assessment for PFBS (USEPA 2021). New PFBS risk screening levels were calculated by the OSD using the USEPA's RSL calculator and the new PFBS toxicity value. The OSD risk screening levels used for evaluating PFOS, PFOA, and PFBS data are discussed further in **Section 6.6**.

1.2 PA/SI Objectives

This PA/SI was conducted consecutively because the results of the PA yielded AOPIs that necessitated continuing onto the SI phase in accordance with CERCLA. Consequently, this report provides the combined objectives of both PA and SI reports. **Section 2** provides the overview for VHFS, and **Sections 3** through **5** comprise the PA portion of this report. **Sections 6** and **7** comprise the SI portion of this report.

1.2.1 PA Objectives

During the PA, investigators collect readily available information and conduct site reconnaissance. This PA evaluates and documents areas where PFAS-containing materials were used, stored, and/or disposed, so the Army can distinguish between sites that pose little or no threat to human health and the environment and sites that require further investigation.

The NCP (40 CFR 300.420(b)) requires the Lead Agency under CERCLA to perform a PA to:

(i) Eliminate from further consideration those sites that pose no threat to public health or the environment;
(ii) Determine if there is any potential need for a removal action;
(iii) Set priorities for Site Inspections; and
(iv) Gather existing data to facilitate later evaluation of the release pursuant to the Hazard Ranking System if warranted.

1.2.2 SI Objectives

An SI is conducted when the PA determines an AOPI exists based on probable use, storage, and/or disposal of PFAS-containing materials. The objective of the SI is to identify whether there has been a release of PFOS, PFOA, and PFBS to the environment from any of the AOPIs identified in the PA and to determine if further investigation is warranted.

The NCP (40 CFR 300.420(c)) requires the Lead Agency to perform a remedial SI as appropriate to:

(i) Eliminate from further consideration those releases that pose no significant threat to public health or the environment;
(ii) Determine the potential need for removal action;
(iii) Collect or develop additional data, as appropriate, to evaluate the release pursuant to the HRS; and
(iv) Collect data in addition to that required to score the release pursuant to the hrs, as appropriate, to better characterize the release for more effective and rapid initiation of the RI/FS or response under other authorities.

Installation-specific data quality objectives (DQOs) and the sampling design and rationale are summarized in **Sections 6.1** and **6.2**.

1.3 PA/SI Process Description

For VHFS, PA/SI development followed a similar process as described in **Sections 1.3.1** through **1.3.5** below. **Section 3** provides a summary of the PA activities completed, and **Section 6** provides a summary

of the SI activities completed for VHFS. The PA and SI processes are documented in the PA/SI Quality Control Checklist included as **Appendix B**.

1.3.1 Pre-Site Visit

First, an installation kickoff teleconference was held between applicable points of contact (POCs) from the United States Army Corps of Engineers (USACE), Base Realignment and Closure (BRAC), VHFS, and SERES-Arcadis Joint Venture (JV). The kickoff call occurred on 9 July 2019, before the site visit, to discuss the goals and scope of the PA, project scheduling, installation access, timeline for the site visit, access to installation-specific databases, and to request available records.

Records research was conducted before the site visit to obtain electronically available documents from the installation and external sources for review. The purpose of the records research was to identify any area on the installation that may have been a location where PFAS-containing materials were used, stored, and/or disposed, as well as to gather information on the physical setting and site history at VHFS. Multiple areas at VHFS have been investigated as part of the former IRP program at VHFS. Where environmental evaluation was proposed, these historical areas were identified as areas requiring environmental evaluation (AREEs) and were appended with a numerical value for VHFS tracking purposes. Multiple AREE sites overlap with identified AOPIs at VHFS. In these cases, AREE reference numbers were included with the full AOPI name throughout the PA/SI process.

A read-ahead package was prepared and submitted to the appropriate program POCs two weeks before the site visit. The read-ahead package contains the following information:

- The PFAS PA kickoff call minutes
- An information paper on the PA portion of the Army's PFAS PA/SI
- Contact information for key POCs
- A list of the data sources requested and reviewed
- A list of preliminary locations identified during the kickoff call and pre-site visit records review to be evaluated for use, storage, and/or disposal of PFAS-containing materials, that may be evaluated as preliminary AOPIs, where additional information on those areas will be collected through personnel interviews, additional document review, and site reconnaissance.
- A list of roles for the installation POC to consider when recommending potential interviewees.

1.3.2 Preliminary Assessment Site Visit

The site visit was conducted on 22 July 2019. An in-brief meeting was held to provide installation staff with the objectives of the site visit and team introductions. **Section 3** includes information regarding personnel interviewed and areas where site reconnaissance was performed during the site visit.

Personnel interviews were conducted with individuals having significant historical knowledge at VHFS. The interviews focused on confirming information discussed in historical documents, collecting information that may have not been in historical documents, corroborating other interviewees' information.

Site reconnaissance included visual surveys that assessed the points of potential use, storage, and/or disposal of PFAS-containing materials, as well as potential secondary impacts, and the migration potential from each AOPI (e.g., stormwater drains, building drains and sumps, cracks in the floor/pavement). Physical attributes of the preliminary locations were documented, including local slope and ground and floor conditions (i.e., paved, or unpaved, visual staining), surface water bodies and surface flow, potential receptors, and the distance to the installation boundary. Access to existing groundwater monitoring wells, if present, were also noted during the site reconnaissance in case the monitoring wells could be proposed for SI sampling. Photo documentation of the preliminary locations was collected, and access limitations or advantages related to potential future sampling activities were noted.

An exit briefing was offered to installation personnel at the conclusion of the site visit to raise any items identified during the site visit, discuss any follow-up items, and review the schedule for submitting deliverables. The exit briefing was conducted via teleconference on 26 July 2019 with BRAC, USACE, and JV personnel to discuss preliminary findings of the PA site visit.

1.3.3 Post-Site Visit

After the site visit, information collected before, during, and after site visit was reviewed and corroborated by cross-referencing records and reviewing interview details and observations noted during site visit reconnaissance. A site visit trip report was completed and provided to the installation POC, BRAC, and USACE regional POCs following the site visit. The information collected during the pre-site visit and site visit activities was compiled to develop the installation-specific PA portion of the PA/SI report. Site data obtained during the PA were used to develop preliminary conceptual site models (CSMs) for each AOPI, which serve as the basis for developing the SI scope of work presented in an installation-specific Quality Assurance Project Plan (QAPP) Addendum. Map document files and associated geographic information system (GIS) data are provided as **Appendix C**. GIS data layers created for the project are included in a Spatial Data Standards for Facilities, Infrastructure, and Environment-compliant geodatabase.

1.3.4 Site Inspection Planning and Field Work

The SI process was initiated at the installation to evaluate PFOS, PFOA, and PFBS presence or absence at each AOPI and determine whether further investigation is warranted. First, an SI kickoff teleconference was held on 19 September 2019 between the applicable POCs from BRAC, USACE, and the JV.

The objectives of the SI kickoff teleconference were to:

- discuss the AOPIs selected for sampling
- gauge regulatory involvement requirements or preferences
- identify overlapping unexploded ordnance or cultural resource areas
- identify specific installation access requirements and potential schedule conflicts
- discuss general SI deliverable and field work schedule information and logistics

Following development of the SI sampling technical approach, an SI scoping teleconference was held to obtain concurrence on the SI sampling plan from BRAC, USACE and VHFS. Additional discussion topics included:

- confirm the plan for investigation derived waste (IDW) handling and disposal
- provide an updated SI deliverable and field work schedule.

A Uniform Federal Policy- QAPP was developed and finalized in May 2020 for the VHFS PA/SI (Arcadis 2020). The QAPP details general planning processes for collecting data and describes the implementation of quality assurance (QA) and quality control (QC) activities. The QAPP was also developed to define the DQOs, present the sampling design and rationale, and provide qualifications for project personnel. A Site Safety and Health Plan (SSHP) was also developed as an attachment to the QAPP to identify specific health and safety hazards that may be encountered at the installation during sampling. The SSHP was designed to supplement the programmatic Accident Prevention Plan (Arcadis 2018), which was developed for Army installations nationwide. The QAPP and SSHP were submitted to the installation and finalized before commencement of field work.

The DQOs, sampling design and rationale, and field methods employed for the SI are summarized from the QAPP developed for VHFS (Arcadis 2020) in **Sections 6.1** through **6.3**.

After finalization of the QAPP Addendum and SSHP, teams completed field planning and coordination with the installation and subcontractors. Once the schedule was determined, field teams mobilized to the installation to complete the scope of work defined in the QAPP Addendum.

1.3.5 Data Analysis, Validation, and Reporting

Environmental samples collected during the SI were submitted to a laboratory which is DoD Environmental Laboratory Accreditation Program (ELAP)-accredited for PFAS analysis (including PFOA, PFOA, and PFBS) in accordance with the DoD Quality Systems Manual (QSM) 5.1.1 (DoD 2018). Laboratory analytical results were then validated and verified by a project chemist to assess the usability of the data collected. Validated analytical results were summarized in the context of OSD risk screening levels (defined in **Section 6.5**). Both PA findings (**Sections 3** through **5**) as well as SI findings (**Sections 6 and 7**) are included in this PA/SI report.

2 INSTALLATION OVERVIEW

The following subsections provide general information about VHFS, including the location and layout, the installation mission(s) over time, a brief site history, current and projected land use, climate, topography, geology, hydrogeology, surface water hydrology, potable wells within a 5-mile radius of the installation, and applicable ecological receptors.

2.1 Site Location

While active, VHFS occupied approximately 701 acres near the town of Warrenton, Virginia in Fauquier County approximately 40 miles southwest of Washington, D.C. VHFS is bordered by Virginia State Route 215 to the north, Lake Brittle and Lake Ashby to the west, residential areas to the south, and a mix of forest and agriculture land to the east (**Figure 2-1**). The southern portion of the VHFS property has been redeveloped into commercial space, single-family homes, detached senior homes, and a park and recreation area (**Figure 2-2**) (IT Corporation 1999).

2.2 Mission and Brief Site History

VHFS was purchased by the War Department in July 1942. During World War II, VHFS served as a training center for signal corps personnel, and as a refitting station for signal units returning from combat. During and after the Korean Conflict, VHFS expanded its facilities in support of military intelligence and communications activities. Following the Korean Conflict, various activities and tenants were present at VHFS. In 1961, the U.S. Army Electronic Material Readiness Activity was moved to VHFS. In 1973, the USEPA took over operation of the photographic interpretation center from the Defense Intelligence Agency. In 1974, the mission of VHFS refocused to a research and development role, with production of new signals warfare technology for military intelligence. In March 1993, the BRAC Commission submitted its recommendation that VHFS be selected for closure (Science Applications International Corporation, 1996). VHFS served as a U.S. Army signals intelligence and electronic warfare facility until 1997.

VHFS underwent environmental investigations and cleanup in the 1990s, as required by DERP and CERCLA, and was eventually transferred out of Army ownership between 1999 and 2003. As detailed in Section 1.1, PFAS gained national environmental awareness only in more recent years. As a result, it was not considered in the earlier environmental work and closure activities at VHFS. Because CERCLA requires that the Army continue to address potential risks from pollutants and contaminants that were released due to former Army operations, the Army is now performing this PA/SI at the former VHFS.

2.3 Current and Projected Land Use

Between 1999 and 2003, VHFS land was sold following the BRAC closure and is now utilized by numerous owners. Currently, VHFS hosts federal administrative offices in leased space, various engineering, technology, commercial and recreational businesses. Land use in the immediate vicinity of VHFS consists of mainly agriculture, commercial, recreational, and residential areas.

2.4 Climate

The climatic conditions at VHFS are variable, with influences from the Atlantic Ocean to the east and the Appalachian Mountains to the west. Summers are characterized by maritime-tropical winds from the south and southwest, which bring warm, humid air to the region. High pressure systems often stagnate over the area, creating air pollution episodes several times during the summer. Winter is characterized by cold, dry, continental polar winds from the northwest. Average temperature at VHFS varies from a monthly low of 34.7 degrees Fahrenheit in January to a mean monthly high of 75.74 degrees Fahrenheit in August. The average annual rainfall is 41.3 inches, while snowfall averages 24 inches annually (Science Applications International Corporation, 1994).

2.5 Topography

VHFS is located near the border between the Coastal Plain and the Piedmont Physiographic Provinces in Virginia. Locally, the topography suggests that VHFS is at the edge of the Piedmont, in the Culpepper basin of the Triassic Age. Localized topography at VHFS is composed of gently rolling hills with slopes generally less than 10%. Elevations on the installation vary from 335 to 430 feet above mean sea level (Science Applications International Corporation, 1994).

2.6 Geology

Overburden material at VHFS is characterized as a thin, unconfined, saturated layer of clay, silt and saprolite (i.e., weathered bedrock) that overlies the bedrock. Much like the bedrock, saprolite is nearly dry and impermeable where it is unfractured, so the quantity of groundwater the overburden contains is limited by its thickness and extent of fracturing (USACE 2017).

The bedrock underlying VHFS consists of shale, sandstone, siltstone, basalt, and diabase. Metamorphosed hornfels, granite, and quartzite can also be found. Basalts comprise the predominant near-surface rock beneath the western portion of the installation, whereas the sedimentary beds are common towards the eastern side. Competent bedrock is encountered at depths ranging from a few feet below ground surface (bgs) towards the northern side of the installation to 39 feet bgs towards the southern side of the installation.

2.7 Hydrogeology

The overburden material across VHFS ranges from 10 to 30 feet in thickness, with surficial water table depths ranging between 5 to 15 feet bgs. Groundwater movement within the overburden reflects streams and topography across the site. Overburden groundwater flow at VHFS is interpreted to traverse the study area from southwest to northeast, presumably towards South Run (Emery & Garrett Groundwater, Inc. 2005). The quantity of groundwater stored in the soil portion of the overburden is limited by the thickness of the soil. The overburden serves as a reservoir for slow recharge to the bedrock along fractures. The saturated overburden material is unconfined (USACE 2017).

There are two separate bedrock aquifers beneath VHFS that have been identified as Aquifer Zone 1 (Turkey Run Formation) and Aquifer Zone 2 (Midland Formation), both of which primarily consist of interbedded sandstone and siltstones. These units are separated by the Hickory Grove Basalt (Emery &

Garrett Groundwater, Inc. 2005). Groundwater flow out of the surrounding basalt units is generally perpendicular to the primary direction of groundwater flow within the bedrock aquifers. The two aquifer zones make up most the local groundwater flow and availability
(Emery & Garrett Groundwater, Inc.2005).

These fractured rock formations have served as the primary drinking water source in the VHFS area. The interbedded nature of the Turkey Run and Midland Formations—combined with secondary features such as faulting, fracturing, and weathering—heavily influence groundwater storage and movement within the two formations. Groundwater flow within the Turkey Run Formation is interpreted to flow along formation strike from the southwest towards the northeast, presumably with flow towards South Run. Within the Midland Formation a groundwater divide separates flow south of Route 652 towards Kettle Run from groundwater flowing northeasterly towards the diabase rock that bisects the aquifer (Emery & Garrett Groundwater, Inc. 2005).

The Hickory Grove Basalt operates as a semi-confining unit between the Turkey Run and Midland Formations. Basalt formations are typically associated with higher permeability zones at the top and bottom of the flow(s); whereas, the central portion of the basalt flow(s) is expected to be associated with few fractures and constitute an aquitard (Emery & Garrett Groundwater, Inc. 2005).

2.8 Surface Water Hydrology

VHFS is located in the Occoquan watershed. Most of the facility drains to South Run via intermittent tributaries and drainage ditches. South Run's upper reaches were inundated by the construction of the Lake Brittle reservoir, whose dam lies approximately half a mile west (upstream) of VHFS. The Western, Central, and Eastern South Run tributaries originate within the VHFS boundary. All tributaries flowing off-site to the northeast are classified as potable-use streams that flow into Lake Manassas, a recreation and City of Manassas drinking water reservoir located one mile north from VHFS. Drainage for the southern portion of the installation flows south and east to Kettle Run, which eventually joins Broad Run approximately 10 miles downstream from Lake Manassas, which then flows into Occoquan Reservoir, a Fairfax County drinking water supply. (Science Applications International Corporation 1996).

2.9 Relevant Utility Infrastructure

The following subsections provide general information regarding the installation's stormwater and wastewater management systems, as well as information on how the utility infrastructures may influence the fate and transport of PFAS at VHFS.

2.9.1 Stormwater Management System Description

Stormwater drainage at VHFS was accomplished by a combined system of natural drainage ditches, open swales, and drainage pipes (Science Applications International Corporation 1996).

The ridgeline on which Harrison Road is constructed defined the primary stormwater drainage divide for VHFS. Approximately 580 acres drained toward the north either directly into South Run or under Vint Hill Road into tributaries of South Run. Approximately 120 acres drained to the south to Kettle Run under Route 602 at three locations. VHFS contained approximately 21,320 linear feet of all types of storm

sewer, 65% installed prior to 1960. The balance was installed by the end of the 1970s. The systems were constructed coincident with building development on the installation. Thus, most of the drainage systems consisted of numerous small-diameter pipes with short distances to receiving channels and outfalls. Approximately 50% of the system contained pipes with diameters of 12 inches or smaller. Pipes were constructed mostly of reinforced concrete, with plain concrete used in a few of the older systems. Some corrugated metal pipes were present in some collection systems but appeared most often in driveway or patrol road open-end culverts. Many of the primary drainage systems were developed for isolated small area collection, and pipes frequently run at relatively flat gradients (CH2M Hill 1995). Recent aerial photography shows the remnants of historical drainage culverts leading to retention ponds, South Run, and its Western, Central and Eastern tributaries.

In early operational years, multiple dedicated drainage systems were installed to manage wastes generated from photographic, metal-etching, metal-cleaning, and vehicle-maintenance operations at the site. From the 1950s to the early-1980s, multiple industrial facilities discharged waste via dedicated sewer line pipes directly into South Run and the Western South Run Tributary (WSRT). Following changes in waste management procedures in the early-1980s, industrial waste pipes leading to surface water bodies were either plugged or abandoned, and generated wastewaters were instead diverted to the sanitary sewer system and directed to the Active Sewage Treatment Plant for processing.

2.9.2 Sewer System Description

When the post was acquired in 1942, two wastewater collection systems and treatment plants were built. As the post expanded, so did the collection systems. Around 1979, one of the treatment plants was replaced with a sewage pumping station, and all treatment was consolidated at the Active Sewage Treatment Plant. The plant was modified as necessary to accommodate all flow, and the collection system was modified to include a major lift station. Retrofitting included the addition of secondary clarifiers, sludge drying beds, aerobic sludge digestion, and ultraviolet disinfection. By 1995, the system consisted of approximately 128 manholes, 52,040 linear feet of collector sewer and sewage force main, two grinder pump systems, four sewage pumping stations, and the Active Sewage Treatment Plant. The system was designed to provide service for approximately 1,500 military personnel, 2,500 civilian residents, and approximately 100 acres of base facility buildings. The collection system was used almost exclusively for the collection of residential domestic sewage. Only a very small part of the flow collected was considered commercial sewage (CH2M Hill 1995).

2.10 Potable Water Supply and Drinking Water Receptors

Drinking water at VHFS is supplied via on-site groundwater production wells managed by Buckland Water and Sewer Assets Corporation. There are four active production wells (PW-1, VNT-1A, PW-3 and PW-4), two on-site offline existing production wells (PW-2 and PW-5), one approved production well (VNT-3B), three back-up production wells (VNT-1C, VNT-1D and VNT-3D) and two production supply exploratory test wells (VNT-3A and VNT-1B) (**Figure 2-2**). Each of the four active production wells has an open-borehole construction. Two active production wells, VNT-1A and Well PW-3, as well as offline production well PW-5 draw water from Aquifer Zone 1. Two active production wells, PW-1 and PW-4, as well as approved production well VNT-3B and offline production well PW-2 draw water from Aquifer Zone 2 (Emery & Garrett Groundwater Investigations, a Division of GZA 2019).

Available well construction details (e.g., borehole depth, casing depth, water bearing zones) are included in **Table 2-1**. Hydrogeologic logs, where available, for identified potable wells are provided as **Appendix D**. Due to the age of the "PW" production wells, limited information is available for these wells. A summary of active on-site production well locations relative to bedrock geology and aquifer zones across VHFS is below (Emery & Garrett Groundwater, Inc. 2005):

- VNT-1A: Open borehole construction beginning at 58 feet bgs within the Turkey Run Formation sandstone. VNT-1A targets groundwater within Aquifer Zone 1.
- PW-1: PW-1 targets groundwater within Aquifer Zone 2.
- PW-3: PW-3 targets groundwater within Aquifer Zone 1.
- PW-4: PW-4 targets groundwater within Aquifer Zone 2.

Approximately 259,000 to 415,072 gallons per day of groundwater recharge could be expected across VHFS. However, pumping influences are known to extend beyond the property boundaries of the site; therefore, it is reasonable to assume that recharge to VHFS will be derived from areas extending beyond the project boundaries (Emery & Garrett Groundwater, Inc. 2005).

There are numerous off-site water supply wells surrounding VHFS which have various owners. An Environmental Data Resources, Inc. (EDR) report includes search results from a variety of environmental, state, city, and other publicly available databases for a referenced property. An EDR report was generated for VHFS, which along with state and county GIS provided by VHFS identified several off-post public and private wells within 5 miles of the installation boundary (**Figure 2-5**) (Emery & Garrett Groundwater, Inc. 2005). The EDR report providing well search results provided as **Appendix E**.

2.11 Ecological Receptors

Due to the availability of adequate toxicity data, the Army focused the PA/SI on human receptors. The PA team collected information regarding ecological receptors that was available in the installation documents reviewed during the PA process. The following information is provided for future reference should the Army decide to evaluate exposure pathways relevant to the ecological receptors.

No plant or wildlife species listed by the U.S. Fish and Wildlife Service or the Commonwealth of Virginia Endangered Species Act as threatened or endangered are known to occur at VHFS. The southern bald eagle (Haliaeetis leucocephalus), an endangered species, is occasionally observed at nearby Lake Manassas. Approximately 5 acres of VHFS property are within the 100- year floodplain of South Run. The Western South Run Tributary is considered a palustrine wetland and is the only wetland on the VHFS property (Science Applications International Corporation 1996).

2.12 Previous PFAS Investigations

Previous (i.e., pre-PA) PFAS investigations relative to VHFS, including both those conducted and not conducted by the Army, are summarized to provide full context of available PFAS data for VHFS. However, only data collected by the Army will be used to make recommendations for further investigation. On-site active production wells (PW-1, VNT-1A, PW-3, and PW-4), two on-site offline production wells (PW-2 and PW-5), one approved production well (VNT-3B), three back-up production wells (VNT-1C,

VNT-1D and VNT-3D) and two production supply exploratory test wells (VNT-3A and VNT-1B) were sampled for PFAS in August 2017 and October 2018 (VNT-1B was only sampled in 2018). PFOS and PFOA were detected in 10 of the 11 wells (PW-4 had no detections), and PFBS was detected in four of the 11 on-site production wells during the latest 2018 sampling event (Emery & Garrett Groundwater Investigations, a Division of GZA. 2019). Analytical samples collected during the Emery & Garrett groundwater investigations were submitted to Eurofins Lancaster Laboratories Environmental (ELLE), an ELAP-accredited laboratory for PFAS analysis, including PFOA, PFOA, and PFBS. Fourteen PFAS-related compounds, including PFOS, PFOA, and PFBS, were analyzed for in groundwater samples using the PFAS analytical Method 537.1.

The PFAS compounds that were analyzed as part of the 2018 groundwater investigations are presented in **Table 2-3** below:

Table 2-3. Analytical Group PFAS Emery and Garrett 2018 Groundwater Investigation

Analyte	CAS Number
Perfluorohexanoic acid (PFHxA)	307-24-4
Perfluoroheptanoic acid (PFHpA)	375-85-9
Perfluorooctanoic acid (PFOA)	335-67-1
Perfluorononanoic acid (PFNA)	375-95-1
Perfluorodecanoic acid (PFDA)	335-76-2
Perfluoroundecanoic acid (PFUnA)	2058-94-8
Perfluorododecanoic acid (PFDoA)	307-55-1
Perfluorotridecanoic acid (PFTrDA)	72629-94-8
Perfluorotetradecanoic acid (PFTA)	376-06-7
Perfluorobutanesulfonic acid (PFBS)	375-73-5
Perfluorohexanesulfonic acid (PFHxS)	355-46-4
Perfluorooctane sulfonate (PFOS)	1763-23-1
N-ethyl perfluorooctane sulfonamidoacetic acid (NEtFOSAA)	2991-50-6
N-methyl perfluorooctane sulfonamidoacetic acid (NMeFOSAA)	2355-31-9

A summary of the 2018 detections is below:

- PFOS detections ranged from 3.1 ng/L in Well VNT-3A to 680 ng/L in Well VNT-3B.
- PFOA detections ranged from 2.1 ng/L in Well VNT-3A to 1,000 ng/L in Well VNT-1B.
- PFBS detections ranged from 2.2 ng/L in PW-5 to 66 ng/L in VNT-3B.
- No PFAS compounds were detected in active well PW-4.

Known PFAS contamination above the OSD risk screening levels in groundwater wells VNT-1B and VNT-3B towards the northern portion of VHFS is believed to originate from proximal areas from shallow soils where AFFF was likely released to the ground during fire training activities at areas requiring environmental evaluation (AREE) 16-2 or where potentially PFAS- containing materials were disposed at AREE 29-2. PFAS released to the shallow surface soils by AFFF and/or PFAS-containing materials likely migrated vertically and horizontally into the underlying aquifers. The well construction for both VNT-1B and VNT-3B is open-borehole and transects through various geologic formations, therefore the source of PFAS mass is unknown. The open sections of both well VNT-1B and well VNT-3B intersect zones of the Hickory Grove Basalt that are inferred to be associated with significant transmissivity. Based on the bedrock groundwater flow direction across the site, it is suspected the PFAS contamination may be migrating from AREE 16-2, to the northeast towards drinking water wells and off site.

Soils at AREE 16-2 were sampled for PFAS in 2018 at the suspected location of the former burn pit. PFOA was detected in two samples; the sample collected from 3 to 5 feet bgs had a detection of 0.00072 milligrams per kilogram (mg/kg), and the sample collected from 7 to 8 feet bgs had a detection of 0.00033 mg/kg. Both PFOS and PFBS were not detected in soil samples collected at AREE 16-2 in 2018 (Emery & Garrett Groundwater Investigations, a Division of GZA. 2018). Soil was not analyzed for PFAS at any other locations.

3 SUMMARY OF PA ACTIVITIES

The following three principal sources of information were used to develop this PA:

1. Records review
2. Personnel interviews
3. Site reconnaissance.

These sources of data, along with their relative application to this PA, are discussed below.

3.1 Records Review

Before and during the site visit, records and reports provided by the Army and the current water system operator, as well as those that were publicly available, were reviewed to identify potential AOPIs. The records reviewed included, but were not limited to, various Installation Restoration Program administrative record documents, compliance documents, VHFS fire department documents, VHFS directorate of public works documents, hydrogeologic reports and GIS files. Internet searches were also conducted to identify publicly available and other relevant information. Additionally, an EDR report generated for VHFS was reviewed to obtain off-post water supply well information. A list of the documents reviewed is provided in **Appendix F**.

3.2 Personnel Interviews

Before arriving for the site visit, PA team members scheduled interviews using the preliminary list of individuals identified by the Army POCs to be knowledgeable about the site's history. The interviewees were identified by the PA team during the preliminary research, in the read-ahead package, by follow-up notification emails, during the in-brief meeting, and through conversations with Army personnel.

The interviews were conducted by the PA team during the site visit. If a previously identified interviewee was not available during the site visit, attempts were made to complete the interview via telephone before or following the site visit or by contacting an alternate interviewee identified by the Army POC.

The list of roles and affiliation for the personnel interviewed during the PA process for VHFS is presented below.

- Engineering/Process Manager (Buckland Water and Sewer Assets Corporation)
- Environmental Support Manager Army BRAC (Calibre)
- CERCLA Project Manager (Virginia Department of Environmental Quality)
- Fire Chief (Fauquier County Department of Fire Rescue and Emergency Management)

The compiled interview logs provided in **Appendix G**.

3.3 Site Reconnaissance

Site reconnaissance and visual surveys were conducted at VHFS of the preliminary locations identified during the records review process, the installation in-brief meeting, and/or during the installation personnel interviews. These areas were classified as an area not retained for further investigation or an AOPI based on a combination of information collected (e.g., records reviewed, personnel interviews, internet searches) as described in **Sections 5.1** and **5.2**, respectively. A photo log from the site reconnaissance is provided in **Appendix H**; photos were used to assist in verification of qualitative data collected in the field. The site reconnaissance logs are provided in **Appendix I**.

Access to existing groundwater monitoring wells, if present, were noted during the reconnaissance portion of the site visit for potential future sampling in case the monitoring wells were to be proposed for site inspection sampling.

4 POTENTIAL PFAS USE, STORAGE, AND/OR DISPOSAL AREAS

VHFS was wholly evaluated for potential, current, and historical use, storage, and/or disposal of PFAS-containing materials. There are a variety of PFAS-containing materials used in relation to current and historical Army operations. However, two activities involve the most prevalent use, storage, and/or disposal; AFFF, and PFAS-containing mist suppressants used in metal plating. Many of the PFAS found in AFFF and metal plating operations are surfactants (which do not volatilize) and are found in a charged or ionic state at environmentally-relevant pH (i.e., pH 5 to 9 standard units). PFOS, PFOA, and PFBS are each negatively charged at environmentally-relevant pH. The media potentially affected by PFAS releases at Army installations are soil, groundwater, surface water, and sediment. Once released to the environment, a primary factor that inhibits the movement of PFAS is the presence of organic matter and organic co-constituents in soils and sediments. Generally, PFAS are mobile in the potentially affected media, and they are not known to be fully broken down by natural processes.

Preliminary locations were then evaluated in the PA (during records review, personnel interviews, and/or site reconnaissance) and were categorized AOPIs or as areas not retained for further investigation at this time. A summary of the observations made, and data collected through records reviews (**Appendix F**), installation personnel interviews (**Appendix G**), and site reconnaissance (**Appendix I**) during the PA process for installation name is presented in subsections below. Further discussion regarding areas not retained for further investigation/AOPIs are presented in **Section 5.1/Section 5.2**.

4.1 AFFF Use, Storage, and Disposal at VHFS

AFFF was developed in the mid-1960s in response to a need for firefighting foams better suited to extinguish Class B, fuel-based fires. AFFF formulations consist of water, an organic solvent, up to 5 percent (%) hydrocarbon surfactants, and 1 to 3% PFAS (Interstate Technology Regulatory Council 2020). AFFF concentrate is designed to be diluted with water to become a 1, 3, or 6% foam. AFFF releases at Department of Defense (DoD) facilities may have occurred during firefighter training, emergency response actions, equipment testing, or accidental releases. Army installations may still house AFFF, commonly stored in closed containers (e.g., 55-gallon drums, 5-gallon buckets), within designated storage buildings or at firehouses.

During document research, two historical fire training areas were identified that could have potentially been a location of AFFF use. AREE 16-1- Possible Fire Training Pit and AREE 16-2– Possible Fire Training Pit were both used in the mid-1970s for VHFS Fire Department training. During training, the pits were filled with petroleum and ignited for fire department training purposes. In the mid-1980s, the pits were filled with gravel and discontinued. Further information on the VHFS fire department training operations (i.e., specifically using AFFF) at this area could not be confirmed; however, it was common practice to utilize AFFF on fuel-based figures during training operations in the 1970s. Additional information regarding each fire training area is provided in **Section 5.2**.

The VHFS Fire Department dissolved in 2000 following the BRAC in 1997. The current Fauquier County Fire and Rescue Chief, who formerly held the role of VHFS Fire Chief from 1997 to 2000 was interviewed. No VHFS Fire Department personnel who were members prior to 1997 were interviewed during or after

the PA site visit and reviewed historical records did not document any AFFF releases. Therefore, any known AFFF use and/or storage at VHFS related to VHFS Fire Department activities prior to 1997 was not confirmed. However, during document review, photos were reviewed which identified two VHFS Fire Department vehicles that appear capable of deploying foam. The vehicles were utilized after the mid-1980s, which is during the time of common AFFF storage and use within fire department vehicles. Due to the identification of potentially AFFF-carrying vehicles in historical photos reviewed, and the lack of historical knowledge from the former VHFS Fire Department to confirm no AFFF use or storage, there is a data gap and possibility of historical AFFF use and storage related to VHFS Fire Department operations.

During the site visit interviews, the former VHFS Fire Chief (1997 to 2000), stated that AFFF was not used for training during his tenure at VHFS. The former Fire Chief also stated that Building 271 was the only fire station to have operated at VHFS.

The former Fire Chief stated that both AFFF and AFFF crash carts were stored in Building 2470, which was demolished in 2005. Building 2470 included a series of garage bays, but the exact location where AFFF was stored within the building could not be confirmed. The former Fire Chief added that fire truck maintenance was performed on-site at the former Vehicle Maintenance Buildings 288 and 290, currently referred to as AREE 9.

4.2 Metal Plating Operations

Potential PFAS use associated with metal plating activities may also be relevant to Army installations. During metal plating operations, a metal surface may be treated with a layer of electrochemically deposited metals in an acid bath. PFAS, specifically PFOS, have been used in metal plating operations as surface tension-reducing wetting agents to mitigate the release of aerosolized chemicals into a working environment. Hard chromium plating is one type of metal plating operation where PFAS-containing mist suppressants were commonly used. Historically, it was common for spent plating baths from metal plating operations to be disposed of in a lined or unlined pit or into a sanitary or storm sewer. Therefore, PFAS present in mist suppressants during the metal plating process could be released to the environment.

During document research, Building 2400 – Electrical Equipment Facility and Pretreatment Tank was identified as a metal-etching site. Wastes discharged from this location as part of metal-etching included chromic acid. Metal-etching operations took place at Building 2400 from 1965 to 1995.

From 1965 to 1978, spent wastes were channeled via a dedicated and tar-sealed clay sewer line from the building directly to the WSRT. From 1978 onwards, spent wastes were first neutralized in a neutralization pit and then funneled to a pretreatment tank. Liquid waste from this tank was diverted to the sanitary sewer systems, and solid waste was applied to the AREE 13: Sludge Disposal Area. All floor drains discharged spills and floor wash waters to the pretreatment tank.

No reports, chemical inventories, or other information detailing the potential use of PFAS-containing surfactants as part of metal-etching operations was found during the PA.

4.3 Photo Processing Facilities

Photo-processing operations were conducted at Building 2400 between 1965 and 1995 by the Army, and at the EPIC Building between 1958 and 1995 by various agencies, including the Army, U.S. Air Force, and USEPA. From 1958 to 1968, photo-processing wastes generated at the EPIC building were channeled via a dedicated and tar-sealed clay sewer line directly to the FPWL located along the WSRT. After the FPWL was dredged for silver in 1968, wastes from the EPIC Building were then funneled directly into the WSRT until 1983, when generated wastes were then diverted to the Active Sewage Treatment Plant. Similar photo-processing operations took place at Building 2400. Waste management procedures for Building 2400 are described in **Section 4.2**. Information detailing the specific photo-processing chemicals used at these locations was not found during PA.

4.4 Sewage Treatment Plant Sludge Management Areas

Two sewage treatment plant, designated as the Active Sewage Treatment Plant and Former Sewage Treatment Plant, were operated by VHFS from 1943 to 1995. Between 1978 and 1981, the Former Sewage Treatment Plant received photographic and metal-etching wastes from Building 2400 and the EPIC Building until its closure in 1981. A sewage lift station was installed following the shut-down of the Former Sewage Treatment Plant to divert sewage waste previously directed to the Former Sewage Treatment Plant to the Active Sewage Treatment Plant for treatment. During their operational histories, sludges generated at the plants were dried in sludge drying beds and stored on-site in piles near the sewage treatment plants. Following the shutdown of the Former Sewage Treatment Plant, residual sludges were disposed of in the Sludge Disposal Area. Prior to 1981, sludges generated at the Active Sewage Treatment Plant were stored in piles next to South Run. Between 1980 and 1991, sludges were aerobically digested and then placed in one of four sand drying beds located proximally to South Run. Since 1991, dried sludges have been disposed of off-site.

4.5 Waste Management/Application Areas

Multiple waste and sludge disposal areas were confirmed or suspected to have been used to manage generated wastes and processed sludges throughout the operational history of VHFS. Based on review of disposal logs, administrative documents, and aerial photography, at least seven waste disposal areas were identified to have received potentially PFAS-containing wastes between 1942 to 1993: the Waste Disposal Area, Sludge Disposal Area, Unlined Sludge Disposal Area (Dump #3), Possible Sludge Disposal Area, Possible Disposal Area, Disposal Area, and Liquid Impoundment Area. Wastes disposed at these areas include photographic wastewaters, sewage sludge, sanitary waste, garbage, and unidentified liquids.

4.6 Car Washes

A former VHFS Fire Chief stated during his interview that two carwash areas operated during his tenure at VHFS. The Automated Car Wash and Outdoor Wash Rack were in operation from at least 1996 to 2006 and served as personal car washes for civilians and VHFS personnel. Car washes are suspect for PFAS use and release due to the historical inclusion of PFAS-containing materials in certain carwash detergents and waxes. Both identified carwashes have since been abandoned and are no longer in use.

No drainage systems or pathways were identified during a site reconnaissance visit to the Automated Car Wash building. During a site-reconnaissance trip to the Outdoor Wash Rack, it was noted that the former car wash area was equipped with 10-inch-tall concrete berms to prevent runoff to the surrounding environment. Reports related to this area indicate that a grit chamber was installed in 1982, which diverted captured runoff to the sanitary sewer system. Information on the specific soaps and waxes used for vehicle cleaning at these locations was not available.

4.7 Readily Identifiable Off-Post PFAS Sources

An exhaustive search to identify all potential off-post PFAS sources (i.e., not related to operations at VHFS) is not part of the PA/SI program. However, potential off-post PFAS sources within a 5-mile radius of the site that were identified during the records search and site visit are described below.

Nearby community fire departments such as the New Baltimore Volunteer Fire and Rescue Company (located approximately one mile from VHFS) and the Nokesville Volunteer Fire Department (located less than five miles from VHFS) could potentially be off-post PFAS sources within close proximity of VHFS, if they use AFFF.

5 SUMMARY AND DISCUSSION OF PA RESULTS

The areas evaluated for potential use, storage and/or disposal of PFAS-containing materials at VHFS were further refined during the PA process and identified either as an area not retained for further investigation or as an AOPI. In accordance with the established process for the PA/SI, six have been identified as areas not retained for further investigation and 23 have been identified as AOPIs. The process used for refining these areas is presented on **Figure 5-1**, below.

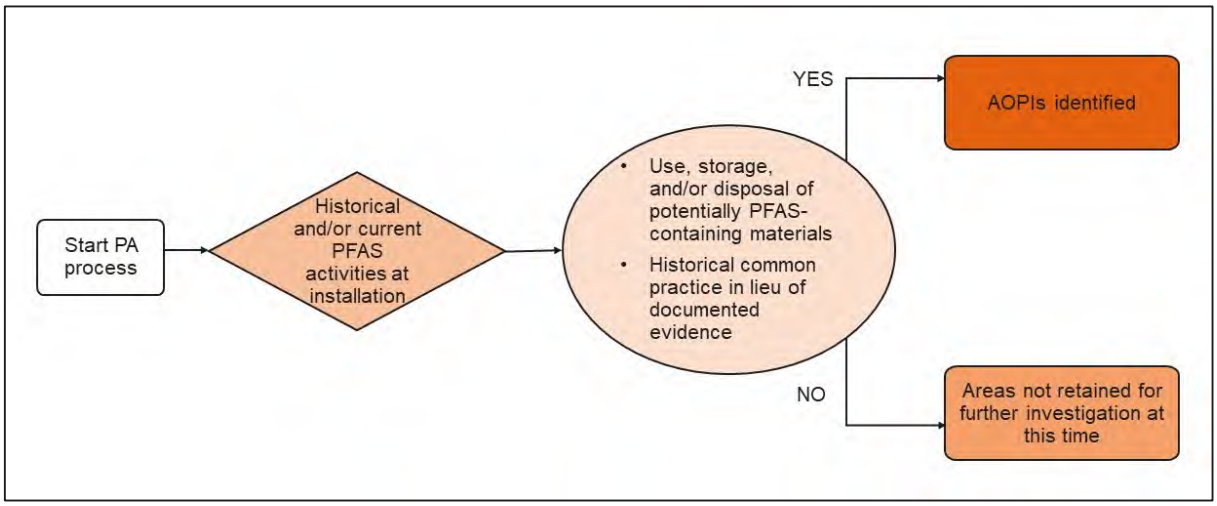


Figure 5-1: AOPI Decision Flowchart

The areas not retained for further investigation are presented in **Section 5.1**. The areas retained as AOPIs are presented in **Section 5.2**. Data limitations for this PA/SI at VHFS are presented in **Section 8**.

5.1 Areas Not Retained for Further Investigation

Through the evaluation of information obtained during records review, personnel interviews, and/or site reconnaissance, the areas described below were categorized as areas not retained for further investigation at this time.

A brief site history and rationale for areas not retained for further investigation is presented in **Table 5-1**, below.

Table 5-1. VHFS Areas Not Retained for Further Investigation

Area Description	Dates of Operation	Relevant Site History	Rationale
Pesticide Mixing Facility and Storage Areas	Prior to 1981	Since 1981, pesticide application and storage has been managed by a contractor and there is no storage at VHFS. Prior to 1977, insecticides were stored in Building 243 and herbicides in Building 320.	Did not identify the potential for PFAS-containing pesticide use or storage at VHFS. Building has since been demolished.
AREE 6: Health Clinic	1965 to 1994	The health clinic located at building 137 was noted to have had three X-ray machines.	Did not confirm large-scale photo processing operations at this location.
AREE 4: Auto Craft Shop	1943 to 1994	Military personnel performed maintenance on personal vehicles until 1994 and was used from 1943 to1967 as a motor pool.	Did not confirm that fire department crash trucks or AFFF-carrying vehicles were serviced at this location.
AREE 30: Motor Pool (Building 305)	Prior to 1996	Motor pool for approximately 20 years. Now surrounded by asphalt but used to be gravel. Vehicle maintenance occurred on gravel parking lot.	Did not confirm that fire department crash trucks or AFFF-carrying vehicles were serviced at this motor pool.
AREE 15: Building 700 Hazardous Waste Storage Building	1990 to Unknown	Building 700 serves as a hazardous waste accumulation facility for 90 days or less.	Did not identify any PFAS-containing chemicals stored at this location.
AREE 29-1: Salvage Yard	Mid-1970s	Located in the northwestern section of VHFS near Route 652 and was historically used as a small, fenced yard with drums/debris.	Did not confirm that any possible PFAS-containing materials were disposed of at this location.

5.2 AOPIs

Overviews for each AOPI identified during the PA process are presented in this section. In certain cases, AOPIs identified at VHFS include the “AREE” designation and their associated identification numbers, as attributed to the sites in historical environmental investigations conducted at VHFS.

The AOPI locations are shown on **Figure 5-2**. Aerial photographs of each AOPI that also show the approximate extent of AFFF use (if applicable) are presented on **Figures 5-3** through **5-15** and include active monitoring wells in the vicinity of each AOPI.

5.2.1 AREE 16-1: Possible Fire Training Pit

The AREE 16-1: Possible Fire Training Pit is identified as an AOPI following records research and site reconnaissance due to the historical use of this area for VHFS Fire Department training exercises. Based on historical documents, an unlined, 50-foot diameter by 3-foot-deep fire training pit was used on a monthly basis for fire department training purposes in the mid-1970s. Two possible locations for this fire training pit were presented in historical documents and were identified as AREE 16-1 and AREE 16-2. The team was unable to confirm if AFFF was released as part of fire training operations at the suspected fire training pit; however, it was common practice to utilize AFFF on fuel-based fires during training operations in the 1970s. Both suspected fire training pits have been identified as AOPIs.

The AREE 16-1: Possible Fire Training Pit is located within the northern confines of the former VHFS site directly along the WSRT. Rolling grassed fields and sparse tree lines dominate the area surrounding the AOPI. During a site reconnaissance trip to the area, a surface water feature was observed to run along topography and terminate at the suspected location of the AOPI. Review of aerial photography indicated that the surface water feature was man-made and may have been connected to a former VHFS building. Surface water (i.e., precipitation) runoff from the AOPI is suspected to infiltrate to groundwater.

As part of a 1994 enhanced preliminary assessment (ENPA), this area was identified as AREE 16-1 Total petroleum hydrocarbon (TPH) field screening of the soil at AREE 16-1 was conducted to delineate the area of contamination and to determine where soil samples should be collected for laboratory analysis. Surface soil samples were collected based on positive TPH results from the field screening. Arsenic exceeded its residential soil risk-based concentration (RBC) as well as its maximum background concentration in the surface soil samples collected at AREE 16-1. A number of dioxins/furans indicative of combustion operations were detected in the surface soil samples. 2.3.7.8-TCDD (2.74E-04 ppm) was the only dioxin/furan to exceed its residential soil RBC (4 3E-06 ppm). In the 1999 ROD, NFA was recommended at AREE 16-1 (IT Corporation 1999).

5.2.2 AREE 17: Unlined Sludge Disposal Area (Dump #3)

The Unlined Sludge Disposal Area (Dump #3) is identified as an AOPI following records research, personnel interviews, and site reconnaissance due to its use between 1953 and 1993 as a disposal area for sludges generated at both the Former Sewage Treatment Plant and Active Sewage Treatment Plant that potentially contained PFAS. According to previous investigations, this unlined area consists of a 318-foot by 390-foot area, and dump wastes extend to a depth of 7 feet bgs.

The AOPI resides atop a local topographic high in the north-central portion of VHFS along an unnamed road that extends westward and parallel to Macintosh Drive. The AOPI is within a densely forested and heavily vegetated pocket surrounded by an otherwise featureless field. Debris from this dump site was observed past the treeline during a site-reconnaissance visit to the site. No buildings or supporting infrastructure were observed during a site-reconnaissance visit or aerial photography review. The outline of a natural or man-made stormwater line was observed to originate from the northwestern portion of the

site and run downward along topography towards the northwest and into the WSRT. The surrounding area is designated for commercial use.

As part of a 1994 ENPA, this area was identified as AREE 17. In the 1999 ROD, NFA was recommended at AREE 17 (IT Corporation 1999).

5.2.3 AREE 29-3: Possible Disposal Area

The Possible Disposal Area is identified as an AOPI following records research, personnel interviews, and site reconnaissance due to evidence of ground-scarring and mounding in aerial photographs from the 1950s consistent with possible disposal activities. Due to data gaps surrounding the types of materials disposed of at this location, coupled with the potential use of PFAS-containing materials in former operations at VHFS, the location was identified as an AOPI.

The AOPI is located within the western-central portion of VHFS along an unnamed road directly east of Kennedy Road. The AOPI consists of a grassed field defined by low topographic relief. The area surrounding the suspected AOPI boundary has been highly redeveloped and regraded. In 2019, a large stormwater retention pond was installed to the south of the AOPI. Review of aerial photography from 2017 also showed evidence of heavy regrading to the north and west of the AOPI. Portions of this regrading activity overlap with the suspected northern boundary of the AOPI. Surface runoff from this AOPI flows eastward along topography and into the WSRT. The AOPI resides within a commercial portion of VHFS.

As part of a 1994 ENPA, this area was identified as AREE 29-3. In the 1999 ROD, NFA was recommended at AREE 29-3 (IT Corporation 1999).

5.2.4 AREE 16-2: Possible Fire Training Pit

The AREE 16-2: Possible Fire Training Pit is identified as an AOPI following records research and site reconnaissance due to the historical use of this area for VHFS Fire Department training exercises, in addition to existing detections of PFOS and PFOA in monitoring and supply wells within the vicinity of the area. Based on historical documents, an unlined, 50-foot diameter by 3-foot-deep fire training pit was used on a monthly basis for fire department training purposes in the mid-1970s. Two possible locations for this fire training pit were presented in historical documents and were identified as AREE 16-1 and AREE 16-2. The team could not confirm if AFFF was released as part of fire training operations at the suspected fire training pit; however, it was common practice to utilize AFFF on fuel-based fires during training operations in the 1970s. Both suspected fire training pits have been identified as AOPIs.

The area encompassing and surrounding the AOPI was redeveloped sometime between 1994 and 2003. The boundaries of the AOPI currently reside on the eastern slope of an elevated man-made berm. Grass fields surround the AOPI. The Vint Hill Parkway is located approximately 160 feet east of the AOPI. No man-man or natural surface water management features were observed during site-reconnaissance trips and review of aerial photography. Surface water (i.e., precipitation) originating from this AOPI either discharges to groundwater or flows eastward along topography and onto the Vint Hill Parkway.

As part of a 1994 ENPA, this area was identified as AREE 16-2. In the 1999 ROD, NFA was recommended at AREE 16-2 (IT Corporation 1999).

5.2.5 AREE 29-2: Possible Sludge Disposal Area

The Possible Sludge Disposal Area is identified as an AOPI following records research, personnel interviews, and site reconnaissance due to review of 1970s aerial photography indicating that this area may have been used to dispose of sewage treatment plant sludge that potentially contained PFAS.

The AOPI is located near the northernmost boundary of VHFS near Route 215 and consists of a raised and grassed mound in an open field area. Surface runoff from the AOPI flows northward along topography before eventually draining to South Run. No buildings or existing infrastructure are present within the immediate vicinity of the AOPI. The AOPI resides within a commercial portion of VHFS.

As part of a 1994 ENPA, this area was identified as AREE 29-2. In the 1999 ROD, NFA was recommended at AREE 29-2 (IT Corporation 1999).

5.2.6 Former Helipad

The former helipad was located directly south of the AREE 16-2: Possible Fire Training Pit. Review of aerial photography shows that the helipad was removed sometime between 1994 and 2004. Historical VHFS Fire Department training at this location could not be confirmed. However, at the landowner's request, this site was investigated during the SI due to the uncertainty if AFFF had been used at the site.

5.2.7 Former VHFS Fire Station (Building 271)

The Former VHFS Fire Station (Building 271) is identified as an AOPI following records research, personnel interviews, and site reconnaissance due to the use of two VHFS Fire Department vehicles capable of AFFF storage and use. Based on historical documents, the identified AOPI was the only fire station in place at VHFS. Dated photographs and aerial photography indicate that the AOPI was in use from at least the 1980s until its demolition in 2003. The AOPI resides along Aiken Drive in the former southwestern quadrant of the Former VHFS. Multiple residential and commercial buildings surround the AOPI boundaries. A small, grassed area now occupies the boundaries of the former fire station. The original south facing Building 271 driveway appears to be in-place. Remnants of the Building 271 utility infrastructure were noted during site reconnaissance visits to the area and in aerial photography. Stormwater inlets located south of the AOPI and along Aiken Drive manage surface water (i.e., precipitation) runoff originating from the AOPI boundaries.

5.2.8 Former Building 2470 – Fire Department Storage Building

The Former Building 2470 – Fire Department Storage Building is identified as an AOPI following personnel interviews, and site reconnaissance due to the confirmed storage of AFFF and a fire department crash trailer capable of storing and releasing AFFF at this location. Information detailing the building's operational history was not available for review during the PA, but review of aerial photography indicates that the building was demolished in 2005. A roadway now resides atop the former building outline. Commercial buildings and parking lots border the western side of the former building outline. The eastern side of the former building outline is bordered by a steep, grassed bank. Surface runoff from the eastern side of the building outline is managed by stormwater inlets along the Vint Hill Parkway, while surface runoff from the eastern side flows downslope and along topography into an unnamed intermittent stream.

5.2.9 AREE 5: Environmental Photographic Interpretation Center (EPIC) Building

AREE 5: EPIC Building is identified as an AOPI following records research, personnel interviews, and site reconnaissance due to the building's use as a large-scale photo processing and developing laboratory. From 1958 to 1968, photographic chemical waste from this building was channeled via a dedicated clay sewer line directly to the FPWL. Following the dredging of the FPWL in 1968, waste from the EPIC Building was channeled directly to the WSRT until 1983. After 1983, waste was then diverted to the Active Sewage Treatment Plant. Information on the specific chemicals used in these operations was not available for review during the PA, however due to the scale of the operation and use, data gaps warranted its designation as an AOPI. The AOPI is in the southwestern portion of the VHFS parcel and resides atop an elevated and grassed hill. The immediate environment surrounding the AOPI consists of sparse vegetation, former barrack infrastructure, and commercial properties. Surface water runoff flows radially away from the building along topography and into stormwater infrastructure. The current land use at the AOPI is designated as commercial.

As part of a 1994 ENPA, this area was identified as AREE 5. In the 1999 ROD, NFA was recommended at AREE 5 (IT Corporation 1999).

5.2.10 AREE 10: Former Photographic Wastewater Lagoon

The FPWL [AREE 10] is identified as an AOPI following records research, personnel interviews, and site reconnaissance. The FPWL was a 90-foot diameter, 4-foot deep holding pond that received photographic wastewaters from the EPIC Building from 1958 to 1968. In 1968, the lagoon was dredged to recover silver and filled; however, it is unknown if outside fill or original soils were used to refill the lagoon.

The AOPI is located within the central portion of VHFS in a heavily vegetated and grassed field area. An intermittent portion of the WSRT transects the AOPI boundary. This same water body manages surface water runoff from the AOPI. The surrounding area is classified for commercial use.

As part of a 1994 ENPA, this area was identified as AREE 10. In the 1999 ROD, NFA was recommended at AREE 10 (IT Corporation 1999).

5.2.11 AREE 11: Former Sewage Treatment Plant - Sludge Drying Beds and Sludge Piles

AREE 11: Former Sewage Treatment Plant Sludge Drying Beds and Sludge Piles are identified as an AOPI following records research, personnel interviews, and site reconnaissance due to its use as a storage area for processed sludges that potentially contained PFAS. This Former Sewage Treatment Plant operated from 1943 until 1981. Between 1978 and 1981, this plant received wastes from the Building 2400 - Electrical Equipment Facility (**Section 5.2.7**). Sludges from this treatment plant were disposed of at the Sludge Disposal Area (**Section 5.2.13**). Wastewaters were discharged to WSRT. Sludges from the Former Sewage Treatment plant were dried in sludge drying beds and then stored on-site in piles near the WSRT. Following closure of the Former Sewage Treatment Plant in 1981, the Sludge Drying Beds were drained and razed.

The Former Sewage Treatment Plant Sludge Drying Beds and Sludge Piles now resides within an undeveloped and heavily grassed and forested area in the central portion of VHFS. Surface runoff from

the AOPI flows along topography and into an intermittent portion of the WSRT that transects the AOPI boundary. Multiple commercial buildings are located directly northeast of the AOPI. The current land use is commercial.

As part of a 1994 ENPA, this area was identified as AREE 11. Shallow and deep surface soil samples were collected in the vicinity of the drying beds and sludge piles as part of a 1998 RI. Groundwater samples were collected downgradient of these areas. Polynuclear aromatic hydrocarbons and pesticides exceeding residential soil RBCs established by the USEPA were present in the surface soil in the drying bed area and the sludge pile area. Mercury contamination, exceeding the residential soil RBC, was present in the surface soil in the sludge pile area. The ecological risk assessment determined that contaminants in surface soil at AREE 11 posed significant potential adverse ecological effects. The sludge pile area was recommended for remediation, and the impacted area was excavated and backfilled shortly after 1999 (IT Corp 1999).

5.2.12 Sewage Lift Station [AREE 28-9]

AREE 28-9: Sewage Lift Station is identified as an AOPI following records research, personnel interviews, and site reconnaissance due to several instances of sewage overflow to the surrounding ground during pump failure or electrical service failure. The sewage lift station was installed following the shut-down of the Former Sewage Treatment Plant in 1981. Sewer wastes from the EPIC Building, and the Building 2400 - Electrical Equipment Facility and Pretreatment Tank, which potentially contained PFAS, were pumped through this sewage lift station to the Active Sewage Treatment Plant starting in 1983.

The Sewage Lift Station AOPI resides within the central portion of VHFS. Review of aerial photography from May 2017 showed the remnants of the AOPI and supporting infrastructure that has since been either removed or demolished. The area surrounding the AOPI now consists of excavated areas, grass, and soil. No natural or man-made surface water runoff pathways were noted during site reconnaissance trips to the AOPI. The surrounding area is currently used for commercial purposes.

As part of a 1994 ENPA, this area was identified as AREE 28-9. In the 1994 PA, no further action was recommended (Science Applications International Corporation 1994).

5.2.13 AREE 7: Building 2400 – Electrical Equipment Facility and Pretreatment Tank

The AREE 7: Building 2400 – Electrical Equipment Facility and Pretreatment Tank is identified as an AOPI following records research, personnel interviews, and site reconnaissance due to the building's use as a photo-developing, metal etching, and graphics work facility. All identified operations that took place at this location have historically been associated with PFAS-containing materials. From 1965 to 1978, wastes from this building were discharged directly into the WSRT. From 1978 until 1995 wastes were held in a neutralization pit (**Section 5.2.8**) before being discharged to a pretreatment tank located directly next to the southeastern wall of Building 2400. Liquid waste from this pretreatment tank was diverted to the sanitary sewer systems, and solid waste was applied to the Sludge Disposal Area (**Section 5.2.13**). Wastes from this building were channeled via a dedicated clay sewer line that was sealed with tar. All floor drains discharged spills and floor wash waters to the pretreatment tank. Operations at this building ceased in 1995.

The AOPI and the surrounding environment has been heavily redeveloped and repurposed for commercial use. The building is surrounded by multiple pedestrian walkways, lawns, buildings, parking lots, and recreational areas. Numerous monitoring wells screened in the surficial aquifer are located to the southeast of the building. Surface water runoff from this AOPI is managed by storm water infrastructure. The land is currently used for commercial purposes.

As part of a 1994 ENPA, this area was identified as AREE 7. In the 1999 ROD, NFA was recommended at AREE 7 (IT Corporation 1999).

5.2.14 AREE 8: Building 2400 - Neutralization Pit

AREE 8: Building 2400 - Neutralization Pit is identified as an AOPI following records research, personnel interviews, and site reconnaissance due to its use as a neutralization pit for wastes generated at the Building 2400 Electrical Equipment Facility, which potentially contained PFAS. Use of the pit for waste processing ceased in 1990.

The AOPI was removed sometime after 1990, and the surrounding environment has been heavily redeveloped for commercial use. The AOPI now consists of a grassed lawn directly southwest of Building 2400 and is surrounded by multiple pedestrian walkways, buildings, parking lots, and recreational areas. Numerous monitoring wells screened in the surficial aquifer are located to the southeast of the area. Surface water runoff from this AOPI is managed by storm water infrastructure. The land is currently used for commercial purposes.

As part of a 1994 ENPA, this area was identified as AREE 8. In the 1996 SI, NFA was recommended for AREE 8 (Science Applications International Corporation, 1996).

5.2.15 AREE 29-4: Disposal Area

The Disposal Area is identified as an AOPI following records research, personnel interviews, and site reconnaissance due to evidence of disposal activities in aerial photographs from the 1950s to1970s. Five distinct areas were visible in the disposal area. Two of the five areas were reportedly used for construction debris disposal. Another area was potentially used to obtain fill material or for liquid disposal. The last two areas were an orange mound area and an orange/brown stain area; however, it was not reported what materials were stored here. Due to the data gaps of materials disposed of in this area and the potential for PFAS use throughout the former operations, this area may be suspect of PFAS release.

The AOPI resides in the northeastern portion of VHFS within an open grassed field defined by low to moderate topographic relief and scattered trees. Surface runoff from this AOPI flows east and west along topography towards two former drainage ditches. Based on review of historical maps and aerial photography, these ditches flow northward towards a retention pond located along the northern boundary of VHFS. The AOPI resides within a commercial portion of VHFS, with residential housing located approximately 500 feet to the east.

As part of a 1994 ENPA, this area was identified as AREE 29-4. In 1998, surface soil samples were collected at the two construction debris piles and at the three other areas of potential contamination. Aluminum (85,000 ppm), beryllium (2.15 ppm), and iron (160,000 ppm) concentrations in surface soil in the area of the former orange mound exceeded residential soil RBCs (78,000 ppm. 0.15 ppm, and 23,000 ppm, respectively) and maximum background concentrations (20.900 ppm. 2.13 ppm, and 70.800 ppm,

respectively). Benzo(a)pyrene (0.1 ppm). a polynuclear aromatic hydrocarbon. slightly exceeded its residential soil RBC (0.088 ppm) in one surface soil sample collected from the construction debris areas. Arsenic (up to 13.6 ppm) exceeded its residential soil RBC (0.43 ppm) and maximum background concentration (4.89 ppm) at the construction debris areas.

The human health risk assessment determined that site-related contamination at AREE 29-4 did not pose an unacceptable human health risk under either current industrial/commercial or potential future residential land-use conditions. The ecological risk assessment concluded that significant potential adverse ecological effects are not posed by the site-related contaminants at AREE 29-4. Based on these results, no action was recommended at AREE 29-4 in the 1999 ROD (IT Corporation 1999).

5.2.16 AREE 29-5: Liquid Impoundment Area

The Liquid Impoundment Area is identified as an AOPI following records research and personnel interviews. Aerial photographs taken in the mid-1960s and 1970s indicated a large rectangular area of ground scarring and a liquid impoundment area (only active in the 1965 aerial) in the southwest corner of the AOPI boundary. Previous investigations concluded that the ground scarring was likely the result of the ongoing antenna field construction and maintenance. No evidence exists from the aerial photography review or interviews to indicate that hazardous materials were stored or released in the liquid impoundment area. Due to the data gaps of materials disposed of in this area and the potential for PFAS use during former operations at VHFS, this area has been identified as an AOPI.

The AOPI resides in the northwestern portion of VHFS. Based on review of aerial photography, the area was regraded sometime between 1994 and 2002. Residential houses were constructed atop the eastern portion of the AOPI boundary between 2003 and 2004. A dense pocket of trees resides atop the western portion of the AOPI boundary. Surface runoff from this AOPI is managed by utility stormwater infrastructure.

As part of a 1994 ENPA, this area was identified as AREE 29-5. In the 1994 PA, NFA was recommended at AREE 29-5 (Science Applications International Corporation 1994).

5.2.17 AREE 13: Sludge Disposal Area

The Sludge Disposal Area is identified as an AOPI following records research, personnel interviews, and site reconnaissance due to its use as a disposal area for sludges generated at both the Former Sewage Treatment Plant and Active Sewage Treatment Plant that potentially contained PFAS starting in 1978. The area was closed in 1992 and twenty thousand cubic feet of sludge were excavated, mixed with pressed sludge cake from the sewage treatment plant digester, and transported to the Fauquier County Landfill. The area has been backfilled and seeded.

The AOPI is located within the north-central portion of VHFS, and has since been backfilled, seeded, and heavily redeveloped. A parking lot, a grassed lawn, commercial use building, and a portion of the Vint Hill Parkway now reside atop the former AOPI boundaries. Multiple buildings within the vicinity of the AOPI are also designated for commercial use. Surface runoff from this location is managed by stormwater utility infrastructure along Macintosh Drive and the Vint Hill Parkway.

As part of a 1994 ENPA, this area was identified as AREE 13. In 1982, the sludges were analyzed for total metals and were determined to be at concentrations sufficiently low for land spreading. Surface and

subsurface soil samples were collected at locations within the disposal area during the SI and Phase I reuse area RI. Iron (75,200 to 230,000 ppm) was the only analyte detected above its residential soil RBC (23,000 ppm) and maximum background concentration (70,800 ppm). In the 1999 ROD, NFA was recommended for AREE 13 (IT Corporation 1999).

5.2.18 AREE 29-6: Possible Burn Pile

The Possible Burn Pile is identified as an AOPI following records research, personnel interviews, and site reconnaissance. Review of aerial photography from 1977 showed a large area of ground scarring along with a pile of dark colored material. Previous investigations conducted at this area reported the pile to be a burn pile. Due to the suspected operational years of this burn pile, and data gaps surrounding the historical use of AFFF at VHFS, the Possible Burn Pile has been identified as an AOPI.

The AOPI resides within the western portion of VHFS. Based on review of aerial photography, the area was regraded sometime between 1994 and 2002. Residential houses were constructed around the AOPI boundary between 2003 and 2004. In addition to residential housing, the area surrounding the AOPI consists of grass lawns and dense pockets of trees and vegetation. Surface runoff from this AOPI flows southward along topography into an unnamed, man-made stream that eventually drains to a large retention pond located east of the AOPI.

As part of a 1994 ENPA, this area was identified as AREE 29-6. In the 1994 PA, NFA was recommended at AREE 29-6 (Science Applications International Corporation, 1994).

5.2.19 AREE 9: Vehicle Maintenance Buildings 288 and 290

The Vehicle Maintenance Buildings 288 and 290 are identified as an AOPI following records research, personnel interviews, and site reconnaissance due to their use as a vehicle maintenance bay for VHFS Fire Department fire trucks from at least 1996 to 2006. Drains from wash racks within the buildings were directed to a grit chamber and eventually discharged to WSRT. Review of aerial photography indicates that these buildings were demolished sometime between 2013 and 2017. A retired VHFS Fire Department member confirmed that fire truck maintenance was conducted at this location during his tenure at the installation from 1996 to 2006. It could not be confirmed during the site-visit whether AFFF-carrying trucks were serviced at this location or if AFFF would have been released during maintenance. Due to these data gap, the buildings were identified as AOPIs.

The AOPI is located within the central portion of VHFS, and immediately south of Vint Hill Parkway. The area surrounding the buildings was redeveloped as part of the Vint Hill Parkway construction. Review of aerial photography indicates that the buildings and surrounding tarmac parking lot were removed between 2013 and 2017. The AOPI now consists of a grass field bordered to the north by Vint Hill Parkway, and to the southeast by a parking lot. Supporting building infrastructure remains around the AOPI. No stormwater infrastructure managing the area was observed during the PA site visit conducted in 2019. Surface runoff likely flows along topography westward along topography.

As part of a 1994 ENPA, this area was identified as AREE 9.Surface soil, subsurface soil, sediment, surface water, and groundwater samples were collected at AREE 9 as part of a 1998 RI. TPH contamination, exceeding the Virginia TPH soil action level for underground storage tanks of 100 ppm, was present in subsurface soil beneath Building 290. A Baseline Risk Assessment conducted at the site

determined that site-related contamination at AREE 9 did not pose an unacceptable human health risk or significant potential adverse ecological effects under either current industrial/commercial or potential future residential land-use conditions, but remediation was recommended because TPH concentrations exceeded the Virginia TPH soil action level for underground storage tanks. The impacted area below Building 260was excavated and backfilled shortly after 1999 (IT Corp 1999)

5.2.20 Automated Car Wash

The Automated Car Wash is identified as an AOPI following personnel interviews, and site reconnaissance. This AOPI operated as an on-site drive-through car wash for civilian vehicles. The building was not open for further inspection during the site-visit, and information on the specific soaps and waxes used at this car wash was not available. Due to these data-gaps, and the historical use of PFAS as active ingredients in certain car wash soaps and waxes, the area was identified as an AOPI.

The AOPI is located within the central portion of VHFS. The car wash building remains but is no longer operational. No drainage systems or pathways were observed originating from the building. The area surrounding the AOPI consists of heavily vegetated grass lawns and tarmac driveways leading to and from the car wash building. A parking lot is located directly northwest of the AOPI. Surface runoff from the AOPI flows northwestward along topography into the nearby parking lot, which is then managed by dedicated stormwater utility infrastructure. The AOPI resides within a commercial and recreational portion of VHFS.

5.2.21 AREE 26: Outdoor Wash Rack

The Outdoor Wash Rack is identified as an AOPI following personnel interviews, and site reconnaissance due to its use as a personal vehicle car wash area during VHFS's operational history. The wash rack is located southwest of Building 161. Starting in 1982, runoff drainage was directed to a grit chamber before being pumped to the sanitary sewer. Ten-inch concrete berms were reportedly installed to prevent runoff from carwash activities and were observed during the 2019 PA site-reconnaissance of the area. Prior to 1982, drainage was directed to the surrounding soils. Information on the specific soaps and waxes used at these wash racks was not available. Due to these data-gaps, and the historical use of PFAS as active ingredients in certain car wash soaps and waxes, the area was identified as an AOPI.

The AOPI is located within the southern portion of VHFS and directly down-hill of Sigler Road. The AOPI consists of a heavily weathered tarmac parking lot to the west, with a dedicated bermed wash pad to the east. Both sections are surrounded by grass. A steep hill separates the AOPI from Sigler Road to the north. Staining along the southern end of the tarmac parking lot was visible in aerial photography from 2017. Surface runoff from the wash rack area is contained within berms and managed by a dedicated stormwater line. Surface runoff from the tarmac parking lot flows southward along topography towards the installation boundary. The AOPI resides within a commercial portion of VHFS.

As part of a 1994 ENPA, this area was identified as AREE 26. In the 1999 ROD, NFA was recommended at AREE 26 (IT Corporation 1999).

5.2.22 AREE 1: Waste Disposal Area (Dump #1)

AREE 1: Waste Disposal Area (Dump #1) is identified as an AOPI following records research, personnel interviews, and site reconnaissance due to its use as a hazardous waste disposal area for photographic wastewaters, sewage sludge, and household garbage from 1942 to 1973. Leachate from this area was observed entering South Run. Additionally, chromium (a chemical compound commonly used in chrome plating operations) was detected in surface soils and stream bed sediments during a 1981 groundwater monitoring event.

The AOPI is consists of a raised mound covered in grass and bounded on all sides by trees. It is located within the western portion of VHFS. The Active Sewage Treatment Plant is located approximately 400 feet east of the AOPI. Multiple residential buildings are located approximately 200 feet southwest of the AOPI boundary. Surface runoff flows radially across topography to the north, west, and east down-hill before eventually draining into South Run, while surface run-off to the south is managed by stormwater inlets along Lake Brittle Road. The AOPI resides within a commercial portion of VHFS.

As part of a 1994 ENPA, this area was identified as AREE 1. Surface and subsurface soils at AREE 1 were sampled during the Phase II reuse area RI for the former VHFS in 1999. Only site-related contaminants in surface soil were found to pose unacceptable risk to human health and/or the environment based on the Baseline Risk Assessment. Human health risks were primarily due to lead and benzo(a)pyrene, although other polynuclear aromatic hydrocarbons, Aroclor-1254 (a polychlorinated biphenyl [PCB]), and other metals also contributed. Monitored natural attenuation was selected as the remedy for AREE-1 and a long-term groundwater monitoring was implemented as part of the remedy. (Shaw Environmental, Inc. 2010).

5.2.23 AREE 2: Active Sewage Treatment Plant – Former Sludge Drying Beds and Sludge Piles

AREE 2: Active Sewage Treatment Plant Sludge Drying Beds is identified as an AOPI following records research, personnel interviews, and site reconnaissance due to its use as a storage area for processed sludges that potentially contained PFAS. The Active Sewage Treatment Plant has been in service since 1952. While VHFS was in operation, the Active Sewage Treatment Plant received sanitary wastewater, industrial wastewater generated from photographic, painting, laboratory, vehicle washing, and metal etching operations, and surface water runoff. Prior to 1980 the Active Sewage Treatment Plant Sludge Drying Beds were used to store processed wastes from these operations. Between 1980 and 1991, sludges were aerobically digested and then placed in one of four sand drying beds located proximally to South Run. Since 1991, dried sludges have been disposed of off-site.

The former sludge drying bed location is now the site of the Active Sewage Treatment Plant sludge processing center. The surrounding environment consists of commercial buildings and infrastructure supporting sewage treatment plant operations to the east, south and west. South Run flows through a heavily vegetated area directly north of the AOPI boundary.

As part of a 1994 ENPA, this area was identified as AREE 2. In the 1996 SI, NFA was recommended for AREE 2 (Science Applications International Corporation 1996).

5.2.24 Bedrock Aquifer (Existing Wells VNT-1B and VNT-3B)

The bedrock aquifer underlying VHFS is identified as an AOPI following records research and personnel interviews due to the confirmed presence of PFOS, PFOA and PFBS in groundwater samples collected from one approved production well (VNT-3B) and one production supply exploratory test well (VNT-1B) located in the northern portion of VHFS. While the source of the PFOS, PFOA, and PFBS detections in the production wells is unclear, VNT-1B is located approximately 200 feet northwest (approximately downgradient) of the AREE 16-2: Possible Fire Training Pit; VNT-3B is located approximately 120 feet south of the AREE 29-2: Possible Sludge Disposal Area, and approximately 725 feet northwest of VNT-1B. The well construction for both VNT-1B and VNT-3B is open-borehole and transects through various geologic formations. The open sections of both well VNT-1B and well VNT-3B intersect zones of the Hickory Grove Basalt that are inferred to be associated with significant transmissivity. **Sections 6.3.2, 6.3.3,** and **7.24** summarize the geophysical logging, profiling synthesis, and packer testing activities conducted at VNT-1B and VNT-3B to evaluate PFAS presence in the Bedrock Aquifer.

6 SUMMARY OF SI ACTIVITIES

Based on the results of the PA at VHFS, an SI for PFOS, PFOA, and PFBS was conducted in accordance with CERCLA. SI sampling was completed at VHFS at all 23 AOPIs to evaluate presence or absence of PFOS, PFOA, and PFBS. As such, a site-specific QAPP (Arcadis 2020) was developed to detail the site-specific proposed scopes of work for the SI. A preliminary CSM was prepared for each of the installation's AOPIs in accordance with the USACE Engineer Manual on Conceptual Site Models, EM 200-1-12 (USACE 2012). The preliminary CSMs identified potential human receptors and chemical exposure pathways based on current and/or reasonably anticipated future land uses. The preliminary CSMs identified soil, groundwater, surface water, and/or sediment pathways as potentially complete which guided the SI sampling. The QAPP Addendum details the sampling design and rationale based on each AOPI's preliminary CSM. The SI scope of work was completed in March and April of 2020 through the collection of field data and analytical samples.

The SI field work was completed in accordance with the standard operating procedures (SOPs), technical guidance instructions (TGIs), sampling design, and QA/QC requirements as detailed in the QAPP Addendum (Arcadis 2020). The subsections below summarize the DQOs, sampling design and rationale, sampling activities and methods, and data analyses procedures for the SI phase at VHFS. Non-conformances to the prescribed procedures in the PQAPP and QAPP Addendum are described in **Section 6.3.3**. Analytical results obtained through SI field activities are summarized in **Section 7**.

6.1 Data Quality Objectives

As identified during the DQO process and outlined in the site-specific QAPP Addendum (Arcadis 2020), the objective of the SI sampling activities to identify whether there has been a release to the environment at the AOPIs identified in the PA. This SI evaluated groundwater, soil, and surface water for PFOS, PFOA, or PFBS presence or absence at each of the sampled AOPIs. In addition, packer testing was conducted on two existing wells to delineate the extent of PFAS impacts and/or identify the primary migration pathways for the chemicals.

6.2 Sampling Design and Rationale

The rationale for sampling at each AOPI is illustrated on **Figure 6-1** below.

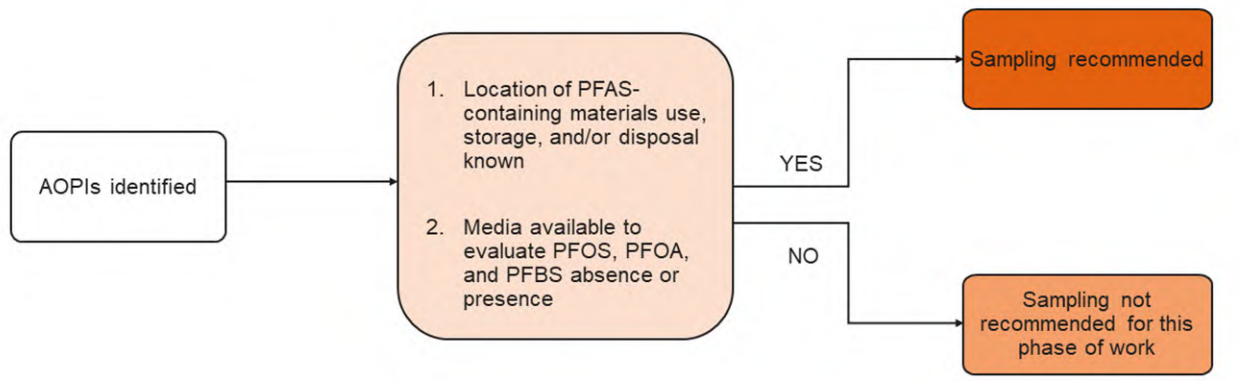


Figure 6-1: AOPI Sampling Decision Tree

The sampling design for SI sampling activities at VHFS is detailed in Worksheet #17 of the QAPP Addendum (Arcadis 2020). A summary of the sampling design is provided below.

Groundwater samples were collected to inform the interpretation of PFAS distribution and migration and update the individual AOPI drinking water CSMs. Samples were collected downgradient of AOPIs from a combination of pre-existing monitoring wells, in addition to temporary wells installed via direct-push technology (DPT) as part of this SI. Shallow (first encountered) groundwater was sampled at each of these sampling points, where groundwater was encountered.

Geophysical logging and packer testing were performed in the northern portion of the former VHFS parcel on existing wells VNT-1B and VNT-3B. Testing was conducted on isolated water-bearing fracture zones as identified by existing boring log descriptions and the preliminary geophysical logging results to properly assess the extent of PFOS, PFOA, and PFBS contamination in both wells.

Soil samples were collected to inform the presence or absence of PFOS, PFOA, and PFBS, evaluate the potential for those areas to be sources of PFAS to surface water and groundwater as an influence to drinking water, and update the individual AOPI CSMs. Soil samples were collected via DPT from discrete points at the AOPIs and analyzed for select PFAS; total organic carbon (TOC), pH, and grain size were analyzed in one soil sample per AOPI.

Surface water samples were collected to inform the presence or absence of PFOS, PFOA, and PFBS in possible secondary source areas. Grab surface water samples were collected from both the South Run and Western South Run Tributary and upstream and downstream locations near the AREE 16-1: Possible Fire Training Pit, the Possible Sludge Disposal Area (AREE 29-2), the AREE 10: Former Photographic Wastewater Lagoon, and the Active Sewage Treatment Plant Sludge Drying Beds (AREE 2). All surface water samples were analyzed for select PFAS, and field parameters (temperature, pH, conductivity, dissolved oxygen, turbidity, and oxidation-reduction potential) were measured during surface water sampling to potentially inform the interpretation of analytical data.

The sampling depths at existing monitoring wells were at approximately the center of the saturated screened interval. **Table 6-1** includes the monitoring well construction details for the wells sampled during the SI (if available).

6.3 Sampling Methods and Procedures

Environmental data were collected and analyzed in accordance with the PQAPP (Arcadis 2019), the SOPs and TGIs included as Appendix A to the PQAPP, the QA/QC requirements identified in Worksheet #20 of the PQAPP, the approved scope and sampling methods outlined in the site-specific QAPP Addendum (Arcadis 2020), and the safety procedures specified in the Accident Prevention Plan (Arcadis 2018) and SSHP (Arcadis 2020). The sampling methods described in the SOPs and TGIs establish equipment requirements, procedures for preparing equipment and containers before sampling, sampling procedures under various conditions, and procedures for storing samples to ensure that sample contamination does not occur during collection and transport. In general, sampling techniques used in the SI were consistent with conventional sampling techniques used in the environmental industry, but special considerations were made regarding PFAS-containing materials and equipment and cross-contamination potential.

The sampling methods employed during the SI are detailed in the PQAPP (Arcadis 2019) and QAPP Addendum (Arcadis 2020); the subsections below provide a summary of the field methods and procedures utilized to complete the SI scope of work. Field notes and field forms (i.e., soil boring logs, groundwater purging logs, equipment calibration forms, tailgate health and safety forms, and sample collection logs) documenting the SI sampling activities are included in **Appendices J** and **K**, respectively.

6.3.1 Field Methods

Groundwater samples were collected using low-flow purging methods from approximately the center of the saturated screened interval at existing monitoring wells. At VHFS, peristaltic pumps equipped with PFAS-free disposable high-density polyethylene tubing were used to collect groundwater samples.

Soil samples were collected via a combination of hand auguring and DPT from discrete points at each of the soil sample locations. Where conditions allowed, hand auguring was used to advance the boring through the initial 5 feet. At each sampling point, soil samples were collected from the top 2 feet of native soil and just above the water table. At sampling locations where boreholes were advanced using DPT, soil samples were collected in PFAS-free acetate liners.

Surface water samples were collected using direct-fill methods just below the water surface.

Decontamination procedures for non-dedicated equipment used during sampling are described in **Section 6.3.6**.

6.3.2 Geophysical Logging

Geophysical logging field activities were implemented on 20 January 2020 and 9 March 2020. Borehole geophysical data were collected from two production supply exploratory test wells (VNT-1B and VNT-3B). Multiple geophysical logging tools were utilized including gamma, fluid temperature, resistivity, caliper, and optical and acoustic televiewer. Below is a summary of each tool's purpose.

- Downhole camera – This provides a live video of the well as the camera is lowered down hole. The camera is used to identify key areas for further characterization with other geophysical tools and to help identify individual depth intervals for vertical groundwater sampling.

- Gamma – All rock and soils emit gamma radiation in varying amounts. Gamma logging records the amount of natural gamma radiation emitted from the rock and provides a useful means of identifying different bedrock formations and correlating stratigraphy between drilling locations.
- Fluid Temperature – The fluid temperature tool records water temperature. Since water flowing into or out of the well at a water-bearing zone, like a fracture, can create perturbations in the temperature profile in a well, a fluid temperature log can provide an indication of open flowing fractures and other transmissive zones.
- Fluid Conductivity – This tool records the electrical conductivity of groundwater and can identify and discriminate between different water-bearing zones if the total dissolved solids or ionic content of the water in the two zones are different.
- Caliper – The caliper tool measures the borehole diameter. Perturbations in the caliper logs can indicate fractures, fracture zones, or areas of friable rock where drilling has enlarged the borehole beyond the nominal bit diameter.
- Optical Televiewer (OTV) – The optical televiewer provides a continuous, detailed, and oriented 360-degree image of the borehole walls, allowing for identification of fractures and measurement of fracture strike, dip, and frequency.

All the above geophysical logs were completed at VNT-1B and VNT-3B. VNT-3B was logged under both ambient and pumping conditions.

The estimated discharge rate approximated at 22 gallons per minute (gpm) at VNT-1B could not be contained by planned IDW management. In response, the VNT-1B well casing was extended 18 inches and a tee fitting was welded to the casing to divert the overflow water originating from the well head. The water was initially containerized in a 250-gallon tank and pumped via hose-line into a secondary containment tank located approximately 500 feet up-hill. Borehole geophysics was completed at VNT-1B on 9 March 2020. The well was logged under ambient conditions only.

The geophysical logging permitted an assessment of each well's condition and provided confirmation of several aspects of the well construction. The primary findings summarized in **Table 6-2** below:

Table 6-2: Well Condition and Construction

	VNT-3B	VNT-1B
Casing Diameter	8-inch (nominal)	6-inch (nominal)
Bottom of Casing	62.85 feet below top of casing (btoc)*	18.75 feet btoc*
Construction Type	Open hole	Open hole
Open Hole Diameter	8-inch (nominal) top of casing to 420 feet btoc 6-inch (nominal) 420 feet btoc to total depth at 480 feet btoc reported on 2005 well record	6-inch (nominal)

	VNT-3B	VNT-1B
Current Open Depth	421.6 feet btoc Compare to 420 feet bgs drilled depth reported on 2005 well record	562.5 feet btoc Compare to 560 feet bgs drilled depth reported on 2005 well record

VNT-3B

The geophysical logging at production supply exploratory test well VNT-1B identified six water-bearing zones. The principal observations are summarized in **Table 6-3**, below.

Table 6-3. Geophysical Logging – VNT-3B Principal Observations

Depth of Potential Water-Yielding Zone	Geophysical Observations	Interpretation
Fractures from 63.3 to 85.3 feet btoc	• Large fracture visible on OTV and video. • Large caliper excursions • Minor fluid temperature and conductivity deviations • Minor flow into and up the borehole under pumping conditions. • Contact boundary between Hickory Grove Basalt and Midland Formation at 85.3 feet btoc	Minor water bearing fracture in borehole.
Fractures and possible voids from 88 to 110 feet btoc	• Fracture visible on OTV and video at 91 feet btoc. • Possible voids visible on OTV and video at 107.5 and 120 feet btoc. • Large caliper excursions • Fluid temperature and conductivity deviations at 90 feet btoc and 109 feet btoc • Minor flow into and up the borehole under pumping conditions.	One or both fractures and possible voids in this interval serve as a minor water bearing zone
Fractures from 235 to 255 feet btoc	• Large fractures visible on OTV and video at 235, 245 and 250 feet btoc. • Large caliper excursions • Fluid temperature and conductivity deviations beginning at 237.5 feet bgs • Flow into and up the borehole under pumping conditions	One or both fractures in this interval serve as a minor water bearing zone

Depth of Potential Water-Yielding Zone	Geophysical Observations	Interpretation
Fractures from 297.5 to 319.5 feet btoc	• Fractures visible on OTV and video from 297.5 to 305, 315, and 320 feet btoc. • Large to medium caliper excursions • Slight deviation in fluid temperature and conductivity starting at 307.5 feet btoc • Flow into and up the borehole under pumping conditions	One or all fractures in this interval serve as a minor water bearing zone.
Fractures from 357.5 to 377.5 feet btoc	• Fractures visible on OTV and video from 360 to 365 and 375 to 377.5 feet btoc. • Steady caliper excursions throughout interval • Fluid temperature and conductivity increase throughout interval • Minor flow into and up the borehole under pumping conditions	One or all fractures in this interval serve as a minor water bearing zone.
Minor fractures from 390 to 405 feet btoc	• Fractures visible on OTV and video throughout interval • Large fracture visible on OTV and video at 405 feet btoc • Large caliper excursions • Fluid temperature and conductivity increase throughout interval • Minor flow into and up the borehole under pumping conditions	One or all fractures in this interval serve as a minor water bearing zone.

VNT-1B

The geophysical logging at production supply exploratory test well VNT-1B identified five water-bearing zones. The principal observations can be summarized in **Table 6-4** below:

Table 6-4. Geophysical Logging – VNT-1B Principal Observations

Depth of Potential Water-Yielding Zone	Geophysical Observations	Interpretation
Fractures at 30, 42.5 and 58 feet btoc	Large fractures visible on OTV and video Temperature and conductivity deviations Minor shift on spinner flow meter	Minor water-bearing fracture in borehole

Depth of Potential Water-Yielding Zone	Geophysical Observations	Interpretation
Fractures from 131 to 147 feet btoc	Minor fractures visible on OTV and video from 131 to 137.5 feet btoc Large fracture with caliper excursion and visible on OTV and video from 144 to 147 feet btoc Moderate shift on spinner flow meter	One or both fractures in this interval serve as a minor water-bearing zone
Fractures from 153 to 177.5 feet btoc	Contact boundary between Turkey Run Formation and Hickory Grove Basalt at 152.9 feet btoc. Minor fractures visible throughout zone on OTV and video Slight fluid temperature and conductivity deviations starting at 165 feet bgs. Moderate shift on spinner flow meter	Fractures in this interval serve as a minor water-bearing zone
Fractures from 230 to 240 feet btoc	Large fractures visible on OTV and video. Large caliper excursions Fluid and conductivity deviations starting at 225 feet btoc.	Fractures in this interval serve as a minor water-bearing zone
Fractures from 465 to 492 feet btoc	Contact boundary between Hickory Grove Basalt and Midland Formation at 488.1 feet btoc. Large fractures visible on OTV and video Rapid fluid and conductivity deviations Large shift on spinner flow meter	Fractures in this interval serve as a moderate water-bearing zone

Profiling Synthesis

The zones 90 to 95 feet btoc, 107 to 124 feet btoc, 242.5 to 251 feet btoc, 357.5 to 387.5 feet btoc, and 402.5 to 405 feet btoc are interpreted to contribute the majority of groundwater yield to VNT-3B. These intervals exist solely within the sand and siltstones of the Midland Formation. VNT-1B was installed under artesian conditions, and two zones from 465 to 490 feet btoc and 555 to 560 feet btoc are interpreted to contribute the majority of groundwater yield to VNT-1B.

6.3.3 Packer testing

Packer testing was employed as part of this PA/SI to delineate the extent of PFAS impacts and/or identify the primary migration pathways for the chemicals. Testing was conducted from 24 March to 27 March 2020, on potential water bearing zones in VNT-3B and VNT-1B as identified by geophysical logging.

Packer testing was conducted by the drilling company Earth Data Northeast, Inc., using a truck mounted rig. To contain purge water, the water was diverted via hose-line to a temporary 10,000-gallon Rain-4-

Rent frac tank staged along a former asphalt roadway approximately halfway between VNT-1B and VNT-3B.

The packer assembly consisted of a pair of inflatable packers separated by a 22-foot section of perforated pipe (i.e., test interval) for VNT-3B, and a 30-foot section for VNT-1B. The test interval was connected to the surface by steel riser pipe connected to a pass-through in the top packer. Once this packer assembly was lowered to a target interval, tanked nitrogen gas was used to inflate the packers and isolate the zone. Three data-logging pressure transducers were used to record water levels inside the test interval, below the bottom packer, and above the top packer. A two-inch diameter Grundfos Redi-Flo2® submersible pump was used both to purge and sample each test interval.

The approach for each test was as follows:

- After a target zone was isolated, the pump and transducers were deployed, and the borehole was allowed to equilibrate until water levels were steady.
- Pumping of each packer test interval began at an approximate rate of 1 gpm, and then adjusted up or down depending on the observed drawdown.
- The planned minimum yield for a test interval to be sampled was 0.25 gpm with 25 feet of drawdown, or an equivalent specific capacity of 0.01 gpm/foot. Intervals with a lower yield could not reasonably be sampled, due the amount of time required to purge enough water to collect a viable sample. Test intervals with yields below this threshold were aborted.
- Test intervals with a sufficient yield were pumped until reaching a purge volume of between 1.5 and 3 times the packer interval volume plus one volume of the water in the stand-pipe.

Of the 10 originally targeted intervals, eight were found to have sufficient yield to collect a sample. As summarized in the table below, these intervals included five intervals in VNT-3B and five intervals in VNT-1B.

Table 6-5. Packer Testing Field Observations

Well	Depth of Test Interval (feet bgs)	Maximum Sustained Pumping Rate (gpm)	Drawdown at Maximum Rate (feet)	Approximate Specific Capacity Test Results (gpm/foot)	Sampled Collected
VNT-3B	63.3 – 85.3	Drawdown unsustainable at 0.25 gpm		None measurable	No
	88 – 110	9	40.86	0.220	Yes
	233 – 255	16	42.4	0.377	Yes
	297.5 – 319.5	15	24.2	0.619	Yes
	380 – 402	15	13.57	1.10	Yes
VNT-1B	28 – 58	5	11.18	0.44	Yes
	120 – 150	7	78.68	0.088	Yes
	153 – 183	Drawdown unsustainable at 0.25 gpm		None measurable	No
	220 – 250	2	47.59	0.042	Yes
	450 – 562	6	Not Measured	Not Measured	Yes

After purging was complete, water quality parameters were measured for each interval using a YSI® 556 Multiprobe System. Prior to sampling, the pumping rate was reduced to approximately 0.25 gpm to enable controlled collection of groundwater into the sampling vials. Samples were collected for analysis of PFAS by USEPA Method 537.

A blank field duplicate was collected from the 450 to 562-foot packer interval in VNT-1B. An equipment blank was collected using a decontaminated Grundfos Redi-Flo2® pump tubing barb as a rinsate item prior to packer testing in VNT-3B. Matrix spike/matrix spike duplicate samples were collected for the 297.5 to 319.5-foot packer test interval in VNT-3B. Trip blanks were submitted with all sample coolers. All samples were submitted to Pace South Carolina (former Shealy Environmental Services, Inc.) for analysis.

6.3.4 Quality Assurance/Quality Control

Worksheets #20 of the PQAPP and QAPP Addendum provide QA/QC requirements for field duplicates, matrix spike/matrix spike duplicates, equipment blanks (EBs), source blanks for water used in the initial decontamination step for drill tooling, and field blanks for laboratory-supplied water used in the final decontamination step.

QA/QC samples were collected at the frequencies specified in the QAPP Addendum (Arcadis 2020), typically at a rate of 1 per 20 samples. For groundwater and surface water, field duplicates and matrix spike/matrix spike duplicate samples were collected for media sampled for PFAS, including PFOS, PFOA, and PFBS only. For soil, field duplicates and matrix spike/matrix spike duplicate samples were collected for media sampled for PFOS, PFOA, and PFBS, TOC, pH, and grain size. EBs were collected for media sampled for PFOS, PFOA, and PFBS at a frequency of one per piece of relevant equipment for each sampling event, as specified in the QAPP Addendum (Arcadis 2020). The decontaminated reusable equipment from which EBs were collected include tubing, drill casing and cutting shoes, hand augers, water-level meters, acetate liners, and stainless-steel trowels as applicable to the sampled media. Source blanks were collected from the water used to pressure-wash drill tooling. Analytical results for QA/QC samples are discussed in **Section 7.24**.

6.3.5 Field Change Reports

No instances of major scope modifications (i.e., those that may have had a significant impact on the project scope and/or data usability/quality, or required stop-work, and warranted discussion with USACE) were encountered during the VHFS SI work.

In some cases, clarifications to the established scope of work were needed but do not necessarily constitute a non-conformance from the sampling plans described in the QAPP Addendum. Minor modifications from and clarifications for the procedures and scope of work detailed in the QAPP Addendum and PQAPP and that did not affect DQOs are documented in Field Change Report FCR-VHFS-01 included as **Appendix L** and are summarized below:

- For soil samples, the sample naming convention was modified so that each sample's identification included the depth interval from which it was collected. The QAPP Addendum originally used "(0-2)" to indicate samples collected from the upper 2 feet of native soil, and "(WT)" to indicate samples collected from just above the water table.

- At AREE 16-1, the sample VHFS-AREE16-1-1-SO-(WT) could not be collected because DPT refusal occurred at 4 feet bgs, and the water table could not be identified above this depth. Therefore, TOC, pH, and grain size analyses were conducted on VHFS-AREE16-1-1-SO-(0-2) instead.
- At AREE 16-1, the sample VHFS-AREE16-1-2-SO-(WT) could not be collected because DPT refusal occurred at 6 feet bgs, and the water table could not be identified above this depth.
- At AREE 16-1, the sample VHFS-AREE16-1-3-SO-(WT) could not be collected because DPT refusal occurred at 2.5 feet bgs, and the water table could not be identified above this depth.
- At AREE 16-1, the sample VHFS-AREE16-1-2-GW could not be collected because DPT refusal occurred at 4 feet bgs and groundwater was not encountered above this depth.
- At AREE 16-1, the sample VHFS-AREE16-1-3-GW could not be collected because DPT refusal occurred at 2 feet bgs and groundwater was not encountered above this depth.
- At AREE 17, lab analysis of TOC, grain size, and pH were conducted on sample VHFS-AREE17-1-SO-(0-2) instead of VHFS AREE17 1 SO-(WT).
- At AREE 17, the sample VHFS-AREE17-1-GW could not be collected because the temporary well did not produce a sufficient volume of water.
- At AREE 17, the sample VHFS-AREE17-2-GW could not be collected because the temporary well did not produce a sufficient volume of water.
- At AREE 29-3, the sample VHFS-AREE29-3-1-GW could not be collected because the temporary well did not produce a sufficient volume of water.
- At AREE 29-2, the sample VHFS-AREE29-2-1-SO-(WT) could not be collected because DPT refusal occurred at 5 feet bgs, and the water table could not be identified above this depth.
- At AREE 29-2, the sample VHFS-AREE29-2-1-GW could not be collected because DPT refusal occurred at 5 feet bgs and groundwater was not encountered above this depth.
- At AREE 16-2, the sample VHFS-AREE16-2-1-SO-(0-2) was not collected because the sampling interval of native soil (5.5 to 7.5 feet bgs) overlapped with the sampling interval of the water table (6 to 8 feet bgs). Therefore, only one sample, representative of both the start of native soil and the water table, was collected [VHFS-AREE16-2-1-SO-(WT)].
- At AREE 16-2, the sample VHFS-AREE16-2-1-GW could not be collected because DPT refusal occurred at 5 feet bgs and groundwater was not encountered above this depth.
- At AREE 16-2, the sample VHFS-AREE16-2-3-GW could not be collected because the temporary well did not produce a sufficient volume of water.
- At AREE 11, the sample VHFS-AREE11-1-SO-(WT) was not collected because the sampling interval of native soil (3.5 to 5.5 feet bgs) overlapped with the sampling interval of the water table (4 to 6 feet bgs). Therefore, only one sample, representative of both the start of native soil and the water table, was collected [VHFS-AREE11-1-SO-(0-2)].

- At AREE 28-9, the sample VHFS-AREE28-9-1-SO-(WT) could not be collected because DPT refusal occurred at 6 feet bgs, and the water table could not be identified above this depth. Therefore, TOC, pH, and grain size analyses were conducted on VHFS-AREE28-9-1-SO-(0-2) instead.
- • At AREE 28-9, the sample VHFS-AREE28-9-1-GW was not collected because DPT refusal occurred at 6 feet bgs and groundwater was not encountered above this depth.
- At AREE 29-4, the sample VHFS-AREE29-4-2-SO-(WT) was not collected because the water table was shallow and coincident with the native soil sampling interval (0.5 to 2.5 feet bgs) at this location. Therefore, only one sample, representative of both the start of native soil and the water table, was collected [VHFS-AREE29-4-2-SO-(0 to 2)].
- At AREE 29-4, the sample VHFS-AREE29-4-2-SO-(WT) was not collected because the temporary well did not produce a sufficient volume of water.
- At AREE 29-5, the sample VHFS-AREE29-5-SO-(0-2) was not collected; therefore, TOC, pH, and grain size analyses were conducted on VHFS-AREE28-9-1-SO-(0-2) instead.
- At AREE 29-5, the sample VHFS-AREE29-5-1-GW was not collected because the temporary well did not produce a sufficient volume of water.
- At AREE 29-6, the sample VHFS-AREE29-6-1-GW could not be collected because DPT refusal occurred at 2 feet bgs. Therefore, a soil sample, VHFS-AREE29-6-1-SO-(0-2) was collected instead.
- At AREE 2, the sample VHFS-AREE2-1-GW could not be collected because the temporary well did not produce a sufficient volume of water.
- Equipment blanks VHFS-EB-5 and VHFS-EB-6 were not collected.
- Field blanks VHFS-FB-3, VHFS-FB-4, and VHFS-FB-5 were not collected.

6.3.6 Decontamination

Non-dedicated reusable sampling equipment (e.g., stainless-steel trowels, hand augers, drill cutting shoes and casing, screen-point samplers, water-level meters) that came into direct contact with sampling media was decontaminated before first use, between sampling locations/intervals, and before demobilization in accordance with P-09, TGI - Groundwater and Soil Sampling Equipment Decontamination (Arcadis 2019; Appendix A).

6.3.7 Investigation-Derived Waste

IDW including groundwater purged during sampling and packer testing, and water from decontamination of drill tooling, which may potentially contain PFAS, was containerized and temporarily stored onsite within one of two frack tanks.

Upon completion of SI activities, the purge water was passed through a treatment train consisting of two granulated activated carbon filters and stored in the second frac tank. Samples of the treated IDW were collected and analyzed for PFAS. Following waste characterization, the treated IDW stored in the tank was sent to a licensed disposal facility.

Soil cuttings were placed back into the originating hole. Non-IDW wastes were removed from the site immediately upon completion of each day's field activities. A post-activity inspection was conducted by the Field SSHO or the PA/SI Project Team Lead identified in this QAPP Addendum and the SSHP (included as an attachment to the Accident Prevention Plan [Attachment 7, provided under separate cover]) to ensure the location was left clean. Equipment IDW includes personal protective equipment and other disposable materials (e.g., gloves, plastic sheeting, Lexan tubes, and high-density polyethylene and silicon tubing) that may come into contact with sampling media.

6.4 Data Analysis

The subsections below summarize the laboratory analytical methods and the methodology used to evaluate data collected during the SI through data verification and usability assessments (as completed by a project chemist, independent of the project team).

6.4.1 Laboratory Analytical Methods

Analytical samples collected during the SI were submitted to Eurofins Lancaster Laboratories Environmental (ELLE) and Pace South Carolina (former Shealy Environmental Services, Inc.), ELAP-accredited laboratories for PFOA, PFOA, and PFBS analysis. Laboratory analyses associated with the SI were completed in accordance with Worksheets #12.1 through #12.5 in the QAPP (Arcadis 2020). PFOS, PFOA, and PFBS were analyzed for in groundwater, soil, and surface water samples using a PFAS analytical method that is ELAP-accredited and compliant with QSM 5.3 (DoD 2019), Table B-15. Potable water samples were analyzed for PFOS, PFOA, and PFBS, according to USEPA Method 537 Version 1.1, in accordance with Worksheet #15 of the VHFS QAPP Addendum (Arcadis 2020). Copies of laboratory analytical reports generated during the SI are included as attachments to the Data Usability Summary Report (DUSR) in **Appendix M**.

Additionally, the following general chemistry and physical characteristic analyses were completed for select soil and sediment samples in accordance with Worksheet #18 of the QAPP Addendum (Arcadis 2020) by the analytical method noted:

- TOC by Solid Waste Test Method 846 9060A
- Grain size analysis by American Society for Testing and Materials D422-63
- pH by Solid Waste Test Method 846 9045D.

These data are collected as they may be useful in future fate and transport studies.

The laboratory LOD is defined as "the lowest concentration for reliable reporting of a non-detect of a specific analyte in a specific matrix with a specific method at 99 percent confidence" (DoD 2017). The lowest concentration of a substance that produces a quantitative result within specified limits of precision and bias is known as the limit of quantitation (LOQ; DoD 2017). Concentrations detected between the LOD and LOQ, therefore, are considered estimates and are qualified as such on laboratory analytical reports. Instrument-specific detection limits (e.g., the smallest analyte concentration that can be demonstrated to be different from zero or a blank concentration with 99 percent confidence; DoD 2017), as provided for each analyte by the laboratory, are reported along with the LODs and LOQs in the laboratory analytical reports included in the DUSR (**Appendix M**).

6.4.2 Data Validation

All analytical data generated during the SI, except grain size, were verified and validated in accordance with the data verification procedures described in Worksheets #34 through #36 of the PQAPP (Arcadis 2019). Each laboratory data package/sample delivery group underwent Stage 3 data validation in accordance with DoD Data Validation Guidelines Module 3 (DoD 2020). Additionally, 10% of the data underwent Stage 4 data validation. Copies of the data validation reports for each sample delivery group are included as attachments to the DUSR in **Appendix M**.

6.4.3 Data Usability Assessment and Summary

A data usability assessment was completed for all analytical data associated with SI sampling at VHFS. Documentation generated during the data usability assessments, which were compiled into a DUSR (**Appendix M**), was prepared in accordance with the USACE Engineer Manual 200-1-10 (USACE 2005), the Final DoD General Data Validation Guidelines (DoD 2019) and the Final DoD Data Validation Procedure for Per-and Polyfluoroalkyl Substances Analysis by QSM Table B-15 (DoD 2020), that reviewed precision, accuracy, completeness, representativeness, comparability, and sensitivity. A statement of overall data usability is included in the DUSR.

Based on the final data usability assessment, the environmental data collected at VHFS during the SI were found to be acceptable and usable for this SI evaluation with the qualifications documented in the DUSR and its associated data validation reports (**Appendix M**), and as indicated in the full analytical tables (**Appendix N**) provided for the SI results. These data are of sufficient quality to meet the objectives and requirements of the PQAPP (Arcadis 2019) and VHFS QAPP Addendum (Arcadis 2020). Data qualifiers applied to laboratory analytical results for samples collected during the SI at VHFS are provided in the data tables, data validation reports, and the Data Usability Summary Table located at the end of DUSR. Qualifiers for data shown on figures are defined in the notes of figures:

6.5 Office of the Secretary of Defense Risk Screening Levels

The OSD risk screening levels for PFOS, PFOA, and PFBS in groundwater (tap water) and soil were calculated using the USEPA's RSL calculator for residential and industrial/commercial worker receptor scenarios and current toxicity values. These risk screening levels are shown in **Table 6-6**.

Table 6-6 OSD Risk Screening Levels Calculated for PFOS, PFOA, PFBS in Tap Water and Soil Using USEPA's Regional Screening Level Calculator

Chemical	Residential Scenario Risk Screening Levels Calculated Using USEPA RSL Calculator [HQ=0.1]		Industrial/Commercial Scenario Risk Screening Levels Calculated Using USEPA RSL Calculator [HQ=0.1]
	Tap Water (ng/L or ppt) [1]	Soil (mg/kg or ppm) [1,2]	Soil (mg/kg or ppm) [1,2]
PFOS	40	0.13	1.6
PFOA	40	0.13	1.6
PFBS	600	1.9	25

Notes:

1. Risk screening levels for tap water and soil provided by the OSD. 2019. Memorandum: Investigating Per- and Polyfluoroalkyl Substances within the Department of Defense Cleanup Program. October 15 (**Appendix A**). The risk screening levels for PFBS in tap water and soil were updated in April 2021 based on the updated toxicity values published by the USEPA (USEPA 2021).
2. All soil data will be screened against both the residential scenario and industrial/commercial risk screening levels (if collected from less than 2 feet bgs), regardless of the current and projected land use of the AOPI. Soil samples collected from greater than 2 feet but less than 15 feet bgs will be compared to the industrial/commercial risk screening levels only.

mg/kg = milligram per kilogram
ng/L = nanograms per liter
ppm = parts per million
ppt = parts per trillion

The OSD residential tap water risk screening levels will be used to compare all groundwater and/or surface water data for this Army PFAS PA/SI. While the current and most likely future land uses of the AOPIs at VHFS are industrial/commercial, both residential and industrial/commercial soil risk screening levels for PFOS, PFOA, and PFBS will be used to evaluate detected soil concentrations. The data from the SI sampling event are compared to the relevant risk screening levels in **Section 7**. If concentrations of PFOS, PFOA, or PFBS are detected greater than the applicable OSD risk screening levels, further study in a remedial investigation is recommended in **Section 10**.

7 SUMMARY AND DISCUSSION OF SI RESULTS

This section summarizes the analytical results obtained from samples collected during the SI at VHFS (field duplicate results are provided in the associated tables). Sampled media and QA/QC samples were analyzed for the constituents prescribed per Worksheet #18 of the QAPP (Arcadis 2020). The sample results discussion below focuses on the PFOS, PFOA, and PFBS analytical results because they have applicable OSD risk screening levels. The Army will make subsequent investigation decisions based on these constituents' concentrations relative to the screening criteria described above.

Tables 7-1 through **7-3** provide a summary of the groundwater, soil, and surface water analytical results for PFOS, PFOA, and PFBS. **Appendix N** includes the full suite of analytical results for these media, as well as for the QA/QC samples. An overview of AOPIs at VHFS with OSD risk screening level exceedances is depicted on **Figure 7-1**. **Figures 7-2** through **7-15** show the PFOS, PFOA, and PFBS analytical results in groundwater, soil, and surface water for each AOPI. Non-detected results are reported as less than the LOQ. Detections of PFOS, PFOA, and/or PFBS greater than the applicable OSD risk screening levels are highlighted in summary tables and on figures. Final qualifiers applied to the data by the laboratory and the project chemist (as defined in **Section 6.4.3**) are presented on the analytical tables. Groundwater and surface water data collected during the SI are reported in ng/L, or parts per trillion, and soil data are reported in mg/kg, or parts per million.

Field parameters measured for groundwater during low-flow purging and sample collection and for surface water during sample collection are provided on the field forms in **Appendix K**. Soil descriptions are provided on the field forms in **Appendix K**. The results of the SI are grouped by AOPI and discussed for each medium as applicable. Groundwater was generally first encountered at depths of approximately 5 to 15 feet bgs.

7.1 Possible Fire Training Pit (AREE16-1)

The subsections below summarize the groundwater, soil, and surface water PFOS, PFOA, and PFBS analytical results associated with AREE 16-1 Possible Fire Training Pit. In total, one groundwater sample (VHFS-AREE-16-1-1-GW), three soil samples (VHFS-AREE16-1-1-SO, VHFS-AREE16-1-2-SO, and VHFS-AREE16-1-3-SO), and one surface water sample (VHFS-AREE16-1-1-SW) were collected at this location. Sample locations and associated analytical chemistry data are indicated on **Figure 7-2**.

7.1.1 Groundwater

Groundwater was sampled at the temporary well VHFS-AREE16-1-1-GW, located near the former Possible Fire Training Pit, downgradient of the inferred area of AFFF use or release **(Figure 7-2)**.

PFOS and PFBS were not detected in groundwater at this AOPI. However, PFOA was detected in this well at concentration estimated to be 2.8 J ng/L (**Table 7-1**).

7.1.2 Soil

At this AOPI, soil samples were collected from three locations; VHFS-AREE16-1-1, which was taken from the depth interval 1 to 3 feet, VHFS-AREE16-1-2, which was collected from 2 to 4 feet, and VHFS-AREE16-1-3, which was collected from 0 to 2 feet.

At all three locations PFOS, PFOA, and PFBS were not detected (**Table 7-2**).

7.1.3 Surface Water

Surface water was sampled at one location, VHFS-AREE16-1-1-SW. PFOS was detected at a concentration of 9.5 ng/L, and PFOA was detected at 6.4 ng/L; PFBS was not detected (**Table 7-3**).

7.2 Unlined Sludge Disposal Area-Dump #3 (AREE 17)

The subsections below summarize the soil PFOS, PFOA, and PFBS analytical results associated with AREE 17-Unlined Sludge Disposal Area (Dump #3). In total, four soil samples were collected at this AOPI; there were two separate boring locations (VHFS-AREE17-1-SO and VHFS-AREE17-2-SO) where two depth intervals were sampled from each. Sample locations and associated analytical chemistry data are indicated on **Figure 7-2**.

7.2.1 Soil

One soil boring, VHFS-AREE17-1-SO, was sampled from the intervals 0 to 2 feet and 4 to 6 feet. The second boring, VHFS-AREE17-2-SO, had two samples collected from 0 to 2 feet and 10 to12 feet.

VHFS-AREE17-1-SO had no detections for PFOS, PFOA, or PFBS in both the 0 to 2 feet and 4 to 6 feet intervals.

VHFS-AREE17-2-SO had one detection of PFOS from the interval 0 to 2 feet, 0.0020 mg/kg. PFOA and PFBS were not detected. Similarly, at this boring location there were no detections above the LOD for PFOS, PFOA, and PFBS within the depth interval 10 to12 feet. (**Table 7-2**).

7.3 AREE 29-3: Possible Disposal Area

The subsections below summarize the soil PFOS, PFOA, and PFBS analytical results associated with AREE 29-3 which is likely the former site used for the disposal of sludge possibly derived from photo-processing activities. In total, two soil samples from one boring (VHFS-AREE-29-3-1-SO) were collected at this location. Sample locations and associated analytical chemistry data are indicated on **Figure 7-2**.

7.3.1 Soil

At this location, soil was sampled at two depth intervals, 1 to 3 feet and 4 to 6 feet. PFOS, PFOA, and PFBS were not detected (**Table 7-2**).

7.4 Possible Fire Training Pit (AREE16-2)

The subsection below summarizes the PFOS, PFOA, and PFBS analytical results for groundwater and soil associated with AREE 16-2 Possible Fire Training Pit. In total, one groundwater sample (VHFS-AREE16-2-2-GW), and two soil samples (VHFS-AREE16-2-1-SO and VHFS-AREE16-2-3-SO) were collected at this location during a first mobilization. Following the completion of initial SI activities, supplemental SI sampling was completed during a supplemental field event on 17 November 2020, and seven soil samples from four borings (VHFS-AREE16-2-2-SO, VHFS-AREE16-2-3-SO, VHFS-AREE16-

2-4-SO, and VHFS-AREE16-2-5-SO) were collected at this AOPI. The results from this supplemental sampling are also discussed below.

Sample locations and associated analytical chemistry data are indicated on **Figure 7-3**.

7.4.1 Groundwater

Groundwater was sampled from the temporary well VHFS-AREE16-2-2, formerly a suspected fire training pit, downgradient of the inferred area of AFFF use or release.

PFOS was detected in groundwater in the well at this AOPI at 35 J- ng/L. PFOA was also detected in this well at a concentration of 20 J- ng/L. PFBS was detected at the VHFS-AREE 16-2-2 temporary well where PFBS concentration was 13 J- ng/L (**Table 7-1**).

7.4.2 Soil

During the first mobilization, at this AOPI, soil was collected from two locations; VHFS-AREE16-2-1, which was collected from depth interval 3 to 5 feet, and VHFS-AREE16-2-3, which was collected from 6 to 8 feet.

PFOS and PFOA were positively detected within soil collected from VHFS-AREE16-2-3; their concentrations were 0.0012 mg/kg and 0.0027 mg/kg, respectively (**Table 7-2**). PFBS was not detected in this soil sample.

PFOS, PFOA, and PFBS were not detected at the location VHFS-AREE16-2-1.

During the second mobilization, at sample location VHFS-AREE16-2-3 soil samples were collected at two discrete depth intervals 0 to 2 feet and 6 to 8 feet. PFOS was positively detected in both depth intervals; the concentration in the sample collected from 0 to 2 feet was 0.0013 mg/kg and the concentration from the 6 to 8 feet depth interval was 0.0012 J. PFOA and PFBS were not detected in either depth interval (**Table 7-2**).

At sample location VHFS-AREE16-2-4 soil samples were collected at two discrete depth intervals 2 feet and 10 to 12 feet. Within the 0 to 2 feet interval, PFOA was detected at a concentration of 0.0016 mg/kg; PFOS and PFBS were not detected (**Table 7-2**). PFOS, PFOA, and PFBS were not detected within the 10 to 12 feet depth interval (**Table 7-2**).

At sample location VHFS-AREE16-2-5 soil samples were collected at two discrete depth intervals 0 to 2 feet and 3 to 4.5 feet. PFOS was positively detected in both depth intervals; the concentration in the sample collected from 0 to 2 feet was 0.0088 mg/kg and the concentration from the 3 to 4.5 feet depth interval was 0.0094 mg/kg. PFOA was positively detected in both depth intervals; the concentration in the sample collected from 0 to 2 feet was 0.00069 mg/kg and the concentration from the 3 to 4.5 feet depth interval was 0.0009 J mg/kg. PFBS was not detected in either interval (**Table 7-2**).

7.5 AREE 29-2: Possible Sludge Disposal Area

The subsections below summarize soil and surface water PFOS, PFOA, and PFBS analytical results associated with AREE 29-2, a possible sludge disposal area. In total, one soil sample (VHFS-AREE29-2-1-SO) and one surface water sample (VHFS-AREE29-2-1-SW) were collected at this location during a

first mobilization. Following the completion of initial SI activities, supplemental SI sampling was completed during a supplemental field event on 17 November 2020, and one additional soil sample was collected at this AOPI. The results from this supplemental sampling are also discussed below. Sample locations and associated analytical chemistry data are indicated on **Figure 7-3**.

7.5.1 Soil

At VHFS-AREE29-2-1-SO, soil was sampled at 0.5 to 2.5 feet. PFOS, PFOA, and PFBS were not detected (**Table 7-2**).

7.5.2 Surface Water

At AREE 29-2-1-SW, surface water was collected at one location. PFOS concentration was 9.2 ng/L, PFOA concentration was 7.3 ng/L, and PFBS was 1.8 J ng/L (**Table 7-3**).

7.6 Former Helipad

This subsection summarizes the PFOS, PFOA, and PFBS analytical results of two soil samples from one boring (VHFS-HELIPAD-1-SO) associated with the location of a former Helipad at VHFS. Sample locations and associated analytical chemistry data are indicated on **Figure 7-3.**

7.6.1 Soil

At VHFS-HELIPAD-1-SO, soil was sampled at two discrete depth intervals, 0 to 2 feet and 16 to 18 feet. Within the 0 to 2 feet interval, PFOA was positively detected with the concentration 0.00062 J mg/kg and PFOS was detected at the concentration 0.00065 J mg/kg; PFBS was not detected (**Table 7-2**).

There were no detections of PFOS, PFOA, and PFBS in the 16 to 18 feet interval.

7.7 Building 271- Fire Station

The subsections below summarize the groundwater and soil PFOS, PFOA, and PFBS analytical results associated with Building 271, the former Fire Station. In total, one groundwater sample (VHS-B271-1-GW) and two soil samples from one boring (VHF-B271-1-SO) were collected at this location. Sample locations and associated analytical chemistry data are indicated on **Figure 7-4**.

7.7.1 Groundwater

Groundwater was collected at the temporary well VHFS-B271. PFOS was detected at 21 ng/L; PFOA was detected at 15 ng/L; and PFBS was detected at 19 ng/L (**Table 7-1**).

7.7.2 Soil

At VHF-B271-1-SO, soil samples were collected at two discrete depth intervals, 0.5 to 2.5 feet and 14 to 16 feet. Within the 0.5 to 2.5 feet depth interval, PFOS and PFOA were detected at 0.0011 mg/kg and 0.00063 J mg/kg, respectively. PFBS was not detected in this interval.

PFOS was detected in the 14 to16 feet depth interval at 0.0011 mg/kg; PFOA and PFBS were not detected in this interval (**Table 7-2**).

7.8 Building 2470- Fire Department Storage Building

The subsections below summarize the groundwater and soil PFOS, PFOA, and PFBS analytical results associated with Building 2470- Fire Department Storage Building. In total, four groundwater samples were collected (VHFSB2470-1-GW, VHFSB2470-2-GW, VHFSB2470-3-GW, and VHFSB2470-4-GW). Sample locations and associated analytical chemistry data are indicated on **Figure 7-5**.

7.8.1 Groundwater

Groundwater was sampled from four temporary wells installed surrounding Building 2470, where AFFF was suspected to be stored.

At VHFS-B2470-1-GW, PFOS and PFOA were not detected, while PFBS was detected at a concentration of 2.0 J- ng/L. At VHFS-B2470-2-GW, PFOS was not detected, while PFOA and PFBS were detected at concentrations of 3.9 ng/L and 2.1 J ng/L, respectively. At VHFS-B2470-3-GW, PFOS and PFOA were not detected, while PFBS was detected at a concentration of 2.6 J- ng/L. At VHFS-B2470-4-GW, PFOS, PFOA, and PFBS were all detected at concentrations of 9.5 ng/L, 9.8 ng/L, and 4.4 ng/L, respectively (**Table 7-1**).

7.9 AREE 5: Environmental Photographic Interpretation Center Building

The following subsections summarize the PFOS, PFOA, and PFBS analytical results for groundwater and soil associated with the former EPIC Building, the former location of a large-scale photo processing and development facility. In total, two groundwater samples (VHFS-AREE5-1-GW and VHFS-AREE5-2-GW) and two soil samples (VHFS-AREE5-1-SO and VHFS-AREE5-2-SO) were collected at this location. Sample locations and associated analytical chemistry data are indicated on **Figure 7-6**.

7.9.1 Groundwater

Groundwater was sampled at two temporary wells installed near the EPIC Building, along a clay sewer line that was used to transport chemical wastes from the building.

PFOS was detected in groundwater at VHFS-AREE5-1, where the concentration was 180 J- ng/L, which exceeded the OSD risk screening level. PFOA was detected in groundwater at VHFS-AREE5-1, where the concentration was 25 J- ng/L. PFBS was detected in VHFS-AREE5-1 at 9.0 J- ng/L. PFOS, PFOA, and PFBS were not detected in VHFS-AREE5-2-GW (**Table 7-1**).

7.9.2 Soil

At this AOPI, soil samples were collected from two locations; VHFS-AREE5-1, which was taken from the depth interval of 16 to 18 feet, and VHFS-AREE5-2, which was collected from 20 to 22 feet.

At both locations PFOS, PFOA, and PFBS were not detected (**Table 7-2**).

7.10 AREE 10: Former Photographic Wastewater Lagoon

The subsections below summarize the groundwater and soil PFOS, PFOA, and PFBS analytical results associated with AREE 10. In total, one groundwater sample (AREE10-1-GW), one surface water sample (AREE10-1-SW) and one soil sample (AREE10-1-SO) were collected at this location. Sample locations and associated analytical chemistry data are indicated on **Figure 7-7**.

7.10.1 Groundwater

Groundwater was sampled at the temporary well VHFS-AREE10-1-GW, at the Former Photographic Wastewater Lagoon, near the inferred area where chemical waste was stored.

PFOS was detected in groundwater in the well at this AOPI at 15 J- ng/L. PFOA was also detected in this well at a concentration of 66 J- ng/L, which exceeded the OSD risk screening level. PFBS was detected at VHFS-AREE10-1, where its concentration was 4.4 J- ng/L (**Table 7-1**).

7.10.2 Soil

At this location, soil was sampled at one discrete depth interval, 3.5 to 5.5 feet. PFOS was detected at 0.0010 J mg/kg; PFOA, and PFBS were not detected (**Table 7-2**).

7.10.3 Surface Water

One surface water sample, VHFS-AREE10-1-SW was collected at this AOPI. PFOS, PFOA, and PFBS were all positively detected at this location at concentrations 33 ng/L, 14ng/L, and 3.4 J ng/L, respectively (**Table 7-3**).

7.11 AREE 11: Former Sewage Treatment Plant - Sludge Drying Beds and Sludge Piles

The subsections below summarize the groundwater and soil PFOS, PFOA, and PFBS analytical results associated with AREE 11: Former Sewage Treatment Plan - Sludge Drying Beds and Sludge Piles. In total, one groundwater sample (AREE11-1-GW) and one soil sample (AREE11-1-SO) were collected at this location. Sample locations and associated analytical chemistry data are indicated on **Figure 7-7**.

7.11.1 Groundwater

Groundwater was sampled at the temporary well, VHFS-AREE11-1, near the inferred area where chemical waste was deposited to dry.

PFOS was positively detected in the groundwater sample collected at this AOPI, its concentration was 140 J- ng/L, which exceeded the OSD risk screening level. PFOA was also detected in this well at a concentration of 42 J- ng/L, which exceeded the OSD risk screening level. PFBS was detected at concentration 4.3 J- ng/L (**Table 7-1**).

7.11.2 Soil

At this location, soil was sampled at 4 to 6 feet. PFOS, PFOA, and PFBS were not detected (**Table 7-2**).

7.12 AREE 28-9: Sewage Lift Station

The subsections below summarize the soil PFOS, PFOA, and PFBS analytical results associated with AREE 28-9-Sewage Lift Station. In total, one soil sample (AREE28-9-1-SO) was collected at this location. Sample locations and associated analytical chemistry data are indicated on **Figure 7-7**.

7.12.1 Soil

At AREE28-9-1-SO, soil was sampled at 4 to 6 feet. PFOS, PFOA, and PFBS were not detected (**Table 7-2**).

7.13 AREE 7: Building 2400 – Electrical Equipment Facility and Pretreatment Tank

The subsections below summarize the groundwater PFOS, PFOA, and PFBS analytical results associated with AREE 7, Building 2400. In total, five groundwater samples (Wells VHFS-NP-PZ2, VHFS-MW34-2, VHFS-MW34-5D, and VHFS-MW34-10C) were collected at this AOPI including one field duplicate. Sample locations and associated analytical chemistry data are indicated on **Figure 7-8**.

7.13.1 Groundwater

Groundwater was sampled at four existing monitoring wells installed surrounding Building 2400, where photo developing, metal etching (involving chromic acid), and graphics work historically occurred.

At VHFS-NP-PZ-2, PFOS, PFOA, and PFBS were all detected at concentrations of 8.9 ng/L, 2.9 J ng/L, and 2.1 J ng/L, respectively. At VHFS-MW34-2, PFOS and PFOA were detected at concentrations of 25 ng/L and 6.6 ng/L, respectively, while PFBS was not detected. At VHFS-MW34-5D, PFOS and PFOA were detected at concentrations of 6.2 ng/L and 2.4 J ng/L, respectively, while PFBS was not detected. At VHFS-MW34-10C, PFOS, PFOA, and PFBS were not detected. (**Table 7-1**)

7.14 AREE 8: Building 2400 - Neutralization Pit

The subsections below summarize the groundwater and soil PFOS, PFOA, and PFBS analytical results associated with AREE 8: Building 2400 - Neutralization Pit. In total, one groundwater sample (Well VHFS-NP-PZ3) and one soil sample (VHFS-AREE8-1-SO) were collected at this location. Sample locations and associated analytical chemistry data are indicated on **Figure 7-8.**

7.14.1 Groundwater

Groundwater was sampled at one location, temporary well VHFS-NP-PZ3. PFOS was detected at a concentration of 3.5 J ng/L. PFOA and PFBS were not detected (**Table 7-1**).

7.14.2 Soil

At this location, soil was sampled at 5 to 6 feet. PFOS, PFOA, and PFBS were not detected (**Table 7-2**).

7.15 AREE 29-4: Disposal Area

The subsections below summarize the groundwater and soil PFOS, PFOA, and PFBS analytical results associated with AREE 29-4: Disposal Area. In total, one groundwater sample (VHFS-AREE 29-4-2-GW) and three soil samples from two borings (VHFS-AREE 29-4-1-SO and VHFS-AREE 29-4-2-SO) were collected at this location. Sample locations and associated analytical chemistry data are indicated on **Figure 7-9**.

7.15.1 Groundwater

Groundwater was sampled at the temporary well, VHFS-AREE 29-4-2-GW, at the Disposal Area, near the inferred area where various wastes were potentially dumped.

PFOS, PFOA, and PFBS were not detected (**Table 7-1**).

7.15.2 Soil

One soil boring, VHFS-AREE29-4-2-SO, was sampled from the interval 0.5 to 2.5 feet. The second boring, VHFSAREE29-4-1-SO, had two samples collected from 0.5 to 2.5 feet and 5.5 to 7.5 feet.

There were no detections of PFOS, PFOA, or PFBS in soil samples collected from boring VHFS AREE29-4-1-SO. Similarly, VHFS-AREE29-4-2-SO had no detections of PFOS, PFOA, or PFBS.

7.16 AREE 29-5: Liquid Impoundment Area

The subsections below summarize the soil PFOS, PFOA, and PFBS analytical results associated with AREE 29-5: Liquid Impoundment Area. In total, one soil sample (VHFS-AREE 29-5-1-SO) was collected at this location. The sample's location and associated analytical chemistry data are indicated on **Figure 7-9**.

7.16.1 Soil

At VHFS-AREE 29-5-1-SO, soil was sampled from 2 to 4 feet. PFOS, PFOA, and PFBS were not detected (**Table 7-2**).

7.17 AREE 13: Sludge Disposal Area

The subsections below summarize the groundwater and soil PFOS, PFOA, and PFBS analytical results associated with AREE 13: Sludge Disposal Area. In total, one groundwater sample (VHFS-AREE13-1-GW) and one soil sample (VHFS-AREE13-1-SO) were collected at this location. Sample locations and associated analytical chemistry data are indicated on **Figure 7-10**.

7.17.1 Groundwater

Groundwater was sampled at the temporary well, VHFS-AREE13-1-GW, near a possible sludge disposal area that potentially received wastes from various operations at VHFS.

PFOS was detected above the OSD risk screening level in groundwater in the well at this AOPI at 450 DJ ng/L (**Table 7-1**). The D qualifier indicates the sample was run at dilution. PFOA was also detected in this well above the OSD risk screening level at a concentration of 1,300 DJ ng/L. PFBS was detected within this well at a concentration of 89 J- ng/L.

7.17.2 Soil

At VHFS-AREE13-1-SO, soil was sampled at 9 to 11 feet. PFOS, PFOA, and PFBS were not detected (**Table 7-2**).

7.18 AREE 29-6: Possible Burn Pile (AREE 29-6)

The subsection below summarizes the PFOS, PFOA, and PFBS analytical results of one soil sample (VHFS-AREE29-6-1-SO) associated with AREE 29-6, a possible burn pile. Sample locations and associated analytical chemistry data are indicated on **Figure 7-11**.

7.18.1 Soil

One soil sample was collected at this location from 0 to 2.5 feet. PFOS was detected at 0.00068 J ng/L (**Table 7-2**). PFOA and PFBS were not detected.

7.19 AREE 9: Vehicle Maintenance Buildings 288 & 290

The subsections below summarize the groundwater PFOS, PFOA, and PFBS analytical results associated with one groundwater sample (VHFS-AREE9-1-GW) collected at, AREE 9, Buildings 288 & 290, formerly vehicle maintenance buildings. Sample locations and associated analytical chemistry data are indicated on **Figure 7-12**.

7.19.1 Groundwater

Groundwater was sampled, via temporary well, at one location (VHFS-AREE9-1-GW) at the former site of the Vehicle Maintenance Buildings. PFOS, PFOA, and PFBS were detected at this location. PFOS concentration was 9.0 J- ng/L, PFOA concentration was 31 J- ng/L, and the concentration of PFBS was 3.0 J- ng/L (**Table 7-1**).

7.20 Automated Car Wash

The subsection below summarizes the PFOS, PFOA, and PFBS analytical results for one groundwater sample (VHFS-CW-1-GW) associated with the former civilian car wash. Sample locations and associated analytical chemistry data are indicated on **Figure 7-12**.

7.20.1 Groundwater

Groundwater was collected at one temporary well (VHFS-CW-1-GW) installed near the former Automated Car Wash. PFOS, PFOA, and PFBS were all detected at this location. PFOS concentration exceeded OSD risk screening levels at 43 J- ng/L. PFOA was detected at 11 J- ng/L and PFBS concentration was estimated to be 3.9 J- ng/L (**Table 7-1**).

7.21 AREE 26: Outdoor Wash Rack

The subsections below summarize the groundwater and soil PFOS, PFOA, and PFBS analytical results associated with the former AREE 26: Outdoor Wash Rack. In total, one groundwater sample (VHFS-AREE26-1-GW) and two soil samples from one boring (VHFS-AREE26-1-SO) were collected at this location. Sample locations and associated analytical chemistry data are indicated on **Figure 7-13**.

7.21.1 Groundwater

Groundwater was collected at one temporary well (VHFS-AREE26-1-GW) installed near the former Wash Racks. PFOS and PFOA were detected at concentrations 11 ng/L. and 9.4 ng/L, respectively (**Table 7-1**). PFBS was not detected.

7.21.2 Soil

At VHFS-AREE26-1-SO, soil was sampled at two depth intervals, 0.5 to 2.5 feet and 11to 13 feet. PFOS, PFOA, and PFBS were not detected (**Table 7-2**).

7.22 AREE 1: Waste Disposal Area (Dump #1)

The subsections below summarize the groundwater and surface water PFOS, PFOA, and PFBS analytical results associated with AREE 1: Waste Disposal Area (Dump #1). In total, three groundwater samples (Wells VHFS-MW1-4, VHFS-GW02W, and VHFS-GW03W) and one surface water sample (VHFS-AREE1-1-SW) were collected at this location. Sample locations and associated analytical chemistry data are indicated on **Figure 7-14**.

7.22.1 Groundwater

Groundwater was sampled at three existing monitoring wells at AREE 1, proximal to where wastes from various operations at VHFS may have been deposited.

At VHFS-MW-1-4, PFOS, PFOA, and PFBS were detected at concentrations of 210 ng/L, 23 ng/L, and 8.6 ng/L, respectively. The detection of PFOS at this well exceeds the OSD risk screening level. At VHFS- GW02W, PFOS, PFOA, and PFBS were detected at concentrations of 1,100 DJ ng/L, 68 ng/L, and 73 ng/L, respectively. The detections of PFOS and PFOA at this well exceed the OSD risk screening level. At VHFS- GW03W, PFOS, PFOA, and PFBS were detected at concentrations of 150 ng/L, 67 ng/L, and 7.3 ng/L, respectively. The detections of PFOS and PFOA at this well exceed the OSD risk screening level. (**Table 7-1**)

7.22.2 Surface Water

Surface water was collected at one location (VHFS-AREE1-1-SW) for this AOPI. PFOS and PFOA were detected. PFOS concentration was 5.0 ng/L and PFOA concentration was 2.7 J ng/L (**Table 7-3**). PFBS was not detected at this location.

7.23 AREE 2: Active Sewage Treatment Plant - Sludge Drying Beds and Sludge Piles

The subsections below summarize the soil and surface water PFOS, PFOA, and PFBS analytical results associated with AREE 2: Active Sewage Treatment Plant Sludge Drying Beds. In total, two soil samples from one boring (VHFS-AREE2-1-SO) and one surface water sample (VHFS-AREE2-1-SW) were collected at this location. Sample locations and associated analytical chemistry data are indicated on **Figure 7-14**.

7.23.1 Soil

At VHFS-AREE2-1-SO, soil was sampled at two discrete depth intervals, 1 to 2 feet and 4 to 6 feet. PFOS was detected in the 1 to 2 feet depth interval at 0.0024 mg/kg; whereas, PFOA and PFBS were not detected in this interval (**Table 7-2**). Within the 4 to 6 feet depth interval, PFOS and PFOA were detected at 0.0024 mg/kg and 0.0011, respectively. PFBS was not detected in this interval.

7.23.2 Surface Water

One surface water sample was collected at this AOPI. At VHFS-AREE2-1-SW, PFOS and PFOA were detected at concentrations of 5.2 ng/L and 2.2 J ng/L, respectively, while PFBS was not detected (**Table 7-3**).

7.24 Bedrock Aquifer

PFOS, PFOA, and PFBS were detected in all eight packer test samples that could be collected, with PFOS and PFOA detections exceeding the combined PFOS and PFOA USEPA lifetime health advisory (LHA) of 70 ng/L in all samples. Nine of the 10 packer test samples from VNT-3B and VNT-1B detected concentrations of PFOA above the OSD risk screening level of 40 ng/L. All five packer test samples from VNT-3B detected concentrations of PFOS above the OSD risk screening level of 40 ng/L. PFOS was not detected above the OSD risk screening level of 40 ng/L in packer test samples from VNT-1B. PFBS was not detected in any of the ten packer test samples at concentrations above the OSD risk screening level of 600 ng/L.

A complete summary of all constituents analyzed for each sample is provided in the attached **Table 7-4** and shown on **Figure 7-15**. The table below presents the detection results for PFOS, PFOA and PFBS.

Table 7-4. Packer Testing Analytical Results

Constituent		PFOS	PFOA	PFBS
2016 USEPA LHA combined for PFOS and PFOA (ng/L)		70		Not Applicable
2019 OSD risk screening level [HQ=0.1] (ng/L)		40	40	600
Well Name	Sample Interval (feet btoc)			
VNT-3B	88-110	690	1000 DJ	70
	233-255	330	410	34
	297.5-319.5	220	270	21
	380-402	730	810	70
VNT-1B	28-58	32	830 DJ	7.1
	120-150 (1)*	30	810	6.9
	120-150 (2)*	21	710	6.4
	120-150 (3)*	18	630	4.6
	450-562	32 (33)	1000 (920)	8.2 (8.4)
	490-562	28	730	6.9

Constituent concentrations are reported as ng/L; Values in parentheses are duplicate results
DJ – The analyte was analyzed at dilution and the result is an estimated quantity
Shaded – constituent detected above the 2016 USEPA LHA level of 70 ng/L combined for PFOS and PFOA.
Underlined – constituent detected above the 2019 OSD risk screening levels using a HQ multiplier of 0.1.

Several conclusions may be drawn from the packer testing:

- The bedrock formation is highly fractured and of high transmissivity. In VNT-3B, only one interval (out of a 421.6-foot deep well) produced insufficient water to sample. In VNT-1B, only one interval (out of a 562.5-foot-deep well) produced insufficient water to sample. VNT-1B intercepts a greater number of hydraulically active fractures and is overall a higher-producing well.
- The packer testing confirmed that PFOS, PFOA and PFBS is present in the two exploratory production-supply test wells. PFOA impacts in VNT-3B are an order-of-magnitude greater than in VNT-1B.
- While the analytical data indicates that PFOS was present in concentrations above the USEPA health advisory and OSD screening levels within all sampled fractures in VNT-1B, the artesian well properties indicate that PFOS in the well may originate from the deeper fractures of the Midland Formation. Previous investigations conducted at VHFS indicate that the Hickory Grove Basalt confines groundwater flow between the Turkey Run Formation and the Midland Formation. Due to the open borehole conditions, there is now a direct groundwater flow pathway between the unconfined Turkey Run Formation and the confined Midland Formation, with artesian well conditions moving deep groundwater from the Midland Formation upwards and outwards into shallower fracture zones located within the Turkey Run Formation. The artesian conditions indicate that the groundwater is recharged at higher elevation than the Site location and the deep PFOS impacts may therefore be related to a hydraulically upgradient source or sources.
- Fracture zones within VNT-3B are located within the Midland Formation. All sampled fracture zones detected concentrations of PFOS similar to VNT-1B, however; PFOA was also detected in VNT-3B at concentrations above the USEPA health advisory and OSD risk screening levels.

- The data support the suspicion that shallow releases of PFAS entered the bedrock due to AFFF releases at the AREE 16-2: Possible Fire Training Pit 2 located atop the overburden overlying the Midland Formation, migrated to VNT-3B and VNT-1B within the Midland Formation, and then moved down the borehole to reach the deepest intervals. The artesian conditions of VNT-1B also makes it probable that deep impacted groundwater moved upwards through the open borehole of the well, through the Hickory Grove Basalt, and outwards into fractures within the Hickory Grove Basalt and the Turkey Run Formation.

This investigation confirmed that impacts of PFOS, PFOA. And PFBS are present in both the Turkey Run Formation, Hickory Grove Basalt, and Midland Formations underlying VHFS. The impacts detected in the former production supply exploratory test wells were found both in shallow and deeper fractures, a condition that likely reflects a combination of different transport mechanisms due to the artesian conditions of VNT-1B. For VNT-3B, the long open borehole may also have provided a transport pathway for carrying PFAS deeper into the Midland Formation than it would have otherwise. For VNT-1B, the long open borehole, combined with heavy artesian conditions, may have provided a transport pathway for carrying PFAS into the shallower fractures of the Hickory Grove Basalt and Turkey Run Formations. It is not understood if the deep Midland Formation impacts are related to hydraulically upgradient remote source or sources that are unrelated to the historical site operations

7.25 TOC, pH, and Grain Size

In addition to sampling soil for PFOS, PFOA, and PFBS, one soil sample per AOPI was analyzed for TOC, pH, moisture content, and grain size data as they may be useful in future fate and transport studies. The TOC in the soil samples ranged from 330 to 12,600 mg/kg. The TOC at this installation was typically within range of that typically observed in topsoil (5,000 to 30,000 mg/kg). The combined percentage of fines (i.e., silt and clay) in soils at VHFS ranged from 31 to 80% with an average of 59%. In general, PFAS constituents tend to be more mobile in soils with less than 20% fines (silt and clay) and lower TOC. The percent moisture of the soil 19.7%] was typical for clay (0 to 20%). The pH of the soil slightly acidic (4 to 6) to neutral (approximately 7). Based on these geochemical and physical soil characteristics observed underlying the installation during the SI, while PFAS constituents are expected to be relatively less mobile in soils with high percentages of fines, depleted TOC may allow for enhanced mobility of the constituents in soil.

7.26 QA/QC Samples

The full analytical results for QA/QC samples collected during the SI are included in **Appendix N**. PFOS, PFOA, and PFBS were not detected in any of the QA/QC samples collected during the SI work.

7.27 Conceptual Site Models

The preliminary CSMs presented in the QAPP Addendum (Arcadis 2020) were re-evaluated and updated, if necessary, based on the SI sampling results. The CSMs presented on **Figures 7-16** through **7-30** and in this section therefore represent the current understanding of the potential for human exposure. For some AOPIs, the CSM is the same and thus shown on the same figure.

Based on the historical use, storage, and/or disposal of PFAS-contaminated materials at the AOPIs, affected media are likely to consist of soil, groundwater, surface water. Release and transport mechanisms include dissolution/desorption from soil to groundwater, transport via sediment carried in and dissolution to stormwater and surface water, discharge/recharge between groundwater and surface water, and adsorption/desorption between surface water and sediment. Generic categories of potential human receptors and their associated exposure scenarios that are typically evaluated in a CERCLA human health risk assessment were considered and include on-installation site workers (e.g., industrial/commercial workers, utility workers, or future construction workers who could be exposed to chemicals in soil at an AOPI or to chemicals in tap water in an industrial/commercial building), on-installation residents (e.g., adults and children who could be exposed to chemicals in tap water in a residence), and on-installation recreational users (e.g., hikers or hunters who could be exposed to chemicals in waterways at an installation). Off-installation receptor types could include drinking water receptors (i.e., commercial/industrial workers or residents) and recreational users.

Human exposure pathways are shown as “complete, “potentially complete”, or “incomplete” on the CSM figures. A complete exposure pathway consists of a constituent source and release mechanism, a transport or retention medium, an exposure point where human contact with the contaminated medium could occur, and an exposure route at the exposure point. If any of these elements is missing, the exposure pathway is incomplete. Pathways are “potentially complete” where data are insufficient to conclude the pathway is either “complete” or “incomplete”.

CSMs were developed for each individual AOPI and were combined where source media, potential migration pathways and exposure media, and human exposure pathway determinations are congruent. The following exposure pathway determinations apply to all CSMs:

- Surface water is not used as a potable water resource on the installation; therefore, exposure via ingestion or dermal contact of surface water for on-installation residents and site workers is incomplete at all sites.
- On-installation recreational users are not likely to contact groundwater; therefore, groundwater exposure pathways via ingestion and dermal contact are incomplete.
- On-installation residents and recreational users are not likely to encounter soil associated with these AOPIs, so soil exposure pathways for these receptors were considered incomplete. Also, since soil is not likely to mobilize off-installation, so the soil exposure pathways for all types of off-installation receptors are incomplete.

Additional exposure pathway descriptions for each CSM are listed below by figure.
Figure 7-16 shows the CSM for AOPI AREE 29-4. AREE 29-4 is a suspected waste disposal area that may have received potentially PFAS-containing wastes from various operations at VHFS.

- PFOS, PFOA, and/or PFBS were not detected in groundwater samples collected at this AOPI; therefore, groundwater exposure pathways via ingestion and dermal contact for on-installation site workers and residents and off-installation receptors were considered incomplete.
- PFOS, PFOA, and/or PFBS were not detected in soil samples collected from this AOPI; therefore, the soil exposure pathways for on-installation site workers were considered incomplete.
- Surface water samples were not collected at this AOPI; however, PFOS, PFOA, and/or PFBS were not detected in groundwater or soil samples, the surface water and sediment exposure pathways for

on-installation recreational users, and all types of off-installation receptors were considered incomplete.

Figure 7-17 shows the CSM for AOPI AREE 28-9, a sewage lift station and AREEs 29-3 and 29-5 which are former disposal sites.

- Groundwater samples were not collected at these AOPIs, but because PFOS, PFOA, and/or PFBS were not detected in soil, which is the source medium for PFAS contamination at these AOPIs, the groundwater exposure pathways via ingestion and dermal contact for on-installation site workers and residents and off-installation receptors were considered incomplete.
- PFOS, PFOA, and/or PFBS were not detected in soil samples collected from these AOPIs; therefore, the soil exposure pathways for on-installation site workers were considered incomplete.
- Surface water samples were not collected at this AOPI; however, PFOS, PFOA, and/or PFBS were not detected in groundwater or soil samples, the surface water and sediment exposure pathways for on-installation recreational users, and all types of off-installation receptors were considered incomplete.

Figure 7-18 shows the CSM for AOPI AREE 29-2, a possible sludge disposal area that may have received PFAS-containing materials from operations at VHFS.

- Groundwater samples were not collected at this AOPI; however, there are no known releases of PFOS, PFOA, and/or PFBS to surface waters, yet PFASs were detected in surface water samples and not soil samples. Therefore, groundwater exposure pathways for on-installation residents and site workers were considered potentially complete. Because PFASs have the potential to migrate off-post, groundwater exposure pathways for off-installation receptors were considered potentially complete.
- PFOS, PFOA, and PFBS were not detected in soil samples collected from this AOPI; therefore, the soil exposure pathways for on-installation site workers were considered incomplete.
- The surface water sample collected at this AOPI had positive detections of PFOS, PFOA, and/or PFBS; therefore, the surface water exposure pathways for on-installation recreational users were considered complete. This surface water sample was collected from South Run which flows off-installation to Lake Manassas, a recreation and drinking water reservoir; surface water exposure pathways for all off-installation receptors were considered potentially complete since samples were only collected on installation.
- Sediment samples were not collected at this AOPI, but surface water samples had positive detections of PFOS, PFOA, and/or PFBS; therefore, the sediment pathway for on-installation recreational users and all off-post receptors were considered potentially complete.

Figure 7-19 shows the CSM for AOPIs AREE 17, an unlined sludge disposal area, AREE 29-6, a former burn pit location and the Helipad.

- Groundwater samples were not collected at these AOPIs, but because PFOS, PFOA, and PFBS were positively detected in soil, which is the source medium for PFAS contamination at these AOPIs, the groundwater exposure pathways via ingestion and dermal contact for on-installation site workers and residents and off-installation receptors were considered potentially complete.
- For on-installation site workers at these AOPIs, the soil exposure pathways via ingestion and dermal contact are complete because PFOS, PFOA, and/or PFBS were positively detected in soil samples.

- Surface water was not collected from these AOPIs. PFOS, PFOA, and/or PFBS were positively detected in soil samples collected at this AOPI. Due to the potential for PFAS-contaminated soil to impact surface water either by groundwater discharge or surface runoff, the soil and sediment exposure pathways for on-installation recreational users were considered potentially complete. South Run is adjacent to these AOPIs and flows off-installation to Lake Manassas, a recreation and drinking water reservoir. Therefore, surface water and sediment exposure pathways for all off-installation receptors were considered potentially complete since samples were only collected on installation.

Figure 7-20 shows the CSM for AOPI AREE 2 which is the former sludge drying beds and sludge piles for the active sewage treatment plant.

- Groundwater samples were not collected at this AOPI, but because PFOS, PFOA, and PFBS were positively detected in soil, which is the source medium for PFAS contamination at these AOPIs, the groundwater exposure pathways via ingestion and dermal contact for on-installation site workers and residents and off-installation receptors were considered potentially complete.
- For on-installation site workers at this AOPI, the soil exposure pathways via ingestion and dermal contact were considered complete because PFOS, PFOA, and/or PFBS were positively detected in soil samples.
- The surface water sample collected at this AOPI had positive detections of PFOS, PFOA, and/or PFBS; therefore, the surface water exposure pathways for on-installation recreational users were considered complete. This surface water sample was collected from South Run which flows off-installation to Lake Manassas, a recreation and drinking water reservoir; surface water exposure pathways for all off-installation receptors were considered potentially complete since samples were only collected on installation.
- Sediment samples were not collected at this AOPI, but surface water samples had positive detections of PFOS, PFOA, and/or PFBS; therefore, the sediment pathway for on-installation recreational users and all off-post receptors were considered potentially complete.

Figure 7-21 shows the CSM for AOPIs AREEs 5, 7 and 11. AREEs 5 and 7 were formerly the Environmental Photographic Interpretation Center and Building 2400 Electrical Equipment Facility and Pretreatment Tank, respectively. These two AOPIs are photo-processing facilities. AREE 11 was the site of sludge drying beds and sludge piles for the former sewage treatment plant. These AOPIs likely had releases of PFAS-containing materials to soil and surface water.

- Groundwater samples collected from these AOPIs had positive detections of PFOS, PFOA, and PFBS. Groundwater samples were collected from monitoring wells and not drinking water wells; therefore, groundwater exposure pathways for on-installation residents and site workers were considered potentially complete. Because contaminated groundwater has the potential to migrate off-installation, groundwater exposure pathways for off-installation receptors were considered potentially complete.
- PFOS, PFOA, and PFBS were not detected in soil samples collected from this AOPI; therefore, the soil exposure pathways for on-installation site workers were considered incomplete.
- Surface water samples were not collected at these AOPIs, but due to potential for contaminated groundwater to recharge surface waterbodies and historical accounts of waste discharges to the Western South Run Tributary, the surface water and sediment exposure pathways for on-installation recreational users were considered potentially complete. Western South Run eventually joins South Run, which discharges to Lake Manassas. Lake Manassas is a recreation and drinking water

reservoir, so surface water and sediment exposure pathways for all off-installation receptors were considered potentially complete since samples were only collected on installation.

Figure 7-22 shows the CSM for AOPIs AREEs 8 and 26. AREE 8 was the location of the neutralization pit for photo-processing activities associated with Building 2400 and AREE 26 is the former outdoor wash rack.

- Groundwater samples collected from these AOPIs had positive detections of PFOS, PFOA, and PFBS. Groundwater samples were collected from monitoring wells and not drinking water wells; therefore, groundwater exposure pathways for on-installation residents and site workers were considered potentially complete. Because contaminated groundwater has the potential to migrate off-installation, groundwater exposure pathways for off-installation receptors were considered potentially complete.
- PFOS, PFOA, and PFBS were not detected in soil samples collected from this AOPI; therefore, the soil exposure pathways for on-installation site workers were considered incomplete.
- Surface water samples were not collected at these AOPIs, but due to potential for contaminated groundwater to recharge surface waterbodies, the surface water and sediment exposure pathways for on-installation recreational users were considered potentially complete. The nearest surface waterbody to these AOPIs is Kettle Run which is not used a potable water source; however, off-installation recreational users may contact surface water or sediment via ingestion or dermal contact, so these exposure pathways were considered potentially complete.

Figure 7-23 shows the CSM for a sludge disposal area, AOPI AREE 13.

- Groundwater samples collected from this AOPI had positive detections of PFOS, PFOA, and/or PFBS. Groundwater samples were collected from monitoring wells and not drinking water wells; therefore, groundwater exposure pathways for on-installation residents and site workers were considered potentially complete. Because contaminated groundwater has the potential to migrate off-installation, groundwater exposure pathways for off-installation receptors were considered potentially complete.
- PFOS, PFOA, and PFBS were not detected in soil samples collected from this AOPI; therefore, the soil exposure pathways for on-installation site workers were considered incomplete.
- Surface water samples were not collected at this AOPI, but due to potential for contaminated groundwater to recharge surface waterbodies the surface water and sediment exposure pathways for on-installation recreational users were considered potentially complete. The nearest surface waterbody to this AOPI is the Western South Run Tributary that eventually joins South Run. South Run discharges to Lake Manassas, a recreation and drinking water reservoir. Therefore, surface water and sediment exposure pathways for all off-installation receptors were considered potentially complete since samples were only collected on installation.

Figure 7-24 shows the CSM for AOPIs AREE 16-1, a suspected fire training area where AFFF may have been used.

- Groundwater samples collected from this AOPI had positive detections of PFOS, PFOA, and/or PFBS. Groundwater samples were collected from monitoring wells and not drinking water wells; therefore, groundwater exposure pathways for on-installation residents and site workers are potentially complete. Because contaminated groundwater has the potential to migrate off-installation, groundwater exposure pathways for off-installation receptors were considered potentially complete.

- PFOS, PFOA, and PFBS were not detected in soil samples collected from this AOPI; therefore, the soil exposure pathways for on-installation site workers were considered incomplete.
- The surface water sample collected at this AOPI had positive detections of PFOS, PFOA, and/or PFBS; therefore, the surface water exposure pathways for on-installation recreational users were considered complete. This surface water sample was collected from the Western South Run Tributary which flows off-installation and joins South Run before discharging to Lake Manassas, a recreation and drinking water reservoir; surface water exposure pathways for all off-installation receptors were considered potentially complete since samples were only collected on installation.
- Sediment samples were not collected at this AOPI, but surface water samples had positive detections of PFOS, PFOA, and/or PFBS; therefore, the sediment pathway for on-installation recreational users and all off-post receptors were considered potentially complete.

Figure 7-25 shows the CSM for AOPIs AREE 1, formerly a waste disposal area that may have received wastes containing PFAS materials. Historical observations indicate that leachate from this site may have impacted surface water.

- Groundwater samples collected from this AOPI had positive detections of PFOS, PFOA, and/or PFBS. Groundwater samples were collected from monitoring wells and not drinking water wells; therefore, groundwater exposure pathways for on-installation residents and site workers were considered potentially complete. Because contaminated groundwater has the potential to migrate off-installation, groundwater exposure pathways for off-installation receptors were considered potentially complete.
- Soil samples were not collected at this AOPI. Due to historical accounts of PFAS-containing releases to the soil at this AOPI and detections of PFOS, PFOA, and/or PFBS in the groundwater at this AOPI, the soil exposure pathway for on-installation site workers was considered potentially complete.
- Surface water samples were not collected at this AOPI, but due to the potential for contaminated groundwater to recharge surface waterbodies and historical accounts of leachate from this area entering South Run, the surface water and sediment exposure pathways for on-installation recreational users were considered potentially complete. South Run discharges to Lake Manassas, a recreation and drinking water reservoir, so surface water and sediment exposure pathways for all off-installation receptors were considered potentially complete since samples were only collected on installation.

Figure 7-26 shows the CSM for AOPIs B2740 and the Automated Car Wash. Building 2740 was formerly a storage building for the on-post Fire Department where accidental releases of AFFF may have impacted soil.

- Groundwater samples collected from these AOPIs had positive detections of PFOS, PFOA, and/or PFBS. Groundwater samples were collected from monitoring wells and not drinking water wells; therefore, groundwater exposure pathways for on-installation residents and site workers were considered potentially complete. Because contaminated groundwater has the potential to migrate off-installation, groundwater exposure pathways for off-installation receptors were considered potentially complete.
- Soil samples were not collected at this group of AOPIs. Due to historical accounts of PFAS-containing releases to the soil at these AOPIs and detections of PFOS, PFOA, and/or PFBS in the groundwater at this AOPI, the soil exposure pathways for on-installation site workers were considered potentially complete.

- Surface water samples were not collected at these AOPIs, but due to potential for contaminated groundwater to recharge surface waterbodies the surface water and sediment exposure pathways for on-installation recreational users were considered potentially complete. The nearest surface waterbody to these AOPIs is Kettle Run which is not used a potable water source; however, off-installation recreational users may contact surface water or sediment via ingestion or dermal contact, so these exposure pathways were considered potentially complete.

Figure 7-27 shows the CSM for AOPI AREE 9, the former site of multiple vehicle maintenance buildings.

- Groundwater samples collected from these AOPIs had positive detections of PFOS, PFOA, and/or PFBS. Groundwater samples were collected from monitoring wells and not drinking water wells; therefore, groundwater exposure pathways for on-installation residents and site workers were considered potentially complete. Because contaminated groundwater has the potential to migrate off-installation, groundwater exposure pathways for off-installation receptors were considered potentially complete.
- Soil samples were not collected at this group of AOPI. Due to historical accounts of PFAS-containing releases to the soil at these AOPIs and detections of PFOS, PFOA, and/or PFBS in the groundwater at this AOPI, the soil exposure pathways for on-installation site workers were considered potentially complete.
- Surface water samples were not collected at these AOPI, but due to potential for contaminated groundwater to recharge surface waterbodies and historical accounts of waste discharges to the Western South Run Tributary, the surface water and sediment exposure pathways for on-installation recreational users were considered potentially complete. Western South Run eventually joins South Run, which discharges to Lake Manassas. Lake Manassas is a recreation and drinking water reservoir, so surface water and sediment exposure pathways for all off-installation receptors were considered potentially complete since samples were only collected on installation.

Figure 7-28 shows the CSM for AOPI AREE 16-2, a suspected fire training area where AFFF may have been used.

- Groundwater samples collected from these AOPI had positive detections of PFOS, PFOA, and/or PFBS. Groundwater samples were collected from monitoring wells and not drinking water wells; therefore, groundwater exposure pathways for on-installation residents and site workers were considered potentially complete. Because contaminated groundwater has the potential to migrate off-installation, groundwater exposure pathways for off-installation receptors were considered potentially complete.
- For on-installation site workers at this AOPI, the soil exposure pathways via ingestion and dermal contact are complete because PFOS, PFOA, and/or PFBS were positively detected in soil samples.
- Surface water samples were not collected at these AOPI, but due to potential for contaminated groundwater to recharge surface waterbodies, the surface water and sediment exposure pathways for on-installation recreational users were considered potentially complete. The nearest surface waterbody to this AOPIs is South Run. South Run discharges to Lake Manassas, a recreation and drinking water reservoir, so surface water and sediment exposure pathways for all off-installation receptors were considered potentially complete since samples were only collected on installation.

Figure 7-29 shows the CSM for AOPIs B271 which is the former Fire Station where accidental releases of AFFF may have impacted soil.

- Groundwater samples collected from these AOPI had positive detections of PFOS, PFOA, and/or PFBS. Groundwater samples were collected from monitoring wells and not drinking water wells; therefore, groundwater exposure pathways for on-installation residents and site workers were considered potentially complete. Because contaminated groundwater has the potential to migrate off-installation, groundwater exposure pathways for off-installation receptors were considered potentially complete.
- For on-installation site workers at this AOPI, the soil exposure pathways via ingestion and dermal contact were considered complete because PFOS, PFOA, and/or PFBS were positively detected in soil samples.
- Surface water samples were not collected at these AOPIs, but due to potential for contaminated groundwater to recharge surface waterbodies the surface water and sediment exposure pathways for on-installation recreational users were considered potentially complete. The nearest surface waterbody to this AOPI is Kettle Run, which is not used a potable water source; however, off-installation recreational users may contact surface water or sediment via ingestion or dermal contact, so these exposure pathways were considered potentially complete.

Figure 7-30 shows the CSM for AOPI AREE 10 which is a former Photographic Wastewater Lagoon

- Groundwater samples collected from these AOPI had positive detections of PFOS, PFOA, and/or PFBS. Groundwater samples were collected from monitoring wells and not drinking water wells; therefore, groundwater exposure pathways for on-installation residents and site workers were considered potentially complete. Because contaminated groundwater has the potential to migrate off-installation, groundwater exposure pathways for off-installation receptors were considered potentially complete.
- For on-installation site workers at this AOPI, the soil exposure pathways via ingestion, dermal contact, and inhalation were considered complete because PFOS, PFOA, and/or PFBS were positively detected in soil samples.
- The surface water sample collected at this AOPI had positive detections of PFOS, PFOA, and/or PFBS; therefore, the surface water exposure pathways for on-installation recreational users were considered complete. This surface water sample was collected from the Western South Run Tributary which flows off-installation and joins South Run before discharging to Lake Manassas, a recreation and drinking water reservoir; surface water exposure pathways for all off-installation receptors were considered potentially complete since samples were only collected on installation.
- Sediment samples were not collected at this AOPI, but surface water samples had positive detections of PFOS, PFOA, and/or PFBS; therefore, the sediment pathway for on-installation recreational users and all off-post receptors were considered potentially complete.

8 OFF-POST PRIVATE POTABLE WELL INVESTIGATION

Based on PFOS, PFOA, and PFBS exceedances of the OSD risk screening levels observed in groundwater downgradient of multiple AOPIs at or near the installation boundary (as discussed in **Section 7**), off-post private potable wells were identified for sampling. An off-post well survey has been completed for an area to be specified by the Army using readily available information from the state of Virginia well records database. County records were also reviewed to identify wells that may not be included in the state database, and relevant parcels were reviewed to compile a list of property owners. Finally, available groundwater modeling reports (i.e., U.S. Geological Survey reports or other) were reviewed for the area. Thereafter, select off-post private potable wells were recommended for sampling based on the understanding of the relationship between on- and off-post hydrogeological conditions. Samples collected as part of this effort will be analyzed in compliance with USEPA Method 537.1 (USEPA 2020). Off-post private potable well sampling results will be discussed in a future report.

9 DATA LIMITATIONS AT VHFS

Data collected during the PA (**Section 3**, **Section 4**, **Section 5**) and SI (**Section 6 and Section 7**) were sufficient to draw the conclusions summarized in **Section 10**. The data limitations relevant to the development of this PA for PFOS, PFOA, and PFBS at VHFS are discussed below.

In March 1993, the BRAC Commission submitted its recommendation that VHFS be selected for closure. Army operations at VHFS officially ceased in 1997, and the VHFS property was sold to various owners. Due to the 1997 site closure, no installation managed administrative record was accessible at VHFS for review, and there were no VHFS personnel stationed at the site to interview. Information and records detailing the use, storage, and/or disposal of PFAS containing materials reviewed during the PA process were limited to certain historical administrative record documents as provided by USACE and BRAC, as well as interviews from two former personnel in the Northern Virginia area familiar with VHFS prior to the site closure.

Documentation specific to AFFF may have been limited (e.g., each AFFF use; procurement records, documentation of AFFF used during crash responses or fire training activities) due to lack of recordkeeping requirements for the full timeline of common AFFF practices. Anecdotal accounts of AFFF use (and therefore likely PFOS, PFOA, and PFBS use) were limited to retired site personnel, whose knowledge of AFFF use may have been restricted by their time spent at the installation or previous roles held that limited their relevant knowledge of potential AFFF (or other PFAS-containing material) use.

A comprehensive well survey was not completed as part of this PA; therefore, the information reviewed regarding off-post wells is limited to what is contained in the off post well search results **Appendix E**.

The searches for ecological receptors and off-post PFOS, PFOA, and PFBS sources were not exhaustive and were limited to easily identifiable and readily available information evaluated during the relevant documents research, Army personnel interviews, and site reconnaissance.

Additionally, the CSMs do not include ecological receptors and exposure pathways. The potential for ecological exposures to PFOS, PFOA, and PFBS may be evaluated at a future date if those pathways warrant further consideration.

Finally, the available PFOS, PFOA, and PFBS analytical data is from limited existing wells and temporary overburden wells completed during the SI. Groundwater samples could not be collected from all AOPIs and source identification or delineation was not completed as part of an SI. Available data, including PFOS, PFOA, and PFBS, is listed in **Appendix N**, which were analyzed per the selected analytical method. The sampling scope of the SI focused on identifying presence or absence of PFOS, PFOA, and PFBS at the AOPIs. SI sampling at locations at or in close proximity of the AOPIs and packer testing wells (VNT-1B and VNT-3B) did not delineate the extent of PFOS, PFOA, and PFBS impacts or identify the primary migration pathways for the chemicals.

Based on the information included within this PA/SI report, a more comprehensive evaluation may be conducted for those AOPIs that warrant further study in a remedial investigation.

10 CONCLUSIONS AND RECOMMENDATIONS

The PFAS PA/SI included two distinct efforts. The PA identified AOPIs at VHFS based on the use, storage, and/or disposal of PFAS-containing materials, in accordance with the 2018 Army Guidance for Addressing Releases of Per-and Polyfluoroalkyl Substances (Army 2018). The SI included multi-media sampling at AOPIs to determine whether or not a release of PFOS, PFOA, and PFBS to the environment occurred.

OSD provided residential risk screening levels for PFOS, PFOA, and PFBS in soil and groundwater (tap water) and industrial/commercial risk screening levels based on the USEPA oral reference dose for PFOS, PFOA, and PFBS in soil (**Appendix A**). A combination of document review, internet searches, interviews with installation personnel, and an installation site visit were used to identify specific areas of suspected PFOS, PFOA, and PFBS use, storage, and/or disposal at VHFS. Following the evaluation, 23 AOPIs were identified.

Drinking water at VHFS is supplied via on-site groundwater production wells. There are four active production wells (PW-1, VNT-1A, PW-3 and PW-4), two on-site offline existing production wells (PW-2 and PW-5), one approved production well (VNT-3B), three back-up production wells (VNT-1C, VNT-1D and VNT-3D) and two production supply exploratory test wells (VNT-3A and VNT-1B). PFAS concentrations (PFOS and PFOA) exceed the LHA screening numbers in VNT-3B and VNT-1B.

Before the SI sampling, a preliminary CSM was developed for each AOPI based on an assessment of existing records, personnel interviews, and site reconnaissance. The preliminary CSMs identified potential human receptors and exposure pathways for groundwater and surface water that is known to be used, or could realistically be used in the future, as a source of drinking water and identified potential soil and sediment exposure pathways.

All AOPIs were sampled during the SI at VHFS to identify presence or absence of PFOS, PFOA, and PFBS at each AOPI. The SI scope of work was completed in accordance with the VHFS QAPP (Arcadis 2020).

- **Overburden Groundwater:** 24 samples were collected in association with 15 of the 23 AOPIs. The temporary or permanent wells ranged from approximately 4 feet bgs to 62 feet bgs. PFAS were detected in temporary monitoring wells at 14 AOPIs and exceeded OSD risk screening levels in samples from six AOPIs. Maximum concentrations of PFOS were observed at the AREE 1: Waste Disposal Area at concentrations of 1,100 ng/L; while maximum concentrations of PFOA were observed at the AREE 13: Sludge Disposal Area at concentrations of 1,300 DJ ng/L.
- **Bedrock Groundwater:** The interval sampling conducted on the production wells VNT-1B and VNT 3-B ranged from 28 feet to 562 feet bgs. PFAS were detected in all intervals within the production wells at concentrations exceeding OSD risk screening levels (PFOS and/or PFOA). The maximum concentrations were observed in VNT-3B between 88 and 110 feet bgs at a combined (PFOS and PFOA) concentration of 1,690 ng/L.
- **Soil:** 40 samples were collected at 18 of the 23 AOPIs. PFAS were detected in soil samples at seven AOPIs; however, all concentrations were below the residential OSD risk screening levels. Maximum concentrations of PFOS and PFOA were observed at the AREE 16-2: Possible Fire Training Pit at concentrations of 0.0.0094 mg/kg; and 0.0011 mg/kg, respectively.

- **Surface Water:** Five samples were collected upstream and downstream along both the South Run and Western South Run Tributary. PFAS were detected in all five surface water samples; however, all concentrations were below the residential OSD risk screening levels. Concentrations ranged from 5 ng/L to 33 ng/L of PFOS and 2.2 ng/L to 14 ng/L of PFOA.

The preliminary CSMs prepared for the PA were re-evaluated and updated, if necessary, as part of the SI. Following the SI sampling, 19 out of the 23 AOPIs with confirmed PFOS, PFOA, and/or PFBS presence were considered to have complete or potentially complete exposure pathways.

- Soil exposure pathways for on-installation site workers are complete at seven AOPIs and potentially complete at four AOPIs.
- Due to a lack of land use controls on and off-installation and downgradient of VHFS, the groundwater exposure pathways are potentially complete for 19 AOPIs. Although there were positive detections of PFAS in groundwater samples, exposure pathways were considered potentially complete because monitoring wells were sampled, not drinking water wells, and tap water/finished water samples were not collected.
- Surface water is not used for drinking water at VHFS but is utilized for drinking water off-post. Additionally, recreational users could contact constituents in surface water and sediment via incidental ingestion and dermal contact. Therefore, the surface water exposure pathways are complete at four AOPIs and potentially complete at 15 AOPIs; while the sediment exposure pathways are potentially complete at 19 AOPIs.

Although the CSMs indicate complete or potentially complete exposure pathways may exist, the recommendation for remedial investigation is based on the comparison of analytical results for PFOS, PFOA, and PFBS to the OSD risk screening levels (**Table 6-2**). Results from this PA/SI indicate further study in a remedial investigation for PFAS is warranted at VHFS in accordance with the October 2019 guidance provided by the OSD. **Table 10-1** below summarizes the sampling at VHFS and rationale for recommendations for future study in a remedial investigation or no action at this time at each AOPI.

Table 10-1 Summary of PFOS, PFOA, and PFBS Sampling at VHFS and Recommendations

AOPI Name	PFOS, PFOA, and/or PFBS detected greater than OSD Risk Screening Levels?			Recommendation	Rationale
	GW	SO	SW		
AREE 16-1: Possible Fire Training Pit	N	N	N	No action at this time	No exceedances of 2019 OSD risk screening levels in GW and SO
AREE 17: Unlined Sludge Disposal Area	NS	N	NS	No action at this time	No exceedances of 2019 OSD risk screening levels in SO
AREE 29-3: Possible Disposal Area	NS	N	NS	No action at this time	No exceedances of 2019 OSD risk screening levels in SO

AOPI Name	PFOS, PFOA, and/or PFBS detected greater than OSD Risk Screening Levels?			Recommendation	Rationale
	GW	SO	SW		
AREE 16-2: Possible Fire Training Pit	N	N	NS	No action at this time	No exceedances of 2019 OSD risk screening levels in GW and SO
AREE 29-2: Possible Sludge Disposal Area	NS	N	N	No action at this time	No exceedances of 2019 OSD risk screening levels in SO
Former Helipad	NS	N	NS	No action at this time	No exceedances of 2019 OSD risk screening levels in SO
Building 271 – Fire Station	N	N	NS	No action at this time	No exceedances of 2019 OSD risk screening levels in GW and SO
Building 2470 - Fire Department Storage Building	N	NS	NS	No action at this time	No exceedances of 2019 OSD risk screening levels in GW
AREE 5: Environmental Photographic Interpretation Center (EPIC) Building	Y	N	NS	Future study in a remedial investigation	Exceedances of 2019 OSD risk screening levels in GW (PFOS)
AREE 10: Former Photographic Wastewater Lagoon	Y	N	N	Future study in a remedial investigation	Exceedances of 2019 OSD risk screening levels in GW (PFOA)
AREE 11: Former Sewage Treatment Plant – Sludge Drying Beds and Sludge Piles	Y	N	NS	Future study in a remedial investigation	Exceedances of 2019 OSD risk screening levels in GW (PFOS/PFOA)
AREE 28-9: Sewage Lift Station	NS	N	NS	No action at this time	No exceedances of 2019 OSD risk screening levels in SO
AREE 7: Building 2400 – Electrical Equipment Facility and Pretreatment Tank	N	NS	NS	No action at this time	No exceedances of 2019 OSD risk screening levels in GW
AREE 8: Building 2400 – Neutralization Pit	N	N	NS	No action at this time	No exceedances of 2019 OSD risk screening levels in GW and SO
AREE 29-4: Disposal Area	N	N	NS	No action at this time	No exceedances of 2019 OSD risk screening levels in GW and SO
AREE 29-5: Liquid Impoundment Area	NS	N	NS	No action at this time	No exceedances of 2019 OSD risk screening levels in SO

AOPI Name	PFOS, PFOA, and/or PFBS detected greater than OSD Risk Screening Levels?			Recommendation	Rationale
	GW	SO	SW		
AREE 13: Sludge Disposal Area	Y	N	NS	Future study in a remedial investigation	Exceedances of 2019 OSD risk screening levels in GW (PFOS/PFOA)
AREE 29-6: Possible Burn Pile	NS	N	NS	No action at this time	No exceedances of 2019 OSD risk screening levels in SO
AREE 9: Vehicle Maintenance Buildings 288 and 290	N	NS	NS	No action at this time	No exceedances of 2019 OSD risk screening levels in GW
Automated Car Wash	Y	NS	NS	Future study in a remedial investigation	Exceedances of 2019 OSD risk screening levels in GW (PFOS)
AREE 26: Outdoor Wash Rack	N	N	NS	No action at this time	No exceedances of 2019 OSD risk screening levels in GW and SO
AREE 1: Waste Disposal Area	Y	NS	N	Future study in a remedial investigation	Exceedances of 2019 OSD risk screening levels in GW (PFOS/PFOA)
AREE 2: Active Sewage Treatment Plant – Former Sludge Drying Beds and Sludge Piles	NS	N	N	No action at this time	No exceedances of 2019 OSD risk screening levels in SO
Bedrock Aquifer (VNT 1B and 3B)	Y	NS	NS	Future study in a remedial investigation	Exceedances of 2019 OSD risk screening levels in GW (PFOS/PFOA)

GW – groundwater
N – no
NS – not sampled
SE – sediment
SO – soil
SW – surface water
Y – yes

Based on the data collected during the PA and the PFAS analytical data collected in April and November 2020 during the SI, in accordance with the guidance provided by the OSD in October 2019, further study in a Remedial Investigation (40 CFR 300.430) is recommended at VHFS at this time. In accordance with CERCLA, site-specific risk will be assessed during a future phase to evaluate whether remedial actions are required.

11 REFERENCES

Arcadis U.S., Inc. (Arcadis). 2018. Accident Prevention Plan: A-E Services, PFASs Contamination in the Cleanup/Restoration Programs at Active Army Installations – Nationwide. Prepared for USACE, Baltimore District. March.

Arcadis. 2020. Final UFP QAPP Addendum, Revision 0, PFAS PA/SI, Vint Hill Farms Station, Virginia. May.

Army. 2018. Army Guidance for Addressing Releases of Per- and Polyfluoroalkyl Substances. September 4. Available online at: https://www.fedcenter.gov/admin/itemattachment.cfm?attachmentid=1150.

Cornell Howland Hayes Merryfield Hill (CH2M Hill). 1995. Draft Environmental Impact Statement Disposal and Reuse of Vint Hill Farms Station Warrenton, Virginia. December.

Department of Defense (DoD). 2017. Fact Sheet: Detection and Quantitation – What Project Managers and Data Users Need to Know. October.

DoD. 2018. Quality Systems Manual, Version 5.1.1, 2018. February.

DoD. 2019. Environmental Data Quality Working Group: Final General Data Validation Guidelines. November 4.

DoD. 2020. Data Validation Guidelines Module 3: Data Validation Procedure for Per- and Polyfluoroalkyl Substances Analysis by QSM Table B-15. May 1.

Emery & Garrett Groundwater, Inc. 2005. Groundwater Supply Development Program, Final Hydrogeologic Report, Yield and Quality Testing of Five Proposed Community Supply Wells, VNT-1A, VNT-1C, VNT-1D, VNT-3B and VNT-3D, Vint Hill Fauquier County, Virginia. February.

Emery & Garrett Groundwater Investigations, LLC. 2017. Hydrogeologic Report. Yield and Quality Testing for Proposed Production Well VNT-3B and Existing Production Well PW-5. October.

Emery & Garrett Groundwater Investigations, LLC. 2018. 2017 Groundwater Level Monitoring Program, Vint Hill Fauquier County, Virginia. January.

Emery & Garrett Groundwater Investigations, a Division of GZA. 2018. Preliminary Investigation Soil Sampling for PFAS Compounds, Former Vint Hill Farms Station Army Base Fauquier County, Virginia. December.

Emery & Garrett Groundwater Investigations, a Division of GZA. 2019. 2018 Groundwater Level Monitoring Program, Vint Hill Fauquier County, Virginia. February.

Interstate Technology Regulatory Council. 2017. History and Use of Per-and Polyfluoroalkyl Substances (PFAS). November. Available online at: https://pfas-1.itrcweb.org/wp-content/uploads/2017/11/pfas_fact_sheet_history_and_use__11_13_17.pdf.

Interstate Technology Regulatory Council. 2020. Section 3.1 Firefighting Foams. Updated April 14. Available online at: https://pfas-1.itrcweb.org/3-firefighting-foams/#3_1

IT Corporation. 1999. Final Decision Document AREEs 13, 14, 16-1, 27, and 29-4. Vint Hill Farms Station Warrenton, Virginia.

Office of the Secretary of Defense (OSD). 2019. Memorandum: Investigating Per- and Polyfluoroalkyl Substances within the Department of Defense Cleanup Program. October.

Science Applications International Corporation. 1994. Final Enhanced Preliminary Assessment. Vint Hill Farms Station Warrenton, Virginia. April.

Science Applications International Corporation. 1996. Final Site Inspection Report. Vint Hill Farms Station Warrenton, Virginia. June.

Shaw Environmental, Inc. 2010. Final Second Five-Year Review Report for Vint Hill Farms Station. Warrenton, Virginia. AREEs 1, 32, and 34. September.

USACE. 2005. Environmental Quality: Guidance for Evaluating Performance-Based Chemical Data, Engineer Manual 200-1-10, CEMP-RA/CECW-E, June 30.

USACE. 2012. Environmental Quality: Conceptual Site Models, Engineer Manual 200-1-12, CEMP-CE, December 28.

USACE. 2017. AREE 34 Groundwater Monitoring Report – Round 28. October 2017

USEPA. 1991. Guidance for Performing Preliminary Assessments Under CERCLA. EPA/540/G-91/013. September. Available online at: https://semspub.epa.gov/work/11/157081.pdf.

USEPA. 2014. Provisional Peer-Reviewed Toxicity Values for Perfluorobutane Sulfonate (CASRN 375-73-5) and Related Compound Potassium Perfluorobutane Sulfonate (CASRN 29420-49-3). EPA/690/R-14/012F. July 17.

USEPA. 2016. Lifetime Health Advisories and Health Effects Support Documents for Perfluorooctanoic Acid and Perfluorooctane Sulfonate. EPA-HQ-OW-2014-0138; FRL-9946-91-OW. Federal Register/ Vol. 81. No. 101. May 25. Available online at: https://www.govinfo.gov/content/pkg/FR-2016-05-25/pdf/2016-12361.pdf.

USEPA. 2020. Method 537.1 Determination of Selected Per- and Polyfluorinated Alkyl Substances in Drinking Water by Solid Phase Extraction and Liquid Chromatography/Tandem Mass Spectrometry(LC/MS/MS). EPA/600/R-20/006. Version 2.0. March. Available online at: https://cfpub.epa.gov/si/si_public_file_download.cfm?p_download_id=539984&Lab=CESER

USEPA 2021. Provisional Peer-Reviewed Toxicity Values for Perfluorobutane Sulfonic Acid (CASRN 375-73-5) and Related Compound Potassium Perfluorobutane Sulfonate (CASRN 29420-49-3). EPA/690/R-21/001F. Available online at: https://ofmpub.epa.gov/eims/eimscomm.getfile?p_download_id=542397

ACRONYMS

%	percent
6:2 FTSA	6:2 fluorotelomer sulfonate
8:2 FTSA	8:2 fluorotelomer sulfonate
AFFF	aqueous film-forming foam
AOPI	area of potential interest
AREE	area requiring environmental evaluation
Army	United States Army
bgs	below ground surface
BRAC	Base Realignment and Closure
btoc	below top of casing
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CSM	conceptual site model
DoD	Department of Defense
DPT	direct-push technology
DQO	data quality objectives
DUSR	Data Usability Summary Report
EB	equipment blank
EDR	Environmental Data Resources, Inc.
ELAP	Environmental Laboratory Accreditation Program
ENPA	enhanced preliminary assessment
EPIC	Environmental Photographic Interpretation Center
FPWL	Former Photographic Wastewater Lagoon
GIS	geographic information system
gpm	gallons per minute
GW	ground water
HQ	hazard quotient
JV	joint venture
IDW	investigation-derived waste
installation	United States Army or Reserve installation
LHA	lifetime health advisory (USEPA)
LOD	limit of detection
LOQ	limit of quantitation
mg/kg	milligrams per kilogram (parts per million)

N	no
NFA	no further action
ng/L	nanograms per liter (parts per trillion)
NS	not sampled
OSD	Office of the Secretary of Defense
OTV	optical televiewer
PA	preliminary assessment
PFAS	per- and polyfluoroalkyl substances
PFBA	perfluorobutanoic acid
PFBS	perfluorobutanesulfonic acid
PFC	perfluorinated chemicals
PFDA	perfluorodecanoic acid
PFDoA	perfluorododecanoic acid
PFHpA	perfluoroheptanoic acid
PFHxA	perfluorohexanoic acid
PFHxS	perfluorohexanesulfonic acid
PFNA	perfluorononanoic acid
PFOA	perfluorooctanoic acid
PFOS	perfluorooctane sulfonate
PFPA	perfluoropentanoic acid
PFTA	perfluorotetradecanoic acid
PFTrDA	perfluorotridecanoic acid
PFUnA	perfluoroundecanoic acid
POC	point of contact
ppm	parts per million
ppt	parts per trillion
PSL	project screening level
QA	quality assurance
QAPP	Quality Assurance Project Plan
QC	quality control
QSM	Quality Systems Manual
RBC	risk-based concentration
ROD	record of decision
RSL	regional screening level
SI	site inspection

SE	sediment
SO	soil
SOP	standard operating procedure
SSHP	Site Safety and Health Plan
SW	surface water
TGI	technical guidance instruction
TOC	total organic carbon
U.S.	United States
USACE	United States Army Corps of Engineers
USEPA	United States Environmental Protection Agency
VHFS	Vint Hill Farms Station
WSRT	Western South Run Tributary
WWTP	wastewater treatment plant
Y	yes

TABLES

Results of Exploratory Test Well Drilling
Vint Hill
Fauquier County, Virginia

Well ID	Date Drilled	UTM Zone 18 East North	Total Depth (feet)	Casing Depth (Diameter) (feet) (inches)	Depth to Bedrock (feet)	Water-Bearing Zones Depth (feet)	Water-Bearing Zones AirLift Yield (gpm)*	AirLift Yield* (gpm)
VNT-1A (Production Well)	1/12-1/13/04	267,321 4,292,585	480	58 (8")	10	120	~1	200 (6" test well)
						185	27	
						257	92	450 (8" well)
						463	53	
VNT-1B (Test Well)	1/13-1/15/04	267,643 4,292,632	560	18 (6")	8	55	20	188 (6" test well)
						95	7	
						490	47	
						559	114	
VNT-1C (Production Well)	2/16-2/17/04	267,088 4,292,233	500	59 (8")	19	81	5	170 (6" test well)
						136	43	
						337	59	350 (8" well)
						489	30	
VNT-1D (Production Well)	2/18/2004	267,341 4,292,220	500 (6") 320 (8")	57 (8")	10	76	18	94 (6" test well) 150 (8" well)
						120-140	42	
						310	17	
VNT-2A (Test Well)	1/15-1/16/04	268,110 4,291,850	500	18 (6")	10	60	20	53 (6" test well)
						76	15	
						102	18	
VNT-3A (Test Well)	1/20-1/22/04	268,425 4,292,493	660	35 (6")	31	474	3	15 (6" test well)
						522	3	
						537	3	
						560	3	
						620	3	
VNT-3B (Production Well)	1/22-1/23/04	267,861 4,292,512	460 (6") 420 (8")	61 (8")	31	109	3	150 (6" test well)
						151	9	
						190	3	300 (8" well)
						280	12	
						365	83	
						390	40	
VNT-3D (Production Well)	2/19-2/20/04	268,152 4,292,514	545 (6") 240 (8")	106 (8")	5	105	5	125 (6" well)
						116	64	
						132	6	240 (8" well)
						166	28	

* Airlift yield determined during drilling of 6 inch diameter test well. Airlift tests involve using the drill rig to "airlift" the water out of the well during the drilling process such that a preliminary measurement of the rate of water produced from each well can be made. An accurate determination of the pumping capacity of each well is determined by conducting a long-term pumping test.

Summary of Available Well Construction Information
Vint Hill
Fauquier County, Virginia

Well ID	Date Drilled	UTM Zone 18 East North	Total Depth (feet)	Casing Depth (Diameter) (feet) (inches)	Depth to Bedrock (feet)	Water-Bearing Zones Depth (feet)	Water-Bearing Zones Airlift Yield (gpm)*	Airlift Yield* (gpm)
Existing Production Well PW-5[1]	unknown	266,647 4,292,044	649	51.8 (8")	unknown	74 113-119 268 304-305 408	Not Available	unknown (Well pumped at 200 gpm for 72 hours as part of 2017 study)
Off-Line Well PW-2[1]	unknown	267,178 4,291,652	450	31 (8")	unknown	31.1 49-50 97 118 200 392	Not Available	unknown
VNT-1A (Production Well)	1/12-1/13/04	267,321 4,292,585	480	58 (8")	10	120 185 257 463	~1 27 92 53	200 (6" test well) 450 (8" well)
VNT-1B (Test Well)	1/13-1/15/04	267,643 4,292,632	560	18 (6")	8	55 95 490 559	20 7 47 114	188 (6" test well)
VNT-1D (Production Well)	2/18/2004	267,341 4,292,220	500 (6") 320 (8")	57 (8")	10	76 120-140 310	18 42 17	94 (6" test well) 150 (8" well)
VNT-3A (Test Well)	1/20-1/22/04	268,425 4,292,493	660	35 (6")	31	474 522 537 560 620	3 3 3 3 3	15 (6" test well)
VNT-3B (Production Well)	1/22-1/23/04	267,861 4,292,512	460 (6") 420 (8")	61 (8")	31	109 151 190 280 365 390	3 9 3 12 83 40	150 (6" test well) 300 (8" well)
VNT-3D (Production Well)	2/19-2/20/04	268,152 4,292,514	545 (6") 240 (8")	106 (8")	5	105 116 132 166	5 64 6 28	125 (6" well) 240 (8" well)

1 = Well construction information for Wells PW-2 and PW-5 is not availabe. Information presented herein was obtained via borehole video camera inspection on July 24, 2017.

* Airlift yield determined during drilling of six-inch-diameter test well. Airlift tests involve using the drill rig to "airlift" the water out of the well during the drilling process such that a preliminary measurement of the rate of water produced from each well can be made. An accurate determination of the pumping capacity of each well is determined by conducting a long-term pumping test.

Table 2-2
Historical PFAS Analytical Results
USAEC PFAS Preliminary Assessment/Site Inspection
Vint Hill Farms Station, Virginia

Location			VNT-1A			PW-3		VNT-1D			PW-5		
Aquifer Zone			Aquifer Zone I										
Sample Date			8/3/2017	3/6/2018	10/17/2018	8/2/2017	3/6/2018	8/22/2017	3/6/2018	10/17/2018	8/3/2017	3/6/2018	10/17/2018
Units	OSD risk screening level*	LHA	ng/L	ng/L	ng/L	ng/L	ng/L	ng/L	ng/L	ng/L	ng/L	ng/L	ng/L
Perfluorooctanoic acid (PFOA)	40	70	3.2	2.9	2.6	4.8	7.5	21	6.2	9.3	ND	3.3	3.2
Perfluorobutanesulfonic acid (PFBS)	40,000	NA	ND	ND	ND	ND	ND	9.9	6	15	ND	2	2.2
Perfluorooctane sulfonate (PFOS)	40	70	3.7	3.5	3.4	3.5	4	25	8.3	11	ND	15	17

Notes and Acronyms:
* risk screening level for tap water. To be conservative, the OSD tap water risk screening levels will be used to compare all groundwater and potable-use surface water for this Army PFAS PA/SI program.

NA - not available
ND- not detected
LHA - United States Environmental Protection Agency lifetime health advisory
ng/L - nanograms per liter
OSD - Office of the Secretary of Defense

Source:
Emery & Garrett Groundwater Investigations, a Divison of GZA. 2019. 2018 Groundwater Level Monitoring Program. Vint Hill, Fauquier County, Virginia. February.

Table 2-2
Historical PFAS Analytical Results
USAEC PFAS Preliminary Assessment/Site Inspection
Vint Hill Farms Station, Virginia

Location			PW-1			PW-4			VNT-1B	VNT-3A		
Aquifer Zone			Aquifer Zone II									
Sample Date			8/3/2017	3/6/2018	10/17/2018	8/3/2017	3/6/2018	10/17/2018	10/17/2018	8/22/2017	3/6/2018	10/17/2018
Units	OSD risk screening level*	LHA	ng/L	ng/L	ng/L	ng/L	ng/L	ng/L	ng/L	ng/L	ng/L	ng/L
Perfluorooctanoic acid (PFOA)	40	70	ND	ND	ND	ND	ND	ND	1,000	3.3	2	2.1
Perfluorobutanesulfonic acid (PFBS)	40,000	NA	ND	ND	ND	ND	ND	ND	7.8	ND	ND	ND
Perfluorooctane sulfonate (PFOS)	40	70	2.3	3.9	3.1	ND	ND	ND	37	3.8	2.5	3.1

Notes and Acronyms:
* risk screening level for tap water. To be conservative, the OSD tap water risk screening levels will be used to compare all groundwater and potable-use surface water for this Army PFAS PA/SI program.

NA - not available
ND- not detected
LHA - United States Environmental Protection Agency lifetime health advisory
ng/L - nanograms per liter
OSD - Office of the Secretary of Defense

Source:
Emery & Garrett Groundwater Investigations, a Divison of GZA. 2019. 2018 Groundwater Level Monitoring Program. Vint Hill, Fauquier County, Virginia. February.

Table 2-2
Historical PFAS Analytical Results
USAEC PFAS Preliminary Assessment/Site Inspection
Vint Hill Farms Station, Virginia

Location			VNT-3B				VNT-3D			PW-2		
Aquifer Zone			Aquifer Zone II									
Sample Date			8/3/2017	11/30/2017	3/6/2018	10/17/2018	8/21/2017	3/6/2018	10/17/2018	8/22/2017	3/6/2018	10/17/2018
Units	OSD risk screening level*	LHA	ng/L	ng/L	ng/L	ng/L	ng/L		ng/L	ng/L		ng/L
Perfluorooctanoic acid (PFOA)	40	70	81	210	280	660	9.2	7.5	7.9	14	12	14
Perfluorobutanesulfonic acid (PFBS)	40,000	NA	5.3	13	19	66	ND	ND	ND	2.3	ND	ND
Perfluorooctane sulfonate (PFOS)	40	70	32	100	190	680	ND	ND	ND	12	11	10

Notes and Acronyms:
* risk screening level for tap water. To be conservative, the OSD tap water risk screening levels will be used to compare all groundwater and potable-use surface water for this Army PFAS PA/SI program.

NA - not available
ND- not detected
LHA - United States Environmental Protection Agency lifetime health advisory
ng/L - nanograms per liter
OSD - Office of the Secretary of Defense

Source:
Emery & Garrett Groundwater Investigations, a Divison of GZA. 2019. 2018 Groundwater Level Monitoring Program. Vint Hill, Fauquier County, Virginia. February.

Table 6-1
Monitoring Well Construction Details
USAEC PFAS Preliminary Assessment/Site Inspection
Vint Hill Farms Station, Virginia

Area of Potential Interest	Sampling Location ID[1]	Total Well Depth (ft bgs)	Measuring Point Elevation (ft amsl)	Measuring Point	April 2020 Depth to Groundwater from MP (ft)	April 2020 Groundwater Elevation (ft amsl)	Screened Interval (ft bgs)	Casing Diameter (inches)	Dedicated Bladder Pump (Y/N)
AREE 1	GW02W	37.25	NM	GS	14.2	NM	NM	2	N
	GW03W	38.2	NM	GS	15.9	NM	NM	2	N
	MW1-4	27.35	NM	GS	15.5	NM	NM	2	N
AREE 7	NP-PZ2	24.2	NM	GS	10.0	NM	NM	4	N
	MW34-2	20.4	NM	GS	7.5	NM	NM	4	N
	MW34-10C	14.8	NM	GS	13.6	NM	NM	4	N
	MW35-5D	62.2	NM	GS	25.6	NM	NM	4	N
AREE 8	NP-PZ3	25.2	NM	GS	10.0	NM	NM	4	N
Building 2470	B2470-1	18	NM	GS	11.1	NM	NM	1	N
	B2470-2	22.85	NM	GS	5.0	NM	NM	1	N
	B2470-3	8.3	NM	GS	1.7	NM	NM	1	N
	B2470-4	10	NM	GS	1.1	NM	NM	1	N
AREE 9	AREE9-1-GW	13.1	NM	GS	10.25	NM	NM	1	N
AREE 16-1	AREE16-1-1-GW	4	NM	GS	0.95	NM	NM	1	N
AREE 16-2	AREE16-2-2-GW	5.2	NM	GS	19	NM	NM	1	N
CW	CW-1-GW	14.5	NM	GS	9.85	NM	NM	1	N
AREE 13	AREE13-1-GW	17.55	NM	GS	7.65	NM	NM	1	N
Building 271	B271-1-GW	15	NM	GS	11.5	NM	NM	1	N
AREE 5	AREE5-1-GW	18.34	NM	GS	10.56	NM	NM	1	N
	AREE5-2-GW	28.05	NM	GS	11.5	NM	NM	1	N
AREE 26	AREE26-1-GW	12.6	NM	GS	6.35	NM	NM	1	N
AREE 29-4	AREE29-4-2-GW	7.84	NM	GS	0.66	NM	NM	1	N

Table 6-1
Monitoring Well Construction Details
USAEC PFAS Preliminary Assessment/Site Inspection
Vint Hill Farms Station, Virginia

Area of Potential Interest	Sampling Location ID[1]	Total Well Depth (ft bgs)	Measuring Point Elevation (ft amsl)	Measuring Point	April 2020 Depth to Groundwater from MP (ft)	April 2020 Groundwater Elevation (ft amsl)	Screened Interval (ft bgs)	Casing Diameter (inches)	Dedicated Bladder Pump (Y/N)
AREE 10	AREE10-1-GW	5.55	NM	GS	4.25	NM	NM	1	N
AREE 11	AREE11-1-GW	8.2	NM	GS	2.7	NM	NM	1	N

Notes:
1. Permanent wells were not installed at the direct-push technology (DPT) sampling locations. The total depth listed indicates the total depth of the temporary borehole; the screened interval listed for DPT sampling points indicates the interval at which the drill casing was retracted for collection of a grab groundwater sample through a decontaminated screen-point sampler.

Acronyms/Abreviations:
amsl - above mean sea level
bgs - below ground surface
ft - feet
GS - ground surface
ID - identification
NA - not available
NM - not measured (not surveyed)

Sources:
Arcadis 2020. Vint Hill Farms Station PFAS SI, Low Flow Purge and Sampling Forms (Appendix K), April.

Table 7-1
Groundwater PFOS, PFOA, and PFBS Analytical Results
USAEC PFAS Preliminary Assessment/Site Inspection
Vint Hill Farms Station, Virginia

					Analyte	PFOS (ng/L)		PFOA (ng/L)		PFBS (ng/L)	
					HAL	70		70		70	
					OSD Tapwater Risk Screening Level, HQ=0.1	40		40		600	
Associated AOPI	Location Type	Location	Sample ID / Parent Sample ID	Sample Date	Sample Type	Result	Qual	Result	Qual	Result	Qual
AREE 1: Waste Disposal Area (Dump #1)	Monitoring Well	VHFS-GW-02	VHFS-GW02W-041620	04/16/2020	N	**1100**	DJ	**68**		**73**	
AREE 1: Waste Disposal Area (Dump #1)	Monitoring Well	VHFS-GW-03	VHFS-GW03W-041620	04/16/2020	N	**150**		**67**		**7.3**	
AREE 1: Waste Disposal Area (Dump #1)	Monitoring Well	VHFS-MW1-4	VHFS-MW1-4-041620	04/16/2020	N	**210**		**23**		**8.6**	
AREE 10: Former Photographic Wastewater Lagoon	Monitoring Well	VHFS-AREE10-1	VHFS-AREE10-1-GW-041720	04/17/2020	N	**15**	J-	**66**	J-	**4.4**	J-
AREE 11: Former Sludge Piles and Drying Beds	Monitoring Well	VHFS-AREE11-1	VHFS-AREE11-1-GW-041720	04/17/2020	N	**140**	J-	**42**	J-	**4.3**	J-
AREE 13: Sludge Disposal Area	Monitoring Well	VHFS-AREE13-1	VHFS-AREE13-1-GW-041720	04/17/2020	N	**450**	DJ	**1300**	DJ	**89**	J-
AREE 16-1: Possible Fire Training Pit	Monitoring Well	VHFS-AREE16-1	VHFS-DUP-3-041620 / VHFS-AREE16-1-1-GW-041620	04/16/2020	FD	5.0	UJ-	**3.3**	J-	5.0	UJ-
			VHFS-AREE16-1-1-GW-041620	04/16/2020	N	4.7	UJ-	**2.8**	J-	4.7	UJ-
AREE 16-2: Possible Fire Training Pit	Monitoring Well	VHFS-AREE16-2	VHFS-AREE16-2-2-GW-041520	04/15/2020	N	**35**	J-	**20**	J-	**13**	J-
AREE 26: Outdoor Wash Racks	Monitoring Well	VHFS-AREE26-1	VHFS-AREE26-1-GW-042020	04/20/2020	N	**11**		**9.4**		3.8	U
AREE 29-4: Disposal Area	Monitoring Well	VHFS-AREE29-4	VHFS-AREE29-4-2-GW-042020	04/20/2020	N	3.8	U	3.8	U	3.8	U
AREE 5: EPIC Building	Monitoring Well	VHFS-AREE5-1	VHFS-AREE5-1-GW-042020	04/20/2020	N	**180**	J-	**25**	J-	**9.0**	J-
AREE 5: EPIC Building	Monitoring Well	VHFS-AREE5-2	VHFS-AREE5-2-GW-042020	04/20/2020	N	4.6	UJ-	4.6	UJ-	4.6	UJ-
AREE 7: Building 2400 Electrical Equipment Facility	Monitoring Well	VHFS-MW34-10C	VHFS-MW34-10C-041420	04/14/2020	N	3.8	UJ-	3.8	UJ-	3.8	UJ-
AREE 7: Building 2400 Electrical Equipment Facility	Monitoring Well	VHFS-MW34-2	VHFS-DUP-1-041420 / VHFS-MW34-2-041420	04/14/2020	FD	**25**		**7.0**		3.7	U
			VHFS-MW34-2-041420	04/14/2020	N	**25**		**6.6**		3.5	U
AREE 7: Building 2400 Electrical Equipment Facility	Monitoring Well	VHFS-MW34-5D	VHFS-MW34-5D-041420	04/14/2020	N	**6.2**		**2.4**	J	3.7	U
AREE 7: Building 2400 Electrical Equipment Facility	Monitoring Well	VHFS-NP-PZ2	VHFS-NP-PZ2-041420	04/14/2020	N	**8.9**		**2.9**	J	**2.1**	J
AREE 8: Neutralization Pit	Monitoring Well	VHFS-NP-PZ3	VHFS-NP-PZ3-041420	04/14/2020	N	**3.5**	J	3.6	U	3.6	U
AREE 9: Vehicle Maintenance Area	Monitoring Well	VHFS-AREE9-1	VHFS-AREE9-1-GW-041820	04/18/2020	N	**9.0**	J-	**31**	J-	**3.0**	J-
Building 2470: Fire Department Storage Area	Monitoring Well	VHFS-B2470	VHFS-B2470-1-GW-041420	04/14/2020	N	3.6	UJ-	3.6	UJ-	**2.0**	J-
			VHFS-B2470-2-GW-041520	04/15/2020	N	3.7	U	**3.9**		**2.1**	J
			VHFS-B2470-3-GW-041520	04/15/2020	N	4.6	UJ-	4.6	UJ-	**2.6**	J-
			VHFS-B2470-4-GW-041520	04/15/2020	N	**9.5**		**9.8**		**4.4**	
Building 271: Fire Station	Monitoring Well	VHFS-B271	VHFS-B271-GW-041820	04/18/2020	N	**21**		**15**		**19**	
Car Wash	Monitoring Well	VHFS-CW-1	VHFS-CW-1-GW-041820	04/18/2020	N	**43**	J-	**11**	J-	**3.9**	J-

Table 7-1
Groundwater PFOS, PFOA, and PFBS Analytical Results
USAEC PFAS Preliminary Assessment/Site Inspection
Vint Hill Farms Station, Virginia

					Analyte	PFOS (ng/L)		PFOA (ng/L)		PFBS (ng/L)	
					HAL	70		70		70	
					OSD Tapwater Risk Screening Level, HQ=0.1	40		40		600	
Associated AOPI	Location Type	Location	Sample ID / Parent Sample ID	Sample Date	Sample Type	Result	Qual	Result	Qual	Result	Qual
Well VNT-1B (Packer Testing)	Monitoring Well	VHFS-VNT-1B	DUP-1_032620 / VHFS-VNT-1B-GW-(450'-562')_032720	03/26/2020	FD	**33**		**920**	DJ	**8.4**	
			VHFS-VNT-1B-GW-(28'-58')_032620	03/26/2020	N	**32**		**830**	DJ	**7.1**	
			VHFS-VNT-1B-GW-1-(120'-150')_032620	03/26/2020	N	**30**		**810**	DJ	**6.9**	
			VHFS-VNT-1B-GW-2-(120'-150')_032620	03/26/2020	N	**21**		**710**		**6.4**	
			VHFS-VNT-1B-GW-3-(120'-150')_032620	03/26/2020	N	**18**		**630**		**4.6**	
			VHFS-VNT-1B-GW-(220'-250')_032620	03/26/2020	N	**33**		**790**	DJ	**7.3**	
			VHFS-VNT-1B-GW-(490'-562')_032720	03/27/2020	N	**28**		**730**		**6.9**	
			VHFS-VNT-1B-GW-(450'-562')_032720	03/27/2020	N	**32**		**1000**	DJ	**8.2**	
Well VNT-3B (Packer Testing)	Monitoring Well	VHFS-VNT-3B	VHFS-VNT-3B-GW-(88'-110')_032420	03/24/2020	N	**690**		**1000**	DJ	**70**	
			VHFS-VNT-3B-GW-(233'-255')_032420	03/24/2020	N	**330**		**410**		**34**	
			VHFS-VNT-3B-GW-(297.5-319.5')_032420	03/24/2020	N	**220**		**270**		**21**	
			VHFS-VNT-3B-GW-(380'-402')_032420	03/24/2020	N	**730**		**810**		**70**	

Notes:
1. **Bolded** values indicate the result was detected greater than the limit of detection.
2. Grey shaded values indicate the result was detected greater than the 2019 Office of the Secretary of Defense (OSD) risk screening levels, using a hazard quotient (HQ) of 0.1 (OSD. 2019. Memorandum: Investigating Per- and Polyfluoroalkyl Substances within the Department of Defense Cleanup Program. October.).

Acronyms/Abbreviations:
-- = not applicable
AOPI = Area of Potential Interest
FD = field duplicate sample
ID = identification
N = primary sample
ng/L = nanograms per liter (parts per trillion)
PFAS = per- and polyfluoroalkyl substances
PFBS = perfluorobutanesulfonic acid
PFOA = perfluorooctanoic acid
PFOS = perfluorooctane sulfonate
Qual = qualifier

Qualifier	Description
DJ	The analyte was analyzed at dilution and the result is an estimated quantity
E	The reported result is above the limit of the calibration range.
J	The analyte was positively identified; however the associated numerical value is an estimated concentration only
J-	The result is an estimated quantity; the result may be biased low.
U	The analyte was analyzed for but the result was not detected above thelimit of quantitation (LOQ).
UJ-	The analyte was analyzed for but was not detected. The reported limit of quantitation (LOQ) is approximate and may be inaccurate or imprecise

Table 7-2
Soil PFOS, PFOA, and PFBS Analytical Results
USAEC PFAS Preliminary Assessment/Site Inspection
Vint Hill Farms Station, Virginia

			Analyte		PFOS (mg/kg)		PFOA (mg/kg)		PFBS (mg/kg)	
			OSD Industrial/Commercial Risk Screening Level, HQ=0.1		1.6		1.6		1600	
			OSD Residential RiskScreening Levels, HQ=0.1		0.13		0.13		1.9	
Associated AOPI	**Location Type**	**Location**	**Sample ID / Parent Sample ID**	**Sample Date**	**Sample Type**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**
AREE 10: Former Photographic Wastewater Lagoon	Soil	VHFS-AREE10-1	VHFS-AREE10-1-SO-(3.5'-5.5')-041720	04/17/2020	N	**0.001**	J	0.0012	U	0.0012	U
AREE 11: Former Sludge Piles and Drying Beds	Soil	VHFS-AREE11-1	VHFS-AREE11-1-SO-(4'-6')-041720	04/17/2020	N	0.0013	U	0.0013	U	0.0013	U
AREE 13: Sludge Disposal Area	Soil	VHFS-AREE13-1	VHFS-AREE13-1-SO(9'-11')-041620	04/16/2020	N	0.0014	U	0.0014	U	0.0014	U
AREE 16-1: Possible Fire Training Pit	Soil	VHFS-AREE16-1	VHFS-AREE16-1-1-SO(1'-3')-041620	04/16/2020	N	0.0012	U	0.0012	U	0.0012	U
			VHFS-AREE16-1-2-SO(2'-4')-041620	04/16/2020	N	0.0011	U	0.0011	U	0.0011	U
			VHFS-AREE16-1-3-SO(0'-2')-041620	04/16/2020	N	0.0012	U	0.0012	U	0.0012	U
			VHFS-DUP-2-041620 / VHFS-AREE16-1-1-SO(1'-3')-041620	04/16/2020	FD	0.0013	U	0.0013	U	0.0013	U
AREE 16-2: Possible Fire Training Pit	Soil	VHFS-AREE16-2	VHFS-AREE16-2-1-SO-(3'-5')-042020	04/20/2020	N	0.0015	U	0.0015	U	0.0015	U
			VHFS-AREE16-2-2-SO-(8-10)-111720	11/17/2020	N	**0.00067**	J	**0.012**		0.0013	U
			VHFS-AREE16-2-3-SO-(0-2)-111720	11/17/2020	N	**0.0013**		0.0012	U	0.0012	U
			VHFS-AREE16-2-3-SO-(6'-8')-042020	04/20/2020	N	**0.0012**		**0.0027**		0.0012	U
			VHFS-AREE16-2-3-SO-(6-8)-111720	11/17/2020	N	**0.0012**	J	0.0014	U	0.0014	U
			VHFS-AREE16-2-4-SO-(0-2)-111720	11/17/2020	N	0.001	U	**0.0016**		0.001	U
			VHFS-AREE16-2-4-SO-(10-12)-111720	11/17/2020	N	0.0011	U	0.0011	U	0.0011	U
			VHFS-AREE16-2-5-SO-(0-2)-111720	11/17/2020	N	**0.0088**		**0.00069**	J	0.0013	U
			VHFS-AREE16-2-5-SO-(3-4.5)-111720	11/17/2020	N	**0.0094**		**0.0009**	J	0.0011	U
AREE 17: Unlined Sludge Disposal Area (Dump #3)	Soil	VHFS-AREE17-1	VHFS-AREE17-1-SO-(0'-2')-041620	04/16/2020	N	0.0011	U	0.0011	U	0.0011	U
			VHFS-AREE17-1-SO-(4'-6')-041620	04/16/2020	N	0.001	U	0.001	U	0.001	U
AREE 17: Unlined Sludge Disposal Area (Dump #3)	Soil	VHFS-AREE17-2	VHFS-AREE17-2-SO-(0'-2')-041620	04/16/2020	N	**0.002**		0.0013	U	0.0013	U
			VHFS-AREE17-2-SO(10'-12')-041620	04/16/2020	N	0.0013	U	0.0013	U	0.0013	U
AREE 2: Active Sewage Treatment Plant	Soil	VHFS-AREE2-1	VHFS-AREE2-1-SO-(1'-2')-042120	04/21/2020	N	**0.0024**		0.0011	U	0.0011	U
			VHFS-AREE2-1-SO-(4'-6)-042120	04/21/2020	N	**0.0024**		**0.0011**		0.001	U
AREE 26: Outdoor Wash Racks	Soil	VHFS-AREE26-1	VHFS-AREE26-1-SO-(0.5'-2.5')-041820	04/18/2020	N	0.0012	U	0.0012	U	0.0012	U
			VHFS-AREE26-1-SO-(11'-13')-041820	04/18/2020	N	0.0011	U	0.0011	U	0.0011	U

Table 7-2
Soil PFOS, PFOA, and PFBS Analytical Results
USAEC PFAS Preliminary Assessment/Site Inspection
Vint Hill Farms Station, Virginia

			Analyte			PFOS (mg/kg)		PFOA (mg/kg)		PFBS (mg/kg)	
			OSD Industrial/Commercial Risk Screening Level, HQ=0.1			1.6		1.6		1600	
			OSD Residential RiskScreening Levels, HQ=0.1			0.13		0.13		1.9	
Associated AOPI	Location Type	Location	Sample ID / Parent Sample ID	Sample Date	Sample Type	Result	Qual	Result	Qual	Result	Qual
AREE 28-9: Sewage Lift Station	Soil	VHFS-AREE28-9	VHFS-AREE28-9-1-SO-(4'-6')-041720	04/17/2020	N	0.0011	U	0.0011	U	0.0011	U
AREE 29-2: Possible Sludge Disposal Area	Soil	VHFS-AREE29-2	VHFS-AREE29-2-1-SO(0.5'-2.5')-041520	04/15/2020	N	0.0012	U	0.0012	U	0.0012	U
			VHFS-AREE29-2-2-SO-(0-2)-111720	11/17/2020	N	0.001	U	0.001	U	0.001	U
			VHFS-DUP-1-041520 / VHFS-AREE29-2-1-SO(0.5'-2.5')-041520	04/15/2020	FD	0.0012	U	0.0012	U	0.0012	U
AREE 29-3: Possible Disposal Area	Soil	VHFS-AREE29-3	VHFS-AREE29-3-1-SO(1'-3')-041620	04/16/2020	N	0.001	U	0.001	U	0.001	U
			VHFS-AREE29-3-1-SO(4'-6')-041620	04/16/2020	N	0.0011	U	0.0011	U	0.0011	U
AREE 29-4: Disposal Area	Soil	VHFS-AREE29-4	VHFS-AREE29-4-1-SO-(0.5'-2.5')-042020	04/20/2020	N	0.0011	U	0.0011	U	0.0011	U
			VHFS-AREE29-4-1-SO-(5.5'-7.5')-042020	04/20/2020	N	0.0011	U	0.0011	U	0.0011	U
			VHFS-AREE29-4-2-SO-(0.5'-2.5')-042020	04/20/2020	N	0.0012	U	0.0012	U	0.0012	U
AREE 29-5: Liquid Impoundment Area	Soil	VHFS-AREE29-5	VHFS-AREE29-5-1-SO-(2'-4')-042020	04/20/2020	N	0.0011	U	0.0011	U	0.0011	U
AREE 29-6: Possible Burn Pile	Soil	VHFS-AREE29-6	VHFS-AREE29-6-1-SO-(0'-2")-042020	04/20/2020	N	**0.00068**	J	0.0012	U	0.0012	U
AREE 5: EPIC Building	Soil	VHFS-AREE5-1	VHFS-AREE5-1-SO-(16'-18')-041820	04/18/2020	N	0.0013	U	0.0013	U	0.0013	U
AREE 5: EPIC Building	Soil	VHFS-AREE5-2	VHFS-AREE5-2-SO-(20'-22')-041820	04/18/2020	N	0.0016	U	0.0016	U	0.0016	U
AREE 8: Neutralization Pit	Soil	VHFS-AREE8-1	VHFS-AREE8-1-SO-(5'-6')-041420	04/14/2020	N	0.0016	U	0.0016	U	0.0016	U
Building 271: Fire Station	Soil	VHFS-B271	VHFS-B271-1-SO-(0.5'-2.5')-041720	04/17/2020	N	**0.011**		**0.00063**	J	0.0011	U
			VHFS-B271-1-SO-(14'-16')-041720	04/17/2020	N	**0.0011**	J	0.0014	U	0.0014	U
Former Helipad	Soil	VHFS-HELIPAD-1	VHFS-HELIPAD-1-SO-(0-2)-111720	11/17/2020	N	**0.00065**	J	**0.00062**	J	0.0012	U
			VHFS-HELIPAD-1-SO-(16-18)-111720	11/17/2020	N	0.0012	U	0.0012	U	0.0012	U

Notes:
1. **Bolded** values indicate the result was detected greater than the limit of detection
2. Data are compared to the 2019 Office of the Secretary of Defense (OSD) risk screening levels for the residential and commerical/industrial scenario (OSD. 2019), using a hazard quotient (HQ) of 0.1. (Memorandum: Investigating Per- and Polyfluoroalkyl Substances within the Department of Defense Cleanup Program. October.).

Acronyms/Abbreviations:
AOPI = Area of Potential Interest
DPT = Direct-Push Technology
FD = field duplicate sample
ID = identification
mg/kg = milligrams per kilogram (parts per million)
N = primary sample
PFAS = per- and polyfluoroalkyl substances
PFBS = perfluorobutanesulfonic acid
PFOA = perfluorooctanoic acid
PFOS = perfluorooctane sulfonate
Qual = qualifier

Qualifier	Description
J	The analyte was positively identified; however the associated numerical value is an estimated concentration only
U	The analyte was analyzed for but the result was not detected above thelimit of quantitation (LOQ).

Table 7-3
Surface Water PFOS, PFOA, and PFBS Analytical Results
USAEC PFAS Preliminary Assessment/Site Inspection
Vint Hill Farms Station, Virginia

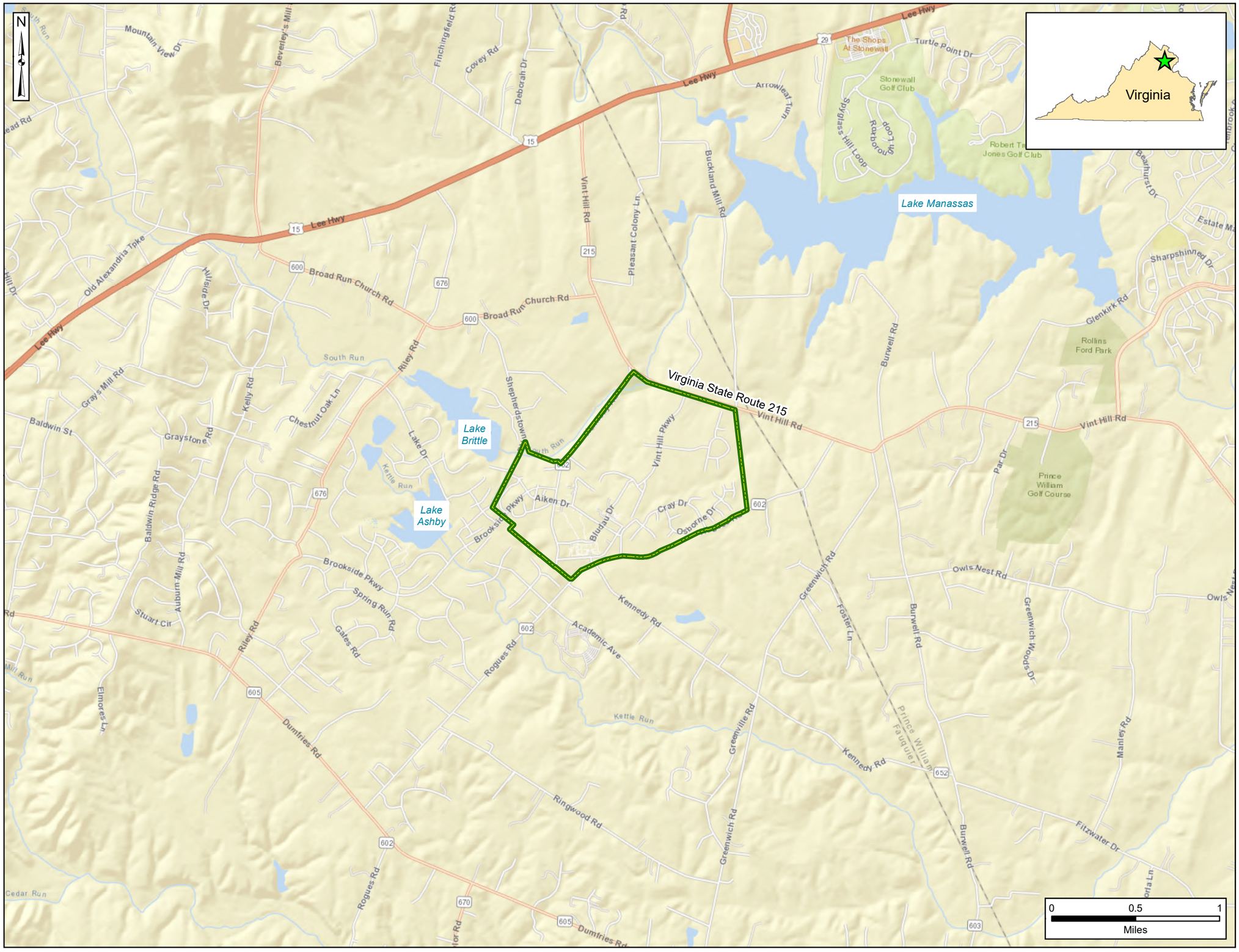
			Analyte			PFOS (ng/L)		PFOA (ng/L)		PFBS (ng/L)	
			HAL			70		70		70	
			OSD Tapwater RiskScreening Level, HQ=0.1			40		40		600	
Associated AOPI	Location Type	Location	Sample ID / Parent Sample ID	Sample Date	Sample Type	Result	Qual	Result	Qual	Result	Qual
AREE 1: Waste Disposal Area (Dump #1)	Surface Water/Seep	VHFS-AREE1-1	VHFS-AREE1-1-SW-041620	04/16/2020	N	**5.0**		**2.7**	J	3.6	U
AREE 10: Former Photographic Wastewater Lagoon	Surface Water/Seep	VHFS-AREE10-1	VHFS-AREE10-1-SW-041720	04/17/2020	N	**33**		**14**		**3.4**	J
AREE 16-1: Possible Fire Training Pit	Surface Water/Seep	VHFS-AREE16-1	VHFS-AREE16-1-1-SW-041620	04/16/2020	N	**9.5**		**6.4**		3.5	U
AREE 2: Active Sewage Treatment Plant	Surface Water/Seep	VHFS-AREE2-1	VHFS-AREE2-1-SW-041620	04/16/2020	N	**5.2**		**2.2**	J	3.7	U
AREE 29-2: Possible Sludge Disposal Area	Surface Water/Seep	VHFS-AREE29-2	VHFS-DUP-2-041520 / VHFS-AREE29-2-1-SW-041520	04/15/2020	FD	**11**		**8.5**		3.6	U
			VHFS-AREE29-2-1-SW-041520	04/15/2020	N	**9.2**		**7.3**		**1.8**	J

Notes:
1. **Bolded** values indicate the result was detected greater than the limit of detection.

Acronyms/Abbreviations:
-- = not applicable
AOPI = Area of Potential Interest
FD = field duplicate sample
ID = identification
N = primary sample
ng/L = nanograms per liter (parts per trillion)
PFAS = per- and polyfluoroalkyl substances
PFBS = perfluorobutanesulfonic acid
PFOA = perfluorooctanoic acid
PFOS = perfluorooctane sulfonate
Qual = qualifier

Qualifier	Description
J	The analyte was positively identified; however the associated numerical value is an estimated concentration only
U	The analyte was analyzed for but the result was not detected above thelimit of quantitation (LOQ).

FIGURES



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Vint Hill Farms, VA

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Figure 2-1
Site Location

Legend

Installation Boundary

Data Sources:
ESRI ArcGIS Online, StreetMap Data

Coordinate System:
WGS 1984, UTM Zone 18 North

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Figure 2-2 Site Layout

Legend

- Installation Boundary
- River/Stream (Perennial)
- Stream (Intermittent)
- Water Body
- Public Supply Surface Water Intake
- Community Supply Well
- Approximate Location of Domestic Well
- On-Site Active Production Well
- On-Site Offline Production Well
- Back-up Production Well
- Approved Production Well
- Exploratory Test Well

VNT-1A
VNT-1B
VNT-1C
VNT-1D
VNT-3A
VNT-3B
VNT-3D
VNT-Well PW-1
VNT-Well PW-2
VNT-Well PW-3
VNT-Well PW-4
VNT-Well PW-5
FCW&SA NEW BALTIMORE REGIONAL
NWB-G3

Data Sources:
EDR, Well Data, 2019
USGS, NHD Data, 2019
ESRI ArcGIS Online, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 18 North

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Figure 2-3 Surficial Geology and Hydrogeological Conditions

Legend

- Installation Boundary
- River/Stream (Perennial)
- Stream (Intermittent)
- Water Body
- Aquifer Zone 1 Groundwater Flow Direction
- Aquifer Zone 2 Groundwater Flow Direction
- Other Groundwater Flow Direction
- Surface Water Flow Direction
- Public Supply Surface Water Intake
- Community Supply Well
- Approximate Location of Domestic Well
- On-Site Active Production Well
- On-Site Offline Production Well
- Back-up Production Well
- Approved Production Well
- Exploratory Test Well

FCW&SA = Fauquier County Water and Sanitation Authority

Bedrock Geology

- (Jw)
- Catharpin Creek Formation (JTrc)
- Diabase (Jd)
- Hickory Grove Basalt (Jhg)
- Midland Formation (Jm)
- Mount Zion Church Basalt (Jmz)
- Sander Basalt (Jsb)
- Sandstone and siltstone; Member of the Sander Basalt (Jss)
- Turkey Run Formation (Jtr)
- Fault

0 500 1,000 Feet

Data Sources:
USGS, Bedrock Geology, 1989
Emery & Garrett, Final Hydrogeologic Report Yield and Quality Testing of Five Proposed Community Supply Wells, Groundwater Data, 2005
EDR, Well Data, 2019
USGS, NHD Data, 2019
ESRI ArcGIS Online, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 18 North

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Figure 2-4
Site Topography

Legend

- Installation Boundary
- River/Stream (Perennial)
- Stream (Intermittent)
- Water Body
- Elevation Contour (feet)

Data Sources:
USGS, Elevation Data, 2020
USGS, NHD Data, 2019
ESRI ArcGIS Online, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 18 North

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Figure 2-5
Off-Post Potable Supply Wells

Legend

- Installation Boundary
- 5-Mile Radius
- River/Stream (Perennial)
- Stream (Intermittent)
- Water Body *
- Public Water System Supply Well
- Public Supply Surface Water Intake
- Community Supply Well
- Non-Community Supply Well
- Approximate Location of Domestic Well

* Lake Manassas is a potable use reservoir.

FCW&SA = Fauquier County Water and Sanitation Authority
PWCSA = Prince William County Service Authority

Data Sources:
USGS, NHD Data, 2019
EDR, Well Data, 2019
ESRI ArcGIS Online, StreetMap Data

Coordinate System:
WGS 1984, UTM Zone 18 North

0 0.5 1 Miles

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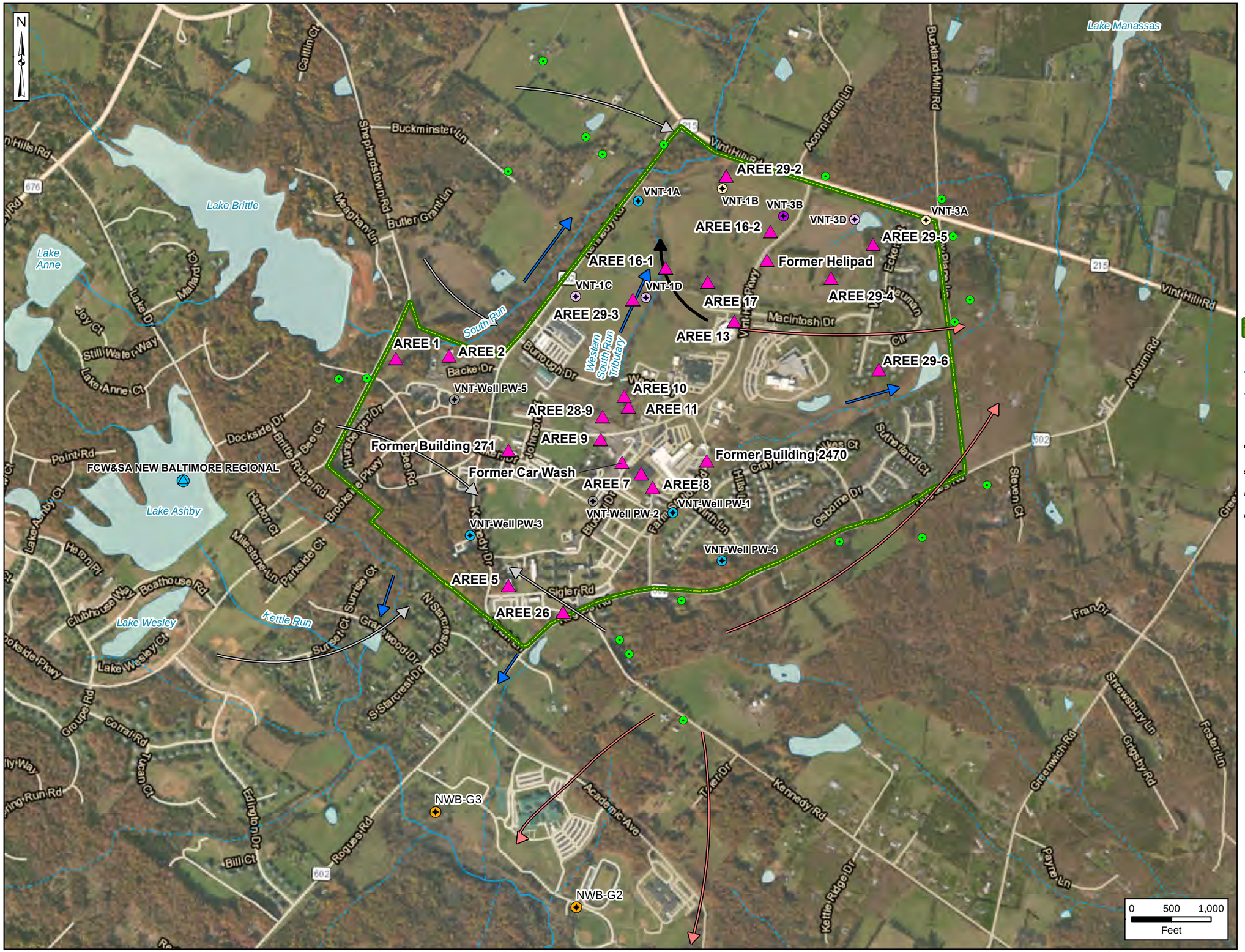

Figure 5-2
AOPI Locations

Legend

- Installation Boundary
- AOPI Location
- River/Stream (Perennial)
- Stream (Intermittent)
- Water Body
- Aquifer Zone 1 Groundwater Flow Direction
- Aquifer Zone 2 GW Flow
- Other GW Flow Direction
- Surface Water Flow Direction
- Public Supply Surface Water Intake
- Community Supply Well
- Approximate Location of Domestic Well
- On-Site Active Production Well
- On-Site Offline Production Well
- Back-up Production Well
- Approved Production Well
- Exploratory Test Well

AOPI = area of potential interest
AREE = Area Requiring Environmental Evaluation
FCW&SA = Fauquier County Water and Sanitation Authority

Data Sources:
Emery & Garrett, Final Hydrogeologic Report Yield and Quality Testing of Five Proposed Community Supply Wells, Groundwater Data, 2005
EDR, Well Data, 2019
USGS, NHD Data, 2019
ESRI ArcGIS Online, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 18 North

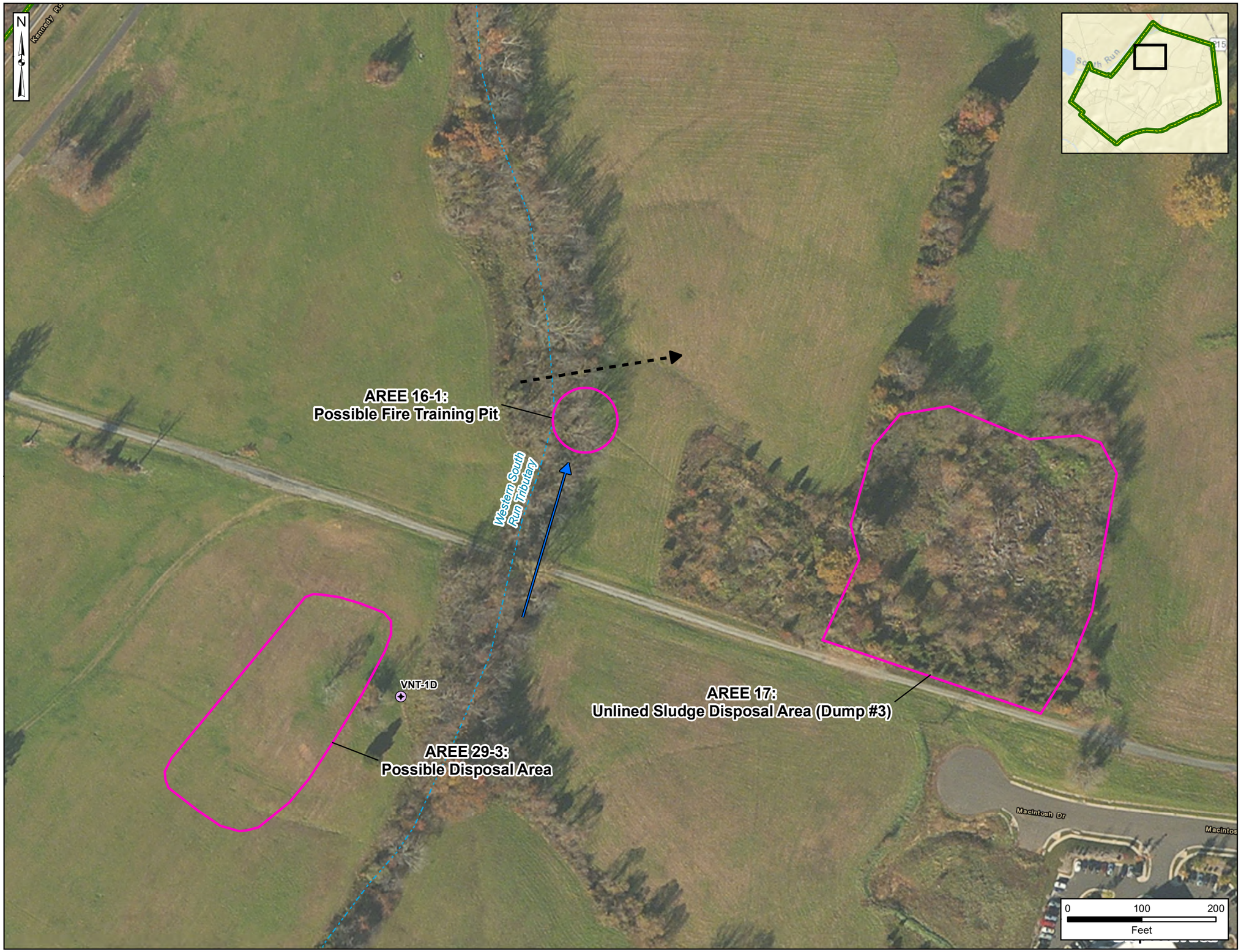

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Figure 5-3
Aerial Photo of AREEs
16-1: Possible Fire Training Pit,
17: Unlined Sludge Disposal Area,
and 29-3: Possible Disposal Area

Legend

- Installation Boundary
- AOPI
- Stream (Intermittent)
- Inferred Overburden Groundwater Flow Direction based on Topography
- Surface Water Flow Direction
- Back-up Production Well

AOPI = area of potential interest
AREE = Area Requiring Environmental Evaluation

Data Sources:
USGS, NHD Data, 2019
ESRI ArcGIS Online, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 18 North

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Figure 5-4
Aerial Photo of AREEs
16-2: Possible Fire Training Pit and
29-2: Possible Sludge Disposal Area
and Former Helipad

Legend

- AOPI
- Installation Boundary
- River/Stream (Perennial)
- Stream (Intermittent)
- Inferred Overburden Groundwater Flow Direction based on Topography
- Surface Runoff Flow Direction
- Approved Production Well
- Exploratory Test Well
- Domestic Well

AOPI = area of potential interest
AREE = Area Requiring Environmental Evaluation

Data Sources:
USGS, NHD Data, 2019
ESRI ArcGIS Online, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 18 North

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Figure 5-5
Aerial Photo of
Former Building 271: Fire Station

Legend

- Installation Boundary
- AOPI
- Inferred Overburden Groundwater Flow Direction based on Topography
- Surface Runoff Flow Direction

AOPI = area of potential interest

Data Sources:
ESRI ArcGIS Online, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 18 North

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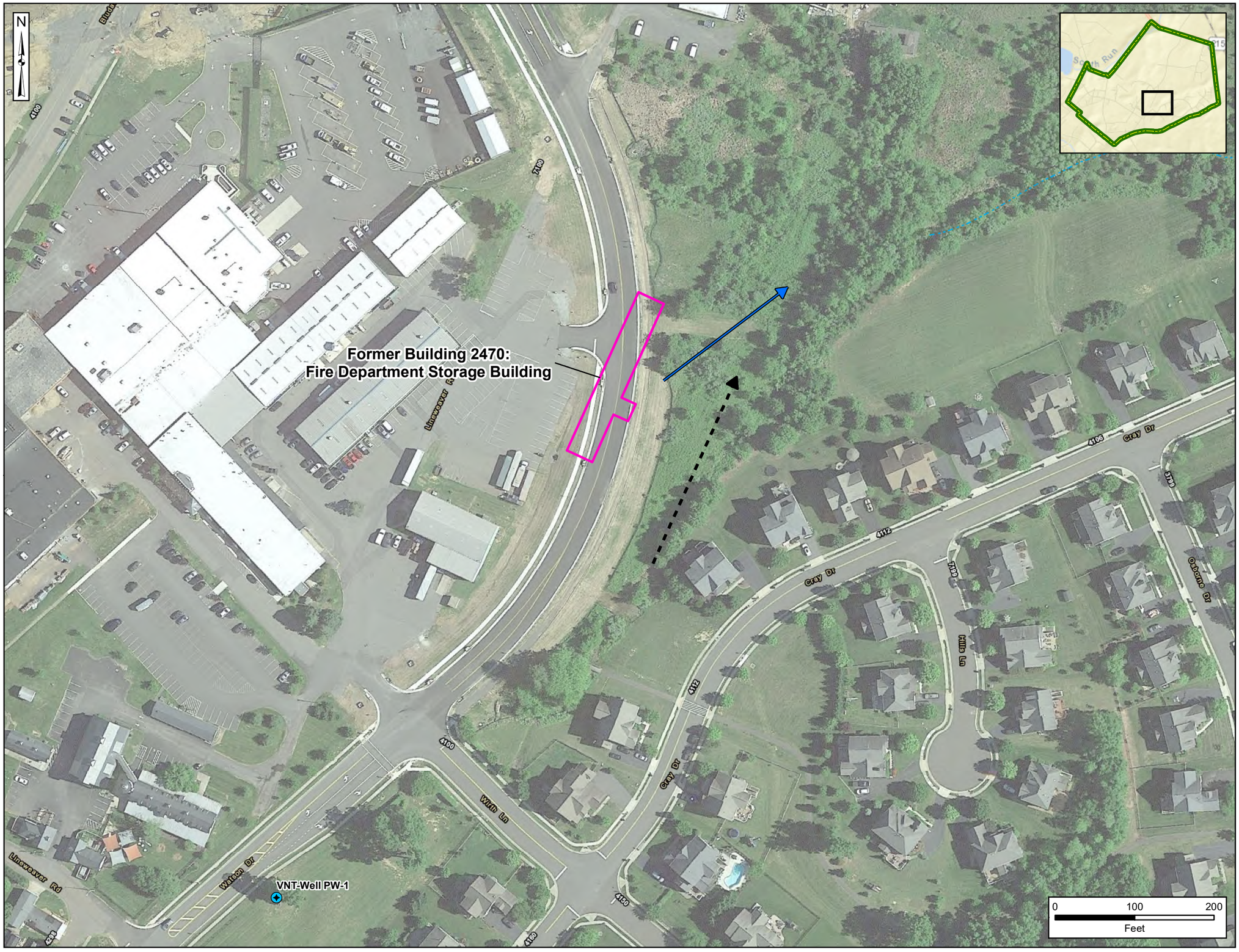
Figure 5-6
Aerial Photo of Former Building 2470: Fire Department Storage Building



Legend

- AOPI
- Installation Boundary
- Stream (Intermittent)
- Inferred Overburden Groundwater Flow Direction based on Topography
- Surface Runoff Flow Direction
- On-Site Active Production Well

AOPI = area of potential interest

Data Sources:
ESRI ArcGIS Online, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 18 North

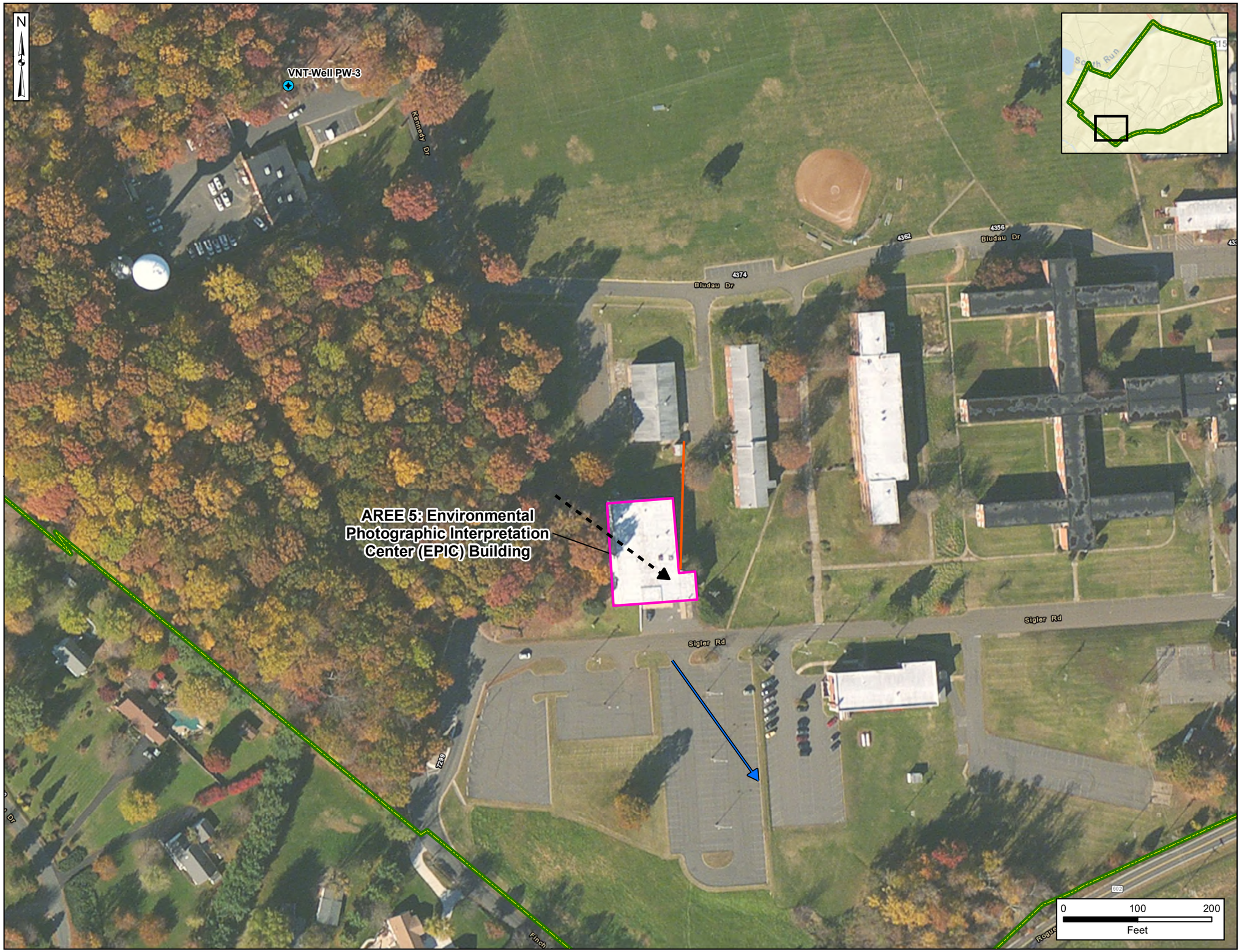


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Figure 5-7
Aerial Photo of AREE 5: Environmental Photographic Interpretation Center (EPIC) Building

Legend

- Installation Boundary
- AOPI
- Process Line
- Inferred Overburden Groundwater Flow Direction based on Topography
- Surface Runoff Flow Direction
- On-Site Active Production Well

AOPI = area of potential interest
AREE = Area Requiring Environmental Evaluation

Data Sources:
USGS, NHD Data, 2019
ESRI ArcGIS Online, Aerial Imagery

Coordinate System:
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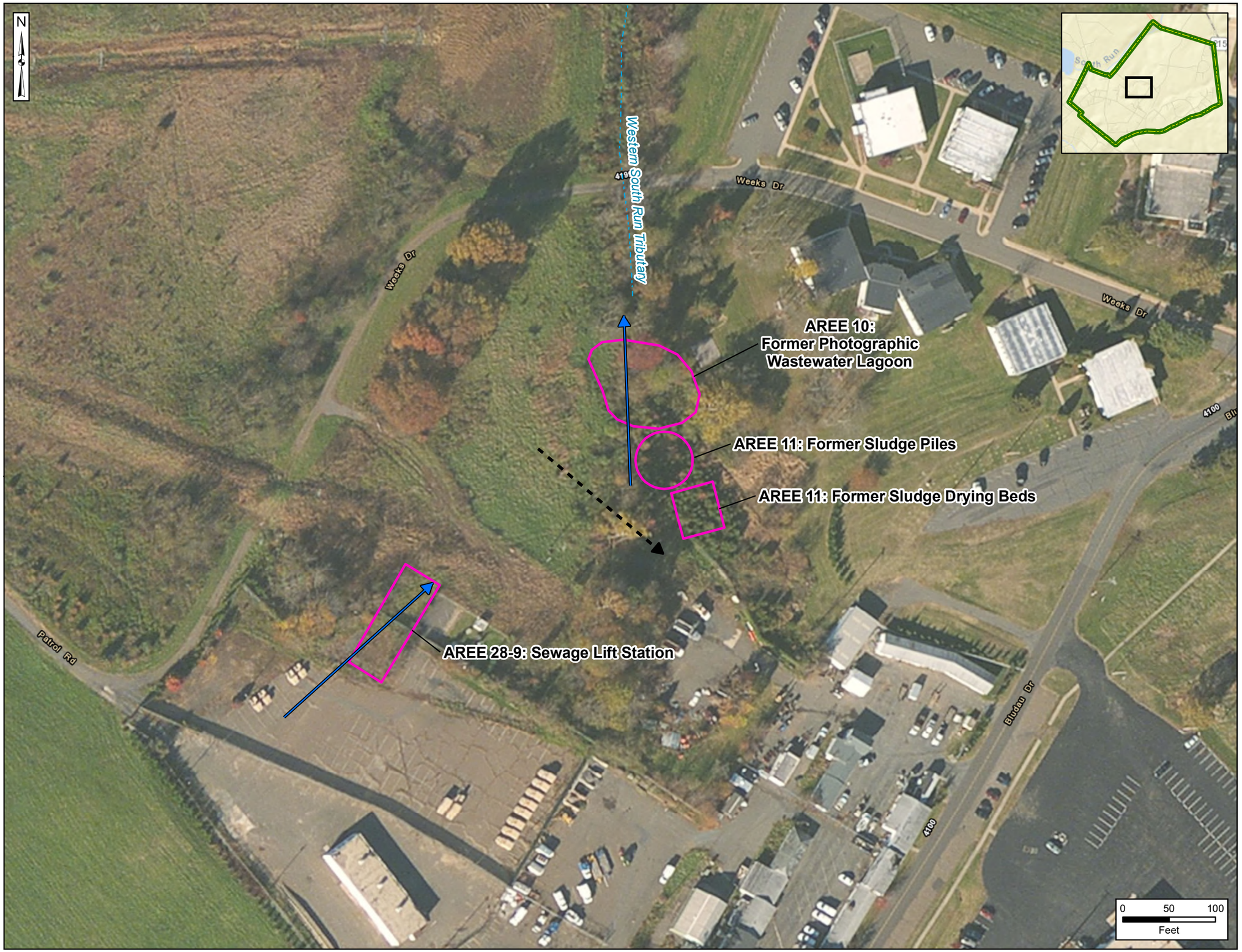

Figure 5-8
Aerial Photo of
AREEs 10: Former Photographic Wastewater Lagoon,
11: Former Sludge Piles, and
28-9: Sewage Lift Station

Legend

- Installation Boundary
- AOPI
- Stream (Intermittent)
- Inferred Overburden Groundwater Flow Direction based on Topography
- Surface Runoff Flow Direction

AOPI = area of potential interest
AREE = Area Requiring Environmental Evaluation

Data Sources:
USGS, NHD Data, 2019
ESRI ArcGIS Online, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 18 North

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Vint Hill Farms, VA

Figure 5-9
Aerial Photo of
AREEs 7: Building 2400 – Electrical Equipment Facility and Pre-Treatment Tank and 8: Neutralization Pit

Legend

- Installation Boundary
- AOPI
- Surface Runoff Flow Direction
- Bedrock Groundwater Flow Direction
- Overburden Groundwater Flow Direction
- Monitoring Well
- On-Site Active Production Well

AOPI = area of potential interest
AREE = Area Requiring Environmental Evaluation

Data Sources:
USACE. *AREE 34 Groundwater Monitoring Report Round 28*, Groundwater Flow Directions, 2017;
ESRI ArcGIS Online, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 18 North

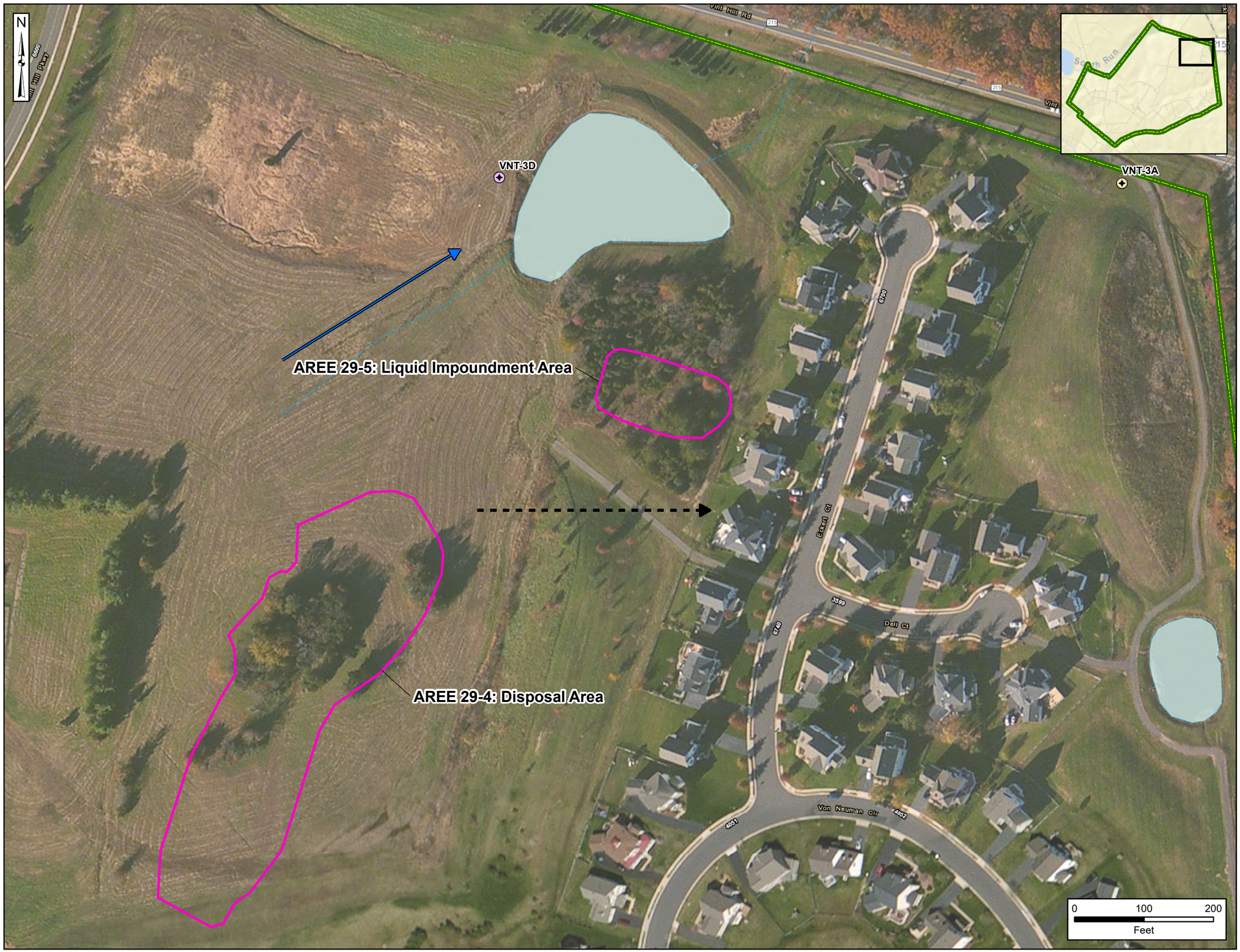

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Figure 5-10
Aerial Photo of AREEs 29-4: Disposal Area and 29-5: Liquid Impoundment Area

Legend

- Installation Boundary
- AOPI
- Stream (Intermittent)
- Water Body
- Inferred Overburden Groundwater Flow Direction based on Topography
- Surface Water Flow Direction
- Back-up Production Well
- Exploratory Test Well

AOPI = area of potential interest
AREE = Area Requiring Environmental Evaluation

Data Sources:
USGS, NHD Data, 2019
ESRI ArcGIS Online, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 18 North

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Figure 5-11
Aerial Photo of
AREE 13: Sludge Disposal Area

Legend

- Installation Boundary
- AOPI
- Stream (Intermittent)
- Inferred Overburden Groundwater Flow Direction based on Topography
- Surface Water Flow Direction
- Back-up Production Well

AOPI = area of potential interest
AREE = Area Requiring Environmental Evaluation

Data Sources:
USGS, NHD Data, 2019
ESRI ArcGIS Online, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 18 North

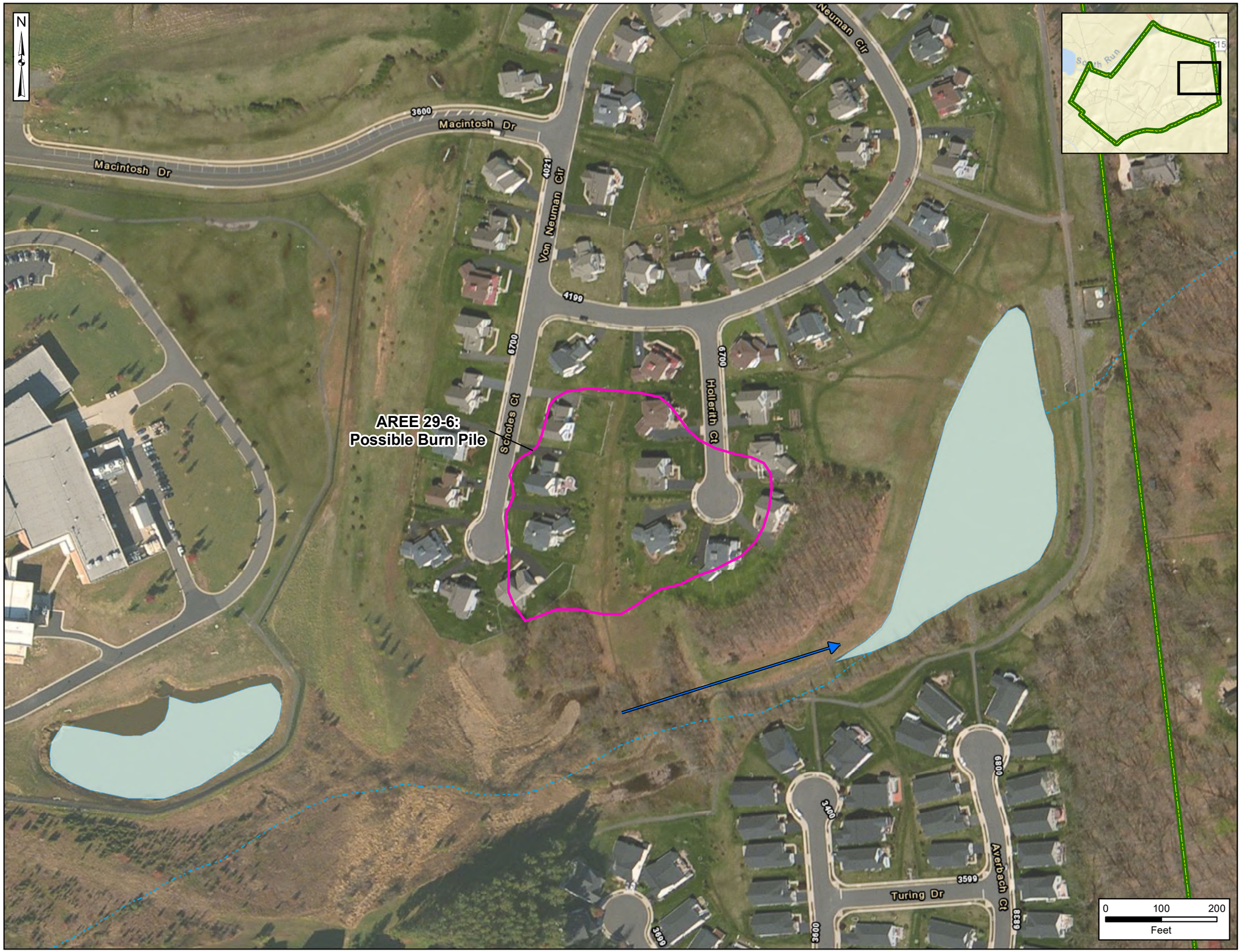

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Figure 5-12
Aerial Photo of
AREE 29-6: Possible Burn Pile

Legend

- Installation Boundary
- AOPI
- Stream (Intermittent)
- Water Body
- Surface Water Flow Direction

AOPI = area of potential interest
AREE = Area Requiring Environmental Evaluation

Data Sources:
USGS, NHD Data, 2019
ESRI ArcGIS Online, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 18 North

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Vint Hill Farms, VA

Figure 5-13
Aerial Photo of
AREE 9: Vehicle Maintenance Area and Former Car Wash

Legend

- Installation Boundary
- AOPI
- Inferred Overburden Groundwater Flow Direction based on Topography
- Surface Runoff Flow Direction
- Monitoring Well

AOPI = area of potential interest
AREE = Area Requiring Environmental Evaluation

Data Sources:
ESRI ArcGIS Online, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 18 North

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Figure 5-14
Aerial Photo of
AREE 26: Outdoor Wash Racks

Legend

- Installation Boundary
- AOPI
- Water Body
- Inferred Overburden Groundwater Flow Direction based on Topography
- Surface Runoff Flow Direction
- Domestic Well

AOPI = area of potential interest
AREE = Area Requiring Environmental Evaluation

Data Sources:
USGS, NHD Data, 2019
ESRI ArcGIS Online, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 18 North

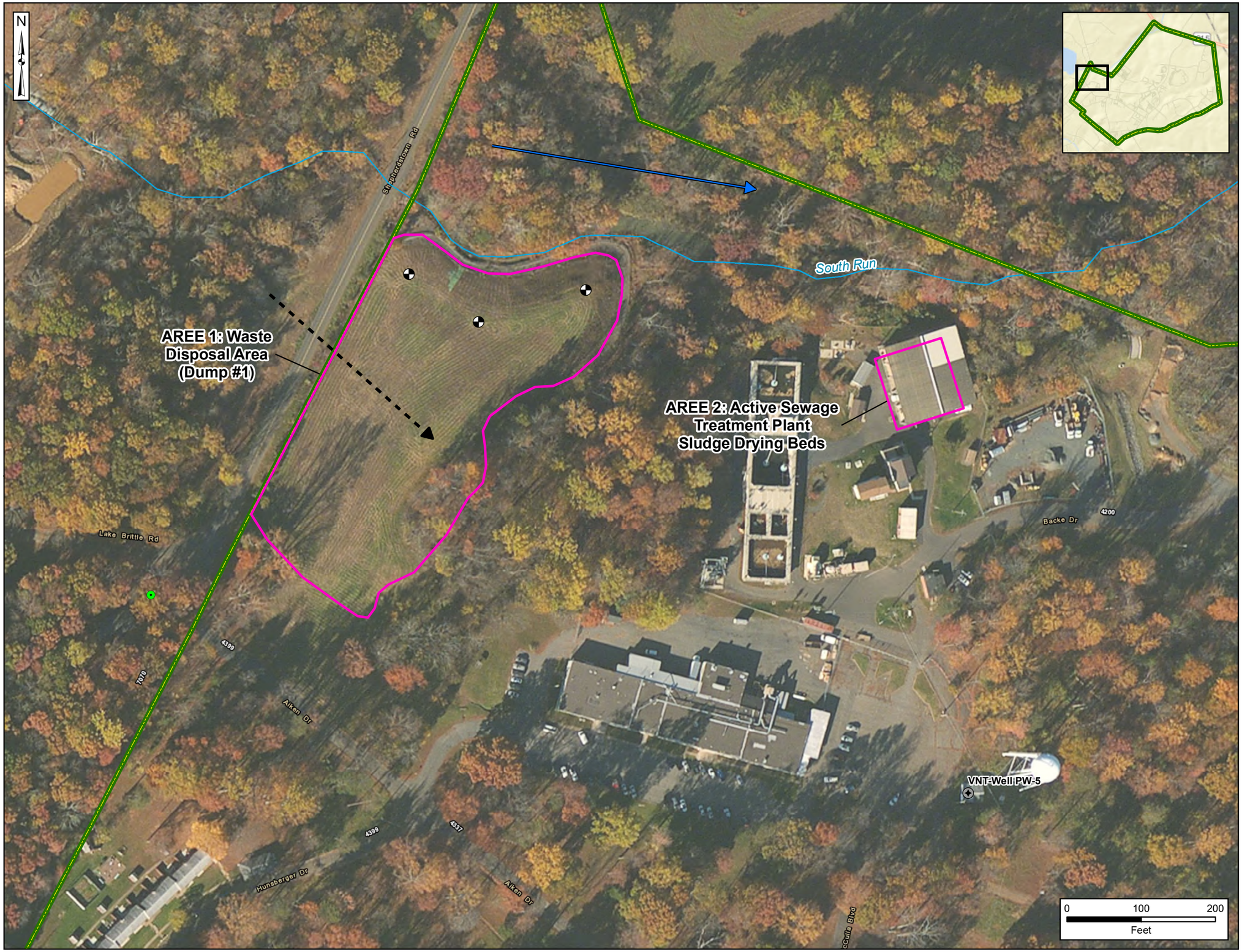

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Figure 5-15
Aerial Photo of AREEs 1: Waste Disposal Area (Dump#1) and 2: Active Sewage Treatment Plant Sludge Drying Beds

Legend

- Installation Boundary
- AOPI
- River/Stream (Perennial)
- Inferred Overburden Groundwater Flow Direction based on Topography
- Surface Water Flow Direction
- On-Site Offline Production Well
- Domestic Well
- Monitoring Well

AOPI = area of potential interest
AREE = Area Requiring Environmental Evaluation

Data Sources:
USGS, NHD Data, 2019
ESRI ArcGIS Online, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 18 North

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Figure 7-1 AOPI Locations and OSD Risk Screening Level Exceedances

Legend

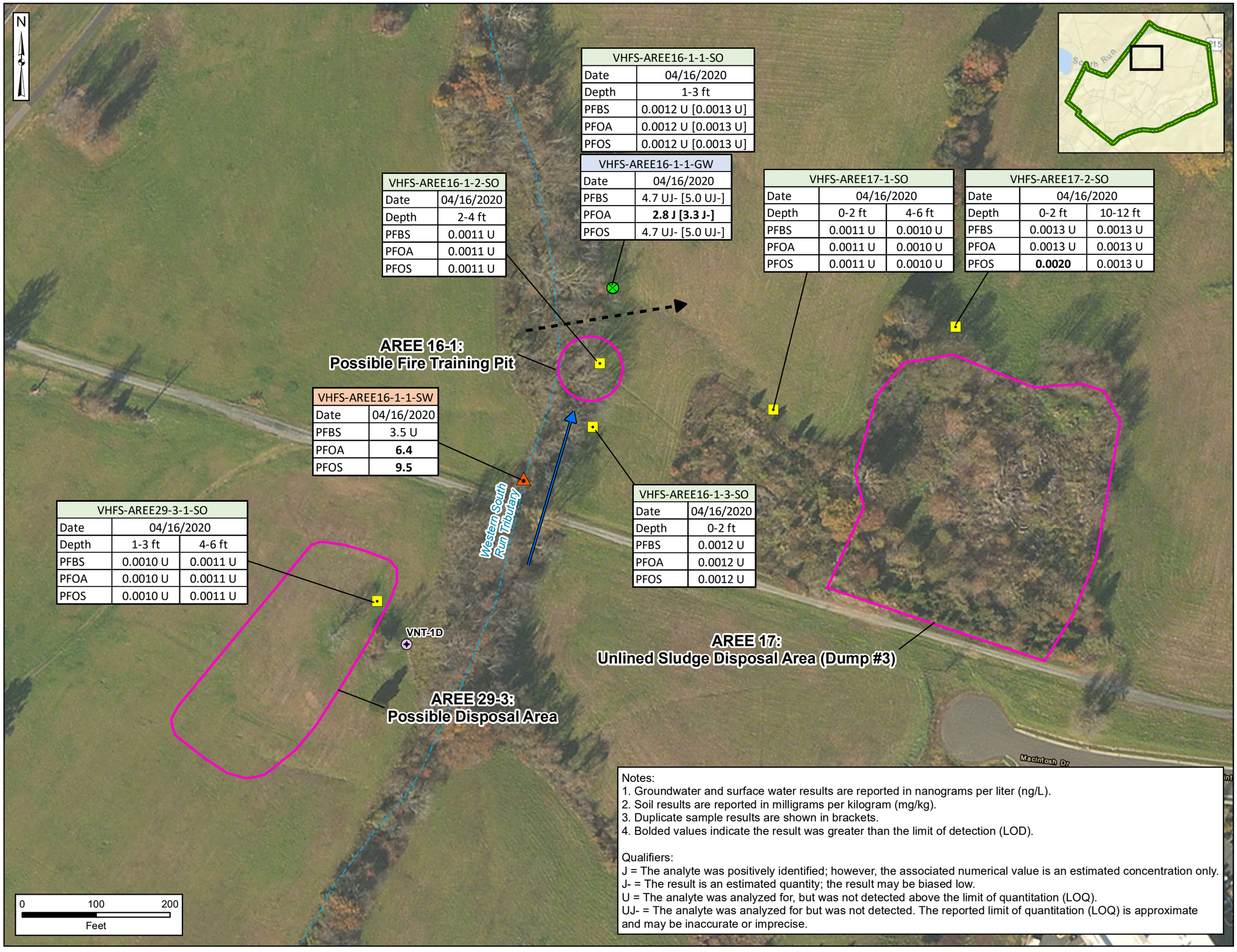
- Installation Boundary
- AOPI Location
- AOPI / Packer Testing Well with OSD Risk Screening Level Exceedance
- River/Stream (Perennial)
- Stream (Intermittent)
- Water Body
- Aquifer Zone 1 Groundwater Flow Direction
- Aquifer Zone 2 GW Flow
- Other GW Flow Direction
- Surface Water Flow Direction
- Public Supply Surface Water Intake
- Community Supply Well
- Approximate Location of Domestic Well
- On-Site Active Production Well
- On-Site Offline Production Well
- Back-up Production Well
- Approved Production Well
- Exploratory Test Well

AOPI = area of potential interest
AREE = Area Requiring Environmental Evaluation
FCW&SA = Fauquier County Water and Sanitation Authority
OSD = Office of the Secretary of Defense

Data Sources:
Emery & Garrett, Final Hydrogeologic Report Yield and Quality Testing of Five Proposed Community Supply Wells, Groundwater Data, 2005
EDR, Well Data, 2019
USGS, NHD Data, 2019
ESRI ArcGIS Online, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 18 North

0 500 1,000 Feet



Notes:
1. Groundwater and surface water results are reported in nanograms per liter (ng/L).
2. Soil results are reported in milligrams per kilogram (mg/kg).
3. Duplicate sample results are shown in brackets.
4. Bolded values indicate the result was greater than the limit of detection (LOD).

Qualifiers:
J = The analyte was positively identified; however, the associated numerical value is an estimated concentration only.
J- = The result is an estimated quantity; the result may be biased low.
U = The analyte was analyzed for, but was not detected above the limit of quantitation (LOQ).
UJ- = The analyte was analyzed for but was not detected. The reported limit of quantitation (LOQ) is approximate and may be inaccurate or imprecise.

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Figure 7-2
AREEs 16-1: Possible Fire Training Pit, 17: Unlined Sludge Disposal Area, and 29-3: Possible Disposal Area
PFOS, PFOA, and PFBS Analytical Results

Legend

- Installation Boundary
- AOPI
- Stream (Intermittent)
- Inferred Overburden Groundwater Flow Direction based on Topography
- Surface Water Flow Direction
- Back-up Production Well

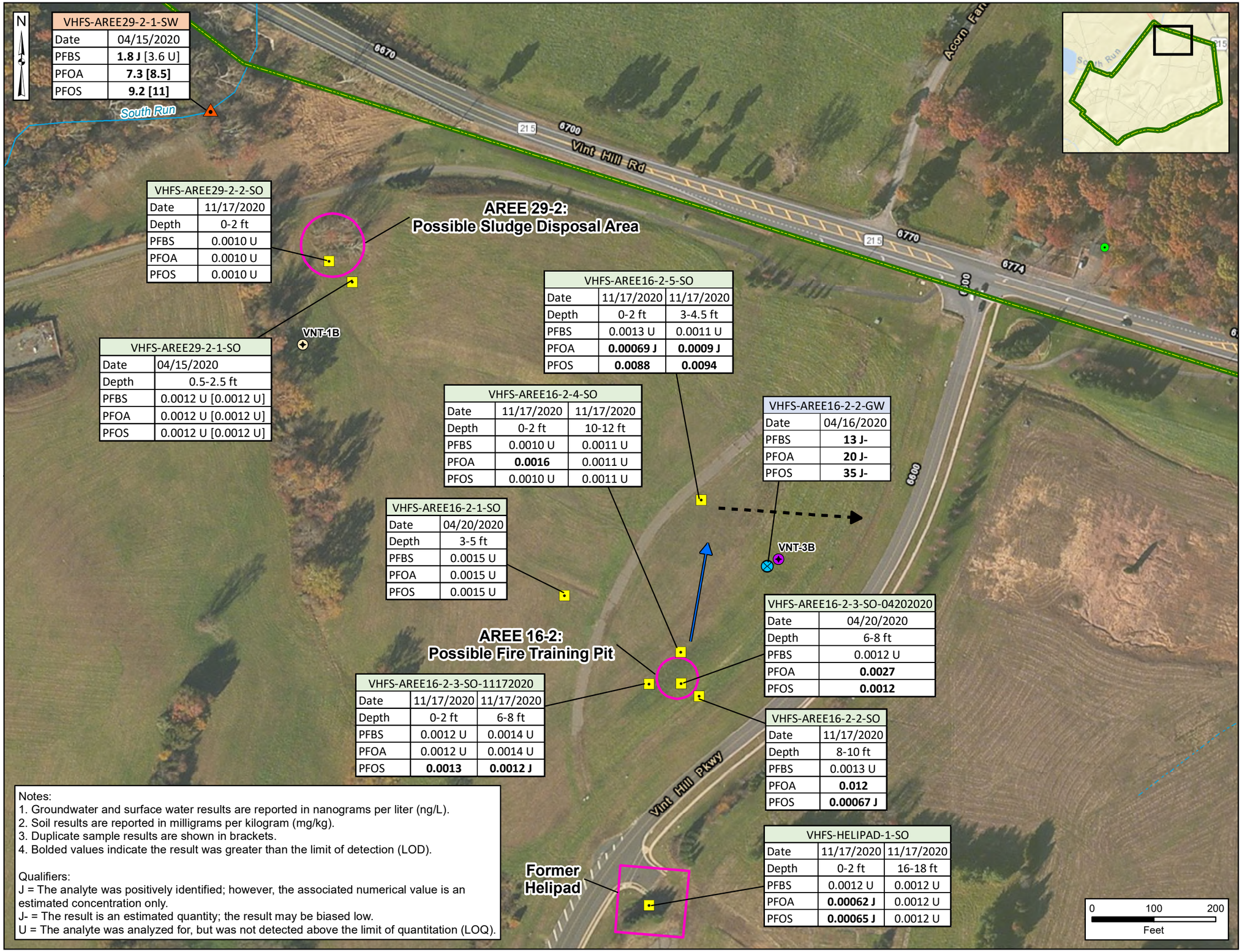
Sample Locations

- Soil (Boring)
- Soil (Boring) & Groundwater (Temporary Well)
- Surface Water

AOPI = area of potential interest
AREE = Area Requiring Environmental Evaluation
ft = feet
GW = groundwater
PFBS = perfluorobutanesulfonic acid
PFOA = perfluorooctanoic acid
PFOS = perfluorooctane sulfonate
SO = soil
SW = surface water

Data Sources:
USGS, NHD Data, 2019
ESRI ArcGIS Online, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 18 North



Notes:
1. Groundwater and surface water results are reported in nanograms per liter (ng/L).
2. Soil results are reported in milligrams per kilogram (mg/kg).
3. Duplicate sample results are shown in brackets.
4. Bolded values indicate the result was greater than the limit of detection (LOD).

Qualifiers:
J = The analyte was positively identified; however, the associated numerical value is an estimated concentration only.
J- = The result is an estimated quantity; the result may be biased low.
U = The analyte was analyzed for, but was not detected above the limit of quantitation (LOQ).

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Figure 7-3
AREEs 16-2: Possible Fire Training Pit, 29-2: Possible Sludge Disposal Area, and Former Helipad
PFOS, PFOA, and PFBS Analytical Results

Legend

- Installation Boundary
- AOPI
- River/Stream (Perennial)
- Stream (Intermittent)
- Inferred Overburden Groundwater Flow Direction based on Topography
- Surface Runoff Flow Direction
- Approved Production Well
- Exploratory Test Well
- Domestic Well

Sample Locations

- Soil (Boring)
- Groundwater (Temporary Well)
- Surface Water

AOPI = area of potential interest
AREE = Area Requiring Environmental Evaluation
ft = feet
GW = groundwater
PFBS = perfluorobutanesulfonic acid
PFOA = perfluorooctanoic acid
PFOS = perfluorooctane sulfonate
SO = soil
SW = surface water

Data Sources:
USGS, NHD Data, 2019
ESRI ArcGIS Online, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 18 North

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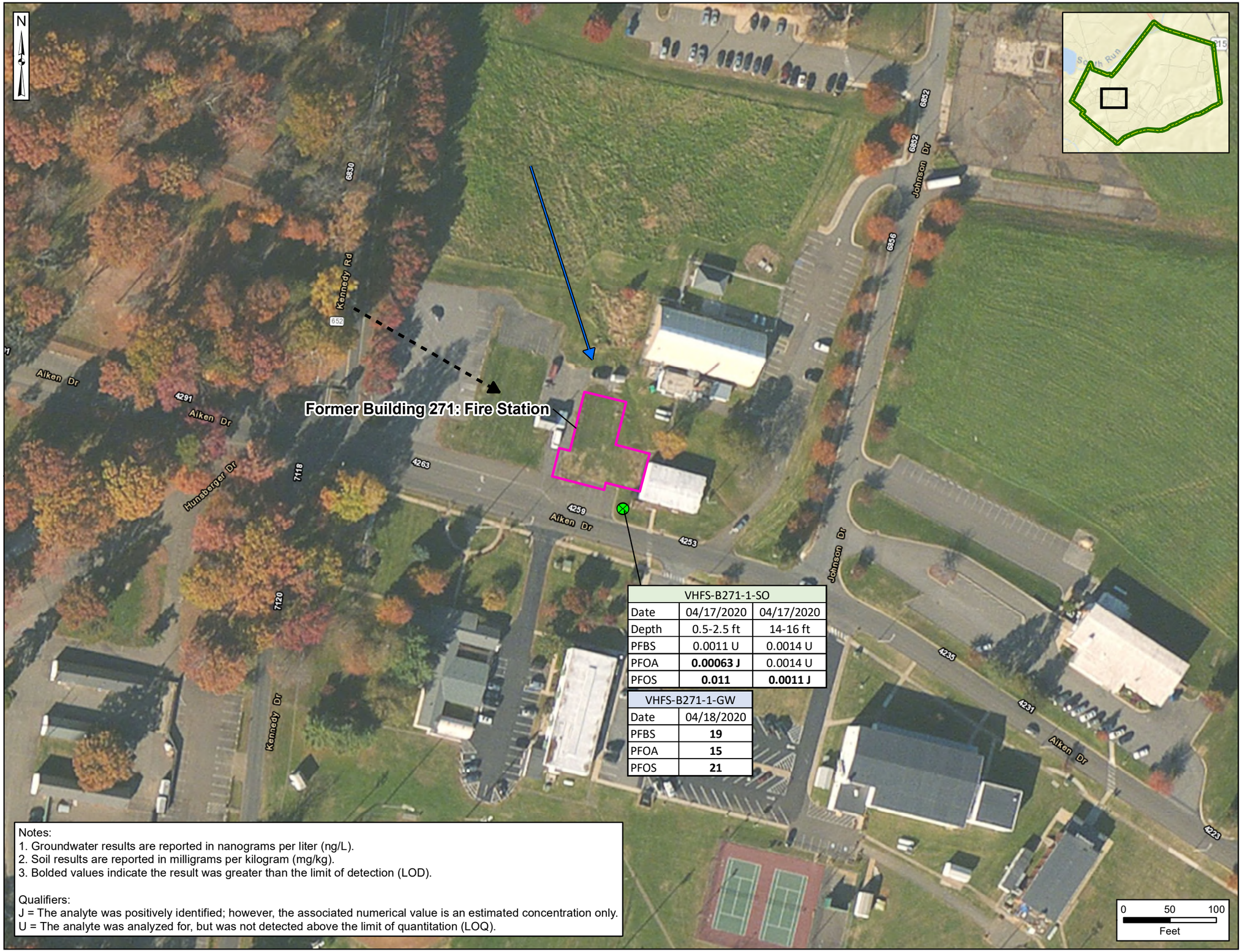
Figure 7-4 Former Building 271: Fire Station PFOS, PFOA, and PFBS Analytical Results



VHFS-B271-1-SO		
Date	04/17/2020	04/17/2020
Depth	0.5-2.5 ft	14-16 ft
PFBS	0.0011 U	0.0014 U
PFOA	**0.00063 J**	0.0014 U
PFOS	**0.011**	**0.0011 J**

VHFS-B271-1-GW	
Date	04/18/2020
PFBS	**19**
PFOA	**15**
PFOS	**21**

Notes:
1. Groundwater results are reported in nanograms per liter (ng/L).
2. Soil results are reported in milligrams per kilogram (mg/kg).
3. Bolded values indicate the result was greater than the limit of detection (LOD).

Qualifiers:
J = The analyte was positively identified; however, the associated numerical value is an estimated concentration only.
U = The analyte was analyzed for, but was not detected above the limit of quantitation (LOQ).

Legend

- AOPI
- Installation Boundary
- Inferred Overburden Groundwater Flow Direction based on Topography
- Surface Runoff Flow Direction

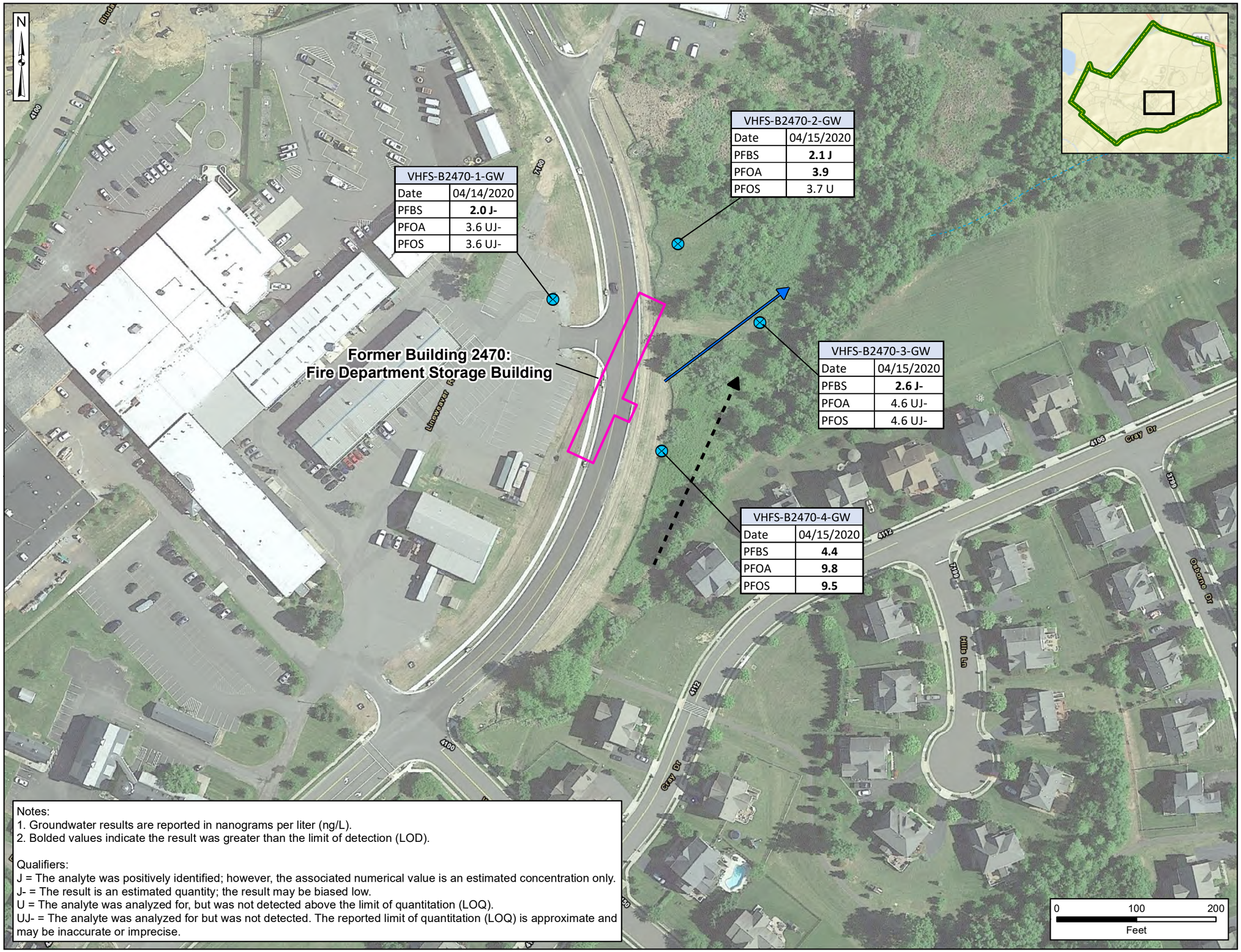
Sample Locations

- Soil (Boring) & Groundwater (Temporary Well)

AOPI = area of potential interest
ft = feet
GW = groundwater
PFBS = perfluorobutanesulfonic acid
PFOA = perfluorooctanoic acid
PFOS = perfluorooctane sulfonate
SO = soil

Data Sources:
ESRI ArcGIS Online, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 18 North



Notes:
1. Groundwater results are reported in nanograms per liter (ng/L).
2. Bolded values indicate the result was greater than the limit of detection (LOD).

Qualifiers:
J = The analyte was positively identified; however, the associated numerical value is an estimated concentration only.
J- = The result is an estimated quantity; the result may be biased low.
U = The analyte was analyzed for, but was not detected above the limit of quantitation (LOQ).
UJ- = The analyte was analyzed for but was not detected. The reported limit of quantitation (LOQ) is approximate and may be inaccurate or imprecise.

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Figure 7-5
Former Building 2470: Fire Department Storage Building PFOS, PFOA, and PFBS Analytical Results

Legend

- AOPI
- Installation Boundary
- Stream (Intermittent)
- Inferred Overburden Groundwater Flow Direction based on Topography
- Surface Runoff Flow Direction

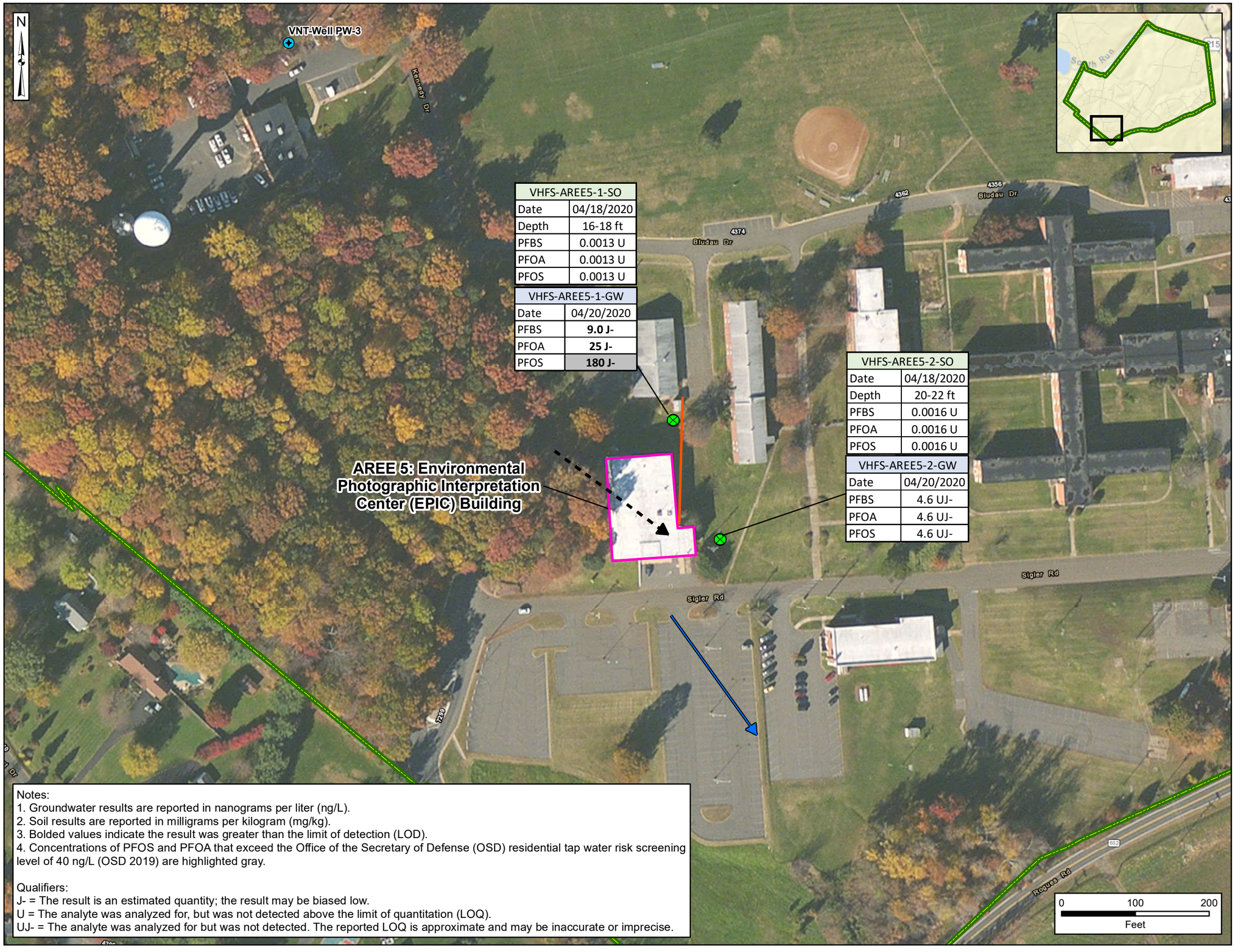
Sample Locations

- Groundwater (Temporary Well)

AOPI = area of potential interest
GW = groundwater
PFBS = perfluorobutanesulfonic acid
PFOA = perfluorooctanoic acid
PFOS = perfluorooctane sulfonate

Data Sources:
USGS, NHD Data, 2019
ESRI ArcGIS Online, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 18 North



VHFS-AREE5-1-SO	
Date	04/18/2020
Depth	16-18 ft
PFBS	0.0013 U
PFOA	0.0013 U
PFOS	0.0013 U

VHFS-AREE5-1-GW	
Date	04/20/2020
PFBS	**9.0 J-**
PFOA	**25 J-**
PFOS	**180 J-**

VHFS-AREE5-2-SO	
Date	04/18/2020
Depth	20-22 ft
PFBS	0.0016 U
PFOA	0.0016 U
PFOS	0.0016 U

VHFS-AREE5-2-GW	
Date	04/20/2020
PFBS	4.6 UJ-
PFOA	4.6 UJ-
PFOS	4.6 UJ-

Notes:
1. Groundwater results are reported in nanograms per liter (ng/L).
2. Soil results are reported in milligrams per kilogram (mg/kg).
3. Bolded values indicate the result was greater than the limit of detection (LOD).
4. Concentrations of PFOS and PFOA that exceed the Office of the Secretary of Defense (OSD) residential tap water risk screening level of 40 ng/L (OSD 2019) are highlighted gray.

Qualifiers:
J- = The result is an estimated quantity; the result may be biased low.
U = The analyte was analyzed for, but was not detected above the limit of quantitation (LOQ).
UJ- = The analyte was analyzed for but was not detected. The reported LOQ is approximate and may be inaccurate or imprecise.

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Figure 7-6
AREE 5: Environmental Photographic Interpretation Center (EPIC) Building
PFOS, PFOA, and PFBS Analytical Results

Legend

- AOPI
- Installation Boundary
- Process Line
- Inferred Overburden Groundwater Flow Direction based on Topography
- Surface Runoff Flow Direction
- On-Site Active Production Well

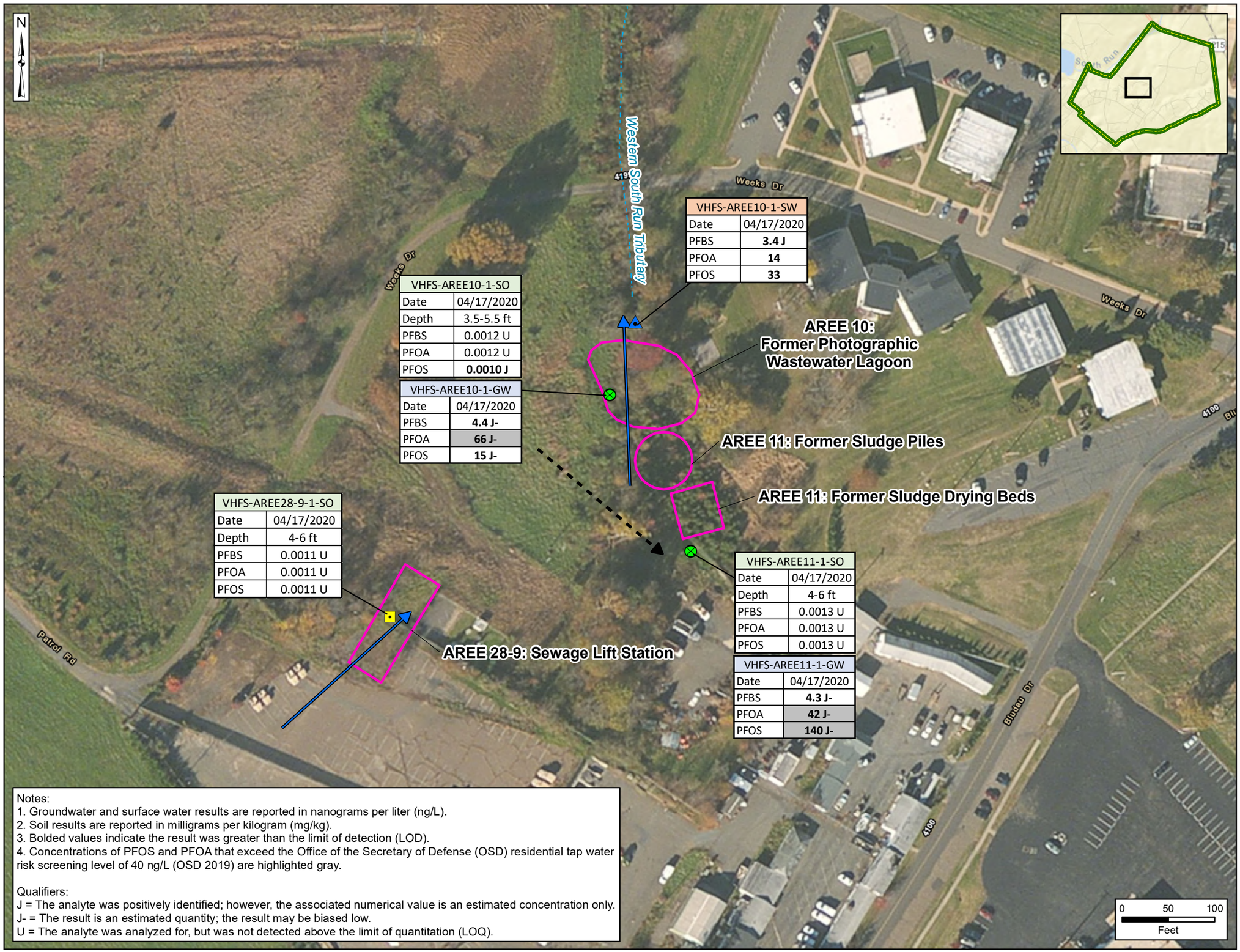
Sample Locations

- Soil (Boring) & Groundwater (Temporary Well)

AOPI = area of potential interest
AREE = Area Requiring Environmental Evaluation
ft = feet
GW = groundwater
PFBS = perfluorobutanesulfonic acid
PFOA = perfluorooctanoic acid
PFOS = perfluorooctane sulfonate
SO = soil

Data Sources:
ESRI ArcGIS Online, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 18 North



Notes:
1. Groundwater and surface water results are reported in nanograms per liter (ng/L).
2. Soil results are reported in milligrams per kilogram (mg/kg).
3. Bolded values indicate the result was greater than the limit of detection (LOD).
4. Concentrations of PFOS and PFOA that exceed the Office of the Secretary of Defense (OSD) residential tap water risk screening level of 40 ng/L (OSD 2019) are highlighted gray.

Qualifiers:
J = The analyte was positively identified; however, the associated numerical value is an estimated concentration only.
J- = The result is an estimated quantity; the result may be biased low.
U = The analyte was analyzed for, but was not detected above the limit of quantitation (LOQ).

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Figure 7-7
AREEs 10: Former Photographic Wastewater Lagoon, 11: Former Sludge Piles, and 28-9: Sewage Lift Station PFOS, PFOA, and PFBS Analytical Results

Legend

- Installation Boundary
- AOPI
- Stream (Intermittent)
- Inferred Overburden Groundwater Flow Direction based on Topography
- Surface Runoff Flow Direction

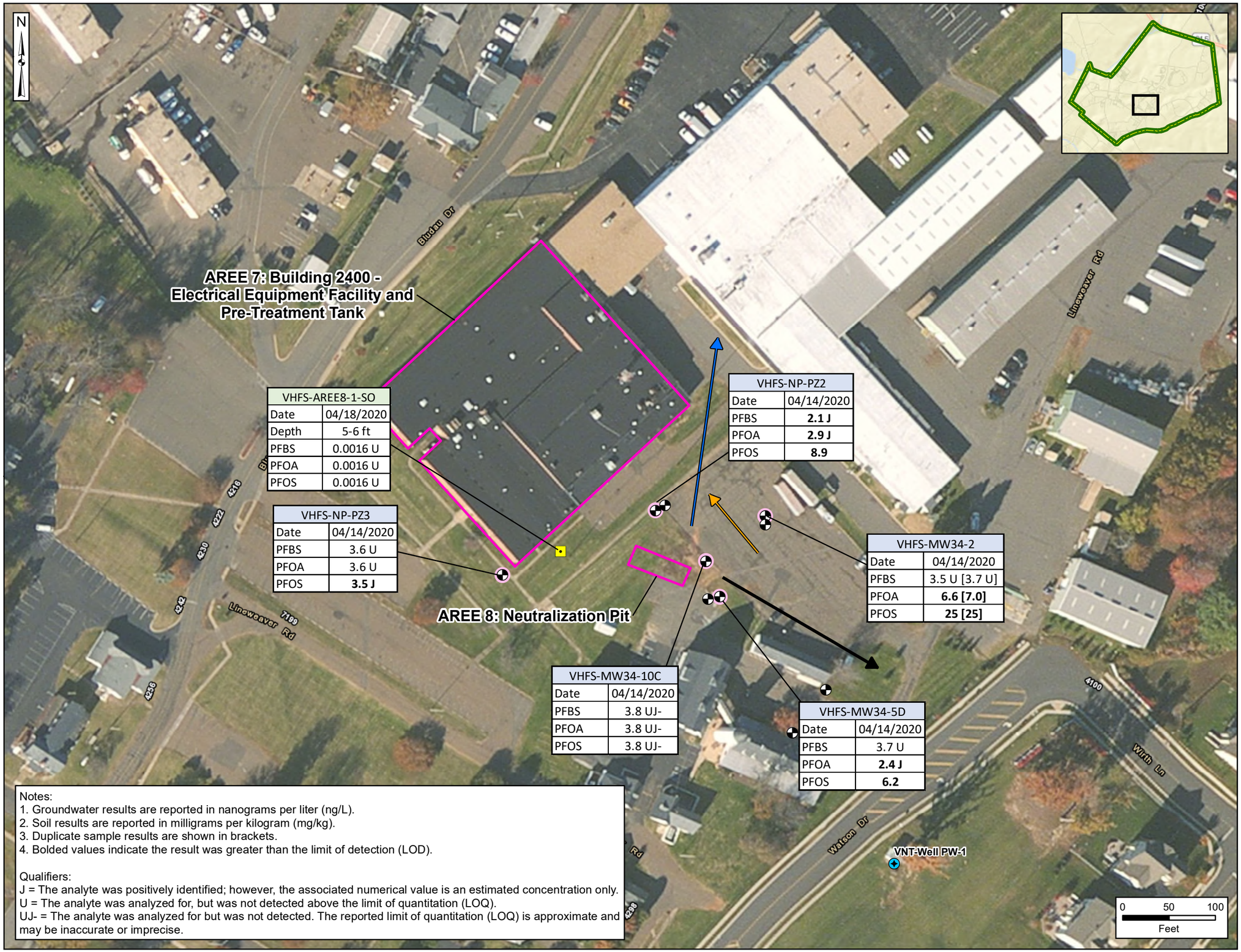
Sample Locations

- Soil (Boring)
- Soil (Boring) & Groundwater (Temporary Well)
- Surface Water

AOPI = area of potential interest
AREE = Area Requiring Environmental Evaluation
ft = feet
GW = groundwater
PFBS = perfluorobutanesulfonic acid
PFOA = perfluorooctanoic acid
PFOS = perfluorooctane sulfonate
SO = soil
SW = surface water

Data Sources:
USGS, NHD Data, 2019
ESRI ArcGIS Online, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 18 North



VHFS-AREE8-1-SO	
Date	04/18/2020
Depth	5-6 ft
PFBS	0.0016 U
PFOA	0.0016 U
PFOS	0.0016 U

VHFS-NP-PZ2	
Date	04/14/2020
PFBS	**2.1 J**
PFOA	**2.9 J**
PFOS	**8.9**

VHFS-NP-PZ3	
Date	04/14/2020
PFBS	3.6 U
PFOA	3.6 U
PFOS	**3.5 J**

VHFS-MW34-2	
Date	04/14/2020
PFBS	3.5 U [3.7 U]
PFOA	**6.6 [7.0]**
PFOS	**25 [25]**

VHFS-MW34-10C	
Date	04/14/2020
PFBS	3.8 UJ-
PFOA	3.8 UJ-
PFOS	3.8 UJ-

VHFS-MW34-5D	
Date	04/14/2020
PFBS	3.7 U
PFOA	**2.4 J**
PFOS	**6.2**

Notes:
1. Groundwater results are reported in nanograms per liter (ng/L).
2. Soil results are reported in milligrams per kilogram (mg/kg).
3. Duplicate sample results are shown in brackets.
4. Bolded values indicate the result was greater than the limit of detection (LOD).

Qualifiers:
J = The analyte was positively identified; however, the associated numerical value is an estimated concentration only.
U = The analyte was analyzed for, but was not detected above the limit of quantitation (LOQ).
UJ- = The analyte was analyzed for but was not detected. The reported limit of quantitation (LOQ) is approximate and may be inaccurate or imprecise.

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Figure 7-8
AREEs 7: Building 2400 – Electrical Equipment Facility and Pre-Treatment Tank and 8: Neutralization Pit
PFOS, PFOA, and PFBS Analytical Results

Legend

- Installation Boundary
- AOPI
- Bedrock Groundwater Flow Direction
- Overburden Groundwater Flow Direction
- Surface Runoff Flow Direction
- Monitoring Well
- On-Site Active Production Well

Sample Locations

- Soil (Boring)
- Groundwater (Existing Well)

AOPI = area of potential interest
AREE = Area Requiring Environmental Evaluation
ft = feet
PFBS = perfluorobutanesulfonic acid
PFOA = perfluorooctanoic acid
PFOS = perfluorooctane sulfonate
SO = soil

Data Sources:
USACE. *AREE 34 Groundwater Monitoring Report Round 28*, Groundwater Flow Directions, 2017;
ESRI ArcGIS Online, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 18 North

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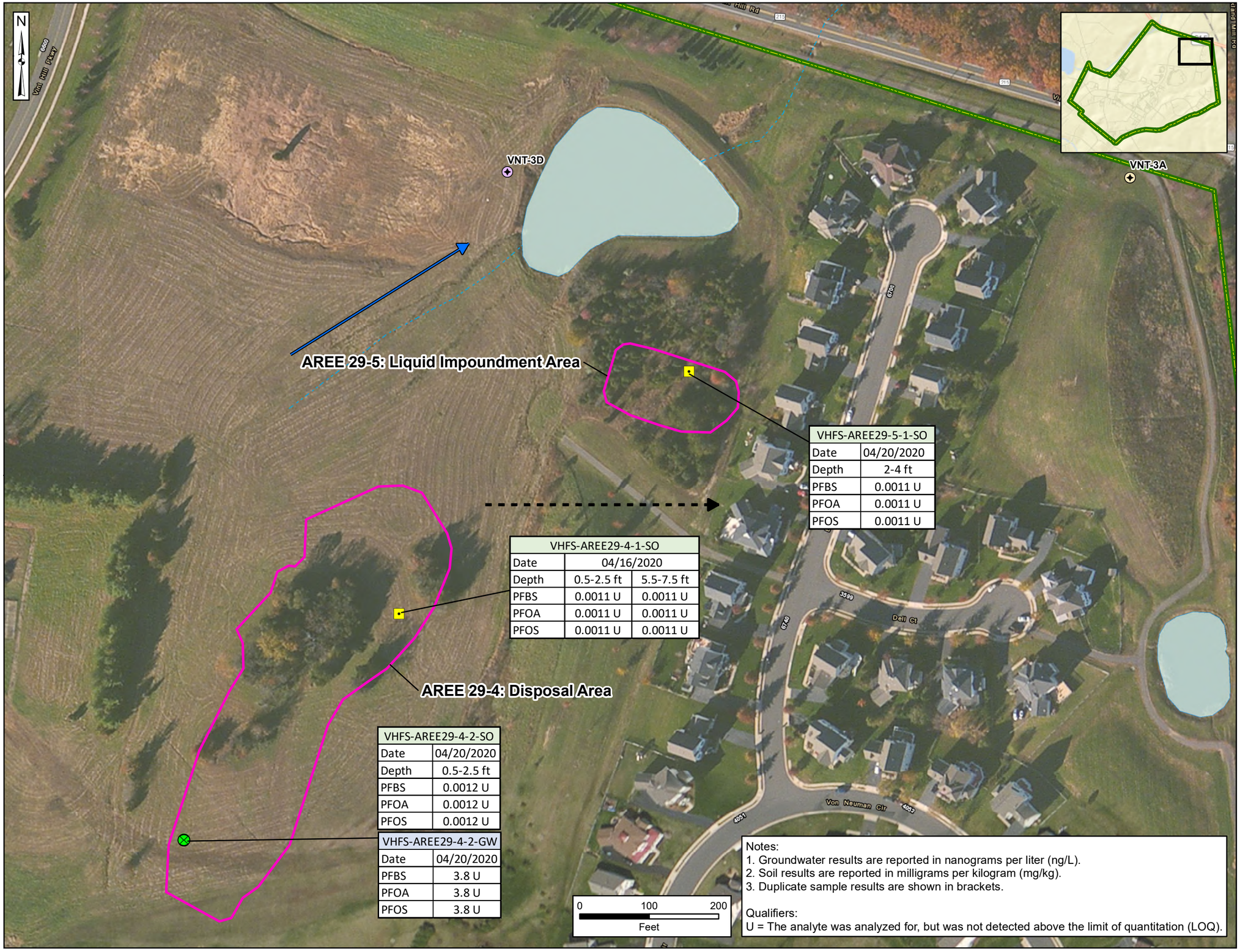
Figure 7-9
AREEs 29-4: Disposal Area and 29-5: Liquid Impoundment Area PFOS, PFOA, and PFBS Analytical Results



VHFS-AREE29-5-1-SO	
Date	04/20/2020
Depth	2-4 ft
PFBS	0.0011 U
PFOA	0.0011 U
PFOS	0.0011 U

VHFS-AREE29-4-1-SO		
Date	04/16/2020	
Depth	0.5-2.5 ft	5.5-7.5 ft
PFBS	0.0011 U	0.0011 U
PFOA	0.0011 U	0.0011 U
PFOS	0.0011 U	0.0011 U

VHFS-AREE29-4-2-SO	
Date	04/20/2020
Depth	0.5-2.5 ft
PFBS	0.0012 U
PFOA	0.0012 U
PFOS	0.0012 U

VHFS-AREE29-4-2-GW	
Date	04/20/2020
PFBS	3.8 U
PFOA	3.8 U
PFOS	3.8 U

Legend

- Installation Boundary
- AOPI
- Stream (Intermittent)
- Water Body
- Inferred Overburden Groundwater Flow Direction based on Topography
- Surface Water Flow Direction
- Back-up Production Well
- Exploratory Test Well

Sample Locations

- Soil (Boring)
- Soil (Boring) & Groundwater (Temporary Well)

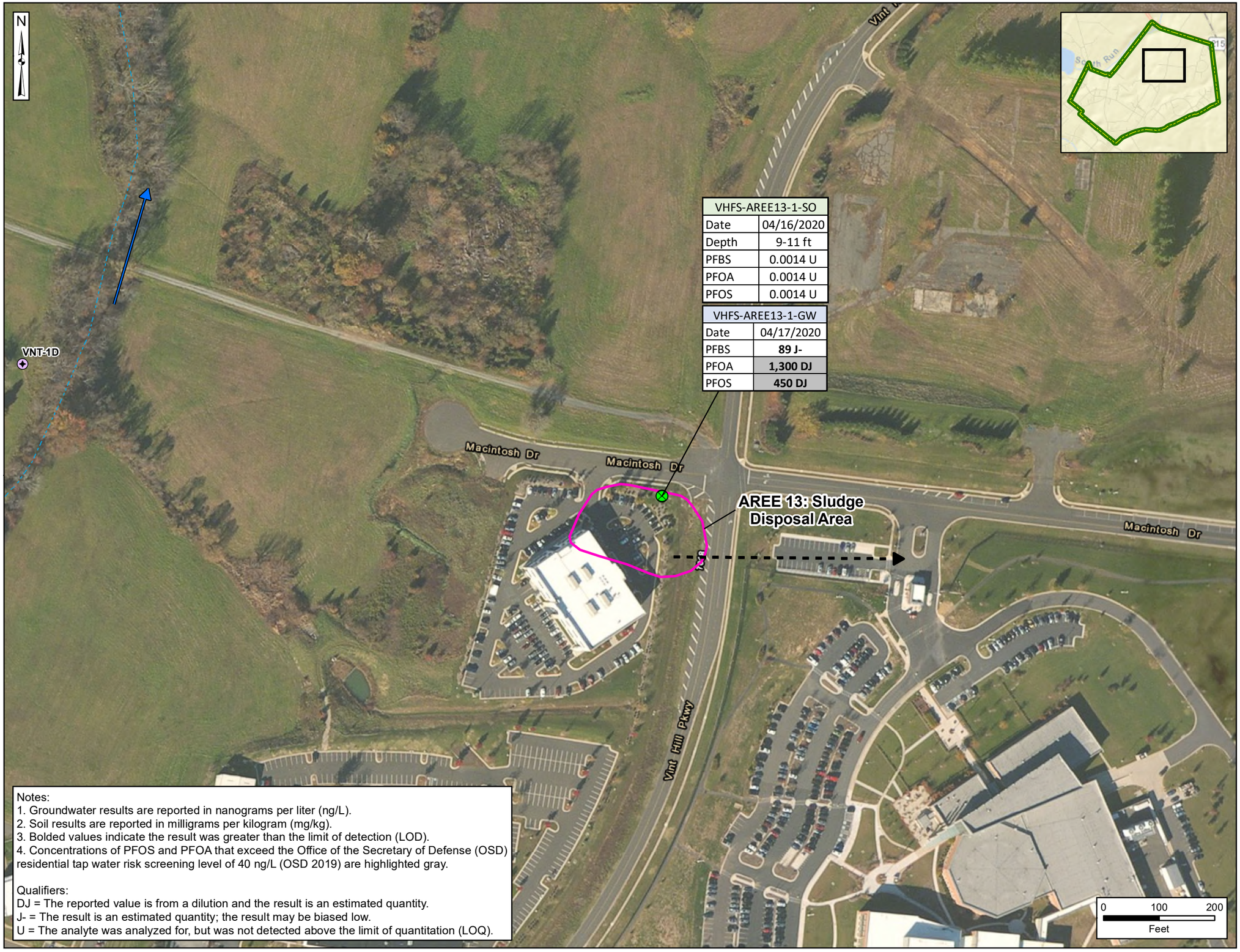
AOPI = area of potential interest
AREE = Area Requiring Environmental Evaluation
ft = feet
GW = groundwater
PFBS = perfluorobutanesulfonic acid
PFOA = perfluorooctanoic acid
PFOS = perfluorooctane sulfonate
SO = soil

Notes:
1. Groundwater results are reported in nanograms per liter (ng/L).
2. Soil results are reported in milligrams per kilogram (mg/kg).
3. Duplicate sample results are shown in brackets.

Qualifiers:
U = The analyte was analyzed for, but was not detected above the limit of quantitation (LOQ).

Data Sources:
USGS, NHD Data, 2019
ESRI ArcGIS Online, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 18 North



Notes:
1. Groundwater results are reported in nanograms per liter (ng/L).
2. Soil results are reported in milligrams per kilogram (mg/kg).
3. Bolded values indicate the result was greater than the limit of detection (LOD).
4. Concentrations of PFOS and PFOA that exceed the Office of the Secretary of Defense (OSD) residential tap water risk screening level of 40 ng/L (OSD 2019) are highlighted gray.

Qualifiers:
DJ = The reported value is from a dilution and the result is an estimated quantity.
J- = The result is an estimated quantity; the result may be biased low.
U = The analyte was analyzed for, but was not detected above the limit of quantitation (LOQ).

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Figure 7-10
AREE 13: Sludge Disposal Area PFOS, PFOA, and PFBS Analytical Results

Legend

- Installation Boundary
- AOPI
- Stream (Intermittent)
- Inferred Overburden Groundwater Flow Direction based on Topography
- Surface Water Flow Direction
- Back-up Production Well

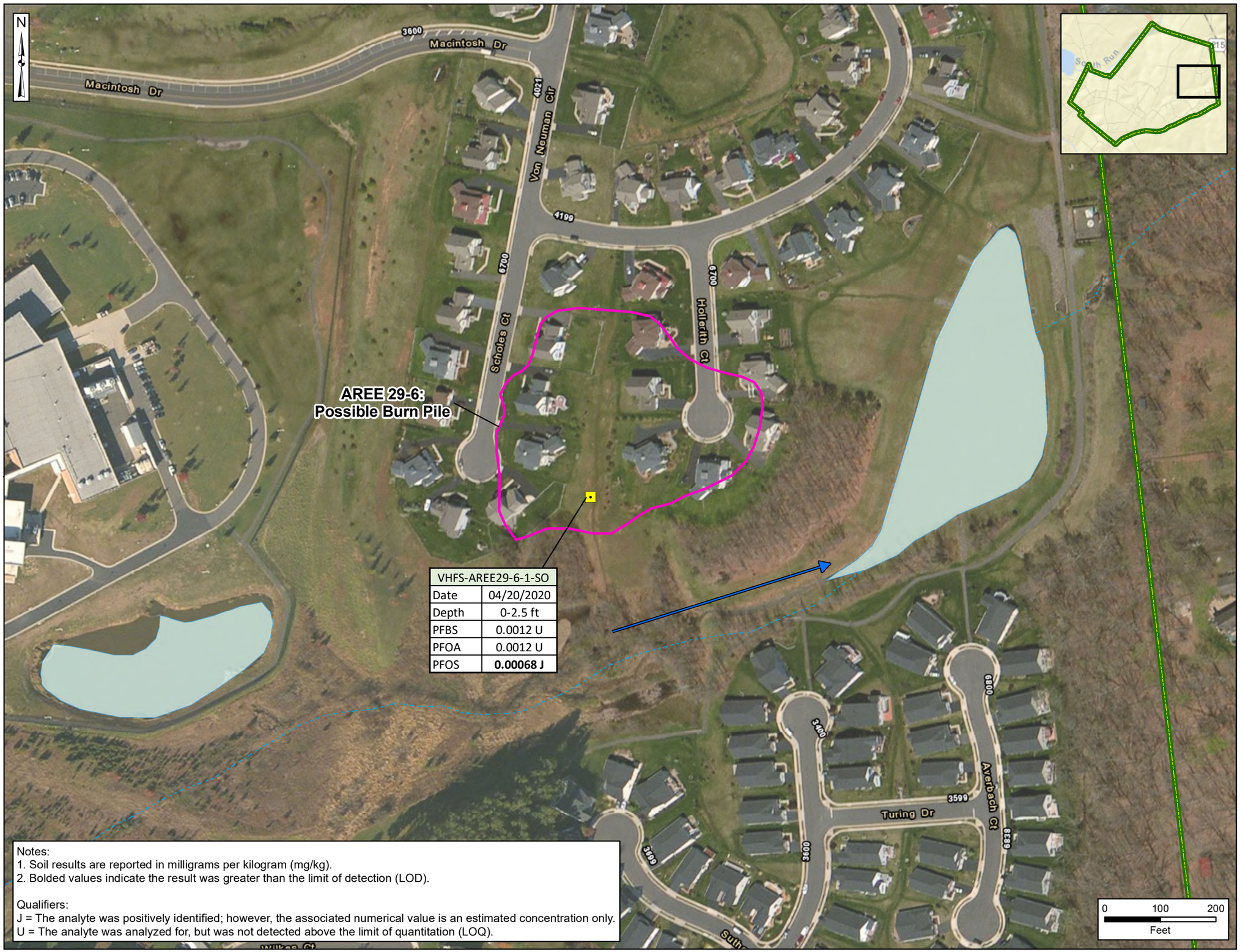
Sample Locations

- Soil (Boring) & Groundwater (Temporary Well)

AOPI = area of potential interest
AREE = Area Requiring Environmental Evaluation
ft = feet
GW = groundwater
PFBS = perfluorobutanesulfonic acid
PFOA = perfluorooctanoic acid
PFOS = perfluorooctane sulfonate
SO = soil

Data Sources:
USGS, NHD Data, 2019
ESRI ArcGIS Online, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 18 North



Notes:
1. Soil results are reported in milligrams per kilogram (mg/kg).
2. Bolded values indicate the result was greater than the limit of detection (LOD).

Qualifiers:
J = The analyte was positively identified; however, the associated numerical value is an estimated concentration only.
U = The analyte was analyzed for, but was not detected above the limit of quantitation (LOQ).

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Figure 7-11
AREE 29-6: Possible Burn Pile PFOS, PFOA, and PFBS Analytical Results

Legend

- Installation Boundary
- AOPI
- Stream (Intermittent)
- Water Body
- Surface Water Flow Direction

Sample Locations

- Soil (Boring)

AOPI = area of potential interest
AREE = Area Requiring Environmental Evaluation
ft = feet
PFBS = perfluorobutanesulfonic acid
PFOA = perfluorooctanoic acid
PFOS = perfluorooctane sulfonate
SO = soil

Data Sources:
USGS, NHD Data, 2019
ESRI ArcGIS Online, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 18 North

Notes:
1. Groundwater results are reported in nanograms per liter (ng/L).
2. Bolded values indicate the result was greater than the limit of detection (LOD).
3. Concentrations of PFOS and PFOA that exceed the Office of the Secretary of Defense (OSD) residential tap water risk screening level of 40 ng/L in the presence of multiple PFAS (OSD 2019) are highlighted gray.

Qualifiers:
J- = The result is an estimated quantity; the result may be biased low.

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Figure 7-12
AREE 9: Vehicle Maintenance Area and Former Car Wash
PFOS, PFOA, and PFBS Analytical Results

Legend

- Installation Boundary
- AOPI
- Inferred Overburden Groundwater Flow Direction based on Topography
- Surface Runoff Flow Direction
- Monitoring Well

Sample Locations

- Groundwater (Temporary Well)

AOPI = area of potential interest
AREE = Area Requiring Environmental Evaluation
GW = groundwater
PFBS = perfluorobutanesulfonic acid
PFOA = perfluorooctanoic acid
PFOS = perfluorooctane sulfonate

Data Sources:
ESRI ArcGIS Online, Aerial Imagery

Coordinate System:
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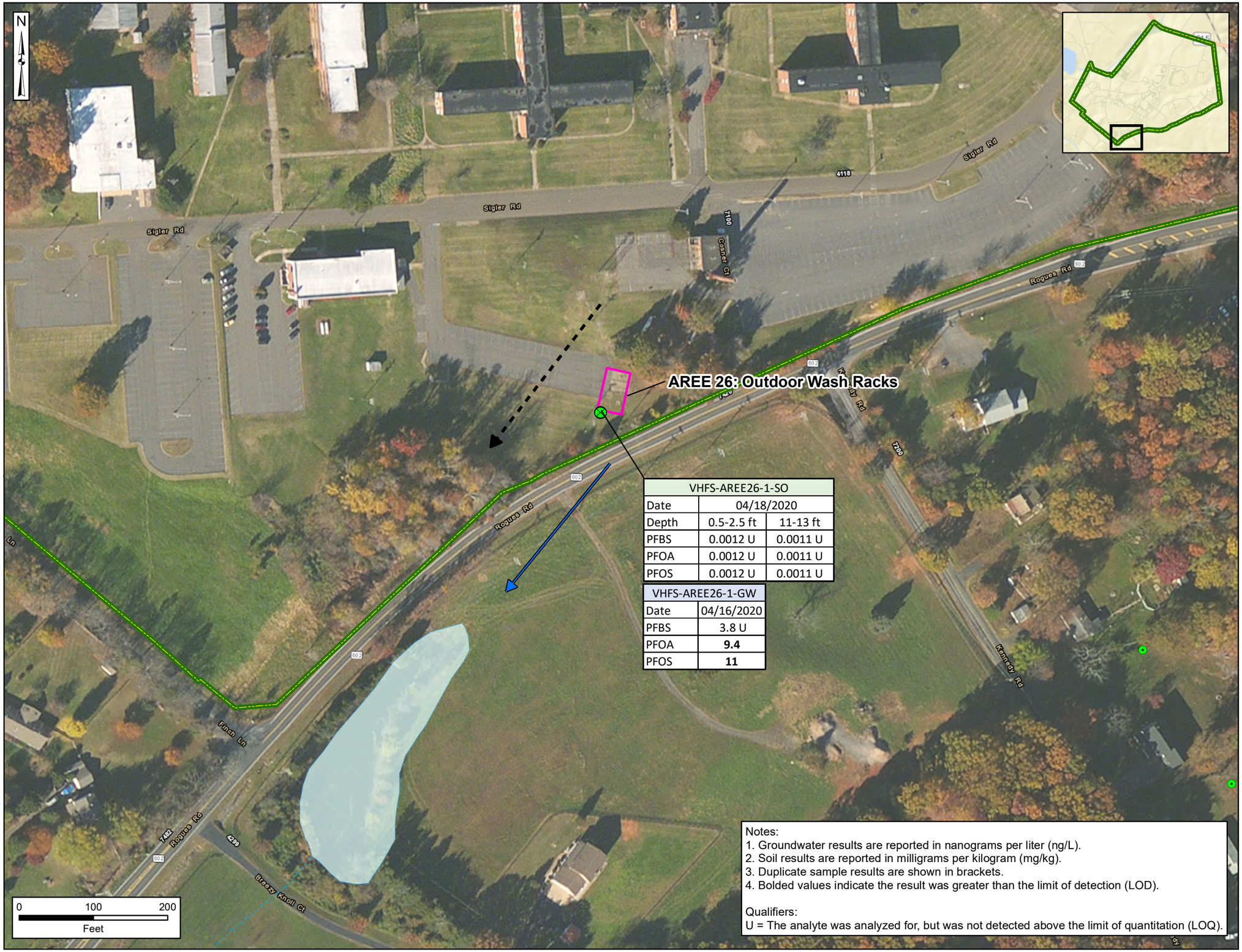
Figure 7-13
AREE 26: Outdoor Wash Racks PFOS, PFOA, and PFBS Analytical Results



VHFS-AREE26-1-SO		
Date	04/18/2020	
Depth	0.5-2.5 ft	11-13 ft
PFBS	0.0012 U	0.0011 U
PFOA	0.0012 U	0.0011 U
PFOS	0.0012 U	0.0011 U

VHFS-AREE26-1-GW	
Date	04/16/2020
PFBS	3.8 U
PFOA	**9.4**
PFOS	**11**

Notes:
1. Groundwater results are reported in nanograms per liter (ng/L).
2. Soil results are reported in milligrams per kilogram (mg/kg).
3. Duplicate sample results are shown in brackets.
4. Bolded values indicate the result was greater than the limit of detection (LOD).

Qualifiers:
U = The analyte was analyzed for, but was not detected above the limit of quantitation (LOQ).

Legend

- Installation Boundary
- AOPI
- Stream (Intermittent)
- Water Body
- Inferred Overburden Groundwater Flow Direction based on Topography
- Surface Runoff Flow Direction
- Domestic Well

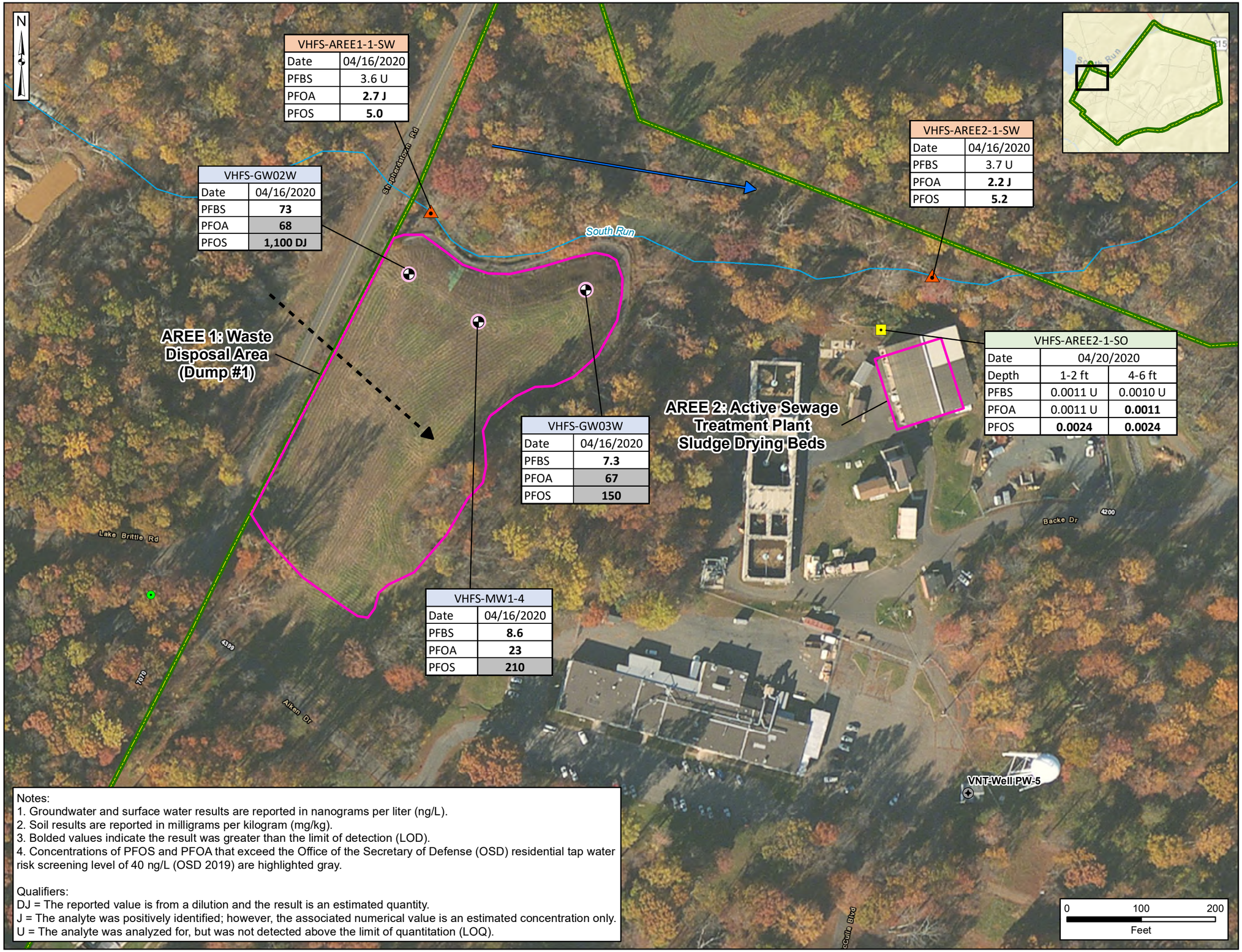
Sample Locations

- Soil (Boring) & Groundwater (Temporary Well)

AOPI = area of potential interest
AREE = Area Requiring Environmental Evaluation
ft = feet
GW = groundwater
PFBS = perfluorobutanesulfonic acid
PFOA = perfluorooctanoic acid
PFOS = perfluorooctane sulfonate
SO = soil

Data Sources:
USGS, NHD Data, 2019
ESRI ArcGIS Online, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 18 North



Notes:
1. Groundwater and surface water results are reported in nanograms per liter (ng/L).
2. Soil results are reported in milligrams per kilogram (mg/kg).
3. Bolded values indicate the result was greater than the limit of detection (LOD).
4. Concentrations of PFOS and PFOA that exceed the Office of the Secretary of Defense (OSD) residential tap water risk screening level of 40 ng/L (OSD 2019) are highlighted gray.

Qualifiers:
DJ = The reported value is from a dilution and the result is an estimated quantity.
J = The analyte was positively identified; however, the associated numerical value is an estimated concentration only.
U = The analyte was analyzed for, but was not detected above the limit of quantitation (LOQ).

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Figure 7-14
AREEs 1: Waste Disposal Area (Dump#1) and 2: Active Sewage Treatment Plant Sludge Drying Beds PFOS, PFOA, and PFBS Analytical Results

Legend

- Installation Boundary
- AOPI
- River/Stream (Perennial)
- Inferred Overburden Groundwater Flow Direction based on Topography
- Surface Water Flow Direction
- On-Site Offline Production Well
- Domestic Well
- Monitoring Well

Sample Locations

- Soil (Boring)
- Surface Water
- Groundwater (Existing Well)

AOPI = area of potential interest
AREE = Area Requiring Environmental Evaluation
ft = feet
PFBS = perfluorobutanesulfonic acid
PFOA = perfluorooctanoic acid
PFOS = perfluorooctane sulfonate
SO = soil
SW = surface water

Data Sources:
USGS, NHD Data, 2019
ESRI ArcGIS Online, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 18 North

Notes:
1. Groundwater results are reported in nanograms per liter (ng/L).
2. Bolded values indicate the result was greater than the limit of detection (LOD).
3. Concentrations of PFOS and PFOA that exceed the Office of the Secretary of Defense (OSD) residential tap water risk screening level of 40 ng/L (OSD 2019) are highlighted gray.
4. Samples collected from the 120-150 interval in VNT 1B were collected at different time periods during pumping and are presented in the order collected.

Qualifiers:
DJ = The reported value is from a dilution and the result is an estimated quantity.

N

South Run

Vint Hill Rd

Acorn Farm Ln

Vint Hill Pkwy

6700

6770

6774

6600

215

AREE 29-2:
Possible Sludge
Disposal Area

AREE 16-2:
Possible Fire
Training Pit

VHFS-VNT-1B-GW							
Date	03/26/2020					03/27/2020	
Depth	28-58 ft	120-150 ft	120-150 ft	120-150 ft	220-250 ft	450-562 ft	490-562 ft
PFBS	**7.1**	**6.9**	**6.4**	**4.6**	**7.3**	**8.2 [8.4]**	**6.9**
PFOA	**830 DJ**	**810 DJ**	**710**	**630**	**790 DJ**	**1,000 DJ [920 DJ]**	**730**
PFOS	**32**	**30**	**21**	**18**	**33**	**32 [33]**	**28**

VHFS-VNT-3B-GW				
Date	04/17/2020			
Depth	88-110 ft	233-255 ft	297.5-319.5 ft	380-402 ft
PFBS	**70**	**34**	**21**	**70**
PFOA	**1,000 DJ**	**410**	**270**	**810**
PFOS	**690**	**330**	**220**	**730**

0 100 200
Feet

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Vint Hill Farms, VA

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Figure 7-15
Production Wells and Bedrock Aquifer (VNT 1B and 3B) PFOS, PFOA, and PFBS Analytical Results

Legend

- AOPI
- Installation Boundary
- River/Stream (Perennial)
- Inferred Overburden Groundwater Flow Direction based on Topography
- Surface Runoff Flow Direction
- Approved Production Well
- Exploratory Test Well
- Domestic Well

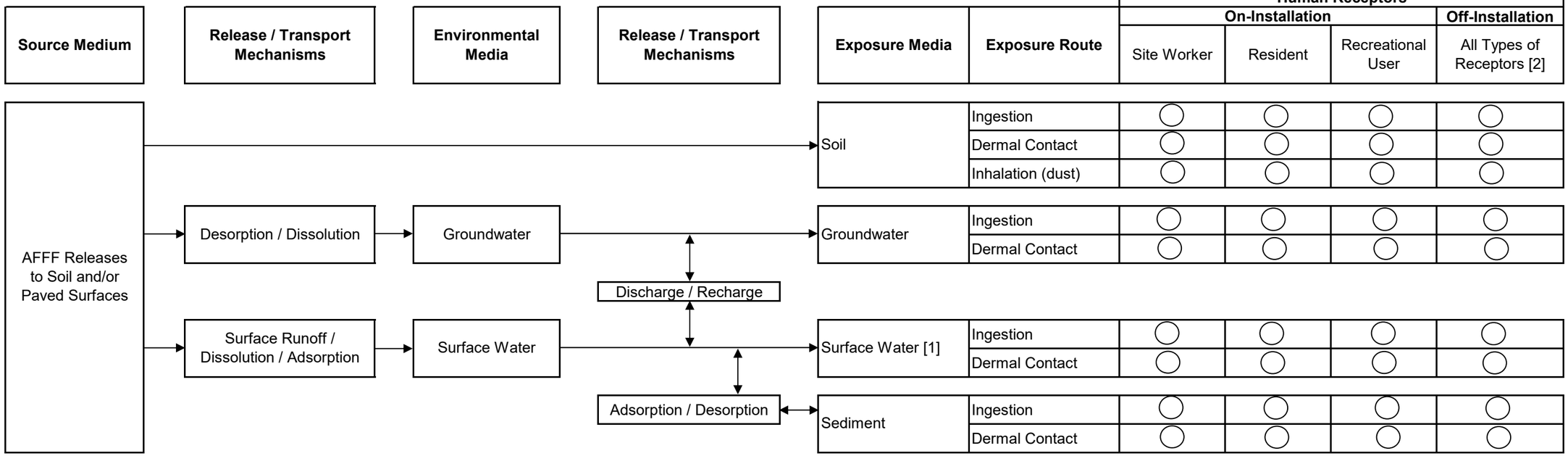
Sample Locations

- Groundwater (Existing Well)

AOPI = area of potential interest
AREE = Area Requiring Environmental Evaluation
ft = feet
PFBS = perfluorobutanesulfonic acid
PFOA = perfluorooctanoic acid
PFOS = perfluorooctane sulfonate

Data Sources:
USGS, NHD Data, 2019
ESRI ArcGIS Online, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 18 North



Legend:

- ● = Complete Exposure Pathway
- ◐ = Potentially Complete Exposure Pathway
- ○ = Incomplete Exposure Pathway

Notes:
[1] Surface water exposure pathway for Site Workers and Residents describes a drinking water scenario, and for Recreational Users describes incidental ingestion and dermal contact during an outdoor recreational scenario.
[2] All types of off-installation human receptors include drinking water receptors and recreational users.

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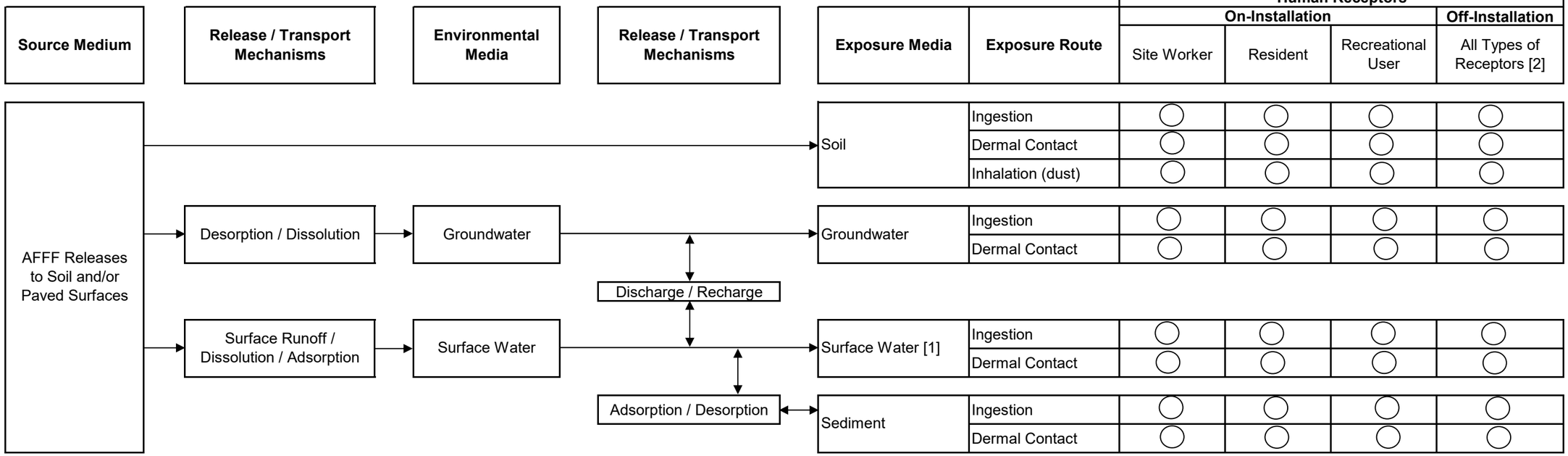
Conceptual Site Model - AREE 29-4
USAEC PFAS Preliminary Assessment / Site Inspection
Vint Hill Farms Station, Virginia

Figure 7-16



Legend:

- ● = Complete Exposure Pathway
- ◐ = Potentially Complete Exposure Pathway
- ○ = Incomplete Exposure Pathway

Notes:
[1] Surface water exposure pathway for Site Workers and Residents describes a drinking water scenario, and for Recreational Users describes incidental ingestion and dermal contact during an outdoor recreational scenario.
[2] All types of off-installation human receptors include drinking water receptors and recreational users.

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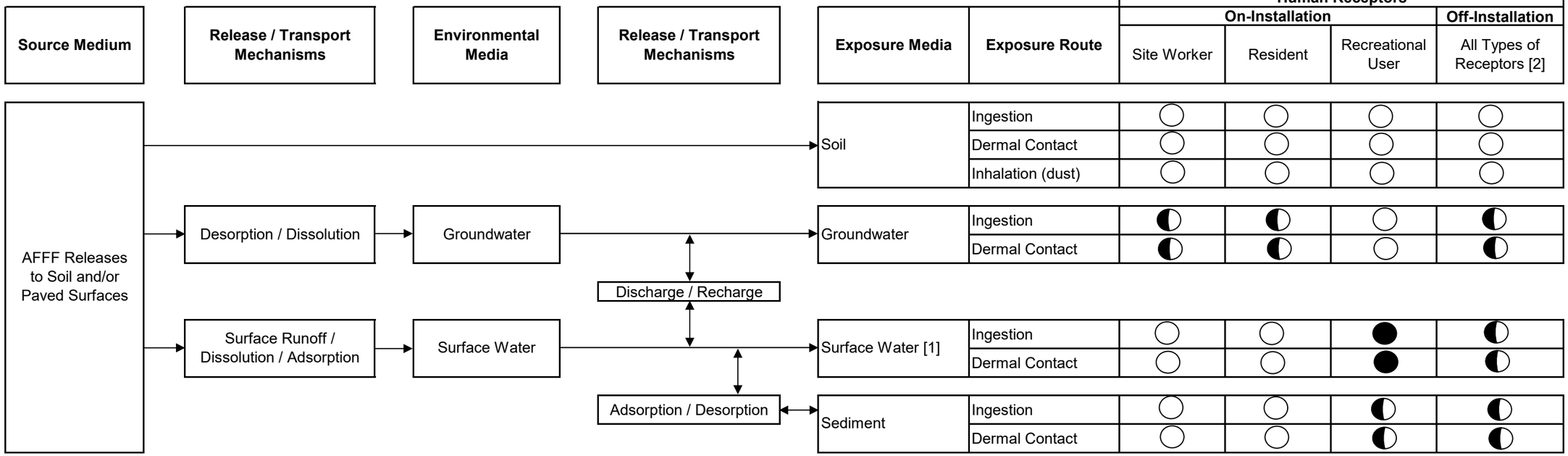
Conceptual Site Model - AREE 28-9, 29-3, and 29-5
USAEC PFAS Preliminary Assessment / Site Inspection
Vint Hill Farms Station, Virginia

Figure 7-17



Legend:

- ● = Complete Exposure Pathway
- ◐ = Potentially Complete Exposure Pathway
- ○ = Incomplete Exposure Pathway

Notes:
[1] Surface water exposure pathway for Site Workers and Residents describes a drinking water scenario, and for Recreational Users describes incidental ingestion and dermal contact during an outdoor recreational scenario.
[2] All types of off-installation human receptors include drinking water receptors and recreational users.

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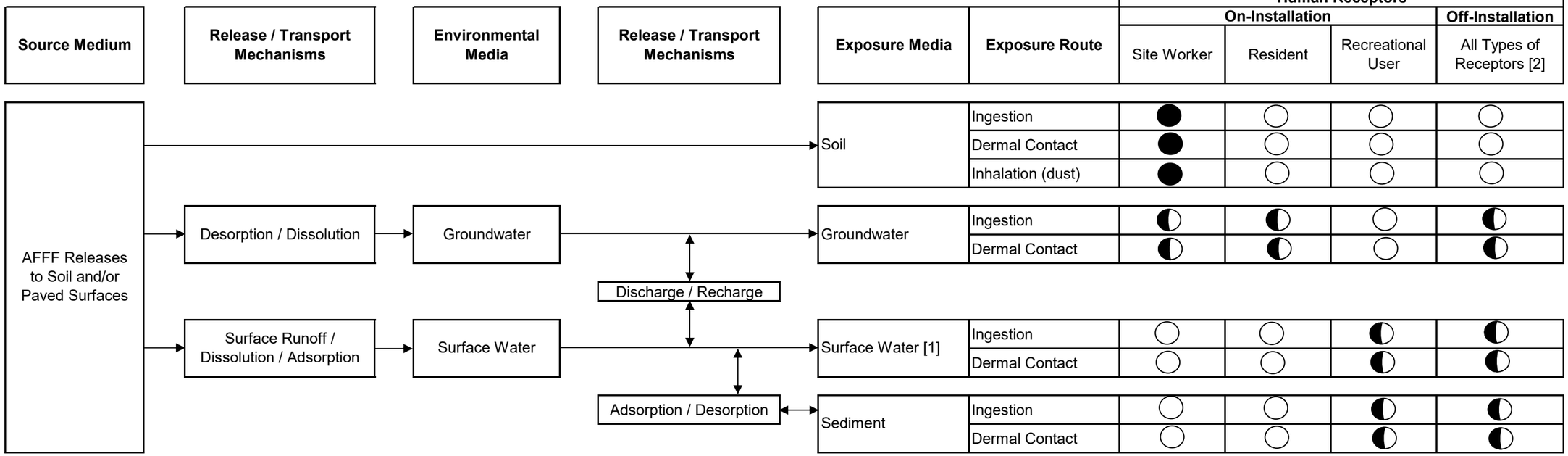
Conceptual Site Model - AREE 29-2
USAEC PFAS Preliminary Assessment / Site Inspection
Vint Hill Farms Station, Virginia

Figure 7-18



Legend:

- ● = Complete Exposure Pathway
- ◐ = Potentially Complete Exposure Pathway
- ○ = Incomplete Exposure Pathway

Notes:
[1] Surface water exposure pathway for Site Workers and Residents describes a drinking water scenario, and for Recreational Users describes incidental ingestion and dermal contact during an outdoor recreational scenario.
[2] All types of off-installation human receptors include drinking water receptors and recreational users.

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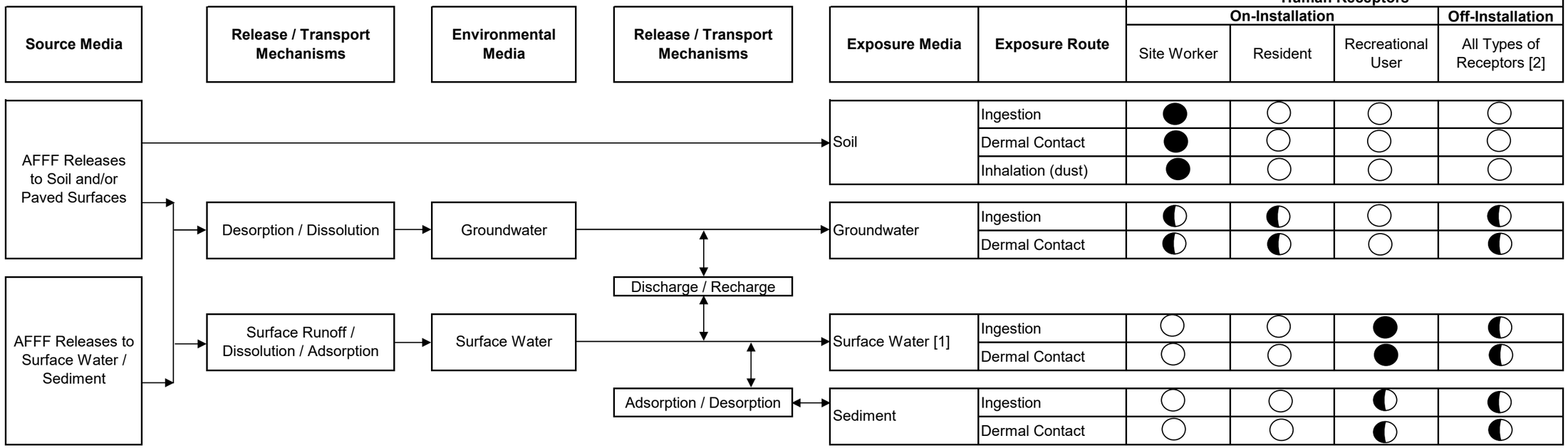
Conceptual Site Model - AREEs 17, 29-6, and the Helipad
USAEC PFAS Preliminary Assessment / Site Inspection
Vint Hill Farms Station, Virginia

Figure 7-19



Legend:

- ● = Complete Exposure Pathway
- ◐ = Potentially Complete Exposure Pathway
- ○ = Incomplete Exposure Pathway

Notes:
[1] Surface water exposure pathway for Site Workers and Residents describes a drinking water scenario, and for Recreational Users describes incidental ingestion and dermal contact during an outdoor recreational scenario.
[2] All types of off-installation human receptors include drinking water receptors and recreational users.

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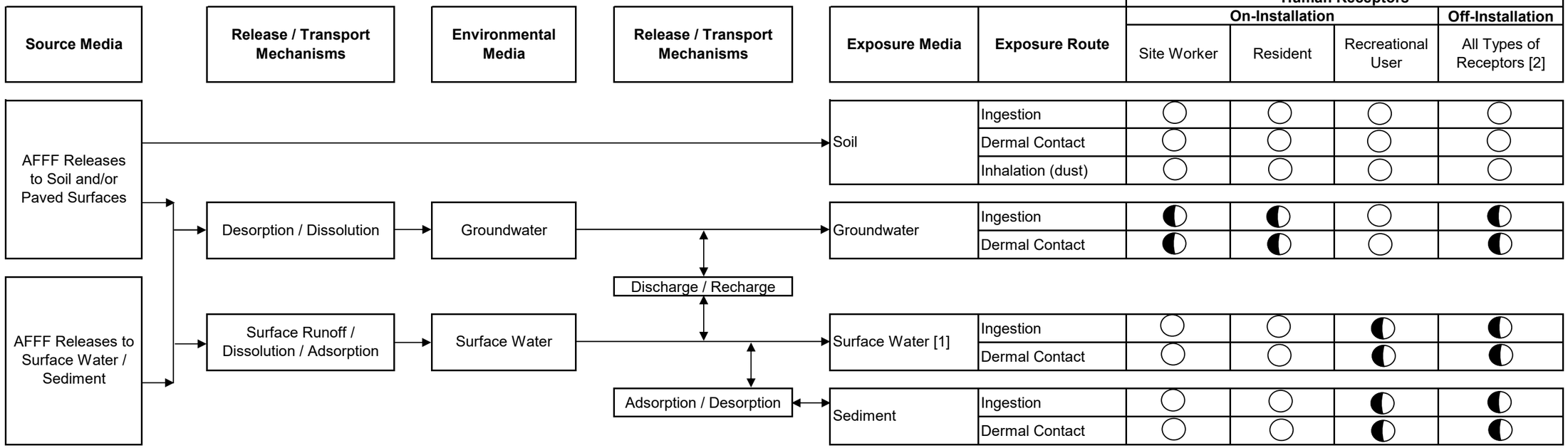
Conceptual Site Model - AREE 2
USAEC PFAS Preliminary Assessment / Site Inspection
Vint Hill Farms Station, Virginia

Figure 7-20



Legend:

- ● = Complete Exposure Pathway
- ◐ = Potentially Complete Exposure Pathway
- ○ = Incomplete Exposure Pathway

Notes:
[1] Surface water exposure pathway for Site Workers and Residents describes a drinking water scenario, and for Recreational Users describes incidental ingestion and dermal contact during an outdoor recreational scenario.
[2] All types of off-installation human receptors include drinking water receptors and recreational users.

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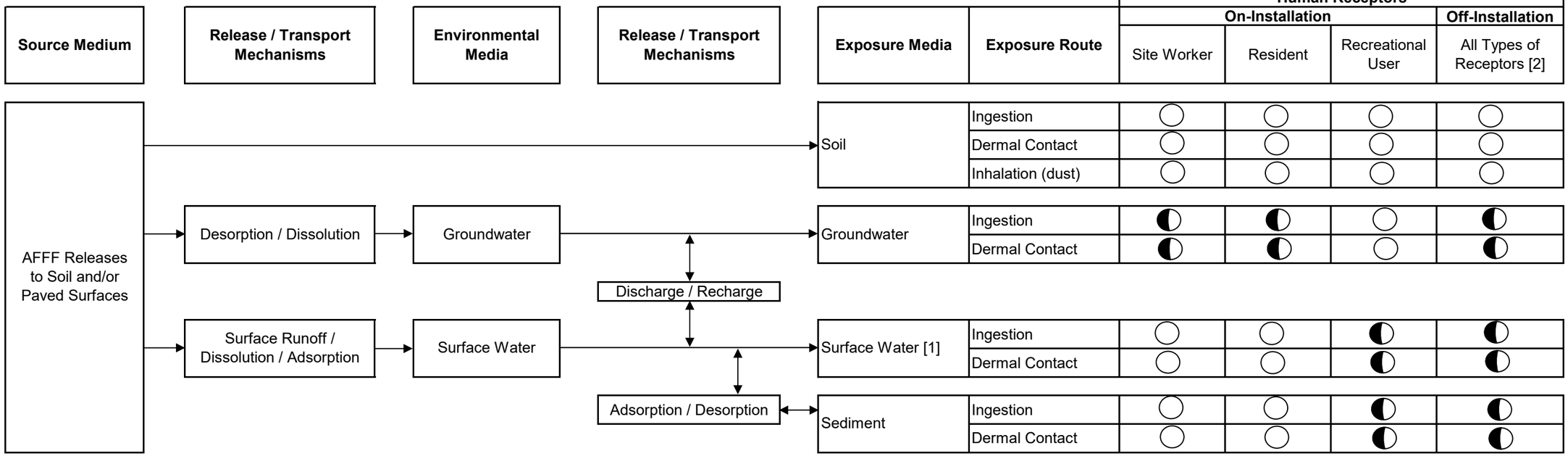
Conceptual Site Model - AREEs 5, 7, and 11
USAEC PFAS Preliminary Assessment / Site Inspection
Vint Hill Farms Station, Virginia

Figure 7-21



Legend:

- ● = Complete Exposure Pathway
- ◐ = Potentially Complete Exposure Pathway
- ○ = Incomplete Exposure Pathway

Notes:
[1] Surface water exposure pathway for Site Workers and Residents describes a drinking water scenario, and for Recreational Users describes incidental ingestion and dermal contact during an outdoor recreational scenario.
[2] All types of off-installation human receptors include drinking water receptors and recreational users.

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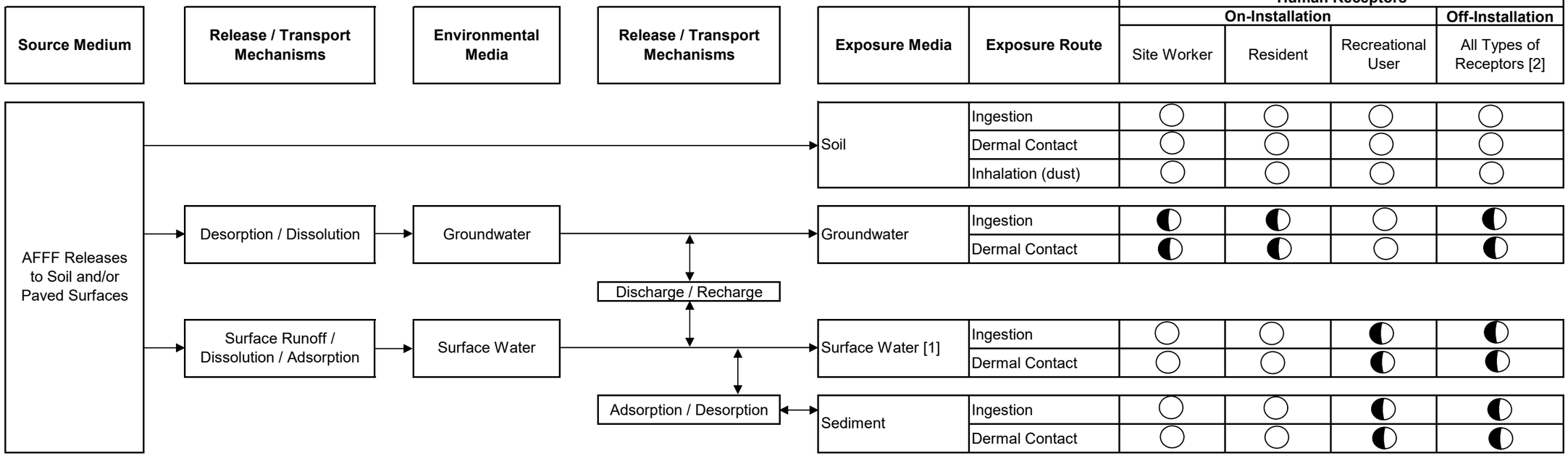
Conceptual Site Model - AREEs 8 and 26
USAEC PFAS Preliminary Assessment / Site Inspection
Vint Hill Farms Station, Virginia

Figure 7-22



Legend:

- ● = Complete Exposure Pathway
- ◐ = Potentially Complete Exposure Pathway
- ○ = Incomplete Exposure Pathway

Notes:
[1] Surface water exposure pathway for Site Workers and Residents describes a drinking water scenario, and for Recreational Users describes incidental ingestion and dermal contact during an outdoor recreational scenario.
[2] All types of off-installation human receptors include drinking water receptors and recreational users.

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Conceptual Site Model - AREE 13
USAEC PFAS Preliminary Assessment / Site Inspection
Vint Hill Farms Station, Virginia

Figure 7-23

Source Medium	Release / Transport Mechanisms	Environmental Media	Release / Transport Mechanisms	Exposure Media	Exposure Route	Human Receptors: On-Installation: Site Worker	On-Installation: Resident	On-Installation: Recreational User	Off-Installation: All Types of Receptors [2]
AFFF Releases to Soil and/or Paved Surfaces				Soil	Ingestion	○	○	○	○
					Dermal Contact	○	○	○	○
					Inhalation (dust)	○	○	○	○
	Desorption / Dissolution	Groundwater		Groundwater	Ingestion	◐	◐	○	◐
					Dermal Contact	◐	◐	○	◐
			Discharge / Recharge						
	Surface Runoff / Dissolution / Adsorption	Surface Water		Surface Water [1]	Ingestion	○	○	●	◐
					Dermal Contact	○	○	●	◐
			Adsorption / Desorption	Sediment	Ingestion	○	○	◐	◐
					Dermal Contact	○	○	◐	◐

Legend:

● = Complete Exposure Pathway

◐ = Potentially Complete Exposure Pathway

○ = Incomplete Exposure Pathway

Notes:

[1] Surface water exposure pathway for Site Workers and Residents describes a drinking water scenario, and for Recreational Users describes incidental ingestion and dermal contact during an outdoor recreational scenario.

[2] All types of off-installation human receptors include drinking water receptors and recreational users.

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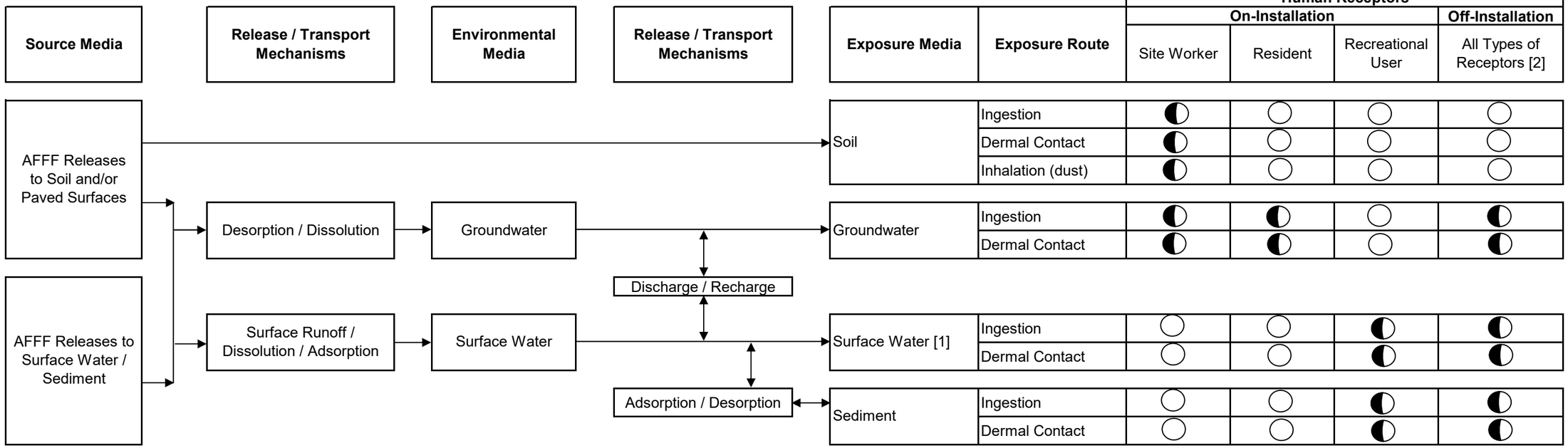
Conceptual Site Model - AREE 16-1

USAEC PFAS Preliminary Assessment / Site Inspection

Vint Hill Farms Station, Virginia

Figure 7-24



Legend:

- ● = Complete Exposure Pathway
- ◐ = Potentially Complete Exposure Pathway
- ○ = Incomplete Exposure Pathway

Notes:
[1] Surface water exposure pathway for Site Workers and Residents describes a drinking water scenario, and for Recreational Users describes incidental ingestion and dermal contact during an outdoor recreational scenario.
[2] All types of off-installation human receptors include drinking water receptors and recreational users.

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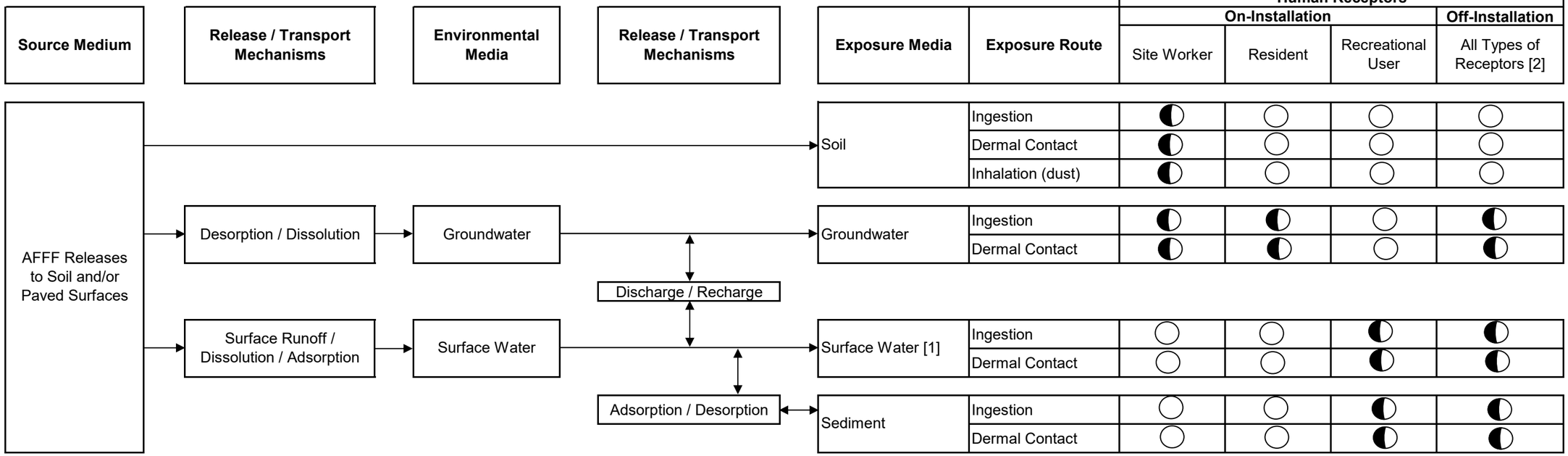
Conceptual Site Model - AREE 1
USAEC PFAS Preliminary Assessment / Site Inspection
Vint Hill Farms Station, Virginia

Figure 7-25



Legend:

- ● = Complete Exposure Pathway
- ◐ = Potentially Complete Exposure Pathway
- ○ = Incomplete Exposure Pathway

Notes:
[1] Surface water exposure pathway for Site Workers and Residents describes a drinking water scenario, and for Recreational Users describes incidental ingestion and dermal contact during an outdoor recreational scenario.
[2] All types of off-installation human receptors include drinking water receptors and recreational users.

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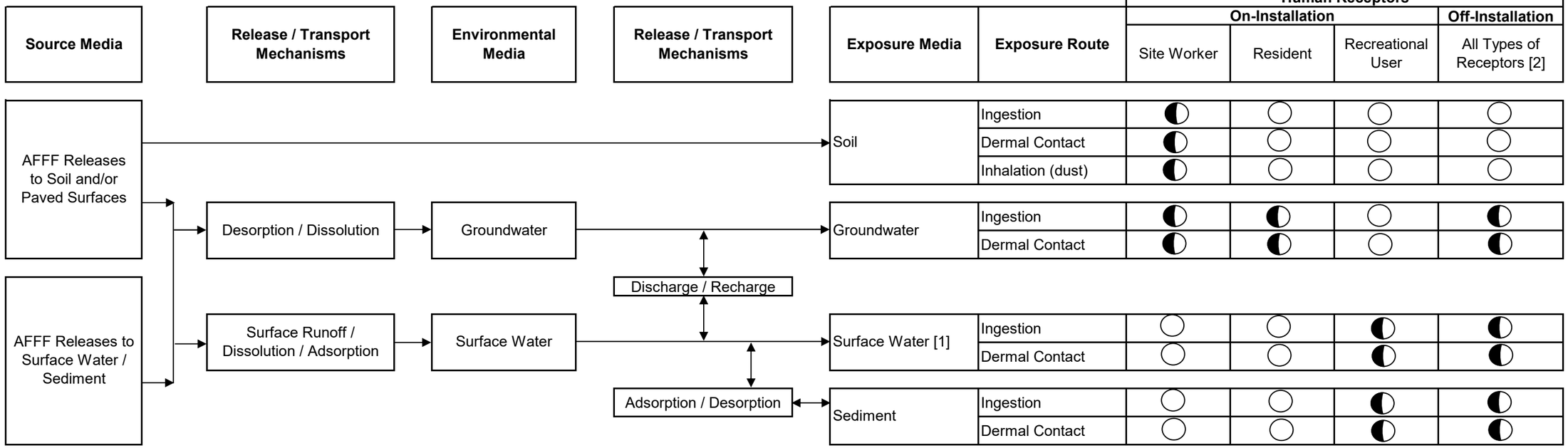
Conceptual Site Model - Building 2740 and Automated Car Wash
USAEC PFAS Preliminary Assessment / Site Inspection
Vint Hill Farms Station, Virginia

Figure 7-26



Legend:

- ● = Complete Exposure Pathway
- ◐ = Potentially Complete Exposure Pathway
- ○ = Incomplete Exposure Pathway

Notes:
[1] Surface water exposure pathway for Site Workers and Residents describes a drinking water scenario, and for Recreational Users describes incidental ingestion and dermal contact during an outdoor recreational scenario.
[2] All types of off-installation human receptors include drinking water receptors and recreational users.

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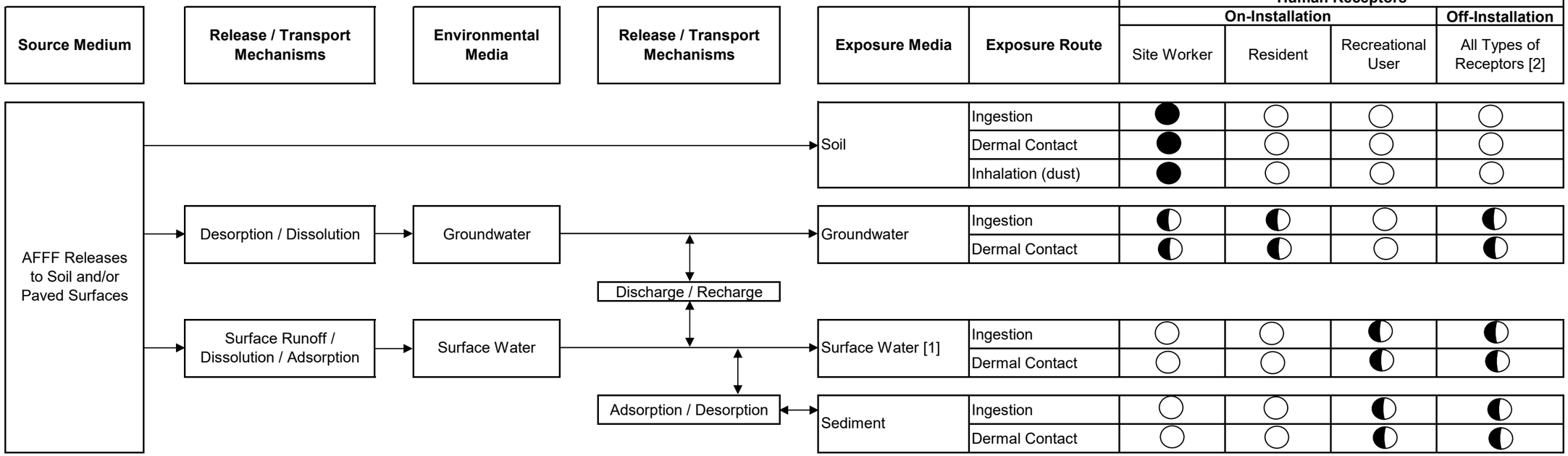
Conceptual Site Model - AREE 9
USAEC PFAS Preliminary Assessment / Site Inspection
Vint Hill Farms Station, Virginia

Figure 7-27



Legend:

● = Complete Exposure Pathway

◐ = Potentially Complete Exposure Pathway

○ = Incomplete Exposure Pathway

Notes:

[1] Surface water exposure pathway for Site Workers and Residents describes a drinking water scenario, and for Recreational Users describes incidental ingestion and dermal contact during an outdoor recreational scenario.

[2] All types of off-installation human receptors include drinking water receptors and recreational users.

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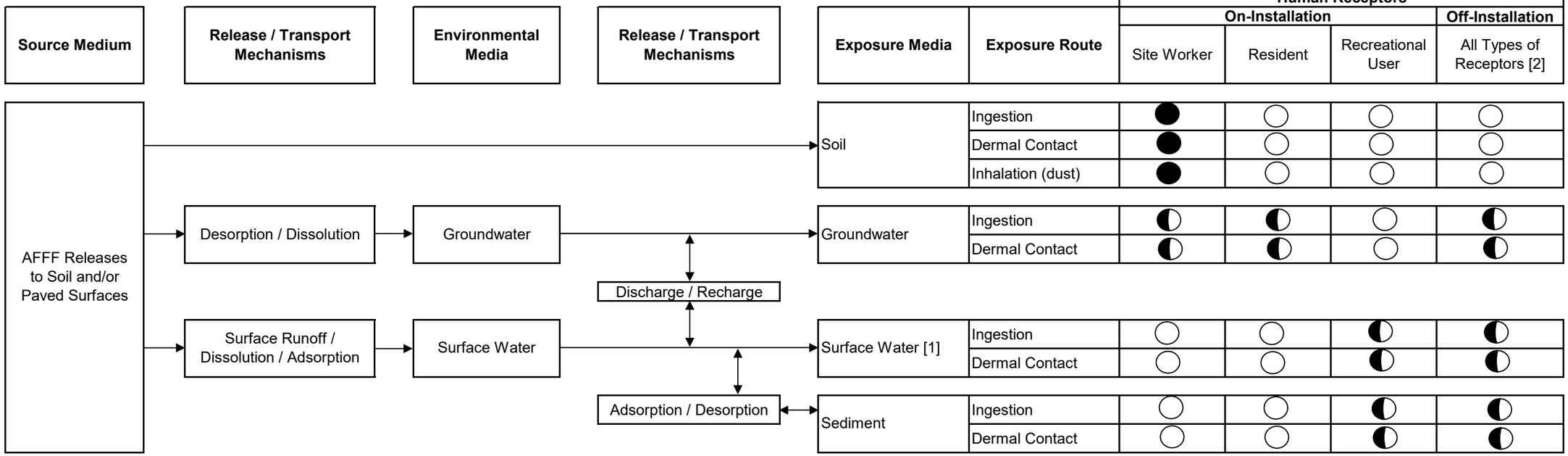
Conceptual Site Model - AREE 16-2

USAEC PFAS Preliminary Assessment / Site Inspection

Vint Hill Farms Station, Virginia

Figure 7-28



Legend:

● = Complete Exposure Pathway

◐ = Potentially Complete Exposure Pathway

○ = Incomplete Exposure Pathway

Notes:

[1] Surface water exposure pathway for Site Workers and Residents describes a drinking water scenario, and for Recreational Users describes incidental ingestion and dermal contact during an outdoor recreational scenario.

[2] All types of off-installation human receptors include drinking water receptors and recreational users.

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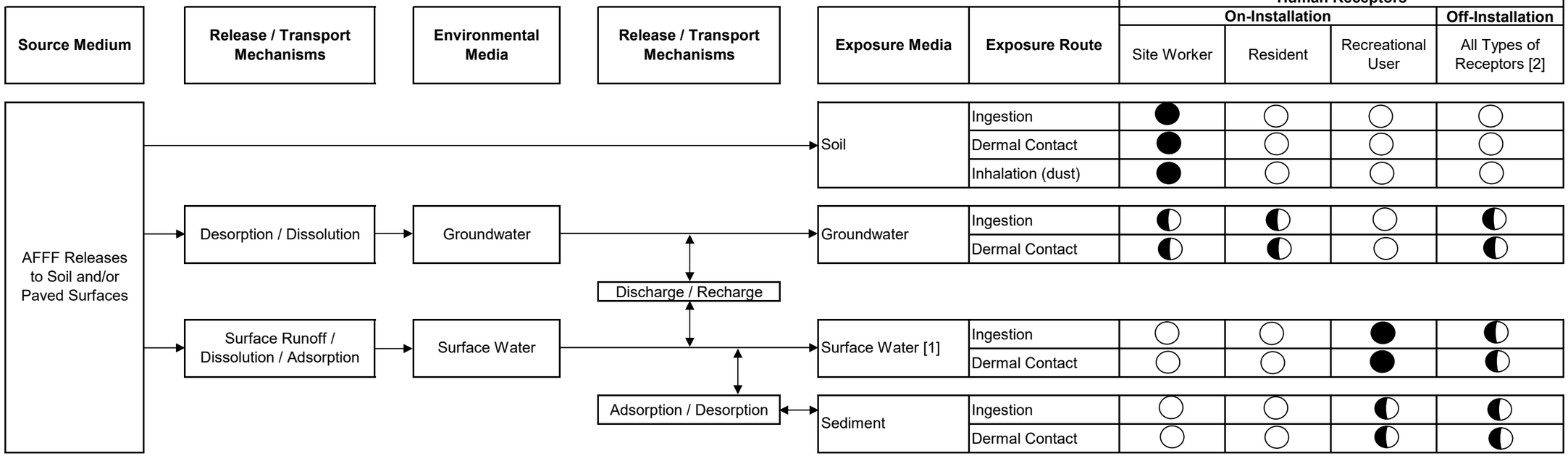
Conceptual Site Model - Building 271
USAEC PFAS Preliminary Assessment / Site Inspection
Vint Hill Farms Station, Virginia

Figure 7-29



Legend:

- ● = Complete Exposure Pathway
- ◐ = Potentially Complete Exposure Pathway
- ○ = Incomplete Exposure Pathway

Notes:
[1] Surface water exposure pathway for Site Workers and Residents describes a drinking water scenario, and for Recreational Users describes incidental ingestion and dermal contact during an outdoor recreational scenario.
[2] All types of off-installation human receptors include drinking water receptors and recreational users.

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Conceptual Site Model - AREE 10
USAEC PFAS Preliminary Assessment / Site Inspection
Vint Hill Farms Station, Virginia

Figure 7-30