FINAL PRELIMINARY ASSESSMENT AND SITE INSPECTION OF PER- AND POLYFLUOROALKYL SUBSTANCES

Former Tarheel Army Missile Plant, North Carolina

Prepared For:
U.S. Army Corps of Engineers, Baltimore District
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Preliminary Assessment and Site Inspection of Per- and Polyfluoroalkyl Substances

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EXECUTIVE SUMMARY

The United States Army (Army) is performing preliminary assessments (PAs) and site inspections (SIs) on the current or potential historical use of per- and polyfluoroalkyl substances (PFAS) with a focus on perfluorooctane sulfonate (PFOS), perfluorooctanoic acid (PFOA), perfluorobutanesulfonic acid (PFBS), perfluorononanoic acid (PFNA), perfluorohexane sulfonate (PFHxS), and hexafluoropropylene oxide dimer acid (HFPO-DA) at Army installations nationwide. The PA identifies areas of potential interest (AOPIs) where PFAS-containing materials were used, stored, and/or disposed, or areas where known or suspected releases to the environment occurred. The SI includes multi-media sampling at AOPIs to determine whether or not a release has occurred. The SI may conclude further investigation is warranted, a removal action is required to address immediate threats, or no further action is required. This Former Tarheel Army Missile Plant (TAMP) PA/SI was completed in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), National Oil and Hazardous Substances Pollution Contingency Plan, and Army/Department of Defense (DoD) policy and guidance.

TAMP is located at 204 Graham-Hopedale Road in Burlington, North Carolina. TAMP consists of 25 buildings occupying approximately 32 acres within the city limits of Burlington, Alamance County. The area surrounding TAMP is mostly residential and commercial. Commercial properties are present along the western and southern boundaries of TAMP. Residential properties border the northern boundary.

The TAMP PA identified two AOPIs for investigation during the SI phase. SI sampling results from the two AOPIs were compared to risk-based screening levels calculated by the Office of the Secretary of Defense (OSD) for PFOS, PFOA, PFBS, PFNA, and PFHxS. Of the six PFAS compounds presented in the 06 July 2022 OSD memorandum, HFPO-DA (commonly referred to as GenX) was not included as an analyte at the time of this SI. Based on the conceptual site model CSM developed during the PA and revised based on SI findings, the presence of HFPO-DA is not anticipated at [installation name] because HFPO-DA is generally not a component of military specification (MIL-SPEC) aqueous film forming foam (AFFF) and based on its history including distribution limitations that restricted use of GenX, it is generally not a component of other products the military used. In addition, it is unlikely that GenX would be an individual chemical of concern in the absence of other PFAS. PFOS, PFOA, PFBS, PFNA and PFHxS were detected in groundwater at both AOPIs; and both AOPIs had PFOS and PFOA in groundwater present at concentrations greater than the risk-based screening levels. PFOS was detected in soil at both AOPIs; and PFOA was detected at one of the two AOPIs. None of the AOPIs had PFOS or PFOA present in soil at concentrations greater than the risk-based screening levels. The TAMP PA/SI identified the need for further study in a CERCLA remedial investigation. **Table ES-1** below summarizes the PA/SI sampling results and provides 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 PA, PFOS, PFOA, PFBS, PFNA, and PFHxS Sampling at TAMP, and Recommendations

AOPI Name	PFOS, PFOA, PFBS, PFNA, and/or PFHxS detected greater than OSD Risk Screening Levels? (Yes/No)		Recommendation
	GW	SO	
Plating Area (Buildings 11 and 20)	Yes	No	Further study in a remedial investigation
Industrial Wastewater Treatment Plant (IWTP) Area (Buildings 23, 29, 30)	Yes	No	Further study in a remedial investigation

Notes:
Light gray shading – detection greater than the OSD risk screening level
GW – groundwater
SO – soil

1 INTRODUCTION

The United States (U.S.) Army (Army) is performing preliminary assessments (PAs) and site inspections (SIs) on the current or potential historical use of per- and polyfluoroalkyl substances (PFAS) with a focus on perfluorooctane sulfonate (PFOS), perfluorooctanoic acid (PFOA), perfluorobutanesulfonic acid (PFBS), perfluorononanoic acid (PFNA), perfluorohexane sulfonate (PFHxS), and hexafluoropropylene oxide dimer acid (HFPO-DA) at Army installations (installations) nationwide. 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 §§ 9600, et seq. (as amended), and the Defense Environmental Restoration Program, 10 United States Code §§ 2701, et seq. The PFAS PA/SI included two distinct efforts. The PA identified locations that are areas of potential interest (AOPIs) at the Former Tarheel Army Missile Plant (TAMP) based on the potential 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 has occurred, and the analytical results were compared to the Office of the Secretary of Defense (OSD) PFOS, PFOA, PFBS, PFNA, and PFHxS risk screening levels in the OSD memo dated July 6, 2022 (OSD 2022) to determine whether further investigation is warranted. HFPO-DA was not in the suite of PFAS compounds analyzed during the SI; therefore, there are no HFPO-DA SI analytical results to screen against the OSD risk screening levels. This report provides the PA/SI for TAMP 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 Department of Defense (DoD) restoration sites (OSD 2019). The DoD guidance provides risk screening levels for PFOS, PFOA, and PFBS in tap water and 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). Based on the updated toxicity assessment for PFBS, the OSD issued a memorandum on 15 September 2021 to include updated PFBS risk screening levels (OSD 2021). On 18 May 2022, the USEPA published an update to the RSLs table. The May 2022 RSL table included six PFAS constituents: PFOS, PFOA, PFBS, PFNA, PFHxS, and HFPO-DA (USEPA 2022). On 06 July 2022, the OSD issued a memorandum to include

revised risk screening levels based on the May 2022 USEPA RSLs (OSD 2022). The July 2022 Memorandum: Investigating Per- and Polyfluoroalkyl Substances within the Department of Defense Cleanup Program is provided for reference as **Appendix A**. These screening criteria are discussed further in **Section 6.5**.

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.

1.2.1 PA Objectives

During the PA, investigators collect readily available information and conduct site reconnaissance. This PA will evaluate and document areas where PFAS-containing materials were potentially 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.

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 SI includes multi-media sampling at AOPIs to determine whether or not a release has occurred. The SI may conclude further investigation is warranted, a removal action is required to address immediate threats, or no further action is required.

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 TAMP, PA/SI development followed the process as described below. **Section 3** provides a summary of the PA activities completed, and **Section 6** provides a summary of the SI activities completed for TAMP. The PA and SI processes are documented in the PA/SI Quality Control Checklist included as **Appendix B**.

1.3.1 Site Background Research

An installation kickoff teleconference was held between applicable points of contact (POCs) from United States Army Environmental Command (USAEC), United States Army Corps of Engineers (USACE), and Arcadis U.S., Inc. (Arcadis). The kickoff call occurred on 11 January 2021, to discuss the goals and scope of the PA, project scheduling, installation access, access to installation-specific data, and to request available records. It was noted during the teleconference that TAMP is not an active installation and there are no personnel or documents at the facility. In addition, Arcadis personnel had knowledge of the site

buildings and layout from a non-PFAS environmental investigation previously conducted at TAMP under a separate contract. Therefore, a site visit was determined to be unnecessary.

Records review was conducted to obtain electronically available documents relevant to the installation from the Army 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 the TAMP.

1.3.2 Preliminary Assessment Site Research

Personnel interviews were conducted with local government individuals having historical knowledge of TAMP. The interviews focused on confirming information discussed in historical documents, collecting information that may have not been in historical documents, and corroborating information.

Site research included surveys of historical documents that referenced 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 reviewed based on information from previous environmental investigations at the site, including local slope and ground and floor conditions (i.e., paved, unpaved), surface water bodies and surface flow, potential receptors, and the distance to the installation boundary. Access to existing groundwater monitoring wells was also noted in case the monitoring wells could be beneficial for SI sampling.

As mentioned in subsection 1.3.1, a site visit was not conducted at TAMP, therefore a site visit trip report was not completed and provided. In lieu of the site visit trip report, a Research Status Report was submitted on 12 February 2021. The Research Status Report contains the following information:

- A list of preliminary locations identified during the records review to be evaluated for use, storage, and/or disposal of PFAS-containing materials.
- A list of off-site non-Army personnel interviewed, their roles, and contact information.
- Relevant data and documents obtained and/or reviewed during the research.
- Site areas identified during research. Historical photographs of areas relevant to the research with brief descriptions.
- A timeline of operations conducted at the site.
- A facility drawing showing prospective AOPIs.

The information collected was compiled to develop the installation-specific PA portion of the PA/SI report (**Section 3**). Site data obtained 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.

1.3.3 Site Inspection Planning and Field Work

The SI process was initiated to evaluate PFOS, PFOA, PFBS, PFNA, and PFHxS presence or absence at each AOPI and determine whether further investigation is warranted. First, an SI kickoff and scoping teleconference was held on 29 July 2022, between the USAEC, USACE and Arcadis.

The objectives of the SI kickoff and scoping teleconference were to:

- discuss the AOPIs selected for sampling and the proposed sampling plan for each AOPI
- confirm the plan for investigation-derived waste (IDW) handling and disposal
- identify specific installation access requirements and potential schedule conflicts
- discuss general SI deliverable and field work schedule information and logistics

A Programmatic Uniform Federal Policy-Quality Assurance Project Plan (PQAPP) was developed and finalized in October 2019 for the USAEC PFAS PA/SI Program (Arcadis 2019). The PQAPP details general planning processes for collecting data and describes the implementation of quality assurance (QA) and quality control (QC) activities for the SI portion for Army installations nationwide. Additionally, a site-specific QAPP Addendum was developed to define the DQOs, present the sampling design and rationale, and provide qualifications for project personnel. The SI field work was completed in accordance with the PQAPP (Arcadis 2019) and the approved site-specific QAPP Addendum. A Site Safety and Health Plan (SSHP) was also developed as an attachment to the QAPP Addendum to identify specific health and safety hazards that may be encountered at the installation during sampling. The SSHP was designed to supplement the Accident Prevention Plan (Arcadis 2018), which was developed for Army installations nationwide. The QAPP Addendum and SSHP were submitted to the Army 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 Addendum developed for TAMP (Arcadis 2022b) in **Sections 6.1** through **6.3**.

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

1.3.4 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 PFOS, PFOA, PFBS, PFNA, and PFHxS analysis by liquid chromatography with tandem mass spectrometry and compliant with the DoD Quality Systems Manual (QSM) 5.3 (DoD and Department of Energy (DOE) 2019). PFAS analysis was performed in compliance with Table B-15 of the DOD/DOE QSM 5.3. 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**).

2 INSTALLATION OVERVIEW

The following subsections provide general information about TAMP, including the location and layout, the site operation(s) over time, a brief site history, current and projected land use, climate, topography, geology, hydrogeology, surface water hydrology, potable wells within a 1-mile radius of the installation, and applicable ecological receptors.

2.1 Site Location

TAMP is located at 204 Graham-Hopedale Road in Burlington, North Carolina. TAMP consists of 25 buildings occupying approximately 32 acres within the city limits of Burlington, in Alamance County (DeMeyer 2019). The area surrounding the TAMP is mostly residential and commercial. Commercial properties are present along the western and southern boundaries of TAMP. Residential properties border the northern boundary (Arcadis-PIKA 2020). The site location is shown on **Figure 2-1** and the site layout, including approximate groundwater and surface water flow directions is shown on **Figure 2-2**.

2.2 Mission and Brief Site History

TAMP was established in 1927 as a small textile manufacturing plant for production of the synthetic fabric rayon. Following closure of the plant in 1931, the property was used as a storage facility. In 1942, the property was acquired by the Defense Plant Corporation. From 1942 through 1944, the facility was leased to the Fairchild Engines and Airplane Corporation for the manufacturing of training aircraft for the U.S. Army Air Force. The existing plant was expanded for use as a testing facility for the manufactured aircraft. Fairchild vacated the facility in 1944, at which time the plant was leased to the Firestone Tire and Rubber Company (Arcadis-PIKA 2020).

At the end of World War II, the plant was categorized as surplus and administration was transferred from the Defense Plant Corporation to the United States General Services Administration (USGSA). Between 1946 and 1958, the Western Electric Company leased the plant from the USGSA/U.S. Department of the Army for manufacturing of commercial electronic equipment. In 1951, the production of civilian electronic equipment ceased and shifted to the production of missile ground guidance systems and components and assembly of the Army's Nike Missiles (Arcadis-PIKA 2020).

In July 1962, the plant was placed under the jurisdiction of the U.S. Army Aviation and Missile Command and designated as TAMP. The property was leased to AT&T for defense-related electronic systems production and maintenance until 1999 when Lucent Technologies took over. In 2004, the U.S. Department of the Army/USGSA sold the property to Hopedale Investments, LLC. The property was used to host a flea market that raised funds for hospice care. The property was sold again in 2013 to Saucier, Inc. and multiple times since (Arcadis-PIKA 2020).

2.3 Current and Projected Land Use

The land use at TAMP consists of predominantly vacant facilities with plans for leasing storage space in two empty buildings. The surrounding area is a mix of residential and commercial use (Arcadis-PIKA 2020).

2.4 Climate

Burlington, North Carolina is classified as hot and muggy in the summer. Winters are very cold. It is wet and partly cloudy year-round. Precipitation averages approximately 45 inches annually. During the hot season, 26 May to 14 September, the average daily high temperature is above 80 degrees Fahrenheit. The cold season, 29 November through 28 February, has an average daily high temperature below 57 degrees Fahrenheit (Arcadis-PIKA 2020).

2.5 Topography

TAMP's topography is generally flat with little topographic relief (**Figure 2-3**). The highest elevation occurs in the southeast portion of the installation, with a gradual decrease in elevation to the northwest. The average surface elevation at TAMP is approximately 624.73 feet above mean sea level (Arcadis-PIKA 2020). The installation drains into the Little Alamance Creek watershed, which is a highly developed urban watershed within the Cape Fear River Basin where watershed drainage is directed to the Atlantic Coast (American Rivers 2023).

2.6 Geology

TAMP lies within the Piedmont physiographic province. Lithology in the Burlington area is characterized by metamorphosed plutonic and volcanic rocks of the Carolina terrane. Metamorphosed granite, granodiorite, diorite, and gabbro dominate the sequence, with volcanic rock types comprising only a small portion. Northeast to northwest trending diabase dikes are commonly mapped cross-cutting metamorphic rocks. In addition, localized shearing may be common in these rocks, as evident by the development of gneissic to schistose foliation. Small-scale folds and highly fractured zones may also be observed (Arcadis-PIKA 2020).

The soils in this region are composed of clayey to sandy silts, commonly referred to as saprolite, derived from extensive physical and chemical weathering of the underlying bedrock. Saprolite composition varies based on the composition of the underlying bedrock. In general, saprolite typically grades from clay rich soils at shallower depths to soils containing a high percentage of sand and gravel sized grains near the bedrock interface (Arcadis-PIKA 2020).

2.7 Hydrogeology

The groundwater system in the Piedmont is generally a two-part system. The saprolite zone constitutes the upper portion, where it serves as the principal storage reservoir for groundwater. A transition zone of coarse, partially weathered bedrock separates the saprolite from the underlying fractured bedrock. Groundwater moves through the transition zone parallel to the bedrock, and through interconnected fracture sets within the bedrock.

Groundwater hydrology is relatively localized and governed by recharge and discharge zones that are generally bounded by surface watersheds. Higher elevations form the watershed boundary, or recharge zones, and perennial surface water bodies in the topographic lows form discharge zones. Groundwater migrates from the higher areas to perennial streams that represent discharge boundaries (Arcadis-PIKA

2020). The regional groundwater discharge point for this area is the Haw River located approximately 1 mile to the northeast of the site.

Based on historical monitoring data, groundwater generally flows from the southeast corner of the site to the northwest. Pump tests performed by Weston Solutions, Inc. in the central and northwestern portions of the site indicate an approximate saprolite K value of 1.2×10^{-3} centimeters per second (equal to 3.5 feet per day) and a bedrock K value of approximately 4.7×10^{-4} centimeters per second (equal to 1.3 feet per day) (Arcadis-PIKA 2020).

2.8 Surface Water Hydrology

Surface water runoff drains into an unnamed stream/drainage ditch located approximately 300 feet west of TAMP's western boundary. The unnamed tributary flows approximately 2,700 feet north into Service Creek. Service Creek flows approximately 1,500 feet east into the Haw River. No water supply extraction points were identified on the Haw River downstream of Service Creek in the Burlington area (Arcadis-PIKA 2020).

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 constituents at TAMP.

2.9.1 Stormwater Management System Description

Stormwater drainage at TAMP is directed to the intermittent stream that flows into an unnamed tributary of the Haw River approximately 300 feet west of the site boundary. Stormwater runoff may reach offsite drainage ditches or streams due to the topography of the site (Arcadis-PIKA 2020).

2.9.2 Sewer System Description

Wastewater generated at TAMP was discharged into the sanitary sewage system and treated at the East Burlington wastewater treatment facility. An industrial wastewater treatment plant was operational from 1972 to 1977 and was used to treat waste generated from metal plating operations at TAMP. Sludge treated at the industrial wastewater treatment plant was taken to an off-site landfill. The industrial wastewater treatment plant potentially received PFAS-containing waste drainage from the metal plating operation sludge and wastewater generated during its operation (Black & Veatch [B&V] Waste Science and Technology 1992).

2.10 Potable Water Supply and Drinking Water Receptors

There are no onsite drinking water or potable wells at TAMP. 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 TAMP, which along with state and county geographic information systems, identified no off-post public and private wells within one

mile of the installation boundary (**Figure 2-4**). The EDR report providing well search results is provided as **Appendix C**.

2.11 Ecological Receptors

The PA team collected information regarding ecological receptors that was available in the installation documents. The following information is provided for future reference should the Army decide to evaluate exposure pathways relevant to the ecological receptors.

Potentially exposed receptors are designated based on the available habitat associated with TAMP. TAMP is located within the Southern Outer Piedmont ecoregion. The Piedmont ecoregion comprises a transitional area between the mostly mountainous ecoregions of the Appalachians to the northwest and the relatively flat coastal plain to the southeast. Pine (mostly loblolly and shortleaf) dominates on old field sites and pine plantations, while mixed oak forest is found in less heavily altered areas (Arcadis-PIKA 2020).

Most of the site is developed except for approximately 2 acres in the eastern portion of the property which contain the only existing ecological habitat consisting of maintained grass and a few mature trees.

Potentially exposed receptors include terrestrial wildlife (i.e., mammals and birds), soil invertebrates, terrestrial plants, aquatic wildlife (i.e., mammals and birds) and aquatic life (i.e., fish and epifaunal invertebrates). The listings of threatened and endangered species, as well as species of concern, were obtained from the U.S. Fish and Wildlife Service online databases for Alamance County. No threatened or endangered species were identified at the site, and the habitat present at the site was found not suitable to support threatened or endangered species. (Arcadis-PIKA 2020).

2.12 Previous PFAS Investigations

No previous (i.e., pre-PA) PFAS investigations relative to TAMP, including both those conducted and not conducted by the Army, were completed prior to this investigation.

3 SUMMARY OF PA ACTIVITIES

To document areas where any potential current and/or historical PFAS-containing materials were used, stored and/or disposed at TAMP, data was collected from three principal sources of information and are described in the subsections below:

1. Records review (historical electronic files provided by the Army)
2. Personnel interviews (city and county personnel with knowledge of TAMP history)
3. Site knowledge and files from previous work at the inactive facility

Preliminary locations of potential use, storage, and/or disposal of PFAS-containing materials were then evaluated in the PA and were categorized as AOPIs or as areas not retained for further investigation at this time based on the information collected (e.g., documents reviewed, city/county personnel interviews, internet searches). A summary of the observations made, and data collected through file reviews (**Appendix D**), city/county personnel interviews (**Appendix E**), photos from previous site work (**Appendix F**) and site areas (**Appendix G**) during the PA process for TAMP is presented in **Section 4**. Further discussion regarding rationale for not retaining areas for further investigation is presented in **Section 5.1**, and further discussion regarding categorizing areas as AOPIs is presented in **Section 5.2**.

3.1 Records Review

The records reviewed included, but were not limited to, various administrative record documents, compliance documents, property transfer files and other electronic files provided by the Army. Internet searches were also conducted to identify publicly available and other relevant information. A list of the specific documents reviewed for TAMP is provided in **Appendix D**.

3.2 Personnel Interviews

Personnel interviews were conducted with individuals having historical knowledge of operations at TAMP.

The list of roles and affiliations of individuals interviewed is presented below.

- Assistant Fire Chief – Burlington Fire Department
- Reference Librarian – May Memorial Library (Alamance County)
- Engineering Manager – Burlington North Carolina Engineering Department

The list of interviewed personnel is provided in **Appendix E**.

3.3 Site Reconnaissance

Site reconnaissance was not conducted at TAMP since the site is inactive with no personnel on site and there are no records stored at the site. A photo log from site visits during a previous Army contract is provided in **Appendix F**; photos were used to assist in verification of qualitative data collected in the field. The site operational areas and buildings are provided in **Appendix G**.

Access to existing groundwater monitoring wells was also noted during the site evaluation in case the monitoring wells could be proposed for SI sampling.

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

TAMP was evaluated for all potential current and historical use, storage, and/or disposal of PFAS-containing materials. As such, this section is organized to summarize the aqueous film-forming foam (AFFF)-related uses first, and all remaining potential PFAS-containing materials in the subsequent section.

4.1 AFFF Use, Storage, and Disposal Areas

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 DoD facilities may have occurred during firefighter training, emergency response actions, equipment testing, or accidental releases. The military still primarily uses AFFF for Class B fires; however, the current formulations of AFFF contain significantly lower amounts of PFOS, PFOA, and their precursors, and significant operational changes have been implemented to restrict uncontrolled releases and non-essential use of PFAS-containing foams. 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.

Available documents did not indicate any historical fire training areas/activities or fire stations at TAMP. There was a water sprinkler system noted in facility drawings and referenced by the Burlington Assistant Fire Chief in the interview. Historical utilization of AFFF has not been noted at TAMP.

4.2 Other PFAS Use, Storage, and/or Disposal Areas

Following document research and city/county personnel interviews, and using site knowledge for TAMP, a plating facility that may have used PFAS-containing mist suppressants for chromium plating operations, and the associated industrial water treatment plant were identified as preliminary locations for use, storage, and/or disposal of PFAS-containing materials (B&V Waste Science and Technology 1992). A summary of information gathered in the PA for each of these preliminary locations is described below. Specific discussion regarding areas not retained for further investigation is presented in **Section 5.1** and specific discussion regarding areas retained as AOPIs is presented in **Section 5.2**.

Potential PFAS use associated with metal plating activities may be relevant to Army installations. During chromium 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.

Several historical documents indicated that chromium metal plating operations took place in Buildings 11 and 20 at TAMP. These buildings, referred to as the Plating Area, were identified as a preliminary AOPI.

Buildings 23, 29, and 30 comprised the Industrial Wastewater Treatment Plant (IWTP) Area, which treated the wastewater discharge from the Plating Area (Buildings 11 and 20) in addition to the other areas of the site (B&V Waste Science and Technology 1992). These buildings were identified as a preliminary AOPI as well.

4.3 Readily Identifiable Off-Post PFAS Sources

An exhaustive search to identify all potential off-post PFAS sources (i.e., not related to operations at TAMP) is not part of the PA/SI. However, potential off-post PFAS sources within a 5-mile radius of the installation were not identified during the records search.

5 SUMMARY AND DISCUSSION OF PA RESULTS

The preliminary locations evaluated for potential use, storage, and/or disposal of PFAS-containing materials at TAMP, 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, two areas have been identified as AOPIs. The process used for refining these areas is presented on **Figure 5-1**, below.

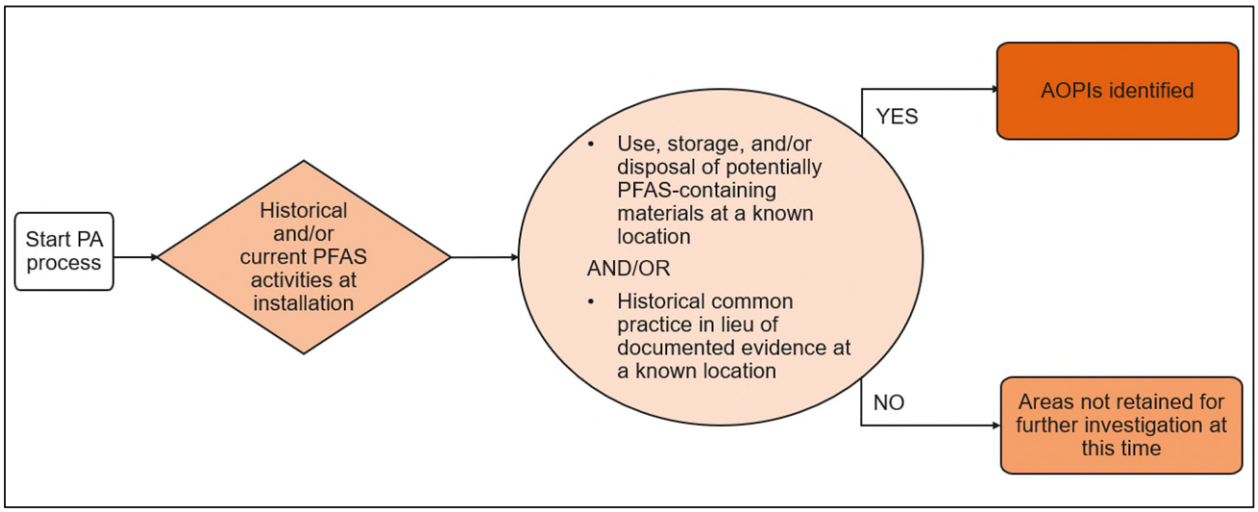

Figure 5-1: AOPI Decision Flowchart

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 TAMP are presented in **Section 8**.

5.1 Areas Not Retained for Further Investigation

Through the evaluation of information obtained during file review, city/county personnel interviews, and/or other research, 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 are presented in **Table 5-1**, below.

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

Area Description	Dates of Operation	Relevant Site History	Rationale
Photo Development Area (Buildings 2 and 16)	1958 to 1980	No information located on development process or surface coatings used.	No evidence of PFOS, PFOA, PFBS, PFNA, and PFHxS containing materials used, stored, and/or disposed of at this location.

5.2 AOPIs

Overviews for each AOPI identified during the PA process are presented in this section.

The AOPI locations are shown on **Figure 5-2**. Aerial photographs of each AOPI that also show the approximate extent of PFAS use are presented on **Figures 5-3** and **5-4** and include active monitoring wells in the vicinity of each AOPI.

5.2.1 Plating Area (Buildings 11 and 20)

The Plating Area (Buildings 11 and 20) is identified as an AOPI based on documentation indicating historical operations that included chromium plating. The Plating Area was operational from 1951 to 1977. Historical operations related to the chromium plating activities in Building 20 included metal degreasing, acid cleaning, and chromate coating (B&V Waste Science and Technology 1992). Additionally, documentation indicated that a chemistry laboratory for the chromium plating operations was located in Building 11. Discharge from this AOPI was directed to the IWTP.

5.2.2 IWTP Area (Buildings 23, 29, and 30)

The IWTP Area (Buildings 23, 29, and 30) is identified as an AOPI based on research of historical files. It was noted the chromium plating area discharged to the IWTP. Permeable grass and/or soil covered areas around the IWTP were identified for potential seepage (B&V Waste Science and Technology 1992). Drainage likely flows to stormwater channels located within TAMP footprint or seeps to the subsurface to the northwest.

6 SUMMARY OF SI ACTIVITIES

Based on the results of the PA at TAMP, an SI for PFOS, PFOA, PFBS, PFNA, and PFHxS was conducted in accordance with CERCLA. SI sampling was completed at TAMP at two AOPIs to evaluate presence or absence of PFOS, PFOA, PFBS, PFNA, and PFHxS in comparison with the OSD risk screening levels. As such, an installation-specific QAPP Addendum (Arcadis 2022b) was developed to supplement the general information provided in the PQAPP (Arcadis 2019) and 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 and groundwater 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 January 2023 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 2022b) and PQAPP (Arcadis 2019). The subsections below summarize the DQOs, sampling design and rationale, sampling activities and methods, and data analyses procedures for the SI phase at TAMP. 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 2022b), the objective of the SI is to identify whether there has been a release to the environment at the AOPIs identified in the PA and to determine if further investigation is warranted. This SI evaluated groundwater, and soil for PFOS, PFOA, PFBS, PFNA, and PFHxS presence or absence at each of the sampled AOPIs.

6.2 Sampling Design and Rationale

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

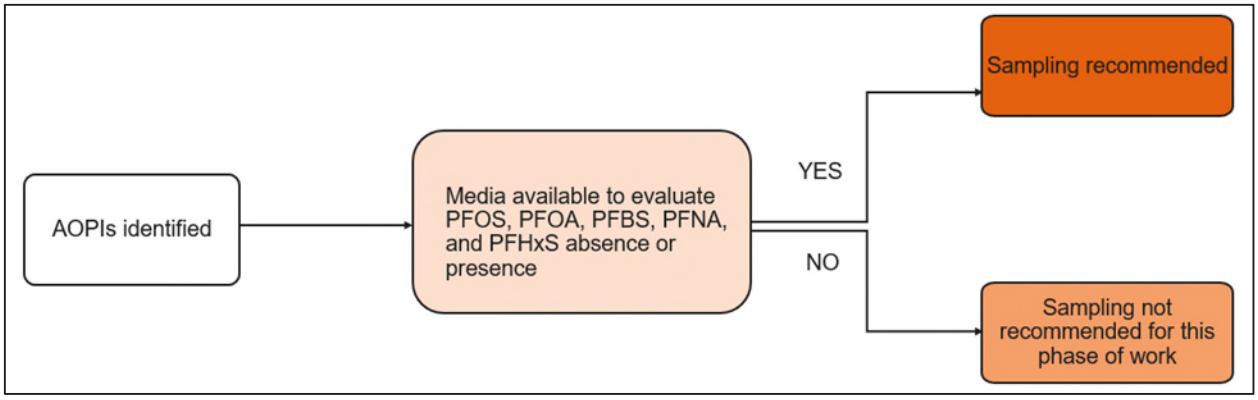

Figure 6-1: AOPI Sampling Decision Tree

The sampling design for SI sampling activities at TAMP is detailed in Worksheet #17 of the QAPP Addendum (Arcadis 2022b). Briefly, groundwater and soil samples were collected using low flow sampling and hand augers, respectively, at the Plating Area (Buildings 11 and 20) and IWTP Area (Buildings 23, 29, and 30). These areas were sampled because information from the PA indicated suspected PFAS-containing materials use, storage, and/or disposal. Sample locations were chosen based on suspected groundwater flow direction, and soil sampling locations were selected based on areas believed to have the highest potential for PFAS impacts. Sample media types (e.g., surface and subsurface soil, groundwater) collected for each AOPI were based on media most likely to confirm the presence or absence of PFOS, PFOA, PFBS, PFNA, and PFHxS directly related to the nature of the suspected use, storage, and/or disposal at each AOPI.

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.

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 2022b), and the safety procedures specified in the Accident Prevention Plan (Arcadis 2018) and SSHP (Arcadis 2022a). 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 2022b). 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 H** and **I**, respectively. Photographs of the sampling activities are included in **Appendix J**.

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. A peristaltic pump with PFAS-free disposable high-density polyethylene tubing was used to collect groundwater samples from the monitoring wells. Groundwater sampling was completed in accordance with TGI-P-11 in Appendix A to the UFP QAPP (Arcadis 2019).

Soil samples were collected using stainless steel hand augers in accordance with TGI-P-12 in Appendix A to the UFP QAPP (Arcadis 2022b). Soil samples were collected in PFAS-free acetate liners.

Decontamination procedures for non-dedicated equipment used during sampling are described in **Section 6.3.4**.

6.3.2 Quality Assurance/Quality Control

Worksheet #20 of the PQAPP and the QAPP Addendum provide QA/QC requirements for field duplicates, matrix spike/matrix spike duplicates, equipment blanks (EBs), 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 2022b), typically at a rate of 1 per 20 parent samples. Field duplicates and matrix spike/matrix spike duplicate samples were collected for media sampled for PFOS, PFOA, PFBS, PFNA, and PFHxS. EBs were collected for media sampled for PFOS, PFOA, PFBS, PFNA, and PFHxS, at a frequency of one per piece of relevant equipment for each sampling event, as specified in the QAPP Addendum (Arcadis 2022b). The decontaminated reusable equipment from which EBs were collected include tubing, hand augers, and water-level meters as applicable to the sampled media. Analytical results for blank samples are discussed in **Section 7.5**.

6.3.3 Field Change Reports

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 Reports included as **Appendix K** and are summarized below:

- For the IWTP AOPI, the location of soil sample TAMP-IWTP-03-SO was moved approximately 10 feet to the northwest due to a sewer pipe identified in the original sample location during utility clearance.

6.3.4 Decontamination

Non-dedicated reusable sampling equipment (e.g., stainless-steel trowels, hand augers, 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).

6.3.5 Investigation-Derived Waste

IDW, including soil cuttings, groundwater, decontamination fluids, and disposable equipment were collected and placed in Department of Transportation-approved 55-gallon drums, labeled as non-hazardous, segregated by medium: waters, and soil, and transported to a staging area pending analysis. Analytical results for IDW samples collected during the SI are discussed in **Section 7.3**.

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 Pace South Carolina (formerly Shealy Environmental Services, Inc.), an ELAP-accredited laboratory for PFAS analysis, including PFOS, PFOA, PFBS, PFNA, and PFHxS, by liquid chromatography with tandem mass spectrometry. Laboratory analyses associated with the SI were completed in accordance with Worksheets #12.1 through #12.5 in the PQAPP (Arcadis 2019). Eighteen PFAS-related compounds, including PFOS, PFOA, PFBS, PFNA, and PFHxS, were analyzed for in groundwater and soil samples using an analytical method that is ELAP-accredited and compliant with QSM 5.3 (DoD and Department of Energy 2019), Table B-15.

Additionally, the following general chemistry and physical characteristic analyses were completed for select soil samples in accordance with Worksheet #18 of the QAPP Addendum (Arcadis 2022b) by the analytical method noted:

- Total organic carbon (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 limit of detection (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 Data Usability Summary Report (DUSR) (**Appendix L**).

6.4.2 Data Validation

All analytical data generated during the SI, except grain size and data generated from IDW profiling, 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 QSM 5.3 (DoD and Department of Energy 2019). 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 L**. The Level IV analytical reports are included within **Appendix L** in the final electronic deliverable only.

6.4.3 Data Usability Assessment and Summary

A data usability assessment was completed for all analytical data associated with SI sampling at TAMP. Documentation generated during the data usability assessments, which were compiled into a DUSR (**Appendix L**), 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

Guidelines Module 3: 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 TAMP 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 L**), and as indicated in the full analytical tables (**Appendix M**) provided for the SI results. These data are of sufficient quality to meet the objectives and requirements of the PQAPP (Arcadis 2019) and TAMP QAPP Addendum (Arcadis 2022b). Data qualifiers applied to laboratory analytical results for samples collected during the SI at TAMP 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, PFBS, PFNA, and PFHxS 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 6-2**.

Table 6-2 OSD Risk Screening Levels Calculated for PFOS, PFOA, PFBS, PFNA, PFHxS and HFPO-DA in Tap Water and Soil Using USEPA's Regional Screening Level Calculator

Chemical	Residential Scenario Risk Screening Levels Calculated Using USEPA RSL Calculator		Industrial/Commercial Scenario Risk Screening Levels Calculated Using USEPA RSL Calculator
	Tap Water (ng/L or ppt) [1]	Soil (mg/kg or ppm) [1,2]	Soil (mg/kg or ppm) [1,2]
PFOS	4	0.013	0.16
PFOA	6	0.019	0.25
PFBS	601	1.9	25
PFNA	6	0.019	0.25
PFHxS	39	0.13	1.6
HFPO-DA[3]	6	0.023	0.35

Notes:
1. Risk screening levels for tap water and soil provided by the OSD. 2022. Memorandum: Investigating Per- and Polyfluoroalkyl Substances within the Department of Defense Cleanup Program. July 06 (**Appendix A**).
2. All soil data will be screened against both the Residential and Industrial/Commercial risk screening levels (if collected from less than 2 feet below ground surface [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.
3. Of the six PFAS compounds presented in the 06 July 2022 OSD memorandum, HFPO-DA (commonly referred to as GenX) was not included as an analyte at the time of this SI. Based on the conceptual site model CSM developed during the PA and revised based on SI findings, the presence of HFPO-DA is not anticipated at [installation name] because HFPO-DA is generally not a component of military specification (MIL-SPEC) aqueous film forming foam (AFFF) and based on its history including distribution limitations that restricted use of GenX, it is generally not a component of other products the military used. In addition, it is unlikely that GenX would be an individual chemical of concern in the absence of other PFAS.

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 for this Army PFAS PA/SI. While the current and most likely future land uses of the AOPIs at TAMP are industrial/commercial, both residential and industrial/commercial soil risk screening levels for PFOS, PFOA, PFBS, PFNA, and PFHxS will be used to evaluate detected soil concentrations. The data from the SI sampling event are compared to the OSD risk screening levels in **Section 7**. If concentrations of PFOS, PFOA, PFBS, PFNA, or PFHxS are detected greater than the applicable OSD risk screening levels, further study in a remedial investigation is recommended in **Section 8**.

7 SUMMARY AND DISCUSSION OF SI RESULTS

This section summarizes the analytical results obtained from samples collected during the SI at TAMP (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 Addendum (Arcadis 2022b). The sample results discussion below focuses on the PFOS, PFOA, PFBS, PFNA, and PFHxS analytical results because they have OSD risk screening levels. The Army will make subsequent investigation decisions based on these constituents' concentrations relative to the OSD risk screening levels.

Tables 7-1 through **7-2** provide a summary of the groundwater and soil analytical results for PFOS, PFOA, PFBS, PFNA, and PFHxS. **Table 7-3** summarizes AOPIs and whether their SI results exceed the OSD risk screening levels. **Appendix M** includes the full suite of analytical results for these media, as well as for the QA/QC samples. An overview of AOPIs at TAMP with OSD risk screening level exceedances is depicted on **Figure 7-1**. **Figures 7-2** through **7-3** show the PFOS, PFOA, PFBS, PFNA, and PFHxS analytical results in groundwater and soil for each AOPI. Non-detected results are reported as less than the LOQ. Detections of PFOS, PFOA, PFBS, PFNA, and/or PFHxS 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 data collected during the SI are reported in ng/L, or parts per trillion, and soil data is reported in mg/kg, or parts per million.

Field parameters measured for groundwater during low-flow purging are provided on the field forms in **Appendix I**. Soil descriptions are provided on the field forms in **Appendix I**. The results of the SI are grouped by AOPI and discussed for each medium as applicable. Groundwater was first encountered at depths of approximately 3 to 13 feet bgs.

Table 7-3 AOPIs and OSD Risk Screening Level Exceedances

AOPI Name	OSD Exceedances (Yes/No)
Plating Area (Buildings 11 and 20)	Yes
IWTP Area (Buildings 23, 29, and 30)	Yes

7.1 Plating Area (Buildings 11 and 20)

The subsections below summarize the groundwater and soil PFOS, PFOA, PFBS, PFNA, and PFHxS analytical results associated with Buildings 11 and 20 – Plating Area.

7.1.1 Groundwater

Groundwater samples were collected from existing monitoring wells MW-101 and MW-106 via low-flow sampling at the Plating Area (Buildings 11 and 20) AOPI (TAMP-PA-MW-101 [duplicate sample collected

at TAMP-FD-01-GW] and TAMP-PA-MW-106; **Figure 7-2**). A summary of PFOS, PFOA, PFBS, PFNA, and/or PFHxS groundwater analytical results is provided in **Table 7-1**.

PFOS was detected at concentrations greater than the OSD risk screening level of 4 ng/L in groundwater samples TAMP-PA-MW-101 (42 ng/L [37 ng/L]) and TAMP-PA-MW-106 (210 ng/L).

PFOA was detected at concentrations greater than the OSD risk screening level of 6 ng/L in groundwater samples TAMP-PA-MW-101 (39 ng/L [32 ng/L]) and TAMP-PA-MW-106 (8.9 ng/L).

PFBS was detected at a concentration below the OSD risk screening level of 601 ng/L in TAMP-PA-MW-101 (3.8 ng/L [3.2 J [estimated] ng/L]). PFBS was not detected above the LOD at sample location TAMP-PA-MW-106.

PFNA and PFHxS were each detected at concentrations below the OSD risk screening levels (6 ng/L and 39 ng/L, respectively) in TAMP-PA-MW-101 (5.4 ng/L [4.7 ng/L] and 6.2 [4.6 ng/L] ng/L, respectively) and TAMP-PA-MW-106 (2.3 J ng/L and 1.9 J ng/L, respectively).

7.1.2 Soil

Two soil samples were collected from one location at the Plating Area (Buildings 11 and 20) AOPI (TAMP-PA-SO-01; **Figure 7-2**). The soil sample location included a surface soil sample collected from 0 to 2 feet bgs (TAMP-PA-01-SO-2) and a subsurface soil sample collected from 2 to 5 feet bgs (TAMP-PA-01-SO-5). A summary of PFOS, PFOA, PFBS, PFNA, and/or PFHxS soil analytical results is provided in **Table 7-2**.

PFOS was detected at concentrations less than the residential OSD risk screening level of 0.013 mg/kg in the surface and subsurface soil samples: TAMP-PA-01-SO-2 (0.0072 mg/kg) and TAMP-PA-01-SO-5 (0.0075 mg/kg).

PFOA, PFBS, PFNA, and/or PFHxS were not detected above the LOD in the soil samples collected at the Plating Area (Buildings 11 and 20) AOPI.

7.2 IWTP Area (Buildings 23, 29, and 30)

The subsections below summarize the groundwater and soil PFOS, PFOA, PFBS, PFNA, and PFHxS analytical results associated with IWTP Area (Buildings 23, 29, and 30).

7.2.1 Groundwater

Groundwater samples were collected from three existing monitoring wells (MW-102, MW-109, and MW-115) via low-flow sampling proximate to the IWTP Area (Buildings 23, 29, and 30) AOPI (TAMP-IWTP-MW-102, TAMP-IWTP-MW-109, and TAMP-IWTP-MW-115; **Figure 7-3**). A summary of PFOS, PFOA, PFBS, PFNA, and/or PFHxS groundwater analytical results is provided in **Table 7-1**.

PFOS was detected at concentrations greater than the OSD risk screening level of 4 ng/L in groundwater samples TAMP-IWTP-MW-102 (16 ng/L), TAMP-IWTP-MW-109 (38 ng/L), and TAMP-IWTP-MW-115 (93 ng/L).

PFOA was detected at concentrations greater than the OSD risk screening level of 6 ng/L in the groundwater sample TAMP-IWTP-MW-102 (16 ng/L), TAMP-IWTP-MW-109 (43 ng/L), and at TAMP-IWTP-MW-115 (25 ng/L).

PFBS was detected at a concentration below the OSD risk screening level of 601 ng/L in TAMP-IWTP-MW-109 (3.0 J ng/L) and TAMP-IWTP-MW-115 (2.1 J ng/L). A J qualifier indicates the analyte was positively identified; however, the associated numerical value is an estimated concentration.

PFNA was detected at a concentration below the OSD risk screening level of 6 ng/L in TAMP-IWTP-MW-102 (1.9 J ng/L), TAMP-IWTP-MW-109 (3.3 J ng/L), and TAMP-PA-MW-115 (1.9 J ng/L).

PFHxS was detected at a concentration below the OSD risk screening level of 39 ng/L in TAMP-IWTP-MW-109 (3.6 ng/L) and TAMP-PA-MW-115 (4.6 ng/L).

7.2.2 Soil

Six soil samples were collected from three locations at the IWTP Area (Buildings 23, 29, and 30) AOPI (TAMP-IWTP-01-SO, TAMP-IWTP-02-SO [duplicate sampled collected at TAMP-FD-01-SO], and TAMP-IWTP-03-SO; **Figure 7-3**). Each soil sample location included a surface soil sample collected from 0 to 2 feet bgs (TAMP-IWTP-01-SO-2 through TAMP-IWTP-03-SO-2) and a subsurface soil sample collected from 2 to 5 feet bgs (TAMP-IWTP-01-SO-5 through TAMP-IWTP-03-SO-5). A summary of PFOS, PFOA, PFBS, PFNA, and/or PFHxS soil analytical results is provided in **Table 7-2**.

PFOS was detected at a concentration below the residential OSD risk screening level of 0.013 mg/kg in TAMP-IWTP-03-SO-2 (0.00084 J mg/kg) and was not detected in the remaining soil samples.

PFOA was detected at a concentration below the residential OSD risk screening level of 0.019 mg/kg in TAMP-IWTP-03-SO-2 (0.00077 J mg/kg) and was not detected in the remaining soil samples.

PFBS, PFNA, and/or PFHxS were not detected in the soil samples collected at the IWTP Area (Buildings 23, 29 and 30) AOPI.

7.3 Investigation Derived Waste

A composite sample of the purge and decontamination wastewater was collected from the 55-gallon drum (which contained approximately 20 gallons of liquid) At the time of this report, this drum was stored on site awaiting pick up. A composite sample was also collected from the 55-gallon drum which contained soil. PFOS, PFOA, PFBS, PFNA, and PFHxS were not detected in the IDW water sample. For IDW soil, PFOS was detected at 0.0014 mg/kg; PFOA, PFBS, PFNA, and PFHxS were not detected in the IDW sample. The PFOS concentration observed did not exceed the OSD risk screening levels.

The IDW water and soil were removed from the site for disposal at an off-post landfill that accepts PFAS-containing waste on May 9, 2023. The IDW disposal was coordinated with Army oversight personnel. The full analytical results (i.e., for all constituents analyzed) for IDW samples collected during the SI are included in **Appendix M**. The IDW documentation is included in **Appendix N**.

7.4 TOC, pH, and Grain Size

In addition to sampling soil for PFOS, PFOA, PFBS, PFNA, and PFHxS, 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 sample at the Plating Area (Buildings 11 and 20) AOPI was 20,500 mg/kg. The TOC in the surface soil sample at this AOPI was within range of what is typically observed in topsoil: (5,000 to 30,000 mg/kg). The combined percentage of fines (i.e., silt and clay) in the surface soil sample at the Plating Area was 41.6%.

The TOC in the surface soil sample at the IWTP Area (Buildings 23, 29, and 30) AOPI was 2,520 mg/kg. The TOC in the surface soil sample at this AOPI was lower than what is typically observed in topsoil: (5,000 to 30,000 mg/kg) and may be indicative of construction fill material. The combined percentage of fines (i.e., silt and clay) in the surface soil sample at the IWTP Area was 5.1%.

The percent moisture of the soil samples (12.4% at the Plating Area and 16.3% at the IWTP Area) was typical for clay (0 to 20%).

The pH of the soil was slightly alkaline (7.3 to 7.6 standard units).

In general, PFAS constituents tend to be more mobile in soils with less than 20% fines (silt and clay) and lower TOC such as the soil at the IWTP Area. The percentage of fines and TOC were higher in the soil at the Plating Area.

7.5 Blank Samples

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

7.6 Conceptual Site Models

The preliminary CSM presented in the QAPP Addendum (Arcadis 2022b) was re-evaluated and updated, if necessary, based on the SI sampling results. The CSM presented on **Figure 7-4** and in this section therefore represents the current understanding of the potential for human exposure.

Many of the PFAS constituents found in 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, PFBS, PFNA, and PFHxS are each negatively charged at environmentally-relevant pH. The media potentially affected by PFOS, PFOA, PFBS, PFNA, and PFHxS 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 constituents is the presence of organic matter and organic co-constituents in soils and sediments. Generally, PFAS constituents are mobile in the potentially affected media, and they are not known to be fully broken down by natural processes.

Based on the use, storage, and/or disposal of PFAS-containing materials at the AOPIs, affected media are likely to consist of soil, groundwater, surface water, and sediment. 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 figure. 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”. Additionally, the CSMs do not include ecological receptors and exposure pathways. The potential for ecological exposures to PFOS, PFOA, PFBS, PFNA, and PFHxS may be evaluated at a future date if those pathways warrant further consideration.

Figure 7-4 shows the CSM for the Plating Area (Buildings 11 and 20) and IWTP Area (Buildings 23, 29, and 30). A single CSM figure was prepared for both AOPIs because the source media, potential migration pathways and exposure media, and human exposure pathway determinations are the same. The plating area was historically used for chromium plating activities. A chemistry laboratory associated with the plating activities was located in Building 11. Operations in Building 20 included metal degreasing, acid cleaning, and chromate coating. Metal plating operations discharged to the IWTP Area with the potential for seepage into surrounding permeable (soil/grass) areas.

The following exposure pathways determinations apply to both AOPIs:

- PFOS and/or PFOA were detected in soil at the AOPIs, and site workers (e.g., staff working at the storage facilities) could contact constituents in soil via incidental ingestion, dermal contact, and inhalation of dust. Therefore, the soil exposure pathway for on-site workers is complete.
- The site is currently used for industrial purposes and no residences or recreational areas are present. However, in the event the site is redeveloped for residential or recreational purposes, hypothetical future on-site residents and recreational users and off-site receptors trespassing onto the site could contact constituents in soil via incidental ingestion, dermal contact, and inhalation of dust. Therefore, the soil exposure pathways for these receptors are potentially complete.
- PFOS, PFOA, PFBS, PFNA, and PFHxS were detected in groundwater at the AOPIs. There are no on-site potable wells at TAMP. On-site drinking water was historically provided by the City of Burlington. However, the groundwater exposure pathways (via drinking water ingestion and dermal contact) for site workers and hypothetical future residents are potentially complete to

account for potential future use of the downgradient on-site groundwater as a potable water source.

- Recreational users are not likely to contact groundwater during outdoor recreational activities; therefore, the groundwater exposure pathway for on-site recreational users is incomplete.
- Groundwater originating at the AOPIs flows off-site through the northwest boundary. Due to the absence of land use controls to prevent potable use of off-site groundwater in the area, the groundwater exposure pathway for off-site drinking water receptors is potentially complete.
- There are no surface water bodies on-site; therefore, the surface water exposure pathways (via drinking water or incidental ingestion and dermal contact) for site workers, residents, and recreational users are incomplete.
- Drainage likely flows to stormwater channels located within TAMP footprint or seeps to the subsurface to the northwest. Stormwater runoff may thereby reach off-site drainage ditches or streams and groundwater originating at the AOPIs may discharge to off-site surface water. No water supply extraction points were identified on the Haw River downstream of Service Creek in the Burlington area; however, the nearby stream and river are classified as drinking water supply sources by the North Carolina Department of Environmental Quality. Therefore, the surface water exposure pathway (via drinking water ingestion and dermal contact) for off-site drinking water receptors is potentially complete. Additionally, recreational users off-site could contact constituents in surface water and sediment through incidental ingestion and dermal contact; therefore, the surface water and sediment exposure pathways for off-site recreational users are potentially complete.

Following the SI sampling, both AOPIs were considered to have complete and potentially complete exposure pathways. Although the CSMs indicate complete and potentially complete exposure pathways may exist, the recommendation for remedial investigation is based on the comparison of analytical results for PFOS, PFOA, PFBS, PFNA, and PFHxS to the OSD risk screening levels (**Table 6-2**).

8 CONCLUSIONS AND RECOMMENDATIONS

The PFAS PA/SI included two distinct efforts. The PA identified two AOPIs at TAMP 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, PFBS, PFNA, and PFHxS to the environment occurred.

OSD provided residential risk screening levels based on the USEPA oral reference dose for PFOS, PFOA, PFBS, PFNA, and PFHxS in soil and groundwater (tap water) and industrial/commercial risk screening levels for PFOS, PFOA, PFBS, PFNA, and PFHxS in soil (**Appendix A**). A combination of document review, internet searches, and interviews with city/county officials familiar with TAMP history were used to identify specific areas of suspected PFOS, PFOA, PFBS, PFNA, and PFHxS use, storage, and/or disposal at TAMP. Following the evaluation, two AOPIs were identified.

Both AOPIs were sampled during the SI at TAMP to identify presence or absence of PFOS, PFOA, PFBS, PFNA, and PFHxS at each AOPI. Of the six PFAS compounds presented in the 06 July 2022 OSD memorandum, HFPO-DA (commonly referred to as GenX) was not included as an analyte at the time of this SI. Based on the conceptual site model CSM developed during the PA and revised based on SI findings, the presence of HFPO-DA is not anticipated at [installation name] because HFPO-DA is generally not a component of military specification (MIL-SPEC) aqueous film forming foam (AFFF) and based on its history including distribution limitations that restricted use of GenX, it is generally not a component of other products the military used. In addition, it is unlikely that GenX would be an individual chemical of concern in the absence of other PFAS. The SI scope of work was completed in accordance with the Final PQAPP (Arcadis 2019) and the TAMP QAPP Addendum (Arcadis 2022b).

Both AOPIs had detections of PFOS, PFOA, PFBS, PFNA, and PFHxS in groundwater and both AOPIs exceeded OSD risk screening levels for groundwater for PFOS and PFOA.

PFOA and PFOS were detected in soil at the IWTP Area (Buildings 23, 29, and 30) AOPI, while only PFOS was detected in soil at the Plating Area (Buildings 11 and 20) AOPI. There were no exceedances of OSD screening levels for soil at either AOPI.

The maximum concentrations of PFOS and PFOA detected in soil and groundwater at TAMP are summarized below by media:

Groundwater

- PFOS was detected at 210 ng/L, above the OSD risk screening level (4 ng/L), in sample TAMP-PA-MW-106 at the Plating Area (Buildings 11 and 20) AOPI.
- PFOA was detected at 43 ng/L, above the OSD risk screening level (6 ng/L), in sample TAMP-IWTP-MW-109 at the IWTP Area (Buildings 23, 29, and 30) AOPI.

Soil

- PFOS was detected at 0.0075 mg/kg, below the OSD residential risk screening level for soil (0.013 mg/kg), in sample TAMP-PA-01-SO-5 at the Plating Area (Buildings 11 and 20) AOPI.

- PFOA was detected at 0.00077 J mg/kg, below the OSD residential risk screening level for soil (0.019 mg/kg), in sample TAMP-IWTP-03-SO-2 at the IWTP Area (Buildings 23, 29, and 30).

Following the SI sampling, both AOPIs with confirmed PFOS, PFOA, PFBS, PFNA, and/or PFHxS presence were considered to have complete and potentially complete exposure pathways. The soil exposure pathway is complete for on-site workers (e.g., staff working at the storage facilities) and potentially complete for hypothetical future on-site residents and recreational users, and for off-site receptors (i.e., trespassers). The groundwater exposure pathways for on-site receptors are potentially complete to account for potential future use of the downgradient on-site groundwater as a source of potable water. Due to a lack of land use controls off-site and downgradient of TAMP, the groundwater exposure pathways for off-site drinking water receptors are also potentially complete for both AOPIs. The nearby stream and river are classified as drinking water supply sources by the North Carolina Department of Environmental Quality; therefore, the surface water exposure pathway (via drinking water ingestion and dermal contact) for off-site drinking water receptors is potentially complete. Additionally, the surface water and sediment exposure pathways are potentially complete for off-site recreational users who could contact constituents in surface water and sediment via incidental ingestion and dermal contact.

Although the CSMs indicate complete and potentially complete exposure pathways may exist, the recommendation for future study in a remedial investigation or no action at this time is based on the comparison of the SI analytical results for PFOS, PFOA, PFBS, PFNA, and PFHxS to the OSD risk screening levels (**Table 6-2**). **Table 8-1** below summarizes the AOPIs identified at TAMP, PFOS, PFOA, PFBS, PFNA, and PFHxS sampling, and recommendations for each AOPI; further investigation is warranted at TAMP. In accordance with CERCLA, site-specific risks will be assessed during a future phase to evaluate whether remedial actions are required.

Table 8-1 Summary of AOPIs Identified during the PA, PFOS, PFOA, PFBS, PFNA, and PFHxS Sampling at TAMP, and Recommendations

AOPI Name	PFOS, PFOA, PFBS, PFNA and/or PFHxS detected greater than OSD Risk Screening Levels? (Yes/No)		Recommendation
	GW	SO	
Plating Area (Buildings 11 and 20)	Yes	No	Further study in remedial investigation
IWTP Area (Buildings 23, 29, 30)	Yes	No	Further study in remedial investigation

Notes:
Light gray shading – detection greater than the OSD risk screening level
GW – groundwater
SO – soil

Data collected during the PA (**Sections 3** through **5**) and SI (**Sections 6** through **7**) were sufficient to draw conclusions and recommendations summarized above. The data limitations relevant to the development of this PA/SI for PFOS, PFOA, PFBS, PFNA, and PFHxS at TAMP are discussed below.

Records gathered for the use, storage and/or disposal of PFAS-containing materials were reviewed during the PA process. Documentation specific to AFFF use (e.g., each AFFF use; procurement records, documentation of AFFF used during crash responses or fire training activities) was not located but may have been limited due to lack of recordkeeping requirements for the full timeline of common AFFF practices. There were no anecdotal accounts of AFFF 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 C)**.

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

Finally, the available PFOS, PFOA, PFBS, PFNA, and PFHxS analytical data is limited to results from on-post monitoring wells, not residential wells or aquifers other than where monitoring wells are screened. Available data, including PFOS, PFOA, PFBS, PFNA, and PFHxS, are listed in **Appendix M** which were analyzed per the selected analytical method. HFPO-DA was not in the suite of PFAS compounds analyzed during the SI at the TAMP; therefore, there are no HFPO-DA SI analytical results to screen against the 2022 OSD risk screening levels.

Results from this PA/SI indicate further study in a remedial investigation is warranted at TAMP in accordance with the guidance provided by the OSD.

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ACRONYMS

%	percent
AFFF	aqueous film-forming foam
AOPI	area of potential interest
Arcadis	Arcadis U.S., Inc.
Army	United States Army
B&V	Black & Veatch
bgs	below ground surface
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CSM	conceptual site model
DoD	Department of Defense
DQO	data quality objective
DUSR	Data Usability Summary Report
EB	equipment blank
EDR	Environmental Data Resources, Inc.
ELAP	Environmental Laboratory Accreditation Program
HFPO-DA	hexafluoropropylene oxide dimer acid
IDW	investigation-derived waste
installation	United States Army or Reserve installation
IWTP	Industrial Wastewater Treatment Plant
LOD	limit of detection
LOQ	limit of quantitation
mg/kg	milligrams per kilogram (parts per million)
ng/L	nanograms per liter (parts per trillion)
OSD	Office of the Secretary of Defense
PA	preliminary assessment
PFAS	per- and polyfluoroalkyl substances
PFBS	perfluorobutanesulfonic acid
PFHxS	perfluorohexane sulfonate
PFNA	perfluorononanoic acid

PFOA	perfluorooctanoic acid
PFOS	perfluorooctane sulfonate
POC	point of contact
ppm	parts per million
ppt	parts per trillion
PQAPP	Programmatic Uniform Federal Policy-Quality Assurance Project Plan
QA	quality assurance
QAPP	Quality Assurance Project Plan
QC	quality control
QSM	Quality Systems Manual
RSL	Regional Screening Level
SI	site inspection
SO	Soil
SOP	standard operating procedure
SSHP	Site Safety and Health Plan
TAMP	Former Tarheel Army Missile Plant
TGI	technical guidance instruction
TOC	total organic carbon
U.S.	United States
USACE	United States Army Corps of Engineers
USAEC	United States Army Environmental Command
USEPA	United States Environmental Protection Agency
USGSA	United States General Services Administration

TABLES

Table 6-1 Monitoring Well Construction Details
USAEC PFAS Preliminary Assessment /Site Inspection
Former Tarheel Army Missile Plant, North Carolina

Area of Potential Interest	Well ID	Approximate Depth to Water (ft btoc)	Well Diameter (inches)	TOC Elevation (ft amsl)	Total Well Depth (ft bgs)	Screened Interval (ft bgs)	Dedicated Equipment (Y/N)
Plating Area (Building 11 and 20)	MW-101	12.77	2	604.8	25	15 - 25	N
	MW-106	9.82	2	604.79	17	7 - 17	N
IWTP Area (Buildings 23, 29, and 30	MW-102	5.95	2	595.79	16	6 - 16	N
	MW-109	4.76	2	597.31	15	5 - 15	N
	MW-115	3.68	2	596.51	14	4 - 14	N

Notes:
1. Depths to water measured 1/11/2023

Acronyms/Abbreviations:
amsl = above mean sea level
bgs = below ground surface
btoc = below top of casing
ft = feet
ID = identification
IWTP = Industrial Wastewater Treatment Plant
N = no
PFAS = per- and polyfluoroalkyl substances
TOC = top of casing
USAEC = Unites States Army Environmental Command
Y = yes

Source:
Arcadis-PIKA. 2020. Remedial Investigation Report, Tarheel Army Missile Plant. April.

Table 7-1 - Groundwater PFOS, PFOA, PFBS, PFNA, and PFHxS Analytical Results
USAEC PFAS Preliminary Assessment/Site Inspection
Former Tarheel Army Missile Plant, North Carolina

				AOPI	PFOS (ng/L)		PFOA (ng/L)		PFBS (ng/L)		PFNA (ng/L)		PFHxS (ng/L)	
				OSD Tapwater Risk Screening Level	4		6		601		6		39	
AOPI	**Location**	**Sample/ Duplicate ID**	**Sample Date**	**Sample Type**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**	**Result**	**Qual**
Industrial Wastewater Treatment Plant Area (Buildings 23, 29, and 30)	TAMP-IWTP-MW-102	TAMP-IWTP-MW-102-01112023	01/11/2023	N	**16**		**16**		3.4	U	**1.9**	J	3.4	U
	TAMP-IWTP-MW-109	TAMP-IWTP-MW-109-01112023	01/11/2023	N	**38**		**43**		**3.0**	J	**3.3**	J	**3.6**	
	TAMP-IWTP-MW-115	TAMP-IWTP-MW-115-01112023	01/11/2023	N	**93**		**25**		**2.1**	J	**1.9**	J	**4.6**	
Plating Area (Buildings 11 and 20)	TAMP-PA-MW-101	TAMP-PA-MW-101-01112023	01/11/2023	N	**42**		**39**		**3.8**		**5.4**		**6.2**	
		TAMP-FD-01-GW-01112023	01/11/2023	FD	**37**		**32**		**3.2**	J	**4.7**		**4.6**	
	TAMP-PA-MW-106	TAMP-PA-MW-106-01112023	01/11/2023	N	**210**		**8.9**		3.5	U	**2.3**	J	**1.9**	J

Table 7-1 - Groundwater PFOS, PFOA, PFBS, PFNA, and PFHxS Analytical Results
USAEC PFAS Preliminary Assessment/Site Inspection
Former Tarheel Army Missile Plant, North Carolina

Notes:
1. **Bolded** values indicate the result was detected greater than the limit of detection.
2. Gray shaded values indicate the result was detected greater than the 2022 Office of the Secretary of Defense (OSD) risk screening levels, (OSD. 2022. Memorandum: Investigating Per- and Polyfluoroalkyl Substances within the Department of Defense Cleanup Program. July).

Acronyms/Abbreviations:
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
PFNA = perfluorononanoic acid
PFHxS = perfluorohexane 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 the limit of quantitation (LOQ).

Table 7-2 Soil PFOS, PFOA, PFBS, PFNA, and PFHxS Analytical Results
USAEC PFAS Preliminary Assessment/Site Inspection
Former Tarheel Army Missile Plant, North Carolina

Analyte					PFOS (mg/kg)		PFOA (mg/kg)		PFBS (mg/kg)		PFNA (mg/kg)		PFHxS (mg/kg)	
OSD Industrial/Commercial Risk Screening Level					0.16		0.25		25		0.25		1.6	
OSD Residential Risk Screening Level					0.013		0.019		1.9		0.019		0.13	
AOPI	Location	Sample ID / Duplicate ID	Sample Date	Sample Type	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual
Industrial Wastewater Treatment Plant Area (Buildings 23, 29, and 30)	TAMP-IWTP-01-SO-2	TAMP-IWTP-01-SO-2-01102023	01/10/2023	N	0.0011	U	0.0011	U	0.0011	U	0.0011	U	0.0011	U
		TAMP-FD-01-SO-01112023	01/10/2023	FD	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U
	TAMP-IWTP-01-SO-5	TAMP-IWTP-01-SO-5-01102023	01/10/2023	N	0.00099	U	0.00099	U	0.00099	U	0.00099	U	0.00099	U
	TAMP-IWTP-02-SO-2	TAMP-IWTP-02-SO-2-01102023	01/10/2023	N	0.0011	U	0.0011	U	0.0011	U	0.0011	U	0.0011	U
	TAMP-IWTP-02-SO-5	TAMP-IWTP-02-SO-5-01102023	01/10/2023	N	0.0012	U	0.0012	U	0.0012	U	0.0012	U	0.0012	U
	TAMP-IWTP-03-SO-2	TAMP-IWTP-03-SO-2-01102023	01/10/2023	N	**0.00084**	J	**0.00077**	J	0.0011	U	0.0011	U	0.0011	U
	TAMP-IWTP-03-SO-5	TAMP-IWTP-03-SO-5-01102023	01/10/2023	N	0.0011	U	0.0011	U	0.0011	U	0.0011	U	0.0011	U
Plating Area (Buildings 11 and 20)	TAMP-PA-01-SO-2	TAMP-PA-01-SO-2-01102023	01/10/2023	N	**0.0072**		0.00099	U	0.00099	U	0.00099	U	0.00099	U
	TAMP-PA-01-SO-5	TAMP-PA-01-SO-5-01112023	01/11/2023	N	**0.0075**		0.0011	U	0.0011	U	0.0011	U	0.0011	U

Table 7-2 Soil PFOS, PFOA, PFBS, PFNA, and PFHxS Analytical Results
USAEC PFAS Preliminary Assessment/Site Inspection
Former Tarheel Army Missile Plant, North Carolina

Notes:
1. **Bolded** values indicate the result was detected greater than the limit of detection
2. Data are compared to the Office of the Secretary of Defense (OSD) risk screening levels for both the residential as well as the industrial/commercial scenarios (OSD. 2022. Memorandum: Investigating Per- and Polyfluoroalkyl Substances within the Department of Defense Cleanup Program. July).
3. Gray shaded values indicate the result was detected greater than the residential scenario risk screening levels (OSD 2022).
4. Gray shaded and italicized values indicate the result was detected greater than the industrial/commercial scenario (i.e., and therefore greater than the residential scenario) risk screening levels (OSD 2022).

Acronyms/Abbreviations:
-- = not applicable
AOPI = area of potential interest
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
PFNA = perfluorononanoic acid
PFHxS = perfluorohexane sulfonate
Qual = qualifier
USAEC = United States Army Environmental Command

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 the limit of quantitation (LOQ).

FIGURES

USAEC PFAS
Preliminary Assessment / Site Inspection
Former Tarheel Army Missile Plant, NC

ARCADIS

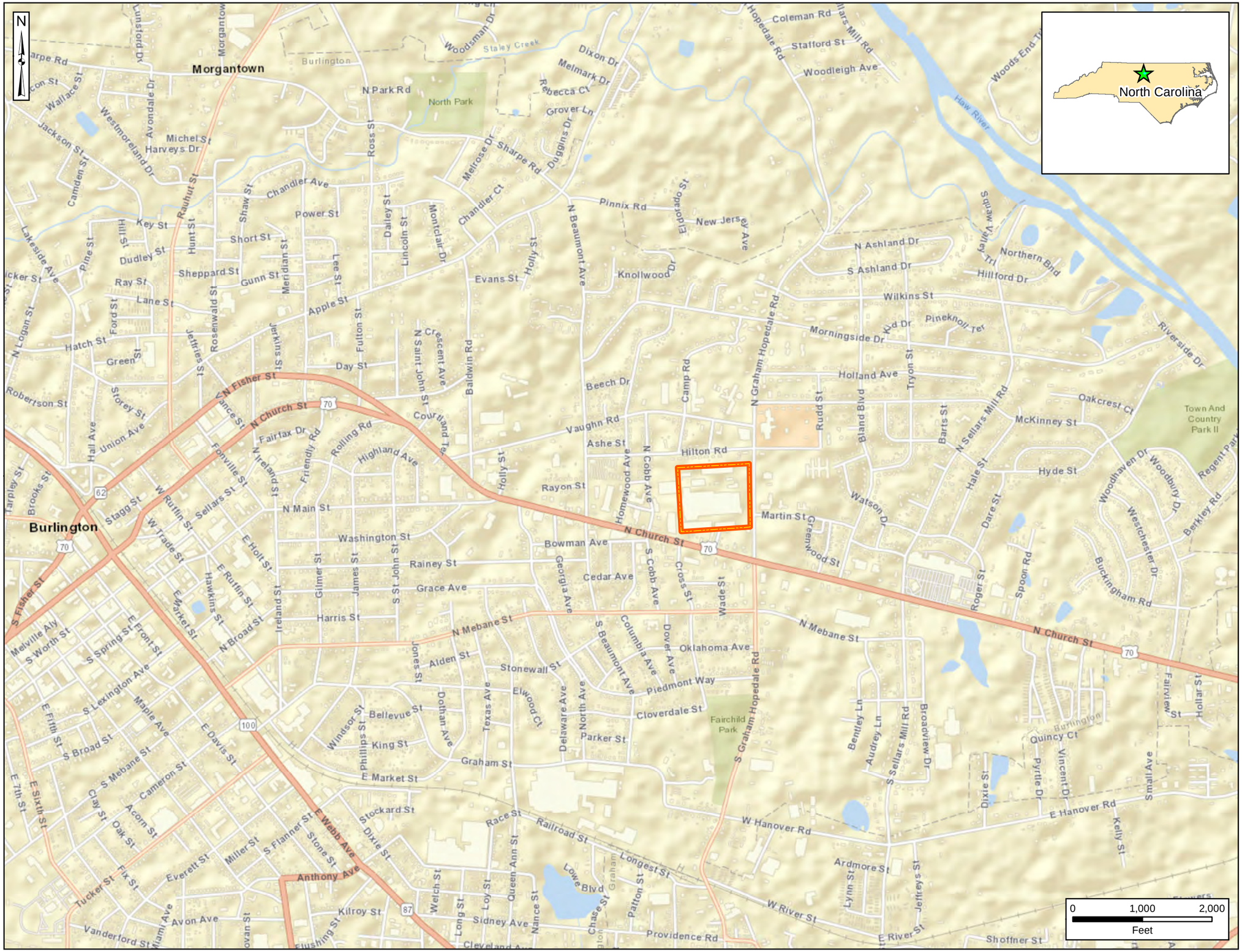


Figure 2-1
Site Location

Legend

Former Installation Boundary

Data Sources:
ESRI ArcGIS Online, StreetMap Data

Coordinate System:
WGS 1984, UTM Zone 17 North

USAEC PFAS
Preliminary Assessment / Site Inspection
Former Tarheel Army Missile Plant, NC

ARCADIS

Figure 2-2
Site Layout

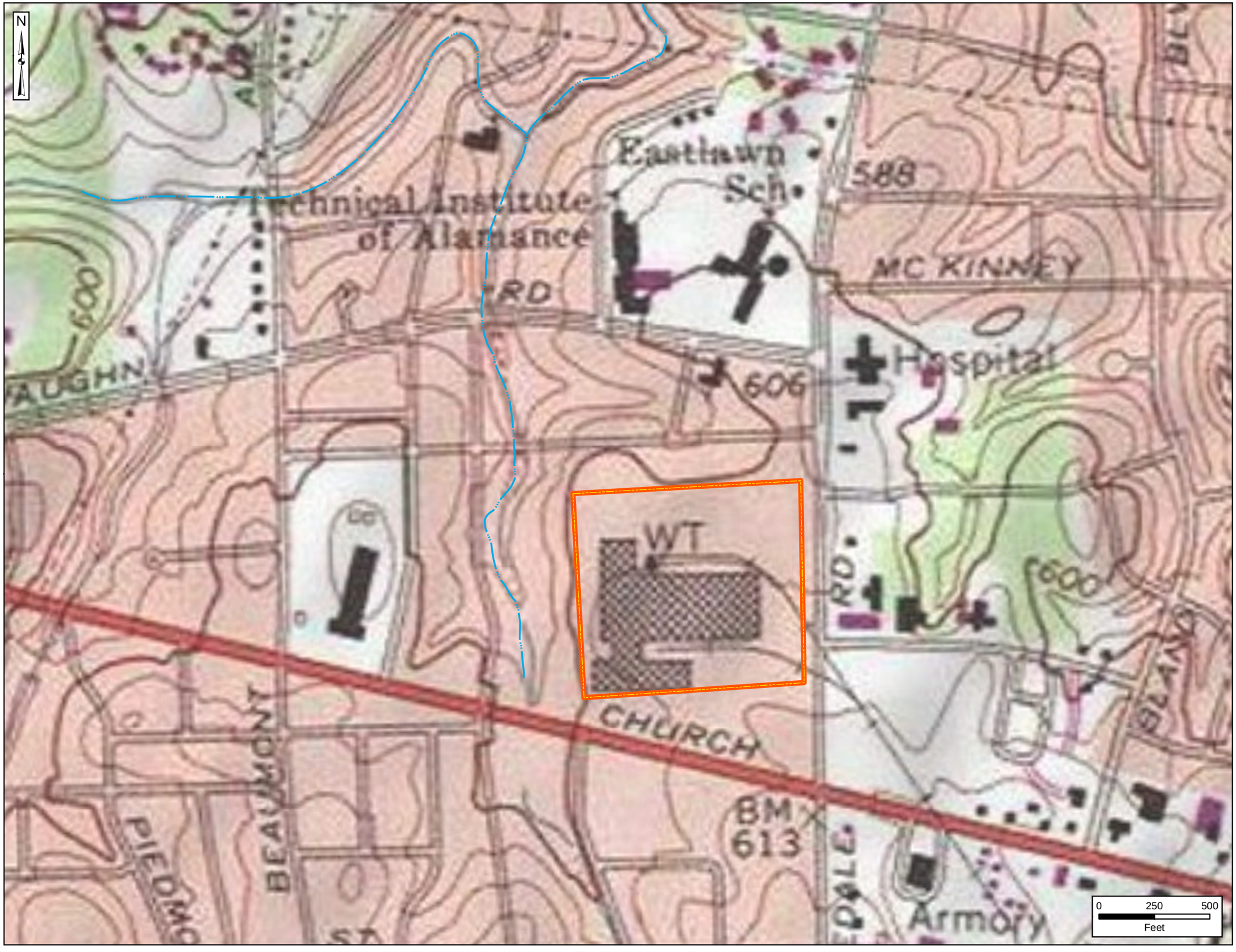
Legend

- Former Installation Boundary
- Drainage Ditch/Stream
- Surface Water Flow Direction
- Groundwater Flow Direction (Saprolite)
- Monitoring Well (bedrock)
- Monitoring Well (saprolite)
- Screen Point (2014)
- Surface Water Sampling Location (2014-2015)
- Piezometer

0 200 400
Feet

Data Sources:
ESRI ArcGIS Online, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 17 North



USAEC PFAS
Preliminary Assessment / Site Inspection
Former Tarheel Army Missile Plant, NC

Figure 2-3
Topographic Map

Legend

- Former Installation Boundary
- Drainage Ditch/Stream

Note: Elevations shown are in feet.

Data Sources:
ESRI ArcGIS Online, USA Topo Map

Coordinate System:
WGS 1984, UTM Zone 17 North

USAEC PFAS
Preliminary Assessment / Site Inspection
Former Tarheel Army Missile Plant, NC

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Figure 2-4
Off-Post Potable Supply Wells

Legend

- Former Installation Boundary
- 1-Mile Radius

Note:
No water wells were identified within a 1-mile radius of the former installation boundary.

Data Sources:
ESRI ArcGIS Online, Street Map Data

Coordinate System:
WGS 1984, UTM Zone 17 North

USAEC PFAS
Preliminary Assessment / Site Inspection
Former Tarheel Army Missile Plant, NC

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Figure 5-2
AOPI Locations

Legend

- Former Installation Boundary
- Plating Area (Buildings 11 and 20)
- IWTP Area (Buildings 23, 29, and 30)
- Drainage Ditch/Stream
- Surface Water Flow Direction
- Groundwater Flow Direction (Saprolite)

AOPI = area of potential interest
IWTP = Industrial Wastewater Treatment Plant

Data Sources:
ESRI ArcGIS Online, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 17 North

USAEC PFAS
Preliminary Assessment / Site Inspection
Former Tarheel Army Missile Plant, NC

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Figure 5-3
Aerial Photo of
Plating Area
(Buildings 11 and 20)

Legend

- Former Installation Boundary
- Groundwater Flow Direction (Saprolite)
- Plating Area (Buildings 11 and 20)
- Monitoring Well (bedrock)
- Monitoring Well (saprolite)
- Piezometer
- Historical Building Footprint
- 20 Building Number

Data Sources:
Google Earth, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 17 North

N

0 50 100
Feet

USAEC PFAS
Preliminary Assessment / Site Inspection
Former Tarheel Army Missile Plant, NC

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Figure 5-4
Aerial Photo of
IWTP Area
(Buildings 23, 29, and 30)

Legend

- Former Installation Boundary
- Groundwater Flow Direction (Saprolite)
- IWTP Area (Buildings 23, 29, and 30)
- Monitoring Well (bedrock)
- Monitoring Well (saprolite)
- Piezometer
- Historical Building Footprint
- 29 Building Number

IWTP = Industrial Wastewater Treatment Plant

Data Sources:
Google Earth, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 17 North

N

0 50 100
Feet

USAEC PFAS
Preliminary Assessment / Site Inspection
Former Tarheel Army Missile Plant, NC

ARCADIS

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

Legend

- Former Installation Boundary
- Plating Area (Buildings 11 and 20)
- IWTP Area (Buildings 23, 29, and 30)
- AOPI with OSD Risk Screening Level Exceedance
- Drainage Ditch/Stream
- Surface Water Flow Direction
- Groundwater Flow Direction (Saprolite)

AOPI = area of potential interest
IWTP = Industrial Wastewater Treatment Plant
OSD = Office of the Secretary of Defense

Data Sources:
ESRI ArcGIS Online, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 17 North

Chemical	Residential Scenario Risk Screening Level		Industrial/Commercial Scenario Risk Screening Level
	Tap Water (ng/L)	Soil (mg/kg)	Soil (mg/kg)
PFOS	4	0.013	0.16
PFOA	6	0.019	0.25
PFBS	601	1.9	25
PFNA	6	0.019	0.25
PFHxS	39	0.13	1.6

TAMP-PA-MW-101	
Date	1/11/2023
PFOS	**42 [37]**
PFOA	**39 [32]**
PFBS	**3.8 [3.2 J]**
PFNA	**5.4 [4.7]**
PFHxS	**6.2 [4.6]**

TAMP-PA-MW-106	
Date	1/11/2023
PFOS	**210**
PFOA	**8.9**
PFBS	3.5 U
PFNA	**2.3 J**
PFHxS	**1.9 J**

TAMP-PA-01-SO		
Depth	0-2 ft bgs	2-5 ft bgs
Date	1/10/2023	1/11/2023
PFOS	**0.0072**	**0.0075**
PFOA	0.00099 U	0.0011 U
PFBS	0.00099 U	0.0011 U
PFNA	0.00099 U	0.0011 U
PFHxS	0.00099 U	0.0011 U

Notes:
1. Groundwater results are reported in nanograms per liter (ng/L).
2. Soil results are reported in milligrams per kilogram (mg/kg).
3. Depths are in feet below ground surface (ft bgs).
4. Bolded results indicate detections.
5. Results that exceed Office of the Secretary of Defense (OSD) residential scenario risk screening levels (OSD 2022) are highlighted gray.

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).

0 50 100 Feet

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Figure 7-2
Plating Area (Buildings 11 and 20) PFOS, PFOA, PFBS, PFNA, and PFHxS Analytical Results

Legend

- Former Installation Boundary
- Groundwater Flow Direction (Saprolite)
- Plating Area (Buildings 11 and 20)
- Monitoring Well (bedrock)
- Monitoring Well (saprolite)
- Piezometer
- Historical Building Footprint

Sampling Locations

- Groundwater (Existing Well)
- Shallow and Subsurface Soil

20 Building Number

PFBS = perfluorobutanesulfonic acid
PFHxS = perfluorohexane sulfonate
PFNA = perfluorononanoic acid
PFOA = perfluorooctanoic acid
PFOS = perfluorooctane sulfonate
SO = soil

Data Sources:
Google Earth, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 17 North

Chemical	Residential Scenario Risk Screening Level		Industrial/Commercial Scenario Risk Screening Level
	Tap Water (ng/L)	Soil (mg/kg)	Soil (mg/kg)
PFOS	4	0.013	0.16
PFOA	6	0.019	0.25
PFBS	601	1.9	25
PFNA	6	0.019	0.25
PFHxS	39	0.13	1.6

TAMP-IWTP-MW-102	
Date	1/11/2023
PFOS	**16**
PFOA	**16**
PFBS	3.4 U
PFNA	**1.9 J**
PFHxS	3.4 U

TAMP-IWTP-MW-109	
Date	1/11/2023
PFOS	**38**
PFOA	**43**
PFBS	**3.0 J**
PFNA	**3.3 J**
PFHxS	**3.6**

TAMP-IWTP-MW-115	
Date	1/11/2023
PFOS	**93**
PFOA	**25**
PFBS	**2.1 J**
PFNA	**1.9 J**
PFHxS	**4.6**

TAMP-IWTP-01-SO		
Depth	0-2 ft bgs	2-5 ft bgs
Date	1/10/2023	1/10/2023
PFOS	0.0011 U [0.0010 U]	0.00099 U
PFOA	0.0011 U [0.0010 U]	0.00099 U
PFBS	0.0011 U [0.0010 U]	0.00099 U
PFNA	0.0011 U [0.0010 U]	0.00099 U
PFHxS	0.0011 U [0.0010 U]	0.00099 U

TAMP-IWTP-02-SO		
Depth	0-2 ft bgs	2-5 ft bgs
Date	1/10/2023	1/10/2023
PFOS	0.0011 U	0.0012 U
PFOA	0.0011 U	0.0012 U
PFBS	0.0011 U	0.0012 U
PFNA	0.0011 U	0.0012 U
PFHxS	0.0011 U	0.0012 U

TAMP-IWTP-03-SO		
Depth	0-2 ft bgs	2-5 ft bgs
Date	1/10/2023	1/10/2023
PFOS	**0.00084 J**	0.0011 U
PFOA	**0.00077 J**	0.0011 U
PFBS	0.0011 U	0.0011 U
PFNA	0.0011 U	0.0011 U
PFHxS	0.0011 U	0.0011 U

Notes:
1. Groundwater results are reported in nanograms per liter (ng/L).
2. Soil results are reported in milligrams per kilogram (mg/kg).
3. Depths are in feet below ground surface (ft bgs).
4. Bolded results indicate detections.
5. Results that exceed Office of the Secretary of Defense (OSD) residential scenario risk screening levels (OSD 2022) are highlighted gray.

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).

0 50 100
Feet

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Figure 7-3
IWTP Area
(Buildings 23, 29, and 30)
PFOS, PFOA, PFBS, PFNA, and PFHxS Analytical Results

Legend

- Former Installation Boundary
- Groundwater Flow Direction (Saprolite)
- IWTP Area (Buildings 23, 29, and 30)
- Monitoring Well (bedrock)
- Monitoring Well (saprolite)
- Piezometer
- Historical Building Footprint

Sampling Locations

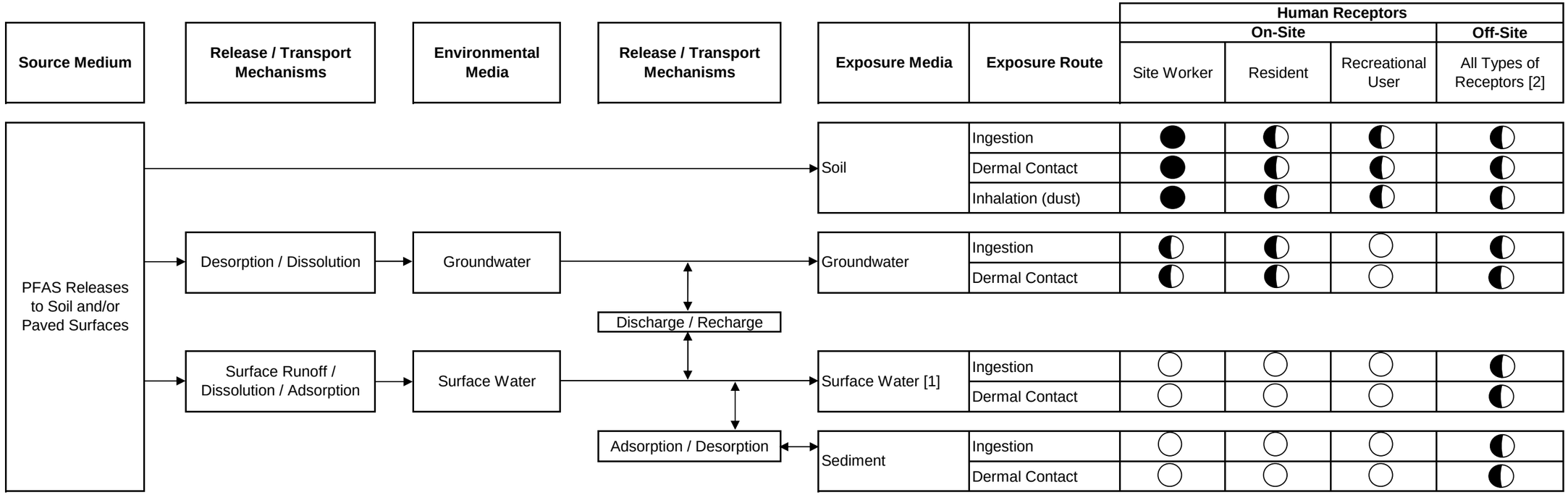
- Groundwater (Existing Well)
- Shallow and Subsurface Soil

29 Building Number

IWTP = Industrial Wastewater Treatment Plant
PFBS = perfluorobutanesulfonic acid
PFHxS = perfluorohexane sulfonate
PFNA = perfluorononanoic acid
PFOA = perfluorooctanoic acid
PFOS = perfluorooctane sulfonate
SO = soil

Data Sources:
Google Earth, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 17 North



Legend:

- ● = Potentially 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.
[3] IWTP = Industrial Wastewater Treatment Plant
[4] PFAS = per- and polyfluoroalkyl substances

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Conceptual Site Model - Plating Area (Buildings 11 and 20) and IWTP Area (Buildings 23, 29, and 30)
USAEC PFAS Quality Assurance Project Plan Addendum
Former Tarheel Army Missile Plant, North Carolina

Figure 7-4

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