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

## Twin Cities Army Ammunition Plant, Minnesota

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2 Hopkins Plaza
Baltimore, Maryland 21201

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# Preliminary Assessment and Site Inspection of Per- and Polyfluoroalkyl Substances

Twin Cities Army Ammunition Plant, Minnesota

Kendra Keon
Site Inspection Project Manager, Arcadis U.S., Inc.

Rhonda Stone, PMP
Project Manager, Arcadis U.S., Inc.

Joseph Quinnan
Technical Lead, Arcadis U.S., Inc.

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Prepared by:

Arcadis U.S., Inc.

7550 Teague Road

Suite 210

Hanover

Maryland 21076

Arcadis Ref.:

30001997

Date:

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# CONTENTS

# TABLES



# FIGURES

# APPENDICES

# 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 (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 Twin Cities Army Ammunition Plant 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.

Twin Cities Army Ammunition Plant (TCAAP) was constructed between 1941 and 1943 in the northern portion of the Minneapolis – St. Paul metropolitan area, in Ramsey County, surrounded by the cities of New Brighton, Arden Hills, Mounds View, and Shoreview, Minnesota. The installation originally consisted of 2,370 acres of land, but portions have since been transferred out of federal ownership to Ramsey County and the City of Arden Hills, while the remaining portions have been reassigned from the Army to the Army Reserve or the National Guard Bureau. TCAAP was primarily used for the production and proof-testing of small caliber ammunition and related materials for the Army. The installation was also used for the manufacture of munitions-related components, handling/storage of strategic and critical materials for other government agencies, and various non-military activities.

The TCAAP PA identified seven AOPIs for investigation and an adaptive sampling approach for two additional AOPIs during the SI phase for a total of nine AOPIs. SI sampling results for the nine AOPIs were compared to risk-based screening levels calculated using the United States Environmental Protection Agency (USEPA) Regional Screening Levels (RSL) Calculator 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 TCAAP 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/or PFHxS were detected in soil and/or groundwater at six of the seven AOPIs; three of the seven AOPIs had PFOS, PFOA, PFBS, PFNA, and/or PFHxS present at concentrations greater than the risk-based screening levels. Due to the detection and/or exceedance of PFOS, PFOA, PFBS, PFNA, and/or PFHxS at two AOPIs, two additional AOPIs were evaluated in a secondary SI sampling event.

PFOS, PFOA, PFBS, PFNA and/or PFHxS were detected in groundwater at one of the two additional AOPIs; one of the two additional AOPIs had PFOS, PFOA, PFBS, PFNA, and/or PFHxS present at concentrations greater than the risk-based screening levels.

Overall, PFOS, PFOA, PFBS, PFNA and/or PFHxS were detected in groundwater at seven of the nine AOPIs; four of the nine AOPIs had PFOS, PFOA, PFBS, PFNA, and/or PFHxS present at concentrations greater than the risk-based screening levels. The TCAAP PA/SI identified the need for further study in a CERCLA remedial investigation for four of the nine AOPIs. **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 Twin Cities Army Ammunition Plant, and Recommendations**

| AOPI Name | PFOS, PFOA, PFBS, PFNA, and/or PFHxS detected greater than OSD Risk Screening Levels? (Yes/No/ND/NS) | | Recommendation |
|---|---|---|---|
| | GW | SO | |
| Fire Station and Training Area Building 157 | Yes | NS[3] | Further study in a remedial investigation |
| Industrial Operations Building 103 | Yes | NS[3] | Further study in a remedial investigation |
| Fire Station Building 557[1] | ND | NS[3] | No action at this time |
| Industrial Operations Building 502 (Site I) | Yes | NS | Further study in a remedial investigation |
| Open Burn/Salvage Area (Site C) | No | NS[3] | No action at this time |
| 3M Medical Equipment R&D Facility Building 538 | No | ND | No action at this time |
| Southwest Sewer System (Site J) | No | NS[3] | No action at this time |
| Sewer Cleanout Drum Storage Building 576[2] | Yes | NS | Further study in a remedial investigation |
| Retrievable Monitored Containment Structure Buildings 962A and 962B[2] | No | NS[3] | No action at this time |

**Notes:**
Light gray shading – detection greater than the OSD risk screening level
GW – groundwater
ND – non-detect
NS – not sampled
SO – soil
[1] – Groundwater was unable to be sampled at this AOPI due to the drill rig hitting refusal prior to reaching groundwater. However, downgradient wells were sampled as planned at the Industrial Operations Building 502 (Site I) AOPI and were used to evaluate the presence or absence of PFAS at this AOPI.
[2] – AOPI was sampled during the second SI event due to detections and/or exceedances in groundwater at the Industrial Operations Building 502 (Site I) AOPI and the Southwest Sewer System (Site J) AOPI.
[3] – Soil samples were not collected at the AOPI based on the soil remediation history and/or land use controls in place.

# 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 Twin Cities Army Ammunition Plant (TCAAP) 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 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 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 Twin Cities Army Ammunition Plant 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 personnel interviews. This PA will evaluate and document areas where PFAS-containing materials were used, stored, and/or disposed, so the Army can distinguish between sites that pose little or no threat to human health and the environment and sites that require further investigation.

### 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 TCAAP, 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 TCAAP. The PA and SI processes are documented in the PA/SI Quality Control Checklist included as **Appendix B**.

### 1.3.1 Pre-Site Records Review and Interviews

First, 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), Minnesota Army National Guard, and Arcadis U.S., Inc. (Arcadis). The kickoff call occurred on 26 January 2021, to discuss the goals and scope of the PA, project scheduling, access to installation-specific databases, and to request available records.

Records review was conducted to obtain electronically available documents from the installation and external sources for review. The purpose of the records research was to identify any area on the

installation that may have been a location where PFAS-containing materials were used, stored, and/or disposed, as well as to gather information on the physical setting and site history at TCAAP.

A read-ahead package was prepared and submitted to the appropriate POCs. The read-ahead package contains the following information:

- The Installation Management Command (IMCOM) operation order
- The Army PA Operations Security requirements package, which includes the antiterrorism/operations security review cover sheet
- The PFAS PA kickoff call minutes
- An information paper on the PA portion of the Army's PFAS PA/SI
- Contact information for key POCs
- A list of the data sources requested and reviewed
- A list of preliminary locations identified during the kickoff call and records review to be evaluated for use, storage, and/or disposal of PFAS-containing materials, where additional information on those areas will be collected through personnel interviews and additional document review.
- A list of roles for to consider when recommending potential interviewees.

### 1.3.2 Preliminary Assessment Site Visit

A site visit was not conducted for TCAAP due to no TCAAP personnel or remaining TCAAP-operated structures being present onsite. Personnel interviews were conducted with individuals having significant historical knowledge at TCAAP. The interviews focused on confirming information discussed in historical documents, collecting information that may have not been in historical documents, and/or corroborating other interviewees' information. **Section 3** includes information regarding personnel interviewed.

### 1.3.3 Post-Records Review and Interviews

Information collected was reviewed and corroborated by cross-referencing records and reviewing interview details. A Research Summary Report was completed to summarize the information collected and was provided to the USAEC POCs and USACE regional POCs. The information collected during records review and interview activities was compiled to develop the installation-specific PA portion of the PA/SI report (**Section 3**). Site data obtained during the PA were used to develop preliminary conceptual site models (CSMs) for each AOPI, which serve as the basis for developing the SI scope of work presented in an installation-specific Quality Assurance Project Plan (QAPP) Addendum.

### 1.3.4 Site Inspection Planning and Field Work

The SI process was initiated at the installation to evaluate PFOS, PFOA, PFBS, PFNA, and PFHxS presence or absence at each AOPI and determine whether further investigation is warranted. A combined SI kickoff and scoping teleconference was held on 30 June 2022 between the Army PA team and TCAAP representatives to obtain concurrence on the SI sampling plan from USAEC and USACE. The

representatives that attended the teleconference included personnel from USAEC, USACE, Minnesota Army National Guard, and Arcadis.

The objectives of the SI kickoff teleconference were to:

- discuss the AOPIs selected for sampling and the proposed sampling plan for each AOPI
- gauge regulatory involvement requirements or preferences
- confirm the plan for investigation derived waste (IDW) handling and disposal
- identify specific site access requirements and potential schedule conflicts
- discuss general SI deliverable and field work schedule information and logistics
- provide an updated SI deliverable and field work schedule.

A Programmatic Uniform Federal Policy-Quality Assurance Project Plan (PQAPP) was developed and finalized in October 2019 for the USAEC PFAS PA/SI (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, an installation-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 USAEC- and USACE-approved installation-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 TCAAP (Arcadis 2023) in **Sections 6.1** through **6.3**.

After finalization of the QAPP Addendum and SSHP, field planning and coordination with the installation representatives and subcontractors was completed. Once the schedule was determined, field teams mobilized to the site to complete the scope of work defined in the QAPP Addendum. As detailed in **Section 6.3.3**, a secondary SI sampling event was conducted at two additional AOPIs due to the detection and/or exceedance of PFOS, PFOA, PFBS, PFNA, and/or PFHxS at two AOPIs.

### 1.3.5 Data Analysis, Validation, and Reporting

Environmental samples collected during the SI were submitted to a laboratory which is DoD Environmental Laboratory Accreditation Program (ELAP)-accredited for 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 2019). 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 TCAAP, including the location and layout, the installation mission(s) over time, a brief site history, current and projected land use, climate, topography, geology, hydrogeology, surface water hydrology, potable wells within a 5-mile radius of the installation, and applicable ecological receptors.

## 2.1 Site Location

TCAAP is located in the northern portion of the Minneapolis – St. Paul metropolitan area in Ramsey County, surrounded by the cities of New Brighton, Arden Hills, Mounds View, and Shoreview, Minnesota as shown on **Figure 2-1**. The installation originally consisted of 2,370 acres, but portions of the property have since been transferred between Ramsey County, the City of Arden Hills, the Army Reserve, and the National Guard Bureau as shown on **Figure 2-2** (PIKA International, Inc. - Arcadis U.S., Inc. Joint Venture [PIKA-Arcadis JV] 2021).

## 2.2 Mission and Brief Site History

TCAAP was constructed between 1941 and 1943 and was the product of the government-owned, contractor-operated war materials production program established during World War II. At its peak, 300 buildings were located on the property with over 26,000 workers. The installation primarily produced and proof-tested small caliber ammunition and related materials for the Army. Other uses included manufacture of munitions-related components, handling/storage of strategic and critical materials for other government agencies, and various non-military activities. Production began in 1942, and operations alternated between periods of activity and standby related to wars until manufacturing ceased in 2005 (PIKA-Arcadis JV 2021). Federal Cartridge Corporation was the prime-operating contractor from 1941 to the 1990s and produced over 16.5 billion rounds of small arms ammunition over 22 years. As of 1994, TCAAP was placed in a modified caretaker status, with most of the former manufacturing and support buildings vacant (Plexus Scientific 2003).

## 2.3 Current and Projected Land Use

Since 1983, the size of the federal portion of TCAAP has periodically shrunk due to property transfers and the majority of the buildings have been demolished. Portions of the original 2,370 acres have since been transferred out of federal ownership to Ramsey County and the City of Arden Hills. Ramsey County and the City of Arden Hills issued plans in 2015 as part of the 2030 Comprehensive Plan to redevelop the property for future residential, commercial, and recreational land use to successfully integrate TCAAP into the rest of the city (Arden Hills 2016). Other acres of property have been remained under federal ownership but reassigned to the Army Reserve or the National Guard Bureau, which leases the property to the Minnesota Army National Guard. The minimal remaining property still owned by the Army has been delegated to Base Realignment and Closure and is in the process of being transferred out of federal ownership (PIKA-Arcadis JV 2021).

## 2.4 Climate

The average summer temperature at TCAAP is 70 degrees Fahrenheit (°F) while the average winter temperate at TCAAP is 15°F with recorded extreme temperatures ranging from -34°F to 108°F. Average daily minimum temperatures are below freezing from November through March. The majority of rainfall occurs during the summer growing season of May through September. Thunderstorms are the principal source of precipitation during this season. Annual precipitation in the area averages approximately 32 inches and snowfall averages approximately 52 inches per season. Prevailing winds are northwesterly from November through April and south-southwesterly from May through October (Sperling's Best Places 2023).

## 2.5 Topography

TCAAP lies near the boundary of the Western Lake Section of the Central Lowland Province, characterized by till plains, moraines, lakes, and lacustrine plains. The topography varies from low extensive marsh in the eastern portion to hilly terrain in the central part of the installation. A distinct topographic feature is the kame in the central part of the installation, which is oriented northeast-southwest for approximately 1 mile and rises approximately 100 feet above the surrounding terrain. Elevations range from 890 feet above mean sea level along Rice Creek to 1,100 feet above mean sea level at the crest of the kame as shown on **Figure 2-3** (Padar et al. 1995).

## 2.6 Geology

The bedrock in the New Brighton Quadrangle consists of the early Ordovician Prairie du Chien Group and the late Cambrian Jordan Sandstone. The bedrock surface is cut by several relatively steep-sided narrow valleys. These bedrock valleys have two pronounced regional trends, northeast-southwest and northwest-southeast, with linear channel segments. There is some evidence that suggests the valleys may have been cut during multiple episodes of erosion, and they may have drained to the north at one time and to the south during a different period. Near TCAAP, the Prairie du Chien is variably fractured and weathered, and contains solution cavities within the dolomite. The St. Lawrence Formation, a 30- to 70-foot-thick shale unit, underlies the Prairie du Chien and consolidated Jordan Sandstone (Plexus Scientific 2003). The geologic units underlying TCAAP are shown on **Figure 2-4**.

During the Pleistocene, the Twin Cities area was covered by at least two continental glacial ice sheets: the Superior Lobe and the Grantsburg Sublobe. Due to glaciation, surficial deposits are discontinuous over the subject property. The unconsolidated glacial deposits in the New Brighton area are up to 447 feet thick and have been divided into four major formations: Hillside Sand, Arsenal Sand, Twin Cities Formation, and Lacustrine Deposits (Plexus Scientific 2003).

The Hillside Sand overlies the bedrock formations throughout the subject property area. The sand is very pale-brown to brown, poorly sorted, medium- to coarse-grained, and has some pebbles and cobbles. It ranges in thickness from about 25 to 450 feet. The Hillside Sand is overlain either by the Arsenal Sand or the Twin Cities Formation. It has an unusually rough and irregular upper surface. The contact of the Hillside Sand with the overlying Twin Cities Formation varies from sharp to gradational to interlayered. There is no distinct lithologic break between the Hillside Sand and the Arsenal Sand. The thickness of the Hillside and Arsenal sands on the subject property ranges from approximately 40 feet to 320 feet. The

Arsenal Sand also occurs in the kame to the east of the subject property and is light gray to brown, well-sorted, fine- to coarse-grained. The thickness of the unit cannot be determined due to the absence of any distinctive lithologic break between it and the underlying Hillside Sand. The Twin Cities Formation overlies the Hillside Sand and contains a mixture of sand, silt, clay, pebbles, cobbles, boulders, and lenses of silt or sand. The thickness of the Twin Cities Formation on the subject property ranges from approximately 30 feet to 110 feet (Plexus Scientific 2003).

The Lacustrine Deposits are a series of sediments deposited by the marginal lakes of the retreating Grantsburg ice sheet. The Lacustrine Deposits lie above the Twin Cities Formation and consist of the Turtle Lake Sand, the New Brighton Formation, and the Fridley Formation (Plexus Scientific 2003).

## 2.7 Hydrogeology

There are four water-bearing stratigraphic units identified beneath TCAAP that have been assigned the nomenclature of Unit 1 through Unit 4 for reference purposes. Groundwater in the TCAAP area has been classified into similar units corresponding to the geologic units (Conestoga-Rovers & Associates 2006). These hydrogeologic units are described below:

- Unit 1 is known as the Fridley Formation, which consists of alluvium and lacustrine deposits. The formation is primarily fine-medium grained sand and clayey silt, which act as an unconfined aquifer. The deposits are discontinuous and range in thickness from 0 to 50 feet and are predominantly found in the north, east, and southwest portions of TCAAP. Groundwater within this unit is also discontinuous (PIKA-Arcadis JV 2021).
- Unit 2 is the Twin Cities Formation, which underlies the Fridley Formation. The formation is made up of Quaternary aged glacial till and is discontinuous, similar to Unit 1, and ranges in thickness from 0 to 125 feet. Unit 2 is regarded as an aquitard to vertical migration of groundwater; however, sand and gravel lenses may also contain water (PIKA-Arcadis JV 2021).
- Unit 3 primarily consists of the Quaternary aged Hillside Sand Formation, which is continuous beneath TCAAP. Near the center of the former installation boundary, the Hillside Sand Formation is overlain by Arsenal Sand which forms a kame. There is no distinct lithologic contact between the Hillside and Arsenal Sands, and both are considered to be included in Unit 3. The unit ranges in thickness from 25 to 450 feet (PIKA-Arcadis JV 2021). The groundwater in Unit 3 migrates southwest and west from TCAAP and is hydraulically connected to the underlying Unit 4 (Conestoga-Rovers & Associates 2006).
- Unit 4 consists of both the bedrock from the Prairie Du Chien Group (Ordovician period) and the Jordan Formation (Cambrian period), which together ranges in thickness from 0 to 200 feet. The Jordan formation consists of fine to coarse-grained quartz sandstone. The Prairie Du Chien Group consists of the finely crystalline dolomite of the Oneota Formation, as well as the quartz sandstone and dolomite members of the Shakopee Formation (PIKA-Arcadis JV 2021). Groundwater within Unit 4 flows southwest from TCAAP (Conestoga-Rovers & Associates 2006).

## 2.8 Surface Water Hydrology

TCAAP contains typical ice-marginal, geomorphic features, including outwash plains, eskers, kettle lakes, and nonintegrated drainage. Marsden Lake and associated wetlands occupy the eastern fourth of TCAAP with Sunfish Lake, a small kettle lake, located south of Marsden Lake. Rice Creek flows southward across the northwest portion of TCAAP, as shown on **Figure 2-4** (Padar et al. 1995).

Surface drainage from the subject property flows, either directly or indirectly, to Rice Creek. Due to the topographically high kame to the east of the subject property, the drainage patterns are to the north, south, and west. Runoff to the east of the subject property flows into Marsden Lake, which drains to the north through a series of swampy areas and artificial ditches into Rice Creek, approximately 0.75 mile north of the site. Rice Creek flows south across the northwestern portion of the site until it leaves the site at about the midpoint of the western boundary. Along the southern boundary, drainage is diverted through ditches into a culvert system that empties, either directly or indirectly, into Round Lake. Water flows south from Round Lake into Valentine Lake and then to Long Lake. Rice Creek, whose 183-square mile watershed contains the TCAAP property, is a left-bank tributary of the Mississippi River. Its watershed contains numerous small lakes. Drainage from TCAAP passes through several lakes and the lower reaches of Rice Creek before arriving at the Mississippi River, approximately 4.5 miles west of the installation (Plexus Scientific 2003).

## 2.9 Relevant Utility Infrastructure

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

### 2.9.1 Stormwater Management System Description

The storm sewer system was designed to carry off all excess rain and melted snow water before any damage could be done to buildings, roads, sanitary sewers, and other utilities in the area. Stormwater generated at TCAAP consisted of the runoff from the many miles of road and sidewalk surfaces, together with the runoff from the roofs in the plant and paved parking lots. The stormwater generated was discharged by sheet flow to surrounding vegetated surfaces and infiltrates into surrounding soils. Stormwater from TCAAP discharged into Rice Creek at five points, Round Lake at one point, and Sunfish Lake at one point (Plexus Scientific 2003)

### 2.9.2 Sewer System Description

The majority of TCAAP's sanitary sewer system was constructed from 1941 to 1943, during the construction of the plant. At completion, there were approximately 31 miles of sanitary sewers. In most of the system, sanitary and industrial wastes were combined at the source buildings before discharging to the sanitary sewer system onsite at TCAAP. The TCAAP sanitary sewer system discharged by gravity into the City of Mounds View sanitary sewers which ultimately discharge into the Metropolitan Council Environmental Service Collection and Treatment System (Plexus Scientific 2003).

## 2.10 Potable Water Supply and Drinking Water Receptors

The City of New Brighton well field is located approximately 2 miles southwest and downgradient from TCAAP. In June 1990, the Army funded the construction of a permanent groundwater treatment facility for the City of New Brighton after it was discovered that a chlorinated solvent plume had migrated offsite. Groundwater is treated using a permanent granular activated carbon and an ultraviolet/peroxide advanced oxidation potential system and is intended to treat chlorinated solvents and supply drinking water to residents. Modifications to the groundwater treatment system were completed in 2018 due to detections of 1,4-dioxane in the water supply. The water supply system for the City of New Brighton was sampled for select PFAS, including PFOA, PFOS, PFBS, and PFHxS, in 2021 as part of a state funded program initiated in 2020. Results were below detection limits for all four PFAS compounds and is further discussed in **Section 2.12**. Additionally, the USEPA funded a groundwater treatment system for the City of St. Anthony in the 1990s, located approximately 4 miles downgradient from TCAAP (Army 2002). Land use restrictions were also implemented at TCAAP, which includes restricting well installations to prevent unacceptable human exposure to any contaminated groundwater. The Minnesota Department of Health Special Well Boring and Construction Area permit requires approval prior to installing any well that could potentially withdraw water from a contaminated aquifer. (PIKA-Arcadis JV 2021).

The property within the former TCAAP boundary does not have any potable water supply wells. Due to land use restrictions preventing exposure to contaminated groundwater, it is unlikely that a potable well would be installed within the former installation in the future.

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 TCAAP, which along with state and county geographic information system provided by the installation identified several off-post public and private wells within 5 miles of the installation boundary (**Figure 2-5**). The EDR report providing well search results provided as **Appendix C**.

## 2.11 Ecological Receptors

The PA team collected information regarding ecological receptors that was available in the installation documents. The Blanding's turtle (*Emydoidea blandingi*) was identified as a state endangered species that may be found within TCAAP (Wenck Associates, Inc. 2012). Additional field habitat assessments have been conducted to verify habitat conditions for the Bald Eagle and the Ghost Tiger Beetle in addition to the Blanding's Turtle (PIKA-Arcadis JV 2021). This information is provided for future reference should the Army decide to evaluate exposure pathways relevant to the three identified ecological receptors.

## 2.12 Previous PFAS Investigations

Previous (i.e., pre-PA) PFAS investigations relative to TCAAP, including both those conducted by the Army and outside stakeholders, are summarized to provide full context of available PFAS data for TCAAP. However, only data collected by the Army will be used to make recommendations for further investigation.

The Minnesota Department of Health began the Statewide PFAS Monitoring Project in 2020 to test for PFAS compounds in public water systems across the state, including PFOS, PFOA, PFBS and PFHxS. A Health Risk Index calculation was used to evaluate the combined risk from chemicals that have similar health effects and available health-based guidance values. There were no PFAS Health Risk Index exceedances in any of the samples collected within 5-miles of TCAAP. The City of New Brighton was sampled in 2021 as part of this program. PFOS, PFOA, PFBS, and PFHxS were not detected in any of the samples collected. The analytical method used and laboratory limit of detection for each PFAS compound sampled remain unknown at the time of this report (Minnesota Department of Health 2023).

In response to the third Unregulated Contaminant Monitoring Rule (UCMR3) and IMCOM Operations Order 16-088, three public water systems (MN1620026 [Saint Paul Regional Water Services], MN1620030 [Vadnais Heights], and MN1270024 [Minneapolis]) located within 5-miles of TCAAP were sampled for six PFAS compounds, including PFOS, PFOA, PFBS, PFHxS, and PFNA in 2013, 2014, and 2015. Sampling was conducted by the USEPA or the public water system. All compounds were not detected at concentrations above the laboratory limit of quantitation (LOQ; 40, 20, 90, 30 and 20 ng/L for PFOS, PFOA, PFBS, PFHxS, and PFNA, respectively). The laboratory which analyzed samples under UCMR3 met the USEPA's UCMR3 Laboratory Approval Program application and Proficiency Testing criteria for USEPA Method 537 Version 1.1 (USEPA 2012). At the time of this report, this is the most recent UCMR3 data collected.

# 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 TCAAP, data was collected from two principal sources of information and are described in the subsections below:

1. Records review
2. Personnel interviews

Preliminary locations of potential use, storage, and/or disposal of PFAS-containing materials were then evaluated in the PA (during records review and/or personnel interviews) and were categorized as AOPIs or as areas not retained for further investigation at this time based on a combination of information collected (e.g., records reviewed, personnel interviews, internet searches). A summary of the observations made, and data collected through records reviews (**Appendix D**), installation personnel and interviews (**Appendix E**) during the PA process for TCAAP 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 for this PA included, but were not limited to, various Installation Restoration Program (IRP) administrative record documents, compliance documents, and geographic information system files. Internet searches were also conducted to identify publicly available and other relevant information. A list of the specific documents reviewed for TCAAP is provided in **Appendix D**.

## 3.2 Personnel Interviews

Interviews were conducted via telephone. The list of roles for the installation personnel interviewed during the PA process for TCAAP is presented below.

- Minnesota Army National Guard Environmental Coordinator
- Army Environmental Support Manager
- Northrup Grumman Corporation Remediation Project Manager
- Former TCAAP Industrial Engineer, Assistant Remedial Project Manager, Commander's Representative, and Remedial Project Manager

The compiled interview logs are provided in **Appendix E**.

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

TCAAP 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.

PFAS containing materials including AFFF may have been used, stored, or disposed at the fire stations, fire training areas, burning areas, and installation storage buildings at TCAAP; however, limited information is available regarding the historical operations at TCAAP related to use, storage, and/or disposal of PFAS-containing materials. There is also limited information regarding emergency response procedures at TCAAP involving the use of AFFF or any other fire-fighting procedures if an emergency occurred. No confirmation of AFFF on the installation was reported or discovered through personnel interviews or records research.

**Fire Stations**

Former fire stations were identified at TCAAP through records review and personnel interviews. There were two known fire stations on the installation: Fire Station and Training Area Building 157 and Fire Station Building 557. Located on the western side of the installation, Fire Station and Training Area Building 157 was the main fire station for the installation until being abandoned prior to 2000. Personnel interviews indicate a fire training area was associated with Building 157 however, the exact location and activities conducted remain uncertain at the time of this report. Fire Station Building 557 is located on the southwest side of the installation and was active beginning in 1941 and abandoned prior to the 1990s. Personnel interviews indicated that foam was used and stored at the fire stations; however, it is uncertain whether the foams contained AFFF.

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

Following document research and personnel interviews at TCAAP, burn and burial areas, metal plating operations, landfills, storage buildings, and research facilities were also identified as preliminary locations for use, storage, and/or disposal of PFAS-containing materials. 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**.

**Metal Plating**

Two buildings at TCAAP were identified for their metal plating operations, Industrial Operations Building 103 and Industrial Operations Building 502 (Site I). During metal plating operations, a metal surface may be treated with a layer of electrochemically deposited metals in an acid bath. PFAS, specifically PFOS, have been used in metal plating operations as surface tension-reducing wetting agents to mitigate the release of aerosolized chemicals into a working environment. Hard chromium plating is one type of metal plating operation where PFAS-containing mist suppressants were commonly used. Historically, it was common for spent plating baths from metal plating operations to be disposed of in a lined or unlined pit or into a sanitary or storm sewer. Therefore, PFAS present in mist suppressants during the metal plating process could be released to the environment. The Southwest Sewer System (Site J) serviced the Industrial Operations Building 502 (Site I) and was known to have defects. Waste generated from Industrial Operations Building 502 (Site I) was historically monitored for other contaminants of concern due to known leaks into the sewer system from the building.

**Burn and Burial Areas**

Multiple burn and/or burial areas were identified at TCAAP through records review and personnel interviews including the Early Burn/Burial Area (Site A), Sewage Sludge Burial Area (Site B), Open Burn Area/Salvage Area (Site C), Chemical Burial Area (Site E), and Burning Area/Fill Site (Site H). Most burn areas are not retained for further investigation since the intent of burn pit operations is to allow materials to burn completely, so the use of firefighting foams or AFFF is unlikely. Many of the burial areas were used for the disposal of various wastes such as sewage sludge, industrial sludge, solvents, explosive-containing wastes, mercury crack cases, construction debris, and chemical waste.

**Landfills**

Two landfills were identified onsite apart from other burial areas. Landfill (Site G) and Landfill (Site 129-15) were both used for the disposal of miscellaneous materials (e.g., absorbent sweepings, propellant research materials, spent solvents, construction and building debris). There is no documented evidence that any PFAS-containing materials were disposed of in either landfill.

**Sludge Storage Areas**

Retrievable Monitored Contaminant Structure Buildings 962A and 962B as well as Sewer Cleanout and Drum Storage Building 576 were used to store drums after sewer cleanouts. A total of 1,058 55-gallon drums were filled during three sewer cleaning events that took place between 1984 and 1986.

**Pesticides**

The Vehicle Maintenance Shop Building 114 was utilized for pesticide mixing and storage, however no evidence of PFAS-containing pesticides was found during records review and personnel interviews. During a telephonic interview with the IMCOM Pest Management Consultant, it was noted that products containing Sulfluramid (i.e., associated with insecticides) may have contained PFAS and were phased out in 1996. During the PA records review, the IMCOM Pest Management Consultant provided records of potentially PFAS-containing pesticides and insecticides used at and/or stored at Army installations, and did not identify TCAAP as an installation having used or stored PFAS-containing pesticides/insecticides. Additionally, the PA team reviewed available pesticide use inventory documentation provided by the installation and did not identify PFAS-containing pesticides use, storage, or disposal.

## 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 TCAAP) is not part of the PA/SI. However, no potential off-post PFAS sources within a 5-mile radius of the installation were 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 TCAAP, 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, nine areas have been identified as AOPIs. The process used for refining these areas is presented on **Figure 5-1**, below.

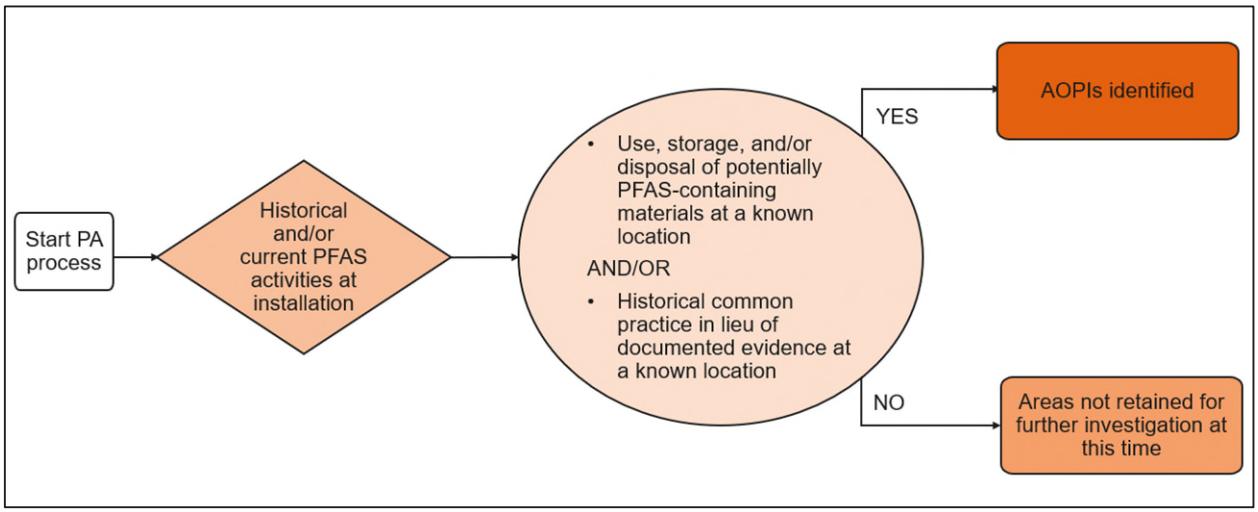


**Figure 5-1: AOPI Decision Flowchart**

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 TCAAP are presented in **Section 8**.

## 5.1 Areas Not Retained for Further Investigation

Through the evaluation of information obtained during records review and/or personnel interviews, 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, and presented on **Figure 5-2**.

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

| Area Description | Dates of Operation | Relevant Site History | Rationale |
|---|---|---|---|
| **Early Burn/Burial Area (Site A)** | 1940s to 1966 | Used for the burning and burial of various wastes such as sewage sludge, solvents, explosive-containing wastes, and mercury crack cases. | No documented evidence of PFAS-containing materials used, stored, or disposed of in this location. |

| Area Description | Dates of Operation | Relevant Site History | Rationale |
|---|---|---|---|
| **Sewage Sludge Burial Area (Site B)** | 1962 to 1966 | Used for disposal of sewage sludge from unknown source areas. | No documented evidence of PFAS-containing materials used, stored, or disposed of in this location. |
| **Leach Pits/Solvent Burn Area (Site D)** | 1949 to 1973 | Disposal area for unused explosives, oil, solvents, scrap propellant, primer, thinner, sump wastes, and mercurous nitrate. In 1985,1,470 cubic yards of soil was excavated, then incinerated in 1989. Some residual soil impacts left on site under 4 to 6-foot soil cover. Soil vapor extraction system was operational from 1986 to 1998 for volatile organic compound extraction. In 2022, 1,300 cubic yards of soil was excavated and disposed of at an offsite landfill. | No documented evidence of PFAS-containing materials used, stored, or disposed of in this location. |
| **Chemical Burial Area (Site E)** | Early 1940s | Used for the disposal of items such as construction debris and unknown chemical wastes, as well as the burning of ammunition boxes. | No documented evidence of PFAS-containing materials used, stored, or disposed of in this location. |
| **Chemical Burn/Burial Area (Site F)** | 1950s to 1985 | Burial and burning area starting in early 1950s of primers, fuzes, small caliber arms, and waste materials. Glyphosate herbicide was applied in 1993 to kill vegetation. | No documented evidence of PFAS-containing materials used, stored, or disposed of in this location. |
| **Landfill (Site G)** | 1940s to 1976 | Disposal area for floor absorbent sweepings, fluorescent lightbulbs, oil filters, propellant research materials, spent solvents, and construction debris. Excavation was conducted in 1978 and a clay cap installed in 1985. | No documented evidence of PFAS-containing materials used, stored, or disposed of in this location. |
| **Burning Area/Fill Site (Site H)** | 1940s to 1967 | Used to burn combustible waste such as paper, wood, cardboard, and other miscellaneous materials. The southern portion was likely | No documented evidence of PFAS-containing materials used, stored, or disposed of in this location. |

| Area Description | Dates of Operation | Relevant Site History | Rationale |
|---|---|---|---|
| | | used as a disposal area for industrial sludge, paint residue, incineration ash, and solvents. | |
| **Primer Tracer Area Building 135** | 1940s to 1970s | Utilized for raw material storage for primer production and tracer mixing. In 2005, 2,354 total tons of soil excavated and sent to an offsite landfill in Buffalo, Minnesota. | No documented evidence of PFAS-containing materials used, stored, or disposed of in this location. |
| **Burn Area (Site 129-5)** | 1945 to 1950s | Open burning pits for scrap explosives, bullets, and spent solvents, as well as disposal of primer/tracer sludge. The area currently underlies a silt-settling pond from former Arsenal Sand and Gravel Company operations in the early 1970s. Approximately 100 cubic yards of soil excavated and disposed of offsite in 1999. | No documented evidence of PFAS-containing materials used, stored, or disposed of in this location. |
| **Landfill (Site 129-15)** | 1970 to 2001 | A landfill used for the disposal of general miscellaneous building materials. A 2-foot soil cover was installed in 2001 to contain contents. | No documented evidence of PFAS-containing materials used, stored, or disposed of in this location. |
| **Vehicle Maintenance Shop Building 114** | 1970s to 1990s | Utilized for pesticide mixing and storage. Potentially leased by 3M for the development of tick free pet collars. The building was also where vehicle washing would have been conducted, except for the fire trucks which were washed at the Fire Station and Training Area Building 157 and Fire Station Building 557. | No documented evidence of PFAS-containing materials used, stored, or disposed of in this location. |

## 5.2 AOPIs

Overviews for each AOPI identified during the PA process are presented in this section. Four of the AOPIs overlap with TCAAP IRP sites as identified below. At the time of this PA, none of the TCAAP IRP sites have historically been investigated or are currently being investigated for the possible presence of PFAS.

The AOPI locations are shown on **Figure 5-3**. Aerial photographs of each AOPI are presented on **Figures 5-4** through **5-10** and include active monitoring wells in the vicinity of each AOPI.

### 5.2.1 Fire Station and Training Area Building 157

The Fire Station and Training Area Building 157 is identified as an AOPI following records research and personnel interviews due to foam being used for training that potentially contained AFFF (**Figure 5-4**). This was the main fire station used by TCAAP for fire response until being abandoned prior to 2000. The area was also used by a local municipality for training, but no foam was reported to have been used during these trainings. Additionally, there was one fire response from this station for an unknown location, but no foam was reportedly used. At the time of this report, this area is located on property owned by Ramsey County (Arcadis 2023).

### 5.2.2 Industrial Operations Building 103

The Industrial Operations Building 103 (IRP ID: TCAAP-16) is identified as an AOPI due to metal plating operations that were conducted (**Figure 5-5**). The building was constructed in 1942 and used until 1998 for the manufacture of various ammunition and other munitions components. The building was leased by Honeywell, Inc. beginning in 1981 (Minnesota Department of Health 2008). Processes including degreasing and machine cleaning, plating waste degeneration and discharge, and X-ray analyses of metal components were among other operations conducted at this location. The building was demolished in 2006 and the concrete slab was removed by Ramsey County in 2014. Contaminated soil was removed in 2009 and 2014 and 2015 and disposed at an offsite landfill (Army 2020). The area is now used for ongoing remedial operations, including a groundwater extraction trench and an air stripper used for treatment of volatile organic compounds within the Unit 1 aquifer (Arcadis 2023).

### 5.2.3 Fire Station Building 557

The Fire Station Building 557 is identified as an AOPI following records research and personnel interviews due to being fully operational during the timeline that AFFF was potentially used or stored (**Figure 5-5**). The former fire station operated from approximately 1941 until being abandoned prior to the 1990s. At the time of this report, this area is located on property owned by Ramsey County (Arcadis 2023).

### 5.2.4 Industrial Operations Building 502 (Site I)

The Industrial Operations Building 502 (Site I) (IRP ID: TCAAP-15) is identified as an AOPI due to metal plating operations (**Figure 5-6**). Building 502 was constructed in 1942 and used until 2004 (Army 2020). The building was leased by Honeywell, Inc. who conducted the chromating, metal plating, metal hardening, stamping of copper liners, zinc casting, and other processes that included degreasing and machine cleaning as well as plating waste generation and discharge (Minnesota Department of Health 2008). Activities also included X-ray analyses of metal components. Lubricants from forge operations in Building 502 were distributed throughout the building by a piping system routed in floor trenches, draining to the Southwest Sewer System. Overflows from the sewer system were diverted into Round Lake around 1953. The sewage from this building was regularly monitored for cyanide and hexavalent chromium.

Between 1985 and 1986, soil was excavated from the exterior of the building. Building 502 was demolished by Ramsey County in 2014 and 2015 and the remediation of contaminated soil beneath and near the former building was completed in 2014 and 2015 (Army 2020).

### 5.2.5 Open Burn Area/Salvage Area (Site C)

The Open Burn Area/Salvage Area (Site C) (IRP ID: TCAAP-05) is identified as an AOPI due documentation of machinery decontamination related to Building 103 (**Figure 5-7**). In May 1962, a 3-foot-deep pit was excavated for waste disposal as well as decontamination of 64 machines from Building 103, where metal plating activities occurred. The machines were contaminated with explosives and burned using wood and fuel oil. Site C was primarily used for burning and disposal activities from 1947 to 1982. Between 2000 and 2007, a total of 21,450 cubic yards of contaminated soil was excavated and transported offsite for disposal. In 2007 and 2008, a 4-foot soil cover was placed over the site (Shaw Environmental, Inc. 2009). At the time of this report, this area is located on property owned by Ramsey County (Arcadis 2023). Ramsey County completed additional soil remedial actions in 2011, including extending the 4-foot thick soil cover to the south and southeast, and excavation of 12,180 cubic yards of contaminated soil until to at least 4 feet below ground surface (bgs) (Army 2020).

### 5.2.6 3M Medical Equipment R&D Facility Building 538

The 3M Medical Equipment R&D Facility Building 538 is identified as an AOPI due to documentation that the building was leased by 3M and used for researching fluorine-containing solid propellants (**Figure 5-8**). 3M also used Building 538 for the research, development, and production of uranium dioxide and thorium dioxide micro-spheres as nuclear fuel. By 1991, the facility was used for medical diagnosis and therapy equipment research and development (R&D and work with radiological materials was also conducted in Buildings 113, 573, 575, and 590). Disposal of drums in the “Clean Fill Area,” also known as Site G, was reported in 1964. (United States Army Toxic and Hazardous Materials Agency 1978). Control of this area has since been reassigned to the National Guard Bureau who licenses the use of the property to the Minnesota Army National Guard (Arcadis 2023).

### 5.2.7 Southwest Sewer System (Site J)

The Southwest Sewer System (Site J) (IRP ID: TCAAP-14) is identified as an AOPI due to servicing multiple buildings, including Building 502, where metal plating activities occurred (**Figure 5-9**). The Southwest Sewer System is also known as Site J, which includes the southwestern portion of the sewer system and soils immediately adjacent. The sewer system was pumped into the Minneapolis sewage system for treatment and disposal while pre-treatment overflow was directed to Round Lake until 1983. At least five sewer line breaks were recorded at TCAAP, and emergency wastes were diverted to Round Lake until repairs were complete. (Montgomery Watson 1994). Two sewer cleanings were conducted between 1984 and 1986 and a third sewer cleaning was conducted in 1986 in the sections associated with waste from Building 502. A total of 1,058 55-gallon drums were filled during the three events. At the time of this report, this area is located on property owned by Ramsey County.

### 5.2.8 Sewer Cleanout Drum Storage Building 576

The Sewer Cleanout Drum Storage Building 576 (**Figure 5-10**) is identified as an AOPI due to waste storage that originated from the Industrial Operations Building 502 (Site I) and Southwest Sewer System (Site J), where analytical results indicated the presence of PFAS. The Sewer Cleanout Drum Storage Building 576 stored the drums associated with the three sewer system cleanout events between 1984 and 1986, including sludge from the sewers surrounding the Industrial Operations Building 502 (Site I) AOPI, where metal plating activities occurred. A total of 1,058 55-gallon drums were filled during three sewer cleaning events related to the Industrial Operations Building 502 (Site I) between 1984 and 1986. Building 576 was also used by Honeywell, Inc. for the storage of depleted uranium and housing of die-casting machines. The property is federally owned, and control has been delegated to the U.S. Army Reserve. Building 576 was included in an expanded SI to evaluate the presence or absence of PFAS based on the analytical results from the Industrial Operations Building 502 (Site I) and the Southwest Sewer System (Site J) AOPIs.

### 5.2.9 Retrievable Monitored Containment Structure Buildings 962A and 962B

The Retrievable Monitored Containment Structure Buildings 962A and 962B (**Figure 5-6**) is identified as an AOPI due to waste storage that originated from the Industrial Operations Building 502 (Site I) and Southwest Sewer System (Site J), where analytical results indicated the presence of PFAS. The Retrievable Monitored Containment Structure Buildings 962A and 962B stored drums associated with the three sewer system cleanout events between 1984 and 1986, including sludge from the sewers surrounding the Industrial Operations Building 502 (Site I) AOPI, where metal plating activities occurred. A total of 1,058 55-gallon drums were filled during three sewer cleaning events related to the Industrial Operations Building 502 (Site I) between 1984 and 1986. A soil excavation was completed in 1986 from the area surrounding Industrial Operations Building 502 (Site I) and the associated sewer lines and this soil was stored in Building 962A. The property was transferred to Ramsey County in 2013. Buildings 962A and 962B were included in an expanded SI to evaluate the presence or absence of PFAS based on the analytical results from the Industrial Operations Building 502 (Site I) and the Southwest Sewer System (Site J) AOPIs.

# 6 SUMMARY OF SI ACTIVITIES

Based on the results of the PA at TCAAP, an SI for PFOS, PFOA, PFBS, PFNA, and PFHxS was conducted in accordance with CERCLA. SI sampling was completed at TCAAP at all nine 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 2023) 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, groundwater, surface water, and/or sediment exposure pathways as potentially complete at all nine AOPIs, 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 December 2022 and January and March 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 2023) 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 TCAAP. Non-conformances to the prescribed procedures in the PQAPP and QAPP Addendum are described in **Section 6.3.3**. Analytical results obtained through SI field activities are summarized in **Section 7**.

## 6.1 Data Quality Objectives

As identified during the DQO process and outlined in the site-specific QAPP Addendum (Arcadis 2023), 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, soil, and sediment 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.

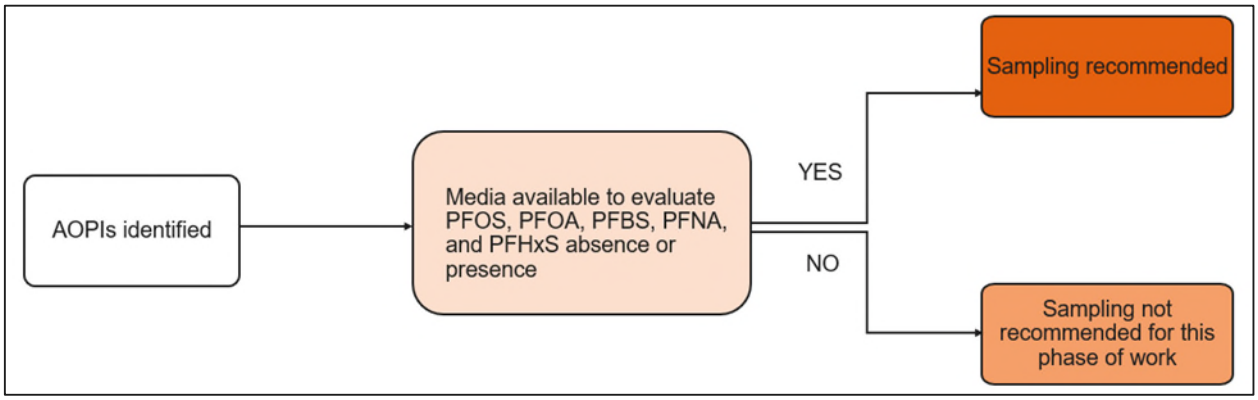


**Figure 6-1: AOPI Sampling Decision Tree**

The sampling design for SI sampling activities at TCAAP is detailed in Worksheet #17 of the QAPP Addendum (Arcadis 2023). Briefly, soil and/or groundwater samples were collected from areas of known or suspected PFAS-containing materials use, storage, and/or disposal. Groundwater and soil were sampled to identify PFOS, PFOA, PFBS, PFHxS, and PFNA presence, type of the 18 selected constituents as listed in Worksheet #15 of the QAPP Addendum and concentrations (Arcadis 2023). For the AOPI where soil samples were collected, one soil sample was also analyzed for total organic carbon (TOC), pH, and grain size. These data are collected as they may be useful in future fate and transport studies. These targeted sampling areas are believed to have the potential for the greatest PFAS concentrations closest to known or suspected use, storage, and/or disposal of PFAS-containing materials. Soil samples were not collected at AOPIs located on the parcel owned by Ramsey County due to soil investigations and remediation completed for 380 acres (Army 2020). Soil would have been remediated in between 2013 and 2017, including any soil potentially impacted by use, storage, and/or disposal of PFAS-containing materials at those areas. Soil samples were not collected from the Sewer Cleanout Drum Storage Building 576 AOPI due to this AOPI being sampled during the expanded SI based on the detections and/or exceedance of PFAS at other AOPIs and winter field conditions at the time of sampling. Other historical soil excavation or remediation efforts completed at each relevant AOPIs are detailed in **Section 5.2**.

In addition to samples being collected near or in proximity to the AOPIs, two additional groundwater samples were collected from the influent of the onsite groundwater treatment systems, the Source Groundwater Recovery System (SGRS) and the Boundary Groundwater Recovery System (BGRS) (referred to as the TCAAP Groundwater Recovery System in Worksheet #17 of the QAPP Addendum [Arcadis 2023]). The groundwater sample from the BGRS is a representative sample of groundwater conditions under three AOPIs: Southwest Sewer System (Site J), Fire Station Building 557, and 3M Medical Equipment R&D Facility Building 538. The BGRS extracts groundwater from eight boundary extraction wells. The groundwater samples from the SGRS is a representative sample of groundwater conditions under three AOPIs: Fire Station Building 557, Industrial Building 502 (Site I), and 3M Medical Equipment R&D Facility Building 538. The SGRS extracts groundwater from nine source control wells.

During the SI sampling event, planned grab groundwater samples were not collected at two of the AOPIs (Fire Station Building 557 and 3M Medical Equipment R&D Facility Building 538) due to the drill rig hitting

refusal prior to reaching groundwater or the direct push technology drilling equipment having limited tooling before reaching groundwater. Impacts of these changes are further detailed in **Section 6.3.3**. The sampling depths at existing monitoring wells were at approximately the center of saturated screened interval. **Table 6-1** includes the monitoring well construction details for the wells sampled during the SI (if available).

## 6.3 Sampling Methods and Procedures

Environmental data were collected and analyzed in accordance with the PQAPP (Arcadis 2019), the SOPs and TGIs included as Appendix A to the PQAPP, the QA/QC requirements identified in Worksheet #20 of the PQAPP, the approved scope and sampling methods outlined in the site-specific QAPP Addendum (Arcadis 2023), and the safety procedures specified in the Accident Prevention Plan (Arcadis 2018) and SSHP (Arcadis 2023). 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 2023). 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 F** and **G**, respectively. Photographs of the sampling activities are included in **Appendix H**.

### 6.3.1 Field Methods

Groundwater samples were collected using low-flow purging methods from approximately the center of the saturated screened interval in existing shallow monitoring wells. The remaining deep well groundwater samples were collected using hydrasleeves, which were also set approximately in the center of the saturated screened interval. Composite soil samples were collected via a decontaminated stainless-steel hand auger from the uppermost 2 feet of soil. Soil from each 0 to 2 feet bgs interval was homogenized on PFAS-free high-density polyethylene plastic sheeting with a decontaminated stainless-steel trowel prior to placement in sample containers. The sediment sample was collected from the upper 10 centimeters using a decontaminated stainless-steel trowel.

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

### 6.3.2 Quality Assurance/Quality Control

Worksheets #20 of the PQAPP and QAPP Addendum provide QA/QC requirements for field duplicates, matrix spike/matrix spike duplicates, equipment blanks (EBs), 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 2023), 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 only. 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 2023). The decontaminated reusable equipment from which EBs were collected include hand augers, water-level meters, hydrasleeve weights, and stainless-steel trowels as applicable to the sampled media. Analytical results for blank samples are discussed in **Section 7.13**.

### 6.3.3 Field Change Reports

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

- FCR-TCAAP-01: At the Southwest Sewer System AOPI, groundwater samples were originally planned to be sampled from wells TCAAP-03F306 and TCAAP-03F308. These wells were found to be extraction wells, so the nearby monitoring wells TCAAP-03U002 and TCAAP-03U702 were chosen to be sampled instead. It was unknown that the original wells were extraction wells until the field work began. At the Industrial Operations Building 103 AOPI, groundwater was originally planned to be collected from TCAAP-01U611R; however, it was discovered in the field that the well contained an active transducer, so the nearby monitoring well TCAAP-01U615 was chosen to be sampled instead. Each well that had to be changed had a respective replacement; therefore, there was no impact on the overall scope of work.
- FCR-TCAAP-02: During the scoping process of the SI, it was decided that sampling at two additional AOPIs (Sewer Cleanout Drum Storage Building 576 and Retrievable Monitored Containment Structure Buildings 962A and 962B) would be contingent on the analytical results from the Industrial Operations Building 502 (Site I) AOPI. A secondary SI sampling event was completed in March 2023 due to the detection and/or exceedance of PFOS, PFOA, PFBS, PFNA, and/or PFHxS at the Industrial Operations Building 502 (Site I) and the Southwest Sewer System (Site J) AOPI during the initial SI sampling event.

Non-conformances to the approved sampling scope and/or procedures may occur during the sampling events. Non-conformances were reviewed and approved in accordance with the following chain of communication: 1) minor modifications or clarifications were communicated within the field team; and 2) major modifications were communicated to USACE in the daily/periodic field status email updates submitted by the SI project manager during the sampling event. Non-conformances to the approved sampling plan which affect the DQOs are documented in Non-Conformance Reports (NCRs) included as **Appendix J** and are summarized below:

- NCR-TCAAP-01: two grab groundwater samples were originally planned at the 3M Medical Equipment R&D Facility Building 538 (TCAAP-B538-1-GW and TCAAP-B538-2-GW). Upon arrival to site, the drilling company only brought enough drill rod to reach 35 feet bgs since the

target Unit 1 aquifer was expected to be reached at a shallower depth than 35 feet bgs. During the drilling operations, groundwater was not found before reaching 35 feet bgs at either location. Therefore, groundwater was not sampled at these locations. Additionally, shallow groundwater at the installation is discontinuous and underlain by the Unit 2 aquitard. Although shallow groundwater was not able to be sampled, soil was sampled as planned. A well downgradient of the AOPI was also sampled. Therefore, determination of presence or absence of PFAS at this AOPI was possible and the impact is minor.

- NCR-TCAAP-02: one grab groundwater sample was originally planned at Fire Station Building 557 (TCAAP-B557-1-GW); however, the drill rig hit refusal at 30 feet bgs during multiple attempts, prior to reaching groundwater, so groundwater was not sampled at this location. Additionally, shallow groundwater associated with Unit 1 is discontinuous and does not extend beyond Site I but migrates downward into the deeper Unit 3 groundwater (PIKA-Arcadis JV 2021). Although groundwater was unable to be sampled at this location, downgradient wells were sampled as planned at the Industrial Operations Building 502 (Site I) AOPI. Therefore, determination of presence or absence of PFAS at this AOPI was possible and the impact is minor.

### 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, excess sediment, 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, soil/sediment, and equipment, transported to a staging area pending SI sample results, and subsequently disposed of. The selected treatment for soil and groundwater IDW was determined once the analytical results of PFAS concentration were available for each media. The soil IDW was spread on the ground surface at the source area where sampling was conducted based on the analytical results of PFAS concentrations in soil. Aqueous IDW including groundwater and decontamination fluids were treated with an onsite granular activated carbon (GAC) treatment method prior to discharge at the onsite groundwater treatment system. A 5-gallon bucket filled with GAC was the selected treatment for these sites. The GAC used in the buckets is a proven media for removing PFAS from water. A 5-gallon bucket of GAC was used to treat approximately 35 gallons of purge water generated and then discharged to the SGRS. After sampling activities, the bucket of spent GAC was taken off-site for proper disposal.

The soil IDW was spread on the ground at the 3M Medical Equipment R&D Facility Building 538 AOPI. The water IDW was disposed of at the onsite SGRS. Disposable equipment IDW was disposed of in municipal waste receptacles. Equipment IDW includes personal protective equipment and other disposable materials (e.g., gloves, plastic sheeting, Lexan tubes, and high density polyethylene and silicon tubing) that may come in contact with sampling media.

## 6.4 Data Analysis

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

### 6.4.1 Laboratory Analytical Methods

Analytical samples collected during the SI were submitted to 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, soil, and sediment 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 and sediment samples in accordance with Worksheet #18 of the QAPP Addendum (Arcadis 2023) by the analytical method noted:

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

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

The laboratory 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 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 K**).

### 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 10% Stage 4 validation of the analytical data. A Stage 4 validation includes all of Stage 1, Stage 2A, Stage 2B and Stage 3 requirements; is a qualitative review of non-detected and detected results from instrument outputs; and includes review of chromatograms. The remaining 100% of the data went through a Stage 2b which, deviated from Worksheet 36 of the PQAPP (Arcadis, 2019), however was conducted in accordance with the guidelines discussed in **Section 6.4.3** and had no to little impact on the

outcome of the data summary and usability.. Copies of the data validation reports for each sample delivery group are included as attachments to the DUSR in **Appendix K**. The Level IV analytical reports are included within **Appendix K** 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 TCAAP. Documentation generated during the data usability assessments, which were compiled into a DUSR (**Appendix K**), 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 TCAAP 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 K**), and as indicated in the full analytical tables (**Appendix L**) provided for the SI results (except for one result, discussed further below). These data are of sufficient quality to meet the objectives and requirements of the PQAPP (Arcadis 2019) and the TCAAP QAPP Addendum (Arcadis 2023). Data qualifiers applied to laboratory analytical results for samples collected during the SI at TCAAP 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.

Though the DUSR (**Appendix I**) concluded that the overall completeness of the data set met the criteria of 95%, one result for perfluorotetradecanoic acid was qualified as potentially unusable with an “X” qualifier due to extracted internal standards exhibiting recoveries less than 20%, which is indicative of matrix interferences. The “X” qualified data was reviewed by the project team and USACE chemist and it was determined that the compound with extracted internal standards recoveries less than 20% would be revised to “R” for the field duplicate sample TCAAP-FD-2-GW-031723. The result that was revised to an “R” qualifier has no impact in the evaluation of recommendations for future study at the AOPI.

## 6.5 Office of the Secretary of Defense Risk Screening Levels

The OSD risk screening levels for PFOS, PFOA, PFBS, PFNA, PFHxS, and HFPO-DA 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 and sediment data will be screened against both the Residential Scenario and Industrial/Commercial risk screening levels (if collected from less than 2 feet bgs), regardless of the current and projected land use of the AOPI.
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 CSM developed during the PA and revised based on SI findings, the presence of HFPO-DA is not anticipated at TCAAP because HFPO-DA is generally not a component of MIL-SPEC 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 TCAAP 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 and sediment 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 TCAAP (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 2023). 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 **7-3** provide a summary of the groundwater, soil, and sediment analytical results for PFOS, PFOA, PFBS, PFNA, and PFHxS. **Table 7-4** summarizes AOPIs and whether their SI results exceed the OSD risk screening levels. **Appendix L** includes the full suite of analytical results for these media, as well as for the QA/QC samples. An overview of AOPIs at TCAAP with OSD risk screening level exceedances is depicted on **Figure 7-1**. **Figures 7-2** through **7-8** show the PFOS, PFOA, PFBS, PFNA, and PFHxS analytical results in groundwater, soil, and sediment 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 are reported in mg/kg, or parts per million. As described in **Section 6.2**, soil samples were not collected at the six AOPIs located on the parcel owned by Ramsey County due to soil investigations and remediation completed between 2013 and 2017 for 380 acres (Army 2020). Other additional soil excavation or remediation efforts completed at each relevant AOPIs are detailed in **Section 5.2**.

Field parameters measured for groundwater during low-flow purging and sample collection are provided on the field forms in **Appendix G**. Soil and sediment descriptions are provided on the field forms in **Appendix G**. The results of the SI are grouped by AOPI and discussed for each medium as applicable. Groundwater was generally first encountered at depths of approximately 5 to 14 feet bgs in the grab groundwater samples and at depths of approximately 55 to 160 feet bgs in the existing monitoring well samples.

**Table 7-4 AOPIs and OSD Risk Screening Level Exceedances**

| AOPI Name | OSD Exceedances (Yes/No) |
|---|---|
| Fire Station and Training Area Building 157 | Yes |
| Industrial Operations Building 103 | Yes |
| Fire Station Building 557 | No |
| Industrial Operations Building 502 (Site I) | Yes |
| Open Burn Area/Salvage Area (Site C) | No |
| 3M Medical Equipment R&D Facility Building 538 | No |
| Southwest Sewer System (Site J) | No |
| Sewer Cleanout Drum Storage Building 576 | Yes |

| AOPI Name | OSD Exceedances (Yes/No) |
|---|---|
| Retrievable Monitored Containment Structure Buildings 962A and 962B | No |

## 7.1 Fire Station and Training Area Building 157

The subsections below summarize the groundwater PFOS, PFOA, PFBS, PFNA, and PFHxS analytical results associated with Fire Station and Training Area Building 157 AOPI shown on **Figure 7-2** and **Table 7-1**. Soil samples were not collected at the Fire Station and Training Area Building 157 AOPI due to soil investigations and remediation conducted by Ramsey County, as described in **Section 6.2**.

### 7.1.1 Groundwater

Three groundwater samples were collected from three existing monitoring wells downgradient of the Fire Station and Training Area Building 157 AOPI (TCAAP-01U615, TCAAP-01U617, and TCAAP-01U618). These groundwater samples coincide with the groundwater samples collected at the Industrial Operations Building 103 AOPI described in **Section 7.2.1** and could have detection impacts from both AOPIs.

- PFOS was detected at a concentration greater than the OSD risk screening level of 4 ng/L in groundwater samples: TCAAP-01U615-012023 (7.0 ng/L) and TCAAP-01U618-011923 (7.3 ng/L).
- PFOA was detected at a concentration greater than the OSD risk screening level of 6 ng/L in two groundwater samples: TCAAP-01U616-012023 (19 ng/L) and TCAAP-01U618-011923 (17 ng/L).
- PFBS was detected at a concentration less than the OSD risk screening level of 601 ng/L in two groundwater samples: TCAAP-01U616-012023 (2.7 J ng/L) and TCAAP-01U618-011923 (3.2 J ng/L). The J qualifier indicates that the analyte was positively identified, however the result is an estimated concentration only.
- PFNA was not detected in any of the groundwater samples collected.
- PFHxS was detected at a concentration less than the OSD risk screening level of 39 ng/L in two groundwater samples: TCAAP-01U616-012023 (4.5 ng/L) and TCAAP-01U618-011923 (19 ng/L).

## 7.2 Industrial Operations Building 103

The subsections below summarize the groundwater PFOS, PFOA, PFBS, PFNA, and PFHxS analytical results associated with Industrial Operations Building 103 AOPI shown on **Figure 7-2** and **Table 7-1**. Soil samples were not collected at the Industrial Operations Building 103 AOPI due to the historical excavation and disposal of contaminated soil, as described in **Section 5.2.2**, and soil investigations and remediation conducted by Ramsey County, as described in **Section 6.2**.

### 7.2.1 Groundwater

Four groundwater samples were collected from four existing monitoring wells at the Industrial Operations Building 103 AOPI (TCAAP-01U615, TCAAP-01U617, TCAAP-01U618, and TCAAP-482083). These groundwater samples coincide with the groundwater samples collected at the Fire Station and Training Area Building 157 AOPI described in **Section 7.1.1** and could have detection impacts from both AOPIs. A collection trench for the groundwater treatment system is located on the southwest side of the former building (**Figure 7-2**). The groundwater sample collected from monitoring well 01U617 represents groundwater conditions on the downgradient side of the collection trench. Monitoring well 482083 is located side-gradient and north of the collection trench.

- PFOS was detected at a concentration greater than the OSD risk screening level of 4 ng/L in two groundwater samples: TCAAP-01U615-012023 (7.0 ng/L) and TCAAP-01U618-011923 (7.3 ng/L).
- PFOA was detected at a concentration greater than the OSD risk screening level of 6 ng/L in three groundwater samples: TCAAP-01U615-012023 (19 ng/L), TCAAP-01U618-011923 (17 ng/L), and TCAAP-482083-012323 (11 ng/L).
- PFBS was detected at a concentration less than the OSD risk screening level of 601 ng/L in three groundwater samples: TCAAP-01U615-012023 (2.7 J ng/L), TCAAP-01U618-011923 (3.2 J ng/L), and TCAAP-482083-012323 (3.1 J ng/L).
- PFNA was not detected in any of the groundwater samples collected.
- PFHxS was detected at a concentration less than the OSD risk screening level of 39 ng/L in two groundwater samples: TCAAP-01U615-012023 (4.5 ng/L) and TCAAP-01U618-011923 (19 ng/L).

## 7.3 Fire Station Building 557

The subsections below summarize the groundwater PFOS, PFOA, PFBS, PFNA, and PFHxS analytical results associated with Fire Station Building 557 AOPI shown on **Figure 7-3** and **Table 7-1**. Soil samples were not collected at the Fire Station Building 557 AOPI due to the soil investigations and remediation conducted by Ramsey County, as described in **Section 6.2**.

### 7.3.1 Groundwater

One proposed groundwater sample was unable to be collected due to the drill rig hitting refusal prior to reaching groundwater (TCAAP-B557-1-GW). One groundwater sample was collected from one existing monitoring well at the Industrial Operations Building 502 (Site I) AOPI (TCAAP-03U028) as described in **Section 7.4.1** and shown on **Figure 7-4**. While this sample is not located within the Fire Station Building 557 AOPI boundary, it is located downgradient of the Fire Station Building 557 AOPI.

- PFOS, PFOA, PFBS, PFNA, and PFHxS were not detected.

## 7.4 Industrial Operations Building 502 (Site I)

The subsections below summarize the groundwater PFOS, PFOA, PFBS, PFNA, and PFHxS analytical results associated with Industrial Operations Building 502 (Site I) AOPI shown on **Figure 7-4** and **Table 7-1**. Soil samples were not collected at the Industrial Operations Building 502 (Site I) AOPI due to the soil investigations and remediation conducted by Ramsey County, as described in **Section 6.2**.

### 7.4.1 Groundwater

Three groundwater samples were collected from three existing monitoring wells at the Industrial Operations Building 502 (Site I) AOPI (TCAAP-03U028, TCAAP-03U003, and TCAAP-03U030).

- PFOS was detected at a concentration greater than the OSD risk screening level of 4 ng/L in groundwater sample TCAAP-03U003-012023 (9.6 ng/L).
- PFOA was detected at a concentration less than the OSD risk screening level of 6 ng/L in groundwater samples TCAAP-03U030-012023 (2.5 J ng/L).
- PFBS, PFNA, and PFHxS were not detected in any of the groundwater samples collected.

## 7.5 Open Burn Area/Salvage Area (Site C)

The subsections below summarize the groundwater PFOS, PFOA, PFBS, PFNA, and PFHxS analytical results associated with Open Burn Area/Salvage Area (Site C) AOPI shown on **Figure 7-5** and **Table 7-1**. Soil samples were not collected at the Open Burn Area/Salvage Area (Site C) AOPI due to the historical excavation and disposal of contaminated soil and the installation of a 4-foot soil cover as described in **Section 5.2.5**.

### 7.5.1 Groundwater

Four groundwater samples were collected from four existing monitoring wells at the Open Burn Area/Salvage Area (Site C) AOPI (TCAAP-01U046, TCAAP-01U564, TCAAP-01U576, TCAAP-03U083 [duplicate sample collected at TCAAP-01U576]).

- PFOS, PFBS, PFNA, and PFHxS were not detected in any of the groundwater samples collected.
- PFOA was detected at a concentration less than the OSD risk screening level of 6 ng/L in three groundwater samples: TCAAP-01U046-012323 (5.0 ng/L), TCAAP-01U564-012323 (3.1 J ng/L), and TCAAP-01U576-012323 (4.0 J ng/L [3.8 J ng/L]).

## 7.6 3M Medical Equipment R&D Facility Building 538

The subsections below summarize the groundwater and soil PFOS, PFOA, PFBS, PFNA, and PFHxS analytical results associated with 3M Medical Equipment R&D Facility Building 538 AOPI shown on **Figure 7-6**, **Table 7-1**, and **Table 7-2**. Grab groundwater samples that were unable to be collected as planned are discussed in **Section 6.3.3** and groundwater was evaluated based on samples collected from existing monitoring wells.

### 7.6.1 Groundwater

Two groundwater samples were collected from two existing monitoring wells downgradient of the 3M Medical Equipment R&D Facility Building 538 AOPI (TCAAP-03U030, TCAAP-03U094).

- PFOS, PFBS, PFNA, and PFHxS were not detected.
- PFOA was detected at a concentration less than the OSD risk screening level of 6 ng/L in groundwater samples TCAAP-03U030-012023 (2.5 J ng/L).

### 7.6.2 Soil

Six soil samples were collected form six locations at the 3M Medical Equipment R&D Facility Building 538 AOPI (TCAAP-B538-1-SO, TCAAP-B538-2-SO, TCAAP-B538-3-SO, TCAAP-B538-4-SO, TCAAP-B538-5-SO, TCAAP-B538-6-SO [duplicate sample collected at TCAAP-B538-1-SO]).

- PFOS, PFOA, PFBS, PFNA, and PFHxS were not detected.

## 7.7 Southwest Sewer System (Site J)

The subsections below summarize the groundwater and sediment PFOS, PFOA, PFBS, PFNA, and PFHxS analytical results associated with the Southwest Sewer System (Site J) AOPI shown on **Figure 7-7**, **Table 7-1**, and **Table 7-3**. Soil samples were not collected at the Southwest Sewer System (Site J) AOPI due to the soil investigations and remediation conducted by Ramsey County, as described in **Section 6.2**.

### 7.7.1 Groundwater

Three groundwater samples were collected from three existing monitoring well at the Southwest Sewer System (Site J) AOPI (TCAAP-03U002, TCAAP-03U078, TCAAP-03U702).

- PFOS, PFBS, PFNA, and PFHxS were not detected.
- PFOA was detected at a concentration less than the OSD risk screening level of 6 ng/L in groundwater samples TCAAP-03U078-012023 (5.4 ng/L).

### 7.7.2 Sediment

One sediment sample was collected from one location adjacent to Round Lake, directly below the outfall of the Southwest Sewer System (Site J) AOPI (TCAAP-SSW-1-SE [duplicate sample also collected]).

- PFOS, PFOA, PFBS, PFNA, and PFHxS were not detected.

## 7.8 Sewer Cleanout Drum Storage Building 576

The subsection below summarizes the groundwater PFOS, PFOA, PFBS, PFNA, and PFHxS analytical results associated with the Sewer Cleanout Drum Storage Building 576 AOPI shown on **Figure 7-8** and **Table 7-1**. Soil samples were not collected at the Sewer Cleanout Drum Storage Building 576 AOPI due to the field conditions at the time of sampling, as described in **Section 6.2**.

### 7.8.1 Groundwater

Two groundwater samples were collected from two existing monitoring wells at the Sewer Cleanout Drum Storage Building 576 AOPI (TCAAP-03U099 and TCAAP-01U060).

- PFOS was detected at a concentration greater than the OSD risk screening level of 4 ng/L in groundwater sample TCAAP-01U060-031723 (8.1 J- ng/L). The J- qualifier indicates that the result is an estimated quantity and may be biased low.
- PFOA was detected at a concentration less than the OSD risk screening level of 6 ng/L in groundwater sample TCAAP-01U060-031723 (3.9 J- ng/L).
- PFBS, PFNA, and PFHxS were not detected.

## 7.9 Retrievable Monitored Containment Structure Buildings 962A and 962B

The subsection below summarizes the groundwater PFOS, PFOA, PFBS, PFNA, and PFHxS analytical results associated with the Retrievable Monitored Containment Structure Buildings 962A and 962B AOPI shown on **Figure 7-4** and **Table 7-1**. Soil samples were not collected at the Retrievable Monitored Containment Structure Buildings 962A and 962B AOPI due to the soil investigations and remediation conducted by Ramsey County, as described in **Section 6.2**.

### 7.9.1 Groundwater

One groundwater sample was collected from one existing monitoring well at the Retrievable Monitored Containment Structure Buildings 962A and 962B AOPI (TCAAP-03U079).

- PFOS, PFOA, PFBS, PFNA, and PFHxS were not detected.

## 7.10 Source Groundwater Recovery System

The subsections below summarize the groundwater and sediment PFOS, PFOA, PFBS, PFNA, and PFHxS analytical results associated with the SGRS shown on **Figure 7-7** and **Table 7-1**.

### 7.10.1 Groundwater

One grab groundwater sample was collected from the influent at the SGRS (TCAAP-SGRS-011723).

- PFOS, PFBS, PFNA, and PFHxS were not detected.
- PFOA was detected at a concentration greater than the OSD risk screening level of 6 ng/L in groundwater samples TCAAP-SGRS-012023 (6.9 ng/L).

## 7.11 Boundary Groundwater Recovery System

The subsections below summarize the groundwater and sediment PFOS, PFOA, PFBS, PFNA, and PFHxS analytical results associated with the BGRS shown on **Figure 7-7** and **Table 7-1**.

### 7.11.1 Groundwater

One grab groundwater sample was collected from the influent at the BGRS (TCAAP-TGRS-011723).

- PFOS, PFOA, PFBS, PFNA, and PFHxS were not detected.

## 7.12 TOC, pH, and Grain Size

In addition to sampling soil for PFOS, PFOA, PFBS, PFNA, and PFHxS, one soil sample from the AOPI with collected soil samples 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 was 4,480 mg/kg. The TOC at this installation was within range of what is typically observed in desert: less than 5,000 mg/kg. The combined percentage of fines (i.e., silt and clay) in soils at TCAAP was 40.9%. In general, PFAS constituents tend to be more mobile in soils with less than 20% fines (silt and clay) and lower TOC. The percent moisture of the soil, 19.9%, was typical for clay (0 to 20%). The pH of the soil was slightly alkaline (7.8 standard units). While PFAS constituents are relatively less mobile in soils with high percentages of fines, depleted TOC may allow for enhanced mobility of the constituents in soil.

## 7.13 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 L**.

## 7.14 Conceptual Site Models

The preliminary CSMs presented in the QAPP Addendum (Arcadis 2023) were re-evaluated and updated, if necessary, based on the SI sampling results. The CSMs presented on **Figures 7-9** through **7-14** and in this section therefore represent the current understanding of the potential for human exposure. For some AOPIs, the source media, potential migration pathways and exposure media, and human exposure pathway determinations are the same and thus, the CSMs are shown on the same figure.

Many of the PFAS constituents found in AFFF and metal plating operations are surfactants (which do not volatilize) and are found in a charged or ionic state at environmentally-relevant pH (i.e., pH 5 to 9 standard units). PFOS, PFOA, 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 and groundwater, and could include 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-site workers (e.g., military personnel, 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-site residents (e.g., adults and children who could be exposed to chemicals in soil at an AOPI or tap water in a residence), and on-site recreational users (e.g., hikers or hunters who could be exposed to chemicals in waterways at an installation). Off-site receptor types could include drinking water receptors (i.e., commercial/industrial workers or residents) and recreational users.

Human exposure pathways are shown as “complete”, “potentially complete”, or “incomplete” on the CSM figures. A complete exposure pathway consists of a constituent source and release mechanism, a transport or retention medium, an exposure point where human contact with the contaminated medium could occur, and an exposure route at the exposure point. If any of these elements is missing, the exposure pathway is incomplete. Pathways are “potentially complete” where data are insufficient to conclude the pathway is either “complete” or “incomplete”. 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 7-9** shows the CSM for Fire Station and Training Area Building 157, Industrial Operations Building 103, and Open Burn/Salvage Area (Site C) AOPIs. Fire Station and Training Area Building 157 was historically used as a fully operational fire station during active periods of the installation and may have been used to store AFFF. Industrial Operations Building 103 was associated with metal plating operations during the 1940s through the 1990s. The Open Burn/Salvage Area (Site C) was used in the 1960s to decontaminate machines associated with Building 103.

- The AOPIs are located on property owned by Ramsey County, which completed soil investigations and remediation within the parcel. Soil remediation at Fire Station and Training Area Building 157 and Industrial Operations Building 103 included excavation of surface soils for offsite disposal. A 4-foot soil cover was placed over the Open Burn/Salvage Area (Site C), and land use controls restrict soil disturbance within the top 4 feet and there are no plans to update these restrictions in the future. Therefore, the soil exposure pathways for all potential human receptors are considered to be incomplete.
- PFOS, PFOA, PFBS, PFNA, and/or PFHxS were detected in groundwater at the AOPIs. The property within the former installation boundary does not have any potable water supply wells. Due to land use restrictions preventing exposure to contaminated groundwater, it is unlikely that a potable well would be installed within the former installation in the future. Therefore, the groundwater exposure pathways (via drinking water ingestion and dermal contact) for on-site workers and residents are incomplete.
- Recreational users are not expected to contact shallow groundwater during outdoor recreational activities. Therefore, the groundwater exposure pathway for on-site recreational users is incomplete.
- Groundwater originating from the AOPIs generally flows south-southwest. The municipal well fields for the City of New Brighton and the City of St. Anthony are located downgradient of the AOPIs. Therefore, the groundwater exposure pathway for off-site drinking water receptors is potentially complete.

- Constituents in shallow groundwater could discharge ultimately to Rice Creek, which flows through the northwest corner of TCAAP and exits the western boundary of the former installation. Site workers and recreational users could contact constituents in surface water and sediment through incidental ingestion and dermal contact. Therefore, the surface water and sediment exposure pathways for on-site workers, on-site recreational users, and off-site receptors are potentially complete.

**Figure 7-10** shows the CSM for the Fire Station Building 557 and Retrievable Monitored Containment Structure Buildings 962A and 962B AOPIs. Fire Station Building 557 was historically used as a fully operational fire station during active periods of the installation and may have been used to store AFFF. Retrievable Monitored Containment Structure Buildings 962A and 962B stored sludge received from the sewers surrounding the Industrial Operations Building 502 (Site I) AOPI, where metal plating activities occurred.

- The AOPIs are located on property owned by Ramsey County, which completed soil investigations and remediation within the parcel. Soil remediation included excavation of surface soils for offsite disposal. Therefore, the soil exposure pathways for all potential human receptors are considered to be incomplete.
- PFOS, PFOA, PFBS, PFNA, and PFHxS were not detected in groundwater at the AOPIs. Therefore, the groundwater exposure pathways are incomplete.
- Based on the incomplete soil and groundwater exposure pathways, the surface water and sediment exposure pathways are also considered to be incomplete.

**Figure 7-11** shows the CSM for Industrial Operations Building 502 (Site I), which was associated with metal plating operations during the 1940s through the 1990s.

- The AOPI is located on property owned by Ramsey County, which completed soil investigations and remediation within the parcel. Soil remediation included excavation of surface soils for offsite disposal. Therefore, the soil exposure pathways for all potential human receptors are incomplete.
- PFOA was detected in groundwater at the Industrial Operations Building 502 (Site I) AOPI. The property within the former installation boundary does not have any potable water supply wells. Due to land use restrictions preventing exposure to contaminated groundwater, it is unlikely that a potable well would be installed within the former installation in the future. Therefore, the groundwater exposure pathways (via drinking water ingestion and dermal contact) for on-site workers and residents are incomplete.
- Recreational users are not expected to contact shallow groundwater during outdoor recreational activities. Therefore, the groundwater exposure pathway for on-site recreational users is incomplete.
- Groundwater originating from the AOPIs generally flows south-southwest. The municipal well fields for the City of New Brighton and the City of St. Anthony are located downgradient of the AOPIs. Therefore, the groundwater exposure pathway for off-site drinking water receptors is potentially complete.
- At the Industrial Operations Building 502 (Site I) AOPI, there are no nearby surface water features or ditches to which shallow groundwater would likely discharge. Therefore, the surface water and sediment exposure pathways for all potential human receptors are incomplete.

**Figure 7-12** shows the CSM for the 3M Medical Equipment R&D Facility Building 538 AOPI. Building 538 was historically leased by 3M between the 1960s and 1990s. Former operations included research into fluorine-containing solid propellants.

- PFOS, PFOA, PFBS, PFNA, and PFHxS were not detected in soil samples from this AOPI. Based on the SI soil sample data, the soil exposure pathways for all potential human receptors are considered to be incomplete.
- PFOA was detected in groundwater at the AOPI. The property within the former installation boundary does not have any potable water supply wells. Due to land use restrictions preventing exposure to contaminated groundwater, it is unlikely that a potable well would be installed within the former installation in the future. Therefore, the groundwater exposure pathways (via drinking water ingestion and dermal contact) for on-site workers and residents are incomplete.
- Recreational users are not expected to contact shallow groundwater during outdoor recreational activities. Therefore, the groundwater exposure pathway for on-site recreational users is incomplete.
- Groundwater originating from the AOPIs generally flows south-southwest. The municipal well fields for the City of New Brighton and the City of St. Anthony are located downgradient of the AOPIs. Therefore, the groundwater exposure pathway for off-site drinking water receptors is potentially complete.
- There are no surface water bodies that flow through the AOPI; therefore, the surface water and sediment exposure pathways for on-site workers and recreational users are incomplete.
- However, constituents could migrate via shallow groundwater discharge to downgradient water features that are accessible to off-site receptors. Therefore, the surface water and sediment exposure pathways for off-site receptors are potentially complete.

**Figure 7-13** shows the CSM for the Southwest Sewer System (Site J) AOPI. The Southwest Sewer System serviced multiple buildings, including Building 502 where metal plating activities occurred.

- The AOPI is located on property currently owned by Ramsey County, which completed soil investigations and remediation within the parcel. Soil remediation included excavation of surface soils for offsite disposal. Therefore, the soil exposure pathways for all potential human receptors are incomplete.
- PFOA was detected in groundwater at the AOPI. The property within the former installation boundary does not have any potable water supply wells. Due to land use restrictions preventing exposure to contaminated groundwater, it is unlikely that a potable well would be installed within the former installation in the future. Therefore, the groundwater exposure pathways (via drinking water ingestion and dermal contact) for on-site workers and residents are incomplete.
- Recreational users are not expected to contact shallow groundwater during outdoor recreational activities. Therefore, the groundwater exposure pathway for on-site recreational users is incomplete.
- Groundwater originating from the AOPIs generally flows south-southwest. The municipal well fields for the City of New Brighton and the City of St. Anthony are located downgradient of the AOPIs. Therefore, the groundwater exposure pathway for off-site drinking water receptors is potentially complete.

- There are no surface water bodies that flow through the AOPI. Historically, overflow was diverted to Round Lake (south of the AOPI and outside the TCAAP boundary) without treatment. PFOS, PFOA, PFBS, PFNA, and PFHxS were not detected in a sediment sample collected from one location adjacent to Round Lake downgradient of the AOPI. Based on the SI sediment data, the surface water and sediment exposure pathways are considered to be incomplete.

**Figure 7-14** shows the CSM for the Sewer Cleanout Drum Storage Building 576 AOPI. Building 576 stored sludge received from the sewers surrounding the Industrial Operations Building 502 (Site I) AOPI, where metal plating activities occurred. The AOPI is on federally owned property, and control has been delegated to the United States Army Reserve.

- Soil samples were not collected at this AOPI due to winter conditions (e.g., snow cover, frozen soil). If PFOS, PFOA, PFBS, PFNA, and/or PFHxS are present in soil, site workers (including soldiers who access the AOPI for training) could contact constituents in soil via incidental ingestion, dermal contact, and inhalation of particulates (e.g., dust). Therefore, the soil exposure pathway for on-site workers is potentially complete.
- The AOPI is not used for residential or recreational purposes, and it is assumed that off-site receptors are not regularly exposed to soil at the AOPI. Therefore, the soil exposure pathways for on-site residents and recreational users and for off-site receptors are considered to be incomplete.
- PFOS and PFOA were detected in groundwater at the Sewer Cleanout Drum Storage Building 576 AOPI. The property within the former installation boundary does not have any potable water supply wells. Due to land use restrictions preventing exposure to contaminated groundwater, it is unlikely that a potable well would be installed within the former installation in the future. Therefore, the groundwater exposure pathways (via drinking water ingestion and dermal contact) for on-site workers and residents are incomplete.
- Recreational users are not expected to contact shallow groundwater during outdoor recreational activities. Therefore, the groundwater exposure pathway for on-site recreational users is incomplete.
- Groundwater originating from the AOPIs generally flows south-southwest. The municipal well fields for the City of New Brighton and the City of St. Anthony are located downgradient of the AOPIs. Therefore, the groundwater exposure pathway for off-site drinking water receptors is potentially complete.
- Shallow groundwater could discharge to Sunfish Lake, located within the AOPI footprint. Therefore, the surface water and sediment exposure pathways for on-site worker and on-site recreational users are potentially complete.

Following the SI sampling, seven of the nine AOPIs were considered to have complete or potentially complete exposure pathways. Although the CSMs indicate complete or potentially complete exposure pathways may exist, the recommendation for remedial investigation is based on the comparison of analytical results for PFOS, PFOA, 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 AOPIs at TCAAP 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 installation personnel were used to identify specific areas of suspected PFOS, PFOA, PFBS, PFNA, and PFHxS use, storage, and/or disposal at TCAAP. Following the evaluation, nine AOPIs were identified.

The property within the former TCAAP boundary does not have any potable water supply wells. Due to land use restrictions preventing exposure to contaminated groundwater, it is unlikely that a potable well would be installed within the former installation in the future.

All AOPIs were sampled during the SI at TCAAP 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 CSM developed during the PA and revised based on SI findings, the presence of HFPO-DA is not anticipated at TCAAP because HFPO-DA is generally not a component of MIL-SPEC 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 TCAAP QAPP Addendum (Arcadis 2023).

Seven of the nine AOPIs had detections of PFOS, PFOA, PFBS, PFNA, and PFHxS in groundwater and four AOPIs exceeded OSD risk screening levels. The maximum concentrations of PFOS, PFOA, PFBS, PFNA, and PFHxS detected in groundwater are summarized below:

**Groundwater**

PFOS was detected at 9.6 ng/L, above the OSD risk screening level for tap water (4 ng/L), in sample TCAAP-03U003-012023 at the Industrial Operations Building 502 (Site I) AOPI

PFOA was detected at 19 ng/L, above the OSD risk screening level for tap water (6 ng/L), in sample TCAAP-01U615-012023 at the Fire Station and Training Area Building 157 and Industrial Operations Building 103 AOPI

PFBS was detected at 3.2 J ng/L, below the OSD risk screening level for tap water (601 ng/L), in sample TCAAP-01U618-011923 at the Industrial Operations Building 502 (Site I) AOPI

PFNA was not detected in any groundwater samples collected

PFHxS was detected at 19 ng/L, below the OSD risk screening level for tap water (39 ng/L), in sample TCAAP-01U618-011923 at the Industrial Operations Building 502 (Site I) AOPI

Following the SI sampling, all seven AOPIs with confirmed PFOS, PFOA, PFBS, PFNA, and/or PFHxS presence in groundwater were considered to have complete or potentially complete exposure pathways. The soil exposure pathway for on-site workers is potentially complete at one AOPI. Due to a lack of land use controls off installation and downgradient of TCAAP, the groundwater exposure pathways for off-installation drinking water receptors are potentially complete for seven AOPIs. Constituents could migrate via shallow groundwater discharge to nearby surface water features and/or ditches. Surface water and sediment exposure pathways are potentially complete for on-site workers, on-site recreational users, and off-site receptors at four AOPIs.

Although the CSMs indicate complete or 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 TCAAP, PFOS, PFOA, PFBS, PFNA, and PFHxS sampling and recommendations for each AOPI; further investigation is warranted at TCAAP. In accordance with CERCLA, site-specific risk 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 Twin Cities Army Ammunition Plant, and Recommendations**

| AOPI Name | PFOS, PFOA, PFBS, PFNA, and/or PFHxS detected greater than OSD Risk Screening Levels? (Yes/No/ND/NS) | | Recommendation |
|---|---|---|---|
| | GW | SO | |
| Fire Station and Training Area Building 157 | Yes | NS[3] | Further study in a remedial investigation |
| Industrial Operations Building 103 | Yes | NS[3] | Further study in a remedial investigation |
| Fire Station Building 557[1] | ND | NS[3] | No action at this time |
| Industrial Operations Building 502 (Site I) | Yes | NS | Further study in a remedial investigation |
| Open Burn/Salvage Area (Site C) | No | NS[3] | No action at this time |
| 3M Medical Equipment R&D Facility Building 538 | No | ND | No action at this time |
| Southwest Sewer System (Site J) | No | NS[3] | No action at this time |

| AOPI Name | PFOS, PFOA, PFBS, PFNA, and/or PFHxS detected greater than OSD Risk Screening Levels? (Yes/No/ND/NS) | | Recommendation |
|---|---|---|---|
| | GW | SO | |
| Sewer Cleanout Drum Storage Building 576[2] | Yes | NS | Further study in a remedial investigation |
| Retrievable Monitored Containment Structure Buildings 962A and 962B[2] | No | NS[3] | No action at this time |

**Notes:**
Light gray shading – detection greater than the OSD risk screening level
GW – groundwater
ND – non-detect
NS – not sampled
SE – sediment
SO – soil
[1] – Groundwater was unable to be sampled at this AOPI due to the drill rig hitting refusal prior to reaching groundwater. However, downgradient wells were sampled as planned at the Industrial Operations Building 502 (Site I) AOPI and were used to evaluate the presence or absence of PFAS at this AOPI.
[2] – AOPI was sampled during the second SI event due to detections and/or exceedances in groundwater at the Industrial Operations Building 502 (Site I) AOPI and the Southwest Sewer System (Site J) AOPI.
[3] – Soil samples were not collected at the AOPI based on the soil remediation history and/or land use controls in place

Data collected during the PA (**Sections 3** through **5**) and SI (**Sections 6** through **8**) 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 TCAAP are discussed below.

The PA process was limited to records review and personnel interviews. No site visit was conducted for TCAAP due to no personnel or remaining structures being present on-site.

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

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

Finally, the available PFOS, PFOA, PFBS, PFNA, and PFHxS analytical data is limited to historical analytical results collected from off-post drinking water supply sources and results from groundwater, soil, and sediment samples from nine AOPIs. Available data, including PFOS, PFOA, PFBS, PFNA, and PFHxS, is listed in **Appendix L**, which were analyzed per the selected analytical method. HFPO-DA was not in the suite of PFAS compounds analyzed during the SI at TCAAP; 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 TCAAP in accordance with the guidance provided by the OSD.

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# ACRONYMS

| | |
|---|---|
| °F | degrees Fahrenheit |
| % | percent |
| AFFF | aqueous film-forming foam |
| AOPI | area of potential interest |
| Arcadis | Arcadis U.S., Inc. |
| Army | United States Army |
| BGRS | Boundary Groundwater Recovery System |
| 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 |
| FCR | Field Change Report |
| GAC | granular activated carbon |
| GW | groundwater |
| HFPO-DA | hexafluoropropylene oxide dimer acid |
| IDW | investigation-derived waste |
| IMCOM | Installation Management Command |
| installation | United States Army or Reserve installation |
| IRP | Installation Restoration Program |
| LOD | limit of detection |
| LOQ | limit of quantitation |
| mg/kg | milligrams per kilogram (parts per million) |
| MIL-SPEC | military specification |
| NCR | non-conformance report |

| | |
|---|---|
| ND | non-detect |
| ng/L | nanograms per liter (parts per trillion) |
| NS | not sampled |
| 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 |
| PIKA-Arcadis JV | PIKA International, Inc. - Arcadis U.S., Inc. Joint Venture |
| 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 |
| R&D | Research and Development |
| RSL | Regional Screening Level |
| SE | sediment |
| SGRS | Source Groundwater Recovery System |
| SI | site inspection |
| SO | soil |
| SOP | standard operating procedure |
| SSHP | Site Safety and Health Plan |
| TCAAP | Twin Cities Army Ammunition Plant |
| TGI | technical guidance instruction |
| TOC | total organic carbon |

| | |
|---|---|
| U.S. | United States |
| UCMR3 | third Unregulated Contaminant Monitoring Rule |
| USACE | United States Army Corps of Engineers |
| USAEC | United States Army Environmental Command |
| USEPA | United States Environmental Protection Agency |

# TABLES

**Table 6-1 - Monitoring Well Construction Details**
**USAEC PFAS Preliminary Assessment/Site Inspection**
**Twin Cities Army Ammunition Plant, Minnesota**

| Sub-Installation | Well ID | Installation Date | Ground Surface Elevation (ft NAVD88) | Top of Casing Elevation (ft NAVD88) | Well Diameter (inches) | Approximate Depth to Water (ft btoc)* | Total Depth (ft btoc) | Screen Length (ft) | Top of Screen (ft bgs) | Bottom of Screen (ft bgs) | Screened Lithologic Unit |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Fire Station and Training Area Building 157 and Industrial Operations Building 103 | 01U615 | 8/28/1984 | 885.83 | -- | 2 | 12.31 | 24.00 | 5.0 | 19.0 | 24.0 | Unit 1 Sand |
| | 01U617 | 11/12/1984 | 885.20 | -- | 2 | 6.8 | 41.00 | 5.0 | 35.0 | 40.0 | Unit 1 Sand |
| | 01U618 | 11/12/1984 | 888.81 | -- | 2 | 5.4 | 21.00 | 5.0 | 15.0 | 20.0 | Unit 1 Sand |
| | 482083 | 7/14/1992 | -- | 887.66 | 2 | 4.5 | 12.00 | 5.0 | 4.5 | 9.5 | Unit 1 Sand |
| Fire Station Building 557 and Industrial Operations Building 502 (Site I) | 03U030 | 8/18/1983 | -- | -- | 4 | 94 | 136 | 20 | 114.0 | 134.0 | Unit 3 Sand |
| | 03U003 | 4/29/1982 | 942.67 | 945.00 | 4 | 79.6 | 119.00 | 20 | 99 | 119 | Unit 3 Sand |
| | 03U028 | 8/23/1983 | -- | -- | 4 | 93.7 | 128.50 | 20 | 108.5 | 128.5 | Unit 3 Sand |
| Open Burn/Salvage Area (Site C) | 01U046 | 8/10/1983 | 884.00 | -- | 2 | 1 | 9.00 | -- | -- | -- | Unit 1 Sand |
| | 01U564 | 12/19/2000 | -- | 888.33 | 2 | 4 | 23.00 | 10.0 | 11.5 | 21.5 | Unit 1 Sand |
| | 01U576 | 4/4/2001 | -- | 888.13 | 2 | 4 | 15 | 5.0 | 5.0 | 10.0 | Unit 3 Sand |
| | 03U083 | 10/9/1985 | 891.00 | -- | 5 | 25 | 160.00 | 20.0 | 135.0 | 155.0 | Unit 3 Sand |
| 3M Medical Equipment R&D Facility Building 538 | 03U094 | 8/24/1984 | 997.00 | -- | 5 | 130.7 | 170.00 | 20 | 149 | 169 | Unit 3 Sand |
| Southwest Sewer System (Site J) | 03U002 | 7/9/1982 | 917.84 | 919.89 | 12, 8, 4 | 64.5 | 99 | 20 | 70 | 90 | Unit 3 Sand |
| | 03U702 | 11/17/1986 | 908.07 | -- | 4 | 54.54 | 106 | 5 | 101 | 106 | Unit 3 Sand |
| | 03U078 | 7/31/1984 | 926 | -- | 5 | 66.7 | 100 | 20 | 76 | 96 | Unit 3 Sand |
| Sewer Cleanout Drum Storage Building 576 | 03U099 | 9/20/1985 | 952.30 | -- | 5 | 90.2 | 130 | 20 | 106.0 | 126.0 | Unit 3 Sand |
| | 01U060 | 8/16/1983 | 950.87 | -- | -- | 11.15 | 16 | -- | -- | -- | Unit 1 Sand |
| Retrievable Monitored Containment Structure Buildings 962A and 962B | 03U079 | 8/14/1984 | 923.32 | -- | 5 | 70.06 | 100 | 20 | 76.0 | 96.0 | Unit 3 Sand |

**Notes:**
*Approximate depth to water in Unit 1 reported is as noted from 1 to 15 feet below ground surface, depending on which area is sampled at TCAAP (TCAAP FY20 APR, Arcadis 2021).
*Approximate depth to water in Unit 3 reported is as noted from 80 to 130 feet below ground surface, depending on which area is sampled at TCAAP (TCAAP FY20 APR, Arcadis 2021).

**Acronyms:**
-- = unknown
bgs = below ground surface
btoc = below top of casing
ft = feet
ID = identification
NAVD88 = North American Vertical Datum 1988
R&D = Research & Development
TCAAP = Twin Cities Army Ammunition Plant

**Table 7-1 - Groundwater PFOS, PFOA, PFBS, PFNA, and PFHxS Analytical Results**
**USAEC PFAS Preliminary Assessment/Site Inspection**
**Twin Cities Army Ammunition Plant, Minnesota**

| AOPI | Location | Sample/ Duplicate ID | Sample Date | Analyte | 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 | |
| | | | | Sample Type | Result | Qual | Result | Qual | Result | Qual | Result | Qual | Result | Qual |
| Fire Station and Training Area Building 157 and Industrial Operations Building 103 | TCAAP-01U617 | TCAAP-01U617-011923 | 01/19/2023 | N | 20 | UJ | 20 | UJ | 20 | UJ | 20 | UJ | 20 | UJ |
| | TCAAP-01U618 | TCAAP-01U618-011923 | 01/19/2023 | N | **7.3** | | **17** | | **3.2** | J | 4.2 | U | **19** | |
| | TCAAP-482083 | TCAAP-482083-012323 | 01/23/2023 | N | 4.9 | U | **11** | | **3.1** | J | 4.9 | U | 4.9 | U |
| Industrial Operations Building 103 | TCAAP-01U615 | TCAAP-01U615-012023 | 01/20/2023 | N | **7.0** | | **19** | | **2.7** | J | 4.1 | U | **4.5** | |
| Fire Station Building 557 and Industrial Operations Building 502 (Site I) | TCAAP-03U028 | TCAAP-03U028-012023 | 01/20/2023 | N | 3.8 | U | 3.8 | U | 3.8 | U | 3.8 | U | 3.8 | U |
| Industrial Operations Building 502 (Site I) | TCAAP-03U003 | TCAAP-03U003-012023 | 01/20/2023 | N | **9.6** | | 3.8 | U | 3.8 | U | 3.8 | U | 3.8 | U |
| Industrial Operations Building 502 (Site I) and 3M Medical Equipment R&D Facility Building 538 | TCAAP-03U030 | TCAAP-03U030-012023 | 01/20/2023 | N | 4.5 | U | **2.5** | J | 4.5 | U | 4.5 | U | 4.5 | U |
| 3M Medical Equipment R&D Facility Building 538 | TCAAP-03U094 | TCAAP-03U094-011923 | 01/19/2023 | N | 3.5 | U | 3.5 | U | 3.5 | U | 3.5 | U | 3.5 | U |
| Open Burn/Salvage Area (Site C) | TCAAP-01U046 | TCAAP-01U046-012323 | 01/23/2023 | N | 4.4 | U | **5.0** | | 4.4 | U | 4.4 | U | 4.4 | U |
| | TCAAP-01U564 | TCAAP-01U564-012323 | 01/23/2023 | N | 4.4 | U | **3.1** | J | 4.4 | U | 4.4 | U | 4.4 | U |
| | TCAAP-01U576 | TCAAP-01U576-012323 | 01/23/2023 | N | 4.1 | U | **4.0** | J | 4.1 | U | 4.1 | U | 4.1 | U |
| | | | 01/23/2023 | FD | 4.3 | U | **3.9** | J | 4.3 | U | 4.3 | U | 4.3 | U |
| | TCAAP-03U083 | TCAAP-03U083-012323 | 01/23/2023 | N | 6.1 | UJ | 6.1 | UJ | 6.1 | UJ | 6.1 | UJ | 6.1 | UJ |
| Southwest Sewer System (Site J) | TCAAP-03U002 | TCAAP-03U002-012023 | 01/20/2023 | N | 4.1 | U | 4.1 | U | 4.1 | U | 4.1 | U | 4.1 | U |
| | TCAAP-03U078 | TCAAP-03U078-012023 | 01/20/2023 | N | 4.7 | U | **5.4** | | 4.7 | U | 4.7 | U | 4.7 | U |
| | TCAAP-03U702 | TCAAP-03U702-012023 | 01/20/2023 | N | 4.0 | U | 4.0 | U | 4.0 | U | 4.0 | U | 4.0 | U |
| Sewer Cleanout Drum Storage Building 576 | TCAAP-03U099 | TCAAP-03U099-031723 | 3/17/2023 | N | 2.0 | U | 2.0 | U | 2.0 | U | 2.0 | U | 2.0 | U |
| | | | 3/17/2023 | FD | 2.2 | U | 2.2 | U | 2.2 | U | 2.2 | U | 2.2 | U |
| | TCAAP-01U060 | TCAAP-01U060-031723 | 3/17/2023 | N | **8.1** | J- | **3.9** | J- | 3.4 | U | 3.4 | U | 3.4 | U |
| Retrievable Monitored Containment Structure Buildings 962A and 962B | TCAAP-03U079 | TCAAP-03U079-031723 | 3/17/2023 | N | 3.3 | U | 3.3 | U | 3.3 | U | 3.3 | U | 3.3 | U |
| SGRS* | TCAAP-SGRS | TCAAP-SGRS-012023 | 01/20/2023 | N | 4.2 | U | **6.9** | | 4.2 | U | 4.2 | U | 4.2 | U |
| TGRS* | TCAAP-TGRS | TCAAP-TGRS-011723 | 01/17/2023 | N | 3.7 | U | 3.7 | U | 3.7 | U | 3.7 | U | 3.7 | U |

**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:**
-- = not applicable
* = location is a groundwater treatment system influent sample, not an AOPI, and groundwater results are representative of conditions for multiple AOPIs
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
R&D = Research and Development
SGRS = Source Groundwater Recovery System
TCAAP = Twin Cities Army Ammunition Plant
TGRS = TCAAP Groundwater Recovery System

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

Table 7-2 Soil PFOS, PFOA, PFBS, PFNA, and PFHxS Analytical Results
USAEC PFAS Preliminary Assessment/Site Inspection
Twin Cities Army Ammunition Plant, Minnesota

| AOPI | Location | Sample ID / Duplicate ID | Sample Date | 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 | |
| | | | | Sample Type | Result | Qual | Result | Qual | Result | Qual | Result | Qual | Result | Qual |
| 3M Medical Equipment R&D Facility Building 538 | TCAAP-B538-1-SO | TCAAP-B538-1-SO-12152022 | 12/15/2022 | N | 0.0011 | U | 0.0011 | U | 0.0011 | U | 0.0011 | U | 0.0011 | U |
| | | TCAAP-FD-1-SO-12152022 | 12/15/2022 | FD | 0.001 | U | 0.001 | U | 0.001 | U | 0.001 | U | 0.001 | U |
| | TCAAP-B538-2-SO | TCAAP-B538-SO-2-12162022 | 12/16/2022 | N | 0.00093 | U | 0.00093 | U | 0.00093 | U | 0.00093 | U | 0.00093 | U |
| | TCAAP-B538-3-SO | TCAAP-B538-SO-3-12162022 | 12/16/2022 | N | 0.0011 | U | 0.0011 | U | 0.0011 | U | 0.0011 | U | 0.0011 | U |
| | TCAAP-B538-4-SO | TCAAP-B538-4-SO-12152022 | 12/15/2022 | N | 0.00099 | U | 0.00099 | U | 0.00099 | U | 0.00099 | U | 0.00099 | U |
| | TCAAP-B538-5-SO | TCAAP-B538-5-SO-12152022 | 12/15/2022 | N | 0.00096 | U | 0.00096 | U | 0.00096 | U | 0.00096 | U | 0.00096 | U |
| | TCAAP-B538-6-SO | TCAAP-B538-SO-6-12162022 | 12/16/2022 | N | 0.001 | U | 0.001 | U | 0.001 | U | 0.001 | U | 0.001 | U |

**Notes:**
1. 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).

**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
R&D - Research and Development

| Qualifier | Description |
|---|---|
| U | The analyte was analyzed for but the result was not detected above the limit of quantitation (LOQ). |

Table 7-3 Sediment PFOS, PFOA, PFBS, PFNA, and PFHxS Analytical Results
USAEC PFAS Preliminary Assessment/Site Inspection
Twin Cities Army Ammunition Plant, Minnesota

| AOPI | Location | Sample ID / Duplicate ID | Sample Date | 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 | |
| | | | | Sample Type | Result | Qual | Result | Qual | Result | Qual | Result | Qual | Result | Qual |
| Southwest Sewer System (Site J) | TCAAP-SSW-1-SE | TCAAP-SSW-1-SE-012023 | 01/20/2023 | N | 0.011 | U | 0.011 | U | 0.011 | U | 0.011 | U | 0.011 | U |
| | | TCAAP-FD-1-SE-012023 | 01/20/2023 | FD | 0.01 | U | 0.01 | U | 0.01 | U | 0.01 | U | 0.01 | U |

**Notes:**
1. 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).

**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

| Qualifier | Description |
|---|---|
| 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
Twin Cities Army Ammunition Plant, MN


**Figure 2-1**
**Site Location**

TCAAP-Retained Property
Former TCAAP Installation Boundary

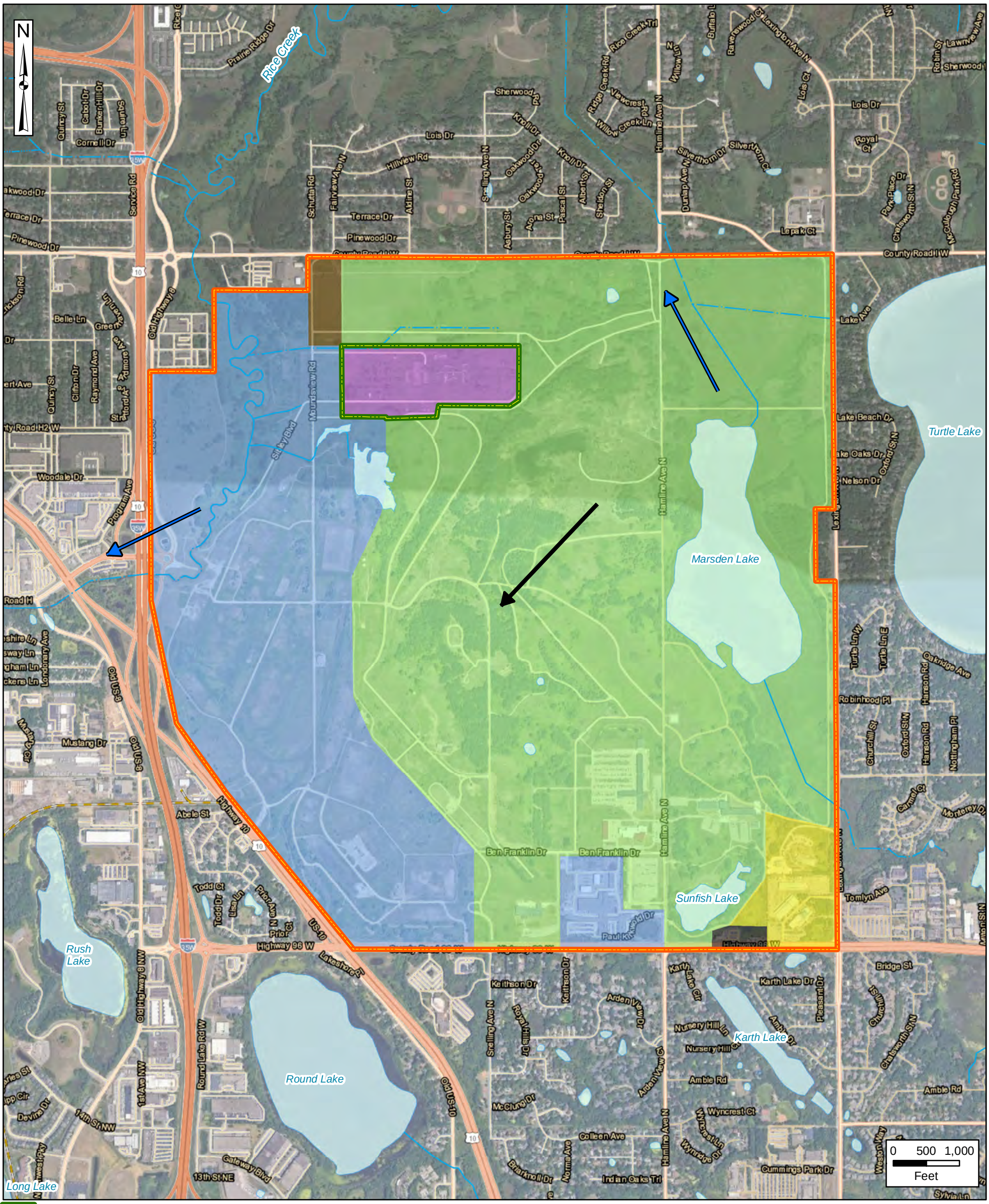
TCAAP = Twin Cities Army Ammunition Plant

Data Sources:
ESRI, ArcGIS Online, Street Map Data

Coordinate System:
WGS 1984, UTM Zone 15 North

USAEC PFAS Preliminary Assessment / Site Inspection
Twin Cities Army Ammunition Plant, MN

# Figure 2-2
# Site Layout




- TCAAP-Retained Property
- Former TCAAP Installation Boundary
- River/Stream (Perennial)
- Stream (Intermittent)
- Canal/Ditch
- Water Body
- Surface Water Flow Direction
- Groundwater Flow Direction

**Land Ownership**

- Ramsey County-Owned Property
- City of Arden Hills - Owned
- Control Delegated to the Base Realignment and Closure Division (what remains of TCAAP)
- Control Delegated to the United States Army Reserve
- Control Delegated to the National Guard Bureau, who in turn has licensed use of the property to the Minnesota Army National Guard
- Easement to Ramsey County

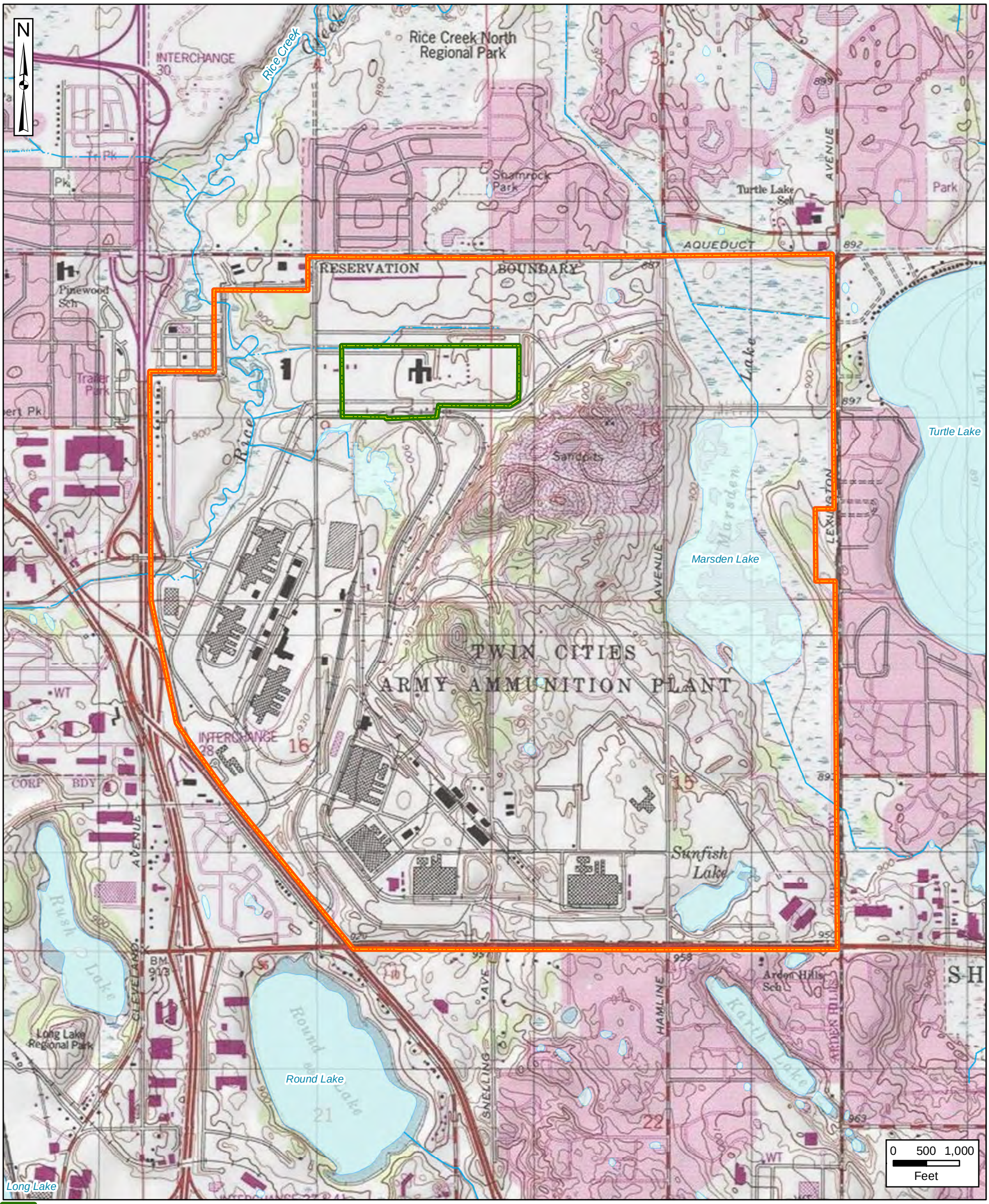
TCAAP = Twin Cities Army Ammunition Plant

Data Sources:
USGS, NHD Data, 2021
Google Earth, Aerial Imagery, 2022

Coordinate System:
WGS 1984, UTM Zone 15 North

USAEC PFAS Preliminary Assessment / Site Inspection
Twin Cities Army Ammunition Plant, MN

**Figure 2-3**
**Topographic Map**




TCAAP-Retained Property
Former TCAAP Installation Boundary
River/Stream (Perennial)
Stream (Intermittent)
Canal/Ditch
Water Body

TCAAP = Twin Cities Army Ammunition Plant

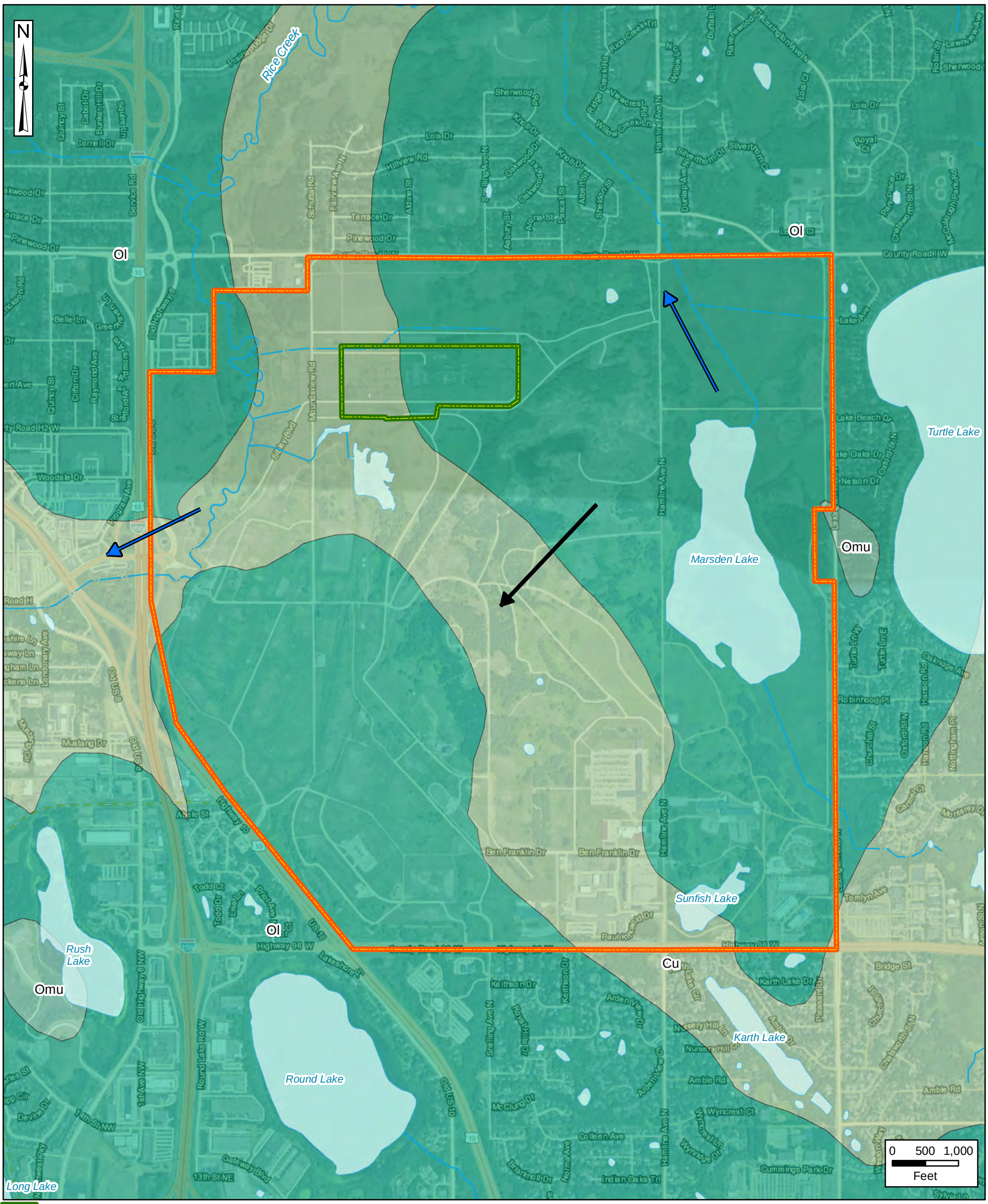
Note: Elevations shown are in feet.

Data Sources:
USGS, NHD Data, 2021
ESRI, ArcGIS Online, USA Topo Map

Coordinate System:
WGS 1984, UTM Zone 15 North

USAEC PFAS Preliminary Assessment / Site Inspection
Twin Cities Army Ammunition Plant, MN

# Figure 2-4
# Geology and Hydrogeology




- TCAAP-Retained Property
- Former TCAAP Installation Boundary
- River/Stream (Perennial)
- Stream (Intermittent)
- Canal/Ditch
- Water Body
- Groundwater Flow Direction
- Surface Water Flow Direction

**Geologic Units**

**Ordovician**

- Middle and Upper Ordovician rocks, undivided (Omu)
- Lower Ordovician rocks, undivided (Ol)

**Cambrian**

- Upper Cambrian, undivided (Cu)

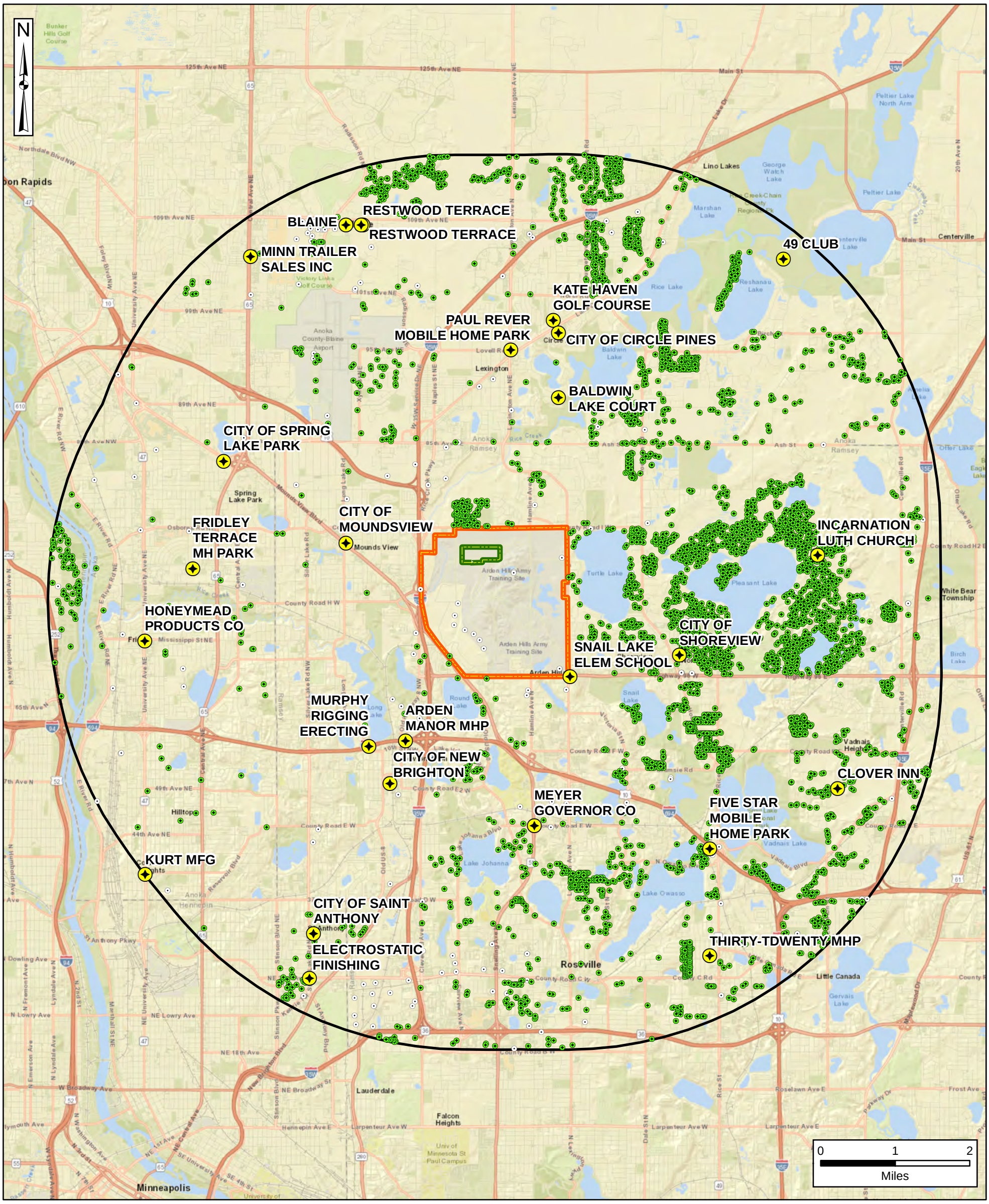
TCAAP = Twin Cities Army Ammunition Plant

Data Sources:
USGS, Geology, 2022
USGS, NHD Data, 2021
Google Earth, Aerial Imagery, 2022

Coordinate System:
WGS 1984, UTM Zone 15 North

USAEC PFAS Preliminary Assessment / Site Inspection
Twin Cities Army Ammunition Plant, MN

# Figure 2-5
# Off-Post Potable Supply Wells




TCAAP-Retained Property
Former TCAAP Installation Boundary
5-Mile Radius
Public Water Supply System Well
Domestic Well
Other Designated Use Water Well

Note:
Other Designated Use Water Wells includes commercial, industrial, and irrigation wells.

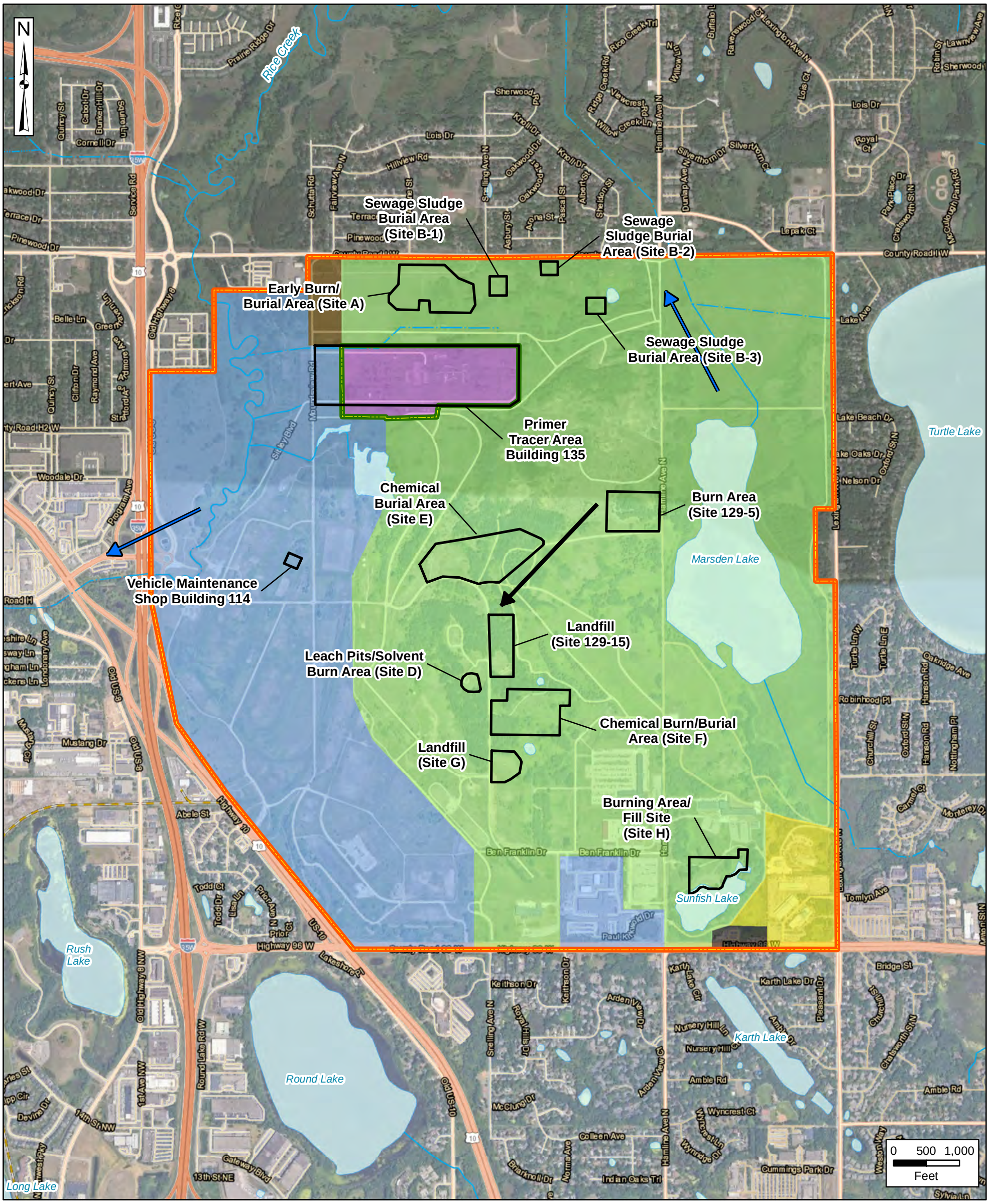
TCAAP = Twin Cities Army Ammunition Plant

Data Sources:
EDR, Public Water Supply System Wells, 2022
MGS/MDH, Domestic and Other Wells, 2023
ESRI, ArcGIS Online, Street Map Data

Coordinate System:
WGS 1984, UTM Zone 15 North

USAEC PFAS Preliminary Assessment / Site Inspection
Twin Cities Army Ammunition Plant, MN

# Figure 5-2
# Areas Not Retained for Further Investigation




TCAAP-Retained Property
Former TCAAP Installation Boundary
Area Not Retained for Further Investigation
River/Stream (Perennial)
Stream (Intermittent)
Canal/Ditch
Water Body

Surface Water Flow Direction
Groundwater Flow Direction

**Land Ownership**
Ramsey County-Owned Property
City of Arden Hills - Owned

Control Delegated to the Base Realignment and Closure Division (what remains of TCAAP)
Control Delegated to the United States Army Reserve
Control Delegated to the National Guard Bureau, who in turn has licensed use of the property to the Minnesota Army National Guard
Easement to Ramsey County

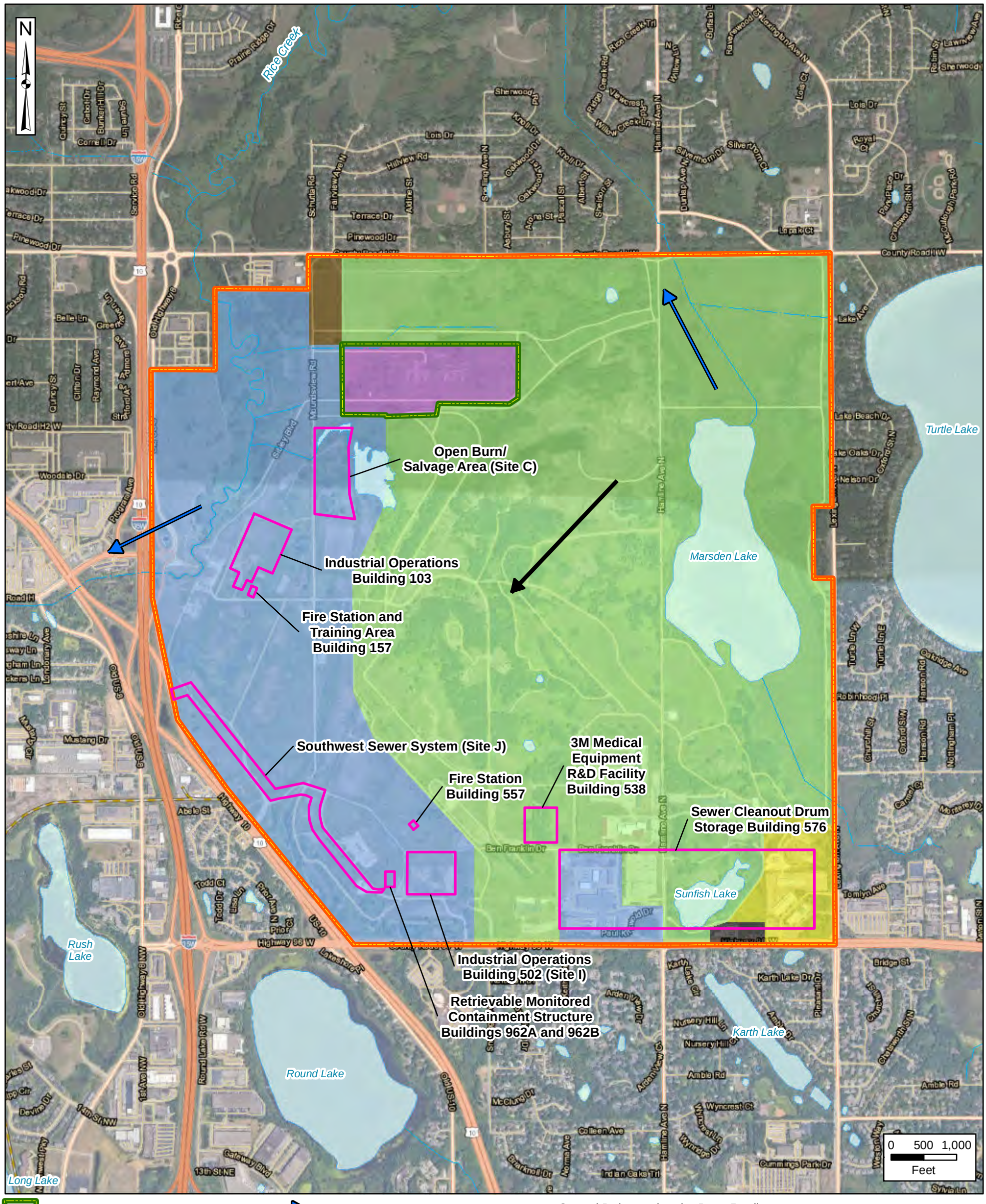
TCAAP = Twin Cities Army Ammunition Plant

Data Sources:
USGS, NHD Data, 2021
Google Earth, Aerial Imagery, 2022

Coordinate System:
WGS 1984, UTM Zone 15 North

USAEC PFAS Preliminary Assessment / Site Inspection
Twin Cities Army Ammunition Plant, MN

# Figure 5-3
# AOPI Locations




- TCAAP-Retained Property
- Former TCAAP Installation Boundary
- AOPI
- River/Stream (Perennial)
- Stream (Intermittent)
- Canal/Ditch
- Water Body
- Surface Water Flow Direction
- Groundwater Flow Direction

**Land Ownership**

- Ramsey County-Owned Property
- City of Arden Hills - Owned
- Control Delegated to the Base Realignment and Closure Division (what remains of TCAAP)
- Control Delegated to the United States Army Reserve
- Control Delegated to the National Guard Bureau, who in turn has licensed use of the property to the Minnesota Army National Guard
- Easement to Ramsey County

AOPI = area of potential interest
R&D = Research and Development
TCAAP = Twin Cities Army Ammunition Plant

Data Sources:
USGS, NHD Data, 2021
Google Earth, Aerial Imagery, 2022

Coordinate System:
WGS 1984, UTM Zone 15 North

USAEC PFAS Preliminary Assessment / Site Inspection
Twin Cities Army Ammunition Plant, MN

# Figure 5-4
# Aerial Photo of Fire Station and Training Area Building 157 and Industrial Operations Building 103


TCAAP-Retained Property
Former TCAAP Installation Boundary
AOPI
Historical Building Footprint
Site K Collection Trench
Monitoring Well
River/Stream (Perennial)
Canal/Ditch
Water Body
Surface Water Flow Direction
Groundwater Flow Direction

AOPI = area of potential interest
TCAAP = Twin Cities Army Ammunition Plant

Data Sources:
USGS, NHD Data, 2021
Google Earth, Aerial Imagery, 2022

Coordinate System:
WGS 1984, UTM Zone 15 North

USAEC PFAS Preliminary Assessment / Site Inspection
Twin Cities Army Ammunition Plant, MN

**Figure 5-5**
**Aerial Photo of Fire Station Building 557**


TCAAP-Retained Property
Former TCAAP Installation Boundary
AOPI
Historical Building Footprint
Monitoring Well
Groundwater Flow Direction

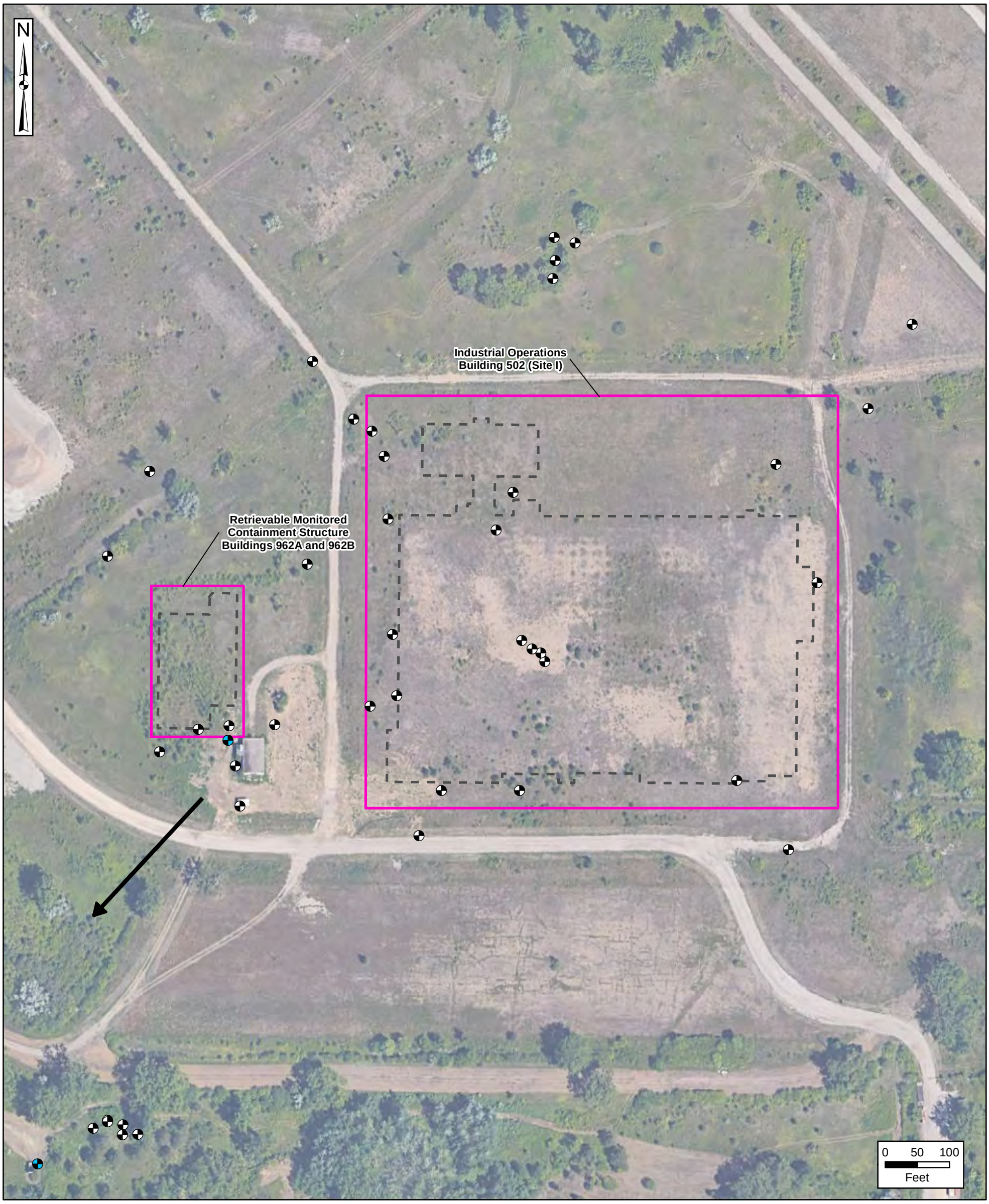
AOPI = area of potential interest
TCAAP = Twin Cities Army Ammunition Plant

Data Sources:
Google Earth, Aerial Imagery, 2022

Coordinate System:
WGS 1984, UTM Zone 15 North

USAEC PFAS Preliminary Assessment / Site Inspection
Twin Cities Army Ammunition Plant, MN

# Figure 5-6
# Aerial Photo of
# Industrial Operations Building 502 (Site I) and
# Retrievable Monitored Containment Structure
# Buildings 962A and 962B




TCAAP-Retained Property
Former TCAAP Installation Boundary
AOPI
Historical Building Footprint
Monitoring Well
Extraction Well
Groundwater Flow Direction

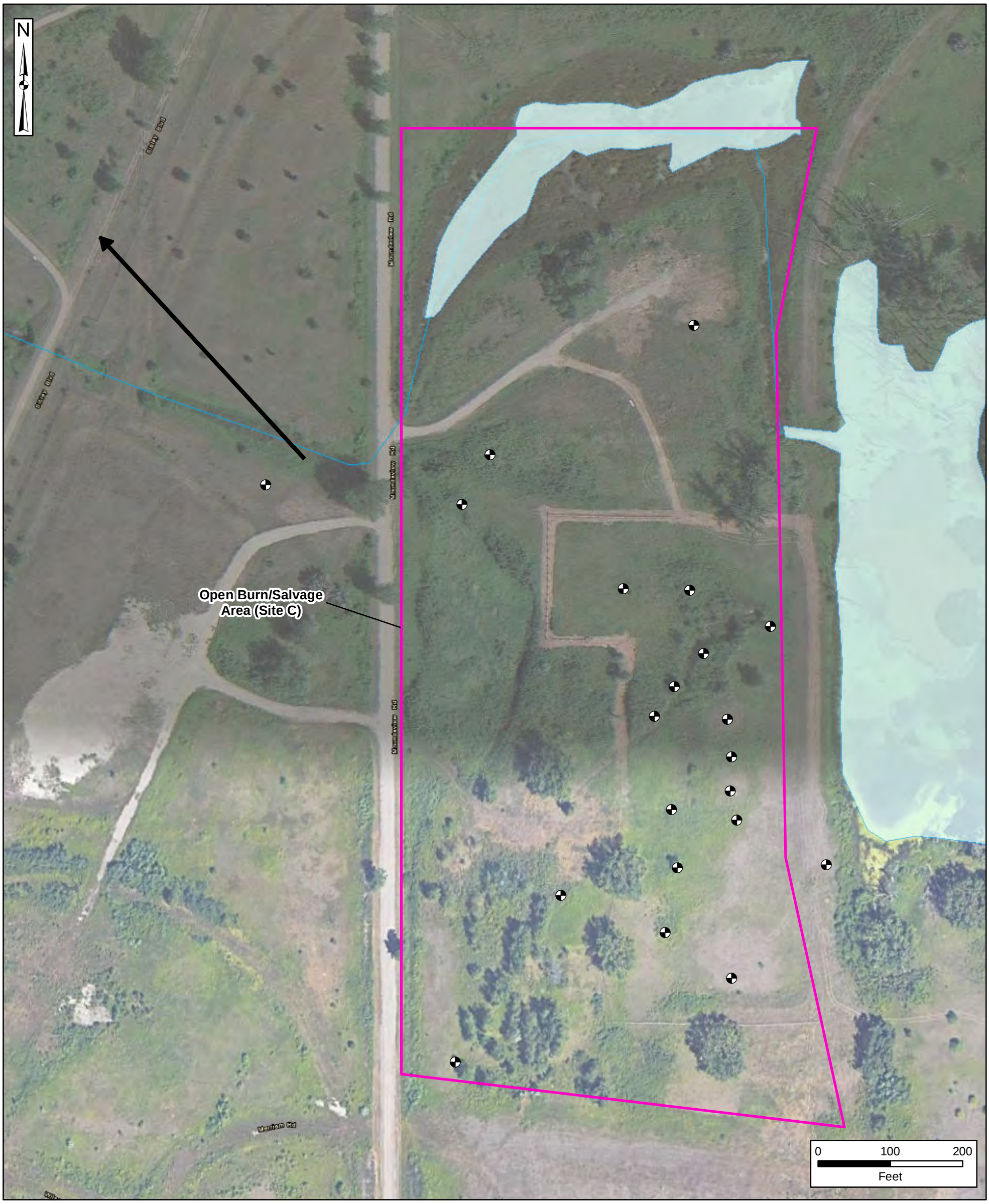
AOPI = area of potential interest
TCAAP = Twin Cities Army Ammunition Plant

Data Sources:
Google Earth, Aerial Imagery, 2022

Coordinate System:
WGS 1984, UTM Zone 15 North

USAEC PFAS Preliminary Assessment / Site Inspection
Twin Cities Army Ammunition Plant, MN

**Figure 5-7**
**Aerial Photo of**
**Open Burn Area/Salvage Area (Site C)**




TCAAP-Retained Property
Former TCAAP Installation Boundary
AOPI
Monitoring Well
Groundwater Flow Direction
River/Stream (Perennial)
Water Body

AOPI = area of potential interest
TCAAP = Twin Cities Army Ammunition Plant

Data Sources:
USGS, NHD Data, 2021
Google Earth, Aerial Imagery, 2022

Coordinate System:
WGS 1984, UTM Zone 15 North

USAEC PFAS Preliminary Assessment / Site Inspection
Twin Cities Army Ammunition Plant, MN

# Figure 5-8
# Aerial Photo of
# 3M Medical Equipment R&D Facility Building 538


- TCAAP-Retained Property
- Former TCAAP Installation Boundary
- Historical Building Footprint
- AOPI
- Site G
- Groundwater Flow Direction
- Monitoring Well

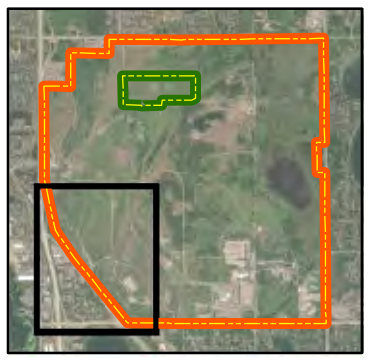
AOPI = area of potential interest
R&D = Research and Development
TCAAP = Twin Cities Army Ammunition Plant

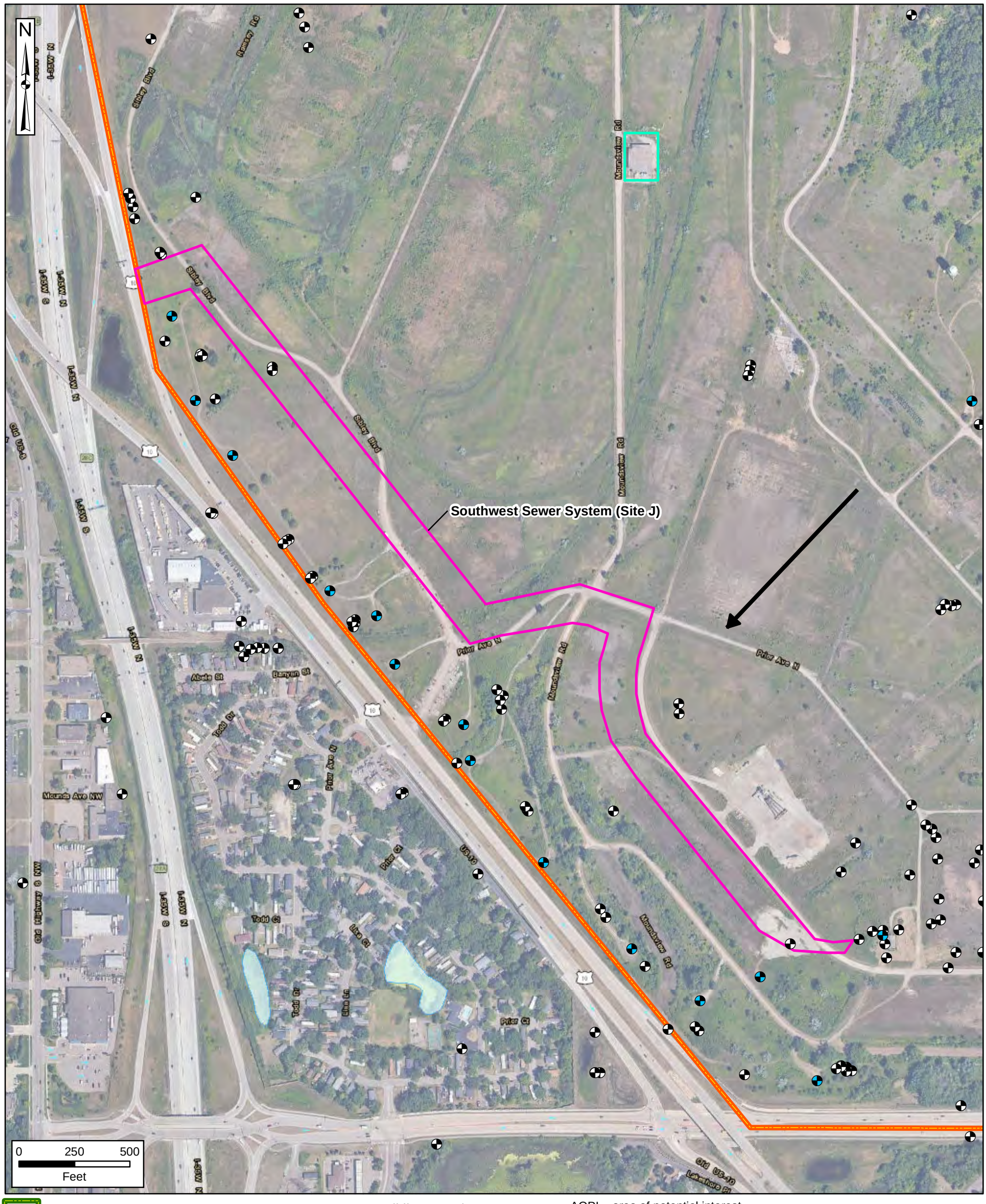
Data Sources:
Google Earth, Aerial Imagery, 2022

Coordinate System:
WGS 1984, UTM Zone 15 North

USAEC PFAS Preliminary Assessment / Site Inspection
Twin Cities Army Ammunition Plant, MN

**Figure 5-9**
**Aerial Photo of**
**Southwest Sewer System (Site J)**






- TCAAP-Retained Property
- Former TCAAP Installation Boundary
- AOPI
- Monitoring Well
- Extraction Well
- Groundwater Flow Direction
- Water Body
- BGRS Building Location (formerly referred to as TGRS)

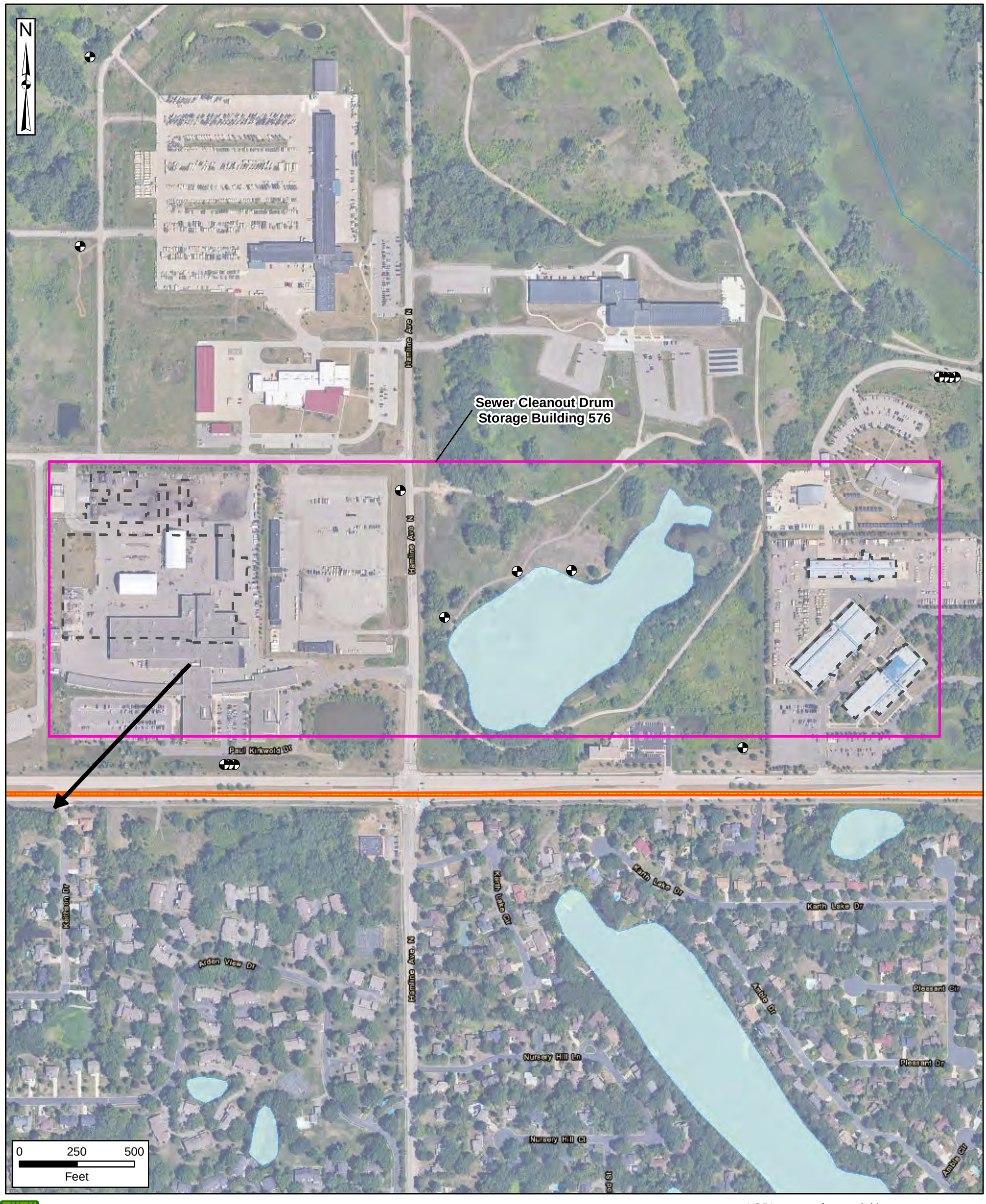
AOPI = area of potential interest
BGRS = Boundary Groundwater Recovery System
TCAAP = Twin Cities Army Ammunition Plant
TGRS = TCAAP Groundwater Recovery System

Data Sources:
USGS, NHD Data, 2021
Google Earth, Aerial Imagery, 2022

Coordinate System:
WGS 1984, UTM Zone 15 North

USAEC PFAS Preliminary Assessment / Site Inspection
Twin Cities Army Ammunition Plant, MN

# Figure 5-10
# Aerial Photo of
# Sewer Cleanout Drum Storage Building 576




TCAAP-Retained Property
Former TCAAP Installation Boundary
AOPI
Historical Building Footprint
Monitoring Well
River/Stream (Perennial)
Water Body
Groundwater Flow Direction

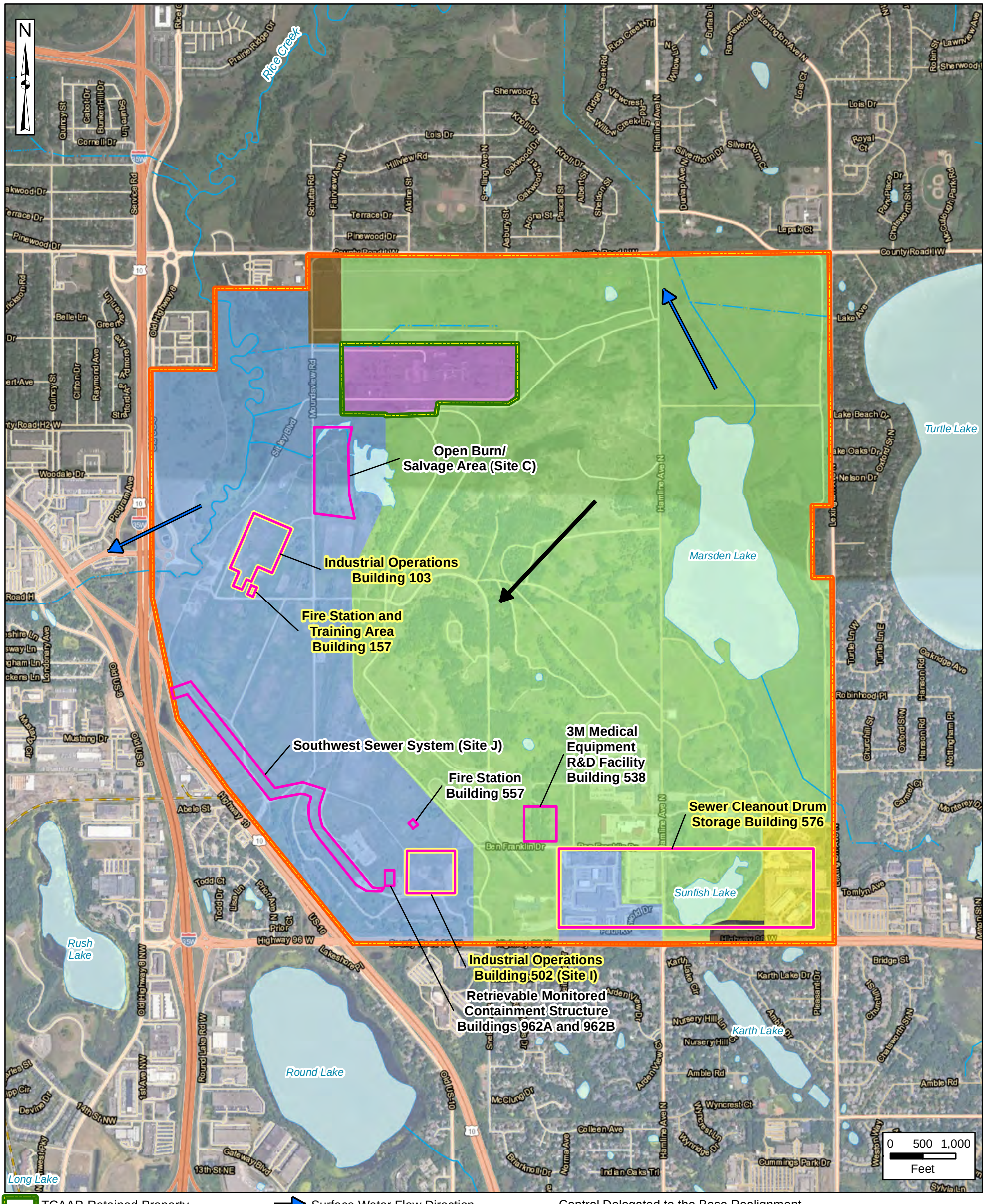
AOPI = area of potential interest
TCAAP = Twin Cities Army Ammunition Plant

Data Sources:
USGS, NHD Data, 2021
Google Earth, Aerial Imagery, 2022

Coordinate System:
WGS 1984, UTM Zone 15 North

USAEC PFAS Preliminary Assessment / Site Inspection
Twin Cities Army Ammunition Plant, MN

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




- TCAAP-Retained Property
- Former TCAAP Installation Boundary
- AOPI
- AOPI with OSD Risk Screening Level Exceedance
- River/Stream (Perennial)
- Stream (Intermittent)
- Canal/Ditch
- Water Body
- Surface Water Flow Direction
- Groundwater Flow Direction

**Land Ownership**

- Ramsey County-Owned Property
- City of Arden Hills - Owned

- Control Delegated to the Base Realignment and Closure Division (what remains of TCAAP)
- Control Delegated to the United States Army Reserve
- Control Delegated to the National Guard Bureau, who in turn has licensed use of the property to the Minnesota Army National Guard
- Easement to Ramsey County

AOPI = area of potential interest
OSD = Office of the Secretary of Defense
R&D = Research and Development
TCAAP = Twin Cities Army Ammunition Plant

Data Sources:
USGS, NHD Data, 2021
Google Earth, Aerial Imagery, 2022

Coordinate System:
WGS 1984, UTM Zone 15 North

USAEC PFAS Preliminary Assessment / Site Inspection
Twin Cities Army Ammunition Plant, MN

# Figure 7-2
# Fire Station and Training Area Building 157 and Industrial Operations Building 103
# PFOS, PFOA, PFBS, PFNA, and PFHxS Analytical Results

| Chemical | Residential Scenario Risk Screening Level Tap Water (ng/L) |
|---|---|
| PFOS | 4 |
| PFOA | 6 |
| PFBS | 601 |
| PFNA | 6 |
| PFHxS | 39 |

| TCAAP-482083 | |
|---|---|
| Date | 1/23/2023 |
| PFOS | 4.9 U |
| PFOA | **11** |
| PFBS | **3.1 J** |
| PFNA | 4.9 U |
| PFHxS | 4.9 U |

| TCAAP-01U617 | |
|---|---|
| Date | 1/19/2023 |
| PFOS | 20 UJ |
| PFOA | 20 UJ |
| PFBS | 20 UJ |
| PFNA | 20 UJ |
| PFHxS | 20 UJ |

| TCAAP-01U615 | |
|---|---|
| Date | 1/20/2023 |
| PFOS | **7.0** |
| PFOA | **19** |
| PFBS | **2.7 J** |
| PFNA | 4.1 U |
| PFHxS | **4.5** |

| TCAAP-01U618 | |
|---|---|
| Date | 1/19/2023 |
| PFOS | **7.3** |
| PFOA | **17** |
| PFBS | **3.2 J** |
| PFNA | 4.2 U |
| PFHxS | **19** |

Notes:
1. Groundwater results are reported in nanograms per liter (ng/L), or parts per trillion.
2. Bolded values indicate detections.
3. Results that exceed the 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).
UJ = The analyte was analyzed for but the result was not detected. The reported limit of quantitation (LOQ) is approximate and may be inaccurate or imprecise.

TCAAP-Retained Property
Former TCAAP Installation Boundary
AOPI
Historical Building Footprint
Site K Collection Trench
Monitoring Well
River/Stream (Perennial)
Canal/Ditch
Water Body
Surface Water Flow Direction
Groundwater Flow Direction

**Sampling Locations**
Groundwater (Monitoring Well)

AOPI = area of potential interest
PFBS = perfluorobutanesulfonic acid
PFHxS = perfluorohexane sulfonate
PFNA = perfluorononanoic acid
PFOA = perfluorooctanoic acid
PFOS = perfluorooctane sulfonate
TCAAP = Twin Cities Army Ammunition Plant

Data Sources:
USGS, NHD Data, 2021
Google Earth, Aerial Imagery, 2022

Coordinate System:
WGS 1984, UTM Zone 15 North

USAEC PFAS Preliminary Assessment / Site Inspection
Twin Cities Army Ammunition Plant, MN

# Figure 7-3
# Fire Station Building 557
# PFOS, PFOA, PFBS, PFNA, and PFHxS Analytical Results


TCAAP-Retained Property
Former TCAAP Installation Boundary
AOPI
Historical Building Footprint
Monitoring Well
Groundwater Flow Direction

**Sampling Locations**

Grab Groundwater

*Proposed groundwater sample was unable to be collected due to the drill rig hitting refusal prior to reaching groundwater. However, downgradient wells were sampled as planned at the Industrial Operations Building 502 (Site I) AOPI and were used to determine the presence or absence of PFAS at this AOPI.

AOPI = area of potential interest
PFAS = per- and polyfluoroalkyl substances
PFBS = perfluorobutanesulfonic acid
PFHxS = perfluorohexane sulfonate
PFNA = perfluorononanoic acid
PFOA = perfluorooctanoic acid
PFOS = perfluorooctane sulfonate
TCAAP = Twin Cities Army Ammunition Plant

Data Sources:
Google Earth, Aerial Imagery, 2022

Coordinate System:
WGS 1984, UTM Zone 15 North

USAEC PFAS Preliminary Assessment / Site Inspection
Twin Cities Army Ammunition Plant, MN

# Figure 7-4
# Industrial Operations Building 502 (Site I) and Retrievable Monitored Containment Structure Buildings 962A and 962B
# PFOS, PFOA, PFBS, PFNA, and PFHxS Analytical Results

| Chemical | Residential Scenario Risk Screening Level Tap Water (ng/L) |
|---|---|
| PFOS | 4 |
| PFOA | 6 |
| PFBS | 601 |
| PFNA | 6 |
| PFHxS | 39 |

| TCAAP-03U028 | |
|---|---|
| Date | 1/20/2023 |
| PFOS | 3.8 U |
| PFOA | 3.8 U |
| PFBS | 3.8 U |
| PFNA | 3.8 U |
| PFHxS | 3.8 U |

| TCAAP-03U030 | |
|---|---|
| Date | 1/20/2023 |
| PFOS | 4.5 U |
| PFOA | **2.5 J** |
| PFBS | 4.5 U |
| PFNA | 4.5 U |
| PFHxS | 4.5 U |

| TCAAP-03U079 | |
|---|---|
| Date | 3/17/2023 |
| PFOS | 3.3 U |
| PFOA | 3.3 U |
| PFBS | 3.3 U |
| PFNA | 3.3 U |
| PFHxS | 3.3 U |

| TCAAP-03U003 | |
|---|---|
| Date | 1/20/2023 |
| PFOS | **9.6** |
| PFOA | 3.8 U |
| PFBS | 3.8 U |
| PFNA | 3.8 U |
| PFHxS | 3.8 U |

Industrial Operations Building 502 (Site I)

Retrievable Monitored Containment Structure Buildings 962A and 962B

Notes:
1. Groundwater results are reported in nanograms per liter (ng/L), or parts per trillion.
2. Bolded values indicate detections.
3. Results that exceed the 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).

0 100 200
Feet

TCAAP-Retained Property
Former TCAAP Installation Boundary
AOPI
Historical Building Footprint
Monitoring Well
Extraction Well
Groundwater Flow Direction

**Sampling Locations**
Groundwater (Monitoring Well)

AOPI = area of potential interest
PFBS = perfluorobutanesulfonic acid
PFHxS = perfluorohexane sulfonate
PFNA = perfluorononanoic acid
PFOA = perfluorooctanoic acid
PFOS = perfluorooctane sulfonate
TCAAP = Twin Cities Army Ammunition Plant

Data Sources:
Google Earth, Aerial Imagery, 2022

Coordinate System:
WGS 1984, UTM Zone 15 North

USAEC PFAS Preliminary Assessment / Site Inspection
Twin Cities Army Ammunition Plant, MN

# Figure 7-5
# Open Burn Area/Salvage Area (Site C)
# PFOS, PFOA, PFBS, PFNA, and PFHxS Analytical Results

N

| Chemical | Residential Scenario Risk Screening Level Tap Water (ng/L) |
|---|---|
| PFOS | 4 |
| PFOA | 6 |
| PFBS | 601 |
| PFNA | 6 |
| PFHxS | 39 |

Moundview Rd

Shiloh Blvd

Open Burn/Salvage Area (Site C)

| TCAAP-01U046 | |
|---|---|
| Date | 1/23/2023 |
| PFOS | 4.4 U |
| PFOA | **5.0** |
| PFBS | 4.4 U |
| PFNA | 4.4 U |
| PFHxS | 4.4 U |

| TCAAP-01U576 | |
|---|---|
| Date | 1/23/2023 |
| PFOS | 4.1 U [4.3 U] |
| PFOA | **4.0 J [3.9 J]** |
| PFBS | 4.1 U [4.3 U] |
| PFNA | 4.1 U [4.3 U] |
| PFHxS | 4.1 U [4.3 U] |

| TCAAP-01U564 | |
|---|---|
| Date | 1/23/2023 |
| PFOS | 4.4 U |
| PFOA | **3.1 J** |
| PFBS | 4.4 U |
| PFNA | 4.4 U |
| PFHxS | 4.4 U |

| TCAAP-03U083 | |
|---|---|
| Date | 1/23/2023 |
| PFOS | 6.1 UJ |
| PFOA | 6.1 UJ |
| PFBS | 6.1 UJ |
| PFNA | 6.1 UJ |
| PFHxS | 6.1 UJ |

Notes:
1. Groundwater results are reported in nanograms per liter (ng/L), or parts per trillion.
2. Bolded values indicate detections.
3. Results in brackets are field duplicate sample results.

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

0 100 200
Feet

TCAAP-Retained Property
Former TCAAP Installation Boundary
AOPI
Monitoring Well
Groundwater Flow Direction
River/Stream (Perennial)
Water Body

**Sampling Locations**
Groundwater (Monitoring Well)

AOPI = area of potential interest
PFBS = perfluorobutanesulfonic acid
PFHxS = perfluorohexane sulfonate
PFNA = perfluorononanoic acid
PFOA = perfluorooctanoic acid
PFOS = perfluorooctane sulfonate
TCAAP = Twin Cities Army Ammunition Plant

Data Sources:
USGS, NHD Data, 2021
Google Earth, Aerial Imagery, 2022

Coordinate System:
WGS 1984, UTM Zone 15 North

USAEC PFAS Preliminary Assessment / Site Inspection
Twin Cities Army Ammunition Plant, MN

# Figure 7-6
# 3M Medical Equipment R&D Facility Building 538
# PFOS, PFOA, PFBS, PFNA, and PFHxS Analytical Results

| 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 |

SITE G
(clean fill area)

| TCAAP-03U094 | |
|---|---|
| Date | 1/19/2023 |
| PFOS | 3.5 U |
| PFOA | 3.5 U |
| PFBS | 3.5 U |
| PFNA | 3.5 U |
| PFHxS | 3.5 U |

| TCAAP-B538-5-SO | |
|---|---|
| Date | 12/15/2022 |
| Depth | 0-2 ft bgs |
| PFOS | 0.00096 U |
| PFOA | 0.00096 U |
| PFBS | 0.00096 U |
| PFNA | 0.00096 U |
| PFHxS | 0.00096 U |

| TCAAP-B538-1-SO | |
|---|---|
| Date | 12/15/2022 |
| Depth | 0-2 ft bgs |
| PFOS | 0.0011 U [0.0010 U] |
| PFOA | 0.0011 U [0.0010 U] |
| PFBS | 0.0011 U [0.0010 U] |
| PFNA | 0.0011 U [0.0010 U] |
| PFHxS | 0.0011 U [0.0010 U] |

3M Medical Equipment R&D Facility Building 538

| TCAAP-B538-3-SO | |
|---|---|
| Date | 12/16/2022 |
| Depth | 0-2 ft bgs |
| PFOS | 0.0011 U |
| PFOA | 0.0011 U |
| PFBS | 0.0011 U |
| PFNA | 0.0011 U |
| PFHxS | 0.0011 U |

TCAAP-B538-1-GW*

TCAAP-B538-2-GW*

| TCAAP-B538-2-SO | |
|---|---|
| Date | 12/16/2022 |
| Depth | 0-2 ft bgs |
| PFOS | 0.00093 U |
| PFOA | 0.00093 U |
| PFBS | 0.00093 U |
| PFNA | 0.00093 U |
| PFHxS | 0.00093 U |

| TCAAP-B538-6-SO | |
|---|---|
| Date | 12/16/2022 |
| Depth | 0-2 ft bgs |
| PFOS | 0.0010 U |
| PFOA | 0.0010 U |
| PFBS | 0.0010 U |
| PFNA | 0.0010 U |
| PFHxS | 0.0010 U |

| TCAAP-B538-4-SO | |
|---|---|
| Date | 12/15/2022 |
| Depth | 0-2 ft bgs |
| PFOS | 0.00099 U |
| PFOA | 0.00099 U |
| PFBS | 0.00099 U |
| PFNA | 0.00099 U |
| PFHxS | 0.00099 U |

| TCAAP-03U030 | |
|---|---|
| Date | 1/20/2023 |
| PFOS | 4.5 U |
| PFOA | **2.5 J** |
| PFBS | 4.5 U |
| PFNA | 4.5 U |
| PFHxS | 4.5 U |

Notes:
1. Groundwater results are reported in nanograms per liter (ng/L), or parts per trillion.
2. Soil results are reported in milligrams per kilogram (mg/kg), or parts per million.

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).

0 100 200
Feet

TCAAP-Retained Property
Former TCAAP Installation Boundary
Historical Building Footprint
AOPI
Site G
Water Body
Groundwater Flow Direction

Monitoring Well
Extraction Well

**Sampling Locations**
Groundwater (Monitoring Well)
Shallow Soil
Shallow Soil / Grab Groundwater

AOPI = area of potential interest
ft bgs = feet below ground surface
PFBS = perfluorobutanesulfonic acid
PFHxS = perfluorohexane sulfonate
PFNA = perfluorononanoic acid
PFOA = perfluorooctanoic acid
PFOS = perfluorooctane sulfonate
R&D = Research and Development
TCAAP = Twin Cities Army Ammunition Plant

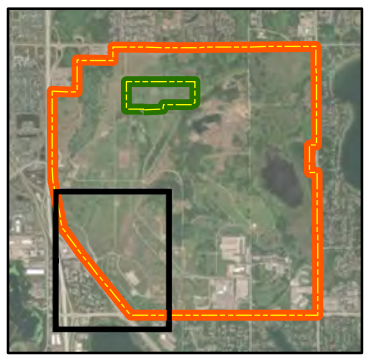
*Proposed groundwater sample was unable to be collected due to the drill rig hitting refusal prior to reaching groundwater.

Data Sources:
Google Earth, Aerial Imagery, 2022

Coordinate System:
WGS 1984, UTM Zone 15 North

USAEC PFAS Preliminary Assessment / Site Inspection
Twin Cities Army Ammunition Plant, MN

# Figure 7-7
# Southwest Sewer System (Site J), SGRS, and BGRS
# PFOS, PFOA, PFBS, PFNA, and PFHxS Analytical Results



| 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 |

| TCAAP-TGRS | |
|---|---|
| Date | 1/20/2023 |
| PFOS | 3.7 U |
| PFOA | 3.7 U |
| PFBS | 3.7 U |
| PFNA | 3.7 U |
| PFHxS | 3.7 U |

| TCAAP-SGRS | |
|---|---|
| Date | 1/20/2023 |
| PFOS | 4.2 U |
| PFOA | **6.9** |
| PFBS | 4.2 U |
| PFNA | 4.2 U |
| PFHxS | 4.2 U |

Southwest Sewer System (Site J)

| TCAAP-03U702 | |
|---|---|
| Date | 1/20/2023 |
| PFOS | 4.0 U |
| PFOA | 4.0 U |
| PFBS | 4.0 U |
| PFNA | 4.0 U |
| PFHxS | 4.0 U |

| TCAAP-03U002 | |
|---|---|
| Date | 1/20/2023 |
| PFOS | 4.1 U |
| PFOA | 4.1 U |
| PFBS | 4.1 U |
| PFNA | 4.1 U |
| PFHxS | 4.1 U |

| TCAAP-03U078 | |
|---|---|
| Date | 1/20/2023 |
| PFOS | 4.7 U |
| PFOA | **5.4** |
| PFBS | 4.7 U |
| PFNA | 4.7 U |
| PFHxS | 4.7 U |

| TCAAP-SSW-1-SE | |
|---|---|
| Date | 1/20/2023 |
| PFOS | 0.011 U [0.010 U] |
| PFOA | 0.011 U [0.010 U] |
| PFBS | 0.011 U [0.010 U] |
| PFNA | 0.011 U [0.010 U] |
| PFHxS | 0.011 U [0.010 U] |

0 250 500
Feet

Notes:
1. Groundwater results are reported in nanograms per liter (ng/L), or parts per trillion.
2. Sediment results are reported in milligrams per kilogram (mg/kg), or parts per million.
3. Bolded values indicate detections.
4. Results that exceed the Office of the Secretary of Defense (OSD) residential scenario risk screening levels (OSD 2022) are highlighted gray.

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

- TCAAP-Retained Property
- Former TCAAP Installation Boundary
- AOPI
- Monitoring Well
- Extraction Well
- Groundwater Flow Direction
- Water Body
- BGRS Building Location (formerly referred to as TGRS)
- SGRS Building Location

**Sampling Locations**
- Groundwater (Monitoring Well)
- Grab Groundwater (Influent)
- Sediment

AOPI = area of potential interest
BGRS = Boundary Groundwater Recovery System
PFBS = perfluorobutanesulfonic acid
PFHxS = perfluorohexane sulfonate
PFNA = perfluorononanoic acid
PFOA = perfluorooctanoic acid
PFOS = perfluorooctane sulfonate
SGRS = Source Groundwater Recovery System
TCAAP = Twin Cities Army Ammunition Plant
TGRS = TCAAP Groundwater Recovery System

Data Sources:
USGS, NHD Data, 2021
Google Earth, Aerial Imagery, 2022

Coordinate System:
WGS 1984, UTM Zone 15 North

USAEC PFAS Preliminary Assessment / Site Inspection
Twin Cities Army Ammunition Plant, MN

# Figure 7-8
# Sewer Cleanout Drum Storage Building 576
# PFOS, PFOA, PFBS, PFNA, and PFHxS Analytical Results

| Chemical | Residential Scenario Risk Screening Level Tap Water (ng/L) |
|---|---|
| PFOS | 4 |
| PFOA | 6 |
| PFBS | 601 |
| PFNA | 6 |
| PFHxS | 39 |

Sewer Cleanout Drum Storage Building 576

| TCAAP-01U060 | |
|---|---|
| Date | 3/17/2023 |
| PFOS | **8.1 J-** |
| PFOA | **3.9 J-** |
| PFBS | 3.4 U |
| PFNA | 3.4 U |
| PFHxS | 3.4 U |

| TCAAP-03U099 | |
|---|---|
| Date | 3/17/2023 |
| PFOS | 2.0 U [2.2 U] |
| PFOA | 2.0 U [2.2 U] |
| PFBS | 2.0 U [2.2 U] |
| PFNA | 2.0 U [2.2 U] |
| PFHxS | 2.0 U [2.2 U] |

Notes:
1. Groundwater results are reported in nanograms per liter (ng/L), or parts per trillion.
2. Results in brackets are field duplicate sample results.
3. Bolded values indicate detections.
4. Results that exceed the Office of the Secretary of Defense (OSD) residential scenario risk screening levels (OSD 2022) are highlighted gray.

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

0 250 500
Feet

TCAAP-Retained Property
Former TCAAP Installation Boundary
AOPI
Historical Building Footprint
Groundwater Flow Direction
River/Stream (Perennial)
Water Body
Groundwater Flow Direction

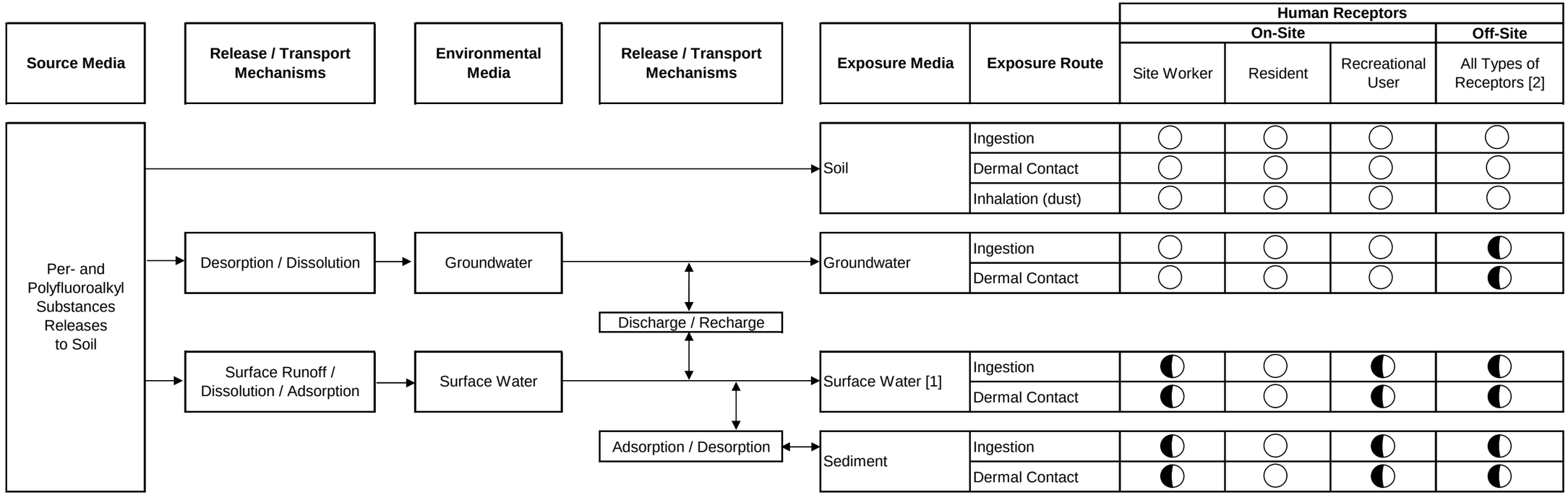
Monitoring Well

**Sampling Locations**
Groundwater (Monitoring Well)

AOPI = area of potential interest
PFBS = perfluorobutanesulfonic acid
PFHxS = perfluorohexane sulfonate
PFNA = perfluorononanoic acid
PFOA = perfluorooctanoic acid
PFOS = perfluorooctane sulfonate
TCAAP = Twin Cities Army Ammunition Plant

Data Sources:
USGS, NHD Data, 2021
Google Earth, Aerial Imagery, 2022

Coordinate System:
WGS 1984, UTM Zone 15 North



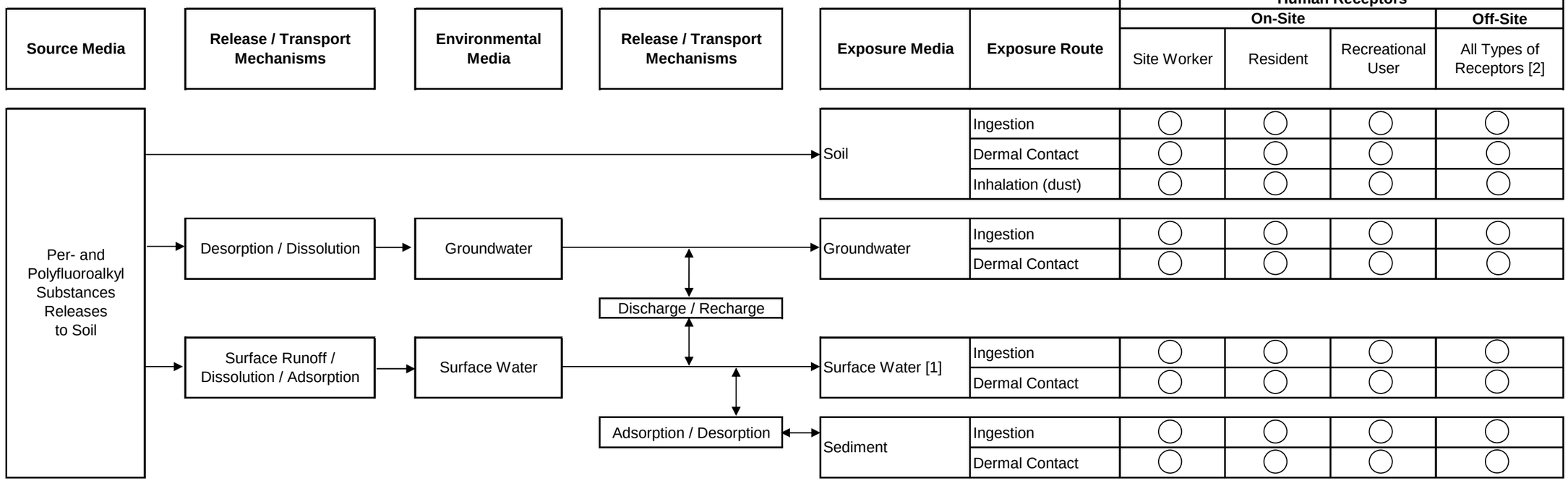

**Legend:**

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

Notes:
[1] Surface water and sediment exposure pathways for Site Workers and Recreational Users describe incidental ingestion and dermal contact during outdoor work or recreational activities, respectively.
[2] All types of off-installation human receptors include drinking water receptors and recreational users.

**Conceptual Site Model for Fire Station and Training Area Building 157, Industrial Operations Building 103, Open Burn/Salvage Area (Site C)**
USAEC PFAS Preliminary Assessment / Site Inspection
Twin Cities Army Ammunition Plant, Minnesota

**Figure 7-9**




**Legend:**

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

Notes:
[1] Surface water and sediment exposure pathways for Site Workers and Recreational Users describe incidental ingestion and dermal contact during outdoor work or recreational activities, respectively.
[2] All types of off-installation human receptors include drinking water receptors and recreational users.

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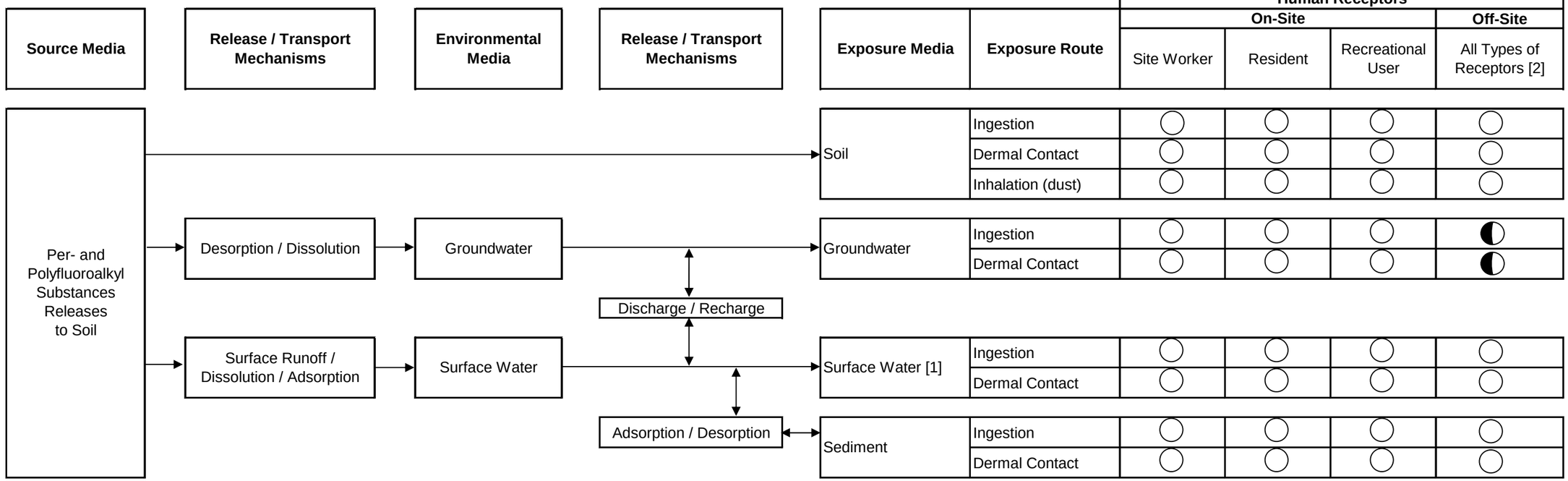
**Conceptual Site Model for Fire Station Building 557 and Retrievable Monitored Containment Structure Buildings 962A and 962B**
USAEC PFAS Preliminary Assessment / Site Inspection
Twin Cities Army Ammunition Plant, Minnesota

**Figure 7-10**




**Legend:**

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

Notes:
[1] Surface water and sediment exposure pathways for Site Workers and Recreational Users describe incidental ingestion and dermal contact during outdoor work or recreational activities, respectively.
[2] All types of off-installation human receptors include drinking water receptors and recreational users.

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**Conceptual Site Model for Industrial Operations Building 502 (Site I)**
USAEC PFAS Preliminary Assessment / Site Inspection
Twin Cities Army Ammunition Plant, Minnesota

**Figure 7-11**

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

**Legend:**

● = Complete Exposure Pathway

◐ = Potentially Complete Exposure Pathway

○ = Incomplete Exposure Pathway

Notes:
[1] Surface water and sediment exposure pathways for Site Workers and Recreational Users describe incidental ingestion and dermal contact during outdoor work or recreational activities, respectively.
[2] All types of off-installation human receptors include drinking water receptors and recreational users.

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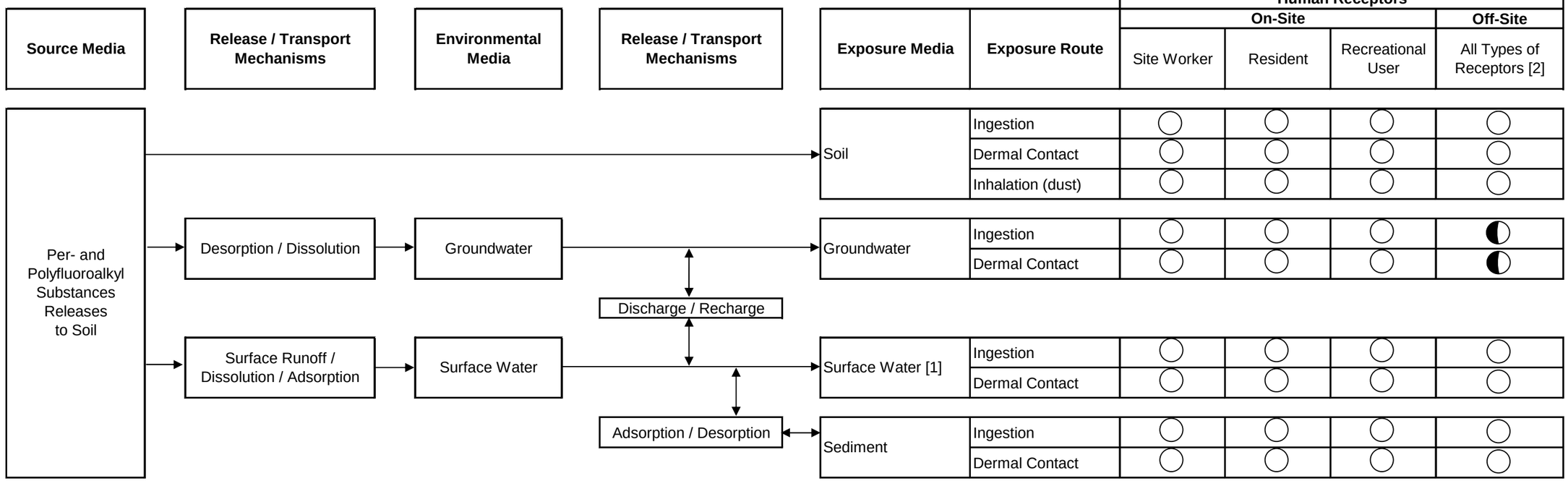
**Conceptual Site Model for 3M Medical Equipment R&D Facility Building 538**
USAEC PFAS Preliminary Assessment / Site Inspection
Twin Cities Army Ammunition Plant, Minnesota

**Figure 7-12**




**Legend:**

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

Notes:
[1] Surface water and sediment exposure pathways for Site Workers and Recreational Users describe incidental ingestion and dermal contact during outdoor work or recreational activities, respectively.
[2] All types of off-installation human receptors include drinking water receptors and recreational users.

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**Conceptual Site Model for Southwest Sewer System (Site J)**
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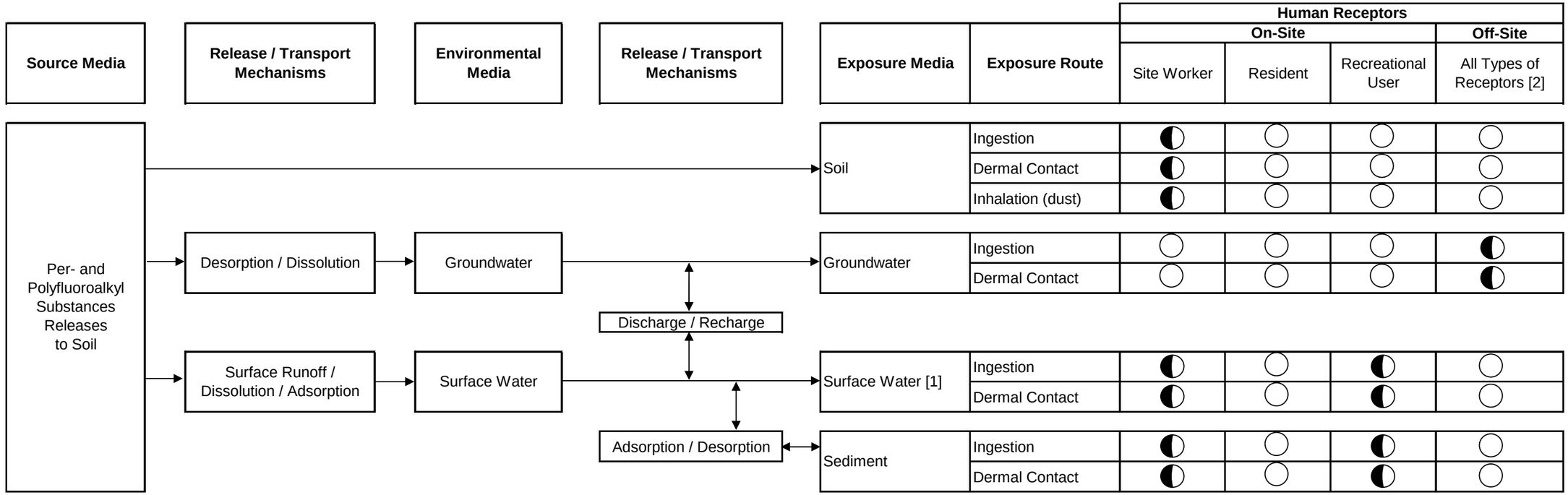
Twin Cities Army Ammunition Plant, Minnesota

**Figure 7-13**




**Legend:**

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

Notes:
[1] Surface water and sediment exposure pathways for Site Workers and Recreational Users describe incidental ingestion and dermal contact during outdoor work or recreational activities, respectively.
[2] All types of off-installation human receptors include drinking water receptors and recreational users.

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**Conceptual Site Model for Sewer Cleanout Drum Storage Building 576**
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**Figure 7-14**

Arcadis U.S., Inc.

7550 Teague Road

Suite 210

Hanover, Maryland  21076

Tel 410 987 0032

Fax 410 987 4392

**www.arcadis.com**