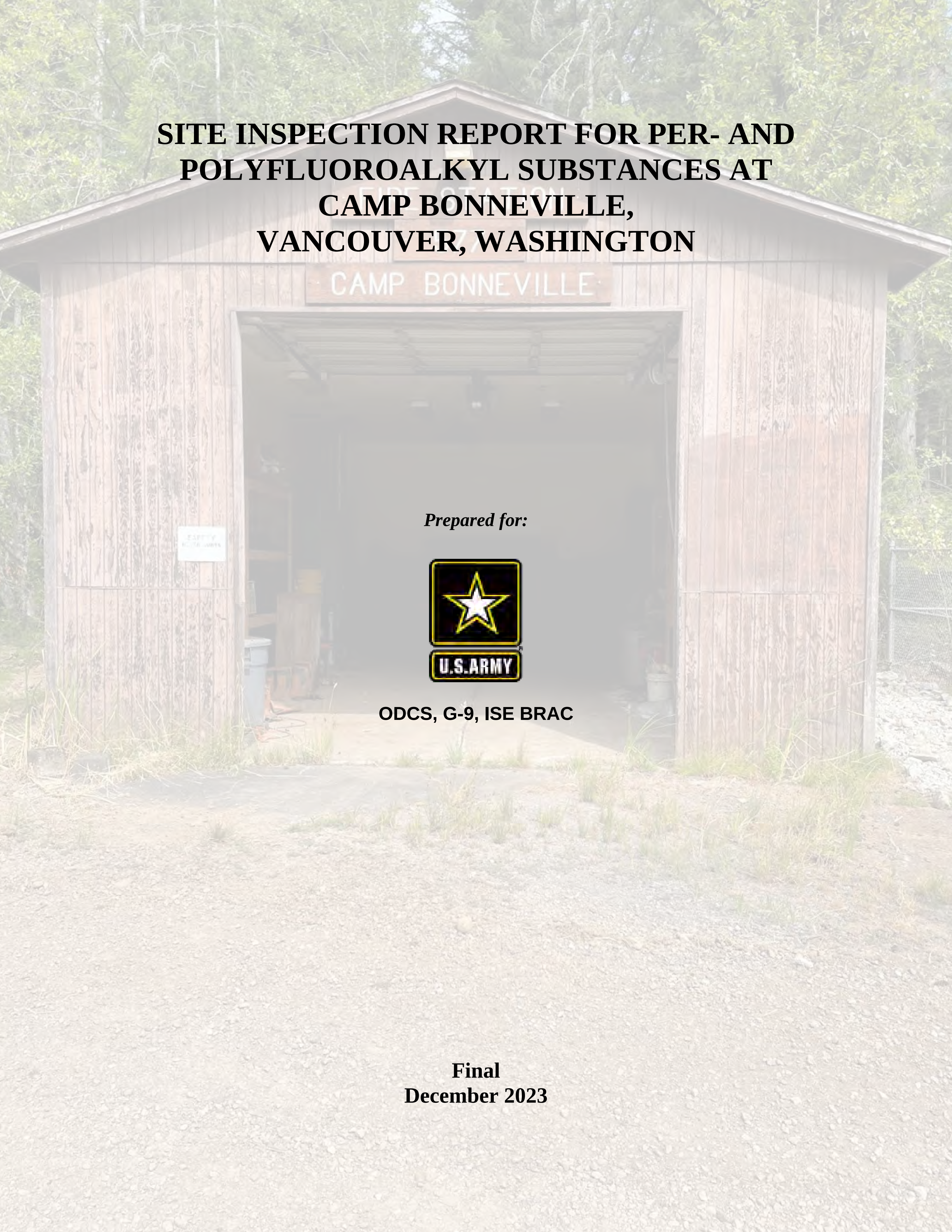

SITE INSPECTION REPORT FOR PER- AND POLYFLUOROALKYL SUBSTANCES AT CAMP BONNEVILLE, VANCOUVER, WASHINGTON

Prepared for:

ODCS, G-9, ISE BRAC

Final
December 2023

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LIST OF ACRONYMS AND ABBREVIATIONS

AFFF	Aqueous Film-Forming Foam
amsl	Above Mean Sea Level
AOPI	Area of Potential Interest
Army	U.S. Army
bgs	Below Ground Surface
BRAC	Base Realignment and Closure
BRAC95	1995 Base Realignment and Closure Commission
BCRRT	Bonneville Conservation Restoration and Renewal Team LLC
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CoC	Chain-of-Custody
CSM	Conceptual Site Model
DERP	Defense Environmental Restoration Program
DI	Deionized
DO	Dissolved Oxygen
DoD	U.S. Department of Defense
DQO	Data Quality Objective
DUA	Data Usability Assessment
EIS	Extracted Internal Standard
ESU	Evolutionarily Significant Unit
FB	Field Blank
FBI	Federal Bureau of Investigation
GPS	Global Positioning System
HDPE	High-Density Polyethylene
HFPO-DA	Hexafluoropropylene Oxide Dimer Acid (GenX)
HQ	Hazard Quotient
ID	Identifier
IDW	Investigation-Derived Waste
LC/MS/MS	Liquid Chromatography with Tandem Mass Spectrometry
LCS	Laboratory Control Sample
LOD	Limit of Detection
LRA	Local Redevelopment Authority
LUC	Land Use Control
MEC	Munitions and Explosives of Concern
MPC	Measurement Performance Criteria
MS	Matrix Spike
MSD	Matrix Spike Duplicate
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NPL	National Priorities List
ORP	Oxygen-Reduction Potential
OSD	Office of the Secretary of Defense
P.E.	Professional Engineer
P.G.	Professional Geologist
PA	Preliminary Assessment
PFAS	Per- and Polyfluoroalkyl Substances
PFBA	Perfluorobutanoic Acid
PFBS	Perfluorobutane Sulfonate
PFHxA	Perfluorohexanoic Acid
PFHxS	Perfluorohexane Sulfonate

LIST OF ACRONYMS AND ABBREVIATIONS (Continued)

PFNA	Perfluorononanoic Acid
PFOA	Perfluorooctanoic Acid
PFOS	Perfluorooctane Sulfonate
PMP	Project Management Professional
ppb	Parts per Billion
PPE	Personal Protective Equipment
ppt	Parts per Trillion
QA	Quality Assurance
QC	Quality Control
QSM	Quality Systems Manual
REM	Registered Environmental Manager
RPD	Relative Percent Difference
RSL	Regional Screening Level
SDG	Sample Delivery Group
SI	Site Inspection
SL	Screening Level
SOP	Standard Operating Procedure
TCLP	Toxicity Characteristic Leaching Procedure
UFP-QAPP	Uniform Federal Policy Quality Assurance Project Plan
USACE	U.S. Army Corps of Engineers
U.S.C.	United States Code
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
UXO	Unexploded Ordnance
WDNR	Washington State Department of Natural Resources
WWTP	Wastewater Treatment Plant

EXECUTIVE SUMMARY

The U.S. Army (Army) is conducting Preliminary Assessments (PAs) and Site Inspections (SIs) to determine the use, storage, disposal, or release of per- and polyfluoroalkyl substances (PFAS) at multiple Base Realignment and Closure (BRAC) installations, nationwide. This report documents SI activities conducted for three areas of potential interest (AOPIs) at the former Camp Bonneville in Vancouver, Washington. AOPIs were identified during the PA phase for investigation through multimedia sampling in an SI phase to determine whether a PFAS release occurred. Activities were completed in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA, 42 United States Code [U.S.C.] §9601, et seq.); the Defense Environmental Restoration Program (DERP, 10 U.S.C. §2700, et seq.); the National Oil and Hazardous Substances Pollution Contingency Plan (NCP, 40 Code of Federal Regulations [CFR] Part 300); Army and U.S. Department of Defense (DoD) policy and guidance; and U.S. Environmental Protection Agency (USEPA) guidance.

The PA identified areas where PFAS-containing materials were used, stored, and/or disposed of, or areas where known or suspected releases to the environment occurred. Based on recommendations from the PA, soil, groundwater, sediment, and/or surface water samples were collected from the three AOPIs. The field investigation at Camp Bonneville was conducted in accordance with the Programmatic Uniform Federal Policy-Quality Assurance Project Plan (UFP-QAPP) (Leidos 2022a) and Camp Bonneville UFP-QAPP Addendum (Leidos 2023a). Samples collected during this SI were analyzed for PFAS using procedures compliant with the DoD Quality Systems Manual (QSM) Version 5.4, Table B-15 (DoD 2021) and the laboratory standard operating procedure (SOP).

To determine if future investigation was warranted at each AOPI, this SI followed established USEPA guidance and DoD policy and guidance for perfluorooctane sulfonate (PFOS), perfluorooctanoic acid (PFOA), perfluorobutanoic acid (PFBA), perfluorobutane sulfonate (PFBS), perfluorononanoic acid (PFNA), perfluorohexanoic acid (PFHxA), perfluorohexane sulfonate (PFHxS), and hexafluoropropylene oxide dimer acid (HFPO-DA) (also known as GenX) (DoD 2023). Samples collected during this SI were compared to risk screening levels (SLs) established as the residential scenario SLs calculated using the USEPA regional screening level (RSL) calculator for soil and the tap water criteria for groundwater and published in the 2023 Office of the Secretary of Defense (OSD) Memorandum (DoD 2023). Since PFAS are a large grouping consisting of thousands of individual chemicals, PFOA, PFOS, PFBA, PFBS, PFNA, PFHxA, PFHxS, and HFPO-DA altogether will be referred to in this report as "Target PFAS."

Conceptual site models (CSMs) were developed during the PA and then updated for each AOPI where Target PFAS were detected at concentrations greater than the limit of detection (LOD). The updated CSMs detail site geological conditions; determine primary and secondary release mechanisms; identify potential human receptors; and detail complete, potentially complete, and incomplete exposure pathways for current and reasonably anticipated future exposure scenarios. PFAS were detected in at least one medium at all three AOPIs. Target PFAS concentrations did not exceed SLs in any samples at Camp Bonneville. PFNA and HFPO-DA were not detected at any AOPI. The figures at the end of this document depict the Target PFAS results from sample locations at the Building 1864 Fire Station AOPI (Figure ES-1) and the Building 4483 Fire Station AOPI and Wash Racks 1 and 2 AOPI (Figure ES-2). Table ES-1 summarizes the AOPIs investigated during the SI and recommendations for further investigation.

Table ES-1. Summary of AOPIs and Recommendations for Further Investigation

AOPI Name	Exceedance of SLs		Recommendation
	Groundwater	Soil	
Building 1864 Fire Station	No	No	Further investigation **not** recommended
Building 4483 Fire Station	–	No	Further investigation **not** recommended
Wash Racks 1 and 2	No	No	Further investigation **not** recommended

– Not Collected

1. INTRODUCTION

The U.S. Army (Army) is conducting Preliminary Assessments (PAs, 40 Code of Federal Regulations [CFR] §300.420(b)) and Site Inspections (SIs, 40 CFR §300.420(c)) to investigate the presence or release of per- and polyfluoroalkyl substances (PFAS), by investigating the use, storage, or disposal of PFAS at multiple Base Realignment and Closure (BRAC) installations, nationwide. This SI is focused on the former Camp Bonneville near Vancouver, Washington and was conducted in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA, 42 United States Code [U.S.C.] §9601 et seq.); the Defense Environmental Restoration Program (DERP, 10 U.S.C. §2701 et seq.); the National Oil and Hazardous Substances Pollution Contingency Plan (NCP, 40 CFR Part 300); Army and U.S. Department of Defense (DoD) policy and guidance; and U.S. Environmental Protection Agency (USEPA) guidance. The former Camp Bonneville is not on the National Priorities List (NPL), and the Army is responsible for compliance with CERCLA in accordance with Executive Order 12580, as amended.

Based on results of the Camp Bonneville PFAS PA (Leidos 2023b), three areas of potential interest (AOPIs) were identified for investigation through multimedia sampling in an SI to determine whether a PFAS release occurred. Camp Bonneville is in Clark County, near Vancouver, Washington, as shown in Figure 1-1. The entire Camp Bonneville is referred to as the “site,” “facility,” or “installation” throughout this document. Any references to “offsite” refers to areas that are outside the original boundary of Camp Bonneville.

1.1 SCOPE AND OBJECTIVES

The overall objective of the SI is to determine the presence or absence of PFAS at each AOPI. This SI Report uses the findings from the PFAS PA in conjunction with soil, groundwater, surface water, and sediment sampling data to determine whether PFAS have been released to the environment and whether a release has affected or may affect specific human health targets. Furthermore, this SI Report evaluates and summarizes the need for additional investigation (40 CFR §300.420(c)(1)).

The SI scope included preparation of project planning documents, field investigation, validation and management of analytical data, comparison of analytical data to the Office of the Secretary of Defense (OSD) screening levels (SLs) published in the 2023 OSD Memorandum (DoD 2023), and documentation of the investigation results. This SI was conducted in accordance with the Programmatic Uniform Federal Policy-Quality Assurance Project Plan (UFP-QAPP) (Leidos 2022a) and Camp Bonneville UFP-QAPP Addendum (Leidos 2023a). The field activities followed site-specific sampling and health and safety protocols, as identified in the Programmatic Accident Prevention Plan (Leidos 2022b) and the Camp Bonneville Site Safety and Health Plan (Appendix A of the Camp Bonneville UFP-QAPP Addendum [Leidos 2023a]).

1.2 CAMP BONNEVILLE DESCRIPTION

Camp Bonneville is in Clark County, Washington, near Vancouver, and was established in 1909 with 309 leased acres as a drill field and rifle range for Vancouver Barracks (Woodward-Clyde 1997). In 1912, the facilities were expanded to include a target range and a road leading to the installation. Use of the facility continued until 1915 when the lease expired, and the Army moved their training activities to Oregon (USACE 1997). In 1918, the Army returned to Camp Bonneville and obtained the original 309 acres, along with an additional 2,711 acres, through purchase and condemnation. The Bonneville cantonment was established in the late 1920s and was used primarily as barracks facilities (EEI 2010). The Killpack cantonment was built and occupied by the Civilian Conservation Corps in 1935. In 1955, the Army arranged to lease an additional 840 acres, in two separate parcels, from the Washington State Department of Natural Resources (WDNR) to expand the training facilities at Camp Bonneville. The Army returned 20 acres of the leased land to WDNR in 1957 (Woodward-Clyde 1997). In 1959, the responsibility for Camp

Bonneville changed from Vancouver Barracks to Fort Lewis, when the former became a sub installation of the latter (URS 2000).

Camp Bonneville was placed on the list of facilities scheduled for closure under the 1995 Base Realignment and Closure Commission (BRAC95). In 1996, all active military training units ceased operations at the camp. All out-grants for use of the facilities were canceled except for the Federal Bureau of Investigation (FBI) firing range (EEI 2010).

Clark County has an interlocal, short-term lease agreement with WDNR, which establishes a forward operating base for helicopter operations. WDNR's helicopter operations at Camp Bonneville assist its efforts to mitigate and improve response times for wildfires in the area. WDNR has been using Camp Bonneville to conduct these operations since 2019 (CCPW 2022a). The agreement includes adequate space for a helicopter, a fuel truck, and Building T-1980 to house crew members and limits WDNR's access of Camp Bonneville to only the barracks, parking area, and airfield near the main camp entrance (CCPW 2022a).

During the PA records reviews, interviews, aerial photographic analysis, and site reconnaissance, Leidos investigated available documentation and physical evidence for areas having a potential historical PFAS release. The sites evaluated include an airstrip, fire stations, landfills, hazardous waste disposal areas, wastewater treatment plants (WWTPs), pesticide facilities, maintenance shops, open burning/open detonation areas, wash racks, and historical building fires. The Camp Bonneville PFAS PA recommended three AOPIs for further investigation in an SI due to known or potential historical PFAS use, storage, and/or release due to Army activities. The AOPIs, as well as the dates of operation and sizes of each area, are presented in Table 1-1 and illustrated in Figure 1-2.

Table 1-1. List of AOPIs at Camp Bonneville

AOPI Name	Dates of Operation	Size (acres)	Rationale
Building 1864 Fire Station	Late 1940s to late 1970s	0.06	Fire station with potential AFFF use.
Building 4483 Fire Station	Late 1980s to 2007	0.16	Fire station with reported AFFF storage on fire truck.
Wash Racks 1 and 2	1978 to 1994 (Wash Rack 1) Unknown to 1980s (Wash Rack 2)	0.03 (Wash Rack 1) 0.01 (Wash Rack 2)	Potentially received PFAS-containing AFFF during fire truck cleaning activities. AFFF is reported to have been present on the fire truck at the adjacent Building 4483 Fire Station.

1.3 REPORT ORGANIZATION

The contents of the remaining sections of this SI Report are summarized below:

- ***Section 2. Environmental Setting***—This section discusses the environmental setting at Camp Bonneville. Demographics, land use, geology, hydrogeology, hydrology, soil, and climate are described.
- ***Section 3. Field Investigation Activities***—This section provides field procedures followed during the implementation of the SI.
- ***Section 4. Data Analysis and Quality Assurance Summary***—This section describes the laboratory chemical analysis program for the investigation. Sample handling procedures, laboratory equipment calibration, laboratory analytical methods, data reporting and validation, and sample data quality assurance (QA)/quality control (QC) are discussed.

- ***Section 5. Site Inspection Screening Levels***—This section presents the Target PFAS with SLs outlined in the 2023 OSD Memorandum (DoD 2023) and the SLs to which SI results are compared.
- ***Section 6. Site Inspection Results***—This section presents the data gathered during the SI activities and updated CSMs.
- ***Section 7. Conclusions and Recommendations***—This section summarizes the SI conclusions and presents recommendations for the Camp Bonneville AOPIs.
- ***Section 8. References*—**This section lists the references that were used in the preparation of this report.
- ***Appendices***—Appendices A through H include data from field activities or related assessments:
  - Appendix A. Daily Field Summary Notes
  - Appendix B. Photograph Log
  - Appendix C. Field Activity Logs
  - Appendix D. Boring Logs
  - Appendix E. Sampling Forms and Calibration Logs
  - Appendix F. Investigation-Derived Waste (IDW) Documents
  - Appendix G. Data Usability Assessment (DUA)
  - Appendix H. Data Presentation Tables.

2. ENVIRONMENTAL SETTING

This section provides general information about Camp Bonneville, including the site location, operational history, current and projected land use, climate, topography, geology, hydrogeology, surface water hydrology, potable wells within a 4-mile radius of the installation, and applicable ecological receptors.

2.1 SITE LOCATION

Camp Bonneville is a former Army facility in Clark County, Washington, approximately 12 miles east of Vancouver, Washington (Figure 1-1). While in operation, Camp Bonneville occupied the 3,840 acres. Camp Bonneville was originally composed of 3,020 acres and leased 820 acres from WDNR. It is on the western slope of the Cascade Mountains in the Lacamas Creek Valley. The installation is mostly forested, except for the approximately 30 acres that comprise the Bonneville and Killpack cantonment areas near the installation's former main entrance. The property surrounding Camp Bonneville is zoned for agriculture, rural residential, and forestry uses (LRA 2005). Camp Bonneville is bounded to the northeast by the WDNR-managed Yacolt Burn State Forest, and the Livingston Quarry gravel mining operation is located along the southern boundary of the site. Figure 2-1 depicts the Camp Bonneville site features.

2.2 SITE OPERATIONAL HISTORY

Camp Bonneville was established with 309 leased acres in 1909 as a drill field and rifle range for Vancouver Barracks (Woodward-Clyde 1997). In 1912, the facilities were expanded to include a target range and a road leading to the installation. Use of the facility continued until 1915 when the lease expired, and the Army moved their training activities to Oregon (USACE 1997). In 1918, the Army returned to Camp Bonneville and obtained the original 309 acres, along with an additional 2,711 acres through purchase and condemnation. The Bonneville cantonment was established in the late 1920s and used primarily as barracks facilities (EEI 2010). The Killpack cantonment was built and occupied by the Civilian Conservation Corps in 1935. In 1955, the Army arranged to lease an additional 840 acres, in two separate parcels, from WDNR to expand the training facilities at Camp Bonneville. The Army returned 20 acres of the leased land to WDNR in 1957 (Woodward-Clyde 1997). In 1959, the responsibility for Camp Bonneville changed from Vancouver Barracks to Fort Lewis, when the former became a sub installation of the latter (URS 2000).

The mission of Camp Bonneville was to provide a training camp for active U.S. Army, U.S. Army Reserve, U.S. National Guard, U.S. Marine Corps Reserve, U.S. Navy Reserve, U.S. Coast Guard Reserve units, and other DoD Reserve personnel (Woodward-Clyde 1997). Military training activities at Camp Bonneville have varied depending on the unit using the facility but generally have included the use of the various firing ranges and training areas. Other military training activities conducted at Camp Bonneville have involved troop maneuvers, encampments, field tactical training, and vehicle support. The facility was also used to house Italian prisoners of war during World War II. When it was not needed for military training activities, Camp Bonneville was used until the 1980s by local civic and nonprofit organizations for retreats and picnics, as a Boy Scout camp, and as a location for high school environmental studies (Woodward-Clyde 1997). Until the mid-1990s, Camp Bonneville was also used by Federal, state, and local law enforcement agencies for firearms training and practice, and general training purposes (URS 2000). The FBI currently owns and manages training facilities that they constructed at Camp Bonneville in 1995.

Camp Bonneville was placed on the list of facilities scheduled for closure under BRAC 95. In 1996, all active military training units ceased operations at the camp. All out-grants for use of the facilities were canceled except for the FBI firing range (EEI 2010).

2.3 DEMOGRAPHICS, PROPERTY TRANSFER, AND LAND USE

Camp Bonneville is approximately 12 miles east of Vancouver, in rural Clark County. The smaller cities of Camas and Washougal are approximately 6 miles to the south of the installation. Clark County is the fastest growing county in Washington, with a 2020 estimated population of 503,311 (U.S. Census Bureau 2020). In 2020, the U.S. Census reported a population 190,915 for the city of Vancouver, with approximately 26,065 people residing in Camas and 17,039 in Washougal (U.S. Census Bureau 2020). The nearest town is the unincorporated community of Proebstel, which is approximately 2 miles west of the installation.

In 1995, Camp Bonneville was placed on the list of facilities scheduled for realignment under the BRAC program. The three parcels that comprise the BRAC property at Camp Bonneville were transferred via a conservation conveyance. In September 2006, the Army transferred ownership of the 3,020-acre Early Transfer Parcel to Clark County (U.S. Army 2012). This initial transfer did not include the remaining 820 acres of Camp Bonneville that were owned by WDNR and leased to the Army. The WDNR parcels were conveyed to Clark County in June 2009. In both cases, Clark County immediately transferred ownership of the land by quitclaim deed to the Bonneville Conservation Restoration and Renewal Team LLC (BCRRT) for the management of remedial actions at the site, including removal of hazardous wastes and unexploded ordnance (UXO) (BCRRT 2007). Clark County subsequently took over site management and cleanup obligations when BCRRT conveyed ownership of the land by quitclaim deed to Clark County in December 2011 (U.S. Army 2012).

Camp Bonneville is currently closed to the public until remedial actions at the site are complete. As the authorized local redevelopment authority (LRA), Clark County plans to reuse the site for recreation. The County's reuse plan has nine specific components: regional park, law enforcement training center, rustic retreat center/outdoor school, Native American culture center, Clark College environmental education, trails and nature area, FBI firing range, timber resource management area, and habitat restoration (LRA 2005).

Clark County has an interlocal, short-term lease agreement with WDNR, which establishes a forward operating base for helicopter operations. WDNR's helicopter operations at Camp Bonneville assist its efforts to mitigate and improve response times for wildfires in the area. WDNR has been using Camp Bonneville to conduct these operations since 2019 (CCPW 2022a). The agreement includes adequate space for a helicopter, a fuel truck, and Building T-1980 to house crew members and limits WDNR's access of Camp Bonneville to only the barracks, parking area, and airfield near the main camp entrance (CCPW 2022a).

The land use surrounding Camp Bonneville is predominantly agricultural farming, rural residential, and forestry. Although the current zoning of neighboring properties requires a minimum 5-acre lot size, many of the residences near the facility were approved on much smaller lots prior to the adoption of the current standards (LRA 2005).

2.4 TOPOGRAPHY

Camp Bonneville is on the western slope of the Cascade Mountains in the Lacamas Creek Valley, where the terrain is generally covered with undergrowth and large stands of coniferous timber (Woodward-Clyde 1997). The western portion of Camp Bonneville consists of low hills and low plains of the Lacamas Creek valley. Elevations range from approximately 300 feet above mean sea level (amsl) in Lacamas Creek at the southwestern corner of the site to 1,000 and 1,400 feet amsl along the moderately steep ridges within the installation boundary to the northwest and southeast, respectively (U.S. Geological Survey National Elevation Dataset, as depicted in Figure 2-1).

2.5 GEOLOGY

Camp Bonneville is located along the structural and physiographic margin between the western foothills of the southern Cascade Mountains and the Portland-Vancouver Basin. The geology in the vicinity of Camp Bonneville is primarily known from geologic mapping performed by Mundorff (1964), Phillips (1987), and Evarts (2006).

The geology at Camp Bonneville can be divided into three general areas that correspond approximately to topographic divisions. The area west of Lacamas Creek is composed of a series of predominantly gravel and semi-consolidated conglomerate with scattered lenses and stringers of sand (Upper Troutdale Formation). Underlying the Troutdale Formation and comprising the area to the north and east of Lacamas Creek are folded and faulted basalt flows, flow breccia, and pyroclastic and andesitic rocks that are folded and faulted. The bottomland along Lacamas Creek is composed of unconsolidated silt, sand, gravel valley fill, with some clay (Mundorff 1964, Phillips 1987).

The Troutdale Formation underlying the western portions of Camp Bonneville is the result of deposition of western flowing streams that crossed the Cascade Range, including the ancestral Columbia River (Evarts 2006). Considerable variation exists in the lithology and thickness of the Troutdale Formation. According to regional logs, the Upper Troutdale Formation in the vicinity of the installation is approximately 150 feet thick and consists of cemented sand, gravel, sandy clay, and boulders. It is underlain by up to 150 feet of the Lower Troutdale Formation, which contains considerably more clay interspersed with sandy and gravelly layers (URS 2000). The bedrock that underlies the alluvial deposits and Troutdale Formation is exposed at the surface in the northern and eastern regions of Camp Bonneville.

2.6 HYDROGEOLOGY

Camp Bonneville lies within the Portland Basin, which is defined as the area bounded by the Tualatin Mountains to the west, the Lewis River to the north, the foothills of the Cascade Range to the east, and the Clackamas River to the south. The Columbia and Willamette Rivers flow through the area and are major discharge areas for the groundwater system (McFarland and Morgan 1996). The following eight hydrogeologic units comprise the Portland Basin aquifer system:

- Unconsolidated sedimentary aquifer
- Troutdale gravel aquifer
- Confining unit 1
- Troutdale sandstone aquifer
- Confining unit 2
- Sand and gravel aquifer
- Older rocks
- An undifferentiated fine-grained unit that occurs where the Troutdale sandstone and the sand and gravel aquifer are absent.

The Troutdale gravel aquifer that underlies the western portion of Camp Bonneville is generally considered an important and productive aquifer in the Portland Basin and commonly serves as source water for municipal, industrial, and irrigation supplies (McFarland and Morgan 1996). USEPA has designated the Troutdale aquifer a "sole source aquifer" (USEPA 2006). USEPA defines a sole or principal source as an aquifer that supplies at least 50 percent of the drinking water consumed in the area overlying the aquifer and for which no alternative source or combination of alternative drinking water sources exist that could physically, legally, and economically supply those dependent upon the aquifer. The Troutdale aquifer system provides approximately 99.4 percent of the available drinking water to the residents living within its area, and no other drinking water sources are available that would be economically feasible to supply these residents (USEPA 2006).

Groundwater recharge within the Portland Basin primarily comes from precipitation and streamflow (McFarland and Morgan 1996). Water also enters the system at significant rates in more urban areas from runoff into dry wells and onsite waste disposal systems. Groundwater movement within the Portland Basin is generally controlled by topography (Mundorff 1964), with groundwater flow moving from upland areas downgradient to local, intermediate, or regional discharge areas, such as streams and springs (McFarland and Morgan 1996). The groundwater at Camp Bonneville typically follows the local topography and flows from higher elevations toward Lacamas Creek, with discharges to Lacamas Creek and its tributaries (EEI 2012).

2.7 SURFACE WATER HYDROLOGY

Camp Bonneville lies within the Lacamas Creek watershed and drainage basin. The principal surface water feature is Lacamas Creek, which flows southward from the confluence of the North and East Forks in the north-central part of Camp Bonneville. The creek is also fed by David and Buck Creeks, which drain the southeastern portion of the installation. Lacamas Creek exits the site in the southwestern corner, discharging to Lacamas Lake, which in turn drains into the Columbia River near Camas, Washington (Hart Crowser 1999). Two artificial impoundments of Lacamas Creek, with a total surface area of less than 4,600 ft^2, were created to support a trout sports fishery. Since base closure, the impoundments have been drained (Calibre 2005).

2.8 WATER USAGE

Camp Bonneville currently has two non-potable supply wells: a 385-foot well at the Bonneville cantonment and a 193-foot well at the Killpack cantonment (ESE 1983). The supply wells are considered non-potable due to deed restrictions in place that prohibit potable water use at Camp Bonneville. An additional well with a depth of 516 feet may have also been present historically at the Killpack cantonment (Mundorff 1964). Well water is pumped, chlorinated, and stored in reservoirs for distribution at the cantonments to provide non-potable water only. An additional non-potable well was reportedly drilled at the FBI range in 1998, extending to a depth of 105 feet (BCRRT 2007). The locations of non-potable wells are shown in Figure 2-1. According to personnel interviews, potable water for the installation is carried in as needed. Deed restrictions are in place prohibiting groundwater use at Landfill 4/Demolition Area 1 and limiting the use of the existing water systems at the Bonneville and Killpack cantonments to non-potable water only (U.S. Army 2006).

Groundwater at Camp Bonneville typically follows the local topography and flows from higher elevations toward Lacamas Creek. According to regional information (Mundorff 1964) and the depths of wells at the property, local water supply wells typically extend into the Troutdale Formation or underlying bedrock and obtain groundwater from depths 150 to 500 feet below ground surface (bgs). A search of the Clark County Geographic Information Services water well database (https://gis.clark.wa.gov/gishome/) resulted in 2,267 domestic water wells located within 4 miles of the installation boundary. The wells within 4 miles of Camp Bonneville include 9 Group A public water system wells; 205 Group B public water system wells; 57 irrigation wells; 858 individual water system wells; and 1,138 unclassified water system wells.

2.9 ECOLOGICAL PROFILE

The Lacamas Creek valley floor consists of open grassy fields, light to densely vegetated areas, and wetland plants near areas with small drainages and depressions in the floodplain of Lacamas Creek (LRA 2005). The existing vegetation around Camp Bonneville is primarily young conifer forest, although patches of mature conifer and a mix of conifer and deciduous forest are also found within the boundaries of the installation. The installation is located at the edge of a prairie that extends into the foothills of the south Cascade Mountains, although no undisturbed tracts of this habitat remain (LRA 2005).

Douglas fir (*Pseudotsuga menziesii*) stands predominate the coniferous forest habitat, and individual western red cedars *(Thuja plicata)*and hemlock trees (*Tsuga heterophylla*) are scattered in drainage locations throughout, with understory species such as vine maple (*Acer circinatum*), salmonberry (*Rubus spectabilis*), elderberry (*Sambucus nigra*), hazelnut (*Corylus avellana*), salal (*Gaultheria shallon*), and sword fern (*Polystichum munitum*) (LRA 2005). Mixed habitat communities of coniferous and deciduous trees are within the area and contain patches of Garry oak (*Quercus garryana*) from the former woodland communities and tree species such as cottonwood (*Populus fremontii*), crabapple (*Malus Fusca*), red alder (*Alnus rubra*), Oregon ash (*Fraxinus latifolia*), Douglas fir (*Pseudotsuga menziesii*), big leaf maple (*Acer macrophyllum*), and willow (*Salix lucida*) (Pentec 1995, as cited in EEI 2010). These mixed habitats have understory species such as Indian plum (*Oemleria cerasiformis*), snowberry (*Symphoricarpos albus*), vine maple (*Acer circinatum*), and lady fern (*Athyrium filix-femina*) (LRA 2005, Parsons 2004).

The state-listed threatened hairy-stemmed checker-mallow (*Sidalcea hirtipes*) has been identified onsite (Pentec 1995, as cited in EEI 2010). In addition, dense sedge (*Carex densa*), Hall's aster (*Symphyotrichum hallii*), Oregon coyote-thistle (*Eryngium petiolatum*), and Western wahoo (*Euonymus occidentalis*) are present along Lacamas Creek (EEI 2010) and are identified as sensitive, vulnerable, or declining plants that could become threatened or endangered in Washington (WDNR 2021).

The county is currently working effectively to manage Camp Bonneville's forests to support a diversity of plants and animals. As part of this program, the county is working to control a number of non-native species at the installation, including bull thistle (*Cirsium vulgare*), Canada thistle (*Cirsium arvense*), herb Robert (*Geranium robertianium*), meadow knapweed (*Centaurea pratensis*), mouse-ear hawkweed (*Hieracium pilosella*), non-native blackberry (*Rubus armeniacus* and *Rubus laciniatus*), Queen Anne's lace (*Daucus carota*), Scotch broom (*Cytisus scoparius*), and tansy ragwort (*Jacobaea vulgaris*) (CCPW 2022b).

In 1994, a partial baseline survey was conducted for nesting raptors, which found 33 raptors, including red-tail hawks (*Buteo jamaicensis*), northern harriers (*Circus hudsonius*), great horned owls (*Bubo virginianus*), turkey vultures (*Cathartes aura*), and a raven (*Corvus corax*) (BCRRT 2007). A 1995 endangered species survey identified priority species of the brush prairie or northern pocket gopher (*Thomomys talpoides*) at Camp Bonneville (Pentec 1995, as cited in EEI 2010). This gopher is an imperiled species of greatest conservation need for Washington (WDNR 2015).

The federally listed threatened Lower Columbia River Evolutionarily Significant Unit (ESU) steelhead trout (*Oncorhynchus mykiss*), the Lower Columbia River ESU Chinook salmon (*Oncorhynchus tshawytscha*), and the Lower Columbia River ESU chum salmon (*Oncorhynchus keta*) are present within Lacamas Creek (EEI 2012). Other endangered species, while not observed, are considered to potentially reside within Clark County and Camp Bonneville. The U.S. Fish and Wildlife Service (USFWS) Environmental Conservation Online System identifies the following four federally threatened bird, fish, and vascular plant species as potentially occurring on or near Camp Bonneville: northern spotted owl (*Strix occidentalis caurina*), yellow-billed cuckoo (*Coccyzus americanus*), bull trout (*Salvelinus confluentus*), and Nelson's checker-mallow (*Sidalcea nelsoniana*) (USFWS 2022). In addition, the monarch butterfly (*Danaus plexippus*) is listed as a candidate species under the Endangered Species Act and is expected to be on or near Camp Bonneville (USFWS 2022). The potential for these threatened and endangered and candidate species to occur does not mean the species are present at Camp Bonneville.

2.10 CLIMATE

The closest major city to Camp Bonneville is Vancouver, Washington, where the summers are short, warm, dry, and clear while the winters are cold, wet, and overcast. Humidity in this area is rare, with the highest chance of a muggy day being in August. The windier part of the year, late October to mid-March, lasts approximately 4.6 months, with the average wind speed being 5 miles per hour (Weather Spark 2022). July, August, and September are the warmest months of the year in Vancouver, with the highest temperature occurring in August at a monthly average temperature of 68.5°F (Table 2-1). However, the humidity levels are low and relatively constant year-round. The coldest period in Vancouver occurs in January, with an average temperature of 39.6°F.

Most precipitation in the area is caused by the passage of low-pressure zones along a path from the Northern Pacific Ocean eastward over the state during the winter and spring. The rainy period of the year lasts for 7 months (mid-May through mid-October), and the most rainfall is typically experienced in November, with an average of 9.1 inches of rain (Weather Spark 2022). Snowfall typically occurs from December to mid-February and averages a monthly high of 2.7 inches in January. The average hourly wind speed in Vancouver varies seasonally, but the windier part of the year typically occurs from late October to mid-March. The highest wind speeds occur in December, with an average hourly wind speed of 5.9 miles per hour (Weather Spark 2022).

Table 2-1. High, Mean, and Low Temperatures for Vancouver, Washington

Average	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Max Temp (°F)	46.7	49.6	54.5	59.8	67.0	72.9	82.1	83.0	75.9	63.1	51.8	45.3	62.6
Mean Temp (°F)	39.6	41.0	44.9	49.2	55.7	61.0	67.7	68.5	62.8	53.3	44.7	39.2	52.3
Min Temp (°F)	35.0	35.3	38.3	41.7	47.3	52.0	56.5	57.8	53.6	46.8	39.8	35.0	44.9

Source: https://en.climate-data.org/north-america/united-states-of-america/washington/vancouver-934/

3. FIELD INVESTIGATION ACTIVITIES

This section provides field procedures followed during the implementation of the SI (40 CFR §300.420(c)(4)(i)). The principal guidance documents used for the Camp Bonneville SI were consistent with the requirements presented in the *Army Guidance for Addressing Releases of PFAS* (U.S. Army 2018).

3.1 SITE INSPECTION DATA QUALITY OBJECTIVES

The data quality objectives (DQOs) were developed to define the problem at the AOPIs, identify the necessary decisions, specify decision-making rules and the level of confidence necessary to resolve the problem, identify the number of samples necessary to support the decision, and obtain agreement from the decision makers before the sampling program was initiated. The Camp Bonneville sample locations were determined based on current site conditions (i.e., groundwater flow direction); presence of site media (e.g., sediment and surface water may not be sampled at a given site); historical data (e.g., suspected location of PFAS release); and historical activities (e.g., remedial activities, disposal of potentially contaminated materials). The project stakeholders concurred that selected sampling schemes would be representative of site conditions prior to initiation of field investigation activities. The field investigation at Camp Bonneville was conducted in accordance with the Programmatic UFP-QAPP (Leidos 2022a) and Camp Bonneville UFP-QAPP Addendum (Leidos 2023a). The field activities employed to execute the Programmatic UFP-QAPP and Camp Bonneville UFP-QAPP Addendum are described below and include any variances or deviations.

3.2 SAMPLE DESIGN AND RATIONALE

Three AOPIs were investigated during the Camp Bonneville SI to determine the presence or absence of PFAS in the environment. Information inputs from the preliminary CSMs presented on Worksheet #10 of the Camp Bonneville UFP-QAPP Addendum (Leidos 2023a) were the basis for sample design at each AOPI. All samples were analyzed for 26 PFAS that includes the Target PFAS list of perfluorooctane sulfonate (PFOS), perfluorooctanoic acid (PFOA), perfluorobutanoic acid (PFBA), perfluorobutane sulfonate (PFBS), perfluorononanoic acid (PFNA), perfluorohexanoic acid (PFHxA), perfluorohexane sulfonate (PFHxS), and hexafluoropropylene oxide dimer acid (HFPO-DA) (also known as GenX).

The general approach for determining the presence or absence of PFAS at an AOPI consisted of collection of three soil samples from each of three soil borings installed within the AOPI. Two soil borings were selected for the collection of groundwater samples. Groundwater was collected as grab samples from temporary monitoring wells installed through the installation. Variations to the general sampling approach included modifications to sample quantities at AOPIs based on size (i.e., additional samples collected at larger AOPIs); omitting surface soil samples in paved or gravel-covered areas; omitting subsurface soil samples due to shallow groundwater; and shifting the location of groundwater samples due to the lack of groundwater in the area. If media were present, one colocated surface water and sediment sample per AOPI were collected.

Each location that was sampled, with a unique set of coordinates, was assigned a specific site location: CBV-XXXX-##.

Where:

- XXXX = abbreviation for the AOPI being sampled
- ## = the sequential number of each sample location within the AOPI.

Each sample that was collected received a unique sample number, related to the site identifier (ID) above, using the following format: CBXXXX##-ZZzz.

Where:

- XXXX = abbreviation for the AOPI being sampled
- ## = the sequential number of each sample location within the AOPI
- ZZ = sample media (i.e., GW = grab groundwater, SS = surface soil, SB = subsurface soil, SW = surface water, SD = sediment)
- zz = the location number within the AOPI (per the site location ID above).

Quality assurance QA/quality control (QC) samples were denoted according to the sample type. Rinsate blanks, field duplicates, and matrix spike (MS) and matrix spike duplicate (MSD) samples were denoted by appending "RB," "FD," "MS," and "MSD," respectively, to the parent sample ID. Field blanks and potable/source water blanks were named using the format of CB-YY-yy.

Where:

- YY = FB (field blank) or SRC (source blank)
- yy = sequential number of each type of blank sample collected.

3.3 FIELD INVESTIGATION ACTIVITIES

SI field activities were conducted from June 6 to June 11, and June 16, 2023. The locations and methods of sample collection during the SI are described in the following sections. Sampling procedures adhered to the Programmatic UFP-QAPP (Leidos 2022a) and Camp Bonneville UFP-QAPP Addendum (Leidos 2023a), and relevant information is summarized below.

Sampling activities at Camp Bonneville included collecting surface and subsurface soil samples from soil borings, groundwater samples from temporary monitoring wells, and sediment and surface water samples where these media were present. Samples were analyzed for 26 PFAS by liquid chromatography with tandem mass spectrometry (LC/MS/MS) compliant with Table B-15 of DoD Quality Systems Manual (QSM) Version 5.4 (DoD 2021) to determine the presence or absence of Target PFAS. A total of 35 samples, excluding QA/QC, were collected among the 3 AOPIs, including 4 temporary monitoring well groundwater samples, 6 surface soil samples, 20 subsurface soil samples, 2 surface water samples, and 3 sediment samples. A breakdown of samples collected at each AOPI is provided in Table 3-1. Prior to beginning sampling, site reconnaissance and utility clearance were conducted. Soil, sediment, and surface water sampling was completed at one AOPI before moving to the next AOPI. Groundwater sampling was completed at all of the AOPIs once sufficient water was present for collection. Any variances or deviations in sampling procedure, such as moving a location due to site conditions, were discussed with the project team and communicated in daily field summary emails (Appendix A). Field procedures and any deviations are discussed in the following sections. Photographs of SI field activities are provided in Appendix B.

Table 3-1. Camp Bonneville AOPI SI Sample Collection

AOPI Name	Groundwater Samples	Soil Samples	Surface Water Samples	Sediment Samples
Building 1864 Fire Station	2	3 SS / 6 SB	1	1
Building 4483 Fire Station	0	2 SS / 7 SB	0	1
Wash Racks 1 and 2	1	1 SS / 7 SB	1	1
Downgradient Groundwater Samples*	1	0 SS / 0 SB	0	0
Total	**4**	**6 SS / 20 SB**	**2**	**3**

*Additional groundwater samples were attempted downgradient from the Building 4483 Fire Station and Wash Racks 1 and 2 AOPIs due to a lack of groundwater at the AOPIs.
SS = Surface soil sample
SB = Subsurface soil sample

3.4 FIELD PROCEDURES

The following sections describe utility clearance, munitions and explosives of concern (MEC) avoidance, bulk source water sampling, soil boring installation and sampling, groundwater sampling, surface water and sediment sampling, equipment calibration, location survey, and deviations and field change requests. Specific details regarding each of these activities are documented on Task Team Activity Log Sheets that are provided in Appendix C.

Because many materials routinely used during environmental investigations can potentially contain PFAS, the field crew conducted SI activities in accordance with the PFAS sampling standard operating procedure (SOP) presented in Appendix A of the Programmatic UFP-QAPP (Leidos 2022a). Procedures include requirements for equipment, containers, handling, and sampling, including PFAS-specific requirements, to ensure that sample contamination does not occur during collection and transport. New, clean nitrile gloves were donned prior to each new sample collected. Sampling containers were labeled with the following information: site name, sample ID, date and time of sample collection, name of sampler, sample preservation, and type of analysis (i.e., PFAS).

3.4.1 Utility Clearance

Prior to initiating intrusive activities, the site was verified to be free of underground utilities. The Field Manager coordinated underground utility clearances through BRAC and WA811 "Call Before You Dig." Other utility clearance activities included consulting individual utility companies (as needed), reviewing available as-built drawings, walking the areas to verify that utilities were marked, looking for signs of unidentified utilities (including overhead utilities), and completion of a Subsurface Clearance Checklist prior to initiating drilling operations. Prior to conducting powered drilling within 25 feet of known or suspected subsurface utilities, boreholes were excavated to a minimum of 5 feet bgs using a low-impact technique (i.e., hand auger) that will not damage the utility.

3.4.2 MEC Avoidance

A certified UXO Technician conducted a survey (visual and magnetometer) prior to all intrusive work to preclude disturbing subsurface MEC. MEC avoidance operations were conducted in accordance with the Department of Defense Explosives Safety Board Technical Paper 18, June 24, 2020, and Appendix A of the Camp Bonneville Site Safety and Health Plan (Appendix A of the UFP-QAPP Addendum [Leidos 2023a]).

3.4.3 Bulk Source Water Sampling

Prior to beginning work, the water supply wells at the Killpack and Bonneville cantonments were not operational due to an extended power supply issue. No bulk source water samples were collected. A 55-gallon drum of PFAS-free deionized (DI) water was procured and used for drilling and decontamination.

3.4.4 Soil Boring Installation and Sampling

All soil samples were collected in accordance with the procedures outlined in the Programmatic UFP-QAPP (Leidos 2022a) and Camp Bonneville UFP-QAPP Addendum (Leidos 2023a). QC samples, including, duplicates, rinsate blanks, and MS/MSDs, were also collected.

Direct push drilling technology was used to advance boreholes into the first water-bearing zone within soil. Each soil core was logged for lithology in accordance with U.S. Army Corps of Engineers (USACE) guidance (ASTM International D2488 [2017]) and recorded on a soil boring log (provided in Appendix D). Soil sample intervals were homogenized in disposable high-density polyethylene (HDPE) bags prior to placing the soil into HDPE sample bottles. Sample bottles were labeled and sealed in zip-lock bags and placed on wet ice for cooling to ≤6°C. Additional details on protocols for obtaining soil samples are outlined on Worksheet #18 and the Leidos SOP "Soil Sampling" provided in the Programmatic UFP-QAPP (Leidos 2022a).

Surface soil samples were collected from 0 to 1 foot bgs. No surface soil was collected if the surface at a boring was gravel, asphalt, or concrete. A maximum of three subsurface soil samples were collected from each soil boring. Subsurface samples were collected as grab samples from 2-foot intervals, and the interval from which the sample was collected was recorded on the boring log. One subsurface soil sample was collected immediately above the water table to evaluate the potential for leaching. A second subsurface soil sample was collected in the central interval within the boring. At two locations, CBV-WR12-01 and CBV-4482-03, a third subsurface soil sample was collected at the depth of refusal in the borehole. If groundwater was encountered at less than 5 feet bgs, only one subsurface soil sample was collected (immediately above the water table). Samples for laboratory analysis were biased toward organic-rich zones, as PFAS may sorb to organics.

Soil borings were abandoned following sample collection by backfilling the borehole with bentonite and sand. Surface restoration was completed to match the surrounding surface (e.g., concrete, asphalt, grass).

3.4.5 Groundwater Sampling

All groundwater samples were collected in accordance with the procedures outlined in the Programmatic UFP-QAPP (Leidos 2022a) and Camp Bonneville UFP-QAPP Addendum (Leidos 2023a). QC samples, including equipment blanks, duplicates, and MS/MSDs, were also collected. Groundwater was sampled from boreholes using a peristaltic pump.

Following completion of drilling each borehole, the drill rods were removed and a temporary monitoring well consisting of a clean, new 1-inch polyvinyl chloride screen and riser was installed in the borehole. Groundwater samples were collected using a peristaltic pump with new HDPE tubing inserted in the temporary monitoring well. Laboratory-supplied HDPE bottles were filled directly from the tubing, labeled, sealed, placed in zip-lock bags, and then placed on wet ice for cooling to ≤6°C. Sample containers were labeled with the following information: site name; sample ID; date and time of sample collection; name of sampler; sample preservation; and type of analysis.

If sufficient volume was present, water quality parameters (pH, temperature, conductivity, dissolved oxygen [DO], oxidation-reduction potential [ORP], and turbidity) were measured and recorded on the groundwater sampling form. In addition, observations of the physical appearance and odor (if any) of the purge water (e.g., organic or sulfide odors, black precipitates) were recorded. Once sampling was complete, all materials were removed from the borehole and the borehole was abandoned. The borehole was sealed with bentonite chips to approximately 1 foot bgs, and the chips were hydrated with PFAS-free DI water. The surface was completed to match the surrounding surface (e.g., asphalt or grass).

3.4.6 Surface Water and Sediment Sampling

All surface water and sediment samples were collected in accordance with the procedures outlined in the Programmatic UFP-QAPP (Leidos 2022a) and Camp Bonneville UFP-QAPP Addendum (Leidos 2023a). QC samples, including equipment blanks, duplicates, and MS/MSDs, were also collected.

Surface water samples were collected from the selected locations by submerging the bottle ware below the water surface, while avoiding sediment agitation. Sediment samples were collected directly from the selected locations from 0 to 6 inches bgs using a nitrile-gloved hand. Each sediment sample was homogenized in a disposable HDPE bag prior to placing the sediment into laboratory-supplied HDPE sample bottles. Sample containers were labeled, sealed in zip-lock bags, and placed on wet ice for cooling to ≤6°C.

Water quality parameters (pH, temperature, conductivity, DO, ORP, and turbidity) were measured and recorded on the surface water/sediment sampling form. Observations made during surface water and sediment sampling were recorded on the sediment/surface water sampling forms provided in Appendix E.

3.4.7 Equipment Calibration

Water quality instruments (i.e., Horiba U-52) used during groundwater sampling and the photoionization detector used during drilling activities were calibrated daily per Worksheet #24 of the Programmatic UFP-QAPP (Leidos 2022a) against known standards in accordance with the manufacturer's instructions and documented on the calibration logs provided in Appendix E.

3.4.8 Location Survey

Environmental sample locations and notable site features were located and mapped using a portable Trimble global positioning system (GPS) unit capable of achieving ± 3 feet accurate results. GPS data were transferred for use in ArcGIS mapping applications during data evaluation and reporting.

3.4.9 Deviations and Field Change Requests

No instances of field modification impacting project scope and/or data usability/quality were encountered during the SI fieldwork. The following minor deviations from the planned sample quantities and locations in the Camp Bonneville UFP-QAPP Addendum (Leidos 2023a) were observed during field activities and summarized for USACE in daily field notes:

- The quantities of samples varied from Table 17-1 of the Camp Bonneville UFP-QAPP Addendum (Leidos 2023a). The deviation in sample quantities is a result of actual field conditions, including gravel/cobble preventing low-impact utility clearance, lack of groundwater, and the lack of surface water at select locations.
  - Surface soil was not collected at CBV-WR12-04 due to subsurface obstruction and gravel at the surface.
  - A second subsurface soil sample was not collected at CBV-4483-02 due to shallow groundwater.
  - Two additional subsurface soil samples were collected at CBV-WR12-01 and CBV-4483-03, based on field observations, to assess soil deeper than 15 feet bgs.
  - Due to insufficient water and slow recharge, groundwater samples were not collected at locations CBV-4483-01, CBV-4483-03, CBV-WR12-01, CBV-WR12-02, and CBV-WR12-03. Two groundwater sampling locations, CBV-FSWR-01 and CBV-FSWR-02, were added to the sampling plan to obtain additional groundwater data. From the two groundwater samples added to the sampling plan, only one sample, CBFSWR01-GW01, was collected. Due to high turbidity and matrix interference, the sample results were deemed invalid.
  - No surface water or sediment were observed at location CBV-4483-05, and thus, a surface water and sediment sample were not collected at this location.
- Sample location CBV-WR12-02 was moved approximately 20 feet southwest of the proposed sample location due to proximity to overhead utilities to the drill rig mast.
- Sample location CBV-WR12-04 was moved approximately 15 feet southeast due to gravel/cobble preventing low-impact utility clearance of the proposed sample location.

3.5 DECONTAMINATION PROCEDURES

To ensure that chemical analysis results reflect the actual concentrations at sample locations, the non-dedicated, reusable equipment used in sampling activities was rigorously cleaned and decontaminated between sample locations in accordance with the Programmatic UFP-QAPP (Leidos 2022a) and Camp Bonneville UFP-QAPP Addendum (Leidos 2023a). The non-disposable sampling equipment used to conduct sampling activities (e.g., hand augers, water level meters, drill rods, small non-dedicated tools) was decontaminated before sampling activities began, between locations, between sampling events, and after sampling activities were completed. Wastewater generated from decontamination activities was handled as IDW.

The decontamination process included an initial scrub with a laboratory-grade, phosphate-free, biodegradable detergent (e.g., Liquinox®) and supplied PFAS-free DI water to remove particulate matter and surface film. Equipment was scrubbed using polyethylene or polyvinyl chloride brushes. Following this scrub, the equipment was then rinsed twice in separate bins containing bulk source water and PFAS-free DI water. Decontaminated sampling equipment was wrapped in thin sheets of HDPE to prevent subsequent contamination if being stored and not used immediately.

3.6 DISPOSITION OF FIELD INVESTIGATION-DERIVED WASTE

The IDW generated during the SI at Camp Bonneville included solids (soil, sediment, and disposables) and liquids (decontamination rinse water and well purge water). These materials were managed in accordance with the IDW Management Plan provided in Appendix B of the Camp Bonneville UFP-QAPP Addendum (Leidos 2023a).

All IDW generated at Camp Bonneville was placed in United Nations-rated, 55-gallon drums for storage, transport, and disposal. Permanent labels for the drums included a unique container number, a description of the contents (i.e., soil or wastewater), the fill date, the source location, the generator’s name (i.e., Camp Bonneville), and a telephone number for the generator’s point of contact (e.g., the Army BRAC Environmental Coordinator). Each bucket or carboy used to temporarily store liquid IDW before it was transferred to a 55-gallon drum was marked “Non-potable Water” or “Decontamination Waste” to comply with requirements of the IDW Management Plan.

The contents of the IDW drums were sampled for characterization and profiling. A solid waste sample was composited by collecting aliquots from the solid waste drums using a decontaminated stainless steel hand auger. The solids were homogenized in an HDPE plastic bag and then placed into laboratory-supplied sample containers. Solid, non-regulated waste and general refuse, including disposable, non-recyclable HDPE bailers, temporary well material, and personal protective equipment (PPE), were contained in separate drums. For drums containing liquid IDW, nitrile gloves were donned and sample bottles were filled directly from the drum. The waste hauler (US Ecology) was contacted prior to sampling to determine parameters required for disposal of waste potentially containing PFAS. The waste hauler provided guidance to analyze for suspected contaminants based on site history and previous investigations. The sample was analyzed for PFAS, toxicity characteristic leaching procedure (TCLP) volatile organic compounds, TCLP semivolatile organic compounds, TCLP metals, TCLP pesticides, TCLP herbicides, pH, and flashpoint. The sample results indicated the waste was non-hazardous.

On September 8, 2023, US Ecology removed the solid and liquid IDW waste drums from Camp Bonneville for disposal. Both solid and liquid waste was disposed of at the US Ecology Idaho, Inc. Grand View Idaho facility. Soiled PPE was drummed and disposed of with the solid IDW. Copies of the waste manifests and certificates of disposal are included in Appendix F.

4. DATA ANALYSIS AND QUALITY ASSURANCE SUMMARY

This section summarizes the QA/QC program and laboratory chemical analysis program implemented as part of the Camp Bonneville SI field activities (40 CFR §300.420(c)(4)). Additional information on these procedures is presented in the Camp Bonneville UFP-QAPP Addendum (Leidos 2023a).

Pace Laboratory, Inc., in West Columbia, South Carolina, was the analytical laboratory under contract for the analysis of PFAS during the Camp Bonneville SI field activities. Sections 4.1 through 4.4 summarize sample handling procedures, laboratory analytical methods, data QA/QC, data reporting and validation, and sample QA/QC. A QA summary of the analytical data is presented in Section 4.5. Appendix G provides the DUA, which details the quality and usability of the SI analytical data and the process performed to evaluate the data for compliance with established QC criteria.

4.1 SAMPLE HANDLING PROCEDURES

A critical aspect of sample collection and analysis protocols is the maintenance of strict chain-of-custody (CoC) procedures, which include tracking and documentation during sample collection, shipment, and laboratory processing. The Sample Manager was responsible for sample custody until the samples were properly packaged, documented, and released to the commercial carrier. The laboratory was responsible for sample custody thereafter in accordance with approved procedures.

4.1.1 Chain-of-Custody Record

CoC forms were used to document the traceability and integrity of all samples from the point of collection to the laboratory by maintaining a record of sample collection, shipment, and receipt by the laboratory. A CoC form was filled out and was signed and dated by each sample custodian.

Shipping containers were sealed with custody tape. Sealed coolers were transported to the commercial carrier for overnight delivery to the laboratory. The air bill number, written on the CoC form, acted as the custody documentation while the sealed coolers were in the possession of the commercial carrier. The CoC form was placed in a resealable plastic bag and taped to the inside lid of the cooler.

When the possession of samples was transferred, the individual relinquishing the samples and the individual receiving the samples signed, dated, and noted the time of transferal on the CoC. This record represents the official documentation for all transferal of sample custody until the samples arrived at the laboratory.

4.1.2 Laboratory Sample Receipt

All samples received by the Laboratory Sample Custodian or designee were checked for proper preservation (e.g., pH, temperature of coolant blank above 2°C or below 6°C); integrity (e.g., leaking, broken bottles); and proper, complete, and accurate documentation and ID of the samples. The temperature of the coolant blank was noted. No insufficiencies and/or discrepancies were noted.

Samples received at the laboratory were logged into the laboratory computer database. Initial entries included field sample number, date of receipt, and analyses required. As samples were received, they were assigned a laboratory sample ID number. The sample custodian labeled each container with its sample ID number, and the samples then were transferred to their designated storage areas.

Samples received by the laboratory were considered to be physical evidence and were handled according to USEPA procedural safeguards. In addition, all data generated from the sample analyses, including all associated calibrations, method blanks, and other supporting QC analyses, were identified with the project name, project number, and sample delivery group (SDG) designation. All data were maintained under the proper custody. The laboratory provided complete security for samples, analyses, and data.

4.2 LABORATORY ANALYTICAL METHODS

The chemical analysis program for the Camp Bonneville SI conforms to the analytical requirements presented in the Programmatic UFP-QAPP (Leidos 2022a) and Camp Bonneville UFP-QAPP Addendum (Leidos 2023a) for the chemical analysis of field investigation samples. All samples were analyzed for PFAS using LC/MS/MS procedures compliant with DoD QSM Version 5.4, Table B-15 (DoD 2021) and the laboratory SOP.

4.3 DATA QUALITY ASSURANCE/QUALITY CONTROL

This section presents the QA/QC procedures applied during sampling and laboratory analysis. This discussion includes laboratory QA/QC (Section 4.3.1) and field QA/QC (Section 4.3.2) procedures. Details on the results of the QC samples (field and laboratory) are presented in the DUA included in Appendix G

4.3.1 Laboratory Quality Assurance/Quality Control

Samples were analyzed for PFAS using LC/MS/MS in compliance with DoD QSM Version 5.4, Table B-15 (DoD 2021). QC checks included holding times, method blanks, calibration standards, extracted internal standards (EISs), laboratory control samples (LCSs), MS/MSDs, and detection limits. The acceptance criteria and laboratory SOP are provided in the Programmatic UFP-QAPP (Leidos 2022a) and Camp Bonneville UFP-QAPP Addendum (Leidos 2023a).

Method Blanks—Method blanks were used to monitor the possibility of laboratory-induced contamination by running a volume of approved reagent water through the entire analytical scheme (i.e., extraction, concentration, analysis). Blank requirements are specified in the DoD QSM Version 5.4, Table B-15 (DoD 2021) and the laboratory SOP.

Matrix Spike/Matrix Spike Duplicates—Additional sample volume was collected from select field sample locations to evaluate accuracy and precision using MS/MSD analyses. MS/MSDs are aliquots of environmental samples to which known concentrations of certain target analytes have been added before sample preparation, cleanup, and determinative procedures have been implemented (SW846 Chapter One). Accuracy was expressed as the percent recovery of each added compound. Precision was expressed as the relative percent difference (RPD) between the MS and MSD results. MS/MSD samples were collected and analyzed at a frequency of 1 for every 20 samples of similar matrix received at the laboratory.

Laboratory Control Samples—LCSs were analyzed to evaluate the accuracy of the analysis in the absence of sample matrix impacts. A known concentration of select compounds were added to the LCS. The spiked samples were analyzed in the same manner as the environmental samples. Accuracy was expressed as the percent recovery of each added compound. An LCS was analyzed with each SDG.

4.3.2 Field Quality Assurance/Quality Control

Table 4-1 summarizes the frequency of field QC samples that were collected during the Camp Bonneville field investigation. The requirements for field QC were established on Worksheet #20 of the Programmatic UFP-QAPP (Leidos 2022a) and Camp Bonneville UFP-QAPP Addendum (Leidos 2023a).

Table 4-1. Frequency of Field QC Samples for Camp Bonneville Field Investigation

QC Sample	Frequency
Field Blank	1 per water source used as final rinse of equipment
Source Water Blank	1 per bulk rinse water source
Equipment Rinsate Blank	1 for every 10 or fewer investigative samples
Field Duplicate	1 for every 10 or fewer investigative samples
Reagent Blank	1 per drinking water sampling event; none required for this event
MS/MSD	1 for every 20 or fewer investigative samples

4.4 DATA REPORTING AND VALIDATION

The Leidos QA Manager or designee initiated a validation of the analytical data packages. One hundred percent of the data were validated using objective criteria taken from the requirements of the Programmatic UFP-QAPP (Leidos 2022a) and DoD QSM Version 5.4 (DoD 2021) and qualified in accordance with the DoD Data Validation Guidelines Module 3 (DoD 2020) and the revised table for sample qualification in the presence of blank contamination (DoD 2022).

Reported laboratory data were reviewed in accordance with DoD QSM Stage 2B validation guidelines to ensure that the QC results fell within appropriate QC limits for holding times, blank contamination, EISs, calibrations, MS/MSDs, LCSs, and ion ratios. Any data validation qualifiers resulting from outlier QC results were applied and a data validation report, as previously described, was prepared. In addition, 10 percent of the data were validated in accordance with DoD QSM Stage 3 guidelines, and analytical results were checked and recalculated from raw data.

Equipment rinsate blanks and field blanks were associated with the corresponding environmental samples. These blanks were evaluated following the same criteria as method blanks, and the associated environmental samples were appropriately qualified as needed. After the data validation for the project was completed, a project DUA (Appendix G) was prepared.

4.5 QUALITY ASSURANCE SUMMARY

A comprehensive QA/QC program was implemented during the sampling event at Camp Bonneville in June 2023. Samples and associated QC samples (e.g., field duplicates, equipment rinsate blanks, field and source water blanks, MSs, MSDs) were collected and analyzed for PFAS using methods specified in the Programmatic UFP-QAPP (Leidos 2022a) and Camp Bonneville UFP-QAPP Addendum (Leidos 2023a). Consistent with the data quality requirements established in the Programmatic UFP-QAPP (Leidos 2022a) and Camp Bonneville UFP-QAPP Addendum (Leidos 2023a) and DQOs, all sample data and associated QC data were evaluated during the review and validation process. Individual sample results were qualified, as necessary, to designate usability of the data toward meeting project objectives. Data qualifiers were applied as required to results for 35 primary samples and 6 field duplicates (approximately 984 data points were evaluated) based on deviations from the measurement performance criteria in the Programmatic UFP-QAPP (Leidos 2022a). Results of the validation are provided in the DUA (Appendix G). The analyses associated with each data quality indicator are summarized below, with details of the results of the QC checks provided in the DUA (Appendix G).

4.5.1 Precision

Precision was evaluated by the analysis of MS/MSDs and field duplicate samples and the RPD between the duplicate spike results. QC results associated with analytical precision met measurement performance criteria (MPC); one analyte in a field duplicate pair exceeded the MPC, but data were not qualified based on this result.

4.5.2 Accuracy

Bias introduced due to blank contamination (in method, instrument, or field blanks) and any impact on accuracy were evaluated during validation. Analytical accuracy was measured through the use of LCSs, MS/MSDs, isotope dilution standards, initial and continuing calibration, and target compound quantitation requirements. Low EIS recoveries (less than 20 percent) resulted in 26 data points qualified as unusable (X qualified) during validation, and with concurrence from the project team, these results were rejected (R qualified) and not used as part of the data set used to evaluate project objectives. An additional 17 results were qualified based on QC samples associated with accuracy that did not meet MPC; these results were considered estimated but usable for evaluating project objectives.

4.5.3 Sensitivity

Sensitivity requirements were evaluated against minimum required limits of quantitation and LODs in the Programmatic UFP-QAPP (Leidos 2022a), and these criteria were met.

4.5.4 Representativeness

Representativeness was satisfied by ensuring that the Programmatic UFP-QAPP (Leidos 2022a) and Camp Bonneville UFP-QAPP Addendum (Leidos 2023a) protocols were followed, appropriate sampling techniques were used, established analytical procedures were implemented, and analytical holding times of the samples were not exceeded. Based on an evaluation of sample collection and receipt, holding times, and precision and accuracy, the samples collected during the Camp Bonneville SI sampling and analysis event are considered to be representative of the environmental conditions.

4.5.5 Comparability

Comparability was achieved by using consistent, documented, and UFP-QAPP-approved methods and meeting project accuracy and precision objectives. Based on the results of QC samples that assessed precision and accuracy assessment, along with the use of established method criteria (i.e., DoD QSM Version 5.4, Table B-15 [DoD 2021]), the data collected during the Camp Bonneville SI are considered to meet project objectives for comparability.

4.5.6 Completeness

Completeness measures the amount of valid data obtained from the sampling and analysis effort. For analytical data to be usable, each data point must be validated and meet criteria without significant non-conformance. The DQOs for the Camp Bonneville SI were set at 90 percent for field sampling and laboratory completeness. All groundwater, surface water, soil, and sediment samples proposed were collected. An additional groundwater sample was collected (CBV-FSWR01-GW01). Analytical completeness was impacted by 26 results qualified as R; objectives were met with a completeness of 97 percent.

4.5.7 Data Usability Assessment

Data that have been qualified as estimated (J, J-, UJ) during validation indicate accuracy, precision, or sensitivity QC measurements may have exceeded criteria, but the results are considered valid. Twenty-six data points within one sample (CBV-FSWR01-GW01) were recommended for exclusion due to EIS exceedance as detailed in Appendix G, and results recommended for exclusion are included in the Notice of Deficient Data (Appendix G).

5. SITE INSPECTION SCREENING LEVELS

Detected concentrations of the Target PFAS in samples collected during this SI are compared to residential scenario SLs calculated using the USEPA regional screening level (RSL) calculator for soil and the tap water criteria for groundwater, as published in the 2023 OSD Memorandum (DoD 2023). This SI uses the SLs and a target hazard quotient (HQ) of 0.1 to evaluate the Target PFAS concentrations. These SLs (Table 5-1) are used to evaluate the data and determine if future investigation is warranted at each AOPI. SLs for the other PFAS analyzed during this SI currently do not exist.

Table 5-1. Screening Levels from the 2023 OSD Memorandum

Chemical	Residential Tap Water HQ = 0.1 (ng/L or ppt)	Residential Soil HQ = 0.1 (μg/kg or ppb)
HFPO-DA	6	23
PFBA	1,800	7,800
PFBS	600	1,900
PFHxA	990	3,200
PFHxS	39	130
PFNA	5.9	19
PFOA	6	19
PFOS	4	13

Note: The residential tap water SLs are used to evaluate groundwater and surface water data. The residential soil SLs are used to evaluate soil and sediment data. The surface water and sediment data are qualitatively evaluated against the SLs. Laboratory results are reported to two significant figures.

6. SITE INSPECTION RESULTS

This section presents the background, summary of analytical results, and the CSM for each AOPI at Camp Bonneville where Target PFAS were detected. Sampled media and QA/QC samples were analyzed for the list of 26 PFAS specified in the Programmatic UFP-QAPP (Leidos 2022a). The sample results discussed below by AOPI focus on the eight Target PFAS outlined in the 2023 OSD Memorandum (DoD 2023): PFOS, PFOA, PFBA, PFBS, PFNA, PFHxA, PFHxS, and HFPO-DA. Analytical data presentation tables for all PFAS analyzed using approved methods are provided in Appendix H.

6.1 CONCEPTUAL SITE MODELS

The preliminary CSMs developed for each AOPI during the PFAS PA were further refined for each AOPI where Target PFAS were detected at concentrations greater than the LOD in sampled media. Based on the SI sample results, CSMs presented for each AOPI represent the current understanding of site conditions with respect to known or suspected sources of PFAS-containing materials, potential transport mechanisms and migration pathways, and potentially exposed human receptors.

The CSMs evaluate ingestion, dermal contact, and inhalation exposure routes for human receptors. The exposure pathways are evaluated as complete, potentially complete, or incomplete in the CSMs presented in figures in each AOPI-specific CSM section. In the absence of toxicity information for the inhalation route, the inhalation exposure pathway of PFAS (via dust) is considered potentially complete for soil where Target PFAS are detected. The remaining exposure pathway designations are determined as follows:

- ***Complete*** – Human exposure pathways are considered complete where Target PFAS have been detected at concentrations exceeding the SLs and no land use controls (LUCs) are in place restricting access or use of the media.
- ***Potentially Complete*** – Human exposure pathways are considered potentially complete if Target PFAS have been detected at concentrations less than the SLs for soil, groundwater, surface water, or sediment or if the SLs have been exceeded along the migration pathway. For example, if Target PFAS are not detected in soil but are detected at concentrations exceeding the SLs in groundwater, the exposure pathway for soil is considered potentially complete. In addition, a groundwater exposure pathway is considered potentially complete where Target PFAS have been detected and could migrate from the AOPI source area to offsite groundwater that is used for drinking water. Exposure pathways are also potentially complete for media where existing LUCs are in place for non-PFAS because the LUCs are not specific to Target PFAS.
- ***Incomplete*** – Human exposure pathways are considered incomplete for media where Target PFAS have not been detected at concentrations greater than the LODs.

Multiple LUCs are in place at Camp Bonneville including restrictions of residential use, groundwater access and use, excavation and land disturbances, and the restriction of public access by way of a perimeter fence and signage. LUCs that apply to the AOPIs are discussed in the relevant AOPI sections below.

6.2 BUILDING 1864 FIRE STATION AOPI

The following subsections describe the background, sampling results, CSM, and recommendation for the Building 1864 Fire Station AOPI.

6.2.1 AOPI Background

The Building 1864 Fire Station is in the Bonneville cantonment and was reportedly constructed during the late 1940s. The building was used as a fire house, a fire equipment shed, and for fire truck storage from the late 1940s until the late 1970s. Building 1864 was used for pesticide mixing and storage between 1977 and 1980, before becoming a roads and grounds shop. The building had one drive-in bay and contained an interior sink that discharged to a dry well along the eastern side of the building. In June and August 2000, soil in front of the building was excavated to 2.5 feet bgs (URS 2004). In approximately 2015, the building collapsed, and the debris remains onsite. Ownership of the building was transferred from the Army to Clark County, and then BCRRT assumed ownership from Clark County in September 2006. BCRRT conveyed ownership of the building back to Clark County in December 2011. Based on the operational time frame of the fire station and because aqueous film-forming foam (AFFF) was stored and used on the fire trucks at Camp Bonneville, PFAS-containing materials may have been used, stored, and/or released at the Building 1864 Fire Station AOPI.

6.2.2 SI Sampling and Results

Soil, groundwater, surface water, and sediment samples were collected from the Building 1864 Fire Station AOPI at the following locations (Figure 6-1):

- Nine soil samples and one QC duplicate sample were collected from three soil borings (CBV-1864-01, CBV-1864-02, and CBV-1864-03). Soil borings CBV-1864-01 and CBV-1864-03 were within the suspected release area, and CBV-1864-02 was downgradient from the suspected release area. One surface soil and two subsurface soil samples were collected from each boring.
- Two groundwater samples were collected from two temporary wells (CBV-1864-01 and CBV-1864-02). Monitoring well CBV-1864-01 was within the suspected release area and monitoring well CBV-1864-02 was downgradient from the suspected release area.
- One colocated surface water and sediment sample and one colocated QC duplicate sample were collected from an unnamed creek downgradient from the suspected release area at location CBV-1864-04.

The Target PFAS analytical results for soil, groundwater, surface water, and sediment samples collected at the Building 1864 Fire Station AOPI are summarized below and presented in Table 6-1 and Figure 6-2.

6.2.2.1 Soil

PFOS and PFBA were detected at estimated concentrations less than the SLs in one surface soil sample collected within the suspected release area at CBV-1864-03. Target PFAS were not detected in any other soil samples.

PFOA, PFHxA, PFHxS, PFBS, PFNA, and HFPO-DA were not detected at concentrations greater than the LODs in any soil samples collected at the Building 1864 Fire Station AOPI.

6.2.2.2 Groundwater

PFOA, PFBA, PFBS, and PFHxA were detected in groundwater samples collected at the Building 1864 Fire Station AOPI. PFOA, PFBA, and PFHxA were detected at concentrations less than the SL at both temporary monitoring wells CBV-1864-01 (estimated PFOA concentration) and CBV-1864-02. In addition, PFBS was detected at an estimated concentration less than the SL downgradient from the suspected release area at temporary monitoring well CBV-1864-02.

PFOS, PFHxS, PFNA, and HFPO-DA were not detected at concentrations greater than the LODs in groundwater samples collected at the Building 1864 Fire Station AOPI.

6.2.2.3 Surface Water

Target PFAS were not detected at concentrations greater than the LODs in surface water samples collected at the Building 1864 Fire Station AOPI.

6.2.2.4 Sediment

Target PFAS were not detected at concentrations greater than the LODs in sediment samples collected at the Building 1864 Fire Station AOPI.

6.2.3 CSM

The Building 1864 Fire Station AOPI is approximately 0.06 acres and is a collapsed structure surrounded by grass, soil, and gravel that slopes to the south. The ground surface elevation is approximately 360 feet amsl. Groundwater flows to the southeast, and groundwater was encountered from approximately 10 to 12.75 feet bgs. Surface water runoff flows to the south; a small unnamed creek that is approximately 100 feet east of Building 1864 flows south toward Lacamas Creek.

Due to the storage and use of AFFF on the Camp Bonneville fire trucks, the surface soil at the AOPI is the source medium for potential PFAS contamination. The primary release mechanism is the potential release of PFAS to surface soils related to the emergency response operations at the Building 1864 Fire Station AOPI. The secondary contaminant migration and fate and transport considerations include downward contaminant migration from soil to groundwater via desorption and dissolution. Constituents could migrate to surface water due to runoff, dissolution, and adsorption from stormwater and recharge to groundwater from surface water.

Current land use at Camp Bonneville is restricted to the conservation of natural resources. Public access is restricted until hazardous waste and MEC remediation is complete; however, future use is expected to include recreation. Due to the current and future land use at Camp Bonneville, the human receptors considered in the CSM are onsite workers with the potential to work at the AOPI, future onsite recreators, and offsite residents living in the vicinity of the former Camp Bonneville.

The soil exposure pathways for onsite workers are potentially complete because Target PFAS were detected at concentrations less than the SLs in surface soil at the Building 1864 Fire Station AOPI. The surface soil exposure pathways for future onsite recreators are potentially complete due to the detection of Target PFAS at concentrations less than the SLs in surface soil at the AOPI; however, the subsurface soil exposure pathways are incomplete as recreators will not be exposed to subsurface soil. The soil exposure pathways for offsite residents are incomplete as migration of soil from the AOPI is not expected.

Groundwater is not currently used for drinking water, and deed restrictions not related to PFAS limit groundwater use at the AOPI to non-potable uses only. However, the onsite groundwater exposure pathways are considered potentially complete for onsite workers because Target PFAS were detected in groundwater at concentrations less than the SLs. Potential future onsite recreators are not expected to contact groundwater due to the depth to groundwater and usage restrictions; therefore, the groundwater exposure pathways for onsite recreators are incomplete. Because drinking water wells are immediately downgradient from Camp Bonneville and Target PFAS were detected in onsite groundwater, the groundwater exposure pathways for offsite residents are potentially complete.

The surface water and sediment exposure pathways are considered incomplete because Target PFAS were not detected at concentrations greater than the LODs.

Figure 6-3 presents the CSM for the Building 1864 Fire Station AOPI.

6.2.4 Recommendation

Target PFAS were not detected at concentrations greater than the SLs; therefore, further investigation is not recommended.

Table 6-1. Target PFAS Results and Screening for the Building 1864 Fire Station AOPI

Location ID	Sample ID	Sample Type	Depth (ft)	Sample Date	HFPO-DA or GenX	PFBA	PFBS	PFHxA	PFHxS	PFNA	PFOA	PFOS
Soil				**Units**	**µg/kg**	**µg/kg**	**µg/kg**	**µg/kg**	**µg/kg**	**µg/kg**	**µg/kg**	**µg/kg**
				Screening Levels	**23**	**7800**	**1900**	**3200**	**130**	**19**	**19**	**13**
CBV-1864-01	CB186401-SS01	SURF	0.00-1.00	06/06/2023	2.6 U	0.65 U	0.65 U	0.65 U	0.65 U	0.65 U	0.65 U	0.65 U
	CB186401-SS01FD	SURF	0.00-1.00 (D)	06/06/2023	2.4 U	0.60 U	0.60 U	0.60 U	0.60 U	0.60 U	0.60 U	0.60 U
	CB186401-SB02	BORE	4.00-6.00	06/06/2023	2.7 U	0.65 U	0.65 U	0.65 U	0.65 U	0.65 U	0.65 U	0.65 U
	CB186401-SB03	BORE	8.00-10.00	06/06/2023	2.6 U	0.65 U	0.65 U	0.65 U	0.65 U	0.65 U	0.65 U	0.65 U
CBV-1864-02	CB186402-SS01	SURF	0.00-1.00	06/06/2023	2.2 U	0.55 U	0.55 U	0.55 U	0.55 U	0.55 U	0.55 U	0.55 U
	CB186402-SB02	BORE	5.00-7.00	06/06/2023	2.5 U	0.60 U	0.60 U	0.60 U	0.60 U	0.60 U	0.60 U	0.60 U
	CB186402-SB03	BORE	10.50-12.50	06/06/2023	2.3 U	0.55 U	0.55 U	0.55 U	0.55 U	0.55 U	0.55 U	0.55 U
CBV-1864-03	CB186403-SS01	SURF	0.00-1.00	06/06/2023	2.3 U	**0.26 J**	0.55 U	0.55 U	0.55 U	0.55 U	0.55 U	**0.32 J**
	CB186403-SB02	BORE	5.50-7.50	06/06/2023	2.4 U	0.60 U	0.60 U	0.60 U	0.60 U	0.60 U	0.60 U	0.60 U
	CB186403-SB03	BORE	10.75-12.75	06/06/2023	2.6 U	0.65 U	0.65 U	0.65 U	0.65 U	0.65 U	0.65 U	0.65 U
Groundwater				**Units**	**ng/L**	**ng/L**	**ng/L**	**ng/L**	**ng/L**	**ng/L**	**ng/L**	**ng/L**
				Screening Levels	**6**	**1800**	**600**	**990**	**39**	**5.9**	**6**	**4**
CBV-1864-01	CB186401-GW01	PNCH	14.50-14.50	06/07/2023	3.9 U	**6.3**	1.9 U	**8.6**	1.9 U	1.9 U	**1.6 J**	1.9 U
CBV-1864-02	CB186402-GW01	PNCH	18.00-18.00	06/08/2023	4.2 U	**31**	**3.3 J**	**5.9**	2.1 U	2.1 U	**4.9**	2.1 U
Surface Water				**Units**	**ng/L**	**ng/L**	**ng/L**	**ng/L**	**ng/L**	**ng/L**	**ng/L**	**ng/L**
				Screening Levels	**6**	**1800**	**600**	**990**	**39**	**5.9**	**6**	**4**
CBV-1864-04	CB186404-SW01	SWTR	0.00-0.00	06/06/2023	4.2 U	2.1 U	2.1 U	2.1 U	2.1 U	2.1 U	2.1 U	2.1 U
	CB186404-SW01FD	SWTR	0.00-0.00	06/06/2023 (D)	3.7 U	1.8 U	1.8 U	1.8 U	1.8 U	1.8 U	1.8 U	1.8 U
Sediment				**Units**	**µg/kg**	**µg/kg**	**µg/kg**	**µg/kg**	**µg/kg**	**µg/kg**	**µg/kg**	**µg/kg**
				Screening Levels	**23**	**7800**	**1900**	**3200**	**130**	**19**	**19**	**13**
CBV-1864-04	CB186404-SD01	SEDI	0.00-0.00	06/06/2023	5.5 U	1.4 U	1.4 U	1.4 U	1.4 U	1.4 U	1.4 U	1.4 U
	CB186404-SD01FD	SEDI	0.00-0.00 (D)	06/06/2023	5.5 U	1.4 U	1.4 U	1.4 U	1.4 U	1.4 U	1.4 U	1.4 U

The SLs are the Residential Scenario SLs calculated using the USEPA RSL calculator provided in the August 2023 OSD Memorandum for Tap Water using an HQ = 0.1.
Bolded values denote detected concentrations.
(D) = Field duplicate sample.
J = The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.
U = The analyte was analyzed for, but not detected above the reported sample quantitation limit.

6.3 BUILDING 4483 FIRE STATION AOPI

The following subsections describe the background, sampling results, CSM, and recommendation for the Building 4483 Fire Station AOPI.

6.3.1 AOPI Background

Building 4483 is in the Killpack cantonment and operated as a fire station from the late 1980s until approximately 2007. The original Building 4483 was constructed as a shed garage sometime prior to 1946 and was located parallel to the main road through the installation, adjacent to Building 4475. Based on the available aerial imagery, the original building was demolished by 1990. In 1993, Building 4483 was replaced by a second building with the same number approximately 30 feet north of the original building footprint. Ownership of Building 4483 was transferred from the Army to Clark County, and then BCRRT assumed ownership from Clark County in September 2006. BCRRT conveyed ownership of the building back to Clark County in December 2011. The building is currently being used for vehicle and equipment storage. According to personnel interviews, AFFF was historically stored on the fire truck that was kept at the fire station as part of a fire protection contract with the local Clark County Fire District. Up to 20 gallons of AFFF were stored on the fire truck in 5-gallon buckets.

6.3.2 SI Sampling and Results

Soil and sediment samples were collected from the Building 4483 Fire Station AOPI at the following locations (Figure 6-4):

- Nine soil samples and one QC duplicate sample were collected from four soil borings within the suspected release area (CBV-4483-01, CBV-4483-02, CBV-4483-03, and CBV-4483-04).
  - Surface soil samples were collected from CBV-4483-03 and CBV-4483-04. Surface soil was not collected at CBV-4483-01 and CBV-4483-02 due to the presence of surface gravel.
  - Two subsurface soil samples were collected from CBV-4483-01, CBV-4483-03, and CBV-4483-04. Due to shallow and localized perched groundwater at CBV-4483-03, a deeper subsurface soil sample (SB04) was collected to assess soil below 15 feet bgs. In addition, only one subsurface soil sample was collected at CBV-4483-02 due to shallow groundwater.
- One sediment sample was collected from CBV-4483-05 in a drainage ditch downgradient from the suspected release area. Surface water was not present in the ditch so a sample was not collected.

Two groundwater samples were planned for the Building 4483 AOPI but were not collected due to insufficient groundwater and slow recharge. Two additional groundwater samples were attempted downgradient from the Building 4483 Fire Station and the Wash Racks 1 and 2 AOPIs during a second mobilization and are discussed further in Section 7 and Appendix G.

The Target PFAS analytical results for soil and sediment at the Building 4483 Fire Station AOPI are summarized below and presented in Table 6-2 and Figure 6-5.

6.3.2.1 Soil

PFOS was detected at a concentration less than the SL in one surface soil sample collected within the suspected release area at CBV-4483-04.

PFOA, PFBA, PFBS, PFHxA, PFHxS, PFNA, and HFPO-DA were not detected at concentrations greater than the LODs in any soil samples collected at the Building 4483 Fire Station AOPI.

6.3.2.2 Sediment

PFOS was detected at an estimated concentration less than the SL in the sediment sample collected downgradient from the suspected release area at location CBV-4483-05.

PFOA, PFBA, PFBS, PFHxA, PFHxS, PFNA, and HFPO-DA were not detected at concentrations greater than the LODs in the sediment sample collected at the Building 4483 Fire Station AOPI.

6.3.3 CSM

The Building 4483 Fire Station AOPI is approximately 0.16 acres. Building 4483 has one drive-in bay and a concrete floor. The exterior ground surface consists of partially vegetated dirt and gravel and slopes to the southwest. The ground surface elevation is approximately 365 feet amsl. Groundwater flows to the southeast, and groundwater was encountered at approximately 6 feet bgs. A drainage ditch is located along the western side of Building 4483 that continues southwest along a gravel driveway leading to the shop office area before connecting with the drainage ditch along the main road. A small unnamed stream is approximately 50 feet east of Building 4483, adjacent to the former location of Wash Rack 1. The stream flows into a culvert that emerges below the gravel pad of the shop office area and flows aboveground for approximately 15 feet before entering another culvert running south under the road and then continuing south toward Lacamas Creek.

Due to the potential storage and use of AFFF on the Camp Bonneville fire trucks, the surface soil at the AOPI is the source medium for potential PFAS contamination. The primary release mechanism is the potential release of PFAS to surface soils related to the emergency response operations at the Building 4483 Fire Station AOPI. The secondary contaminant migration and fate and transport considerations include downward contaminant migration from soil to groundwater via desorption and dissolution. Constituents could migrate to surface water due to runoff, dissolution, and adsorption from stormwater and recharge to groundwater from surface water.

Current land use at Camp Bonneville is restricted to the conservation of natural resources. Public access is restricted until hazardous waste and MEC remediation is complete; however, future use is expected to include recreation. Due to the current and future land use at Camp Bonneville, the human receptors considered in the CSM are onsite workers with the potential to work at the AOPI, future onsite recreators, and offsite residents living in the vicinity of the former Camp Bonneville.

The soil exposure pathways for onsite workers are potentially complete because Target PFAS were detected at concentrations less than the SLs in surface soil at the Building 4483 Fire Station AOPI. The surface soil exposure pathways for future onsite recreators are potentially complete due to the detection of Target PFAS at concentrations less than the SLs in surface soil at the AOPI; however, the subsurface soil exposure pathways are incomplete as recreators will not be exposed to subsurface soil. The soil exposure pathways for offsite residents are incomplete as migration of soil off the AOPI is not expected.

Groundwater is not currently used for drinking water and deed restrictions, not related to PFAS, limit future groundwater use to non-potable water only at the AOPI. Groundwater samples were not collected at the Building 4483 Fire Station AOPI due to insufficient water and slow recharge. However, Target PFAS were detected in groundwater at the Wash Racks 1 and 2 AOPI at concentrations less than the SLs, and due to the proximity between the two AOPIs, the groundwater exposure pathways for onsite workers at the Building 4483 Fire Station AOPI are considered potentially complete. Potential future onsite recreators are not expected to contact groundwater due to the depth to groundwater and usage restrictions; therefore, the groundwater exposure pathways for onsite recreators are incomplete. Because drinking water wells are immediately downgradient from Camp Bonneville and Target PFAS were detected in onsite groundwater at the nearby Wash Racks 1 and 2 AOPI, the groundwater exposure pathways for offsite residents for the Building 4483 Fire Station AOPI are potentially complete.

Target PFAS were detected at concentrations less than the SLs in sediment at the AOPI, making the onsite surface water and sediment exposure pathways potentially complete. Because the surface water drainage network is discharged offsite, the offsite surface water and sediment exposure pathways are potentially complete.

Figure 6-6 presents the CSM for the Building 4483 Fire Station AOPI.

6.3.4 Recommendation

Target PFAS were not detected at concentrations greater than the SLs; therefore, further investigation is not recommended. In addition, although groundwater samples were not collected at the AOPI due to lack of groundwater, soil and sediment samples were distributed across the footprint of the AOPI and resulted in only two very low detections of Target PFAS at concentrations less than the SLs.

Table 6-2. Target PFAS Results and Screening for the Building 4483 Fire Station AOPI

Location ID	Sample ID	Sample Type	Depth (ft)	Sample Date	HFPO-DA or GenX	PFBA	PFBS	PFHxA	PFHxS	PFNA	PFOA	PFOS
Soil				**Units**	**µg/kg**	**µg/kg**	**µg/kg**	**µg/kg**	**µg/kg**	**µg/kg**	**µg/kg**	**µg/kg**
				Screening Levels	**23**	**7800**	**1900**	**3200**	**130**	**19**	**19**	**13**
CBV-4483-01	CB448301-SB02	BORE	6.00-8.00	06/08/2023	2.7 U	0.65 U	0.65 U	0.65 U	0.65 U	0.65 U	0.65 U	0.65 U
	CB448301-SB03	BORE	13.00-15.00	06/08/2023	2.7 U	0.65 U	0.65 U	0.65 U	0.65 U	0.65 U	0.65 U	0.65 U
CBV-4483-02	CB448302-SB02	BORE	3.50-5.50	06/08/2023	2.3 U	0.55 U	0.55 U	0.55 U	0.55 U	0.55 U	0.55 U	0.55 U
CBV-4483-03	CB448303-SS01	SURF	0.00-1.00	06/08/2023	2.1 U	0.55 U	0.55 U	0.55 U	0.55 U	0.55 U	0.55 U	0.55 U
	CB448303-SB02	BORE	4.00-6.00	06/08/2023	2.4 U	0.60 U	0.60 U	0.60 U	0.60 U	0.60 U	0.60 U	0.60 U
	CB448303-SB02FD	BORE	4.00-6.00 (D)	06/08/2023	2.4 U	0.60 U	0.60 U	0.60 U	0.60 U	0.60 U	0.60 U	0.60 U
	CB448303-SB04	BORE	18.00-20.00	06/09/2023	2.4 U	0.60 U	0.60 U	0.60 U	0.60 U	0.60 U	0.60 U	0.60 U
CBV-4483-04	CB448304-SS01	SURF	0.00-1.00	06/08/2023	2.0 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	**1.0**
	CB448304-SB02	BORE	6.00-8.00	06/08/2023	2.4 U	0.60 U	0.60 U	0.60 U	0.60 U	0.60 U	0.60 U	0.60 U
	CB448304-SB03	BORE	13.00-15.00	06/08/2023	2.4 U	0.60 U	0.60 U	0.60 U	0.60 U	0.60 U	0.60 U	0.60 U
Sediment				**Units**	**µg/kg**	**µg/kg**	**µg/kg**	**µg/kg**	**µg/kg**	**µg/kg**	**µg/kg**	**µg/kg**
				Screening Levels	**23**	**7800**	**1900**	**3200**	**130**	**19**	**19**	**13**
CBV-4483-05	CB448305-SD01	SEDI	0.00-0.00	06/07/2023	2.1 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	**0.20 J**

The SLs are the Residential Scenario SLs calculated using the USEPA RSL calculator provided in the August 2023 OSD Memorandum for Tap Water using an HQ = 0.1.
Bolded values denote detected concentrations.
(D) = Field duplicate sample.
J = The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.
U = The analyte was analyzed for, but not detected above the reported sample quantitation limit.

6.4 WASH RACKS 1 AND 2 AOPI

The following subsections describe the background, sampling results, CSM, and recommendation for the Wash Racks 1 and 2 AOPI.

6.4.1 AOPI Background

Wash Rack 1 was immediately west of Building 4475. It consisted of a wooden two-track vehicle ramp that was used for vehicle washing between 1978 and approximately 1994 (EEI 2010). In June 2000, Wash Rack 1 was dismantled and the soil beneath was excavated to 3.5 feet bgs (URS 2004). Wash Rack 2, also referred to as the vehicle maintenance rack, was at the northeastern corner of the shop office area, adjacent to Building 4476. It was constructed of two parallel wooden timbers with gravel in between, and it was used as a wash rack and vehicle maintenance rack until it was deconstructed in the 1980s (Woodward-Clyde 1997). Ownership of the property associated with Wash Racks 1 and 2 was transferred from the Army to Clark County, and then BCRRT assumed ownership from Clark County in September 2006. BCRRT conveyed ownership of the property back to Clark County in December 2011. AFFF is reported to have been present on the fire truck at the adjacent Building 4483 Fire Station. Wash Racks 1 and 2 are being considered a single AOPI due to their proximity and similar use and because these facilities may have received PFAS-containing AFFF during fire truck cleaning activities.

6.4.2 SI Sampling and Results

Soil, groundwater, surface water, and sediment samples were collected from the Wash Racks 1 and 2 AOPI at the following locations (Figures 6-4):

- Eight soil samples and one QC duplicate were collected from three soil borings (CBV-WR12-01, CBV-WR12-03, and CBV-WR12-04). Soil borings CBV-WR12-01, CBV-WR12-03 were within the suspected release area and CBV-WR12-04 was downgradient from the suspected release area.
  - One surface soil sample was collected from CBV-WR12-03. Surface soil was not collected at CBV-WR12-04 due to the presence of surface gravel. In addition, CBV-WR12-01 was in the area of a former excavation that removed soil to a depth of 3.5 feet bgs; therefore, no surface soil was present for sample collection.
  - Two subsurface soil samples were collected from CBV-WR12-01, CBV-WR12-03, and CBV-WR12-04. In addition, a deeper subsurface soil sample (SB04) was collected from CBV-WR12-01 in order to assess soil deeper 15 feet bgs.
- One groundwater sample and one QC duplicate were collected from the temporary monitoring well CBV-WR12-04 side gradient of Wash Rack 1 and downgradient from the suspected release area of Wash Rack 2. Groundwater samples were not collected from locations CBV-WR12-01, CBV-WR12-02, and CBV-WR12-03 due to insufficient water and slow recharge.
- One colocated surface water and sediment sample was collected from CBV-WR12-05 downgradient from the suspected release area.

Two additional groundwater samples were attempted downgradient from the Building 4484 Fire Station and the Wash Racks 1 and 2 AOPI during a second mobilization and are discussed further in Section 7 and Appendix G.

The Target PFAS analytical results for soil, groundwater, surface water, and sediment at the Wash Racks 1 and 2 AOPI are summarized below and presented in Table 6-3 and Figures 6-5.

6.4.2.1 Soil

Target PFAS were not detected at concentrations greater than the LOD in any soil samples collected at the Wash Racks 1 and 2 AOPI.

6.4.2.2 Groundwater

PFOS, PFBA, and PFHxA were detected at estimated concentrations less than the SLs downgradient from the suspected release area at monitoring well CBV-WR12-04.

PFOA, PFHxS, PFBS, PFNA, and HFPO-DA were not detected at concentrations greater than the LODs in any groundwater samples collected at the Wash Racks 1 and 2 AOPI.

6.4.2.3 Surface Water

PFOS and PFHxS were detected at estimated concentrations less than the SLs downgradient from the suspected release area at location CBV-WR12-05.

PFOA, PFBA, PFBS, PFHxA, PFNA, and HFPO-DA were not detected at concentrations greater than the LODs in the surface water sample collected at the Wash Racks 1 and 2 AOPI.

6.4.2.4 Sediment

PFOS was detected at an estimated concentration less than the SL downgradient from the suspected release area at location CBV-WR12-05.

PFOA, PFBA, PFBS, PFHxA, PFHxS, PFNA, and HFPO-DA were not detected at concentrations greater than the LODs in the sediment sample collected at the Wash Racks 1 and 2 AOPI.

6.4.3 CSM

Wash Rack 1 is approximately 0.03 acres and is in a partially vegetated, dirt and gravel open storage area, which is enclosed within the chain-link fence that surrounds the shop office area. Wash Rack 2 is approximately 0.01 acres and is in a partially open clearing that has been revegetated with a mixture of tall grasses, brush, and trees. The ground surface elevation at the Wash Racks 1 and 2 AOPI is approximately 365 feet amsl. Groundwater flows to the southeast, and groundwater was encountered at 11 feet bgs. Surface water runoff from Wash Rack 1 flows toward the road and into an unnamed stream that crosses the site. The stream flows into a culvert that emerges below the gravel pad of the shop office area and then flows aboveground for approximately 15 feet before entering another culvert running south under the road and then continuing south toward Lacamas Creek. The ground surface at Wash Rack 2 slopes to the south toward the road. Surface water from Wash Rack 2 flows toward a ditch that runs along the northern side of the road and joins the stream and runs under the road through the same culvert.

Due to the washing of fire trucks that stored and used AFFF, the surface soil at the AOPI is the source medium for potential PFAS contamination. The primary release mechanism is the potential release of PFAS to surface soils related to washing fire trucks at the Wash Racks 1 and 2 AOPI. The secondary contaminant migration and fate and transport considerations include downward contaminant migration from soil to groundwater via desorption and dissolution. Constituents could migrate to surface water due to runoff, dissolution, and adsorption from stormwater and recharge to groundwater from surface water.

Current land use at Camp Bonneville is restricted to the conservation of natural resources. Public access is restricted until hazardous waste and MEC remediation is complete; however, future use is expected to include recreation. Due to the current and future land use at Camp Bonneville, the human receptors considered in the CSM are onsite workers with the potential to work at the AOPI, future onsite recreators, and offsite residents living in the vicinity of the former Camp Bonneville.

The soil exposure pathways are incomplete because Target PFAS were not detected at concentrations greater than the LODs in soil at the Wash Racks 1 and 2 AOPI.

Groundwater is not currently used for drinking water, and deed restrictions unrelated to PFAS limit groundwater use at the AOPI to non-potable uses only. However, Target PFAS were detected in groundwater at concentrations less than the SLs, making the onsite groundwater exposure pathway for onsite workers potentially complete for the duration of the restrictions. Potential future onsite recreators are not expected to contact groundwater due to the depth to groundwater and usage restrictions; therefore, the groundwater exposure pathways for onsite recreators are incomplete. Because drinking water wells are immediately downgradient from Camp Bonneville and Target PFAS were detected in onsite groundwater, the groundwater exposure pathway for offsite residents is potentially complete.

Target PFAS were detected at concentrations less than the SLs in both surface water and sediment at the AOPI, making the onsite surface water and sediment exposure pathways potentially complete. Because the surface water drainage network is discharged offsite, the offsite surface water and sediment exposure pathways are potentially complete.

Figure 6-7 presents the CSM for the Wash Racks 1 and 2 AOPI.

6.4.4 Recommendation

Target PFAS were not detected at concentrations greater than the SLs; therefore, further investigation is not recommended.

Table 6-3. Target PFAS Results and Screening for the Wash Racks 1 and 2 AOPI

Location ID	Sample ID	Sample Type	Depth (ft)	Sample Date	HFPO-DA or GenX	PFBA	PFBS	PFHxA	PFHxS	PFNA	PFOA	PFOS
Soil				**Units**	**µg/kg**	**µg/kg**	**µg/kg**	**µg/kg**	**µg/kg**	**µg/kg**	**µg/kg**	**µg/kg**
				Screening Levels	**23**	**7800**	**1900**	**3200**	**130**	**19**	**19**	**13**
CBV-WR12-01	CBWR1201-SB02	BORE	6.00-8.00	06/09/2023	2.2 U	0.55 U	0.55 U	0.55 U	0.55 U	0.55 U	0.55 U	0.55 U
	CBWR1201-SB03	BORE	13.00-15.00	06/09/2023	2.4 U	0.60 U	0.60 U	0.60 U	0.60 U	0.60 U	0.60 U	0.60 U
	CBWR1201-SB04	BORE	23.00-25.00	06/09/2023	2.3 U	0.60 U	0.60 U	0.60 U	0.60 U	0.60 U	0.60 U	0.60 U
	CBWR1201-SB04FD	BORE	23.00-25.00 (D)	06/09/2023	2.3 U	0.60 U	0.60 U	0.60 U	0.60 U	0.60 U	0.60 U	0.60 U
CBV-WR12-03	CBWR1203-SS01	SURF	0.00-1.00	06/07/2023	2.4 U	0.60 U	0.60 U	0.60 U	0.60 U	0.60 U	0.60 U	0.60 U
	CBWR1203-SB02	BORE	6.00-8.00	06/07/2023	2.6 U	0.65 U	0.65 U	0.65 U	0.65 U	0.65 U	0.65 U	0.65 U
	CBWR1203-SB03	BORE	13.00-15.00	06/07/2023	2.7 U	0.65 U	0.65 U	0.65 U	0.65 U	0.65 U	0.65 U	0.65 U
CBV-WR12-04	CBWR1204-SB02	BORE	4.50-6.50	06/09/2023	2.5 U	0.60 U	0.60 U	0.60 U	0.60 U	0.60 U	0.60 U	0.60 U
	CBWR1204-SB03	BORE	9.00-11.00	06/09/2023	2.7 U	0.65 U	0.65 U	0.65 U	0.65 U	0.65 U	0.65 U	0.65 U
Groundwater				**Units**	**ng/L**	**ng/L**	**ng/L**	**ng/L**	**ng/L**	**ng/L**	**ng/L**	**ng/L**
				Screening Levels	**6**	**1800**	**600**	**990**	**39**	**5.9**	**6**	**4**
CBV-WR12-04	CBWR1204-GW01	PNCH	13.00-13.00	06/10/2023	3.8 U	**1.5 J**	1.9 U	**2.2 J**	1.9 U	1.9 U	1.9 U	**1.2 J**
	CBWR1204-GW01FD	PNCH	13.00-13.00	06/10/2023 (D)	4.3 U	**1.5 J**	2.1 U	**3.7 J**	2.1 U	2.1 U	2.1 U	2.1 U
Surface Water				**Units**	**ng/L**	**ng/L**	**ng/L**	**ng/L**	**ng/L**	**ng/L**	**ng/L**	**ng/L**
				Screening Levels	**6**	**1800**	**600**	**990**	**39**	**5.9**	**6**	**4**
CBV-WR12-05	CBWR1205-SW01	SWTR	0.00-0.00	06/07/2023	4.1 U	2.0 U	2.0 U	2.0 U	**1.1 J**	2.0 U	2.0 U	**2.5 J**
Sediment				**Units**	**µg/kg**	**µg/kg**	**µg/kg**	**µg/kg**	**µg/kg**	**µg/kg**	**µg/kg**	**µg/kg**
				Screening Levels	**23**	**7800**	**1900**	**3200**	**130**	**19**	**19**	**13**
CBV-WR12-05	CBWR1205-SD01	SEDI	0.00-0.00	06/07/2023	3.1 U	0.75 U	0.75 U	0.75 U	0.75 U	0.75 U	0.75 U	**0.38 J**

The SLs are the Residential Scenario SLs calculated using the USEPA RSL calculator provided in the August 2023 OSD Memorandum for Tap Water using an HQ = 0.1.
Bolded values denote detected concentrations.
(D) = Field duplicate sample.
J = The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.
U = The analyte was analyzed for, but not detected above the reported sample quantitation limit.

7. CONCLUSIONS AND RECOMMENDATIONS

An SI is conducted when the PFAS PA determines an AOPI exists based on probable use, storage, and/or disposal of PFAS-containing materials. The SI includes multimedia sampling at AOPIs to determine whether 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 (40 CFR §300.420(5)). This SI Report used the findings from the PFAS PA in conjunction with soil, groundwater, surface water, and sediment sampling data for each AOPI to determine whether Target PFAS have been released to the environment and whether a release has affected or may affect specific human health targets.

Before the SI sampling, a preliminary CSM was developed in the PFAS PA for each AOPI based on an evaluation of existing records, personnel interviews, and site reconnaissance. The preliminary CSMs identified potential human receptors and exposure pathways for groundwater and surface water that is known to be used, or could realistically be used in the future, as a source of drinking water and identified potential soil and sediment exposure pathways. All AOPIs were sampled during the SI at Camp Bonneville to further evaluate PFAS-related releases and identify the presence or absence of Target PFAS.

PFOS was detected at concentrations less than the SLs in one surface soil sample collected at both the Building 1864 Fire Station and Building 4483 Fire Station AOPIs. PFBA was also detected at a concentration less than the SL in one surface soil sample collected at the Building 1864 Fire Station AOPI. Target PFAS were not detected at concentrations greater than the LODs in any other soil samples collected.

Target PFAS were detected in samples collected from both temporary groundwater wells at the Building 1864 Fire Station AOPI and the one groundwater well at the Wash Racks 1 and 2 AOPI. Detected concentrations of PFOA, PFBA, PFBS and PFHxA at the Building 1864 Fire Station AOPI and PFOS, PFBA, and PFHxA at the Wash Racks 1 and 2 AOPI did not exceed their respective SLs. The remaining Target PFAS were not detected at concentrations greater than the LOD in any samples.

PFOS was detected (estimated concentration) in the sediment sample at the Building 4483 Fire Station AOPI and at estimated concentrations in the colocated surface water and sediment samples at the Wash Racks 1 and 2 AOPI.

The CSMs were updated for each AOPI where Target PFAS were detected at concentrations greater than the LODs. The updated CSMs detail site geological conditions; determine primary and secondary release mechanisms; identify potential human receptors; and detail complete, potentially complete, and incomplete exposure pathways for current and reasonably anticipated future exposure scenarios.

Potentially complete soil exposure pathways are present at the Building 1864 Fire Station AOPI and the Building 4483 Fire Station AOPI because Target PFAS were detected at concentrations less than the SLs.

The onsite groundwater exposure pathways are potentially complete at the Building 1864 Fire Station AOPI and the Wash Racks 1 and 2 AOPI, where non-PFAS related deed restrictions limit future groundwater use to non-potable water only, because Target PFAS were detected at concentrations less than the SLs. Groundwater samples were not collected at the Building 4483 Fire Station AOPI due to insufficient water and slow recharge; however, groundwater exposure pathways are considered potentially complete due to the AOPI's proximity to the Wash Racks 1 and 2 AOPI where Target PFAS were detected at concentrations less than the SLs. The offsite groundwater exposure pathways are potentially complete for all three AOPIs due to the potential for migration to offsite groundwater wells immediately downgradient from Camp Bonneville.

The onsite and offsite exposure pathways for surface water and sediment are considered potentially complete at the Building 4483 Fire Station and Wash Racks 1 and 2 AOPIs, where Target PFAS were detected at concentrations less than the SLs and the network eventually discharges offsite (i.e., off-post).

A remobilization to the site on June 16, 2023, to attempt collection of additional groundwater data resulted in attainment of a groundwater sample downgradient from the Building 4483 Fire Station and Wash Racks 1 and 2 AOPIs (i.e., near Lacamas Creek). Results for this sample were X-qualified due to matrix interference and were thus rejected (Appendix G).

SI sampling results were compared to the OSD risk-based SLs presented in Section 5 to determine if further investigation is warranted at each AOPI, as follows:

- If the maximum detected concentration for a given analyte in soil or groundwater exceeds the SL, it is concluded that further investigation is warranted.
- If the maximum detected concentration is less than the SL, it is concluded that further investigation is not warranted.

Table 7-1 summarizes the conclusions and recommendations for each AOPI. All three AOPIs are not recommended for further investigation or evaluation.

Table 7-1. Summary of PFAS Detected and Recommendations

AOPI	Detection of HFPO-DA, PFBA, PFBS, PFHxA, PFHxS, PFNA, PFOS, and/or PFOA				Recommendation and Rationale
	Groundwater	Soil	Surface Water	Sediment	
Building 1864 Fire Station	Detected	Detected	Detected	Detected	SLs were not exceeded; further investigation not recommended
Building 4483 Fire Station	–	Detected	–	Detected	SLs were not exceeded; further investigation not recommended
Wash Racks 1 and 2	Detected	Detected	Detected	Detected	SLs were not exceeded; further investigation not recommended

– Not Collected

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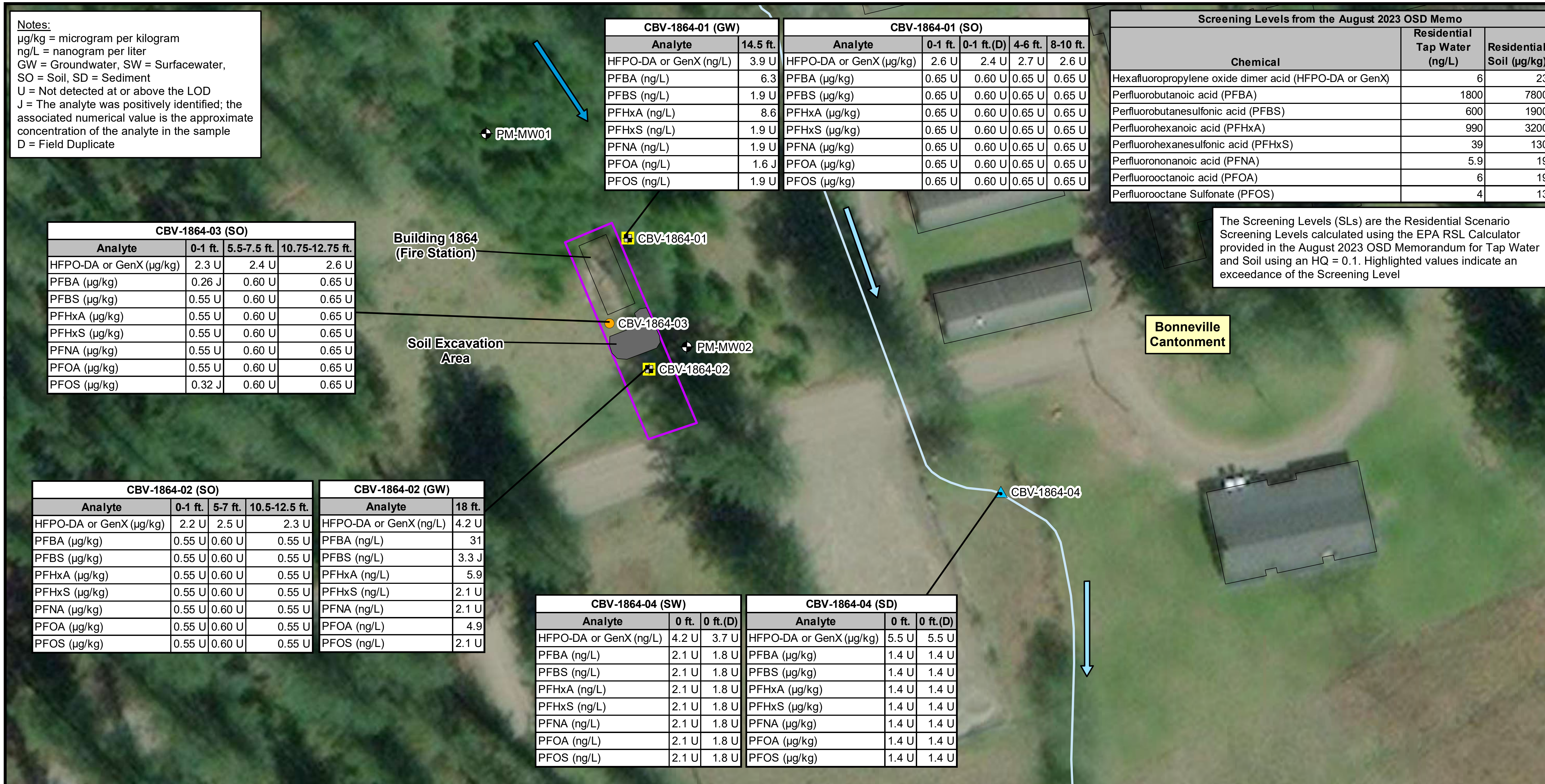
FIGURES



Notes:
µg/kg = microgram per kilogram
ng/L = nanogram per liter
GW = Groundwater, SW = Surfacewater,
SO = Soil, SD = Sediment
U = Not detected at or above the LOD
J = The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample
D = Field Duplicate

CBV-1864-01 (GW)

Analyte	14.5 ft.
HFPO-DA or GenX (ng/L)	3.9 U
PFBA (ng/L)	6.3
PFBS (ng/L)	1.9 U
PFHxA (ng/L)	8.6
PFHxS (ng/L)	1.9 U
PFNA (ng/L)	1.9 U
PFOA (ng/L)	1.6 J
PFOS (ng/L)	1.9 U

CBV-1864-01 (SO)

Analyte	0-1 ft.	0-1 ft.(D)	4-6 ft.	8-10 ft.
HFPO-DA or GenX (µg/kg)	2.6 U	2.4 U	2.7 U	2.6 U
PFBA (µg/kg)	0.65 U	0.60 U	0.65 U	0.65 U
PFBS (µg/kg)	0.65 U	0.60 U	0.65 U	0.65 U
PFHxA (µg/kg)	0.65 U	0.60 U	0.65 U	0.65 U
PFHxS (µg/kg)	0.65 U	0.60 U	0.65 U	0.65 U
PFNA (µg/kg)	0.65 U	0.60 U	0.65 U	0.65 U
PFOA (µg/kg)	0.65 U	0.60 U	0.65 U	0.65 U
PFOS (µg/kg)	0.65 U	0.60 U	0.65 U	0.65 U

Screening Levels from the August 2023 OSD Memo

Chemical	Residential Tap Water (ng/L)	Residential Soil (µg/kg)
Hexafluoropropylene oxide dimer acid (HFPO-DA or GenX)	6	23
Perfluorobutanoic acid (PFBA)	1800	7800
Perfluorobutanesulfonic acid (PFBS)	600	1900
Perfluorohexanoic acid (PFHxA)	990	3200
Perfluorohexanesulfonic acid (PFHxS)	39	130
Perfluorononanoic acid (PFNA)	5.9	19
Perfluorooctanoic acid (PFOA)	6	19
Perfluorooctane Sulfonate (PFOS)	4	13

The Screening Levels (SLs) are the Residential Scenario Screening Levels calculated using the EPA RSL Calculator provided in the August 2023 OSD Memorandum for Tap Water and Soil using an HQ = 0.1. Highlighted values indicate an exceedance of the Screening Level

CBV-1864-03 (SO)

Analyte	0-1 ft.	5.5-7.5 ft.	10.75-12.75 ft.
HFPO-DA or GenX (µg/kg)	2.3 U	2.4 U	2.6 U
PFBA (µg/kg)	0.26 J	0.60 U	0.65 U
PFBS (µg/kg)	0.55 U	0.60 U	0.65 U
PFHxA (µg/kg)	0.55 U	0.60 U	0.65 U
PFHxS (µg/kg)	0.55 U	0.60 U	0.65 U
PFNA (µg/kg)	0.55 U	0.60 U	0.65 U
PFOA (µg/kg)	0.55 U	0.60 U	0.65 U
PFOS (µg/kg)	0.32 J	0.60 U	0.65 U

CBV-1864-02 (SO)

Analyte	0-1 ft.	5-7 ft.	10.5-12.5 ft.
HFPO-DA or GenX (µg/kg)	2.2 U	2.5 U	2.3 U
PFBA (µg/kg)	0.55 U	0.60 U	0.55 U
PFBS (µg/kg)	0.55 U	0.60 U	0.55 U
PFHxA (µg/kg)	0.55 U	0.60 U	0.55 U
PFHxS (µg/kg)	0.55 U	0.60 U	0.55 U
PFNA (µg/kg)	0.55 U	0.60 U	0.55 U
PFOA (µg/kg)	0.55 U	0.60 U	0.55 U
PFOS (µg/kg)	0.55 U	0.60 U	0.55 U

CBV-1864-02 (GW)

Analyte	18 ft.
HFPO-DA or GenX (ng/L)	4.2 U
PFBA (ng/L)	31
PFBS (ng/L)	3.3 J
PFHxA (ng/L)	5.9
PFHxS (ng/L)	2.1 U
PFNA (ng/L)	2.1 U
PFOA (ng/L)	4.9
PFOS (ng/L)	2.1 U

CBV-1864-04 (SW)

Analyte	0 ft.	0 ft.(D)
HFPO-DA or GenX (ng/L)	4.2 U	3.7 U
PFBA (ng/L)	2.1 U	1.8 U
PFBS (ng/L)	2.1 U	1.8 U
PFHxA (ng/L)	2.1 U	1.8 U
PFHxS (ng/L)	2.1 U	1.8 U
PFNA (ng/L)	2.1 U	1.8 U
PFOA (ng/L)	2.1 U	1.8 U
PFOS (ng/L)	2.1 U	1.8 U

CBV-1864-04 (SD)

Analyte	0 ft.	0 ft.(D)
HFPO-DA or GenX (µg/kg)	5.5 U	5.5 U
PFBA (µg/kg)	1.4 U	1.4 U
PFBS (µg/kg)	1.4 U	1.4 U
PFHxA (µg/kg)	1.4 U	1.4 U
PFHxS (µg/kg)	1.4 U	1.4 U
PFNA (µg/kg)	1.4 U	1.4 U
PFOA (µg/kg)	1.4 U	1.4 U
PFOS (µg/kg)	1.4 U	1.4 U

LEGEND:
- BRAC Parcel Boundary
- Area of Potential Interest (AOPI)
- Current Building
- Soil Excavation Area
- Groundwater Flow Direction
- Surface Water Flow Direction
- Unnamed Creek
- Soil Boring (1)
- DPT Groundwater Sample/Soil Boring (2)
- Existing Monitoring Well
- Surface Water/Sediment (1)

NOTES:
1. Background Source: ESRI World Imagery (Vivid/Maxar, 4/2020).
2. Groundwater flow directions are from the 1999 Multi-Sites Investigation, Shannon and Wilson, Inc

Feet: 0 25 50 100

N

WA STATE PLANE SOUTH (NAD83)

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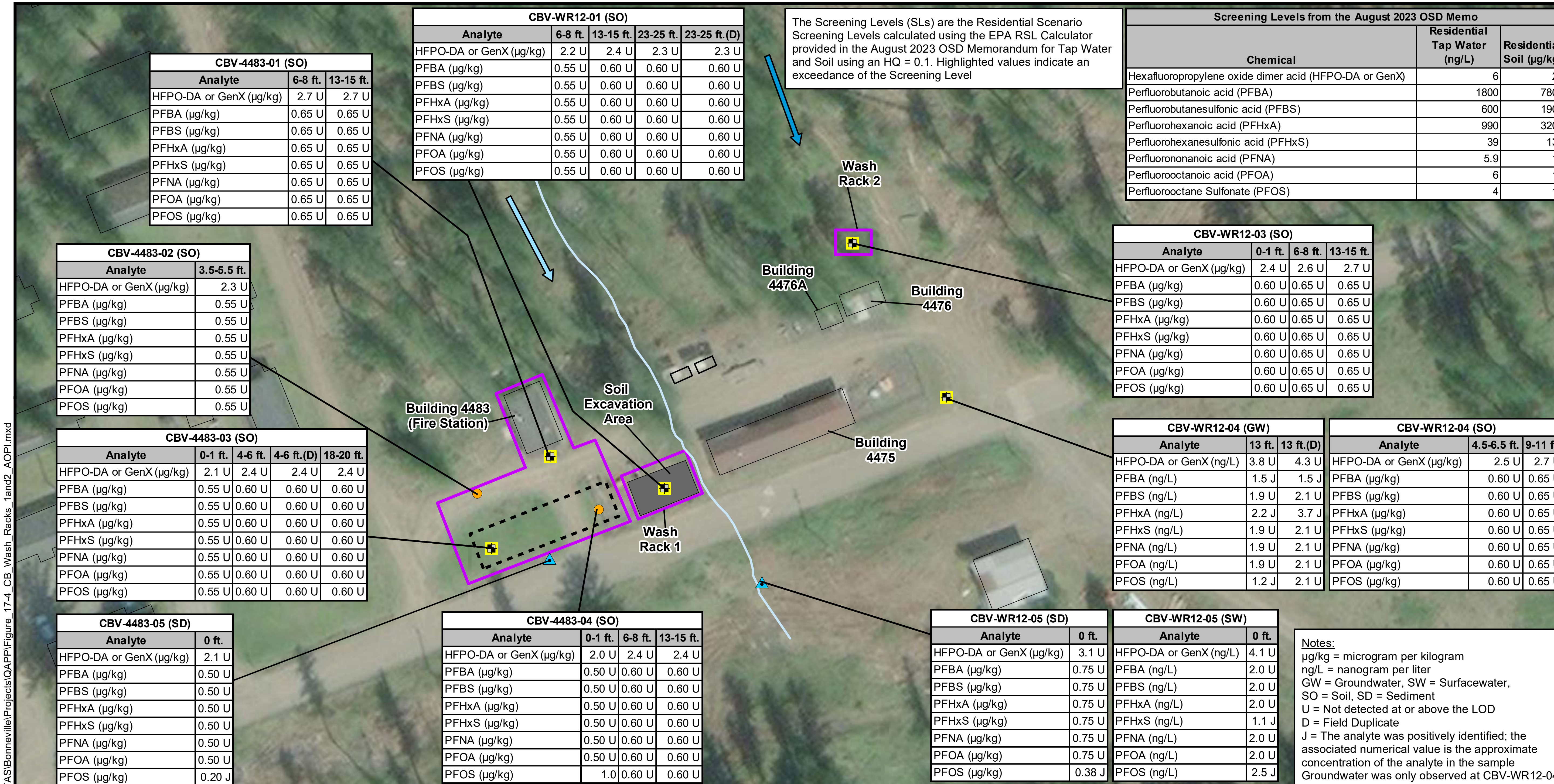
BUILDING 1864 FIRE STATION AOPI SAMPLE RESULTS

CAMP BONNEVILLE
VANCOUVER, WASHINGTON

FIGURE: ES-1 DATE: 9/27/2023

PROJECT: \GIS_DATA\BRAC_PFAS\Bonneville\Projects\QAPP\Figure_17-2_CB_Building_1864_Fire_Station_AOPI.mxd



CBV-WR12-01 (SO)				
Analyte	6-8 ft.	13-15 ft.	23-25 ft.	23-25 ft.(D)
HFPO-DA or GenX (µg/kg)	2.2 U	2.4 U	2.3 U	2.3 U
PFBA (µg/kg)	0.55 U	0.60 U	0.60 U	0.60 U
PFBS (µg/kg)	0.55 U	0.60 U	0.60 U	0.60 U
PFHxA (µg/kg)	0.55 U	0.60 U	0.60 U	0.60 U
PFHxS (µg/kg)	0.55 U	0.60 U	0.60 U	0.60 U
PFNA (µg/kg)	0.55 U	0.60 U	0.60 U	0.60 U
PFOA (µg/kg)	0.55 U	0.60 U	0.60 U	0.60 U
PFOS (µg/kg)	0.55 U	0.60 U	0.60 U	0.60 U

The Screening Levels (SLs) are the Residential Scenario Screening Levels calculated using the EPA RSL Calculator provided in the August 2023 OSD Memorandum for Tap Water and Soil using an HQ = 0.1. Highlighted values indicate an exceedance of the Screening Level

Screening Levels from the August 2023 OSD Memo		
Chemical	Residential Tap Water (ng/L)	Residential Soil (µg/kg)
Hexafluoropropylene oxide dimer acid (HFPO-DA or GenX)	6	23
Perfluorobutanoic acid (PFBA)	1800	7800
Perfluorobutanesulfonic acid (PFBS)	600	1900
Perfluorohexanoic acid (PFHxA)	990	3200
Perfluorohexanesulfonic acid (PFHxS)	39	130
Perfluorononanoic acid (PFNA)	5.9	19
Perfluorooctanoic acid (PFOA)	6	19
Perfluorooctane Sulfonate (PFOS)	4	13

CBV-4483-01 (SO)		
Analyte	6-8 ft.	13-15 ft.
HFPO-DA or GenX (µg/kg)	2.7 U	2.7 U
PFBA (µg/kg)	0.65 U	0.65 U
PFBS (µg/kg)	0.65 U	0.65 U
PFHxA (µg/kg)	0.65 U	0.65 U
PFHxS (µg/kg)	0.65 U	0.65 U
PFNA (µg/kg)	0.65 U	0.65 U
PFOA (µg/kg)	0.65 U	0.65 U
PFOS (µg/kg)	0.65 U	0.65 U

CBV-4483-02 (SO)	
Analyte	3.5-5.5 ft.
HFPO-DA or GenX (µg/kg)	2.3 U
PFBA (µg/kg)	0.55 U
PFBS (µg/kg)	0.55 U
PFHxA (µg/kg)	0.55 U
PFHxS (µg/kg)	0.55 U
PFNA (µg/kg)	0.55 U
PFOA (µg/kg)	0.55 U
PFOS (µg/kg)	0.55 U

CBV-WR12-03 (SO)			
Analyte	0-1 ft.	6-8 ft.	13-15 ft.
HFPO-DA or GenX (µg/kg)	2.4 U	2.6 U	2.7 U
PFBA (µg/kg)	0.60 U	0.65 U	0.65 U
PFBS (µg/kg)	0.60 U	0.65 U	0.65 U
PFHxA (µg/kg)	0.60 U	0.65 U	0.65 U
PFHxS (µg/kg)	0.60 U	0.65 U	0.65 U
PFNA (µg/kg)	0.60 U	0.65 U	0.65 U
PFOA (µg/kg)	0.60 U	0.65 U	0.65 U
PFOS (µg/kg)	0.60 U	0.65 U	0.65 U

CBV-4483-03 (SO)				
Analyte	0-1 ft.	4-6 ft.	4-6 ft.(D)	18-20 ft.
HFPO-DA or GenX (µg/kg)	2.1 U	2.4 U	2.4 U	2.4 U
PFBA (µg/kg)	0.55 U	0.60 U	0.60 U	0.60 U
PFBS (µg/kg)	0.55 U	0.60 U	0.60 U	0.60 U
PFHxA (µg/kg)	0.55 U	0.60 U	0.60 U	0.60 U
PFHxS (µg/kg)	0.55 U	0.60 U	0.60 U	0.60 U
PFNA (µg/kg)	0.55 U	0.60 U	0.60 U	0.60 U
PFOA (µg/kg)	0.55 U	0.60 U	0.60 U	0.60 U
PFOS (µg/kg)	0.55 U	0.60 U	0.60 U	0.60 U

CBV-WR12-04 (GW)		
Analyte	13 ft.	13 ft.(D)
HFPO-DA or GenX (ng/L)	3.8 U	4.3 U
PFBA (ng/L)	1.5 J	1.5 J
PFBS (ng/L)	1.9 U	2.1 U
PFHxA (ng/L)	2.2 J	3.7 J
PFHxS (ng/L)	1.9 U	2.1 U
PFNA (ng/L)	1.9 U	2.1 U
PFOA (ng/L)	1.9 U	2.1 U
PFOS (ng/L)	1.2 J	2.1 U

CBV-WR12-04 (SO)		
Analyte	4.5-6.5 ft.	9-11 ft.
HFPO-DA or GenX (µg/kg)	2.5 U	2.7 U
PFBA (µg/kg)	0.60 U	0.65 U
PFBS (µg/kg)	0.60 U	0.65 U
PFHxA (µg/kg)	0.60 U	0.65 U
PFHxS (µg/kg)	0.60 U	0.65 U
PFNA (µg/kg)	0.60 U	0.65 U
PFOA (µg/kg)	0.60 U	0.65 U
PFOS (µg/kg)	0.60 U	0.65 U

CBV-4483-05 (SD)	
Analyte	0 ft.
HFPO-DA or GenX (µg/kg)	2.1 U
PFBA (µg/kg)	0.50 U
PFBS (µg/kg)	0.50 U
PFHxA (µg/kg)	0.50 U
PFHxS (µg/kg)	0.50 U
PFNA (µg/kg)	0.50 U
PFOA (µg/kg)	0.50 U
PFOS (µg/kg)	0.20 J

CBV-4483-04 (SO)			
Analyte	0-1 ft.	6-8 ft.	13-15 ft.
HFPO-DA or GenX (µg/kg)	2.0 U	2.4 U	2.4 U
PFBA (µg/kg)	0.50 U	0.60 U	0.60 U
PFBS (µg/kg)	0.50 U	0.60 U	0.60 U
PFHxA (µg/kg)	0.50 U	0.60 U	0.60 U
PFHxS (µg/kg)	0.50 U	0.60 U	0.60 U
PFNA (µg/kg)	0.50 U	0.60 U	0.60 U
PFOA (µg/kg)	0.50 U	0.60 U	0.60 U
PFOS (µg/kg)	1.0	0.60 U	0.60 U

CBV-WR12-05 (SD)	
Analyte	0 ft.
HFPO-DA or GenX (µg/kg)	3.1 U
PFBA (µg/kg)	0.75 U
PFBS (µg/kg)	0.75 U
PFHxA (µg/kg)	0.75 U
PFHxS (µg/kg)	0.75 U
PFNA (µg/kg)	0.75 U
PFOA (µg/kg)	0.75 U
PFOS (µg/kg)	0.38 J

CBV-WR12-05 (SW)	
Analyte	0 ft.
HFPO-DA or GenX (ng/L)	4.1 U
PFBA (ng/L)	2.0 U
PFBS (ng/L)	2.0 U
PFHxA (ng/L)	2.0 U
PFHxS (ng/L)	1.1 J
PFNA (ng/L)	2.0 U
PFOA (ng/L)	2.0 U
PFOS (ng/L)	2.5 J

Notes:
µg/kg = microgram per kilogram
ng/L = nanogram per liter
GW = Groundwater, SW = Surfacewater,
SO = Soil, SD = Sediment
U = Not detected at or above the LOD
D = Field Duplicate
J = The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample
Groundwater was only observed at CBV-WR12-04

PROJECT: \GIS_DATA\BRAC_PFAS\Bonneville\Projects\QAPP\Figure_17-4_CB_Wash_Racks_1and2_AOPI.mxd

LEGEND:
- BRAC Parcel Boundary
- Area of Potential Interest (AOPI)
- Current Building
- Former Building
- Wash Rack-1 Soil Excavaton
- Unnamed Creek
- Soil Boring (2)
- DPT Groundwater Sample/Soil Boring (5)
- Surface Water/Sediment (2)
- Groundwater Flow Direction
- Surface Water Flow Direction

NOTES:
1. Background Source: ESRI World Imagery (Vivid/Maxar, 4/2020).
2. Groundwater flow directions are from the 1999 Multi-Sites Investigation, Shannon and Wilson, Inc.

0 50 100 200 Feet

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WA STATE PLANE SOUTH (NAD83)

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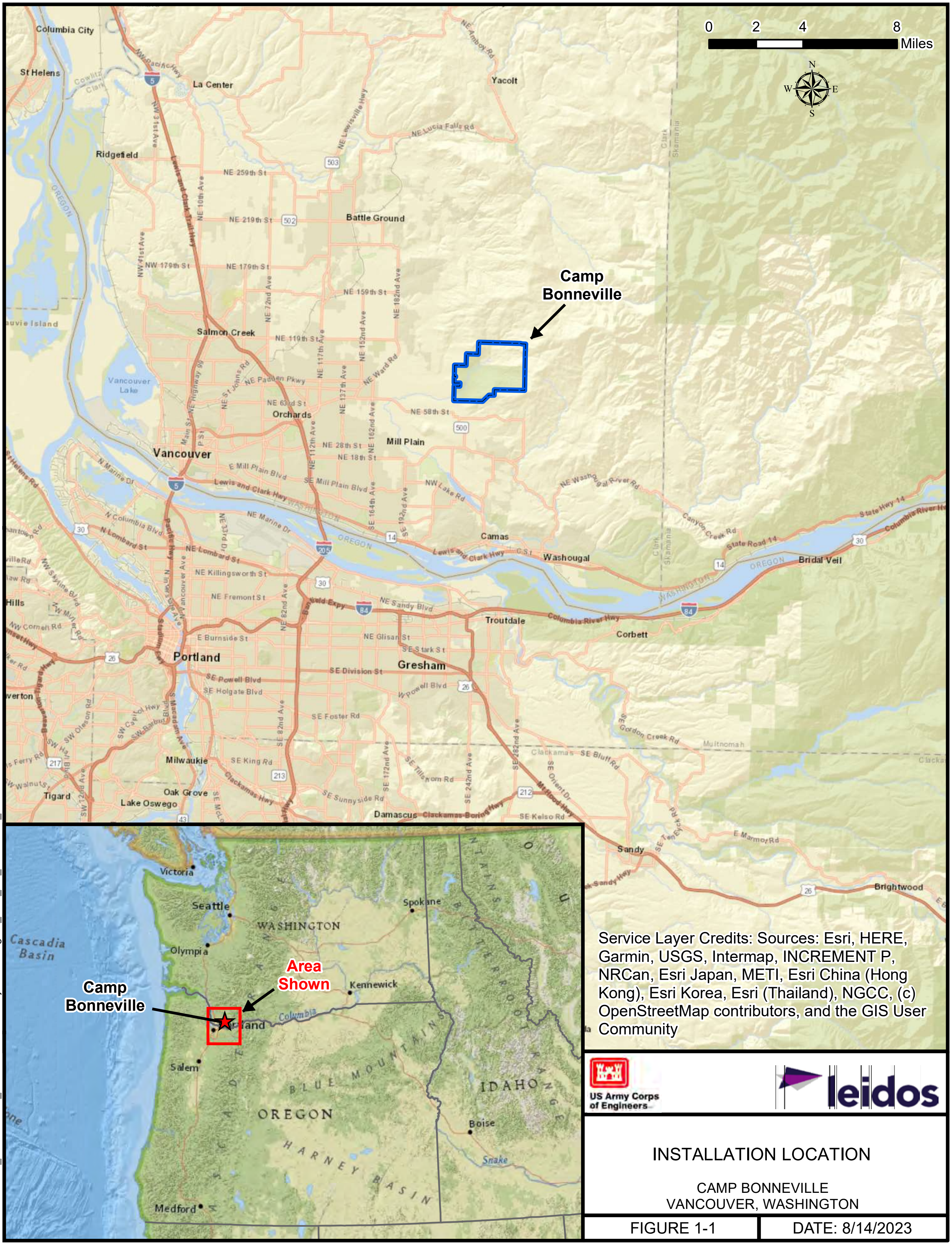
BUILDING 4483 FIRE STATION AOPI AND WASH RACKS 1 AND 2 AOPI SAMPLE RESULTS
CAMP BONNEVILLE
VANCOUVER, WASHINGTON

FIGURE: ES-2 | DATE: 9/27/2023



US Army Corps of Engineers

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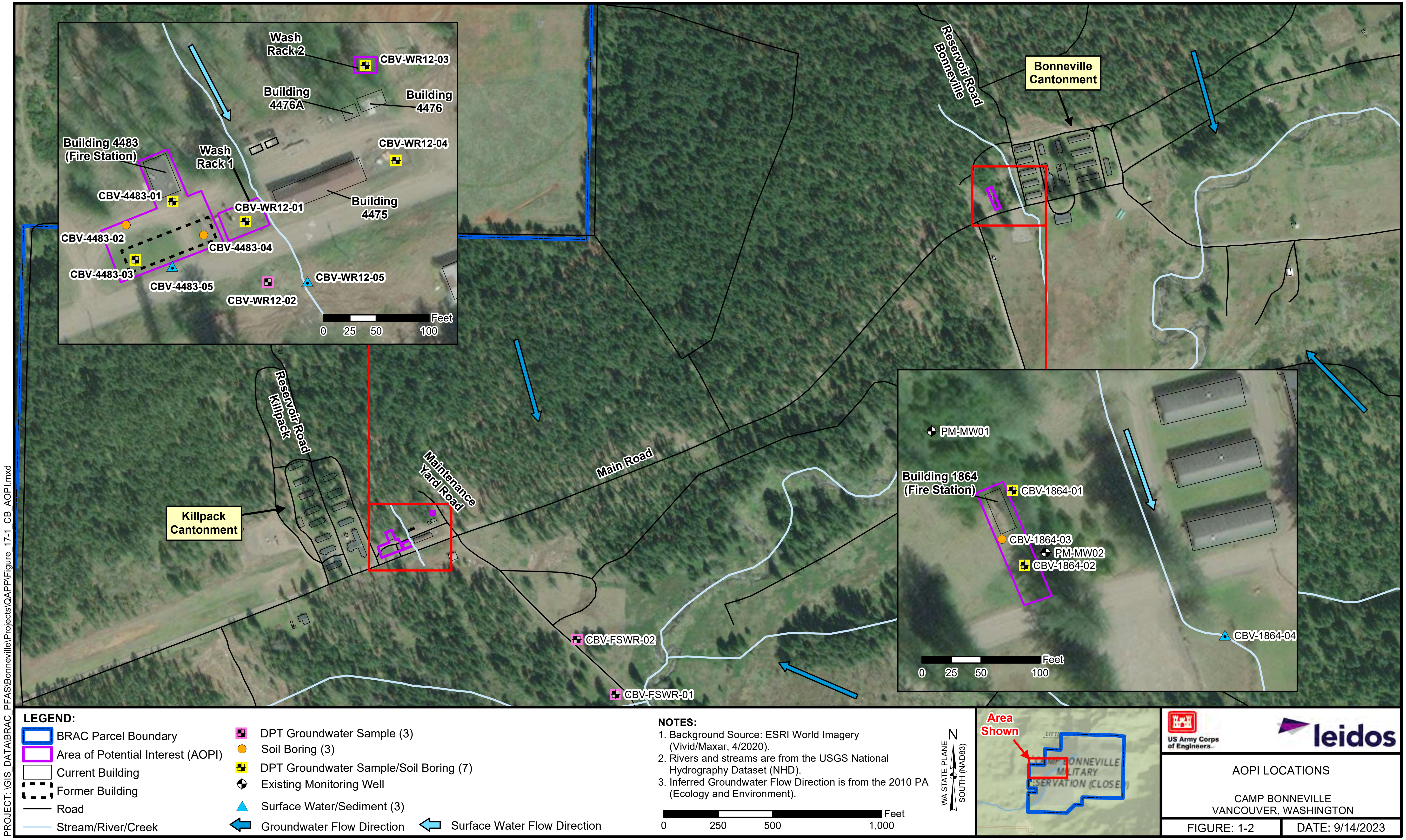
INSTALLATION LOCATION

CAMP BONNEVILLE
VANCOUVER, WASHINGTON

FIGURE 1-1 DATE: 8/14/2023

PROJECT: \GIS_DATA\BRAC_PFAS\Bonneville\Projects\PA\Figure_10-1_CB_Installation_Location.mxd



Wash Rack 2
CBV-WR12-03
Building 4476A
Building 4476
CBV-WR12-04
Building 4483 (Fire Station)
Wash Rack 1
CBV-4483-01
CBV-WR12-01
Building 4475
CBV-4483-02
CBV-4483-04
CBV-4483-03
CBV-4483-05
CBV-WR12-05
CBV-WR12-02
Feet
0 25 50 100
Bonneville Reservoir Road
Bonneville Cantonment
Killpack Reservoir Road
Maintenance Yard Road
Main Road
Killpack Cantonment
PM-MW01
Building 1864 (Fire Station)
CBV-1864-01
CBV-1864-03
PM-MW02
CBV-1864-02
CBV-1864-04
CBV-FSWR-02
CBV-FSWR-01
Feet
0 25 50 100
LEGEND:
BRAC Parcel Boundary
Area of Potential Interest (AOPI)
Current Building
Former Building
Road
Stream/River/Creek
DPT Groundwater Sample (3)
Soil Boring (3)
DPT Groundwater Sample/Soil Boring (7)
Existing Monitoring Well
Surface Water/Sediment (3)
Groundwater Flow Direction
Surface Water Flow Direction
NOTES:
1. Background Source: ESRI World Imagery (Vivid/Maxar, 4/2020).
2. Rivers and streams are from the USGS National Hydrography Dataset (NHD).
3. Inferred Groundwater Flow Direction is from the 2010 PA (Ecology and Environment).
Feet
0 250 500 1,000
N
WA STATE PLANE SOUTH (NAD83)
Area Shown
US Army Corps of Engineers
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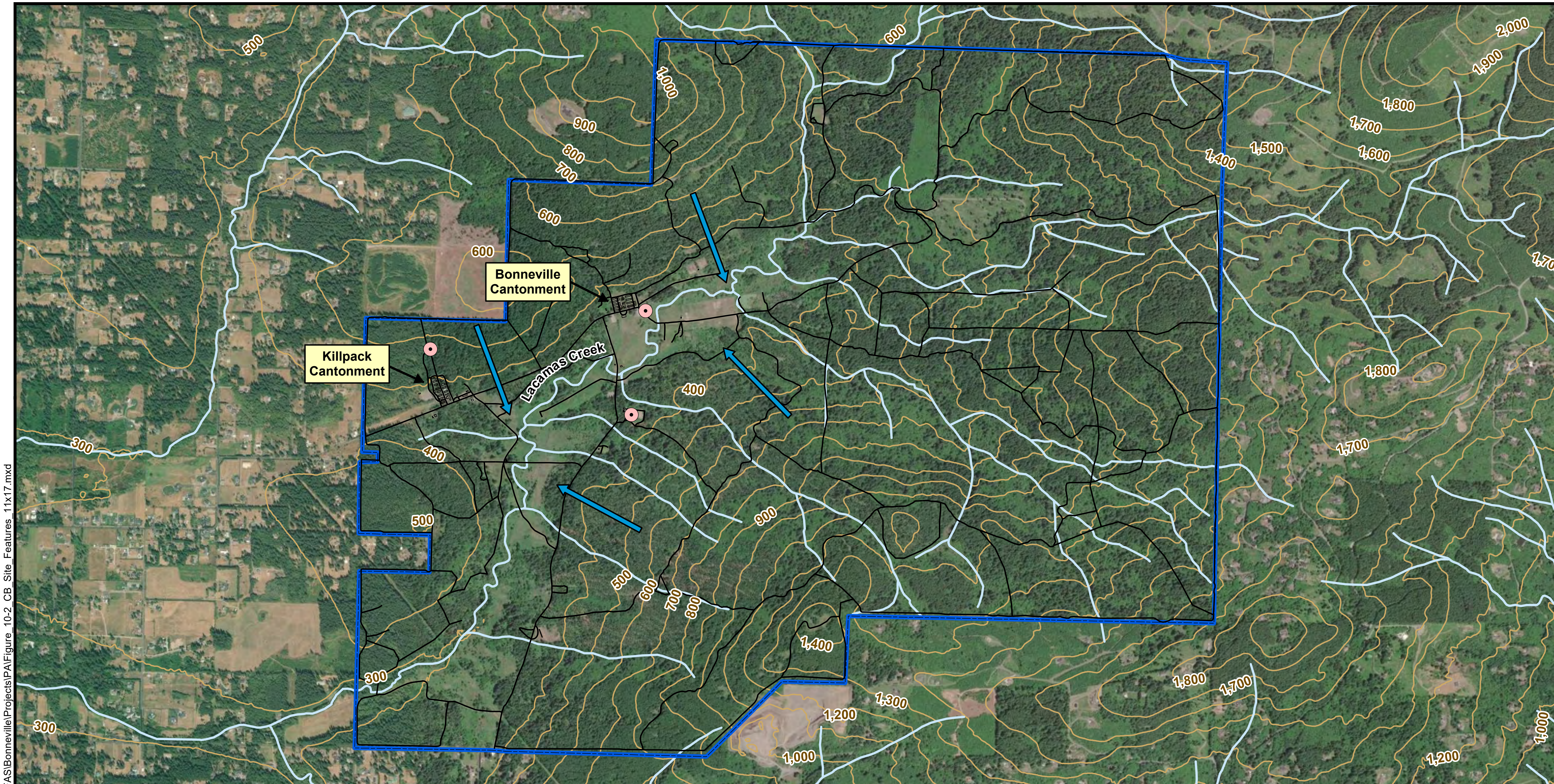
AOPI LOCATIONS
CAMP BONNEVILLE
VANCOUVER, WASHINGTON
FIGURE: 1-2
DATE: 9/14/2023
PROJECT: \GIS_DATA\BRAC_PFAS\Bonneville\Projects\QAPP\Figure_17-1_CB_AOPI.mxd



LEGEND:

- BRAC Parcel Boundary
- Creek/Stream
- Elevation Contour (100 ft)
- Road
- Building
- Non-Potable Well
- Groundwater Flow Direction

NOTES:

1. Background Source: ESRI World Imagery (Vivid/Maxar, 4/2020).
2. Data Sources: USGS National Elevation Dataset (NED), USGS National Hydrography Dataset (NHD).
3. Inferred Groundwater Flow Direction is from the 2010 PA (Ecology and Environment).

0 1,000 2,000 4,000 Feet

N

WA STATE PLANE SOUTH (NAD83)

US Army Corps of Engineers

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SITE FEATURES

CAMP BONNEVILLE
VANCOUVER, WASHINGTON

FIGURE: 2-1 | DATE: 8/24/2023

PROJECT: \GIS_DATA\BRAC_PFAS\Bonneville\Projects\PA\Figure_10-2_CB_Site_Features_11x17.mxd

LEGEND:

- BRAC Parcel Boundary
- Area of Potential Interest (AOPI)
- Current Building
- Soil Excavation Area
- Groundwater Flow Direction
- Surface Water Flow Direction
- Unnamed Creek
- Soil Boring (1)
- DPT Groundwater Sample/Soil Boring (2)
- Existing Monitoring Well
- Surface Water/Sediment (1)

NOTES:

1. Background Source: ESRI World Imagery (Vivid/Maxar, 4/2020).
2. Groundwater flow directions are from the 1999 Multi-Sites Investigation, Shannon and Wilson, Inc.

0 25 50 100 Feet

N

WA STATE PLANE SOUTH (NAD83)

US Army Corps of Engineers

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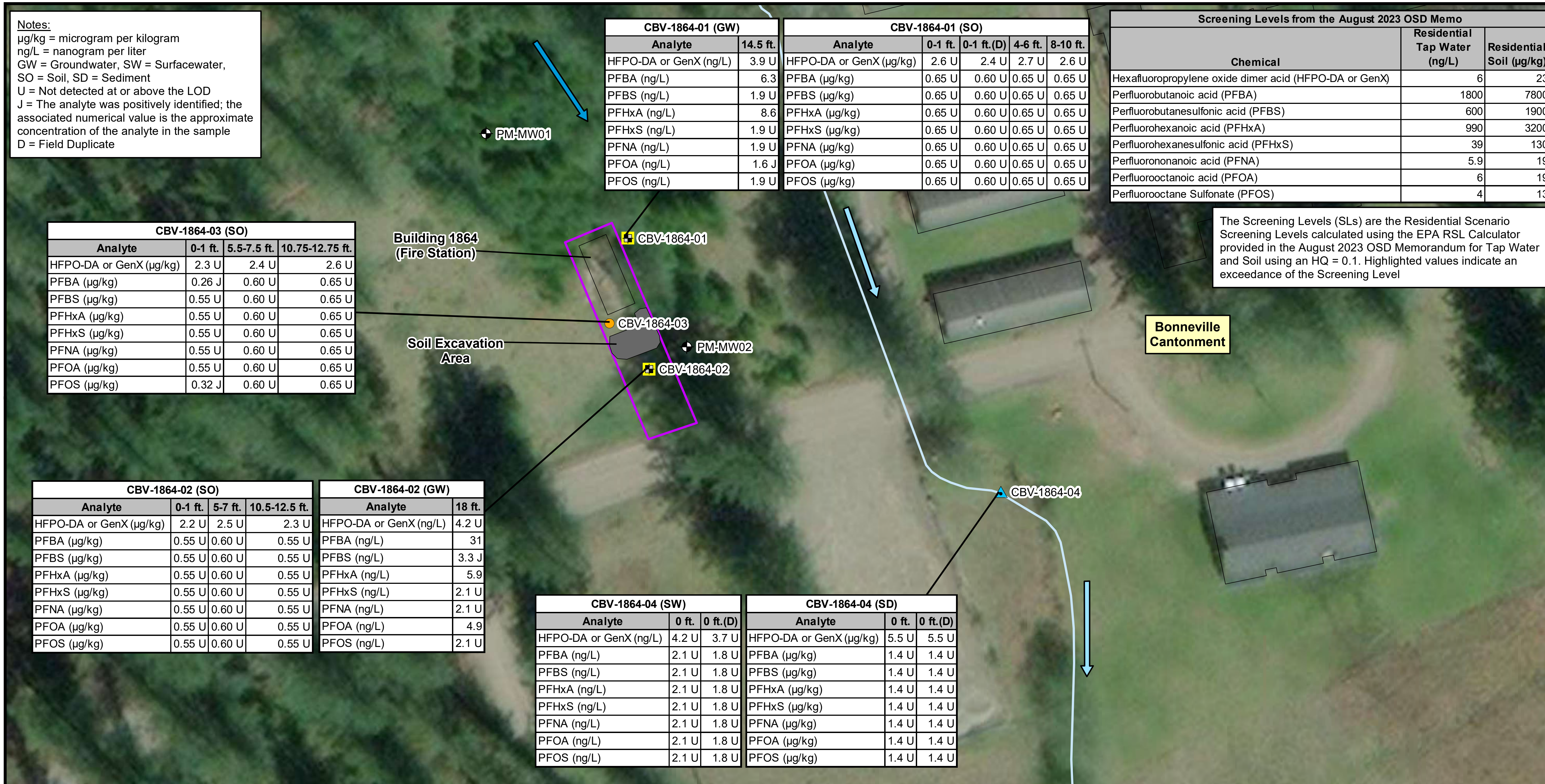
BUILDING 1864 FIRE STATION AOPI
SAMPLE LOCATIONS

CAMP BONNEVILLE
VANCOUVER, WASHINGTON

FIGURE: 6-1	DATE: 8/24/2023

PROJECT: \GIS_DATA\BRAC_PFAS\Bonneville\Projects\QAPP\Figure_17-2_CB_Building_1864_Fire_Station_AOPI.mxd



Notes:
µg/kg = microgram per kilogram
ng/L = nanogram per liter
GW = Groundwater, SW = Surfacewater,
SO = Soil, SD = Sediment
U = Not detected at or above the LOD
J = The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample
D = Field Duplicate

CBV-1864-01 (GW)	
Analyte	14.5 ft.
HFPO-DA or GenX (ng/L)	3.9 U
PFBA (ng/L)	6.3
PFBS (ng/L)	1.9 U
PFHxA (ng/L)	8.6
PFHxS (ng/L)	1.9 U
PFNA (ng/L)	1.9 U
PFOA (ng/L)	1.6 J
PFOS (ng/L)	1.9 U

CBV-1864-01 (SO)				
Analyte	0-1 ft.	0-1 ft.(D)	4-6 ft.	8-10 ft.
HFPO-DA or GenX (µg/kg)	2.6 U	2.4 U	2.7 U	2.6 U
PFBA (µg/kg)	0.65 U	0.60 U	0.65 U	0.65 U
PFBS (µg/kg)	0.65 U	0.60 U	0.65 U	0.65 U
PFHxA (µg/kg)	0.65 U	0.60 U	0.65 U	0.65 U
PFHxS (µg/kg)	0.65 U	0.60 U	0.65 U	0.65 U
PFNA (µg/kg)	0.65 U	0.60 U	0.65 U	0.65 U
PFOA (µg/kg)	0.65 U	0.60 U	0.65 U	0.65 U
PFOS (µg/kg)	0.65 U	0.60 U	0.65 U	0.65 U

Screening Levels from the August 2023 OSD Memo		
Chemical	Residential Tap Water (ng/L)	Residential Soil (µg/kg)
Hexafluoropropylene oxide dimer acid (HFPO-DA or GenX)	6	23
Perfluorobutanoic acid (PFBA)	1800	7800
Perfluorobutanesulfonic acid (PFBS)	600	1900
Perfluorohexanoic acid (PFHxA)	990	3200
Perfluorohexanesulfonic acid (PFHxS)	39	130
Perfluorononanoic acid (PFNA)	5.9	19
Perfluorooctanoic acid (PFOA)	6	19
Perfluorooctane Sulfonate (PFOS)	4	13

The Screening Levels (SLs) are the Residential Scenario Screening Levels calculated using the EPA RSL Calculator provided in the August 2023 OSD Memorandum for Tap Water and Soil using an HQ = 0.1. Highlighted values indicate an exceedance of the Screening Level

CBV-1864-03 (SO)			
Analyte	0-1 ft.	5.5-7.5 ft.	10.75-12.75 ft.
HFPO-DA or GenX (µg/kg)	2.3 U	2.4 U	2.6 U
PFBA (µg/kg)	0.26 J	0.60 U	0.65 U
PFBS (µg/kg)	0.55 U	0.60 U	0.65 U
PFHxA (µg/kg)	0.55 U	0.60 U	0.65 U
PFHxS (µg/kg)	0.55 U	0.60 U	0.65 U
PFNA (µg/kg)	0.55 U	0.60 U	0.65 U
PFOA (µg/kg)	0.55 U	0.60 U	0.65 U
PFOS (µg/kg)	0.32 J	0.60 U	0.65 U

CBV-1864-02 (SO)			
Analyte	0-1 ft.	5-7 ft.	10.5-12.5 ft.
HFPO-DA or GenX (µg/kg)	2.2 U	2.5 U	2.3 U
PFBA (µg/kg)	0.55 U	0.60 U	0.55 U
PFBS (µg/kg)	0.55 U	0.60 U	0.55 U
PFHxA (µg/kg)	0.55 U	0.60 U	0.55 U
PFHxS (µg/kg)	0.55 U	0.60 U	0.55 U
PFNA (µg/kg)	0.55 U	0.60 U	0.55 U
PFOA (µg/kg)	0.55 U	0.60 U	0.55 U
PFOS (µg/kg)	0.55 U	0.60 U	0.55 U

CBV-1864-02 (GW)	
Analyte	18 ft.
HFPO-DA or GenX (ng/L)	4.2 U
PFBA (ng/L)	31
PFBS (ng/L)	3.3 J
PFHxA (ng/L)	5.9
PFHxS (ng/L)	2.1 U
PFNA (ng/L)	2.1 U
PFOA (ng/L)	4.9
PFOS (ng/L)	2.1 U

CBV-1864-04 (SW)		
Analyte	0 ft.	0 ft.(D)
HFPO-DA or GenX (ng/L)	4.2 U	3.7 U
PFBA (ng/L)	2.1 U	1.8 U
PFBS (ng/L)	2.1 U	1.8 U
PFHxA (ng/L)	2.1 U	1.8 U
PFHxS (ng/L)	2.1 U	1.8 U
PFNA (ng/L)	2.1 U	1.8 U
PFOA (ng/L)	2.1 U	1.8 U
PFOS (ng/L)	2.1 U	1.8 U

CBV-1864-04 (SD)		
Analyte	0 ft.	0 ft.(D)
HFPO-DA or GenX (µg/kg)	5.5 U	5.5 U
PFBA (µg/kg)	1.4 U	1.4 U
PFBS (µg/kg)	1.4 U	1.4 U
PFHxA (µg/kg)	1.4 U	1.4 U
PFHxS (µg/kg)	1.4 U	1.4 U
PFNA (µg/kg)	1.4 U	1.4 U
PFOA (µg/kg)	1.4 U	1.4 U
PFOS (µg/kg)	1.4 U	1.4 U

LEGEND:
- BRAC Parcel Boundary
- Area of Potential Interest (AOPI)
- Current Building
- Soil Excavation Area
- Groundwater Flow Direction
- Surface Water Flow Direction
- Unnamed Creek
- Soil Boring (1)
- DPT Groundwater Sample/Soil Boring (2)
- Existing Monitoring Well
- Surface Water/Sediment (1)

NOTES:
1. Background Source: ESRI World Imagery (Vivid/Maxar, 4/2020).
2. Groundwater flow directions are from the 1999 Multi-Sites Investigation, Shannon and Wilson, Inc

Feet
0 25 50 100

N
WA STATE PLANE SOUTH (NAD83)

Area Shown

US Army Corps of Engineers

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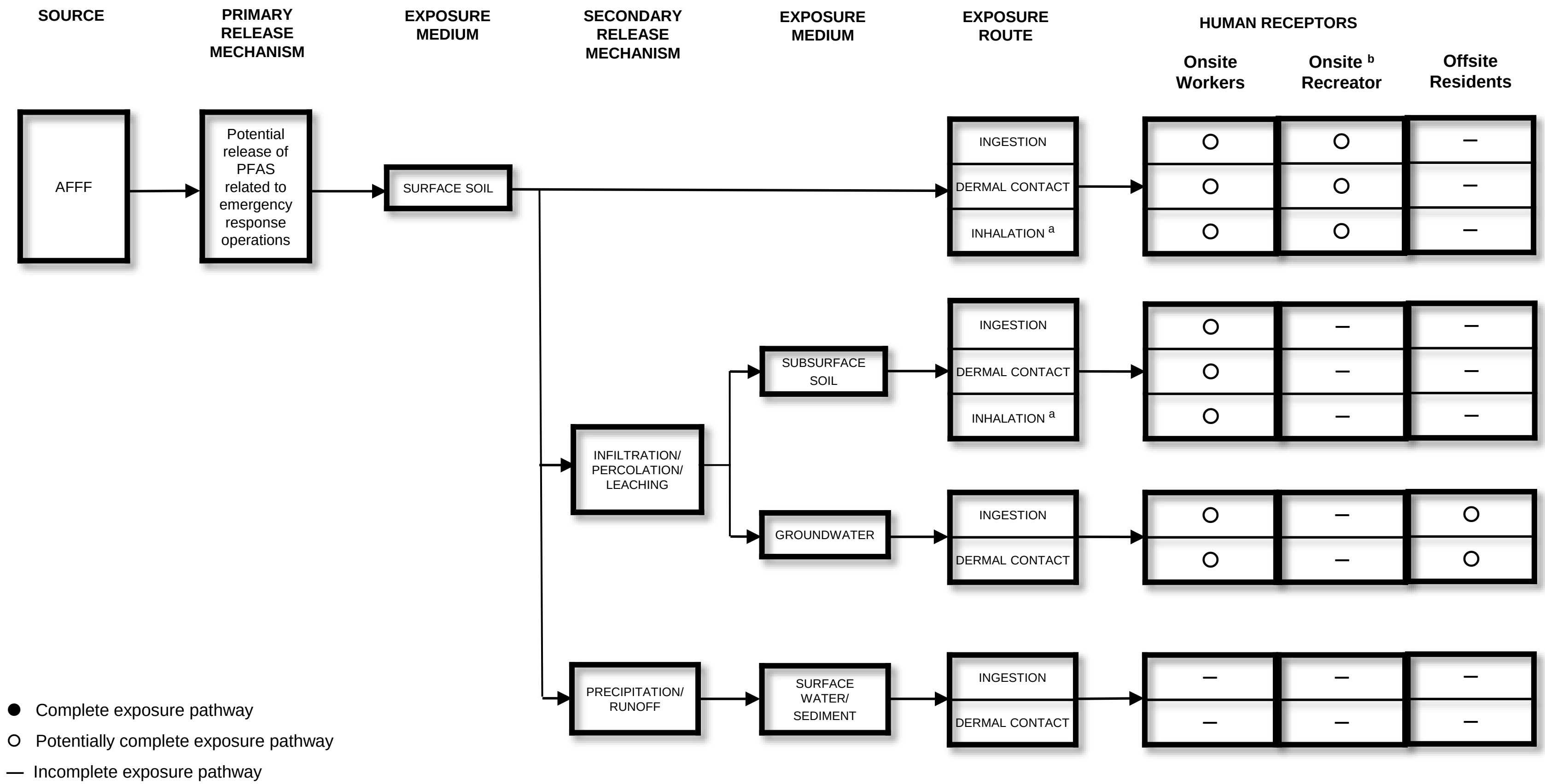
BUILDING 1864 FIRE STATION AOPI SAMPLE RESULTS

CAMP BONNEVILLE
VANCOUVER, WASHINGTON

FIGURE: 6-2 DATE: 9/27/2023

PROJECT: \GIS_DATA\BRAC_PFAS\Bonneville\Projects\QAPP\Figure_17-2_CB_Building_1864_Fire_Station_AOPI.mxd



[a] Inhalation of PFAS is considered potentially complete because no toxicity information is available for the inhalation route.

[b] Currently, no onsite recreator pathways exist; however, future land use will include recreation.

Figure 6-3. Human Health CSM for Building 1864 Fire Station AOPI

LEGEND:

- BRAC Parcel Boundary
- Area of Potential Interest (AOPI)
- Current Building
- Former Building
- Wash Rack-1 Soil Excavaton
- Unnamed Creek
- Soil Boring (2)
- DPT Groundwater Sample/Soil Boring (5)
- Surface Water/Sediment (2)
- Groundwater Flow Direction
- Surface Water Flow Direction

NOTES:

1. Background Source: ESRI World Imagery (Vivid/Maxar, 4/2020).
2. Groundwater flow directions are from the 1999 Multi-Sites Investigation, Shannon and Wilson, Inc.

0 50 100 200 Feet

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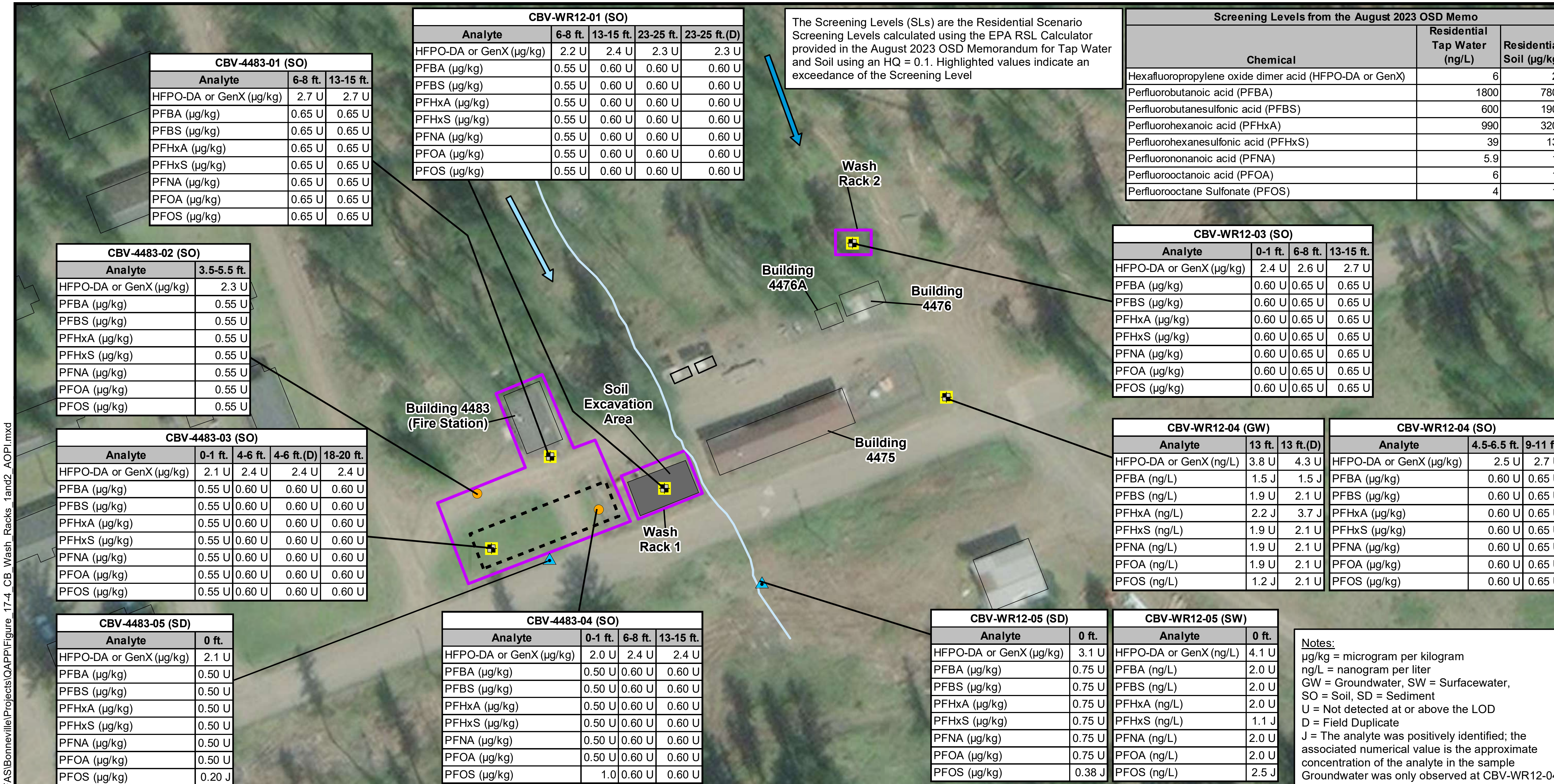
BUILDING 4483 FIRE STATION AOPI AND WASH RACKS 1 AND 2 AOPI SAMPLE LOCATIONS

CAMP BONNEVILLE
VANCOUVER, WASHINGTON

FIGURE: 6-4 | DATE: 9/27/2023

PROJECT: \GIS_DATA\BRAC_PFAS\Bonneville\Projects\QAPP\Figure 17-4 CB Wash Racks 1and2 AOPI.mxd



CBV-WR12-01 (SO)				
Analyte	6-8 ft.	13-15 ft.	23-25 ft.	23-25 ft.(D)
HFPO-DA or GenX (µg/kg)	2.2 U	2.4 U	2.3 U	2.3 U
PFBA (µg/kg)	0.55 U	0.60 U	0.60 U	0.60 U
PFBS (µg/kg)	0.55 U	0.60 U	0.60 U	0.60 U
PFHxA (µg/kg)	0.55 U	0.60 U	0.60 U	0.60 U
PFHxS (µg/kg)	0.55 U	0.60 U	0.60 U	0.60 U
PFNA (µg/kg)	0.55 U	0.60 U	0.60 U	0.60 U
PFOA (µg/kg)	0.55 U	0.60 U	0.60 U	0.60 U
PFOS (µg/kg)	0.55 U	0.60 U	0.60 U	0.60 U

The Screening Levels (SLs) are the Residential Scenario Screening Levels calculated using the EPA RSL Calculator provided in the August 2023 OSD Memorandum for Tap Water and Soil using an HQ = 0.1. Highlighted values indicate an exceedance of the Screening Level

Screening Levels from the August 2023 OSD Memo		
Chemical	Residential Tap Water (ng/L)	Residential Soil (µg/kg)
Hexafluoropropylene oxide dimer acid (HFPO-DA or GenX)	6	23
Perfluorobutanoic acid (PFBA)	1800	7800
Perfluorobutanesulfonic acid (PFBS)	600	1900
Perfluorohexanoic acid (PFHxA)	990	3200
Perfluorohexanesulfonic acid (PFHxS)	39	130
Perfluorononanoic acid (PFNA)	5.9	19
Perfluorooctanoic acid (PFOA)	6	19
Perfluorooctane Sulfonate (PFOS)	4	13

CBV-4483-01 (SO)		
Analyte	6-8 ft.	13-15 ft.
HFPO-DA or GenX (µg/kg)	2.7 U	2.7 U
PFBA (µg/kg)	0.65 U	0.65 U
PFBS (µg/kg)	0.65 U	0.65 U
PFHxA (µg/kg)	0.65 U	0.65 U
PFHxS (µg/kg)	0.65 U	0.65 U
PFNA (µg/kg)	0.65 U	0.65 U
PFOA (µg/kg)	0.65 U	0.65 U
PFOS (µg/kg)	0.65 U	0.65 U

CBV-4483-02 (SO)	
Analyte	3.5-5.5 ft.
HFPO-DA or GenX (µg/kg)	2.3 U
PFBA (µg/kg)	0.55 U
PFBS (µg/kg)	0.55 U
PFHxA (µg/kg)	0.55 U
PFHxS (µg/kg)	0.55 U
PFNA (µg/kg)	0.55 U
PFOA (µg/kg)	0.55 U
PFOS (µg/kg)	0.55 U

CBV-WR12-03 (SO)			
Analyte	0-1 ft.	6-8 ft.	13-15 ft.
HFPO-DA or GenX (µg/kg)	2.4 U	2.6 U	2.7 U
PFBA (µg/kg)	0.60 U	0.65 U	0.65 U
PFBS (µg/kg)	0.60 U	0.65 U	0.65 U
PFHxA (µg/kg)	0.60 U	0.65 U	0.65 U
PFHxS (µg/kg)	0.60 U	0.65 U	0.65 U
PFNA (µg/kg)	0.60 U	0.65 U	0.65 U
PFOA (µg/kg)	0.60 U	0.65 U	0.65 U
PFOS (µg/kg)	0.60 U	0.65 U	0.65 U

CBV-4483-03 (SO)				
Analyte	0-1 ft.	4-6 ft.	4-6 ft.(D)	18-20 ft.
HFPO-DA or GenX (µg/kg)	2.1 U	2.4 U	2.4 U	2.4 U
PFBA (µg/kg)	0.55 U	0.60 U	0.60 U	0.60 U
PFBS (µg/kg)	0.55 U	0.60 U	0.60 U	0.60 U
PFHxA (µg/kg)	0.55 U	0.60 U	0.60 U	0.60 U
PFHxS (µg/kg)	0.55 U	0.60 U	0.60 U	0.60 U
PFNA (µg/kg)	0.55 U	0.60 U	0.60 U	0.60 U
PFOA (µg/kg)	0.55 U	0.60 U	0.60 U	0.60 U
PFOS (µg/kg)	0.55 U	0.60 U	0.60 U	0.60 U

CBV-WR12-04 (GW)		
Analyte	13 ft.	13 ft.(D)
HFPO-DA or GenX (ng/L)	3.8 U	4.3 U
PFBA (ng/L)	1.5 J	1.5 J
PFBS (ng/L)	1.9 U	2.1 U
PFHxA (ng/L)	2.2 J	3.7 J
PFHxS (ng/L)	1.9 U	2.1 U
PFNA (ng/L)	1.9 U	2.1 U
PFOA (ng/L)	1.9 U	2.1 U
PFOS (ng/L)	1.2 J	2.1 U

CBV-WR12-04 (SO)		
Analyte	4.5-6.5 ft.	9-11 ft.
HFPO-DA or GenX (µg/kg)	2.5 U	2.7 U
PFBA (µg/kg)	0.60 U	0.65 U
PFBS (µg/kg)	0.60 U	0.65 U
PFHxA (µg/kg)	0.60 U	0.65 U
PFHxS (µg/kg)	0.60 U	0.65 U
PFNA (µg/kg)	0.60 U	0.65 U
PFOA (µg/kg)	0.60 U	0.65 U
PFOS (µg/kg)	0.60 U	0.65 U

CBV-4483-05 (SD)	
Analyte	0 ft.
HFPO-DA or GenX (µg/kg)	2.1 U
PFBA (µg/kg)	0.50 U
PFBS (µg/kg)	0.50 U
PFHxA (µg/kg)	0.50 U
PFHxS (µg/kg)	0.50 U
PFNA (µg/kg)	0.50 U
PFOA (µg/kg)	0.50 U
PFOS (µg/kg)	0.20 J

CBV-4483-04 (SO)			
Analyte	0-1 ft.	6-8 ft.	13-15 ft.
HFPO-DA or GenX (µg/kg)	2.0 U	2.4 U	2.4 U
PFBA (µg/kg)	0.50 U	0.60 U	0.60 U
PFBS (µg/kg)	0.50 U	0.60 U	0.60 U
PFHxA (µg/kg)	0.50 U	0.60 U	0.60 U
PFHxS (µg/kg)	0.50 U	0.60 U	0.60 U
PFNA (µg/kg)	0.50 U	0.60 U	0.60 U
PFOA (µg/kg)	0.50 U	0.60 U	0.60 U
PFOS (µg/kg)	1.0	0.60 U	0.60 U

CBV-WR12-05 (SD)	
Analyte	0 ft.
HFPO-DA or GenX (µg/kg)	3.1 U
PFBA (µg/kg)	0.75 U
PFBS (µg/kg)	0.75 U
PFHxA (µg/kg)	0.75 U
PFHxS (µg/kg)	0.75 U
PFNA (µg/kg)	0.75 U
PFOA (µg/kg)	0.75 U
PFOS (µg/kg)	0.38 J

CBV-WR12-05 (SW)	
Analyte	0 ft.
HFPO-DA or GenX (ng/L)	4.1 U
PFBA (ng/L)	2.0 U
PFBS (ng/L)	2.0 U
PFHxA (ng/L)	2.0 U
PFHxS (ng/L)	1.1 J
PFNA (ng/L)	2.0 U
PFOA (ng/L)	2.0 U
PFOS (ng/L)	2.5 J

Notes:
µg/kg = microgram per kilogram
ng/L = nanogram per liter
GW = Groundwater, SW = Surfacewater,
SO = Soil, SD = Sediment
U = Not detected at or above the LOD
D = Field Duplicate
J = The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample
Groundwater was only observed at CBV-WR12-04

LEGEND:
- BRAC Parcel Boundary
- Area of Potential Interest (AOPI)
- Current Building
- Former Building
- Wash Rack-1 Soil Excavaton
- Unnamed Creek
- Soil Boring (2)
- DPT Groundwater Sample/Soil Boring (5)
- Surface Water/Sediment (2)
- Groundwater Flow Direction
- Surface Water Flow Direction

NOTES:
1. Background Source: ESRI World Imagery (Vivid/Maxar, 4/2020).
2. Groundwater flow directions are from the 1999 Multi-Sites Investigation, Shannon and Wilson, Inc.

0 50 100 200 Feet

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BUILDING 4483 FIRE STATION AOPI AND WASH RACKS 1 AND 2 AOPI SAMPLE RESULTS
CAMP BONNEVILLE
VANCOUVER, WASHINGTON

FIGURE: 6-5 DATE: 9/27/2023

PROJECT: \GIS_DATA\BRAC_PFAS\Bonneville\Projects\QAPP\Figure_17-4_CB_Wash_Racks_1and2_AOPI.mxd

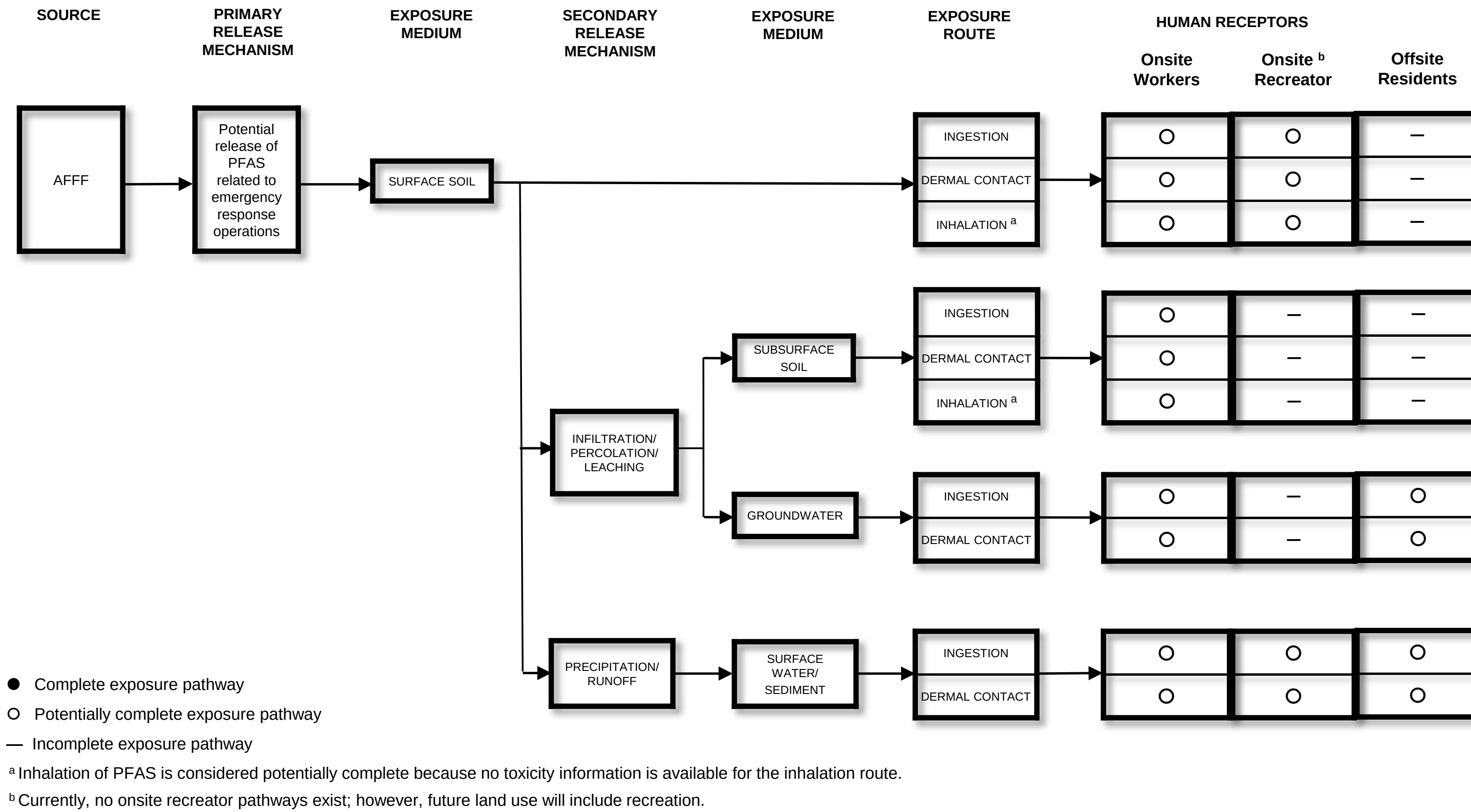
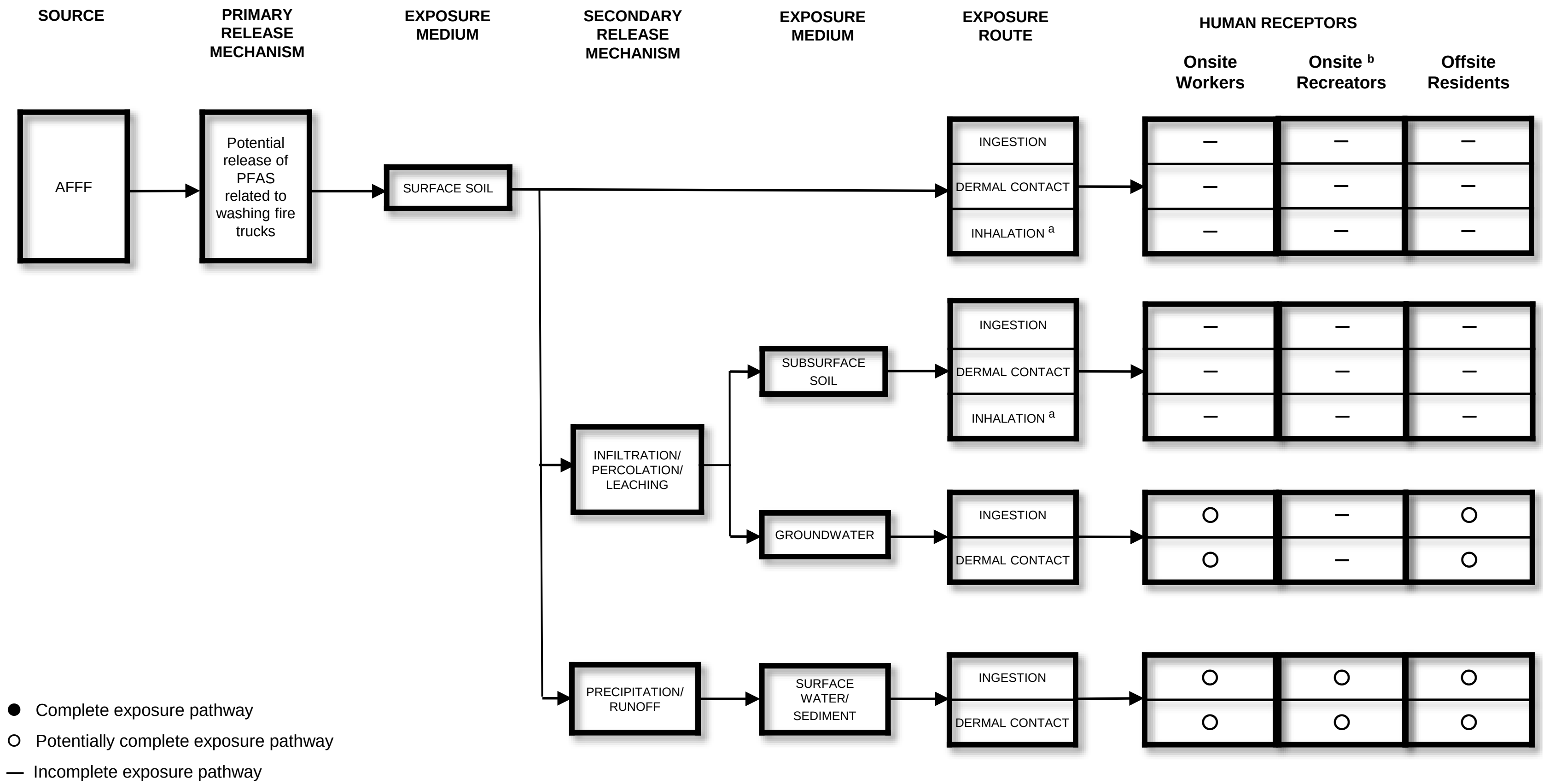


Figure 6-6. Human Health CSM for Building 4483 Fire Station AOPI



[a] Inhalation of PFAS is considered potentially complete because no toxicity information is available for the inhalation route.

[b] Currently, no onsite recreator pathways exist; however, future land use will include recreation.

Figure 6-7. Human Health CSM for Wash Racks 1 and 2 AOPI