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FINAL PRELIMINARY ASSESSMENT OF PER- AND POLYFLUOROALKYL SUBSTANCES

Yakima Training Center

Yakima, Washington

Joint Base Lewis-McChord Public Works – Environmental Division

IMLM-PWE

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Final Preliminary Assessment of Per-and Polyfluoroalkyl Substances

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ACRONYMS

°F	degrees Fahrenheit
%	percent
AFFF	aqueous film-forming foam
AOPI	area of potential interest
Arcadis	Arcadis U.S., Inc.
Army	U.S. Army
bgs	below ground surface
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CSM	conceptual site model
DoD	Department of Defense
EDR	Environmental Data Resources, Inc.
FTP	fire training pit
GIS	geographic information system
HAL	health advisory level
HQAES	Headquarters Army Environmental System
IMCOM	Installation Management Command
installation	U.S. Army and Reserve installation
IRP	Installation Restoration Program
JBLM	Joint Base Lewis-McChord
MCL	maximum contaminant level
MPRC	Multi-Purpose Range Complex
ng/L	nanogram per liter
PA	preliminary assessment
PAIC	Pomona Artesian Irrigation Company
PFAS	per- and polyfluoroalkyl substances
PFOA	perfluorooctanoic acid
PFOS	perfluorooctane sulfonate
POC	point of contact
RCRA	Resource Conservation and Recovery Act

RFA	Resource Conservation and Recovery Act facility assessment
RFI	Resource Conservation and Recovery Act facility investigation
SAIC	Science Applications International Corporation
SWMU	solid waste management unit
TVR/MATES	Tracked Vehicle Repair/Old Mobilization and Training Equipment Site
U.S.	United States
USACE	United States Army Corps of Engineers
USAEC	United States Army Environmental Command
USEPA	United States Environmental Protection Agency
WWTP	wastewater treatment plant
YFCR/YTCR	Army Environmental Database-Restoration's abbreviation for Yakima Firing Center/Yakima Training Center
YRS	Yakima Research Station
YTC	Yakima Training Center

EXECUTIVE SUMMARY

The United States Army Corps of Engineers, Baltimore District, contracted Arcadis U.S., Inc. to conduct preliminary assessments (PAs) for the U.S. Army Environmental Command on the current or potential historical use of per- and polyfluoroalkyl substances (PFAS), with a focus on perfluorooctane sulfonate and perfluorooctanoic acid at U.S. Army (Army) installations (installations) nationwide. The delivery order number for this PA is W912DR17F0396 under contract number W912DR-13-D-0019, titled Hazardous, Toxic, and Radioactive Waste Architectural and Engineering Services. This report provides the PA for Yakima Training Center (YTC) and was completed in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980.

Programmatically, the Army has focused its PA efforts on two common sources of PFAS at Army installations: 1) the use of aqueous film-forming foam (AFFF); and 2) chromium plating. However, other sources of PFAS are also documented in this PA. A combination of document reviews, internet keyword searches, and an installation site visit comprising interviews with installation personnel and site reconnaissance were used to identify specific areas of suspected PFAS releases.

Three areas of potential interest (AOPIs) have been identified for this PA at YTC. Potential PFAS source types and the results of this PA are summarized in Table ES-1, below. Potential source types are noted as not applicable at YTC if the PA research did not identify any PFAS relevance or they are not present at the installation.

Table ES-1. Summary of AOPIs Identified during the Preliminary Assessment

PFAS Source Type	AOPI Name
Firefighter training areas	YFCR-53 – Former Fire Training Pit
	Building 868 – Bird Bath Wash Rack/Former Fire Training Pit Area
Fire nozzle testing area	Building 323 – Refractometer AFFF Solutions Testing Area

The following potential PFAS sources were evaluated at YTC but did not result in an AOPI designation: fire stations, fire response areas, crash sites or landing areas, fuel spills, installation storage warehouses, hangars and/or buildings with AFFF suppression systems, chromium plating operations facilities or waste disposal areas, pesticide use, automobile maintenance shops, photo-processing facilities, laundry/water-proofing facilities, car washes, wastewater treatment systems, landfills, stormwater or sanitary sewer components, or remediated soil application areas.

A site-specific conceptual site model focused on drinking water pathways was then developed for each AOPI based on an evaluation of historical site activities, review of existing records, personnel interviews and site reconnaissance.

Results from this PA may be used to determine if a site inspection for PFAS is warranted at YTC.

1 INTRODUCTION

The United States (U.S.) Army Corps of Engineers (USACE), Baltimore District, contracted Arcadis U.S., Inc. (Arcadis) to conduct preliminary assessments (PAs) for the U.S. Army Environmental Command (USAEC) on the current and historical use of per- and polyfluoroalkyl substances (PFAS), with a focus on perfluorooctane sulfonate (PFOS) and perfluorooctanoic acid (PFOA) at select active U.S. Army (Army) installations (installations) nationwide. The delivery order number for this PA is W912DR17F0396 under contract number W912DR-13-D-0019, titled Hazardous, Toxic and Radioactive Waste Architectural and Engineering Services. This report provides the PA completed by Arcadis for Yakima Training Center (YTC) in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA).

1.1 Project Background

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

The focus of the Army's PA program for PFAS is to identify the locations at installations where PFAS, specifically PFOS and PFOA, were used and if a suspected release occurred at each location. Arcadis has been tasked with identifying 1) locations where Class B firefighting foam (i.e., aqueous film-forming foam [AFFF]) was stored or used and if a suspected release occurred at these locations; and 2) locations where chromium plating operations occurred and if a suspected release occurred at these locations.

AFFF was developed in the mid-1960s in response to a need for firefighting foams better suited to extinguish Class B, fuel-based fires. AFFF formulations consist of water, an organic solvent, up to 5 percent (%) hydrocarbon surfactants, and 1 to 3% PFAS. AFFF concentrate is designed to be diluted with water to become a 1, 3, or 6% foam. AFFF releases at Department of Defense (DoD) facilities may have occurred during firefighter training, emergency response actions, equipment testing, or accidental releases. Therefore, primary source areas of AFFF include firefighter training areas, current and historical fire stations, nozzle testing areas, crash sites, fuel spill fire responses, and hangars and buildings with AFFF suppression systems. The military still primarily uses AFFF for Class B fires; however, significant operational changes have been made to restrict uncontrolled releases and non-essential use of PFAS-based foams. Army installations may still house AFFF, commonly stored in closed containers (e.g., 55-gallon drums, 5-gallon buckets), within designated storage buildings or at firehouses.

Potential PFAS use associated with chromium plating activities may also be relevant to Army installations. During hard chromium plating, a metal surface is treated with a layer of electrochemically-deposited chromium in a chromic acid bath. PFAS, specifically PFOS, have been used in hard chromium plating operations as surface tension-reducing wetting agents to mitigate the release of aerosolized hexavalent chromium into a working environment. Historically, it was common for spent plating baths from plating

operations to be disposed of in a lined or unlined pit, or into a sanitary or storm sewer. Therefore, PFAS present in mist suppressants during the plating process could be released to the environment.

In addition to AFFF and chromium plating-related releases, other potential releases of PFAS at Army installations may be associated with the use of some types of pesticides, laundering or water proofing facilities, car washes, engine lubricants, and photo processing. Secondary source areas of PFAS include residuals present in stormwater and sewer systems, wastewater treatment plants (WWTPs), landfills, and remediated soil application areas.

Many of the PFAS found in AFFF and chromium plating operations are surfactants (which do not volatilize) and are found in a charged or ionic state at environmental pH (i.e., pH 5 to 9 standard units), including PFOS and PFOA, which are both negatively charged. Because the focus of the Army's PFAS PA program is on releases from AFFF and metal plating operations, the major PFAS releases of concern at Army installations are therefore likely to contain PFAS that do not volatilize. The primary media of concern for PFAS releases at Army installations are thus soil, groundwater, surface water, and sediment. Once released to the environment, the main factor that inhibits the movement of PFOS/PFOA is the presence of organic matter and other organic constituents of concern in soils and sediments. Generally, PFOS and PFOA are mobile in the media of interest and they are not known to be broken down by natural processes.

The regulatory environment related to PFAS is evolving as research continues. Currently, there is no set federal maximum contaminant level (MCL) defined for any PFAS. In 2016, the United States Environmental Protection Agency (USEPA) established a lifetime health advisory level (HAL) of 70 nanograms per liter (ng/L) in drinking water for PFOS or PFOA and for the sum of PFOS and PFOA when both are present (USEPA 2016a). A USEPA Office of Ground Water and Drinking Water Memorandum indicates that the USEPA HAL for PFOS and PFOA are non-enforceable and non-regulatory (USEPA 2016b). In addition, some states have proposed or established their own standards for PFAS, which include PFOS and PFOA.

1.2 Preliminary Assessment Objectives

A PA is a limited-scope investigation performed on every Comprehensive Environmental Response, Compensation, and Liability Information System site. During a PA, investigators collect readily available information and conduct site and environs reconnaissance where appropriate. The PA is designed to distinguish between sites that pose little or no threat to human health and the environment and sites that require further investigation. The PA also identifies sites requiring further assessment for possible emergency response actions (USEPA 1991). The objective of this PA is to identify areas of potential interest (AOPIs) in accordance with the Army Guidance for Addressing Releases of Per-and Polyfluoroalkyl Substances (Army 2018), where a release of PFAS to the environment could have occurred. This PA evaluates and documents areas where an AFFF release or chromium plating operations occurred, as well as other potential releases of PFAS.

1.3 Preliminary Assessment Process Description

For each installation, PA development follows a similar process involving pre-site visit, site visit, and post-site visit activities. The following sub-sections summarize the activities in each phase of the process.

1.3.1 Pre-Site Visit

First, an installation kickoff teleconference is held between the Arcadis project manager, the Arcadis regional team lead, the Arcadis PA team, the USAEC environmental support manger and regional team chief, the USAEC program management team, the USACE regional point of contact (POC), and installation POCs. The kickoff call occurs 4 to 6 weeks before the site visit to discuss the goals and scope of the PA, project scheduling, installation access, timeline for the site visit, and access to installation-specific databases, and to request available records.

A records search is also conducted before the site visit to obtain electronically available documents from the installation and external sources for review by the Arcadis PA team. The purpose of the records search is to identify the physical setting and site history relevant to the use and release of PFAS to the environment and to develop preliminary conceptual site models (CSMs) related to drinking water pathways for AOPIs at the installation.

Lastly, a read-ahead package is prepared by Arcadis and submitted to the appropriate program POCs 2 weeks before the site visit. The read-ahead package contains the following information:

- The Installation Management Command (IMCOM) operation order
- The antiterrorism/operations security review cover sheet (**Appendix A**)
- The PFAS PA kickoff call minutes
- An information paper on the Army's PFAS PA program
- Contact information for key program POCs
- A list of the data sources requested and reviewed by the Arcadis PA team
- A list of preliminary locations for site reconnaissance
- A list of roles for the installation POC to consider when recommending potential interviewees.

1.3.2 Site Visit

The site visit is conducted by the Arcadis PA team after the installation POCs are notified of the site visit dates and are provided the information necessary for Arcadis staff to access the installation. The site visit begins with an installation in-brief to provide installation staff with the objectives of the site visit and team introductions. Personnel interviews, an on-post records search, and site reconnaissance at potential AOPIs are conducted by the Arcadis PA team during the site visit.

The site reconnaissance at the potential AOPIs includes visual surveys that assess the points of potential PFAS release, potential secondary impacts, and the migration potential from each AOPI. Physical attributes of the potential AOPIs are documented, including ground and floor conditions, the presence/absence of groundwater monitoring wells, surface water bodies, potential receptors (with a primary focus on human ingestion of drinking water), and the distance to the installation boundary. Photo documentation of the potential AOPIs may be collected, and access limitations or advantages related to potential future sampling activities are noted.

An exit briefing is offered to installation personnel at the conclusion of the site visit to raise any issues identified during the site visit, discuss any follow-up items, and review the schedule for submitting deliverables.

1.3.3 Post-Site Visit

After the site visit, information collected pre-, during, and post-site visit is reviewed and corroborated by cross-referencing records and reviewing interview details and observations noted during site visit reconnaissance. A site visit trip report is completed following the site visit and is provided to the installation POC, applicable USAEC POCs, and USACE regional POCs. The information collected during the pre-site visit and site visit activities is compiled to develop the installation-specific PA. Site data obtained during the PA are used to develop drinking water pathway CSMs for each AOPI. Map document files and associated geographic information system (GIS) data are attached to this report (**Appendix B**). GIS data layers created for the project are included in a Spatial Data Standards for Facilities, Infrastructure, and Environment-compliant geodatabase. The PA process is documented in the Installation PA Quality Control Checklist (**Appendix C**).

2 INSTALLATION OVERVIEW

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

2.1 Site Location

YTC (originally known as the Yakima Firing Center) is a satellite installation of Joint Base Lewis-McChord (JBLM) and is located approximately 100 miles east of JBLM and about 5 miles northeast of the city of Yakima (population 75,000; **Figure 2-1**). It encompasses 327,231 acres within Yakima and Kittitas Counties in central Washington state. The eastern border of the facility is the Columbia River. The YTC population is predominantly transient soldiers performing maneuvers with a few permanent adult residents and on-site workers and no children. Less than 500 military and civilians are permanently stationed at YTC, including active duty service members, the Washington National Guard, the Army Reserves, and Marine Reserves members; transient units can swell the YTC population into the thousands for short periods. The only significant adjacent population center is Selah, to the west (population 6,300) (YTC 2017).

2.2 Mission and Brief Site History

The mission of the YTC is to provide military training facilities, maneuver areas, and ranges for the U.S. and allied nations. Since 1941 the YTC has been used for training artillery, infantry, and engineering units. It is primarily used by the Army, Army Reserve, and Washington National Guard. Prior to 1941, the facility area was privately owned and used for ranching and mining operations (USACE 2012).

Historical environmental investigations and cleanup programs have been conducted at YTC. The JBLM Environmental Restoration Program is the lead executing agency for YTC; YTC is not on the National Priorities List (YTC 2017) but is addressed under the Resource Conservation and Recovery Act (RCRA). The USEPA completed a RCRA facility assessment (RFA) for YTC in 1995, which identified 77 solid waste management units (SWMU) and 38 areas of concern, and recommended corrective action for a majority of the units and areas. These sites are designated with Army Environment Database-Restoration sites names: Yakima Firing Center (YFCR) or Yakima Training Center (YTCR). Cleanup programs have been completed or are in progress for the following primary constituents of concern in soil and groundwater at YTC: munitions and explosives of concern; petroleum, oil, and lubricants; and volatile organic compounds (YTC 2017).

2.3 Current and Projected Land Use

YTC is divided into the cantonment area (approximately 1,000 acres in the southwest corner of the installation bounds) with administrative and maintenance buildings, and the down-range areas (the bulk of the lands), which are a series of undeveloped ridges used as maneuver training areas (**Figure 2-2**). The cantonment area is largely covered with asphalt and administrative buildings. Open areas include fields of sparse vegetation. While most environmental sites investigated under the RFAs were closed with no

further action decisions, land use controls and/or long-term management remedies remain in place at six Installation Restoration Program (IRP) sites for various constituents of concern.

The land use controls are in place at YTC to prohibit residential land use, excavation, and drinking water well installation to prevent exposure to impacted soil and groundwater at the previously investigated YFCR and YTCR sites. They will remain in-place until Washington State Model Toxics Control Act cleanup levels are attained. Military munitions response program sites identified in the RFA have all been closed (YTC 2017). Outside of the cantonment area, there are several areas that have been used in the past to treat or dispose of wastes. Past waste management practices at most of these areas is not well documented (Science Applications International Corporation [SAIC] 1995).

YTC houses a public juvenile fishing pond open to youth 15 years and younger and does not require a recreation card with YTC; the pond is stocked by the Washington State Fisheries Department. Civilian hunters and recreationalists can obtain recreation cards with YTC to access the public lands with a successful background check and registration of weapons. The public can also access the Palouse to Cascades Trail without recreation cards; mountain biking or horseback riding is not permitted in the down-range areas. Land use in the areas around YTC is primarily agricultural or undeveloped grazing lands. The areas around Selah, Moxee and Black Rock Valleys, and Badger Pocket are host to either irrigated orchards and farmland, or dry land wheat farming (SAIC 1995).

2.4 Climate

YTC is located within the semiarid Columbia Basin, which is characterized by sagebrush/wheatgrass steppe and grasslands (SAIC 1995). Precipitation is generally limited to the winter months in the form of snow and averages 8.8 inches; winters are cool, and summers are hot and dry. Mean annual temperature is 51 degrees Fahrenheit (ºF). The average January temperature is 28 º F and the average July temperature is 72º F. Prevailing winds are from the west-northwest in both seasons and are controlled by valley trends (Shapiro and Associates 1991). Average annual potential evapotranspiration is estimated to be between 25 and 37 inches which significantly limits local recharge to aquifers at the site from precipitation (USACE 2012).

2.5 Topography

YTC is located within the Walla Walla Plateau, a sub-province of the Columbia Plateau physiographic province. The area constitutes a transitional zone between the Cascade Mountains to the west and the main part of the Columbia Plateau to the east. The Walla Walla Plateau consists of a series of southeast-trending ridges and intervening valleys; this topography is a result of folding and uplifting of basalts and interbedded sediments of the Columbia Basalt Group (Shapiro and Associates 1991). Landforms in the Columbia Basin are characterized by irregular plains and table lands with moderate to high relief. Elevations on YTC vary from approximately 440 feet above mean sea level along the eastern border with the Columbia River to over 4,000 feet along some of the major east-west trending anticlinal and synclinal ridges (**Figure 2-3**; SAIC 1995). Continued uplift of the plateau has allowed streams and rivers to cut deeply into the basalts, resulting in steep-sided ravines. North-south trending drainages dissect the ridges and flow parallel toward the Columbia River to the east or the Yakima River to the west. In general, the

western part of the installation is rolling to hilly, and the topography becomes increasingly rugged to the east in transition down to the Columbia River (Shapiro and Associates 1991).

2.6 Geology

The YTC and surrounding region is underlain by a thick sequence of basalt lava flows with interbedded, weakly consolidated sediments. The lava flows, known collectively as the Columbia River Basalt Group, underlie much of eastern Washington, and have a total thickness of greater than 10,000 feet in parts of the region. Individual flows range from a few feet to more than 100 feet thick. Each flow typically consists of a vesicular or rubbly flow top, a relatively thick internal zone that has a hackly texture of random cooling joints, and lower zone that is characterized by columnar jointing perpendicular to the base of the flow (USACE 2012). Overlying the basalt sequence in the YTC vicinity is a sequence of sedimentary strata known as the Ellensburg Formation. This formation is composed of partially consolidated sand and gravel, and sediments ranging from unconsolidated sand, silt, and clay to weakly indurated sandstone, siltstone, and claystone. These sediments range from a few feet to several hundred feet thick and are generally thickest underlying lowland areas. Younger deposits that locally overlie the Ellensburg Formation and the Columbia River Basalt in the YTC area include unconsolidated quaternary alluvial sand and gravel along the stream channels and floodplains, alluvial fan deposits of silty sand and gravel along the flanks of the ridges, and windblown silt (loess) deposits (USACE 2012).

Within the Yakima Fold Belt, the Columbia River Basalt and Ellensburg Formation have been deformed into a series of east-northeast-trending anticlines and synclines. Owing to the relatively young age of this deformation, the anticlines are expressed as ridges and intervening synclines form valleys. The YTC cantonment area is mostly located within the synclinal valley between the anticlinal Yakima Ridge to the south and Umtanum Ridge to the north (Tetra Tech 2017).

2.7 Hydrogeology

Extensive folding of the sedimentary and Columbia River basalt strata in the area has created a complex groundwater system with highly variable hydraulic properties, depths to water, and flow directions at any given location at YTC. Groundwater in the region occurs principally within the following principal aquifers (not all are present everywhere across YTC): surficial unconsolidated alluvial deposits, sedimentary units (principally the sand and gravels) of the Ellensburg Formation, the Saddle Mountains Basalt, the Wanapum Basalt, and the Grande Ronde Basalt (Tetra Tech 2017).

The alluvial deposits are typically moderately to highly permeable, and groundwater within them generally is unconfined. The water table in these deposits is typically at or near the elevation of the nearby streams. In the Ellensburg Formation, groundwater is found in the gravel layers within the surficial sedimentary formations, and can be either unconfined or confined by overlying finer-grained materials, depending on the thickness and composition of the formation. Within the sequences of basalt, groundwater is predominantly found within the weathered, more fractured contact zones and within sedimentary interflow zones (Tetra Tech 2017; USACE 2012). The basalt flows and associated sedimentary interbeds form the most productive aquifer system in the region. Groundwater within this system occurs principally within fracture and rubble zones of the basalt flows and in the sand and gravel layers that occur between some of the flows. The water-yielding zones within this sequence range from a few feet to over 50 feet thick.

Their lateral extent ranges from short distances or up to several miles, depending on the stratigraphic continuity of the water-bearing unit (USACE 2012).

Reported depths to groundwater range from 20 feet below ground surface (bgs) in stream valleys to more than 200 feet bgs at higher elevations at YTC. Groundwater springs occur where incised stream valleys intercept aquifers (**Section 2.8**; Tetra Tech 2017). In the cantonment area of YTC, the uppermost groundwater occurs in shallow, perched zones in the vesiculated fractured basalt near the top or bottom of the Pomona Flow of the Saddle Mountain Basalt, depending on the area. Depth to groundwater can range from 10 to 100 feet bgs in the cantonment area, and the flow direction of the perched water is to the west and southwest off-post toward the Yakima River (Tetra Tech 2017).

A highly productive regional basalt aquifer underlies the cantonment area at depth. The groundwater at depth in this area occurs in basalt fractures and interbedded sediments. This flow system is presumably recharged from a considerably higher area farther up slope, and is confined under pressure beneath less permeable strata consisting of basalt or fine-grained sediment (USACE 2012).

2.8 Surface Water Hydrology

The dominant surface water bodies in the region around YTC are the Columbia River to the east and the Yakima River to the west. Both rivers flow from north to south in the vicinity of YTC. The Yakima River flows into the Columbia River approximately 120 miles downstream from YTC. The Columbia River's flow (more than 120,000 cubic feet per second) is regulated by a series of dams. Two major hydroelectric dams (Wanapum and Priest Rapids) are located on the Columbia River near the eastern border of YTC (SAIC 1995). The Columbia River receives runoff from several streams draining from the eastern side of YTC, including Hanson Creek, Alkali Canyon Creek, Corral Canyon Creek, Sourdough Canyon Creek, and Cold Creek. The Yakima River's flow (average of approximately 2,500 cubic feet per second) is regulated by the Roza Dam in the vicinity of YTC. The Yakima River receives runoff from several streams draining from the western side of YTC, including Squaw, Burbank, and Selah Creeks. High evapotranspiration and low precipitation limit surface runoff from YTC. Only Alkali, Cold, and Squaw Creeks are perennial; most other creeks and drainages are ephemeral though a few are intermittent following a large storm event (Shapiro and Associates, Inc. 1991). Though some flash runoff events may occur at YTC if rain falls on snow or frozen ground, flooding is not an issue within the YTC boundaries (DoD 2010).

A number of springs (ranging from seasonal to perennial) and seeps also feed some streams. Approximately 148 springs have been developed at YTC to provide water for agriculture and livestock. Three surface water impoundments or ponds (Kiddies Pond, Taylor Pond, and Eaton's Pond) are located at YTC, supported by earthen dams to hold water year-round. Taylor Pond has historically been used primarily in support of fire suppression activities; Kiddies Pond is a fishing pond for juvenile use. Two irrigation canals divert water from the Yakima River in the vicinity of YTC to supplement irrigation water. Peak surface water runoff occurs during the winter-spring snowmelt period (Shapiro and Associates, Inc. 1991).

2.9 Potable Wells

The drinking water supply for YTC is provided entirely from groundwater sources. Six wells provide water for three permitted drinking water distribution systems located in the cantonment area and at the Yakima Research Station (YRS) and the Multi-Purpose Range Complex (MPRC; DoD 2010). Prior to distribution and use, this water is treated, typically at the wellhead, by chlorination. Water for the permitted drinking water distribution system in the cantonment area is stored in two tanks with a combined storage capacity of 1,130,000 gallons. Available well construction details for the installation's on-post potable water supply wells are provided in **Table 2-1**. Additional information about these wells is provided below:

- The Pomona drinking water well reportedly flows at 250 gallons per minute and is the primary drinking water supply well for the installation. The well is located at Building 829 in the cantonment area and is artesian as the aquifer is confined under pressure. The high artesian pressure in this well is interpreted to indicate that groundwater flow to this well is due largely to the structural downwarp in which the YTC is located. The well is completed in the Wanapum and/or Grande Ronde Formation with open borehole completion between depths of approximately 353 and 407 feet bgs; historical surveys indicate that water enters the Pomona well at approximately 401 feet bgs, apparently along a sedimentary interbed or fracture zone (Tetra Tech 2017). Water is pumped to the entry point of the distribution system at Building 550 for chlorination and then pumped to Reservoir #590. The Pomona well is pumped 11 months of the year (DoD 2017).
- The Jordan well is located at Building 550. Jordan well is pumped one month a year, treated and also sent to Reservoir #590 (DoD 2017). The well is completed to 617 feet bgs with casing open from 365 feet bgs. Static water level is reportedly around 50 feet bgs (YTC 2003).
- The Badger Gap well is located at Building 2110. Water is pumped to a reservoir for chlorination (approximately one gallon of bleach added to the reservoir every three months). The well is government-owned and contractor-operated (DoD 2017).
- The Bowers well is located at Building 860. No other information was provided for this well.
- MPRC has one well with a storage capacity of 1,200 gallons. The MPRC well is located between Buildings 84H (main MPRC building) and 84B (treatment building); water is pumped to Building 84B for chlorination and then to a reservoir. The well is government-owned and contractor-operated.
- At YRS, there are two wells with a combined storage capacity of 375,000 gallons. The YRS well is located at Building 1901 where it is chlorinated, and then pumped to a reservoir. It is completed to 602 feet bgs with casing open from 307 feet bgs; static water level is reportedly around 325 feet bgs (YTC 2003). The YRS well reportedly serves as the state sampling location for drinking water and is sampled at a hydrant located at the intersection of Firing Center Road and Jack Daniels Road (DoD 2017).

Additional potable wells are located within the range/training areas (**Figure 2-2**) and have a combined storage capacity of 415,300 gallons (DoD 2010). Water from these remaining wells located throughout the range/training areas is treated as needed and is not part of the primary drinking water system (DoD 2010).

YTC currently has sufficient water resources to meet and surpass the existing maximum water demand. Deep aquifer water supplies are adequate for foreseeable needs at YTC. Non-potable water for fire suppression is obtained from both ground and surface water sources. There are 17 fast-fill wells, three spring-fed fast-fill wells, two fast-fill tanks (which are kept filled through water delivery by the YTC fire department), and five earthen ponds and two heli-wells installed in the range areas around YTC for use in fire suppression activities. Surface water from the Columbia River represents one of the primary sources of water for aerial firefighting (the fire season does not overlap the occurrence of juvenile salmon in the river). Water used by troops during training would either be drawn from the cantonment area system and hauled to the field or drawn from one of the training area wells.

Additionally, approximately 100 feet from the Pomona well, the Pomona Artesian Irrigation Company (PAIC) well is installed in the same aquifer as the Pomona well. The PAIC well is the production well for the PAIC water system which serves about 60 homes and businesses west of YTC. This well is also referred to as the Pomona Heights well (USACE 2012) and is artesian. Flow rate information for the PAIC well is not known.

In addition, several residential drinking water wells have been installed just northwest of the YTC cantonment area boundary (i.e., less than 3,000 feet; Tetra Tech 2017). The locations of these residential wells are shown on **Figure 2-4** as provided in the 2017 Tetra Tech report; the screened depth of these wells was not provided. However, the State of Washington Department of Ecology Well Report Viewer database online indicates several more supply wells in the area with water well use designations at residential addresses (not depicted on figure as exact coordinates of wells were not readily available); these wells are installed with total depths ranging from 70 to 467 feet bgs. The Environmental Database Resources, Inc. (EDR) report is provided as **Appendix D** and contains the results of the public and state supply well search within 5 miles of the installation. The locations of these public and state wells are also depicted on **Figure 2-4**, as per the data provided in **Appendix D**; however, it should be noted that the EDR report may include wells that have use designations other than potable water supply (i.e., exploratory wells, piezometers or monitoring wells, agricultural use wells) which are not specified in the report. State supply wells are likely to largely be piezometers and monitoring wells.

2.10 Ecological Receptors

Although the focus of this PFAS PA program is on human receptors via drinking water pathways, the Arcadis PA team collected information on ecological receptors that was available in the installation documents reviewed during the PA process. The following information is provided for future reference should the Army decide to evaluate exposure pathways relevant to the ecological receptors.

YTC is characterized by shrub-steppe vegetation, dominated by species of big sagebrush and bunchgrasses such as bluebunch wheatgrass and Sandberg's bluegrass. Noxious weeds control in the training areas includes measures to manage knapweed, kochia, and various thistles in uplands, and purple loosestrife in wetland and riparian areas. No plant species known to occur on YTC are federally listed under the Endangered Species Act. Protective measures (i.e., stakes) are in place for populations of sensitive plant species that have the potential to be damaged by military training activities at YTC (DoD 2010).

The tributaries to the Columbia River which flow across YTC are intermittent and have been observed to be used by Chinook salmon fry during early rearing but the tributaries are too small for their spawning. Several other fish species are found in streams on the installation including the threespine stickleback, largescale sucker, mountain sucker, longnose dace, chiselmouth, prickly sculpin, redside shiner, and the non-native eastern brook trout. No federally listed fish species are known to use rivers and streams on YTC (DoD 2010).

Wildlife at YTC uses three predominant habitat types: shrub-steppe uplands (95% of land coverage at YTC), cliffs and talus slopes, and riparian and permanently wet areas. A total of 246 wildlife species occur or are likely to occur at YTC: 8 amphibians, 14 reptiles, 174 birds, and 50 mammals. Deer mice, sagebrush voles, Great Basin pocket mice, least chipmunks, and northern pocket gophers account for 98 percent of the mammals at YTC; other small and mid-sized animals on the installation include black-tailed jackrabbits, Townsend's ground squirrels, Merriam's shrews, racoons, minks, muskrats, beavers, badgers, porcupines, harvest mice, long-tailed voles, and bats. Large mammals found at YTC include cougars, coyotes, mule deer, bighorn sheep, and elk (DoD 2010). No federally listed species are known to inhabit YTC, though some species (Columbia spotted frog, American white pelican, and sandhill cranes) have endangered status with the Washington state list.

3 SUMMARY OF PA ACTIVITIES

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

- Installation records
- Personnel interviews
- Site reconnaissance.

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

3.1 Records Review

Before and during the site visit, records and reports provided by the installation, as well as those that were publicly available, were reviewed to identify potential AOPIs. The records reviewed included, but were not limited to, various IRP administrative record documents, compliance documents, and GIS files. Internet searches were also conducted to identify publicly available and other relevant information. Additionally, an EDR report generated for YTC was reviewed to obtain off-post water supply well information. A list of the documents reviewed is provided in **Appendix E**.

3.2 Personnel Interview

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

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

The list of roles for the installation personnel interviewed during the PA process for YTC (affiliation is with YTC unless otherwise noted) is presented below.

- Installation Restoration Program Manager (JBLM/YTC)
- Fire Chief
- Assistant Fire Chief
- Spill Prevention, Control, and Countermeasures Staff
- Airfield Safety Manager for Vagabond Army Heliport
- Stormwater Pollution Prevention Planner
- Natural Resource Manager
- Pesticide Application Manager

- GIS Coordinator
- WWTP Operator
- Fire Chief (Kittitas Valley Fire and Rescue)

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

3.3 Site Reconnaissance

The Arcadis PA team conducted site reconnaissance and visual surveys at the potential AOPIs identified during the records review process, the installation in-brief meeting, and during the installation personnel interviews (**Table 3-1**, below). Under some circumstances, the team may not have conducted site reconnaissance at an AOPI identified in the read-ahead package due to additional information obtained during personnel interviews or if access to the site was restricted. However, the area still may have been classified as a non-AOPI or an AOPI in **Sections 5.1** and **5.2**, respectively. A photo log from the site reconnaissance is provided in **Appendix G**; photos were used to assist in verification of qualitative data collected in the field. The site reconnaissance logs are provided in **Appendix H**.

Groundwater monitoring wells were noted during the reconnaissance portion of the site visit, if present, for future use if the installation transitions to PA-phase sampling or the site inspection phase of this program.

Table 3-1. Site Reconnaissance Areas

Site Identifier	Description and Relevance
Wells	
YFCR-53	Active monitoring wells Fire Training Pit (FTP)-1, -13, -14, -15, and -16 associated with the former FTP IRP site.
Fire Related Areas	
YFCR-53*	Former FTP utilized 2-3 times per year until 1987, with one exercise in 1990. The area was excavated in 2003 with some excavated material used as its own backfill. Current vegetative cover consists of grasses and shrubs, and surface water features are ephemeral.
Aviation Areas	
Building 396	Vagabond Army Heliport. No crash responses reported around the airstrip. Surface water runoff is directed to the wastewater treatment plant.
Buildings and Facilities	
Building 323*	Area utilized by the YTC fire department for refractometer solution testing. Solutions of AFFF and water were mixed and tested quarterly from 1997 to 2004, with some solution discharged to the ground. Most solution dried up on the asphalt before reaching the ditch which flows to the oil-water separator across Firing Center Road (7th Avenue).

Building 321	Storage area utilized by the YTC fire department. Two racks of AFFF including Class A and B foams were onsite; some Class B AFFF containers had been repurposed to store Class A foams which had been drained from other equipment and scheduled for disposal. The fire department indicated that the Class A foams stored in the repurposed Class B AFFF containers were not used elsewhere due to cross-contamination concerns.
Building 751	Vehicle maintenance shop which was formerly utilized as a storage area by the YTC fire department. Two pallets of AFFF would reportedly be stored adjacent to Conex containers under a metal cover. No spills were reported.
Building 821	Storage area formerly utilized by the YTC fire department. Approximately one pallet of AFFF was historically stored here (one pallet consisted of 27-36 five-gallon containers).
Building 809	Pesticide storage area. Mixing and storage building has inwardly sloping floors with closed drainage.
Building 868*	“Bird Bath” vehicle wash rack. Retired personnel recalled a possible burn pit in this area prior to construction of the wash rack.
Waste Management Facilities	
Building 650	Wastewater treatment plant. YTC has a closed system for wastewater and some surface water runoff from the installation. Sludge generated at the plant is dried and transported to off-post landfills.

* indicates the area has been further identified as an AOPI. Please note, this summary is not all-inclusive of all AOPIs at YTC, as site reconnaissance visits were not performed at each potential AOPI.

4 SUMMARY OF PA DATA COLLECTED

A summary of the observations made, and data collected through records reviews (**Appendix E**), installation personnel interviews (**Appendix F**), and site reconnaissance (**Appendix H**) during the PA process for YTC is presented below.

4.1 Previous PFAS Investigations

In May 2016, the USEPA issued a PFOS and PFOA HAL of 70 ng/L (USEPA 2016a); subsequently, in June 2016, the Army issued a guidance publication for PFAS assessments (Army 2018). In response to these actions, the third Unregulated Contaminant Monitoring Regulation, and IMCOM Operations Order 16-088, Army installations began initial PFAS sampling in 2016 at water supply wells.

The Pomona well was sampled for 23 PFAS (including PFOS and PFOA) in April 2016. PFAS were detected at low concentrations (less than 10 ng/L combined, and less than the HAL); however, the laboratory utilized experienced severe quality control issues, and the data is considered unreliable. Follow-up sampling was therefore conducted in October 2016 at six drinking water and potable water supply wells: the Pomona, Bowers, Jordan, MPRC, Badger Gap, and YRS wells. The samples collected were analyzed for six PFAS; results were non-detect at all six wells for all six constituents analyzed (**Table 4-1**).

4.2 Potable Water Supply and Drinking Water Receptors

On-post receptors obtain drinking water primarily from the Pomona and Jordan wells, as described in **Section 2.9**. Some off-post receptors obtain drinking water from the PAIC well (located on-post), and several other residential wells installed in the shallow aquifer are located within 5 miles of the installation, west of the cantonment area (Figure 2-4; Appendix D). Previous investigations have demonstrated that the deeper aquifer used for drinking water on-post (i.e., Pomona and Jordan wells) is not connected to the shallow aquifer beneath YTC (i.e., where contamination is found from IRP sites). For example, tetrachloroethylene which was found in a plume at depths of up to 80 feet bgs at the old tracked vehicle repair/mobilization and training equipment site (TVR/MATES) has not been observed during the YTC 5-year reviews just south of the site in the Pomona drinking water supply well or the PAIC well (DoD 2010). The historical documents reviewed during the PA did not specify if the off-post, shallow residential wells were sampled as part of the IRP investigations; these wells are not known to have been sampled for PFAS either.

4.3 AFFF Use and Storage at Installation

Approximately 40 gallons of Ansulite 3% AFFF remain in each of three fire trucks (E-29, E-229, and E-329), and a total of 30 gallons of Ansulite 3% AFFF is stored in 5-gallon containers in Building 321 (IMCOM 2016). During the site visit, photographs of at least five blue 5-gallon containers of 6% AFFF were provided to Arcadis by Directorate of Public Works personnel; the location of where the photographs were taken was reportedly at the Armed Forces Reserve Center building, and the containers have since been moved. Historically, the YTC Fire Department reportedly stored pallets of AFFF onsite at two

locations, Building 751 (outdoor storage) and Building 821 (indoor storage). No leaks or spills were reported at the current or former storage facilities.

Given the time period of operation, AFFF was likely used during firefighter training activities at the former FTP (YFCR-53) and what is now the Bird Bath vehicle wash rack. The YTC Fire Department indicated that if AFFF was used here during the historical training exercises, AFFF would have also been released though nozzle testing and tank flushing at the sites. Nozzle testing with AFFF is performed to ensure optimal flow and release of AFFF mixture in case of emergency use, and involves spraying AFFF through fire equipment which could result in a release to the environment if the mixture was not fully contained. From 1997 to 2004, the parking lot outside of Building 323 was utilized by the YTC fire department for quarterly refractometer AFFF solution testing, with some solution discharged to the ground. The lot reportedly may have also been used as a tank flushing area.

Additionally, the YTC Fire Department indicated that about 50 gallons of mixed AFFF solution would have been used around 2008 in response to a UH-60 helicopter crash in Range 5; an exact crash location could not be provided. YTC has a limited capacity for aircraft traffic, so crash response was not common. However, the fire department did historically operate an aircraft rescue and fire fighting vehicle, which was disposed in 2000. The fire department reportedly kept 1.5 times the amount of AFFF on hand needed to reservice the vehicle but did not recall it ever being fully reserviced due to its infrequency of use.

4.4 Fire Stations, Firefighter Training Areas, and Firefighting Activities

As described in **Sections 3.3** and **4.3**, two former firefighter training areas were identified at YTC (YFCR-53 and the Bird Bath vehicle wash rack). Firefighter training activities were conducted two to three times per year until 1987 and once in 1990. The YTC fire department provided details for former and current storage locations for AFFF and equipment testing areas as noted in **Sections 3.3** and **4.3**.

4.5 Chromium Plating Operations

No current or historical chromium plating operations were identified at YTC.

4.6 Readily Identifiable Off-Post PFAS Sources

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

YTC's fire department is actively involved in fighting regional brush fires which frequently start during training operations, and the department backs up local emergency service agencies during wildfire response in the surrounding areas (i.e., Kittitas Valley, Selah, Yakima). However, wildfires are not typically responded to with AFFF.

YTC fire department personnel recalled an off-post fire response to a semi-truck crash in the Burbank Creek area west of Range 12; AFFF was used during the response, but the volume of AFFF used was

not provided. The Kittitas Valley fire department also reported responding to truck fires off-post along Interstate 82 (i.e., west of the installation, downgradient of the installation potable water wells) with Class B foams; frequency of the responses and estimated volume of AFFF used was not provided. The town of Selah has two fire departments located within 5 miles and upgradient of YTC.

4.7 Relevant Utility Infrastructure

General information regarding the installation's stormwater and wastewater management systems are discussed below. This infrastructure may influence the fate and transport of PFAS at YTC, as further detailed in **Section 5.2** as applicable.

YTC's geographic location with arid climate conditions and high evapotranspiration rates limits runoff from precipitation events; the stormwater season is considered to generally fall from mid-October through April. Stormwater from the cantonment area is managed through a series of structural control devices (e.g. ditches, swales, oil/water separators) which are designed to collect runoff and direct it to natural and man-made drainage systems. These drainages then discharge off-post; the main discharge from the cantonment area exits through Outfall 1, and consists of comingled industrial, non-industrial, and open land discharges. The YTC stormwater drainage systems ultimately or potentially discharge to the Yakima River (YTC 2015).

Pavement wash waters from permitted external building wash-downs are treated through oil/water separators, including from the North 300 Motor Pool/Training Units (i.e., where the refractometer testing solutions area is located outside of Building 323; YTC 2015). Wash rack water waste from other wash rack facilities are plumbed either to a closed-loop/recycle/cleaning system, the WWTP, a vault for containerization and sent to One Stop Yard (who handles all hazardous waste generated by YTC with the exception of those generated by the National Guard), or to a retention basin for infiltration/evaporation. The retention basins are plumbed to oil/water separators prior to discharge (none of which discharges directly to a water body; YTC 2015).

The WWTP is operated by the Directorate of Public Works staff, and its activities are covered by the National Pollutant Discharge Elimination System wastewater permit for the facility. The treatment process includes a gravity grit channel, primary and secondary sedimentation tanks, trickling filters, primary and secondary digesters, a final sedimentary tank, and ultraviolet disinfection. Sludge generated by the wastewater treatment plant is dried and transported to off-post landfills. The WWTP has a permitted effluent discharge to the Yakima River (YTC 2015).

4.8 Other Potential PFAS Sources at YTC

In addition to AFFF and chromium plating-related sources, other potential sources of PFAS may be associated with the use of some types of pesticides, car washes, engine lubricants, laundry or water proofing facilities, and photo processing facilities.

Following the document research and site visit, Arcadis did not identify AOPIs related to these other potential PFAS sources. Further discussion regarding areas not retained as AOPIs is presented in **Section 5.1**.

5 SUMMARY OF AOPIs AND AREAS RESEARCHED

The areas evaluated for potential PFAS use or storage and/or potential release to the environment at YTC were further refined during the PA process and classified either as an AOPI or non-AOPI. Of these areas, seven have been identified as non-AOPIs and three have been identified as AOPIs, in accordance with the established process for the PA program. The process used for refining these areas is presented on **Figure 5-1**, below.

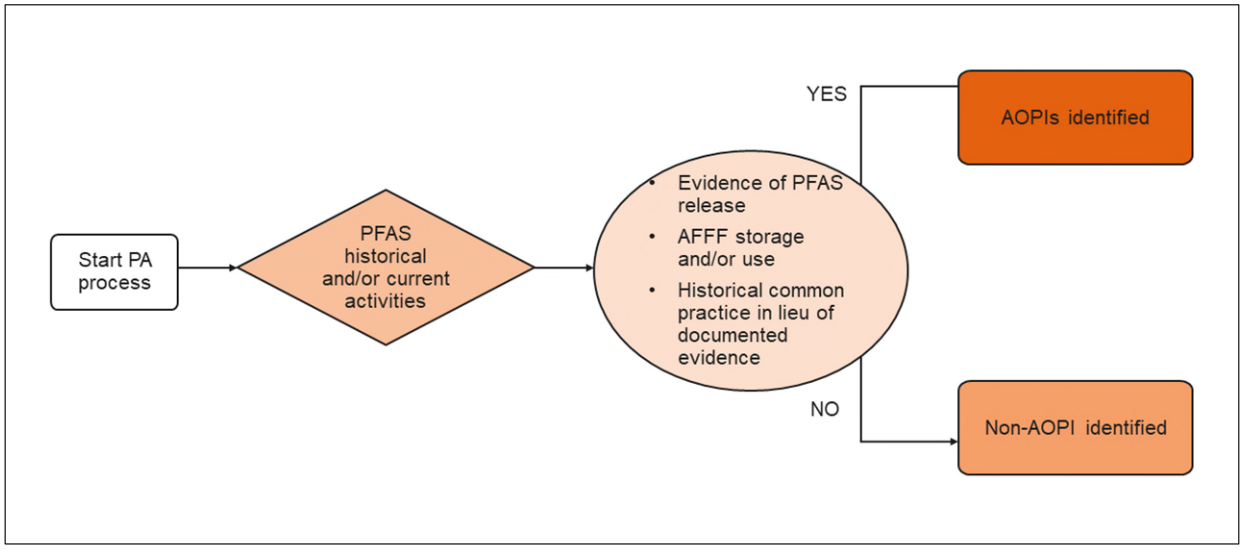

Figure 5-1: AOPI Decision Flowchart

The areas identified as non-AOPIs are presented in **Section 5.1**. The areas retained as AOPIs and their corresponding drinking water pathway CSMs are presented in **Section 5.2**. No Army Reserve/National Guard areas were identified as non-AOPIs or AOPIs at YTC.

One of the AOPIs identified during this PA overlaps with a YTC IRP site and/or Headquarters Army Environmental System (HQAES) site (i.e., the former FTP). This AOPI, overlapping IRP site identifier, HQAES number, and current site status are discussed in **Section 5.2.1**. At the time of this PA, none of the YTC IRP sites have historically been investigated or are currently being investigated for the possible presence of PFAS.

The AOPI locations and estimated aerial extent of AFFF use at each are shown on **Figure 5-2**, along with the active monitoring wells in the vicinity of each AOPI. Construction details for the monitoring wells in the vicinity of the AOPIs are included as **Appendix I**.

Data limitations identified during the PA for YTC are presented in **Section 5.3**.

5.1 Non-AOPIs

Through the analysis of information obtained during document research, personnel interviews, and/or site reconnaissance, the areas described below were categorized as non-AOPIs. These areas were previously identified as potential PFAS sources (e.g., AFFF storage, non-AFFF fire incidents, non-

chromium plating activities, car washes, auto maintenance, photo processing, pesticide use or storage, WWTPs, landfills) at YTC. However, following site research conducted for this PA, PFAS use or release was not suspected for these areas.

A brief site history for non-AOPIs and the rationale for eliminating the areas as AOPIs is presented in **Table 5-1**, below.

Table 5-1. Installation Areas Identified as Non-AOPIs

Area Description	Dates of Operation	Relevant Site History	Reason Eliminated
Building 650 – WWTP	Unknown to current	YTC operates on a closed-loop system for wastewater and some stormwater runoff from the installation. Sludge generated by the plant is dried and transported to off-post landfills. The WWTP effluent discharges to the Yakima River.	No evidence of PFAS release.
Building 751 – Vehicle Maintenance Shop	Unknown	Building formerly utilized as a storage area by the YTC fire department. Two pallets of AFFF would reportedly be stored adjacent to Conex containers under a metal cover. No spills or leaks were reported.	No evidence of PFAS release.
Building 396 – Vagabond Army Heliport	Unknown to current	No crash responses reported at the airstrip. Surface water runoff from the area is directed to the WWTP.	No evidence of PFAS release.
Building 821 – Fire Department Storage Area	Unknown	Building formerly utilized as a storage area by the YTC fire department. Approximately one pallet of AFFF was historically stored here (one pallet consisted of 27 to 36 five-gallon containers).	No evidence of PFAS release.
Building 321 – Fire Department Storage Area	Unknown to current	Two racks of AFFF including Class A and Class B foams remain in storage. Some empty Class B AFFF containers have been repurposed to store Class A foams which have been drained from other equipment and scheduled for disposal.	No evidence of PFAS release. The Class A foams stored in repurposed Class B AFFF containers have not been used elsewhere due to cross-contamination concerns.
Building 296 – Hangar	2017 to present	This building is a newly constructed hangar at Selah Airstrip. The	No evidence of PFAS release.

Area Description	Dates of Operation	Relevant Site History	Reason Eliminated
		building is equipped with a water-only deluge system.	
Former Building 2065 – Fire/Crash Rescue Station	1980s to 1990s	This building at Selah Airstrip was originally constructed to serve as a fire/crash rescue station (U.S. Army Public Health Command 2010) and was reportedly used only periodically. Personnel interviews indicated that while a crash truck was parked outside of the building and stored AFFF in its tank, the truck was never used and no leaks or spills of AFFF was reported. The building was demolished in 2016.	No evidence of PFAS release.
Doris Fire Station	Not applicable	Station was never occupied; fire trucks were sometimes temporarily parked at the station during missions only.	No evidence of PFAS release.
Building 809 – Pesticide Storage Area	Unknown to current	Mixing and storage of various pesticides in a no-outlet concrete containment structure.	No evidence of PFAS release.
Landfills	Unknown to current	Mixed use landfills for on-post waste disposal.	No evidence of receipt of AFFF or chromium plating wastes.

5.2 AOPIs and CSMs

AOPI overviews and the corresponding drinking water pathway CSM summaries for each AOPI identified during the PA process are presented in this section. Based on the documented or potential historical use, storage, or release of PFAS at the AOPIs, affected media are likely to consist of soil, groundwater, surface water, and sediment. Release and transport mechanisms include dissolution/desorption from soil to groundwater, runoff/dissolution/adsorption with surface water or stormwater, and recharge to groundwater from surface water. While other potential exposure media (i.e., soil and sediment) besides drinking water sources (i.e., groundwater and/or surface water) may be impacted by PFAS, direct ingestion via drinking water is the most likely exposure route and thus the Army's primary concern for human exposure. Therefore, the focus of the Army's PA program is on potential human exposures via drinking water ingestion. The potential for human exposures to PFAS through non-drinking water pathways has not yet been established and may be evaluated at a future date if it is determined that those pathways warrant further consideration. The CSMs presented in this report focus on drinking water pathways via groundwater and surface water that are known to be used as a source of potable water. YTC obtains drinking water via six on-post potable wells as described in **Section 2.9**; several private

residential wells and other potable water wells are installed in the vicinity of the cantonment area of YTC (**Figure 2-4**).

A groundwater exposure pathway is considered potentially complete where constituents of concern could migrate from the AOPI source area to groundwater that is used for drinking water. Otherwise, the groundwater exposure pathway is considered incomplete. The following parameters are used to determine if an AOPI source area had a potentially complete groundwater exposure pathway:

- AOPIs located upgradient or in the vicinity of drinking water sources and that have the potential to influence groundwater associated with these potable sources are considered to have a potentially complete groundwater exposure pathway for on-post drinking water receptors.
- AOPIs located outside the vicinity or downgradient of on-post potable sources (drinking water wells) are considered to have an incomplete groundwater exposure pathway for on-post receptors due to Army land controls which prevent any intrusive work without directorate of public works approval per the Master Plan and the dig permitting process.
- AOPIs that have the potential to influence groundwater that flows off post are considered to have a potentially complete exposure pathway for off-post receptors.

A surface water exposure pathway is considered potentially complete where constituents of concern could be present in a surface water body (e.g., a reservoir or large river) that serves as a potable water source. Otherwise, the surface water exposure pathway is considered incomplete. There are no on-post surface water features used as a drinking water source. Off-post, the Yakima and Columbia Rivers are known to be used as a drinking water source; while specific locations of drinking water intakes near YTC are not known, constituents are not likely to migrate from soil to these surface water features due to YTC's arid climate and ephemeral nature of on-post surface water features. Therefore, surface water is not identified as a potential exposure medium for on- or off-post receptors.

AOPI-specific drinking water pathway CSM summaries are provided below in **Tables 5-2** through **5-4** and in **Figures 5-3** through **5-4.**

5.2.1 YFCR-53 Former Fire Training Pit (HQAES Site 1214A.1050)

The YFCR-53 Former Fire Training Pit was identified as an AOPI following document research, personnel interviews, and site reconnaissance trips due to reported historical firefighter training activities, during which PFAS was likely released given the time period of operation of the site. Installation fire department staff indicated that the pit area would have also been used for nozzle and flow testing when the pit was in operation. **Figure 5-2** shows the likely areal extent of AFFF use for this AOPI.

The YFCR-53 Former Fire Training Pit site is located in the northeast portion of the cantonment area and was identified as SWMU 59 in the 1995 RCRA Facility Investigation (RFI). The site was used to practice extinguishing fires two or three times per year from an unknown start date until 1987, with a single training event in 1990. Practice events consisted of saturating an open, unlined earthen pit with water, adding and igniting 500 to 1,000 gallons of waste fuel, and then extinguishing the fire. During the 1990s, the site was used for storing stockpiles of waste sand filter material and sediments from the adjacent vehicle wash rack treatment system (i.e., Building 868 – Bird Bath Vehicle Wash Rack) as well as storing fuel bladders. An RFI was conducted in 2001 to determine the extent of petroleum impacts in soil, and

based on the results, a removal action of approximately 1,350 tons of petroleum-impacted soil was completed in 2003 (USACE 2012). The disposal location of the soil is not known; however, it has been documented that some of the excavated material was used as the excavation's own backfill. The site is currently undeveloped and is not being used or expected to be used in the future; land use controls are in place. It consists of vegetative cover (grasses and shrubs) with ephemeral surface water features nearby.

Five operable monitoring wells (FTP-1 and FTP-13 through -16) are located downgradient of the area which was impacted by petroleum, oil, and lubricants constituents; analytical groundwater and soil samples historically collected at the FTP have not been analyzed for PFAS. The monitoring well construction details are included in **Appendix I**. Shallow groundwater (i.e., encountered at 10-25 feet bgs) in this area flows southwest; the next deepest groundwater bearing unit is at approximately 150 feet bgs. The Pomona and PAIC drinking water supply wells are approximately 1 mile southwest of the AOPI (Tetra Tech 2017).

The CSM information for YFCR-53 is presented in **Table 5-2** below and on **Figure 5-3**.

Table 5-2. AOPI CSM Information Profile – YFCR-53 Former Fire Training Pit

Profile Type	Information Needs	Preliminary Assessment Findings
Site profile	AOPI site structures/ description	The ground is flat and sparsely vegetated (undeveloped) at this AOPI.
	Latitude, longitude	46.68332, -120.43929
Land use	Current/future land use	Industrial
CSM profile (**Figure 5-3**)	Source media	Soil
	Migration routes/ release mechanisms	Constituents could migrate from soil to groundwater via desorption and dissolution. Constituents are not likely to migrate from soil to surface water due to YTC's arid climate and the ephemeral nature of the on-post surface water features.
	Exposure pathways, media, and human receptors	Perched groundwater within this area flows southwest towards the on-post drinking water wells (Pomona, PAIC, and Jordan wells). However, the perched aquifer does not appear to be connected to the drinking water aquifer. Therefore, there is an incomplete exposure pathway for drinking water receptors using the on-post potable wells, and for the off-post receptors using the on-post PAIC potable well. Perched groundwater originating at this AOPI could eventually migrate off-post; therefore, there is a potentially complete

Profile Type	Information Needs	Preliminary Assessment Findings
		exposure pathway for off-post receptors.

5.2.2 Bird Bath Vehicle Wash Rack/Former Firefighter Training Area (Building 868)

The Bird Bath Wash Rack and Former Firefighter Training Area (now identified as Building 868) was identified as an AOPI following personnel interviews and site reconnaissance trips. Retired installation personnel noted historical firefighter training activities (and therefore likely AFFF use) in the area prior to construction of the wash rack facility. The area is adjacent to the YFCR-53 Former Fire Training Pit AOPI and therefore may have also likely been used as a training area. Google Earth aerial imagery indicates that the wash rack facility was not installed until after 1996; the imagery indicates a rectangular depression in 1996 in the area of the current wash rack that may have been a bermed pit.

Groundwater conditions at this site are expected to be similar to that observed at former Fire Training Pit YFCR-53: shallow groundwater (i.e., encountered at 10-25 feet bgs) in this area flows southwest, and the next deepest groundwater bearing unit is at approximately 150 feet bgs. The Pomona and PAIC drinking water supply wells are approximately 1 mile southwest of the AOPI.

The Bird Bath Wash Rack and Former Firefighter Training Area CSM information is presented in **Table 5-3** below and on **Figure 5-3**.

Table 5-3. AOPI CSM Information Profile – Bird Bath Vehicle Wash Rack/Former Firefighter Training Area (Building 868)

Profile Type	Information Needs	Preliminary Assessment Findings
Site profile	AOPI site structures/ description	The area is now a built-up, tiered concrete structure with a large, bermed asphalt drying pad on which sediments from wash rack operations accumulate. The asphalt pad has some cracking with vegetation growing through it. The northwest abutment slopes steeply toward the cantonment area and is sparsely vegetated.
	Latitude, longitude	46.68282, -120.43796
Land use	Current/future land use	Industrial
CSM profile (**Figure 5-3**)	Source media	Soil
	Migration routes/ release mechanisms	Constituents could migrate from soil to groundwater via desorption and dissolution. Constituents are not likely to migrate from soil to surface water due to YTC's arid climate and the

Profile Type	Information Needs	Preliminary Assessment Findings
		ephemeral nature of the on-post surface water features.
	Exposure pathways, media, and human receptors	Perched groundwater within this area flows southwest towards the on-post drinking water wells (Pomona, PAIC, and Jordan wells). However, the perched aquifer does not appear to be connected to the drinking water aquifer. Therefore, there is an incomplete exposure pathway for drinking water receptors using the on-post potable wells, and for the off-post receptors using the on-post PAIC well. Perched groundwater originating at this AOPI could eventually migrate off-post; therefore, there is a potentially complete exposure pathway for off-post receptors.

5.2.3 Refractometer Solutions Testing Area (Building 323)

The Refractometer Solutions Testing Area (near Building 323) was identified as an AOPI following personnel interviews and site reconnaissance trips due to the reported AFFF mixing and testing of the crash trucks' nozzles conducted by the YTC Fire Department.

East of Building 323, the asphalt parking lot was reportedly used for refractometer testing of mixed AFFF solutions from at least 1997 to 2004 (quarterly testing). The AFFF and water were mixed at this location, and some of the solution was discharged to the asphalt ground. Most of the solution reportedly dried up on the asphalt before it could flow to the ditch to the north of the parking lot; however, residual PFAS may have run off during precipitation events to the ditch (which flows to an oil-water separator that eventually leads to an outfall off-post [**Section 4.7**]). The AOPI is not associated with a previous IRP site. Shallow groundwater in this area flows southwest. Based on its proximity to the old TVR/MATES site, groundwater may be expected to be encountered at 10-45 feet bgs near this AOPI. The next encountered groundwater aquifer in the TVR/MATES sites was at the Selah interbed of the Ellensburg Formation, beneath the Pomona basalt flow with depths to water ranging 60 to 100 feet bgs; this deeper groundwater flows west toward the Yakima River. The Pomona and PAIC drinking water supply wells (whose water intakes are around 400 feet bgs) are approximately 1,000 feet northeast of the AOPI.

The Refractometer AFFF Solutions Testing Area CSM information is presented in **Table 5-4** below and on **Figure 5-4**.

Table 5-4. AOPI CSM Information Profile – Refractometer Solutions Testing Area (Building 323)

Profile Type	Information Needs	Preliminary Assessment Findings
Site profile	AOPI site structures/ description	This AOPI is a large, clear paved area to the east of current and former AFFF storage buildings. The lot

Profile Type	Information Needs	Preliminary Assessment Findings
		slopes gently north, and runoff flows into stormwater ditches and to an oil/water separator across Firing Center Road (**Figure 5-2**).
	Latitude, longitude	46.67372, -120.45573
Land use	Current/future land use	Industrial
CSM profile (**Figure 5-3**)	Source media	Paved surfaces
	Migration routes/ release mechanisms	Constituents could migrate from the paved surfaces via runoff from precipitation events to the unlined stormwater ditch to the north of the asphalt parking lot. Runoff from this AOPI would flow into the oil/water separator across Firing Center Road. Constituents could migrate to groundwater through cracks in the paved surfaces or through the unlined ditch via surface water runoff.
	Exposure pathways, media, and human receptors	Perched groundwater within this area flows southwest away from the on-post drinking water wells (Pomona, PAIC, and Jordan wells). Additionally, the perched aquifer does not appear to be connected to the drinking water aquifer. Therefore, there is an incomplete exposure pathway for drinking water receptors using the on-post potable wells, and the off-post receptors using the on-post PAIC well. Perched groundwater originating at this AOPI could eventually migrate off-post; therefore, there is a potentially complete exposure pathway for off-post receptors.

5.3 Data Limitations at YTC

The data limitations relevant to the development of this PA for PFAS at YTC are discussed below.

Records reviewed during the PA process were limited in information regarding AFFF use; procurement records of AFFF and documentation of AFFF used during crash responses or firefighter training activities were not available. Anecdotal accounts of AFFF use (and therefore likely PFAS release) were limited to available installation personnel, whose knowledge of AFFF use may have been restricted by their time spent at the installation or previous roles held that limited their relevant knowledge of potential AFFF (or other PFAS) use.

A comprehensive well survey was not completed as part of this PA, therefore the information reviewed regarding off-post wells is limited. The EDR well search report (**Appendix D**), historical site documents (Tetra Tech 2017), and online databases (Department of Ecology 2019) were referenced when identifying potential off-post drinking water receptors.

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

The CSMs presented in this report intentionally focus on the potential for human exposure through ingestion of groundwater or surface water that is used as a source of potable water. The Army implements controls which prevent any intrusive work without directorate of public works approval per the Master Plan and the dig permitting process. Therefore, the potential for future exposures of on-post receptors through new potable well installations is considered improbable. However, these Army controls do not prevent future consumption of drinking water for land if it is no longer controlled by the Army. Potential human exposures through other environmental media (e.g., soil/airborne dust, sediment, aquatic biota) are not evaluated. The potential for human exposure to PFAS through non-drinking water exposure pathways as well as ecological receptor exposures to PFAS have not yet been established and may be evaluated at a future date if it has been determined that those pathways warrant further consideration.

Finally, the available PFAS analytical data is limited to results from on-post drinking water well sources; no data is available to identify PFAS presence or absence at the AOPIs or in off-post wells (including residential wells installed in the shallow aquifer less than a half-mile from the cantonment area). Data gaps may be addressed during a site inspection.

6 CONCLUSIONS

Arcadis conducted this PA to document PFAS releases at YTC, in accordance with, and as contracted by USACE Baltimore District. Programmatically, the Army has focused its PFAS PA efforts on two major sources of potential PFAS (including PFOS and PFOA) releases to the environment at the installations included in the contract: 1) the use of AFFF and 2) the use of mist suppressants associated with chromium plating operations. However, other sources of PFAS at the installation have been documented in this PA. Although there is currently no federal MCL defined for any PFAS, a HAL has been established for both PFOS and PFOA. A combination of document review, internet searches, interviews with installation personnel, and an installation site visit were used to identify specific areas of suspected PFAS use and releases at YTC.

A total of 10 potential areas of PFAS release were evaluated. Following the evaluation, 3 AOPIs were identified. The PFAS source types identified during this PA at YTC are listed below:

- Two former firefighter training areas (YFCR-53 Former Fire Training Pit and the Bird Bath Vehicle Wash Rack/Former Fire Training Pit Area [Building 868]), and
- A fire nozzle testing area (Refractometer Solutions Testing Area [Building 323]).

A site-specific drinking water pathway CSM was developed for each AOPI based on an assessment of existing records, personnel interviews, and site reconnaissance trips. The drinking water pathway CSMs developed for this PA did not identify any of the three AOPIs as impacting or having the potential to impact on-post drinking water receptors. However, the exposure pathway for off-post drinking water receptors is potentially complete for the three AOPIs.

Although the most recent (i.e., 2018) PFAS analytical data reportedly demonstrate non-detect concentrations of PFAS in the on-post drinking water supply wells, four PFAS (including PFOA) have been detected at low concentrations (i.e., less than the HAL) in the Pomona and PAIC wells (0.43 J ng/L and 0.53 J ng/L PFOA, respectively, in April 2016). As it has not been demonstrated that the shallow aquifer is in communication with the drinking water aquifer, it is suspected that the low-level detections of PFAS in the Pomona and PAIC wells may be due to equipment contamination (i.e., tubing, well construction materials).

Results from this PA may be used to determine if a site inspection for PFAS is warranted at YTC.

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TABLES

Table 2-1: Potable Well Construction Details
USAEC PFAS Preliminary Assessment
Yakima Training Center, WA

Well Identification	Building Location	Basin	Easting	Northing	Casing Depth (ft bgs)	Total Depth (ft bgs)	Approximate Static Water Level (ft bgs)
Badger Pocket/ Badger Gap	P-U084E	Yakima	708607.6875 707116.5087	5192417.0000 5192944.1759	490	510	175
Bowers	P-0860	Yakima	696344.7162	5173298.4509	241	541	162
Dead Truck Farm	P-0020	Yakima	707154.0000	5203249.0000	40	150	53
Doris	P-3002	Columbia	728443.7002	5194962.1377	580	580	435
Exit 11	P-2239	Yakima	701394.5625	5188940.0000	200	580	289
Hester	NA	Yakima	703211.0454	5172606.5475	315	585	244
Jordan	P-0551 (P-0550)	Yakima	695149.8483	5171842.6186	365	617	53
MPRC	P-U084B	Columbia	717131.3750	5185002.5000	1300	1311	1005
North Filey Road	P-0010	Columbia	730923.2891	5167831.9164	40	950	533
PAIC	P-0840	Yakima	694859.3956	5172220.3995	(NA - similar to Pomona well*)		
Pomona	P-0829	Yakima	694871.1001	5172244.3853	353	407	artesian
Range 19	P-2229	Yakima	706162.6875	5184387.0000	135	425	93
Range 55	P-2555	Yakima	718105.7771	5168615.0850	105	135	72
Range Control	P-1804	Yakima	703217.6792	5172521.3933	281	302	266
Selah Airstrip	P-2060	Yakima	704259.7500	5176188.0000	73	91	47
YRS	P-1721	Yakima	701889.5431	5172927.9990	307	602	324

Acronyms:
bgs – below ground surface
ft – feet
MPRC – Multi-Purpose Range Complex
PAIC – Pamona Artesian Irrigaion Company
TOC – top of casing
YRS – Yakima Research Station

Sources:
Data table: Yakima Training Center. 2003. Yakima Training Center Well Data. June.
*Construction details not provided on source table noted above. Additional information regarding PAIC well construction is as provided by the United States Army Corps of Engineers in the 2012 Periodic Review Report, Yakima Training Center, Yakima, Washington.

Table 4-1. Historical PFAS Analytical Results
USAEC PFAS Preliminary Assessment
Yakima Training Center, WA

Well ID		Pomona (Bldg 829)	Bowers (Bldg 860)	Jordan (Bldg 550)	MPRC (Bldg 84B)	Badger Gap (Bldg 2110)	YRS (Bldg 1901)
Sample ID		YTC_GW_991042 PomonaWell_FW	YTC_GW_991042 BowersWell_FW	YTC_GW_991042 JordanWell_FW	YTC_GW_07035T MPRCWell_FW	YTC_GW_070349 BadgerGap_FW	YTC_GW_07029LY RSBLDG1901_FW
Laboratory		EEA	EEA	EEA	EEA	EEA	EEA
Sample Date		10/26/2016	10/25/2016	10/26/2016	10/25/2016	10/25/2016	10/26/2016
PFAS (ng/L)	**HAL**						
Perfluorobutanesulfonic acid (PFBS)	--	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
Perfluoroheptanoic acid (PFHpA)	--	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
Perfluorohexanesulfonic acid (PFHxS)	--	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
Perfluorooctanoic acid (PFOA)	70	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
Perfluorononanoic acid (PFNA)	--	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
Perfluorooctanesulfonic acid (PFOS)	70	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0

Notes and Acronyms:

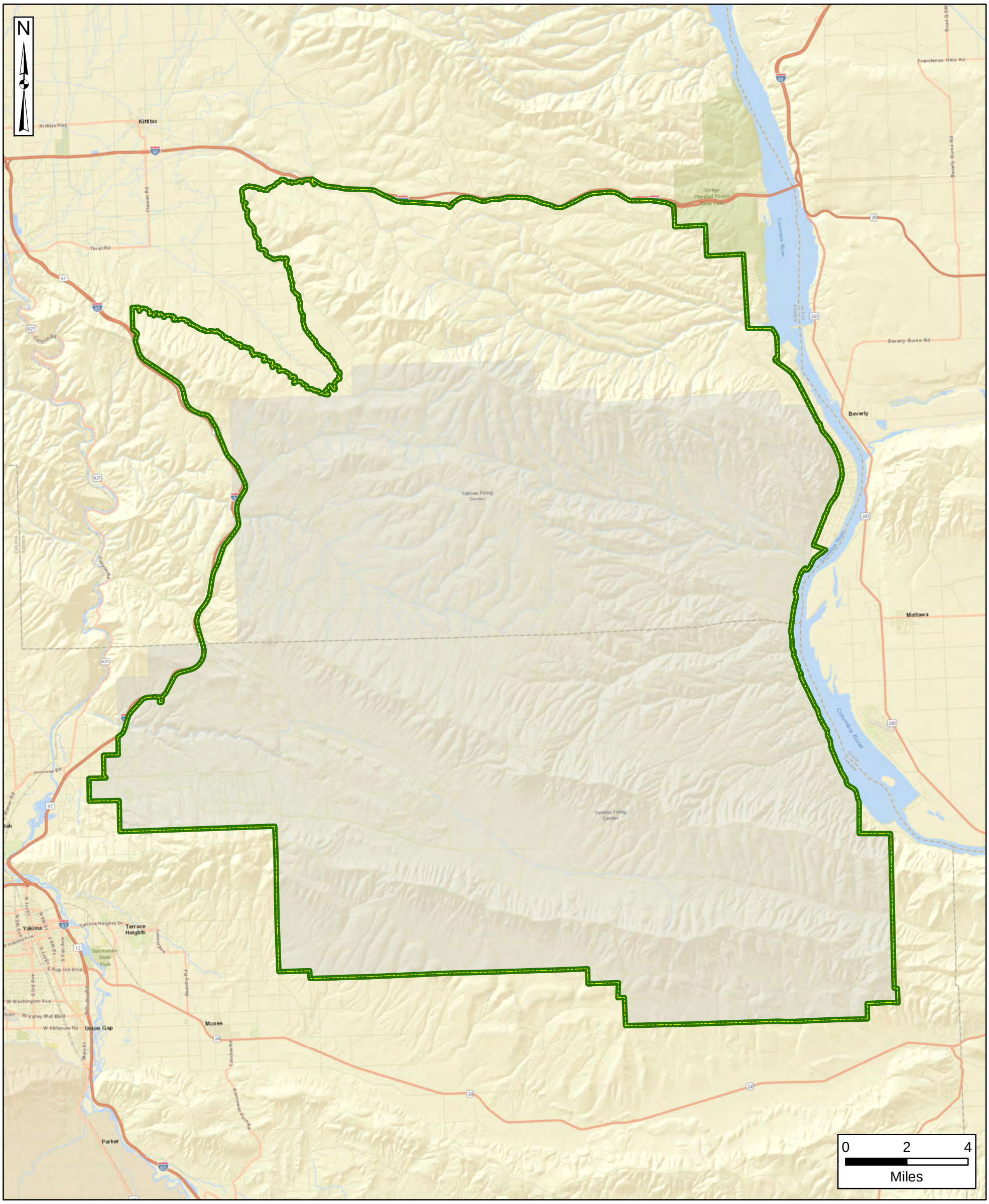
1. All data and qualifier definitions are as provided in laboratory analytical reports.

-- = not applicable
< = concentration not detected greater than the noted method reporting limit
Bldg = building
EEA = Eurofins Eaton Analytical
HAL = 2016 United States Environmental Protection Agency Health Advisory Level of 70 ng/L for PFOS, PFOA, or the sum of PFOS and PFOA
MPRC = Multi-purpose Range Complex
ng/L = nanograms per liter
PFAS = per- and polyfluoroalkyl substances
YRS = Yakima Research Station

FIGURES

USAEC PFAS Preliminary Assessments
Yakima Training Center, WA

Figure 2-1
Site Location



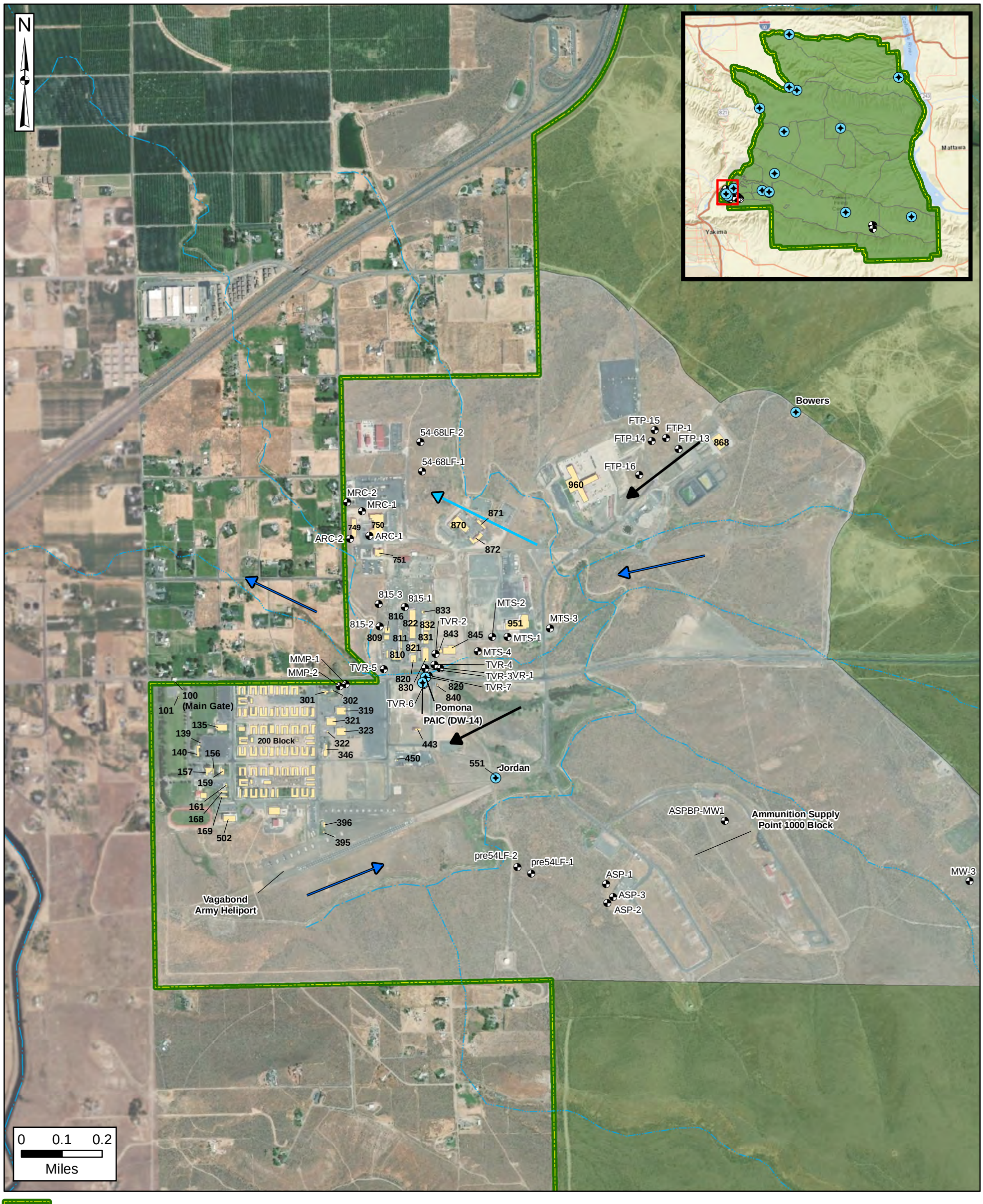
Installation Boundary

Data Sources:
Yakima Training Center, GIS Data, 2018
ESRI ArcGIS Online, Street Map Data

Coordinate System:
WGS 1984, UTM Zone 10 North

USAEC PFAS Preliminary Assessments
Yakima Training Center, WA

Figure 2-2
Site Layout



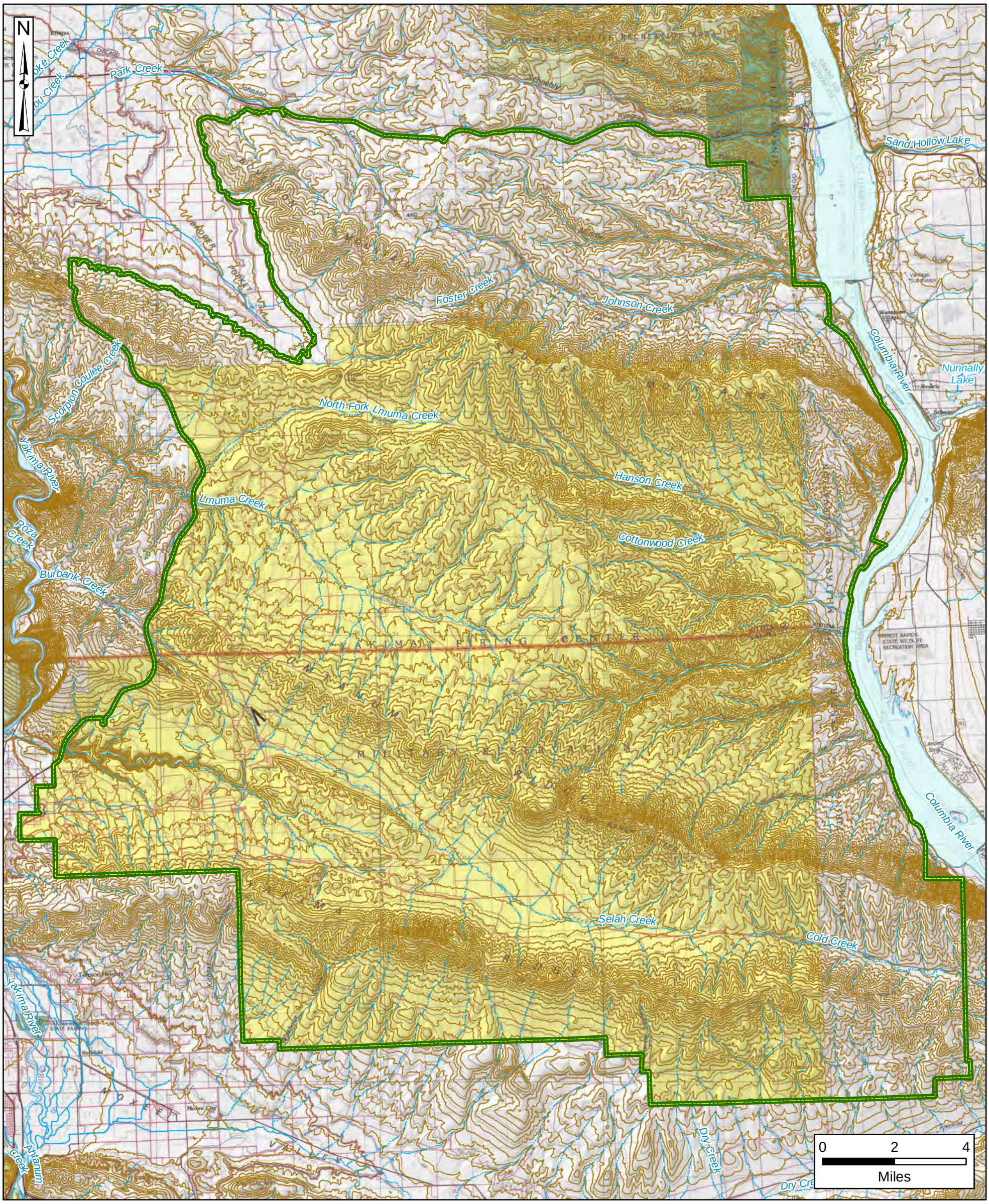
Installation Boundary
Cantonment Area
Range/Training Area
Building
Potable Water Well
Monitoring Well
River/Stream (Perennial)
River/Stream (Intermittent)
Canal/Ditch
Surface Water Flow Direction
Potable Groundwater Flow Direction
Perched Groundwater Flow Direction

Data Sources:
Yakima Training Center, GIS Data, 2018
ESRI ArcGIS Online, Aerial Imagery

Coordinate System:
WGS 1984, UTM Zone 10 North

USAEC PFAS Preliminary Assessments
Yakima Training Center, WA

Figure 2-3
Topography Map



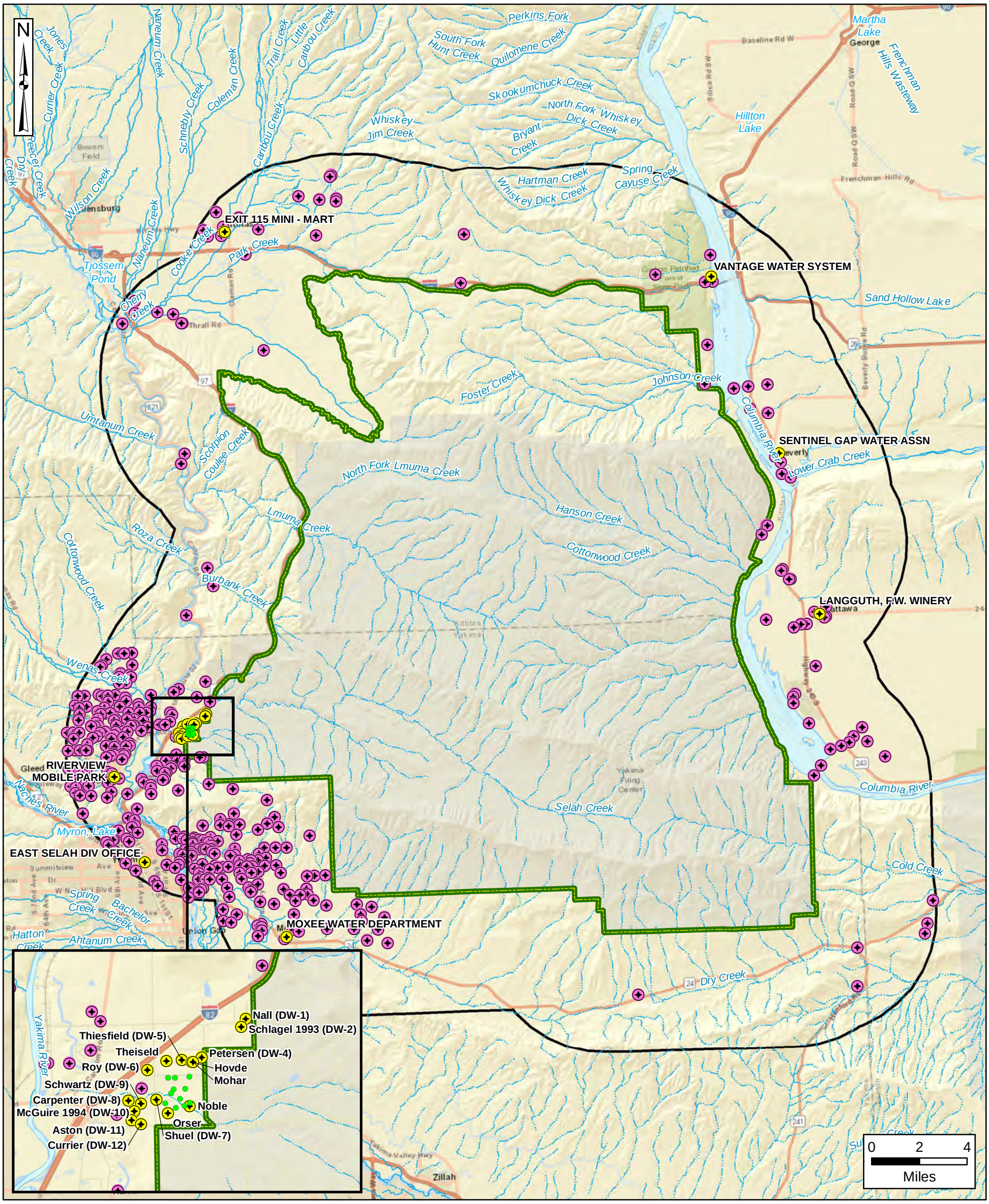
Installation Boundary
Elevation Contour (100 ft)
River/Stream (Perennial)
River/Stream (Intermittent)
Water Body

Data Sources:
Yakima Training Center, GIS Data, 2018
ESRI ArcGIS Online, Topo Map

Coordinate System:
WGS 1984, UTM Zone 10 North

USAEC PFAS Preliminary Assessments
Yakima Training Center, WA

Figure 2-4
Off-site Potable Well Locations



Installation Boundary
5-Mile Radius
River/Stream (Perennial)
River/Stream (Intermittent)
Water Body

Public Supply Well
State Supply Well
Residential Supply Well*

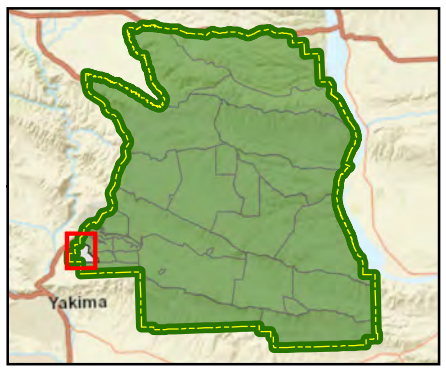
*Location of residential wells are as provided in the Final Groundwater Monitoring Report: Fire Training Pit and Tracked Vehicle Repair/Old Mobilization and Training Equipment Site, Joint Base Lewis-McChord and Yakima Training Center, Yakima, Washington (Tetra Tech, 2017).

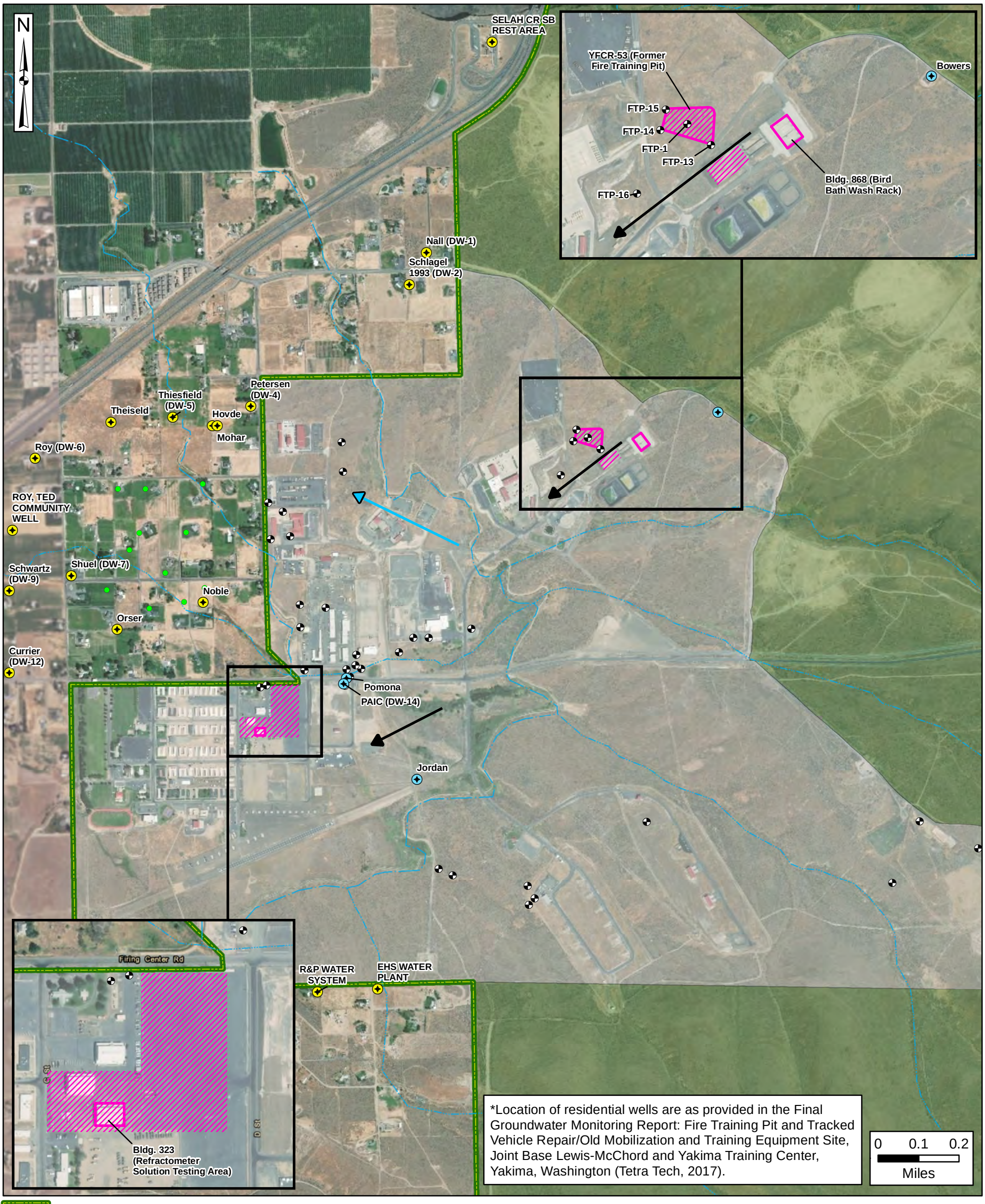
Data Sources:
Yakima Training Center, GIS Data, 2018
ESRI ArcGIS Online, Street Map Data

Coordinate System:
WGS 1984, UTM Zone 10 North

USAEC PFAS Preliminary Assessments
Yakima Training Center, WA

Figure 5-2
AOPI Locations and Extent of AFFF Use



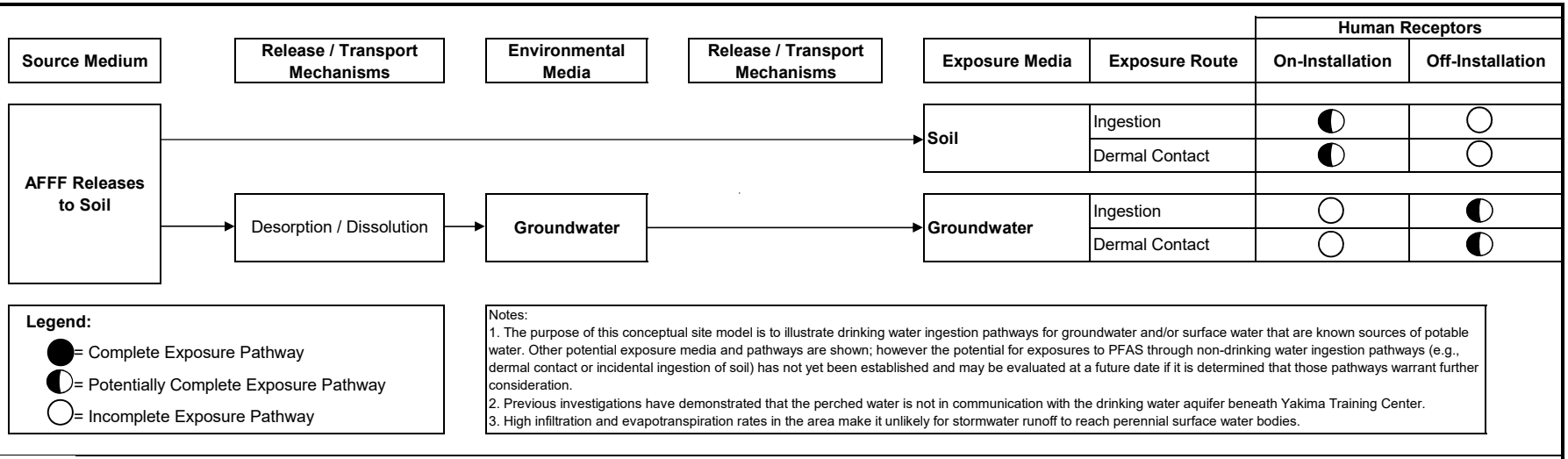


- Installation Boundary
- Cantonment Area
- Range/Training Area
- AOPI
- AFFF Use Area
- Monitoring Well
- Drinking Water Well (On-Installation)
- Water Supply Well (Off-Installation)
- Residential Supply Well*
- River/Stream (Perennial)
- River/Stream (Intermittent)
- Canal/Ditch
- Potable Groundwater Flow Direction
- Perched Groundwater Flow Direction

AFFF = Aqueous Film-Forming Foam
AOPI = Area of Potential Interest
Bldg. = building

Data Sources:
Yakima Training Center, GIS Data, 2018
ESRI ArcGIS Online, Aerial Imagery

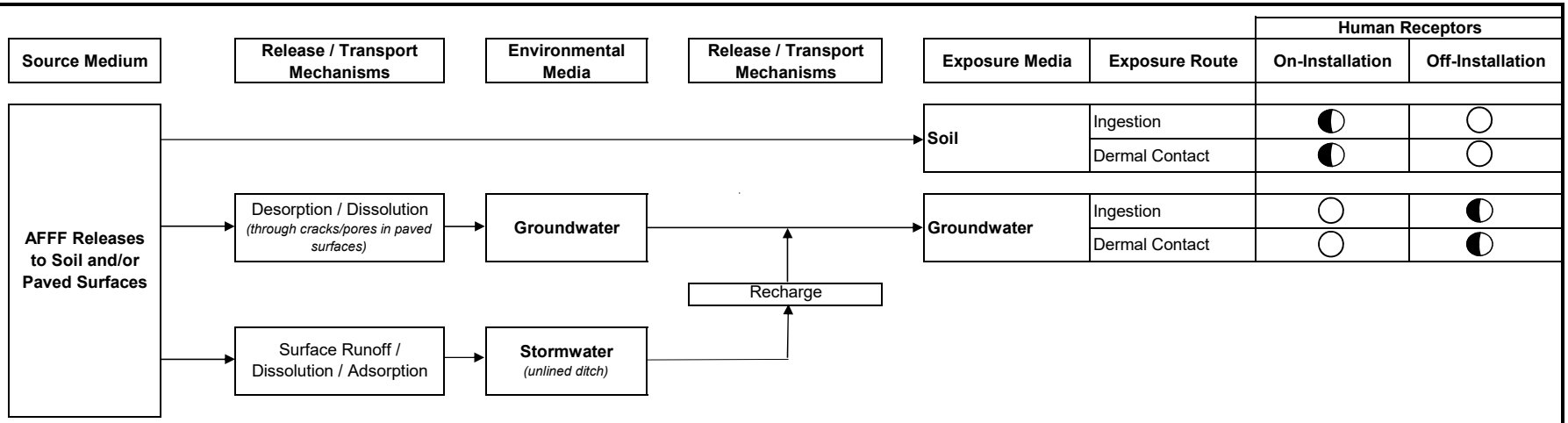
Coordinate System:
WGS 1984, UTM Zone 10 North



ARCADIS

Conceptual Site Model for Drinking Water Pathway - YFCR-53 Former Fire Training Pit and Bird Bath
USAEC PFAS Preliminary Assessment
Yakima Training Center, Washington

Figure 5-3



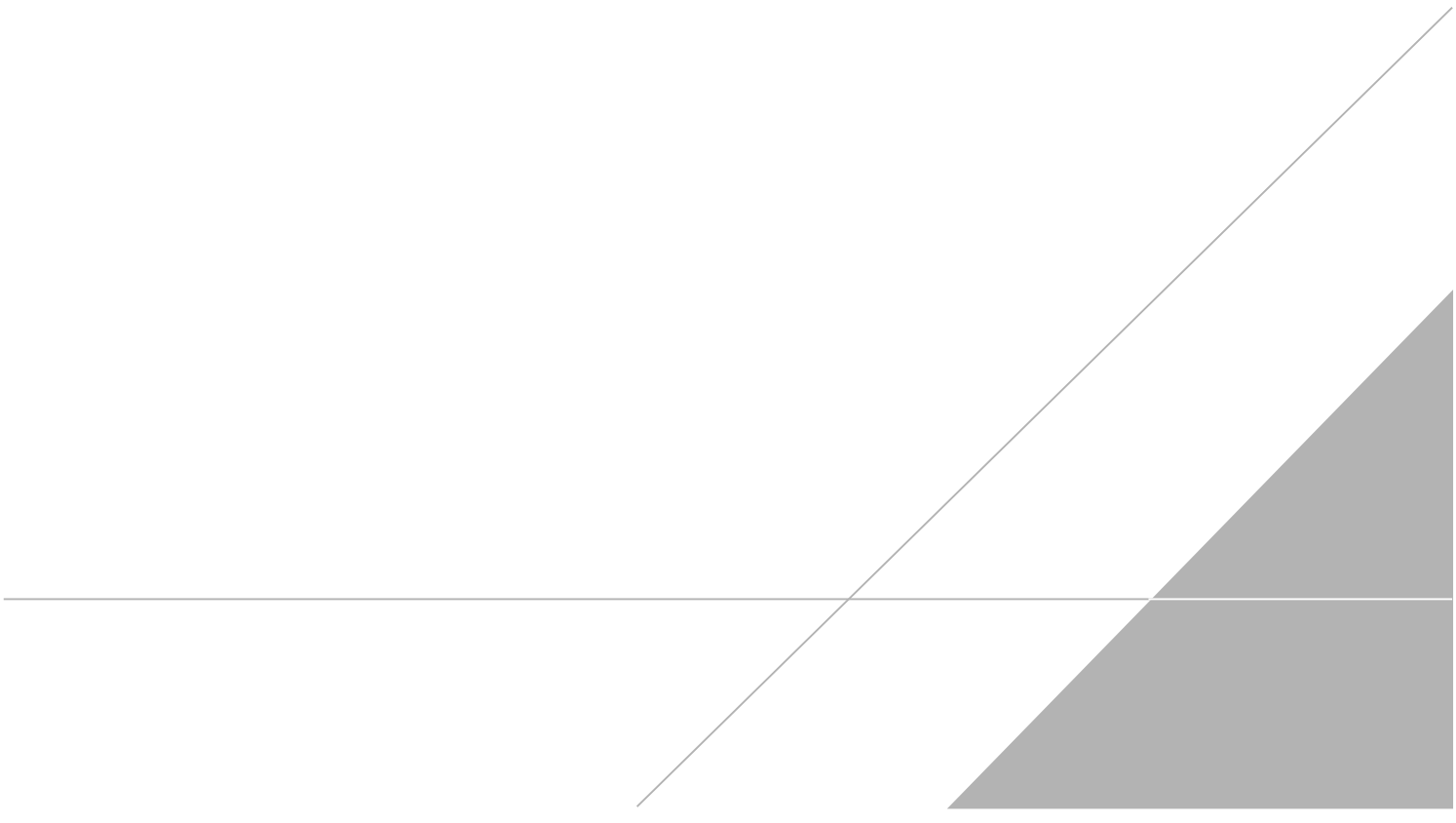
ARCADIS

Conceptual Site Model for Drinking Water Pathway - Refractometer Testing Area Building 323
USAEC PFAS Preliminary Assessment
Yakima Training Center, Washington

Figure 5-4

APPENDIX A

Antiterrorism/Operations Security Review Cover Sheet

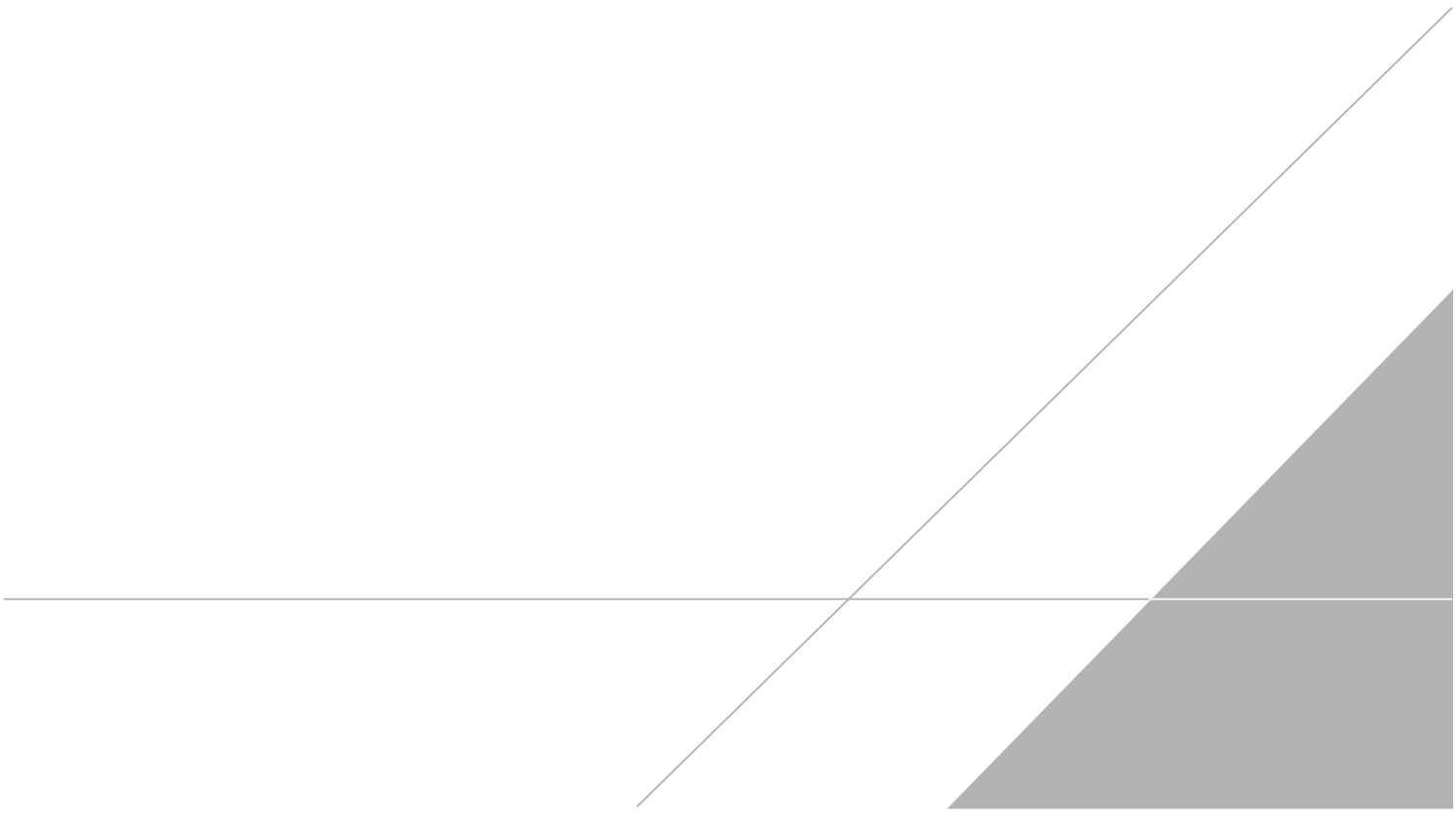


APPENDIX B

GIS Deliverable (electronic copy)

APPENDIX C

Installation PA Quality Control Checklist



APPENDIX D

Installation EDR Survey Reports

APPENDIX E

Compiled Research Log

APPENDIX F

Compiled Interview Logs

APPENDIX G

Site Reconnaissance Photos

APPENDIX H

Compiled Site Reconnaissance Logs

APPENDIX I

Monitoring Well Inventory

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