

2016 ANNUAL REPORT

Groundwater Monitoring and Whole-House Filter Program for Moses Lake Wellfield Superfund Site (Former Larson Air Force Base)

Moses Lake, Washington

CERCLIS Site No. WAD988466355

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EXECUTIVE SUMMARY

The purpose of this Annual Report is to summarize findings from the 2016 Moses Lake Wellfield Superfund Site (Site) sampling program. The U.S. Army Corps of Engineers (USACE) conducted this sampling program on behalf of the U.S. Environmental Protection Agency (EPA), Region 10. The objectives of this sampling program are 1) to ensure protection of human health by sampling groundwater and comparing contaminant concentrations to the federal drinking water maximum contaminant level (MCL) for Site contaminants such as trichloroethene (TCE), and 2) to gather baseline data prior to the implementation of groundwater pump and treat systems. As part of the sampling program, USACE also installs and maintains whole-house filter (WHF) treatment systems at ten private properties to prevent human exposure to TCE and related contaminants of concern (COCs) at levels that exceed the MCLs.

The 2016 sampling program consisted of four sampling events that occurred in February, May, August, and November. During the 2016 sampling program, the TCE MCL (5.0 micrograms per liter [µg/L]) was exceeded in approximately 33% of the monitoring and extraction wells. Neither the TCE MCL nor the cis-1,2-dichloroethene (cis-DCE) MCL was exceeded in the private wells. However, the TCE MCL was exceeded in WP-04, the well that services Granite Construction for industrial purposes.

USACE sampled approximately 68 private wells and 75 monitoring and extraction wells over the course of the year, and also replaced granular activated carbon (GAC) annually for the private wells with WHFs. There have been no detections of TCE or cis-DCE in the mid or effluent samples from the WHFs (the latter leads into the homes), which confirmed that the WHFs are protecting human health. An action threshold of 2 µg/L TCE has been used to place private wells on quarterly sampling (as opposed to annual sampling), and an action threshold of 3.5 µg/L TCE has been used to determine which private wells receive a WHF. In 2016, no private wells exceeded the TCE action threshold of 3.5 µg/L; thus, no WHFs were installed.

At EPA's request, in May 2016, four private wells and four monitoring wells were sampled for perfluorinated alkyl acids (PFAAs). There were no detects of PFAAs in the private wells; however, three of the four monitoring wells exceeded the EPA health advisory for combined perfluorooctanesulfonic acid (PFOS) and perfluorooctanoic acid (PFOA). Also in May 2016, 12 monitoring wells and 8 private wells were sampled for 1,4-dioxane. No wells exceeded EPA's screening level of 0.67 µg/L. During the 2015 sampling program, samplers noticed a petroleum smell emanating from monitoring well 00BW01. In May 2016, 00BW01 was sampled for diesel range organics (DRO), gasoline range organics (GRO), benzene, toluene, ethylbenzene, and xylene (BTEX). DRO was the only detected constituent.

A WHF efficiency memo was prepared for WP-125 and WP-123. The memo concluded that the WHFs are working sufficiently to reduce TCE. There were no detections of TCE in the mid or effluent ports.

A seasonal trend analysis was prepared and submitted to EPA in August 2016. The trend analysis covered a subset of wells that were sampled quarterly (eight sampling events) from June 2014 through February 2016. The trend analysis identified seasonal trends and specified the months that the monitoring wells (January) and private wells (some in January, some in August) should be sampled to capture the highest TCE concentrations.

Recommendations from the 2015 sampling program and the status as of the end of 2016 are provided in Section 6. Because the work plan for 2017 had already been finalized on November 3, 2016, before 2016 events were completed, recommendations from the 2016 sampling program were not fully known at that time. Thus, recommendations made in this Annual Report, also in Section 6, might not be implemented until 2018.

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ACRONYMS

1,1-DCE	1,1-dichloroethene
ADR	Automated data review
AFB	Air Force Base
BTEX	Benzene, toluene, ethylbenzene, xylene
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
cis-DCE	cis-1,2-dichloroethene
CSM	Conceptual site model
COC	Contaminant of concern
1,2-DCA	1,2-dichloroethane
1,1-DCA	1,1-dichloroethane
DERP-FUDS	Defense Environmental Restoration Program - Formerly Used Defense Sites
DQIs	Data Quality Indicators
DQOs	Data Quality Objectives
DRO	Diesel range organics
DoD QSM	Department of Defense Quality Systems Manual for Environmental Laboratories
DSHS	(Washington) Department of Social and Health Services
GAC	Granular activated carbon
GRO	Gasoline range organics
IA	Interagency Agreement
IROD	Interim Record of Decision
MCL	Maximum contaminant level
MWH	Montgomery Watson Harza
NC	Not calculated
µg/L	Micrograms per liter
PDB	Passive diffusion bag
PE	Performance evaluation
PFBS	Perfluorobutanesulfonic acid
PFAA	Perfluorinated alkyl acids
PFHpA	Perfluoroheptanoic acid
PFHxS	Perfluorohexanesulfonic acid
PFNA	Perfluorononanoic acid
PFOA	Perfluorooctanoic acid
PFOS	Perfluorooctanesulfonic acid
QC	Quality Control
QAPP	Quality Assurance Project Plan
QCSR	Quality Control Summary Report
RI	Remedial Investigation
RL	Reporting limit
ROE	Right-of-entry
SEDD	Staged electronic data deliverable
TCE	Trichloroethene
trans-DCE	trans-1,2-dichloroethene
1,1,1-TCA	1,1,1-trichloroethane

USACE	United States Army Corps of Engineers
USEPA	United States Environmental Protection Agency
VC	Vinyl chloride
VOC	Volatile organic compounds
WDOE	Washington State Department of Ecology
WDOH	Washington State Department of Health
WHF	Whole-house filter

1. INTRODUCTION

The purpose of this Annual Report is to summarize findings from the 2016 Moses Lake Wellfield Superfund Site (Site) groundwater sampling program. The U.S. Army Corps of Engineers (USACE) conducted this sampling program on behalf of the U.S. Environmental Protection Agency (EPA), Region 10, pursuant to the 2008 Interim Record of Decision (IROD) for the Site (EPA 2008) and the 2016 USACE Work Plan-Quality Assurance Project Plan (WP-QAPP; USACE 2016). USACE provides ongoing technical assistance focused on groundwater sampling and whole-house filter (WHF) maintenance as required to protect human health. This report is organized as follows:

- Section 1: Introduction
- Section 2: Sampling and Field Activities for 2016
- Section 3: Analysis, Data Validation, and Results
- Section 4: State Well Inventory Database Search
- Section 5: Summary and Discussion
- Section 6: Recommendations

1.1. 2016 Sampling Program Scope of Work

The scope of work for the USACE 2016 sampling program consisted of the following activities:

- Notifying residents of 2015 annual sampling results in early 2016;
- Obtaining and updating rights-of-entry (ROEs) for site access;
- Awarding a new WHF base contract for WHF maintenance;
- Maintaining and servicing the WHF treatment systems;
- Preparing a WHF efficiency memo;
- Preparing a seasonal trend analysis to ascertain the months with highest TCE concentrations;
- Collecting, analyzing, and evaluating contaminant of concern (COC) data and groundwater elevation data in groundwater monitoring wells;
- Collecting, analyzing, and evaluating COC data in unfiltered private wells and private wells with WHF systems
- Sampling a subset of wells for perfluorinated alkyl acids (PFAAs), specifically perfluorooctanesulfonic acid (PFOS) and perfluorooctanoic acid (PFOA); 1,4-dioxane; diesel range organics (DRO); gasoline range organics (GRO); and benzene/toluene/ethylbenzene/xylene (BTEX);
- Coordinating and contracting with laboratories and subcontractors for data analysis and data validation;

- Updating the project database (EQuIS™) with sampling results and updating an Excel spreadsheet with sampling results;
- Updating the online mapping system with TCE results;
- Reviewing the Washington State Department of Ecology (WDOE) well inventory database for newly constructed private wells that may be at risk for COCs; and
- Preparing a WP-QAPP for the 2016 work; and preparing an Annual Report summarizing 2016 activities (this document).

1.2. Site Background

The Site is located within and beyond the northwestern region of the City of Moses Lake, Washington. See Figure 1 for the Site's location and Figure 2 for the institutional control (IC) boundaries and plumes. The Site encompasses approximately 15 square miles and includes the Grant County International Airport and surrounding area (formerly the Larson Air Force Base [LAFB]), commercial facilities, and residences.

Previous environmental investigations conducted at the Site identified contamination of soil and groundwater resulting from historic operation of the former LAFB and industrial activities associated with the aircraft industry. Potential source areas are scattered throughout the Site, and approximately 1000 acres of groundwater have been identified as contaminated to date.

Previous investigations focused primarily on the former LAFB. The former LAFB occupied approximately 9607 acres and was active from 1942 until 1966. In 1988, three municipal wells operated by the City of Moses Lake were found to be contaminated with trichloroethene (TCE). Additionally, TCE was historically detected in two domestic wells operated by the Skyline Water System, Inc., a private water provider located in unincorporated Grant County south of the former LAFB property. Domestic (residential) and commercial (light or heavy industrial) private well locations outside the former base have also had detections of TCE. TCE concentrations associated with the Site have been found to exceed EPA's National Primary Drinking Water Standards (the maximum contaminant level [MCL]) under the Federal Safe Drinking Water Act. The MCL represents the maximum level (i.e., concentration) of the contaminant allowed in drinking water, and is set at 5 µg/L for TCE.

Based on the TCE detections described above, between 1989 and 1993 the city chose to fix the three contaminated city water-supply wells south of the airport by extending the casings down to the lower basalt aquifers. In addition, the Skyline community, which was dependent on the Skyline water system, received an alternative water source (bottled water) between 1997 and 2003. In 2003, USACE completed construction of a replacement water-supply well, which draws water from a deeper, uncontaminated groundwater aquifer and currently provides drinking water to the Skyline community.

Following findings of contaminated domestic (private) wells and upon request from Region 10 EPA, USACE began a private well groundwater sampling program in 2001. The groundwater sampling program has been used to ensure that humans are not exposed to contaminant concentrations above the MCL, and to

monitor TCE plume migration. Under this program, drinking water from private wells¹ and small drinking water systems (Group A and B systems)² were sampled (with some gaps between sampling events) for TCE-related compounds. Recently, USACE has also been sampling monitoring wells at least annually, and those data are presented with the results from private wells and small drinking water systems in an annual report (this document). City of Moses Lake wells are routinely sampled for VOCs per Washington State Department of Health (WDOH) requirements, and the results are posted on WDOH's website. However, since the wells that WDOH samples are all screened below the contaminated aquifers, those data are not included in this report.

For ease of reporting, small drinking water systems are reported as part of private wells. The majority of private wells sampled are located in the Cascade Valley area immediately downgradient of the main (north) and south plumes (see Figure 4 through Figure 12). In 2002, following two private well monitoring events, a WHF treatment system was designed and installed at five residential sites where it was determined that TCE contamination could potentially exceed the drinking water standard for TCE (5 µg/L).

Groundwater monitoring wells have been installed over the last 22 years in order to monitor contamination at the Site. Groundwater elevation data are collected where available to evaluate groundwater flow direction and are also used to evaluate plume migration at groundwater monitoring wells.

An IROD was signed in September 2008 (EPA 2008) for cleanup actions in areas with soil and groundwater contamination that exceed risk-based concentrations. The IROD required groundwater pump and treat systems to be installed for two of the five identified TCE plumes. The IROD further specified that cleanup levels will be attained throughout all the plumes, but active remediation may be discontinued if it can be demonstrated that natural attenuation (through dilution) can remediate the remnant plumes in a reasonable timeframe (within an estimated 30 years for cleanup).

The IROD specifies that information gathered during groundwater monitoring, as well as design and operation of the selected groundwater pump and treat system, be used to determine the need for refinement of the selected groundwater remedy to meet groundwater restoration goals. Currently, EPA is designing a pump and treat system for the south plume that is anticipated to be operational in 2018 (see Figure 2). Information from operation of the south plume pump and treat system will be used to make decisions on a second pump and treat system that is planned to be installed for the main plume.

The COCs monitored in the groundwater sampling program are as follows:

- trichloroethene (TCE)
- cis-1,2-dichloroethene (cis-DCE)
- trans-1,2-dichloroethene (trans-DCE)

¹ Private wells consist of wells used for drinking and other domestic uses, and industrial process wells.

² A "Group A" public water system is defined in RCW 70.119A.020 as a public water system with at least 15 service connections regardless of the number of people; or a system serving an average of 25 or more people per day for at least 60 days per year, regardless of number of service connections; or a system serving 1,000 or more people on two or more consecutive days. A "Group B" public water system is any public water system that does not meet the definition of a Group A system. For ease of reporting, small drinking water systems are reported as part of private wells.

- vinyl chloride (VC)
- 1,1-dichloroethene (1,1-DCE)
- 1,2-dichloroethane (DCA)
- 1,1,1-trichloroethane (TCA)
- 1,1-dichloroethane (1,1-DCA)

Only TCE, however, has a cleanup level established in the IROD, and the other VOCs have either never been detected or have been detected only at levels significantly below any established MCL or risk-based cleanup level.

1.3. Geologic Setting

The Site occupies a nearly flat fluvial terrace bounded to the east by Crab Creek and to the south and west by Moses Lake. The geologic units affected by contamination include, with increasing depth and from youngest to oldest, the following: sand and coarse gravel deposited by huge glacial floods (Hanford formation), silt and sand deposited in lakes and rivers (Ringold Formation, locally eroded away to the north and east), and several extensive basalt flows of the Wanapum Basalt Formation. The Wanapum Basalt at the Site is divided into three members as follows, from geologically youngest to oldest: the Priest Rapids Member, the Roza Member, and the Frenchman Springs Member. At the Site, the Roza Member consists of three basalt flows, of which Roza 1 is the youngest and always the first encountered. The Priest Rapids Member overlies the Roza Member in the central portions of the Site, but is mostly highly weathered and has been eroded away entirely along the east and west margins. The basalt flows typically have a vesiculated, fractured, and sometimes brecciated flowtop overlying a dense flow interior characterized by vertical cooling fractures. The deeper and less weathered the basalt flows are, the more likely these fractures are to be completely filled by secondary minerals (EPA 2008).

Figure 3 illustrates the hydrogeologic conceptual model, which shows the geological members as defined in the IROD. The hydrostratigraphic units relevant to the Site are as follows (EPA 2008):

- Hanford Formation (**aquifer** in areas, but unsaturated beneath a substantial portion of the Site)
- Ringold Formation (water-confining unit, absent in areas)
- Priest Rapids and flow-top of Roza 1 (**aquifer**)
- Dense flow interior of Roza 1 (water-confining unit)
- Roza 2 flow top (**aquifer**)
- Dense flow interior of Roza 2 (water-confining unit)

TCE has been detected in all three aquifers described above, indicating that there is some connectivity between the units and the aquifers. For example, the highest concentrations of TCE are found in the Priest Rapids and flow-top of Roza 1 aquifer, which indicates that water is able to move through the Ringold Formation. The TCE occurrence and migration pathways are also illustrated on Figure 3, showing the complexity of contaminant flow through the fractured basalts.

Monitoring well nomenclature is based on the hydrogeologic conceptual model. The Hanford Formation aquifer is generally associated with the “AW” series of monitoring wells; the Priest Rapids and Roza 1 aquifer is associated with “BW” series of monitoring wells; and the Roza 2 basalt flow is associated with the “CW” series of monitoring wells. An example of monitoring well nomenclature is 12BW05, which represents a well drilled in 2012 (12), screened within the Priest Rapids and Roza 1 aquifer (BW), and fifth in the BW monitoring well installation series (05) for that year.

TCE contamination is found primarily in the upper basalt aquifers (Priest Rapids and Roza 1, and Roza 2). Some of the private wells may be drawing water from the overlying alluvium, but driller logs suggest that the majority of the private wells are open only in basalt. Some draw from several basalt flows, but rarely from below Roza 2.

1.4. Previous Investigations

Please see prior Annual Reports for a summary of previous investigations.

1.5. USACE Investigation Strategy

The USACE investigation strategy, with input from EPA, includes sampling groundwater monitoring wells and private wells to ensure protection of human health by comparing the results to the federal drinking water MCL for Site contaminants such as TCE that resulted from historic Site activities. The investigation strategy for monitoring wells and private wells was provided in the WP-QAPP for 2016 and is adjusted each year for the sampling program.

1.5.1. Groundwater Monitoring Wells and Extraction Wells

Groundwater monitoring well sampling has been focused on identifying TCE concentrations, tracking plume extent and migration, and collecting groundwater elevation data to evaluate groundwater flow direction. Samples have been collected using dedicated bladder pumps or passive diffusion bags (PDBs). The majority of the monitoring wells are located east and northeast of the Cascade Valley area (see Figure 4).

Groundwater analytical data will be used to assess plume migration before and after the groundwater pump and treat system is operational, and will support groundwater contour modeling. Monitoring data will be used to assess the effectiveness of the future south plume groundwater pump and treat system in restoring groundwater to federal drinking water standards and state cleanup levels.

1.5.2. Private Wells

The Moses Lake IROD requires preventing human exposure to COC concentrations in groundwater that are above their MCLs. TCE is the focus for interim groundwater monitoring activities, since it is the only COC that historically has exceeded its MCL (5 µg/L) and is the only groundwater COC listed in the IROD. The investigation strategy for the private well sampling program historically began with a list of existing private wells within the 5 µg/L TCE plume boundary or near the leading edge of the plume boundary. The majority of private wells sampled are located in Cascade Valley immediately downgradient of the main and south plumes (see Figure 5). Some well owners were recruited for the private groundwater sampling program in

the 1990s and early 2000s. Other residents have asked to be included in the sampling program over the years. USACE successfully recruited many additional home owners in 2012/2013, and the private well network was also optimized in 2013 to remove a number of non-detect wells that were outside of the plume area. As more information has become available that helps identify private wells that may be affected by TCE contamination, well owners have been and will continue to be recruited for evaluation.

The 2016 sampling strategy for private wells was to sample annually the entire suite of wells, and quarterly those with either WHFs or TCE detections that have historically been greater than 2.0 µg/L. Groundwater elevation data are not obtained from the private wells due to the potential for entangling the water level indicator cable with pump plumbing and/or cables present in the private wells.

2. SAMPLING AND FIELD ACTIVITIES FOR 2016

The 2016 sampling program consisted of four events that occurred in February, May, August, and November, as described below. A detailed report for each sampling event can be found in Appendix A (Field Sampling Reports). Table 1 lists the wells that were sampled for each event, and Appendix B includes comprehensive analytical results for all 2016 events.

A summary of each sampling event is provided below for groundwater monitoring wells and private wells. USACE only sampled properties where the well is located and for which we had rights-of-entry (ROEs). No sampling was conducted at homes that are supplied by neighboring wells; however, in many cases ROEs have been obtained to facilitate sending sampling results.

Private wells with WHFs (see Table 2) were sampled at the influent port (upstream of the filtration system), at the mid port (between the lead and lag filter units), and at the lag port (downstream of the lag filter unit and prior to water entering the residence) after granular activated carbon (GAC) replacement. WHFs were inspected every six months to ensure all parts were working properly and to replace the fines filters; both GAC vessels of each system were replaced annually. Private wells without WHFs were sampled from a water tap as close to the well head as possible.

2.1. Event 1 (February 2016)

2.1.1. Groundwater Monitoring Wells

During Event 1, 31 groundwater monitoring wells consisting of seven bladder pump wells and 24 PDB wells were sampled for VOCs in accordance with the WP-QAPP. Groundwater elevation data were collected from all sampled monitoring wells. After samples were collected, PDBs were deployed in wells without dedicated bladder pumps.

2.1.2. Private Wells

During Event 1, ten private wells with WHFs were sampled for VOCs. WP-14, WP-70, WP-83, WP-86, WP-119, WP-121, WP-123, WP-124, and WP-129 were sampled at the influent port only to document incoming TCE concentrations. WP-125 was sampled from the influent, mid, and effluent sampling ports to

document the presence of TCE in the influent port and evaluate efficiency of the filters based on the results from the effluent port. Before sample collection, totalizer flow meter readings were recorded.

Five private wells without WHFs (WP-04, WP-27, WP-131, WP-167, and WP-168) were also sampled for VOCs because TCE concentrations between 2 and 3.5 µg/L had been detected at those locations during previous sampling events. Data collected from these wells was used for the seasonal trend analysis.

For the 2016 sampling program, EPA requested on January 26, 2016, that the USACE sample certain compounds in addition to VOCs at select wells as follows:

- PFAAs at private wells WP-119, WP-121, WP-124, and WP-125 via Method 537

However, incorrect bottles were provided by the lab and insufficient water was collected. Therefore, the February samples could not be analyzed (they were sampled in May instead).

2.2. Event 2 (May 2016)

2.2.1. Groundwater Monitoring Wells

During Event 2, 75 groundwater monitoring wells consisting of 39 bladder pump wells and 36 PDB wells were sampled for VOCs in accordance with the Work Plan-QAPP. Groundwater elevation data were collected from all sampled monitoring wells. After samples were collected, PDBs were deployed in wells without dedicated bladder pumps.

For the 2016 sampling program, EPA requested sampling of certain compounds in addition to VOCs at select wells as follows:

- PFAAs at monitoring wells 04BW04, 04CW01, 91AW14, and 99BW16; monitoring well 99AW10 was planned to be sampled; however site access was not safe and no sample was collected.
- 1,4-dioxane at monitoring wells 00BW10, 00BW12, 00BW15, 02BW01, 04BW05, 12BW02, 12BW07, 14BW01, 99BW01, 99BW12, 99BW15, 99BW16; and
- DRO, GRO, and BTEX at 00BW11.

2.2.2. Private Wells

In May 2016, GAC vessels were replaced at five WHF residences (WP-14, WP-70, WP-83, WP-86 and WP-125). Before sample collection, totalizer flow meter readings were recorded. After the GAC vessels were replaced, the mid and effluent ports were sampled for VOCs to ensure the filter systems were working properly. Analytical results confirmed that the WHFs reduced effluent concentrations to below the TCE action threshold.

During Event 2, five additional private wells with WHFs were sampled for VOCs. WP-119, WP 121, WP-123, WP-124, and WP-129 were sampled at the influent port only to document incoming TCE concentrations.

In May 2016, 58 private wells without WHFs were also sampled for VOCs. However, several additional wells could not be sampled: the owner at WP-118 did not answer (b) (6) and the property is (b) (6); WP-25W was not functioning; and WP-88, WP-175, and 176 were not occupied.

For the 2016 sampling program, EPA requested sampling of certain compounds in addition to VOCs at a subset of wells as follows:

- 1,4-dioxane at WP-168, WP-121 (influent only), WP-125 (influent only), WP-144, WP-45, WP-52, WP-69, and WP-74.

The PFAAs that were unsuccessfully collected in February, were successfully collected in May at WP-119, WP-121, WP-124, and WP-125, all of which have WHFs. The influent and effluent ports were sampled.

2.3. Event 3 (August 2016)

2.3.1. Groundwater Monitoring Wells

No monitoring wells were sampled during the August 2016 sampling event. PDBs were deployed in some monitoring wells to be sampled in November 2016.

2.3.2. Private Wells

During Event 3, ten private wells with WHFs were sampled for VOCs. WP-14, WP-70, WP-83, WP-86, WP-121, WP-123, WP-124, and WP-129 were sampled at the influent port only to document incoming TCE concentrations; WP-125 was sampled from the influent, mid, and effluent sampling ports to document the presence of TCE in the influent port and efficiency of the filters based on the results from the effluent port. Before sample collection, totalizer flow meter readings were recorded.

Five private wells without WHFs (WP-04, WP-27, WP-131, WP-167, and WP-168) were also sampled for VOCs in August 2016. These wells were sampled because TCE concentrations between 2 and 3.5 µg/L were detected at those locations during previous sampling events.

2.4. Event 4 (November 2016)

2.4.1. Groundwater Monitoring Wells

During Event 4, 32 groundwater monitoring wells consisting of eight bladder pump wells and 24 PDB wells were sampled for VOCs in accordance with the WP-QAPP. Groundwater elevation data were collected from all sampled monitoring wells.

2.4.2. Private Wells

In early November 2016, GAC vessels were replaced at three WHF residences: WP-119, WP-121, and WP-123. WP-124 and WP-129 were delayed with EPA approval to early 2017³. Before sample collection, totalizer flow meter readings were recorded. During Event 4, five private wells with WHFs were sampled for VOCs. WP-14, WP-70, WP-83, WP-86 and WP-125 were sampled at the influent port only to document incoming TCE concentrations. WP-119, WP-121, WP-123, WP-124, and WP-129 were sampled from the influent, mid, and effluent sampling ports to document the presence of TCE in the influent port and efficiency of the filters based on the results from the effluent port.

Five private wells without WHFs (WP-04, WP-27, WP-131, WP-167, and WP-168) were also sampled for VOCs. These wells were sampled because TCE concentrations between 2 and 3.5 µg/L were detected at those locations in previous sampling events.

2.5. Right-of-Entry Acquisition

Right-of-entry (ROE) forms are used to obtain permission to enter onto property to conduct water sampling. In general, USACE only obtained ROEs from property owners (and tenants, if applicable) where a well is located. During 2016 sampling year, USACE acquired new ROEs at WP-154, WP-131, WP-54, WP-152, and WP-145. During 2016 sampling year, USACE was unable to acquire ROEs for the following wells:

- WP-11: The owner indicated on May 17, 2016, that he did not want the Government involved with his property. He is on well water.
- WP-137: The owner was amenable to having his water sampled but did not want to sign an ROE. The EPA remedial project manager, who was onsite during the May 2016 sampling event, approved sampling this property without an ROE.

USACE will continue to make an attempt at least annually to acquire an ROE.

3. ANALYSIS, DATA VALIDATION, AND RESULTS

The sections below discuss analytical and data validation procedures; groundwater elevations and analytical results for monitoring/extraction wells; and analytical results for private wells. A comprehensive table of all analytical results is provided in Appendix B.

3.1. Analytical and Data Validation Procedures

All sampling and analytical activities were executed in compliance with project data quality objectives, and the results are considered acceptable for use.

The analytical laboratory used for this project was Analytical Resources, Inc. (ARI) of Tukwila, WA. Samples were analyzed by EPA Method 524.3 for VOCs, by Publication ECY97-602 for DRO and GRO, by EPA Method 8021 for BTEX, by EPA Method 522 for 1,4-dioxane, and by EPA Method 537 for

³ The WHF sampling program was revised for 2017 so that water would be sampled BEFORE filter exchange, to ensure that the WHFs remain protective in the last month(s) before exchange.

PFAAs. These methods produce data with the analytical sensitivity required to evaluate whether drinking water meets the federal MCLs for applicable analytes. A Quality Control Summary Report (QCSR) summarizing analytical performance expressed in terms of data quality indicators (DQIs) can be found in Appendix F.

Laboratory Data Consultants, Inc. (LDC) of Carlsbad, CA, performed the data validation task. The Data Validation Report (DVR; Appendix G [cd only]) presents Stage 2a and Stage 4 data validation results for samples collected. Data validation was performed in accordance with the requirements outlined in LDC's SOW for services; the USACE Work Plan-QAPP; the U.S. Department of Defense Quality Systems Manual for Environmental Laboratories, Version 5.0 (DOD 2013); and EPA's National Functional Guidelines for Superfund Organic Methods Data Review (EPA 2016). Based on the data quality assessment presented in the QCSR and the DVR, the overall quality of data is known and acceptable for the intended use. In 2016, the PFAAs were validated by USACE staff rather than LDC because the request from EPA to analyze PFAAs occurred after LDC's contract was put in place. Rather than modify the contract, EPA approved USACE staff to validate the data.

Water samples and associated quality control (QC) samples were collected from groundwater monitoring wells and private wells in accordance with the WP-QAPP. Field QC samples included field duplicates, field blanks, trip blanks, matrix spikes (MSs), and matrix spike duplicates (MSDs). A performance evaluation (PE) sample, provided by Environmental Resource Associates of Arvada, CO, was submitted for VOC analysis during the November 2016 sampling event.

3.2. Monitoring Wells - Results

3.2.1. Groundwater Elevations

Groundwater elevations recorded during sampling are presented in Table 3. The data from May 2016 were used to create groundwater contour plots for the Priest Rapids/Roza 1 and Roza 2 aquifers. The data were interpolated using the Kriging method and created using the computer program Surfer Version 13 from Golden Software.

The general flow direction in the Priest Rapids-Roza 1 aquifer in the northern portion of the Site is to the southwest (see Figure 7), which is consistent with previous groundwater elevation data. The groundwater flow direction within the south plume is southerly, which is consistent with previous groundwater elevation data.

The flow direction in the Roza 2 aquifer radiates to the northwest and south from well 12CW03; well 12CW03 is located in the northern portion of the south plume (see Figure 8). The contours were blanked between 12CW04 and the other Roza 2 monitoring wells to the north due to lack of data. The exact location of the peak elevation of the groundwater in the Roza 2 aquifer is not known due to this lack of data.

The software-generated groundwater contours were reviewed by a hydrogeologist and deemed to be accurate. The data for the groundwater elevation figures are based on Event 3 (May 2016) only.

Groundwater elevation data were not collected from private wells due to the risk of entangling the water level indicator cord with private well pumps. In addition, unless the residents' and neighbors' use of water could be controlled, the elevations collected would not be indicative of natural contours.

3.2.2. Analytical Results

Analytical results for TCE in the groundwater monitoring and extraction wells are provided in Table 4 and shown in Figure 9 (Priest Rapids-Roza 1) and Figure 10 (Roza 2). The highest TCE result from any of the four events was used to generate the figures. Of the 75 monitoring and extraction wells sampled, 32 wells had no detections above the reporting limits for VOCs, 43 wells had TCE detections above 0.2 µg /L, and a subset (six) also had cis-DCE detections. Twenty-five of those 43 wells exceeded the MCL (5.0 µg /L) for TCE. The maximum TCE detection in the Priest Rapids-Roza 1 aquifer was 92.2 µg /L in well 12BW05 in November 2016, which was slightly less than the maximum TCE concentration (106 µg /L) in November 2014 and slightly more than the maximum TCE concentration (89.3 µg/L) in November 2015. The maximum cis-DCE detection in the Priest Rapids-Roza 1 aquifer was 2.74 µg /L at well 04BW06 in May 2016. The maximum TCE detection in the Roza 2 aquifer was 6.10 µg/L at well 04CW07 in November 2016. Well 04CW07 is the only Roza 2 monitoring well that exceeded the TCE MCL (5.0 µg /L); it is located below the southern portion of the south plume. There were no cis-DCE detections in the Roza 2 aquifer.

For 2016, EPA also recommended sampling PFAAs at a subset of monitoring wells. Of the six PFAAs reported, all six were detected in May 2016: perfluorooctanesulfonic Acid (PFOS), perfluoroheptanoic acid (PFHpA), perfluorohexanesulfonic acid (PFHXS), perfluorononanoic acid (PFNA), perfluorobutane sulfonic acid (PFBS), and perfluorooctanoic acid (PFOA). In addition, monitoring wells 91AW14, 99BW16, and 04CW01 exceeded the provisional health advisory level established by EPA for combined PFOS and PFOA. See Figure 11 for the 2015 and 2016 PFAA results (2015 results from two additional monitoring wells were included at EPA's request).

EPA's health advisory, which identifies the concentration of PFOA and PFOS in drinking water at or below which adverse health effects are not anticipated to occur over a lifetime of exposure, is 0.07 parts per billion (70 parts per trillion) for PFOA and PFOS. Health advisories are non-regulatory and reflect EPA's assessment of the best available peer-reviewed science. The results are presented in Table 5.

EPA also requested that the emerging contaminant 1,4-dioxane be sampled at a subset of monitoring wells across the site. Of the 12 monitoring wells sampled for 1,4-dioxane, only four wells had detections above the detection limit. None of the wells exceeded the screening level of 0.67 µg /L.

In addition, USACE had noticed strong odors in well 00BW11 in 2015; consequently, in 2016, USACE analyzed a sample for DRO/GRO/BTEX, and only DRO was detected at 100 µg/L. There is no EPA MCL for DRO; however, the Model Toxics Control Act (MTCA), Washington's cleanup law, has a groundwater cleanup level of 500 µg /L.

3.3. Private Wells without WHFs– Results

This section summarizes the results for private wells without WHFs.

3.3.1. Analytical Results

Analytical results for the private wells without WHFs are provided in Table 6. TCE and cis-DCE were the only analytes detected out of the eight VOC analytes evaluated in 2015. Of the 58 private non-WHF well locations sampled, TCE results can be summarized as follows: 18 had no detections (i.e., results were < 0.2 µg/L), and 40 had TCE detections at or above 0.2 µg/L. Of those 47, WP-04, WP-131, WP-167, and WP-168 had TCE concentrations above 2.0 µg/L for at least one event and were sampled quarterly. WP-27 was also sampled quarterly during the 2016 sampling year because it had historical detections greater than 2.0 µg/L; however, none of the 2016 results were above 2.0 µg/L. WP-04 exceeded the TCE MCL (5.0 µg/L); however, this well is not used for drinking water. Five private wells had cis-DCE detections.

The maximum TCE concentration was 6.23 µg/L at WP-04 in May 2016. The maximum cis-DCE concentration was also at WP-04 in May 2016; the cis-DCE concentration was 2.09 µg/L, though this value is considerably lower than the cis-DCE MCL (70 µg/L). Well WP-04 is used for industrial process water and had TCE concentrations that were consistently above the MCL during all 2016 sampling events. Between February 2016 and November 2016 the TCE concentrations ranged from 5.84 to 6.23 µg/L, and the graph in Appendix D shows a rising trend. No WHF is needed at this location because the water is not being consumed. The business associated with WP-04 has been previously informed of the elevated risk associated with TCE. EPA provided signage for the business to place on the well house and at other locations where workers could come in contact with contaminated water.

No private wells (except for WP-04 as discussed above) exceeded the TCE action level of 3.5 µg/L that triggers installation of a WHF; thus, no WHFs were installed during the 2016 sampling program.

3.4. Private Wells with WHFs – Results

The analytical results and the efficiency of the WHFs are discussed below.

3.4.1. Analytical Results

Table 7 provides the TCE and cis-DCE analytical results for the private wells with WHFs. Table 8 summarizes purge volumes and totalizer readings collected prior to sampling at WHF wells. For the 2016 sampling year, the WHFs were successful in reducing TCE and cis-DCE to undetected concentrations in the effluent ports, which lead into the homes, indicating that the WHFs are working effectively. Contractor-analyzed spent GAC did not exceed any Toxicity Characteristic Leaching Procedure (TCLP) thresholds in 2016.

3.4.2. Whole-House Filter Efficiency Analysis

In June 2016, USACE staff prepared a Whole-House Filter Efficiency Memo (see Appendix C) that evaluated the efficiency of the Siemens AWC-1230 WHF systems installed in September 2014 and April 2015 at Moses Lake private wells WP-123 and WP-125. USACE staff reviewed TCE concentrations and totalizer readings over a year-long period to evaluate whether the filters worked sufficiently to protect residents from exposure to TCE concentrations greater than the MCL. In addition, this memo evaluated whether there was sufficient evidence to reduce filter sampling frequency from quarterly to something less frequent.

The memo concluded that the WHFs are working sufficiently to ensure protection of human health. USACE staff recommended continuing to sample the WHF influent ports quarterly (at the time the memo was prepared) at WP-123 and WP-125 to evaluate seasonal trends. USACE staff also recommended that the sampling frequency for the mid and effluent ports could be reduced to annual sampling and still protect human health based on the current flow rates, TCE concentrations, and assumption of annual replacement of WHF GAC vessels and fines filters. See also Section 6.1.3.

3.5. Seasonal Trend Analysis for Trichloroethene

A seasonal trend analysis for TCE was prepared and submitted to EPA in August 2016. The trend analysis covered a subset of wells that were sampled quarterly (eight sampling events) from June 2014 through February of 2016. The objective of the analysis was to evaluate seasonal fluctuations in TCE concentrations within private wells and monitoring wells (including extraction wells) to identify which season or month had the highest concentrations so that one season or month could be targeted for future sampling events. The results for monitoring wells indicated that there is a strong correlation between groundwater elevations and TCE concentrations, and that sampling in January would result in the highest TCE concentrations. Private well TCE concentrations did not correlate as strongly to groundwater elevations in the Hanford Formation and Priest Rapids-Roza 1 aquifers. Unlike the monitoring wells, there was no consistent seasonal influence on maximum TCE concentrations. Based on professional judgment, the report recommended to sample specific private wells in January and August to further evaluate potential maximum concentrations.

3.6. Customer Notification of 2016 Results

The results from the 2016 sampling program (the content of this 2016 Annual Report) are expected to be mailed in February 2017.

4. STATE WELL INVENTORY DATABASE SEARCH

To determine whether additional private wells were installed within or near the VOC plume (within the IC boundary), information from the WDOE Well Logs database⁴ was queried. The well logs for those wells in or near the IC boundary are provided in Appendix H. The locations of those wells, plus additional wells outside of the IC boundary, are shown on Figure 12.

The database was searched for wells constructed or well logs received between January 1, 2016 and December 31, 2016 and screened or open to the upper basalt flows in Priest Rapids-Roza 1 and Roza 2 geologic members (see Figure 3). Following the Groundwater Institutional Control Boundary (see Figure 2), all or portions of the following Township, Range, and Sections were queried: T19N, R28E, Sections 4, 5, 6, 7, 8, 9, 16, 17, 18 and T20N, R28E, Sections 16, 17, 19, 20, 21, 22, 27, 28, 29, 30, 31, 32, 33, 34.

Thirteen wells were identified in the query and two of those wells are located near other wells that have had detections of TCE. BHW096 is located southwest of WP-18N and WP-18S, and BIU598 is located in Cascade Valley near WP-111; USACE recommends both for annual sampling. Both wells appear to be

⁴ <https://fortress.wa.gov/ecy/waterresources/map/WCLWebMap/textsearch.aspx>

drawing groundwater from the Roza 1 aquifer. Groundwater from these formations has historically had TCE contamination in some areas.

5. SUMMARY AND DISCUSSION

Summary and discussion of the TCE plume and WHF work for 2016 is provided below.

5.1. Site TCE Plume Discussion

During the 2016 sampling program, the TCE MCL of 5.0 µg/L was exceeded in approximately 30% of the monitoring and extractions wells, primarily in the Priest Rapids/Roza 1 monitoring wells. Regarding the private wells, approximately 58 of the 71 private wells (including WHFs) located in the Cascade Valley had detections of TCE (> 0.20 µg/L) during the 2016 sampling program; however, only WP-04 (Granite Construction) exceeded the TCE MCL of 5.0 µg/L.

TCE concentrations for each well are summarized in Figure 6, Figure 9, and Figure 10. For wells that were sampled during multiple events, the maximum TCE concentration was chosen (not all were sampled multiple times). The contours were initially generated using the Kriging gridding method in Golden Software's Surfer® program Version 13, which numerically estimates plume boundaries based on input data. The Surfer® Kriging method used a log-transformed distribution. Where deemed appropriate, the computer-generated contours were adjusted based on professional judgment (e.g. open-ended contours used where there are data gaps). The Priest Rapids/Roza 1 main plume is open-ended to the southwest due to lack of monitoring well data in the downgradient direction. The Priest Rapids/Roza 1 northeast plume is only defined by one monitoring well (99BW15) and two private wells (WP-14 and WP-83). The northeast plume contours are open to the northeast due to lack of data in the upgradient direction. The Priest Rapids/Roza 1 South Plume is open-ended to the southwest due to lack of monitoring wells and uncertainty of where private wells are screened.

It is anticipated that private wells, including those in the Cascade Valley, draw water from the upper basalt aquifers (Priest Rapids-Roza 1 and Roza 2) and potentially the overlying alluvium. However, limited private well construction information makes it difficult to correlate individual private wells with a specific aquifer. In addition, there are only two groundwater monitoring wells located within the Cascade Valley, and they are too distant from the other clusters of monitoring wells to help delineate the origin of groundwater contamination occurring in the Cascade Valley. The majority of private wells in Cascade Valley are downgradient from or near the leading edge of the contaminant plume. Several of the wells sampled in the Cascade Valley area are immediately downgradient of the main (north) and/or south plumes. Additional monitoring wells upgradient of Cascade Valley are expected to be installed in February 2017 and will be sampled to better understand plume migration. The new monitoring data will help refine the conceptual site model (CSM), help predict TCE concentrations at residential wells, and delineate the extent of TCE contamination in the Priest Rapids/Roza 1 and Roza 2 aquifers.

TCE results from WP-04 exceeded the TCE MCL of 5 µg/L during every sampling event in 2016. There are multiple homes with WHF systems clustered near WP-04; however, it is unclear if these homes are drawing water from the same plumes. None of the homes located near WP-04 have exceeded the TCE MCL of 5 µg/L, though during the 2015 sampling program, WP-125 exceeded the action level of 3.5 µg/L and

received a WHF system. Contours around WP-04 are open to the northeast due to lack of data in the upgradient direction. Current data suggest that the private wells downgradient of WP-04 (generally southwest, see Figure 5) without WHF systems are the most at risk of exceeding the TCE MCL. Based on the groundwater elevation contours for Priest Rapids/Roza 1 monitoring wells (Figure 7) and the 2016 TCE contours (Figure 9), the source of TCE contamination in the northern Cascade Valley could be from the main TCE plume or an unidentified source.

Following the June 2013 sampling event, USACE recommended and EPA agreed to 2.0 µg/L TCE as the lower threshold value above which private wells would be monitored quarterly for a minimum of one year given the limited amount of available historic data for private wells. This recommendation was made to evaluate groundwater fluctuations based on seasonal changes (i.e., change in irrigation activities, decrease in precipitation, etc.) and determine whether fluctuations would necessitate action to prevent ingestion of contaminated drinking water. This recommendation for quarterly sampling of private wells ended with February 2016 to generate data for trend analyses.

Due to the presence of multiple contaminant plumes and uncertainty of private well construction, private wells within the Moses Lake area with any historic COC detections are recommended for continued annual sampling until a better understanding of plume migration has been documented. Additional houses may be added based on their proximity to wells with elevated concentrations.

5.2. Suggested Improvements to Sampling Program

To help with understanding the plumes, USACE recommends installing pressure transducers and data loggers (both referred to as transducers) to monitor groundwater levels at the Site. Groundwater elevation data at the site are currently collected during groundwater sampling events, which have occurred one to four times per year. The current groundwater elevation monitoring frequency is adequate when there are no changes to the groundwater flow regime. However, the groundwater flow regime at Moses Lake will be affected by increased flows in Crab Creek and the operation of a pump and treat system. Transducers allow for several groundwater level measurements per day to be collected, which can be used to observe fluctuations in groundwater elevations that periodic groundwater level monitoring would not record. Several changes in short-term groundwater elevations that could be important to document include the following:

- **Changes in flow direction and gradient.** Changes in the flow direction and gradient can affect the movement of contaminants at the site
- **Hydraulic connection between different aquifers.** Recharge from Crab Creek will likely impact the Hanford Formation and Priest Rapids/Roza 1 aquifers. Groundwater elevation data may show the rate of recharge in each aquifer and the location where the largest increase will occur.
- **Rate of recharge across the site.** The timing and magnitude of groundwater elevation increases caused by recharge from Crab Creek can be used to refine estimate of groundwater flow velocity across the site.
- **Identify the optimal time to collect groundwater samples.** The highest TCE concentrations have been measured during the highest groundwater elevations.

The transducers would be placed primarily in wells screened in the Hanford and Priest Rapids/Roza 1 formations near Crab Creek and within the Priest Rapid/Roza 1 wells near the pump and treat system. Transducers would also be installed in a couple of wells spaced across the site for which historical groundwater data show the greatest fluctuations.

5.3. Whole-House Filters

The WHFs are working as intended and reducing cis-DCE and TCE concentrations in effluent samples (i.e., in the water that is supplied to the homes) below both the MCLs and the detection limits for each. The WHF GAC vessels were exchanged annually; the fines filters were replaced approximately every six months, and the WHF systems were also inspected for general functionality at that time. No new WHFs were installed in 2016. The results of the WHF efficiency analysis confirmed that the WHFs are working as intended. Based on discussion with EPA in September 2014, the WHF ports continued to be sampled in 2015 and 2016 as follows:

- In the first year after installation, all ports (influent, mid, effluent) will be sampled quarterly.
- At end of first year, an efficiency analysis will be performed.
- In the second year (assuming all is well based on the analysis), the influent port will be sampled quarterly, and the mid and effluent ports annually.
- At end of the second year, a seasonal analysis will be done to decide which quarter is best for annual sampling, with the preference of having the majority of the WHFs on the same schedule.
- In the third year and beyond, all three ports would be sampled only annually.
- USACE will strive to put the WHFs on the same schedule for annual sampling.

6. RECOMMENDATIONS

Section 6.1 includes recommendations from the 2015 Annual Report and status of their implementation as of December 31, 2016. Section 6.2 includes recommendations for 2017 and beyond based on 2016 activities.

6.1. 2015 Annual Report Recommendations and Status as of December 31, 2016

6.1.1. Groundwater Monitoring Wells

- Evaluate historical groundwater elevation data and TCE concentrations for evidence of seasonal fluctuations to ensure conservative timing of future optimized annual sampling events in the groundwater monitoring program.
 - Status: Based on the 2016 trend analysis that suggested a maximum month for TCE concentrations, all groundwater wells will be sampled annually starting in January 2017.
- Evaluate recent groundwater elevation data collected in support of the anticipated south plume pump and treatment system in parallel with historic groundwater information to ensure sufficient

baseline data are available to support pump and treat system optimization analysis following start-up of the south plume pump and treat system.

- o Status: Quarterly elevation data were collected from 2014 through 2016 to create a baseline to compare pre- and post-operation conditions of the pump and treat system.
- There are currently only two monitoring wells located in Cascade Valley. The monitoring well pair is located just south of Dick Road, which is approximately one mile south of the main plume. Installation of additional monitoring wells in the northern part of Cascade Valley is recommended to refine the CSM and determine the source of the TCE impacting the private wells.
 - o Status: EPA has not asked USACE to carry out this recommendation.
- Installation of six monitoring wells in the Roza 1 basalt aquifer upgradient of Cascade Valley (generally upgradient of WP-04) and downgradient of 04BW06 is planned for summer 2016 to better define the origin of contaminant concentrations in the private wells of Cascade Valley. Presently, it is unclear whether contamination impacting the north Cascade Valley is coming from the distal portion of the main plume, or another unidentified TCE source.
 - o Status: Well installation began in October 2016 and is scheduled to be completed in early spring of 2017. Figure 13 shows the approximate locations of the six new monitoring wells.
- Enter existing monitoring well boring logs and WDOE driller logs (when deemed suitable for interpretation) into a geologic database so that subsurface cross-sections can be readily generated through the main and south plumes and into Cascade Valley.
 - o Status: EPA has not asked USACE to carry out this recommendation.

6.1.2. Private Wells

- Sample newly installed private well, BHW096, identified through WDOE records search. It appears to be drawing groundwater from the Roza I aquifer. Groundwater from this formation has historically had VOC contamination in some areas. Prior to sampling, USACE will obtain an ROE from homeowner.
 - o Status: The house was not accessible because there are unleashed dogs on the property. A letter will be sent to the owners in an attempt to obtain an ROE so that the water could be sampled in August 2017.
- Continue collecting annual groundwater samples from all private wells with any historic COC detections to document plume migration.
 - o Status: Completed; continuing in 2017.
- Continue updating the sampling program by adding new private wells, small public water systems (and monitoring wells) with high likelihood of COC detections as they are identified through Ecology's well log database.
 - o Status: No new wells were added to the sampling regime in 2016. However, a WDOE well search was performed to identify new wells within the site.

- For private wells that exceed 2.0 µg/L TCE, continue collecting quarterly groundwater samples for at least four quarters to evaluate patterns in seasonal and temporal system variability that support future sampling frequency and timing recommendations.
 - Status: Completed; need to discuss future sampling frequency with EPA.
- Continue to communicate with residents who have not agreed to groundwater monitoring but are located in areas anticipated to have elevated TCE concentrations. Document attempted communication with residents, that the residents have declined to participate in the monitoring program, and that the Government has informed residents of the risks associated with exposure to water exceeding the MCL for TCE.
 - Status: Completed. See Section 2.5.
- Conduct a comprehensive review of Ecology’s drillers’ logs versus assigned private well numbers (WP series) and evaluate which private wells may be suitable for incorporation into a geologic database.
 - Status: EPA has not asked USACE to carry out this recommendation. This information would be useful to indicate in what geologic units the wells are installed.
- Purchase signs stating “Non-potable water, do not drink” water for Granite Construction (WP-04) due to exceedances of the TCE MCL during 2014, 2015 (and Feb 2016). Mail letter to Granite Construction informing them that they should not drink the water due to health risks. Provide signs to Granite Construction in May 2016 and continue to remind them that the water is not suitable for drinking.
 - Status: USACE mailed a letter to Granite Construction in April 2016. In May, two signs were posted at WP-04 and two more were provided to the woman at the front desk. (Note: In addition, two signs were posted on each WHF shed at WP-124 and WP-125. One sign was posted on irrigation line at WP-121).

6.1.3. Whole House Filter Systems

- Continue to install and maintain WHF systems at private wells that exceed the action threshold of 3.5 µg/L TCE.
 - Status: Maintenance occurred; no new WHFs were installed.
- Continue to monitor the efficiency of WHF systems by tracking if TCE exceeds its action level of 3.5 µg/L at the mid or effluent ports, and take steps to correct any issues.
 - Status: Completed. No homes had detections of any VOCs at the mid and effluent ports.
- Use information from the WHF totalizing flow meters, which measure the volume of water treated by the WHF systems, to monitor and evaluate the efficiency of the treatment systems.
 - Status: Completed. A WHF Efficiency Memo was completed for WP-123 and WP-125.
- Over time, if concentrations at the influent ports to WHFs decline, work with EPA to determine which WHFs can be removed from residential wells.

- o Status: No WHFs have been removed from the sampling program yet.

6.2. 2016 Annual Report Recommendations for 2017 and beyond

General. USACE recommends that EPA continue to coordinate with Bureau of Reclamation (Bureau) and share information with USACE to understand the impacts of the Bureau's water management activities, since the activities may significantly affect the groundwater elevations and TCE concentrations in Moses Lake and all USACE actions taken to date (trend analysis, sampling frequency, understanding of plumes, etc).

6.2.1. Groundwater Monitoring Wells

- Install pressure transducers and data loggers in monitoring wells to monitor changes to groundwater elevations; changes could affect sampling timing and contaminant migration.

6.2.2. Private Wells

- Since 2017 will consist only of yearly sampling (except for 9 wells, which will be sampled twice), USACE recommends discussing with EPA what course of action should be taken if a private well exceeds 2.0 µg/L or 3.5 µg/L only once.
- USACE recommends adding two private wells to the sampling regime: BHW096, which is located southwest of WP-18N and WP-18S, and BIU598, which is located in Cascade Valley near WP-111. Both wells appear to be drawing groundwater from the Roza 1 aquifer. Groundwater from these formations has historically had TCE contamination in some areas.

6.2.3. Whole-House Filter Systems

- Continue servicing GAC vessels annually and fines filters approximately every six months, after sampling has occurred.

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Figures

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Moses Lake Wellfield Contamination Superfund Site General Location Map

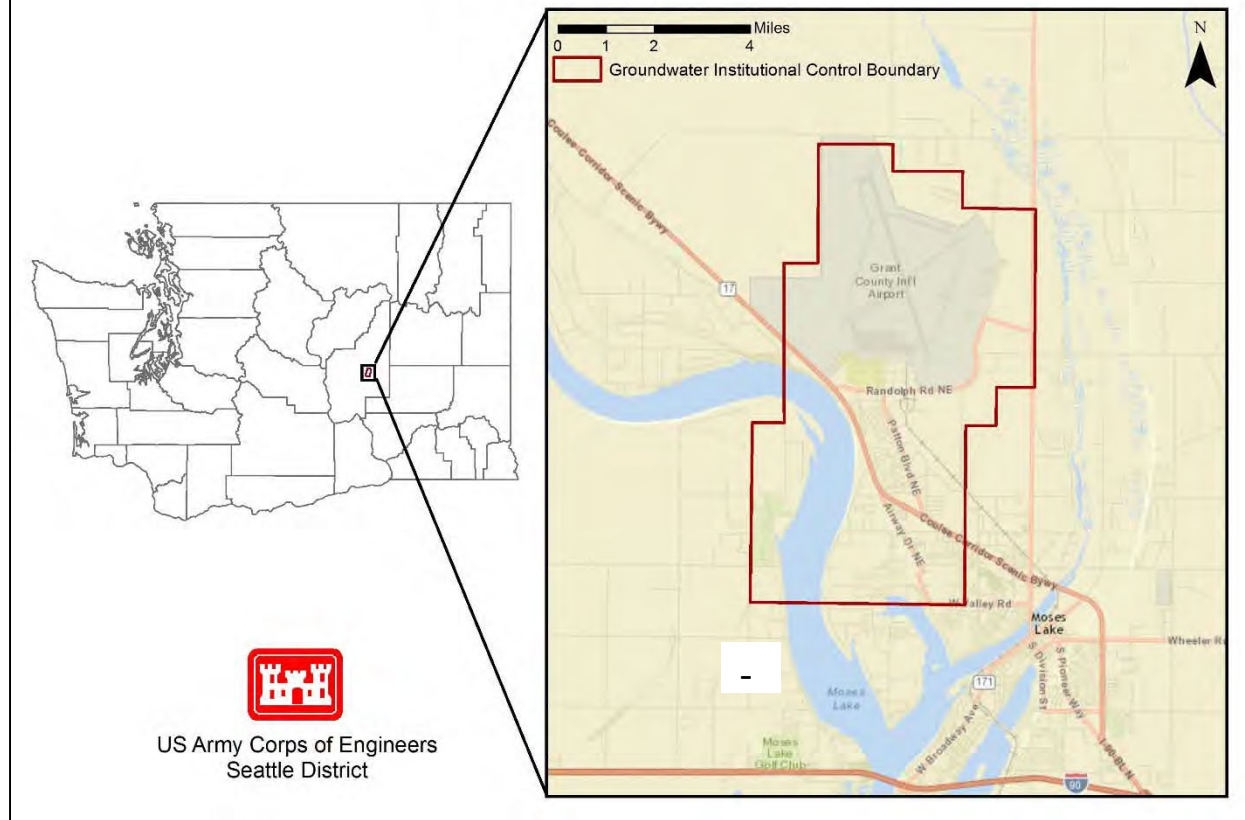


Figure 1. General Location Map for Moses Lake Wellfield Superfund Site (EPA 2008).

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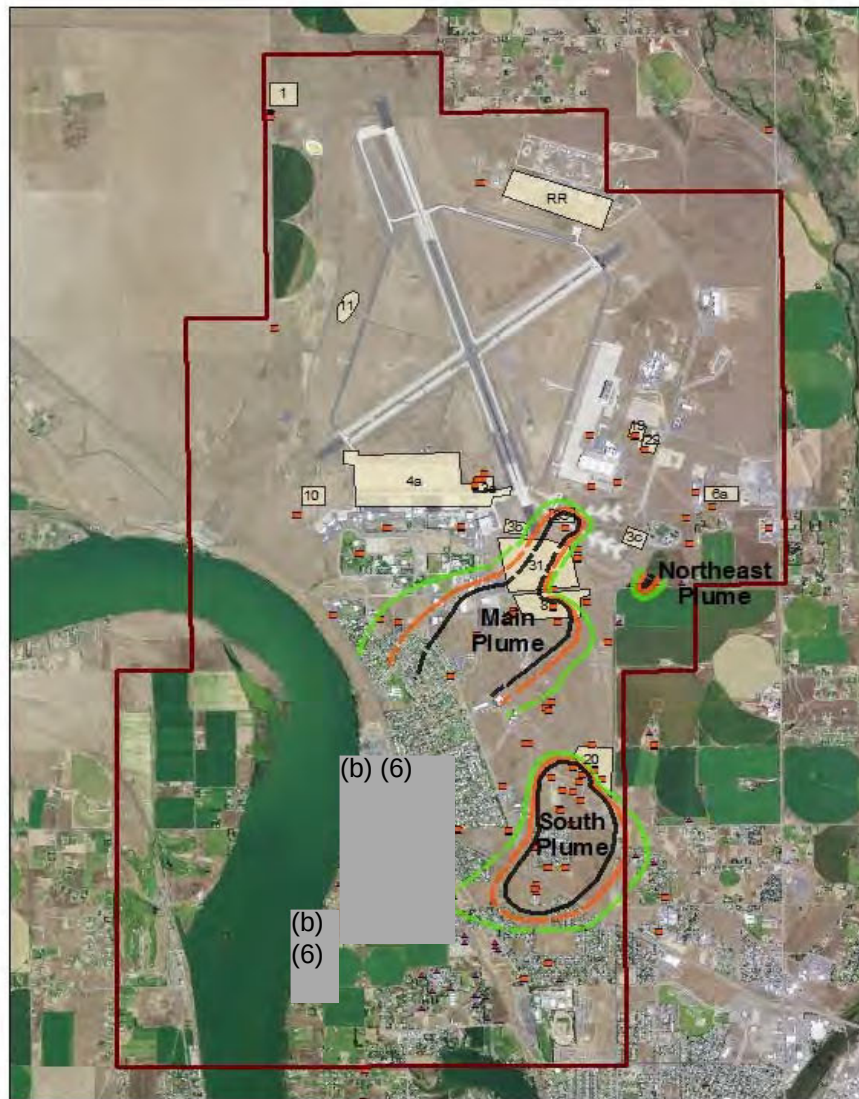
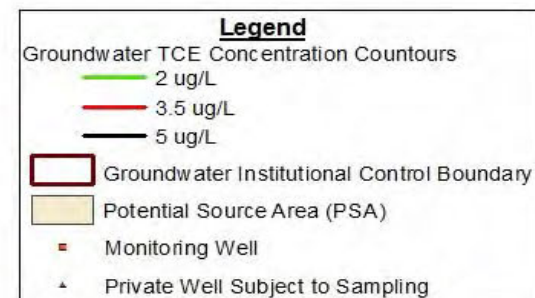


Figure 2: Groundwater Plume Extent and Institutional Control Boundary

Moses Lake Wellfield Contamination Superfund Site



Potential Source Areas Identified in IROD

- PSA 1 – Liquid Waste Disposal Area
- PSA 3 – Aircraft Wash Rack and Associated Culverts
- PSA 6a – Base Closure Landfill
- PSA 8 – Randolph Road Base Dump
- PSA 10 – Fire Training Area Burn Pit A
- PSA 11 – Fire Training Area Burn Pit B
- PSA 19 – Liquid Oxygen (LOX) Plant
- PSA 20 – South Base Dump
- PSA 22 – Paint Hangar Leach Pit
- PSA 31 – 19th Ave. Base Dump
- PSA 33 – Dump at the End of Runway 32
- RR – Rocket Research Perchlorate Disposal



US Army Corps of Engineers
Seattle District

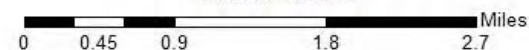


Figure 2. Groundwater plume extent as of May 2016 and institutional control boundary

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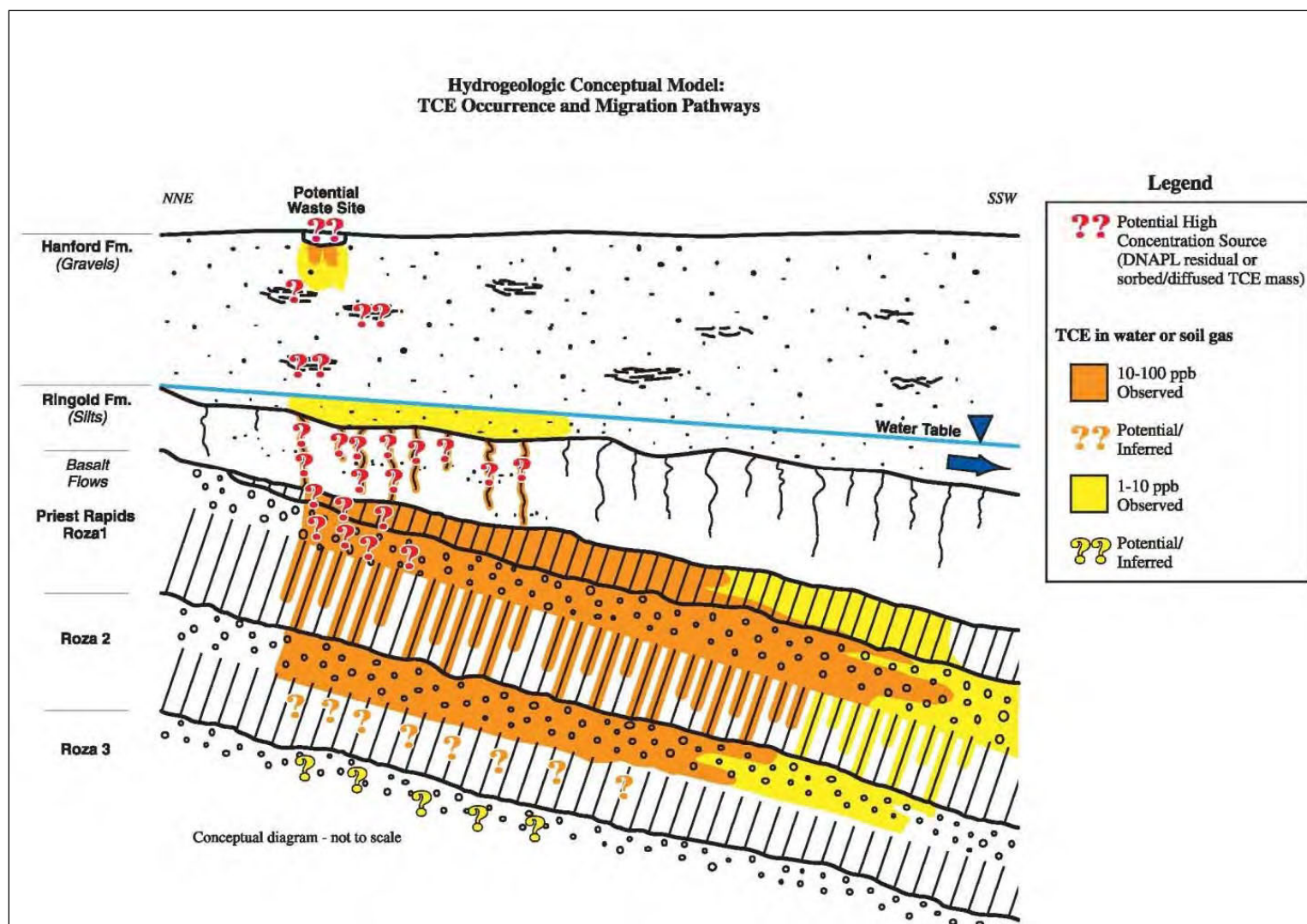


Figure 3. Hydrogeologic Conceptual Model (EPA 2008)

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NOTE: Figures 4 through 12 are located after the list of titles below.

Figure 4. Map of Wells and Sampling Status for 2016

Figure 5. Map of Wells - Cascade Valley Inset

Figure 6. Cascade Valley Inset with TCE Contours and Results (Highest Value Shown)

Figure 7. Priest Rapids-Roza 1 Monitoring Wells (BW series) with Groundwater Elevations (May 2016 Results)

Figure 8. Roza 2 Monitoring Wells (CW series) with Groundwater Elevations (May 2016 Results)

Figure 9. Priest Rapids-Roza 1 Monitoring Wells (BW series) with TCE Contours & Results (Highest Value Shown)

Figure 10. Roza 2 Monitoring Wells (CW series) with TCE Contours & Results (Highest Value Shown)

Figure 11. 2015 and 2016 Perfluorinated Alkyl Acids Results

Figure 12. Map of Private Wells (Ecology's Database) Associated with Appendix H

Figure 13. Map of Six Newly Drilled Monitoring Wells

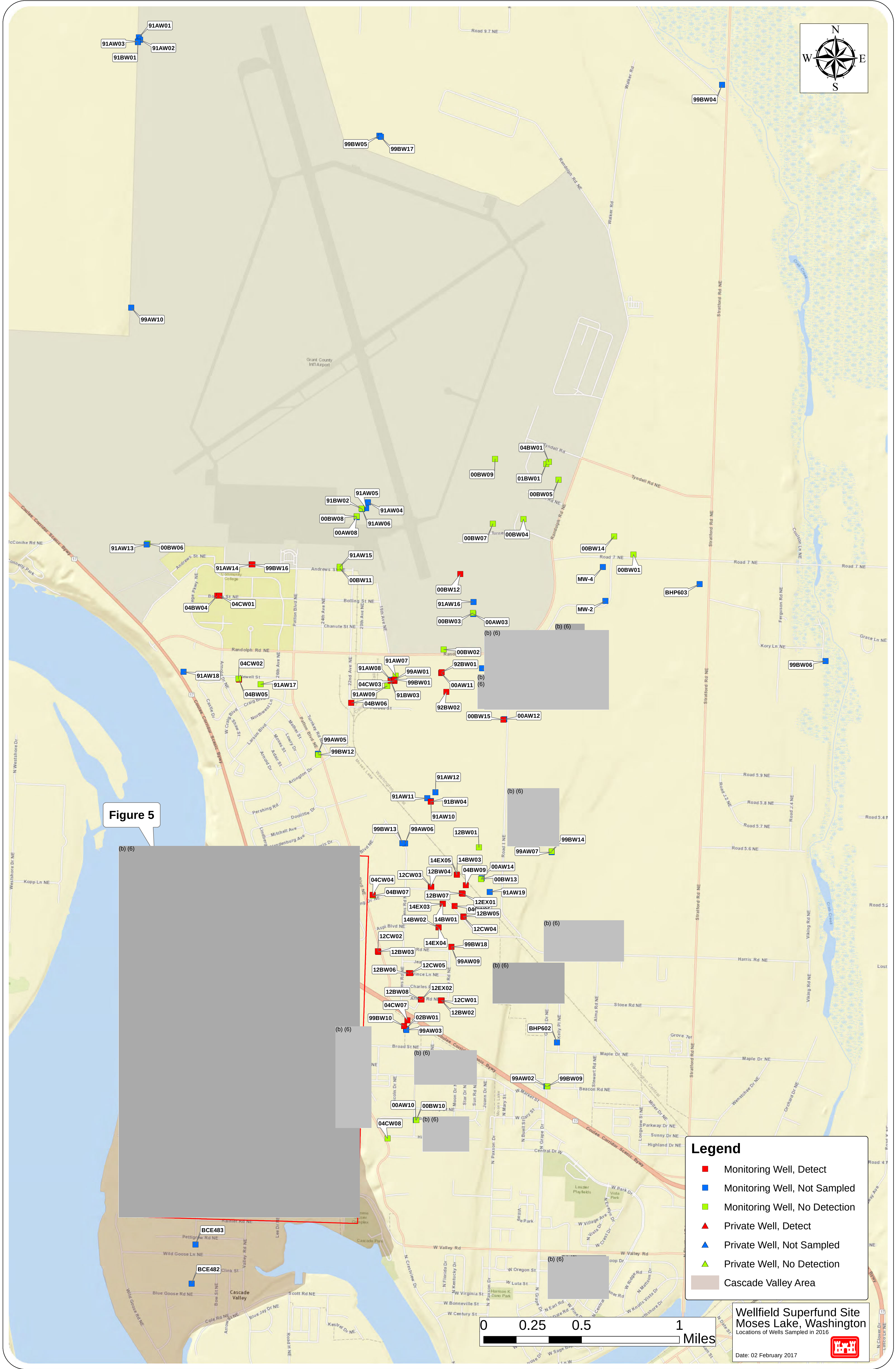


Figure 4. Map of Wells and Sampling Status for 2016

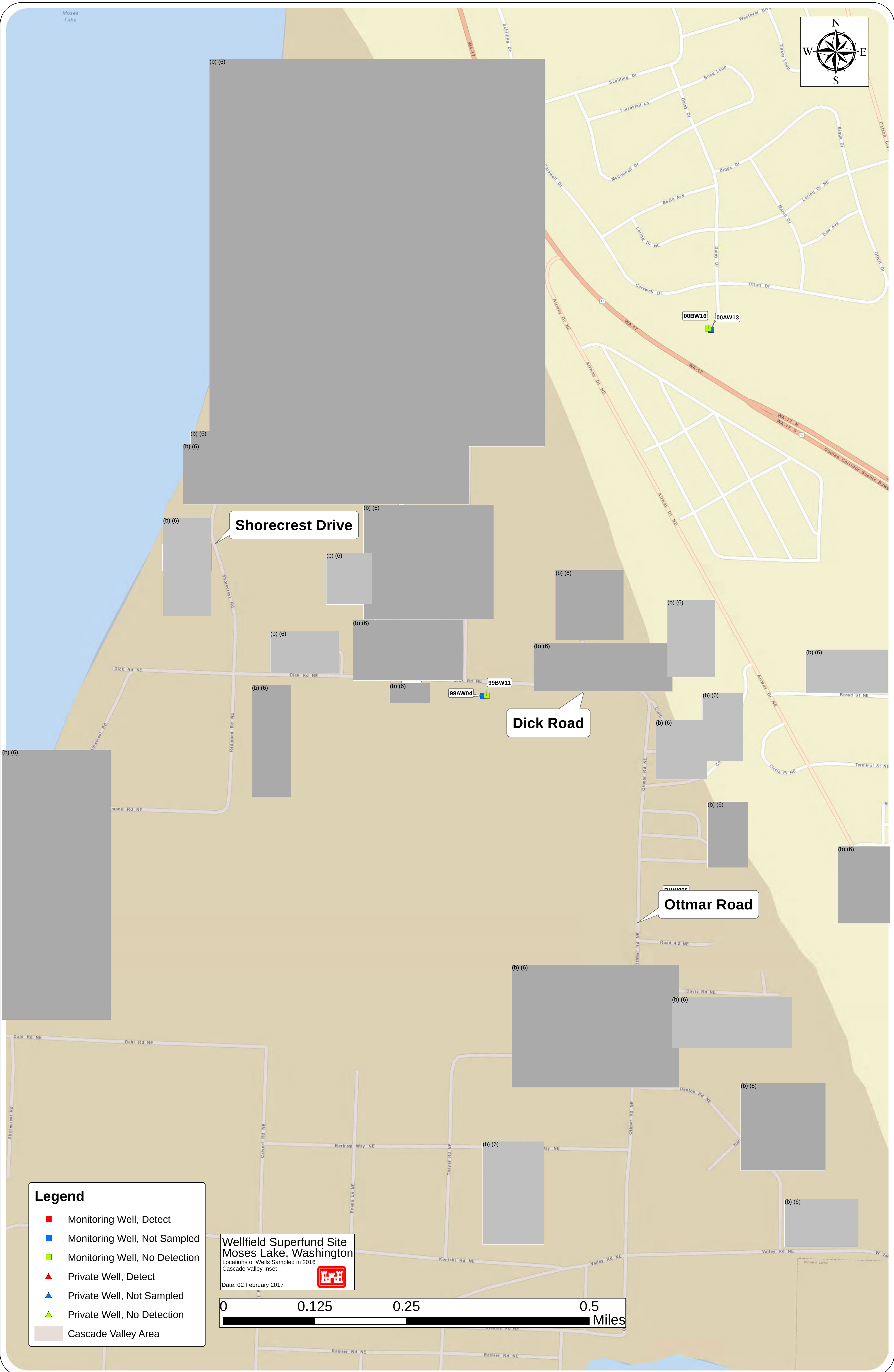


Figure 5. Map of Wells - Cascade Valley Inset

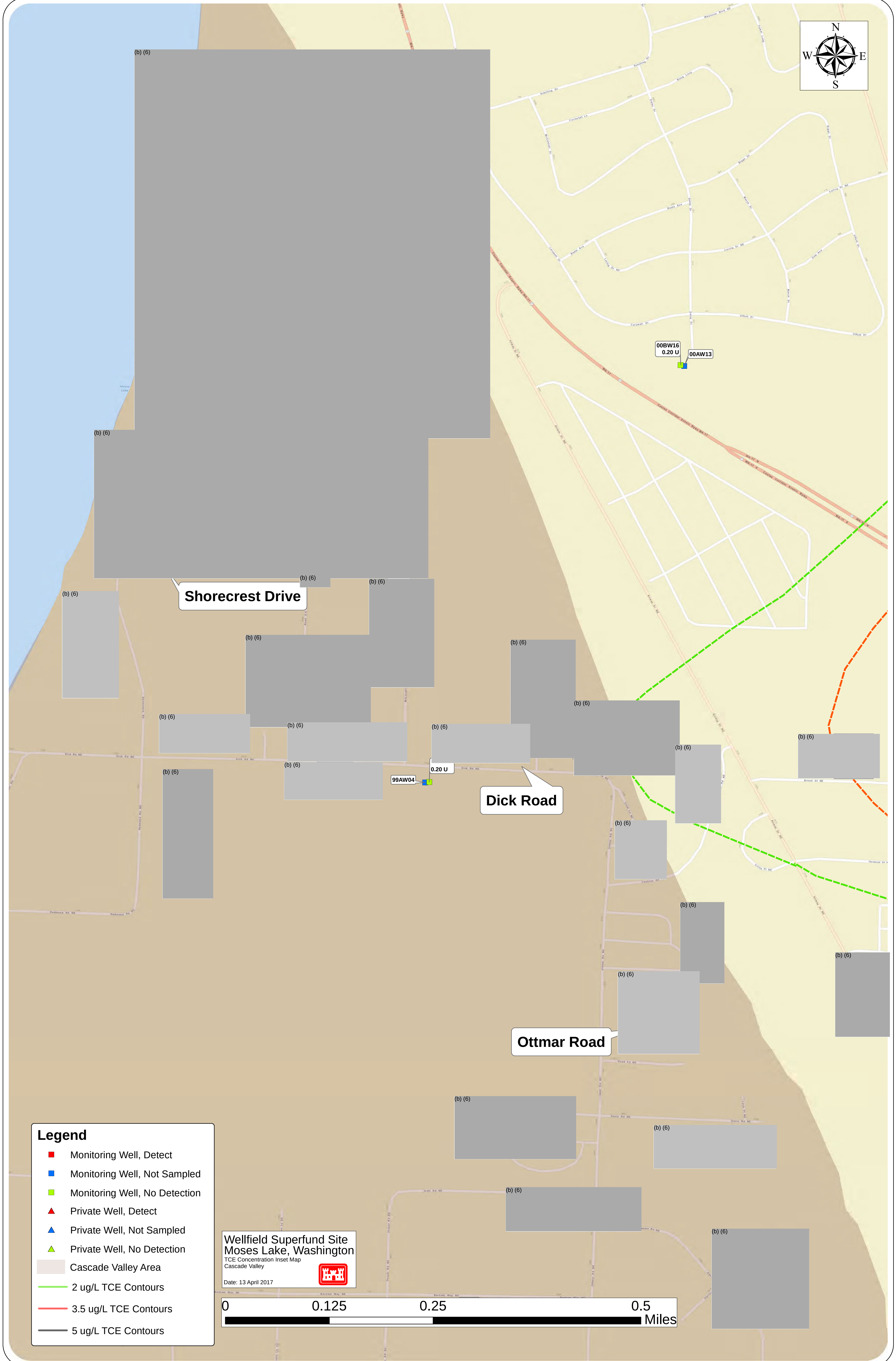


Figure 6. Cascade Valley Inset with TCE Contours and Results (Highest Value Shown)

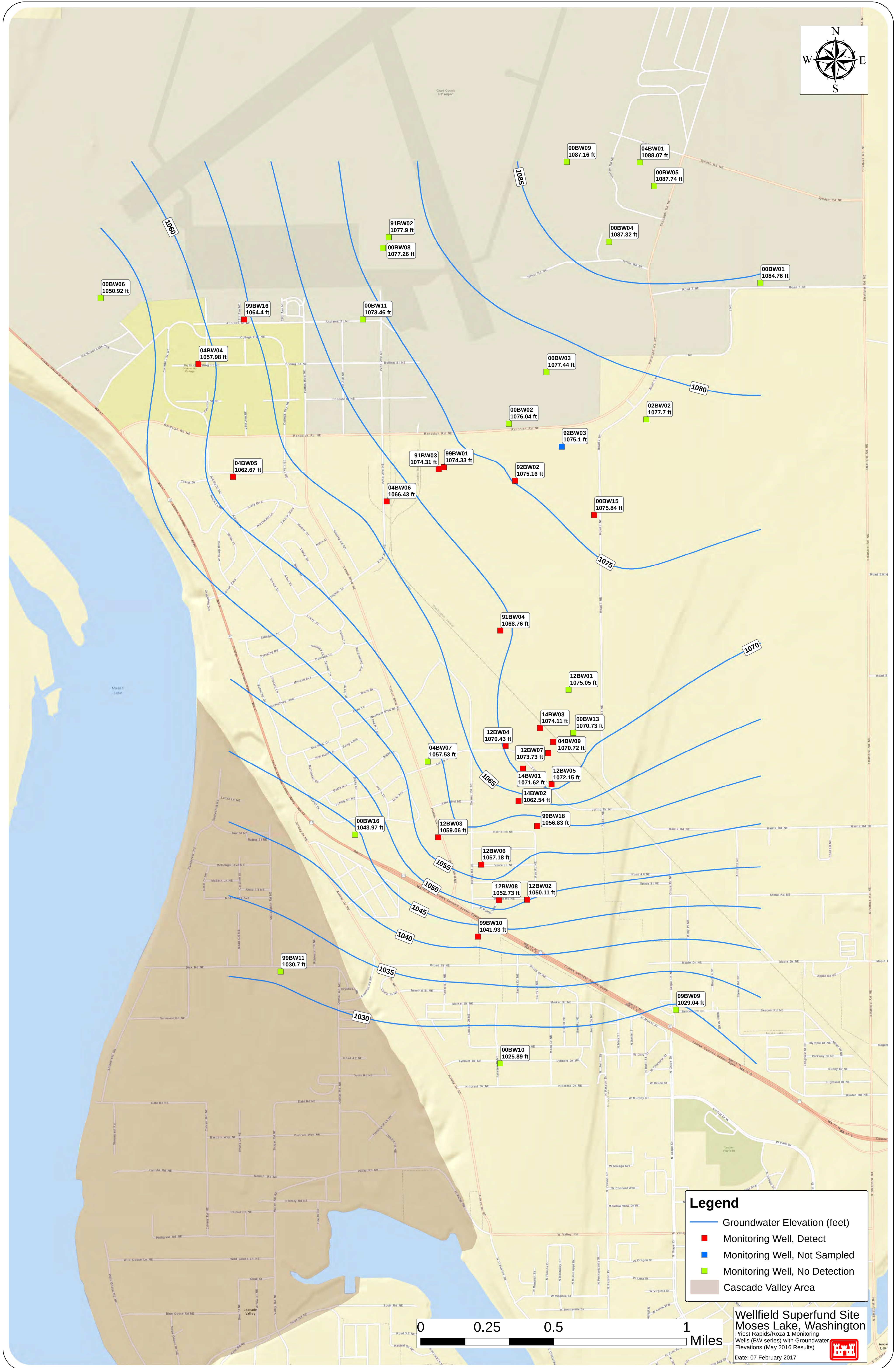


Figure 7. Priest Rapids-Roza 1 Monitoring Wells (BW series) with Groundwater Elevations (May 2016 Results)

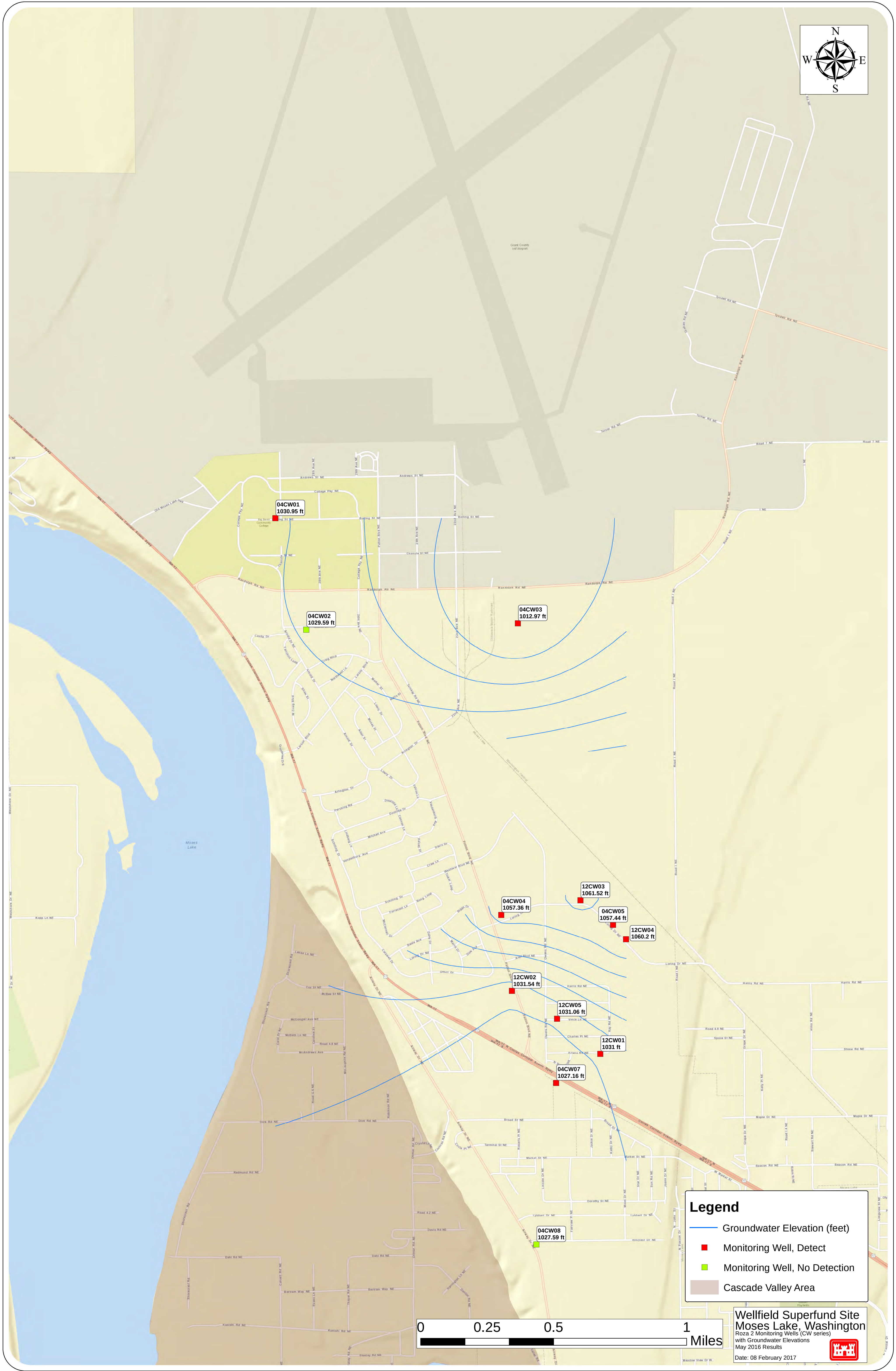


Figure 8. Roza 2 Monitoring Wells (CW series) with Groundwater Elevations (May 2016 Results)

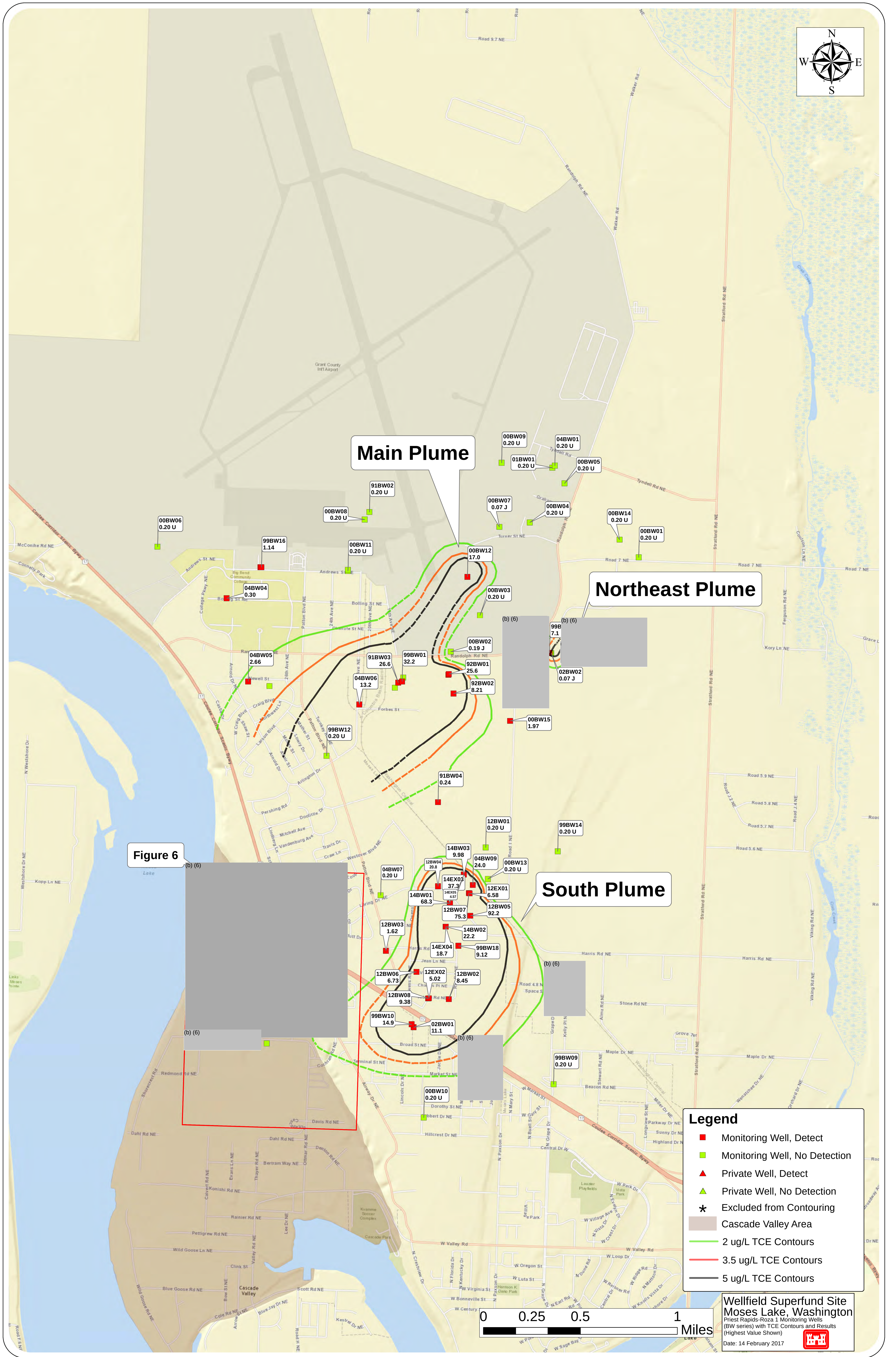


Figure 9. Priest Rapids-Roza 1 Monitoring Wells (BW series) with TCE Contours and Results (Highest Value Shown)

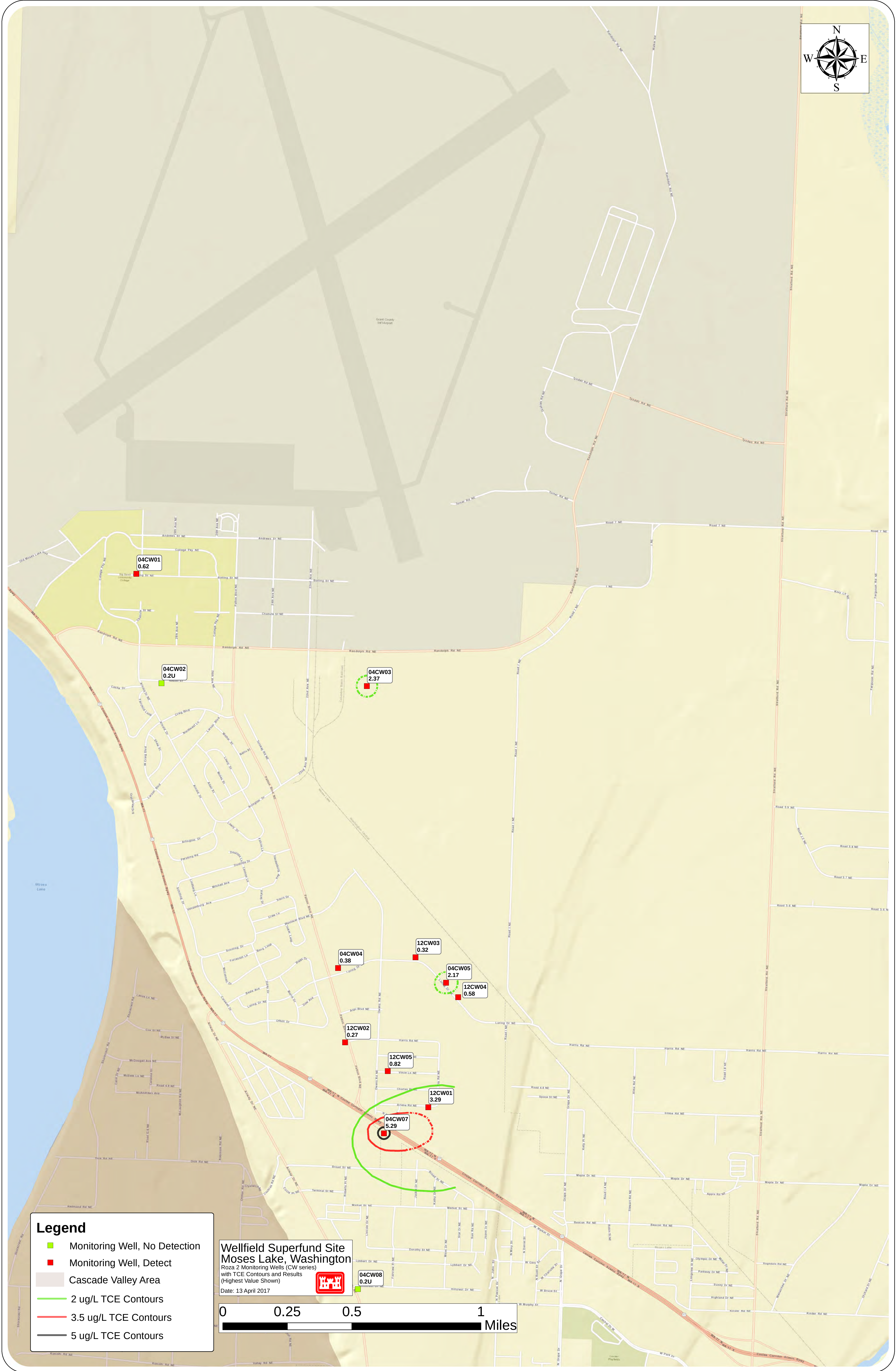


Figure 10. Roza 2 Monitoring Wells (CW series) with TCE Contours and Results (Highest Value Shown)



Well ID	00BW06	
Sample Date	2/24/2015	
Aquifer	Priest Rapids-Roza 1	
Unit	µg/L	
Sample Type	N	FD
PFOS	0.0100 U	0.0100 U
PFOA	0.0101 J	0.00897 J
PFOS+PFOA	0.0101	0.01897
PFHpA	0.00396 J	0.00332 J
PFNA	0.0404	0.0384
PFBS	0.0300 U	0.0300 U
PFHxS	0.0439	0.0412

Well ID	91AW14
Sample Date	5/18/2016
Aquifer	Hanford Formation
Unit	µg/L
Sample Type	N
PFOS	0.119
PFOA	0.143
PFOS+PFOA	0.262
PFHpA	0.0196
PFNA	0.0592
PFBS	0.0765
PFHxS	0.395

Well ID	99BW16
Sample Date	5/18/2016
Aquifer	Priest Rapids-Roza 1
Unit	µg/L
Sample Type	N
PFOS	0.348
PFOA	0.336
PFOS+PFOA	0.684
PFHpA	0.0427
PFNA	0.0201
PFBS	0.162
PFHxS	0.718

Well ID	91AW13
Sample Date	2/24/2015
Aquifer	Hanford Formation
Unit	µg/L
Sample Type	N
PFOS	0.0100 U
PFOA	0.00700 U
PFOS+PFOA	0.017
PFHpA	0.00300 U
PFNA	0.0488
PFBS	0.0300 U
PFHxS	0.0100 U

Well ID	04BW04
Sample Date	5/18/2016
Aquifer	Priest Rapids-Roza 1
Unit	µg/L
Sample Type	N
PFOS	0.0112 J
PFOA	0.00627 J
PFOS+PFOA	0.01747
PFHpA	0.00262 J
PFNA	0.0200 U
PFBS	0.0900 U
PFHxS	0.0217 J

Well ID	04CW01	
Sample Date	5/18/2016	
Aquifer	Roza 2	
Unit	µg/L	
Sample Type	N	FD
PFOS	0.052	0.0711
PFOA	0.105	0.14
PFOS+PFOA	0.157	0.2111
PFHpA	0.0169	0.0215
PFNA	0.0200 U	0.0200 U
PFBS	0.0318 J	0.0423 J
PFHxS	0.252	0.334

Legend

N: Normal
FD: Field Duplicate
J: Estimated result
U: Undetected
µg/L: micrograms per liter
PFOS: Perfluorooctanesulfonic Acid
PFOA: Perfluorooctanoic Acid
PFHpA: Perfluoroheptanoic Acid
PFNA: Perfluorononanoic Acid
PFBS: Perfluorobutanesulfonic Acid
PFHxS: Perfluorohexanesulfonic Acid

Wellfield Superfund Site
Moses Lake, Washington
Monitoring Wells with Perfluorinated
Alkyl Acids Sampling Results
from 2015 and 2016
Date: 13 April 2017



Yellow highlighted cells indicate the sample exceeded EPA's 2016 Lifetime Health Advisory of 0.07 micrograms per liter for the combined concentrations of PFOA and PFOS.

Figure 11. 2015 and 2016 Perfluorinated Alkyl Acids Results

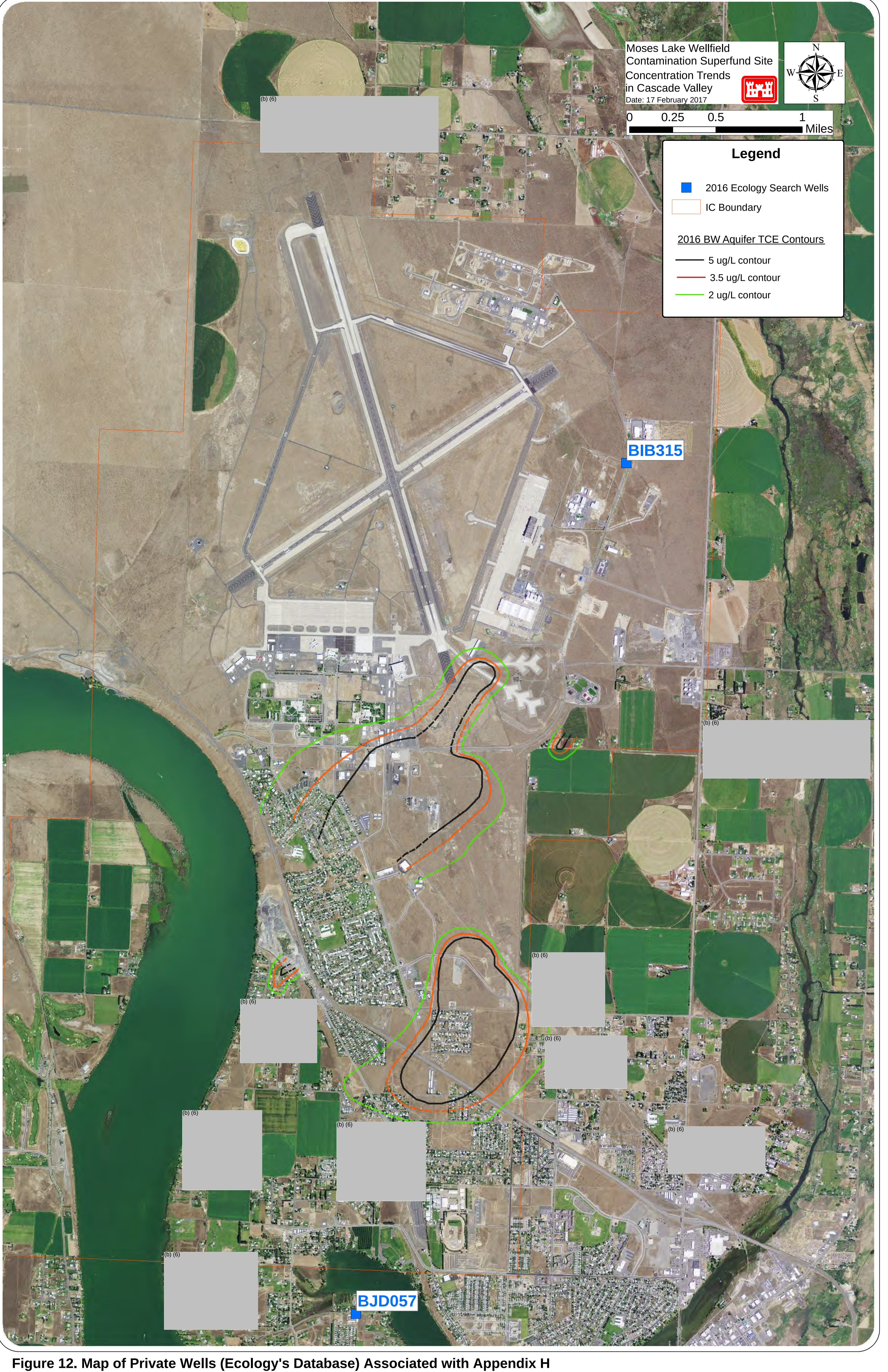
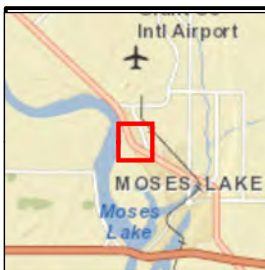


Figure 12. Map of Private Wells (Ecology's Database) Associated with Appendix H

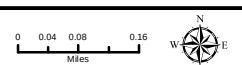


2016 Well Locations



Legend

◆ Well Locations



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Figure 13. Map of Six Newly Drilled Monitoring Wells

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Tables

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Table 1. Wells Sampled during 2016 Sampling Year

	February 2016		May 2016		August 2016		November 2016	
Well ID	COC	GW. Elevation	COC	GW. Elevation	COC	GW. Elevation	COC	GW. Elevation
Hanford Formation Wells								
00AW11			V	X			V	X
99AW01			V	X			V	X
99AW08			V	X				
99AW09			V	X			V	X
91AW07			V	X				
91AW09			V	X				
91AW14			V+PFAA	X				
91AW15			V	X				
91AW17			V	X				
00BW01			V	X				
00BW02			V	X				
00BW03			V	X				
00BW04			V	X				
00BW05			V	X				
00BW06			V	X				
00BW07			V	X				
00BW09			V	X				
00BW10			V	X				
00BW11			V+DRO+GRO+BTEX	X				
00BW12			V+1,4-dioxane	X				
00BW13			V	X				
00BW14			V	X				
00BW15			V	X				
00BW16			V	X				
01BW01			V	X				
02BW01	V	X	V	X		X	V	X
02BW02			V	X				
04BW01			V	X				
04BW04			V+PFAA	X				
04BW05			V	X				
04BW06			V	X				
04BW07			V	X				
04BW09	V	X	V	X			V	X
04CW01			V+PFAA	X				
04CW02			V	X				
04CW03			V	X				
04CW04			V	X				
04CW05	V	X	V	X		X	V	X

Table 1. Wells Sampled during 2016 Sampling Year

	February 2016		May 2016		August 2016		November 2016	
Well ID	COC	GW. Elevation	COC	GW. Elevation	COC	GW. Elevation	COC	GW. Elevation
04CW07A	V	X	V	X		X	V	X
04CW07B		X		X				X
04CW08			V	X				
12BW01			V	X				
12BW02	V	X	V	X		X	V	X
12BW03A	V	X	V	X		X	V	X
12BW03B		X		X				X
12BW04A	V	X	V	X		X	V	X
12BW04B		X		X				X
12BW05	V	X	V	X		X	V	X
12BW06	V	X	V	X		X	V	X
12BW07	V	X	V	X		X	V	X
12BW08	V	X	V	X		X	V	X
12CW01	V	X	V	X		X	V	X
12CW02	V	X	V	X		X	V	X
12CW03	V	X	V	X		X	V	X
12CW04	V	X	V	X		X	V	X
12CW05	V	X	V	X		X	V	X
12EX01	V	X	V	X		X	V	X
12EX02	V	X	V	X		X	V	X
14BW01	V	X	V	X		X	V	X
14BW02	V	X	V	X		X	V	X
14BW03	V	X	V	X		X	V	X
14EX03	V	X	V	X		X	V	X
14EX04	V	X	V	X		X	V	X
14EX05	V	X	V	X		X	V	X
91BW02			V	X				
91BW03			V	X				
91BW04	V	X	V	X			V	X
92BW01	V	X	V	X			V	X
92BW02			V	X			V	X
99BW01			V	X				
99BW09			V	X				
99BW10	V	X	V	X			V	X
99BW11			V	X				
99BW12			V	X				
99BW14			V	X				
99BW15			V+1,4-dioxane	X				
99BW16			V+PFAA+1,4-dioxane	X				
99BW18	V	X	V	X			V	X
WP-03			V					

Table 1. Wells Sampled during 2016 Sampling Year

	February 2016		May 2016		August 2016		November 2016	
Well ID	COC	GW. Elevation	COC	GW. Elevation	COC	GW. Elevation	COC	GW. Elevation
WP-04	V		V		V		V	
WP-09			V					
WP-10			V					
WP-105			V					
WP-111			V					
WP-116			V					
WP-119	V		V+PFAA+1,4-dioxane		V		V	
WP-120			V					
WP-121	V		V+PFAA+1,4-dioxane		V		V	
WP-122			V					
WP-123	V		V		V		V	
WP-124	V		V+PFAA+1,4-dioxane		V		V	
WP-125	V		V+PFAA+1,4-dioxane		V		V	
WP-126			V					
WP-127			V					
WP-128			V					
WP-129	V		V		V		V	
WP-130			V					
WP-131	V		V		V		V	
WP-136			V					
WP-137			V					
WP-138			V					
WP-139			V					
WP-14	V		V		V		V	
WP-143			V					
WP-144			V+1,4-dioxane					
WP-145			V					
WP-147			V					
WP-148			V					
WP-149			V					
WP-150			V					
WP-152			V					
WP-153			V					
WP-154			V					
WP-155			V					
WP-156			V					
WP-165			V					
WP-167	V		V		V		V	
WP-168	V		V+1,4-dioxane		V		V	
WP-169			V					

Table 1. Wells Sampled during 2016 Sampling Year

	February 2016		May 2016		August 2016		November 2016	
Well ID	COC	GW. Elevation	COC	GW. Elevation	COC	GW. Elevation	COC	GW. Elevation
WP-170			V					
WP-171			V					
WP-172			V					
WP-173			V					
WP-177			V					
WP-178			V					
WP-179			V					
WP-180			V					
WP-27	V		V		V		V	
WP-28			V					
WP-33			V					
WP-45			V+1,4-dioxane					
WP-50			V					
WP-52			V+1,4-dioxane					
WP-54			V					
WP-57			V					
WP-65			V					
WP-66			V					
WP-68			V					
WP-69			V+1,4-dioxane					
WP-70	V		V		V		V	
WP-71A			V					
WP-71B			V					
WP-74			V+1,4-dioxane					
WP-82			V					
WP-83	V		V		V		V	
WP-86	V		V		V		V	
Total MW	28		75		0		32	
Total PW	15		68		15		15	

V = VOCs

X = measurement taken

PFAA = perfluoroalkyl acids

Table 2. Private Wells with Whole-House Filter Systems

WELL ID	Date WHF System Installed/Replaced	Comment
WP-14	May 2013	Replaced WHF from mid-2000s
WP-70	May 2013	Replaced WHF from mid-2000s
WP-82	Removed	Was installed in early 2000s though no detections exceeded action threshold; was removed in 2013 because results continued to be less than action threshold.
WP-83	May 2013	Replaced WHF from mid-2000s
WP-86	May 2013	Replaced WHF from mid-2000s
WP-119	Aug 2013	Newly installed
WP-121	Aug 2013	Newly installed
WP-129	Sep 2013	Newly installed
WP-124	Oct 2013	Newly installed
WP-123	Sep 2014	Newly installed
WP-125	Apr 2015	Newly installed

Table 3. Monitoring Wells – Groundwater Elevations

Well ID	Water Level Elevation Feb 2016	Water Level Elevation May 2016	Water Level Elevation August 2016	Water Level Elevation August 2016	Screen Interval	Bladder Pump Installed?	Stick Up or Flush Mount	NAD 83 Coordinates	
00AW11		1074.48		1075.4	81-91	Yes	Stick Up	47.180903	-119.30661
00BW01	1083.35	1084.76			68-78	Yes	Stick Up	47.190079	-119.28616
00BW02	1075.01	1076.04			87-97	Yes	Stick Up	47.182638	-119.306417
00BW03	1076.94	1077.44			85-95	Yes	Stick Up	47.185409	-119.303345
00BW04	1087.15	1087.32			70-80	Yes	Stick Up	47.192445	-119.298192
00BW05	1087.58	1087.74			80-90	Yes	Stick Up	47.195435	-119.294518
00BW06	1051.93	1050.92			180-190	Yes	Stick Up	47.189802	-119.338849
00BW07	1081.96				75-85	Yes	Stick Up	47.192043	-119.301497
00BW08	1076.42	1077.26			92-102	Yes	Stick Up	47.192293	-119.316264
00BW09	1086.99	1087.16			79.5-89.5	Yes	Stick Up	47.196831	-119.301469
00BW10	1032.29	1025.89			186.2-196.2	Yes	Stick Up	47.147826	-119.307873
00BW11	1072.87	1073.46			107-117	Yes	Flush Mount	47.188424	-119.317939
00BW12	1077.47				101-111	Yes	Stick Up	47.188245	-119.304851
00BW13	1068.43	1070.73			133-143	Yes	Stick Up	47.165764	-119.301631
00BW14	1084.72				62-72	Yes	Flush Mount	47.191362	-119.288309
00BW15	1073.54	1075.84			105.6-115.6	Yes	Stick Up	47.177595	-119.299711
00BW16	1046.53	1043.97			186.4-196.4	Yes	Stick Up	47.160398	-119.319182
01BW01	1088.09				85-95	Yes	Flush Mount	47.196578	-119.295897
02BW01	1043.69	1141.01*	1037.35	1045.6	188-192.5	Removed	Flush Mount	47.154543	-119.309278
02BW02	1075.1	1077.7			109-118.5	Yes	Flush Mount	47.182746	-119.295425
04BW01	1087.9	1088.07			96-116	No	Stick Up	47.196733	-119.295632
04BW04	1057.2	1057.98			190-210	No	Stick Up	47.186124	-119.331118
04BW05	1062.04	1062.67			176-196	No	Stick Up	47.179966	-119.328492
04BW06	1065.89	1066.43			174-194	No	Stick Up	47.178499	-119.316265
04BW07	1057.26	1057.53			195-215	No	Stick Up	47.164316	-119.313303
04BW09	1068.54	1070.72		1071.05	139.5-149.5	No	Flush Mount	47.16529	-119.303267
04CW01	1034.79	1030.95			298-308	No	Stick Up	47.186125	-119.330888
04CW02	1031.2	1029.59			297-307	No	Stick Up	47.180036	-119.328547
04CW03	1026.02	1012.97			264-284	No	Stick Up	47.180214	-119.311653
04CW04	1057.4	1057.36			303-313	No	Stick Up	47.16437	-119.313331
04CW05	1057.44	1057.44	1055.15	1058.28	260-280	No	Stick Up	47.163731	-119.304417
04CW07	1032.65	1027.16	1015.32	1030.2	283-293/ 303-309	No	Stick Up	47.155184	-119.309159
04CW08	1032.54	1027.59			294-314	No	Flush Mount	47.146414	-119.310925
12BW01	1072.6	1075.05			162 - 172	No	Stick Up	47.168105	-119.301971
12BW02	1051.98	1050.11	1050.11	1055.95	174 - 194	No	Flush Mount	47.156722	-119.305516
12BW03	1058.7	1059.06	1058.66	1061.73	179-189/ 199-219	No	Stick Up	47.160178	-119.312552

Table 3. Monitoring Wells – Groundwater Elevations

Well ID	Water Level Elevation Feb 2016	Water Level Elevation May 2016	Water Level Elevation August 2016	Water Level Elevation August 2016	Screen Interval	Bladder Pump Installed?	Stick Up or Flush Mount	NAD 83 Coordinates	
12BW04	1069.07	1070.43	1071.15	1071.38	158-168/178-188	No	Stick Up	47.165106	-119.307067
12BW05	1069.91	1072.15	1073.63	1072.86	167 - 187	No	Stick Up	47.162973	-119.303437
12BW06	1057.05	1057.18	1056.68	1060.38	170 - 200	No	Flush Mount	47.158669	-119.309139
12BW07	1071.74	1073.73	1075.18	1074.31	160 - 180	No	Stick Up	47.16467	-119.303665
12BW08	1053.08	1052.73	1051.72	1056.77	178 - 198	No	Flush Mount	47.156729	-119.307772
12CW01	1036.42	1031	1018.2	1034.01	274 - 294	No	Flush Mount	47.156724	-119.30559
12CW02	1037.07	1031.54	1018.35	1033.21	300 - 320	No	Stick Up	47.16022	-119.312575
12CW03	1061.51	1061.52	1059.35	1062.29	288-298	No	Stick Up	47.165098	-119.306996
12CW04	1060.34	1060.2	1057.77	1061.23	255 - 265	No	Stick Up	47.16294	-119.303394
12CW05	1036.27	1031.06	1018.31	1033.98	287 - 307	No	Flush Mount	47.158672	-119.309
12EX01	1071.74	1073.85	1075.31	1074.31	160 - 180	No	Stick Up	47.16465	-119.30358
12EX02	1053.03	1052.72	1051.61	1056.72	180 - 198	No	Flush Mount	47.156733	-119.307692
14BW01	1070.04	1071.62	1072.78	1072.47	160-180	No	Stick Up	47.163858	-119.305713
14BW02	1061.57	1062.54	1062.88	1064.8	157-187	No	Stick Up	47.162105	-119.306092
14BW03	1072.14	1074.11	1075.37	1074.46	143-173	No	Stick Up	47.166044	-119.304279
14EX03	1069.74	1071.41	1072.36	1072.18	160-180	No	Stick Up	47.163859	-119.305689
14EX04	1061.64	1062.6	1062.97	1064.87	157-187	No	Stick Up	47.162104	-119.306073
14EX05	1072.18	1064.09	1075.41	1074.42	143-173	No	Stick Up	47.166044	-119.304263
91AW07	1074.41	1075.34			81-101	No	Stick Up	47.180598	-119.311535
91AW09		1075.06		1064.89	81-101	Yes	Stick Up	47.179826	-119.31241
91AW14	1063.56	1064.42			116-136	No	Stick Up	47.188512	-119.327511
91AW15		1072.94			89-109	Yes	Flush Mount	47.188513	-119.317936
91AW17		1071.31			108-128	Yes	Stick Up	47.179675	-119.326143
91BW02	1077.02	1077.9			137-147	Yes	Stick Up	47.192871	-119.315772
91BW03	1073.29	1074.31			170-180	Yes	Stick Up	47.180218	-119.312071
91BW04	1067.08	1068.76		1069.32	178-188	Yes	Stick Up	47.171379	-119.307337
92BW01	1073.77	1075.16		1076.14	143-153	Yes	Stick Up	47.18096	-119.306561
92BW02	1073.74	1075.1		1075.99	147-157	Yes	Stick Up	47.179523	-119.305986
99AW01		1075.3		1075.9	101-111	Yes	Stick Up		
99AW08		1077.37			70-80	Yes	Flush Mount	47.182757	-119.295516
99AW09		1064.13			97.5-107.5	Yes	Stick Up	47.160705	-119.304635
99BW01	1073.31	1074.33			141.5-151.5	Yes	Stick Up	47.180311	-119.311651
99BW09	1033.66	1029.04			110-120	Yes	Stick Up	47.150603	-119.293789
99BW10	1043.56	1041.93		1045.74	175-185	Yes	Flush Mount	47.15475	-119.3095
99BW11	1036.01	1030.7			102-112	Yes	Flush Mount	47.153011	-119.325283
99BW12	1065.44				162-172	Yes	Flush Mount	47.174589	-119.319677
99BW14	1066.98				85-95	Yes	Stick Up	47.16798	-119.294074
99BW15	1074.74				90-100	Yes	Flush Mount	47.182758	-119.295615
99BW16	1063.59	1064.4			146-156	Yes	Stick Up	47.188514	-119.327413
99BW18	1056.01	1056.83		1059.61	143-153	Yes	Stick Up	47.160705	-119.304635

Table 3. Monitoring Wells – Groundwater Elevations

Well ID	Water Level Elevation Feb 2016	Water Level Elevation May 2016	Water Level Elevation August 2016	Water Level Elevation August 2016	Screen Interval	Bladder Pump Installed?	Stick Up or Flush Mount	NAD 83 Coordinates
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Notes:

* The groundwater elevation recorded at 02BW01 in May is 100 feet higher than surrounding water levels and other measurements at the well. The water level was not used for the groundwater contour maps.

Table 4. Monitoring and Extraction Wells – Sampling Results

MONITORING AND EXTRACTION WELL RESULTS				CIS-DCE	TCE
Well ID	Sample Name	Sample Date	Sample Type	Results µg/L (MCL 70)	Results µg/L (MCL 5)
Hanford Formation Wells					
00AW11	1605N00AW11	5/21/2016	N	0.20 U	1.32
00AW11	1611N00AW11	11/15/2016	N	0.20 U	1.64
91AW07	1605N91AW07	5/21/2016	N	0.20 U	0.10 J
91AW09	1605N91AW09	5/20/2016	N	0.20 U	0.18 J
91AW14	1605N91AW14	5/18/2016	N	0.20 U	3.94
91AW15	1605N91AW15	5/17/2016	N	0.20 U	0.06 J
91AW17	1605N91AW17	5/19/2016	N	0.20 U	0.15 J
99AW01	1605N99AW01	5/21/2016	N	0.20 U	0.20 U
99AW01	1611N99AW01	11/14/2016	N	0.20 U	0.20 U
99AW08	1605N99AW08	5/20/2016	N	0.20 U	0.16 J
99AW09	1605N99AW09	5/23/2016	N	0.20 U	1.74
99AW09	1611N99AW09	11/15/2016	N	0.20 U	2.38
99AW09	1611D99AW09	11/15/2016	FD	0.20 U	2.13
Priest Rapids/ Roza 1 Wells					
00BW01	1605N00BW01	5/16/2016	N	0.20 U	0.20 U
00BW02	1605N00BW02	5/17/2016	N	0.20 U	0.19 J
00BW03	1605N00BW03	5/17/2016	N	0.20 U	0.20 U
00BW04	1605N00BW04	5/16/2016	N	0.20 U	0.20 U
00BW05	1605N00BW05	5/16/2016	N	0.20 U	0.20 U
00BW05	1605D00BW05	5/16/2016	FD	0.20 U	0.20 U
00BW06	1605N00BW06	5/17/2016	N	0.20 U	0.07 J
00BW07	1605N00BW07	5/17/2016	N	0.20 U	0.20 U
00BW09	1605N00BW09	5/16/2016	N	0.20 U	0.20 U
00BW10	1605N00BW10	5/20/2016	N	0.20 U	0.20 U
00BW11	1605N00BW11	5/17/2016	N	0.20 U	0.20 U
00BW12	1605N00BW12	5/18/2016	N	0.20 U	17.0
00BW13	1605N00BW13	5/22/2016	N	0.20 U	0.20 U
00BW14	1605N00BW14	5/16/2016	N	0.20 U	0.20 U
00BW15	1605N00BW15	5/19/2016	N	0.38	1.97
00BW16	1605N00BW16	5/23/2016	N	0.20 U	0.20 U
00BW16	1605D00BW16	5/23/2016	FD	0.20 U	0.20 U
01BW01	1605N01BW01	5/16/2016	N	0.20 U	0.20 U
02BW01	1602N02BW01	2/24/2016	N	0.20 U	10.9
02BW01	1605N02BW01	5/20/2016	N	0.20 U	10.7
02BW01	1605D02BW01	5/20/2016	FD	0.20 U	9.99
02BW01	1611N02BW01	11/17/2016	N	0.20 U	11.1
02BW02	1605N02BW02	5/20/2016	N	0.20 U	0.07 J

Table 4. Monitoring and Extraction Wells – Sampling Results

MONITORING AND EXTRACTION WELL RESULTS				CIS-DCE	TCE
Well ID	Sample Name	Sample Date	Sample Type	Results µg/L (MCL 70)	Results µg/L (MCL 5)
04BW01	1605N04BW01	5/16/2016	N	0.20 U	0.20 U
04BW04	1605N04BW04	5/18/2016	N	0.20 U	0.30
04BW05	1605N04BW05	5/19/2016	N	0.10 J	2.66
04BW06	1605N04BW06	5/20/2016	N	2.74	13.2
04BW07	1605N04BW07	5/22/2016	N	0.20 U	0.20 U
04BW09	1602N04BW09	2/24/2016	N	0.20 U	21.8
04BW09	1605N04BW09	5/22/2016	N	0.20 U	20.1
04BW09	1611N04BW09	11/16/2016	N	0.20 U	24.0
12BW01	1605N12BW01	5/22/2016	N	0.20 U	0.20 U
12BW02	1602N12BW02	2/22/2016	N	0.20 U	8.45
12BW02	1605N12BW02	5/20/2016	N	0.20 U	7.77
12BW02	1611N12BW02	11/17/2016	N	0.20 U	7.89
12BW03	1602N12BW03A	2/23/2016	N	0.20 U	1.62
12BW03	1602N12BW03B	2/23/2016	N	0.20 U	0.65
12BW03	1605N12BW03A	5/22/2016	N	0.20 U	0.94
12BW03	1605N12BW03B	5/22/2016	N	0.20 U	0.51
12BW03	1611N12BW03A	11/17/2016	N	0.20 U	0.61
12BW03	1611N12BW03B	11/17/2016	N	0.20 U	0.47
12BW04	1602N12BW04A	2/24/2016	N	0.20 U	18.2
12BW04	1602N12BW04B	2/24/2016	N	0.20 U	19.0
12BW04	1605N12BW05	5/22/2016	N	0.20 U	85.5
12BW04	1605N12BW04A	5/22/2016	N	0.20 U	17.3
12BW04	1605N12BW04B	5/22/2016	N	0.20 U	20.2
12BW04	1611N12BW04A	11/16/2016	N	0.20 U	20.8
12BW04	1611N12BW04B	11/16/2016	N	0.20 U	20.6
12BW05	1602N12BW05	2/24/2016	N	0.20 U	79.9
12BW05	1611N12BW05	11/16/2016	N	0.20 U	92.2
12BW06	1602N12BW06	2/23/2016	N	0.20 U	6.73
12BW06	1602D12BW06	2/23/2016	FD	0.20 U	6.28
12BW06	1605N12BW06	5/23/2016	N	0.20 U	4.84
12BW06	1611N12BW06	11/17/2016	N	0.20 U	6.20
12BW06	1611D12BW06	11/17/2016	FD	0.20 U	5.91
12BW07	1602N12BW07	2/24/2016	N	0.20 U	63.8
12BW07	1605N12BW07	5/19/2016	N	0.20 U	75.3
12BW07	1611N12BW07	11/16/2016	N	0.20 U	71.0
12BW08	1602N12BW08	2/22/2016	N	0.20 U	9.38
12BW08	1605N12BW08	5/23/2016	N	0.20 U	7.45
12BW08	1611N12BW08	11/17/2016	N	0.20 U	8.87
14BW01	1602N14BW01	2/23/2016	N	0.20 U	59.0

Table 4. Monitoring and Extraction Wells – Sampling Results

MONITORING AND EXTRACTION WELL RESULTS				CIS-DCE	TCE
Well ID	Sample Name	Sample Date	Sample Type	Results µg/L (MCL 70)	Results µg/L (MCL 5)
14BW01	1605N14BW01	5/19/2016	N	0.20 U	68.3
14BW01	1611N14BW01	11/17/2016	N	0.20 U	59.5
14BW01	1611D14BW01	11/17/2016	FD	0.20 U	59.1
14BW02	1602N14BW02	2/23/2016	N	0.20 U	22.2
14BW02	1605N14BW02	5/22/2016	N	0.20 U	21.9
14BW02	1611N14BW02	11/17/2016	N	0.20 U	20.5
14BW03	1602N14BW03	2/24/2016	N	0.20 U	9.35
14BW03	1602D14BW03	2/24/2016	FD	0.20 U	9.11
14BW03	1605N14BW03	5/22/2016	N	0.20 U	9.17
14BW03	1611N14BW03	11/16/2016	N	0.20 U	9.98
91BW02	1605N91BW02	5/17/2016	N	0.20 U	0.20 U
91BW03	1605N91BW03	5/20/2016	N	0.20 U	26.6
91BW04	1602N91BW04	2/23/2016	N	0.20 U	0.24
91BW04	1605N91BW04	5/22/2016	N	0.20 U	0.15 J
91BW04	1611N91BW04	11/15/2016	N	0.20 U	0.20 U
92BW01	1602N92BW01	2/23/2016	N	0.20 U	25.6
92BW01	1602D92BW01	2/23/2016	FD	0.20 U	25.3
92BW01	1605N92BW01	5/21/2016	N	0.20 U	21.0
92BW01	1605D92BW01	5/21/2016	FD	0.20 U	21.8
92BW01	1611N92BW01	11/15/2016	N	0.20 U	21.9
92BW02	1605N92BW02	5/21/2016	N	0.74	7.27
92BW02	1611N92BW02	11/15/2016	N	0.87	8.21
99BW01	1605N99BW01	5/19/2016	N	0.20 U	32.2
99BW09	1605N99BW09	5/21/2016	N	0.20 U	0.20 U
99BW10	1602N99BW10	2/23/2016	N	0.20 U	14.9
99BW10	1605N99BW10	5/23/2016	N	0.20 U	12.0
99BW10	1611N99BW10	11/15/2016	N	0.20 U	12.0
99BW11	1605N99BW11	5/23/2016	N	0.20 U	0.20 U
99BW12	1605N99BW12	5/19/2016	N	0.20 U	0.20 U
99BW12	1605D99BW12	5/19/2016	FD	0.20 U	0.20 U
99BW14	1605N99BW14	5/21/2016	N	0.20 U	0.20 U
99BW15	1605N99BW15	5/18/2016	N	1.71	7.16
99BW16	1605N99BW16	5/18/2016	N	0.20 U	1.14
99BW18	1602N99BW18	2/23/2016	N	0.20 U	9.12
99BW18	1605N99BW18	5/23/2016	N	0.20 U	6.49
99BW18	1611N99BW18	11/15/2016	N	0.20 U	6.62
Roza 2 Wells					
04CW01	1605N04CW01	5/18/2016	N	0.20 U	0.44
04CW01	1605D04CW01	5/18/2016	FD	0.20 U	0.48

Table 4. Monitoring and Extraction Wells – Sampling Results

MONITORING AND EXTRACTION WELL RESULTS				CIS-DCE	TCE
Well ID	Sample Name	Sample Date	Sample Type	Results µg/L (MCL 70)	Results µg/L (MCL 5)
04CW02	1605N04CW02	5/19/2016	N	0.20 U	0.06 J
04CW03	1605N04CW03	5/21/2016	N	0.20 U	2.05
04CW04	1605N04CW04	5/22/2016	N	0.20 U	0.40
04CW05	1602N04CW05	2/24/2016	N	0.20 U	2.38
04CW05	1605N04CW05	5/22/2016	N	0.20 U	2.41
04CW05	1605D04CW05	5/22/2016	FD	0.20 U	2.07
04CW05	1611N04CW05	11/16/2016	N	0.20 U	2.25
04CW07	1602N04CW07A	2/24/2016	N	0.20 U	5.52
04CW07	1602N04CW07B	2/24/2016	N	0.20 U	5.73
04CW07	1605N04CW07A	5/23/2016	N	0.20 U	6.01
04CW07	1605N04CW07B	5/23/2016	N	0.20 U	5.66
04CW07	1611N04CW07A	11/17/2016	N	0.20 U	5.79
04CW07	1611N04CW07B	11/17/2016	N	0.20 U	6.10
04CW08	1605N04CW08	5/23/2016	N	0.20 U	0.20 U
12CW01	1602N12CW01	2/22/2016	N	0.20 U	3.74
12CW01	1605N12CW01	5/23/2016	N	0.20 U	3.16
12CW01	1611N12CW01	11/17/2016	N	0.20 U	3.61
12CW02	1602N12CW02	2/23/2016	N	0.20 U	0.37
12CW02	1605N12CW02	5/22/2016	N	0.20 U	0.33
12CW02	1611N12CW02	11/17/2016	N	0.20 U	0.20 U
12CW03	1602N12CW03	2/24/2016	N	0.20 U	0.28
12CW03	1605N12CW03	5/22/2016	N	0.20 U	0.31
12CW03	1611N12CW03	11/16/2016	N	0.20 U	0.20 U
12CW04	1602N12CW04	2/24/2016	N	0.20 U	0.51
12CW04	1605N12CW04	5/22/2016	N	0.20 U	0.44
12CW04	1611N12CW04	11/16/2016	N	0.20 U	0.52
12CW05	1602N12CW05	2/23/2016	N	0.20 U	0.80
12CW05	1605N12CW05	5/23/2016	N	0.20 U	0.65
12CW05	1611N12CW05	11/17/2016	N	0.20 U	0.62
Extraction Wells					
12EX01	1602N12EX01	2/24/2016	N	0.27	6.58
12EX01	1605N12EX01	5/22/2016	N	0.28	5.46
12EX01	1611N12EX01	11/16/2016	N	0.18 J	4.21
12EX02	1602N12EX02	2/22/2016	N	0.20 U	4.81
12EX02	1605N12EX02	5/23/2016	N	0.20 U	5.02
12EX02	1611N12EX02	11/17/2016	N	0.20 U	4.47
14EX03	1602N14EX03	2/23/2016	N	0.35	32.4
14EX03	1605N14EX03	5/22/2016	N	0.34	35.4
14EX03	1605D14EX03	5/22/2016	FD	0.36	37.3

Table 4. Monitoring and Extraction Wells – Sampling Results

MONITORING AND EXTRACTION WELL RESULTS				CIS-DCE	TCE
Well ID	Sample Name	Sample Date	Sample Type	Results µg/L (MCL 70)	Results µg/L (MCL 5)
14EX03	1611N14EX03	11/16/2016	N	0.40	35.4
14EX04	1602N14EX04	2/23/2016	N	0.20 U	18.7
14EX04	1605N14EX04	5/22/2016	N	0.20 U	17.2
14EX04	1611N14EX04	11/17/2016	N	0.20 U	16.5
14EX05	1602N14EX05	2/24/2016	N	0.15 J	3.61
14EX05	1605N14EX05	5/22/2016	N	0.13 J	3.67
14EX05	1611N14EX05	11/16/2016	N	0.13 J	4.57

Cells shaded red exceed 5.0 µg/L TCE MCL risk level.

N -Normal Sample

FD -Field Duplicate

U -Undetected

J -Estimated

MCL-Maximum Contaminant Level

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Table 5. Perfluorinated Alkyl Acids and 1,4-Dioxane in Select Monitoring Wells

				PFOS	PFOA	PFOS+ PFOA	PFHpA	PFNA	PFBS	PFHxS	1,4 Dioxane
Well ID	Sample ID	Date	Sample Type	0.2 µg/L (provisional health advisory)	0.4 µg/L (provisional health advisory)	0.07 µg/L (EPA health advisory) combined LOQ=0.06		0.013 µg/L (New Jersey DOH requested as MCL)	380 µg/L (MCL)		0.67 µg/L*
Monitoring Wells											
Hanford Formation Wells											
91AW14	1605N91AW14	5/18/2016	N	0.119	0.143	0.262	0.0196	0.0592	0.0765	0.395	
Priest Rapids/ Roza 1 Wells											
00BW10	1605N00BW10	5/20/2016	N								0.03 J
00BW12	1605N00BW12	5/18/2016	N								0.09
00BW15	1605N00BW15	5/19/2016	N								0.06 U
02BW01	1605N02BW01	5/20/2016	N								0.06 U
04BW04	1605N04BW04	5/18/2016	N	0.0112 J	0.00627 J	0.01747	0.00262 J	0.0200 U	0.0900 U	0.0217 J	
04BW05	1605N04BW05	5/19/2016	N								0.06 U
12BW02	1605N12BW02	5/20/2016	N								0.06 U
12BW07	1605N12BW07	5/19/2016	N								0.06 U
14BW01	1605N14BW01	5/19/2016	N								0.06 U
99BW01	1605N99BW01	5/19/2016	N								0.1
99BW12	1605N99BW12	5/19/2016	N								0.05 J
99BW15	1605N99BW15	5/18/2016	N								0.25
99BW16	1605N99BW16	5/18/2016	N	0.348	0.336	0.684	0.0427	0.0201	0.162	0.718	0.03
Roza 2 Wells											
04CW01	1605N04CW01	5/18/2016	N	0.052	0.105	0.157	0.0169	0.0200 U	0.0318 J	0.252	
04CW01	1605D04CW01	5/18/2016	FD	0.0711	0.14	0.2111	0.0215	0.0200 U	0.0423 J	0.334	

Table 5. Perfluorinated Alkyl Acids and 1,4-Dioxane in Select Monitoring Wells

				PFOS	PFOA	PFOS+ PFOA	PFHpA	PFNA	PFBS	PFHxS	1,4 Dioxane
Well ID	Sample ID	Date	Sample Type	0.2 µg/L (provisional health advisory)	0.4 µg/L (provisional health advisory)	0.07 µg/L (EPA health advisory) combined LOQ=0.06		0.013 µg/L (New Jersey DOH requested as MCL)	380 µg/L (MCL)		0.67 µg/L*
Field Blanks: Monitoring Wells											
FB0191AW14	1605FB0191AW14	5/18/2016	FB	0.0400U	0.0200 U		0.0100 U	0.0200 U	0.0900 U	0.0300 U	
FB0299BW16	1605FB0299BW16	5/18/2016	FB	0.0400U	0.0200 U		0.0100 U	0.0200 U	0.0900 U	0.0300 U	
FB0304BW04	1605FB0304BW04	5/18/2016	FB	0.0400U	0.0200 U		0.0100 U	0.0200 U	0.0900 U	0.0300 U	
FB0404CW01	1605FB0404CW01	5/18/2016	FB	0.0400U	0.0200 U		0.0100 U	0.0200 U	0.0900 U	0.0300 U	
Private Wells											
WP-168	16051605NWP168	5/18/2016	N								0.06 U
WP-119A1	1605NWP119A1	5/17/2016	N	0.0400U	0.0200 U		0.0100 U	0.0200 U	0.0900 U	0.0300 U	
WP-119C1	1605NWP119C1	5/17/2016	N	0.0400U	0.0200 U		0.0100 U	0.0200 U	0.0900 U	0.0300 U	
WP-121A1	1605NWP121A1	5/17/2016	N	0.0400U	0.0200 U		0.0100 U	0.0200 U	0.0900 U	0.00442 J	0.06 U
WP-121C1	1605NWP121C1	5/17/2016	N	0.0400U	0.0200 U		0.0100 U	0.0200 U	0.0900 U	0.0300 U	
WP-124A1	1605NWP124A1	5/18/2016	N	0.0400U	0.0200 U		0.0100 U	0.0200 U	0.0900 U	0.0300 U	
WP-124C1	1605NWP124C1	5/18/2016	N	0.0400U	0.0200 U		0.0100 U	0.0200 U	0.0900 U	0.0300 U	
WP-125A1	1605NWP125A1	5/17/2016	N	0.0400U	0.0200 U		0.0100 U	0.0200 U	0.0900 U	0.0300 U	0.06 U
WP-125C1	1605NWP125C1	5/17/2016	N	0.0400U	0.0200 U		0.0100 U	0.0200 U	0.0900 U	0.0300 U	
WP-144	1605NWP144	5/18/2016	N								0.04 J
WP-45	1605NWP45	5/18/2016	N								0.06 U
WP-52	1605NWP52	5/18/2016	N								0.06 U
WP-69	1605NWP69	5/18/2016	N								0.06 U
WP-74	1605NWP74	5/18/2016	N								0.06 U
Field Blanks: Private Wells											

Table 5. Perfluorinated Alkyl Acids and 1,4-Dioxane in Select Monitoring Wells

				PFOS	PFOA	PFOS+ PFOA	PFHpA	PFNA	PFBS	PFHxS	1,4 Dioxane
Well ID	Sample ID	Date	Sample Type	0.2 µg/L (provisional health advisory)	0.4 µg/L (provisional health advisory)	0.07 µg/L (EPA health advisory) combined LOQ=0.06		0.013 µg/L (New Jersey DOH requested as MCL)	380 µg/L (MCL)		0.67 µg/L*
WP-119	1605FBWP119	5/17/2016	FB	0.0400U	0.0200 U		0.0100 U	0.0200 U	0.0900 U	0.0300 U	
WP-121	1605FBWP121	5/17/2016	FB	0.0400U	0.0200 U		0.0100 U	0.0200 U	0.0900 U	0.0300 U	
WP-124	1605FBWP124	5/18/2016	FB	0.0400U	0.0200 U		0.0100 U	0.0200 U	0.0900 U	0.0300 U	
WP-125	1605FBWP125	5/17/2016	FB	0.0400U	0.0200 U		0.0100 U	0.0200 U	0.0900 U	0.0300 U	

* EPA has calculated a screening level of 0.67 µg/L for 1,4-dioxane in tap water based on a 1 in 1,000,000 lifetime excess cancer risk (EPA 2013c).

Yellow = exceedance

PFBS Perfluorobutanesulfonic Acid
 PFHpA Perfluoroheptanoic Acid
 PFHxS Perfluorohexanesulfonic Acid
 PFNA Perfluorononanoic Acid
 PFOS Perfluorooctanesulfonic Acid
 PFOA Perfluorooctanoic Acid

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Table 6. Private Wells without WHFs – Sampling Results

PRIVATE WELL WITHOUT WHF - RESULTS				CIS-DCE	TCE
Well ID	Sample Name	Sample Date	Sample Type	Results µg/L (MCL 70)	Results µg/L (MCL 5)
WP-03	1605DWP03	5/16/2016	FD	0.23	1.06
WP-03	1605NWP03	5/16/2016	N	0.23	1.16
WP-04	1602NWP04	2/22/2016	N	2.08	6.14
WP-04	1605NWP04	5/17/2016	N	2.09	6.23
WP-04	1608NWP04	8/17/2016	N	1.89	5.84
WP-04	1611NWP04	11/16/2016	N	1.98	5.92
WP-09	1605NWP09	5/17/2016	N	0.20 U	0.20 U
WP-10	1605NWP10	5/16/2016	N	0.20 U	0.20 U
WP-105	1605NWP105	5/16/2016	N	0.20 U	0.45
WP-111	1605NWP111	5/18/2016	N	0.20 U	0.22
WP-111	1605DWP111	5/18/2016	FD	0.20 U	0.20
WP-116	1605NWP116	5/16/2016	N	0.46	1.92
WP-120	1605NWP120	5/16/2016	N	0.20 U	0.35
WP-122	1605NWP122	5/16/2016	N	0.20 U	0.17 J
WP-126	1605NWP126	5/16/2016	N	0.14 J	0.99
WP-127	1605NWP127	5/16/2016	N	0.20 U	0.89
WP-128	1605NWP128	5/17/2016	N	0.20 U	0.42
WP-130	1605NWP130	5/16/2016	N	0.20 U	0.45
WP-131	1602NWP131	2/24/2016	N	0.20 U	0.88
WP-131	1605NWP131	5/17/2016	N	0.11 J	3.12
WP-131	1608NWP131	8/17/2016	N	0.20 U	1.69
WP-131	1611NWP131	11/16/2016	N	0.20 U	1.30
WP-136	1605NWP136	5/16/2016	N	0.20 U	1.19
WP-137	1605NWP137	5/17/2016	N	0.20 U	1.31
WP-138	1605NWP138	5/16/2016	N	0.20 U	0.55
WP-139	1605NWP139	5/16/2016	N	0.20 U	0.80
WP-143	1605NWP143	5/17/2016	N	0.20 U	0.57
WP-144	1605NWP144	5/18/2016	N	0.20 U	0.25
WP-145	1605NWP145	5/16/2016	N	0.20 U	0.32
WP-147	1605NWP147	5/17/2016	N	0.20 U	0.16 J
WP-148	1605NWP148	5/18/2016	N	0.20 U	0.16 J
WP-149	1605NWP149	5/17/2016	N	0.20 U	0.07 J
WP-150	1605NWP150	5/17/2016	N	0.20 U	0.08 J
WP-152	1605NWP152	5/16/2016	N	0.20 U	0.20
WP-153	1605NWP153	5/18/2016	N	0.20 U	0.26
WP-153	1605DWP153	5/18/2016	FD	0.20 U	0.25
WP-154	1605NWP154	5/18/2016	N	0.20 U	0.29
WP-155	1605NWP155	5/16/2016	N	0.20 U	0.29
WP-156	1605NWP156	5/16/2016	N	0.20 U	0.38

Table 6. Private Wells without WHFs – Sampling Results

PRIVATE WELL WITHOUT WHF - RESULTS				CIS-DCE	TCE
Well ID	Sample Name	Sample Date	Sample Type	Results µg/L (MCL 70)	Results µg/L (MCL 5)
WP-165	1605NWP165	5/16/2016	N	0.20 U	0.16 J
WP-167	1602NWP167	2/23/2016	N	0.20 U	1.35
WP-167	1605NWP167	5/16/2016	N	0.20 U	2.21
WP-167	1608NWP167	8/17/2016	N	0.20 U	2.17
WP-167	1611NWP167	11/16/2016	N	0.20 U	1.80
WP-168	1602NWP168	2/23/2016	N	0.20 U	2.04
WP-168	1605NWP168	5/16/2016	N	0.20 U	2.04
WP-168	1605DWP168	5/16/2016	FD	0.20 U	2.47
WP-168	1608NWP168	8/17/2016	N	0.20 U	2.26
WP-168	1611NWP168	11/16/2016	N	0.20 U	2.47
WP-169	1605NWP169	5/16/2016	N	0.20 U	1.51
WP-170	1605NWP170	5/18/2016	N	0.20 U	0.71
WP-171	1605NWP171	5/18/2016	N	0.20 U	0.20 U
WP-172	1605NWP172	5/16/2016	N	0.20 U	0.47
WP-173	1605NWP173	5/18/2016	N	0.20 U	0.20 U
WP-177	1605NWP177	5/16/2016	N	0.20 U	0.07 J
WP-178	1605NWP178	5/16/2016	N	0.20 U	0.21
WP-179	1605NWP179	5/16/2016	N	0.20 U	0.09 J
WP-180	1605NWP180	5/18/2016	N	0.20 U	0.06 J
WP-27	1602NWP27	2/24/2016	N	0.20 U	1.36
WP-27	1602DWP27	2/24/2016	FD	0.20 U	1.34
WP-27	1605NWP27	5/17/2016	N	0.20 U	1.66
WP-27	1608NWP27	8/16/2016	N	0.20 U	1.56
WP-27	1611NWP27	11/15/2016	N	0.20 U	1.25
WP-27	1611DWP27	11/15/2016	FD	0.20 U	1.43
WP-28	1605NWP28	5/17/2016	N	0.20 U	1.57
WP-33	1605NWP33	5/18/2016	N	0.20 U	0.60
WP-45	1605NWP45	5/18/2016	N	0.20 U	0.70
WP-45	1605DWP45	5/18/2016	FD	0.20 U	0.73
WP-50	1605NWP50	5/17/2016	N	0.20 U	0.20 U
WP-52	1605NWP52	5/17/2016	N	0.20 U	0.17 J
WP-52	1605DWP52	5/17/2016	FD	0.20 U	0.19 J
WP-54	1605NWP54	5/17/2016	N	0.20 U	0.20 U
WP-57	1605NWP57	5/18/2016	N	0.20 U	0.41
WP-57	1605DWP57	5/18/2016	FD	0.20 U	0.44
WP-65	1605NWP65	5/16/2016	N	0.20 U	0.38
WP-66	1605NWP66	5/16/2016	N	0.35	1.52
WP-68	1605NWP68	5/16/2016	N	0.20 U	0.59
WP-69	1605DWP69	5/18/2016	FD	0.18 J	1.57
WP-69	1605NWP69	5/18/2016	N	0.18 J	1.54
WP-71A	1605NWP71A	5/18/2016	N	0.20 U	0.18 J

Table 6. Private Wells without WHFs – Sampling Results

PRIVATE WELL WITHOUT WHF - RESULTS				CIS-DCE	TCE
Well ID	Sample Name	Sample Date	Sample Type	Results µg/L (MCL 70)	Results µg/L (MCL 5)
WP-71B	1605NWP71B	5/18/2016	N	0.20 U	0.40
WP-74	1605NWP74	5/18/2016	N	0.21	1.13
WP-82	1605NWP82	5/17/2016	N	0.20 U	0.09 J

	Cell shaded yellow - exceeded 2.0 µg/L TCE in 2013 and has been sampled quarterly since
	Cells shaded red - exceeded 5.0 µg/L TCE MCL risk level. This well does not have a WHF system because water is used for industrial purposes only.

N -Normal Sample

FD -Field Duplicate

U -Undetected

J -Estimated

MCL-Maximum Contaminant Level

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Table 7. Private Wells with WHFs- Analytical Results**NOTE:** Mid and effluent results in all cases were <0.20 µg/L for cis-DCE and TCE and therefore are not shown.

PRIVATE WHF WELL RESULTS					cis-DCE	TCE
Well ID	Sample Name	Sample Date	Sample Type	Sample Location	Results µg/L (MCL 70)	Results µg/L (MCL 5)
WP-119	1602NWP119A1	2/24/2016	N	Influent	0.16 J	2.92
WP-119	1605NWP119A1	5/17/2016	N	Influent	0.18 J	3.54
WP-119	1605DWP119A1	5/17/2016	FD	Influent	0.18 J	3.76
WP-119	1608NWP119A1	8/17/2016	N	Influent	0.17 J	3.57
WP-119	1611NWP119A1	11/16/2016	N	Influent	0.25	3.02
WP-119	1611NWP119B1	11/16/2016	N	Mid	0.20 U	0.20 U
WP-119	1611NWP119C1	11/16/2016	N	Effluent	0.20 U	0.20 U
WP-121	1602NWP121A1	2/24/2016	N	Influent	0.14 J	3.16
WP-121	1602DWP121A1	2/24/2016	FD	Influent	0.12 J	3.32
WP-121	1605NWP121A1	5/17/2016	N	Influent	0.17 J	4.06
WP-121	1608NWP121A1	8/17/2016	N	Influent	0.15 J	4.23
WP-121	1611NWP121A1	11/16/2016	N	Influent	0.15 J	3.34
WP-121	1611NWP121B1	11/16/2016	N	Mid	0.20 U	0.20 U
WP-121	1611NWP121C1	11/16/2016	N	Effluent	0.20 U	0.20 U
WP-123	1602NWP123A1	2/24/2016	N	Influent	0.30	2.21
WP-123	1605NWP123A1	5/16/2016	N	Influent	0.26	3.71
WP-123	1608NWP123A1	8/17/2016	N	Influent	0.17 J	3.14
WP-123	1611NWP123A1	11/16/2016	N	Influent	0.49	2.77
WP-123	1611NWP123B1	11/16/2016	N	Mid	0.20 U	0.20 U
WP-123	1611DWP123B1	11/16/2016	FD	Mid	0.20 U	0.20 U
WP-123	1611NWP123C1	11/16/2016	N	Effluent	0.20 U	0.20 U
WP-124	1602NWP124A1	2/24/2016	N	Influent	1.00	3.83
WP-124	1605NWP124A1	5/18/2016	N	Influent	0.88	3.87
WP-124	1608NWP124A1	8/17/2016	N	Influent	0.93	4.03
WP-124	1611NWP124A1	11/15/2016	N	Influent	1.45	4.85
WP-125	1602NWP125A1	2/24/2016	N	Influent	0.76	2.95
WP-125	1602NWP125B1	2/24/2016	N	Mid	0.20 U	0.20 U
WP-125	1602NWP125C1	2/24/2016	N	Effluent	0.20 U	0.20 U
WP-125	1605NWP125A1	5/17/2016	N	Influent	0.92	3.70
WP-125	1605NWP125B1	5/17/2016	N	Mid	0.20 U	0.20 U
WP-125	1605NWP125C1	5/17/2016	N	Effluent	0.20 U	0.20 U
WP-125	1608NWP125A1	8/17/2016	N	Influent	0.73	3.44
WP-125	1611NWP125A1	11/15/2016	N	Influent	1.02	3.98
WP-129	1602NWP129A1	2/24/2016	N	Influent	0.20 U	3.13
WP-129	1605NWP129A1	5/16/2016	N	Influent	0.11 J	3.12
WP-129	1608NWP129A1	8/17/2016	N	Influent	0.20 U	1.46
WP-129	1611NWP129A1	11/15/2016	N	Influent	0.11 J	3.39
WP-14	1602NWP14A1	2/23/2016	N	Influent	0.71	2.85

Table 7. Private Wells with WHFs- Analytical Results

PRIVATE WHF WELL RESULTS					cis-DCE	TCE
Well ID	Sample Name	Sample Date	Sample Type	Sample Location	Results µg/L (MCL 70)	Results µg/L (MCL 5)
WP-14	1605NWP14A1	5/18/2016	N	Influent	0.85	3.22
WP-14	1605NWP14B1	5/18/2016	N	Mid	0.20 U	0.20 U
WP-14	1605NWP14C1	5/18/2016	N	Effluent	0.20 U	0.20 U
WP-14	1608NWP14A1	8/17/2016	N	Influent	0.85	3.14
WP-14	1608DWP14A1	8/17/2016	FD	Influent	0.92	3.45
WP-14	1611NWP14A1	11/16/2016	N	Influent	0.89	3.11
WP-70	1602NWP70A1	2/24/2016	N	Influent	0.19 J	3.06
WP-70	1605NWP70A1	5/16/2016	N	Influent	0.23	2.98
WP-70	1605NWP70B1	5/16/2016	N	Mid	0.20 U	0.20 U
WP-70	1605NWP70C1	5/16/2016	N	Effluent	0.20 U	0.20 U
WP-70	1608NWP70A1	8/17/2016	N	Influent	0.20 J	3.66
WP-70	1608DWP70A1	8/17/2016	FD	Influent	0.23	3.89
WP-70	1611NWP70A1	11/15/2016	N	Influent	0.29	3.52
WP-83	1602NWP83A1	2/23/2016	N	Influent	0.24	1.28
WP-83	1605NWP83A1	5/17/2016	N	Influent	0.23	1.05
WP-83	1605NWP83B1	5/17/2016	N	Mid	0.20 U	0.20 U
WP-83	1605NWP83C1	5/17/2016	N	Effluent	0.20 U	0.20 U
WP-83	1608NWP83A1	8/17/2016	N	Influent	0.22	1.05
WP-83	1611NWP83A1	11/16/2016	N	Influent	0.29	1.12
WP-86	1602NWP86A1	2/23/2016	N	Influent	0.20 U	2.31
WP-86	1605NWP86A1	5/17/2016	N	Influent	0.20 U	2.13
WP-86	1605NWP86B1	5/17/2016	N	Mid	0.20 U	0.20 U
WP-86	1605NWP86C1	5/17/2016	N	Effluent	0.20 U	0.20 U
WP-86	1608NWP86A1	8/17/2016	N	Influent	0.20 U	1.03
WP-86	1611NWP86A1	11/16/2016	N	Influent	0.20 U	2.07

Sample ID locations are as follows:

A-influent before lead, B- in between lead and lag filter (mid), C - effluent after lag

N -Normal Sample

FD -Field Duplicate

U -Undetected

J -Estimated

Table 8. Whole House Filters – Purge and Totalizer Volume Summary

Date	Well System	Flow Meter Initial (Gal)	Flow Meter Final (Gal)
February 2016 Sampling Event			
2/24/2016	WP-70	223,044	223,049
2/23/2016	WP-86	537,667	537,672
2/23/2016	WP-83	1,831,332	1,831,337
2/23/2016	WP-14	1,570,451	1,570,457
2/24/2016	WP-119	178,083	178,088
2/24/2016	WP-121	63,276	63,283
2/24/2016	WP-124	256,683	256,687
2/24/2016	WP-129	99,970	99,987
2/24/2016	WP-123	187,865	187,871
2/24/2016	WP-125	332,048	332,053
May 2016 Sampling Event			
5/16/2016	WP-70	237,065	237,068
5/17/2016	WP-86	577,204	577,208
5/18/2016	WP-83	1,929,404	1,929,408
5/18/2016	WP-14	1,728,251	1,728,256
5/17/2016	WP-119	188,096	188,105
5/17/2016	WP-121	68,690	68,695
5/18/2016	WP-124	275,513	275,518
5/16/2016	WP-129	120,800	120,806
5/16/2016	WP-123	204,680	204,685
5/17/2016	WP-125	449,538	449,543
August 2016 Sampling Event			
8/17/2016	WP-70	250,430	250,435
8/17/2016	WP-86	654,355	654,360
8/17/2016	WP-83	2,214,585	2,214,595
8/17/2016	WP-14	1,989,093	1,989,118
8/17/2016	WP-119	204,951	204,961
8/17/2016	WP-121	78,101	78,116
8/17/2016	WP-124	292,767	292,772
8/17/2016	WP-129	162,733	162,733
8/17/2016	WP-123	278,623	278,633
8/17/2016	WP-125	562,451	562,456
November 2016 Sampling Event			
11/15/2016	WP-70	267,749	267,759
11/16/2016	WP-86	729,764	729,772
11/16/2016	WP-83	2,367,352	2,367,362
11/16/2016	WP-14	2,159,369	2,159,384
11/16/2016	WP-119	216,945	216,955
11/15/2016	WP-121	83,563	83,568
11/15/2016	WP-124	313,180	313,190
11/15/2016	WP-129	183,660	183,625

Table 8. Whole House Filters – Purge and Totalizer Volume Summary

Date	Well System	Flow Meter Initial (Gal)	Flow Meter Final (Gal)
11/16/2016	WP-123	305,983	305,996
11/15/2016	WP-125	634,562	634,565

APPENDIX A - Field Sampling Reports (CD only)

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Private Wells and Monitoring Wells Groundwater Sampling Field Report February 2016 Field Sampling Event

Moses Lake Wellfield Superfund Site Moses Lake, Washington

(b) (6)



Field Investigation:
22-25 February 2016
Report Prepared:
March 2016

By: Technical Services Branch



**US Army Corps
of Engineers** ®
Seattle District

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1.0 BACKGROUND AND OBJECTIVE OF INVESTIGATION

1.1 BACKGROUND

The Moses Lake Wellfield Superfund Site is located between the Grant County Airport and the City of Moses Lake, Washington. The Site includes the former Larson Air Force Base (LAFB) property, Port of Moses Lake property and adjacent private properties affected by Site groundwater contamination. The Site is listed on the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980 National Priorities List (NPL) for Uncontrolled Hazardous Waste Sites.

The Moses Lake Wellfield Superfund Site is an area of approximately 15 square miles, which includes the former LAFB, commercial facilities, and residences. The former LAFB occupied approximately 9,607 acres three miles northwest of the City of Moses Lake. The United States Air Force was active at the site from 1942 until 1966. During 1988 and 1989, the Washington State Department of Health confirmed the presence of trichloroethylene (TCE) above the Federal Maximum Contaminant Level (MCL) in three City of Moses Lake municipal wells and two Skyline community wells. The Seattle District, US Army Corps of Engineers (USACE) completed a Remedial Investigation (RI) phase in 2003. Appendix A of this report shows the general location map and a site map.

During the course of the RI, several private wells were tested and found to be contaminated with TCE. In 2001, the USACE contracted installation of carbon filtration units – known as whole house filter systems (WHF) - at five of those wells. Several years of groundwater monitoring data has been evaluated since the original WHF systems were installed.

The final results of the Phase I RI released in a report in March 1993 indicated that TCE was consistently found in shallow alluvial and upper basalt (α -basalt) groundwater in the central area of the former base.

On October 14, 1992, the affected areas of the former LAFB and off-site down gradient areas, termed the "Moses Lake Wellfield Contamination", were listed on the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) of 1980 for Uncontrolled Hazardous Waste Sites. The former LAFB property is one part of the Moses Lake Wellfield Superfund Site; the site also includes the contaminant plume.

Chemical results from 1993 and 1994 combined with historical data indicated that TCE occurred in the central and southern portion of the former LAFB in alluvial and α -basalt groundwater. In 2004, USACE confirmed TCE contamination in the next lower basalt aquifer (c-basalt). As of 1995, the data suggest that more than one source may have contributed TCE to the alluvial and α -basalt groundwater in the central portion of the former LAFB.

In 1998, URS Greiner completed a sampling round of private water wells and wells for Class A and Class B water systems east, south and southwest of the previously known TCE plume. There were eight detections of TCE during this study. Four wells that were previously outside the plume extent were found to be above the detection limit.

1.2 GROUNDWATER SAMPLING EVENT SUMMARY AND OBJECTIVES

In coordination with the US Environmental Protection Agency (USEPA) Region 10, two USACE environmental field teams deployed to conduct the February 2016 Moses Lake Wellfield groundwater sampling event during a single mobilization. The events described in this report involve USACE field teams verifying sample point locations; discussion of sampling techniques; recording groundwater observations; collecting groundwater samples; and shipping those samples by overnight delivery for laboratory analysis. Environmental sampling team members responsible for the February 2016 field event were Joseph Marsh, Matthew Brookshier, Karah Haskins, and Jacob Williams.

All of the work described in this report was accomplished in accordance with the Moses Lake Wellfield Superfund Site Quality Assurance Project Plan. In addition, the teams followed the guidance presented in: the Seattle District, USACE Safety and Health Plan; USACE Safety Manual EM 385-1-1; Seattle District, USACE, Sampling Standard Operating Procedures (SOP).

The private wells and monitoring wells designated for sampling are displayed on a map found at Appendix A. These wells have been selected based on their down-gradient locations relative to the inferred flow direction of TCE-contaminated groundwater and validated sampling analytical data from previous monitoring events.

The two environmental field teams deployed to the Site and collected groundwater samples from 15 private well systems, and 28 monitoring wells during the February 2016 sampling event as summarized below:

Team 1: Joseph Marsh and Matthew Brookshier collected groundwater samples from 4 monitoring wells fitted with dedicated bladder pumps, and 10 monitoring wells fitted with laboratory-filled passive diffusion bag samplers. Team 1 also collected static water level data from all other designated project monitoring wells in coordination with team 2. These activities were conducted between 22 and 25 February 2016.

Team 2: Karah Haskins and Jacob Williams collected groundwater samples from 10 private whole-house filter systems, 5 private well systems and 14 monitoring wells fitted with passive diffusion bags. In coordination with team 1, they also collected static water level data in designated project monitoring wells as required. These activities were conducted between 22 and 25 February 2016.

The objectives of groundwater sampling at Moses Lake are to: 1) collect representative samples from designated private well systems and monitoring wells yielding data of known and sufficient quality to evaluate TCE concentrations and define existing TCE plumes; 2) to assure compliance with the requirements of USEPA; and 3) to make critical project - specific decisions based on the evaluated data.

2.0 DESCRIPTION OF WORK

2.1 ACTIVITIES PRIOR TO THE FEBRUARY 2016 GROUNDWATER SAMPLING EVENT

The USACE project team worked to collect signatures on Department of the Army Right of Entry forms as required before conducting the well sampling on private, city or county government property. For most properties, previously signed Right of Entry forms were still valid. For all properties designated for sample collection, owners (and renters if applicable) were contacted to coordinate sample collection times during the scheduled field sampling week.

Prior to conducting sampling activities at each location, both teams verified the address or well location and map location matched, and that the Right of Entry form had been signed prior to arriving at each sampling location.

Each team was responsible for identifying potential health and safety hazards at each sampling location. If a hazard is verified at a private well sampling location, an alternate hose bib connected to the same water source may be selected in a safer area of the subject property. In the case of hazardous monitoring well conditions, the well may be situated in an active construction zone requiring the cancellation of sampling at that well until the next scheduled sampling event.

Also for private well sampling, the field team was tasked with determining the most appropriate cold-water tap or other sample port as close to each wellhead as practical. At each location, the team worked to collect water samples from the same sample point selected during previous sampling events to ensure consistent results. The team was briefed that groundwater samples would not be collected from taps delivering chlorinated, aerated, softened or filtered water.

2.2 PRIVATE WELL SAMPLING PROCEDURES

During the February 2016 groundwater sampling event, samples were collected from a total of 15 private wells consisting of: 5 private well system hose bibs (WP-4, WP-27, WP-131, WP-167, and WP-168), and 10 WHF systems (WP-14, WP-70, WP-83, WP-86, WP-119, WP-121, WP-123, WP-124, WP-125, and WP-129).

USACE (in cooperation with USEPA) has determined private well and WHF groundwater purging shall to consist of: allowing water flow at the sampling port at a rate of approximately 0.5 to 1 gallon per minute (gpm), while measuring the temperature of the water stream with a digital thermometer every two minutes until stabilization is achieved. These procedures follow the general principles of the New Hampshire private well system water sampling guidance.

During purging, the flow rate at each location was verified by graduated cylinder. While purging continued, the field team monitored the surrounding area and flowing water for unusual observations and odors as purge water was captured in a five gallon bucket. They

recorded the start time of the purging in the field logbook immediately after opening each hose bib sample point and establishing the flow rate. While one team member used the digital thermometer to measure water temperatures, the other recorded the temperatures every two minutes until the parameters stabilized.

Upon reaching stabilization, the approximate total purged volume was recorded in the project field book along with any other significant observations. The team then conducted the sample collection activities.

Prior to collecting a water sample, the team reduced the flow rate at each tap to approximately 150 to 200 ml/min. to minimize sample water turbulence and aeration. The samplers donned protective eyewear and new, clean, Nitrile gloves to prevent exposure to contaminants and cross-contamination. All groundwater samples were collected in pre-cleaned certified containers obtained from the analytical laboratory.

All sample containers were filled with water directly from each tap – forming a meniscus at the top of each vial to provide zero headspace samples as required. Sample point location and components of each plumbing system were noted to assist in data interpretation. A photographic record of each sample point was made by the team. In addition, each team placed handle tags (indicating that water samples were taken by USACE on that date and time) on the front doors of homes sampled if nobody was home during sample collection. A photo was taken of the handle tag and front of house in that case for the project files.

After the sample containers have been filled, sample labels describing project, location, analysis, team members, preservative, sampling date, and collection time are placed on the containers. The samples are then packaged in bubble wrap bags and plastic zipper type bags, placed into pre-iced sample shipping coolers and prepared for shipment as described in Section 3.0. All sampling teams worked to ensure each property was left just as they found it with no damage done, and any doors or gates closed as required.

2.3 WHOLE HOUSE FILTER SAMPLING PROCEDURES

In coordination with USEPA and affected Moses Lake area homeowners, granular activated carbon (GAC) water filters have been installed in private well systems showing TCE results of 3.5 µg/l or greater. Each GAC filter system consists of two lightweight composite GAC filter tanks (acting as lead and lag filters), associated piping, bag filters (to prevent GAC particles from entering the household plumbing system), pressure gauges and valved/regulated sample collection ports.

As described previously, groundwater samples were collected from 10 WHF systems during this February 2016 sampling event. Each system was purged according to the revised private well sampling SOP consisting of allowing water flow at a hose bib nearest the wellhead at a rate of approximately 0.5 to 1 gpm, while measuring the temperature of the water stream with a digital thermometer every two minutes until stabilization is achieved. Purge flow rates averaged approximately 0.5 gpm as measured with graduated cylinder, and purged water at

each location was captured in a five gallon bucket to verify purged volumes. During purging, continuous temperature readings were recorded using a digital thermometer until water temperature stabilization was achieved. Once water temperature had stabilized, the hose bib was closed, and the field team prepared to collect samples from the pre-determined WHF sample ports (labeled “A” for the lead inlet port, “B” for the lead outlet port, and “C” for the lag outlet port).

WHF sample collection consists of opening each designated sample port valve fully to allow the maximum restricted flow rate of approximately 150 to 200 ml/min to flow into a capture bucket for a few seconds to ensure organic matter or air bubbles have been flushed out of the system. Restrictors have been placed on the sampling lines to provide a smooth, non-turbulent stream at a low-flow rate to minimize loss of volatiles that may be present in the water stream. Next, the sampling team immediately fills three pre-preserved VOA vials to zero headspace. New Nitrile gloves were donned before collecting samples at each port. All discharged water was directed into a five gallon plastic bucket for transfer to ground surface away from the shed or pump house GAC filter location after the samples were collected.

After filling the sample containers, sample labels describing project, location, analysis, team members, preservative, sampling date, and collection time were placed on each container and the container was placed in a plastic zipper bag. The bagged sample vials were placed into bubble wrap bags. Finally, the filled sample containers were placed into pre-iced shipping coolers to begin sample cooling to the required 4° Celsius sample preservation temperature prior to shipment to the analytical laboratory. One set of trip blanks were required and included per sample shipping cooler.

2.4 MONITORING WELL SAMPLING PROCEDURES

2.4.1 MONITORING WELL SAMPLING USING DEDICATED BLADDER PUMPS

Moses Lake monitoring well groundwater purging and sampling was performed in accordance with the Seattle District’s Low-Flow Ground Water Purging and Sampling SOP, prepared in March 1999 and revised on 1 Sep 2009. Data generated during purging were recorded on the MicroPurge/Low-Flow Sampling Log forms (Appendix C).

The team verified each monitoring well location and identification number with project maps and tables. They verified work can proceed safely in the vicinity of moving vehicular traffic, heavy industry, and other hazards as required. The team used a pry bar, socket wrench or pinhead hex wrench as needed to open each flush mount monitoring well cover plate, and a Masterlock #485 padlock key for the standard “stick-up” well completions. Prior to purging each well, the depth to static water level in each well was measured and checked periodically to monitor draw down as a guide to flow rate adjustment (no greater than 0.4 foot drawdown is permitted to prevent sampling stagnant casing water).

Purging operations at each well commenced once the following equipment was prepared: the MP20 MicroPurge® Controller equipped with an adjustable pressure regulator was connected to

the Well Wizard® bladder pumps via air line and quick connect fittings. Another air line was quick-connected to a pressurized CO₂ cylinder to drive the pump. Pump flow rates were then adjusted during a “pre-purge” period to maximize withdrawal rates and minimize excessive drawdown in each well. The evacuated pre-purge volume at each well was intended to flush out a bladder pump and tubing volume prior to monitoring stabilization parameters. Finally, a QED MicroPurge® basics MP20 Flow Cell was connected to the pump’s discharge line at ground surface to measure established water quality stabilization parameters (pH, specific conductivity, temperature, DO, ORP, and turbidity).

Depth to water measurements during purging were monitored and recorded to verify that minimal drawdown occurred. A graduated measuring cup was used to determine the volume purged. Generally, acceptable low-flow rates are no greater than 500 milliliters per minute (ml/min.), and are typically closer to 400 ml/min. for the Well Wizard® bladder pump systems, depending upon the amount of water level drawdown detected during pumping at each well. Purge data was recorded on the micro-purge logs every two minutes.

Low-flow purging continued until three consecutive measurements of the stabilization parameters met stabilization requirements.

Stabilization parameter requirements for all private well and bladder pump monitoring wells are as follows:

Temperature	+/- 0.2 °C
Specific Conductivity	+/- 0.020 millisiemens/centimeter (mS/cm)
DO	+/- 0.2 milligrams/liter (mg/l)
pH	+/- 0.2 units
ORP	+/- 20 millivolts (mV)

At each monitoring well, groundwater sample collection would begin immediately after achieving stabilization of water quality parameters during low flow purging.

Prior to sample collection, the samplers donned protective eyewear and new, clean, Nitrile gloves to prevent exposure to contaminants and cross-contamination. All groundwater samples were collected in pre-cleaned, certified containers obtained from the analytical laboratory.

All sample containers were filled immediately following purging by disconnecting the flow-through cell from the pump tubing system, and capturing water directly from the discharge end of the tubing. All sample containers were carefully filled at a low-flow rate to minimize agitation. During sample collection, significant physical observations were recorded in the Micropurge/Low-Flow Sampling Log data forms and project field book as needed.

After filling the sample containers, sample labels describing project, location, analysis, team members, preservative, sampling date, and collection time were placed on each container and

the container was placed in a plastic zipper bag. The bagged sample vials were placed into bubble wrap bags. Finally, the filled sample containers were placed into pre-iced shipping coolers to begin sample cooling to the required 4° Celsius sample preservation temperature prior to shipment to the analytical laboratory. One set of trip blanks were required and included per sample shipping cooler.

At the conclusion of groundwater sampling at each well, the flush mount well covers were bolted closed and stick up well caps padlocked.

2.4.2 MONITORING WELL SAMPLING USING PASSIVE DIFFUSION BAGS

Passive diffusion bags (PDBs) were been selected by the Moses lake Project Delivery Team as the most appropriate, cost-effective method for groundwater sample collection from Moses Lake monitoring wells lacking dedicated bladder pumps. The PDBs were purchased from ALS Environmental laboratory under license by the US Geological Survey and The General Electric Company, both co patent-holders. The 1 ¼" diameter low-density polyethylene PDBs were pre-filled with 220 ml or 330 ml of ASTM Type II certified, laboratory-grade, deionized water. Each filled PDB was then heat sealed by the laboratory prior to shipment to USACE via overnight delivery in hermetically sealed pouches.

USACE ensures a minimum of 14 days of PDB equilibration time before returning to the Moses Lake site for groundwater sample collection per established PDB guidance. During this event, both sampling teams worked to collect the PDB samples as described in Section 2.5.3. PDB retrieval and sampling consisted of the following procedures:

1. The team verified each monitoring well location and identification number with project maps and the sample matrix. They verified work can proceed safely in the vicinity of moving vehicular traffic as required. The PDBs were prepared over clean sheets of aluminum foil prior to being placed into each well. The team used a pry bar, socket wrench or pinhead hex wrench as needed to open each flush mount monitoring well cover plate, and a Masterlock #485 padlock key for the standard "stick-up" monitoring well completions. The team donned new Nitrile gloves for groundwater sample collection.
2. The team carefully hauled each weighted PDB to the surface using the nylon suspension line. The sampling team carefully cut the top corner off each PDB and filled each sample vial. The team filled each vial just to overflowing and maintained a reverse meniscus. There was no down time once the PDB has been brought to the surface until sample collection was complete at each well. Any residual sample water in the used PDBs was discharged to ground surface.
3. Each PDB represented a unique sample ID number based on the well ID (and sample interval if two PDBs are deployed into one well). With the exception of the MS/MSD, all QC samples were submitted "blind" to the laboratory using a separate unique sample ID number not labeled as duplicate or trip blank per USACE standard sampling procedure. One set of trip blanks were required and included per sample shipping cooler. An extra laboratory- prepared

PDB was shipped to the site and was used for collection of the trip and field blanks at the direction of the USACE project chemist.

4. Once recovered and sampled the PDBs and suspension lines were be discarded as non-hazardous municipal waste. In addition, gloves, paper towels, bags, and other solid waste materials were disposed of as municipal waste. The PDBs and other solid waste material were placed into a large plastic garbage bag and tied securely prior to disposal. The stainless steel weights were decontaminated and returned to the Seattle District, USACE office.

5. Finally, the team securely capped and locked each monitoring well riser and cover plate when finished.

2.5 SAMPLING EVENT ACTIVITIES AND OBSERVATIONS

2.5.1 TEAM 1 MONITORING WELL BLADDER PUMP SAMPLING

Groundwater sample collection commenced immediately after achieving stabilization of water quality parameters during low flow purging at each well using dedicated bladder pump systems as described previously. The team worked from the far north end of the Site, moving to the far south end sampling each designated well as it was encountered. The project well maps and sample matrix were used to ensure samples were collected at the correct locations. The team used one 15 lb. compressed CO₂ cylinder acquired from Oxarc in Moses Lake to drive the pump systems, airlines, pump controllers, and flow cells to conduct the sampling of dedicated bladder pumps.

During the February 2016 sampling event, Team 1 collected groundwater samples from a pre-determined set of four monitoring wells fitted with dedicated bladder pumps: 91BW04, 92BW01, 99BW10, and 99BW18.

Even though a right of entry permit has been signed, and verbal or written permission granted to collect samples at each designated monitoring well, the sampling team always attempted to contact the property owner for each monitoring well location before beginning the field sampling activities.

Per agreement with Grant County Airport security, Joseph Marsh used his ramp security badge to access all monitoring wells within the restricted area without an escort. On the afternoon of 23 February, 2016, water levels were measured in the following airport wells: 00BW12, 00BW03, 00BW02, 00BW11, 91BW02, 00BW08, and 00BW06. Both teams worked together to measure static water levels in all other designated project monitoring wells before completing the sampling event.

Other than property owner notifications, no special access procedures were required for any of the other bladder pump monitoring wells sampled during this event.

Prior to sample collection, the samplers donned protective eyewear and new, clean, Nitrile gloves to prevent exposure to contaminants and cross-contamination. All sample containers

were filled immediately following low-flow purging by disconnecting the flow-through cell from the pump tubing system, and capturing pumped groundwater directly from the discharge end of the pump tubing. During sample collection, physical observations were recorded in the Micro-purge/Low-Flow Sampling Log data forms.

Stabilization of water quality parameters during purging occurred within six minutes during this event. Measured temperatures ranged from 12.61°C at well 91BW04 to 13.85°C at well 99BW10. Specific conductivity ranged from 0.35mS/cm (well 99BW10) to 0.49 mS/cm (well 91BW04). Dissolved oxygen measurements ranged from 5.31 ppm (well 99BW18) to 6.81 ppm (well 92BW01). PH values ranged from 6.59 units (well 92BW01) to 7.39 units (well 91BW04). Oxygen reduction potential ranged from 94 mV (well 99BW10) to 251 mV (well 92BW01).

Significant Observations Made During Team 1 Bladder Pump Sampling

Team 1 met with the new manager of Airport Mini-Storage (8524 Broad Street, NE, Moses Lake) while conducting sampling activities at well 99BW10. She reported that a new security fence would be installed soon, and we would need a proximity card or passcode to open the gate. The team exchanged information with her, and she promised to give us a proximity card or the passcode before the next sampling event. Wells 99BW10, 02BW01, and 04CW07 are located on mini-storage property.

Team 1 met with a neighbor while measuring water levels at well 04CW08. He reported the property where this well is located has been sold. He thought the new owners are planning to install a private well on this property, and would probably like to talk to us. A new right of entry form must be signed if, in fact, the property has been sold.

During water level measurements at well 91BW02, a slight petroleum odor was noted on the water meter cable as detected previously – possibly related to active petroleum remediation efforts being conducted by contractor for the Port at this location.

No other significant observations were made during this event.

2.5.2 TEAM 2 PRIVATE WELL SYSTEM SAMPLING

While environmental field team 1 worked independently on their set of wells, Team 2 collected samples at their own pre-assigned set of 10 whole house filter well system sample ports, five private well system hose bibs, and 14 PDB monitoring wells requiring sampling and/or PDB installation for the next sampling event.

During the period of 22-25 February 2016, Team 2 collected groundwater samples from the following 10 private well systems with whole house filters installed: WP-14, WP-70, WP-83, WP-86, WP-119, WP-121, WP-123, WP-124, WP-125, and WP-129. During that same time period, they collected groundwater samples from the following five private well systems: WP-4, WP-27, WP-131, WP-167, and WP-168.

All required 40 ml VOA sample vials were obtained from Vendor ESS by the USACE contract lab ARI, and delivered to USACE pre-preserved with maleic and ascorbic acid.

Trip blanks were sent inside each sample shipping cooler delivered to the analytical lab.

Upon arrival at each private well property designated for sample collection, the team verified they were at the correct address using maps, notes, and the sampling matrix, and verified through field documentation they were ready to collect samples at the correct sampling point (hose bib, or suitable water discharge port nearest to the wellhead. The team always attempted to contact the owner or resident at each private well location before beginning the field sampling activities.

Per modified SOP, sampling point valves were opened, and water allowed to flow at approximately 0.5 to 1 gpm into a capture bucket. Next, water temperature readings were measured every two minutes until stabilization was achieved. During the February sampling event, water temperature stabilization ranged from 4 to 8 minutes elapsed purging time with most locations reaching stabilization within six minutes as shown in Table 1 below.

TABLE 1: PRIVATE WELL STABILIZED WATER TEMPERATURES AND PURGE TIMES

Well Location ID	Stable Temp. °C	Total Purge Time (Minutes)
WP-04	15.7	8
WP-14	18.2	6
WP-27	15.1	6
WP-70	14.9	6
WP-83	11.8	6
WP-86	8.0	6
WP-119	7.4	6
WP-121	7.8	6
WP-123	8.3	6
WP-124	na	na
WP-125	14.2	4
WP-129	20.8	6

WP-131	11.7	6
WP-167	13.8	6
WP-168	No stabilization	na

Note: Team could not access hose bib for water temperatures at WP-124. Temperature did not stabilize at WP-168, so team purged one gpm for 15 minutes and then collected samples.

Upon achieving stabilization, the final stabilized readings were entered into the project field book. Prior to collecting a water sample, the flow rate at each tap was reduced to approximately 100 to 200 ml/min. to minimize sample aeration and turbulence. The sampling team donned new Nitrile gloves prior to sample collection at each residence. In the case of the WHF sample ports, restrictors on the sample ports provided a stream of sample water at approximately 150 to 200 ml/min. All sample containers were be filled with water directly from each tap – forming a meniscus at the top of each vial to provide zero headspace samples as required. A photographic record of each sample point was made by the team.

Significant observations made during Private Well/WHF Sampling

Team 2 will arrange with the property owners at WP-04 to pick up a spare key to the well house to make access easier in the future. Team 2 was also told by business on site that they do not drink the well water (they have bottled water delivered), and the well water was being used by the concrete mix plant, also on the property.

Rainwater was observed filling flush mount well vaults to top of the well casings at 12EX02, 12BW08, and 12BW06. Sufficient rainwater was bailed out of the well vaults to prevent the water from draining into the well casings once the water-tight plugs were removed for sampling.

At WP-167, the closest hose bib to the wellhead is of the type that does not permit low flow sampling. Care was taken to collect representative samples at this location.

At WP-27, the purged water appeared milky white at first (possibly due to numerous micro-sized bubbles), then ran clear by end of purge time.

At WP-124, the team could not safely access the hose bib for purging. Samples were collected from designated ports after purging the sample tubing. The team also detected pesticide/herbicide/fertilizer odors in the well house.

No other significant observations were made during this event.

2.5.3 PASSIVE DIFFUSION BAG SAMPLING AND DEPLOYMENT

Both USACE environmental field teams split up the effort of PDB sample collection and deployment of new pre-filled PDBs in a pre-determined set of 24 monitoring wells during the February 2016 event.

The selected PDB wells were: 02-BW01; 04-BW09; 04-CW05; 04-CW07; 12-BW02; 12-BW03; 12-BW04; 12-BW05; 12-BW06; 12-BW07; 12-BW08; 12-CW01; 12-CW02; 12-CW03; 12-CW04; 12-CW05; 12-EX01; 12-EX02; 14BW01, 14BW02, 14BW03, 14EX03, 14EX04, and 14EX05.

All required 40 ml amber glass VOA sample vials were obtained from Vendor ESS (certified new, clean, QC Class) by the USACE contract lab ARI, and delivered to USACE pre-preserved with maleic and ascorbic acid.

The teams first verified each monitoring well location and identification number with project maps and the sample matrix. The teams also verified that work could proceed safely in the vicinity of moving vehicular traffic or other physical, biological, or environmental hazards that may have been present near each monitoring well.

Each team member donned new Nitrile gloves for groundwater sample collection at each well. Once the wells were unlocked and opened, one team member lifted the well riser plug and began hauling the PDB vertically to the surface.

Once each PDB was raised to the surface, the sampling team worked together to carefully cut the top corner off each bag using decontaminated steel scissors. Next, one person held the open sample vials and the other carefully and slowly tilted the bags - open side down - toward each open sample vial. The pre-preserved vials were filled just to overflowing to maintain a reverse meniscus. Then the vials were immediately capped making sure there were no bubbles or headspace per standard VOC sampling procedure. This entire sampling process can be completed within one minute to minimize loss of volatiles while preventing introduction of contaminants into the water from surface sources. After all required vials were filled; any residual sample water remaining in the used PDBs was discharged to ground surface. Therefore, no Investigation-derived waste (IDW) water was generated during this sampling event.

The sampling teams continued use of protective mesh PDB sleeves in wells with steel risers due to a greater potential for damage to the PDB membranes (monitoring wells 12EX01, 12EX02, 14EX03, 14EX04, and 14EX05).

Once recovered and sample water removed, the PDBs and suspension lines were discarded as non-hazardous municipal waste. In addition, gloves, paper towels, bags, and other solid waste materials were disposed of as municipal waste. The PDBs and other solid waste material were placed into a large plastic garbage bag and tied securely prior to disposal. The stainless steel weights were decontaminated and reused during the deployment of the new pre-filled PDBs for the next sampling event.

After collecting water samples from the PDBs, the teams deployed new PDB assemblies into the following larger set of 37 monitoring wells selected for groundwater sampling during the May 2016 sampling event: 91AW07, 91AW14, 02BW01, 04BW01, 04BW04, 04BW05, 04BW06, 04BW07, 04BW09, 04CW01, 04CW02, 04CW03, 04CW04, 04CW05, 04CW07, 04CW08, 12BW01, 12BW02, 12BW03, 12BW04, 12BW05, 12BW06, 12BW07, 12BW08, 12CW01, 12CW02, 12CW03, 12CW04, 12CW05, 12EX01, 12EX02, 14BW01, 14BW02, 14BW03, 14EX03, 14EX04, and 14EX05.

For the May 2016 event, two sizes of PDBs were ordered: The bags consisted of the standard 220 ml size, and a larger 330 ml bag selected to accommodate primary and field duplicate samples where required. In some wells, two 330 ml PDBs were connected in tandem and lowered to the mid-screen depth to accommodate primary, field duplicate, and MS/MSD sample volumes as required. Two PDBs were installed at two mid-screen depths if a designated well had two screened intervals (as found in wells 04CW07, 12BW03, and 12BW04). All PDBs and stainless steel anchor weights were purchased from ALS Environmental, and shipped to the District office by UPS overnight delivery.

Following the established PDB deployment procedures, both environmental team members worked together using a table of Moses Lake monitoring well logs to determine the number of required weights, length of nylon suspension line, and number of PDBs required at each designated well.

Each team member donned a new pair of Nitrile gloves prior to working on PDB assemblies at each well. Steel weights, suspension lines, and PDBs were quickly assembled on a strip of clean aluminum foil on the tailgate of the sampling vehicle. The prepared assembly of PDB, suspension lines, and weights was lowered into place at each well within 10 to 15 minutes to reduce the possibility of contaminants entering the diffusion bags during deployment.

At each specific well, the team lowered the weight into the well first, followed by the suspension line and PDB. The team worked to keep the assembly centered within the well casing as they slowly lower it to the well bottom. When the team felt the weight hit well bottom, they pulled up the line approximately one foot and tied it off securely to the casing plug or well cap. This method ensured the PDB would always be centered at the mid-well screen depth. Finally, the well cap was locked, or the cover plate secured with locking bolts depending on type of well encountered – stick up or flush mount.

All laboratory-filled PDBs arrived at the USACE office in good condition prior to field deployment. Each PDB was packed in groups of 10 into sealed foil pouches to prevent inadvertent contamination until deployment into the designated monitoring wells. No specific difficulties or problems were noted during PDB deployment.

Significant Observations Made During Passive Diffusion Bag Sampling

Numerous rust particles were observed on the PDBs and PDB suspension lines installed in wells 14EX03 and 14EX04.

No other significant observations were made during this event.

3.0 INVESTIGATION-DERIVED WASTE

No investigation-derived waste was generated during this sampling event. All residual PDB water or purged well water was transferred directly to ground surface on each property away from the sample collection point.

4.0 SAMPLE PACKAGING AND DELIVERY

As mentioned in the narrative of each sampling event, groundwater samples were packaged in shipping coolers on ice and under chain of custody for overnight shipment to the USACE contract laboratory Analytical Resources, Inc. during the course of the sampling event.

All sample shipping coolers were prepared for laboratory delivery in the following manner: Each cooler was lined (sides and bottom) with plastic "bubble-wrap" sheets for shock absorption. A large 30-gallon plastic garbage bag was then placed into the cooler to contain the sample water in the event of container breakage during shipment to the laboratories. The glass sample vials were labeled, placed into plastic zip-seal bags, and placed into foam shipping blocks or bubble-wrap bags for shock protection. All the samples were placed in the shipping coolers as indicated on the corresponding chain of custody forms. Gallon size plastic zipper bags of cubed ice bags were placed between and on top of the samples in each cooler to ensure maintenance of the required four degrees Celsius (plus/minus two degrees) sample preservation temperature. The completed chain of custody (COC) forms were placed in gallon size plastic zipper bags and taped to the inside of each cooler lid. Two custody seals were affixed to the outside of each cooler. The custody seals were placed so that the coolers could not be opened without breaking the seals. Each cooler was then securely sealed with fiber tape. The field team ensured drain plugs were securely taped inside and out to prevent possible water leakage.

The laboratory was informed of the sample delivery and ensured the samples were properly accepted and checked in upon receipt the following morning after the sample containers were shipped. All sample coolers and sample containers were accounted for at the contract laboratory following each shipment.

5.0 LABORATORY ANALYSIS

Chemical analyses performed on the samples were as follows: VOCs (Method 524.3). Also, for a pre-determined subset of four private whole house filter system wells (WP-119, WP-121,

WP-124, and WP-125), groundwater samples were intended to be collected for Perfluorinated Compounds. However, the analytical laboratory did not supply sufficient sample containers to collect the required sample volume according to the analytical method. These samples will be collected during the May 2016 sampling event.

6.0 DECONTAMINATION PROCEDURES

PDB weights, flow cells and associated tubing, water level indicator meters, and water volume measurement containers used by each team were decontaminated at the end of the project with an Alconox®-water solution followed by triple rinsing using distilled water in the USACE Geology Laboratory.

7.0 PROTECTION LEVEL

All sampling activities were conducted under Worker Protection Level D. For this project, personnel protective equipment included reflective safety vests, safety splash protection glasses, Nitrile gloves, and safety steel toe boots. New pairs of Nitrile gloves were donned prior to handling acid-preserved sample containers and between each unique private well sample point or monitoring well.

End of Field Sampling Report

APPENDIX A

Site and Well Location Maps

(Available in USACE Project Files)

APPENDIX B

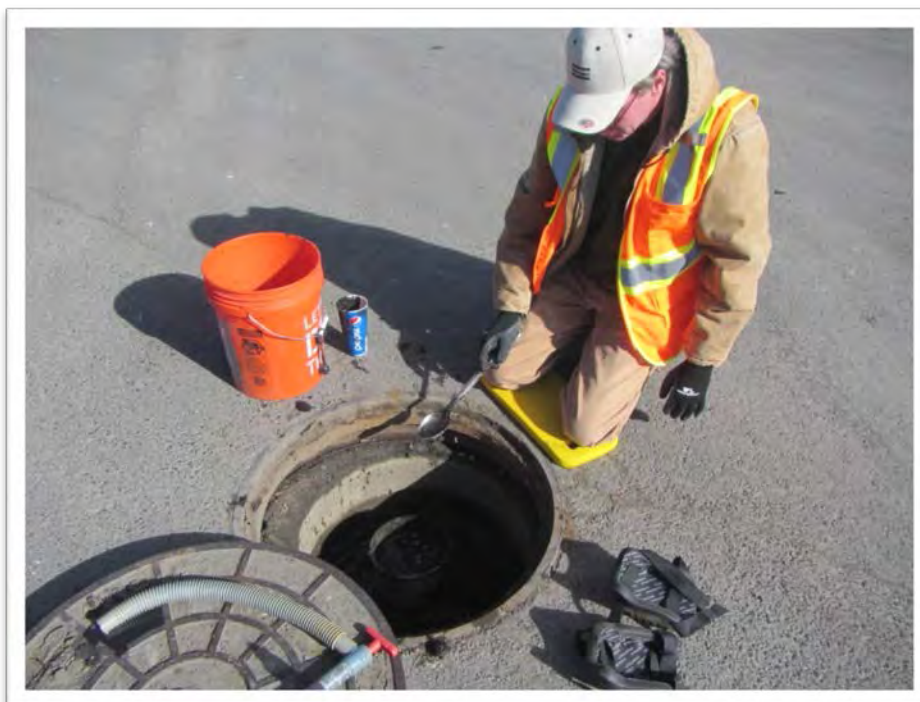
Field Sampling Photos

Figure 1



(160222-04CW01-1) Matt Brookshier shown ready to deploy new passive diffusion bag into well 04CW01.

Figure 2



(160223-00BW14-1) Matt Brookshier shown cleaning out well vault to access well 00BW14.

Photographer: Joseph Marsh



Figure 3



(160222-99BW09-1) Close proximity of New Genie lift vehicles to well 99BW09.

Figure 4



(160223-99BW10-1) Purging bladder pump well 99BW10.

Photographer: Joseph Marsh

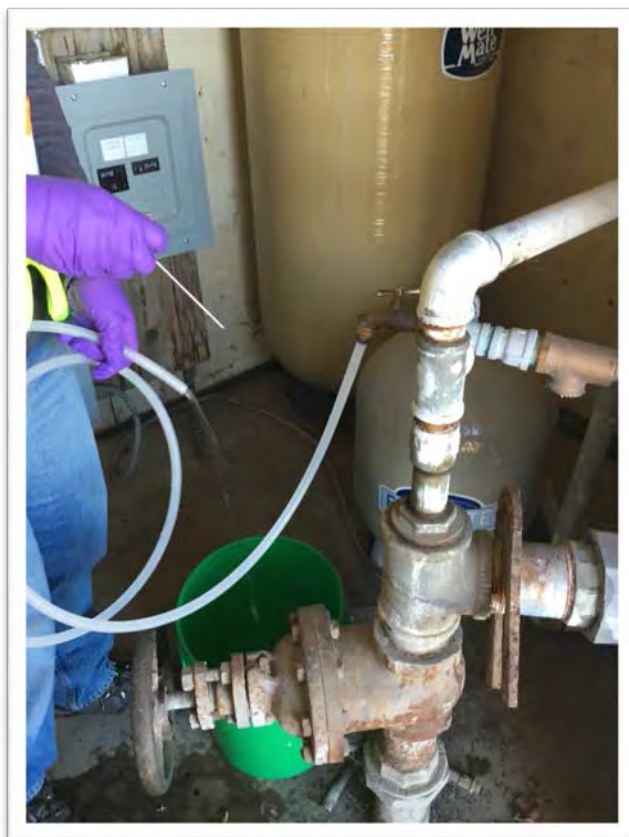


Figure 5



(160223-92BW01-2) Many monitoring well padlocks are beginning to show signs of corrosion, and will need to be replaced in the near future.

Figure 6

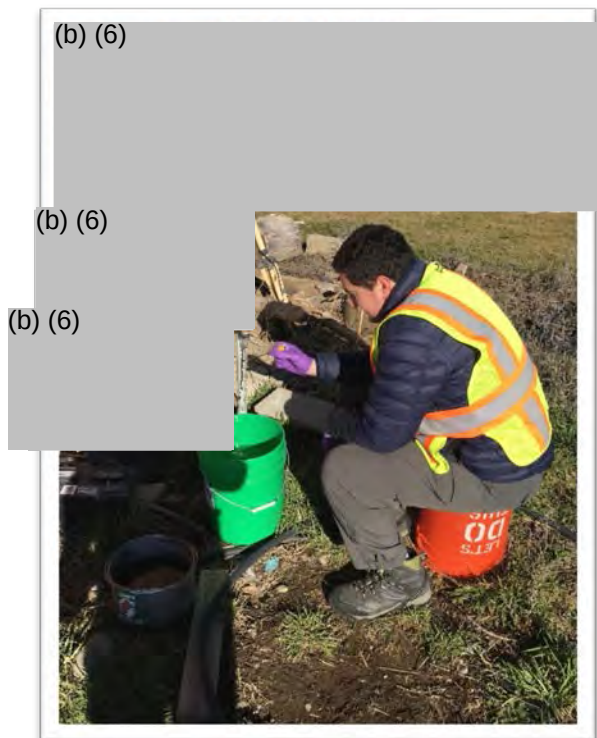


(160222-WP04) Purging activities at well WP04.

Photographer: Marsh/Haskins



Figure 9



(160223-WP14) Jake Williams shown measuring water temperature for stabilization from yard hydrant nearest to well WP-14.

Figure 10



(160224-WP27) Measuring water temperature at well WP-27.



Figure 7

(b) (6)



(160224-WP123) Door handle tag left after sampling at WP123 where residents were not at home.

Figure 8



(160224-WP125) Teflon sample tubing used for purging and sampling at well WP125.

Photographer: Karah Haskins



APPENDIX C

Field Notes

(Micropurge Logs available in USACE Project Files)

PROJECT: MOSES LAKE
WELLFIELD
Groundwater
Sampling

FY-16
TEAM 1



Rite in the Rain.

ALL-WEATHER

LEVEL

Nº 311

Project: Moses Lake Wellfield
February 2016 Groundwater Sampling
Team: Joseph Marsh
Matt Brookshier (Team 1)

SAMPLING TABLE				
WELL	SAMPLE ID	(2016) DATE	TIME	VOL (524.3) 3 x 40ml VOA pres. Mal/ACC acid
92BW01	1602N92BW01	2-23	0850	9 *
92BW01 F ₂	1602D92BW01	2-23	0920	3
91BW04	1602N91BW04	2-23	0935	3
99BW18	1602N99BW18	2-23	1020	3
99BW10	1602N99BW10	2-23	1059	3
Trip Blank	1602TB01	2-23	1130	2

- All samples on this page shipped in Cooler A1 for delivery to ARI.
- only 2 vials required for trip blank.
- * Extra Volume for MS-MSD.

Moses Lake Wellfield
February 2016 Groundwater Sampling
Table continued...

WELL	SAMPLE ID	(2016) DATE	TIME	VOL (524.3) 3 x 40ml VOA pres. Mal/ACC acid
04BW09	1602N04BW09	2-24	1226	3
04CW05	1602N04CW05	2-24	0935	9* 3
04CW05 F ₂	1602D04CW05	2-24	NA	3 NA
12BW04	1602N12BW04A	2-24	1352	3 Dual Comp.
12BW04	1602N12BW04B	2-24	1358	3 Dual Comp.
12BW05	1602N12BW05	2-24	0859	3
12BW07	1602N12BW07	2-24	0959	3
12CW03	1602N12CW03	2-24	1339	3
12CW04	1602N12CW04	2-24	0840	3
12EX01	1602N12EX01	2-24	1015	3
14BW03	1602N14BW03	2-24	1304	9*
14EX05	1602N14EX05	2-24	1245	3
PDB Pre-Deploy Trip	1602PDTB01	2-24	1407	3
Trip Blank	1602TB02	2-24	1430	2
44BW03 F.D.	1602D14BW03	2-24	1320	3

- All samples on this page shipped in cooler A2 for delivery to ARI.
- only 2 vials required for trip Blank.
- * Extra Volume for MS/MSD.

Rite in the Rain

Moses Lake Wellfield

Groundwater Sampling Team

2-22-16

Joseph Marsh, Matt Brookshier

Project start

1235 99BW16 = 123.77' - start of field event

91AW14 = 123.13' Deployed:

04CW01 = 159.4' → 2 ea 330^{ml} PDB

1259 = 04BW04 = 137.79' → 1 ea 220^{ml} PDB

04CW02 = 160.79' → 1 ea 220^{ml}

04BW05 = 129.80' → 1 ea 220^{ml}

* Note: safety plan briefed at start of fieldwork ^{swp} Deployed:

04BW01 = 64.04' 1 ea 220^{ml} PDB

01BW01 = 64.84' -

00BW05 = 64.07' -

00BW01 = 46.70' -

CDSI - Vault flooded - will return tomorrow, SWL

00BW09 = 70.08' -

00BW04 = 62.82' -

00BW07 = 68.27' -

02BW02 = 69.64' -

99BW15 = 70.31' -

99BW14 = 59.56' -

99BW12 = 112.57' -

1615 - end of Day 1

Am n w l

2-23-16

Moses Lake Wellfield

Feb, 2016 Groundwater Sampling Field Notes, cont.

0730 - Travel to Safeway to buy ice for sampler today. Mob. to field after bagging ice for sample preservation

0814 - Setup @ 92BW01 bagging ice, flow cell calibrated, SWL = 84.70' purging stagnant water from system - then micropurge to stability

0850 - Sample time (p)

(0920) - Sample time (PD), close + lock well. Mob. to next well 91BW09

Setup - SWL = 85.04' pre-purging stagnant water from system micropurge to stability

0935 sample time close + lock well, Mob. to 99BW18

0956 setup + pre-purging stagnant system water. Micropurge to stabilization

1022 = Sample time, NSTR, close + lock well, Mob. to 99BW10 Setup + pre-purging of stagnant water in casing - then micropurge to stabilization. SWL = 131.43'

1059 = Sample time, close + lock well in the rain

2-23-16 cont.

- Met new manager at Mini-storage
- she says the property will have an electronic fence requiring a key card or code in near future -
- she will coordinate with us when the upgrade is implemented -
- (I gave her my ^{business} card - J. Marsh)

1220 - Delivered one cooler (AI) with groundwater samples to ARI via Grant County Airport FedEx.

1230 - 1300 Lunch

~~1250~~ 1310 } SWL = 56.21' @ CDS1 well
 DOBW14 } after cleaning out vault + filled with sediment + surface water.

- Mob. to airport wells for water levels.

SWLs

DOBW12 =	79.21'	
DOBW03 =	82.78'	
DOBW02 =	86.35'	
DOBW11 =	91.91'	no fuel odor
DOBW08 =	91.01'	
91BW02 =	92.43'	minor fuel- ^{retro} odor.
DOBW06 =	146.99'	1 ^{trans.} PDB
(Tank Farm) → 04BW06 =	105.11'	→ PDB deployed

2-23-16 cont.

Mob. to "Tank Farm" wells

SWL

04CW03 =	136.47'	→ installed 220w PDB
99BW01 =	89.24'	← Needs new locks
91AW07 =	87.65'	→ installed 220w PDB
91BW03 =	89.07'	
92BW02 =	82.08'	
1537 hrs. DOBW15 =	79.92'	
99BW09 =	72.77'	
1557 hrs. DOBW10 =	137.00'	church lot
04CW08 =	142.55'	oil PDB removed new 220w PDB deployed

Talked to neighbor -

(b) (6)

(b) (6)

We will need
get a new

ROE signed.

1630 - end of field day.

In the end

Rite in the Rain

Moses Lake wellfield
2-24-16

0730 - returned used CO₂ bottle to OXARC
 - picked up 2 bags 10lb. ice
 at Safeway.

0800 Mobilize to wellfield, setup of first
 PDB well - 12CW04 SWL = 100.73'
 PDB (220ml) pulled, sample time = 0840
 close + lock well. Mob to adjacent well

0850 - 12BW05 91.17' = SWL one 220ml PDB
 retrieved - sample time = 0859
 deploy 1 new 220ml PDB in both
 wells 12CW04 + 12BW05 at this
 location. close + lock well.

- Mob. to 04CW05 SWL = 98.55'
 pulling one 220ml PDB - should be 2 330ml PDB

0935 - sample time (P) 0935 ^{NA} ~~sample time (PD)~~
 *cannot take MSMSD or FD sample here,
 deployed 2 220ml PDB here for
 P, MSMSD, FD Next time per plan.

0951 12BW07 SWL = 90.22'
 pulled one PDB 220ml sample time = 0959
 replace one new 220ml PDB

12EX01 SWL = 90.27'
 pulled one 220ml PDB in mesh - rusty
 from casing. sample time = 1015
 deploy one new 220ml PDB in mesh
 into well.

2-24-16 continued.

1130^{hr} 1200^{hr} lunch break.

1300 - 04BW09 flush mount SWL = 86.04'
 pulling PDB - one 220ml.
 Sample time = 1226, replacing well with
 New 220ml PDB. close + lock well
 Mob. to 2.

14EX05 SWL = 88.00'
 pulled PDB 1x 220ml sample time = 1245
 deployed one 220ml PDB, close + lock well

14BW03 SWL = 88.14'
 pulled PDB (2x 330ml Bags here ^{Not per Plan})
 will take Sample time = (P) 1304
 P/MSMSD/ and FD = (FD) 1320
 here redeploy one 220ml PDB in this well

12BW04 SWL = 99.95'
 pulled 2 intervals ~~(Biot)~~ 2 220ml Bags.
 A sample time = 1352 2x 220ml
 B Sample time = 1358 Bags redeployed
 close + lock well in well

12CW03 SWL = 107.52'
 pulled one 220ml PDB, replaced with
 New 220ml PDB. sample time = 1339
 close + lock well *Rite in the Rain*

2-24-16 cont.

(Cooler
A2)

1445 * Shipped one sample cooler to HCF via FedEx
 04BW07 = SWL = 125.74'
 deployed one 220ml PDB per plan

04CW04 - SWL = 126.45'
 deployed one 220ml PDB per plan

00BW13 → SWL = 85.79'
 * closed + locked each well sampled. at end.

1610hrs - 12BW01 SWL = 85.87'
 deployed 1 new 220 ml PDB
 per Plan for May sampling. close
 + lock well.

* re-installed new bolts in well
 cover plate (5/16" bolts) at well
 12CW01.

1625 - end of Day.

Jm RAL

2-25-16

Moses Lake Wellfield
Team 1 GW sampling

23

water level readings

0846 - 99BW11 - SWL = 50.15'

0902 - 00BW16 - SWL = 133.51'

1000 - Meeting at new monitoring well site.

Sampling event complete

1100 - Return to District Office

Jm RAL

Rite in the Rain

Protects Moses Lake Wellfield
Groundwater Sampling



Book 7

Rite in the Rain®

ALL-WEATHER

**ENVIRONMENTAL
FIELD BOOK**

Nº 550F

FY 15/16

MAY 2015 thru

TEAM 2

Location Moses Lake Date 2/22/16

Project / Client

Feb 2016 sampling

WL-04 need to call
about getting copy of key
for future. turned 7 gal

time	0	2	4	6	8
temp	16.1	16.1	16.1	15.7	15.7

Water used to be pumped
to tank for use in bldg
but pipe was crushed.
only people that use
pump are CWC.

Guy in bldg does not recall
people drinking water because
~~#1 tank~~ bldg has delivered
drinking water

Sample time 1321

12EX02 rain water in casing
had some flaky white
floating in water. water
was level w/ well head

Location Moses Lake Date 2/22/16

Project / Client

Feb 2016 sampling

WL: 119.57

Sample time 1353

12BW08

water in casing
up to well head

WL: 119.42

Sampling 1420

12CW01

WL: 132.51

Sample time 1455

Needs SCREWS/BOLTS12BW02

WL: 116.82

Sample time 1515

END DAY 1

Rft

Location Moses Lake Date 2/23
 Project / Client

Feb 2016 sampling

12CW02

WL: 150.03

Sample time: 0810

12BW03

WL: 128.34

Sample time

A 0830

B 0835

WP-83

Temp	11.8	11.8	11.8	11.8
Time	0	2	4	6

Totalizer: 1831337.0

purged 5 gal

SAMPLE A: 0922

Location Moses Lake Date 2/23

Project / Client

Feb 2016
Sampling

WP-14

totalizer 1570457.1

time	0	2	4	6
temp	18.4	18.4	18.2	18.2

purged 7 gal

sample time 0940

14BW02

WL: 107.81

sample time: 1000

14EX04

WL: 108.03

sample time: 1023

12BW06

water in casing to riser

WL: 117.60

Sample

N: 1110

D: 1115

Location Moses Lake Date 2/23

Project / Client

Feb 2016 sampling2CW05

WL: 137.85

Sample: 1140

water in well casing

WP-86

Totalizer 0537672.5

Time	0	2	4	6
Temp	8.2	8.2	8.0	8.0

purged 5gal.

sample 1425

~~WP-167~~

Time	0	2	4	6
Temp				

Location Moses Lake Date 2/23/15 75Project / Client Feb 2016 SAMPLINGWP-1687

Time	0	2	4	6
Temp	13.6	13.6	13.8	13.8

purged 15gal sprayer
doesn't allow for low flow.

sample 1445

WP-168

Time	0	2	4	6
Temp				

(b) (6)

Temp never stabilized,
purged at 1 gal/min
for 15 min

sample 1510

Location Moses Lake Date 2/23Project / Client Feb 201614BW01

WL: 96.05

Sample: 1615

14EX03 deployed 2-330

WL: 96.38

Sample 1635

DAY 2 END KFT

Location Moses Lake Date 2/24/2016 77Project / Client Feb 2016 samplingWP-27Milky colored water
came out of spigot at
first & then cleared

Time	0	2	4	6
Temp	15.1	15.1	15.1	15.1

Water system was on when
we arrived. purged 2.5 galWP-129

totalizer 99.9870

Time	0	2	4	6
Temp	20.7	20.8	20.8	20.8

purged 15 gal first
then 5 moretotalizer was spinning
further inside home
but normal water purge
spigot was not using totalizer

sample 0930

Location Moses lake Date 2/24/16
 Project / Client Feb 2016 sampling

WP-119A1

Totalizer: 178088.1

Time	0	2	4	6
Temp	7.2	7.2	7.3	7.4

VOCA: 1000

PFCA: 1020

PFC C: 1010

WP121

Totalizer: 63283.3

Time	0	2	4	6	8
Temp	7.6	7.7	7.6	7.8	

VOCA: 1020

PFCA: 1025

PFC C: 1030

VOC dup: 1022

purged 7gal

Location Moses lake Date 2/24/16 79
 Project / Client Feb 2016 Sampling

WP-123 no one home

Time	0	2	4	6
Temp	8.2	8.2	8.2	8.3

Totalizer: 187871.3
 Sample 1100

WP-125

Time	0	2	4	6
Temp	14.2	14.2	14.2	

Totalizer 332053.1

VOC/PFC A 1130

B 1135

VOC/PFC C 1140

WP-70

Time	0	2	4	6
Temp	14.9	14.9	14.9	14.9

Totalizer: 223048.6
 Sample: 1315
 purged 5gal

Location Moses lake Date 2/24

Project / Client

Feb 2016 sampling

WP-131

Time	0	2	4	6
Temp	11.4	11.5	11.4	11.7

purged 20 gal

sample time 1345

WP-124 totalizer 256686.7

no purge. Spigot behind
fence & no one home

A 1410

C 1420

took field RB smelled
pest / herb / fertilizer

1602FRB01

Location Moses lake Date 2/24

Project / Client

Feb 2016 Sampling

02BW01

WL 131.17
Sample 1500

1602PDTB02

Time: 1510

94CW07

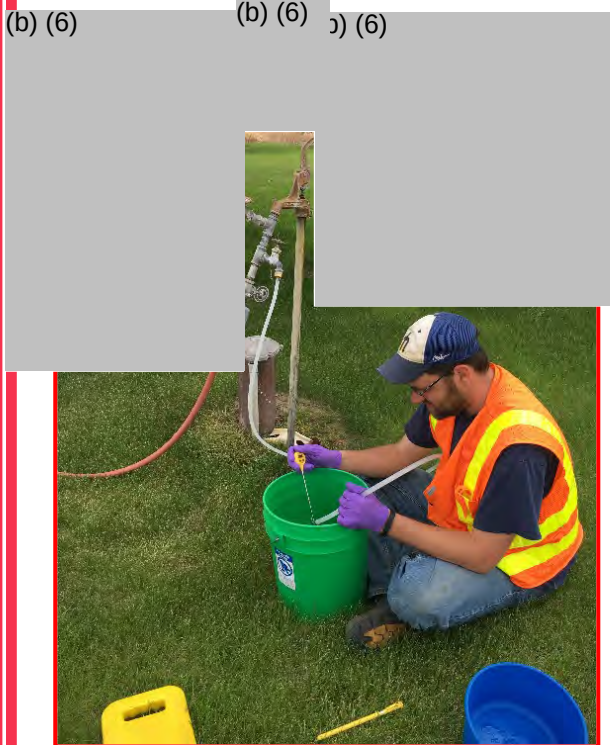
WL

~~Sample~~: 143.55

Sample A 1530
Sample B 1535

Private Wells and Monitoring Wells Groundwater Sampling Field Report May 2016 Field Sampling Event

Moses Lake Wellfield Superfund Site Moses Lake, Washington



Field Investigation:
16-23 May 2016

Report Prepared:
June 2016

By: Technical Services Branch



**US Army Corps
of Engineers** ®
Seattle District

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1.0 BACKGROUND AND OBJECTIVE OF INVESTIGATION

1.1 BACKGROUND

The Moses Lake Wellfield Superfund Site is located between the Grant County Airport and the City of Moses Lake, Washington. The Site includes the former Larson Air Force Base (LAFB) property, Port of Moses Lake property and adjacent private properties affected by Site groundwater contamination. The Site is listed on the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980 National Priorities List (NPL) for Uncontrolled Hazardous Waste Sites.

The Moses Lake Wellfield Superfund Site is an area of approximately 15 square miles, which includes the former LAFB, commercial facilities, and residences. The former LAFB occupied approximately 9,607 acres three miles northwest of the City of Moses Lake. The United States Air Force was active at the site from 1942 until 1966. During 1988 and 1989, the Washington State Department of Health confirmed the presence of trichloroethylene (TCE) above the Federal Maximum Contaminant Level (MCL) in three City of Moses Lake municipal wells and two Skyline community wells. The Seattle District, US Army Corps of Engineers (USACE) completed a Remedial Investigation (RI) phase in 2003. Appendix A of this report shows the general location map and a site map.

During the course of the RI, several private wells were tested and found to be contaminated with TCE. In 2001, the USACE contracted installation of carbon filtration units – known as whole house filter systems (WHF) - at five of those wells. Several years of groundwater monitoring data has been evaluated since the original WHF systems were installed.

The final results of the Phase I RI released in a report in March 1993 indicated that TCE was consistently found in shallow alluvial and upper basalt (α -basalt) groundwater in the central area of the former base.

On October 14, 1992, the affected areas of the former LAFB and off-site down gradient areas, termed the "Moses Lake Wellfield Contamination", were listed on the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) of 1980 for Uncontrolled Hazardous Waste Sites. The former LAFB property is one part of the Moses Lake Wellfield Superfund Site; the site also includes the contaminant plume.

Chemical results from 1993 and 1994 combined with historical data indicated that TCE occurred in the central and southern portion of the former LAFB in alluvial and α -basalt groundwater. In 2004, USACE confirmed TCE contamination in the next lower basalt aquifer (c-basalt). As of 1995, the data suggest that more than one source may have contributed TCE to the alluvial and α -basalt groundwater in the central portion of the former LAFB.

In 1998, URS Greiner completed a sampling round of private water wells and wells for Class A and Class B water systems east, south and southwest of the previously known TCE plume. There were eight detections of TCE during this study. Four wells that were previously outside the plume extent were found to be above the detection limit.

1.2 GROUNDWATER SAMPLING EVENT SUMMARY AND OBJECTIVES

In coordination with the US Environmental Protection Agency (USEPA) Region 10, three USACE environmental field teams deployed to conduct the May 2016 Moses Lake Wellfield groundwater sampling event during a single mobilization. The events described in this report involve USACE field teams verifying sample point locations; discussion of sampling techniques; recording groundwater observations; collection of groundwater samples; and shipment of those samples by overnight delivery for laboratory analysis. Environmental sampling team members responsible for the May 2016 field event were Joseph Marsh, Matthew Brookshier, Karah Haskins, David Clark, Jacob Williams, and Blair Kinser.

All of the work described in this report was accomplished in accordance with the Moses Lake Wellfield Superfund Site Quality Assurance Project Plan (QAPP). In addition, the teams followed the guidance presented in: the Seattle District, USACE Safety and Health Plan; USACE Safety Manual EM 385-1-1; Seattle District, USACE, Sampling Standard Operating Procedures (SOP).

At the direction of USEPA, the QAPP was amended for the May 2016 sampling event to include sampling and analysis of 1,4-Dioxane and Perfluorinated Compounds (PFCs) at select wells in addition to the established sample collection and analysis for VOCs.

The private wells and monitoring wells designated for sampling are displayed on a map found at Appendix A. These wells have been selected based on their down-gradient locations relative to the inferred flow direction of TCE-contaminated groundwater and validated sampling analytical data from previous monitoring events.

The three environmental field teams deployed to the Site and collected groundwater samples from a total of 69 private well systems, and 76 monitoring wells during the May 2016 sampling event as summarized below:

Team 1: Joseph Marsh and Matthew Brookshier collected groundwater samples from 40 monitoring wells fitted with dedicated bladder pumps, and 36 monitoring wells fitted with laboratory-prepared passive diffusion bag samplers. New passive diffusion bag samplers shall be deployed during the August 2016 field event since sampling at those wells will not be required until November, 2016. Team 1 also collected static water level data from all designated project monitoring wells. These activities were conducted from 16 through 23 May 2016.

Team 2: Karah Haskins and David Clark collected groundwater samples from four private whole-house filter systems, and 28 private well systems. These activities were conducted from 16 through 18 May 2016.

Team 3: Jacob Williams and Blair Kinser collected groundwater samples from six private whole-house filter systems, and 31 private well systems. These activities were conducted from 16 through 19 May 2016.

The objectives of groundwater sampling at Moses Lake are to: 1) collect representative samples from designated private well systems and monitoring wells yielding data of known and sufficient quality to evaluate TCE concentrations and define existing TCE plumes; 2) to assure compliance with the requirements of USEPA; and 3) to make critical project - specific decisions based on the evaluated data.

2.0 DESCRIPTION OF WORK

2.1 ACTIVITIES PRIOR TO THE MAY 2016 GROUNDWATER SAMPLING EVENT

The USACE project team worked to collect signatures on Department of the Army Right of Entry forms as required before conducting the well sampling on private, city or county government property. For most properties, previously signed Right of Entry forms were still valid. For all properties designated for sample collection, owners (and renters if applicable) were contacted to coordinate sample collection times during the scheduled field sampling week.

Prior to conducting sampling activities at each location, both teams verified the address or well location and map location matched, and that the Right of Entry form had been signed prior to arriving at each sampling location.

Each team was responsible for identifying potential health and safety hazards at each sampling location. If a hazard is verified at a private well sampling location, an alternate hose bib connected to the same water source may be selected in a safer area of the subject property. In the case of hazardous monitoring well conditions, the well may be situated in an active construction zone requiring the cancellation of sampling at that well until the next scheduled sampling event.

Also for private well sampling, the field team was tasked with determining the most appropriate cold-water tap or other sample port as close to each wellhead as practical. At each location, the team worked to collect water samples from the same sample point selected during previous sampling events to ensure consistent results. The team was briefed that groundwater samples would not be collected from taps delivering chlorinated, aerated, softened or filtered water.

2.2 PRIVATE WELL SAMPLING PROCEDURES

During the May 2016 groundwater sampling event, samples were collected from a total of 69 private wells consisting of: 59 private well system hose bibs (WP-3, WP-4, WP-9, WP-10, WP-27, WP-28, WP-33, WP-45, WP-50, WP-52, WP-54, WP-57, WP-65, WP-66, WP-68, WP-69, WP-71A, WP-71B, WP-74, WP-82, WP-105, WP-111, WP-116, WP-120, WP-122, WP-126, WP-127, WP-128, WP-130, WP-131, WP-136, WP-137, WP-138, WP-139, WP-143, WP-144, WP-145, WP-147, WP-148, WP-149, WP-150, WP-152, WP-153, WP-154, WP-155, WP-156,

WP-164, WP-165, WP-167, WP-168, WP-169, WP-170, WP-171, WP-172, WP-173, WP-177, WP-178, WP-179, and WP-180), and 10 WHF systems (WP-14, WP-70, WP-83, WP-86, WP-119, WP-121, WP-123, WP-124, WP-125, and WP-129).

USACE (in cooperation with USEPA) has determined private well and WHF groundwater purging shall to consist of: allowing water flow at the sampling port at a rate of approximately 0.5 to 1 gallon per minute (gpm), while measuring the temperature of the water stream with a digital thermometer every two minutes until stabilization is achieved. These procedures follow the general principles of the New Hampshire private well system water sampling guidance.

During purging, the flow rate at each location was verified by graduated cylinder. While purging continued, the field team monitored the surrounding area and flowing water for unusual observations and odors as purge water was captured in a five gallon bucket. They recorded the start time of the purging in the field logbook immediately after opening each hose bib sample point and establishing the flow rate. While one team member used the digital thermometer to measure water temperatures, the other recorded the temperatures every two minutes until the parameters stabilized.

Upon reaching stabilization, the approximate total purged volume was recorded in the project field book along with any other significant observations. The team then conducted the sample collection activities.

Prior to collecting a water sample, the team reduced the flow rate at each tap to approximately 150 to 200 ml/min. to minimize sample water turbulence and aeration. The samplers donned protective eyewear and new, clean, Nitrile gloves to prevent exposure to contaminants and cross-contamination. All groundwater samples were collected in pre-cleaned certified containers obtained from the analytical laboratory.

All sample containers were filled with water directly from each tap – forming a meniscus at the top of each vial to provide zero headspace samples as required. Sample point location and components of each plumbing system were noted to assist in data interpretation. A photographic record of each sample point was made by the team. In addition, each team placed handle tags (indicating that water samples were taken by USACE on that date and time) on the front doors of homes sampled if nobody was home during sample collection. A photo was taken of the handle tag and front of house in that case for the project files.

After the sample containers have been filled, sample labels describing project, location, analysis, team members, preservative, sampling date, and collection time are placed on the containers. The samples are then packaged in bubble wrap bags and plastic zipper type bags, placed into pre-iced sample shipping coolers and prepared for shipment as described in Section 3.0. All sampling teams worked to ensure each property was left just as they found it with no damage done, and any doors or gates closed as required.

2.3 WHOLE HOUSE FILTER SAMPLING PROCEDURES

In coordination with USEPA and affected Moses Lake area homeowners, granular activated carbon (GAC) water filters have been installed in private well systems showing TCE results of 3.5 µg/l or greater. Each GAC filter system consists of two lightweight composite GAC filter tanks (acting as lead and lag filters), associated piping, bag filters (to prevent GAC particles from entering the household plumbing system), pressure gauges and valved/regulated sample collection ports.

As described previously, groundwater samples were collected from 10 WHF systems during this May 2016 sampling event. Each system was purged according to the revised private well sampling SOP consisting of allowing water flow at a hose bib nearest the wellhead at a rate of approximately 0.5 to 1 gpm, while measuring the temperature of the water stream with a digital thermometer every two minutes until stabilization is achieved. Purge flow rates averaged approximately 0.5 gpm as measured with graduated cylinder, and purged water at each location was captured in a five gallon bucket to verify purged volumes. During purging, continuous temperature readings were recorded using a digital thermometer until water temperature stabilization was achieved. Once water temperature had stabilized, the hose bib was closed, and the field team prepared to collect samples from the pre-determined WHF sample ports (labeled "A" for the lead inlet port, "B" for the lead outlet port, and "C" for the lag outlet port).

WHF sample collection consists of opening each designated sample port valve fully to allow the maximum restricted flow rate of approximately 150 to 200 ml/min to flow into a capture bucket for a few seconds to ensure organic matter or air bubbles have been flushed out of the system. Restrictors have been placed on the sampling lines to provide a smooth, non-turbulent stream at a low-flow rate to minimize loss of volatiles that may be present in the water stream. Next, the sampling team immediately fills three pre-preserved VOA vials to zero headspace. New Nitrile gloves were donned before collecting samples at each port. All discharged water was directed into a five gallon plastic bucket for transfer to ground surface away from the shed or pump house GAC filter location after the samples were collected.

After filling the sample containers, sample labels describing project, location, analysis, team members, preservative, sampling date, and collection time were placed on each container and the container was placed in a plastic zipper bag. The bagged sample vials were placed into bubble wrap bags. Finally, the filled sample containers were placed into pre-iced shipping coolers to begin sample cooling to the required 4° Celsius sample preservation temperature prior to shipment to the analytical laboratory. One set of trip blanks were required and included per sample shipping cooler.

2.4 MONITORING WELL SAMPLING PROCEDURES

2.4.1 MONITORING WELL SAMPLING USING DEDICATED BLADDER PUMPS

Moses Lake monitoring well groundwater purging and sampling was performed in accordance with the Seattle District's Low-Flow Ground Water Purging and Sampling SOP, prepared in March 1999 and revised on 1 Sep 2009. Data generated during purging were recorded on the MicroPurge/Low-Flow Sampling Log forms (Appendix C).

The team verified each monitoring well location and identification number with project maps and tables. They verified work can proceed safely in the vicinity of moving vehicular traffic, heavy industry, and other hazards as required. The team used a pry bar, socket wrench or pinhead hex wrench as needed to open each flush mount monitoring well cover plate, and a Masterlock #485 padlock key for the standard "stick-up" well completions. Prior to purging each well, the depth to static water level in each well was measured and checked periodically to monitor draw down as a guide to flow rate adjustment (no greater than 0.4 foot drawdown is permitted to prevent sampling stagnant casing water).

Purging operations at each well commenced once the following equipment was prepared: the MP20 MicroPurge[®] Controller equipped with an adjustable pressure regulator was connected to the Well Wizard[®] bladder pumps via airline and quick connect fittings. Another airline was quick-connected to a pressurized CO₂ cylinder to drive the pump. Pump flow rates were then adjusted during a "pre-purge" period to maximize withdrawal rates and minimize excessive drawdown in each well. The evacuated pre-purge volume at each well was intended to flush out a bladder pump and tubing volume prior to monitoring stabilization parameters. Finally, a QED MicroPurge[®] basics MP20 Flow Cell was connected to the pump's discharge line at ground surface to measure established water quality stabilization parameters (pH, specific conductivity, temperature, DO, ORP, and turbidity).

Depth to water measurements during purging were monitored and recorded to verify that minimal drawdown occurred. A graduated measuring cup was used to determine the volume purged. Generally, acceptable low-flow rates are no greater than 500 milliliters per minute (ml/min.), and are typically closer to 400 ml/min. for the Well Wizard[®] bladder pump systems, depending upon the amount of water level drawdown detected during pumping at each well. Purge data was recorded on the micro-purge logs every two minutes.

Low-flow purging continued until three consecutive measurements of the stabilization parameters met stabilization requirements.

Stabilization parameter requirements for all private well and bladder pump monitoring wells are as follows:

Temperature	+/- 0.2 °C
Specific Conductivity	+/- 0.020 millisiemens/centimeter (mS/cm)
DO	+/- 0.2 milligrams/liter (mg/l)

pH	+/- 0.2 units
ORP	+/- 20 millivolts (mV)

At each monitoring well, groundwater sample collection would begin immediately after achieving stabilization of water quality parameters during low flow purging.

Prior to sample collection, the samplers donned protective eyewear and new, clean, Nitrile gloves to prevent exposure to contaminants and cross-contamination. All groundwater samples were collected in pre-cleaned, certified containers obtained from the analytical laboratory.

All sample containers were filled immediately following purging by disconnecting the flow-through cell from the pump tubing system, and capturing water directly from the discharge end of the tubing. All sample containers were carefully filled at a low-flow rate to minimize agitation. During sample collection, significant physical observations were recorded in the Micropurge/Low-Flow Sampling Log data forms and project field book as needed.

After filling the sample containers, sample labels describing project, location, analysis, team members, preservative, sampling date, and collection time were placed on each container and the container was placed in a plastic zipper bag. The bagged sample vials were placed into bubble wrap bags. Finally, the filled sample containers were placed into pre-iced shipping coolers to begin sample cooling to the required 4° Celsius sample preservation temperature prior to shipment to the analytical laboratory. One set of trip blanks were required and included per sample shipping cooler.

At the conclusion of groundwater sampling at each well, the flush mount well covers were bolted closed and stick up well caps padlocked.

2.4.2 MONITORING WELL SAMPLING USING PASSIVE DIFFUSION BAGS

Passive diffusion bags (PDBs) were been selected by the Moses lake Project Delivery Team as the most appropriate, cost-effective method for groundwater sample collection from Moses Lake monitoring wells lacking dedicated bladder pumps. The PDBs were purchased from ALS Environmental laboratory under license by the US Geological Survey and The General Electric Company, both co patent-holders. The 1 ¼" diameter low-density polyethylene PDBs were pre-filled with 220 ml or 330 ml of ASTM Type II certified, laboratory-grade, deionized water. Each filled PDB was then heat sealed by the laboratory prior to shipment to USACE via overnight delivery in hermetically sealed pouches.

USACE ensures a minimum of 14 days of PDB equilibration time before returning to the Moses Lake site for groundwater sample collection per established PDB guidance. During this event, both sampling teams worked to collect the PDB samples as described in Section 2.5.3. PDB retrieval and sampling consisted of the following procedures:

1. The team verified each monitoring well location and identification number with project maps and the sample matrix. They verified work can proceed safely in the vicinity of moving vehicular traffic as required. The PDBs were prepared over clean sheets of aluminum foil prior to being placed into each well. The team used a pry bar, socket wrench or pinhead hex wrench as needed to open each flush mount monitoring well cover plate, and a Masterlock #485 padlock key for the standard “stick-up” monitoring well completions. The team donned new Nitrile gloves for groundwater sample collection.
2. The team carefully hauled each weighted PDB to the surface using the nylon suspension line. The sampling team carefully cut the top corner off each PDB and filled each sample vial. The team filled each vial just to overflowing and maintained a reverse meniscus. There was no down time once the PDB has been brought to the surface until sample collection was complete at each well. Any residual sample water in the used PDBs was discharged to ground surface.
3. Each PDB represented a unique sample ID number based on the well ID (and sample interval if two PDBs are deployed into one well). With the exception of the MS/MSD, all QC samples were submitted “blind” to the laboratory using a separate unique sample ID number not labeled as duplicate or trip blank per USACE standard sampling procedure. One set of trip blanks were required and included per sample shipping cooler. An extra laboratory-prepared PDB was shipped to the site and was used for collection of the trip and field blanks at the direction of the USACE project chemist.
4. Once recovered and sampled, the empty PDBs and suspension lines were discarded as non-hazardous municipal waste. In addition, gloves, paper towels, bags, and other solid waste materials were disposed of as municipal waste. The PDBs and other solid waste material were placed into a large plastic garbage bag and tied securely prior to disposal. The stainless steel weights were decontaminated and returned to the Seattle District, USACE office.
5. Finally, the team securely capped and locked each monitoring well riser and cover plate when finished.

2.5 SAMPLING EVENT ACTIVITIES AND OBSERVATIONS

2.5.1 TEAM 1 MONITORING WELL BLADDER PUMP SAMPLING

Groundwater sample collection commenced immediately after achieving stabilization of water quality parameters during low flow purging at each well using dedicated bladder pump systems as described previously. The team worked from the far north end of the Site, moving to the far south end sampling each designated well as it was encountered. The project well maps and sample matrix were used to ensure samples were collected at the correct locations. The team used three 15 lb. compressed CO₂ cylinders acquired from Oxarc in Moses Lake to drive the pump systems, airlines, pump controllers, and flow cells to conduct the sampling of dedicated bladder pumps.

During the May 2016 sampling event, Team 1 collected groundwater samples from a pre-determined set of 40 monitoring wells fitted with dedicated bladder pumps.

Even though a right of entry permit has been signed, and verbal or written permission granted to collect samples at each designated monitoring well, the sampling team always attempted to contact the property owner for each monitoring well location before beginning the field sampling activities.

Per agreement with Grant County Airport security, Joseph Marsh used his ramp security badge to access all monitoring wells within the restricted area without an escort.

Team 1 worked to measure static water levels in all designated project monitoring wells before completing the sampling event.

Other than property owner notifications, no special access procedures were required for any of the other bladder pump monitoring wells sampled during this event.

Prior to sample collection, the samplers donned protective eyewear and new, clean, Nitrile gloves to prevent exposure to contaminants and cross-contamination. All sample containers were filled immediately following low-flow purging by disconnecting the flow-through cell from the pump tubing system, and capturing pumped groundwater directly from the discharge end of the pump tubing. During sample collection, physical observations were recorded in the Micro-purge/Low-Flow Sampling Log data forms.

Stabilization of water quality parameters during purging occurred within six minutes during this event. Measured temperatures ranged from 13.88°C at well 91BW04 to 17.18°C at well 02BW02. Specific conductivity ranged from 0.20mS/cm (well 00BW03) to 0.62 mS/cm (well 00BW02). Dissolved oxygen measurements ranged from a low 0.85 ppm (well 91AW15) to 9.63 ppm (well 92BW01). PH values ranged from 6.99 units (well 92BW01) to 7.85 units (well 99BW15). Oxygen reduction potential ranged from 161 mV (well 00BW05) to 600 mV (well 99BW14).

Significant Observations Made During Team 1 Bladder Pump Sampling

Team 1 met with the manager of Airport Mini-Storage (8524 Broad Street, NE, Moses Lake) while conducting sampling activities. She asked for more project information, and the team handed her a project information sheet.

00BW14 – debris filling bottom of deep vault – had to clean out to open well cover.

00BW07 – is now located behind a new Genie fence and gate. Gate is usually open, but may have to contact Genie security for access in the future.

00BW04 – total depth of well converted to flush mount by contractors = 81.45' bgs.

Met with local resident Doug Bierman who was curious about the project, and asked if we could sample his private well. We handed him a project information sheet and told him we would follow up with EPA and get back to him.

No other significant observations were made during this event.

2.5.2 TEAM 2 AND 3 PRIVATE WELL AND WHF SYSTEM SAMPLING

During the period of 16-18 May 2016, Team 2 collected groundwater samples from 4 WHF systems, and 28 private well systems. During that same time period, Team 3 collected groundwater samples from 6 whole house filter well systems, and 31 private well systems.

All required 40 ml VOA sample vials were obtained from Vendor ESS by the USACE contract lab ARI, and delivered to USACE pre-preserved with maleic and ascorbic acid.

Trip blanks were sent inside each sample shipping cooler delivered to the analytical lab.

Upon arrival at each private well property designated for sample collection, the team verified they were at the correct address using maps, notes, and the sampling matrix, and verified through field documentation they were ready to collect samples at the correct sampling point (hose bib, or suitable water discharge port nearest to the wellhead. The team always attempted to contact the owner or resident at each private well location before beginning the field sampling activities.

Per modified SOP, sampling point valves were opened, and water allowed to flow at approximately 0.5 to 1 gpm into a capture bucket. Next, water temperature readings were measured every two minutes until stabilization was achieved. During the May sampling event, water temperature stabilization ranged from 4 to 12 minutes elapsed purging time with most locations reaching stabilization within six minutes as shown in Table 1 below.

TABLE 1: PRIVATE WELL STABILIZED WATER TEMPERATURES AND PURGE TIMES

Well Location ID	Stable Temp. °C	Total Purge Time (Minutes)
WP-03	15.7	6
WP-04	Note A	Note A
WP-09	16.2	12
WP-10	17.5	6
WP-14	19.5	6
WP-27	16.7	6
WP-28	18.3	6
WP-33	15.8	6

WP-45	20.4	6
WP-50	16.1	6
WP-52	16.2	8
WP-54	15.9	6
WP-65	Note A1	Note A1
WP-57	15.5	6
WP-66	16.2	6
WP-68	17.2	6
WP-69	17.3	4
WP-70	15.1	6
WP-71A	16.1	6
WP-71B	17.3	6
WP-74	18.3	6
WP-82	15.1	8
WP-83	16.2	6
WP-86	16.2	6
WP-103	16.4	6
WP-105	17.7	6
WP-111	16.3	6
WP-116	17.8	6
WP-119	16.6	6
WP-120	15.7	6
WP-121	17.6	6
WP-122	17.0	8

WP-123	16.0	6
WP-124	17.2	6
WP-125	17.6	2
WP-126	17.4	6
WP-127	16.0	6
WP-128	15.6	6
WP-129	15.4	10
WP-130	18.4	6
WP-131	17.9	4
WP-136	17.4	4
WP-137	18.0	2
WP-139	18.5	10
WP-143	Note A2	Note A2
WP-144	17.5	6
WP-145	15.7	6
WP-147	16.4	6
WP-148	16.2	6
WP-149	16.0	6
WP-150	17.7	6
WP-152	Note A3	Note A3
WP-154	17.7	6
WP-155	17.5	6
WP-156	16.4	6
WP-164	15.5	6

WP-165	Note A4	Note A4
WP-167	15.9	6
WP-168	16.4	6
WP-170	15.1	6
WP-171	15.3	14
WP-172	17.5	6
WP-173	15.3	10
WP-177	15.3	2
WP-178	16.2	6
WP-179	23.5	10
WP-180	18.4	6

Notes:

Note A: Not Measured.

Note A1: Water collected through hose. Accurate water temperature reading not possible.

Note A2: No steady stream possible here. Purged 20 gallons, then collected sample.

Note A3: Physical site conditions prevented water temperature measurement.

Note A4: Additional piping at wellhead prevented accurate temperature readings.

Upon achieving stabilization, the final stabilized readings were entered into the project field book. Prior to collecting a water sample, the flow rate at each tap was reduced to approximately 100 to 200 ml/min. to minimize sample aeration and turbulence. The sampling team donned new Nitrile gloves prior to sample collection at each residence. In the case of the WHF sample ports, restrictors on the sample ports provided a stream of sample water at approximately 150 to 200 ml/min. All sample containers were be filled with water directly from each tap – forming a meniscus at the top of each vial to provide zero headspace samples as required. A photographic record of each sample point was made by the team.

Significant observations made during Private Well/WHF Sampling (Teams 2 and 3)

Non-Potable Water warning signs deployed at WP-04 and WP-125.

Owner at WP-11 refused sample collection. Unknown if owner will allow sampling next year until we contact (b) (6) to find out.

WP-121 had strange odors (b) (6) team collected a field blank in that area.

WP-154 and WP-156 – equipment blanks collected.

WP-65 and WP-68 – Teflon sample tubing used due to splitters and other unusual conditions at sample points.

(b) (6) WP-128. No samples collected until later when the owners returned to the house.

No other significant observations were made during this event.

2.5.3 PASSIVE DIFFUSION BAG SAMPLING AND DEPLOYMENT

Team 1 performed all of the required PDB sample collection activities at the 36 pre-designated PDB wells during the May 2016 event.

All required 40 ml amber glass VOA sample vials were obtained from Vendor ESS (certified new, clean, QC Class) by the USACE contract lab ARI, and delivered to USACE pre-preserved with maleic and ascorbic acid.

The teams first verified each monitoring well location and identification number with project maps and the sample matrix. The teams also verified that work could proceed safely in the vicinity of moving vehicular traffic or other physical, biological, or environmental hazards that may have been present near each monitoring well.

Each team member donned new Nitrile gloves for groundwater sample collection at each well. Once the wells were unlocked and opened, one team member lifted the well riser plug and began hauling the PDB vertically to the surface.

Once each PDB was raised to the surface, the sampling team worked together to carefully cut the top corner off each bag using decontaminated steel scissors. Next, one person held the open sample vials and the other carefully and slowly tilted the bags - open side down - toward each open sample vial. The pre-preserved vials were filled just to overflowing to maintain a reverse meniscus. Then the vials were immediately capped making sure there were no bubbles or headspace per standard VOC sampling procedure. This entire sampling process can be completed within one minute to minimize loss of volatiles while preventing introduction of contaminants into the water from surface sources. After all required vials were filled; any residual sample water remaining in the used PDBs was discharged to ground surface. Therefore, no Investigation-derived waste (IDW) water was generated during this sampling event.

The sampling teams continued use of protective mesh PDB sleeves in wells with steel risers due to a greater potential for damage to the PDB membranes (monitoring wells 12EX01, 12EX02, 14EX03, 14EX04, and 14EX05).

Once recovered and sample water removed, the PDBs and suspension lines were discarded as non-hazardous municipal waste. In addition, gloves, paper towels, bags, and other solid waste materials were disposed of as municipal waste. The PDBs and other solid waste material were

placed into a large plastic garbage bag and tied securely prior to disposal. The stainless steel weights were decontaminated and reused during the deployment of the new pre-filled PDBs for the next sampling event.

Significant Observations Made During Passive Diffusion Bag Sampling

Flush mount well vaults 12CW05, 12BW08, and 12EX02 were all flooded and had to be bailed out with a hand pump to access the well risers for sample collection.

Numerous rust particles were observed on the PDBs and PDB suspension lines installed in wells 14EX03 and 14EX04.

No other significant observations were made during this event.

3.0 INVESTIGATION-DERIVED WASTE

No investigation-derived waste was generated during this sampling event. All residual PDB water or purged well water was transferred directly to ground surface on each property away from the sample collection point.

4.0 SAMPLE PACKAGING AND DELIVERY

As mentioned in the narrative of each sampling event, groundwater samples were packaged in shipping coolers on ice and under chain of custody for overnight shipment to the USACE contract laboratory Analytical Resources, Inc. during the course of the sampling event.

All sample shipping coolers were prepared for laboratory delivery in the following manner: Each cooler was lined (sides and bottom) with plastic "bubble-wrap" sheets for shock absorption. A large 30-gallon plastic garbage bag was then placed into the cooler to contain the sample water in the event of container breakage during shipment to the laboratories. The glass sample vials were labeled, placed into plastic zip-seal bags, and placed into foam shipping blocks or bubble-wrap bags for shock protection. All the samples were placed in the shipping coolers as indicated on the corresponding chain of custody forms. Gallon size plastic zipper bags of cubed ice bags were placed between and on top of the samples in each cooler to ensure maintenance of the required four degrees Celsius (plus/minus two degrees) sample preservation temperature. The completed chain of custody (COC) forms were placed in gallon size plastic zipper bags and taped to the inside of each cooler lid. Two custody seals were affixed to the outside of each cooler. The custody seals were placed so that the coolers could not be opened without breaking the seals. Each cooler was then securely sealed with fiber tape. The field team ensured drain plugs were securely taped inside and out to prevent possible water leakage.

The laboratory was informed of the sample delivery and ensured the samples were properly accepted and checked in upon receipt the following morning after the sample containers were

shipped. All sample coolers and sample containers were accounted for at the contract laboratory following each shipment.

5.0 LABORATORY ANALYSIS

Chemical analyses performed on the samples were as follows: VOCs (Method 524.3).

Additional Analyses: For this event, the teams collected 1,4 Dioxane and Perfluorinated Compounds samples for analysis at pre-determined wells in addition to the standard VOC samples.

The teams collected samples for **1,4 Dioxane** analysis at two WHF locations (WP-121, WP-125), 6 private wells (WP-25, WP-69, WP-74, WP-144, WP-168, and WP-175), 7 bladder pump wells (00BW10, 00BW12, 00BW15, 99BW01, 99BW12, 99BW15, and 99BW16), and 5 PDB wells (04BW05, 12BW07, 14BW01, 12BW02, and 02BW01).

The teams collected samples for **Perfluorinated Compounds** analysis at 4 WHF locations (WP-119, WP-121, WP-124, and WP-125), 3 bladder pump wells (99AW10, 99BW16, and 91AW14), and two PDB wells (04BW04, and 04CW01).

6.0 DECONTAMINATION PROCEDURES

PDB weights, flow cells and associated tubing, water level indicator meters, and water volume measurement containers used by each team were decontaminated at the end of the project with an Alconox®-water solution followed by triple rinsing using distilled water in the USACE Geology Laboratory.

7.0 PROTECTION LEVEL

All sampling activities were conducted under Worker Protection Level D. For this project, personnel protective equipment included reflective safety vests, safety splash protection glasses, Nitrile gloves, and safety steel toe boots. New pairs of Nitrile gloves were donned prior to handling acid-preserved sample containers and between each unique private well sample point or monitoring well.

End of Field Sampling Report

APPENDIX A

Site and Well Location Maps

(Available in USACE Project Files)

APPENDIX B

Field Sampling Photos

(Available in USACE Project Files)

APPENDIX C

Field Notes

(Micropurge Logs Available in USACE Project Files)

MOSES LAKE WELLFIELD

Groundwater sampling table

TEAM 1: Joseph Marsh, Matthew Brookshire

MAY 2016 event - Monitoring wells

WELL	SAMPLE ID	SAMPLE DATE	TIME	VOCs	DRD	GRD	BTEX
00BW09	1605N00BW09	5-16	0910	3	-	-	-
00BW14	1605N00BW14	5-16	1002	3	-	-	-
00BW01	1605N00BW01	5-16	1040	3	-	-	-
01BW01	1605N01BW01	5-16	1235	3	-	-	-
04BW01	1605N04BW01	5-16	1207	3	-	-	-
00BW05	1605N00BW05	5-16	1315	9	-	-	-
00BW05 ^F	1605D00BW05	5-16	1330	3	-	-	-
00BW04	1605N00BW04	5-16	1350	3	-	-	-
00BW03	1605N00BW03	5-17	0855	3	-	-	-
00BW02	1605N00BW02	5-17	0926	3	-	-	-
00BW11	1605N00BW11	5-17	1015	3	84	39	-
91AW15	1605N91AW15	5-17	1047	3	-	-	-
91BW02	1605N91BW02	5-17	1205	3	-	-	-
Trip Blanks	1605TB00BW11	-	-	3	-	3	-
Trip Blanks	1605TB01	5-17	1030	2	-	3	-

* Samples shown on this page represent samples on COC1 shipped in Cooler 1.

Airbill: 805511118694

Shipped: 1400 hrs.

MOSES LAKE Wellfield

MAY 2016 EVENT TEAM 1

SAMPLE TABLE CONT.

Field Notes Begin on pg. 77

WELL	SAMPLE ID	SAMPLE DATE	TIME	VOCs	1,4 DICHALE	PERFLUORINATED compounds	DRD	GRD/BTEX
00BW06	1605N00BW06	5-17	1302	3	-	-	-	-
00BW07	1605N00BW07	5-17	1433	3	-	-	-	-
91AW14	1605N91AW14	5-18	0900	3	-	2	-	-
99BW16	1605N99BW16	5-18	0927	3	1	2	-	-
04BW04 ^P	1605N04BW04	5-18	1150	3	-	2	-	-
04CW01 ^P	1605N04CW01	5-18	1012	9	-	6	-	-
04CW01 ^F	1605D04CW01	5-18	1030	3	-	2	-	-
00BW12	1605N00BW12	5-18	1420	3	1	-	-	-
99BW15	1605N99BW15	5-18	1328	3	1	-	-	-
Field Blank	1605FB0191AW14	5-18	0900	-	-	1	-	-
Field Blank	1605FB0299BW16	5-18	0927	-	-	1	-	-
Field Blank	1605FB0304BW04	5-18	1150	-	-	1	-	-
Field Blank	1605FB0404CW01	5-18	1012	-	-	1	-	-
Trip Blank	1605TB02	5-18	0900	2	-	-	-	3
00BW11	1605D00BW11	5-17	1030	-	-	-	2	3

* Field Blanks associated with PFC wells

* Samples shown on this page represent

COC2 - shipped in COOLER 2

Added 00BW11 DRD - GRD/BTEX
Field Duplicates

Airbill: 802585435388

Shipped: 1530 hrs.

MOSES LAKE WELLFIELD
MAY 2016 EVENT TEAM1
SAMPLING TABLE continued...

WELL	SAMPLE ID	SAMPLE DATE	TIME	VOCs	1,4-DIOXANE
04BW05	1605N04BW05	5-19	0841	3	1
99BW01	1605N99BW01	5-19	1102	3	1
00BW15	1605N00BW15	5-19	1025	3	1
99BW12	1605N99BW12	5-19	1338	3	1
99BW12	1605D99BW12	5-19	1345	3	-
12BW07	1605N12BW07	5-19	1245	3	1
14BW01	1605N14BW01	5-19	1212	3	1
Trip Blank	1605TB03	5-19	1235	2	-

* Samples on this page represent
Samples on CDC 3 shipped
in Cooler 3.

AIRBILL: 8075 8543 3377
Shipped: 1445 Mrs.

MOSES LAKE WELLFIELD
MAY 2016 EVENT - TEAM1
SAMPLING TABLE continued...

WELL	SAMPLE ID	SAMPLE DATE	TIME	VOCs	1,4-DIOXANE
04CW02	1605N04CW02	5-19	1446	3	-
91AW17	1605N91AW17	5-19	0942	3	-
12BW02	1605N12BW02	5-20	0835	3	-
02BW01	1605N02BW01	5-20	0926	3	-
02BW01	1605D02BW01	5-20	0940	3	-
00BW10	1605N00BW10	5-20	1017	3	-
Trip Blank	1605TB04	5-20	0900	2	-

* Samples on this page represent
Samples on CDC 4 shipped in
Cooler 4.

Airbill: 8075 8543 3355
Shipped:

MOSES LAKE WELLFIELD
MAY 2016 EVENT - TEAM 1
SAMPLE TABLE Continued...

WELL	SAMPLE WELL ID	SAMPLE DATE	TIME	VOCs
04BW06	1605N04BW06	5-20	1235	3
91AW09	1605N91AW09	5-20	1300	3
91BW03	1605N91BW03	5-20	1332	3
99AW08	1605N99AW08	5-20	1510	3
02BW02	1605N02BW02	5-20	1445	3
99BW14	1605N99BW14	5-21	0844	3
04CW03	1605N04CW03	5-21	0906	3
99AW01	1605N99AW01	5-21	0932	3
91AW07	1605N91AW07	5-21	1006	3
00AW11	1605N00AW11	5-21	1308	3
92BW01	1605N92BW01	5-21	1235	3
92BW01 ^f	1605D92BW01	5-21	1244	3
92BW02	1605N92BW02	5-21	1340	3
99BW09	1605N99BW09	5-21	1437	3
TRIP Blank	1605T605	5-21	1100	2

* Samples on this page represent
Samples on COC 5 shipped
in Cooler 5.

AIRBILL: 807585433366
shipped: 5-23-16

MOSES LAKE WELLFIELD
MAY 2016 EVENT - TEAM 1
Sample Table Cont.

WELL	SAMPLE ID	SAMPLE DATE	TIME	VOCs
91BW04	1605N91BW04	5-22	0844	3
12BW01	1605N12BW01	5-22	0900	3
00BW13	1605N00BW13	5-22	0927	3
12CW04	1605N12CW04	5-22	1158	3
12BW05	1605N12BW05	5-22	1206	3
04CW05	1605N04CW05	5-22	1215	3
04CW05 ^f	1605D04CW05	5-22	1228	3
12EX01	1605N12EX01	5-22	1234	3
04BW09	1605N04BW09	5-22	1250	3
14BW03	1605N14BW03	5-22	1302	3
14EX05	1605N14EX05	5-22	1314	3
12CW03	1605N12CW03	5-22	1352	3
12BW04A	1605N12BW04A	5-22	1401	3
12BW04B	1605N12BW04B	5-22	1405	3
TRIP Blank	1605T606	5-22	1030	2

* Samples on this page represent
Samples on COC 6 shipped
in Cooler 6

AIRBILL: 807585433366
shipped: 5-23-16

Moses Lake Wellfield
May 2016 event, Team 1

Moses Lake Wellfield
May 2016 event
Team 1
Sample table, Cont.

WELL	SAMPLE ID	DATE	TIME	VOC
04BW07	1605N04BW07	5-22	1416	3
04CW04	1605N04CW04	5-22	1422	3
14EX03	1605N14EX03	5-22	1455	3
14EX03	1605N14EX03	5-22	1512	3
14BW02	1605N14BW02	5-22	1522	3
14EX04	1605N14EX04	5-22	1530	3
12CW02	1605N12CW02	5-22	1542	3
12BW03A	1605N12BW03A	5-22	1550	3
12BW03B	1605N12BW03B	5-22	1555	3
00BW16	1605N00BW16	5-23	0855	3
00BW16	1605N00BW16	5-23	0910	3
99AW09	1605N99AW09	5-23	0955	3
Trip Blank	1605TB07	5-23	0800	2

* samples on this page represent
samples on C007, shipped in
Corder 7.

Airbill: 8075 854333466
shipped 5-23-16

(X) 2 MS
2 msd
due to lack
of volume

WELL	SAMPLE ID	DATE	TIME	VOC
99BW18	1605N99BW18	5-23	0932	3
12BW06	1605N12BW06	5-23	1112	3
12CW05	1605N12CW05	5-23	1132	3
12BW08	1605N12BW08	5-23	1310	3
12EX02	1605N12EX02	5-23	1257	3
12CW01	1605N12CW01	5-23	1326	3
99BW10	1605N99BW10	5-23	1550	3
04CW07A	1605N04CW07A	5-23	1410	3
04CW07B	1605N04CW07B	5-23	1412	3
99BW11	1605N99BW11	5-23	1549	3
04CW08	1605N04CW08	5-23	1505	3
Trip Blank	1605TB08	5-23	1015	2

* samples on this page represent
samples on C008 and shipped
in Corder 8.

Airbill: 8075 85433344
shipped: 5-23-16

Page left blank

In name

MOSET LAKE WELLFIELD

MAY 2016 EVENT TEAM 1

Field Activity Notes

- 0730- Calibrated flow cell, prepped supplies -
Bought ice for cooling samples + picked up CO₂
- 0835 Checked in with Genie Staff
- 0849 Setup @ 00BW09 - pre purging
SWL = 69.91' micropurge to
stabilization - water clear,
NSTR -
- 0910 sample time, close + lock well
Mob to CDS1 - 00BW14 in vault
some sediment + debris in vault
pre purging, then micropurge to
stability. NSTR - site hazardous
due to surface wastes + traffic (garbage
trucks + forklifts). Close up
well - Bolt cover plate + replace
manhole covers. Mob out of CDS1
+ to next well in field - 00BW01
SWL 45.29' pre purging then
micropurge to stability
- 1040 = Sample time, NSTR, close + lock
well. Mob. to Lunch - 1115 - 1145
- 1158 Setup @ 04BW01 - PDB well
SWL = 63.87
Sample time - VOCs from PDB New PDB
not replaced
until Aug. 5th

Moses Lake Wellfield
Field Notes continued

5-16-16

04BW01 continued - New PDBs

To be deployed in August

1207 - sample time

close + lock well, mob to

1214 - 01BW01 setup, pre-purging
and micropurge to stability. NSTR1235 = Sample time, close, secure well
(flush mount) mob to 00BW05

00BW05 SWL = 63.91'

stick up well pre-purging, micropurge
to stabilization, NSTR

1315 = Sample time, close + lock well

1330 = Field dup time ~~for~~ then ↑

mob. 00BW04 SWL = 62.65'

↳ No pump. using Discrete
Interval Bailer Sampling device.1350 = Sample time, close - secure
flush mount well cover

All samples collected today have been
labeled, bagged, and packed on ice
in sample cooler - to be held overnight
under chain of custody in hotel room.

- Team inspects well site at 00BW07
and discovers gate and fence now surround
the monitoring well as part of Genie
property - must coordinate with Genie
for access to well.

Moses Lake Wellfield Field Notes

5-16-16

5-17-16

1630 - end of day 1.

Jim Allen

5-17-16

0730 - Buying ice - calibrated flow cell
equipment ready for sampling

0822 - Setup @ 00BW03 SWL 82.28'

pre-purge from micropurge to
stability - NSTR - clear water0855 = Sample time, close + lock well
mob. to 00BW02 open well

(Sticky cover) SWL = 85.32'

pre-purge - micropurge to stability

0926 - Sample time, close + lock well
NSTR

Setting up at 00BW11 and 91AW15
simultaneously. SWL - 00BW11 = 91.32
91AW15 SWL = 91.64'

1015 = 00BW11 (P) Sample Time
close - secure well. 1038 (FD) Sample Time

purging - micropurge @ 91AW15
clear NSTR

1047 - sample time, close, lock well →

Moses Lake Well field

5-17-16

Team 1 Notes

1155- 91BW02 - setup - no pump
 should be diffusion bag
 - will use discrete interval
 sampler to recover VOC sample

SWL = ~~99~~ 91.55'

1205 = sample time close up well.

SWL @ 00BW08 = 90.17'

mib. to 00BW06

SWL = 148.0' pre purging

Then micropurge to stability

1302 - sample time, close + lock well.
 well, Depart Airport for
 FedEx to ship cooler 1/2

1400 - Shipped 1 cooler (ARI) via Grant
 County Airport

- Talked to Facility Manager
 at Genie - Nick Womack

setup ok @ 00BW07

pre purged + micropurge to stability

1433 - sample time, close + lock well

* Note: Location now on Genie property

mib. back to 00BW04 to sound

well + determine PDB placement
 depth in August 81.59' Top of PVC
 To Bottom

Moses Lake Well field

Team 1 May 2016

81.59
 - 0.14 instrument point

81.45 00BW04 TOTAL Depth

* set PDB @ approx. 75' Below Top of
 riser in future.

↓ In 12 U

5-18-16

5730 - calibrated flow cell, prepped
 equipment for sampling - bought ice

0830 - setup @ 91AW14, SWL = 122.27'

Pre purging + micropurge to stability.

Sampling VOCs + PFC here. NSTR

0900 sample time, close + lock well, mib to 99BW16
 opening well Both in pair have bladder pumps

99BW16 SWL = 122.96'

pre purging, then micropurge to stability

0927 = Sample time, VOC, 1A-Dioxane, PFC
 close + lock well.

04BW04 PDB well, SWL = 137.01'

04CW01 04CW04 PDB well SWL = 163.24'

04BW04 + 04CW01 sampled by PDB + discrete
 interval samplers, close - lock well

04CW01 04CW04 sample times (P) 1012

(FD) 1030

Mosey Lake Wellfield
May 2016 Field Notes

(b) (6)

Rd. E. 7

5-18-16
Approached by citizens,
discussed project
+ requested sampling
at (b) (6) home.
x provided project
information sheet
to (b) (6)

1150 = 04BW05 sample time PDB
close/lock well

1303- setup at 99BW15
pre purging bladder pump well-
flush mount, micropurge to
stability NSTR

1328 = Sample time, close up, secure well
Mob. to Airport 00BW12
Pre purging, then micropurge to
stabilization, NSTR

1420 = Sample time, close/lock well
Depart restricted Airfield property
for FedEx station at airport

1530- one cooler shipped to ARE

1600 Recon, for tomorrow's wells.

1630- end of day

Jim N. W.

Mosey Lake Wellfield
May 2016 Field Notes Team 1

5-19-16

0730- calibrate flow cell- buy ice,
prep supplies.

0823 - 04BW05 SWL 129.17'
pulled one PDB+ used one new
discrete interval sampler to collect
samples. NSTR

0841 - Sample time, close+lock well,
will Mob. to 91AW17 next
due to city request that we
not work there later than today.

0921 91AW17 schedule change
SWL = 117.01', pre purging then
micropurge to stability

0942 - Sample time, close+lock well
Mob. to 00BW15 SWL = 77.62'
Pre purging- dedicated bladder pump
micropurge to stability

1025 Sample time, close+lock well
Mob. to 99BW01 SWL = 88.22'
Pre purge then micropurge to stability

1102 = Sample time, close/lock well
Lunch

Setup at 14BW01 PDB well SWL = 94.47'
1212 = Sample time, close+lock well

5-19-16

Moses Lake Wellfield
Team 1 MAY 20161236 = Setup @ 12BW07 SWL = 88.23'
PDB well

1245 = sample time, close + lock well.

1317- 99BW12 setup - pre-purge
Micro-purge to stability, NSTR.1338 - sample time, close + lock
well. (Beaumont slightly swelling
in vault as per normal functioning)
* FD Time 1345.

- Ship 1 cooler via Fedex to ARI.

04CW02 setup for PDB sampling
VOC only SWL = 162.40'1446 = Sample time
close + lock well, NSTRsite inspection, purchasing supplies
1600 end of Day

Jm 12/16

5-20-16

0730- calibrate flow cell, buy ice, prep supplies

0820- Setup 12BW02 pdb well SWL = 118.69'
0835- sample time, close, secure well.

Team 1

Moses Lake Wellfield
5-20-16 conts0900- Mob. to 02BW01
SWL = 133.85'collecting samples using PDB
+ Dedicated Sampling Device,0926 = sample time (P) 0940 (FD)
retrieving lost sampling device in well
close + lock well.Setup at 06BW10 at church parking lot
SWL = 143.40' Bladder pump well.
Pre-purging, then micro-purge to
stability. Higher than normal gas
pressure used ~~to~~ due to well depth.1017 = sample time -
close - secure well.1130 Ship one cooler (11A)
to ARI via Front Country
Intl Airport Fedex.1145-
1215 Lunch1220- Setup at 04BW06 PDB well
SWL = 104.57' NSTR

1235 = sample time close + lock well

→

Moses Lake Wellfield

5-20-16

1240- Setup @ 91AW09 SWL=86.74'
 pre-purging, then micropurge to
 stabilization, well pad undisturbed
 by rodents.

1300 = Sample time, close + lock well.
 Mob. to 91BW03.

pre-purging - deep pump - near
 operating limits. SWL=88.05'
 micropurge to stability

1332 = Sample time, close + lock well

1427 at 02BW02 SWL
~~02BW02~~ 67.04'
 (Picked up 2 ea CO₂ bottles
 1 CO₁₅, 1 CO₅.)

pre-purging
 micropurge to stability

1445 = Sample time, close + secure well
 mob. over to adjacent well

99AW08 - opened up - vault full
 of cobwebs. SWL=67.59'

pre-purging, then micropurge
 to stability - NSTR

1510 = Sample time close + lock well

1600 - end of field day

Jim R. W.

Moses Lake Wellfield

Team 1 May 2016

5-21-16

0730- calibrate flow cell - buy rice
 Prep supplies

Setup at 99BW14 → High ORP.
 then micropurge to stabilization

0844 = Sample time, close + lock well
 setup @ 04CW03 PDB well -

0906 = pulled + sample time, closed
 + locked SWL=149.52'
 mob. to 99AW01 pre-purging
 micropurge to stability.

0932 = Sample time, close + lock well.
 Mob. to 91AW07 SWL=86.72'
 PDB well.

1006 = Sample time, well closed + locked
 No significant problems this morning

1100-
 1130 Lunch

1204 Setup @ 92BW01 SWL=83.31'
 pre-purge, then micropurge to stability

1235 = Sample time (P) 1244 (FD)
 Close/lock well.

mob. to 00AW11 SWL=83.18'
 pre-purging then micropurge to stability

1308 = Sample time, close + lock well.

Moses Lake Wellfield
Team 1

5-21-16

1322 mob to 92BW02 SWL = 80.72'
pre-purge, then micropurge to
stability

1340 = sample time, close + lock well
mob. to 99BW09

1418 = setup at 99BW09, SWL = 77.39'
prepurging, then micropurge to
stabilization

1437 = sample time, close + lock well,
packed samples, worked on equipment
1600-end of day. *on 12th*
5-16 5-22-16

0819 - setup at 91BW04 SWL = 83.36'
pre purge then micropurge to
stability - High OEP - over 600 mV

0844 = sample time, close - lock well
mob. to 12BW01 SWL = 83.42'

0900 = sample time, close - lock well
00BW13 → SWL = 83.49'
prepurge + micropurge to stability
= sample time, close - lock well

12CW04 SWL = 100.87'
1158 = sample time

12BW05 SWL = 88.93'
1206 = sample time

Moses Lake Wellfield
Team 1

5-22-16

PDB wells cont.

1210
1205 → 04CW05 SWL = 98.55'
1215 = (P) sample time 1228 = (FD) sample time
close + lock well. NOTE mob to

12EX01 SWL = 88.16'
1234 = sample time, close + lock well mob to

1247 04BW09 → SWL = 83.86'
flush mount - meter - insert in well

1250 = sample time, close/secure well.

Setup @ 14BW03 SWL = 86.17'

1302 = sample time

Setup at 14EX05 SWL = 96.09'

1314 = sample time, close/lock well

16CW03 SWL = 107.51

Sample Time = 1352 close/lock well

12BW04 SWL = 98.59'

1401 = 'A' sample time,

1405 = 'B' sample time close/lock well

mob. to 04BW07 SWL = 125.47'

1416 = PDB well sample time
close, lock well, mob to adjacent
PDB well 04CW04 SWL = 126.49'

1422 = sample time, close/lock well

Moses Lake Wellfield
Team 1

5-22-16

Mob. to 14EX03
PDB well -

SWL = 94.71'

Sample time (P) 1455 (FD) 1512
 close + lock well. Note: due to
 narrow PDBs sent by Lab -
 only 2 MS + 2 MSD Vials
 could be collected with
 P + FD samplers.

Mob. to 14BW02 SWL = 106.84'

1522 = PDB sample time, close + lock
well - at adjacent EXT. well

14EX04 SWL = 107.07'

1530 = PDB sample time, close-lock well

setup at

12CW02, SWL = 155.56'

1842 = PDB sample time, close/lock well

Mob. to south adjacent well 12BW03

SWL @ 12BW03 = 127.98'

1550 = "A" sample time

1555 = "B" sample time close/lock well

No significant problems today.

1600 end of day.

J. R. W.

Moses Lake Wellfield
Team 1

5-23-16

0730 - calibrated flow cell, buy ice,
prep supplies.

setup @ 00BW16

SWL = 136.07' Bladder pump

pre-purge then Micro-purge to stability

0855 Sample time: (P) 0910 = (FD)

close - secure well - Mob to -

0910 - 99BW18 SWL = 104.76'

pre-purge - then Micro-purge to
stability, NSTR

0932 = Sample time, close-lock well

Mob. to 99AW09 SWL = 97.49'

pre-purging, then Micro-purge to stability

0955 = Sample time, close/lock well

Note: Scot from Airport fire training
 in grass on across project - getting
 on clothes + equipment, unknown impact.

Mob. to Fedex to ship carters

5, 6, and 7.

setup at

1102 - 12BW06, vault flooded - pumped out
into bucket to transfer into ditch

(Surface water) SWL = 117.47'

1112 PDB sample time, well secured

Mob. to 12CW05 →

Moses Lake Wellfield
Team 1

5-23-16 continued
well 12CW05 setup - vault flooded
SWL = 143.06' G water disposed away
1132 = Sample Time (PDB) from well,
close - secure well no problems
today,

1150
1220 - Lunch time

Mob. to 12BW08 SWL = 119.77'
(water removed from vault)
1310 = Sample time PDB well - close-secure well

Mob. to -
12EX02 SWL = 119.88' water removed
from vault
1257 = Sample time @ PDB well
close/secure vault cover plate
Mob. to 12CW01 No water
in vault -
SWL = 137.93'

1326 = Sample time @ PDB ~~well~~ well
close-secure well 15/16" bolts

Back to Mini-Storage - gave manager Project sheet,

1402 Mob. to 04CW07 - dual interval
PDB well. SWL = 149.04' > NSTR

1410 "A" sample time 1412 "B" sample time
close+lock well - Mob. south to -

Setup @ 99BW10 SWL = 133.06'
pre purging + micropurge to
stability > NSTR

1550 = Sample time, close-lock well

Moses Lake Wellfield
TEAM 1
NOTES

5-23-16
Mob to well 04CW08 SWL =
1505 = PDB sample time (147.56' = SWL)
close-secure well,

Mob to 99BW11 SWL = 55.46'
prepurging + micropurge to stability
1600 = Sample time, close+lock well
No significant problems today

Sampling complete,

1620 final Sample Cooler shipped to AREI

1630 - end of day,

Return to District Office
on 5-24-16

[Signature]

88

Location Moses Lake Date _____

Project / Client 2016 May Sampling

[illegible]

39

Location Moses Lake Date 8/2/2018

Project / Client 2016 May Sampling

[illegible]

90

Location Moses Lake Date 5/16
 Project / Client May 2016
private wells

WP-03 left door hanger

Time	15.3	15.6	15.7	15.7
Temp	0	2	4	6

purged 5 gal

Sample N: 0845

D: 0830

WP-68 left door hanger

Time	0	2	4	6
Temp	17.2	17.2	17.2	17.2

purged 5 gal

large splitter connected so sample was taken using tube

Sample time 0930

WP-116 left door hanger

Time	0	2	4	6
Temp	17.7	17.7	17.7	17.8

Sample time 0945

purged 5 gal

WP-66 left door hanger

Time	0	2	4	6
Temp	16.1	16.2	16.3	16.2

purged 5 gal,

Sample
1010

91

Location Moses Lake Date 5/16
 Project / Client May 2016 private wells

WP-126 left door hanger

Time	0	2	4	6
Temp	17.3	17.5	17.5	17.4

purged 5 gal

air bubbles in tube

Sample time: 1030

WP-165

Take 15ft pipe and connect to ~~outside~~ pipe. then turn knob against wall until water is on. Sample 1049

WP-130 left door hanger

Time	0	2	4	6
Temp	18.5	18.4	18.3	18.4

purged 5 gal

sample time 1130

WP-172 time

0	2	4	6	
Temp	17.8	17.8	17.7	17.5

purged 5 gal sample time 1200