FINAL REPORT
FY16 PHASE I REGIONAL SITE INSPECTIONS
FOR PERFLUORINATED COMPOUNDS

167th AIRLIFT WING
WEST VIRGINIA AIR NATIONAL GUARD
MARTINSBURG AIR NATIONAL GUARD BASE
MARTINSBURG, WEST VIRGINIA

Contract #: W9133L-14-D-0002
Delivery Order 0006

Amec Foster Wheeler Project #: 2-9133-0006

October 22, 2018
FY16 Phase I Regional Site Inspections
For Perfluorinated Compounds
West Virginia Air National Guard – 167th Airlift Wing
Martinsburg Air National Guard Base
Martinsburg, West Virginia

Prepared for:
National Guard Bureau
Operations Division, Restoration Branch
Joint Base Andrews, MD 20762-5157

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October 22, 2018

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EXECUTIVE SUMMARY

Amec Foster Wheeler Environment & Infrastructure, Inc. (Amec Foster Wheeler) was contracted by the National Guard Bureau (NGB) Operations Restoration Branch (A4OR) under Contract #W9133L-14-D-0002, Delivery Order 0006 to conduct Phase I Regional Site Inspections (SIs) for Perfluorinated Compounds (PFCs) at multiple Air National Guard (ANG) Installations. This report has been prepared for SIs conducted at on-Base Potential Release Locations (PRLs) identified on the 167th Airlift Wing (167th AW), West Virginia Air National Guard, Martinsburg Air National Guard Base (MANGB), in the city of Martinsburg, West Virginia. This report presents the results and recommendations from the 2017 SI field activities conducted in October and November 2017 at MANGB. The objectives of the SI were to determine the presence or absence of PFCs at each PRL and the Base boundary, and based on the findings:

1) Determine if a PRL is eligible for a decision of No Further Action (NFA);
2) Assess if PFCs are migrating off-Base; and
3) Provide data which can be used for developing Data Quality Objectives if further investigations are recommended.

To meet the objectives, Amec Foster Wheeler performed SIs at the following ten PRLs:

- PRL 1: Former Fire Training Area (FTA) (IRP Site 4);
- PRL 2: Hangar 119;
- PRL 3: Former Hangar 128;
- PRL 4: Former Hangar 110;
- PRL 5: Building 139 – Northeast Fire Department Equipment Testing Area
- PRL 6: Former Building 114 (Old Tower)
- PRL 7: Former Building 111 – Former Fire Department
- PRL 8: Building 303 – Current Fire Department
- PRL 9: Building 140 – Former Fire Department
- PRL 10: Former Wastewater Treatment Plant (WWTP)

As part of the SI, groundwater at the Base boundary was also evaluated at six locations downgradient from the PRLs.

Based on recommendations from the Preliminary Assessment (PA) conducted by BB&E, Inc.
(BB&E) in August 2015, soil, groundwater, surface water, and sediment samples were collected and analyzed from eight PRLs. Collected samples were analyzed for the PFCs listed on the United States Environmental Protection Agency’s (USEPA) Third Unregulated Contaminant Monitoring Rule (UCMR3) list (USEPA, 2012). The detected PFC concentrations were compared against screening criteria for perfluorooctanoic acid (PFOA), perfluorooctanesulfonic acid (PFOS), and perfluorobutane sulfonate (PFBS) including: the USEPA lifetime drinking water Health Advisory (HA) for PFOS (USEPA, May 2016a) and HA for PFOA (USEPA, May 2016b); the USEPA Regional Screening Level (RSL) table for PFBS in residential soil (USEPA, 2017); the USEPA RSL for PFBS in tap water; and calculated screening levels using the USEPA screening level calculator for PFOA and PFBS in soil and sediment. These screening criteria are presented in Table ES-1.

Table ES-1: USEPA and USAF SI Screening Criteria

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Chemical Abstract Number</th>
<th>USEPA Regional Screening Level Table (November 2017)a</th>
<th>Air Force Guidance for Soils and Sedimentsb (μg/kg)</th>
<th>USEPA Health Advisory Drinking Water (Surface Water or Groundwater) (μg/L)c</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Residential Soil (μg/kg)</td>
<td>Tap Water (μg/L)d</td>
<td></td>
</tr>
<tr>
<td>Perfluorobutane sulfonate (PFBS)</td>
<td>375-73-5</td>
<td>1,300,000d</td>
<td>400e</td>
<td>NL</td>
</tr>
<tr>
<td>Perfluorooctanoic acid (PFOA)</td>
<td>335-67-1</td>
<td>NL</td>
<td>NL</td>
<td>1,260</td>
</tr>
<tr>
<td>Perfluorooctane sulfonate (PFOS)</td>
<td>1763-23-1</td>
<td>NL</td>
<td>NL</td>
<td>1,260</td>
</tr>
</tbody>
</table>

Notes:

a USEPA Regional Screening Levels (USEPA, 2017a).
b Screening levels calculated using the USEPA Regional Screening Level calculator [https://epa-prgs.ornl.gov/cgi-bin/chemicals/csl_search]. The toxicity value input for the calculator is the Tier 3 value reference dose of 0.00002 milligrams per kilogram per day (mg/kg/day) derived by USEPA in their Drinking Water Health Advisories for both PFOS (USEPA, 2016a) and PFOA (USEPA, 2016b).
c USEPA, 2016b. Drinking Water Health Advisory for Perfluorooctanoic Acid (PFOA) and USEPA, 2016a. Drinking Water Health Advisory for Perfluorooctane Sulfonate (PFOS).
d PFBS RSL for Residential Soil (based on a target hazard quotient [THQ] of 1.0) concentration presented in the SI Work Plan (Amec Foster Wheeler, 2017) was 1,600,000 μg/kg based on the May 2016 RSL values. This table has been updated to include the more recent RSL values published in November 2017.
e PFBS RSL for Tap Water (based on a THQ of 1.0) presented in the SI Work Plan (Amec Foster Wheeler, 2017) was 380 μg/L based on the May 2016 RSL values. This table has been updated to include the more recent RSL values published in November 2017.

Only groundwater and surface water were sampled during the SI, but analytical results have been compared to the tap water screening levels.

* Note: When PFOA and PFOS are both present, the combined detected concentrations of the compounds are compared with the 0.07 μg/L health advisory value.

NL = not listed μg/kg = micrograms per kilogram μg/L = micrograms per liter
Based on comparison of analytical data to the screening criteria in the table above eight PRLs (PRL 1, PRL 2, PRL 3, PRL 4, PRL 5, PRL 7, PRL 9 and PRL 10), and a portion of the Base boundary had concentrations of PFCs exceeding guidance levels. However, PFCs were detected in groundwater and soil at each of PRLs investigated; therefore further investigations are recommended at all 10 PRLs. Amec Foster Wheeler also recommends that further investigations include analysis of additional compounds, including precursor compounds, to supplement the UCMR3 list. Precursor compounds have potential to result in increased concentrations downgradient and can serve as a lingering source. An overview of conclusions from SI activities and recommendations for future investigations are presented on Table ES-2.

Table ES-2: Screening Criteria Exceedances and Recommendations

<table>
<thead>
<tr>
<th>PRL</th>
<th>Soil</th>
<th>SW</th>
<th>SD</th>
<th>GW</th>
<th>Recommendations</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>X</td>
<td></td>
<td></td>
<td>X</td>
<td>Soil and GW investigation to evaluate the extent of the confirmed PFC release. Soils in the saturated zone should be investigated as a potential contributing source to GW.</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
<td>X</td>
<td></td>
<td>GW investigation to evaluate the extent of the confirmed PFC release. Soil investigation, including soils in the saturated zone, to determine if the soil may be a contributing source to GW.</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td>GW investigation to evaluate the extent of the confirmed PFC release. Soil investigation, including soils in the saturated zone, to determine if the soil may be a contributing source to GW.</td>
</tr>
<tr>
<td>4</td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td>GW investigation to evaluate the extent of the confirmed PFC release. Soil investigation, including soils in the saturated zone, to determine if the soil may be a contributing source to GW.</td>
</tr>
<tr>
<td>5</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td>Soil and GW investigation to evaluate the extent of the confirmed PFC release. Soils in the saturated zone should be investigated as a potential contributing source to GW.</td>
</tr>
<tr>
<td>6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>GW investigation to evaluate the extent of the confirmed PFC release. Soil investigation, including soils in the saturated zone, to determine if the soil may be a contributing source to GW.</td>
</tr>
<tr>
<td>7</td>
<td></td>
<td></td>
<td>X</td>
<td></td>
<td>GW investigation to evaluate the extent of the confirmed PFC release. Soil investigation, including soils in the saturated zone, to determine if the soil may be a contributing source to GW.</td>
</tr>
<tr>
<td>8</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>GW investigation to evaluate the extent of the confirmed PFC release. Soil investigation, including soils in the saturated zone, to determine if the soil may be a contributing source to GW.</td>
</tr>
<tr>
<td>PRL</td>
<td>Screening Criteria Exceedance</td>
<td>Recommendations</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>--------------</td>
<td>-------------------------------</td>
<td>--------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Soil</td>
<td>SW</td>
<td>SD</td>
<td>GW</td>
<td>GW investigation to evaluate the extent of the confirmed PFC release. Soil investigation, including soils in the saturated zone, to determine if the soil may be a contributing source to GW.</td>
</tr>
<tr>
<td>9</td>
<td></td>
<td></td>
<td>X</td>
<td></td>
<td>GW investigation to evaluate the extent of the confirmed PFC release. Soil investigation, including soils in the saturated zone, to determine if the soil may be a contributing source to GW.</td>
</tr>
<tr>
<td>10</td>
<td></td>
<td></td>
<td>X</td>
<td></td>
<td>GW investigation to evaluate the extent of the confirmed PFC release. Soil investigation, including soils in the saturated zone, to determine if the soil may be a contributing source to GW. Sediment investigation to evaluate the extent of the PFC release.</td>
</tr>
<tr>
<td>Base Boundary Wells</td>
<td></td>
<td></td>
<td>X</td>
<td></td>
<td>GW Investigation to evaluate the extent of the confirmed PFC release at BW-02. Surface water and sediment investigation to evaluate the stormwater retention basin as a potential source of PFCs to the environment. Evaluation of the presence of PFC contamination in groundwater off-Base both up and downgradient.</td>
</tr>
</tbody>
</table>

Notes:

GW = Groundwater  X – Screening criteria exceedance
SW = Surface Water  PFC - Perfluorinated Compound
1.0 INTRODUCTION

Amec Foster Wheeler Environment and Infrastructure, Inc. (Amec Foster Wheeler) was contracted by the National Guard Bureau Operations Restoration Branch (NGB/A4OR) under Contract #W9133L-14-D-0002, Delivery Order 0006 to conduct Phase I Regional Site Inspections (SIs) for Perfluorinated Compounds (PFCs) at multiple Air National Guard (ANG) Installations. The scope of the Contract included performance of a SI at on-Base Potential Release Locations (PRLs) identified at the 167th Airlift Wing (167th AW), West Virginia Air National Guard, Martinsburg Air National Guide Base (MANGB), in the city of Martinsburg, West Virginia. This SI Report describes the objectives, procedures, and activities which were completed, and presents Amec Foster Wheeler's findings and recommendations. The Base location is shown in Figure 1, and the Base and area features are shown on Figure 2.

1.1 Background

The Department of Defense (DoD) began investigations at military bases under the Installation Restoration Program (IRP) with the goal of identifying, evaluating, and remediating areas of contamination (the program is now referred to as the Environmental Restoration Program). Prior to the PFC Preliminary Assessment (PA) (BB&E, Inc. [BB&E], 2015), potential releases of PFCs from use and storage of aqueous film forming foam (AFFF) had not been evaluated at MANGB.

In 2015, BB&E conducted a PA to identify potential sites of historic environmental releases of PFC related to AFFF usage and storage. BB&E researched the potential existence of any documented Fire Training Area (FTA) in operation since 1970 or any other use or release of AFFF. BB&E interviewed available installation personnel as part of the PA.

Based on past use and storage of AFFF at MANGB, the PA identified 13 PRLs where releases of PFCs might have occurred, including FTAs, hangars, current and former fire departments, a former wastewater treatment plant (WWTP), storage buildings, etc. Ten of the 13 PRLs were recommended for further inspection, and three PRLs warranted No Further Action (NFA) (Table 1).
### Table 1
Preliminary Assessment Recommendations

<table>
<thead>
<tr>
<th>Location (AOC)</th>
<th>Use</th>
<th>Recommendation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Former FTA (IRP Site 4)</td>
<td>Former Fire Training Area (FTA)</td>
<td>Soil and groundwater inspection</td>
</tr>
<tr>
<td>2. Hangar 119</td>
<td>Hangar with AFFF Fire Suppression System (FSS)</td>
<td>Soil and groundwater inspection</td>
</tr>
<tr>
<td>3. Former Hangar 128</td>
<td>Former Hangar with AFFF FSS</td>
<td>Soil and groundwater inspection</td>
</tr>
<tr>
<td>4. Former Hangar 110</td>
<td>Former Hangar with AFFF FSS</td>
<td>Soil and groundwater inspection</td>
</tr>
<tr>
<td>5. Building 139 -Northeast Fire Department Equipment Testing Area&lt;sup&gt;1&lt;/sup&gt;</td>
<td>Fire Truck Equipment Testing</td>
<td>Soil, sediment, surface water, and groundwater inspection</td>
</tr>
<tr>
<td>6. Former Building 114 - Old Tower</td>
<td>Other Building Type with AFFF storage near building</td>
<td>Groundwater inspection</td>
</tr>
<tr>
<td>7. Former Building 111 – Former Fire Department</td>
<td>Fire Station</td>
<td>Soil and groundwater inspection</td>
</tr>
<tr>
<td>8. Building 303 - Current Fire Department</td>
<td>Fire Station</td>
<td>Soil and groundwater inspection</td>
</tr>
<tr>
<td>9. Building 145 - Hazmart Pharmacy</td>
<td>Building with AFFF FSS</td>
<td>NFA</td>
</tr>
<tr>
<td>10. Building 140 - Former Fire Department</td>
<td>Fire Station</td>
<td>Soil and groundwater inspection</td>
</tr>
<tr>
<td>11. Former Building 106 - Former Base Supply Building</td>
<td>Building with AFFF storage</td>
<td>NFA</td>
</tr>
<tr>
<td>12. Building 103 - CE Covered Storage</td>
<td>Building with AFFF storage</td>
<td>NFA</td>
</tr>
<tr>
<td>13. Former Wastewater Treatment Plant (WWTP)</td>
<td>WWTP</td>
<td>Soil, sediment, surface water, and groundwater inspection (drainage area and downgradient)</td>
</tr>
</tbody>
</table>

**Notes:**

1 - Although recommended in the PA, no surface water or sediment sampling was proposed in the SI work plan (Amec Foster Wheeler, 2017).
1.2 Purpose and Scope

The purpose of the SI is to determine the presence or absence of PFCs in soil, sediment, surface water, and/or groundwater at the ten locations recommended for further investigation in the PA (BB&E, 2015), and at the Base boundary. The data collected during the SI has been used to develop recommendations for appropriate paths forward to either provide a NFA conclusion or recommendations for further investigations or remedial actions.

Based on locations where AFFF was potentially used or stored, thirteen Areas of Concern (AOCs) were evaluated at the Base during the PA. Due to findings of no known AFFF release at AOC 9 (Building 145 - Hazmart Pharmacy), AOC 11 (Former Building 106 - Former Base Supply Building), and AOC 12 (Building 103 - CE Covered Storage), NFA was recommended for these three areas. Ten AOCs were recommended for further investigations in the PA (BB&E, 2015) based on findings of a release, or suspected release of AFFF. The 10 AOCs recommended for further inspection are referenced as PRLs in this SI, which are illustrated on Figure 3, and summarized in the Table 2 below:

Table 2: PRL Summary

<table>
<thead>
<tr>
<th>Location</th>
<th>Preliminary Assessment AOC No.</th>
<th>Site Inspection PRL No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Former Fire Training Area (IRP Site 4)</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Hangar 119</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Former Hangar 128</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Former Hangar 110</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Building 139 -Northeast Fire Department Equipment Testing Area</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Former Building 114 - Old Tower</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Former Building 111 – Former Fire Department</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>Building 303 - Current Fire Department</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>Building 145 - Hazmart Pharmacy</td>
<td>9</td>
<td>N/A</td>
</tr>
<tr>
<td>Building 140 - Former Fire Department</td>
<td>10</td>
<td>9</td>
</tr>
<tr>
<td>Former Building 106 - Former Base Supply Building</td>
<td>11</td>
<td>N/A</td>
</tr>
<tr>
<td>Building 103 – Civil Engineering Covered Storage</td>
<td>12</td>
<td>N/A</td>
</tr>
<tr>
<td>Former Wastewater Treatment Plant</td>
<td>13</td>
<td>10</td>
</tr>
</tbody>
</table>

Notes:
AOC- Area of Concern
PRL – Potential Release Location
IRP – Installation Restoration Program
No. - Number
SI investigative tasks at these 10 PRLs are summarized on Table 3, and include:

- Advancement of 29 soil borings utilizing roto sonic drilling techniques to a maximum depth of 15 feet (ft) below ground surface (bgs), or first encountered groundwater, to facilitate collection of up to two soil samples from each boring (57 total soil samples);
- Installation of 16 temporary monitoring wells at locations downgradient of the PRLs and along the base boundary to facilitate collection of 16 groundwater samples;
- Collection of one surface water sample from PRL 3 in a drainage ditch northeast of Former Hangar 128 (although a surface water sample was planned for PRL 10, no water was present during the SI field activities; therefore, no sample was collected); and
- Collection of two sediment samples, one each from PRL 3 and PRL 10.

Field activities were conducted in accordance with the Final SI Work Plan, which included a Quality Assurance Project Plan (QAPP), Field Sampling Plan (FSP), and Site Health and Safety Plan (SHSP) (Amec Foster Wheeler, 2017). The scope of the SI is detailed in the following sections.
2.0 INSTALLATION DESCRIPTION

Section 2.1 describes the location and environs of MANGB. A brief history of MANGB is provided in Section 2.2.

2.1 Location

The MANGB is located at the Eastern West Virginia Regional Airport in Berkeley County, West Virginia, approximately 2.5 miles south of Martinsburg, West Virginia (Figures 1 and 2). The Base occupies the northeastern portion of the airport and shares the runway facilities. The area designated for use by the 167th AW includes a total of 346 acres (EARTH TECH, 1996). Berkeley County lies within the Northern Appalachian Ridges and Valleys physiographic province. The major landforms consist of a series of parallel ridges and valleys that have a southwest-northeast orientation. The Martinsburg area is located within the Shenandoah Valley, which is part of the Great Valley of the Appalachians that extends from Georgia to New York. Elevations on the Base range from approximately 560 ft above mean sea level (AMSL) in the west to 520 ft AMSL in the east (AECOM, 2015). Each of the 10 PRLs are located in separate areas across the MANGB. The locations of each PRL are shown on Figure 3.

2.2 Organization and History

Originally titled Shepherd Field, the Base was first used in 1922 as a public airfield by the city of Martinsburg (AECOM, 2015). The field was used for flying encampments by Maryland National Guard flying units in 1928 and 1929. In October 1958, a new ANG facility was completed and the AW was installed. From that time to the present, various types of military aircraft have been based in the 167th AW, with the missions changing with each type of aircraft. These aircraft have included F-86s, T-33s, C-119s, and C-121s. As of 1994, twelve C-130 aircraft were assigned to the AW. The mission of the unit is to support the flying operations of the C-130 aircraft (ANG, 2013).
3.0 ENVIRONMENTAL SETTING

The following sections provide information on the environmental setting at MANGB. This information was summarized from the Regional Compliance Restoration Program Preliminary Assessment/Site Inspection (AECOM, 2015) and other sources cited below.

3.1 Climate

The climate in Martinsburg is defined as moderate and is characterized by four highly variable seasons with warm summers and no dry season. The temperature typically varies from 23 degrees Fahrenheit (°F) to 88°F and is rarely below 0°F or above 91°F. The average cold season (1 December to 9 March) temperature is 32°F and average warm season (29 May to 16 September) temperature is 73°F. Average annual precipitation is 37.54 inches with an average annual snowfall of 25.3 inches. The typical number of days with measurable precipitation is 117. Prevailing winds are from the west-northwest at an average of 11 miles per hour.

3.2 Topography

Topography is characterized by nearly level to gently rolling terrain; however, the site is located on improved land with minor topographic variation. The natural topography has been altered or leveled in areas to accommodate development (AMEC, 2002). The Base overall is relatively flat.

3.3 Geology

Berkeley County is located in the ridge and valley province of the Appalachian Mountains. Geology in the region consists of eroded limestone, shale, and sandstone formed during the mountain building episode of the late Paleozoic period, approximately 300 million years ago. Bedrock underlying a portion of the Base consists predominantly of fractured and faulted limestone. Previous geological studies have shown that areas with shallow depth (less than 10 ft) to bedrock are present in areas of the existing MANGB. A fault line runs north-south bisecting the Base east of the control tower. Shale bedrock also underlies the westernmost portions of the Base (AMEC, 2002).

3.4 Soils

According to the National Resources Conservation Service Web Soil Survey (NRCS, 2018), soils in the vicinity of the Former FTA (PRL 1) are mapped as Carbo-Endcav silty clay loams (3 to 8
percent slopes). Soils in the vicinity of Building 139 – Northeast Fire Department Equipment Testing Area (PRL 5) are mapped as Carbo-Endcav silty clay loams (8 to 15 percent slopes) and Huntington silt loam. Soils in the vicinity of Building 303 – Current Fire Department (PRL 8) are mapped as Weikert-Berks channery silt loams (8 to 15 percent slopes). Soils at the other seven PRLs are mapped as Urban Land.

Soils observed during the SI activities generally consisted of fine silt and clays over layers of clay with sand or gravel. Occasional layers of finer material (silty sand) and coarser material (gravelly sand) were encountered. Soil boring logs are included in Appendix A.

3.5 Surface Water Hydrology

Surface water from the MANGB discharges to small intermittent and perennial streams located at the boundaries of the Base. Generally, surface water from the northern half of the Base, flows northward into Cold Spring Run, and surface water from the southern half, from the runway, flows eastward into Sulfur Spring Run. These streams flow eastward into Opequon Creek and ultimately northeast into the Potomac River. Runoff from impervious areas is transported off the property through overland flow or by storm drain systems that discharge toward the northeast corner of the Property. Drainage at the Base consists of unlined shallow swales, rip-rap lined ditches, culverts, and piping with catch basins and manholes. The majority of storm water runoff is conveyed via swales and piping to a drainage ditch that traverses the Base from the south of Building 134, past Building 121 and Building 131, to a point of discharge at the north boundary of the Base (AECOM, 2015). In addition, two storm water detention basins that were constructed in late 2006 to early 2007 are located along the western portion of the Base. Based on this date of construction, it is unlikely that these basins would have received waters impacted by AFFF (BB&E, 2015). Surface water from the Base apron and around the Current Fire Department (Building 303) are routed through the storm water system to the basins.

3.6 Hydrogeology

Groundwater in Berkeley County occurs in limestone and shale bedrock. Drilled wells commonly supply domestic water systems in rural areas. Groundwater supply obtained from limestone is generally abundant; however, the depth to good water-bearing strata varies and water levels are subject to a rapid and wide range of seasonal fluctuations. The average depth of wells in these areas is about 150 to 200 ft bgs. Groundwater yield from shale is generally less than that of limestone; however, the depth and yield is generally more dependable. Most wells in these areas
are 100 to 150 ft deep (AMEC, 2002).

The primary water-bearing stratum in the Martinsburg area is the Beekmantown Limestone. Wells in this formation are generally in the 200-ft range and have an average yield of 69 gallons per minute. Estimated depth to groundwater on the installation ranges from 25 to 40 ft and has been encountered during previous evaluations at 40 to 50 ft bgs. Groundwater flow is estimated to be toward the northern portion of the main runway. Groundwater flow in the area south of the runway generally flows eastward toward Opequon Creek, approximately 1 mile east of the installation (AMEC, 2002).

Groundwater samples for PFC analysis have not previously been collected at the MANGB. No groundwater monitoring wells currently exist on the main MANGB property; however, one well is reported to exist south of the firing range (Building 144) approximately 3,500 ft south of the main Base. The Base currently uses drinking water from the city of Martinsburg and use of the “firing range well” was discontinued in 2006 due to high arsenic concentrations (BB&E, 2015).

A limestone quarry is located approximately two miles north of MANBG. The quarry and city of Martinsburg pump water from the same aquifer at similar well depths (West Virginia Department of Environmental Protection [WVDEP], 2016). The city of Martinsburg’s Big Springs Deep Well, the quarry, and MANGB are aligned along a geologic strike. Underground tunnels associated with historic limestone mining are also present at the quarry. These tunnels extend southwest from the existing open pit quarry area to within approximately 0.6 miles of the airport runway.

3.7 Critical Habitat and Threatened/Endangered Species

According to the United States Fish and Wildlife Service (USFWS), there are four endangered species found in Berkeley County: the red knot, northeastern bulrush, harperella, and the Indiana bat (USFWS, 2014). The red knot is a species of bird whose status is proposed threatened. Northeastern bulrush and harperella are species of flowering plants that are endangered. The Indiana bat is an endangered mammal species. However, since the general area of the Base is developed, these species are not likely to be found at the PRLs.

3.8 City of Martinsburg Water Supply

The nearest public water supply (Big Spring Water Filtration Plant) is just over one mile hydraulically downgradient from the Base. Another public water supply (Kilmer Springs Water Filtration Plant) is located approximately four miles north of the Base, hydraulically downgradient.
A review of the 2014 city of Martinsburg’s Water Quality Report (city of Martinsburg, 2015) revealed detections of Perfluorooctanesulfonic Acid (PFOS) and Perfluorooctanoic Acid (PFOA), but at levels below the then-current United States Environmental Protection Agency (USEPA) recommended provisional health advisory levels of 0.2 μg/L for PFOS and 0.4 μg/L for PFOA (WVDEP, 2016). In an interview with Mr. Sam Blair of the city of Martinsburg’s Water and Sewer Department, it was reported that the highest concentrations of PFOS and PFOA were 0.071 μg/L and 0.079 μg/L respectively. These concentrations reflected an average of both the Big Spring and Kilmer Spring Water Filtration Plants (BB&E, 2015).

When USEPA updated the PFOS/PFOA health advisory levels in May 2016, these prior detections exceeded the current Lifetime Health Advisories for PFOS/PFOA and the West Virginia Bureau for Public Health advised the Big Spring’s deep well be discontinued. The WVDEPs Division of Water and Waste Management then began investigating the source of PFOS/PFOA impacts in Martinsburg’s deep well (WVDEP, 2016). The Kilmer Springs Water Filtration Plant is currently used as the city’s water supply while the Big Springs Deep Well remains closed.

According to the September 2002 Environmental Baseline Survey (EBS) (AMEC, 2002), there were two groundwater wells at the MANGB. The well located at Building 101 was approximately 100 ft deep and was abandoned in 2010. The well was previously investigated for potential drinking water use and was found to have a high bacteria content.

A second well, located south of the firing range (Building 144) approximately 3,500 ft south of the main Base, was used to supply potable water (AMEC, 2002). Use of this “firing range well” ceased in 2006 due to high arsenic concentrations. Further action was not required at this time, but it was recommended that the well be abandoned if no longer needed. There was no abandonment record noted for the well during the file review portion of the PA (BB&E, 2015).

A review of the Environmental Data Resources (EDR) Radius Map™ Report with Geocheck® dated 21 July 2015, lists seven water wells within a one-mile radius of the MANGB (EDR, 2015). The seven wells appear on the United States Geological Survey database which usually lists monitoring or test wells. However, in a phone conversation with Mr. Steve Knipe of the city of Martinsburg’s Water and Sewer Department, Mr. Knipe indicated there are multiple private potable water wells in the area. Based on this information, until the existence and status of nearby potable water wells can be confirmed, these wells should be treated as active potable water wells and potential receptors to any groundwater contamination (BB&E, 2015).
4.0 PRELIMINARY ASSESSMENT

BB&E was contracted by the NGB to perform a PA at the Base with the objective of collecting and reviewing available information about any known or suspected releases of AFFF due to the use, handling, release or on-Base disposal at MANGB. The PA process included a review of documented FTAs in operation since 1970, and any other use or release of AFFF, and the completion of a Base reconnaissance. The Base reconnaissance included an inspection of potential sites of historical environmental releases, interviews with Base personnel, and a review of available on-Base documentation.

Based on past use and storage of AFFF at MANGB, the PA identified 13 AOCs where releases of PFC might have occurred, including FTAs, hangars, current and former fire departments, a former WWTP, storage buildings, etc. Ten of the 13 AOCs were recommended for further inspection, and three AOCs warranted NFA (AOCs 9, 11, and 12).

The findings of AFFF use and storage at each of the ten AOCs recommended for inclusion in the SI, as documented in the PA Site Visit Report, are summarized below. The PA recommended NFA at AOCs 9, 11, and 12, and these are not included in the ensuing text. The ten AOCs recommended for inclusion in the SI are referred to hereafter utilizing their respective PRL number (PRL 1 through PRL 10), as discussed in Section 1.2. The following sections provide a summary for each PRL which are reflective of the conditions at the time of the 2015 PA (BB&E, 2015).

4.1 PRL 1: Former FTA (IRP Site 4) – Fire Training Area

A historic FTA existed at the Base from 1960 and is referenced in a March 1986 Phase I Records Search prepared by the Hazardous Materials Technical Center (HMTC, 1986) and a September 2002 EBS prepared by AMEC (AMEC, 2002). However, these documents do not agree on the dates of usage. The March 1986 PA indicates the FTA was operational from 1960 until about 1975. The 2002 EBS indicates the FTA was operational from 1960 until about 1986. Base personnel interviewed in the PA acknowledge that some burning may have occurred up until 1979 but it was only for the burning of wood materials (no fuels or solvents). They were unaware of the FTA being used through 1986. In either case, the historic FTA did exist and was investigated and closed as IRP Site 4 (BB&E, 2015).

IRP Site 4 was an open, gravel-bottomed, elliptical bermed pit, located north of Taxiway A. Flammable liquids were poured into the pit and were ignited for fire-training exercises. The pit
measured approximately 20 by 30 ft and was lined with several layers of thick plastic sheeting that degraded over time. Approximately 75 ft north of the pit, the ground slopes steeply toward a man-made drainage ditch. Water that accumulated in the pit was sometimes drained from the pit into the nearby drainage ditch. The remedial action, including excavation, on-site thermal treatment of contamination and confirmation monitoring, was completed in 1996 and it was determined that contaminant levels at the site posed negligible risk to public health and the environment (BB&E, 2015). The WVDEP reviewed the sampling results which confirmed that all contaminant levels were below target clean up levels, and determined that NFA was required (AMEC, 2002). However, PFCs were not contaminants of concern during IRP investigations. As such, soil and/or groundwater samples were not analyzed for PFCs.

4.2 PRL 2: Hangar 119

Hangar 119 was constructed in the 1960s and was equipped with an AFFF fire suppression system (FSS) from approximately 1989 until 2007. The suppression system was designed to contain, store, and in the case of system engagement, ultimately discharge the AFFF inside the hangar. In 2007, Hangar 119 was converted to house various functions such as Civil Engineering (CE) and Environmental Management and the AFFF FSS was removed. AFFF from the 2007 removal was turned in to the Defense Reutilization and Marketing Office and sent to Battle Creek, Michigan (BB&E, 2015).

One spill was reported while the system was in place. The spill occurred in the 1990s and consisted of an approximate 500-gallon release to the hangar floor. The AFFF was hosed down the sanitary sewer drains which were connected to an oil/water separator (OWS) as was the case with all the hangars at that time. Prior to 2007, the sanitary drains inside Hangar 119 were connected to the Base’s WWTP which discharged its effluent into the storm water drainage system which flows toward Cold Spring Run. According to Base personnel, sludge from the WWTP was sent off-site to a landfill for disposal and therefore not disposed on Base. The WWTP was demolished in 2007 and the sanitary sewer connected to the city of Martinsburg. Other Hangar 119 releases of AFFF occurred during FSS tests. It was estimated by Base personnel that an AFFF FSS test took place approximately every five years. Approximately 100 to 200 gallons of AFFF was released during each test. As indicated above, prior to 2007, AFFF from system tests was discharged to the Base WWTP (BB&E, 2015).
4.3 PRL 3: Former Hangar 128

The hangar was constructed in the 1980s and was demolished in 2008. Hangar 128 was equipped with an AFFF FSS until decommissioning prior to demolition. The suppression system was designed to contain, store, and in the case of system engagement, ultimately discharge the AFFF inside the hangar. According to CE drawings, the hangar drained to the sanitary sewer which, prior to 2007, was connected to the Base WWTP which discharged to the storm water drainage system. In the 1990s, approximately 500 gallons of AFFF was released to the hangar floor. The AFFF was hosed down the sanitary sewer drains which were connected to an OWS as was the case with all the hangars at that time. However, prior to 2007 the sanitary sewer drains inside Hangar 128 were connected to the Base’s WWTP which discharged its effluent into the storm water drainage system which flows toward Cold Spring Run. The WWTP was demolished in 2007 and the sanitary sewer connected to the city of Martinsburg (BB&E, 2015).

Other Hangar 128 releases of AFFF occurred during FSS tests. It was estimated by Base personnel that an AFFF FSS test took place approximately every five years. Approximately 100-200 gallons of AFFF was released during each test. As indicated above, prior to 2007, AFFF from system tests was discharged to the Base WWTP (BB&E, 2015).

4.4 PRL 4: Former Hangar 110

Building 110 was constructed in the 1950s and demolished in 2011. The building was used as a hangar and was equipped with an AFFF FSS. The installation date for the AFFF FSS is not known; however, the system was decommissioned prior to demolition. As with other buildings at the Base, the floor drains in Hangar 110 discharged to the sanitary sewer system prior to 2007 when it was connected to the Base WWTP. Effluent from the Base WWTP was discharged to the storm water drainage system. The WWTP was demolished in 2007 and the sanitary sewer connected to the city of Martinsburg (BB&E, 2015).

According to the personnel interviewed during the PA, approximately 500 gallons of AFFF was released to the hangar floor in the 1990s. The AFFF was hosed down the sanitary sewer drains which were connected to an OWS as was the case with all the hangars at that time. However, prior to 2007 the sanitary sewer drains inside Hangar 110 were connected to the Base’s WWTP which discharged its effluent into the storm water drainage system which flows toward Cold Spring Run. According to personnel interviewed during the PA, releases of AFFF may have occurred during FSS testing at Former Hangar 110. It was estimated by Base personnel that an AFFF FSS
test took place approximately every five years. Approximately 100-200 gallons of AFFF was released during each test. As indicated above, prior to 2007 AFFF from system tests was discharged to the Base WWTP (BB&E, 2015).

4.5 PRL 5: Building 139 – Northeast Fire Department Equipment Testing Area

This area consists of a low-lying vegetative area just northeast of Building 139. According to base personnel interviewed during the PA, nozzles were tested at this Fire Department Testing Area from at least 1990 to 2008. Nozzles were tested over a fence and onto the low-lying vegetative area. A storm water conveyance ditch nearby appears to flow toward Cold Spring Run. The frequency of the nozzle tests was targeted to be completed quarterly; however, Base personnel indicated that the testing was sporadic. Personnel interviewed were not aware of any other testing areas at Base (BB&E, 2015).

4.6 PRL 6: Former Building 114 (Old Tower)

According to personnel interviewed during the PA, bulk storage of AFFF existed near Building 114 (current Red Ramp) in the 1990s. Also, in the 1990s, there was a release of AFFF to the soil in this area from a storage container. It was estimated that less than 100 gallons was released. There was no special effort made to clean up the spill and it was allowed to naturally dissipate. When new hangars were constructed in the area from 2007 to 2010, this area was covered by approximately 2 ft of concrete (BB&E, 2015).

4.7 PRL 7: Former Building 111 – Former Fire Department

Building 111 was constructed in the 1950s and was demolished in 2011. After demolition, the area was regraded. From at least 2002 to 2008, the building was noted as a supply warehouse and sometime prior to 2002, it was the location of the former Base fire department. According to personnel interviewed during the PA, in the 1990s, a P-2 Fire Truck parked on the south side of Former Building 111 leaked approximately 50 gallons of AFFF to the soil in this area. The leak travelled into an open ditch and flowed toward Former Building 110. There was no special effort made to clean up the spill and it was allowed to naturally dissipate. Personnel interviewed were not aware of any other releases of AFFF at Former Building 111. However, fire trucks were historically power washed outside of Former Building 111 and it is possible that if any foam residue existed on the trucks, it could have been washed to the soil (BB&E, 2015).
4.8 PRL 8: Building 303 – Current Fire Department

Building 303 houses the current fire station and was constructed in 2009. This is the only building on Base that currently stores AFFF. In addition to the AFFF storage in the four fire department trucks, additional AFFF is stored in 5-gallon containers which are manually loaded into fire trucks equipped with a bayonet system that punctures the container within the fire truck’s containment tank. There is no overhead fill system. A series of floor drains within the concrete floor lead to an OWS that appears to drain to an open ditch. While there have been no documented releases of AFFF from this new building, any potential release could flow toward the storm water drainage system (BB&E, 2015).

4.9 PRL 9: Building 140 – Former Fire Department

Building 140 was constructed in the 1990s and served as the former fire department building. There was no AFFF storage at Building 140, with the exception of what was stored on the fire department trucks. However, fire department vehicles were power-washed inside Building 140. Any foam on the vehicle would have flowed into a floor drain and then to an OWS which connected to the Base WWTP prior to 2007. The WWTP was demolished in 2007 and the sanitary sewer connected to the city of Martinsburg. Building 140 is currently used as the new aerospace ground equipment building (BB&E, 2015).

4.10 PRL 10: Former Wastewater Treatment Plant

The former WWTP was constructed in the 1950s and demolished in 2007. Base sanitary sewer lines (including from hangars and fire stations) drained to the WWTP. The WWTP consisted of a wet well (underground pit), flow splitter box, clarifier, sand filters, chlorine contact tank, and a dechlorination tank before discharge. The effluent discharged to an open grass-lined ditch that drains toward Cold Spring Run. Any discharges of AFFF into the sanitary sewer prior to 2007 from hangars or fire stations would have been treated through this system and discharged to this open ditch (BB&E, 2015).

There is no documentation that AFFF discharged to the sanitary sewer had leaked out along the old sewer lines. However, the integrity of the sewer conveyance pipes at the time of the WWTP operation is unknown. After 2007, the sanitary sewer system at the Base was connected to the city of Martinsburg Publicly Owned Treatment Works (POTW). The effluent from the POTW is discharged to Tuscarora Creek which is a tributary of Opequon Creek (BB&E, 2015).
5.0 FIELD PROGRAM METHODS

The following subsections summarize utility clearance and permitting activities; soil boring installation, sampling, and abandonment; temporary groundwater monitoring well construction, development, sampling, and abandonment; surface water sampling, and sediment sampling. SI activities were conducted in accordance with the Work Plan and the ANG Investigation Guidance (ANG, 2009). The SI field activities were conducted during 17 October through 30 November 2017. Photographs of field activities are included in Appendix B.

5.1 Utility Location and Clearance

Prior to commencement of SI activities, drilling locations were pre-marked, and the MANGB Point of Contact (POC) submitted an internal Base dig permit for the SI field activities on 29 September 2017.

On 17 October 2017, Mid-Atlantic Utility Locating, LLC of Ashburn, VA (Mid-Atlantic) cleared Base utilities at each of the 44-proposed soil boring and temporary monitoring well locations using geophysical techniques. Equipment employed by Mid-Atlantic included ground-penetrating radar and electro-magnetic induction locating equipment.

Utility clearance activities were performed at the direction and oversight of Amec Foster Wheeler, with the MANGB POC accompanying as an escort.

5.2 Permits

As described in Section 5.1, Amec Foster Wheeler obtained the internal Base dig permit from the MANGB POC. It was determined by the MANGB POC that Federal Aviation Administration (FAA) permits were required for performance of SI activities. An FAA permit was completed to obtain work clearance approval for each of the borings and temporary well locations. Amec Foster Wheeler obtained a Final Determination Letter dated 21 July 2017 from Mr. Matt Digiulian of the FAA providing work clearance approval. No other permits were required or obtained.

5.3 Soil Boring Installation

Between 18 October and 21 November 2017, 43 soil borings were advanced with 16 temporary monitoring wells installed (two temporary monitoring wells were co-located with soil sample locations) to investigate potential PFC impacts in soil and groundwater at MANGB. It should be
noted that, there were 44 soil borings locations proposed in the Work Plan. However, per the Work Plan surface water was present at location 03SB01, therefore, it was converted from a soil boring to sediment sampling location. The borings were advanced by Cascade using roto sonic drilling techniques. Soil borings advanced solely for soil sample collection were completed at 15 ft bgs or first encountered boulder/bedrock. Soil borings advanced for installation of temporary monitoring wells were completed below the water table or at a maximum depth of approximately 40 ft bgs. Individual borehole depths are provided in the soil boring logs included in Appendix A.

Soil boring locations were selected based on PRL use and physical characteristics to target the most probable AFFF release areas. Forty-three soil borings were advanced in and around the ten PRLs using sonic drilling methods (27 borings for soil sampling only, 14 borings for temporary monitoring well installation, and two borings for combined temporary monitoring well installation and soil sampling). Soil cores were collected continuously for field screening at 5-ft intervals in decontaminated cores and new, dedicated high-density polyethylene (HDPE) plastic liner sleeves. Drilling rods/tools were decontaminated between borings in accordance with protocol described in the Final Work Plan (Amec Foster Wheeler, 2017).

5.4 Soil Sampling

Shallow soil samples were generally collected from the upper two ft of soil, directly beneath asphalt or pavement, if present. Deep soil samples were collected from the 2-ft interval above refusal (e.g. boulder/bedrock), or 15 ft bgs, whichever was encountered first.

Soil samples were collected from single-use HDPE sleeves. After retrieval from the core barrel, the sleeve was opened lengthwise and the soil was examined. Soil characteristics were logged in accordance with the Unified Soil Classification System. Soil was also visually inspected for other evidence of contamination. Shallow soil samples were collected from the upper two ft of soil, directly beneath asphalt or pavement, if present. Deep soil samples were collected from 13 to 15 ft bgs or the 2-ft interval above encountered boulder/bedrock, as the water table was not encountered in the upper 15 ft of each soil boring. Soil samples were collected in laboratory-provided, 6-ounce HDPE containers and immediately cooled with ice to less than 4°C.

5.5 Soil Boring Abandonment

Following the completion of drilling activities, each boring was backfilled with grout to ground surface and topped with bentonite chips.
5.6 Temporary Monitoring Well Installation and Development

Sixteen temporary monitoring wells were installed to investigate potential groundwater impacts at the ten MANGB PRLs and at the Base boundaries. The primary purpose of installing the temporary monitoring wells was to assess groundwater quality downgradient of the PRLs. Temporary monitoring well locations were determined based on historical groundwater data and topographic contours, historical indications of possible impact, and Base features such as buildings and the Base boundary. In general, temporary monitoring wells were installed at locations with the greatest potential to intercept PFCs dissolved in groundwater based on available data and might not represent the highest concentrations at each PRL.

Soil cores were collected continuously to verify soil lithology, then inspected, logged, and field screened in accordance with the FSP. Temporary monitoring wells were installed in accordance with Amec Foster Wheeler’s PFC-specific Standard Operating Procedure for installation of monitoring wells (AFW-04).

The temporary monitoring well borings were advanced utilizing roto sonic drilling technique and tools. Temporary monitoring wells were constructed within borings using a two-inch diameter, schedule 40 polyvinyl chloride (PVC) riser with a 10-ft, 0.010-inch slot screened interval with the water table bisecting the well screen. New dedicated well materials were used at each temporary monitoring well location. The annulus surrounding each well screen and riser was backfilled with No.1 filter sand, which was placed from the bottom of the borehole to the bentonite seal. No annular seals were installed.

The temporary monitoring wells were developed using a pump to purge the screened interval and remove fine particles that had accumulated. Water quality parameters were monitored and recorded at periodic intervals. Monitoring wells were considered adequately developed when water quality parameters had stabilized and turbidity was low (i.e., <50 Nephelometric Turbidity Units where feasible). Where groundwater recharge was insufficient to allow stabilization, wells were pumped dry and allowed to recharge before sampling.

Well development water was containerized in steel 55-gallon drums and managed in accordance with Section 5.13. Equipment and pumps inserted into the well were decontaminated following each use in accordance with Section 5.12. Well development logs are included in Appendix C.

5.7 Water Level Measurements

Prior to well purging, static water level measurements were collected with an electronic water
level meter. Water levels were measured as a distance below the top of the PVC riser and recorded on field data sheets.

5.8 Groundwater Sampling

Sixteen groundwater samples were collected from temporary monitoring wells with a submersible pump. Groundwater samples were not collected using USEPA Low Stress (low flow) Purging and Sampling Procedure for the Collection of Groundwater Samples from Monitoring Wells. Groundwater samples were collected using a ProActive Stainless Steel Mega-Monsoon XL submersible pump with ProActive Low Flow with Power Booster 3 XL LCD Controller. Although the low flow controller is designed to regulate low flow sampling as low as 40 milliliters per minute (mL/min), the submersible pump would shut off at low flow rates. Pumping speeds were kept as low as possible while maintaining constant pumping.

The initial water level was recorded using an electronic water level meter prior to purging and sampling activities. The submersible pump was inserted into the monitoring well to the depth recorded in the sampling logs, above the bottom of the well to prevent disturbances and re-suspension of sediment present in the bottom of the well. In general, the pump intake was placed in the middle of the saturated interval. The pump discharge tubing was connected to a flow-through cell containing a multi-parameter Sonde Instrument to record water parameters. Except in cases of insufficient recharge, or where the pump shut off at low speeds, the pump rate during purging was maintained between 100 and 300 mL/min with a steady flow rate maintained. The following parameters were monitored during purging: temperature, pH, oxidation-reduction potential (ORP), dissolved oxygen, turbidity, temperature, and specific conductivity on approximately five-minute intervals. The water level was monitored during this same time interval. The well was considered stabilized after three consecutive readings as follows:

- +/−0.1 for pH,
- +/−3% for specific conductance (conductivity),
- +/−10 millivolts for ORP,
- +/−10% for dissolved oxygen, and
- +/−10% for turbidity.

Groundwater sampling logs and water quality instrument calibration logs are included in Appendix D and Appendix E respectively.
5.9 Temporary Monitoring Well Abandonment

Following the completion of sampling activities, each temporary well was pulled from the ground allowing the formation to collapse into the borehole. Subsequent boring abandonment was completed in accordance with Section 5.5.

5.10 Surface Water Sampling

One surface water sample was collected at PRL 3 (Former Hangar 128). Prior to sample collection, the following parameters were monitored as per the Work Plan: temperature, pH, ORP, dissolved oxygen, turbidity, and specific conductivity. The surface water sample was collected from mid-depth in the center of the water column. The surface water sample was collected using the sample container itself. After retrieval from the sampling device, the surface water samples were inspected for visual evidence of contamination. Surface water samples were immediately cooled with ice to less than 4°C. Surface water sampling logs are included in Appendix F.

5.11 Sediment Sampling

Two sediment samples were collected, one each from PRL 3 (Former Hangar 128) and PRL 10 (Former WWTP). Samples were collected from the upper 0.5 ft of sediment utilizing a clean stainless-steel hand auger. The hand auger was used to collect a 6-inch plug of sediment. After retrieval, sediment was transferred to a clean stainless-steel bowl, homogenized, and then placed in 6-ounce HDPE laboratory-supplied containers. Samples were immediately cooled with ice to less than 4°C. Re-usable sampling equipment was decontaminated in accordance with the Final Work Plan (Amec Foster Wheeler, 2017). Sediment sampling logs are included in Appendix F.

5.12 Decontamination

Field sampling equipment (e.g. water level indicators, pumps, bowls, trowels, hand augers, and other downhole equipment) was decontaminated prior to initial use, and between samples. Liquinox® soap diluted with PFC-free water was used to wash sampling equipment with a clean HDPE brush used to remove debris and particulates. PFC-free water was used to rinse soapy water from the sampling equipment. The PFC-free water was obtained from an onsite water source. Prior to use, a sample of the water was submitted to Vista Analytical Laboratories, Inc. (Vista) for analysis of the six PFC compounds on the Third Unregulated Contaminant Monitoring Rule (UCMR 3) list. Concentrations were reviewed to ensure Amec Foster Wheeler’s internal PFC-free criteria were met. Decontamination fluids were containerized in steel 55-gallon drums.
and managed in accordance with Section 5.13.

5.13 Investigation Derived Waste Management

Investigative Derived Waste (IDW) (including soil cuttings, abandoned monitoring wells, purge water, development water, and decontamination fluids) was collected and contained in labeled, secured, steel 55-gallon drums. Drums were staged on-site in an area designated by the MANGB POC. A total of 21 IDW soil drums, four IDW PVC pipe drums, and eight IDW liquid drums were generated as part of the SI activities. After the completion of field activities, representative composite samples were collected for both soil and liquid IDW. Soil IDW samples were collected using clean disposable gloves and homogenized in a decontaminated stainless steel bowl, then placed in laboratory-supplied containers and immediately cooled with ice to less than 4°C. Liquid IDW samples were collected from individual drums using decontaminated stainless steel bowls and homogenized in empty laboratory-provided HDPE deionized water containers, then poured into laboratory-supplied sample containers and immediately cooled with ice to less than 4°C. New, disposable nitrile gloves were donned prior to sample collection and were worn throughout the sample collection process. Soil and liquid IDW samples were analyzed for Toxicity Characteristic Leaching Procedure (TCLP) volatile organic compounds, TCLP semi volatile organic compounds, TCLP Resource Conservation and Recovery Act metals, and total polychlorinated biphenyls. The soil, PVC, and liquid IDW were characterized as non-hazardous and waste profiles were signed by the MANGB POC. IDW was picked up by Capitol Environmental Services, Inc. on 16 February 2018 and transported to Environmental Recovery Corporation in Lancaster, PA. The IDW Profiles and Waste Manifest are provided in Appendix G.

5.14 Laboratory

PFC samples were submitted to Vista in El Dorado Hills, California. Waste Characterization samples were submitted to TestAmerica Laboratories Inc. in Arvada Colorado. Both laboratories are accredited under the DoD Environmental Laboratory Accreditation Program and maintain a National Environmental Laboratory Accreditation Program. Laboratory analytical reports and chain of custody forms are provided in Appendix H.

5.15 Field Quality Assurance/Quality Control Sample Results

Quality Assurance and Quality Control (QA/QC) samples, including field duplicates matrix
spike/matrix spike duplicates (MS/MSD), equipment rinsate samples, and field blanks were analyzed for the same PFC parameters as the associated project samples. The analytical results for the field duplicates are presented in Table 4 through Table 7.

### 5.16 Data Validation and Usability

Amec Foster Wheeler performed a data quality review of samples collected during field activities and submitted to Vista for analysis of PFCs, consisting of: 62 soil samples (including five field duplicates); three sediment samples (including one field duplicate); and 24 aqueous samples (including 16 primary groundwater samples, one primary surface water sample, three field duplicates, three equipment rinsate blanks, and one decontamination source water sample).

The laboratory analytical data generated during the SI were reviewed by a qualified analytical chemist for conformance with the project Data Quality Objectives specified in the QAPP found in the Final Work Plan (Amec Foster Wheeler, 2017). Amec Foster Wheeler performed USEPA Stage 4 validation on 10 percent (%) of the field samples and USEPA Stage 2B validation on the remaining field samples associated with this sampling event. The Stage 4 validation includes review of the QC results in the laboratory’s analytical report and reported on QC summary forms as well as recalculation checks and review of the instrument raw data outputs. The Stage 2B validation includes review of the QC results in the laboratory’s analytical report and reported on QC summary forms with no review of the associated raw data. Data from equipment and field blanks did not undergo validation because results from these samples are only used to assess data usability for field samples. The validation was performed in general accordance with: Amec Foster Wheeler Final QAPP found within the Final Work Plan (Amec Foster Wheeler, 2017); DoD Quality Systems Manual for Environmental Laboratories (DOD, 2017); and USEPA Determination of Selected Perfluorinated Alkyl Acids in Drinking Water by Solid Phase Extraction and Liquid Chromatography/Tandem Mass Spectrometry (USEPA, 2009).

Amec Foster Wheeler evaluated 510 data records from field samples during the validation. Amec Foster Wheeler J qualified\(^1\) or UJ qualified\(^2\) 137 records (27%) as estimated values because of

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\(^1\) The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.

\(^2\) The analyte was not detected above the reported sample quantitation limit. However, the reported quantitation limit is approximate and may or may not represent the actual limit of the quantitation necessary to accurately and precisely measure the analyte in the sample.
holding time exceedances, high or low internal standard recoveries, imprecision between MS and MSD results, analyte concentrations outside the equipment’s calibration range, and/or imprecision between field duplicate results. Laboratory analytical reports and chain of custody forms are provided in Appendix H. The Data Validation Report, including qualified data, is included as Appendix I.
6.0 SITE INVESTIGATIONS

This SI field program was designed to collect data needed to evaluate the presence/absence of PFC at each of the ten PRLs. The scope of the SI was designed using recommendations presented in the PA prepared by BB&E. The following sections describe the investigation approach that was used to fulfill the objectives of the SI. The work was conducted in accordance with the QAPP, SHSP, and FSP presented in the approved Final Work Plan (Amec Foster Wheeler, 2017).

6.1 Field Activities Summary

Site Inspection activities are summarized in Table 3 and consist of advancement of 29 soil borings and installation of 16 temporary wells, and collection of 57 soil samples, 16 groundwater samples, one surface water sample, and two sediment samples. Individual sampling locations are shown on Figure 4 through Figure 14. Soil boring and monitoring well construction, well development, groundwater sampling, and surface water/sediment sampling logs are included in Appendices A, C, D, and F, respectively.

6.2 General Work Plan Deviations

Deviations from the general work plan included one or more of the following conditions:

- The base POC completed and signed a Base CE Work Clearance Request on 29 September 2017.
- Soil borings were advanced using sonic drilling instead of hollow-stem auger or direct-push technology. The decision to use sonic drilling was made due to drill rig availability. The use of sonic drilling is not expected to affect sample results.
- The November 2017 USEPA residential soil Regional Screening Level (RSL) value for Perfluorobutanesulfonic Acid (PFBS) (1,300,000 micrograms per kilogram [μg/kg]) was used as the screening value in place of the May 2016 USEPA residential soil RSL value for PFBS (1,600,000 μg/kg). The updated RSL value was not published at the time the Work Plan was finalized.
- The November 2017 USEPA Tap Water RSL value for PFBS [400 micrograms per liter (μg/L)] was used as the screening value in place of the May 2016 USEPA Tap Water RSL value for PFBS (380 μg/L). The updated RSL value was not published at the time the Work Plan was finalized.
• 54 drums of drilling water were generated by the sonic drilling and not disposed of as IDW. Drilling water was filtered through activated carbon charcoal, flowed through the MANGB oil-water separator, and discharged to the municipal sewer. A temporary National Pollutant Discharge Elimination Permit was obtained through WVDEP for discharge of drilling water (Appendix G).

• Groundwater samples were not collected using USEPA Low Stress (low flow) Purging and Sampling Procedure for the Collection of Groundwater Samples from Monitoring Wells due to slow groundwater recharge. Groundwater samples were collected using a ProActive Stainless Steel Mega-Monsoon XL submersible pump with ProActive Low Flow with Power Booster 3 XL LCD Controller. The low flow controller is designed to regulate low flow sampling as low as 40 mL/minute; however, at sufficiently low speeds, the submersible pump would shut off. Pumping speeds were kept as low as possible while maintaining constant pumping.

• A ProActive Stainless Steel Monsoon submersible pump with low flow controller was used to collect groundwater samples due to the low recharge rate and the depth to groundwater. An equipment blank, ESHEP-EB-001-103117, was collected from the stainless-steel downhole pump end to confirm the pump was PFC-free.

Work Plan deviations specific to an individual PRL are discussed in the following sub sections.

6.3 PRL 1: Former FTA (IRP Site 4)

6.3.1 Site Deviations

One deviation from the Work Plan occurred at this PRL. Due to insufficient groundwater, TW-01 was not developed or purged prior to sampling and no water quality parameters were recorded. No other deviations, apart from the general Work Plan deviations (see Section 6.2), occurred at this PRL.

6.3.2 Soil Sampling

Three soil borings (01SB01, 01SB02, and 01SB03) were advanced using sonic drilling techniques on 18 and 19 October 2017, and two soil samples were collected from each boring. Per the Work Plan, the shallow sample at 01SB01 was collected from surficial material (0-2 ft bgs), and the shallow samples at 01SB02 and 01SB03 were collected from the upper 2-ft of native material beneath the burn pit fill (5-7 ft bgs and 8-10 ft bgs respectively). The deep sample at 01SB01 was collected from 3-5 ft bgs, just above bedrock refusal. The deep samples at 02SB02 and
02SB03 were collected from 13 to 15 ft bgs. A total of six soil samples were collected at this PRL.

6.3.3 Groundwater Sampling

Temporary monitoring well TW-01 was drilled to a depth of 40 ft bgs on 19 October 2017, and a well screen was installed from 30 - 40 ft bgs. No groundwater was observed during drilling. Groundwater was measured at a depth of 38.5 ft below top of casing (TOC) in TW-01 on 21 November 17 and one groundwater sample was collected.

Soil boring and temporary monitoring well locations are illustrated on Figure 4.

6.4 PRL 2: Hangar 119

6.4.1 Site Deviations

No deviations, apart from the general Work Plan deviations (see Section 6.2), occurred at this PRL.

6.4.2 Soil Sampling

Three soil borings (02SB01, 02SB02, and 02SB03) were advanced at PRL 2 on 27 and 30 October 2017, and shallow soil samples (0-2 ft bgs) were collected from each boring. The borings were completed using sonic drilling techniques, and deep samples (13 -15 ft or the last 2 ft before refusal) were collected from the bottom of each boring. A total of six soil samples were collected at this PRL.

6.4.3 Groundwater Sampling

Temporary monitoring well TW-02 was drilled to a depth of 40 ft bgs on 30 October 2017, and a well screen was installed from 29.5 - 39.5 ft bgs. Groundwater was measured at a depth of 27.9 ft below TOC in TW-02 prior to purging and sampling. One groundwater sample was collected on 31 October 2017.

Soil boring and temporary monitoring well locations are illustrated on Figure 5.

6.5 PRL 3: Former Hangar 128

6.5.1 Site Deviations

One deviation from the Work Plan occurred at this PRL. Due to insufficient groundwater, TW-03 was pumped dry during development and groundwater parameters did not stabilize. A groundwater sample was collected upon recharge. No other deviations, apart from the general
Work Plan deviations (see Section 6.2), occurred at this PRL.

### 6.5.2 Sediment Sampling

One sediment sample (03SD01) was collected at PRL 3 on 6 November 2017. The sediment sample was collected using hand tools from the upper 0.5 ft of sediment in the drainage ditch located northeast of the former hangar, downgradient from PRL 3.

### 6.5.3 Surface Water Sampling

One surface water sample (03SW01) was collected at PRL 3 on 6 November 2017. The surface water sample was collected in the drainage ditch located northeast of the former hangar, downgradient from PRL 3.

### 6.5.4 Soil Sampling

Two soil borings (03SB02 and 03SB03) were advanced at PRL 3 on 6 November 2017, and shallow soil samples (0-2 ft bgs) were collected from each boring. The borings were completed using sonic drilling techniques, and deep samples (13-15 ft bgs or the last two ft before refusal) were collected from the bottom of each boring. A total of four soil samples were collected at this PRL. Surface water was present at the 03SB01 location during field investigations; therefore, consistent with the Work Plan, a surface water and sediment sample were collected in lieu of the soil sample 03SB01.

### 6.5.5 Groundwater Sampling

Temporary monitoring well TW-03 was drilled to a depth of 30 ft bgs on 6 November 2017, and a well screen was installed from 19 - 29 ft bgs. Groundwater was measured at a depth of 17.2 ft below TOC in TW-03 prior to developing and sampling. One groundwater sample was collected on 21 November 2017.

Soil boring, temporary monitoring well, surface water and sediment sample locations are illustrated on Figure 6.

### 6.6 PRL 4: Former Hangar 110

#### 6.6.1 Site Deviations

No deviations, apart from the general Work Plan deviations (see Section 6.2), occurred at this PRL.
6.6.2 Soil Sampling

Three soil borings (04SB01, 04SB02, and 04SB03) were advanced at PRL 4 on 30 October and 1 November 2017, and shallow soil samples (0-2 ft bgs) were collected from each boring. The borings were completed using sonic drilling techniques, and deep samples (13-15 ft bgs or the last two ft before refusal) were collected from the bottom of each boring. A total of six soil samples were collected at this PRL.

6.6.3 Groundwater Sampling

Temporary monitoring well TW-04 was drilled to a depth of 41 ft bgs on 31 October and 1 November 2017, and a well screen was installed from 30 - 40 ft bgs. Groundwater was measured at a depth of 8.72 ft below TOC in TW-03 prior to purging and sampling. One groundwater sample was collected on 1 November 2017.

Soil boring and temporary monitoring well locations are illustrated on Figure 7.

6.7 PRL 5: Building 139 (Northeast Fire Department Equipment Testing)

6.7.1 Site Deviations

One deviation from the Work Plan occurred at this PRL. Due to insufficient groundwater, TW-05 was pumped dry during development and groundwater parameters did not stabilize. A groundwater sample was collected upon recharge. No other deviations, apart from the general Work Plan deviations (see Section 6.2), occurred at this PRL.

6.7.2 Soil Sampling

Three soil borings (05SB01, 05SB02, and 05SB03) were advanced at PRL 5 on 23 October 2017, and shallow soil samples (0-2 ft bgs) were collected from each boring. The borings were completed using sonic drilling techniques, and deep samples (13-15 ft bgs or the last 2 ft before refusal) were collected from the bottom of each boring. A total of six soil samples were collected at this PRL.

6.7.3 Groundwater Sampling

Temporary monitoring well TW-05 was drilled to a depth of 40 ft bgs on 24 October 2017, and a well screen was installed from 30 - 40 ft bgs. Groundwater was measured at a depth of 36.2 ft below TOC in TW-05 prior to sampling. One groundwater sample was collected on 21 November 2017.
Soil boring and temporary monitoring well locations are illustrated on Figure 8.

6.8  PRL 6: Former Building 114 (Old Tower)

6.8.1 Site Deviations

One deviation from the Work Plan occurred at this PRL. Temporary well TW-06 was installed with a 15-ft screen. No other deviations, apart from the general Work Plan deviations (see Section 6.2), occurred at this PRL.

6.8.2 Soil Sampling

Three soil borings (06SB01, 06SB02, and 06SB03) were advanced at PRL 6 on 9 November 2017, and shallow soil samples (0-2 ft bgs) were collected from each boring. The borings were completed using sonic drilling techniques, and deep samples (13-15 ft bgs or the last 2 ft before refusal) were collected from the bottom of each boring. A total of six soil samples were collected at this PRL.

6.8.3 Groundwater Sampling

Temporary monitoring well TW-06 was drilled to a depth of 40 ft bgs on 9 and 13 November 2017, and a well screen was installed from 25 -40 ft bgs. TW-06 was co-located with soil boring 06SB02. Groundwater was measured at a depth of 27.35 ft below TOC in TW-06 prior to purging and sampling. One groundwater sample was collected on 13 November 2017 as per the Work Plan.

Soil boring and temporary monitoring well locations are illustrated on Figure 9.

6.9  PRL 7: Former Building 111 (Former Fire Department)

6.9.1 Site Deviations

No deviations, apart from the general Work Plan deviations (see Section 6.2), occurred at this PRL.

6.9.2 Soil Sampling

Three soil borings (07SB01, 07SB02, and 07SB03) were advanced at PRL 7 on 25 October 2017, and shallow soil samples (0-2 ft bgs) were collected from each boring. The borings were completed using sonic drilling techniques, and deep samples (13-15 ft bgs or the last 2 ft before refusal) were collected from the bottom of each boring. A total of six soil samples were collected at this PRL.
6.9.3 Groundwater Sampling

Temporary monitoring well TW-07 was drilled to a depth of 40 ft bgs on 26 October 2017, and a well screen was installed from 30 -40 ft bgs. TW-07 was co-located with soil boring 07SB01. Groundwater was measured at a depth of 29.73 ft below TOC in TW-07 prior to purging and sampling. One groundwater sample was collected on 26 October 2017.

Soil boring and temporary monitoring well locations are illustrated on Figure 10.

6.10 PRL 8: Building 303 – Current Fire Department

6.10.1 Site Deviations

Two deviations from the Work Plan occurred at this PRL.

- Sufficient rock was present to keep the borehole for TW-08 open, so no well screen was set. A groundwater sample was collected from the open borehole at TW-08.
- Due to insufficient groundwater, TW-08 was pumped dry during development and groundwater parameters did not stabilize. A groundwater sample was collected upon recharge.

No other deviations, apart from the general Work Plan deviations (see Section 6.2), occurred at this PRL.

6.10.2 Soil Sampling

Three soil borings (08SB01, 08SB02, and 08SB03) were advanced at PRL 8 on 13 and 14 November 2017, and shallow soil samples (0-2 ft bgs) were collected from each boring. The borings were completed using sonic drilling techniques, and deep samples (13 -15 ft bgs or the last 2 ft before refusal) were collected from the bottom of each boring. A total of six soil samples were collected at this PRL.

6.10.3 Groundwater Sampling

Temporary monitoring well TW-08 was drilled to a depth of 40 ft bgs on 15 November 2017. No well screen was installed. Groundwater was measured at a depth of 34.6 ft below TOC in TW-08 prior to sampling. One groundwater sample was collected on 15 November 2017.

Soil boring and temporary monitoring well locations are illustrated on Figure 11.
6.11 PRL 9: Building 140 – Former Fire Department

6.11.1 Site Deviations

One deviation from the Work Plan occurred at this PRL. Sufficient rock was present to keep the borehole for TW-09 open, so no well screen was set. A groundwater sample was collected from the open borehole at TW-09. No other deviations, apart from the general Work Plan deviations (see Section 6.2), occurred at this PRL.

6.11.2 Soil Sampling

Three soil borings (09SB01, 09SB02, and 09SB03) were advanced at PRL 9 on 2 November 2017, and shallow soil samples (0-2 ft bgs) were collected from each boring. The borings were completed using sonic drilling techniques, and deep samples (13-15 ft bgs or the last 2 ft before refusal) were collected from the bottom of each boring. A total of six soil samples were collected at this PRL.

6.11.3 Groundwater Sampling

Temporary monitoring well TW-09 was drilled to a depth of 30 ft bgs on 2 November 2017. No well screen was installed. Groundwater was measured at a depth of 16.58 ft below TOC in TW-09 prior to sampling. One groundwater sample was collected on 3 November 2017.

Soil boring and temporary monitoring well locations are illustrated on Figure 12.

6.12 PRL 10: Former Wastewater Treatment Plant

6.12.1 Site Deviations

One deviation from the Work Plan occurred at this PRL; No surface water sample (10SW01) was collected from the drainage ditch located northeast of the former WWTP, downgradient from PRL 10, due to lack of surface water at the time of sampling. No other deviations, apart from the general Work Plan deviations (see Section 6.2), occurred at this PRL.

6.12.2 Sediment Sampling

One sediment sample (10SD01) was collected at PRL 10 on 19 October 2017. The sediment sample was collected using hand tools from the upper 0.5 ft of sediment in the drainage ditch located northeast of the former WWTP, downgradient from PRL 10.
6.12.3 Soil Sampling

Three soil borings (10SB01, 10SB02, and 10SB03) were advanced at PRL 10 on 19 October 2017, and shallow soil samples (0-2 ft bgs) were collected from each boring. Two borings (10SB01 and 10SB03) were completed using sonic drilling techniques, and deep samples (13-15 ft bgs or the last 2 ft before refusal) were collected from the bottom of each boring. Boring 10SB02 was advanced with a hand auger to 2 ft bgs and no deep sample was collected due to refusal. A total of five soil samples were collected at this PRL.

6.12.4 Groundwater Sampling

Temporary monitoring well TW-10 was drilled to a depth of 37 ft bgs on 20 October 2017, and a well screen was installed from 27-37 ft bgs. Groundwater was measured at a depth of 32.0 ft below TOC in TW-10 prior to purging and sampling. One groundwater sample was collected on 20 October 2017.

Soil boring, temporary monitoring well, and sediment sample locations are illustrated on Figure 13.

6.13 Base Boundary Wells

6.13.1 Site Deviations

Two deviations from the Work Plan occurred at this PRL.

- Well screens were not installed in three boundary wells (BW), BW01, BW-05, and BW-06. Sufficient rock was present to keep the boreholes open, so no well screen was set. A groundwater sample was collected from the open borehole at these locations. Groundwater samples were collected from open boreholes at these boundary wells.

- Due to insufficient groundwater, BW-01 was not developed and a grab sample was collected. BW-05 was pumped dry during development and groundwater parameters did not stabilize. A groundwater sample was collected at BW-05 upon recharge. A groundwater sample was collected at BW-06 after multiple hours of development although groundwater parameters did not stabilize.

No other deviations, apart from the general Work Plan deviations (see Section 6.2), occurred at this PRL.
6.13.2 Groundwater Sampling

Temporary monitoring well BW-01 was drilled to a depth of 40 ft bgs on 21 November 2017 and the initial depth to water was measured at 35 ft below TOC. No well screen was installed. One groundwater sample was collected on 21 November 2017.

Temporary monitoring well BW-02 was drilled to a depth of 40 ft bgs on 20 November 2017, and a well screen was installed from 30-40 ft bgs. Groundwater was measured at a depth of 34.5 ft below TOC prior to purging and sampling. One groundwater sample was collected on 21 November 2017.

Temporary monitoring well BW-03 was drilled to a depth of 40 ft bgs on 16 November 2017, and a well screen was installed from 27.5-37.5 ft bgs. Groundwater was measured at a depth of 32.5 ft below TOC prior to purging and sampling. One groundwater sample was collected on 16 November 2017.

Temporary monitoring well BW-04 was drilled to a depth of 30 ft bgs on 8 November 2017, and a well screen was installed from 20-30 ft bgs. Groundwater was measured at a depth of 20.34 ft below TOC prior to purging and sampling. One groundwater sample was collected on 9 November 2017.

Temporary monitoring well BW-05 was drilled to a depth of 40 ft bgs on 7 November 2017 and the initial depth to groundwater was measured at 32.5 ft below TOC. No well screen was installed. One groundwater sample was collected on 20 November 2017.

Temporary monitoring well BW-06 was drilled to a depth of 40 ft bgs on 17 November 2017. No well screen was installed. Groundwater was measured at a depth of 32.5 ft below TOC prior to purging and sampling. One groundwater sample was collected on 17 November 2017.

Base boundary monitoring well locations are illustrated on **Figure 14**.
7.0 SOIL AND GROUNDWATER STANDARDS

A soil or groundwater standard is an environmental and/or public health statute or rule used in identifying Base contamination that may pose a risk to human health or the environment. Soil and groundwater standards are federal and state human health and environment-based regulations used to:

- Determine the appropriate levels of Base clean-up;
- Define and formulate remedial action alternatives; and,
- Govern implementation and operation of the selected remedial action.

Currently no promulgated Standards exist for the six PFCs sampled during the SI program.

In accordance with Interim Air Force Guidance on Sampling and Response Actions for Perfluorinated Compounds at Active and Base Realignment and Closure Installations [United States Air Force (USAF), August 2012] and USEPA lifetime drinking water HAs for PFOS (USEPA, May 2016a) and PFOA (USEPA, May 2016b), a release is considered confirmed if the following concentrations are exceeded:

**PFOS:**
- 0.07 μg/L in groundwater/surface water that is used as or contributes to a drinking water source (combined with PFOA value).
- 1,260 μg/kg in soil (calculated in the absence of RSL values).
- 1,260 μg/kg in sediment (calculated in the absence of RSL values).

**PFOA:**
- 0.07 μg/L in groundwater/surface water (combined with PFOS value).
- 1,260 μg/kg in soil (calculated in the absence of RSL values).
- 1,260 μg/kg in sediment (calculated in the absence of RSL values).

USEPA has also derived RSL values for PFBS, for which there is a Tier 2 toxicity value (USEPA, November 2017). The RSL values with a target hazard quotient of 1.0 are used for this SI. The USAF will also consider a release to be confirmed if the following concentrations are exceeded:

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3 Air Force Guidance screening levels calculated using the USEPA Regional Screening Level calculator [https://epa-prgs.ornl.gov/cgi-bin/chemicals/csl_search]. The toxicity value input for the calculator is the Tier 3 value reference dose of 0.00002 mg/kg/day derived by USEPA in their Drinking Water Health Advisories for both PFOS (USEPA, 2016a) and PFOA (USEPA, 2016b).
NGB/A4OR

PFBS:

- 400 μg/L in groundwater/surface water.
- 1,300,000 μg/kg in soil/sediment.

The Health Advisory (HA), RSLs and USAF guidance screening levels are collectively referred to as screening criteria in this Report. **Table 8** presents the screening criteria for comparing the analytical results for PFBS, PFOA, and PFOS.
8.0 SITE INVESTIGATION RESULTS

This section presents the soil, groundwater, surface water, and sediment data collected during the SI activities and a comparison of detections. Detections of PFBS, PFOA and PFOS are compared to the screening criteria as defined in the Work Plan, and presented in Table 8. Locations of detected analytes are shown on Figure 15 through Figure 25.

8.1 PRL 1: Former FTA (IRP Site 4)

8.1.1 PRL 1 Soil Analytical Results

Six soil samples were collected and analyzed from three soil borings as described in Section 6.3.2: 01SB01 from 0-2 and 3-5 ft bgs; 01SB02 from 5-7 and 13-15 ft bgs; and 01SB03 from 8-10 and 13-15 ft bgs. A field duplicate was collected at 01SB03 from 13-15 ft bgs. Analytical results from soil samples indicate that the six PFC compounds were detected above the laboratory reporting limit in all samples collected, with one compound exceeding the screening criterion. PFOS was detected in 01SB03 from 8-10 ft bgs at a concentration of 1,710 μg/kg, which is above the 1,260 μg/kg standard.

Comparisons of analytical results to applicable screening criteria are presented on Table 4. The soil boring locations showing detected compounds are depicted on Figure 15.

8.1.2 PRL 1 Groundwater Analytical Results

One groundwater sample was collected from TW-01 and analyzed as described in Section 6.3.3. Analytical results from the groundwater sample indicate that six PFC compounds were detected at concentrations above the laboratory detection limit, with two compounds exceeding the groundwater screening criterion. PFOS and PFOA were detected in TW-01 above the 0.07 μg/L USEPA Drinking Water HA (USEPA, 2016a), at concentrations of 45.7 μg/L and 18.9 μg/L, respectively. The combined PFOS and PFOA concentration is 64.6 μg/L at this location.

Comparisons of analytical results to applicable screening criteria are presented on Table 5. The temporary monitoring well location showing detected compounds is illustrated on Figure 15.

8.2 PRL 2: Hangar 119

8.2.1 PRL 2 Soil Analytical Results

Six soil samples were collected and analyzed from three soil borings as described in Section
6.4.2: 02SB01 from 0-2 and 13-15 ft bgs; 02SB02 from 0-2 and 13-15 ft bgs; and 02SB03 from 0-2 and 8-10 ft bgs. Analytical results from soil samples indicate that five PFCs were detected above the laboratory reporting limit in at least one sample; however, no compounds exceeded the screening criteria in the six samples collected from PRL 1.

Comparisons of analytical results to applicable screening criteria are presented on Table 4. The soil boring locations showing detected compounds are depicted on Figure 16.

8.2.2 PRL 2 Groundwater Analytical Results

One groundwater sample was collected from TW-02 and analyzed as described in Section 6.4.3. Analytical results from the groundwater sample indicate that six PFC compounds were detected at concentrations above the laboratory detection limit, with two compounds exceeding the USEPA Drinking Water HA of 0.07 μg/L. PFOS and PFOA were detected in TW-02 at concentrations of 0.544 μg/L and 0.112 μg/L, respectively. The combined PFOS and PFOA concentration is 0.656 μg/L at this location.

Comparisons of analytical results to applicable groundwater screening criteria are presented on Table 5. The monitoring well location showing detected compounds is illustrated on Figure 16.

8.3 PRL 3: Former Hangar 128

8.3.1 PRL 3 Sediment Analytical Results

One sediment sample was collected and analyzed as described in Section 6.5.2, 03SD01 from 0-0.5 ft bgs. Analytical results from the sediment sample indicate five PFC compounds were detected above the laboratory reporting limit; however, no compounds exceeded the screening criterion in the sediment sample collected from PRL 3.

Comparisons of analytical results to applicable criteria are presented on Table 6. The sediment sample location showing detected compounds are depicted on Figure 17.

8.3.2 PRL 3 Surface Water Analytical Results

One surface water sample (03SW01) was collected and analyzed as described in Section 6.5.3. A field duplicate was collected at this location. Analytical results from the surface water sample indicate six PFCs were detected above the laboratory reporting limit; with two compounds exceeding the surface water screening criterion of 0.07 μg/L. PFOS and PFOA were detected in
the primary sample at concentrations of 2.92 μg/L\(^4\) and 0.142 μg/L, respectively. The combined PFOS and PFOA concentration is 3.062 μg/L in the primary sample. PFOS and PFOA were detected in the duplicate sample at concentrations of 2.89 μg/L and 0.133 μg/L, respectively. The combined PFOS and PFOA concentration is 3.023 μg/L in the duplicate sample.

Comparisons of analytical results to applicable screening criteria are presented on Table 7. The surface water location showing detected compounds is illustrated on Figure 17.

### 8.3.3 PRL 3 Soil Analytical Results

Four soil samples were collected and analyzed from two soil borings as described in Section 6.5.4: 03SB02 from 0-2 and 13-15 ft bgs; and 03SB03 from 0-2 and 12-14 ft bgs. Analytical results from soil samples indicate PFOS is the only PFC present above the laboratory reporting limit, and detected in two of the four samples collected. There were no exceedances of the screening criteria in the four samples collected from PRL 3.

Comparisons of analytical results to applicable screening criteria are presented on Table 4. The soil boring locations showing detected compounds are depicted on Figure 17.

### 8.3.4 PRL 3 Groundwater Analytical Results

One groundwater sample was collected from TW-03 and analyzed as described in Section 6.5.5. Analytical results from the groundwater sample indicate that six PFC compounds were detected at concentrations above the laboratory detection limit, with two compounds exceeding the USEPA Drinking Water HA of 0.07 μg/L. PFOS and PFOA were detected at concentrations of 3.34 μg/L and 0.112 μg/L, respectively. The combined PFOS and PFOA concentration is 3.452 μg/L at this location.

Comparisons of analytical results to applicable criteria are presented on Table 5. The temporary monitoring well location showing detected compounds is illustrated on Figure 17.

### 8.4 PRL 4: Former Hangar 110

#### 8.4.1 PRL 4 Soil Analytical Results

Six soil samples were collected and analyzed from three soil borings as described in Section

\(^4\) Result J qualified indicating that the result was positively identified and the associated numerical value is the approximate concentration of the analyte in the sample.
6.6.2: 04SB01 from 0-2 and 13-15 ft bgs; 04SB02 from 0-2 and 11-13 ft bgs; and 04SB03 from 0-2 and 13-15 ft bgs. A field duplicate was collected at 04SB03 from 0-2 ft bgs. Analytical results from soil samples indicate that three PFC compounds were detected above the laboratory reporting limit in at least one sample; however, no compounds exceeded the screening criteria in the six samples collected from PRL 4.

Comparisons of analytical results to applicable screening criteria are presented on Table 4. The soil boring locations showing detected compounds are depicted on Figure 18.

8.4.2 PRL 4 Groundwater Analytical Results

One groundwater sample was collected from TW-04 and analyzed as described in Section 6.6.3. Analytical results from the groundwater sample indicate that six PFC compounds were detected at concentrations above the laboratory detection limit, with two compounds exceeding the USEPA Drinking Water HA of 0.07 μg/L. PFOS and PFOA were detected in TW-04 at concentrations of 0.981 μg/L and 0.319 μg/L, respectively. The combined PFOS and PFOA concentration is 1.3 μg/L at this location.

Comparisons of analytical results to applicable groundwater screening criteria are presented on Table 5. The monitoring well location showing detected compounds is illustrated on Figure 18.

8.5 PRL 5: Building 139 – Northeast Fire Department Equipment Testing Area

8.5.1 PRL 5 Soil Analytical Results

Six soil samples were collected and analyzed from three soil borings as described in Section 6.7.2: 05SB01 from 0-2 and 10-12 ft bgs; 05SB02 from 0-2 and 5-7 ft bgs; and 05SB03 from 0-2 and 13-15 ft bgs. Analytical results from soil samples indicate that six PFC compounds were detected above the laboratory reporting limit in at least one sample, with one compound exceeding the screening criterion. PFOS was detected in 05SB01 from 0-2 ft bgs at a concentration of 2,140 μg/kg, above the 1,260 μg/kg screening level.

Comparisons of analytical results to applicable screening criteria are presented on Table 4. The soil boring locations showing detected compounds are depicted on Figure 19.

8.5.2 PRL 5 Groundwater Analytical Results

One groundwater sample was collected from TW-05 and analyzed as described in Section 6.7.3. Analytical results from the groundwater sample indicate that six PFC compounds were detected
at concentrations above the laboratory detection limit, with two compounds exceeding the USEPA Drinking Water HA of 0.07 μg/L. PFOS and PFOA were detected in TW-05 at concentrations of 2.68 μg/L and 1.01 μg/L, respectively. The combined PFOS and PFOA concentration is 3.69 μg/L at this location.

Comparisons of analytical results to applicable criteria are presented on Table 5. The temporary monitoring well location showing detected compounds is illustrated on Figure 19.

8.6 PRL 6: Former Building 114 (Old Tower)

8.6.1 PRL 6 Soil Analytical Results

Six soil samples were collected and analyzed from three soil borings as described in Section 6.8.2: 06SB01 from 0-2 and 13-15 ft bgs; 06SB02 from 0-2 and 11-13 ft bgs; and 06SB03 from 0-2 and 3-5 ft bgs. A field duplicate was collected at 06SB01 from 0-2 ft bgs. Analytical results from soil samples indicate that three PFC compounds were detected above the laboratory reporting limit in at least one sample; however, no compounds exceeded the screening criteria in the six samples collected from PRL 6.

Comparisons of analytical results to applicable screening criteria are presented on Table 4. The soil boring locations showing detected compounds are depicted on Figure 20.

8.6.2 PRL 6 Groundwater Analytical Results

One groundwater sample was collected from TW-06 and analyzed as described in Section 6.8.3. Analytical results from the groundwater sample indicate that two of six PFCs were detected at concentrations above the laboratory detection limit; however, no compounds exceeded the screening criteria.

Comparisons of analytical results to applicable screening criteria are presented on Table 5. The temporary monitoring well location showing detected compounds is illustrated on Figure 20.

8.7 PRL 7: Former Building 111 (Former Fire Department)

8.7.1 PRL 7 Soil Analytical Results

Six soil samples were collected and analyzed from three soil borings as described in Section 6.9.2: 07SB01 from 0-2 and 10-12 ft bgs; 07SB02 from 0-2 and 6-8 ft bgs; and 07SB03 from 0-2 and 7-9 ft bgs. A field duplicate was collected at 07SB02 from 6-8 ft bgs. Analytical results from soil samples indicate that six PFC compounds were detected above the laboratory reporting limit.
in at least one sample; however, no compounds exceeded the screening criteria in the six samples collected from PRL 7.

Comparisons of analytical results to applicable screening criteria are presented on Table 4. The soil boring locations showing detected compounds are depicted on Figure 21.

8.7.2 PRL 7 Groundwater Analytical Results

One groundwater sample was collected from TW-07 and analyzed as described in Section 6.9.3. Analytical results from the groundwater sample indicate that six PFC compounds were detected at concentrations above the laboratory detection limit, with two compounds exceeding the USEPA Drinking Water HA of 0.07 μg/L. PFOS and PFOA were detected in TW-07 at concentrations of 4.35 μg/L and 1.23 μg/L, respectively. The combined PFOS and PFOA concentration is 5.58 μg/L at this location.

Comparisons of analytical results to applicable screening criteria are presented on Table 5. The temporary monitoring well location showing detected compounds is illustrated on Figure 21.

8.8 PRL 8: Building 303 (Current Fire Department)

8.8.1 PRL 8 Soil Analytical Results

Six soil samples were collected and analyzed from three soil borings as described in Section 6.10.2: 08SB01 from 0-2 and 10-12 ft bgs; 08SB02 from 0-2 and 6-8 ft bgs; and 07SB03 from 0-2 and 12-14 ft bgs. Analytical results from soil samples indicate that six PFC compounds were detected above the laboratory reporting limit in at least one sample; however, no compounds exceeded the screening criteria in the six samples collected from PRL 8.

Comparisons of analytical results to applicable screening criteria are presented on Table 4. The soil boring locations showing detected compounds are depicted on Figure 22.

8.8.2 PRL 8 Groundwater Analytical Results

One groundwater sample was collected from TW-08 and analyzed as described in Section 6.10.3. Analytical results from the groundwater sample indicate that four of six PFCs were detected at concentrations above the laboratory detection limit; however, no compounds exceeded the screening criteria.

Comparisons of analytical results to applicable screening criteria are presented on Table 5. The temporary monitoring well location showing detected compounds is illustrated on Figure 22.
8.9  PRL 9: Building 140 (Former Fire Department)

8.9.1 PRL 9 Soil Analytical Results

Six soil samples were collected and analyzed from three soil borings as described in Section 6.11.2: 09SB01 from 0-2 and 13-15 ft bgs; 09SB02 from 0-2 and 11-13 ft bgs; and 09SB03 from 0-2 and 8-10 ft bgs. Analytical results from soil samples indicate that six PFC compounds were detected above the laboratory reporting limit in at least one sample; however, no compounds exceeded the screening criteria in the six samples collected from PRL 9.

Comparisons of analytical results to applicable screening criteria are presented on Table 4. The soil boring locations showing detected compounds are depicted on Figure 23.

8.9.2 PRL 9 Groundwater Analytical Results

One groundwater sample was collected from TW-09 and analyzed as described in Section 6.11.3. Analytical results from the groundwater sample indicate that six PFC compounds were detected at concentrations above the laboratory detection limit, with two compounds exceeding the USEPA Drinking Water HA of 0.07 μg/L. PFOS and PFOA were detected in TW-09 at concentrations of 0.297 μg/L and 0.100 μg/L, respectively. The combined PFOS and PFOA concentration is 0.397 μg/L at this location.

Comparisons of analytical results to applicable screening criteria are presented on Table 5. The temporary monitoring well location showing detected compounds is illustrated on Figure 23.

8.10  PRL 10: Former Wastewater Treatment Plant

8.10.1 PRL 10 Sediment Analytical Results

One sediment sample was collected and analyzed as described in Section 6.12.2, 10SD01 from 0-0.5 ft bgs. A field duplicate was collected at this location. Analytical results from the sediment sample indicate five PFC compounds were detected above the laboratory reporting limit; however, no compounds exceeded the screening criteria in the sediment sample collected from PRL 10.

Comparisons of analytical results to applicable criteria are presented on Table 6. The sediment sample location showing detected compounds are depicted on Figure 24.

8.10.2 PRL 10 Soil Analytical Results

Five soil samples were collected and analyzed from three soil borings as described in Section 6.12.3: 10SB01 from 0-2 and 3-5 ft bgs; 10SB02 from 0-2 ft bgs; and 10SB03 from 4-6 and 13-
15 ft bgs. A field duplicate was collected at 10SB01 from 0-2 ft bgs. Analytical results from soil samples indicate that six PFC compounds were detected above the laboratory reporting limit in at least one sample; however, no compounds exceeded the screening criteria in the six samples collected from PRL 10.

Comparisons of analytical results to applicable screening criteria are presented on Table 4. The soil boring locations showing detected compounds are depicted on Figure 24.

### 8.10.3 PRL 10 Groundwater Analytical Results

One groundwater sample was collected from TW-10 and analyzed as described in Section 6.12.4. A field duplicate was collected at this location. Analytical results from the groundwater sample indicate that six PFC compounds were detected at concentrations above the laboratory detection limit, with one compound exceeding the USEPA Drinking Water HA of 0.07 μg/L. PFOS was detected in the primary and duplicate samples at concentrations of 0.255 μg/L and 0.345 μg/L, respectively. The combined PFOS and PFOA concentrations at the primary and duplicate samples are 0.278 μg/L and 0.363 μg/L, respectively.

Comparisons of analytical results to applicable screening criteria are presented on Table 5. The temporary monitoring well location showing detected compounds is illustrated on Figure 24.

### 8.11 Base Boundary Wells

#### 8.11.1 Boundary Well Groundwater Analytical Results

Six groundwater samples were collected at temporary wells located along the base boundary, with samples collected from each as described in Section 6.13.2. A summary of analytical results includes the following:

- One groundwater sample was collected from BW-01. Analytical results from the groundwater sample indicate that one PFC compound was detected at a concentration above the laboratory detection limit; however, no compounds exceeded the USEPA Drinking Water HA of 0.07 μg/L.
- One groundwater sample was collected from BW-02. A field duplicate was collected at this location. Analytical results from the groundwater sample indicate that six PFC compounds were detected at concentrations above the laboratory detection limit. Although no individual compounds exceeded screening criteria, the combined PFOS and PFOA result exceeded the USEPA Drinking Water HA of 0.07 μg/L in both the primary...
(0.103 μg/L) and duplicate (0.0961 μg/L) samples.

- One groundwater sample was collected from BW-03. Analytical results from the groundwater sample indicate that one PFC compound was detected at a concentration above the laboratory detection limit; however, no compounds exceeded the USEPA Drinking Water HA of 0.07 μg/L.

- One groundwater sample was collected from BW-04. Analytical results from the groundwater sample indicate that one PFC compound was detected at a concentration above the laboratory detection limit; however, no compounds exceeded the USEPA Drinking Water HA of 0.07 μg/L.

- One groundwater sample was collected from BW-05. Analytical results from the groundwater sample indicate that one PFC compound was detected at a concentration above the laboratory detection limit; however, no compounds exceeded the USEPA Drinking Water HA of 0.07 μg/L.

- One groundwater sample was collected from BW-06. Analytical results from the groundwater sample indicate that no PFC compounds were detected at a concentration above the laboratory detection limit.

Comparisons of analytical results to applicable screening criteria are presented on **Table 5**. The temporary monitoring well locations showing detected compounds are illustrated on **Figure 25**.
9.0 CONCLUSIONS/RECOMMENDATIONS

This section presents the SI conclusions and recommendations at each PRL. The recommendations are based upon data collected by Amec Foster Wheeler during this SI, and an evaluation of results compared to applicable screening criteria. Amec Foster Wheeler recommends that further investigations include analysis of additional compounds, including precursor compounds, to supplement the UCMR3 list. Precursor compounds have potential to result in increased concentrations downgradient and can serve as a lingering source.

9.1 PRL 1: Former FTA (IRP Site 4)

A review of soil analytical data compared to soil screening criteria indicates an exceedance of USAF guidance screening levels exists at PRL 1 for PFOS. There are no USEPA RSL exceedances for PFBS, and no Air Force Guidance screening level exceedances for PFOA at this location.

A review of groundwater data compared to screening criteria indicates an exceedance of the USEPA Drinking Water HA for PFOS and PFOA exists downgradient of PRL 1. PFBS did not exceed its respective screening criterion at this location.

Based on the SI results, the following are recommended for PRL 1:

- Additional investigations to further evaluate concentrations and extent of PFCs in soil.
- Additional investigations to further evaluate concentrations and extent of PFCs in groundwater.
- Additional investigations to evaluate soils (including within the saturated zone, as a potential contributing source to groundwater.

9.2 PRL 2: Hangar 119

A review of soil analytical data compared to screening criteria indicates there are no USEPA RSL exceedances for PFBS, and no USAF guidance screening level exceedances for PFOS or PFOA at PRL 2.

A review of groundwater data compared to screening criteria indicates an exceedance of the USEPA Drinking Water HA for PFOS and PFOA exists downgradient of PRL 2. PFBS did not exceed its respective screening criterion at this location.

Based on the SI results, the following is recommended for PRL 2:

- Additional investigations to further evaluate concentrations and extent of PFCs in soil.
- Additional investigations to further evaluate concentrations and extent of PFCs in groundwater.
- Additional investigations to evaluate soils (including within the saturated zone, as a potential contributing source to groundwater.

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167th Airlift Wing, West Virginia Air National Guard
Martinsburg Air National Guard Base
October 2018
Additional investigations to further evaluate concentrations and extent of PFCs in groundwater.

Additional investigations to evaluate soil (including soil within the saturated zone, as a potential contributing source to groundwater.

9.3 PRL 3: Former Hangar 128

A review of sediment analytical data compared to screening criteria indicates there are no USEPA RSL exceedances for PFBS, and no USAF guidance screening level exceedances for PFOS or PFOA at PRL 3.

A review of surface water data compared to screening criteria indicates an exceedance of the USEPA Drinking Water HA exists at PRL 3 for PFOS and PFOA. PFBS did not exceed its respective screening criterion at this location.

A review of soil analytical data compared to screening criteria indicates there are no USEPA RSL exceedances for PFBS, and no USAF guidance screening level exceedances for PFOS or PFOA at PRL 3.

A review of groundwater analytical data compared to screening criteria indicates an exceedance of the USEPA Drinking Water HA for PFOS and PFOA exists downgradient of PRL 3. PFBS did not exceed its respective screening criterion at this location.

Based on the SI results, the following are recommended for PRL 3:

- Additional investigations to further evaluate concentrations of PFCs in surface water. This should include an evaluation to identify the source, and downstream investigation to determine the nature and extent of the release. A second round of surface water samples should be collected concurrent with this evaluation to relate concentrations within the stormwater basin to concentrations up- and down-stream.
- Additional investigations to further evaluate concentrations and extent of PFCs in groundwater.
- Additional investigations to evaluate soil (including soil within the saturated zone, as a potential contributing source to groundwater.

9.4 PRL 4: Former Hangar 110

A review of soil analytical data compared to screening criteria indicates there are no USEPA RSL exceedances for PFBS, and no USAF guidance screening level exceedances for PFOS or PFOA
at PRL 4.

A review of groundwater data compared to screening criteria indicates an exceedance of the USEPA Drinking Water HA for PFOS and PFOA exists downgradient of PRL 4. PFBS did not exceed its respective screening criterion at this location.

Based on the SI results, the following is recommended for PRL 4:

- Additional investigations to further evaluate concentrations and extent of PFCs in groundwater.
- Additional investigations to evaluate soil (including soil within the saturated zone, as a potential contributing source to groundwater.

9.5 **PRL 5: Building 139 – Northeast Fire Department Equipment Testing Area**

A review of soil analytical data compared to soil screening criteria indicates an exceedance of Air Force Guidance exists at PRL 5 for PFOS. There are no USEPA RSL exceedances for PFBS, and no USAF guidance screening level exceedances for PFOA at this location.

A review of groundwater data compared to screening criteria indicates an exceedance of the USEPA Drinking Water HA for PFOS and PFOA exists downgradient of PRL 5. PFBS did not exceed its respective screening criterion at this location.

Based on the SI results, the following are recommended for PRL 5:

- Additional investigations to further evaluate concentrations and extent of PFCs in soil.
- Additional investigations to further evaluate concentrations and extent of PFCs in groundwater.
- Additional investigations to evaluate soil (including soil within the saturated zone, as a potential contributing source to groundwater.

9.6 **PRL 6: Former Building 114 (Old Tower)**

A review of soil analytical data indicates there are detections of PFCs, however, compared to screening criteria there are no USEPA RSL exceedances for PFBS, and no USAF guidance screening level exceedances for PFOS or PFOA at PRL 6.

A review of groundwater data indicates detections of PFCs, however, a comparison to screening criteria found no exceedances of the USEPA Drinking Water HA for PFOS or PFOA, and no exceedances of the USEPA Tap Water RSL for PFBS downgradient of PRL 7.
Based on the SI results, the following are recommended for PRL 6:

- Additional investigations to further evaluate concentrations and extent of PFCs in groundwater.
- Additional investigations to evaluate soil (including soil within the saturated zone), as a potential contributing source to groundwater.

9.7 PRL 7: Former Building 111 (Former Fire Department)

A review of soil analytical data compared to screening criteria indicates there are no USEPA RSL exceedances for PFBS, and no USAF guidance screening level exceedances for PFOS or PFOA at PRL 7.

A review of groundwater data compared to screening criteria indicates an exceedance of the USEPA Drinking Water HA for PFOS and PFOA exists downgradient of PRL 7. PFBS did not exceed its respective screening criterion at this location.

Based on the SI results, the following is recommended for PRL 7:

- Additional investigations to further evaluate concentrations and extent of PFCs in groundwater.
- Additional investigations to evaluate soil (including soil within the saturated zone, as a potential contributing source to groundwater.

9.8 PRL 8: Building 303 (Current Fire Department)

A review of soil analytical data indicates there are detections of PFCs, however, compared to screening criteria there are no USEPA RSL exceedances for PFBS, and no USAF guidance screening level exceedances for PFOS or PFOA at PRL 8.

A review of groundwater data indicates detections of PFCs, however, comparison to screening criteria found no exceedances of the USEPA Drinking Water HA for PFOS or PFOA, and no exceedances of the USEPA Tap Water RSL for PFBS downgradient of PRL 8.

Based on the SI results, the following is recommended for PRL 8:

- Additional investigations to further evaluate concentrations and extent of PFCs in groundwater.
- Additional investigations to evaluate soil (including soil within the saturated zone, as a potential contributing source to groundwater.
9.9 **PRL 9: Building 140 (Former Fire Department)**

A review of soil analytical data compared to screening criteria indicates there are no USEPA RSL exceedances for PFBS, and no USAF guidance screening level exceedances for PFOS or PFOA at PRL 9.

A review of groundwater data compared to screening criteria indicates an exceedance of the USEPA Drinking Water HA for PFOS and PFOA exists downgradient of PRL 9. PFBS did not exceed its respective screening criterion at this location.

Based on the SI results, the following is recommended for 9:

- Additional investigations to further evaluate concentrations and extent of PFCs in groundwater.
- Additional investigations to evaluate soil (including soil within the saturated zone, as a potential contributing source to groundwater.

9.10 **PRL 10: Former Wastewater Treatment Plant**

A review of sediment analytical data compared to screening criteria indicates there are no USEPA RSL exceedances for PFBS, and no USAF guidance screening level exceedances for PFOS or PFOA at PRL 10.

A review of soil analytical data compared to screening criteria indicates there are no USEPA RSL exceedances for PFBS, and no USAF guidance screening level exceedances for PFOS or PFOA at PRL 10.

A review of groundwater data compared to screening criteria indicates an exceedance of the USEPA Drinking Water HA for PFOS exists downgradient of PRL 10. PFOA and PFBS did not exceed their respective screening criteria at this location.

Based on the SI results, the following is recommended for 10:

- Additional investigations to further evaluate concentrations and extent of PFCs in groundwater.
- Additional investigations to evaluate soil (including soil within the saturated zone, as a potential contributing source to groundwater.

9.11 **Base Boundary Wells**

A review of groundwater data compared to screening criteria found no exceedances of the
USEPA Tap Water RSL for PFBS at the six boundary wells, and no exceedances of the USEPA Drinking Water HA for PFOS or PFOA at five of the six boundary wells. At BW-02, concentrations of PFOS and PFOA were individually below screening criteria; however, the combined concentration exceeded USEPA Drinking Water HA.

Based on the SI results, the following is recommended for the Base Boundary:

- Additional investigations to further evaluate concentrations of PFCs in groundwater near BW-02. This should include a source evaluation and delineation to determine the nature and extent of the release.
- Investigations of off-Base groundwater upgradient to evaluate potential sources of PFCs migrating onto the Base and downgradient to further evaluate the migration pathway and the extent of PFC contamination.
- Investigations of a stormwater retention basin which is present immediately adjacent to BW-02. Collection of sediment and surface water samples are recommended to confirm or eliminate the retention basin as a potential source of PFCs to the environment. This evaluation should be supplemented with a records review to better understand the contributions (both on-Base and off-Base) to the stormwater system.

9.12 PRL Sites Summary

In summary, SI activities determined that two PRLs have USAF guidance screening level exceedances for soil. Based on these findings, Amec Foster Wheeler recommends additional investigations at PRLs 1 and 5 to evaluate soil conditions.

SI activities determined that PFCs were detected in groundwater at the 10 PRLs investigated and at the Base boundary. Eight of the PRLs and one Base boundary location have USEPA Drinking Water HA exceedances. Based on these findings, Amec Foster Wheeler recommends additional investigations at each of the PRLs to further evaluate groundwater conditions and soils that may be an ongoing source of contamination.

Amec Foster Wheeler also recommends additional investigation at PRL 3 to further evaluate surface water conditions, and near BW-02 to further evaluate sediment and surface water conditions.

These recommendations are summarized in the following table:
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Notes:
GW = Groundwater
X – Screening criteria exceedance
SW = Surface Water
PFC - Perfluorinated Compound
10.0 REFERENCES


WVDEP (West Virginia Department of Environmental Protection), 2016. PFOS detections in a Martinsburg, WV water supply well. September.
TABLES
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### Table 3
Summary of Soil Analytical Testing Results
FY16 Phase I Regional Site Inspections for Perfluorinated Compounds
167th Airlift Wing, West Virginia Air National Guard
Eastern West Virginia Regional Airport Shepherd Field (EWVRA), Martinsburg, West Virginia

<table>
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<th>Sample Type</th>
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<th>Perfluorooctanoic acid (PFOA)</th>
<th>Perfluorobutanesulfonic acid (PFBS)</th>
<th>Perfluoroheptanoic acid (PFHpA)</th>
<th>Perfluorohexanesulfonic acid (PFHxS)</th>
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**Screening Level:**
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- $1.26^1$
- $1300^2$
- NA
- NA
- NA
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Table 4
Summary of Groundwater Analytical Testing Results
FY16 Phase I Regional Site Inspections for Perfluorinated Compounds
167th Airlift Wing, West Virginia Air National Guard
Eastern West Virginia Regional Airport Shepherd Field (EWVRA), Martinsburg, West Virginia

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<th>Location</th>
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<th>Sample Type</th>
<th>Perfluorooctanesulfonic acid (PFOS)</th>
<th>Perfluorooctanoic acid (PFOA)</th>
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Health Advisory: 0.07 0.07 0.07 NA NA NA NA

EPA RSL Tapwater¹: NA NA NA 400 NA NA NA

¹ Tapwater: Perfluorinated compounds detected in drinking water systems. The reported levels are the maximum contaminant levels (MCLs) set by the Environmental Protection Agency (EPA) for public water supplies.
### Table 4
Summary of Groundwater Analytical Testing Results
FY16 Phase I Regional Site Inspections for Perfluorinated Compounds
167th Airlift Wing, West Virginia Air National Guard
Eastern West Virginia Regional Airport Shepherd Field (EWVRA), Martinsburg, West Virginia

#### Location: 167th Airlift Wing, West Virginia Air National Guard (EWVRA), Martinsburg, West Virginia

#### Sample Information

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<th>PFOS+PFOA</th>
<th>Perfluorobutanesulfonic acid (PFBS)</th>
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<td>Perfluorooctanoic acid (PFOA)</td>
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</tr>
<tr>
<td>PFOS+PFOA</td>
<td>0.07</td>
</tr>
<tr>
<td>Perfluorobutane sulfonic acid (PFBS)</td>
<td>NA</td>
</tr>
<tr>
<td>Perfluoroheptanoic acid (PFHpA)</td>
<td>NA</td>
</tr>
<tr>
<td>Perfluorohexane sulfonic acid (PFHxS)</td>
<td>NA</td>
</tr>
<tr>
<td>Perfluorononanoic acid (PFNA)</td>
<td>NA</td>
</tr>
</tbody>
</table>

#### EPA RSL Tapwater¹

<table>
<thead>
<tr>
<th>Location</th>
<th>Sample ID</th>
<th>Date</th>
<th>Depth (ft.)</th>
<th>Type</th>
<th>Perfluorooctane sulfonic acid (PFOS)</th>
<th>Perfluorooctanoic acid (PFOA)</th>
<th>PFOS+PFOA</th>
<th>Perfluorobutane sulfonic acid (PFBS)</th>
<th>Perfluoroheptanoic acid (PFHpA)</th>
<th>Perfluorohexane sulfonic acid (PFHxS)</th>
<th>Perfluorononanoic acid (PFNA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>BBW BW-06 ESHEP-GW-BW06-111717</td>
<td>17-Nov-17</td>
<td>33.0-33.0</td>
<td>N</td>
<td>U</td>
<td>0.00543 U</td>
<td>0.00543 U</td>
<td>NA</td>
<td>0.00543 U</td>
<td>0.00543 U</td>
<td>0.00543 U</td>
<td>0.00543 U</td>
</tr>
</tbody>
</table>

#### Notes:

- **Light Blue Shaded** = Exceeds Health Advisory
- Underlined results exceed the EPA RSL standard.
- **FD** = Field Duplicate Sample
- **ft** = Feet
- **ID** = Identification
- **J** = The analyte was positively identified and the associated numerical value is the approximate concentration of the analyte in the sample.
- **N** = Normal Field Sample
- **NA** = Not applicable
- **PRL** = Potential Release Location
- **U** = The analyte was analyzed for, but was not detected above the reported limit of detection (LOD).
- **UJ** = The reported quantitation limit is approximate and may or may not represent the actual limit of quantitation necessary to accurately and precisely measure the analyte in the sample.
- µg/L = micrograms per liter

PFAS analysis by Modified USEPA Method 537 using Liquid Chromatography and Tandem Mass Spectrometry
Health Advisory from USEPA Office of Water, 2016a and 2016b, Health Advisories (HAS) for drinking water.
¹EPA Regional Screening Levels (June 2017) [https://www.epa.gov/risk/regional-screening-levels-rsl-generic-tables-june-2017]
### Table 5
Summary of Sediment Analytical Testing Results
FY16 Phase I Regional Site Inspections for Perfluorinated Compounds
167th Airlift Wing, West Virginia Air National Guard
Eastern West Virginia Regional Airport Shepherd Field (EWVRA), Martinsburg, West Virginia

<table>
<thead>
<tr>
<th>Location</th>
<th>Sample ID</th>
<th>Sample Date</th>
<th>Sample Depth (ft.)</th>
<th>Sample Type</th>
<th>Perfluorooctanesulfonic acid (PFOS)</th>
<th>Perfluorooctanoic acid (PFOA)</th>
<th>Perfluorobutanesulfonic acid (PFBS)</th>
<th>Perfluorohexanoic acid (PFHxS)</th>
<th>Perfluorohexanesulfonic acid (PFHxS)</th>
<th>Perfluorononanoic acid (PFNA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>03SD01</td>
<td>ESHEP-03-SD01-0-0.5</td>
<td>06-Nov-17</td>
<td>0.0-0.5</td>
<td>N</td>
<td>0.041</td>
<td>0.00109J</td>
<td>0.000958U</td>
<td>0.000526J</td>
<td>0.000469J</td>
<td>0.0000694J</td>
</tr>
<tr>
<td>10SD01</td>
<td>ESHEP-10-SD01-0-0.5</td>
<td>19-Oct-17</td>
<td>0.0-0.5</td>
<td>N</td>
<td>0.0171</td>
<td>0.000654J</td>
<td>0.000999U</td>
<td>0.000769J</td>
<td>0.000469J</td>
<td>0.0000296J</td>
</tr>
<tr>
<td></td>
<td>ESHEP-SD-DUP01-101917</td>
<td>19-Oct-17</td>
<td>0.0-0.5</td>
<td>FD</td>
<td>0.0145</td>
<td>0.00079J</td>
<td>0.001U</td>
<td>0.00034J</td>
<td>0.000164J</td>
<td>0.0000348J</td>
</tr>
</tbody>
</table>

**Notes:**
- Light Blue Shaded = Exceeds Screening Level
- FD = Field Duplicate Sample
- ft = Feet
- ID = Identification
- J = The analyte was positively identified and the associated numerical value is the approximate concentration of the analyte in the sample.
- N = Normal Field Sample
- NA = Not applicable
- PRL = Potential Release Location
- U = The analyte was analyzed for, but was not detected above the reported limit of detection (LOD).
- mg/kg = milligrams per kilogram
- PFAS analysis by Modified USEPA Method 537 using Liquid Chromatography and Tandem Mass Spectrometry

*Screening levels calculated using the EPA Regional Screening Level calculator [https://epa-prgs.ornl.gov/cgi-bin/chemicals/csl_search]


**Table 6**  
Summary of Surface Water Analytical Testing Results  
FY16 Phase I Regional Site Inspections for Perfluorinated Compounds  
167th Airlift Wing, West Virginia Air National Guard  
Eastern West Virginia Regional Airport Shepherd Field (EWWRA), Martinsburg, West Virginia

### Analyte:
- Perfluorooctanesulfonic acid (PFOS)
- Perfluorooctanoic acid (PFOA)
- PFOS+PFOA
- Perfluorobutanesulfonic acid (PFBS)
- Perfluoroheptanoic acid (PFHpA)
- Perfluorohexanesulfonic acid (PFHxS)
- Perfluorononanoic acid (PFNA)

### Health Advisory:

<table>
<thead>
<tr>
<th>Health Advisory:</th>
<th>0.07</th>
<th>0.07</th>
<th>0.07</th>
<th>NA</th>
<th>NA</th>
<th>NA</th>
<th>NA</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>EPA RSL Tapwater¹:</th>
<th>NA</th>
<th>NA</th>
<th>NA</th>
<th>400</th>
<th>NA</th>
<th>NA</th>
<th>NA</th>
</tr>
</thead>
</table>

### Notes:
- Light Blue Shaded = Exceeds Health Advisory
- Underlined results exceed the EPA RSL standard.
- FD = Field Duplicate Sample
- ft = Feet
- ID = Identification
- J = The analyte was positively identified and the associated numerical value is the approximate concentration of the analyte in the sample.
- N = Normal Field Sample
- NA = Not applicable
- PRL = Potential Release Area
- µg/L = micrograms per liter
- PFAS analysis by Modified USEPA Method 537 using Liquid Chromatography and Tandem Mass Spectrometry
- Health Advisory from USEPA Office of Water, 2016a and 2016b, Health Advisories (HAs) for drinking water.
- EPA Regional Screening Levels (November 2017)  

### Results:

<table>
<thead>
<tr>
<th>PRL</th>
<th>Location</th>
<th>Sample ID</th>
<th>Sample Date</th>
<th>Sample Depth (ft.)</th>
<th>Sample Type</th>
<th>µg/L</th>
<th>µg/L</th>
<th>µg/L</th>
<th>µg/L</th>
<th>µg/L</th>
<th>µg/L</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>03SW01</td>
<td>ESHEP-03-SW01-110617</td>
<td>06-Nov-17</td>
<td>0.5-0.5</td>
<td>N</td>
<td>2.92</td>
<td>0.142</td>
<td>3.062</td>
<td>0.0164</td>
<td>0.0882</td>
<td>0.432</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ESHEP-SW-DUP01-110617</td>
<td>06-Nov-17</td>
<td>0.5-0.5</td>
<td>FD</td>
<td>2.89</td>
<td>0.133</td>
<td>3.023</td>
<td>0.0127</td>
<td>0.0843</td>
<td>0.353</td>
</tr>
</tbody>
</table>
## Table 7
### SI Screening Criteria
FY16 Phase I Regional Site Inspections for Perfluorinated Compounds
167th Airlift Wing, West Virginia Air National Guard, Martinsburg, West Virginia

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Chemical Abstract Number</th>
<th>USEPA Regional Screening Level Table (November 2017)(^a)</th>
<th>Air Force Guidance for Soils and Sediments(^b) (μg/kg)</th>
<th>USEPA Health Advisory Drinking Water (Surface Water or Groundwater) (μg/L)(^c)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Perfluorobutane sulfonate (PFBS)</td>
<td>375-73-5</td>
<td>1,300,000(^d)</td>
<td>400(^o)</td>
<td>NL</td>
</tr>
<tr>
<td>Perfluorooctanoic acid (PFOA)</td>
<td>335-67-1</td>
<td>NL</td>
<td>NL</td>
<td>1,260</td>
</tr>
<tr>
<td>Perfluorooctane sulfonate (PFOS)</td>
<td>1763-23-1</td>
<td>NL</td>
<td>NL</td>
<td>1,260</td>
</tr>
</tbody>
</table>

Notes:

\(^a\) USEPA Regional Screening Levels (USEPA, 2017a).

\(^b\) Screening levels calculated using the USEPA Regional Screening Level calculator [https://epa-prgs.ornl.gov/cgi-bin/chemicals/csl_search]. The toxicity value input for the calculator is the Tier 3 value reference dose of 0.00002 milligrams per kilogram per day (mg/kg/day) derived by USEPA in their Drinking Water Health Advisories for both PFOS (USEPA, 2016a) and PFOA (USEPA, 2016b).

\(^c\) USEPA, 2016b. *Drinking Water Health Advisory for Perfluorooctanoic Acid (PFOA)* and USEPA, 2016a. *Drinking Water Health Advisory for Perfluorooctane Sulfonate (PFOS).*

\(^d\) PFBS RSL (based on a THQ of 1.0) for Residential Soil concentration presented in the SI Work Plan (Amec Foster Wheeler, 2017) was 1,600,000 μg/kg based on the May 2016 RSL values. This table has been updated to include the more recent RSL values published in November 2017.

\(^e\) PFBS RSL (based on a THQ of 1.0) for Tap Water presented in the SI Work Plan (Amec Foster Wheeler, 2017) was 380 μg/L based on the May 2016 RSL values. This table has been updated to include the more recent RSL values published in November 2017.

\(^f\) Only groundwater and surface water were sampled during the SI, but analytical results have been compared to the tap water screening levels.

\(^o\) Note: When PFOA and PFOS are both present, the combined detected concentrations of the compounds are compared with the 0.07 μg/L health advisory value.

\(NL\) = not listed

μg/kg = micrograms per kilogram

μg/L = micrograms per liter
Martinsburg
Air National Guard Base
Martinsburg, West Virginia

Legend
- Base Area (approximate)

Location of Site

Notes & Sources
Sources: Base Area datalayer obtained from Figure 2 (Site Features and Potential AOCs) of the Final Perfluorinated Compounds Preliminary Assessment Site Visit Report prepared by BB&E and dated December 2015.
Martinsburg  
Air National Guard Base  
Martinsburg, West Virginia  

Legend  
- Base Area (approximate)

SITE & AREA FEATURES  

Notes & Sources  
Sources: Base Area data layer obtained from Figure 2 (Site Features and Potential AOCs) of the Final Perfluorinated Compound's Preliminary Assessment Site Visit Report prepared by BB&E and dated December 2015. Lakes and ponds and rivers and stream data layers sourced from WV GIS Clearinghouse.
### SAMPLE LOCATIONS

<table>
<thead>
<tr>
<th>PRL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Martinsburg Air National Guard Base</td>
</tr>
<tr>
<td>Martinsburg, West Virginia</td>
</tr>
</tbody>
</table>

### Legend

- **Temporary Well**
- **Soil Sample**
- **Surface Water/Sediment Sample**
- **Assumed Groundwater Flow Direction**
- **AFFF-PFC-PRL (approximate)**
- **Base Area (approximate)**

### Location of Site

#### Notes & Sources

Amec Foster Wheeler Environment & Infrastructure, Inc.
4021 Stirrup Creek Dr., Suite 100
Durham, NC 27703
(919) 381-9900

**FIGURE 3**

**Location of Site**

**Legend**

- **PRL**
- **SAMPLE LOCATIONS**

**Martinsburg Air National Guard Base**

**Martinsburg, West Virginia**

- **Temporary Well**
- **Soil Sample**
- **Surface Water/Sediment Sample**
- **Assumed Groundwater Flow Direction**
- **AFFF-PFC-PRL (approximate)**
- **Base Area (approximate)**

**Notes:**

- **AFFF:** Aqueous film forming foam
- **PFC:** Perfluorinated compounds
- **PRL:** Potential release location

**Sources:**

- Figures 2 (Site Features and Potential AOCs) of the Final Perfluorinated Compounds Preliminary Assessment Site Visit Report prepared by BB&E and dated December 2016.

### Notes & Sources

Amec Foster Wheeler Environment & Infrastructure, Inc.
4021 Stirrup Creek Dr., Suite 100
Durham, NC 27703
(919) 381-9900
**FIGURE 4**

**PRL 1 SAMPLE RESULTS**
Martinburg Air National Guard Base
Martinburg, West Virginia

**Legend**
- Temporary Monitoring Well
- Soil Sample
- Approximate Groundwater Flow
- Potential AFFF PFC PRL (approximate)
- Installation Area (approximate)

**Notes & Sources**
- **Notes:** AFFF - aqueous film forming foam
- μg/kg - micrograms per kilogram
- μg/L - micrograms per liter
- PFL - potential release location
- PFC - perfluorocarbons
- PFOS - Perfluorooctanesulfonic acid
- PFOA - Perfluorooctanoic acid
- PFBS - Perfluorobutanesulfonic acid
- PFHpA - Perfluorohexanoic acid
- PFHxS - Perfluorohexanesulfonic acid
- PFNA - Perfluorononanoic acid

- **B** - The analyte was found in an associated blank, as well as in the sample.
- **J** - The analyte was positively identified and the associated numerical value is the approximate concentration of the analyte in the sample.
- **Q** - The analyte is both B qualified because of blank detection and J qualified because of an additional QC issue.
- **U** - The analyte was analyzed for, but was not detected above the reported limit of detection (LOD).

- **BOLD** text indicates a detection.
- **YELLOW** highlighted cells indicate 0.07 μg/L Health Advisory Exceedance in water or 1,260 μg/kg Air Force Calculated Screening Level Exceedance in soil.

**Sources:** Potential AFFF PFC PRLs and Installation Area datalayers obtained from Figure 2 of the Final Perfluorinated Compounds Preliminary Assessment Site Visit Report prepared by BB&E and dated December 2015.

---

**Table:**

<table>
<thead>
<tr>
<th>Location</th>
<th>Analyte</th>
<th>Depth (ft)</th>
<th>Result (μg/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>TW-01</td>
<td>PFOS</td>
<td>10</td>
<td>17.0</td>
</tr>
<tr>
<td></td>
<td>PFOA</td>
<td>10</td>
<td>76.1</td>
</tr>
<tr>
<td></td>
<td>PFBS</td>
<td>10</td>
<td>3.19</td>
</tr>
<tr>
<td></td>
<td>PFHpA</td>
<td>10</td>
<td>7.69</td>
</tr>
<tr>
<td></td>
<td>PFHxS</td>
<td>10</td>
<td>165</td>
</tr>
<tr>
<td></td>
<td>PFPNA</td>
<td>10</td>
<td>1.39 J</td>
</tr>
<tr>
<td></td>
<td>PFOS</td>
<td>15</td>
<td>460</td>
</tr>
<tr>
<td></td>
<td>PFOA</td>
<td>15</td>
<td>40.3</td>
</tr>
<tr>
<td></td>
<td>PFBS</td>
<td>15</td>
<td>0.722 J</td>
</tr>
<tr>
<td></td>
<td>PFHpA</td>
<td>15</td>
<td>2.20</td>
</tr>
<tr>
<td></td>
<td>PFHxS</td>
<td>15</td>
<td>62.0</td>
</tr>
<tr>
<td></td>
<td>PFPNA</td>
<td>15</td>
<td>1.07 J</td>
</tr>
</tbody>
</table>

---

**Figure:**
- **1. Former FTA (IRP Site 4)**
- **SOIL**
- **GROUNDBWATER**

---

**Source:** Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
**PRL 2 SAMPLE RESULTS**

Martinsburg
Air National Guard Base
Martinsburg, West Virginia

**Legend**
- Temporary Monitoring Well
- Soil Sample
- Approximate Groundwater Flow
- Potential AFFF PFC PRL (approximate)

**Notes & Sources**

Notes:
- AFFF - aqueous film forming foam
- μg/kg - micrograms per kilogram
- μg/L - micrograms per liter
- PRL - potential release location
- PFC - perfluorinated compounds
- PFOS - Perfluorooctanesulfonic acid
- PFDA - Perfluorodecanoic acid
- PFHxS - Perfluorohexanesulfonic acid
- PFNA - Perfluorononanoic acid
- B - The analyte was found in an associated blank, as well as in the sample.
- J - The analyte was positively identified and the associated numerical value is the approximate concentration of the analyte in the sample.
- Q - The analyte is both B qualified because of blank detection and J qualified because of an additional QC issue.
- U - The analyte was analyzed for, but was not detected above the reported limit of detection (LOD). **BOLD** text indicates a detection.
- **YELLOW** highlighted cells indicate 0.07 μg/L Health Advisory Exceedance in water or 1,260 μg/kg Air Force Calculated Screening Level Exceedance in soil.

Sources: Potential AFFF PFC PRLs and Installation Area datalayers obtained from Figure 2 of the Final Perfluorinated Compounds Preliminary Assessment Site Visit Report prepared by BB&E and dated December 2015.
**Figure 6 - PRL 3 Sample Results**

Martinsburg Air National Guard Base
Martinsburg, West Virginia

**Table 6.1 - PRL 3 Sample Results**

<table>
<thead>
<tr>
<th>Location</th>
<th>Analyte</th>
<th>Depth (ft)</th>
<th>Result (μg/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>TW-03</td>
<td>PFOA</td>
<td>28</td>
<td>0.122</td>
</tr>
<tr>
<td></td>
<td>PFBS</td>
<td>28</td>
<td>0.0607</td>
</tr>
<tr>
<td></td>
<td>PFHpA</td>
<td>28</td>
<td>0.024</td>
</tr>
<tr>
<td></td>
<td>PFHxS</td>
<td>28</td>
<td>0.008</td>
</tr>
<tr>
<td></td>
<td>PFNa</td>
<td>28</td>
<td>0.0305</td>
</tr>
</tbody>
</table>

**Table 6.2 - Soil PRL 3 Sample Results**

<table>
<thead>
<tr>
<th>Location</th>
<th>Analyte</th>
<th>Depth (ft)</th>
<th>Result (μg/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>03SW01</td>
<td>PFOA</td>
<td>0-0.5</td>
<td>9.09</td>
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<td>PFBS</td>
<td>0-0.5</td>
<td>0.938</td>
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<td>PFHpA</td>
<td>0-0.5</td>
<td>0.526</td>
</tr>
<tr>
<td></td>
<td>PFHxS</td>
<td>0-0.5</td>
<td>2.56</td>
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<td></td>
<td>PFHxN</td>
<td>0-0.5</td>
<td>0.694</td>
</tr>
</tbody>
</table>

**Notes & Sources**

- **Notes:**
  - AFFF - aqueous film forming foam
  - μg/kg - micrograms per kilogram
  - μg/L - micrograms per liter
  - PRL - potential release location
  - PFC - perfluorinated compounds
  - PFOA - Perfluorooctanoic acid
  - PFBS - Perfluorobutanesulfonic acid
  - PFHpA - Perfluorohexanoic acid
  - PFHxS - Perfluorohexanesulfonic acid
  - PFNA - Perfluorononanoic acid
  - B - The analyte was found in an associated blank, as well as in the sample.
  - J - The analyte was positively identified and the associated numerical value is the approximate concentration of the analyte in the sample.
  - Q - The analyte is both B qualified because of blank detection and J qualified because of an additional QC issue.
  - U - The analyte was analyzed for, but was not detected above the reported limit of detection (LOD).

- **Legend:**
  - Temporary Monitoring Well
  - Soil Sample
  - Surface Water/Sediment Sample
  - Potential AFFF PFC PRL (approximate)
  - Installation Area

- **Sources:**
  - Potential AFFF PFC PRL and Installation Area data layers obtained from Figure 2 of the Final Perfluorinated Compounds Preliminary Assessment Site Visit Report prepared by BB&E and dated December 2015.
TABLE 7-1

GROUNDWATER

<table>
<thead>
<tr>
<th>Location</th>
<th>Analyte</th>
<th>Depth (ft)</th>
<th>Result (μg/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>TW-04</td>
<td>PFOS</td>
<td>35</td>
<td>0.081</td>
</tr>
<tr>
<td></td>
<td>PFNA</td>
<td>35</td>
<td>0.010</td>
</tr>
<tr>
<td></td>
<td>PFBS</td>
<td>35</td>
<td>0.0896</td>
</tr>
<tr>
<td></td>
<td>PFHpA</td>
<td>35</td>
<td>0.132</td>
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<td></td>
<td>PFHxO</td>
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<td>0.025</td>
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<tr>
<td></td>
<td>PFNA</td>
<td>35</td>
<td>0.0128</td>
</tr>
</tbody>
</table>

FIGURE 7-1

SOIL

<table>
<thead>
<tr>
<th>Location</th>
<th>Analyte</th>
<th>Depth (ft)</th>
<th>Result (μg/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>04S02</td>
<td>PFOS</td>
<td>0-2</td>
<td>0.06 U</td>
</tr>
<tr>
<td></td>
<td>PFOA</td>
<td>0-2</td>
<td>0.06 U</td>
</tr>
<tr>
<td></td>
<td>PFBS</td>
<td>0-2</td>
<td>0.06 U</td>
</tr>
<tr>
<td></td>
<td>PFHpA</td>
<td>0-2</td>
<td>0.06 U</td>
</tr>
<tr>
<td></td>
<td>PFNA</td>
<td>0-2</td>
<td>0.06 U</td>
</tr>
<tr>
<td></td>
<td>PFOS</td>
<td>11-13</td>
<td>0.095 J</td>
</tr>
<tr>
<td></td>
<td>PFOA</td>
<td>11-13</td>
<td>0.095 J</td>
</tr>
<tr>
<td></td>
<td>PFBS</td>
<td>11-13</td>
<td>1.03 U</td>
</tr>
<tr>
<td></td>
<td>PFHpA</td>
<td>11-13</td>
<td>1.03 U</td>
</tr>
<tr>
<td></td>
<td>PFNA</td>
<td>11-13</td>
<td>1.03 U</td>
</tr>
</tbody>
</table>

Legend

- Temporary Monitoring Well
- Soils Sample
- Approximate Groundwater Flow
- Potential AFFF PFC PRL (approximate)
- Installation Area (approximate)

Notes & Sources

- Amec Foster Wheeler
- Environment & Infrastructure, Inc.
- 4921 Stirrup Creek Drive, Suite 100
- Durham, NC 27703
- Notes: AFFF - aqueous film forming foam
  μg/kg - micrograms per kilogram
  μg/L - micrograms per liter
  PRL - potential release location
  PFC - perfluorinated compounds
  PFOA - Perfluorooctanoic acid
  PFBS - Perfluorobutanesulfonic acid
  PFHpA - Perfluorohexahydroperfluoropentanoic acid
  PFHxS - Perfluorohexanesulfonic acid
  PFNA - Perfluorononanoic acid

- B - The analyte was found in an associated blank, as well as in the sample.
- J - The analyte was positively identified and the associated numerical value is in the approximate concentration of the analyte in the sample.
- Q - The analyte is both B qualified because of blank detection and J qualified because of an additional QC issue.
- U - The analyte was analyzed for, but was not detected above the reported limit of detection (LOD).

- BOLD text indicates a detection.
- YELLOW highlighted cells indicate 0.07 μg/L Health Advisory Exceedance in water or 1,260 μg/kg Air Force Calculated Screening Level Exceedance in soil.

Sources: Potential AFFF PFC PRLs and Installation Area data layers obtained from Figures 2 of the Final Perfluorinated Compounds Preliminary Assessment Site Visit Report prepared by BB&E dated December 2015.
**Figure 8 - PRL 5 Sample Results**

**Martinsburg Air National Guard Base, Martinsburg, West Virginia**

**Legend**
- Temporary Monitoring Well
- Soil Sample
- Approximate Groundwater Flow
- Potential AFFF PFC PRL (approximate)
- Installation Area (approximate)

**Notes & Sources**

AFFF - aqueous film forming foam  
ft - feet  
μg/kg - micrograms per kilogram  
μg/L - micrograms per liter  
PPL - potential release location  
PFC - perfluorinated compounds  
PFOA - Perfluorooctanoic acid  
PTMO - Perfluorooctanesulfonic acid  
PFBS - Perfluorobutanesulfonic acid  
PFHpA - Perfluoroheptanoic acid  
PFHxS - Perfluorohexanesulfonic acid  
PFNA - Perfluorononanoic acid  
B - The analyte was found in an associated blank, as well as in the sample.  
J - The analyte was positively identified and the associated numerical value is the approximate concentration of the analyte in the sample.  
Q - The analyte is both B qualified because of blank detection and J qualified because of an additional QC issue.  
U - The analyte was analyzed for, but was not detected above the reported limit of detection (LOD).  
**Bold** text indicates a detection.  
**Yellow** highlighted cells indicate 0.07 μg/L Health Advisory Exceedance in water or 1,260 μg/kg Air Force Calculated Screening Level Exceedance in soil.

Sources: Potential AFFF PFC PRLs and Installation Area datalayers obtained from Figure 2 of the Final Perfluorinated Compounds Preliminary Assessment Site Visit Report prepared by BB&E and dated December 2015.

---

**Table: Sample Results**

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<th>Result (μg/kg)</th>
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</thead>
<tbody>
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<td>PFBS</td>
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<td></td>
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<td>0.778 J</td>
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<td></td>
<td>PFNA</td>
<td>0 - 2</td>
<td>1.36 J</td>
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<tr>
<td></td>
<td>PFOS</td>
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<td>PFBS</td>
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**Table: GROUNDWATER**

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<td></td>
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<td>0.0232</td>
</tr>
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**Notes:**

B - The analyte was found in an associated blank, as well as in the sample.  
J - The analyte was positively identified and the associated numerical value is the approximate concentration of the analyte in the sample.  
Q - The analyte is both B qualified because of blank detection and J qualified because of an additional QC issue.  
U - The analyte was analyzed for, but was not detected above the reported limit of detection (LOD).  
**Bold** text indicates a detection.  
**Yellow** highlighted cells indicate 0.07 μg/L Health Advisory Exceedance in water or 1,260 μg/kg Air Force Calculated Screening Level Exceedance in soil.

Sources: Potential AFFF PFC PRLs and Installation Area datalayers obtained from Figure 2 of the Final Perfluorinated Compounds Preliminary Assessment Site Visit Report prepared by BB&E and dated December 2015.
**GROUNDWATER**

<table>
<thead>
<tr>
<th>Location</th>
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<th>Depth (ft)</th>
<th>Result (μg/L)</th>
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</thead>
<tbody>
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<td>TW-06</td>
<td>PFOS</td>
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<td>PFOA</td>
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<td>0.00539 U</td>
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<td></td>
<td>PFBS</td>
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<td>0.00539 U</td>
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<td></td>
<td>PFHxS</td>
<td>35</td>
<td>0.00539 U</td>
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<tr>
<td></td>
<td>PFNA</td>
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<td>0.00539 U</td>
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**SOIL**

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<th>Result (μg/kg)</th>
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</thead>
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<td>PFOA</td>
<td>0 - 2</td>
<td>0.36 μg/kg</td>
</tr>
<tr>
<td></td>
<td>PFBS</td>
<td>0 - 2</td>
<td>0.36 μg/kg</td>
</tr>
<tr>
<td></td>
<td>PFHxS</td>
<td>0 - 2</td>
<td>0.36 μg/kg</td>
</tr>
<tr>
<td></td>
<td>PFNA</td>
<td>0 - 2</td>
<td>0.36 μg/kg</td>
</tr>
<tr>
<td></td>
<td>PFOS</td>
<td>11 - 13</td>
<td>0.965 U</td>
</tr>
<tr>
<td></td>
<td>PFOA</td>
<td>11 - 13</td>
<td>0.965 U</td>
</tr>
<tr>
<td></td>
<td>PFBS</td>
<td>11 - 13</td>
<td>0.965 U</td>
</tr>
<tr>
<td></td>
<td>PFHxS</td>
<td>11 - 13</td>
<td>0.965 U</td>
</tr>
<tr>
<td></td>
<td>PFNA</td>
<td>11 - 13</td>
<td>0.965 U</td>
</tr>
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</table>

**Notes & Sources**

Notes:
- AFFF - aqueous film forming foam
- ft - feet
- μg/kg - micrograms per kilogram
- μg/L - micrograms per liter
- PRL - potential release location
- PFC - perfluorinated compounds
- PFOS - Perfluorooctanesulfonic acid
- PFDA - Perfluorooctanoic acid
- PFBS - Perfluorobutanesulfonic acid
- PFHpA - Perfluoroheptanoic acid
- PFHxS - Perfluorohexanesulfonic acid
- PFNA - Perfluorononanoic acid
- B - The analyte was found in an associated blank, as well as in the sample.
- J - The analyte was positively identified and the associated numerical value is the approximate concentration of the analyte in the sample.
- Q - The analyte is both B qualified because of blank detection and J qualified because of an additional QC issue.
- U - The analyte was analyzed for, but was not detected above the reported limit of detection (LOD).

**Figures**

- **Figure 9 - PRL 6 Sample Results**

**Sources & Credits**

- Amec Foster Wheeler
  - 4021 Stirrup Creek Drive, Suite 100
  - Durham, NC 27703

- Formal geologic, earth science, geographic, CANIS, Air Force A & G, AGRIS, ENET & other GIS User Community

- BOLD text indicates a detection.
- YELLOW highlighted cells indicate 0.07 μg/L Health Advisory Exceedance in water or 1,260 μg/kg Air Force Calculated Screening Level Exceedance in soil.
**PRL 7 SAMPLE RESULTS**

Martinsburg Air National Guard Base
Martinsburg, West Virginia

**Legend**

- Temporary Monitoring Well
- Soil Sample
- Approximate Groundwater Flow
- Potential AFFF PFC PRL (approximate)
- Installation Area

**Notes & Sources**

Notes:
- AFFF - aqueous film forming foam
- μg/kg - micrograms per kilogram
- μg/L - micrograms per liter
- PRL - potential release location
- PFC - perfluorinated compounds
- PFOS - Perfluorooctanesulfonic acid
- PFDA - Perfluorooctanoic acid
- PFBS - Perfluorobutanesulfonic acid
- PFHpA - Perfluorohexanoic acid
- PFHxS - Perfluorohexanesulfonic acid
- PFNA - Perfluorononanoic acid
- B - The analyte was found in an associated blank, as well as in the sample.
- J - The analyte was positively identified and the associated numerical value is the approximate concentration of the analyte in the sample.
- Q - The analyte is both B qualified because of blank detection and J qualified because of an additional QC issue.
- U - The analyte was analyzed for, but was not detected above the reported limit of detection (LOD).

**Notes & Sources**

- **BOLD** text indicates a detection.
- **YELLOW** highlighted cells indicate 0.07 μg/L Health Advisory Exceedance in water or 1,260 μg/kg Air Force Calculated Screening Level Exceedance in soil.

Sources:
- Potential AFFF PFC PRLs and Installation Area datalayers obtained from Figure 2 of the Final Perfluorinated Compounds Preliminary Assessment Site Visit Report prepared by BB&E and dated December 2015.

**Legend**

- Temporary Monitoring Well
- Soil Sample
- Approximate Groundwater Flow
- Potential AFFF PFC PRL (approximate)
- Installation Area

**Notes & Sources**

Notes:
- AFFF - aqueous film forming foam
- μg/kg - micrograms per kilogram
- μg/L - micrograms per liter
- PRL - potential release location
- PFC - perfluorinated compounds
- PFOS - Perfluorooctanesulfonic acid
- PFDA - Perfluorooctanoic acid
- PFBS - Perfluorobutanesulfonic acid
- PFHpA - Perfluorohexanoic acid
- PFHxS - Perfluorohexanesulfonic acid
- PFNA - Perfluorononanoic acid
- B - The analyte was found in an associated blank, as well as in the sample.
- J - The analyte was positively identified and the associated numerical value is the approximate concentration of the analyte in the sample.
- Q - The analyte is both B qualified because of blank detection and J qualified because of an additional QC issue.
- U - The analyte was analyzed for, but was not detected above the reported limit of detection (LOD).

**Notes & Sources**

- **BOLD** text indicates a detection.
- **YELLOW** highlighted cells indicate 0.07 μg/L Health Advisory Exceedance in water or 1,260 μg/kg Air Force Calculated Screening Level Exceedance in soil.

Sources:
- Potential AFFF PFC PRLs and Installation Area datalayers obtained from Figure 2 of the Final Perfluorinated Compounds Preliminary Assessment Site Visit Report prepared by BB&E and dated December 2015.

**Notes & Sources**

Notes:
- AFFF - aqueous film forming foam
- μg/kg - micrograms per kilogram
- μg/L - micrograms per liter
- PRL - potential release location
- PFC - perfluorinated compounds
- PFOS - Perfluorooctanesulfonic acid
- PFDA - Perfluorooctanoic acid
- PFBS - Perfluorobutanesulfonic acid
- PFHpA - Perfluorohexanoic acid
- PFHxS - Perfluorohexanesulfonic acid
- PFNA - Perfluorononanoic acid
- B - The analyte was found in an associated blank, as well as in the sample.
- J - The analyte was positively identified and the associated numerical value is the approximate concentration of the analyte in the sample.
- Q - The analyte is both B qualified because of blank detection and J qualified because of an additional QC issue.
- U - The analyte was analyzed for, but was not detected above the reported limit of detection (LOD).

**Notes & Sources**

- **BOLD** text indicates a detection.
- **YELLOW** highlighted cells indicate 0.07 μg/L Health Advisory Exceedance in water or 1,260 μg/kg Air Force Calculated Screening Level Exceedance in soil.

Sources:
- Potential AFFF PFC PRLs and Installation Area datalayers obtained from Figure 2 of the Final Perfluorinated Compounds Preliminary Assessment Site Visit Report prepared by BB&E and dated December 2015.
**Legend**

- Temporary Monitoring Well
- Soil Sample
- Approximate Groundwater Flow (PRL & PFC)
- Installation Area (approximate)

**Notes & Sources**

- Potential AFFF
- PFC
- PRL
- Installation Area

**Figure 11 - PRL 8 Sample Results**

**Notes:**
- AFFF - aqueous film forming foam
- ft - feet
- μg/kg - micrograms per kilogram
- μg/L - micrograms per liter
- PRL - potential release location
- PFC - perfluorinated compounds
- PFOS - Perfluorooctanesulfonic acid
- PFOA - Perfluorooctanoic acid
- PFBS - Perfluorobutanesulfonic acid
- PFHpA - Perfluoroheptanoic acid
- PFHxS - Perfluorohexanesulfonic acid
- PFNA - Perfluorononanoic acid

- B - The analyte was found in an associated blank, as well as
  in the sample.
- J - The analyte was positively identified and the associated
  numerical value is the approximate concentration of the
  analyte in the sample.
- Q - The analyte is both B qualified because of blank detection
  and J qualified because of an additional QC issue.
- U - The analyte was analyzed for, but was not detected above
  the reported limit of detection (LOD).

- BOLD  text indicates a detection.
- YELLOW highlighted cells indicate 0.07 μg/L Health Advisory Exceedance in water or 1,260 μg/kg Air Force Calculated Screening Level Exceedance in soil.

**Sources:** Potential AFFF PFC PRLs and Installation Area datalayers obtained from Figure 2 of the Final Perfluorinated Compounds Preliminary Assessment Site Visit Report prepared by BB&E and dated December 2015.
**PRL 9 SAMPLE RESULTS**

Martinsburg
Air National Guard Base
Martinsburg, West Virginia

---

**Legend**

- **Temporary Monitoring Well**
- **Soil Sample**
- **Approximate Groundwater Flow**
- **Potential AFFF PFC PRL (approximate)**
- **Installation Area (approximate)**

---

**Notes & Sources**

Notes:
- AFFF - aqueous film forming foam
- ft - feet
- μg/kg - micrograms per kilogram
- μg/L - micrograms per liter
- PRL - potential release location
- PPC - perfluorinated compounds
- PFOS - Perfluorooctanesulfonic acid
- PFDA - Perfluorodecanoic acid
- PFBS - Perfluorobutanesulfonic acid
- PFHpA - Perfluoroheptanoic acid
- PFHxS - Perfluorohexanesulfonic acid
- PFNA - Perfluorononanoic acid

- B - The analyte was found in an associated blank, as well as in the sample.
- J - The analyte was positively identified and the associated numerical value is the approximate concentration of the analyte in the sample.
- Q - The analyte is both B qualified because of blank detection and J qualified because of an additional QC issue.
- U - The analyte was analyzed for, but was not detected above the reported limit of detection (LOD).

**Bold** text indicates a detection.

**Yellow** highlighted cells indicate 0.07 μg/L Health Advisory Exceedance in water or 1,260 μg/kg Air Force Calculated Screening Level Exceedance in soil.

Sources: Potential AFFF PFC PRLs and Installation Area datalayers obtained from Figure 2 of the Final Perfluorinated Compounds Preliminary Assessment Site Visit Report prepared by BB&E and dated December 2015.

---

**FIGURE 12**

Martinsburg
Air National Guard Base
Martinsburg, West Virginia

---

**Legend**

- **Temporary Monitoring Well**
- **Soil Sample**
- **Approximate Groundwater Flow**
- **Potential AFFF PFC PRL (approximate)**
- **Installation Area (approximate)**

---

**Notes & Sources**

Notes:
- AFFF - aqueous film forming foam
- ft - feet
- μg/kg - micrograms per kilogram
- μg/L - micrograms per liter
- PRL - potential release location
- PPC - perfluorinated compounds
- PFOS - Perfluorooctanesulfonic acid
- PFDA - Perfluorodecanoic acid
- PFBS - Perfluorobutanesulfonic acid
- PFHpA - Perfluoroheptanoic acid
- PFHxS - Perfluorohexanesulfonic acid
- PFNA - Perfluorononanoic acid

- B - The analyte was found in an associated blank, as well as in the sample.
- J - The analyte was positively identified and the associated numerical value is the approximate concentration of the analyte in the sample.
- Q - The analyte is both B qualified because of blank detection and J qualified because of an additional QC issue.
- U - The analyte was analyzed for, but was not detected above the reported limit of detection (LOD).

**Bold** text indicates a detection.

**Yellow** highlighted cells indicate 0.07 μg/L Health Advisory Exceedance in water or 1,260 μg/kg Air Force Calculated Screening Level Exceedance in soil.

Sources: Potential AFFF PFC PRLs and Installation Area datalayers obtained from Figure 2 of the Final Perfluorinated Compounds Preliminary Assessment Site Visit Report prepared by BB&E and dated December 2015.

---

**FIGURE 12**

Martinsburg
Air National Guard Base
Martinsburg, West Virginia

---

**Legend**

- **Temporary Monitoring Well**
- **Soil Sample**
- **Approximate Groundwater Flow**
- **Potential AFFF PFC PRL (approximate)**
- **Installation Area (approximate)**

---

**Notes & Sources**

Notes:
- AFFF - aqueous film forming foam
- ft - feet
- μg/kg - micrograms per kilogram
- μg/L - micrograms per liter
- PRL - potential release location
- PPC - perfluorinated compounds
- PFOS - Perfluorooctanesulfonic acid
- PFDA - Perfluorodecanoic acid
- PFBS - Perfluorobutanesulfonic acid
- PFHpA - Perfluoroheptanoic acid
- PFHxS - Perfluorohexanesulfonic acid
- PFNA - Perfluorononanoic acid

- B - The analyte was found in an associated blank, as well as in the sample.
- J - The analyte was positively identified and the associated numerical value is the approximate concentration of the analyte in the sample.
- Q - The analyte is both B qualified because of blank detection and J qualified because of an additional QC issue.
- U - The analyte was analyzed for, but was not detected above the reported limit of detection (LOD).

**Bold** text indicates a detection.

**Yellow** highlighted cells indicate 0.07 μg/L Health Advisory Exceedance in water or 1,260 μg/kg Air Force Calculated Screening Level Exceedance in soil.

Sources: Potential AFFF PFC PRLs and Installation Area datalayers obtained from Figure 2 of the Final Perfluorinated Compounds Preliminary Assessment Site Visit Report prepared by BB&E and dated December 2015.
### FIGURE 13

**PRL 10 Sample Results**

Martinsburg Air National Guard Base
Martinsburg, West Virginia

**Legend**

- Temporary Monitoring Well
- Soil Sample
- Sediment Sample
- Approximate Groundwater Flow
- Potential AFFF PFC PRL (approximate)
- Installation Area

**Notes & Sources**

- AFFF - aqueous film forming foam
- ft - feet
- μg/kg - micrograms per kilogram
- μg/L - micrograms per liter
- PRL - potential release location
- PFC - perfluorinated compounds
- PFOS - Perfluorooctanesulfonic acid
- PFOA - Perfluorooctanoic acid
- PFBS - Perfluorobutanesulfonic acid
- PFHpA - Perfluoroheptanoic acid
- PFHxS - Perfluorohexanesulfonic acid
- PFNA - Perfluorononanoic acid
- B - The analyte was found in an associated blank, as well as in the sample.
- J - The analyte was positively identified and the associated numerical value is the approximate concentration of the analyte in the sample.
- Q - The analyte is both B qualified because of blank detection and J qualified because of an additional QC issue.
- U - The analyte was analyzed for, but was not detected above the reported limit of detection (LOD).

#### Groundwater

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<th>Result (μg/L)</th>
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</thead>
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<td>10S00</td>
<td>PFOS</td>
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<td>0.00573 U</td>
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<tr>
<td>10S00</td>
<td>PFOA</td>
<td>35</td>
<td>0.0023 U</td>
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<tr>
<td>10S00</td>
<td>PFBS</td>
<td>35</td>
<td>0.00573 U</td>
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<tr>
<td>10S00</td>
<td>PFHxS</td>
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<td>0.0232 U</td>
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<tr>
<td>10S00</td>
<td>PFNA</td>
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<td>0.00573 U</td>
</tr>
</tbody>
</table>

**Sediment**

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<th>Result (μg/kg)</th>
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</thead>
<tbody>
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<td>0.6541</td>
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<tr>
<td>10S00</td>
<td>PFBS</td>
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<td>0.999 U</td>
</tr>
<tr>
<td>10S00</td>
<td>PFHxS</td>
<td>0 - 0.5</td>
<td>1.66 J</td>
</tr>
<tr>
<td>10S00</td>
<td>PFNA</td>
<td>0 - 0.5</td>
<td>0.296 J</td>
</tr>
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</table>

**Soil**

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<th>Result (μg/kg)</th>
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</thead>
<tbody>
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<td>0.866 U</td>
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<td>PFBS</td>
<td>0 - 2</td>
<td>0.986 U</td>
</tr>
<tr>
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<td>PFHxS</td>
<td>0 - 2</td>
<td>1.086 U</td>
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<tr>
<td>10S00</td>
<td>PFNA</td>
<td>0 - 2</td>
<td>0.078 J</td>
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<td>PFOA</td>
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<td>0.502 J</td>
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<tr>
<td>10S00</td>
<td>PFBS</td>
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<td>0.966 U</td>
</tr>
<tr>
<td>10S00</td>
<td>PFHxS</td>
<td>3 - 5</td>
<td>0.966 U</td>
</tr>
<tr>
<td>10S00</td>
<td>PFNA</td>
<td>3 - 5</td>
<td>0.966 U</td>
</tr>
</tbody>
</table>

**Notes:**
- Air Force Calculated Screening Level Exceedance in soil.
- Health Advisory Exceedance in water or 1,260 μg/kg.
APPENDIX A

SOIL BORING AND MONITORING WELL CONSTRUCTION LOGS
SOIL CLASSIFICATION AND REMARKS

SEE KEY SYMBOL SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS USED BELOW.

Silty fine to coarse grained SAND and coarse angular GRAVEL; [FILL], red, Roots and organics top 1 ft. Some clay from 3-5 ft.

CLAY, some well-graded angular Gravel (broken boulder fragments), little fine to coarse grained sand and silt (CL), tan, homogenous, occasional orange oxidation mottling, moist, moderately plastic, slow dilatancy, moderate toughness, medium dry strength, stiff

Same as above

STOPPED AT 15 FT BGS

SOIL BORING / MONITORING WELL RECORD

Project: Martinsburg Air National Guard Base
Project No: 291330006
Boring No. 01SB02

CHECKED BY: SH

271 Mill Road
Chelmsford, MA 01824

THIS RECORD IS A REASONABLE INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BETWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.
### Soil Classification and Remarks

See key symbol sheet for explanation of symbols and abbreviations used below.

<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Legend</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Well-graded SAND and GRAVEL, some clay, light brown; [FILL]</td>
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<tr>
<td>5</td>
<td>CLAY, some Sand, trace coarse gravel (CH), brown, homogenous, moist, moderately plastic, no dilatancy, moderate toughness, medium dry strength, very stiff</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Limestone boulder</td>
<td></td>
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<tr>
<td>15</td>
<td>Same as above</td>
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<tr>
<td></td>
<td>CLAY, some well-graded Sand, little fine gravel (CH), light brown, homogenous, dry, moderately plastic, no dilatancy, moderate toughness, high dry strength, very stiff</td>
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</tbody>
</table>

### Soil Boring / Monitoring Well Record

**Project:** Martinsburg Air National Guard Base  
**Project No:** 291330006  
**Boring No.:** 02SB02  
**Checked By:** SH  

<table>
<thead>
<tr>
<th>Start Date</th>
<th>Ground Elevation (ft)</th>
<th>Vertical Datum</th>
<th>Northing</th>
<th>Easting</th>
<th>Horizontal Datum</th>
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THIS RECORD IS A REASONABLE INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BETWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.
SOIL CLASSIFICATION AND REMARKS

SEE KEY SYMBOL SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS USED BELOW.

DEPTH (ft)

0

5

10

15

20

25

S-1

ESHEP-02SB03-0-2

0.0

80/40

S-2

ESHEP-02SB03-8-10

0.0

80/40

S-3

Stopped at 15 ft bgs

MONITORING WELL CONSTRUCTION DETAILS AND REMARKS

DEPTH (ft)

0

5

10

15

20

25

SAMPLE ID

TYPE

PID (Ft)

S-1

ESHEP-02SB03-0-2

0.0

80/40

S-2

ESHEP-02SB03-8-10

0.0

80/40

S-3

Stopped at 15 ft bgs

LEGEND

0

5

10

15

20

25

DE PHT

FILL CLAY, some well-graded Sand and Gravel

SAME AS ABOVE, TANNOISH BROWN

CLAY, some well-graded Sand, little fine to coarse gravel (CH), light brown, moist, moderately plastic, no dilatancy, moderate toughness, medium dry strength, stiff

POSSIBLE BEDROCK OR Boulder

START DATE: 10/30/2017
END DATE: 10/30/2017
DRILLER: Cascade
EQUIPMENT: Prosocic 10adr7
METHOD: Roto Sonic
HOLE DIA.: 4" OD
SITE: PRL 2
LOGGED BY: Sean Hulburt

GROUND ELEVATION: ft.

VERTICAL DATUM:

NORTHING: 227895.8243 ft.
EASTING: -491563.2947 ft.
HORIZONTAL DATUM:

271 Mill Road
Chelmsford, MA 01824

Page 1 of 1
**SOIL CLASSIFICATION AND REMARKS**

**Silty angular GRAVEL:** [FILL]

**SAME AS ABOVE**

**CLAY, some well-graded Gravel and Sand (CH), tannish brown, homogenous, moist, moderately plastic, no dilatancy, moderate toughness, medium dry strength, very stiff**

---

**SOIL BORING / MONITORING WELL RECORD**

Project: Martinsburg Air National Guard Base  
Project No: 291330006  
Boring No. 03SB02  
Checked By: SH

---

This record is a reasonable interpretation of subsurface conditions at the exploration location. Subsurface conditions at other locations and at other times may differ. Interfaces between strata are approximate. Transitions between strata may be gradual.
SOIL CLASSIFICATION AND REMARKS

SEE KEY SYMBOL SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS USED BELOW.

Clayey GRAVEL and SAND, light brown; [FILL]

CLAY, little well-graded sand, trace fine gravel (CH), light reddish brown, homogenous, moist, moderately plastic, no dilatancy, moderate toughness, medium dry strength, very stiff

Same as above

MONITORING WELL CONSTRUCTION DETAILS AND REMARKS

SAMPLES

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<th>TYPE</th>
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Stopped at 15 ft bgs

SOIL BORING / MONITORING WELL RECORD

Project: Martinsburg Air National Guard Base
Project No: 291330006
Boring No. 04SB03
Checked By: SH

START DATE: 11/1/2017
END DATE: 11/1/2017
GROUND ELEVATION: ft.
VERTICAL DATUM:
NORTHING: 227848.6231 ft.
EASTING: -491129.7666 ft.
HORIZONTAL DATUM:

METHOD: Roto Sonic

HOLE DIA.: 4" OD
SITE: PRL 4
LOGGED BY: Sean Hulbert

THIS RECORD IS A REASONABLE INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BETWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.
SOIL CLASSIFICATION AND REMARKS

SEE KEY SYMBOL SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS USED BELOW.

CLAY, some well-graded Sand, trace gravel and silt (CH), light brown, homogenous, roots and organics topsoil from 0-6 inches, moist, highly plastic, no dilatancy, moderate toughness, medium dry strength, stiff

Angular coarse GRAVEL (broken cobbles and boulders), some Clay and well-graded Sand (GC), light brownish gray, coarse grained, homogenous, angular, moist

Same as above

Possible boulder or bedrock

MONITORING WELL CONSTRUCTION DETAILS AND REMARKS

SAMPLE

<table>
<thead>
<tr>
<th>SAMPLE ID</th>
<th>TYPE</th>
<th>PID</th>
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</table>

Stopped at 15 ft bgf

SOIL BORING / MONITORING WELL RECORD

Project: Martinsburg Air National Guard Base
Project No: 291330006
Boring No. 05SB01
Checked By: SH

271 Mill Road
Chelmsford, MA 01824

THIS RECORD IS A REASONABLE INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BETWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.
SOIL CLASSIFICATION AND REMARKS

CLAY, little well-graded sand, trace silt and fine gravel (CH), light brown, homogenous, roots, dark brown topsoil from 0 to 6 in, moist, highly plastic, no dilatancy, high toughness, medium dry strength, very stiff

SAME AS ABOVE

SAME AS ABOVE, INCREASING GRAVEL BELOW 12 FEET

SOIL BORING / MONITORING WELL RECORD

Project: Martinsburg Air National Guard Base
Project No: 291330006
Boring No. 05SB03

START DATE: 10/23/2017
END DATE: 10/23/2017
DRILLER: Cascade
EQUIPMENT: Prosonic 10dr7
METHOD: Roto Sonic
HOLE DIA.: 4" OD
SITE: PRL 5
LOGGED BY: Sean Hulburt

GROUND ELEVATION: ft.
VERTICAL DATUM: NAD88
NORTHING: 229046.0313 ft.
EASTING: -490927.117 ft.
HORIZONTAL DATUM: NAD88

THIS RECORD IS A REASONABLE INTERPRETATION OF SUBSURFACE CONDITIONS AT THE LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BETWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.
SOIL CLASSIFICATION AND REMARKS

SEE KEY SYMBOL SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS USED BELOW.

- Organic Soil with Gravel (OL) Loose topsoil, dark brown, homogenous, moist, non-plastic, stiff
- Same as above
- Cobbles, gravel, clay, [FILL], light brown
- CLAY, some well-graded Sand (CH), light brown, homogenous, moist, moderately plastic, no dilatancy, moderate toughness, medium dry strength, very stiff
- Same as above

SAMPLES

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</table>

MONITORING WELL CONSTRUCTION DETAILS AND REMARKS

STOPPED AT 18 FT BGS

SOIL BORING / MONITORING WELL RECORD

Project: Martinsburg Air National Guard Base
Project No: 291330006
Boring No. 06SB01

CHECKED BY: SH

271 Mill Road
Chelmsford, MA 01824

THIS RECORD IS A REASONABLE INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BETWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.
SOIL BORING / MONITORING WELL RECORD
Project: Martinsburg Air National Guard Base
Project No: 291330006
Boring No. 06SB03
Checked By: SH

START DATE: 11/9/2017
END DATE: 11/9/2017
DRILLER: Cascade
EQUIPMENT: Prosonic 10sdr7
METHOD: Roto Sonic
HOE DIA.: 4" OD
SITE: PRL 6
LOGGED BY: Sean Hulbert
GROUND ELEVATION: ft.
VERTICAL DATUM:
NORTHING: 227354.4468 ft.
EASTING: -493205.1215 ft.
HORIZONTAL DATUM:

THIS RECORD IS A REASONABLE INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BETWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.
SOIL CLASSIFICATION AND REMARKS

SEE KEY SYMBOL SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS USED BELOW.

DEPTH
(ft)

ELEV.
(ft)

LEGEND

S-1
S-2
S-3

SAMPLE
ID

0.0

0.0

0.0

0.0

GROWN ELEVATION: ft.

GROUND ELEVATION: ft.

VERTICAL DATUM: 227627.2372 ft.

NORTHING: -491070.2954 ft.

EASTING: HORIZONTAL DATUM:

DRILLER: Cascade

EQUIPMENT: Prosonic 10dr7

METHOD: Roto Sonic

HOLE DIA.: 4" OD

SITE: PRL 7

LOGGED BY: Sean Hulbert

SOIL BORING / MONITORING WELL RECORD

Project: Martinsburg Air National Guard Base

Project No: 291330006

Boring No. 07SB02

Checked By: SH

THIS RECORD IS A REASONABLE INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BETWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.
SOIL CLASSIFICATION AND REMARKS

CLAY, some well-graded Sand, trace silt and fine gravel (CH), light reddish brown, homogenous, topsoil 0-4 in., moist, moderately plastic, no dilatancy, moderate toughness, high dry strength, stiff

5 ft

Same as above, mottling below 7 feet

10 ft

Same as above

15 ft

Note: decreasing sand below 5 ft bgs

20 ft

Stopped at 15 ft bgs

PROJECT: Martinsburg Air National Guard Base
Project No: 291330006
Boring No. 09SB01

START DATE: 11/2/2017
END DATE: 11/2/2017
DRILLER: Cascade
EQUIPMENT: Prosonic 10dr7
METHOD: Roto Sonic
HOLE DIA.: 4" OD
SITE: PRL 9
LOGGED BY: Sean Hulbert

GROUND ELEVATION: 0 ft.
VERTICAL DATUM: NAD 1988
NORTHING: 227658.6939 ft.
EASTING: -490838.9768 ft.
HORIZONTAL DATUM: NAD 83 WGS 84

THIS RECORD IS A REASONABLE INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BETWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.
SOIL CLASSIFICATION AND REMARKS

SEE KEY SYMBOL SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS USED BELOW.

- Well-graded SAND, some Clay and coarse Gravel (SC), brown, homogenous, angular, roots and organics, moist
- Well-graded GRAVEL (broken boulder) (GW), dark gray, fine to coarse grained, homogenous, dry
- CLAY, some well-graded Sand and Gravel (CL), tan, homogenous, moist, slightly plastic, no dilatancy, moderate toughness, medium dry strength, stiff
- See remarks, [FILL]

MONITORING WELL CONSTRUCTION DETAILS AND REMARKS

Encountered possible old leach field drain line at 8 ft bgs, removed chunk of small pvc pipe. Encountered abundant sand and water below 8 ft bgs. Made call to stop boring, verified as built drawings to ensure no utility.

SOIL BORING / MONITORING WELL RECORD

Project: Martinsburg Air National Guard Base
Project No: 291330006
Boring No. 10SB01
Checked By: SH

START DATE: 10/19/2017
END DATE: 10/19/2017
DRILLER: Cascade
EQUIPMENT: Prosonic 10dr7
METHOD: Roto Sonic
HOLE DIA.: 4" OD
SITE: PRL 10
LOGGED BY: Sean Hulburt

GROUNDS ELEVATION: ft.
VERTICAL DATUM:
NORTHING: 228430.1867 ft.
EASTING: -491519.3842 ft.
HORIZONTAL DATUM:
THIS RECORD IS A REASONABLE INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BETWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

| SAMPLE ID | TYPE | PID | RECOVER
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3D View of Boring Log:

271 Mill Road
Chelmsford, MA 01824
### Soil Classification and Remarks

See key symbol sheet for explanation of symbols and abbreviations used below.

CLAY, some Sand and fine Gravel (CL), brown, homogenous, top 6in - organics, roots and plant matter,, moist, moderately plastic, no dilatancy, moderate toughness, medium dry strength, stiff

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<th>SAMPLE ID</th>
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<tbody>
<tr>
<td>S-1</td>
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<td>24/24</td>
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</table>

Moved sample location twice to avoid gravel refusal. Bottom of hand boring at 2 ft bgs, no refusal.
**SOIL CLASSIFICATION AND REMARKS**

SEE KEY SYMBOL SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS USED BELOW.

- **Broken BOULDER and COBBLES**, little well-graded sand and silt (GW), dark gray, fine to coarse grained, angular, dry
- **Lean CLAY**, some Silt, little fine angular gravel and well-graded sand (CL), gray, homogenous, some organics, moist, moderately plastic, no dilatancy, moderate toughness, medium dry strength, very stiff
  - Same as above, tan, stiff
- **Same as above**

**MONITORING WELL CONSTRUCTION DETAILS AND REMARKS**

<table>
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<th>SAMPLE ID</th>
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<td>ESHEP-10SB03-13-15</td>
<td></td>
<td>0.0</td>
<td>60/90</td>
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</table>

- Topsoil from 0-0.5 ft bgs
- Stopped at 15 ft bgs

**SOIL BORING / MONITORING WELL RECORD**

Project: Martinsburg Air National Guard Base

Project No: 291330006

Checked By: SH

Boring No. 10SB03

THIS RECORD IS A REASONABLE INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BETWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.
SOIL CLASSIFICATION AND REMARKS

SEE KEY SYMBOL SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS USED BELOW.

Fat Clay with Sand (CH), light brown, no odor, homogenous, moist, moderately plastic, no dilatancy, moderate toughness, medium dry strength, stiff

Dark gray limestone

Same as above

Same as above

(CONTINUED ON FOLLOWING PAGE)

SOIL BORING / MONITORING WELL RECORD

Project: Martinsburg Air National Guard Base
Project No: 291330006
Well No. BW-01

Checked By: SH

271 Mill Road
Chelmsford, MA 01824

THIS RECORD IS A REASONABLE INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BETWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.
SOIL CLASSIFICATION
AND REMARKS

SEE KEY SYMBOL SHEET FOR EXPLANATION
OF SYMBOLS AND ABBREVIATIONS USED BELOW.

No Sample Or No Recovery Obtained ‘Void’(Continued)

LEGEN

(continued)

SAMPLES

MONITORING WELL
CONSTRUCTION DETAILS
AND REMARKS

DEPTH
(ft)

25

30

Tan to gray dolomite/limestone

35

40

45

50

START DATE: 11/20/2017
END DATE: 11/21/2017
DRILLER: Cascade
EQUIPMENT: Prosonic 10sdr7
METHOD: Roto Sonic
HOLE DIA.: 6-inch
SITE: BW-02
LOGGED BY: Sean Hulbert

GROUND ELEVATION: ft.
VERTICAL DATUM:
NORTHING: 228205.1649 ft.
EASTING: -494725.9162 ft.
HORIZONTAL DATUM:

SOIL BORING / MONITORING WELL RECORD
Project: Martinsburg Air National Guard Base
Project No: 291330006
Well No. BW-02
Checked By: SH

THIS RECORD IS A REASONABLE INTERPRETATION OF SUBSURFACE CONDITIONS AT THE
EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES
MAY DIFFER. INTERFACES BETWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA
MAY BE GRADUAL.
SOIL CLASSIFICATION
AND REMARKS

SEE KEY SYMBOL SHEET FOR EXPLANATION
OF SYMBOLS AND ABBREVIATIONS USED BELOW.

CLAY, some well-graded Sand, trace fine gravel (CH), light
reddish brown, homogenous, moist, moderately plastic, no
dilatancy, moderate toughness, medium dry strength, stiff

Same as above

Dark gray limestone, calcite filled veins

Same as above

(CONTINUED ON FOLLOWING PAGE)

SOIL BORING / MONITORING WELL RECORD

Project: Martinsburg Air National Guard Base
Project No: 291330006
Well No. BW-03

CHECKED BY: SH

THIS RECORD IS A REASONABLE INTERPRETATION OF SUBSURFACE CONDITIONS AT THE
EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES
MAY DIFFER. INTERFACES BETWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA
MAY BE GRADUAL.
SOIL BORING / MONITORING WELL RECORD

Project: Martinsburg Air National Guard Base
Project No: 291330006
Well No. BW-03
Checked By: SH

START DATE: 11/16/2017
END DATE: 11/16/2017
DRILLER: Cascade
equipment: Prosonic 10dr7
METHOD: Roto Sonic
HOLE Dia.: 6-inch
SITE: BW-03
LOGGED BY: Sean Hulbert

GROUND ELEVATION: ft.
VERTICAL DATUM: 228991.8405 ft.
EASTING: -493467.2357 ft.
HORIZONTAL DATUM:

THIS RECORD IS A REASONABLE INTERPRETATION OF SUBSURFACE CONDITIONS AT THE
EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES
MAY DIFFER. INTERFACES BETWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA
MAY BE GRADUAL.

SOIL CLASSIFICATION
AND REMARKS
SEE KEY SYMBOL SHEET FOR EXPLANATION
OF SYMBOLS AND ABBREVIATIONS USED BELOW.

DEPTH
(ft)

25

SAME AS ABOVE (Continued)

30

SAME AS ABOVE

35

NO SAMPLE OR NO RECOVERY OBTAINED Void

40

Dark gray limestone

45

50

DEPTH
(ft)

MONITORING WELL CONSTRUCTION DETAILS
AND REMARKS

FLUSH PER MIN.
Sample ID
Type
Depth

24.5-25.5 ft bgs
Filter sand
25.5-40 ft bgs

S-5

27.5-40 ft bgs

Stopped at 40 ft
bgs
SOIL CLASSIFICATION AND REMARKS

SEE KEY SYMBOL SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS USED BELOW.

CLAY, little well-graded sand (CH), light brown, no odor, moist, moderately plastic, no dilatancy, moderate toughness, medium dry strength, very stiff

Dark gray limestone

Same as above

No Sample Or No Recovery Obtained Void

Dark gray limestone

No Sample Or No Recovery Obtained Void

Dark gray limestone

Same as above

(Continued on following page)

SOIL BORING / MONITORING WELL RECORD

Project: Martinsburg Air National Guard Base
Project No: 291330006
Well No. BW-04

Checked By: SH

271 Mill Road
Chelmsford, MA 01824

Page 1 of 2
SOIL CLASSIFICATION AND REMARKS

SEE KEY SYMBOL SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS USED BELOW.

DEPTH (ft)

25

No Sample Or No Recovery Obtained. Void

30

Dark gray limestone

MONITORING WELL CONSTRUCTION DETAILS AND REMARKS

Depth

STOPPED AT 30 FT BGS DUE TO PRESENCE OF GROUND WATER

SOIL BORING / MONITORING WELL RECORD

Project: Martinsburg Air National Guard Base

Project No: 291330006

Well No. BW-04

Checked By: SH

START DATE: 11/7/2017

GROUND ELEVATION: ft.

11/9/2017

VERTICAL DATUM:

DRILLER: Cascade

NORTHING: 228859.3532 ft.

EASTING: -491914.1758 ft.

EQUIPMENT: Prosonic 10sd7

HORIZONTAL DATUM:

METHOD: Roto Sonic

HOLE DIA.: 6-inch

SITE: BW-04

LOGGED BY: Sean Hulburt

THIS RECORD IS A REASONABLE INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BETWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.
SOIL CLASSIFICATION AND REMARKS

SEE KEY SYMBOL SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS USED BELOW.

DEPTH (ft)

25

Dark gray limestone

30

SAME AS ABOVE

35

40

45

50

SOIL BORING / MONITORING WELL RECORD

Project: Martinsburg Air National Guard Base
Project No: 291330006
Well No. BW-06
Checked By: SH

START DATE: 11/17/2017
END DATE: 11/20/2017
DRILLER: Cascade
EQUIPMENT: Prosonic 10sdr7
METHOD: Roto Sonic
HOLE DIA.: 6-inch
SITE: BW-08
LOGGED BY: Sean Hulbert

GROUND ELEVATION: ft.
VERTICAL DATUM: NORTHING: 228649.1187 ft.
EASTING: -492970.0222 ft.
HORIZONTAL DATUM: 2012

STOPPED AT 40 ft bgd

THIS RECORD IS A REASONABLE INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BETWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.
SOIL CLASSIFICATION AND REMARKS

SEE KEY SYMBOL SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS USED BELOW.

Fill of varying lithology from clay to gravel; [FILL], Brown from 0 to 3 ft bgs then red from 3 to 10 ft bgs,

0

Same as above

CLAY, some fine Gravel, little medium sand and silt (CH), reddish brown, homogenous, moist, moderately plastic, slow dilatancy, high toughness, high dry strength, hard

10

Same as above, decreasing gravel below 22 feet

15

(CONTINUED ON FOLLOWING PAGE)

SOIL BORING / MONITORING WELL RECORD

Project: Martinsburg Air National Guard Base
Project No: 291330006
Well No. TW-01
Checked By: SH

THIS RECORD IS A REASONABLE INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BETWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.
SOIL CLASSIFICATION AND REMARKS

SEE KEY SYMBOL SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS USED BELOW.

DEPTH (ft)

25

Same as above, decreasing gravel below 22 feet (Continued)

30

Boulder, fine grained sediment

Same as 12-20 ft, reddish brown, homogenous, dry, highly plastic, no dilatancy, high toughness, high dry strength, hard

40

Dark gray limestone

GROUND ELEVATION: ft.

VERTICAL DATUM: NAD 83

EASTING: 226247.9076 ft.

HORIZONTAL DATUM: NAD 83

-495508.5925 ft.

METHOD: Roto Sonic

HOLE DIA.: 6-inch

SITE: PRL 1

LOGGED BY: Sean Hulbert

MONITORING WELL CONSTRUCTION DETAILS AND REMARKS

SAMPLES

MONITORING WELL CONSTRUCTION DETAILS AND REMARKS

Project: Martinsburg Air National Guard Base

Project No: 291330006

Well No. TW-01

Checked By: SH

Amec Foster Wheeler

271 Mill Road

Chelmsford, MA 01824

Page 2 of 2
SOIL CLASSIFICATION AND REMARKS

SEE KEY SYMBOL SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS USED BELOW.

0
Organic rich CLAY and fine SAND (OL/Oh), brownish black, homogenous, moist, slightly plastic, slow dilatancy, low toughness, low dry strength, medium stiff

CLAY, trace silt and fine grained sand (CH), reddish brown, strong odor, homogenous, moist, highly plastic, no dilatancy, moderate toughness, stiff

CLAY, some well-graded Sand, little silt and fine gravel (CH), reddish brown, moist, moderately plastic, no dilatancy, moderate toughness, very stiff

Well-graded GRAVEL, some clay (GC), tannish brown, fine to coarse grained, homogenous, angular, moist

Same as above

Dark gray limestone, possible bedrock

Same as above

SAMPLES

MONITORING WELL CONSTRUCTION DETAILS AND REMARKS

At 2 ft bgs encountered an old cast iron pipe that was empty but soil around it has strong petroleum odor. Stopped drilling to assess and determined the line is most likely abandoned.

STOPPED FOR DAY AT 25 FT BGS 10/31

SOIL BORING / MONITORING WELL RECORD

Project: Martinsburg Air National Guard Base
Project No: 291330006
Well No. TW-04

CHECKED BY: SH

271 Mill Road
Che尔斯ford, MA 01824

Page 1 of 2
SOIL CLASSIFICATION
AND REMARKS

SEE KEY SYMBOL SHEET FOR EXPLANATION
OF SYMBOLS AND ABBREVIATIONS USED BELOW.

CLAY, little well-graded sand and silt, trace fine to coarse
gravel (CH), light brown, no odor, homogenous, Topsoil, 0-6
in. dry, highly plastic, no dilatancy, high toughness, high dry
strength, hard

ELEV
(ft)

DEPTH

0

5

10

15

20

25

(CONTINUED ON FOLLOWING PAGE)

SAMPLES

MONITORING WELL
CONSTRUCTION DETAILS
AND REMARKS

Depth

Sample

ID

Type

Recovery

()

ELEV

(ft)

.vendorisy,

1

0.0

2012

0.0

2012

Began running
6 in outer
casing at 10 ft

S-1

S-2

S-3

START DATE: 10/23/2017
END DATE: 10/24/2017
DRILLER: Cascade
EQUIPMENT: Prosonic 10sdr7
METHOD: Roto Sonic
HOLE DIA.: 6-inch
SITE: PRL 5
LOGGED BY: Sean Hulbert

GROUND ELEVATION: ft.
VERTICAL DATUM:
NORTHING: 229072.6951 ft.
EASTING: -490832.926 ft.
HORIZONTAL DATUM:

SOIL BORING / MONITORING WELL RECORD

Project: Martinsburg Air National Guard Base
Project No: 291330006
Well No. TW-05
Checked By: SH

THIS RECORD IS A REASONABLE INTERPRETATION OF SUBSURFACE CONDITIONS AT THE
EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES
MAY DIFFER. INTERFACES BETWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA
MAY BE GRADUAL.
SOIL CLASSIFICATION AND REMARKS

SEE KEY SYMBOL SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS USED BELOW.

Well-graded GRAVEL and well-graded SAND, some Clay and Silt (GC), light brown, fine to coarse grained, homogenous, subangular, moist

Limestone boulder

Broken COBBLES and well-graded GRAVEL, some Clay, trace well-graded sand (GC), light brown, fine to coarse grained, homogenous, angular, moist

CLAY, some fine grained Sand and fine Gravel (CH), light brown, homogenous, moist, highly plastic, no dilatancy, moderate toughness, medium dry strength, very stiff

Same as above

Possible bedrock/boulder, dark gray/limestone

Dark gray limestone, infilled veins with calcite

Same as above

(CONTINUED ON FOLLOWING PAGE)

MONITORING WELL CONSTRUCTION DETAILS AND REMARKS

Native material backfill 0-27 ft bgs

Void at 19 ft bgs, lost drilling water return. Tagged water at 18.9 ft bgs, will drill deeper to confirm.

SOIL BORING / MONITORING WELL RECORD

Project: Martinsburg Air National Guard Base
Project No: 291330006
Well No. TW-07
Checked By: SH

START DATE: 10/25/2017
END DATE: 10/27/2017
DRILLER: Cascade
EQUIPMENT: Prosonic 10dr7
METHOD: Roto Sonic
HOLE DIA.: 6-inch
SITE: PRL 7
LOGGED BY: Sean Hulburt

GROUND ELEVATION: ft.
VERTICAL DATUM: ft.
NORTHING: 227686.3519 ft.
EASTING: -491684.2056 ft.
HORIZONTAL DATUM:

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## Soil Classification and Remarks

**Well-graded GRAVEL and SAND, some Clay, light brown; [FILL]**

**CLAY, little fine to medium sand, trace fine gravel (CH), light reddish brown, moist, moderately plastic, no dilatancy, moderate toughness, medium dry strength strength, stiff**

**Same as above, moist, stiff**

**Dark gray limestone**

**Same as above**

**Clayey debris filled void**

(Continued on following page)

---

### Soil Boring / Monitoring Well Record

**Project:** Martinsburg Air National Guard Base  
**Project No:** 291330006  
**Well No:** TW-09

- **Start Date:** 11/2/2017  
- **End Date:** 11/6/2017  
- **Driller:** Cascade  
- **Equipment:** Prosonic 10sdr7  
- **Method:** Roto Sonic  
- **Hole Dia.:** 6-inch  
- **Site:** PRL 9  
- **Logged By:** Sean Hulbert

This record is a reasonable interpretation of subsurface conditions at the exploration location. Subsurface conditions at other locations and at other times may differ. Interfaces between strata are approximate. Transitions between strata may be gradual.
SOIL CLASSIFICATION
AND REMARKS

SEE KEY SYMBOL SHEET FOR EXPLANATION
OF SYMBOLS AND ABBREVIATIONS USED BELOW.

DEPTH
(ft)

LEGEND

SAMPLES

MONITORING WELL
CONSTRUCTION DETAILS
AND REMARKS

ELEV
(ft)

SAMPLE
ID

TYPE

RECOVERED
(ft)

DEPTH
(ft)

Clayey debris filled void

---

S-4

0.0

2090

Stopped at 30 ft
bgs due water
bearing zone

---

START DATE: 11/2/2017
END DATE: 11/6/2017
DRILLER: Cascade
EQUIPMENT: Prosonic 10 dr7
METHOD: Roto Sonic
HOLE DIA.: 6-inch
SITE: PRL 9
LOGGED BY: Sean Hulburt

GROUND ELEVATION: ft.
VERTICAL DATUM: NORTHING: 227795.8465 ft.
EASTING: -490892.1037 ft.
HORIZONTAL DATUM:

SOIL BORING / MONITORING WELL RECORD
Project: Martinsburg Air National Guard Base
Project No: 291330006
Well No. TW-09
Checked By: SH

THIS RECORD IS A REASONABLE INTERPRETATION OF SUBSURFACE CONDITIONS AT THE
EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES
MAY DIFFER. INTERFACES BETWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA
MAY BE GRADUAL.
SOIL CLASSIFICATION AND REMARKS

SEE KEY SYMBOL SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS USED BELOW.

0
CLAY, some fine grained Sand and fine Gravel (CL), brown, homogenous, dry, slightly plastic, no dilatancy, low toughness, medium stiff

5
Same as above, homogenous, moist, moderately plastic, no dilatancy, moderate toughness, medium dry strength, very stiff

10
Same as above

15
Crushed rock

20
No recovery. All material washed away by water used for drilling.

(CONTINUED ON FOLLOWING PAGE)

MONITORING WELL CONSTRUCTION DETAILS AND REMARKS

SAMPLES

DEPTH

DEPTH

SAMPLE
ID

TYPE

RECOVERED

5.0
S-2

15.0
S-3

Bentonite chip seal 23-25 ft lbs

SOIL BORING / MONITORING WELL RECORD

Project: Martinsburg Air National Guard Base
Project No: 291330006
Well No. TW-10

START DATE: 10/20/2017
END DATE: 10/23/2017
DRILLER: Cascade
EQUIPMENT: Prosonic 10sd7
METHOD: Roto Sonic
HOLE DIA.: 4" OD
SITE: PRL 10

GROUND ELEVATION: ft.
VERTICAL DATUM: NAD 83
NORTHING: 228572.3741 ft.
EASTING: -491497.5093 ft.
HORIZONTAL DATUM: NAD 83

CHECKED BY: SH

LOGGED BY: Sarah Levine

THIS RECORD IS A REASONABLE INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLOURATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BETWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.
**SOIL CLASSIFICATION AND REMARKS**

SEE KEY SYMBOL SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS USED BELOW.

No recovery. All material washed away by water used for drilling. (Continued)

CLAY, some coarse Gravel, some crushed rock (CL), yellowish brown, homogenous, wet, moderately plastic, no dilatancy, moderate toughness, medium dry strength, medium stiff

Same as 15-20 ft

**MONITORING WELL CONSTRUCTION DETAILS AND REMARKS**

- Filter sand 25-37 ft bgs
- 0.010 Slotted PVC Screen 27-37 ft bgs
- Stopped at 37 ft bgs

**SOIL BORING / MONITORING WELL RECORD**

Project: Martinsburg Air National Guard Base
Project No: 291330006
Well No. TW-10

Checked By: SH

271 Mill Road
Chelmsford, MA 01824

START DATE: 10/20/2017
END DATE: 10/23/2017
GROUND ELEVATION: ft.

DRILLER: Cascade
DRILLING: EASTING:
NO. DRILL: 10

EQUIPMENT: Prosonic 10dr7
LATITUDE:

METHOD: Roto Sonic
LONGITUDE:

HOLE DIA.: 4" OD

SITE: PRL 10

LOGGED BY: Sarah Levine

THIS RECORD IS A REASONABLE INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BETWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.
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<tr>
<th>Photographer:</th>
<th>Sarah Levine</th>
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<tbody>
<tr>
<td>Date:</td>
<td>10/25/2017</td>
</tr>
<tr>
<td>Photograph:</td>
<td>ST-01</td>
</tr>
<tr>
<td>Direction:</td>
<td>West</td>
</tr>
<tr>
<td>Description:</td>
<td>Partial view of staging area</td>
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<table>
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<th>Photographer:</th>
<th>Sarah Levine</th>
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<tbody>
<tr>
<td>Date:</td>
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<tr>
<td>Photograph:</td>
<td>ST-02</td>
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<tr>
<td>Direction:</td>
<td>Southeast</td>
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<tr>
<td>Description:</td>
<td>Rig at staging area awaiting repair</td>
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</tbody>
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## Attachment 1 – Photographic Log

<table>
<thead>
<tr>
<th>Client:</th>
<th>Air National Guard</th>
<th>Project Number:</th>
<th>291330006.09</th>
</tr>
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<tbody>
<tr>
<td>Site Name:</td>
<td>Martinsburg ANGB</td>
<td>Site Location:</td>
<td>Martinsburg, WV</td>
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<thead>
<tr>
<th>Photographer:</th>
<th>Sarah Levine</th>
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<tbody>
<tr>
<td>Date:</td>
<td>10/19/2017</td>
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<tr>
<td>Photograph:</td>
<td>SB-001</td>
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<tr>
<td>Direction:</td>
<td>West</td>
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<tr>
<td>Description:</td>
<td>Drilling of 01SB01</td>
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<th>Photographer:</th>
<th>Sarah Levine</th>
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<tbody>
<tr>
<td>Date:</td>
<td>10/18/2017</td>
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<tr>
<td>Photograph:</td>
<td>SB-002</td>
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<td>Direction:</td>
<td>Southwest</td>
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<tr>
<td>Description:</td>
<td>Drilling 01SB02</td>
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<td><strong>Photographer:</strong></td>
<td>Sarah Levine</td>
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<tr>
<td><strong>Date:</strong></td>
<td>10/27/2017</td>
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<td><strong>Photograph:</strong></td>
<td>SB-003</td>
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<td><strong>Direction:</strong></td>
<td>North</td>
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<tr>
<td><strong>Description:</strong></td>
<td>02SB01 location</td>
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<th>Sarah Levine</th>
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<tr>
<td><strong>Date:</strong></td>
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<td><strong>Photograph:</strong></td>
<td>SB-004</td>
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<tr>
<td><strong>Direction:</strong></td>
<td>Southeast</td>
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<tr>
<td><strong>Description:</strong></td>
<td>Hand-augering at location 10SB02</td>
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</tbody>
</table>
## Attachment 1 – Photographic Log

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<th>Air National Guard</th>
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<tr>
<td>Site Name:</td>
<td>Martinsburg ANGB</td>
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<tr>
<td>Site Location:</td>
<td>Martinsburg, WV</td>
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</tbody>
</table>

| Photographer: | Sarah Levine |
| Date: | 10/19/2017 |
| Photograph: | SB-005 |
| Direction: | Southeast |
| Description: | Overview of 10SB02 ditch |

| Photographer: | Sarah Levine |
| Date: | 10/23/2017 |
| Photograph: | SB-006 |
| Direction: | N |
| Description: | Surface completion of 05SB03 after borehole abandonment; representative of backfilled boreholes and temporary wells |
### Attachment 1 – Photographic Log

<table>
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<th>Client:</th>
<th>Air National Guard</th>
<th>Project Number:</th>
<th>291330006.09</th>
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<tbody>
<tr>
<td>Site Name:</td>
<td>Martinsburg ANGB</td>
<td>Site Location:</td>
<td>Martinsburg, WV</td>
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</table>

#### Photographer: Sarah Levine

#### Date: 10/18/2017

#### Photograph: PRL1-001

#### Direction: West

#### Description: Drilling of TW-1

---

#### Photographer: Sarah Levine

#### Date: 10/18/2017

#### Photograph: PRL1-002

#### Direction:

#### Description: PRL-1 soil cuttings
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<tr>
<th><strong>Client:</strong></th>
<th><strong>Project Number:</strong></th>
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<td>Air National Guard</td>
<td>291330006.09</td>
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<th><strong>Site Name:</strong></th>
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<tr>
<td>Martinsburg ANGB</td>
<td>Martinsburg, WV</td>
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<th><strong>Photographer:</strong></th>
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<th><strong>Photograph:</strong></th>
<th><strong>Direction:</strong></th>
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<tbody>
<tr>
<td>Sarah Levine</td>
<td>10/19/2017</td>
<td>PRL1-003</td>
<td>Northwest</td>
<td>Temporary well TW-01 installation</td>
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<td><strong>Photographer:</strong></td>
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<td><strong>Photograph:</strong></td>
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<tr>
<td>Sarah Levine</td>
<td>10/19/2017</td>
<td>PRL1-004</td>
<td>North-northeast</td>
<td>Completed TW-01 installation</td>
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<td>Photograph:</td>
<td>PRL5-001</td>
<td>Direction:</td>
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<tr>
<td>Description:</td>
<td>Drilling of TW-05</td>
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<table>
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<th>Date:</th>
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<td>TW-05 soil cuttings</td>
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<td>Date:</td>
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<td>Photograph:</td>
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<td>Direction:</td>
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<tr>
<td>Description:</td>
<td>Drilling halted at TW-05 to repair drill rig</td>
<td></td>
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<table>
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<tr>
<th>Photographer:</th>
<th>Sarah Levine</th>
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<td>Date:</td>
<td>10/27/2017</td>
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<td>Photograph:</td>
<td>PRL5-004</td>
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<td>Direction:</td>
<td>West</td>
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<tr>
<td>Description:</td>
<td>Installation of temporary well TW-05</td>
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<tr>
<td>Client:</td>
<td>Air National Guard</td>
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<td>---</td>
<td>---</td>
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<tr>
<td>Project Number:</td>
<td>291330006.09</td>
</tr>
<tr>
<td>Site Name:</td>
<td>Martinsburg ANGB</td>
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<tr>
<td>Site Location:</td>
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**Photographer:**
Sarah Levine

**Date:**
10/24/2017

**Photograph:**
PRL5-005

**Direction:**
West

**Description:**
Completion of TW-05

---

**Photographer:**
Sarah Levine

**Date:**
10/25/2017

**Photograph:**
PRL7-001

**Direction:**
North

**Description:**
Overall view of TW-07 drilling area
<table>
<thead>
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<th>Photographer:</th>
<th>Sarah Levine</th>
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<tbody>
<tr>
<td>Date:</td>
<td>10/25/2017</td>
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<tr>
<td>Photograph:</td>
<td>PRL7-002</td>
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<tr>
<td>Direction:</td>
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<tr>
<td>Description:</td>
<td>TW-07 borehole and drilling water containment tub</td>
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<table>
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<th>Sarah Levine</th>
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<tr>
<td>Date:</td>
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<tr>
<td>Photograph:</td>
<td>PRL7-003</td>
</tr>
<tr>
<td>Direction:</td>
<td>North</td>
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<tr>
<td>Description:</td>
<td>Developing TW-07</td>
</tr>
<tr>
<td>Photographer:</td>
<td>Sarah Levine</td>
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<tr>
<td>Date:</td>
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<tr>
<td>Description:</td>
<td>Drums with recovered drilling water and TW-07 development water</td>
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<table>
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<tr>
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<th>Sarah Levine</th>
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<td>Date:</td>
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<tr>
<td>Photograph:</td>
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<tr>
<td>Direction:</td>
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</tr>
<tr>
<td>Description:</td>
<td>Rig set up at location TW-10</td>
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<tr>
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<td>Date:</td>
<td>10/23/2017</td>
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<tr>
<td>Photograph:</td>
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<td>Direction:</td>
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<td>Description:</td>
<td>Well development of TW-10</td>
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<table>
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<th>Sarah Levine</th>
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<td>PRL10-002</td>
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<td>Direction:</td>
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<td>Description:</td>
<td>Development water from location TW-10</td>
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WELL DEVELOPMENT LOG

Project Name: Phase 1 Regional Site Inspections for Per-Fluorinated Compounds at Multiple Air National Guard Installations

Project Number: 291330006

Contract: W9133L-14-D-0002

Installation: PITTS

Well ID: Tw-01

Measuring Point: Top of Riser

Development Method: Total Volume Purged (gal):

Total Volume Purged (gal):

Technician(s): Sean hulburt

3 Casing Volumes (gal):

Initial Depth to Water (ft):

Measuring Point: Total Depth of Well (ft):

Development Method: Depth to Water After Purging (ft):

Total Volume Purged (gal):

Technician(s):

Date Started/Date Completed:

Project Name:

Project Number:

Phase 1 Regional Site Inspections for Per-Fluorinated Compounds at Multiple Air National Guard Installations

291330006

Contract: W9133L-14-D-0002

Installation: PITTS

Well ID: Tw-01

Measuring Point: Top of Riser

Development Method: Total Volume Purged (gal):

Total Volume Purged (gal):

Technician(s): Sean hulburt

3 Casing Volumes (gal):

Initial Depth to Water (ft):

Measuring Point: Total Depth of Well (ft):

Development Method: Depth to Water After Purging (ft):

Total Volume Purged (gal):

Technician(s):

Date Started/Date Completed:

Project Name:

Signature:

QA/QC'd by: QA/QC Date:

Rev. 1, Date: 12/29/2016
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<th>Water Level (feet)</th>
<th>Rate (Mil/min)</th>
<th>Temp. (°C)</th>
<th>pH (units)</th>
<th>DO (mg/L)</th>
<th>ORP (mV)</th>
<th>Turbidity (NTU)</th>
<th>Cum. Volume (gal.)</th>
<th>Comments/Observations</th>
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<td>3000</td>
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<tr>
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<td>16.58</td>
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<td>10/31/17 11:13</td>
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<td>16.46</td>
<td>6.96</td>
<td>0.827</td>
<td>3.90</td>
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<td>16.39</td>
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</table>

**Calculations:**

Saturated well casing volume: \[ V = \pi (R^2)H \times 7.48 \text{ gal/ft}^3 \]

\[ V = \pi (R^2)H \times 7.48 \text{ gal/ft}^3 = \pi \times \left(2.0 \text{ in}/12 \text{ in/ft}\right)^2 \times 14.40 \times 7.48 \text{ gal/ft}^3 = 2.4 \text{ gal.} \]

**Notes:**

None

**QA/QC’d by:** Sarah Levine

**QA/QC Date:** 12/12/2017
### WELL DEVELOPMENT LOG

**Project Name:** Phase 1 Regional Site Inspections for Per-Fluorinated Compounds at Multiple Air National Guard Installations  
**Project Number:** 291330006

**Contract:** W9133L-14-D-0002  
**Installation:** ESHEP  
**Well ID:** T-03  
**Measuring Point:** Top of Riser  
**Development Method:** PUMPED

<table>
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<th>Intake Depth (feet)</th>
<th>Water Level (feet)</th>
<th>Rate (gpm)</th>
<th>Temp. (°C)</th>
<th>pH (units)</th>
<th>Specific Electrical Conductance (mS/cm)</th>
<th>DO (mg/L)</th>
<th>ORP (mV)</th>
<th>Turbidity (NTU)</th>
<th>Cum. Volume (gal.)</th>
<th>Comments/Observations During Purging</th>
</tr>
</thead>
<tbody>
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<td>19</td>
<td>1000</td>
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<td>.890</td>
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<td>6.77</td>
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<td>.720</td>
<td>4.15</td>
<td>63.1</td>
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<td>600</td>
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<td>6.57</td>
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<td>69</td>
<td>250</td>
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**Instruments (Manufacturer, Model, and Serial No.):**  
Calibrated Within Criteria (Y/N): Yes  
Calibrated Equipment Calibration (Y/N): Yes  
Lamotte 2020 1286, YSI 556 MPS 86749

**Calculations:**

- **Saturated well casing volume:** $V = \pi (R^2)H * 7.48 \text{ gal/ft}^3$
- **Specific Electrical Conductance:** $\text{mS/cm}$
- **DO:** mg/L
- **ORP:** mV
- **Turbidity:** NTU

**Notes:** None

**QA/QC’d by:** Sarah Levine  
**QA/QC Date:** 12/13/2017
Initial Depth to Water (ft):
Measuring Point:
Total Depth of Well (ft):
Development Method:
Depth to Water After Purging (ft):
Total Volume Purged (gal):
1 Casing Volume (gal):
3 Casing Volume (gal):
Technician(s):  
Equipment Calibrated (Y/N): 
Calibrated Within Criteria (Y/N): 
Instruments (Manufacturer, Model, and Serial No.):
  Turbidity Meter, Water Quality Meter, Water Level Meter, Geosubmersible Pump Lamotte 2020 1286, YSI 556 MPS 86749
Calculations:
Saturated well casing volume: $V = \pi (R^2)H \times 7.48 \text{ gal/ft}^3$

$V = \pi (R^2)H \times 7.48 \text{ gal/ft}^3$
$\pi = 3.14$
$R = \text{ well radius (ft)} = (\text{ well diameter (in)}/12 (\text{ in/ft}))/2$
$H = \text{ height of water column (ft)}$

Notes: Used monsoon pump, refer to eb 01 sample
### WELL DEVELOPMENT LOG

**Project Name:** Phase 1 Regional Site Inspections for Per-Fluorinated Compounds at Multiple Air National Guard Installations  
**Project Number:** 291330006

**Contract:** W9135L-14-D-0002  
**Task Order:** 0006

**Installation:** ESHEP  
**Date Started/Date Completed:** 10/24/17/10/24/17

**Measuring Point:** Top of Casing  
**Total Depth of Well (ft):** 40.0

**Development Method:** PUMPED  
**Depth to Water After Purging (ft):** 38.7

**Total Volume Purged (gal):** 5  
**Total Volume Purged (gal):** 3

**Technician(s):** Sarah Levine, Sean Hulburt

### Calculations:

**Saturated well casing volume:** 

V = \( \pi \left( \frac{R^2}{12} \right) \times H \times 7.48 \ \text{gal/ft}^3 \)

V = \( \pi \left( \frac{2.0 \ \text{in}}{12 \ \text{in/ft}} \right)^2 \times \frac{1}{12} \ \text{ft}^2 \times 7.00 \times 7.48 \ \text{gal/ft}^3 \)

\( = 1.1 \ \text{gal} \)

**Notes:**

Water quality parameters were collected before well was set. Well development was not possible due to lack of recharge. Dry well was set at TW05.

**QA/QC'd by:** Sarah Levine  
**QA/QC Date:** 12/11/2017

---

<table>
<thead>
<tr>
<th>Date/Time</th>
<th>Intake Depth (feet)</th>
<th>Water Level (feet)</th>
<th>Rate (Gpm)</th>
<th>Temp. (°C)</th>
<th>pH</th>
<th>Specific Electrical Conductance (mS/cm)</th>
<th>DO (mg/L)</th>
<th>ORP (mV)</th>
<th>Turbidity (NTU)</th>
<th>Cum. Volume (gal.)</th>
<th>Comments/Observations During Purging</th>
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<td>18.04</td>
<td>7.45</td>
<td>0.544</td>
<td>1.65</td>
<td>58.0</td>
<td>Over</td>
<td>0</td>
<td>Pumping Started</td>
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<td>10/24/17 09:45</td>
<td>39.5</td>
<td>34</td>
<td>0.5</td>
<td>18.04</td>
<td>7.45</td>
<td>0.544</td>
<td>1.65</td>
<td>58.0</td>
<td>Over</td>
<td>0</td>
<td>Pumping Started</td>
</tr>
<tr>
<td>10/24/17 09:49</td>
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<td>39</td>
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<td>Na</td>
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<td>Na</td>
<td>Na</td>
<td>Na</td>
<td>5</td>
<td>Well dry, pump stopped</td>
</tr>
<tr>
<td>10/24/17 10:34</td>
<td>39.5</td>
<td>38.7</td>
<td>0</td>
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<td>Na</td>
<td>Na</td>
<td>Na</td>
<td>Na</td>
<td>Na</td>
<td>5</td>
<td>Checked water level; no recharge</td>
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**Instruments (Manufacturer, Model, and Serial No.):**

- Turbidity Meter, Water Quality Meter, Water Level Meter, Mega Monsoon Pump
- LaMotte 2020 1286-3511
- YSI 556 MPS 09F101780

**QA/QC'd by:** Sarah Levine  
**QA/QC Date:** 12/11/2017
**WELL DEVELOPMENT LOG**

**Project Name:** Phase 1 Regional Site Inspections for Per-Fluorinated Compounds at Multiple Air National Guard Installations

**Project Number:** 291330006

**Contract:** W9133L-14-D-0002

**Installation:** ESHEP

**Well ID:** Tw-06

**Measuring Point:** Top of Riser

**Development Method:** PUMPED

**Total Volume Purged (gal):**

**Technician(s):** Sean Hulburt

### Calculations:

**Saturated well casing volume:**

\[ V = \pi (R^2) H \times 7.48 \text{ gal/ft}^3 \]

- \( V \) = Volume (gal/ft)
- \( \pi \approx 3.14 \)
- \( R \) = well radius (in)/12 (in/ft)/2
- \( H \) = height of water column (ft)

**Cum. Volume (gal.):**

**Comments/Observations During Purging (color, sediment, etc.):** Pumping Started

### Instruments (Manufacturer, Model, and Serial No.):

- Turbidity Meter, Water Quality Meter, Water Level Meter, Mega Monsoon Pump
- Lamotte 2020 1286,
- YSI 556 MPS 86749

### Calculations:

**Saturated well casing volume:**

\[ V = \pi (R^2) H \times 7.48 \text{ gal/ft}^3 \]

- \( V \) = Volume (gal/ft)
- \( \pi \approx 3.14 \)
- \( R \) = well radius (in)/12 (in/ft)/2
- \( H \) = height of water column (ft)

**Notes:**

None

**QA/QC’d by:** Sarah Levine

**QA/QC Date:** 12/13/2017
### WELL DEVELOPMENT LOG

**Project Name:** Phase 1 Regional Site Inspections for Per-Fluorinated Compounds at Multiple Air National Guard Installations  
**Project Number:** 291330006

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<th>Water Level (feet)</th>
<th>Rate (Gpm)</th>
<th>Temp. (°C)</th>
<th>pH (units)</th>
<th>Specific Electrical Conductance (mS/cm)</th>
<th>DO (mg/L)</th>
<th>ORP (mV)</th>
<th>Turbidity (NTU)</th>
<th>Cum. Volume (gal.)</th>
<th>Comments/Observations During Purging (color, sediment, etc.)</th>
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<td>205.4</td>
<td>142</td>
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<td>Pumping Started</td>
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<td>29.73</td>
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<td>10</td>
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</table>

**Calculations:**

Saturated well casing volume: \( V = \frac{\pi (R^2) H}{2} \times 7.48 \text{ gal/ft}^3 \)

- \( V = \text{Volume (gal/ft)} \)
- \( \pi = \pi \approx 3.14 \)
- \( R = \text{well radius (ft)} = (\text{well diameter (in)} / 12 \text{ (in/ft)}) / 2 \)
- \( H = \text{height of water column (ft)} \)

\( V = \pi (R^2) H / 2 \times 7.48 \text{ gal/ft}^3 = 2.1 \text{ gal.} \)

**Notes:** None

**QA/QC’d by:** Sarah Levine

**QA/QC Date:** 12/11/2017

---

**Instruments (Manufacturer, Model, and Serial No.):**

- Equipment Calibrated (Y/N): Yes  
- Calibrated Within Criteria (Y/N): Yes  
- Turbidity Meter, Water Quality Meter, Water Level Meter, Mega Monsoon Pump  
- LaMotte 2020 1286-3511, YSI 556 MPS 09F101780

**Signature:**

Sarah Levine

**Name (Print):** Sarah Levine
## WELL DEVELOPMENT LOG

### Project Information
- **Project Name:** Phase 1 Regional Site Inspections for Per-Fluorinated Compounds at Multiple Air National Guard Installations
- **Project Number:** 291330006
- **Contract:** W9133L-14-D-0002
- **Installation:** ESHEP
- **Measuring Point:** Top of Riser
- **Development Method:** PUMPED
- **Total Volume Purged (gal):** 159.5
- **Depth to Water After Purging (ft):** 35.9
- **Total Volume Purged (gal):** 159.5
- **Depth to Water After Purging (ft):** 35.9
- **Well ID:** 291330006
- **Tw-08**

### Instrument Calibration
- **Instruments (Manufacturer, Model, and Serial No.):**
  - Turbidity Meter, Water Quality Meter, Water Level Meter, Mega Monsoon Pump
  - Lamotte 2020 1286,
  - YSI 556 MPS 86749

### Calculations

\[ V = \frac{\pi}{4} R^2 H \times 7.48 \text{ gal/ft}^3 \]

- \( V \) = Volume (gal/ft)
- \( R \) = well radius (ft) = (well diameter (in)/12 (in/ft))/2
- \( H \) = height of water column (ft)

- **V** = \( \frac{\pi}{4} (2.0 \text{ in)/12 (in/ft)/2} )^2 \times 7.48 \text{ gal/ft}^3 = 0.7 \text{ gal.} \)

### Notes
- Well pumped dry a total of 6 times during drilling water removal. Once during development. A total of 325 gallons of drilling water was used. 275 gallons flowed back remaining 50 gallons was pumped out. After pumping dry during purging, turbidity was low enough to collect sample.

### QA/QC Information
- **QA/QC'd by:** Sarah Levine
- **QA/QC Date:** 12/13/2017

### Date/Time Interval Information

<table>
<thead>
<tr>
<th>Date/Time</th>
<th>Intake Depth (feet)</th>
<th>Water Level (feet)</th>
<th>Rate (ml/min)</th>
<th>Temp. (°C)</th>
<th>pH (units)</th>
<th>Specific Electrical Conductance (mS/cm)</th>
<th>DO (mg/L)</th>
<th>ORP (mV)</th>
<th>Turbidity (NTU)</th>
<th>Cum. Volume (gal.)</th>
<th>Comments/Observations During Purging</th>
</tr>
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<tbody>
<tr>
<td>11/15/17 14:27</td>
<td>35</td>
<td>37</td>
<td>2000</td>
<td>15.77</td>
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<td>Pumping Started</td>
</tr>
<tr>
<td>11/15/17 14:30</td>
<td>35</td>
<td>37</td>
<td>2000</td>
<td>15.68</td>
<td>6.80</td>
<td>1.488</td>
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<td>159</td>
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<td>2000</td>
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<td>6.80</td>
<td>1.488</td>
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<td>37.6</td>
<td>2000</td>
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<td>6.80</td>
<td>1.488</td>
<td>7.54</td>
<td>159</td>
<td>57</td>
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</table>

### Signature
- **Signature:**
- **Name (print):**
- **QA/QC Date:** 12/13/2017

### Equipment Calibration (Y/N): **Yes**

### Calibrated Within Criteria (Y/N): **Yes**

**Instruments (Manufacturer, Model, and Serial No.):**

- Turbidity Meter, Water Quality Meter, Water Level Meter, Mega Monsoon Pump
- Lamotte 2020 1286,
- YSI 556 MPS 86749

**Calculations:**

\[ V = \frac{\pi}{4} R^2 H \times 7.48 \text{ gal/ft}^3 \]

- **V** = \( \frac{\pi}{4} (2.0 \text{ in)/12 (in/ft)/2} )^2 \times 7.48 \text{ gal/ft}^3 = 0.7 \text{ gal.} \)
### WELL DEVELOPMENT LOG

**Project Name:** Phase 1 Regional Site Inspections for Per-Fluorinated Compounds at Multiple Air National Guard Installations  
**Project Number:** 291330006  
**Contract:** W9133L-14-D-0002  
**Task Order:** 0006  
**Installation:** ESHEP  
**Date Started/Date Completed:** 11/03/17/11/03/17  
**Measuring Point:** Tw-09  
**Initial Depth to Water (ft):** 16.8  
**Total Depth of Well (ft):** 40.0  
**Development Method:** PUMPED  
**Depth to Water After Purging (ft):** 16.8  
**Total Volume Purged (gal):** 11.4  
**Technician(s):** Sean Hulburt

<table>
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<tr>
<th>Date/Time</th>
<th>Intake Depth (feet)</th>
<th>Water Level (feet)</th>
<th>Rate (Ml/m)</th>
<th>Temp. (°C)</th>
<th>pH (units)</th>
<th>Specific Electrical Conductance (mS/cm)</th>
<th>DO (mg/L)</th>
<th>ORP (mV)</th>
<th>Turbidity (NTU)</th>
<th>Cum. Volume (gal.)</th>
<th>Comments/Observations During Purging</th>
</tr>
</thead>
<tbody>
<tr>
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<td>16.85</td>
<td>3000</td>
<td>16.18</td>
<td>6.07</td>
<td>645</td>
<td>6.05</td>
<td>120.36</td>
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<td>34</td>
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<tr>
<td>11/03/17 12:09</td>
<td>25</td>
<td>16.85</td>
<td>3000</td>
<td>16.18</td>
<td>5.79</td>
<td>645</td>
<td>6.05</td>
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<td>19.4</td>
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<td>11/03/17 13:17</td>
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<td>16.88</td>
<td>3000</td>
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<td>644</td>
<td>6.06</td>
<td>114.8</td>
<td>12.2</td>
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</tbody>
</table>

**Calculations:**

Saturated well casing volume: \( V_0 = \pi (R^2)H \times 7.48 \text{ gal/ft}^3 \)

\[ V_0 = \pi (R^2)H \times 7.48 \text{ gal/ft}^3 = \pi \times (2.0 \text{ in}/12 \text{ in/ft})^2 \times 23.20 \times 7.48 \text{ gal/ft}^3 = 3.8 \text{ gal.} \]

**Notes:** None

**QA/QC'd by:** Sarah Levine  
**QA/QC Date:** 12/12/2017

---

**Instruments (Manufacturer, Model, and Serial No.):**

- Turbidity Meter, Water Quality Meter, Water Level Meter, Mega Monsoon Pump
- Lamotte 2020 1286,
- YSI 556 MPS 86749

**Equipment Calibrated (Y/N):** Yes  
**Calibrated Within Criteria (Y/N):** Yes

---

**Calculations:**

Saturated well casing volume: \( V_0 = \pi (R^2)H \times 7.48 \text{ gal/ft}^3 \)

\[ V_0 = \pi (R^2)H \times 7.48 \text{ gal/ft}^3 = \pi \times (2.0 \text{ in}/12 \text{ in/ft})^2 \times 23.20 \times 7.48 \text{ gal/ft}^3 = 3.8 \text{ gal.} \]
## WELL DEVELOPMENT LOG

### Project Name:
Phase 1 Regional Site Inspections for Per-Fluorinated Compounds at Multiple Air National Guard Installations

### Project Number:
291330006

### Contract:
W9133L-14-D-0002

### Task Order:
006

### Installation:
ESHEP

### Date Started/Date Completed:
10/20/17/10/20/17

### Initial Depth to Water (ft):
32.0

### Total Depth of Well (ft):
37.0

### Development Method:
PUMPED

### Depth to Water After Purging (ft):
35.61

### Total Volume Purged (gal):

### 1 Casing Volume (gal):

### 3 Casing Volumes (gal):

### Equipment Calibrated (Y/N):
Yes

### Calibrated Within Criteria (Y/N):
Yes

### Instruments (Manufacturer, Model, and Serial No.):
Turbidity Meter, Water Quality Meter, Mega Monsoon Pump
LaMotte 2020 1286-3511,
YSI 556 MPS 09F101780

### QA/QC'd by:
Sarah Levine

### QA/QC Date:
12/11/2017

### Calculations:

**Saturated well casing volume:**

\[ V = \pi R^2 H \times 7.48 \text{ gal/ft}^3 \]

\[ \pi = 3.14 \]

\[ R = \text{well radius (ft)} = \frac{\text{well diameter (in)}}{12} \times \frac{1}{2} \]

\[ H = \text{height of water column (ft)} \]

\[ V = \pi R^2 H \times 7.48 \text{ gal/ft}^3 \]

\[ = \pi \times \left(\frac{2.0 \text{ (in)}}{12} \times \frac{1}{2}\right)^2 \times 5.00 \times 7.48 \text{ gal/ft}^3 \]

\[ = 0.8 \text{ gal.} \]

### Notes:
None

### Signature:
Sarah Levine

### Date/Time | Intake Depth (feet) | Water Level (feet) | Rate (Gpm) | Temp. (°C) | pH (units) | Specific Electrical Conductance (mS/cm) | DO (mg/L) | ORP (mV) | Turbidity (NTU) | Cum. Volume (gal.) | Comments/Observations During Purging (color, sediment, etc.)
--- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | ---
10/20/17 11:52 | .37 | 35.60 | .73 | 17.61 | 7.22 | 0.554 | 6.67 | 221.4 | 982 | 21 | Light brown
10/20/17 11:53 | .37 | 35.83 | .73 | 16.67 | 7.05 | 0.532 | 5.63 | 218.2 | 1843 | 9 | Light brown, turbid
10/20/17 11:57 | .37 | 35.61 | .73 | 17.57 | 6.97 | 0.556 | 4.52 | 217.6 | 917 | 26 | Brown tint
10/20/17 12:01 | .37 | 35.5 | .73 | 17.02 | 7.04 | 0.537 | 5.13 | 215.5 | 1952 | 6 | Light brown, turbid
10/20/17 12:05 | .37 | 36.08 | .73 | 16.42 | 6.98 | 0.537 | 4.78 | 219.4 | 1174 | 15 | Light brown
10/20/17 12:10 | .37 | 35.63 | .73 | 16.52 | 7.09 | 0.527 | 5.68 | 218.1 | 1691 | 12 | Light brown, turbid
10/20/17 12:14 | .37 | 35.63 | .73 | 16.42 | 6.98 | 0.537 | 4.78 | 219.4 | 1174 | 15 | Light brown
10/20/17 12:20 | .37 | 35.60 | .73 | 17.61 | 7.22 | 0.554 | 6.67 | 221.4 | 982 | 21 | Light brown
10/20/17 12:26 | .37 | 35.60 | .73 | 17.61 | 7.22 | 0.554 | 6.67 | 221.4 | 982 | 21 | Light brown
10/20/17 12:33 | .37 | 35.61 | .73 | 17.57 | 6.97 | 0.556 | 4.52 | 217.6 | 917 | 26 | Brown tint

### Comments/Observations During Purging:
- Pumping Started
- Brown, turbid
- Light brown, turbid
- Light brown, turbid
- Light brown, turbid
- Light brown
- Light brown
- Light brown
- Light brown
- Light brown
- Light brown
### WELL DEVELOPMENT LOG

**Project Name:** Phase 1 Regional Site Inspections for Per-Fluorinated Compounds at Multiple Air National Guard Installations  
**Project Number:** 291330006

**Contract:** W9133L-14-D-0002  
**Task Order:** 0006

**Installation:** PITTS  
**Date Started/Date Completed:** 11/21/17/11/21/17

**Well ID:** Bw-01  
**Initial Depth to Water (ft):** 40.0

**Measuring Point:** Top of Riser  
**Total Depth of Well (ft):** 40.0

**Development Method:**  
**Depth to Water After Purging (ft):**

**Total Volume Purged (gal):**

**Technician(s):** Sean huburt  
**1 Casing Volume (gal):**

**Equipment Calibrated (Y/N):** Yes  
**Calibrated Within Criteria (Y/N):** Yes

**Saturated well casing volume:**

\[ V = \pi (R^2) H \times 7.48 \text{ gal/ft}^3 \]

- **V** = Volume (gal/ft)
- **\pi** = 3.14
- **R** = well radius (ft) = (well diameter (in)/12 (in/ft))/2
- **H** = height of water column (ft)

**Instruments (Manufacturer, Model, and Serial No.):**

- Water Quality Meter, Water Level Meter, Peristaltic Pump  
  - Horiba u 52 US2 73969

**Calculations:**

\[ V = \pi (R^2) H \times 7.48 \text{ gal/ft}^3 \]

- **V** = Volume (gal/ft)
- **\pi** = 3.14
- **R** = well radius (ft) = (well diameter (in)/12 (in/ft))/2
- **H** = height of water column (ft)

**Notes:**

- Dry upon completion

**QA/QC’d by:**

**QA/QC Date:**

---

**Dry upon completion**

Sean huburt
### WELL DEVELOPMENT LOG

**Project Name:** Phase 1 Regional Site Inspections for Per-Fluorinated Compounds at Multiple Air National Guard Installations  
**Project Number:** 291330006  
**Task Order:** 0006  
**Date Started/Date Completed:** 11/21/17/11/21/17  
**Initial Depth to Water (ft):** 34.5  
**Total Depth of Well (ft):** 40.0  
**Depth to Water After Purging (ft):** 32.8  
**Total Volume Purged (gal):** 59.9  
**1 Casing Volume (gal):** 45.5  
**2 Casing Volumes (gal):** 32.0  
**3 Casing Volumes (gal):** 30.0  
**Calibrated Within Criteria (Y/N):** Yes  
**Calibrated Within Date:** 12/13/2017  
**QA/QC Date:** 12/13/2017  
**QA/QC’d by:** Sarah Levine

### Instruments (Manufacturer, Model, and Serial No.):  
- Turbidity Meter, Water Quality Meter, Water Level Meter, Geosubmersible Pump  
- Lamotte 2020 1286, YSI 556 MPS 86749

### Calculations:  
**Saturated well casing volume:**  
\[ V = \frac{\pi}{3} (R^3) \times 7.48 \text{ gal/ft}^3 \]  
where:  
- \( V \) = Volume (gal/ft)  
- \( \pi = 3.14 \)  
- \( R \) = well radius (ft) = (well diameter (in)/12 (in/ft))/2  
- \( H \) = height of water column (ft)

**Cum. Volume (gal.):**  
\[ V = \frac{\pi}{3} (R^3) \times 7.48 \text{ gal/ft}^3 \]  
\[ = \frac{\pi}{3} (2.0 \text{ (in)/12} (\text{in/ft}))^3 \times 7.48 \text{ gal/ft}^3 \]  
\[ = 0.9 \text{ gal.} \]

**Notes:**  
None

**QA/QC’d by:** Sarah Levine  
**QA/QC Date:** 12/13/2017

---

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<thead>
<tr>
<th>Date/Time</th>
<th>Intake Depth (feet)</th>
<th>Water Level (feet)</th>
<th>Rate (GPM)</th>
<th>Temp. (°C)</th>
<th>pH</th>
<th>DO (mg/L)</th>
<th>ORP (mV)</th>
<th>Turbidity (NTU)</th>
<th>Cum. Volume (gal.)</th>
<th>Comments/Observations During Purging (color, sediment, etc.)</th>
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</table>

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**Signature:**

V = Volume (gal/ft)  
\( \pi = 3.14 \)  
R = well radius (ft) = (well diameter (in)/12 (in/ft))/2  
H = height of water column (ft)
## WELL DEVELOPMENT LOG

**Project Name:** Phase 1 Regional Site Inspections for Per-Fluorinated Compounds at Multiple Air National Guard Installations  
**Project Number:** 291330006

**Contract:** W9133L-14-D-0002  
**Task Order:** 006  
**Installation:** ESHEP  
**Date Started/Date Completed:** 11/16/17/11/16/17  
**Well ID:** Bw-03  
**Initial Depth to Water (ft):** 38.5  
**Total Depth of Well (ft):** 37.0  
**Measuring Point:** Top of Riser  
**Development Method:** PUMPED  
**Depth to Water After Purging (ft):** 36.5  
**Total Volume Purged (gal):** 0.1  
**Technician(s):** Sean Hulburt

### WELL DEVELOPMENT LOG

<table>
<thead>
<tr>
<th>Date/Time</th>
<th>Intake Depth (feet)</th>
<th>Water Level (feet)</th>
<th>Rate (Mil/Min)</th>
<th>Temp. (°C)</th>
<th>pH (units)</th>
<th>Specific Electrical Conductance (mS/cm)</th>
<th>DO (mg/L)</th>
<th>ORP (mV)</th>
<th>Turbidity (NTU)</th>
<th>Cum. Volume (gal.)</th>
<th>Comments/Observations During Purging (color, sediment, etc.)</th>
</tr>
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<tbody>
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<td>4.95</td>
<td>163.9</td>
<td>68.4</td>
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</table>

### Instruments (Manufacturer, Model, and Serial No.):

- **Equipment Calibrated (Y/N):** Yes  
- **Calibrated Within Criteria (Y/N):** Yes

- Turbidity Meter, Water Quality Meter, Water Level Meter, Mega Monsoon Pump  
  - Lamotte 2020 1286  
  - YSI 556 MPS 8749

### Calculations:

- **Saturated well casing volume:**  
  \[ V = \pi (R^2)H \times 7.48 \text{ gal/ft}^3 \]
  
  \[ V = \pi (\text{diameter (in)/12 (in/ft)})^2 \times 0.50 \times 7.48 \text{ gal/ft}^3 \]
  
  \[ V = 0.1 \text{ gal.} \]

### Notes:

- **None**

### QA/QC’d by: Sarah Levine  
**QA/QC Date:** 12/13/2017

---

**Rev. 1, Date: 12/29/2016 Page 1 of 1**
**WELL DEVELOPMENT LOG**

Project Name: Phase 1 Regional Site Inspections for Per-Fluorinated Compounds at Multiple Air National Guard Installations  
Project Number: 291330006

Contract: W913L-14-D-0002  
Task Order: 0006

Installation: ESHEP  
Date Started/Date Completed: 11/09/17/11/09/17

Well ID: Bw-04  
Initial Depth to Water (ft): 20.34

Measuring Point: Top of Riser  
Total Depth of Well (ft): 30.0

Development Method: PUMPED  
Depth to Water After Purging (ft): 22.7

Total Volume Purged (gal):  
1 Casing Volume (gal): 672

Technician(s):  
3 Casing Volumes (gal): 21

Equipment Calibrated (Y/N): Y  
Calibrated Within Criteria (Y/N): Y

Saturated well casing volume: \[ V = \pi (R^2)H \times 7.48 \text{ gal/ft}^3 \]

\[ V = \pi (R^2)H \times 7.48 \text{ gal/ft}^3 = \pi \times (2.0 \text{ in}/12 \text{ in/ft})^2 \times 9.66 \times 7.48 \text{ gal/ft}^3 = 1.6 \text{ gal.} \]

Instruments (Manufacturer, Model, and Serial No.):  
Turbidity Meter, Water Quality Meter, Water Level Meter, Mega Monsoon Pump  
Lamotte 2020 1286, YSI 556 MPS 86749

Calculations:

**Saturated well casing volume: \[ V = \pi (R^2)H \times 7.48 \text{ gal/ft}^3 \]**

\[ V = \pi (R^2)H \times 7.48 \text{ gal/ft}^3 = \pi \times (2.0 \text{ in}/12 \text{ in/ft})^2 \times 9.66 \times 7.48 \text{ gal/ft}^3 = 1.6 \text{ gal.} \]

Notes: None

QA/QC’d by: Sarah Levine  
QA/QC Date: 12/12/2017

Rev. 1, Date: 12/29/2016  
Page 1 of 1
### WELL DEVELOPMENT LOG

#### Project Name:
Phase 1 Regional Site Inspections for Per-Fluorinated Compounds at Multiple Air National Guard Installations

#### Project Number:
291330006

**Contract:** W9133L-14-D-0002  
**Task Order:** 0006  
**Date Started/Date Completed:** 11/16/2017 - 11/20/2017

**Measuring Point:** Top of Riser  
**Development Method:** PUMPED

### Instruments (Manufacturer, Model, and Serial No.):
- Turbidity Meter
- Water Quality Meter
- Water Level Meter
- Geosubmersible Pump
- Mega Monosoon Pump

- Lamotte 2020 1286, YSI 556 MPS 86749

**QA/QC'd by:** Sarah Levine  
**QA/QC Date:** 12/13/2017

**Calibrated Within Criteria (Y/N):** Yes

**Equipment Calibrated (Y/N):** Yes

**Notes:** Sampled on 11/20/17. Eshep-gw-bw-05-112017 at 1125.

**Signature:**

**Calculations:**

**Saturated well casing volume:**

\[ V = \pi (R^2)H \times 7.48 \text{ gal/ft}^3 \]

\[ V = \pi (R^2)H \times 7.48 \text{ gal/ft}^3 \]

\[ = \pi \times (2.0 \text{ in}/12 \text{ in/ft})^2 \times 7.51 \times 7.48 \text{ gal/ft}^3 \]

\[ = 1.2 \text{ gal.} \]

**QA/QC’d by:** Sarah Levine  
**QA/QC Date:** 12/13/2017

**Rev. 1, Date: 12/29/2016**
**WELL DEVELOPMENT LOG**

**Project Name:** Phase 1 Regional Site Inspections for Per-Fluorinated Compounds at Multiple Air National Guard Installations  
**Project Number:** 291330006

<table>
<thead>
<tr>
<th>Date/Time</th>
<th>Intake Depth (feet)</th>
<th>Water Level (feet)</th>
<th>Rate (Ml/m)</th>
<th>Temp. (°C)</th>
<th>pH (units)</th>
<th>Specific Electrical Conductance (mS/cm)</th>
<th>DO (mg/L)</th>
<th>ORP (mV)</th>
<th>Turbidity (NTU)</th>
<th>Cum. Volume (gal.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>11/17/17 11:30</td>
<td>1000</td>
<td>35</td>
<td>1000</td>
<td>17.98</td>
<td>6.55</td>
<td>795</td>
<td>1.25</td>
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<td>Turbid</td>
</tr>
<tr>
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<td>11/17/17 11:44</td>
<td>33</td>
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<td>17.45</td>
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<td>-106</td>
<td>Err</td>
<td>Turbid</td>
<td></td>
</tr>
<tr>
<td>11/17/17 12:00</td>
<td>34.6</td>
<td>11/17/17 12:16</td>
<td>37</td>
<td>1000</td>
<td>17.33</td>
<td>6.48</td>
<td>815</td>
<td>.96</td>
<td>-87</td>
<td>Err</td>
</tr>
<tr>
<td>11/17/17 12:40</td>
<td>35.7</td>
<td>11/17/17 12:50</td>
<td>35.7</td>
<td>1000</td>
<td>16.39</td>
<td>6.29</td>
<td>.820</td>
<td>1.23</td>
<td>-63.3</td>
<td>377</td>
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<tr>
<td>11/17/17 13:02</td>
<td>35.7</td>
<td>11/17/17 13:10</td>
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<td>15.93</td>
<td>6.16</td>
<td>.840</td>
<td>.88</td>
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<td>1000</td>
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<tr>
<td>11/17/17 13:17</td>
<td>35.7</td>
<td>11/17/17 13:23</td>
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<td>1.10</td>
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<td>11/17/17 13:28</td>
<td>35.7</td>
<td>11/17/17 13:38</td>
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</tr>
</tbody>
</table>

**Calculations:**

**Saturated well casing volume:**  
\[ V = \pi (\text{R}^2)H \times 7.48 \text{ gal/ft}^3 \]

- \( V = \text{Volume (gal/ft)} \)
- \( \pi = 3.14 \)
- \( R = \text{well diameter (in)/12 (in/ft)} \)
- \( H = \text{height of water column (ft)} \)

**Notes:**

Ould not stabilize parameters ran out to 2hours

**Equipment Calibrated (Y/N):** Yes  
**Calibrated Within Criteria (Y/N):** Yes

**Instruments (Manufacturer, Model, and Serial No.):**

- Turbidity Meter, Water Quality Meter, Water Level Meter, Mega Monsoon Pump  
- Lamotte 2020 1286, YSI 556 MPS 86749

**Calculations:**

**Saturated well casing volume:**  
\[ V = \pi (\text{R}^2)H \times 7.48 \text{ gal/ft}^3 \]

- \( V = \pi (\text{R}^2)H \times 7.48 \text{ gal/ft}^3 \)
- \( \pi = (2.0 \text{ (in)/12 (in/ft)})^2 \times 17.00 \times 7.48 \text{ gal/ft}^3 \)
- \( = 2.8 \text{ gal.} \)

**QA/QC’d by:** Sarah Levine  
**QA/QC Date:** 12/13/2017
## Groundwater Sampling Record

### Project Information
- **Project Name:** Phase 1 Regional Site Inspections for Per-Fluorinated Compounds at Multiple Air National Guard Installations
- **Project Number:** 291330006
- **Task Order:** 006
- **Contract:** W9113L-14-D-0002
- **Installation:** ESHEP
- **Well ID:** TW-01
- **Initial Depth to Water (ft):** 38.5
- **Total Depth of Well (ft):** 40.0
- **Method of Purging:** Pumping
- **Measuring Point (toc, tor, etc.):** Top of Riser

### Sampling Data

<table>
<thead>
<tr>
<th>Time</th>
<th>Water Level (feet)</th>
<th>Flow Rate (mL/min)</th>
<th>Cum. Volume (gal.)</th>
<th>Temp. (°C)</th>
<th>pH (SU)</th>
<th>Specific Electrical Conductance (mS/cm)</th>
<th>DO (mg/L)</th>
<th>ORP (mV)</th>
<th>Turbidity (NTU)</th>
<th>Comments/Observations During Purging</th>
</tr>
</thead>
<tbody>
<tr>
<td>10:40</td>
<td>1000</td>
<td></td>
<td></td>
<td>±0.5°C</td>
<td>±0.1</td>
<td>±3%</td>
<td>±10%</td>
<td>±10%</td>
<td>±10% and &lt;10 NTU</td>
<td>Pumping/Purging Started</td>
</tr>
</tbody>
</table>

### Quality Control
- **Stability Reached (Y/N):** No
- **QA/QC Samples (Yes/No):** Yes
- **QA/QC Date:** 12/13/2017
- **Sample ID:** Eshep-ge-tw01-112117
- **Method of Sampling:** Submersible pump
- **Sample Collection Time:** 10:45
- **Sample Date:** 11/21/17
- **Sample Depth (ft):** 39
- **Total Volume Purged (gal):** 2
- **Depth to Water After Sampling (ft):** 39

### Preservative
- **Preservative (s):** Ice (4 °C)
- **Sample Container Type(s):** 125 mL plastic, 250 mL amber glass

### Instruments
- **Instruments (Manufacturer, Model, and Serial No.):**
- **Equipment Calibrated (Y/N):** Calibrated Within Criteria (Y/N):

### Calculations
- **Saturated well casing volume:**
  \[ V = \frac{\pi R^2 H}{3} \]

### Notes
- Highly suspect for rain water. Well was dry for one week, then heavy rain. Well immediately pumped dry. Barely enough to fill sample bottles.

### Signature
- **Signature:**
- **Name (print):** Sean Hulturbust

### QA/QC'd by
- **Sarah Levine**
- **QA/QC Date:** 12/13/2017
GROUNDWATER SAMPLING RECORD

Project Name: Phase 1 Regional Site Inspections for Per-Fluorinated Compounds at Multiple Air National Guard Installations
Project Number: 291330006

Contract: W9133L-14-D-0002
Installation: ESHEP
Well ID: TW-02

Initial Depth to Water (ft): 27.9
Total Depth of Well (ft): 41.0
Method of Purging: Pumping
Measuring Point (toc, tor, etc.): Top of Riser

Method of Purging:
1 Casing Volume (gal): 6.4
3 Casing Volumes (gal): 19.2

Pump Intake Depth (feet):

Time | Water Level | Flow Rate | Cum. Volume | Temp. | pH | Specific Electrical Conductance | DO | ORP | Turbidity | Comments/Observations
--- | --- | --- | --- | --- | --- | --- | --- | --- | --- | ---
10:34 | 3000 | | | | | | | | | Pumping Purging Started

Stability Reached (Y/N): Yes
If No, Provide Explanation: 

Sample ID: Eshep-ww-02-103117
Method of Sampling: Sub pump
Sample Date: 10/31/17
Sample Collection Time: 11.49
Total Volume Purged (gal): 16
Sample Depth (ft): 35
Depth to Water After Sampling (ft): 25.7

Instruments (Manufacturer, Model, and Serial No.):
- Turbidity Meter, Water Quality Meter, Water Level Meter, Geosubmersible Pump
  Lamotte 2020 1286, YSI 556 MPS 86749
- Equipment Calibrated (Y/N): Yes
  Calibration Within Criteria (Y/N): Yes

Calculations:

Saturated well casing volume: \( V = \pi (R^2) H + 7.48 \text{ gal/ft}^3 \)

\( V = \pi (R^2) H + 7.48 \text{ gal/ft}^3 \)
\( \pi = \pi (\text{Volume (gal/ft)}^3) \)
\( R = \text{well radius (ft)} = (\text{well diameter (in)/12 (in/ft)/2})^2 \)
\( H = \text{height of water column (ft)} \)

Notes:
- Eshep-eb-01-103117 collected here. Pfas free water and di water used
- See well development record for field parameters - MHL 4/9/18

QA/QC’d by: Sarah Levine
QA/QC Date: 12/12/2017

Rev. 1, Date: 12/29/2016
### GROUNDWATER SAMPLING RECORD

**Project Name:** Phase 1 Regional Site Inspections for Per-Fluorinated Compounds at Multiple Air National Guard Installations  
**Project Number:** 291330006  
**Contract:** W9133L-14-D-0002  
**Installation:** ESHEP  
**Well ID:** TW-03  
**Initial Depth to Water (ft):** 17.2  
**Well Diameter (in):** 30.0  
**Total Depth of Well (ft):** 30.0  
**Method of Purging:** Pumping  
**Measuring Point (toc, tor, etc.):** Top of Riser  
**Pump Intake Depth (feet):** 28

<table>
<thead>
<tr>
<th>Time</th>
<th>Water Level (feet)</th>
<th>Flow Rate (mL/min)</th>
<th>Cum. Volume (gal.)</th>
<th>Temp. (°C)</th>
<th>pH (SU)</th>
<th>Specific Electrical Conductance (mS/cm)</th>
<th>DO (mg/L)</th>
<th>ORP (mV)</th>
<th>Turbidity (NTU)</th>
<th>Comments/Observations During Purging</th>
</tr>
</thead>
<tbody>
<tr>
<td>12:44</td>
<td>1000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Pumping/Purging Started</td>
</tr>
</tbody>
</table>

**Stability Reached (Y/N):** No  
If No, Provide Explanation: No - Pumped dry  
**Final Values:**

<table>
<thead>
<tr>
<th>Sample ID:</th>
<th>Method of Sampling:</th>
<th>Sample Date:</th>
<th>Sample Collection Time:</th>
<th>Total Volume Purged (gal):</th>
<th>Sample Depth (ft):</th>
<th>Depth to Water After Sampling (ft):</th>
</tr>
</thead>
<tbody>
<tr>
<td>Estero-gw-tw03-11217</td>
<td>Submersible pump</td>
<td>11/21/17</td>
<td>13/05</td>
<td>4</td>
<td>28</td>
<td>Dry</td>
</tr>
</tbody>
</table>

**QA/QC Samples (Yes/No):** Yes

**Duplicate ID:** NA

**Sample Container Type(s):** 125 ml plastic, 250 ml amber glass

**Preservative(s):** Ice (4 °C)

**Analysis/Method(s):** PFAS (EPA 537-modified), TOC (EPA 9060)

**Instruments (Manufacturer, Model, and Serial No.):**

- Turbidity Meter, Water Quality Meter, Water Level Meter, Mega Monsoon Pump
- Lamotte 2020 1286, YSI 556 MPS 86749

**Calculations:**

**Saturated well casing volume:**

\[ V = \pi (R^2)H \approx 7.48 \text{ gal/ft}^3 \]

\[ \begin{align*}
\pi &= 3.14 \\
R &= \text{well radius (ft)} = \text{well diameter (in)/12 (in/ft)/2} \\
H &= \text{height of water column (ft)}
\end{align*} \]

\[ V = \pi (2.0 \text{ in}/12 \text{ in/ft}/2)^2 \times 12.60 \times 7.48 \text{ gal/ft}^3 = 2.1 \text{ gal.} \]

**Notes:** Well pumped dry half way through stabilization. Grabbed sample when water level reached pump depth. See well development record for field parameters: MRL 4/9/18

**QA/QC’d by:** Sarah Levine  
**QA/QC Date:** 12/13/2017

**Calculations:**

- Saturated well casing volume:  
  \[ V = \pi (R^2)H \approx 7.48 \text{ gal/ft}^3 \]

- Turbidity Meter, Water Quality Meter, Water Level Meter, Mega Monsoon Pump
  - Lamotte 2020 1286, YSI 556 MPS 86749

**Notes:** Well pumped dry half way through stabilization. Grabbed sample when water level reached pump depth. See well development record for field parameters: MRL 4/9/18

**QA/QC’d by:** Sarah Levine  
**QA/QC Date:** 12/13/2017
<table>
<thead>
<tr>
<th>Time</th>
<th>Water Level (feet)</th>
<th>Flow Rate (mL/min)</th>
<th>Cum. Volume (gal.)</th>
<th>Temp. (°C)</th>
<th>pH (SU)</th>
<th>Specific Electrical Conductance (mS/cm)</th>
<th>DO (mg/L)</th>
<th>ORP (mV)</th>
<th>Turbidity (NTU)</th>
<th>Comments/Observations During Purging (color, sediment, odor, etc.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>13:10</td>
<td>1100</td>
<td></td>
<td></td>
<td>±0.5°C</td>
<td>±0.1</td>
<td>±3%</td>
<td>±10%</td>
<td>±10%</td>
<td>±10% and &lt;10 NTU</td>
<td>Pumping/Purging Started</td>
</tr>
</tbody>
</table>

Stability Reached (Y/N): Yes

If No, Provide Explanation

NA

<table>
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<tr>
<th>Final Values:</th>
<th>Sample ID:</th>
<th>Method of Sampling:</th>
<th>QA/QC Samples (Yes/No):</th>
<th>Duplicate ID:</th>
<th>Sample Container Type(s):</th>
<th>Total Volume Purged (gal):</th>
<th>Sample Depth (ft):</th>
<th>Stability Reached (Y/N):</th>
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<tr>
<td></td>
<td>Edshep-geo-tw04-110117</td>
<td>Submersible pump.</td>
<td>No</td>
<td>NA</td>
<td>125 ml plastic, 250 ml amber glass</td>
<td>15</td>
<td>35</td>
<td>Yes</td>
</tr>
</tbody>
</table>

Instruments (Manufacturer, Model, and Serial No.):

Equipment Calibrated (Y/N): Yes

Calibrated Within Criteria (Y/N): Yes

Calculations:

Saturated well casing volume: 

\[ V = \pi (R^2)H \times \text{7.48 gal/ft}^3 \]

where:

- \( V \) = Volume (gal/ft)
- \( R \) = well radius (ft) = (well diameter (in)/12 (in/ft))/2
- \( H \) = height of water column (ft)

\[ V = \pi (2.0 \, \text{in/ft})^2 \times 31.28 \times 7.48 \, \text{gal/ft}^3 \]

Turbidity Meter, Water Quality Meter, Water Level Meter, Geosubmersible Pump

Lamotte 2020 1286, YSI 556 MPS 86749

QA/QC'd by: Sarah Levine

QA/QC Date: 12/12/2017

Name (print): Sean hultburt

Notes:

None

See well development record for field parameters- MHL 4/9/18

Signature:
## GROUNDWATER SAMPLING RECORD

### Project Name:
Phase 1 Regional Site Inspections for Per-Fluorinated Compounds at Multiple Air National Guard Installations

### Project Number:
291330006

### Contract:
W9133L-14-D-0002

### Installation:
ESHEP

### Well ID:
TW-35

### Initial Depth to Water (ft):
36.2

### Total Depth of Well (ft):
45.0

### Method of Purging:
Pumping

### Measuring Point (toc, tor, etc.):
Top of Riser

### Pump Intake Depth (feet):
39

### 1 Casing Volume (gal):

<table>
<thead>
<tr>
<th>Time</th>
<th>Water Level (feet)</th>
<th>Flow Rate (mL/min)</th>
<th>Cum. Volume (gal.)</th>
<th>Temp. (°C)</th>
<th>pH (SU)</th>
<th>Specific Electrical Conductance (mS/cm)</th>
<th>DO (mg/L)</th>
<th>ORP (mV)</th>
<th>Turbidity (NTU)</th>
<th>Comments/Observations During Purging</th>
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</thead>
<tbody>
<tr>
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<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Pumping/Purging Started</td>
</tr>
</tbody>
</table>

Stabilization Criteria:
- STG at 0.5°C
- pH ±0.1
- Specific Electrical Conductance ±3%
- DO ±10%
- ORP ±10%
- Turbidity <10 NTU

Stability Reached (Y/N): No

### Final Values:
- Submersible pump
- Method of Sampling: No
- Sample Date: 11/21/17
- Sample Collection Time: 11:45
- Total Volume Purged (gal): 5
- Sample Depth (ft): 39
- Depth to Water After Sampling (ft): Dry

### Instruments (Manufacturer, Model, and Serial No.):
- Calibrated Within Criteria (Y/N): -
- Water Level Meter, Mega Monsoon Pump

### Calculations:

Saturated well casing volume: $$V = \pi R^2 h = 7.48 \text{ gal/ft}^3$$

$$V = \pi \left( (2.0 \text{ in})/12 \text{ (in/ft)} \right)^2 \times 3.80 \times 7.48 \text{ gal/ft}^3 = 0.8 \text{ gal.}$$

### Notes:
Well was pumped dry at several times previously. Collected grab sample and well pumped dry.

See well development record for field parameters- MHL 4/8/18

### QA/QC'd by:
Sarah Levine

### QA/QC Date:
12/13/2017

### Signature:
Sean hulburt
<table>
<thead>
<tr>
<th>Time</th>
<th>Water Level (feet)</th>
<th>Flow Rate (mL/min)</th>
<th>Cum. Volume (gal.)</th>
<th>Temp. (°C)</th>
<th>pH (SU)</th>
<th>Specific Electrical Conductance (mS/cm)</th>
<th>DO (mg/L)</th>
<th>ORP (mV)</th>
<th>Turbidity (NTU)</th>
<th>Comments/Observations During Purging</th>
</tr>
</thead>
<tbody>
<tr>
<td>10:27</td>
<td>2000</td>
<td></td>
<td></td>
<td>±0.5°C</td>
<td>±0.1</td>
<td>±3%</td>
<td>±10%</td>
<td>±10%</td>
<td>±10% and &lt;10 NTU</td>
<td>Pumping/Purging Started</td>
</tr>
</tbody>
</table>

Stability Reached (Y/N): Yes

Final Values:

<table>
<thead>
<tr>
<th>Sample ID:</th>
<th>QA/QC Samples (Yes/No):</th>
<th>Duplicate ID:</th>
<th>Sample Container Type(s):</th>
<th>Preservation(s):</th>
<th>Analysis/Method(s):</th>
<th>Equipment Calibrated (Y/N):</th>
<th>Comments/Observations During Purging</th>
</tr>
</thead>
<tbody>
<tr>
<td>#N/A</td>
<td>NA</td>
<td>NA</td>
<td>125 ml plastic, 250 ml amber glass</td>
<td>Ice (4 °C)</td>
<td>PFAS (EPA 537-modified), TOC (EPA 9060)</td>
<td>Yes</td>
<td>Submersible pump</td>
</tr>
</tbody>
</table>

QA/QC’d by: Sarah Levine

QA/QC Date: 12/13/2017
# Groundwater Sampling Record

**Project Name:** Phase 1 Regional Site Inspections for Per-Fluorinated Compounds at Multiple Air National Guard Installations  
**Project Number:** 291330006  
**Contract:** W9133-L-14-D-0002  
**Installation:** ESHEP  
**Well ID:** TW-07  
**Date:** 10/26/17  
**Initial Depth to Water (ft):** 29.73  
**Total Depth of Well (ft):** 40.0  
**Well Diameter (in):** 2.0  
**Method of Purging:** Monsoon  
**Total Volume Purged (gal):** 7  
**Pump Intake Depth (feet):** 35  
**Measuring Point (toc, tor, etc.):** Top of Casing

<table>
<thead>
<tr>
<th>Time</th>
<th>Water Level (feet)</th>
<th>Flow Rate (Gpm)</th>
<th>Cum. Volume (gal.)</th>
<th>Temp. (°C)</th>
<th>pH (SU)</th>
<th>Specific Electrical Conductance (mS/cm)</th>
<th>DO (mg/L)</th>
<th>ORP (mV)</th>
<th>Turbidity (NTU)</th>
<th>Comments/Observations During Purging (color, sediment, odor, etc.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>14:58</td>
<td>.39</td>
<td>.39</td>
<td>0</td>
<td>16.28</td>
<td>7.03</td>
<td>0.473</td>
<td>2.96</td>
<td>97.1</td>
<td>12.4</td>
<td>Clear</td>
</tr>
<tr>
<td>14:58</td>
<td>29.61</td>
<td>.39</td>
<td>0</td>
<td>16.28</td>
<td>7.03</td>
<td>0.473</td>
<td>2.96</td>
<td>97.1</td>
<td>12.4</td>
<td>Pumping/Purging Started</td>
</tr>
<tr>
<td>15:02</td>
<td>29.70</td>
<td>.39</td>
<td>1.56</td>
<td>16.66</td>
<td>7.03</td>
<td>0.481</td>
<td>3.02</td>
<td>91.8</td>
<td>11.26</td>
<td>Clear</td>
</tr>
<tr>
<td>15:06</td>
<td>26.82</td>
<td>.39</td>
<td>3.11</td>
<td>16.40</td>
<td>7.02</td>
<td>0.478</td>
<td>3.05</td>
<td>83.3</td>
<td>9.35</td>
<td>Clear</td>
</tr>
<tr>
<td>15:10</td>
<td>26.88</td>
<td>.39</td>
<td>4.78</td>
<td>16.33</td>
<td>7.01</td>
<td>0.476</td>
<td>3.13</td>
<td>77.9</td>
<td>7.74</td>
<td>Clear</td>
</tr>
<tr>
<td>15:14</td>
<td>29.70</td>
<td>.39</td>
<td>6.24</td>
<td>16.31</td>
<td>7.01</td>
<td>0.476</td>
<td>3.17</td>
<td>74.5</td>
<td>7.01</td>
<td>Clear</td>
</tr>
</tbody>
</table>

**Stability Reached (Y/N):** Yes  
**QA/QC Samples (Yes/No):**  
**Duplicate ID:** NA  
**Sample Container Type(s):** Amber glass 250ml, HDPE 125ml  
**Preservative(s):** Ice (4 °C), H2SO4  
**Analysis/Method(s):** PFAS (EPA 537), TOC (EPA 9060)  
**Sample Date:** 10/26/17  
**Sample Collection Time:** 15:15  
**Sample Depth (ft):** 35  
**Total Volume Purged (gal):** 7  
**Initial Depth to Water (ft):** 29.72

**Instruments (Manufacturer, Model, and Serial No.):**  
**Equipment Calibrated (Y/N):** Yes  
**Calibrated Within Criteria (Y/N):** Yes

**Calculations:**  
**Saturated well casing volume:**  
\[ V = \pi R^2 H + 7.48 \text{ gal/ft}^3 \]

**Turbidity Meter, Water Quality Meter, Water Level Meter, Mega Monsoon Pump**

**LaMotte 2100Q 1286-3511, YSI 556 MPS 09F101780**

**Notes:**  
See well development record for additional field parameters - MNL 4/10/18

**QA/QC’d by:** Sarah Levine  
**QA/QC Date:** 12/11/2017
### GROUNDWATER SAMPLING RECORD

**Project Name:** Phase 1 Regional Site Inspections for Per-Fluorinated Compounds at Multiple Air National Guard Installations  
**Project Number:** 29130006

<table>
<thead>
<tr>
<th>Contract:</th>
<th>W9113L-14-D-0002</th>
</tr>
</thead>
<tbody>
<tr>
<td>Installation:</td>
<td>ESHEP</td>
</tr>
<tr>
<td>Well ID:</td>
<td>TW-9B</td>
</tr>
<tr>
<td>Initial Depth to Water (ft):</td>
<td>34.6</td>
</tr>
<tr>
<td>Total Depth of Well (ft):</td>
<td>45.0</td>
</tr>
<tr>
<td>Method of Purging:</td>
<td>Pumping</td>
</tr>
<tr>
<td>Measuring Point (toc, tor, etc.):</td>
<td>Top of Riser</td>
</tr>
<tr>
<td>Pump Intake Depth (ft):</td>
<td>35</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Time</th>
<th>Water Level (feet)</th>
<th>Flow Rate (mL/min)</th>
<th>Cum. Volume (gal.)</th>
<th>Temp. (°C)</th>
<th>pH (SU)</th>
<th>Specific Electrical Conductance (mS/cm)</th>
<th>DO (mg/L)</th>
<th>ORP (mV)</th>
<th>Turbidity (NTU)</th>
<th>Comments/Observations During Purging</th>
</tr>
</thead>
<tbody>
<tr>
<td>14:27</td>
<td>2000</td>
<td></td>
<td></td>
<td>±0.5°C</td>
<td>±0.1</td>
<td>±3%</td>
<td>±10%</td>
<td>±10%</td>
<td>±10% and &lt;10 NTU</td>
<td>Pumping/Purging Started</td>
</tr>
</tbody>
</table>

- Stabilization Criteria: ±0.5°C, ±0.1, ±3%
- DO: ±10%
- ORP: ±10%
- Turbidity: ±10% and <10 NTU

**Stability Reached (Y/N):** No

**Final Values:**

<table>
<thead>
<tr>
<th>Sample ID:</th>
<th>Method of Sampling:</th>
</tr>
</thead>
<tbody>
<tr>
<td>#N/A</td>
<td>Submersible pump</td>
</tr>
</tbody>
</table>

**QA/QC Samples (Yes/No):** No

**Duplicate ID:** NA

**Sample Collection Time:** 14:45

**Sample Depth (ft):** 35

**Depth to Water After Sampling (ft):** 35.8

**Instruments (Manufacturer, Model, and Serial No.):**

<table>
<thead>
<tr>
<th>Equipment Calibrated (Y/N):</th>
<th>Calibrated Within Criteria (Y/N):</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>

- Turbidity Meter: Water Quality Meter, Water Level Meter, Mega Monsoon Pump
- Lamotte 2020 1286, YSI 556 MPS 86749

**Calculations:**

- Saturated well casing volume: \( V = \pi (R^2)H \) ft\(^3\), where \( \pi = 3.14 \), \( R \) is well radius (ft) = (well diameter in (in)/12 in (ft))/2, \( H \) is height of water column (ft)

- Cumulative Volume Purged (gal):

\[
\text{Cum. Volume Purged (gal)} = \pi \times (2.0 \text{ (in)/12 in (ft)}/2)^2 \times 5.40 \times 7.48 \text{ gal/ft}^3 = 0.9 \text{ gal.}
\]

**Notes:**

- Turbidity low at time of collection
- See well development record for field parameters- M&H, 4/9/18

**QA/QC’d by:** Sarah Levine

**QA/QC Date:** 12/13/2017

**Signature:**

- Name (print): Sean hultburt
**GROUNDWATER SAMPLING RECORD**

<table>
<thead>
<tr>
<th>Time</th>
<th>Water Level (feet)</th>
<th>Flow Rate (mL/min)</th>
<th>Cum. Volume (gal.)</th>
<th>Temp. (°C)</th>
<th>pH (SU)</th>
<th>Specific Electrical Conductance (mS/cm)</th>
<th>DO (mg/L)</th>
<th>ORP (mV)</th>
<th>Turbidity (NTU)</th>
<th>Comments/Observations During Purging</th>
</tr>
</thead>
<tbody>
<tr>
<td>12:47</td>
<td>3000</td>
<td></td>
<td></td>
<td>0.5°C</td>
<td>±0.1</td>
<td>±3%</td>
<td>±10%</td>
<td>±10%</td>
<td>±10% and &lt;10 NTU</td>
<td>Pumping/Purging Started</td>
</tr>
</tbody>
</table>

**Stability Reached (Y/N):** Yes

**Final Values:**

<table>
<thead>
<tr>
<th>Sample ID:</th>
<th>Method of Sampling:</th>
<th>Sample Date:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zdhop-gw-tw03-110317</td>
<td>Submersible pump:</td>
<td>11/03/17</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>QA/QC Samples (Yes/No):</th>
<th>Duplicate ID:</th>
<th>Sample Collection Time:</th>
</tr>
</thead>
<tbody>
<tr>
<td>No</td>
<td>NA</td>
<td>13.20</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sample Container Type(s):</th>
<th>Total Volume Purged (gal):</th>
<th>Sample Depth (ft):</th>
</tr>
</thead>
<tbody>
<tr>
<td>125 ml plastic, 250 ml amber glass</td>
<td>20</td>
<td>25</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Preservative(s):</th>
<th>Analysis/Method(s):</th>
<th>Depth to Water After Sampling (ft):</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ice (4 ºC)</td>
<td>PFAS (EPA 537-modified), TOC (EPA 9000)</td>
<td>16.8</td>
</tr>
</tbody>
</table>

**Instruments (Manufacturer, Model, and Serial No.):**

Turbidity Meter, Water Quality Meter, Water Level Meter, Mega Monsoon Pump
Lamotte 2020 1286, YSI 556 MPS 86749

**Calculations:**

**Saturated well casing volume:** 
\[ V = \frac{\pi}{R^2} \cdot H = \frac{\pi}{2} \cdot (7.48 \text{ gal/ft}^3) \]

\[ V = \frac{\pi}{2} \cdot (R^2) \cdot H = 7.48 \text{ gal/ft}^3 \]

\[ \pi = 3.14 \]

\[ R = \text{well radius (in)/12 (in/ft)/2} \]

\[ H = \text{height of water column (ft)} \]

**Signature:**

Sean hulbury

**Notes:**

See well development record for field parameters- MHL 4/9/18

**QA/QC’d by:** Sarah Levine

**QA/QC Date:** 12/12/2017
## GROUNDWATER SAMPLING RECORD

**Project Name:** Phase 1 Regional Site Inspections for Per-Fluorinated Compounds at Multiple Air National Guard Installations  
**Contract:** W9133L-14-D-0002  
**Installation:** ESHEP  
**Well ID:** TW-10  
**Initial Depth to Water (ft):** 32.0  
**Total Depth of Well (ft):** 37.0  
**Method of Purging:** Submersible  
**Measuring Point (toc, tor, etc.):** Top of Casing  
**Sample ID:** Method of Sampling:  
**QA/QC Samples (Yes/No):** Yes  
**Sample Container Type(s):** 125ml HDPE  
**Preservative(s):** Ice (4 °C)  
**Analysis/Method(s):** PFAS (EPA 537)  
**Stability Reached (Y/N):** Yes  
**Equipment Calibrated (Y/N):** Yes  
**Instruments (Manufacturer, Model, and Serial No.):** Turbidity Meter, Water Quality Meter, Water Level Meter, Mega Monsoon Pump  
**Calculated Values:**  
- Saturated well casing volume: \[ V = \pi (R^2)(H^{1/2})^{7.48} \text{ gal/ft}^3 \]  
- Flow Rate (Gpm)  
- Cum. Volume (gal.)  
- Temp. (°C)  
- pH (SU)  
- Specific Electrical Conductance (mS/cm)  
- DO (mg/L)  
- ORP (mV)  
- Turbidity (NTU)  

### Summary of Sampling Results

<table>
<thead>
<tr>
<th>Time</th>
<th>Water Level (feet)</th>
<th>Flow Rate (Gpm)</th>
<th>Cum. Volume (gal.)</th>
<th>Temp. (°C)</th>
<th>pH</th>
<th>Specific Electrical Conductance (mS/cm)</th>
<th>DO (mg/L)</th>
<th>ORP (mV)</th>
<th>Turbidity (NTU)</th>
<th>Comments/Observations During Purging</th>
</tr>
</thead>
<tbody>
<tr>
<td>12:53</td>
<td>74</td>
<td>3.7</td>
<td>10.05</td>
<td>6.85</td>
<td>0.528</td>
<td>3.84</td>
<td>214.9</td>
<td>1169</td>
<td></td>
<td>Pumping/Purging Started</td>
</tr>
<tr>
<td>12:58</td>
<td>34.3</td>
<td>74</td>
<td>3.7</td>
<td>16.05</td>
<td>6.85</td>
<td>0.528</td>
<td>3.84</td>
<td>214.9</td>
<td>1169</td>
<td>Brown tint</td>
</tr>
<tr>
<td>13:03</td>
<td>34.3</td>
<td>74</td>
<td>7.4</td>
<td>15.58</td>
<td>6.88</td>
<td>0.520</td>
<td>3.63</td>
<td>186.8</td>
<td>84.1</td>
<td>Light brown tint</td>
</tr>
<tr>
<td>13:09</td>
<td>34.37</td>
<td>74</td>
<td>11.1</td>
<td>15.59</td>
<td>6.90</td>
<td>0.525</td>
<td>3.60</td>
<td>178.9</td>
<td>51.7</td>
<td>Clear</td>
</tr>
<tr>
<td>13:13</td>
<td>34.40</td>
<td>74</td>
<td>14.8</td>
<td>15.52</td>
<td>6.91</td>
<td>0.519</td>
<td>3.62</td>
<td>170.6</td>
<td>35.3</td>
<td>Clear</td>
</tr>
<tr>
<td>13:18</td>
<td>34.42</td>
<td>74</td>
<td>18.5</td>
<td>15.55</td>
<td>6.90</td>
<td>0.520</td>
<td>3.62</td>
<td>167.9</td>
<td>18.5</td>
<td>Clear</td>
</tr>
</tbody>
</table>

### Analysis/Method(s)
- Final Values:
  - Flow Rate (Gpm): 74
  - Cum. Volume (gal.): 10.05
  - Temp. (°C): 6.85
  - pH: 0.528
  - Specific Electrical Conductance (mS/cm): 3.84
  - DO (mg/L): 214.9
  - ORP (mV): 1169
  - Turbidity (NTU): 1169

### Note
- See well development record for additional parameters: MHL 4/10/18

**QA/QC by:** Sarah Levine  
**QA/QC Date:** 12/11/2017

---

*Signature:*

*Name (print):* Sarah Levine
## GROUNDWATER SAMPLING RECORD

<table>
<thead>
<tr>
<th>Project Name:</th>
<th>Phase 1 Regional Site Inspections for Per-Fluorinated Compounds at Multiple Air National Guard Installations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contract:</td>
<td>W9133L-14-D-0002</td>
</tr>
<tr>
<td>Installation:</td>
<td>ESHEP</td>
</tr>
<tr>
<td>Well ID:</td>
<td>BW-01</td>
</tr>
<tr>
<td>Initial Depth to Water (ft):</td>
<td>35.0</td>
</tr>
<tr>
<td>Total Depth of Well (ft):</td>
<td>40.0</td>
</tr>
<tr>
<td>Method of Purging:</td>
<td>Pumping</td>
</tr>
<tr>
<td>Measuring Point (toc, tor, etc.):</td>
<td>Top of Riser</td>
</tr>
<tr>
<td>Pump Intake Depth (feet):</td>
<td>15.56</td>
</tr>
</tbody>
</table>

### Sampling Record

<table>
<thead>
<tr>
<th>Time</th>
<th>Water Level (feet)</th>
<th>Flow Rate (mL/min)</th>
<th>Cum. Volume (gal.)</th>
<th>Temp. (°C)</th>
<th>pH (SU)</th>
<th>Specific Electrical Conductance (mS/cm)</th>
<th>DO (mg/L)</th>
<th>ORP (mV)</th>
<th>Turbidity (NTU)</th>
<th>Comments/Observations During Purging (color, sediment, odor, etc.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>15:56</td>
<td>Na</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Pumping/Purging Started</td>
</tr>
</tbody>
</table>

| Stability Reached (Y/N): | No |

### Final Values

| Sample ID: | Eshgp-sw-bw01-11217 |
| QA/QC Samples (Yes/No): | No |
| Duplicate ID: | NA |
| Sample Container Type(s): | 125 ml plastic, 250 ml amber glass |
| Preservative(s): | IHE (4 °C) |
| Analysis/Method(s): | PFAS (EPA 537-modified), TOC (EPA 9000) |

### Equipment

- Water Level Meter, Mega Monsoon Pump

### Calculations

- Saturated well casing volume: \( V = \frac{\pi (R^2)}{2}H^2 \times 7.48 \text{ gal/ft}^3 \)

- Flow Rate: \( V = \frac{\pi (R^2)}{2}H^2 \times 7.48 \text{ gal/ft}^3 \)

### Notes

Well was pumped dry 6 times before it was unable to recover. Managed to fill bottles from what left in line.

No field parameters collected - MHL 4/10/18

QA/QC'd by: Sarah Levine

QA/QC Date: 12/13/2017

Signature: [Signature Image]

Name (print): Sean Hulburt

Rev. 1, Date: 12/29/2016
## Groundwater Sampling Record

### Project Details
- **Project Name:** Phase 1 Regional Site Inspections for Per-Fluorinated Compounds at multiple Air National Guard Installations
- **Project Number:** 291330006
- **Contract:** W9113L-14-D-0002
- **Installation:** ESHEP
- **Well ID:** BW-02
- **Initial Depth to Water (ft):** 34.5
- **Total Depth of Well (ft):** 45.0
- **Method of Purging:** Pumping
- **Measuring Point (toc, tor, etc.):** Top of Riser
- **Pump Intake Depth (feet):** 38.5

### Water Level and Flow Rate Summary

<table>
<thead>
<tr>
<th>Time</th>
<th>Water Level (feet)</th>
<th>Flow Rate (mL/min)</th>
<th>Cum. Volume (gal.)</th>
<th>Temp. (°C)</th>
<th>pH (SU)</th>
<th>Specific Electrical Conductance (mS/cm)</th>
<th>DO (mg/L)</th>
<th>ORP (mV)</th>
<th>Turbidity (NTU)</th>
<th>Comments/Observations During Purging (color, sediment, odor, etc.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>07:25</td>
<td>1000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Stabilization Criteria</td>
<td></td>
<td></td>
<td>±0.5°C</td>
<td>Pumping/Purging Started</td>
</tr>
</tbody>
</table>

### QA/QC Details
- **Sample ID:** Eshep-gw-bw02-112117
- **Method of Sampling:** Submersible pump
- **Sample Date:** 11/21/17
- **Sample Collection Time:** 08:20
- **Sample Depth (ft):** 38.5
- **Depth to Water After Sampling (ft):** 32.5

### Instruments
- Turbidity Meter, Water Quality Meter, Water Level Meter, Mega Monsoon Pump
- Lamotte 2020 1286, YSI 556 MPS 86749

### Calculations

\[ V = \pi \left( R^2 \right) H \times 7.48 \text{ gal/ft}^3 \]

- **Saturated well casing volume:**
  - \( V = \pi \left( R^2 \right) H \times 7.48 \text{ gal/ft}^3 \)
  - \( \pi = 3.14 \)
  - \( R = \text{well radius (ft)} = (\text{well diameter (in)/2})/2 \)
  - \( H = \text{height of water column (ft)} \)

### Notes
- See well development record for field parameters APR 4/10/18
- Sean hulbrit

### QA/QC'd by
- **Sarah Levine**
- **Date:** 12/13/2017
<table>
<thead>
<tr>
<th>Project Name: Phase 1 Regional Site Inspections for Per-Fluorinated Compounds at Multiple Air National Guard Installations</th>
<th>Project Number: 291330006</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contract: W9133L-14-D-0002</td>
<td>Task Order: 0006</td>
</tr>
<tr>
<td>Installation: ESHEP</td>
<td>Technician(s): Schew</td>
</tr>
<tr>
<td>Well ID: BW-03</td>
<td>Date: 11/16/17</td>
</tr>
<tr>
<td>Initial Depth to Water (ft): 32.5</td>
<td>Well Diameter (in): 2.0</td>
</tr>
<tr>
<td>Total Depth of Well (ft): 40.0</td>
<td>1 Casing Volume (gal): 1.2</td>
</tr>
<tr>
<td>Method of Purging: Pumping</td>
<td>3 Casing Volumes (gal): 3.7</td>
</tr>
<tr>
<td>Measuring Point (toc, tor, etc.): Top of Riser</td>
<td>Pump Intake Depth (feet): 35</td>
</tr>
</tbody>
</table>

### GROUNDWATER SAMPLING RECORD

**Stabilization Criteria:**

- **Water Level:** 
  - Stabilized after 0.5°C rise
  - Stabilized after 0.1°C rise
  - Stabilized after 3% rise

**Comments/Observations During Purging:**

- Pumping/Purging Started

**Stability Reached (Y/N):** Yes

**Final Values:**

| Sample ID: | Ezhep-gw-bw03-111817 |
| Sample Collection Time: | 14:10 |
| Sample Date: | 11/16/17 |
| Analysis/Method(s): | PFAS (EPA 537-modified), TOC (EPA 9060) |
| Depth to Water After Sampling (ft): | 37.5 |

**Calculations:**

- Calculating saturated well casing volume:
  \[
  V = \frac{\pi (R^2)H}{4} \times 7.48 \text{ gal/ft}^3
  \]

  \[
  V = \frac{\pi (3.14/2)^2}{4} \times 7.48 \text{ gal/ft}^3
  \]

  = 1.2 gal.

**Notes:**

- See well development record for field parameters- MHL 4/10/18

**QA/QC’d by:** Sarah Levine

**QA/QC Date:** 12/13/2017
## Groundwater Sampling Record

**Project Name:** Phase 1 Regional Site Inspections for Per-Fluorinated Compounds at Multiple Air National Guard Installations  
**Project Number:** 291330006

- **Contract:** W9113L-14-D-0002  
- **Installation:** ESHEP  
- **Well ID:** BW-94  
- **Initial Depth to Water (ft):** 20.34  
- **Total Depth of Well (ft):** 30.0  
- **Method of Purging:** Pumping  
- **Measuring Point (toc, tor, etc.):** Top of Riser  
- **Pump Intake Depth (feet):** 25

### Water Level (feet) Data

<table>
<thead>
<tr>
<th>Time</th>
<th>Water Level</th>
<th>Flow Rate (mL/min)</th>
<th>Cum. Volume (gal.)</th>
<th>Temp. (°C)</th>
<th>pH (SU)</th>
<th>Specific Electrical Conductance (mS/cm)</th>
<th>DO (mg/L)</th>
<th>ORP (mV)</th>
<th>Turbidity (NTU)</th>
<th>Comments/Observations During Purging</th>
</tr>
</thead>
<tbody>
<tr>
<td>07:20</td>
<td>2000</td>
<td></td>
<td></td>
<td>±0.5°C</td>
<td>±0.1</td>
<td>±3%</td>
<td>±10%</td>
<td>±10%</td>
<td>±10% and &lt;10 NTU</td>
<td>Pumping/Purging Started</td>
</tr>
</tbody>
</table>

**Stability Reached (Y/N):** Yes  
**Final Values:** Submersible pump  
**Sample ID:** Chang-gw-bw-04-110917  
**Method of Sampling:** No  
**Sample Date:** 11/09/17  
**Sample Collection Time:** 07:50  
**Total Volume Purged (gal):** 25  
**Sample Depth (ft):** 25  
**Depth to Water After Sampling (ft):** 23

- **QA/QC Samples (Yes/No):** No  
- **Duplicate ID:** NA  
- **Sample Container Type(s):** 125 ml plastic, 250 ml amber glass  
- **Preservative(s):** Ice (4 °C)  
- **Analysis/Method(s):** PFAS (EPA 537-modified), TOC (EPA 9060)  
- **Equipment Calibrated (Y/N):** Yes  

**Instruments (Manufacturer, Model, and Serial No.):**
- Turbidity Meter, Water Quality Meter, Water Level Meter, Mega Monsoon Pump
- Lamotte 2020 1286, YSI 556 MPS 86749
- Calibrated Within Criteria (Y/N): Yes

### Calculations:

- **Saturated well casing volume:**  
  \[ V = \frac{\pi (R^2/2)H^2 + 7.48 \text{ gal}/\text{ft}^3}{1000} \]

- **Volume (gal/ft):**  
  \[ V = \frac{\pi (R^2/2)H^2}{1000} + 7.48 \text{ gal}/\text{ft}^3 \]

- **Well radius (ft) = (well diameter (in)/12 (in/ft))/2**
- **Height of water column (ft)**

**Notes:** See well development record for field parameters- MHL 4/10/18

**QA/QC'd by:** Sarah Levine  
**QA/QC Date:** 12/12/2017

**Rev. 1, Date: 12/29/2016**

**Name (print):** Sean Hulbert
**GROUNDWATER SAMPLING RECORD**

- **Project Name:** Phase 1 Regional Site Inspections for Per-Fluorinated Compounds at Multiple Air National Guard Installations
- **Project Number:** 291330006
- **Contract:** W9133J-14-D-0002
- **Installation:** ESHEP
- **Well ID:** B6-05
- **Initial Depth to Water (ft):** 32.5
- **Total Depth of Well (ft):** 40.0
- **Method of Purging:** Pumping
- **Measuring Point (loc, tor, etc.):** Top of Riser
- **Well Diameter (in):** 12
- **Well Casing Volume (gal):** 3.7
- **Pumping/Purging Started:** 11/20/17
- **Date:**
- **Temperature (°C):** ±0.5°C
- **pH (SU):** ±0.1
- **Specific Conductance (mS/cm):** ±3%
- **DO (mg/L):** ±10%
- **ORP (mV):** ±10%
- **Turbidity (NTU):** ±10% and <10 NTU

### Field Data

<table>
<thead>
<tr>
<th>Time</th>
<th>Water Level (feet)</th>
<th>Flow Rate (mL/min)</th>
<th>Cum. Volume (gal.)</th>
<th>Temp. (°C)</th>
<th>pH (SU)</th>
<th>Specific Electrical Conductance (mS/cm)</th>
<th>DO (mg/L)</th>
<th>ORP (mV)</th>
<th>Turbidity (NTU)</th>
<th>Comments/Observations During Purging</th>
</tr>
</thead>
<tbody>
<tr>
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<td>11:15</td>
<td></td>
<td></td>
<td></td>
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<td></td>
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<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Dry</td>
</tr>
</tbody>
</table>

### Calculations:

- **Saturated well casing volume:**
  \[ V = \pi \left( R^2 \right) \left( H \right) \times 7.48 \text{ gal/ft}^3 \]

  \[ R = 3.14 \]

  \[ H = \text{height of water column (ft)} \]

\[ V = \pi \left( 2.0 \text{ in/12 (in/ft)/2} \right)^2 \times 7.50 \times 7.48 \text{ gal/ft}^3 = 1.2 \text{ gal} \]

### Notes:

- Insufficient volume for low flow sampling and parameters pumped dry on 11/16/17

### QA/QC:

- **QA/QC’d by:**
- **QA/QC Date:** 12/29/2016
**GROUNDWATER SAMPLING RECORD**

**Project Name:** Phase 1 Regional Site Inspections for Per-Fluorinated Compounds at Multiple Air National Guard Installations

<table>
<thead>
<tr>
<th>Contract:</th>
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<td>Installation:</td>
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<tr>
<td>Well ID:</td>
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<tr>
<td>Initial Depth to Water (ft):</td>
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<td>Total Depth of Well (ft):</td>
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<tr>
<td>Method of Purging:</td>
<td>Pumping</td>
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<tr>
<td>Measuring Point (toc, tor, etc.):</td>
<td>Top of Riser</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Time</th>
<th>Water Level (feet)</th>
<th>Flow Rate (mL/min)</th>
<th>Cum. Volume (gal.)</th>
<th>Temp. (°C)</th>
<th>pH (SU)</th>
<th>Specific Electrical Conductance (mS/cm)</th>
<th>DO (mg/L)</th>
<th>ORP (mV)</th>
<th>Turbidity (NTU)</th>
<th>Comments/Observations During Purging</th>
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<tbody>
<tr>
<td>11:38</td>
<td>1000</td>
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<td></td>
<td>±0.5°C</td>
<td>±0.1</td>
<td>±3%</td>
<td>±10%</td>
<td>±10%</td>
<td>±10% and &lt;10 NTU</td>
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</tr>
</tbody>
</table>

**Stability Reached (Y/N):** Other (some do not stabilize) - If No, Provide Explanation

**Final Values:**

| Sample ID: | Eshep-ge-tw06:111717 |
| QA/QC Samples (Yes/No): | No |
| Duplicate ID: | NA |
| Sample Container Type(s): | 125 ml plastic, 250 ml amber glass |
| Preservative(s): | Ice (4 °C) |
| Analysis/Method(s): | PFAS (EPA 537-modified), TOC (EPA 9000) |
| Instruments (Manufacturer, Model, and Serial No.): | Turbidity Meter, Water Quality Meter, Water Level Meter, Mega Monsoon Pump Lamotte 2020 1286, YSI 556 MPS 86749 |

**Calculations:**

- **Saturated well casing volume:** 
  
  \[ V = \pi (R^2)H \] 

  \[ \pi = 3.14 \] 

  \[ R = \text{well radius (ft)} = \text{well diameter (in)/12 (in/ft)} / 2 \] 

  \[ H = \text{height of water column (ft)} \]

**Signature:**

**Name (print):** Sean hulburt

**QA/QC Date:** 12/13/2017
### Water Quality Sampling Instrument Calibration Form

**Project Name:** Phase 1 Regional Site Inspections for Per-Fluorinated Compounds at Multiple Air National Guard Installations  
**Project Number:** 291330006  
**Contract:** W9133L-14-D-0002  
**Task Order:** 0006  
**Date:** 10/20/17

**Installation:** ESHEP  
**Calibration Start Time:** 11:16

**Sample Technician(s):** Sarah Levine, Sean Hulburt  
**Calibration End Time:** 11:56

#### Readings Before Calibration

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<th>Turbidity (NTUs)</th>
<th>Specific Electrical Conductance (mS/cm)</th>
<th>D.O. (%)</th>
<th>Salinity (%)</th>
<th>ORP/Eh (mV)</th>
<th>Barometric Pressure (mm Hg)</th>
<th>Comments</th>
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</thead>
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<td>10/20/17</td>
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<td>4.03</td>
<td>10.05</td>
<td>1.237</td>
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<td></td>
<td>6.97</td>
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#### Readings After Calibration

<table>
<thead>
<tr>
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<th>Time (24hr)</th>
<th>Temperature (°C)</th>
<th>pH (SU)</th>
<th>Turbidity (NTUs)</th>
<th>Specific Electrical Conductance (mS/cm)</th>
<th>D.O. (%)</th>
<th>Salinity (%)</th>
<th>ORP/Eh (mV)</th>
<th>Barometric Pressure (mm Hg)</th>
<th>Comments</th>
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</thead>
<tbody>
<tr>
<td>10/20/17</td>
<td>12:55</td>
<td>Na</td>
<td>4.00</td>
<td>10.00</td>
<td>1.409</td>
<td>100</td>
<td>Na</td>
<td>220.0</td>
<td>760</td>
<td>None</td>
</tr>
<tr>
<td></td>
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#### Calibration Materials Record:

**pH Calibration Standards**

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<th>Standard</th>
<th>Cal. Standard Lot #</th>
<th>Expiration Date</th>
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<tbody>
<tr>
<td>pH (4)</td>
<td>G163-22</td>
<td>06/22/19</td>
</tr>
<tr>
<td>pH (7)</td>
<td>G163-23</td>
<td>06/22/19</td>
</tr>
<tr>
<td>pH (10)</td>
<td>G166-09</td>
<td>12/22/18</td>
</tr>
</tbody>
</table>

**Specific Electrical Conductance, Salinity, Dissolved Oxygen (DO) and Oxidation Reduction Potential (ORP) Calibration Standards**

<table>
<thead>
<tr>
<th>Standard</th>
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<tbody>
<tr>
<td>Spec. Conductance</td>
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<td>Salinity</td>
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<tr>
<td>D.O.</td>
<td>NA</td>
<td>10/22/17</td>
</tr>
<tr>
<td>ORP</td>
<td>NA</td>
<td>10/22/17</td>
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</table>

**Turbidity Standards**

<table>
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<tr>
<td>10</td>
<td>C689840</td>
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<tr>
<td>20</td>
<td>NA</td>
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<tr>
<td>100</td>
<td>NA</td>
<td>10/22/17</td>
</tr>
<tr>
<td>800</td>
<td>NA</td>
<td>10/22/17</td>
</tr>
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**Instruments (Manufacturer, Model, and Serial No.):**

<table>
<thead>
<tr>
<th>Manufacturer/Model</th>
<th>Serial No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water Quality Meter</td>
<td>YSI556MPS 09F101780</td>
</tr>
<tr>
<td>Turbidity Meter</td>
<td>LaMotte 2020 1286-3511</td>
</tr>
</tbody>
</table>

**Calibrated Within Acceptance Criteria (Y/N):** Yes

**If No, Provide Explanation:** NA

**Name (print):** Sarah Levine

**Signature:**

**QA/QC’d by:** Sarah Levine  
**QA/QC Date:** 12/11/2017
WATER QUALITY SAMPLING INSTRUMENT CALIBRATION FORM

Project Name: Phase 1 Regional Site Inspections for Per-Fluorinated Compounds at Multiple Air National Guard Installations
Project Number: 291330006

Contract: W9133L-14-D-0002
Task Order: 0006
Date: 10/24/17

Installation: ESHEP
Calibration Start Time: 07:20
Calibration End Time: 07:58

Serial No
Water Quality Meter: 09F101780
Turbidity Meter: 1286-3511

QA/QC'd by: Sarah Levine

Readings Before Calibration

<table>
<thead>
<tr>
<th>Date</th>
<th>Time (24hr)</th>
<th>Temperature (°C)</th>
<th>pH (SU)</th>
<th>Turbidity (NTUs)</th>
<th>Specific Electrical Conductance (mS/cm)</th>
<th>D.O. (%)</th>
<th>Salinity (%)</th>
<th>ORP/Eh (mV)</th>
<th>Barometric Pressure (mm Hg)</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
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<td>3.98</td>
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<td>237.2</td>
<td>760</td>
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</tr>
<tr>
<td>10/24/17</td>
<td>07:55</td>
<td>Na</td>
<td>4.00</td>
<td>10.00</td>
<td>1.409</td>
<td>100</td>
<td>Na</td>
<td>240.0</td>
<td>760</td>
<td>None</td>
</tr>
</tbody>
</table>

Readings After Calibration

<table>
<thead>
<tr>
<th>Date</th>
<th>Time (24hr)</th>
<th>Temperature (°C)</th>
<th>pH (SU)</th>
<th>Turbidity (NTUs)</th>
<th>Specific Electrical Conductance (mS/cm)</th>
<th>D.O. (%)</th>
<th>Salinity (%)</th>
<th>ORP/Eh (mV)</th>
<th>Barometric Pressure (mm Hg)</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>10/24/17</td>
<td>07:55</td>
<td>Na</td>
<td>4.00</td>
<td>10.00</td>
<td>1.409</td>
<td>100</td>
<td>Na</td>
<td>240.0</td>
<td>760</td>
<td>None</td>
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</tbody>
</table>

Calibration Materials Record:

<table>
<thead>
<tr>
<th>pH Calibration Standards</th>
<th>Specific Electrical Conductance, Salinity, Dissolved Oxygen (DO) and Oxidation Reduction Potential (ORP) Calibration Standards</th>
<th>Turbidity Standards</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard</td>
<td>Cal. Standard Lot #</td>
<td>Expiration Date</td>
</tr>
<tr>
<td>pH (4)</td>
<td>G163-22</td>
<td>06/22/19</td>
</tr>
<tr>
<td>pH (7)</td>
<td>G163-23</td>
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</tr>
<tr>
<td>pH (10)</td>
<td>G163-09</td>
<td>12/22/18</td>
</tr>
<tr>
<td></td>
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</table>

Instruments (Manufacturer, Model, and Serial No.):

<table>
<thead>
<tr>
<th>Water Quality Meter:</th>
<th>Manufacturer/Model</th>
<th>Serial No</th>
</tr>
</thead>
<tbody>
<tr>
<td>YSI556MPS</td>
<td>09F101780</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Turbidity Meter:</th>
<th>Manufacturer/Model</th>
<th>Serial No</th>
</tr>
</thead>
<tbody>
<tr>
<td>LaMotte 2020</td>
<td>1286-3511</td>
<td></td>
</tr>
</tbody>
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Calibrated Within Acceptance Criteria (Y/N): Yes

If No, Provide Explanation: NA

Notes: ORP standard brought from Durham Office. No high turbidity standards provided by FEI

QA/QC’d by: Sarah Levine
QA/QC Date: 12/11/2017
## WATER QUALITY SAMPLING INSTRUMENT CALIBRATION FORM

### Project Name:
Phase 1 Regional Site Inspections for Per-Fluorinated Compounds at Multiple Air National Guard Installations

### Project Number:
291330006

### Contract:
W9133L-14-D-0002

### Task Order:
0006

### Date:
10/26/17

### Installation:
ESHEP

### Sample Technician(s):
Sarah Levine, Sean Hulburt

### Calibration Start Time:
14:51

### Calibration End Time:
07:48

#### Readings Before Calibration

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<th>Turbidity (NTUs)</th>
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<th>D.O. (%)</th>
<th>Salinity (%)</th>
<th>ORP/Eh (mV)</th>
<th>Barometric Pressure (mm Hg)</th>
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<tbody>
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#### Readings After Calibration

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<thead>
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<th>Time (24hr)</th>
<th>Temperature (°C)</th>
<th>pH (SU)</th>
<th>Turbidity (NTUs)</th>
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<th>Salinity (%)</th>
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#### Calibration Materials Record:

<table>
<thead>
<tr>
<th>pH Calibration Standards</th>
<th>Specific Electrical Conductance, Salinity, Dissolved Oxygen (DO) and Oxidation Reduction Potential (ORP) Calibration Standards</th>
<th>Turbidity Standards</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard</td>
<td>Cal. Standard Lot #</td>
<td>Expiration Date</td>
</tr>
<tr>
<td>pH (4)</td>
<td>G163-22</td>
<td>06/22/19</td>
</tr>
<tr>
<td>pH (7)</td>
<td>G163-23</td>
<td>06/22/19</td>
</tr>
<tr>
<td>pH (10)</td>
<td>G166-09</td>
<td>12/22/18</td>
</tr>
<tr>
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### Instruments (Manufacturer, Model, and Serial No.):

<table>
<thead>
<tr>
<th>Water Quality Meter:</th>
<th>Manufacturer/Model</th>
<th>Serial No</th>
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</thead>
<tbody>
<tr>
<td>YSI556 MPS</td>
<td></td>
<td>09F101780</td>
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</tbody>
</table>

| Turbidity Meter:      | LaMotte 2020       | 1286-3511 |

### Calibration Within Acceptance Criteria (Y/N): Yes

### If No, Provide Explanation: NA

### QA/QC by: Sarah Levine

### QA/QC Date: 12/11/2017
# WATER QUALITY SAMPLING INSTRUMENT CALIBRATION FORM

## Project Information
- **Project Name:** Phase 1 Regional Site Inspections for Per-Fluorinated Compounds at Multiple Air National Guard Installations
- **Project Number:** 291330006
- **Contract:** W9133L-14-D-0002
- **Task Order:** 0006
- **Date:** 11/01/17

## Calibration Details
- **Installation:** ESHEP
- **Sample Technician(s):** Sch
- **Calibration Start Time:** 12:14
- **Calibration End Time:** 12:31

## Readings Before Calibration
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<th>D.O. (mg/L)</th>
<th>Salinity (%)</th>
<th>ORP/Eh (mV)</th>
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<tbody>
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## Readings After Calibration
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<th>Time (24hr)</th>
<th>Temperature (°C)</th>
<th>pH (SU)</th>
<th>Turbidity (NTUs)</th>
<th>Specific Electrical Conductance (mS/cm)</th>
<th>D.O. (mg/L)</th>
<th>Salinity (%)</th>
<th>ORP/Eh (mV)</th>
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<tbody>
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<td>11/01/17</td>
<td>12:31</td>
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<td>1.409</td>
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## Calibration Materials Record
- **pH Calibration Standards**
  - pH 4: G163-22 (06/22/19)
  - pH 7: G163-23 (06/22/19)
  - pH 10: G166-09 (12/22/18)

- **Specific Electrical Conductance, Salinity, Dissolved Oxygen (DO) and Oxidation Reduction Potential (ORP) Calibration Standards**
  - Specific Conductance: G083-08 (03/3/19)
  - Salinity: Na
  - D.O.: Na
  - ORP: 1422 (04/1/22)

- **Turbidity Standards**
  - 10: C796782 (05/01/18)
  - 20: C689840 (02/01/18)
  - 100: Na
  - 800: Na

## Instruments (Manufacturer, Model, and Serial No.)
- **Water Quality Meter:** YSI556MPS 86749
- **Turbidity Meter:** Lamotte 2020 1286

## Quality Assurance/Quality Control (QA/QC)
- **QA/QC by:** Sarah Levine
- **QA/QC Date:** 12/12/2017

## Calibration Materials
- **Calibrated Within Acceptance Criteria (Y/N):** Yes
- **Calibration Start Time:** 12:14
- **Calibration End Time:** 12:31

## Signature
- **Signature:** [Signature]
- **Name (print):** Sean Hulburt

## Notes
- **Calibrated Within Acceptance Criteria:** Yes
- **If No, Provide Explanation:** NA
WATER QUALITY SAMPLING INSTRUMENT CALIBRATION FORM

Project Name: Phase 1 Regional Site Inspections for Per-Fluorinated Compounds at Multiple Air National Guard Installations
Project Number: 291330006
Contract: W9133L-14-D-0002
Task Order: 0006
Date: 11/03/17
Installation: ESHEP
Calibration Start Time: 12:41
Calibration End Time: 12:52
QA/QC'd by: Sarah Levine

Readings Before Calibration

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<th>D.O. (mg/L)</th>
<th>Salinity (%)</th>
<th>ORP/Eh (mV)</th>
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Readings After Calibration

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Calibration Materials Record:

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<th>Turbidity Standards</th>
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<tbody>
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<td>pH (4)</td>
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Instruments (Manufacturer, Model, and Serial No.):

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<th>Water Quality Meter:</th>
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Calibrated Within Acceptance Criteria (Y/N): Yes

If No, Provide Explanation: NA

Notes: None

Rev. 1, Date: 12/29/2016
**WATER QUALITY SAMPLING INSTRUMENT CALIBRATION FORM**

**Project Name:** Phase 1 Regional Site Inspections for Per-Fluorinated Compounds at Multiple Air National Guard Installations  
**Project Number:** 291330006

**Contract:** W9133L-14-D-0002  
**Task Order:** 0006  
**Date:** 11/09/17

**Installation:** ESHEP  
**Calibration Start Time:** 06:51

**Sample Technician(s):** Sch  
**Calibration End Time:** 07:06

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### Readings After Calibration

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### Calibration Materials Record:

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**Instruments (Manufacturer, Model, and Serial No.):**

- **Water Quality Meter:** YSI556MPS 86740
- **Turbidity Meter:** Lamotte 2020 1286

**Calibrated Within Acceptance Criteria (Y/N):** Yes

**If No, Provide Explanation:** NA

**Notes:**

**Signature:**

**QA/QC’d by:** Sarah Levine  
**QA/QC Date:** 12/12/2017
# WATER QUALITY SAMPLING INSTRUMENT CALIBRATION FORM

## Project Name:
Phase 1 Regional Site Inspections for Per-Fluorinated Compounds at Multiple Air National Guard Installations

## Project Number:
291330006

## Contract:
W9133L-14-D-0002

## Task Order:
0006

## Date:
11/13/17

## Installation:
ESHEP

## Calibration Start Time:
10:25

## Calibration End Time:
10:30

### Readings Before Calibration

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<th>D.O. (mg/L)</th>
<th>Salinity (%)</th>
<th>ORP/Eh (mV)</th>
<th>Barometric Pressure (mm Hg)</th>
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### Readings After Calibration

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### Calibration Materials Record:

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<td>pH (10)</td>
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#### Specific Electrical Conductance, Salinity, Dissolved Oxygen (DO) and Oxidation Reduction Potential (ORP) Calibration Standards

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### Instruments (Manufacturer, Model, and Serial No.):

- **Water Quality Meter:**
  - Manufacturer/Model: YSI556MPS
  - Serial No: 86749

- **Turbidity Meter:**
  - Manufacture/Model: Lamotte 2020
  - Serial No: 1286

**Calibrated Within Acceptance Criteria (Y/N):** Yes

**If No, Provide Explanation:** NA

**QA/QC’d by:** Sarah Levine

**QA/QC Date:** 12/13/2017
**WATER QUALITY SAMPLING INSTRUMENT CALIBRATION FORM**

**Project Name:** Phase 1 Regional Site Inspections for Per-Fluorinated Compounds at Multiple Air National Guard Installations  
**Project Number:** 291330006  
**Site:** ESHEP  
**Sample Technician(s):** Sean Hulburt

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**Readings After Calibration**

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**Calibration Materials Record:**

- **pH Calibration Standards**
  - Spec. Conductance: YSI 556 MPS  
  - Manufacturer/Model: Lamotte 2020  
  - Serial No: 1206  
  - Calibration Within Acceptance Criteria (Y/N): Yes

- **Turbidity Standards**
  - Calibration Within Acceptance Criteria (Y/N): NA

**Total Readings Before Calibration:** 3  
**Total Readings After Calibration:** 3

**Calibrated Within Acceptance Criteria (Y/N): Yes**

**QA/QC Date:** 12/13/2017  
**QA/QC’d by:** Sarah Levine

**Calibration Start Time:** 12:28  
**Calibration End Time:** 13:57

**Notes:**

- **Instruments (Manufacturer, Model, and Serial No.):**
  - pH: YSI 556 MPS  
  - Turbidity: NA  
  - ORP: NA  
  - D.O.: NA

- **Calibrated Within Acceptance Criteria (Y/N):** Yes

**Calibration Standards Lot #:**

- pH: G083-08 03/30/19  
- Spec. Conductance: C689840 02/19/18

- Turbidity: NA

- ORP/Eh: G163-22 06/22/19  
- D.O.: G163-23 06/22/19  
- Salinity: G166-09 12/22/18
### Water Quality Sampling Instrument Calibration Form

**Project Name:** Phase 1 Regional Site Inspections for Per-Fluorinated Compounds at Multiple Air National Guard Installations  
**Project Number:** 291330006

**Contract:** W9133L-14-D-0002  
**Task Order:** 0006  
**Date:** 11/16/17

**Installation:** ESHEP  
**Sample Technician(s):** Sch

#### Calibration Start Time: 15:11  
**Calibration End Time:** 14:13

#### Readings Before Calibration

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<tr>
<td></td>
<td></td>
<td></td>
<td>9.6</td>
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<td>Na</td>
</tr>
</tbody>
</table>

#### Readings After Calibration

<table>
<thead>
<tr>
<th>Date</th>
<th>Time (24hr)</th>
<th>Temperature (°C)</th>
<th>pH (SU)</th>
<th>Turbidity (NTUs)</th>
<th>Specific Electrical Conductance (mS/cm)</th>
<th>D.O. (mg/L)</th>
<th>Salinity (%)</th>
<th>ORP/Eh (mV)</th>
<th>Barometric Pressure (mm Hg)</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>11/16/17</td>
<td>15:22</td>
<td>12.3</td>
<td>4</td>
<td>0</td>
<td>1.400</td>
<td>Na</td>
<td>Na</td>
<td>Na</td>
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<td>Na</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>7</td>
<td>10</td>
<td></td>
<td>Na</td>
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<td>Na</td>
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<td>Na</td>
<td>Na</td>
<td>Na</td>
</tr>
</tbody>
</table>

#### Calibration Materials Record:

- **pH Calibration Standards**
  - pH (4)  
  - pH (7)  
  - pH (10)

- **Specific Electrical Conductance, Salinity, Dissolved Oxygen (DO) and Oxidation Reduction Potential (ORP) Calibration Standards**
  - Spec. Conductance  
  - Salinity  
  - D.O.  
  - ORP

- **Turbidity Standards**
  - Turbidity Standards

#### Instruments (Manufacturer, Model, and Serial No.):

- **Water Quality Meter:** YSI556 MPS  
  - Manufacturer/Model: YSI556 MPS  
  - Serial No: 86749

- **Turbidity Meter:** Lamotte 2020  
  - Manufacturer/Model: Lamotte 2020  
  - Serial No: 1286

**Calibrated Within Acceptance Criteria (Y/N):** Yes

**If No, Provide Explanation:** NA

**QA/QC'd by:** Sarah Levine  
**QA/QC Date:** 12/13/2017

**Signature:**

**Name (print):** Sean Hulburt

**Revision:** Rev. 1, Date: 12/29/2016  
**Page:** 1 of 1
**WATER QUALITY SAMPLING INSTRUMENT CALIBRATION FORM**

**Project Number:** 291330006  
**Contract:** 11108  
**Installation:** ESHEP  
**Task Order:** 0906

### Calibration Details

<table>
<thead>
<tr>
<th>Calibration Start Time</th>
<th>Calibration End Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>11/17/17 11:08</td>
<td>11/17/17 11:34</td>
</tr>
</tbody>
</table>

### Calibration Materials

- **pH Calibration Standards:**
  - G083-08 03/30/19
  - G163-22 06/22/19
  - G163-23 06/22/19
  - G166-09 12/22/18

- **Specific Electrical Conductance, Salinity, Dissolved Oxygen (DO) and Oxidation Reduction Potential (ORP) Calibration Standards:**
  - C689840 11/13/17
  - C796782 05/19/18

- **Turbidity Standards:**
  - 1422 04/01/22

### Calibration Readings

<table>
<thead>
<tr>
<th>Date</th>
<th>Time (24hr)</th>
<th>Temperature (°C)</th>
<th>pH (SU)</th>
<th>Salinity (%)</th>
<th>ORP/Eh (mV)</th>
<th>Barometric Pressure (mm Hg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>11/17/17</td>
<td>11/09</td>
<td>11</td>
<td>1.23</td>
<td>3.42</td>
<td>1.40</td>
<td>Na</td>
</tr>
<tr>
<td>11/17/17</td>
<td>11/34</td>
<td>11</td>
<td>4.0</td>
<td>3.42</td>
<td>1.40</td>
<td>Na</td>
</tr>
</tbody>
</table>

### Calibration Before and After

#### Before Calibration

- **pH:** 3.42
- **Salinity:** 3.42
- **ORP/Eh:** 1.40
- **Barometric Pressure:** Na

#### After Calibration

- **pH:** 3.42
- **Salinity:** 3.42
- **ORP/Eh:** 1.40
- **Barometric Pressure:** Na

### Calibration Details

<table>
<thead>
<tr>
<th>Date</th>
<th>Time (24hr)</th>
<th>Temperature (°C)</th>
<th>pH (SU)</th>
<th>Salinity (%)</th>
<th>ORP/Eh (mV)</th>
<th>Barometric Pressure (mm Hg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>11/17/17</td>
<td>11/09</td>
<td>11</td>
<td>1.23</td>
<td>3.42</td>
<td>1.40</td>
<td>Na</td>
</tr>
<tr>
<td>11/17/17</td>
<td>11/34</td>
<td>11</td>
<td>4.0</td>
<td>3.42</td>
<td>1.40</td>
<td>Na</td>
</tr>
</tbody>
</table>

### Calibration Meters

- **pH:** YSI 556 MPS  
- **Specific Electrical Conductance, Salinity, Dissolved Oxygen (DO) and Oxidation Reduction Potential (ORP):**
  - Lamotte 2020

### Calibration by

- **QA/QC Date:** 12/13/2017
- **Name:** Sean Hulburt
WATER QUALITY SAMPLING INSTRUMENT CALIBRATION FORM

**Project Name:** Phase 1 Regional Site Inspections for Per-Fluorinated Compounds at Multiple Air National Guard Installations  
**Contract:** W9133L-14-D-0002  
**Task Order:** 0006  
**Project Number:** 291330006  
**Date:** 11/21/17

---

**Installation:** ESHEP  
**Sample Technician(s):** Sch

---

### Readings Before Calibration

<table>
<thead>
<tr>
<th>Date</th>
<th>Time (24hr)</th>
<th>Temperature (°C)</th>
<th>pH (SU)</th>
<th>Turbidity (NTUs)</th>
<th>Specific Electrical Conductance (mS/cm)</th>
<th>D.O. (mg/L)</th>
<th>Salinity (%)</th>
<th>ORP/Eh (mV)</th>
<th>Barometric Pressure (mm Hg)</th>
<th>Comments</th>
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<tbody>
<tr>
<td>11/21/17</td>
<td>07:20</td>
<td>6.67</td>
<td>3.5</td>
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<td>237</td>
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### Readings After Calibration

<table>
<thead>
<tr>
<th>Date</th>
<th>Time (24hr)</th>
<th>Temperature (°C)</th>
<th>pH (SU)</th>
<th>Turbidity (NTUs)</th>
<th>Specific Electrical Conductance (mS/cm)</th>
<th>D.O. (mg/L)</th>
<th>Salinity (%)</th>
<th>ORP/Eh (mV)</th>
<th>Barometric Pressure (mm Hg)</th>
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<tbody>
<tr>
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<td>6.81</td>
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### Calibration Materials Record:

**pH Calibration Standards**

<table>
<thead>
<tr>
<th>Standard</th>
<th>Cal. Standard Lot #</th>
<th>Expiration Date</th>
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</thead>
<tbody>
<tr>
<td>pH (4)</td>
<td>G163-22</td>
<td>06/22/19</td>
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<td>06/22/19</td>
</tr>
<tr>
<td>pH (10)</td>
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<td>12/22/18</td>
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**Specific Electrical Conductance, Salinity, Dissolved Oxygen (DO) and Oxidation Reduction Potential (ORP) Calibration Standards**

<table>
<thead>
<tr>
<th>Standard</th>
<th>Cal. Standard Lot #</th>
<th>Expiration Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spec. Conductance</td>
<td>G083-08</td>
<td>03/3/19</td>
</tr>
<tr>
<td>Salinity</td>
<td>Na</td>
<td>11/2/17</td>
</tr>
<tr>
<td>D.O.</td>
<td>Na</td>
<td>11/2/17</td>
</tr>
<tr>
<td>ORP</td>
<td>1422</td>
<td>04/01/22</td>
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</table>

**Turbidity Standards**

<table>
<thead>
<tr>
<th>Standard</th>
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<th>Expiration Date</th>
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<tbody>
<tr>
<td>10</td>
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</tr>
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**Instruments (Manufacturer, Model, and Serial No.):**

<table>
<thead>
<tr>
<th>Water Quality Meter:</th>
<th>Manufacturer/Model</th>
<th>Serial No</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>YSI556MPS</td>
<td>8679</td>
</tr>
</tbody>
</table>

| Turbidity Meter:     | Lamotte 2020       | 1286      |

**Calibrated Within Acceptance Criteria (Y/N):** Yes

If No, Provide Explanation: NA

---

**QA/QC by:** Sarah Levine  
**QA/QC Date:** 12/13/2017

---

**Signature:**

**Name (print):** Sean Hulburt

---

Rev. 1, Date: 12/29/2016
**SAMPLE COLLECTION LOG**

**SEDIMENT / SURFACE SOIL / SURFACE WATER**

<table>
<thead>
<tr>
<th>Project Name:</th>
<th>Phase 1 Regional Site Inspections for Per-Fluorinated Compounds at Multiple Air National Guard Installations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contract:</td>
<td>W9133L-14-D-0002</td>
</tr>
<tr>
<td>Installation:</td>
<td>ESHEP</td>
</tr>
<tr>
<td>Location ID:</td>
<td>Swsd-01</td>
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<tr>
<td>Technician(s):</td>
<td></td>
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**SEDIMENT SAMPLE**

<table>
<thead>
<tr>
<th>Sample Depth (ft):</th>
<th>NA</th>
<th>Sample ID:</th>
<th>Estep-10-S001-0-0.5</th>
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<tbody>
<tr>
<td>MS/MSD Collected:</td>
<td>Yes</td>
<td>Sample Date:</td>
<td>10/19/17</td>
</tr>
<tr>
<td>Duplicate ID:</td>
<td>ESHEP-SD-DUP01-101917</td>
<td>Sample Collection Time:</td>
<td>13.00</td>
</tr>
<tr>
<td>Sample Container Type(s):</td>
<td>6oz plastic</td>
<td>Sample Collection Methods:</td>
<td>Hand auger</td>
</tr>
<tr>
<td>Preservative(s):</td>
<td>Ice (4 °C)</td>
<td>Analysis/Method(s):</td>
<td>PFAS (EPA 537)</td>
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**SURFACE SOIL SAMPLE**

<table>
<thead>
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<th>Sample ID:</th>
<th>NA</th>
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</thead>
<tbody>
<tr>
<td>MS/MSD Collected:</td>
<td>NA</td>
<td>Sample Date:</td>
<td>NA</td>
</tr>
<tr>
<td>Duplicate ID:</td>
<td>NA</td>
<td>Sample Collection Time:</td>
<td>NA</td>
</tr>
<tr>
<td>Sample Container Type(s):</td>
<td>NA</td>
<td>Sample Collection Methods:</td>
<td>NA</td>
</tr>
<tr>
<td>Preservative(s):</td>
<td>NA</td>
<td>Analysis/Method(s):</td>
<td>NA</td>
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</table>

**SURFACE WATER SAMPLE**

<table>
<thead>
<tr>
<th>Time</th>
<th>Intake Depth (in)</th>
<th>Temp. (°C)</th>
<th>pH (units)</th>
<th>Specific Electrical Conductance (mS/cm)</th>
<th>DO (mg/L)</th>
<th>ORP (mV)</th>
<th>Turbidity (NTU)</th>
<th>Comments/Observations During Purging (color, sediment, etc.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>NA</td>
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<td>NA</td>
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<td>NA</td>
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<tr>
<td>Sample Depth (ft):</td>
<td>NA</td>
<td>Sample Collection Time:</td>
<td>NA</td>
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<td>NA</td>
<td>Sample Collection Methods:</td>
<td>NA</td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MS/MSD Collected:</td>
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<td>Surface Water Depth (ft):</td>
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<td></td>
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</tr>
<tr>
<td>Duplicate ID:</td>
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<td>Water Body and Water Quality Characteristics:</td>
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<tr>
<td>Sample Container Type(s):</td>
<td>NA</td>
<td>Instruments (Manufacturer, Model, and Serial No.):</td>
<td>NA</td>
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<td></td>
<td></td>
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<tr>
<td>Preservative(s):</td>
<td>NA</td>
<td>Equipment Calibrated (Y/N):</td>
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<td></td>
<td></td>
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<tr>
<td>Analysis/Method(s):</td>
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<td>Calibrated Within Criteria (Y/N):</td>
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</tbody>
</table>

**Location Sketch:**

![Location Sketch](image)

**Notes:** None

**Signature:**

Sean Hulburt

**Name (print):** Sarah Levine

**QA/QC Date:** 12/11/2017

Rev. 1, Date: 12/29/2016
# SAMPLE COLLECTION LOG

## SEDIMENT / SURFACE SOIL / SURFACE WATER

**Project Name:** Phase 1 Regional Site Inspections for Per-Fluorinated Compounds at Multiple Air National Guard Installations  
**Project Number:** 291330006

**Contract:** W9133L-14-D-0002  
**Task Order:** 0006

**Installation:** ESHEP  
**Date:** 11/06/17

**Location ID:** Ph 3  
**Northing/Easting:** Sch  
**Sample Collection Time:** Not Collected

### SEDIMENT SAMPLE

**Description**  
NAME (USCS Symbol): color, moisture, % by wt, plasticity, dilatancy, toughness, dry strength, consistency

<table>
<thead>
<tr>
<th>Sample Depth (ft)</th>
<th>MS/MSD Collected</th>
<th>Duplicate ID</th>
<th>Sample Container Type(s)</th>
<th>Preservative(s)</th>
<th>Sample ID</th>
<th>Sample Date</th>
<th>Sample Collection Time</th>
<th>Sample Collection Methods</th>
<th>Preservative(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - 0.5</td>
<td>No</td>
<td>NA</td>
<td>8 oz hdpe</td>
<td>ice (4 °C)</td>
<td>Eshep-03-sd01-110617</td>
<td>11/06/17</td>
<td>11:20</td>
<td>Grab</td>
<td></td>
</tr>
</tbody>
</table>

### SURFACE SOIL SAMPLE

**Description**  
NAME (USCS Symbol): color, moisture, % by wt, plasticity, dilatancy, toughness, dry strength, consistency

<table>
<thead>
<tr>
<th>Sample Depth (ft)</th>
<th>MS/MSD Collected</th>
<th>Duplicate ID</th>
<th>Sample Container Type(s)</th>
<th>Analysis/Method(s)</th>
<th>Sample ID</th>
<th>Sample Date</th>
<th>Sample Collection Time</th>
<th>Sample Collection Methods</th>
<th>Preservative(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
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</tr>
</tbody>
</table>

### SURFACE WATER SAMPLE

**Time**  
<table>
<thead>
<tr>
<th>Time</th>
<th>Intake Depth (in)</th>
<th>Temp. (°C)</th>
<th>pH (units)</th>
<th>Specific Electrical Conductance (mS/cm)</th>
<th>DO (mg/L)</th>
<th>ORP (mV)</th>
<th>Turbidity (NTU)</th>
<th>Comments/Observations During Purging (color, sediment, etc.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
</tbody>
</table>

**Sample Depth (ft):** 0 - 0.5  
**Sample ID:** Eshep-03sw01-110617  
**Sample Collection Time:** 11:30  
**Sample Collection Methods:** Grab  
**Surface Water Depth (ft):** .5  
**Water Body and Water Quality Characteristics:** Outfall, Flowing, Clear

**Location Sketch:**
![Location Sketch]

**Instruments (Manufacturer, Model, and Serial No.):**
Stainless Steel Spoon, Manual Hand Tools, Other(s): Sample containers

**Equipment Calibrated (Y/N):** NA  
**Calibrated Within Criteria (Y/N):** NA

**Notes:** 03sb01replacement

**QA/QC'd by:** Sarah Levine  
**QA/QC Date:** 3/22/2018

---

**Signature:** Sean Hulburt  
**Name (print):** Sean Hulburt

---

Rev. 1, Date: 12/29/2016  
Page 1 of 1
## Non-Hazardous Waste Manifest

1. **Generator's US EPA ID No.**
   
   NA

2. **Manifest Document No.**
   
   D58834

3. **Generator's Name and Mailing Address**
   
   Martinsburg Air National Guard Base - 167th Air Ref.
   167 Air Ref Wing 3601 Winchester Avenue
   Martinsburg, WV 25406
   304-216-5418

4. **Transporter 1 Company Name**
   
   Environmental Recovery Corporation

5. **Transporter 1 US EPA ID Number**
   
   PAD98728749

6. **Transporter 1 State Transporter’s ID**
   
   717-393-3827

7. **Transporter 2 Company Name**
   
   NA

8. **Transporter 2 US EPA ID Number**
   
   NA

9. **Transporter 2 State Transporter’s ID**
   
   NA

10. **Transporter 2 State Facility’s ID**
    
    NA

11. **Transporter 2 Facility’s Phone**
    
    NA

12. **Waste Description**

   a. Non RCRA/DOT Solids (Soil Cuttings)
   
      - Containers: 32
      - Type: DM
      - Total Weight: 25,600
      - Unit: LBS

   b. Non RCRA/DOT Solids (PVC Pipes)
   
      - Containers: 4
      - Type: DM
      - Total Weight: 1,000
      - Unit: LBS

   c. Non RCRA/DOT Liquids (Groundwater)
   
      - Containers: 8
      - Type: DM
      - Total Weight: 2,000
      - Unit: LBS

13. **Special Handling Instructions and Additional Information**

   1. Approval #: 1802-00348-SPT
   2. Approval #: 1802-00347-SPT
   3. Approval #: 1802-00348-LWT

14. **Facility’s Name and Site Address**

   Environmental Recovery Corporation
   1076 Old Manheim Pike
   Lancaster, PA 17601

15. **Designated Facility Name and Site Address**

   Environmental Recovery Corporation
   1076 Old Manheim Pike
   Lancaster, PA 17601

---

**Supplier’s Certification:** I hereby certify that the contents of this shipment are fully and accurately described and are in all respects in proper condition for transport. The materials described on this manifest are not subject to federal hazardous waste regulations.

**Date:** 2/16/18

**Signature:** [Signature]

---

**Transporter’s Acknowledgment of Receipt of Materials**

**Transporter’s Name:** Dennis Wagner

**Date:** 2/16/18

**Signature:** [Signature]

---

**Facility’s Acknowledgment of Receipt of Materials**

**Facility’s Name:** [Name]

**Date:** [Date]

**Signature:** [Signature]

---

**Certification of Receipt of the Waste Materials Covered by this Manifest:**

**Facility Owner or Operator:** [Name]

**Date:** 2/16/18

**Signature:** [Signature]

---

**Copy Details:**

- **White Copy:** Environmental Recovery Corp.
- **Yellow Copy:** Invoice Copy
- **Pink Copy:** Transporter
- **Gold Copy:** Generator
## Generator Name
MARTINSBURG AIR NATIONAL GUARD BASE - 167th AIRLIFT WING

## Site Address
167th AIRLIFT WING, 3801 Winchester Ave

## City
Martinsburg

## State
WV

## Zip
25405

## Phone#
(304) 616-5418

## Fax#

## Contact Name
Captain Blake Bennett

## City of Generator Site
Berkeley County

## Bill to Name
Capitol Environmental Services, Inc.

## Mailing Address
200 Biddle Ave, Suite 205

## City
Newark

## State
DE

## Zip
19702

## Phone#
302-380-3737

## Fax#

## Contact Name
Terri Fort

### Waste Information

**Waste Name**: GROUNDWATER

- **Quantity**: 8 drums
- **Frequency**: ONCE

#### Chemical Composition (must equal 100%)

<table>
<thead>
<tr>
<th>Chemical Name</th>
<th>Avg%</th>
<th>Min%</th>
<th>Max%</th>
</tr>
</thead>
<tbody>
<tr>
<td>WATER</td>
<td>98</td>
<td>95</td>
<td>100</td>
</tr>
<tr>
<td>SEDIMENT</td>
<td>2</td>
<td>0</td>
<td>5</td>
</tr>
</tbody>
</table>

#### Preferred Disposal Method:
- Roll-off

#### Flash Point (°F)
- NONE

#### pH
- 6 to 9

#### Color
- VARIES

#### Water (%)
- 98

#### Solids (%)
- 2

#### Odor:
- None

#### TX < 1000ppm (Yes or No)
- YES

#### Pumpable (Yes or No)
- NO

#### Hazardous Material (Yes or No)
- NO

### Process Generating Waste:
IDW FROM SITE INVESTIGATION

### Shipping Name:
NONHAZARDOUS, NON-REGULATED

### EMAIL ADDRESS TO SEND APPROVAL TO:
blake.w.bennett.mil@mail.mil

I hereby certify that the above described waste is Non-Hazardous and is Pennsylvania Residual Waste and has been disclosed to the best of my ability.

167th AW Environmental Engineer 6 Feb 2018

---

For ERC Use Only

Approved By

Residual Waste Code

Date
**WASTE PROFILE**

**Generator Name:** MARTINSBURG AIR NATIONAL GUARD BASE - 167th Airlift Wing  
**Site Address:** 167th Airlift Wing, 3801 Winchester Ave  
**City:** Martinsburg  
**State:** WV  
**Zip:** 25405  
**Phone #:** (304) 616-5418  
**Contact Name:** Captain Blake Bennett  

**County of Generator Site:** Berkeley County

**Bill to Name:** Capitol Environmental Services, Inc  
**Mailing Address:** 200 Biddle Ave. Suite 205  
**City:** Newark  
**State:** DE  
**Zip:** 19702  
**Phone #:** 302-380-3737  
**Contact Name:** Terri Fort

### Waste Information

**Waste Name:** SOIL CUTTINGS  
**Quantity:** 21 drums  
**Frequency:** Once

**Chemical Composition (must equal 100%)**

<table>
<thead>
<tr>
<th>Chemical Name</th>
<th>Avg%</th>
<th>Min%</th>
<th>Max%</th>
</tr>
</thead>
</table>

**Preferred Disposal Method:**  
- Landfill  
- Waste to Energy  
- Recycling/Treatment

- Flash Point (°F)  
- pH  
- Color  
- Water (%)  
- Solids (%)  
- Solid  
- Liquid  
- Sludge  
- Odor: None  
- Mild  
- Strong  
- TX < 1000 ppm (Yes or No)  
- (If TX > 1000 ppm, a pre-sample is required)  
- Pumpable (Yes or No) Air/Water  
- Hazardous Material (Yes or No)

**Shipping Name:**

**EMAIL ADDRESS TO SEND APPROVAL TO:**

I hereby certify that the above described waste is Non-Hazardous and is Pennsylvania Residual Waste and has been disclosed to the best of my ability

**Signature**

**Title**

**Date**

**Approved By**

**Residual Waste Code**

**Date**
**Waste Profile**

**Generator Name:** MARTINSBURG AIR NATIONAL GUARD BASE - 167th AIRLIFT WING

**Site Address:** 167th AIRLIFT WING, 3801 Winchester Ave

**City:** Martinsburg  
**State:** WV  
**Zip:** 25405

**Phone #:** (304) 616-5418

**Contact Name:** Captain Blake

**County of Generator Site:** Berkeley County

**Bill to Name:** Capitol Environmental Services, Inc

**Mailing Address:** 200 Biddle Ave. Suite 205

**City:** Newark  
**State:** DE  
**Zip:** 19702

**Phone #:** 302-380-3737

**Contact Name:** Terri

**Waste Information**

**Waste Name:** SOIL CUTTINGS

**Quantity:** 21 drums  
**Frequency:** Once

**Chemical Composition (must equal 100%)**

<table>
<thead>
<tr>
<th>Chemical Name</th>
<th>Avg%</th>
<th>Min%</th>
<th>Max%</th>
</tr>
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<tbody>
<tr>
<td></td>
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<td></td>
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<td></td>
<td></td>
</tr>
</tbody>
</table>

**Preferred Disposal Method:**

- Landfill
- Waste to Energy
- Recycling/Treatment

**Flash Point (°F):**

**pH:**

**Color:**

**Water (%):**

**Solids (%):**

**Solid:**

**Liquid:**

**Sludge:**

**Odor:**

- None
- Mild
- Strong

**TX < 1000ppm (Yes or No):**

**IF TX >1000 ppm, a pre-sample is required**

**Pumpable (Yes or No):**

**Air/Water:**

**Hazardous Material (Yes or No):**

**Process Generating Waste:**

**Shipping Name:**

**EMAIL ADDRESS TO SEND APPROVAL TO:**

I hereby certify that the above described waste is Non-Hazardous and is Pennsylvania Residual Waste and has been disclosed to the best of my ability

**Signature:**

**Title:**

**Date:**

**Approved By:**

**Residual Waste Code:**

**Date:**
# Non-Hazardous Waste Manifest

## Generator's Information
- **Name**: Environmental Recovery Corporation
- **Address**: 1076 Old Manheim Pike, Lancaster, PA 17601
- **US EPA ID Number**: PAD967266749

## Transporter Information
- **Company Name**: Environmental Recovery Corporation
- **Address**: 1076 Old Manheim Pike, Lancaster, PA 17601
- **US EPA ID Number**: PAD967266749

## Waste Description

<table>
<thead>
<tr>
<th>No.</th>
<th>Type</th>
<th>Total Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Dm</td>
<td>25,600</td>
</tr>
<tr>
<td>2</td>
<td>Dm</td>
<td>1,000</td>
</tr>
<tr>
<td>3</td>
<td>Dm</td>
<td>2,000</td>
</tr>
</tbody>
</table>

### Additional Descriptions for Materials Listed Above
1. Approval #: 1802-00346-SPT
2. Approval #: 1802-00347-SPT
3. Approval #: 1802-00348-LWT

### Special Handling Instructions and Additional Information
PO: 

### Generator's Certification
- **Date**: 2/16/18

### Transporter's Acknowledgement of Receipt of Materials
- **Date**: 2/16/18

### Facility Owner or Operator: Certification of receipt of the waste materials covered by this manifest, except as noted in Item 19.
- **Date**: 2/16/18

---

White Copy: Environmental Recovery Corp.  Yellow Copy: Invoice Copy  Pink Copy: Transporter  Gold Copy: Generator
## WASTE PROFILE

### Generator Information

- **Generator Name**: MARTINSBURG AIR NATIONAL GUARD BASE - 167th AIRLIFT WING
- **Site Address**: 167th AIRLIFT WING, 3801 Winchester Ave
- **City**: Martinsburg
- **State**: WV
- **Zip**: 25405
- **Phone #**: (304) 616-5418
- **Fax #**: 
- **Contact Name**: Captain Blake Bennett
- **Mailing Address**: 
- **County of Generator Site**: Berkeley County

### Bill to Information

- **Bill to Name**: Capitol Environmental Services, Inc
- **Mailing Address**: 200 Biddle Ave. Suite 205
- **City**: Newark
- **State**: DE
- **Zip**: 19702
- **Fax #**: 
- **Contact Name**: Terri Fort

### Waste Information

- **Waste Name**: SOIL CUTTINGS
- **Quantity**: 21 drums
- **Frequency**: Once
- **Preferred Disposal Method**: Recycling/Treatment

<table>
<thead>
<tr>
<th>Chemical Name</th>
<th>Avg%</th>
<th>Min%</th>
<th>Max%</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td></td>
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<td></td>
</tr>
</tbody>
</table>

- **Flash Point (°F)**: 
- **pH**: 
- **Color**: 
- **Water (%)**: 
- **Solids (%)**: 
- **Solid**: 
- **Liquid**: 
- **Sludge**: 
- **Odor**: None
- **TX < 1000ppm (Yes or No)**: No
- **Pumpable (Yes or No)**: Air/Water
- **Hazardous Material (Yes or No)**: No

### Process Generating Waste:

- **Shipping Name**: 

**EMAIL ADDRESS TO SEND APPROVAL TO:**

I hereby certify that the above described waste is Non-Hazardous and is Pennsylvania Residual Waste and has been disclosed to the best of my ability.

**Signature**

**Title**

**Date**
**WASTE PROFILE**

**Generator Name:** MARTINSBURG AIR NATIONAL GUARD BASE - 167th AIRLIFT WING  
**Site Address:** 167th AIRLIFT WING, 3801 Winchester Ave

<table>
<thead>
<tr>
<th>City</th>
<th>State</th>
<th>Zip</th>
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</thead>
<tbody>
<tr>
<td>Martinsburg</td>
<td>WV</td>
<td>25405</td>
</tr>
</tbody>
</table>

**Phone #** (304) 616-5418  
**Contact Name** Captain Blake Bennett  
**County of Generator Site** Berkeley County

**Bill to Name** Capitol Environmental Services, Inc  
**Mailing Address** 200 Biddle Ave. Suite 205

<table>
<thead>
<tr>
<th>City</th>
<th>State</th>
<th>Zip</th>
</tr>
</thead>
<tbody>
<tr>
<td>Newark</td>
<td>DE</td>
<td>19702</td>
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</table>

**Contact Name** Terri Fort

### Waste Information

<table>
<thead>
<tr>
<th>Waste Name</th>
<th>Quantity</th>
<th>Frequency</th>
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<tbody>
<tr>
<td>SOIL CUTTINGS</td>
<td>21 drums</td>
<td>Once</td>
</tr>
</tbody>
</table>

**Preferred Disposal Method:** Landfill  
**Flash Point (°F):**  
**pH:**  
**Color:**  
**Water (%)**  
**Solids (%):**  
**Solid**  
**Liquid**  
**Sludge**  
**Odor:** None  
**Mild**  
**Strong**  
**TX < 1000 ppm (Yes or No):**  
**Pumpable (Yes or No):** Air/Water  
**Hazardous Material (Yes or No):**

**Process Generating Waste:**

**Shipping Name:**

**EMAIL ADDRESS TO SEND APPROVAL TO:**

I hereby certify that the above described waste is Non-Hazardous and is Pennsylvania Residual Waste and has been disclosed to the best of my ability

<table>
<thead>
<tr>
<th>Signature</th>
<th>Title</th>
<th>Date</th>
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</thead>
</table>

**For ERC Use Only**

<table>
<thead>
<tr>
<th>Approved By</th>
<th>Residual Waste Code</th>
<th>Date</th>
</tr>
</thead>
</table>
Generator Name: MARTINSBURG AIR NATIONAL GUARD BASE - 167th Airlift Wing
Site Address: 167th Airlift Wing, 3801 Winchester Ave

City: Martinsburg
State: WV
Zip: 25405

Phone #: (304) 616-5418
Fax: #

Contact Name: Captain Blake Bennett

Mailing Address: 200 Biddle Ave. Suite 205
City: Newark
State: DE
Zip: 19702
Phone #: 302-380-3737
Fax: #

Contact Name: Terri Fort
First: Terri
Last: Fort

Waste Name: SOIL CUTTINGS
Quantity: 21 drums
Frequency: Once

Chemical Composition (must equal 100%)

Chemical Name | Avg% | Min% | Max%
--- | --- | --- | ---

Preferred Disposal Method:
Landfill
Waste to Energy
Recycling/Treatment

Flash Point (°F)

pH

Color

Water (%) Solids (%)

Solid Liquid Sludge

Odor: None Mild Strong

TX < 1000ppm (Yes or No)
(IF TX >1000 ppm, a pre-sample is required)

Pumpable (Yes or No)
Air/Water

Hazardous Material (Yes or No)

Process Generating Waste:

Shipping Name:

EMAIL ADDRESS TO SEND APPROVAL TO:

I hereby certify that the above described waste is Non-Hazardous and is Pennsylvania Residual Waste and has been disclosed to the best of my ability

Signature
Title
Date

For ERC Use Only

Approved By
Residual Waste Code
Date
November 27, 2017

Scott Mandirola
WV/DEP Office of Water & Waste Management
Permitting and Engineering Branch
601 57th Street
Charleston, WV 25304

Re: Request for temporary permission to accept flow

Dear Mr. Mandirola:

Wood, PLC contacted the District office in November 2017 with a request to dispose of wastewater from a drilling operation at the Air National Guard. The District corresponded with Mr. Netar Wadhwa and made Wood, PLC aware of the parameters that would be required for testing.

The total amount of wastewater is estimated at 3100 gallons and would be discharged at a rate of one thousand gallons a day. The discharge would begin upon acceptance of this request and proceed for four days.

If you have any questions or need any additional information, please let me know.

Sincerely,

Rodney Harner
Assistant General Manager-Operations

Cc: Curtis B. Keller, General Manager
Netar Wadhwa, WV DEP
ANALYTICAL REPORT

TestAmerica Laboratories, Inc.
TestAmerica Denver
4955 Yarrow Street
Arvada, CO 80002
Tel: (303)736-0100

TestAmerica Job ID: 280-103753-1
Client Project/Site: Martinsburg, WV ANG

For:
AMEC Foster Wheeler E & I, Inc
271 Mill Road
Chelmsford, Massachusetts 01824

Attn: Denise King

Authorized for release by:
11/27/2017 11:14:16 AM
Stephanie Rothmeyer, Project Manager I
(303)736-0182
stephanie.rothmeyer@testamerica.com

The test results in this report meet all 2003 NELAC and 2009 TNI requirements for accredited parameters, exceptions are noted in this report. This report may not be reproduced except in full, and with written approval from the laboratory. For questions please contact the Project Manager at the e-mail address or telephone number listed on this page.

This report has been electronically signed and authorized by the signatory. Electronic signature is intended to be the legally binding equivalent of a traditionally handwritten signature.

Results relate only to the items tested and the sample(s) as received by the laboratory.
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<th>Page</th>
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<td>Receipt Checklists</td>
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Definitions/Glossary

Client: AMEC Foster Wheeler E & I, Inc
Project/Site: Martinsburg, WV ANG

TestAmerica Job ID: 280-103753-1

Qualifiers

<table>
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<tr>
<th>Metals</th>
<th>Qualifier</th>
<th>Description</th>
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<tr>
<td>Q</td>
<td>One or more quality control criteria failed.</td>
<td></td>
</tr>
<tr>
<td>U</td>
<td>Undetected at the Limit of Detection.</td>
<td></td>
</tr>
<tr>
<td>J</td>
<td>Estimated: The analyte was positively identified; the quantitation is an estimation</td>
<td></td>
</tr>
</tbody>
</table>

General Chemistry

<table>
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<th>Qualifier</th>
<th>Description</th>
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<tr>
<td></td>
<td>Undetected at the Limit of Detection.</td>
</tr>
</tbody>
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Glossary

<table>
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<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tbody>
<tr>
<td>%R</td>
<td>Listed under the &quot;D&quot; column to designate that the result is reported on a dry weight basis</td>
</tr>
<tr>
<td>CFL</td>
<td>Contains Free Liquid</td>
</tr>
<tr>
<td>CNF</td>
<td>Contains No Free Liquid</td>
</tr>
<tr>
<td>DER</td>
<td>Duplicate Error Ratio (normalized absolute difference)</td>
</tr>
<tr>
<td>DL</td>
<td>Detection Limit (DoD/DOE)</td>
</tr>
<tr>
<td>DL, RA, RE, IN</td>
<td>Indicates a Dilution, Re-analysis, Re-extraction, or additional Initial metals/anion analysis of the sample</td>
</tr>
<tr>
<td>DLC</td>
<td>Decision Level Concentration (Radiochemistry)</td>
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<tr>
<td>EDL</td>
<td>Estimated Detection Limit (Dioxin)</td>
</tr>
<tr>
<td>LOD</td>
<td>Limit of Detection (DoD/DOE)</td>
</tr>
<tr>
<td>LOQ</td>
<td>Limit of Quantitation (DoD/DOE)</td>
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<tr>
<td>MDA</td>
<td>Minimum Detectable Activity (Radiochemistry)</td>
</tr>
<tr>
<td>MDC</td>
<td>Minimum Detectable Concentration (Radiochemistry)</td>
</tr>
<tr>
<td>MDL</td>
<td>Method Detection Limit</td>
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<tr>
<td>ML</td>
<td>Minimum Level (Dioxin)</td>
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<tr>
<td>NC</td>
<td>Not Calculated</td>
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<tr>
<td>ND</td>
<td>Not Detected at the reporting limit (or MDL or EDL if shown)</td>
</tr>
<tr>
<td>PQL</td>
<td>Practical Quantitation Limit</td>
</tr>
<tr>
<td>QC</td>
<td>Quality Control</td>
</tr>
<tr>
<td>RER</td>
<td>Relative Error Ratio (Radiochemistry)</td>
</tr>
<tr>
<td>RL</td>
<td>Reporting Limit or Requested Limit (Radiochemistry)</td>
</tr>
<tr>
<td>RPD</td>
<td>Relative Percent Difference, a measure of the relative difference between two points</td>
</tr>
<tr>
<td>TEF</td>
<td>Toxicity Equivalent Factor (Dioxin)</td>
</tr>
<tr>
<td>TEQ</td>
<td>Toxicity Equivalent Quotient (Dioxin)</td>
</tr>
</tbody>
</table>
CASE NARRATIVE

Client: AMEC Foster Wheeler E & I, Inc
Project: Martinsburg, WV ANG
Report Number: 280-103753-1

With the exceptions noted as flags or footnotes, standard analytical protocols were followed in the analysis of the samples and no problems were encountered or anomalies observed. In addition all laboratory quality control samples were within established control limits, with any exceptions noted below. Each sample was analyzed to achieve the lowest possible reporting limit within the constraints of the method. In some cases, due to interference or analytes present at high concentrations, samples were diluted. For diluted samples, the reporting limits are adjusted relative to the dilution required.

Calculations are performed before rounding to avoid round-off errors in calculated results.

All holding times were met and proper preservation noted for the methods performed on these samples, unless otherwise detailed in the individual sections below.

RECEIPT

The sample was received on 11/17/2017 at 9:00 AM; the sample arrived in good condition, properly preserved and, where required, on ice. The temperature of the cooler at receipt was 4.2° C.

Total Metals/Mercury and TSS analysis are reported under SDG 280-103753-1 on a 5 business day TAT. The Free Cyanide analysis is logged for 10 business day TAT and will be reported under SDG 280-103753-2.

TOTAL METALS (ICP)

Sample DW-01-1117 (280-103753-1) was analyzed for Total Metals (ICP) in accordance with 6010C. The samples were prepared on 11/21/2017 and analyzed on 11/22/2017.

The low level continuing calibration verification (CCVL) associated with batch 280-396211 recovered above the upper control limit for As. The samples associated with this CCV were non-detect for the affected analyte; therefore, the data have been reported. Associated results are flagged "Q".

No analytical or quality issues were noted, other than those described above or in the Definitions/Glossary page.

TOTAL MERCURY

Sample DW-01-1117 (280-103753-1) was analyzed for total mercury in accordance with 7470A. The samples were prepared and analyzed on 11/21/2017.

No analytical or quality issues were noted, other than those described above or in the Definitions/Glossary page.

TOTAL SUSPENDED SOLIDS

Sample DW-01-1117 (280-103753-1) was analyzed for total suspended solids in accordance with SM20 2540D. The samples were analyzed on 11/20/2017.

The following sample was diluted due to slow filtration and high Total Suspended Solids: DW-01-1117 (280-103753-1). Elevated reporting limits (RLs) are provided.

No analytical or quality issues were noted, other than those described above or in the Definitions/Glossary page.
**Detection Summary**

Client: AMEC Foster Wheeler E & I, Inc  
Project/Site: Martinsburg, WV ANG

<table>
<thead>
<tr>
<th>Analyte</th>
<th>Result</th>
<th>Qualifier</th>
<th>LOQ</th>
<th>DL</th>
<th>Unit</th>
<th>Dil Fac</th>
<th>D Method</th>
<th>Prep Type</th>
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<tr>
<td>Chromium</td>
<td>17</td>
<td>15</td>
<td>0.66</td>
<td>ug/L</td>
<td></td>
<td>1</td>
<td>6010C</td>
<td>Total/NA</td>
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<tr>
<td>Copper</td>
<td>26</td>
<td>15</td>
<td>4.2</td>
<td>ug/L</td>
<td></td>
<td>1</td>
<td>6010C</td>
<td>Total/NA</td>
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<tr>
<td>Nickel</td>
<td>2.7</td>
<td>40</td>
<td>2.6</td>
<td>ug/L</td>
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<td>1</td>
<td>6010C</td>
<td>Total/NA</td>
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<tr>
<td>Silver</td>
<td>1.0</td>
<td>15</td>
<td>0.93</td>
<td>ug/L</td>
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<td>1</td>
<td>6010C</td>
<td>Total/NA</td>
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<tr>
<td>Zinc</td>
<td>40</td>
<td>150</td>
<td>4.5</td>
<td>ug/L</td>
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<td>1</td>
<td>6010C</td>
<td>Total/NA</td>
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<tr>
<td>Total Suspended Solids</td>
<td>86</td>
<td>8.0</td>
<td>2.2</td>
<td>mg/L</td>
<td></td>
<td>1</td>
<td>SM 2540D</td>
<td>Total/NA</td>
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</table>

This Detection Summary does not include radiochemical test results.

TestAmerica Job ID: 280-103753-1
## Method Summary

**Client:** AMEC Foster Wheeler E & I, Inc  
**Project/Site:** Martinsburg, WV ANG

<table>
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<tr>
<th>Method</th>
<th>Method Description</th>
<th>Protocol</th>
<th>Laboratory</th>
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<td>Metals (ICP)</td>
<td>SW846</td>
<td>TAL DEN</td>
</tr>
<tr>
<td>7470A</td>
<td>Mercury (CVAA)</td>
<td>SW846</td>
<td>TAL DEN</td>
</tr>
<tr>
<td>SM 2540D</td>
<td>Solids, Total Suspended (TSS)</td>
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<td>TAL DEN</td>
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### Protocol References:
- SM = "Standard Methods For The Examination Of Water And Wastewater",

### Laboratory References:
- TAL DEN = TestAmerica Denver, 4955 Yarrow Street, Arvada, CO 80002, TEL (303)736-0100

---

TestAmerica Denver  

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11/27/2017
### Sample Summary

**Client:** AMEC Foster Wheeler E & I, Inc  
**Project/Site:** Martinsburg, WV ANG  
**TestAmerica Job ID:** 280-103753-1

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## Client Sample Results

Client: AMEC Foster Wheeler E & I, Inc  
Project/Site: Martinsburg, WV ANG  
TestAmerica Job ID: 280-103753-1

### Method: 6010C - Metals (ICP)

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### General Chemistry

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## QC Sample Results

**Method:** 6010C - Metals (ICP)

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**Matrix:** Water  
**Analysis Batch:** 396211

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**Matrix:** Water  
**Analysis Batch:** 396211

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**Matrix:** Water  
**Analysis Batch:** 396211

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### Lab Sample ID: 280-103753-1 MS
**Matrix:** Water  
**Analysis Batch:** 396211

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Client: AMEC Foster Wheeler E & I, Inc  
Project/Site: Martinsburg, WV ANG

TestAmerica Job ID: 280-103753-1

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11/27/2017
## QC Sample Results

**Client:** AMEC Foster Wheeler E & I, Inc  
**Project/Site:** Martinsburg, WV ANG

### Method: 6010C - Metals (ICP) (Continued)

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### Method: 7470A - Mercury (CVAA)

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<td>0.027 ug/L</td>
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### Method: SM 2540D - Solids, Total Suspended (TSS)

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<th>Sample Qualifier</th>
<th>MB Result</th>
<th>MB Qualifier</th>
<th>LOQ</th>
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<tr>
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<td>2.8</td>
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<td>4.0</td>
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## QC Sample Results

Client: AMEC Foster Wheeler E & I, Inc  
Project/Site: Martinsburg, WV ANG

**Method: SM 2540D - Solids, Total Suspended (TSS) (Continued)**

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TestAmerica Denver

Page 11 of 17  
11/27/2017
# QC Association Summary

**Client:** AMEC Foster Wheeler E & I, Inc  
**Project/Site:** Martinsburg, WV ANG  
**TestAmerica Job ID:** 280-103753-1

## Metals

### Prep Batch: 396036

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## General Chemistry

### Analysis Batch: 395948

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**Client Sample ID: DW-01-1117**

**Date Collected:** 11/15/17 15:20  
**Date Received:** 11/17/17 09:00

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<th>Prepared or Analyzed</th>
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**Laboratory References:**

TAL DEN = TestAmerica Denver, 4955 Yarrow Street, Arvada, CO 80002, TEL (303)736-0100
Accreditation/Certification Summary

Client: AMEC Foster Wheeler E & I, Inc  
Project/Site: Martinsburg, WV ANG

TestAmerica Job ID: 280-103753-1

Laboratory: TestAmerica Denver

Unless otherwise noted, all analytes for this laboratory were covered under each accreditation/certification below.

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### Maine

State Program 1  
**Identification Number**: CO0002  
**Expiration Date**: 03-03-19

The following analytes are included in this report, but accreditation/certification is not offered by the governing authority:

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SM 2540D  
**Identification Number**: 8-999-405  
**Expiration Date**: 12-31-17

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**Pennsylvania**  
**Identification Number**: 68-00664  
**Expiration Date**: 07-31-18

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* Accreditation/Certification renewal pending - accreditation/certification considered valid.