N00158.AR.000547
NASJRB WILLOW GROVE
5090.3a

TECHNICAL MEMORANDUM PERFLUORINATED COMPOUNDS GROUNDWATER INVESTIGATION 4 JUNE 2015 THROUGH 1 JULY 2015 SHENANDOAH WOODS HOUSING COMPLEX NAWC WARMINSTER NASJRB WILLOW GROVE PA

04/01/2016

RESOLUTION CONSULTANTS

Resolution Consultants
A Joint Venture of AECOM & EnSafe
510 Carnegie Center
Princeton, New Jersey 08540

Technical Memorandum
Perfluorinated Compounds Groundwater Investigation
Shenandoah Woods Housing Complex
Naval Air Warfare Center, Warminster, Pennsylvania
4 June 2015 through 1 July 2015

1.0 INTRODUCTION

This Technical Memorandum summarizes the findings of the additional groundwater investigation performed by Resolution Consultants (Resolution) at the Shenandoah Woods Housing Complex, located at the former Naval Air Warfare Center (NAWC) Warminster between 4 June 2015 and 1 July 2015, under Naval Facilities Engineering Command (NAVFAC) Atlantic, Comprehensive Long-Term Environmental Action, Navy (CLEAN) Contract No. N62470-11-D-8013, Contract Task Order (CTO) WE 28.

The former NAWC Warminster is an 824-acre facility located in Warminster Township, Northampton Township, and Ivyland Borough, Bucks County, PA. As a result of the Defense Base Realignment and Closure Act (BRAC), NAWC Warminster was closed on 31 March 1997; the entire property, except for the Shenandoah Woods parcel, has been transferred to the private sector for redevelopment. Custody of the Shenandoah Woods Housing Complex on the NAWC Warminster property was transferred to NASJRB Willow Grove located in nearby Horsham Township, Montgomery County, Pennsylvania. Historic waste disposal locations were grouped within three general areas on the former NAWC property (see Figure 1): Area A (Sites 1, 2, and 3), Area B (Sites 5, 6, and 7), and Area C (Sites 4 and 8). A fourth general area (Area D) primarily includes the former main building complex at the former NAWC Warminster. This perfluorinated compounds (PFCs) investigation focused on the former Navy housing area, consisting of approximately 55 acres, which includes a portion of Site 5 of Area B.

PFCs are persistent in the environment and are an emerging class of environmental contaminants. PFCs are used to make a wide range of products including oil-, stain-, heat-, and water-resistant materials such as clothing (i.e. GORE-TEX®), carpeting (i.e. Scotchguard™), furniture, food packaging (i.e. popcorn bags), flooring (i.e. Stainmaster™), non-stick cookware (i.e. Teflon®), stain/water resistant paint, and roofing materials. They were also used as surfactants in metal plating baths, shampoos, moisturizers, shaving cream, oil well surfactants, aqueous film forming foam (AFFF), and semiconductor baths. Additional applications of PFCs include use in rust inhibitors, starting materials for herbicides/pesticides, acid mist suppressants, aviation hydraulic fluids, and adhesives. (Tetra Tech 2014).

Short-term Preliminary Health Advisories (PHA) were developed by the USEPA for perfluorooctanesulfonic acid (PFOS) (0.2 micrograms per liter (µg/L)) and perfluorooctanoic acid (PFOA) (0.4 µg/L) to reduce potential exposure through drinking water (EPA 2009 and 2014). Currently, there are not PHAs for the remaining four PFCs (perfluorononanoic acid [PFNA], perfluorohexanesulfonic acid [PFHxS], perfluoroheptanoic acid [PFHpA] and perfluorobutanesulfonic acid [PFBS]) evaluated during this sudy.

PFCs (PFOA and PFOS) were identified in on-site and off-site wells in the vicinity of NAWC Area C during the five year review (Tetra Tech 2011). Sampling for PFCs was initiated at Shenandoah Woods in 2015 in support of property transfer (Resolution, 2015). Monitoring wells HN-107, HN-108, and HN-109 were installed and soil samples collected from 23 March through 27 March 2015. Soil sample results were below the laboratory detection limits except for SB7 (PFOS 6.040 J µg/kg). The monitoring wells were sampled on 16 April 2015. Concentrations of PFOS and PFOA in the groundwater samples were below their respective EPA PHA in all monitoring wells sampled except PFOS in HN-108I. PFOS

detected in the groundwater samples collected from HN-108I (0.236 µg/L) exceeded the PHA for PFOS (0.2 µg/L). Detectable concentrations of PFOS and PFOA were reported in all groundwater samples collected except in those obtained from HN-108S.

This additional investigation was initiated to further characterize the occurrence and concentrations of six PFCs: PFOA, PFOS, PFNA, PFHxS, PFHpA and PFBS in groundwater at Shenandoah Woods. Installation of monitoring wells was requested by the Pennsylvania Department of Environmental Protection to determine if PFCs are present in shallow groundwater and might be discharged by basement sump pumps if the area is redeveloped. A maximum depth for each well of 25 feet below ground surface (bgs) was proposed to account for the possible future use of basement sump pumps. The six PFCs were analyzed to be consistent with previous investigations. During this investigation, groundwater samples were collected from six monitoring wells with one blind duplicate. Groundwater data for PFOS and PFOA were compared to the PHAs. PFC sample locations are shown on **Figure 1**. Note that three dual-nested monitoring well pairs were installed in Shenandoah Woods during previous investigation activities performed in April 2015. These wells are also shown on **Figure 1**; but were not sampled during the July 2015 groundwater sampling event.

2.0 FIELD ACTIVITIES

Between 4 June and 12 June 2015, six monitoring wells were installed and developed at Shenandoah Woods (Site 5) to identify potential PFC impacts to shallow groundwater. The wells were sampled approximately two weeks later on 30 June and 1 July 2015.

Monitoring Well Installation

Monitoring well locations were selected in accessible areas within the residential portions of Shenandoah Woods. Well installation details are summarized below.

On 4 June 2015, a geophysical survey was performed by PULS, Inc. of Bethlehem, PA under Resolution oversight for utility clearance purposes in each of the six proposed well locations. On 8 June and 9 June 2015, the initial boreholes were advanced at the HN-110 to HN-115 locations (**Figure 1**). The boreholes were advanced by Raab Drilling of Perkasie, PA, a Pennsylvania licensed driller, using an air rotary drill rig, under oversight of a Resolution geologist. Based on previous investigations at the Site and discussions with the US EPA, the target depth for the monitoring wells was a maximum of 25 feet bgs. At each location, a 10-inch carbide hammer was used to advance borings to 25 feet bgs. Six flush mounted, two-inch diameter monitoring wells were completed at each location. Monitoring wells were constructed with two-inch polyvinyl chloride (PVC) 0.01-inch well screen and riser. The annular space was filled with Number 1 sand to two feet above the well screen. The monitoring well was sealed above the screen using bentonite slurry via pressure grout injection to 1-foot bgs. The well seal cured for 24 hours prior to surface completion of the well pad.

Monitoring wells were developed on 11 June and 12 June 2015. Soil cuttings and groundwater generated during drilling and well development purge water were containerized in drums. The drums were transported to the NAWC groundwater treatment plant where they were staged pending characterization and off-site disposal. Off site disposal was completed on 23 July 2015

Completed monitoring wells were surveyed in Pennsylvania South State Plane, UTM Zones 17 and 18, by R.L. Showalter & Associates of Chalfont, PA. A well construction table is provided as **Table 1**. Well locations are shown on **Figure 1**. Boring logs and well construction diagrams are included in **Attachment 1**.

Groundwater Sampling

On 30 June and 1 July 2015, monitoring wells were gauged and sampled in accordance with US EPA Region 1 Low-Stress Sampling Guidance (EPA 2010). Precautions were taken to avoid sample contamination and/or bias during collection per the draft Sampling and Analysis Plan (SAP) (Battelle, 2015). Products containing Teflon® were not used during sample collection, handling, or transportation. Sampling personnel did not use any waterproof items, wore only well-laundered clothing, and attempted to identify and isolate any potential PFC-containing materials that might cross-contaminate groundwater samples.

During gauging, depth to groundwater was measured above the well screens in three of the six monitoring wells (HN-111, HN-114, and HN-115). Groundwater was encountered during drilling at 21 feet bgs in HN-110, 24.5 feet bgs in HN-111, 22 feet bgs in HN-112, 18 feet bgs in HN-114, and 22 feet bgs in HN-115. Water was not encountered in HN-113 during drilling. Well screen intervals were proposed from 15 to 25 feet bgs to coincide with the depths of sump pumps that may be installed in basements if/when the land is redeveloped. Monitoring well screens were set from 15 to 25 feet based on the depths of water encountered during drilling; however, water levels rose after well installation. During drilling, weathered bedrock was noted through the entire boring column to 25 feet bgs. The depth of weathered bedrock is consistent with a geophysical investigation designed to investigate bedrock water-bearing fractures beneath the site at Area C (U.S. Geological Survey 2008). Area C was divided by the U.S. Geological Survey into shallow and deep hydrogeologic units. The shallow unit is comprised of sandstone. The deep hydrogeologic unit is defined as water-bearing bedrock beneath the shallow hydrogeologic unit, and typically exhibits artesian conditions (Batelle 2015). Consistent with shallow hydrogeologic conditions at Area C, boring data from monitoring wells HN-110 through 115 does not suggest confined or semi confined conditions.

Groundwater was purged using dedicated, high-density, polyethylene tubing that was discarded after each sample was collected. Groundwater was extracted using a stainless steel submersible pump that was decontaminated before each use with distilled water and Alconox detergent. Monitoring wells were purged continuously until water quality parameters (pH, conductivity, dissolved oxygen, and turbidity) stabilized. Once parameters stabilized, groundwater samples were collected for analysis in clean, laboratory-supplied, PFC-free, high-density polyethylene bottles. A blind duplicate and a field blank were collected using laboratory-certified, PFC-free, deionized water. Matrix spike and matrix spike duplicate samples were collected and analyzed at a rate of one per 20 samples. Samples were packaged with ice in a cooler, and shipped via laboratory courier under chain-of-custody to Accutest Laboratories of Orlando, Florida (**Attachment 2**). Samples were analyzed for PFCs using EPA Method 537 modified for environmental media. Data validation was completed by the Resolution Project Chemist. The data were found to be valid as reported and suitable for decision-making purposes. The data validation report is provided in this document as **Attachment 3.**

3.0 RESULTS

Detectable concentrations of PFOS were reported in all groundwater samples collected on 30 June and 1 July 2015 and PFOA was detected in all samples except HN-112 and HN-113. However, concentrations of PFOS and PFOA in the groundwater samples were below their respective EPA PHA's in all monitoring wells sampled.

Where they were detected, concentrations of PFOS were higher than PFOA in all samples. The highest concentration of PFOS was detected in monitoring well HN-110 (0.127 µg/L). The most common detection of the four additional analyzed PFCs without PHAs was PFHxS, which was reported in all of the groundwater samples. The highest concentration of PFHxS was detected in monitoring well HN-110

(0.0475 µg/L). The concentrations of all analytes were below their respective detection limits in the field blank collected during the monitoring well sampling. Analytical results from the groundwater investigation are summarized in **Table 2**.

4.0 REFERENCES

Battelle. 2015. Final Sampling and Analysis (SAP) Plan. October.

Department of Defense (DOD). 2011. Internal Navy Correspondence on Perfluorinated Compounds Clarification.

Naval Facilities Engineering Command (NFEC). 2000. Record of Decision for OU-10 (Site 5 Soil and Area B Surface Water/Sediment) at NAWC Warminster.

Resolution. 2015. Technical Memorandum Perfluorinated Compounds Soil and Groundwater Investigation, Shenandoah Woods Housing Complex, Naval Air Warfare Center, Warminster, Pennsylvania.

Tetra Tech. 2014. Evaluation of Potential Sources of Perfluorinated Compounds, Former Naval Warfare Center Warminster, Pennsylvania.

— 2011. Third Five-Year Report, Former Naval Air Warfare Center, Warminster, Pennsylvania.

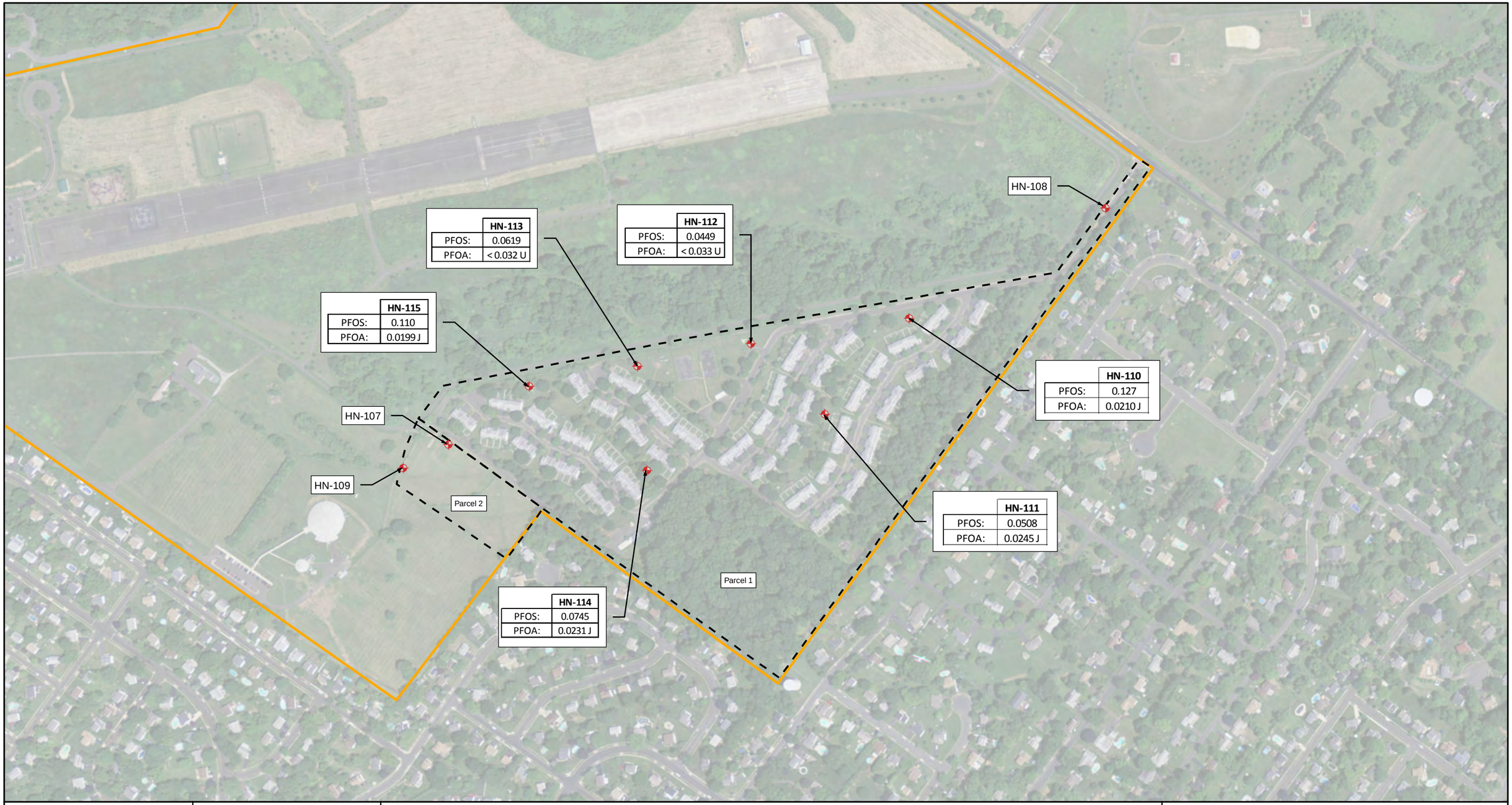
United States Environmental Protection Agency (US EPA). 2009. Provisional Health Advisories for Perfluorooctanoic Acid (PFOA) and Perfluorooctane Sulfonate (PFOS).

— 2010. Region I. Low Stress (low flow) Purging and Sampling Procedure for the Collection of Groundwater Samples from Monitoring Wells.

— 2014. Emerging Contaminants – Perfluorooctane Sulfonate (PFOS) and Perfluorooctanoic Acid (PFOA) Fact Sheet.

United States Geological Survey (USGS). 2008. Interpretation of Borehole Geophysical Logs at Area C, Former Naval Air Warfare Center, Warminster Township, Bucks County, Pennsylvania, 2007. Open-File Report 2008-1207.

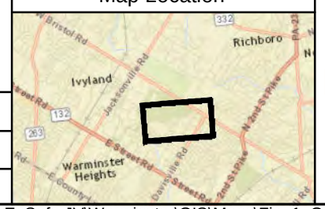
FIGURES



AECOM

Drawn:	BC	8/6/2015
Approved:	PJ	8/6/2015
Project #:	60276503	

Map Location



Legend

- Monitoring Wells
- Naval Air Warfare Center (NAWC) Site Boundary
- Site Parcel Boundaries

Notes:
PFOS/PFOA results reported in micrograms per liter (µg/L)
PFOS - Perfluorooctanesulfonic acid, **PFOA** - Perfluorooctanoic acid
J - Estimated Concentration
U - Indicates not detected above reporting detection limit
ft - Feet

USEPA Preliminary Health Advisory Levels
PFOS - 0.2 µg/L, **PFOA** - 0.4 µg/L

N

0 200 400 800

Scale in Feet

FIGURE 1
GROUNDWATER RESULTS
JULY 2015

SHENANDOAH WOODS
NAWC WARMINSTER
BUCKS COUNTY, PENNSYLVANIA

W:\Govt\Projects\NavyCLEAN AECOM-EnSafe JV\Warminster\GIS\Maps\Fig_1_Groundwater_Results_July_2015.mxd

TABLES

Table 1
Well Construction Summary
NAWC Warminster

Well	Total Depth (ft bgs)	Screened interval (ft bgs)	Elevation (ft amsl)	Well Type	Installed
HN-110	25	15-25	361.74	Flush	6/8/2015
HN-111	25	15-25	355.38	Flush	6/8/2015
HN-112	25	15-25	364.34	Flush	6/9/2015
HN-113	25	15-25	367.13	Flush	6/9/2015
HN-114	25	15-25	348.46	Flush	6/9/2015
HN-115	25	15-25	352.43	Flush	6/9/2015

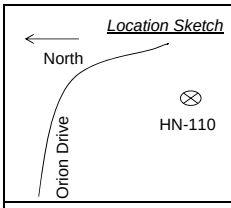
ft bgs feet below ground surface
ft amsl feet above mean sea level
Survey completed by Showalter and Associates
Coordinate System: PA State Plane Southeast, US Feet

Table 2
PFC Investigation - July 2015
Validated Results Summary
NAWC Warminster - Shenandoah Woods

			Sample ID	HN-110_06302015	HN-111_07012015	HN-112_07012015	HN-113_07012015	HN-114_07012015	DUP-070115	HN-115_07012015	FB-07012015
			Location	HN-110	HN-111	HN-112	HN-113	HN-114	HN-115	HN-115	
			Screen Interval	15-25	15-25	15-25	15-25	15-25	15-25	15-25	15-25
			Sample Date	6/30/2015	7/1/2015	7/1/2015	7/1/2015	7/1/2015	7/1/2015	7/1/2015	7/1/2015
			Sampled Delivery Group	FA25785	FA25785	FA25785	FA25785	FA25785	FA25785	FA25785	FA25785
Chemical Name	**CAS**	**Units**	**EPA Health Advisory Level**								
Perfluorobutanesulfonic Acid (PFBS)	375-73-5	µg/L	NA	< 0.015 U	< 0.015 U	< 0.017 U	< 0.016 U	< 0.016 U	< 0.015 U	< 0.016 U	< 0.015 U
Perfluoroheptanoic Acid (PFHpA)	375-85-9	µg/L	NA	0.0293	< 0.015 U	< 0.017 U	< 0.016 U	< 0.016 U	< 0.015 U	< 0.016 U	< 0.015 U
Perfluorohexanesulfonic Acid (PFHxS)	355-46-4	µg/L	NA	0.0475	0.0254	0.0291	0.0165 J	0.0282	0.0401	0.0416	< 0.015 U
Perfluorononanoic Acid (PFNA)	375-95-1	µg/L	NA	0.0132 J	< 0.015 U	< 0.017 U	< 0.016 U	< 0.016 U	< 0.015 U	< 0.016 U	< 0.015 U
Perfluorooctanesulfonic Acid (PFOS)	1763-23-1	µg/L	**0.2**	0.127	0.0508	0.0449	0.0619	0.0745	0.104	0.110	< 0.015 U
Perfluorooctanoic Acid (PFOA)	335-67-1	µg/L	**0.4**	0.0210 J	0.0245 J	< 0.033 U	< 0.032 U	0.0231 J	0.0194 J	0.0199 J	< 0.031 U

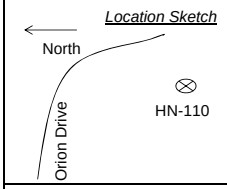
Notes:
CAS Chemical Abstracts Service Number
U indicates not detected above reporting detection limit
J indicates estimate value
EPA Environmental Protection Agency
Gray shading indicate exceedance of EPA Health Advisory Level
µg/L micrograms per liter
Screen Interval is expressed in feet below ground surface

ATTACHMENT 1



Unit 1131	Client: Department of the Navy			Boring:	**HN-110**
	Project Number: 60276503				
	Site Location: NAWC Warminster, Pennsylvania				
	Coordinates: 327575.627 2749319.293	TOC Elevation: 361.74		Sheet:	1 of 2
Unit 1127	Drilling Method: Air Rotary/Percussion			Well Installed:	Single riser
	Sample Type(s): NA	Boring Diameter: 6 in.		Screen:	15-25
Weather: Clear 80's F	Logged By: G. Richards	Start Date: 6/8/2015		Depth of Boring:	25
Drilling Contractor: RAAB (Rick Raab)	GS Elevation: 362.01	Date Complete: 6/12/2015		Water Level:	21

Depth (ft)	Sample Depth	Blow Count	% Recovery	PID (ppm)	Graphic Log	USCS/Lithology	Description	Saturation/ Well Construction	Well Completion Details
1		Not Applicable	Not Applicable	0.0		ML	Cleared to 5 ft. bgs. via vacuum truck and air knife. Unimproved surface. 0 to 5 ft. bgs: CLAYEY SILT (ML); light brown and strong brown with sporadic orangish-red mottling; dense; low plasticity; low liquid limit; trace muscovite; sporradic, banded, iron oxidation (up to 1 in.); dry.	Concrete 1 ft. hydrated bentonite 3/8 in.	
2									
3									
4									
5				0.0					
6		Not Applicable					Soft and easily drilled.	2 in. PVC riser	
7									
8									
9						Silt-stone	Soil/rock contact. 9 ft. bgs.: SILTSTONE (Stockton Fm.); dark red; micaceous (muscovite); soft; weathered; dry.		
10									
11									
12									
13								13 ft.	
14						SS	14 ft. bgs.: SILTY SANDSTONE (Stockton Fm.); light tan to light reddish-brown; very fine-grained; hard; heavily oxidized with iron oxide concretions; dry.		
15								15 ft.	
16									
17								#1 Sand	
18						Silt-stone	18 ft. bgs.: SILTSTONE (Stockton Fm.); dark red; micaceous (muscovite); soft; weathered; dry.	0.01 in. slotted screen	
19									
20									



Unit 1131 | Unit 1127

Client: Department of the Navy

Project Number: 60276503

Site Location: NAWC Warminster, Pennsylvania

Coordinates: 327575.627 2749319.293 TOC Elevation: 361.74

Drilling Method: Air Rotary/Percussion

Sample Type(s): NA Boring Diameter: 6 in.

Boring: **HN-110**

Sheet: 2 of 2

Well Installed: Single riser

Screen: 15-25

Weather: Clear 80's F

Logged By: G. Richards Start Date: 6/8/2015

Drilling Contractor: RAAB (Rick Raab)

GS Elevation: 362.01 Date Complete: 6/12/2015

Depth of Boring: 25

Water Level: 21

Depth (ft)	Sample Depth	Blow Count	% Recovery	PID (ppm)	Graphic Log	USCS/Lithology	Description	Saturation/ Well Construction	Well Completion Details
21		Not Applicable				Silt-stone	First observed water at approximately 21 ft. bgs. yield ~3-5 gpm.		
22							22 ft. bgs.: SILTSTONE (Stockton Fm.);dark red; micaceous (muscovite); heavily oxidized; soft drilling; fractured; saturated.	0.01 in. slotted screen	
23								#1 Sand	
24									
25							TD: 25 ft. bgs.		TD=25 ft.
26									
27									
28									
29									
30									
31									
32									
33									
34									
35									
36									
37									
38									
39									
40									

Legend:

Air rotary/ percussion

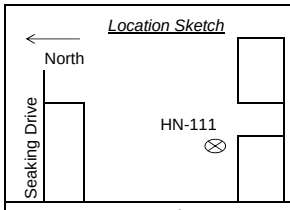
First observed groundwater

PID Photoionization detector
USCS Unified soil classification system
ppm Parts per million
ft. Feet
bgs. Below ground surface
PVC Polyvinyl chloride
in. Inches
TD Total depth

ML Silt
gpm Gallons per minute
Fm. Formation
SS Sandstone
TOC Top of casing
GS Ground surface

Prepared in accordance with:

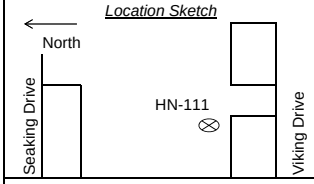
Engineering Geology Field Manual, 2nd Edition.
D2487 Practice for Classification of Soils (USCS).
D2488 Practice for Description and Identification of Soils (Visual-Manual Procedure).
CalTrans Soil and Rock Logging, Classification, and Presentation Manual 2010 Edition



Client: Department of the Navy			Boring: **HN-111**
Project Number: 60276503			
Site Location: NAWC Warminster, Pennsylvania			
Coordinates: 326171.200 2753435.672	TOC Elevation: 355.38		Sheet: 1 of 2
Drilling Method: Air Rotary/Percussion			Well Installed: Single riser
Sample Type(s): NA	Boring Diameter: 6 in.		Screen: 15-25
Weather: Clear 80's F	Logged By: G. Richards	Start Date: 6/8/2015	Depth of Boring: 25
Drilling Contractor: RAAB (Rick Raab)	GS Elevation: 355.73	Date Complete: 6/12/2015	Water Level: 24.5

Depth (ft)	Sample Depth	Blow Count	% Recovery	PID (ppm)	Graphic Log	USCS/Lithology	Description	Saturation/ Well Construction	Well Completion Details
1		Not Applicable	Not Applicable	1.5		ML/CL	Cleared to 5 ft. bgs. via vacuum truck and air knife. 0 to 5 ft. bgs.: SILT and CLAY (ML/CL); light orangish-brown with strong brown lenses; stiff; dense; non-plastic to slight plasticity ; trace muscovite; iron oxidation; dry.	Concrete 1 ft. hydrated bentonite 3/8 in.	
2									
3									
4				0.0					
5									
6		Not Applicable					Soft and easily advanced.	2 in. PVC riser	
7									
8									
9									
10						Silt-stone	10 ft. bgs.: SILTSTONE (Stockton Fm.); light brown; micaceous; soft; moist to damp,		
11									
12									
13								13 ft.	
14									
15								15 ft.	
16									
17								#1 Sand	
18						Silt-stone		0.01 in. slotted screen	
19							20 ft. bgs.: SILTSTONE (Stockton Fm); strong reddish-brown; weathered; soft; dry to slightly moist.		
20									

Location Sketch



Client: Department of the Navy

Project Number: 60276503

Site Location: NAWC Warminster, Pennsylvania

Coordinates: 326171.200 2753435.672 TOC Elevation: 355.38

Drilling Method: Air Rotary/Percussion

Sample Type(s): NA Boring Diameter: 6 in.

Boring: **HN-111**

Sheet: 2 of 2

Well Installed: Single riser

Screen: 15-25

Weather: Clear 80's F

Logged By: G. Richards Start Date: 6/8/2015

Drilling Contractor: RAAB (Rick Raab)

GS Elevation: 355.73 Date Complete: 6/12/2015

Depth of Boring: 25

Water Level: 24.5

Depth (ft)	Sample Depth	Blow Count	% Recovery	PID (ppm)	Graphic Log	USCS/Lithology	Description	Saturation/ Well Construction	Well Completion Details
21		Not Applicable				Silt-stone	22 ft. bgs: SILTSTONE (Stockton Fm.); bright red; very soft; heavily weathered; cuttings return as slightly plastic clay; wet.	0.01 in. slotted screen	
22							.	#1 Sand	
23									
24									
25							25 ft. bgs.: Same as above; very slight infiltration, less than 1 gpm.		TD=25 ft.
26							TD: 25 ft. bgs.		
27									
28									
29									
30									
31									
32									
33									
34									
35									
36									
37									
38									
39									
40									

Legend:

Air rotary/ percussion

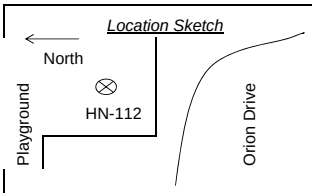
First observed groundwater

PID Photoionization detector
USCS Unified soil classification system
ppm Parts per million
ft. Feet
bgs. Below ground surface
PVC Polyvinyl chloride
in. Inches
TD Total depth

ML Silt
gpm Gallons per minute
Fm. Formation
TOC Top of casing
GS Ground surface
CL Clay

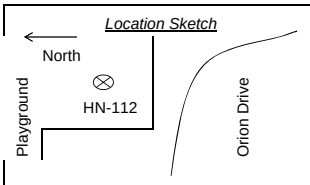
Prepared in accordance with:

Engineering Geology Field Manual, 2nd Edition.
D2487 Practice for Classification of Soils (USCS).
D2488 Practice for Description and Identification of Soils (Visual-Manual Procedure).
CalTrans Soil and Rock Logging, Classification, and Presentation Manual 2010 Edition



Client: Department of the Navy		Boring:	**HN-112**
Project Number: 60276503			
Site Location: NAWC Warminster, Pennsylvania			
Coordinates: 326476.476 2753114.737	TOC Elevation: 364.34	Sheet:	1 of 2
Drilling Method: Air Rotary/Percussion		Well Installed:	Single riser
Sample Type(s): NA	Boring Diameter: 6 in.	Screen:	15-25
Weather: Clear 80's F	Logged By: G. Richards / Start Date: 6/8/2015	Depth of Boring:	25
Drilling Contractor: RAAB (Rick Raab)	GS Elevation: 364.65 / Date Complete: 6/12/2015	Water Level:	22

Depth (ft)	Sample Depth	Blow Count	% Recovery	PID (ppm)	Graphic Log	USCS/Lithology	Description	Saturation/ Well Construction	Well Completion Details
1		Not Applicable	Not Applicable	0.0		ML	Cleared to 5 ft. bgs. via vacuum truck and air knife. Unimproved surface. 0 to 5 ft. bgs.: CLAYEY SILT (ML); variegated brown, light brown, strong brown; some gravel, angular; dense; stiff; nonplastic to slightly plastic; dry. FILL to	Concrete 1 ft.	
2									
3									
4				0.0				hydrated bentonite 3/8 in.	
5									
6									
7						Silt-stone	7 ft. bgs.: SILTSTONE (Stockton Fm.); strong red; soft; slightly weathered; dry.	2 in. PVC riser	
8									
9									
10									
11									
12		Not Applicable							
13								13 ft.	
14									
15								15 ft.	
16									
17						SS	16.5 ft. bgs.: SANDSTONE (Stockton Fm.); light brown to tan; fine-grained; hard; dry.	#1 Sand	
18						Silt-stone	17.5 ft. bgs.: SILTSTONE/MUDSTONE (Stockton Fm.); strong red; very soft; dry.	0.01 in. slotted screen	
19									
20									



Client: Department of the Navy		Boring:	**HN-112**
Project Number: 60276503			
Site Location: NAWC Warminster, Pennsylvania			
Coordinates: 326476.476 2753114.737	TOC Elevation: 364.34	Sheet:	2 of 2
Drilling Method: Air Rotary/Percussion		Well Installed:	Single riser
Sample Type(s): NA	Boring Diameter: 6 in.	Screen:	15-25
Weather: Clear 80's F	Logged By: G. Richards / Start Date: 6/8/2015	Depth of Boring:	25
Drilling Contractor: RAAB (Rick Raab)	GS Elevation: 364.65 / Date Complete: 6/12/2015	Water Level:	22

Depth (ft)	Sample Depth	Blow Count	% Recovery	PID (ppm)	Graphic Log	USCS/Lithology	Description	Saturation/ Well Construction	Well Completion Details
21		Not Applicable				Silt-stone	22 ft. bgs.: Same as above; cuttings return as nonplastic fines with some evidence of water. Yield = 3 to 5 gallons removed at 22 ft. bgs. after 10 minutes.	0.01 in. slotted screen	
22									
23								#1 Sand	
24									
25							25 ft. bgs.: SILTSTONE (Stockton Fm.); strong red; soft drilling; fractured; weathered; micaceous; dry.		TD=25 ft.
26							TD: 25 ft. bgs.		
27									
28									
29									
30									
31									
32									
33									
34									
35									
36									
37									
38									
39									
40									

Legend:

Air rotary/ percussion

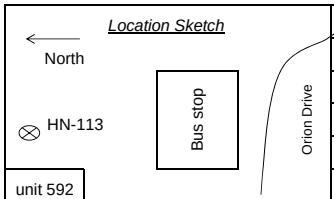
First observed groundwater

PID Photoionization detector
USCS Unified soil classification system
ppm Parts per million
ft. Feet
bgs. Below ground surface
PVC Polyvinyl chloride
in. Inches
TD Total depth

ML Silt
gpm Gallons per minute
Fm. Formation
SS Sandstone
TOC Top of casing
GS Ground surface

Prepared in accordance with:

Engineering Geology Field Manual, 2nd Edition.
D2487 Practice for Classification of Soils (USCS).
D2488 Practice for Description and Identification of Soils (Visual-Manual Procedure).
CalTrans Soil and Rock Logging, Classification, and Presentation Manual 2010 Edition



Client: Department of the Navy			Boring: **HN-113**
Project Number: 60276503			
Site Location: NAWC Warminster, Pennsylvania			
Coordinates: 326399.288 275638.680	TOC Elevation: 367.13		Sheet: 1 of 2
Drilling Method: Air Rotary/Percussion			Well Installed: Single riser
Sample Type(s): none	Boring Diameter: 6 in.		Screen: 15-25
Weather: Clear 80's F	Logged By: G. Richards	Start Date: 6/8/2015	Depth of Boring: 25
Drilling Contractor: RAAB (Rick Raab)	GS Elevation: 367.51	Date Complete: 6/9/2015	Water Level: Not observed

Depth (ft)	Sample Depth	Blow Count	% Recovery	PID (ppm)	Graphic Log	USCS/Lithology	Description	Saturation/ Well Construction	Well Completion Details
1		Not Applicable	Not Applicable	0.0		ML/CL	Cleared to 5 ft. bgs. via vacuum truck and air knife. Unimproved surface. 0 to 5 ft. bgs: SILT and CLAY (ML/CL); variegated brown, light brown, and strong brown; stiff; dense; non-plastic to slightly plastic; some gravel grading out by 1 ft.; dry.	Concrete	
2									
3									
4								hydrated bentonite 3/8 in.	
5				0.0					
6		Not Applicable				Silt-stone	7 ft. bgs.: SILTSTONE (Stockton Fm.); dull red; medium hard; micaceous; contains some quartz; oxidized and weathered; argilliceous; dry.	2 in. PVC riser	
7									
8									
9									
10									
11									
12									
13								13 ft.	
14									
15								15 ft.	
16									
17						Silt-stone		#1 Sand	
18								0.01 in. slotted screen	
19									
20							20 ft. bgs.: Same as above; dry.		

Location Sketch

North

HN-113

Bus stop

Orion Drive

unit 592

Client: Department of the Navy			Boring: **HN-113**
Project Number: 60276503			
Site Location: NAWC Warminster, Pennsylvania			
Coordinates: 326399.288 275638.680	TOC Elevation: 367.13		Sheet: 2 of 2
Drilling Method: Air Rotary/Percussion			Well Installed: Single riser
Sample Type(s): none	Boring Diameter: 6 in.		Screen: 15-25
Weather: Clear 80's F	Logged By: G. Richards	Start Date: 6/8/2015	Depth of Boring: 25
Drilling Contractor: RAAB (Rick Raab)	GS Elevation: 367.51	Date Complete: 6/12/2015	Water Level: Not observed

Depth (ft)	Sample Depth	Blow Count	% Recovery	PID (ppm)	Graphic Log	USCS/Lithology	Description	Saturation/ Well Construction	Well Completion Details
21		Not Applicable		0.0		Silt-stone	25 ft. bgs.: SILTSTONE (Stockton Fm.); strong red; easy drilling; soft to medium hard; weathered; micaceous; trace quartz; oxidized iron; dry.	0.01 in. slotted screen; #1 Sand	TD=25
22									
23									
24									
25							TD: 25 ft. bgs.		
26									
27									
28									
29									
30									
31									
32									
33									
34									
35									
36									
37									
38									
39									
40									

Legend:

Air rotary/ percussion

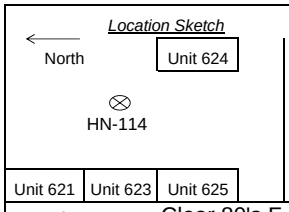
First observed groundwater

PID Photoionization detector
USCS Unified soil classification system
ppm Parts per million
ft. Feet
bgs. Below ground surface
PVC Polyvinyl chloride
in. Inches
TD Total depth

CL Clay
ML Silt
Fm. Formation
TOC Top of
GS Ground surface

Prepared in accordance with:

Engineering Geology Field Manual, 2nd Edition.
D2487 Practice for Classification of Soils (USCS).
D2488 Practice for Description and Identification of Soils (Visual-Manual Procedure).
CalTrans Soil and Rock Logging, Classification, and Presentation Manual 2010 Edition



Client: Department of the Navy			Boring: **HN-114**
Project Number: 60276503			
Site Location: NAWC Warminster, Pennsylvania			
Coordinates: 325936.005 2752652.069	TOC Elevation: 348.46		Sheet: 1 of 2
Drilling Method: Air Rotary/Percussion			Well Installed: Single riser
Sample Type(s): none	Boring Diameter: 6 in.		Screen: 15-25
Weather: Clear 80's F	Logged By: G. Richards	Start Date: 6/8/2015	Depth of Boring: 25
Drilling Contractor: RAAB (Rick Raab)	GS Elevation: 348.77	Date Complete: 6/9/2015	Water Level: 18

Depth (ft)	Sample Depth	Blow Count	% Recovery	PID (ppm)	Graphic Log	USCS/Lithology	Description	Saturation/ Well Construction	Well Completion Details
1		Not Applicable	Not Applicable	0.0		ML	Cleared to 5 ft. bgs. via vacuum truck and air knife. Unimproved surface.	Concrete	
2							0 to 5 ft. bgs: SANDY SILT (ML); light brown and brown; silt (70%); very fine sand (25%); trace clays; trace cobbles (up to 6 in.), sandstone, weathered, hard, micaceous; nonplastic; grading to silty very fine sand; dry.		
3									
4				0.0				hydrated bentonite 3/8 in.	
5									
6	Not Applicable	Not Applicable							
7								2 in. PVC riser	
8						Silt-stone	8 ft. bgs.: SILTSTONE (STOCKTON Fm.); red; hard; micaceous; dry.		
9									
10									
11						SS	11 ft. bgs.: SANDSTONE (Stockton Fm.); yellowish-tan; hard; moderately weathered; fractured; wet.		
12									
13								13 ft.	
14									
15						Silt-stone	15 ft. bgs.: SILTSTONE/MUDSTONE (Stockton Fm.); red; micaceous; dry.	15 ft.	
16								0.01 in. slotted screen	
17								#1 Sand	
18						SS	17.5 ft. bgs.:SANDSTONE (STOCKTON Fm.); yellowish-tan-brown; micaceous; medium soft.		
19						Silt-stone	19 ft. bgs.: SILTSTONE (Stockton Fm.); red to strong brown; wet.		
20									

Location Sketch

North

Unit 624

HN-114

Unit 621 | Unit 623 | Unit 625

Orion Drive

Client: Department of the Navy

Project Number: 60276503

Site Location: NAWC Warminster, Pennsylvania

Coordinates: 325936.005 2752652.069 TOC Elevation: 348.46

Drilling Method: Air Rotary/Percussion

Sample Type(s): none Boring Diameter: 6 in.

Weather: Clear 80's F

Drilling Contractor: RAAB (Rick Raab)

Logged By: G. Richards

GS Elevation: 348.77

Start Date: 6/8/2015

Date Complete: 6/12/2015

Boring: **HN-114**

Sheet: 2 of 2

Well Installed: Single riser

Screen: 15-25

Depth of Boring: 25

Water Level: 18

Depth (ft)	Sample Depth	Blow Count	% Recovery	PID (ppm)	Graphic Log	USCS/Lithology	Description	Saturation/ Well Construction	Well Completion Details
21		Not Applicable				SS	20 ft. bgs.: SILTY SANDSTONE (Stockton Fm.); reddish to strong brown; micaceous; heavily oxidized; wet.	0.01 in. slotted screen	
22									
23								#1 Sand	
24									
25							25 ft. bgs.: Same as above; wet.		TD=25
26							TD: 25 ft. bgs.		
27									
28									
29									
30									
31									
32									
33									
34									
35									
36									
37									
38									
39									
40									

Legend:

Air rotary/ percussion

First observed groundwater

PID Photoionization detector
USCS Unified soil classification system
ppm Parts per million
ft. Feet
bgs. Below ground surface
PVC Polyvinyl chloride
in. Inches
TD Total depth

ML Silt
Fm. Formation
TOC Top of
GS Ground surface
SS Sandstone

Prepared in accordance with:

Engineering Geology Field Manual, 2nd Edition.
D2487 Practice for Classification of Soils (USCS).
D2488 Practice for Description and Identification of Soils (Visual-Manual Procedure).
CalTrans Soil and Rock Logging, Classification, and Presentation Manual 2010 Edition

Location Sketch

North

HN-115

Unit 595 | Unit 597

Client: Department of the Navy

Project Number: 60276503

Site Location: NAWC Warminster, Pennsylvania

Coordinates: 326269.128 2752203.529 TOC Elevation: 352.43

Drilling Method: Air Rotary/Percussion

Sample Type(s): none Boring Diameter: 6 in.

Boring: **HN-115**

Sheet: 1 of 2

Well Installed: Single riser

Screen: 15-25

Weather: Clear 80's F

Logged By: G. Richards Start Date: 6/8/2015

Drilling Contractor: RAAB (Rick Raab)

GS Elevation: 352.28 Date Complete: 6/12/2015

Depth of Boring: 25

Water Level: 22

Depth (ft)	Sample Depth	Blow Count	% Recovery	PID (ppm)	Graphic Log	USCS/Lithology	Description
1		Not Applicable	Not Applicable	0.0		ML	Cleared to 5 ft. bgs. via vacuum truck and air knife. Unimproved surface. 0 to 5 ft. bgs: SANDY SILT (ML); light brown to strong brown; very fine sand; dense; well sorted; fragments of siltstone, dark red, hard; nonplastic; moist below 4 ft.
2							
3							
4				0.0			
5							
6		Not Applicable				Silt-stone	6 ft. bgs.: SILTSTONE (Stockton Fm.); red; soft; weathered; dry.
7							
8							
9							
10							10 ft. bgs.: SILTSTONE (Stockton Fm.); red; medium hard; weathered; dry.
11							Possibly thin interbeds of very fine, micaceous sandstone.
12							
13							
14							
15							
16							
17						Silt-stone	
18							
19							20 ft. bgs.: Same as above; dry.
20							

Saturation/ Well Construction

Concrete

1 ft.

hydrated bentonite 3/8 in.

2 in. PVC riser

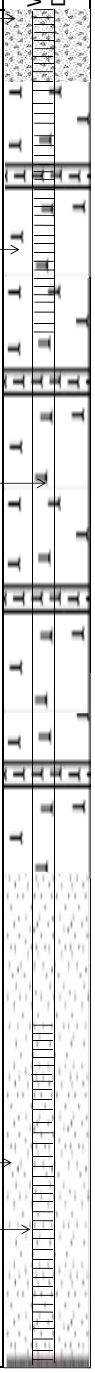
13 ft.

15 ft.

#1 Sand

0.01 in. slotted screen

Well Completion Details



Location Sketch

North

HN-115

Unit 595 | Unit 597

Client: Department of the Navy

Project Number: 60276503

Site Location: NAWC Warminster, Pennsylvania

Coordinates: 326269.128 2752203.529 TOC Elevation: 352.43

Drilling Method: Air Rotary/Percussion

Sample Type(s): none Boring Diameter: 6 in.

Boring: **HN-115**

Sheet: 2 of 2

Well Installed: Single riser

Screen: 15-25

Weather: Clear 80's F

Logged By: G. Richards Start Date: 6/8/2015

Drilling Contractor: RAAB (Rick Raab)

GS Elevation: 352.28 Date Complete: 6/12/2015

Depth of Boring: 25

Water Level: 22

Depth (ft)	Sample Depth	Blow Count	% Recovery	PID (ppm)	Graphic Log	USCS/Lithology	Description	Saturation/ Well Construction	Well Completion Details
21		Not Applicable				Silt-stone	22 ft. bgs: Same as above; cuttings return aggregated indicating water. Used air to blow out boring. Slow infiltration.	0.01 in. slotted screen	
22									
23								#1 Sand	
24									
25							25 ft. bgs.: SILTSTONE (Stockton Fm.); red; moderately hard; weathered; micaceous; dry.		TD=25
26							TD: 25 ft. bgs.		
27									
28									
29									
30									
31									
32									
33									
34									
35									
36									
37									
38									
39									
40									

Legend:

Air rotary/ percussion

First observed groundwater

PID Photoionization detector
USCS Unified soil classification system
ppm Parts per million
ft. Feet
bgs. Below ground surface
PVC Polyvinyl chloride
in. Inches
TD Total depth

ML Silt
Fm. Formation
TOC Top of
GS Ground surface

Prepared in accordance with:

Engineering Geology Field Manual, 2nd Edition.
D2487 Practice for Classification of Soils (USCS).
D2488 Practice for Description and Identification of Soils (Visual-Manual Procedure).
CalTrans Soil and Rock Logging, Classification, and Presentation Manual 2010 Edition

ATTACHMENT 2

GROUNDWATER LOW-STRESS PURGE AND SAMPLING DATA

6/30/15
1

Project Name: NAWC Warminster – Area B | Project No.: 60276503 | Date: 6/30/2015

Project Location: Warminster PA | Weather: overcast 70's °F

Well Number: HN-110 | Sampler: Pedro Lopes and Geoff Richards

PURGING AND SAMPLING DEVICE

Pump Type and Model: SS monsoon | Decontamination Procedure: Alconox and clean water

Tubing Diameter and Material: 3/8"x ½" poly | Well Previously Sampled: first of day

WELL INFORMATION

Well Diameter (in.): 2" | Depth to Bottom (ft., TOC): 25.10

Initial Depth to Water (ft., TOC): 15.25 | Screened Interval (ft., bgs): 15-25 ft

INDICATOR PARAMETER MONITORING | Pump Set at Depth (ft., TOC): 20 ft

Time:		0841	0846	0856	0900	0906	0915	0921	0930	0940	0948	0954	0959	1004
Purge Rate (mL/min):		~250	~250	~250	~250	~250	~250	~250	~250	~250	~250	~250	~250	~250
Depth to Water (ft.):		15.38	15.27	15.27	15.28	15.28	15.29	15.28	15.28	15.28	15.28	15.28	15.28	15.28
Volume Purged (liters)		2	~3.2	6.5	8.6	10	16	18.5	22	25	27	29	32	34
Parameter and Stabilization Range*														
Temp. (°C)	± 3%	14.02	14.93	14.24	14.06	14.14	12.40	13.80	13.82	14.35	14.08	14.65	13.73	13.90
pH	± 0.1	6.74	5.48	4.98	6.00	4.82	5.49	4.72	4.73	4.74	4.77	4.79	4.80	4.81
SC (m mhos)	± 3%	0.120	0.118	0.116	0.116	0.115	0.113	0.113	0.112	0.113	0.111	0.111	0.111	0.111
DO* (mg/L)	± 10 % if >1	7.94	6.71	6.73	6.69	6.52	6.84	6.16	5.87	5.59	5.45	5.31	5.42	5.27
ORP (mv)	± 10 mv	156	206	244	246	261	237	279	282	282	285	286	287	287
Turbidity (NTU)	± 10%	>1000	>1000	165	1000	516	152	95.8	51.0	40.8	27.3	22.8	19.0	16.0
TDS g/L	none	0.077	0.077	0.076	0.075	0.075	0.073	0.073	0.073	0.073	0.072	0.072	0.072	0.072
Color/odor	none	reddish brown	SAA	slightly turbid	slightly turbid	SAA	clearing	clear	Clear	Clear	Clear	Clear	Clear	Clear
Time:														
Purge Rate (mL/min):														
Depth to Water (ft.):														
Parameter and Stabilization Range*														
pH (std units)	± 0.1													
Conductivity (m mhos)	± 3%													
Turbidity (NTU)	± 10%													
DO* (mg/L)	± 10 %													
Temp. (°C)	N/A													
ORP (mv)	± 10 mv													

* Stabilization requires three consecutive readings within the range indicated. Once the well is stabilized, the sample may be collected. DO is the key indicator parameter for VOC analyses; turbidity is the key indicator parameter for all other analyses.

Sample: HN-110 | Sample time: 1037

Comments/Analytes: PFCs – LC 537 Modified (x6)

Initially very turbid

GROUNDWATER LOW-STRESS PURGE AND SAMPLING DATA

Project Name: _____ Project No.: _____ Date: _____

Project Location: _____ Weather: _____

Well Number: HN-110 Sampler: _____

PURGING AND SAMPLING DEVICE

Pump Type and Model: _____ Decontamination Procedure: _____

Tubing Diameter and Material: _____ Well Previously Sampled: _____

WELL INFORMATION

Well Diameter (in.): _____ Depth to Bottom (ft., TOC): _____

Initial Depth to Water (ft., TOC): _____ Screened Interval (ft., bgs): _____

INDICATOR PARAMETER MONITORING Pump Set at Depth (ft., TOC):

Time:		1013	1020	1028	1035								
Purge Rate (mL/min):		~250	~250	~250	~250								
Depth to Water (ft.):		15.28	15.28	15.28	15.28								
Volume Purged (liters)		37.5	40	42.5	45								
Parameter and Stabilization Range*													
Temp. (°C)	± 3%	14.22	15.93	14.85	13.61								
pH	± 0.1	4.95	5.10	5.34	5.46								
SC (m mhos)	± 3%	0.110	0.110	0.111	0.115								
DO* (mg/L)	± 10 % if >1	4.89	4.76	4.85	5.15								
ORP (mv)	± 10 mv	282	273	261	256								
Turbidity (NTU)	± 10%	11.7	9.9	4.87	9.8								
TDS g/L	none	0.071	0.072	0.072	0.075								
Color/odor	none	clear	clear	clear	clear								
Time:													
Purge Rate (mL/min):													
Depth to Water (ft.):													
Parameter and Stabilization Range*													
pH (std units)	± 0.1												
Conductivity (m mhos)	± 3%												
Turbidity (NTU)	± 10%												
DO* (mg/L)	± 10 %												
Temp. (°C)	N/A												
ORP (mv)	± 10 mv												

* Stabilization requires three consecutive readings within the range indicated. Once the well is stabilized, the sample may be collected. DO is the key indicator parameter for VOC analyses; turbidity is the key indicator parameter for all other analyses.

Sample: HN-110 ~~1035~~ Sample time: 1037

Comments/Analytes:

Note: Bore log → sandstone fractured siltstone → Vol removed → Hm VOA

Baseline geochem indicative of infiltration & rapid recharge based on variability coupled ε of drawdown ε-goes → water sampled is formational & further gw is not in equilibrium ε formation.

GROUNDWATER LOW-STRESS PURGE AND SAMPLING DATA

~~6/30/2015~~ 7/1/15

Project Name: NAWC Warminster – Area B | Project No.: 60276503 | Date: ~~6/30/2015~~ 7/1/15

Project Location: Warminster PA | Weather: 72°F P. Sunny

Well Number: HAV-111 | Sampler: Pedro Lopes and Geoff Richards

PURGING AND SAMPLING DEVICE

Pump Type and Model: SS monsoon | Decontamination Procedure: Alconox and clean water

Tubing Diameter and Material: 3/8"x ½" poly | Well Previously Sampled: ~~HAV-115~~ 1st of DAY

WELL INFORMATION

Well Diameter (in.): 2" | Depth to Bottom (ft., TOC): 24.70

Initial Depth to Water (ft., TOC): 14.40 | Screened Interval (ft., bgs): 15-25 ft

INDICATOR PARAMETER MONITORING | Pump Set at Depth (ft., TOC): 22 * During development 3 to ~1ft above bottom then no hold

Time:		1454	0855	0900	0905	0910	0915	0920	0925	0930	0935	0940	
Purge Rate (mL/min):		~250	~250	~250	~250	~250	~250	~250	~250	~250	~250	~250	
Depth to Water (ft.):		14.45	14.47	14.45	14.47	14.47	14.47	14.47	14.47	14.47	14.47	14.47	
Volume Purged (liters)		1.75	1.0	3.0	7.0	11.0	16.0	20.0	22.0	25.0	28	30	
Parameter and Stabilization Range*													
Temp. (°C)	± 3%	13.82	13.82	14.00	13.49	12.98	12.80	13.67	14.25	14.04	13.24	13.56	
pH	± 0.1	4.48	4.90	4.84	4.80	4.74	4.71	4.66	4.69	4.68	4.68	4.68	
SC (m mhos)	± 3%	0.194	.238	.205	.170	.160	.155	.156	.154	.151	.149	.147	
DO* (mg/L)	± 10 % if >1	4.27	9.32	8.45	8.21	7.99	7.86	7.38	6.83	7.03	7.09	7.02	
ORP (mv)	± 10 mv		288	308	313	319	324	323	321	320	323	323	
Turbidity (NTU)	± 10%	Too	360	373	208	89.7	13.8	12.3	9.6	7.5	6.4	5.7	
TDS g/L	none	0.126	0.151	.132	.110	.105	.101	.101	.100	.098	.097	.096	
Color/odor	none	light tan cloudy	clear	TAN	TAN	Clear	Clear	Clear	Clear	Clear	Clear	Clear	
Time:													
Purge Rate (mL/min):													
Depth to Water (ft.):													
Parameter and Stabilization Range*													
pH (std units)	± 0.1												
Conductivity (m mhos)	± 3%												
Turbidity (NTU)	± 10%												
DO* (mg/L)	± 10 %												
Temp. (°C)	N/A												
ORP (mv)	± 10 mv												

* Stabilization requires three consecutive readings within the range indicated. Once the well is stabilized, the sample may be collected. DO is the key indicator parameter for VOC analyses; turbidity is the key indicator parameter for all other analyses.

Sample: 0945 | Sample time: HAV-111

Comments/Analytes:

GROUNDWATER LOW-STRESS PURGE AND SAMPLING DATA

7/1/15

Project Name: NAWC Warminster – Area B | Project No.: 60276503 | Date: ~~6/30/2015~~

Project Location: Warminster PA | Weather: overcast 79 to 80's °F

Well Number: HN-112 | Sampler: Pedro Lopes and Geoff Richards

PURGING AND SAMPLING DEVICE

Pump Type and Model: SS monsoon | Decontamination Procedure: Alconox and clean water

Tubing Diameter and Material: 3/8"x ½" poly | Well Previously Sampled: HN-111 (yesterday)

WELL INFORMATION

Well Diameter (in.): 2" | Depth to Bottom (ft., TOC): 25.20

Initial Depth to Water (ft., TOC): 17.59 | Screened Interval (ft., bgs): 15-25 ft

Pump Set at Depth (ft., TOC): 23.5 ft *fracture 2' bottom of well, #2 infiltrations above

INDICATOR PARAMETER MONITORING

Time:		0900	0915	0920	0925	0930	0935	0940	0945	0950	0955	1000	1005	1010
Purge Rate (mL/min):		~320	~450	400	240	400	440	400	320	260	200	260	140	340
Depth to Water (ft.):		17.81	17.72	17.68	17.68	17.76	17.70	17.67	17.62	17.66	17.65	17.68	17.64	17.65
Volume Purged (liters)		~~1.5~~	7.1	9	10.2	12	14.2	16.2	17.8	19.5	20.5	21.8	22.5	24.2
Parameter and Stabilization Range*														
Temp. (°C)	± 3%	14.11	13.42	14.43	14.90	19.03	19.20	14.72	15.30	15.12	15.14	15.36	15.31	15.30
pH	± 0.1	5.91	5.36	5.21	5.21	5.20	5.21	5.20	5.20	5.19	5.20	5.20	5.20	5.21
SC (m mhos)	± 3%	0.317	0.323	0.329	0.328	0.331	0.334	0.337	0.338	0.339	0.338	0.336	0.336	0.337
DO* (mg/L)	± 10 % if >1	10.82	7.36	6.77	6.13	6.56	6.15	5.88	5.41	5.24	5.17	5.02	4.89	4.88
ORP (mv)	± 10 mv	163	175	172	175	179	185	185	181	183	184	184	184	185
Turbidity (NTU)	± 10%	>1000	>1000	902	584	418	172	93.0	44.1	26.3	10.5	8.9	7.9	6.8
TDS	none	0.206	0.210	0.214	0.213	0.217	0.217	0.219	0.220	0.220	0.219	0.218	0.219	0.218
Color/odor	none	brown turbid	turbid clearing	slightly turbid	cloudy	slightly cloudy	clear	clear	clear	clear	clear	clear	clear	clear
Time:														
Purge Rate (mL/min):														
Depth to Water (ft.):														
Parameter and Stabilization Range*														
pH (std units)	± 0.1													
Conductivity (m mhos)	± 3%													
Turbidity (NTU)	± 10%													
DO* (mg/L)	± 10 %													
Temp. (°C)	N/A													
ORP (mv)	± 10 mv													

* Stabilization requires three consecutive readings within the range indicated. Once the well is stabilized, the sample may be collected. DO is the key indicator parameter for VOC analyses; turbidity is the key indicator parameter for all other analyses.

Sample: HN-112 | Sample time: T = 1012

Comments/Analytes: Trouble keeping constant Q = controller issue. Although there is clear evidence of recharge. Fracture 2' bottom of well HN 23 + 24 ft. Very little to no infiltrations above. Dry density drilling.

GROUNDWATER LOW-STRESS PURGE AND SAMPLING DATA

Project Name: NAWC Warminster – Area B | Project No.: 60276503 | Date: ~~6/30/2015~~ 7-1-15

Project Location: Warminster PA | Weather: 75°F Sunny

Well Number: HN-113 | Sampler: Pedro Lopes and Geoff Richards

PURGING AND SAMPLING DEVICE

Pump Type and Model: SS monsoon | Decontamination Procedure: Alconox and clean water

Tubing Diameter and Material: 3/8"x ½" poly | Well Previously Sampled: HN-111

WELL INFORMATION

Well Diameter (in.): 2" | Depth to Bottom (ft., TOC): 25'

Initial Depth to Water (ft., TOC): 19.83 | Screened Interval (ft., bgs): 15-25 ft

INDICATOR PARAMETER MONITORING | Pump Set at Depth (ft., TOC): 23'

Time:		1000	1005	1010	1015	1020	1025	1030	1035	1040	1045	1050	1055
Purge Rate (mL/min):		~300	~300	~300	~300	~300	~300	~300	~300	~300	~300	~300	~300
Depth to Water (ft.):		20.30	20.70	21.04	21.60	21.51	21.53	NA	NA	NA	NA	NA	NA
Volume Purged (liters)		1.0	3.0	5.0	9.0	12.0	13.0	16.0	20.0	22.00	24.00	26.0	
Parameter and Stabilization Range*													
Temp. (°C)	± 3%	16.24	16.00	15.79	14.46	15.76	15.76	14.64	14.53	15.79	16.08	16.18	16.10
pH	± 0.1	4.82	4.74	4.81	4.99	5.17	5.18	5.16	5.15	5.28	5.33	5.34	5.34
SC (m mhos)	± 3%	.209	.211	.208	.204	.186	.184	.180	.178	.167	.159	.156	.154
DO* (mg/L)	± 10 % if >1	4.85	4.38	4.40	5.02	5.60	5.66	5.60	5.57	5.94	6.34	6.36	6.40
ORP (mv)	± 10 mv	302	304	294	276	251	250	242	238	232	237	237	238
Turbidity (NTU)	± 10%	219	305	160	88.1	34.2	30.3	22.1	18.6	19.1	9.9	8.8	6.2
TDS	none	.136	.137	.135	.132	.121	.119	.117	.116	.108	.103	.101	.100
Color/odor	none	TAN	TAN	TAN	TAN	TAN	Clear	Clear	clear	Clear	Clear	clear	Clear
Time:													
Purge Rate (mL/min):													
Depth to Water (ft.):													
Parameter and Stabilization Range*													
pH (std units)	± 0.1												
Conductivity (m mhos)	± 3%												
Turbidity (NTU)	± 10%												
DO* (mg/L)	± 10 %												
Temp. (°C)	N/A												
ORP (mv)	± 10 mv												

* Stabilization requires three consecutive readings within the range indicated. Once the well is stabilized, the sample may be collected. DO is the key indicator parameter for VOC analyses; turbidity is the key indicator parameter for all other analyses.

Sample: HN-113 Sample time: 1100

Comments/Analytes:

GROUNDWATER LOW-STRESS PURGE AND SAMPLING DATA

Project Name: NAWC Warminster | Project No.: 60276503 | Date: 7/1/15

Project Location: Warminster PA | Weather: clear 80's

Well Number: HN-114 | Sampler: G.R

PURGING AND SAMPLING DEVICE

Pump Type and Model: SS Monsoon | Decontamination Procedure: Alconox + clean water

Tubing Diameter and Material: 3/8" x 1/2" poly | Well Previously Sampled: HN-112

WELL INFORMATION

Well Diameter (in.): 2" | Depth to Bottom (ft., TOC): 24.85

Initial Depth to Water (ft., TOC): 9.42 ft | Screened Interval (ft., bgs): 15-25 ft

Pump Set at Depth (ft., TOC): ~20 ft

INDICATOR PARAMETER MONITORING

Time:		1039	1045	1050	1055	1100	1110	1120	1130	1140*	1150	1200	1210
Purge Rate (mL/min):		/	350	330	280	600	250	200	200	200	400	400	400
Depth to Water (ft.):		9.44	9.42	9.42	9.46	9.46	9.46	9.46	9.46	9.46	9.45	9.46	9.44
Volume Purged (liters)		0	1.75	3.4	4.8	7.5	10	12	14	16	20	24	26.5
Parameter and Stabilization Range*													
Temp. (°C)	± 3%	/	15.91	15.58	15.58	15.30	15.76	16.00	16.14	16.22	14.21	15.53	
pH	± 0.1	/	5.74	6.01	5.93	5.62	5.60	5.58	5.37	5.30	5.83	5.76	5.64
SC (m mhos)	± 3%	/	0.232	0.208	0.203	0.186	0.177	0.174	0.173	0.172	0.172	0.173	0.174
DO* (mg/L)	± 10 % if >1	/	4.57	4.39	4.37	4.36	4.30	4.19	4.16	4.08	4.19	4.04	4.03
ORP (mv)	± 10 mv	/	192	187	200	220	220	219	232	241	229	230	237
Turbidity (NTU)	± 10%	/	518	475	418	345	226	169	150	104	30.7	33.3	34.7
TDS	none	/	0.151	0.135	0.135	0.120	0.115	0.113	0.112	0.112	0.112	0.112	0.113
Color/odor	none	/	slightly turbid	cloudy	clear	clear	clear	clear	clear	clear	SAA	SAA	SAA
Time:													
Purge Rate (mL/min):													
Depth to Water (ft.):													
Parameter and Stabilization Range*													
pH (std units)	± 0.1												
Conductivity (m mhos)	± 3%												
Turbidity (NTU)	± 10%												
DO* (mg/L)	± 10 %												
Temp. (°C)	N/A												
ORP (mv)	± 10 mv												

* Stabilization requires three consecutive readings within the range indicated. Once the well is stabilized, the sample may be collected. DO is the key indicator parameter for VOC analyses; turbidity is the key indicator parameter for all other analyses.

Sample: HN-114 | Sample time: C = 1212

Comments/Analytes: Sustainable recharge ≈ 450 mL/min. Water column slightly turbid.

* 1140 → removed tubing & flushed flow through cell of accumulated sediment.

GROUNDWATER LOW-STRESS PURGE AND SAMPLING DATA

Project Name: NAWC Warminster – Area B | Project No.: 60276503 | Date: ~~6/30/2015~~ 7.1.15

Project Location: Warminster PA | Weather: 77°F Sunny

Well Number: HN-115 | Sampler: Pedro Lopes and Geoff Richards

PURGING AND SAMPLING DEVICE

Pump Type and Model: SS monsoon | Decontamination Procedure: Alconox and clean water

Tubing Diameter and Material: 3/8"x ½" poly | Well Previously Sampled: HN-113

WELL INFORMATION

Well Diameter (in.): 2" | Depth to Bottom (ft., TOC): 25.03

Initial Depth to Water (ft., TOC): 10.44 | Screened Interval (ft., bgs): 15-25 ft

INDICATOR PARAMETER MONITORING | Pump Set at Depth (ft., TOC): 20'

Time:		1155	1200	1205	1210	1215	1220	1225	1230	1235	1240	1245	1250	1255
Purge Rate (mL/min):		~300	~300	~300	~300	~300	~300	~300	~300	~300	~300	~300	~300	~300
Depth to Water (ft.):		10.60	10.51	10.52	10.52	10.52	10.52	10.52	10.52	10.52	10.52	10.52	10.52	10.52
Volume Purged (liters)		1	2	4	6	8	10	13	16	20	24	26	27	28
Parameter and Stabilization Range*														
Temp. (°C)	± 3%	17.00	18.66	18.74	17.61	17.20	17.05	16.48	16.23	16.40	17.88	18.00	18.01	18.09
pH	± 0.1	5.90	5.61	5.56	5.50	5.42	5.40	5.44	5.47	5.50	5.55	5.64	5.70	5.67
SC (m mhos)	± 3%	.196	.190	.187	.177	.173	.170	.167	.166	.166	.166	.166	.165	.165
DO* (mg/L)	± 10 % if >1	3.90	3.42	3.48	3.66	3.82	4.06	4.60	4.85	4.95	4.71	4.80	4.84	4.80
ORP (mv)	± 10 mv	212	218	208	207	214	216	219	133	223	222	218	218	219
Turbidity (NTU)	± 10%	1000	1000	1000	942	888	418	204	131	74.9	40.5	27.2	25.3	26.1
TDS	none	.127	.124	.121	.115	.113	.111	.108	.108	.108	.108	.108	.107	0.107
Color/odor	none	Brown	Brown	TAN	TAN	TAN	TAN	TAN	TAN	Clear	Clear	Clear	Clear	Clear
Time:														
Purge Rate (mL/min):														
Depth to Water (ft.):														
Parameter and Stabilization Range*														
pH (std units)	± 0.1													
Conductivity (m mhos)	± 3%													
Turbidity (NTU)	± 10%													
DO* (mg/L)	± 10 %													
Temp. (°C)	N/A													
ORP (mv)	± 10 mv													

* Stabilization requires three consecutive readings within the range indicated. Once the well is stabilized, the sample may be collected. DO is the key indicator parameter for VOC analyses; turbidity is the key indicator parameter for all other analyses.

Sample: HN-115 | Sample time: 1300 | Collected DUP sample DUP-070115 @ 1200

Comments/Analytes: Collected MS + MSD

PINE ENVIRONMENTAL SERVICES INC.
REPLACEMENT ONLY FORM

Copy

COMPANY AECOM

CONTRACT # J292136 CUSTOMER PO

SHIP TO: 125 Rock Rd. (606-30

Horsham, PA

SHIP DATE	SHIP METHOD	EQUIPMENT NEEDED	QTY	PINE ID #	MAS ITEM #	DATE RETURNED
6/30	Pine	Nansson	1	16384	RWSA19010	
6/30	Pine	Controller	1	16563	RWSA19015	
6/30	Pine	Manne Battery	1	906232-29729	RWSA90957	
[redacted]						
6/30	Pine	U-52 Flow	1	24573	RWSA53010	
				31158		

ADD ON

ADDm

CONTACT:	Gus Richards
PHONE	(215) 315-4150

PINE ORDER TAKER INITIALS TNV

Accutest Laboratories Southeast

Chain of Custody

FA25785

ACCUTEST LABORATORIES

4405 Vineland Road Suite C-15 Orlando, Fl 32811
TEL: 407-425-6700 FAX: 407-425-0707
www.accutest.com

ACCUTEST JOB #: FA25785 PAGE 1 OF 1

Accutest Quote # SKIFF #

Client / Reporting Information

AECOM
125 Rock Road
Horsham, PA 19044
Send results to: Patti Jannett patti.jannett@aecom.com
215-315-4325
Sampler(s) Name(s) (Printed)
Sampler 1: Paco Lopes Sampler 2: Geoff Richards

Project Information

Project Name: NAWC Warminster
Street
City Warminster State PA
Project # 60276503
Fax # 215-315-4151
Client Purchase Order #

Analytical Information

LL537UCMR

Matrix Codes

DW - Drinking Water
GW - Ground Water
WW - Water
SW - Surface Water
SO - Soil
SL - Sludge
OI - Oil
LIQ - Other Liquid
AIR - Air

Accutest Sample #	Field ID / Point of Collection	COLLECTION DATE	TIME	SAMPLED BY:	MATRIX	TOTAL # OF BOTTLES	CONTAINER INFORMATION OTHER	NONE	HCl	NaOH	HNO3	H2SO4	NaOH+ZnAc	DI WATER	MEOH	LAB USE ONLY
1	HN-110	6/30/15	1037	PL/GR	GW	2		X							X	
2	HN-111	7/1/15	0945	PL	GW	2		X							X	
3	HN-112	7/1/15	1012	GR	GW	2		X							X	
4	HN-113	7/1/15	1100	PL	GW	2		X							X	
5	HN-114	7/1/15	1212	GR	GW	2		X							X	
6	HN-115	7/1/15	1300	PL/GR	GW	2		X							X	
7	Dup-070115	7/1/15	1200	PL/GR	GW	2		X							X	
8	FB_07012015	7/1/15	1227	PL/GR	WW	2		X							X	
(6)	MS	7/1/15	1310	PL/GR	GW	2		X							X	
	MSD	7/1/15	1310	PL/GR	GW	2		X							X	

Turnaround Time (Business days)

- [X] Std. 10 Business Days
- 7 Day *RUSH*
- 5 Day *RUSH*
- 3 Day *EMERGENCY*
- 2 Day *EMERGENCY*
- 1 Day *EMERGENCY*
- Other

Approved By: / Date/Rush Code:

Emergency or Rush T/A Data Available VIA Email or Labink

Data Deliverable Information

- [ ] COMMERCIAL "A" (RESULTS ONLY)
- [ ] COMMERCIAL "B" (RESULTS PLUS QC)
- [ ] REDT1 (EPA LEVEL 3)
- [ ] FULLT1 (EPA LEVEL 4)
- [x] EDD'S

Comments / Remarks

Hard Copy of results

Sample Custody must be documented below each time samples change possession, including courier delivery.

Relinquished by Sampler/Affiliation	Date Time:	Received By/Affiliation	Relinquished By/Affiliation	Date Time:	Received By/Affiliation
1 AECOM	7/1/15 1451	2 AECOM (Mike) Sturge	3 Geoff Richards/AECOM	7/2/15 1100	4
Relinquished by/Affiliation	Date Time:	Received By/Affiliation	Relinquished By/Affiliation	Date Time:	Received By/Affiliation
5		6 FP	7 FP 070315	900	8

Lab Use Only: Custody Seal In Place: Y N Temp Blank Provided: Y N Preserved Where Applicable: Y N Total # of Coolers: Cooler Temperature (s) Celsius: 2.8

5.1 5

FA25785: Chain of Custody
Page 1 of 3

ATTACHMENT 3

Resolution Consultants
250 Apollo Drive
Chelmsford, MA 01824

978.905.2100 tel
978.905.2101 fax

Data Validation Report

Project:	NAWC Warminster, PA
Laboratory:	Accutest Laboratories
Job Numbers:	FA25785
Analyses/Method:	PFCs by Liquid Chromatography/Mass Spectrometry/Mass Spectrometry (LC/MS/MS)/ EPA Method 537 modified
Validation Level:	Limited
Resolution Consultants Project Number:	60276503, Shenandoah task
Prepared by:	Paula DiMattei/Resolution Consultants Completed on:7/22/2015
Reviewed by:	Lori Herberich /Resolution Consultants

File Name: Warminster FA25785_PFCs

SUMMARY

The samples listed below were collected by Resolution Consultants from the NAWC Warminster, PA site on June 30 and July 1, 2015.

SDG	Sample ID*	Matrix/Sample Type
FA25785	HN-110 _06302015	Groundwater
	HN-111 _07012015	Groundwater
	HN-112 _07012015	Groundwater
	HN-113 _07012015	Groundwater
	HN-114 _07012015	Groundwater
	HN-115 _07012015	Groundwater
	Dup-070115	Field duplicate of HN-115
	FB-07012015	Field Blank

*The date of sample collection was appended to the sample ID in the project database in order to maintain unique sample IDs.

Data validation activities were conducted with reference to:

- Accutest Laboratories SOP: Analysis of Perfluorinated Alkyl Acids by LC/MS/MS; MS 014.1, Rev. Date: 05/14
- USEPA Contract Laboratory Program National Functional Guidelines for Chlorinated Dioxin/Furan Data review (USEPA, September 2011);
- USEPA Contract Laboratory Program National Functional Guidelines for Superfund Organic Methods Data Review (June 2008); and
- Quality Systems Manual (QSM) for Environmental Laboratories, Version 4.2 (DoD, October 2010)

In the absence of method-specific information, laboratory quality control (QC) limits, project-specific requirements and/or professional judgment were used as appropriate.

REVIEW ELEMENTS

The data were evaluated based on the following review elements (where applicable to the method):

- ✓ Data completeness (chain-of-custody (COC)/sample integrity
- ✓ Holding times/sample preservation
- ✓ Initial calibration/initial and continuing calibration verification
- ✓ Laboratory method blanks/equipment blanks
- ✓ Surrogate recoveries
- ✓ Matrix spike (MS) and/or matrix spike duplicate (MSD) results
- ✓ Laboratory control sample (LCS) results
- ✓ Field duplicate results
- ✓ Internal standard results
- ✓ Sample results/reporting issues

The symbol (✓) indicates that no validation qualifiers were applied based on this parameter. An NA indicates that the parameter was not included as part of this data set or was not applicable to this validation and therefore not reviewed. The symbol (✗) indicates that a QC nonconformance resulted in the qualification of data. Any QC nonconformance that resulted in the qualification of data is discussed below. In addition, nonconformances or other issues that were noted during validation, but did not result in qualification of data, may be discussed for informational purposes only.

The data appear valid as reported and may be used for decision making purposes. Qualification of the data was not required.

RESULTS

Data Completeness/Sample Integrity

The data package was reviewed and found to meet acceptance criteria for completeness:

- The COCs were reviewed for completeness of information relevant to the samples and requested analyses, and for signatures indicating transfer of sample custody.
- The laboratory sample login sheet(s) were reviewed for issues potentially affecting sample integrity, including the condition of sample containers upon receipt at the laboratory.
- Completeness of analyses was verified by comparing the reported results to the COC requests.

Holding Times/Sample Preservation

Sample preservation and preparation/analysis holding times were reviewed for conformance with the QC acceptance criteria. All QC acceptance criteria were met or qualification of the data was not required.

Initial Calibration/Initial and Continuing Calibration Verification

Calibration data were reviewed for conformance with the QC acceptance criteria to ensure that:

- the initial calibration (ICAL) percent relative standard deviation (%RSD) or correlation coefficient (r)/coefficient of determination (r^2) method acceptance criteria were met;
- the initial calibration verification standard (ICV) percent recovery acceptance criteria were met; and
- the continuing calibration verification standard (CCV) frequency and method percent recovery criteria were met.

The QC acceptance criteria were met.

Laboratory Method Blanks/Equipment Blanks

Laboratory method blanks and field blanks are evaluated as to whether there are contaminants detected above the detection limit (DL). Target compounds were not detected in the laboratory method blank or field blank [FB-07012015] associated with the samples in this data set.

Surrogate Recoveries

The surrogate recoveries (%Rs) were reviewed for conformance with the QC acceptance criteria. All QC acceptance criteria were met or qualification of the data was not required.

MS/MSD Results

The MS/MSD %Rs and relative percent differences (RPDs) were reviewed for conformance with the QC acceptance criteria. All QC acceptance criteria were met.

LCS Results

The LCS %Rs were reviewed for conformance. All QC acceptance criteria were met.

Field Duplicate Results

Field duplicate RPDs were reviewed for conformance with the Resolution Consultants QC criteria of $\leq$30% for aqueous matrices. These criteria apply if both results were greater than five times the limit of quantitation (LOQ). All field duplicate precision criteria were met.

Internal Standard Results

The internal standard (IS) results were reviewed for conformance with the QC acceptance criteria. All QC acceptance criteria were met.

Sample Results/Reporting Issues

If applicable, compounds detected at concentrations less than the limit of quantitation (LOQ) but greater than the detection limit (DL) were qualified by the laboratory as estimated (J). This "J" qualifier was retained during data validation.

QUALIFICATION ACTIONS

Qualification of the sample data was not required.