



Technical Memorandum
Perfluorinated Compounds Soil and Groundwater Investigation
Shenandoah Woods Housing Complex
Naval Air Warfare Center, Warminster, Pennsylvania
19 March 2015 through 31 May 2015

1.0 INTRODUCTION

This Technical Memorandum summarizes the findings of a soil and groundwater investigation performed by Resolution Consultants (Resolution) at the Shenandoah Woods Housing Complex, located at the former Naval Air Warfare Center (NAWC) Warminster between 19 March 2015 and 31 May 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 the 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 study. The PHAs for PFOS and PFOA are not directly applicable to soil.

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). This investigation was initiated at Shenandoah Woods in 2015 to support property transfer by characterizing the occurrence and concentrations of six PFCs: PFOA, PFOS, PFNA, PFHxS, PFHpA and PFBS, in soil and groundwater. During this investigation, eight soil samples and one blind duplicate were collected from four boring locations and 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 Figures 1 and 2.



2.0 FIELD ACTIVITIES

As part of this investigation, soil borings were advanced and three dual-nested monitoring well pairs were installed in the Shenandoah Woods parcel. On 19 March 2015, a geophysical survey was performed by PULS, Inc. of Bethlehem, PA under Resolution oversight for utility clearance purposes in each of the proposed boring and monitoring well locations.

Soil Borings

On 23 March and 24 March 2015, two soil borings (SB01 and SB02) were advanced using direct push technology to 5.5 feet below ground surface (bgs) and four soil samples, one blind duplicate, and one matrix spike/matrix duplicate were collected from the boring sidewall from depths between 0.5 feet bgs to 3 feet bgs. Soil samples were collected above perched groundwater encountered at approximately 3.5 feet bgs.

Soil borings were advanced at two of the nested monitoring well locations. Four soil samples were collected from the sidewall of two monitoring wells (HN-107 and HN-109). Soil samples were collected at depths ranging from 0.8 feet bgs to 8 feet bgs.

Monitoring Well Installation

Dual nested monitoring well pair locations were selected hydraulically down-gradient of Sites 5, 6, and 7. Well installation details are summarized below.

On 23 March through 27 March 2015, the initial boreholes were advanced at the HN-107, HN-108, and HN-109 locations (**Figure 2**). 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, the target depths for shallow monitoring wells were approximately 50 feet below ground surface (bgs) and 100 feet bgs for the intermediate monitoring wells. At each location, a 10-inch carbide hammer was used to advance borings to 20 feet bgs and 10-inch steel outer casing was installed. Borings were advanced through the outer casing to the maximum depth of 100 feet bgs using an 8-inch carbide hammer. Two flush mounted, 2-inch diameter monitoring wells were completed at each location. Monitoring wells were constructed with 2-inch polyvinyl chloride (PVC) well screen and riser. The annular space was filled with Number 1 sand to two feet above the well screen. Filter pack material was used under the sump cap (minimum of 6 inches). To seal the annular space between the shallow and intermediate wells, a five foot thick (minimum) hydrated bentonite plug was installed above the filter pack and the monitoring well was sealed above the shallow screen using bentonite slurry via pressure grout injection to 0.5 feet bgs. The well seal cured for 24 hours prior to surface completion of the well pad. After 24 hours, no loss of annular space grout to the formation was observed. A 10-inch diameter man-hole cover was installed within a 2 foot by 2 foot concrete pad at each well location.

Monitoring wells were developed on 2 April 2015. Soil cuttings and groundwater generated during drilling were captured by an in-line containment system. Soil cuttings were containerized in a roll-off and groundwater generated during drilling and well development purge water were containerized in drums. The roll-off and drums were transported to the NAWC groundwater treatment plant. The roll off was removed for disposal, the drums were removed for off site disposal 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 construction details are summarized in **Table 1** and the well locations are shown in **Figures 1 and 2**. Boring logs and well construction diagrams are included in **Attachment 1**.



Groundwater Sampling

On 16 April 2015, monitoring wells were gauged and sampled in accordance with 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 all six monitoring wells. Well screen intervals were selected based on where saturated conditions and/or fractures were encountered during drilling. During drilling, weathered bedrock was noted in the upper 55 to 77 feet of the boring, which gradually transitioned into competent Stockton Formation bedrock. This 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 Area C, lithologic boring data and the depths groundwater was encountered in monitoring wells HN-107 S/I, HN-108 S/I, and HN-109 S/I suggest confined to semi confined conditions. Generally, the lithology identified was highly weathered from the surface until approximately 55 to 77 feet bgs. Finer grained materials (siltstone and mudstone) were identified above the more permeable sandstone units and fractures.

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

There are no screening levels for PFCs in soil, however, constituents of interest were not detected above the laboratory detection limits in soil samples with the exception of SB7. The sample collected from SB7 at 0.5 feet bgs had an estimated (J) PFOS concentration (6.040 J $\mu\text{g/kg}$). The concentration of PFOS in the accompanying blind duplicate of SB7 was below the detection limit for all analytes. Analytical results from eight of the nine soil samples collected during this investigation were below reporting limits for all six PFC analytes. Analytical results from the soil investigation are summarized in **Table 2**.

Concentrations of PFOS and PFOA in the groundwater samples collected on 16 April 2015 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 $\mu\text{g/L}$) exceeded the PHA for PFOS (0.2 $\mu\text{g/L}$). Detectable concentrations of PFOS and PFOA were reported in all groundwater samples collected except in those obtained from HN-108S.



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

Concentrations of PFOA were higher than PFOS in all samples collected except HN-108I. The highest concentration of PFOA was detected in monitoring well HN-109I (0.0718 µg/L), which is below the PHA of 0.4 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-108I (0.134 µg/L). The concentration of all analytes were below their respective detection limits in all field blanks, collected each day of sampling. Analytical results from the groundwater investigation are summarized in **Table 3**.

4.0 REFERENCES

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

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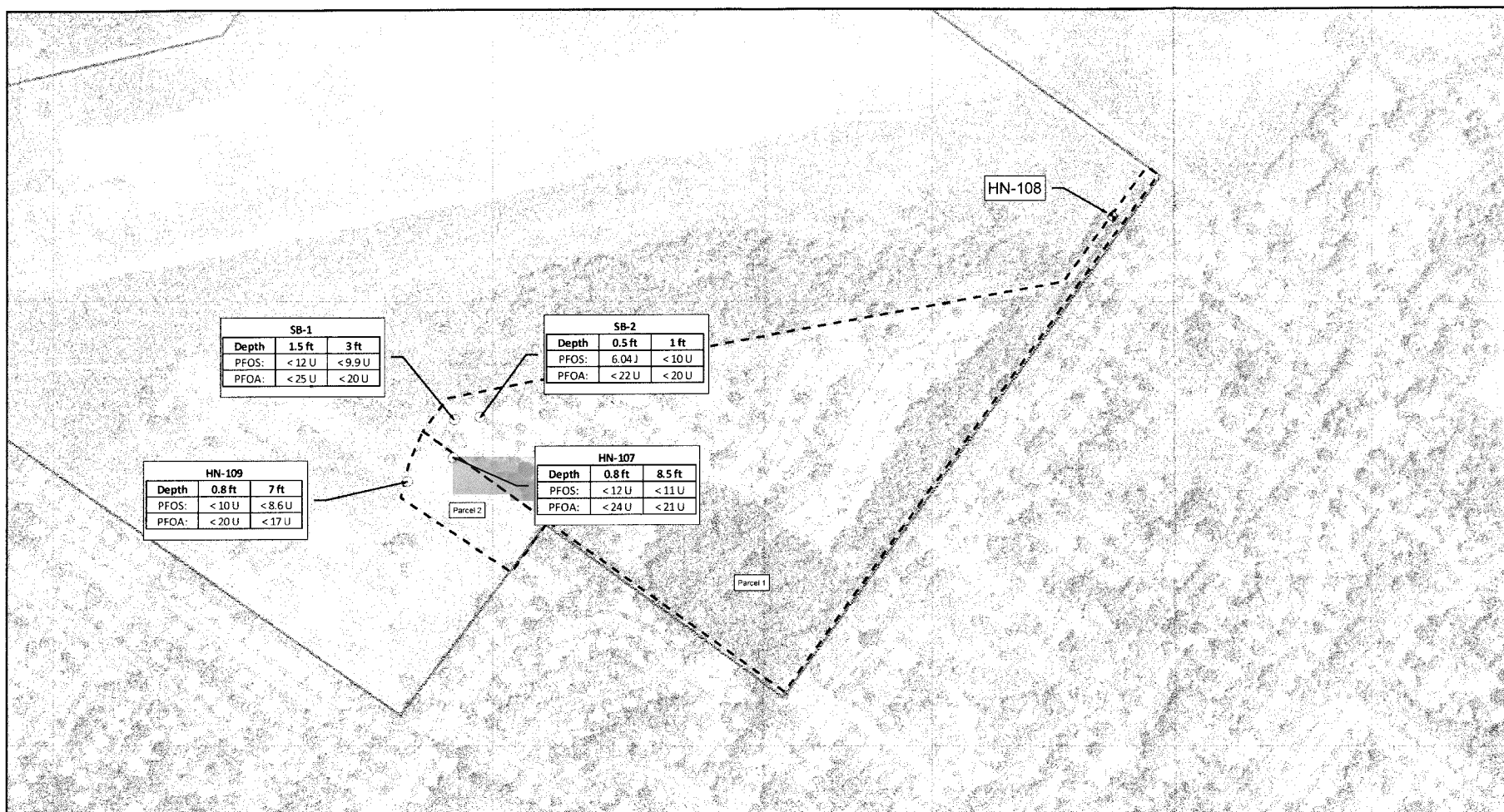
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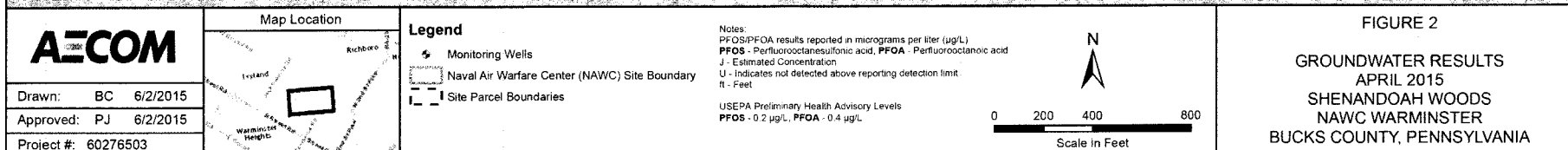
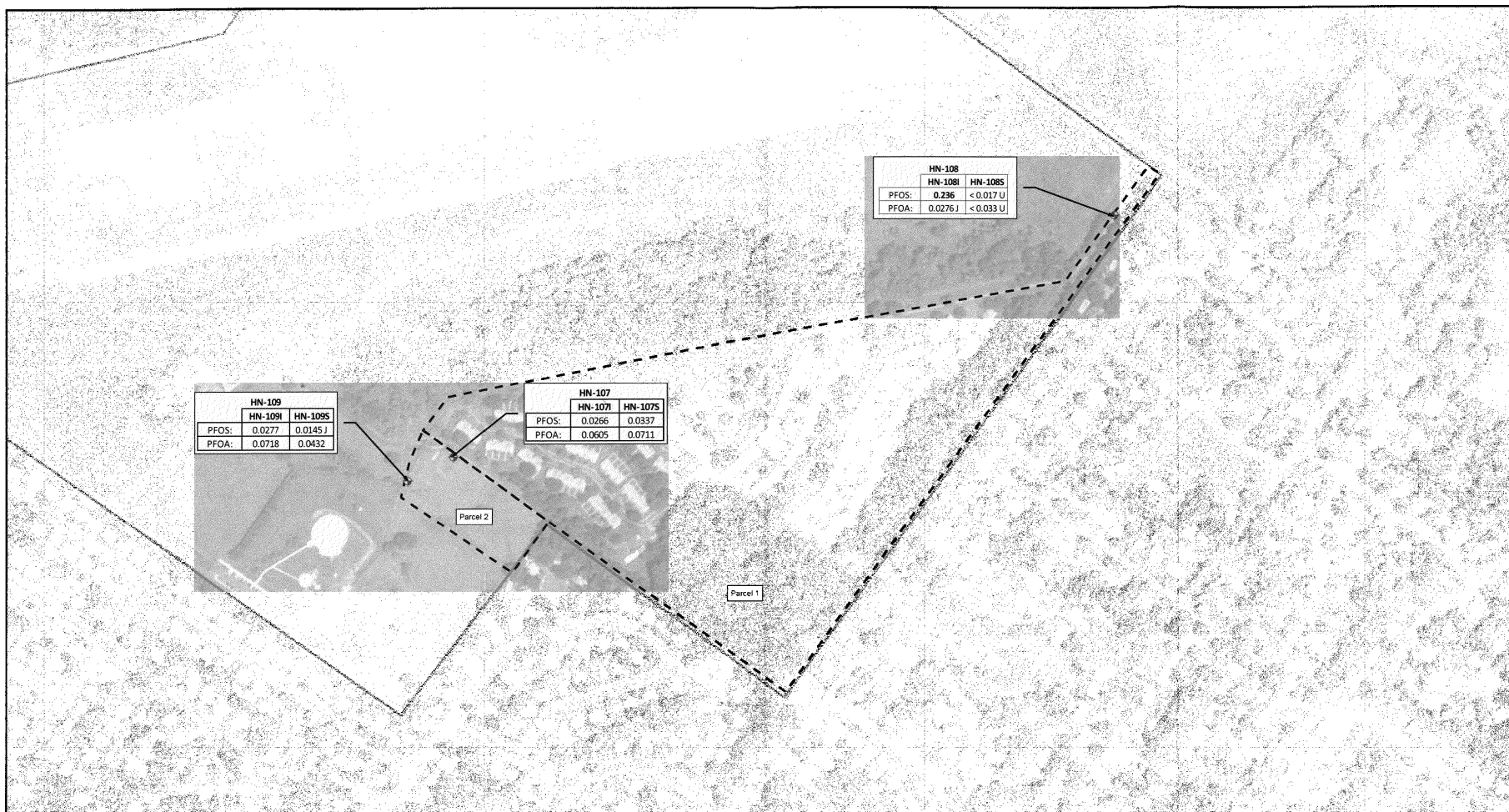
FIGURES

FIGURES



	Map Location	Legend Soil Boring Monitoring Well Naval Air Warfare Center (NAWC) Site Boundary Site Parcel Boundaries	Notes: PFOS/PFOA results reported in micrograms per kilogram (µg/kg) PFOS - Perfluorooctanesulfonic acid, PFOA - Perfluorooctanoic acid J - Estimated Concentration U - Indicates not detected above reporting detection limit ft - Feet	 Scale in Feet	FIGURE 1 SOIL SAMPLE RESULTS MARCH 2015 SHENANDOAH WOODS NAWC WARMINSTER BUCKS COUNTY, PENNSYLVANIA
	Drawn: BC 8/6/2015				
	Approved: PJ 8/6/2015				
	Project #: 60276503				

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TABLES

TABLES

Table 1
Well Construction Summary
NAWC Warminster

Well	Total Depth (ft bgs)	Screened interval (ft)	Elevation (ft amsl)	Mount	Installed
HN-107S	65	45-65	346.42	Flush	Mar-15
HN-107I	100	90-100	346.43		
HN-108S	65	45-65	380.08	Flush	Mar-15
HN-108I	100	90-100	379.98		
HN-109S	32	22-32	347.35	Flush	Mar-15
HN-109I	85	75-85	347.37		

ft bgs feet below ground surface

ft msl feet above mean sea level

Table 2

PFC Investigation - April 2015

Validated Results Summary

NAWC Warminster - Shenandoah Woods

Sample ID	Sample Location	Sample Date	Sampled Delivery Group	S1-0.8_03232015	S2-0.8_03232015	S-DUP_03242015	S3-1.5_03232015	S4-8.5_03232015	S5-1.0_03232015	S6-7_03242015	S7-0.5_03242015	S8-3_03242015
				HN-107 - 0.8 ft	HN-109 - 0.8 ft	SB-2	SB-1 - 1.5 ft	SB-1 - 8.5 ft	SB-2 - 1.0 ft	HN-107 - 7 ft	SB-2 - 0.5 ft	SB-1 - 3 ft
Chemical Name	CAS	Units		3/23/2015	3/23/2015	3/24/2015	3/23/2015	3/23/2015	3/23/2015	3/24/2015	3/24/2015	3/24/2015
				FA23101	FA23101	FA23101	FA23101	FA23101	FA23101	FA23101	FA23101	FA23101
Perfluorobutanesulfonic Acid (PFBS)	375-73-5	µg/Kg		< 12 U	< 10 U	< 11 U	< 12 U	< 11 U	< 10 U	< 8.6 U	< 11 U	< 9.9 U
Perfluoroheptanoic Acid (PFHpA)	375-85-9	µg/Kg		< 12 U	< 10 U	< 11 U	< 12 U	< 11 U	< 10 U	< 8.6 U	< 11 U	< 9.9 U
Perfluorohexanesulfonic Acid (PFHxS)	355-46-4	µg/Kg		< 12 U	< 10 U	< 11 U	< 12 U	< 11 U	< 10 U	< 8.6 U	< 11 U	< 9.9 U
Perfluorononanoic Acid (PFNA)	375-95-1	µg/Kg		< 12 U	< 10 U	< 11 U	< 12 U	< 11 U	< 10 U	< 8.6 U	< 11 U	< 9.9 U
Perfluorooctanesulfonic Acid (PFOS)	1763-23-1	µg/Kg		< 12 U	< 10 U	< 11 U	< 12 U	< 11 U	< 10 U	< 8.6 U	6.04 J	< 9.9 U
Perfluorooctanoic Acid (PFOA)	335-67-1	µg/Kg		< 24 U	< 20 U	< 22 U	< 25 U	< 21 U	< 20 U	< 17 U	< 22 U	< 20 U

Sample ID	Sample Date	Sampled Delivery Group	EB-032315	FB-032315	FB-032415
			3/23/2015	3/23/2015	3/24/2015
Chemical Name	CAS	Units	FA23101	FA23101	FA23101
Perfluorobutanesulfonic Acid (PFBS)	375-73-5	µg/L	< 0.015 U	< 0.016 U	< 0.015 U
Perfluoroheptanoic Acid (PFHpA)	375-85-9	µg/L	< 0.015 U	< 0.016 U	< 0.015 U
Perfluorohexanesulfonic Acid (PFHxS)	355-46-4	µg/L	< 0.015 U	< 0.016 U	< 0.015 U
Perfluorononanoic Acid (PFNA)	375-95-1	µg/L	< 0.015 U	< 0.016 U	< 0.015 U
Perfluorooctanesulfonic Acid (PFOS)	1763-23-1	µg/L	< 0.015 U	< 0.016 U	< 0.015 U
Perfluorooctanoic Acid (PFOA)	335-67-1	µg/L	< 0.031 U	< 0.032 U	< 0.031 U

Notes:

CAS Chemical Abstracts Service Number

U indicates not detected above reporting detection limit

J indicates estimated value

ft feet

µg/Kg micrograms per kilogram

µg/L micrograms per liter

Table 3
PFC Investigation - April 2015
Validated Results Summary
NAWC Warminster - Shenandoah Woods

				Sample ID	HN-107I_04162015	HN-107S_04162015	HN-108I_04172015	HN-108S_04172015
				Location	HN-107I	HN-107S	HN-108I	HN-108S
				Screen Interval	90-100	45-65	90-100	45-65
				Sample Date	4/16/2015	4/16/2015	4/17/2015	4/17/2015
				Sampled Delivery Group	FA23700	FA23700	FA23700	FA23700
Chemical Name	CAS	Units	EPA Health Advisory Level					
Perfluorobutanesulfonic Acid (PFBS)	375-73-5	µg/L	NA	< 0.015 U	< 0.015 U	0.0353	0.0664	
Perfluoroheptanoic Acid (PFHpA)	375-85-9	µg/L	NA	< 0.015 U	0.00862 J	0.0259	< 0.017 U	
Perfluorohexanesulfonic Acid (PFHxS)	355-46-4	µg/L	NA	0.0398	0.0444	0.134	0.0131 J	
Perfluorononanoic Acid (PFNA)	375-95-1	µg/L	NA	< 0.015 U	< 0.015 U	< 0.015 U	< 0.017 U	
Perfluorooctanesulfonic Acid (PFOS)	1763-23-1	µg/L	0.2	0.0266	0.0337	0.236	< 0.017 U	
Perfluorooctanoic Acid (PFOA)	335-67-1	µg/L	0.4	0.0605	0.0711	0.0276 J	< 0.033 U	

				Sample ID	HN-109S_04162015	DUP-041615	HN-109I_04162015	FB-041615	FB-041715
				Location	HN-109S	HN-109S	HN-109I		
				Screen Interval	22-32	22-32	75-85		
				Sample Date	4/16/2015	4/16/2015	4/16/2015	4/16/2015	4/17/2015
				Sampled Delivery Group	FA23700	FA23700	FA23700	FA23700	FA23700
Chemical Name	CAS	Units	EPA Health Advisory Level						
Perfluorobutanesulfonic Acid (PFBS)	375-73-5	µg/L	NA	0.0413	0.0414	0.0448	< 0.016 U	< 0.015 U	
Perfluoroheptanoic Acid (PFHpA)	375-85-9	µg/L	NA	< 0.017 U	< 0.016 U	< 0.017 U	< 0.016 U	< 0.015 U	
Perfluorohexanesulfonic Acid (PFHxS)	355-46-4	µg/L	NA	0.0275	0.0262	0.0494	< 0.016 U	< 0.015 U	
Perfluorononanoic Acid (PFNA)	375-95-1	µg/L	NA	< 0.017 U	< 0.016 U	< 0.017 U	< 0.016 U	< 0.015 U	
Perfluorooctanesulfonic Acid (PFOS)	1763-23-1	µg/L	0.2	0.0145 J	0.0134 J	0.0277	< 0.016 U	< 0.015 U	
Perfluorooctanoic Acid (PFOA)	335-67-1	µg/L	0.4	0.0432	0.0412	0.0718	< 0.032 U	< 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

Attachments

ATTACHMENT 1

Location Sketch		Client: Department of the Navy				Boring: HN-107S/I					
North		Project Number: 60276503				Sheet: 1 of 5					
Duplexes		Site Location: NAWC Warminster, PA				Well Installed: Dual nested					
HN-107S/I		Coordinates: 2751877.177 326037.182 TOC Elevation: 346.42/346.43				Screen: 45-65/90-100					
		Drilling Method: Air Rotary/Percussion				Depth of Boring: 100					
		Sample Type(s): Split Spoon				Boring Diameter: 10 in./8.25 in.					
		Weather: Clear 30-40's °F				Logged By: G. Richards					
		Drilling Contractor: RAAB (Rick Raab)				Date Complete: 3/27/2015					
		GS Elevation: 346.7				Water level: 1 ft./56 ft./76 ft.					
Depth (ft)	Sample Depth	Blow Count	% Recovery	PID (ppm)	Graphic Log	USCS/Lithology	Description	Saturation/ Well Construction	Well Completion Details		
1	S1	Not Applicable	Not Applicable	0.0		CL	Cleared to 5 ft. bgs. via vacuum truck and hand auger.	Concrete			
2	0 to 4.5 ft. bgs.: SILTY CLAY with GRAVEL (CL); brown and dark brown; clay (85%); sand and gravel (5-10%); angular; trace silt; high plasticity; soft; septic odor; debris (plastic and cement); wet to saturated at 1.2 ft.										
3	S1-0.8 collected 1143										
4											
5											
6		6	10%	0.0		Silt-stone	5 to 7 ft. bgs.: SILTSTONE (Stockton Fm.); dark reddish-brown; decomposed/intensely weathered; soft; saturated.	2 in. PVC riser			
7		12									
8		14									
9	S4	15	80%	0.0		Silt-stone	7 to 9 ft. bgs.: SILTSTONE (Stockton Fm.); reddish-brown; intensely weathered; soft; iron oxide banding and lamination; micaceous; bottom 4 in. competent sandstone; saturated to 8 ft. grading to dry.	Hydrated bentonite grout			
10		17									
11		22									
12		24		NR		Silt-stone	S4-8.5 collected 1340	10 in. Steel casing and			
13											
14											
15		Not Applicable				Silt-stone	15 ft. bgs.: SILTSTONE (Stockton Fm.); dull reddish-brown; moderately to slightly weathered; dry.				
16											
17											
18											
19											
20											
20							20 ft. bgs.: Same as above; dry.				

		Client: Department of the Navy		Boring: HN-107S/I	
		Project Number: 60276503			
		Site Location: NAWC Warminster, PA		Sheet: 2 of 5	
		Coordinates: 2751877.177 326037.182 TOC Elevation: 346.42/346.43		Well Installed: Dual nested	
		Drilling Method: Air Rotary/Percussion		Screen: 45-65/90-100	
		Sample Type(s): Split Spoon		Boring Diameter: 10 in./8.25 in.	
Weather: Clear 30-40's °F		Logged By: G. Richards		Start Date: 3/23/2015	
Drilling Contractor: RAAB (Rick Raab)		GS Elevation: 346.7		Date Complete: 3/27/2015	
				Depth of Boring: 100	
				Water level: 1 ft./56 ft./76 ft.	

Depth (ft)	Sample Depth	Blow Count	% Recovery	PID (ppm)	Graphic Log	USCS/Lithology	Description	Saturation/Well Construction	Well Completion Details
21							10 in. steel casing set at 20 ft. bgs. Boring diameter reduced to 8.25 in.		
22						Silt-stone			
23							23 ft. bgs.: Same as above; dry.		
24									
25						SS	25 ft. bgs.: SANDSTONE (Stockton Fm.); gray; fine-grained; moderately weathered to fresh; hard; micaceous; dry.		
26									
27							27 ft. bgs.: Same as above, argillaceous SILTSTONE (Stockton Fm.); moderately weathered; dry.		
28						SS/ Silt-stone			
29									
30									
31									
32									
33									
34						SS			
35							35 ft. bgs.: SANDSTONE (Stockton Fm.); buff/tan; fine-grained; moderately hard; fresh to moderately weathered; dry.		
36									
37									
38									
39									
40						SS	40 ft. bgs.: Same as above; dry.		

		Client: Department of the Navy				Boring: HN-107S/I			
		Project Number: 60276503							
		Site Location: NAWC Warminster, PA							
		Coordinates: 2751877.177 326037.182 TOC Elevation: 346.42/346.43				Sheet: 3 of 5			
Weather: Clear 30-40's °F		Drilling Method: Air Rotary/Percussion		Well Installed: Dual nested					
Drilling Contractor: RAAB (Rick Raab)		Sample Type(s): Split Spoon		Boring Diameter: 10 in./8.25 in.		Screen: 45-65/90-100			
		Logged By: G. Richards		Start Date: 3/23/2015		Depth of Boring: 100			
		GS Elevation: 346.7		Date Complete: 3/27/2015		Water level: 1 ft./56 ft./76 ft.			
Depth (ft)	Sample Depth	Blow Count	% Recovery	PID (ppm)	Graphic Log	USCS/Lithology	Description	Saturation/ Well Construction	Well Completion Details
41									
42									
43									
44									
45						SS	45 ft. bgs.: SILTY SANDSTONE (Stockton Fm.); tan; fine-grained; moderately hard; moderately weathered; dry to slightly wet.	Hydrated bentonite 1/2 in. TR30	
46									
47									
48									
49									
50									
51						SS	51 ft. bgs.: Same as above; wet.	#1 Silica sand	
52									
53									
54							54 ft. bgs.: Same as above; dry to slightly wet.	0.01 in. slotted screen	
55							Use air from drill rig to blow out boring. Very little water.		
56						Silt-stone	54 to 56 ft. bgs.: SILTSTONE (Stockton Fm.); dry, becoming saturated at 56 ft.		
57									
58									
59									
60									2 in. PVC riser

		Client: Department of the Navy			Boring: HN-107S/I	
		Project Number: 60276503			Sheet: 4 of 5	
Site Location: NAWC Warminster, PA			Coordinates: 2751877.177 326037.182 TOC Elevation: 346.42/346.43			
Drilling Method: Air Rotary/Percussion			Well Installed: Dual nested			
Sample Type(s): Split Spoon			Boring Diameter: 10 in./8.25 in. Screen: 45-65/90-100			
Weather: Clear 30-40's °F			Logged By: G. Richards Start Date: 3/23/2015			
Drilling Contractor: RAAB (Rick Raab)			GS Elevation: 346.7 Date Complete: 3/27/2015			
			Depth of Boring: 100			
			Water level: 1 ft./56 ft./76 ft.			

Depth (ft)	Sample Depth	Blow Count	% Recovery	PID (ppm)	Graphic Log	USCS/Lithology	Description	Saturation/Well Construction	Well Completion Details
61						SS	62 ft. bgs.: Arkosic SANDSTONE (Stockton Fm.); light gray to white; medium to coarse-grained; fractured; hard; weathered, cuttings have oxidized surfaces; saturated.	#1 Silica sand	
62								0.01 in. Slotted screen	
63									
64									
65						Mud-stone	67 ft. bgs.: MUDSTONE/SILTSTONE (Stockton Fm.); brown; cuttings return as clay; moist.	65 ft.	
66									
67									
68									
69						Silt-stone	70 ft. bgs.: MUDSTONE/SILTSTONE (Stockton Fm.); reddish-brown; cuttings return as clay; moist.	67 ft.	
70									
71									
72									
73							72 ft. bgs.: SILTSTONE (Stockton Fm.); moist.	Hydrated bentonite 1/2 in. TR30	
74									
75							75 ft. bgs.: Same as above; reddish-brown; cuttings return as clay; wet.		
76							76 ft. bgs.: High yield fracture.		
77									
78									
79									
80								2 in. PVC riser	

		Client: Department of the Navy			Boring: HN-107S/I	
		Project Number: 60276503				
		Site Location: NAWC Warminster, PA			Sheet: 5 of 5	
		Coordinates: 2751877.177 326037.182 TOC Elevation: 346.42/346.43			Drilling Method: Air Rotary/Percussion	
Weather: Clear 30-40's °F			Logged By: G. Richards		Well Installed: Dual nested	
Drilling Contractor: RAAB (Rick Raab)			GS Elevation: 346.7		Date Complete: 3/27/2015	
Sample Type(s): Split Spoon			Boring Diameter: 10 in./8.25 in.		Screen: 45-65/90-100	
Depth (ft)			Sample Depth		Blow Count	
% Recovery			PID (ppm)		Graphic Log	
USCS/Lithology			Description		Saturation/Well Construction	
Well Completion Details						
81						
82						
83						
84						
85						
86						
87						
88						
89						
90						
91						
92						
93						
94						
95						
96						
97						
98						
99						
100						
80 ft. bgs.: SILTSTONE/MUDSTONE (Stockton Fm.); hard; cuttings return as clay. 85 ft. bgs.: Same as above. 90 ft. bgs.: SILTSTONE/SHALE (Stockton Fm.); dark gray; hard. 95 ft. bgs.: Same as above; fracture; 6 in. drop of hammer; saturated; high yield. 76 to 100 ft. bgs.: high yield. TD=100 ft. bgs. Approximately 1000 gallons of water contained.			Hydrated bentonite 1/2 in. TR30 88 ft. #1 Silica sand 90 ft. 0.01 in. Slotted screen 100 ft.			

Legend:

- Split spoon sample
- 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

TR30 Time release 30 minutes

NR No recovery

in. Inches

TD Total depth

Fm. Formation

SS Sandstone

SH Shale

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

Location Sketch		Client: Department of the Navy				Boring: HN-108S/I			
Bristol Rd.		Project Number: 60276503				Sheet: 1 of 5			
gate		Site Location: NAWC Warminster, PA				Well Installed: Dual nested			
Orion Rd.		Coordinates: 2754686.937 327115.265 TOC Elevation: 380.08/379.98				Screen: 45-65/90-100			
HN-108S/I		Drilling Method: Air Rotary				Depth of Boring: 100			
		Sample Type(s): NA				Water level: 55			
Weather: Clear 30-40's °F		Logged By: G. Richards		Start Date: 3/23/2015		GS Elevation: 380.25			
Drilling Contractor: RAAB (Rick Raab)		Date Complete: 3/27/2015							
Depth (ft)	Sample Depth	Blow Count	% Recovery	PID (ppm)	Graphic Log	USCS/Lithology	Description	Saturation/ Well Construction	Well Completion Details
1							Cleared to 5 ft. bgs. via vacuum truck and hand auger.	Concrete	
2							Not logged or sampled.	1 ft.	
3									
4									
5									
6									
7						ML	7 ft. bgs.: SILT (ML); overburden; reddish-brown; nonplastic; dense; fragments of siltstone; soft drilling; dry.	2 in. PVC riser	
8									
9							Soil-rock contact. No transition zone of decomposed rock.		
10						SS	10 ft. bgs.: Argillaceous SANDSTONE (Stockton Fm.); reddish-brown; fine-grained; hard; weathered, heavily oxidized; dry.		
11									
12									
13						Silt-stone	13 ft. bgs.: SANDY SILTSTONE (Stockton Fm.); dull red; soft; dry.		
14									
15									
16									
17						SS	17 ft. bgs.: Arkosic SANDSTONE (Stockton Fm.); reddish-brown, fresh surface is blue-gray; medium-grained; hard; weathered, oxidized; micaceous; dry.	Hydrated bentonite grout	
18									
19									
20							20 ft. bgs.: Same as above.	10 in. Steel casing-end	

Location Sketch 			Client: Department of the Navy Project Number: 60276503 Site Location: NAWC Warminster, PA Coordinates: 2754686.937 327115.265 TOC Elevation: 380.08/379.98 Drilling Method: Air Rotary Sample Type(s): NA			Boring: HN-108S/I Sheet: 2 of 5 Well Installed: Dual nested Screen: 45-65/90-100		
Weather: Clear 30-40's °F Drilling Contractor: RAAB (Rick Raab)			Logged By: G. Richards GS Elevation: 380.25			Start Date: 3/23/2015 Date Complete: 3/27/2015		
Depth (ft) 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40			Sample Depth Not Applicable			Blow Count Not Applicable		
% Recovery 			PID (ppm) Not Applicable			Graphic Log 		
USCS/Lithology SS SS Silt-stone SS/ Silt-stone			Description 10 in. Steel casing set at 20 ft. bgs. Boring diameter reduced to 8.25 in. 23 ft. bgs.: SANDSTONE (Stockton Fm.); tan to light brown; very fine-grained; medium hard; cuttings return as fine dust; dry. 28 ft. bgs.: Arkosic SANDSTONE (Stockton Fm.); orange tan and light brown; medium to fine-grained; hard; moderately weathered; trace micas; slightly moist to dry. 30 ft. bgs.: SILTSTONE (Stockton Fm.); dull red; soft; dry. 30 to 40 ft. bgs.: Interbedded SANDSTONE and SILTSTONE (Stockton Fm.); dull red; weathered; hard; dry.			Saturation/ Well Construction Hydrated bentonite grout 2 in. PVC riser		
Well Completion Details (Empty columns for completion details)								

Location Sketch			Client: Department of the Navy			Boring: HN-108S/I			
Bristol Rd.			Project Number: 60276503			Sheet: 3 of 5			
gate			Site Location: NAWC Warminster, PA			Well Installed: Dual nested			
Orion Rd.			Coordinates: 2754686.937 327115.265 TOC Elevation: 380.08/379.98			Screen: 45-65/90-100			
HN-108S/I			Drilling Method: Air Rotary			Depth of Boring: 100			
			Sample Type(s): NA			Water Level: 55			
Weather: Clear 30-40's °F			Logged By: G. Richards			Start Date: 3/23/2015			
Drilling Contractor: RAAB (Rick Raab)			GS Elevation: 380.25			Date Complete: 3/27/2015			
Depth (ft)	Sample Depth	Blow Count	% Recovery	PID (ppm)	Graphic Log	USCS/Lithology	Description	Saturation/ Well Construction	Well Completion Details
41						SS	40 ft. bgs.: SANDSTONE (Stockton Fm.); dark red; fine grained; moderate to heavily weathered; micaceous; dry.		
42						SS			
43									
44									
45						SS	45 ft. bgs.: SANDSTONE (Stockton Fm.); strong brown; fine grained; hard; micaceous; fractured; slightly wet.		
46									
47							47 ft. bgs.: Same as above; wet.	2 in. PVC riser	
48						Silt-stone	48 ft. bgs.: SILTSTONE (Stockton Fm.); wet.		
49								48 ft.	
50								Hydrated bentonite 1/2 in. TR30	
51						Clay-stone	50 ft. bgs.: CLAYSTONE (Stockton Fm.); strong brown; wet.		
52									
53						SS	Slightly fractured SANDSTONE above 55 ft. cuttings wet with silt/mud.		
54									
55							55 ft. bgs: Arkosic SANDSTONE (Stockton Fm); orangish brown; medium grained; medium hard; saturated.	55 ft.	
56									
57						SS/ Silt-stone	Interbedded SANDSTONE and SILTSTONE (Stockton Fm.); hard; cuttings return as brown sandy silt; hard drilling, slow; fractured with high yield.	0.01 in. Slotted screen	
58									
59									
60								#1 Silica Sand	

Location Sketch						Client: Department of the Navy		Boring: HN-108S/I	
Bristol Rd.						Project Number: 60276503			
						Site Location: NAWC Warminster, PA		Sheet: 4 of 5	
Coordinates: 2754686.937 327115.265 TOC Elevation: 380.08/379.98						Drilling Method: Air Rotary		Well Installed: Dual nested	
Sample Type(s): NA						Boring Diameter: 10 in./8.25 in.		Screen: 45-65/90-100	
Weather: Clear 30-40's °F						Logged By: G. Richards		Start Date: 3/23/2015	
Drilling Contractor: RAAB (Rick Raab)						GS Elevation: 380.25		Date Complete: 3/27/2015	
						Depth of Boring: 100		Water Level: 55	
Depth (ft)	Sample Depth	Blow Count	% Recovery	PID (ppm)	Graphic Log	USCS/Lithology	Description	Saturation/Well Construction	Well Completion Details
61						SS	60 ft. bgs.: SANDSTONE (Stockton Fm.); brown; arkosic; medium-grained; saturated; water less turbid/clear.		
62									
63							63 ft. bgs.: Fracture; hammer drop.	0.01 in. Slotted screen	
64									
65						SS	65 ft. bgs.: SANDSTONE (Stockton Fm.); orangish brown; lost water; fracture.	65 ft.	
66								#1 Sand	
67						SS	68 ft. bgs.: Same as above; hard.	66 ft.	
68									
69									
70							No return cuttings/contained; very soft; advance 12 ft. in 1 minute.		
71									
72							72 ft. bgs.: No cuttings; very soft.	Hydrated bentonite 1/2 in. TR30	
73									
74									
75						Mud-Stone	75 to 80 ft. bgs.: Interbedded MUDSTONE and SANDSTONE (Stockton Fm.); hard; saturated, high yield.		
76									
77						SS	77 ft. bgs.: SANDSTONE (Stockton Fm.); maroon-red; very fine-grained; heavily weathered; micaceous.		
78									
79						Mud-Stone	79 ft. bgs.: MUDSTONE (Stockton Fm.); soft; cuttings return as mud; saturated with high yield.	2 in. PVC riser	
80									

Location Sketch 			Client: Department of the Navy			Boring: HN-108S/I		
			Project Number: 60276503					
Site Location: NAWC Warminster, PA			Coordinates: 2754686.937 327115.265 TOC Elevation: 380.08/379.98			Sheet: 5 of 5		
Drilling Method: Air Rotary			Sample Type(s): NA			Boring Diameter: 10 in./8.25 in.		
Weather: Clear 30-40's °F			Logged By: G. Richards			Start Date: 3/23/2015		
Drilling Contractor: RAAB (Rick Raab)			GS Elevation: 380.25			Date Complete: 3/27/2015		
						Depth of Boring: 100		
						Water Level: 55		

Depth (ft)	Sample Depth	Blow Count	% Recovery	PID (ppm)	Graphic Log	USCS/Lithology	Description	Saturation/ Well Construction	Well Completion Details
81						SH	81 ft. bgs.: SHALE (Stockton Fm.); dark grayish-brown; hard.	2 in. PVC riser	
82									
83								Hydrated bentonite 1/2 in. TR30	
84									
85						SS	85 ft. bgs.: SANDSTONE (Stockton Fm.); dark blue-gray; very fine-grained; hard; micaceous; saturated.		
86						Clay-stone	86 ft. bgs.: CLAYSTONE (Stockton Fm.); reddish-brown; thinly bedded.		
87						SS	87 ft. bgs.: SANDSTONE (Stockton Fm.); light-gray; fine and medium-grained; appears to be alternating thinly bedded; red SILTSTONE with blue-gray SANDSTONE; saturated.		
88									
89								#1 Silica Sand	
90							90 ft. bgs.: SANDSTONE (Stockton Fm.); blue-gray; fine and medium-grained; hard; saturated.		
91									
92							Hammer bouncing; competent; hard; advancing ~1ft./minute.		
93									
94									
95							95 ft. bgs.: Same as above; competent SANDSTONE (Stockton Fm.); micaceous; saturated.		
96								0.01 in. Slotted screen	
97						SS/ Silt-stone	97 ft. bgs.: Interbedded SANDSTONE and thin bedded SILTSTONE (Stockton Fm.).		
98									
99									
100							TD = 100 ft. bgs.		

Legend: ☒ Split spoon sample ☒ 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 TR30 Time release 30 minutes NR No recovery	in. Inches TD Total depth Fm. Formation SS Sandstone SH Shale TOC Top of casing GS Ground surface	Prepared in accordance with: Engineering Geology Field Manual, 2 nd 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
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		Client: Department of the Navy				Boring: HN-109S/I			
		Project Number: 60276503							
		Site Location: NAWC Warminster, PA							
		Coordinates: 2751688.399 325998.153 TOC Elevation: 347.35/347.37				Sheet: 3 of 5			
Drilling Method: Air Rotary/Percussion		Well Installed: Dual nested							
Sample Type(s): Split Spoon		Boring Diameter: 10 in./8.25 in.		Screen: 22-32/75-85					
Weather: Clear 30-40's °F		Logged By: G. Richards		Start Date: 3/23/2015		Depth of Boring: 100			
Drilling Contractor: RAAB (Rick Raab)		GS Elevation: 347.63		Date Complete: 3/27/2015		Water Level: 2ft./18 ft./50 ft.			
Depth (ft)	Sample Depth	Blow Count	% Recovery	PID (ppm)	Graphic Log	USCS/Lithology	Description	Saturation/ Well Construction	Well Completion Details
41						SS/SH	40 ft. bgs.: Interbedded SANDSTONE and CLAYSTONE (Stockton Fm.); dark blue grey; hard; contains quartzite; cuttings also return as mud, nonplastic fines; little water, drying.	Hydrated bentonite 1/2 in. TR30	
42									
43							No cuttings from 42 to 49 to 35 ft. bgs.		
44									
45									
46									
47									
48									
49									
50						SS	50 ft. bgs.: SANDSTONE (Stockton Fm.); fine to medium grained; quartz rich; medium hard; saturated.		
51									
52									
53									
54									
55						SS	55 ft. bgs.: Same as above; water bearing fracture; oxidation on surfaces.		
56									
57						Clay-stone	57 ft. bgs.: CLAYSTONE (Stockton Fm.); strong brown; cuttings return as mud. Saturated.		
58							58 ft. bgs.: Fracture, small drop in hammer.		
59								2 in. PVC riser	
60									

ATTACHMENT 2

GROUNDWATER LOW-STRESS PURGE AND SAMPLING DATA

Project Name: NAWC WarminsterProject No.: 60276503Date: 9/16/13Project Location: Warminster, PAWeather: 50-70°FWell Number: HN-107 ShallowSampler: BK/60R

PURGING AND SAMPLING DEVICE

Pump Type and Model: 55 Monsoon 15098Decontamination Procedure: dist. rinse / purgeTubing Diameter and Material: 1/2" x 3/4" HDPEWell Previously Sampled: 1st sampling event

WELL INFORMATION

Well Diameter (in.): 2"Depth to Bottom (ft., TOC): 65.36Initial Depth to Water (ft., TOC): 3.69Screened Interval (ft., bgs): 6.5-11.5

INDICATOR PARAMETER MONITORING

Pump Set at Depth (ft., TOC): 55 ft

Time:		0853	0905	0915	0921	0930	0935	0940	0945	0950	0955	1000	
Purge Rate (mL/min):		—	2450	2460	300	300-450	460	250-460	350-400	420	400-450	350	
Depth to Water (ft.):		3.50	5.31	6.16	6.11	6.74	7.30	7.01	7.24	7.32	7.32	7.35	
Volume Purged (liters)		0	15.1	3.25	5	7.2	9.5	11	12.5	14	15.75	16.5	
Parameter and Stabilization Range*		pushing flushing											
Temp. (°C)	± 3%	—	12.50	12.82	12.62	12.96	13.05	12.99	13.01	13.07	13.11	13.17	
pH	± 0.1	—	7.14	7.04	7.06	7.05	7.05	7.08	7.10	7.10	7.10	7.10	
SC (m mhos)	± 3%	—	0.767	0.767	0.768	0.768	0.768	0.768	0.768	0.767	0.767	0.769	
DO* (mg/L)	± 10 % if >1	—	16.39	14.28	13.94	13.63	12.63	12.13	11.62	11.11	10.74	10.42	
ORP (mv)	± 10 mv	—	32	-3	-8	-15	-18	-22	-25	-27	-28	-30	
Turbidity (NTU)	± 10%	—	92.3	21.7	3.8	2.5	2.4	0.8	0.4	0.4	0.4	0.4	
TDS g/L	none	—	0.491	0.491	0.492	0.491	0.491	0.492	0.491	0.491	0.491	0.492	
Color/odor	none	—	clear cloudy	clear	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-107S Sample time: 7:1005Comments/Analytes: HN-107S low flow/stress purging

GROUNDWATER LOW-STRESS PURGE AND SAMPLING DATA

Project Name: NAWC Warminster Project No.: 60276503 Date: 4/16/15
 Project Location: Warminster, PA Weather: clear 65°F
 Well Number: HN-107 Intermediate Sampler: BK/LR

PURGING AND SAMPLING DEVICE

Pump Type and Model: 55 Manson 15098 Decontamination Procedure: deal rinse/lignin
 Tubing Diameter and Material: 2" x 3/8" HDPE Well Previously Sampled: NA - 1st sample from well 4

WELL INFORMATION

Well Diameter (in.): 2" Depth to Bottom (ft., TOC): 99.10
 Initial Depth to Water (ft., TOC): 15.89 Screened Interval (ft., bgs): 90-100 (89-99)

INDICATOR PARAMETER MONITORING

Pump Set at Depth (ft., TOC): 95.84

Time:		1017	1022	1030	1035	1040	1045	1050	1055	1100			
Purge Rate (mL/min):		✓	±250	±250	±250	±250	±250	±200	±200	±200			
Depth to Water (ft.):		15.97	16.02	16.10	16.09	16.10	16.06	16.07	16.06	16.04			
Volume Purged (liters)		✓	0.75	3.5	4	5	7.5	8	9.25	10.0			
Parameter and Stabilization Range*													
Temp. (°C)	± 3%	✓	13.06	13.11	13.11	13.11	13.27	13.22	13.24	13.31			
pH	± 0.1	✓	7.11	7.15	7.16	7.16	7.17	7.18	7.18	7.18			
SC (m mhos)	± 3%	✓	0.720	0.717	0.700	0.613	0.697	0.694	0.685	0.684			
DO* (mg/L)	± 10 % if > 1	✓	3.03	2.35	2.18	1.99	1.85	1.84	1.77	1.77			
ORP (mv)	± 10 mv	✓	-31	-43	-46	-48	-51	-51	-51	-52			
Turbidity (NTU)	± 10%	✓	404	18.0	7.7	4.1	2.0	2.0	2.1	2.1			
TDS	none	✓	0.502	0.457	0.448	0.443	0.440	0.438	0.438	0.438			
Color/odor	none	✓	light brown	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-107J Sample time: τ = 1105
 Comments/Analytes: slight color a turbidity initially clearing rapidly a Q4 DTM
equilibrated rapidly to low discharge volume.

GROUNDWATER LOW-STRESS PURGE AND SAMPLING DATA

Project Name: NAWC Warminster Project No.: 60276503 Date: 4-17-2015
 Project Location: Warminster, PA Weather: LT. RAIN
 Well Number: HN-108 Shallow Sampler: BK-PL

PURGING AND SAMPLING DEVICE

Pump Type and Model: SS MONSOON Decontamination Procedure: LIQUINOR + H₂O
 Tubing Diameter and Material: 1/2" x 3/8" Well Previously Sampled: HN-108F on 4-16-15

WELL INFORMATION

Well Diameter (in.): 2" Depth to Bottom (ft., TOC): 65.04
 Initial Depth to Water (ft., TOC): 28.13 Screened Interval (ft., bgs): 55-65

INDICATOR PARAMETER MONITORING

Pump Set at Depth (ft., TOC): 60'

Time:	908	913	918	923	928	933	938	943	948	953	958	
Purge Rate (mL/min):	4.250	4.250	4.250	4.250	4.250	4.250	4.250	4.250	4.250	4.250	4.250	
Depth to Water (ft.):	29.95	30.01	30.56	31.01	31.76	31.95	31.97	31.99	32.00	32.01	32.02	
Volume Purged (liters)	0	1.4	2.8	4.2	5.6	7	8.4	10.1	13.2	14.7	16.2	
Parameter and Stabilization Range*												
Temp. (°C)	± 3%	12.86	12.04	12.05	12.21	11.80	11.87	12.53	12.50	12.41	12.40	12.37
pH	± 0.1	7.83	7.12	6.81	6.74	6.71	6.74	6.73	6.70	6.57	6.55	6.56
SC (m mhos)	± 3%	0.197	0.226	0.227	0.231	0.244	0.263	0.277	0.274	0.240	0.240	0.238
DO* (mg/L)	± 10 % if > 1	16.12	12.86	10.23	9.44	9.77	9.54	9.58	9.56	9.54	9.54	9.54
ORP (mv)	± 10 mv	121	156	132	179	181	180	181	189	191	190	191
Turbidity (NTU)	± 10%	91.7	128	132	137	163	164	162	101	80.7	80.1	79.7
TDS	none	0.128	0.147	0.148	0.150	0.159	0.180	0.181	0.176	0.157	0.154	0.155
Color/odor	none	5 TAN	clear	clear	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-108S Sample time: 1000

Comments/Analytes: _____

GROUNDWATER LOW-STRESS PURGE AND SAMPLING DATA

Project Name: NAWC Warminster Project No.: 60276503 Date: 4-17-2015
 Project Location: Warminster, PA Weather: LT. RAIN
 Well Number: HN-108 Intermediate Sampler: BE-DC

PURGING AND SAMPLING DEVICE

Pump Type and Model: SS. Monsoon Decontamination Procedure: 1 gallon H₂O
 Tubing Diameter and Material: 1/2" x 3/8" Well Previously Sampled: HN-108 SHALLOW

WELL INFORMATION

Well Diameter (in.): 2" Depth to Bottom (ft., TOC): 100.07
 Initial Depth to Water (ft., TOC): 37.75 Screened Interval (ft., bgs):

INDICATOR PARAMETER MONITORING

Pump Set at Depth (ft., TOC):

Time:		1015	1020	1025	1030	1035	1040	1045	1050	1055	1100	1105	1110
Purge Rate (mL/min):		1.250	1.250	1.250	1.250	1.250	1.250	1.250	1.250	1.250	1.250	1.250	1.250
Depth to Water (ft.):		39.76	39.75	39.75	39.78	39.76	39.75	39.74	39.76	39.69	39.61	39.69	39.68
Volume Purged (liters)		1.25	clear	clear	clear	clear	clear	clear	clear	clear	clear	clear	clear
Parameter and Stabilization Range*													
Temp. (°C)	± 3%	12.09	11.92	11.95	12.01	12.05	12.07	12.11	12.21	12.16	12.25	12.29	12.31
pH	± 0.1	6.64	6.64	6.67	6.79	6.86	6.94	6.98	7.02	7.10	7.13	7.14	7.15
SC (m mhos)	± 3%	0.176	0.501	0.501	0.477	0.450	0.430	0.419	0.409	0.403	0.355	0.392	0.369
DO* (mg/L)	± 10 % if > 1	13.49	4.68	5.67	4.35	5.26	4.84	5.32	5.32	5.40	5.33	5.32	5.38
ORP (mv)	± 10 mv	187	85	76	74	72	68	65	63	60	59	58	86
Turbidity (NTU)	± 10%	41.4	123	72.1	25.6	19.3	13.3	6.3	4.1	3.8	0.0	0.0	0.0
TDS	none	0.176	0.720	0.321	0.310	0.293	0.280	0.273	0.266	0.262	0.255	0.294	0.153
Color/odor	none	0	1.5	3.0	4.5	6.0	7.5	9.0	10.5	12.0	13.5	15.0	17.5
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.													

* 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-108 I Sample time: 1115
 Comments/Analytes:

GROUNDWATER LOW-STRESS PURGE AND SAMPLING DATA

Project Name: NAWC Warminster Project No.: 60276503 Date: 4/16/15
 Project Location: Warminster, PA Weather: clear 60°F
 Well Number: HN-109 Shallow Sampler: 612/BK

PURGING AND SAMPLING DEVICE

Pump Type and Model: SS Miniserv Decontamination Procedure: And rinse
 Tubing Diameter and Material: 1/2" x 1/4" Well Previously Sampled: 1st sample

WELL INFORMATION

Well Diameter (in.): 2" Depth to Bottom (ft., TOC): 31.9
 Initial Depth to Water (ft., TOC): 3.96 Screened Interval (ft., bgs): 22 - 32

INDICATOR PARAMETER MONITORING

Pump Set at Depth (ft., TOC): 34.84

Time:		130	140	150	160	170	185	190	200	210	220	230						
Purge Rate (mL/min):		✓	200	2250	2250	2200	200	200	200	200	200	200						
Depth to Water (ft.):		3.68	3.75	4.13	4.11	3.99	3.96	3.95	3.91									
Volume Purged (liters)		✓	1.25	3.0	5.0	8.5	8.5	9.25	10									
Parameter and Stabilization Range*						6.75												
Temp. (°C)	± 3%	✓	11.33	10.27	10.25	10.50	10.67	10.69	10.75									
pH	± 0.1	✓	6.56	6.30	6.16	6.12	6.14	6.16	6.19									
SC (m mhos)	± 3%	✓	0.584	0.569	0.571	0.572	0.572	0.570	0.570									
DO* (mg/L)	± 10 % if >1	✓	17.50	16.07	15.52	14.84	14.58	14.46	14.38									
ORP (mv)	± 10 mv	✓	171	159	166	167	165	164	163									
Turbidity (NTU)	± 10%	✓	46.5	15.0	4.9	1.2	0.5	0.1	0.1									
TDS	none	✓	0.372	0.365	0.365	0.366	0.366	0.365	0.365									
Color/odor	none	✓	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-109.5 Sample time: 7:13:27
 Comments/Analytes: _____

GROUNDWATER LOW-STRESS PURGE AND SAMPLING DATA

Project Name: NAWC Warminster Project No.: 60276503 Date: 4/16/15
 Project Location: Warminster, PA Weather: clear 70°F
 Well Number: HN-109 Intermediate Sampler: 62/BK

PURGING AND SAMPLING DEVICE

Pump Type and Model: SS Miniserv Decontamination Procedure: deal rinse & alcohol
 Tubing Diameter and Material: 1/2" x 3/8" HDPE Well Previously Sampled: NA

WELL INFORMATION

Well Diameter (in.): 2" Depth to Bottom (ft., TOC): 84.44
 Initial Depth to Water (ft., TOC): 17.20 Screened Interval (ft., bgs): 75 to 85 (74.5 to 81.5)

INDICATOR PARAMETER MONITORING

Pump Set at Depth (ft., TOC): 80 ft

Time:	1345	1355	1405	1410	1420	1425	1430	1435				
Purge Rate (mL/min):	<u>4</u>	<u>400</u>	<u>400</u>	<u>400</u>	<u>400</u>	<u>400</u>	<u>400</u>	<u>400</u>				
Depth to Water (ft.):	<u>17.21</u>	<u>17.64</u>	<u>17.66</u>	<u>17.68</u>	<u>17.68</u>	<u>17.69</u>	<u>17.69</u>	<u>17.68</u>				
Volume Purged (liters)	<u>✓</u>	<u>3.25</u>	<u>6.5</u>	<u>7.5</u>	<u>9.5</u>	<u>12</u>	<u>14.5</u>					
Parameter and Stabilization Range*												
Temp. (°C)	± 3%	<u>✓</u>	<u>12.65</u>	<u>12.66</u>	<u>12.71</u>	<u>12.70</u>	<u>12.62</u>	<u>12.60</u>	<u>12.67</u>			
pH	± 0.1	<u>✓</u>	<u>7.07</u>	<u>7.12</u>	<u>7.13</u>	<u>7.15</u>	<u>7.16</u>	<u>7.18</u>	<u>7.18</u>			
SC (m mhos)	± 3%	<u>✓</u>	<u>0.723</u>	<u>0.716</u>	<u>0.713</u>	<u>0.712</u>	<u>0.712</u>	<u>0.711</u>	<u>0.718</u>			
DO* (mg/L)	± 10 % if > 1	<u>✓</u>	<u>2.74</u>	<u>2.06</u>	<u>1.87</u>	<u>1.74</u>	<u>1.66</u>	<u>1.54</u>	<u>1.50</u>			
ORP (mv)	± 10 mv	<u>✓</u>	<u>-10</u>	<u>-17</u>	<u>-19</u>	<u>-20</u>	<u>-22</u>	<u>-23</u>	<u>-24</u>			
Turbidity (NTU)	± 10%	<u>✓</u>	<u>48.0</u>	<u>6.0</u>	<u>2.2</u>	<u>1.0</u>	<u>0.4</u>	<u>0.2</u>	<u>0.4</u>			
TDS <u>1/1</u>	none	<u>✓</u>	<u>0.462</u>	<u>0.458</u>	<u>0.457</u>	<u>0.456</u>	<u>0.456</u>	<u>0.455</u>	<u>0.455</u>			
Color/odor	none	<u>✓</u>	<u>clear</u>	<u>clear</u>	<u>clear</u>	<u>clear</u>	<u>clear</u>	<u>clear</u>	<u>clear</u>			
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-109I Sample time: 1440

Comments/Analytes: _____



Accutest Laboratories Southeast

Chain of Custody

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

ACCUTEST JOB #:

PAGE 1 OF 1

Client / Reporting Information		Project Information		Analytical Information												Matrix Codes
AECOM		Project Name: NAWC Warminster <i>Area B</i>		<i>LC53700AR</i>												DW - Drinking Water
125 Rock Road		Street														GW - Ground Water
Horsham, PA 19044		City Warminster State PA														WW - Water
Send results to: Patti Jannett <i>patti.jannett@aecom.com</i>		Project # 60276503														SW - Surface Water
215-315-4325		Fax # 215-315-4151														SO - Soil
Sampler(s) Name(s) (Printed):		Client Purchase Order #														SL - Sludge
Sampler 1: <i>BILL KENNEDY</i> Sampler 2: <i>04/16/15</i>																OI - Oil
Accutest Sample #	Field ID / Point of Collection	COLLECTION		CONTAINER INFORMATION												LAB USE ONLY
		DATE	TIME	SAMPLED BY:	MATRIX	TOTAL # OF BOTTLES	OTHER	NONE	HCl	NaOH	HNO3	H2SO4	NaOH+Zn	DI WATER	MEOH	
	HN-1075	4/14/15	1005	24/GR	GW	2		X								X
	HN-107I	4/14/15	1105	84/GR	GW	2		X								X
	HN-1095	4/14/15	1323	84/GR	GW	2		X								X
	HN-109E	4/16/15	1440	24/GR	GW	2		X								X
	DUP-041615	4/16/15	1200	24/GR	GW	2		X								X
	FB-041615	4/16/15	1600	84/GR	GW	2		X								X
	HN-1085	4/17/15	1000	84/GR	GW	2		X								X
	HN-108I	4/17/15	1115	84/GR	GW	2		X								X
	FB-041715	4/17/15	1130	84/GR	GW	2		X								X
Turnaround Time (Business days)		Data Deliverable Information		Comments / Remarks												
☒ Std. 10 Business Days		Approved By: / Date/Rush Code:		☐ COMMERCIAL "A" (RESULTS ONLY)												
7 Day RUSH				☐ COMMERCIAL "B" (RESULTS PLUS QC)												
5 Day RUSH				☐ REDT1 (EPA LEVEL 3)												
3 Day EMERGENCY				☐ FULLT1 (EPA LEVEL 4)												
2 Day EMERGENCY				☒ EDD'S												
1 Day EMERGENCY																
Other																
Emergency or Rush T/A Data Available VIA Email or Lablink																
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 <i>[Signature]</i>		4/17/15 1400		2 AECOM LOCKED OFFICE		3 <i>[Signature]</i>		4/17/15 1440		4 <i>[Signature]</i>						
Relinquished by/Affiliation:		Date Time:		Received By/Affiliation		Relinquished By/Affiliation		Date Time:		Received By/Affiliation						
5				6		7				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:

US00008258

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: FA23101
Analyses/Method: PFCs by Liquid Chromatography/Mass Spectrometry/Mass Spectrometry (LC/MS/MS)/ EPA Method 537 modified
Validation Level: Limited
Resolution Consultants 60276503.SI.MS
Project Number:
Prepared by: Paula DiMattei/Resolution Consultants Completed on: 4/27/2015
Reviewed by: Lori Herberich /Resolution Consultants
File Name: Warminster FA23101_PFCs

SUMMARY

The samples listed below were collected by Resolution Consultants from the NAWC Warminster, PA site on March 23-24, 2015.

SDG	Sample ID	Matrix/Sample Type
FA23101	S1-0.8_03232015	Soil
	S2-0.8_03232015	Soil
	S3-1.5_03232015	Soil
	S4-8.5_03232015	Soil
	S5-1.0_03232015	Soil
	S6-7_03242015	Soil
	S7-0.5_03242015	Soil
	S8-3_03242015	Soil
	S-DUP_03242015	Field duplicate of S7-0.5_03242015
	EB-032315	Equipment blank
	FB-032315	Field blank
	FB-032415	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);
- Quality Systems Manual (QSM) for Environmental Laboratories, Version 4.2 (DoD, October 2010); and
- the project-specific Sampling and Analysis Plan.

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. 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 (X) 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.

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, field blanks and equipment rinsate blanks were evaluated as to whether there are contaminants detected above the detection limit (DL). Target compounds were not detected in the laboratory method blank, field blanks or equipment blanks 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 with the QC acceptance criteria. All QC acceptance criteria were met.

Field Duplicate Results

Field duplicate RPDs were reviewed for conformance with the Resolution Consultants QC criteria of $\leq 50\%$ for solid 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.



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: FA23700
Analyses/Method: PFCs by Liquid Chromatography/Mass Spectrometry/Mass Spectrometry (LC/MS/MS)/ EPA Method 537 modified
Validation Level: Limited
Resolution Consultants 60276503.SI.MS
Project Number:
Prepared by: Paula DiMattei/Resolution Consultants Completed on: 5/8/2015
Reviewed by: Lori Herberich /Resolution Consultants
File Name: Warminster FA23700_PFCs

SUMMARY

The samples listed below were collected by Resolution Consultants from the NAWC Warminster, PA site on April 16-17, 2015.

SDG	Sample ID	Matrix/Sample Type
FA23700	DUP-041615	Field duplicate of HN-109S_04162015
	FB-041615	Field blank
	FB-041715	Field blank
	HN-107I_04162015	Groundwater
	HN-107S_04162015	Groundwater
	HN-108I_04172015	Groundwater
	HN-108S_04172015	Groundwater
	HN-109I_04162015	Groundwater
	HN-109S_04162015	Groundwater

*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); and

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. 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 (X) 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 field blanks associated with the samples in this data set.

The method blank associated with samples HN-107S, HN-107I, HN-109S, HN-109I, DUP-041615 and FB-041615 contained Perfluorohexanesulfonic Acid (PFHxS) [0.00863 $\mu\text{g/L}$] and Perfluorooctanesulfonic Acid (PFOS) [0.102 $\mu\text{g/L}$]. Since the PFOS amount in the method blank exceeded the reporting limit (RL), re-extraction of all associated samples was performed with two exceptions: 1) Sample HN-107S was not re-extracted because there was insufficient sample volume available for re-extraction and 2) The field blank FB-041615 was not re-extracted since no target compounds were detected in this blank. However, it should be noted that the re-extraction was performed outside of the 14-day extraction holding time criterion.

Although the method blank associated with the re-extraction batch was free from contamination, professional judgement was used to report the original analyses which were performed within holding time and without qualification since the method blank contamination in the original batch appears to be an anomaly. The sample results in the re-extraction/reanalysis were similar to the original analyses of these samples and the field blank (FB-041615) prepared in the original batch was free from contamination.

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 criterion of $\leq 30\%$ for aqueous matrices. This criterion applies 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.