

TECHNICAL MEMORANDUM

CH2MHILL

Investigation of Groundwater Flow and Perchlorate at Site 21, Indian Head Division-NSWC

Indian Head, Maryland

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Introduction

This technical memorandum presents a summary of the investigation activities and analytical results at Site 21, Indian Head Division—Naval Surface Warfare Center (IHDIV-NSWC). The Draft Final Remedial Investigation Report for Sites 11, 13, 17, 21 and 25 (CH2M HILL, August 2002) identified perchlorate in the groundwater sample collected from the upgradient monitoring well (IS21MW04) for Site 21. Pre-feasibility study (pre-FS) sampling performed after the draft final report was submitted confirmed the presence of perchlorate at Site 21. Because the perchlorate was identified in the upgradient monitoring well, the source was not readily identifiable. The report also noted that the groundwater flow regime at Site 21 was not well defined.

A draft work plan for additional investigation of perchlorate in the vicinity of IS21MW04 was submitted to the IHIRT on October 24, 2002 followed by further clarification of the scope during the October 2002 IHIRT meeting. During a November 7, 2002 conference call it was agreed that the objective of the field effort would be to determine if perchlorate in groundwater is associated with the landfill (Site 21). On November 13, 2002, a draft final work plan memorandum was submitted to the IHIRT. On November 21, 2002, a final work plan was submitted to the IHIRT (CH2M HILL, November 2002).

Background

Site 21, the Bronson Road Landfill, is located between Building 602 and Bronson Road. In August of 2000, four groundwater samples were collected from monitoring wells installed earlier in the month as part of the remedial investigation conducted at the site. The samples

were analyzed for perchlorate as well as for other parameters. Perchlorate was detected in the sample collected from IS21MW01 at an estimated (i.e., J qualified) concentration of 2 micrograms per liter ($\mu\text{g}/\text{L}$) and the sample collected from IS21MW04 at a concentration of 2,000 $\mu\text{g}/\text{L}$ (Figure 1). Monitoring well IS21MW04 is located upgradient of the landfill, which suggests that material disposed of at the landfill is not the source of the perchlorate. Additionally, a literature search conducted at IHDIV-NSWC did not identify a potential source of perchlorate at Site 21. Pre-FS sampling conducted in July 2002 (CH2M HILL, October 2002) confirmed the presence of perchlorate in groundwater. It should be noted that for the July 2002 sampling event perchlorate was not detected in the sample collected from IS21MW01 and the concentration observed in the sample collected from IS21MW04 was 2,900 $\mu\text{g}/\text{L}$.

The draft final remedial investigation report also concluded that the groundwater flow regime was not well defined at Site 21. One monitoring well, IS21MW04, was installed upgradient of the landfill and three monitoring wells (IS21MW01, IS21MW02, and IS21MW03) were installed downgradient of the landfill. Water levels measured in the four wells during the initial (August 2000) and follow-up (July 2002) sampling events indicate that groundwater generally flows from the northeast to the southwest. However, at times, flow to the west and northwest is expected, most notably in the northern portion of the site. Additionally, there is some uncertainty whether groundwater encountered at IS21MW04 flows toward the landfill or flows more toward the east because well IS21MW04 is near the top of a topographic rise that may represent a groundwater divide.

Field Activities

CH2M HILL collected soil and groundwater samples at Site 21 in December 2002. Seven soil boring locations (IS2101 through IS2107) were proposed in the final work plan. During the field effort, however, it was determined that one proposed location (IS2106) could not be accessed due to snow creating hazardous slippery conditions. Soil borings were advanced using a hollow-stem auger (HSA) rig at the six locations shown on Figure 1. The borings were placed at distances ranging from approximately 50 feet to approximately 100 feet from monitoring well IS21MW04 (Figure 1). The north and south locations provided analytical results in these geographic directions from IS21MW04. The borings located in an arc from northwest to southwest provided spatial data between monitoring wells IS21MW04 and IS21MW01 (to the west) and between IS21MW04 and the landfill (Site 21). By this approach, the direction the perchlorate is migrating could be determined.

During advancement of each boring, split-spoon samples were collected every 5 feet from ground surface to the top of the water table for lithology. Split-spoon samples were not collected below the water table. Soil boring logs are provided in Appendix A.

Geoprobe groundwater samples were collected at two depths: the shallower sample was collected at a depth representative of the IS21MW04 well screen, relative to the water table at the time of sampling; the deeper sample was collected at a depth representative of the IS21MW04 well screen, relative to the water table in August 2000. All samples were submitted to an off site laboratory for perchlorate analysis using United States Environmental Protection Agency (USEPA) Method 314.

Soil samples were collected at the surface and at the interval identified as having the highest silt and clay content, the most likely interval in which to find residual perchlorate. Soil samples were withheld from the analytical laboratory pending the results of groundwater sampling. The decision to analyze soil samples was made by the IHIRT during the December 13, 2002 conference call. It was determined that the data would be analyzed for future needs. One surface soil (location IS2107) and six subsurface soil (all locations) samples were submitted to an off site laboratory for perchlorate analysis using USEPA Method 314.

Results

The perchlorate analytical results for groundwater are presented in Table 1 and shown on Figure 1. On Table 1, sample depths are defined by the last four digits in the sample identification (e.g., IS2103GP4044 indicates the groundwater sample collected from a depth interval of 40 to 44 feet below ground surface). Perchlorate was detected in all six shallow groundwater samples at concentrations that ranged from 35 µg/L to 1,800 µg/L and in all six deep groundwater samples at concentrations that ranged from 29 µg/L to 1,500 µg/L (Figure 1).

The perchlorate analytical results for surface and subsurface soil are provided in Tables 2 and 3, respectively. The results are also shown on Figure 1. Except for location IS2107 with a subsurface soil perchlorate concentration of 8.6 µg/kg, all other soil (surface and subsurface) samples are non-detect for perchlorate.

Conclusion

Perchlorate concentrations at the locations sampled show very low values to the north and northwest of well IS21MW04 and a decrease in concentration from well IS21MW04 to the west and southwest of IS21MW04. This pattern implies that groundwater flow direction is to the west and southwest, which in turn suggests that the perchlorate detected at well IS21MW04 is not associated with the landfill.

As discussed during the December 13, 2002 conference call the goal of the investigation was met. During the conference call it was agreed that the perchlorate detected is not associated with the landfill and, hence, will be investigated as a future site. It was further agreed by the IHIRT, during the conference call, to proceed with the Feasibility Study for Site 21.

References

CH2M HILL. *Draft Final Remedial Investigation Report, Sites 11, 13, 17, 21, and 25, Indian Head Division-NSWC*, Indian Head, Maryland. August 2002.

CH2M HILL. *Technical Memorandum: Pre-Feasibility Study Groundwater Sampling Activities Site 21 (Bronson Road Landfill), Indian Head Division-NSWC*, Indian Head, Maryland October 2002

CH2M HILL. *Technical Memorandum: Final Work Plan Investigation of Groundwater Flow and Perchlorate at Site 21, Indian Head Division-NSWC*, Indian Head, Maryland. November 2002.

Appendix A – Boring Logs

Boring Logs

Table 1
 Perchlorate Concentration in Groundwater Samples
 Investigation of Groundwater Flow and Perchlorate at Site 21
 IHDIV-NSWC
 Indian Head, Maryland

Station ID	IS2101		IS2102			IS2103		IS2104		IS2105			IS2107	
Sample ID	IS2101GP4448	IS2101GP4953	IS2102GP4246	IS2102GP4246P	IS2102GP4852	IS2103GP4044	IS2103GP4650	IS2104GP3640	IS2104GP4650	IS2105GP4852	IS2105GP4852P	IS2105GP4044	IS2107GP4448	IS2107GP5054
Sample Date	12/05/02	12/06/02	12/05/02	12/05/02	12/06/02	12/04/02	12/04/02	12/03/02	12/03/02	12/09/02	12/09/02	12/06/02	12/10/02	12/11/02
Chemical Name														
Explosives (µg/L)														
Perchlorate	1,800	88	480	480	29	1,500	1,500	41	42	38	35	35	530	190

Notes:
 µg/L = microgram per liter
 A shaded cell indicates that perchlorate is detected.
 P = Duplicate sample

Table 2
 Perchlorate Concentration in Surface Soil Sample
 Investigation of Groundwater Flow and Perchlorate at Site 21
 IHDIV-NSWC
 Indian Head, Maryland

Station ID	IS2107
Sample ID	IS2107SS0002
Sample Date	12/09/02
Chemical Name	
Explosives (µg/kg)	
Perchlorate	9.4 U
Wet Chemistry (mg/kg)	
% Solids	85

Note:

µg/kg = micrograms per kilogram

mg/kg = milligrams per kilogram

Table 3
 Perchlorate Concentration in Subsurface Soil Samples
 Investigation of Groundwater Flow and Perchlorate at Site 21
 IHDIV-NSWC
 Indian Head, Maryland

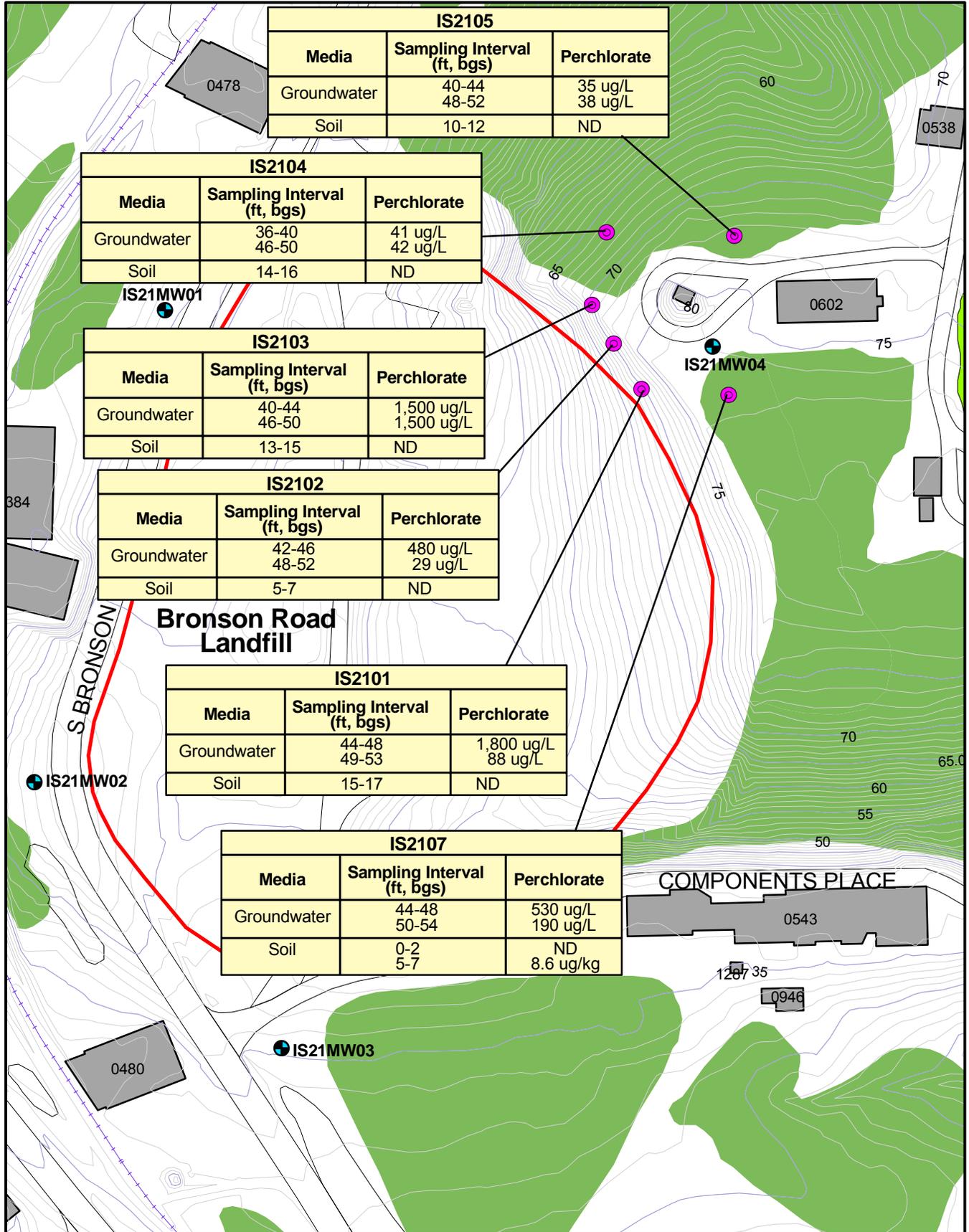
Station ID	IS2101		IS2102	IS2103	IS2104	IS2105	IS2107
	Sample ID						
Sample Date	12/05/02	12/05/02	12/04/02	12/03/02	12/03/02	12/06/02	12/09/02
Chemical Name							
Explosives ($\mu\text{g}/\text{kg}$)							
Perchlorate	9.5 U	9.2 U	9.3 U	9.5 U	9.3 U	8.9 U	8.6
Wet Chemistry (mg/kg)							
% Solids	84	87	86	85	86	90	95

Notes:

$\mu\text{g}/\text{kg}$ = micrograms per kilogram

mg/kg = milligrams per kilogram

A shaded cell indicates that perchlorate is detected.



LEGEND

- Monitoring Well Location
- Sampling Locations
- IR Site Location
- Buildings

ND = Not Detected
 ug/L = micrograms per liter



Figure 1
 Perchlorate Concentrations in Groundwater and
 Soil Samples Collected in December 2002

Site 21
 IHDIV-NSWC
 Indian Head, Maryland



Appendix A – Boring Logs

		PROJECT NUMBER 156175.FI.F1		Site 21 Perchlorate Investigation Boring Number: IS2101			
		BORING LOG					
PROJECT : Indian Head			LOCATION : Indian Head, Maryland				
ELEVATION :			DRILLING CONTRACTOR : Parrett Wolff				
DRILLING METHOD AND EQUIPMENT USED : Drill Rig 2" split spoon							
START : 12/05/2002		END : 12/05/2002		LOGGER : Ed Carpenetti			
DEPTH BELOW SURFACE (FT)		INTERVAL (FT)		Moisture Content	Munsell Code	CORE DESCRIPTION SOIL NAME, COLOR RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. PID (ppm)
	RECOVERY (FT)	USGS CODE					
0-2'	1.0'			Dry	Brown 10YR4/4	0-1' Find sand with pebbles.	
5'-7'	2.0'			Dry	Yellowish Brown 10YR5/6	Silty clay with black organic matter and rounded pebbles.	
10'-12'	2.0'			Dry	Brownish Yellow 10YR6/6 Dark Yellowish	Silty clay with some black organic material.	
15'-17'	2.0'			Dry	Brown 10YR4/4	Silty clay with some pebbles present.	Collect a soil sample.
20'-22'	2.0'			Dry	NA	Fine black silty, ashy organic material with well rounded pebbles.	
25'-27'	2.0'			Dry	Yellowish Red 10YR5/6	Dark grey clayey silt 5YR 4/1 grading to a yellowish red 10YR5/6 clayey silt.	
30'-32'	0.5'			Dry	Black	Fine silty organic material with some plastic in the spoon.	
35'-37'	2.0'			Damp	Yellowish Brown 10YR5/4	Fine to medium sand with gravel and pebbles present.	
40'-42'	1.0'			Wet	Strong Brown 7.5YR5/8	Silt.	Groundwater level @ 42' bgs.
44'-48'							Collect groundwater sample
49'-53'							Collect groundwater sample
End Boring @ 53' bgs							

		PROJECT NUMBER 156175.FI.FI		Site 21 Perchlorate Investigation Boring Number: IS2102		
		BORING LOG				
PROJECT : Indian Head			LOCATION : Indian Head, Maryland			
ELEVATION :			DRILLING CONTRACTOR : Parrett Wolff			
DRILLING METHOD AND EQUIPMENT USED : Drill Rig 2" split spoon						
START : 12/04/2002		END : 12/04/2002		LOGGER : Ed Carpenetti		
DEPTH BELOW SURFACE (FT)	INTERVAL (FT)		Moisture Content	Munsell Code	CORE DESCRIPTION SOIL NAME, COLOR RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. PID (ppm)
	RECOVERY (FT)	USGS CODE				
0-2'	1.6'		Dry	Brown 10YR4/3	0 - 6" Top Soil 6" - 2' Fine to medium sand with some gravel.	
5'-7'	2.0'		Dry	Dark Yellowish Brown 10YR3/4	Brown fine to medium sand from 5.0 to 5.5' bgs. Clay to clayey sand with black organic material.	Collected a soil sample.
10'-12'	2.0'		Dry	Brownish Yellow 10YR6/6	A brownish yellow 10YR6/6 to a dark yellowish brown 10 YR 3/4 silty clay. Some black organic matter present.	
15'-17'	0.5'		Dry	Black	Black ash and gravel.	
20-22'	0		NA	NA	No recovery.	
25'-27'	2.0'		Dry	Yellowish Brown 10YR4/4	Fine to course sand with gravel and pebbles.	
30'-32'	2.0'		Damp	Yellowish Brown 10YR4/4	Fine to course angular sand with pebbles and gravel.	
35'-37'	2.0'		Damp	Yellowish Brown 10YR5/4	Fine to medium sand with gravel present. Color ranges from dark brown 10YR3/3 (find sand) to yellowish brown 10YR5/4 course sand.	
40'-42'	1.0'		Wet	Dark Yellowish Brown 10YR4/6	41'-42' Very wet gravelly sand.	Groundwater level @ 41' bgs.
42'-46'						Collect groundwater sample
48'-52'						Collect groundwater sample
End Boring @ 52' bgs						

	PROJECT NUMBER 156175.FI.FI	Site 21 Perchlorate Investigation Boring Number: IS2103
	BORING LOG	

PROJECT : Indian Head	LOCATION : Indian Head, Maryland
ELEVATION :	DRILLING CONTRACTOR : Parrett Wolff
DRILLING METHOD AND EQUIPMENT USED : Drill Rig 2" split spoon	
START : 12/03/2002	END : 12/03/2002
LOGGER : Ed Carpenetti	

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)		Moisture Content	Munsell Code	CORE DESCRIPTION SOIL NAME, COLOR RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. PID (ppm)		
							RECOVERY (FT)	USGS CODE
0-2'	1.5'			Dry	Brown 7.5YR5/8 6" - 2' Clayey silt.			
3-5'	2.0'			Dry	Yellowish Red 5YR4/6 Silty Clay.			
8-10'	2.0'			Dry	Yellowish Brown 5YR4/6 Silty clay with some gravel present.			
13-15'	2.0'			Dry	Reddish Brown 5YR4/4 Clayey silt with some white flakes.	Collect a soil sample.		
18-20'	2.0'			Dry	Yellowish Brown 7.5YR5/8 Medium to course angular sand with gravel and pebbles.			
23-25'	2.0'			Dry	Strong Brown 7.5YR5/6 Medium to course angular sand with quartz gravel and pebbles.			
28-30'	2.0'			Dry	Yellowish Brown 10YR4/4 Fine to course sand ranging in color from yellow 10YR8/8 to dark yellowish brown 10YR4/4. Some quartz gravel is present. There is a 4" layer of ash at 29' bgs.			
33-35'	2.0'			Damp	Yellowish Brown 10YR5/8 Fine sand mixed with pebbles and gravel.			
38-40'	2.0'			Wet	Pale Brown 10YR6/3 Fine to medium sand.	Groundwater table @ 39' bgs.		
40'-44'						Collect groundwater sample		
46'-50'						Collect groundwater sample		
End Boring @ 50' bgs								

				PROJECT NUMBER		Site 21 Perchlorate Investigation	
				156175.FI.FI		Boring Number: IS2104	
BORING LOG							
PROJECT : Indian Head				LOCATION : Indian Head, Maryland			
ELEVATION :				DRILLING CONTRACTOR : Parrett Wolff			
DRILLING METHOD AND EQUIPMENT USED : Drill Rig 2" split spoon							
		START : 12/03/2002		END : 12/03/2002		LOGGER : Ed Carpenetti	
DEPTH BELOW SURFACE (FT)	INTERVAL (FT)		Moisture Content	Munsell Code	CORE DESCRIPTION SOIL NAME, COLOR RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS	
	RECOVERY (FT)	USGS CODE				DEPTH OF CASING, DRILLING RATE DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. PID (ppm)	
0-2'	1.5'		Dry	Brown 7.5YR5/8	0 - 6" Top Soil 6" - 2' Clay, clayey silt towards the bottom part of the spoon.		
4'-6'	1.0'		Dry	Red 2.5YR 4/8	Clay, strong brown in color grading to clayey silt to silty clay Some gravel is present.		
9'-11'	2.0'		Dry	Yellowish Red 5YR5/6	Silty Clay		
14'-16'	2.0'		Dry	5YR5/6	Clayey silt grading to silt.	Collect a soil sample.	
19'-21'	2.0'		Dry	Strong Brown 7.5YR5/6	Fine sand mixed with coarse sand and gravel.	No odor	
24'-26'	2.0'		Dry	Yellowish Brown 7.5YR5/8	Fine sand grading to coarse angular sand with pebbles and gravel mixed in.	No odor	
29'-31'	1.5'		Damp	Yellowish Brown 7.5YR5/8	Fine to coarse angular sand with pebbles and gravel present.		
34'-36'	2.0'		Wet	reddish yellow 7.5YR7/6	Silty clay with gravel from 34'-34.5', strong brown 7.5YR5/6. Grading to clay to silty clay from 34.5'-35', grading to medium to fine sand with pebbles.	Groundwater table at 36' bgs.	
36'-40'				reddish yellow 7.5YR7/6	Fine to medium angular sand.	Collect groundwater sample	
39'-41'	2.0'		Wet	7.5YR7/6			
46'-50'						Collect groundwater sample	
End Boring @ 50' bgs							

		PROJECT NUMBER 156175.FI.FI		Site 21 Perchlorate Investigation Boring Number: IS2105		
		BORING LOG				
PROJECT : Indian Head			LOCATION : Indian Head, Maryland			
ELEVATION :			DRILLING CONTRACTOR : Parrett Wolff			
DRILLING METHOD AND EQUIPMENT USED : Drill Rig 2" split spoon						
START : 12/05/2002		END : 12/05/2002		LOGGER : Ed Carpenetti		
DEPTH BELOW SURFACE (FT)					CORE DESCRIPTION	COMMENTS
INTERVAL (FT)	RECOVERY (FT)	USGS CODE	Moisture Content	Munsell Code	SOIL NAME, COLOR RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. PID (ppm)
0'-2'	1.0'		Dry	Brown 7.5YR4/4	0-0.5' Top Soil 0.5'-2.0' Clayey silt grading to clay mixed with gravel.	Soil sample was collected.
5'-7'	2.0'		Dry	Yellowish Red 5YR5/6	Clayey silt.	
10'-12'	2.0'		Dry	Yellowish Red 5YR5/6	Clayey silt.	Soil sample was collected.
15'-17'	2.0'		Dry	Strong Brown 7.5YR5/8	Silt.	
20'-22'	2.0'		Dry	Yellowish Brown 10YR4/4	Fine silty sand strong brown in color 7.5YR5/8 grading to fine to coarse sand with angular gravel. Yellowish Brown	
25'-27'	0.5'		Dry	Yellowish Brown 10YR4/4	Fine to coarse sand with angular gravel.	
30'-32'	2.0'		Dry	Yellowish Brown 10YR4/4	Fine to coarse sand with pebbles and gravel.	
35'-37'	2.0'		Damp	Yellowish Brown 10YR4/4	35'-36.5' Same as above. 36.5'-37' Medium to fine sand strong brown 10YR5/8.	
40'-42' 40'-44'	2.0'		Wet	Strong Brown 10YR5/8	40'-41' Clay. 41'-42' Medium sand.	Groundwater level @ 42' bgs. Collect groundwater sample
48'-52'						Collect groundwater sample
End Boring @ 52' bgs						

