APPENDIX M

TDCS PROBE HOLE INSTALLATION DATA

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SUMMARY OF PROBE HOLE DRILLING AND SAMPLING

This summary reflects conditions as of December 2010 regarding Probe Holes PH-1 and PH-2 drilled from Work room 2-1 in TDCS Tunnel 2. Tables P-1 and P-2 summarize the drilling data and PCB sampling and testing results respectively.

Summary of Probe Hole PH-1

Between December 10 and 15, 2008, probe hole PH-1 (formerly known as P-1) was drilled from Workroom 2-1. The purpose of drilling the probe hole was to evaluate the extent of DNAPL beyond the end of Tunnel 2. The hole was drilled 300 feet in a southerly direction with an upward slope of approximately 2 degrees (refer to Figure PH-1). The probe hole was drilled by the diamond core method using HQ-size coring equipment. Continuous rock core was collected during the drilling of PH-1. Groundwater and crushed rock core samples were collected and tested for PCB. The PH-1 boring log is attached.

The work performed for the installation of probe hole PH-1 included:

- Core drilling a nominal 4-inch diameter hole,
- Observation of drilling for changes in conditions (water, DNAPL etc.)
- Core logging and evaluation of joints and fracture
- Preparation and storage in wooden core boxes
- Installing borehole packer and stem pipe with valve at the end of each day
- Sampling of accumulated groundwater from borehole packer valve at beginning of each day
- Testing of groundwater sample for PCB
- Decontamination and rinse blank PCB testing of borehole packer, stem piping and valve prior to each day of use
- Selection, sampling, preparation and testing of rock core samples for PCB
- Final fit-out of the probe hole well head with a PVC pipe, 3 inch diameter, DNAPL collection and sampling reservoir and tubing drain to tunnel gutter

In the effort to collect daily water samples from PH-1, during the drilling, a packer and pipe fitted with a valve were installed to isolate the interval of the borehole drilled that day. The

following morning the valve was opened to collect groundwater that had accumulated in the packed-off interval of the borehole. Only one section of the borehole (250 to 300 feet) yielded a water sample. Because no water samples could be collected from the first 250 feet of the borehole, rock core samples were collected for PCB analyses. These rock core samples were collected from depths where, based on examination of the core, there appeared to be open fractures. Table P-2 summarizes the results of the PCB analyses of water and rock core samples. During the drilling of PH-1 there were no observations, visual or olfactory, that indicated PCB was present on the rock core or in the drill return water. However, on December 16, one day after the completion of probe hole drilling, DNAPL was observed flowing from the borehole into Workroom 2-1.

On December 30, 2008, a reservoir was installed at the collar of PH-1 to collect the DNAPL flowing from the hole. At the time of the DNAPL reservoir installation, approximately 500 ml of DNAPL that had accumulated in a low spot in the cross drain in Workroom 2-1 was collected. Between December 30 and January 30, 2008, DNAPL recovery from PH-1 has been at a rate of approximately 0.8 L per week.

DNAPL was collected from PH-1 during Phase Three construction when access was readily available. During that time DNAPL collection from PH-1 ranged from 0.25 to 0.95 liters per week, and the rate of inflow of groundwater and DNAPL was declining by the end of Phase Three construction. On May 14, 2009, the groundwater flow from PH-1 was measured, to be one drop per minute. The DNAPL collection reservoir was left connected at the collar of the hole and re-fitted with a plastic tube draining all flow directly to the Tunnel 2 gutter.

On September 16, 2010 700 ml of DNAPL was collected and the valve closed to allow DNAPL to continue to separate from groundwater and accumulate in the reservoir.

Summary of Probe Hole PH-2

Probe hole PH-2 was drilled from workroom 2-1 between May 6 and 11, 2009, to the full length of 300 feet and left with a continuous open interval in rock from the end of the stainless steel casing (at 2.5 ft depth) to the end of the hole. Probe hole PH-2 was drilled to evaluate the extent of DNAPL beyond the end of Tunnel 2, similar to probe hole PH-1. PH-2 was drilled 300 feet in a southerly direction (approximately 30° southwest of PH-1) with an upward slope of

approximately 5 degrees from horizontal (refer to Figure PH-2). The probe hole was drilled by the diamond core method using HQ-size coring equipment. Continuous rock core was collected during the drilling of PH-2. Groundwater and crushed rock core samples were collected and tested for PCB. The PH-2 boring log is attached.

The work performed during installation of probe hole PH-2 included:

- Installation of a 6-inch diameter stainless steel collar casing grouted in an 8-inch diameter core hole;
- Core drilling a nominal 4-inch diameter hole;
- Observation of drilling for changes in conditions (water, DNAPL etc.);
- Core logging and evaluation of joints and fracture;
- Preparation and storage in wooden core boxes;
- Installing borehole packer and stem pipe with valve at the end of each day;
- Sampling of accumulated groundwater from borehole packer valve at beginning of each day;
- Testing of groundwater sample for PCB;
- Decontamination of borehole packer, stem piping and valve prior to each day of; use including rinse blank PCB testing
- Selection, sampling, preparation and testing of rock core samples for PCB;
- Performing borehole alignment survey after every 50 feet of drilling;
- Verification of final borehole depth based on evaluation of borehole survey results; and
- Final fit-out of the probe hole well head with the stainless steel flange and 2 inch diameter ball valve and piping to tunnel gutter.

Observations for the presence of DNAPL made during the drilling of PH-2 indicated that a chemical odor was noticed when the hole was at a length of 190 feet. The driller noted possible water inflow at a depth of 189.5 feet. Sampling of the groundwater entering the borehole and the rock core for PCB analysis was conducted during the drilling of PH-2. In an effort to collect daily water samples from PH-2, during the drilling, a packer and pipe fitted with a valve were installed in the borehole to isolate the portion of the borehole drilled each day. The following morning the valve was opened to collect water that had accumulated in the packed-off portion of the borehole. Only one section of the borehole (170 to 225 feet) yielded a water sample. Because no water samples could be collected from the first 170 feet and the last 75 feet of the borehole, rock core samples were collected for PCB analyses. These rock core samples were collected from locations where, based on examination of the core, there appeared to be open fractures. Table P-2 summarizes the results of the PCB analyses of water and rock core samples. One day after the completion of probe hole drilling, DNAPL was observed dripping from the borehole into Workroom 2-1.

The groundwater flow from PH-2 was measured on May 14, 2009, to be 5 milliliters per minute. The well head valve was left open and the flow allowed to drain through a plastic tube to the Tunnel 2 gutter drain.

PH-2 was converted to multi level vibrating wire piezometer, PZ-202, on March 3, 2010. Prior to installing the piezometer string, a small quantity of PCB oil had accumulated in the well head casing and was removed using absorbant pads. Data from PZ-202 is saved hourly via a newly installed multiplexer in workroom 1-1 and MUX cable from the multiplexer to the data logger at the top of the shaft. Tetra Tech GEO collects, saves to network, transfers to database, prepares plots and reports to NYSDEC weekly.

Borehole ID	Location Tunnel: Station	Azimuth (Grid)	Inclination Up From Horizontal	Drilled Length (ft)	Depth (ft)	Elevation (ft. NGVD)	Rock Unit	Initial Flow (gpm) 5/14/2009	Remarks
TUNNEL 2	2								
PH-1	2:2+87	220°	2°	300	0	43.25	LSHS	*	HQ Core, * water flow = $1 \text{ drop}/1 \text{ minute}$
					300	53.72	LSHS		
PH-2	2:2+92	187.5°	5°	300	0	44.12	LSHS	*	HQ Core, * water flow = 5 milliliters/1 minute
					300	66.36	LSHS		

Table P-1 TDCS Probe Hole Summary Drilling Data

Probe Hole ID	Date Drilled	Drilled Interval (ft to ft)	Water Sample	Rock Sample Interval (ft to ft)	PCB Test Results (µg/L) Water	PCB Test Results (µg/g) Rock	Remarks
PH-1	12/10/2008	0 to 49.7	No	8.2	No Test	0.0678	
	12/11/2008	49.7 to 156?	No	99	No Test	0.135	
	12/12/2008	156? to 221.6	No	Not Taken	No Test	No Test	
	12/13/2008	221.6 to 255.6	No	274	No Test	3.42	
	12/15/2008	255.6 to 300	2 Liter	Not Taken	1,700,000.00	No Test	
PH-2	5/6/2009	0 to 5.5	No	Not Taken	No Test	No Test	
	5/7/2009	5.5 to 95	No	10.2 to 10.7	No Test	0.548	
	5/8/2009	95 to 170	No	147.4 to 150	No Test	0.708	
	5/9/2009	170 to 225	2 Liter	Not Taken	21,200.00	No Test	
	5/10/2009	225 to 300	No	235 to 239.4	No Test	5.03	

TABLE P-2 TDCS Probe Hole Drilling - PCB Testing Results

Notes:

1. Two one liter groundwater samples were taken and analyzed for PCBs for each sampling event.

2. "No" indicates that no groundwater had accumulated.

3. PH-2 was converted to a fully grouted multi level vibrating wire piezometer, PZ-202, on March 3, 2010. The fully grouted installation seals the hole from fluid flow, and, therefore, no DNAPL or groundwater can be collected.



BORING START R00M 2-1 ğ 250 20 150 8 20 APPROX. 700' TO RIVER BANK HUDSON RIVER RIVER ELEV. 140.23 MEASURED AT R-4 FEB. 2009 ROOM 2-1 OUTLINE © STA 2+80 RIVER BOTTOM ELEV. 137± 299.17 – PH–2 – HORIZONTAL ROCK CORING PROBE HOLE, 4 INCH. COLLAR -N 1201312.06 E 697001.56 EL. 44.12 DIAMETER (HQ SIZE) 300 FT. DNAPL AT 190 FT. - BEDDING FEATURE BOH EL. 66.36' PROJECTED INCLINATION/5" APPROX. 22.24' — LPCB IN GROUNDWATER (SEE NOTE 4)

300.00'

SECTION AT PH-2

Scale in feet

0

240

220

200

180

160

140

120 ELEVATION

100

80

60

20

0

(NGVD)

FET

z

HUDSON RIVER

PLAN VIEW

240

220

200

180

160 (NCVD)

100

80

20

0

FET 140

z

N 120

ELEVATI

NOTE:

- 1. PROBE HOLE COLLAR LOCATION FROM SURVEY SUBMITTED MAY 2009 BY MERCO/OBAYASH
- 2. PROBE HOLE ALIGNMENT AND INCLINATION BASED ON FIELD MEASUREMENTS OF DRILL RODS AT INITIAL SET UP AND BOREHOLE DEVIATION SURVEY SUBMITTED MAY 2009 BY MERCO/OBAYASHI
- 3. PH-2 CORED DRILLED, HQ SIZE REFER TO CORE BORING REPORT
- 4. PCB ENCOUNTERED IN GROUNDWATER SAMPLES COLLECTED FROM DEPTH 170' TO 225' ON 5/9/2009. DNAPL OBSERVED ON ROCK CORE AT DEPTH OF 190
- 5. WATER IN FLOW RATE: NIL (LESS THAN 0.01 GPM) AT END OF DRILLING 5/11/2009
- 6. BEDDING FEATURE ENCOUNTERED AT DEPTH 190'





				BORING NO.	PH-1							
PROJECT:	TDCS, Hud	IOD NO 4	2204177									
CONTRACT	General Elect OR: Merce) D								PAGE NO.:	22041/7 1 of 6	
EQUIPMENT	USED: B	eretta T-43								ELEVATION:	42	
GROUNE	WATER		DEPTH TO	: 			ORIENTATION	C	ORE BARREL	DATE START:	12/9/2008	
DATE	HRS AFT	WATER	BUT. OF CASING	BO1 BO1	L OF I F	x	VERTICAL HORIZONTAI	SIZE	T-46 Rotary Bit	DATE FINISH:	12/15/2008 Cruy	
	com		CILCLICO	110	22	28	INCLINED	Bit (ft)		PREPARED BY:	JAL	
							BEARING	Barrel (ft)		LOCATION:	PH-1, Work	
						88	ANG. FROM VERT.	Total (ft)		Room 2-1		
DEPTH	DRILL	CORE NO.	SAMPLE	RECO	VERY	POD						
IN FFFT	RATE	DEPTH	NUMBER			(%)		FIELD CI	LASSIFICATION AND REP	MARKS		
FEEI	IVILIN/F1	KANGE	0	FT	%	0	TT 1 1 11 1 1 . 4	1.0				
		0-1.1	0	0	0	0	Hand-drilled to 1.	l II his de CUIAT	Thinst.1.t.		500	
							calcite healed frac	DIACK SHAL	LE; near nonzontal to and stringers 1/16" to	1/4" thick: occa	sional	
		1.1-6.1	1	5.2	104	100	pyrite nodules (up	to $2"$); occa	asional horizontal pyr.	ite partings/lamir	nae (1/16"	
5		-					to 1/4" thick); trac	e fossils.		- D 1 Ch		
	5,33						healed near vertic	o above; exc cal (80°-90°)	ept 4.5' - 6.1' Lower J): 6 1' - 10 7' calcite h	ealed fractures ar	nd veins	
							imparting "marble	ed" appearan	ice, near vertical, (80°	°-90°)	iu (emb	
		6.1-11.1	2	4.95	99	97	SHALE, similar to	o above; exc	ept 7.5' - 9.6' near ver	rtical Lower Basa	al Shear	
10		-					Fracture, calcite h	ealed, smoo	th slickensides, at 80° ar vertical (80° - 90°)	-90°; 6.1'-10.7'	calcite	
	3.42						nealed fluctures a	na venib, ne				
		11 1-14 7	3	38	106	100						
	0.00		-		100	100						
15	2.29	-										
		-										
		14.7-19.7	4	5.1	102	100						
	0.52	_										
20	2,55	-										
			_									
		19.7-24.7	5	4.95	99	99						
	2.05	_										
25	3.23											
		24 7 20 7	r	47	04	04						
		24.7-29.7	6	4.7	94	94						
	2.68	-										
30	2.00	_										
		207247	7	51	100	100						
		29.7-34.7	1	5.1	102	100						
	126	-										
35	1.2.5	-										
		347307	Q	52	104	100						
		J 4 .7-39.7	0	5.4	104	100						
	1.35											
40												
		30 7 44 7	Q	5	100	100						
		59.1-44.1	,	5	100	100						
15	1.12											
45												
		44 7-49 7	10	5	100	100						
		11.7-49.7	10		100	100						
	1.36	<u> </u>										
	(Continued)											
		200	ייים			A 'T'		IOD/TO (33.777 A 177 FT		
FIELD HARDNESS BEDDING V. HARD - KNIFE CAN'T SCRATCH V. THIN 2"					2"	AI	HORIZONTAL (0-5°)	V. CLOSE	Z"	FRES	H UND	
V. HARD - NNIFE CAN'I SURAI CH HARD - SCRATCHES DIFFICULT MOD. HARD - SCRATCHES EASILY SOFT - GROVES V. SOFT - CARVES		THIN MEDIUM THICK V. THICK	2"- 12"- 36"- >12	12" -36" 120" 20"	SHALL MODI STEE	OW OR LOW ANGLÉ (5-35°) BRATELY DIPPING (35-55°) POR HIGH ANGLE (55-85°) VERTICAL (85-90°)	CLOSE MOD. CLOSE WIDE V. WIDE	2"-12" 12"-36" 36"-120" >120"	V. SLIC SLIGH MODER MOD. SE V. SEVI	HT HT VERE ERE ETE		



			(ORE	BOF	RING	REPORT		BORING NO. PH-1		
DEPTH IN FFFT	DRILL RATE MIN/ET	CORE NO. DEPTH	SAMPLE NUMBER	RECO	VERY	RQD (%)		FIELD CLASSIFICATION AND REM	MARKS		
		49.7-54.7	11	5	% 100	100	Mod. Hard, fresh t calcite healed frac pyrite nodules (up to 1/4" thick); trac	Aod. Hard, fresh black SHALE; near horizontal to midangular(0° to 50°) alcite healed fractures/veins and stringers, 1/16" to 1/4" thick; occasional yrite nodules (up to 2"); occasional horizontal pyrite partings/laminae (1/16" to 1/4" thick); trace fossils. <i>(continued)</i>			
55	1.20	54.7-59.7	12	5.15	103	100					
60	1.35	-									
65	1.29	59.7-64.7	13	5	100	100					
		64.7-69.7	14	5.1	102	100					
70	1.13	69.7-74.7	15	5	100	100					
75	1.04	-									
80	1.10	74.7-79.7	16	5.1	102	100					
	0.07	79.7-84.7	17	5	100	100					
85		84.7-89.7	18	5.1	102	100					
90	1.03	80 7 04 7	10	4.8	06	96					
95	1.13		15	- .0							
100	1.11	94.7-99.7	20	4.1	82	100	SHALE, similar to	o above; 98.7' - 99.3' Joint at 35°,	polished to smooth.		
100	2.04	99.7- 102.2	21	3.4	136	100					
105	1.46	- 102.2- - 104.7	22	2.5	100	100	SHALE, similar to	o above; except 103.9' - 104.7' Lo	w angle fracture		
110	1.17	104.7- 109.7	23	5	100	100	Mod. Hard to Hard; fresh black SHALE, occasional calcite healed fractures and veins, stringers occasionally imparting a marbelized appearance, moderate to wide spacing, near horizontal to subvertical (0° - 85°), 1/16" to 1/4" thick; occasional pyrite nodules (up to 1"); occasional pyrite stringers, tightly healed, (1/16" to 1/4" thick); occasional very thin fossil shell horizons.				
								(Continued)			
FIELD HARDNESS BEDDING V. HARD - KNIFE CAN'T SCRATCH V. THIN <2"			2"	ATTITUDE AND ANGLE JOINTS / SHEAR / FRACTURE WEATHERING HORIZONTAL (0-5°) V. CLOSE <2"			FRESH				
HARD - SCRATCHES DIFFICULT MOD. HARD - SCRATCHES EASILY SOFT - GROVES V. SOFT - CARVES			THIN MEDIUM THICK V. THICK	2"- 12"- 36"- >12	12" -36" 120" 20"	SHALD MODE STEEE	UW OR LOW ANGLE (5-35°) RATELY DIPPING (35-55°) ? OR HIGH ANGLE (55-85°) VERTICAL (85-90°)	CLOSE 2"-12" MOD.CLOSE 12"-36" WIDE 36'-120" V.WIDE >120"	V. SLIGHT SLIGHT MODERATE MOD. SEVERE V. SEVERE COMPLETE		



			C	ORE	BOF	RING	REPORT	BORING NO. PH-1		
DEPTH IN FEET	DRILL RATE MIN/FT	CORE NO. DEPTH RANGE	SAMPLE NUMBER	RECO	VERY	RQD (%)	FIELD CLASSIFICATION AND RE	PAGE 3 OF 6		
	1.38	109.7- 114.7	24	5	100	100	Mod. Hard to Hard; fresh black SHALE, occasiona and veins, stringers occasionally imparting a marb to wide spacing, near horizontal to subvertical (0° occasional pyrite nodules (up to 1"); occasional py	ard to Hard; fresh black SHALE, occasional calcite healed fractures is, stringers occasionally imparting a marbelized appearance, moderate spacing, near horizontal to subvertical (0° - 85°), 1/16" to 1/4" thick; ial pyrite nodules (up to 1"); occasional pyrite stringers, tightly healed,		
115		114.7- 119.7	25	4.9	98	98	(1/16" to 1/4" thick); occasional very thin fossil sh	ell norizons. (<i>commuea)</i>		
120	1.48	119.7- 124.7	26	5.1	102	100				
125	1.29	-								
120		124.7- 129.7	27	5.1	102	100				
130	1.54	-					SHALE, similar to above; Open fracture, smooth to	o rough face, midangular at		
		129.7- 134.7	28	4.9	98	98				
135	2.95	134.7-	29	5	100	100				
140	1.63	139.7								
	132	139.7- 144.7	30	5	100	100				
145		144.7- 149.7	31	5.25	105	100				
150	1.02	149.7- 154.7	32	5	100	100	Mod. Hard to Hard; black SHALE, occasional calc midangualr (10° -40°), 1/16" to 1/4" thick; occasio occasional pyrite stringers; occasional very thin for	ite veins, near horizontal to nal pyrite nodules (up to 1"); ssil shell horizons.		
155	1.50	154.7-	33	5.1	102	100				
160	2.08	. 139.7								
	1.75	159.7- 164.7	34	5	100	100				
165	1.75	164.7- 169.7	35	5.9	118	100				
170	1.79						10-miles - 1			
FIELD HARDNESS BEDDING				DDING		АТΊ	(Communed)	WEATHERING		
VI. HARD KNIEP CANT SCRATCH V.THIN Clipse HORIZONTAL (0.5°) V.CLOSE C2" FRESH HARD - SCRATCHES DIFFICULT THIN Clipse HORIZONTAL (0.5°) V.CLOSE Close V.SLIGHT V.SLIGHT MOD. HARD - SCRATCHES BASILY MEDIUM 12"-36" SHALLOW OR LOW ANGLE (5-35°) V.CLOSE 2"-12" V.SLIGHT SOFT - GROVES THICK 36"-120" MODERATELY DIPINO (35-58°) WIDE 36"-120" MODERAT V. SOFT - CARVES V.THICK >120" VERTICAL (85-90") V.WIDE >120" WOD.SEVER V. SOFT - CARVES V.THICK >120" VERTICAL (85-90") V.WIDE >120" WOD.SEVER					RESH V. SLIGHT SLIGHT MODERATE MOD.SEVERE V. SEVERE COMPLETE					



			C	ORE	BOI	RING	BORING NO. PH-1			
		1							PAGE 4 OF 6	
DEPTH IN FEET	DRILL RATE MIN/FT	CORE NO. DEPTH RANGE	SAMPLE NUMBER	RECO	VERY	RQD (%)		FIELD CLASSIFICATION AND REI	MARKS	
		169.7- 174.7	36	4.8	% 96	100	Mod. Hard to Hard midangualr (10° -4 occasional pyrite s	1; black SHALE, occasional calc 40°), 1/16" to 1/4" thick; occasion stringers; occasional very thin fos	ite veins, near horizontal to nal pyrite nodules (up to 1"); sil shell horizons.	
175	1.50						(continued)			
110		174.7- 179.7	37	5	100	90	SHALE, similar to	o above; except Joint at 175', smc	oth, midangular at 60°	
180	1.70	1797-				100	SHALE, similar to Mod. Hard, fresh l and stringers, near	b above; except Joint at 178.6', sn black SHALE; near horizontal to brorizontal to vertical (0° to 50°)	nooth, midangular at 60° midangular calcite veins , 1/16" to 1/4" thick;	
		184.7	38	5	100	100	occasional pyrite r	odules (up to 2"); occasional ver	y thin fossil shell horizons.	
185	1.47	1047								
100		184.7-	39	5	100	100				
190	1.75	189.7- 194.7	40	5	100	100				
	1.47	_								
195	1.47									
		194.7- 199.7	41	5	100	100				
200	1.73	-								
		199.7- 204.7	42	4.9	98	100				
205	1.83									
		204.7- 209.7	43	5	100	100				
210	1.63	-								
		209.7-	44	4.0	00	100				
		214.7		4.2	20	100				
215	2.07									
		214.7-	45	5.2	104	100				
	2.42	219.7								
220	2.45									
		219.7- 224.7	46	5	100	100				
225	1.87									
		224.7- 229.7	47	5.1	102	100				
230	1.76									
		-						200 - 1 - 1		
	HELD HARDNESS BEDDING						(Continued)			
FII V. HARD	FIELD HARDNESS V. HARD - KNIFE CAN'T SCRATCH		V. THIN		2"	AL	HTODE AND ANGLE HORIZONTAL (0-5°)	V. CLOSE Q"	FRESH	
hakd Mod. hard Soft V. Soft	- SCKATCHES - SCRATCHES - GROVES - CARVES	difficult BASILY	THIN MEDIUM THICK V. THICK	2"- 12"- 36"- >1:	12" -36" 120" 20"	SHALL MODE STEEI	UW OR LOW ANGLE (5-35°) ERATELY DIPPING (35-55°) ? OR HIGH ANGLE (55-85°) VERTICAL (85-90°)	CLOSE 2"-12" MOD. CLOSE 12"-36" WIDE 36"-120" V. WIDE >120"	V. SLIGHT SLIGHT MODERATE MOD. SEVERE V. SEVERE COMPLETE	



			(CORE	BOF	RING	REPORT		BORING NO. PH-1			
DEPTH	DRILL	CORE NO.							PAGE 5 UF 6			
IN FEET	RATE MIN/FT	DEPTH RANGE	SAMPLE NUMBER	RECO FT	VERY	RQD (%)		FIELD CLASSIFICATION AND REM	MARKS			
		229.7-	48	5	100	100	Mod. Hard, fresh l	black SHALE; near horizontal to	midangular calcite veins			
		234.7					occasional pyrite r	notizontal to vertical (0° to 50°), nodules (up to 2"); occasional ver	y thin fossil shell horizons.			
235	1.91	-					(continued)	-	-			
		234.7-	49	52	104	100						
		239.7		0.2	101	100						
240	1.80											
		239.7-	50	48	96	100						
		244.7	00		,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	100						
245	1.75											
		244.7-	51	44	88	100						
		249.7				100	SHALE, similar to to core at 60°, clea	o above; Two partings/fresh break wage spacing 0.1', trace fossils	ts at 247.2' and 248.2', angle			
250	1.56											
		249.7-	52	5.2	104	100						
		254.7				100						
255	NM	-										
		254.7-	53	5.2	104	100						
260	1.99	-										
		259.7-	54	5.25	105	100	00					
265	1.81	-										
		264.7-	55	5.3	106	100						
		209.7										
270	INIM											
		269.7-	56	4.6	92	92						
	1.67	2/4.7					SHALE, similar to	above; except 273' to 276.3', JT	Bedding plane, calcite lined			
275	1.07						278.95', horizontal	$1 (0^{\circ})$, calcite lined, smooth to rou	igh.			
		274.7- 279.7	57	4.2	84	84						
	1.91											
280		070.7										
		279.7- 284.4	58	5.35	114	100						
207	2.10											
285												
		-										
200	1.59	-										
290												
								(Continued)				
FIELD HARDNESS BEDDING A				AT	ITUDE AND ANGLE	JOINTS / SHEAR / FRACTURE	WEATHERING					
v. HARD HARD MOD. HARD	 KNIFE CAN'T SCRATCHES SCRATCHES 	SCRATCH DIFFICULT EASILY	V. THIN THIN MEDIUM	< 2"- 12"	2" 12" -36"	SHALL MODE	HORIZONTAL (0-5°) OW OR LOW ANGLE (5-35°) BRATELY DIPPING (35-55°)	V. CLOSE <2" CLOSE 2"-12" MOD. CLOSE 12"-36"	FRESH V. SLIGHT SLIGHT			
SOFF - GROVES THICK 36"-120" STEEP OR HIGH ANGLE (55-85°) WIDE 36"-120" V. SOFT - CARVES V. THICK >120" VERTICAL (85-90°) V. WIDE >120" N						MODERATE MOD. SEVERE V. SEVERE COMPLETE						



			0	CORE	BOF	RING	REPORT	BORING NO. PH-1	
DEPTH IN FEET	DRILL RATE MIN/FT	CORE NO. DEPTH RANGE	SAMPLE NUMBER	RECO	VERY	RQD (%)		FIELD CLASSIFICATION AND RE	MARKS
295	NM	284.4-300	59	15.6	100	100	SHALE, similar to along outside edge 278.95', horizonta	b above; except 273' to 276.3', JT e, smooth to rough, subvertical ($1(0^\circ)$, calcite lined, smooth to rou	Bedding plane, calcite lined 80°); Joints at 278.2' and 1gh. (<i>continued</i>)
300	NM						Bottom of boring	at 300 ft	
305		-					Note: See separate fractures observed fractures detailed induced (di) fractu	e detailed Discontinuity Log for a l in core for boring PH-1. Note th in log are considered to be Drill l ures along intact incipient feature	lescription of joints and at with few exceptions, the Breaks (DB) or drilling s.
310		-							
315		-							
320		-							
325		-							
330		-							
335		-							
340		-							
345		-							
350		-							
FI	ELD HARDN	ESS	BEI	DDING		ATT	ITUDE AND ANGLE	JOINTS / SHEAR / FRACTURE	WEATHERING
V. HARD HARD MOD. HARD SOFT V. SOFT	- KNIFE CAN'T - SCRATCHES - SCRATCHES - GROVES - CARVES	SCRATCH DIFFICULT EASILY	V. THIN THIN MEDIUM THICK V. THICK	< 2"- 12"- 36"- >1:	2" 12" -36" 120" 20"	SHALD MODE STEEP	HORIZONTAL (0-5°) DW OR LOW ANGLE (5-35°) RATELY DIPPING (35-55°) OR HIGH ANGLE (55-85°) VERTICAL (85-90°)	V. CLOSE <2" CLOSE 2"-12" MOD. CLOSE 12"-36" WIDE 36"-120" V. WIDE >120"	FRESH V.SLIGHT SLIGHT MODERATE MOD.SEVERE V.SEVERE COMPLETE



CORE BORING REPORT

										BORING NO.	PH-2	
PROJECT:	TDCS, Hud	son Falls, NY										
CLIENT:	General Elect	tric								JOB NO.:	117-2204189	
CONTRACT	OR: Merco) 								PAGE NO.:	1 of 6	
GROUNI	TUSED: BO	eretta 145	ΠΕΡΤΗ Τ Ω).			ORIENTATION		OPE BAPPEL	DATE START	5/6/2000	
GROOM	HRS AFT		BOT. OF	,. Вот	C. OF		VERTICAL	TYPE	HO	DATE FINISH	5/11/2009	
DATE	COMP	WATER	CASING	но	DLE	x	HORIZONTAL	SIZE	5.2 feet	DRILLER:	Crux	
							INCLINED	Bit (ft)		PREPARED BY:	SL & JL	
							BEARING	Barrel (ft)		LOCATION:	TDCS	
						95	ANG. FROM VERT.	Total (ft)		Workroom 2-1		
DEPTH	DRILL	CORE NO.	6 4 3 67 F									
IN	RATE	DEPTH	SAMPLE	RECC	VERY	RQD		FIELD C	LASSIFICA TION AND RI	EMARKS		
FEET	MIN/FT	RANGE	NUMBER	FT	%	(70)						
							8" Core Collar, C	Brout 2.5-2.	95'			
		0-2.5	1	n/a	0	n/a						
								011415			1 1: .:	
		2.5-5.7	2	3.5	109	100	Mod. hard, black	, SHALE; (zontal and n	$\sim ccasional calcite vei$	ns with some matrix $(1 - 1) = 1$	arbelization,	
5							angle open fractu	res. tight. s	mooth, fresh, near ve	2, <1 min to min ertical (80° - 90°)	c occasionall	
							healed fractures,	calcite fille	d, near vertical (80° -	- 90°).	,	
		5 7-10	3	4 35	101	100			•	-		
		0., 10	5		101							
10							36 1 1 1 1 1 1	CILATE		1 / '	1/1	
							Mod. hard, black	, SHALE; (ostly near h	orizontal and mid-an	ns and stringers $\alpha = (<10^\circ - 50^\circ)$	with some	
		10-15	4	5	100	100	1mm thick: occas	sional pyrite	e nodules, 1" to 2.5"	thick: high angle	e open	
				_			fractures, calcite,	slicks, stria	ations, undulating (70	0°-80°); occasion	al healed	
15							fractures, calcite	filled, near	vertical (80° - 90°).		_	
15							Mod. hard, black	, SHALE; o	occasional calcite vei	ns and stringers	with some	
		15 20	5	5 15	103	100	marbelization, m	ostly near h	orizontal (<10° - 40°) maath frozh mid an), <1 mm to 1mr	n thick; high	
		15-20	5	5.15	105		angle open fractures, ught, smooth, fresh, indeangle to hear vertical (4000°); occasional healed fractures, calcite and pyrite filled, near vertical (1000°);					
20							90°).	ilearea ilaet	ares, carerie and pyri	te mied, near ve	Taear (00	
20							· · ·					
		20-25	6	5	100	100						
25							Mod hard black	SHALE: C	occasional calcite vei	ne and stringers	mostly near	
							horizontal (<10°	- 40°). <1 m	im to 1mm thick: occ	casional healed f	ractures.	
		25-30	7	5	100	100	calcite filled, nea	r vertical (7	′0° - 90°).		,	
30												
		30-35	8	5.05	101	100						
			_									
35												
55							Mod. hard, black	, SHALE; o	occasional calcite vei	ns and stringers,	mostly near	
		35_40	٥	5 15	103	100	norizontal (<10° healed fractures	- 30°), <1 m calcite fillo	im to imm thick; trad	ce tossits, calcite - 90°)	e; occasional	
		55-40	7	5.15	105		neared fractures,	calente IIIIe	u, near vertuear (ov -	- JV J.		
10		1										
40												
		10.17	10	6.00	1.01	1.00						
		40-45	10	5.05	101	100						
		1										
45												
		45-50	11	5	100	100						
									(Continued)			
FIELD HARDNESS BEDDING						AT:	TITUDE AND ANGLE	JOINTS	/ SHEAR / FRACTURE	WEATH	ERING	
V. HARD	- KNIFE CANT	SCRATCH	V. THIN	< ?"	2"	SHALL	HORIZONTAL (0-5°)	V. CLOSE	<2"	FRES	зн знт	
MOD. HARD	- SCRATCHES	EASILY	MEDIUM	12"	-36"	MODE	CRATELY DIPPING (35-559)	MOD. CLOSE	12"-36" 26"-320"	SLIG	HT	
V. SOFT	- GROVES - CARVES		V. THICK	-"ەد 1<	20"	SILE	VERTICAL (85-90°)	V. WIDE	>120"	MODER MOD. SE	VERE	
										V. SEV COMPL	ere lete	
L										1		



								BORING NO. PH-2	
DEPTH	DRILL	CORE NO.	CAMPLE	DECO	MED X			TAGE 2 OF 0	
IN FEET	RATE MIN/FT	DEPTH RANGE	NUMBER	RECO	VEKI	RQD (%)	FIELD CLASSIFICA TION AND RE	MARKS	
		50-55	12	5.15	% 103	100	Mod. hard, black, SHALE; occasional calcite veir horizontal to mid-angle(10° - 50°), <1 mm to 1mm high angle open fractures, rough, fresh to slightly near vertical (50° - 80°); occasional healed fractur	is and stringers, near 1 thick; calcite, trace fossils; weathered, mid-angle to es, calcite and pyrite filled,	
55		55-60	13	4.95	99	100	near vertical (70° - 90°).		
60		60-65	14	5	100	100	Mod. hard, black, SHALE; occasional calcite veir horizontal (<10° - 30°), <1 mm to 1mm thick; pyr occasional healed fractures, calcite and pyrite fille	ns and stringers, mostly near ite, trace fossils, calcite; ad, near vertical (70° - 90°).	
65		65.70	15	5.05	105	100			
70		65-70	15	5.25	105	100			
75		70-75	16	5.05	101	100	SHALE, similar to above, except low angle open rough, fresh, horizontal (0°).	fracture, slightly open,	
75		75-80	17	5.1	102	100			
80		80-85	18	5.1	102	100			
85		85-90	19	5	100	100			
90		90-95	20	5	100	100	Mod. hard, black, SHALE; occasional calcite veir mid-angle (<10° - 30°), <1 mm to 1mm thick; trac and pyrite; high angle open fractures, tight, fresh, (50° - 80°); ocassional healed fractures, some calc	is, near horizontal to e fossils throughout, calcite mid-angle to near vertical ite and pyrite filled, near	
95		95-100	21	5.2	104	100	ventical (60° - 70°), pyrite hodules, 1/2 .		
100		100-105	22	5.15	103	100	Mod. hard, black, SHALE; occasional calcite veir mid-angle ($<10^{\circ}$ - 50°), <1 mm to 1mm thick; trac and pyrite; occasional healed fractures, some calc vertical (70° - 90°).	is, near horizontal to e fossils throughout, calcite ite and pyrite filled, near	
105		105-110	23	5.05	101	100			
110							(Continued)		
FI	FIELD HARDNESS BEDDING				AT	ATTITUDE AND ANGLE JOINTS / SHEAR / FRACTURE WEATHERING			
V. HARD - KNIFE CANT SCRATCH V. THIN <2" HARD - SCRATCHES DIFFICULT THIN 2".12" MOD. HARD - SCRATCHES EASILY MEDIUM 12".36" SOFT - GROVES THICK 36".120" V. SOFT - CARVES V. THICK >120"				< 2"- 12" 36"- >1	2" 12" -36" 120" 20"	SHALL MODE STEEF	HORIZONTAL (0.5%) V. CLOSE <2" FRESH LOW OR LOW ANGLE (5-35%) CLOSE 2"-12" V. SLIGHT VERATELY DIPPING (35-55%) MOD. CLOSE 12"-36" SLIGHT EP OR HIGH ANGLE (55-85%) WIDE 36"-120" MODERATE VERTICAL (85-90%) V. WIDE >120" MOD. SEVERE COMPLETE COMPLETE COMPLETE V.		

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								BORING NO. PH-2		
DEPTH	DPILI	CORENO						PAGE 3 OF 6		
IN	RATE	DEPTH	SAMPLE	RECO	VERY	RQD	FIELD CLASSIFICA TION AND F	EMARKS		
FEET	MIN/FT	RANGE	NOWIDER	FT	%	(70)				
		110-115	24	5.1	102	100	Mod. hard, black, SHALE; occasional calcite ve mid-angle (<10° - 50°), <1 mm to 1mm thick; tra	ins, near horizontal to ice fossils throughout, calcite		
		110-115	27	5.1	102		and pyrite; occasional healed fractures, some cal vertical (70° - 90°). (continued)	cite and pyrite filled, near		
115										
		115-120	25	5	100	100				
120										
		120-125	26	5.15	103	100				
1.05		-								
125										
		125-130	27	5.3	106	100				
		-								
130										
		130-135	28	5	100	100				
		150 155	20		100					
135							SHALE, similiar to above, except high angle op	en fracture, near vertical, tight		
							to signify open, nesi to signify weatherd, sinot	ui, @ 154.1-155.		
		135-140	29	5	100	100				
140							SHALE, similiar to above, except high angle (80 smooth fresh @ 138.6'	°-90°) open fracture, tight,		
1.0		-					shooti, nosi, @ 150.0.			
		140-145	30	4.9	98	100				
1.45		-								
145										
		145-150	31	5.1	102	100	SHALE similiar to above avaant high angle (0))) open fracture, tight to		
		-					slightly open, fresh to slightly weathered, smoot	h, @ 147.4-150'.		
150										
		150-155	32	51	102	100				
					102					
155							Mod hard black SHALE: occasional calcite ve	ins and stringers near		
		1.55.1.00		1.05	05	1.00	horizontal to mid-angle ($<10^{\circ} - 50^{\circ}$), $<1 \text{ mm to 2}$	mm thick; trace fossils		
		155-160	55	4.85	97		to slightly weathered, some graphite coating, cal	cite and pyrite, mid-angle to		
160							near vertical $(70^\circ - 90^\circ)$; occasional healed fract	res, some calcite and pyrite		
		-					inieu, near verticar (00 - 90).			
		160-165	34	5.25	105	100				
165										
105		-								
		165-170	35	5.1	102	100				
		-								
170										
							(Continued)			
FIELD HARDNESS BEDDING V HARD KNIFE CANT SCRATCH V THIN				DDING	211	AT	ATTITUDE AND ANGLE JOINTS / SHEAR / FRACTURE WEATHERING			
v. nakd Hard Mod. hard	- KNIFE CAN'I - SCRATCHES - SCRATCHES	DIFFICULT	V. IHIN THIN MEDIUM	< 2"- 1.2"	2" 12" -36"	SHALL MODF	HORIZONTAL (u-57) V. CLOSE <2" OW OR LOW ANGLE (5-35°) CLOSE 2"-12" RATELY DIPPING (35-55°) MOD. CLOSE 12"-36"	V. SLIGHT SLIGHT		
SOFT V. SOFT	- GROVES - CARVES		THICK V. THICK	36"- >1	120" 20"	STEEF	P OR HIGH ANGLE (55-85%) WIDE 36"-120" VERTICAL (85-90%) V. WIDE >120"	MODERATE MOD. SEVERE		
								V. SEVERE COMPLETE		

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									BORING NO. PH-2	
DEDTU		COPENO							PAGE 4 OF 6	
IN DEPTH	RATE	DEPTH	SAMPLE	RECOVERY		RQD	FIELD CLASSIFICA TION AND REMARKS			
FEET	MIN/FT	RANGE	NUMBER	FT	%	(%)				
175		170-175	36	5	100	100	Mod. hard, black, horizontal to mid- throughout, calcite to slightly weather	SHALE; occasional calcite vei angle (<10° - 50°), <1 mm to 2 e and pyrite; high angle open fi red, some graphite coating, calc	ns and stringers, near mm thick; trace fossils actures, tight to open, fresh ite and pyrite, mid-angle t	
1/5		175-180	37	4.9	98	100	near vertical (70° - filled, near vertica	- 90°); occasional healed fractu al (60° - 90°). <i>(continued)</i>	res, some calcite and pyrite	
180		180-185	38	5.25	105	100				
185										
		185-190	39	5.2	104	100				
190										
		190-195	40	5.1	102	100				
195										
		195-200	41	5	100	100				
200										
		200-205	42	5.05	101	100				
205										
		205-210	43	5	100	100				
210							Shale similar to a	hove except high angle open f	racture along bedding plan	
				_	100	100	smooth fresh, near	r vertical (70° - 90°).	acture arong beauing plan	
		210-215	44	>	100	100				
215										
		215-220	45	5	100	100				
220										
220										
		220-225	46	5.1	102	100				
225										
223							Mod. hard to hard mid-angle (<10° -	, black, SHALE; occasional ca 60°). <1 mm to 1mm thick: tra	licite veins, near horizontal ce fossils, calcite and pyrit	
		225-230	47	5.1	102	100	pyrite nodules, 1/2 near vertical (40°	2" thick; occasional healed frac - 90°).	tures, some calcite filled,	
230										
								(Continued)		
FIELD HARDNESS			BEI	DDING		ATT	TITUDE AND ANGLE	JOINTS / SHEAR / FRACTURE	WEATHERING	
V. HARD - KNIFE CAN'T SCRATCH HARD - SCRATCHES DIFICULT MOD. HARD - SCRATCHES EASILY SOFT - GROVES V. SOFT - CARVES			V. THIN THIN MEDIUM THICK V. THICK	< 2"- 12" 36"- >1	2" 12" -36" 120" 20"	SHALL MODE STEEF	HURIZONTAL (0-5°) OW OR LOW ANGLE (5-35°) RATELY DIPPING (35-55°) POR HIGH ANGLE (55-85°) VERTICAL (85-90°)	V. CLOSE <2" CLOSE 2"-12" MOD. CLOSE 12"-36" WIDE 36"-120" V. WIDE >120"	FRESH V SLIGHT SLIGHT MODERATE MOD.SEVERE V.SEVERE COMPLETE	

GeoTrans, Inc.

										BORING NO.	PH-2
DEPTH	DRILL	CORE NO.	CAMDIE	DECO	WEDX					Inde 7 of 0	
IN FEET	RATE MIN/FT	DEPTH RANGE	NUMBER	FT	WERY	RQD (%)	FIELD CLASSIFICA TION AND REMARKS				
225		230-235	48	5.1	102	100	Mod. hard to hard, 1 mid-angle (<10° - 6 pyrite nodules, 1/2" near vertical (40° - 9	black, SHALE; occas 10°), <1 mm to 1mm t 1 thick; occasional hea 90°) (continued)	sional cal hick; trac aled fract	cite veins, near e fossils, calcit ures, some calc	horizontal to e and pyrite; ite filled,
235		235-240	49	5.15	103	100		50).((<i>tonunued)</i>			
240											
		240-245	50	5.1	102	100					
245											
250		245-250	51	4.95	99	100	Shale, similar to ab pyrite, near vertical	ove, except high angl (80° - 90°).	e open fra	acture, tight, sn	100th, fresh,
200		250 255	50	1.95	07	100					
		230-233	52	4.03	97	100					
255		255-260	53	5.2	104	100					
260							Mad hand black S	IIALE: according las	laita main	a anno almator	ing and
		260-265	54	5	100	100	displacement, near trace fossils, calcite filled, near vertical	horizontal to mid-ang and pyrite; occasion: (60° - 90°).	tle (<10° - al healed	- 50°), <1 mm t fractures, some	to 1mm thick; e calcite
265		265-270	55	5	100	100					
270											
		270-274.9	56	4.9	100	100					
275											
		274.9- 280.1	57	5.2	100	100					
280							Hard, black, SHAL	E; occasional calcite	veins, sor	me clustering a -60° < 1 mm t	nd o 1mm thick:
		280.1- 285.1	58	5	100	100	occasional healed f bedding planes, spa	fractures, some calcite ced 0.4 - 0.6 feet, nea	e filled, n ar vertical	ear vertical (60 l (60° - 80°).	° - 90°);
285											
		285.1- 290.1	59	5	100	100	SHALE, similiar to slighly weathered, s	above, except high a smooth, (50°-90°), @	ngle oper 287.55-2	n fracture, tight 88.55'.	, fresh to
290											
मान	UD HARDN	ESS	BEI			Δ.T ^{*1}	TTIDE AND ANGLE	(Cor	CTURE	WF A TH	FRING
V. HARD - KNIFE CANT SCRATCH V. THIN <2" HARD - SCRATCHES DIFFICULT THIN 2"-12"				SHALL	HORIZONTAL (0-5°) OW OR LOW ANGLE (5-35°)	V. CLOSE <2" CLOSE 2"-12	2"	FRE V. SLI	SH GHT		
MOD. HARD - SCRATCHES EASILY SOFT - GROVES V. SOFT - CARVES			MEDIUM THICK V. THICK	MEDIUM 12"-36" THICK 36"-120" V. THICK >120"			MODERATELY DIPPING (35-55°) MOD. CLOSE 12*-36" SLI STEEP OR HIGH ANGLE (55-85°) WIDE 36"-120" MOD. VERTICAL (85-90°) V. WIDE >120" MOD. VERTICAL (85-90°) V. WIDE >120" MOD.			HT RATE EVERE /ERE LETE	



									BORING NO. PH-2 PAGE 6 OF 6	
DEPTH IN FEET	DRILL RATE MIN/FT	CORE NO. DEPTH RANGE	SAMPLE NUMBER	RECC)VERY	RQD (%)		FIELD CLASSIFICA TION AND REMARKS		
205		290.1- 295.1	60	5	100	100	Hard, black, SHA displacement, nea occasional healed	LE; occasional calcite veins, so ar horizontal to mid-angle ($<10^{\circ}$ d fractures, some calcite filled, r	me clustering and - 60°), <1 mm to 1mm thick; hear vertical (60° - 90°);	
273		295.1- 300.1	61	5	100	100	bedding planes, s	pacea 0.4 - 0.6 feet, near vertier	1 (60° - 80°)(communa)	
300		 					Bottom of boring PH-2 converted t	at 300.1 feet. to PZ-202 on 3/2/10-3/3/10.		
305		- - - -								
310										
315										
320										
325										
330										
335		• • •								
340										
345										
350										
	T D HARDN	Tee	BE				TTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTT	IONITE / SHEAD / EDACTINE	WF A THED ING	
V. HARD - KNIFE CANT SCRATCH HARD - SCRATCHES DIFFICULT MOD. HARD - SCRATCHES EASILY SOFT - GROVES V. SOFT - CARVES		V. THIN 2*-12* THIN 2*-12* MEDIUM 12*-36* THICK 36*-120* V. THICK >120*		HORIZONTAL (0-5°) SHALLOW OR LOW ANGLE (5-35°) MODERATELY DIPPING (35-55°) STEEP OR HIGH ANGLE (55-85°) VERTICAL (85-90°)		V. CLOSE <2" CLOSE 2"-12" MOD. CLOSE 12"-36" WIDE 36"-120" V. WIDE >120"	FRESH V. SLIGHT SLIGHT MODERATE MOD.SEVERE V. SEVERE COMPLETE			

Groundwater Sampling Procedure for TDCS Tunnels Rock Core Probe Holes

- 1 MO-JV deliver to GE Water Treatment Plant: probe hole drill string (core bits, drill steel and stabilizers); groundwater sampling equipment (borehole packer, down-hole pump and pipe) and; any other components to be used in-hole. All drill string and groundwater sampling components that will be going in-hole shall be decontaminated before use.
- 2 GEOTRANS decontaminate all probe hole drill string components using steam cleaner and take "Rinse Blank" sample for testing.
- 3 GEOTRANS wrap all probe hole drill string components in plastic for transportation to workroom 2-1 in tunnel 2.
- 4 MO-JV transport decontaminated drill string components (plastic wrapped) to Workroom 2-1 in tunnel 2.
- 5 MO-JV set-up drill string for drilling only unwrap drill string pieces immediately prior to use. MO-JV personnel to use only new and unused gloves to handle decontaminated components.
- 6 GEOTRANS decontaminate groundwater sampling equipment with steam cleaner at the decon pad on the ground surface and take "Rinse Blank" sample for testing.
- 7 GEOTRANS wrap groundwater sampling equipment in plastic for transportation to workroom 2-1 in tunnel 2. All personnel use only new unused gloves to handle decontaminated components.
- 8 MO-JV start next shift of core drilling for probe hole.
- 9 MO-JV, after drilling last core run for the shift, transport groundwater sampling equipment (plastic wrapped) to workroom 2-1.
- 10 GEOTRANS unwrap and install, with MO-JV assistance, groundwater sampling equipment in borehole. All personnel use only new unused gloves to handle decontaminated components.
- 11 MO-JV inflate packer at depth directed by the engineer.
- 12 MO-JV close water return valve to keep water flow in probe hole.
- 13 MO-JV, at the start of the next shift of drilling, open water return valve.
- 14 MO-JV, operate pump if necessary as directed by engineer
- 15 GEOTRANS collect water sample (2 liter maximum) for PCB from the interval drilled during each shift. All personnel use only new unused gloves when taking samples.
- 16 GEOTRANS measure volume of water drained from sampling interval.
- 17 MO-JV remove groundwater sampling equipment and transport to GE Water Treatment Plant for decontamination.
- 18 GEOTRANS transport groundwater sample to surface for testing.
- 19 Repeat steps 6 through 18 until probe hole is drilled to full depth.

APPENDIX D

Protocol for Collecting and Analyzing Rock Core Samples for Organic Chemical Concentrations

Prepared for General Electric, Inc. Hudson Falls, New York Facility

Prepared by Beth L. Parker, Ph.D. Department of Earth Sciences University of Waterloo Waterloo, ON N2L 3G1

February 10, 1999

The purpose of the proposed rock core analyses adjacent to fractures is to gain better insight into the number, position and characteristics of the discrete fracture pathways that control DNAPL and groundwater flow. This document presents a proposed method for measuring organic chemical concentrations in rock core subsamples collected at depth-discrete locations adjacent to hydraulically active fractures evident in continuous core. Rock samples are crushed then submerged in hexane in order to extract the hydrophobic chemicals from aqueous and sorbed phases. The hexane extract is analyzed for polychlorinated biphenyls (PCBs) and other semi-volatile organic chemicals known to be present in the DNAPL at the site (specifically, trichlorobenzene (TCB), bis-(2-ethylhexyl)phthalate (BEHP), and phenyl xylyl ethane (PXE). This method of extraction and analysis is similar to the EPA methods for analysis of sediment on soil for semi-volatile organic compounds (SVOC).

The low solubility and high affinity for sorption to the rock matrix will cause these organic contaminants to be present in a narrow zone immediately adjacent to the contaminant migration pathways in hydraulically active fractures and bedding planes. These same properties enhance the likelihood of detection in depth-discrete samples.

Methods:

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PCB and SVOC samples: The subsamples of NX or HQ rock core will be taken on both sides of a targeted fracture or bedding plane feature, see Figure D-1. A targeted feature is an open fracture or bedding plane that offers potential for being a fluid flow pathway (water or DNAPL). The first set of samples will include the fracture surface and the core up to 1 cm distance away from this surface. A second set of samples will be taken immediately adjacent to the first set extending 1 to 2 cm away from the targeted feature. Wherever the targeted fracture/bedding plane occurs at a change in lithology or mineral alterations, samples from both sides of the fracture will be analyzed in the initial round of analyses. Where there is no distinction in rock matrix, the sample pairs may be considered to be field duplicates.

Wipe samples will be taken along specific fracture or bedding planes where DNAPL phase is observed or suspected in order to capture the chemical composition of the mobile DNAPL at the time of core collection. These wipe samples will consist of a clean fabric soaked in hexane and wiped over the two opposing fracture surfaces. The mass of contaminants can be reported on a total surface area basis. Comparison of wipe samples to the rock matrix samples along the same fracture may be used to infer past and present day DNAPL characteristics.

Field duplicates consist of sample pairs on both sides of a fracture or bedding plane where the lithology appears to be the same. Sample duplicates will be obtained by taking duplicate aliquots of hexane from the sample container at the same time, hence after the same extraction time. Equipment blanks consist of hexane wipes of the core tube and rock crusher following decontamination procedures. Trip blanks will consist of sample containers containing a known weight and volume of high purity hexane that is placed among the other prepared sample containers. A trip blank will be kept with each batch of sample containers being sent to the field. The field blank will be stored in the cooler or refrigerator and returned to the laboratory with the

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samples. Aliquots of hexane from the trip blanks will be obtained in a similar manner as the sample extract aliquots and at least on trip blank per shipment of samples to the laboratory for analysis.

Field Procedures:

The fresh rock core will be removed from the core barrel and placed in a aluminum foillined tray. A foil-lined split PVC tube at least the length of the core barrel will be used for inspecting the core. A continuous sheet of clean foil will be used to cover the sample during the core logging, inspection and subsampling activities. These precautions are to prevent contact with sorbing surfaces, cross contamination, and moisture loss from the rock core. The core will be logged immediately and the fractures/bedding planes identified for sampling. The sample size will be 1 cm length of core including the fracture plane (1 cm thick disk of NX or HQ core) providing an estimated 30 to 50 grams of sample (wet-weight basis), respectively. A spacer (wooden block) will be placed in the core box with the core to indicate the position of the samples taken and sample ID.

The core subsamples will be crushed as soon as possible after collection to avoid crosscontamination or moisture loss from the water-saturated rock matrix. If a sample cannot be crushed immediately after collection, it will be tightly wrapped in a clean piece of aluminum foil unit it is crushed and placed into the sample containers. Each individual sample will be handled separately. If there is evidence of DNAPL phase running along the inside of the core barrel and possibly cross-contaminating the outside of the core, the outer few mm of core will be trimmed using a chisel. Cross contamination of DNAPL fluid due to drilling may also cause previously uninvaded fractures to become contaminated. The combination of wipe samples and two successive matrix samples should allow interpretation of this condition.

The sample will then placed in the clean rock crusher sleeve, crushed using several blows of a stainless steel piston and emptied directly into a pre-weighed sample container holding a known volume and weight of hexane. The sample container will be a 120 ml clear glass sample bottle, a screw cap with teflon-lined septum and a continuous sheet of aluminum foil to avoid hexane and sample contact with the septum. The container containing the crushed rock sample will be weighed again to determine the wet-weight of rock sample will be determined from the difference in weights. This allows concentrations of chemical constituents to be reported on a mass per unit mass of wet rock (ug/g). A 1:1 ratio of sample to analytical grade hexane is desired, therefore, if 30 to 50 grams of rock core can be obtained from 1-cm slices of NX and HQ cores, respectively, than 30 to 50 milliliters of hexane should be placed into each of the sample containers with the screw cap, septum and foil liner and weighed prior to sample collection. Once sample containers have been prepared and weighed they will be kept at 4°C in a refrigerator or in a cooler with ice before and after sample collection.

Extraction rate and completeness can be enhanced using a Soxhlet or heated technique. It is desired to extract all of the aqueous, sorbed and any immiscible phase mass into the hexane prior to taking an aliquot of hexane for analysis. Crushing the rock core to sand or pea gravel size pieces should enhance extraction rates. If PCB analyses on the samples is to be performed separately as a priority prior to SVOC constituent analyses, the separate aliquots should be collected at the same time to maintain consistent conditions and truer comparisons of results.

Equipment Decontamination:

After each core run, the core barrel should be cleaned with alconox detergent and water to remove rock flour and contaminants and rinsed thoroughly with clean water. The wash and rinse waters should be collected and treated or disposed of in the proper manner. Between samples, the rock hammer, chisels and rock crusher used in sample collection should be decontaminated using a series of wet, disposable wipes; beginning with hexane, followed by acetone or methanol and finally with water. The equipment should be dry prior to re-use.

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NX OR HQ CORE

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Figure D-1 Rock Core Sub-Sampling Approach at GE Hudson Falls, New York Site. (to accompany protocol prepared by B.L. Parker, Feb. 10, 1999)