ent TLO SW.615
9/5/17

Earth Science Strategies Consulting, Inc. ▽

2013 Supplemental Monitoring Well Installation Report

Island County Solid Waste Complex

Coupeville, Washington

Prepared by:

Earth Science Strategies Consulting, Inc.
613 NE 4th Street
Coupeville, WA 98239
360-632-2829

for:

Island County Department of Public Works
Solid Waste Division

October 15, 2013

State of Washington Licensed Geologist
Hydrogeologist
1469
Mark David Varljen

Matthew M. Lewis

Matthew M. Lewis
Hydrogeology Intern

Mark D Varljen

Mark D. Varljen, LG, LHG
Hydrogeologist/Project Director

Table of Contents

Appendices

List of Figures

List of Tables

1 INTRODUCTION

This report documents the drilling, installation, and hydraulic testing of four supplemental monitoring wells completed at the Island County Solid Waste Facility (ICSWF) located in Island County, Washington (Figure 1). This work, conducted between June and August 2013, was completed in partial fulfillment of the objectives outlined in the "*Work Plan for Further Assessment of Groundwater Contamination by Vinyl Chloride*" dated January 28, 2013, and specifically according to the "*Scope of Work and Field Procedures*" document dated April 24, 2013.

The objective of the work was to support the on-going evaluation of groundwater contamination by vinyl chloride (VC) at the site, specifically by establishing additional monitoring points necessary to better define the impacted area and evaluate plume dynamics (i.e. whether or not the VC plume is expanding, static, or shrinking). A secondary objective of the work was to provide additional aquifer property data and calibration points for future fate and transport modeling. This future additional evaluation work, when completed after two years of monitoring, aims to determine whether or not off-site migration of VC is possible and thus whether or not active remediation is necessary.

This report documents the drilling and construction of the new monitoring wells, presents the results of laboratory and field testing activities, and summarizes lithologic and groundwater flow information in the form of cross sections and a groundwater elevation map, respectively. Evaluations of the nature and extent of vinyl chloride and synthesis of this information into a revised conceptual model, as well as evaluations of plume stability and predicted contaminant fate and transport and the likelihood of off-site transport will be presented in future documents after long term monitoring data have been collected.

2 BOREHOLE ADVANCEMENT

LOCATIONS

The locations of the four new monitoring wells (E5D, E6D, E7D, and E8D) in relation to existing wells and other site features are shown on Figure 2. The locations were selected to provide upgradient (E6D), lateral (E7D and E8D) and downgradient (E5D) monitoring surrounding the well (E2D) where vinyl chloride has repeatedly been detected at the highest concentrations at the site. Monitoring well E6D was installed in the road and was completed with a flush-mount well monument adjacent to the west side of the scale house and directly east of the County's closed Municipal Solid Waste (MSW) landfill. Well E7D, also installed in the road and completed with a flush-mount monument, was installed approximately 275 feet north of the scale house, and 70 feet east of the roll-off container tipping walls, directly east of the County's closed Construction, Demolition, and Landclearing (CDL) landfill. Flush-mounted wells are bolted shut with a gasket to seal out precipitation and stormwater runoff. Well E8D was installed in a wooded area approximately 275 feet east of the scale house, and E5D was installed 450 feet northeast of the scale house at the edge of the trees. Monitoring wells E5D and E8D were both installed with locking "stick-up" well monuments, each of which were surrounded by protective bollards and painted bright yellow for visibility.

DRILLING OPERATIONS, SOIL SAMPLING, AND LOGGING

Drilling and well construction was completed by Cascade Drilling, LP (Woodinville, WA) at the direction Earth Science Strategies Consulting, Inc. (ESSCI). All of the work was directly supervised by either a licensed hydrogeologist, or a staff geologist who was under the direct supervision of (and in regular cellular telephone contact with) a licensed hydrogeologist.

Boreholes were advanced using the sonic drilling method which employs the use of high-frequency, resonant energy to advance a core barrel or casing into subsurface formations. The method is very fast, produces less investigation-derived waste than other methods, and produces nearly continuous relatively undisturbed core samples. At this site the sonic drill was used to advance a core barrel (either 6"or 8" diameter) up to 20' per "core run" depending on geologic conditions. After retrieving the core barrel from each "run", the cores were extracted for geologic logging and soil sampling, and a temporary steel casing was advanced to the point that the core barrel was advanced, and the hole cleaned out (again using a core barrel; however the sediments removed from this core run were disturbed and unsuitable for logging and sampling). The procedure was repeated until the desired depth was reached. Target depths were determined based on observed geologic materials. The drilling objective was to reach the same water bearing zone ("Aquifer 2") screened by monitoring well E2D. This zone is located beneath an approximate 50-ft thick semi-confining layer (generally extending from around 150 ft bls to approximately 200 ft bls). The specific depth and screen zone was selected based on generalized formation grain size (i.e. the well screen would be set adjacent to the most permeable materials within the target zone).

At this site, a conductor casing/telescopic procedure was used to prevent cross-contamination during drilling between the shallow (~145-150') water bearings zone ("Aquifer 1" or the perched zone) and the target zone at ~200-220'. A 10" diameter temporary casing was implemented for monitoring wells E5D and E6D; 8" diameter for E7D and E8D. These temporary casings were advanced approximately 5 feet into the semi-confining layer. At this point the casing was retracted approximately 1' and bentonite slurry was pushed out of the borehole to seal the casing into the confining layer. After the bentonite had set at least 12 hours, drilling proceeded using smaller diameter core barrels (4" or 6") and steel casing (8" for E5D and E6D; 6" for E7D and E8D) until the target depths were reached (between 200 – 220' below land surface).

All soil cores were extruded into plastic liners for inspection, logging, and sampling by the on-site geologist as appropriate. Boring logs are presented in Appendix A. Following visual description of the removed soil cores, soils from the saturated zones were checked for the presence of VOCs by placing soil collected from the core at 10' intervals into zip-top plastic bags (one for each interval), allowing the soil to equilibrate with the headspace air in the bag for approximately 15 minutes, and then evaluating the headspace air with a photoionization detector (PID). All PID readings were recorded on the boring logs and no samples were found to have significant PID values, although some minor detections were encountered at well E7D. All soil cuttings were placed in steel storage bins and transported to an appropriate area on ICSW property, as designated by ICSW staff. All drilling equipment was decontaminated between boreholes to minimize the potential for cross-contamination. Due to the nature of the drilling method, the drilling process did not generate contaminated water that would require special handling or disposal.

LABORATORY TESTING

Samples for laboratory analysis were collected from the cores extracted from the boreholes at the elevations of the monitoring well screens, and from select locations at E7D where PID readings were noted. Samples for VOC analysis were collected from the extruded cores using laboratory-provided disposable undisturbed core samplers and placed directly in laboratory-provided 40 ml vials containing methanol preservative. Other parameters (geotechnical) were sampled by the laboratory from undisturbed cores which were left in the plastic liners, secured for shipping, and delivered to the laboratory in a sample cooler. All samples for chemical analysis were packed in a cooler maintained at 4 degrees C and shipped to TestAmerica, a certified analytical laboratory. Analyses included:

- Volatile Organic Compounds
- Total Organic Carbon (TOC)
- Bulk Density
- Grain Size
- Porosity

The laboratory report from TestAmerica is provided in Appendix B.

Results of the laboratory geotechnical analyses are summarized in Table 1

Results of the chemical (TOC and VOC) analyses are summarized in Table 2. While some VOCs were detected in the soil samples, the concentrations may be considered minimal, and some of the detections are thought to be false positives/laboratory artifacts as evidenced by the detections of some constituents in the laboratory "blank" sample.

Table 3 shows hydraulic conductivity values determined using methods by Hazen, Shepherd, and Zhang & Brusseau using the grain-size distribution curves and percentages of gravel, sand, silt, and clay. These hydraulic conductivity values are considered complementary to the primary values determined by slug testing (discussed in the next section).

3 WELL COMPLETION AND TESTING

WELL CONSTRUCTION

Once the target depth was reached at each location, a groundwater monitoring well was installed. All monitoring wells were installed in accordance with WAC 173-160-420 (Minimum Standards for Construction and Maintenance of Wells; Resource Protection Wells) and according to industry standard practices for resource protection wells. Complete construction details are shown on the well logs and construction diagrams contained in Appendix A.

Monitoring wells E5D and E6D were completed as 4" diameter wells with "v-wrap" screens (for greater open area than machine-slotted) to facilitate possible future use as remediation wells (injection or extraction), should this be necessary. Monitoring wells E7D and E8D were completed as 2" diameter wells, also with "V-wrap" screens. All screens are 5' long. Screen slot size and sandpack specifications were selected as was appropriate for the materials encountered in the screen zones. Schedule 80 PVC casing with centralizers were used for all monitoring wells. Following placement of the clean silica sand filter in the annular space between each well screen and the formation, the well was vibrated and/or surged (depending on the circumstances of each well) to ensure the filter pack was seated and there were no void spaces. The remainder of the annular space in each boring was filled with hydrated chip bentonite, pelletized bentonite, or bentonite grout, as conditions dictated while the steel casing was extracted. The PVC well casings (for wells E5D and E8D) terminate approximately 2.5 feet above the ground surface except. For the wells that are located in the road (locations E6D and E7D), the PVC casing terminates approximately 6" below the ground surface. Each well was completed at the ground surface with either flush-mount subsurface vaults for wells in traffic areas, or "stick-up" protectors surrounded by protective bollards in other areas depending on location. Well identification tags were affixed to the wells and permanent elevation reference points marked on the top of the PVC casings. Following construction, the wells were surveyed for vertical and horizontal position by TMI Surveying, Inc. of Freeland, WA. A summary of the survey information and well construction data is provided in Table 4.

MONITORING WELL DEVELOPMENT

Each groundwater monitoring well was developed by ESSCI staff following installation to ensure good hydraulic connection between the well and the aquifer and to remove any solids that could potentially be mobilized during the sampling process. Sometimes a "skin" of clay and silt particles forms on the borehole wall as a result of drilling. The development process is designed to remove this skin to maximize hydraulic continuity, as well as to "set" the sand pack and remove fine-grained material from the area immediately adjacent to the well screen. Adequate development is necessary to ensure accurate water levels (fine soil particles can plug the well openings), the long-term viability (water production ability) of the wells, and the elimination of artifact turbidity in samples which can interfere with laboratory analyses. Well development was accomplished using surging and high volume pumping. Turbidity was measured and documented during the development process, and development proceeded until turbidity declined and stabilized to the maximum extent possible. All non-disposable well development equipment was decontaminated using a non-phosphate detergent (Alconox) wash and an initial clean tap water rinse followed by a final distilled water rinse. A summary of information collected during development is provided in Table 5.

HYDRAULIC CONDUCTIVITY TESTING

Slug tests were conducted on the new monitoring wells to measure hydraulic conductivity. The slug testing procedure involves instantaneously removing a "slug" of water from the well casing and measuring the rate of water level recovery. A variety of mathematical treatments (depending on geologic conditions and monitoring well configuration) may then applied to the data to develop an estimate of hydraulic conductivity. Given that the wells screens from these proposed monitoring wells were submerged (i.e., the top of the screen is below the static water level), the casing pressurizing method of slug testing was used to maximize the size of the "slug," which increases the representativeness of the results. To implement the slug tests, a pressure transducer was installed in each well prior to testing. The well casing was then be pressurized with nitrogen to depress the static water level in the well to a point just above the well screen. After the desired displacement was achieved and the water level and casing pressure stabilized, the pressure was be instantaneously released from the well casing, allowing the water level to rise. The change in water level was recorded by the pressure transducer connected to a data logger. At least two slug tests were completed at each of the four groundwater monitoring wells. The pressure transducer was decontaminated between each well using the standard three-step process of Alconox detergent, followed by a tap water rinse, and finally a distilled water rinse. Table 6 presents a summary of the slug test results. Appendix C presents more detailed calculations of graphs of the well response during testing.

SAMPLING PUMP INSTALLATION

Following well development and slug testing, each new monitoring well was outfitted with a dedicated QED model T1250 (stainless-steel body, Teflon bladder) bladder pump with stainless steel inlet screen, Teflon-lined polyethylene tubing, well cap, and discharge adaptor. Pump intakes were set at the midpoint of each screen. Table 7 presents the details of each sampling pump installation.

4 CONDITIONS ENCOUNTERED

STRATIGRAPHY AND AQUIFER PROPERTIES

The geologic conditions encountered were generally consistent with those reported by previous investigations conducted at the Site. Following a thick (approximately 140') unsaturated zone composed of coarse sand and gravel, a semi-confining layer of gray, fine-grained sediments separates a discontinuous perched water-bearing zone (encountered at approximately 60' above msl, or approximately 140' bls) from a lower aquifer encountered at approximately 0' msl, or 200' bls. This sequence is illustrated in the cross-sections shown in Figures 3 and 4 (cross section locations are shown on Figure 2). No modifications to the existing geologic site conceptual model are suggested by the new borings, however the slug testing conducted showed a significantly lower hydraulic conductivity (0.8 – 10 ft/day) than had previously been suggested by grain size data (224 ft/day) for this aquifer. Because the slug testing is considered to be more reliable than the previous estimates from grain size data, this is considered a significant revision to the assumptions governing groundwater flow and transport.

GROUNDWATER FLOW

Depth to water measurements were collected in July 2013 from the four new monitoring wells in addition to existing monitoring wells E2D, E3D, E4D, and N3D and converted to water level elevations based on the surveyed top of casing elevations. Figure 5 shows the water level elevations, interpolated contours, and assumed groundwater flow direction. Consistent with previous investigations, the generalized groundwater flow direction was found to be from southwest to northeast, with a gradient of 0.004 ft/ft. Based on the revised hydraulic conductivity of 1-10 ft/day, and the measured porosity average of 33% (Table 1), the estimated groundwater flow velocity is between 4.4 – 44 ft/year. This is considerably slower than had been previously assumed due to the lower hydraulic conductivity and higher porosity (prior to the measurements collected by this investigation indicating a porosity of 33%, an assumption of 25% was used previously to estimate groundwater flow velocities).

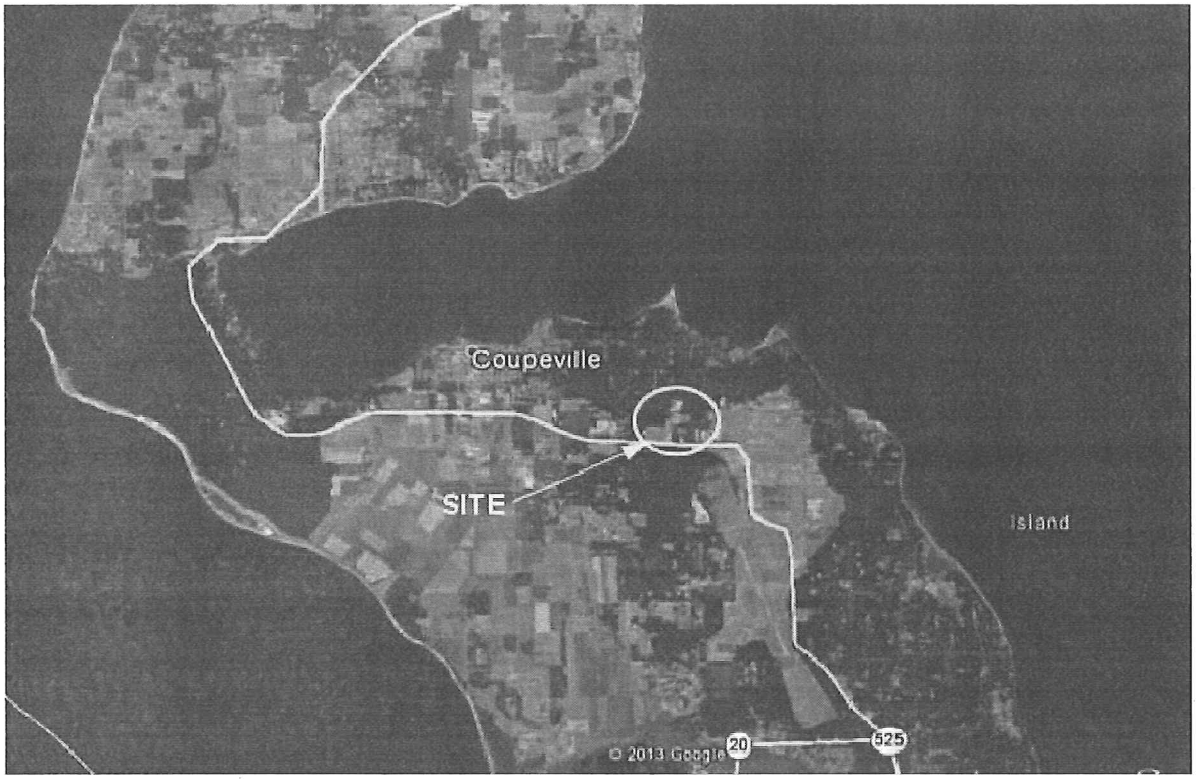


Figure 1. Site Location

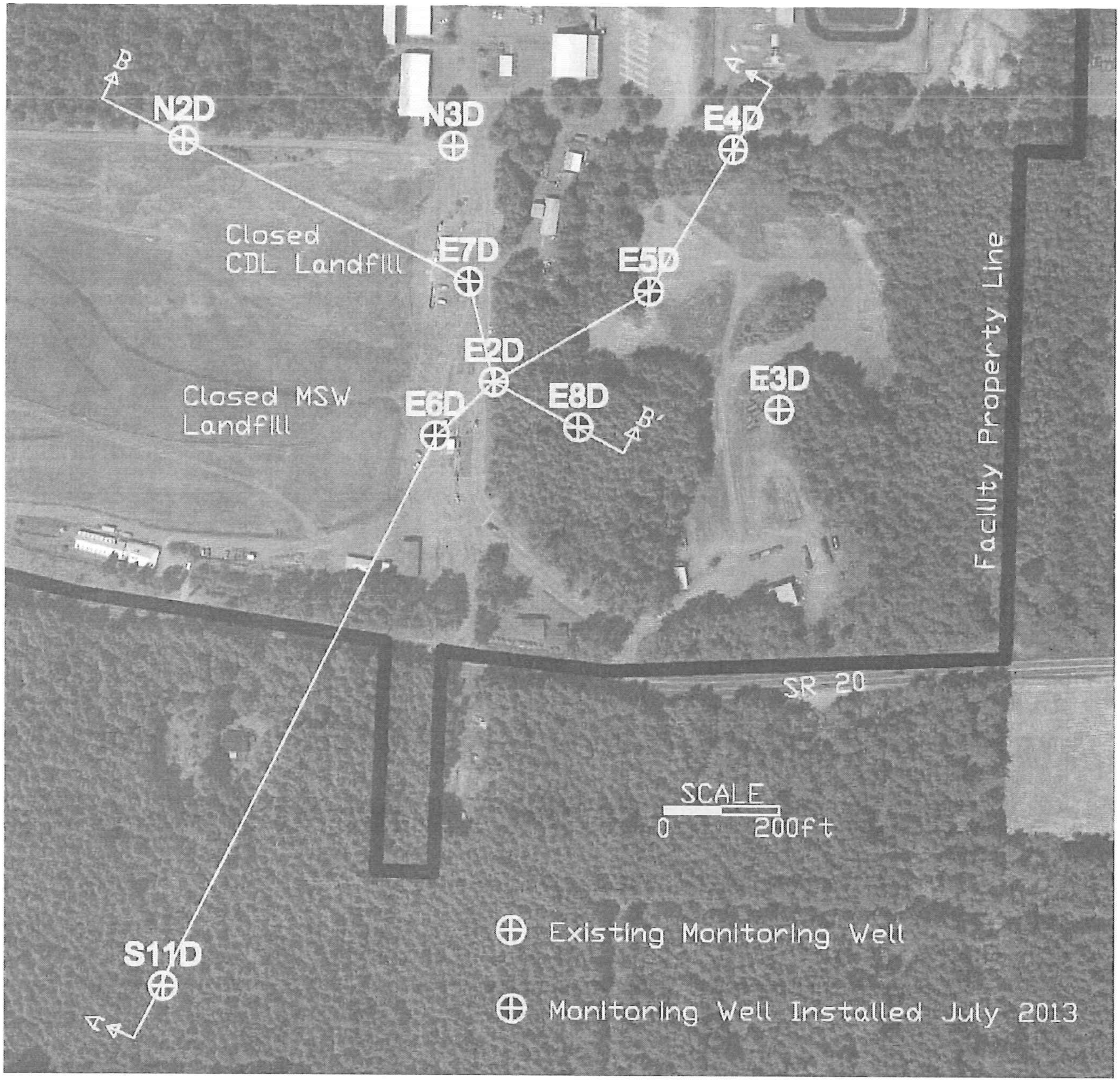
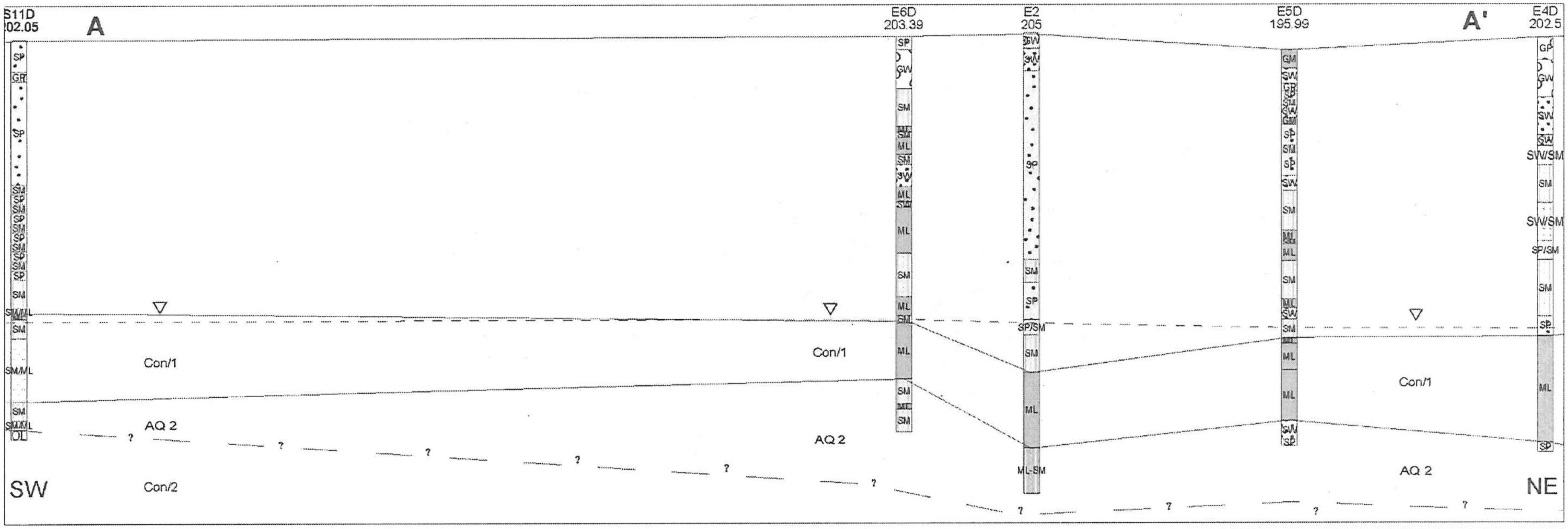


Figure 2. Monitoring Well and Cross Section Locations

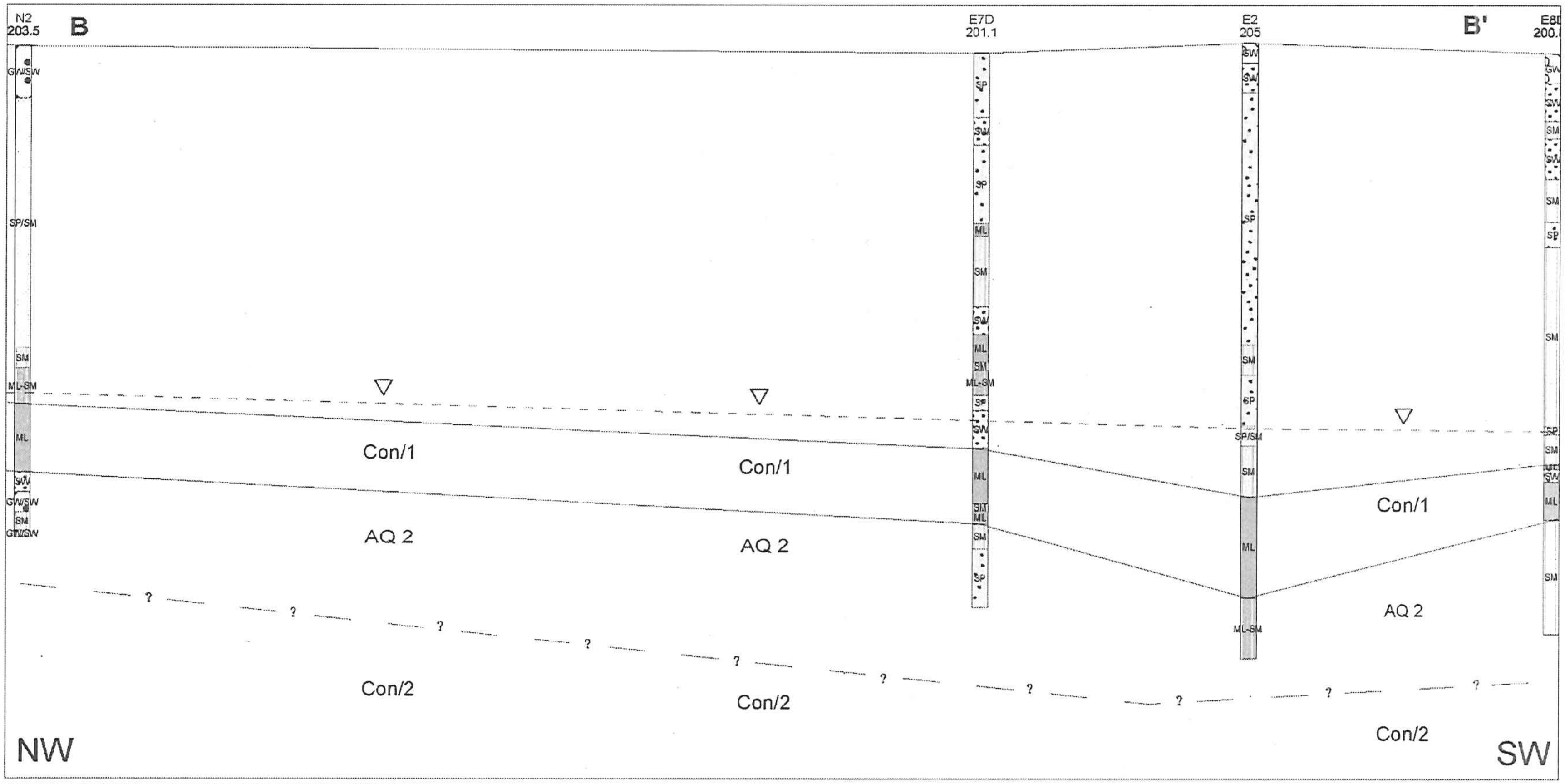


Earth Science Strategies Consulting, Inc.

Figure 3

Cross Section A - A'
Island County Solid Waste Facilty
Coupeville, Washington

- ▨ GM
- ▢ GP
- ▢ GW
- ■ ML
- ▥ ML-SM
- ▥ SM
- ⁘ SP
- ⁘ SW
- ▤ SP/SM
- ▤ SM/ML
- ● GW/SW
- ⁘ SW/SM



Earth Science Strategies Consulting, Inc.

Figure 4

Cross Section A - A'
Island County Solid Waste Facility
Coupeville, Washington

▨	GM	▨	ML-SM	▨	SP/SM
▨	GP	▨	SM	▨	SM/ML
▨	GW	▨	SP	▨	GW/SW
▨	ML	▨	SW	▨	SW/SM

↗ Assumed groundwater flow direction

Figure 5. Groundwater Elevation Contour Map, July 2013

Table 1. Summary of Aquifer Sample Geotechnical Properties

Sample ID	Depth [ft]	% GRAVEL			% SAND			% Fines	Bulk Density [g/cm^3]	Porosity [%]	Soil Description
		cobbles and boulders	coarse	fine	coarse	medium	fine				
E5D	203	0.0	0.0	0.0	0.0	5.9	63.3	30.8	1.76	35.9	Gray, med SAND, little to no fines
E5D	208	0.0	0.0	27.1	14.6	21.8	19.6	16.9	2.29	17.8	Gray, silty, gravelly, coarse SAND
E6D	210	0.0	0.0	0.0	0.0	0.1	76.0	23.9	1.65	39.3	Gray, fine SAND
E7D	210	0.0	0.0	0.0	0.0	12.5	66.5	21.0	1.84	33.5	Brown, slightly silty, med SAND
E8D	212	0.0	0.0	0.0	0.0	0.0	87.5	12.5	1.58	41.3	Gray, silty fine SAND

MSL mean sea level

Table 2. Summary of Chemical Analyses

Sample Name	TOC [mg/Kg]	Methylene Chloride [ug/Kg]	Chloromethane [ug/Kg]	Bromomethane [ug/Kg]	Toluene [ug/Kg]	1,2,4 - Trichloro benzene [ug/Kg]	1,2,3 - Trichloro benzene [ug/Kg]	Methyl acetate [ug/Kg]	Acetone [ug/Kg]
5-203	<1230	43 J, H	<130	<130	<130	<130	<130	<130	<670
5-208	<1120	34 J, H	**140 H, B**	**230 H, B**	45 J, H	23 J, H, B	26 J, H, B	<120	<590
6-210	**1890**	<67	<67	<67	<67	<67	<67	<67	<330
7-20	NA	<54	47 J, H, B	**67 H, B**	<54	<54	<54	37 J, H	<270
7-40	NA	<49	31 J, H, B	47 J, H, B	<49	<49	<49	<54	<240
7-70	NA	<38	<38	<38	<38	<38	<38	<38	<190
7-160	NA	<64	18 J, H, B	<64	37 J, H	<64	<64	53 J, H	98 J, H
7-210	<1140	<66	<66	<66	<66	<66	<66	<66	<330
8-212	<1200	<58	**61 H, B**	**85 H, B**	<58	<58	<58	<54	<290
VHBKLME	NA	<48	44 J, H, B	**65 H, B**	<48	<48	<48	<48	<240

B compound was found in blank and sample

U indicates the analyte was analyzed for but not detected

* recovery or RPD exceeds control limits

J result is les than the RL but greater than or equal to the MDL and the concentration is an approximate value

H sample was prepped or analyzed beyond the specified holding time

NA not analyzed

Table 3. Hydraulic Conductivity Estimates from Grain Size Data

		Grain Size Data						Calculated Hydraulic Conductivity [ft/day]				
Sample ID	Depth [ft]	% Gravel	% Sand	% Silt	% Clay	D10 (mm)	D50 (mm)	Hazen H	Shepherd Ch	Zhang & Brusseau	Alyamani & Sen	Average
E5D	203	0	69.2	20.5	10.3	0.045	0.125	6.89	14.56	0.17	2.61	**6.05**
E5D	208	27.1	56	11.3	5.6	0.020	1.000	1.36	450.00	0.04	130.06	**145.37**
E6D	210	0	76.1	15.3	7.6	0.020	0.120	1.36	13.61	0.40	5.17	**5.14**
E7D	210	0	79	5.3	15.8	0.038	0.250	4.91	45.69	0.48	0.33	**12.85**
E8D	212	0	87.5	8.4	4.2	0.074	0.160	18.63	21.88	1.37	12.48	**13.59**

H - uniform highly sorted sand, C=1200

Ch- Channel

Table 4. Monitoring Well Survey Data and As-Built Measurements

Well Name	July 2013 Survey Coordinates (1)			Site Coordinates (2)			July 2013 Event		TD [bgs]	TOS [bgs]	TOSE	BOS [bgs]	BOSE	SMPE
	Easting	Northing	TOCE	Easting	Northing	TOCE	DTW	WLE						
E5D	1198000	446406	202.32	10277	9758	198.56	146.57	51.99	211.30	206.30	-7.75	211.30	-12.75	-10.25
E6D	1197630	446155	206.73	9907	9507	202.97	149.6	53.37	209.25	204.25	-1.29	209.25	-6.29	-3.79
E7D	1197688	446421	204.26	9965	9773	200.50	147.56	52.94	209.50	204.50	-4.01	209.50	-9.01	-6.51
E8D	1197879	446171	206.89	10156	9522	203.13	150.83	52.30	214.60	209.60	-6.47	214.60	-11.48	-8.97

(1) As provided by TMI, Inc. - NAD-83/96 Horizontal and NAVD 88 Vertical

(2) Converted to local relative coordinates system and NAVD 1929 Vertical, as used in previous studies (by others)

TOCE - top of casing elevation (ft msl)
DTW - depth to water below top of casing (ft)
WLE - water level elevation (ft msl)
TD - total depth of boring (ft)
bgs - below ground surface
TOS - depth to top of screen (ft)
TOSE - top of screen elevation (ft msl)
BOS - depth to bottom of screen (ft)
BOSE - bottom of screen elevation (ft msl)
SMPE - screen midpoint elevation (ft msl)

Table 5. Well Development Information

Well ID	Depth to Water [ft]	Depth to Bottom [ft]	Length of Stick-up [ft]	Post-Development Turbidity [ntu]
E5D	146.54	211.30	1.57	30.1
E6D	149.00	209.25	-0.42	1.21
E7D	147.33	209.50	-0.60	171
E8D	150.44	214.60	2.28	28.8

Table 6. Hydraulic Conductivity Results From Slug Test Data

Test Name	Hvorslev Method			Bouwer & Rice Method			AVG [ft/day]
	K [ft/sec]	K [ft/day]	K [cm/s]	K [ft/sec]	K [ft/day]	K [cm/s]	
E5D 1	1.1E-04	9.5	3.4E-03	1.3E-04	11	3.9E-03	**10.3**
E5D 2	9.8E-05	8.5	3.0E-03	1.1E-04	9.4	3.3E-03	**8.9**
E5D 3	6.9E-05	6.0	2.1E-03	7.9E-05	6.8	2.4E-03	**6.4**
E6D 2	9.7E-06	0.8	3.0E-04	1.0E-05	0.88	3.1E-04	**0.9**
E6D 3	9.2E-06	0.8	2.8E-04	1.0E-05	0.89	3.1E-04	**0.8**
E7D 1	4.7E-05	4.0	1.4E-03	4.9E-05	4.2	1.5E-03	**4.1**
E7D 2	3.9E-05	3.4	1.2E-03	3.9E-05	3.4	1.2E-03	**3.4**
E8D 1	1.4E-05	1.2	4.2E-04	1.5E-05	1.3	4.6E-04	**1.2**
E8D 2	1.5E-05	1.3	4.6E-04	1.6E-05	1.4	4.9E-04	**1.3**
E8D 3	1.2E-05	1.1	3.7E-04	1.4E-05	1.2	4.2E-04	**1.1**

Appendix A

Boring Logs and Well Completion Diagrams

Earth Science Strategies Consulting, Inc.

Island County Solid Waste Facility
Coupeville, Washington

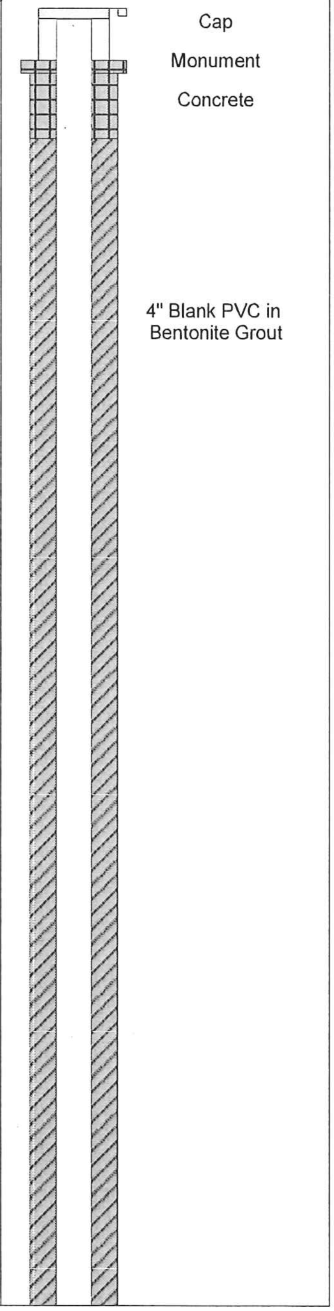
Started/Completed : 6/3/2013
Drilling Method : Sonic Core
Diameter : 10" to 150', 8" to 210'
Sampling Device : Sonic Core
Drilled By : Cascade Drillers, LP
Total Depth : 210
Logged By : Mark Varljen
Reviewed By : Mark Varljen

Monitoring Well: E5D

(Page: 1 of 4)

Surveyed By : TMI
Northing Coordinate : 9740.03
Easting Coordinate : 10298.35
TOC Elevation : 202.32
Depth to Water : 146.54 bTOC

Depth [ft]	Surf. Elev. [ft]	USCS	Graphic	Description	Remarks	PID VOC [ppm]
0	200	GM		Dark Brown, very silty, gravelly sand; ORGANICS + Fill material: wood, metal debris, soil...		
5				No recovery.		
10	190	SW		Loose (?) brown, gravelly, coarse SAND w/ cobbles (1.5" - 5" elongate); some oxidation.		
15						
20	180	GP		Brown, very sandy GRAVEL w/ scattered cobbles		
25		SP		Brown, coarse SAND (clean), few scattered cobbles.		
		SM		Brown, slightly silty, med SAND; some mottling		
30	170	SW		Brown, gravelly, coarse SAND w/ cobbles.		
35		GM		Gray-brown, silty, gravelly SAND w/ large (4"- 5") cobbles.		
40	160	SP		Brown, gravelly, coarse SAND. Gravel content decresing w/ depth.		
45						



Earth Science Strategies Consulting, Inc.

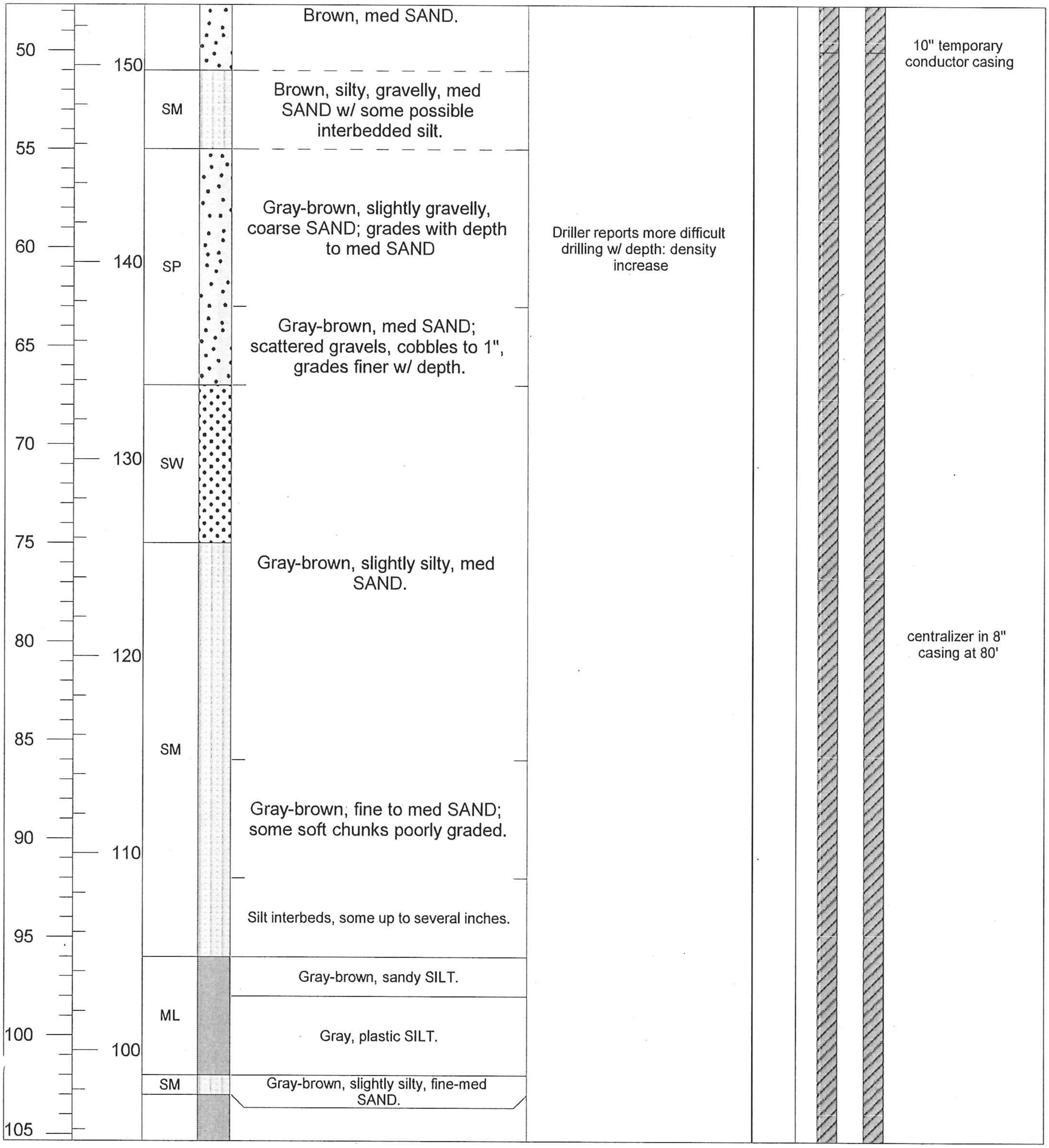
Island County Solid Waste Facility
Coupeville, Washington

Started/Completed	: 6/3/2013
Drilling Method	: Sonic Core
Diameter	: 10" to 150', 8" to 210'
Sampling Device	: Sonic Core
Drilled By	: Cascade Drillers, LP
Total Depth	: 210
Logged By	: Mark Varljen
Reviewed By	: Mark Varljen

Monitoring Well: E5D

(Page: 2 of 4)

Surveyed By	: TMI
Northing Coordinate	: 9740.03
Easting Coordinate	: 10298.35
TOC Elevation	: 202.32
Depth to Water	: 146.54 bTOC



Brown, med SAND.

Brown, silty, gravelly, med SAND w/ some possible interbedded silt.

Gray-brown, slightly gravelly, coarse SAND; grades with depth to med SAND

Gray-brown, med SAND; scattered gravels, cobbles to 1", grades finer w/ depth.

Gray-brown, slightly silty, med SAND.

Gray-brown, fine to med SAND; some soft chunks poorly graded.

Silt interbeds, some up to several inches.

Gray-brown, sandy SILT.

Gray, plastic SILT.

Gray-brown, slightly silty, fine-med SAND.

Driller reports more difficult drilling w/ depth: density increase

10" temporary conductor casing

centralizer in 8" casing at 80'

Earth Science Strategies Consulting, Inc.

Island County Solid Waste Facility
Coupeville, Washington

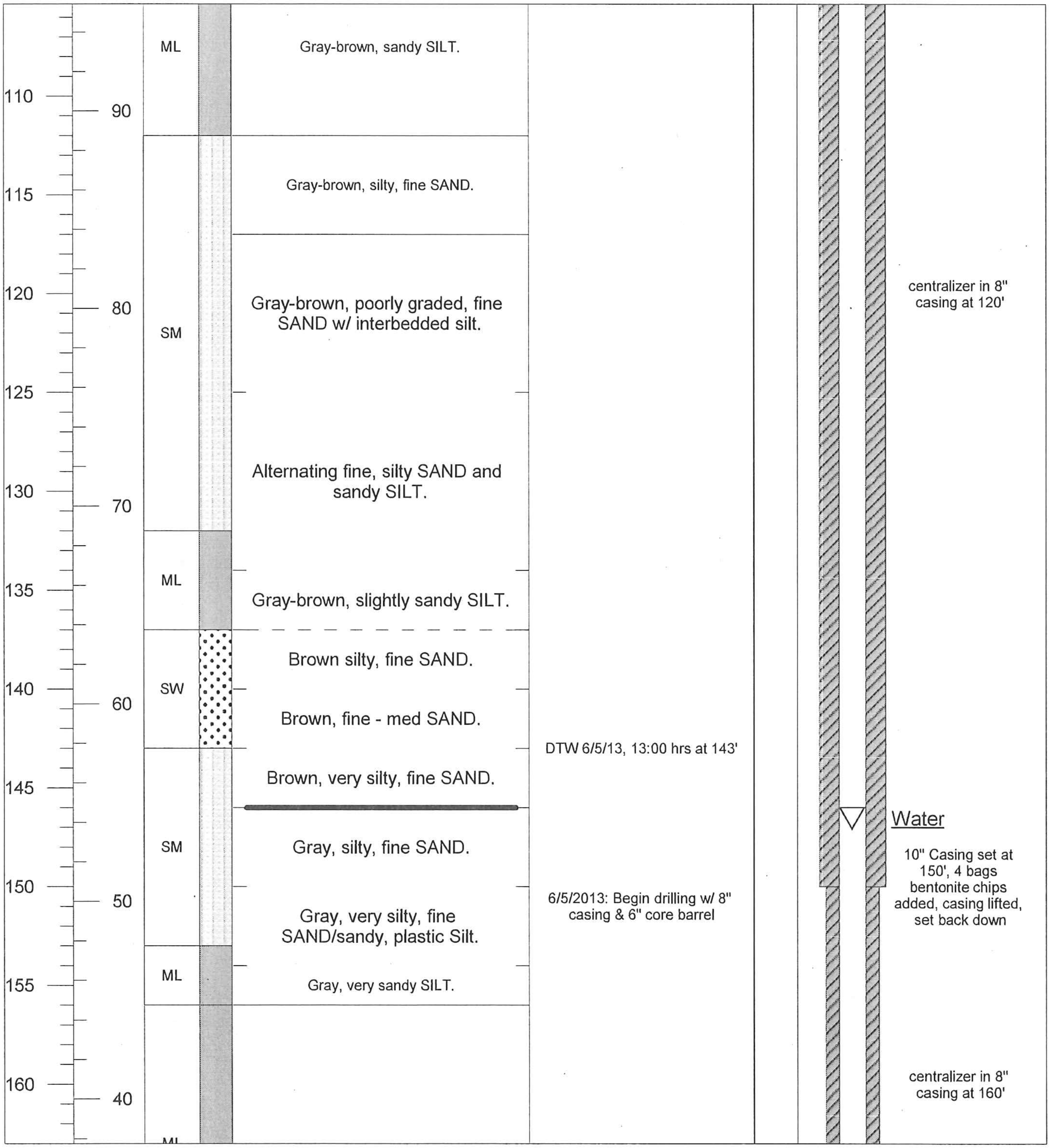
Started/Completed : 6/3/2013
Drilling Method : Sonic Core
Diameter : 10" to 150', 8" to 210'
Sampling Device : Sonic Core
Drilled By : Cascade Drillers, LP

Total Depth : 210
Logged By : Mark Varljen
Reviewed By : Mark Varljen

Monitoring Well: E5D

(Page: 3 of 4)

Surveyed By : TMI
Northing Coordinate : 9740.03
Easting Coordinate : 10298.35
TOC Elevation : 202.32
Depth to Water : 146.54 bTOC



Gray-brown, sandy SILT.

Gray-brown, silty, fine SAND.

Gray-brown, poorly graded, fine SAND w/ interbedded silt.

Alternating fine, silty SAND and sandy SILT.

Gray-brown, slightly sandy SILT.

Brown silty, fine SAND.

Brown, fine - med SAND.

Brown, very silty, fine SAND.

Gray, silty, fine SAND.

Gray, very silty, fine SAND/sandy, plastic Silt.

Gray, very sandy SILT.

DTW 6/5/13, 13:00 hrs at 143'

6/5/2013: Begin drilling w/ 8" casing & 6" core barrel

centralizer in 8" casing at 120'

10" Casing set at 150', 4 bags bentonite chips added, casing lifted, set back down

centralizer in 8" casing at 160'

Earth Science Strategies Consulting, Inc.

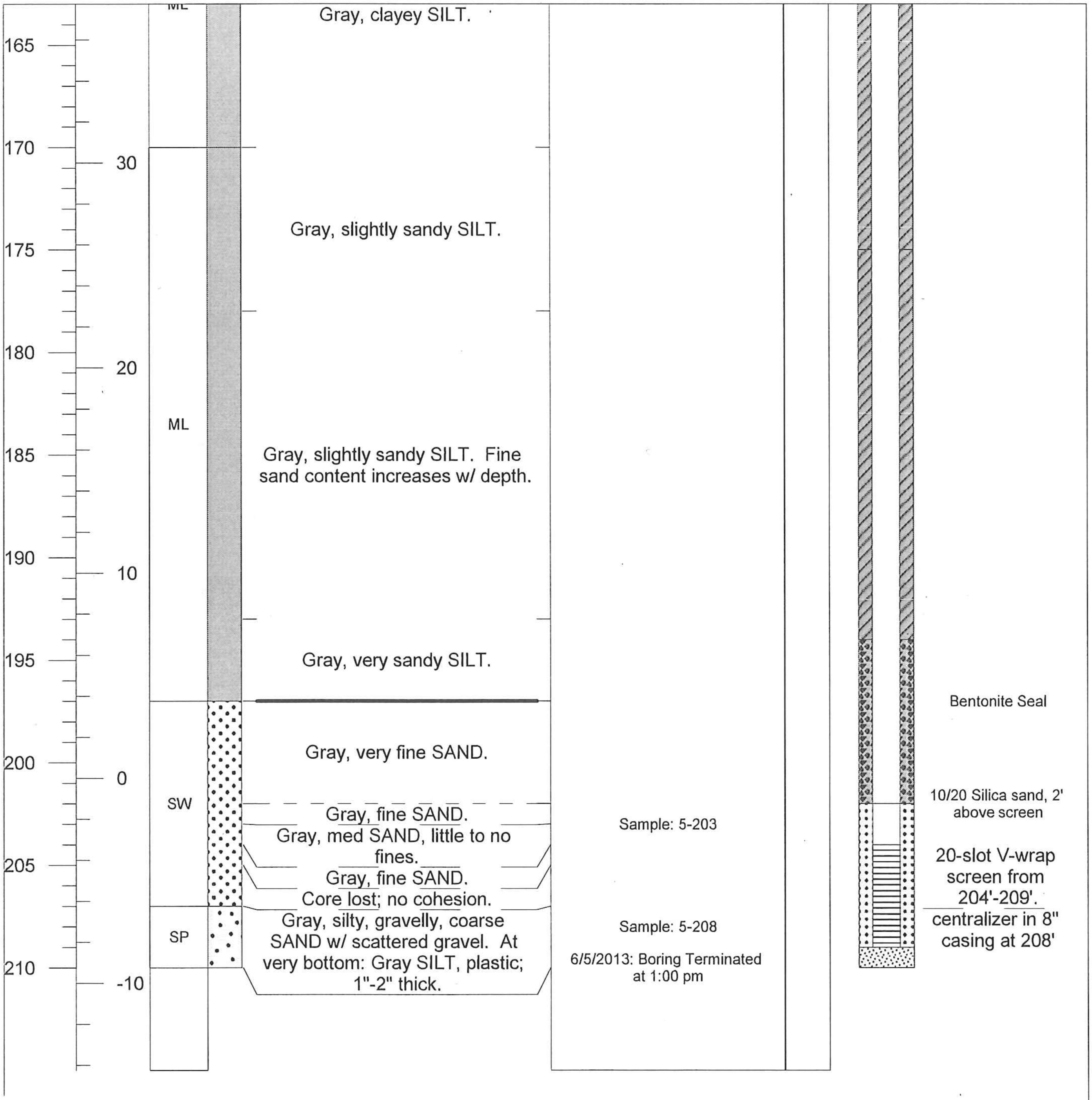
Island County Solid Waste Facility
Coupeville, Washington

Started/Completed	: 6/3/2013
Drilling Method	: Sonic Core
Diameter	: 10" to 150', 8" to 210'
Sampling Device	: Sonic Core
Drilled By	: Cascade Drillers, LP
Total Depth	: 210
Logged By	: Mark Varljen
Reviewed By	: Mark Varljen

Monitoring Well: E5D

(Page: 4 of 4)

Surveyed By	: TMI
Northing Coordinate	: 9740.03
Easting Coordinate	: 10298.35
TOC Elevation	: 202.32
Depth to Water	: 146.54 bTOC



Gray, clayey SILT.

Gray, slightly sandy SILT.

Gray, slightly sandy SILT. Fine sand content increases w/ depth.

Gray, very sandy SILT.

Gray, very fine SAND.

Gray, fine SAND.

Gray, med SAND, little to no fines.

Gray, fine SAND.

Core lost; no cohesion.

Gray, silty, gravelly, coarse SAND w/ scattered gravel. At very bottom: Gray SILT, plastic; 1"-2" thick.

Sample: 5-203

Sample: 5-208

6/5/2013: Boring Terminated at 1:00 pm

Bentonite Seal

10/20 Silica sand, 2' above screen

20-slot V-wrap screen from 204'-209'.

centralizer in 8" casing at 208'

Earth Science Strategies Consulting, Inc.

Island County Solid Waste Facility
Coupeville, Washington

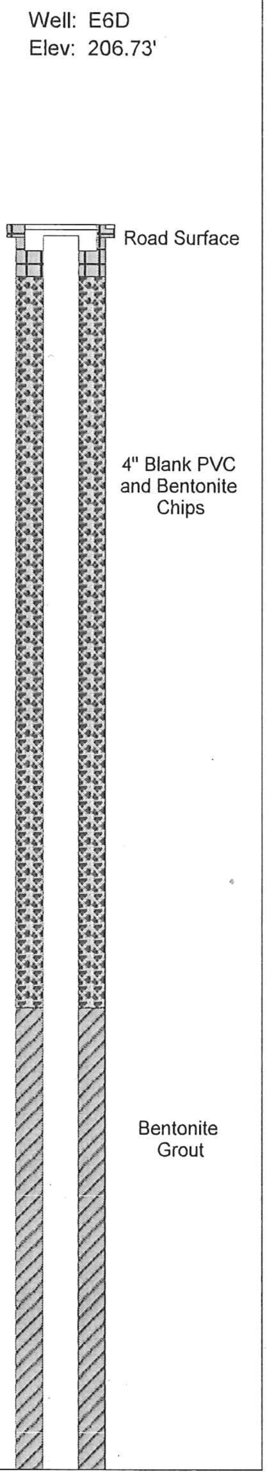
Started/Completed : 6/13/2013
Drilling Method : Sonic Core
Diameter : 10" to 157', 8" to 210'
Sampling Device : Sonic Core
Drilled By : Cascade Drillers, LP
Total Depth : 210
Logged By : Allen Chartrand
Reviewed By : Mark Varljen

Monitoring Well: E6D

(Page: 1 of 4)

Surveyed By : TMI
Northing Coordinate : 9489.38
Easting Coordinate : 9927.61
TOC Elevation : 206.73
Depth to Water : 149 bTOC

Depth [ft]	Surf. Elev. [ft]	USCS	Description	Remarks	PID VOC [ppm]
0		SP	Brown-gray, coarse, gravelly SAND w/ small cobbles + loadfill debris		
5			Slightly finer, gravelly SAND.		
	200	GW	Brown, sandy GRAVEL.		
10			Brown-gray, gravelly SAND w/ some fines		< 25
15			Brown, gravelly, silty, SAND.		
	190		Gray, gravelly, silty, SAND.		
20			Slightly brownish gray, gravelly SAND.	11:00 AM	< 25
25	180		Brown, silty, fine SAND w/ cobble.		
30		SM	Well graded, silty SAND w/ cobble.		< 25
			Well graded, silty SAND w/ cobble.		
35	170		Poorly graded, silty SAND.		
40			Poorly graded, coarse SAND w/ some fines.		< 25
			Well graded, coarse SAND w/ some fines.		
45			Poorly graded sandy SILT.		
	160		Brown/gray well graded silty SAND w/		



Earth Science Strategies Consulting, Inc.

Island County Solid Waste Facility
Coupeville, Washington

Started/Completed	: 6/13/2013
Drilling Method	: Sonic Core
Diameter	: 10" to 157', 8" to 210'
Sampling Device	: Sonic Core
Drilled By	: Cascade Drillers, LP
Total Depth	: 210
Logged By	: Allen Chartrand
Reviewed By	: Mark Varljen

Monitoring Well: E6D

(Page: 2 of 4)

Surveyed By	: TMI
Northing Coordinate	: 9489.38
Easting Coordinate	: 9927.61
TOC Elevation	: 206.73
Depth to Water	: 149 bTOC

			cobble.			
		ML				10" temporary conductor casing
50			Sandy SILT.		< 25	
		SM	Silty SAND w/ small cobbles			
55			Well graded, silty SAND.			
			Poorly graded, sandy SILT.			
	150	ML	Gravelly SAND w/ fines.			
60					< 25	
			Poorly Graded, dark brown, coarse SAND.			
65		SM	Dark brown, silty SAND.			
	140		Well graded SAND.			
70			Poorly graded, gravelly SAND.		12	
		SW				
75						
	130		Poorly Graded SAND.			
80					< 25	
			Brown, sandy SILT; less sand.			
85		ML	Silty SAND.			
	120		Well graded, fine SAND.			
90		SW	Brown poorly graded SAND w/ flecks fo silt.		112	
			Well graded sand SILT w/ pea gravels.			
95						
	110					
			Darker brown, poorly graded, fine SAND.			
100				6/20/2013	< 25	
		ML	Brown, poorly graded, fine SAND with some flecks of silt.			
105						

Earth Science Strategies Consulting, Inc.

Island County Solid Waste Facility
Coupeville, Washington

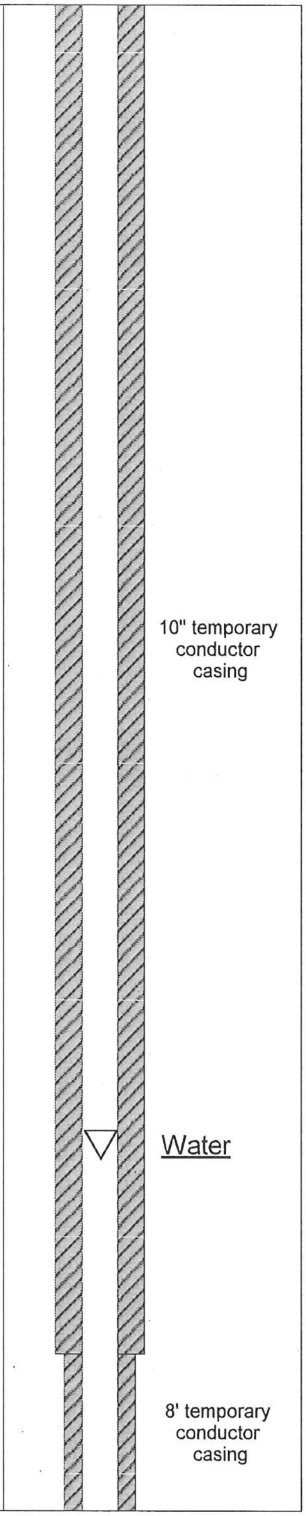
Started/Completed	: 6/13/2013
Drilling Method	: Sonic Core
Diameter	: 10" to 157', 8" to 210'
Sampling Device	: Sonic Core
Drilled By	: Cascade Drillers, LP
Total Depth	: 210
Logged By	: Allen Chartrand
Reviewed By	: Mark Varljen

Monitoring Well: E6D

(Page: 3 of 4)

Surveyed By	: TMI
Northing Coordinate	: 9489.38
Easting Coordinate	: 9927.61
TOC Elevation	: 206.73
Depth to Water	: 149 bTOC

	100		Brown, poorly graded, fine SAND with flecks of silt increasing w/ depth.		
110					17
			Progressively finer, striated, brown-gray SILT w/ little sand.		
115					
	90		Silty sand (high silt content).		
			SILT w/ little sand.		
120					0
			Silty SAND		
125					
	80	SM			
130			Poorly graded, silty SAND; sand grades to silt w/ depth.		0
135					
	70		Seems saturated		
140			Brown, sandy SILT.	Geotech Sample at 3:00 pm	0
		ML			
145					
	60		Brown, silty SAND. Sand grades to silt w/ depth.		
150		SM		6/21/2013	0
			Brown, sandy SILT.		
155			Silty SAND w/ silt flecks.		
	50				
160					0
			Gray, slighty sandy SILT.		



Earth Science Strategies Consulting, Inc.

Island County Solid Waste Facility
Coupeville, Washington

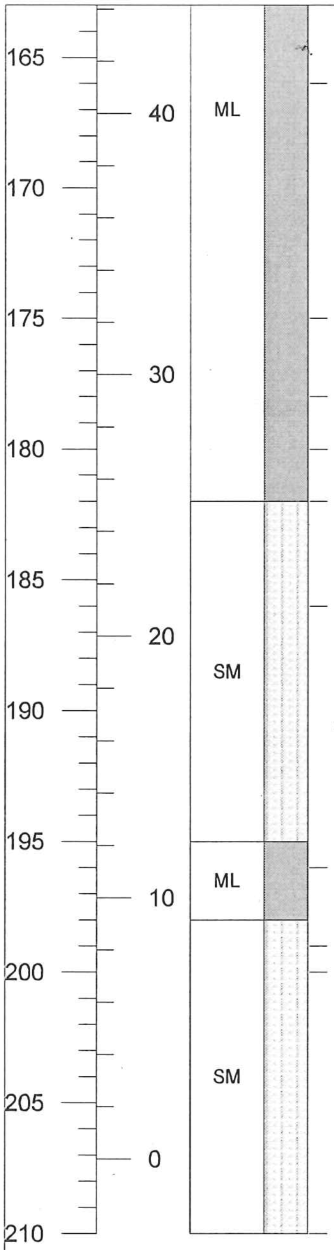
Started/Completed : 6/13/2013
Drilling Method : Sonic Core
Diameter : 10" to 157', 8" to 210'
Sampling Device : Sonic Core
Drilled By : Cascade Drillers, LP

Total Depth : 210
Logged By : Allen Chartrand
Reviewed By : Mark Varljen

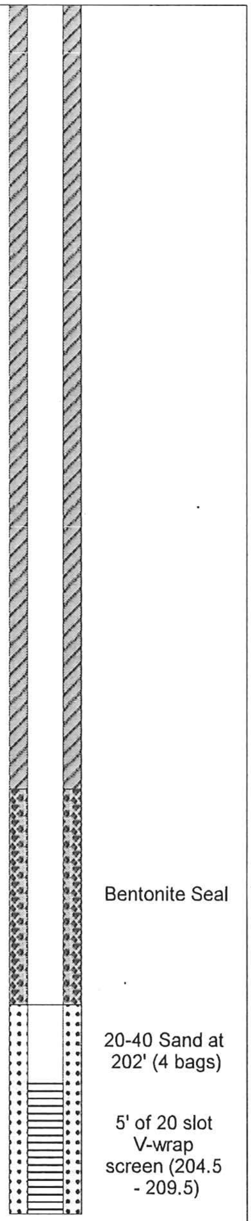
Monitoring Well: E6D

(Page: 4 of 4)

Surveyed By : TMI
Northing Coordinate : 9489.38
Easting Coordinate : 9927.61
TOC Elevation : 206.73
Depth to Water : 149 bTOC



ML	Gray SILT w/ some sand.	Geotech Sample	0
	Gray, sandy SILT.		
	Gray SILT w/ little sand.		
	Gray, sandy SILT		0
SM	Gray, SAND w/ fine flecks of silt.		
	Gray, silty SAND; increasing silt content w/ depth.		0
ML	Gray, sandy SILT.		
SM	Gray, silty SAND.	Geotech Sample: E6D-200 (was labeled E7D-200 but corrected)	0
	Gray, fine SAND.		
		6/21/2013: Boring Terminated at 2:45 pm	



Earth Science Strategies Consulting, Inc.

Island County Solid Waste Facility
Coupeville, Washington

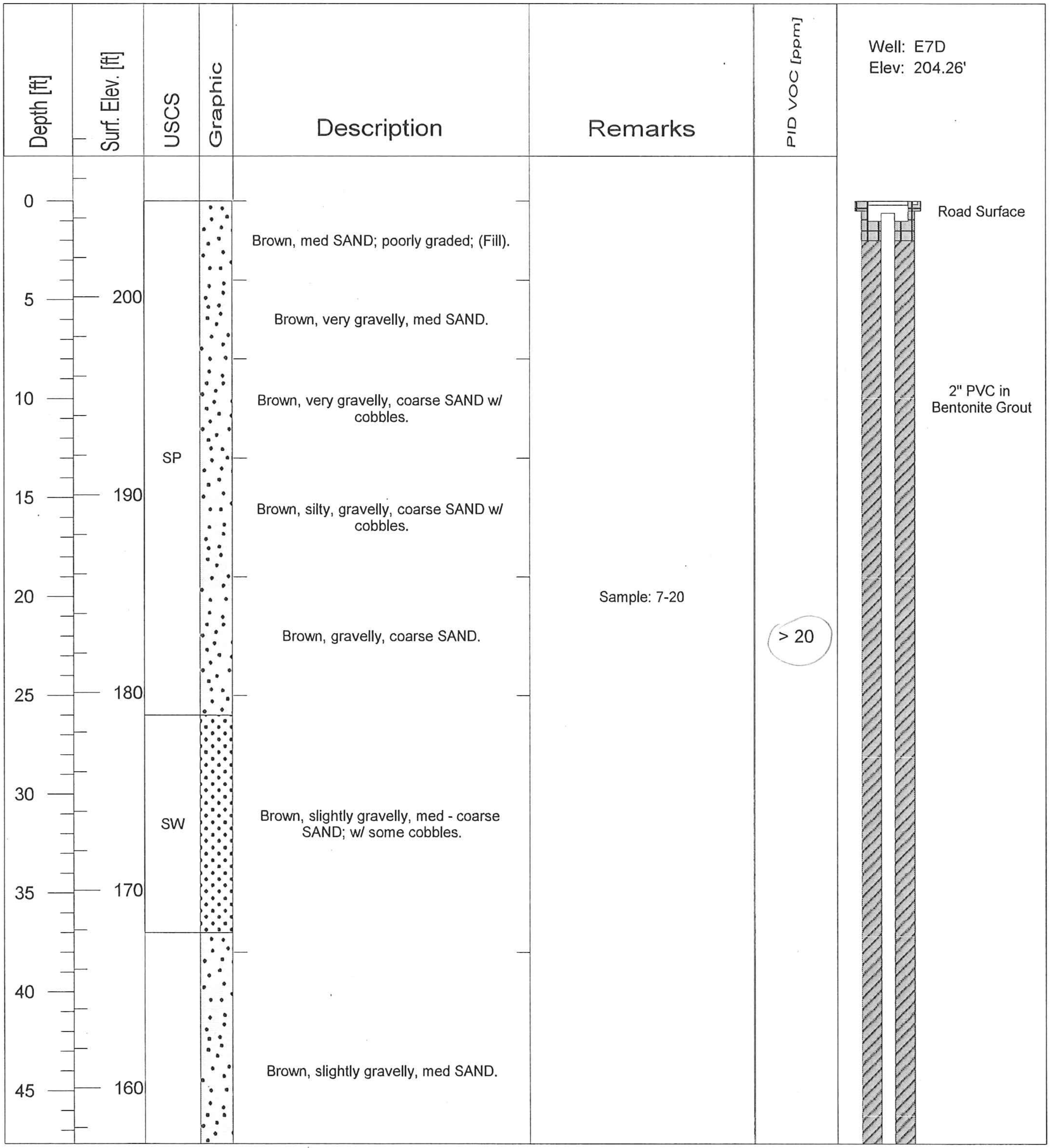
Started/Completed : 6/18/2013
Drilling Method : Sonic Core
Diameter : 8" to 165', 6" to 220'
Sampling Device : Sonic Core
Drilled By : Cascade Drillers, LP

Total Depth : 220
Logged By : Mark Varljen
Reviewed By : Mark Varljen

Monitoring Well: E7D

(Page: 1 of 4)

Surveyed By : TMI
Northing Coordinate : 9755.34
Easting Coordinate : 9986.01
TOC Elevation : 204.26
Depth to Water : 146.82 bTOC



Brown, med SAND; poorly graded; (Fill).

Brown, very gravelly, med SAND.

Brown, very gravelly, coarse SAND w/ cobbles.

Brown, silty, gravelly, coarse SAND w/ cobbles.

Brown, gravelly, coarse SAND.

Brown, slightly gravelly, med - coarse SAND; w/ some cobbles.

Brown, slightly gravelly, med SAND.

Sample: 7-20

> 20

Earth Science Strategies Consulting, Inc.

Island County Solid Waste Facility
Coupeville, Washington

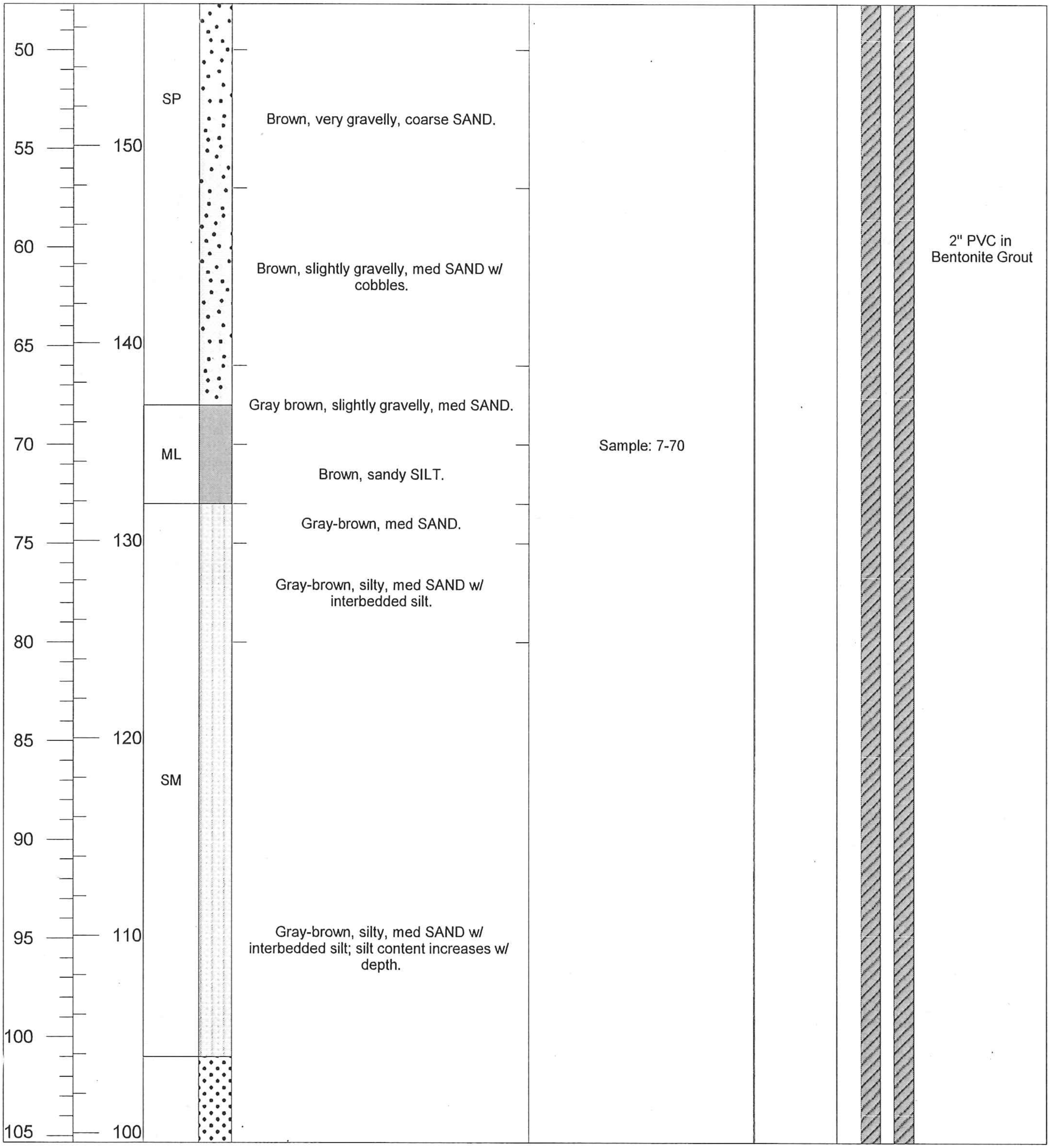
Started/Completed : 6/18/2013
Drilling Method : Sonic Core
Diameter : 8" to 165', 6" to 220'
Sampling Device : Sonic Core
Drilled By : Cascade Drillers, LP

Total Depth : 220
Logged By : Mark Varljen
Reviewed By : Mark Varljen

Monitoring Well: E7D

(Page: 2 of 4)

Surveyed By : TMI
Northing Coordinate : 9755.34
Easting Coordinate : 9986.01
TOC Elevation : 204.26
Depth to Water : 146.82 bTOC



Brown, very gravelly, coarse SAND.

Brown, slightly gravelly, med SAND w/ cobbles.

Gray brown, slightly gravelly, med SAND.

Brown, sandy SILT.

Gray-brown, med SAND.

Gray-brown, silty, med SAND w/ interbedded silt.

Gray-brown, silty, med SAND w/ interbedded silt; silt content increases w/ depth.

Sample: 7-70

2" PVC in Bentonite Grout

Earth Science Strategies Consulting, Inc.

Island County Solid Waste Facility
Coupeville, Washington

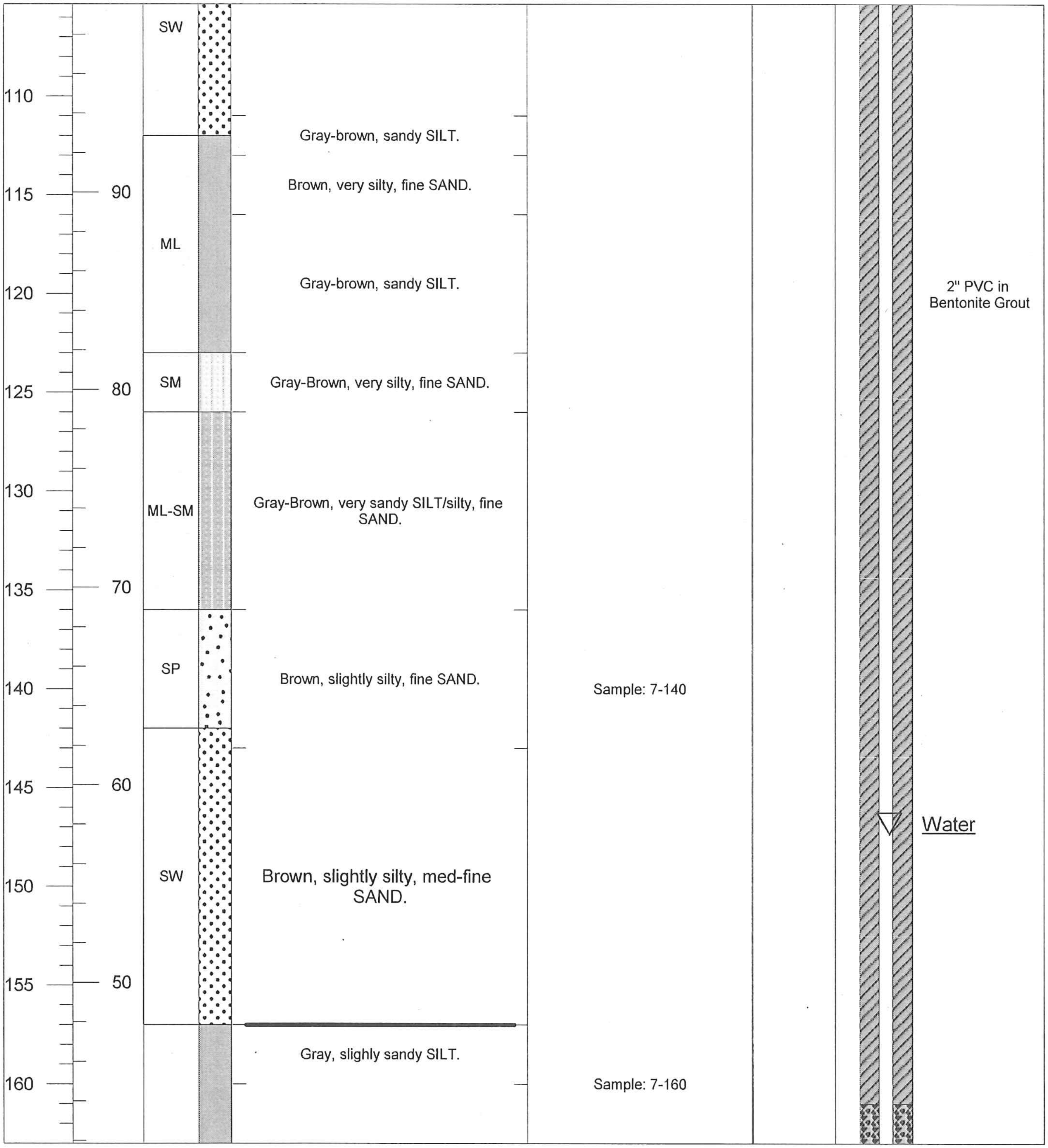
Started/Completed : 6/18/2013
Drilling Method : Sonic Core
Diameter : 8" to 165', 6" to 220'
Sampling Device : Sonic Core
Drilled By : Cascade Drillers, LP

Total Depth : 220
Logged By : Mark Varljen
Reviewed By : Mark Varljen

Monitoring Well: E7D

(Page: 3 of 4)

Surveyed By : TMI
Northing Coordinate : 9755.34
Easting Coordinate : 9986.01
TOC Elevation : 204.26
Depth to Water : 146.82 bTOC



Gray-brown, sandy SILT.

Brown, very silty, fine SAND.

Gray-brown, sandy SILT.

Gray-Brown, very silty, fine SAND.

Gray-Brown, very sandy SILT/silty, fine SAND.

Brown, slightly silty, fine SAND.

Brown, slightly silty, med-fine SAND.

Gray, slighly sandy SILT.

Sample: 7-140

Sample: 7-160

2" PVC in Bentonite Grout

Earth Science Strategies Consulting, Inc.

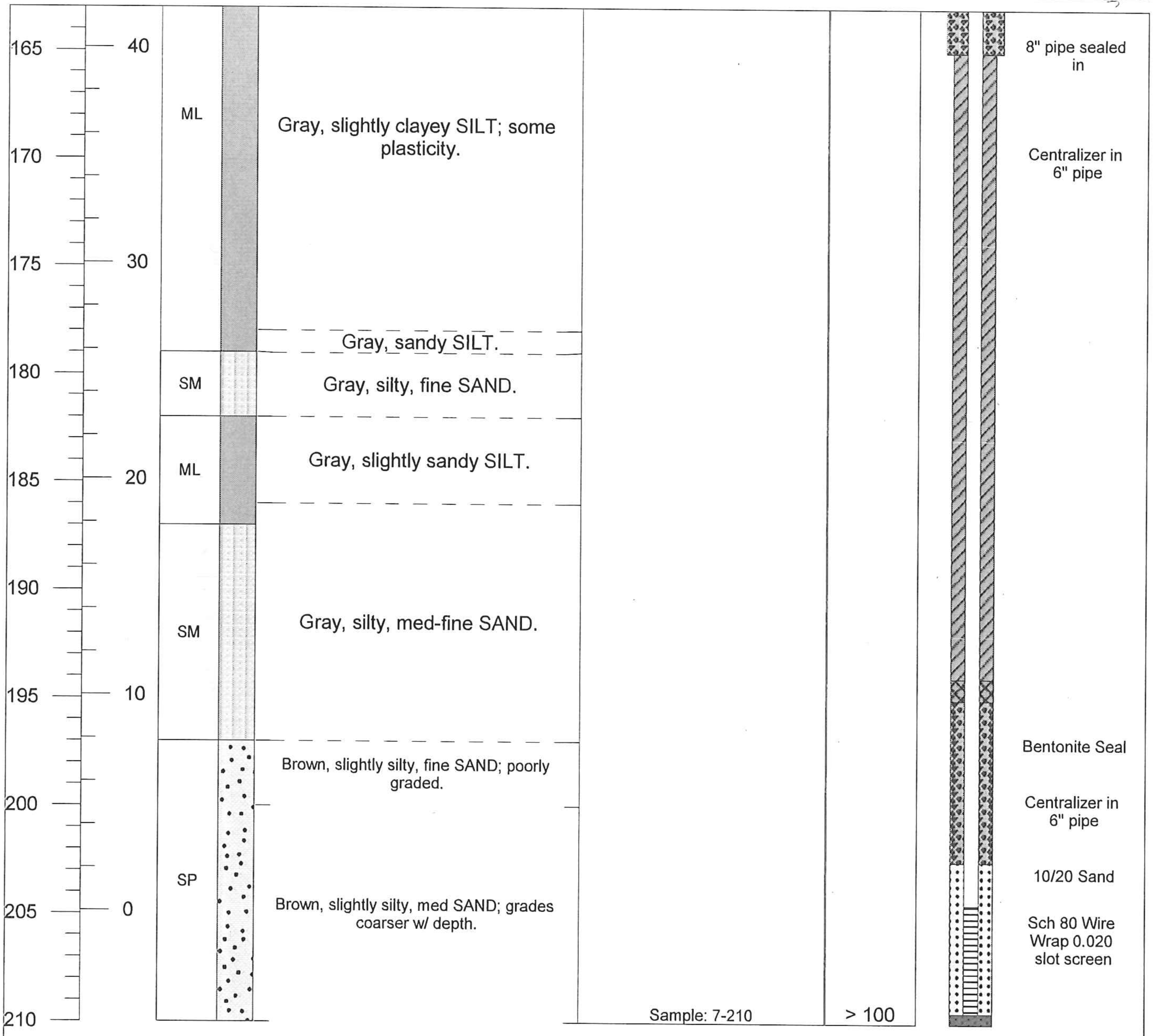
Island County Solid Waste Facility
Coupeville, Washington

Started/Completed	: 6/18/2013
Drilling Method	: Sonic Core
Diameter	: 8" to 165', 6" to 220'
Sampling Device	: Sonic Core
Drilled By	: Cascade Drillers, LP
Total Depth	: 220
Logged By	: Mark Varljen
Reviewed By	: Mark Varljen

Monitoring Well: E7D

(Page: 4 of 4)

Surveyed By	: TMI
Northing Coordinate	: 9755.34
Easting Coordinate	: 9986.01
TOC Elevation	: 204.26
Depth to Water	: 146.82 bTOC



Gray, slightly clayey SILT; some plasticity.

Gray, sandy SILT.

Gray, silty, fine SAND.

Gray, slightly sandy SILT.

Gray, silty, med-fine SAND.

Brown, slightly silty, fine SAND; poorly graded.

Brown, slightly silty, med SAND; grades coarser w/ depth.

Sample: 7-210

> 100

Earth Science Strategies Consulting, Inc.

Island County Solid Waste Facility
Coupeville, Washington

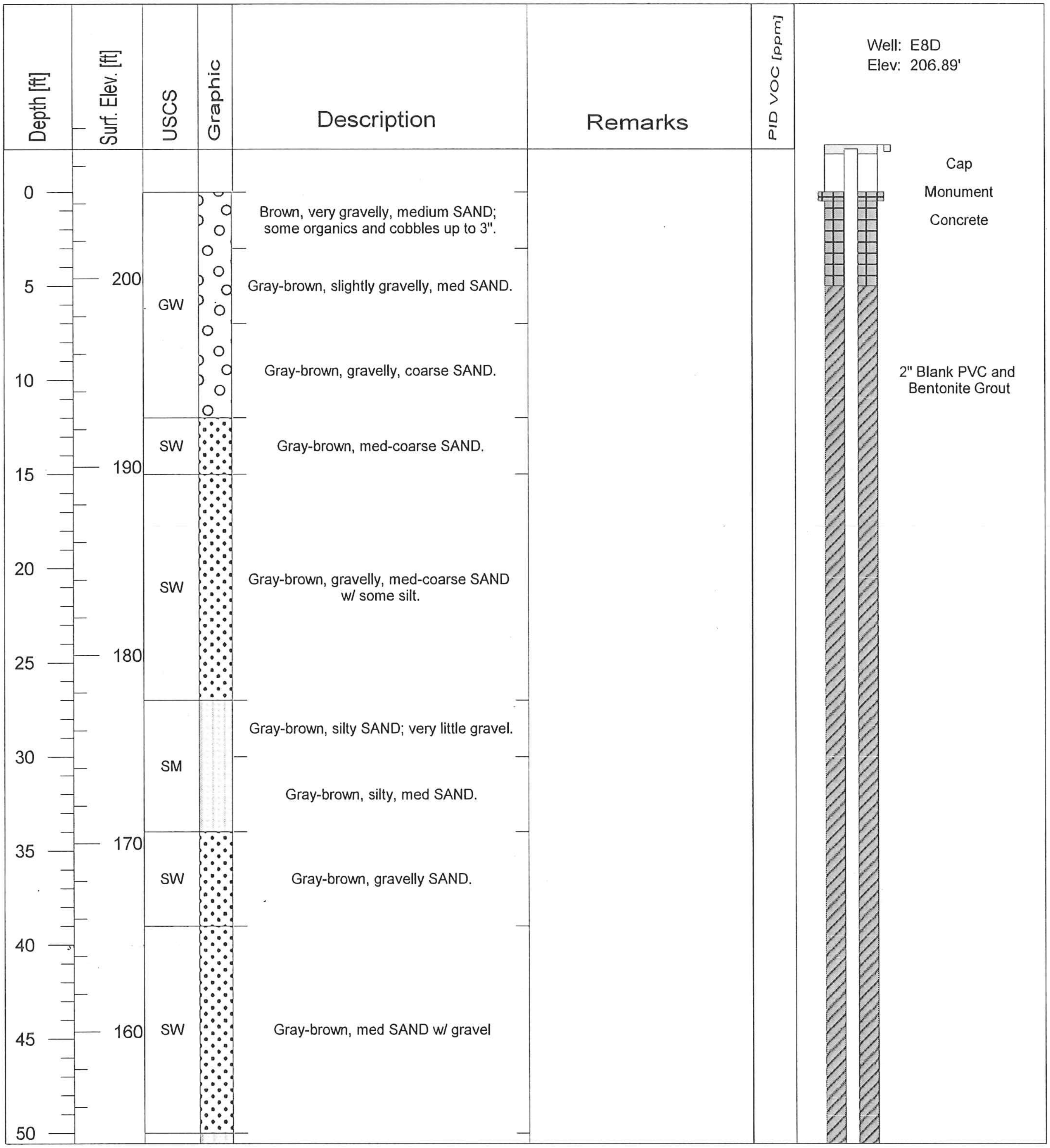
Started/Completed : 6/7/2013
Drilling Method : Sonic Core
Diameter : 8" to 165, 6" to 230
Sampling Device : Sonic Core
Drilled By : Cascade Drillers, LP

Total Depth : 230
Logged By : Mark Varljen
Reviewed By : Mark Varljen

Monitoring Well: E8D

(Page: 1 of 4)

Surveyed By	: TMI
Northing Coordinate	: 9504.91
Easting Coordinate	: 10176.71
TOC Elevation	: 206.89
Depth to Water	: 150.44 bTOC



USCS	Description
GW	Brown, very gravelly, medium SAND; some organics and cobbles up to 3".
	Gray-brown, slightly gravelly, med SAND.
	Gray-brown, gravelly, coarse SAND.
SW	Gray-brown, med-coarse SAND.
SW	Gray-brown, gravelly, med-coarse SAND w/ some silt.
SM	Gray-brown, silty SAND; very little gravel.
	Gray-brown, silty, med SAND.
SW	Gray-brown, gravelly SAND.
SW	Gray-brown, med SAND w/ gravel

Earth Science Strategies Consulting, Inc.

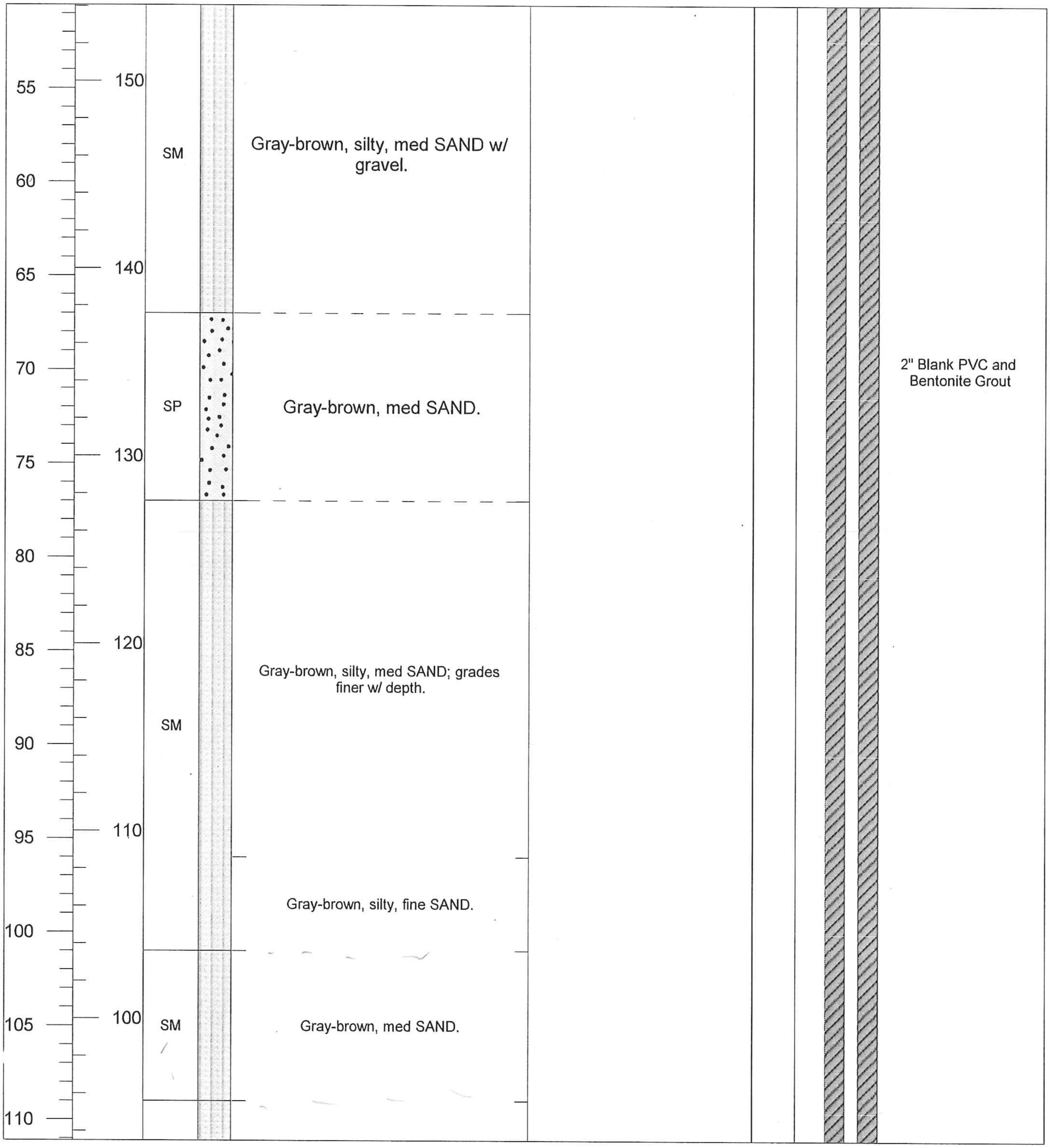
Island County Solid Waste Facility
Coupeville, Washington

Started/Completed : 6/7/2013
Drilling Method : Sonic Core
Diameter : 8" to 165, 6" to 230
Sampling Device : Sonic Core
Drilled By : Cascade Drillers, LP

Total Depth : 230
Logged By : Mark Varljen
Reviewed By : Mark Varljen

Monitoring Well: E8D

Surveyed By : TMI
Northing Coordinate : 9504.91
Easting Coordinate : 10176.71
TOC Elevation : 206.89
Depth to Water : 150.44 bTOC



Gray-brown, silty, med SAND w/ gravel.

Gray-brown, med SAND.

Gray-brown, silty, med SAND; grades finer w/ depth.

Gray-brown, silty, fine SAND.

Gray-brown, med SAND.

2" Blank PVC and Bentonite Grout

Earth Science Strategies Consulting, Inc.

Island County Solid Waste Facility
Coupeville, Washington

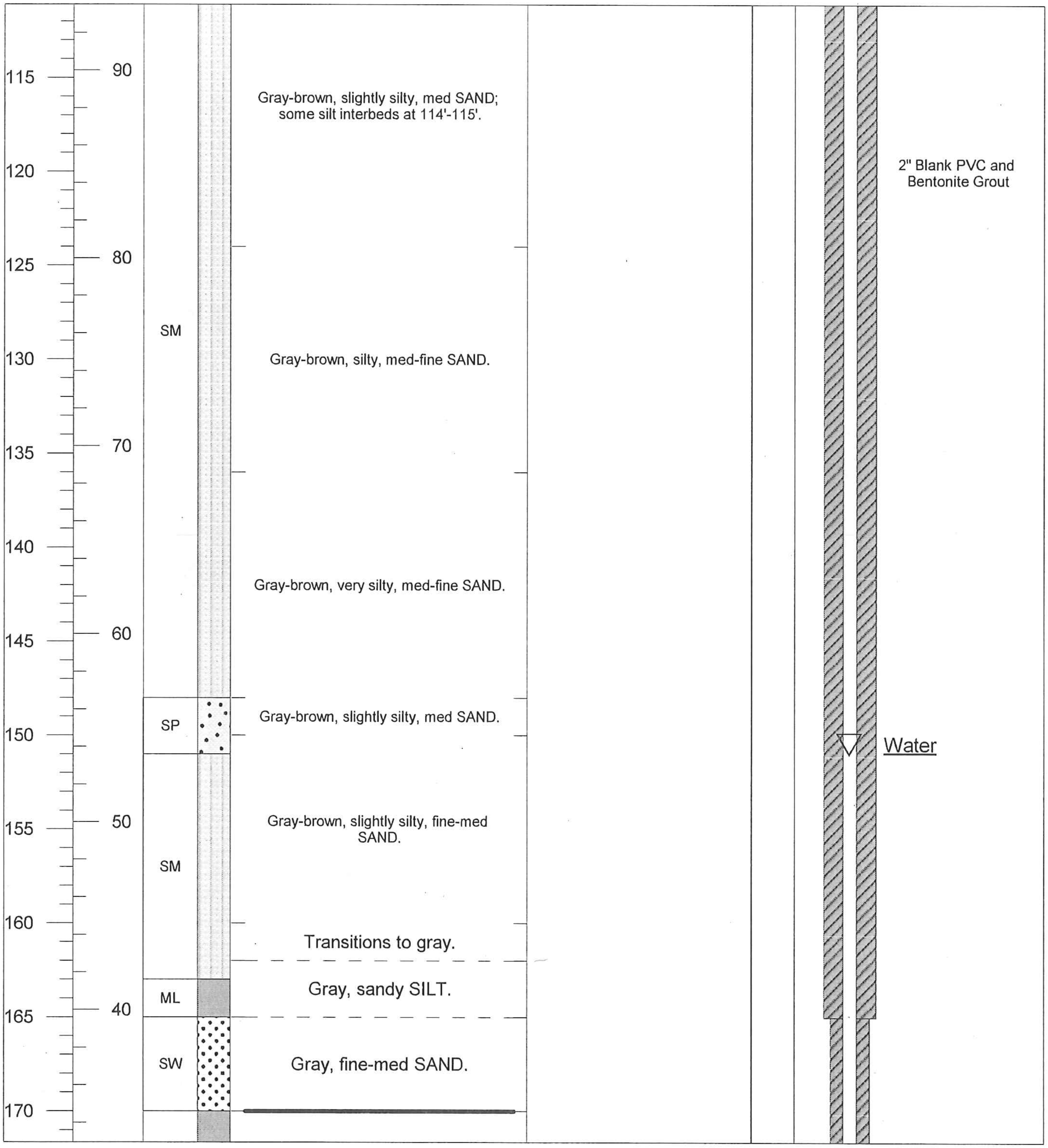
Started/Completed : 6/7/2013
Drilling Method : Sonic Core
Diameter : 8" to 165, 6" to 230
Sampling Device : Sonic Core
Drilled By : Cascade Drillers, LP

Total Depth : 230
Logged By : Mark Varljen
Reviewed By : Mark Varljen

Monitoring Well: E8D

(Page: 3 of 4)

Surveyed By : TMI
Northing Coordinate : 9504.91
Easting Coordinate : 10176.71
TOC Elevation : 206.89
Depth to Water : 150.44 bTOC



Gray-brown, slightly silty, med SAND; some silt interbeds at 114'-115'.

Gray-brown, silty, med-fine SAND.

Gray-brown, very silty, med-fine SAND.

Gray-brown, slightly silty, med SAND.

Gray-brown, slightly silty, fine-med SAND.

Transitions to gray.

Gray, sandy SILT.

Gray, fine-med SAND.

Earth Science Strategies Consulting, Inc. ∇

Island County Solid Waste Facility
Coupeville, Washington

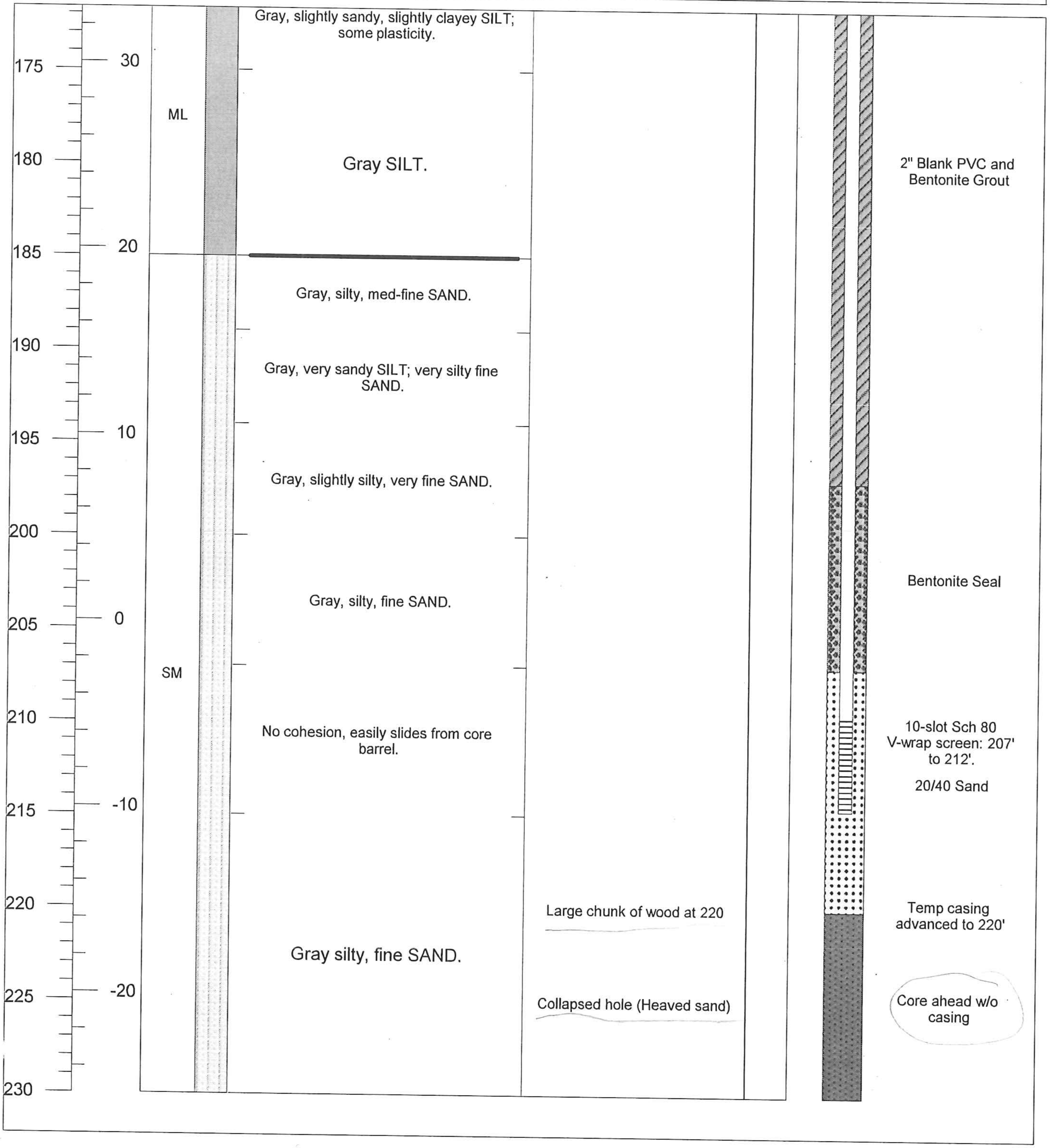
Started/Completed : 6/7/2013
Drilling Method : Sonic Core
Diameter : 8" to 165, 6" to 230
Sampling Device : Sonic Core
Drilled By : Cascade Drillers, LP

Total Depth : 230
Logged By : Mark Varljen
Reviewed By : Mark Varljen

Monitoring Well: E8D

(Page: 4 of 4)

Surveyed By : TMI
Northing Coordinate : 9504.91
Easting Coordinate : 10176.71
TOC Elevation : 206.89
Depth to Water : 150.44 bTOC



Gray, slightly sandy, slightly clayey SILT; some plasticity.

Gray SILT.

Gray, silty, med-fine SAND.

Gray, very sandy SILT; very silty fine SAND.

Gray, slightly silty, very fine SAND.

Gray, silty, fine SAND.

No cohesion, easily slides from core barrel.

Gray silty, fine SAND.

Large chunk of wood at 220

Collapsed hole (Heaved sand)

2" Blank PVC and Bentonite Grout

Bentonite Seal

10-slot Sch 80 V-wrap screen: 207' to 212'.

20/40 Sand

Temp casing advanced to 220'

Core ahead w/o casing

Appendix B

Laboratory Data as Provided by TestAmerica

Appendix D

Slug Test Data and Calculations

MONITORING WELLS

WELL E7D

NORTHING (Y) 446421.132 FT

EASTING (X) 1197687.840 FT

ELEVATION (Z) 204.26 FT TOP OF PVC

WELL E6D

NORTHING (Y) 446155.193 FT

EASTING (X) 1197629.618 FT

ELEVATION (Z) 206.73 FT TOP OF PVC

WELL E8D

NORTHING (Y) 446170.638 FT

EASTING (X) 1197878.784 FT

ELEVATION (Z) 206.89 FT TOP OF PVC

WELL E5D

NORTHING (Y) 446405.944 FT

EASTING (X) 1198000.366 FT

ELEVATION (Z) 202.32 FT TOP OF PVC

WELL ID: E5D Nitro 1

Local ID: E5D
Date: 8/20/2013
Time: 15:03

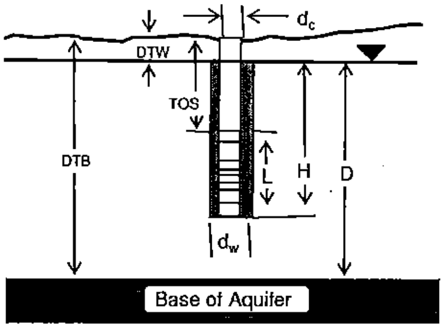
INPUT

Construction:
Casing dia. (d_c) 4 Inch
Annulus dia. (d_w) 8 Inch
Screen Length (L) 5 Feet

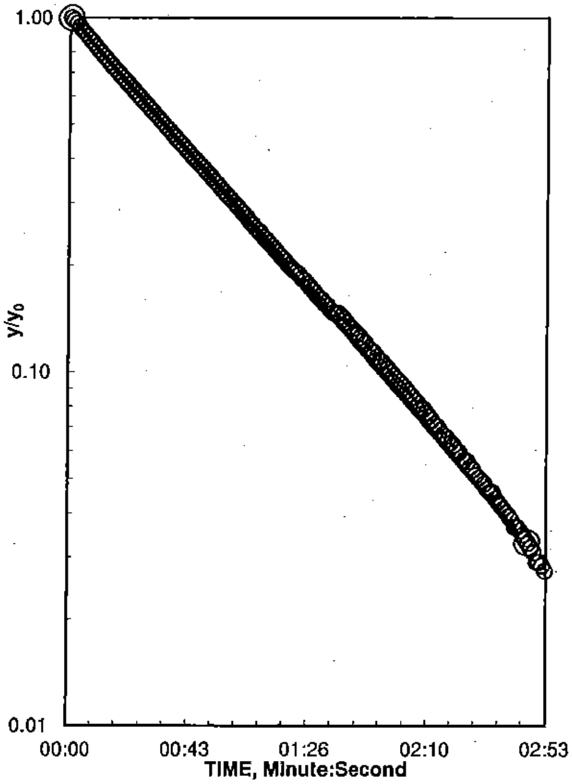
Depths to:
water level (DTW) 146.54 Feet
top of screen (TOS) 206.3 Feet
Base of Aquifer (DTB) 250 Feet

Annular Fill:
across screen -- Medium Sand
above screen -- Bentonite

Aquifer Material -- Fine Sand



Adjust slope of line to estimate K



COMPUTED

L_{wetted} 5 Feet
D = 103.46 Feet
H = 64.76 Feet
L/r_w = 15.00
$y_{0\text{-DISPLACEMENT}}$ = 4.27 Feet
$y_{0\text{-SLUG}}$ = 4.27 Feet

From look-up table using L/r_w
Partial penetrate A = 2.063
B = 0.312

ln(Re/rw) = 2.247
Re = 3.15 Feet

Slope = 0.008952 $\log_{10}$/sec
$t_{90\%}$ recovery = 112 sec

Input is consistent.

K = 11 Feet/Day

REMARKS:

Bouwer and Rice analysis of slug test, WRR 1976

Aquifer is a silty, fine SAND in the Puget Lowland.

WELL ID: E5D Nitro 2

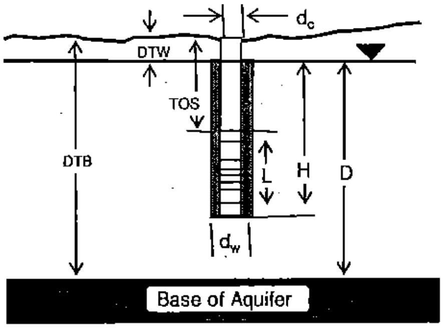
Local ID: E5D
Date: 8/20/2013
Time: 15:55

INPUT

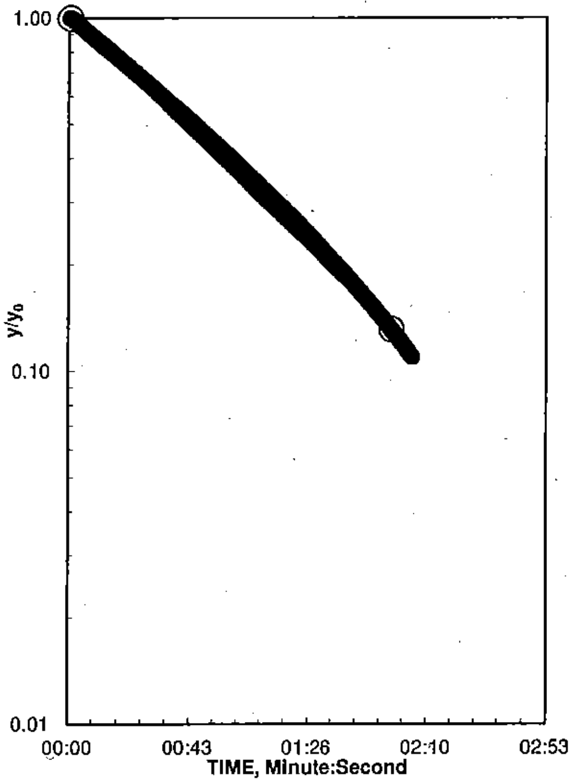
Construction:	
Casing dia. (d_c)	4 Inch
Annulus dia. (d_w)	8 Inch
Screen Length (L)	5 Feet
Depths to:	
water level (DTW)	146.54 Feet
top of screen (TOS)	206.3 Feet
Base of Aquifer (DTB)	250 Feet

Annular Fill:
across screen -- Medium Sand
above screen -- Bentonite

Aquifer Material -- Fine Sand



Adjust slope of line to estimate K



COMPUTED

L_{wetted}	5 Feet
D =	103.46 Feet
H =	64.76 Feet
L/r_w =	15.00
$y_{0\text{-DISPLACEMENT}}$ =	20.14 Feet
$y_{0\text{-SLUG}}$ =	20.14 Feet
From look-up table using L/r_w	
Partial penetrate A =	2.063
B =	0.312
ln(Re/rw) =	2.247
Re =	3.15 Feet
Slope =	0.007577 $\log_{10}$/sec
$t_{90\%}$ recovery =	132 sec

Input is consistent.

K = 9.4 Feet/Day

REMARKS:

Bouwer and Rice analysis of slug test, WRR 1976

Aquifer is a silty, fine SAND in the Puget Lowland.

WELL ID: E5D Nitro 3

Local ID: E5D
Date: 8/20/2013
Time: 16:13

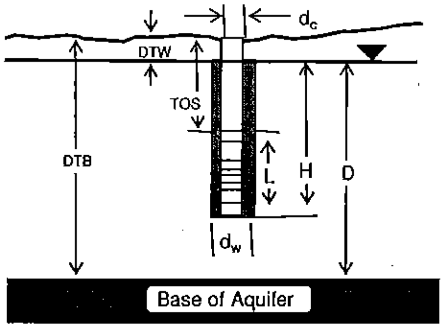
INPUT

Construction:
Casing dia. (d_c) 4 Inch
Annulus dia. (d_w) 8 Inch
Screen Length (L) 5 Feet

Depths to:
water level (DTW) 146.54 Feet
top of screen (TOS) 206.3 Feet
Base of Aquifer (DTB) 250 Feet

Annular Fill:
across screen -- Medium Sand
above screen -- Bentonite

Aquifer Material -- Fine Sand



COMPUTED

L_{wetted} 5 Feet
D = 103.46 Feet
H = 64.76 Feet
L/r_w = 15.00
$y_{0\text{-DISPLACEMENT}}$ = 20.85 Feet
$y_{0\text{-SLUG}}$ = 20.85 Feet

From look-up table using L/r_w
Partial penetrate A = 2.063
B = 0.312

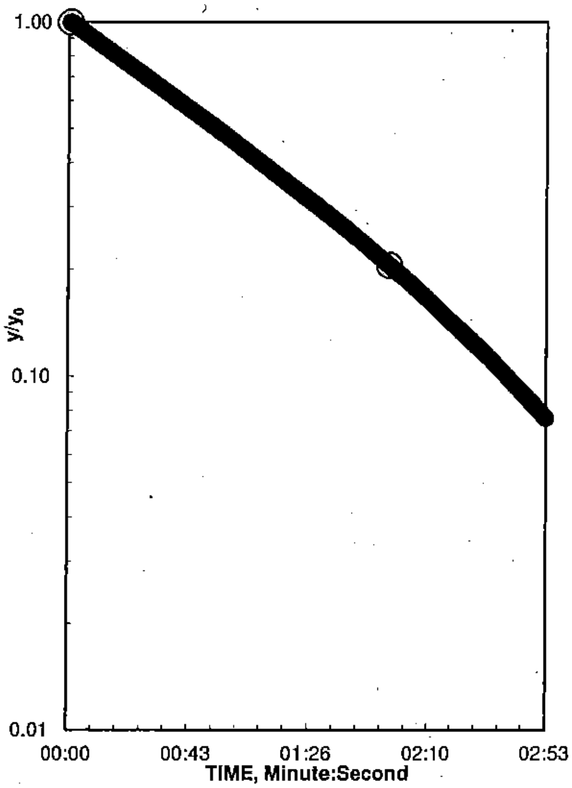
ln(Re/rw) = 2.247
Re = 3.15 Feet

Slope = 0.005985 $\log_{10}$/sec
$t_{90\%}$ recovery = 167 sec

Input is consistent.

K = 7.4 Feet/Day

Adjust slope of line to estimate K



REMARKS:

Bouwer and Rice analysis of slug test, WRR 1976

Aquifer is a silty, fine SAND in the Puget Lowland.

WELL ID: E6D Nitro 2

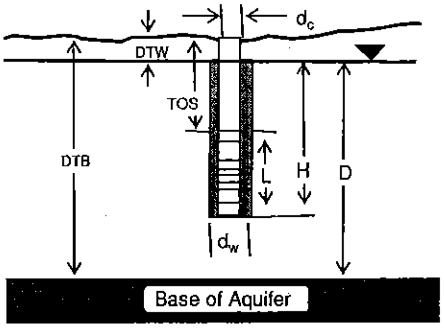
Local ID: E6D
Date: 8/19/2013
Time: 15:13

INPUT

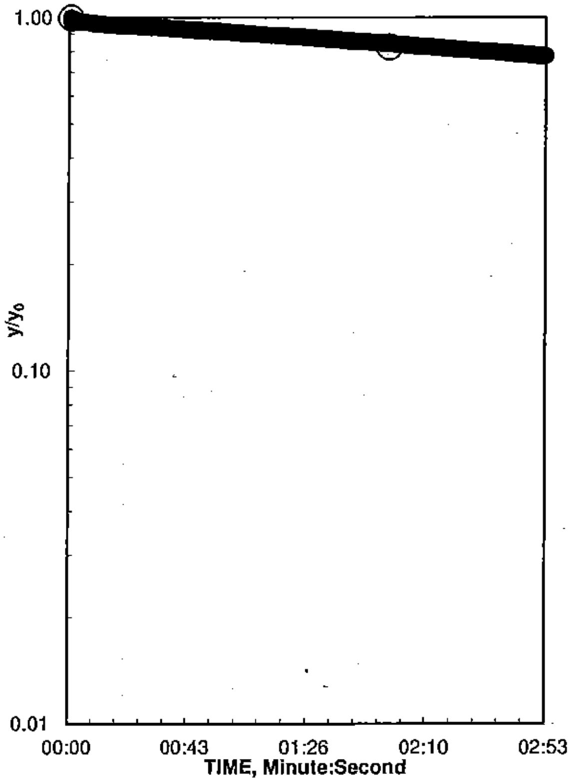
Construction:	
Casing dia. (d_c)	4 Inch
Annulus dia. (d_w)	8 Inch
Screen Length (L)	5 Feet
Depths to:	
water level (DTW)	149 Feet
top of screen (TOS)	204.25 Feet
Base of Aquifer (DTB)	250 Feet

Annular Fill:
across screen -- Medium Sand
above screen -- Bentonite

Aquifer Material -- Fine Sand



Adjust slope of line to estimate K



COMPUTED

L_{wetted}	5 Feet
D =	101 Feet
H =	60.25 Feet
L/r_w =	15.00
$y_{0\text{-DISPLACEMENT}}$ =	1.55 Feet
$y_{0\text{-SLUG}}$ =	1.55 Feet
From look-up table using L/r_w	
Partial penetrate A =	2.063
B =	0.312
ln(Re/rw) =	2.227
Re =	3.09 Feet
Slope =	0.000719 $\log_{10}$/sec
$t_{90\%}$ recovery =	1391 sec

Input is consistent.

K = 0.88 Feet/Day

K= 0.88 is less than likely minimum of 3 for Fine Sand

REMARKS: Bouwer and Rice analysis of slug test, WRR 1976

Aquifer is a silty, fine SAND.

WELL ID: E6D Nitro 3

Local ID: E6D
Date: 8/19/2013
Time: 15:46

INPUT

Construction:

Casing dia. (d_c)	4 Inch
Annulus dia. (d_w)	8 Inch
Screen Length (L)	5 Feet

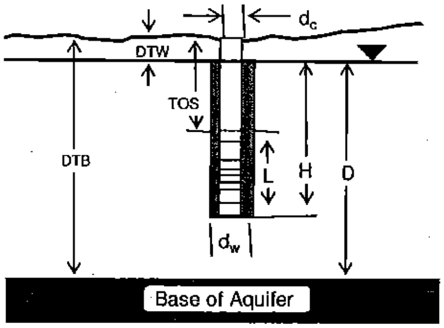
Depths to:

water level (DTW)	149 Feet
top of screen (TOS)	204.25 Feet
Base of Aquifer (DTB)	250 Feet

Annular Fill:

across screen -- Medium Sand
above screen -- Bentonite

Aquifer Material -- Fine Sand



COMPUTED

L_{wetted}	5 Feet
D =	101 Feet
H =	60.25 Feet
L/r_w =	15.00
$y_{0\text{-DISPLACEMENT}}$ =	1.74 Feet
$y_{0\text{-SLUG}}$ =	1.74 Feet

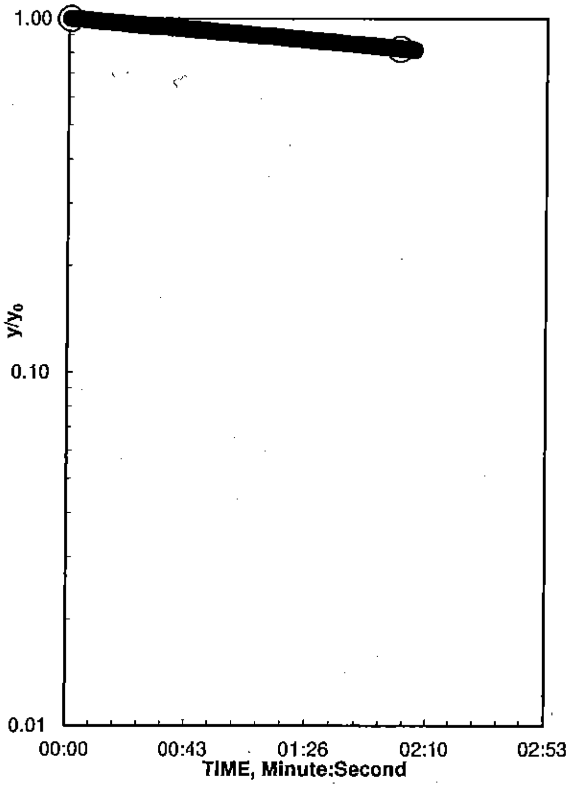
From look-up table using L/r_w

Partial penetrate A =	2.063
B =	0.312
ln(Re/rw) =	2.227
Re =	3.09 Feet
Slope =	0.000722 $\log_{10}$/sec
$t_{90\%}$ recovery =	1385 sec

Input is consistent.

K = 0.89 Feet/Day

Adjust slope of line to estimate K



K= 0.89 is less than likely minimum of 3 for Fine Sand

REMARKS:

Bouwer and Rice analysis of slug test, WRR 1976

Aquifer is a silty, fine SAND in the Puget Lowland.

WELL ID: E7D Nitro 1

Local ID: E7D
Date: 8/19/2013
Time: 12:32

INPUT

Construction:

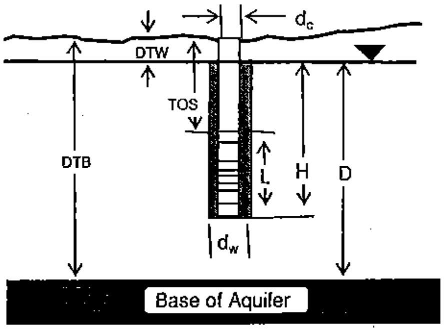
Casing dia. (d_c)	2 Inch
Annulus dia. (d_w)	6 Inch
Screen Length (L)	5 Feet

Depths to:

water level (DTW)	146.82 Feet
top of screen (TOS)	204.5 Feet
Base of Aquifer (DTB)	250 Feet

Annular Fill:
across screen -- Medium Sand
above screen -- Bentonite

Aquifer Material -- Fine Sand



COMPUTED

L_{wetted}	5 Feet
D =	103.18 Feet
H =	62.68 Feet
L/r_w =	20.00
$y_{0\text{-DISPLACEMENT}}$ =	18.05 Feet
$y_{0\text{-SLUG}}$ =	18.05 Feet

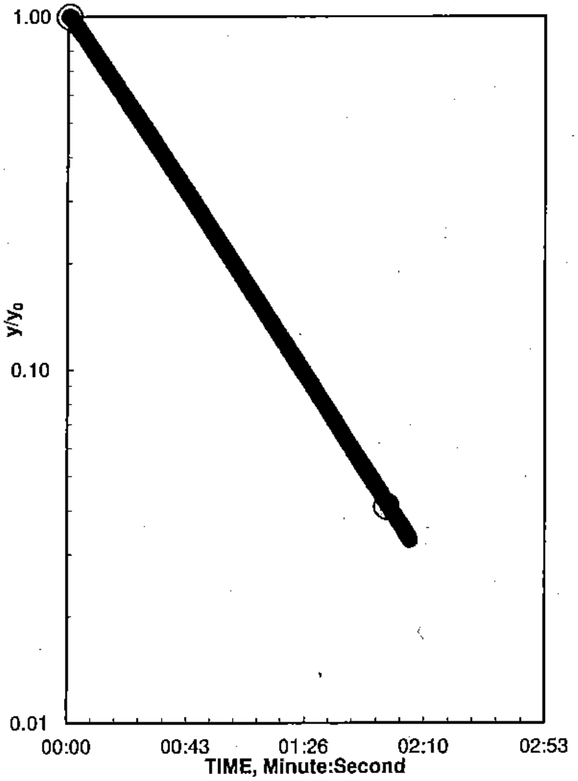
From look-up table using L/r_w

Partial penetrate A =	2.202
B =	0.345
ln(Re/rw) =	2.519
Re =	3.10 Feet
Slope =	0.012011 $\log_{10}$/sec
$t_{90\%}$ recovery =	83 sec

Input is consistent.

K = 4.2 Feet/Day

Adjust slope of line to estimate K



REMARKS:

Bouwer and Rice analysis of slug test, WRR 1976

Aquifer is a silty, fine SAND in the Puget Lowland.

WELL ID: E7D Nitro 2

Local ID: E7D
Date: 8/19/2013
Time: 12:45

INPUT

Construction:

Casing dia. (d_c)	2 Inch
Annulus dia. (d_w)	6 Inch
Screen Length (L)	5 Feet

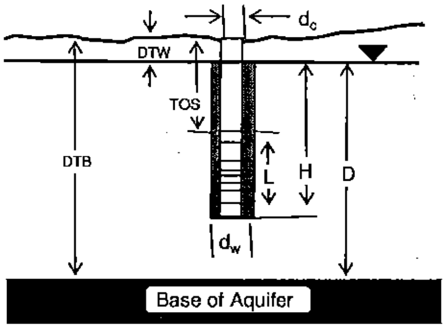
Depths to:

water level (DTW)	146.82 Feet
top of screen (TOS)	204.5 Feet
Base of Aquifer (DTB)	250 Feet

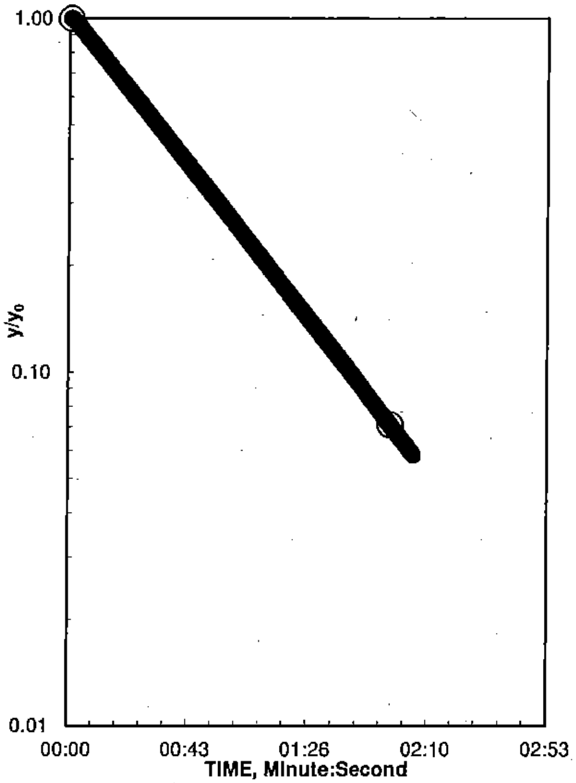
Annular Fill:

across screen -- Medium Sand
above screen -- Bentonite

Aquifer Material -- Fine Sand



Adjust slope of line to estimate K



COMPUTED

L_{wetted}	5 Feet
D =	103.18 Feet
H =	62.68 Feet
L/r_w =	20.00
$y_{0\text{-DISPLACEMENT}}$ =	20.47 Feet
$y_{0\text{-SLUG}}$ =	20.47 Feet

From look-up table using L/r_w

Partial penetrate A =	2.202
B =	0.345
ln(Re/rw) =	2.519
Re =	3.10 Feet
Slope =	0.00992 $\log_{10}$/sec
$t_{90\%}$ recovery =	101 sec

Input is consistent.

K = 3.4 Feet/Day

REMARKS:

Bouwer and Rice analysis of slug test, WRR 1976

Aquifer is a silty, fine SAND in the Puget Lowland.

WELL ID: E8D Nitro 1

Local ID: E8D
Date: 8/20/2013
Time: 10:58

INPUT

Construction:

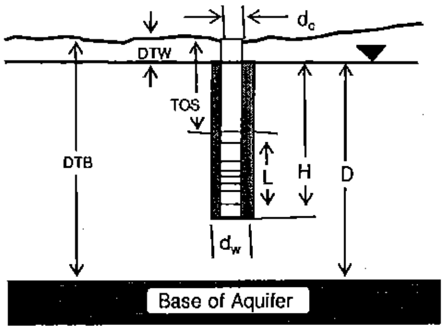
Casing dia. (d_c)	2 Inch
Annulus dia. (d_w)	6 Inch
Screen Length (L)	5 Feet

Depths to:

water level (DTW)	150.44 Feet
top of screen (TOS)	209.9 Feet
Base of Aquifer (DTB)	250 Feet

Annular Fill:
across screen -- Medium Sand
above screen -- Bentonite

Aquifer Material -- Fine Sand



COMPUTED

L_{wetted}	5 Feet
D =	99.56 Feet
H =	64.46 Feet
L/r_w =	20.00
$y_{0\text{-DISPLACEMENT}}$ =	7.59 Feet
$y_{0\text{-SLUG}}$ =	7.60 Feet

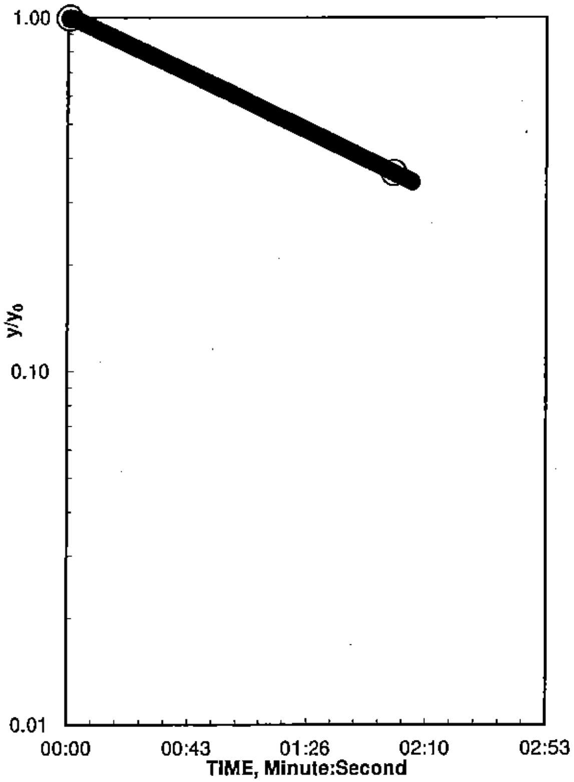
From look-up table using L/r_w

Partial penetrate A =	2.202
B =	0.345
ln(Re/rw) =	2.541
Re =	3.17 Feet
Slope =	0.003742 $\log_{10}$/sec
$t_{90\%}$ recovery =	267 sec

Input is consistent.

K = 1.3 Feet/Day

Adjust slope of line to estimate K



K= 1.3 is less than likely minimum of 3 for Fine Sand

REMARKS:

Bouwer and Rice analysis of slug test, WRR 1976

Aquifer is a silty, fine SAND in the Puget Lowland.

WELL ID: E8D Nitro 2

Local ID: E8D
Date: 8/20/2013
Time: 11:23

INPUT

Construction:

Casing dia. (d_c)	2 Inch
Annulus dia. (d_w)	6 Inch
Screen Length (L)	5 Feet

Depths to:

water level (DTW)	150.44 Feet
top of screen (TOS)	209.9 Feet
Base of Aquifer (DTB)	250 Feet

Annular Fill:

across screen -- Medium Sand
above screen -- Bentonite

Aquifer Material -- Fine Sand

COMPUTED

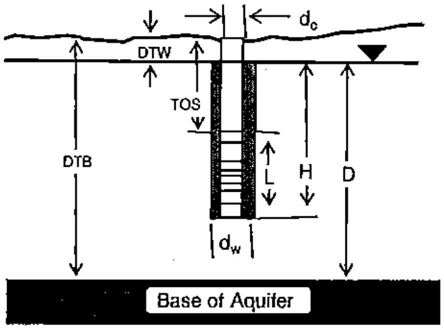
L_{wetted}	5 Feet
D =	99.56 Feet
H =	64.46 Feet
L/r_w =	20.00
$y_{0\text{-DISPLACEMENT}}$ =	9.56 Feet
$y_{0\text{-SLUG}}$ =	9.56 Feet

From look-up table using L/r_w

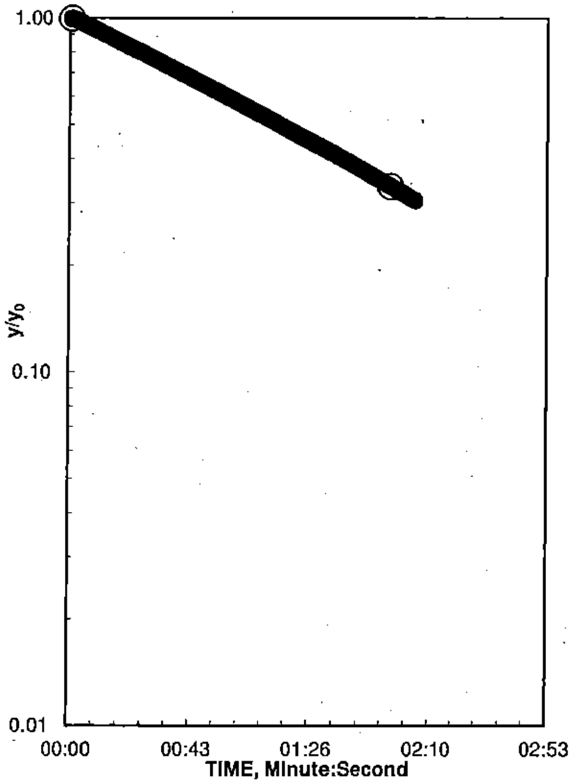
Partial penetrate A =	2.202
B =	0.345
ln(Re/rw) =	2.541
Re =	3.17 Feet
Slope =	0.00413 $\log_{10}$/sec
$t_{90\%}$ recovery =	242 sec

Input is consistent.

K = 1.4 Feet/Day



Adjust slope of line to estimate K



K= 1.4 is less than likely minimum of 3 for Fine Sand

REMARKS:

Bouwer and Rice analysis of slug test, WRR 1976

Aquifer is a silty, fine SAND in the Puget Lowland.

WELL ID: E8D Nitro 3

Local ID: E8D
Date: 8/20/2013
Time: 11:48

INPUT

Construction:

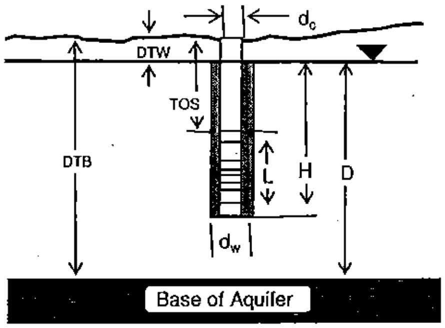
Casing dia. (d_c)	2	Inch
Annulus dia. (d_w)	6	Inch
Screen Length (L)	5	Feet

Depths to:

water level (DTW)	150.44	Feet
top of screen (TOS)	209.9	Feet
Base of Aquifer (DTB)	250	Feet

Annular Fill:
across screen -- Medium Sand
above screen -- Bentonite

Aquifer Material -- Fine Sand



COMPUTED

L_{wetted}	5	Feet
D =	99.56	Feet
H =	64.46	Feet
L/r_w =	20.00	
$y_{0\text{-DISPLACEMENT}}$ =	16.63	Feet
$y_{0\text{-SLUG}}$ =	16.63	Feet

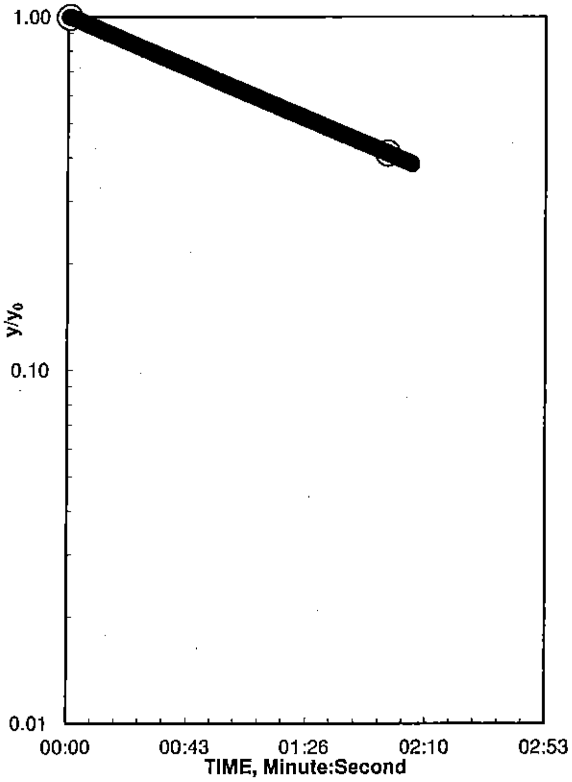
From look-up table using L/r_w

Partial penetrate A =	2.202	
B =	0.345	
ln(Re/rw) =	2.541	
Re =	3.17	Feet
Slope =	0.003358	$\log_{10}$/sec
$t_{90\%}$ recovery =	298	sec

Input is consistent.

K = 1.2 Feet/Day

Adjust slope of line to estimate K



K= 1.2 is less than likely minimum of 3 for Fine Sand

REMARKS:

Bouwer and Rice analysis of slug test, WRR 1976

Aquifer is a silty, fine SAND in the Puget Lowland.