SHALLOW AQUIFER CHARACTERIZATION
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Everett Landfill and Tire Fire Site
Everett, Washington
HWA Project No. 98165-610

Prepared for
City of Everett Public Works Department

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HWA GEOSCIENCES INC.
• Geotechnical Engineering
• Hydrogeology
• Geoenvironmental Services
• Inspection & Testing

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SHALLOW AQUIFER CHARACTERIZATION STUDY
EVERETT LANDFILL AND TIRE FIRE SITE
EVERETT, WASHINGTON

1.0 INTRODUCTION

This report summarizes the results of a ground water investigation completed by HWA GeoSciences Inc. (HWA) for the City of Everett, at the Everett Landfill and Tire Fire Site (Everett Landfill) in Everett, Washington. This work was performed in accordance with the guidelines for the Shallow Aquifer Characterization defined in the Consent Decree No. 012036406 governing the Everett Landfill Tire-Fire Site. Specifically, this report addresses condition F-8 of the Scope of Work and Schedule (Consent Decree Exhibit D). Additional information regarding the Shallow Aquifer Characterization is provided in the Cleanup Action Plan (CAP) (Consent Decree Exhibit C).

1.1 Purpose and Objectives

The purpose of this investigation was to determine the quality of the ground water within the shallow aquifer throughout the portion of the landfill underlain by the aquitard in order to identify zones of the landfill where a breach between the shallow and deep aquifers might cause an exceedance of cleanup standards in the deep aquifer at the point of compliance. Figure 2 shows the approximate extents of the aquitard. The shallow aquifer is the saturated leachate zone at the base of landfill waste. This information will be used to assist future development at the landfill, specifically for the foundation types. Future pile installation at the landfill will consider the ground water quality and potential risk to the deep aquifer from the methods of installing piles (e.g., augercast vs. driven piles), as per the CAP (Ecology, 2001).

1.2 Scope of Services

A Sampling and Analysis Plan (SAP) for this study was submitted by HWA to the City of Everett, and is included as Appendix A. The scope of work completed for this project was in general accordance with the SAP and included a focused approach to ground water investigation. The scope of work is summarized below:

- Review available data
- Drill 21 borings with mobile drive-point device (e.g., Geoprobe)
- Drill 13 borings with a tracked hollow stem auger (HSA) rig
- Collect 34 ground water samples

- Perform laboratory analyses on samples
- Prepare a report summarizing the findings of the investigation and delineate pile zones for development

1.3 PROJECT DESCRIPTION

The Everett Landfill site is located west of and adjacent to the Snohomish River, south of 36th Street, in Everett, Washington. Figure 1 shows the site location. Historically the Everett Landfill has been used as a burn dump, a scrap metal recycling and burial yard, and a municipal landfill. The landfill was closed in 1974 in compliance with standards at the time (Floyd & Snider, 2000). In 1977 a commercial recycling operation began storing and handling used rubber tires. Two separate fires occurred in 1983 and 1984 in the tire piles. The site was listed in 1989 under the Model Toxics Control Act (MTCA) due the presence of the tire ash. Subsequent Interim Actions have occurred between 1995 and 1998 and included regrading of the site and installation of a leachate collection system, in order to minimize and control the generation of leachate from the site. In 2001, a Consent Decree between the Department of Ecology and the City of Everett was put in place, defining requirements for both existing and future developed site conditions.

The site is designated as an area for redevelopment in the City of Everett's Comprehensive Land Use Plan. Before redevelopment can proceed, the construction and operation constraints need to be defined to ensure that contaminated materials do not compromise environmental exposure pathways, as defined in the CAP.

2.0 FIELD METHODOLOGY

HWA conducted a subsurface exploration program between February 10 and 28, 2003. The program consisted of drilling and sampling 34 borings. Appendix A contains the SAP, which describes the site investigation methodologies.

2.1 SITE EXPLORATIONS

2.1.1 Soil Sampling

Cascade Drilling, Inc. (Cascade), under subcontract to HWA, advanced the borings to depths of 10 to 41 feet below grade. Cascade provided a mobile drive-point sampling device (probe rig) to collect soil and ground water samples from 21 borings. The device consisted of hydraulic drive assemblies mounted on either a tracked skid-steer loader (e.g., Bobcat) or pickup truck. The probe rig drove a four-foot long steel pipe (2-inch diameter) with a glycol modified polyethylene terephthalate (PETG) inner sleeve into the ground using a hydraulic impact driver. Soil cores were retrieved by withdrawing the pipe. Soil samples were then retrieved from the sampler and removed for logging and sampling. Cascade also used a track-mounted HSA drilling rig with 8.25-inch outside diameter augers to drill a further 13 borings at locations where drive-point sampling could not penetrate to ground water. Soil samples were collected through the hollow-stem of the auger using a standard split spoon sampler driven ahead of the bit. All borings and wells were drilled and installed according to Ecology Minimum Standards for Construction and Maintenance of Wells (Chapter 173-160 WAC).

Figure 2 shows the sampling locations. The sampling area included most of the landfill, in order to gain a better understanding of shallow aquifer/leachate quality, although the CAP specified that this one-time sampling occur only in the area underlain by the aquitard (Ecology, 2001). Appendix B contains the boring logs. An HWA environmental geologist/engineer collected continuous soil samples from the probe locations. Split spoon samples were collected from the HSA borings at 2.5-foot intervals. Pertinent information including soil sample depths, stratigraphy, soil engineering characteristics, and ground water occurrence was recorded.

After all probe borings reached their maximum depth and were sampled, Cascade withdrew the steel pipes from the ground and grouted the holes to four inches below the ground surface using granular bentonite. Cascade sealed the HSA borings to four inches below the ground surface using granular bentonite, introduced through the augers as they were withdrawn from the ground. Cascade patched the surface holes with the original surface soil or asphalt to match the existing surface.

2.1.2 Ground Water Sampling

Ground water samples were collected at 11 of the probe locations by installing a temporary ¾-inch diameter PVC well screen (0.010-inch slot) in the borehole. Ground water was collected from the remaining 10 probe locations by driving a section of pipe containing a retractable four-foot long stainless steel screen (0.004-inch slot). After reaching the desired depth, the pipe was retracted, exposing the screen to the soil. Temporary 2-inch diameter PVC well screen (0.010-inch slot) was used in the 13 HSA boreholes. Ground water was collected using a peristaltic pump and Teflon-lined polyethylene tubing lowered into the screen. New Teflon-lined polyethylene tubing was used for each ground water sample. For locations where the depth to ground water was greater than 22 feet, a foot valve at the bottom of the tubing was used to assist in collecting the ground water sample.

2.2 Analytical Methods

HWA submitted the 34 ground water samples to CCI Analytical Laboratories, Inc. (CCI), Everett, Washington, for organic analyses, and to the Everett Environmental Laboratory (EEL) for inorganic analyses. The laboratories analyzed the ground water samples for the following constituents, based on the suite of analytes approved for evaluation ground water monitoring:

Analysis	Method
Volatile organic compounds (VOCs)	EPA 8260
Semivolatile organic compounds (SVOCs)	EPA 8270
Pesticides/poly-chlorinated biphenyls (PCBs)	EPA 8082/8081
Dissolved metals*	EPA 6000/7000 series
Chloride	EPA 300A
Nitrate/Nitrite	EPA 300A

* antimony, arsenic, cadmium, chromium(III), chromium(VI), chromium(III+VI), copper, lead, nickel, selenium, zinc, iron and manganese

3.0 GEOLOGY AND HYDROGEOLOGY

3.1 REGIONAL AND SITE GEOLOGIC CONDITIONS

Geological information for the site was obtained from the *Geologic Map of the Everett Quadrangle, Snohomish County, Washington* (Minard, 1985). The mapping indicates that the site vicinity is generally underlain by Holocene alluvium consisting of unconsolidated deposits of clay, silt and very fine to fine sand, with abundant organic material and peat deposits. Areas of fill are also common in the vicinity of the site. Previous explorations at the Everett Landfill indicate the following sequence of strata in the area, from youngest to oldest (Floyd & Snider, 1999):

- Soil fill and landfill cover occurs over the entire landfill site to depths of six to 20 feet
- Waste from previous landfill operations is present to depths of up to approximately 33 feet.
- Peat, silt, and silty peat deposits occur near the original surface elevation in the eastern half of the site, beneath the waste. This unit acts as an aquitard where present.
- Loose sand (alluvium) underlies the peat in the eastern portion of the landfill.
- Glacial soils comprised of dense sand and silty sand underlie the waste in the western potion of the site, and underlie the loose sand to the east.
- Stiff silt and silty sands (Transitional Beds) overly the glacial sands in some areas, and possibly underlie the waste in some areas, particularly at the western site boundary, near the glacial uplands.

Subsurface soils encountered in HWA's explorations were generally consistent with previous investigations, and included a layer of soil fill overlying waste material. The bottom of the waste was only penetrated in 11 borings. Silty peat was only encountered in three of these borings, located in the eastern two-thirds of the site, at depths between 30 and 35 feet. Fine to medium sand with interbedded silt layers overlying very stiff silt was encountered below the waste in the other eight borings, which were located in the western third of the site. Each of the layers is described below:

- **Fill** – Fill was encountered in all of the boreholes, ranging in thickness from 0.5 to 19 feet. The fill was variable in composition and consistency, and included gravelly sand, silty sand and silt. In the central portion of the site, the fill was overlain by approximately 0.5 feet of biosolids (applied as cover over much of the landfill).

- **Waste** – Waste was encountered in all of the boreholes, ranging in depths from 0.5 feet to greater than 32 feet. The waste varied in composition, and consisted mainly of silty sand with intermixed wood debris, concrete and household waste.

- **Peat** – Soft, wet, brown peat with silt was encountered in two borings at depths of 31 and 35 feet below ground surface. This low permeability layer has been referred to as the upper leachate aquitard in previous investigations at the Everett Landfill.

- **Sand** – Loose to dense, fine to medium sand with interbedded silt layers, underlies the waste in the western third of the site.

- **Silt** – Very stiff silt underlying the sand was encountered in five boreholes along the western boundary of the site between 11 and 15 feet below the ground surface. These borings were located relatively close to the steep slope west of the site, and this silt may be Quaternary Transitional Beds deposits.

3.2 Ground Water Conditions

Previous studies indicate a shallow water-bearing zone, perched on the silty peat aquitard that is present under the eastern two-thirds of the site. The shallow aquifer flows to the east through the waste and is intercepted by the leachate collection system along the eastern boundary of the site. Figure 2 shows the extent of the aquitard, as defined in the Brownfield Feasibility Study (Floyd & Snider, 2000), and confirmed by subsequent explorations.

A deeper aquifer flows under the entire site through the dense glacial soils. The deep aquifer discharges east to the Snohomish River.

Ground water was encountered in all 34 HWA borings. Depth to ground water was between 2.2 and 28.4 feet below ground surface. Figure 2 shows the ground water elevation and interpreted contours for the shallow aquifer. The ground water flow direction was generally to the east. The ground water gradient tends to flatten to the east across the area where the aquitard is present.

4.0 RESULTS

The following sections present the results of ground water samples collected from the borings. Tables 1 and 2 summarize the analytical results. Appendix C contains the analytical laboratory reports.

The Everett Landfill site is under an Ecology Consent Decree, and has established site specific cleanup levels and monitoring requirements set forth in the Consent Decree and specified in the Cleanup Action Plan (CAP). These cleanup levels do not apply directly to the shallow (or leachate) aquifer, but were used for comparison purposes, to estimate relative leachate quality over the landfill. The CAP specified the following (Ecology, 2001):

> *The area of the landfill that is underlain by aquitard will be sampled to obtain a statistically relevant set of characterization data. If data shows that areas of the landfill contain contaminant concentrations in leachate that could, if connected to the lower aquifer, cause an exceedance of cleanup levels at the point of compliance, pile installation within that zone will be restricted to augercast piling. Drilled augercast piles will have no negative impact on the hydraulic properties of the aquitard since concrete is placed under head as the auger is removed maintaining a strong hydraulic seal at the aquitard. Pile installation restrictions will not be necessary in the western portions of the Site where the aquitard is not present (page 7-4).*

4.1 Inorganic Analytical Results

Inorganic compounds were detected in shallow ground water at concentrations exceeding the landfill cleanup levels at 23 of 34 borings, including: chloride, copper, nickel, lead, and zinc. Most of the inorganic cleanup level exceedances are due to nickel. The nickel cleanup level established in the Cleanup Action Plan (10 µg/L) was based on the chronic toxicity clean up level for marine surface water. For comparison, the MTCA Method B standard formula value cleanup level for nickel in ground water is 320 µg/L, and the EPA maximum contaminant level (MCL) for drinking water is 100 µg/L. Figure 3 shows the inorganic analytical results of the February 2003 sampling.

4.2 Organic Analytical Results

Organic compounds were detected in shallow ground water at concentrations exceeding the landfill cleanup levels at 11 of the 34 borings, including: benzene, toluene, xylenes, 1,4-dichlorobenzene, bis(2-ethylhexyl)phthalate, naphthalene, carbazole, and b-BHC. Figure 4 shows the organic analytical results.

TABLE 1
GROUND WATER INORGANIC ANALYTICAL RESULTS
(all results in µg/L except as noted)

ANALYTE	CL	SA-1	SA-2	SA-3	SA-4	SA-5	SA-6	SA-7	SA-8	SA-9	SA-10	SA-11	SA-12	SA-13	SA-14
Conventionals															
Chloride (mg/L)	230	**19**	**40.2**	**131**	**21.5**	**193**	**238**	**94.3**	**15.3**	**26**	**126**	**392**	**4.7**	**3.1**	**3.8**
Nitrate (mg/L)	10	**0.114**	**0.048**	**0.579**	**0.072**	>0.098	**0.204**	**0.083**	**0.013**	**0.093**	**0.811**	**1.46**	**0.084**	**0.067**	>0.084
Nitrite (mg/L)	1	**0.023**	<0.002	**0.04**	<0.002	**0.004**	**0.006**	<0.002	<0.002	**0.094**	**0.04**	**0.024**	**0.063**	**0.03**	<0.050
Metals (µg/L)															
Antimony	30	<30	<30	<30	<30	<30	<30	<30	<30	<30	<30	<30	<30	<30	<30
Arsenic	BKG	**20**	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20
Cadmium	5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Chromium	50	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Chromium(III)	16000	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Chromium(VI)	11	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Copper	10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	**17**	<10
Iron	BKG	**45600**	**5110**	47	**11500**	**40100**	**9870**	**8150**	**14900**	**132000**	**56900**	**22700**	**46600**	**24600**	**70400**
Lead	10	<10	<10	<10	<10	<10	<10	**18**	<10	<10	<10	<10	<10	<10	<10
Manganese	BKG	**1660**	**102**	**67**	**186**	**710**	**226**	**862**	**1210**	**1820**	**1470**	**1530**	**1500**	**2850**	**3660**
Nickel	10	**48**	<10	<10	<10	**20**	<10	<10	<10	**36.1**	**34.8**	**55.8**	<10	**36.5**	**14.6**
Selenium	20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20
Zinc	76.6	**40**	**10**	<8	**24**	**32**	**17**	**27**	<8	**76**	**92**	**66**	**9**	**17**	<8

CL - Everett Landfill cleanup level
Bold - above PQL
Shaded - exceeds landfill cleanup level
BKG - background, established after 3 year evaluation monitoring period

TABLE 1 (continued)
GROUND WATER INORGANIC ANALYTICAL RESULTS
(all results in µg/L except as noted)

ANALYTE	CL	SA-15	SA-16	SA-17	SA-18	SA-19	SA-20	SA-21	SA-22	SA-23	SA-24	SA-25	SA-26	SA-27	SA-28
Conventionals															
Chloride (mg/L)	230	**12.3**	**44.2**	**5.6**	**30.5**	**53.2**	**37.3**	**283**	**16.5**	**156**	**82.3**	**104**	**88.6**	**213**	**50.5**
Nitrate (mg/L)	10	**0.032**	**0.718**	**1.14**	>0.064	**0.145**	**0.679**	**0.482**	**0.119**	**0.145**	**0.172**	**0.144**	**0.594**	**0.12**	**0.417**
Nitrite (mg/L)	1	**0.132**	**0.025**	**0.012**	<0.100	**0.009**	**0.031**	**0.012**	**0.019**	**0.024**	**0.01**	**0.002**	**0.02**	**0.002**	**0.048**
Metals (µg/L)															
Antimony	30	<30	<30	<30	<30	<30	<30	<30	<30	<30	<30	<30	<30	<30	<30
Arsenic	BKG	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20
Cadmium	5	<1	<1	<1	**1.1**	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Chromium	50	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Chromium(III)	16000	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Chromium(VI)	11	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Copper	10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Iron	BKG	**118000**	**612**	**4760**	**85700**	**8900**	**33100**	**577**	**30400**	**40800**	**39700**	**30700**	**41300**	**31700**	**75700**
Lead	10	<10	<10	<10	**224**	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Manganese	BKG	**2880**	**1610**	**269**	**486**	**544**	**1000**	**414**	**1180**	**733**	**1510**	**480**	**1310**	**243**	**457**
Nickel	10	**53.4**	<10	**14**	**13.9**	<10	**12.5**	**27.8**	<10	<10	**48.4**	**11**	**15.4**	**14.7**	**14**
Selenium	20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20
Zinc	76.6	**8**	**8**	<8	**333**	**11**	**11**	**8**	**8**	<8	**12**	<8	**13**	<8	**8**

CL - Everett Landfill cleanup level
Bold - above PQL
Shaded - exceeds landfill cleanup level
BKG - background, established after 3 year evaluation monitoring period

TABLE 1 (continued)
GROUND WATER INORGANIC ANALYTICAL RESULTS
(all results in µg/L except as noted)

ANALYTE	CL	SA-29	SA--30	SA-31	SA-32	SA-33	SA-34
Conventionals							
Chloride (mg/L)	230	**232**	**106**	**207**	**569**	**48.5**	**258**
Nitrate (mg/L)	10	**0.346**	**0.634**	**0.018**	**0.546**	**0.566**	**0.205**
Nitrite (mg/L)	1	**0.012**	**0.005**	<0.002	**0.01**	**0.024**	**0.012**
Metals (µg/L)							
Antimony	30	<30	<30	<30	<30	<30	<30
Arsenic	BKG	<20	<20	<20	<20	<20	<20
Cadmium	5	<1	<1	<1	<1	<1	<1
Chromium	50	<10	<10	<10	<10	<10	<10
Chromium(III)	16000	<10	<10	<10	<10	<10	<10
Chromium(VI)	11	<10	<10	<10	<10	<10	<10
Copper	10	<10	<10	<10	<10	<10	<10
Iron	BKG	**21000**	**4200**	**9090**	**2840**	**50600**	**18400**
Lead	10	<10	<10	<10	<10	<10	<10
Manganese	BKG	**834**	**115**	**106**	**700**	**6000**	**838**
Nickel	10	**24.4**	<10	<10	**25.4**	**14.7**	**14.7**
Selenium	20	<20	<20	<20	<20	<20	<20
Zinc	76.6	**18**	<8	**12**	**17**	**74**	**15**

CL - Everett Landfill cleanup level
Bold - above PQL
Shaded - exceeds landfill cleanup level
BKG - background, established after 3 year evaluation monitoring period

TABLE 2
GROUND WATER ORGANIC ANALYTICAL RESULTS (detections only)
(all results in µg/L)

ANALYTE	CL	SA-3	SA-7	SA-8	SA-9	SA-10	SA-11	SA-12	SA-13	SA-14	SA-15	SA-18	SA-19	SA-20
VOC*														
Trichlorofluoromethane	2400	<2	<2	<2	**900**	<2	<2	<2	<2	<2	<2	<2	<2	<2
Cis-1,2-Dichloroethene	70	<5	<5	<5	<5	<5	**14**	<5	<5	<5	<5	<5	<5	<5
Benzene	5	<5	<5	<5	<5	**7**	**12**	<5	<5	<5	<5	**13**	**7**	<5
Toluene	40	<5	<5	<5	**12**	**12**	**67**	<5	**24**	<5	<5	<5	<5	<5
Chlorobenzene	100	<5	<5	<5	**12**	<5	**9**	**10**	<5	**9**	**5**	**9**	**5**	**14**
Ethylbenzene	30	<5	<5	<5	**11**	**12**	**19**	<5	<5	<5	<5	<5	**5**	<5
M+P Xylene	20	<5	<5	<5	**48**	**13**	**39**	<5	<5	<5	**12**	<5	<5	<5
O-Xylene	20	<5	<5	<5	<5	**5**	**9**	<5	<5	<5	<5	<5	<5	<5
Isopropylbenzene	640	<2	<2	<2	**3**	<2	**4**	<2	<2	<2	<2	**4**	<2	**5**
1,4-Dichlorobenzene	10	<10	<10	<10	**10**	<10	<10	<10	<10	<10	<10	<10	<10	<10
Naphthalene	320	<10	<10	<10	**13**	<10	**42**	<10	<10	<10	<10	**12**	<10	<10
SVOC*														
Phenol	9600	<10	<10	<10	<20	<10	**11**	<10	<10	<10	<10	<10	<10	<10
1,4-Dichlorobenzene	10	<10	<10	<10	<20	<10	<10	<10	<10	<10	<10	<10	<10	<10
2,4-Dimethylphenol	320	<10	<10	<10	<20	<10	<10	<10	<10	<10	<10	<10	<10	<10
Naphthalene	320	<10	<10	<10	<20	<10	**31**	<10	<10	<10	<10	**13**	<10	<10
Acenaphathene	643	<10	<10	<10	<20	<2	<2	<10	<10	<10	<10	<10	<10	<10
Diethylphthalate	12800	<10	**14**	<10	<20	<10	<10	<10	<10	<10	**79**	<10	<10	<10
Fluorene	640	<10	<10	<10	<20	<2	<2	<10	<10	<10	<10	<10	<10	<10
Carbazole	10	<10	<10	<10	<20	<10	<10	<10	<10	<10	<10	<10	<10	<10
Di-N-Butylphthalate	1600	<4	<4	<4	<30	<4	<4	<4	<4	<4	<4	<4	<4	<43
Fluoranthene	90	<10	<10	<10	<20	<10	<10	<10	<10	<10	<10	<10	<10	<10
Pyrene	480	<10	<10	<10	<20	<10	<10	<10	<10	<10	<10	<10	<10	<10
Butylbenzylphthalate	1252	<10	<10	<10	<20	<10	<10	<10	<10	<10	<10	<10	<10	<10
Bis(2-Ethylhexyl)Phthalate	10	<10	<10	<10	<30	**16**	<10	<10	<10	<10	<10	<10	<10	<10
PCB/Pesticides*														
b-BHC	0.06	<0.1	<0.05	<0.05	<0.05	<0.1	**0.1**	<0.05	<0.05	<0.05	<0.1	<0.1	<0.1	<0.1
4,4' -DDD	0.36	<0.1	<0.05	<0.05	**0.06**	<0.1	<0.1	<0.05	<0.05	<0.05	<0.1	<0.1	<0.1	**0.3**

* - No other VOCs, SVOCs, Pesticides or PCBs detected above reporting limits (see Appendix C for list of compounds analyzed)
CL - Everett Landfill cleanup level
Bold - above PQL
Shaded - exceeds landfill cleanup level

TABLE 2 (continued)
GROUND WATER ORGANIC ANALYTICAL RESULTS (detections only)
(all results in µg/L)

ANALYTE	CL	SA-21	SA-22	SA-23	SA-24	SA-25	SA-26	SA-27	SA-28	SA-29	SA-32	SA-33	SA-34
VOC*													
Trichlorofluoromethane	2400	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Cis-1,2-Dichloroethene	70	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Benzene	5	**11**	<5	<5	<5	**6**	<5	<5	**13**	<5	**6**	<5	**5**
Toluene	40	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	**91**
Chlorobenzene	100	**5**	**5**	**8**	**4**	**12**	**5**	**9**	**10**	<5	<5	<5	**7**
Ethylbenzene	30	<5	<5	<5	<5	<5	<5	<5	**5**	<5	**6**	<5	<5
M+P Xylene	20	**5**	<5	<5	**6**	<5	<5	<5	<5	**6**	**8**	<5	**5**
O-Xylene	20	**5**	<5	<5	<5	<5	<5	<5	<5	<5	**5**	<5	<5
Isopropylbenzene	640	**4**	<2	<2	<2	**3**	<2	**7**	**4**	<2	**5**	<2	<2
1,4-Dichlorobenzene	10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Naphthalene	320	<10	<10	<10	<10	<10	**26**	**13**	**480**	<10	**66**	<10	<10
SVOC*													
Phenol	9600	<10	<10	<10	<10	<10	<10	<10	<10	<10	<20	<10	<10
1,4-Dichlorobenzene	10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<20	<10	<10
2,4-Dimethylphenol	320	<10	<10	<10	<10	<10	<10	<10	<10	<10	<20	<10	<10
Naphthalene	320	<10	<10	<10	<10	<10	**26**	**18**	**380**	<10	<20	<10	<10
Acenaphathene	643	<10	<10	<10	<10	<10	<10	<10	**29**	<10	<20	<10	<10
Diethylphthalate	12800	<10	<10	<10	<10	<10	<10	<10	<10	<10	<20	<10	<10
Fluorene	640	<10	<10	<10	<10	<10	<10	<10	<10	<10	<20	<10	<10
Carbazole	10	<10	<10	<10	<10	<10	<10	<10	**10**	<10	<20	<10	<10
Di-N-Butylphthalate	1600	<4	<4	<4	<4	<4	<4	<4	<4	<4	<30	<4	**14**
Fluoranthene	90	<10	<10	<10	<10	<10	<10	<10	<10	<10	<20	<10	<10
Pyrene	480	<10	<10	<10	<10	<10	<10	<10	<10	<10	<20	<10	<10
Butylbenzylphthalate	1252	<10	<10	<10	<10	<10	<10	<10	<10	<10	<20	<10	<10
Bis(2-Ethylhexyl)Phthalate	10	<10	<10	**27**	**10**	<10	**24**	<10	**10**	<10	<30	<10	<10
PCB/Pesticides*													
b-BHC	0.06	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	**0.2**	<0.1	<0.1
4,4' -DDD	0.36	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	**0.2**	<0.1	<0.1

* - No other VOCs, SVOCs, Pesticides or PCBs detected above reporting limits (see Appendix C for list of compounds analyzed)
CL - Everett Landfill cleanup level
Bold - above PQL
Shaded - exceeds landfill cleanup level

5.0 DISCUSSION

The shallow aquifer characterization study was intended to identify zones of the landfill where a breach between the shallow and deep aquifers might cause an exceedance of cleanup standards in the deep aquifer at the point of compliance. Deep foundation systems in these areas should be restricted to augercast piles or other equivalent piling types that minimize the potential to create new groundwater flowpaths parallel to the pile. The rationale for using augercast piles instead of driven piles is that the likelihood of creating a hydraulic connection between the shallow and deep aquifer is higher with the use of driven piles. Driven pile systems employing some form of external grouting would also decrease the potential for cross-connection of shallow and deep zones.

The point of compliance for the deep aquifer per the CAP is:

> *downgradient of the landfill, between the landfill and the point of discharge into the Snohomish River, outside the boundary of landfilled materials, no further than 100' east of the most easterly existing railroad tracks.*

Contaminants in the shallower aquifer migrating to the deep aquifer and then towards the river from the landfill would be subject to various mechanisms that attenuate their concentrations over time and distance, including dispersion, diffusion, sorption, biodegradation, volatilization, etc. The potential for driven piles to adversely impact the deep aquifer at the point of compliance therefore exists in areas where the concentrations of contaminants in the shallow aquifer are significantly above the cleanup levels over large areas. This is a relatively conservative assumption, as impacts to the deep aquifer have not been observed downgradient of the existing transfer station, which is built on numerous driven piles through the waste and aquitard.

Figure 5 shows the proposed area for restricting pile types to augercast piling or equivalent. This zone overlies the aquitard, and encompasses shallow aquifer sampling points with multiple, overlapping contaminant exceedances. No cleanup level exceedances were detected in the shallow aquifer in the area north of the proposed pile-restriction zone. The area south of the proposed pile-restriction zone includes the 41st Street overcrossing embankment, where pile-supported development is not anticipated, and where few shallow aquifer exceedances were located. Areas south of the embankment are additionally furthest from the river (>1000 feet), and unlikely to result in cleanup level exceedances in the deep aquifer at the point of compliance.

6.0 REFERENCES

Floyd & Snider, Inc., May 19, 1999, *Technical Memorandum: Summary of Existing Conditions Riverfront Redevelopment Pilot Project, Everett, Washington*, Prepared for City of Everett.

Floyd & Snider, Inc. November 20, 2000, *Brownfield Feasibility Study, Everett Landfill/Tire Fire Site,* Prepared for City of Everett.

Floyd & Snider, Inc., April, 2001, *Compliance Monitoring and Contingency Plan*, Prepared for City of Everett.

HWA GeoSciences Inc. *Geotechnical Report, 41st Street Overcrossing Project, Everett, Washington*, February 17, 2000.

Minard, 1985. *Geologic Map of the Everett Quadrangle, Snohomish County, Washington,* U.S. Geological Survey, Miscellaneous Field Studies, Map MF-1748.

State of Washington Superior Court. Consent Decree No. 01-2-03640-6. State of Washington, Department of Ecology, Plaintiff, v. City of Everett, Defendant. April 2001. Includes Exhibit C: Washington State Department of Ecology, April, 2001, *Everett Landfill/Tire Fire Site, Cleanup Action Plan,* Washington State Department of Ecology Toxics Cleanup Program Northwest Regional Office.

7.0 CONDITIONS AND LIMITATIONS

The conclusions expressed by HWA are based solely on material referenced in this report. Observations were made under the conditions stated. Within the limitations of scope, schedule and budget, HWA attempted to execute these services in accordance with generally accepted professional principles and practices in the area at the time the report was prepared. No warranty, express or implied, is made. Experience has shown that subsurface soil and ground water conditions can vary significantly over small distances. It is always possible that contamination may exist in areas that were not sampled. HWA's findings and conclusions must not be considered as scientific or engineering certainties, but rather as our professional opinion concerning the significance of the limited data gathered and interpreted during the course of the assessment.

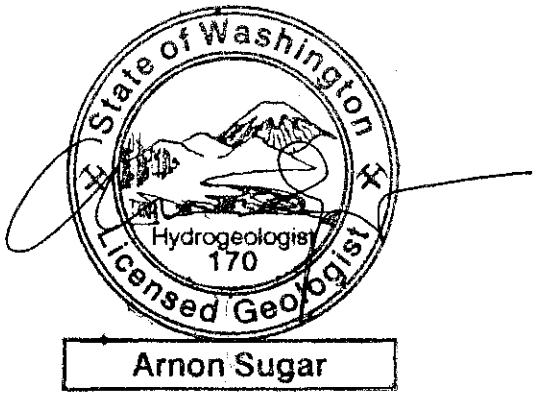
This study and report have been prepared on behalf of the City of Everett, for the specific application to the subject property. We are not responsible for the impacts of any changes

in environmental standards, practices, or regulations subsequent to performance of services. We do not warrant the accuracy of information supplied by others, nor the use of segregated portions of this report.

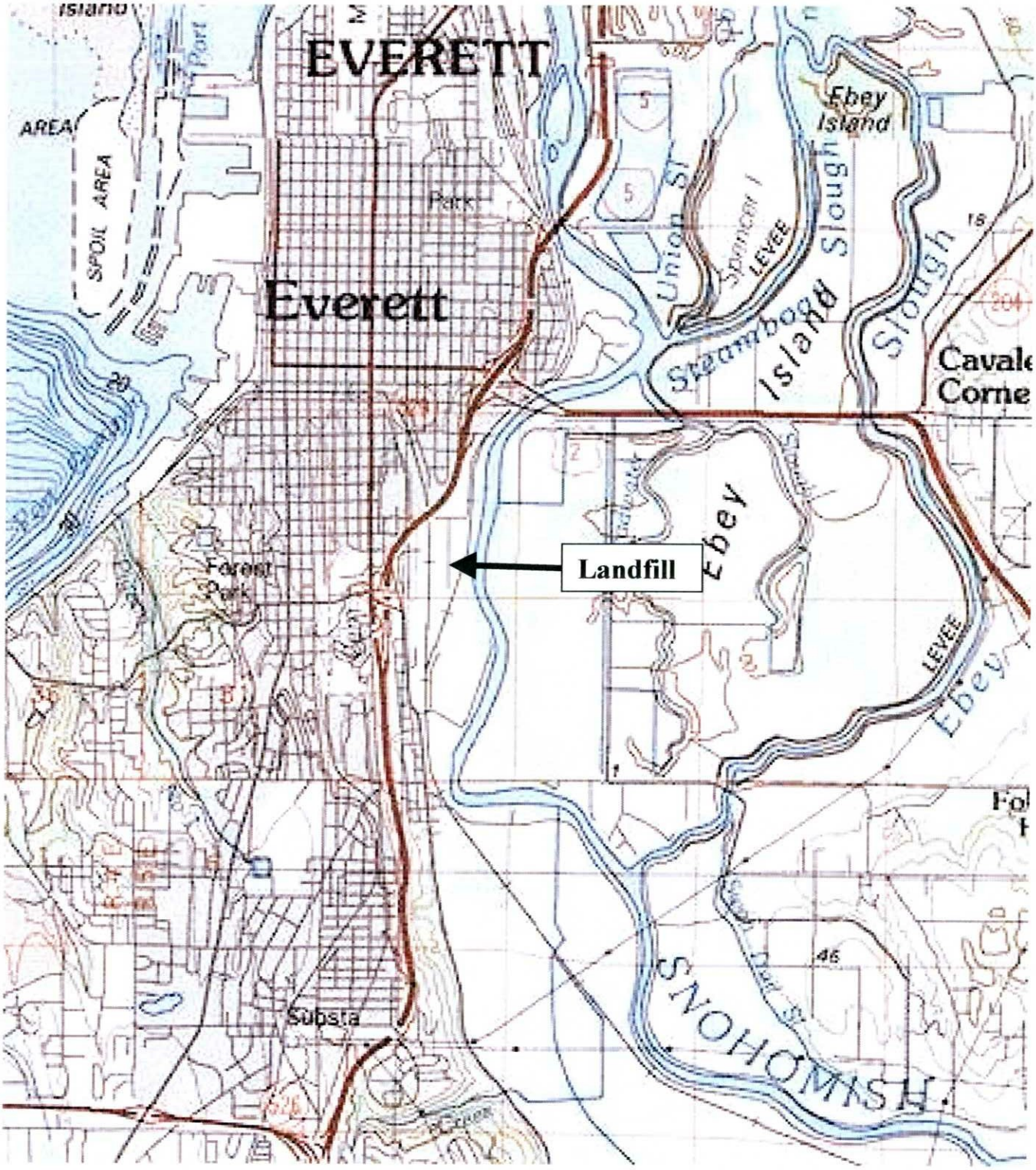
We appreciate this opportunity to be of service.

Sincerely,

HWA GEOSCIENCES INC.



Arnie Sugar, L.G., L.H.G.
Vice President



HWA GEOSCIENCES INC.

EVERETT LANDFILL
EVERETT, WASHINGTON

SITE LOCATION

PROJECT NO.: 98165 FIGURE: 1

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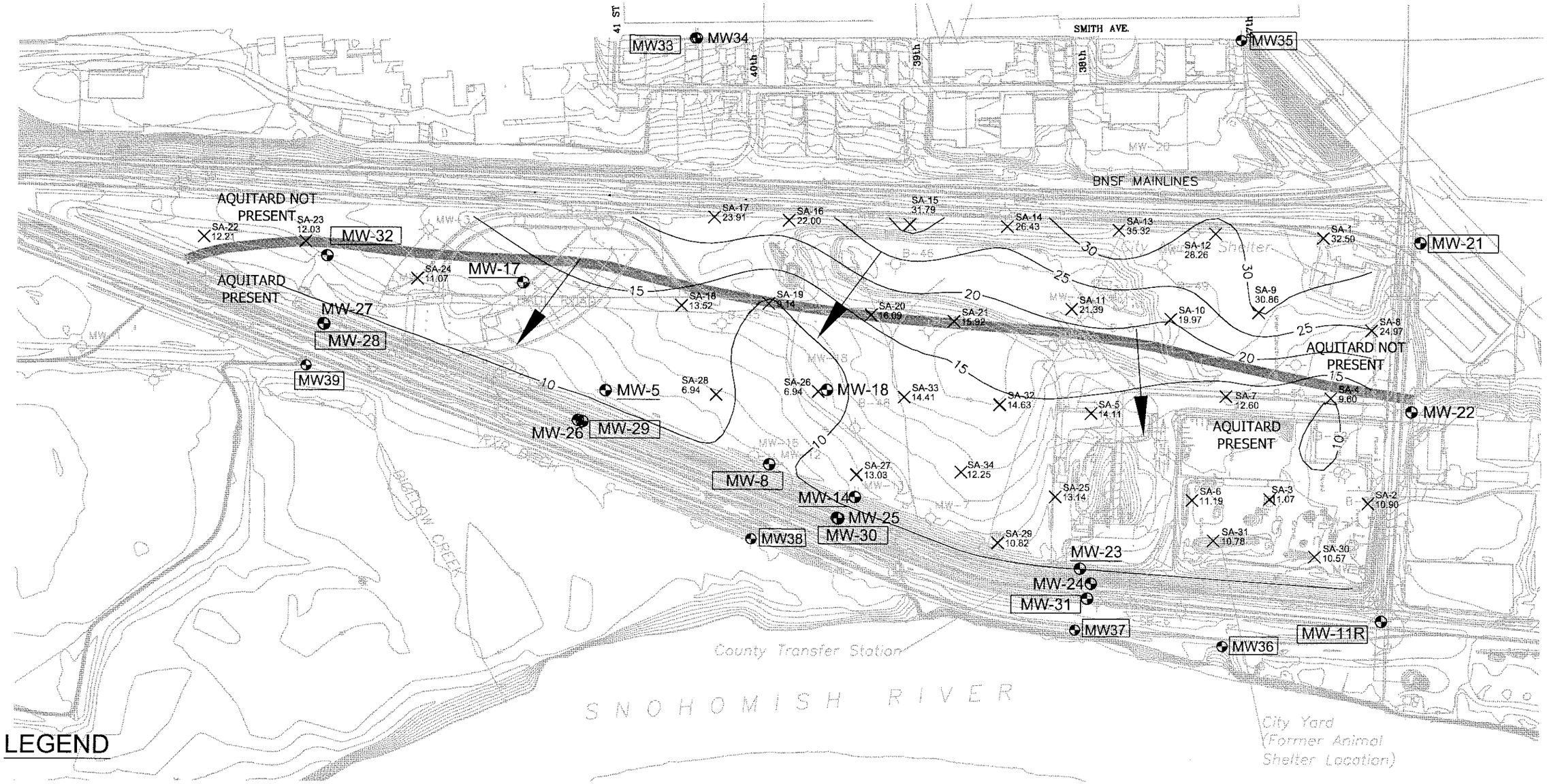


LEGEND

SA-28 / 6.94 — SHALLOW AQUIFER PROBE NUMBER / GROUNDWATER ELEVATION

GROUNDWATER FLOW DIRECTION

MW-12 — SHALLOW MONITORING WELLS FOR GROUND WATER QUALITY SAMPLING

ESTIMATED LIMIT OF AQUITARD

MW-16 — DEEP MONITORING WELLS FOR GROUND WATER QUALITY SAMPLING

0' 100' 200' 300' 600'

SCALE: 1"=300'

MW-5 — MONITORING WELLS FOR ABANDONMENT AFTER EVALUATION MONITORING

BASE MAP PROVIDED BY: FLOYD & SNIDER INC.

H:/1PROJECTS/1998 PROJECTS/98165 EVERETT LANDFILL/CAD/98165.DWG

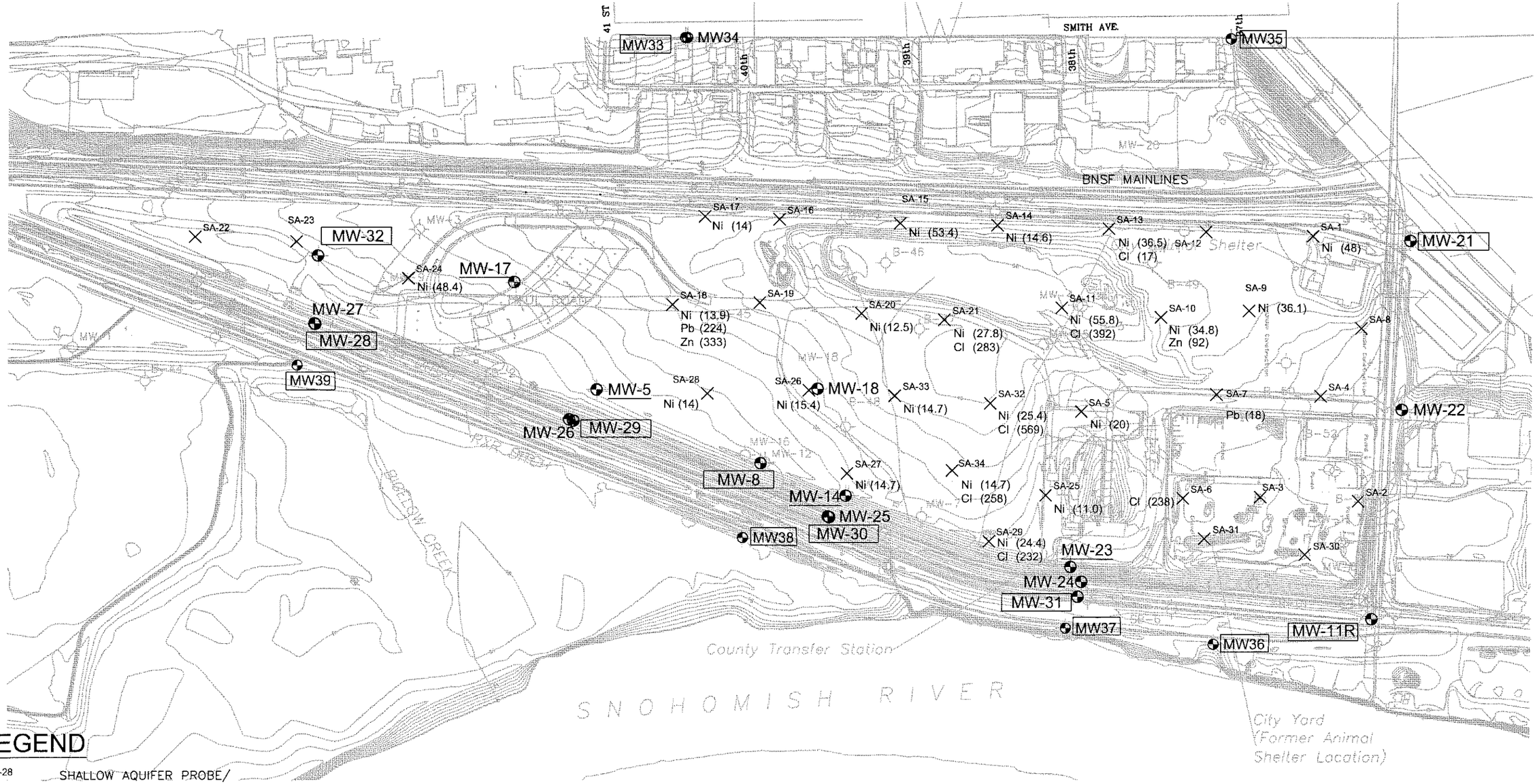
HWA GEOSCIENCES INC.

EVERETT LANDFILL
EVERETT, WASHINGTON

SHALLOW AQUIFER
GROUND WATER ELEVATIONS
FEBRUARY 2003

DRAWN BY KS	FIGURE NO. 2
CHECKED BY AS	
DATE 4.3.03	PROJECT NO. 1998-165

REV 04 KLS 8/5/03



LEGEND

SA-28 — SHALLOW AQUIFER PROBE/ TEMPORARY WELL

MW-12 — SHALLOW MONITORING WELLS FOR GROUND WATER QUALITY SAMPLING

MW-16 — DEEP MONITORING WELLS FOR GROUND WATER QUALITY SAMPLING

MW-5 — MONITORING WELLS FOR ABANDONMENT AFTER EVALUATION MONITORING

INORGANICS KEY

Ni (48)	NICKEL (48µg/L)
Cl (392)	CHLORIDE (392µg/L)
Pb (18)	LEAD (18µg/L)
Zn (92)	ZINC (92µg/L)

0' 100' 200' 300' 600'

SCALE: 1"=300'

HWA GEOSCIENCES INC.

EVERETT LANDFILL
INORGANIC RESULTS

EVERETT, WASHINGTON

SHALLOW AQUIFER CHARACTERIZATION

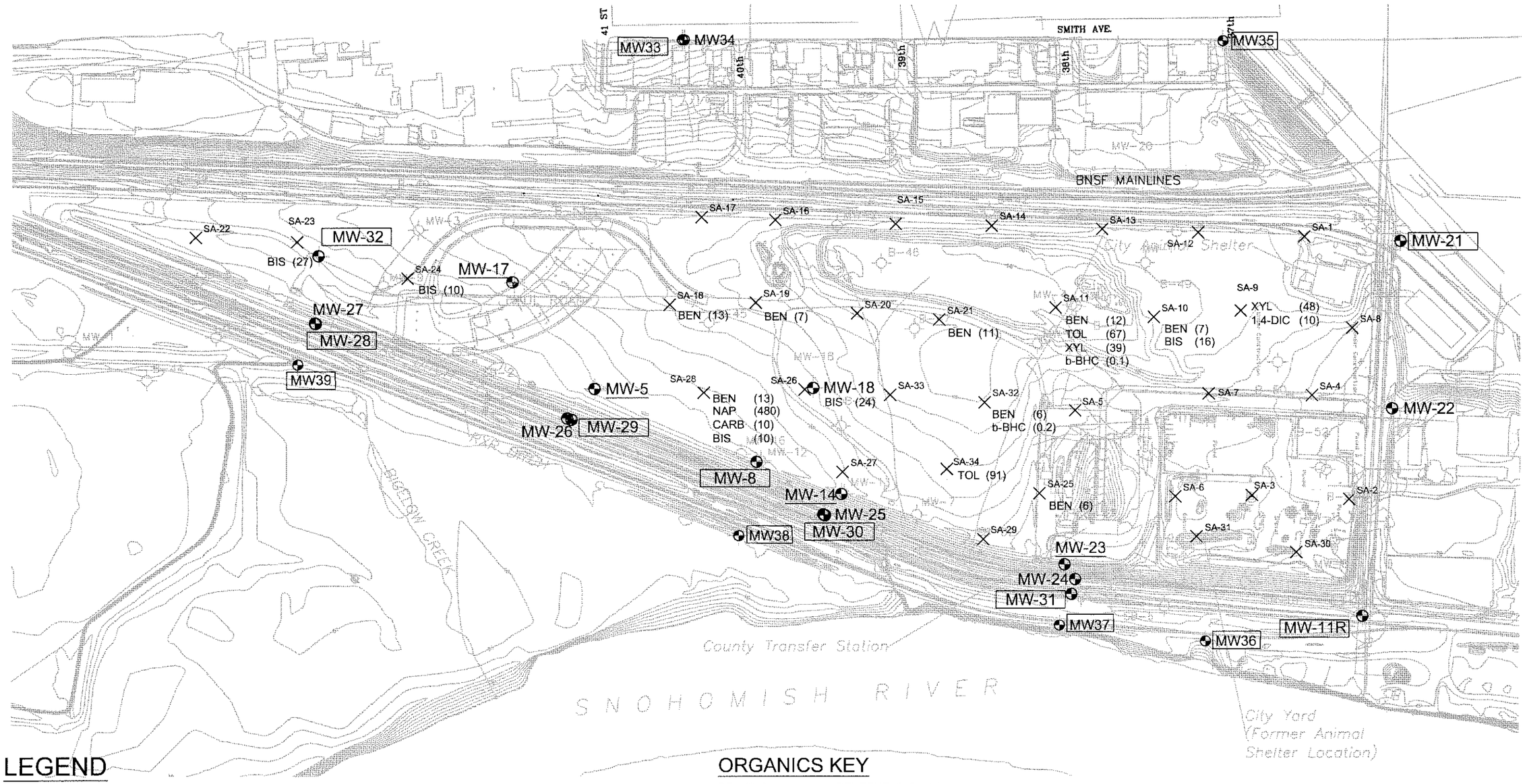
DRAWN BY KS
CHECKED BY AS
DATE 4.3.03

FIGURE NO. 3

PROJECT NO. 1998-165

REV 06 KLS 6/28/05

BASE MAP PROVIDED BY: FLOYD & SNIDER INC.
H:/1PROJECTS/1998 PROJECTS/98165 EVERETT LANDFILL/CAD/98165.DWG



LEGEND

- SA-28 — SHALLOW AQUIFER PROBE/ TEMPORARY WELL
- MW-12 — SHALLOW MONITORING WELLS FOR GROUND WATER QUALITY SAMPLING
- MW-16 — DEEP MONITORING WELLS FOR GROUND WATER QUALITY SAMPLING
- MW-5 — MONITORING WELLS FOR ABANDONMENT AFTER EVALUATION MONITORING

ORGANICS KEY

BEN (243)	BENZENE (243µg/L)
TOL (67)	TOLUENE (67µg/L)
XYL (48)	M+P XYLENE (48µg/L)
1,4-DIC (10)	1,4-DICHLOROBENZENE (10µg/L)
NAP (3)	NAPTHALENE (3µg/L)
CARB (10)	CARBAZOLE (10µg/L)
BIS (16)	BIS (2-ETHYLHEXYL) PHTHALATE (16µg/L)
b-BHC (.2)	b-BHC (.2µg/L)

0' 100' 200' 300' 600'

SCALE: 1"=300'

BASE MAP PROVIDED BY: FLOYD & SNIDER INC.

H:/1PROJECTS/1998 PROJECTS/98165 EVERETT LANDFILL/CAD/98165.DWG

HWA GEOSCIENCES INC.

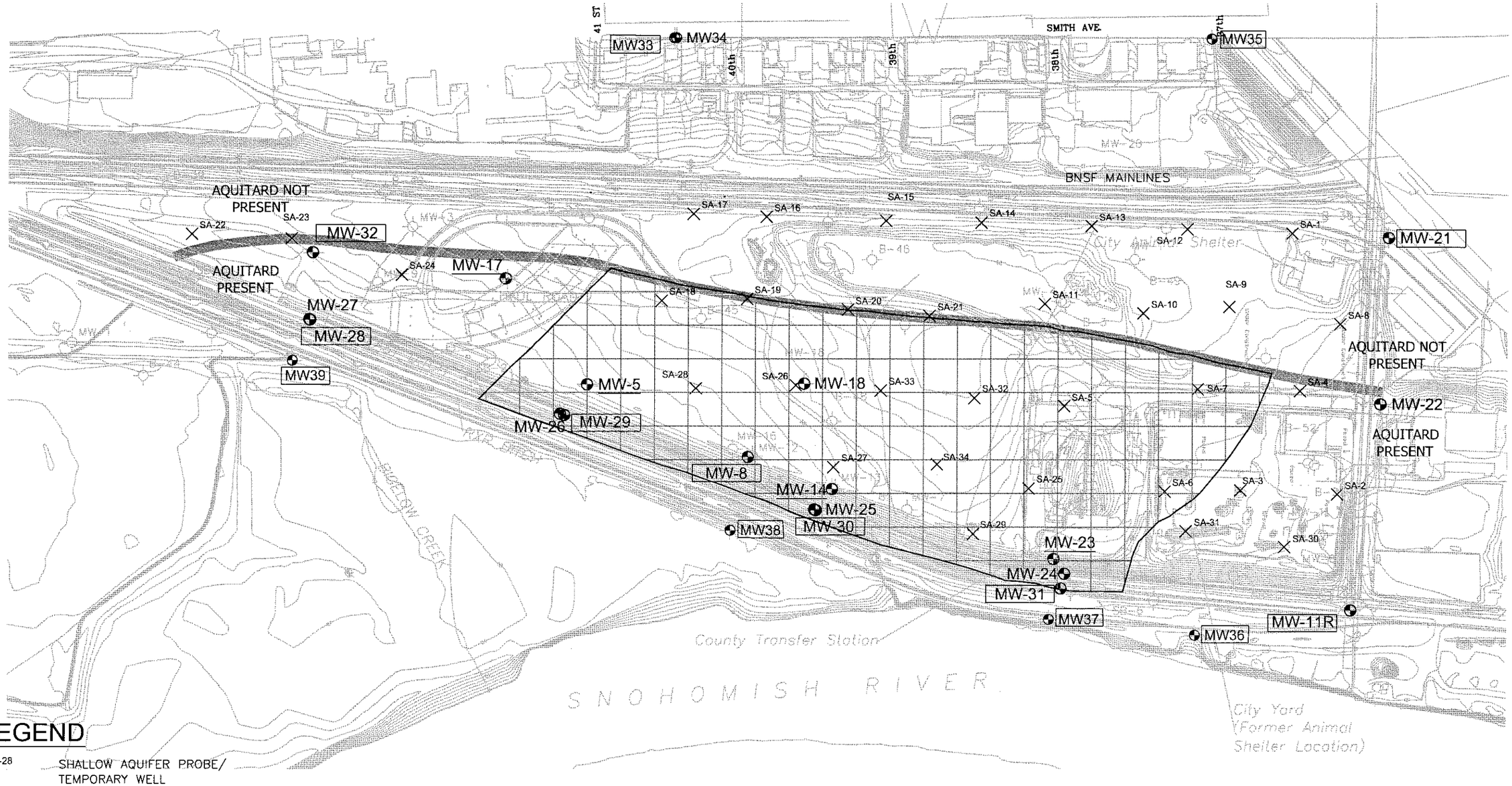
EVERETT LANDFILL
ORGANIC RESULTS

EVERETT, WASHINGTON

SHALLOW AQUIFER CHARACTERIZATION

DRAWN BY KS	FIGURE NO. 4
CHECKED BY AS	
DATE 4.2.03	PROJECT NO. 1998-165

REV 05 KLS 6/27/05



LEGEND

- SA-28 — SHALLOW AQUIFER PROBE/ TEMPORARY WELL
- MW-12 — SHALLOW MONITORING WELLS FOR GROUND WATER QUALITY SAMPLING
- MW-16 — DEEP MONITORING WELLS FOR GROUND WATER QUALITY SAMPLING
- MW-5 — MONITORING WELLS FOR ABANDONMENT AFTER EVALUATION MONITORING
- PILE RESTRICTION ZONE
- ESTIMATED LIMIT OF AQUITARD

0' 100' 200' 300' 600'

SCALE: 1"=300'

BASE MAP PROVIDED BY: FLOYD & SNIDER INC.

H:/1PROJECTS/1998 PROJECTS/98165 EVERETT LANDFILL/CAD/98165.DWG

HWA GEOSCIENCES INC.

EVERETT LANDFILL
PILE RESTRICTION ZONE

EVERETT, WASHINGTON

SHALLOW AQUIFER CHARACTERIZATION

DRAWN BY KS	FIGURE NO. 5
CHECKED BY AS	
DATE 4.3.03	PROJECT NO. 1998-165

REV 05 KLS 8/29/03

APPENDIX A

SAMPLING AND ANALYSIS PLAN

EVERETT LANDFILL

SHALLOW AQUIFER CHARACTERIZATION STUDY

SAMPLING AND ANALYSIS PLAN

Project No. 98165-530

December 18, 2002

Prepared For

City of Everett

by

HWA GEOSCIENCES INC.

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EVERETT LANDFILL
SHALLOW AQUIFER CHARACTERIZATION STUDY
SAMPLING AND ANALYSIS PLAN

1.0 INTRODUCTION

This Sampling and Analysis Plan (SAP) provides the scope and rationale for the shallow aquifer characterization study sampling to be conducted in early 2003 by HWA GeoSciences Inc. (HWA) for the City of Everett at the City of Everett Landfill and Tire Fire Site (Site). This SAP establishes the level of effort and describes the specific field activities for this site sampling event.

The SAP will be submitted to the Washington State Department of Ecology (Ecology) for review. Sampling and analysis will be conducted by HWA, under contract to the City of Everett Public Works Department (City). HWA will report the findings to the City, who will then report results to Ecology.

1.1 PROJECT BACKGROUND

The landfill is located west of the Snohomish River south of 36th Street, in Everett, Washington. Figure 1 shows the site location. This sampling event will document shallow groundwater quality conditions throughout the landfill site, with particular emphasis to future site development plans. The purpose of the sampling is to determine the quality of the groundwater within the shallow aquifer throughout the landfill. This information will be used to assist future development at the landfill, specifically for the foundation types (augercast vs. driven piles). Future pile installation at the landfill must consider the groundwater quality and potential risk to groundwater in the deeper aquifer.

1.2 PURPOSE AND OBJECTIVES

The plan as presented herein:

- Specifies procedures for field sampling activities;
- Identifies analytical testing methods and quality assurance (QA) procedures to be implemented during sampling activities and laboratory analyses;
- Meets the requirements of WAC 173-340-820, the Model Toxics Control Act (MTCA), for sampling and analysis plans; and
- Provides a common point of reference for all involved parties in the coordination of site activities.

Shallow aquifer characterization will involve sampling of the shallow aquifer at approximately 35 initial locations throughout the interior of the landfill. Sampling locations will be determined using an EPA methodology for verification clean up sampling (EPA *Field Manual for Grid Sampling of PCB Spill Sites to Verify Cleanup*, May 1986). The methodology for determining sample locations is based on a hexagonal grid design laid out within a circle centered on the sample area. Sample locations are determined by 1) identifying the area to be evaluated, 2) determining the center of the smallest circle surrounding the sample area, 3) determine the number of samples required (based on the radius of the circle), and 4) selecting sample locations based on a hexagonal grid arranged about the area center. Some sample locations are adjusted for logistical reasons (e.g., access, presence of existing monitoring well, etc.) Temporary monitoring well points (see Section 2.1) would be installed and abandoned at each grid point to collect one-time ground water samples.

A one time sampling will be done in the 35 temporary wells, with the wells immediately being abandoned after sampling. These samples will then be analyzed, as detailed below.

For any of these temporary sampling locations where the results show an exceedance of a ground water cleanup level for the former Everett Landfill site (as defined in Appendix Q of the Brownfield Feasibility Study (FS) for the Everett Landfill/Tire Fire Site, (FSI, 2000)), four additional temporary borings will be installed to verify that results accurately reflect conditions at this location. We have budgeted approximately 25 additional sampling points for up to 6 "hot spots" to be further defined.

If a sample from a temporary well shows a ground water cleanup level exceedance, then sampling data from all adjacent sampling points will be averaged to determine an area-wide concentration. If this area-wide concentration exceeds the ground water cleanup level, HWA will then perform a contaminant transport evaluation using the EPA model BIOSCREEN to calculate specific contaminant concentrations at the compliance point (Snohomish River) based on the compound's concentration at a point in the landfill. If the concentration of a zone is predicted by BIOSCREEN to result in a compliance point exceedance, then pile installation within that zone would be restricted to augercast piling. The BIOSCREEN modeling would be done only after all sampling is completed.

HWA will prepare a report summarizing the findings of this study and recommending if any limits on pile types or locations exist for the landfill development.

HWA will contract with licensed drillers to properly install and abandon all temporary wells immediately after sampling, to abandon existing wells at the landfill per the Compliance Monitoring and Contingency Plan (see Figure 2), and the piezometers installed near the east ditch as part of a previous hydrogeological investigation (see Appendix S of the Brownfield FS for the Landfill Site, (FSI, 2000)).

1.3 PROJECT ORGANIZATION

Individuals responsible for ensuring the quality of the field operations and the collection of data are identified in this section. The City will provide oversight of all project activities and is the point of contact with the Department of Ecology. Sampling activities, data evaluation, and reporting will be performed by HWA. Laboratory analysis will be done by Ecology-certified laboratories, and include the City of Everett Environmental Laboratory (for conventional and metals analyses) and by CCI Analytical Laboratories, Inc., Everett, Washington for organic parameters. Telephone Contacts for this project include:

Mark Sadler	City of Everett Project Manager (425) 257-8967, cell 425-210-0103
Jim Bailey	HWA Project Manger (425) 774-0106 cell (206) 794-3112
Arnie Sugar	HWA Task Manager (425) 774-0106 cell (206) 794-3130
Greg Emens	HWA Field Operations (425) 774-0106 cell (206) 794-3132
Julie Sklare	Everett Environmental Lab Project Manager (425) 257-7208
Jeff Wright	Everett Environmental Lab supervisor (425) 257-8231
John Murnane	Cascade Drilling, Inc. (425) 485-8908
Chuck Rancatti	CCI Analytical Laboratories Project Manger (425) 356-2600

1.4 PROJECT SCHEDULE

The initial round of sampling is scheduled by February 2003, or within two weeks following SAP approval by Ecology. Sample laboratory analysis will be completed within three weeks of sample delivery to the laboratory. A proposed schedule is shown below:

Week	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Work plan approval	x														
First round sampling		■													
Lab results			■	■	■										
Ecology reporting/Mtg							■								
Second round sampling									■						
Lab results										■	■	■			
Report													■	■	■

2.0 SAMPLING & ANALYSIS

Planned site sampling includes collection of ground water from 35 to 60 temporary ground water monitoring well points. The following sections describe the sampling rationale and methods.

2.1 GROUND WATER SAMPLING

HWA will employ a mobile drive point sampling device (e.g., Geoprobe) to collect ground water samples. The device consists of a hydraulic drive assembly mounted on a tracked skid-steer loader (e.g., Bobcat). The probe rig drives a steel pipe (1.25 inch diameter rods or 2-inch split spoon sampler) into the ground using a hydraulic impact driver. Soil cores can be retrieved by withdrawing the pipe or split-barrel sampler. Ground water samples can be bailed or pumped through a retractable screen in the pipe. Cascade Drilling, Inc., under subcontract to HWA will operate the probe rig and assist in collecting samples. All field work will be supervised by an HWA geologist or engineer competent in soil logging, well installation, and sampling. The proposed initial (first round) well point locations are shown on Figure 2.

Maximum probe depth will be 15 feet, first encountered ground water, or probe refusal, whichever is shallowest. If refusal is encountered before reaching ground water, another boring will be attempted a few feet away. We will collect soil core samples at two-foot intervals for logging purposes. No soil or waste samples will be collected for laboratory analysis.

At each sampling interval, the geologist will log the soil samples and obtain and record pertinent information including soil sample depths, stratigraphy, ground water occurrence, and any visual or olfactory observations regarding the presence of contamination. Soil classifications presented on exploration soil logs will be based on visual and laboratory observations, in general accordance with ASTM D-2487, ASTM D-2488, and the Unified Soil Classification System (USCS).

2.1.1 Borehole Abandonment

After all probes reach their maximum depth and are sampled, the steel pipe will be withdrawn from the ground and the hole grouted to the ground surface using hydrated granular or powdered bentonite.

2.2 SAMPLE COLLECTION METHODOLOGY

Temporary well points wells will be purged before sample collection to obtain groundwater samples that are representative of the formation water. Well points will be purged and sampled using low-flow purging methods (Barcelona et al. 1994). Sampling staff will measure groundwater levels to the nearest 0.01-foot using a decontaminated electronic well probe prior to collection of samples. Prior to collection of groundwater samples, the wells will be purged by pumping a small volume of water to ensure sampled water represents aquifer conditions. The volume pumped will be determined in the field based on stabilization of field parameters: specific conductance, dissolved oxygen, and pH. Wells will be purged by very slowly lowering semi-rigid polyethylene tubing to a depth corresponding to roughly the midpoint of the screen, securing the tubing to prevent vertical movement, connecting it to a peristaltic pump, and then pumping at a rate not to exceed 0.5 liters/minute (0.132 gallons/minute). At a minimum, two pump and tubing

volumes will be purged (1/2" I.D. tubing = 0.010 gallon/lineal foot, 0.17" I.D. tubing = 0.001 gallon/lineal foot = 5 ml/lineal foot). Samples from all wells will be collected once the parameter values have stabilized over the course of three sets of measurements as follows:

specific conductance	10 µS/cm
dissolved oxygen	2 mg/L
pH	0.1

If a well can be pumped dry prior to reaching the desired purge volume, it will be allowed to recover prior to sampling, using the minimum time between purging and sampling that would allow collection of sufficient sample volume. Samples will be pumped directly into the appropriate containers, as provided by the laboratory. A Field Data Sampling Sheet (provided in Appendix A) will be filled out for each sample. New tubing will be used for each well point. All purge water will be collected and discharged to one of the two leachate wet wells.

Dissolved metals samples will be filtered through a disposable 0.45-micron filter at the time of sample collection. The filters will attach directly to the discharge tube of the sampling pump. The filter must be changed between sample points, or more frequently if clogging occurs. Samples that have been field-filtered or that require laboratory filtering must be noted on the Chain-of-Custody forms in the comments section. The laboratory will note which samples require filtering on the individual bottle labels.

After collection, all samples will be labeled, chilled in a cooler to 4°C, and shipped to the testing laboratory for analysis. Full chain-of-custody and field documentation procedures will be employed, as described in Section 2.6. The laboratory will analyze the water samples for the constituents listed in Table 1 and the CMCP. Lab methods and PQLs will be per the Compliance Monitoring and Contingency Plan (CMCP) (FSI, 2001) except for those parameters listed on Table 1, which defines the methods and PQLs achievable by the selected laboratories. PQLs listed in Table 1 are equal to or less than site action levels listed in the CMCP.

Table 1
Proposed Analytical Methods for Selected Parameters

Analyte	Proposed Analytical Method	Method PQL (µg/L)
Inorganics		
Nitrate	300.0 / 353.2	8
Nitrite	300.0 / 354.1	8
Chloride	300.0 / 325.2	800
Dissolved Metals		
Antimony	204.2 / 7041	30
Arsenic	206.2 / 7060	20
Cadmium	213.2 / 7131	1
Chromium (III&VI)	200.7 / 6010 / 7191	24
Chromium(III)	Subtraction	24
Chromium(VI)	7196 / 7197	10
Copper	220.2 / 7211	10
Lead	239.2	10
Nickel	200.8 / 6020 / 249.2 / 7521	10
Selenium	270.2 / 7740	20
Zinc	200.7 / 6010 / 7951	32
Iron	200.7 / 6010	56
Manganese	200.7 / 6010	4
Pesticides		
DDD, 4,4-	8081	0.1
DDT, 4,4-	8081	0.1
hexachlorocyclohexane;beta- (beta-BHC)	8081	0.06
Polychlorinated Biphenyls		
aroclor 1242 (PCB)	8082	0.65
aroclor 1254 (PCB)	8082	1.3

Analyte	Proposed Analytical Method	Method PQL (µg/L)
Volatile Organics		
acetone	8260	10
benzene	8260	5
butanone,2- (methyl ethyl ketone)	8260	10
chlorobenzene	8260	5
chloroform (trichloromethane)	8260	5
chloromethane	8260	10
dichloroethene;cis, 1,2-	8260	5
dichlorobenzene,1,4-	8260	10
dichloroethane;1,1-	8260	5
dichloromethane (methylene chloride)	8260	5
dichlorobenzene,1,2-	8260	10
ethylbenzene	8260	5
isopropylbenzene (cumene)	8260	1
naphthalene	8260	10
toluene	8260	5
trichlorobenzene;1,2,4-	8260	10
trichlorofluoromethane	8260	0.3
vinyl chloride	8260	10
xylene; O-	8260	5
xylene; M,P-	8260	5
4-isopropyltoluene	8260	10
n-butylbenzene	8260	10
n-propyl benzene (phenylpropane)	8260	10
sec-butylbenzene (2-phenylbutane)	8260	10
1,2,4-trimethyl benzene	8260	10
1,3,5-trimethyl benzene	8260	10
Semi-Volatile Organics		
acenaphthene	8270	10
anthracene	8270	10
benzoic acid	8270	50
butyl benzyl phthalate (benzyl butyl phthalate)	8270	10
bis(2-ethylhexyl) phthalate	8270	10
carbazole	8270	10
dichlorobenzene;1,2-	8270	10
dichlorobenzene;1,4-	8270	10
diethyl phthalate	8270	10
dimethylphenol;2,4-	8270	10
di-n-butylphthalate	8270	4
fluoranthene	8270	10
fluorene	8270	10
naphthalene	8270	10
nitrosodiphenylamine;N-*	8270	10
phenol	8270	10
pyrene	8270	10

Analyte	Proposed Analytical Method	Method PQL (µg/L)
trichlorobenzene;1,2,4-	8270	10
2-methylnaphthalene	8270	10
4-methylphenol	8270	10

* N-nitrosodiphenylamine analysis will include 1,2-diphenylhydrazine and diphenylamine because the chromaticrits of these compounds cannot be separated.

2.2.1 Sample Collection

When filling the sample bottles, the following procedures and precautions will be adhered to:

1. Sample bottles will be filled directly from the dedicated pump tubing, or filter apparatus, with minimal air contact.
2. Bottle caps will be removed carefully so that the inside of the cap is not touched. Caps must never be put on the ground. Caps for volatile organic compound (VOC) vials will contain a Teflon-lined septum. The Teflon side of the septum must be facing the sample to prevent contamination of the sample through the septum.
3. The sampling team will wear appropriate nonpowdered latex or nitrile gloves (PVC or vinyl gloves can leave trace levels of phthalate or vinyl chloride). Gloves will be changed between wells or more often.
4. Tubing or hoses from the sampling systems must not touch or be placed in the sample bottles.
5. Semivolatile organic compound (SVOC) bottles and VOC vials must be filled so that they are headspace-free. These sample bottles therefore need to be slightly overfilled (water tension will maintain a convex water surface in the bottle). The caps for these bottles will be replaced gently, to eliminate air bubbles in the sample. The bottles must then be checked by inverting them and tapping them sharply with a finger. If air bubbles appear, open the bottle, add more water, and repeat the process until all air bubbles are gone. Do not empty the bottle and refill it, as VOC bottles already contain preservatives.
6. Sample bottles, caps, or septums that fall on the ground before filling will be discarded.
7. Metals sampling will be conducted with "clean technique." Bottles will be bagged in plastic and the cap placed in the bag during sampling.

Table 2 shows sample bottle requirements and preservatives. Samples will be collected in the reverse order shown on Table 2, in the event sample volume is limited. The analytical laboratory will provide the sample containers and necessary preservatives.

TABLE 2
SAMPLE BOTTLE REQUIREMENTS

Analytical Parameter	Required Bottle*	Preservative
Nitrate, Nitrite, Chloride	(2) 500 ml poly	
Dissolved metals	(2) 500 ml poly	HNO_3 to pH<2**
PCBs/Pesticides	1 L amber glass	
VOCs	(2) 40 ml VOA	HCl to pH<2
SVOCs	(2) 500 ml amber glass	

* Collect one sample in triplicate per 20 samples for the matrix spike & matrix spike duplicate, and another sample in triplicate per 20 samples for the field duplicate and field blank. Mark all QC samples on Chain of Custody form as separate samples. Fill out separate FSDS for each QC sample (see Section 2.6.1.1).

** May not be required if samples are delivered to lab same day

2.3 EQUIPMENT DECONTAMINATION

In order to mitigate the potential for cross-contamination, all nondedicated, sample-contacting, and downhole equipment used in the collection and sampling processes will be decontaminated before sample collection. Included are probe rods, split spoons, core barrels, drive cones/shoes, well screens, and groundwater-level measurement devices.

A water level probe must be dedicated to groundwater monitoring well use only. Under no circumstance shall this dedicated probe be used to measure other fluid levels (e.g., leachate). The following steps will constitute the decontamination procedure:

1. Wash items in a solution of non-phosphate (e.g., Alconox) detergent and tap water
2. Rinse with tap water
3. Rinse with deionized water
4. Air dry in a clean environment

Decontaminated equipment will be stored and transported in clean containers or wrapping.

2.4 SAMPLE PRESERVATION, STORAGE, AND SHIPMENT

2.4.1 Sample Preservation

The sample containers (including preservative, if required) will be prepared and provided by the analytical laboratory. Samples will be preserved consistent with analytical laboratory recommendations. After each bottle is filled and capped, the sample container will be inverted to ensure complete mixing of the sample with the preservative. The sample container should not be shaken.

2.4.2 Temperature Control

The sample container and samples will be cooled to 4°C, from the time the sample is collected through analysis. Samples will be maintained in temperature-regulated refrigerators, in coolers, or in sample coolers containing double-bagged or commercially frozen icepacks. The icepacks will be frozen solid before use.

2.4.3 Sample Packing and Storage

Before the sample bottles are packed into the shipment coolers, the sample designations will be recorded in the appropriate spaces on the Chain-of-Custody form. After the samples are collected, the bottles will be capped and placed in the sample cooler. The frozen icepacks will be placed into the sample cooler such that they are not in direct contact with the sample bottles. Glass containers should not be packed in contact with each other. Bottle holders, cushions, or bubble wrap will be used for glass bottles to protect them from breakage.

Bottles will be wiped clean with paper towels before placement in the sample cooler. The sample cooler must be kept as clean as possible to minimize the potential for cross-contamination. Bottle caps will be checked to ensure they are tight and will not become loose when inserted in the cooler. Bottle caps will not be taped.

The Chain-of-Custody form will be placed in a plastic bag, sealed, and placed inside the sample cooler or taped to the inside lid of the cooler. A copy of the Chain-of-Custody form will be retained for verification.

Samples will be stored at 4°C, in an enclosed cooler or dedicated refrigerator where possible, before shipment to the laboratory. Samples will be shipped daily to the laboratory to ensure proper temperature control and that holding time requirements are met.

2.5 QUALITY ASSURANCE/QUALITY CONTROL

Samples will be collected and analyzed with sufficient quality assurance/quality control (QA/QC) to ensure representative and reliable results. The overall QA objective for this

investigation is to ensure that all decisions based on laboratory and field data are technically sound, statistically valid, and properly documented. Specific QA protocols will be executed and are described for all activities related to the collection of samples, the analyses of these samples by the laboratory, and the handling of data generated during the investigation. There are two parts to the QA/QC program for this project: field and laboratory.

2.5.1 Field

Field QA/QC includes proper documentation of field activities and sampling/handling procedures, as described in Section 2.6. Field QA/QC samples will consist of the following:

- One duplicate per 20 samples
- One field blank per 20 samples
- One trip blank per sample shipment (VOCs only)

2.5.1.1 Duplicates and Split Samples

Duplicate samples will be collected from an area with known or suspected contamination. Duplicates are used to confirm analytical results from a given sample point. Duplicate samples are collected in the field using a matching set of laboratory-supplied bottles and sampling from the selected well. Each duplicate should be sampled by alternating between the regular and the duplicate sample bottles, proceeding in the designated sampling order. The well where the duplicate is collected must be identified on the field sampling data sheet. All duplicates shall be blind-labeled (i.e., the well designation is not listed on the sample bottle or Chain-of-Custody form). Once a duplicate is collected, it is handled and shipped in the same manner as the rest of the samples. Duplicate results will be reported in the laboratory results as separate samples, using the designation DUP-(#).

Split samples are collected when a well is sampled with a third party (e.g., Ecology). Split samples should be collected using the same method as a duplicate, alternating between sample bottles, and proceeding in the designated sampling order. The well at which a split sample is collected must be identified on the field sampling data sheet. Also note the condition of the bottles or preservatives, the sample-collection method (if different from the standard), and the selected agency laboratory.

2.5.1.2 Trip Blanks

Trip blanks are used to detect contamination that may be introduced in bottle preparation, in transit to or from the sampling site, or in the field. Trip blanks are samples of volatile-organic-free, laboratory-quality water (Type II reagent grade) that are prepared at the laboratory. They remain with the sample bottles while in transit to the site, during sampling, and during the return trip to the laboratory. Trip blank sample bottles are not opened at any time during this process. Trip blanks are to be reported in the laboratory

results as separate samples, using the designation TB-(#). Each sample cooler that includes bottles for VOC analysis must include a trip blank, whether it was requested or not.

2.5.1.3 Field Blanks

Field blanks are used to detect contamination that may be introduced in the field. Field blanks will be prepared in the field by pumping laboratory reagent-quality water through new tubing and into the equipment blank bottles. The well at which the field blank is prepared must be identified on the field sampling data sheet. Field blank results will be reported in the laboratory results as separate samples, using the designation FB-(#).

2.5.2 Laboratory

Laboratory QA/QC samples will consist of the following:

- One matrix spike (MS) per 20 samples
- One matrix spike duplicate (MSD) per 20 samples

Method-specific QA/QC samples may include the following:

- Method blanks
- Duplicates
- Instrument calibration verification standards
- Laboratory control samples
- Surrogate spiked samples
- Performance evaluation QC check samples

2.5.3 Data Evaluation

Data evaluation will include checking holding times, method blank results, surrogate recovery results, field and laboratory duplicate results, completeness, detection limits, laboratory control sample results, and Chain-of-Custody forms. After the data has been checked, it will be entered into the project database with any assigned data qualifiers.

2.6 FIELD DOCUMENTATION AND CHAIN-OF-CUSTODY

The following sections describe the recording system for documenting all site field activities, and the sample chain-of-custody procedures.

2.6.1 Field Documentation

An accurate chronological recording of all field activities is vital to the documentation of

any environmental investigation. To accomplish this, field team members will maintain field log books and data sheets providing a daily record of significant events, observations, deviations from the sampling plan and measurements collected during the field activities.

2.6.1.1 Field Sampling Data Sheet

A field sampling data sheet (example in Appendix A) will be filled out for each sample point ad for each QC sample (field blanks, duplicates. etc.) This sheet contains information regarding site and well conditions, sampling and purging procedures, and field measurements. At a minimum, the following information must be documented:

1. **Purging Information**, including date, time, well number, casing volume, elapsed time, discharge color (if different than for sampling), water level before and after purging. Note if the well was dry, purged dry, or was otherwise impossible to sample.
2. **Purging and Sampling Equipment**, including pump type and tubing material.
3. **Field Measurements**, including fluid surface elevation (depth to groundwater or to leachate), temperature, pH, dissolved oxygen, and specific conductance.
4. **Additional Field Measurements**, as necessary.

2.6.1.2 Field Observations

The comments section on the field sampling data sheet will include such field observations as the following:

- Weather condition: wind direction, speed, upwind activities (ensure that vehicles or gasoline-engine generators or compressors are not upwind of sampling activities), temperature, and barometric pressure (if required).
- Sample appearance, including odor, color, and turbidity:
  - Odor: (e.g., rotten eggs, earthy, strong, moderate, slight, metallic, landfill gas - ***do not sniff sample***).
  - Color: True "color" is the color after turbidity has been removed, if samples are filtered. True color may be caused by metallic ions, humus, peat, or industrial chemicals. Hold the sample up to the light and describe the true color in as much detail as possible (color charts are acceptable descriptive methods). If samples are not filtered, then color may be a function of turbidity.
  - Turbidity (regardless of whether turbidity measurements are taken):
    - None: sample is clear.
    - Trace: sediment slightly clouds or colors sample; does not accumulate in bottle.

- Moderate: definite cloudiness, sediment accumulates at bottom of bottle.
- High: muddy or dark brown appearance.

  When a turbidity-measuring device is used, measurements must be provided in nephelometric units.

- Reference point for well measurements (i.e., is it clearly marked on top of casing?).
- Well I.D. where the field blank or duplicate sample is collected.
- Calculations for purge volumes and temperature conversions. Note when wells are purged dry.
- Duplicate field measurement results.
- Other conditions, such as sample splits with regulatory agencies, potential safety or health hazards (e.g., landfill gas in well).

2.6.1.3 Sample Certification

The bottom of the field sampling data sheet must be signed to certify that the sampling procedures were in accordance with those described in this sampling plan. The person certifying the sampling assumes full responsibility that the sampling process satisfied the required criteria.

2.6.2 Sample Identification

Following sample collection, field personnel will affix labels to each sample container. Samplers will use waterproof ink, plastic bags, or clear tape to ensure labels remain legible even when wet. A sample label form that may be copied on to adhesive label paper is provided in Appendix A. Samplers will record the following information on the labels:

- Project name and number
- Sample identification number
- Date and time of collection
- Required test methods
- Name of sample collector

Sample numbering will follow the following format:

WP-29-0103 = well point WP-29 collected in January 2003

DUP 1, DUP 2, etc. = duplicate (do not indicate which well a duplicate is from)

TB 1, TB 2, etc. = trip blank

FB 1, FB 2, etc. = field blank

2.6.3 Chain-Of-Custody Record

The objective of the chain-of-custody procedures is to allow the tracking of possession and handling of individual samples from the time of field collection through laboratory analysis. Once a sample is collected, it becomes part of the chain-of-custody process. A sample is "in custody" when: (1) it is in someone's possession, (2) it is within visual proximity of that person, (3) it is in that person's possession, but locked up and sealed (e.g., during transport), or (4) it is in a designated secure sample storage area. Sampling staff will complete a Chain-of-Custody form, which will accompany each batch of samples. The record will contain the following information:

- Project name and number
- Names of sampling team members
- Requested testing program
- Required turnaround time
- Sample number
- Date and time collected
- Sample type
- Matrix
- Number of containers
- Special Instructions
- Signatures of persons involved in the chain of possession

When sample custody is transferred to another individual, the samples must be relinquished by the present custodian and received by the new custodian. This will be recorded at the bottom of the Chain-of-Custody form where the persons involved will sign, date and note the time of transfer. An HWA Chain-of-Custody form is provided in Appendix A.

Sampling team members will keep sample coolers in locked vehicles while not in active use or visual range. If couriers are used to transport samples, Chain-of-Custody seals will be affixed to sample coolers.

2.7 INVESTIGATION-DERIVED WASTE

Purge water from the wells will be collected and discharged to the leachate wet wells. Solid waste (e.g., disposable bailers, gloves, etc.) will be disposed of as ordinary municipal waste. Excess soil samples will be disposed of at the landfill.

2.8 CALIBRATION AND USE OF METERS

Before being taken to the field, equipment must be cleaned and checked for malfunctions. Meters must be calibrated each morning before they are used in the field, following manufacturers' procedures. Equipment will be calibrated at least daily. All field monitoring equipment will be calibrated consistent with manufacturers' procedures using instrument calibration standards prepared according to the manufacture's specifications.

In all cases, proper documentation must be made of all calibration procedures for each sampling event, including calibration methodology (one- or two-point calibration, difference, standard concentration, and expiration date).

Logbooks should be maintained for all field meters. The logbooks must contain the same information as those for permanent laboratory instruments (serial number, name and model of meter, year purchased, etc.). The books also must contain quality control (QC) results, maintenance performed by the factory, and calibration notes for each day the equipment is used. Instruments used to measure pH and electrical conductivity should be calibrated at least once each day of sampling. Temperature-measuring devices should be calibrated against a standardized laboratory thermometer at a frequency recommended by the manufacturer. Additional data (e.g., turbidity, dissolved oxygen) should be calibrated in accordance with manufacturer recommendations and documented.

2.9 FIELD MEASUREMENTS

2.9.1 Static Water Level Measurements

The depth-to-water should be recorded to the nearest hundredth of a foot (0.01 ft). Water levels should be measured before and after purging to assess drawdown effects at each well. Water levels are preferably measured before purging a well and as close in time as possible, to minimize interference from drawdown or barometric pressure effects.

3.0 DATA ANALYSIS AND REPORTING

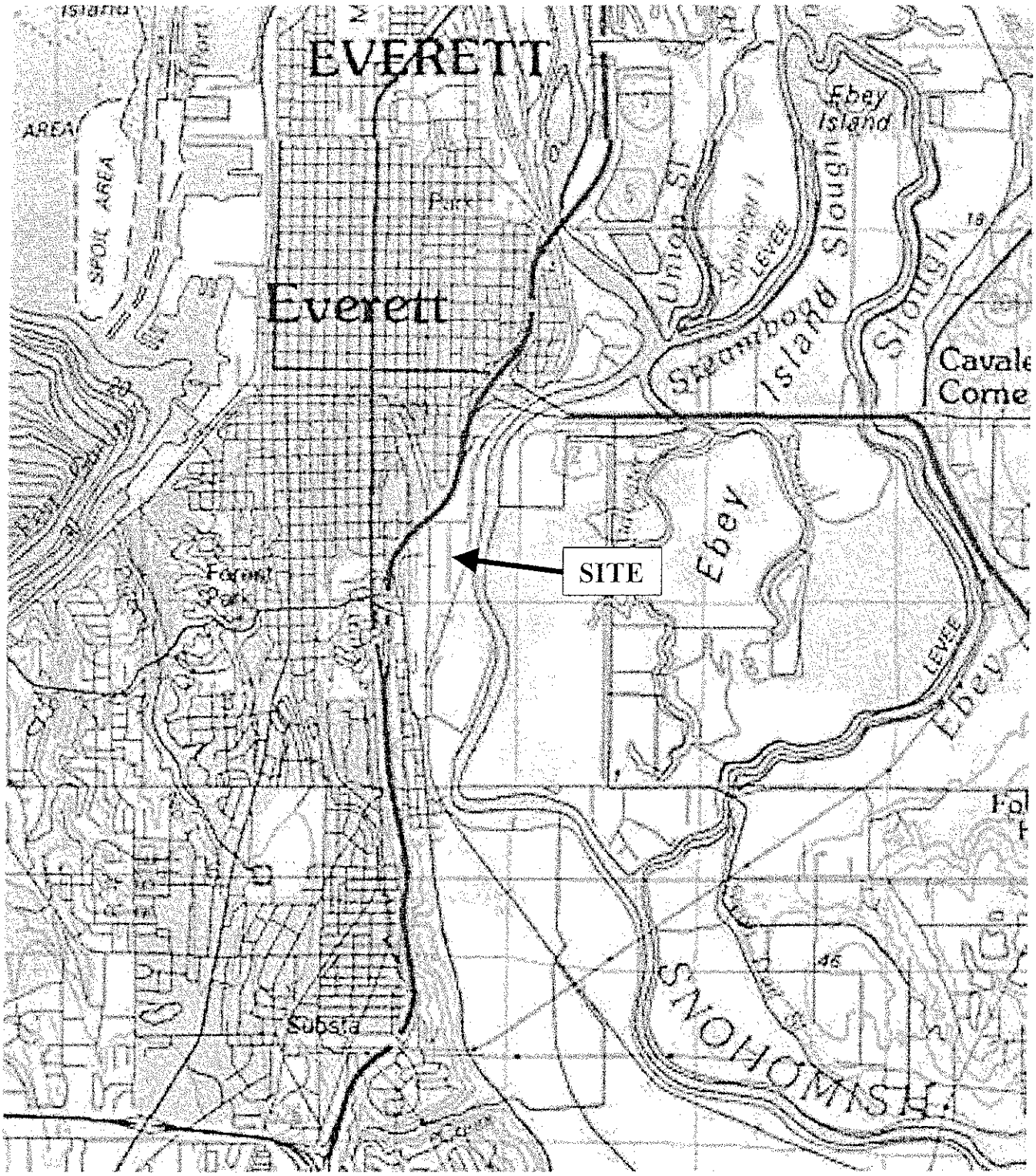
Results of the sampling and laboratory testing will be summarized in a spreadsheet, plotted on a site map, and the data compared to the site groundwater cleanup levels. A report will describe any significant field sampling issues, laboratory QA/QC testing, water level monitoring data and water quality testing results.

4.0 REFERENCES

Barcelona, Michael J., Wehrmann, H. Allen, and Varljen, Mark D. 1994. Reproducible Well Purging Procedures and VOC stabilization Criteria for Ground Water Sampling. *Ground Water* Vol. 32, No. 1, pp. 12-22. January-February.

Floyd & Snider Inc. (FSI), 2001. Attachment CAP-2 – *Compliance Monitoring and Contingency Plan, Everett Landfill/Tire Fire Site Cleanup Action Plan.* Seattle, Washington, March 2001.

Floyd & Snider Inc. (FSI), 2000. *Brownfield Feasibility Study, Everett Landfill/Tire Fire Site,* Seattle, Washington, November 2000.

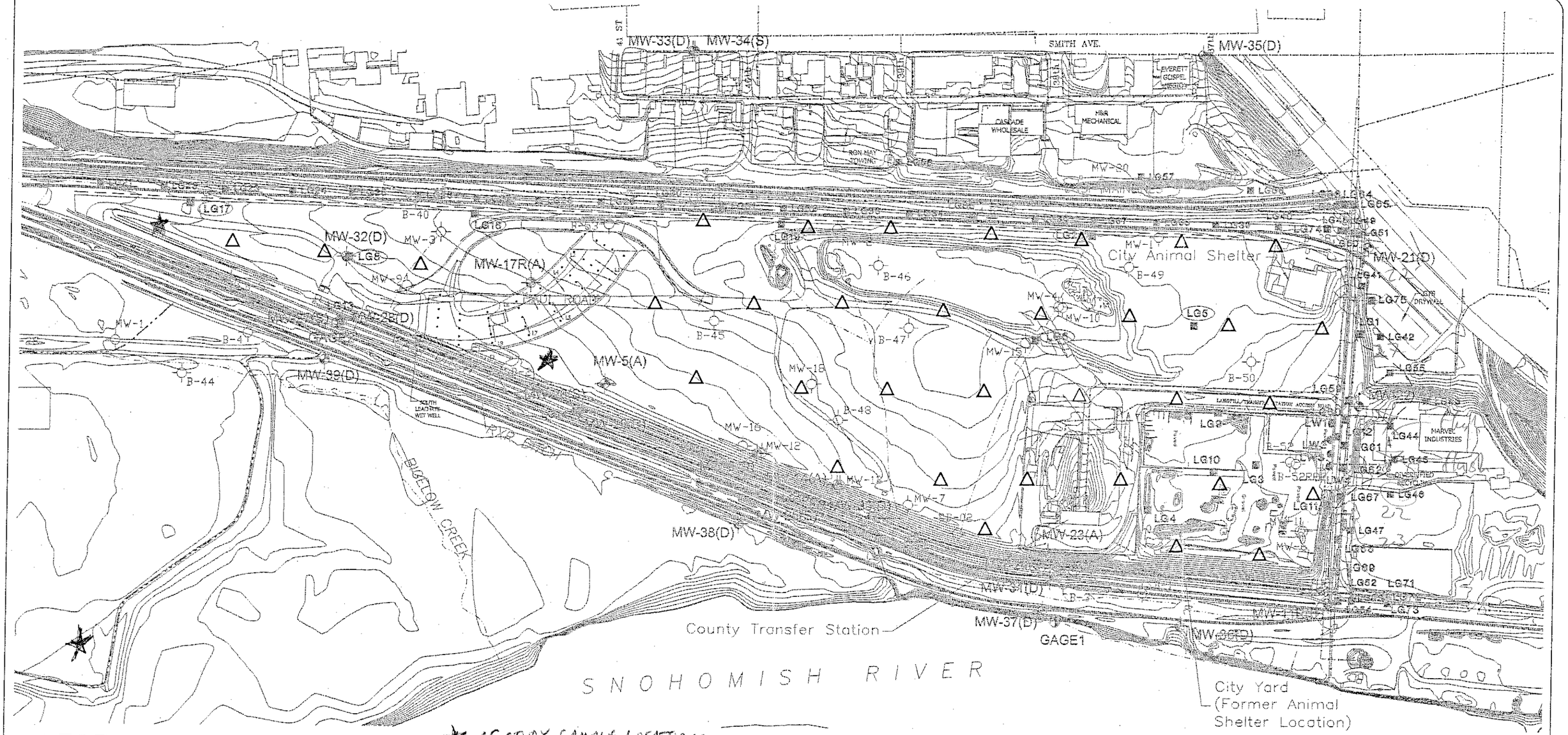


HWA GeoSciences Inc.

EVERETT LANDFILL
EVERETT, WASHINGTON

SITE LOCATION

PROJECT NO.: 98165 FIGURE: 1



★ BF STUDY SAMPLE LOCATION

LEGEND

- △ PROPOSED SHALLOW AQUIFER SAMPLING LOCATION
- LG-40 EXISTING LFG PROBE
- LW-1 GAS EXTRACTION WELL
- LG-5 EXISTING LFG PROBE SCHEDULED FOR DECOMISSONING
- APPROXIMATE LIMITS OF REFUSE
- SOIL BORING OR ABANDONED MONITORING WELL

MW-12(S) SHALLOW MONITORING WELLS FOR GROUND WATER QUALITY SAMPLING

MW-16(D) DEEP MONITORING WELLS FOR GROUND WATER QUALITY SAMPLING

MW-5(A) MONITORING WELLS FOR ABANDONMENT AFTER EVALUATION MONITORING

GAGE1 SURFACE WATER GAGING POINT

REFERENCE : Base map provided by Floyd & Snider Inc.

0' 100' 200' 300' 600'

SCALE: 1"=300'

H:\1Projects\1998 Projects\98165 Everett Landfill\cad\530\98164-200-02.DWG

HWA GEOSCIENCES INC.

EVERETT LANDFILL
EVERETT, WASHINGTON

PROPOSED SHALLOW AQUIFER SAMPLING LOCATION MAP

DRAWN BY SM
CHECKED BY AS
DATE 12.11.02

FIGURE NO. 2

PROJECT NO. 98165-530

APPENDIX A

CHAIN OF CUSTODY FORM
FIELD SAMPLING DATA SHEET
SAMPLE LABELS

HWA GEOSCIENCES INC.
19730 64th Ave. W., Suite 200, Lynnwood, WA 98036 (425)774-0106
4500 Kruse Way, Suite 300, Lake Oswego, OR 97035 (503)675-2424

Chain of Custody and Laboratory Analysis Request

DATE: 4-10-02
PAGE: 1 of 1

PROJECT NAME: Everett Landfill #: 98165
SITE CODE:
SAMPLERS NAME: KRK PHONE: 425-774-0106
SAMPLERS SIGNATURE: Kevin R Knapp
HWA CONTACT: Arnie Sugar PHONE: 425-774-0106

HWA SAMPLE ID	DATE	TIME	MATRIX	LAB ID	# OF BOTTLE	PCBs / Pesticides	SVOCs	VOCs	REMARKS
MW-22-0402	4/10	0947	H_2O			X	X	X	
MW-11R-0402	1	1110	1			X	X	X	
MW-36-0402	1	1355	1			X	X	X	
MW-37-0402	↓	1244	↓			X	X	X	
Dup-31-0402	4/10	1525	H_2O			X	X	X	
TB, 2 blank		-	H_2O					X	

PRINT NAME	SIGNATURE	COMPANY	DATE	TIME	REMARKS
Relinquished by: Kevin R Knapp	Kevin R Knapp	HWA Geo Sciences	4-10-02	1602	
Received by:	FED EXPRESS	AD	4/11/02	1693	
Relinquished by:					
Received by:					

DISTRIBUTION: WHITE - Return to HWA; YELLOW - Retain by Lab; PINK - Retain by Sampler

CITY OF EVERETT
ENVIRONMENTAL LABORATORY
3200 CEDAR STREET; EVERETT, WA 98201
Phone: (425)257-8230 Fax: (425)257-8228

ANALYSIS REQUEST
CHAIN OF CUSTODY

PROJECT # 98165

Date: 4-10-02

Client: Hart Crowser		Address: 19730 64th Ave. W. #200 Lynnwood, WA 98036	
Program:	Sample Site: Everett Landfill		
Phone: 425-774-0106	Collected By: KRK	Requested By:	

Requested sample report date (If less than 30 days): _____

Purpose: ____ In Lab Contract ____ Outside Lab Contract

Sample Description:	LIMS ID # (Lab Use Only)	Sample Date	Sample Time	Comp Grab	Sample Matrix	Cl, NO3, SO4	Ag, As, Ba, Cd, Pb, Se, Zn, Fe, Mn	Cr (VI)	Cr (III)	Cr MT					
						Analyses Requested									
MW-22-0402		4/10	0948		H_2O	X	X	X	X	X	X				
MW-HR-0402		4/10	1110		"	X	X	X	X	X	X				
MW-36-0402		4/10	1355		"	X	X	X	X	X	X				
MW-37-0402		4/10	1244		H_2O	X	X	X	X	X	X				
MW-91-0402		4/10	1525		H_2O	X	X	X	X	X	X				

--INDICATE: LAB PERFORMING ANALYSIS / # OF CONTAINERS--

CHAIN OF CUSTODY

*Relinquished: Kevin R Kingsley	Received: [signature] Rudish	Date: 4-10-02	Time: 1559
*Relinquished:	Received:	Date	Time
*Relinquished:	Received:	Date	Time
*Relinquished:	Received:	Date	Time

COMMENTS:

All appr. metals, field f. Hered.

**Because the City of Everett Environmental Laboratory is a public agency, data, test results, reports and other documents are public records and therefore subject to disclosure to third parties upon their request pursuant to RCW Chap. 42.17.*

HWA GEOSCIENCES INC.
19730 64th Avenue West, Suite 200 Lynnwood, WA 98036
Tel: 425-774-0106 / Fax: 425-774-2714 / E-Mail: hwa@hongwest.com

FIELD SAMPLING DATA SHEET

Project Name: _____ Well Number: _____
Project Number: _____ Sample Number: _____
Project Location: _____ Weather: _____
Client/Contact: _____ Date: _____

WELL MONITORING:

Time	Well Depth	Depth to Water	Measuring Point (TOC?)	Measuring Point Elevation	Water Level Elevation	Gallons in Well (Pore Volume)

(2" case = 0.163 gal/ft)
(4" case = 0.653 gal/ft)

WELL PURGING:

Time	Method	Gallons	Pore Volumes	pH	Conductivity	Temperature		

WELL SAMPLING:

Time	Sampling Method	Sample Analysis	Container Number	Container Volume	Container Type	Field Filtered (Y/N)	Preservative	Iced (Y/N)

COMMENTS/NOTES: (Include equipment used: Bailers, Filters, Well Probe, pH/Conductivity Meter, etc.)

Total # of Bottles: _____ Sampler: _____ Signature: _____

HWA GeoSciences Inc.
Everett Landfill #98165
Sampler ____ Date/Time _____
Analysis: Chloride

Sample _____

HWA GeoSciences Inc.
Everett Landfill #98165
Sampler ____ Date/Time _____
Analysis: Nitrate/Nitrite

Sample _____

HWA GeoSciences Inc.
Everett Landfill #98165
Sampler ____ Date/Time _____
Analysis: Dissolved Metals

Sample _____

HWA GeoSciences Inc.
Everett Landfill #98165
Sampler ____ Date/Time _____
Analysis: Pesticides/PCBs

Sample _____

HWA GeoSciences Inc.
Everett Landfill #98165
Sampler ____ Date/Time _____
Analysis: VOCs

Sample _____

HWA GeoSciences Inc.
Everett Landfill #98165
Sampler ____ Date/Time _____
Analysis: VOCs

Sample _____

HWA GeoSciences Inc.
Everett Landfill #98165
Sampler ____ Date/Time _____
Analysis: SVOCs

Sample _____

HWA GeoSciences Inc.
Everett Landfill #98165
Sampler ____ Date/Time _____
Analysis:

Sample _____

HWA GeoSciences Inc.
Everett Landfill #98165
Sampler ____ Date/Time _____
Analysis:

Sample _____

HWA GeoSciences Inc.
Everett Landfill #98165
Sampler ____ Date/Time _____
Analysis:

Sample _____

APPENDIX B

BORING LOGS

RELATIVE DENSITY OR CONSISTENCY VERSUS SPT N-VALUE

COHESIONLESS SOILS			COHESIVE SOILS		
Density	N (blows/ft)	Approximate Relative Density(%)	Consistency	N (blows/ft)	Approximate Undrained Shear Strength (psf)
Very Loose	0 to 4	0 - 15	Very Soft	0 to 2	<250
Loose	4 to 10	15 - 35	Soft	2 to 4	250 - 500
Medium Dense	10 to 30	35 - 65	Medium Stiff	4 to 8	500 - 1000
Dense	30 to 50	65 - 85	Stiff	8 to 15	1000 - 2000
Very Dense	over 50	85 - 100	Very Stiff	15 to 30	2000 - 4000
			Hard	over 30	>4000

USCS SOIL CLASSIFICATION SYSTEM

MAJOR DIVISIONS			GROUP DESCRIPTIONS	
Coarse Grained Soils	Gravel and Gravelly Soils	Clean Gravel (little or no fines)	GW	Well-graded GRAVEL
			GP	Poorly-graded GRAVEL
	More than 50% of Coarse Fraction Retained on No. 4 Sieve	Gravel with Fines (appreciable amount of fines)	GM	Silty GRAVEL
			GC	Clayey GRAVEL
More than 50% Retained on No. 200 Sieve Size	Sand and Sandy Soils	Clean Sand (little or no fines)	SW	Well-graded SAND
			SP	Poorly-graded SAND
	50% or More of Coarse Fraction Passing No. 4 Sieve	Sand with Fines (appreciable amount of fines)	SM	Silty SAND
			SC	Clayey SAND
Fine Grained Soils	Silt and Clay	Liquid Limit Less than 50%	ML	SILT
			CL	Lean CLAY
			OL	Organic SILT/Organic CLAY
50% or More Passing No. 200 Sieve Size	Silt and Clay	Liquid Limit 50% or More	MH	Elastic SILT
			CH	Fat CLAY
			OH	Organic SILT/Organic CLAY
Highly Organic Soils			PT	PEAT

TEST SYMBOLS

%F	Percent Fines	
AL	Atterberg Limits:	PL = Plastic Limit LL = Liquid Limit
CBR	California Bearing Ratio	
CN	Consolidation	
DD	Dry Density (pcf)	
DS	Direct Shear	
GS	Grain Size Distribution	
K	Permeability	
MD	Moisture/Density Relationship (Proctor)	
MR	Resilient Modulus	
PID	Photoionization Device Reading	
PP	Pocket Penetrometer Approx. Compressive Strength (tsf)	
SG	Specific Gravity	
TC	Triaxial Compression	
TV	Torvane Approx. Shear Strength (tsf)	
UC	Unconfined Compression	

SAMPLE TYPE SYMBOLS

- 2.0" OD Split Spoon (SPT) (140 lb. hammer with 30 in. drop)
- Shelby Tube
- 3-1/4" OD Split Spoon with Brass Rings
- Small Bag Sample
- Large Bag (Bulk) Sample
- Core Run
- Non-standard Penetration Test (3.0" OD split spoon)

GROUNDWATER SYMBOLS

- Groundwater Level (measured at time of drilling)
- Groundwater Level (measured in well or open hole after water level stabilized)

COMPONENT DEFINITIONS

COMPONENT	SIZE RANGE
Boulders	Larger than 12 in
Cobbles	3 in to 12 in
Gravel	3 in to No 4 (4.5mm)
Coarse gravel	3 in to 3/4 in
Fine gravel	3/4 in to No 4 (4.5mm)
Sand	No. 4 (4.5 mm) to No. 200 (0.074 mm)
Coarse sand	No. 4 (4.5 mm) to No. 10 (2.0 mm)
Medium sand	No. 10 (2.0 mm) to No. 40 (0.42 mm)
Fine sand	No. 40 (0.42 mm) to No. 200 (0.074 mm)
Silt and Clay	Smaller than No. 200 (0.074mm)

COMPONENT PROPORTIONS

PROPORTION RANGE	DESCRIPTIVE TERMS
< 5%	Clean
5 - 12%	Slightly (Clayey, Silty, Sandy)
12 - 30%	Clayey, Silty, Sandy, Gravelly
30 - 50%	Very (Clayey, Silty, Sandy, Gravelly)
Components are arranged in order of increasing quantities.	

NOTES: Soil classifications presented on exploration logs are based on visual and laboratory observation. Soil descriptions are presented in the following general order:

Density/consistency, color, modifier (if any) GROUP NAME, additions to group name (if any), moisture content. Proportion, gradation, and angularity of constituents, additional comments. (GEOLOGIC INTERPRETATION)

Please refer to the discussion in the report text as well as the exploration logs for a more complete description of subsurface conditions.

MOISTURE CONTENT

DRY	Absence of moisture, dusty, dry to the touch.
MOIST	Damp but no visible water.
WET	Visible free water, usually soil is below water table.

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EVERETT, WASHINGTON

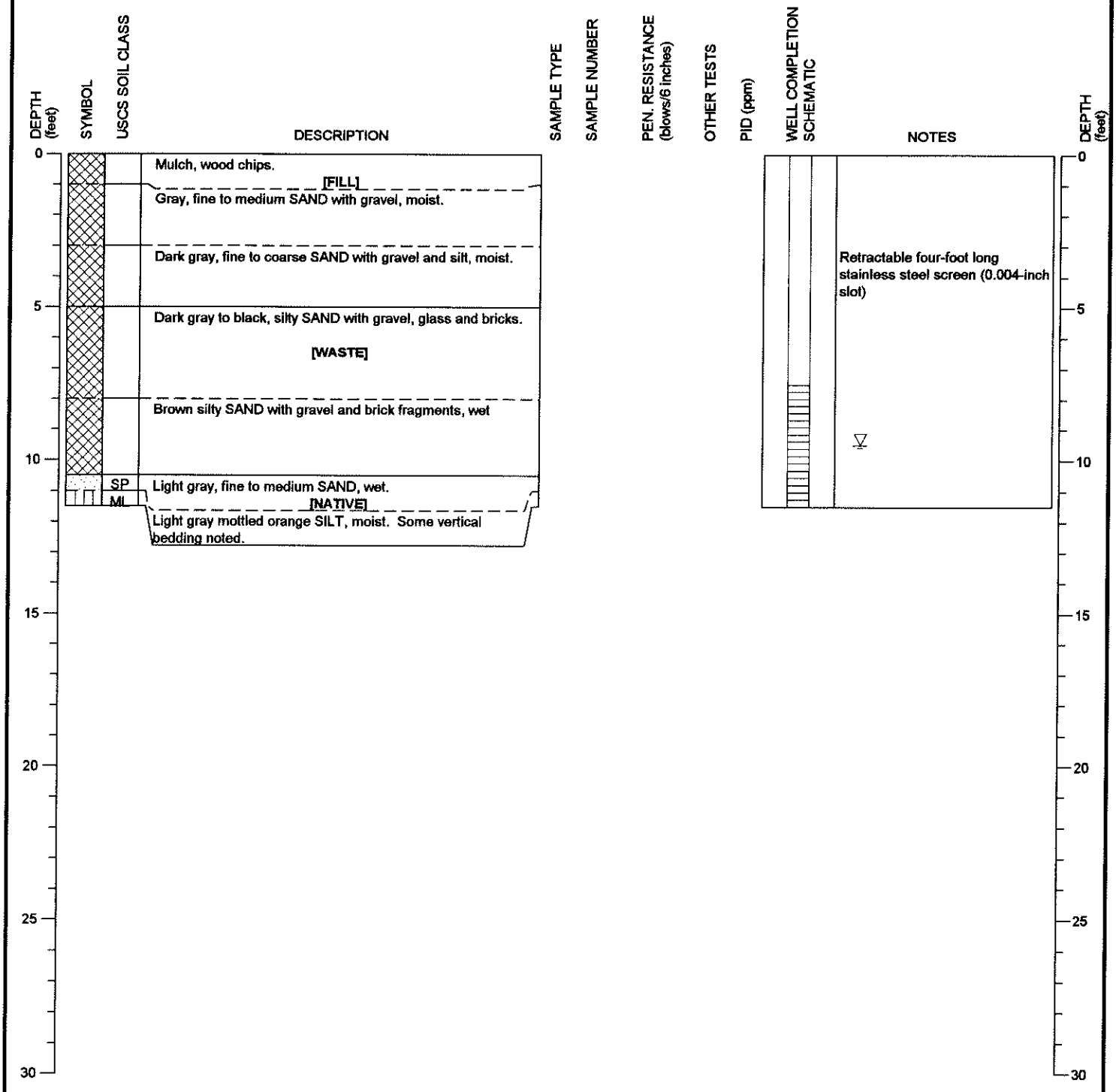
LEGEND OF TERMS AND SYMBOLS USED ON EXPLORATION LOGS

PROJECT NO.: 98165 FIGURE: B-1

DRILLING COMPANY: Cascade Drilling, Inc.
DRILLING METHOD: Geoprobe-Truck Mounted
SAMPLING METHOD: 2" OD PETG Liner
LOCATION: Everett, Washington

SURFACE ELEVATION: ± feet

DATE STARTED: 2/10/2003
DATE COMPLETED: 2/10/2003
LOGGED BY: B. Robinson



NOTE: This log of subsurface conditions applies only at the specified location and on the date indicated and therefore may not necessarily be indicative of other times and/or locations.

HWA GEOSCIENCES INC.

EVERETT LANDFILL
EVERETT, WASHINGTON

MONITORING WELL:
SA-01

PAGE: 1 of 1

PROJECT NO.: 98165

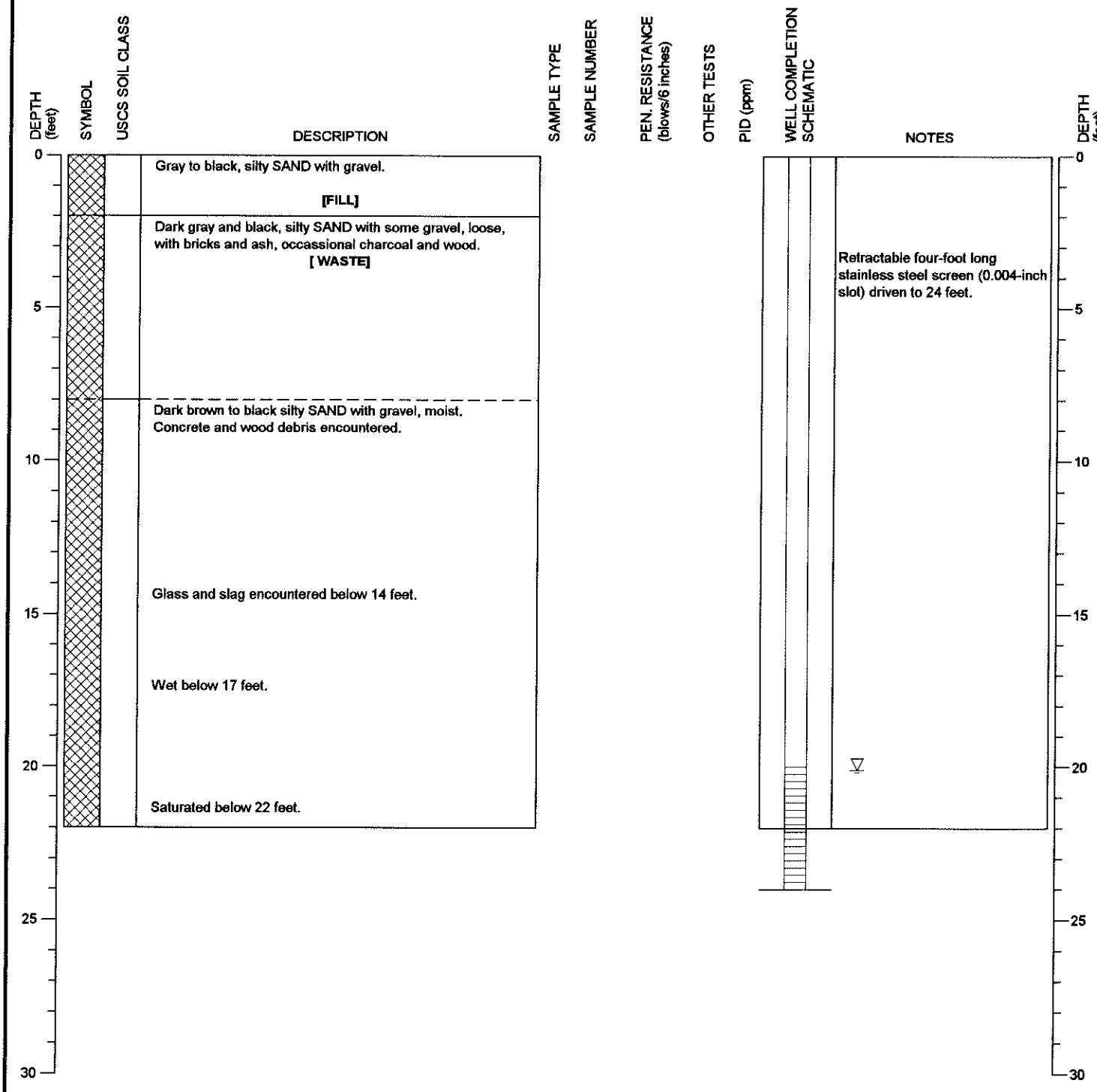
FIGURE: B-2

MWELL 98165.GPJ 7/11/03

DRILLING COMPANY: Cascade Drilling, Inc.
DRILLING METHOD: Geoprobe-Truck Mounted
SAMPLING METHOD: 2" OD PETG Liner
LOCATION: Everett, Washington

SURFACE ELEVATION: ± feet

DATE STARTED: 2/10/2003
DATE COMPLETED: 2/10/2003
LOGGED BY: B. Robinson



NOTE: This log of subsurface conditions applies only at the specified location and on the date indicated and therefore may not necessarily be indicative of other times and/or locations.

HWA GEOSCIENCES INC.

EVERETT LANDFILL
EVERETT, WASHINGTON

MONITORING WELL:
SA-02

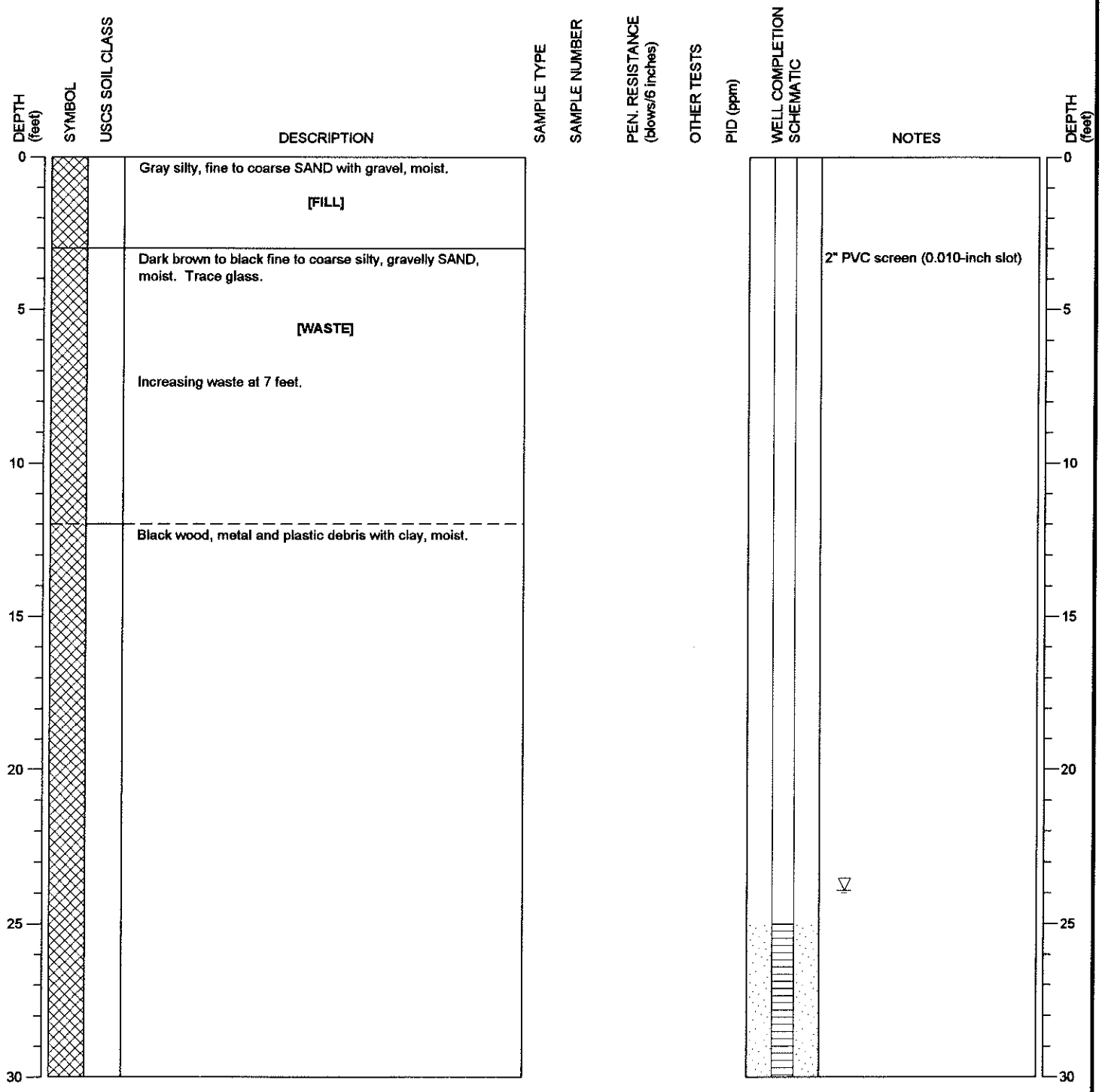
PROJECT NO.: 98165

FIGURE: B-3

DRILLING COMPANY: Cascade Drilling, Inc.
DRILLING METHOD: HSA, 8" OD, Tracked Rig
SAMPLING METHOD: 3" D&M on winch line
LOCATION: Everett, Washington

SURFACE ELEVATION: ± feet

DATE STARTED: 2/28/2003
DATE COMPLETED: 2/28/2003
LOGGED BY: B. Robinson



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HWA GEOSCIENCES INC.

EVERETT LANDFILL
EVERETT, WASHINGTON

MONITORING WELL:
SA-03

PAGE: 1 of 1

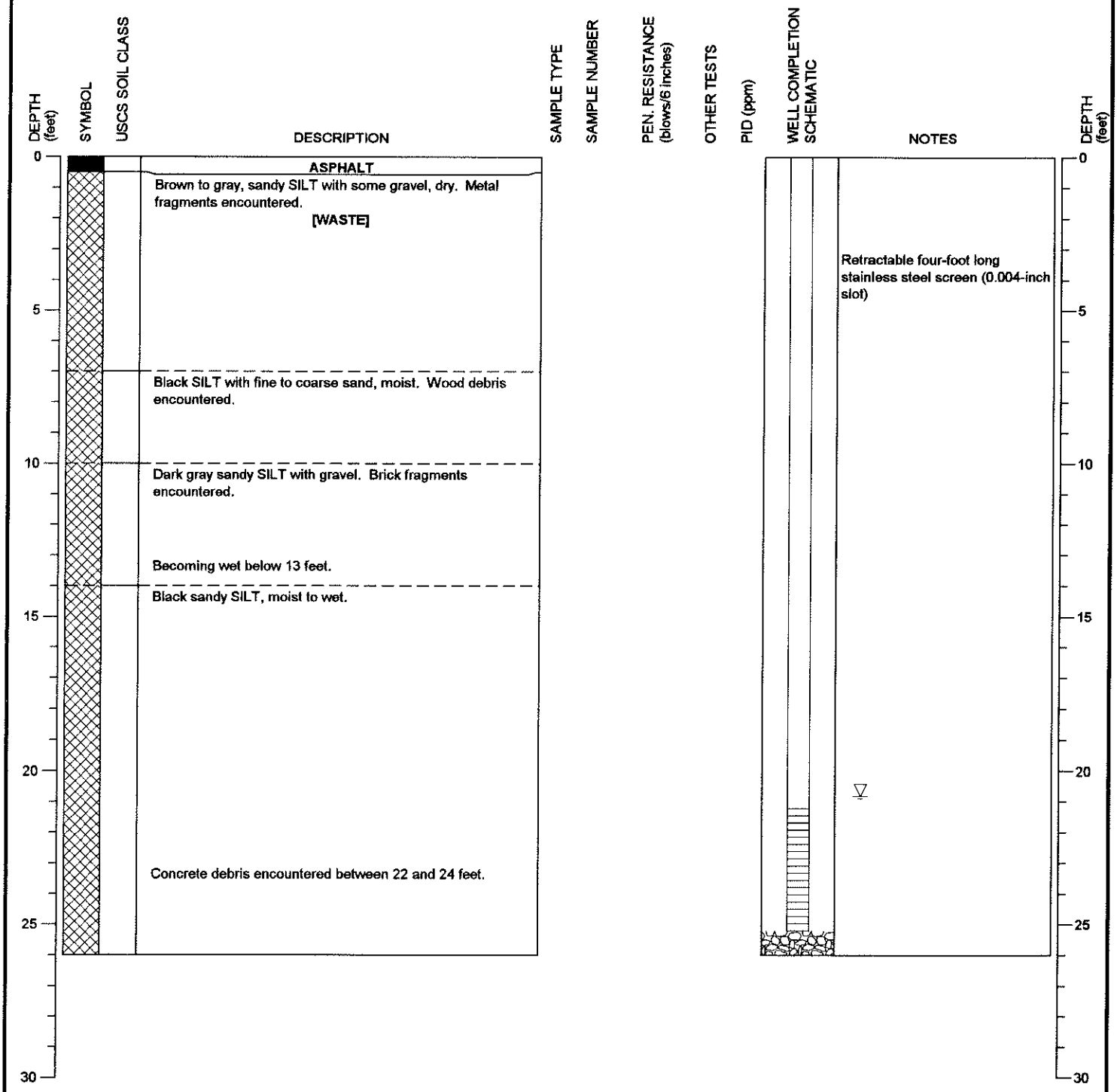
PROJECT NO.: 98165 FIGURE: B-4

MWELL 98165.GPJ 7/11/03

DRILLING COMPANY: Cascade Drilling, Inc.
DRILLING METHOD: Geoprobe-Truck Mounted
SAMPLING METHOD: 2" OD PETG Liner
LOCATION: Everett, Washington

SURFACE ELEVATION: ± feet

DATE STARTED: 2/11/2003
DATE COMPLETED: 2/11/2003
LOGGED BY: B. Robinson



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HWA GEOSCIENCES INC.

EVERETT LANDFILL
EVERETT, WASHINGTON

MONITORING WELL:
SA-04

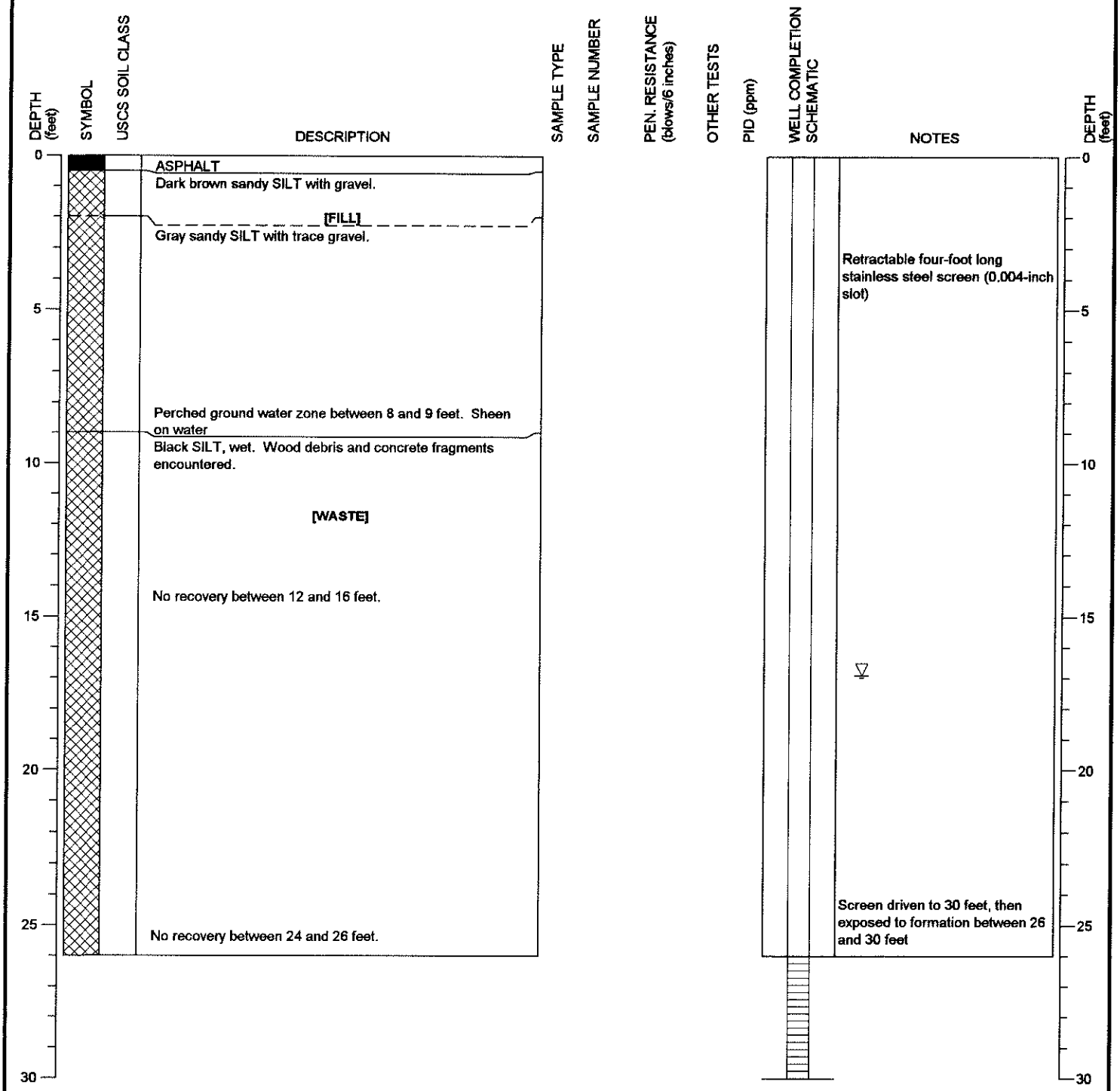
PROJECT NO.: 98165

FIGURE: B-5

DRILLING COMPANY: Cascade Drilling, Inc.
DRILLING METHOD: Geoprobe-Truck Mounted
SAMPLING METHOD: 2" OD PETG Liner
LOCATION: Everett, Washington

SURFACE ELEVATION: ± feet

DATE STARTED: 2/11/2003
DATE COMPLETED: 2/11/2003
LOGGED BY: B. Robinson



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HWA GEOSCIENCES INC.

EVERETT LANDFILL
EVERETT, WASHINGTON

MONITORING WELL:
SA-05

PAGE: 1 of 1

PROJECT NO.: 98165

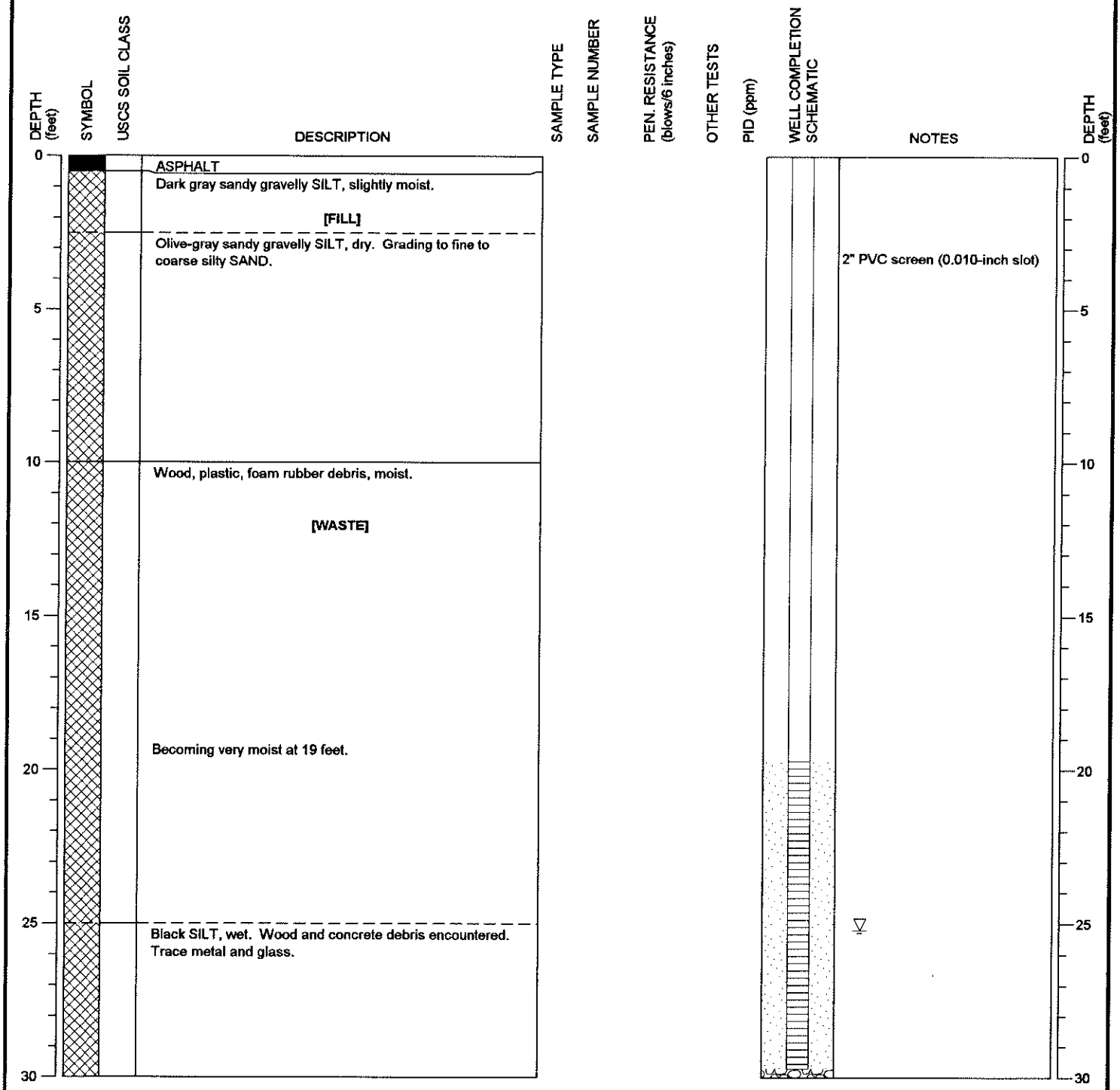
FIGURE: B-6

MWELL 98165.GPJ 7/11/03

DRILLING COMPANY: Cascade Drilling, Inc.
DRILLING METHOD: HSA, 8" OD, Tracked Rig
SAMPLING METHOD: 3" D&M on winch line
LOCATION: Everett, Washington

SURFACE ELEVATION: ± feet

DATE STARTED: 2/28/2003
DATE COMPLETED: 2/28/2003
LOGGED BY: B. Robinson



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HWA GEOSCIENCES INC.

EVERETT LANDFILL
EVERETT, WASHINGTON

MONITORING WELL:
SA-06

PAGE: 1 of 1

PROJECT NO.: 98165

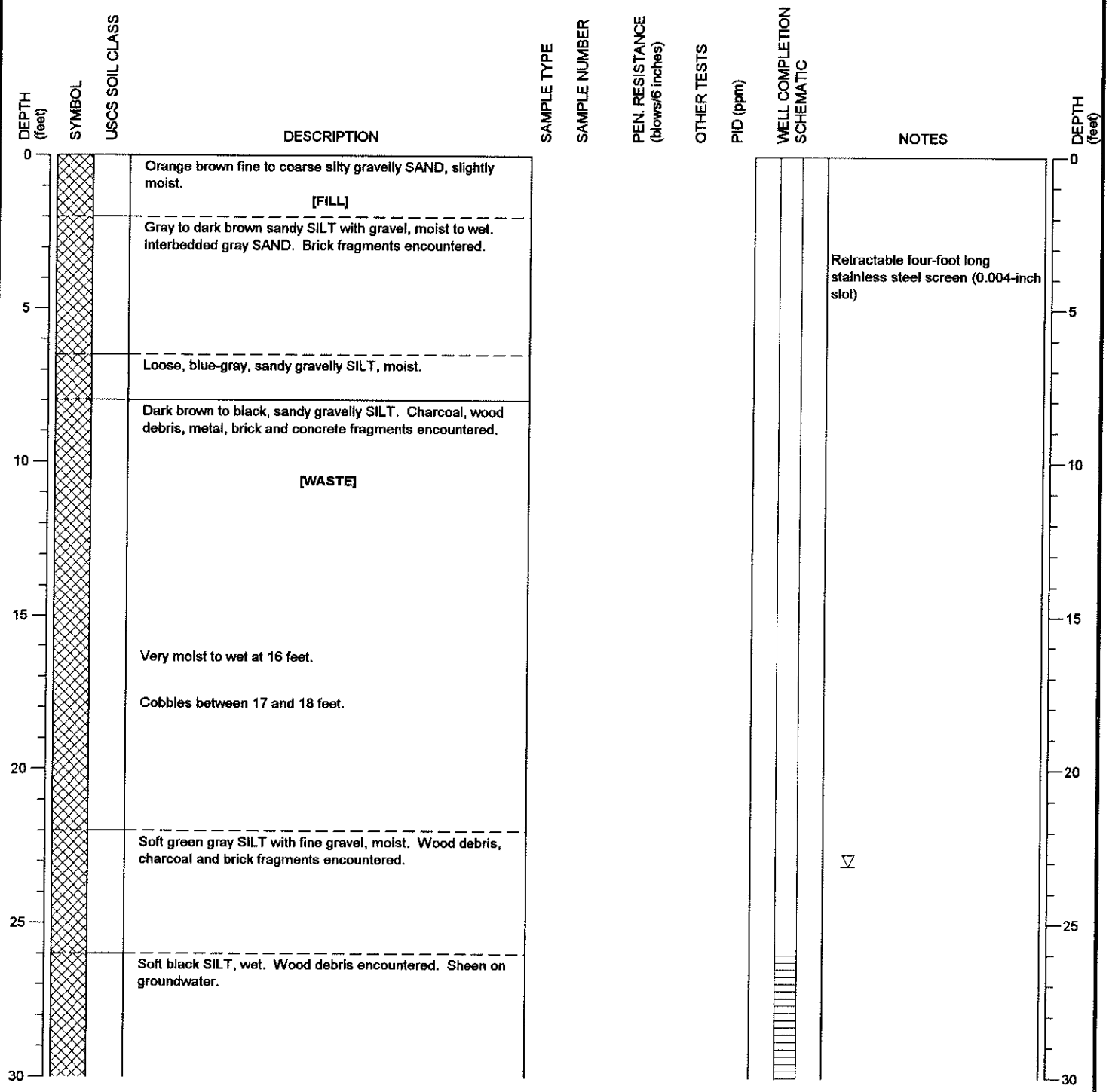
FIGURE: B-7

MWELL 98165.GPJ 7/11/03

DRILLING COMPANY: Cascade Drilling, Inc.
DRILLING METHOD: Geoprobe-Truck Mounted
SAMPLING METHOD: 2" OD PETG Liner
LOCATION: Everett, Washington

SURFACE ELEVATION: ± feet

DATE STARTED: 2/12/2003
DATE COMPLETED: 2/12/2003
LOGGED BY: B. Robinson



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HWA GEOSCIENCES INC.

EVERETT LANDFILL
EVERETT, WASHINGTON

MONITORING WELL:
SA-07

PROJECT NO.: 98165

FIGURE: B-8

DRILLING COMPANY: Cascade Drilling, Inc.
DRILLING METHOD: Geoprobe-Truck Mounted
SAMPLING METHOD: 2" OD PETG Liner
LOCATION: Everett, Washington

SURFACE ELEVATION: ± feet

DATE STARTED: 2/12/2003
DATE COMPLETED: 2/12/2003
LOGGED BY: B. Robinson

DEPTH (feet)	SYMBOL	USCS SOIL CLASS	DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	PEN. RESISTANCE (blows/6 inches)	OTHER TESTS	PID (ppm)	WELL COMPLETION SCHEMATIC	NOTES	DEPTH (feet)
30			Dark gray to brown sandy SILT with gravel, moist.								30
35											35
40											40
45											45
50											50
55											55
60											60

NOTE: This log of subsurface conditions applies only at the specified location and on the date indicated and therefore may not necessarily be indicative of other times and/or locations.

HWA GEOSCIENCES INC.

EVERETT LANDFILL
EVERETT, WASHINGTON

MONITORING WELL:
SA-07

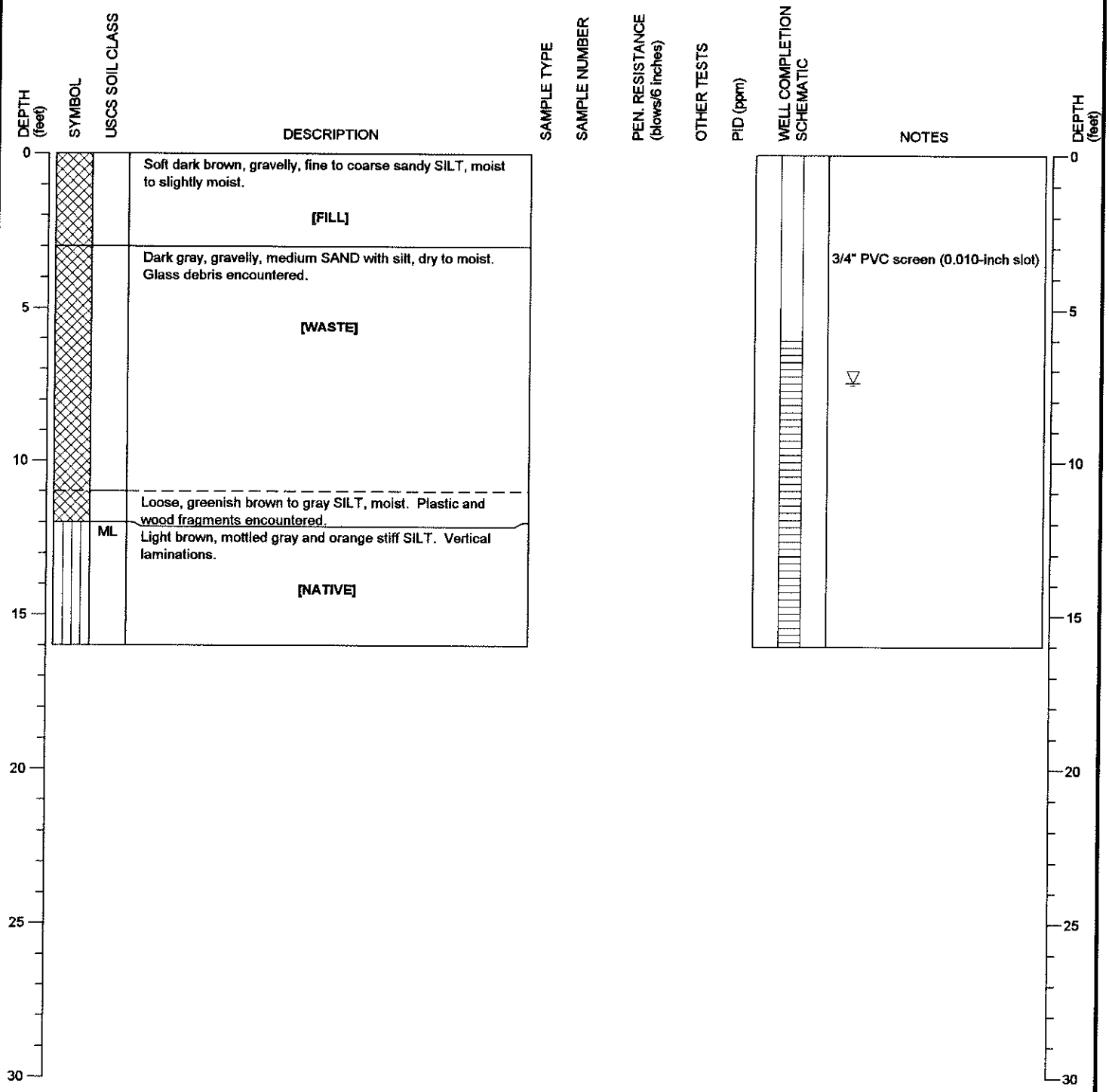
PROJECT NO.: 98165

FIGURE: B-8

DRILLING COMPANY: Cascade Drilling, Inc.
DRILLING METHOD: Geoprobe-Bobcat Mounted
SAMPLING METHOD: 2" OD PETG Liner
LOCATION: Everett, Washington

SURFACE ELEVATION: ± feet

DATE STARTED: 2/12/2003
DATE COMPLETED: 2/12/2003
LOGGED BY: B. Robinson



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HWA GEOSCIENCES INC.

EVERETT LANDFILL
EVERETT, WASHINGTON

MONITORING WELL:
SA-08

PAGE: 1 of 1

PROJECT NO.: 98165

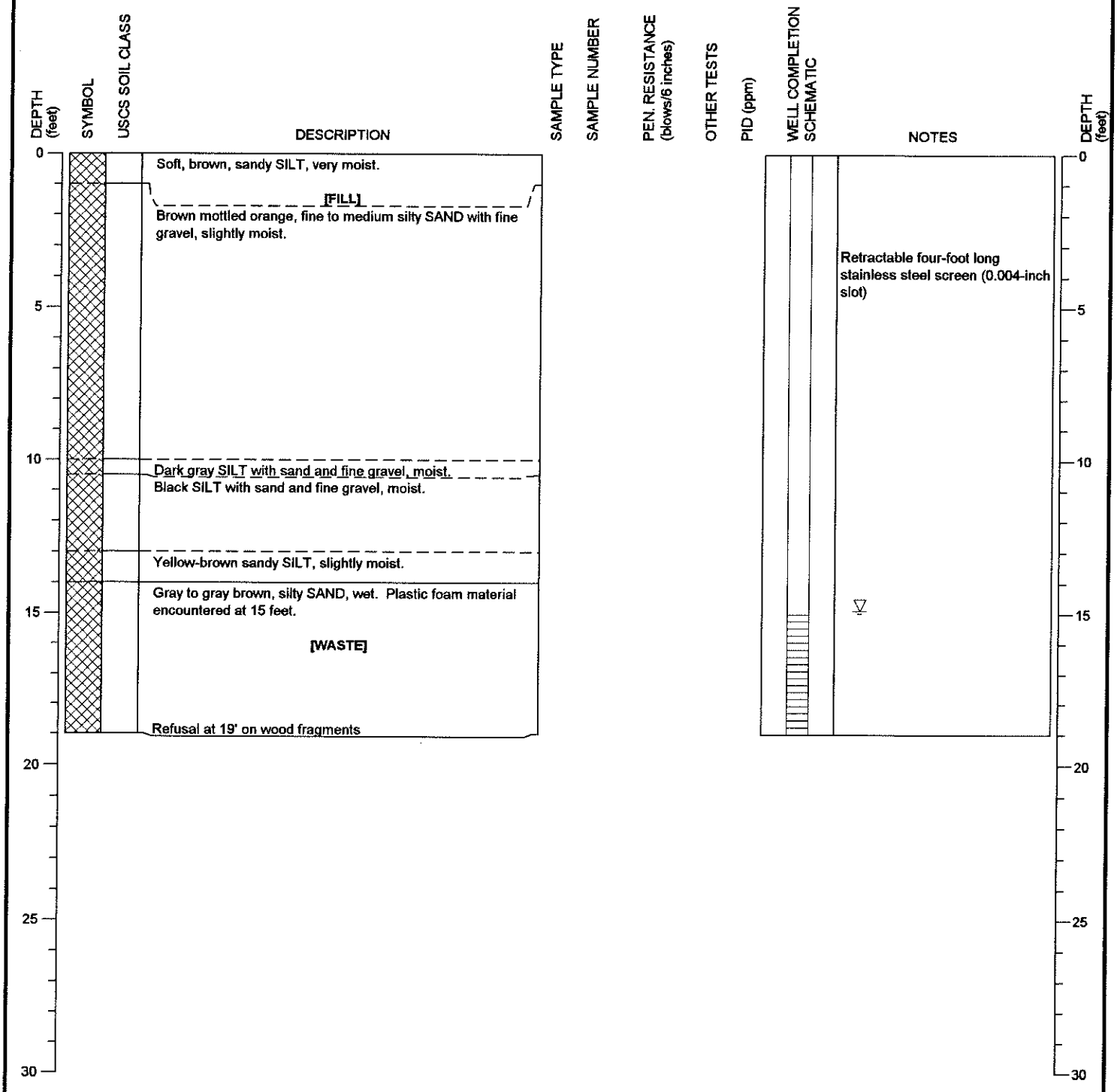
FIGURE: B-9

MWELL 98165.GPJ 7/11/03

DRILLING COMPANY: Cascade Drilling, Inc.
DRILLING METHOD: Geoprobe-Truck Mounted
SAMPLING METHOD: 2" OD PETG Liner
LOCATION: Everett, Washington

SURFACE ELEVATION: ± feet

DATE STARTED: 2/12/2003
DATE COMPLETED: 2/12/2003
LOGGED BY: B. Robinson



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HWA GEOSCIENCES INC.

EVERETT LANDFILL
EVERETT, WASHINGTON

MONITORING WELL:
SA-09

PAGE: 1 of 1

PROJECT NO.: 98165

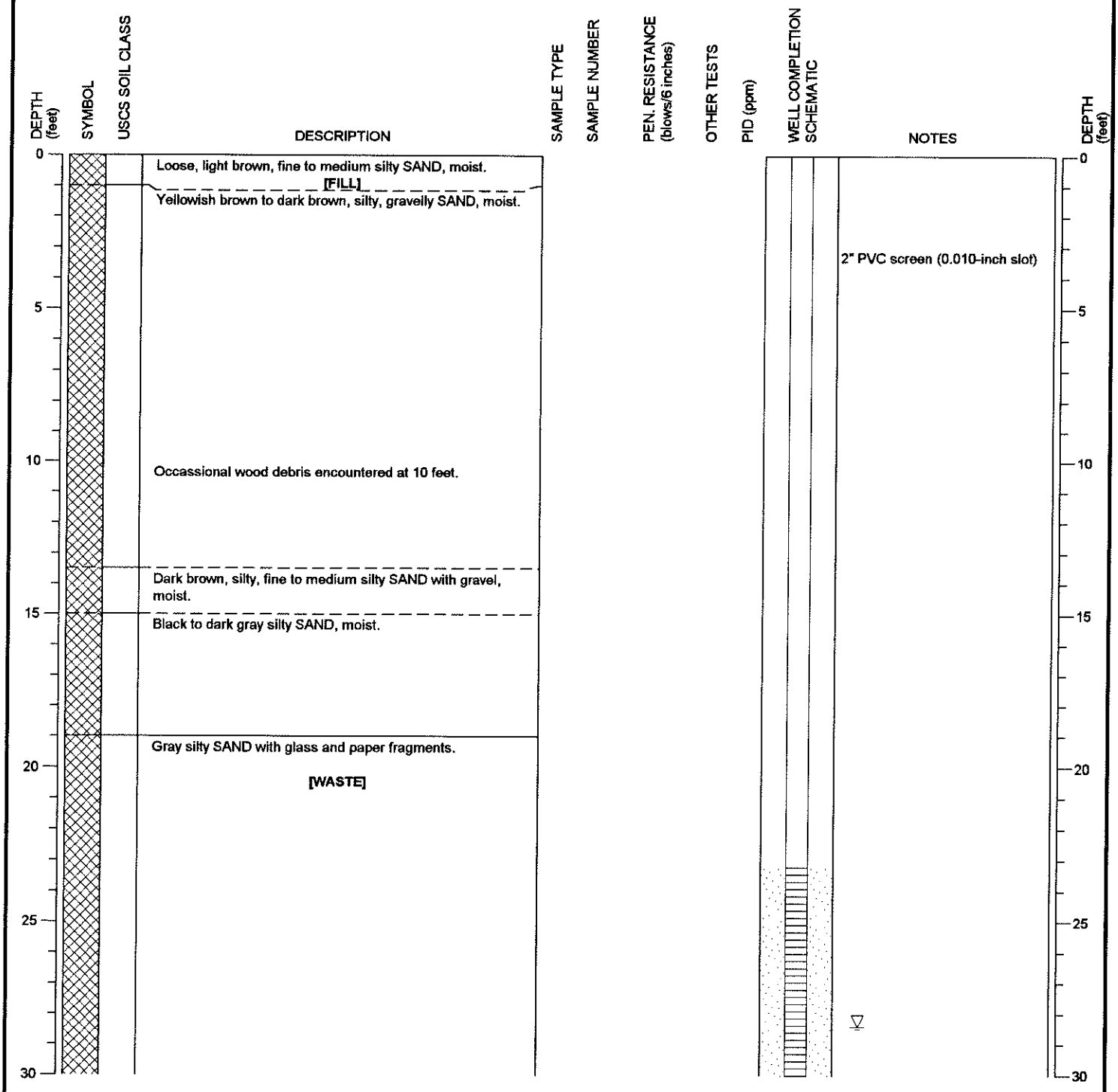
FIGURE: B-10

MWELL 98165.GPJ 7/11/03

DRILLING COMPANY: Cascade Drilling, Inc.
DRILLING METHOD: HSA, 8" OD, Tracked Rig
SAMPLING METHOD: 3" D&M on winch line
LOCATION: Everett, Washington

SURFACE ELEVATION: ± feet

DATE STARTED: 2/24/2003
DATE COMPLETED: 2/24/2003
LOGGED BY: B. Robinson



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HWA GEOSCIENCES INC.

EVERETT LANDFILL
EVERETT, WASHINGTON

MONITORING WELL:
SA-10

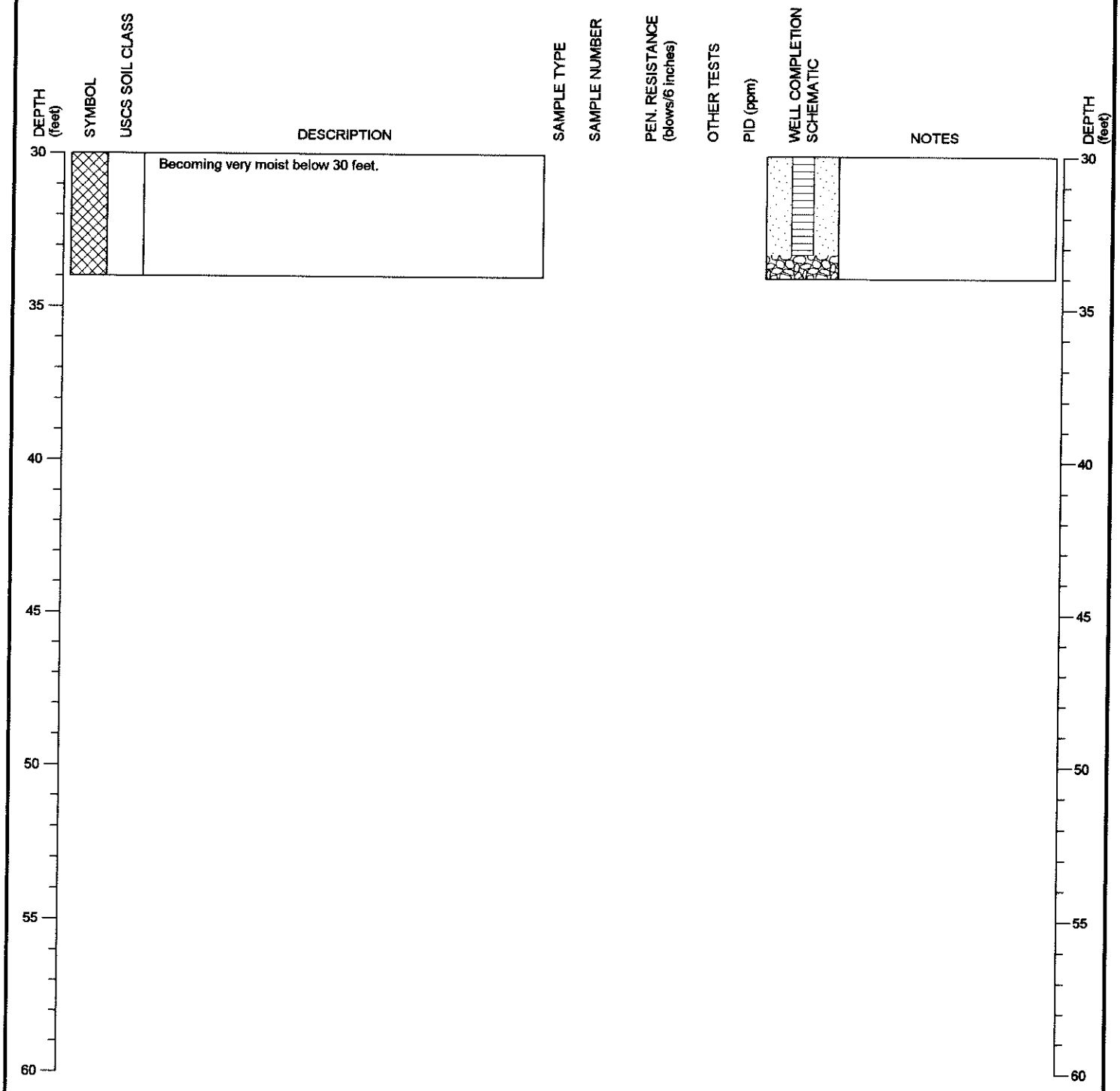
PROJECT NO.: 98165

FIGURE: B-11

DRILLING COMPANY: Cascade Drilling, Inc.
DRILLING METHOD: HSA, 8" OD, Tracked Rig
SAMPLING METHOD: 3" D&M on winch line
LOCATION: Everett, Washington

SURFACE ELEVATION: ± feet

DATE STARTED: 2/24/2003
DATE COMPLETED: 2/24/2003
LOGGED BY: B. Robinson



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HWA GEOSCIENCES INC.

EVERETT LANDFILL
EVERETT, WASHINGTON

MONITORING WELL:
SA-10

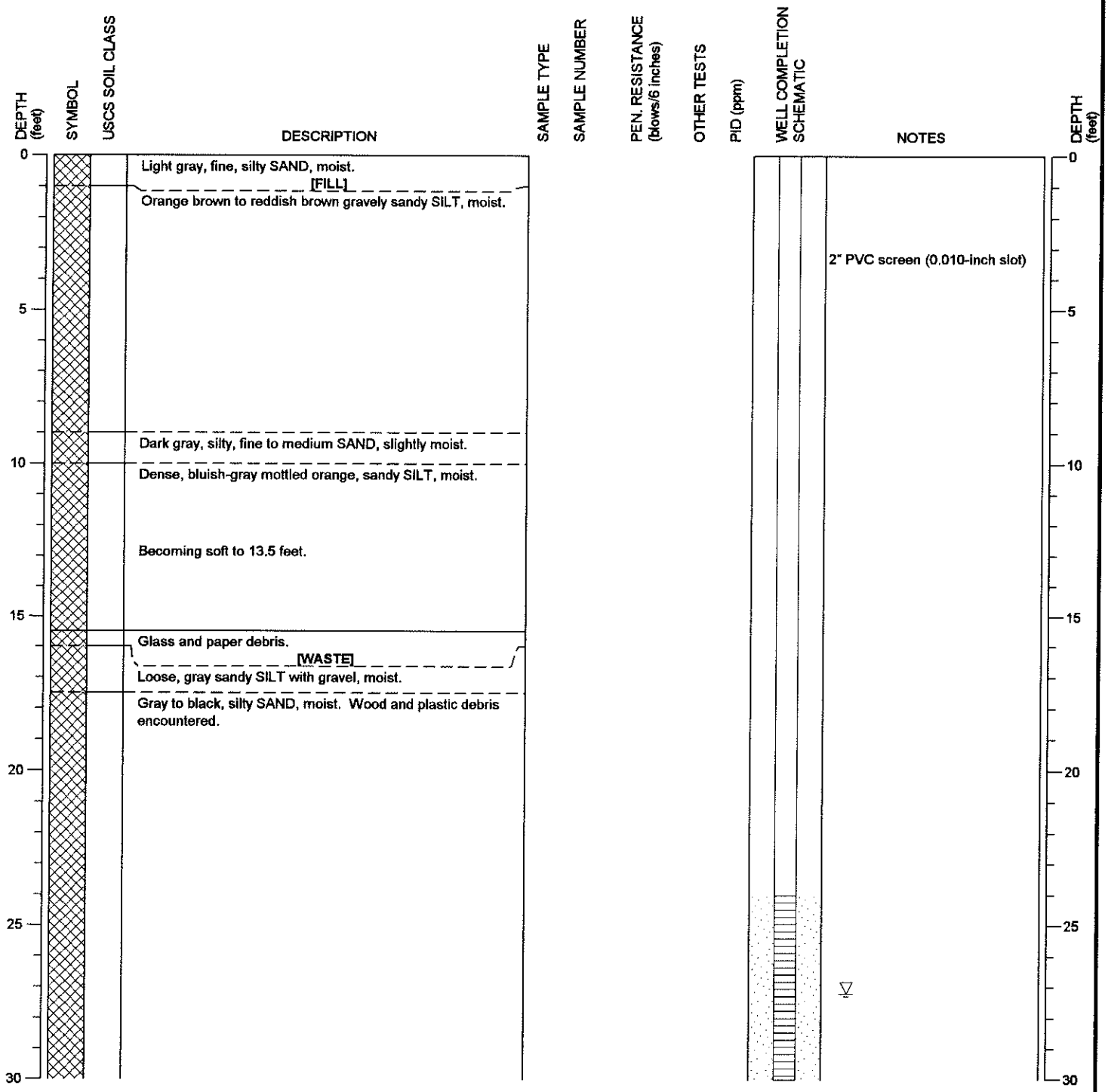
PROJECT NO.: 98165

FIGURE: B-11

DRILLING COMPANY: Cascade Drilling, Inc.
DRILLING METHOD: HSA, 8" OD, Tracked Rig
SAMPLING METHOD: 3" D&M on winch line
LOCATION: Everett, Washington

SURFACE ELEVATION: ± feet

DATE STARTED: 2/24/2003
DATE COMPLETED: 2/24/2003
LOGGED BY: B. Robinson



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HWA GEOSCIENCES INC.

EVERETT LANDFILL
EVERETT, WASHINGTON

MONITORING WELL:
SA-11

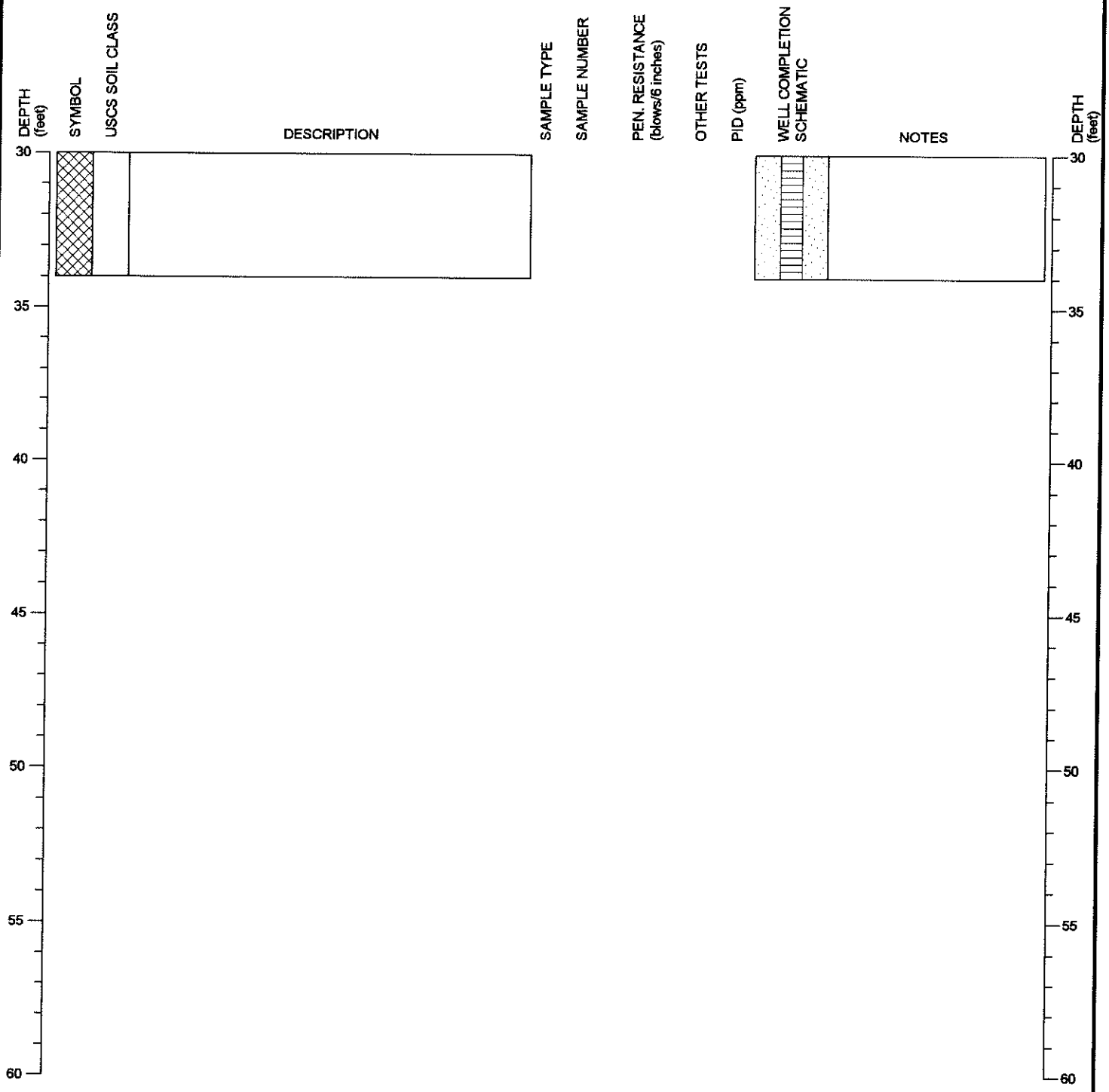
PROJECT NO.: 98165

FIGURE: B-12

DRILLING COMPANY: Cascade Drilling, Inc.
DRILLING METHOD: HSA, 8" OD, Tracked Rig
SAMPLING METHOD: 3" D&M on winch line
LOCATION: Everett, Washington

SURFACE ELEVATION: ± feet

DATE STARTED: 2/24/2003
DATE COMPLETED: 2/24/2003
LOGGED BY: B. Robinson



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HWA GEOSCIENCES INC.

EVERETT LANDFILL
EVERETT, WASHINGTON

MONITORING WELL:
SA-11

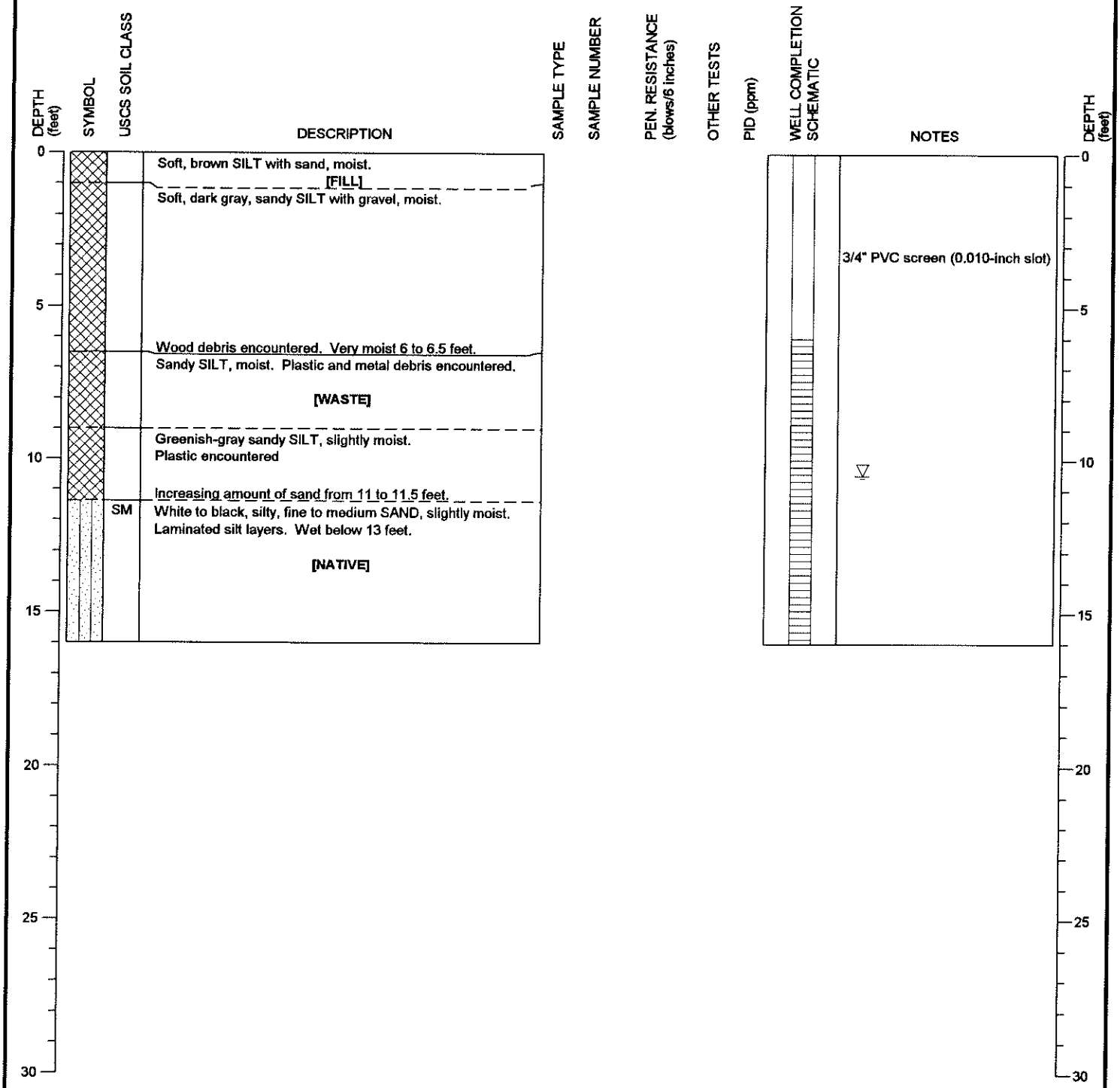
PROJECT NO.: 98165

FIGURE: B-12

DRILLING COMPANY: Cascade Drilling, Inc.
DRILLING METHOD: Geoprobe-Bobcat Mounted
SAMPLING METHOD: 2" OD PETG Liner
LOCATION: Everett, Washington

SURFACE ELEVATION: ± feet

DATE STARTED: 2/13/2003
DATE COMPLETED: 2/13/2003
LOGGED BY: B. Robinson



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HWA GEOSCIENCES INC.

EVERETT LANDFILL
EVERETT, WASHINGTON

MONITORING WELL:
SA-12

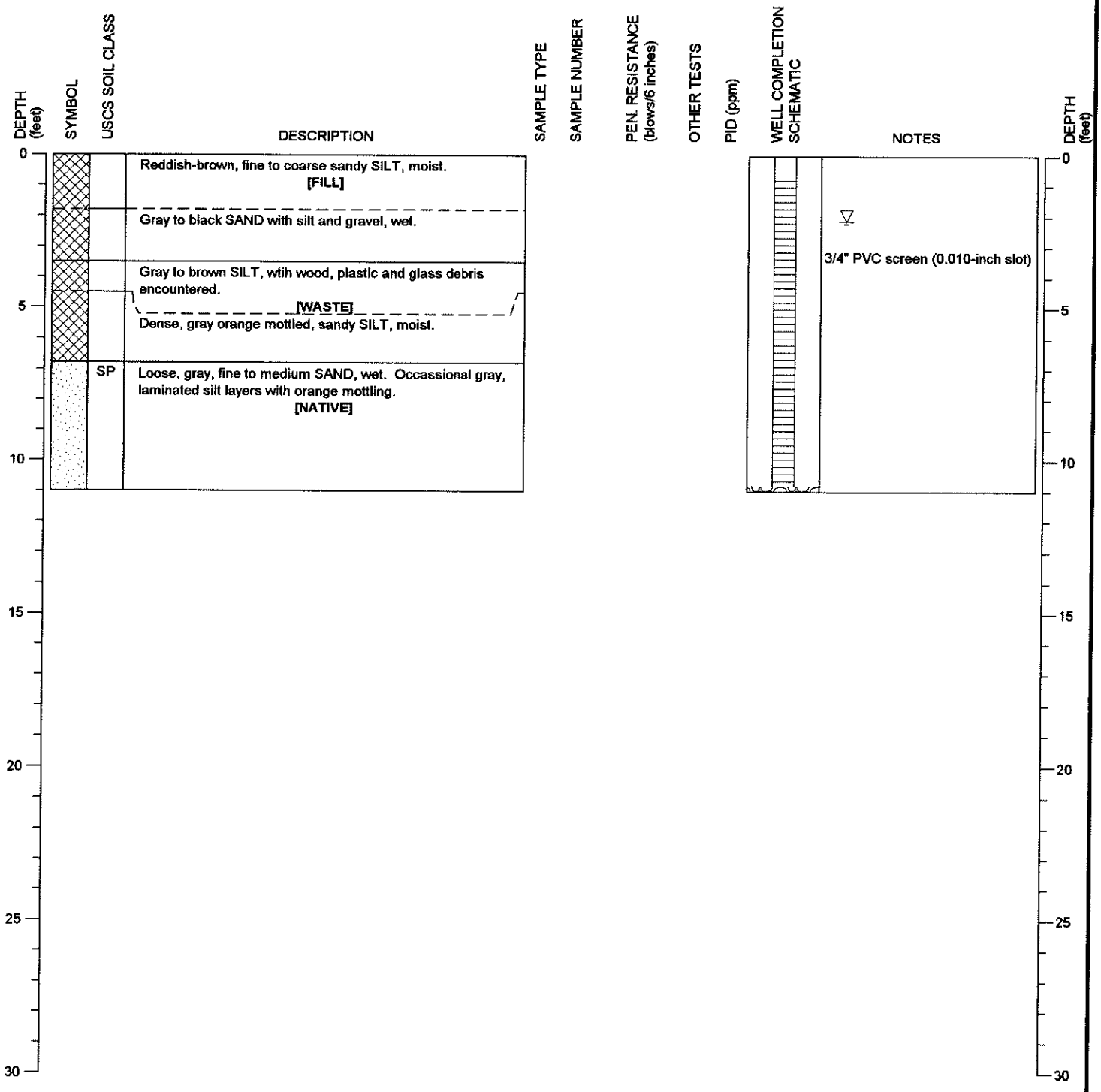
PROJECT NO.: 98165

FIGURE: B-13

DRILLING COMPANY: Cascade Drilling, Inc.
DRILLING METHOD: Geoprobe-Bobcat Mounted
SAMPLING METHOD: 2" OD PETG Liner
LOCATION: Everett, Washington

SURFACE ELEVATION: ± feet

DATE STARTED: 2/13/2003
DATE COMPLETED: 2/13/2003
LOGGED BY: B. Robinson



NOTE: This log of subsurface conditions applies only at the specified location and on the date indicated and therefore may not necessarily be indicative of other times and/or locations.

HWA GEOSCIENCES INC.

EVERETT LANDFILL
EVERETT, WASHINGTON

MONITORING WELL:
SA-13

PAGE: 1 of 1

PROJECT NO.: 98165

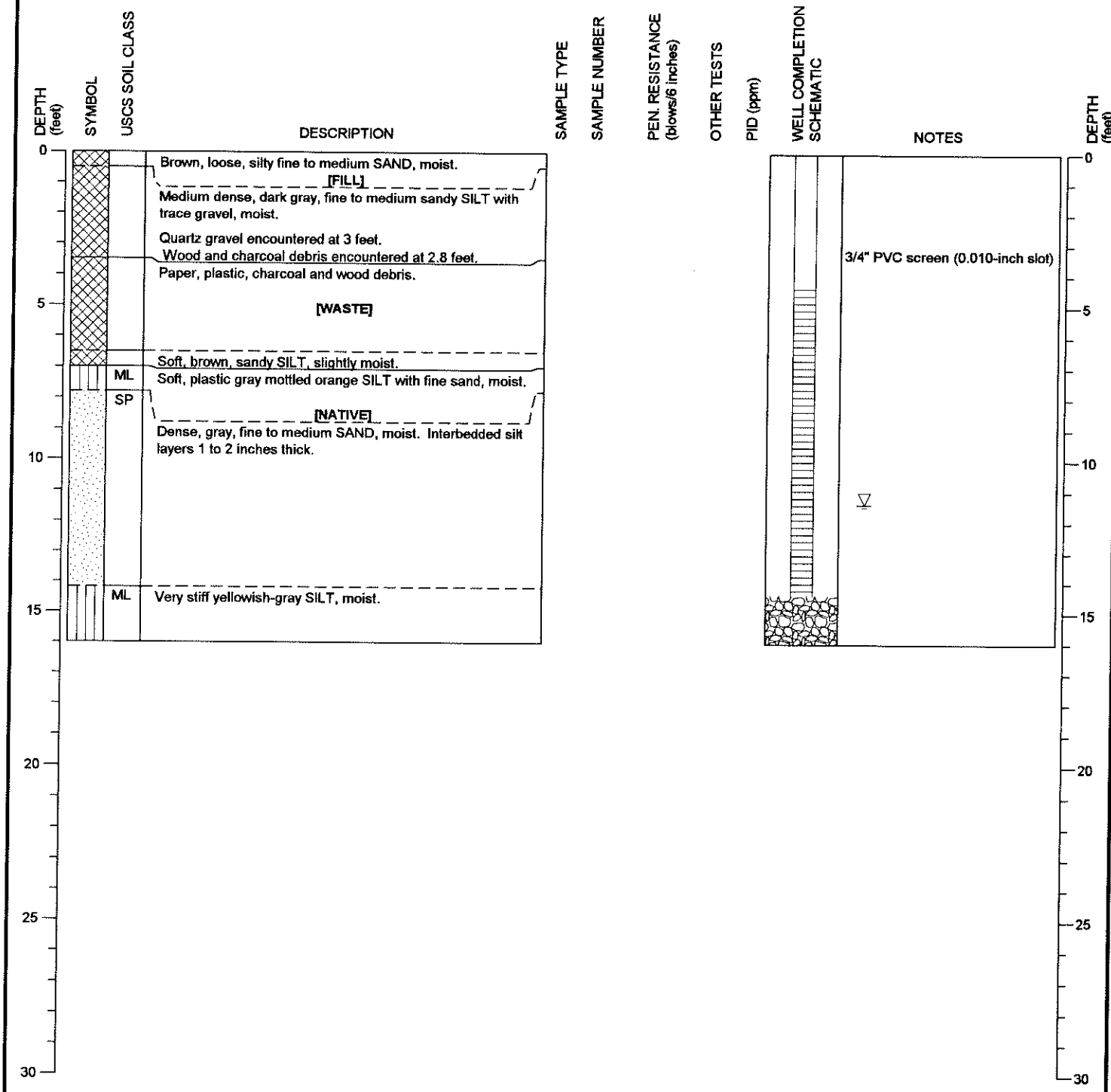
FIGURE: B-14

MWELL 98165.GPJ 7/11/03

DRILLING COMPANY: Cascade Drilling, Inc.
DRILLING METHOD: Geoprobe-Bobcat Mounted
SAMPLING METHOD: 2" OD PETG Liner
LOCATION: Everett, Washington

SURFACE ELEVATION: ± feet

DATE STARTED: 2/13/2003
DATE COMPLETED: 2/13/2003
LOGGED BY: B. Robinson



NOTE: This log of subsurface conditions applies only at the specified location and on the date indicated and therefore may not necessarily be indicative of other times and/or locations.

HWA GEOSCIENCES INC.

EVERETT LANDFILL
EVERETT, WASHINGTON

MONITORING WELL:
SA-14

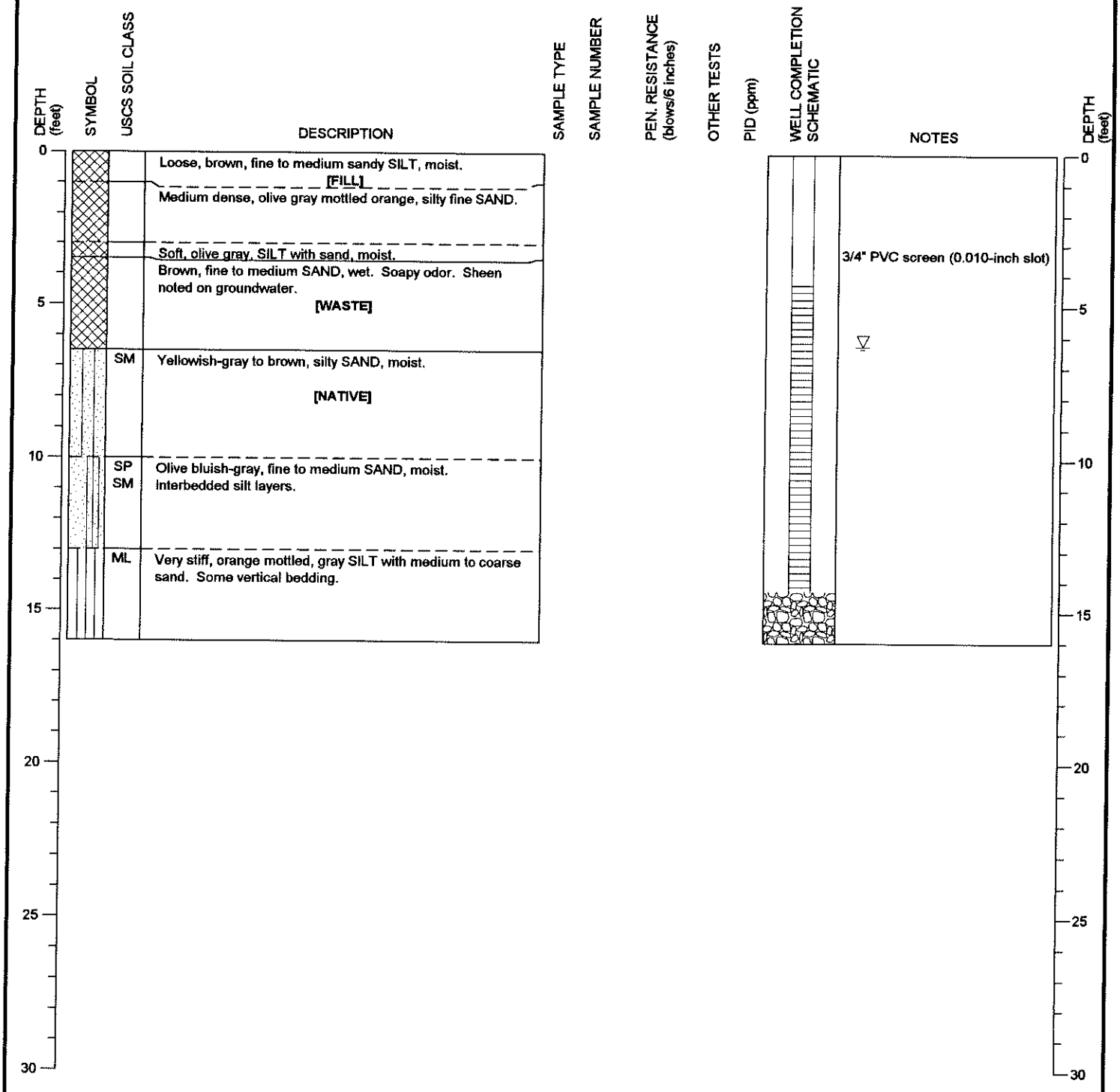
PROJECT NO.: 98165

FIGURE: B-15

DRILLING COMPANY: Cascade Drilling, Inc.
DRILLING METHOD: Geoprobe-Bobcat Mounted
SAMPLING METHOD: 2" OD PETG Liner
LOCATION: Everett, Washington

SURFACE ELEVATION: ± feet

DATE STARTED: 2/13/2003
DATE COMPLETED: 2/13/2003
LOGGED BY: B. Robinson



NOTE: This log of subsurface conditions applies only at the specified location and on the date indicated and therefore may not necessarily be indicative of other times and/or locations.

HWA GEOSCIENCES INC.

EVERETT LANDFILL
EVERETT, WASHINGTON

MONITORING WELL:
SA-15

PAGE: 1 of 1

PROJECT NO.: 98165

FIGURE: B-16

MWELL 98165.GPJ 7/11/03

DRILLING COMPANY: Cascade Drilling, Inc.
DRILLING METHOD: HSA, 8" OD, Tracked Rig
SAMPLING METHOD: 3" D&M on winch line
LOCATION: Everett, Washington

SURFACE ELEVATION: ± feet

DATE STARTED: 2/27/2003
DATE COMPLETED: 2/27/2003
LOGGED BY: B. Robinson

DEPTH (feet)	SYMBOL	USCS SOIL CLASS	DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	PEN. RESISTANCE (blows/6 inches)	OTHER TESTS	PID (ppm)	WELL COMPLETION SCHEMATIC	NOTES
0			Dark brown mottled gray, sandy SILT. [FILL]							
			Dark gray, silty SAND. Plastic debris encountered. [WASTE]							
5			Wood and GRAVEL with wood debris.							
10		SP	Dense, gray fine to coarse SAND, wet. [NATIVE]							2" PVC screen (0.010-inch slot)
15										
20										
25										
30										

NOTE: This log of subsurface conditions applies only at the specified location and on the date indicated and therefore may not necessarily be indicative of other times and/or locations.

HWA GEOSCIENCES INC.

EVERETT LANDFILL
EVERETT, WASHINGTON

MONITORING WELL:
SA-16

PAGE: 1 of 1

PROJECT NO.: 98165

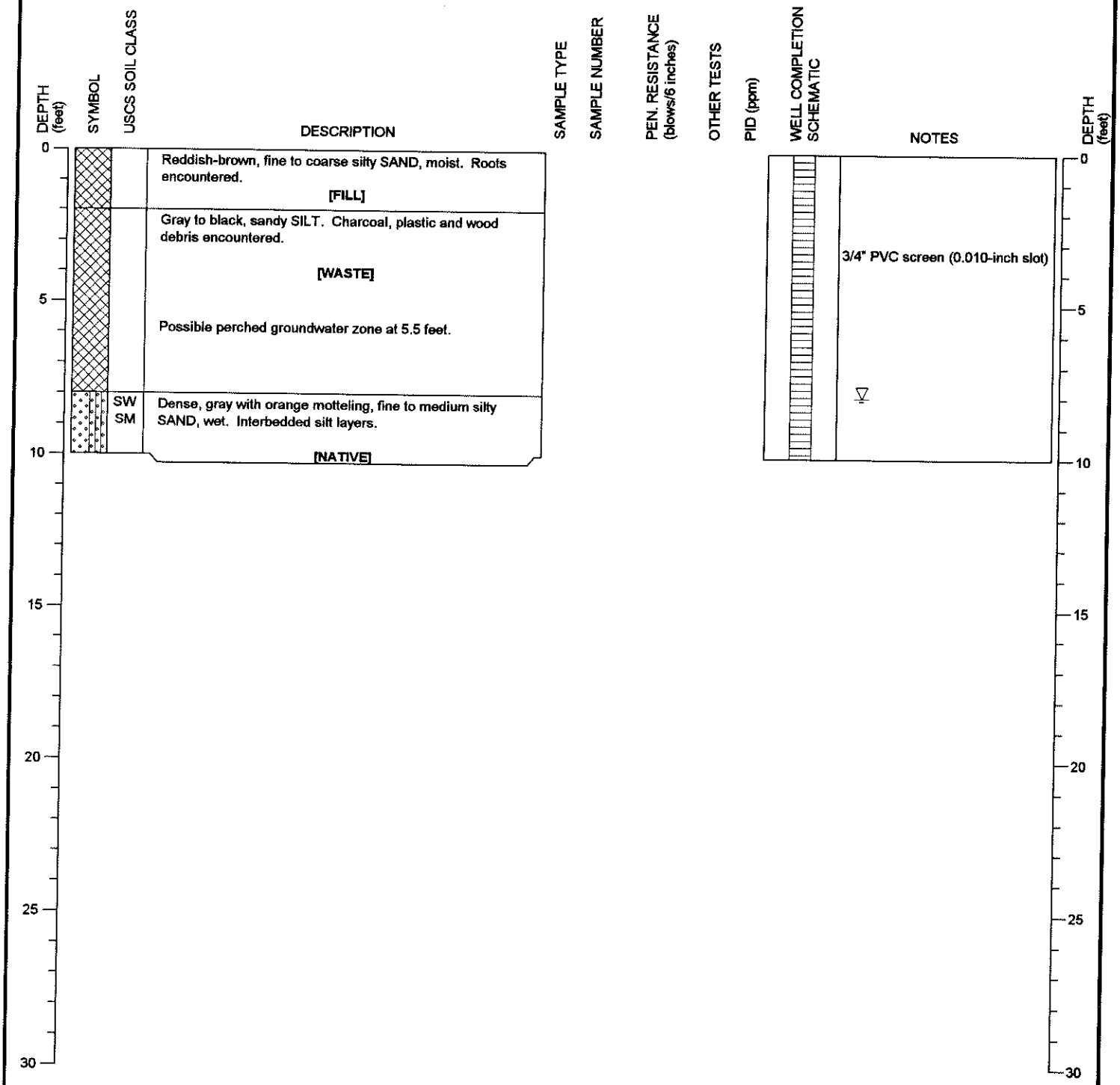
FIGURE: B-17

MWELL 98165.GPJ 7/11/03

DRILLING COMPANY: Cascade Drilling, Inc.
DRILLING METHOD: Geoprobe-Bobcat Mounted
SAMPLING METHOD: 2" OD PETG Liner
LOCATION: Everett, Washington

SURFACE ELEVATION: ± feet

DATE STARTED: 2/14/2003
DATE COMPLETED: 2/14/2003
LOGGED BY: B. Robinson



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HWA GEOSCIENCES INC.

EVERETT LANDFILL
EVERETT, WASHINGTON

MONITORING WELL:
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PROJECT NO.: 98165

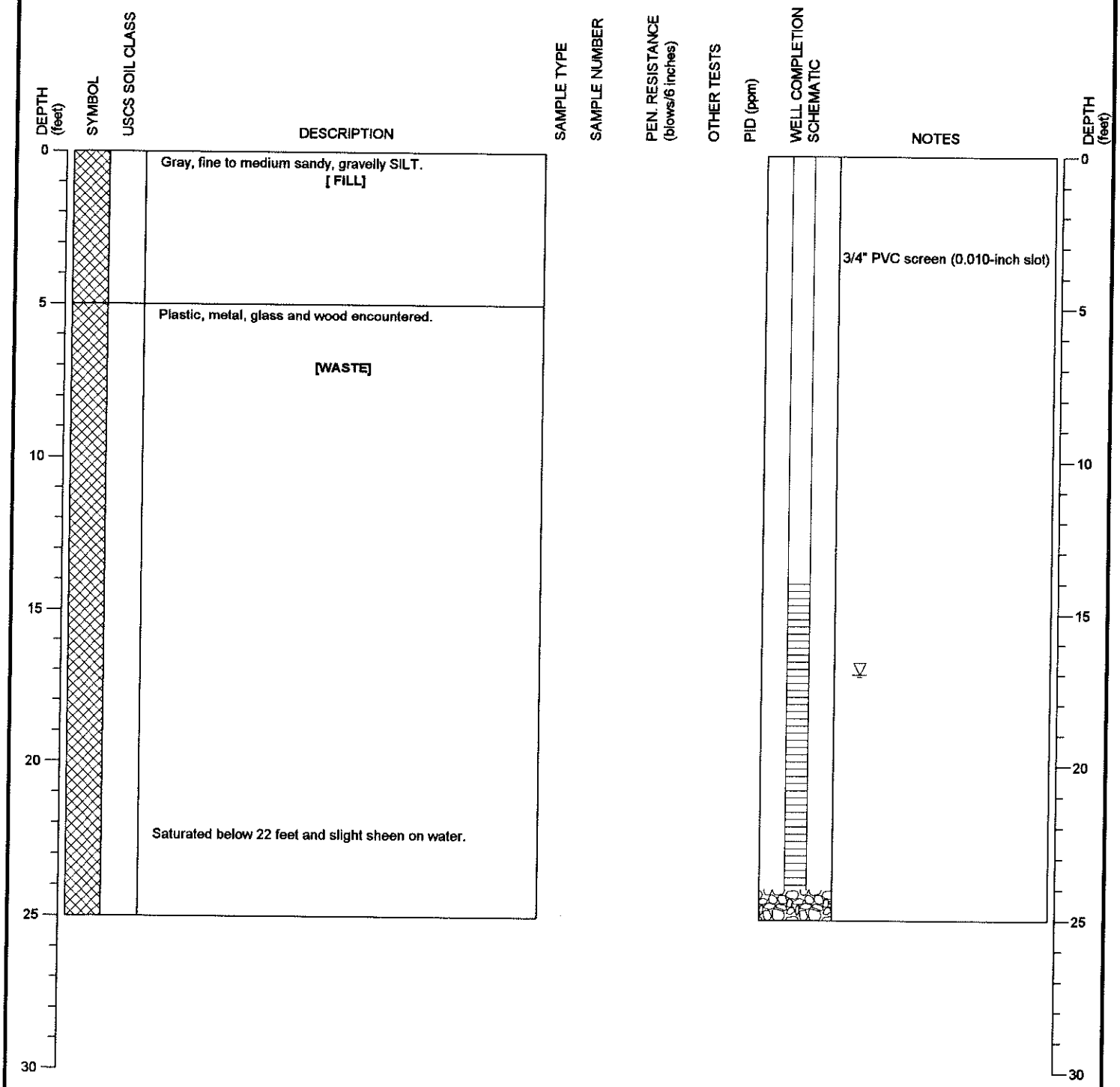
FIGURE: B-18

MWELL 98165.GPJ 7/11/03

DRILLING COMPANY: Cascade Drilling, Inc.
DRILLING METHOD: Geoprobe-Bobcat Mounted
SAMPLING METHOD: 2" OD PETG Liner
LOCATION: Everett, Washington

SURFACE ELEVATION: ± feet

DATE STARTED: 2/14/2003
DATE COMPLETED: 2/14/2003
LOGGED BY: B. Robinson



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HWA GEOSCIENCES INC.

EVERETT LANDFILL
EVERETT, WASHINGTON

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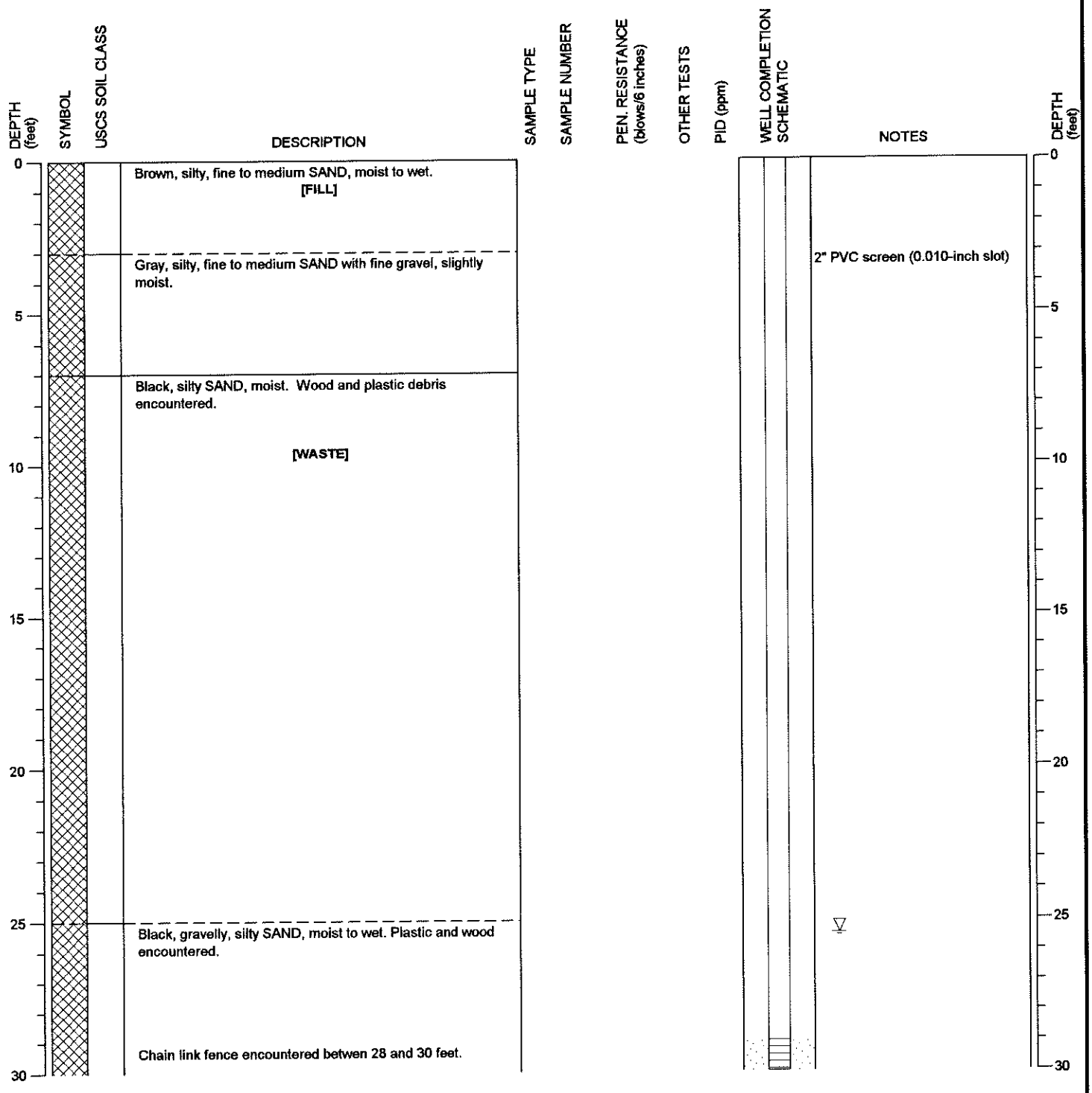
FIGURE: B-19

MWELL 98165.GPJ 7/11/03

DRILLING COMPANY: Cascade Drilling, Inc.
DRILLING METHOD: HSA, 8" OD, Tracked Rig
SAMPLING METHOD: 3" D&M on winch line
LOCATION: Everett, Washington

SURFACE ELEVATION: ± feet

DATE STARTED: 2/25/2003
DATE COMPLETED: 2/25/2003
LOGGED BY: B. Robinson



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HWA GEOSCIENCES INC.

EVERETT LANDFILL
EVERETT, WASHINGTON

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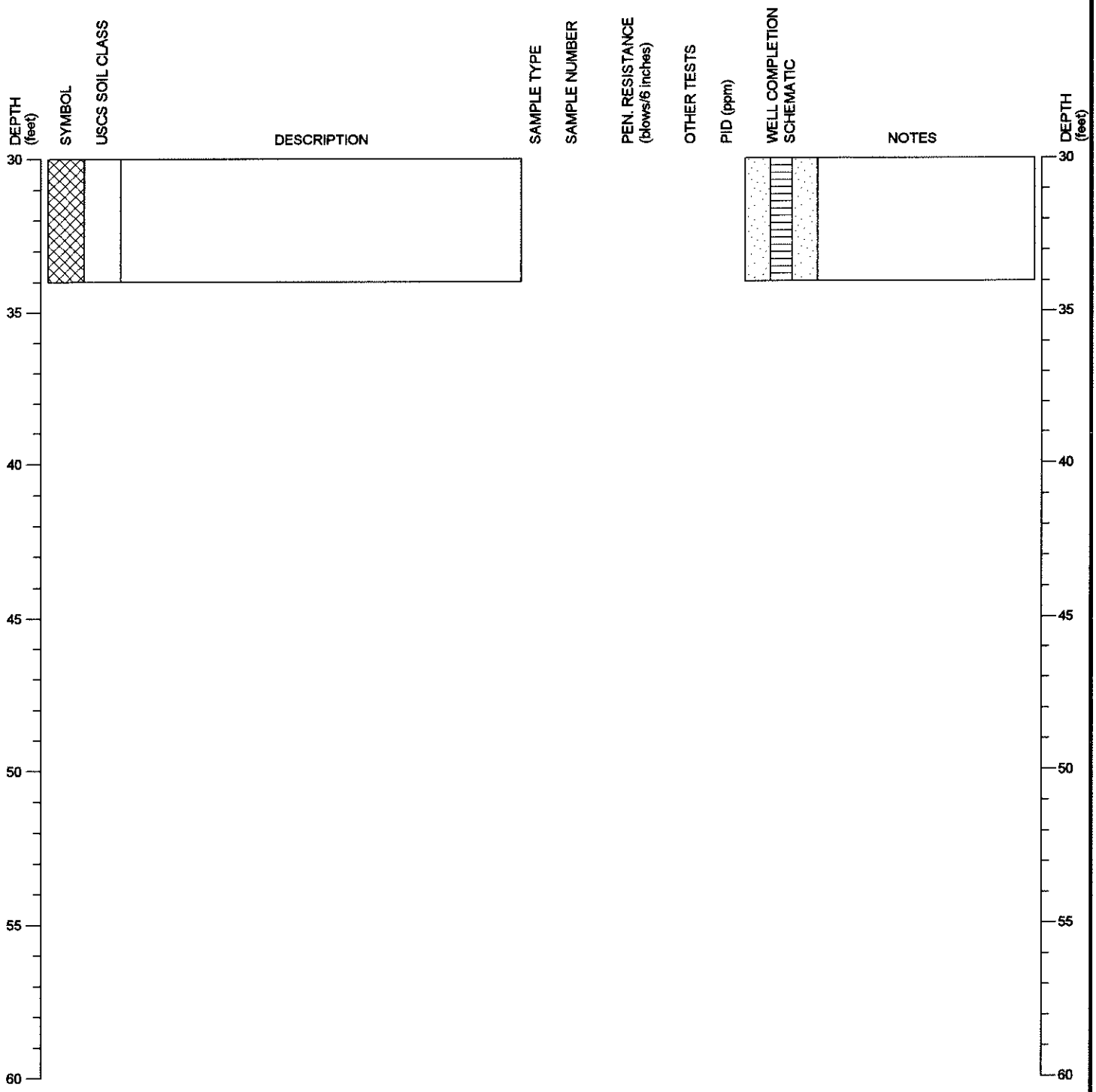
PROJECT NO.: 98165

FIGURE: B-20

DRILLING COMPANY: Cascade Drilling, Inc.
DRILLING METHOD: HSA, 8" OD, Tracked Rig
SAMPLING METHOD: 3" D&M on winch line
LOCATION: Everett, Washington

SURFACE ELEVATION: ± feet

DATE STARTED: 2/25/2003
DATE COMPLETED: 2/25/2003
LOGGED BY: B. Robinson



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HWA GEOSCIENCES INC.

EVERETT LANDFILL
EVERETT, WASHINGTON

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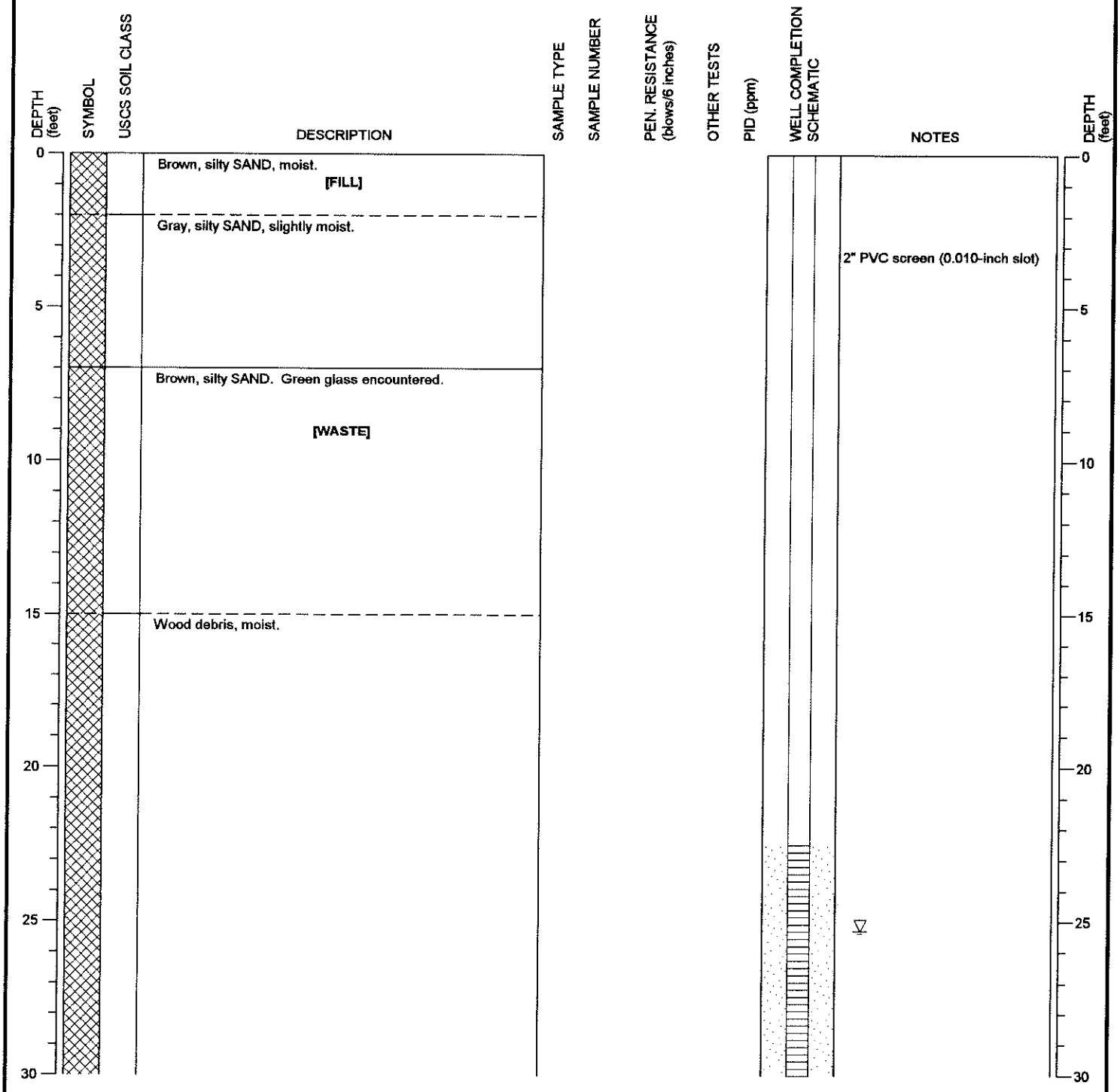
PROJECT NO.: 98165

FIGURE: B-20

DRILLING COMPANY: Cascade Drilling, Inc.
DRILLING METHOD: HSA, 8" OD, Tracked Rig
SAMPLING METHOD: 3" D&M on winch line
LOCATION: Everett, Washington

SURFACE ELEVATION: ± feet

DATE STARTED: 2/24/2003
DATE COMPLETED: 2/24/2003
LOGGED BY: B. Robinson



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HWA GEOSCIENCES INC.

EVERETT LANDFILL
EVERETT, WASHINGTON

MONITORING WELL:
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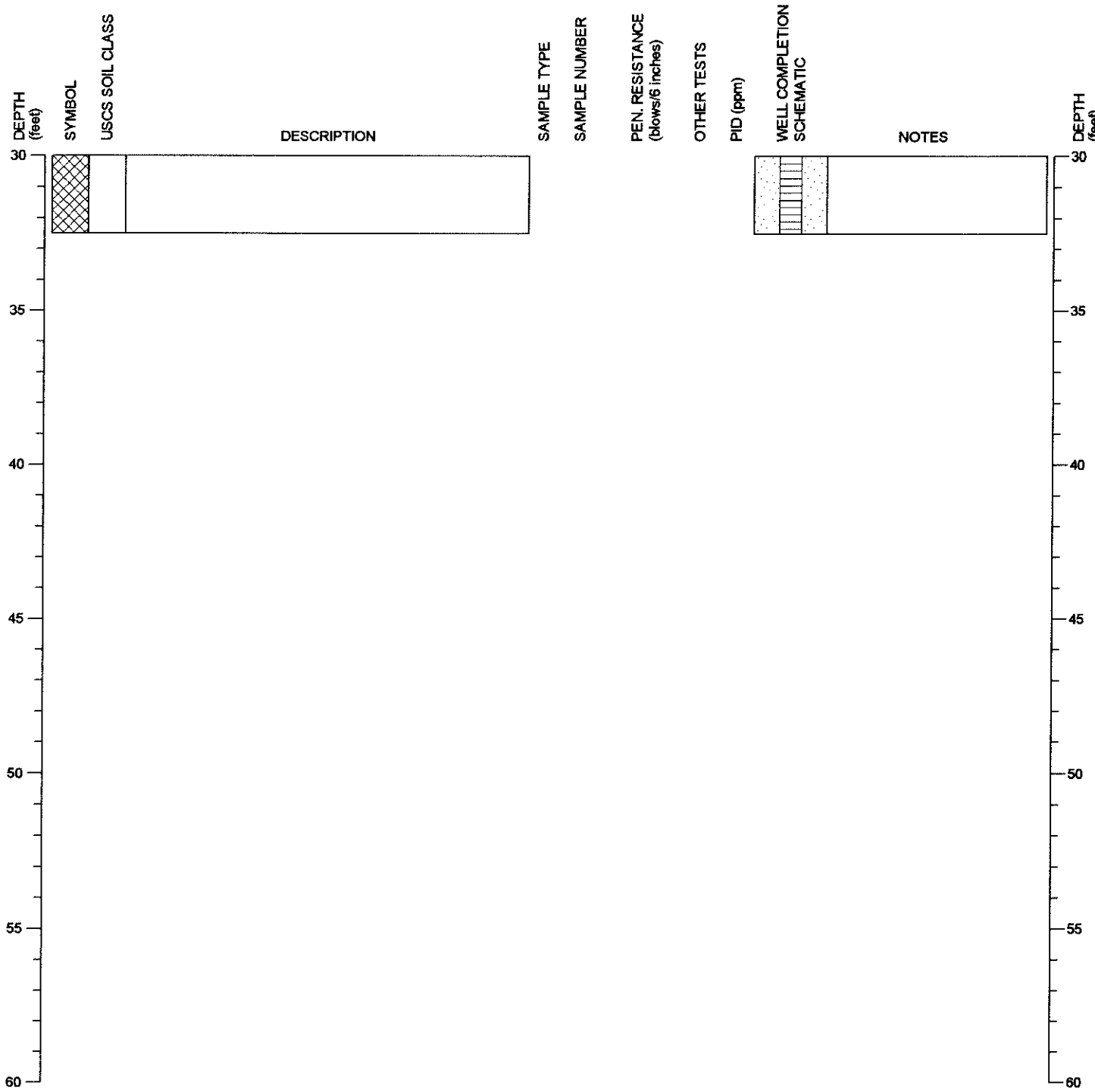
PROJECT NO.: 98165

FIGURE: B-21

DRILLING COMPANY: Cascade Drilling, Inc.
DRILLING METHOD: HSA, 8" OD, Tracked Rig
SAMPLING METHOD: 3" D&M on winch line
LOCATION: Everett, Washington

SURFACE ELEVATION: ± feet

DATE STARTED: 2/24/2003
DATE COMPLETED: 2/24/2003
LOGGED BY: B. Robinson



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HWA GEOSCIENCES INC.

EVERETT LANDFILL
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MONITORING WELL:
SA-20

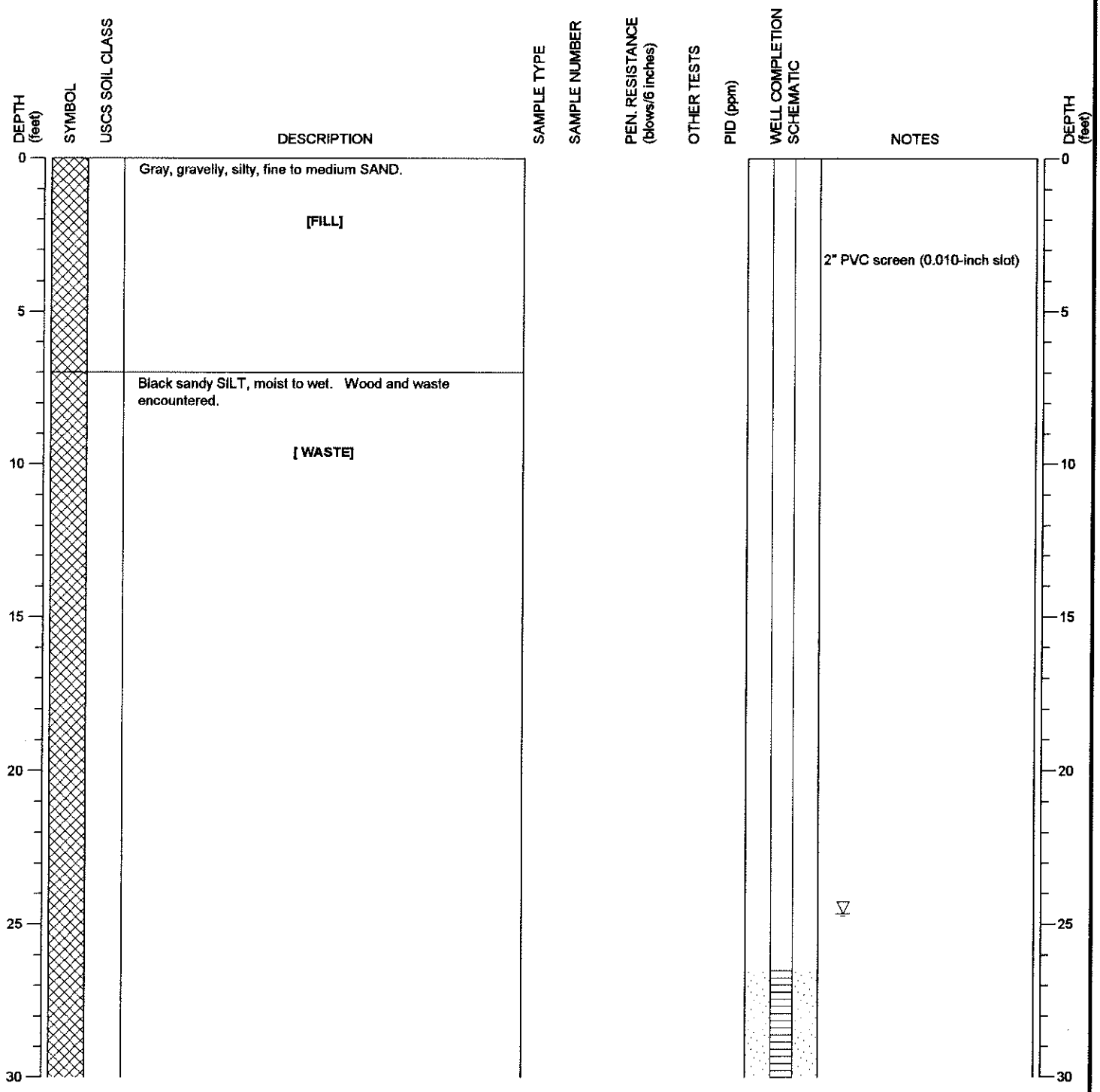
PROJECT NO.: 98165

FIGURE: B-21

DRILLING COMPANY: Cascade Drilling, Inc.
DRILLING METHOD: HSA, 8" OD, Tracked Rig
SAMPLING METHOD: 3" D&M on winch line
LOCATION: Everett, Washington

SURFACE ELEVATION: ± feet

DATE STARTED: 2/24/2003
DATE COMPLETED: 2/24/2003
LOGGED BY: B. Robinson



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HWA GEOSCIENCES INC.

EVERETT LANDFILL
EVERETT, WASHINGTON

MONITORING WELL:
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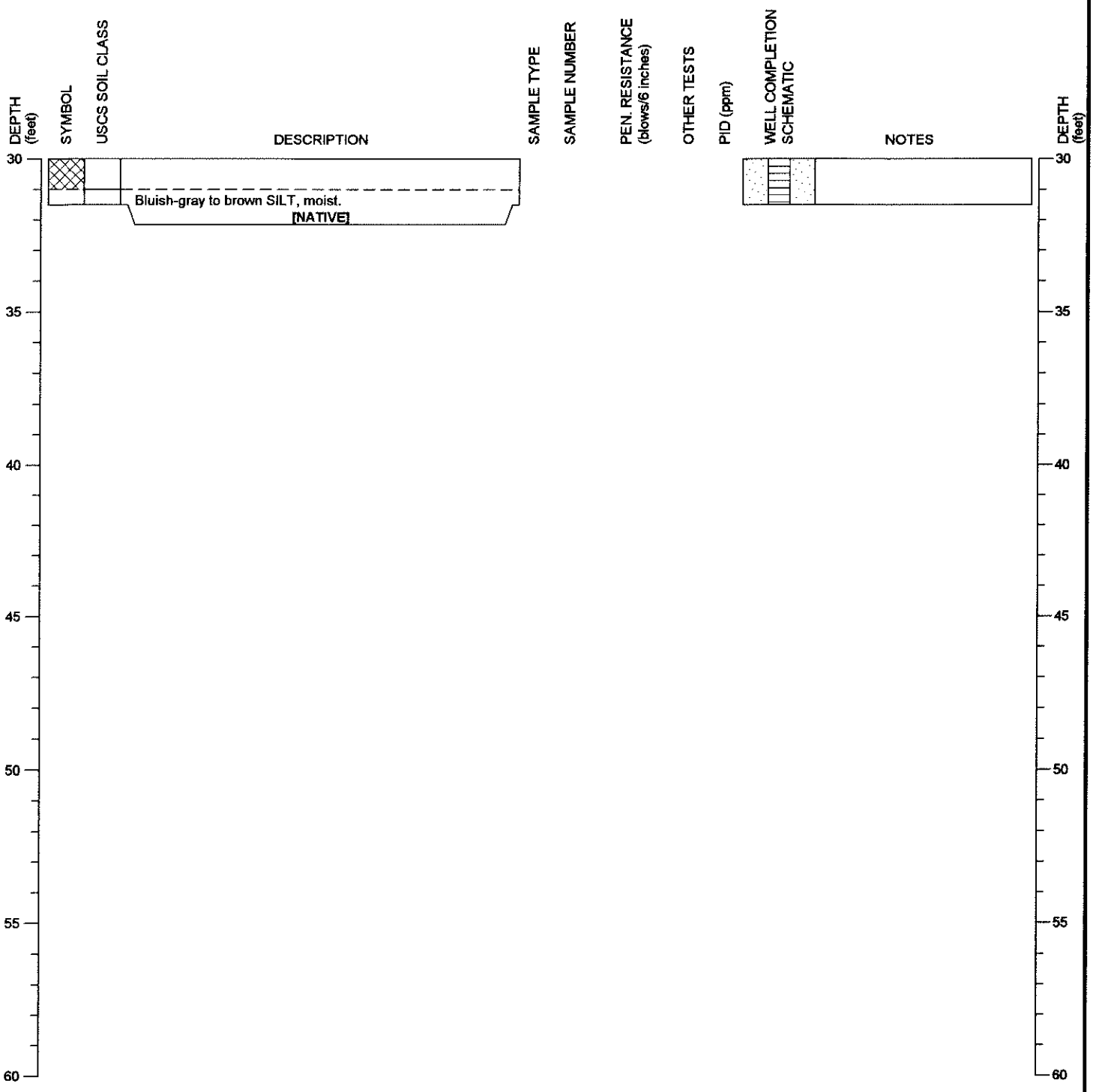
PROJECT NO.: 98165

FIGURE: B-22

DRILLING COMPANY: Cascade Drilling, Inc.
DRILLING METHOD: HSA, 8" OD, Tracked Rig
SAMPLING METHOD: 3" D&M on winch line
LOCATION: Everett, Washington

SURFACE ELEVATION: ± feet

DATE STARTED: 2/24/2003
DATE COMPLETED: 2/24/2003
LOGGED BY: B. Robinson



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HWA GEOSCIENCES INC.

EVERETT LANDFILL
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MONITORING WELL:
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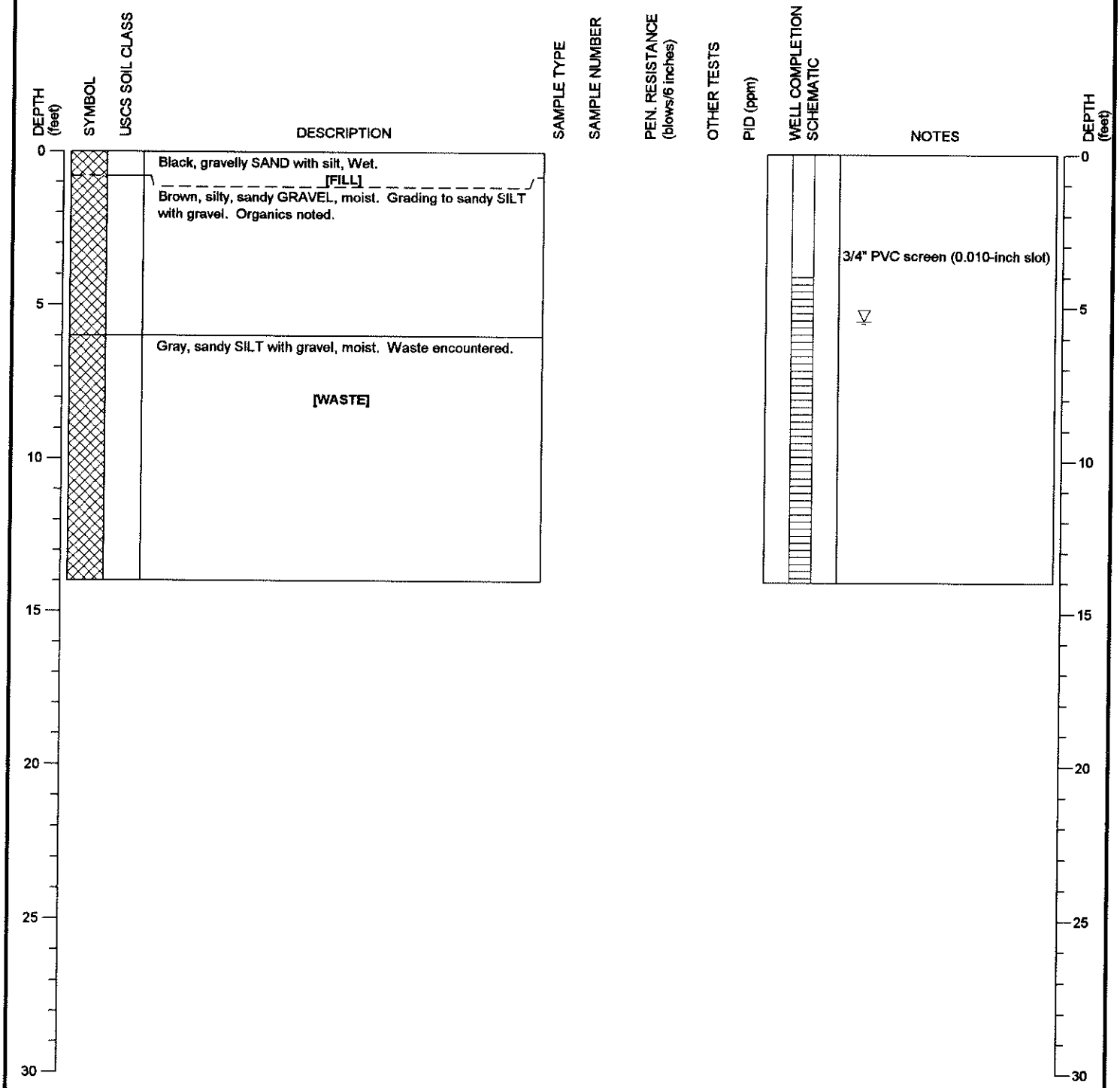
FIGURE: B-22

DRILLING COMPANY: Cascade Drilling, Inc.
DRILLING METHOD: Geoprobe-Truck Mounted
SAMPLING METHOD: 2" OD PETG Liner
LOCATION: Everett, Washington

SURFACE ELEVATION: ± feet

DATE STARTED: 2/18/2003
DATE COMPLETED: 2/18/2003
LOGGED BY: K. Knapp



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HWA GEOSCIENCES INC.

EVERETT LANDFILL
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MONITORING WELL:
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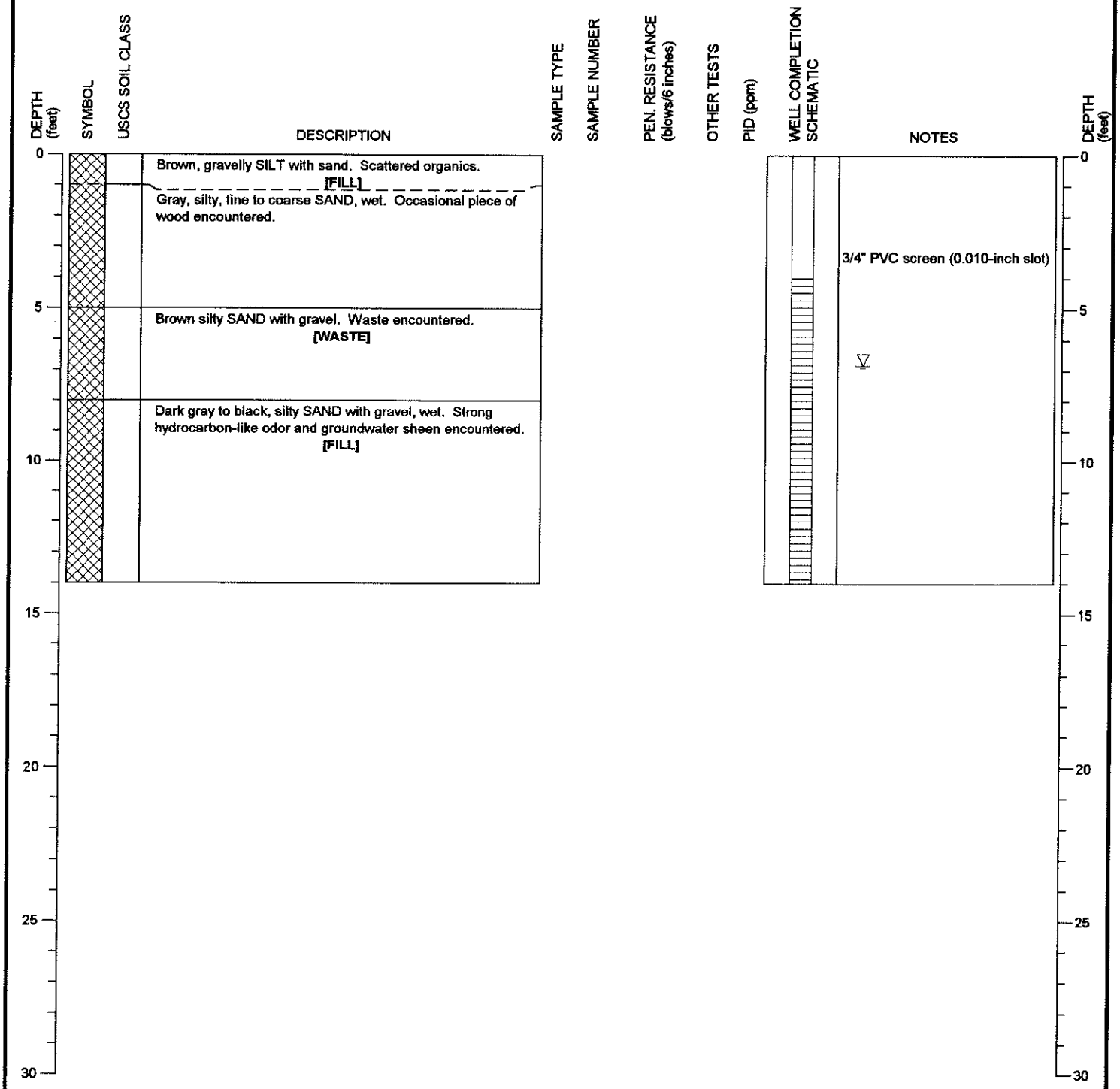
FIGURE: B-23

MWELL 98165.GPJ 7/11/03

DRILLING COMPANY: Cascade Drilling, Inc.
DRILLING METHOD: Geoprobe-Truck Mounted
SAMPLING METHOD: 2" OD PETG Liner
LOCATION: Everett, Washington

SURFACE ELEVATION: ± feet

DATE STARTED: 2/18/2003
DATE COMPLETED: 2/18/2003
LOGGED BY: K. Knapp



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HWA GEOSCIENCES INC.

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MONITORING WELL:
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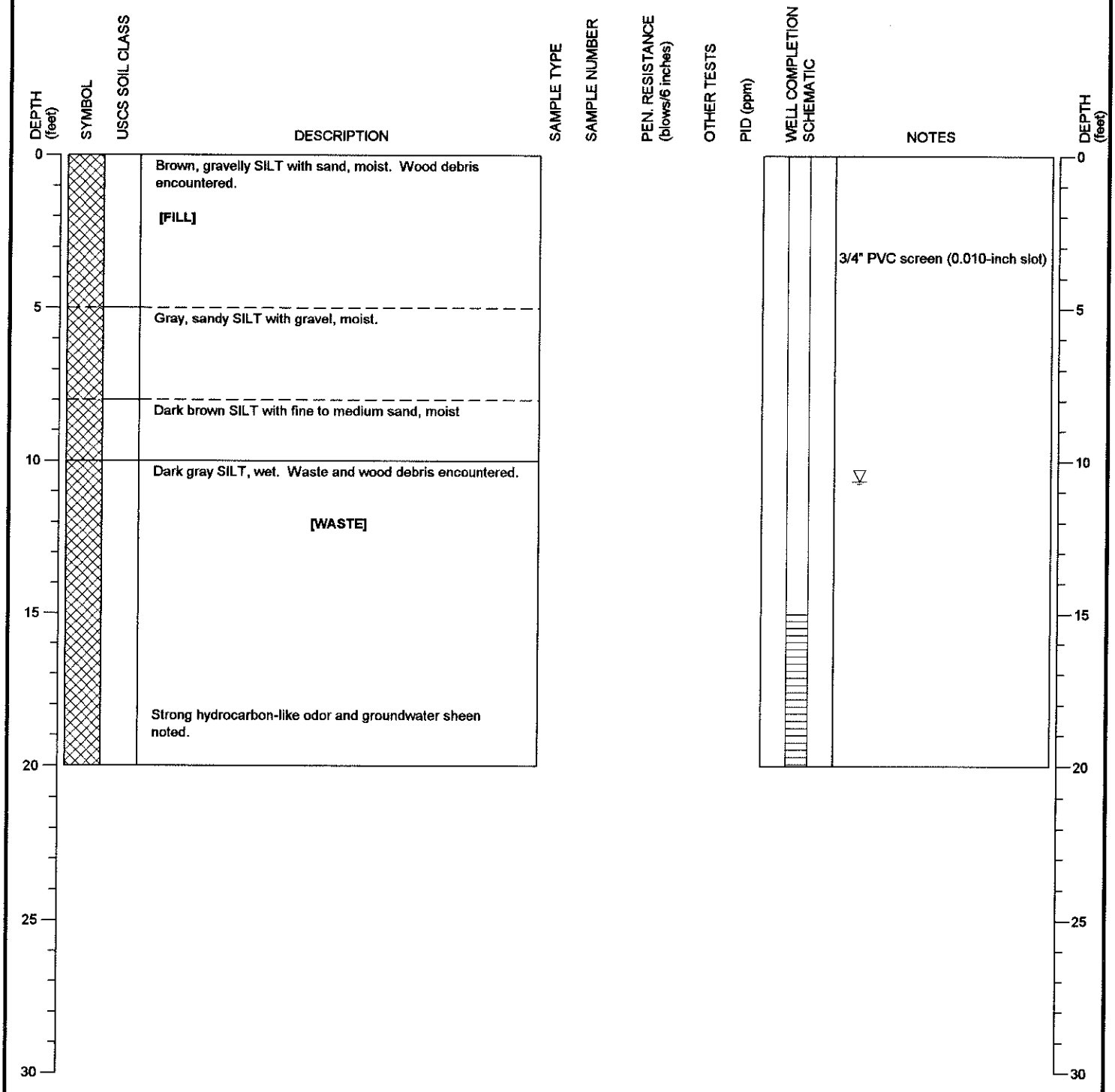
FIGURE: B-24

MWELL 98165.GPJ 7/11/03

DRILLING COMPANY: Cascade Drilling, Inc.
DRILLING METHOD: Geoprobe-Truck Mounted
SAMPLING METHOD: 2" OD PETG Liner
LOCATION: Everett, Washington

SURFACE ELEVATION: ± feet

DATE STARTED: 2/18/2003
DATE COMPLETED: 2/18/2003
LOGGED BY: K. Knapp



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HWA GEOSCIENCES INC.

EVERETT LANDFILL
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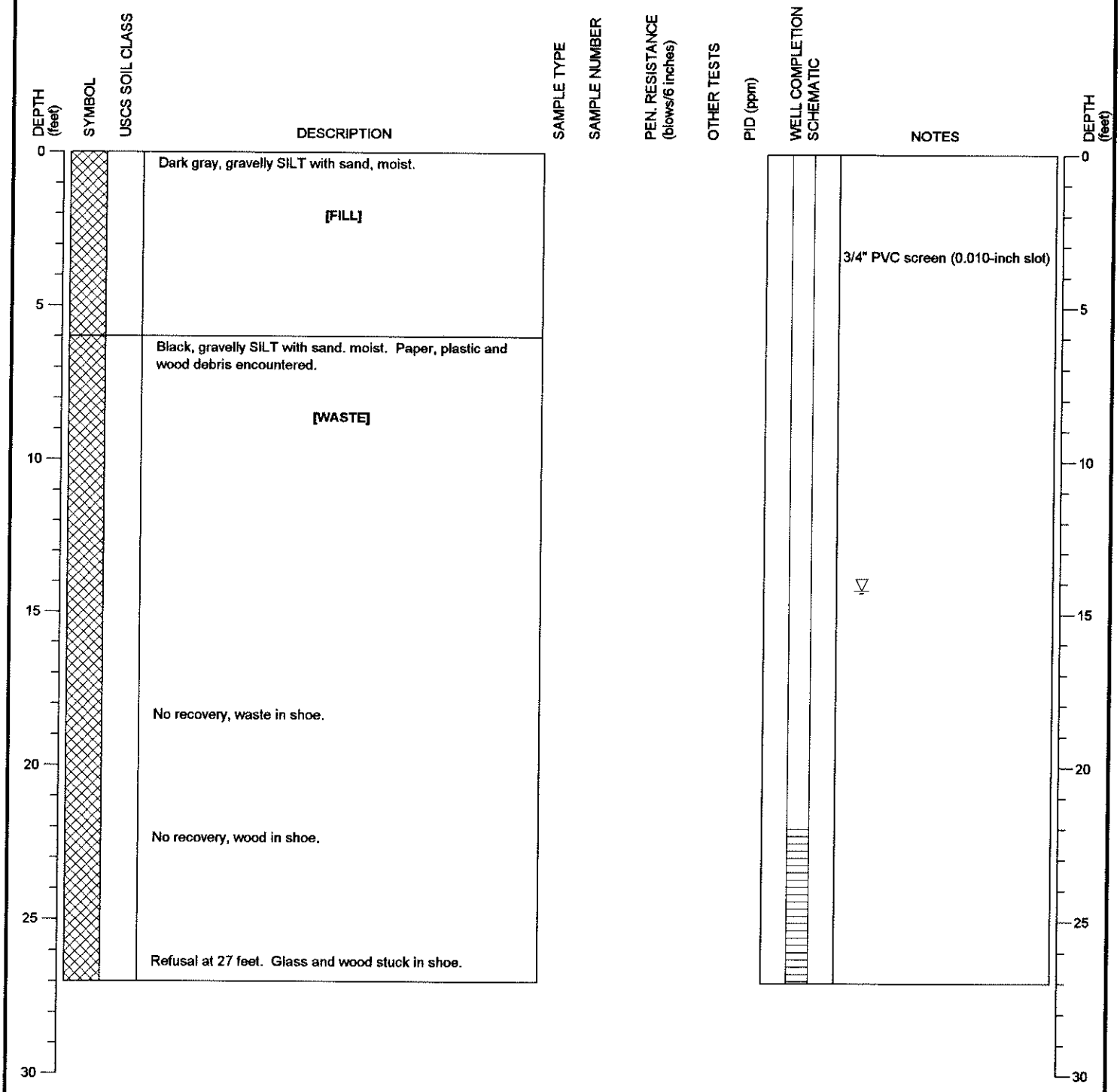
FIGURE: B-25

MWELL 98165.GPJ 7/11/03

DRILLING COMPANY: Cascade Drilling, Inc.
DRILLING METHOD: Geoprobe-Truck Mounted
SAMPLING METHOD: 2" OD PETG Liner
LOCATION: Everett, Washington

SURFACE ELEVATION: ± feet

DATE STARTED: 2/18/2003
DATE COMPLETED: 2/19/2003
LOGGED BY: K. Knapp



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HWA GEOSCIENCES INC.

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MONITORING WELL:
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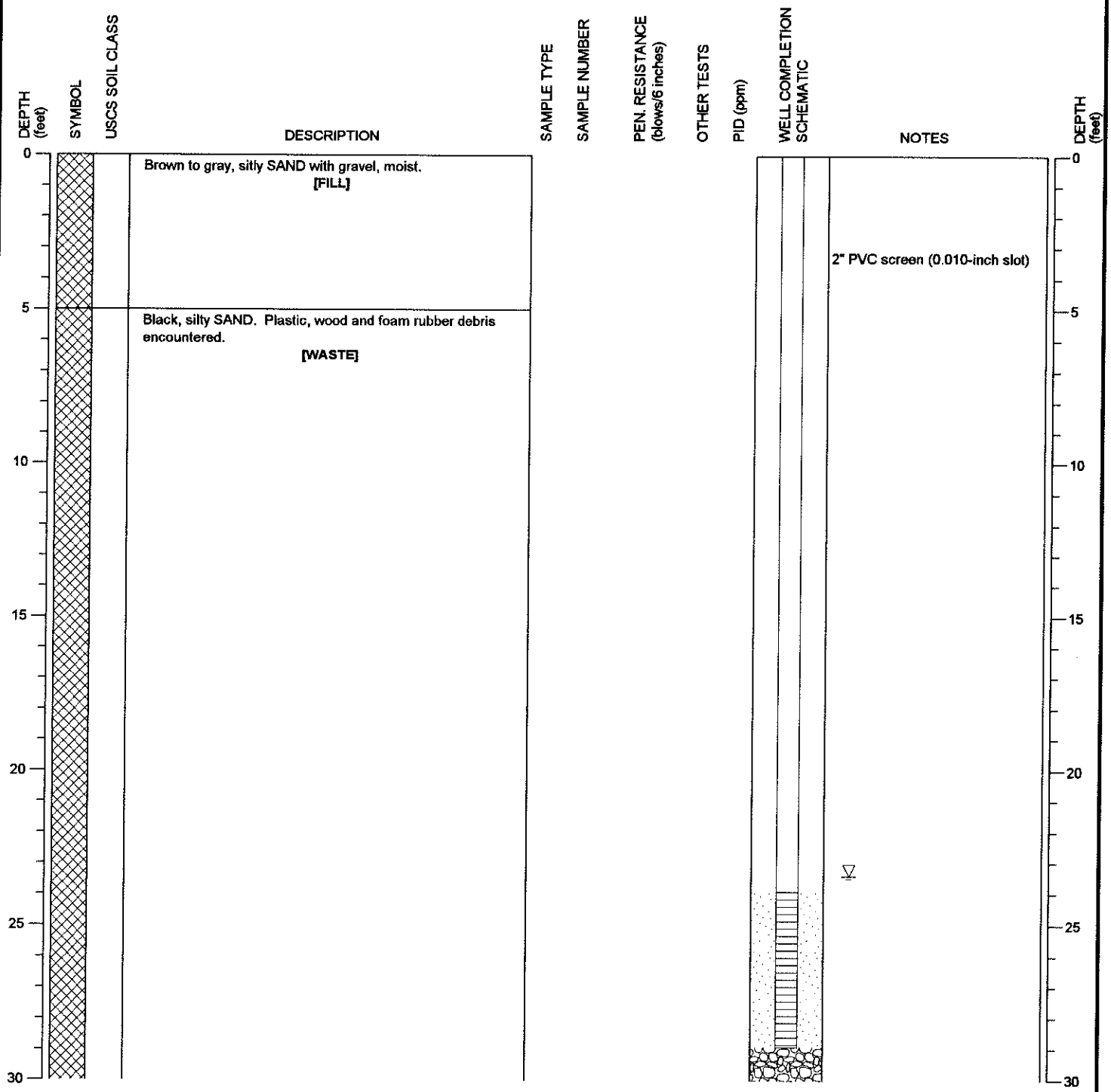
PROJECT NO.: 98165

FIGURE: B-26

DRILLING COMPANY: Cascade Drilling, Inc.
DRILLING METHOD: HSA, 8" OD, Tracked Rig
SAMPLING METHOD: 3" D&M on winch line
LOCATION: Everett, Washington

SURFACE ELEVATION: ± feet

DATE STARTED: 2/26/2003
DATE COMPLETED: 2/26/2003
LOGGED BY: B. Robinson



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HWA GEOSCIENCES INC.

EVERETT LANDFILL
EVERETT, WASHINGTON

MONITORING WELL:
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PROJECT NO.: 98165

FIGURE: B-27

DRILLING COMPANY: Cascade Drilling, Inc.
DRILLING METHOD: HSA, 8" OD, Tracked Rig
SAMPLING METHOD: 3" D&M on winch line
LOCATION: Everett, Washington

SURFACE ELEVATION: ± feet

DATE STARTED: 2/26/2003
DATE COMPLETED: 2/26/2003
LOGGED BY: B. Robinson

DEPTH (feet)	SYMBOL	USCS SOIL CLASS	DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	PEN. RESISTANCE (blows/6 inches)	OTHER TESTS	PID (ppm)	WELL COMPLETION SCHEMATIC	NOTES	DEPTH (feet)
30											30
35											35
40											40
45											45
50											50
55											55
60											60

NOTE: This log of subsurface conditions applies only at the specified location and on the date indicated and therefore may not necessarily be indicative of other times and/or locations.

HWA GEOSCIENCES INC.

EVERETT LANDFILL
EVERETT, WASHINGTON

MONITORING WELL:
SA-26

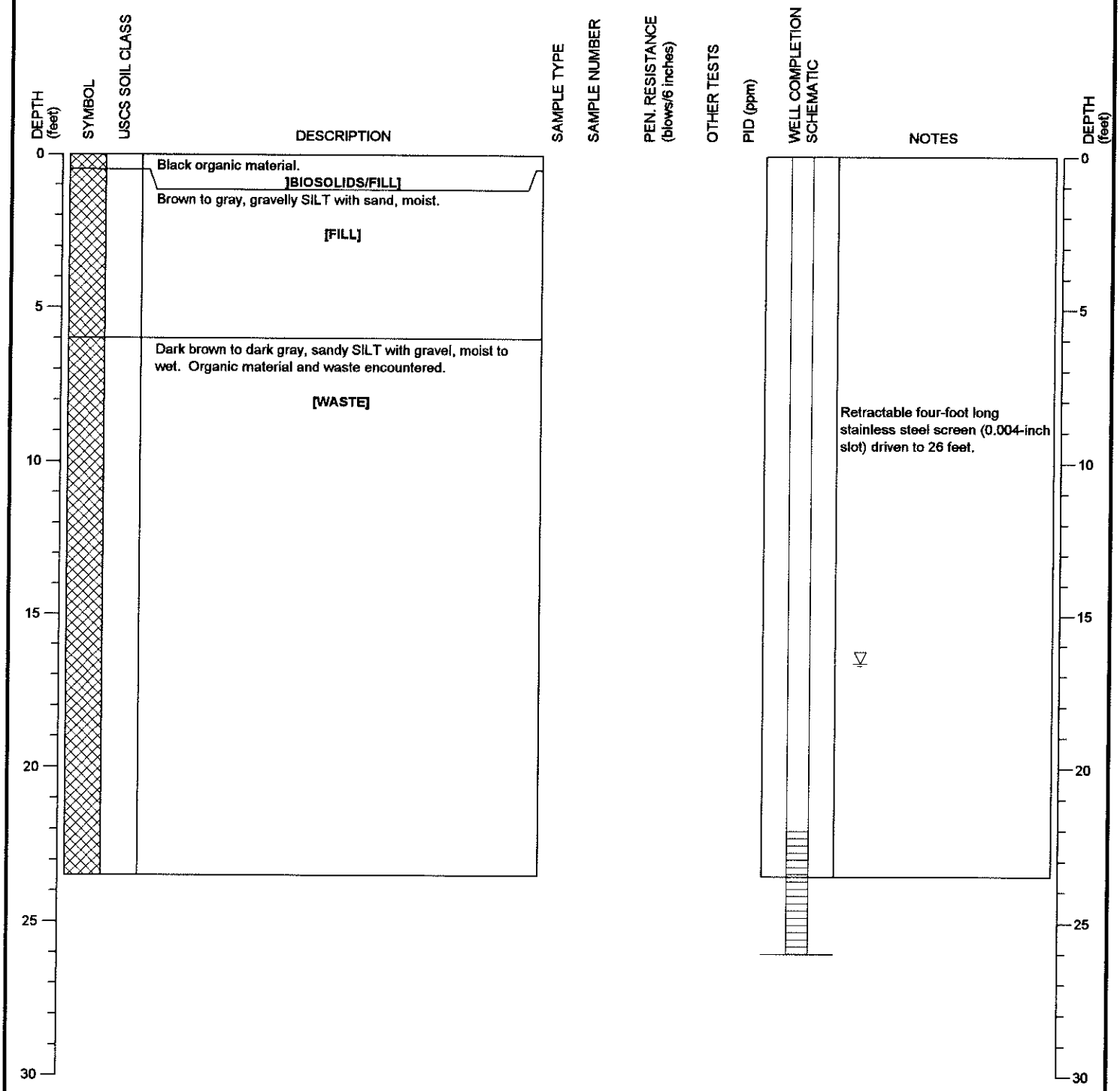
PROJECT NO.: 98165

FIGURE: B-27

DRILLING COMPANY: Cascade Drilling, Inc.
DRILLING METHOD: Geoprobe-Truck Mounted
SAMPLING METHOD: 2" OD PETG Liner
LOCATION: Everett, Washington

SURFACE ELEVATION: ± feet

DATE STARTED: 2/19/2003
DATE COMPLETED: 2/19/2003
LOGGED BY: K. Knapp



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HWA GEOSCIENCES INC.

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EVERETT, WASHINGTON

MONITORING WELL:
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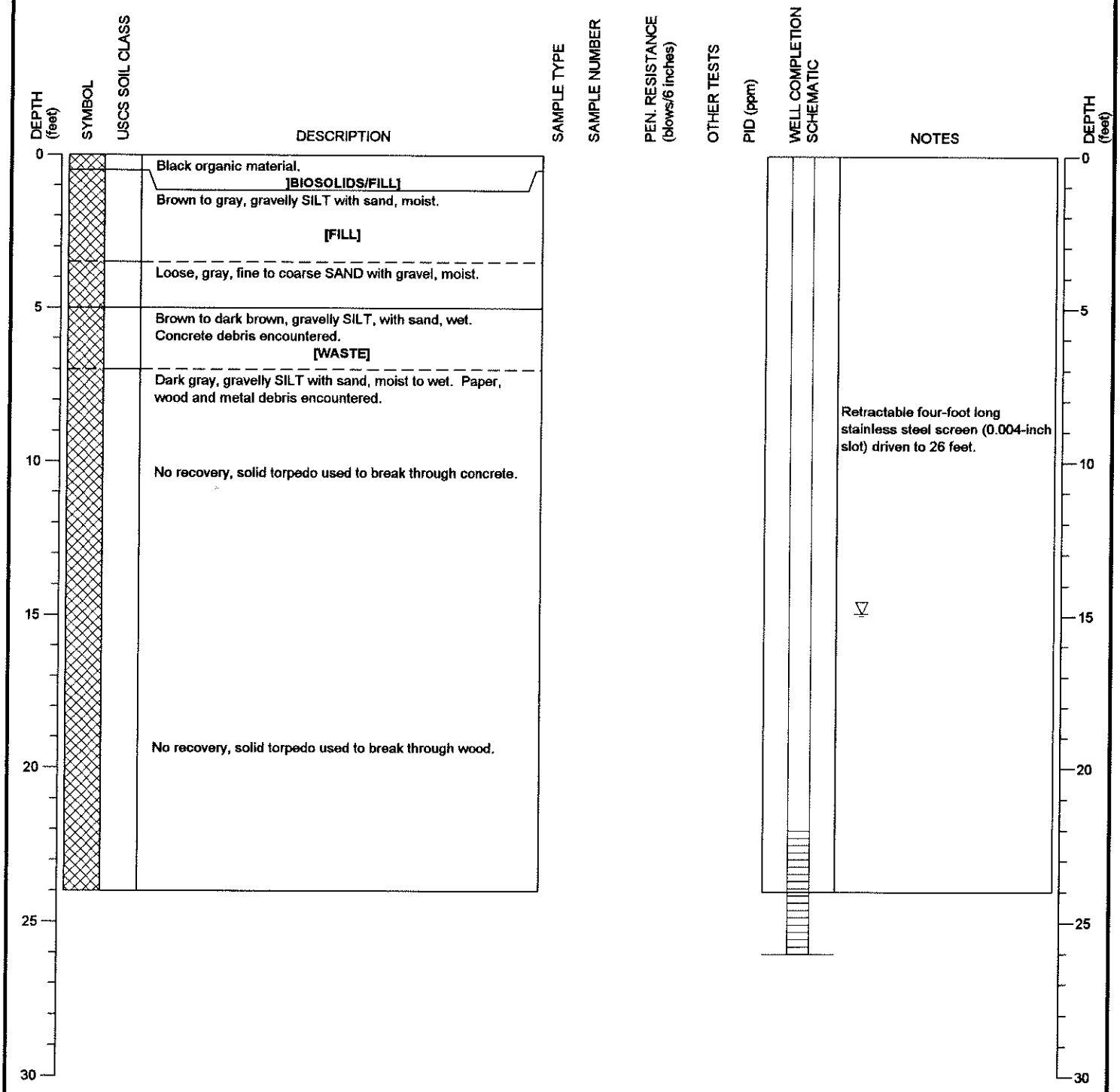
FIGURE: B-28

MWELL 98165.GPJ 7/11/03

DRILLING COMPANY: Cascade Drilling, Inc.
DRILLING METHOD: Geoprobe-Truck Mounted
SAMPLING METHOD: 2" OD PETG Liner
LOCATION: Everett, Washington

SURFACE ELEVATION: ± feet

DATE STARTED: 2/19/2003
DATE COMPLETED: 2/19/2003
LOGGED BY: K. Knapp



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HWA GEOSCIENCES INC.

EVERETT LANDFILL
EVERETT, WASHINGTON

MONITORING WELL:
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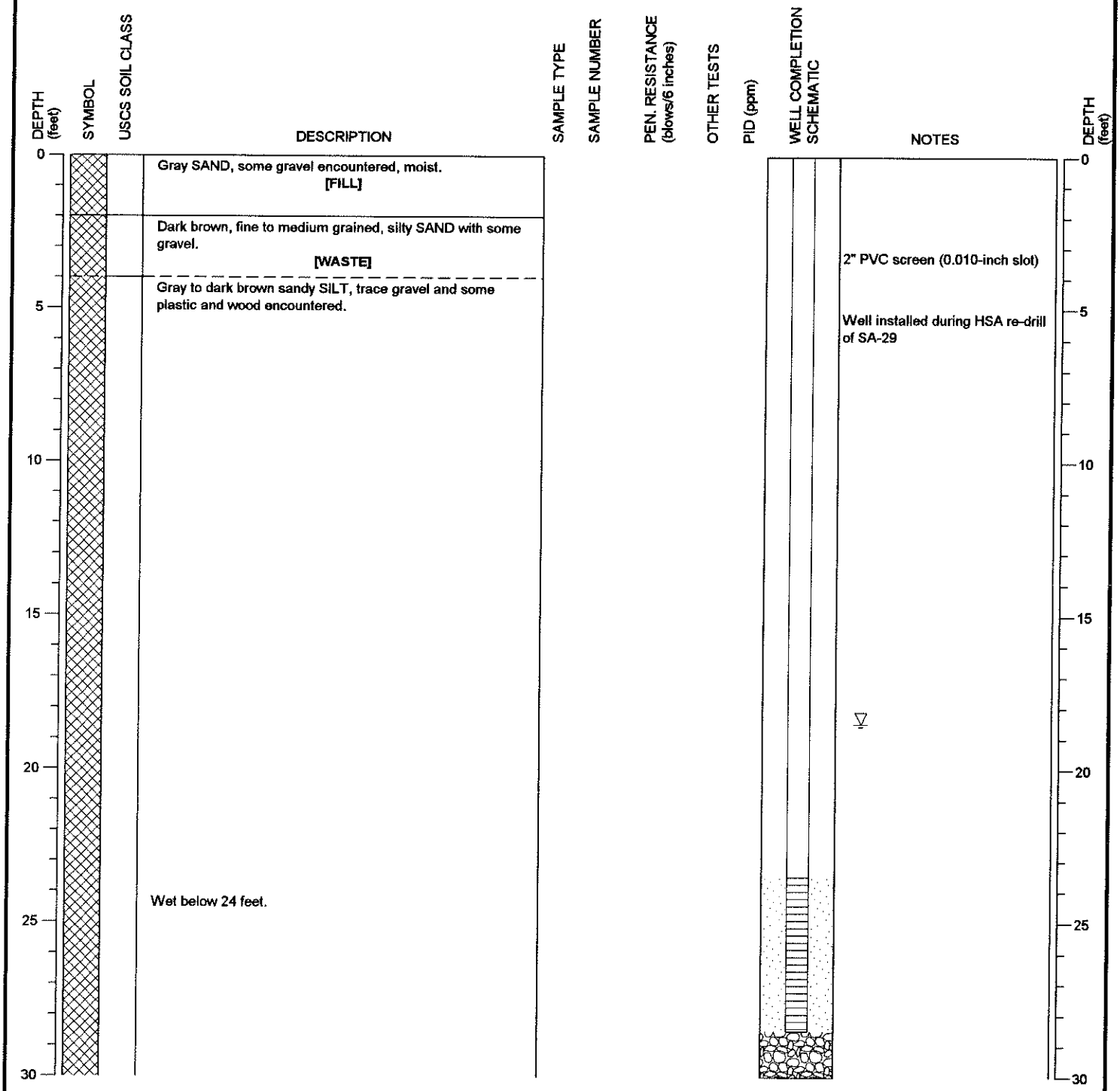
FIGURE: B-29

MWELL 98165.GPJ 7/11/03

DRILLING COMPANY: Cascade Drilling, Inc.
DRILLING METHOD: HSA, 8" OD, Tracked Rig
SAMPLING METHOD: 3" D&M on winch line
LOCATION: Everett, Washington

SURFACE ELEVATION: ± feet

DATE STARTED: 2/27/2003
DATE COMPLETED: 2/27/2003
LOGGED BY: B. Robinson



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HWA GEOSCIENCES INC.

EVERETT LANDFILL
EVERETT, WASHINGTON

MONITORING WELL:
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PROJECT NO.: 98165

FIGURE: B-30

DRILLING COMPANY: Cascade Drilling, Inc.
DRILLING METHOD: HSA, 8" OD, Tracked Rig
SAMPLING METHOD: 3" D&M on winch line
LOCATION: Everett, Washington

SURFACE ELEVATION: ± feet

DATE STARTED: 2/27/2003
DATE COMPLETED: 2/27/2003
LOGGED BY: B. Robinson

DEPTH (feet)	SYMBOL	USCS SOIL CLASS	DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	PEN. RESISTANCE (blows/6 inches)	OTHER TESTS	PID (ppm)	WELL COMPLETION SCHEMATIC	NOTES	DEPTH (feet)
30											30
35		ML	Dark gray SILT with some sand, wood, wet [NATIVE]								35
40											40
45											45
50											50
55											55
60											60

NOTE: This log of subsurface conditions applies only at the specified location and on the date indicated and therefore may not necessarily be indicative of other times and/or locations.

HWA GEOSCIENCES INC.

EVERETT LANDFILL
EVERETT, WASHINGTON

MONITORING WELL:
SA-29

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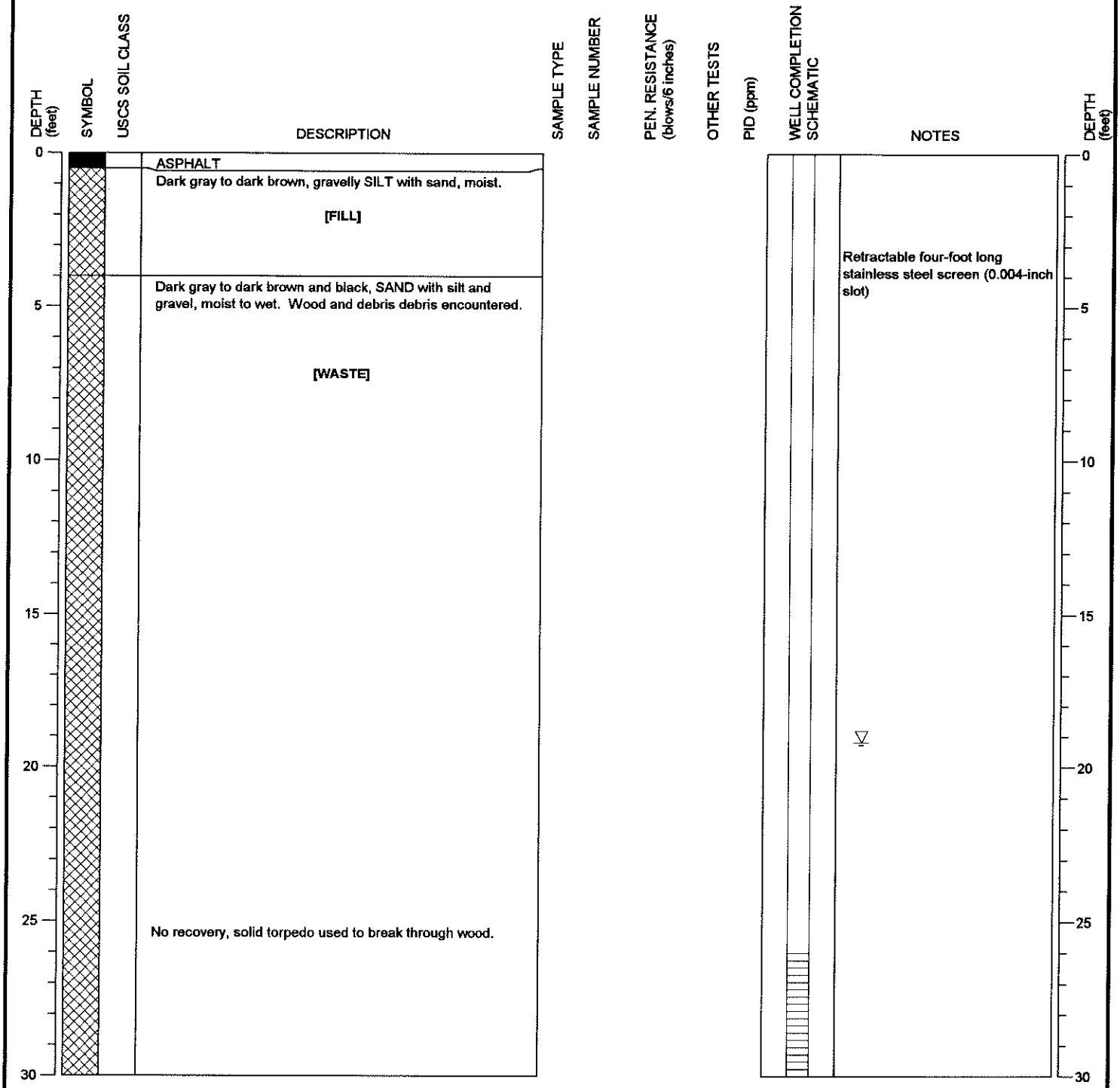
FIGURE: B-30

DRILLING COMPANY: Cascade Drilling, Inc.
DRILLING METHOD: Geoprobe-Truck Mounted
SAMPLING METHOD: 2" OD PETG Liner
LOCATION: Everett, Washington

SURFACE ELEVATION: ± feet

DATE STARTED: 2/20/2003
DATE COMPLETED: 2/20/2003
LOGGED BY: K. Knapp



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HWA GEOSCIENCES INC.

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FIGURE: B-31

MWELL 98165.GPJ 7/11/03

DRILLING COMPANY: Cascade Drilling, Inc.
DRILLING METHOD: Geoprobe-Truck Mounted
SAMPLING METHOD: 2" OD PETG Liner
LOCATION: Everett, Washington

SURFACE ELEVATION: ± feet

DATE STARTED: 2/20/2003
DATE COMPLETED: 2/20/2003
LOGGED BY: K. Knapp

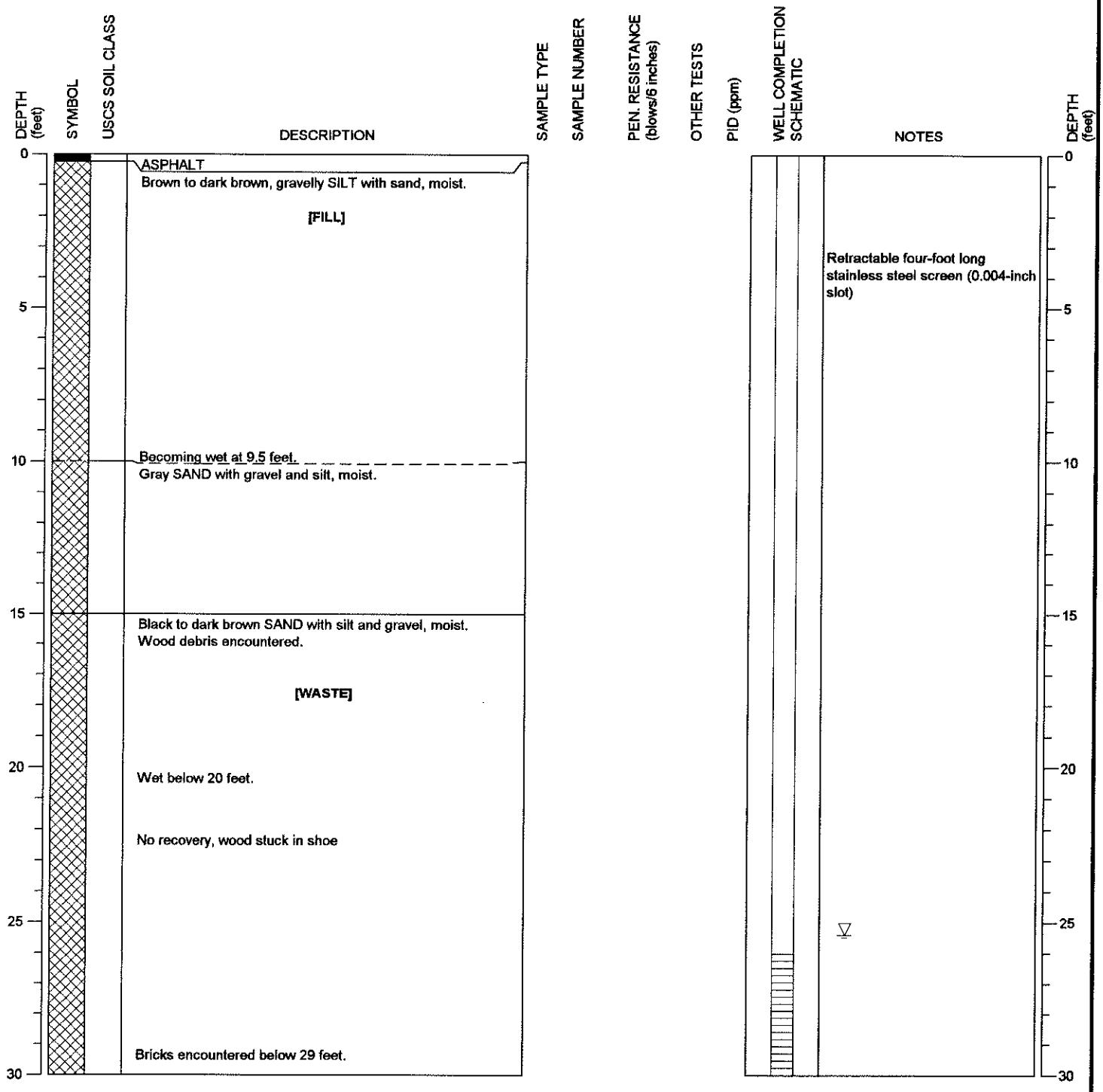

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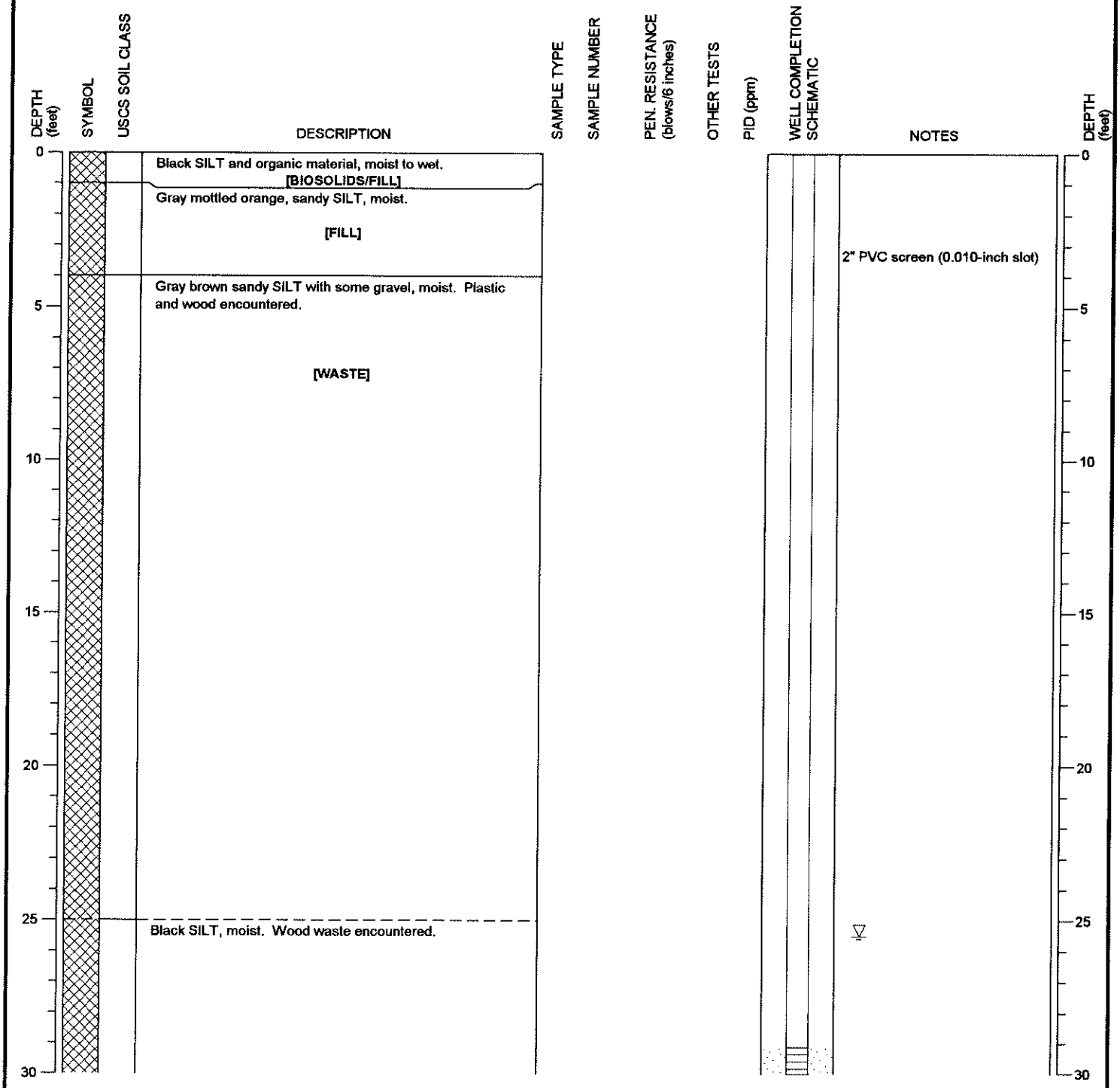
FIGURE: B-32

MWELL 98165.GPJ 7/14/03

DRILLING COMPANY: Cascade Drilling, Inc.
DRILLING METHOD: HSA, 8" OD, Tracked Rig
SAMPLING METHOD: 3" D&M on winch line
LOCATION: Everett, Washington

SURFACE ELEVATION: ± feet

DATE STARTED: 2/26/2003
DATE COMPLETED: 2/26/2003
LOGGED BY: B. Robinson



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HWA GEOSCIENCES INC.

EVERETT LANDFILL
EVERETT, WASHINGTON

MONITORING WELL:
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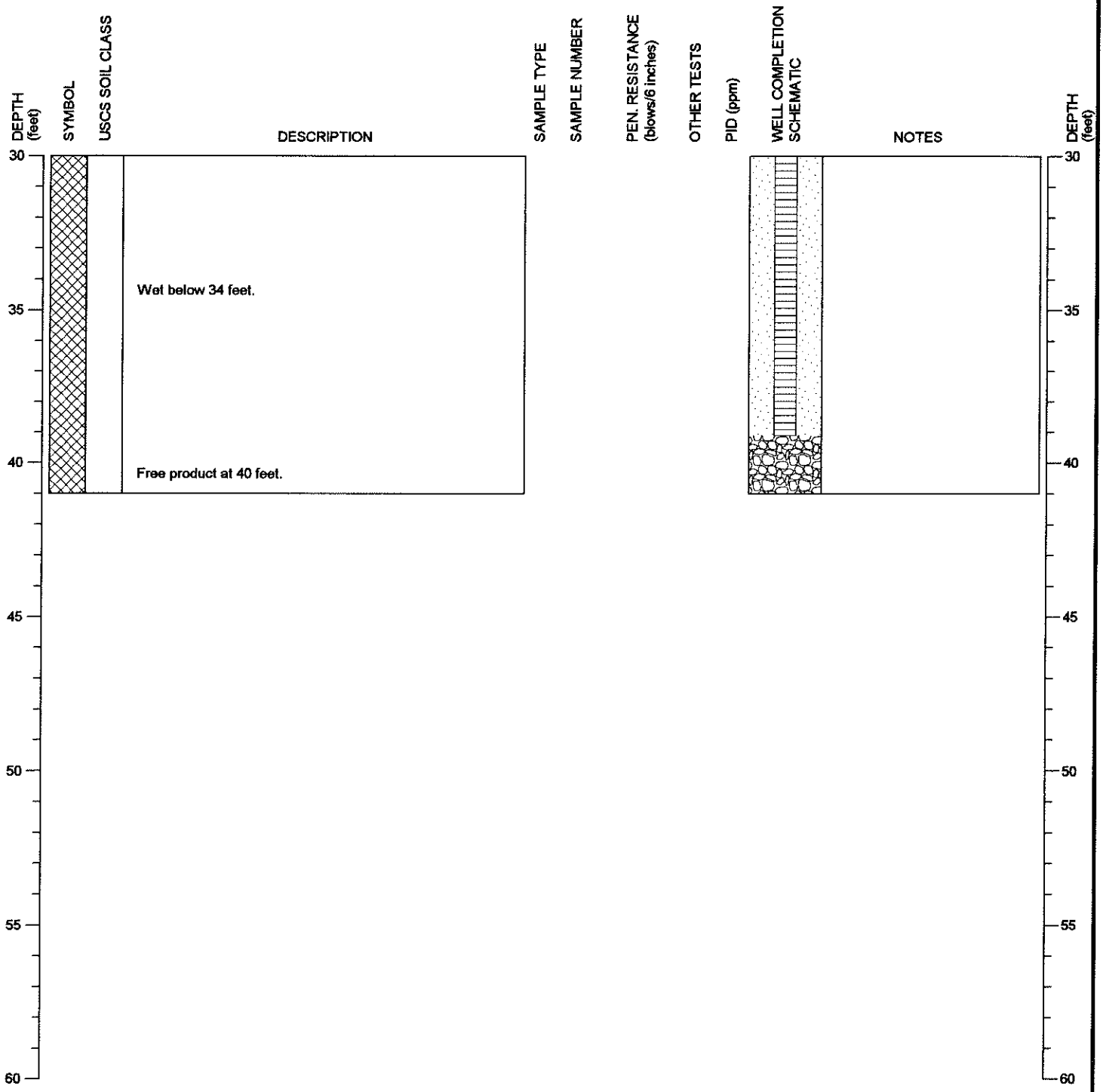
FIGURE: B-33

DRILLING COMPANY: Cascade Drilling, Inc.
DRILLING METHOD: HSA, 8" OD, Tracked Rig
SAMPLING METHOD: 3" D&M on winch line
LOCATION: Everett, Washington

SURFACE ELEVATION: ± feet

DATE STARTED: 2/26/2003
DATE COMPLETED: 2/26/2003
LOGGED BY: B. Robinson



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HWA GEOSCIENCES INC.

EVERETT LANDFILL
EVERETT, WASHINGTON

MONITORING WELL:
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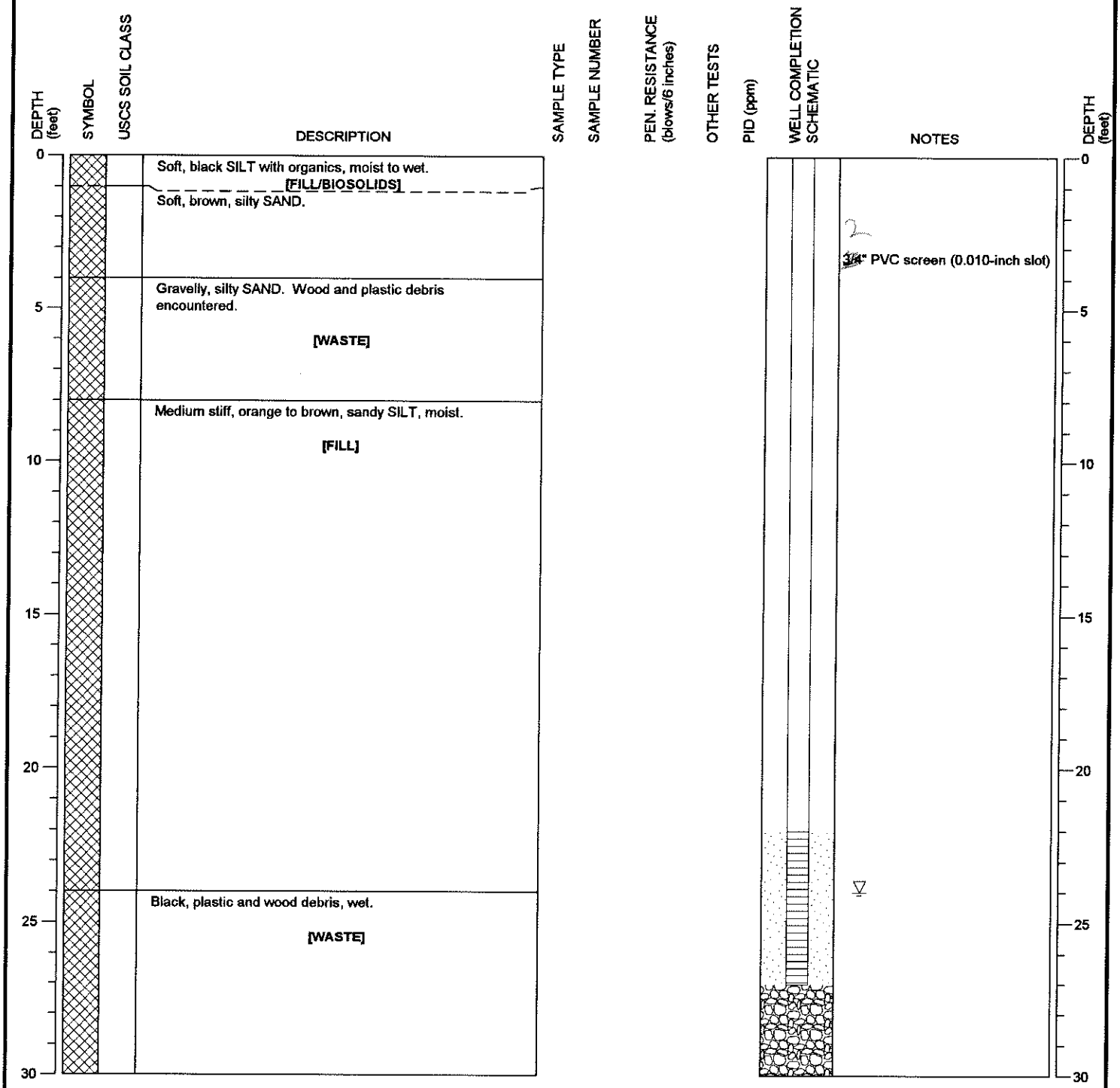
PROJECT NO.: 98165

FIGURE: B-33

DRILLING COMPANY: Cascade Drilling, Inc.
DRILLING METHOD: HSA, 8" OD, Tracked Rig
SAMPLING METHOD: 3" D&M on winch line
LOCATION: Everett, Washington

SURFACE ELEVATION: ± feet

DATE STARTED: 2/26/2003
DATE COMPLETED: 2/26/2003
LOGGED BY: B. Robinson



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HWA GEOSCIENCES INC.

EVERETT LANDFILL
EVERETT, WASHINGTON

MONITORING WELL:
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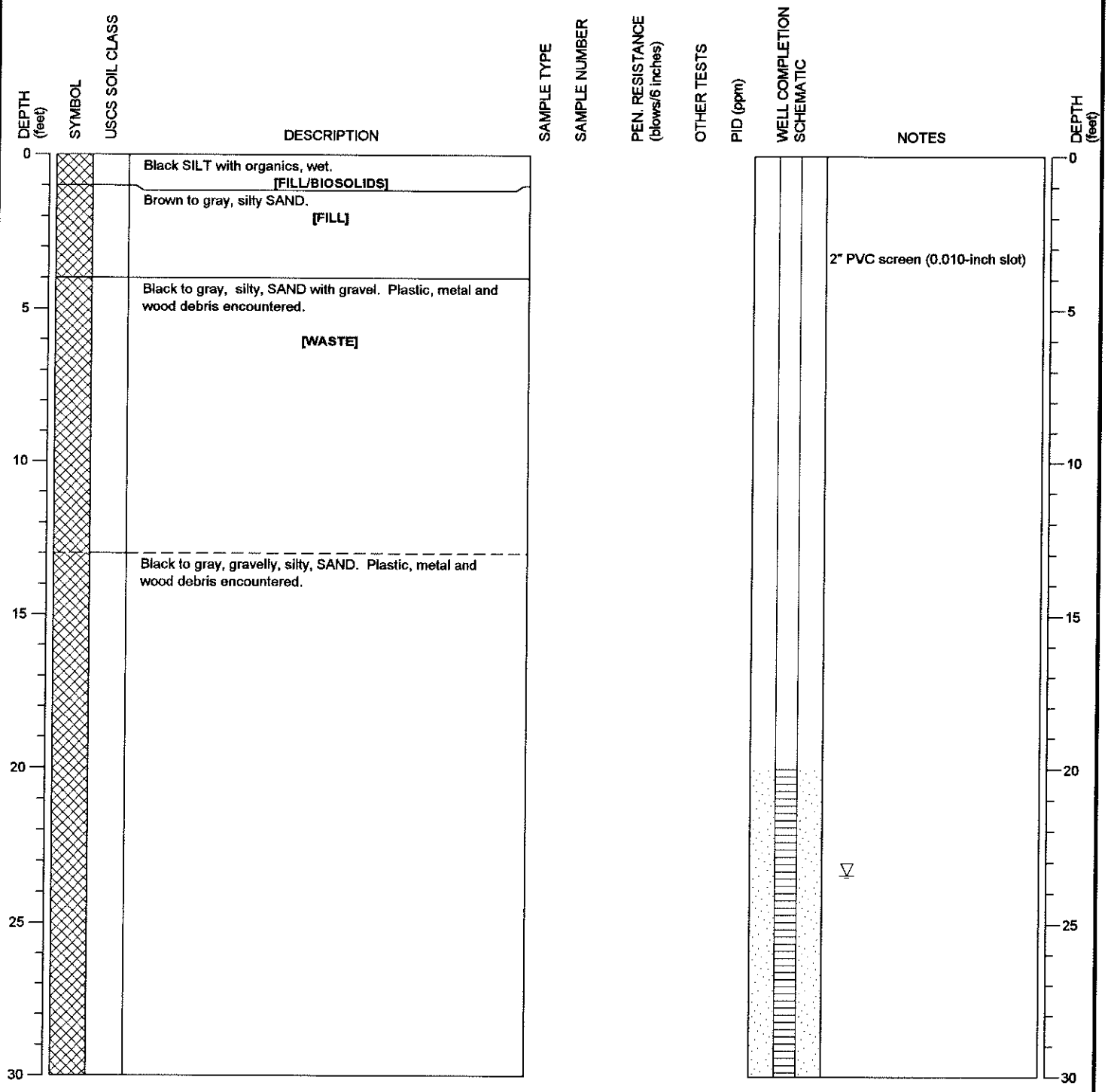
FIGURE: B-34

MWELL 98165.GPJ 7/11/03

DRILLING COMPANY: Cascade Drilling, Inc.
DRILLING METHOD: HSA, 8" OD, Tracked Rig
SAMPLING METHOD: 3" D&M on winch line
LOCATION: Everett, Washington

SURFACE ELEVATION: ± feet

DATE STARTED: 2/27/2003
DATE COMPLETED: 2/27/2003
LOGGED BY: B. Robinson



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HWA GEOSCIENCES INC.

EVERETT LANDFILL
EVERETT, WASHINGTON

MONITORING WELL:
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FIGURE: B-35

MWELL 98165.GPJ 7/11/03