



**US Army Corps
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Engineering Research and
Development Center

**Geophysical Investigations Around Buildings 35-750 and 35-752,
Fort Richardson, Alaska**

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DRAFT REPORT

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INTRODUCTION

We performed a geophysical study around Buildings 35-750 and 35-752 in May 2000 to determine the possible locations where PCB oils were drained from transformers now removed from the site, and to attempt to locate soil contaminated with petroleum. To do this, we used ground-penetrating radar (GPR) to locate former trenches and depressions in the subsurface and DC resistivity to identify soil contaminated with petroleum.

SITE BACKGROUND

Buildings 35-750 and 35-752 are located southwest of Fort Richardson's main cantonment between the Davis Highway and Ship Creek (Fig. 1). Building 35-750 functions as a control center for the high frequency transmitters operated by the U.S. Air Force. Five transformers with PCB's were formerly located on the east side of the building (Fig. 1). Building 35-752 was used to house generators that supplied electricity to the transformers at Building 35-750 between 1953 and 1987, when the generators were removed.

In 1982, the PCB oil in four 750-kVA transformers was drained out of them before they were removed. There are two different reports on how the oil was disposed of. One version states that the oil was allowed to flow south along the east edge of Building 35-750 and across the parking lot along a low area on the ground surface where it pooled in a

natural depression at the approximate center of the current parking lot (Jim King, personal communication, former Fort Richardson Fire Dept. personnel). A temporary soil berm was constructed to prevent flow of the oils south from the parking lot into the cooling pond (Jim King, personal communication). Another version states that the oil flowed within a trench from the transmitters to an excavated pit located in the approximate center of the parking lot (Fig. 1).

Four 50-gallon drums of diesel fuel were poured on the pooled PCB oils, and this mixture was ignited by the Fort Richardson Fire Department (Jim King, personal communication). The diesel and PCB oils were almost burned to completion before they were extinguished with foam.

A garage bay was added to Building 35-750 in 1983 (Fig. 2). Therefore, the PCB oils may have flowed from the transformers through a trench formerly located where the new garage bay was built, and we would be unable to identify its existence with our analyses.

A larger, 150-kVA transformer was drained in 1984 (ENSR 2000). Based upon interviews with people here then, it is thought that the PCB oils from this transformer were drained onto the ground and flowed eastward into an existing depression just east of the driveway around Building 35-750 (Fig. 1). These oils were not burned because the collection area was too wet. It is unknown if a trench was actually excavated to divert these PCB oils into this depression. The exact location of this PCB oil collection area is not known.

To remove PCB-contaminated soil, an Air Force contractor excavated the parking lot area to an estimated depth of 0.9 m (3 ft) in October 1997 (ENSR 2000). The area where PCB oils were suspected to have been drained in 1984 was not excavated. Approximately 1223 m³ (1600 yd³) of soil was collected and stockpiled on Elmendorf Air Force Base (EAFB) (ENSR 1998b). In September 1998, the soil was moved from EAFB by B.C. Excavating, Inc., and trucked to a new stockpile location southwest of Building 35-750. Approximately 688 m³ (900 yd³) of soil from the Tank 1109 removal project at Building 35-752 was added to the new soil stockpile (ENSR 1998b). In addition, about 7 to 15 cm (3 to 6 in.) of native soil within the footprint of the first stockpile on EAFB was excavated and moved to the new stockpile near Building 35-752.

The parking lot and circular driveway for Building 35-750 were subsequently leveled with gravel fill and paved.

In 1994, ENSR collected five composite soil samples in the stockpile near Building 35-750. All five samples tested positive for PCB, Diesel Range Organics (DRO), and Residual Range Organics (RRO).

Several site investigations were previously done at Building 35-752. In 1990, the Alaska District, Corps of Engineers, sampled soil and ground water in the area of former underground storage tanks (UST's) located south of the building for petroleum hydrocarbon contamination (USACE 1990). In 1993, Harding Lawson Associates (HLA) also sampled soil and ground water at this location to assess the extent of PCB contaminated soil and petroleum hydrocarbons in the soil and ground water (HLA 1994a, HLA 1994b). ENSR later conducted a field study to determine the extent of PCB and petroleum hydrocarbon contamination in soil and ground water across the site, and also measured PCB levels in dust sampled inside Building 35-752 (ENSR 1994). The Remedial Investigation/Feasibility Study (RI) at Operable Unit D (ENSR 1996, 1998a) also reported on investigations at this site.

Between 1990 and 1994, 11 boreholes were drilled in the study area and monitoring wells were installed (Fig. 1) (AP-2982, AP-2983, AP-2984, AP-2985, AP-2986, AP-2987, AP-3231, AP-3232, AP-3502, AP-3503, and AP-3504). In conjunction with the Building 35-752 site assessment and RI (Fig. 1), 19 additional soil borings were drilled (HLA 1994a, ENSR 1994, ENSR 1996, and ENSR 1998a). Ground water elevation measurements show that the ground water flows northwest across the site (ENSR 1994). The borehole log stratigraphy from these wells consists of discontinuous layers of silty gravel, sandy gravel, sandy, silty gravel, sand with gravel, and sandy silt. The water table ranges from 3 to 4.8 m (10 to 16 ft) below the ground surface.

METHODS

Ground-Penetrating Radar

In ground-penetrating radar (GPR), radio waves are reflected and diffracted at material interfaces, making horizons evident in its digital record. The signal amplitude strength is

determined by the contrast in relative dielectric permittivity ϵ across the interface. The thickness d of a layer is interpreted using the echo delay formula for normal incidence

$$d = ct/2\sqrt{\epsilon} \quad (1)$$

where c is the free space speed of light (3×10^8 m/s), t is time, and the factor of two accounts for the round trip propagation path.

Buried objects such as pipes, electrical wires, or drums result in hyperbolas in the record. Excavation features such as buried trenches can be detected in the radar record if there is a material or density change between the original excavation surface and the fill material above the feature. Borehole logs provide ground truth for interpreting the radar records.

CRREL collected GPR data using 200- and 400-MHz antennas to determine the locations of subsurface layers, objects, and former trenches penetrating to depths of 11 and 8.5 m respectively. Fifty-three GPR transects were established in a 5-m grid that covered the parking lot, the area just south of Building 35-752, and the area just east of Building 35-750 (Fig. 3). In addition, 13 angled transects that trend northwest to southeast and 16 transects that trend east to west, each spaced about 1 m apart, were profiled to look for the presumed former trench on the southeast corner of Building 35-750 (Fig. 4). The antennas were towed by hand at a constant speed. Each GPR transect profile record was examined and processed digitally on a computer. Particular attention was paid to identifying possible former trenches between the transformers and the burn pit or collection area, and former excavation surfaces associated with the burn pit.

The locations of GPR transects were mapped by GPS using a Trimble Pro-XR receiver and a TSC1 datalogger. The GPS data were corrected in real-time from a National Geodetic Survey continuously operating reference station (CORS) station in Kenai, AK. Horizontal error of the GPS data varies according to the number of available satellites and their positions relative to one another, but is generally less than 1 m.

DC Resistivity

Resistivity is a measure of the difficulty of driving an electrical current through the ground. In the DC resistivity method, an electrical current from a battery is driven into two outer copper electrodes and the induced voltage between two inner electrodes is then measured (Fig. 5). An apparent resistivity is calculated from the ratio of voltage to current. Electrodes are spaced equally from one another to form an array, and the distance between adjacent electrodes is called the a -spacing. This type of array with equal distance between each consecutive electrode is called a Wenner array. The larger the a -spacing the deeper into the ground the electrical current travels.

A sounding is obtained by continually varying the a -spacing, which results in data from multiple depths at a single point, and provides information similar to a borehole log. A profile is obtained by collecting resistivity data at one depth (one a -spacing) along a transect. Profiles are useful for mapping lateral changes in ground resistivity. Together, soundings and profiles provide a detailed picture of resistivity variation in the subsurface.

In general, sediments of small grain size, like clay and silt, have low resistivity values and sediments of large grain size, like gravel, have higher resistivity values. Moisture decreases resistivity in soils. Petroleum contamination can cause extremely high resistivity values (DeRyck et al. 1993, Delaney 1996).

Two soundings and two profiles were made to the south and east of the paved area (Fig. 6). Resistivity measurements were not possible within the driveway and parking lot areas because of the asphalt cover.

RESULTS

Ground-Penetrating Radar

GPR data show the presence of numerous diffraction hyperbolas from subsurface objects that are interpreted as pipes, electrical wires, and electrical conduits (Fig. 7). The dielectric permittivity was calculated to be 12.4 using hyperbola slopes from the GPR data. This value was then used to determine the depth below ground surface of reflections seen in the GPR data using equation 1. In addition, two continuous and several discontinuous horizons are present in the GPR data (Fig. 7 and 8). The upper continuous horizon is interpreted as the base of the parking lot construction materials.

The deeper continuous horizon is interpreted as the base of the fill area that resulted from the parking lot excavation. The deepest horizon is discontinuous and is interpreted as a stratigraphic change from silty sand to clean sand or sandy gravel (Fig. 7 and 8).

The 1-m grid data contain trench-like features located southeast of Building 35-750 (Fig. 9). They appear to be associated with the current or previous locations of electrical lines. There is, however, no indication of a continuous trench from the former location of the transformers to the presumed burn pit area.

A prominent linear feature was located between Building 35-750 and 35-752 on the 1-m grid transects at approximately 10 m from the start of each transect (Fig. 9). It is oriented north-south and interpreted as a buried utilidor (Fig. 4). As-built drawings from Building 35-752 show a concrete conduit running from the generators in Building 35-752 to the transformers outside Building 35-750 at the same location, confirming this interpretation.

The parking lot fill varies in depth from 0.2 m near its edges to 0.9 m depth below the current ground surface in the southeast (Fig. 10). In general, the parking lot was excavated to the greatest depth in its southeast quadrant, or a greater amount of fill material was added here, or both.

DC Resistivity

To define vertical variations in the resistivity values, the sounding results were modeled using RESIX^{PLUS}™ software (Fig. 11). Profiles were examined for lateral changes that would presumably indicate subsurface material changes. The soil type at a depth of approximately 3.5 m along each profile was interpreted using resistivity and borehole data.

Sounding one is located 3 m northwest of AP-3229 (Fig. 6). The sounding data were interpreted using the borehole log for AP-3229, consisting of an upper silty gravel to a depth of approximately 1 m, sandy gravel from 1 to 1.95 m, and silty, sandy gravel from 1.95 to 5.6 m (Fig. 11).

Sounding 2 is located approximately 18 m northeast of AP-3917 (Fig. 6). The stratigraphy at sounding 2 was interpreted using the borehole log from AP-3917 as silty, sandy gravel to 0.5 m, silt with sand from 0.5 to 1.4 m, sand with gravel from 1.4 to 3.6

m, silty sandy gravel from 3.6 to 6 m, and silty sand with gravel from 6 to 12.6 m depth (Fig. 11).

Profile 1 trends west to east, and is located just south of the paved area and Building 35-752 (Fig. 6). The profile generally shows values consistent with moist, silty sediments. Values of 673 to 821 ohm-m from 7.5 to 17.5 m occurred in the area without fill (Fig. 12). The resistivity values ranged from 444 to 567 ohm-m between 22.5 and 47.5 m along the profile. Contaminated soil above several UST's was removed from this area and a silty gravel fill was added. The lower resistivity in the fill sediments indicates a higher silt content than the sediment from 7.5 to 17.5 m along the profile.

Profile 2 trends south to north from AP-3231 at 0 to 50 m (Fig. 6). The profile data generally increase along profile 2, with values ranging from 901 ohm-m at 7.5 m to 1198 ohm-m at 17 m (Fig. 12). This increase is interpreted as a change in stratigraphy from less resistive silty, sandy gravel to more resistive sand with gravel. A second increase in resistivity to 1590 ohm-m at 50 m is interpreted as a change to a more resistive sandy gravel based on resistivity values for sandy gravel on Fort Richardson.

DISCUSSION

There is no evidence from the GPR data of a depression that could be associated with the 1982 burn pit or a trench that would have extended from the transformers at Building 35-750 to the center of the parking lot area. We assume that these features were removed during parking lot excavation in 1997.

Before it was paved, the parking lot was maintained by adding gravel and grading. These processes may have caused mixing and an increased volume of PCB-contaminated sediments. Therefore, the excavation of the parking lot area in 1997 may not have been sufficient to remove all PCB-contaminated sediments, especially in the southwest and northeast corners where the excavation was shallow (Fig 10).

The resistivity soundings and profiles do not indicate the presence of a highly resistive anomaly that could be attributed to petroleum contamination. However, the absence of high resistivity values does not indicate that the site is clean. Due to physical constraints of the resistivity technique, low concentration or deep petroleum contamination might not

be detected. In addition, resistivity analyses were not possible where the asphalt is present, limiting the extent of data collection in the parking lot area.

CONCLUSIONS

This geophysical investigation did not find evidence for a subsurface depression that may be associated with the burn pit in the parking lot area. Several trench-like features were located, but they were associated with buried utilities and not the transformer drainage trench. It is suspected that the PCB oils flowed in a shallow trench from the transformer area to the burn pit. It is likely that the northern part of the trench was buried beneath the garage bay addition and the rest of the trench was removed during parking lot excavation in 1997.

Resistivity data from the south and east sides of the lot do not indicate petroleum contamination; however, PCB-oil contaminated soils may still exist beneath the asphalt parking lot and in areas not included in this investigation. Additional soil sampling for PCB's and hydrocarbons within the parking lot area and periphery is recommended.

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De Ryck, S.M., J.D. Redmann, and A.P. Annan (1993) Geophysical monitoring of a controlled kerosene spill. Proceedings of the Symposium on the Application of Geophysics to Engineering and Environmental Problems (SAGEEP'93), San Diego, California, pp. 5-20.

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ENSR (1998a) Final RI/FS Operable Unit D Fort Richardson, Alaska, Volume Ia, Remedial Investigation Report, DACA85-94-D0010. For USACE, Alaska District, CENPA-EN, Anchorage, AK.

ENSR (1998b) Stockpile letter report, PCB stockpile, Building 35-752 area, DACA85-94-D-0010. For USACE, Alaska District, CENPA-EN, Anchorage, AK.

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Harding Lawson Associates (HLA) (1994b) Draft site assessment/remedial investigation and corrective action plan, Site 4, Building 35-752, high frequency transmitter site, Fort Richardson, Alaska. For USACE, Alaska District, Project Support Section, Anchorage, AK.

US Army Corps of Engineers (USACE) (1990) Sampling report, underground storage tank remediation, Fort Richardson, Alaska, Memorandum for CENPA-EB-MB-A.

FIGURES

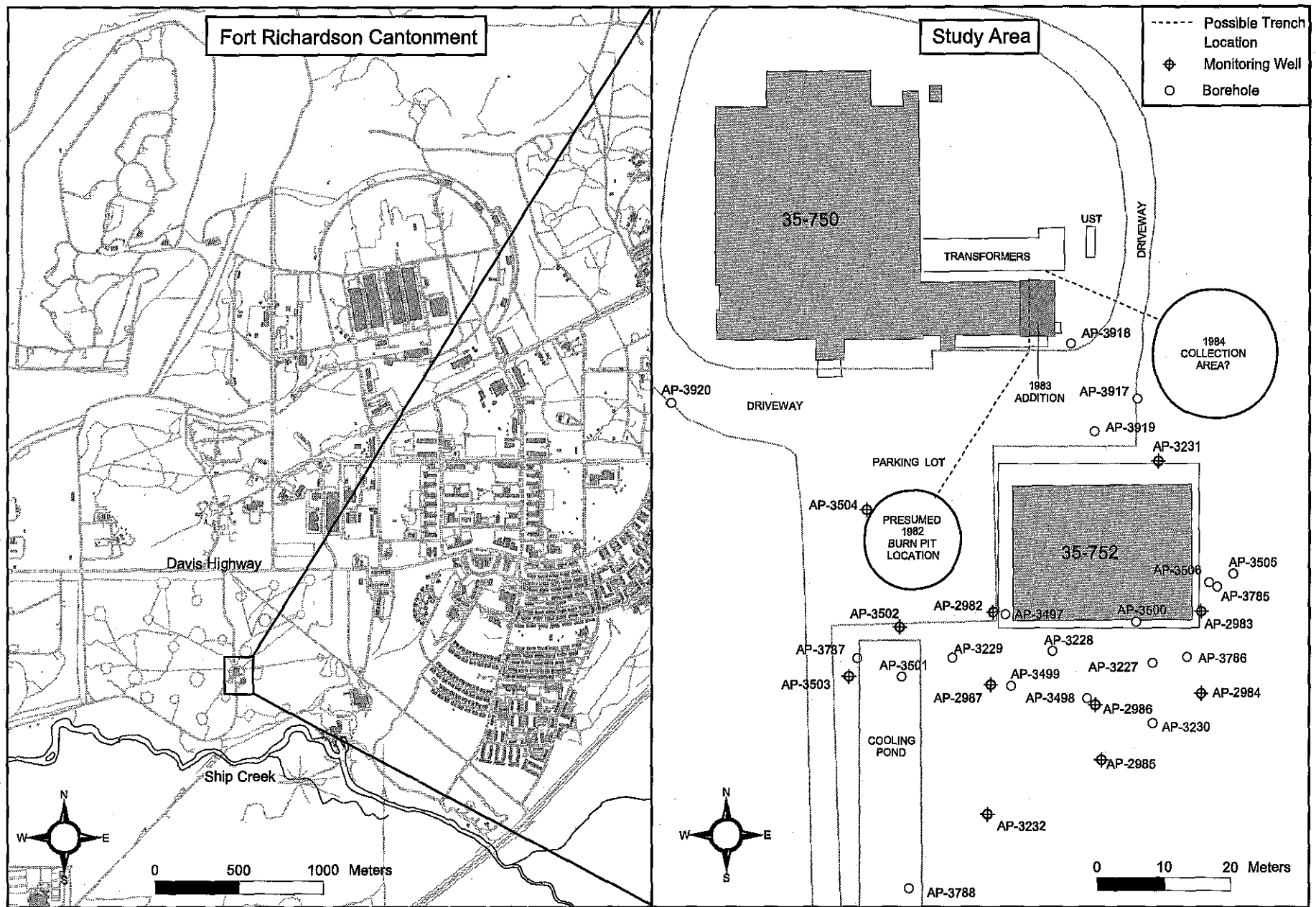
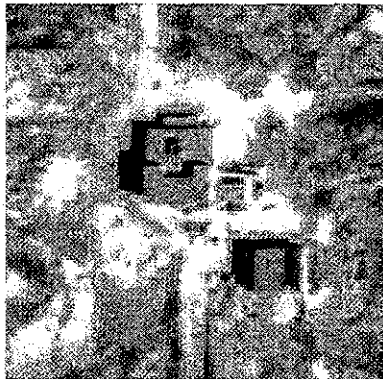


Figure 1. Location of study area on Fort Richardson, with the assumed location of the burn pit, collection area, transformers, and monitoring wells identified.

1962



1974



1983

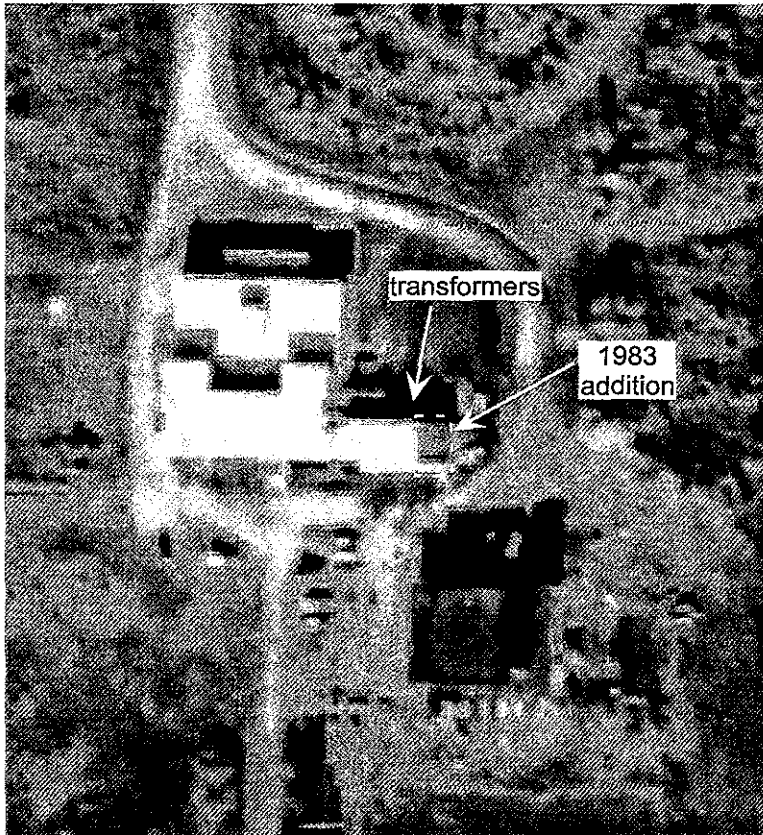


Figure 2. Aerial photographs of Buildings 35-750 and 35-752 from 1962, 1974, and 1983. The transformers and garage addition are identified.

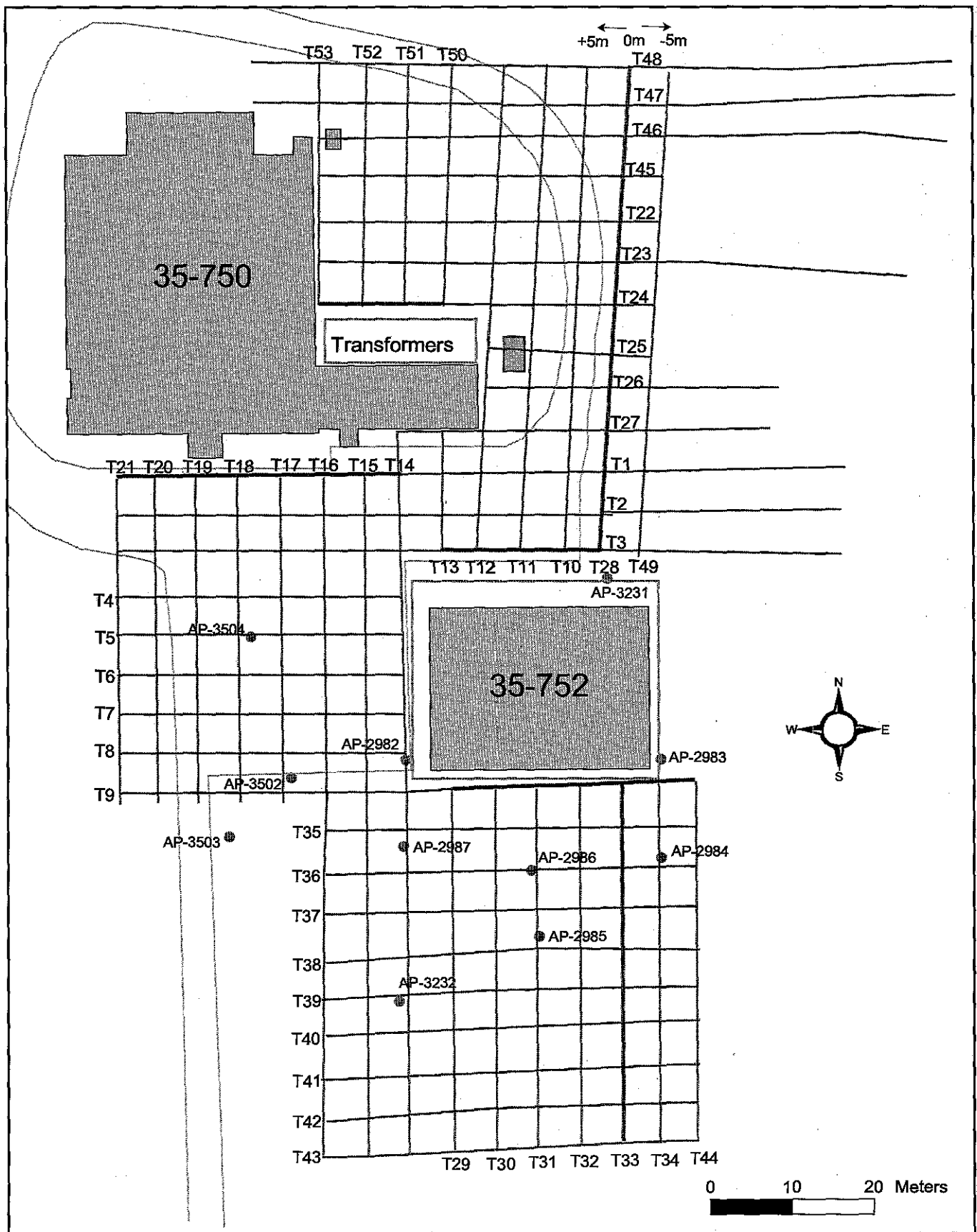


Figure 3. GPR transect locations in the 5-m grid. Bold lines in grid represent 0-m mark locations. Monitoring wells are shown.

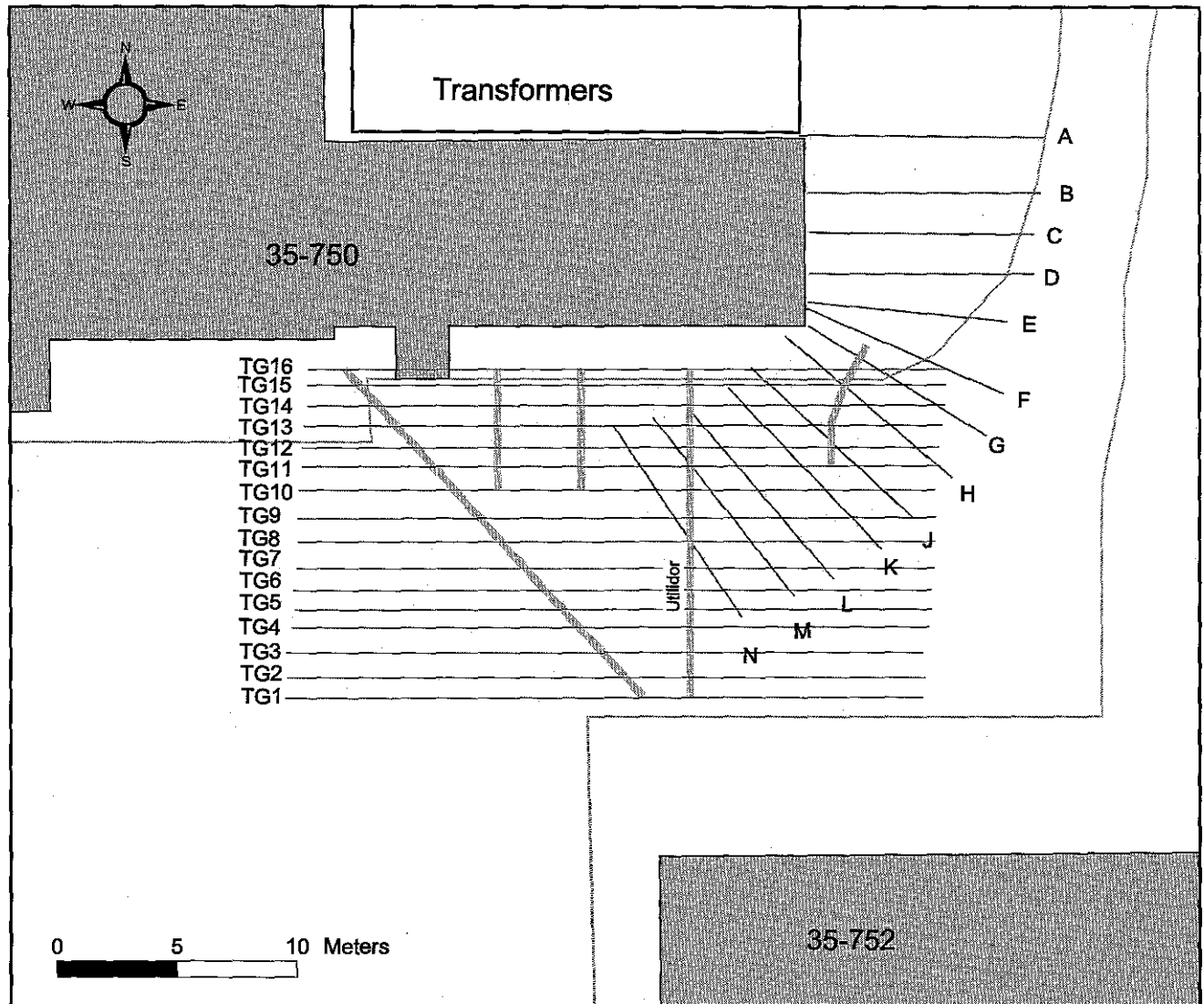


Figure 4. Locations of the detailed 1-m grid (TG) and angled transects (capital letters). The 1-m grid transects were recorded from east to west. Angled transects were collected west to east or northwest to southeast. Thicker gray lines indicate locations of buried objects interpreted as utility lines.

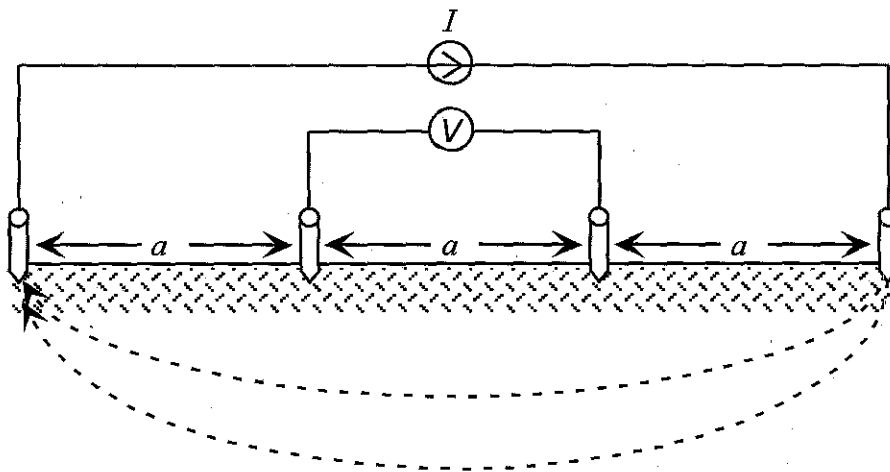


Figure 5. Wenner electrode array configuration with spacing a . A measured current, I , is forced between the two outer electrodes, and the induced potential, V , is measured between the two inner electrodes. The dashed lines depict current return paths in the earth.

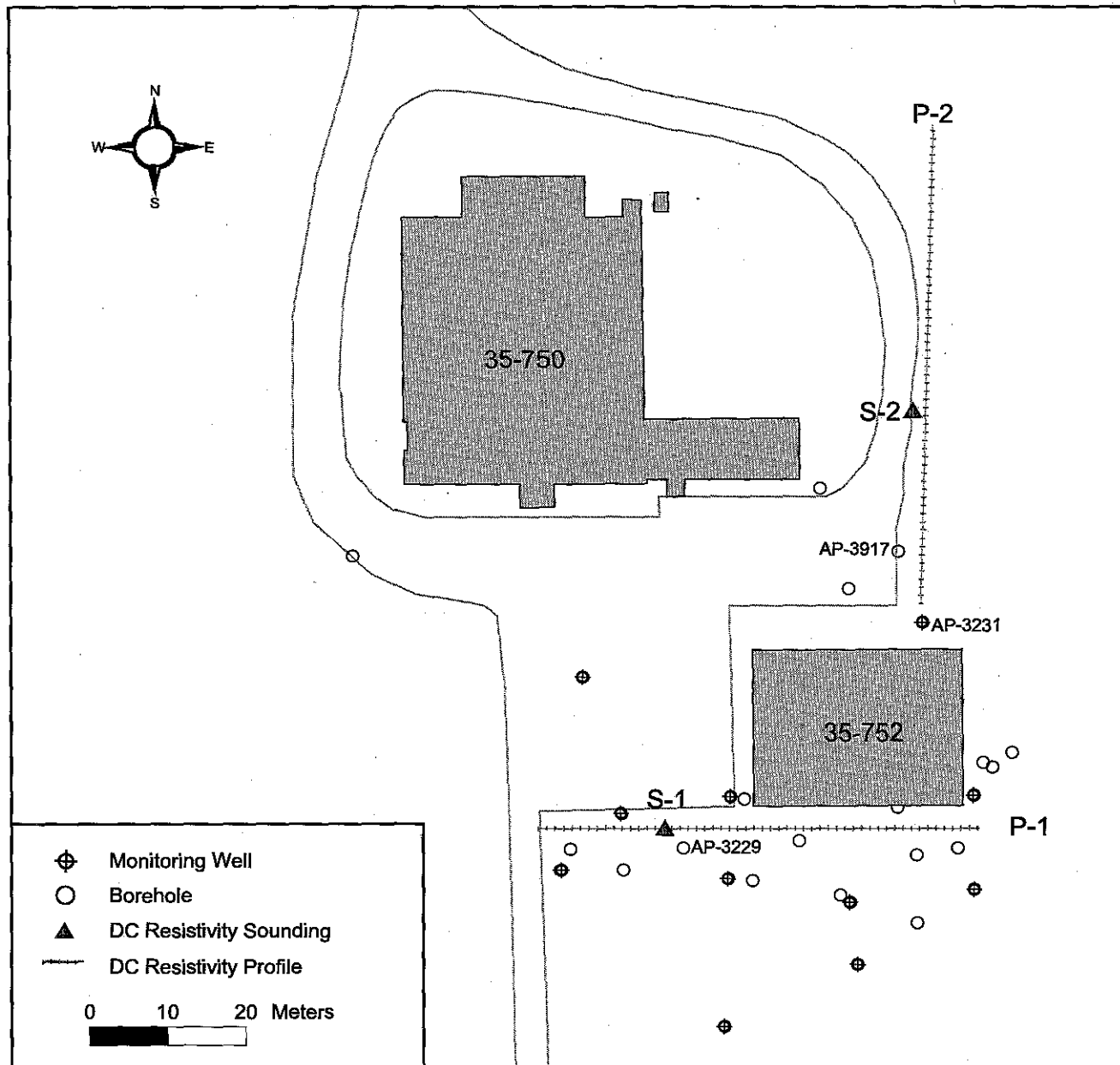


Figure 6. DC Resistivity sounding and profile locations.

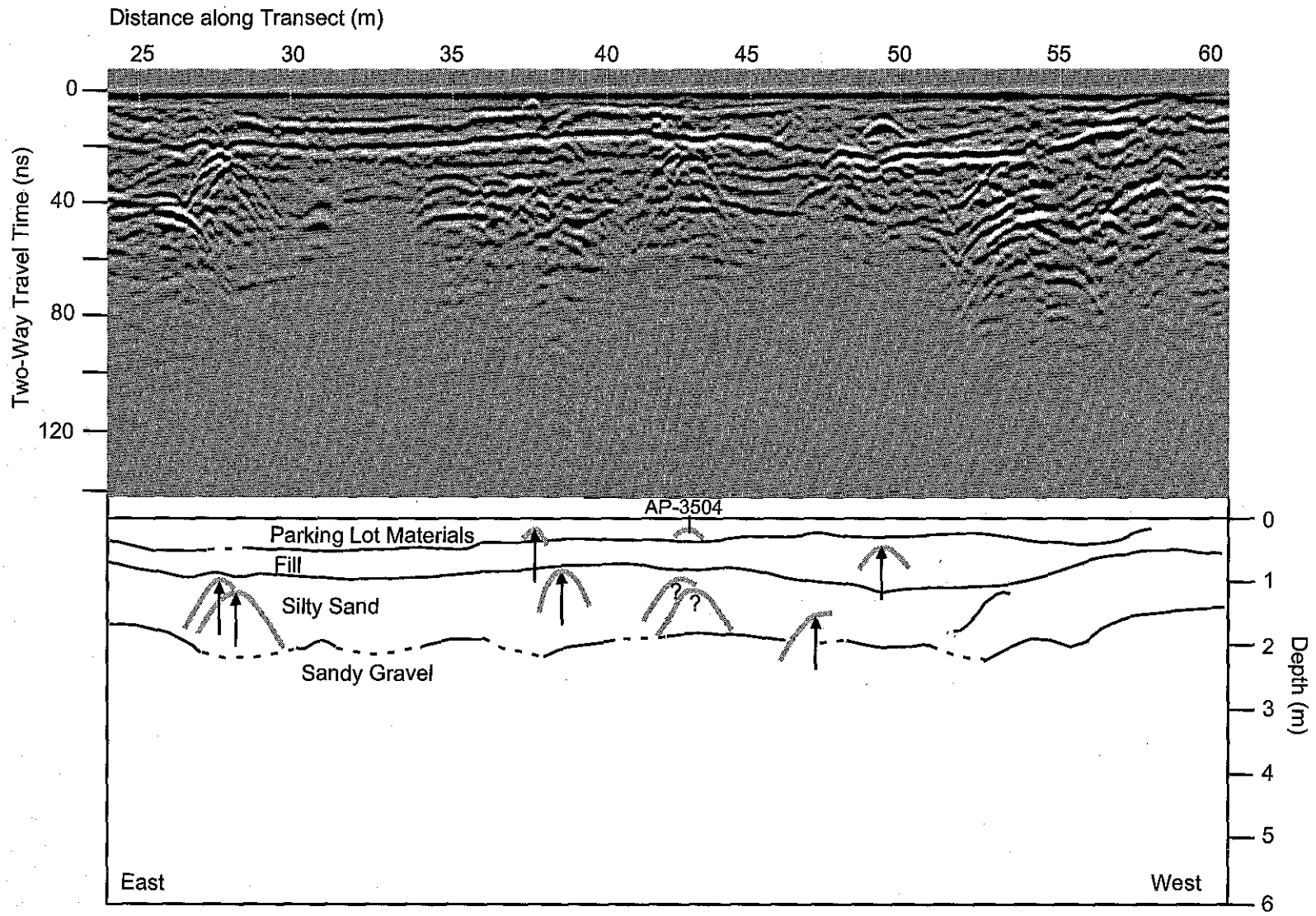


Figure 7. Interpreted 200 MHz GPR record for 5-m grid T5. Arrows indicate probable locations of buried utility lines.

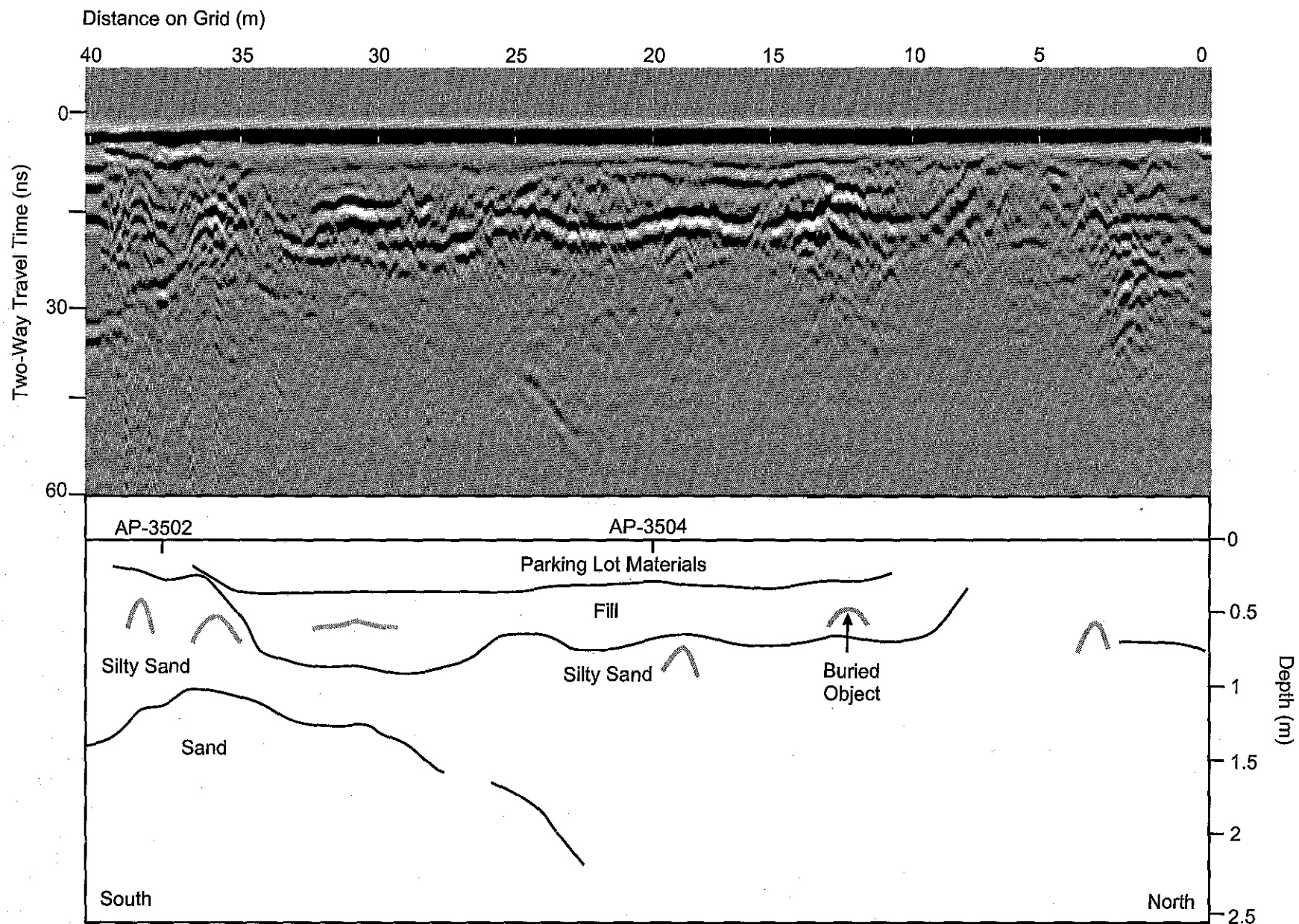


Figure 8. Digital GPR data (top) and interpretation (bottom) for TA17 showing stratigraphy and buried objects. The data were collected with a 400-MHz antenna at 120 ns.

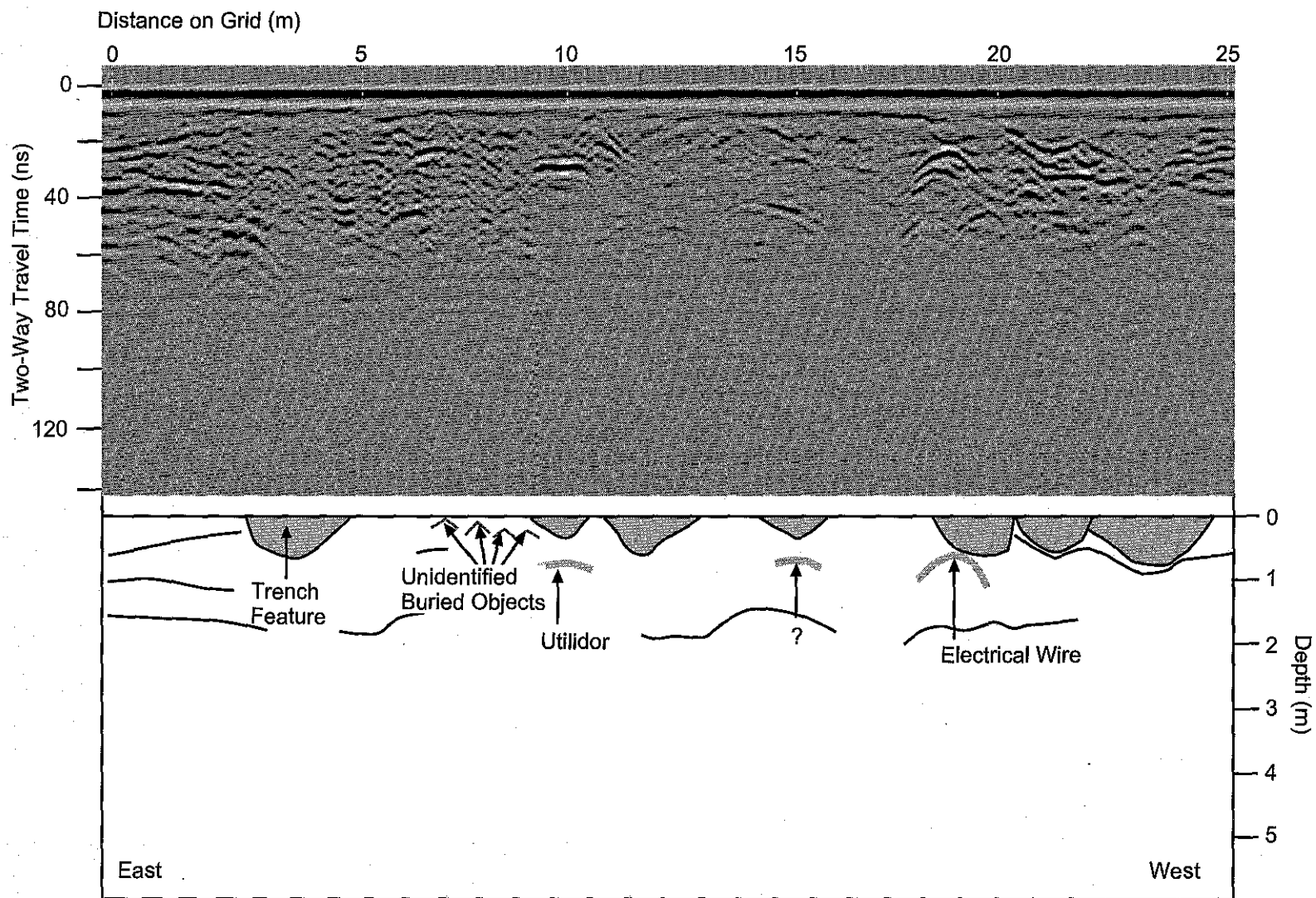


Figure 9. Interpreted 200-MHz GPR record for 1-m grid TXG-8. Trench-like features are shown in gray.

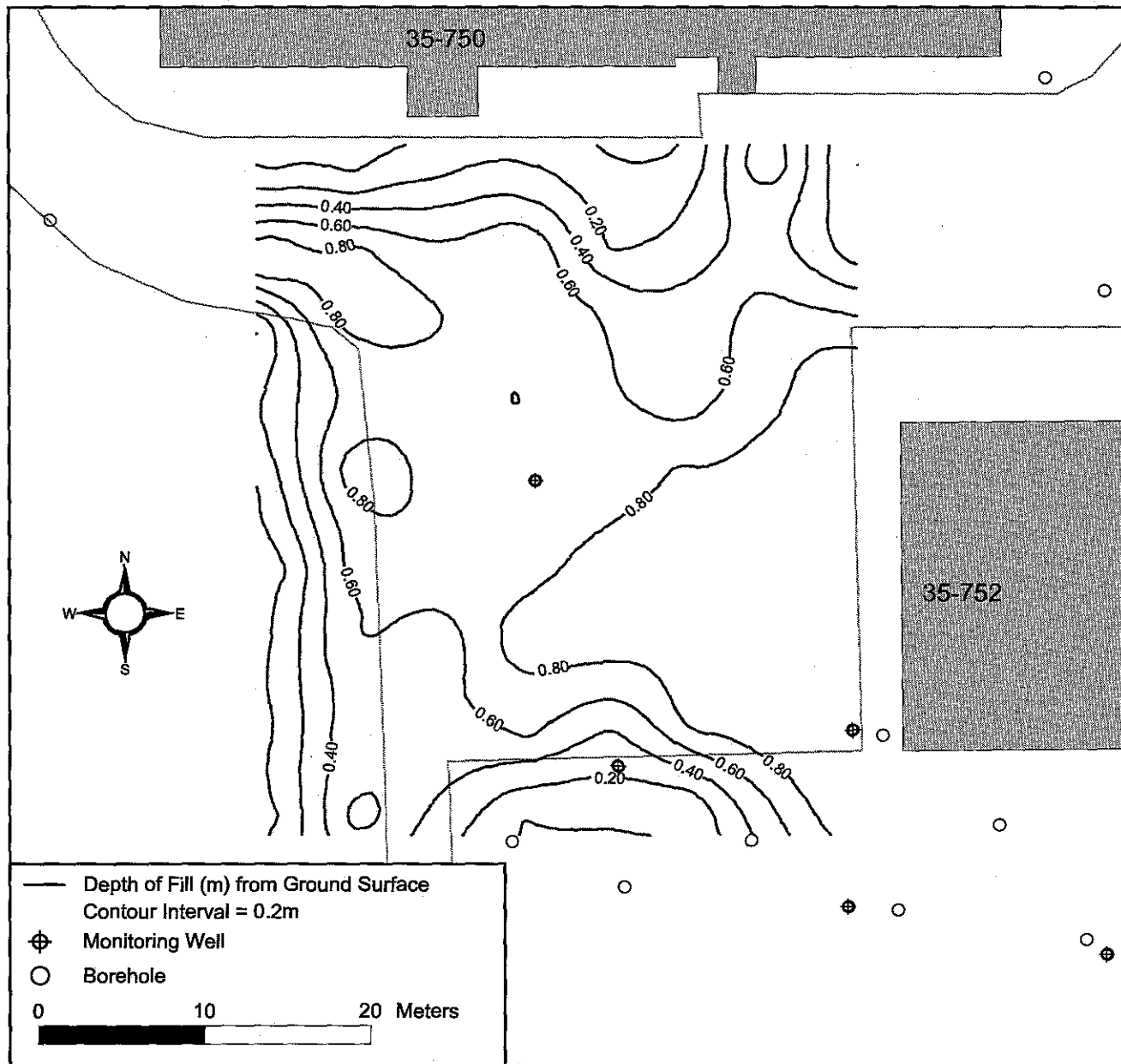


Figure 10. Modeled depth to bottom of fill from the current ground surface (m).

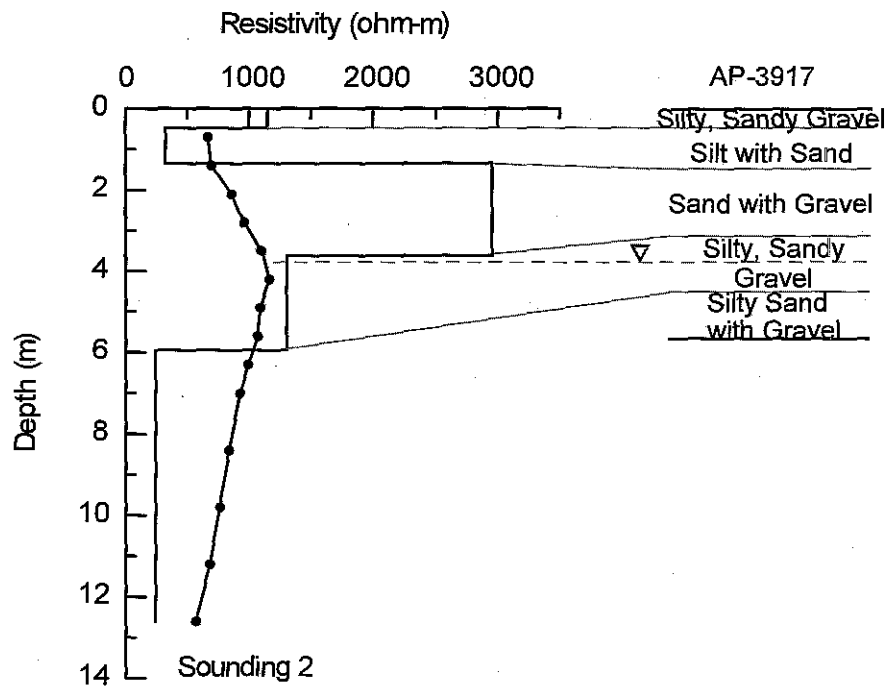
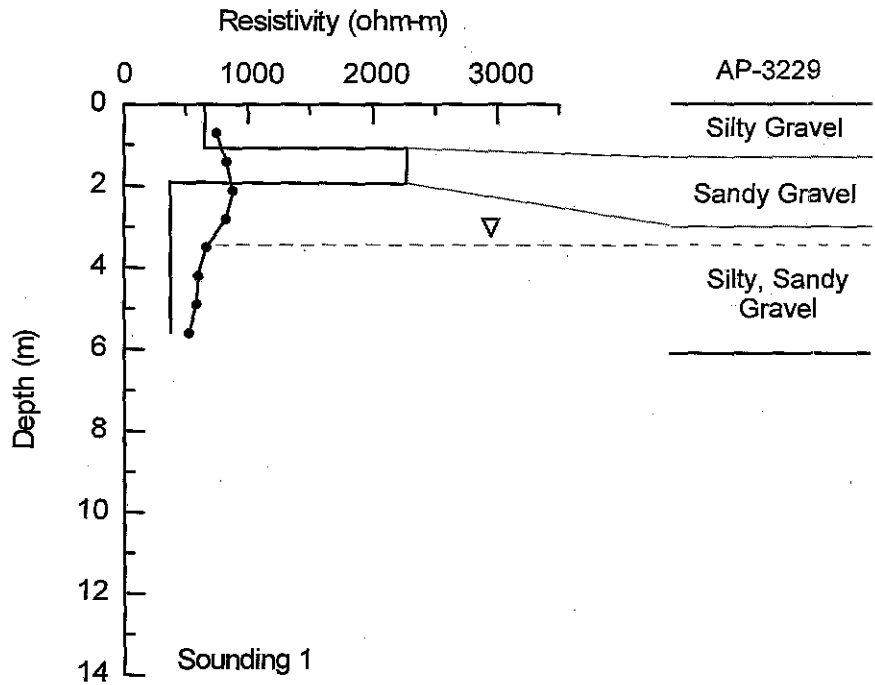


Figure 11. Sounding data collected with DC resistivity and interpretations using nearby borehole logs. The dotted line shows the raw data. The solid line shows the layered model.

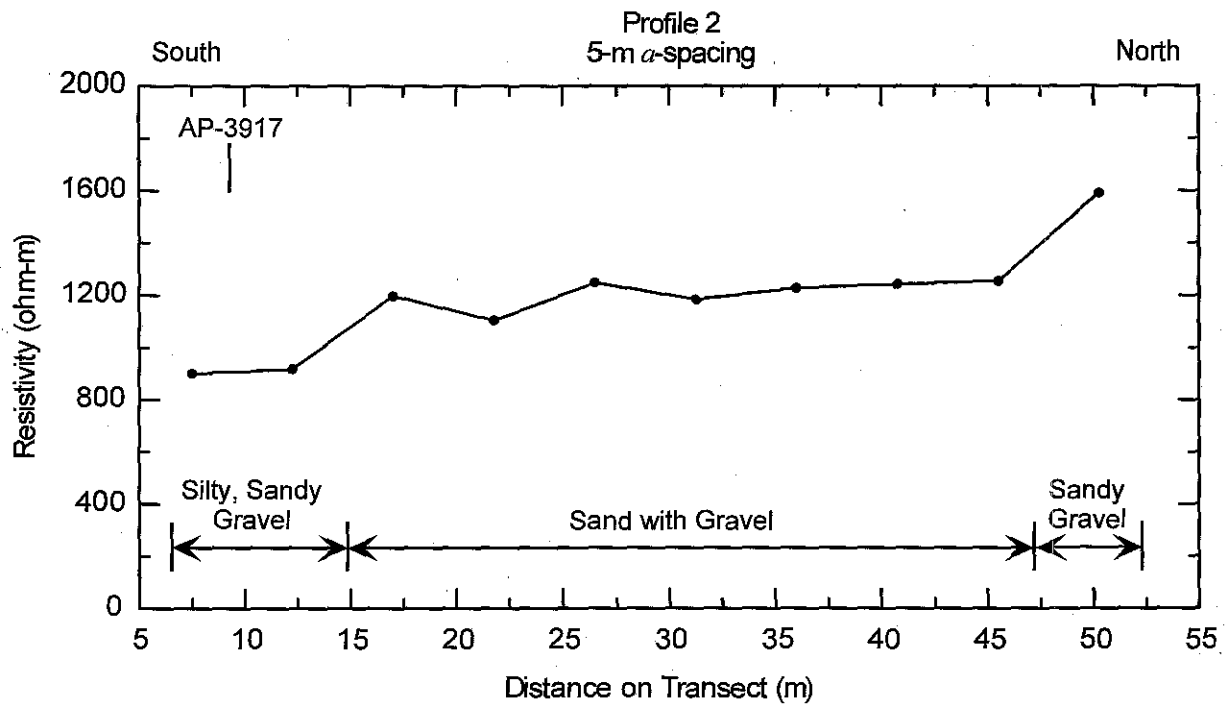
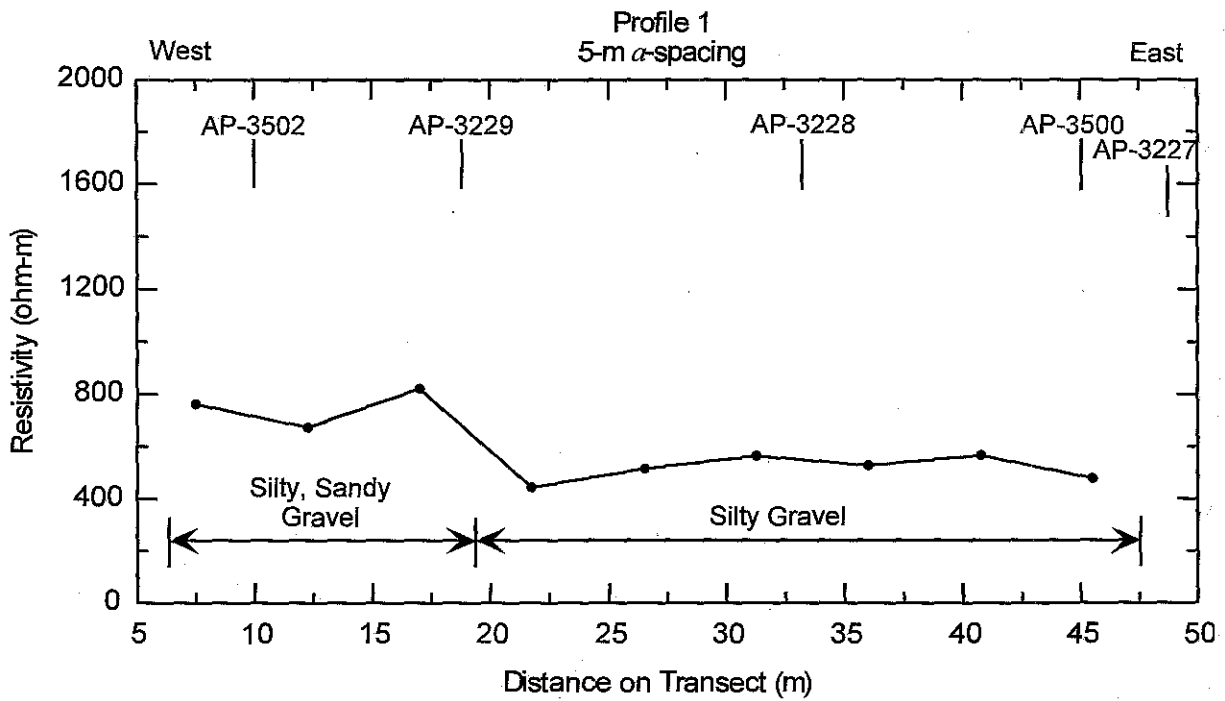


Figure 12. DC resistivity Profile 1 (top) and Profile 2 (bottom) data. Stratigraphic interpretations based on the resistivity and nearby borehole logs are shown.

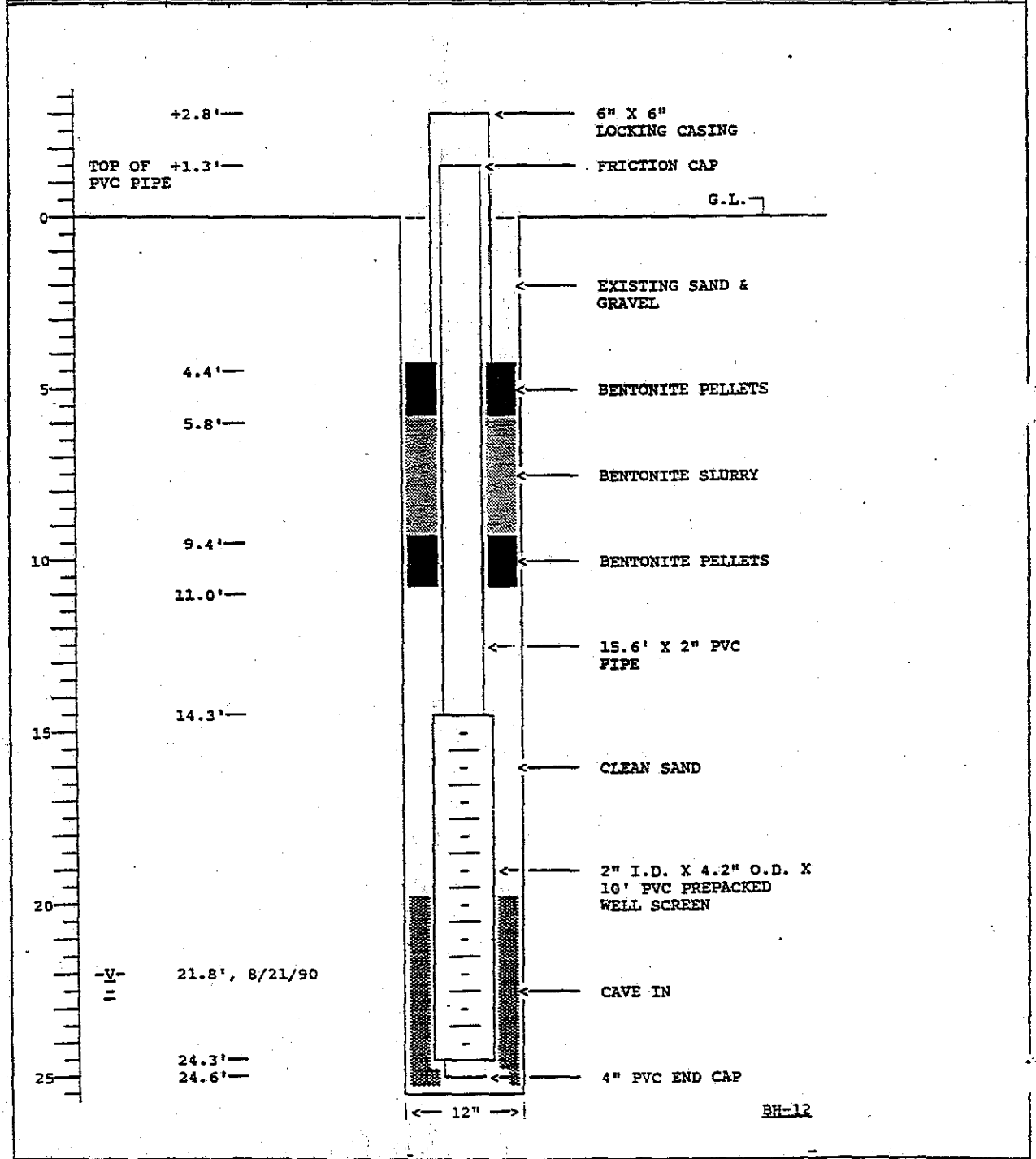
APPENDIX A

Borehole logs referenced in this report.

DEPARTMENT OF THE ARMY		Project FT RICHARDSON, AK		Piezometer	
		UST REMEDIATION		Sheet 1 of 2	
North Pacific Division U.S. Army Engineer District Alaska		Location Coordinates			
		Northing 113,158		Easting 125,665	
EXPLORATION LOG		Drilling Agency XXX Corps of Engineers			
		Other Alaska District			
Hole Number		Name of Driller		Weather	
Field BH-12 Permanent AP-2982		K. Mitchell		Overcast, 60°	
Type of Hole		Depth To		Depth Drilled	Total Depth
<input type="checkbox"/> Test Pit <input checked="" type="checkbox"/> Auger Hole		0.0		24.0	24.0
Size and Type of Bit		Elevation Datum		Type of Equipment	
12" Hollow Stem		XXX MSL		Acker Soil Max	
Number of Samples	Type of Samples		Depth to Groundwater	Date	
4	Grab and Drive		16.0	21 August 1990	
Top of Hole Elevation	Inspector		Chief, Soils Section	Chief, Geotechnical Branch	
262.20	T. Reed		J. Raychel	D. Thomas	

Depth in Feet	% Water	Sample	Soil Legend	Classification	Max Size	Description and Remarks
					3"	brown, moist, rounded gravel, coarse to fine sand
5		1	GC-GM	Silty, Clayey GRAVEL with Sand and Cobbles	4"	56%Gr 27%Sa 17%Fines F2 brown, moist, rounded gravel, coarse to fine sand, LL=22, PI=4, HNu<1 *11/14/11
10		2	GW	Well-Graded GRAVEL with Sand	3"	65%Gr 30%Sa 5%Fines S1 gray to brown, moist, subangular gravel, medium to coarse sand, HNu=0 *23/49/52
15		3	GW-GM	Well-Graded GRAVEL with Silt and Sand	2"	53%Gr;38%Sa;9%Fines S1 brown to gray, wet, rounded gravel, medium to coarse sand, HNu=2.0 *14/23/29
20		4	GM	Silty GRAVEL with Sand	1 1/2"	44%Gr 41%Sa 15%Fines F2 brown, wet, rounded gravel, medium to coarse sand, HNu=0 *16/12/14
						Bottom of hole 24.0 Elevation 238.2
						Groundwater elev. 246.2 estimated during drilling
						*Number of blows to drive a 2.5" I.D. split spoon sampler each 6" increment with a 300-pound hammer falling 30"
						Monitoring well installed (see installation log)

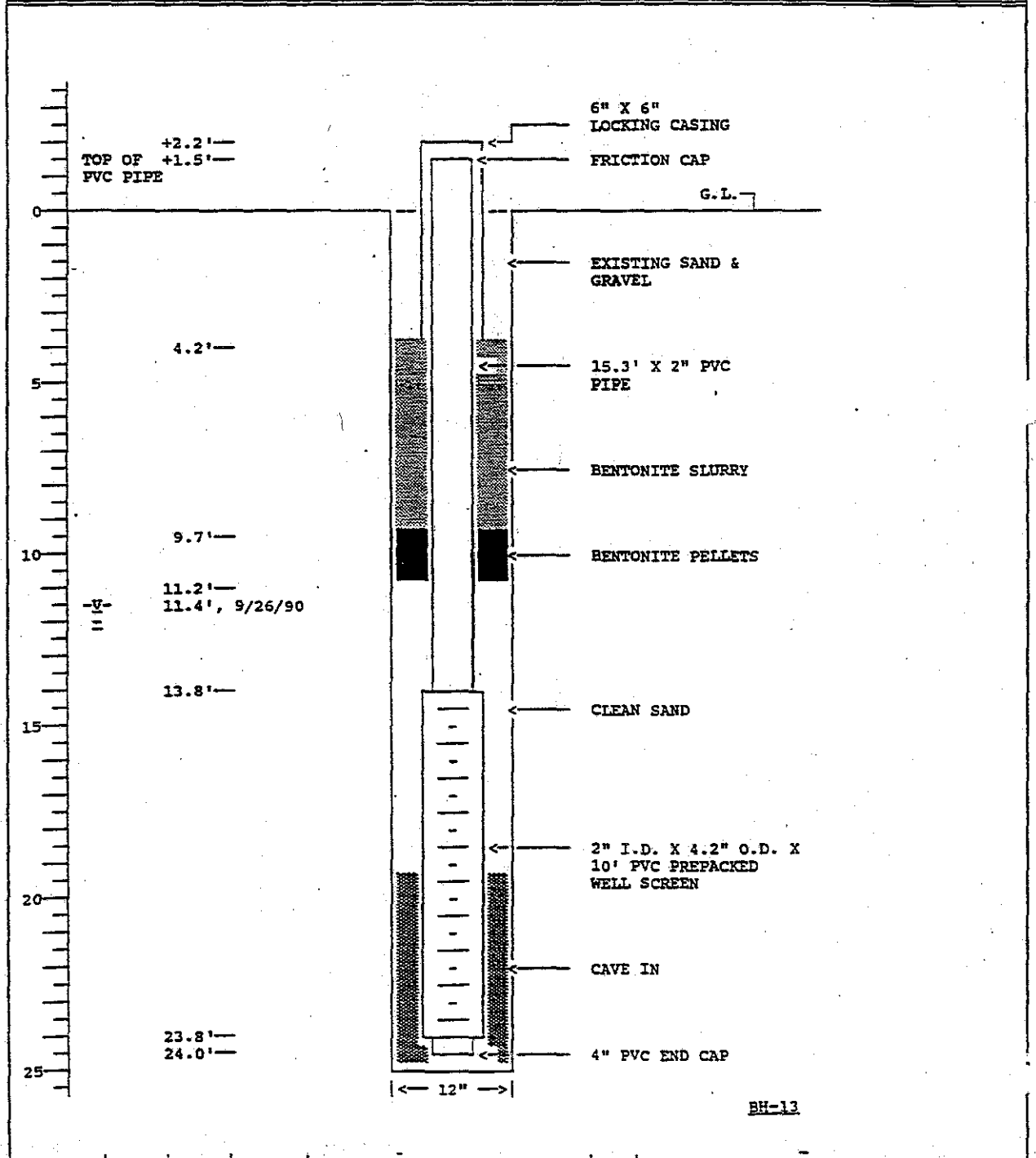
DEPARTMENT OF THE ARMY		Project FT RICHARDSON, AK		Piezometer	
North Pacific Division U.S. Army Engineer District Alaska		UST REMEDIATION		Sheet 2 of 2	
INSTALLATION LOG		Location Coordinates			
		Northing 113,158		Easting 125,665	
		Drilling Agency XXX Corps of Engineers			
		other Alaska District			
Hole Number		Name of Driller		Weather	
Field BH-12 Permanent AP-2982		K. Mitchell		Overcast, 60°	
Type of Hole		Depth To		Depth Drilled	
<input type="checkbox"/> Test Pit <input checked="" type="checkbox"/> Auger Hole		0.0		24.0	
Size and Type of Bit		Elevation Datum		Type of Equipment	
12" Hollow Stem		<input checked="" type="checkbox"/> MSL		Acker Soil Max	
Number of Samples		Type of Samples		Depth to Groundwater	
0				16.0	
				Date	
				21 August 1990	
Top of Hole Elevation		Inspector		Chief, Soils Section	
262.20		T. Reed		J. Raychel	
				Chief, Geotechnical Branch	
				D. Thomas	



Project FT RICHARDSON, AK		Hole Number	
UST REMEDIATION		AP-2982	

DEPARTMENT OF THE ARMY		Project FT RICHARDSON, AK		Piezometer			
North Pacific Division		UST REMEDIATION		Sheet 1 of 1			
U.S. Army Engineer District Alaska		Location Coordinates		Northing 113,158 Easting 125,767			
EXPLORATION LOG		Drilling Agency		XXX Corps of Engineers			
Hole Number		Name of Driller		Weather			
Field BH-13 Permanent AP-2983		K. Mitchell		Overcast, 65°			
Type of Hole		Depth To		Depth Drilled			
Test Pit		XXX Auger Hole		0.0			
Size and Type of Bit		Elevation		Type of Equipment			
12" Hollow Stem		XXX MSL		Acker Soil Max			
Number of Samples		Type of Samples		Date			
4		Grab and Drive		21 August 1990			
Top of Hole Elevation		Inspector		Chief, Soils Section			
262.70		T. Reed		J. Raychel			
				Chief, Geotechnical Branch			
				D. Thomas			
Depth in Feet	% Water	Sample	Soil Legend	Classification	Max Size	Description and Remarks	
					3"	brown, moist, rounded gravel, medium to coarse sand, HNu=0	
5		1	GP-GM	Poorly Graded GRAVEL with Silt, Sand, and Cobbles	3 1/2"	70%Gr 24%Sa 6%Fines S1 brown, moist, rounded gravel, medium to coarse sand, HNu=0 *10/18/19	
10		2	GP-GM	Poorly Graded GRAVEL with Silt, Sand, and Cobbles	4"	47%Gr 46%Sa 7%Fines S1 brown, moist, rounded gravel, medium to coarse sand, HNu=0 *33/34/45	
15		3	GW	Well-Graded GRAVEL with Sand and Cobbles	5"	61%Gr 36%Sa 3%Fines PFS brown, wet, semi-rounded gravel, medium to coarse sand, HNu=0 *11/28/39	
20		4	SP	Poorly Graded SANDS with Gravel and Cobbles	5"	45%Gr 50%Sa 5%Fines NFS brown, wet, rounded gravel, fine to coarse sand, HNu=7 *19/30/24	
25						Bottom of hole 24.0 Elevation 238.7	
						Groundwater elev. 245.7 estimated during drilling	
						*Number of blows to drive a 2 1/2" I.D. split spoon sampler each 6" increment with a 300-pound hammer falling 30"	
30						Monitoring well installed (see installation log)	
				Project FT RICHARDSON, AK		Hole Number	
				UST REMEDIATION		AP-2983	
						Piezometer	

DEPARTMENT OF THE ARMY		Project FT RICHARDSON, AK		Piezometer	
North Pacific Division U.S. Army Engineer District Alaska		UST REMEDIATION		Sheet 2 of 2	
INSTALLATION LOG		Location Coordinates			
		Northing 113,158		Easting 125,767	
		Drilling Agency XXX Corps of Engineers			
		Other Alaska District			
Hole Number		Name of Driller		Weather	
Field BH-13 Permanent AP-2983		K. Mitchell		Overcast, 65°	
Type of Hole		Depth To		Depth Drilled	
Test Pit <input type="checkbox"/> XXX Auger Hole <input checked="" type="checkbox"/>		0.0		24.0	
Total Depth		24.0			
Size and Type of Bit		Elevation Datum		Type of Equipment	
12" Hollow Stem		XXX MSL		Acker Soil Max	
Number of Samples		Type of Samples		Depth to Groundwater	
0				17.0	
Date		22 August 1990			
Top of Hole Elevation		Inspector		Chief, Soils Section	
262.70		T. Reed		J. Raychel	
		Chief, Geotechnical Branch		D. Thomas	



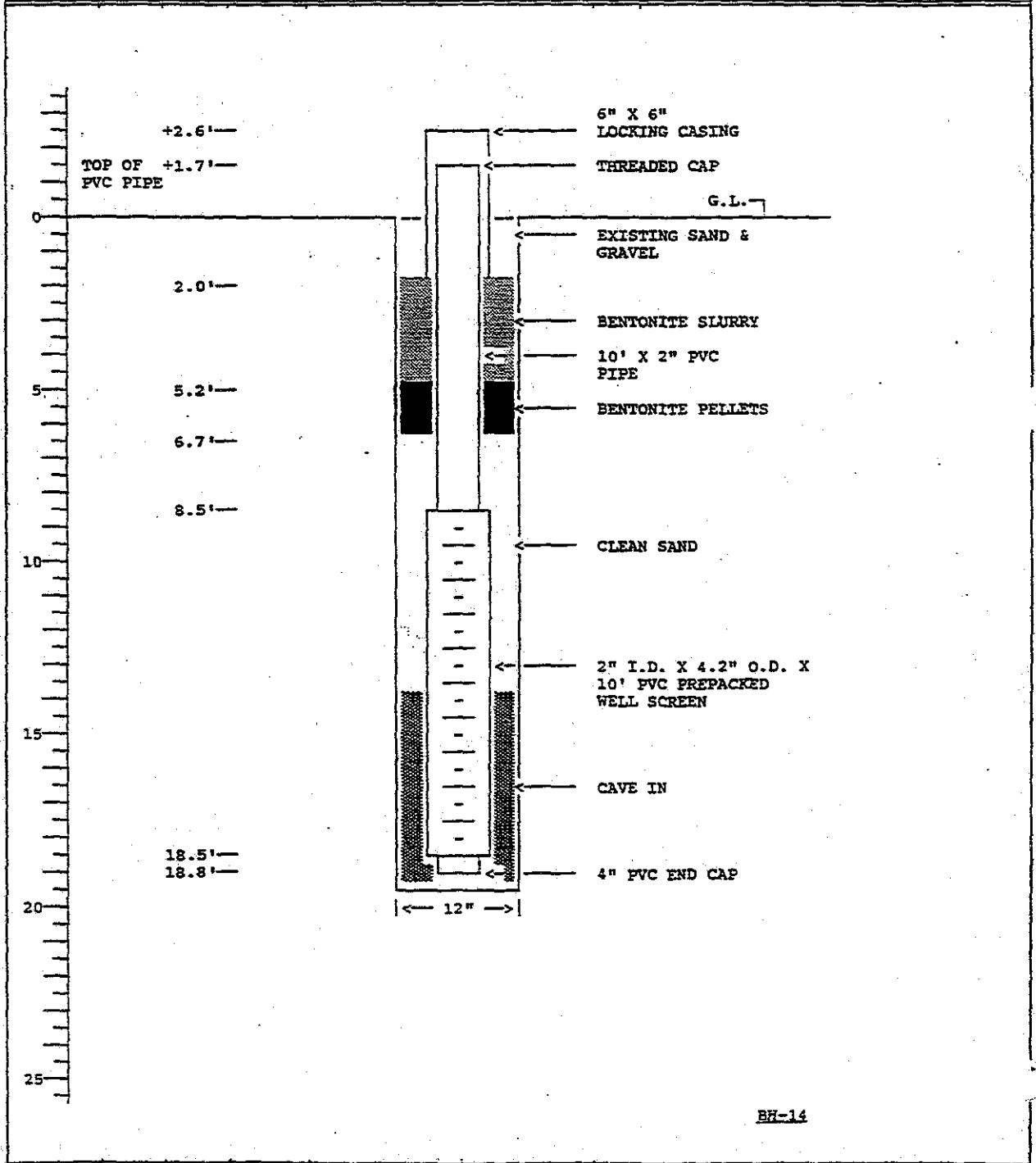
Project FT RICHARDSON, AK		Hole Number	
UST REMEDIATION		AP-2983	

DEPARTMENT OF THE ARMY		Project FT RICHARDSON, AK UST REMEDIATION		Piezometer Sheet 1 of 2		
North Pacific Division U.S. Army Engineer District Alaska		Location Coordinates Northing 113,118 Easting 125,767				
EXPLORATION LOG		Drilling Agency XXX Corps of Engineers		Other Alaska District		
Hole Number Field BH-14 Permanent AP-2984		Name of Driller K. Mitchell		Weather Overcast, 65°		
Type of Hole Test Pit XXX Auger Hole		Depth To 0.0		Depth Drilled 19.0		
Total Depth 19.0		Size and Type of Bit 12" Hollow Stem		Elevation Datum XXX MSL		
Type of Equipment Acker Soil Max		Number of Samples 4		Type of Samples Drive		
Depth to Groundwater 14.0		Date 22 August 1990		Top of Hole Elevation 259.50		
Inspector T. Reed		Chief, Soils Section J. Raychel		Chief, Geotechnical Branch D. Thomas		
Depth in Feet	% Water	Sample	Soil Legend	Classification	Max Size	Description and Remarks
		1			4"	no soil sample taken, brown, moist, sandy gravel, HNu=0, Fill
5		2	ML	SILT with Sand	2"	23%Sa 77%Fines F4 brown, moist, traces of gravel, fine sand, HNu=1 *4/6/8
10		3	GW	Well-Graded GRAVEL with Sand	2 1/2"	64%Gr 32%Sa 4%Fines S1 brown, moist, angular gravel, medium to coarse sand, HNu=0 *8/18/22
15	Y	4	GW-GM	Well-Graded GRAVEL with Silt and Sand	2"	52%Gr 37%Sa 11%Fines F1 brown, wet gravel, medium to coarse sand, HNu=0 *9/18/25
20						Bottom of hole 19.0 Elevation 240.5 Groundwater elev. 245.5 estimated during drilling *Number of blows to drive a 2.5" I.D. split spoon sampler each 6" increment with a 300-pound hammer falling 30" Monitoring well installed (see installation log)
25						
30						

Project FT RICHARDSON, AK
UST REMEDIATION

Hole Number
AP-2984
Piezometer

DEPARTMENT OF THE ARMY		Project FT RICHARDSON, AK		Piezometer	
North Pacific Division		UST REMEDIATION		Sheet 2 of 2	
U.S. Army Engineer District Alaska		Location Coordinates			
INSTALLATION LOG		Northing 11,318		Easting 125,767	
		Drilling Agency XXX Corps of Engineers			
		Other Alaska District			
Hole Number		Name of Driller		Weather	
Field BH-14 Permanent AP-2984		K. Mitchell		Overcast, 65°	
Type of Hole		Depth To		Depth Drilled	
Test Pit		0.0		19.0	
Total Depth		19.0			
Size and Type of Bit		Elevation Datum		Type of Equipment	
12" Hollow Stem		XXX MSL		Acker Soil Max	
Number of Samples		Type of Samples		Depth to Groundwater	
0				14.0	
				Date	
				22 August 1990	
Top of Hole Elevation		Inspector		Chief, Soils Section	
259.50		T. Reed		J. Raychel	
				Chief, Geotechnical Branch	
				D. Thomas	

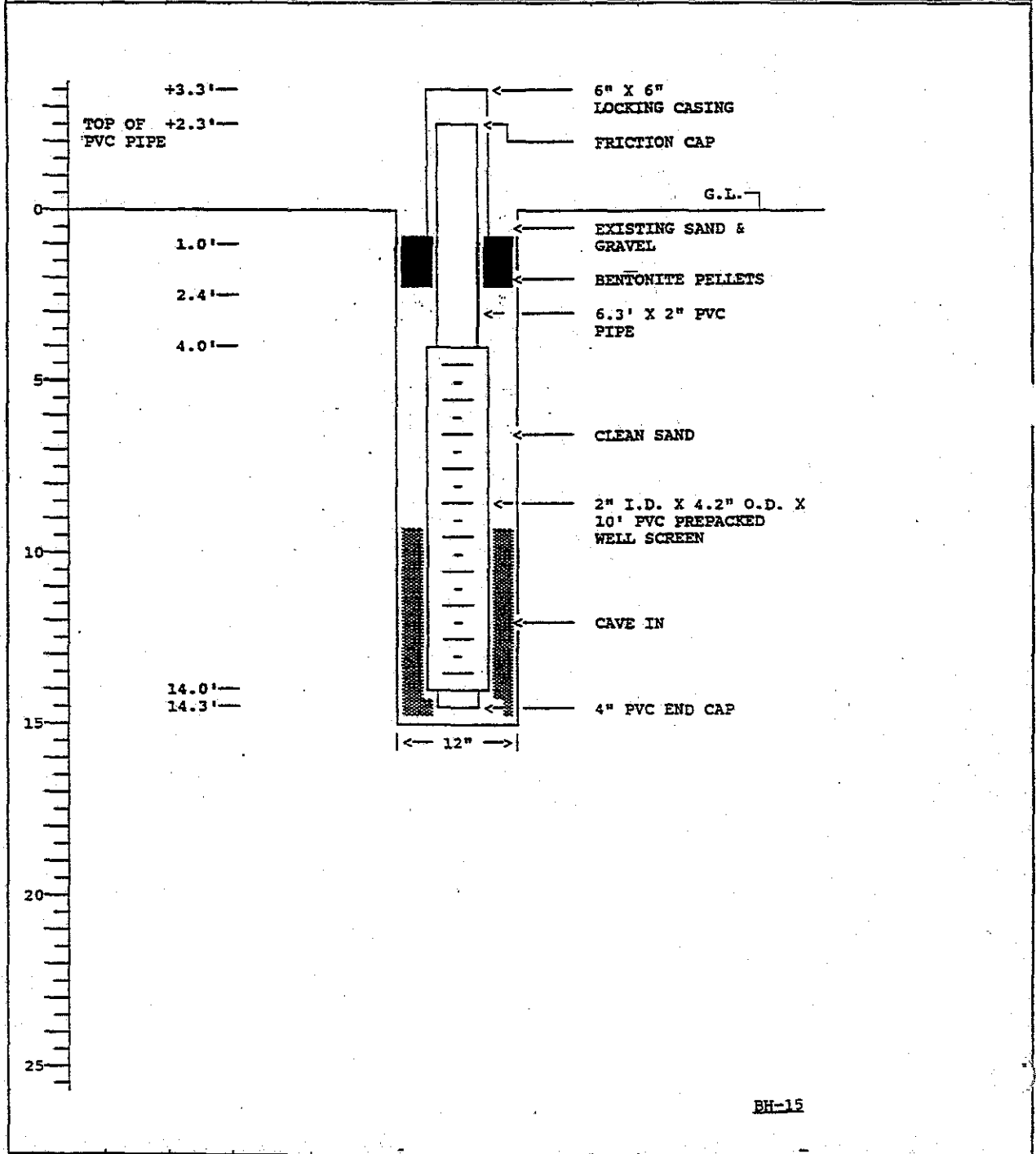


BH-14

Project FT RICHARDSON, AK		Hole Number	
UST REMEDIATION		AP-2984	
		Piezometer	

DEPARTMENT OF THE ARMY		Project FT RICHARDSON, AK		Piezometer			
North Pacific Division U.S. Army Engineer District Alaska		UST REMEDIATION		Sheet 1 of 1			
EXPLORATION LOG		Location Coordinates		Northing 113,086 Easting 125,718			
		Drilling Agency		[XXX] Corps of Engineers			
		Other		Alaska District			
Hole Number		Name of Driller		Weather			
Field BH-15 Permanent AP-2985		K. Mitchell		Light rain, 65°			
Type of Hole		Depth To		Depth Drilled			
[] Test Pit [XXX] Auger Hole		0.0		14.0			
Total Depth				14.0			
Size and Type of Bit		Elevation Datum		Type of Equipment			
12" Hollow Stem		[XXX] MSL		Acker Soil Max			
Number of Samples		Type of Samples		Depth to Groundwater			
2		Drive		10.5			
Date				23 August 1990			
Top of Hole Elevation		Inspector		Chief, Soils Section			
257.20		T. Reed		J. Raychel			
		Chief, Geotechnical Branch		D. Thomas			
Depth in Feet	% Water	Sample	Soil Legend	Classification	Max Size	Description and Remarks	
						brown, moist silt with gravel, HNu=0 at 2' depth	
5		1	GW	Well-Graded GRAVEL ³ with Sand		65%Gr 30%Sa 5%Fines PFS brown to gray, moist, rounded gravel, medium to coarse sand, HNu=0 *6/26/34	
10		2	SP	Poorly Graded SAND ⁴ with Gravel and Cobbles		33%Gr 62%Sa 5%Fines S2 brown to gray, wet, subrounded gravel, medium to coarse sand, HNu=0 *12/37/37	
15						Bottom of hole 14.0 Elevation 243.2	
20						Groundwater elev. 246.7 estimated during drilling	
25						*Number of blows to drive a 2 1/2" I.D. split spoon sampler each 6" increment with a 300-pound hammer falling 30"	
30						Monitoring well installed (see installation well)	
				Project FT RICHARDSON, AK		Hole Number	
				UST REMEDIATION		AP-2985	
						Piezometer	

DEPARTMENT OF THE ARMY		Project FT RICHARDSON, AK		Piezometer	
North Pacific Division		UST REMEDIATION		Sheet 2 of 2	
U.S. Army Engineer District Alaska		Location Coordinates			
INSTALLATION LOG		Northing 113,086		Easting 125,718	
		Drilling Agency XXX Corps of Engineers			
		Other Alaska District			
Hole Number		Name of Driller		Weather	
Field BH-15 Permanent AP-2985		K. Mitchell		Light rain, 65°	
Type of Hole		Depth To		Depth Drilled	
Test Pit XXX Auger Hole		0.0		14.0	
Total Depth		14.0			
Size and Type of Bit		Elevation Datum		Type of Equipment	
12" Hollow Stem		XXX MSL		Acker Soil Max	
Number of Samples		Type of Samples		Depth to Groundwater	
0				10.5	
				Date	
				23 August 1990	
Top of Hole Elevation		Inspector		Chief, Soils Section	
257.20		T. Reed		J. Raychel	
				Chief, Geotechnical Branch	
				D. Thomas	

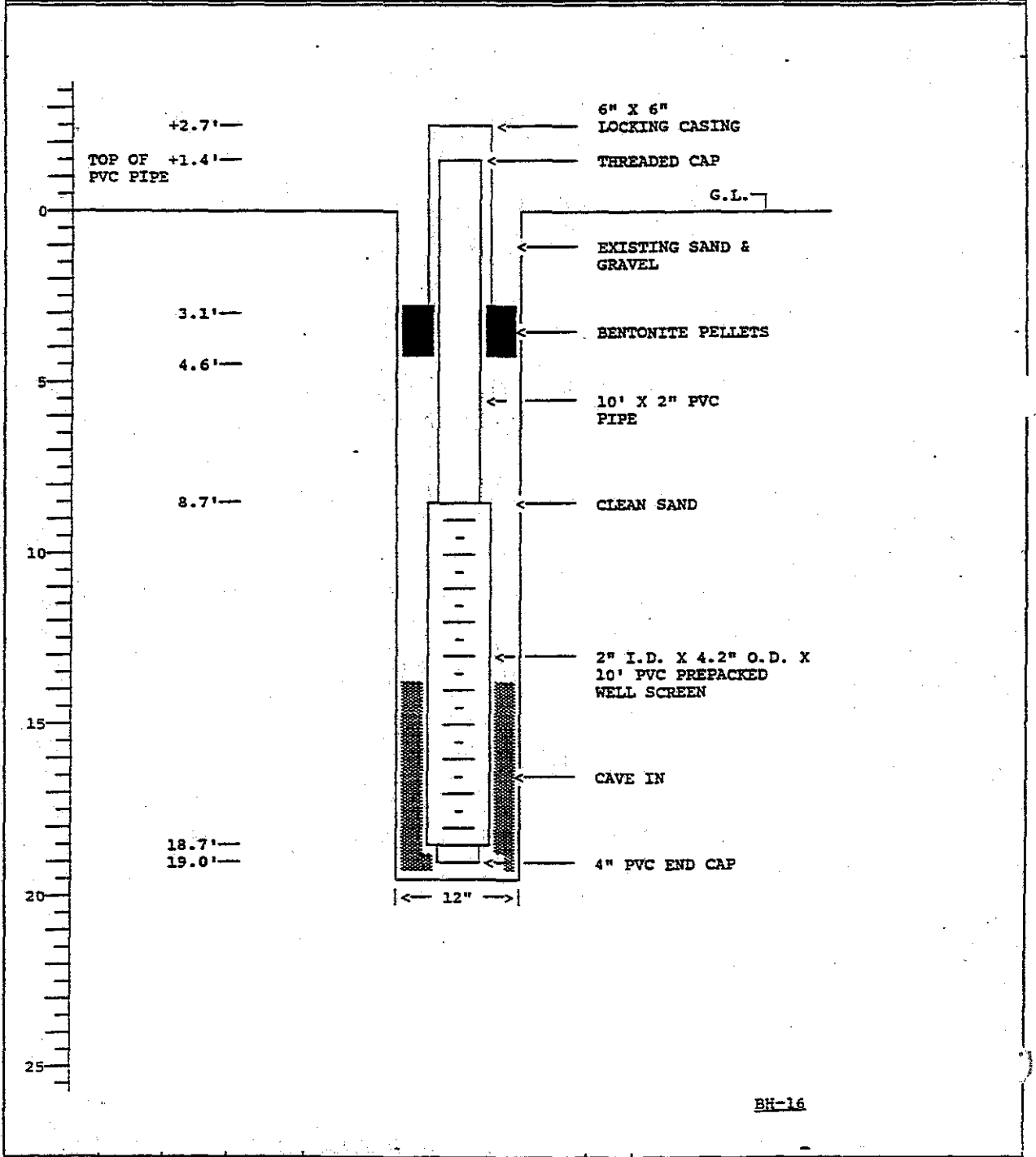


BH-15

Project FT RICHARDSON, AK		Hole Number	
UST REMEDIATION		AP-2985	
		Piezometer	

DEPARTMENT OF THE ARMY		Project FT RICHARDSON, AK		Piezometer		
North Pacific Division		UST REMEDIATION		Sheet 1 Of 1		
U.S. Army Engineer District Alaska		Location Coordinates				
EXPLORATION LOG		Northing 113,113		Easting 125,715		
		Drilling Agency <input checked="" type="checkbox"/> Corps of Engineers				
		<input type="checkbox"/> Other Alaska District				
Hole Number		Name of Driller		Weather		
Field BH-16 Permanent AP-2986		K. Mitchell		Overcast, 60°		
Type of Hole		Depth To		Depth Drilled	Total Depth	
<input type="checkbox"/> Test Pit <input checked="" type="checkbox"/> Auger Hole		0.0		19.0	19.0	
Size and Type of Bit		Elevation Datum		Type of Equipment		
12" Hollow Stem		<input checked="" type="checkbox"/> MSL		Acker Soil Max		
Number of Samples		Type of Samples		Depth to Groundwater	Date	
3		Drive		14.0	23 August 1990	
Top of Hole Elevation		Inspector		Chief, Soils Section	Chief, Geotechnical Branch	
259.20		T. Reed		J. Raychel	D. Thomas	
Depth in Feet	% Water	Sample	Soil Legend	Classification	Max Size	Description and Remarks
4"					4"	brown, moist, rounded sandy gravel, medium to coarse sand with cobbles, HNu=0, Fill
5		1	GW	Well-Graded GRAVEL with Sand and Cobbles	4"	75%Gr 23%Sa 2%Fines NFS brown, moist, angular gravel, medium to coarse sand, HNu=0, may be Fill *9/30/21
10		2	GW	Well-Graded GRAVEL with Sand	3"	61%Gr 34%Sa 5%Fines S1 brown to gray, wet, rounded gravel, medium to coarse sand, strong petro odor, HNu=200 *13/27/32
15		3	GW-GM	Well-Graded GRAVEL with Silt and Sand	2"	51%Gr 43%Sa 6%Fines S1 brown to gray, wet, angular gravel, medium to coarse sand, HNu=0 *19/22/22
20						Bottom of hole 19.0 Elevation 240.2 Groundwater elev. 245.2 estimated during drilling *Number of blows to drive a 2.5" I.D. split spoon sampler each 6" increment with a 300-pound hammer falling 30" Monitoring well installed (see installation log)
25						
30						
				Project FT RICHARDSON, AK		Hole Number
				UST REMEDIATION		AP-2986
						Piezometer

DEPARTMENT OF THE ARMY		Project FT RICHARDSON, AK		Piezometer	
North Pacific Division		UST REMEDIATION		Sheet 2 of 2	
U.S. Army Engineer District Alaska		Location Coordinates		Northing 113,113 Easting 125,715	
INSTALLATION LOG		Drilling Agency		XXX Corps of Engineers	
Hole Number		Name of Driller		Weather	
Field BH-16 Permanent AP-2986		K. Mitchell		Overcast, 60°	
Type of Hole		Depth To		Depth Drilled	
XXX Auger Hole		0.0		19.0	
Size and Type of Bit		Elevation Datum		Type of Equipment	
12" Hollow Stem		XXX HSL		Acker Soil Max	
Number of Samples		Type of Samples		Depth to Groundwater	
0				14.0	
Date		23 August 1990			
Top of Hole Elevation		Inspector		Chief, Soils Section	
259.20		T. Reed		J. Raychel	
		Chief, Geotechnical Branch		D. Thomas	



BH-16

Project FT RICHARDSON, AK	Hole Number
UST REMEDIATION	AP-2986

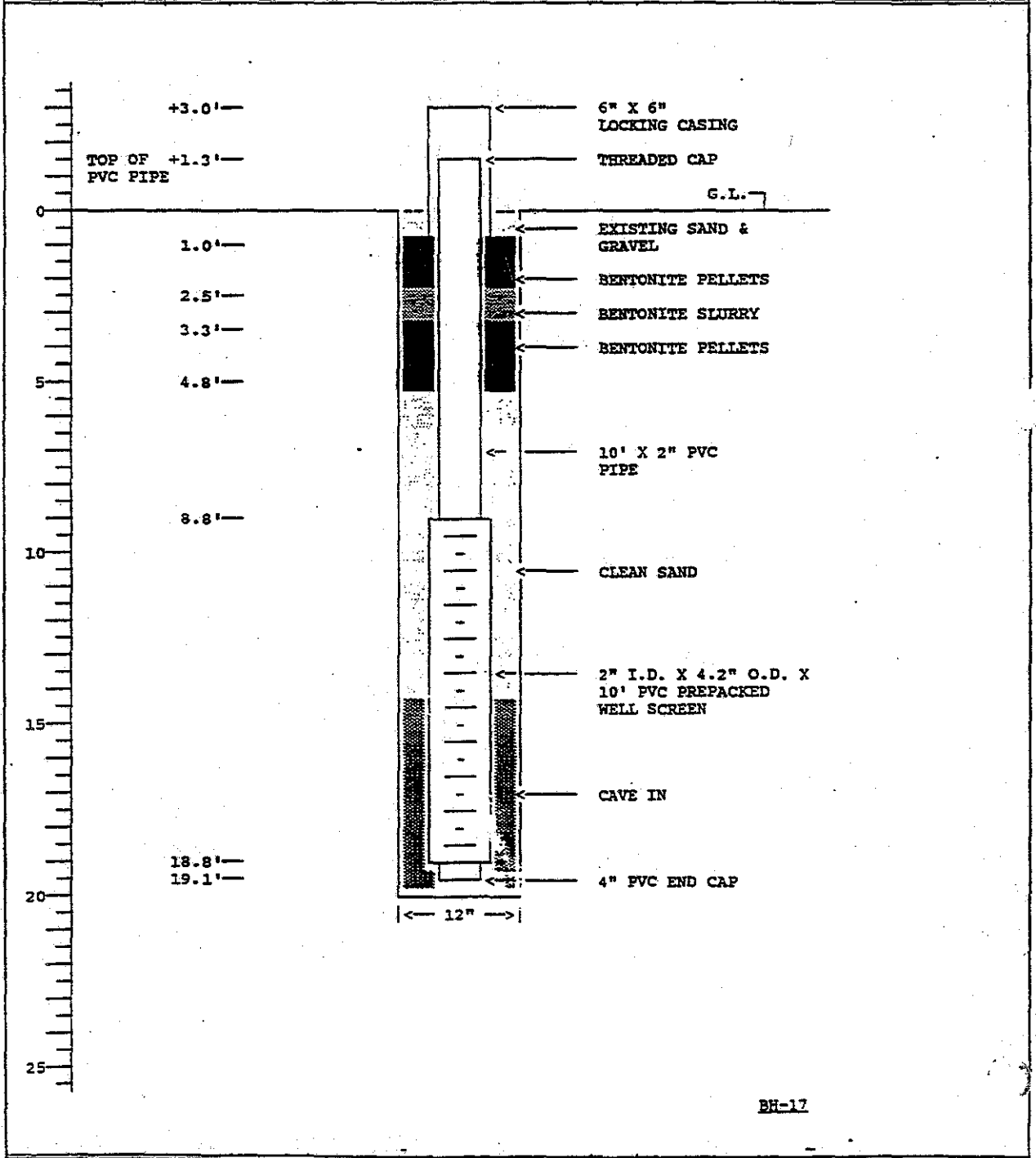
DEPARTMENT OF THE ARMY		Project FT RICHARDSON, AK		Piezometer	
North Pacific Division		UST REMEDIATION		Sheet 1 of 2	
U.S. Army Engineer District Alaska		Location Coordinates			
		Northing 113,123		Easting 125,664	
EXPLORATION LOG		Drilling Agency <input checked="" type="checkbox"/> Corps of Engineers			
		Other Alaska District			
Hole Number		Name of Driller		Weather	
Field BH-17 Permanent AP-2987		K. Mitchell		Overcast, 60°	
Type of Hole		Depth To		Depth Drilled	
<input type="checkbox"/> Test Pit <input checked="" type="checkbox"/> Auger Hole		0.0		19.0	
Total Depth		19.0			
Size and Type of Bit		Elevation Datum		Type of Equipment	
12" Hollow Stem		<input checked="" type="checkbox"/> MSL		Acker Soil Max	
Number of Samples		Type of Samples		Date	
3		Grab and Drive		24 August 1990	
Depth to Groundwater		Date			
13.5					
Top of Hole Elevation		Inspector		Chief, Soils Section	
260.10		T. Reed		J. Raychel	
		Chief, Geotechnical Branch		D. Thomas	

Depth in Feet	% Water	Sample	Soil Legend	Classification	Max Size	Description and Remarks
4"					4"	brown, moist, rounded sandy gravel w/ cobbles, medium to coarse sand, HNu=0 at 2' depth, Fill
5"		1	GP-GM	Poorly Graded GRAVEL with Silt, Sand, and Cobbles	5"	69%Gr 23%Sa 8%Fines S1 brown, moist, subangular gravel, fine to medium sand, HNu=0 *32/60 for 4"
10"		2	GW	Well-Graded GRAVEL with Sand	3"	66%Gr 29%Sa 5%Fines S1 gray, wet, subrounded gravel, medium to coarse sand, HNu=0 *13/23/20
15"		3	SP	Poorly Graded SAND with Gravel and Cobbles	6"	43%Gr 53%Sa 4%Fines NFS gray, wet, rounded gravel, medium to coarse sand, HNu=0 *12/25/59
20"						Bottom of hole 19.0 Elevation 241.1 Groundwater elev. 246.6 estimated during drilling *Number of blows to drive a 2 1/2" I.D. split spoon sampler each 6" increment with a 300-pound hammer falling 30" Monitoring well installed (see installation log)
25"						
30"						

Project FT RICHARDSON, AK
UST REMEDIATION

Hole Number
AP-2987
Piezometer

DEPARTMENT OF THE ARMY		Project FT RICHARDSON, AK		Piezometer	
North Pacific Division		UST REMEDIATION		Sheet 2 of 2	
U.S. Army Engineer District Alaska		Location Coordinates		Northing 113,123 Easting 125,664	
INSTALLATION LOG		Drilling Agency		XXX Corps of Engineers	
		Other		Alaska District	
Hole Number		Name of Driller		Weather	
Field BH-17 Permanent AP-2987		K. Mitchell		Overcast, 60°	
Type of Hole		Depth To		Depth Drilled	
Test Pit		XXX Auger Hole		0.0	
				19.0	
				19.0	
Size and Type of Bit		Elevation		Type of Equipment	
12" Hollow Stem		XXX MSL		Acker Soil Max	
Datum					
Number of Samples		Type of Samples		Depth to Groundwater	
0				13.5	
				Date	
				243 August 1990	
Top of Hole Elevation		Inspector		Chief, Soils Section	
260.10		T. Reed		J. Raychel	
				Chief, Geotechnical Branch	
				D. Thomas	



BH-17

Project FT RICHARDSON, AK	Hole Number
UST REMEDIATION	AP-2987
	Piezometer

LOG OF BORING AP-3227

Drilling Co. S P Enterprises Driller R. Wagster
 Field Engineer J. Mitchell Drill Rig Mobile B-61
 Elevation (ft) 260.70 Date Drilled 8/23/93
 Northing (ft) 113133.40 Easting (ft) 125742.84

Sampling Method	Blows/Foot *	Moisture Content (%)	PSA -200 (%)	Atterberg Limits	Headspace OVA (ppm)	Sample Number **	Depth (ft)	Samples	Soil Description
SS	11								SANDY GRAVEL (GP) loose, dry, brown gravel to 3-inch diameter
SS	14			>70		001SL	5		SILTY SAND WITH GRAVEL (SM) loose, moist, brown to gray gravel to 2-inch diameter
SS	18	8.8	20.8	NP	120	002SL	10		medium dense
SS	46								
SS	68				70	003SL	15		water level during drilling
SS	64				6				SANDY GRAVEL (GP) dense, wet, gray fuel odor noted in sample
									SAND (SP) dense, wet, brown fuel odor noted in sample
SS	57				8		20		GRAVELLY SAND (SP) dense, wet, brown to gray
									boring backfilled with bentonite

OVA = ORGANIC VAPOR ANALYZER

Notes: * Blow counts obtained by driving a 4-inch O.D. split-spoon sampler 18 inches with a 300-pound hammer falling 30 inches. The blow count is the number of blows required to advance the sampler the final 12 inches unless otherwise noted.

** The prefix 93RTS has been omitted for brevity. QA/QC duplicate samples in italics



Harding Lawson Associates
 Engineering and
 Environmental Services

Log of Boring AP-3227

Site Assessment/Release Investigation and Corrective Action Plan
 Fort Richardson, Alaska

PLATE

C1

DRAWN
DC

PROJECT NUMBER
24212

APPROVED
JLR

DATE
11/93

FILE NAME
118d

LOG OF BORING AP-322B

Drilling Co. S P Enterprises Driller R. Wagster
 Field Engineer J. Mitchell Drill Rig Mobile B-61
 Elevation (ft) 261.56 Date Drilled 8/24/93
 Northing (ft) 113138.88 Easting (ft) 125693.63

Sampling Method	Blows/ Foot *	Moisture Content (%)	PSA -200 (%)	Atterberg Limits	Headspace OVA (ppm)	Sample Number **	Depth (ft)	Samples	Soil Description
SS	12				2		0		SANDY GRAVEL (GP) loose, moist, brown
SS	54				65	004SL	5		SILTY GRAVEL (GM) medium dense, moist, brown to gray gravel to 3-inch diameter
SS	14				10		10		
SS	58				550				dense
SS	155				1000				GRAVEL WITH SILT AND SAND (GP-GM) very dense, moist to wet, gray
SS	97				250	005SL 006SL 007SL	15		water level during drilling
SS	132	5.6	7.6	NP		008SL	20		brown
									boring backfilled with bentonite

OVA = ORGANIC VAPOR ANALYZER

Notes: * Blow counts obtained by driving a 4-inch O.D. split-spoon sampler 18 inches with a 300-pound hammer falling 30 inches. The blow count is the number of blows required to advance the sampler the final 12 inches unless otherwise noted.

** The prefix 93RTS has been omitted for brevity. QA/QC duplicate samples in italics



Harding Lawson Associates
 Engineering and
 Environmental Services

Log of Boring AP-322B

Site Assessment/Release Investigation and Corrective Action Plan
 Fort Richardson, Alaska

C2

DRAWN
DC

PROJECT NUMBER
24212

APPROVED
SLA

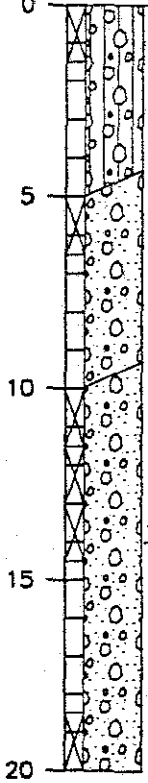
DATE
11/93

FILE NAME
118d

LOG OF BORING AP-3229

Drilling Co. S P Enterprises Driller R. Wagster
 Field Engineer J. Mitchell Drill Rig Mobile B-61
 Elevation (ft) 260.80 Date Drilled 8/24-25/93
 Northing (ft) 113136.12 Easting (ft) 125645.17

Sampling Method	Blows/Foot	Moisture Content (%)	PSA -200 (%)	Atterberg Limits	Headspace OVA (ppm)	Sample Number**	Depth (ft)
SS	27				2		0
SS	58				3		5
SS	101				0	009SL	10
SS	148	3.4	7.0	NP	3	010SL 011SL 012SL	10-15
SS	98						15
SS	74				4	013SL	20



SILTY GRAVEL (GM)
medium dense, moist, brown

SANDY GRAVEL (GP)
dense, moist, brown
gravel to 3-inch diameter

GRAVEL WITH SILT AND SAND (GP-GM)
very dense, moist to wet, brown
gravel to 2-inch diameter

water level during drilling

dense

OVA = ORGANIC VAPOR ANALYZER

Notes: * Blow counts obtained by driving a 4-inch O.D. split-spoon sampler 18 inches with a 300-pound hammer falling 30 inches. The blow count is the number of blows required to advance the sampler the final 12 inches unless otherwise noted.
 ** The prefix 93RTS has been omitted for brevity. OA/GC duplicate samples in italics



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Log of Boring AP-3229

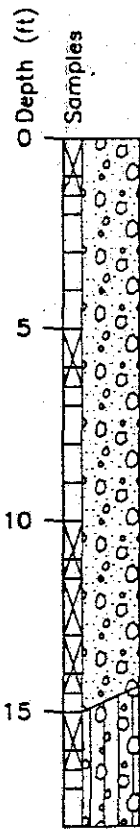
Site Assessment/Release Investigation and Corrective Action Plan
 Fort Richardson, Alaska

PLATE
C3

LOG OF BORING AP-3230

Drilling Co. S P Enterprises Driller R. Wagster
 Field Engineer J. Mitchell Drill Rig Mobile B-5
 Elevation (ft) 257.90 Date Drilled 8/26/93
 Northing (ft) 113104.04 Easting (ft) 125743.11

Sampling Method	Blows/ Foot *	Moisture Content (%)	PSA -200 (%)	Atterberg Limits	Headspace OVA (ppm)	Sample Number **
SS	17				0	
SS	84				0	020SL
SS	62				66	
SS	85				0	
SS	61	6.1	5.2	NP		021SL 022SL 023SL
SS	59				8	024SL



GRAVEL WITH SILT AND SAND (GW-GM)
 loose, moist to wet, brown
 gravel to 1.5-inch diameter
 organics noted in sample

dense

water level during drilling

SILTY GRAVEL (GM)
 dense, wet, brown

boring backfilled with bentonite

OVA = ORGANIC VAPOR ANALYZER

Notes: * Blow counts obtained by driving a 4-inch O.D. split-spoon sampler 18 inches with a 300-pound hammer falling 30 inches. The blow count is the number of blows required to advance the sampler the final 12 inches unless otherwise noted.

** The prefix 93RTS has been omitted for brevity. OA/OC duplicate samples in italics



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Log of Boring AP-3230

Site Assessment/Release Investigation and Corrective Action Plan
 Fort Richardson, Alaska

C4

DRAWN
DC

PROJECT NUMBER
24212

APPROVED
JMA

DATE
11/93

FILE NAME
118d

LOG OF BORING AP-3231

Drilling Co. S P Enterprises Driller P. Waaster
 Field Engineer J. Mitchell Drill Rig Mobile B-61
 Elevation (ft) 262.75 Date Drilled 3/26/93
 Northing (ft) 113231.42 Easting (ft) 125746.40

Sampling Method	Blows/ Foot *	Moisture Content (%)	PSA -200(%)	Atterberg Limits	Headspace OVA (ppm)	Sample Number **	Depth (ft)	Stratigraphy	Description
SS	16				6		0	GRAVELLY SILT (ML)	loose, moist, brown organics noted in sample.
SS	40						5	SANDY GRAVEL (GP)	medium dense, moist to wet, brown
SS	61				2	017SL	10		dense gravel to 3-inch diameter
SS	51				2	018SL	15		medium dense water level during drilling
SS	43	8.1	20.3	NP	2	019SL	20	SILTY GRAVEL WITH SAND (GM)	medium dense, wet, brown monitoring well installed

OVA = ORGANIC VAPOR ANALYZER

Notes: * Blow counts obtained by driving a 4-inch O.D. split-spoon sampler 18 inches with a 300-pound hammer falling 30 inches. The blow count is the number of blows required to advance the sampler the final 12 inches unless otherwise noted.

** The prefix 93RST has been omitted for brevity. QA/QC duplicate samples in italics



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Log of Boring AP-3231

Site Assessment/Release Investigation and Corrective Action Plan
 Fort Richardson, Alaska

PLATE

C5

DRAWN
DC

PROJECT NUMBER
24212

APPROVED
JLT

DATE
11/93

FILE NAME
118c

LOG OF BORING AP-3232

Drilling Co. S P Enterprises Driller P. Wagster
 Field Engineer J. Mitchell Drill Rig Mobile B-51
 Elevation (ft) 257.37 Date Drilled 8/25/93
 Northing (ft) 113059.72 Easting (ft) 125661.57

Sampling Method	Blows/ Foot *	Moisture Content (%)	PSA -200 (%)	Atterberg Limits	Headspace OVA (ppm)	Sample Number **	Depth (ft)	Samples
SS	18				4		0	SILT (ML) loose, dry, brown organics noted in sample
SS	43				4	014SL	5	SAND WITH GRAVEL (SP) medium dense, moist to wet, brown gravel to 1.5-inch diameter
SS	88	8.9	3.3	NP	4	015SL	10	water level during drilling dense
SS	38					016SL	15	GRAVELLY SILT (ML) medium dense, wet, brown monitoring well installed

OVA = ORGANIC VAPOR ANALYZER

Notes: * Blow counts obtained by driving a 4-inch O.D. split-spoon sampler 18 inches with a 300-pound hammer falling 30 inches. The blow count is the number of blows required to advance the sampler the final 12 inches unless otherwise noted.

** The prefix 93RTS has been omitted for brevity. QA/QC duplicate samples in italics



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Log of Boring AP-3232

Site Assessment/Release Investigation and Corrective Action Plan
 Fort Richardson, Alaska

PLN
C6

DRAWN
 DC

PROJECT NUMBER
 24212

APPROVED
 JLT

DATE
 11/93

FILE NAME
 118d

BORING LOG

BORING NUMBER: AP-3497

CLIENT: United States Army Corps of Engineers
 PROJECT NAME: Fort Richardson, Operable Unit D
 PROJECT LOCATION: Building 35-752
 JOB NUMBER: 9000-036
 LOGGED BY: J. Winkler APPROVED BY: S. Wing
 DRILLED BY: Hughes Drilling Co.
 METHOD: 4.25" ID HSA
 FILENAME: AP3497

BORING DEPTH (ft): 20
 BORING DIAMETER (in): 6
 WELL DEPTH (ft): NA
 WELL DIAMETER (in): NA
 REFERENCE ELEVATION (ft): 262.7
 CASING STICKUP (ft): NA
 FIELD PARTY: H. Kent

SCREEN LENGTH (ft): NA
 SCREEN TYPE: NA
 SLOT SIZE (in): NA
 FILTER PACK: NA
 DATE STARTED: 11-2-94
 DATE COMPLETED: 11-2-94
 NORTHING: 113156.78
 EASTING: 125670.72

DEPTH feet	LENGTH	RECOVERY	SAMP. NO.	SAMP. TYP.	BLOWS/6 in.	PID (ppm)	GRAPHIC LOG	SOIL CLASS	DESCRIPTION AND REMARKS	WELL DIAGRAM
7								GW	Medium orangish-brown SANDY GRAVEL (GW), coarse rounded to subangular gravel, fine to medium sand, slight coarse sand, dry, loose, no odor.	
8						166.6			same as above	
9									same as above	
10						233.3			same as above	
11										
15										
6						6.6			Brownish-gray SANDY GRAVEL (GW), medium to coarse subrounded gravel, fine sand, slight medium to coarse sand, slight silt, dry, loose, no odor.	
9										
10										
10						19.9			same as above	
8										
10										
14										
18						33.3				
8										
23									Drilling very hard, GRAVEL (GW)	
21										
23										
6								SW	Medium gray SAND (SW), medium to coarse, slight fine sand, silt, gravel, very moist, loose, moderate to strong hydrocarbon odor.	
12										
20						233.4			same as above, Very strong hydrocarbon odor, very moist.	
18										
15										
17										
14										
16									Medium brownish-gray SAND (SW), medium to coarse, slight fine sand and silt, some rounded medium gravel, bottom 2" angular to rounded gravel, saturated to wet, slight hydrocarbon odor	
12										
18						2.7				
23										
32									Total depth = 20 feet	

BORING LOG

BORING NUMBER: AP-3498

CLIENT: United States Army Corps of Engineers
 PROJECT NAME: Fort Richard: Operable Unit D
 PROJECT LOCATION: Building 35-752
 JOB NUMBER: 9000-036
 LOGGED BY: J. Winkler APPROVED BY: S. Wing
 DRILLED BY: Hughes Drilling Co.
 METHOD: 4.25" ID HSA
 FILENAME: AP3498

BORING DEPTH (ft): 16
 BORING DIAMETER (in): 6
 WELL DEPTH (ft): NA
 WELL DIAMETER (in): NA
 REFERENCE ELEVATION (ft): 264.6
 CASING STICKUP (ft): NA
 FIELD PARTY: H. Kent

SCREEN LENGTH (ft): NA
 SCREEN TYPE: NA
 SLOT SIZE (in): NA
 FILTER PACK: NA
 DATE STARTED: 11-2-94
 DATE COMPLETED: 11-2-94
 NORTHING: 113116.16
 EASTING: 125711.42

DEPTH feet	LENGTH RECOVERY	SAMP. NO.	SAMP. TYP.	BLOWS/6 in.	PTD (ppm)	GRAPHIC LOG	SOIL CLASS	DESCRIPTION AND REMARKS	WELL DIAGRAM
1				3			GW	Dark brown SANDY GRAVEL (GW), medium sand, medium to coarse rounded gravel, slight fine sand and silt, moist, no odor. same as above, color change to medium orangish-brown at 3.5', increase in fine sand and silt Medium orangish-brown SANDY GRAVEL (GW), coarse rounded to subrounded gravel, fine to medium sand, some coarse sand with depth, moist, no odor. same as above	
3			5	2.2					
5			5						
8			8	3.6					
9			8						
11			5	1.8					
11			11						
16			16	6.2					
17			26						
8			8						
10			7			SW	Medium gray SAND (SW), medium to coarse, slight fine sand, silt, and medium gravel, very moist, loose, strong hydrocarbon odor.		
11			11						
14			1242						
15			15						
15			5			GW	Medium gray SANDY GRAVEL (GW), coarse sand, subrounded to angular gravel, very strong hydrocarbon odor, sheen on sampler, very moist.		
16			11						
17			13.9						
								Total depth = 16 feet	

BORING LOG

BORING NUMBER: AP-3499

CLIENT: United States Army Corps of Engineers

BORING DEPTH (ft): 16

SCREEN LENGTH (ft): NA

PROJECT NAME: Fort Richardson, Operable Unit D

BORING DIAMETER (in): 6

SCREEN TYPE: NA

PROJECT LOCATION: Building 35-752

WELL DEPTH (ft): NA

SLOT SIZE (in): NA

JOB NUMBER: 9000-036

WELL DIAMETER (in): NA

FILTER PACK: NA

LOGGED BY: J. Winkler APPROVED BY: S. Wing

REFERENCE ELEVATION (ft): 264.6

DATE STARTED: 11-2-94

DRILLED BY: Hughes Drilling Co.

CASING STICKUP (ft): NA

DATE COMPLETED: 11-2-94

METHOD: 4.25" ID HSA

FIELD PARTY: H. Kent

NORTHING: 113122.18

FILENAME: AP3499

EASTING: 125674.32

DEPTH feet	LENGTH RECOVERY	SAMP. NO.	SAMP. TYP.	BLOWS/6 in.	PID (ppm)	GRAPHIC LOG	SOIL CLASS	DESCRIPTION AND REMARKS	WELL DIAGRAM
1				1			GW	Dark brown SANDY GRAVEL (GW), medium to coarse sand, medium to coarse rounded gravel, slight silt, moist, no odor.	
2				5					
3				6	8.7				
4				4			SM	Medium orangish-brown SANDY SILT (SM), fine sand, slight medium sand and gravel, few pockets of light gray clay, some wood, moist same as above, clay increasing with depth and sand decreasing.	
5				4					
6				2	5.5				
7				2			SW	Medium orangish-brown SAND (SW), medium to coarse sand, slight rounded gravel, very moist, no odor. same as above, some silt, some gravel, moist to wet, same as above, soil gray, strong hydrocarbon odor, saturated Medium gray SAND (SW), medium to coarse sand, some subrounded to angular gravel, saturated, strong hydrocarbon odor	
8				2					
9				1					
10				1	5.5				
11				6					
12				5			SW	Total depth = 16 feet	
13				15					
14				12					
15				13					
16				15	8.7				
17				33					
18				8					
19				11					
20				21					
21				18					

BORING LOG

BORING NUMBER: AP-3500

CLIENT: United States Army Corps of Engineers
 PROJECT NAME: Fort Richardson, Operable Unit D
 PROJECT LOCATION: Building 35-752
 JOB NUMBER: 9000-036
 LOGGED BY: J. Winkler APPROVED BY: S. Wing
 DRILLED BY: Hughes Drilling Co.
 METHOD: 4.25" ID HSA
 FILENAME: AP3500

BORING DEPTH (ft): 18
 BORING DIAMETER (in): 6
 WELL DEPTH (ft): NA
 WELL DIAMETER (in): NA
 REFERENCE ELEVATION (ft): 262.5
 CASING STICKUP (ft): NA
 FIELD PARTY: H. Kent

SCREEN LENGTH (ft): NA
 SCREEN TYPE: NA
 SLOT SIZE (in): NA
 FILTER PACK: NA
 DATE STARTED: 11-2-94
 DATE COMPLETED: 11-2-94
 NORTHING: 113153.19
 EASTING: 125735.07

DEPTH feet	LENGTH	RECOVERY	SAMP. NO.	SAMP. TYP.	BLOWS/6 in.	PTD (ppm)	GRAPHIC LOG	SOIL CLASS	DESCRIPTION AND REMARKS	WELL DIAGRAM
1								GW		
3								GW		
4						16.4		GW	Dark brown SANDY GRAVEL (GW), fine to medium sand, medium to coarse rounded gravel, slight coarse sand and silt. very moist, no odor.	
3								SM		
3						30.9		SM	Medium brown SANDY SILT/SILTY SAND (SM), fine sand, slight gravel at top, clay at bottom, homogeneous, very moist to wet, moderate hydrocarbon (diesel?) odor	
2								GW		
2						8.0		GW		
4								GW		
10								GW	Medium brownish-gray SANDY GRAVEL (GW), medium to coarse sand, slight fine sand, rounded to subrounded gravel, dry to moist, no odor.	
11								GW		
13								GW		
14						17.5		GW	same as above	
14								GW		
7								GW		
12								GW		
17						30.2		GW		
22								SW		
10								SW	Medium gray SAND (SW), medium to coarse sand, some subrounded to angular gravel, very moist to wet, very strong hydrocarbon odor.	
22								SW	Medium orange-brown SAND (SW), medium to coarse sand, very moist, very strong hydrocarbon odor.	
25								OR		
17								OR		
31								OR		
28								OR		
27								OR		
27								OR		
33								OR		
25								OR		
28								OR		
31								OR		
20									Total depth = 18 feet	

BORING LOG

BORING NUMBER: AP-3501

CLIENT: U.S. Army Corps of Engineers
 PROJECT NAME: Fort Richards-- Operable Unit D
 PROJECT LOCATION: Building 35-752
 JOB NUMBER: 9000-036
 LOGGED BY: J. Winkler APPROVED BY: S. Wing
 DRILLED BY: Hughes Drilling
 METHOD: 4.25" ID HSA
 FILENAME: AP3501

BORING DEPTH (ft): 15
 BORING DIAMETER (in): 6
 WELL DEPTH (ft): NA
 WELL DIAMETER (in): NA
 REFERENCE ELEVATION (ft): 262.4
 CASING STICKUP (ft): NA
 FIELD PARTY: H. Kent

SCREEN LENGTH (ft): NA
 SCREEN TYPE: NA
 SLOT SIZE (in): NA
 FILTER PACK: NA
 DATE STARTED: 12/8/95
 DATE COMPLETED: 12/8/95
 NORTHING: 125620.33
 EASTING: 113126.81

DEPTH feet	LENGTH	RECOVERY	SAMP. NO.	SAMP. TYP.	BLOWS/6 in.	PID (ppm)	GRAPHIC LOG	SOIL CLASS	DESCRIPTION AND REMARKS	WELL DIAGRAM
0								GW	Angle boring: deviated 45 degrees from vertical, beginning at grade level. SANDY GRAVEL, dark brown to black, fine to medium sandy gravel, medium to coarse gravel, saturated at 4 ft bgs. GRAVEL, sandy to coarse, medium to dark-brown, wet, no odors.	
5										
10										
15										
20										
25										
30										
									Total measured depth = 15' Approximate true vertical depth = 10.6'	

BORING LOG BORING NUMBER: AP-3502

CLIENT: United States Army Corps of Engineers
 PROJECT NAME: Operable Unit D
 PROJECT LOCATION: Building 35-752
 JOB NUMBER: 9000-036
 LOGGED BY: J. Winkler APPROVED BY: S. Wing
 DRILLED BY: Hughes Drilling Co.
 METHOD: 4.25" ID HSA
 FILENAME: B752MW-1

BORING DEPTH (ft): 22
 BORING DIAMETER (in): 6
 WELL DEPTH (ft): 80
 WELL DIAMETER (in): 2
 SURFACE ELEVATION (ft): 261.3
 TOP OF PVC ELEVATION (ft): 261.05
 FIELD PARTY: H. Kent
 SCREEN LENGTH (ft): 10
 SCREEN TYPE: Slotted PVC
 SLOT SIZE (in): 0.020
 FILTER PACK: 10-20 silica
 DATE STARTED: 11-7-94
 DATE COMPLETED: 11-7-94
 NORTHING: 113150.70
 EASTING: 125618.86

DEPTH feet	LENGTH RECOVERY	SAMP. NO.	SAMP. TYP.	BLOWS/6 in.	PID (ppm)	GRAPHIC LOG	SOIL CLASS	DESCRIPTION AND REMARKS	WELL DIAGRAM
1				1	9.8	•••••	SM	Dark to medium brown SILTY SAND (SM), fine sand, homomgeneous, very moist, slight natural (organic) odor.	<p style="font-size: small;">2" SCH. 40 PVC 2" SCH. 40 PVC 8 SLOT SCREEN SAND PACK GROUT</p>
2				4	0.8	•••••		same as above	
4				4	0.5	•••••		same as above. grain size increasing with depth, very moist, no odor.	
4				3		•••••			
4				4		•••••			
5				13		•••••			
15				9	0.8	•••••	SW	Medium brown SAND (SW), fine to medium with slight coarse sand, some interbedded gravel, some iron oxidation staining (orange), moist, no odor	
17				21	0.4	•••••		same as above	
20				20	2	•••••		same as above, saturated at 15'	
20				25		•••••			
25				28		•••••			
28				22		•••••			
15				6		•••••			
24				24		•••••		drill ahead	
28				24		•••••			
24						•••••			
Total depth = 22 feet.									

BORING LOG BORING NUMBER: AP-3503

CLIENT: United States Army Corps of Engineers

BORING DEPTH (ft): 19

SCREEN LENGTH (ft): 10

PROJECT NAME: Operable Unit D

BORING DIAMETER (in): 6

SCREEN TYPE: Slotted PVC

PROJECT LOCATION: Building 35-752

WELL DEPTH (ft): 80

SLOT SIZE (in): 0.020

JOB NUMBER: 9000-036

WELL DIAMETER (in): 2

FILTER PACK: 10-20 silica

LOGGED BY: J. Winkler APPROVED BY: S. Wing

SURFACE ELEVATION (ft): 260.9

DATE STARTED: 11-8-94

DRILLED BY: Hughes Drilling Co.

TOP OF PVC ELEVATION (ft): 263.66

DATE COMPLETED: 11-8-94

METHOD: 4.25" ID HSA

FIELD PARTY: H. Kent

NORTHING:

FILENAME: B752MW-2

EASTING:

DEPTH feet	LENGTH	RECOVERY	SAMP. NO.	SAMP. TYP.	BLOWS/6 in.	PTD (ppm)	GRAPHIC LOG	SOIL CLASS	DESCRIPTION AND REMARKS	WELL DIAGRAM
					2	2.4	○ ○ ○ ○	GW	SANDY GRAVEL (GW), possible fill	<p style="font-size: small;">2" SCH. 40 PVC 2" SCH. 40 PVC, 8 SLOT Screen GROUT SAND PACK</p>
					2	2.1	● ● ● ●	SM	Med. brown SANDY SILT to SILTY SAND (SM), fine to medium sand, trace coarse rounded gravel, moist, no odor.	
					3	2.2	● ● ● ●		same as above, sand grain size increasing with depth, very moist, no odor	
5					2	1.9	● ● ● ●	SW	Med. brown SAND (SW), fine to medium with slight coarse sand, some silt, slight gravel, very moist, no odor.	
					3	1.9	● ● ● ●		same as above, increase in gravel (6" gravel layer @8.5').	
					4	1.1	● ● ● ●		Med. brown SAND (SW), fine to medium sand, subangular to rounded interbedded gravel, saturated @11', no odor.	
10					4		● ● ● ●		drill ahead	
					7		● ● ● ●			
					8		● ● ● ●			
					16		● ● ● ●			
					23		● ● ● ●			
					37		● ● ● ●			
					30		● ● ● ●			
					35		● ● ● ●			
15							● ● ● ●			
20							● ● ● ●		Total depth = 19 feet	
25							● ● ● ●			
30							● ● ● ●			

BORING LOG BORING NUMBER: AP-3504

CLIENT: United States Army Corps of Engineers
 PROJECT NAME: Operable Unit 2
 PROJECT LOCATION: Building 35-752
 JOB NUMBER: 9000-036
 LOGGED BY: J. Winkler APPROVED BY: S. Wing
 DRILLED BY: Hughes Drilling Co.
 METHOD: 4.25" ID HSA
 FILENAME: B752MW-3

BORING DEPTH (ft): 24
 BORING DIAMETER (in): 6
 WELL DEPTH (ft): 24
 WELL DIAMETER (in): 2
 SURFACE ELEVATION (ft): 261.6
 TOP OF PVC ELEVATION (ft): 261.54
 FIELD PARTY: H. Kent

SCREEN LENGTH (ft): 10
 SCREEN TYPE: Slotted PVC
 SLOT SIZE (in): 0.020
 FILTER PACK: 10-20 silica
 DATE STARTED: 11-7-94
 DATE COMPLETED: 11-7-94
 NORTHING: 113208.25
 EASTING: 125603.48

DEPTH feet	LENGTH	RECOVERY	SAMP. NO.	SAMP. TYP.	BLOWS/6 in.	PTD (ppm)	GRAPHIC LOG	SOIL CLASS	DESCRIPTION AND REMARKS	WELL DIAGRAM
48						2.4	○ ○ ○ ○ ○ ○ ○ ○	GW	SANDY GRAVEL (GW), possible FILL, bottom 1' SILTY SAND (SM)	<p style="font-size: small;">2" SCH. 40 PVC 2" SCH. 40 PVC, 8 SLOT SCREEN SAND PACK GROUT</p>
42							● ● ● ● ● ● ● ●	SM	Medium brown SILTY SAND (SM), fine sand, homomogeneous, soil has orange tint (possible iron oxidation staining), dry, no odor.	
18							● ● ● ● ● ● ● ●	SM	same as above	
10							○ ○ ○ ○ ○ ○ ○ ○	GW	Grayish brown to medium brown SANDY GRAVEL (GW), fine to medium sand, angular to subrounded gravel, dry, no odor.	
3						1.8	● ● ● ● ● ● ● ●	SM	same as above	
4							● ● ● ● ● ● ● ●	SM	same as above	
9						0.9	○ ○ ○ ○ ○ ○ ○ ○	GW	same as above, with slight orange staining (iron oxidation).	
8							○ ○ ○ ○ ○ ○ ○ ○	GW	same as above, gravel layer (4") @11.5'	
14						0.4	○ ○ ○ ○ ○ ○ ○ ○	GW	same as above, coarse sand increasing with depth.	
14						0.4	○ ○ ○ ○ ○ ○ ○ ○	GW	same as above, coarse sand increasing with depth.	
20						0.4	○ ○ ○ ○ ○ ○ ○ ○	GW	same as above, coarse sand increasing with depth.	
9						0.2	○ ○ ○ ○ ○ ○ ○ ○	GW	same as above, coarse sand increasing with depth.	
14						0.2	○ ○ ○ ○ ○ ○ ○ ○	GW	same as above, coarse sand increasing with depth.	
22						0.2	○ ○ ○ ○ ○ ○ ○ ○	GW	same as above, coarse sand increasing with depth.	
8						0.2	○ ○ ○ ○ ○ ○ ○ ○	GW	same as above, coarse sand increasing with depth.	
24						0.2	○ ○ ○ ○ ○ ○ ○ ○	GW	same as above, coarse sand increasing with depth.	
29						0.2	○ ○ ○ ○ ○ ○ ○ ○	GW	same as above, coarse sand increasing with depth.	
27						0.2	○ ○ ○ ○ ○ ○ ○ ○	GW	same as above, coarse sand increasing with depth.	
8						0.2	○ ○ ○ ○ ○ ○ ○ ○	GW	same as above, coarse sand increasing with depth.	
16						0.2	○ ○ ○ ○ ○ ○ ○ ○	GW	same as above, coarse sand increasing with depth.	
19						0.2	○ ○ ○ ○ ○ ○ ○ ○	GW	same as above, coarse sand increasing with depth.	
25						0.2	○ ○ ○ ○ ○ ○ ○ ○	GW	same as above, coarse sand increasing with depth.	
16						0.2	○ ○ ○ ○ ○ ○ ○ ○	GW	same as above, coarse sand increasing with depth.	
12						0.2	○ ○ ○ ○ ○ ○ ○ ○	GW	same as above, coarse sand increasing with depth.	
21						0.2	○ ○ ○ ○ ○ ○ ○ ○	GW	same as above, coarse sand increasing with depth.	
26						0.2	○ ○ ○ ○ ○ ○ ○ ○	GW	same as above, coarse sand increasing with depth.	
Total depth = 24 feet										

BORING LOG

BORING NUMBER: AP-3505

CLIENT: United States Army Corps of Engineers
 PROJECT NAME: Fort Richardson, Operable Unit D
 PROJECT LOCATION: Building 35-752
 JOB NUMBER: 9000-036
 LOGGED BY: J. Winkler APPROVED BY: S. Wing
 DRILLED BY: Hughes Drilling Co.
 METHOD: 4.25" ID HSA
 FILENAME: AP3505

BORING DEPTH (ft): 16
 BORING DIAMETER (in): 6
 WELL DEPTH (ft): NA
 WELL DIAMETER (in): NA
 REFERENCE ELEVATION (ft): 262.9
 CASING STICKUP (ft): NA
 FIELD PARTY: H. Kent

SCREEN LENGTH (ft): NA
 SCREEN TYPE: NA
 SLOT SIZE (in): NA
 FILTER PACK: NA
 DATE STARTED: 11-3-94
 DATE COMPLETED: 11-3-94
 NORTHING: 113175.73
 EASTING: 125783.00

DEPTH feet	LENGTH RECOVERY	SAMP. NO.	SAMP. TYP.	BLOWS/6 in.	PID (ppm)	GRAPHIC LOG	SOIL CLASS	DESCRIPTION AND REMARKS	WELL DIAGRAM
3				5.2		•••••	SM	Medium brown SANDY SILT to SILTY SAND (SM), fine sand, slight coarse rounded gravel, slight clay, moist, no odor, top 1-1.5' FILL same as above same as above, increase in fine sand.	
3						•••••			
5				3.1		•••••			
4				4		•••••			
6				3.1		•••••			
10						•••••			
6						•••••			
9						•••••			
13						•••••			
11						•••••			
11				8.9		•••••	SP	Medium grayish-brown SAND (SP), fine to medium sand, with subangular to rounded gravel interbedded, moist, no odor.	
16						•••••			
24						•••••			
42						•••••			
10				2.3		○ ○ ○ ○ ○	GW	Medium orange-brown SANDY GRAVEL (GW), medium to coarse sand, angular subrounded gravel, very moist, no odor. same as above	
15						○ ○ ○ ○ ○			
14						○ ○ ○ ○ ○			
15				2.0		○ ○ ○ ○ ○			
8						○ ○ ○ ○ ○			
16						○ ○ ○ ○ ○			
8						○ ○ ○ ○ ○			
20								Total depth = 16 feet	

BORING LOG

BORING NUMBER: AP-3506

CLIENT: United States Army Corps of Engineers
 PROJECT NAME: Fort Richardson, Operable Unit D
 PROJECT LOCATION: Building 35-752
 JOB NUMBER: 9000-036
 LOGGED BY: J. Winkler APPROVED BY: S. Wing
 DRILLED BY: Hughes Drilling Co.
 METHOD: 4.25" ID HSA
 FILENAME: AP3506

BORING DEPTH (ft): 16
 BORING DIAMETER (in): 6
 WELL DEPTH (ft): NA
 WELL DIAMETER (in): NA
 REFERENCE ELEVATION (ft): 263.3
 CASING STICKUP (ft): NA
 FIELD PARTY: H. Kent

SCREEN LENGTH (ft): NA
 SCREEN TYPE: NA
 SLOT SIZE (in): NA
 FILTER PACK: NA
 DATE STARTED: 11-3-94
 DATE COMPLETED: 11-3-94
 NORTHING: 113172.32
 EASTING: 125771.18

DEPTH feet	LENGTH	RECOVERY	SAMP. NO.	SAMP. TYP.	BLOWS/6 in.	PID (ppm)	GRAPHIC LOG	SOIL CLASS	DESCRIPTION AND REMARKS	WELL DIAGRAM
2						5.2		SM	Medium brown SANDY SILT to SILTY SAND (SM), fine sand, slight coarse rounded gravel, slight clay, moist, no odor, top 1' FILL	
3										
4										
7										
5					5	3.6		SW	Medium grayish-brown SAND (SW), fine to medium sand, with interbedded subangular to rounded gravel, moist, no odor.	
10										
18										
6					6	4.1			same as above	
6										
11										
16					16	3.6		GW	Medium orange-brown SANDY GRAVEL (GW), medium to coarse sand, angular subrounded gravel, very moist, no odor.	
18										
9										
15										
10					10	3.6			same as above	
13										
9										
10										
13					13					
16										
24										
28										
15					16	5.2		SW	Medium gray SAND (SW), medium to coarse, no odor.	
24										
24										
									Total depth = 16 feet	

BORING LOG

BORING NUMBER: AP-3785

CLIENT: USACE

BORING DEPTH (ft): 13

SCREEN LENGTH (ft):

PROJECT NAME: Ft. Richardson - OUD

BORING DIAMETER (in): 8

SCREEN TYPE:

SITE: 35-752

WELL DEPTH (ft):

SLOT SIZE (in):

JOB NUMBER: 9000-119

WELL DIAMETER (in):

FILTER PACK:

LOGGED BY: J. Shapiro APPROVED BY: S. Wrenn

SURFACE ELEVATION (ft): 262.7

DATE STARTED: 10/02/96

DRILLED BY: Hughes Drilling

TOP OF CASING ELEV. (ft):

DATE COMPLETED: 10/02/96

METHOD: CME 75, 4.25 ID HSA

FIELD PARTY: C. Pelz

NORTHING: 113169.75

EASTING: 125775.03

DEPTH feet	LENGTH	RECOVERY	SAMP. NO.	SAMP. TYP.	BLOWS/FT.	PIU (ppm)	GRAPHIC LOG	SOIL CLASS	DESCRIPTION AND REMARKS	WELL DIAGRAM
5			965752 25SL	SS	16	2.5		SW	Yellow/orange Well-graded SAND (SW), fine to medium, some coarse sand, little gravel to 2 inch diameter, subangular to subrounded, dry, mostly 1 to 2 inch gravel in cuttings.	
10			965752 26SL	SS	31	1.0			Olive gray Well-graded SAND with Gravel (SW), fine to coarse grained, some gravel to 2 inch diameter, blocky, subrounded (mostly pea size), moist.	
12.5									Groundwater encountered at 12.5 ft bgs.	
13									End of boring at 13 feet.	

BORING LOG

BORING NUMBER: AP-3786

CLIENT: USACE

BORING DEPTH (ft): 12

SCREEN LENGTH (ft):

PROJECT NAME: Ft. Richardson - OUD

BORING DIAMETER (in): 8

SCREEN TYPE:

SITE: 35-752

WELL DEPTH (ft):

SLOT SIZE (in):

JOB NUMBER: 9000-119

WELL DIAMETER (in):

FILTER PACK:

LOGGED BY: J. Shapiro APPROVED BY: S. Wrenn

SURFACE ELEVATION (ft): 260.9

DATE STARTED: 10/03/96

DRILLED BY: Hughes Drilling

TOP OF CASING ELEV. (ft):

DATE COMPLETED: 10/03/96

METHOD: CME 75, 4.25 ID HSA

FIELD PARTY: C. Pelz

NORTHING: 113136.33

EASTING: 125760.30

DEPTH feet	LENGTH RECOVERY	SAMP. NO.	SAMP. TYP.	BLOWS/FT.	PID (ppm)	GRAPHIC LOG	SOIL CLASS	DESCRIPTION AND REMARKS	WELL DIAGRAM
0 - 4		965752 27SL	SS	4	0.5		SP	Dark brown Poorly Graded SAND with Gravel (SP), silty, fine grained, some pea gravel, subrounded, trace roots, dry. Yellow/orange, Poorly Graded SAND (SP), very fine sand, little medium to coarse sand, little pea sized gravel, dry.	
4 - 9		965752 28SL	SS	9	1.1			Lithology same as above, dry to moist at 5.75 feet.	
9 - 11.5		965752 29SL	SS	9	28.3			Olive gray and light brown Poorly Graded SAND (SP), silty, fine grained, little medium to coarse sand, little gravel to 2 inch diameter, subangular to subrounded, moist to wet, slight diesel odor. Groundwater at 11.5 feet.	
11.5 - 12								End of boring at 12 feet.	

BORING LOG

BORING NUMBER: AP-3787

CLIENT: USACE

BORING DEPTH (ft): 12

SCREEN LENGTH (ft):

PROJECT NAME: Ft. Richardson - OUD

BORING DIAMETER (in): 8

SCREEN TYPE:

SITE: 35-752

WELL DEPTH (ft):

SLOT SIZE (in):

JOB NUMBER: 9000-119

WELL DIAMETER (in):

FILTER PACK:

LOGGED BY: J. Shapiro APPROVED BY: S. Wrenn

SURFACE ELEVATION (ft): 258.9

DATE STARTED: 10/03/96

DRILLED BY: Hughes Drilling

TOP OF CASING ELEV. (ft):

DATE COMPLETED: 10/03/96

METHOD: CME 75, 4.25 ID HSA

FIELD PARTY: C. Pelz

NORTHING: 113135.92

EASTING: 125598.45

DEPTH feet	LENGTH RECOVERY	SAMP. NO.	SAMP. TYP.	BLOWS/FT.	PID (ppm)	GRAPHIC LOG	SOIL CLASS	DESCRIPTION AND REMARKS	WELL DIAGRAM
0-2		965752 30SL	SS	2	1.1		SP	Medium brown Poorly Graded SAND (SP), silty, fine grained, little medium to coarse sand, little pea gravel, dry to moist. Black contact grading to medium gray, loose, coarse to medium sand, with trace gravel to 2 inch diameter, subangular, wet.	
2-4		965752 31SL	SS	2	1.5		SP SM	Light brown, lithology same as upper 10 inches, wet. Coarse sand, pea size gravel, loose, wet. Light gray, organically rich silt, little sand, thin band of organics at 3.75 feet, wet.	
4-5		965752 33SL	SS	27	1.3		SP SM	Light brown, fine sand, moist. Light brown Poorly Graded SAND with Silt and Gravel (SP-SM), coarse to medium grained, some cobbles to 3 inch diameter, angular, blocky, some silt, wet to dry at 6.08 feet.	
5-10		965752 34SL	SS	45	1.4		SW	Light brown Well-graded SAND with Gravel (SW), silty, fine to coarse grained, some pea sized 1/4 to 2 inch diameter gravel, subrounded, trace cobbles, angular, blocky, tight, moist.	
10-12		965752 35SL	SS	47	2.5		SP SM	Light yellow/orange to olive gray Poorly Graded SAND with Silt (SP-SM), silty, fine to coarse grained, trace gravel to 2.5-inch diameter, subangular to subrounded, wet. Yellow/orange to olive gray Poorly Graded SAND with Gravel (SP), coarse grained sand, and fine gravel to 3/4-inch diameter, rounded, wet. End of boring at 12 feet.	

BORING LOG

CLIENT: USACE

PROJECT NAME: Ft. Richardson - OUD

SITE: 35-752

JOB NUMBER: 9000-119

LOGGED BY: J. Shapiro APPROVED BY: S. Wrenn

DRILLED BY: Hughes Drilling

METHOD: CME 75, 4.25 ID HSA

BORING NUMBER: AP-3788

BORING DEPTH (ft): 12

BORING DIAMETER (in): 8

WELL DEPTH (ft):

WELL DIAMETER (in):

SURFACE ELEVATION (ft): 258.2 msl

TOP OF CASING ELEV. (ft):

FIELD PARTY: C. Peiz

SCREEN LENGTH (ft):

SCREEN TYPE:

SLOT SIZE (in):

FILTER PACK:

DATE STARTED: 10/03/96

DATE COMPLETED: 10/03/96

NORTHING: 113,023.75

EASTING: 125,622.64

DEPTH feet	LENGTH RECOVERY	SAMP. NO.	SAMP. TYP.	BLOWS/FT.	PID (ppm)	GRAPHIC LOG	SOIL CLASS	DESCRIPTION AND REMARKS	WELL DIAGRAM
0-2		965752 36SL and 965752 37SL (dup)	SS	2	1.5		ML	Olive gray SILT (ML), organically rich, little coarse sand in the top 2 inches, little fine sand, moist.	
2-20		965752 38SL	SS	20	1.7		SP	Light brown Poorly Graded SAND (SP), medium to coarse grained, little pea sized gravel to 1/2-inch diameter, rounded, wet.	
20-24		965752 39SL and 965752 40SL (dup)	SS	24	1.1		SW	Medium brown Well-graded SAND (SW), fine to coarse grained, little silt, little fine gravel to 2.5 inch diameter, subrounded, moist.	
24-25		965752 41SL	SS	25	1.7		SP	Light brown Poorly Graded SAND with Gravel (SP), medium to coarse grained, little silt, little gravel to 1-inch diameter, subrounded, some pea sized gravel, in bottom 5 inches, subrounded, wet.	
25-12								Olive gray Poorly Graded SAND (SP), coarse grained, gravel to 2 inch diameter, subrounded and angular, loose, wet. Light yellow/orange, coarse to medium grained sand, gravel to 2 inch diameter, subrounded, loose, wet.	
12-12								End of boring at 12 feet.	

BORING LOG

BORING NUMBER: AP3917

CLIENT: USACE

BORING DEPTH (ft): 19

SCREEN LENGTH (ft): 10

PROJECT NAME: Ft. Richardson, UST 1109, OUD

BORING DIAMETER (in): 8

SCREEN TYPE: PVC

SITE: Bldg. 35-752

WELL DEPTH (ft): 18.67

SLOT SIZE (in): 0.008

JOB NUMBER: 9000-107

WELL DIAMETER (in): 2

FILTER PACK: 40-60 fieldpack

LOGGED BY: J. Shapiro APPROVED BY: S. Wrenn

SURFACE ELEVATION (ft): 262.3

DATE STARTED: 5/19/98

DRILLED BY: Hughes Drilling

TOP OF CASING ELEV. (ft): 261.92

DATE COMPLETED: 5/19/98

METHOD: CME 75, 4.25 ID HSA, 3" OD SS

FIELD PARTY: D. Britch

NORTHING: 113261.05

EASTING: 125735.99

DEPTH feet	LENGTH	RECOVERY	SAMP. NO.	SAMP. TYP.	BLOWS/FT.	PID (ppm)	GRAPHIC LOG	SOIL CLASS	DESCRIPTION AND REMARKS	WELL DIAGRAM
0			985752 003SL	SS	8	6.4		GM	Dark brown Silty GRAVEL with Sand (GM), gravel 1/4 in. to 1.5 in. diameter, subrounded, some medium sand, greater than 15% silt.	<p>2" Sch. 40 PVC bentonite chips 2" PVC 0.008" Slotted Scr., 40-60 fieldpack 10-20 outer annulus</p>
0							ML	Yellowish-orange SILT (ML), zone of fine to medium sand at 18 to 21" in spoon, little gravel, 1/4 in. to 1/2 in. diameter, subrounded. Color change to dark brown/black at 21" in spoon. Color change may be due to bits of coal.		
5			985752 004SL	SS	10	6.9		SP-SM	Dark to light brown Poorly Graded SAND with Silt and Gravel (SP-SM). 5-5.33' Medium to coarse sand, 15% gravel, 1/4 in. to 1/2 in. diameter, subrounded, trace silt, moist. 5.33'-5.75' Fine sand grading to silt and back to fine sand, dry to moist. 5.75'-6.33' Fine to coarse sand, 20% gravel, 1/4 in. diameter, moist.	
10			985752 005SL	SS	39	43.1		GM	Yellowish-orange Silty GRAVEL with Sand (GM), Gravel 1/4 in. to 2 in. diameter, subrounded to subangular, poorly graded, some medium to coarse sand, some silt, wet, slight petroleum odor, possible staining at bottom of sample. Water level measured while drilling at approximately 11.7 ft bgs.	
15			985752 006SL	SS	25	350		SP-SM	Dark gray Poorly Graded SAND with Silt and Gravel (SP-SM), medium to coarse sand, little gravel to 2 in. diameter, subrounded, little silt, strong petroleum odor, staining, saturated. Grain Size Analysis: 38% Gravel, 56% Sand, 7% Fines.	
20									End of boring at 19 feet.	

BORING LOG

CLIENT: USACE

PROJECT NAME: Ft. Richardson, UST 1109, OUD

SITE: Bldg. 35-752

JOB NUMBER: 9000-107

LOGGED BY: J. Shapiro APPROVED BY: S. Wrenn

DRILLED BY: Hughes Drilling

METHOD: CME 75, 4.25 ID HSA, 3" OD SS

BORING NUMBER: AP3918

BORING DEPTH (ft): 19

BORING DIAMETER (in): 8

WELL DEPTH (ft): 18.67

WELL DIAMETER (in): 2

SURFACE ELEVATION (ft): 263.2

TOP OF CASING ELEV. (ft): 265.78

FIELD PARTY: D. Britch

SCREEN LENGTH (ft): 10

SCREEN TYPE: PVC

SLOT SIZE (in): 0.008

FILTER PACK: 40-60 fieldpack

DATE STARTED: 5/19/98

DATE COMPLETED: 5/19/98

NORTHING: 113228.05

EASTING: 125703.51

DEPTH feet	LENGTH RECOVERY	SAMP. NO.	SAMP. TYP.	BLOWS/FT.	PTD (ppm)	GRAPHIC LOG	SOIL CLASS	DESCRIPTION AND REMARKS	WELL DIAGRAM
0-5		985752 007SL	SS	8	11.9*		SM	Light brown Silty SAND (SM), 60% silt and fine sand, some coarse sand and gravel, gravel 1/4 in. to 2 1/2 in. diamter, subangular to subrounded, dry. Rootlets in top 6 in.	<p>2" Sch. 40 PVC, vented at top.</p> <p>bentonite chips</p> <p>2" PVC 0.008" Slotted Scr., 40-60 fieldpack</p> <p>10-20 outer annulus</p>
5-10		985752 008SL	SS	5	20.8*		SP ML	Lt. brown Poorly Graded SAND with Gravel (SP), fine to medium sand, and gravel, 1/4 to 1 in. diam., subrounded, trace fines, moist. Lt. brown SILT (ML), silt with a couple of large pieces of gravel, 1 to 2 in. diam., rounded, moist.	
10-15		985752 009SL	SS	54	17.4*		GP-GM	Light brown Poorly Graded GRAVEL with Silt and Sand (GP-GM), gravel 1 in. to 2 in. diameter, subrounded to angular, some shattered by the spoon, some fine to coarse sand, little silt, dry to moist. Water measured while drilling at approximately 12.5 ft bgs. No product detected with interface probe although globules of (apparent) product were noticed on the probe upon retrieval.	
15-19		985752 010SL	SS	30	450		SP-SM	Dark gray Poorly Graded SAND with Silt and Gravel (SP-SM), medium to coarse sand, some gravel, little silt, strong hydrocarbon odor, sheen on spoon. Grain Size Analysis: 42% Gravel, 48% Sand, 10% Fines.	
19								End of boring at 19 feet.	

BORING LOG

CLIENT: USACE

PROJECT NAME: Ft. Richardson, UST 1109, OUD

SITE: Bldg. 35-752

JOB NUMBER: 9000-107

LOGGED BY: J. Shapiro APPROVED BY: S. Wrenn

DRILLED BY: Hughes Drilling

METHOD: CME 75, 4.25 ID HSA, 3" OD SS

BORING NUMBER: AP3919

BORING DEPTH (ft): 24

BORING DIAMETER (in): 8

WELL DEPTH (ft):

WELL DIAMETER (in):

SURFACE ELEVATION (ft): 262.75

TOP OF CASING ELEV. (ft):

FIELD PARTY: D. Britch

SCREEN LENGTH (ft):

SCREEN TYPE:

SLOT SIZE (in):

FILTER PACK:

DATE STARTED: 5/20/98

DATE COMPLETED: 5/20/98

NORTHING: 113245.46

EASTING: 125715.07

DEPTH feet	LENGTH	RECOVERY	SAMP. NO.	SAMP. TYP.	BLOWS/FT.	PTD (ppm)	GRAPHIC LOG	SOIL CLASS	DESCRIPTION AND REMARKS	WELL DIAGRAM
			985752 011SL	SS	9	10.9*		GP-GM	Approximately 1 ft of asphalt underlain by fill. Light brown Poorly Graded GRAVEL with Silt and Sand (GP-GM), gravel 1/4 in. to 2 in. diameter, subrounded to subangular, and medium to coarse sand, little silt, moist.	
5			985752 012SL	SS	16	56*		SP-SM	Light brown Poorly Graded SAND with Silt and Gravel (SP-SM), medium to coarse sand, some gravel, 1/4 in. to 1.5 in. diameter, subrounded, little silt, moist.	
10			985752 013SL and 025SL (dup)	SS	27	521			Dark gray Poorly Graded SAND with Silt and Gravel (SP-SM), medium to coarse sand, and gravel, 1/4 in. to 2 in. diameter, subangular to subrounded, poorly graded, little silt, wet, staining, strong hydrocarbon odor. Grain Size Analysis: 59% Gravel, 36% Sand, 6% Fines.	
15			985752 014SL and 028SL (dup)	SS	23	850			Dark gray Poorly Graded SAND with Silt and Gravel (SP-SM), strong hydrocarbon odor. 15-15.92' Medium to coarse sand and fine gravel (1/4 in. to 1/2 in. diameter, poorly graded, subrounded to subangular), little silt, wet. 15.92-16.42' Fine to medium sand, trace fines, wet. Water level measured while drilling at approximately 12.3 ft bgs. Product detected with interface probe - unable to determine thickness.	
20								SP		

BORING LOG

BORING NUMBER: AP3919

CLIENT: USACE

BORING DEPTH (ft): 24

SCREEN LENGTH (ft):

PROJECT NAME: Ft. Richardson, UST 1109, OUD

BORING DIAMETER (in): 8

SCREEN TYPE:

SITE: Bldg. 35-752

WELL DEPTH (ft):

SLOT SIZE (in):

JOB NUMBER: 9000-107

WELL DIAMETER (in):

FILTER PACK:

LOGGED BY: J. Shapiro APPROVED BY: S. Wrenn

SURFACE ELEVATION (ft): 262.75

DATE STARTED: 5/20/98

DRILLED BY: Hughes Drilling

TOP OF CASING ELEV. (ft):

DATE COMPLETED: 5/20/98

METHOD: CME 75, 4.25 ID HSA, 3" OD SS

FIELD PARTY: D. Britch

NORTHING: 113245.46

EASTING: 125715.07

DEPTH feet	LENGTH	RECOVERY	SAMP. NO.	SAMP. TYP.	BLOWS/FT.	PID (ppm)	GRAPHIC LOG	SOIL CLASS	DESCRIPTION AND REMARKS	WELL DIAGRAM
20-22	18	SS	985752015SL	5	43	122		SP	20-20.75' Dk. gray Poorly Graded SAND with Gravel (SP), medium to coarse sand, and fine gravel (1/4 to 1/2 in. diam.), trace fines, saturated.	
			SM					20.75-21.58' Olive gray Silty SAND with Gravel (SM), fine sand, some silt, little gravel, to 1 in. diam., subrounded to subangular, poorly graded, wet.		
			CL					21.58-21.92' Olive gray Sandy CLAY with Gravel (CL), fine sand, some gravel, to 1 in. diameter, subangular to subrounded, poorly graded, wet.		
								Greenish gray to yellowish-orange Sandy CLAY with Gravel (CL), wet, similar to 21.58 to 21.92' interval. No noticeable staining or odor.		
End of boring at 22 feet. Last spoon collected from 22 to 24 ft bgs.										
NOTE: Sample 985752015SL is for 20 to 20.75 ft bgs. Sample 985752016SL is for 20.75 to 21.92 ft bgs.										

BORING LOG

CLIENT: USACE

PROJECT NAME: Ft. Richardson, UST 1109, OUD

SITE: Bldg. 35-752

JOB NUMBER: 9000-107

LOGGED BY: J. Shapiro APPROVED BY: S. Wrenn

DRILLED BY: Hughes Drilling

METHOD: CME 75, 4.25 ID HSA, 3" OD HSA

BORING NUMBER: AP3920

BORING DEPTH (ft): 22

BORING DIAMETER (in): 8

WELL DEPTH (ft): 20

WELL DIAMETER (in): 2

SURFACE ELEVATION (ft): 262.9

TOP OF CASING ELEV. (ft): 262.43

FIELD PARTY: D. Britch

SCREEN LENGTH (ft): 10

SCREEN TYPE: PVC

SLOT SIZE (in): 0.008

FILTER PACK: 40-60 fieldpack

DATE STARTED: 5/20/98

DATE COMPLETED: 5/20/98

NORTHING: 113260.09

EASTING: 125705.39

DEPTH feet	LENGTH	RECOVERY	SAMP. NO.	SAMP. TYP.	BLOWS/FT.	PID (ppm)	GRAPHIC LOG	SOIL CLASS	DESCRIPTION AND REMARKS	WELL DIAGRAM
			985752023SL and 985752024SL	SS	32	63.8 47.4		GP-GM SP	<p>Olive gray Poorly Graded GRAVEL with Silt (GP-GM), fine to medium gravel 1/4 in. to 1 in. diameter), subrounded to rounded, little silt, little coarse sand, saturated, loose.</p> <p>Grain Size Analysis: 46% Gravel, 51% Sand, 5% Fines.</p> <p>Greenish gray Poorly Graded SAND with Gravel (SP), fine sand, some gravel 1/2 in. to 2 in., subangular to subrounded, poorly graded, wet.</p> <p>Grain Size Analysis: 17% Gravel, 47% Sand, 33% Fines.</p> <p>End of boring at 20 feet. Last split spoon collected from 20 to 21.5 ft bgs.</p> <p>*Indicates elevated ATH reading may be due to baggie rather than an indication of contamination.</p> <p>NOTE: 985752023SL is sample of 20 to 20.8 ft bgs. 985752024SL is sample of 20.8 to 21.5 ft bgs.</p>	

APPENDIX B

GPR investigation notes are located in file GPRinfo.xls (Microsoft Excel 2000), and in .txt format for those who do not use Excel.

The GPR digital data are organized by date collected in *.bmp files. Refer to GPRinfo.xls for information on the digital data files.

The DC Resistivity data are located in a folder named "resistivity."

Appendix B is located on CDROM available from the authors (Beth Astley (907) 384-0513, bastley@crrel.usace.army.mil) or from the Department of Public Works Environmental Library if not included with this report.

