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HYDROGEOLOGIC ASSESSMENT AND GROUND-WATER MONITORING PLAN NAS CECIL FIELD FL

10/1/1983

GERAGHTY & MILLER, INC.

HYDROGEOLOGIC ASSESSMENT AND GROUND-WATER MONITORING PLAN, NAS CECIL FIELD, JACKSONVILLE, FLORIDA

Prepared for

NAVAL FACILITIES ENGINEERING COMMAND
Southern Division
Charleston, South Carolina

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INTRODUCTION

The Department of the Navy operates a Naval Air Station (NAS) at Cecil Field near Jacksonville, Florida, at the location shown in Figure 1. The NAS contains an inactive sanitary landfill as well as grease-disposal pits. In accordance with Chapter 17-4, Florida Administrative Code (FAC), Section 17-4.245(6)(d), a ground-water monitoring plan must be submitted to the Florida Department of Environmental Regulation (FDER) for these sites. Presented herein is the hydrology and hydrogeologic setting of the site, locations and construction details of proposed monitor wells, and a water-quality sampling and analysis plan.

BACKGROUND

Sanitary Landfill

Sanitary wastes from the base have been placed in a landfill west of Rowell Creek. The landfill area has been developed in two stages as shown in Figure 2. The earlier area, commonly called the "Old Landfill", was closed approximately 20 years ago, at which time landfilling was shifted to an adjacent tract to the northwest, which was closed and covered in 1975. Site drawings dated 1955-59 show the designated landfill area extending east of Rowell Creek; however, aerial photos from that approximate time show no landfill activity east of the creek.

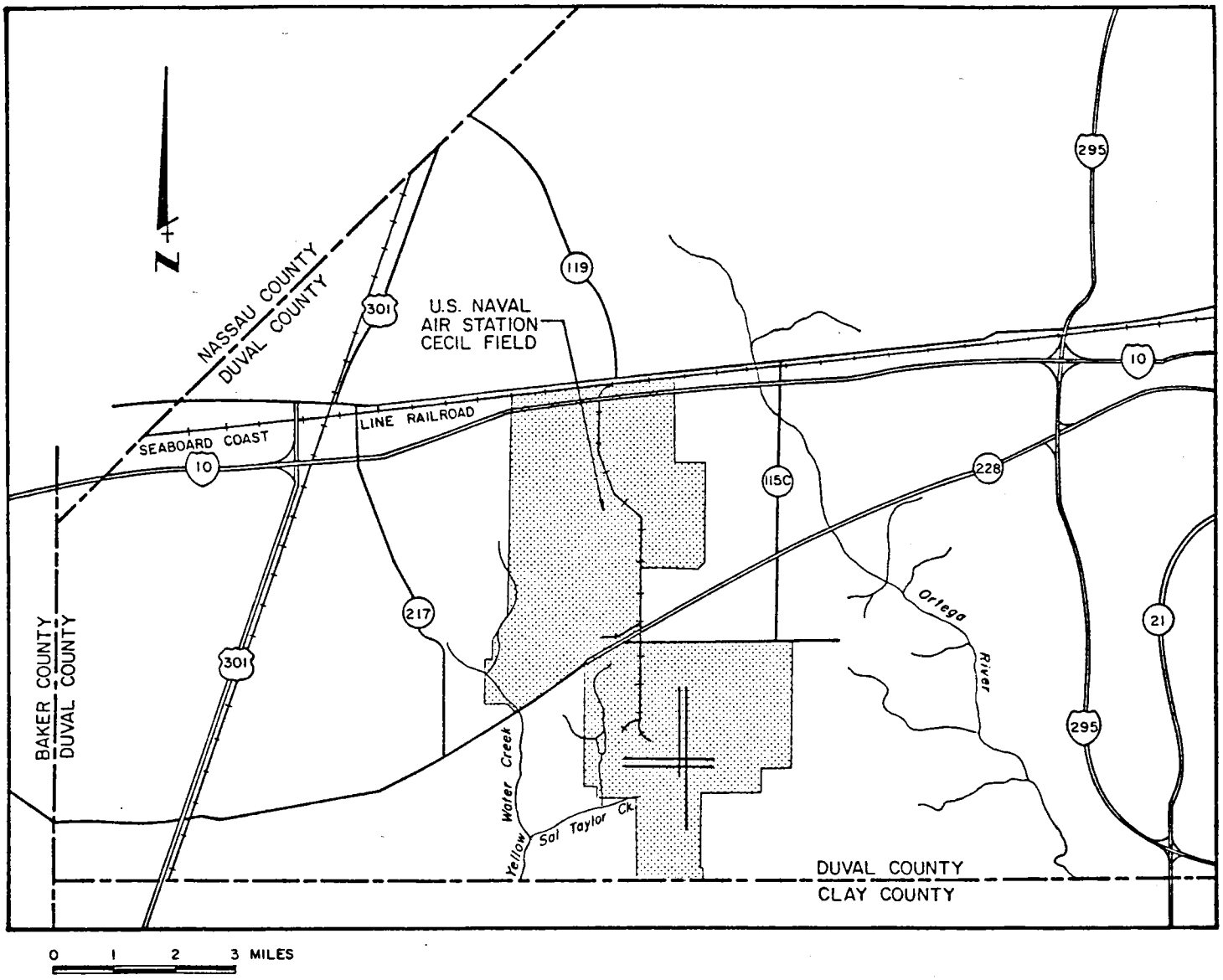


Figure 1. Regional Map Showing the Location of NAS Cecil Field.

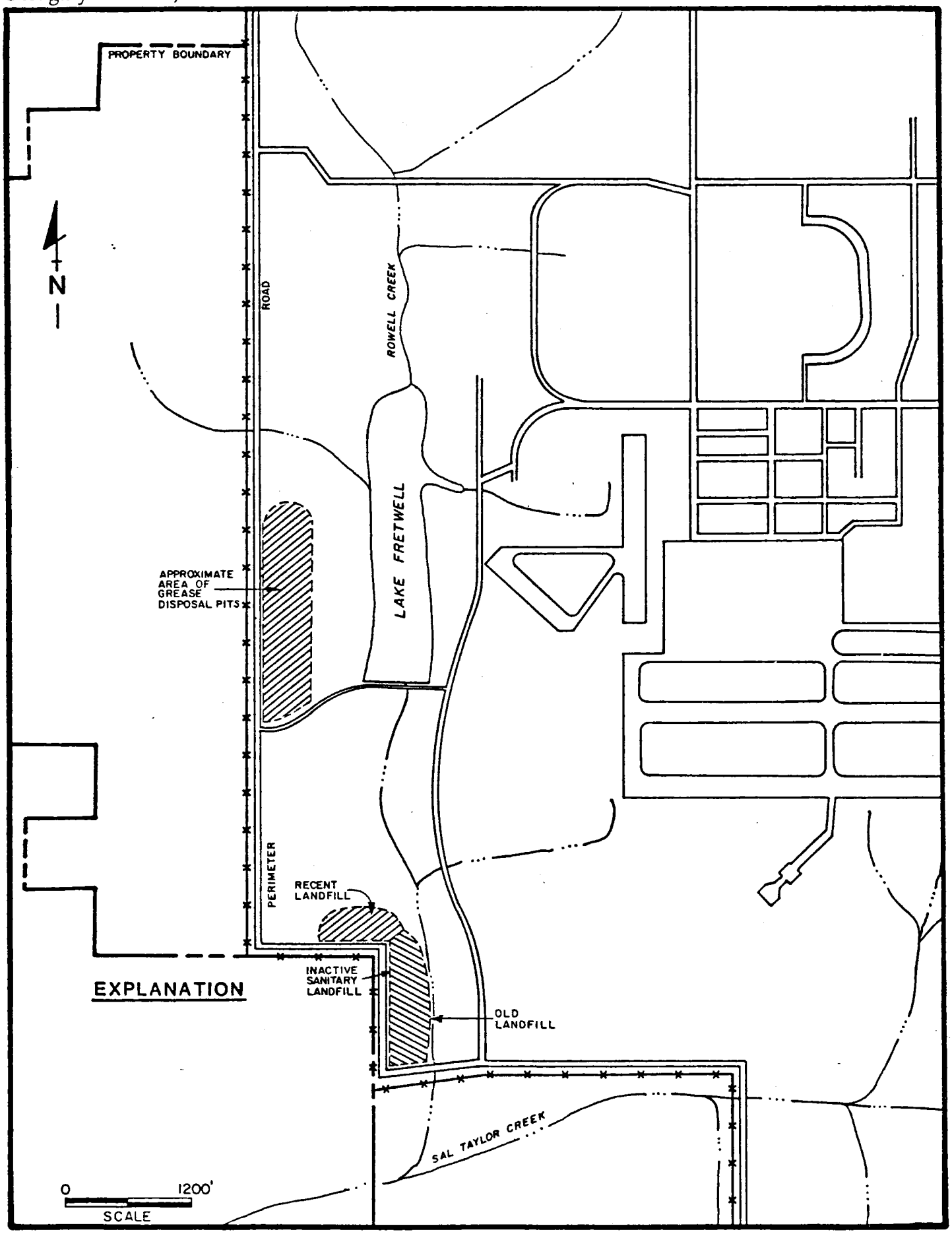


Figure 2. Areas of Sanitary Landfill and Grease Disposal Pits.

Grease Disposal Pits

For an unknown number of years, grease from grease traps in the sanitary sewer system has been disposed of in pits between Perimeter Road and Lake Fretwell. Until recently, waste oils and sludges from oil/water separators at the NAS were also buried in the pits. It is therefore possible that the pits contain organic solvents used in degreasing operations. The pits are believed to have been dug several feet deep with capacities of a few thousand gallons each. The number and locations of the pits were not precisely recorded although the locations of the most recent pits are apparent from disturbance of the land surface. It is, however, believed that all of the individual pits were located along Perimeter Road within the area shown in Figure 2.

WELL INVENTORY

In the area around Cecil Field, the Hawthorn Formation contains a limestone layer approximately 20 ft thick which occurs at a depth of approximately 60 to 125 feet, from which nearly all domestic water supplies are drawn. Larger supplies are obtained from the Floridan aquifer at depths of approximately 450 to over 1,000 feet.

Within one mile of the sanitary landfill and grease pit areas, there are wells on the NAS and in a small unincorporated community on Nathan Hale Road, west of the NAS and

south of Normandy Boulevard (State Route 228). At the NAS, there are 9 public drinking-water supply wells, of which one (PS-1) is located within one mile of the sites. The public-supply wells are open to the Floridan aquifer at depths of from 480 to 1,350 feet. Other wells at the NAS are either not used for drinking water or are not in use. Records of only two wells in the community on Nathan Hale Road are available; however, it is probable that most if not all drinking water wells there tap the secondary artesian aquifer.

Construction details of wells for which records are available, within one mile of the disposal areas, are presented in Table 1. Locations of these wells are shown in Figure 3. Public supply wells, PS-2, PS-3, PS-4 and PS-5 at the NAS are included in Table 1 and Figure 3, although they are slightly more than one mile from the disposal areas.

HYDROGEOLOGIC SYSTEM

Topography and Drainage

The site is located in the physiographic division referred to as the Duval Upland. Land-surface elevations vary from about 50 ft msl (feet, mean sea level) to about 80 ft msl. There are three surface-water drainage features near the sites including Yellow Water Creek, Rowell Creek, and Sal Taylor Creek. Rowell Creek discharges into Sal Taylor Creek, which in turn discharges into Yellow Water Creek. Presented

Table 1. Inventory of Wells For Which Records Are Available Within One Mile of Disposal Areas.

Well Designation	Owner	Date Installed	Total Depth (ft)	Interval Open to Formation (ft depth)	Status
PS-1	U.S. Navy	1976	770	486- 770	In use
PS-2*	U.S. Navy	1976	780	493- 780	In use
PS-3*	U.S. Navy	1953	950	? - 950	In use
PS-4*	U.S. Navy	1953	1303	485-1303	In use
PS-5*	U.S. Navy	1956	1350	? -1350	In use
J391	U.S. Navy	1941	887	400- 887	Unknown
J2876	U.S. Navy	1956	964	396- 964	Unknown
A	U.S. Navy	?	?	?	Unknown
B	U.S. Navy	?	?	?	Unknown
C	U.S. Navy	?	120±	?	Unknown
D	U.S. Navy	?	800±	?	Abandoned
DS-143	U.S. Navy	1941	990	?	Unknown
DS-94*	Private	?	64	?	Unknown
DS-142	Private	?	125	?	Unknown

* Slightly more than one mile from disposal areas.

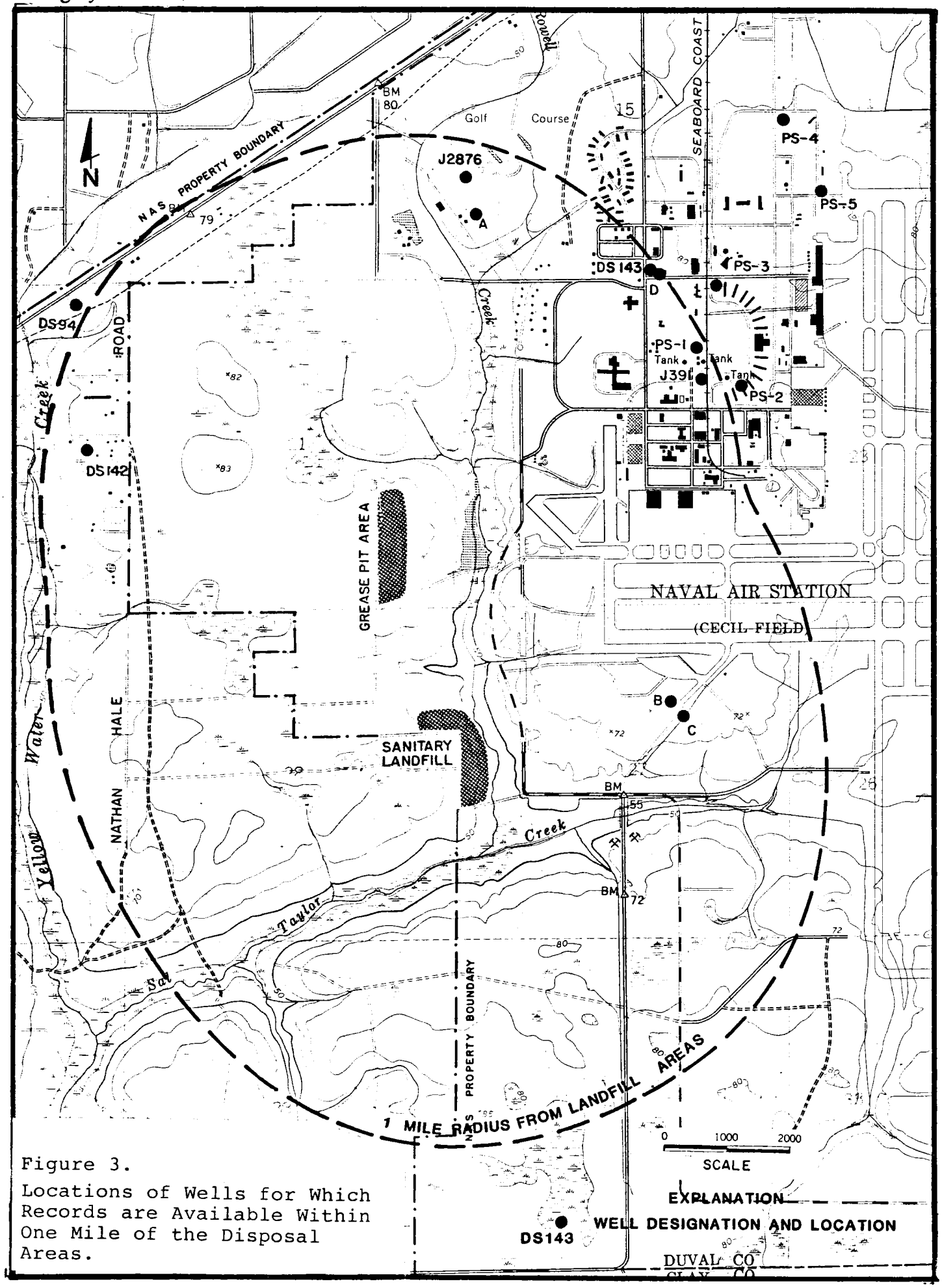


Figure 3.
Locations of Wells for Which Records are Available Within One Mile of the Disposal Areas.

in Figure 4 is a map showing the surface-water drainage features in the vicinity of the sites. As can be seen in Figure 4, a small dam has been constructed across Rowell Creek just upstream from the inactive landfill.

Geologic Framework

The geologic framework underlying the NAS Cecil Field generally consists of unconsolidated deposits of sands and clays overlying a thick sequence of marine carbonate rocks. This is illustrated in Figure 5, which is a geologic column based on data presented by the Florida Geological Survey of an on-site well (G. W. Leve, 1966).

The uppermost unconsolidated deposits consist of sands and clayey sands approximately 20 to 40 ft in thickness which are underlain by calcareous silty clays, clays, and clayey sands associated with the Pliocene and upper Miocene deposits. Beneath these is the Hawthorn Formation which consists primarily of gray to blue-green calcareous, phosphatic, sandy clays, and clayey sands interbedded with thin discontinuous lenses of phosphatic sands, sandy limestones, and dolostones. The Hawthorn Formation comprises the confining deposits which hydraulically separate the surficial aquifer from the underlying Floridan aquifer, although the permeable limestone layers within these confining deposits form what is referred to as the secondary artesian aquifer.

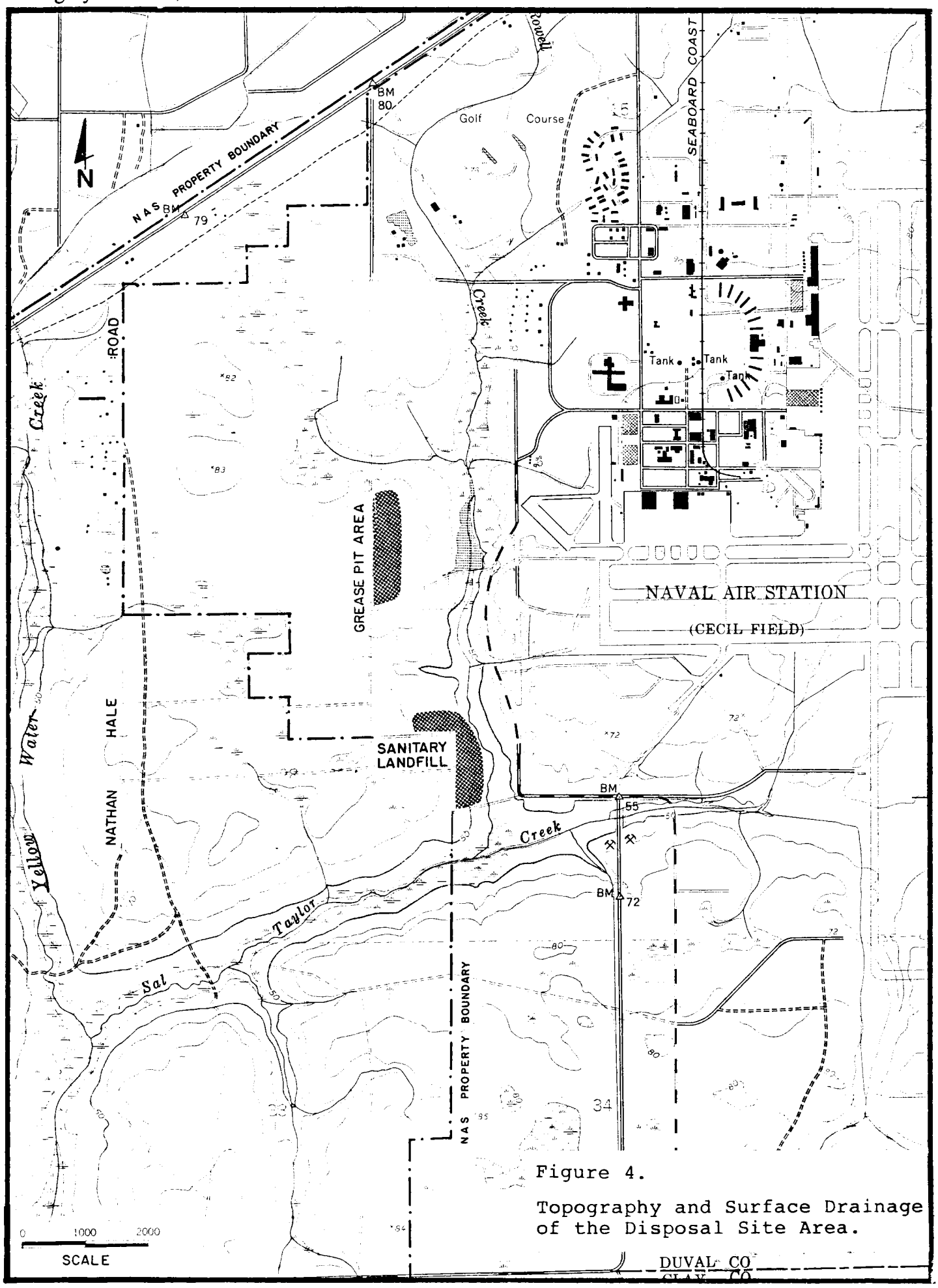


Figure 4.

Topography and Surface Drainage of the Disposal Site Area.

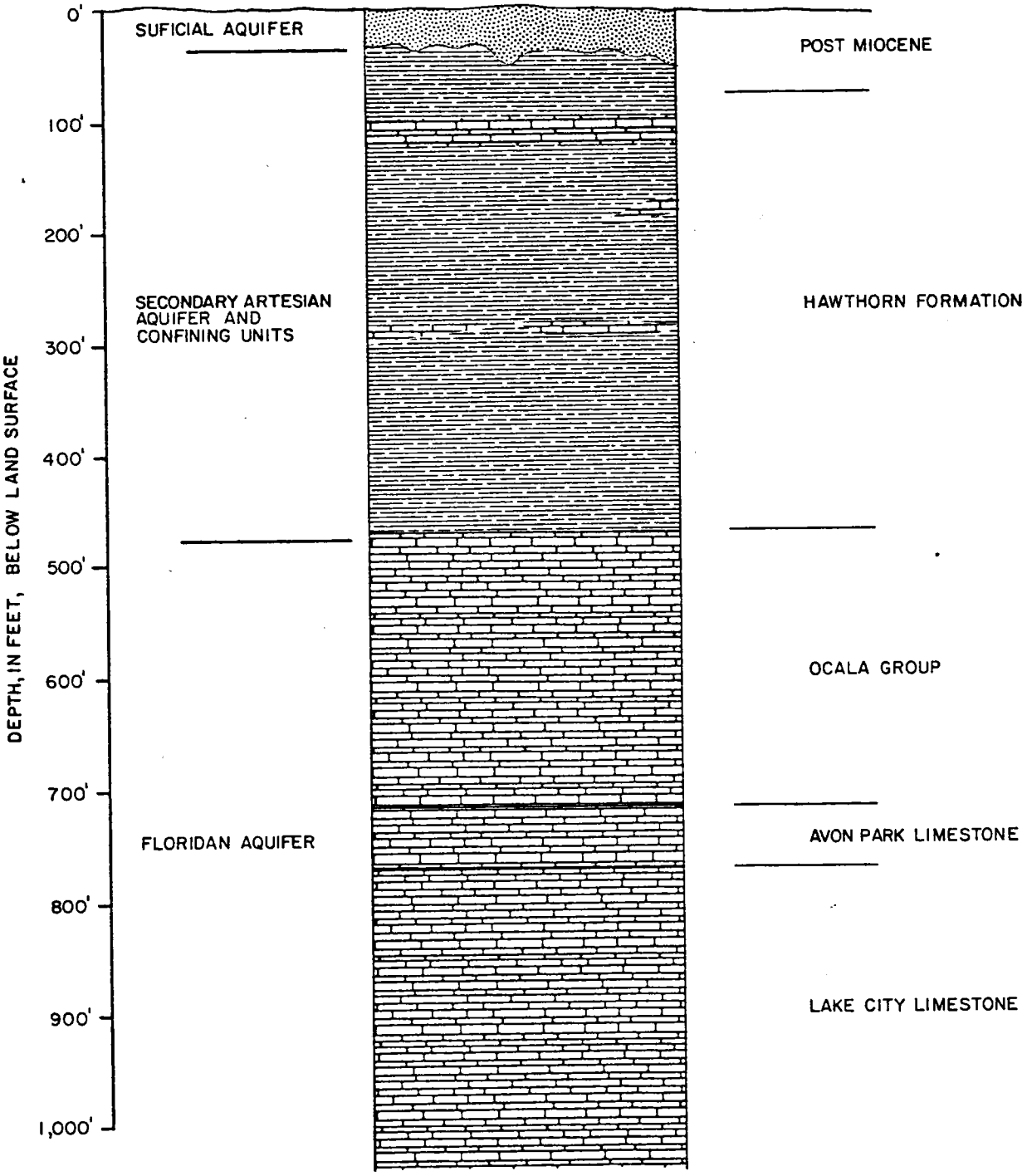


Figure 5. Generalized Geologic Column for the NAS Cecil Field Area.

The top of the Floridan aquifer generally coincides with the basal portion of the Hawthorn Formation. The Floridan aquifer consists, in order of increasing depth, of the Ocala Group, Avon Park Limestone, and the Lake City Limestone.

Surficial Aquifer

The surficial aquifer is comprised of the uppermost fine to medium-grained quartz sands and clayey sands that overlie the clayey confining units. Inspection of the geologic logs presented in Appendix A shows that the surficial aquifer ranges in thickness from about 20 to 40 ft.

Grain-size analyses of the surficial sediments generally show that these sediments are composed of a fine-grained sand containing small amounts of silt and clay. Grain-size analyses of sand samples from several exploratory borings are presented in Appendix B. Analyses of the data presented in Appendix B indicates that the permeabilities of these sands range from about 120 to 220 gpd/ft^2 (gallons per day per square foot) and average about 150 gpd/ft^2 (F.D. Masch and K.J. Denny, 1966).

Ground-water flow is three-dimensional and has the potential to move laterally or vertically, depending upon the permeability of the sediments through which it is moving and the prevailing hydraulic gradients. In the study area, ground-water movement is primarily lateral through the

surficial aquifer as vertical movement is impeded by underlying clayey sediments.

The major control on the lateral movement of ground-water in the surficial aquifer is topography. Under natural conditions, ground-water moves from areas of relatively high head, such as topographic highs to areas of natural discharge, such as streams, swamps, or ditches. Figure 6, which was prepared from land-surface topography, shows the inferred direction of shallow ground-water flow in the vicinity of the sites. At the locations of the sites, shallow ground water discharges into Rowell and possibly Sal Taylor Creeks.

The water quality of the surficial aquifer is good, containing less than 250 mg/l (milligrams per liter) of TDS (total dissolved solids) and generally meeets EPA's (Environmental Protection Agency) drinking-water standards.

Secondary Artesian Aquifer

The secondary artesian aquifer is composed of the sand, limestone, and dolostone lenses that are interbedded in the clayey confining units between the surficial aquifer and the underlying Floridan aquifer. The primary source of water from the secondary artesian aquifer in this area is a limestone layer which is 20 to 25 ft thick, occurring at a depth of about 60 to 125 feet. Ground-water flow in the secondary artesian aquifer in western Duval County is

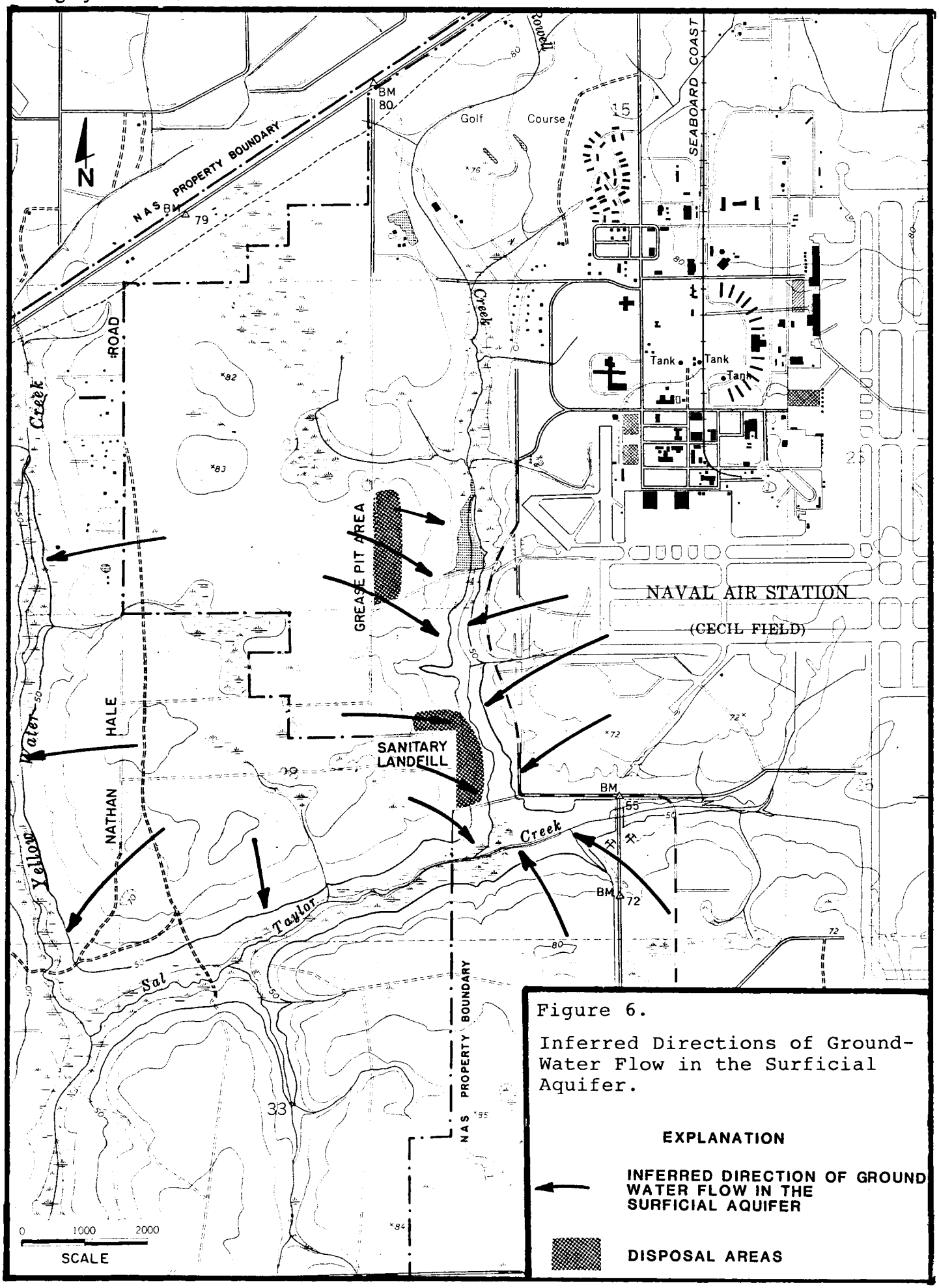


Figure 6.

Inferred Directions of Ground-Water Flow in the Surficial Aquifer.

EXPLANATION

INFERRED DIRECTION OF GROUND WATER FLOW IN THE SURFICIAL AQUIFER

DISPOSAL AREAS

generally toward the east as can be seen in the potentiometric surface contour map (1969) shown in Figure 7. The elevations of artesian head in the secondary artesian aquifer suggest that in upland areas there is a downward movement of water from the surficial to the secondary artesian aquifer while in the stream valleys the movement of ground water is upward from the secondary artesian aquifer into the surficial aquifer.

Water quality in the secondary artesian aquifer is good and generally meets EPA's drinking-water standards. Presented in Table 2 are water-quality analyses from off-site wells tapping the secondary artesian aquifer within 5 miles of the disposal sites. As can be seen in this table, the water contains about 250 mg/l of TDS, 14 mg/l of chloride, 1 mg/l or less of iron, and had a pH of about 8.

Floridan Aquifer

The Floridan aquifer consists of limestone and dolostones of the Ocala Group, Avon Park Limestone, and the Lake City Limestone. The top of the Floridan aquifer occurs at a depth of about 500 ft at the NAS Cecil Field. A transmissivity of 190,000 gpd/ft (gallons per day per foot) and storage coefficient of 2.08×10^{-4} were determined for the Floridan Aquifer at a site a few miles east of Cecil Field (Leve, 1968).

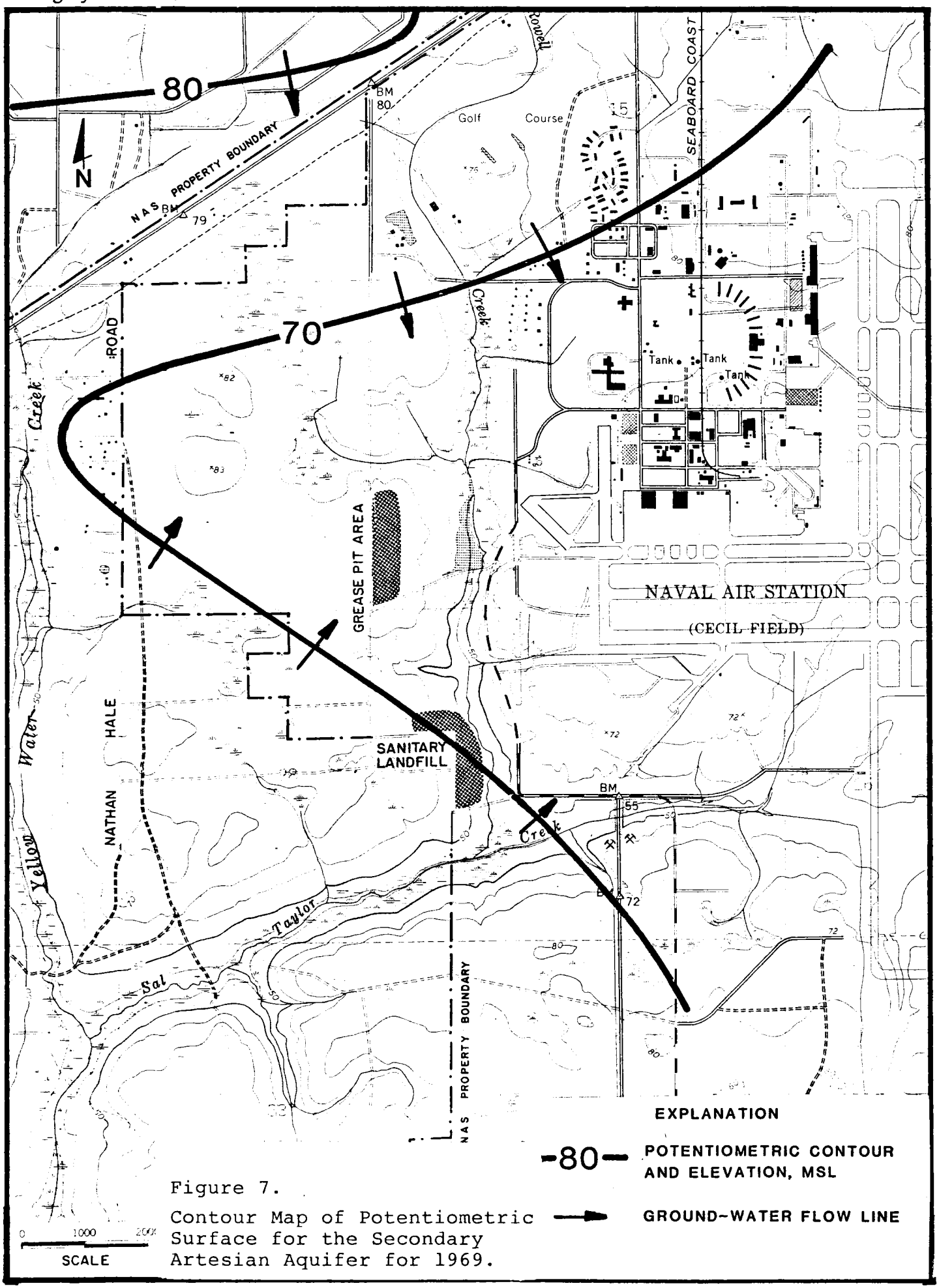


Figure 7.

Contour Map of Potentiometric Surface for the Secondary Artesian Aquifer for 1969.

Table 2. Water Quality Analyses From The Secondary Artesian Aquifer In The NAS Cecil Field Vicinity[1]

Well Designation	DS-202	DS-142	DS-5
Well Location	NE¼, SE¼, NE¼ Sec. 21, T3S, R25E	NE¼, NE¼, SE¼ Sec.20, T3S, R24E	NW¼, NW¼, SW¼ Sec. 6, T3S, R25E
Surface Elevation (ft. MSL)	50	70	90
Well Depth (ft.)	60	125	146
Iron	0.01	1.0	0.65
Silica	19	26	22
Calcium	43	58	56
Magnesium	16	13	20
Sodium	6.6	14	6.4
Potassium	1.2	2.1	1.9
Bicarbonate	213	256	270
Sulfate	0.8	0.8	0.0
Chloride	12	12	14
Fluoride	0.5	0.4	0.3
Nitrate	0.1	0.1	0.2
Phosphate	0.56	0.04	0.27
Hardness (Ca-Mg)	174	198	222
Dissolved Solids	205	253	254
pH (units)	7.8	7.9	8.1

[1]From Fairchild, 1972

NOTE: Concentrations of Constituents in mg/l.

Ground-water flow directions in the Floridan aquifer for September 1982 are illustrated in Figure 8. As can be seen in this figure, ground-water flow is toward the east-northeast. In September 1982, the elevation of the potentiometric surface of the Floridan aquifer at Cecil Field was about 50 ft msl. When compared with the potentiometric elevation of about 70 ft msl for the secondary artesian aquifer (Figure 7), it is apparent that the hydraulic gradient between the two aquifers is downward. Presented in Table 3 are water-quality analyses from two on-site production wells, Nos. 1 and 2, located in the Naval Housing Area. These waters contained about 140 mg/l of TDS, 0.1 mg/l of iron, 10 mg/l of chloride, and 23 mg/l of sulfate.

PROPOSED MONITOR-WELL NETWORK

It is possible that an upward gradient exists between the secondary artesian and the surficial aquifer at the disposal sites. If this is the case, then the potential for downward movement of contaminants from these sites into aquifers below the surficial sands is minimized and the flow would be restricted to lateral movement through the surficial sands and towards Rowell Creek. Therefore, emphasis on the design of the monitoring system has been placed on monitoring the surficial aquifer and surface water at the site; monitoring of the secondary artesian aquifer has also been proposed in order to determine whether or not there is a potential for downward movement. Presented in Figure 9 is a

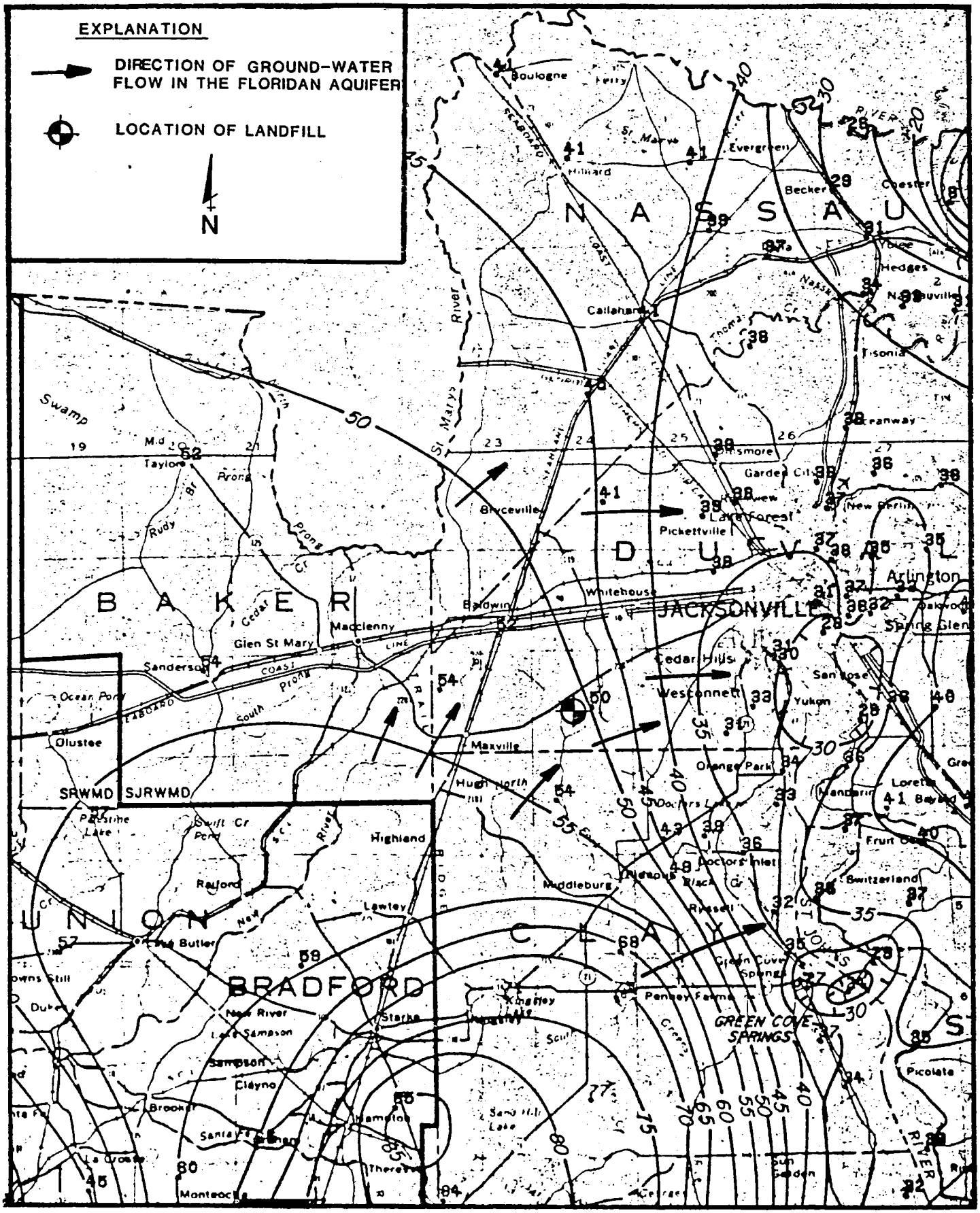


Figure 8. Contour Map of Potentiometric Surface for Floridan Aquifer for September 1982.

Geraghty & Miller, Inc.

Table 3. Water-Quality Analyses From the Floridan Aquifer at Cecil Field NAS.

DOW-LAB RESEARCH INC Box 7362 - Orlando, Fla. 32804
1153 West Fairbanks Ave. (305) 645-0212

(NOTE: Please fill out the upper part of this report)

CHEMICAL WATER ANALYSIS REPORT

REPORT TO: W. Earl Flogd and Son DATE OF REPORT: 3/18/76

CLIENT IDENTIFICATION: Cecil Field Naval Housing Project-Well # 1 Permit # 76-9

SAMPLED BY: DATE OF SAMPLING: 3/16/76

APPEARANCE OF SAMPLE: (Underline) CLEAR; CLOUDY; COLORED; WITH SUSPENDED MATTER.
SOURCE OF SAMPLE: (Underline) MUNICIPAL WATER; PRIVATE WATER WORKS; WELL; OTHER:

LABORATORY DETERMINATIONS

	ppm		ppm
Total Dissolved Solids @ 25°	136	Manganese, as Mn	< 0.01
Total Hardness, EDTA, as $CaCO_3$	120	Sodium, as Na	2.3
Calcium Hardness, as $CaCO_3$	100	Chloride, as Cl	10
Magnesium Hardness, as $CaCO_3$	20	Fluoride, as F	0.3
Carbonate Hardness, as $CaCO_3$	90		
Non-Carbonate Hardness, as $CaCO_3$	30	Nitrate, Nitrite } as N	-
Acidity, Free, as $CaCO_3$	0		
Acidity, Total, as $CaCO_3$	10	Total Phosphate, as PO_4	0.25
Total Alkalinity, as $CaCO_3$	90	Silica, as SiO_2	17.5
Carbonate Alkalinity, as $CaCO_3$	0	Sulphate, as SO_4	21
Bicarbonate Alkalinity, as $CaCO_3$	90		
Hydroxide Alkalinity, as OH	0	Odor Threshold	1
Carbonate, as CO_3	0	Color, P-C Standard	1
Bicarbonate, as HCO_3	110		
		Turbidity, JTU	1
Carbon Dioxide, as CO_2	9		
		pH @ 25°C	8.5
Calcium, as Ca	40		
		pHs	7.3
Magnesium, as Mg	4.9	Ryznar Stability Index	6.1
		Langelier Saturation Index	+ 1.2
Copper, as Cu	< 0.02		
		Other Determinations:	
Iron, as Fe	0.1	Hydrogen sulfide:	1.0

SIGNED: Roxane R. Dow
(Chemist)

Determinations based on Standard Methods, 13th ed., APHA, AWWA, WPCF.
To convert ppm to grains per gallon, divide ppm by 17.1.
This report is not to be construed as encompassing microbiological sanitary determinations.

Table 3 (Continued).

DOW-LAB RESEARCH INC Box 7362 - Orlando, Fla. 32804
1153 West Fairbanks Ave. (305) 645-0212

(NOTE: Please fill out the upper part of this report)

CHEMICAL WATER ANALYSIS REPORT

REPORT TO: W. Earl Floyd and Son DATE OF REPORT: 3/18/76

CLIENT IDENTIFICATION: Cecil Field Naval Housing Project Well #2 Permit # 76-10

SAMPLED BY: DATE OF SAMPLING: 3/15/76

APPEARANCE OF SAMPLE: (Underline) CLEAR; CLOUDY; COLORED; WITH SUSPENDED MATTER.
SOURCE OF SAMPLE: (Underline) MUNICIPAL WATER; PRIVATE WATER WORKS; WELL; OTHER:

LABORATORY DETERMINATIONS

	ppm		ppm
		Manganese, as Mn	< 0.01
Total Dissolved Solids @ 25°	143		
		Sodium, as Na	4.6
Total Hardness, EDTA, as $CaCO_3$	120		
		Chloride, as Cl	10
Calcium Hardness, as $CaCO_3$	90		
Magnesium Hardness, as $CaCO_3$	30	Fluoride, as F	0.4
Carbonate Hardness, as $CaCO_3$	90		
Non-Carbonate Hardness, as $CaCO_3$	30	Nitrate } as N Nitrite }	-
Acidity, Free, as $CaCO_3$	0		
Acidity, Total, as $CaCO_3$	10	Total Phosphate, as PO_4	0.2
Total Alkalinity, as $CaCO_3$	90	Silica, as SiO_2	16
Carbonate Alkalinity, as $CaCO_3$	0	Sulphate, as SO_4	23
Bicarbonate Alkalinity, as $CaCO_3$	90		
Hydroxide Alkalinity, as OH	0	Odor Threshold	2
Carbonate, as CO_3	0	Color, P-C Standard	3
Bicarbonate, as HCO_3	110		
		Turbidity, JTU	2
Carbon Dioxide, as CO_2	9		
		pH @ 25°C	7.9
Calcium, as Ca	36		
		pHs	7.0
Magnesium, as Mg	7.3	Ryznar Stability Index	6.1
		Langelier Saturation Index	+ 0.9
Copper, as Cu	< 0.02		
		Other Determinations:	
Iron, as Fe	0.1	Hydrogen sulfide:	5.0

SIGNED: Roxane R. Dow
(Chemist)

Determinations based on Standard Methods, 13th ed., APHA, AWWA, WPCF.
To convert ppm to grains per gallon, divide ppm by 17.1.
This report is not to be construed as encompassing microbiological sanitary determinations.

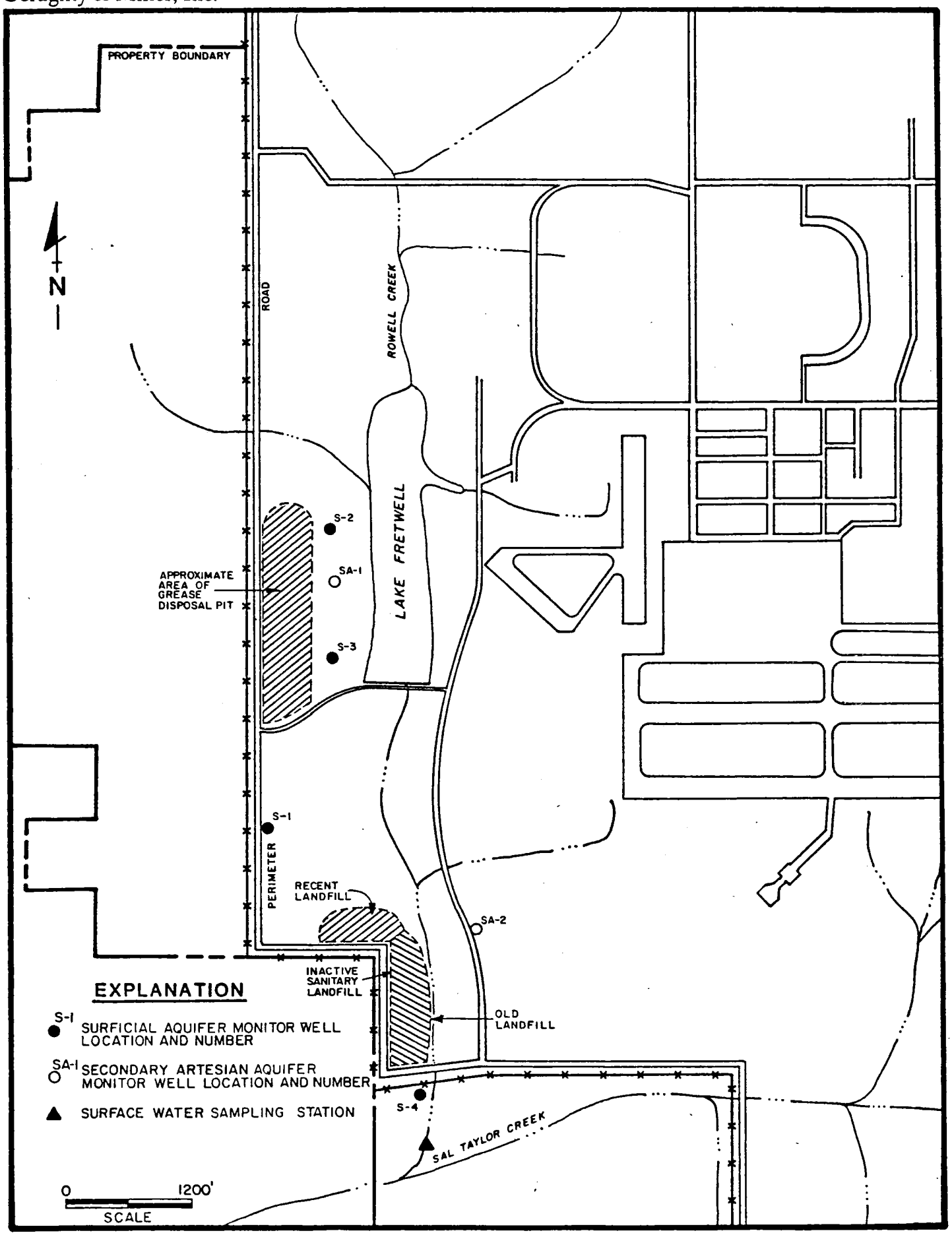


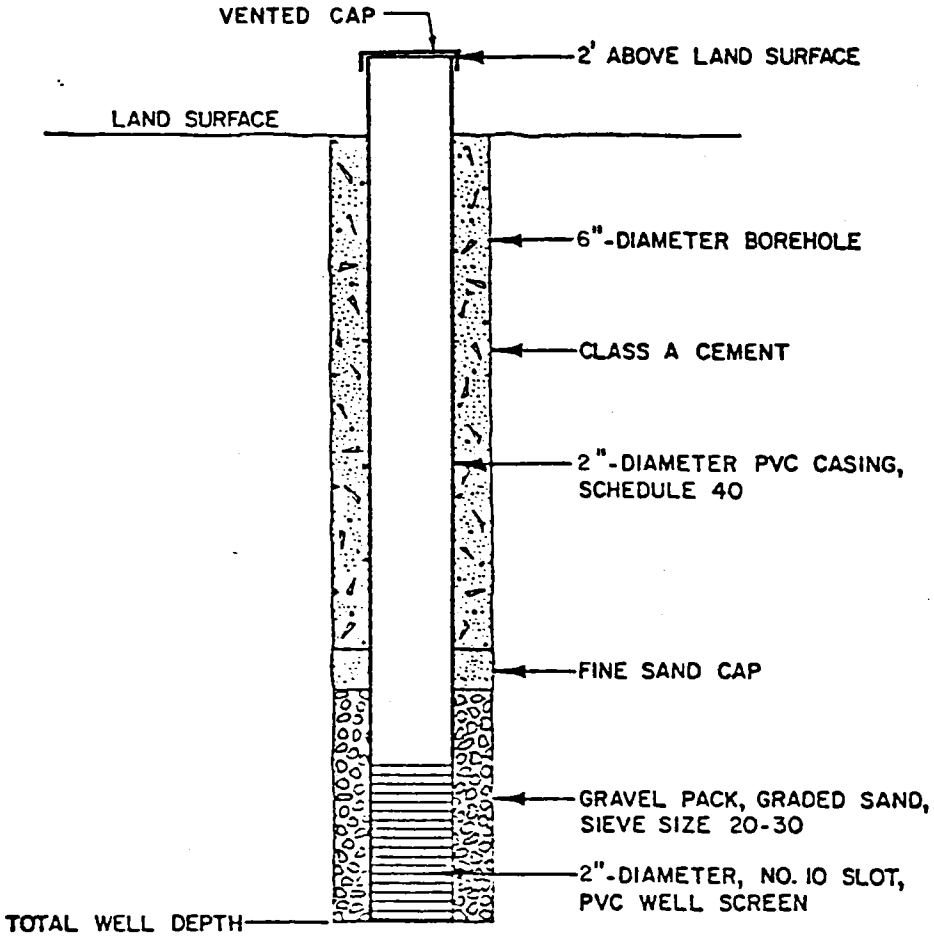
Figure 9. Proposed Ground and Surface Water Monitoring Network.

monitor system consisting of a network of six (6) ground-water monitoring wells and one surface water monitoring station. Two of the wells will be finished into the secondary artesian aquifer and four will be screened in the surficial sands. One of the surficial wells is situated upgradient from the disposal areas in order to establish background water quality. The surface water monitoring station is located near the mouth of Rowell Creek, south of the landfill; a permanent staff gage will be installed in Rowell Creek at the sampling station.

The surficial wells will be drilled to the base of the surficial sands at a depth of about 20 ft. These wells will be screened throughout the saturated thickness of the sand.

The secondary artesian wells will be drilled into a permeable limestone layer at an anticipated depth of about 60 to 100 ft, and will be cased to the top of the limestone. Construction details for the proposed monitor wells are presented in the schematic diagrams shown in Figures 10 and 11.

Sampling of the monitor wells and Rowell Creek will be done in accordance with the sampling and analysis plan included in Appendix C.



NOT TO SCALE

WELL NUMBER	ELEVATION (FT. MSL)	TOTAL DEPTH (FT.)

MEASUREMENT FROM TOP OF CASING

Figure 10. Schematic Diagram of Proposed Surficial Aquifer Monitor Well.

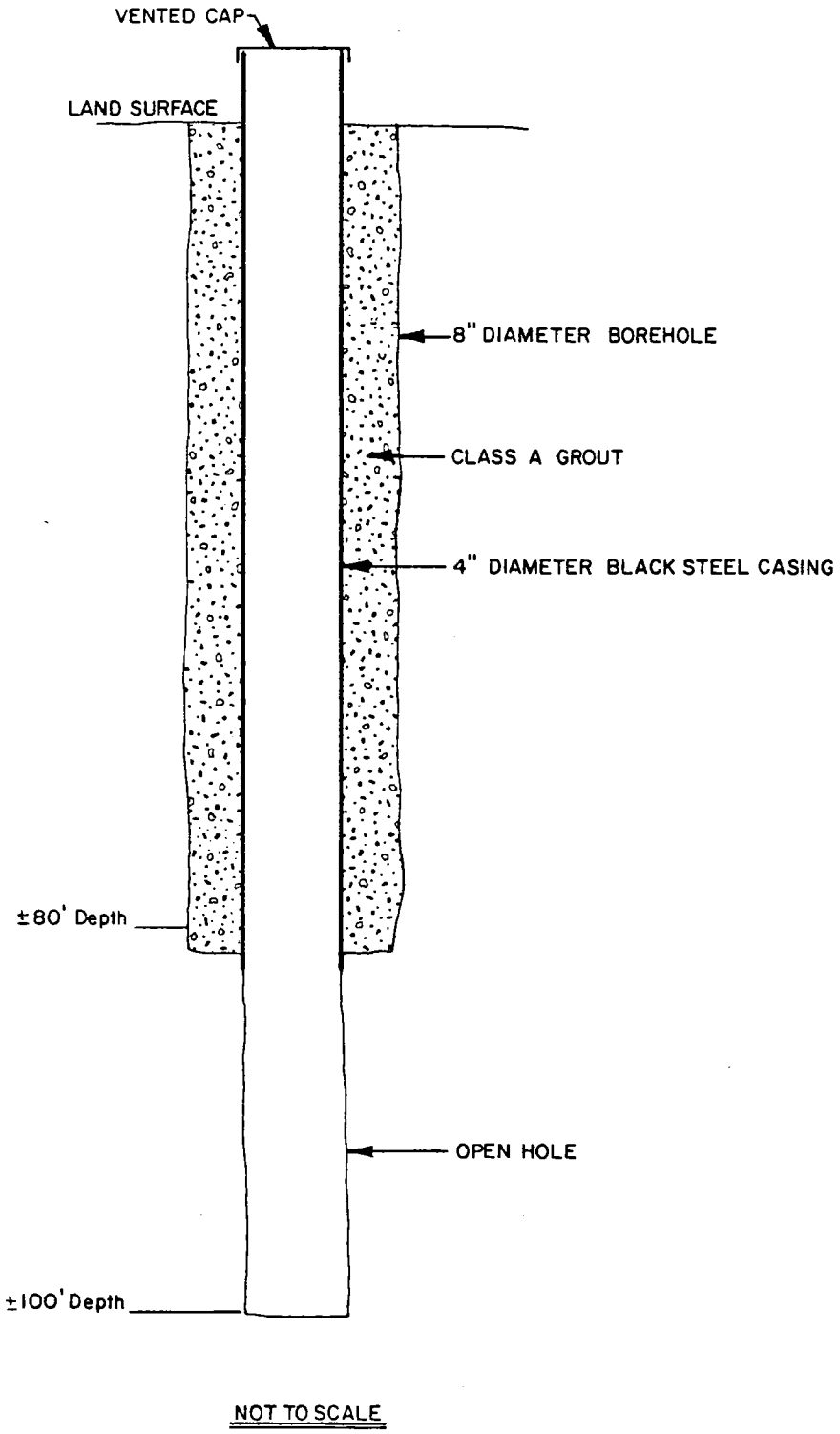


Figure 11. Schematic Diagram of Proposed Secondary Artesian Monitor Well.

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APPENDIX A

Lithologic Logs

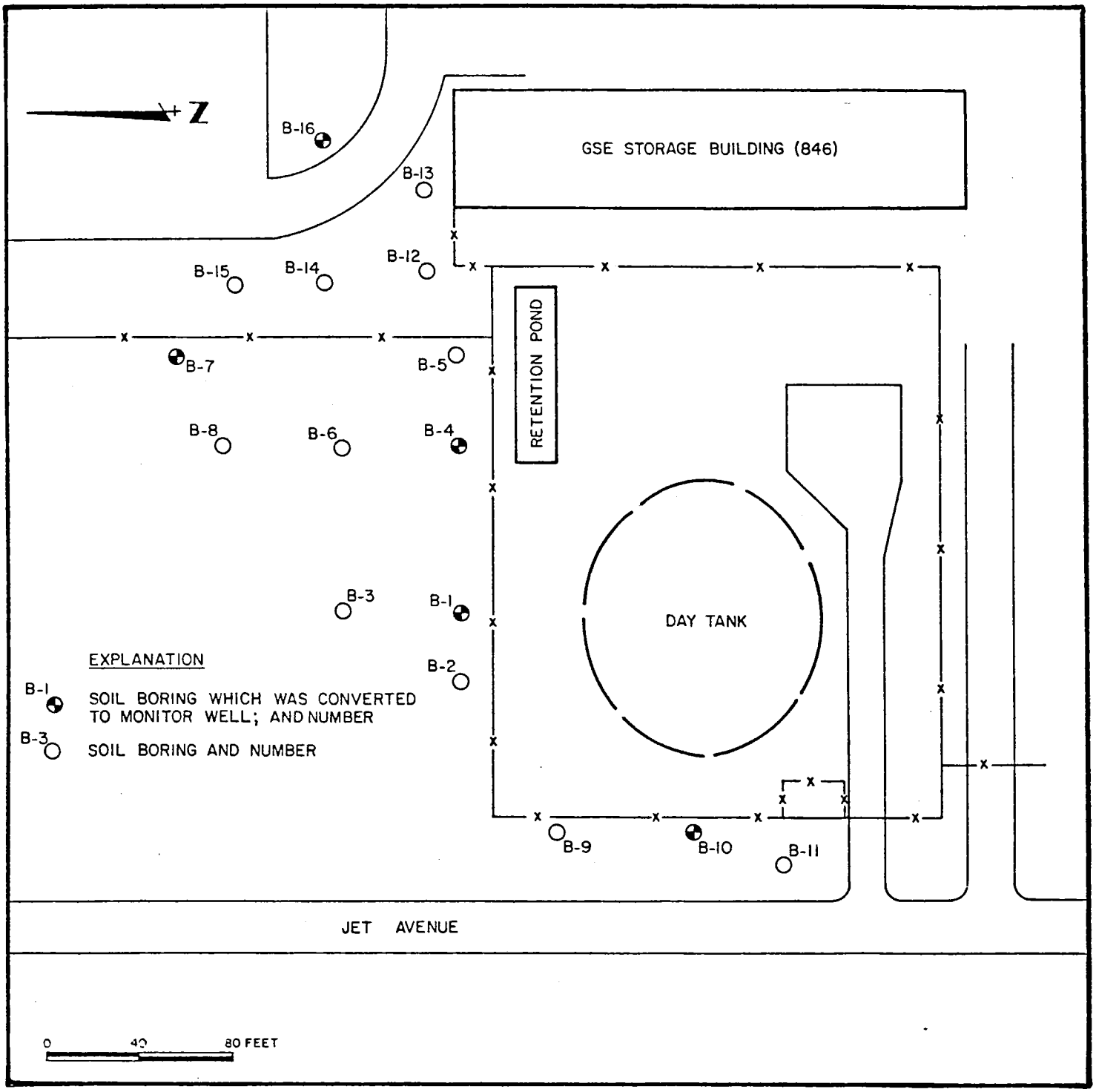

Figure A-1. Locations of Borings B-1 to B-16 Drilled Near the Day Tank During G&M Field Program (Tables A-1 through A-16)

Table A-1. Lithologic Log of Boring B-1.

Description	Depth (ft)	Thickness (ft)
Sand; quartz, very fine to fine-grained, silty, gray to black	0 - 3	3
Sand; quartz, very fine-grained, silty, dark brown	3 - 4.5	1.5
Sand; quartz, very fine-grained, very silty, brown	4.5 - 7	2.5
Sand; quartz, very fine-grained, silty, light brown; trace of clay	7 - 8	1
Sand; quartz, very fine to fine-grained, silty, tan	8 - 9.5	1.5
Sand; quartz, very fine to fine-grained, silty, tan	9.5 - 11	1.5

Table A-2. Lithologic Log of Boring B-2.

Description	Depth (ft)	Thickness (ft)
Sand; quartz, very fine to fine-grained, silty, gray and brown.....	0 - 1	1
Sand; quartz, very fine to fine-grained, silty, gray and black.....	1 - 2	1
Sand; quartz, very fine to fine-grained, slightly silty, brown; root material.....	2 - 5	3
Augered, no sample.....	5 - 7	2
Quartz, sandy, very fine-grained, silty, dark brown.....	7 - 8.5	1.5
Sand; quartz, very fine to fine-grained, silty, brown.....	8.5 - 10	1.5

Table A-3. Lithologic Log of Boring B-3.

Description	Depth (ft)	Thickness (ft)
Sand; quartz, very fine to fine-grained, silty, gray and black.....	0 - 1	1
Sand; quartz, very fine-grained, silty, gray...	1 - 2	1
Sand; quartz, very fine to fine-grained, silty, dark brown.....	2 - 3	1
Sand; quartz, very fine-grained, very silty, brown.....	3 - 4.5	1.5
Augered, no sample.....	4.5 - 6	1.5
Sand; quartz, very fine-grained, silty, tan....	6 - 9	3

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Table A-4. Lithologic Log of Boring B-4.

Description	Depth (ft)	Thickness (ft)
Sand; quartz, very fine-grained, silty, gray....	0 - 1	1
Sand; quartz, very fine-grained, silty, dark brown and black.....	1 - 2.5	1.5
Silt, sandy, brown.....	2.5 - 3	0.5
Augered, no sample.....	4 - 6	2
Sand; quartz, very fine to fine-grained, slightly silty, tan.....	6 - 7.5	1.5

Table A-5. Lithologic Log of Boring B-5.

Description	Depth (ft)	Thickness (ft)
Sand; quartz, very fine-grained, silty, gray....	0 - 1	1
Sand; quartz, very fine-grained, silty, dark brown.....	1 - 2.5	1.5
Sand; quartz, very fine to fine-grained, silty, tan.....	2.5 - 3	0.5
Sand; quartz, very fine to fine-grained, silty, gray.....	3 - 4	1
Sand; quartz, very fine-grained, very silty, reddish-brown.....	4 - 6.5	2.5
Sand; quartz, very fine to fine-grained, silty, tan.....	6.5 - 9.0	2.5
Sand; quartz, very fine to fine-grained, silty, tan.....	9.0 - 10.5	1.5

Table A-6. Lithologic Log of Boring B-6.

Description	Depth (ft)	Thickness (ft)
Sand; quartz, very fine to fine-grained, silty, gray and brown.....	0 - 1	1
Sand; quartz, very fine-grained, slightly silty, brown.....	1 - 3	3
Sand; quartz, very fine-grained, very silty, brown.....	3 - 5	2
Sand; quartz, very fine-grained, silty, light brown.....	5 - 6	1
Sand; quartz, very fine to fine-grained, slightly silty, tan.....	6 - 9	3

Table A-7. Lithologic Log of Boring B-7.

Description	Depth (ft)	Thickness (ft)
Sand; quartz, very fine to fine-grained, silty, gray and brown	0 - 2	2
Sand; quartz, very fine to fine-grained, slightly silty, tan	2 - 3.5	1.5
Sand; quartz, very fine-grained, silty, reddish-brown and tan	3.5 - 5.5	2
Sand; quartz, very fine to fine-grained, slightly silty, tan	5.5 - 6.0	0.5
Sand; quartz, very fine to fine-grained, silty, white and tan	6 - 7	1
No sample	7 - 9.5	2.5

Table A-8. Lithologic Log of Boring B-8.

Description	Depth (ft)	Thickness (ft)
Sand; quartz, very fine-grained, silty, gray....	0 - 1	1
Silt, sandy, reddish-brown.....	1 - 4	3
Sand; quartz, very fine-grained, silty, light brown.....	4 - 6	2
Sand; quartz, very fine to fine-grained, silty, white and tan.....	6 - 7.5	1.5
Sand; quartz, very fine to fine-grained, silty, white and tan.....	7.5 - 9	1.5

Table A-9. Lithologic Log of Boring B-9.

Description	Depth (ft)	Thickness (ft)
Sand; quartz, very fine to fine-grained, silty, brown.....	0 - 1	1
Sand; quartz, very fine-grained, silty, gray....	1 - 2	1
Sand; quartz, very fine-grained, silty, brown...	2 - 4	2
Sand; quartz, very fine-grained, silty, reddish-brown.....	4 - 4.5	0.5
Silt, sandy, reddish-brown.....	4.5 - 6	1.5
Sand; quartz, very fine to fine-grained, very silty, white and tan.....	6 - 8	2
Sand; quartz, very fine to fine-grained, white to tan.....	8 - 9	1

Table A-10. Lithologic Log of Boring B-10.

Description	Depth (ft)	Thickness (ft)
Sand; quartz, very fine-grained, silty, gray....	0 - 3	3
Sand; quartz, very fine to fine-grained, silty, brown.....	3 - 4.5	1.5
Sand; quartz, very fine-grained, silty, brown; root fragments.....	4.5 - 6	1.5
Sand; quartz, very fine to fine-grained, silty, brown.....	6 - 9	3

Table A-11. Lithologic Log of Boring B-11.

Description	Depth (ft)	Thickness (ft)
Sand; quartz, very fine-grained, silty, gray and black.....	0 - 3	3
Sand; quartz, very fine to fine-grained, dark brown; root fragments.....	3 - 5.5	2.5
Sand; quartz, very fine-grained, silty, brown; root fragments.....	5.5 - 6	0.5
Sand; quartz, very fine to fine-grained, silty, reddish-brown.....	6 - 7.5	1.5
Sand; quartz, very fine to fine-grained, silty, light brown.....	7.5 - 10.5	3

Table A-12. Lithologic Log of Boring B-12.

Description	Depth (ft)	Thickness (ft)
Sand; quartz, fine-grained, gray and black.....	0 - 3	3
Sand; quartz, very fine-grained, silty, brown...	3 - 6	3
Sand; quartz, very fine to fine-grained, slightly silty, tan and brown.....	6 - 7.5	1.5
Sand; quartz, very fine to fine-grained, slightly silty, white and tan.....	7.5 - 10.5	3

Table A-13. Lithologic Log of Boring B-13.

Description	Depth (ft)	Thickness (ft)
Sand; quartz, fine-grained, gray and black.....	0 - 3	3
Sand; quartz, very fine-grained, silty, brown...	3 - 7.5	4.5
Sand; quartz, very fine to fine-grained, slightly silty, white and tan.....	7.5 - 10.5	3

Table A-14. Lithologic Log of Boring B-14.

Description	Depth (ft)	Thickness (ft)
Sand; quartz, very fine-grained, silty, gray....	0 - 1	1
Sand; quartz, very fine-grained, silty, brown...	1 - 2.5	1.5
Sand; quartz, very fine to fine-grained, slightly silty, light brown.....	2.5 - 3.5	1
Sand; quartz, very fine-grained, silty, dark brown.....	3.5 - 4.5	1
Sand; quartz, very fine to fine-grained, silty, brown.....	4.5 - 9	4.5
Sand; quartz, very fine to fine-grained, silty, tan and brown.....	9 - 10.5	1.5

Table A-15. Lithologic Log of Boring B-15.

Description	Depth (ft)	Thickness (ft)
Fill material.....	0 - 0.5	0.5
Sand; quartz, very fine-grained, silty, gray....	0.5 - 1	0.5
Sand; quartz, very fine-grained, silty, brown...	1 - 3	2
Sand; quartz, very fine-grained, silty, reddish-brown.....	3 - 7.5	4.5
Sand; quartz, fine-grained, silty, tan.....	7.5 - 10.5	3

Table A-16. Lithologic Log of Boring B-16.

Description	Depth (ft)	Thickness (ft)
Sand; quartz, very fine-grained, silty, gray....	0 - 1	1
Sand; quartz, very fine-grained, silty, gray and brown.....	1 - 4	3
Sand; quartz, very fine-grained, very silty, tan.....	4 - 6	2
Sand; quartz, very fine to fine-grained, silty, light brown.....	6 - 10.5	4.5
Sand; quartz, very fine to fine-grained, silty, tan.....	10.5 - 12	1.5

Figure A-2. Locations of Borings Drilled by Harlan Engineering Laboratories (Table A-17 to A-27).

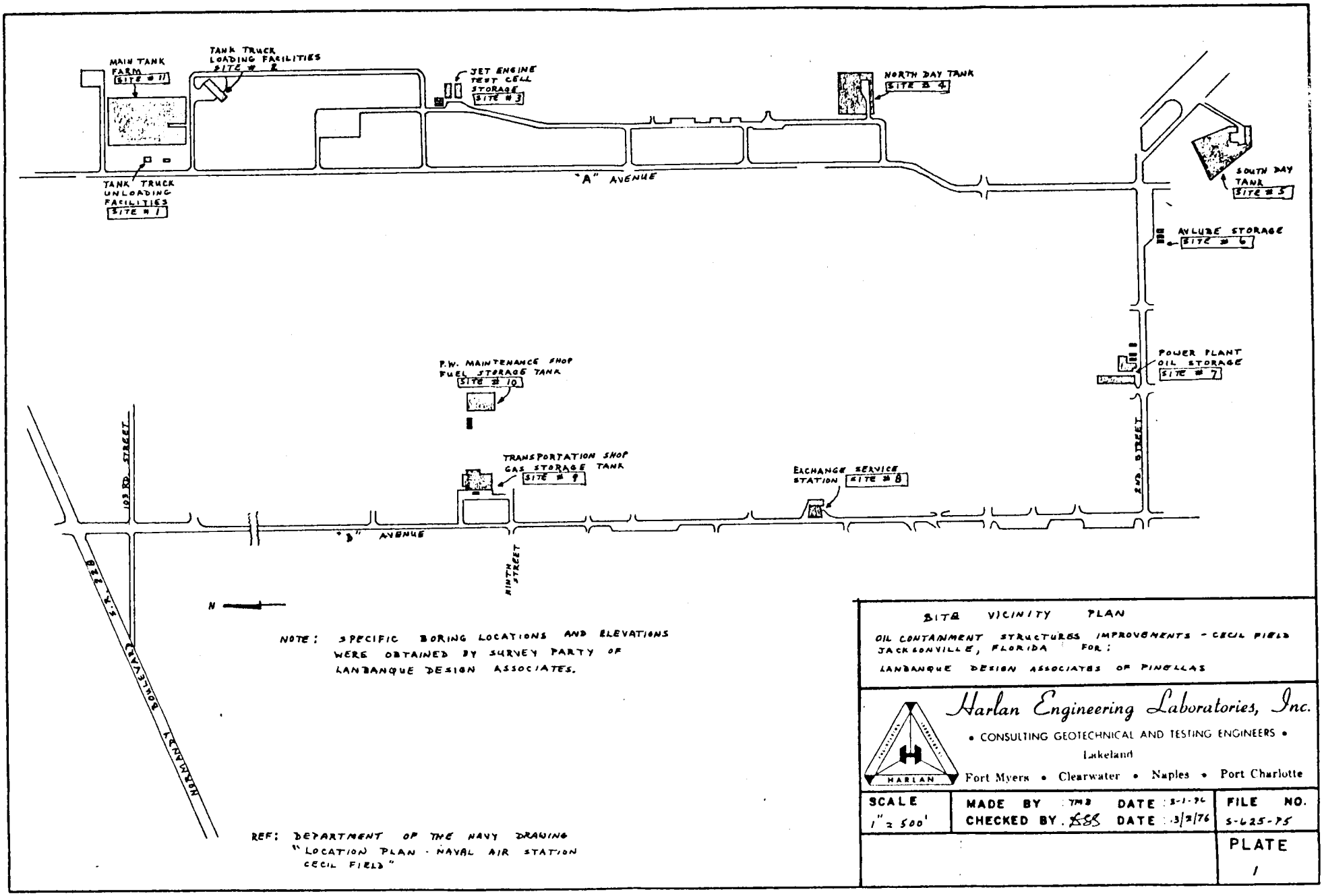

Table A-17. Lithologic Log of the Boring Installed at Site #1.

HARLAN ENGINEERING LABORATORIES, INC.

SOIL BORING LOG

Client: Lanbanque Design Associates of Pinellas
Project: Oil Containment Structures Impro.
Location: Cecil Field, Jacksonville, FL
Elevation Reference: Existing Ground Surface
Depth to Water: 7'6"

Boring No.: B-10/Channel Invert Site #1
Boring Date: February 12, 1976
Job No.: S-625-P5

Depth	Standard Penetration		Unified Soils Classification		Description	RELATIVE DENSITY
Ft.	Blows Per 6"	Value "N"	Type	Symbol		Dr %
0	1=12"/1	1+		CL	Gray Sandy Clay w/roots. (Very	—
	1-2-2	4				5
	2-2-2	4				5
5	2-2-3	5				9
10	3-6-7	13		SP	Black Fine Sand w/heavy organic stain. (Medium Dense)	27
15	8-9-11	20				45
					Boring Terminated at 15'.	
20						
25						

REMARKS: i) Dr % Relative Density based on "N" values as per B. K. Hough "Basic Soils Engineering"

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Table A-18. Lithologic Log of the Boring Installed at Site #2.

HARLAN ENGINEERING LABORATORIES, INC.

SOIL BORING LOG

Client: Lanbanque Design Associates of Pinellas
Project: Oil Containment Structures Impro.
Location: Cecil Field, Jacksonville, FL
Elevation Reference: Existing Ground Surface
Depth to Water: 3'6"

Boring No.: B-11/Channel Invert Site #2
Boring Date: February 13, 1976
Job No.: S-625-P5

Depth	Standard Penetration		Unified Soils Classification		Description	RELATIVE DENSITY
Ft.	Blows Per 6"	Value "N"	Type	Symbol		Dr-%
0						
	1=12"/1	1+		SP	Dark Gray Fine Sand w/roots & wood pieces. (Very Loose to Loose)	0
	1-1-2	3				3
	2-4-3	7				17
5	2-4-5	9				23
					Gray Fine Sand. (Dense)	
	7-13-19	32				75
10						
	15-22-25	47				86
15					Boring Terminated at 15'.	
20						
25						

REMARKS: i) Dr-% Relative Denstiy based on "N" values as per B. K. Hough "Basic Soils Engineering.

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Table A-19. Lithologic Logs of Borings Installed at Site #3.

HARLAN ENGINEERING LABORATORIES, INC.

SOIL BORING LOG

Client: Lanbanque Design Associates of Pinellas
Project: Oil Containment Structures Impro.
Location: Cecil Field, Jacksonville, FL-Bldg. #320
Elevation Reference: Existing Ground Surface
Depth to Water: 8'6"

Boring No.: B-1/MW-1/P-1/Site #3
Boring Date: February 10, 1976
Job No.: S-625-P5

Depth	Standard Penetration		Unified Soils Classification		Description	RELATIVE DENSITY
Ft.	Blows Per 6"	Value "N"	Type	Symbol		Dr %
0	1-3-3	6		SP	Dark Gray Fine Sand. (Loose)	11
	3-3-3	6				11
	1-3-2	5				9
5	2-3-5	8		CL	Gray Sandy Clay. (Firm)	20
				SP	Gray Fine Sand. (Loose)	
10	2-3-4	7				17
15	2-3-4	7				17
					Boring Terminated at 15'.	
20						
25						

REMARKS:
i) Dr-% Relative Density based on "N" values as per B. K. Hough "Basic Soils Engineering"
ii) Permeability (Vertical) Test performed.
iii) Monitoring Well (MW-1) installed as shown - Refer Plate 2

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Sheet 1 of 19

Table A-19 (Continued)

HARLAN ENGINEERING LABORATORIES, INC.

SOIL BORING LOG

Client: Lanbanque Design Associates of Pinellas
Project: Oil Containment Structures Impro.
Location: Cecil Field, Jacksonville, FL-Bldg. #320
Elevation Reference: Existing Ground Surface
Depth to Water: 4'6"

Boring No.: A-1/P-2/Site #3
Boring Date: February 10, 1976
Job No.: S-625-P5

Elev.	Depth	Standard Penetration		Unified Soils Classification		Description
	Ft.	Blows Per 6"	Value "N"	Type	Symbol	
					SP	Brown & Gray Fine Sand.
	5					Gray Fine Sand w/some silt & clay.
	10					Dark Brown Fine Sand w/organic stain.
						Gray Fine Sand.
	15					Boring Terminated at 15'.

REMARKS: i) Permeability (Horizontal) Test performed.

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Table A-20. Lithologic Logs of Borings Installed at Site #4.

HARLAN ENGINEERING LABORATORIES, INC.

SOIL BORING LOG

Client: Lanbanque Design Associates of Pinellas
Project: Oil Containment Structures Impro.
Location: Cecil Field, Jacksonville, FL-Bldg.#293A
Elevation Reference: Existing Ground Surface
Depth to Water: 5'6"

Boring No.: B-2/P-3/Site #4
Boring Date: February 10, 1976
Job No.: S-625-P5

Depth	Standard Penetration		Unified Soils Classification		Description	RELATIVE DENSITY
Ft.	Blows Per 6"	Value "N"	Type	Symbol		Dr %
0						
	2-2-3	5		SP	Dark Gray to Brown Fine Sand. (Loose)	9
	3-3-4	7				17
	3-5-6	11			Gray Fine Sand. (Medium Dense)	27
5	10-5-8	13			Gray Fine Sand w/some silt. (Medium Dense)	35
10	5-6-9	15				36
					Brown Fine Sand w/trace of roots. (Dec. vegetation) (Medium Dense)	
	9-11-14	25				52
15					Boring Terminated at 15'.	
20						
25						

REMARKS: i) Dr-% Relative Density based on "N" values as per B. K. Hough "Basic Soils Engineering".
ii) Permeability (vertical) Test performed.

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Table A-20 (Continued)

HARLAN ENGINEERING LABORATORIES, INC.

SOIL BORING LOG

Client: Lanbanque Design Associates of Pinellas
Project: Oil Containment Structures Impro.
Location: Cecil Field, Jacksonville, FL-Site #4
Elevation Reference: Existing Ground Surface
Depth to Water: 7'

Boring No.: A-2/MW-2/P-4/Site #4
Boring Date: February 10, 1976
Job No.: S-625-P5

Elev.	Depth	Standard Penetration		Unified Soils Classification		Description
	Ft.	Blows Per 6"	Value "N"	Type	Symbol	
					SP	Dark Brown Fine Sand.
						Brown Fine Sand.
	5					Brown Fine Sand w/some silt.
						Brown Fine Sand.
	10					
	15					Boring Terminated at 15'.

REMARKS:
i) Field Permeability (Horizontal) Test performed.
ii) Monitoring Well (MW-2) installed as shown - Refer Plate #2

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Table A-21. Lithologic Logs of Borings Installed at Site #5.

HARLAN ENGINEERING LABORATORIES, INC.

SOIL BORING LOG

Client: Lanbanque Design Associates of Pinellas
Project: Oil Containment Structures Impro.
Location: Cecil Field, Jacksonville, FL -Site #5
Elevation Reference: Existing Ground Surface
Depth to Water: 7'

Boring No.: B-3/P-5/Site #5
Boring Date: February 11, 1976
Job No.: S-625-P5

Depth	Standard Penetration		Unified Soils Classification		Description	RELATIVE DENSITY
Ft.	Blows Per 6"	Value "N"	Type	Symbol		Dr %
0						
	11-6-6	12		SP	Gray Fine Sand. (Medium Dense Loose)	32
	3-3-5	8				20
	6-5-4	9				23
5	3-2-2	4				5
					Soil has fuel smell.	
					Brown Fine Sand w/some silt. (Very Dense to Medium Dense)	
10	15-30-25	55				90
	9-12-13	25				52
15					Boring Terminated at 15'.	
20						
25						

REMARKS: i) Dr-% Relative Density based on "N" values as per Dr. B. K. Hough "Basic Soils Engineering".
ii) Permeability (Horizontal) Test performed.

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Table A-21 (Continued).

HARLAN ENGINEERING LABORATORIES, INC.

SOIL BORING LOG

Client: U. S. Navy c/o Lanbanque Design
Project: Oil Containment Structures
Location: Cecil Field, Jacksonville, FL
Elevation Reference: Existing Ground Surface
Depth to Water: 7'

Boring No.: A-3 (extra) Site #5
Boring Date: February 13, 1976
Job No.: S-625-P5

Elev.	Depth	Standard Penetration		Unified Soils Classification		Description
	Ft.	Blows Per 6"	Value "N"	Type	Symbol	
	5				SP	Dark Brown Fine Sand.
	10					
	15					Boring Terminated at 15'.

REMARKS:

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Table A-21 (Continued).

HARLAN ENGINEERING LABORATORIES, INC.

SOIL BORING LOG

Client: Lanbanque Design Associates of Pinellas
Project: Oil Containment Structures Impro.
Location: Cecil Field, Jacksonville, FL-Site #5
Elevation Reference: Existing Ground Surface
Depth to Water:

Boring No.: A-3I/MW-3/P-9/Site #5
Boring Date: February 11, 1976
Job No.: S-625-P5

Elev.	Depth	Standard Penetration		Unified Soils Classification		Description
	Ft.	Blows Per 6"	Value "N"	Type	Symbol	
	5				SP	Dark Brown Fine Sand w/some silt.
	10					
	15					Boring Terminated at 15'.

REMARKS: i) Permeability (vertical) Test performed.
ii) Monitoring Well (MW-3) installed as shown - Refer Plate # 2

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Table A-21 (Continued)

HARLAN ENGINEERING LABORATORIES, INC.

SOIL BORING LOG

Client: Lanbanque Design Associates of Pinellas
Project: Oil Containment Structures Impro.
Location: Cecil Field, Jacksonville, FL-Site #5
Elevation Reference: Existing Ground Surface
Depth to Water: 7'

Boring No.: A-3*/P-6/Site #5
Boring Date: February 11, 1976
Job No.: S-625-P5

Elev.	Depth	Standard Penetration		Unified Soils Classification		Description
	Ft.	Blows Per 6"	Value "N"	Type	Symbol	
	5				SP	Dark Brown Fine Sand w/some silt. (Smell of fuel in soil)
	10					
	15					Boring Terminated at 15'.

REMARKS:

* i) Auger boring located outside the fence line.
ii) Permeability (vertical) test performed.

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Table A-22. Lithologic Logs of Borings Installed at Site #6.

HARLAN ENGINEERING LABORATORIES, INC.

SOIL BORING LOG

Client: Lanbanque Design Associates of Pinellas
Project: Oil Containment Structures Impro.
Location: Cecil Field, Jacksonville, FL-Bldg. #43JKL
Elevation Reference: Existing Ground Surface
Depth to Water: 6'6"

Boring No.: B-4/Site #6
Boring Date: February 11, 1976
Job No.: S-625-P5

Depth	Standard Penetration		Unified Soils Classification		Description	RELATIVE DENSITY
Ft.	Blows Per 6"	Value "N"	Type	Symbol		Dr %
0	1-2-2	4		SP	Gray Fine Sand. (Very Loose to Loose)	5
	2-3-4	7				17
	2-2-3	5		SM	Brown Silty Sand. (Loose to Medium Dense)	9
5	2-3-6	9				23
10	5-10-12	22				48
15	4-5-6	11				27
					Boring Terminated at 15'.	
20						
25						

REMARKS: i) Dr-% Relative Density based on "N" values as per B. K. Hough "Basic Soils Engineering"

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Table A-22 (Continued)

HARLAN ENGINEERING LABORATORIES, INC.

SOIL BORING LOG

Client: Lanbanque Design Associates of Pinellas
Project: Oil Containment Structures Impro.
Location: Cecil Field, Jacksonville, FL-Site #6
Elevation Reference: Existing Ground Surface
Depth to Water: 6'6"

Boring No.: A-4/Site #6
Boring Date: February 11, 1976
Job No.: S-625-P5

Elev.	Depth	Standard Penetration		Unified Soils Classification		Description
	Ft.	Blows Per 6"	Value "N"	Type	Symbol	
					SP	Dark Gray Fine Sand.
	5				SM	Brown Silty Fine Sand.
	10					
	15					Boring Terminated at 15'.

REMARKS:

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Table A-23. Lithologic Log of the Boring Installed at Site #7.

HARLAN ENGINEERING LABORATORIES, INC.

SOIL BORING LOG

Client: Lanbanque Design Associates of Pinellas
Project: Oil Containment Structures Impro.
Location: Cecil Field, Jacksonville, FL-Bldg. #11
Elevation Reference: Existing Ground Surface
Depth to Water: 7'

Boring No.: B-5/Site #7
Boring Date: February 11, 1976
Job No.: S-625-P5

Depth	Standard Penetration		Unified Soils Classification		Description	RELATIVE DENSITY
Ft.	Blows Per 6"	Value "N"	Type	Symbol		Dr %
0	2-5-6	11		SC	Brown Fine Sand w/clay-wood & asphalt. (Fill)(Medium Dense)	27
	2-1-2	3		SP	Brown Fine Sand w/trace of organic stains. (Very Loose)	3
	1-2-1	3				3
5	1-2-2	4				5
10	9-12-15	27			Brown Fine Sand. (Medium Dense)	60
15	10-7-7	14				35
					Boring Terminated at 15'.	
20						
25						

REMARKS: i) Dr-% Relative Density based on "N" values as per B. K. Hough "Basic Soils Engineering".

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Table A-24. Lithologic Logs of the Boring Installed at Site #8.

HARLAN ENGINEERING LABORATORIES, INC.

SOIL BORING LOG

Client: Lanbanque Design Associates of Pinellas
Project: Oil Containment Structures Impro.
Location: Cecil Field, Jacksonville, FL-Bldg.#46
Elevation Reference: Existing Ground Surface
Depth to Water: 4'6"

Boring No.: B-6/Site #8
Boring Date: February 11, 1976
Job No.: S-625-P5

Depth	Standard Penetration		Unified Soils Classification		Description	RELATIVE DENSITY
Ft.	Blows Per 6"	Value "N"	Type	Symbol		Dr %
0						
	1-2-3	5		SP	Dark Gray Fine Sand. (Loose)	9
	3-3-3	6			Light Gray Fine Sand. (Loose to Very Loose)	11
	3-1-2	3				3
5	2-2-4	6			Black Fine Sand w/heavy Organic Stain. (Loose to Very Dense)	11
10	15-33-49	82			(Possible cemented sand pocket)	100%
15	9-8-13	21				46
					Boring Terminated at 15'.	
20						
25						

REMARKS: i) Dr-% Relative Density based on "N" values as per B. K. Hough "Basic Soils Engineering".

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Table A-25. Lithologic Log of the Boring Installed at Site #9.

HARLAN ENGINEERING LABORATORIES, INC.

SOIL BORING LOG

Client: Lanbanque Design Associates of Pinellas
Project: Oil Containment Structures Impro.
Location: Cecil Field, Jacksonville, FL/Bldg. #80
Elevation Reference: Existing Ground Surface
Depth to Water: 5'

Boring No.: B-7/Site #9
Boring Date: February 11, 1976
Job No.: S-625-P5

Depth	Standard Penetration		Unified Soils Classification		Description	RELATIVE DENSITY
Ft.	Blows Per 6"	Value "N"	Type	Symbol		Dr %
0	3-6-6	12		SC	Gray Clayey Sand w/limerock. (Medium Dense)	30
	5-4-4	8		SP	Gray Fine Sand	20
	2-2-1	3				3
5	1=2'					0
10	1=12"/2	2+				0
	1-1-2	3				3
15					Boring Terminated at 15'.	
20						
25						

REMARKS:

i) Dr-% Relative Density based on "N" values as per B. K. Hough "Basic Soils Engineering"

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Table A-26. Lithologic Log of the Boring Installed at Site #10.

HARLAN ENGINEERING LABORATORIES, INC.

SOIL BORING LOG

Client: Lanbanque Design Associates of Pinellas
Project: Oil Containment Structures Impro.
Location: Cecil Field, Jacksonville, FL-Bldg. #8
Elevation Reference: Existing Ground Surface
Depth to Water: 5'6"

Boring No.: B-8/Site #10
Boring Date: February 12, 1976
Job No.: S-625-P5

Depth	Standard Penetration		Unified Soils Classification		Description	RELATIVE DENSITY
Ft.	Blows Per 6"	Value "N"	Type	Symbol		Dr %
0	5-5-5	10		SP	Gray-Brown Fine Sand. (Loose)	25
	3-3-3	6				11
	3-4-5	9				23
5	4-5-5	10		SM	Gray Silty Sand. (Loose)	25
	3-3-5	8				20
10				SP	Gray Fine Sand w/trace of silt. (Loose)	
15	2-3-4	7				17
					Boring Terminated at 15'.	
20						
25						

REMARKS: i) Dr-% Relative Density based on "N" values as per B. K. Hough "Basic Soils Engineering"

Lakeland ☐ Ft. Myers ☐ Naples ☐ Clearwater ☒

Table A-27. Lithologic Logs of Borings Installed at Site #11.

HARLAN ENGINEERING LABORATORIES, INC.

SOIL BORING LOG

Client: Lanbanque Design Associates of Pinellas
Project: Oil Containment Structures Impro.
Location: Cecil Field, Jacksonville, FL-Site #11
Elevation Reference: Existing Ground Surface
Depth to Water: 2'6"

Boring No.: B-9/MW-5/P-7/Site #11
Boring Date: February 12, 1976
Job No.: S-625-P5

Depth	Standard Penetration		Unified Soils Classification		Description	RELATIVE DENSITY
Ft.	Blows Per 6"	Value "N"	Type	Symbol		Dr %
0						
	1-1-4	5		SP	Gray Fine Sand w/roots. (Loose)	9
	4-6-9	15			Brown Fine Sand. (Medium Dense to Loose)	36
	6-8-7	15				36
5	4-8-11	19				43
10	3-3-3	6				11
	2-3-4	7				17
15					Boring Terminated at 15'.	
20						
25						

REMARKS:
i) Dr-% Relative Density based on "N" values as per B. K. Hough "Basic Soils Engineering."
ii) Permeability (vertical) Test performed
iii) Monitoring well (MW-5) installed as shown - Refer Plate # 2

Lakeland ☐ Ft. Myers ☐ Naples ☐ Clearwater ☒

Table A-27 (Continued)

HARLAN ENGINEERING LABORATORIES, INC.

SOIL BORING LOG

Client: Lanbanque Design Associates of Pinellas
Project: Oil Containment Structures Impro.
Location: Cecil Field, Jacksonville, FL-Site #11
Elevation Reference: Existing Ground Surface
Depth to Water: 5'6"

Boring No.: A-7/P-8/Site #11
Boring Date: February 12, 1976
Job No.: S-625-P5

Elev.	Depth	Standard Penetration		Unified Soils Classification		Description
	Ft.	Blows Per 6"	Value "N"	Type	Symbol	
	5				SP	Dark Brown Fine Sand.
	10					
	15					Boring Terminated at 15'.

REMARKS:

i) Permeability (Horizontal) Test performed.

Lakeland ☐ Ft. Myers ☐ Naples ☐ Clearwater ☒

Table A-28. Lithologic Log of the Boring Installed at the Stream Exit.

HARLAN ENGINEERING LABORATORIES, INC.

SOIL BORING LOG

Client: Lanbanque Design Associates of Pinellas
Project: Oil Containment Structures Impro.
Location: Cecil Feild, Jacksonville, FL-Storm Drain
Elevation Reference: Existing Ground Surface
Depth to Water: 4'

Boring No.: A-6/MW-4/Stream Exit
Boring Date: February 10, 1976
Job No.: S-625-P5

Elev.	Depth	Standard Penetration		Unified Soils Classification		Description
	Ft.	Blows Per 6"	Value "N"	Type	Symbol	
	5				SP	Dark Brown Fine Sand.
	10					
	15					
	20					Boring Terminated at 20'.

REMARKS:
i) Monitoring Well (MW-4) installed as shown - Refer Plate #2

Lakeland ☐ Ft. Myers ☐ Naples ☐ Clearwater ☒

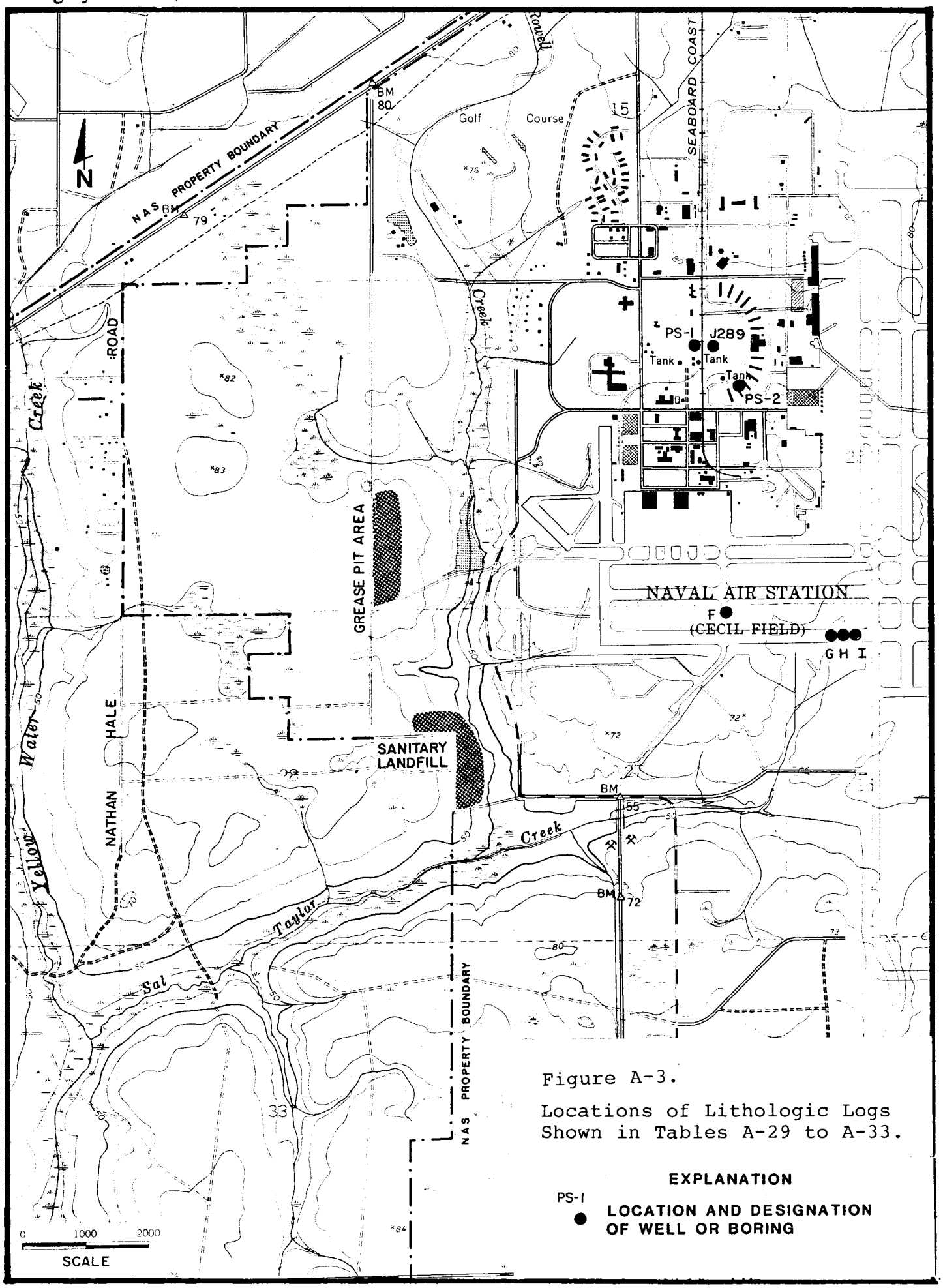


Figure A-3.

Locations of Lithologic Logs Shown in Tables A-29 to A-33.

EXPLANATION

PS-1 ● **LOCATION AND DESIGNATION OF WELL OR BORING**

Table A-29. Lithologic Log of Well J-289 at NAS Cecil Field

Well Designation: J-289
Surface Elevation: 80.0 MSL

Depth (ft)	Description
0- 2	Soil
2- 8	Fine sand
8- 10	Sandy clay
10- 20	Blue marl
20- 60	Blue marl
60- 64	Blue marl
64- 88	Rock
88-105	Rock
105-255	Marl with thin streaks of rock
255-275	Hard rock
275-290	Sandy marl
290-295	Hard rock
295-310	Gray sandy marl
310-316	Rock
316-355	Marl and rock
355-368	Rock
368-390	Marl
390-430	Green marl
430-441	Hard bed rock
441-490	Soft lime rock
490-545	Hard white lime
545-560	Soft lime
560-605	Hard lime
605-620	Hard lime
620-635	Hard lime
635-663	Hard lime
663-715	Soft brown lime
715-750	Hard brown lime
750-765	Brown lime water

Table A-30. Lithologic Log of Well D-66 in Vicinity of NAS Cecil Field

Well Designation: D-66
Location: Sec. 9, T3S, R24E
Surface Elevation: 79.6 MSL

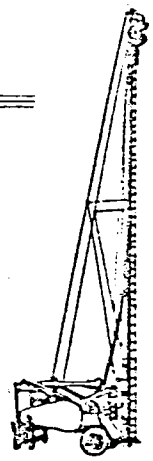
Depth (ft)	Description
0-40	Surface sand
40-60	Sandy marl
60-80	Porous lime, water bearing
80-100	Porous lime, water bearing
100-118	Rock
118-156	Chalk white sand
156-184	Gray sandy marl
184-203	Gray sandy marl
203-230	Rock
230-260	Sandy marl
260-272	Green marl
272-290	Rock
290-310	Rock and black sand
310-390	Gray sandy marl
390-435	Green marl
435-455	Rock
455-470	Sand and shell
470-482	Hard lime rock
482-530	Soft white lime
530-562	Hard white lime
562-575	Soft lime
575-600	Hard white lime
600-620	Hard white lime
620-644	Hard white lime
644-710	Soft white lime
710-730	Hard brown lime
730-780	Hard brown lime

TOTAL DEPTH: 780'

Table A-31. Lithologic Log of Well PS-1 at NAS Cecil Field

W. Earl Floyd & Son

WELL DRILLING CONTRACTORS
INDUSTRIAL — MUNICIPAL — IRRIGATION
WELLS
TURBINE AND SUBMERSIBLE
SALES & SERVICE



Distributor for
FAIRBANKS MORSE
Line Shaft and Submersible Turbines

TELEPHONE 781-1313
8901 HERLONG ROAD
JACKSONVILLE, FLORIDA 32210

INFORMATION and WELL LOG
on
CECIL FIELD NAVAL HOUSING PROJECT WELLS
PROJECT NO. Fy 7457

Wells started and finished, March 1976

Well No. 1 - Permit No. 76-9

WELL LOG

From	To	Character of Material
0 ft. -	30 ft. -	Sand
30 ft. -	80 ft. -	Clay and Shell
80 ft. -	100 ft. -	Rock
100 ft. -	120 ft. -	Rock and Gray Marl
120 ft. -	228 ft. -	Gray Marl
228 ft. -	231 ft. -	Rock (soft)
231 ft. -	270 ft. -	Marl
270 ft. -	294 ft. -	Rock & Marl
294 ft. -	398 ft. -	Rock & Marl
3 94 ft. -	401 ft. -	Green Clay
401 ft. -	428 ft. -	Rock and Marl
428 ft. -	440 ft. -	Hard Rock
440 ft. -	468 ft. -	Hard and Soft Rock
468 ft. -	476 ft. -	Hard cap Rock
476 ft. -	750 ft. -	White Lime Rock
750 ft. -	770 ft. -	Hard Brown Lime

Well No. 1

Well had 103 ft. of 8-inch, Schedule 40 T & C connected by a concentric weld reducer, to 383 feet of 6-inch T & C, Schedule 40, for a total cased depth of 486 feet.

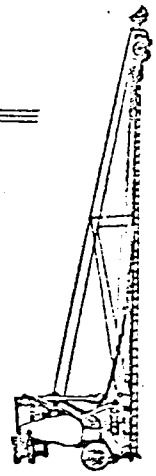
135 bags of cement slurry, weighing 14 lbs. per gallon was pumped thru the well annalus to ground surface.

Service and Satisfaction Guaranteed

Table A-32. Lithologic Log of Well PS-2 at NAS Cecil Field

W. Earl Floyd & Son

WELL DRILLING CONTRACTORS
INDUSTRIAL — MUNICIPAL — IRRIGATION
WELLS
TURBINE AND SUBMERSIBLE
SALES & SERVICE



Distributor for
FAIRBANKS MORSE
Line Shaft and Submersible Turbines

TELEPHONE 781-1313
8901 HERLONG ROAD
JACKSONVILLE, FLORIDA 32210

INFORMATION and WELL LOG
on
CECIL FIELD NAVAL HOUSING PROJECT WELLS
PROJECT NO. Fy 7457

Wells started and finished, March 1976

Well No. 2 - Permit No. 76-10

WELL LOG From	To	Character of Material
0 ft.	30 ft.	Sand
30 ft.	80 ft.	Clay and Shell
80 ft.	100 ft.	Rock
100 ft.	120 ft.	Rock and Gray Marl
120 ft.	228 ft.	Gray Marl
228 ft.	231 ft.	Rock (soft)
231 ft.	270 ft.	Marl
270 ft.	294 ft.	Rock and Marl
294 ft.	394 ft.	Rock and Marl
394 ft.	401 ft.	Green Clay
401 ft.	428 ft.	Rock and Marl
428 ft.	440 ft.	Hard Rock
440 ft.	468 ft.	Hard and Soft Rock
468 ft.	476 ft.	Hard Cap Rock
476 ft.	750 ft.	White Lime Rock
750 ft.	770 ft.	Hard Brown Lime
770 ft.	780 ft.	Hard Brown Lime

Well No. 2

Well had 100 ft. of 8-inch, schedule 40 T & C connected by a concentric weld reducer, to 393 ft. of 6-inch T & C Schedule 40 for a total cased depth of 493 ft.

135 bags of cement slurry, weighing 14 lbs. per gallon was pumped thru the well annalus to ground surface.

Service and Satisfaction Guaranteed

Table A-33. Lithologic Logs of Soil Borings Along The Southern East-West Runway[1]

Boring F at Station 29+56 (offset 350'N)
Surface elevation: 71.8 ft MSL

0-1 ft	Topsoil
1-2	Gray clay
2-4.2	White sand with traces of clay
4.2-5.3	Reddish sandy clay
5.3-6.1	White sand
6.1-8.5	White sand with traces of clay

Boring G at Station 47+10 (centerline)
Surface elevation: 62.9 ft MSL

0-0.4 ft	Top soil
0.4-1.4	Dark gray sand
1.4-5.5	Black sand
5.5-10	Gray sand

Boring H at Station 48+00 (centerline)
Surface elevation: 63.2 ft MSL

0-0.4 ft	Top soil
0.4-3.8	Gray soil
3.8-4.5	Dark gray sand
4.5-9.5	Light yellow sand

Boring I at Station 48+75 (centerline)

0-0.4 ft	Top soil
0.4-1.0	Dark gray sand
1.0-2.6	Black sand
2.6-8	Light gray sand

[1]Source: Smith & Gillespie, Architects & Engineers, 1956

APPENDIX B

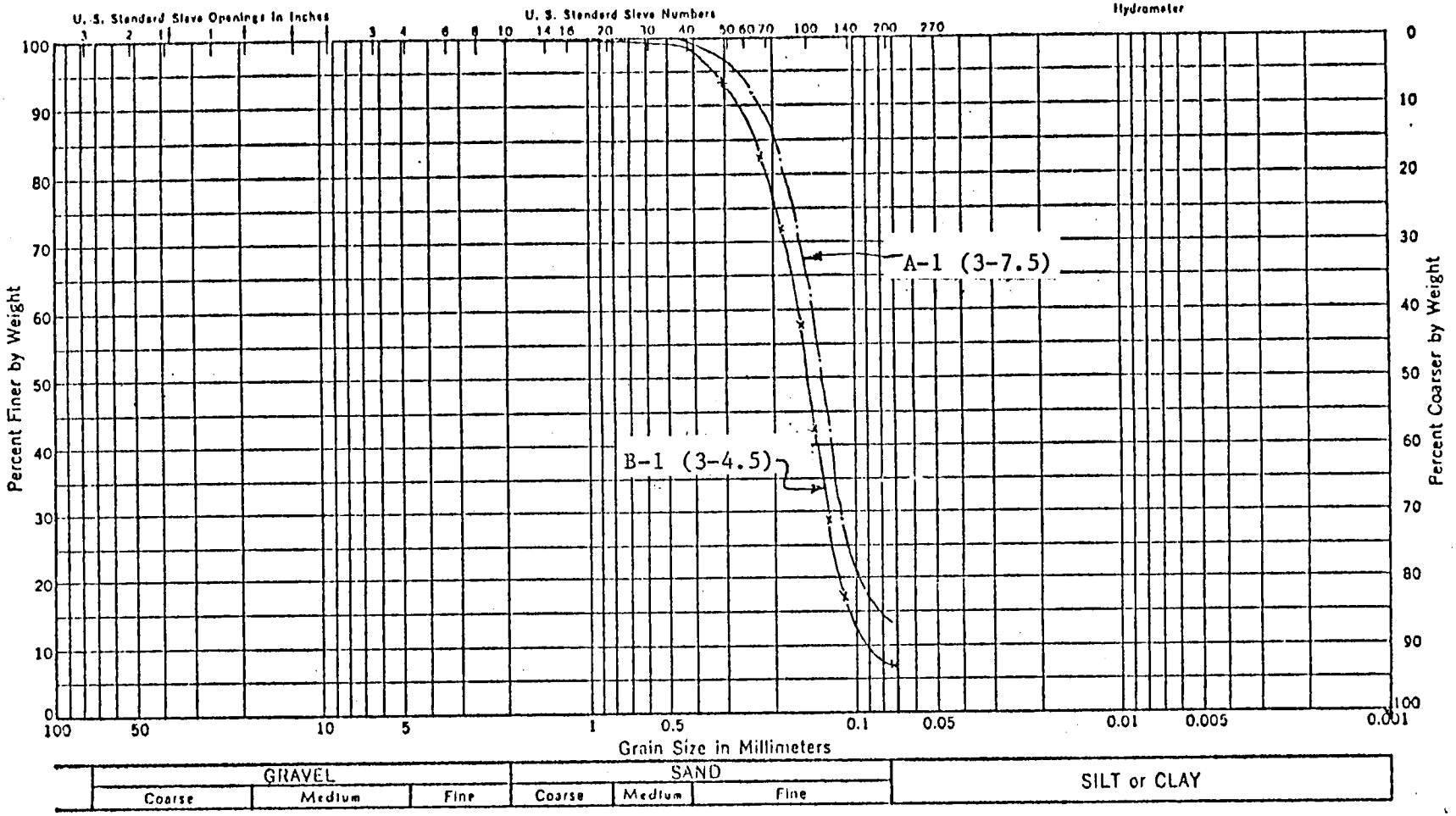
Grain-Size Analyses

Table B-1. Summary of the Hydraulic Conductivities Calculated From Grain-Size Analyses

Site No.[1]	Sample Depth (ft)	Hydraulic Conductivity (gpd/ft^2)
3	3-4.5	140
3	3-7.5	125
4	4-7.0	120
5	8.5-10.0	140
5	7.0-15.0	135
5	0.0-15.0	200
11	8.5-10.0	135
11	13.5-15.0	145
12	0.0-20.0	220

[1] Refer to Figure A-2 for Site Locations

Table B-2. Grain-Size Distributions of Sediment Samples Collected at the Site (see Figure A-2 for Locations) (Harlan Engineering Laboratory, Inc., March 1976).



SAMPLE NO.	DEPTH IN FEET	LL	PL	PI	CLASSIFICATION
B-1	3-4.5	(SITE # 3)			Fine Sand w/trace of silt.
A-1	3-7.5	(SITE # 3)			Fine Sand w/some silt.

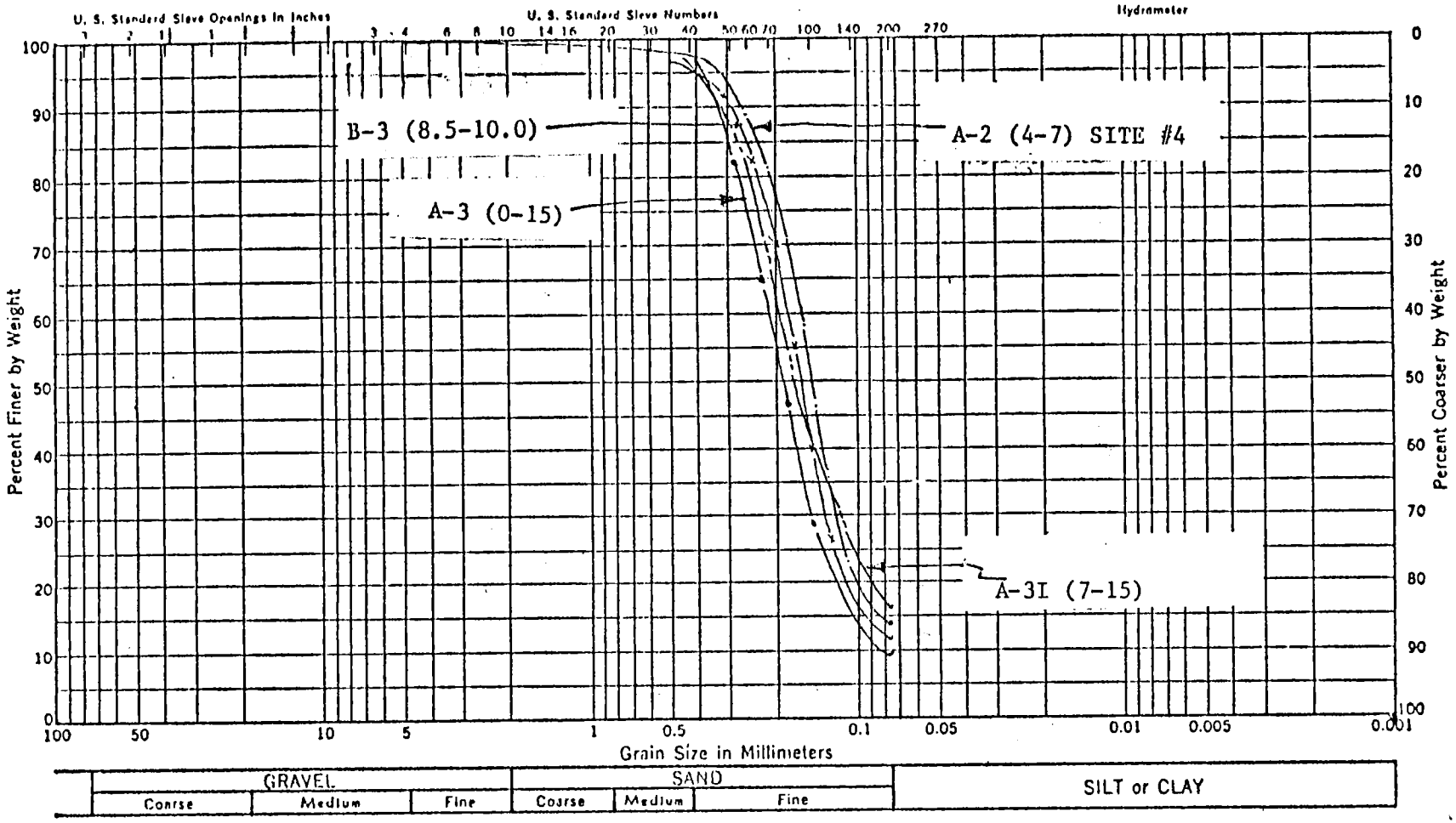
OIL CONTAINMENT STRUCTURES IMPRO.
NAS, CECIL FIELD, FLORIDA
FOR:
LANBANQUE DESIGN ASSOCIATES
ST. PETERSBURG, FLORIDA

PLATE 3

HARLAN ENGINEERING LABS, INC.
LAKELAND, FLORIDA.

DRAWN	APPROVED	DATE	JOB No.
DSS		3-1-76	S-625-P5

Table B-2 (Continued)



SAMPLE NO.	DEPTH FEET	LL	PL	PI	CLASSIFICATION
A-2	4-7	(SITE # 4)			Fine Sand w/some silt.
B-3	8.5-10	(SITE # 5)			Fine Sand w/some silt.
A-3I	7-15	(SITE # 5)			Fine Sand w/some silt.
A-3	0-15	(SITE # 5)			Fine Sand w/some silt.

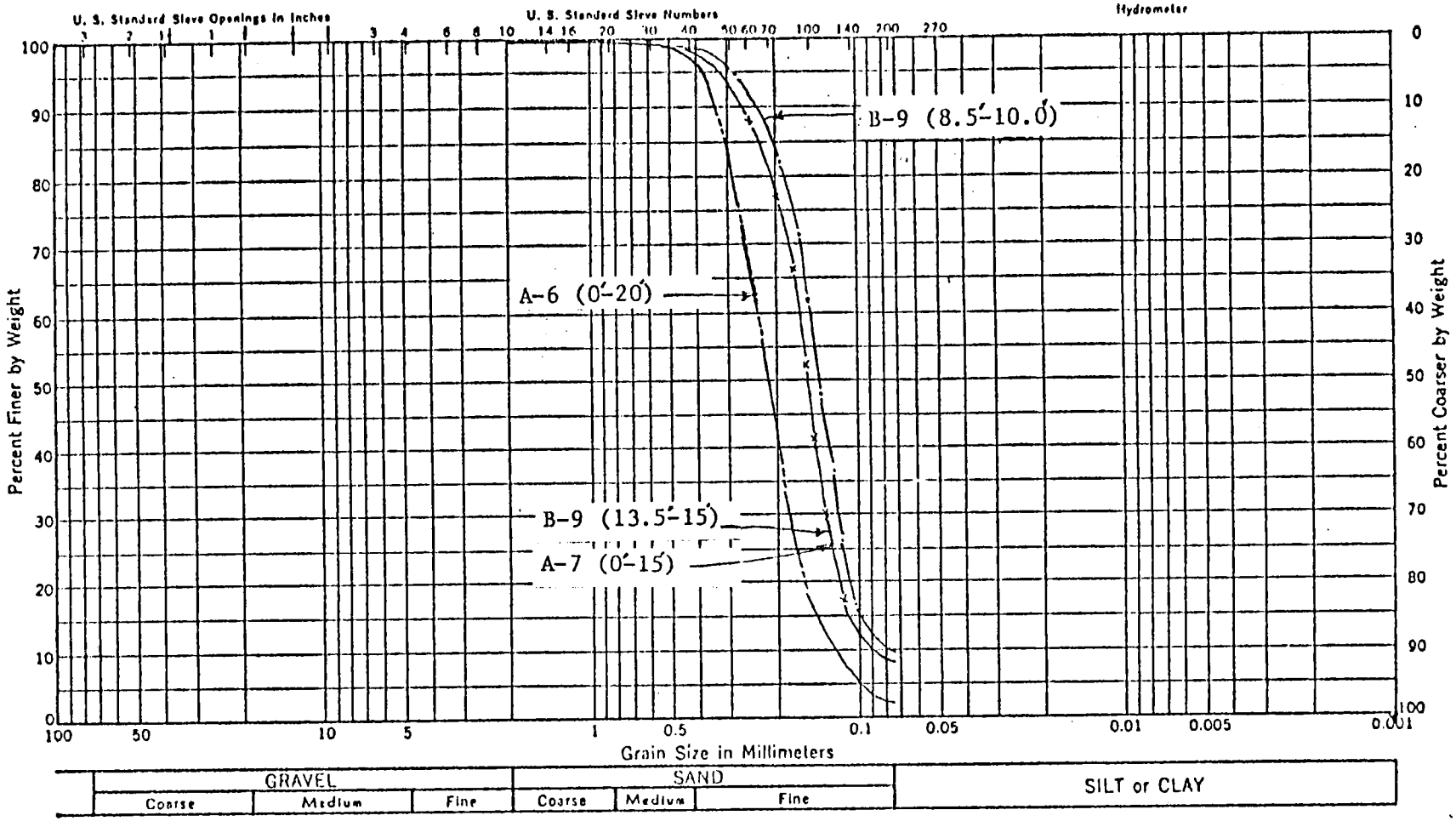
OIL CONTAINMENT STRUCTURES IMPRO.
NAS, CECIL FIELD, FLORIDA
FOR:
LANBANQUE DESIGN ASSOCIATES
ST. PETERSBURG, FLORIDA

PLATE 4

HARLAN ENGINEERING LABS, INC.
LAKELAND, FLORIDA.

DRAWN	APPROVED	DATE	JOB No.
DSS		3-1-76	S-625-P5

Table B-2 (Continued)



SAMPLE NO.	DEPTH IN FEET	LL	PL	PI	CLASSIFICATION
B-9	8.5-10	(SITE # 11)			Fine Sand w/some silt.
	13.5-15	(SITE # 11)			Fine Sand w/trace of silt.
A-7	0-15	(SITE #11)			Fine Sand w/trace of silt.
A-6	0-20	STREAM EXIT			Fine Sand.

OIL CONTAINMENT STRUCTURES IMPRO.
NAS, CECIL FIELD, FLORIDA
FOR:
LANBANQUE DESIGN ASSOCIATES
ST. PETERSBURG, FLORIDA

PLATE 5

HARLAN ENGINEERING LABS, INC.
LAKELAND, FLORIDA

DRAWN	APPROVED	DATE	JOB No.
DSS		3-1-76	S-625-P5

APPENDIX C

PROPOSED GROUND-WATER SAMPLING AND ANALYSIS PLAN FOR NAVAL AIR STATION, CECIL FIELD

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1.0 INTRODUCTION

Chapter 17-4.6(d) of the Florida Administrative Code requires owners and operators of facilities that discharge into the ground water to obtain and analyze samples from a ground-water monitoring system. The requirement includes the development and implementation of a ground-water sampling and analysis plan which must include procedures and techniques for sample collection.

To comply with these requirements at NAS Cecil Field, Florida, the following "Sampling and Analysis Plan" has been prepared.

2.0 SAMPLE COLLECTION AND SHIPMENT

2.1 Frequency of Sample Collection

Table 2.1 presents water quality parameters which should be monitored at NAS Cecil Field on a quarterly basis during the first year of monitoring and semi-annually in succeeding years. A map showing locations of the proposed monitor wells and a surface-water sampling station is presented in Figure C-1.

2.2 Equipment

Sampling equipment needed for collecting representative samples of ground water are presented below.

(1) 100-ft fiberglass or plastic measuring tape with weighted bottom (or) water-level indicator ("m-scope") consisting of an ammeter, electrode, and 100-ft cable;
(2) Several gallons of distilled water and wash bottle;
(3) Clean rags;
(4) Plastic sheeting or large size garbage bags;
(5) Bottom filling PVC bailer and 120-ft nautical rope, peristaltic pump, or submersible pump;
(6) Graduated bucket;
(7) Sample bottles;
(8) Sample bottle labels, waterproof marking pen;
(9) pH meter;
(10) Thermometer;
(11) Specific conductivity meter;

Table 2.1: Water Quality Parameters

Parameter	Monitor Wells S-2, S-3 and SA-1 (grease pit area)	Monitor Wells S-1 (upgradient) and S-4 & SA-2 (landfill area)	Surface-water Sampling Station (Rowell Creek)
Temperature (field)	x	x	x
pH	x	x	x
Specific Conductance (field)	x	x	x
Total Dissolved Solids	x	x	x
Chloride		x	x
Sulfate		x	x
Nitrate		x	x
Arsenic		x	x
Barium		x	x
Cadmium		x	x
Chromium		x	x
Fluoride		x	x
Lead		x	x
Mercury		x	x
Selenium		x	x
Silver		x	x
Volatile Organic Carbon Scan	x	x	
Turbidity			x

(12) Preservatives for water samples;
(13) Field data forms, clipboard, pen; and
(14) Optional: ice chest and ice or freezer packs.

2.3 Sample Collection Method

2.3.1 Procedures for Measuring Water Levels

(a) Place plastic sheeting around well to protect sampling equipment from potential contamination.

(b) After unscrewing outer casing cap, measure the depth to water in the well. All measurements are made from top of PVC casing.

- Using the M-scope, drop the probe down the center of the casing and allow cord to go untangled down the well. When ammeter indicates a closed electrical circuit, determine depth to water from top of PVC casing. Record depth to water on field data form (Figure C-2). Subtract this value from elevation at top of PVC casing to find elevation of water level (see Figures C-3 and C-4 for elevation of top of casing),

(or)

- Using a fiberglass or plastic 100-ft tape with sandpaper backing on first five feet, drop weighted tape down center of casing. After water is encountered in well, record measurement of tape at top of casing, wind up tape and record the measurement where tape is wet. Subtract the "wet" measurement from the "held" measurement to determine the depth to water. Subtract this value from the elevation at top of PVC casing to find elevation of water level.

- The water-level measurements must be obtained at each sampling point every time water samples are collected.

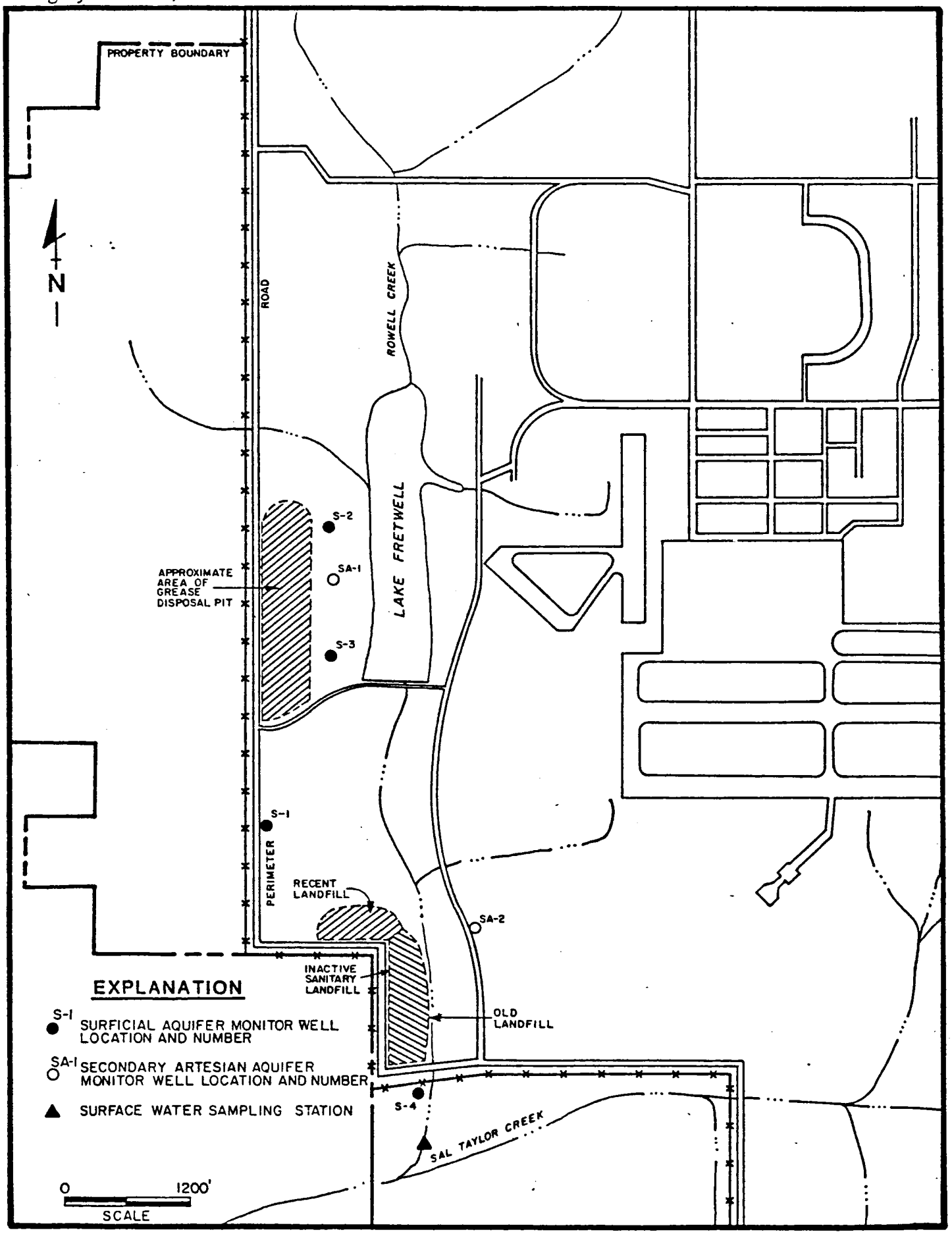


Figure C-1. Proposed Ground and Surface Water Monitoring Network.

Geraghty & Miller, Inc.

FIGURE 2: GROUND-WATER SAMPLING DATA FORM

Date: _____

Spring/Well Number: _____ Time: _____ to _____

Sampled by: _____ Weather: _____

GROUND-WATER ELEVATION

A. (1) Length of Tape Held at Top of Outer Casing: _____ (or) m-scope reading: _____

(2) Length of Tape Wet: _____

(3) Depth to Water (1 minus 2): _____

Water Level Elevation - Subtract Depth to Water from Elevation of Outer Casing: _____

Depth to Well Bottom: _____

Height of Water Column (h) = _____

WATER SAMPLING DATA

Volume of water in well:

$\pi r^2 h$ _____

_____

Amount of water removed from well: _____

Method of water removal: _____

Was well pumped dry? _____

FIELD ANALYSES AND REMARKS

Temperature: _____

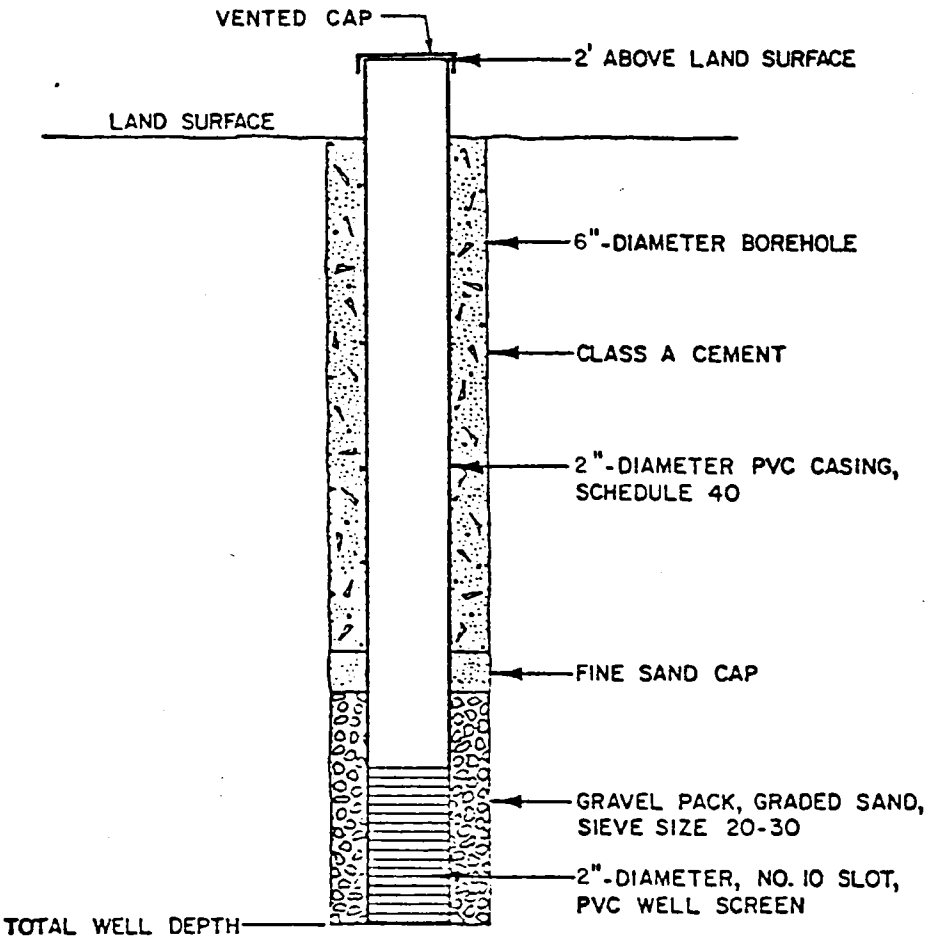
Specific Conductance: _____

pH: _____

Physical Appearance: _____

Number & Type of Samples Collected: _____

_____

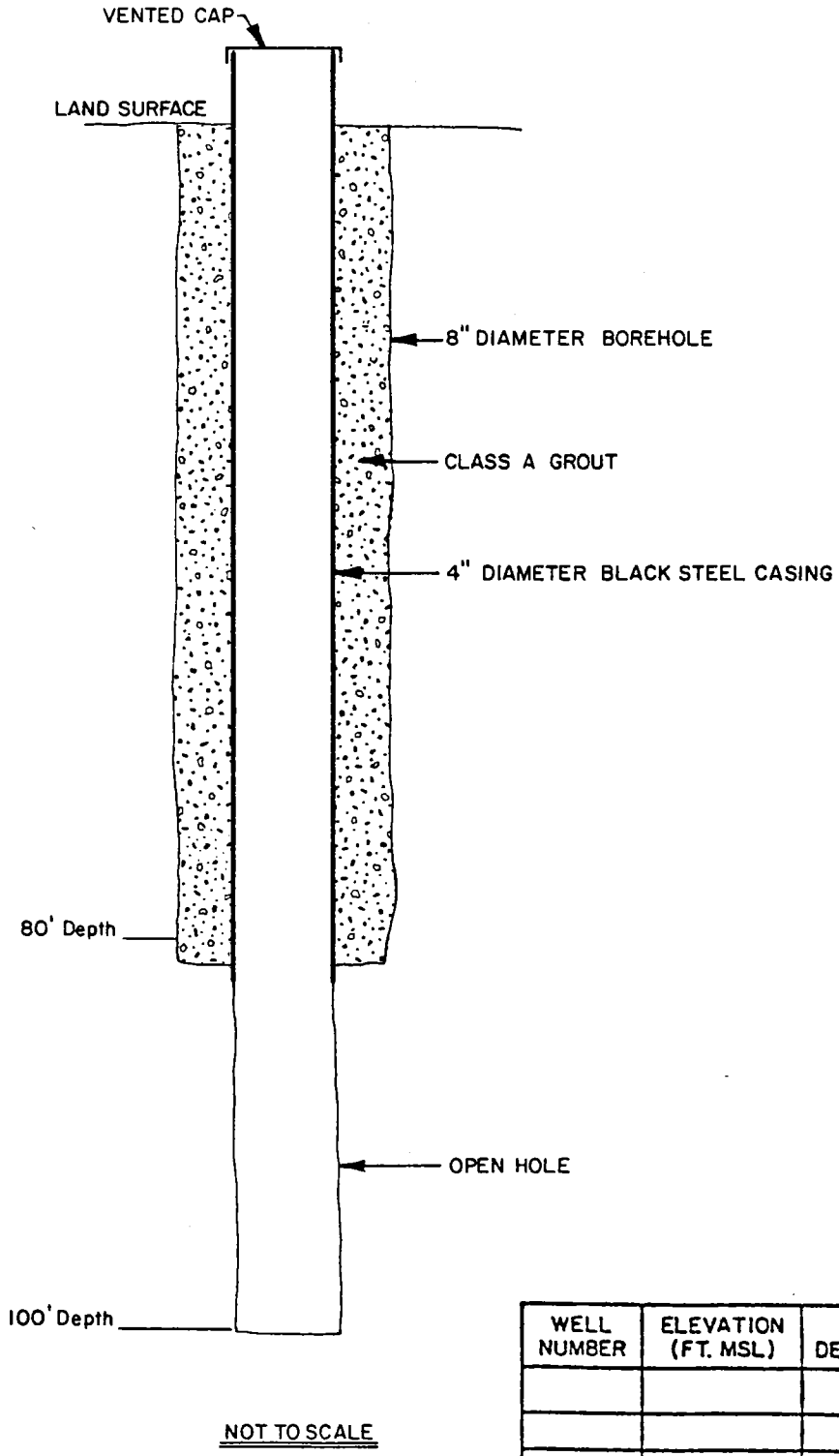


NOT TO SCALE

WELL NUMBER	ELEVATION (FT. MSL)	TOTAL DEPTH (FT.)

MEASUREMENT FROM TOP OF CASING

Figure C-3. Schematic Diagram of Surficial Aquifer Monitor Well.



WELL NUMBER	ELEVATION (FT. MSL)	TOTAL DEPTH (FT.)

MEASUREMENT FROM TOP OF CASING

Figure C-4. Schematic Diagram of Secondary Artesian Monitor Well.

(c) Clean M-scope or tape bottom with distilled water and wipe dry with clean rag.

2.3.2 Procedures for Removing Standing Water in Wells

(a) Remove at least one well volume of standing water using either the peristaltic pump, submersible pump, or a hand bailer.

- To find the volume of standing water in the well, use the following calculation:

$$V = 3.14\ r^2 h$$

where V = volume (ft^3)

r = radius of monitor well casing (ft)

h = height of standing water in well (ft)

- The height of standing water in the well is found by subtracting the depth to water measurement from the total depth of the well (refer to Figure C-3 for depth of monitor wells).

- It is generally recommended to remove three to five well volumes of water from the well to insure an accurate sample of ground-water quality but this may not be possible if the wells are low yielding. At the least, the well should be pumped or bailed to dryness before sampling. Use graduated bucket to measure volume of water removed from the well.

- The "Procedures Manual for Ground Water Monitoring at Solid Waste Disposal Facilities," pp 220 to 270, should be consulted for further information concerning the amount of water to evacuate from the well, types of pumps or

bailers to use in sampling ground water, and procedures to follow for using pumps or bailers. Another reference source is the U.S. Geological Survey (USGS) publication, "Guidelines for Collection and Field Analysis of Ground-Water Samples for Selected Unstable Constituents," pp 3 to 9.

(b) Clean bailer or pump with distilled water before use in other wells to prevent possible cross contamination of ground water in the monitor wells.

2.3.3 Procedures for Sample Collection and Field Analyses

(a) Allow well to recharge sufficiently to obtain samples. In some wells, this may require waiting a few minutes to a few hours; in other wells recovery time may be extremely slow and sampling may not be possible until after 24 hours. If the well is incapable of producing sufficient water required for analyses, composite sampling may be necessary where small quantities of samples are taken several days in a row.

(b) Analyses of pH, temperature, and specific conductance should be made in the field at the time of sampling because these parameters change rapidly and a laboratory analysis might not be representative of the true ground-water quality. Remove enough water from well to determine temperature of water, specific conductivity, and pH. Record values on field data sheet and discard water in a manner so as to avoid potential contamination.

(c) Rinse sample bottle with sampled ground water <u>except</u> when bottle is fixed with a preservative.

(d) Transfer water from well sampling device to sample bottles provided by the laboratory. Care should be

taken not to agitate sample in order to limit amount of added oxygen to water sample. Minimize the number of containers used in order to limit the addition of outside contaminants. Sample bottles should be prepared as specified by the 1974 and 1979 EPA "Manual of Methods for Chemical Analysis of Water and Wastes" (EPA 625/6-74-003 and EPA 600/4-79-020).

(e) If there is insufficient water in the well to supply the necessary volumes for samples specified above, the sample collector should fill up as many bottles as possible, preserve and label as required, and continue sampling daily until the remaining bottles are filled.

2.3.4 Surface Water Sampling Procedure

The collection of water samples from the sampling station on Rowell Creek will be done in accordance with EPA, 1980, Standard Operating Procedures and Quality Assurance Manual. At each sampling period, the water level from the staff gage will be recorded and stream discharge will be estimated.

3.0 ANALYTICAL PROCEDURES

Analyses of water samples collected from monitor wells will be performed by an approved laboratory.

Bibliography

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