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HYDROGEOLOGIC ASSESSMENT AND GROUNDWATER MONITORING NTC ORLANDO FL
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GERAGHTY AND MILLER

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FINAL REPORT

Hydrogeologic Assessment and Ground - Water Monitoring Plan, Naval Training Center, Orlando, Florida

Prepared for

NAVAL FACILITIES
ENGINEERING COMMAND
SOUTHERN DIVISION
Charleston, South Carolina

GERAGHTY & MILLER, INC.
GROUND-WATER CONSULTANTS

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HYDROGEOLOGIC ASSESSMENT AND GROUND-WATER MONITORING PLAN, NAVAL TRAINING CENTER, ORLANDO, FLORIDA

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July 1984

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INTRODUCTION

The Department of the Navy operates a Naval Training Center in Orlando, Florida. As shown in Figure 1, the Naval Training Center collectively consists of three distinct facilities: the NTC North, the NTC Annex (formally known as McCoy Air Force Base), and NTC Herndon Annex. In accordance with Chapter 17-4 FAC (Florida Administrative Code), Section 17-4.245(6)(d), a ground-water monitoring plan has been prepared for submittal to the FDER (Florida Department of Environmental Regulation). The sites requiring ground-water monitoring include: (1) an inactive landfill and inactive wastewater treatment lagoons at the NTC North, and (2) an inactive landfill and active wastewater treatment lagoons at the NTC Annex. No sites need to be monitored at the NTC Herndon Annex. Presented herein is background information for these sites, the hydrogeologic setting of the sites, an inventory of area wells, locations and construction details of existing and proposed monitor wells, and a water-quality sampling and analysis plan.

Background

The Naval Training Center occupies land formerly owned by the United States Air Force (USAF). The transition of this land from the USAF to the Navy occurred over the course of a few years: NTC North and NTC Herndon Annex in 1968, and the NTC Annex in 1974.

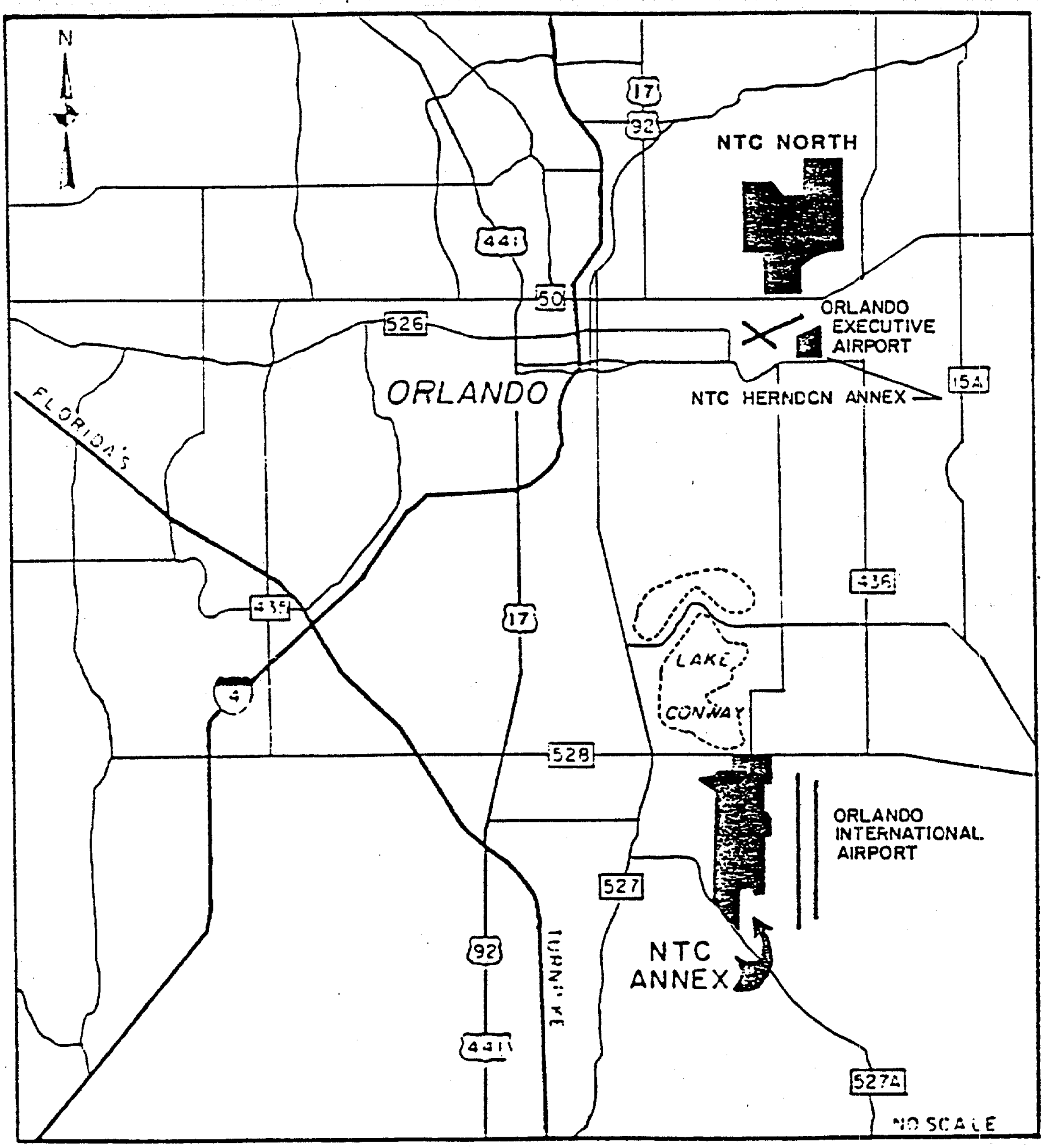

Figure 1. Map Showing the Location of the Naval Training Center Including NTC north, NTC Herndon Annex, and NTC Annex.

When the Navy began operation of these facilities, the two landfills, one at NTC North and one at NTC Annex, had already been closed out under the auspices of the USAF. The Navy did however, operate the wastewater-treatment facility at the NTC North for about eight years (the wastewater is presently being discharged to the Iron Bridge Road wastewater-treatment plant); the wastewater-treatment plant at the NTC Annex is still being operated, under the auspices of the City of Orlando.

Since closure of the landfills all solid wastes generated at the Naval Training Center is disposed of at a county-owned landfill. Some items, no longer usable, are sold to outside contractors for recycling including furniture and office equipment, paints, spent lubricants, and spent batteries. Although no manifest system presently is in place to track the fate of these products, the Navy is in the process of developing one.

NAVAL TRAINING CENTER DISPOSAL AREAS

NTC North

The NTC North is located approximately three (3) miles east of Interstate 4 and just north of State Road 50 (See Figure 1). This facility contains two (2) disposal sites including an inactive 15-acre landfill and two (2) inactive wastewater-treatment lagoons; the locations of these sites is shown in Figure 2. The landfill presently is overlain by a

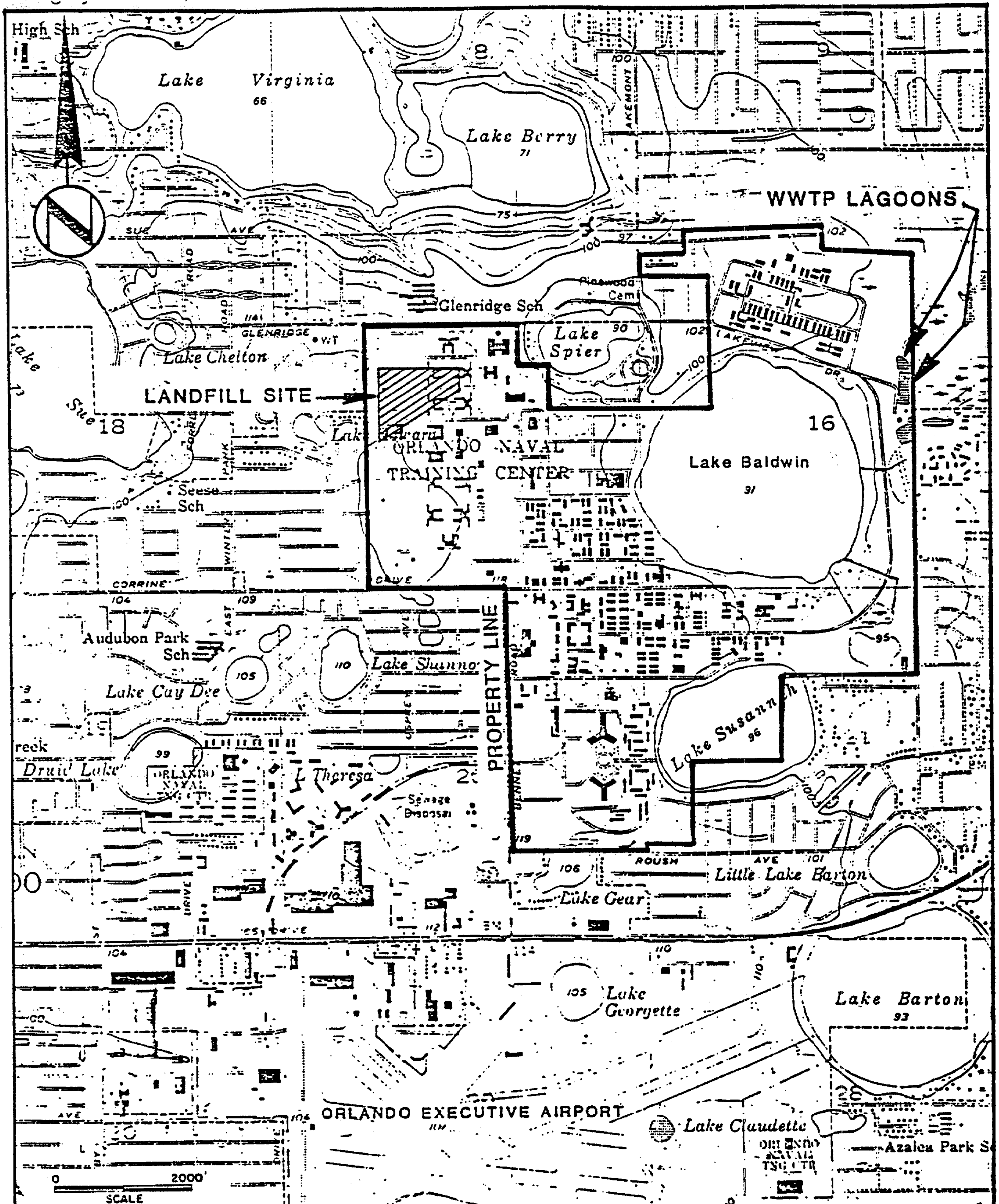

Figure 2. Map Showing the Approximate Locations of the Inactive Landfill and WWTP Lagoons, NTC North.

drill field and Barracks 1 and 3, and is bordered by Recruit Barracks 2 and 4, Perimeter Road, and a mock training battleship.

During the seven years it was operated (1960-1967), trenches were constructed as needed each being approximately 10 ft (feet) deep, 10 to 20 ft wide, and 50 ft long. As each trench was filled, it was covered with approximately 3 inches of top soil and occasionally, refuse was burned prior to burial (R. Bullard and E. Lee, personal interviews). The waste material disposed of at this landfill reportedly consisted of yard wastes (paper, plastics, trees, and construction material) and photochemical wastes including film and development chemicals (R. Bullard, personal interview). The amount of photochemical wastes disposed of is unknown.

A wastewater treatment plant (WWTP) also was located at the facility northeast of Lake Baldwin on what is now Truman Road. The WWTP handled a waste stream of about 35,000 to 50,000 gallons per day (gpd) from the on-base hospital. The effluent from the WWTP was disposed into two (2) lagoons located north and south of the treatment plant (See Figure 2). Since 1976, the wastewater has been pumped to the City of Orlando's Iron Bridge Road WWTP facility. The buildings associated with the WWTP have since been razed and the lagoons have been filled with tree limbs and bricks along with a final soil cover.

NTC Annex

The NTC Annex is located due south of State Road 528 and west of the Orlando International Airport (See Figure 1). The NTC Annex was acquired from the USAF in 1974 and contained two disposal sites: (1) an inactive landfill and an active WWTP. The locations of these disposal sites are shown in Figure 3.

The 64-acre landfill was operated between 1956 and 1973 and was closed prior to acquisition of the land by the Navy. In 1981, a nine-hole golf course was constructed over a majority of the landfill. The landfill reportedly contains yard wastes, photochemical wastes, and abandoned airplane parts. Disposal procedures were identical to those at the NTC North landfill: trenching, deposition of waste material, burial and covering, and occasional burning of refuse (C. Broyles, personal interview).

The Navy presently owns a 1.2-million gallons per day (mgd) wastewater-treatment facility at the NTC Annex, which is operated by the City of Orlando (See Figure 3). Effluent from the wastewater treatment plant is discharged into three lagoons for nitrogen removal by water hyacinths. Effluent from these lagoons is then discharged to a drainage canal that feeds Boggy Creek, and ultimately discharges to East Lake Tohopekaliga.

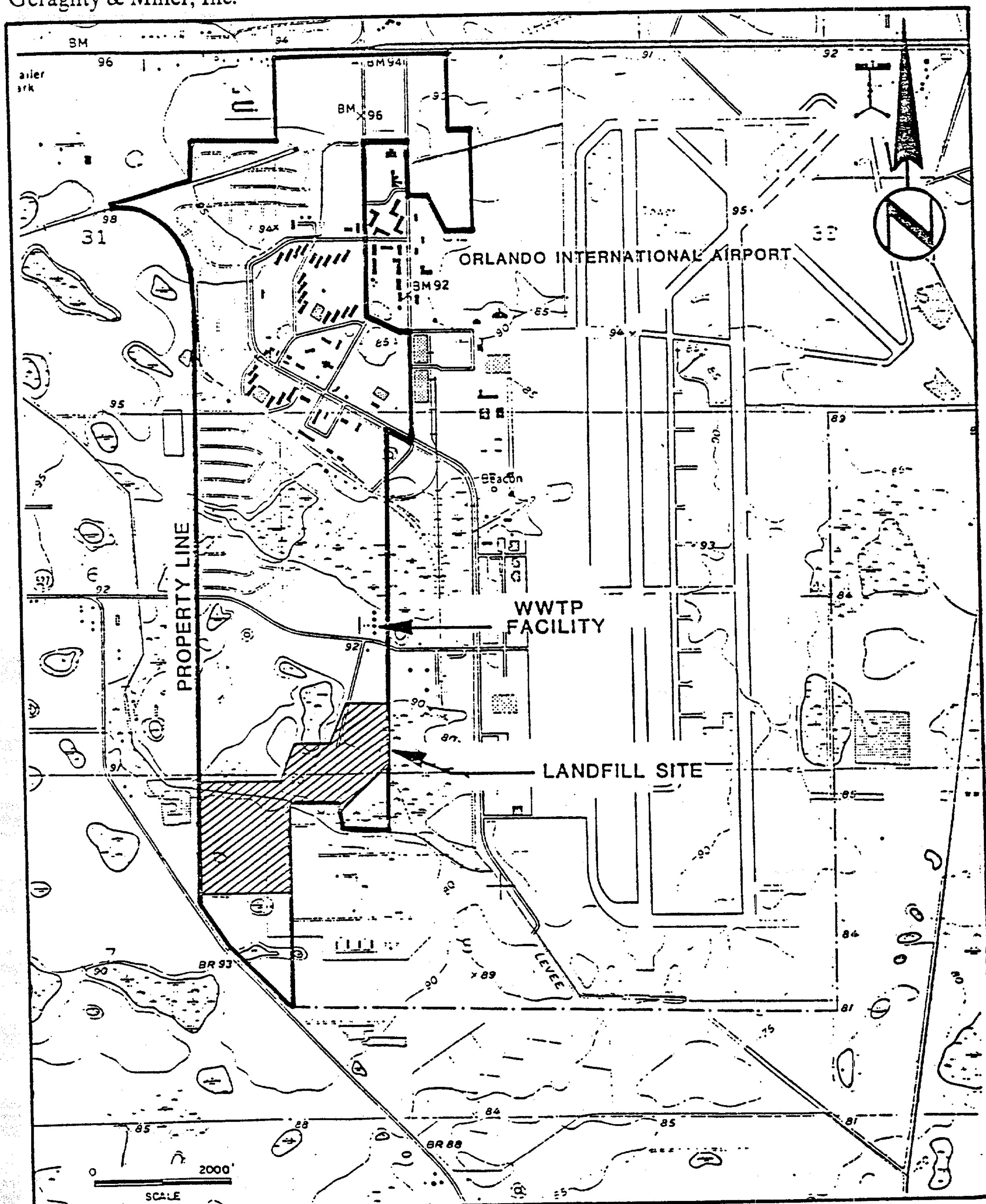

Figure 3. Map Showing the Approximate Locations of the Inactive Landfill and WWTP Facility, NTC Annex.

Presently under development is an alternate wastewater-treatment disposal plan referred to as Conserve I. As part of this plan, the wastewater-treatment facility at the NTC Annex will be modified to a pump station. Water collected from this facility will be pumped to a nitrification-denitrification treatment system located off-site for disposal into ten rapid infiltration basins. Thereafter, the three lagoons at the NTC annex will be closed out.

NTC Herndon Annex

The NTC Herndon Annex, which is located due south of NTC North along S.R. 50, was acquired from the USAF in 1968 (See Figure 1.) Contained within the NTC Herndon Annex is a computer center, flight-training building, uniform-supply warehouse, and several office buildings. Based on interviews with personnel from the Naval Training Center, it is reported that no on-site waste disposal practices occurred at NTC Herndon Annex by either the USAF or the Navy.

WELL INVENTORY

An inventory of wells located within one mile of the disposal sites was performed using information contained within a recent consultant's report (Boyle Engineering Corporation, 1982b) and from the U.S. Geological Survey. Presented in Figures 4, 5, and 6 are the locations of these wells; Table 1 provides infromation on well number, casing

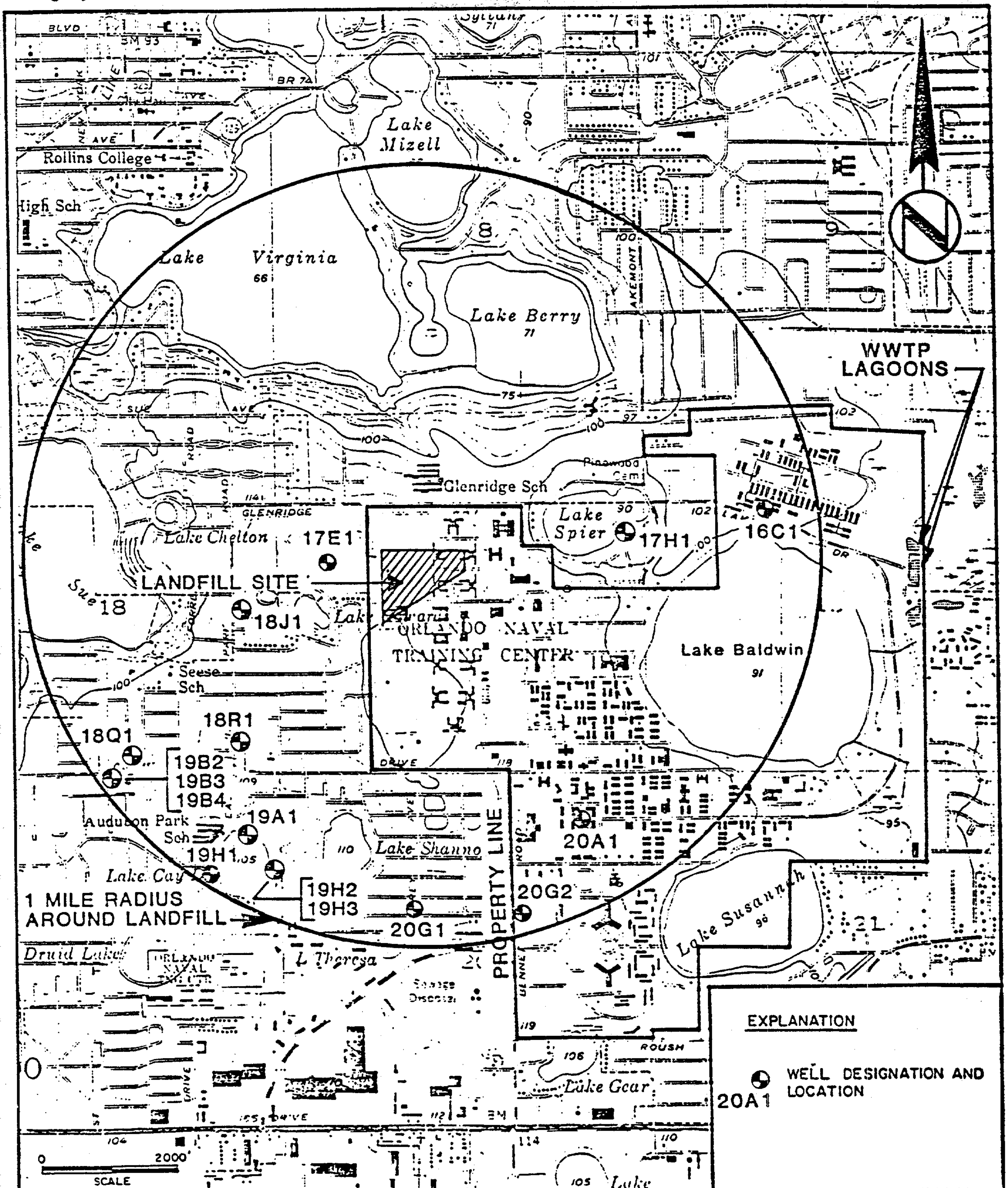

Figure 4. Locations of Wells Within One Mile of the Inactive Landfill, NTC North.

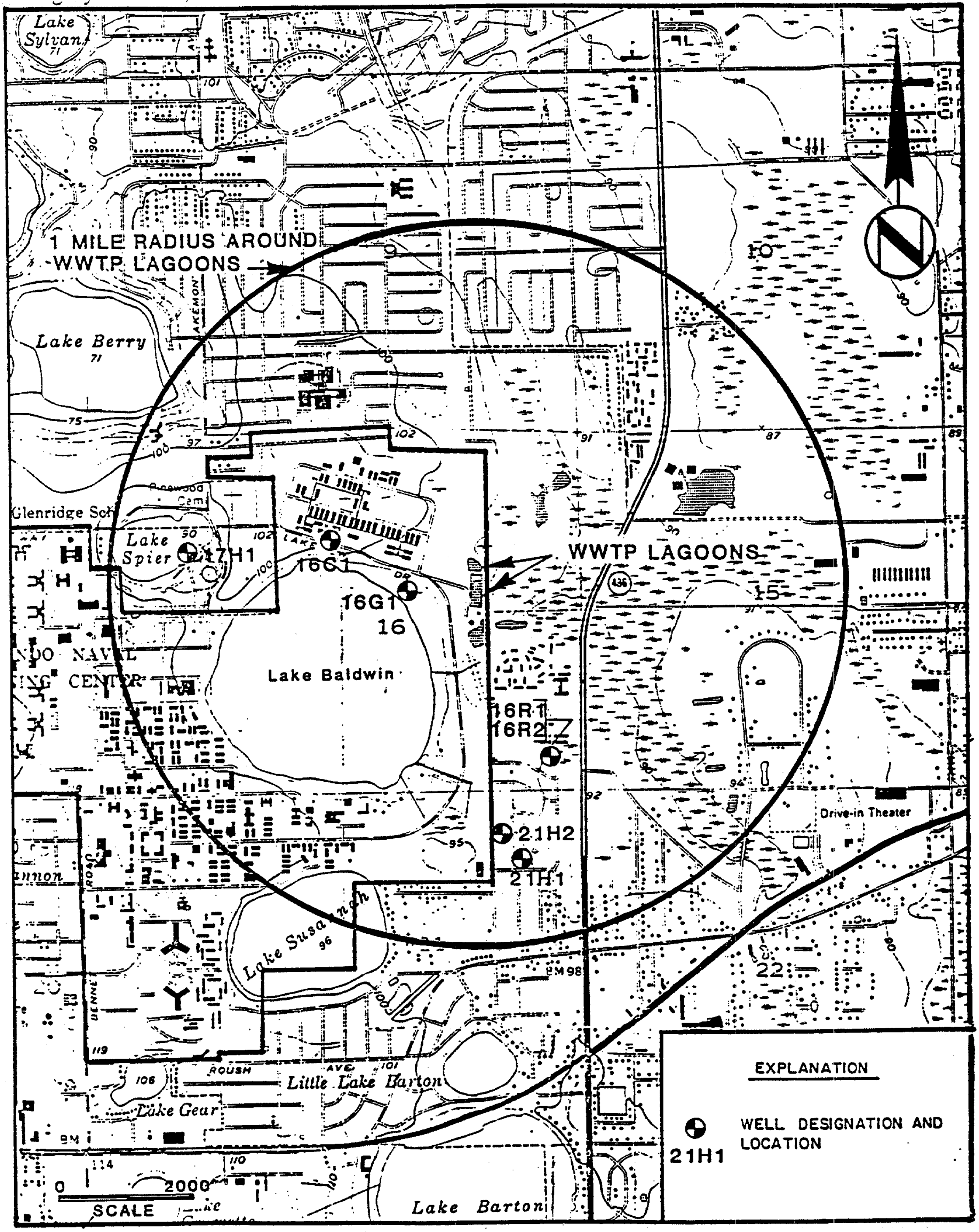

Figure 5. Locations of Wells Within One Mile of the Inactive WWTP Lagoons, NTC North.

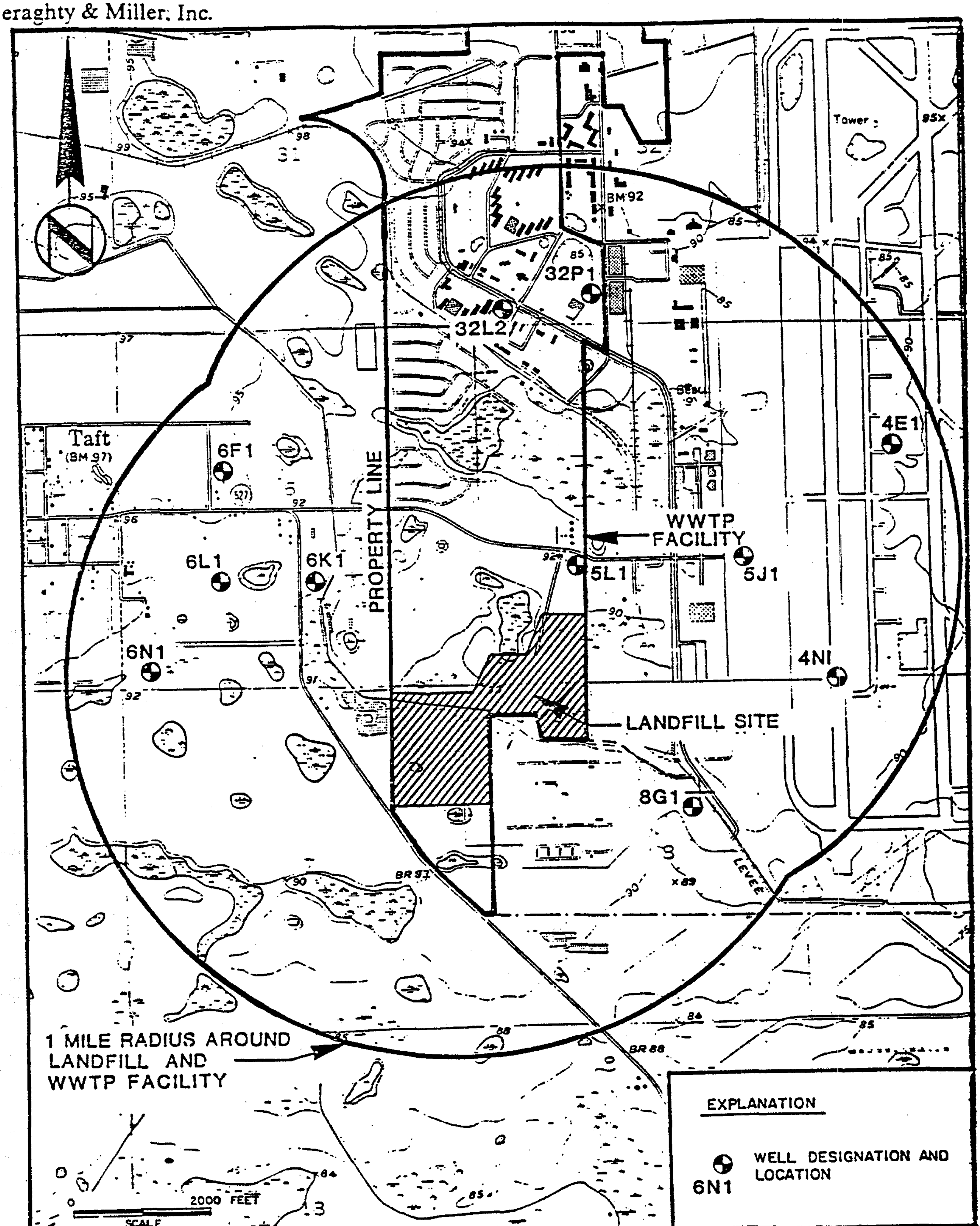

Figure 6. Locations of Wells Within One Mile of the Inactive Landfill and the WWTP Lagoons, NTC Annex.

Table 1. Inventory of Nearby Wells

Site	Well Number	Total Depth	Depth Cased	Owner	Use of Well
NTC North	22S-30E-20G1	464	205	City of Orlando	-
	22S-30E-19H2	453	180	City of Orlando	Destroyed
	22S-30E-19H3	1003	496	City of Orlando	Destroyed
	22S-30E-21H1	1371	1080	Orlando Utility	Withdrawal
	22S-30E-19A1	478	157	City of Orlando	Drainage
	22S-30E-21H2	250	170	M. Carrington	Withdrawal
	22S-30E-19B2	728	249	City of Orlando	Drainage
	22S-30E-19B3	462	292	City of Orlando	Drainage
	22S-30E-19B4	485	292	W.C. Phillips	Drainage
	22S-30E-18Q1	-	-	Orange County	Withdrawal
	22S-30E-16R1	475	225	So. States Util.	Withdrawal
	22S-30E-16R2	570	215	So. States Util.	Withdrawal
	22S-30E-18R1	437	247	Orange County	Destroyed
	22S-30E-18J1	425	113	Orange County	Destroyed
	22S-30E-17H1	-	-	Orange County	Destroyed
	22S-30E-17E1	1300	1206	Florida Utilities	Withdrawal
	22S-30E-16C1	680	-	So. States Util.	-
	22S-30E-16G1	570	-	-	-
	22S-30E-19H1	710	-	-	-
	22S-30E-20A1	400	-	-	-
	22S-30E-20G2	420	-	Navy	Irrigation
NTC Annex	23S-30E-32L2	375	-	Navy	Irrigation
	23S-30E-32P1	420	-	Navy	Irrigation
	24S-30E-4N1	216	-	Greater Orlando Aviation Authority	Abandoned
	24S-30E-5J1	400	-	U.S. Engineers	-
	24S-30E-6F1	450		Orange County Board of Education	-
	24S-30E-6K1	465	-	Boggy Creek Trailer Park	-
	24S-30E-6L1	320	-	-	-
	24S-30E-6N1	330	-	-	-
	24S-30E-8G1	215	-	Greater Orlando Aviation Authority	Abandoned
	24S-30E-4E1	216	-	Greater Orlando Aviation Authority	Abandoned
	24S-30E-5L1	215	-	Navy	Irrigation

and total depth, owner of each well and use. Each well in Table 1 is identifiable on Figures 4, 5, and 6 by using the last three or four digits in the well number. These wells reportedly penetrate a depth of at least 215 ft, and either withdraw water from or drain water to the Floridan aquifer.

The primary water supplies in the area are the Orlando Utilities Commission and Winter Park Utilities. Based on telephone conversations with personel from Orlando Utilities Commission (W. Birbyshaw) and from Winter Park Utilities (E. Gurr) only Orlando Utilities Commission has one supply well within one mile of the disposal sites (Table 1 and Figure 5).

Potable water used at the Naval Training Center is supplied from both the Orlando Utilities Commission and Winter Park Utilities; the wells located at the NTC North and NTC Annex are only utilized for irrigation purposes.

HYDROGEOLOGIC SYSTEM

Topography and Drainage

The Naval Training Center is located in the intermediate region of the Atlantic Coastal Plain in Orange County as described by Lichtler, et al. (1968). Altitudes in this region generally range between 85 and 125 feet above mean sea level (ft, msl). Land surface topography is relatively flat throughout the area. At the NTC North, the area is drained into Lake Spier, Lake Baldwin, Lake Susannah, Lake Gear, and by a county-owned drainage canal into the Little Econlockhatee River. At NTC Annex, drainage is conveyed through numerous golf course retention lakes and ditches, into Boggy Creek.

Geologic Framework

The geologic framework underlying the Naval Training Center generally consists of undifferentiated sediments primarily composed of sand, clay, and shell. These sediments overlie a thick sequence of marine carbonate rocks. A generalized geologic column based on information from Lichtler, et al. (1968) is illustrated in Figure 7.

The uppermost deposits of quartz sand contain varying amounts of clay and shell and extend to a depth of approximately 65 ft. Beneath these undifferentiated sediments is the Hawthorne formation, which consists primarily of gray-green, clayey sands, and sandy clays interbedded with thin discontinuous lenses of phosphatic sands and limestones. The low-permeability sediments of the Hawthorne formation comprise the confining deposits which retard vertical movement of water and hydraulically separate the surficial aquifer from the underlying Floridan aquifer. The permeable limestone layers within these confining deposits form what is referred to as the secondary artesian aquifer. Below the Hawthorne Formation, the Floridan aquifer is composed primarily of limestone and dolostone. This aquifer consists, in order of increasing depth, of the Ocala

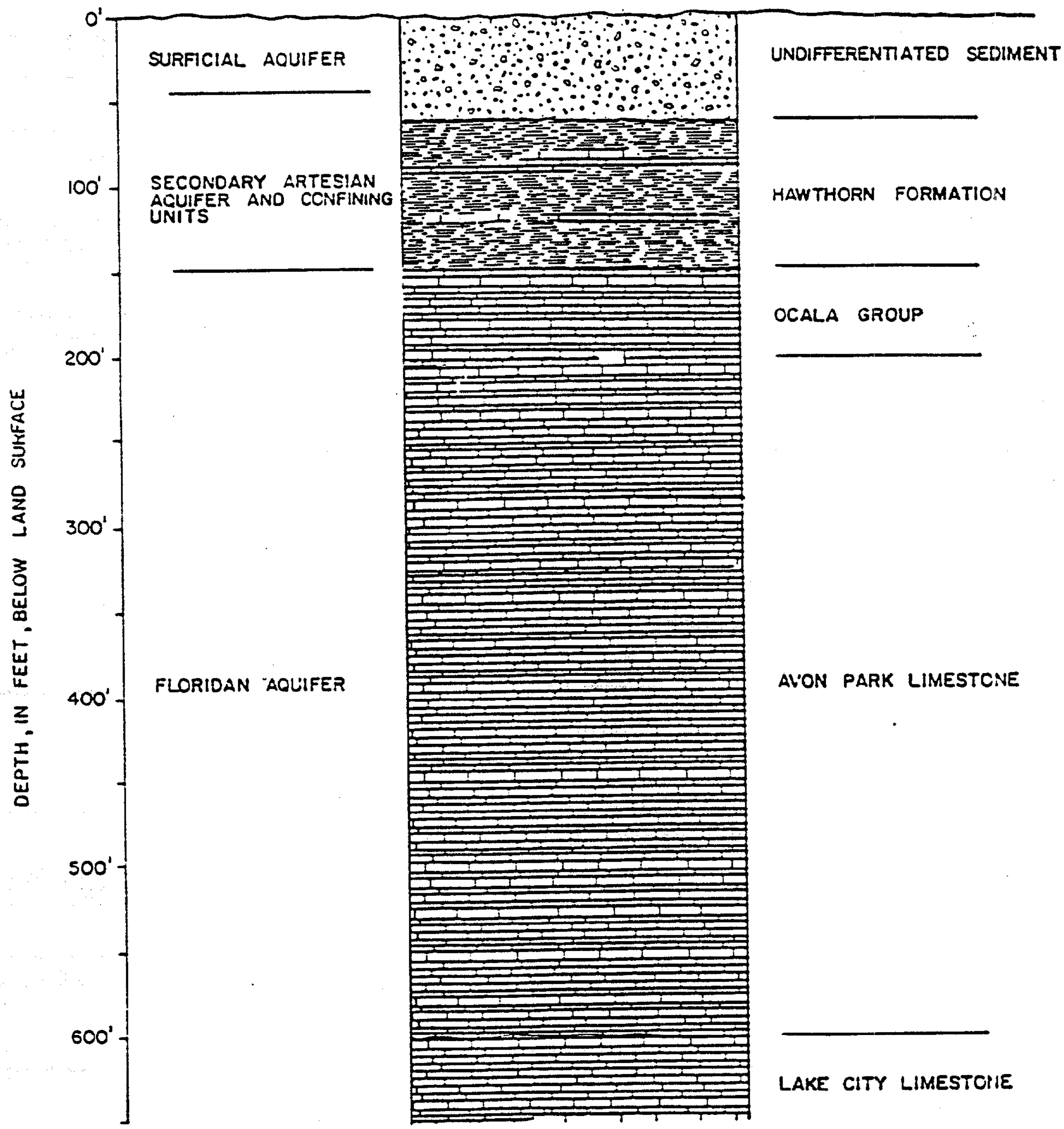

Figure 7. Generalized Geologic Cross-Section at the Naval Training Center.

Group, Avon Park Limestone, and the Lake City Limestone (Lichtler, et al., 1968).

Surficial Aquifer

The surficial aquifer primarily is composed of quartz sands and clayey sands that overlie the confining units of the Hawthorne Formation. In most areas the base of the aquifer extends approximately 40 ft below land surface (Lichtler, et al., 1968).

The permeability of the surficial aquifer was determined from bailing tests performed at the NTC Annex (Conklin, Porter and Holmes, Engineers, 1982). The results, which are summarized in Appendix A, ranged from 0.1 to 4.5 ft/day (feet per day) and averaged 2.8 ft/day. Laboratory constant-head tests on remolded Shelby tube samples resulted in vertical permeabilities that averaged 5.1 ft/day.

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. Although the potential for downward movement of ground water exists at the Naval Training Center, ground-water movement primarily is 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, lakes, or ditches. Based on the topography, the inferred direction of ground-water flow in the surficial aquifer at NTC North (Figure 8) from the inactive landfill is north-northeast toward Lakes Virginia, Berry, and Spier. At the inactive WWTP lagoons at the NTC North, the flow is either east toward Lake Baldwin or southeast toward a swampy area.

At NTC Annex, shallow ground-water flow is east and southeast according to on-site observation well water-level data (Conklin, Porter, and Holmes on December 7, 1982). Figure 9 shows direction of shallow ground-water flow in the vicinity of the disposal sites at the NTC Annex.

Secondary Artesian Aquifer

The secondary artesian aquifer occurs within the clayey confining beds of the Hawthorne formation and is composed of discontinuous lenses of sand, limestone, and dolostone. These aquifers generally are found at depths ranging from 60 to 150 ft below land surface. The transmissivity and storage coefficient for the secondary artesian aquifer is reported to be 31,800 gpd/ft (gallons per day per foot) and 0.003, respectively (Boyle Engineering Corporation 1982a).

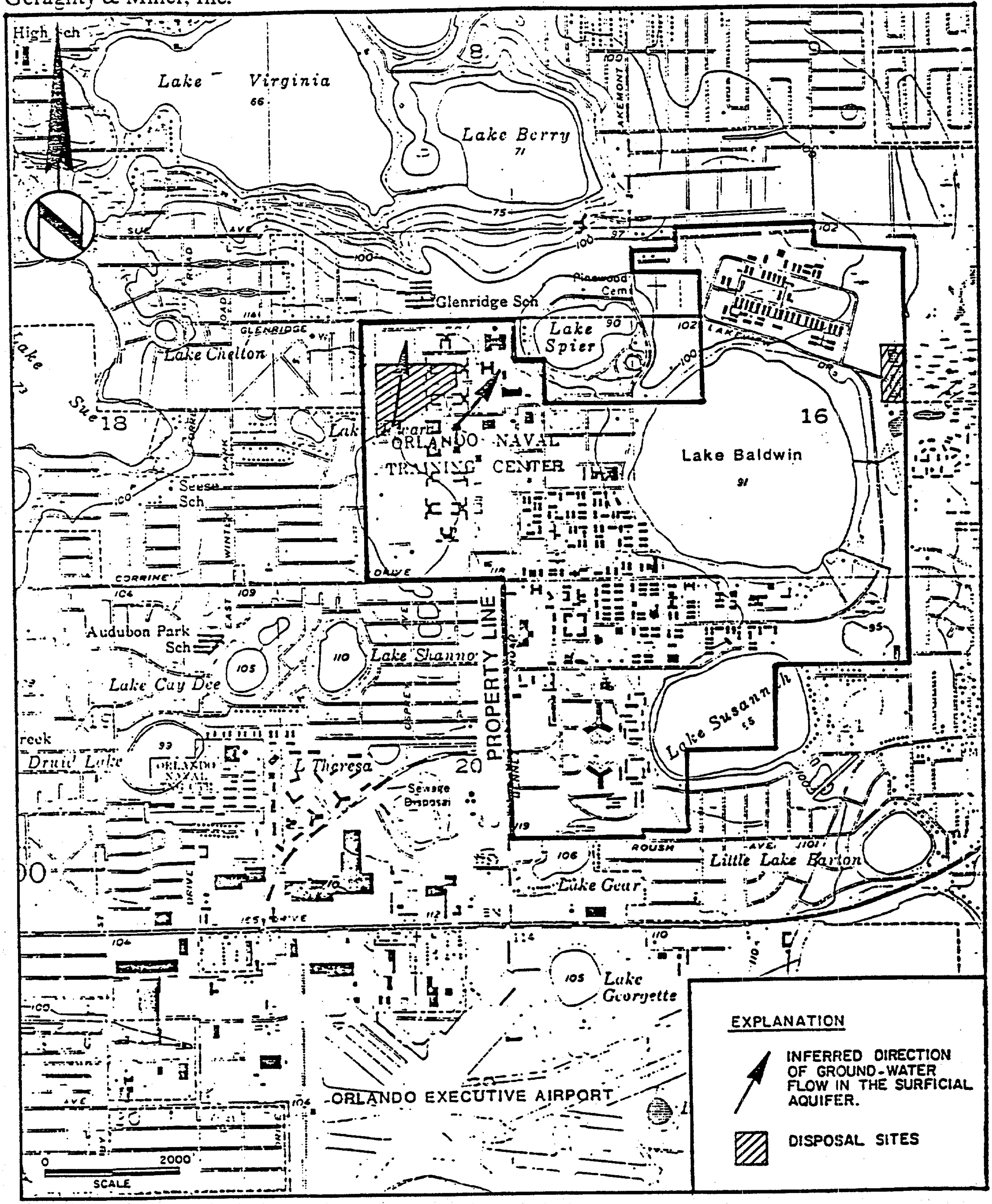

Figure 8. Inferred Direction of Ground-Water Flow in the Surficial Aquifer at NTC North

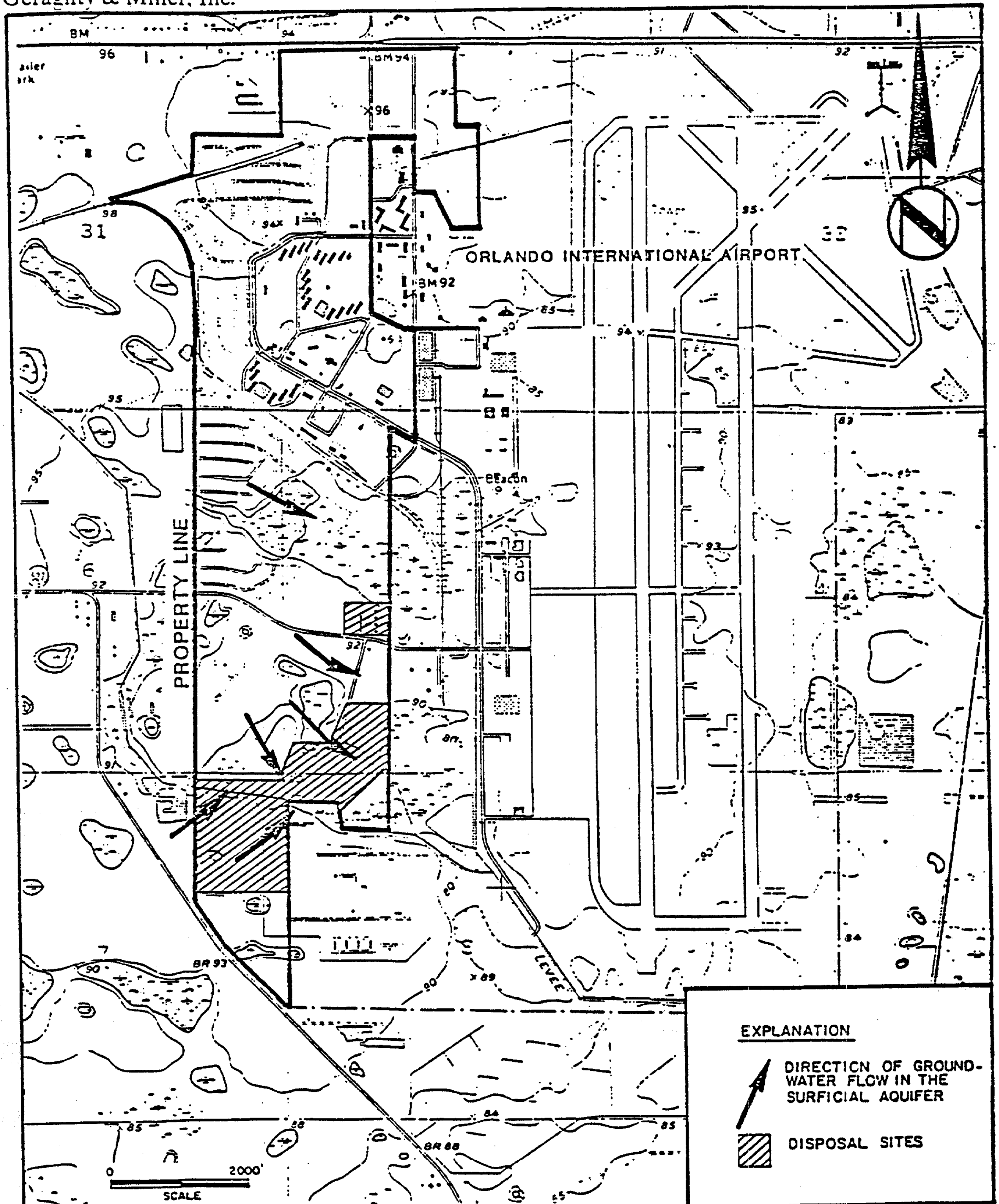

Figure 9. Inferred Direction of Ground-Water Flow in the Surficial Aquifer, NTC Annex

Floridan Aquifer

The Floridan aquifer consists of the Ocala Group, Avon Park Limestone, and the Lake City Limestone. The top of this aquifer generally occurs at a depth of approximately 150 to 200 ft below land surface, depending on the extent of erosion of the Ocala Group, and consists of nearly 2,000 ft of limestone and dolostone (Lichtler, et al., 1968).

The aquifer has two primary producing zones: an upper zone, which extends to a depth of about 600 ft, and a lower producing zone at a depth of approximately 1,000 to 1,500 ft (Lichtler, et al., 1968). The upper zone has a transmissivity which ranges between 270,000 and 596,000 gpd/ft and the lower zone has a transmissivity of between 4,300,000 and 5,000,000 gpd/ft (Boyle Engineering Corporation, 1982a).

Figure 10 illustrates the potentiometric surface of the Floridan aquifer at the Naval Training Center for September 1983. As can be seen, the regional ground-water flow in the Floridan aquifer is easterly.

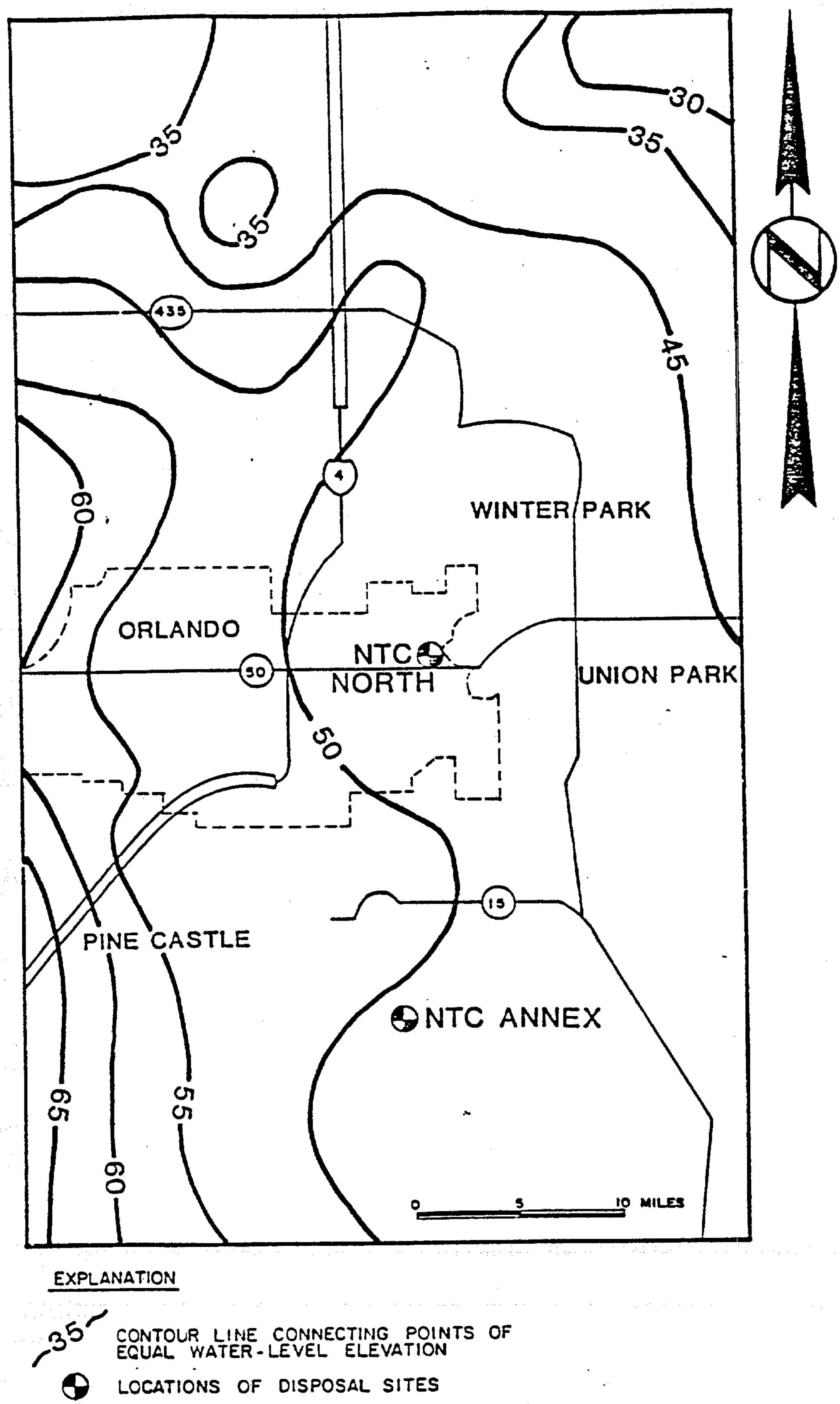

Figure 10. Potentiometric Surface of the Floridan Aquifer, September, 1983 (Source: U.S.G.S.)

PROPOSED MONITOR-WELL NETWORK

A ground-water monitoring plan has been prepared for the NTC North and NTC Annex with emphasis on monitoring the surficial aquifer. A monitoring program for NTC Herndon Annex has not been prepared due to the absence of past or present waste-disposal practices which could potentially discharge to the shallow ground water.

NTC North

At NTC North, a total of six monitor wells will be installed: four wells surrounding the landfill area, and two wells at the abandoned wastewater treatment plant lagoons (Figures 11 and 12). The excavation depth of the landfills at NTC were reported to be the water table (believed to range between 3 and 9 feet below land surface); therefore, the installed monitor wells will be constructed to a depth of at least 12 feet below land surface.

NTC Annex

The monitor-well network at NTC Annex will be split between the closed landfill and the present WWTP. Six wells (Figure 13) will be monitored quarterly around the landfill; four wells will be installed by G&M, and two are existing wells. Two wells (Figure 13) will also be installed around the lagoons at the WWTP. Presently there are two existing wells at the WWTP but their depth and construction details make them unsuitable for monitoring. Based on the reported

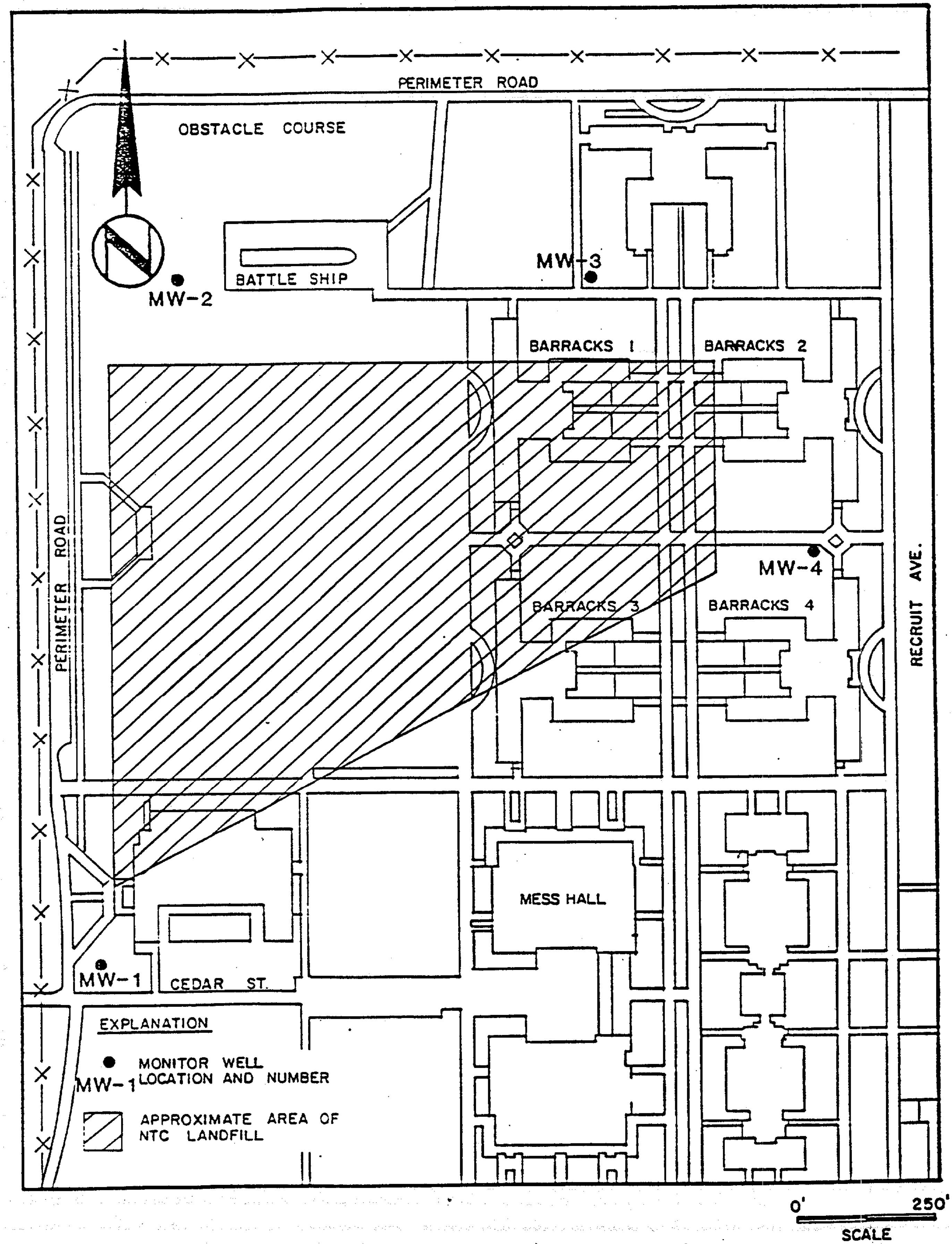

Figure 11. Proposed Ground-Water Monitor Network at the Inactive Landfill, NTC North

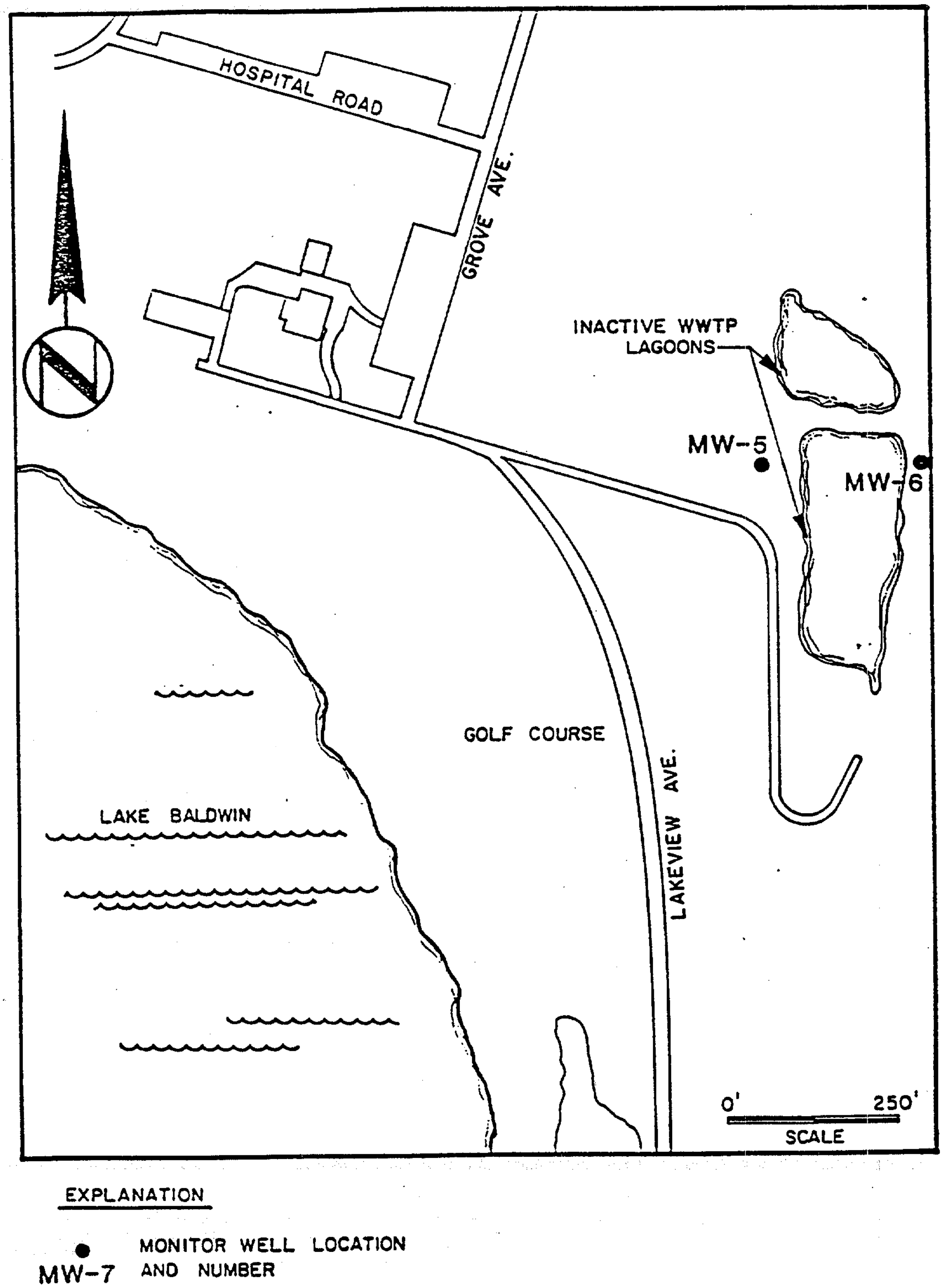

Figure 12. Proposed Ground-Water Monitor Network at the Inactive WWTP Lagoons, NTC North

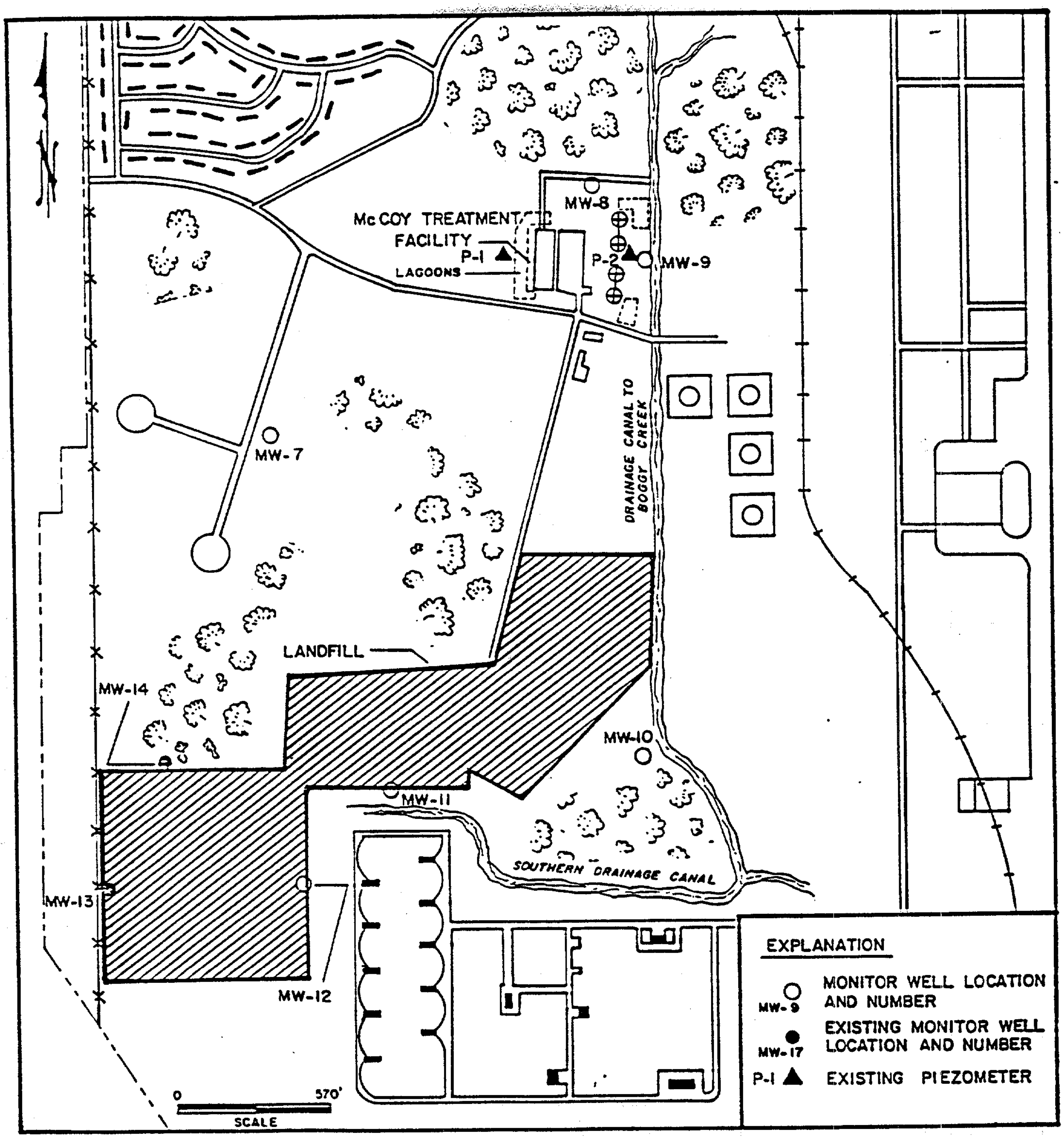

Figure 13. Proposed Ground-Water Monitor Network at the Inactive Landfill and WWTP Facility, NTC Annex

construction depths of the landfill and WWTP lagoons, the newly installed monitor wells will penetrate to a minimum depth of 12 feet below land surface. Construction details of the proposed and existing monitor wells are presented in the schematic diagrams shown in Figures 14 and 15.

Ground-Water Monitoring

At each site, one monitor well will be situated upgradient from the disposal area in order to establish background water quality. Monitor well MW-1 at NTC North and monitor well MW-7 at NTC Annex will serve as the upgradient wells.

Sampling of the monitor wells will be done in accordance with the sampling and analysis plan included in Appendix B. As seen in Table B-1 in Appendix B, the first quarter water-quality samples will be analyzed for the complete list of primary and secondary drinking-water parameters along with other selected parameters. During the second through fourth quarterly sampling rounds, only the parameters that will provide an indication of ground-water contamination or may be reasonably expected to be present in the ground water (based on the first quarter laboratory results and waste material) will be analyzed.

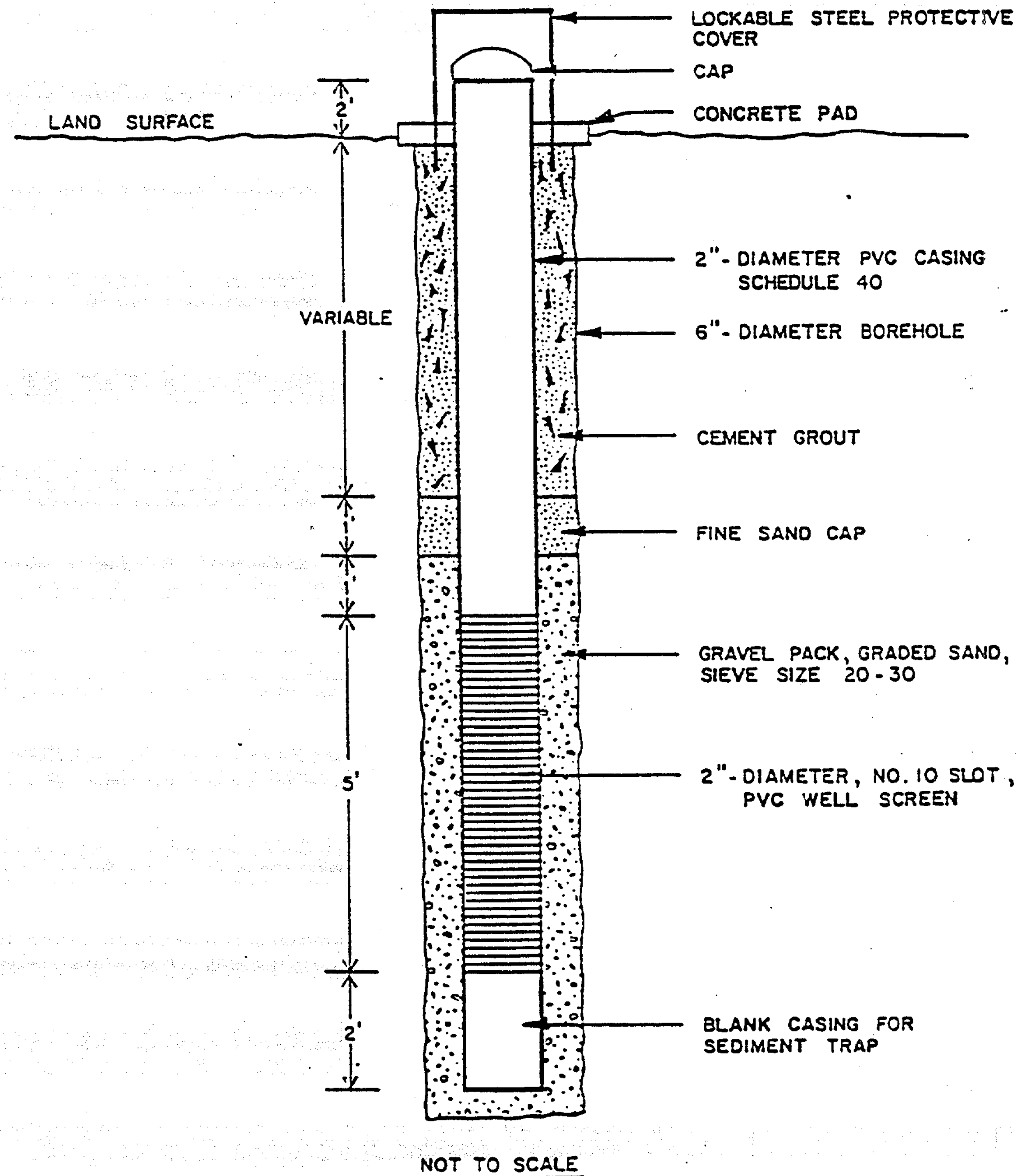

Figure 14. Typical Installed Permanent Monitor Well.

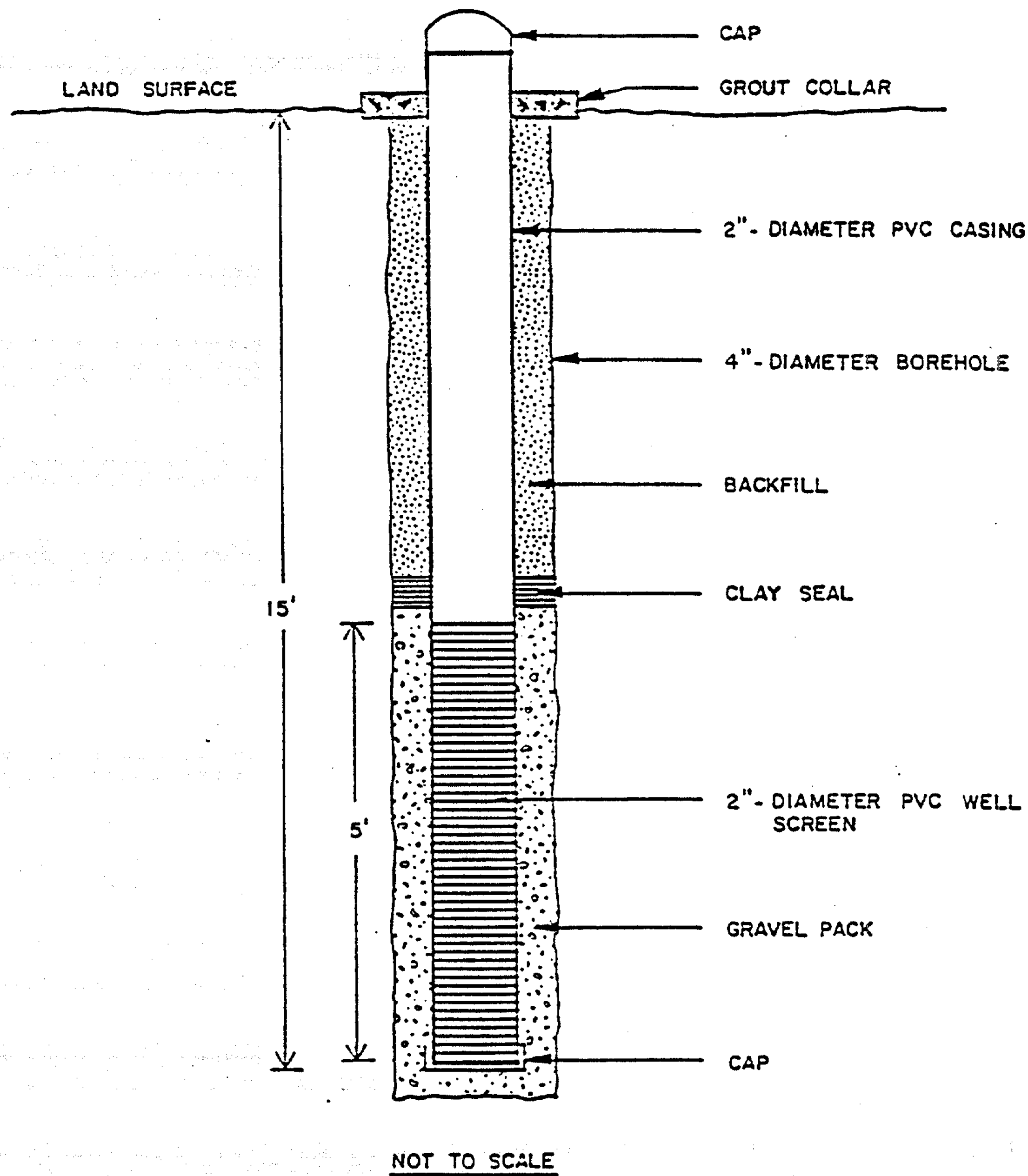

Figure 15. Typical Existing Monitor Well.

Following the first quarter sampling round, an "as-built" ground-water monitoring network report will be submitted to the FDER. This report will include the location and construction details of the installed monitor wells, site-specific geologic information, laboratory results from the first quarter samples, and water-level elevation data collected from the wells. At this time, the second through fourth quarter parameters (Table B-1) for monitoring will be confirmed at each monitored site.

A second report will be prepared and submitted to the FDER after the completion of one year of sampling in which the water-quality results for the year will be evaluated, including any significant deviation in the water quality at each well, direction and rate of ground-water flow, and future course of action for compliance with FDER regulations.

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APPENDIX A

PERMEABILITY TEST DATA FOR NTC ANNEX

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PERMEABILITY TEST DATA FOR NTC ANNEX

As reported by Conklin, Porter, and Holmes (1982), field testing was conducted at NTC Annex during November and December, 1982, to estimate the permeability of the surficial soils and the water-table aquifer. An air-entry permeameter was utilized at seven selected locations to test the vertical permeability of the surficial soils (Figures A-1, A-2, and Table A-1). Bailing tests were conducted at 22 shallow piezometers to test the horizontal permeability of the water-table aquifer (Table A-1). Use of the air-entry permeameter involves excavating the soil within a 2-foot diameter area to the depth where the most restrictive permeability layer is encountered (Bouwer, 1966). In the study area, this layer was generally well-defined and was found at depths ranging from land surface to 20 inches below land surface. Bailing tests conducted at the piezometers consisted of measuring the static water level at each piezometer, removing water from the casing as quickly as possible using a bailing device, and recording the subsequent rise in water level in the casing as a function of time until the level returned to the original static level. Using the bailing test data, permeability values were estimated, based on a method described by Bouwer and Rice (1976) (Table A-1).

Laboratory testing to estimate the vertical permeability of the subsurface materials also was conducted (Table A-1). These tests utilized five relatively undistrubed Shelby tube

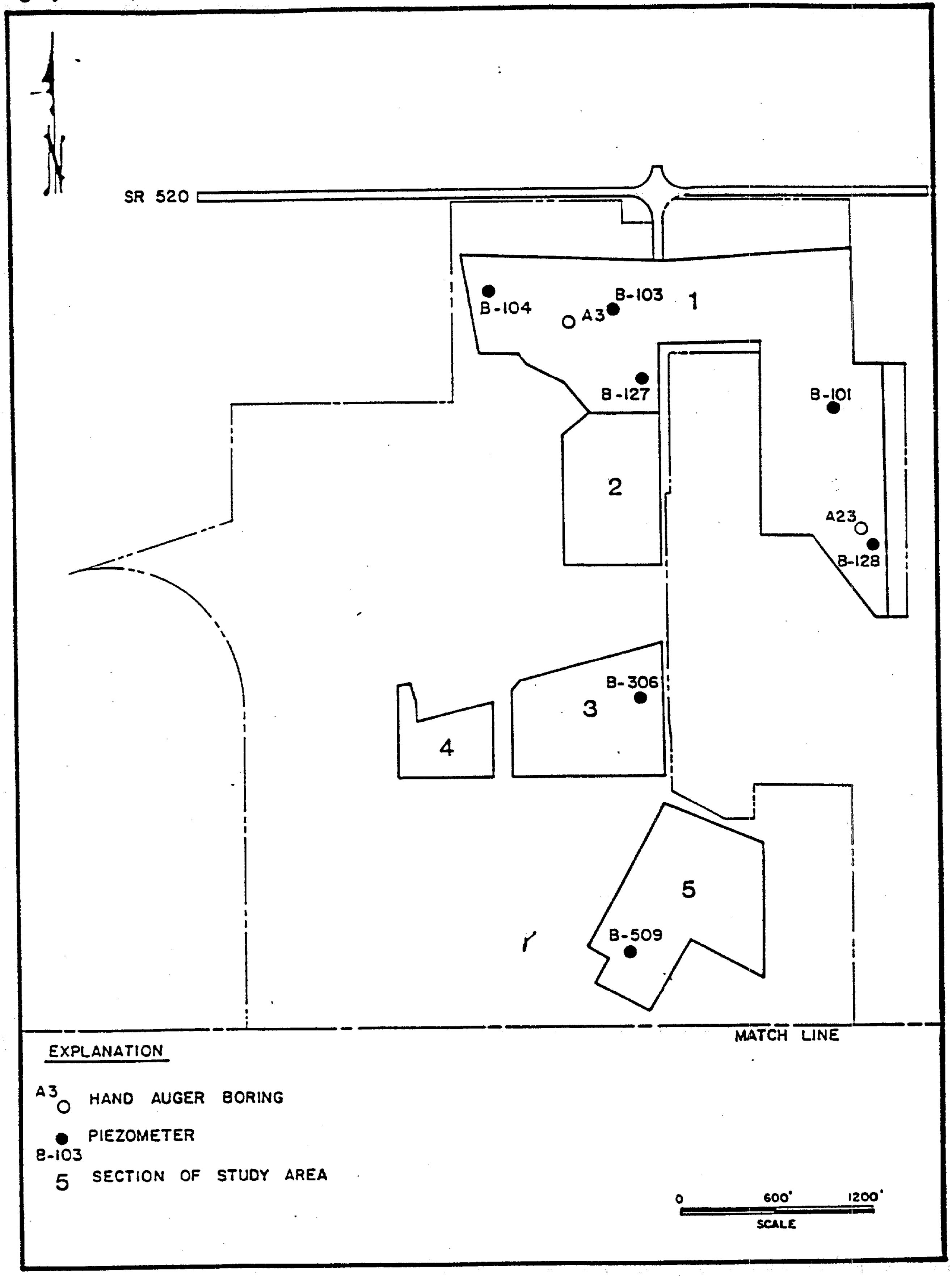

Figure A-1. Locations of Hand Auger Borings and Piezometers Used for Permeability Test Data, NTC Annex

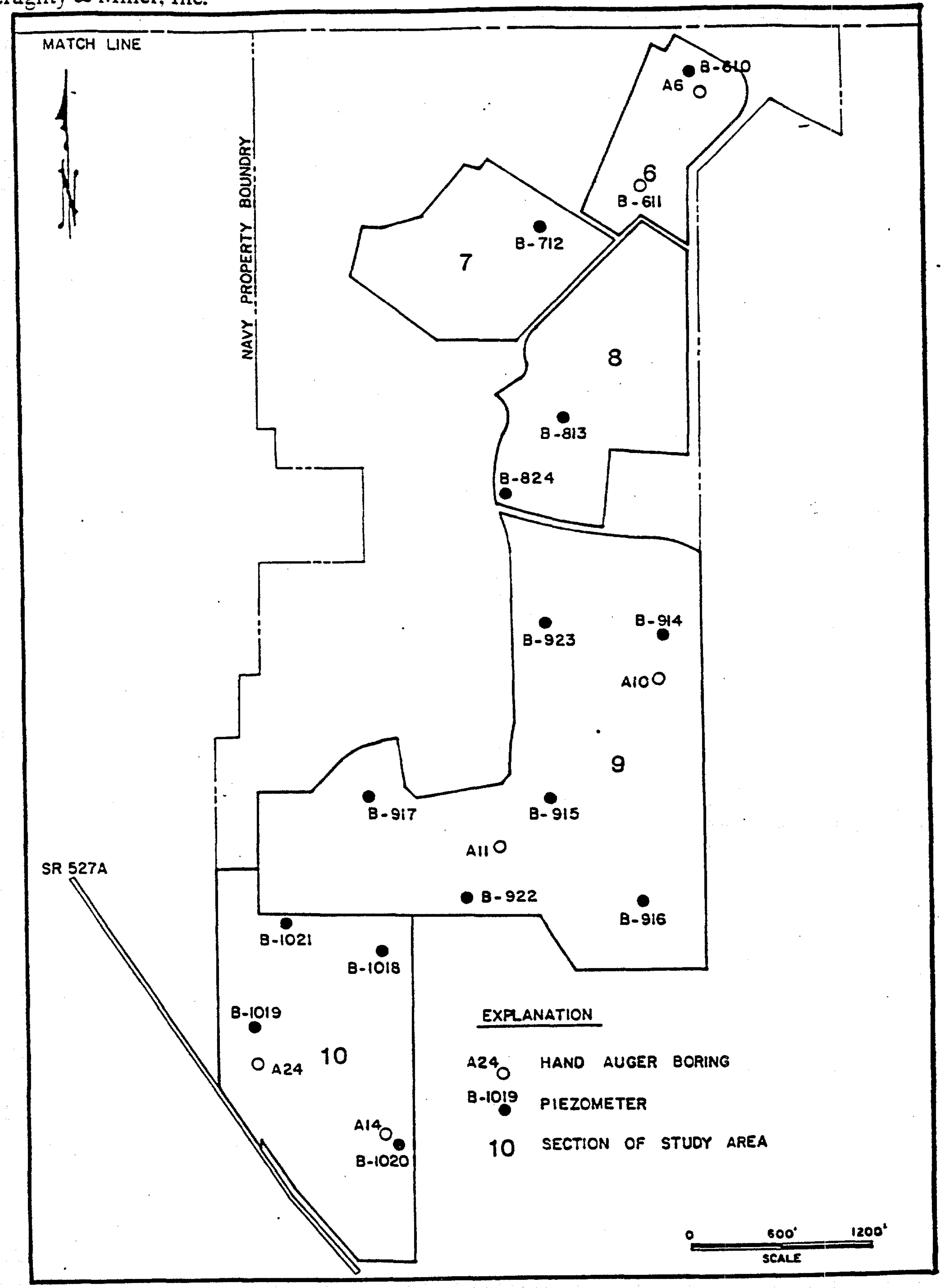

Figure A-2. Locations of Hand Auger Borings and Piezometers Used for Permeability Test Data, NTC Annex

TABLE A-1. Permeability Test Data

Test Number	Boring Number	Section Number	Type of Test	Depth of Material Tested	Stratum Number	Type of Material Tested	Permeability Estimated by SCS (inch/hour)	Permeability Measured (inch/hour)	Permeability Measured (feet/day)
1	A23	1	A	1.2-1.7	1	D	0.6-6	12.7	25.4
2	A1	1	A	1.0-1.5	1	D	0.6-6	0.32	0.6
3	A6	6	A	0.7-1.2	1	D	0.6-6	21.4	42.8
4	A24	10	A	1.7-1.9	1	D	0.6-6	1.1	2.2
5	A10	9	A	0.6-1.1	1	D	0.6-6	11.2	22.4
6	A14	10	A	1.0-1.4	1	D	0.6-6	0.18	0.4
7	A11	9	A	0 -0.5	1	E	6.0-20	7.6	15.2
8	B-101	1	B	10-15	1	G,H	--	--	0.1
9	B-103	1	B	10-15	1	G	--	--	3.1
10	B-104	1	B	10-15	1	G	--	--	2.0
11	B-127	1	B	10-15	1	K	--	--	4.2
12	B-128	1	B	10-15	1	K	--	--	2.9
13	B-306	3	B	10-15	1	K	--	--	5.4
14	B-509	5	B	10-15	1	K	--	--	0.7
15	B-610	6	B	10-15	1	G	--	--	3.4
16	B-611	6	B	10-15	1	K	--	--	2.6
17	B-712	7	B	10-15	1	G,H	--	--	2.0
18	B-813	8	B	10-15	1	G,H	--	--	2.8
19	B-824	8	B	10-15	1	K	--	--	4.1
20	B-914	9	B	10-15	1	G	--	--	3.4
21	B-915	9	B	10-15	1	K	--	--	5.3
22	B-916	9	B	10-15	1	F,H	--	--	2.0
23	B-917	9	B	10-15	1	H	--	--	0.2
24	B-922	9	B	10-15	1	K	--	--	2.7
25	B-923	9	B	10-15	1	K	--	--	3.7
26	B-1018	10	B	10-15	1	F,G	--	--	4.9
27	B-1019	10	B	10-15	1	K	--	--	4.6
28	B-1020	10	B	10-15	1	H	--	--	0.2
29	B-1021	10	B	10-15	1	K	--	--	1.3
30	B-103	1	C	12.6-13.2	1	G	--	--	3.1
31	B-1018	10	C	12.0-12.5	1	G	--	--	7.1
32	B-103	1	C	36.7-37.2	2	I	--	--	4.8×10^{-3}
33	B-610	6	C	53.0-53.7	2	J	--	--	4.0×10^{-4}
34	B-1018	10	C	42.5-43.0	2	I	--	--	1.6×10^{-4}

A = Air-entry permeameter
B = Bailing test in piezometer
C = Laboratory permeability test
D = Leon soil series (B Horizon)
E = Disturbed Leon soil

F = Fine sand
G = Slightly silty fine sand
H = Slightly silty slightly clayey fine sand
I = Slightly silty slightly sandy clay
J = Clay
K = Sand; no samples taken at this depth

samples of sand and clay. The tests performed on the clay samples utilized a falling-head method, and the samples were from depths ranging from 36.7 to 53.6 feet below land surface. The tests performed on the sand samples utilized a constant-head method and remolded samples from depths ranging from 12.0 to 13.2 feet. In conjunction with the laboratory permeability testing, tests were performed to determine unit weight and moisture content of the undisturbed samples (Table A-2).

TABLE A-2. LABORATORY SOIL TEST DATA

Boring	Sample Depth (feet)	Type of Material Tested	Dry Unit Weight (lbs/ft^3)	Moisture Content (percent)
B-103	12.6-13.2	Slightly silty fine sand	103.9	21.6
B-1018	12.0-12.5	Slightly silty fine sand	105.5	21.1
B-103	36.7-37.2	Slightly silty slightly sandy clay	83.7	37.8
B-610	53.0-53.7	Clay	64.4	59.7
B-1018	42.5-43.0	Slightly silty slightly sand clay	46.2	96.2

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APPENDIX B

PROPOSED GROUND-WATER SAMPLING AND ANALYSIS PLAN FOR NAVAL TRAINING CENTER AND NAVAL TRAINING CENTER ANNEX, ORLANDO

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1.0 INTRODUCTION

Chapter 17-4.245(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 NTC and NTCA, Orlando, 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 NTC and NTCA on a quarterly basis during the first year of monitoring. Maps showing locations of the proposed monitor wells and a surface-water sampling station at all sites are presented in Figures B-1 through B-3.

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 B-1. Ground-Water Monitoring Parameters and Sampling Frequency for Compliance with Chapters 17-3 and 17-4, FAC, NTC North and NTC Annex, Orlando

Ground-water Monitoring Parameter	First Year of Water Quality Monitoring[1/]							
	NTC North				NTC Annex			
	4 monitor wells at NTC North landfill		2 monitor wells at old wastewater treatment plant lagoons		6 monitor wells at NTC Annex landfill		2 monitor wells at wastewater treatment plant lagoons	
	1st	2nd-4th	1st	2nd-4th	1st	2nd-4th	1st	2nd-4th
Primary Drinking Water Parameters[2/]	x		x		x		x	
Secondary Drinking Water Parameters[3/]	x		x		x		x	
Partial List								
Temperature (field)	x	x	x	x	x	x	x	x
pH (field & lab)	x	x	x	x	x	x	x	x
Specific conductance (field)	x	x	x	x	x	x	x	x
Total Dissolved Solids		x		x		x		x
Chemical Oxygen Demand		x		x		x		x
Nitrates		x		x		x		x
Arsenic		x		x		x		x
Barium		x		x		x		x
Cadmium		x		x		x		x
Chromium		x		x		x		x
Lead		x		x		x		x
Iron		x		x		x		x
Manganese		x		x		x		x
Zinc		x		x		x		x
Volatile Organic Compounds	x	x	x	x	x	x	x	x
Phenols	x	x	x	x	x	x	x	x

1/ The first year of monitoring is divided into first quarter sampling and second to fourth quarter sampling. After a full year of ground-water monitoring, the parameters and sampling frequency will be evaluated and reassessed prior to the second year of monitoring.

2/ Primary Drinking Water Parameters will exclude coliform turbidity and radium 226 and 228.

3/ [illegible]

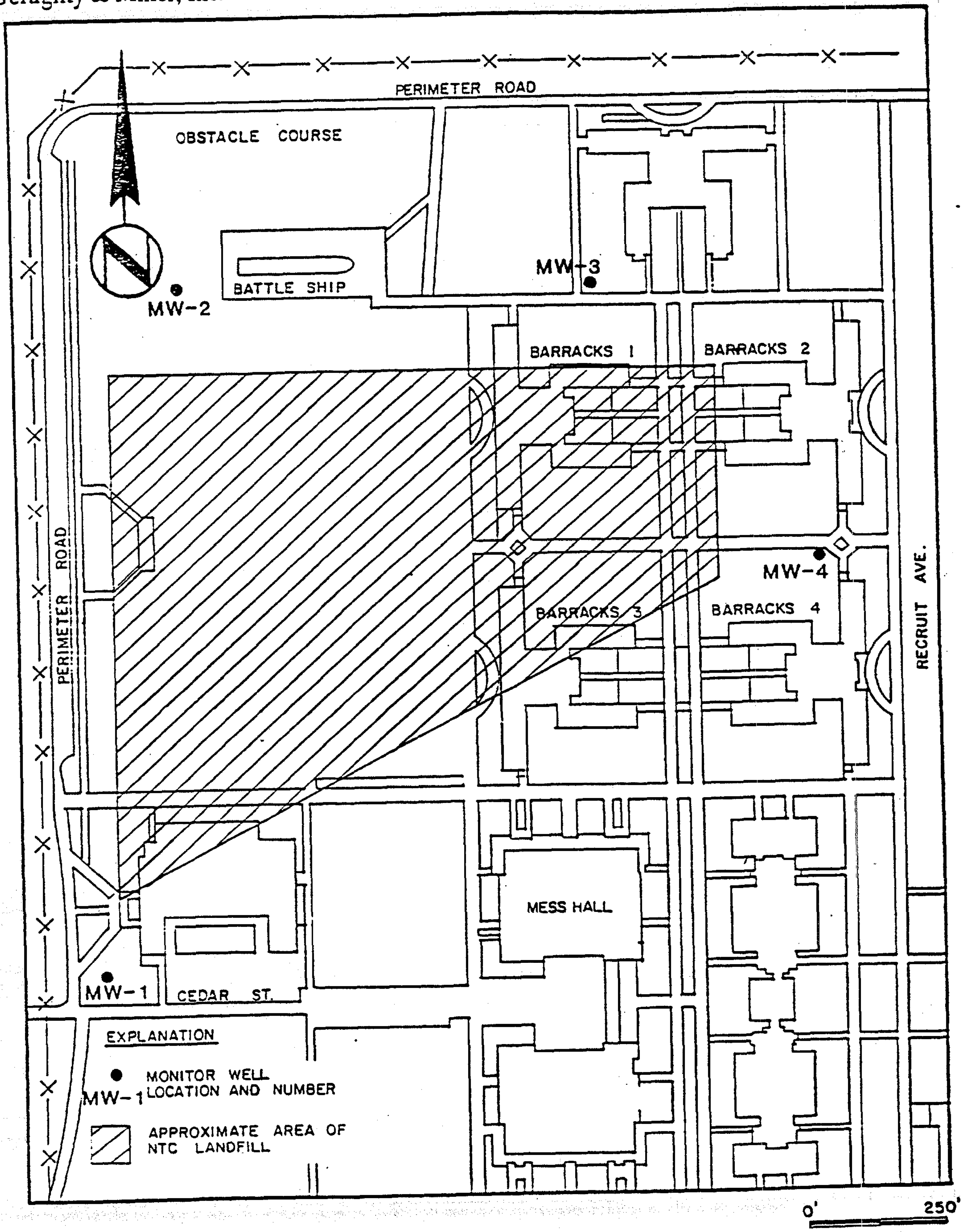
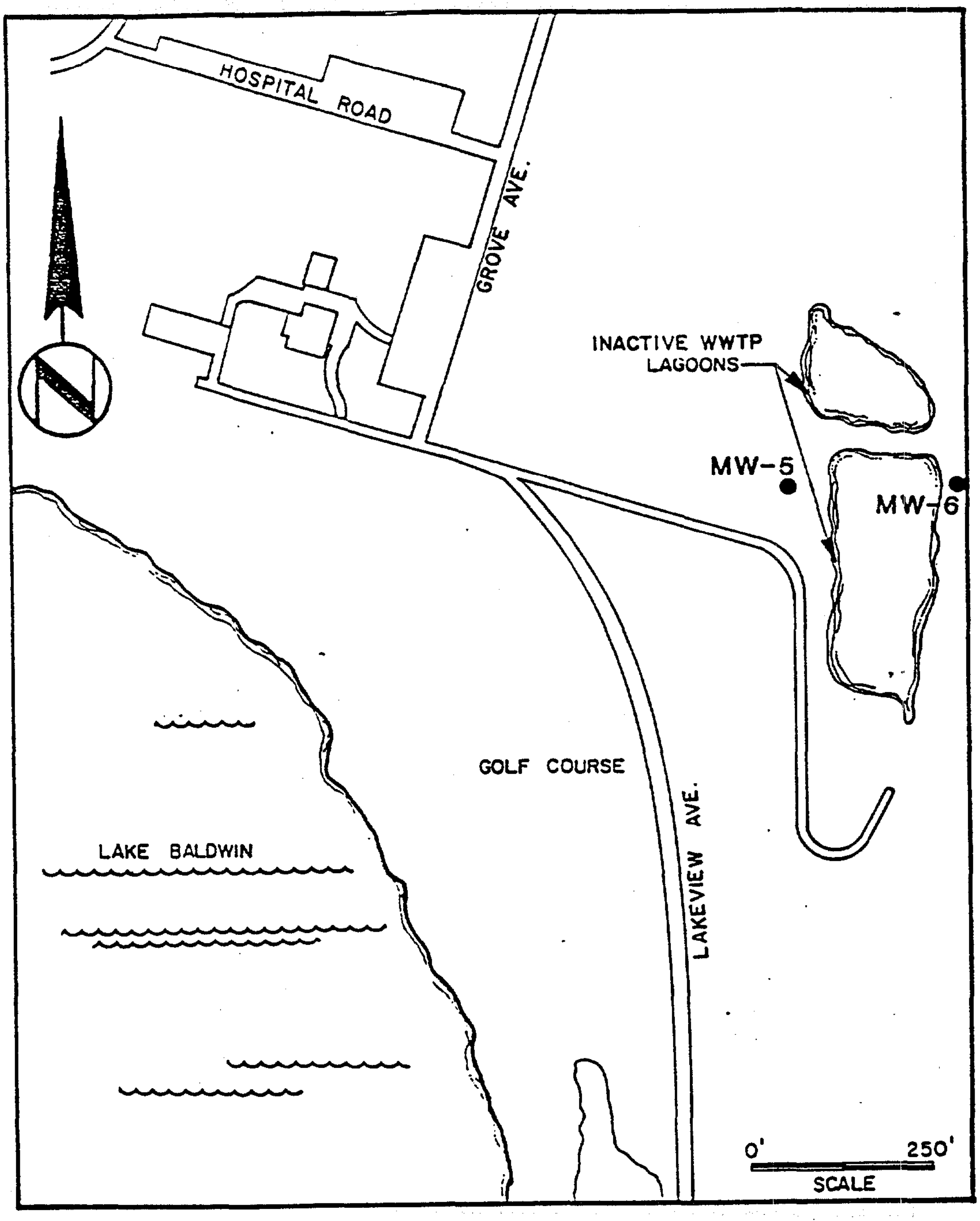


Figure B-1. Proposed Ground-Water Monitor Network at the Inactive Landfill, NTC North



EXPLANATION

● MW-7 MONITOR WELL LOCATION AND NUMBER

Figure B-2. Proposed Ground-Water Monitor Network at the Inactive WWTP Lagoons, NTC North

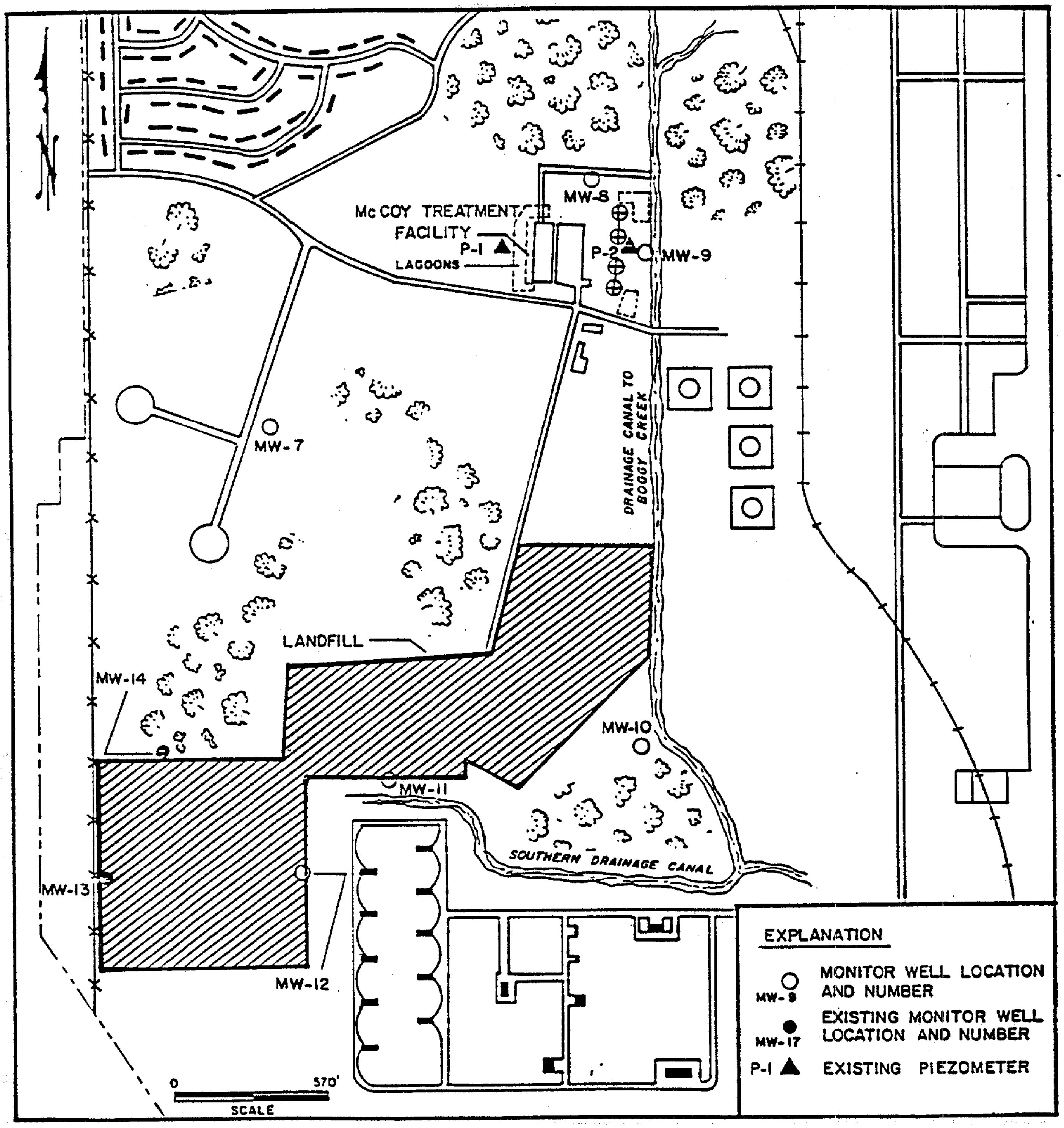


Figure B-3. Proposed Ground-Water Monitor Network at the Inactive Landfill and WWTP Facility, NTC Annex

(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 B-4). Subtract this value from elevation at top of PVC casing to find elevation of water level (see Figures B-5 and B-6 for elevation of top of casing),

(or)

- Using a fiberglass or plastic 100-ft tape with chalk 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.

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Figure B-4. WATER-QUALITY SAMPLING FORM

PROJECT NUMBER: ______________________

Sample Number: ______________________ Date: ______________________

Sample Type: ______________________ Time: ____________ To: ____________

Sampled By: ______________________ Weather: ______________________

GROUND-WATER/SURFACE-WATER ELEVATION

(1) M.P.? ____________ Elevation ______________

(2) Tape Held: ____________ (at M.P.) M-Scope Reading: ____________

(3) Tape Wet: ____________

(4) Depth to Water: ____________ (2 minus 3) SURFACE WATER

(5) Depth of Well: ____________ (from M.P.) Reading at Staff Gage: ____________

(6) Height of Water Column: ______ (5 minus 4) Elevation of Staff Gage: ____________

(7) Elevation of Water: ____________ (1 minus 4) Elevation of Water Surface: ____________

WATER SAMPLE COLLECTION DATA

Volume of Water in well:

$\pi r^2 h$: ______________________ (ft^3) x 7.48 = ______________________ (gal.)

r = radius of well (ft)

h = height of water column (ft)

Volume Removed from Well: ______________ Pumping Rate: ______________

Method of Removal: ______________ Pumping Time: ______________

Method of Sampling: ______________ Pump On: ______________

Time of Sampling: ______________ Pump Off: ______________

FIELD ANALYSES AND REMARKS

Temperature: ______________ Reason for Sampling: ______________

Specific Conductance: ______________

pH: ______________

Other (Specify): ______________ Method of Shipment: ______________

Physical Appearance: ______________________________

Type of Analyses: ______________________________

Container Size and Type: ______________________________

Preservative: ______________________________

REMARKS: ______________________________

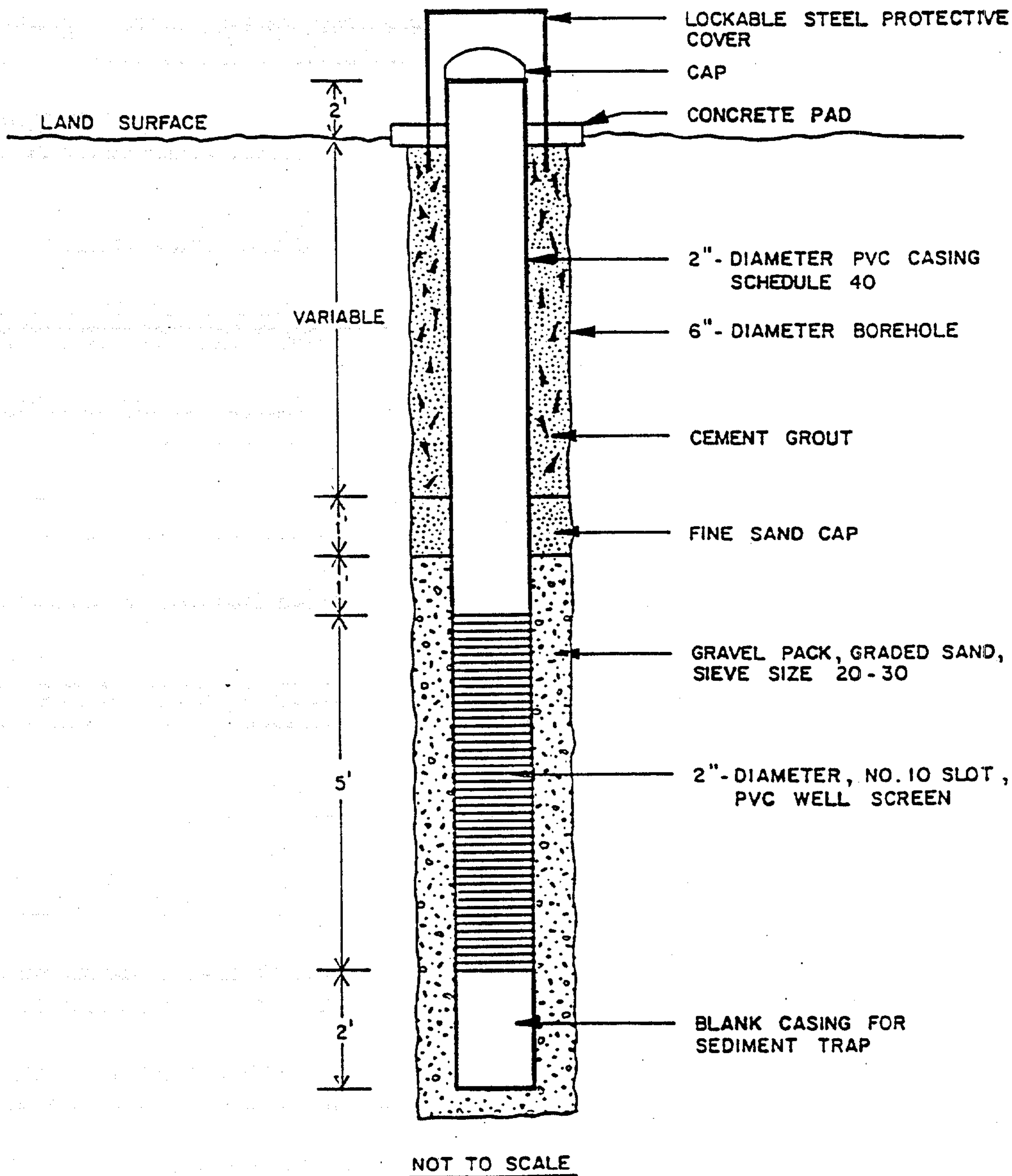

Figure B-5. Typical Installed Permanent Monitor Well.

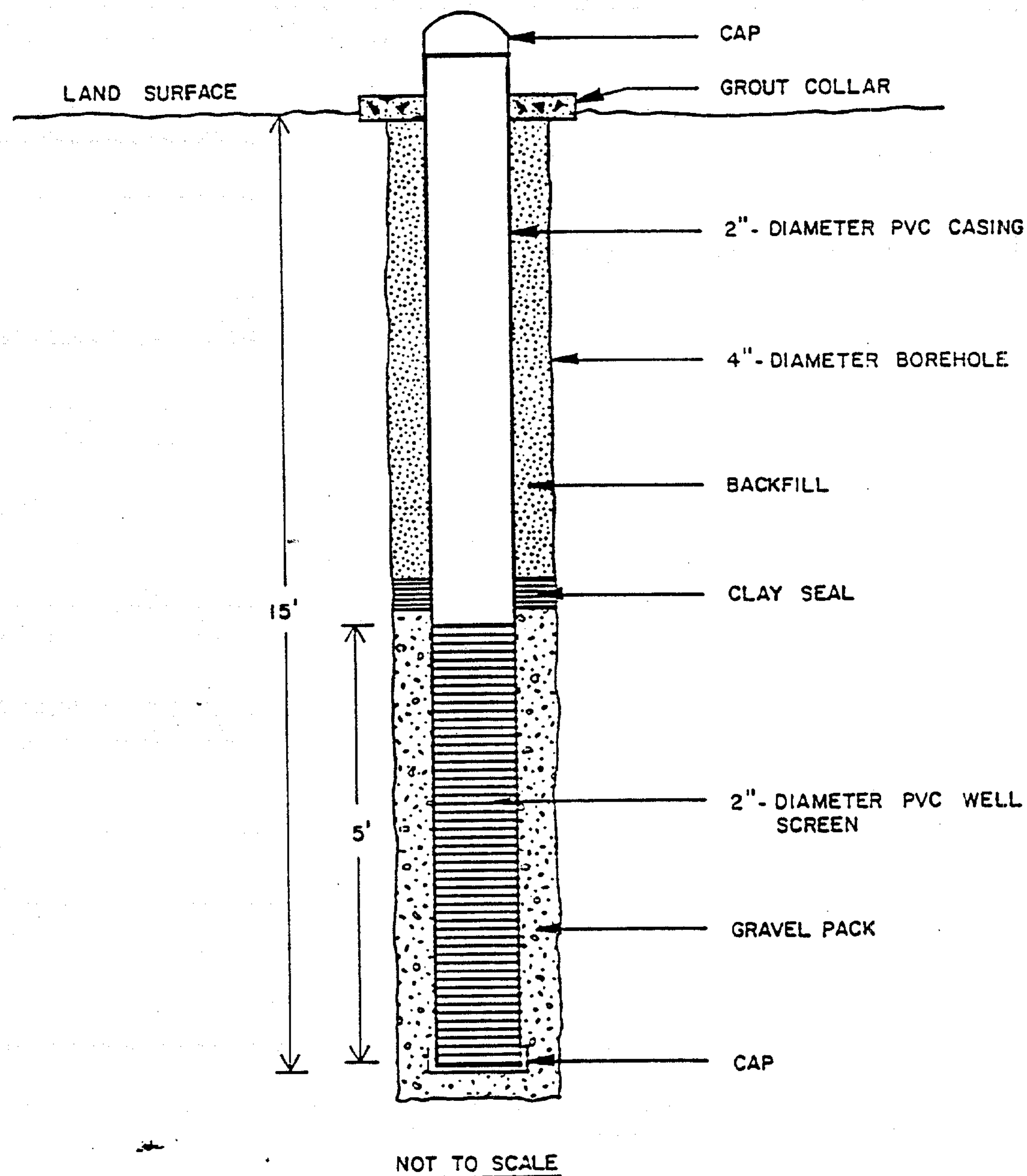

Figure B-6. Typical Existing Monitor Well.

(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) To remove 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.

- 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 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 Boggy 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 FDER approved laboratory.

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