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FINAL HYDROHEOLOGIC ASSESSMENT AND GROUND-WATER MONITORING PLAN NAS WHITING FIELD FL
6/26/1984
GERAHTY & MILLER, INC

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FINAL REPORT

Hydrogeologic Assessment and Ground-Water Monitoring Plan, U.S. Naval Air Station, Whiting Field, 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, U.S. NAVAL AIR STATION, WHITING FIELD, FLORIDA

Prepared for

SOUTHERN DIVISION, NAVAL FACILITIES ENGINEERING COMMAND
Charleston, South Carolina

June 26, 1984

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Ground-Water Consultants
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INTRODUCTION

Whiting Field Naval Air Station is a pilot training facility located 5 miles north of Milton, Florida. Wastes generated at the station have been disposed of at a number of locations on base. In accordance with Chapter 17.4, FAC (Florida Administrative Code), Section 17-4.245(6)(d), a ground-water monitoring plan must be submitted to the FDER (Florida Department of Environmental Regulation) for these sites. Presented herein is the hydrogeologic setting of the area, locations and construction details of proposed monitor wells, and a water-quality sampling and analysis plan.

BACKGROUND

Relatively little hazardous waste is generated at Whiting Field. Source activities include:

aircraft and vehicle maintenance,
POL (petroleum, oils & lubricants) storage,
painting and paint stripping,
pest control,
photo processing,
battery repair
fire-fighting training.

Waste from these sources has in the past been disposed of at various places on base. In an initial assessment by the Navy in 1983 of disposal sites at Whiting Field, six landfill areas were identified as possibly containing hazardous waste. These six sites as well as a seventh landfill, a battery acid disposal site and a waste solvents underground storage site, are recommended for further study to determine if they have caused ground-water contamination. Three additional sites, an AVGAS spill area and two crash crew fire fighting training areas, were considered and found to have a small potential for ground-water contamination. Locations of these sites are shown in Figure 1 and a summary of the sites recommended for further study is presented in Table 1.

Landfills

There has been little control or accounting of the types of waste which have been disposed of at the landfills; although, landfill #1 was dug specifically for disposal of residue sludge from fuel tanks and filters. Landfills #3, #6, and #7 are known to occupy former borrow pits; however, the origins, operations, and contents of most are uncertain. Landfills #1, #2, #3, #4, and #5 have been closed and covered; #6 currently receives domestic waste and #7 receives construction debris.

Battery Shop

At the battery shop, waste acid or electrolyte solution had until recently been poured down the drain of a sink which discharged to a dry well just west of the building. The dry well consists of a section of 60-inch-diameter concrete culvert set vertically in the ground and filled with gravel. This disposal system was used from 1967 until 1984 when the drain was disconnected. A 4-inch-diameter vitrified clay tile line leads from the east end of the battery shop to

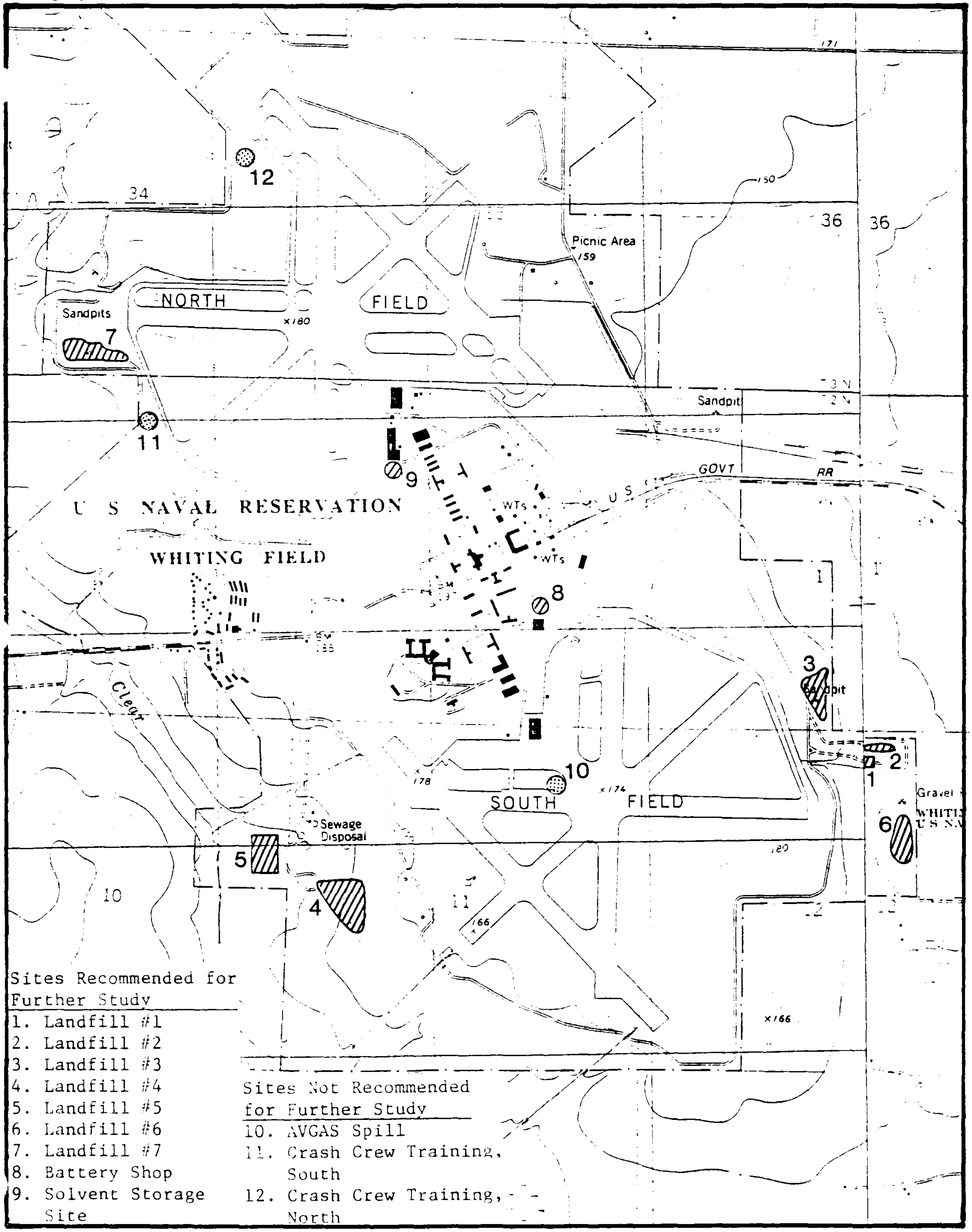

Figure 1. Locations of Disposal and Storage Sites Considered For Further Study.

Table 1. Summary of Waste Disposal and Storage Sites Recommended for Further Study

Site	Operative Dates	Area (ft^2)	Volume (ft^2)	Type of Waste
Landfill #1	1945-1965	1900	4,000	Fuel tank sludge, tetraethyl lead
Landfill #2	1943-1970	200,000	Unknown	Municipal, construction, solvents, paint thinner, waste oil
Landfill #3	1965-1973	160,000	Unknown	Construction, possibly Pesticides
Landfill #4	1965-1979	1,700,000	Unknown	Municipal, paint stripping waste, oil residue
Landfill #5	1943-1965	260,000	Unknown	Municipal, construction, waste oil
Landfill #6	1979-present	260,000	300,000	Municipal
Landfill #7	? -present	250,000	Unknown	Municipal, construction
Battery Rework Shop (Site #8)	1964-1984	20	Unknown	Battery acid
Solvents Storage Tanks (Site #9)	1980-1984	400	Unknown	Solvents and paint stripping waste

a paved ditch. It is not known what, if anything, may have been discharged through this line. This site is of particular concern because the dry well is located only 110 ft (feet) from the south production well. Water from the south well has recently been sampled for chemical analysis, the partial results of which are presented in Table B-1 of Appendix B. Metals concentrations were found to be below primary drinking water standards; the analysis for organic compounds is not yet complete.

Waste Solvents Storage Site

Waste solvents and residue from paint-stripping operations at Building 2941 have been stored in two 500 gallon underground metal tanks, from which the contents were periodically pumped for off-site disposal. The tanks were installed in 1980 and were removed in April of 1984. During removal, one of the tanks was punctured by a backhoe and an estimated 120 gallons of the liquid content spilled onto the ground. About 50 gallons of the liquid was immediately pumped from the ground and approximately 6 cubic yards of contaminated soil was excavated and taken off-site. Subsequent examination of the tanks revealed additional holes, as much as 1/2 inch in diameter, corroded through the sides. A partial chemical analysis of waste from the paint stripping rinse tank is presented in Table 2.

Table 2. Chemical Analysis of Water From the Paint Stripping Rinse Tank at Building 2941.

TECHNICAL SERVICES, INC.

ENVIRONMENTAL CONSULTANTS — INDUSTRIAL CHEMISTS
105 STOCKTON STREET — P.O. BOX 52329
JACKSONVILLE, FLORIDA 32201
(904) 353-5761

Laboratory No. 40946 June 16, 1981

Sample of Paint Stripping Waste

Date Received May 22, 1981

For OFFICER IN CHARGE OF CONSTRUCTION, Building 1429, Naval Air Stati
Whiting Field, Milton, Florida 32570

Marks: PO#N62467-80-C-0464, Industrial Waste from Aircraft Maintenance Dept,N. Whiting Field, Milton, Florida

CERTIFICATE OF ANALYSIS OR TESTS

Ignitability:	Non-flammable
Corrosivity:	pH 7.40, not corrosive based on pH corrosivity characteristic.
Reactivity:	Non-reactive (by definition)
Total Phenols	1866 mg/l
Total Suspended Solids	184 mg/l
Total Organic Carbon	2140 mg/l
E.P.TOXICITY:	
Arsenic, mg/l	< 0.001
Barium, mg/l	0.20
Cadmium, mg/l	0.10
Chromium, mg/l	36.2
Lead, mg/l	0.093
Mercury, mg/l	< 0.0004
Selenium, mg/l	< 0.01
Silver, mg/l	< 0.0007

NOTE: Paint stripper waste not expected to contain any pesticide residues.

cc: Mr. Laurens Pitts
SOUTHERN DIVISION
Naval Facilities Engineering Command
P.O. Box 10068
Charleston, S.C. 29411
ATTN: Mr. Joe McCulley

Respectfully submitted,

TECHNICAL SERVICES, INC.

BY Harvey C. Gray, Jr.

AVGAS Spill Area

Approximately 25,000 gallons of high octane aviation fuel was spilled at the South Field in the summer of 1972. The leakage occurred when a rubber fueling hose was accidentally cut and leaked unnoticed over a 3-day weekend. The fuel flowed about 200 feet across a concrete apron and onto a low grassed area where it was ponded and caused the vegetation to be killed in an area of approximately 2 acres.

As a volume of petroleum product moves downward through unsaturated soil, thin films of the product are strongly held on the soil particles through which it passes. Downward migration will continue until the product is thus exhausted and immobilized or until it reaches the water table. The volume of soil required to immobilize the spilled fuel can be calculated from the equation (API, 1972):

$$V_s = \frac{0.20V_f}{P\ Sr} \quad \text{in which}$$

V_s = volume of soil (yd^3)
V_f = volume of fuel (barrels)
P = porosity of soil (dimensionless)
S_r = residual saturation of the fuel (dimensionless)

Assuming:

V_f = 25,000 gal = 595 bls
P = 0.30
S_r for light fuels = 0.10

Then: $V_s = 3967\ yd^3$

Assuming the area of infiltration to be 2 acres (9680 yd^2), the product would have penetrated to a depth of 0.4 yd (1.2

ft) before being immobilized. The water table at this site is estimated to be about 100 feet below the surface.

This calculation is very conservative because it assumes no evaporation loss. It is likely that evaporation was substantial from a stream of highly volatile gasoline spread over a 200-ft long strip of pavement and a ponded area of 2 acres. In the 12 years since the spill, bacterial action should have decomposed essentially all of the fuel held in the soil and therefore no further action is recommended for this site.

Crash Crew Training Areas

During the last 25 years, the general area on the west side of North Field has been used for training in fire fighting. Presently, the two sites shown in Figure 1 are being used; however, the specific training sites have periodically been relocated. During a training session, approximately 110 gallons of JP-4 fuel is poured into shallow surface depressions, ignited and then extinguished using AFFF (aqueous film forming foam). According to records, 6285 gallons of fuel and 3148 gallons of foaming agent were used during the last year. The particular foaming agent most recently used, AOW-6, has the properties and contents given in Table 3.

Surficial soils at these sites have relatively low permeabilities and therefore, it is likely that a high

Table 3. Properties and Contents of Foaming Agent AOW-6.

Specific gravity	1.031
pH	7.9
COD (mg/l)	350,000
BOD (mg/l)	135,000 (5 day), 300,000 (30 day)
Surfactants (mg/l as MBAS)	80,000 (as active agents)
Fluoride (mg/l)	2,500
Ethylene glycol	10%
Diethylene glycol monobutyl ether	10%
Water	72%

proportion of any unburned fuel evaporates rather than infiltrating the ground. Fuel which does infiltrate would be immobilized in the upper part of the unsaturated zone and is not likely to reach the water table at an estimated depth of 80 feet. Because of the relatively small amounts of fuel and foam used and the large area over which they have been applied during the 25-year use, it is recommended that no further study be done at these sites.

WELL INVENTORY

Essentially, all potable and industrial water supplies in the Whiting Field vicinity are obtained from surficial sands known collectively as the sand and gravel aquifer, which extends from the surface to an approximate elevation of -150 ft msl (feet mean sea level). Screen settings are at depths of about 150 to 350 ft depending on surface elevation and the occurrence of clay lenses which lie at somewhat erratic depths. An inventory of wells within one mile of the waste disposal sites is presented in Table 4 and the locations of the wells are shown in Figure 2. The area includes most of Whiting Field and small residential neighborhoods south and east of the base.

Potable water on base is currently supplied by 3 wells, the north (W-N4), south (W-S3), and west (W-W3) wells; however, these are only the latest in a sequence of wells which have been replaced because of insufficient capacity or poor water quuality. When the base was built in 1943, 3

Table 4. Inventory of Wells Within one Mile of Disposal Sites.

Well Designation	Owner	Date Installed	Casing Diameter (inches)	Surface Elevation (ft msl)	Total Depth (ft msl)	Screened Interval (ft msl)	Gravel Pack Interval (ft msl)	Status
W-N1	Navy	1943						Abandoned 1951
W-N2	Navy	1951	16	168.1	(-256.4)	(-1.4)-(-31.4)	60-(-31)	Not in use
W-N3	Navy	1975		171.5	(-58.5)	36.5-(-23.5)		Abandoned 1975
W-N4	Navy	1975	16/12	180.0	(-38)			In use
W-W1	Navy	1943						Abandoned 1951
W-W2	Navy	1951		197.6	(-157.4)	14.1-(-47.0)		Abandoned 1965
W-W3	Navy	1965		180.0	(-35.0)	10.0-(-30.0)	80-(-30)	In use
W-S1	Navy	1943						Abandoned 1951
W-S2	Navy	1951		181.5	(-159.5)	12.0-(-33.0)	17-(-33)*	In use
P-3	Point Baker Water System	1978		200**	(-20)**			In use
P-4	Point Baker Water System	1983						In use
USGS	U.S. Geological Survey	1974	6	125.0	(-1165)	Cased to (-860)		Monitor well

* Assumed
** Estimated

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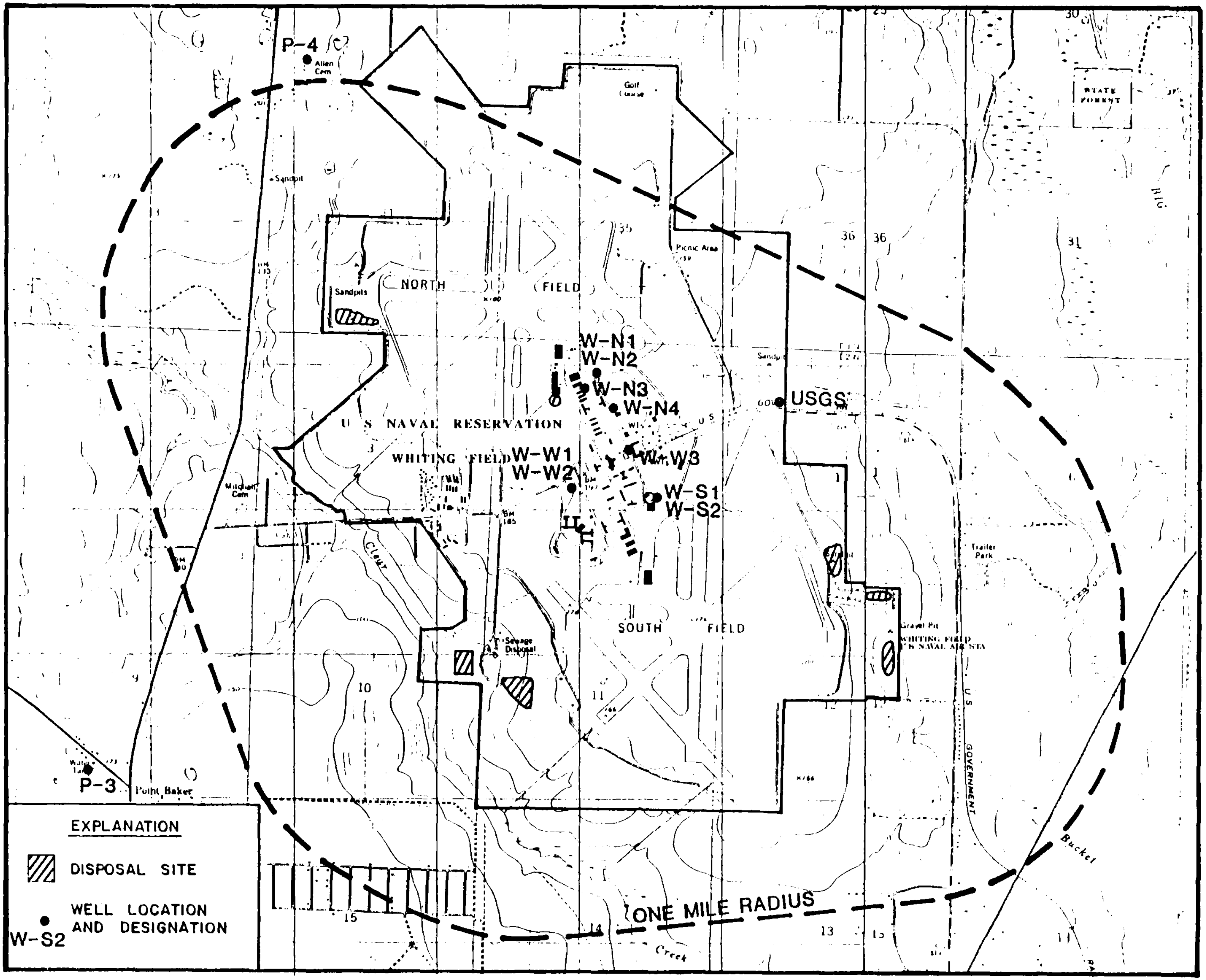

Figure 2. Locations of Wells Within One Mile of Disposal Sites.

wells were drilled, the original north (W-N1), south (W-S1), and west (W-W1) wells. In 1951 these wells were abandoned and replaced by new wells (W-N2, W-S2, and W-W2, respectively) within 75 ft of the original wells. The new wells were probably constructed to deliver increased yields. The west and north wells, however, contained objectionable levels of iron and were replaced by W-W3 in 1965 and W-N3 in 1975, respectively. The replacement north well, which was drilled as a test well, was also found to have an unacceptable iron concentration and was subsequently abandoned and replaced by the currently used north well (W-N4). Locations of the Navy wells are shown in Figure 3. Current average pumpage from the wells at Whiting Field is: North well, 438 gpm (gallons per minute); West well, 479 gpm; and South well, 474 gpm. Flow from the three (3) active supply wells is combined before entering the distribution system.

Water for the City of Milton is supplied by five (5) wells, for East Milton by two (2) wells, and for the Point Baker-Allentown area by three (3) wells, all of which are screened in the sand and gravel aquifer and all of which are outside of the one-mile radius; however, two of the Point Baker wells (P-3 and P-4) are so close that they are included in the inventory. Average pumpage from these two wells is: P-3, 500 gpm; and P-4, 200 gpm. Water from the Point Baker system is available to residences west and north of Whiting Field, and water from the Milton system is available to those

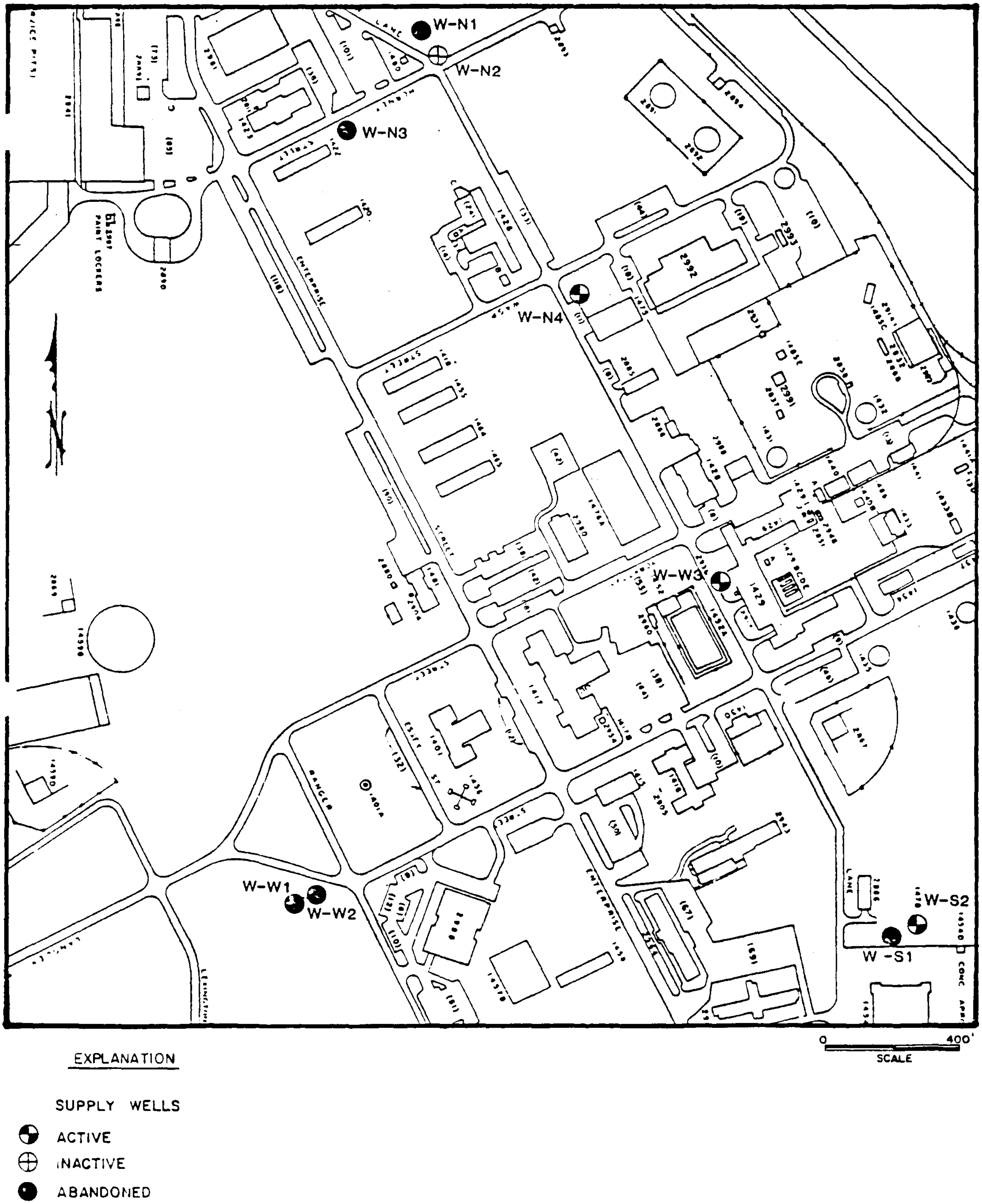

Figure 3. Locations of NAS Supply Wells

east and south of Whiting Field. It is believed that few if any private wells in these areas are still used.

HYDROGEOLOGIC SETTING

Topography and Drainage

Whiting Field is located on an upland area isolated on three sides by the erosion of the deep valleys of Clear Creek on the south and west, and Big Coldwater Creek on the east, both of which are tributary to Blackwater River to the south. Topographic relief from the highest part of Whiting Field to Blackwater River is almost 200 ft. Ancient marine terraces can be seen in the nearly level upland surface and on the valley slopes southeast of the base at elevations of 70 and 30 ft msl.

Because of the relatively steep valley walls, erosion became a serious problem when the land was disturbed for construction of the base. Soil conservation measures in the form of extensive contouring and construction of large paved ditches were instituted to transmit surface runoff down the slopes with minimal erosion. A system of ditches and storm sewers was also constructed to drain the upland area of the base. These and other surface-water drainage lines are shown in Figure 4.

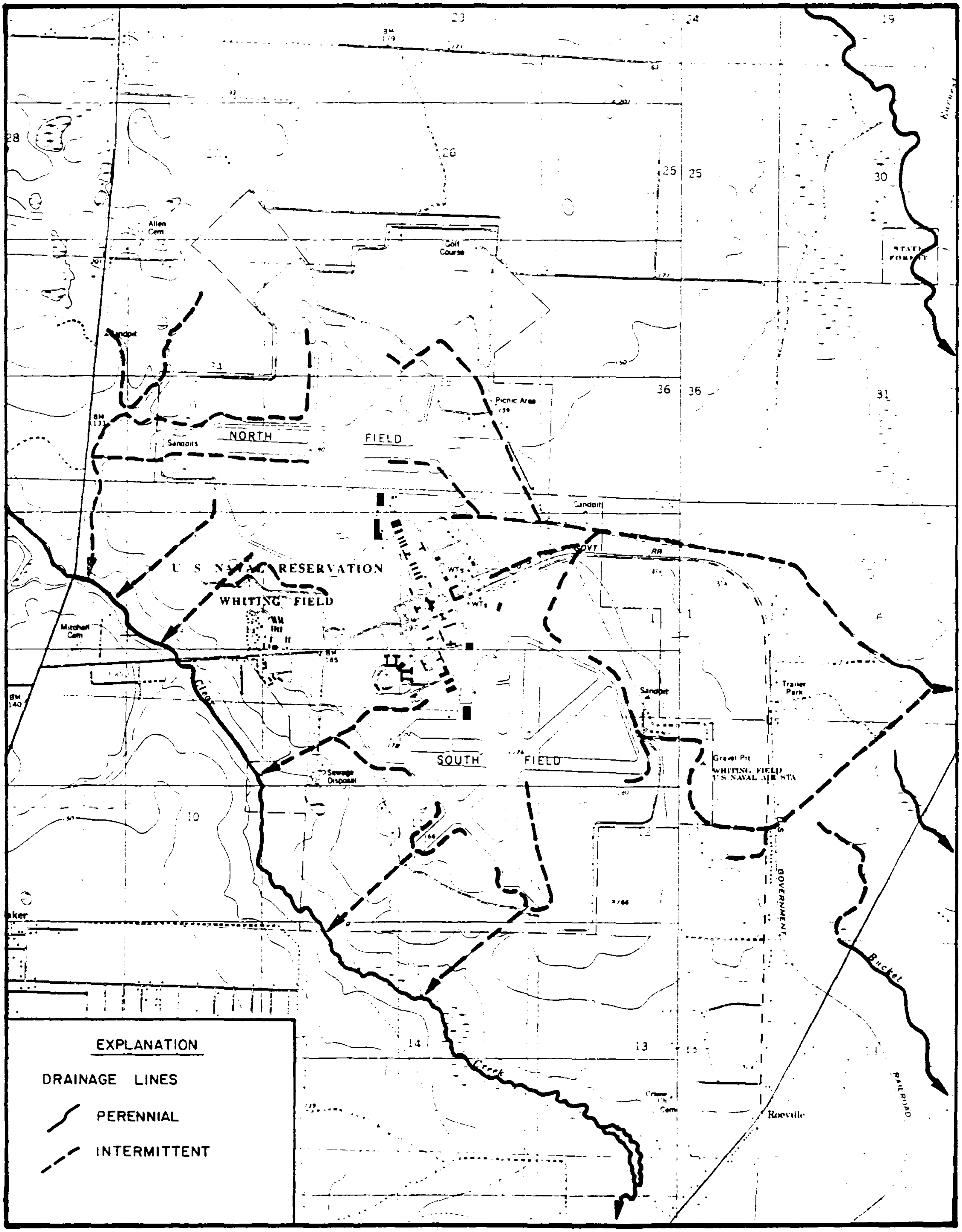

Figure 4. Locations of Surface Drainage Lines.

Geologic Framework

The geologic sequence of layers underlying Whiting Field is illustrated in Figure 5, a composite geologic column constructed from published data and logs of wells in the area. Lithologic logs of borings and wells in the Whiting Field area and their locations are included in Appendix A.

The uppermost sediments extending to a depth of about 350 ft comprise the so-called sand and gravel aquifer. It is underlain by the relatively impermeable Pensacola clay, below which are thick layers of limestone and shale to a depth of nearly 2,000 ft.

Sand and Gravel Aquifer

The sand and gravel aquifer includes the upper Miocene coarse clastics, the Citronelle formation, and marine terrace deposits, three units which have similar hydraulic properties and sometimes are indistinguishable. The aquifer consists of poorly-sorted, fine to coarse sands with gravel and lenses of clay which may be as much as 60 ft thick. In some areas, the formation also contains wood fragments of all sizes, including whole tree trunks, occurring mostly in layers which may be as much as 25 feet thick (Marsh, 1966); however, logs of wells drilled on base do not indicate the presence of wood fragments in the immediate area.

The formation contains lensatic zones within the sand which are cemented by iron oxide minerals. These lenses,

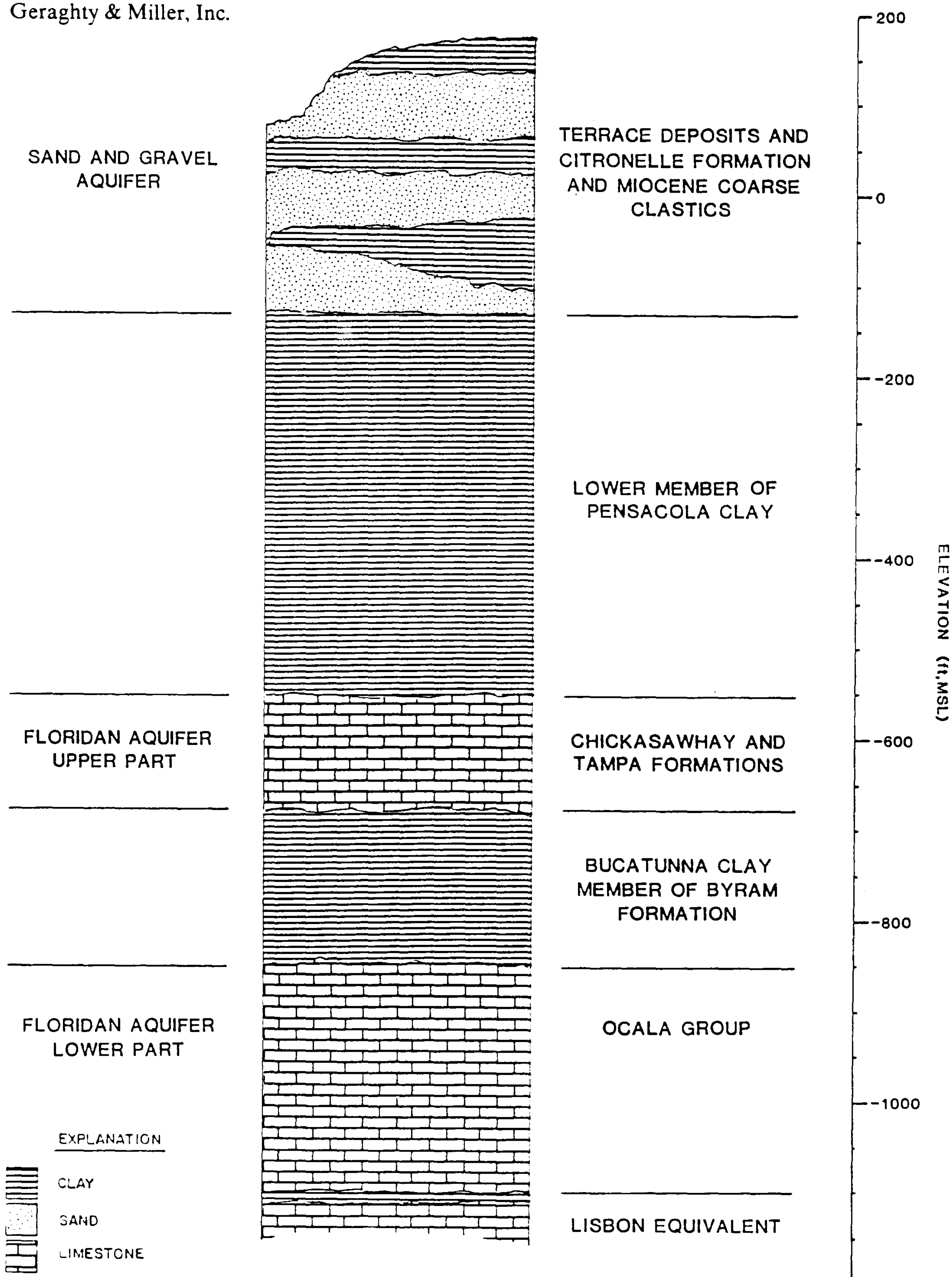

Figure 5. Generalized Geologic Column Representative of the Whiting Field Area.

known locally as "hardpan", have low permeabilities, and along with the clay lenses, are responsible for the occurrence of perched water tables and artesian conditions in the aquifer. In the Whiting Field area, major clay lenses occur in the uppermost 30 ft and in the depth interval of approximately 110 to 170 ft (elevation 10-70 ft msl). The vertical positions of these clay lenses in relation to the screened intervals of the NAS supply wells is shown in Figure 6. Although the clays appear to be continuous, they may contain permeable zones.

Floridan Aquifer

The limestone layers constitute the regionally extensive Floridan aquifer, which in this area is divided into an upper and lower part separated by the Bucatunna clay. The upper Floridan aquifer is an important source of water in areas east of Santa Rosa County; however, toward the west, it is increasingly mineralized and is generally not used as a water supply. The lower Floridan aquifer is highly mineralized in the Whiting Field area and is, in fact, designated for use as a waste-disposal injection zone. Chemical analyses of water from the upper and lower parts of the Floridan aquifer are included in Appendix B, Table B-2.

Subsurface Hydrology

The potentiometric surface of the upper Floridan aquifer at Whiting Field is approximately 50 ft msl and has been

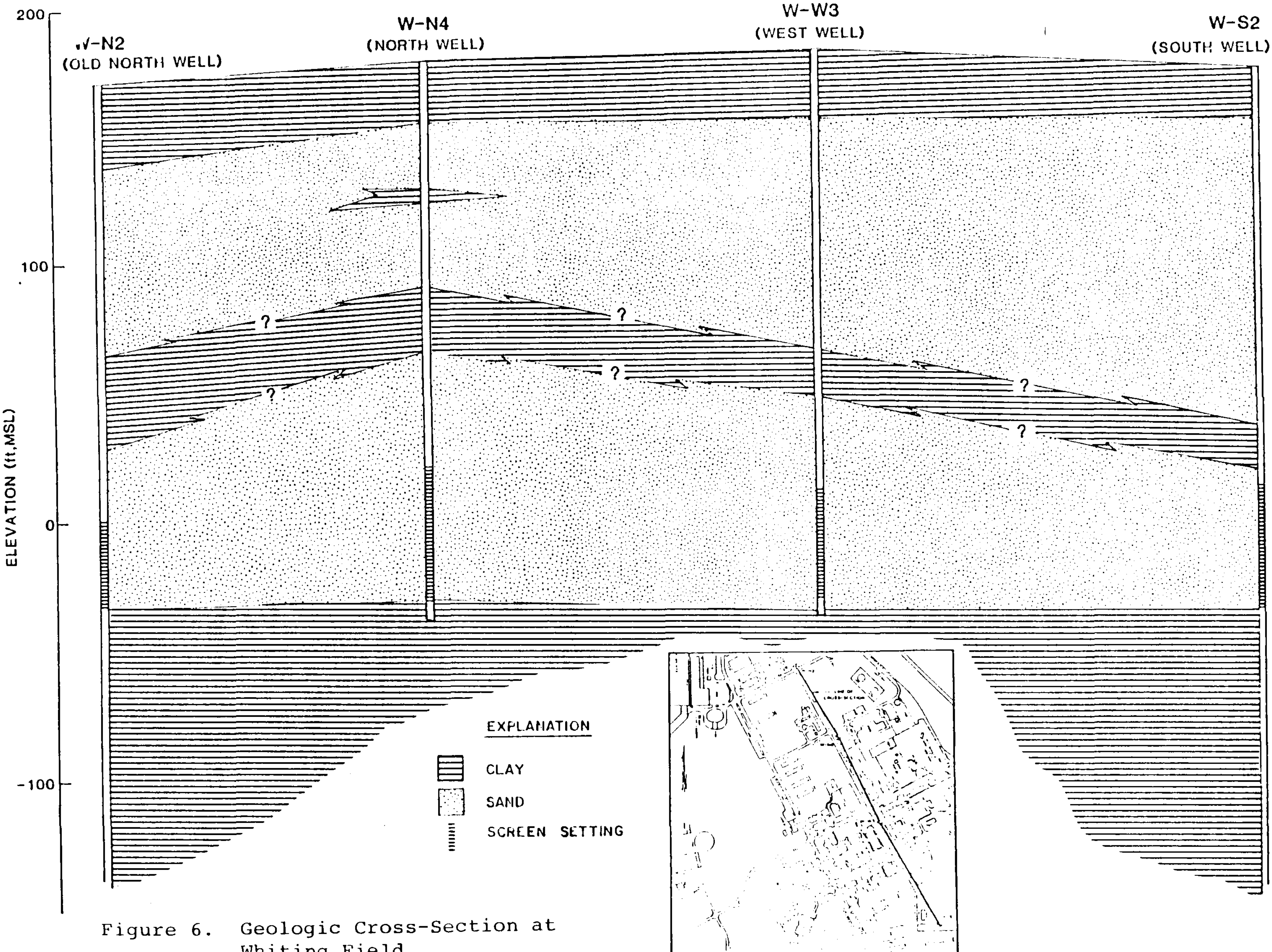

Figure 6. Geologic Cross-Section at Whiting Field.

declining because of heavy pumpage from the aquifer at Fort Walton Beach. Ground-water movement in the aquifer is toward the southeast as can be seen in the potentiometric surface map of Figure 7. The potentiometric surface of the lower Floridan aquifer has increased by several feet to approximately 130 ft msl since 1974 because of waste injection at nearby industrial plants (J.B. Martin, USGS, 1984, oral communication). There is, therefore, a potential for upward movement of water from the lower to the upper Floridan; however, the intervening Bucatunna clay has a low permeability and allows essentially no flow between the two aquifers. Recharge to the upper Floridan occurs primarily in northern Santa Rosa County and southern Alabama, where the aquifer is at or near the surface.

In the sand and gravel aquifer, static water levels at Whiting Field range from approximately 70 ft msl in the center of the station to about 30 ft msl along Clear Creek and Big Coldwater Creek. This, along with the low permeability of the confining deposits (Pensacola clay), indicates little potential for movement of ground water vertically between the Floridan and the sand and gravel aquifers.

Ground-water flow in the saturated portion of the sand and gravel aquifer is nearly horizontal. Shallow ground water normally moves from topographic highs to areas of discharge, such as streams. Figure 8, which was prepared

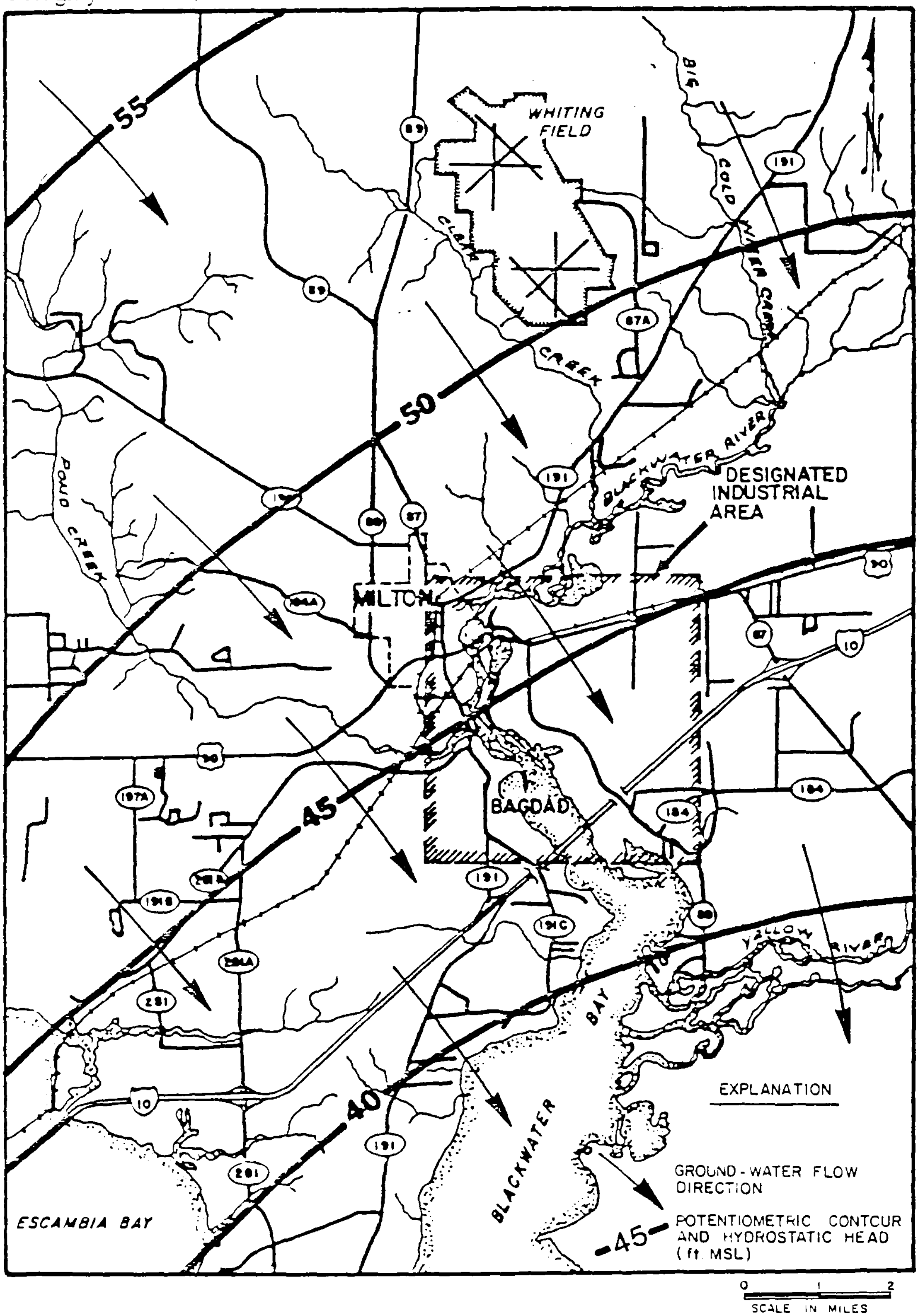

Figure 7. Contour Map of the Potentiometric Surface of the Upper Floridan Aquifer in the Whiting Field Area, 1980.

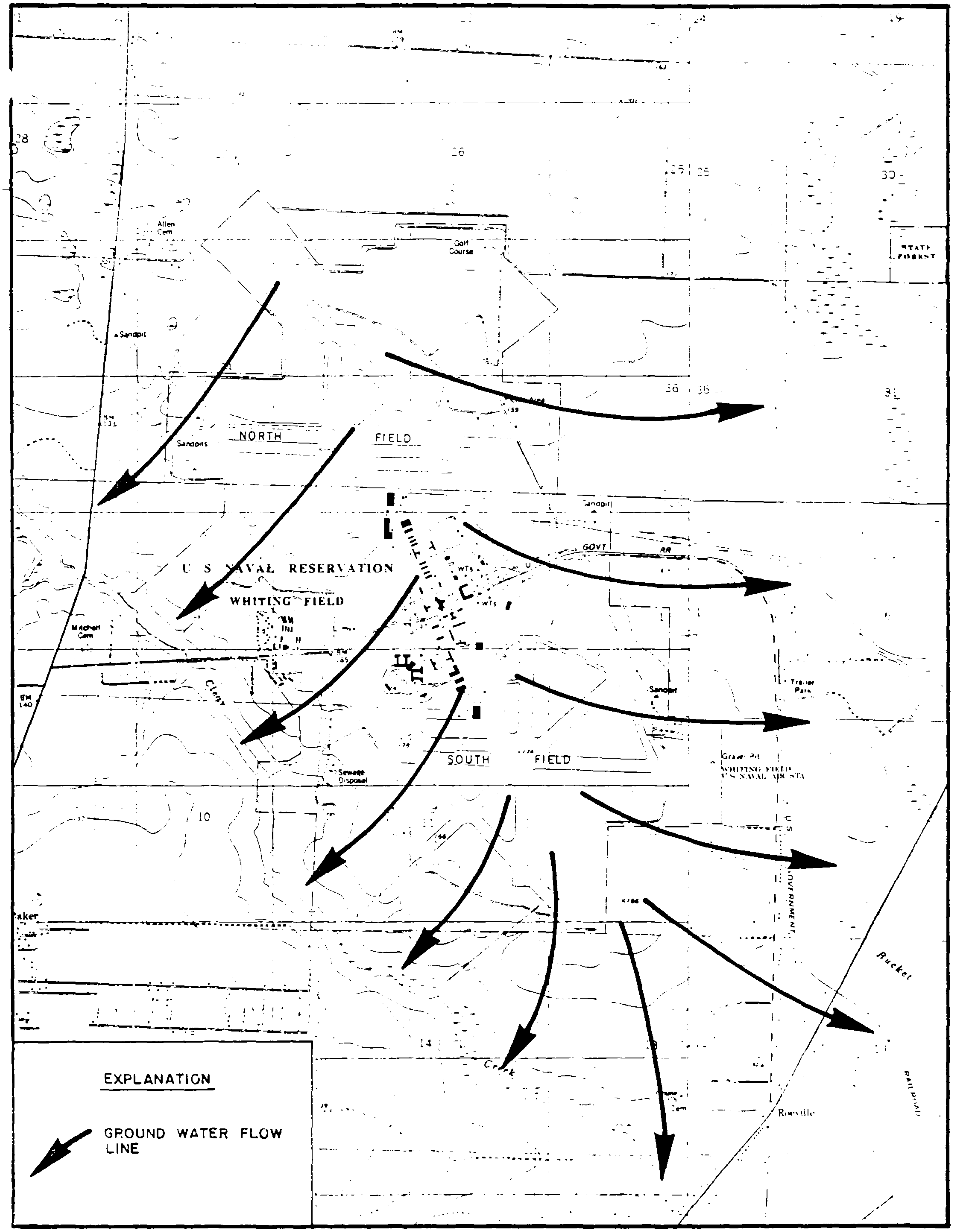

Figure 8. Inferred Directions of Ground-Water Movement in the Sand and Gravel Aquifer.

using the surface topography, shows inferred directions of ground-water flow within the sand and gravel aquifer. These flow lines do not, however, reflect the influence of cones of depression which occur around the three Navy production wells.

The sand and gravel aquifer is recharged by infiltration of rainwater at the surface. The downward movement of water through the unsaturated zone is interrupted at clay layers, above which perched water tables may exist. Flow in the perched saturated zones is primarily horizontal with some downward leakage through the clay, depending upon its vertical permeability.

The following specific capacities were determined from test pumping of the 1951 NAS wells:

W-N2	16.7 gpm/ft (gallons per minute per foot of drawdown)
W-W2	23.0 gpm/ft
W-S2	21.7 gpm/ft

From these values, an average transmissivity for the pumped zone of the sand and gravel aquifer is estimated to be about 37,000 gpd/ft (gallons per day per foot). This agrees rather well with a transmissivity of 54,600 gpd/ft determined from a pumping test at Milton (NWFWMD, 1980).

WATER QUALITY

As noted above, the upper and lower Floridan aquifers are highly mineralized whereas the sand and gravel aquifer contains water of generally good quality, as do Big Coldwater Creek and Blackwater River, the baseflows of which are maintained by discharge from the sand and gravel aquifer.

Total dissolved solids and total hardness of water in the sand and gravel aquifer generally are less than 50 ppm (parts per million) and nitrate is about 1 ppm. However, because of high levels of dissolved carbon dioxide, the water is acidic with a pH of 5.0 to 5.5 and locally high concentrations of iron are found. Results of chemical analyses of ground water and surface water are contained in Appendix B.

GROUND-WATER MONITORING PLAN

Extent of Zone of Discharge

A ground-water monitoring plan has been prepared in accordance with Chapter 17-4.245(6)(d) FAC to detect the potential movement of constituents from nine disposal and/or storage sites. These nine sites are considered to be "existing installations" since each was utilized, and therefore potentially discharging to ground water, prior to July 1, 1982. In accordance with Section 17-4.245(3)(d) FAC, "existing installations" shall have a zone of discharge extending to the property line. Therefore, it is assumed that for Whiting Field the point of compliance for constituents other than "free froms" will be at the edge of the zone of discharge or the property line. No zone of discharge is allowed for those constituents referred to as "free froms" as defined in Section 17-3.402(1) FAC.

Background Ground-Water Quality Conditions

Background water quality will be established from analyses made on water samples from the north supply well (W-N4). The north well, was selected because it is hydraulically upgradient from the sites and is representative of the water-quality characteristics of the sand and gravel aquifer at Whiting Field; this well was recently sampled for EPA's list of organic priority pollutants and none were found (see Table B-5 in Appendix B).

After approval of the ground-water monitoring plan, a water sample will be collected from well W-N4 and analyzed for a partial list of the FDER's primary and secondary drinking-water constituents as identified in Table 5. The collected data will then be utilized to characterize the natural ground-water quality characteristics of the sand and gravel aquifer at Whiting Field.

Locations and Construction Details of Proposed Monitor Wells

Nine monitor wells, screened in the shallowest permeable, saturated zone, will be installed hydraulically downgradient from the nine designated disposal and storage sites. The locations of the proposed monitor wells and estimated depths to water are shown in Figures 9 through 13. Each proposed monitor well has been located immediately downgradient from its respective disposal site in order that possible contaminants migrating from these sites can be detected as early as possible.

The monitor wells will be either 2-inches or 4-inches in diameter, depending upon the anticipated depth to water. In areas where static water level exceeds a depth of 20 ft, the monitor wells will consist of 4-inch-diameter PVC casing and screen and will be equipped with submersible pumps for obtaining water samples. A schematic diagram illustrating the construction details of a typical 4-inch-diameter monitor well is presented in Figure 14. Where the water table is

Table 5. Ground-Water Quality Parameters and Frequency of Sample Collection

Constituent	Sites: Background (North well)	Landfills	Battery Shop	Solvents Storage
Arsenic	1	1,2,3,4	1	1
Barium	1	1,2,3,4	1	1
Cadmium	1	1,2,3,4	1,2,3,4	1,2,3,4
Chromium (Hexavalent)	1	1,2,3,4	1,2,3,4	1,2,3,4
Fluoride	1	1	1	1
Lead	1	1,2,3,4	1,2,3,4	1,2,3,4
Mercury	1	1	1	1
Nitrate (as N)	1	1	1	1
Selenium	1	1	1	1
Silver	1	1	1	1
Endrin	1	1	1	1
Lindane	1	1	1	1
Methoxychlor	1	1	1	1
Toxaphene	1	1	1	1
2,4-D	1	1	1	1
2,4,5-TP Silvex	1	1	1	1
Turbidity	1	1	1	1
Chloride	1	1	1	1
Copper	1	1	1	1
Foaming Agents	1	1	1	1
Hydrogen Sulfide	1	1	1	1
Iron	1	1	1	1
Manganese	1	1	1	1
Sulfate	1	1	1	1
TDS	1	1	1	1
Zinc	1	1,2,3,4	1,2,3,4	1
Color	1	1	1	1
Odor	1	1	1	1
pH (field)	1	1,2,3,4	1,2,3,4	1,2,3,4
Specific Conductance (field)	1	1,2,3,4	1,2,3,4	1,2,3,4
VOC (volatile organics- Method 601)	*	1,2,3,4	1	1,2,3,4

Note: Numbers refer to quarterly sampling periods during the first monitoring year.

* Analysis for EPA organic priority pollutants was made in April, 1984 (See Appendix B).

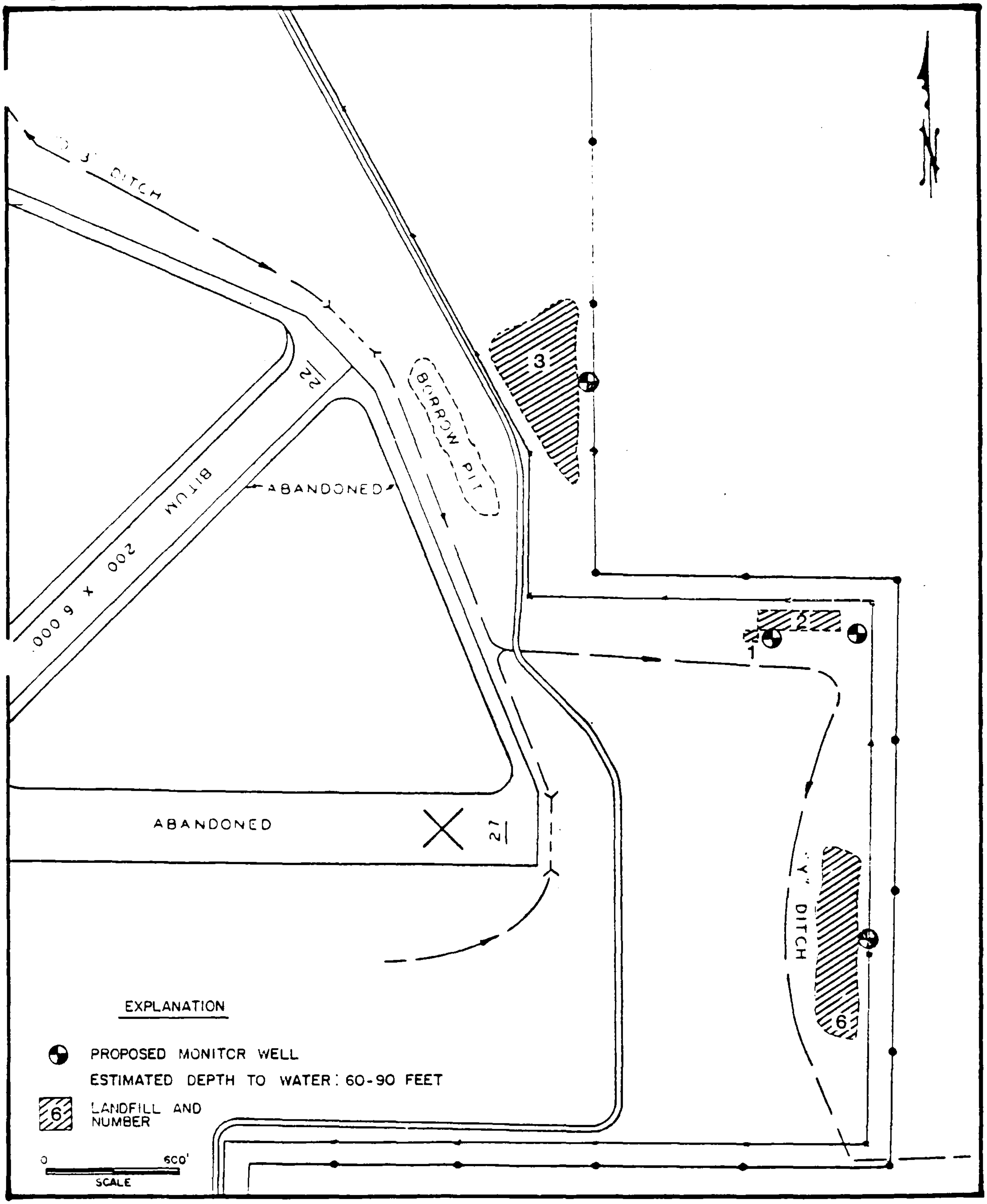

Figure 9. Locations of Proposed Monitor Wells For Landfills No. 1, 2, 3 and 6.

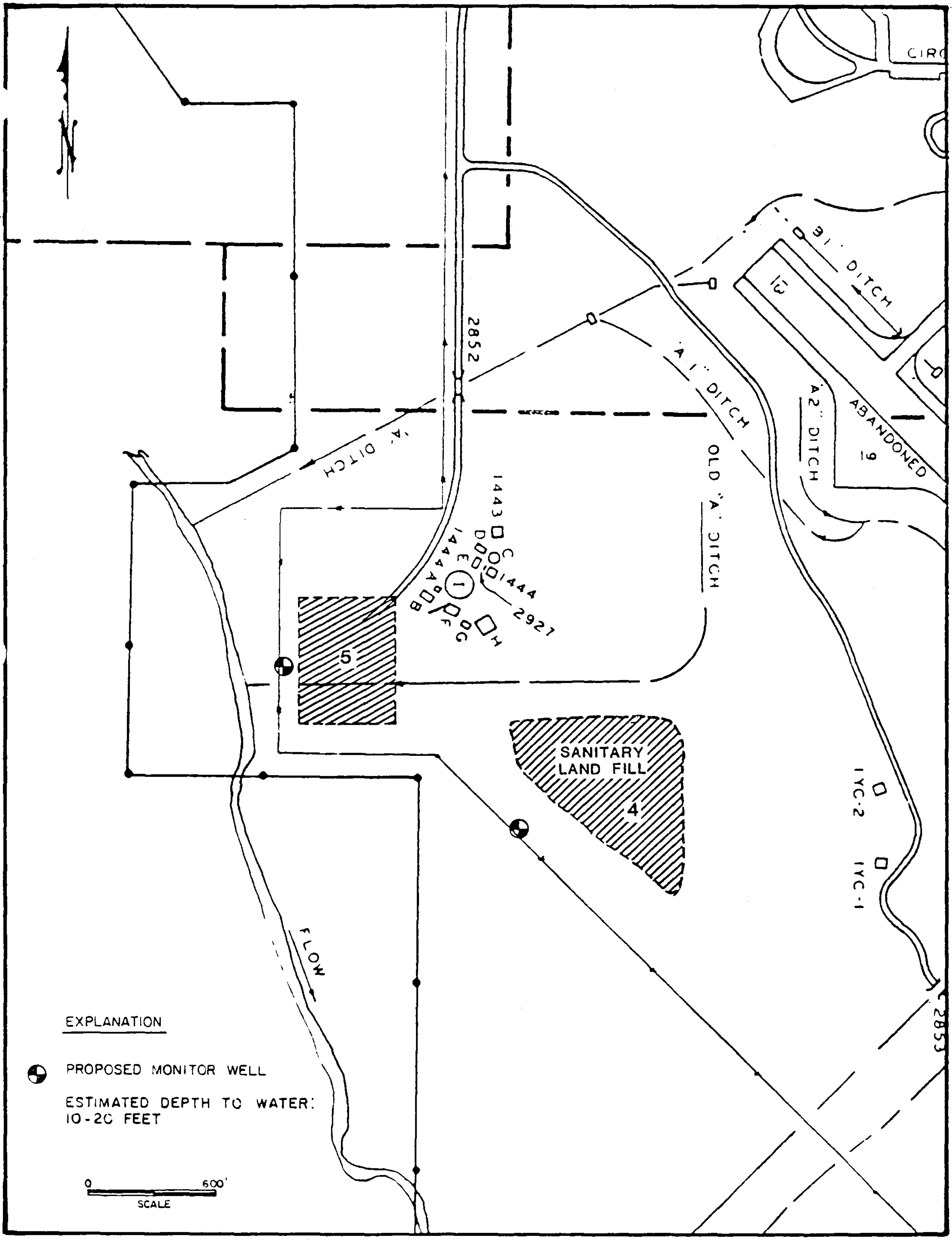

Figure 10. Locations of Proposed Monitor Wells for Landfills No. 4 and 5.

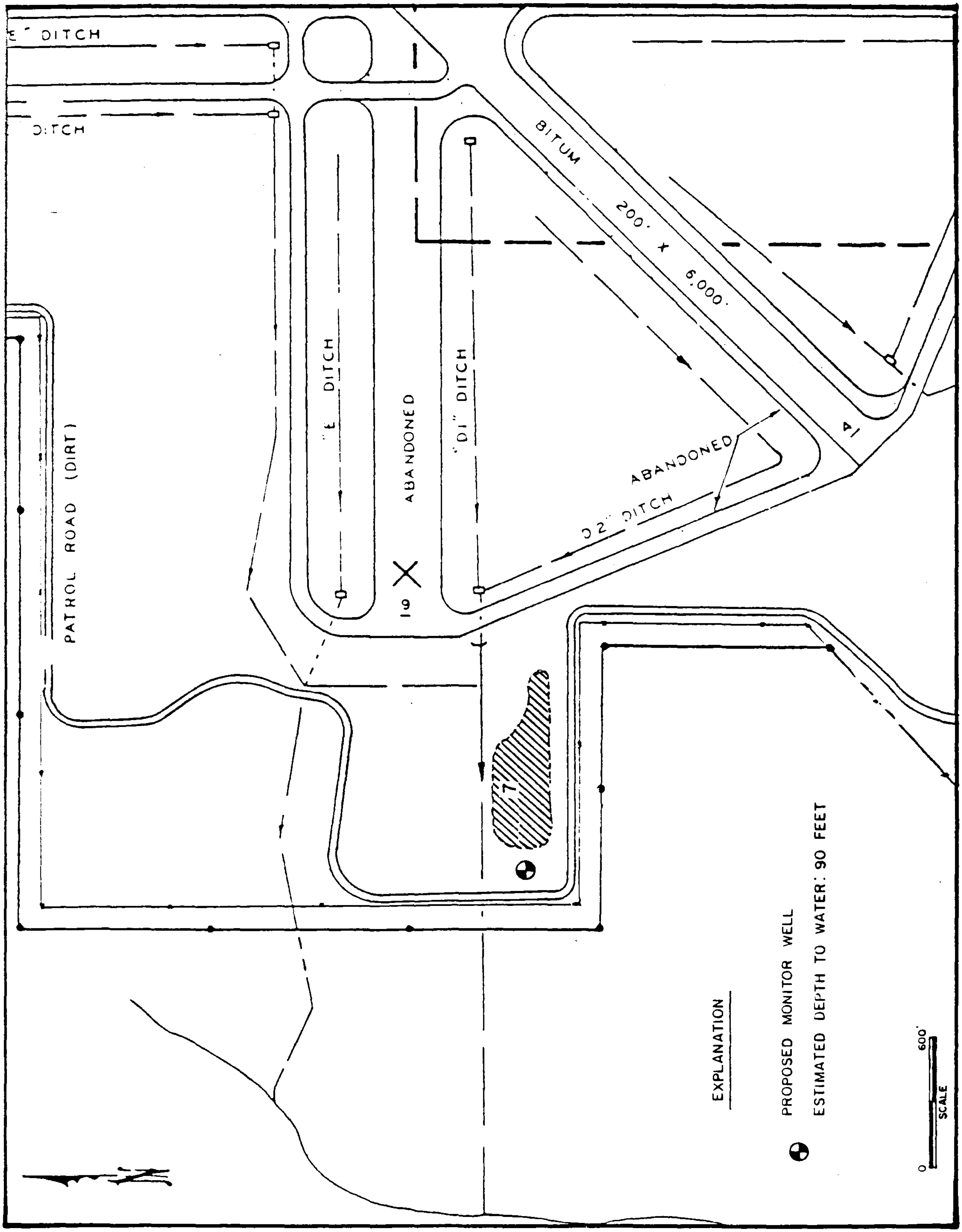

Figure 11. Location of Proposed Monitor Well For Landfill No. 7.

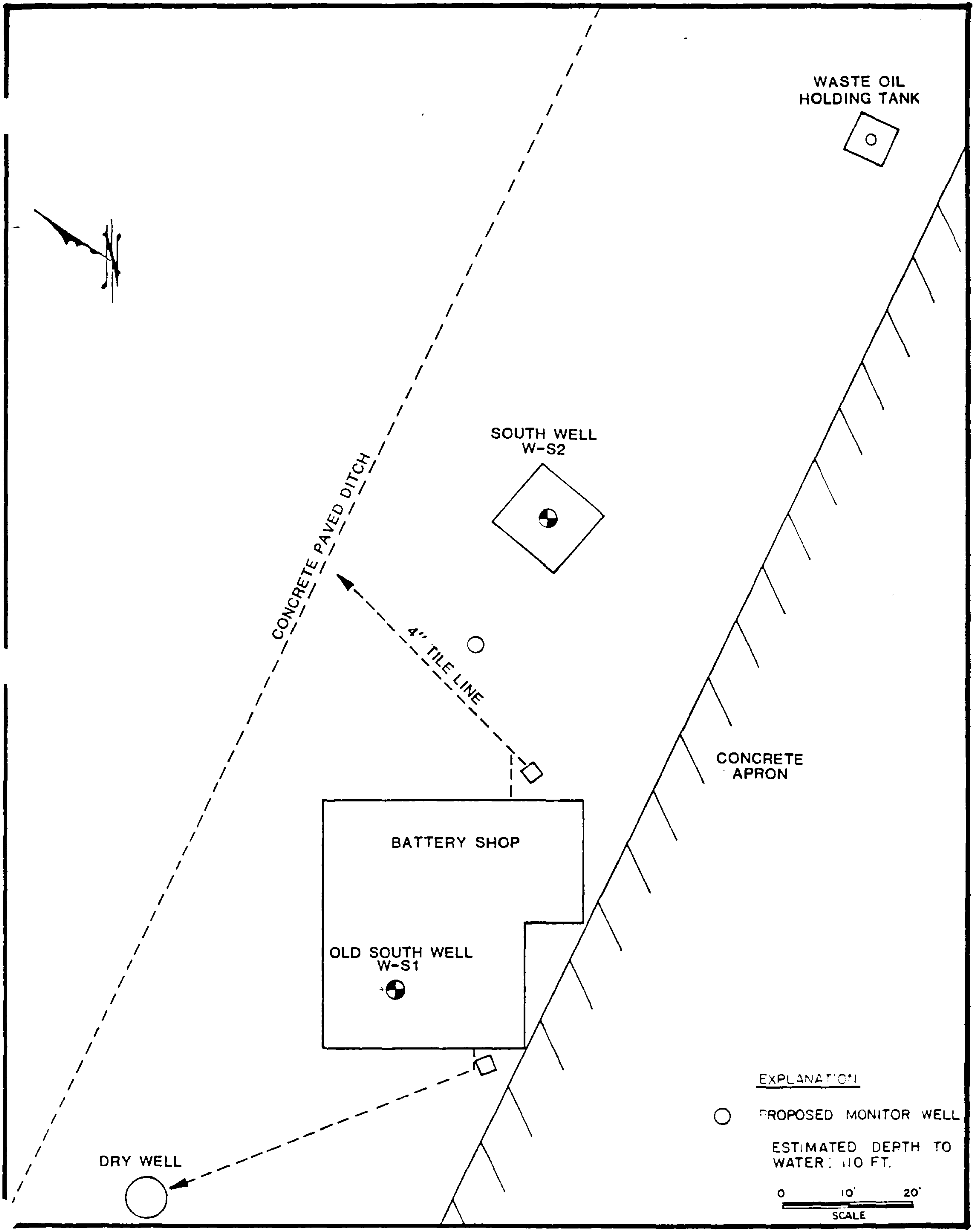

Figure 12. Location of Proposed Monitor Well for Battery Shop Site.

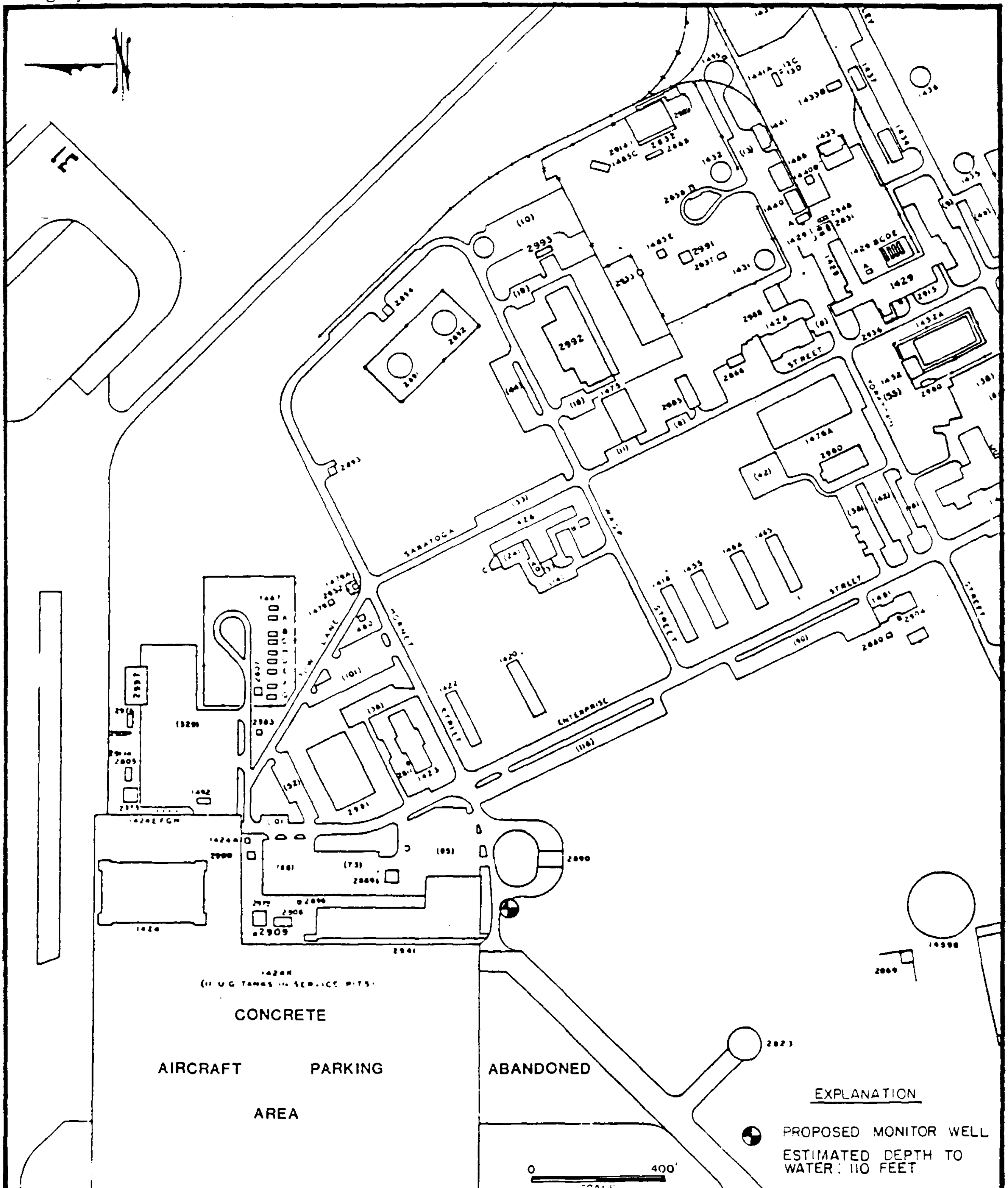

Figure 13. Location of Proposed Monitor Well for Waste Solvent Underground Storage Site.

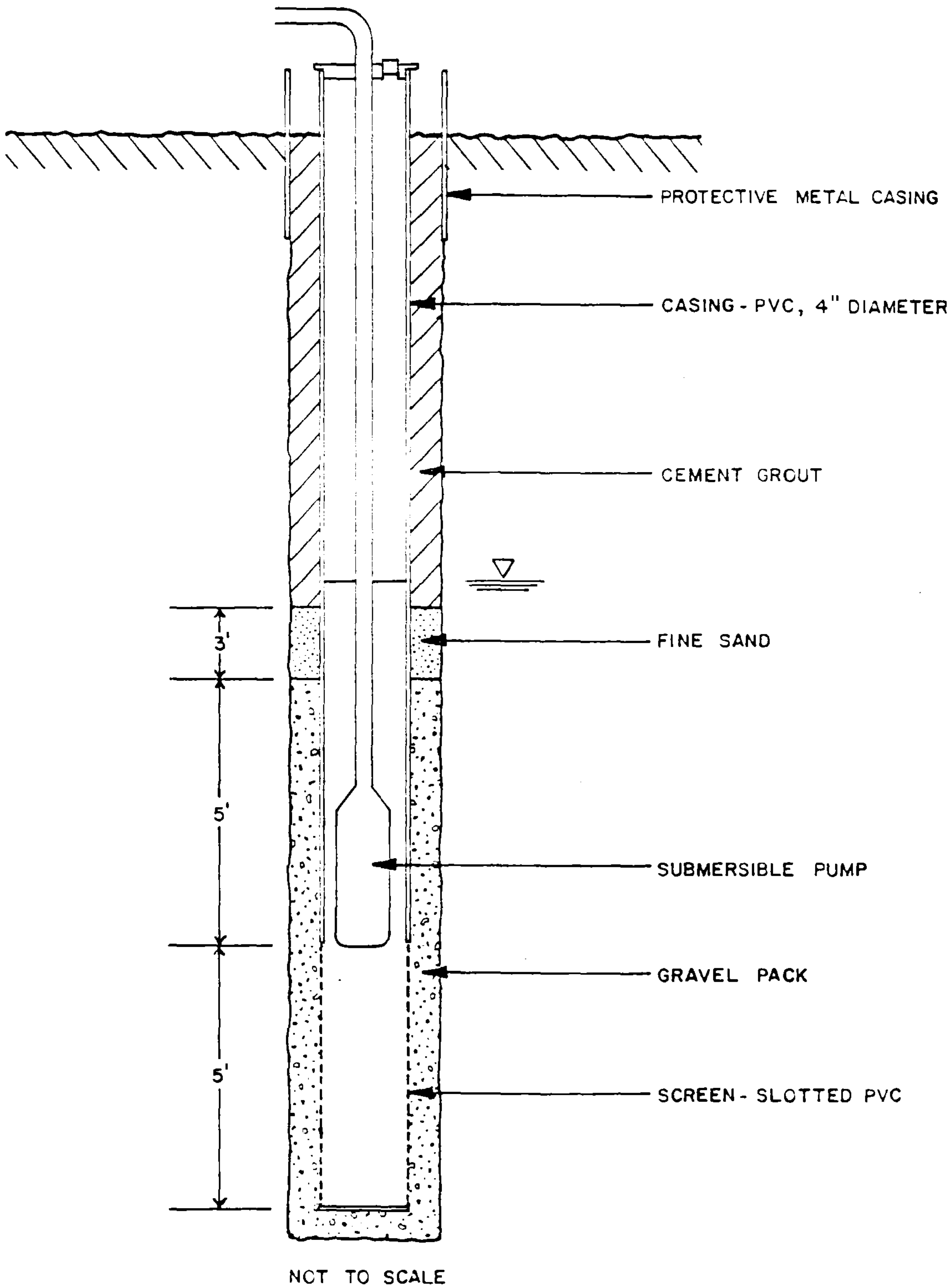

Figure 14. Schematic Diagram Showing Construction of Deep Monitor Well.

shallower than 20 ft, wells can be evacuated by suction pumping; therefore, in these areas the monitor wells will consist of 2-inch-diameter PVC casing and screen. A schematic diagram illustrating the construction details of a typical 2-inch-diameter monitor well is presented in Figure 15.

The monitor wells will be constructed by the mud-rotary method of drilling. During the drilling, representatives from Geraghty & Miller, Inc., will oversee the work. Soil samples will be collected every 5 ft and their mineral and physical characteristics will be described by the Geraghty & Miller, Inc., representative. After the borehole is drilled to its total depth, the well casing and attached well screen will be inserted into the borehole and the annulus around the well screen will be gravel packed by the tremie method. The annulus above the gravel pack will be grouted, using a neat cement grout by the tremie method, up to land surface. Upon completion, each monitor well will be adequately developed and will be protected at land surface by a metal protective casing. Sections of casing and screen will be joined by threaded couplings without the use of PVC bonding cement and the drilling equipment will be thoroughly cleaned before drilling each well in order to avoid cross contamination.

After completion of all of the monitor wells, the first quarter water samples will be collected from each and analyzed for the constituents itemized in Table 5.

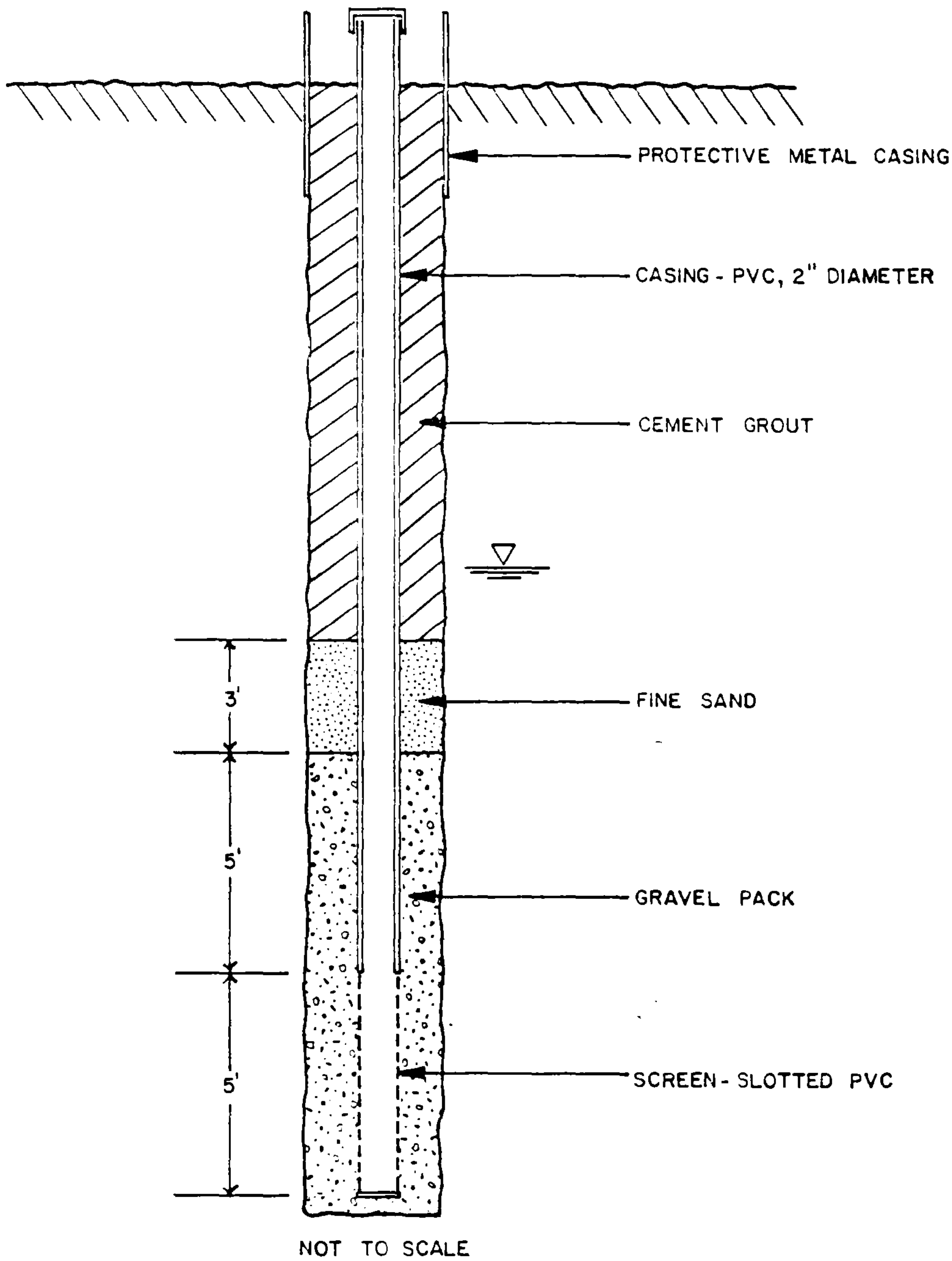

Figure 15. Schematic Diagram Showing Construction of Shallow Monitor Well.

Thereafter, quarterly sampling will continue for one year (second through fourth quarter) and analyses will be conducted for the constituents also shown in Table 4. Additional constituents may be analyzed for based upon the results of the first quarter sampling.

Sampling and Chemical Analysis Protocol

In conformance with 17-4.245(6)(d) FAC, a ground-water sampling and analysis plan has been prepared for Whiting Field. The detailed plan is presented in Appendix C of this report.

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APPENDIX A

LITHOLOGIC LOGS

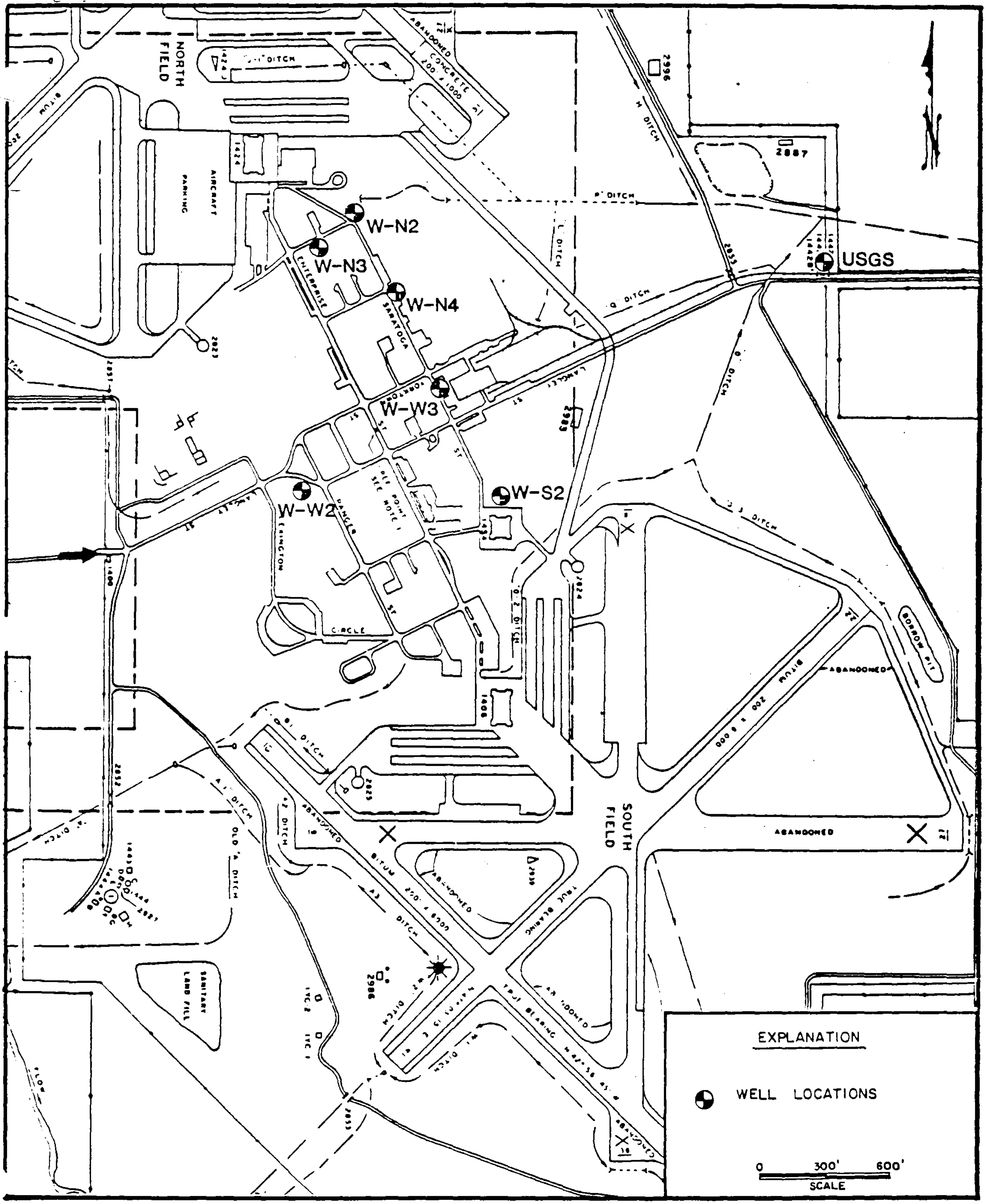

Figure A-1. Locations of Wells For Which Lithologic Logs Are Presented.

TABLE A-1. LITHOLOGIC LOG OF NAS OLD NORTH SUPPLY WELL

Well designation: W-N2
Surface Elevation: 168.1 ft msl

Depth (ft)	Description	Elevation (ft msl)
0 - 30	Sandy clay	168 - 138
30 - 44	Loose muddy sand and gravel	138 - 124
44 - 66	White sand with clay streaks	124 - 102
66 - 89	White sand with clay balls	102 - 79
89 - 102	Muddy sand	79 - 66
102 - 113	Clay	66 - 55
113 - 135	Yellow sandy clay	55 - 33
135 - 140	Clay	33 - 28
140 - 140.4	Rock	28 - 27.6
140.4 - 156	Muddy Sand	27.6 - 12
156 - 183	Pack sand, clay streaks	12 - (-15)
183 - 200	Brown pack sand with loose streaks	(-15) - (-32)
200 - 237	Sandy clay	(-32) - (-69)
237 - 254	Soft yellow clay	(-69) - (-86)
254 - 275	Muddy sand	(-86) - (-107)
275 - 304	Pack sand	(-107) - (-136)
304 - 312	Sandy shale	(-136) - (-144)
312 - 365	Hard sandy shale	(-144) - (-197)
365 - 424	Clay	(-197) - (-256)

TABLE A-2. LITHOLOGIC LOG OF NAS TEST WELL

Well designation: W-N3
Surface elevation: 171.5 ft msl

Depth (ft)	Description	Elevation (ft msl)
0 - 2	Topsoil	171 - 169
2 - 9	Sandy	169 - 162
9 - 22	Red clay to yellow chalk	162 - 149
22 - 27	Yellow sand, clay streaks	149 - 144
27 - 39	Clay	144 - 132
39 - 42	Coarse sand, clay stringers	132 - 129
42 - 52	Coarse sand, clay stringers, loose	129 - 119
52 - 62	Coarse sand, clay stringers, tight	119 - 109
62 - 75	Sand, cut well	109 - 96
75 - 80	Sand, tight	96 - 91
80 - 90	Sand, loose	91 - 81
90 - 100	Sand	81 - 71
100 - 119	Yellow clay	71 - 52
119 - 125	Sand	52 - 46
125 - 137	Muddy sand	46 - 34
137 - 145	Sand, cut well	34 - 26
145 - 165	Sand	26 - 6
165 - 176	Sand, small clay strings	6 - (-5)
176 - 198	Sand; iron minerals at 23-27 ft	(-5) - (-27)
198 - 217	Muddy sand	(-27) - (-46)
217 - 222	Black chalk	(-46) - (-51)
222 - 229	Sandy, bad looking	(-51) - (-58)

TABLE A-3. LITHOLOGIC LOG OF NAS NORTH SUPPLY WELL

well designation: W-N4
Surface elevation: 180 ft msl

Depth (ft)	Description	Elevation (ft msl)
0 - 15	Sandy clay	180 - 165
15 - 25	Pink chalk	165 - 155
25 - 40	Fine muddy sand	155 - 140
40 - 50	Muddy sand	140 - 130
50 - 54	Clay	130 - 126
54 - 65	Muddy sand	126 - 115
65 - 85	Fine muddy sand	115 - 95
85 - 90	Fine packed sand	95 - 90
90 - 114	Clay	90 - 66
114 - 125	Muddy sand	66 - 55
125 - 137	Fine packed sand	55 - 43
137 - 157	Muddy sand with mud balls	43 - 23
157 - 167	Sand (coarse good) some gravel	23 - 13
167 - 177	Sand (good)	13 - 3
177 - 195	Sand	3 - (-15)
195 - 203	Sand (red)	(-15) - (-23)
203 - 210	Sand	(-23) - (-30)
210 - 218	Clay and mud	(-30) - (-38)

TABLE A-4. LITHOLOGIC LOG OF NAS ABANDONED WEST WELL

well designation: W-W2
Surface elevation: 197.6 ft msl

Depth (ft)	Description	Elevation (ft msl)
0 - 9	Sand	198 - 189
9 - 22	Clay	189 - 176
22 - 32	Muddy sand	176 - 166
32 - 35	Clay	166 - 163
35 - 74	Sandy clay	163 - 124
74 - 124	Coarse pack sand	124 - 74
124 - 120	Soft yellow muddy sand	74 - 70
120 - 158	Sandy clay	70 - 40
158 - 178	Coarse pack sand	40 - 20
178 - 199	Coarse to fine pack sand	20 - (-1)
199 - 221	Coarse pack sand	(-1) - (-23)
221 - 244	Pack sand, streak	(-23) - (-46)
244 - 245	Rock	(-46) - (-47)
245 - 260	Soft sand and clay	(-47) - (-62)
260 - 270	Pack sand	(-62) - (-52)
270 - 294	Hard fine sand	(-52) - (-96)
294 - 355	Hard and soft blue sandy shale	(-96) - (-157)

TABLE A-5. LITHOLOGIC LOG OF NAS WEST SUPPLY WELL

Well designation: W-W3
Surface elevation: 180 ft msl

Depth (ft)	Description	Elevation (ft msl)
0 - 23	Red sandy clay	180 - 157
23 - 50	Fine sand and white clay	157 - 130
50 - 73	Sand and white clay balls	130 - 107
73 - 76	Sand and gravel	107 - 104
76 - 88	Fine sand	104 - 92
88 - 90	Fine sand and clay	92 - 90
90 - 105	Medium sand	90 - 75
105 - 113	Loose medium sand	75 - 67
113 - 132	Pink and yellow clay	67 - 48
132 - 150	Medium sand	48 - 30
150 - 153	Loose sand	30 - 27
153 - 156	Yellow clay	27 - 24
156 - 165	Loose sand	24 - 15
165 - 175	Medium sand	15 - 5
175 - 195	Sand and gravel	5 - (-15)
195 - 215	Loose sand and gravel	(-15) - (-35)
215 - 220	Yellow clay and iron rock	(-35) - (-40)

TABLE A-6. LITHOLOGIC LOG OF NAS SOUTH SUPPLY WELL

Well designation: W-S2
Surface elevation: 181.5 ft msl

Depth (ft)			Description	Elevation (ft msl)		
0	-	27	Red sandy clay	181	-	154
27	-	66	Sand and clay balls	154	-	115
66	-	88	Sand	115	-	93
88	-	110	Pack sand	93	-	71
110	-	121	Sand and clay balls	71	-	60
121	-	133	Fine pack sand	60	-	48
133	-	146	Pack sand	48	-	35
146	-	148	Clay	35	-	33
148	-	155	Loose sand and gravel	33	-	26
155	-	173	Soft sandy clay	26	-	8
173	-	197	Pack sand and soft streaks	8	-	(-16)
197	-	215	Pack sand	(-16)	-	(-34)
215	-	245	Yellow clay	(-34)	-	(-64)
245	-	251	Rock	(-64)	-	(-70)
251	-	255	Clay	(-70)	-	(-74)
255	-	273	Red sandy clay	(-74)	-	(-92)
273	-	340	Sandy shale	(-92)	-	(-159)

TABLE A-7. LITHOLOGIC LOG OF USGS DEEP MONITOR WELL.

Well designation: USGS
Surface elevation: 125.0 ft msl

Lithology	Thickness (feet)	Depth (feet)
Clay, white to brown, sticky; sand, white to clear quartz, medium.	20	20
Sand, clear to white quartz, medium; clay, brown to red.	20	40
Sand, clear to white, medium to coarse; gravel, white to yellow, very coarse to pea size; clay, brown.	20	60
Sand, clear to white, medium to coarse, sub-rounded to rounded; gravel, clear to white, very coarse; clay, light brown.	90	150
Clay, yellow to brown, sticky; gravel, very coarse to small pebbles; sand, medium, clear to white.	10	160
Sand, clear to white, medium to coarse, sub-rounded to angular; gravel--very coarse to pebble; clay, light brown.	50	210
Clay, green-gray to red, sticky; gravel, very coarse to pea size; sand, clear to white medium.	10	220
Sand, white to clear, medium to coarse; gravel, white to clear, very coarse to pebbles; clay, yellow brown to green, sticky.	30	250

TABLE A-7. (Continued)

Lithology	Thickness (feet)	Depth (feet)
Sand, clear to purple, medium to coarse, subrounded to subangular; clay, brown; gravel, clear to rose, very coarse to pea size.	40	290
Clay, gray brown to yellow brown; sand, clear to white, medium to coarse; gravel, clear to red, very coarse; black phosphorite grains.	40	330
Clay, dark green, sticky; sand, clear to white, subangular to subrounded; shell fragments; black phosphorite grains.	120	450
Sand, clear to white, medium; clay, dark green, soft; shell fragments; black phosphorite grains.	80	530
Clay, dark gray, soft, sticky; sand, white to clear, angular to subangular; shell fragments.	110	640
Limestone, gray, finely crystalline, porous; sand, clear to white, medium; clay, dark gray, soft, sticky; black phosphorite grains; pyrite; shell fragments.	30	670

TABLE A-7 (Continued)

Lithology	Thickness (feet)	Depth (feet)
Limestone, light gray, fine; sand, clear to white, medium; clay, gray to green, brittle, soft; black phosphorite grains; pyrite; shell fragments.	120	790
Sand, clear to white, medium; limestone, gray, fine; shell fragments; black phosphorite grains.	40	830
Clay, dark green, soft, sticky; sand, white to yellow, angular to subangular; limestone, gray, fine; shell fragments.	50	880
Clay, dark green, soft, very dense, waxy; sand, clear to white, medium.	100	980
Limestone, white, finely crystalline; sand, clear to white, medium; black phosphorite grains.	30	1010
Limestone, white, finely crystalline; pyrite; green glauconite; black phosphorite grains; shell fragments.	50	1060
Limestone, white to tan, limonite stains on limestone, finely crystalline; green glauconite; sand, clear quartz.	30	1090
Clay, light gray, soft, waxy; limestone, white to tan, finely crystalline.	20	1110

TABLE A-7 (Continued)

Lithology	Thickness (feet)	Depth (feet)
Limestone, white, finely crystalline; black phosphorite grains; pyrite; trace of clay.	20	1130
Limestone, white, finely crystalline; shell fragments; phosphorite; green glauconite; sand, clear qhartz, medium.	20	1150
Limestone, white to tan to gray; shell fragments; foraminifers; limonite clay, white; clay, gray, silty.	40	1190
Sand, clear quartz; medium, subangular; limestone, white to tan, crystalline.	40	1230
Limestone, white to tan, finely crystalline; shell fragments; sand, clear quartz, medium; limonite clay.	30	1260
Limestone, white to tan; sand, clear quartz, medium; shell fragments; clay, light gray, soft; black phosphorite, black.	20	1280
Clay, gray, soft; black phosphorite grains, abundant; sand, clear quartz, medium; limestone fragments.	10	1290

APPENDIX B

WATER-QUALITY ANALYSES

Pioneer

11 EAST OLIVE ROAD PHONE ... 474 ...
PENSACOLA FLORIDA 32514

TABLE B-1. CHEMICAL ANALYSIS OF SOUTH WELL.

DRINKING WATER CHEMICAL ANALYSIS

System Name: RCA Base Support Services NAS Whiting Field — County: Santa Rosa — Collector:

Address: Receiving Dept., Bldg. 2832, Milton, Florida 32570 — System I.D. No: — DER District:

Sample Site: South Well — Raw or Treated: Raw — Temperature:

Date and Time Collected: March 2, 1984 — Field Chlorine, mg/l: — Field pH:

Circle one: 40 Community public water system 41 Non-community public water system 42 Other public water system 43 Private water system

Circle one: 1 Compliance 2 Recheck 3 Other (indicate below parameters to be tested for items 2 or 3).

PRIMARY STANDARDS			SECONDARY STANDARDS			GENERAL	
PARAMETER	METHOD	RESULT**	PARAMETER	METHOD*	RESULT**	PARAMETER	RESULT**
Arsenic as As		<0.001	Chloride as Cl			Total Hardness as $CaCO_3$ (c)	
Barium as Ba		<0.1	Color*			Total Alkalinity as $CaCO_3$	
Cadmium as Cd		0.004	Copper as Cu			N.C.H. as $CaCO_3$ (c)	
Chromium as Cr		0.004	Corrosivity*			Bicarbonate as HCO_3	
Lead as Pb		<0.01	Foaming Agents			Calcium as Ca	
Mercury as Hg		<0.0001	H_2S			Magnesium as Mg	
Selenium as Se		<0.001	Iron as Fe			Carbon Dioxide as CO_2 (c)	
Silver as Ag		<0.001	Manganese as Mn			Bicarbonate as $CaCO_3$ (c)	
Nitrate as N		0.44	Odor*			Carbonate as $CaCO_3$ (c)	
Fluoride as F		0.12	pH*			Hydroxide as $CaCO_3$ (c)	
Turbidity, NTU		0.10	Sulfate as SO_4			Sodium as Na	
			TDS				
Endrin			Zinc as Zn			pHs* (c)	
Lindane						Stability Index* 2pHs-pH (c)	
Methoxychlor						Saturation Index* pH-pHs (c)	
Toxaphene						INTERPRETATION Stable	
2,4-D						Corrosive	
2,4,5-TP Silvex						Scale Forming	
Trihalomethanes			DER reviewer				
			Action required				

Note: *All results in mg/liter except those so noted ... (c) = Calculated value **BDL = Below detection limit (see reverse side)

Date and Time Received: March 2, 1984 — Laboratory I.D. No: 81142

Date Reported: March 13, 1984 — Analyst:

Analysts:

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Approved by W. F. Bowers, Laboratory Director

TABLE B-2. CHEMICAL ANALYSES OF WATER FROM THE FLORIDAN AND SAND AND GRAVEL AQUIFERS.

	CONCENTRATIONS			
	SAND-AND-GRAVEL AQUIFER[1]	FLORIDAN AQUIFER UPPER LIMESTONE[2]	FLORIDAN AQUIFER LOWER LIMESTONE[3]	
	August 1976	July 1975	Jan. 1974	Sept. 1977
alkalinity as $CaCO_3$	2	576	323	303
*aluminum, dissolved	-	20	50	-
*arsenic, dissolved	0	0	0	-
bicarbonate HCO_3	2	613	370	368
*boron, dissolved	-	740	600	-
*cadmium, dissolved	4	-	-	-
calcium, dissolved	.08	2.2	5.0	4.1
carbon, organic total	-	3.0	2.0	-
carbonate	-	44	12	-
chemical oxygen demand	-	26	12	-
chloride, dissolved	2.7	86	330	400
*chromium, dissolved	10	0	0	-
*chromium, hexavalent	-	0	0	-
*cobalt, dissolved	-	1	1	-
color (platinum cobalt scale)	5	100	8	0
*copper, dissolved	-	-	1	-
dissolved solids, residue at 180°C	12	840	870	998
fluoride, dissolved	.0	3.8	3.0	2.2
hardness, as $CACO_3$	4	8	21	22
hardness, noncarbonate	2	0	0	0
*iron, dissolved	.00	170	100	20
*lead, dissolved	14	8	0	-
magnesium, dissolved	-	.7	2.0	2.7
*manganese, dissolved	-	0	17	-
*mercury, dissolved	.0	.0	0.0	-
nitrate, NO_3 as N	.50	.00	.00	.01
nitrite, NO_2 as N	.00	.00	.01	-
nitrogen, NH_3 as N	-	1.0	.74	.74
nitrogen, total organic as N	-	.60	.30	.08
nitrogen, total as N	-	1.6	1.0	-
pH	5.1	8.8	8.7	8.4
phosphorus, total ortho as P	.00	.00	.03	.03
phosphorus, total as P	.01	.08	.03	.03
potassium, dissolved	.4	5.6	9.7	11
silica, dissolved	6.4	14	34	34
sodium, dissolved	2.3	330	320	380
specific conductivity (umhos at 25°C)	20	1,190	1,560	1,890
*strontium, dissolved	-	60	0	350
turbidity (NTU)	1	6	8	16
water temperature (°C)	23.5	24.0	30.0	27.5
*zinc, dissolved	-	3	10.0	-

[1] Sample from Milton municipal well No. 4

[2] Sample from USGS shallow monitor well 15 miles south of Whiting Field

[3] Sample from USGS monitor well at Whiting Field.

* Concentrations in ug/l; other concentrations in mg/l

From NWFWMD, 1980

TABLE B-3. Chemical Analysis of Whiting Field Water Supply.

Pioneer
LABORATORY, INC.

11 EAST OLIVE ROAD PHONE (904) 474-1001
PENSACOLA, FLORIDA 32514

To: RCA Base Support Services, NAS Whiting Dield, Receiving Dept. Bldg. 283
Milton, Florida 32570, Date of Order: 2/3/84, Lab I.D. # 204.

DRINKING WATER PRIORITY POLLUTANT ANALYSIS

Purgeables:

Acrolein	< 10
Acrylonitrile	< 10
Benzene	< 1
Bromodichloromethane	< 1
Bromoform	< 1
Bromomethane	< 1
Carbon-tetrachloride	< 1
Chlorobenzene	< 1
Chloroethane	< 1
2-Chloroethylvinyl ether	< 1
Chloroform	< 1
Chloromethane	< 1
Dibromochloromethane	< 1
Dichlorodifluoromethane	< 1
1,1-Dichloroethane	< 1
1,2-Dichloroethane	< 1
1,1-Dichloroethene	< 1
1,2-Dichloroethene	< 1
1,2-Dichloropropane	< 1
cis-1,3-Dichloropropene	< 1
trans-1,3-Dichloropropene	< 1
Ethylbenzene	< 1
Methylene Chloride	< 1
Tetrachloroethane	< 1
1,1,1-Trichloroethane	< 1
1,1,2-Trichloroethane	< 1
Trichloroethene	< 1
Trichlorofluoromethane	< 1
Toluene	< 1
Vinyl Chloride	< 1
Xylene	< 1
Styrene	< 1
Dichlorobenzene	< 1
1,2-Dibromoethane(EDB)	< 0.05
N-hexane	< 1
1,2-Dichloropropene	< 1
1,2-Dibromo-3-Chloropropane	< 1

NOTE: All results reported in parts per billion.
< = less than
Florida Certification #81142

NOTE: Sample taken from combined stream from all three supply wells.

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Approved by W. F. Bowers
W. F. Bowers
Laboratory Director

Pioneer
LABORATORY, INC
11 EAST OLIVE ROAD PHONE (904) 474-1001
PENSACOLA, FLORIDA 32514

To RCA Base Support Services, NAS Whiting Field, Receiving Dept. Bldg. 2832, Milton, Florida 32570, Date of Order: 2/3/84, Lab I.D. # 204.

DRINKING WATER PRIORITY POLLUTANT ANALYSIS

Pesticides:

Aldrin	<0.05
a-BHC	<0.05
b-BHC	<0.05
g-BHC	<0.05
d-BHC	<0.05
Chlordane	<0.05
4,4'-DDD	<0.05
4,4'-DDE	<0.05
4,4'-DDT	<0.05
Dieldrin	<0.05
Endosulfan I	<0.05
Endosulfan II	<0.05
Endosulfan Sulfate	<0.05
Ethion	<0.05
Trithion	<0.05
o,p-DDT, DDE and DDD	<0.05
Tedion	<0.05
Endrin Aldehyde	<0.05
Heptachlor	<0.05
Heptachlor Epoxide	<0.05
Toxaphene	<0.3
PCB-1016	<0.2
PCB-1221	<0.2
PCB-1232	<0.2
PCB-1242	<0.2
PCB-1248	<0.2
PCB-1254	<0.2
PCB-1260	<0.2
Aldicarb (non extractable)	<25
Diazinon	<1
Malathion	<1
Parathion	<1
Guthion	<1
Kelthane(Dicofal)	<1

NOTE: All results are reported in parts per billion.
< = less than
Florida Certification #81142

W. F. Bowers

Approved by W. F. Bowers
Laboratory Director

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F. G. HEALY

TABLE B-3 (Continued)

Pioneer LABORATORY INC

11 EAST OLIVE ROAD PHONE (904) 474-1001
PENSACOLA, FLORIDA 32514

To: RCA Base Support Services, NAS Whiting Field, Receiving Dept. Bldg. 2832, Milton Florida. 32570, Date of Order: 2/3/84, Lab I.D. #204.

DRINKING WATER PRIORITY POLLUTANT ANALYSIS

Base Neutral Extractables:

Acenaphthene	< 5
Acenaphthylene	< 5
Anthracene	< 5
Benzo(a)anthracene	< 5
Benzo(b)fluoranthene	< 5
Benzo(k)fluoranthene	< 5
Benzo(a)pyrene	< 5
Diethylphthalate	< 5
Dimethylphthalate	< 5
2,4-Dinitrotoluene	< 5
2,6-Dinitrotoluene	< 5
Dioctylphthalate	< 5
1,2-Diphylhydrazine	< 5
Fluoranthene	< 5
Benzo(g,h,i)perylene	< 5
Benzidine	< 5
Bis(2-chloroethyl)ether	< 5
Bis(2-chloroethoxy)methane	< 5
Bis(2-ethylhexyl)phthalate	< 5
Bis(2-chloroisopropyl)ether	< 5
4-Bromophenyl phenyl ether	< 5
Butyl benzyl phthalate	< 5
2-Chloronaphthalene	< 5
4-Chlorophenyl phenyl ether	< 5
Chrysene	< 5
Dibenzo(a,h)anthracene	< 5
Di-n-butylphthalate	< 5
1,3-Dichlorobenzene	< 5
1,4-Dichlorobenzene	< 5
1,2-Dichlorobenzene	< 5
3,3'-Dichlorobenzidine	< 5
Fluorene	< 5
Hexachlorobenzene	< 5
Haxachlorobutadiene	< 5
Hexachloroethane	< 5
Hexachlorocyclopentadiene	< 5
Indeno(1,2,3-cd)pyrene	< 5
Isophorone	< 5
Naphthalene	< 5
Nitrobenzene	< 5
N-Nitrosodimethylamine	< 5
N-Nitrosodi-n-propylamine	< 5
N-Nitrosodiphenylamine	< 5
Phenanthrene	< 5
Pyrene	< 5
2,3,7,8-Tetrachlorodibenzo-p-dioxin(Dioxin)	< 5
1,2,4-Trichlorobenzene	< 5

Approved by W. F. Bowers
W. F. Bowers
Laboratory Director

RECEIVED
MAR 14 1984
F. G. HEALY

NOTE: Results are reported in parts per billion. < = less than
Florida Certification #81142.

Pioneer LABORATORY, INC.

11 EAST OLIVE ROAD PHONE (904) 474-1001
PENSACOLA, FLORIDA 32514

To: RCA Base Support Services, NAS Whiting Field, Receiving Dept. Bldg. 283[illegible] Milton, Florida 32570, Date of Order: 2/3/84, Lab I.D. # 204.

DRINKING WATER PRIORITY POLLUTANT ANALYSIS

Acid Extractables:

2-Chlorophenol	<5
2,4-Dichlorophenol	<5
2,4-Dimethylphenol	<5
2,4-Dinitrophenol	<5
2-Methyl-4,6-Dinitrophenol	<5
2-Nitrophenol	<5
4-Nitrophenol	<5
Pentachlorophenol	<5
Phenol	<5
2,4,6-Trichlorophenol	<5

NOTE: All results reported in parts per billion.
< = less than
Florida Certification #81142

W. F. Bowers

Approved by W. F. Bowers
Laboratory Director

RECEIV.
MAR 1[illegible]
F. G. HEAL

TABLE B-4. Surface Water Chemical Analyses

RANGE OF CHEMICAL ANALYSIS FOR BLACKWATER RIVER, BIG COLDWATER CREEK, AND POND CREEK.

SITE	Range	Discharge (ft^3/s)	Specific conductance (umho/cm at 25°C)	pH (units)	Color (Platinum-Cobalt units)	Temperature (°C)	Iron (Fe) in ug/L	Alkalinity as $CaCO_3$, in mg/L	Bicarbonate (HCO_3), in mg/L	Calcium (Ca), in mg/L	Chloride (Cl), in mg/L	Fluoride (F), in mg/L	Hardness, noncarbonate, in mg/L	Hardness, total (Ca, Mg), in mg/L	Magnesium (Mg), in mg/L	Nitrate as (NO_3), in mg/L	Phosphate (PO_4), in mg/L	Potassium (K), in mg/L	Dissolved solids (sum), in mg/L	Silica (SiO_2), in mg/L	Sodium (Na), in mg/L	Sulfate (SO_4), in mg/L	Dissolved Oxygen (DO), in mg/L
Big Coldwater Creek near Milton, FL (1/59-7/75)	HIGH	2465	150	7.5	60	27.8	220	28	34	5.6	8.0	0.4	6.0	18	1.5	1.9	.05	0.7	28	34.0	21.0	2.4	9.2
	LOW	298	15	5.3	2	13.3	0	0	0	0.5	1.0	0	0	2	0.1	0	0	0	11	1.9	0.4	0	6.2
Pond Creek near Milton, FL (1/58-8/74)	HIGH	60	22	6.2	45	23.5	60	3	4	1.8	3.8	0.1	2	6	0.9	.09	.04	0.4	18	8.4	2.5	1.2	8.9
	LOW	32	15	5.2	0	11.7	10	2	2	0.4	1.8	0	0	2	0.1	.0	.01	0	10	3.7	1.6	0	6.9
Blackwater River near Baker, FL (1977 water year)	HIGH	1270	25	5.7	50	24	370	0	0	1.1	3.9	0.1	5	5	0.6	0	0	0.7	17	6.3	3.5	9.3	0
	LOW	119	21	4.6	40	20	120	0	0	1.0	2.8	0	4	4	0.4	0	0	0.3	16	5.8	1.9	0.3	0

From: NWFWMD, 1980.

Table B-5. Results of the Analyses for EPA's Organic Priority Pollutants From the North Supply Well, W-N4.

Compound	Sample ID: CAA ID:	Whiting North Well 8401255
		Concentration ug/l (ppb)[2]
(2v) acrolein		
(3v) acrylonitrile		
(4v) benzene		
(6v) carbon tetrachloride		
(7v) chlorobenzene		
(10v) 1,2-dichloroethane		
(11v) 1,1,1,-trichloroethane		
(13v) 1,1-dichloroethane		
(14v) 1,1,2-trichloroethane		
(15v) 1,1,2,2-tetrachloroethane		
(16v) chloroethane		
(19v) 2-chloroethylvinyl ether		
(23v) chloroform		
(29v) 1,1-dichloroethylene		
(30v) trans-1,2-dichloroethylene		
(32v) 1,2-dichloropropane		
(33v) trans-1,3-dichloropropene		
cis-1,3-dichloropropene		
(38v) ethylbenzene		
(44v) methylene chloride		
(45v) chloromethane		
(46v) bromomethane		
(47v) bromoform		
(48v) bromodichloromethane		
(49v) fluorotrichloromethane		
(50v) dichlorodifluoromethane		
(51v) chlorodibromomethane		
(85v) tetrachloroethylene		
(86v) toluene		
(87v) trichloroethylene		
(88v) vinyl chloride		
Detection Limit		1

[1]U.S. EPA. 1982. Methods for Organic Chemical Analysis of Municipal and Industrial Wastewater. EPA 600/4-82-057. EPA/EMSL, Cincinnati, Ohio.

[2]Concentrations less than the detection limit are left blank. Concentrations between 1 and 10 times the detection limit are listed as trace levels (TR). Acrolein and acrylonitrile are 100 and 10 times the detection limit respectively.

Table B-5 (Continued)

CAMBRIDGE ANALYTICAL ASSOCIATES, INC.

Table 3A (cont'd.). Concentration of Acid/Base/Neutral Extractables (Method 625[1])

Client: Geraghty and Miller — Report No.: 84-297

Compound		Concentration - ug/l (ppb)[2]
	Sample ID:	Whiting North Well
	CAA ID:	8401255
ACID COMPOUNDS		
(21A) 2,4,6-trichlorophenol		
(22A) p-chloro-m-cresol		
(24A) 2-chlorophenol		
(31A) 2,4-dichlorophenol		
(34A) 2,4-dimethylphenol		
(57A) 2-nitrophenol		
(58A) 4-nitrophenol		
(59A) 2,4-dinitrophenol		
(60A) 4,6-dinitro-2-methylphenol		
(64A) pentachlorophenol		
(65A) phenol		
Detection Limit		2
BASE/NEUTRAL COMPOUNDS		
(1B) acenaphthene		
(5B) benzidine		
(8B) 1,2,4-trichlorobenzene		
(9B) hexachlorobenzene		
(12B) hexachloroethane		
(18B) bis (2-chloroethyl) ether		
(20B) 2-chloronapthalene		
(25B) 1,2-dichlorobenzene		
(26B) 1,3-dichlorobenzene		
(27B) 1,4-dichlorobenzene		
(28B) 3,3'-dichlorobenzidine		
(35B) 2,4-dinitrotoluene		
(36B) 2,6-dinitrotoluene		
(37B) 1,2-diphenylhydrazine		
(39B) fluoranthene		
(40B) 4-chlorophenyl phenyl ether		
(41B) 4-bromophenyl phenyl ether		

Table B-5 (Continued)

CAMBRIDGE ANALYTICAL ASSOCIATES, INC.

Table 3B (cont'd). Concentration of Acid/Base/Neutral Extractables (Method 625[1])

Client: Geraghty and Miller Report No.: 84-297

Compound	Sample ID: / CAA ID:	Concentration - ug/l (ppb)[2] Whiting North Well 8401255
BASE NEUTRAL COMPOUNDS (cont'd)		
(42B) bis (2-chloroisopropyl) ether		
(43B) bis (2-chloroethoxy) methane		
(52B) hexachlorobutadiene		
(53B) hexachlorocyclopentadiene		
(54B) isophorone		
(55B) naphthalene		
(56B) nitrobenzene		
(62B) N-nitrosodiphenylamine		
(63B) N-nitrosodipropylamine		
(66B) bis (2-ethylhexyl) phthalate		
(67B) benzyl butyl phthalate		
(68B) di-n-butyl phthalate		
(69B) di-n-octyl phthalate		
(70B) diethyl phthalate		
(71B) dimethyl phthalate		
(72B) benzo(a)anthracene		
(73B) benzo(a)pyrene		
(74B) benzo(b)fluoroanthene		
(75B) benzo(k)fluoroanthene		
(76B) chrysene		
(77B) acenaphthylene		
(78B) anthracene		
(79B) benzo(ghi)perylene		
(80B) fluorene		
(81B) phenanthrene		
(82B) dibenzo(a,h)anthracene		
(83B) ideno(1,2,3-cd)pyrene		
(84B) pyrene		
Detection Limit		2

[1] U.S. EPA, 1982. Methods for Organic Chemical Analysis of Municipal and Industrial Wastewater. EPA 600/4-82-057. EPA/EMSL, Cincinnati, Ohio.

[2] Concentrations less than the detection limit are left blank. Concentrations between 1 and 10 times the limit of detection are listed as trace levels (TR).

Table B-5 (Continued)

CAMBRIDGE ANALYTICAL ASSOCIATES, INC.

Table 4 (cont'd.). Concentration of Pesticides and PCBs (Method 608[1])

Client: Geraghty and Miller | Report No.: 84-297

Compound		Concentration - ug/l (ppb)[2]
	Sample ID:	Whiting North Well
	CAA ID:	8401255
PESTICIDES AND PCBs		
(89P) aldrin		
(90P) dieldrin		
(91P) chlordane		
(92P) 4,4'-DDT		
(93P) 4,4'-DDE		
(94P) 4,4'-DDD		
(95P) endosulfan-alpha		
(96P) endosulfan-beta		
(97P) endosulfan sulfate		
(98P) endrin		
(99P) endrin aldehyde		
(100P) heptachlor		
(101P) heptachlor epoxide		
(102P) BHC-alpha		
(103P) BHC-beta		
(104P) BHC-delta		
(105P) BHC-gamma (lindane)		
(106P) PCB - 1242		
(107P) PCB - 1254		
(108P) PCB - 1221		
(109P) PCB - 1232		
(110P) PCB - 1248		
(111P) PCB - 1260		
(112P) PCB - 1016		
(113P) toxaphene		
Detection Limit		.01

[1] U.S. EPA, 1982. Methods for Organic Chemical Analysis of Municipal and Industrial Wastewater. EPA 600/4-82-057. EPA/EMSL, Cincinnati, Ohio.

[2] Concentrations less than the detection limit are left blank. Concentrations between 1 and 10 times detection limit are listed as trace levels (TR).

APPENDIX C

PROPOSED GROUND-WATER SAMPLING AND ANALYSIS PLAN FOR U.S. NAVAL AIR STATION, WHITING FIELD

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

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 the U.S. Naval Air Station, Whiting 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 the water-quality parameters which should be monitored at the NAS Whiting Field on a quarterly basis during the first year of monitoring and semi-annually in succeeding years. Maps showing locations of the proposed monitor wells are presented in Figures C-1, C-2, C-3, C-4, and C-5.

2.2 Equipment

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

(1) 200-ft fiberglass or plastic measuring tape with weighted bottom (or) water-level indicator ("m-scope") consisting of an ammeter, electrode, and 200-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;
(12) Preservatives for water samples;
(13) Field data and chain-of-custody forms, clipboard, pen; and
(14) Optional: ice chest and ice or freezer packs.

Table 2.1. Ground-Water Quality Parameters and Frequency of Sample Collection

Constituent	Sites: Background (North well)	Sites: Landfills	Sites: Battery Shop	Sites: Solvents Storage
Arsenic	1	1,2,3,4	1	1
Barium	1	1,2,3,4	1	1
Cadmium	1	1,2,3,4	1,2,3,4	1,2,3,4
Chromium (Hexavalent)	1	1,2,3,4	1,2,3,4	1,2,3,4
Fluoride	1	1	1	1
Lead	1	1,2,3,4	1,2,3,4	1,2,3,4
Mercury	1	1	1	1
Nitrate (as N)	1	1	1	1
Selenium	1	1	1	1
Silver	1	1	1	1
Endrin	1	1	1	1
Lindane	1	1	1	1
Methoxychlor	1	1	1	1
Toxaphene	1	1	1	1
2,4-D	1	1	1	1
2,4,5-TP Silvex	1	1	1	1
Turbidity	1	1	1	1
Chloride	1	1	1	1
Copper	1	1	1	1
Foaming Agents	1	1	1	1
Hydrogen Sulfide	1	1	1	1
Iron	1	1	1	1
Manganese	1	1	1	1
Sulfate	1	1	1	1
TDS	1	1	1	1
Zinc	1	1,2,3,4	1,2,3,4	1
Color	1	1	1	1
Odor	1	1	1	1
pH (field)	1	1,2,3,4	1,2,3,4	1,2,3,4
Specific Conductance (field)	1	1,2,3,4	1,2,3,4	1,2,3,4
VOC (volatile organics-Method 601)		1,2,3,4	1	1,2,3,4

Note: Numbers refer to quarterly sampling periods during the first monitoring year.

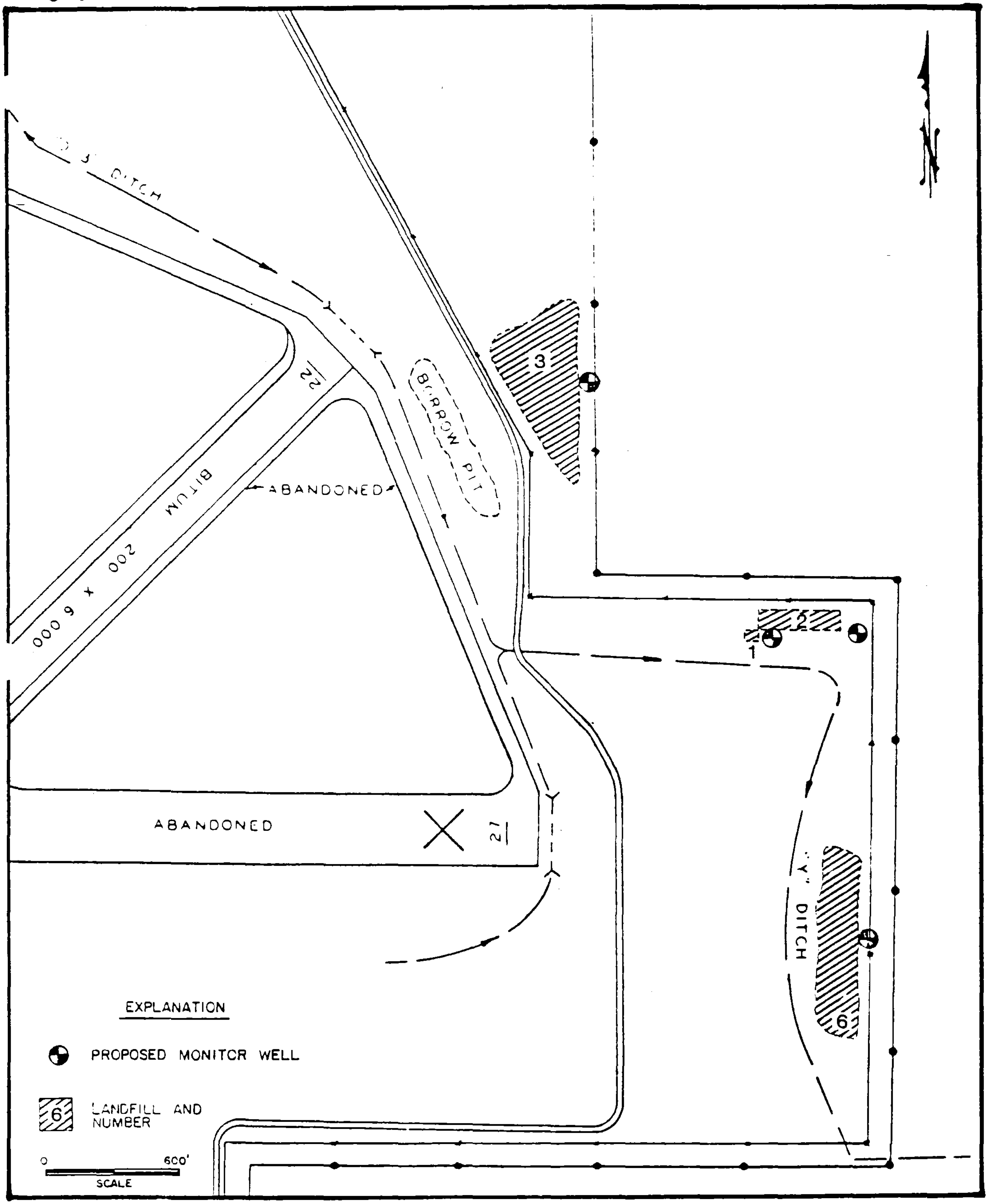

Figure C-1. Proposed Locations of Monitor Wells for Landfill Sites #1, #2, #3, and #6.

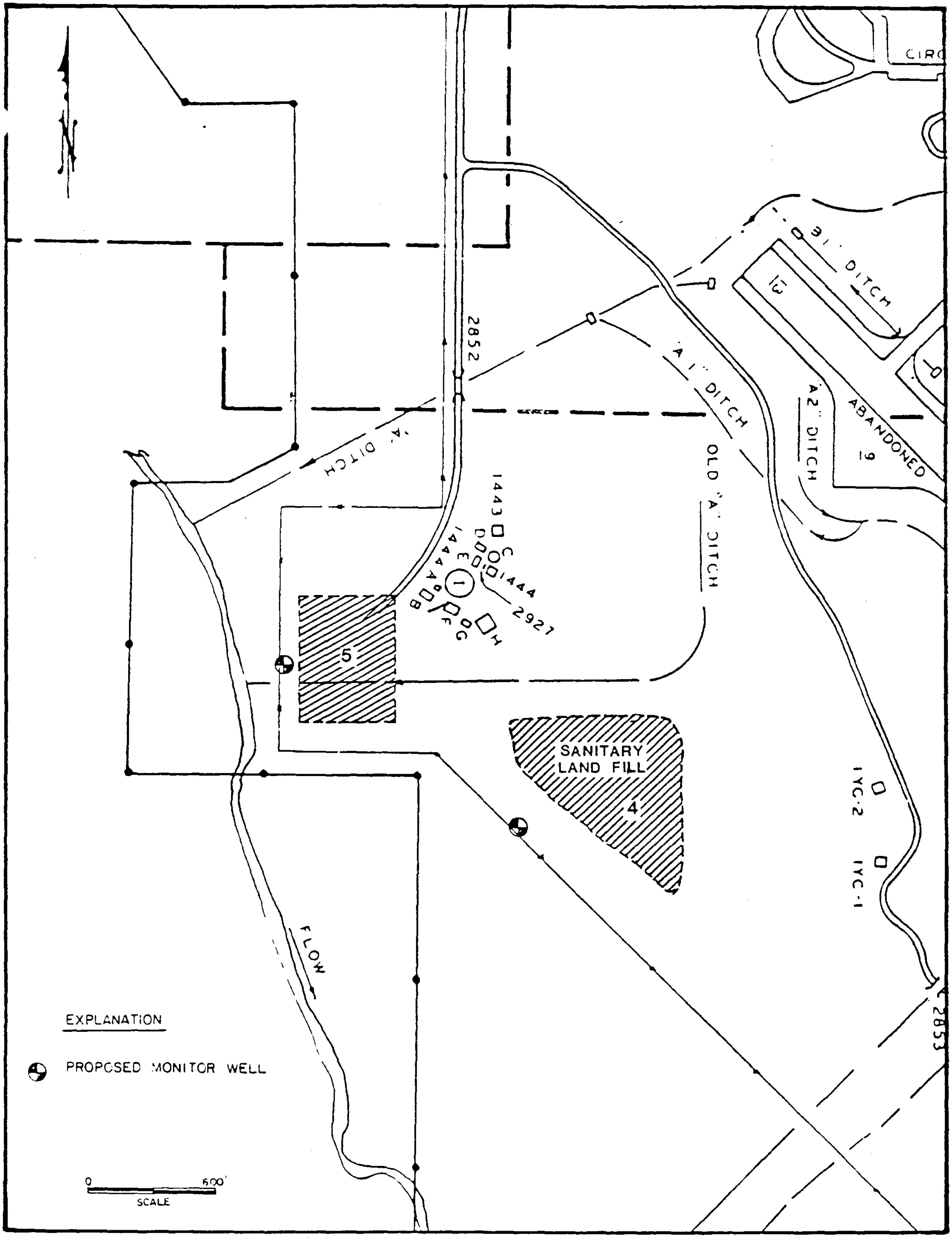

Figure C-2. Proposed Location of Monitor Wells for Landfill Sites #4 and #5.

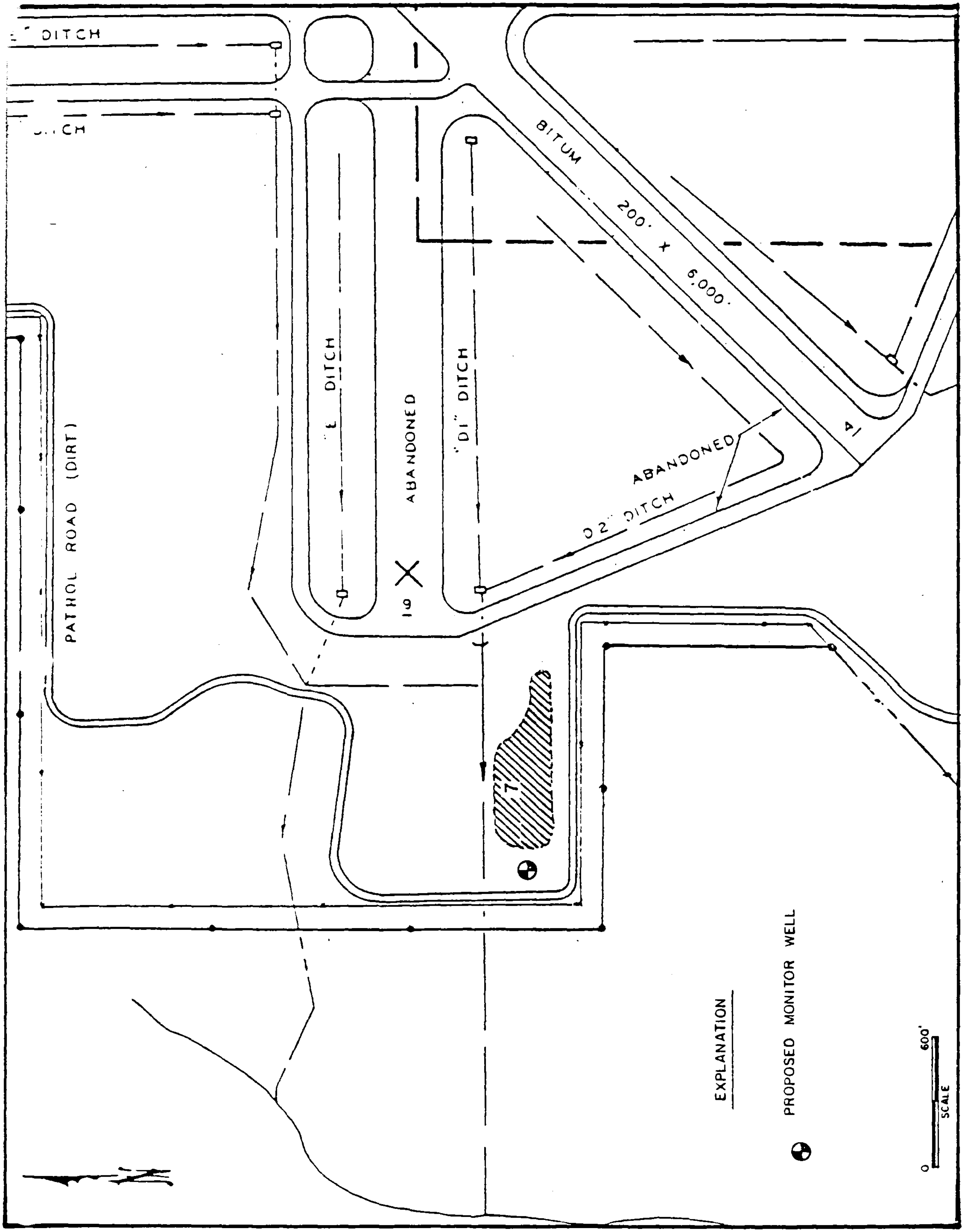

Figure C-3. Proposed Location of Monitor Well for Landfill #7.

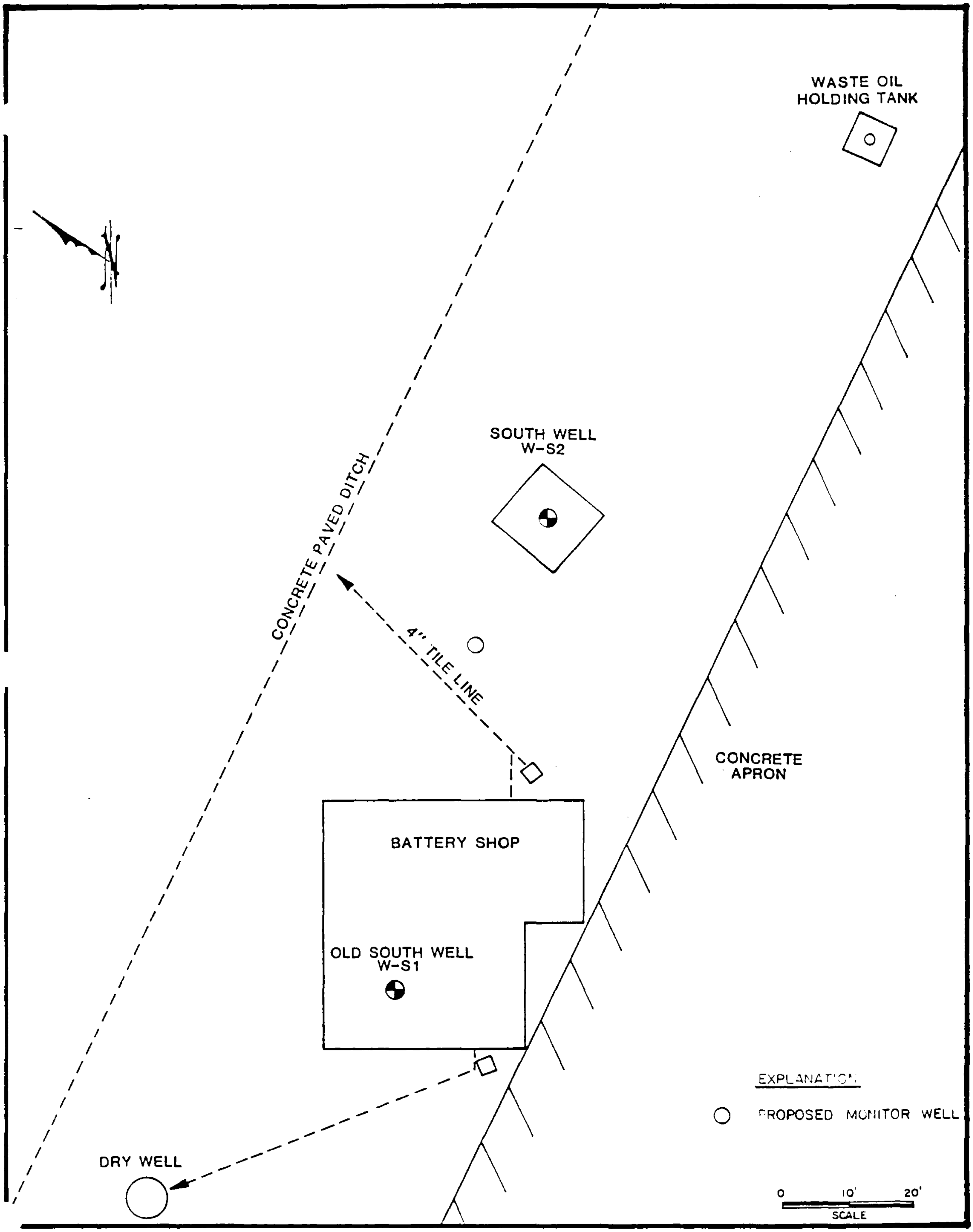

Figure C-4. Proposed Location of Monitor Well for Battery Shop Site.

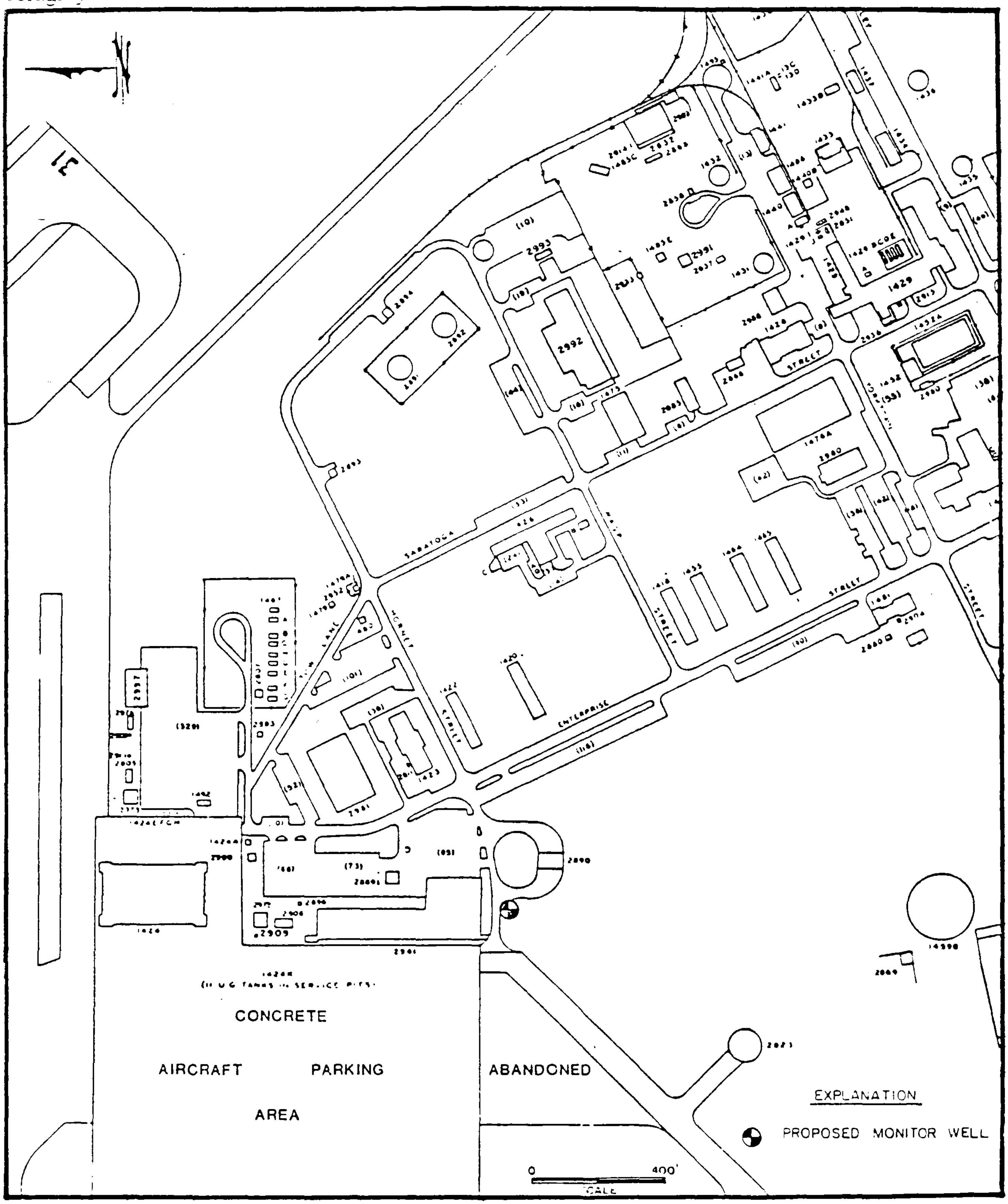

Figure C-5. Location of Proposed Monitor Well for Solvents Storage Site.

2.3 Sample Collection Method

2.3.1 Procedures for Measuring Water Levels

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

(b) After unscrewing casing cap or access plug, 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-6). Subtract this value from elevation at top of PVC casing to find elevation of water level (see Figures C-7 and C-8 for elevation of top of casing),

  (or)

- Using a fiberglass or plastic 200-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.

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

Figure C-6. Ground-Water Sampling Data Form

Date: ____________________

S ...ng/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: ____________

____

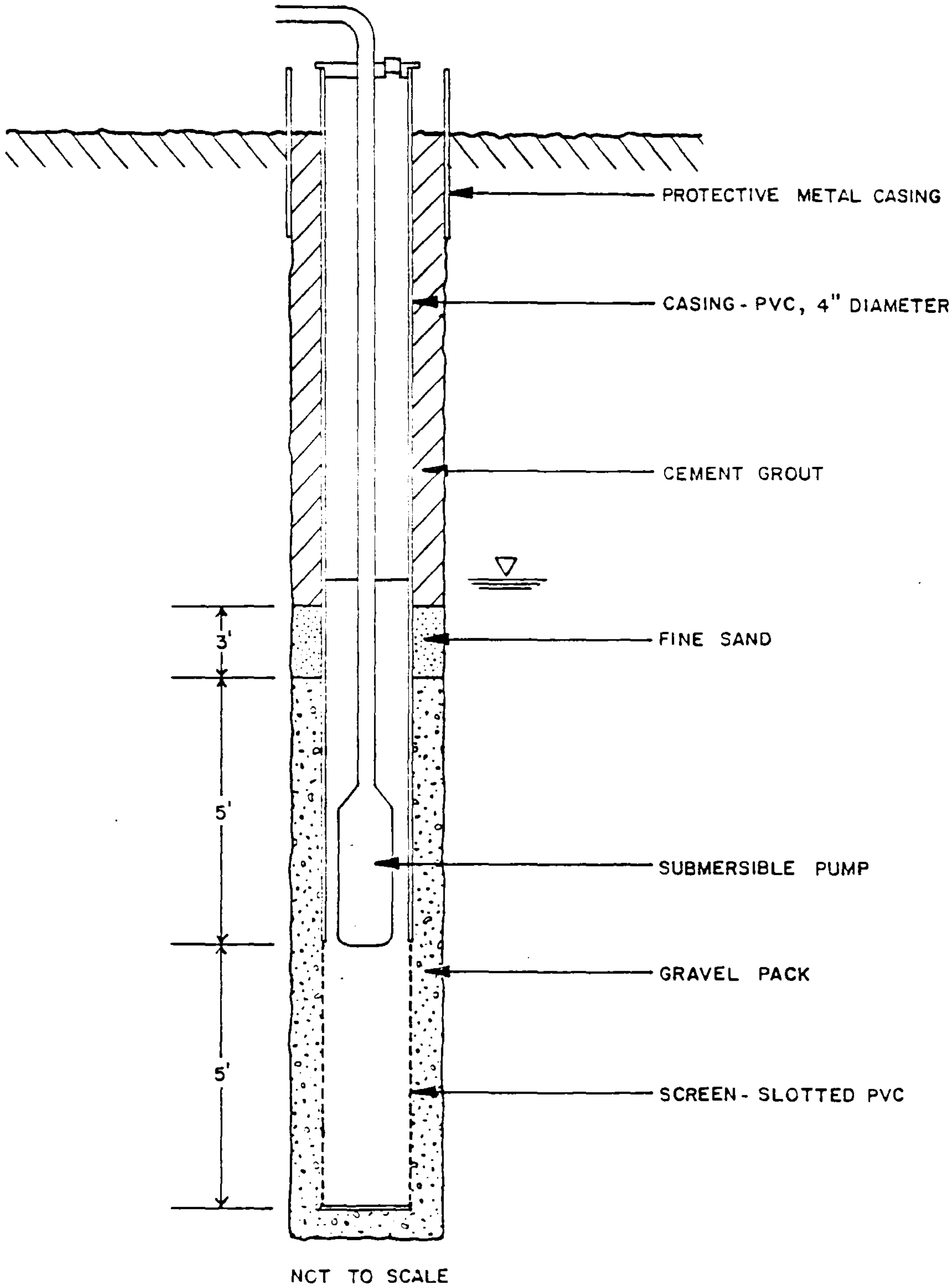

Figure C-7. Schematic Diagram Showing Construction of Deep Monitor Well.

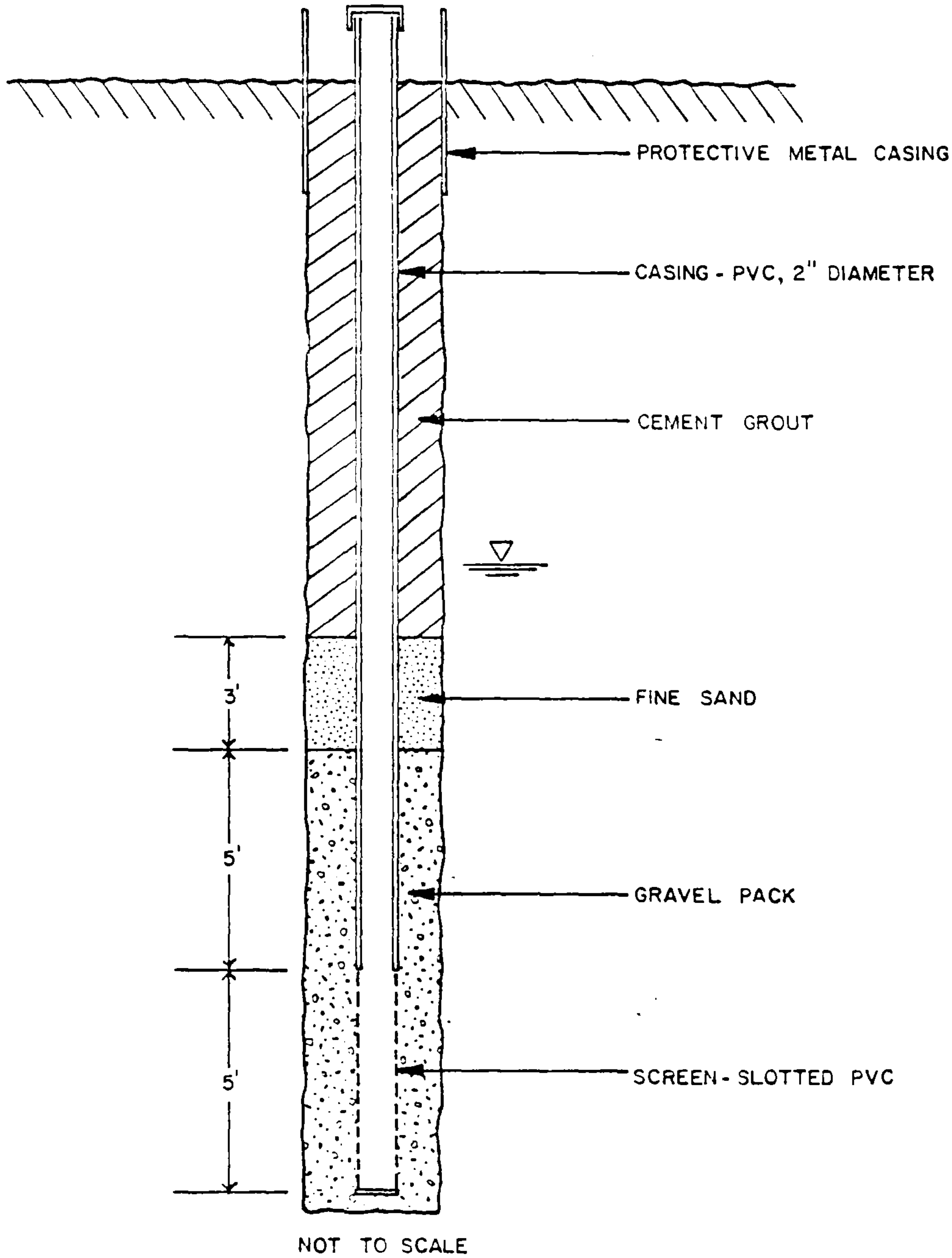

Figure C-8. Schematic Diagram Showing Construction of Shallow Monitor Well.

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:

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

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-7 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.

(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.

3.0 ANALYTICAL PROCEDURES

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

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