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VOLUME 2

PRELIMINARY REVIEW DOCUMENT FOR RCRA/CERCLA ACTIVITIES NAS MEMPHIS MILLINGTON, TENNESSEE

Prepared For:
Department of the Navy
Southern Division
Naval Facilities Engineering Command
Charleston, South Carolina
Contract No. N62467-88-C-0198

Prepared By:
ERC Environmental and Energy Services Co.
725 Pellissippi Parkway
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INTRODUCTION

This Preliminary Review Document (PRD) was prepared in support of RCRA and CERCLA activities to be performed at Naval Air Station (NAS) Memphis, Millington, Tennessee. It includes copies of reports of previous environmental investigations performed at the NAS. These include:

- The Navy's Initial Assessment Study (IAS) Report dated November 1983
- The Navy's NACIP Verification Phase Confirmation Study Report dated November 1985
- Sampling Results Report for NAS Memphis Solid Waste Management Units (SWMUs) Number 3, 4, and 40
- Comments from the Tennessee Department of Health and Environment (TDHE) on past documents, specifically on the April 1987 draft RCRA Facility Assessment (RFA) Inventory Report and the April 1987 draft RCRA Facility Investigation (RFI) Plan.

These are tabbed as Appendices I through V of the PRD.

A RCRA Facility Assessment (RFA) Report and a Visual Site Inspection Report (VSIR) were prepared concurrently with this report. The RFA is an update of the draft RFA Inventory Report. The draft RFI Site Investigation Plan was not updated concurrently with this report nor is a copy of the April 1987 draft included in this PRD.

NOVEMBER 1983

INITIAL ASSESSMENT STUDY OF NAVAL AIR STATION MEMPHIS MILLINGTON, TENNESSEE

NEESA 13-038

NAVAL ENERGY AND ENVIRONMENTAL
SUPPORT ACTIVITY
Port Hueneme, California 93043

RELEASE OF THIS DOCUMENT REQUIRES PRIOR NOTIFICATION
OF THE CHIEF OFFICIAL OF THE STUDIED ACTIVITY

INITIAL ASSESSMENT STUDY

NAVAL AIR STATION MEMPHIS

MILLINGTON, TENNESSEE

UIC: 00639

Prepared by:

Harmon Engineering & Testing
1550 Pumphrey Ave.
Auburn, AL 36830

Contract No. N62474-82-C-C358

Initial Assessment Study Team Members

Bruce Ferguson, Project Manager/Field Team Leader, Chemist
Mark Shearon, Project Manager/Report Team Leader, Biologist
Steve Jones, Biologist
Cameron McDonald, Chemist/Health Physicist
Robert Cook, Hydrogeologist
Ronald Thompson, Civil Engineer
Jim Johnson, Document Coordinator

Naval Energy and Environmental Support Activity
Contract Coordinator
Patricia A. Gandy, P.E.

Prepared for:

Navy Assessment and Control
of Installation Pollutants Department
Naval Energy and Environmental Support Activity
Port Hueneme, California 93043

November 1983

EXECUTIVE SUMMARY

This report presents the results of an Initial Assessment Study (IAS) conducted at the Naval Air Station (NAS) Memphis, Millington, Tennessee. The purpose of an IAS is to identify and assess sites posing a potential threat to human health or to the environment due to contamination from past hazardous material operations.

Ground water contamination is the primary concern in the NAS Memphis region. Recent studies indicate that the area's shallow ground water is hydraulically linked with the deeper potable water aquifer. Both NAS Memphis and the city of Millington obtain their potable and industrial water supplies from wells in this deeper aquifer.

Based on information from historical records, aerial photographs, field inspections and personnel interviews, a total of twelve potentially-contaminated sites were identified at NAS Memphis. Each of the sites was evaluated with regard to contamination characteristics, migration pathways and pollutant receptors.

The study concludes that while none of the sites poses an immediate threat to human health or to the environment, five warrant further investigation under the Navy Assessment and Control of Installation Pollutants (NACIP) Program, to assess potential long-term impacts. A Confirmation Study, involving actual sampling and monitoring of the five sites, is recommended to confirm or deny the existence of the suspected contamination and to quantify the extent of any problems which may exist. The five sites recommended for confirmation are listed below in order of priority.

- Site 3, N-121 Plating Shop Dry Well
- Site 7, N-126 Plating Shop Dry Well
- Site 2, South Side Landfill
- Site 4, N-121 Plating Shop Storm Drain and Sewer
- Site 8, Cemetery Landfill

The results of the Confirmation Study will be used to evaluate the necessity of conducting mitigating actions or clean-up operations.

NEPSS

Naval
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Protection
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Service

FOREWORD

The Department of the Navy developed the Navy Assessment and Control of Installation Pollutants (NACIP) Program to identify and control environmental contamination from past use and disposal of hazardous substances at Navy and Marine Corps installations. The NACIP Program is part of the Department of Defense Installation Restoration Program, and is similar to the Environmental Protection Agency's "Superfund" Program authorized by the Comprehensive Environmental Response, Compensation, and Liability Act of 1980.

In the first phase of the NACIP Program, a team of engineers and scientists conducts an Initial Assessment Study (IAS). The IAS team collects and evaluates evidence of contamination that may pose a potential threat to human health or the environment. The IAS includes a review of archival and activity records, interviews with activity personnel, and an on-site survey of the activity. This report documents the findings of an IAS at the Naval Air Station (NAS) Memphis, Millington, Tennessee.

Further confirmation studies under the NACIP Program were recommended at five areas at NAS Memphis. Southern Division Naval Facilities Engineering Command will assist NAS Memphis in implementing those recommendations.

Questions regarding this report should be referred to the Naval Energy and Environmental Support Activity, 112N, at AUTOVON 360-3351, FTS 799-3351, or commercial 805-982-3351. Questions concerning confirmation work or other follow-on efforts should be referred to Southern Division at AUTOVON 794-5510, FTS 679-5510, or commercial 803-743-5510.

W. L. Nelson

WILLIAM L. NELSON, LCDR, CEC, USN
Environmental Officer
Naval Energy and Environmental Support Activity

ACKNOWLEDGEMENTS

The Initial Assessment Study (IAS) at Naval Air Station Memphis, Millington, Tennessee, was completed thanks to the support, assistance, and cooperation of numerous Navy personnel. In addition to our appreciation to the entire Navy organization, the IAS team expresses its gratitude to Patricia Gandy—Naval Energy and Environmental Support Activity, Dick Bozung—Southern Division, Naval Facilities Engineering Command, and George E. Robertson—Naval Air Station Memphis Public Works Office.

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CHAPTER 1. INTRODUCTION

1.1 PROGRAM BACKGROUND. Past hazardous waste disposal methods, although acceptable at the time, have often caused unexpected long-term problems through release of hazardous pollutants into the soil and ground water. In response to increasing national concern regarding these problems, the U.S. Congress directed the Environmental Protection Agency (EPA) to develop a comprehensive national program to manage past disposal sites. The program is outlined in the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of December 1980.

1.1.1 DOD Program. Department of Defense (DOD) efforts in this area preceded the nationwide CERCLA program. In 1975, the U.S. Army developed, for DOD, a pilot program to investigate past disposal sites at military installations. DOD defined the program as the Installation Restoration Program in 1980, and instructed the services to comply with program guidelines.

1.1.2 Navy Program. The Navy manages its part of the program, the Navy Assessment and Control of Installation Pollutants (NACIP), in three phases. Phase one, the Initial Assessment Study (IAS), identifies potential threats to human health or to the environment caused by past hazardous substance storage, handling, or disposal practices at naval activities. Phase two, the Confirmation Study, analyzes contaminants present at sites of concern and determines their migration paths. Phase three, Remedial Actions, provides the required corrective measures to mitigate or eliminate confirmed problems.

1.2 AUTHORITY. The Chief of Naval Operations initiated the NACIP Program in OPNAVNOTE 6240 of 11 September 1980, superseded by OPNAVINST 5090.1. Commander, Naval Facilities Engineering Command (COMNAVFACENGCOM) manages the program within the existing structure of the Naval Environmental Protection Support Service (NEPSS), which is administered by the Naval Energy and Environmental Support Activity (NAVENENVSA). NAVENENVSA conducts the program's first phase, the IAS, in coordination with COMNAVFACENGCOM Engineering Field Divisions (EFDs). Activities are selected for an Initial Assessment Study by the Chief of Naval Operations (CNO), based on the recommendations by COMNAVFACENGCOM, the regional EFDs, and NAVENENVSA. Approval of the Naval Air Station (NAS) Memphis for an IAS is contained in CNO letter serial 451/391407 of 31 March 1982.

1.3 SCOPE.

1.3.1 Past Operations. The NACIP Program focuses attention on past hazardous substance storage, use, and disposal practices on Navy property. Current practices are regularly surveyed for conformity to state and federal regulations and, therefore, are not included in the scope of the NACIP Program. The Initial Assessment Study report addresses operating non-hazardous disposal and storage areas, only if they were hazardous waste

disposal or storage areas in the past. Current operations are investigated, solely, to determine types and quantities of chemicals used, and disposal methods practiced.

1.3.2 Results. An IAS recommends, if necessary, mitigating actions to be performed by the activity or EFDs, or any sampling and monitoring (confirmation studies) to be administered by the EFD under the NACIP Program. Based on these recommendations, COMNAVFACENGCOM schedules confirmation studies for those sites which have been determined by scientific and engineering judgment to be potential hazards to human health or to the environment.

1.4 INITIAL ASSESSMENT STUDY.

1.4.1 Record Search. The Initial Assessment Study begins with an investigation of activity records, followed by record searches at various government agencies including EFDs, national and regional archives and record centers, and U.S. Geological Survey offices. In this basic step, study team members review records to gather information regarding the activity's missions, industrial processes, waste disposal records, and known environmental contamination. Typical examples of records include activity master plans and histories, environmental impact statements, cadastral records, and aerial photographs. Appendix A lists the agencies contacted during this search.

1.4.2 On-Site Survey. After the record search, the study team conducts an on-site survey to further document past operating and disposal operations and identify potentially contaminated areas. With the assistance of an activity point-of-contact, the study team inspects the activity during ground and aerial tours and interviews long-term employees and retirees.

Information obtained from interviews is verified by data from other sources or corroborating interviews before inclusion in the report. If information for certain sites is conflicting or inadequate, the team may collect samples for clarification.

1.4.3 Confirmation Study Ranking System. With information collected during the study, team members evaluate each site for its potential hazard to human health or to the environment. A two-step Confirmation Study Ranking System (CSRS), developed at NAVENENVSA, is used to systematically evaluate the relative severity of potential problems. When using the CSRS, as the first step, a flowchart, based on type of waste, containment, and hydrogeology, eliminates innocuous sites from further consideration. If the flowchart indicates a site has potential contamination, a ranking model is applied. The ranking model assigns a numerical score to each site. The score reflects the characteristics of the waste, the potential migration pathways from the site, and possible contaminant receptors on and off the activity.

1.4.4 Site Ranking. After rating a site, engineering judgment is applied to determine the need for a Confirmation Study or for an immediate mitigating action. At sites recommended for further work, CSRS scores are

used to develop a priority list for scheduling projects. For a more detailed description, refer to NAVENENVSA Confirmation Study Ranking System, NEESA 20.2-042.

1.4.5 Confirmation Study Criteria. A Confirmation Study is recommended for sites at which (1) sufficient evidence exists to indicate the presence of contamination and (2) the contamination poses a potential threat to human health or to the environment.

1.5 CONFIRMATION STUDY. The EFD conducts the Confirmation Study which has two phases—verification and characterization. In the verification phase, short-term analytical testing and monitoring determine whether specific toxic and hazardous materials, identified in the IAS, are present in hazardous concentrations. If required, a characterization phase, using longer-term testing and monitoring, provides more detailed information concerning the horizontal and vertical distribution of contamination migrating from sites, as well as site hydrogeology. If sites require Remedial Actions or additional monitoring programs, the confirmation study recommendations include the necessary planning information for the work, such as design parameters.

1.6 IAS REPORT CONTENTS. The results of the study conducted for Naval Air Station (NAS) Memphis are presented in this report. The records search was performed during February 1983, and the on-site survey was conducted during the period of 14-18 March 1983. The information in this report is current as of those dates.

Significant findings and conclusions are presented in Chapter 2 and recommendations are presented in Chapter 3. Chapter 4 describes general activity information, history, physical features, and biology. Chapters 5 through 7 trace the use of chemicals and hazardous materials, from storage and transfer, through manufacturing and operations, to waste processing and disposal. Chapter 8 provides detailed documentation to support the findings, conclusions, and recommendations presented in Chapters 2 and 3.

CHAPTER 2. SIGNIFICANT FINDINGS AND CONCLUSIONS

2.1 INTRODUCTION. This chapter summarizes the significant findings and conclusions of the Initial Assessment Study (IAS) at the Naval Air Station (NAS) Memphis. Figures 2-1 and 2-2 identify the locations of sites examined during the on-site survey. Samples collected from several of the sites, during the IAS, were used to determine if contaminants were present. The results of these analyses are discussed under the appropriate site headings.

Hydrogeology and surface drainage are discussed with regard to those aspects relevant to potential contaminant migration pathways and to receptors of contaminants. Next, sites recommended for confirmation are discussed and the most significant findings are summarized. Five sites, numbers 2, 3, 4, 7 and 8, are recommended for confirmation. Finally, sites not recommended for confirmation are discussed.

2.2 HYDROGEOLOGY. Ground water contamination was emphasized in the definition of confirmation objectives and actions. Monitoring of shallow ground water contamination, which may result from past NAS Memphis activities, is warranted because the shallow ground water of the NAS Memphis region has recently been shown to be hydraulically-linked to the Memphis Sand, an artesian aquifer used in metropolitan Memphis for potable and industrial water supplies. Federal and state geologic survey reports indicate that permeable areas or "windows" exist in the upper-confining layer of the Memphis Sand (see Section 4.5). Contaminant-bearing water from the shallow aquifer could migrate through these windows into the Memphis Sand, and ultimately reach the municipal water supply.

Investigations have not yet pin-pointed the windows of infiltration. However, the rate of contaminant movement into the Memphis Sand, through these windows, depends on several factors including horizontal distance to the windows from the contaminant source, continuity of the shallow ground water system, rate of lateral migration toward the window, and the hydraulic character of the sands within the window. No specific data regarding the shallow ground water system at NAS Memphis are available. However, both NAS Memphis and the city of Millington obtain potable and industrial water supplies from the Memphis Sand aquifer. The NAS Memphis supply is obtained from six wells located within the facility boundary. The city of Millington obtains its water from four closely-spaced wells located 0.3 mile west of NAS Memphis.

2.3 SURFACE DRAINAGE. Surface drainage for the entire facility flows into the Big Creek Drainage Canal. Although fish were observed in some of the large perimeter drainages, no indication that the drainages are suitable for recreational activities exists. While some of the drainage ditches at NAS Memphis have been used in the past for discard of fluid wastes generated by various shops, there is no indication that this practice has continued to the present.

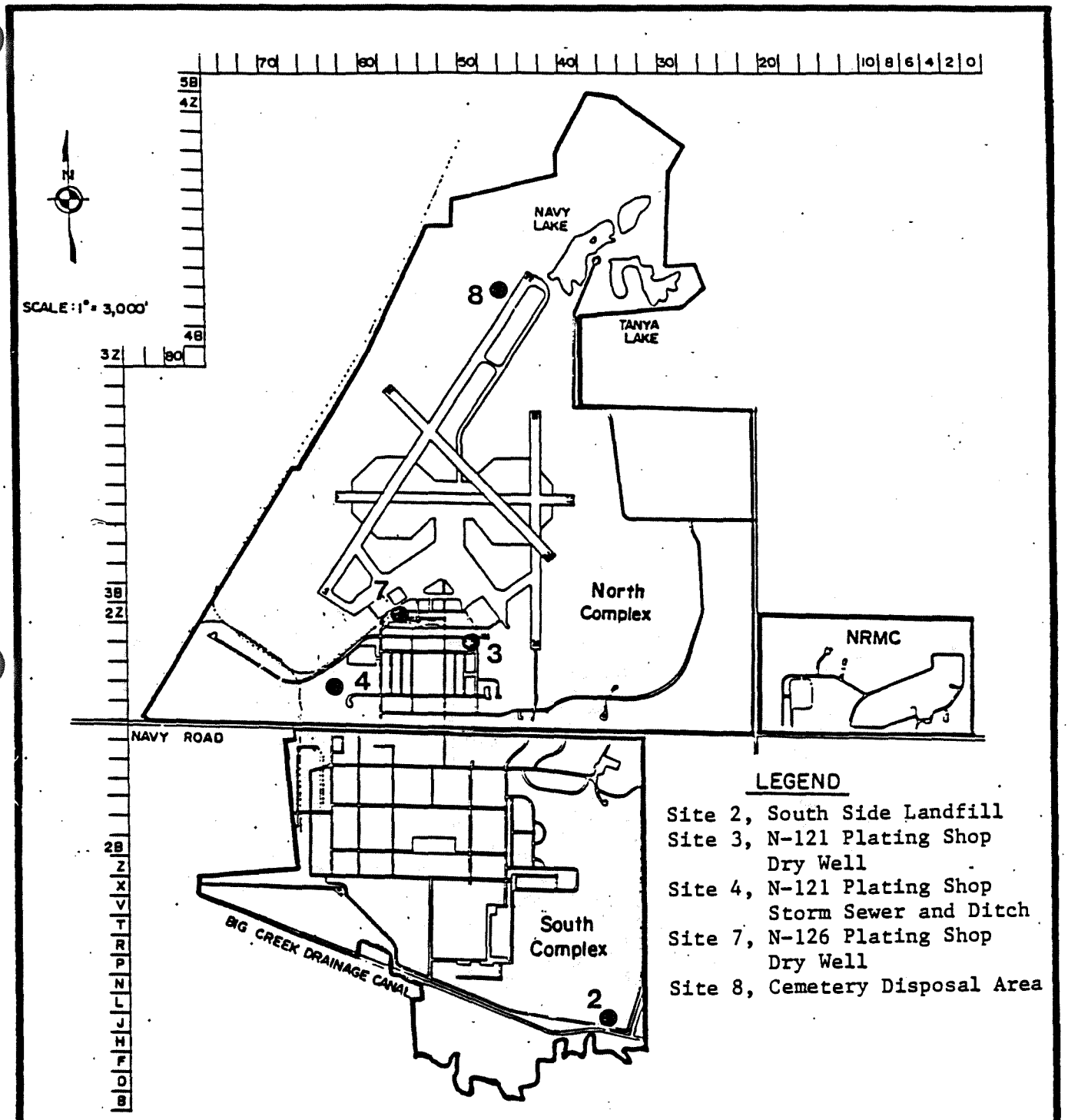
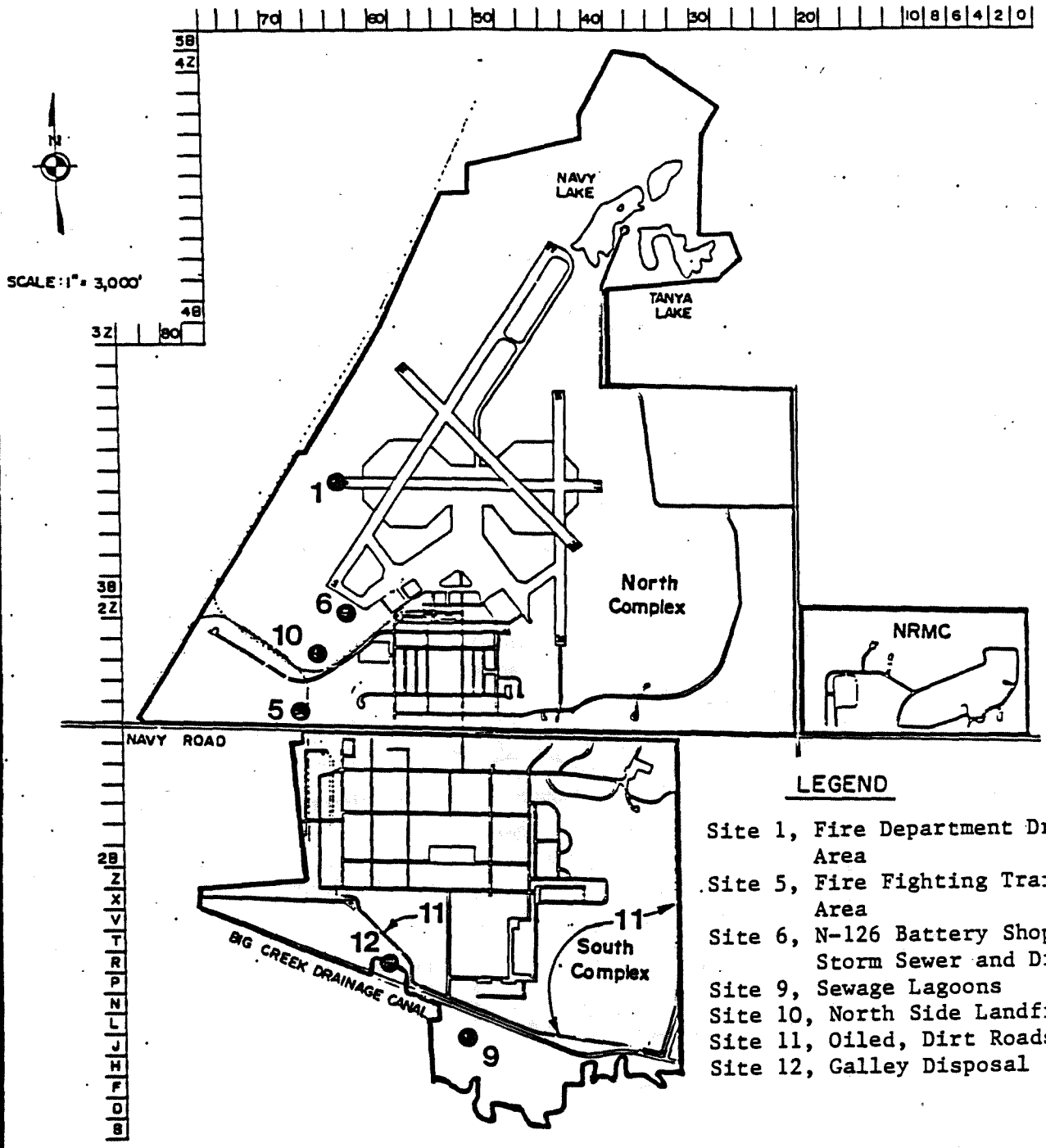


FIGURE 2-1
CONFIRMATION SITE LOCATIONS

INITIAL ASSESSMENT
STUDY NAVAL AIR STATION
MEMPHIS



LEGEND

Site 1, Fire Department Drill Area
Site 5, Fire Fighting Training Area
Site 6, N-126 Battery Shop Storm Sewer and Ditch
Site 9, Sewage Lagoons
Site 10, North Side Landfill
Site 11, Oiled, Dirt Roads
Site 12, Galley Disposal

FIGURE 2-2
NON-CONFIRMATION SITE LOCATIONS

INITIAL ASSESSMENT STUDY NAVAL AIR STATION MEMPHIS

2.4 SITES RECOMMENDED FOR CONFIRMATION. Table 2-1 presents a list of the confirmation sites discussed in this section. The following paragraphs provide a summary of the findings of the IAS as they pertain to each site.

2.4.1 Site 2, South Side Landfill. The South Side Landfill is located on the South Complex adjacent to Big Creek Drainage Canal. The landfill was opened in 1942. Reportedly, this landfill served as the disposal area for solid waste generated at NAS Memphis until it was closed in 1970. Available photographs and field investigations indicate that the landfill covered approximately 40 acres.

This site was used for the disposal of household, office, and industrial solid wastes generated at NAS Memphis. Reportedly, wastes included household refuse generated by NAS Memphis housing, aircraft parts generated by maintenance activities, wastewater treatment plant sludges generated by the trickling filter treatment plant, and waste oils, oily sludges and solvents generated from industrial operations. Waste oil and oil sludges disposed at this site, reportedly, did not exceed one ton per year. Estimates indicated that approximately two tons per year of wastewater treatment plant sludges were disposed at the landfill.

The disposal procedure used at the site was the trench-and-cover method, in which combustible material disposed at the site was burned before covering. During landfill operations, no effort was made to segregate waste going into the trenches.

The South Side Landfill's location and the absence of a liner or leachate collection system make it a likely source of both surface water and shallow ground water contamination. Potential for surface water contamination exists because the landfill is located immediately adjacent to the Big Creek Drainage Canal. Ground water contamination could occur because the shallow aquifer has a static water table level only three to nine feet below the surface.

Because of the landfilling of material, which poses a contamination threat to the shallow ground water, and the potential for contaminated shallow ground water to migrate into the Memphis Sand aquifer, this site is recommended for confirmation study.

2.4.2 Site 3, N-121 Plating Shop Dry Well. Building N-121, located on the North Complex, contained a plating shop which operated daily from 1953 to 1965. Plating operations consisted of cadmium, chromium, copper, and nickel plating, using cyanide-based solutions. The dry well, a ten- by ten- by six-foot-deep pit filled with gravel, located next to Building N-121, was used for the disposal of both concentrated plating solutions and overflow from the tanks. Wastes discharged into the dry well percolated through the gravel bed and into the surrounding soil. The remaining plating wastewater was discharged to the storm drain (Site 4).

Wastes discharged from the plating operations averaged approximately 18,000 gallons per day. Although the actual division of discharge, between the

TABLE 2-1

SITES RECOMMENDED FOR CONFIRMATION

NAS MEMPHIS

SITE NAME	SITE NUMBER	MAP COORDINATES[a]	PERIOD OF OPERATION	TYPE OF MATERIAL DISPOSED OF	COMMENTS
South-Side Landfill	2	40,L	1942-1970	Residential and industrial solid and liquid waste	During its period of operation, was primary disposal area for the facility. Trench and fill method of disposal, with all burnable material burned prior to covering.
N-121 Plating Shop Dry Well	3	50,2X	1953-1965	Concentrated plating solution	Cadmium, chromium, copper and nickel plating conducted.
N-121 Plating Shop Storm Sewer and Ditch	4	50,2X to 64,2R	1953-1965	Plating solutions spills wash down water	Sediment samples collected from the drainage ditch contained nickel, cadmium, and chromium.
N-126 Plating Shop Dry Well	7	58,3B	Mid-1950s	Waste from plating operation	Included cadmium, chromium, and nickel plating. Sample from dry well contained above metals.
Cemetery Disposal Area	8	46,4J	Unknown	Three canisters of ethylene oxide, all types of wastes from public works shops and rubble	Exact location of ethylene oxide burial not known, hazardous waste burial sign located in the general area.

[a]Referenced to the General Development Map, 1981.

storm drain (Site 4) and the dry well, was not reported, the concentrated overflow and discarded plating solution accounted for no more than fivepercent (900 gallons per day) of this waste discharged, while the wastewater from the operation accounted for the remaining 95 percent. Soil samples collected from the dry well during the on-site survey indicated the presence of nickel (3,200 ppm), cadmium (250 ppm), and chromium (180 ppm). Cyanide was not included in these analyses.

Due to the localized presence of shallow ground water which could transmit contamination to the Memphis Sand, this site is recommended for confirmation study.

2.4.3 Site 4, N-121 Plating Shop Storm Sewer and Ditch. Site 4, N-121 Plating Shop Storm Sewer and Ditch, is located on the North Complex. The concrete storm sewer flows, in a westerly direction, along Casablanca to First Avenue, then southwesterly, to an open drainage ditch, 800 feet north of Navy Road and 250 feet east of Access Road No. 2. The site consists of a 3,300-foot section of concrete sewer, emptying into an 800-foot section of open drainage ditch, which discharges to North Fork Creek. Wash-down water and spills from the plating operations conducted in Building N-121, between 1953 and 1965, were discharged directly to this storm sewer. As stated in the preceding section, total wastewater generated by the plating operation was estimated at 18,000 gallons per day. The storm sewer and ditch received approximately 95 percent or 17,000 gallons per day of the wastewater generated. Sediment samples collected from two points in the open drainage ditch indicate that nickel (32 and 38 ppm), chromium (38 and 157 ppm), and cadmium (1 and 9 ppm) were present.

Because of the potential for these metals to migrate to the downstream aquatic environment, where they may enter the food chain and bioaccumulate in the tissues of fish and other aquatic organisms, this site is recommended for confirmation study.

2.4.4 Site 7, N-126 Plating Shop Dry Well. Building N-126, located in the North Complex, housed the plating operations of the Aircraft Intermediate Maintenance Department during the mid-1950s. A dry well, a ten- by ten- by six-foot-deep pit filled with gravel, located next to Building N-126, was used for the disposal of concentrated nickel, cadmium, and chromium cyanide-based plating solutions, as well as rinse water from the operation. Wastes were discharged into the dry well and allowed to percolate into the soil. Soil samples collected from the dry well, during the on-site survey, indicate the presence of nickel (32 ppm), cadmium (1240 ppm), and chromium (223 ppm). These metals could migrate to the shallow ground water in the vicinity of the site.

Because of possible migration of shallow ground water to the deeper, water-supply aquifer and transmission of contamination to the deeper, water-supply aquifer, this site is recommended for confirmation study.

2.4.5 Site 8, Cemetery Disposal Area. The Cemetery Disposal Area is located on the North Complex adjacent to Runway 22-4. Reportedly, wastes generated in many of the shops were disposed in the area. Materials which may have been disposed in the area include metallic scrap, waste chemicals, waste oil, cleaning solution, transformers, and capacitors. Past disposal

of "suspicious" chemicals, in the area beyond the cemetery has been mentioned. Surface conditions and debris in the area seem to indicate that the disposal site covered approximately eight acres; however, a review of available photographs indicates a disturbed area of approximately five acres. The only recorded disposal of hazardous material at the site was the burial of three 25-pound canisters of ethylene oxide between 1965 and 1967. The waste was, reportedly, buried at a depth of approximately 8 feet.

Because of facility personnel's references regarding the disposal of chemical waste in the area, the sandy nature of the soil, the presence of shallow ground water in the area, and the potential migration of shallow ground water to the deeper, water-supply aquifer, this site is recommended for confirmation study.

2.5 SITES NOT RECOMMENDED FOR CONFIRMATION STUDY. Table 2-2 contains a list of the sites identified during the IAS, which are not recommended for confirmation study. Seven sites (numbers 1, 5, 6, 9, 10, 11 and 12) are discussed in this section.

2.5.1 Site 1, Fire Department Drill Area. The Fire Department Drill Area is located on the North Complex, at the end of an abandoned runway. The area was used from 1960 to 1981 to train firemen in rescue techniques for downed aircraft. JP-4 and waste fuels were sprayed on and around the aircraft simulator and ignited. The fire created by the burning fuel was then extinguished by the fire fighting crew. Approximately 55 to 100 gallons of fuel were used for each training session; one session was conducted per month.

The location of the drill area on an abandoned, asphalt runway limits the potential for migration of waste materials into the soil and ground water. Although cracks exist in the runway, making it an imperfect barrier, the quantities of fuel seepage into the soil would have been minimal. Additional containment of the fuel was provided by curbing, which prevented the fuel from saturating the ground in the immediate area.

Because of the remote location of the drill area, the small quantities of fuel used, and the minimal potential for escape of contaminants, this site is not recommended for confirmation study.

2.5.2 Site 5, Fire-Fighting Training Area. The Fire Fighting Training Area is located on the North Complex adjacent to the Navy Road. The area consists of three unbermed, shallow, rectangular, concrete-lined pits used for hand-held extinguisher practice and two 75-foot-diameter, circular pits used in aircraft fire fighting practice. The two circular pits have a double-lip curbing to contain fuel during the burning operation. In 1977, an oil-water separator was installed to process effluent from these operations. The training area was used from 1940 to 1977, without an oil-water separator. JP-4 fuel was used in all pits to create fire for training purposes.

Prior to 1977, discharge from the Aircraft Training Area went directly to the storm sewer system. Installation of the oil-water separator, in 1977, alleviated that problem. A number of explosions occurred in the sewer, as

TABLE 2-2

SITES NOT RECOMMENDED FOR CONFIRMATION

NAS MEMPHIS

SITE NAME	SITE NUMBER	MAP COORDINATES[a]	PERIOD OF OPERATION	TYPE OF MATERIAL DISPOSED OF	COMMENTS
Fire Department Drill Area	1	64,3L	1960-1981	JP-4 Fuel, and waste fuels	Conducted fire fighter training, fuel discharged to surface and ignited.
Fire-Fighting Training Area	5	68,2R	1949-1977	JP-4	Prior to installation of oil-water separator, unburned fuel occasionally overflowed into drainage ditch.
N-126 Battery Shop Storm Sewer and Ditch	6	64,2Z to 60,3D	1955-1981	Liquid waste from battery shop; spills and washdown water	Erosion is evident in the ditch, where the storm sewer discharges.
Sewage Lagoons	9	54,J	1969-1978	Wastewater generated by NAS activities	Primarily sanitary in nature.
North-Side Landfill	10	64,2X	1950-1969	Primarily demolition rubble	Probably received North Side solid wastes until 1969.
Oiled, Dirt Roads	11	See Comments	1942-1960	Waste Oils	Oils were spread on roads for dust control. Not limited to any specific area. Limited sampling shows no PCBs.
Galley Disposal	12	60,P	Unknown	Food cans	No evidence of other materials being discarded in the area; apparently not a supervised disposal area.

[a] Referenced to the General Development Map, 1981.

a result of ignition of unburned fuel after installation of the separator. Cleaning of the separator and modification of operational procedures have eliminated the explosions. The operation of the two large pits did not have a detrimental effect on the adjacent environment, since containment was provided during the burning operation and effluent was small. However, prior to 1977, overflow discharge occasionally occurred from the rectangular basins. Normally, approximately 40 gallons of fuel, placed in the basins for training, were ignited repeatedly to permit each student the opportunity of extinguishing a fire. The discharge from these basins flowed to the adjacent storm drainage systems. Since 1977, the fuel has been allowed to burn itself out following the last burn of the day.

Since only small quantities of fuel were discharged, and no evidence of contamination of adjacent land from past operation of these facilities exists, no confirmation study is recommended for this site.

2.5.3 Site 6, N-126 Battery Shop Storm Sewer and Ditch. Electrolyte spills and drippings (about 100 gallons per year) from the Battery Shop, Building N-126, were discharged into floor drains connected to the storm sewer, from 1955 until 1981, when the shop ceased operation. The storm sewer emptied into a drainage ditch. Substantial erosion and scouring of the ditch has occurred at the sewer's discharge to the ditch. Any contaminated sediment deposited during Battery Shop operations (1955-1981), should have been removed by the scouring effects of high, storm-water flow.

No indication of detrimental effects on the receiving stream, North Fork Creek, was noted in the area of the discharge. Therefore, the site is not recommended for confirmation study.

2.5.4 Site 9, Sewage Lagoons. Two inactive sewage lagoons are located on the South Complex, south of the Big Creek Drainage Canal. The lagoons were used as a part of the wastewater-treatment systems for NAS Memphis from 1969 to 1978. Wastewater treated at the facility was, primarily, sanitary in nature, though including limited amounts of industrial waste generated by such activities as Aircraft Intermediate Maintenance. The sewage lagoons, currently, support an abundance of aquatic life. The isolation, provided by the lagoon dikes and lining material, makes migration of material contained within the lagoon, to the surrounding environment, unlikely. Therefore, the site is not recommended for confirmation study.

2.5.5 Site 10, North Side Landfill. The North Side Landfill is located on the North Complex adjacent to Dakar Road. This area was most extensively used between 1954 and 1969. Field investigations indicated the landfill covered approximately 20 acres. Material disposed of at this site, reportedly, consisted of mostly construction rubble and other inert materials. Therefore, this site is not recommended for confirmation study.

2.5.6 Site 11, Oiled, Dirt Roads. Waste oils were spread on dirt roads to minimize dust during the summer at NAS Memphis from 1942 through the 1960s. The oil-spreading practice was not confined to any specific area or road. In the past, there was no concern about PCB; therefore, transformer oil, containing PCB was probably mixed with other waste oils before spreading on

the roads. No definite quantities of PCB-contaminated oils used, or the areas where they were disposed, could be established. Samples were taken during the on-site survey, along dirt roads which were most frequently subjected to the oil-spreading practice. None of the samples collected had detectable levels of PCB. As no direct evidence of PCB contamination was identified, confirmation study is not recommended.

2.5.7 Site 12, Galley Disposal. The Galley Disposal area is located on the South Complex, adjacent to Perimeter Road and was used to discard empty food cans from a galley. No indication that any other waste was disposed of in this area was found. Due to the innocuous nature of material disposed of in this area, confirmation study is not recommended.

CHAPTER 3. RECOMMENDATIONS

3.1 INTRODUCTION. Five sites are recommended for confirmation studies. These sites, along with the recommended study actions, are listed in Table 3-1.

Section 3.2 presents the recommendations for the work necessary to identify any contamination resulting from materials disposed of at these locations. The primary concern for sites 2, 3, 7 and 8 is the migration of contaminants into ground water. Surface water contamination is the primary concern for Site 4.

3.2 CONFIRMATION STUDIES.

3.2.1 Site 2, South Side Landfill.

Type of samples:	Ground water
Ground water monitoring wells:	Five (see Figure 3-1)
Number of samples:	20 (four from each well)
Frequency:	Quarterly, for one year
Analytical parameters:	pH, total organic carbon (TOC), total organic halide (TOX), and specific conductance.

Remarks: The pH and specific conductance will provide an indicator for inorganic compounds, while TOC and TOX will provide an indicator for organic compounds.

The five, ground-water-monitoring wells should be installed as indicated in Figure 3-1. Assuming the ground water movement is southwesterly, with shallow ground water discharge, potentially, occurring to Big Creek Drainage Canal, well numbers 2, 3, 4, and 5 will provide downgradient data, while well No. 1 will supply upgradient data. The ground water gradient for the shallow ground water aquifer should be verified after installation of the first three wells, to ensure the remaining wells are placed downgradient. Each of the wells will be drilled to a depth of 10 feet below water table.

No surface water monitoring is recommended for Big Creek Drainage Canal. Ground water movement in the direction of Big Creek Drainage Canal will be intercepted by monitoring well numbers 2, 3, 4, and 5.

TABLE 3-1

SUMMARY OF CONFIRMATION STUDY RECOMMENDATIONS

NAS MEMPHIS

SITE NAME	SITE NO.	MAP COORDINATES	RECOMMENDED ACTION	NO. OF SAMPLE LOCATIONS	NO. OF SAMPLES	TYPE OF ANALYSIS	ANALYSIS FREQUENCY	CSRS SCORE
South-Side Landfill	2	40,L	Groundwater monitoring	5	20	pH, sp. cond., TOX, TOC	Quarterly for one year	20.11
N-121 Plating Shop Dry Well	3	50,2X	Groundwater monitoring	4	16	Cd, Cr, Cu, Ni, CN, Sp. Cond., pH	Quarterly for one year	33.52
			Core samples (Soil)	5	40	Cd, Cr, Cu, Ni, CN	Once	
N-121 Plating Shop Storm Sewer	4	50,2X to	Transect sediment samples	5	5	Cd, Cr, Cu, Ni CN	Once	
		64, 2R	Sediment samples	3	3	Cd, Cr, Cu, Ni CN	Once	25.05
N-126 Plating Shop Dry Well	7	58, 3B	Groundwater monitoring	4	16	Cd, Cr, Cu, Ni, CN, pH, sp. cond.	Quarterly for one year	33.52
			Core samples (Soil)	5	40	Cd, Cr, Cu, Ni, CN	Once	
Cemetery Landfill	8	46,4J	Groundwater monitoring	4	20	pH, sp. cond., TOC, TOX	Quarterly for one year	6.76

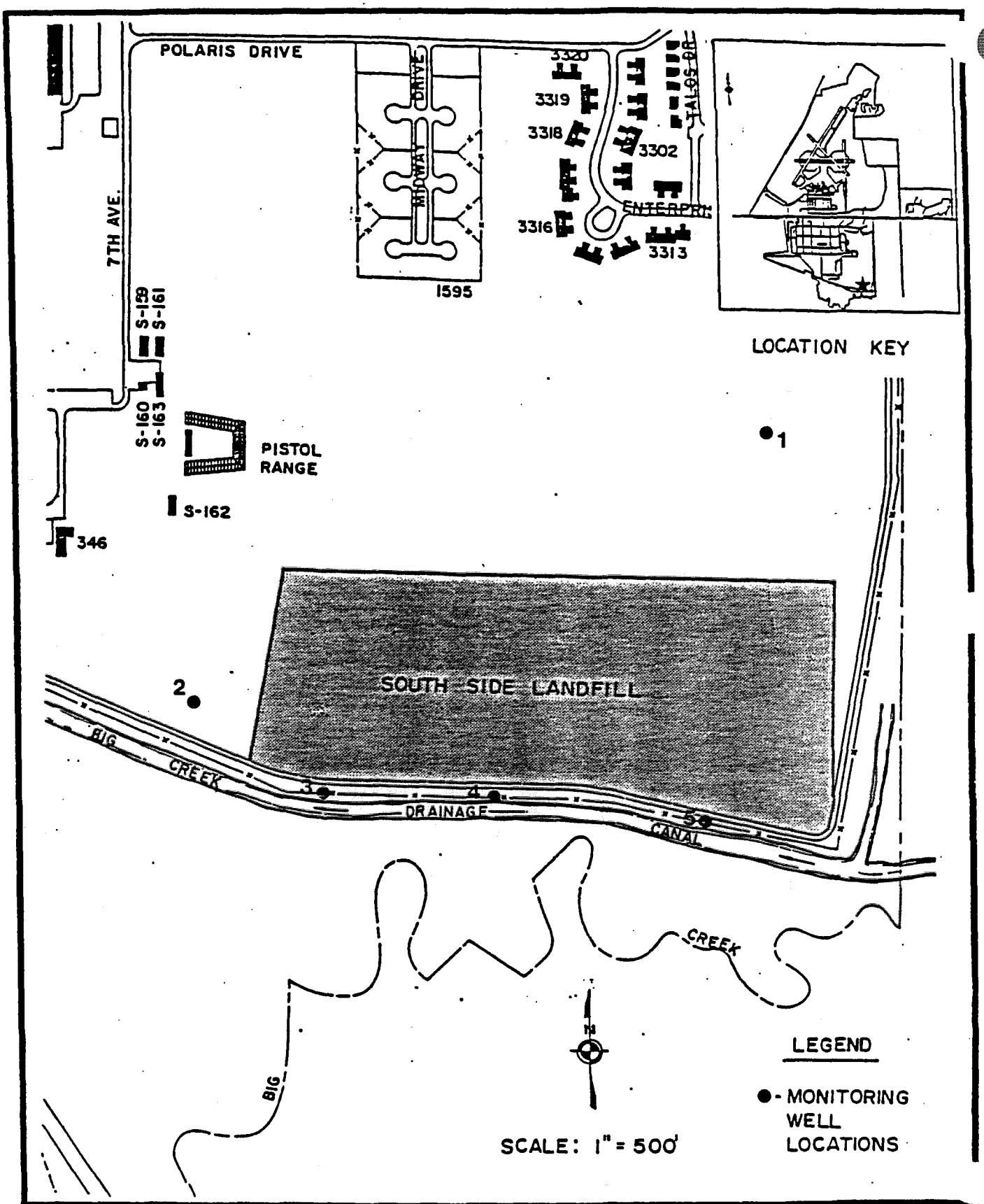


FIGURE 3-1
SOUTH SIDE LANDFILL, (SITE 2)
MONITORING WELL LOCATIONS

INITIAL ASSESSMENT STUDY
NAVAL AIR STATION
MEMPHIS

3.2.2 Site 3, N-121 Plating Shop Dry Well.

Type of samples:	Soil and ground water
Ground water monitoring wells:	Four (see Figure 3-2)
Core sample locations:	Five (at each well and at the center of the dry well)
Number of samples:	16 ground water samples, approximately 40 soil samples
Frequency:	Ground water--quarterly, for one year Soil--once
Analytical parameters:	Soil--Total and Extraction Procedure leachate concentrations for cadmium, chromium, nickel, cyanide, and copper. Water--cadmium, chromium, nickel, total cyanide, copper, pH, specific conductance

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Remarks: The confirmation study will be conducted in two steps, verification and characterization. The characterization step will only be conducted if results from verification are positive.

Verfification:

Metals were found in samples of the sludge collected from the upper portion of the dry well during the IAS. A core sample collected through the center of the dry well will determine the extent of vertical migration of the contaminants. A six-inch segment of the core should be saved at two-foot intervals; the first should be taken from a depth of 18 to 24 inches. Each six-inch segment will be homogenized and analyzed for the parameters indicated above. The total depth of the core should be 16 feet. Results of the Extraction Procedure leachate analysis will determine the need for installation of ground water monitoring wells and conducting additional analysis.

Characterization:

Ground water monitoring wells, if required, should be installed at the locations indicated on Figure 3-2 and extend to 10 feet below the water table. Six-inch segments of core should be collected at two-foot intervals during the construction of the wells. These cores should be saved and evaluated, only if the first analysis of ground water indicates contamination.

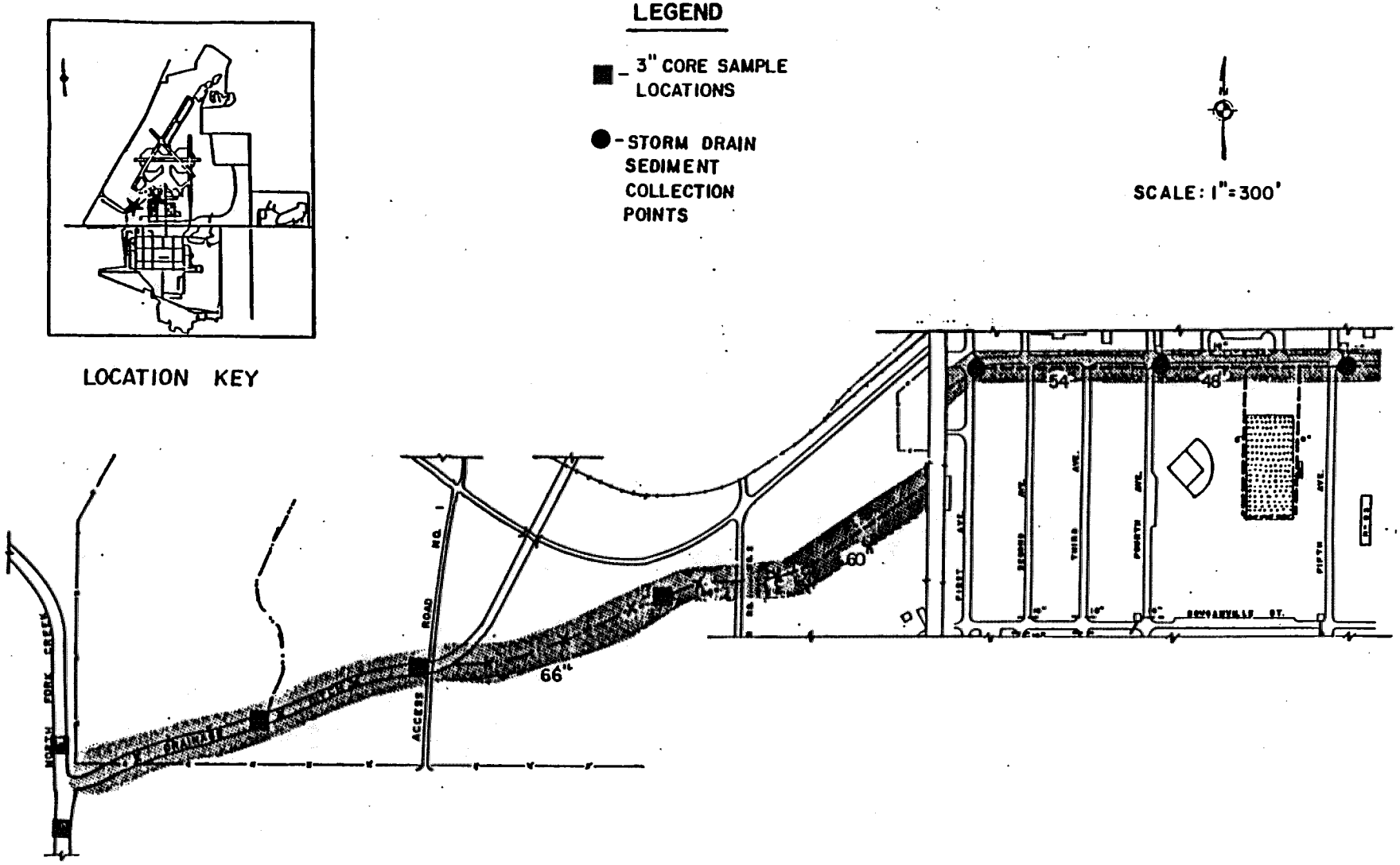

FIGURE 3-3
N-121 PLATING SHOP STORM SEWER AND DITCH (SITE 4) SAMPLE LOCATIONS

INITIAL ASSESSMENT STUDY
NAVAL AIR STATION MEMPHIS

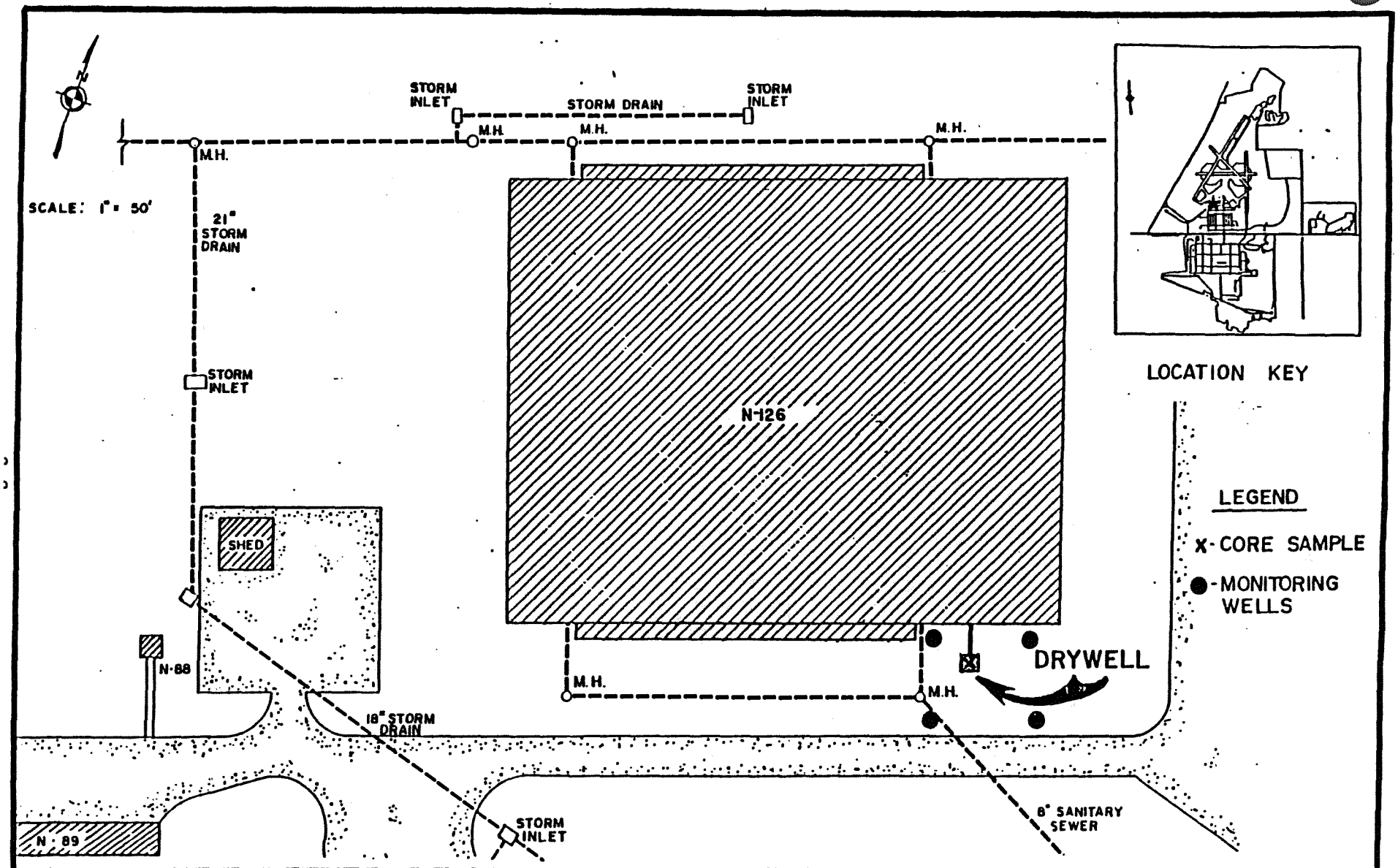

FIGURE 3-4
N-126 PLATING SHOP DRY WELL (SITE 7)
SAMPLE LOCATIONS

INITIAL ASSESSMENT STUDY
NAVAL AIR STATION MEMPHIS

Remarks: The confirmation study will be conducted in two steps, verification and characterization. The characterization step will be conducted only if results from verification are positive.

Verification:

Metals were found in samples of the sludge collected from the upper portion of the dry well during the IAS. The core sample collected through the center of the dry well will determine the extent of vertical migration of the contaminants. A six-inch segment of the core should be saved at two-foot intervals; the first should be taken from a depth of 18 to 24 inches. Each six-inch segment will be homogenized and analyzed for the parameters indicated above. The total depth of the core should be 16 feet. Results of the Extraction Procedure leachate analysis will determine the need for installation of ground water monitoring wells and conducting additional analysis.

Characterization:

Ground water monitoring wells, if required, should be installed at the locations indicated on Figure 3-4 and extend to 10 feet below the water table. Six-inch segments of core should be collected at two-foot intervals during the construction of the wells. These cores should be saved and evaluated only if the first analysis of ground water indicates contamination.

3.2.5 Site 8, Cemetery Disposal Area.

Type of samples:	Ground water
Ground water monitoring wells:	Four (see Figure 3-5)
Number of samples:	16 (four from each well)
Frequency:	Quarterly, for one year
Analytical parameters:	pH, total organic carbon (TOC), total organic halide (TOX), specific conductance

Remarks: Ground water monitoring wells should be installed at the locations indicated in Figure 3-5. If ground water movement is influenced by the local surface drainage, ground water movement would be to the northwest. Installation of the wells, in this arrangement, would provide one upgradient

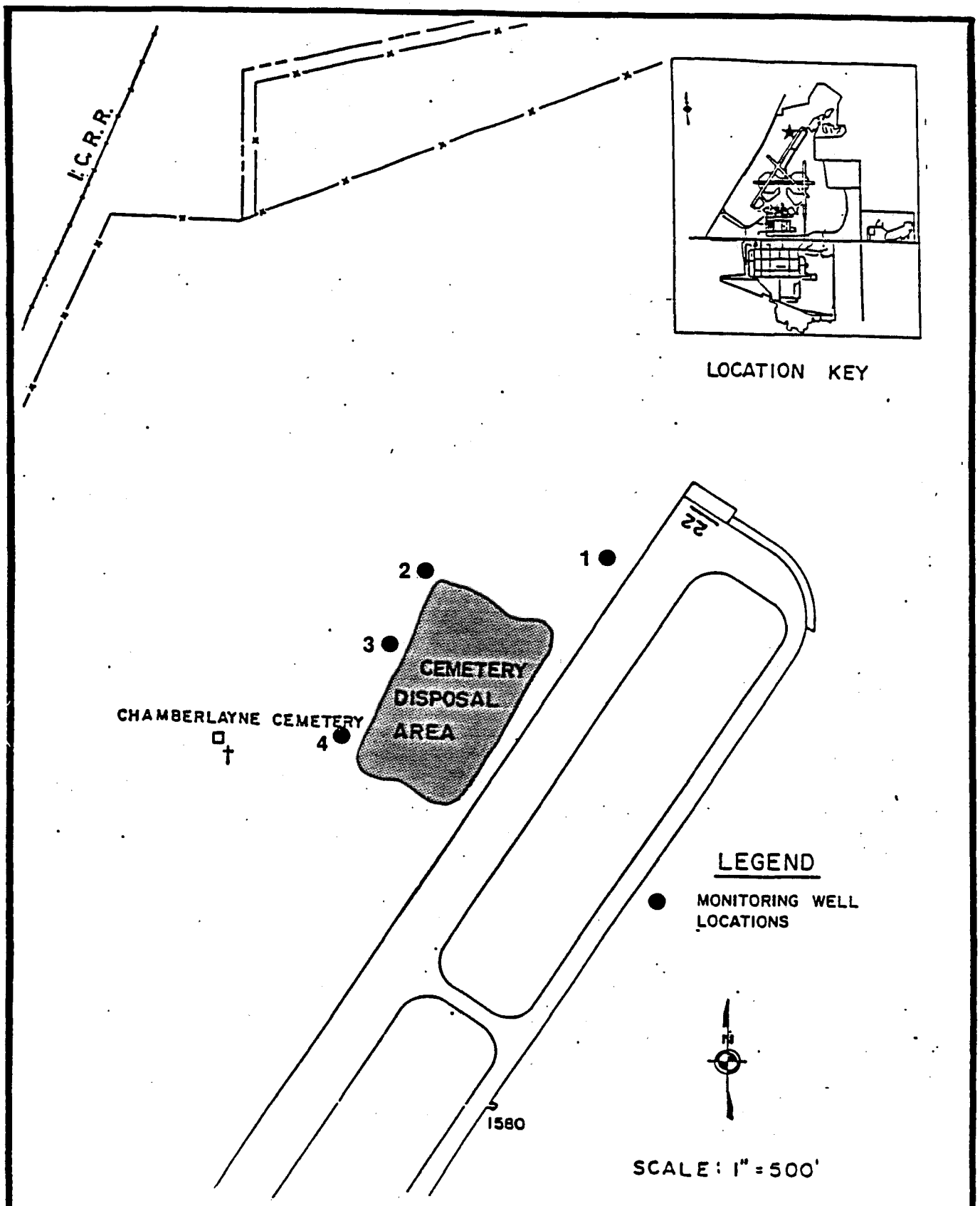

FIGURE 3-5
CEMETERY DISPOSAL AREA (SITE 10)
SAMPLE LOCATIONS

INITIAL ASSESSMENT
STUDY NAVAL AIR
STATION MEMPHIS

well and three downgradient. The direction of ground water movement should be verified following installation of the first three wells. Each well should extend to a depth of 10 feet below the water table.

3.3 ADDITIONAL RECOMMENDATIONS. In order to aid in future development, locate sites 2 through 10 on the facility general development maps and retain the identification of those which already appear on current maps. Future development plans for these areas should consider previous use when establishing locations for new construction or expanded operations.

CHAPTER 4. BACKGROUND

4.1 INTRODUCTION.

4.1.1 Location and Organization. As shown on Figure 4-1, Naval Air Station (NAS) Memphis is located 13 miles east of the Mississippi River, in northern Shelby County, Tennessee. The facility is in Millington, approximately 20 miles northeast of the city of Memphis. Figure 4-2 shows how Navy Road divides the 3,500 acres, owned by NAS Memphis, into the North Complex and the South Complex. The city of Millington borders the base on the west and south sides, and agricultural and residential areas surround the facility on the north and east sides.

The mission of NAS Memphis is to maintain and operate facilities and to provide services and material to support operations of aviation activities, units of the Naval Education and Training Command, and other activities and units as designated by the Chief of Naval Operations. NAS Memphis serves as host for more than 20 tenant activities at the facility. Those major tenant activities, potentially capable of generating hazardous waste, are discussed in the following section.

4.1.2 Host/Tenant Relationships. As the host activity, Naval Air Station Memphis provides logistical, maintenance, security, recreation, air operations, and exchange support for all tenants. NAS Memphis accomplishes this mission through ten departments. These departments are headed by military personnel, but are primarily staffed with civilians.

Of the tenant activities for which NAS Memphis serves as host, the Naval Air Technical Training Center (NATTC) is the largest. NATTC accomplishes its mission of training selected Navy and Marine Corps aviation personnel in aeronautical, technical phases of naval aviation and other related subjects, through its 21 different schools. The schools themselves are categorized into larger, school groups, according to the skills taught. The majority of the student body is comprised of enlisted men attending basic schools designated to prepare them for fleet operations. Approximately 5,000 to 6,000 students and 1,500 staff and faculty perform NATTC activities. The center occupies 70 buildings with over 3 million square feet of space.

NAS Memphis also serves as host for the Memphis area Naval Air Reserve Unit (NARU). The mission of the unit is the training of more than 2,000 Naval Air Reservists, from 10 states. Two operational squadrons, under the administration of the local area coordinator for NAS Memphis, are located on the North Complex. While NARU, as such, does not command any aircraft, various squadrons, under the administrative command, fly and maintain aircraft.

The Naval Regional Medical Center (NRMC) is located on the eastern edge of NAS Memphis. The NRMC provides inpatient and outpatient medical and dental care to all eligible beneficiaries in the regional area. Medical services

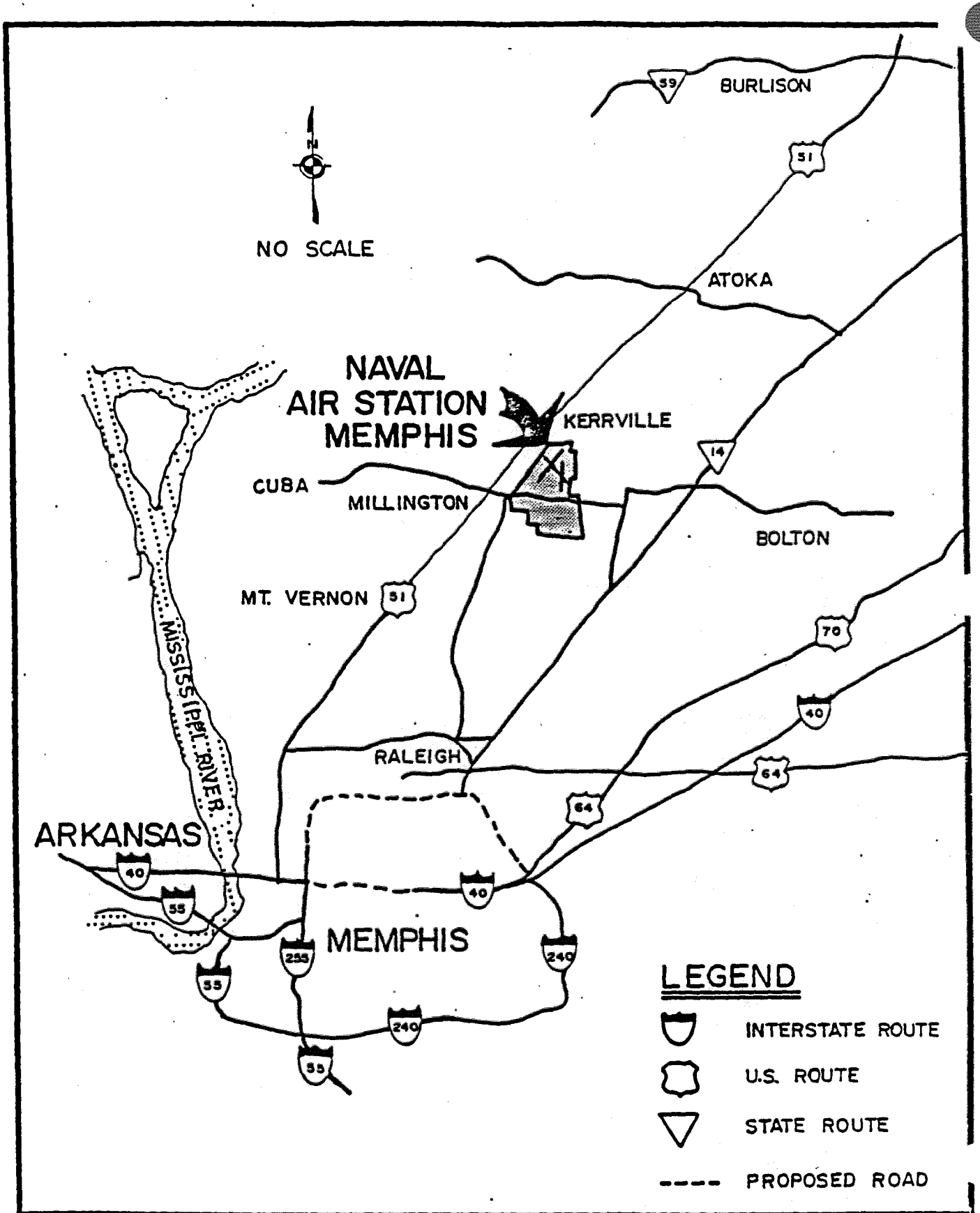

FIGURE 4-1
GENERAL LOCATION MAP

INITIAL ASSESSMENT
STUDY NAVAL AIR
STATION MEMPHIS

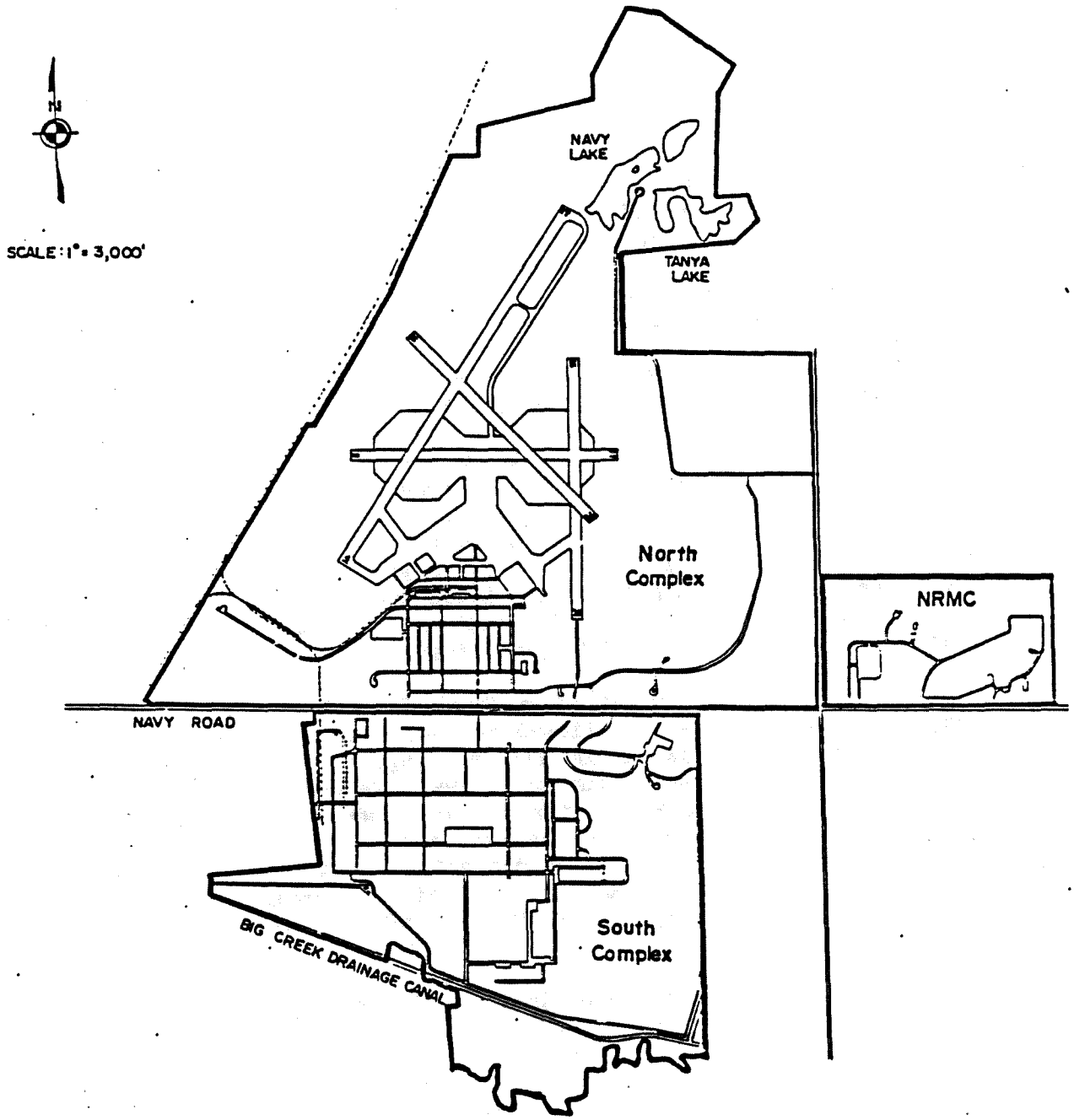

FIGURE 4-2
FACILITY MAP

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include surgery, family practice, psychiatry, physical therapy, and alcoholism treatment. The Branch Clinic, located on the South Complex, provides outpatient services such as physical examinations, immunizations, and other limited medical treatment. The NRMC Dental Service provides inpatient and outpatient care consisting of oral/maxillofacial surgery and routine dental care.

The Chief of Naval Technical Training (CNTECHTRA) is headquartered at NAS Memphis, where a staff of approximately 250 personnel administers the Technical Training Program for the U.S. Navy world-wide. While the training mission of CNTECHTRA spans the nation, other responsibilities relevant to the mid-southern United States are also filled. CHTECHTRA is primarily an administrative unit which is, simply, housed at NAS.

Construction Battalion Unit-404 (CBU-404) also receives support from the host activity. This construction unit is responsible for providing technical support for self-help projects, as well as the training of Naval and Marine Corps construction personnel. The unit consists of 31 Navy personnel, and 15 Marine Corps personnel on detail.

4.1.3 Leases And Agreements. NAS Memphis presently has four outlease agreements and leases about 60 acres for recreation purposes, in the vicinity of Navy Lake. The largest outlease is a 377-acre agricultural plot along the western border of the North Complex. The city of Millington leases a small area (0.87 acres) in the extreme southwest corner of the North Complex, the Memphis Federal Credit Union outleases a sign space along the southern perimeter of the North Complex, and a bank outlease on the South Complex uses a space of 1,927 square feet.

4.2 HISTORICAL SUMMARY. Development of a naval facility in the Memphis area was conceived in January 1942, followed in April 1942, by the purchase of land by the federal government in the Millington area. Following acquisition of the land, work was begun on a Naval Reserve Aviation Base with a project cost of more than $5 million, spent on what is now the North Complex. While waiting for the work to be completed on the installation, the Naval Reserve Aviation Base set up headquarters in the Shelby County Courthouse. The Naval Reserve Air Base was officially commissioned on 15 September 1942, with the primary responsibility of training cadets for action in World War II.

During World War I, an Army Air Corps Training Field was located on a portion of the present South Complex. Known as Park Field, it was closed following World War I, and the land was turned over to the Department of Agriculture. In 1942, plans were made to construct a Naval Training Station on approximately 1,050 acres to the south of Navy Road. In order to obtain the required land for the training station, the 910 acres which made up Park Field (federal government-owned) were utilized in conjunction with an adjacent 140 acres. On 23 September 1942, the Naval Training Station was officially commissioned. The station was designed to be a self-supporting command with its own supply, public works, medical, dental, and disbursing officers. The mission of the command was training in aviation technical fields.

In June 1942, the property survey was conducted for the construction of the U.S. Naval Hospital, adjacent to the Naval Reserve Aviation Base. Groundbreaking occurred on 6 August of the same year and the 600-bed hospital was officially commissioned 17 March 1943.

On 6 February 1943, the name of the Naval Training School was changed to Naval Air Technical Training Center, and in July 1946, Chief of Naval Air Technical Training headquarters were moved from Pensacola, Florida to Memphis, Tennessee. In July 1971, NAS Memphis became the headquarters for all Navy technical training under a Navy-wide reorganization. The new command was responsible for technical training at 52 activities, in 27 geographic locations in the United States.

In April 1949, NAS assumed logistical support for all commands at Memphis, except the U.S. Naval Hospital. Before this date, the various commands were independent with each performing its own logistical support. The major commands were the U.S. Naval Hospital, the Chief of Naval Air Technical Training, the Naval Air Technical Training Center, and the Naval Air Station.

In early 1972, a new 230-bed hospital was completed. Portions of the old hospital buildings have now been renovated for Chief of Naval Technical Training. The majority of the property, originally controlled by the hospital, was placed under the control of the Naval Air Station. The new facility was designated as the Naval Regional Medical Center in 1975.

4.3 PHYSICAL FEATURES.

4.3.1 Climatology. The climate of NAS Memphis is characterized by relatively mild winters, with snow or ice occurring an average of ten times per year, and hot summers with temperatures above 90°F. The average dates of the last freezing temperature, in spring and the first freezing temperature, in the fall, are March 20 and November 10, respectively. Prolonged extremes of temperature are rare during either summer or winter.

The climate data for Memphis, Tennesse shown in Table 4-1 is also representative of the Millington area, as Memphis is close to Millington, with slight altitude difference. Total annual precipitation in the Millington area may be slightly less than that in the Memphis area.

The average annual precipitation is approximately 49 inches and fairly well distributed throughout the year. It provides an adequate supply of moisture for vegetative cover. Normally, precipitation is greatest in winter and early spring due to low pressure systems which develop in the area. On occasion, heavy local rainstorms drop more than four inches of precipitation. The lightest precipitation occurs in late summer and early fall. Figure 4-3 illustrates the average water balance for the area (Sease, 1970). Thunderstorms at NAS Memphis average eight per month during the spring and summer months and two per month during the winter months. These storms are characterized by heavy rains and high winds which frequently cause damage. Records indicate that winds, in excess of 50

TABLE 4-1

MEMPHIS, TENNESSEE CLIMATOLOGICAL SUMMARY[a]

NORMALS, MEANS, AND EXTREMES

	TEMPERATURE					PRECIPITATION IN INCHES						WIND	
	NORMAL			EXTREMES		WATER EQUIVALENT				SNOW, ICE PELLETS			
MONTH	DAILY MAXIMUM	DAILY MINIMUM	MONTHLY	RECORD HIGHEST	RECORD LOWEST	NORMAL	MAXIMUM MONTHLY	MINIMUM MONTHLY	MAXIMUM IN 24 HRS	MAXIMUM MONTHLY	MAXIMUM IN 24 HRS	MEAN SPEED MPH	PRE-VAILING DRCTN
J	49	32	40	78	-4	4.9	12.2	0.8	3.9	12.2	6.5	10.4	S
F	53	34	44	81	-11	4.7	9.4	1.1	3.6	7.6	5.8	10.4	S
M	61	41	51	85	12	5.1	12.1	1.5	6.0	17.3	16.1	11.2	S
A	73	52	62	91	29	5.4	12.3	2.0	3.6	T	T	10.6	S
M	81	61	71	99	38	4.4	11.6	0.8	4.9	0.0	0.0	8.9	S
J	89	68	79	104	48	3.5	6.9	T	4.8	0.0	0.0	8.1	S
J	92	72	82	108	52	3.5	8.8	0.4	4.7	0.0	0.0	7.5	S
A	91	70	80	105	48	3.3	9.6	0.4	4.0	0.0	0.0	7.0	S
S	84	63	74	103	36	3.0	7.6	0.2	4.6	0.0	0.0	7.5	E
O	75	51	63	95	25	2.6	6.2	T	3.4	0.0	0.0	7.8	S
N	62	40	51	85	9	3.9	8.6	0.8	3.6	1.5	1.2	9.2	S
D	52	34	43	79	-13	4.7	13.1	1.0	5.4	14.3	14.3	10.0	S
YR	72	52	62	108	-13	49.1	13.1	T	6.0	17.3	16.1	9.1	S

T - Trace.

PREVAILING WIND DIRECTION - Record through 1963.

[a]Local climatological data for Memphis, Tennessee, National Oceanic and Atmospheric Administration National Climatic Center, Asheville, N.C.

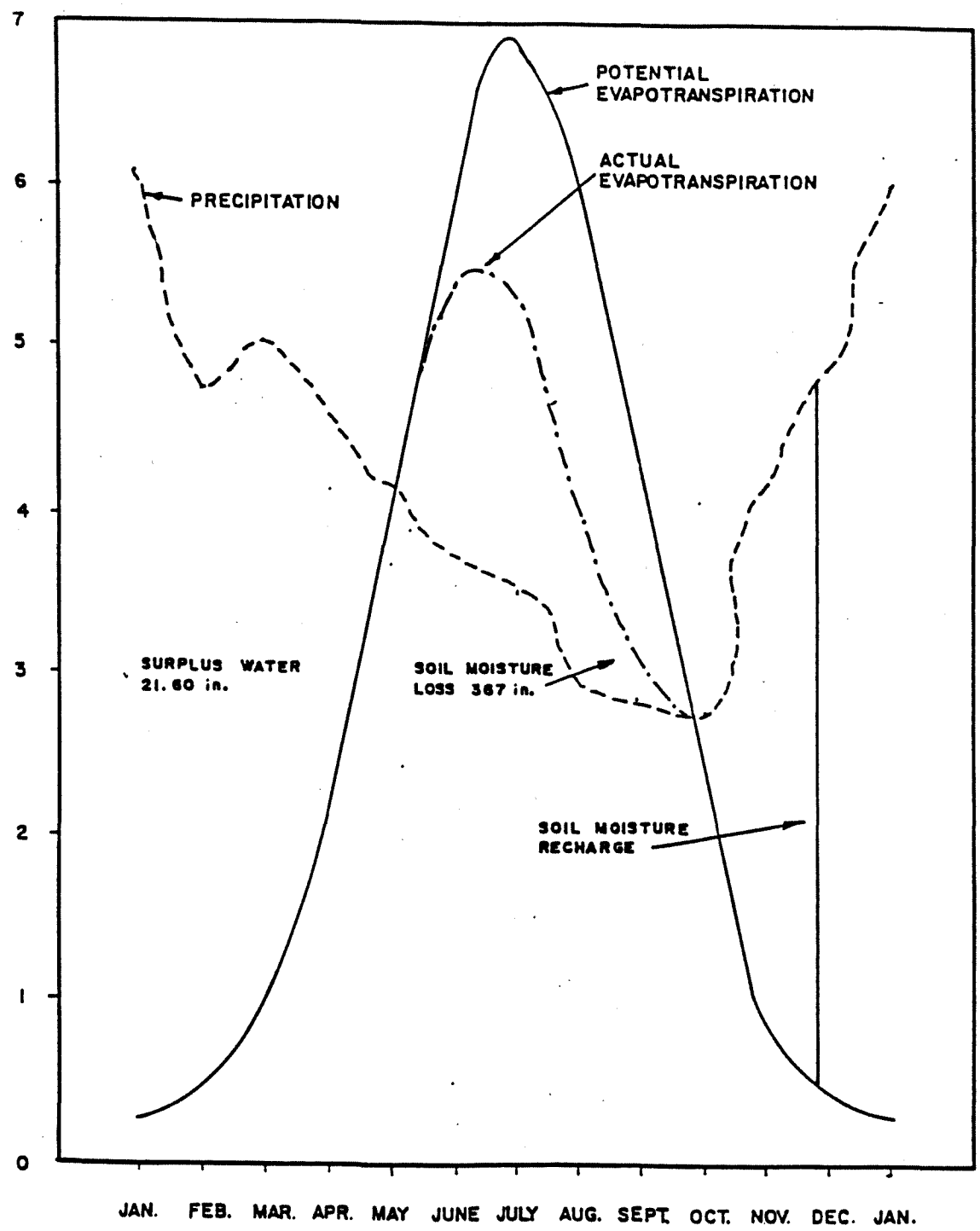

FIGURE 4-3
AVERAGE WATER BALANCE

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knots, occur at least once per year and can be expected from any direction. In addition to thunderstorms, NAS Memphis is located in an area susceptible to tornadoes. At least three tornadoes have occurred on or very near the facility.

4.3.2 Topography. Topography, natural drainages, and cultural features of the facility vicinity are shown on the U.S. Geological Survey Millington and Brunswick 7 1/2 Topographic Quadrangles. Elevations on NAS Memphis vary, from approximately 250 feet above mean sea level (MSL), along the southern border adjacent to Big Creek Drainage Canal, to 350 feet above MSL, in the northern portion of the facility, near the Navy Lake picnic area. Figure 4-4 provides topographic information. Slopes are very gentle in the southern and central portion of the base with steeper grades in the northern sector of highest elevations and relief. Section 4.3.5.1 discusses the effect of the topography on the surface drainage.

4.3.3 Geology. NAS Memphis is situated in the Gulf Coastal Plain Province near the center of the northern part of the Mississippi Embayment, a broad trough or syncline that plunges gently towards the south. The regional structure is homoclinal and formations dip to the west and south into the embayment, the axis of which approximates the course of the Mississippi River (Parks and Lounsbury, 1975). Approximately 3,000 feet of unconsolidated sediment have been deposited in this structural trough in the vicinity of NAS Memphis. These sediments record several periods of transgression and regression of the Gulf of Mexico, since early Cretaceous time.

Sedimentary units underlying the facility consist of surface and near-surface Pleistocene and Holocene alluvium and terrace deposits underlain by Eocene clastic sediments including the Memphis Sand ("500-foot sand") and the deeper Wilcox-Fort Pillow ("1,400-foot sand") aquifers. Pleistocene loess deposits occupy high areas in the northern sector of the facility. Beneath the Eocene strata are approximately 800 feet of undifferentiated Midway Group sediments of Paleocene age. The Midway Group is underlain by approximately 700 feet of Upper Cretaceous sediments including the Owl Creek, Ripley, and Demopolis formations. These units are underlain by an interval of Upper Cretaceous sand, approximately 100-feet thick. These stratigraphic units, unconformably, overlie a thick sequence of Paleozoic sedimentary formations. Surface geologic relationships and the general stratigraphic section, as modified from Cushing and others 1970, are shown in Figure 4-5.

Stratigraphic units of particular interest to this study, those containing the shallow ground water aquifer and the upper principle artesian aquifer, are those ranging in age from Holocene through Eocene. Holocene materials, generally, consist of unconsolidated alluvial sands, clays and gravel. Locally, Pleistocene loess deposits occur in areas topographically higher than the Holocene alluvium and are composed of wind-blown silts of generally low permeabilities. Other Pleistocene deposits occur as terraces consisting of alluvial sands and gravels marking the course of natural surface drainage systems.

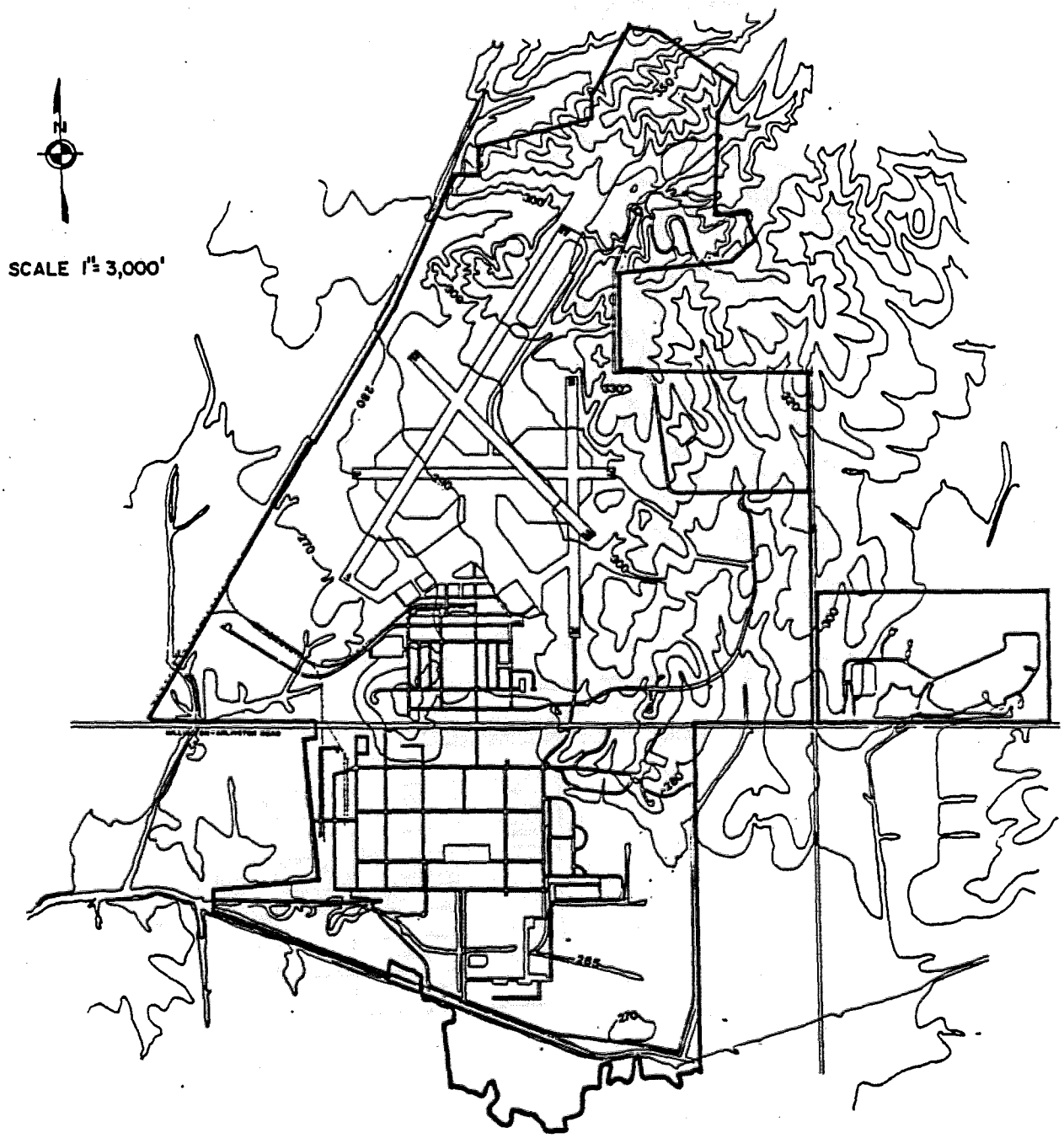

FIGURE 4-4
TOPOGRAPHIC MAP

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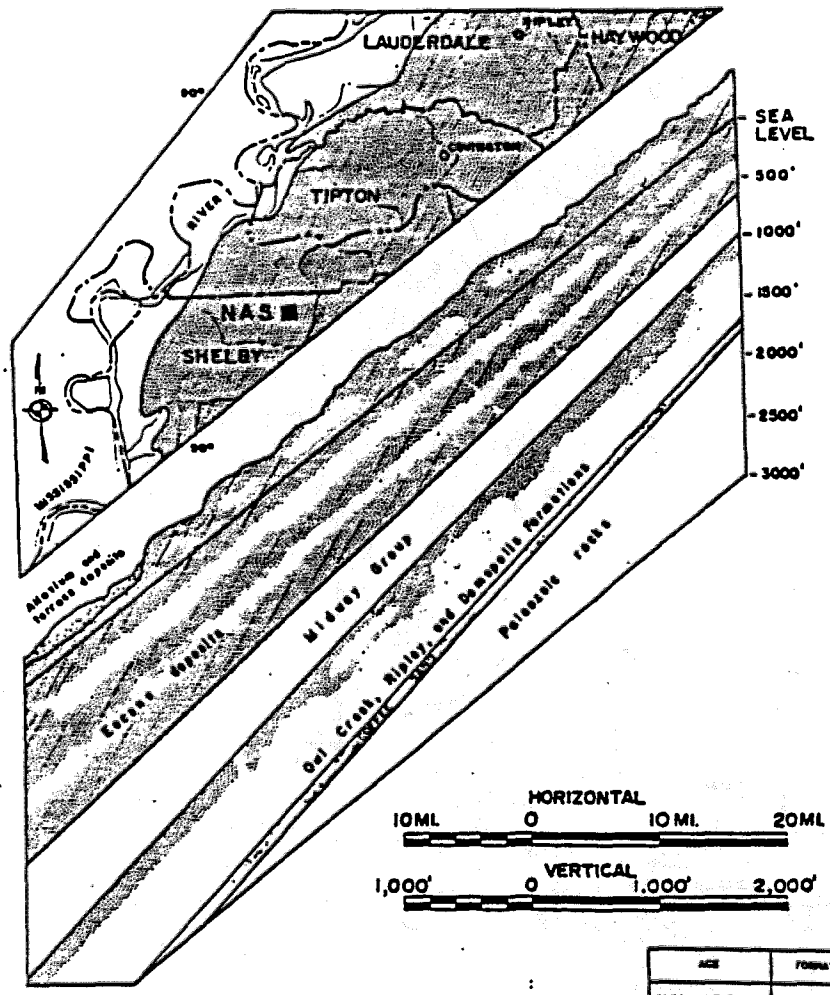
STUDY NAVAL AIR
STATION MEMPHIS



AGE	FORMATION	THICKNESS*	LITHOLOGY	DESCRIPTION
PLEISTOCENE HOLOCENE	—	—		Alluvium and terrace deposits.
EOCENE	Jackson Formation	190+		Gray, blue-green, tan clays with local lignite and sands.
	Memphis Sand	310+		Fine- to coarse-grained sand with other lignite, tan clay, and silt.
	Wilcox Group	200+		Gray to greenish brown carbonaceous clay; local lignite, fine grained sand lenses.
	Fort Pillow Sand	240+		Fine/medium grained unconsolidated to poorly consolidated sands; other lignite and clay.
PALEOCENE	Midway Group	1000 +600+ 1300		Undifferentiated Upper Cretaceous sediments.
UPPER CRETACEOUS	Owl Creek-Ripley-Demopolis Formations	2000 +700+		Upper Cretaceous sediments.
		+100		Lower Cretaceous sand.
PALEOZOIC	Paleozoic sediments.	3500 500 3000		Paleozoic sediments.

*Thicknesses are based on logs and are only an approximation.

FIGURE 4-5
GENERAL STRATIGRAPHIC SECTIONS

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The uppermost units of Eocene age in the area of NAS consist of approximately 190 feet of gray, bluish-gray, greenish-gray, and tan clays that locally contain minor lignite and fine-grained sands, and are considered to be the Jackson Formation. These units are generally impermeable and are considered to be the upper confining beds for the upper artesian aquifer, the Memphis Sand.

Immediately beneath the Jackson Formation is the Memphis Sand, a fine- to coarse-grained sand containing minor amounts of lignite, tan clay, and silt. A thick clay bed occurs locally at its surface. Coarse channel sands, likewise, occur locally near the bottom of the unit.

Immediately underlying the Memphis Sand is the upper clay unit of the Wilcox Group, an approximately 200-foot thick sequence of gray, greenish-gray to brown carbonaceous clay that locally contains thin lignite and fine-grained sand lenses. The unit is of low permeability and generally separates water in the Memphis Sand from that within the underlying Fort Pillow Sand ("1,400-foot sand").

The Fort Pillow Sand is composed of approximately 240 feet of fine- to medium-grained, unconsolidated to poorly-consolidated sands containing minor amounts of lignite and clay. Beneath the Fort Pillow Sand is a lower confining bed composed of gray, greenish-gray, and brown carbonaceous clay and lignite.

The general zone extending from Marked Tree, Arkansas, northeastward to New Madrid, Missouri—a distance of approximately 70 miles—is characterized by periodic, unusually intense seismic activity as illustrated by the New Madrid earthquakes of 1811 and 1812 (McKeown and Pakiser, 1982). The southwestern end of this zone of seismic activity lies approximately 35 miles northwest of NAS Memphis (Figure 4-6). Recent investigations by a number of workers indicate that the seismic activity associated with this trend is related to deep subsurface rifting, of which the eastern boundary is thought to lie some 10 to 15 miles northwest of the facility (Figure 4-6).

A review of historical records related to seismic activity in this region shows that an event of 4 January 1843 had its approximate epicenter about 40 miles northwest of NAS Memphis. This activity was felt over an area of 1,500,000 km^2 with an epicentral intensity of VIII and body-wave magnitude of 6.0. Damage in the Memphis area consisted of bricks knocked out of parapet walls, tops knocked off of chimneys, and broken windows. A slightly less intense earthquake having the same epicenter occurred on 17 August 1865. A catalogue of earthquakes of the central United States indicates a clustering of epicenters for relatively mild (3.0 to 4.9 m_b—body-wave magnitude) seismic activity extending northeastward from Memphis to the general vicinity of NAS Memphis. The facility lies approximately 20 miles east of the eastern boundary of the zone of sand-blows produced by the 1811-1812 events.

Although significant fault systems are developed within the general zone of seismic activity, their detailed extent, attitude, and past effects have not been determined for the facility area. Early in the study of

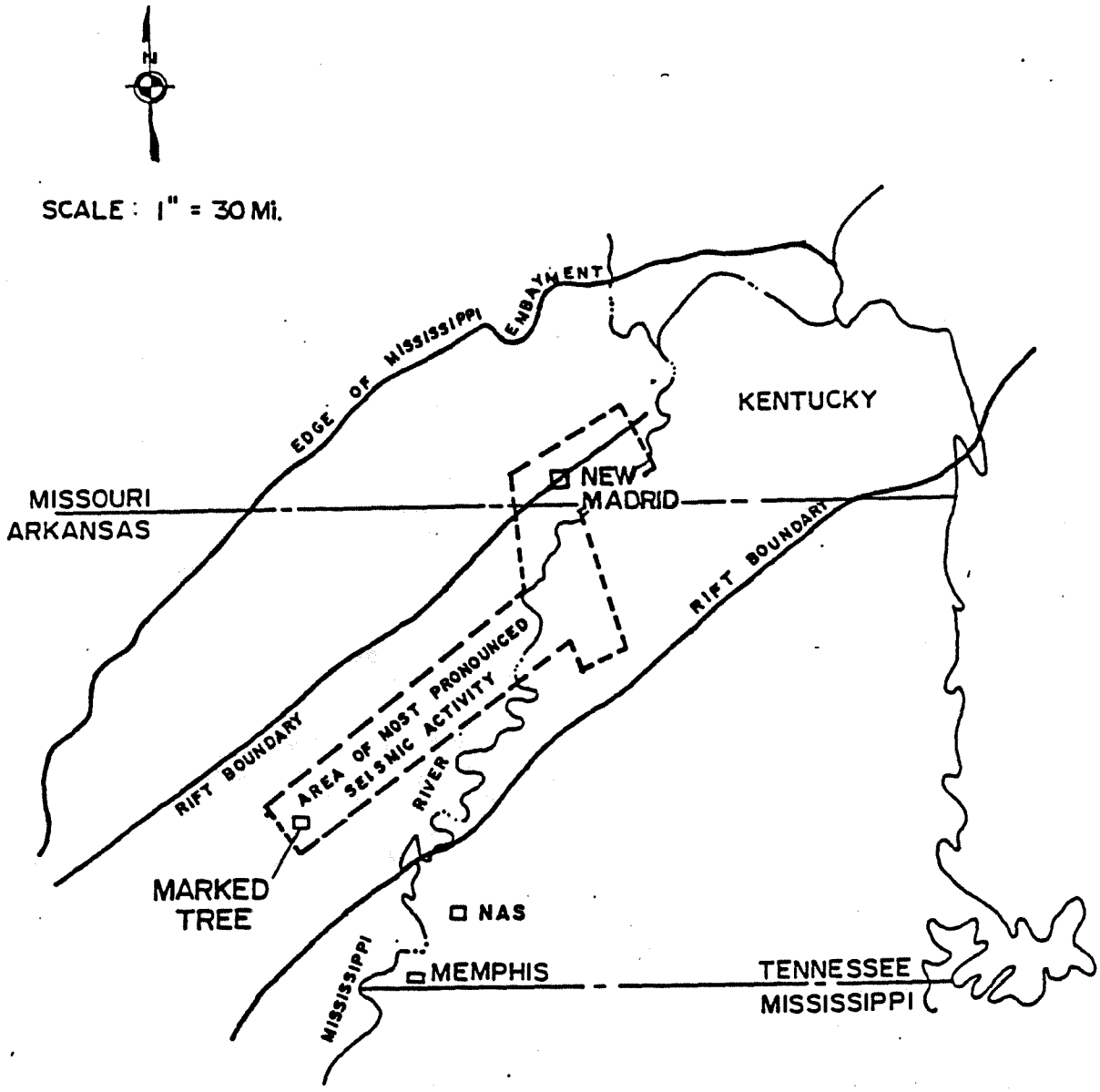

FIGURE 4-6
SEISMIC ACTIVITY ZONE

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STATION MEMPHIS

structural deformation in the Mississippi Embayment, it was recognized that, as the region subsided during the formation of the regional syncline, faulting of the unconsolidated sediments and, perhaps, underlying Paleozoic rocks occurred. This formed a rectangular pattern of faults trending northeast and northwest. One of the major faults in this system, the Big Creek Fault, trends northeast from near West Helena, Arkansas, along the western edge of the Memphis area to Reelfoot Lake near the Tennessee-Kentucky border. In the Reelfoot Lake area, this fault appears to be related to the major fault systems of significance, with respect to the seismic activity of the region. This fault is thought to be significant because it apparently restricts the movement of ground water from the west, into the general Memphis area. Geomorphological evidence and electric logs of wells indicate that as much as 50 feet of displacement has occurred, related to faults south of Memphis in the Hickory Hill well field area.

4.3.4 Soils. Soils within NAS Memphis and the surrounding area belong to the Loring, Falaya, Memphis, Henry, Calloway, Collins, Granada, and Waverly series or their graded and/or filled equivalents (Figure 4-7).

The survey of Sease (1970) indicates greater than fifty percent of the facility is now graded or filled, silty lands. In general, these soils are all derived from loess or loess materials that have been naturally-transported short distances downslope. Loring and Falaya soils characterize the northern and western portions of the North Complex. Henry and Granada series soils occur predominantly in the southwest quarter of the North Complex. Collins and Waverly soils series generally occur on slopes adjacent to drainages. Waverly soils dominate portions of the flood plain of Big Creek.

Memphis and Loring soils series are generally developed on upland areas from deposits of loess. They are silty in texture and occur to depths in excess of 30 inches. Well-drained and friable, they have physical properties favorable to the infiltration of water.

Granada, Calloway and Henry soils series and their disturbed derivatives are medium-textured, mostly silty loams, have a fragipan layer at approximately two feet, and transmit water vertically at slow rates. Water accumulates above the fragipan layer during wet periods.

Calloway, Henry and Waverly soils series, of low-lying areas, are generally silty or loamy with a pan or compacted layer occurring at about 20 to 24 inches. They receive much seepage and runoff from topographically-higher areas. They reflect slow, internal drainage and excess surface water. These soils are generally permeable and friable to a depth of about 18 to 20 inches, but below this depth, water movement is quite slow. Water is held above the pan layer and saturates or waterlogs the root zone for considerable periods during winter and spring. During winter, water may stand on the surface during rainy periods, but during summer months, the perched water table is not present except during unusually long rainy periods.

Collins soils series are deeply developed and generally well-drained. They are silty or loamy and occur to depths exceeding 30 inches. Infiltration rates are generally high in these soils.

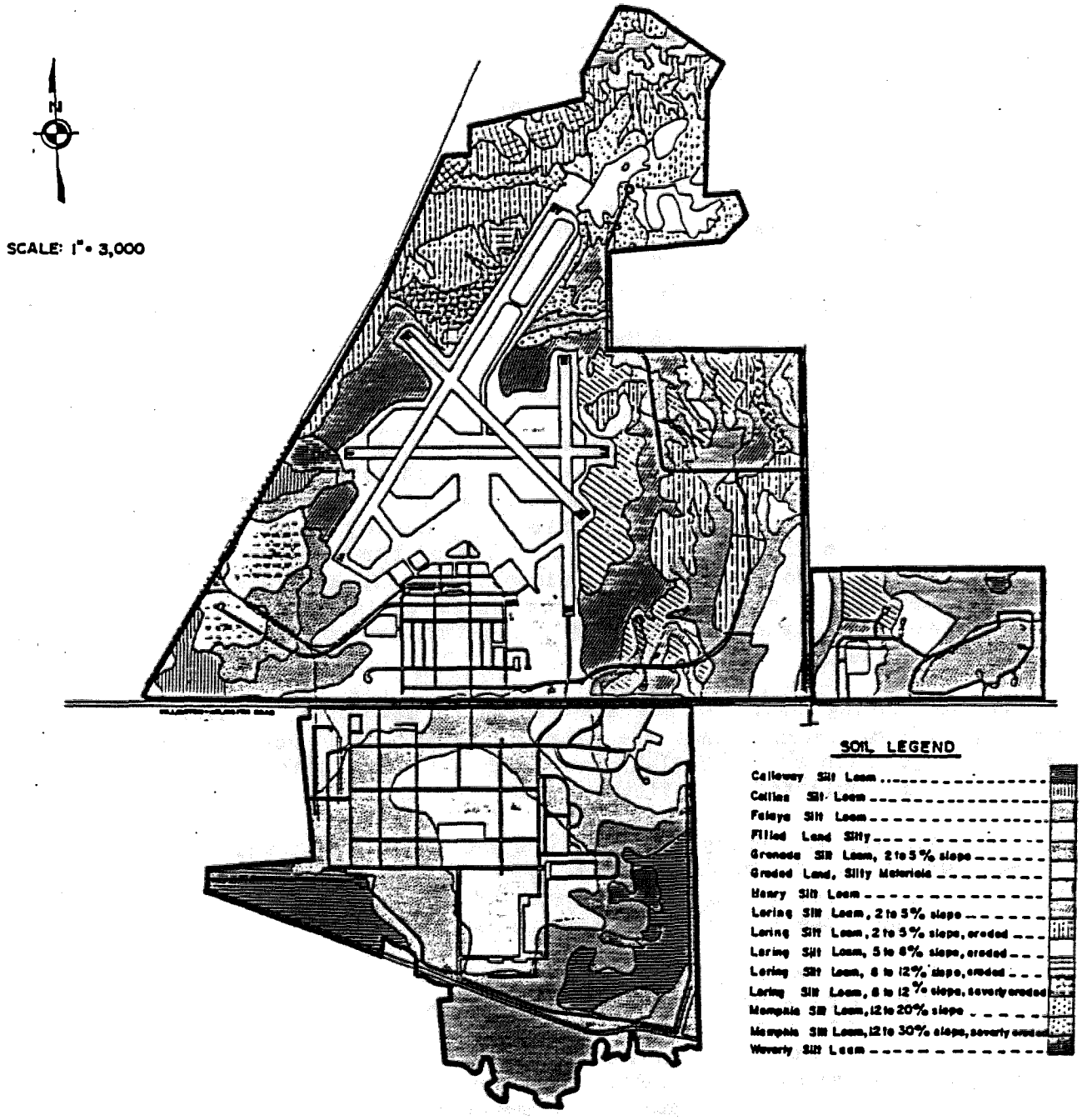

FIGURE 4-7
SOILS LOCATION MAP

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NAVAL AIR STATION
MEMPHIS, TENNESSEE

Falaya soils (which typify bottomlands) are medium textured and have locally-low infiltration rates. Slow movement of surface water results in standing surface pools, for up to 24 hours, after rainy periods. The water table commonly rises to within 15 to 20 inches of the surface in rainy seasons.

Examination of shallow boring logs at 14 construction sites indicates that the depth of silty and clay-rich materials ranges from a maximum of 51 feet below surface, in areas of the North Complex, to an average of 35 feet below surface, in the South Complex area. In the South Complex area, numerous boring logs indicate the presence of a blue-gray silty clay zone between 18 feet and 20 feet below surface. Borings for the new NRMC indicate that silts and clays extend to a depth of 43 feet (+245 feet MSL) and grade to sands and gravels. Boring logs from the vicinity of Building S-237 report traces of marine fossils in gray silt, encountered at a depth of 20 feet.

4.3.5 Hydrology and Migration Potential.

4.3.5.1 Surface Water. Distribution of flowing surface waters and flood plains on, and in, the immediate vicinity of the base is shown on Figure 4-8. The entire facility is drained by a series of natural, modified, or constructed drainages, all of which comprise a tributary system of Big Creek Drainage Canal.

Waters from the northwest side of the North Complex drain into North Fork Creek, a south-flowing tributary to Big Creek Drainage Canal. Waters on the northeast side of the North Complex flow either directly south to Big Creek Drainage Canal or tributaries, or to Casper Creek, ultimately reaching Big Creek Drainage Canal.

Much of the South Complex is drained by an array of ditches that merge and finally enter Big Creek at various points. Most such ditches parallel major roads within the South Complex. Much of the South Complex is within both the 100-year (+257.8 feet MSL) and standard-project flood plain (elevation +260.6 feet MSL) of Big Creek Drainage Canal. The extreme southwest corner of the North Complex, also, lies within these flood plains, as does the western half of the NRMC, representing the immediate drainage basins of North Fork Creek and Casper Creek. The southern portion of the South Complex was flooded in 1973 and 1974, during storms which breached the levy of the Big Creek Drainage Canal.

Flow rates in drainages within and surrounding the facility vary because of the extreme seasonal variation in precipitation. Flooding is not uncommon, with resulting shallow areas of standing water within the South Complex and the extreme southwestern portion of the North Complex. Examination of Big Creek Drainage Canal indicates full-bank conditions during times of maximum rainfall. Similarly, identical conditions are suspected for drainage ditches on the South Complex and for North Fork and Casper Creeks. The presence of loess-derived soils and related high runoff rates are, in part, responsible for the unusual seasonal fluctuation in amounts of flowing water.

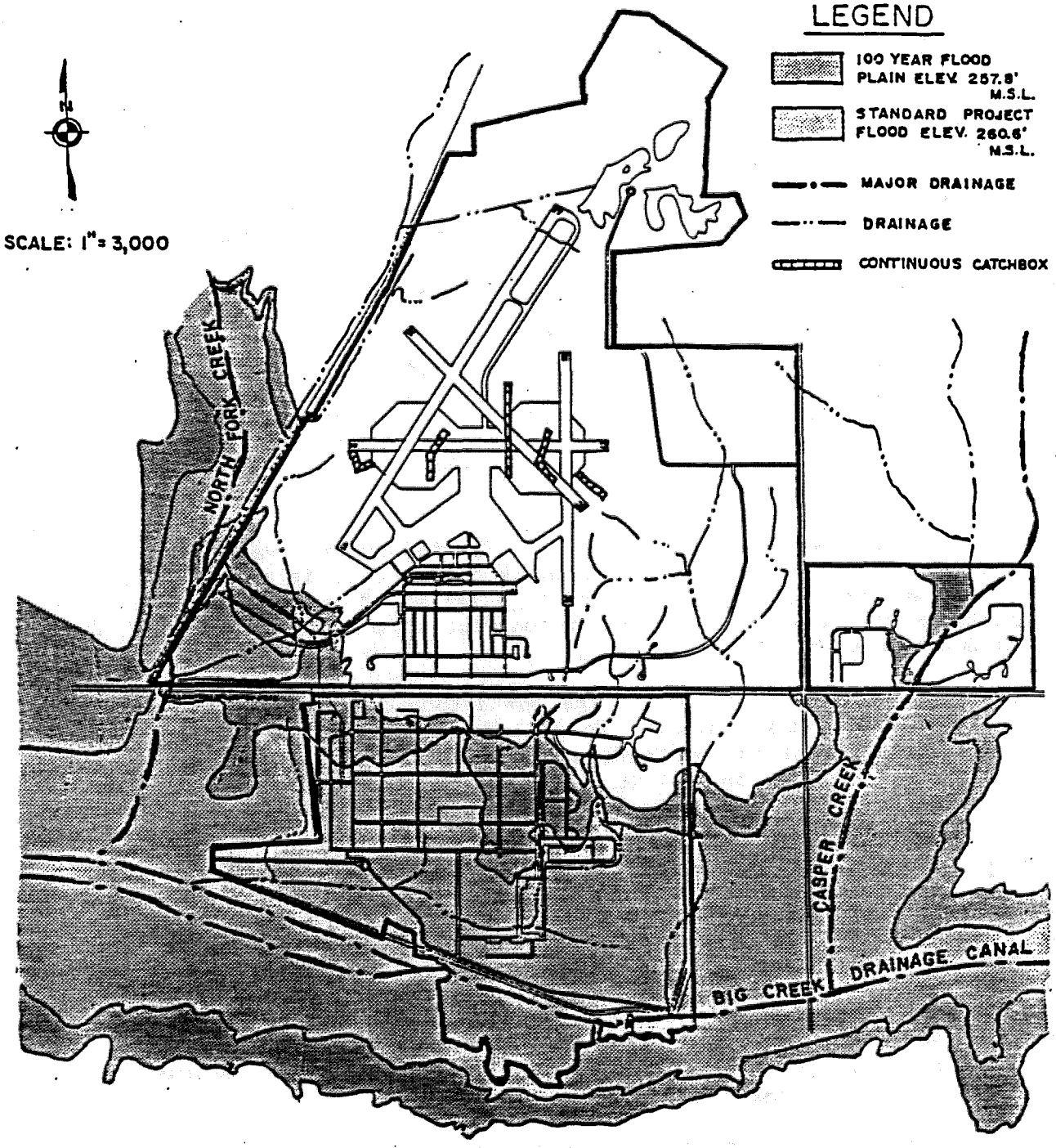

FIGURE 4-8
DRAINAGE PATTERN AND
FLOODPLAIN LOCATIONS

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Natural, modified, and constructed drainages within and adjacent to NAS Memphis appear to be utilized only for the containment and discharge of runoff. Although fish were observed in the larger perimeter drainages, no indication that these drainages are suitable for recreational activities exists.

The only significant surface water impoundment on the facility is at the extreme north end of the North Complex, where former borrow pits have been converted into recreational lakes. Tanya Lake, another recreational facility, is located immediately beyond the northeast boundary of NAS Memphis. Approximately three-fourths of a mile to the east-northeast of the facility is Casper Lake, an impoundment hosting Casper Creek Park on its shores. Additional small impoundments occur in the horse farm area of the North Complex and as hazards on the Navy Golf Course. Two contiguous sewage treatment ponds are located immediately south of Big Creek Drainage Canal on the South Complex. These ponds are inactive and presently unused.

4.3.5.2 Ground Water. The Memphis metropolitan area is one of the largest in the United States that depends solely on ground water for its potable and industrial supply. Enormous quantities of water are available from two principal artesian aquifers: the Memphis Sand ("500-foot sand") and the Fort Pillow Sand ("1,400-foot sand"). In 1979, approximately ninety-seven percent of inventoried pumpage in the Memphis area (about 200 mgd) was from the Memphis Sand. Until recently, this supply was held in reserve as a secondary source for the municipal system. Both of these major ground water aquifers and a shallow ground water aquifer system underlie the facility. Both the city of Millington and NAS Memphis obtain their water supply from the Memphis Sand. The NAS Memphis wells are all located within the NAS Memphis boundary and the Millington wells (see Figure 4-12 for well locations) are located only 0.3 mile west of NAS Memphis.

Shallow water table conditions above the Memphis Sand, typically, occur in fluvial deposits and alluvium. Small-capacity domestic wells in the Memphis area pump from such deposits. Alluvial aquifers, locally, have a relatively high production potential, but due to hardness, high iron, and total dissolved solids contents, are less desirable, for many purposes, than water from the Memphis Sand. The occurrence and specific characteristics of the shallow ground water aquifer, in the Memphis area, are difficult to determine, based on available data. However, the flow direction in such aquifers is usually controlled by topography, being, generally, toward the nearest major natural drainage where discharge may occur as base-flow or into adjacent springs.

The hydrology of the major artesian aquifer systems in the Memphis area has been discussed in detail by Criner and others (1964). Data in this publication were gathered from a large number of wells and quite adequately show the structural attitude and other characteristics of the principle artesian aquifers and the effects of municipal pumping on the piezometric surface of the Memphis Sand, as of August 1960. By extrapolation, the results of this work are valid in the present study.

In the facility area, the Memphis Sand strikes to the northeast and dips to the northwest at approximately 10 feet per mile. The upper surface of the aquifer is intercepted, based on well data from NAS Memphis, at between -10

to +11 feet MSL. The artesian nature of the Memphis Sand projects a piezometric surface in the facility area at an elevation of approximately +230 feet MSL, approximately 220 feet above the top of the aquifer. These and other data indicate a general southwestward gradient to the piezometric surface toward the strikingly-developed cone of depression in the immediate Memphis area well fields (Criner and others, 1964). While demands on the Memphis Sand have increased since 1960, the general gradient direction is still to the southwest toward the Memphis well fields. The gradient has increased an unknown (although significant) amount from the 2.5 feet per mile, determined from the 1960 data (Criner and others, 1964).

Until recently, recharge of the Memphis Sand was thought to occur only in areas to the east of the Memphis area (updip) where the sand crops out or is very near land surface. This general recharge area covers a considerable portion of Fayette, western Hardeman, and southeastern Haywood Counties. The nearest approach of this recharge zone to NAS Memphis is approximately 25 miles east-southeast in the north central portion of Fayette County. However, current data indicates that at least part of the recharge to the Memphis Sand is probably derived by vertical leakage from the shallow ground water aquifer systems, through the upper confining bed. Further, local windows of permeable sand exist in the confining bed, through which any contaminant in the shallow ground water aquifer could enter the upper artesian aquifer system (Memphis Sand). The potential for such leakage has been pointed out by several authors.

Additional evidence of vertical leakage as a recharge component of the Memphis Sand has been provided in the research of Parks and others (1981). In this work, a leakage factor of approximately 20 percent of the recharge over the Memphis area had to be applied to a computer model of the Memphis Sand in order to simulate known historic water levels.

This discovery has heightened concern about the possibility of contaminants in the shallow water table aquifer, ultimately reaching the Memphis Sand. Well logs from the Memphis area indicate that in many places the clay beds making up the bulk of the confining bed, above the Memphis Sand, contain numerous sand beds or lenses, and that at a few localities sand is predominant. One investigator concludes that, although the confining unit serves as a barrier to the movement of ground water, it is imperfect as a sealant.

The locations of such windows where vertical leakage into the Memphis Sand can occur are not certain, because of inadequate well logs. The rate of contaminant movement into the Memphis Sand would be dependent upon the horizontal distance from the windows, continuity of the shallow ground water system, rate of lateral migration toward the window, and the hydrologic character of the sands within the window.

The rate of lateral movement for water in the Memphis Sand, as determined in one reference, was equal to approximately 14 feet per year for every foot of gradient per mile. This equaled approximately 35 feet per year in the NAS Memphis area, in 1960. The rate of movement down the Memphis area cone of depression is thought to have increased to between 50 and 60 feet per year, at present.

Data relative to the shallow ground water aquifer was obtained from construction boring logs for twelve widely-scattered sites at NAS Memphis. These sites include the following buildings: N-126, S-242, E-6, 773, S-133, N-91, N-79, 757, 776, S-237, 400 through 407, and S-21. The data suggests a seasonal fluctuation of the shallow ground water table from approximately the present local surface, to approximately 21 feet below local surface. In general, very shallow ground water conditions exist in the South Complex area, within and near the flood plain of Big Creek. Somewhat deeper water table conditions occur in the North Complex area.

Construction borings on the South Complex indicate that while interception of water level occurs at variable depths, a gradual rise in static water level, to within 3 to 9 feet below the surface, occurs for all locations.

The boring data further suggests that the shallow water table aquifer is within the zone of silty clays, above an interval of sands and gravels of unknown thickness. The hydrologic character of this relatively-shallow zone of sands and gravels is unknown, although the gradient probably is generally to the south and southwest toward both Big Creek and the Mississippi River. Water contained in this interval is probably segregated from the underlying Memphis Sand by the impermeable, upper-confining clay. Data that would indicate recharge to the Memphis Sand aquifer, through windows, was not found for the NAS Memphis area.

The shallow water table data suggests that the general gradient is toward Big Creek in the South Complex area and at least portions of the North Complex. Locally, the general gradient is toward natural, modified, or constructed ditches, particularly during seasonal rainy periods.

The City of Millington obtains its potable and industrial water supply from a series of four closely-spaced wells approximately 0.3 mile west of NAS Memphis. These wells are approximately 400 feet deep and utilize water in the Memphis Sand aquifer. The water is hard, with an average iron content of 2.5 ppm. The surface of the Memphis Sand lies at a depth of approximately 278 feet, and is approximately 140 feet thick, based on drillers' logs for the four wells. Elevation of the top of Memphis Sand is approximately -9 feet MSL, on average, for the four wells.

Outlying areas receive water from the Shelby County Utility Board, although a few residential wells exist approximately one mile northeast of the North Complex, along the Kerrville-Rosemark Road. While other scattered residential wells may be located in the general Millington area, exact locations could not be determined. These wells all use water from the shallow ground water aquifer and would be characterized by very local recharge.

4.4 BIOLOGICAL FEATURES.

4.4.1 Ecology, Terrestrial, and Aquatic Flora and Fauna.

4.4.1.1 General Ecology. Terrestrial vegetation is composed of hardwood/pine forest associations interspersed throughout the facility. Additional ground cover includes some grasses, in improved and semi-improved areas, and native grasses, wild flowers, and herbaceous shrubs, in undisturbed and ruderal areas.

Terrestrial fauna occurring on the facility are represented by small game and non-game mammals, waterfowl and other avions, furbearers, and fish. The game management areas depicted on Figure 4-9 cover 463 acres.

A ten-acre marsh area presently exists in the southeast corner of the South Complex at the old South Complex Landfill area. This area supports typical wetland vegetation, i.e., reeds, cattails, and black willows, as well as an abundance of filamentous algae, comprised of green (Chlorophyta) and blue-green (Cyanophyta) species. Wildlife species observed include waterfowl, frogs and turtles. Fish were not observed in approximately one-half acre of standing water, which averages 6 to 8 inches deep.

Fourteen lakes and ponds totaling 47 acres comprise the major surface water habitats on the base. Seven of the ponds are utilized for either fishery-stocking programs or recreation. Additional surface water is represented by several small streams, some of which are intermittent. The two abandoned biological lagoons, at the southern boundary of the South Complex, are presently under consideration for development as recreational or fishery facilities. These lagoons total approximately 14 acres and currently support several forage species, e.g., Gambusia affinis (mosquito fish).

The dominant aquatic habitat is the Navy Lake-Tanya Lake system, located at the north end of the airfield. Navy Lake, Tanya Lake, and the small marsh area adjacent to Navy Lake, are the focus of a large recreational area providing boating, fishing, picnicking, and other outdoor sports. The primary water source for this system is a small, unnamed stream which enters through the marsh area at the north end of the Navy Lake. Acreage, immediately adjacent to the lake, is predominantly improved and semi-improved areas. Shore areas are virtually absent due to the steep topography of the shoreline. Vegetation found in the immediate lake vicinity includes grasses, cattails, cane, black willow, sweet gum, and weeping willow.

4.4.1.2 Terrestrial Ecology. Terrestrial vegetation on improved grounds (golf course, buildings, recreational areas, etc.) consists primarily of bermuda grass and ornamental shrubs and trees. Johnson grass (Sorghum halepense), native range grasses (Andropogan sp.), Serica lespedza, partridge pea, and upland hardwoods and pine are representative of semi-improved and unimproved areas. Forested areas are composed of loblolly pine, yellow poplar, sycamore, sweet gum, green ash, and mixed hardwoods. Figure 4-10 shows the types and distributions of wooded associations.

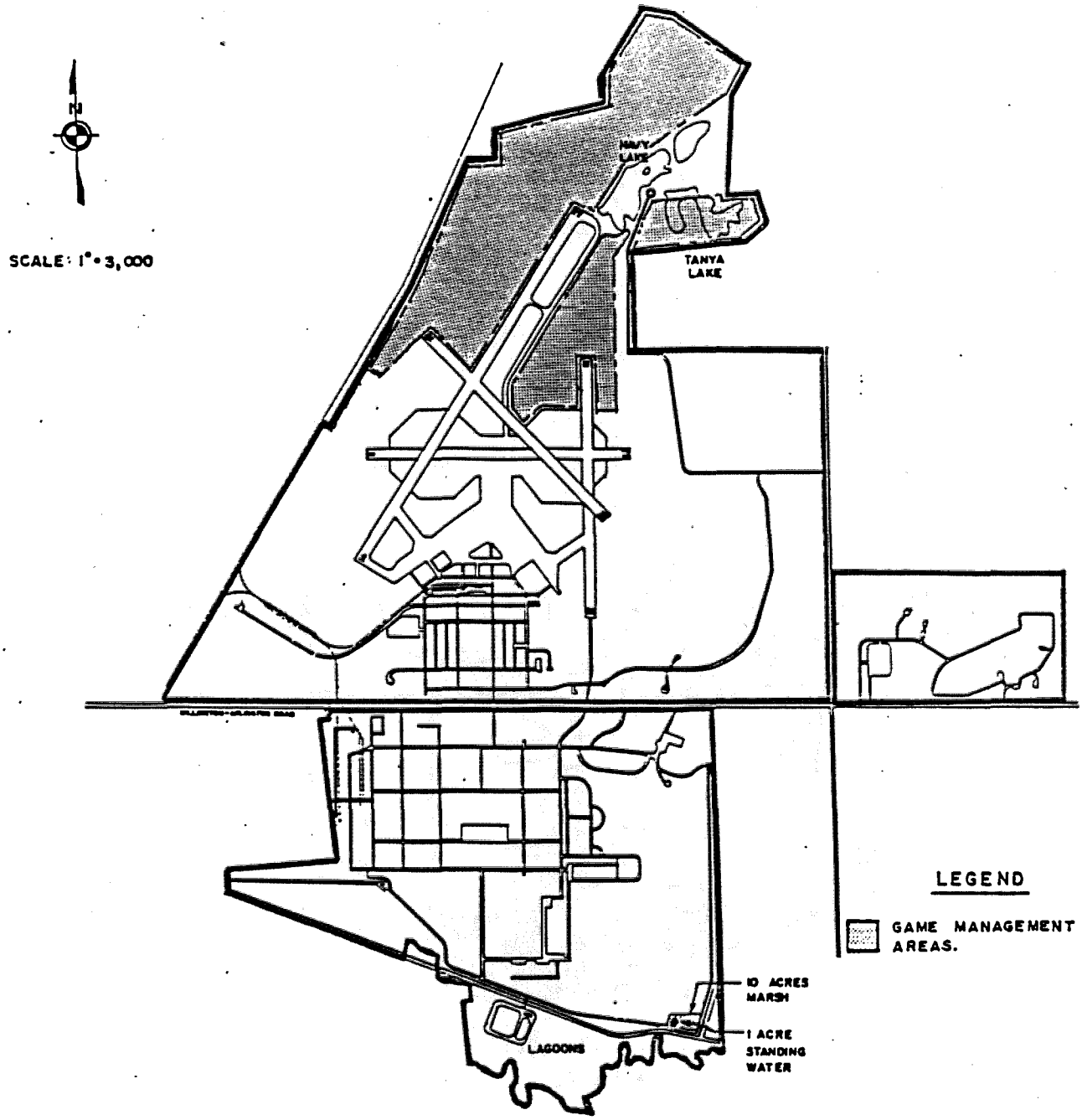

FIGURE 4-9
GAME MANAGEMENT AREAS

INITIAL ASSESSMENT
STUDY NAVAL AIR
STATION MEMPHIS

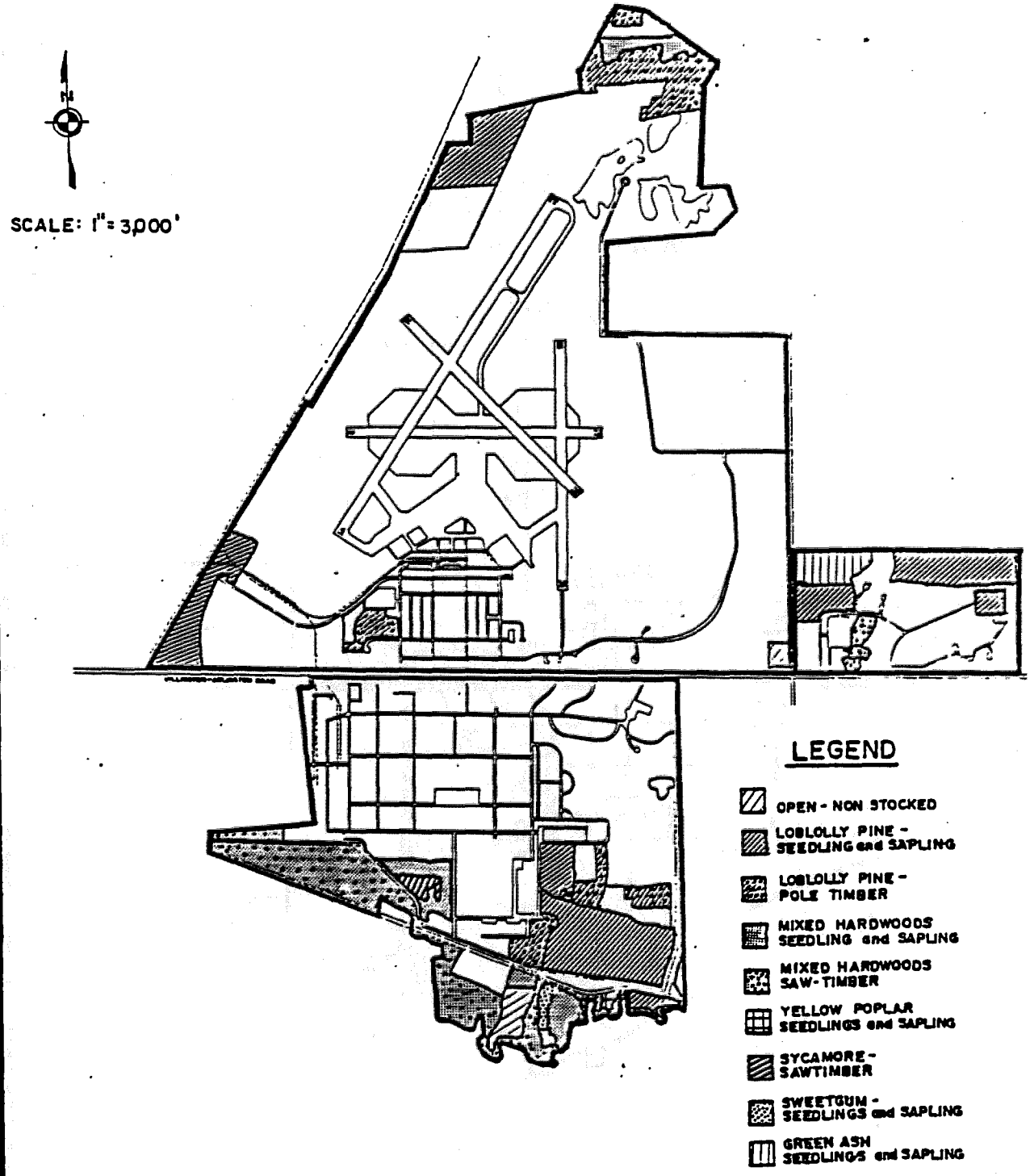

FIGURE 4-10
FORESTED AREAS

INITIAL ASSESSMENT
STUDY NAVAL AIR
STATION MEMPHIS

Cursory examination of vegetation conditions reveals that most areas are supporting healthy, unstressed species. Planted pines and hardwoods have been successfully established in several areas. Ruderal sites, which have not been subjected to planned reclamation, are generally supporting voluntary trees and grasses. However, one tract previously used for trash disposal at the south end of the airfield, is presently unsuitable for supporting vegetative cover. Voluntary vegetation in this area has not occurred successfully and planned reclamation will be required to reestablish the area.

Diverse resident fauna are represented by game and non-game species. Table 4-2 lists the terrestrial species presently known to inhabit the facility. Most species are managed by habitat improvement and population-control measures, in order to promote healthy and sufficient stocks.

Those species which are, reportedly, in abundance and healthy include rabbits, gray squirrels, and fox squirrel. Dove and quail are, apparently, less abundant than the area can support and recommendations have been made for improved management of these species.

Those species which are, reportedly, in abundance and healthy include rabbits, gray squirrels, and fox squirrel. Dove and quail are, apparently, less abundant than the area can support and recommendations have been made for improved management of these species.

4.4.1.3 Aquatic Ecology. Aquatic vegetation on NAS Memphis is very sparse and limited, primarily, to riparian forms. Cane, cattails, and arum species dominate the banks of unimproved pond areas. Green (Chlorophyta) and blue-green (Cyanophyta) algae are abundant, but not excessive, in most ponds and marshes. Based on the conditions and usage, the waters in these lakes and ponds should be typified by phytoplankton and periphyton representative of temperate freshwater systems. Eutrophication of the lake/pond habitats has not been reported nor observed in the on-site survey.

Representative aquatic fauna are listed in Table 4-3. These listings focus on vertebrate and game species and exclude such categories as amphibians and macroin-vertebrates. NAS Memphis currently conducts an active fisheries program consisting of nursery and stocking activities. Figure 4-11 illustrates the locations of all the lakes and ponds and their utilization in the fisheries program.

4.4.2 Rare, Threatened, Or Endangered Species' Critical Habitats. Appendix B lists those species currently listed as rare, threatened or endangered which are known to inhabit in Shelby County, Tennessee. None of the referenced species are reported to inhabit NAS Memphis (Corps of Engineers, 1981).

4.4.3 Impact On Habitats. Several inactive landfilling and disposal areas exist on the facility. Reclamation of one of these areas (South-Side Landfill) has been successfully implemented and no visible signs of surface contamination or vegetative stress are apparent. Other smaller, less significant areas have voluntarily reestablished. As previously discussed,

TABLE 4-2

CURRENT TERRESTRIAL FAUNA AT NAS MEMPHIS

CLASSIFICATION	COMMON NAME
Upland game	Rabbit Gray Squirrel Fox Squirrel Quail Dove
Fur-bearers	Muskrat Mink Beaver
Non-game	Skunk Opossum Racoon Fox Coyote

TABLE 4-3

CURRENT AQUATIC FAUNA AT NAS MEMPHIS

CLASSIFICATION	COMMON NAME
Waterfowl	Domestic ducks Mallard ducks Canadian geese
Game fish	White crappie Large-mouthed bass Blue gill Channel catfish Green sunfish
Forage fish	Fat-head minnows Mosquito fish
Rough fish	Carp Golden shiner

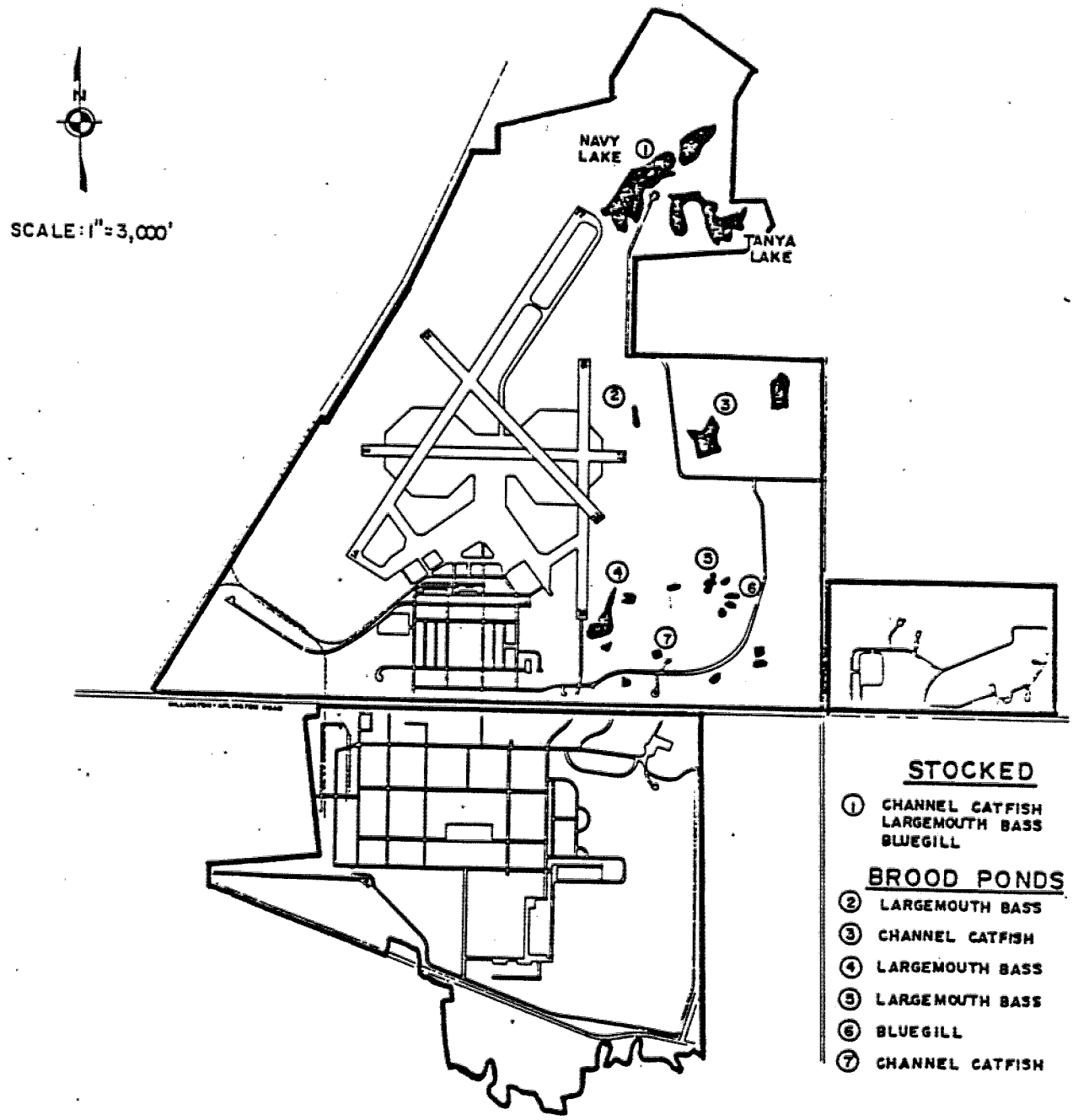

FIGURE 4-11
FISHERIES HABITAT AREAS

INITIAL ASSESSMENT
STUDY NAVAL AIR
STATION MEMPHIS

an inactive disposal site of undetermined size is located at the south end of Runway 4. This area has not undergone much revegetation because of the lack of topsoil and insufficient ground cover over the discarded rubble.

Use and storage of chemicals at NAS Memphis are, presently, limited and have been limited in past activities. No environmentally-adverse effects are apparent in habitat areas from such activities. The majority of land associated with the facility is comprised of improved and semi-improved grounds, and environmental impacts on habitats in surrounding areas are insignificant.

4.5 WATER QUALITY.

4.5.1 Surface Water. The major surface water feature in the NAS Memphis area is Big Creek, which flows through north central Shelby County for 28 miles and intersects with the Loosahatchie River at mile 8.0 (Allan and Hoshall, 1976). Big Creek is a major tributary of the Loosahatchie River, and the water quality of Big Creek bears a direct influence on the quality of the Loosahatchie (Mid-South Water Quality Management, 1979). Big Creek forms the southern boundary of NAS Memphis. This segment has been channelized and deepened to provide increased flood control.

The Big Creek system is classified by the state of Tennessee as suitable for fishing and aquatic life, irrigation, and livestock and wildlife watering. Treated municipal sewage and agricultural drainage compose the two major sources of impact on Big Creek. In the vicinity of NAS, Big Creek receives sanitary sewage discharge from the city of Millington and from NAS Memphis. Considering the Big Creek system as a whole, the major impact is agricultural activity.

A 1976 water-quality study, conducted as part of a regional "208" study, reveals that dissolved oxygen concentrations in Big Creek, below Millington, frequently fell below the 5.0 mg/liter standard, while dissolved oxygen concentrations upstream of Millington were rarely less than 5.0 mg/liter. The same study also indicated that biochemical oxygen demands (BOD) are generally low, and that nutrients, e.g., nitrogen and phosphorous, are present in moderate to low concentrations throughout the Big Creek system.

4.5.2 Ground Water. Ground water in the NAS Memphis area is obtainable, primarily, from three aquifers. These are the alluvial sands and gravels, which occur down to a depth of approximately 160 feet, the Memphis Sands (the "500-foot sands") and the Fort Pillow Sands of the Wilcox group (the "1,400-foot sands").

Water from the alluvial sands and gravels is abundant, but hard and, generally, not utilized for drinking water supplies. However, the water is acceptable for irrigation and livestock watering. The Memphis and Fort Pillow sands typically yield high-quality water which is characteristically moderate to soft, with a low mineral content. The Fort Pillow is, reportedly, the better of the two supplies.

Chemical analyses of ground water presently being utilized at NAS Memphis indicates that the water is generally good, with the exception of moderate to high hardness. Available analytical reports reveal high carbon dioxide concentrations and moderate iron levels.

4.6 WATER SUPPLY. Since 1942, all water utilized at NAS Memphis has been derived from the Memphis Sand, since 1942. Water was initially produced from two wells in the North Complex and three wells in the South Complex. Subsequently, well No. 1, in the Northern Complex, was abandoned and a twin well was drilled in 1982. A third well was established in the North Complex in 1960. Locations and data illustrating the character of these wells are shown in Table 4-4. The well data indicates a general southerly gradient of approximately four feet per mile, when the well was originally installed, and a historical decline in static water level of up to 34 feet, as illustrated by well 2S.

Pumping elevations have been lowered, accordingly, with time. Drawdown appears to have remained essentially constant for individual wells, and variability between wells ranges from 50 feet for well 3N, to as little as 13 feet for well 1S. Performance data for wells 2N and 2S indicate a historic decrease in capacity per foot of drawdown, from 45 gallons per minute (gpm), in 1955, to 25 gpm, in 1976, at Well 2N, and from 19.4 gpm to 14.5 gpm from 1969 to 1976 in Well 2S. Present capacity of these wells varies from 732 gpm for well 3N to 600 gpm for well 2S.

A well was drilled in early 1983 to test the deeper Fort Pillow Sand Aquifer (approximately 1,500 feet), in the northwest corner of the South Complex. Water quality was, reportedly, better than that contained in the shallower Memphis Sand. Logs and other details related to this test well were unavailable for this report.

Two water treatment plants are currently in use (Buildings S-75 and N-78), one each, on the North and South complexes. Both treatment systems provide the same function, and the distribution system is interconnected to allow an exchange of flow between the North and South complexes. The water is chlorinated, fluorinated, and filtered through a sand bed before distribution. More than 60 miles of cast iron pipe (Figure 4-12) transport the treated water throughout the base.

Treated water is stored in a 500,000-gallon elevated tank on the North Complex and in a 500,000-gallon clear well on the South Complex, located at the water treatment plant. During periods of peak demand or loss of pumping capacity, line pressure is maintained by the elevated storage tank.

4.7 ADJACENT LAND USE. Figure 4-13 illustrates adjacent land use and outlease properties for NAS Memphis. The majority of land along the perimeter of the base is utilized for agricultural purposes. Areas to the northwest, north, northeast, and east of the North Complex are utilized for agriculture, primarily the planting of row crops. Due north of the North Complex is a small, farm community (Kerrville). Northeast of the North Complex is a recreational area (golf course). Wherry Housing, an off-base housing project for NAS Memphis, is located on the eastern perimeter of the North Complex, just west of Bethel Road. Land use to the east, south, and

TABLE 4-4

ILLUSTRATIVE DATA FOR WELLS ON NAS[a]

WELL #	LOCATION	SURFACE EL. (FT MSL)	TOTAL DEPTH (FT)	STATIC WATER LEVEL ELEVATION FT MSL (YR); FT MSL (YR)	DRAWDOWN-FT; ELEVATION (FT MSL) 9/82 (6/82/ N. 5-3)	FLOW RATE (GPM)
Old # 1N	N-88	282	728	240 (1942) -------Abandoned----------		
New # 1N	SE N-88	282	523	212 (1982); 206 (1982)	27; 179	715
# 2N	N-78	283	509	239 (1942); 235 (1982)	39; 196	614
# 3N	34S	285	510	----------; 224 (1982)	50; 174	732
# 1S	S-110	266	395	235 (1942); 202 (1982)	13; 189	632
# 2S	S-75	264	378	232 (1942); 198 (1982)	34; 164	600
# 3S	S-107	265	345	234 (1942); 212 (1974); 217 (9/82)	20; 197	709
New Test Well	NE S-242	267	1500±	data unavailable----------		

[a]Records from Public Works Engineering Department.

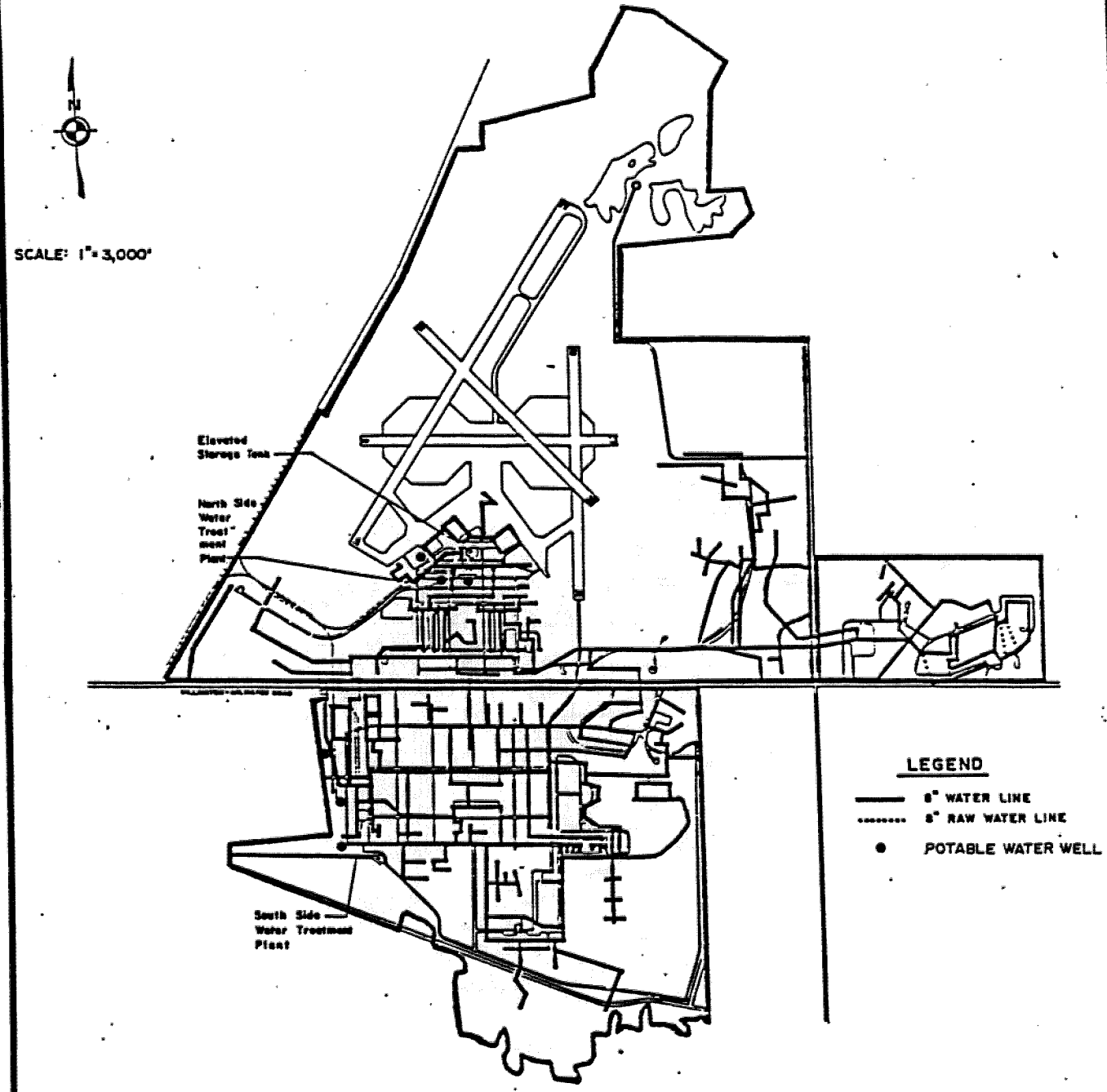

FIGURE 4-12
WATER DISTRIBUTION SYSTEM

INITIAL ASSESSMENT
STUDY NAVAL AIR
STATION MEMPHIS

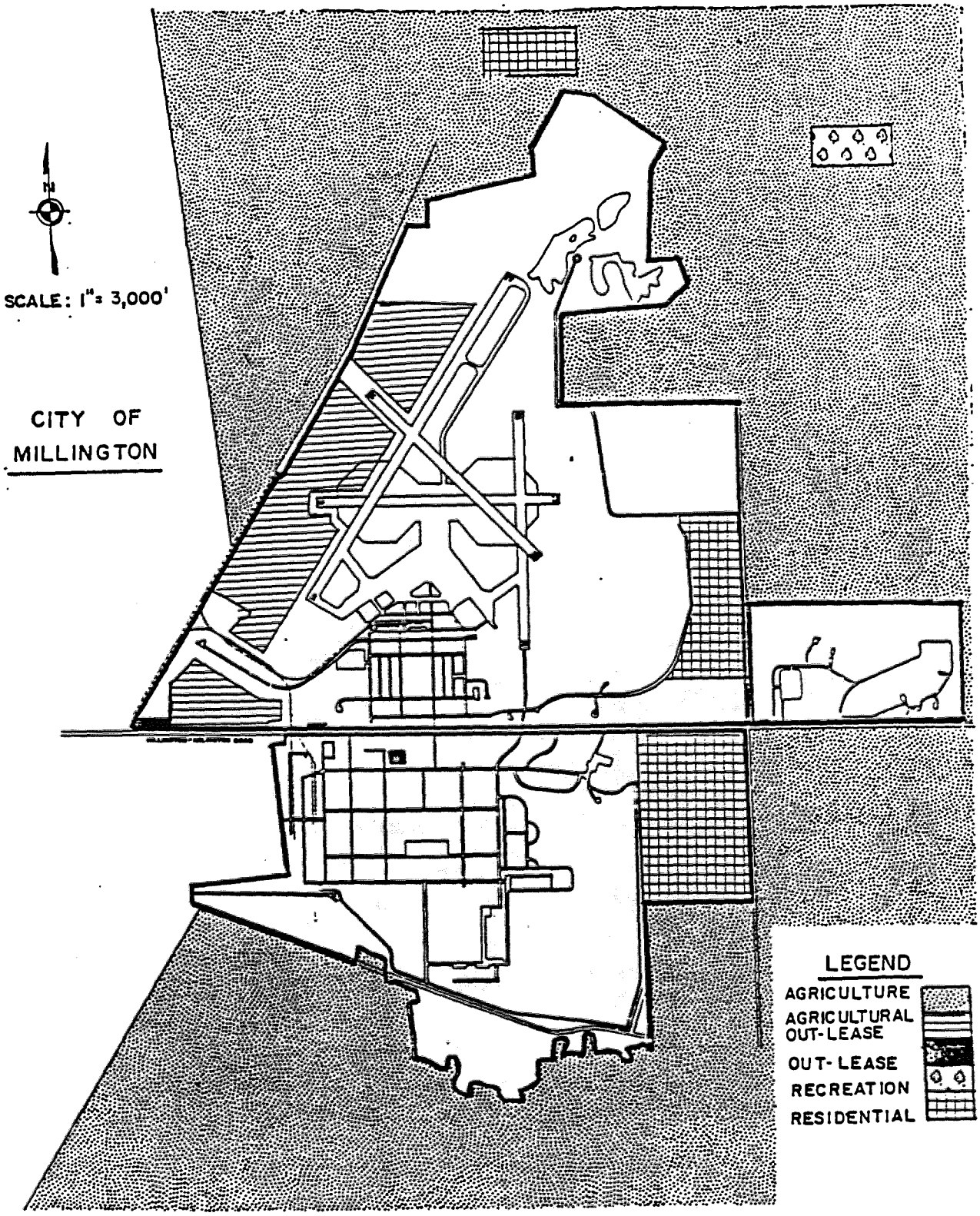

FIGURE 4-13
ADJACENT LAND USE MAP

INITIAL ASSESSMENT
STUDY NAVAL AIR
STATION MEMPHIS

southwest of the South Complex is primarily agricultural, with one small, residential section located between the South Complex and Bethel Road. Most of the western section bordering both the North and South complexes is an urban/residential area which includes the city of Millington, and has a total population of about 20,000. It is primarily an agricultural community with minimal local business and commerce.

4.8 LEGAL ACTIONS. Two incidents have been reported in which an action of the facility resulted in claims against NAS Memphis. Both involved the use of herbicides or pesticides, and both resulted in payment of damages by NAS Memphis.

Between June and October 1955, cattle from a farm on the south side of NAS Memphis broke through a fence surrounding an area located where the abandoned sewage lagoons are now. Apparently the cattle ate weeds which had been treated with sodium arsenite, a herbicide. About a dozen cows died, and the owner made a claim against NAS Memphis. After investigation by the NAS Memphis Legal Department, the claim (or some part of it) was paid. Prior to this incident, NAS Memphis had used Brulins, a nonselective herbicide. Because of the high cost of Brulins, a Navy entomologist had recommended that the base switch to sodium arsenite, which was a stock Navy pest control agent. NAS Memphis switched back to Brulins or to another herbicide after this incident.

About 1970 there was substantial damage to two cotton fields adjoining NAS Memphis. Fields on the Densford Farm (north of the NAS Memphis stables), and on the Bolton Farm (due west of the South Complex), were damaged when the NAS Memphis fenceline was sprayed with herbicide-contaminated pesticide. Wind carried the spray onto the plants in the field. The damage was clearly documented with photographs, which showed that cotton plant damage was most severe next to the NAS Memphis farm property boundary and progressively, less severe in plants further from the fence. The two farms made a damage claim against NAS Memphis. After investigation by the NAS Memphis Legal Department, each farmer was reimbursed for damages.

CHAPTER 5. WASTE GENERATION

5.1 INTRODUCTION. Since the primary mission of NAS Memphis is (and has been) training, large-scale industrial, ordnance, and radiological operations have not been performed. Several smaller industrial operations, presently conducted by the training groups and by NAS Memphis, have the potential for generating only small amounts of potentially- hazardous material. Those operations are discussed in this section.

Operations which generate non-hazardous waste material have not been considered. Operations such as household-waste removal, rubble disposal, and maintenance activities may have contributed waste to some of the sites that have been considered, but since such operations are typically non-hazardous, those operations will not be discussed. The major departments of NAS Memphis which conduct industrial-type operations, of limited scope, are the Public Works Department (PWD), the Aircraft Intermediate Maintenance Department (AIMD), the Recreation Department (RD), and the Supply Department (SD). Similar small-scale operations are conducted by Naval Air Technical Training Center (NATTC). The Naval Regional Medical Center (NRMC) also generates small amounts of radioactive wastes during normal operation.

The following sub-sections describe the industrial operations with the potential to generate hazardous waste.

5.2 MACHINE SHOPS.

5.2.1 Public Works Department (PWD). The Public Works Machine Shop, located in Building S-183, since 1943, is a support activity for maintenance required at various on-base facilities. The shop contains lathes, pipe threading and cutting equipment, drill presses, welders, etc., and the primary waste materials generated are metal shavings, scrap pipe, and scrap metals. Dumpsters are located adjacent to the building, for disposal of waste material generated. Small amounts of cutting oils are lost during machining, as the oil coats the metal parts which have been cut. Thus, no cutting oil is lost as waste, but makeup oils must be added to the machine as the oil is depleted.

5.2.2 Aircraft Intermediate Maintenance Department (AIMD). The Aircraft Intermediate Maintenance Department, located in Building N-126 since the mid-1950s, utilizes a machine shop to support the various aircraft maintenance activities which cannot be conducted at the squadron level, but require less than total overhaul. The shop has lathes, milling equipment, drill presses, welders, and other equipment necessary to machine a variety of metals, primarily aluminum and steel. Exotic metals are not normally used in the shops. Primary wastes from the shops are metal shavings and small amounts of cutting oil. Most of the cutting oil which remains on the parts, following machining, is removed by degreasing operations prior to painting or other corrosion control. It then becomes waste in an emulsion, along with the degreasers. The material is picked up for disposal by an off-base contractor. Prior to 1980, the material was mixed with waste oils and disposed of through Defense Property Disposal Office (DPDO).

5.2.3 Naval Air Technical Training Center (NATTC). The Naval Air Technical Training Center has operated several small machine shops in various hangars for student training purposes. The primary waste generated has consisted of small amounts of metal shavings, which are disposed of through the normal solid waste disposal channels. Hazardous wastes or significant quantities of waste oil have never been generated by the operation of the school.

5.3 METAL PLATING. Metal plating operations are not currently performed at NAS Memphis. Previously, small operations were performed by AIMD of NAS Memphis and within one of the schools at NATTC. The following sub-sections summarize those operations.

5.3.1 Aircraft Intermediate Maintenance Department (AIMD). A small plating operation was conducted in Building N-126 during the mid-1950s. Based on engineering drawings of the building and discussions with personnel, rinse water and solution from the plating tanks were, evidently, discharged into a 600-cubic-foot dry well, located to the south of the building. Samples collected from this well indicate that nickel, chromium, and cadmium plating was conducted as part of the intermediate maintenance. The amount of plating waste generated or the extent of plating performed at the building is unknown.

5.3.2 Naval Air Technical Training Center (NATTC). In 1953, Building N-121 was constructed to house the Plating School. It operated in that building until 1965, when plating training was discontinued. The entire Plating School was a small operation, training 12 to 15 students per class.

The operation consisted of three or four tanks used for cadmium, chromium, copper, and nickel plating training. Only small articles such as small aircraft parts and hand tools were plated.

Waste from the Plating School at Building N-121 was discharged either into a dry well or storm sewer. Building drawings indicate that the concentrated baths would be dumped into a 600-cubic-foot, gravel-filled, dry well at the south side of the building. A sump in the floor drained all spills and wash-ups into the storm sewer. Records were not available of the amounts of plating performed or wastewater discharged. The estimated discharge from the plating operation including both wastewater and concentrated solution was 18,000 gallons per day.

5.4 DEGREASING AND SOLVENT CLEANING.

5.4.1 Public Works Department (PWD). Degreasing and solvent cleaning has been conducted at the vehicle maintenance shop, since initiation of vehicle maintenance in 1943. Wastes generated by these operations have always been collected and stored, until being either picked up by a contractor or taken to DPDO for disposal. From the mid-1950s until approximately 1980, the material was mixed with waste oil disposed through DPDO. Since 1980, wastes have been collected by a contractor for off-base disposal.

when it was moved to Building N-10. After operating there from 1975 to 1979, operations were consolidated with the NATTC laboratory in Building S-61.

The photo laboratory operated by NARU was small and used only in support of training operations. The waste material generated by the laboratories in Buildings N-126 and N-10 was treated to reclaim the silver for resale, and the resulting biodegradable material was discharged into the sanitary sewer.

5.6.2 Naval Air Technical Training Center (NATTC). The photographic lab has been located in Building S-61 since 1944. The photo shop supports all photographic operations for NAS Memphis and tenants. Approximately 90,000 frames of film and slides and 140,000 prints are processed each year. The spent photographic fixer, from the developing operation, is treated to reclaim silver for resale, prior to discharge into the sanitary sewer.

5.6.3 Recreation Department (RD). The Recreation Department operates a small photographic lab in Building S-60 for the use of NAS Memphis personnel. The wastewater from the operation is treated to reclaim silver, and the remaining solution is discharged into the sanitary sewer.

5.7 GAUGE SHOPS. The Precision Measuring Equipment (PME) Shop (operated by AIMD) is used, presently, for calibration and repair of instruments, used in aircraft maintenance. Previously, its mission was repair and calibration of aircraft instruments. Military personnel operate the shop and no long-term civilian employees were identified; therefore, information on past waste generation and disposal practices was not available.

5.8 ELECTRICAL SHOP. The Public Works Department has maintained an electrical shop in Building S-77 since the 1940s. This shop provides all electrical maintenance service at NAS Memphis, change-out service for transformers, and repair service for buildings, located on the facility.

The primary waste material of concern is the transformer oils from out-of-service transformers which may contain PCB. In the past, transformer oils were collected in drums and picked up for disposal with other oils generated at NAS Memphis. Since PCB were of no concern in the past, some PCB-containing transformer oil may have been mixed with other waste oil and spread on roads. Currently, as transformers are taken out of service, they are tested to determine if PCB is present. If the transformers are found to be contaminated, they are stored at the PCB Storage Area until picked up by an approved disposal contractor.

5.9 PEST CONTROL SHOPS.

5.9.1 Public Works Department (PWD). The Public Works Pest Control Shop has been located in Building S-335, since 1949. A list of the estimated annual quantities of material used for pest control is in Table 5-2. All mixing and storage of pesticides and clean-up of equipment, with the exception of large truck sprayers, occurs at this location. Large, truck sprayers are washed on the washrack at the Transportation Shop. The diluted wash water from equipment clean-up is discharged into the sanitary sewer.

TABLE 5-2

ESTIMATED ANNUAL USAGE OF PESTICIDES
AND HERBICIDES AT NAS MEMPHIS

PESTICIDE	QUANTITY
Dursban 4E	5 gal
Baygon 1.5	8 gal
PX-11-Check Pest	4 gal
Sevin 80%	32 bags
Dylox 80%	28 cases[a]
D-Phenothrin	150 cases[b]
Diazinon 2%	600 lbs
Malathion 5%	150 lbs
ULD-BP 300	5 gal
Pxronl Oil	14 gal
Dichlorous, Strip	96 dozen
Ban Bug Resin Strip	48 dozen
Octagon Roach Spray	3 gal
Chlordane Gold Crest	20 gal
Insecticide Chlordane	10 gal
Wasp Freeze	84 cans
Hyvar x Bromacil	150 lbs
Dalapon 85	165 lbs
Ammate X	60 lbs
Ded-Weed, Silvex	30 gal
Round-up	26 gal
Surfactant	23 gal
Atrinal/Plantregulator	2 cases[c]
Altosid Briquets	7 cases[d]
Malathion 57%	385 gal
Malathion 95%	165 gal
Eaton Rodent Care	120 lbs
Anticoagulant	24 lbs
Rozol Tracking Powder	51 lbs

[a] 12 bags per case
[b] 24 cans per case
[c] 6 boxes per case
[d] 400 Briquets per case

From the early 1950s, until approximately 1970, 15 mosquito barrels were located at various bridges and streams on the facility. The barrels were filled with No. 2 fuel oil and allowed to drip on the water to form a film for mosquito control. In the early 1970s, when more emphasis was placed on water quality, the practice was discontinued.

The Pest Control Shop responsibilities include food-service roach and mice control; housing roach, flea, wasp and mice control; fence-row weed killing; mosquito fogging; limited termite control; and larvacide of standing-water areas.

The shop also maintains a biological, fly-control program on the North Complex, in the stable area. For the last two years, this program has consisted of periodic release of Pteromalids wasps to control the fly population. It has been more successful than previous attempts and requires less manpower. Assistance, in selection of materials and methods for conducting the various pest control functions, is provided by the SOUTHNAVFACENGCOM entomologist.

5.9.2 Recreation Department (RD). The Recreation Department has its own certified pest control officer. Most of the activities handled by the Recreation Department relate to the use of herbicide for weed control at the golf course. On the rare occasion when pesticides are used, the Public Works Department Pest Control Shop provides supervision. Pesticides used by the Recreation Department are stored in Building S-335.

5.10 BOILER PLANTS. Steam is provided to the facility by two individual steam plants and distribution systems. Building S-75, on the South Complex, is the largest steam plant, with five boilers, with a combined capacity of 300,000 pounds per hour, at 125 pounds per square inch gauge. The boilers are natural gas-fired with a fuel oil backup. Three, 100,000-gallon tanks are used for back-up fuel. Until 1978, steam was provided to the North Complex by six boilers, located in Building N-15, capable of providing 90,000 pounds per hour of steam, at 100 pounds per square inch gauge. In 1978, the North and South complex steam lines were joined together to allow Building S-75 to provide all the steam requirements. The Building N-15 steam plant was demolished in 1983.

Boiler blowdown fluctuates, substantially, between the winter and summer months and ranges between 5,000 to 10,000 gallons per day. The boilers are cleaned annually for inspection. Reportedly, only high-pressure water is used in the cleaning operation. The effluent is discharged to the storm sewer. Containers, for the chemicals used in boiler water treatment, are rinsed when empty and taken to DPDO for disposal. This practice has been established for 10 to 12 years. Prior to the initiation of DPDO disposal, some of the chemical containers were reportedly disposed of at the landfill.

The second steam system provides steam to the old hospital. The steam plant, Building E-11, at the old hospital, provided 75,000 pounds per hour, at 100 pounds per square inch gauge, using five locomotive-type boilers. The plant was abandoned and replaced by a new plant, Building 773,

containing two boilers with a total capacity of 16,000 pounds per hour. The new plant provides service to the old hospital buildings, which is currently used by CNTECHTRA.

The NRMC, Building H-100, has its own steam plant within the building which consist of three boilers with a total capacity of 36,000 pounds per hour.

5.11 AIR CONDITIONING AND REFRIGERATION SHOPS.

5.11.1 Public Works Department (PWD). The Public Works Department maintains an air-conditioning and refrigeration shop in Building S-184. Shop personnel are responsible for maintenance of small, on-base air-conditioning and refrigeration units. Maintenance of the large air-conditioning and cooling towers is handled by a contract service agreement.

Primary wastes, generated by the shop, are acid solution used to clean compressor coils and waste oil drained from the compressors. The coils are cleaned yearly with a sulfuric acid solution, to remove build-up which causes plugging of the coils. The used solution is neutralized and discharged to the sanitary sewer system. Oil, drained from compressors, is collected from the units and taken to the oil storage tank at the Transportation Shop for off-base disposal.

5.11.2 Naval Air Technical Training Center (NATTC). A small refrigeration shop, located in Building S-51, is used in conjunction with training operations. Wastes generated include small amounts of Freon, oils, and acids which are disposed of through the Public Works Department.

5.12 BATTERY SHOPS.

5.12.1 Public Works Department (PWD). A small, battery storage area is maintained adjacent to Building S-76. Batteries which provide power to the emergency lighting system are stored in this area. In addition, vehicle-replacement batteries are stored here by the Transportation Department. Since this is, primarily, a storage area, wastes are not generated.

5.12.2 Aircraft Intermediate Maintenance Department (AIMD). The AIMD battery shop provides battery maintenance and repair for the ground support equipment shop, as well as for various aircraft. The primary user of the battery shop is the ground support equipment shop. The battery locker was moved from Building N-126 to Building N-102, in early 1983. An estimated 50 to 60 batteries per month require servicing and charging, and 5 to 8 batteries per month must be replaced. Spent batteries, with electrolyte, are turned in to DPDO for resale. Batteries were reported to have been disposed of through DPDO, at least, since the mid-1950s.

The only waste that has been generated by the battery shop is a small amount of electrolyte, resulting from spillage during filling operations. This electrolyte is washed from the battery top (or the surface on which spilled), neutralized with sodium bicarbonate, and flushed down the sink

drain into the sanitary sewer. Since electrolyte is not normally removed from any of the batteries before disposal, only small quantities of acid are generated.

5.12.3 Naval Air Technical Training Center (NATTC). NATTC operates a school for the maintenance of aircraft ground support equipment. The only battery shop utilized by the school is for ground support equipment. The small amount of waste electrolyte generated by the battery shop is neutralized with sodium bicarbonate, prior to discharge into the sanitary sewer. Due to the few ground support vehicles, use of this battery shop and generation of waste is minimal.

5.12.4. Construction Battalion Unit-404 (CBU-404). CBU-404 maintains a small battery shop in the corner of A Company Maintenance Shop. Only thirty-one vehicles are assigned to the battalion; battery maintenance performed is for those vehicles. Electrolyte is turned in with the batteries, to the property disposal office. The small amount of electrolyte spillage is simply washed to the ground.

In 1982, a pit was dug and filled with limestone gravel in anticipation of the disposal of battery electrolyte. For environmental considerations, the pit was never used and was filled with dirt, a short time later.

5.13 VEHICLE MAINTENANCE SHOPS.

5.13.1 Public Works Department (PWD). The Public Works Department operates a vehicle maintenace shop in Building S-9 (since 1943) which is responsible for normal maintenance and repair of vehicles used at the facility. Wastes generated at this shop include spent oils, battery acid, and cleaning solvents. All of the materials generated at the shop are collected and transported from NAS Memphis for reuse or disposal. Since approximately 1978, all oils from vehicles and shop areas within the PWD have been stored in a 500-gallon tank, until adequate quantities are generated for pick-up. The tank is pumped out two or three times annually. Prior to 1978, quantities generated were in the same range (1,000-1,500 gallons), but the waste oil generated was collected in 55-gallon drums, for disposal. Selling of waste oil dates back at least 20 years. However, some of the oils generated were spread on roads for dust control, during summer, until 1970. Battery electrolytes and solvents are also stored in 55-gallon drums, until adequate quantities are on hand for pickup. Since 1980, batteries and drained electrolytes have been picked up at the transportation yard by an off-base contractor. Between 120 to 150 batteries are replaced by the shop, annually. Prior to 1980, batteries were transported to the DPDO yard for storage, prior to disposal. The practice of disposal through the DPDO yard, reportedly, dates back to the 1950s.

5.13.2 Aircraft Intermediate Maintenance Department (AIMD). A maintenance shop is located in Building N-102 for the ground support equipment (GSE) utilized by AIMD. Wastes generated by the shop include spent engine and hydraulic oils, cleaning solvents, mineral spirits, and other compounds, normally associated with vehicle maintenance.

Spent oils and chemicals are segregated and are stored in drums outside the shop. When drums are filled, the Public Works Department coordinates removal by a contractor to an approved off-site facility.

5.13.3 Naval Air Technical Training Center (NATTC). A series of vehicle repair and maintenance shops are located in buildings S-228 through S-231. These shops use small amounts of dry-cleaning solvent and carbon-removing compounds in teaching students proper methods of maintaining ground support equipment and other engines utilized by the Navy. Less than ten gallons of waste solvent are generated each month, by the various maintenance shops. The spent solvents generated by the shops are stored in 55-gallon drums outside the buildings, until disposal by an off-site contractor.

5.13.4 Construction Battalion Unit (CBU-404). A vehicle/heavy equipment shop is located in Building S-344, for maintaining vehicles and equipment assigned to the unit. This shop generates the usual wastes expected from an organizational shop, including mineral spirits used for degreasing, hydraulic and engine oils, scrap metal, rubber, and other parts from the equipment. Waste oils are collected by the fuels branch for consolidation with oil from other facility waste generators and subsequent resale. Non-hazardous solid waste is picked up by a contractor and transported to the Shelby County Landfill.

5.13.5 Other Shops. Other vehicle maintenance shops include the auto hobby shop, in Building N-114, operated by the Recreation Department, and the Navy Exchange Service Station, located at Building 341. These two shops are primarily for automobile servicing and the major waste generated is waste oil and lubricants. Waste oils from each of these shops are collected in drums and then consolidated with oil from the rest of the facility for resale. No other potentially-hazardous wastes are generated by either the service station or the auto hobby shop.

5.14 FIRE FIGHTING TRAINING. The Fire Fighting School is operated by NATTC to train naval personnel in the proper techniques of extinguishing fires, related to aviation. The training area consists of three small concrete pits and two large mats. JP-4 is used to sustain fire in each of the areas.

Approximately 300 students are trained each year and approximately 1,800 gallons of JP-4 are required for operation. The fuel is delivered by the Fuels Branch and stored on-site in one of the four underground tanks (one 5,000-gallon tank and three 2,000-gallon tanks. Each time a fire is needed, the required volume of fuel is pumped via underground lines to the appropriate pit or mat.

The small concrete pits are used for practice with hand-held fire extinguishers. For each class (10 to 15 students), approximately 40 gallons of fuel is poured into the pit and ignited. After each student has extinguished the fire, it is re-ignited. The process is repeated until all fuel is burned out. Any fuel remaining at the end of the class period is allowed to burn out.

The large mats are diked containers with a simulated cockpit in the center. Large fires are put out with a mixture of foam and water to provide

practice with large-scale equipment and fire trucks. The water that accumulates in the pit (from fire fighting and rain water) is run through an oil-water separator before piped discharge into the sanitary sewer. The JP-4 collected in the separator is stored in a small tank before being recycled to start other fires.

Since waste fuel and oil is not generated and the water is discharged to the sanitary sewer, the major chance for contamination is from overflow of the oil-water separator. In the event that the oil-water separator overflows and the storm sewer is flooded, a surface discharge results. This surface discharge would be contaminated with fuel which could affect the environment.

5.15 MEDICAL AND DENTAL FACILITIES. The Naval Regional Medical Center (NRMC) Memphis provides medical and dental care to eligible naval personnel and beneficiaries, as well as to eligible civil service beneficiaries. NRMC consists of the main, 230-bed, Medical Hospital and Center, and the South Complex Branch Clinic, which contains medical and dental facilities.

5.15.1 Medical. The NRMC Hospital provides a range of medical services including general surgery, family practice, obstetrics and gynecology, psychiatry, physical therapy, and emergency medical service. Facilities include a radioisotope laboratory, X-ray machines, and clinical and anatomic pathology labs. Outpatient clinics are at the hospital and at the Branch Medical Clinic (Bldg. 771). None of the current waste management practices represent a hazard or even a potential health and safety or environmental risk.

Low-level radioactive wastes generated by the Radioisotope Laboratory and by the Nuclear Medicine Department are stored on-site, until no longer radioactive, and then disposed of in the Shelby County Landfill (see Section 6.10). Pathological wastes from pathology laboratories, the morgue, and from treatment of infected or isolated patients are incinerated in a natural gas-fired pathological waste incinerator located in the basement of the hospital. The incinerator ash is stored in cans until sent to the county landfill.

Approximately 1,800 gallons of spent photographic fixer solutions from the hospital and clinic X-ray labs are generated every year. The solution is processed through silver recovery cartridges attached to the developing equipment, and the treated solution is discharged to the sanitary sewer system. The reclaimed silver is turned over to DPDO for resale. Non-hazardous solid wastes from hospital operation and wet garbage from the food service are disposed of by contractors at the Shelby County Landfill. Greases are sent to a rendering company. Sanitary waste from the hospital and the clinic are processed by the NAS Memphis sewage treatment plant.

From 1944 to 1972, major medical services were housed in a 44-unit, 600-bed facility, just east of the existing NRMC. Low-level radioactive wastes were generated by the old hospital in small quantities, just as now. During the last few years of the old hospital's operation, it is likely that these wastes were treated in much the same fashion as they are today, but it is possible that some dry, contaminated wastes, i.e., used syringes, lead containers, could have been deposited in the landfill on the southeast

corner of NAS Memphis. Since the isotope used in the late 1960s with the longest half-life (270 days) was Cobalt^{57}, any radioactive waste deposited in the landfill would not be detectable now.

All types of pathological wastes from the old hospital and remains from the morgue were burned in an old, locomotive-type (Kewanee), brick-lined boiler (Building E-11). Little or no boiler ash required disposal, and fly ash emissions from the boiler stack were not controlled. Use of the boiler, which is now being demolished, was discontinued when the new hospital was opened. Before demolition began, all friable asbestos in the boiler building was removed according to EPA specifications.

Spent, photographic fixer solution from the old hospital was processed through silver recovery cartridges for a number of years. The date that these cartridges were first used could not be determined. It is thought that the old films were sent away for silver reclamation processing.

Several dispensaries have been located at various times around NAS Memphis including the main dispensary (Building N-22, now demolished), Building S-61 and possibly Building S-52. The only waste stream which might be of concern is the spent X-ray fixer solution, from film developing at the old main dispensary (Building N-22). This solution was not processed for silver recovery before being poured down the drain. The pipes underneath the old building site could have a silver coating from the waste solution, but due to their location and state of disuse, the pipes should not pose a hazard to ground water.

5.15.2 Dental. The Dental Clinic is located in Building 771, with the Branch Medical Clinic. It consists of two branches, general dentistry and oral-maxillofacial. The general dentistry program provides preventive dentistry, restorative, prosthetic, endodontic, and periodontic services, all on an outpatient basis. The oral-maxillofacial program deals with oral and maxillofacial pathology, trauma, and acquired or developmental defects. Spent X-ray fixer solution and amalgam scraps, with Mercury halide (HgX) solution, are two kinds of hazardous wastes generated by the dental service. The waste fixer solution is sent to the hospital X-ray department for processing. Amalgam waste is kept in a stainless steel container, covered with HgX solution for mercury vapor reduction. When full, the containers are transferred to the DPDO. Approximately ten pounds of amalgam scrap and eight gallons of HgX solution are generated, annually, by the Dental Clinic.

At one time, the Dental Clinic was located in Building S-61 or Building S-52. Since it was not possible to determine when silver recovery cartriges were first used in film processing labs at NAS, it must be assumed that some of the silver-containing waste fixer solution was poured down the drain in this building. The amalgam wastes were probably reclaimed by DPDO.

5.16 Water Treatment Plants. Two water treatment plants are currently in use (buildings S-75 and N-78). Both treatment systems provide the same treatment, i.e., chlorination, lime-adjustment, fluorination, and filtration. Backwash from the filtration system is discharged to the sanitary sewer system. The backwash of the filters is accomplished by

flushing clean water through the filters, at a high rate, to remove the material collected from the water during treatment. Backwashing occurs when the head loss reaches an unacceptable level through the filters. The quantity of backwash will not exceed five percent of the water treated. Fluoride drums are washed after they are emptied and taken to DPDO for disposal. Chlorine cylinders utilized for chlorination of the water are handled on an exchange basis. Other wastes generated at the plant are disposed of as normal solid waste.

5.17 AIRCRAFT MAINTENANCE AND SERVICING. Aircraft stationed at NAS Memphis are serviced by AIMD, NATTC, and NARU. AIMD and NARU are responsible for servicing the operational aircraft assigned and NATTC is responsible for training Navy personnel in proper servicing techniques. Each of these organizations generates a variety of waste oils, hydraulic and engine oils, greases and lubricants, and solvents and degreasers. Wastes from each of the organizations are consolidated in drums for disposal or resale.

The largest generator of waste materials is AIMD, followed by NARU. NATTC generates a very small amount, due to the mission of the organization. Large quantities of waste products are not generated by any of these organizations.

CHAPTER 6. MATERIAL HANDLING—STORAGE AND TRANSPORTATION

6.1 INTRODUCTION. NAS Memphis has a variety of material handling areas. Areas such as rubble handling, garbage disposal and normal supply operations have been omitted from this report since those operations are not associated with hazardous materials.

Since the NAS Memphis mission is technical training, large scale industrial operations that require major material storage and transportation are not present at the base. The following sections discuss those operations which may involve the storage and transportation of hazardous material.

6.2 MATERIALS STORAGE: DEFENSE PROPERTY DISPOSAL OFFICE (DPDO). The Defense Property Disposal Office has operated a storage yard on the South Complex since the early 1950s. The disposal yard serves as a temporary holding facility for inert scrap material that is to be disposed by the Memphis DPDO office. Until approximately 1980, batteries generated by the various NAS Memphis activities were stored in the yard and disposed, at least, on an annual basis. Some fluctuation has occurred in the quantity of batteries handled by the yard, but a typical quantity was identified as 40,000-50,000 lb/yr. Since the 1950s, batteries have primarily been received without the battery acid being drained and stored at a designated location within the yard. Reportedly, no hazardous wastes have been stored or maintained at the NAS Memphis DPDO storage area, with the exception of the battery acid and one reported disposal of pesticide material. Materials that may be considered hazardous are stored by the Public Works Department prior to removal off-site. Since the late 1960s, DPDO has hired an outside contractor for on-site pickup and disposal of hazardous waste materials at a permitted off-site facility.

6.3 CHEMICALS AND HAZARDOUS MATERIALS STORAGE. Due to the mission of NAS Memphis (i.e., training), large quantities of chemicals or other hazardous materials are not used in industrial operations or generated by the various shops. The chemicals that are used and the hazardous wastes that are generated are stored in the vicinity of the user or generator. A central storage area does not exist for chemicals or other hazardous materials.

6.4 PETROLEUM, OILS AND LUBRICANTS (POL). The major uses of POL at NAS Memphis are as fuels for steam generation, aviation fuel, and motor vehicles. The types of fuels used and the major storage locations are summarized in Table 6-1. Approximately 15 additional small tanks (capacity less than 1,000 gallons) are used at various locations around the facility for storing fuel for emergency generators.

Prior to 1967, many small fuel oil tanks were located near barracks, residential houses, and other locations around NAS Memphis. These small tanks were used to store heating oil, before natural gas was installed in 1967. As the tanks were taken out of service, the oil was pumped from each tank. Some of the tanks were removed, some filled with sand, and some filled with water. No record was found of the locations of these tanks or of any of the present tank conditions.

TABLE 6-1

LOCATION AND CAPACITY OF POL STORAGE TANKS

TYPE OF FUEL STORED	BUILDING NUMBER	TANK CAPACITY ($x10^3$ GAL)
Steam Generation/ Space Heating Fuel		
No. 2 Fuel Oil	N-1239	100
	N-304	100
	N-3 (1558)	25
	BOQ	18.5
	Staff 1 (E-84)	10
	Staff 2 (E-85)	10
	Hosp 1	12
	Hosp 2	12
	S-599	2
	S-89	2
	N-91	3
No. 6 Fuel Oil	S-1 (1557)	100
	S-2 (1556)	100
	S-1240	100
Aviation Fuel		
JP-4	336	420
	337	420
AVGAS	N-303	25
	N-1241	25
AV-LUBE	N-1 (369)	8
	N-2 (370)	8
Vehicle Fuel		
MOGAS	N-1242	15
	N-1243	15
	S-1	8
	S-2	4.5
Diesel	N-301	7.5

Spill Control. A spill prevention, control, and countermeasure plan has been in effect for NAS Memphis since the early 1970s. All ove-ground tanks and loading areas are properly diked to prevent runoff case of spillage. Runoff water from each of the loading areas is passed rough an oil-water separator prior to discharge to the storm sewer tem.

ore oil-water separators were installed at the fuel-loading areas, never the oil-water sludges from the storm tanks were removed, they e simply run out on the ground near the tank. Even though this sludge mostly water, it was common practice to pump from the tank until oil fuel) ran from the pipe. This caused a small amount of oil to be lled on the ground during each de-sludging operation. With the addition the oil-water separators, the sludge was first passed through the arators, the water was discharged, and the oil reclaimed.

le small amounts of fuel and oil spillage are evident by stained areas the ground and have occurred at many of the tank loading areas, no major spills have been recorded since the early 1970s. The only reported lls consisted of five to ten gallons of fuel, inadvertently run on the nd when the hoses were drained during filling operations. Reportedly, several occasions, this oil-filled dirt was loaded and taken to the h Side Landfill.

2 POL Disposal. The Supply Department, Fuels Branch is responsible ribution of fuel oil and motor vehicle fuel, after delivery to the by a contractor. Collection of waste oils and solvents for orary storage, until disposal by sale can be arranged, is also the onsibility of the Fuels Branch. Old 25,000-gallon fuel storage tanks used for waste storage.

r to the time the oil resale was initiated in 1971, waste oil was only used as a road sealant to aid in dust reduction. Reportedly, all red roads surrounding the facility were sprayed for dust control. This tice was discontinued about 1970. Waste oil was also burned in the generation plants until the sale of the waste oil was initiated.

10,000 gallons of waste POL is currently generated at NAS Memphis lly. The annual quantities generated in the past were similar, with occurring in the early 1950s and 1960s. This POL consists of waste le oil, machine cutting oil, hydraulic fluid, petroleum-based asing solvents, and any other oily waste.

PESTICIDE STORAGE. The Public Works Department operates the pest ol program for NAS Memphis. Approximately one year's supply of cides is stored at the Public Works Pest Control Shop (Building). A list of these chemicals and the approximate quantities stored isted in Table 5-1. Building S-355 has been used for pesticide ge, since the early 1950s.

The Pest Control Shop and adjacent buildings have been flooded twice in recent years. In addition to the major floods, moderately heavy rains occasionally cause from one to two inches of water to stand inside Building S-335. Since all materials are stored on shelves above floor level, this flooding doesn't affect materials. Reportedly, no materials have been damaged or lost as a result of flooding.

6.6 POLYCHLORINATED BIPHENYL (PCB) STORAGE. Currently, five in-service transformers at NAS Memphis have been identified as containing PCB. Table 6-2 shows the location of these transformers and the quantity of PCB material in each transformer. Reportedly, all of these transformers are in good condition (no leaks) and only one minor leak has occurred in the past. These transformers are all located on concrete pads.

TABLE 6-2

IN-SERVICE PCB-CONTAINING TRANSFORMERS

IDENTIFICATION NUMBER	LOCATION (BLDG NO.)	VOLUME OF PCB CONTAINING MATERIAL (GALLONS)
G-859869A	H-100	205
G-859869B	H-100	205
37198	H-98	73
MGB-0125	S-769	670
MGB-0124	S-769	760

In addition to the transformers containing PCB, several capacitors around the facility are also known to contain PCB-contaminated oils. These capacitors are presently in service and reportedly in good condition.

Eight out-of-service PCB-containing transformers were stored at NAS Memphis awaiting disposal at the time of the on-site survey. These transformers were stored in the open area to the west of Building S-242 on a concrete pad. The disposal of the transformers had already been scheduled through DPDO. Records indicate that nine 55-gallon drums containing synthetics and PCB were stored in the area, in 1980.

No areas of PCB contamination at NAS Memphis were identified during the survey. In the early days of the facility activity (1942 through 1970), PCB-containing transformer oil was probably mixed with other waste oils, which were spread on the dirt roads on the facility to minimize dust during the summer. Portions of the PCB-containing oil may also have been disposed at the South-Side Landfill. Records indicate efforts to label PCB transformers occurred, at least, as early as 1978.

PCB contamination incident did occur and has been cleaned up. The concrete swimming pools, one at the CPO Club (Building S-191) and the other at the NCO Club (Building S-80), had PCB-contamination problems which resulted from the original asphalt pool liners which were put in around 1945. During the cleanup, all filter media (sand, pea gravel, and rocks) were removed and the liners on pool sides and bottoms were taken out. All of this was placed in sealed 55-gallon drums and stored in the pool at Building S-80. Eventually the drums were shipped out to a hazardous waste disposal area. The pool at Building S-80 was caved in and covered over. The pool at Building S-191 is still empty.

6.7 STORAGE LOTS AND SCRAP YARDS. A drum storage area is located on the South Complex, adjacent to the western boundary of the facility. Drainage from this area is into a major north-south drainage ditch along the western boundary, which ultimately discharges to Big Creek Drainage Canal. This is the same ditch which receives drainage from the PCB transformer storage area. The drum storage area is designated as Building S-175. The only materials stored at the site, at the time of the survey, were hydrofluoric acid and methanol.

NAS Memphis has never had a designated scrap yard (other than the DPDO yard). However, several areas have been used temporarily as scrap yards, during construction and demolition projects. The area currently used for storage of PCB transformers was used for storage of sand and gravel until four to five years ago.

6. MATERIALS AND WASTE TRANSPORTATION. Solid waste generated at the facility is presently transported off-site by contractor personnel. Since the South Side Landfill was closed (1970), all residential and other non-hazardous trash and garbage has been transported to the Shelby County Municipal Landfill. Contractor personnel are responsible for every aspect of waste handling, from pickup at the various generation points, to disposal in the landfill.

Hazardous solid waste is collected at a central point before disposal by a contractor at an approved hazardous waste landfill, located off-base. The Public Works Department is responsible for proper collection, storage, characterization, and container-marking before pickup by the contractor.

6.9 ORDNANCE. As a technical training center, NAS Memphis is not authorized to handle anything larger than Class B ordnance. While practice bombs and inert rockets are loaded on aircraft, on-site, for training purposes, no practice bombing ranges are located at the activity, so no inert bombs or rockets are at NAS Memphis. The only ordnance operation presently located at the facility is one small pistol firing range, which has been used, since the late 1940s, for weapons qualification. A skeet range was also located in the area near the current pistol range location, in the 1950s. A small indoor pistol range has been located on the north side of NAS Memphis, since the late 1940s. A rifle range was also located in the North Complex, in the past. The exact location of the range is unknown and all remains of the range have been removed. No significant hazardous waste generation or disposal was reported from either the past or the present firing range activity.

NAS Memphis has an allocation of less than 60,000 rounds per year of small arms ammunition which includes .45 and .38 caliber, and 00 buckshot. All ammunition for use at NAS Memphis is ordered through the Supply Department. Upon arrival at the facility, personnel at the Armory are notified and pickup and storage of the ammunition is performed by the ordnance personnel. All ammunition is either stored at the Armory, in Building S-159, or in one of the magazines.

Disposal of ordnance materials is accomplished by transportation to Fort Campbell, Kentucky.

6.10 LOW-LEVEL RADIOACTIVE WASTE STORAGE. The radioisotopes used for diagnostic and treatment purposes in the NRMC Hospital are received, stored and dispersed by the Nuclear Medicine Department, on the second floor of NRMC Hospital. Table 6-3 lists the isotopes currently in use and their half-lives. The procedures discussed below have been followed since the new hospital was occupied in 1972.

TABLE 6-3

RADIOISOTOPES CURRENTLY IN USE AT NRMC

ISOTOPE	HALF LIFE
^{123}I	13 hours
^{125}I	60 days
^{131}I	8.05 days
^{99m}Tc	6 hours

The hospital Nuclear Regulatory Commission license allows liquid wastes, containing less than one microcurie of these isotopes, to be dumped into the sanitary sewer system. Most isotopes are received and dispensed in test packages containing individual patient dose quantities of a microcurie or less. Since the isotopes excreted by the patient are in an amount less than a microcurie, they are discharged directly into the sanitary sewer system.

Solid, low-level radioactive waste generated by the MRMC Hospital is in very low quantity and radioactivity. It consists of contaminated packaging, syringes, gloves, and other miscellaneous medical treatment and laboratory equipment. The waste is collected in marked 55-gallon drums and stored in a secure, cement-block room, in the basement of the hospital, for a period of ten half-lives of the longest-lived radioisotopes in each one. At the end of this time, radioactivity in the drums is very low and the drums are disposed of, by permit, in the Shelby County Landfill. The annual volume of low-level radioactive waste generated at NRMC Hospital is approximately three 55-gallon drums.

Radioactive material and waste handling practices at the old hospital are uncertain, but a radiology department existed from the beginning of operation, in 1943. Radioisotopes were used for diagnostic and treatment purposes at least as early as 1967. Table 6-4 lists isotopes known to be used in the old hospital. Isotopes were received and dispensed in individual dose syringes by the Nuclear Medicine Pharmacy or the Radiology Department. Used containers and syringes were collected by the same department for storage and disposal.

TABLE 6-4

RADIOISOTOPES USED AT OLD NRMC

ISOTOPE	USE	HALF LIFE
^{99m}Tc	Brain scan	6 hours
^{198}Au	Liver scan	65 hours
^{197}Hg	Kidney scans	65 hours
^{57}Cr	Spleen scans	27.8 days
^{85}Sr	Bone scan	64 days
^{57}Co	Schillings test	270 days
^{131}I	Placental localization	8.05 days
	Lung scans	
	Thyroid therapy	
	Thyroid uptake	

Information on waste handling procedures, in the earlier years of hospital operation, was not available. Repeated attempts were made to find individuals who might have worked in nuclear medicine, but none could be located. Personnel from the old hospital did not report any special procedures or specific low-level radioactive waste handling contracts.

CHAPTER 7. WASTE PROCESSING

7.1 INTRODUCTION. This chapter reviews the various methods of waste processing used at NAS Memphis. Sewage treatment, waste fuel and solvent recycling, incineration, and solid waste disposal are discussed. With the exception of wastewater treatment, very little waste processing is conducted at the facility. Only small amounts of waste products are generated by operations at NAS Memphis, which makes on-site processing of material for re-use or alternate use uneconomical. The processing of waste materials is primarily confined to the collection and storage of material, until transportation off the facility can be accomplished.

7.2 SEWAGE TREATMENT PLANT. A number of modifications of the NAS Memphis wastewater treatment system have occurred throughout its years of operation. During early years (1941-1954), separate wastewater treatment facilities were maintained on the North and South complexes. The North Complex plant was an activated sludge plant, consisting of a settling tank, aeration tank, digester, and final clarifier. Use of the plant was discontinued around 1954, at which time the wastewater from the North Complex was discharged to the South Complex treatment plant. The North Complex plant was then demolished.

The South Complex Treatment Plant, which has been in operation since 1941, consists of an Imhoff tank for primary treatment, followed by two trickling filters, final clarifiers, and chlorination for secondary treatment. Effluent from the treatment plant discharges to Big Creek Drainage Canal under the State of Tennessee National Pollutant Discharge Elimination System (NPDES) Discharge Permit No. TN 0000698. Sludge from the final clarifiers is pumped to the sand drying beds and disposed of (after adequate drying) at the Shelby County Landfill.

For a period starting in 1969, a portion of the wastewater was treated by a two-cell oxidation pond or lagoon, located south of the Big Creek Drainage Canal. Use of the ponds was discontinued in 1978, when the pipeline across the canal collapsed. These lagoons are discussed in Chapter 8.

7.3 WASTE FUEL AND SOLVENT RECYCLING. Waste fuel and solvent recycling has never been conducted on a large scale at NAS Memphis. Fuels, oils, and solvents are reused to whatever extent possible, but once spent, oils and solvents are generally disposed of by a contractor. Those waste materials generated in sufficient quantities are, however, collected for resale by the DPDO. The fire department has used from 55 to 100 gallons per month of waste fuel for training of fire fighting crews, since 1960. Reportedly, some of the waste fuel was burned at the steam plants or incinerators, prior to the 1970s.

7.4 INCINERATORS. Reportedly, incinerators were used for the destruction of pathological waste at NRMC and on the North and South complexes for destruction of classified documents and other paper waste. Ash from each of these incinerators is placed in standard trash cans and disposed of in a sanitary landfill. Currently the ash is disposed of in the Shelby County

landfill; in the past, however, it was disposed of at the South Side Landfill. Only small quantities of ash are generated by these operations.

Pathological waste, infectious waste, surgery room waste, and other contaminated wastes have been incinerated in a natural gas-fired incinerator on the east side of Building 100, since 1972. Access to this incinerator is in the basement. This incinerator was designed to comply with air pollution regulations. Prior to construction of the new hospital in 1972, pathological waste was incinerated in an old locomotive-type boiler located in Building E-11. Other wastes (paper) generated by the old hospital were burned in the incinerator located in Building E-10, but it was abandoned in the 1950s.

A classified document incinerator is currently located behind Building S-75. The incinerator uses natural gas as a fuel source to ensure complete incineration of the classified material being burned. This incinerator was previously located just east of Building N-15 and was designated as Incinerator No. 1579. It provided the same function at this location.

An additional classified documents incinerator, used during the 1960s, was located on the North Complex near the abandoned wastewater treatment plant site. This incinerator has been abandoned and removed and the exact location of the unit is not readily determined.

CHAPTER 8. DISPOSAL SITES AND POTENTIALLY-CONTAMINATED AREAS

8.1 INTRODUCTION. Each of the sites identified during the Initial Assessment Study are discussed in this chapter. Information was compiled from a combination of personal interviews, record reviews and on-site investigation. Table 8-1 summarizes the sites identified during the survey and gives map coordinates for their location on the 1981 general development maps. Specific information concerning recommendations relating to each of the sites is presented in Chapter 3.

The primary concern for the NAS Memphis area is ground water contamination. Ground water underlying the facility is shallow, the water table ranging from three to nine feet below surface. The shallow ground water of the NAS Memphis region has been shown to be hydraulically-linked to the Memphis Sand, an artesian aquifer used in the area for potable and industrial water supplies. NAS Memphis obtains its water supply from six wells located in this deeper aquifer, within the boundaries of the facility. The city of Millington also obtains its water supply from a well field in the deeper aquifer approximately three-tenths of a mile west of NAS Memphis. The Memphis Sand aquifer is also used by the city of Memphis for a portion of its water needs.

Surface drainage for the entire facility is ultimately to Big Creek Drainage Canal. Although fish were observed in some of the large perimeter drainages, there is no indication that the drainages are suitable for recreational activities. While some of the drainage ditches on NAS Memphis have been used in the past for discard of fluid wastes generated by various shops, no indication that this practice has continued to the present exists.

8.2 SITE 1, FIRE DEPARTMENT DRILL AREA. As shown on Figure 8-1, the Fire Department Drill Area is located in the northwest quadrant of the North Complex, at the end of abandoned Runway 9. The Drill Area consists of a 300-foot-long segment of the 200-foot-wide runway. The asphalt runway is in poor condition (Figure 8-2) and has numerous cracks which have grass growing through them.

The area was used for fire fighting training at a simulated crash site, from 1960 through 1981. The shell of an aircraft situated at the center of the asphalt pad was set on fire with JP-4 or other waste fuel to allow students to practice extinguishing the fire. Training sessions were conducted approximately once per month and 55 to 100 gallons of fuel were used during each session. A tank is located immediately east of the aircraft shell within a containment area constructed of railroad rails. The tank, apparently used to simulate an aircraft cockpit, is elevated on a steel pallet and appears to have been unused for some time. A second tank is located on the northwest side of the asphalt pad and is elevated on a steel stand. This tank has a capacity of approximately 200 gallons and was apparently used for storage of fuel used for the fires. This tank has no containment and it has been out of service for some time.

TABLE 1

DISPOSAL SITES INVESTIGATED AT NAS MEMPHIS

SITE NAME	SITE NUMBER	MAP COORDINATES[a]	PERIOD OF OPERATION	TYPE OF MATERIAL DISPOSED OF	COMMENTS
Fire Department Drill Area	1	64,3L	1960-1981	JP-4 Fuel, other waste fuels	Conducted fire-fighter training, fuel discharged to surface and ignited.
South-Side Landfill	2	40,L	1942-1970	Residential and industrial solid and liquid waste	Primary disposal area for the facility during its period of operation. Trench and fill method of disposal with all burnable material burned prior to covering.
N-121 Plating Shop Dry well	3	50,2X	1953-1965	Concentrated plating solution	Cadmium, chromium, copper and nickel plating conducted.
N-121 Plating Shop Storm Sewer	4	50,2X to 64,2R	1953-1965	Plating solutions spills wash down water	Sediment samples collected from the drainage ditch contained nickel, cadmium and chromium.
Fire-Fighting Training Area	5	68,2R	1949-1977	JP-4	Prior to installation of oil-water separator, unburned fuel occasionally overflowed into drainage ditch.
N-126 Battery Shop Storm Sewer Ditch	6	64,2Z to 60,3D	1955-1981	Liquid waste from battery shop; spills and washdown water	Erosion is evident in the ditch where the storm sewer discharges.

CONTINUED

TABLE 8-1 (Continued)

DISPOSAL SITES INVESTIGATED AT NAS MEMPHIS

SITE NAME	SITE NUMBER	MAP COORDINATES[a]	PERIOD OF OPERATION	TYPE OF MATERIAL DISPOSED OF	COMMENTS
N-126 Plating Shop Dry well	7	58,3B	Mid 1950s	Waste from plating operation	Included cadmium, chromium and nickel plating. Waste sample from dry well contained above metals.
Cemetery Disposal Area	8	46,4J	Unknown	Three canisters of ethylene oxide, all types of wastes from public works shops and some rubble	Exact location of ethylene oxide burial not known, hazardous waste burial sign located in the general area.
Sewage Lagoons	9	54,J	1969-1978	Sludge accumulation	Minimal industrial operations discharged to the treatment facility during period of operation. Contaminants may have built up in bottom sediments.
North-Side Landfill	10	64,2X	1940s-1969	Primarily demolition rubble	Probably receive North Side solid wastes until 1964.
Oiled, Dirt Roads	11	See Comments	1942-1960	Waste Oils	Oils (possibly contaminated with PCB were was spread on roads for dust control.
Galley Disposal	12	60,P	Unknown	Food cans	No evidence of other materials being discarded in the area, apparently not a supervised disposal area.

[a]Referenced to the General Development Map, 1981.

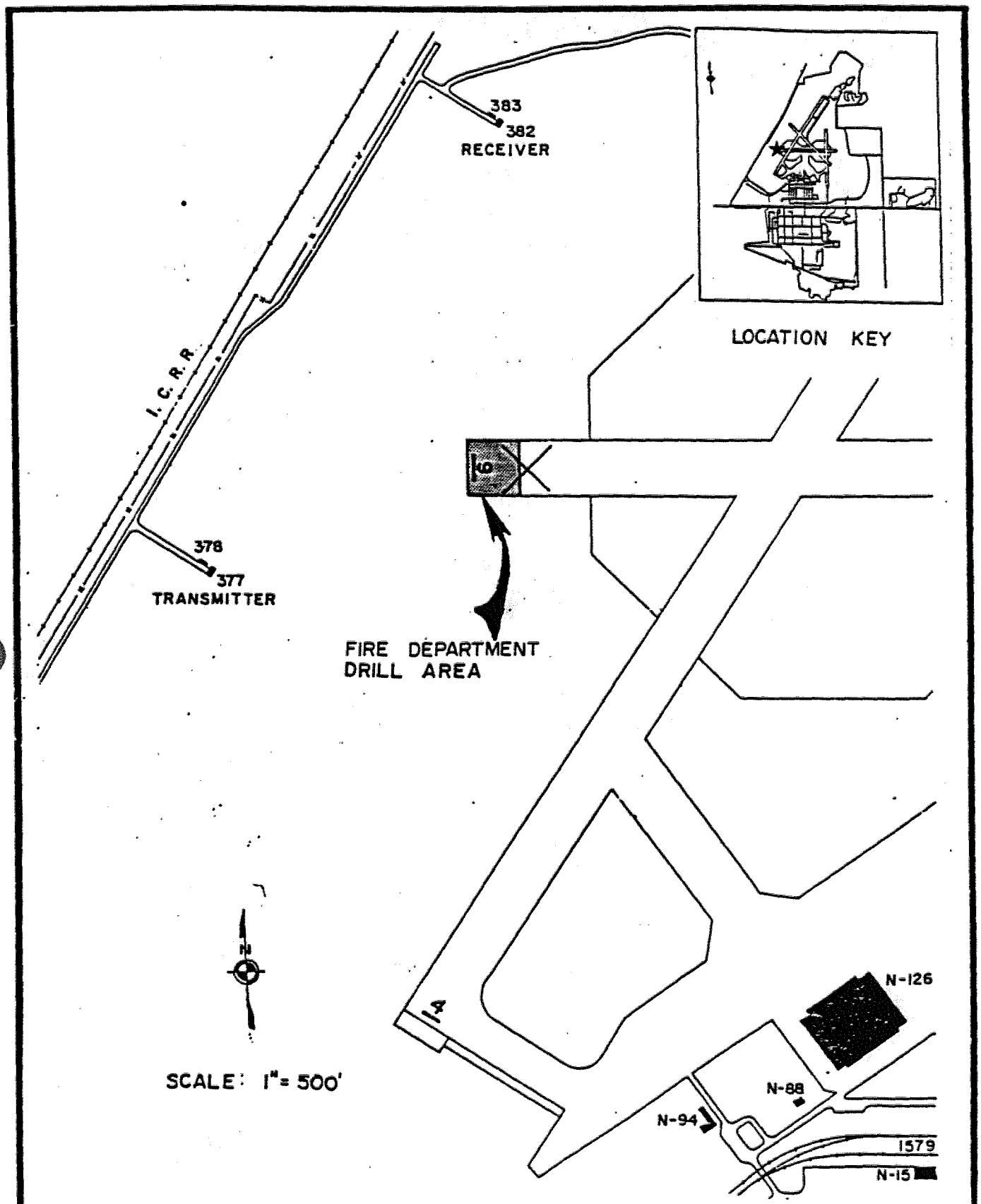

FIGURE 8-1
SITE 1, FIRE DEPARTMENT DRILL AREA

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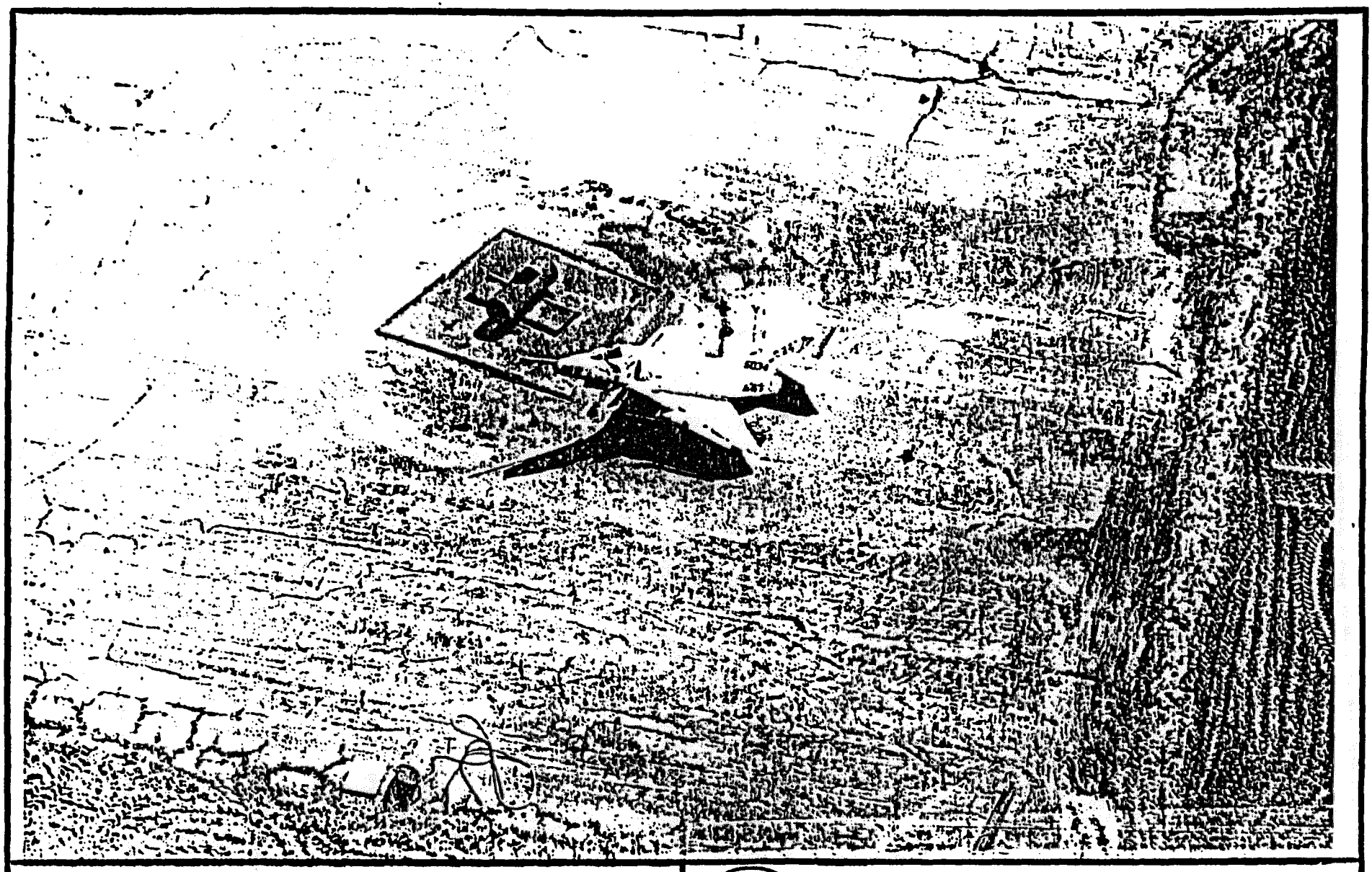

FIGURE 8-2
SITE 1, FIRE DEPARTMENT DRILL AREA PHOTOGRAPH

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NAVAL AIR STATION MEMPHIS

A traverse along Big Creek Drainage Canal adjacent to the landfill indicated only minimal ground water seepage entering the canal above the water line, at the time of the on-site survey. Locally, bank erosion of the canal has proceeded toward the landfill to the point of intersection of the Perimeter Road. Construction debris consisting of metal, reinforcing rods and concrete slabs has been deposited into the eroded areas to slow the erosion process.

During the on-site survey, fragments of asphalt, concrete, metal scrap and plastic debris were found exposed at various locations within this site. With the exception of two empty 55-gallon drums and four empty five-gallon cans, no liquid waste containers were found.

Vegetation within the landfill area does not appear to be stressed, although volunteer pines have not (as might be expected) taken over the site. Numerous ash trees, planted in 1977, appear to be thriving.

Because of the disposal of material that could pose a potential danger to human health if migration to potable ground water sources occur, this site is recommended for confirmation study.

8.4 SITE 3, N-121 PLATING SHOP DRY WELL. Figure 8-4 shows the location of Building N-121 on the North Complex. The dry well is a 4-foot section, of 3-foot diameter concrete pipe, that expands to a 10- by 10- by 6-foot deep pit. According to design blueprints, the pit is filled with 3/4- to 1 1/2-inch diameter gravel.

Building N-121 was constructed in 1953 to house the NATTC Plating School, and it continued to operate there, until 1965, when plating training was discontinued. Small articles were plated to instruct students in proper plating techniques. Three or four tanks (estimated size of 400 to 500 gallons each) were used for cadmium, chromium, copper, and nickel-plating training. Solutions were cyanide based. The amount or type of plating, amount of waste discharge, or even the exact curriculum of the plating school could not be obtained from records or interviews. The total discharge from the plating operation, including concentrated solution, was estimated to be 18,000 gallons per day. This waste was primarily discharged to the storm sewer (Site 4); however, as much as 900 gallons per day could have gone to the dry well.

Design drawings of the building indicate that the dry well received discharge from the concentrated plating baths via a six-inch drain line. The plating solution was allowed to percolate through the gravel and into the soil. A soil sample taken from the top surface of the dry well, during the on-site survey, indicated nickel was present at 3,200 ppm, cadmium at 250 ppm, and chromium at 180 ppm (all concentrations are total metals). The extent of the high metal concentrations in and below the pit is unknown.

Because there is the potential for metal contamination in the dry well to migrate to the potable water supply aquifer, confirmation study is recommended for this site.

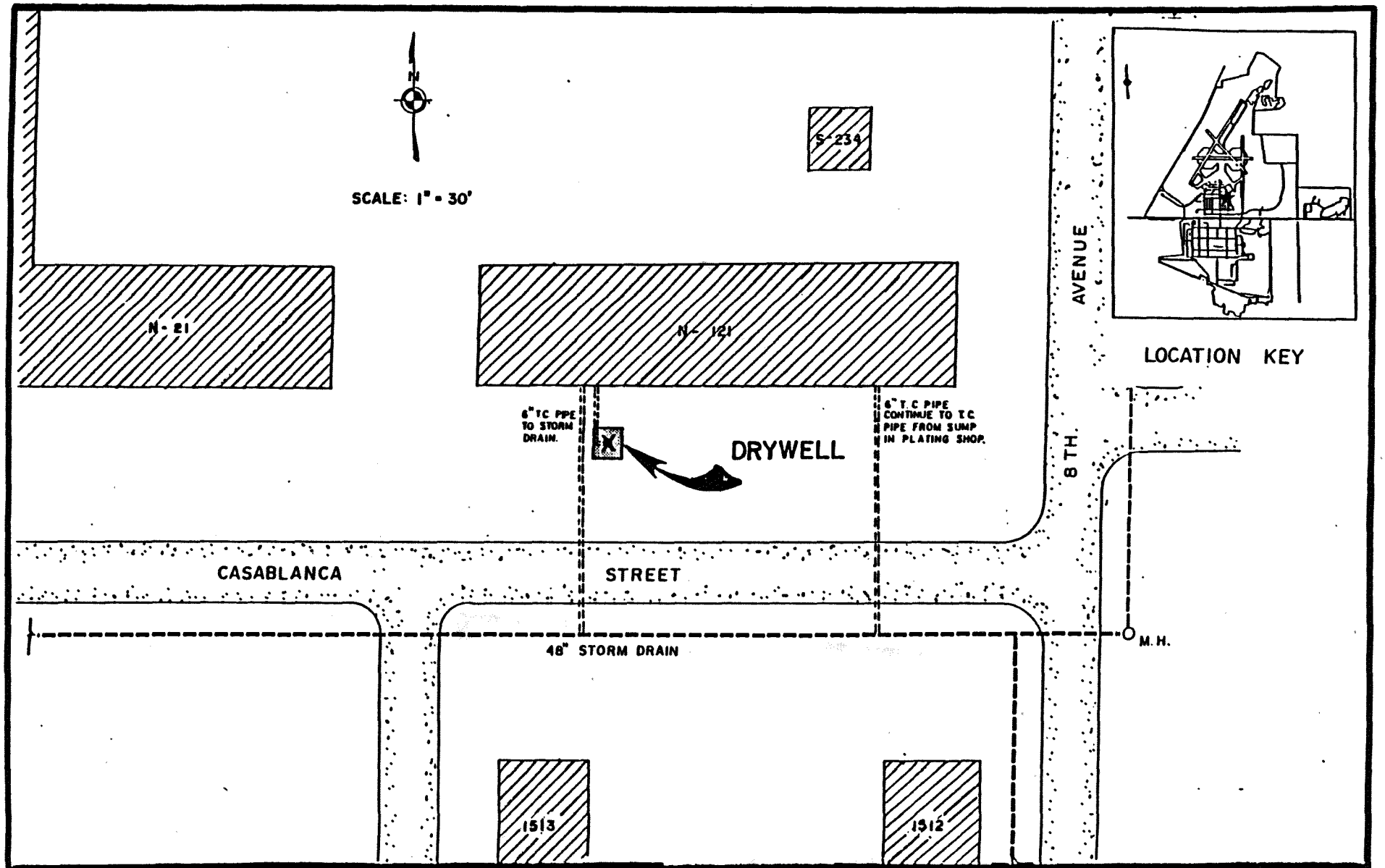

FIGURE 8-4
SITE 3, N-121 PLATING SHOP DRY WELL

INITIAL ASSESSMENT STUDY
NAVAL AIR STATION MEMPHIS

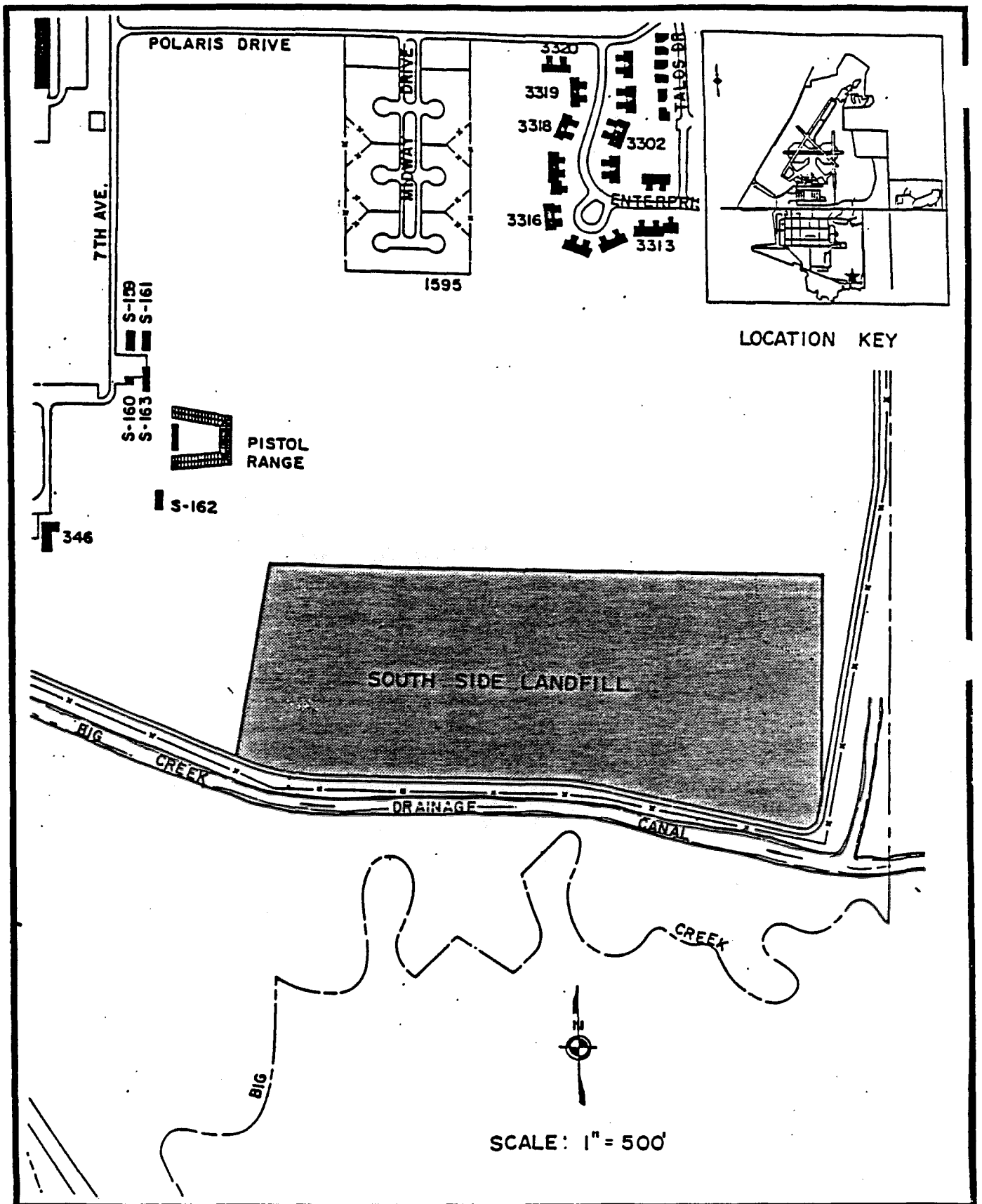

FIGURE 8-3
SITE 2, SOUTH
SIDE LANDFILL

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STATION MEMPHIS

Drainage from the site is in a southwesterly direction, to a point approximately 800 feet west of the site, where the drainage is collected by a north-south drainage ditch near the western perimeter of NAS Memphis. The ditch discharges into North Fork Creek.

The site is bounded on the northwest, southwest and southeast sides by recently-tilled land, and on the northeast side by grass adjacent to Runway 4. The soils surrounding the burning pad are alluvium, of undeterminable
age, characterized by unsorted rounded pebbles and cobbles in a matrix of brown, loamy soil. The soil surrounding the asphalt does not appear to be oil-contaminated nor is any contamination evident on the asphalt.

Due to the limited usage of the site, the small quantities of fuel used and the absence of evidence of contamination, confirmation study is not recommended for the site.

8.3 SITE 2, SOUTH SIDE LANDFILL. The South Side Landfill is located in the southeast quadrant of the South Complex, immediately north of the Big Creek Drainage Canal. Figure 8-3 shows that the landfill is bounded on the south by Perimeter Road and the levy that constrains flood-stage waters in Big Creek Drainage Canal. On-site survey and review of available photographs indicate that landfill expansion was in a westerly direction from its opening in 1942, until 1970, when it was closed. The total area affected was approximately 42 acres.

Reportedly, this site was used for disposal of solid waste generated on both the North and South complexes, until 1970, when transportation of solid waste off-station began. Waste disposed of at the site included residential waste generated by NAS Memphis housing, office solid waste, aircraft parts generated by maintenance activities, wastewater treatment plant sludges generated by the trickling filter plant, ash from incinerators, waste oils, oily sludges, and solvents generated by industrial operations. No records were maintained for quantities of materials disposed, but estimates based on the level of activity indicate oily waste and oily sludges did not exceed one ton per year. Sludges generated by the wastewater treatment plant are estimated to be approximately two tons per year on an average basis.

The disposal procedure used at the site was the trench-and-cover method. Combustible material disposed of at the site was burned before covering. Waste oil was used in some cases to aid in the burning process. Since there was no concern for PCB in the past, it is possible that some of these oils and the previously mentioned waste oil and sludges were PCB-contaminated. In addition to the possibility of PCB contamination, waste solvents were also frequently mixed with waste oils and may have been included in the oils disposed at the landfill.

The landfill site accepts drainage from the east and north, and generally drains to the south and west. Portions of the site appear to have a very shallow water table throughout much of the year. During the on-site survey, approximately one-half acre in the western portion of the landfill was covered by standing water which appears to be trapped by the levy along Big Creek Drainage Canal.

Small areas in the fire-pit training vicinity appear to exhibit signs of previous oil spills: dead vegetation over areas of a few square feet and gray, greasy-looking soil. These areas appear to be only surface contamination with minimal environmental impact. Shallow soil borings taken during the on-site survey, adjacent to area drainage ditches and around the perimeter of the site, disclosed no visible hydrocarbon contamination.

The two large circular pits located immediately south of the rectangular pits are used to simulate rescue of a pilot from a downed, burning aircraft. The pits are filled with JP-4 fuel and ignited. Student fire fighters extinguish the fire andrescue a dummy pilot. The fuel for burning is stored in an underground tank east of the easternmost circular burning pit.

An oil-water separator was installed at the fire fighting training area in 1977. Prior to this time, the water/oil/foam mixture from the pits was discharged directly to a storm drainage ditch, north of the site. Several explosions occurred in the drain line from the ignition of unburned JP-4 fuel in the lines, after the installation of the oil-water separator. The explosions were eliminated by modification of operational procedures. One oil spill of approximately 50 gallons was reported in September 1980, after the installation of the oil-water separator. This spill resulted from the malfunction of the drain line. It was cleaned up and no environmental impact was evident.

Surface drainage from the fire fighting training area flows into a series of open trenches and underground culverts running to the north, into a southwest-flowing drainage ditch that intersects North Fork Creek. Drainage around the perimeter of the training area is to the east, west, and north into artificially constructed ditches, that ultimately flow into the main southwest-flowing ditch, discharging to North Fork Creek.

Material generated at the site was discharged to the storm drainage ditch north of the site, prior to installation of the oil/water separator. Due to the small quantities discharged and no evidence of environmental contamination at the site, confirmation study is not recommended.

8.7 SITE 6, N-126 BATTERY SHOP STORM SEWER AND DITCH. The storm sewer located north of Building N-126 received acid waste generated by the AIMD battery shop, in Building N-126, between 1955 and 1981. As indicated on Figure 8-8, the storm sewer transported the waste to an open drainage ditch, which ultimately discharges to North Fork Creek. On-site inspection of the drainage ditch, at the mouth of the discharge pipe, revealed that erosion has occurred along the sides and bottom of the 10-foot-deep ditch.

Interviews with personnel and record reviews indicated that waste generated was battery electrolyte spillage and drippings. In recent years, the waste was neutralized with sodium bicarbonate. Records and interviews indicated that quantities of electrolyte disposed of down the drain were small. Although no records were maintained for waste discharged, current activities would indicate approximately 100 to 200 gallons per year were discharged.

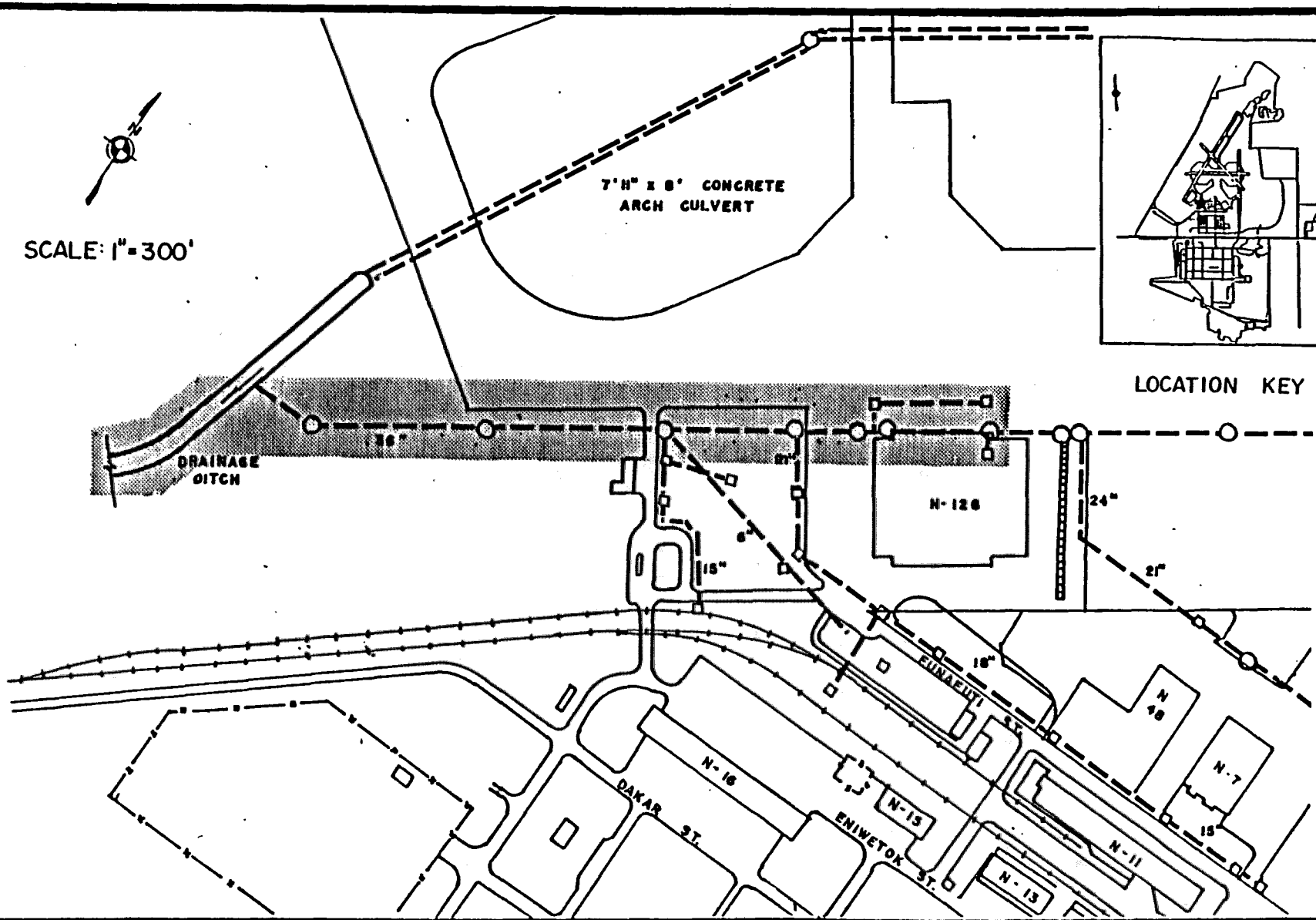

FIGURE 8-8
SITE 6, N-126 BATTERY SHOP STORM SEWER AND DITCH

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As a result of the large volume of water drained during rain storms, residual contamination from the discharge at Building N-126 is not expected. Sediment accumulation was not observed at any point in the ditch, downstream of the storm sewer outlet. Sediment collection or contamination, inside the storm-sewer line, is not expected, due to the flushing action of the large amount of water drained through the sewer during rain storms. Therefore, confirmation study is not recommended for this site.

8.8 SITE 7, N-126 PLATING SHOP DRY WELL. As shown in Figure 8-9, Building N-126 is located on the North Complex in the Air Operations area. The dry well is approximately ten- by ten- by six-feet deep and is filled with crushed gravel. The dry well received plating waste from a small plating operation conducted in Building N-126 by AIMD during the mid-1950s. Waste was discharged into the dry well and allowed to percolate through the gravel and into the soil. Although it was not verified by records or personnel interviews, samples indicated that nickel, chromium, and cadmium plating was conducted in this shop.

The plating shop was completely dismantled several years ago and personnel with any knowledge of the operation could not be located. Based on the construction drawings, it was not possible to define the exact operation, either in volume of plating performed or amount of discharge. Apparently the pit was used to percolate all liquid wastes from the plating operation into the soil.

During the site survey, a sample of the sediment was collected from the dry well. Analysis of the sample indicates nickel was present at 32 ppm, cadmium at 1240 ppm, and chromium at 223 ppm (all concentrations are total metals). The extent of the metals contamination in and below the pit is not known.

Due to the presence of metals contamination, that could potentially migrate to the potable water supply aquifer, confirmation study is recommended for this site.

8.9 SITE 8, CEMETERY DISPOSAL AREA. The cemetery disposal area, as indicated by Figure 8-10, is located in the northeast quadrant of the North Complex, adjacent to Runway 22-4 (Map Coordinates 46,4J). The disposal area is bounded on the east side by a northerly-flowing drainage and on the west and northwest by planted pines, approximately ten years old. The Chamberlayne Cemetery, which dates from the early 1800s, is located approximately 500 feet west of the southern end of the disposal area.

The on-site survey identified an area of approximately eight acres as the disposal area. Based on review of available photographs, less area (five acres) was indicated as disturbed. This could indicate that some of the debris noted during the on-site survey was not a result of disposal operations.

The site history records indicate that the only hazardous materials buried in this general area were three 25-pound canisters of ethylene oxide. The exact location of the burial could not be determined, although a sign indicating buried hazardous waste has been erected in the area. Although

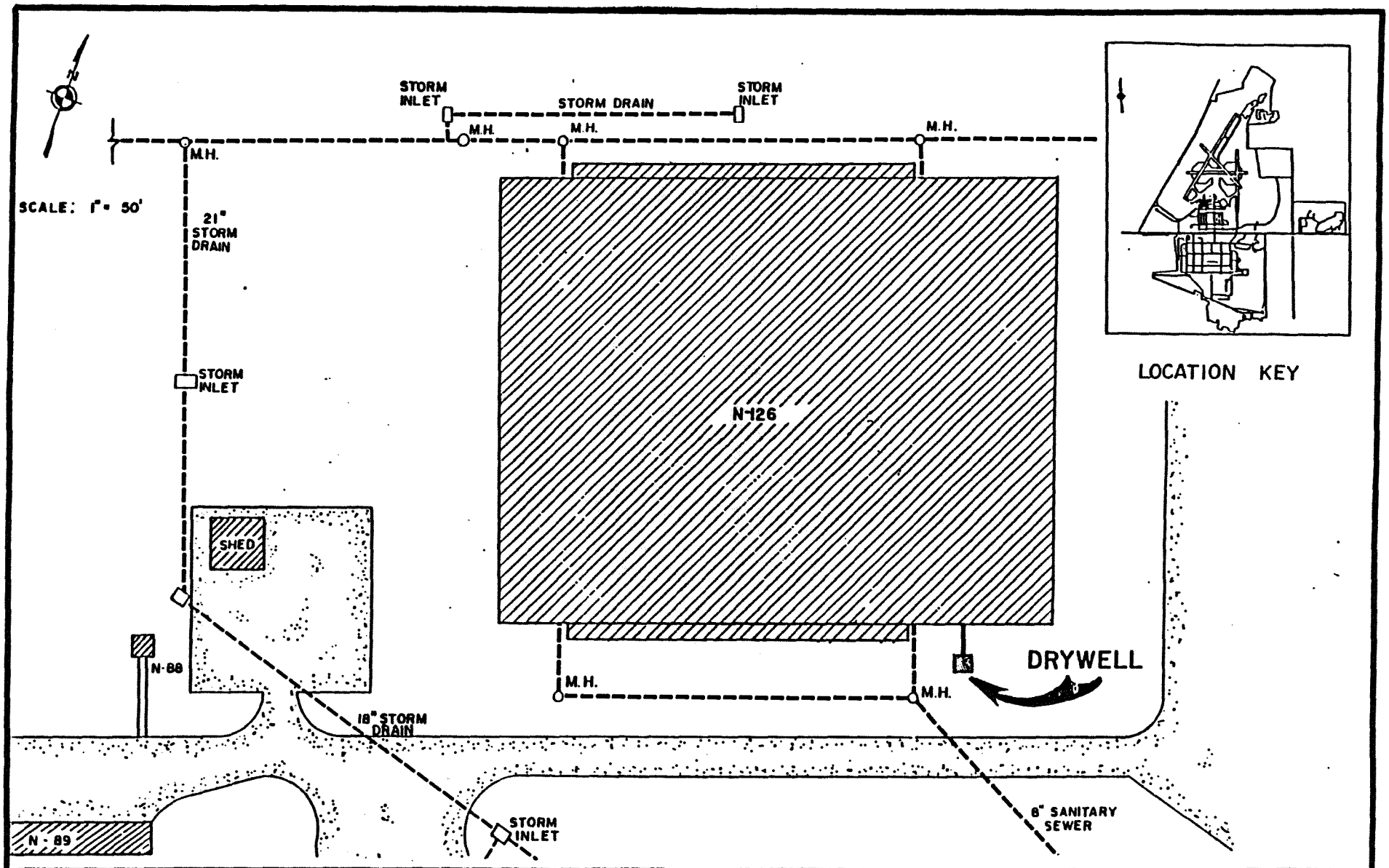

FIGURE 8-9
SITE 7, N-126 PLATING SHOP DRY WELL

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NAVAL AIR STATION MEMPHIS

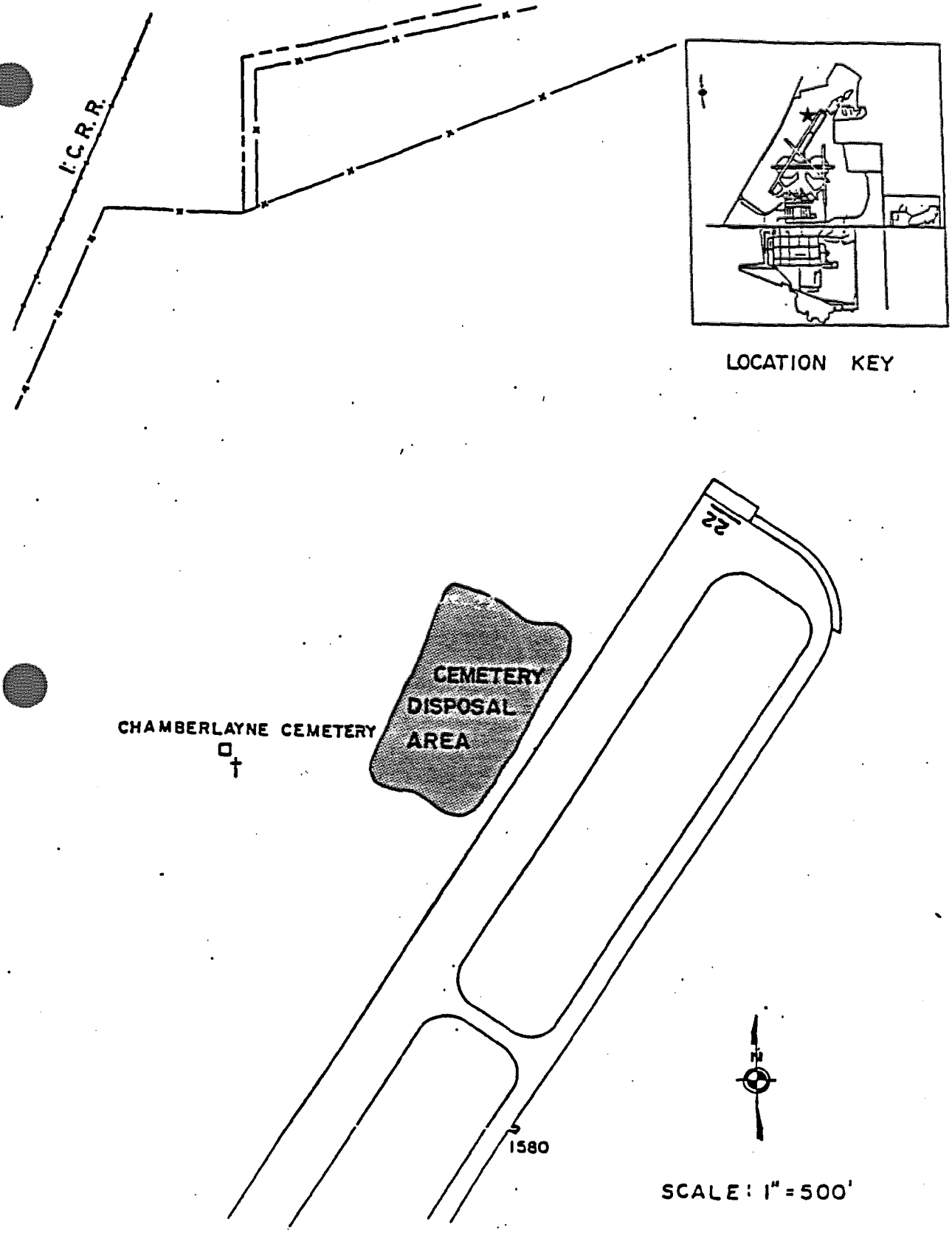

FIGURE 8-10
SITE 8, CEMETERY
DISPOSAL AREA

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STUDY NAVAL AIR
STATION MEMPHIS

this is the only recorded burial of hazardous waste at the site, personnel indicate that all types of waste from the PWD shops were disposed of at the area. These materials may have included metallic scrap, waste chemicals, waste oil, cleaning solutions, and scrap from the electrical shop, which may have included transformers and capacitors. Disposal of "suspicious" chemicals in the area beyond the cemetery has been mentioned. Waste observed at the surface included an old tire, electrical cable, rope, and asphalt rubble.

The site is topographically high (approximately 325 feet MSL) and covered by only sparse vegetation. The surface is disturbed with local terraces and a few areas of low, rounded hills. The vegetation present appears to be healthy, and consists primarily of blackberries, goldenrod, and grasses. Wildlife observed during the on-site survey included rabbits, opossums, and squirrels.

Drainage from the site is in a northerly direction into an intermittent drainage ditch that flows west toward the NAS perimeter. This drainage structure intersects a southerly-flowing tributary of North Fork Creek. Because hazardous materials have reportedly been disposed at the site, and potential exists for migration of the material into the ground water, confirmation study is recommended for this site.

8.10 SITE 9, SEWAGE LAGOONS. Two inactive sewage lagoons are located in the extreme southeastern portion of the South Complex between the reservation boundary and Big Creek Drainage Canal. As indicated in Figure 8-11, the lagoon system is made up of two lagoons which occupy approximately 15 acres. Figure 8-12 provides an aerial view of the lagoon system and surrounding area. The west lagoon is approximately square and contains 9.6 acres, and the east lagoon is rectangular and contains 3.2 acres. The discharge structure for the lagoon system is located adjacent to the smaller lagoon.

These lagoons were used as a part of the wastewater treatment facilities for NAS Memphis, from 1969 until 1978, when the pipe-line crossing the Big Creek Drainage Canal collapsed. Prior to 1978, wastewater produced at the facility was split, approximately sixty-five percent to the Trickling Filter Plant and 35 percent to the lagoons. Wastewater generated was primarily of a sanitary nature with limited amounts of industrial type waste generated by such activities as the Aircraft Intermediate Maintenance Department.

Surface drainage around the lagoons is generally to the west and north toward the Big Creek Drainage Canal. The lagoon dikes appear to be in good condition, and no evidence could be found of waters from either lagoon breaching the containment berms. Some erosion of the dike has occurred on the north side of the large lagoon adjacent to Big Creek Drainage Canal. If not controlled, this erosion could eventually affect the integrity of the lagoon.

Aquatic life is abundant in both lagoons. Large numbers of turtles, minnows and frogs were observed during the field investigation. In addition to aquatic life, geese reportedly frequent the lagoons.

Since only limited amounts of industrial wastes were discharged to the lagoons, and the material contained in the lagoons is protected by dikes, no confirmation study is recommended.

8.11 SITE 10, NORTH SIDE LANDFILL. The North Side Landfill is located in the southwest quadrant of the North Complex at Map Coordinates 64,2X. Figure 8-13 indicates the landfill is bounded on the south by Dakar Road and extends in a southwesterly direction approximately 2,000 feet from the end of Runway 4.

This site was reportedly used, in the past, as a general disposal area for demolition materials from buildings and for rubble. In addition, data collected during the on-site survey indicates this landfill probably served as the primary disposal area for all wastes from the North Complex, prior to its consolidation with the South Complex in 1949. Review of available photographs indicates extensive use of the area between 1954 and 1964, with a decrease in activity by 1969.

Limits of the area were identified by field investigation of the general area observed to contain rubble. The area is readily identified due to the existence of exposed debris including asphalt, concrete rubble, broken glass, porcelain tiles, and scrap metal. Due to the absence of adequate soil cover material, only sparse vegetation has taken over portions of the site. Observations during field investigation indicate that construction debris is the most prominent material present at this site. Based on the estimated area and assuming an average fill depth of six feet, an estimated 200,000 cubic yards of material has been deposited into the area.

Even though the landfill, apparently, received all wastes from the North Complex before the functions were consolidated, no record or indication of the disposal of hazardous wastes was found. The operations conducted on the North Complex, during the time that all waste went to the landfill, were such that substantial amounts of hazardous waste were not generated. The only possibility for generation of hazardous waste was small quantities of waste oils, greases, or cleansers from aircraft servicing.

Drainage for the landfill is by natural and constructed drainage ditches that carry the runoff to North Fork Creek. Portions of the landfill are within the floodplain of the creek. Water seepage from the banks of local drainage ditches appears to contain iron, as evidenced by stained soil and debris in the bottom of the ditches. The north boundary of the landfill appears to fall along a major drainage ditch from a point where it discharges under Dakar Road, to the end of the taxiway for Runway 4.

The soils in this area are characterized by rounded pebbles and cobbles and are alluvium of possible Holocene Age. In general, the soils over the fill area appear to be thin and do not sustain vegetative cover well. An area of approximately two acres, which shows fairly recent activity, has little or no vegetation.

During the field investigation, several auger holes (apparently drilled for construction purposes) were found which indicated the water table was within three feet of the surface. This would indicate that portions of the fill area are saturated by shallow ground water during wet seasons.

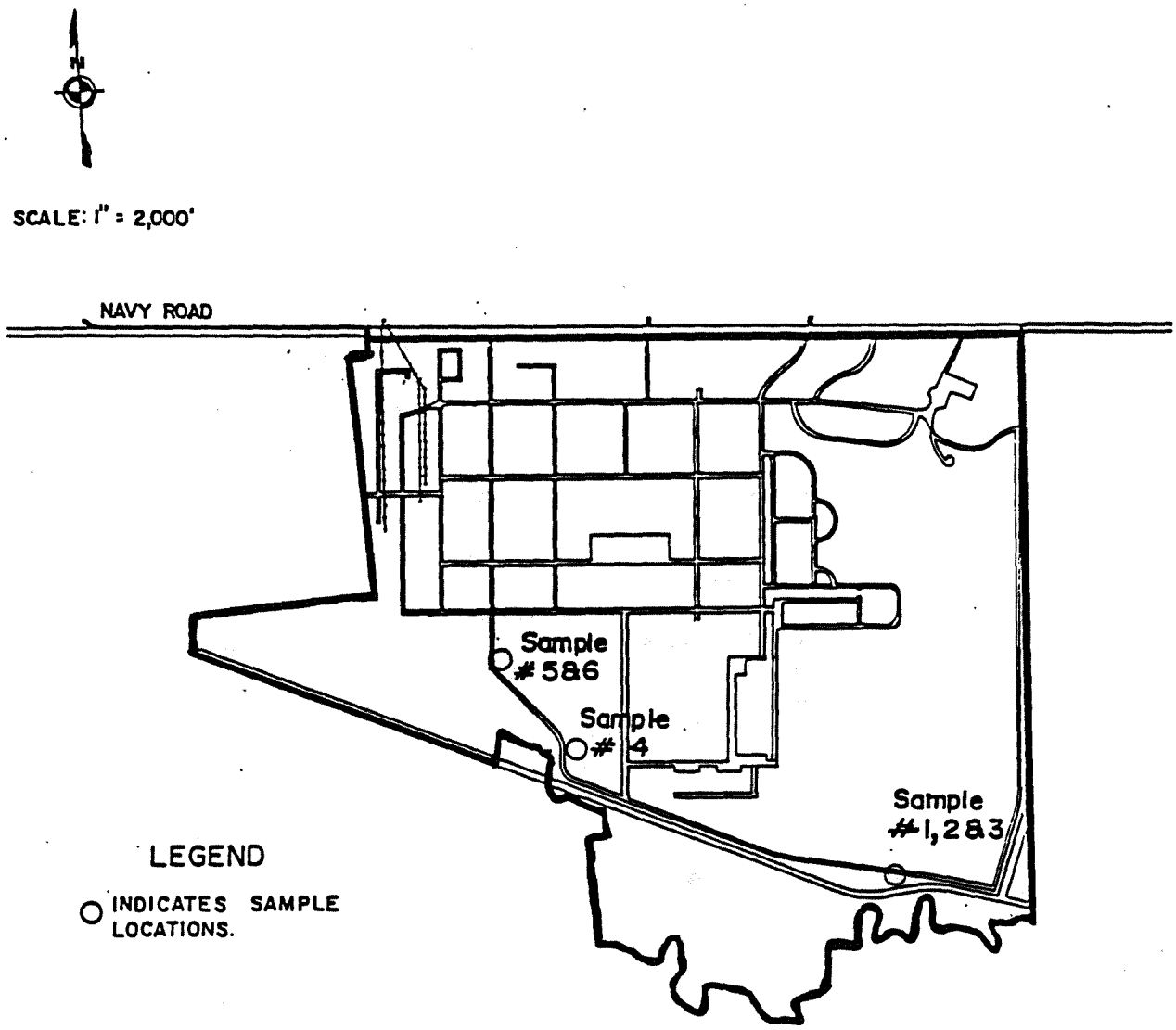

FIGURE 8-14
SITE 11, OILED, DIRT ROADS

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APPENDIX A

AGENCIES CONTACTED DURING STUDY

AGENCIES CONTACTED DURING STUDY

1) Naval Energy & Environmental Support Activity NAVENENVSA, Port Hueneme, Calif.

2) Ordnance Environmental Support Office (OESO), Indian Head, Md.

3) Naval Historical Center, Operation Archives, Building 210-4, Washington Navy Yard, Washington, D.C.

4) National Archives Cartographic Branch, Washington, D.C.

5) National Archives Navy and Old Army Branch. Washington, D.C.

6) Washington National Records Center, GSA Records Branch, Suitland, Md.

7) Washington National Records Center, GSA Archives Branch, Suitland, Md.

8) Federal Archives & Records Center, East Point, Ga.

9) Naval Facilities Engineering Command Headquarters, Real Estate Branch, Alexandria, Va.

10) Naval Sea System Command, Crystal City, Documents Branch, Alexandria, Va.

11) Naval Sea System Command, Crystal City, Activity Files, Alexandria, Va.

12) DOD Explosives Safety Board, Hoffman Building 1, Alexandria, Va.

13) United States Geological Survey, Reston, Va.

14) United States Environmental Protection Agency Environmental Photographic Interpretation Center, Warrenton, Va.

15) State of Tennessee Department of Public Health, Nashville, Tenn.

16) Southern Division, Naval Facilities Engineering Command, Charleston, S.C.

17) National Audubon Society, New York, N.Y.

18) Department of Conservation, Tennessee Natural Heritage Program, Nashville, Tenn.

APPENDIX B

RARE, ENDANGERED AND THREATENED SPECIES OCCURRING IN SHELBY COUNTY

Rare, Endangered, Threatened Species

Occurring in Shelby County

Scientific Name	Common Name	Status[1]
Birds		
Falco peregrinus	Peregrine Falcon	E/E/E
Grus canadensis	Sandhill Crane	E/D/T
Haliaeetus leucocephalus	Bald Eagle	E/E/E
Aimephila aestivalis	Bachman's Sparrow	*/E/E
Actinia mississippiensis	Mississippi Kite	*/E/E
Pandion haliaetus	Osprey	*/E/E
Accipiter cooperii	Coopers Hawk	*/T/E
Accipiter striatus	Sharp-Skinned Hawk	*/T/E
Botaurus lentiginosus	American Bittern	*/*/E
Rallus elegans	King Rail	*/*/E
Rallus limicola	Virginia Rail	*/*/E
Sterna albifrons	Least Tern	*/*/E
Tyto alba	Barn Owl	*/D/E
Ammodramus savannarum	Grasshopper Sparrow	*/T/T
Circus cyaneus	Marsh Hawk	*/T/S
Nycticorax nycticorax	Black-Crowned Night Heron	*/T/T
Thryomanes bewickii	Bewicks Wren	*/T/T
Ardea herodias	Great Blue Heron	*/D/T
Gallinula chloropus	Common Gallinule	*/*/T
Axobrychus exilis	Least Bittern	*/D/T
Nyctanassa violacea	Yellow-Crowned Night Heron	*/*/T
Porphyrula martinica	Purple Gallinule	*/*/T
Riparia riparia	Bank Swallow	*/*/T
Anhinga anhinga	Anhinga	*/D/S
Buteo lineatus	Red-Shouldered Hawk	*/D/S
Casmerodius albus	Great Egret	*/D/S
Cathartes aura	Turkey Vulture	*/D/S
Chondestes grammoeus	Lark Sparrow	*/D/S
Coragyps atratus	Black Vulture	*/D/S
Limnothlypis swainsonii	Swainson's Warbler	*/D/S
Melanerpes erythrocephalus	Red-Headed Woodpecker	*/D/S

[1] Key to Status Listings
Federal/State/Tennessee Heritage Program
- E - endangered
- T - Threatened
- D - in need of management
- * - not listed

Scientific Name	Common Name	Status[1]
Phalacrocorax auritus	Double-Crested Cormorant	*/D/S
Pooecetes gramineus	Vesper Sparrow	*/D/S
Sphyrapicus varius	Yellow-Bellied Sapsucker	*/D/S
Actitis macularin	Spotted Sandpiper	*/*/S
Aegolius acadicus	Saw-Whet Owl	*/*/S
Bubulcus ibis	Cattle Egret	*/*/S
Corvus ossifragus	Fish Crow	*/*/S
Egretta thula	Snowy Egret	*/*/S
Florida caerulea	Little Blue Heron	*/*/S
Fulica americana	American Coot	*/*/S
Nuttallornis borealis	Olive-Sided Flycatcher	*/*/S
Passerculus sandwichensis	Savannah Sparrow	*/*/S
Passerina ciris	Painted Bunting	*/*/S
Podilymbus podiceps	Pied-Billed Grebe	*/*/S
Sturnella neglecta	Western Meadowlark	*/*/S
Vireo bellii	Bell's Vireo	*/*/S
Vireo gilvus	Warbling Virea	
Fishes		
Cycleptus elongatus	Blue sucker	*/T/E
Mammals		
Felis concolor	Cougar	E/E/E
Myotis sodalis	Indiana Bat	E/E/E
Lutra canadensis	River Otter	*/T/T
Myotis grisescans	Gray Bat	E/E/E
Myotis leibii	Small-Footed Bat	*/D/S
Neotoma floridana	Easter Woodrat	*/D/S
Pleotus rafinesqueii	Rafinesques Big-Eared Bat	*/D/S
Sorex longirostus	Southeastern Shrew	*/D/S
Synaptomys cooperi	Southern Bog Lemmimg	*/D/S
Zapus herdsonius	Meadow Jumping Mouse	*/D/S
Gasypus novemcinctus	Nine-Banded Armadillo	*/*/S
Sylvilagus aquaticus	Swamp Rabbit	*/*/S

[1] Key to Status Listings
Federal/State/Tennessee Heritage Program
- E - endangered
- T - Threatened
- D - in need of management
- * - not listed

Scientific Name	Common Name	Status[1]
Reptiles		
Cnemidophorus sexlineatus sexlineatus	Six-Lived Racerunner	*/D/S
Macroclemys temminckii	Alligator Snapping Turtle	*/D/S
Natrix cyclopion cyclopion	Greenwater Snake	*/D/S
Ophisaurus attenuatus longicaudus	Eastern Slender Glass Snake	*/D/S
Amphibians		
Ambystoma talpoideum	Mole Salamander	*/D/S
Mollusks		
(none)		

[1] Key to Status Listings
Federal/State/Tennessee Heritage Program
- E - endangered
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- * - not listed

NACIP Program Confirmation Study, Verification Phase, NAS-Memphis

Prepared for

DEPARTMENT OF THE NAVY
Southern Division,
Naval Facilities
Engineering Command
CHARLESTON, SOUTH CAROLINA

GERAGHTY & MILLER, INC.
GROUND-WATER CONSULTANTS

LANDMARK OFFICE CENTER
14310 N. Dale Mabry Hwy., Ste. 200, Tampa, Florida 33618 (813) 961-15

GERAGHTY & MILLER, INC.

NACIP PROGRAM
CONFIRMATION STUDY,
VERIFICATION PHASE,
NAS-MEMPHIS

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DEPARTMENT OF THE NAVY
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Charleston, South Carolina

November 1985

Prepared by

Geraghty & Miller,Inc.
Ground-Water Consultants
14310 N. Dale Mabry Hwy, Suite 200
Post Office Box 271173
Tampa, Florida 33688

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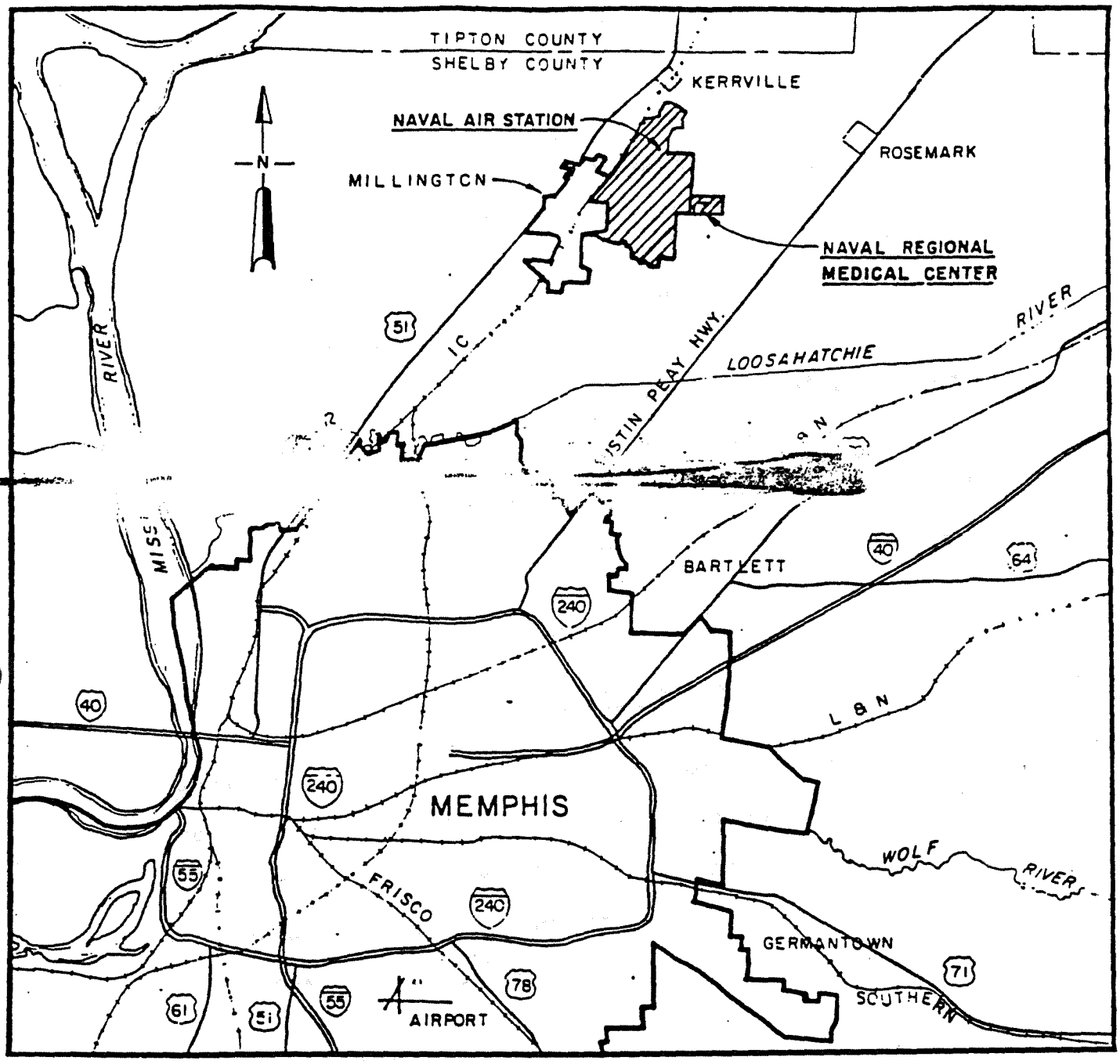
INTRODUCTION

In July 1984, Geraghty & Miller, Inc., (G&M) was retained by the Naval Facilities Engineering Command, Southern Division (Navy) to provide hydrogeologic consulting services at the Naval Air Station (NAS) Memphis, in Millington, Tennessee (see Figure 1). Specifically, G&M was to assist the Navy in the Verification Step of the Confirmation Phase of the Navy Assessment and Control of Installation Pollutants (NACIP) program. This program is designed to identify contamination of Navy lands resulting from the past operations and to institute corrective measures as needed.

The NACIP program consists of three phases. The first phase is the Initial Assessment Study (IAS) which utilizes record searches and personal interviews to collect and evaluate all evidence supporting the existence of a contamination problem at an installation. The second phase, the Confirmation Study, involves on-site investigations to confirm or refute the existence of contamination, and to quantify the extent of the problem if contamination is present. The third and final phase is the implementation of corrective actions and remedial measures to control or mitigate the contamination.

The Confirmation Study consists of two parts, verification and characterization. During verification, the presence or absence of potential contaminants in ground water



0 1 2 3 4 MILES
SCALE

Figure 1. Map Showing the Regional Location of NAS Memphis.

at each of the sites recommended for study in the IAS is assessed. Based on these findings, the characterization phase is initiated in order to determine the nature and extent of contamination at sites requiring additional study.

The results of the verification study and recommendations for further characterization at selected sites is presented in this report. The locations of the six (6) sites studied are shown in Figure 2; the site identification numbering system used in the IAS report has been retained for this report. Each individual site, along with sample locations, are shown in Figures 7 through 13.

BACKGROUND

Project Setting

NAS Memphis is located in Millington, Tennessee approximately 20 miles northeast of the City of Memphis and 13 miles east of the Mississippi River. The facility is bordered on the west and south by the City of Millington and the north and east by agricultural and residential areas.

The source of potable water for both NAS Memphis and the City of Millington is the Memphis Sand, the top of which lies at a depth of approximately 400 ft (feet) below land surface. The NAS Memphis supply wells are all located on base property and the city supply wells are located approximately 0.3 miles west of NAS Memphis. The location of each water supply well at NAS is presented in Figure 3. Reportedly, the existing

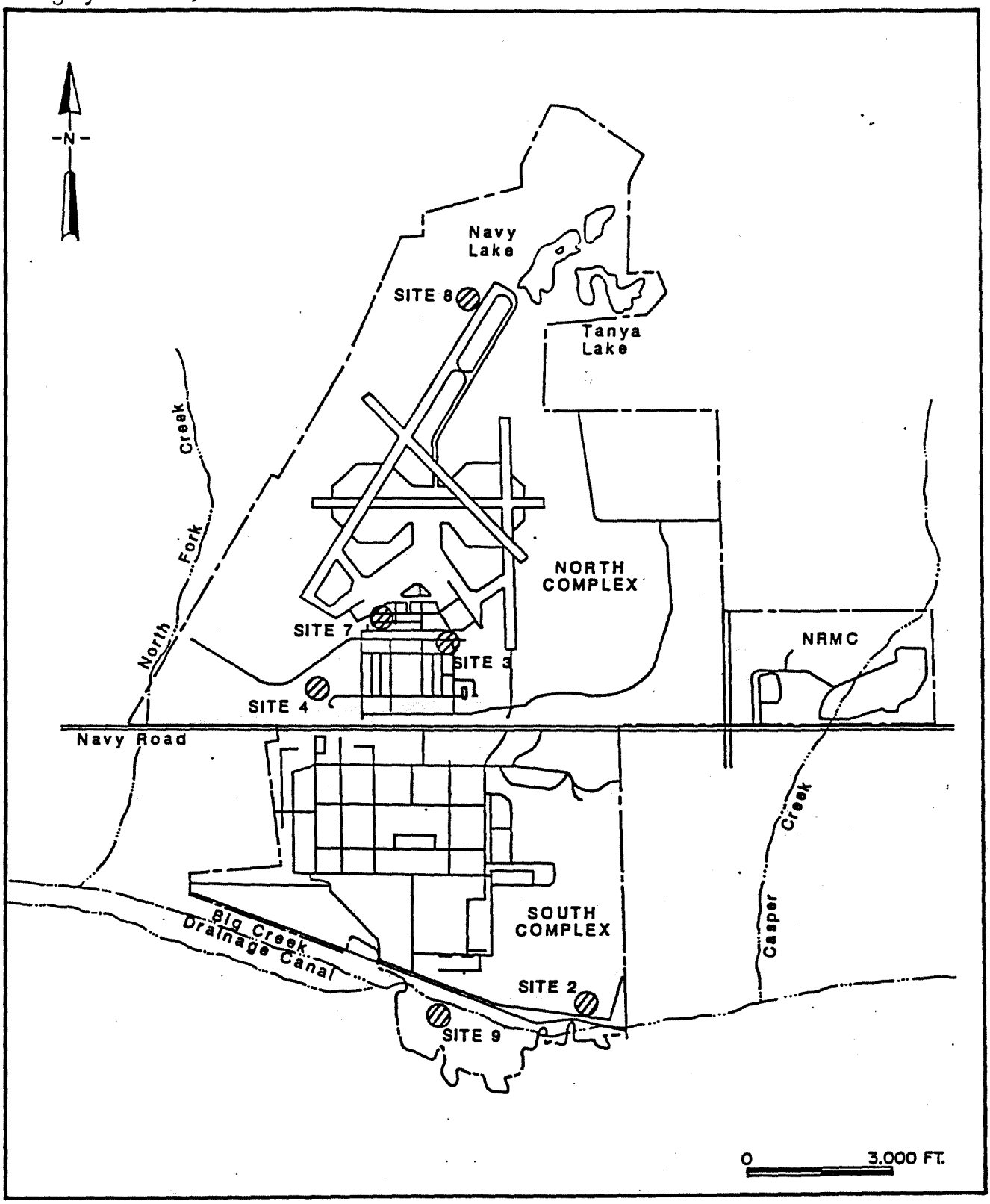
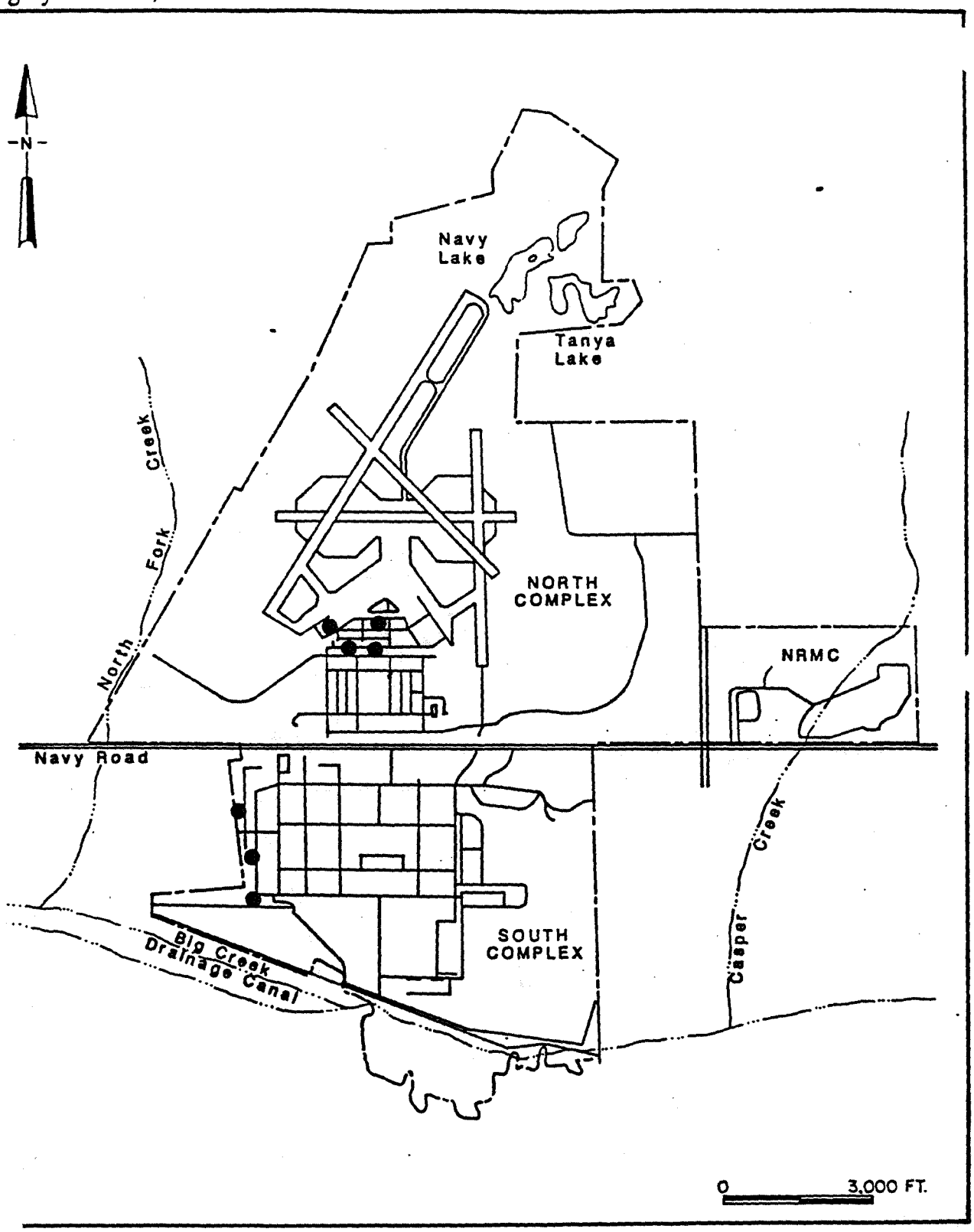


Figure 2. Location of the Six Sites Studied During the Verification Phase.



ure 3. Locations of On-Site Potable Water Wells.

supply wells penetrate a depth that ranges from 345 ft to 523 ft below land surface. The shallow ground-water system generally has relatively high levels of iron; however,occasionally it is tapped for small-capacity domestic wells.

Site Studied

Since it was commissioned in 1942, the mission of the NAS has been to provide services and material to support operations of aviation activities, units of the Naval Education and Training Command, and other activities and units as designated by the Chief of Naval Operations. In support of these activities, some hazardous wastes have been generated.

The IAS, which was conducted during 1983, recommended that confirmation studies be conducted at five sites; Sites 2,3,4,7 and 8. One other site (Site 9, Sewage Lagoons) was also included in this verification study due to the proposed use of these lagoons for recreational activities, such as fishing. After the initiation of the Verification Study, the Navy decided not to use the lagoons for recreational purposes. The historical and current status of each site is summarized in Table 1.

Work Performed

In January 1984 a review was undertaken of historic and geologic information available for the disposal areas. Site

TABLE 1

SUMMARY OF THE HISTORICAL AND CURRENT STATUS OF EACH SITE

SITE NO.	IDENTIFIED BY	VERIFICATION RECOMMENDED BY	CHARACTERIZATION RECOMMENDED BY	STATUS
1	IAS	Not Recommended	Not Recommended	Inactive
2	IAS	IAS	Not Recommended	Inactive
3	IAS	IAS	VS	Characterization
4	IAS	IAS	VS	Characterization
5	IAS	Not Recommended	Not Recommended	Inactive
6	IAS	Not Recommended	Not Recommended	Inactive
7	IAS	IAS	VS	Characterization
8	IAS	IAS	VS	Characterization
9	IAS	NAS Memphis	Not Recommended	Inactive
10	IAS	Not Recommended	Not Recommended	Inactive
11	IAS	Not Recommended	Not Recommended	Inactive
12	IAS	Not Recommended	Not Recommended	Inactive

visits, lithologic logs, aerial photos and maps were employed to determine site geology, expected depth to the water table, and the locations of any fill areas. This information was supplemented by data contained in the IAS, which was completed in November, 1983 in a document entitled "Initial Assessment Study Naval Air Station Memphis, Millington, Tennessee". The field work associated with this confirmation study was conducted in December 1984 and June 1985 and included the items described below.

Monitor Wells

A total of 12 monitor wells were installed at Sites 2,3,7 and 8, the locations of which are shown in the section where each individual site is discussed. The schematic diagram of a typical monitor well is shown in Figure 4, and construction details of each monitor well are presented in Table 1. The method employed to install the monitor wells was either by mud-rotary drilling using a 6-inch-diameter bit or by 6-inch-diameter hollow stem auger without drilling fluid at locations where water was not readily available. The wells were constructed using 2-inch-diameter schedule 40 PVC casing and screen, which were joined by threaded fittings so that no PVC bonding cement was used. Each well was developed by swabbing and air lift pumping until the drilling fluid and fine sediment was removed from the filter pack. The PVC casing is protected at the surface by a 4-inch-square

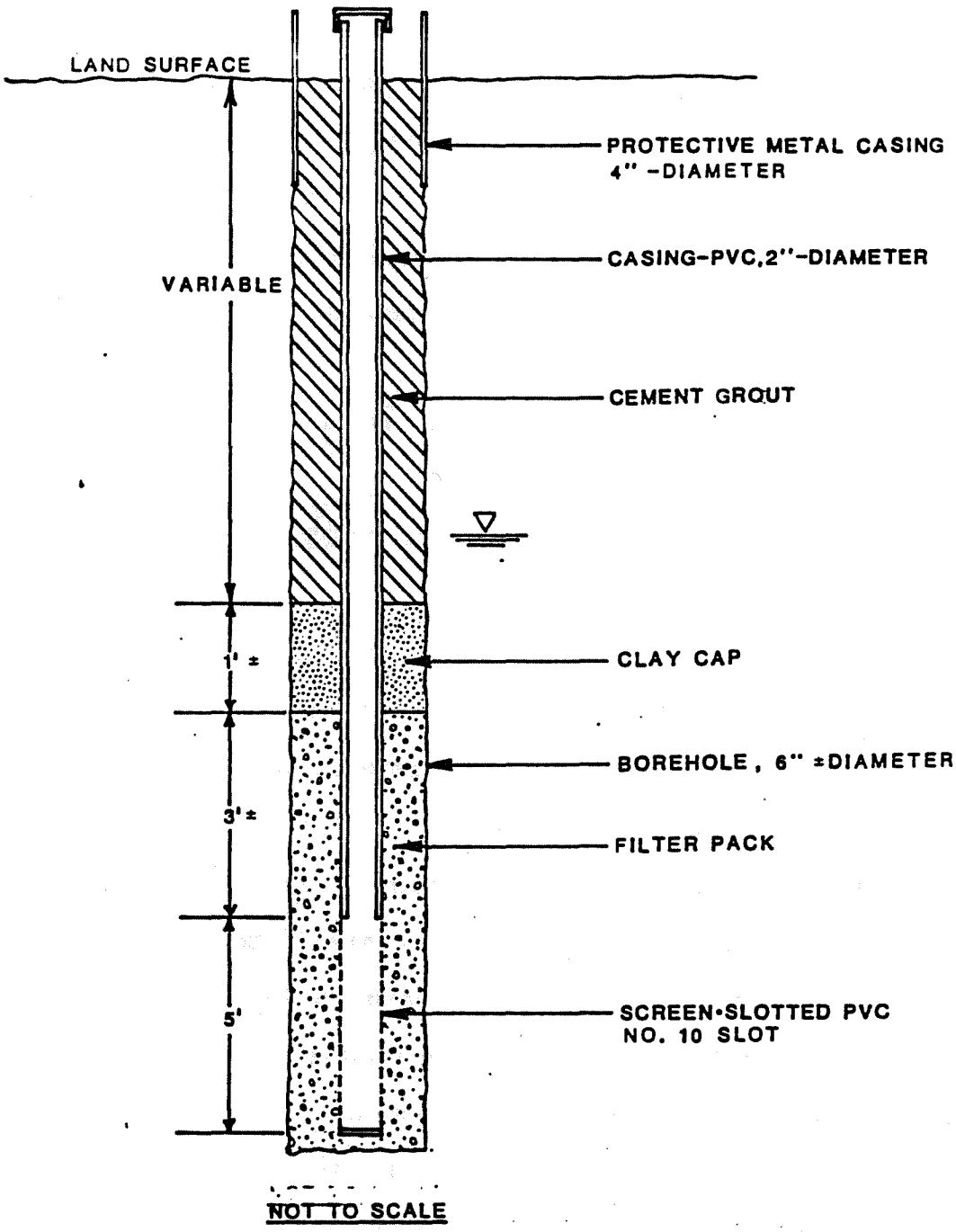


Figure 4. Schematic Diagram of Typical Monitor-Well Construction.

lockable steel casing except at Site 7 where the well was installed at land surface and protected by a steel cover.

Surveying

After completion of the monitor wells, the elevation of the top of the PVC casing of each monitor well was measured by a certified surveyor, Harry Fulton & Associates, Inc. (901-668-7171). The top of the casing serves as a reference point from which all water-level measurements are made. Top of casing and ground-water elevations, referenced to mean sea level, are presented in Table 2.

Sampling and Analysis

A total of eight (8) sediment samples were collected for chemical analysis from Sites 4 and 9. Sediment samples were collected with a Ponar dredge sampling device. The sampling equipment was thoroughly cleaned between sampling sites to prevent possible cross-contamination.

In addition to collecting sediment samples, soil samples were collected at Site 7. These samples were obtained from various depths below land surface while drilling the borehole for monitor well GM-9. The soil samples were subsequently delivered to a laboratory for analysis.

All 12 monitor wells were also sampled for chemical analysis. Ground-water samples were collected from the monitor wells by first evacuating 3 to 5 well volumes of

TABLE 2. CONSTRUCTION DETAILS OF INSTALLED MONITOR WELLS

Monitor Well	Total Depth (Ft below land surface)	Screen Interval Below Land Surface (Ft)	Elevation at top of Casing (Ft, msl)	Ground-Water Elevation (Ft, msl)
GM-1	49	44-49	268.96	263.02
GM-2	44	39-44	266.71	257.03
GM-3	45	40-45	269.51	255.66
GM-4	22	17-22	269.45	258.15
GM-5	57	42-57	267.38	254.32
GM-6	50	45-50	288.75	261.67
GM-7	60	55-60	286.26	261.64
GM-8	20	15-20	286.88	277.52
GM-9	54	49-54	283.86	260.52
GM-10	30	25-30	329.16	306.23
GM-11	30	25-30	321.74	304.64
GM-12	25	20-25	324.04	302.95

water using a PVC hand pump assembly. Once the well was evacuated, a teflon bailer was used to collect ground-water for actual chemical analysis. The sampling equipment was thoroughly cleaned between sample sites.

Field measurements of temperature, pH, and specific conductance of water samples were made at the time of sample collection. The samples were preserved on ice until delivery to the laboratory within 24 hours of sampling. Chemical analysis of all samples were conducted by ERCO/Energy Resource Company, Inc., 205 Alewife Brook Parkway, Cambridge, Massachusetts, 02138.

HYDROGEOLOGIC SETTING

Topography and Drainage

NAS Memphis lies in the East Gulf Coastal Plain section of the Coastal Plain Province and is characterized by a gently sloping terrain and moderately steep hills. In general, land surface elevations vary from 270 ft msl (feet above mean sea level) in the southeast border along Big Creek Drainage Canal to 350 ft msl in the northern portion of the base near Tanya Lake. Surface-water runoff in the southern portion of NAS Memphis is directly into Big Creek Drainage Canal. The eastern and western portions of the base drain to Casper Creek and North Fork Creek, respectively, which in turn drain to Big Creek Drainage Canal (see Figure 2).

Geologic Framework

The Naval base is located in the north-central part of the Mississippi embayment where the subsurface sediments are formed by depositional processes of wind and streams.

The sequence of geologic sediments underlying NAS Memphis is illustrated in Figure 5, which is a generalized geologic column. The uppermost stratographic unit consists of sand, gravel, silt and clay and extends to a depth of approximately 175 ft in some areas. These units are underlain by clays of the Jackson Formation.

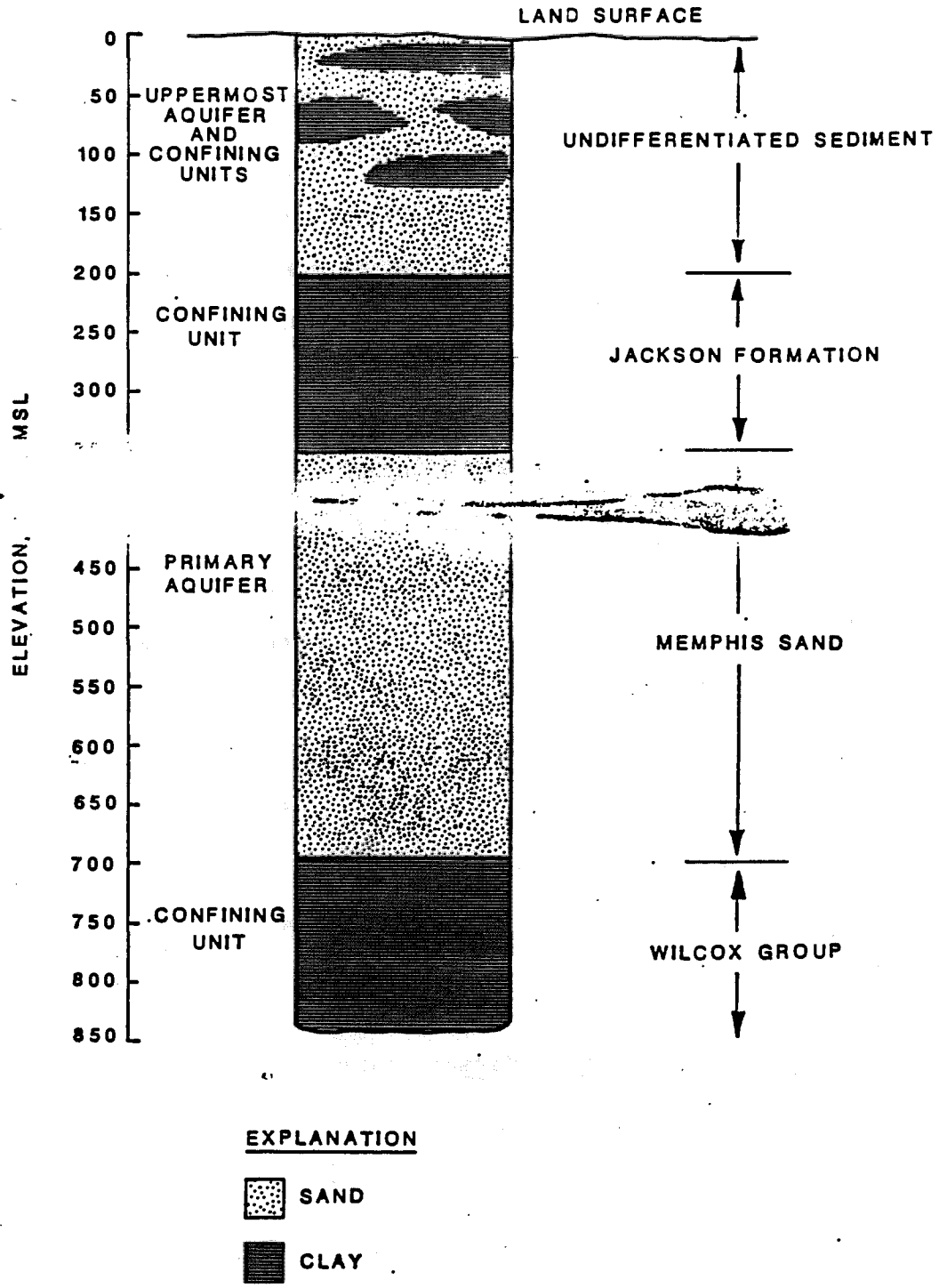


Figure 5. Generalized Geologic Column.

The nature of the surficial sediments at the NAS are illustrated in the geologic cross-section presented in Figure 6, which was prepared from logs of the borings drilled during this investigation. The figure shows that the surficial sediments are composed of soft gray clay, firm silty blue clay and gravelly sand. Water contained within the uppermost aquifer is sometimes used for industrial and irrigation purposes.

Beneath these undifferentiated sediments lies the Jackson Formation, which consists primarily of gray, bluish-gray, greenish-gray and tan clays. The low-permeability sediments of the Jackson Formation comprise the confining deposits which retard verticle movement of water and hydraulically separate the uppermost aquifer from the underlying Memphis Sand. The Memphis Sand, or 500-foot sand, which consists of fine to coarse grain sand is the primary aquifer in the Memphis area. The clayey confining bed located beneath the Memphis Sand is the Wilcox Group.

Ground-Water System

Stratigraphic units within the upper sediments at NAS contain a perched zone and an uppermost aquifer. The perched zone located within the soft gray clay is formed due to the underlying firm blue clay which restricts vertical ground-water flow to the underlying sands which make up the uppermost aquifer. Permeability tests run on Shelby tube samples collected during monitor well installation suggests

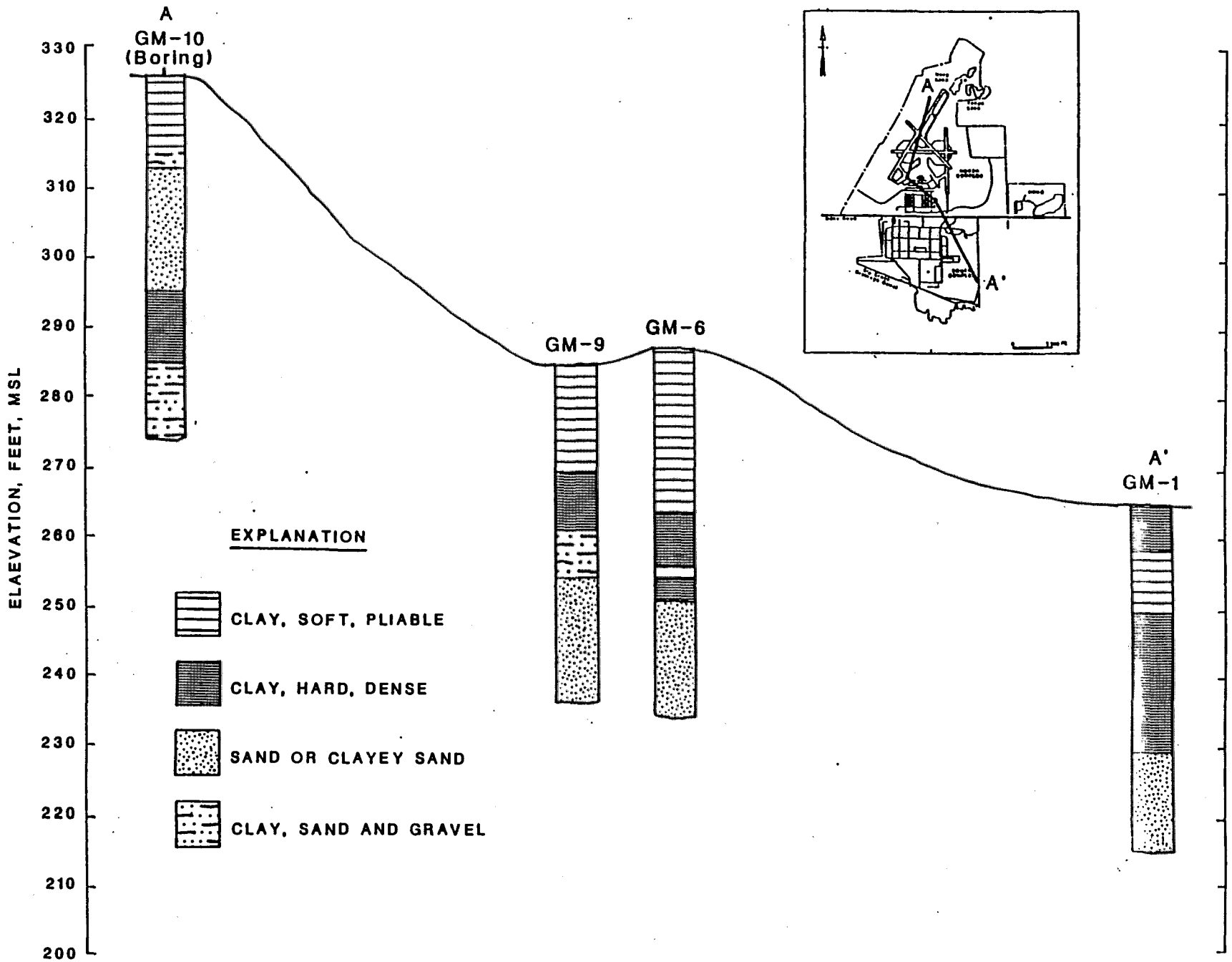


Figure 6. Geologic Cross Section of the Uppermost Surficial Sediments.

vertical permeabilities within the gray clay and blue clay that range from 1.5×10^{-6} to 5.2×10^{-7} cm/sec (centemeters per second) and 5.9×10^{-6} to 8.5×10^{-6} cm/sec, respectively.

SOUTHSIDE LANDFILL (SITE 2)

Background

The Southside Landfill is located in the southeast portion of the south complex adjacent to Big Creek Drainage Canal. The site is immediately bounded on the north by dense vegetation consisting of underbrush and trees. NAS Memphis housing is located further to the north beyond the vegetation. To the east and west of the site lies the NAS Memphis property boundary and the south complex entrance road, respectively (Figure 7).

Disposal on the 40-acre site began in 1942 and reportedly consisted of household refuse from Navy housing, aircraft parts, wastewater treatment plant sludges generated by the NAS trickling filter and waste oils and oil sludges. The disposal rate for the waste oil and oil sludges reportedly did not exceed one ton per year and approximately two tons per year of sludges from the trickling filter.

The disposal method employed at the site was the trench-and-cover method. The waste materials were not separated prior to disposal, however, combustible material disposed at the site was burned prior to covering the waste.

Findings and Recommendations

Five monitor wells were installed around Site 2 at the locations shown in Figure 7. Four of the wells were finished

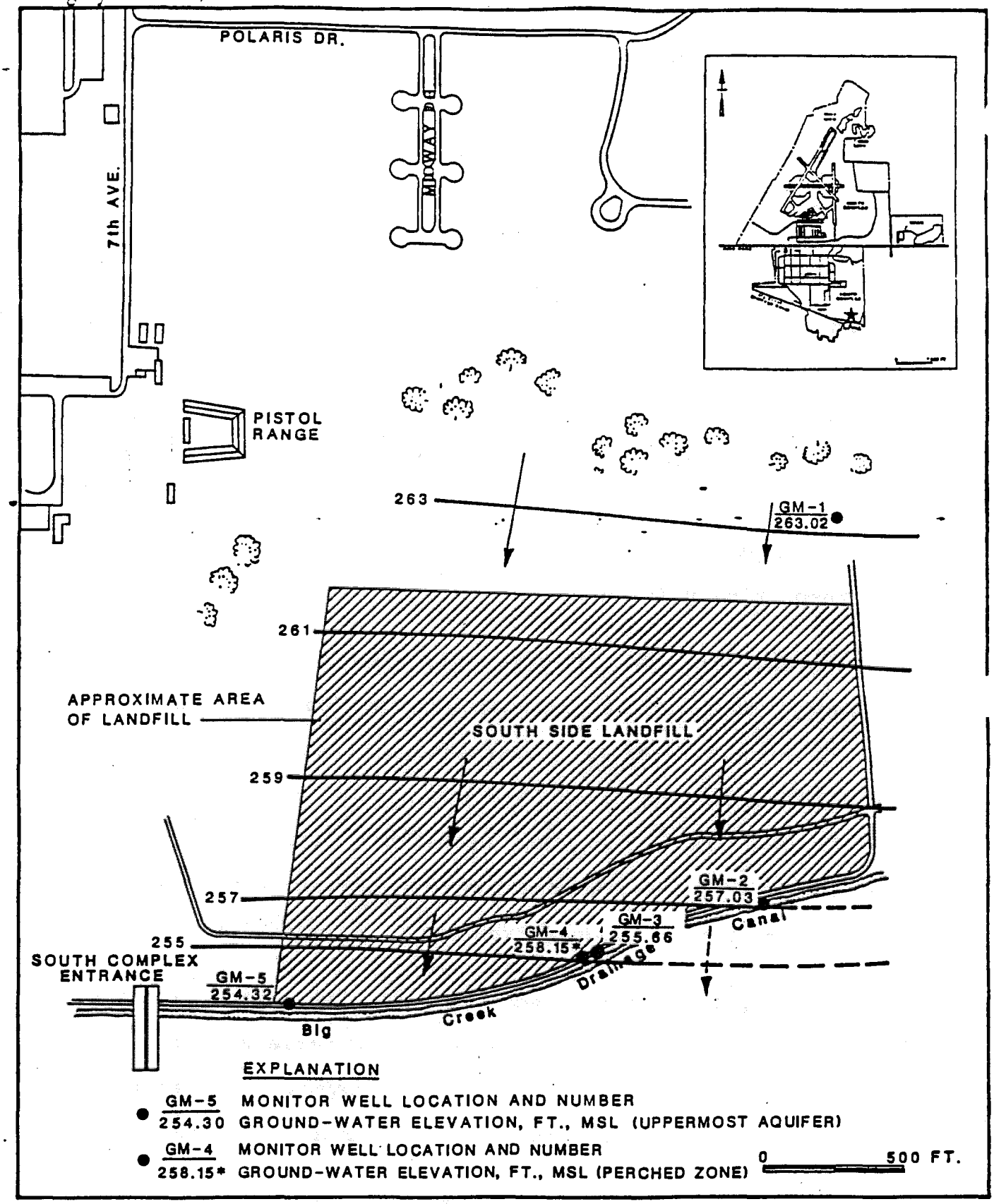


Figure 7. Monitor-Well Locations and Ground-Water Flow Directions at Southside Landfill (Site 2).

into the top of the uppermost aquifer (GM-1,2,3 and 5) and one well (GM-4) was finished into the shallow perched zone.

Geologic logs of borings drilled at the site show the lithology above the uppermost aquifer is composed of soft or hard, dense clay (Appendix A). Laboratory analysis performed on Shelby tubes collected while installing the monitor wells suggest that vertical permeabilities of the clay range from 8.5×10^{-6} to 1.5×10^{-6} cm/sec.

[illegible] 7 and indicate the ground-water in the uppermost aquifer flows in a south to southwesterly direction toward Big Creek Drainage Canal. A net downward hydraulic gradient of approximately 16 ft exists between the perched zone and the uppermost aquifer at the site.

Water samples were collected from each of the 5 monitor wells and were analyzed for pH and specific conductance in the field and in an independent chemical laboratory (ERCO/Energy Resource Company, Inc.) for volatile organic compounds (VOCs) (Method 601), cyanide and metals including: cadmium, chromium, copper, nickel, lead and zinc.

As can be seen in Table 3, the pH ranged from 6.6 to 7.4 and the specific conductance ranged from 200 to 600 umhos/cm (micromhos per centimeter). VOCs and cyanide were not detected in any of the five monitor wells (See Appendix B). Metal concentrations in each monitor well were below EPA's

TABLE 3. SUMMARY OF pH, SPECIFIC CONDUCTANCE AND TEMPERATURE IN MONITOR WELLS JUNE 18 AND 19, 1985

Monitor Well Number	pH	Specific Conductance (umhos/cm)	Temperature (°C)
GM-1	6.6	200	15
GM-2	6.7	540	18
GM-3	7.3	600	18
GM-4	6.8	600	18
GM-5	6.8	240	18
GM-6	7.3	420	18
GM-7	6.9	510	18
GM-8	6.6	410	18
GM-9	6.9	280	20
GM-10	6.6	230	18
GM-11	7.4	100	16
GM-12	7.2	250	17

(Environmental Protection Agency) interum primary drinking-water standards for chromium, copper, nickel, lead and zinc. Although there is no drinking water standard for nickel, the concentrations for this compound were low.

Based on the findings from the investigation, this site does not pose a threat to human health or the environment. Therefore, additional work does not appear warranted at this site.

PLATING SHOP DRY WELL AT N-121 (SITE 3) AND STORM SEWER AND DITCH (SITE 4)

Background

The plating shop dry well (Site 3) is located at Building N-121 on Casablanca Road (Figure 8). Site 4 storm sewer and ditch flows westerly from N-121 along Casablanca Road to First Avenue, then southwesterly to a section of open drainage ditch which eventually discharges to North Fort Creek (Figure 9). Operations within the plating shop consisted of cadmium, chromium, copper and nickel plating using cyanide based solutions. The dry well, a 10 ft x 10 ft x 6 ft pit filled with gravel was used for the disposal of concentrated plating solutions. Waste solutions which were not disposed to the dry well were discharged to the storm sewer and ditch. Reportedly approximately 18,000 gpd (gallons per day) of wastewater was generated by the plating operations with 95 percent, or approximately 17,000 gpd flowing to the storm sewer and ditch.

Findings and Recommendations

Three monitor wells were installed at the plating shop dry well including GM-6, GM-7 and GM-8 at the locations shown in Figure 8; do to site restrictions no well was installed into the dry well itself. Ground-water elevations at the two monitor wells installed into the uppermost aquifer indicates that the horizontal ground-water gradient within the uppermost aquifer is relatively flat, however, based on

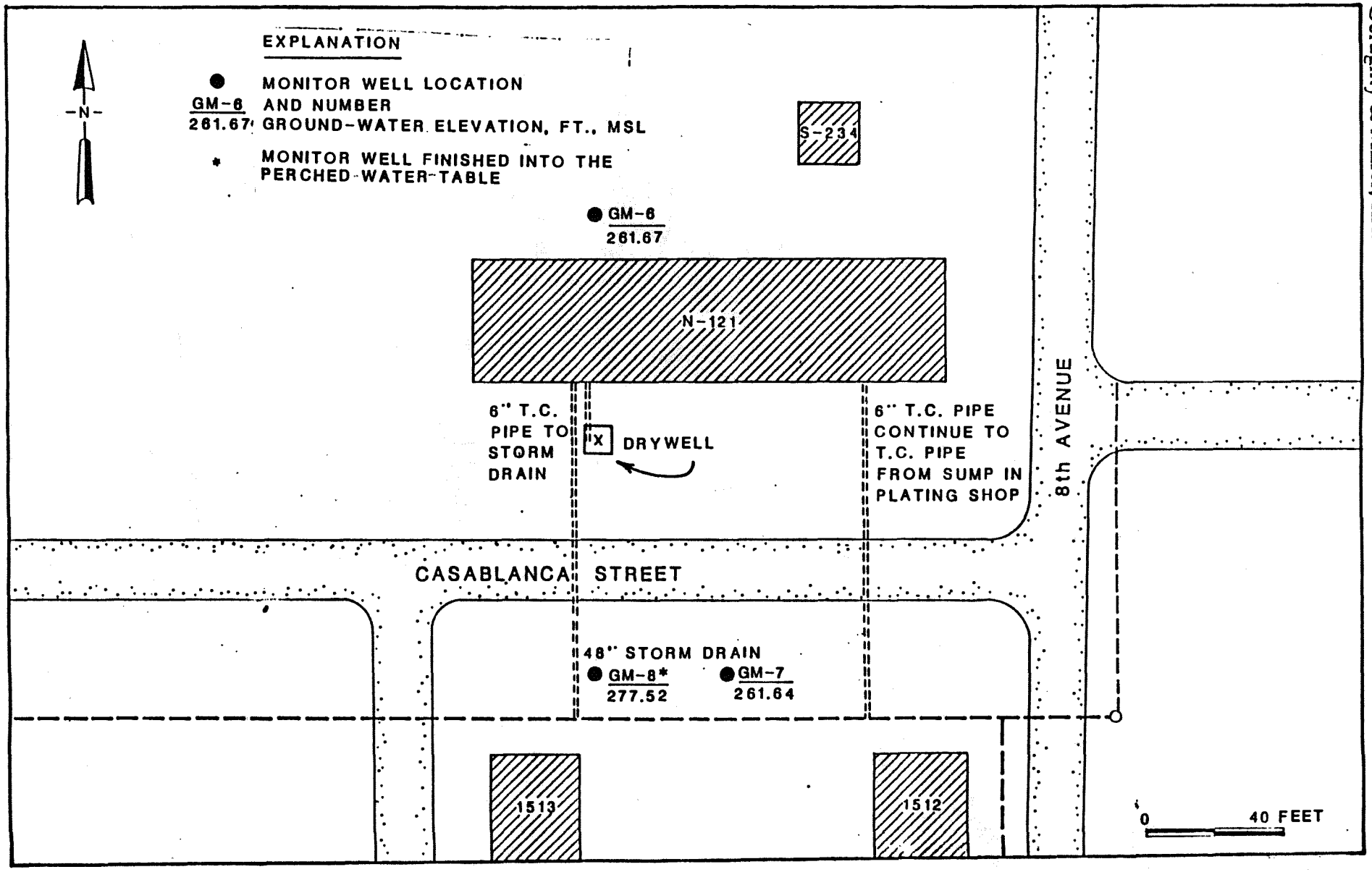


Figure 8. Location of Monitor Wells at the Plating Shop Dry Well Near Building N-121 (Site 3).

Geraghty & Miller, Inc.

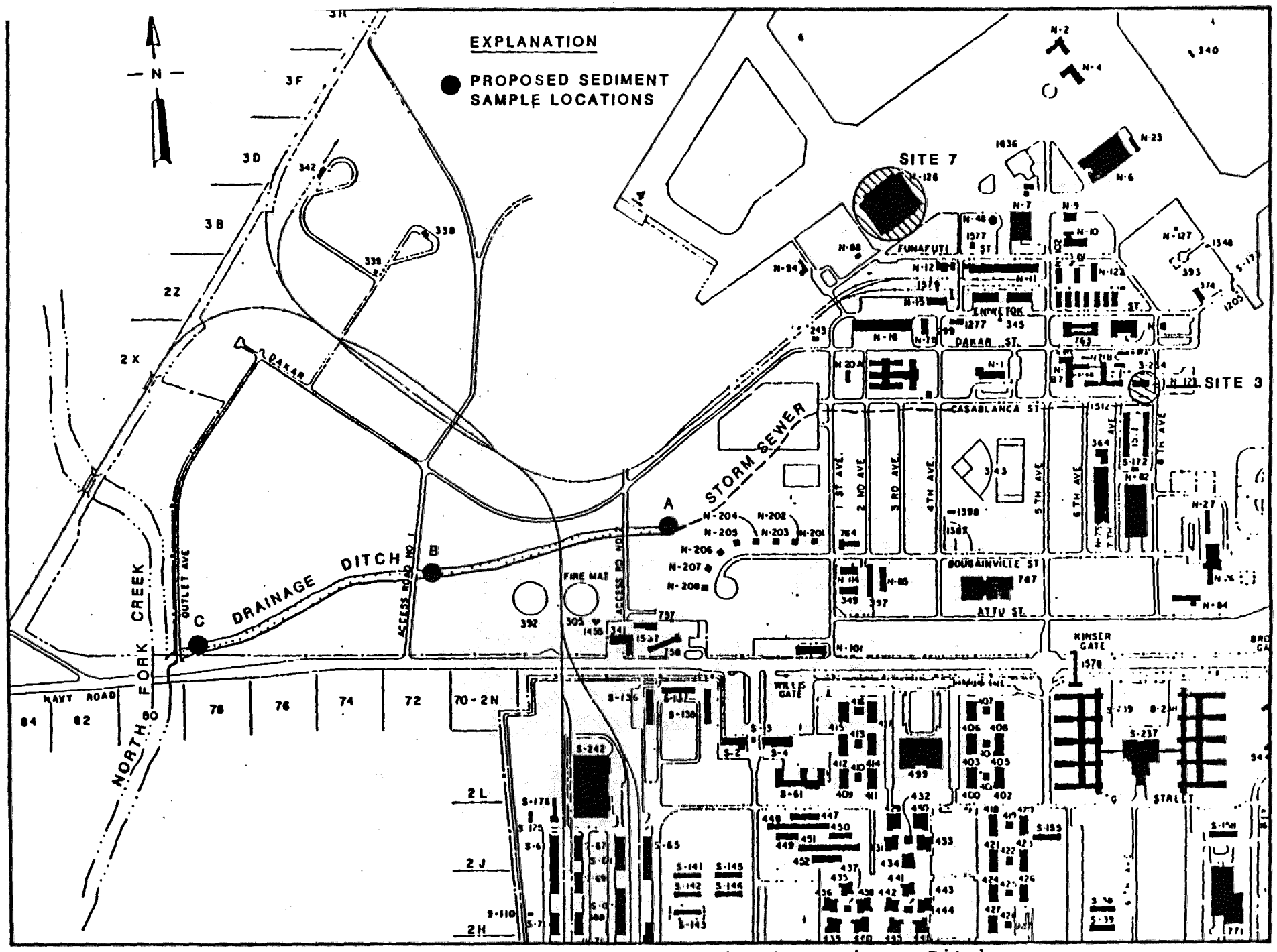


Figure 9. Locations of Sediment Samplin ites in the Drainage Ditch.

topography it is believed that ground-water flow in the uppermost aquifer is in a southerly direction.

Field analysis of water sampled from the monitor wells around the plating shop dry well indicated that the pH and specific conductance ranged from 6.6 to 7.3 and 410 to 510 umhos/cm, respectively. The results of chemical analysis for VOCs, metals and cyanide, which are presented in Appendix B, show that no VOCs or cyanide were detected and that metal c[illegible] chromium, copper, nickel, lead and zinc do [illegible]

Laboratory analysis of sediment samples taken from Site 4 drainage ditch at the locations shown in Figure 9 are presented in Appendix C and indicate that no cyanide was detected, however, high concentrations of total metals were found including: cadmium, 0.44 to 1.3 ppm (parts per million); chromium, 16 to 35 ppm; copper, 17 to 28 ppm; nickel, 16 to 24 ppm; lead, 16 to 96 ppm and zinc, 69 to 120 ppm.

It is recommended that a second round of ground-water samples be collected at Site 3 and analyzed for metal concentrations only. Based upon the relatively high metal concentrations detected in soil samples below the Plating Shop dry well at N-126 (Site 7), an additional monitor well located in the dry well at this site is also recommended if access problems can be overcome. Shelby tube samples should be collected on 5-ft intervals to a total depth of 65 ft

below ground level during the installation of the well. Beginning with the 5-ft sample, every other samples (i.e., 5, 15, 25, 35, 45, 55, and 65) should be analyzed for E.P. Toxicity. The other samples should be retained and analyzed only if the initial results indicate that the soils exceed the characteristics of E.P. Toxicity or if the data suggests that significant concentrations of metals could leach into the ground water.

At Site 4, it is recommended that a second round of sediment samples be collected and analyzed for both total metals and for E.P. Toxicity at the locations indicated in Figure 10. At the time of sample collection, the pH of the surface water at each sample location will also be determined. These data will then be used to determine whether or not these sediments are considered to be a hazardous waste and to determine the potential for these sediments to leach these metals at a pH of about 5.0.

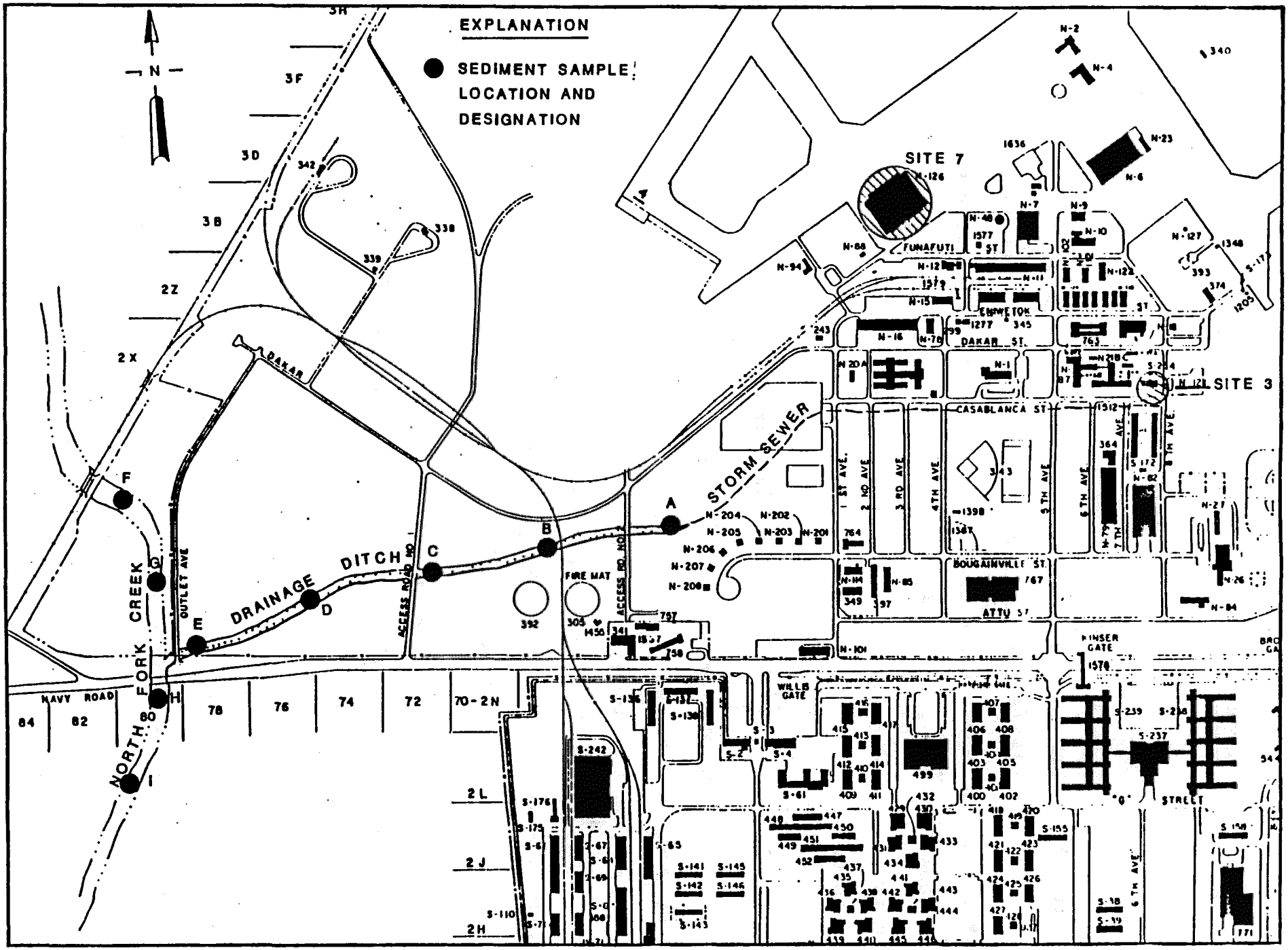


Figure 10. Proposed Locations of Sediment Sampling Sites in the Drainage Ditch (Site 4).

Geraghty & Miller, Inc.

PLATING SHOP DRY WELL AT N-126 (SITE 7)

Background

A dry well identical in construction to the dry well at Site 3, N-121 is located in front of Building N-126 which housed the plating operations of The Aircraft Intermediate Maintenance Department during the mid-1950's. Plating wastes disposed to the dry well included nickel, cadmium and chromium-based solutions. No waste disposal rates have been reported.

Findings and Recommendations

One monitor (GM-9) was installed through the existing dry well to a depth of approximately 50 ft below land surface at the location shown in Figure 11. Analysis of Shelby tube samples collected during the drilling indicate that the vertical permeability of the clay located beneath the site ranges from 5.9×10^{-6} TO 5.2×10^{-7} cm/sec.

Soil samples collected during the drilling of the monitor well were analyzed for selected metals and cyanide. The results of this analysis are presented in Appendix C. Only low levels of cyanide were detected in the soil with the greatest concentration (0.812 ppm) occurring at a depth interval of 14 to 15 ft below ground level. Relatively high concentrations of total metals were detected in the soil with chromium (34 ppm) and zinc (64 ppm) found at the greatest concentrations. Although all depth intervals sampled

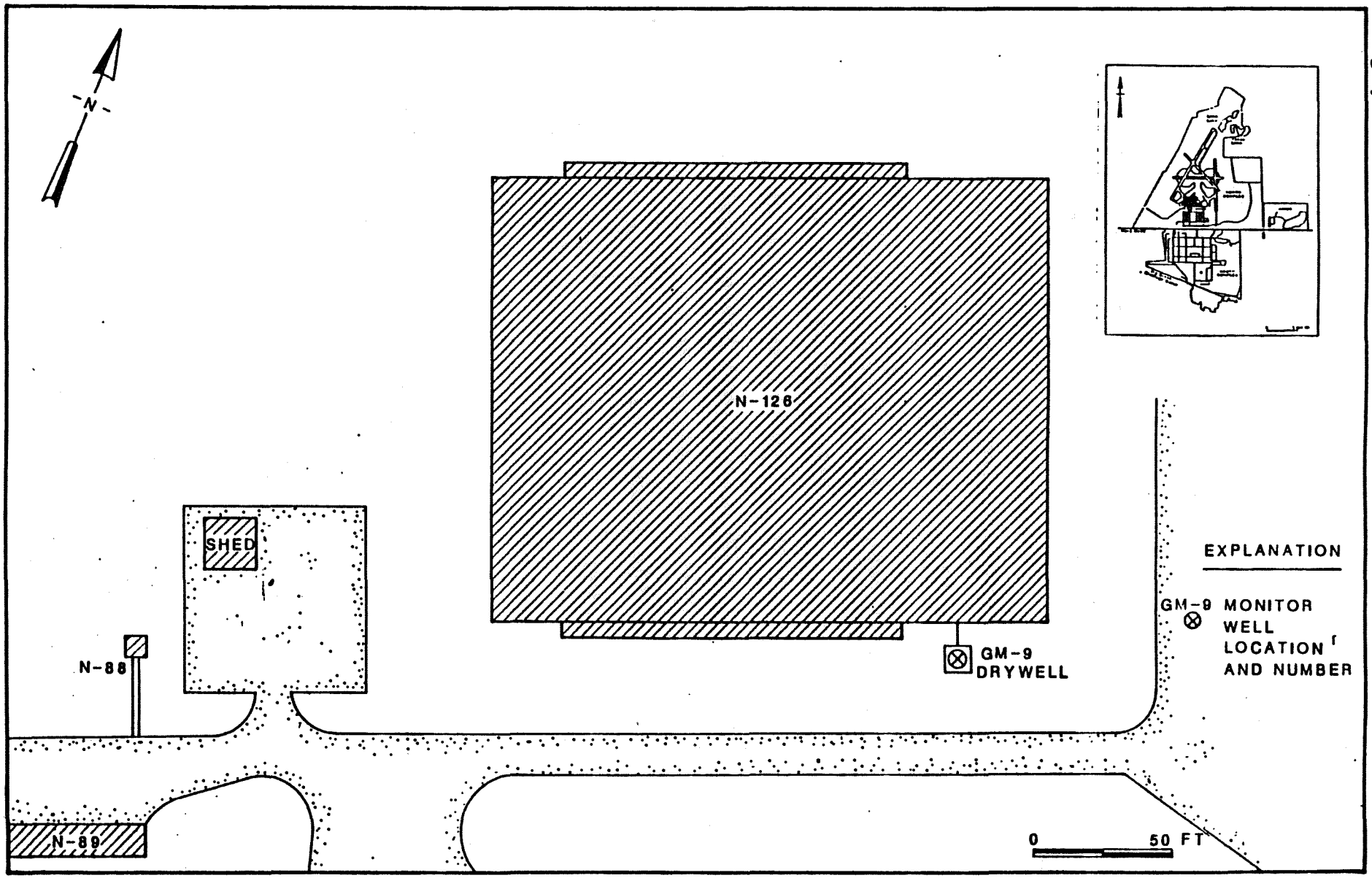


Figure 11. Locations of the Soil Boring/Monitor Well Installed at the Plating Shop Dry Well Near Building N-126 (Site 7).

Geraghty & Miller, Inc.

indicated significant concentrations of total metals, the lowest levels were found in the deepest sample taken at a depth of 23 to 24 ft below land surface.

Field analysis of water sampled from monitor well GM-9 had a pH reading of approximately 6.9 and a specific conductance of 280 umhos/cm. No VOCs or cyanide were detected in water samples from this well and metal concentrations did not exceed EPA's drinking water standards.

It is recommended that a second round of water samples be collected and analyzed for metals to confirm the earlier findings. In addition, a second boring should be drilled to a depth of 50 ft below ground level and Shelby tube samples collected on 5 ft intervals and analyzed for E.P. Toxicity in a manner identical to the sample collection and analysis procedures followed during the Site 3 dry well monitor well installation.

CEMETERY DISPOSAL AREA (SITE 8)

Background

The Cemetery Disposal Area is located on the north complex adjacent to Runway 22-4 (Figure 12). Reportedly the five to eight acre site received waste materials which included scrap metal, waste oil, cleaning solutions, transformers, capacitors, and "suspicious chemicals" including three 25-pound canisters of ethylene oxide. The [illegible] 8 ft.

Findings and Recommendations

One soil boring and three shallow monitor wells (GM-10, GM-11 and GM-12) were installed at the site. The soil boring was sampled to a depth of 53 ft below land surface to locate the top of the uppermost aquifer and the monitor wells were installed to a depth of approximately 20 ft within the perched water table. Water-level measurements taken on June 19, 1985 indicate that horizontal ground-water flow within the perched water table is in a easterly direction (Figure 12).

No VOCs or cyanide were detected in water samples collected from monitor wells GM-10 through GM-12 and the metal concentrations in ground-water samples from each well were below EPA's drinking-water standards except for chromium in GM-11 which was 0.077 ppm.

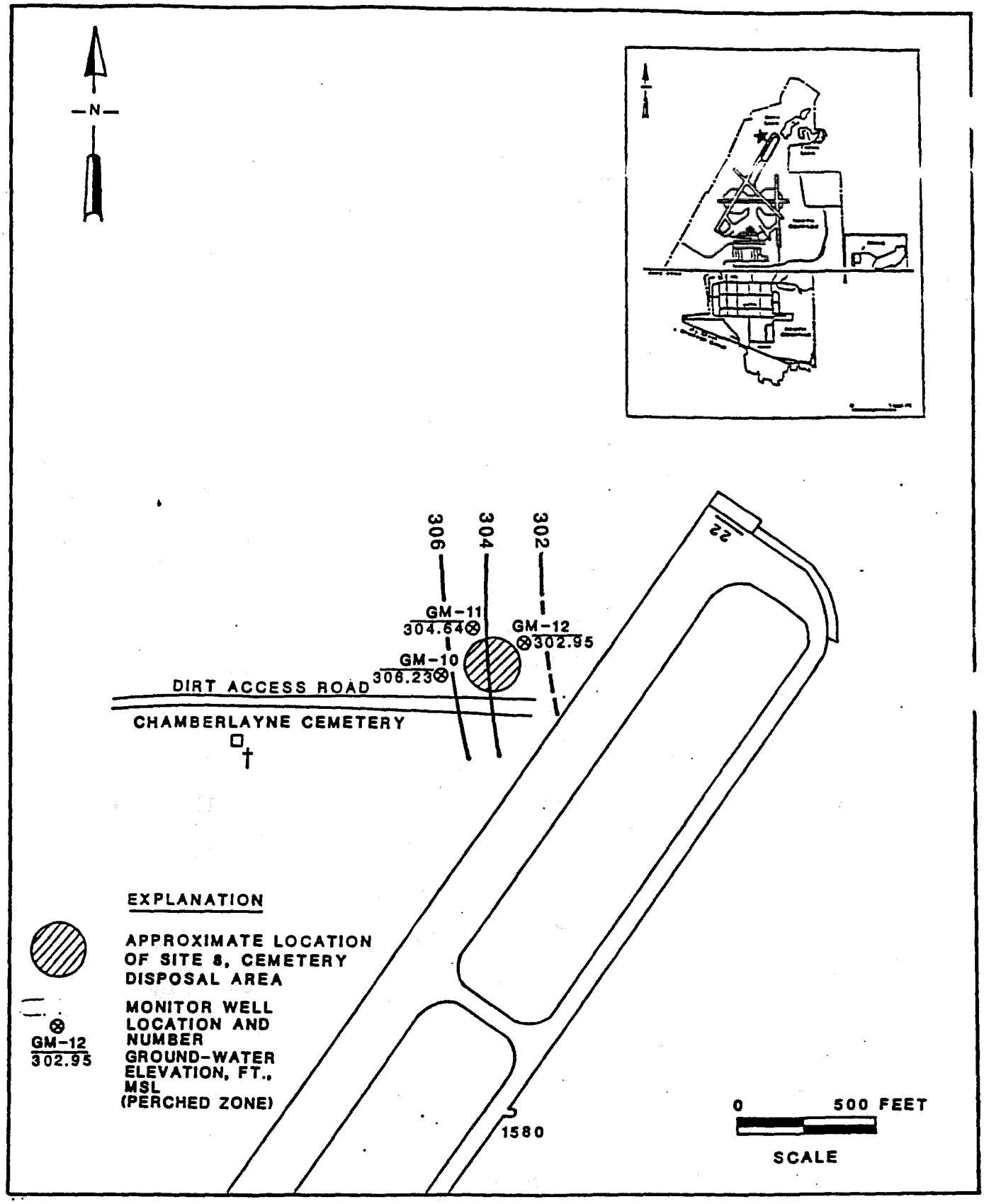


Figure 12. Monitor-Well Locations and Ground-Water Flow Directions at the Cemetery Disposal Area (Site 8).

A second round of water-quality sampling is recommended at this site. Although no VOCs were detected in the ground water, it has been reported that "suspicious chemicals" have been disposed at this site. Therefore, it is recommended that ground-water samples from GM-12 (downgradient well) be collected and analyzed for EPA Priority Pollutants and ethylene oxide to evaluate the potential contamination from these unknown chemicals. Ground-water samples from all three wells should also be analyzed for VOCs and metals to confirm the findings from this study.

SEWAGE LAGOONS (SITE 9)

Background

Two inactive sewage lagoons are located on the South Complex south of Big Creek Drainage Canal (Figure 13). Reportedly, from 1969 to 1978 the lagoons accepted sanitary and industrial wastewater effluent from the NAS WWTP (Waste Water Treatment Plant). Prior to the initiation of the Verification Study, the Navy was considering using the lagoons for recreational purposes.

Findings and Recommendations

On December 19, 1984 five sediment samples were collected from the two lagoons at the locations indicated in Figure 13. Each of the five samples were analyzed for the following metals: cadmium, chromium, copper, nickel and lead. The total metal concentrations shown in Appendix C were below laboratory detection limits.

Although the data collected is believed to be sufficient to conclude that the lagoon will not have an adverse impact on ground water, it is not recommended that the Navy implement a recreational program at the Sewage Lagoons at this time. Although no metal concentrations greater than laboratory detection limits were found in the lagoon sediments, visual observations made at the site by a G&M hydrologist during sediment sampling indicates that the sediments are easily disturbed by boating activity. Increased

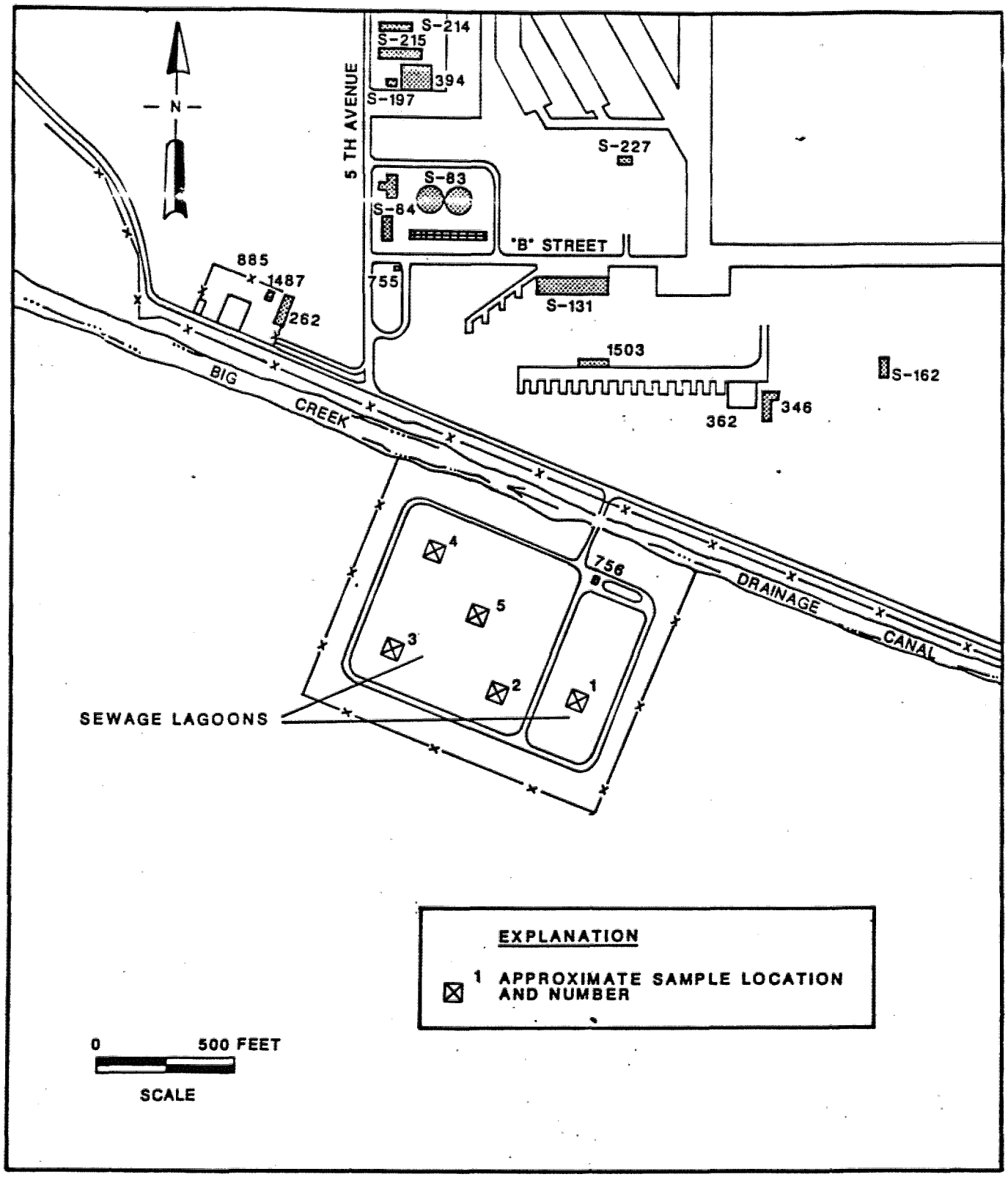


Figure 13. Locations of Sediment Samples Collected From Sewage Lagoons (Site 9).

activity at the site may disturb bottom sediments, potentially releasing metals or other constituents, making them available for uptake by aquatic life. Since the Navy decided not to use the sewage lagoons for recreational purposes prior to the release of this report and because the collected data indicates that the lagoons will not have an adverse impact on ground water, no further investigations appear warranted at this site.

APPENDIX A

LITHOLOGIC LOGS

LITHOLOGIC LOG FOR MONITOR WELL GM-1

escription	Depth (ft)	Thickness (ft)
.ay, road soil, brown.....	0 - 2.5	2.5
.ay, firm, green and yellow.....	2.5 - 8.5	6.0
.ay, pliable, brown.....	8.5 - 10.0	1.5
.ay, pliable, soft, marbled, brown, ellow, green.....	10.0 - 14.5	4.5
.ay, pliable, blue.....	14.5 - 35.0	20.5
.ay, slightly sandy, medium pack, blue...	35.0 - 37.0	2.0
ay, slightly sandy, gravel, medium pack ue.....	37.0 - 44.0	7.0
nd, coarse grain, gravel, loose pack, n and brown.....	44.0 - 50.0	6.0

LITHOLOGIC LOG FOR MONITOR WELL GM-2

cription	Depth (ft)	Thickness (ft)
y, pliable, brown and gray.....	0 - 12.5	12.5
y, pliable, blue.....	12.5 - 17.5	5.0
y, pliable, silty, blue.....	17.5 - 22.5	5.0
, pliable, sandy, medium grain, gray..	22.5 - 27.5	5.0
, soft, sandy, fine grain, dark gray..	27.5 - 30.0	2.5
, medium grain, clayey, dark gray.....	30.0 - 38.0	8.0
, medium to coarse grain, gravel, tan.	38.0 - 46.0	8.0
, soft, tan.....	46.0 - 48.0	2.0

LITHOLOGIC LOG FOR MONITOR WELL GM-3

Description	Depth (ft)	Thickness (ft)
Soil, organic, slightly clayey, brown.....	0.0 - 5.0	5.0
Clay, firm, green and yellow.....	5.0 - 10.0	5.0
Clay, firm, silty, green and yellow.....	10.0 - 13.0	3.0
Clay, very silty, slightly sandy, gray and yellow.....	13.0 - 15.0	2.0
Clay, pliable, blue-gray with yellow.....	15.0 - 20.0	5.0
Clay, pliable, blue-gray.....	20.0 - 30.0	10.0
Sand, silty, clayey, gray.....	30.0 - 32.0	2.0
No Sample.....	32.0 - 35.0	3.0
Sand, medium to coarse grain, tan.....	35.0 - 47.0	12.0

LITHOLOGIC LOG FOR MONITOR WELL GM-4

Description	Depth (ft)	Thickness (ft)
Soil, organic, medium pack, brown.....	0. - 2.5	2.5
Soil, slightly clayey, pliable, brown-gray.....	2.5 - 4.0	1.5
Clay, pliable, brownish-gray with yellow..	4.0 - 7.5	3.5
Clay, pliable, medium to dense pack, green.....	7.5 - 12.5	5.0
Clay, pliable, silty, green and gray.....	12.5 - 17.5	5.0
Clay, pliable, silty, medium pack, blue-gray.....	17.5 - 22.5	5.0

LITHOLOGIC LOG FOR MONITOR WELL GM-5

Description	Depth (ft)	Thickness (ft)
Soil, slightly clayey, medium pack, brown	0.0 - 5.0	5.0
Clay, pliable, marbled green, yellow, brown	5.0 - 20.0	15.0
Clay, silty, hard, gray and yellow	20.0 - 25.0	5.0
Clay, hard, blue-gray	25.0 - 40.0	15.0
Sand, course to fine-grained, brown-green	40.0 - 45.0	5.0
Sand, course to fine-grained, gravel, brown-green	45.0 - 50.0	5.0

LITHOLOGIC LOG FOR MONITOR WELL GM-6

Description	Depth (ft)	Thickness (ft)
Soil, granular, medium to firm pack, brown	0 - 2.5	2.5
Soil, slightly clayey, medium pack, brown	2.5 - 5.0	2.5
Clay, hard, dense pack, light brown	5.0 - 7.0	2.0
Clay, pliable, marbled brown, yellow and gray	7.0 - 17.0	10.0
Clay, pliable, blue-gray	17.0 - 21.0	4.0
Clay, pliable, marbled yellow and green	21.0 - 22.0	1.0
Clay, hard, dense pack, amber	22.0 - 30.0	8.0
Clay, pliable, silty, blue-gray	30.0 - 32.0	2.0
Clay, dense, brittle, amber	32.0 - 35.0	3.0
Clay, very sandy, course grain, amber	35.0 - 42.0	7.0
Sand, medium grain, loose pack, light amber	42.0 - 52.0	10.0

LITHOLOGIC LOG FOR MONITOR WELL GM-7

Description	Depth (ft)	Thickness (ft)
Soil, clayey, granular, brown.....	0.0 - 10.0	10.0
Clay, pliable, marbled yellow, green and brown.....	10.0 - 25.0	15.0
Clay, dense, blue-gray.....	25.0 - 45.0	20.0
Clay, silty, light gray.....	45.0 - 50.0	5.0
Sand, medium to fine grain, tan.....	50.0 - 65.0	15.0

LITHOLOGIC LOG OF MONITOR WELL GM-8

Description	Depth (ft)	Thickness (ft)
Soil, granular, medium to dense pack, brown.....	0 - 3.5	3.5
Clay, hard, dense dark green.....	3.5 - 7.5	4.0
Clay, pliable, marbled yellow and gray....	7.5 - 15.0	7.5
Clay, pliable, medium pack, gray.....	15.0 - 20.0	5.0

LITHOLOGIC LOG FOR MONITOR WELL GM-9

Description	Depth (ft)	Thickness (ft)
No Sample.....	0 - 14.0	14.0
Clay, pliable, green.....	14.0 - 17.0	3.0
Clay, dense, hard, green-brown.....	17.0 - 18.0	1.0
Clay, dense, hard, amber.....	18.0 - 19.0	1.0
Clay, dense, hard, marbled green and amber.....	19.0 - 24.0	5.0
Clay, medium pack, slightly sandy, amber..	24.0 - 34.0	10.0
Sand, medium grain, clayey, orange.....	34.0 - 39.0	5.0
Sand, medium to fine-grain, slightly clayey, orange-yellow.....	39.0 - 44.0	5.0
Sand, medium to fine-grain, tan to orange.....	44.0 - 49.0	5.0

LITHOLOGIC LOG FOR MONITOR WELL GM-10

Description	Depth (ft)	Thickness (ft)
lay, pliable, medium pack, brown.....	0 - 10.0	10.0
lay, pliable, loose pack, brown.....	10.0 - 20.0	10.0
lay, pliable, loose pack, gravelly, own.....	20.0 - 25.0	5.0
nd, medium grain, clayey, gravelly, ange.....	25.0 - 30.0	5.0
nd, medium grain, clayey, orange.....	30.0 - 33.0	3.0
ay, firm, dense pack, orange-yellow.....	33.0 - 40.0	7.0
ay, firm, dense pack, slightly gravelly, ay.....	40.0 - 43.0	3.0
y, sandy, fine-grain, dense pack, gray.	43.0 - 52.0	9.0
y, gravelly, medium pack, gray.....	52.0 - 53.0	1.0

LITHOLOGIC LOG FOR MONITOR WELL GM-11

Description	Depth (ft)	Thickness (ft)
Clay, pliable, medium pack, brown.....	0 - 12.0	12.0
Clay, pliable, loose pack, brown.....	12.0 - 30.0	18.0

LITHOLOGIC LOG FOR MONITOR WELL GM-12

Description	Depth (ft)	Thickness (ft)
Clay, pliable, medium pack, brown.....	0 - 17.0	17.0
Cl[illegible] pack, slightly [illegible])	[illegible]	5.0
Clay, pliable, medium pack, very gravelly.	22.0 - 24.0	2.0
Clay, sandy, medium grain, gravelly, orange.....	24.0 - 28.0	4.0

APPENDIX B

Water-Quality Results

GERAGHTY & MILLER, INC.

WELL LOG

PROJECT: Navy - Memphis T290ME1 DATE: 6-17-85 SHEET: 1 OF ____

LOCATION: Millington TN, landfill site DRILLING CONTRACTOR: Am. Drilling Crew

WELL NUMBER: GM-2 DRILLING METHOD: solid stem auger

SAMPLE DESCRIBED BY: BJS SAMPLING METHOD: sample off flight

SAMPLE DESCRIPTION	Blow/ft	DEPTH INTERVAL (FEET)	THICKN (FEE
Clay, pliable, brown and gray		0 - 2.5'	
same as above		2.5' - 7.5'	
same as above		7.5' - 12.5'	
Clay, pliable, blue; moist water level @ 13 ft. (~~[illegible]~~)		12.5 - 17.5'	
Clay, plastic, silty, blue		17.5' - 22.5'	
Clay, sandy, plastic, gray; sand, medium-grained, gray.		22.5 - 27.5'	
Clay, sandy (fine grained) soft, dark gray:		27.5 - ~~[illegible]~~ 30'	
Sand, medium-grained, clayey, dark gray.		30 - 32.5'	
same as above		32.5 - 36'	
Sand, medium to coarse-grained, tan; gravel.		36 - 38'	
same as above		38' - 46'	
Clay, soft, cream to tan		46 - 48	
Screen 44 - 39'			
Sand 44 - 36'			
bentonite 36' - 35			
grout 35' - 0'			

GERAGHTY & MILLER, INC.

WELL LOG

PROJECT: NAS Memphis DATE: 12-14-84 SHEET: 1 OF ____

LOCATION: Millington Southside Ladder (GM-3) DRILLING CONTRACTOR: Geoscience Testing

WELL NUMBER: GM-3 DRILLING METHOD: Mud Rotary

SAMPLE DESCRIBED BY: DG SAMPLING METHOD: Wash

SAMPLE DESCRIPTION Shelby at 12' & 32'	blow/ft	DEPTH INTERVAL (FEET)	THICKNESS (FEET)
* see log of GM-1 for details			
Soil, slightly clayey, brown		0-5'	
Clay, medium grain, green & yellow		5-10'	
~~loose sample~~ clay, same as above but silty		10-13'	
Shelby tube		~~12-14~~ 13-15	
clay, plastic, ~~mottled~~ blue grey w/ yellow streaks		15-20'	
blue grey clay		20-25	
same as above		25-30	
Shelby tube - slightly sandy clay		30-32	
No sample		32-35	
Sand, medium to coarse grain, traces of lignite, ~~no~~ ~~tan~~		35-40	
same as above		40-~~45~~ 47	

	Theory	Theory actual	actual
total depth	~~40~~	47	45 ~~47~~
sand	40-45	42-47	40-45 ~~42-47~~
silter	37-45	39-47	38-45 ~~40-47~~
clay sand	36-37	38-39	37-38 ~~[illegible]~~
grout	0-36	0-38	0-37 ~~0-37~~

ERCO
205 Alewife Brook Parkway, Cambridge, Massachusetts 02138 (617) 661-3111 Telex 650-255-7697 (MCI)

A DIVISION OF
ENSECO
INCORPORATED

July 16, 1985

Mr. Barry Switzer
Geraghty & Miller, Inc.
14310 North Dale Mabry Highway
Tampa, FL 33618

Dear Barry:

Enclosed please find the results for the 13 samples received on June 20, 1985, and analyzed for volatile organic compounds using the EPA 601 Method, metals, and cyanide.

If you have any questions, please do not hesitate to call me.

Sincerely,

Nancy Stewart

Nancy Stewart
Manager, Volatile
Organics Laboratory

NS:jw
Encl.

Regional and international offices:

- Suite 115, Statesman Insurance Building, 3815 Montrose, Houston, Texas 77006 (713) 523-7311
- 525 Central Avenue, Cedarhurst, New York 11516 (516) 295-1162
- c/o Bectech Trading Co., Ltd., P.O. Box 101-41, Taipei, Taiwan (R.O.C.) Tel. 5013908

CLIENT	Geraghty & Miller, Inc.
CLIENT ID	GM-1
ERCO ID	17131
SAMPLE RECEIVED	6/20/85
ANALYSIS COMPLETED	6/29/85
RESULTS IN	µg/l (ppb)

ERCO / A Division of ENSECO

VOLATILE ORGANICS ANALYSIS
BY EPA METHOD 601

- Data Report -

	Compound	Result	Minimum Reporting Limit
45V	Chloromethane	ND	5
46V	Bromomethane	ND	5
88V	Vinyl chloride	ND	2
16V	Chloroethane	ND	5
44V	Methylene chloride	ND	1
29V	1,1-dichloroethylene	ND	1
13V	1,1-dichloroethane	ND	1
30V	1,2-trans-dichloroethylene	ND	1
23V	Chloroform	ND	1
10V	1,2-dichloroethane	ND	1
11V	1,1,1-trichloroethane	ND	1
6V	Carbon tetrachloride	ND	1
48V	Bromodichloromethane	ND	1
32V	1,2-dichloropropane	ND	2
33V	Trans-1,3-dichloropropylene	ND	2
87V	Trichloroethylene	ND	1
51V	Dibromochloromethane	ND	1
33V	Cis-1,3-dichloropropylene	ND	2
14V	1,1,2-trichloroethane	ND	2
47V	Bromoform	ND	5
15V	1,1,2,2-tetrachloroethane	ND	2
85V	Tetrachloroethylene	ND	1
7V	Chlorobenzene	ND	5
19V	2-chloroethyl vinyl ether	ND	10

Reported by: MTR
Checked by: NS

ND = Not detected above the minimum reporting limit.

CLIENT	Geraghty & Miller, Inc.
CLIENT ID	GM-2
ERCO ID	17132
SAMPLE RECEIVED	6/20/85
ANALYSIS COMPLETED	6/29/85
RESULTS IN	µg/l (ppb)

ERCO / A Division of ENSECO

VOLATILE ORGANICS ANALYSIS
BY EPA METHOD 601

- Data Report -

	Compound	Result	Minimum Reporting Limit
45V	Chloromethane	ND	5
46V	Bromomethane	ND	5
88V	Vinyl chloride	ND	2
16V	Chloroethane	ND	5
44V	Methylene chloride	ND	1
29V	1,1-dichloroethylene	ND	1
13V	1,1-dichloroethane	ND	1
30V	1,2-trans-dichloroethylene	ND	1
23V	Chloroform	ND	1
10V	1,2-dichloroethane	ND	1
11V	1,1,1-trichloroethane	ND	1
6V	Carbon tetrachloride	ND	1
48V	Bromodichloromethane	ND	1
32V	1,2-dichloropropane	ND	2
33V	Trans-1,3-dichloropropylene	ND	2
87V	Trichloroethylene	ND	1
51V	Dibromochloromethane	ND	1
33V	Cis-1,3-dichloropropylene	ND	2
14V	1,1,2-trichloroethane	ND	2
47V	Bromoform	ND	5
15V	1,1,2,2-tetrachloroethane	ND	2
85V	Tetrachloroethylene	ND	1
7V	Chlorobenzene	ND	5
19V	2-chloroethyl vinyl ether	ND	10

Reported by: MTA
Checked by: JRS

ND = Not detected above the minimum reporting limit.

CLIENT	Geraghty & Miller, Inc.
CLIENT ID	GM-3
ERCO ID	17133
SAMPLE RECEIVED	6/20/85
ANALYSIS COMPLETED	6/29/85
RESULTS IN	µg/l (ppb)

ERCO / A Division of ENSECO

VOLATILE ORGANICS ANALYSIS
BY EPA METHOD 601

- Data Report -

	Compound	Result	Minimum Reporting Limit
45V	Chloromethane	ND	5
46V	Bromomethane	ND	5
88V	Vinyl chloride	ND	2
16V	Chloroethane	ND	5
44V	Methylene chloride	ND	1
29V	1,1-dichloroethylene	ND	1
13V	1,1-dichloroethane	ND	1
30V	1,2-trans-dichloroethylene	ND	1
23V	Chloroform	ND	1
10V	1,2-dichloroethane	ND	1
11V	1,1,1-trichloroethane	ND	1
6V	Carbon tetrachloride	ND	1
48V	Bromodichloromethane	ND	1
32V	1,2-dichloropropane	ND	2
33V	Trans-1,3-dichloropropylene	ND	2
87V	Trichloroethylene	ND	1
51V	Dibromochloromethane	ND	1
33V	Cis-1,3-dichloropropylene	ND	2
14V	1,1,2-trichloroethane	ND	2
47V	Bromoform	ND	5
15V	1,1,2,2-tetrachloroethane	ND	2
85V	Tetrachloroethylene	ND	1
7V	Chlorobenzene	ND	5
19V	2-chloroethyl vinyl ether	ND	10

Reported by: MT
Checked by: JLS

ND = Not detected above the minimum reporting limit.

CLIENT	Geraghty & Miller, Inc.
CLIENT ID	GM-4
ERCO ID	17134
SAMPLE RECEIVED	6/20/85
ANALYSIS COMPLETED	6/29/85
RESULTS IN	µg/l (ppb)

ERCO / A Division of ENSECO

VOLATILE ORGANICS ANALYSIS
BY EPA METHOD 601

- Data Report -

	Compound	Result	Minimum Reporting Limit
45V	Chloromethane	ND	5
46V	Bromomethane	ND	5
[illegible]	[illegible]loride	ND	2
[illegible]	[illegible]	[illegible]	5
[illegible]	[illegible] chloride	[illegible]	1
29V	1,1-dichloroethylene	ND	1
13V	1,1-dichloroethane	ND	1
30V	1,2-trans-dichloroethylene	ND	1
23V	Chloroform	ND	1
10V	1,2-dichloroethane	ND	1
11V	1,1,1-trichloroethane	ND	1
6V	Carbon tetrachloride	ND	1
48V	Bromodichloromethane	ND	1
32V	1,2-dichloropropane	ND	2
33V	Trans-1,3-dichloropropylene	ND	2
87V	Trichloroethylene	ND	1
51V	Dibromochloromethane	ND	1
33V	Cis-1,3-dichloropropylene	ND	2
14V	1,1,2-trichloroethane	ND	2
47V	Bromoform	ND	5
15V	1,1,2,2-tetrachloroethane	ND	2
85V	Tetrachloroethylene	ND	1
7V	Chlorobenzene	ND	5
19V	2-chloroethyl vinyl ether	ND	10

Reported by: [illegible]
Checked by: [illegible]

ND = Not detected above the minimum reporting limit.

CLIENT	Geraghty & Miller, Inc.
CLIENT ID	GM-5
ERCO ID	17135
SAMPLE RECEIVED	6/20/85
ANALYSIS COMPLETED	6/29/85
RESULTS IN	µg/l (ppb)

ERCO / A Division of ENSECO

VOLATILE ORGANICS ANALYSIS
BY EPA METHOD 601

- Data Report -

	Compound	Result	Minimum Reporting Limit
45V	Chloromethane	ND	5
46V	Bromomethane	ND	5
88V	Vinyl chloride	ND	2
16V	Chloroethane	ND	5
44V	Methylene chloride	ND	1
29V	1,1-dichloroethylene	ND	1
13V	1,1-dichloroethane	ND	1
30V	1,2-trans-dichloroethylene	ND	1
23V	Chloroform	ND	1
10V	1,2-dichloroethane	ND	1
11V	1,1,1-trichloroethane	ND	1
6V	Carbon tetrachloride	ND	1
48V	Bromodichloromethane	ND	1
32V	1,2-dichloropropane	ND	2
33V	Trans-1,3-dichloropropylene	ND	2
87V	Trichloroethylene	ND	1
51V	Dibromochloromethane	ND	1
33V	Cis-1,3-dichloropropylene	ND	2
14V	1,1,2-trichloroethane	ND	2
47V	Bromoform	ND	5
15V	1,1,2,2-tetrachloroethane	ND	2
85V	Tetrachloroethylene	ND	1
7V	Chlorobenzene	ND	5
19V	2-chloroethyl vinyl ether	ND	10

Reported by: MR
Checked by: AS

ND = Not detected above the minimum reporting limit.

CLIENT	Geraghty & Miller, Inc.
CLIENT ID	GM-6
ERCO ID	17136
SAMPLE RECEIVED	6/20/85
ANALYSIS COMPLETED	6/29/85
RESULTS IN	µg/l (ppb)

ERCO / A Division of ENSECO

VOLATILE ORGANICS ANALYSIS
BY EPA METHOD 601

- Data Report -

	Compound	Result	Minimum Reporting Limit
45V	Chloromethane	ND	5
46V	Bromomethane	ND	5
88V	Vinyl chloride	ND	2
16V	Chloroethane	ND	5
44V	Methylene chloride	ND	1
29V	1,1-dichloroethylene	ND	1
13V	1,1-dichloroethane	ND	1
30V	1,2-trans-dichloroethylene	ND	1
23V	Chloroform	ND	1
10V	1,2-dichloroethane	ND	1
11V	1,1,1-trichloroethane	ND	1
6V	Carbon tetrachloride	ND	1
48V	Bromodichloromethane	ND	1
32V	1,2-dichloropropane	ND	2
33V	Trans-1,3-dichloropropylene	ND	2
87V	Trichloroethylene	ND	1
51V	Dibromochloromethane	ND	1
33V	Cis-1,3-dichloropropylene	ND	2
14V	1,1,2-trichloroethane	ND	2
47V	Bromoform	ND	5
15V	1,1,2,2-tetrachloroethane	ND	2
85V	Tetrachloroethylene	ND	1
7V	Chlorobenzene	ND	5
19V	2-chloroethyl vinyl ether	ND	10

Reported by: [illegible]
Checked by: [illegible]

ND = Not detected above the minimum reporting limit.

CLIENT	Geraghty & Miller, Inc.
CLIENT ID	GM-7
ERCO ID	17137
SAMPLE RECEIVED	6/20/85
ANALYSIS COMPLETED	7/1/85
RESULTS IN	µg/l (ppb)

ERCO / A Division of ENSECO

VOLATILE ORGANICS ANALYSIS
BY EPA METHOD 601

- Data Report -

	Compound	Result	Minimum Reporting Limit
45V	Chloromethane	ND	5
46V	Bromomethane	ND	5
88V	Vinyl chloride	ND	2
16V	Chloroethane	ND	5
44V	Methylene chloride	ND	1
29V	1,1-dichloroethylene	ND	1
13V	1,1-dichloroethane	ND	1
30V	1,2-trans-dichloroethylene	ND	1
23V	Chloroform	ND	1
10V	1,2-dichloroethane	ND	1
11V	1,1,1-trichloroethane	ND	1
6V	Carbon tetrachloride	ND	1
48V	Bromodichloromethane	ND	1
32V	1,2-dichloropropane	ND	2
33V	Trans-1,3-dichloropropylene	ND	2
87V	Trichloroethylene	ND	1
51V	Dibromochloromethane	ND	1
33V	Cis-1,3-dichloropropylene	ND	2
14V	1,1,2-trichloroethane	ND	2
47V	Bromoform	ND	5
15V	1,1,2,2-tetrachloroethane	ND	2
85V	Tetrachloroethylene	ND	1
7V	Chlorobenzene	ND	5
19V	2-chloroethyl vinyl ether	ND	10

Reported by: MA
Checked by: NS

ND = Not detected above the minimum reporting limit.

CLIENT	Geraghty & Miller, Inc.
CLIENT ID	GM-8
ERCO ID	17138
SAMPLE RECEIVED	6/20/85
ANALYSIS COMPLETED	7/1/85
RESULTS IN	µg/l (ppb)

ERCC / A Division of ENSECO

VOLATILE ORGANICS ANALYSIS
BY EPA METHOD 601

- Data Report -

	Compound	Result	Minimum Reporting Limit
45V	Chloromethane	ND	5
46V	Bromomethane	ND	5
88V	Vinyl chloride	ND	2
16V	Chloroethane	ND	5
44V	Methylene chloride	ND	1
29V	1,1-dichloroethylene	ND	1
13V	1,1-dichloroethane	ND	1
30V	1,2-trans-dichloroethylene	ND	1
23V	Chloroform	ND	1
10V	1,2-dichloroethane	ND	1
11V	1,1,1-trichloroethane	ND	1
6V	Carbon tetrachloride	ND	1
48V	Bromodichloromethane	ND	1
32V	1,2-dichloropropane	ND	2
33V	Trans-1,3-dichloropropylene	ND	2
87V	Trichloroethylene	ND	1
51V	Dibromochloromethane	ND	1
33V	Cis-1,3-dichloropropylene	ND	2
14V	1,1,2-trichloroethane	ND	2
47V	Bromoform	ND	5
15V	1,1,2,2-tetrachloroethane	ND	2
85V	Tetrachloroethylene	ND	1
7V	Chlorobenzene	ND	5
19V	2-chloroethyl vinyl ether	ND	10

Reported by: [illegible]
Checked by: [illegible]

ND = Not detected above the minimum reporting limit.

CLIENT	Geraghty & Miller, Inc.
CLIENT ID	GM-9
ERCO ID	17139
SAMPLE RECEIVED	6/20/85
ANALYSIS COMPLETED	7/1/85
RESULTS IN	µg/l (ppb)

ERCO / A Division of ENSECO

VOLATILE ORGANICS ANALYSIS
BY EPA METHOD 601

- Data Report -

	Compound	Result	Minimum Reporting Limit
45V	Chloromethane	ND	5
46V	Bromomethane	ND	5
88V	Vinyl chloride	ND	2
16V	Chloroethane	ND	5
44V	Methylene chloride	ND	1
29V	1,1-dichloroethylene	ND	1
13V	1,1-dichloroethane	ND	1
30V	1,2-trans-dichloroethylene	ND	1
23V	Chloroform	ND	1
10V	1,2-dichloroethane	ND	1
11V	1,1,1-trichloroethane	ND	1
6V	Carbon tetrachloride	ND	1
48V	Bromodichloromethane	ND	1
32V	1,2-dichloropropane	ND	2
33V	Trans-1,3-dichloropropylene	ND	2
87V	Trichloroethylene	ND	1
51V	Dibromochloromethane	ND	1
33V	Cis-1,3-dichloropropylene	ND	2
14V	1,1,2-trichloroethane	ND	2
47V	Bromoform	ND	5
15V	1,1,2,2-tetrachloroethane	ND	2
85V	Tetrachloroethylene	ND	1
7V	Chlorobenzene	ND	5
19V	2-chloroethyl vinyl ether	ND	10

Reported by: WTR
Checked by: NS

ND = Not detected above the minimum reporting limit.

CLIENT	Geraghty & Miller, Inc.
CLIENT ID	GM-10
ERCO ID	17140
SAMPLE RECEIVED	6/20/85
ANALYSIS COMPLETED	7/1/85
RESULTS IN	µg/l (ppb)

ERCO / A Division of ENSECO

VOLATILE ORGANICS ANALYSIS
BY EPA METHOD 601

- Data Report -

	Compound	Result	Minimum Reporting Limit
45V	Chloromethane	ND	5
[illegible]	[illegible]ane	[illegible]	5
[illegible]	[illegible]	[illegible]	2
[illegible]	[illegible]hane	[illegible]	5
44V	Methylene chloride	ND	1
29V	1,1-dichloroethylene	ND	1
13V	1,1-dichloroethane	ND	1
30V	1,2-trans-dichloroethylene	ND	1
23V	Chloroform	ND	1
10V	1,2-dichloroethane	ND	1
11V	1,1,1-trichloroethane	ND	1
6V	Carbon tetrachloride	ND	1
48V	Bromodichloromethane	ND	1
32V	1,2-dichloropropane	ND	2
33V	Trans-1,3-dichloropropylene	ND	2
87V	Trichloroethylene	ND	1
51V	Dibromochloromethane	ND	1
33V	Cis-1,3-dichloropropylene	ND	2
14V	1,1,2-trichloroethane	ND	2
47V	Bromoform	ND	5
15V	1,1,2,2-tetrachloroethane	ND	2
85V	Tetrachloroethylene	ND	1
7V	Chlorobenzene	ND	5
19V	2-chloroethyl vinyl ether	ND	10

Reported by: [illegible]
Checked by: NS

ND = Not detected above the minimum reporting limit.

CLIENT	Geraghty & Miller, Inc.
CLIENT ID	GM-11
ERCO ID	17141
SAMPLE RECEIVED	6/20/85
ANALYSIS COMPLETED	7/1/85
RESULTS IN	µg/l (ppb)

ERCO / A Division of ENSECO

VOLATILE ORGANICS ANALYSIS
BY EPA METHOD 601

- Data Report -

	Compound	Result	Minimum Reporting Limit
45V	Chloromethane	ND	5
46V	Bromomethane	ND	5
88V	Vinyl chloride	ND	2
16V	Chloroethane	ND	5
44V	Methylene chloride	ND	1
29V	1,1-dichloroethylene	ND	1
13V	1,1-dichloroethane	ND	1
30V	1,2-trans-dichloroethylene	ND	1
23V	Chloroform	ND	1
10V	1,2-dichloroethane	ND	1
11V	1,1,1-trichloroethane	ND	1
6V	Carbon tetrachloride	ND	1
48V	Bromodichloromethane	ND	1
32V	1,2-dichloropropane	ND	2
33V	Trans-1,3-dichloropropylene	ND	2
87V	Trichloroethylene	ND	1
51V	Dibromochloromethane	ND	1
33V	Cis-1,3-dichloropropylene	ND	2
14V	1,1,2-trichloroethane	ND	2
47V	Bromoform	ND	5
15V	1,1,2,2-tetrachloroethane	ND	2
85V	Tetrachloroethylene	ND	1
7V	Chlorobenzene	ND	5
19V	2-chloroethyl vinyl ether	ND	10

Reported by: [illegible]
Checked by: KS

ND = Not detected above the minimum reporting limit.

CLIENT	Geraghty & Miller, Inc.
CLIENT ID	GM-12
ERCO ID	17142
SAMPLE RECEIVED	6/20/85
ANALYSIS COMPLETED	7/1/85
RESULTS IN	µg/l (ppb)

ERCO / A Division of ENSECO

VOLATILE ORGANICS ANALYSIS
BY EPA METHOD 601

- Data Report -

	Compound	Result	Minimum Reporting Limit
45V	Chloromethane	ND	5
46V	Bromomethane	ND	5
88V	Vinyl chloride	ND	2
16V	Chloroethane	ND	5
44V	Methylene chloride	ND	1
29V	1,1-dichloroethylene	ND	1
13V	1,1-dichloroethane	ND	1
30V	1,2-trans-dichloroethylene	ND	1
23V	Chloroform	ND	1
10V	1,2-dichloroethane	ND	1
11V	1,1,1-trichloroethane	ND	1
6V	Carbon tetrachloride	ND	1
48V	Bromodichloromethane	ND	1
32V	1,2-dichloropropane	ND	2
33V	Trans-1,3-dichloropropylene	ND	2
87V	Trichloroethylene	ND	1
51V	Dibromochloromethane	ND	1
33V	Cis-1,3-dichloropropylene	ND	2
14V	1,1,2-trichloroethane	ND	2
47V	Bromoform	ND	5
15V	1,1,2,2-tetrachloroethane	ND	2
85V	Tetrachloroethylene	ND	1
7V	Chlorobenzene	ND	5
19V	2-chloroethyl vinyl ether	ND	10

Reported by: [illegible]
Checked by: [illegible]

ND = Not detected above the minimum reporting limit.

CLIENT	Geraghty & Miller, Inc.
CLIENT ID	Trip blank
ERCO ID	17143
SAMPLE RECEIVED	6/20/85
ANALYSIS COMPLETED	7/10/85
RESULTS IN	µg/l (ppb)

ERCO / A Division of ENSECO

VOLATILE ORGANICS ANALYSIS
BY EPA METHOD 601

- Data Report -

	Compound	Result	Minimum Reporting Limit
45V	Chloromethane	ND	5
46V	Bromomethane	ND	5
88V	Vinyl chloride	ND	2
16V	Chloroethane	ND	5
44V	Methylene chloride	ND	1
29V	1,1-dichloroethylene	ND	1
13V	1,1-dichloroethane	ND	1
30V	1,2-trans-dichloroethylene	ND	1
23V	Chloroform	ND	1
10V	1,2-dichloroethane	ND	1
11V	1,1,1-trichloroethane	ND	1
6V	Carbon tetrachloride	ND	1
48V	Bromodichloromethane	ND	1
32V	1,2-dichloropropane	ND	2
33V	Trans-1,3-dichloropropylene	ND	2
87V	Trichloroethylene	ND	1
51V	Dibromochloromethane	ND	1
33V	Cis-1,3-dichloropropylene	ND	2
14V	1,1,2-trichloroethane	ND	2
47V	Bromoform	ND	5
15V	1,1,2,2-tetrachloroethane	ND	2
85V	Tetrachloroethylene	ND	1
7V	Chlorobenzene	ND	5
19V	2-chloroethyl vinyl ether	ND	10

Reported by: [illegible]
Checked by: [illegible]

ND = Not detected above the minimum reporting limit.

Sample Received: 6/20/85

Analysis Completed: 7/11/85

All Results in: µg/l (ppb)

Reported by: CAK

Checked by: LAS

Client: Geraghty & Miller, Inc.

ERCO / A DIVISION OF ENSECO, INC.

INORGANIC ANALYSIS

- Data Report -

ERCO ID	CLIENT ID	Cd	Cr	Cu	Ni	Pb	Zn
17131	GM-1	<0.5	23	14	9.5	9.0	31
17132	GM-2	1.0	31	24	18	16	75
17133	GM-3	<0.5	30	22	8.0	9.8	37
17134	GM-4	0.6	5.8	12	10	5.3	40
17135	GM-5	0.6	8.3	9.0	<5	7.3	29
17136	GM-6	<0.5	23	9.0	<5	5.0	20
17137	GM-7	0.7	7.8	12	6.8	5.8	27
17138	GM-8	0.9	6.5	13	8.5	5.3	38
17139	GM-9	2.0	9.0	<5	<5	<5	9.5
17140	GM-10	<0.5	14	12	7.5	6.0	35
17141	GM-11	1.0	77	61	66	22	160
17142	GM-12	<0.5	15	13	5.8	<5	50

If customer has any questions regarding analysis, refer to sample in question by its ERCO ID#.

Sample Received: 6/20/85

Analysis Completed: 6/28/85

All Results in: mg/l (ppm)

Reported by: PR

Checked by: RGW

Client: Geraghty & Miller

ERCO / A DIVISION OF ENSECO, INC.

INORGANIC ANALYSIS

- Data Report -

ERCO ID	CLIENT ID	Total Cyanide
17131	GM-1	<0.010
17132	GM-2	<0.010
17133	GM-3	<0.010
17134	GM-4	<0.010
17135	GM-5	<0.010
17136	GM-6	<0.010
17137	GM-7	<0.010
17138	GM-8	<0.010
17139	GM-9	<0.010
17140	GM-10	<0.010
17141	GM-11	<0.010
17142	GM-12	<0.010

If customer has any questions regarding analysis, refer to sample in question by its ERCO ID#.

Sample Received: 6/20/85

Analysis Completed: 6/28/85

All Results in: mg/l (ppm)

Reported by: PR

Checked by: RGW

Client: Geraghty & Miller

ERCO / A DIVISION OF ENSECO, INC.

INORGANIC ANALYSIS

- Data Report -

ERCO ID	CLIENT ID	Total Cyanide
17131	GM-1	<0.010
17132	GM-2	<0.010
17133	GM-3	<0.010
17134	GM-4	<0.010
17135	GM-5	<0.010
17136	GM-6	<0.010
17137	GM-7	<0.010
17138	GM-8	<0.010
17139	GM-9	<0.010
17140	GM-10	<0.010
17141	GM-11	<0.010
17142	GM-12	<0.010

If customer has any questions regarding analysis, refer to sample in question by its ERCO ID#.

APPENDIX C

Soil and Sediment Analysis Results

ERCO
205 Alewife Brook Parkway, Cambridge, Massachusetts 02138 (617) 661-3111 Telex 650-256-7697 (MCI)

A DIVISION OF
ENSECO
INCORPORATED

June 11, 1985

Mr. Douglas Grant
Geraghty & Miller
13902 North Dale Mabry Highway
Tampa, FL 33618

Dear Doug:

Enclosed is a copy of the results for the analyses performed on the eight sydiment samples received on December 20, 1984.

If there are any questions concerning these data, I would be happy to answer them for you. I can be contacted at 661-3111 x56.

Sincerely,

Robert Watkins
Inorganic Laboratory
Manager

Regional and international offices:

- Suite 115, Statesman Insurance Building, 3815 Montrose, Houston, Texas 77006 (713) 523-7311
- 525 Central Avenue, Cedarhurst, New York 11516 (516) 295-1162

Sample Received: 12/20/84

Analysis Completed: 1/11/85

All Results in: ug/g (ppm) dry wt.

Reported by: LMS

Checked by: LAS

ERCO / A Division of ENSECO

INORGANIC ANALYSIS

- Data Report -

Client: Geraghty & Miller

ERCO ID	CLIENT ID	Cd	Cr	Cu	Ni	Pb	Zn
12580	A	1.3	19	18	22	35	90
12581	B	0.44	16	17	16	16	69
12582	C	1.2	35	28	24	96	120

If customer has any questions regarding analysis, refer to sample in question by its ERCO ID#.

Sample Received: 12/20/84

Analysis Completed: 1/16/85

All Results in: ug/ml (ppm)

Reported by: LMS

Checked by: LAS

A Division of ENSECO

IORGANIC ANALYSIS

EP TOXICITY

- Data Report -

Client: Geraghty & Miller

ERCO ID	CLIENT ID	Cd	Cr	Cu	Ni	Pb
12575	#1	<0.01	<0.10	<0.10	<0.[illegible]	<0.10
12576	#2	<0.01	<0.10	<0.10	<0.[illegible]	<0.10
12577	#3	<0.01	<0.10	<0.10	<0.[illegible]	<0.10
12578	#4	<0.01	<0.10	<0.10	<0.[illegible]	<0.10
12579	#5	<0.01	<0.10	<0.10	<0.[illegible]	<0.10

If customer has any questions regarding analysis, refer to sample in question by its ERCO ID#.

Sample Received: 12/20/84

Analysis Completed: 12/22/84

All Results in: ug/gm (ppm)

Reported by: PR

Checked by: RGW

ERCO / A Division of ENSECO

INORGANIC ANALYSIS

- Data Report -

Client: Geraghty & Miller

ERCO ID	CLIENT ID	Cyanide
12580	A	<0.01
12581	B	<0.01
12582	C	<0.01

If customer has any questions regarding analysis, refer to sample in question by its ERCO ID#.

ERCO
205 Alewife Brook Parkway, Cambridge, Massachusetts 02138 (617) 661-3111 Telex 650-256-7697 (MCI)

A DIVISION OF
ENSECO
INCORPORATED

June 25, 1985

Mr. Douglas Grant
Geraghty & Miller
Landmark Plaza
14310 N. Dale Mabry Highway
Tampa, FL 33618

Dear Doug:

Enclosed please find the results for the six samples received on June 12, 1985, and analyzed for metals and cyanide.

If you have any questions, please do not hesitate to call me.

Sincerely,

Nancy Stewart

Nancy Stewart
Manager, Volatile
Organics Laboratory

NS:rb
Encl.

Regional and international offices:
• Suite 115, Statesman Insurance Building, 3815 Montrose, Houston, Texas 77006 (713) 523-7311
• 525 Central Avenue, Cedarhurst, New York 11516 (516) 295-1162

Sample Received: 6/12/85

Analysis Completed: 6/20/85

All Results in: µg/g (ppm) dry weight

Reported by: [illegible]

Checked by: [illegible]

Client: Geraghty & Miller

ERCO / A DIVISION OF ENSECO, INC.

INORGANIC ANALYSIS

- Data Report -

ERCO ID	CLIENT ID	Cd	Cr	Cu	Ni	Pb	Zn
	GM-9						
16938	14-15 ft	15	27	16	13	22	64
16939	15-16 ft	1.9	21	11	12	12	35
16940	17-18 ft	0.27	19	10	11	12	27
16941	18-19 ft	<0.25	30	13	10	12	34
16942	20-21 ft	3.1	34	13	15	13	45
16943	23-24 ft	0.59	15	9.3	7.8	7.9	25

If customer has any questions regarding analysis, refer to sample in question by its ERCO ID#.

Sample Received: 6/12/85

Analysis Completed: 6/17/85

All Results in: µg/g (ppm) dry weight

Reported by:

Checked by:

Client: Geraghty & Miller Inc.

ERCO / A DIVISION OF ENSECO, INC.

INORGANIC ANALYSIS

- Data Report -

ERCO ID	CLIENT ID	Total Cyanide
	GM-9	
16938	14-15 ft	0.812
16939	15-16 ft	<0.313
16940	17-18 ft	<0.315
16941	18-19 ft	<0.315
16942	20-21 ft	<0.301
16943	23-24 ft	<0.317

If customer has any questions regarding analysis, refer to sample in question by its ERCO ID#.

GERAGHTY & MILLER, INC.

WELL LOG

plastic = pliable

PROJECT: NAS Memphis DATE: 12-9-84 SHEET: 1 OF ____

LOCATION: Millington TN DRILLING CONTRACTOR: Geraghty Testing

WELL NUMBER: GM-6 upgradient of N-121 DRILLING METHOD: Solid Stem Auger

SAMPLE DESCRIBED BY: DG SAMPLING METHOD: off auger flight

SAMPLE DESCRIPTION	blow/ft	DEPTH INTERVAL (FEET)	THICKNESS (FEET)
Soil, granular, medium to firm pack brown (dirt)		0 - 2.5	
slightly clayey soil, medium pack, brown		2.5-5.0	
clay, dense pack, flaky, light brown		5.0 - 7.0	
clay, ~~dense pack~~, plastic, marbled, brown, yellow & grey		7.0 - 10.0	
clay, medium pack, pliable, marbled - brown yellow & grey		10 - 12.5	
same as above (moister ↑)		12.5 - 15.0	▼
same as above but softer		15 - 17.0	▼ (perched)
clay, soft, dense pack, blue (grey)		17.0 - 21	dry
clay, soft, dense pack, marbled - yellow + green		21 - 22	
clay, dense pack, brittle, amber (yellow)		22 - 27	
same as above		27 - 30	
clay, soft, pliable, blue-grey (silty)		30 - 32	
clay, dense pack, brittle, amber		32 - 35	
very sandy clay, course grain, medium pack, amber		35 - 37	
same as above but wet		37 - 40.5	▼
sandy, clay, course grain, firm pack, marbled white & amber		40.5 - 42	
sand, ~~course~~ medium grain, loose pack, light amber (light brown)		42 - 52	

	Thru	actual
Total Depth	50	50
screen	45-50	45-50
Sand	42-50	42-50
clayseal	41-42	40-42
grout	0-42	0-40

1 minutes neg
1 vantage ultralight neg
1 cool mild

GERAGHTY & MILLER, INC.

WELL LOG

PROJECT: NAS - Memphis DATE: 12-11-84 SHEET: 1 OF

LOCATION: Millington TN DRILLING CONTRACTOR: Aquatech Testing

WELL NUMBER: GM-7 (Accumulated N-121) DRILLING METHOD: Mud rotary

SAMPLE DESCRIBED BY: DC SAMPLING METHOD: Undisturbed sample

SAMPLE DESCRIPTION Shelby tubes 10' ~~18'~~ ~~20'~~ 33'	blow/ft	DEPTH INTERVAL (FEET)	THICKNESS (FEET)
** see log of GM-6 & GM-8 for details Soil,	→	0-5	
		5-10'	
Clay, soil, brown		~~0-3'~~	
~~see above~~		~~5-10'~~	
clay, mottled yellow-brown		12-15'	
[illegible]		[illegible] - 20	
clay [illegible]		25-35	
Shelby tube		35-37	
clay of blue-gray type		37-40	
same as above		40-45	
clay, silty, ~~[illegible]~~ light gray		45-50	
sand, medium to fine grain, tan		50-55	
same as above		55-65	

GERAGHTY & MILLER, INC.

WELL LOG

PROJECT: NAS Memphis DATE: 12-1554 SHEET: 1 OF

LOCATION: Southside landfill DRILLING CONTRACTOR: Gamco Tabg

WELL NUMBER: GM-4 shallow DRILLING METHOD: Solid auger

SAMPLE DESCRIBED BY: DG SAMPLING METHOD: off auger flight

SAMPLE DESCRIPTION	blows/ft	DEPTH INTERVAL (FEET)	THICKNES (FEET)
Soil, granular, medium pack, brown, (dirt)		0 - 2.5	
soil, slightly clay, pliable, brown - gray		2.5 - 4.0	
clay, pliable, fine grain, brownish-gray with yellow streaks		4.0 - 7.5	
clay, fine grain, pliable, medium to denser pack, green		7.5 - 12.5	
same as above but w/ gray lenses, silty and ↑ moisture		12.5 - 17.5	
~~grac~~		~~17.5~~	
clay, fine grain, silty, pliable, medium pack, gray-blue		17.5 - 22.5	

	actual
total depth	22
screen	17 - 22
filter pack	12 - 22
clay seal	11 - 12
~~clay~~ grout	0 - 11

GERAGHTY & MILLER, INC.

WELL LOG

PROJECT: NAS Memphis DATE: 12-15-84 SHEET: 1 OF

LOCATION: GM-5 at Southside landfill DRILLING CONTRACTOR: American Testing

WELL NUMBER: GM-5 DRILLING METHOD: Mud rotary

SAMPLE DESCRIBED BY: DG SAMPLING METHOD: Wash sampling

SAMPLE DESCRIPTION	blow/ft	DEPTH INTERVAL (FEET)	THICKNE (FEET
Soil, slightly clayey, medium pack. brown		0-5	
Clay, of the green-yellow-brown ~~[illegible]~~ top		5-10	
Clay, Firm pack same color as above		10-15	
same as above		15-20	
clay, silty, dense pack, gry w/ yellow streak		20-25	
clay - blue gry top		25-30	
same as above		30-35	
same as above		35-40	
Sand, fine to coarse, trace of lignite, brown-green		40-45	
same as above but w/ gravel		45-50	

	Theory	actual
total depth	47'	57
screen	42-47	42-57
filter pack	39-47	48-57
clay seal	35-39	-48
grout	0-35	

GERAGHTY & MILLER, INC.

WELL LOG

PROJECT: T290ME1 DATE: 6-10-85 SHEET: 1 OF

LOCATION: Hangar DRILLING CONTRACTOR: (Tom Crawford) American Drilling

WELL NUMBER: GM-9 DRILLING METHOD: Solid-stem auger

SAMPLE DESCRIBED BY: BJS/WDG SAMPLING METHOD: Sample from auger flig

SAMPLE DESCRIPTION	blow/ft	DEPTH INTERVAL (FEET)	THICKNES (FEET)
Clay, fine, dense, green, pliable		14-15	
same as above but dryer		15-16	
same as above		16-17	
Clay, fine, dense, green, stiff		17-18	
Clay, dense, stiff amb,		18-19	
Clay, dense, marbled green & amber, dry		19-20	
same as above		20-21	
same as above		21-24	
Clay, slightly sandy, medium green, amber/orange		34-34	
Sand, clayey, loose, medium grain orange		35-39	
sand, slightly clayey, loose, medium to fine, orange yellow		39-44'	
Sand, medium to fine, loose, tan to orange		44-49	

Screen 54' - 49'
Sand (1 bag) 45'-40' (tagged at 45', added 1 bag, tagged 40')
Bentonite

GERAGHTY & MILLER, INC.

WELL LOG

PROJECT: Navy - Memphis DATE: 6-13-85 SHEET: 1 OF

LOCATION: Millington; cemetery site DRILLING CONTRACTOR: Amer. Drill. (Crowl

WELL NUMBER: ~~GM-10~~ (boring) DRILLING METHOD: solid-stem auger

SAMPLE DESCRIBED BY: BSS/DG SAMPLING METHOD: sample off flights

SAMPLE DESCRIPTION	Blow/ft	DEPTH INTERVAL (FEET)	THICKNESS (FEET)
clay, pliable, medium peak, brown		0 - 10	
SAME AS ABOVE, BUT LOOSE AND WET AT 15 FT.		10 - 15	
"		15-20	
" , BUT W/ LARGE GRAVEL. [WATER-BEARING FORMATION.]		20-25	
Sand, clayey, medium-grained, orange; gravel. Very wet		25-30	
Sand, medium-grained, clayey, orange.		30- 33	
Clay, firm, dense peak, orange-yellow.		33 - 40'	
clay, fine-grained, gravel, dense, light grey		40 - 43	
Clay, sandy, fine-sand, dense, dark grey		43- 45.	
same as above		45 - 52	
Clay, gravelly, medium peak, gray		52- 53	

GM-16

	Theog	Actual
TD	30'	
screen	25-30	
sand	22 - 30	
pellets	21-22	
grout	0-21	

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	Theory	actual
Total depth	65'	60
Screen	60-65'	55-60
Filter pack	57 - 65	52 - 60
Clay seal	56 - 57	51 - 52
Grout	0 - 57	

GERAGHTY & MILLER, INC.

WELL LOG

PROJECT: NAS- Memphis DATE: 12-13 SHEET: 1 OF

LOCATION: Millington TN DRILLING CONTRACTOR: American Drilling

WELL NUMBER: GM-8 (N-121) DRILLING METHOD: Solid Stem Auger

SAMPLE DESCRIBED BY: DG SAMPLING METHOD: Sample of auger flight

SAMPLE DESCRIPTION	blow/ft	DEPTH INTERVAL (FEET)	THICKNESS (FEET)
Soil, granular, medium to dense pack, brown (dirt)		0 - 3.5	
Clay, ~~[illegible]~~, very dense pack, dark green - brown		3.5 - 7.5	
clay, ~~[illegible]~~ pack, plastic, mottled yellow & gray		7.5 - 12.5	
Clay, ~~[illegible]~~, medium plastic pack, moist, gray & yellow		12.5 - 15.0	
Clay, fine grain, medium plastic pack, moist, gray		15. - 17.5	
same as above (very moist)		17.5 - 20.0	

total depth 20'
screen 15-20
Filter pack 10-20
clay seal 9-10

GERAGHTY & MILLER, INC.

WELL LOG

PROJECT: NAS - Memphis DATE: 6-14-85 SHEET: 1 OF

LOCATION: Millington, TN - cemetery site DRILLING CONTRACTOR: Amer. Drill. (Crew for

WELL NUMBER: GM-11 DRILLING METHOD: solid-stem auger

SAMPLE DESCRIBED BY: BJS SAMPLING METHOD: sample off flights

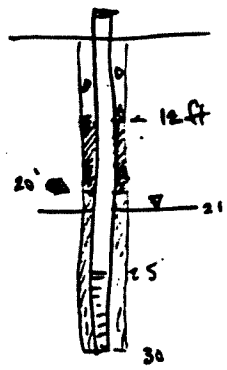
SAMPLE DESCRIPTION	Blow/ft	DEPTH INTERVAL (FEET)	THICKNESS (FEET)
Clay, pliable, medium peak, brown		0-~~7~~ 12	
SAME AS ABOVE, BUT MOIST AND WET @ 10 FT		12-17	
" w.l @ 21.5 FT		17-22	
"		22-27.5	
"			
"		27.5-30'	

Theoretical

Screen 25'-30'
Sand 30'-20'
Bentonite 20'-19'
grout 19'-0'

Actual

Screen 25'-30
Sand 30'-12'
Bentonite 12'-11'
grout 11'-0'



GERAGHTY & MILLER, INC.

WELL LOG

PROJECT: NAS- Memphis DATE: 6-13-85 SHEET: 1 OF ____

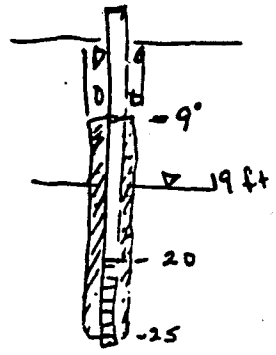
LOCATION: cemetery site DRILLING CONTRACTOR: Amer. Testing (Cont)

WELL NUMBER: GM-12 DRILLING METHOD: solid stem auger

SAMPLE DESCRIBED BY: BJS/WDG SAMPLING METHOD: sample off flights

SAMPLE DESCRIPTION SHELBY TUBE	blow/ft	DEPTH INTERVAL (FEET)	THICKNES (FEET)
Clay, pliable, medium packed, brown (Moist @ 7 ft)		0 - 7	
SAME AS ABOVE		7 - 12	
		12 - 17	
" ; gravel, very wet		17 - 22	
" ; lot of gravel, large stones.		22 - 24	
(Two shelby tubes; no recovery)			
~~Clay~~, Sandy, med. grained clayey, orange; gravel		24 - 28	
w/ cavel at 19 ft.		T.D. = 28 ft	

Theoretical		Actual
Screen	—	25'-20
sand	—	25'-9'
bentonite	—	9'-7'
grout	—	grout 7'-0'



Geraghty & Miller, Inc.

WATER-QUALITY SAMPLING FORM

PROJECT NUMBER: T290ME1

Sample Number: EM-1 Date: 6-19-85

Sample Type: GRAB Time: _____ To: _____

Sampled By: BJS Weather: _____

GROUND-WATER/SURFACE-WATER ELEVATION

(1) M.P.? TOC Elevation _____

(2) Tape Held: 28.00 (at M.P.) M-Scope Reading: _____

(3) Tape Wet: 22.06

(4) Depth to Water: 5.94 (2 minus 3) **SURFACE WATER**

(5) Depth of Well: 49.00 (from M.P.) Reading at Staff Gage: _____

(6) Height of Water Column: 43.06 (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:

$\pi r^2 h$: $\pi(\frac{1}{12})^2$ 43.06 = .94 (ft^3) x 7.48 = 7 x 3 = 21 (gal.)

r = radius of well (ft)

h = height of water column (ft)

Volume Removed from Well: 25 gallons Pumping Rate: _____

Method of Removal: heat pump Pumping Time: _____

Method of Sampling: teflon bailer Pump On: _____

Time of Sampling: 0900 Pump Off: _____

FIELD ANALYSES AND REMARKS

Temperature: 15°C Reason for Sampling: _____

Specific Conductance: 200 micromhos/cm

pH: ~~7.3~~ 6.60

Other (Specify): _____

Method of Shipment: Fed Express to Ecco

Physical Appearance: clear

Type of Analyses: _____

Container Size and Type: 1 4oz glass (cyanide) NaOH; 1 qt plastic (metals) HNO_3

Preservative: 2-30 ml vials (VOA) EPA Method 601

REMARKS: _____

Geraghty & Miller, Inc.

WATER-QUALITY SAMPLING FORM

PROJECT NUMBER: T29QME1

Sample Number: GM-2 Date: 6-19-85

Sample Type: GEAB Time: _____ To: _____

Sampled By: BJS Weather: _____

GROUND-WATER/SURFACE-WATER ELEVATION

(1) M.P.? TOC Elevation _____

(2) Tape Held: 12.00 (at M.P.) M-Scope Reading: _____

(3) Tape Wet: 2.32

(4) Depth to Water: 9.68 (2 minus 3) SURFACE WATER

(5) Depth of Well: 44.0 (from M.P.) Reading at Staff Gage: _____

(6) Height of Water Column: 34.32 (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:

$\pi r^2 h$: $\pi(\frac{1}{12})^2$ 34.32 = .75 (ft^3) x 7.48 = 5.6 x 3 = 16.8 (gal.)

r = radius of well (ft)

h = height of water column (ft)

Volume Removed from Well: 25 gallons Pumping Rate: _____

Method of Removal: hand pump Pumping Time: _____

Method of Sampling: teflon bailer Pump On: _____

Time of Sampling: 1040 Pump Off: _____

FIELD ANALYSES AND REMARKS

Temperature: 18°C Reason for Sampling: _____

Specific Conductance: 540 micromhos/cm

pH: 6.73

Other (Specify): _____

Method of Shipment: Fed Express to ERCO

Physical Appearance: slightly cloudy

Type of Analyses: _____

Container Size and Type: 1 4g glass (cyanide) NaOH; 1 pt plastic (metals) HNO_3.

Preservative: 2-30 ml vials (VOA) EPA Method 601

REMARKS: _____

Geraghty & Miller, Inc.

WATER-QUALITY SAMPLING FORM

PROJECT NUMBER: T290ME1

Sample Number: GM-3 Date: 6-19-85

Sample Type: GRAB Time: _____ To: _____

Sampled By: BJJ Weather: _____

GROUND-WATER/SURFACE-WATER ELEVATION

(1) M.P.? TOC Elevation _____

(2) Tape Held: 15.00 (at M.P.) M-Scope Reading: _____

(3) Tape Wet: 1.15

(4) Depth to Water: 13.85 (2 minus 3) **SURFACE WATER**

(5) Depth of Well: 45.00' (from M.P.) Reading at Staff Gage: _____

(6) Height of Water Column: 31.15 (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:

$\pi r^2 h$: $\pi(\frac{1}{12})^2\ 31.15 = .68$ (ft^3) x 7.48 = 5 x 3 = 15 (gal.)

r = radius of well (ft)

h = height of water column (ft)

Volume Removed from Well: 30 gallons Pumping Rate: _____

Method of Removal: hand pump Pumping Time: _____

Method of Sampling: teflon bailer Pump On: _____

Time of Sampling: 1110 Pump Off: _____

FIELD ANALYSES AND REMARKS

Temperature: 18°C Reason for Sampling: _____

Specific Conductance: 600 micromhos/cm

pH: 7.30

Other (Specify): _____

Method of Shipment: Fed Express to ERCO

Physical Appearance: slightly cloudy

Type of Analyses: _____

Container Size and Type: 1 4oz glass (cyanide) NaOH; 1 qt plastic (metals) HNO_3

Preservative: 2-30 ml vials, VOA EPA Method 601

REMARKS: _____

Geraghty & Miller, Inc.

WATER-QUALITY SAMPLING FORM

PROJECT NUMBER: 7290 MEI

Sample Number: GM-4 Date: 6-19-85

Sample Type: GRAB Time: _____ To: _____

Sampled By: BJS Weather: _____

GROUND-WATER/SURFACE-WATER ELEVATION

(1) M.P.? TOC Elevation _____

(2) Tape Held: 13.00 (at M.P.) M-Scope Reading: _____

(3) Tape Wet: 1.70

(4) Depth to Water: 11.30 (2 minus 3) SURFACE WATER

(5) Depth of Well: 22.00 (from M.P.) Reading at Staff Gage: _____

(6) Height of Water Column: 10.7 (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:

$\pi r^2 h$: $\pi(\frac{1}{12})^2(10.70) = .23$ (ft^3) x 7.48 = 1.74 x 3 = 5.23 (gal.)

r = radius of well (ft)

h = height of water column (ft)

Volume Removed from Well: 15 gallons Pumping Rate: _____

Method of Removal: hand pump Pumping Time: _____

Method of Sampling: teflon bailer Pump On: _____

Time of Sampling: 1240 Pump Off: _____

FIELD ANALYSES AND REMARKS

Temperature: 18°C Reason for Sampling: _____

Specific Conductance: 600 micromhos/cm

pH: 6.80

Other (Specify): _____

Method of Shipment: Fed. Express to ERCO

Physical Appearance: slightly cloudy

Type of Analyses: _____

Container Size and Type: 1 4 g glass (cyanide) NaOH; 1 gal plastic (metals)

Preservative: HNO_3; 2- 30 ml vials (VOA-601)

REMARKS: pumped dry twice, then sampled.

Geraghty & Miller, Inc.

WATER-QUALITY SAMPLING FORM

PROJECT NUMBER: T29DME1

Sample Number: GM-5 Date: 6-19-85

Sample Type: GRAB Time: _____ To: _____

Sampled By: BJS Weather: _____

GROUND-WATER/SURFACE-WATER ELEVATION

(1) M.P.? TOC Elevation _____

(2) Tape Held: 17.00 (at M.P.) M-Scope Reading: _____

(3) Tape Wet: 3.94

(4) Depth to Water: 13.06 (2 minus 3) SURFACE WATER

(5) Depth of Well: 54.00 (from M.P.) Reading at Staff Gage: _____

(6) Height of Water Column: 40.94 (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:

$\pi r^2 h$: $\pi(\frac{4}{12})^2(40.94) = .89$ (ft³) x 7.48 = 6.68 x 3 = 20 (gal.)

r = radius of well (ft)

h = height of water column (ft)

Volume Removed from Well: 25 gallons Pumping Rate: _____

Method of Removal: hand pump Pumping Time: _____

Method of Sampling: teflon bailer Pump On: _____

Time of Sampling: 1335 Pump Off: _____

FIELD ANALYSES AND REMARKS

Temperature: 18°C Reason for Sampling: _____

Specific Conductance: 240 µmhos/cm

pH: 6.76

Other (Specify): _____

Method of Shipment: Fed. Express to ERCO

Physical Appearance: slightly cloudy - brown tint

Type of Analyses: _____

Container Size and Type: 1 4 oz glass (cyanide) NaOH; 1 qt plastic (metals)

Preservative: HNO_3; 2 - 30 ml vials (VOA - 601)

REMARKS: _____

Geraghty & Miller, Inc.

WATER-QUALITY SAMPLING FORM

PROJECT NUMBER: 7290ME1

Sample Number: GM-6 Date: 6-18-85

Sample Type: GRAB Time: _____ To: _____

Sampled By: BJS Weather: _____

GROUND-WATER/SURFACE-WATER ELEVATION

(1) M.P.? TOC Elevation _____

(2) Tape Held: 29.00 (at M.P.) M-Scope Reading: _____

(3) Tape Wet: 1.92

(4) Depth to Water: 27.08 (2 minus 3) SURFACE WATER

(5) Depth of Well: 50.00 (from M.P.) Reading at Staff Gage: _____

(6) 22.92 (5 minus 4) Elevation of [illegible] Gage: _____

(7) _____ (6 minus 7) [illegible] Surface: _____

WATER SAMPLE COLLECTION DATA

Volume of Water in well:

$\pi r^2 h$: $\pi(\frac{1}{12})^2$ 22.92 = .50(ft³) x 7.48 = 3.74 x 3 = 11.25 (gal.)

r = radius of well (ft)

h = height of water column (ft)

Volume Removed from Well: 28 gallons. Pumping Rate: _____

Method of Removal: hand pump Pumping Time: _____

Method of Sampling: teflon bailer. Pump On: _____

Time of Sampling: 1739 Pump Off: _____

FIELD ANALYSES AND REMARKS

Temperature: 18°C Reason for Sampling: _____

Specific Conductance: 420 micromho/cm

pH: 7.32

Other (Specify): _____

Method of Shipment: Fed. Express to ERCO

Physical Appearance: clear - yellow tint

Type of Analyses: _____

Container Size and Type: 1 4oz glass (CN) NaOH; 1 qt plastic (metals) HNO3

Preservative: 2- 30 ml vials; VOA EPA Method 601.

REMARKS: _____

Geraghty & Miller, Inc.

WATER-QUALITY SAMPLING FORM

PROJECT NUMBER: T290ME1

Sample Number: GM-1 Date: 6-18-85

Sample Type: GRAB Time: _____ To: _____

Sampled By: BJS Weather: _____

GROUND-WATER/SURFACE-WATER ELEVATION

(1) M.P.? TOC Elevation _____

(2) Tape Held: 26.00 (at M.P.) M-Scope Reading: _____

(3) Tape Wet: 1.38

(4) Depth to Water: 24.62 (2 minus 3) SURFACE WATER

(5) Depth of Well: 60.00 (from M.P.) Reading at Staff Gage: _____

(6) Height of Water Column: 35.38 (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:

$\pi r^2 h$: $\pi(\frac{1}{12})^2 35.38 = .77$ (ft³) x 7.48 = 5.77 x 3 = 17.3 (gal.)

r = radius of well (ft)

h = height of water column (ft)

Volume Removed from Well: ~~30~~ 42 gallons. Pumping Rate: _____

Method of Removal: hand pump Pumping Time: _____

Method of Sampling: teflon bailer Pump On: _____

Time of Sampling: 1432 Pump Off: _____

FIELD ANALYSES AND REMARKS

Temperature: 18°C Reason for Sampling: _____

Specific Conductance: 510 micromhos/cm

pH: 6.89

Other (Specify): _____

Method of Shipment: Fed Express to ERCO

Physical Appearance: slightly cloudy

Type of Analyses: _____

Container Size and Type: 1 qt glass (CN), NaOH ; 1 qt plastic (Cd, Cr, Cu, Ni, Pb, Zn)

Preservative: HNO_3, 2 - 40 ml vials, EPA Method 601.

REMARKS: _____

Geraghty & Miller, Inc.

WATER-QUALITY SAMPLING FORM

PROJECT NUMBER: T290MEI

Sample Number: GM-8 Date: 6-18-85

Sample Type: GRAB Time: _____ To: _____

Sampled By: BTS Weather: _____

GROUND-WATER/SURFACE-WATER ELEVATION

(1) M.P.? TOC Elevation _____

(2) Tape Held: 12.00 (at M.P.) M-Scope Reading: _____

(3) Tape Wet: 2.64

(4) Depth to Water: 9.36 (2 minus 3) SURFACE WATER

(5) Depth of Well: 20' (from M.P.) Reading at Staff Gage: _____

(6) Height of Water Column: 10.64 (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:

$\pi r^2 h$: $\pi(\frac{1}{12})^2$ 10.64 = .23 (ft^3) x 7.48 = 1.73 x 3 = 5.2 (gal.)

r = radius of well (ft)

h = height of water column (ft)

Volume Removed from Well: >5 gallons. Pumping Rate: _____

Method of Removal: hand pump Pumping Time: _____

Method of Sampling: teflon bailer Pump On: _____

Time of Sampling: 1708 Pump Off: _____

FIELD ANALYSES AND REMARKS

Temperature: 18°C Reason for Sampling: _____

Specific Conductance: 410 micromhos/cm

pH: 6.59

Other (Specify): _____

Method of Shipment: _____

Physical Appearance: clear

Type of Analyses: _____

Container Size and Type: 1 4g glass (CN) NaOH; 1 qt plastic (metals) HNO_3;

Preservative: 2-40ml vials EPA Method 601

REMARKS: Well pumped dry; so evacuated w/ bailer.

Geraghty & Miller, Inc.

WATER-QUALITY SAMPLING FORM

PROJECT NUMBER: T290 ME1

Sample Number: GM-9 Date: 6-18-85

Sample Type: GRAB Time: _____ To: _____

Sampled By: RJS Weather: _____

GROUND-WATER/SURFACE-WATER ELEVATION

(1) M.P.? TOC Elevation _____

(2) Tape Held: 26.00 (at M.P.) M-Scope Reading: _____

(3) Tape Wet: 2.66

(4) Depth to Water: 23.34 (2 minus 3) SURFACE WATER

(5) Depth of Well: 54.00 (from M.P.) Reading at Staff Gage: _____

(6) Height of Water Column: 30.66 (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:

$\pi r^2 h$: $\pi (\frac{1}{12})^2$ 30.66 = .67 (ft^3) x 7.48 = 5 x 3 = 15 (gal.)

r = radius of well (ft)

h = height of water column (ft)

Volume Removed from Well: 30 gallons. Pumping Rate: _____

Method of Removal: hand pump Pumping Time: _____

Method of Sampling: teflon bailer Pump On: _____

Time of Sampling: 1830 Pump Off: _____

FIELD ANALYSES AND REMARKS

Temperature: 20°C Reason for Sampling: _____

Specific Conductance: 280 micromhos/cm

pH: 6.88.

Other (Specify): _____

Method of Shipment: Fed Express to Enco

Physical Appearance: clear

Type of Analyses: _____

Container Size and Type: 1 4oz glass (CN) NaOH; 1 pt plastic (metals) HNO_3;

Preservative: 2-30 ml vials VOA, EPA Method 601

REMARKS: _____

Geraghty & Miller, Inc.

WATER-QUALITY SAMPLING FORM

PROJECT NUMBER: T290ME1

Sample Number: GM-10 Date: 6-19-85

Sample Type: GEAR Time: _____ To: _____

Sampled By: BJS Weather: _____

GROUND-WATER/SURFACE-WATER ELEVATION

(1) M.P.? TOC Elevation _____

(2) Tape Held: 25.00 (at M.P.) M-Scope Reading: _____

(3) Tape Wet: 2.07

(4) Depth to Water: 22.93 (2 minus 3) **SURFACE WATER**

(5) Depth of Well: 30.00 (from M.P.) Reading at Staff Gage: _____

(6) Height of Water Column: 7.07 (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:

$\pi r^2 h$: $\pi(\frac{1}{12})^2 (7.07) = .15\ (ft^3) \times 7.48 = 1.15 \times 3 = 3.46$ (gal.)

r = radius of well (ft)

h = height of water column (ft)

Volume Removed from Well: 15 gallons Pumping Rate: _____

Method of Removal: hand pump Pumping Time: _____

Method of Sampling: teflon bailer Pump On: _____

Time of Sampling: 1445 Pump Off: _____

FIELD ANALYSES AND REMARKS

Temperature: 18°C Reason for Sampling: _____

Specific Conductance: 230 µmhos/cm

pH: 6.62

Other (Specify): _____

Method of Shipment: Fed Express to ERCO

Physical Appearance: clear, orange-tint

Type of Analyses: _____

Container Size and Type: 1 1g glass (cyanide) NaOH; 1 qt plastic (metals) HNO_3;

Preservative: 2-30 ml vials (VOA) Method 601

REMARKS: _____

Geraghty & Miller, Inc.

WATER-QUALITY SAMPLING FORM

PROJECT NUMBER: T290ME1

Sample Number: GM-11 Date: 6-19-85

Sample Type: GRAB Time: _____ To: _____

Sampled By: RJS Weather: _____

GROUND-WATER/SURFACE-WATER ELEVATION

(1) M.P.? TOC Elevation _____

(2) Tape Held: 19.00 (at M.P.) M-Scope Reading: _____

(3) Tape Wet: 1.90

(4) Depth to Water: 17.10 (2 minus 3) SURFACE WATER

(5) Depth of Well: 30.00 (from M.P.) Reading at Staff Gage: _____

(6) Height of Water Column: 12.90 (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:

$\pi r^2 h$: $\pi(\frac{1}{12})^2(12.90) = .28\ (ft^3) \times 7.48 = 2.1 \times 3 = 6.3$ (gal.)

r = radius of well (ft)

h = height of water column (ft)

Volume Removed from Well: >10 gallons Pumping Rate: _____

Method of Removal: hand pump Pumping Time: _____

Method of Sampling: teflon bailer Pump On: _____

Time of Sampling: 1700 hrs Pump Off: _____

FIELD ANALYSES AND REMARKS

Temperature: 16°C Reason for Sampling: _____

Specific Conductance: 100 µmhos/cm

pH: 7.39

Other (Specify): _____

Method of Shipment: Fed Express to ERCO

Physical Appearance: very cloudy, orange tint.

Type of Analyses: _____

Container Size and Type: 1-4 oz glass (cyanide) NaOH; 1-qt plastic (metals) HNO_3;

Preservative: 2-30 ml vials (VOA-601)

REMARKS: Wouldn't clear up — possible that bottom plug on well screen has come off — pump is pulling in filter pack sand. Much precipitate when added preservatives to CN and metals bottles.

Geraghty & Miller, Inc.

WATER-QUALITY SAMPLING FORM

PROJECT NUMBER: T290ME1

Sample Number: [illegible] Date: 6-19-85

Sample Type: GRAB Time: _____ To: _____

Sampled By: BJS Weather: _____

GROUND-WATER/SURFACE-WATER ELEVATION

(1) M.P.? TOC Elevation _____

(2) Tape Held: 25.00 (at M.P.) M-Scope Reading: _____

(3) Tape Wet: 3.91

(4) Depth to Water: 21.09 (2 minus 3) SURFACE WATER

(5) Depth of Well: 25.00 (from M.P.) Reading at Staff Gage: _____

(6) [illegible] 3.91 (5 minus 4) Elevation of [illegible] Gage: _____

(7) [illegible] urface: _____

WATER SAMPLE COLLECTION DATA

Volume of Water in well:

$\pi r^2 h$: $\pi(\frac{1}{12})^2(3.91) = .085$ (ft³) x 7.48 = 0.6 x 3 = 1.8 (gal.)

r = radius of well (ft)

h = height of water column (ft)

Volume Removed from Well: 5 gallons Pumping Rate: _____

Method of Removal: hand pump Pumping Time: _____

Method of Sampling: teflon bailer Pump On: _____

Time of Sampling: 1710 hrs Pump Off: _____

FIELD ANALYSES AND REMARKS

Temperature: 17°C Reason for Sampling: _____

Specific Conductance: 250 µmhos/cm

pH: 7.20

Other (Specify): _____

Method of Shipment: Fed Express to ERCO

Physical Appearance: slightly cloudy; orange tint

Type of Analyses: _____

Container Size and Type: 1 4 oz glass (cyanide) NaOH; 1 qt plastic (metals) HNO_3;

Preservative: 2-30 ml vials CVOA-601)

REMARKS: _____

Geraghty & Miller, Inc.

WATER-QUALITY SAMPLING FORM

PROJECT NUMBER: NAS - Memphis → see back for locations and depth

Sample Number: #1, #2, #3, #4 & #5 Date: 12-19-84

Sample Type: Sediment From Lagoon Time: _____ To: _____

Sampled By: DG Weather: Raining

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: All are muck (#5 has cigarette butts in it)

Type of Analyses: EP toxicity (Cd, Cr, Ni, Cu, Pb)

Container Size and Type: _____

Preservative: _____

REMARKS: There is life in both lagoons - minnows, water bugs, turtles

CHAIN OF CUSTODY RECORD

PROJECT NUMBER:

GERAGHTY & MILLER, INC.
WATER-RESOURCES CONSULTANTS
CARROLLWOOD VILLAGE EXECUTIVE CENTER
13902 North Dale Mabry Highway, Tampa, Florida 33618/ (813) 961 - 1921

SAMPLE NUMBER	SAMPLE SOURCE	DATE	TIME	COMP.	GRAB	NO. OF CONTAINER	SIZE OF CONTAINER	ANALYSIS REQUIRED	REMARKS
	GM-1	6-19	0900		✓	4	various sizes	Ca, Cr, Cu, Ni, Pb, Zn,	CN, VOA (method 601
	GM-2	6-19	1040		x	"	"	"	
	GM-3	6-19	1110		x	"	"	"	
	GM-4	6-19	1240		x	"	"	"	
	GM-5	6-19	1335		x	"	"	"	
	GM-6	6-18	1739		x	"	"	"	
	GM-7	6-18	1432		x	"	"	"	
	GM-8	6-18	1708		x	"	"	"	
	GM-9	6-18	1830		x	"	"	"	
	GM-10	6-19	1445		x	"	"	"	
	GM-11	6-19	1700		x	"	"	"	
	GM-12	6-19	1710		x	"	"	"	
	trip blank	6-18	1432		x	2	40 ml		

SAMPLES COLLECTED BY: (Signature)	DATE	TIME	RELINQUISHED BY: (Signature)	DATE	TIME	RECEIVED BY: (Signature)
Barry James Stutzke	6-18 6-19	-	Barry James Stutzke	6-19	1830 hrs	
METHOD OF SHIPMENT			RELINQUISHED BY: (Signature)			RECEIVED BY: (Signature)
REMARKS:			RELINQUISHED BY: (Signature)			RECEIVED BY: (Signature)
			RELINQUISHED BY: (Signature)			RECEIVED AT LABORATORY BY:

Geraghty & Miller, Inc.

WATER-QUALITY SAMPLING FORM

PROJECT NUMBER: NAS - Memphis

Sample Number: A (Drainage ditch at SW property boundary) Date: 12-19-84

Sample Type: Sediment sample Time: _____ To: _____

Sampled By: DG Weather: Rainy

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: N/A 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: Mucky, loose, light brown

Type of Analyses: Metals (Cd, Cr, Cu, Ni, Pb, Zn) and CN

Container Size and Type: 150 ml and 250 ml

Preservative: None

REMARKS: Mucky

Geraghty & Miller, Inc.

WATER-QUALITY SAMPLING FORM

PROJECT NUMBER: NAS-Memphis

Sample Number: B (Drainage ditch near Rd #1) Date: 12-1984

Sample Type: Sediment Time: _____ To: _____

Sampled By: DG Weather: Rainy

GROUND-WATER/SURFACE-WATER ELEVATION

(1) M.P.? N/A 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: Clayey, Firm, light brown

Type of Analyses: Metals (Cd, Cr, Cu, Ni, Pb, Zn) and CN

Container Size and Type: _____

Preservative: None preserved

REMARKS: Clayey

Geraghty & Miller, Inc.

WATER-QUALITY SAMPLING FORM

PROJECT NUMBER: NAS - Memphis

Sample Number: C (drainage ditch were sewer line opens) Date: 12-19-84

Sample Type: Sediment Time: _____ To: _____

Sampled By: DG 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: metals (Cd, Cr, Cu, Ni, Pb, Zn) and CN

Container Size and Type: _____

Preservative: None

REMARKS: _____

CHAIN OF CUSTODY RECORD

PROJECT NUMBER: NAS - Memphis 1984

GERAGHTY & MILLER, INC.

WATER-RESOURCE[illegible] CONSULTANTS

CARROLLWOOD VILLAG[illegible] UTIVE CENTER

13902 North Dale Mabry Highway, Tam[illegible]la 33618/ (813) 961 - 1921

SAMPLE NUMBER	SAMPLE SOURCE	DATE	TIME	COMP.	GRAB	NO. OF CONTAINER	SIZE CONTA[illegible]	ANALYSIS REQUIRED	REMARKS
#1	Sediment sample of Lagoon	12-19	AM		X	1		[illegible]ox (Cd, Cr, Ni, Cu, Pb,)	
#2	↓	↓	↓		↓	↓		↓	
#3									
#4									
#5									
A	Sediment sample of Stream		PM			2		[illegible]d, Cr, Cu, Ni, Pb, Zn & CN	
B	↓	↓	↓		↓	↓		↓	
C									

SAMPLES COLLECTED BY: (Signature)	DATE	TIME	RELINQUISHED BY: (Signature)	DATE	TIME	RECEIVED BY: (Signature)
Douglas Grant	12-19-84	1415	Douglas Grant	12-19-84	1415	
METHOD OF SHIPMENT: Air Freight (Fed Ex)			RELINQUISHED BY: (Signature)			RECEIVED BY: (Signature)
REMARKS:			RELINQUISHED BY: (Signature)			RECEIVED BY: (Signature)
			RELINQUISHED BY: (Signature)			RECEIVED AT LABORATORY BY:

CHAIN OF CUSTODY RECORD

PROJECT NUMBER: T290ME1

GERAGHTY & MILLER, INC.
WATER-RESOURCES CONSULTANTS
CARROLLWOOD VILLAGE EXECUTIVE CENTER
~~13002~~ 14510 North Dale Mabry Highway, Tampa, Florida 33618/ (813) 961 - 1921

SAMPLE NUMBER	SAMPLE SOURCE	DATE	TIME	COMP.	GRAB	NO. OF CONTAINER	SIZE OF CONTAINER	ANALYSIS REQUIRED	REMARKS
GM-9	SOIL FROM 14' - 15'	6-10	P.M.		X	1	(glass) Small	Cd, Cr, Cu, Ni, Pb, Zn, CN	
GM-9	SOIL FROM 15' - 16'	6-10	PM		X	1	small glass	Cd, Cr, Cu, Ni, Pb, Zn, CN	
GM-9	SOIL FROM 17' - 18'	"	"		"	"	"	"	
GM-9	SOIL FROM 18' - 19'	"	"		"	"	"	"	
GM-9	SOIL FROM 20' - 21'	"	"		"	"	"	"	
GM-9	SOIL FROM 23' - 24'	"	"		"	"	"	"	

SAMPLES COLLECTED BY: (Signature)	DATE	TIME	RELINQUISHED BY: (Signature)	DATE	TIME	RECEIVED BY: (Signature)
Douglas Grant	6/10	PM	Douglas Grant	6/11	1200	
METHOD OF SHIPMENT: Air Freight			RELINQUISHED BY: (Signature)			RECEIVED BY: (Signature)
REMARKS:			RELINQUISHED BY: (Signature)			RECEIVED BY: (Signature)
			RELINQUISHED BY: (Signature)			RECEIVED AT LABORATORY BY:

GEO Construction Testing, Inc.
650 New York St. | P.O. Box 14486 | Memphis, TN 38114 | Telephone 901 278-2000

GEO Construction Testing

February 5, 1985

Memphis, Tennessee

REPORT OF Permeability & Unit Weight

FOR Geraghty & Miller

JOB Naval Air Station, Millington, TN

SAMPLE FROM

SOURCE OF MATERIAL

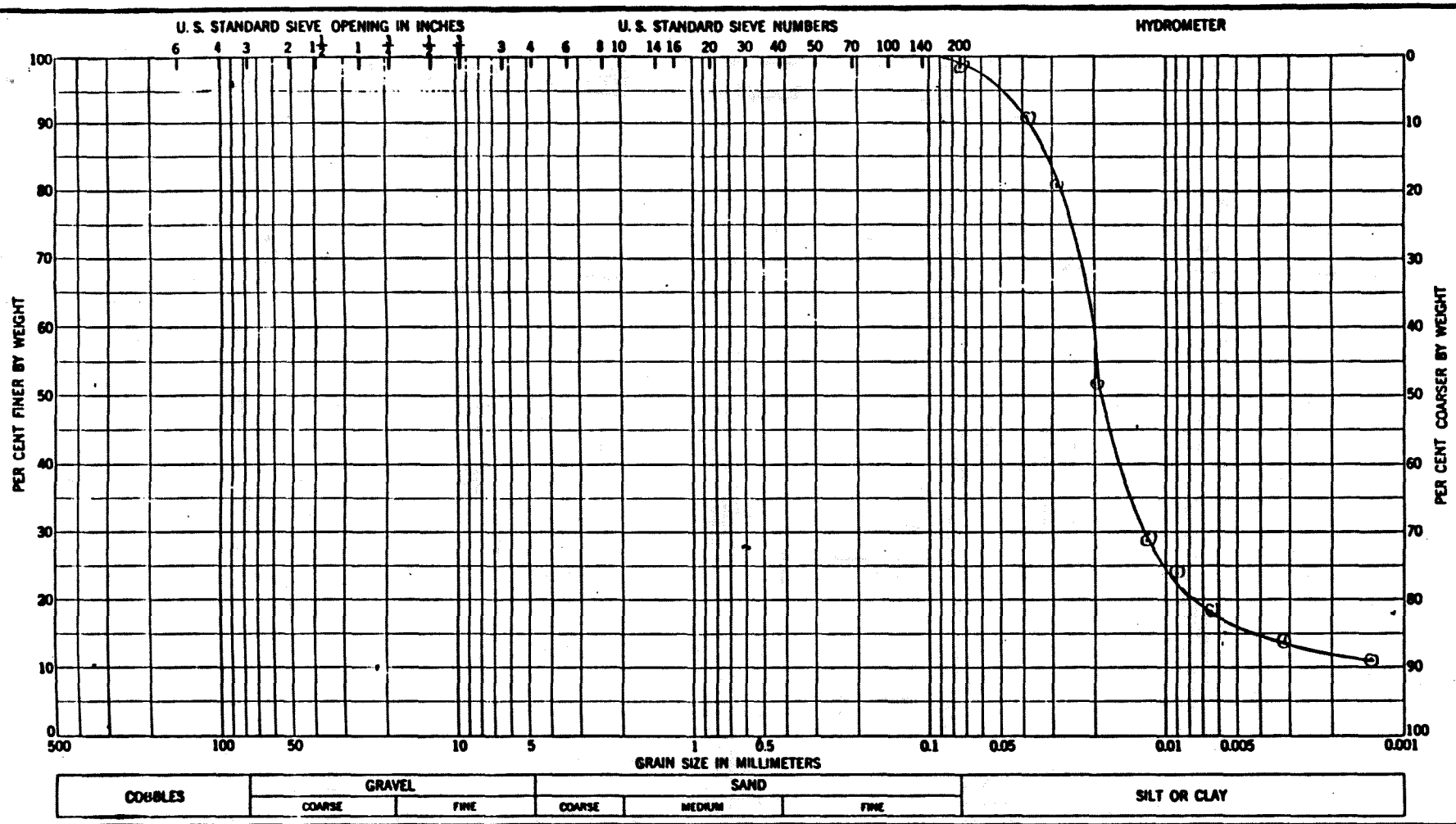
Boring Number	Depth Feet	Wet Weight (pcf)	Dry Weight (pcf)	Moisture (%)	PPR (tsf)	Torvane (tsf)	Permeability (cm/sec)
GM-3	13.0-15.0	122.7	94.0	30.5	1.6	0.3	1.58×10^{-6}
GM-3	30.0-32.0	120.9	91.7	31.9	3.5	0.45	8.54×10^{-6}
GM-7	10.0-12.0	120.1	93.1	28.9	1.0	0.3	5.20×10^{-7}
GM-7	35.0-37.0	119.1	92.3	29.0	1.3	0.6	5.96×10^{-6}

REMARKS:

COPIES TO:

Approved By: Owen L. Bryle
Laboratory Supervisor

LABORATORY NO. SR-127



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
GM-3	13'-15'	Sand - 2%				
		Silt - 82%				
		Clay - 16%				

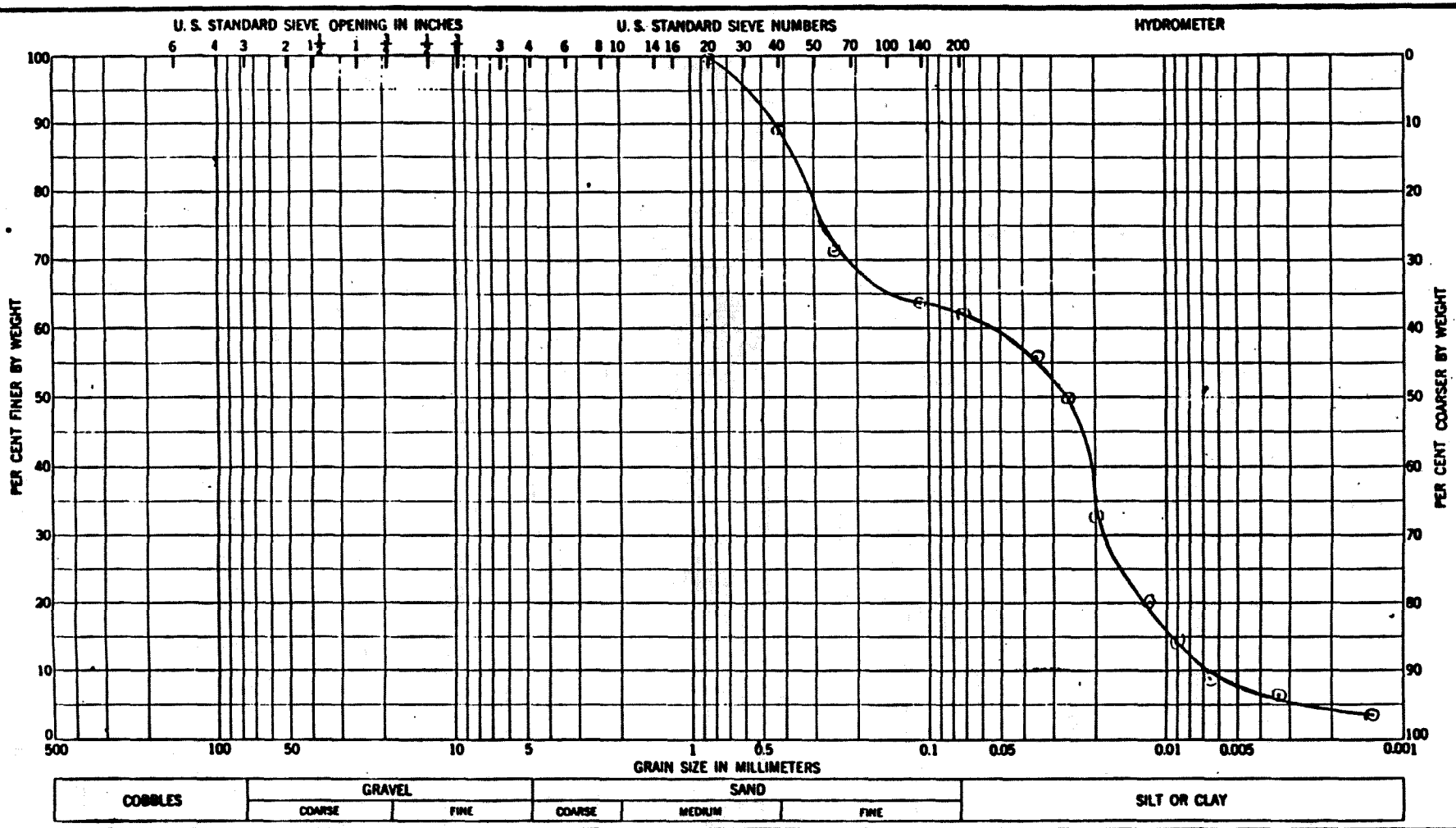
GRADATION CURVES

Project: Naval Air Station
Geraghty & Miller

Area:

Boring No.: GM-3

Date: February 11, 1985



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
GM-3	30'-32'	Sand - 38%				
		Silt - 54%				
		Clay - 8%				

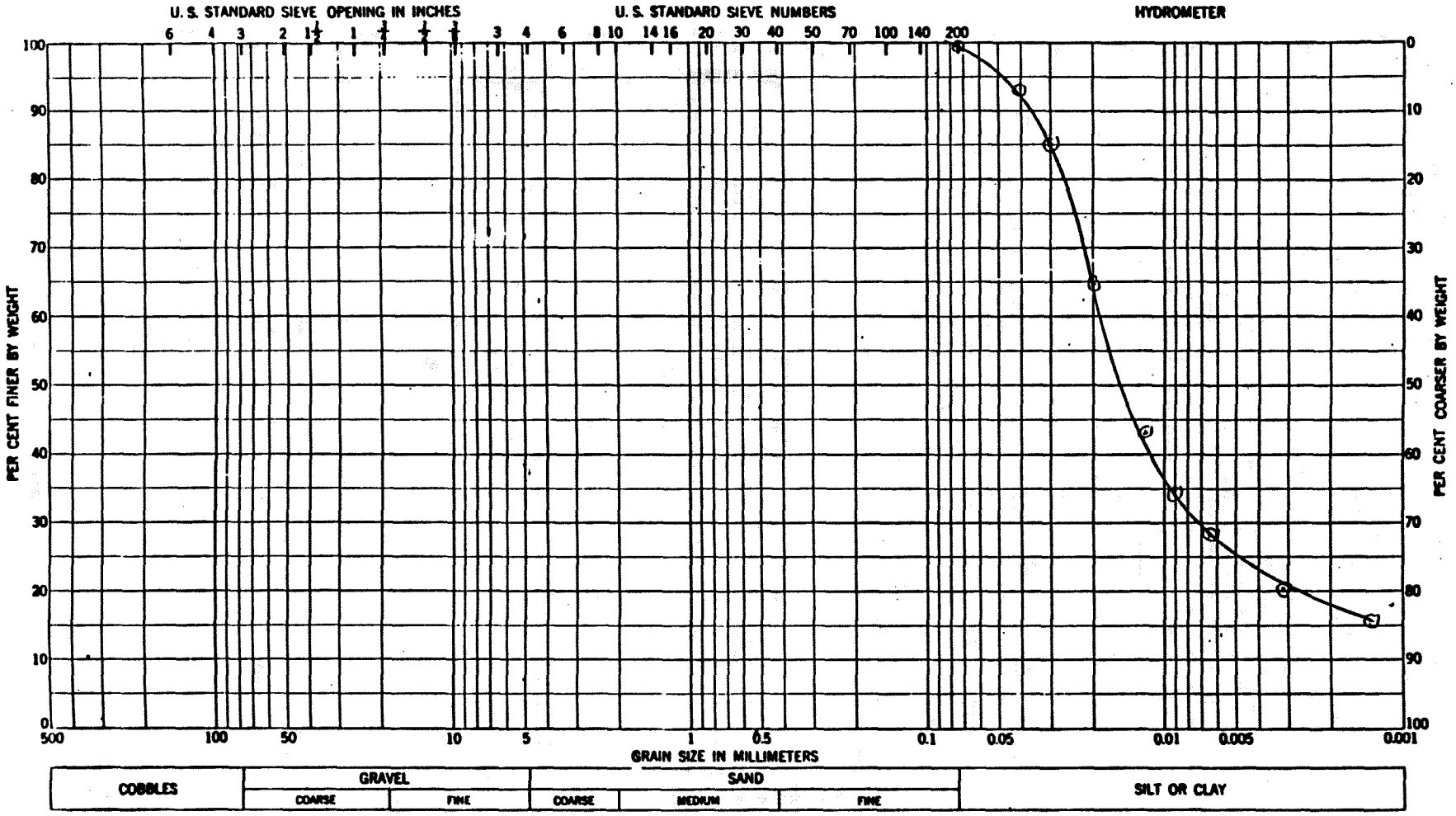
GRADATION CURVES

Project: Naval Air Station
Geraghty & Miller

Area:

Boring No.: GM-3

Date: February 11, 1985



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
GM-7	10'-12'	Sand - 1%				
		Silt - 74%				
		Clay - 25%				

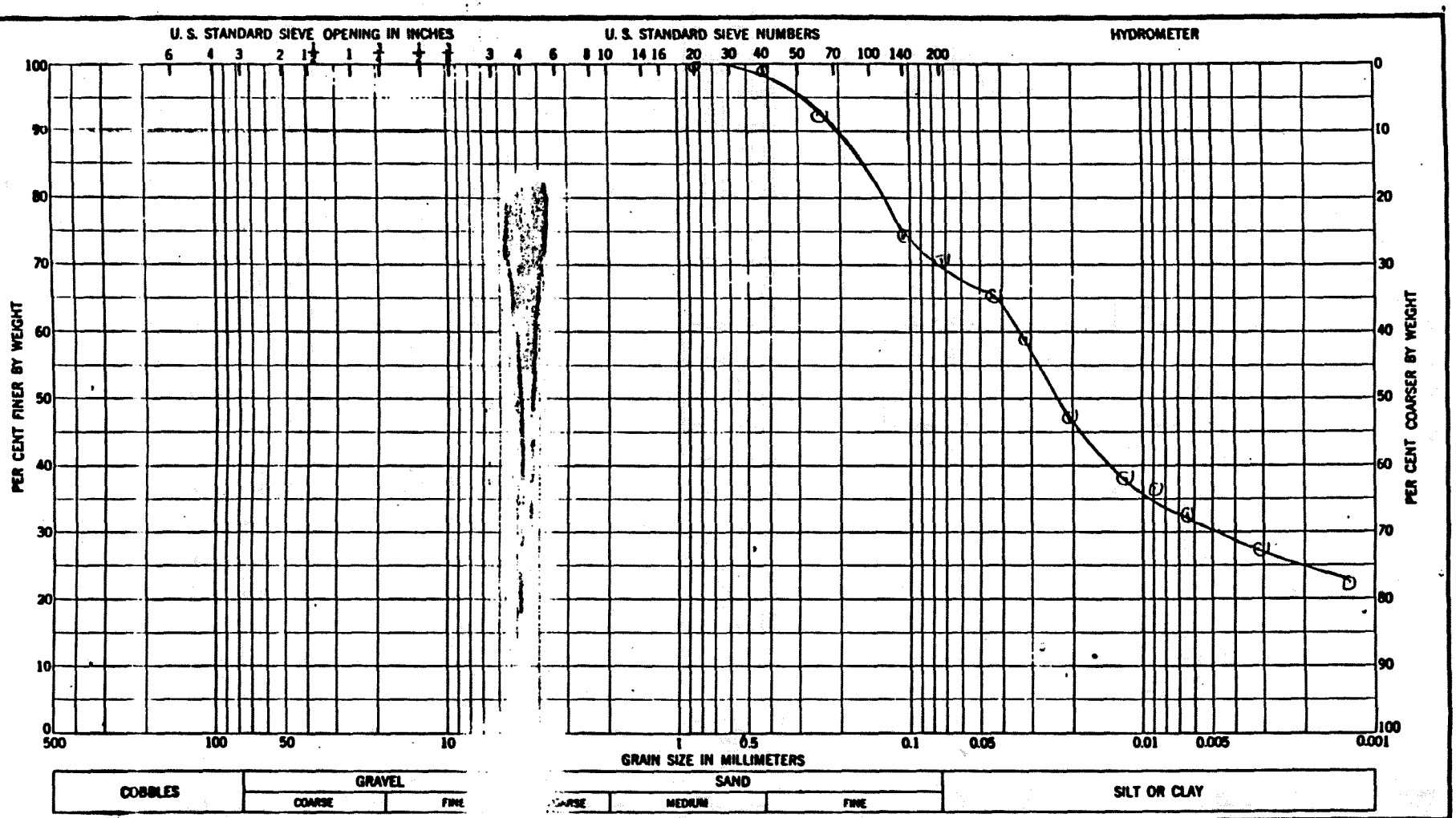
GRADATION CURVES

Project: Naval Air Station
Geraghty & Miller

Area:

Boring No.: GM-7

Date: February 11, 1985



Sample No.	Elev or Depth	Classifi.	Nat w %	LL	PL	PI
GM-7	35'-37'	Sand - 30%				
		Silt - 40%				
		Clay - 30%				

GRADATION CURVES

Project: Naval Air Station
Geraghty & Miller

Area:

Boring No.: GM-7

Date: February 11, 1985

END OF DOCUMENT

FINAL

SOLID WASTE MANAGEMENT UNIT #28 SAMPLING RESULTS

NAS MEMPHIS, SOUTHSIDE

Prepared for

Roy P. Harrover & Associates
Architects

Contract No. N62467-84-C-0152
(Aviation Support Equipment Training Bldg.)

Prepared by

Environmental and Safety Designs, Inc.
Memphis, Tennessee

January 1989

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2.3 Sampling Techniques 4
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1.0 INTRODUCTION

Environmental and Safety Designs (EnSafe) was contracted by Roy P. Harrover and Associates in conjunction with Southern Division Naval Facilities Engineering Command to investigate the possibility of metal and/or petroleum hydrocarbon contamination in soils at the Southside Sewage Treatment Plant (SWMU 28) located at Naval Air Station (NAS) Memphis (Figure 1).

The Southside Sewage Treatment Plant operated from 1943 until 1984. The plant included primary settling tanks, trickling filters, final settling tanks, and sludge drying beds. The plant received sewer discharge from housing and some industrial areas. The industrial discharge is presumed to have contained a variety of oils, solvents, paints and other chemicals. According to Navy personnel at the site there was no documented release of hazardous waste to the environment.

2.0 SAMPLING RATIONALE

The Site Investigation Sampling Plan proposed to collect samples for chemical and physical analysis in order to determine the areal extent, if any, of contamination from heavy metals or petroleum hydrocarbons associated with SWMU 28.

2.1 Sampling Procedure

The objective of sampling the Southside Sewage Treatment Plant

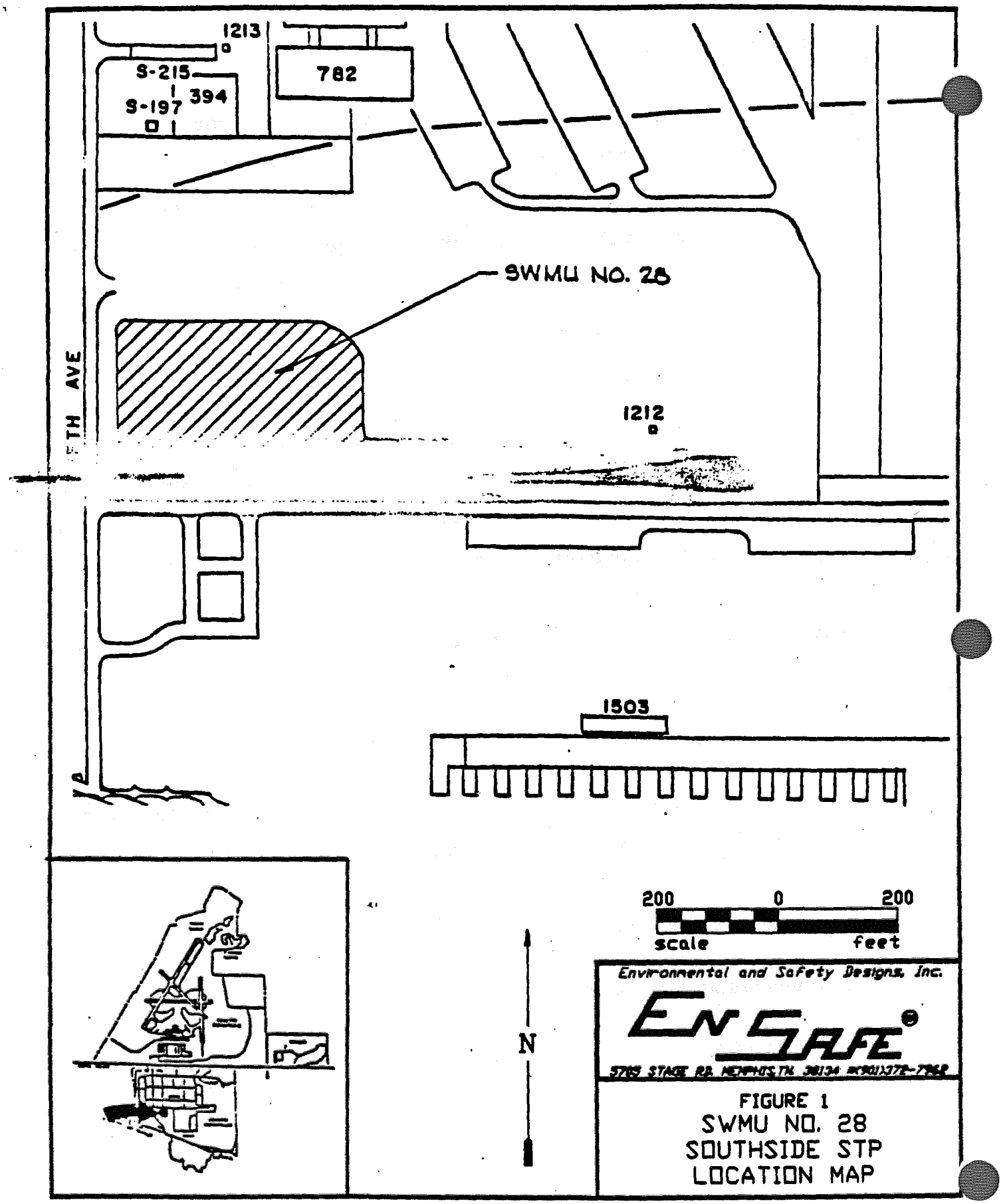


FIGURE 1
SWMU NO. 28
SOUTHSIDE STP
LOCATION MAP

was to determine if any hazardous constituents existed in the soil due to past operations at the site. Since there was no evidence that contamination existed the investigation did not address groundwater, surface water, or air quality.

Eight shallow borings were placed within the parameters of the former Treatment Plant. One additional boring was placed in an area thought to be free of possible contamination for background. The borings were located in accordance with the sampling plan as follows: Figure 2 shows the sampling locations in relation to SWMU 28.

B1 One - 8.5 foot boring located on the south end of the final settling tanks. The boring was originally scheduled for 15 feet, however; due to impenetrable subsurface conditions the boring was discontinued at 8.5 feet,

B2 One - 15 foot boring located on the north end of the final settling tanks

B3 One - 15 foot boring on the south end of the primary settling tanks

B4 One - 15 foot boring on the north end of the primary settling tanks

B5 One - 15 foot boring on the west end of the trickling filters

B6 One - 15 foot boring on the east end of the trickling filters

B7 One - 5 foot boring within the sludge drying beds between 50

and 150 feet from the west end.

B8 One - 5 foot borings within the sludge drying beds between 50 and 150 feet from the east end.

B9 Two - background composite samples, one at 4.5 - 5.5 feet, and one between 14 and 15 feet. The boring location for the background samples was located approximately 40 feet west from the southwest corner of Bldg. S-1212 (See Figure 1).

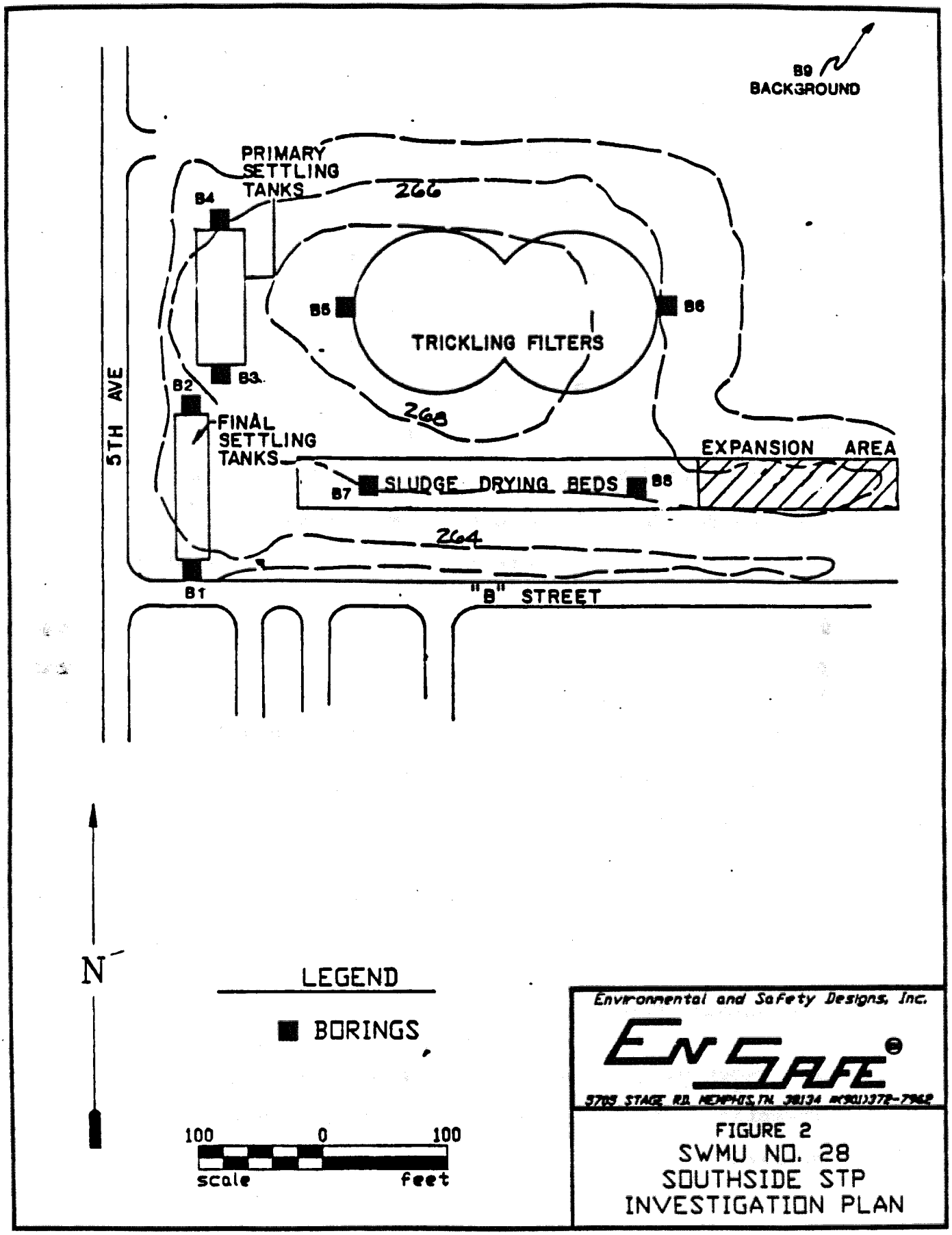
2.2 Soil Sampling

The drilling operations for the sampling plan were executed in an orderly and systematic manner to optimize the value of each boring. Sampling techniques incorporated the use of solid flight augers in lieu of the proposed hollow stem techniques.

One composite soil sample was collected from the lower 1 foot of each boring after being logged by the site geologist. The sample was preserved at 4 degrees Centigrade and shipped by overnight delivery to a qualified laboratory for analysis.

2.3 Sampling Techniques

Soil samples were taken by removing the solid flight auger from the annulus of the boring and driving an eighteen (18) inch


B9
BACKGROUND
PRIMARY SETTLING TANKS
B4
266
B5
B6
TRICKLING FILTERS
B3
B2
5TH AVE
FINAL SETTLING TANKS
268
EXPANSION AREA
B7
SLUDGE DRYING BEDS
B8
264
B1
"B" STREET
N
LEGEND
BORINGS
100
0
100
scale
feet
Environmental and Safety Designs, Inc.
EN SAFE
5709 STAGE RD. MEMPHIS, TN. 38134 (901)372-7962
FIGURE 2
SWMU NO. 28
SOUTHSIDE STP
INVESTIGATION PLAN

split-spoon sampler. Upon withdrawal of the sampler the external layer of soil was removed using a clean spatula. The samples were composited and placed in pre-cleaned 250 ml glass jars, capped with a teflon coated lid, labeled and sealed.

To prevent cross contamination all sampling equipment was decontaminated between samples. Decontamination procedures occurred at the NAS Memphis carwash on the northside of the air station. The sequence for decontamination consisted of the following steps: 1) steam cleaning, 2) rinse with tap water, and 3) rinse with distilled water. A sample of the final rinsate was collected for analysis per the original sampling plan. All personnel handling the samples wore latex surgical gloves which were discarded between samples.

2.4 Custody Procedure

To assure the samples were maintained in a safe and reliable manner, a strict chain-of-custody procedure was followed. This was implemented in the field and carried throughout the entire analytical process. All parties handling the samples signed the chain-of-custody form and this form has become a part of the permanent records.

3.0 ANALYTICAL PROCEDURES

Two types of analysis were implemented at the NAS Memphis site investigation; on-site screening and laboratory analysis of samples.

An Hnu organic vapor detector was used in accordance with the Sampling and Quality Assurance Plan for screening of air quality for contaminants emitting from each bore hole, and for on site screening of each soil sample. Prior to drilling, a background organic vapor detector of 0.2 parts per million (ppm) was established. The background reading was established by measuring ambient air from an open field immediately south of the former Treatment Plant. Readings from the photoionization detector never varied +/- 0.05 from background, indicating that no abnormal concentrations of organic vapors were encountered at the site.

The soil samples, one rinsate sample, and two background samples were analyzed for 8 EP toxicity metals and benzene, toluene, and xylene (BTX). The trip blank was analyzed for BTX only.

Soil samples were extracted by EPA Method 1310, Extraction Procedure (EP) Toxicity Method. Samples were then analyzed by direct aspiration atomic absorption techniques, except arsenic and selenium which were analyzed by gaseous hydride methods, and mercury which was analyzed by cold vapor atomic absorption.

BTX analysis used EPA Methods 8020 for aromatics and Method 5030 for volatile parameters. Quality control included the analysis of one duplicate sample ID, B5-A), one trip blank (sample ID, SWMU 28-TB), and one sample from the rinsate collected (sample ID, SWMU 28- Rinsate).

4.0 RESULTS AND CONCLUSIONS

A total of eleven composite soil samples were collected from the area corresponding with the former Southside Sewage Treatment Plant. Nine composite samples were collected from the aforementioned locations (Sect. 2-1), one of which (B5-A) was a duplicate sample. An additional two samples were collected for background, each corresponding to sampling depths established in the Sampling and Quality Assurance Plan.

[illegible] composite sample was analyzed for [illegible] esents the analytical results from all samples collected. The samples showed no detectable levels of contamination above normal background for metals, and all BTX analysis were below detection limits. The complete laboratory results are included in Appendix B.

TABLE 1
DATA SUMMARY FOR SWMU 28
AND RELATED QUALITY ASSURANCE

	EP TOXICITY RESULTS mg/l								BTX RESULTS µg/kg			
Sample ID	Arsenic	Barium	Cadmium	Chromium	Lead	Mercury	Selenium	Silver	Benzene	Ethylbenzene	Toluene	Xylene
B1	<1.00	1.03	<0.50	<1.00	<1.00	<0.20	<0.50	<1.00	<10	<10	<10	<10
B2	<1.00	<1.00	<0.50	<1.00	<1.00	<0.20	<0.50	<1.00	<10	<10	<10	<10
B3	<1.00	<1.00	<0.50	<1.00	<1.00	<0.20	<0.50	<1.00	<10	<10	<10	<10
B4	<1.00	<1.00	<0.50	<1.00	<1.00	<0.20	<0.50	<1.00	<10	<10	<10	<10
B5	<1.00	<1.00	<0.50	<1.00	<1.00	<0.20	<0.50	<1.00	<10	<10	<10	<10
B5A	<1.00	<1.00	<0.50	<1.00	<1.00	<0.20	<0.50	<1.00	<10	<10	<10	<10
B6	<1.00	<1.00	<0.50	<1.00	<1.00	<0.20	<0.50	<1.00	<10	<10	<10	<10
B7	<1.00	<1.00	<0.50	<1.00	<1.00	<0.20	<0.50	<1.00	<10	<10	<10	<10
B8	<1.00	<1.00	<0.50	<1.00	<1.00	<0.20	<0.50	<1.00	<10	<10	<10	<10
B9- 4.5	<1.00	<1.00	<0.50	<1.00	<1.00	<0.20	<0.50	<1.00	<10	<10	<10	<10
B9-13.5	<1.00	<1.00	<0.50	<1.00	<1.00	<0.20	<0.50	<1.00	<10	<10	<10	<10
Rinsate	<1.00	<1.00	<0.50	<1.00	<1.00	<0.20	<0.50	<1.00	<10	<10	<10	<10
SWMU28-TB	<1.00	<1.00	<0.50	<1.00	<1.00	<0.20	<0.50	<1.00	<10	<10	<10	<10

APPENDIX A
LABORATORY RESULTS

GENERAL ENGINEERING LABORATORIES

Environmental Engineering and Analytical Services

Molly F. Greene
President

George C. Greene, P.E., Ph.D.
Vice President
SC Registration No. 9103

RECEIVED JAN - 3 1989

Laboratory Certifications:

FL	E87156/87294
NC	233
SC	10120
VA	00151
NACIP	Approved

CERTIFICATE OF ANALYSIS

Client: ENVIRONMENTAL & SAFETY DESIGNS, INC
P.O. BOX 341315
MEMPHIS , TN 38184

Date: 12/28/88

Contact: MR. J. SPEAKMAN, PhD, PE

Released by: A.M. Crane
ALLAN M. CRANE

cc/fc: ENSA/ENSA9

Page No.: 1

Parameter	Sample ID :	SWMU28 B1	SWMU28 B2	SWMU28 B3	SWMU28 B4
		12/08/88	12/08/88	12/08/88	12/08/88
	Lab ID :	88120506	88120507	88120508	88120509
	Sample Type :	15	15	15	15
	Date Received:	12/09/88	12/09/88	12/09/88	12/09/88
	Collected by :	ENSA	ENSA	ENSA	ENSA
ARSENIC		<1.00 ppm	<1.00 ppm	<1.00 ppm	<1.00 ppm
BARIUM		1.03 ppm	<1.00 ppm	<1.00 ppm	<1.00 ppm
CADMIUM		<0.50 ppm	<0.50 ppm	<0.50 ppm	<0.50 ppm
CHROMIUM		<1.00 ppm	<1.00 ppm	<1.00 ppm	<1.00 ppm
LEAD		<1.00 ppm	<1.00 ppm	<1.00 ppm	<1.00 ppm
MERCURY		<0.20 ppm	<0.20 ppm	<0.20 ppm	<0.20 ppm
SELENIUM		<0.50 ppm	<0.50 ppm	<0.50 ppm	<0.50 ppm
SILVER		<1.00 ppm	<1.00 ppm	<1.00 ppm	<1.00 ppm
EP TOX EXTRACTION-SOLID		YES	YES	YES	YES
MERCURY DIGESTION (EP TOX)		YES	YES	YES	YES
BENZENE		<10 ppb	<10 ppb	<10 ppb	<10 ppb
ETHYLBENZENE		<10 ppb	<10 ppb	<10 ppb	<10 ppb
TOLUENE		<10 ppb	<10 ppb	<10 ppb	<10 ppb
XYLENE		<10 ppb	<10 ppb	<10 ppb	<10 ppb
MOISTURE CONTENT (loss @ 105C)		22 wt%	25 wt%	20.1 wt%	35 wt%

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Environmental Engineering and Analytical Services

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President

George C. Greene, P.E., Ph.D.
Vice President
SC Registration No. 9103

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Laboratory Certifications:
FL E87156/87204
NC
SC
VA
NACIP

Approved

CERTIFICATE OF ANALYSIS

Client: ENVIRONMENTAL & SAFETY DESIGNS, INC
P.O. BOX 341315
MEMPHIS , TN 38184

Date: 12/29/88

Contact: MR. J. SPEAKMAN, PhD, PE

Released by: A.M. Crane
ALLAN M. CRANE

cc/fc: ENSA/ENSA9

Page No.: 1

Parameter	Sample ID :	SWMU28 B5 12/09/88	SWMU28 B5A 12/09/88	SWMU28 B6 12/09/88	SMWU28 B7 12/09/88
	Lab ID :	88120548	88120549	88120550	88120551
	Sample Type :	15	15	15	15
	Date Received:	12/12/88	12/12/88	12/12/88	12/12/88
	Collected by :	ENSA	ENSA	ENSA	ENSA
ARSENIC		<1.00 ppm	<1.00 ppm	<1.00 ppm	<1.00 ppm
BARIUM		<1.00 ppm	<1.00 ppm	<1.00 ppm	<1.00 ppm
CADMIUM		<0.50 ppm	<0.50 ppm	<0.50 ppm	<0.50 ppm
CHROMIUM		<1.00 ppm	<1.00 ppm	<1.00 ppm	<1.00 ppm
LEAD		<1.00 ppm	<1.00 ppm	<1.00 ppm	<1.00 ppm
MERCURY		<0.20 ppm	<0.20 ppm	<0.20 ppm	<0.20 ppm
SELENIUM		<0.50 ppm	<0.50 ppm	<0.50 ppm	<0.50 ppm
SILVER		<1.00 ppm	<1.00 ppm	<1.00 ppm	<1.00 ppm
EP TOX EXTRACTION-SOLID		YES	YES	YES	YES
MERCURY DIGESTION (EP TOX)		YES	YES	YES	YES
BENZENE		<10 ppb	<10 ppb	<10 ppb	<10 ppb
ETHYLBENZENE		<10 ppb	<10 ppb	<10 ppb	<10 ppb
TOLUENE		<10 ppb	<10 ppb	<10 ppb	<10 ppb
XYLENE		<10 ppb	<10 ppb	<10 ppb	<10 ppb
MOISTURE CONTENT (loss @ 105C)		24 wt%	26 wt%	22.1 wt%	26.0 wt%

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GENERAL ENGINEERING LABORATORIES

Environmental Engineering and Analytical Services

Molly F. Greene
President

George C. Greene, P.E., Ph.D.
Vice President
SC Registration No. 9103

Laboratory Certifications:

FL	E87156/87294
NC	233
SC	10120
VA	00151
NACIP	Approved

CERTIFICATE OF ANALYSIS

Client: ENVIRONMENTAL & SAFETY DESIGNS, INC
P.O. BOX 341315
MEMPHIS , TN 38184

Date: 12/30/88

Contact: MR. J. SPEAKMAN, PhD, PE

Released by: A.M. Crane
ALLAN M. CRANE

cc/fc: ENSA/ENSA9

Page No.: 1

Parameter	Sample ID :	SWMU28 B8 12/09/88	SWMU28 B9-4.5 12/09/88	SWMU28 B9-13.5 12/09/88	SWMU28 RINSATE 12/09/88
	Lab ID :	88120552	88120553	88120554	88120555
	Sample Type :	15	15	15	12
	Date Received:	12/12/88	12/12/88	12/12/88	12/12/88
	Collected by :	ENSA	ENSA	ENSA	ENSA
ARSENIC		<1.00 ppm	<1.00 ppm	<1.00 ppm	<1.00 ppm
BARIUM		<1.00 ppm	<1.00 ppm	<1.00 ppm	<1.00 ppm
CADMIUM		<0.50 ppm	<0.50 ppm	<0.50 ppm	<0.50 ppm
CHROMIUM		<1.00 ppm	<1.00 ppm	<1.00 ppm	<1.00 ppm
LEAD		<1.00 ppm	<1.00 ppm	<1.00 ppm	<1.00 ppm
MERCURY		<0.20 ppm	<0.20 ppm	<0.20 ppm	<0.20 ppm
SELENIUM		<0.50 ppm	<0.50 ppm	<0.50 ppm	<0.50 ppm
SILVER		<1.00 ppm	<1.00 ppm	<1.00 ppm	<1.00 ppm
EP TOX EXTRACTION-SOLID		YES	YES	YES	
MERCURY DIGESTION (EP TOX)		YES	YES	YES	YES
BENZENE		<10 ppb	<10 ppb	<10 ppb	<10 ppb
ETHYLBENZENE		<10 ppb	<10 ppb	<10 ppb	<10 ppb
TOLUENE		<10 ppb	<10 ppb	<10 ppb	<10 ppb
XYLENE		<10 ppb	<10 ppb	<10 ppb	<10 ppb
MOISTURE CONTENT (loss @ 105C)		20.8 wt%	32 wt%	24 wt%	

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GENERAL ENGINEERING LABORATORIES

Environmental Engineering and Analytical Services

Molly F. Greene
President

George C. Greene, P.E., Ph.D.
Vice President
SC Registration No. 9103

Laboratory Certifications:

FL	E87156/87294
NC	237
SC	1012
VA	00151
NACIP	Approved

CERTIFICATE OF ANALYSIS

Client: ENVIRONMENTAL & SAFETY DESIGNS, INC
P.O. BOX 341315
MEMPHIS , TN 38184

Date: 12/28/88

Contact: MR. J. SPEAKMAN, PhD, PE

Released by: ALLAN M. CRANE

cc/fc: ENSA/BTEXI

Page No.: 1

Sample ID : SWMU28
TB
[illegible]/88

Parameter	Collected by : ENSA
BENZENE	<10 ppb
ETHYLBENZENE	<10 ppb
TOLUENE	<10 ppb
XYLENE	<10 ppb

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EnSafe
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CHAIN OF CUSTODY RECORD

PAGE 1 of 1

CLIENT NAME: EnSafe

COLLECTED BY: Paul V. Stoddard

	SAMPLE ID	DATE	TIME	comp.	grab	well	SAMPLE LOCATION	# of Containers	pH, Sp. Cond	TOC	TOX	Cl, F, SO4	NITRATES	VOC	METALS	PESTICIDE	HERBICIDE	PHENOL	ACID/BASE EXT	COLIFORM	CYANIDE				REMARKS
506	SWMU28 B1	12/05/88		X				2																	EP TOX METALS METHOD 1310
507	SWMU28 B2	"		X				2																	BTX METHODS 8020 & 5030
508	SWMU28 B3	"		X				2																	~~BTX~~ METHODS ON
509	SWMU28 B4	"		X				2																	All Samples

Relinquished by:	Date	Time	Received by:	Relinquished by:	Date	Time	Received by:
[signature]	12/6/88	1001					

Relinquished by:	Date	Time	Received by Lab by:	Date	Time	Remarks
			[signature]	12/7/88	1015	

F - filtered P - preserved

EnSafe
Environmental and Safety Designs, Inc.

CHAIN OF CUSTODY RECORD

PAGE 1 of 1

CLIENT NAME: EnSafe

COLLECTED by: Paul V. Goddard

	SAMPLE ID	DATE	TIME	comp	grab	well	SAMPLE LOCATION	# of Containers	pH, Sp. Cond	TOC	TOX	Cl, F, SO4	NITRATES	VOC	METALS	PESTICIDE	HERBICIDE	PHENOL	ACID/BN Ext	COLIFORM	CYANIDE				REMARKS
548	SWMU 28 B5	12/9/88		X				2																	EP TOX METALS METHOD 1310
549	SWMU 28 B5a	"		X				2																	BTX - METHODS 8020 & 5030
550	SWMU 28 B6	"		X				2																	ON ALL SAMPLES EXCEPT
551	SWMU 28 B7	"		X				2																	
552	SWMU 28 B8	"		X				2																	
553	SWMU 28 B9-4.5	"		X				2																	
554	SWMU 28 B9-13.5	"		X				2																	
555	SWMU 28 RINSATE	"				X		2																	
556	SWMU 28 TB	"				X		4																	SWMU 28-TB Volatiles only (BTX)

Relinquished by:	Date	Time	Received by:	Relinquished by:	Date	Time	Received by:
Paul Goddard	12/9/88						

Relinquished by:	Date	Time	Received by:	Date	Time	Remarks
			[illegible]	12/12/88	8:00	

FINAL SUBMITTAL

SITE SAMPLING
AND
QUALITY ASSURANCE PLAN

NAS MEMPHIS, SOUTHSIDE

Prepared for

Roy P. Harrover & Associates
Architects

Contract No. N62467-84-C-0152
(Aviation Support Equipment Training Bldg.)

Prepared by

Environmental and Safety Designs, Inc.
Memphis, Tennessee

November 1988

1.0 INTRODUCTION

The following is a Site Sampling and Quality Assurance Plan for an investigation of the possibility of metal and/or petroleum hydrocarbon contamination in soils at the former Southside Sewage Treatment Plant (SWMU 28), NASMEMPHIS.

The Southside Sewage Treatment Plant (Figure 1) operated from 1943 until 1984. The plant included primary settling tanks, trickling filters, final settling tanks, and sludge drying beds. The plant received sewer discharge from housing and some industrial areas. The industrial discharge is presumed to have contained a variety of oils, solvents, paints and other chemicals. According to Navy personnel at the site there is no documented release of hazardous waste to the environment.

2.0 SAMPLING PLAN

2.1 Sampling Objectives

The Site Investigation Sampling Plan proposes to collect samples for chemical and physical analysis in order to determine the areal extent, if any, of contamination from heavy metals or petroleum hydrocarbons associated with SWMU 28.

2.2 Sampling Protocol and Rationale

The objective of sampling the Southside Sewage Treatment Plant

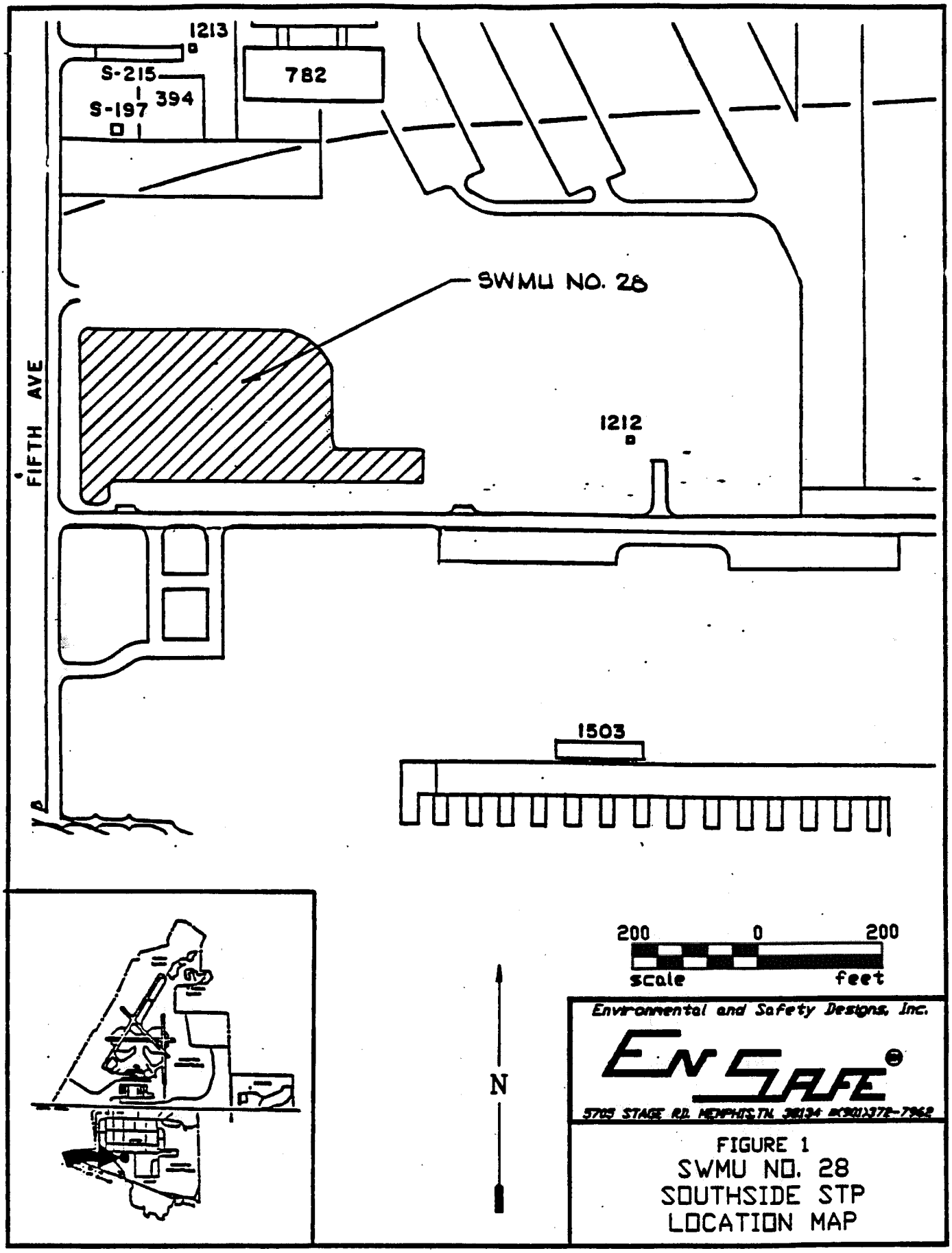

FIGURE 1
SWMU NO. 28
SOUTHSIDE STP
LOCATION MAP

is to determine if any hazardous constituents exist in the soil due to past operations at the site. Since there is no evidence that contamination exists, there will be no investigation that addresses groundwater, surface water, or air quality at this time.

Eight borings will be placed within the parameters of the Treatment Plant. One additional boring will be placed in an area thought to be free of possible contamination for background. The borings will be located as follows:

[illegible] the final settling tanks

B2 One - 15 foot boring located on the north end of the final settling tanks

B3 One - 15 foot boring on the south end of the primary settling tanks

B4 One - 15 foot boring on the north end of the primary settling tanks

B5 One - 15 foot boring on the west end of the trickling filters

B6 One - 15 foot boring on the east end of the trickling filters

B7 Two - 5 foot borings within the sludge drying beds between 50 and 150 feet from the west and east ends.

B8 Two - background composite sample, one at 4.5 - 5.5 feet

and one between 14 and 15 feet. The background samples will come from a predetermined area to be representative of native soils.

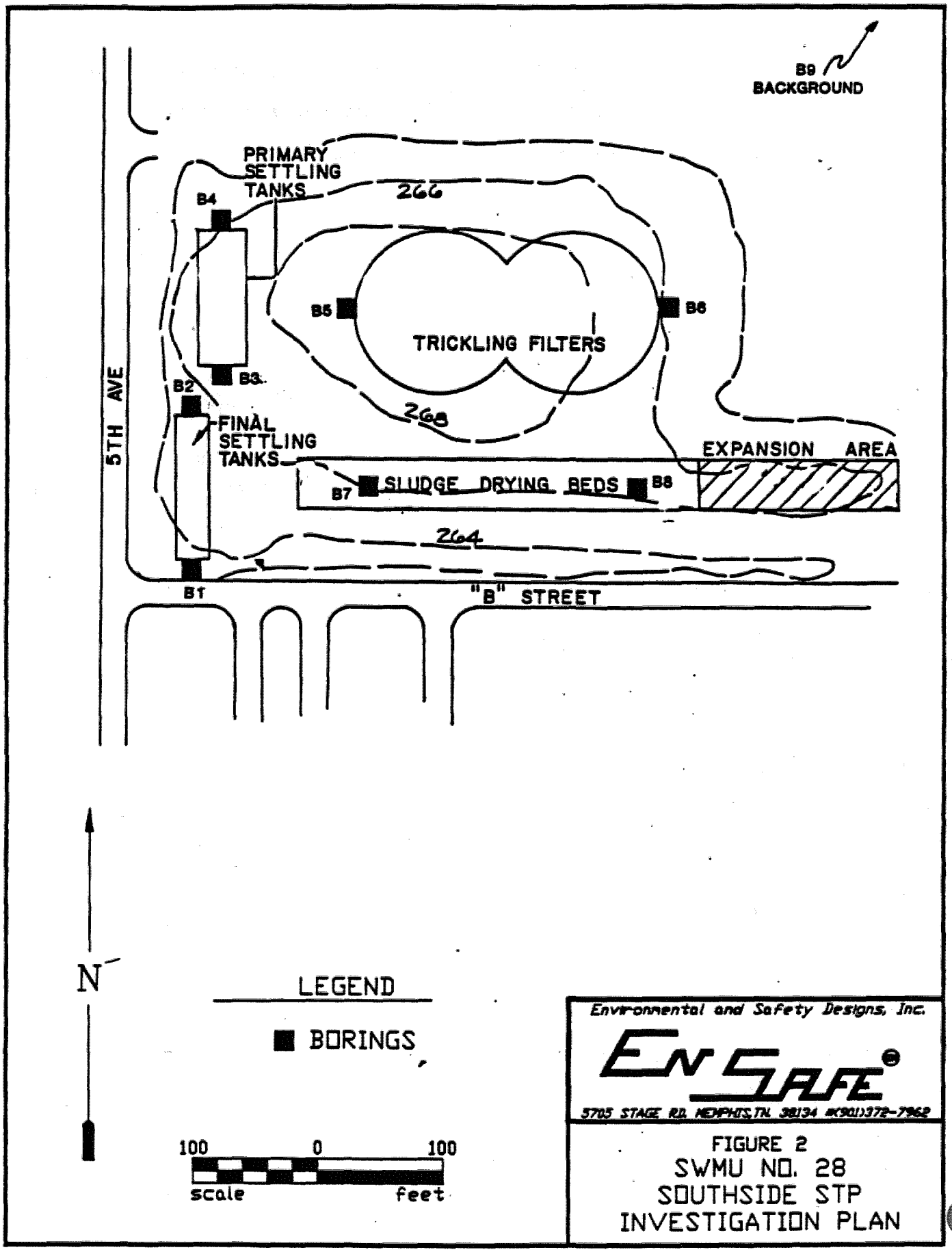

FIGURE 2
SWMU NO. 28
SOUTHSIDE STP
INVESTIGATION PLAN

Figure 2 shows the proposed sampling locations in relation to SWMU 28.

2.2 Soil Sampling

The drilling operations for the sampling plan will be executed in an orderly and systematic manner to optimize the value of each boring. Sampling techniques will incorporate the use of hollow stem auger techniques.

One soil samples will be collected from the lower 1 foot of each boring after being logged by the site geologist. The sample will be preserved at 4 degrees Centigrade and shipped by overnight delivery to a qualified laboratory for analysis.

2.3 Sampling Techniques

Soil samples will be taken by removing the hollow stem auger from the annulus of the boring and driving an eighteen (18) inch split-spoon sampler. Upon withdrawal of the sampler the external layer of soil will be removed using a clean spatula. The samples will be composited and placed in pre-cleaned 250 ml glass jars, capped with a teflon coated lid, labeled and sealed.

The split-spoon sampler will be decontaminated between samples to prevent cross-contamination. Also all personnel handling the samples will wear latex surgical gloves which will be discarded between samples.

To prevent cross-contamination, all equipment : split-spoon sampler, spatula, sample jars, etc., will be decontaminated before initial use and between each sample. Decontamination will follow these steps:

1) rinse with a dilute trisodium phosphate mixture

2) rinse with tap water

3) rinse with distilled water.

2.4 Custody Procedure

To assure the samples are maintained in a safe and reliable manner, a strict chain-of-custody procedure will be followed. This will be implemented in the field and carried throughout the entire analytical process. All parties handling the samples will sign the chain-of-custody form (Figure 3) and this form will become a part of the permanent records.

2.5 Analytical Procedures

Two types of analytical procedures will be used in the NASMEMPHIS investigation.

1) On site screening of air quality for contaminants emitting from each bore hole, and on site screening of each soil sample will be done by using an Hnu organic vapor detector in accordance with the scope of work.

2) The soil samples, one rinsate sample, and two background samples will be analyzed for the following parameters:

FIGURE 3

CHAIN OF CUSTODY RECORD

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PAGE ___ of ___

CLIENT NAME

COLLECTED BY

SAMPLE ID	DATE	TIME	comp	grab	well	SAMPLE LOCATION	# of Containers	pH, Sp. Cond	TOC	TOX	Cl, Fl, SO4	NITRATES	VOC	METALS	PESTICIDE	HERBICIDE	PHENOL	ACID/B/N Ext	COLIFORM	CYANIDE				REMARKS
									F P		F	F P		F P			P		P	P F P	F P	F P		

SAMPLE ANALYSIS (x)

F - filtered P - preserved

Relinquished by:	Date	Time	Received by:	Relinquished by:	Date	Time	Received by:
Relinquished by:	Date	Time	Received by lab by:	Date	Time	Remarks	

a) 8 EP toxicity metals using EPA Method 1310, and

b) BTX, using EPA Methods 8020 for aromatics and Method 5030 for volatile parameters.

3.0 QUALITY ASSURANCE PROCEDURES

3.1 Quality Assurance in the Field

To monitor the quality of field sampling protocols, the following Quality Assurance samples will be collected:

Field Blank (deionized water transferred in the field)	1
Soil Duplicate (randomly chosen from soil samples)	1
Travel Blank (deionized water)	1

The Field Blank and soil duplicate will be analyzed for the 8 RCRA metals and BTX with the collected field samples. The travel blank will be analyzed for BTX only (due to the possibility of volatile parameters losses or introductions during shipment).

The soil samples collected for the NAS Memphis SWMU 28 investigation will be placed in amber, glass bottles, pre-cleaned to EPA specifications for environmental glassware. The bottles will be fitted with teflon[1] lids and stored in insulated containers at 4 degrees Centigrade. The chain of custody provisions are described in Section 2.0.

3.2 Laboratory Quality Assurance

The laboratory will be required to perform at least one matrix spike of a soil sample to monitor percent recovery of the analysis. In addition appropriate laboratory blanks are required for each analysis.

The laboratory Quality Assurance Program is provided as Appendix 1.

---

1 Teflon is a registered trademark of the Dupont Company.

APPENDIX 1

LABORATORY QUALITY ASSURANCE PROTOCOLS

HANDBOOK FOR ANALYTICAL QUALITY CONTROL

GENERAL ENGINEERING LABORATORIES

VOLUME I

GENERAL DESCRIPTIONS AND METHODOLOGIES

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Appendix 2: Log Sheets
- Autoclaves
- Deionized Water
- Ovens & Incubators
- pH Meters
- Bacteriological Media
- Bacteriological Membrane Filters
- Sterile Funnels
- Standard Log - Table of Containers
- Concentrated Stock Standards
- Intermediate Standards
- Working Standards

Appendix 3: Chain of Custody Document
Appendix 4: EPA Recommended Holding Times and Sample Preservation Requirements

I. INTRODUCTION

The analytical laboratory provides both quantitative and qualitative data which is used for decision making in many areas. These decisions often involve the expenditure of large amounts of money. In environmental data, false positive data can result in needless expenditures while false negative data can result in the spread of contamination and serious endangerment to both human health and the environment. Incorrect or misleading data can do more harm than no data at all.

Data from our laboratory are often used to define whether or not regulatory or contractural conditions are being met. In the case of water, the data is often used to determine whether or not the wateer can be used for its intended purpose. Decisions involving process changes, plant modifications, or the construction of new facilities may be based primarily on the results of laboratory analyses. The financial implications of such decisions are generally significant and the potential for adverse impact on the environment and the possibility for endangerment to our health is serious. Thus it is essential that the results of analyses conducted in our laboratory be accurate and reliable.

The professional [illegible] is based largely on the accuracy, reliability [illegible] the laboratory. The integrity of the analysts [illegible] maintaining [illegible]

Environmental samples must be tested in accordance with accepted regulatory methods. Standard laboratory procedures are described in the Laboratory Procedures Manual. All of these procedures are approved EPA methodologies.

It is essential that all analyses be carried out in strict accordance with the standard procedures in order to insure uniformity of both intralaboratory and interlaboratory test results. It is also essential that all raw data and analytical conditions be recorded in the appropriate laboratory data book in the standard format in order to insure that the test results can be reconstructed by any capable analyst at a later date.

The Handbook for Analytical Quality Control consists of four volumes:

Volume I	General Descriptions and Methodologies
Volume II	Quality Control Data for Wet Chemical Analyses
Volume III	Quality Control Data for Metals Analyses
Volume IV	Quality Control Data for Organics Analyses

II. UTILITY SERVICES

The following utilities are provided to each individual laboratory and to the individual work stations in the main laboratory by way of pipe racks which run above the ceiling:

+ Cold Water
+ Hot Water
+ Deionized Water
+ Compressed Air
+ Natural Gas
+ Vacuum
+ 110 Volt AC
+ 220 Volt AC (at selected stations)
+ Lighting
+ Wastewater Drainage

The pipe racks have been designed to allow utilities to be provided to additional or temporary work stations at any location in the laboratory by simply teeing into the desired overhead line and dropping down to the location.

Cold Water

City water is distributed throughout the laboratory through 3/4 inch Copper tubing. The water enters the building through the Sample Storage Room.

Hot Water

Hot water is distributed throughout the laboratory through 3/4 inch Copper tubing. A 50 gallon quick recovery electric hot water heater is located in the Utility Room.

Deionized Water

Deionized water is distributed throughout the laboratory through half inch schedule 40 PVC pipe. This water is made from city water by a Continental Services Deionization System capable of producing 20 gpm of laboratory pure water. The system is located in the Utility Room and consists of the following units:

+ 10 micron Prefilter: for removal of particulates prior to passing through the ion exchange resin beds;
+ Primary Ion Exchange Bed: for primary removal of trace level cations and anions;
+ Polishing Ion Exchange Bed: for secondary removal of trace level cations and anions and for reserve exchange capacity when the primary cylinder is depleted;
+ Activated Carbon Filter: for removal of trace level organics;
+ Ultraviolet Light: for distruction of any bacterial growth which might pass through the system.

This system is designed to produce laboratory pure water with the following specifications:

+ Conductivity	<5.0 umhos/cm @ 25°C
+ pH	5.5 - 7.5
+ TOC	<1.0 mg/L
+ Trace Metals, Single	<0.05 mg/L
+ Trace Metals, Combined (Cd, Cr, Cu, Ni, Pb, Zn)	<1.0 mg/L
+ Free Chlorine	<0.1 mg/L
+ Standard Plate Count	<10,000/ml

Actual experience and routine monthly Quality Control checks on this water demonstrate that the actual levels of contaminants are below the method detection limits for trace level metals and organics analyses. This water is therefore suitable for use as a blank in all laboratory procedures.

Compressed Air

Compressed air is provided at 70 psig by a Sears two cylinder air compressor, Model No. 106.17554 having a capacity of 5.8 scfm at 90 psi. The compressed air is passed through two Wilkerson filters, Model Nos. F20-02-000 and M20-02-F00, containing activated carbon cartridges to remove trace levels of oil and particulates and distributed throughout the laboratory through half inch schedule 40 galvanized pipe. The compressor and filters are located in the Utility Room.

Natural Gas

Natural gas is distributed throughout the laboratory through half inch schedule 40 black iron pipe for use in applications requiring gas burners. All gas valves have been installed in locations at least three feet removed from electrical outlets and electric radient heaters.

Vacuum

Vacuum is distributed throughout the laboratory through half inch schedule 40 PVC pipe from a Precision Scientific Model 75 vacuum pump. The vacuum pump is located in the Utility Room. Two small vacuum pumps are available for use at temporary work stations.

Electrical Service - 110 Volt

Electrical service is provided throughout the laboratory for laboratory instrumentation and equipment. All 110 volt outlets are on 20 amp circuits. Computers and laboratory instruments are on dedicated circuits.

Electrical Service - 220 Volt

Several instruments and ovens require 220 volt power. Where required, 30 amp single phase and double phase circuits are provided. Laboratory instruments are on dedicated circuits.

Lighting

Fluorescent lighting is provided throughout the laboratory at a minimum intensity of 100 foot candles at the surface of the work bench. The intensity is reduced in laboratories with computer terminals to minimize eye strain when working with the CRT.

Wastewater Drainage

Wastewater lines run in the service trenches located along the outside walls of instrument rooms and beneath the work benches in the main laboratory. These lines are constructed of two inch schedule 40 PVC pipe to facilitate the construction of additional tie-ins and traps when required.

III. EQUIPMENT

This section discusses specifications, operation, and preventive maintenance requirements of the various pieces of support equipment found in the laboratory. Proper operation of the laboratory equipment is essential to efficient and reliable operation of the laboratory. Routine maintenance and care of the equipment will minimize down time and help to insure that quality control is maintained in the laboratory.

Examples of Log Sheets used for recording the performance of the various pieces of equipment in the laboratory are shown in Appendix II.

Autoclaves

The autoclave is used for sterilizing bottles and glassware for bacteriological work. The proper use, care, and maintenance of the autoclave is outlined in the following guidelines:

+ Record the date, time temperature, type of material sterilized, and analyst's name on the Autoclave Log Sheet each time the autoclave is used.

+ Test the performance of the autoclave with spore strips or suspensions each week.

+ Drain the reservoir after each use and insure that the drain does not become plugged with parafin or other foreign material.

+ Wipe down the inside and outside each week with a damp cloth.

Automatic Pipets

Automatic pipets are available for general use in the laboratory. These instruments are very precise, however their accuracy must be checked and adjusted before each use. They are particularly useful for preparing standard reagents and for making repetitive dilutions. The proper use, care, and maintenance of the automatic pipets is outlined in the following guidelines:

+ Always store the pipet in an upright position. Never lay the pipet on its side as any moisture in the barrel can then contact the plunger and cause corrosion. The pipet will then become contaminated and lose calibration.

+ Plastic tips should be returned to the wash station for cleaning unless they are badly soiled in which case they should be discarded.

+ Remove the barrel after use and check for signs of liquid in the barrel or on the plunger. Clean thoroughly with deionized water, wipe dry and protect the end of the plunger with a thin film of stop cock grease before reassembling.

Balances

The analytical balances are sensitive insturments capable of detecting the weight of a finger print. They are subject to corrosion from laboratory reagents, finger prints, humidity, and dust. These instruments are located in the main laboratory just outside of the acid digestion room in an area free from drafts and traffic in the laboratory. The benches upon which the balances are placed are designed to be free of vibrations.

The analytical balances are cleaned and adjusted annually by professional technicians.

Proper use, care, and maintenance of the analytical balances is outlined in the following guidelines:

+ Never move the balance unless the weight and beams have been properly secured.

+ Insure that the balance is level prior to use.

+ Never touch weights, balance pans, or items which are being weighed on the analytical balance with bare hands.

+ Protect all weights, spatulas, and balances from corrosion by keeping the area around the balances clean and free of clutter. Wipe up spills as soon as they occur.

+ Where available, preweigh positions should be utilized to protect the balance from overweight conditions.

+ When not in use, the beam should be raised from the knife edge and the weights should be returned to the beam. Objects should be removed from the pans, and the weighing compartment should be cleaned and closed.

+ Return reagents to the reagent shelves and discard weighing boats and papers after use. Insure that the balance benches are clean.

Computers

Computers and peripheral equipment such as terminals, plotters, printers, and tape drives are used throughout the laboratory to log and track samples, monitor the status of laboratory tests, control instruments, evaluate accuracy and precision of laboratory results, and prepare client reports. The computer is extremely integral to the daily operation of the laboratory. It is essential that all laboratory be thorougly trained in the proper use of the computer and that the computer be properly cared for and maintained. The proper use, care, and maintenance of the computer and peripheral equipment is outlined in the following guidelines:

+ Do not attempt to use the computer without first reading the appropriate manuals and receiving instructions and authorization from your supervisor.

+ Exert care not to damage disks and tapes.

+ Insure that backup disks and tapes are stored in the designated location.

+ Wipe down the computer, peripheral equipment and work area weeekly with a damp cloth or as often as required to eliminate the accumulation of dust.

+ Cover computing equipment with a dust cover each evening.

+ Do not place food or drinks near computing equipment.

Distillation Appparatus

The following glass stills are available for distillation procedures:

+ Rotary Vacuum Evaporator: for solvent recovery and procedures requiring low temperature distillation;

+ Cyanide Still: For distillation and absorption of Cyanides as required in the laboratory procedures manual for Cyanide analyses;

+ Soxhlet Extraction Apparatus: for Soxhlet Extraction procedures and other sample prep procedures requiring solvent extractions;

+ General Purpose Reflux and Distillation Apparatus: for special purpose and custom distillation procedures.

Distillation procedures are generally set up and conducted in the solvent recovery and distillation room. Cooling water, vacuum, and heat are provided to various stations in this room.

Because glass distillation equipment is subjected to extremes in temperatures, special care should be taken minimize thermal stress which could cause the glassware to crack.

Distillation flasks should never be allowed to boil dry any longer than absolutely necessary. Application of heat to a dry flask will bake residues onto the walls of the flask which are difficult if not impossible to remove. High heat on a dry flask can also cause the flask to shatter.

All distillation glassware should be cleaned immediately after use and either set up for future use or placed in the proper glassware drawers.

Filtration Apparatus

Membrane filtration equipment is used for both sterile and nonsterile work. Filtration apparatus used for sterile work should be segregated from other equipment. The proper use, care, and maintenance of the filtration apparatus is outlined in the following guidelines:

+ Use prepackaged sterilized funnels and filters for bacteriological work.

+ Check funnel bodies and bases for scratches on the inside surfaces and signs of leaks.

+ Clean filteration apparatus after each use according to the appropriate glassware cleaning procedures.

Fume Hoods

The following fume hoods are available in the laboratory:

+ one 6 foot fiberglass add air hood: located in the acid digestion room for corrosive work

+ one 4 foot fiberglass hood: located in the acid digestion room for corrosive work

+ one 6 foot fiberglass add air hood: located in the solvent extraction room for solvent work

+ one 2 foot fiberglass hood: located in the TOX room:

Exhaust for the first three hoods listed above is provided by a single high capacity in line blower loacted on the roof of the main laboratory. Make up air for the two add air hoods is provided by a single squirrel cage blower located on the roof above the acid digestion room.

Spills and residues in fume hoods should be wiped up immediately. All fume hoods should be throughly wiped down on a weekly basis with a clean damp cloth to prevent the buildup of corrosive or toxic residues.

Signs of corrosion or malfunction should be noted and scheduled for repair as soon as possible.

Grinders and Homogenizers

The grinder is located in the acid digestion room. Insure that the wheels are not adjusted tighter than necessary in order to minimize unnecessary wear on the wheels. Flush the grinder with an ample portion of the sample before collecting the aliquot for analysis. Allow the grinder to run until all sample has been run through but do not allow the grinder to run empty longer than necessary.

Hot Plates and Heating Mantles

Hot plates and heating mantles are available to provide heat for distillations, digestions, and sample concentrating procedures.

Care should be taken to protect heating mantles from spills which could deteriorate the insulating materials and cause electrical shorts.

The proper use, care, and maintenance of the hot plates and heating mantles is outlined in the following guidelines:

+ Inspect electrical components regularly for signs of wear or corrosion. Equipment which shows signs of possible electrical malfunction should be tagged and scheduled for immediate repair.

+ Wipe down hot plates used for acid digestions after each use with a damp cloth to minimize corrosion.

+ Remove hot plates and variacs from corrosive environments when not in use.

Incu[illegible]

[illegible], Demand (B[illegible]) and [illegible]. The prope[illegible]ance of the incubators is outlined in the following guidelines:

+ The Total Coliform Incubator should be maintained at 35±0.5°C. Measure the temperature daily with a thermometer having 0.5°C divisions and record the temperature on the Total Coliform Incubator Log Sheet.

+ The Fecal Coliform Incubator should be maintained at 44.5±0.2°C. Measure the temperature daily with a thermometer having 0.1°C divisions and record the temperature in the Fecal Coliform Incubator Log Sheet.

+ The BOD Incubator should be maintained at 20±1°C. Measure the temperature daily with a thermometer having 1°C divisions and record the temperature in the BOD Incubator Log Sheet.

+ Wipe the incubators down inside and outside with a damp towel once a month.

+ Drain the water from the Fecal Coliform Incubator monthly, clean with detergent and refill.

Microscopes

One phase contrast and one binocular dissecting microscope are available for microscopic examinations. These microscopes are located in the bacteriology laboratory. The phase contrast microscope should be used only by trained analysts. The proper use, care, and maintenance of the microscopes is outlined in the following guidelines:

+ Clean the optics and stage after each use with lens paper.

+ Keep the instrument covered when not in use.

+ Store optics in the proper container.

Muffle Furnaces

Several muffle furnaces are available for ashing samples and for other procedures requiring high temperatures. Muffle furnaces should be used in the Acid Digestion Room. If a smokey sample is to be ashed, the muffle furnace should be placed in a fume hood. The proper use, care, and maintenance of the muffle furnaces is outlined in the following guidelines:

+ Inspect electrical components regularly for signs of wear or corrosion. Equipment which shows signs of possible electrical malfunction should be tagged and scheduled for immediate repair.

+ Wipe down the inside and outside of the muffle furnaces each week with a damp cloth to minimize corrosion.

Ovens

Ovens are available at several locations in the laboratory. Several ovens are for general purpose drying. The temperature settings of these ovens may be adjusted as needed for the particular application. Other ovens are used for special purpose analyses. The temperature settings on these ovens should not be adjusted unless the ovens are out of calibration. The proper use, care, and maintenance of the ovens is outlined in the following guidelines:

+ The Residues Drying Oven should be set at 105±1°C. Measure the temperature daily with a thermometer having 0.5°C divisions and record the temperature on the Residues Drying Oven Log Sheet.

+ Clean up spills immediately with a damp cloth.

+ Wipe down the inside and outside of the ovens monthly with a damp cloth.

Quebec Colony Counter

The Quebec Colony Counter is used for identifying and counting bacteria colonies. The proper use, care, and maintenance of the colony counter is outlined in the following guidelines:

+ Wipe down the magnifying lens and light stand with a soft damp cloth to insure that they are clean and free of dust particles prior to use.

Refrigerators

Several refrigerators are available for storage of samples, standards, and reagents which are subject to degredation at ambient temperatures. The proper use, care, and maintenance of the refrigerators is outlined in the following guidelines:

+ Sample storage refrigerators should be set at 4°C. Measure the temperature daily with a thermometer having 0.5°C divisions and record the temperature on the Sample Refrigerator Log Sheet.

+ Identify and date all containers in the refrigerator and remove and discard outdated material.

+ Clean up spills immediately with a damp cloth.

+ Wipe down the inside and outside of the refrigerators monthly with a damp cloth.

Thermometers

Thermometers are used throughout the laboratory in most analyses to obtain support data for the primary information being sought. It is important that the proper thermometer be

selected for the specific task at hand to insure accurate results. The proper use, care, and maintenance of the thermometers is outlined in the following guidelines:

+ Insure that the proper thermometer is being used for the particular application. Select a thermometer with the appropriate immersion length and sufficient temperature range and divisions to provide the accuracy required.

+ In many cases thermometers are dedicated to a specific use. Care should be taken to protect these thermometers from breaking.

+ After use, clean the thermometer with detergent and cold water. Place it back in its protective case and return it to the thermometer drawer.

Ultraviolet Sterilizer

The ultraviolet sterilizer is required for bacteriological work. The proper use, care, and maintenance of the sterilizer is outlined in the following guidelines:

+ Unplug the unit and clean the UV lamps monthly by wiping with a clean soft cloth moistened with ethanol.

+ Perform spread plate irradiation quarterly to insure that the lamps are operating efficiently.

+ Test the UV lamps quarterly with a light meter and replace if they emit less than 80% of their rater output.

Water Baths

Several water baths are available for a variety of procedures in various locations in the laboratory. The proper use, care, and maintenance of the water baths is outlined in the following guidelines:

+ Clean up spills immediately with a damp cloth.

+ Drain the water monthly and clean the inside of the bath with detergent.

+ Wipe down the outside monthly with a damp cloth.

IV. INSTRUMENTATION

AccurateAccurate and reliable analysis in the laboratory is insured by the use of EPA approved analytical procedures and state of the art instrumentation. Training sessions are held regularly to familiarize the analysts with new methodologies. Proper use and care of the instrumentation in the analytical laboratory is essential for the development of accurate and reliable data. The following discussion of analytical instrumentation is organized into the three areas of analyses: Metals, Organics, and Wet Chemical.

METALS ANALYSES

Metals analyses are done in the laboratory on advanced Perkin Elmer instrumentation using the following technologies:

Inductively Coupled Plasma (ICP)

The Perkin Elmer Model 5500 ICP is used for most metals analyses. This technology generally gives better detection limits than conventional flame atomic absorption technology and is subject to fewer interferences. Instrument software allows analyses to be made at multiple emission wavelengths to avoid interferences and to confirm results. The emission spectra can be examined by the spectroscopist when the instrument indicates the potential presence of interferences. In this way the spectroscopist can determine whether or not interfering spectral lines are giving false positives. This is an option which is not normally available on routine atomic absorption instrumentation. The importance of this capability can not be overemphasized when the potential economic impact of a false positive is considered.

Flame Atomic Absorption (AA)

The Perkin Elmer Model 5500 AA is used to analyze for certain metals (such as Sodium and Lithium) whose emission/absorption spectra are more stable at the lower temperatures of conventional flame AA. Here also, the spectra can be examined by the spectroscopist when interferences are suspected. This instrument has the capability to use either air/Acetylene or Nitrous Ozide/Acetylene flames for analysis.

Graphite Furnace (HGA)

The Perkin Elmer Model HGA 500 is used for low level metals analyses when detection limits below those obtainable by ICP are required. Typically, this technology is required for drinking water and groundwater analyses. With this technology, it is essential that the analytical method be optimized for each sample matrix. The instrument software allows the spectroscopist to set temperatures and instrument conditions while observing the absorption spectra. In doing so, matrix interferences which this technology are typically subject to can be minimized, and the method parameters can be optimized.

Cold Vapor Atomic Absorption

The spectrometer and data processing sections of the Perkin Elmer Model 5500 AA are used with an Instrumentation Laboratories Atomic Vapor Accessory Model 440 for routine and low level Mercury analyses.

ORGANICS ANALYSES

Routine as well as custom organics analyses are done in the laboratory on state of the art Tracor Model 560 gas chromatographs and a Finnigan Model OWA/20C GC/Mass Spectrometer. Screening type analyses are done for indicators of organic contamination on a Dohrmann Model DC 80 Total Organic Carbon Analyzer and a Mitsubishi Model 10 Total Organic Halide Analyzer.

Output from all of the Gas Chromatographs is fed directly into the Minicomputer by way of dual channel interfaces. The analyst has the ability to monitor instrument performance and manipulate raw data from the computer console. Specialty software integrates the raw data, identifies peaks, regresses the data, and interfaces the computed results with the results data base for the sample under analysis.

Tracor Model 560 GC

The gas chromatographs are equipped with the following detectors and accessories:

+ Electron Capture Detector (ECD): The Electron Capture Detector is used for most analyses requiring the detection of low levels of organic compounds in water samples. This detector is typically capable of achieving detection limits in the fractional part per billion range. Special training and licenses are required for this instrument because of the radioactive isotope in the detector.

+ Hall Electrolytic Conductivity Detector (Hall): The two Hall Electrolytic Conductivity Detectors are used for analyses of organic compounds containing Halogens, Nitrogen, or Sulfur groups. These detectors can also be used for the analysis of volatile organics in water samples, as well as for the analyses of extracts of soils, sludges, and oils. They are also used to confirm results obtained on the ECD.

+ Flame Ionization Detector (FID): The Flame Ionization Detector is used for routine analyses of wastewaters and hazardous wastes. This instrument is capable of detecting a broad spectrum of organic compounds, however, it is generally not capable of achieving the detection limits obtainable with the ECD and Hall Detectors.

Both gas chromatographs are equipped with both packed and capillary columns. Capillary columns are used in analyses requiring high resolution and low detection limits. Packed columns are used for confirmation and custom organic analyses.

Tracor Model 540 GC

The 540 is equipped with both capillary and packed column injectors and Photoionization and Hall Detectors which can be connected directly to the columns or in series. A Purge and Trap Auto Sampler is also used on the 540. While this instrument has the capability to analyze for a broad spectrum of organic compounds, it is used primarily for the analysis of the volatile Priority Pollutants.

Finnigan Model OWA/20C GC/Mass Spectrometer

The GC/Mass Spec is used for Priority Pollutant analyses, Appendix VIII analyses, and comprehensive analysis of unknown organic compounds. This instrument is the most versatile GC/Mass Spec available today for the identification of unknown organic compounds. The instrument is equipped with both packed and capillary columns and uses state of the art technology and a computer data base of over 31,000 organic compounds to identify and quantitate unknown organics. Strict quality control procedures are built into the operation of this instrument to confirm the analytical results and eliminate false positives commonly found in environmental samples.

Dohrmann Model DC 80 TOC Analyzer

The TOC analyzer is used for the determination of Total Organic Carbon (TOC) as well as Total Carbon in aqueous samples. TOC is one of the indicator parameters required for routine gounrdwater monitoring by state and federal regulations. Accurate and reproducible analysis is critical in any groundwater program. This instrument utilizes ultraviolet light, Potassium Persulfate, and Ultra High Purity Oxygen to oxidize the organic compounds to Carbon Dioxide which is then

quantitated in an infrared detector. This state of the art technology eliminates most of the maintenance and stability problems common with the older high temperature combustion technologies. Peripheral equipment allow this instrument to be used for the determination of TOC in solids and sludges, as well as for the determination of Purgeable Organic Carbon in aqueous samples.

Mitsubishi Model 10 TOX Analyzer

The TOX analyzer is used for the determination of Total Organic Halogens (TOX) in both aqueous and nonaqueous samples. TOX is another one of the groundwater indicator parameters required by federal and state regulations. As with TOC, accurate and reproducible analysis is critical in any routine groundwater program. This instrument utilizes the absorption, combustion, and coulometric titration technologies specified in EPA Method 9020. The microprocessor controlled titration allows rapid recovery of the instrument and a high degree of precision.

WET CHEMICAL ANALYSES

Wet chemical analyses are done with a variety of speciality and general purpose instruments. The following discussion presents these instruments in alphabetical order.

Conductivity Meters

Several portable conductivity meters are available for both laboratory and field use. The proper use, care, and maintenance of the conductivity meters is outlined in the following guidelines:

+ Check the cell constants periodically to insure that the meter conditions have not changed.

+ If drifting or irratic response is experienced, check the batteries and replace if required.

+ Because Conductivity is a function of temperature, it is important to either measure the Conductivity at 25°C or record the temperature at the time of measurement.

+ Rinse the probe with deionized water after use and replace the protective cover. Badly soiled probes may require a detergent wash prior to the deionized water rinse.

Selective Ion and pH Meters

Selective ion and pH meters are available for use at several locations in the laboratory. Portable meters may also be used for field work.

Plastic bodied, gel filled combination pH electrodes have been found to give the most reliable service and are therefore used for all routine laboratory work.

The proper use, care, and maintenance of these meters is outlined in the following guidelines:

+ Calibrate the pH meters in accordance with the procedure applicable to the meter. Record the date, standard readings, expiration date of the standard, and the analyst's name on the pH Meter Calibration Log Sheet.

+ Date the standard buffers when they are prepared and discard them on or before the expiration date.

+ Because pH is a function of the temperature, it is important to either measure the pH at 25°C or to record the temperature at the time of measurement.

+ Rinse the probe with deionized water after use and either replace the protective cover or store the electrode in the appropriate standard solution.

+ Wipe down the instrument weekly with a damp cloth.

RFA 300

The Alpkem RFA 300 (Rapid Flow Analyzer) is used for the quantitation of Totall Phenols in aqueous samples. This instrument is completely automated to facilitate the analysis of quality control spikes and blanks. Other wet methods such as Cyanides, and Nutrients can be easily handled by this instrument with the insertion of additional modules.

Spectrophotometer - UV/Visible

The spectrophotometer is available for colorimetric analyses in the laboratory. The proper use, care, and maintenance of this instrument is outlined in the following guidelines:

+ Wipe down the surface of the instrument weekly with a damp cloth.

[illegible] with lens paper.

+ Optical cells should be handled with extreme care to prevent scratches. The cells should be acid cleaned if badly soiled. Care should be taken when cleaning with a brush to prevent scratching. Finger prints and smudges must be removed with lens paper before inserting the cell into the instrument.

+ Light absorbance will change as the optical cells are rotated from one position to another. It is therefore essential to insure that the cells are always inserted into the instrument with the mark in exactly the same position.

+ Instrument sensitivity should be monitored against standard solutions to detect the occurance of electrical, mechanical, or optical problems at an early stage.

Turbidimeter

The turbidimeter is used for the determination of turbidity in the laboratory. The proper use, care, and maintenance of this instrument is outlined in the following guidelines:

+ Calibrate the instrument on the day of use with standard Formazin solution.

+ Protect the sample cuvettes from scratches and fingerprints.

+ Wipe the instrument down weekly with a damp cloth.

V. GLASSWARE

The measurement of constituents in water and wastewater at the ppm and ppb levels demands methods of maximum sensitivity. These methods are very sensitive to contamination resulting from improperly cleaned glassware. Thus the task of cleaning glassware should be given every bit as much attention by the analyst as the test procedure itself.

Several types of glassware and glassware related items are used in the laboratory:

+ Borosilicate or polyethylene: These materials can be used for all analyses, sample collections, and reagent storage unless instructed otherwise by the specific procedure.

+ Kimax and Pyrex: These are trade names for conventional heat resistant borosilicate glass. Both are used interchangeably in the laboratory. Almost all of the volumetric glassware as well as beakers, and cylinders are made of these materials.

+ Corex: This material is harder and more expensive than conventional borosilicate glass. Most of the pipets in the inorganic laboratory are made of this material in order to minimize breakage.

+ Glass or high density polyethylene stoppers are used with ground glass joints. Cork or rubber stoppers are used in other cases, however, rubber is not used when organic anal yses are to be performed.

+ Teflon plugs are used in burets and teflon stopcocks are used in separatory funnels.

+ Teflon liners are used in sample bottles for routine water and wastewater analyses.

+ Aluminum foil can be used as cap liners for organics analyses in lieu of Teflon.

VOLUMETRIC GLASSWARE

Class A volumetric glassware must be used for all quantitative analytical work. Solutions must be measured at the temperature at which the glassware was calibrated (usually 20 ° C).

Volumetric flasks are calibrated "to contain" (TC).

Volumetric pipets are calibrated "to deliver" (TD). When empying volumetric pipets, they should be held in the vertical position and the outflow should be unrestricted. The tip of the pipet should be put in contact with the wall of the receiving vessel for approximately two seconds after the free flow has stopped. In no case should the remaining fluid be blown or tapped from the tip of the pipet.

Burets are used to deliver definite volumes. Burets should not be dried after cleaning. Rather they should be rinsed two or three times and left filled with the titrant. If the buret is not to be used for a period of time it should be filled with deioinized water. All burets should be capped or covered with aluminum foil to prevent dust from accumulating on the inside. The stopcock, if not Teflon, should be greased with a very thin film of stopcock grease to prevent it from freezing up.

Chipped or cracked volumetric glassware should not be used for quantitative work unless the calibration is unaffected by the damage.

CLEANING OF GENERAL GLASSWARE

All glassware for general wet chemistry procedures should be cleaned according to the following steps:

+ Rinse well with tap water.

+ Wash or soak in a 5% solution of Contrad. Contrad is a phosphate free, biodegradable surface active cleaning agent obtained from Curtin Matheson Scientific Company. The Contrad is diluted to 5% by volume. The 5% solution is good as long as the pH is > 8.5.

+ Rinse thoroughly with tap water.

+ Rinse with three small volumes of deionized water.

+ Badly soiled glassware is cleaned by the above procedure and then soaked in a Chromic Acid bath for fifteen to thirty minutes. Sometimes, an overnight soaking is required to remove organic residues.

+ Rinse glassware soaked in Chromic Acid very thoroughly with both tap water and deionized water to insure that trace levels of Chromium are removed.

+ Note that Chromic Acid is extremely corrosive. Wear protective clothing when working with this material and use caution to prevent spills.

CLEANING OF ORGANIC GLASSWARE

Cleaning of glassware for organics analyses requires a solvent rinse and a period of time to dry in a drying oven. The following steps should be carefully followed to insure that the glassware is scrupulously clean:

+ Rinse the glassware with tap water immediately after use.

+ If the glass is extremely dirty, it may be soaked overnight in a water bath.

+ Wash the glass in the contrad solution described in the procedure for cleaning general laboratory glass. Liquinox may be substituted for contrad.

+ Rinse thoroughly with hot tap water.

+ Rinse thoroughly with deionized water.

+ Rinse thoroughly with nanograde hexane.

+ Rinse thoroughly with nanograde acetone.

+ Place in a drying-oven that is at 180 to 200° C for at least one hour.

+ One exception to the above glass preparation is the prep of forty milliliter vials for the analysis of volatile organics. These vials are placed in the oven after the deionized water rinse. No solvent is used to rinse this glassware. Also, these vials should not be placed in the oven with any solvent-rinsed glass. Cross contamination can easily occur when solvent-rinsed glassware is mixed in the oven with volatile organic analysis glassware.

+ Glassware for herbicide analysis is rinsed with 10% HCl before the acetone rinse.

CLEANING OF GLASSWARE FOR METALS ANALYSIS

Erlenmeyer flasks used in metals analysis and BOD bottles used for mercury analysis are cleaned according to the following procedure:

+ 150 mL of the following acid mixture is boiled in the Erlenmeyer or BOD bottle until it flushes against the entire surface area of the glass. (The acid mixture is 600 mL of deionized water + 200 mL of nitric acid + 200 mL of hydrochloric acid + 50 mL of sulfuric acid.)

+ Rinse the acid-washed glass thoroughly with deionized water.

Volumetric flasks, graduated cylinders, pipets, and other glass used in metal analyses are cleaned in the following procedure:

+ Rinse the glassware thoroughly with 2 N nitric acid.

+ Rinse the acid-rinsed glassware thoroughly with deionized water.

VI. REAGENTS, SOLVENTS, AND GASES

Analytical Reagent Grade (AR) chemicals are used for most analyses in the inorganic laboratory. Ultrapure or pesticide grade reagents are used for organic work. This includes pesticide grade solvents.

If the purity of a reagent is not specified by the procedure, it is intended that AR Grade chemicals be used.

Standards and solutions should be labeled with the following information when they are prepared:

+ Compound
+ Concentration
+ Parameters for which reagent is to be used
+ Date
+ Name of Analyst

Also when a standard is prepared, it should be logged into the Standard Log Book. Log sheets used in the Standard Log Book are shown in Appendix II. There is a separate Standard Log Book for organic standards and general wet tests/metals standards. The standard should be listed in the overall log at the beginning of the book. Specific weighing data and other critical information should be included in the Stock Standard Section of the book. If separate intermediate and working standards are prepared from the stock standard, then they should be included in the Sections marked Intermediate Standards and Working Standards in the Log Book. In these sections are also included other important information about the preparation and storage of these standards. When a standard is out of date or discarded, it should be deleted from the current standard log book. The Standard Log Book should be reviewed periodically. Standard Methods gives the shelf life for the inorganic and wet chemistry standards and reagents. Pesticide and herbicide stock standards should be prepared once a year and intermediate and working standards should be prepared twice a year. Volatile organic standards should be prepared on a working basis. If volatile organic stock standards are stored, they should be stored in very small vials with no head space. Even with proper storage, volatile standards do not last more then one to two weeks.

INORGANIC ANALYSES

AR grade reagents are used for all quantative inorganic analyses.

To avoid waste and to insure that fresh reagents are used for quantitative procedures, only the amount of reagent required for the scheduled work should be prepared.

METALS ANALYSES

ICP/AA standards are purchased as 1000 ppm stock standards from the various scientific supply houses. Working standards and sample dilutions are prepared with deionized water.

Acid digestions are done with AR grade Nitric and/or Hydrochloric Acid. Samples and standards must be brought to the same acid Normality before analysis.

The following gases, purchased from Sunox or Merrit Holland, are used for ICP/AA work:

+ Liquid Argon
+ Lab 380 Atomic Absorption Acetylene
+ Medical Grade Nitrous Oxide
+ Ultra high purity Nitrogen

Air is supplied to the AA by the laboratory air compressor (see the Utilities Section for details).

ORGANIC ANALYSES

Nanograde or pesticide grade solvents are used for organic glass prep, extraction, and analysis. Standard reference material is purchased from Chem Service or obtained from the EPA repository at Research Triangle Park, North Carolina.

The following gasses are purchased from Sunox or Merrit Holland and are used for Organic work:

GC/Mass Spec

+ Breathing Quality Air
+ Ultra high purity Helium

Gas Chromatographs

+ Ultra high purity Helium
+ Ultra high purity Hydrogen
+ Breathing Quality Air
+ Ultra high purity Argon/Methane

TOX Analyzer

+ Zero Grade Argon
+ Zero Grade Oxygen

TOC Analyzer

+ Zero Grade Oxygen

Gases are passed through drying tubes and molecular sieves before entering the GC.

REAGENT BLANK

A background or reagent blank should be determined for each new lot of solvent or reagent for each procedure. Refer to the specific procedure for details.

METHOD BLANK

After determining the individual reagent blanks, a method blank should be determinded by following the steps of the specific procedure each time the analysis is performed. This is included in each procedure in the Laboratory Procedures Manual.

VII. QUALITY CONTROL

PURPOSE AND OBJECTIVES

The intralaboratory quality control progam is a continuing, systematic, inhouse regimen intended to ensure the production of analytical data of continuing high validity. Theobjectives of intralaboratory quality control follow:

a. To provide a measure of the precision of analytical methods.

b. To maintain a continuing assessment of the accuracy and precision of analysts within the laboratory group.

c. To identify weak methodology and provide a continuing source of research problems aimed at overcoming deficiencies.

d. To detect training needs within the analytical group.

e. To provide a permanent record of instrument performance as a basis for validating data [illegible] performance.

Previous sections discussed basic elements of quality control as it applies to laboratory services, intrumentation, glassware, reagents, solvents, and gases. Assuming that the guidelines specified in these chapters are being followed, and that the specific test procedures detailed in the Procedures Manuals are being followed, the accuracy and precision of each procedure must be determined. Then, to insure that valid data is being produced, systematic checks must show that the test results remain reproducible, and that the methodology is in fact measuring the actual quantity of the desired parameter.

The laboratory QC program begins with the sample collection and ends with the signed report. It is essential that the entire staff understand and participate in the QC program to insure accurate and reliable results.

QUALITY CONTROL FOR ACCURACY AND PRECISION

Precision refers to the agreement or reproducibility of a set of replicate results among themselves without assumption of any prior information as to the true result. Precision is usually expressed in terms of the deviation, variance, or range. Accuracy is the nearness of a result or the mean of a set of results to the true volue. Accuracy is usually expressed in terms of error, bias, or percentage recovery.

Good precision often is an indication of good accuracy, but one can obtain good precision with poor accuracy if a systematic (determinate) error is present in the method used. Systematic errors are either positive or negative in sign. The other general classification of errors in analysis is indeterminate (random) errors. These are errors injerent in the analytical methods because of uncertainties in measurements. An example is the measurement of the height of a gas chromatographic peak with a ruler, which even the most careful analyst can measure only to the nearest one mm. Indeterminate errors are random, that is, they are just as likely to be positive as negative. For this reason, the average of several replicate measurements is always more reliable than any of the indiviaula measurements. Although random errors are unavoidable, determinate errors can be corrected once their cause is located.

Absolute error is the difference between the experimental result and the true volue. Relative error is absolute error divided by the true volue and multiplied by 100 to yield percent

relative error or by 1000 to yield parts per thousand relative error. Bias is defined as the mean of the differences (having regard for signs) of the results from the true value.

In addition to recording numerical results of each analysis of an internal QC sample, it is necerssary to construct a Quality Control Chart. A separate chart must be generated for both Accuracy Data as well as Precision Data. The purpose of this chart is to provide grapahic assessment of accuracy and precision for the analysis of each substrate and instant detection of erroneous data. The charts allow quick and easy observation of recovery trends for a particular analysis and have long term value for the self evaluation of analytical output by staff personnel. Another significant value of the charts is that of providing a laboratory administrator with a rapid assessment of the continuing analytical capability of the staff chemists as related to the output of valid analytical data.

The applicability of control chart technics is based on the assumption that laboratory data approximate a normal distribution. The data from such a system, however, can be presented in a different graphic way by plotting on the vertical scale the units of the test results and on the horizontal scale the order or sequence in which the results were obtained. The mean and limits of despersion in terms of the standard deviation are calculated and plotted as in the control chart in Figure 1.

For the best results make at least 20 determinations on a sample before calculating the standard deviation or plotting the control chart. All results need not be obtained on the same day; optimally accumulate them as part of a day-to-day operation. A result may be obtained on a control sample each time an unknown or group of unknowns is analyzed.

For example, consider the collection of results, in milligrams per liter, obtained by analysis of a water sample for copper, shown in Table 1.

The mean of this series is 0.256 mg/L, the standard deviation is 0.020 mg/L, and the resulting control chart is that of Figure 2.

The upper and lower control limits (UCL and LCL) are at +3 and -3 standard deviations from the mean, respectively, and the upper and lower warning limits (UWL and LWL) at +2 and -2 standard deviations.

This is a control chart for individuals, and is used most frequently in chemical analysis. Laboratory control requires adding known or standard samples to the unknown samples, thus increasing both the cost and time or analysis.

If a result falls outside the control limits on an individual control chart, the analysis is said to be "out of contol"; take immediate action to determine the cause of the outlying result. Consider unreliable any analytcal results obtained for samples on the same day as the erroneous result occurred on the known sample and repeat the analyses after corrective action has been taken and the procedure is back in control. It sometimes is desirable to take milder action when the results exceed the warning limits, a because an unduly high percentage of results exceeding these limits is a warning that laboratory precision may not be as good as expected or that distribution of results is not normal.

Accuracy in analytical chemistry is a measure of the differnece between the mean of the results and the true value. Most frequently, accuracy is expressed in terms of the mean error:

mean error = mean - true value

Accuracy can be determined only if the control sample is prepared in the laboratory from known amouns of pure regents. The accuracy of the determination is the differnece between the mean of the 20 determinations(collected for the construction of the initial control chart) and the true value or known amount chemical added.

The true value (TV) also can be plotted on the control chart. Usually it falls only slightly above or below the mean. If the true value is more than half way between the mean and the upper or lower warning limit (i.e., the mean error is greater than one standard deviation), check the method, reagent, glassware, technic, or instruments for bias and take corrective action.

The above description outlines a good quality control program. The quality control program is incorporated into an overall insurance for quality called quality assurance.

QUALITY ASSURANCE

Quality assurance in the laboratory has come to mean many things and to some is merely equated with good laboratory operations such as:

+ Adequately trained and experienced personnel.

+ Good physical facilities and equipment.

+ Certified reagents and standards.

+ Frequent servicing and calibration of instruments, and

+ A knowledge and understanding management.

While all of these are important, none in itself assures reliability of laboratory data. A good analytical quality control program consists of three factors: (1) using only methods that have been studied collaboratively and found acceptable; (2) routinely analyzing a control sample at least once in each batch of samples (10% Spikes); and (3) confirming the ability of the laboratory to produce acceptable results by requiring analysis of a few reference sample once or twice a year.

In certain wet chemistry tests, it will be necessary to run 10% of the samples in duplicate as well as the 10% Spike rule.

QC CHECKS

The following guidelines are detailed in the individual procedures:

+ Standard curves should be prepared for each new batch of reagents.

+ Run one reagent blank and one deionized water blank (if applicable) with each series of tests.

+ Run one midpoint standard, or two standards which bracket the expected results (if applicable) with each series of tests.

+ Run one Spike with each batch of ten samples.

+ Run one duplicate analysis with each batch of ten samples.

QUALITY ASSURANCE NOMENCLATURE

The following discussions detail a "Rigorous Quality Assurance Program" which should be followed if specifically requested or in situations where data may be examined in court. Under normal circumstances, field spikes and split samples are not required and would represent an unnecessary financial burden to the client.

The following nomenclature is used in the guidelines for the rigorous quality assurance program:

+ A1 = First replicate of sample A
+ A2 = Second replicate of sample A
+ B = Sample taken simultaneously with sample A
+ BSF = Field spike of sample B
+ BSL = Laboratory spike of sample B
+ DF = Field spike of deionized water
+ DL = Laboratory spike of deionized water
+ T = True value of all spikes

STEPS FOR FIELD PERSONNEL

These guidelines are applicable to the "Rigorous Quality Assurance Program":

+ Take independent simultaneous samples A and B at the same sampling point.

+ Split sample A into equal volumes and label A1 and A2.

+ Split sample B into equal portions, add a spike T to one portion and label it BSF. T should approximately double the expected parameter concentration.

+ Add the same spike, T, to a deionized water sample from the laboratory and label it DF.

+ Treat all samples and blanks in the same manner.

STEPS FOR LABORATORY PERSONNEL

These quidelines are applicable to the "Rigorous Quality Assurance Program":

+ Analyze a blank and midpoint standard as specified in the specific procedure.

+ Analyze sample DF to determine the percent recovery.

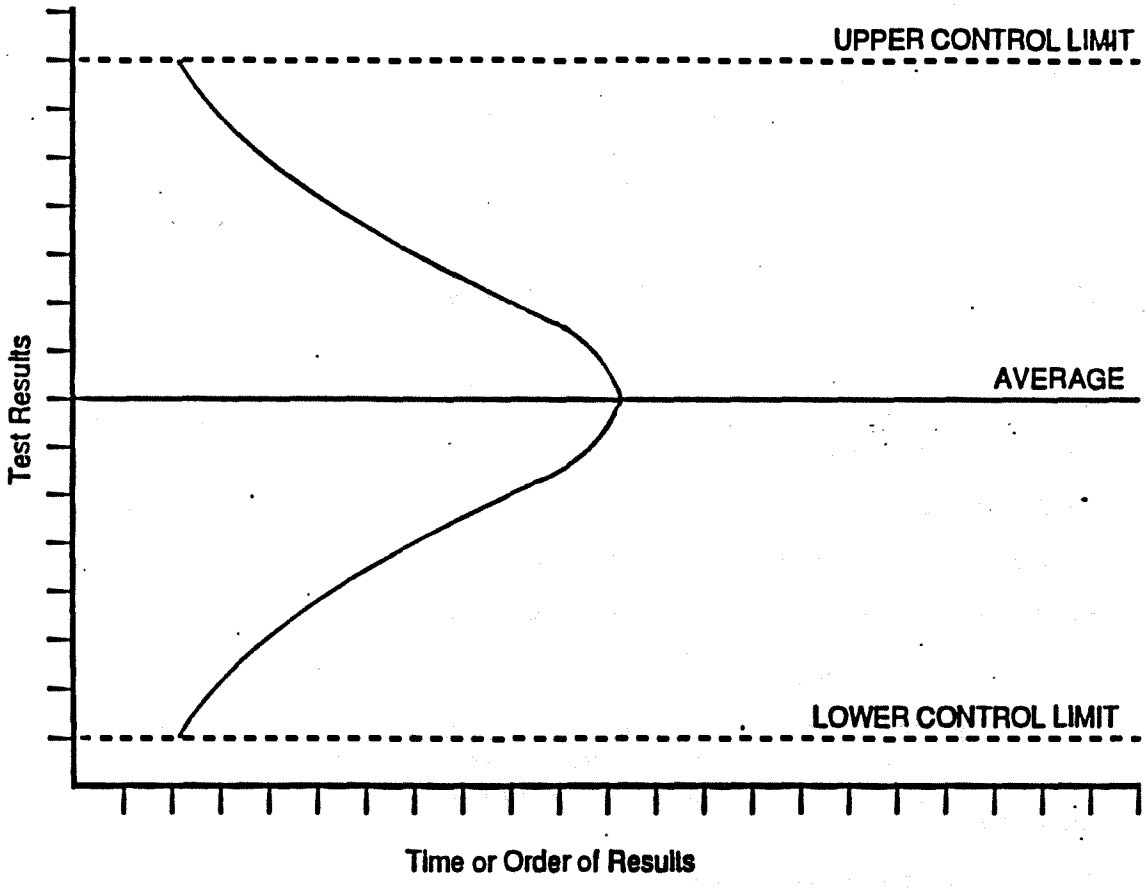
+ Analyze samples B and BSF. If B is below the detection limit, or if B > 10T or <0.1T, then go to the next step. Otherwise, insure that the percent recovery is the same as for DF. If it is not, spike an aliquot of B, label it BSL, and analyze it to determine if the percent recovery problem is short or long term.

+ Analyze A1 and A2 and check the precision.

+ Calculate the absolute difference between A1 and B to insure that the field sampling provided representative field samples.

If problems are encountered in any of the above steps, they must be resolved before continuing to the next step.

Once this sequence has been satisfactorily completed, the validity of the data has been indisputably established.



General Engineering Laboratories
Engineering and Analytical Services

1313 Ashley River Road
P.O. Box 30712
Charleston, S.C. 29407
Phone (803) 556-8171

FIGURE 1

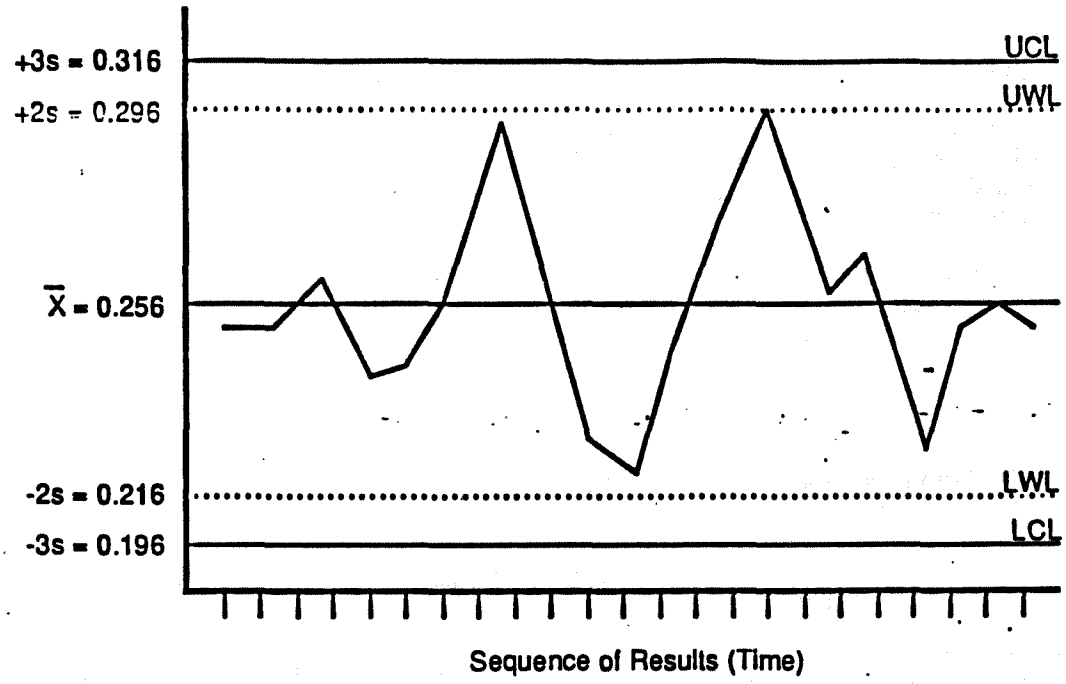


FIGURE 2

1.	0.251	11.	0.229
2.	0.250	12.	0.250
3.	0.250	13.	0.283
4.	0.263	14.	0.300
5.	0.235	15.	0.262
6.	0.240	16.	0.270
7.	0.260	17.	0.225
8.	0.290	18.	0.250
9.	0.262	19.	0.256
10.	0.234	20.	0.250

TABLE 1

VIII. DATA REGRESSION AND REPORTING

Data regression and reporting is one of the most important tasks of the laboratory, and the one where most of the errors occur. Extreme care must be taken by the analyst to avoid mathematical errors and by the data clerk to insure that data is reported in a concise and correct manner.

Sample Receipt

Data handling begins when the sample is received in the laboratory, whether it is brought in by company personnel or by the client, or received through the mail.

As soon as possible after receipt of the sample it is the responsibility of the data clerk to log the sample into the Laboratory Information Management System (LIMS). The lab manager should be immediately notified that the sample has arrived and made aware of the analytical and turnaround requirements.

The LIMS software has been developed by the Perkin Elmer Corporation specifically for sample and data processing in the analytical laboratory. The software is written in FORTRAN and runs on a 32 bit mini computer. The minicomputer has a 300 megabyte hard disk which is capable of [illegible] The information on the disk is backed up to a [illegible]

Analytical data is entered directly by the analyst into a LIMS data file which is automatically created during the log in procedure for each sample. All regression analyses and statistical evaluations are done within the LIMS system.

When data is cleared for release by the laboratory manager, the data clerk accesses the appropriate report formatting routine to produce the client's report.

Clients with large volumes of analytical data or clients with very short turnaround requirements have the ability to access their own data directly through a modem and terminal which can be set up in their office.

Significant Figures

Significant figures should not be reported beyond the accuracy of the specific procedure. Reported analytical values should contain only significant figures. Values reported with more significant figures than warranted by the procedure are misleading and reflect adversely on the credibility of the laboratory.

A value is made up of significant figures when it contains all digits known to be true and one last digit which is in doubt. For example, if a value is reported as 18.8 the 18 is known to be true and the 0.8 is uncertain but thought to be more correct than 0.7 or 0.9.

Rounding Off

Since all laboratory calculations are done either directly in the computer or on a calculator, the analyst must generally round off the final answer to the appropriate significant figures. The following guidelines apply to rounding off:

+ Rounding off should be done only on the figure to be reported. Extra figures should be carried through the calculation in order to prevent the loss of meaningful accuracy.

+ If the figure following those to be retained is less than 5, it is dropped and the retained figures are left unchanged. (e.g. 11.444 becomes 11.44)

+ If the figure following those to be retained is greater than 5, it is dropped and the last retained figure is increased by 1. (e.g. 11.446 becomes 11.45)

+ If the figure following those to be retained is equal to 5, it is dropped and last retained figure is left unchanged if it is even, or it is increased by one if it is odd. (e.g. 11.445 becomes 11.44 but 11.455 becomes 11.46)

Records

All laboratory records which are not entered directly into the LIMS are to be entered into bound laboratory data books in ink. Pencils are not to be used for recording data. It is important for the analyst to be ever mindful that the data he or she generates may be used in court as legal evidence. For this reason, it is imperative that sufficient data be recorded to completely document the conditions of the test and the results. Errors should be stricken through with a single line in such a manner that the errors remain legible.

As a minimum, the analyst should record the following information in a clear and concise manner in the lab book at the time the test is performed:

+ Lab Number
+ Date
+ Client Code
+ Parameter Analyzed
+ All measurements applicable to the specific procedure, including weights, instrument readings, etc. which are required to calculate the final result.
+ All instrument settings or test conditions which differ from those specified in the specific procedure, and an explaination why the conditions where changed.
+ A summary of any difficulties which might have been experienced and their resolution.

The value to be reported should be entered into the LIMS as soon after it is calculated as possible. Care should be taken to insure that the correct units are noted.

Chain-of-Custody

Projects requiring the submission of data as legal evidence, and various other projects where the data is to be reported to state or federal regulatory agencies require that Chain-of-Custody procedures be followed. A sample Chain-of-Custody Document is shown in Appendix 3. The following guidelines are applicable to the projects requiring Chain-of-Custody control of the samples:

+ The person collecting the sample should complete the Chain-of-Custody Record at the time of sample collection. All information required on the record should be completed and both the record and the sample bottles should be initialed by the person collecting the sample.

+ The samples should be kept in the personal posession of the person collecting the sample, or locked up until they can be delivered to the laboratory.

+ Upon delivery of the samples to the laboratory, both the sample collector and the data clerk should sign the Chain-of-Custody record in the appropriate boxes.

+ The data clerk should log the samples into the LIMS immediately upon receipt and deliver them to the designated sample custodian. It is the sample custodian's responsibility to insure that the samples are delivered to the appropriate analyst for analysis and returned to the proper storage location.

+ It is imperative that no visitors be allowed in the laboratory unless accompanied by authorized laboratory personnel.

+ Samples should be retained in the custody of the laboratory until authorization to destroy or discard them is given by the laboratory manager.

Reports

The data clerk is responsible for generating a concise and accurate report of the analytical data as soon as the data has been authorized for release. All client reports are generated by the LIMS software from internal data files. All reports must be review, signed and released by at least one authorized person. The signed report is returned to the data clerk for delivery to the client. A hard copy of the report is placed in the client's file when the report is sent out.

Turnaround

The good reputation and respect which this laboratory currently enjoys has been built over the years by providing quality results in the time required by the client and by following up with engineering and chemical interpretation to support the data. The importance of providing prompt turnaround can not be over emphasized. Much of the work this laboratory is currently. doing is here because other laboratories were unable to provide the turnaround required by the client.

The normal turnaround time for routine samples is two weeks. Process quality control and speciality samples receive high priority when they enter the laboratory and are turned around within the constraints of the particular analytical procedures. In times of heavy work loads, work which is not critical is put on a lower priority so that critical work can be completed.

Analyses must always be completed within the recommended EPA holding times shown in Appendix 4. In the event that an analysis can not be completed within the recommended holding time, a notation to that effect must be made in the laboratory notebook and on the client's report.

IX. SKILLS AND TRAINING

Analytical procedures in the laboratory can be graded according to their degree of complexity. It is essential that each task be thoroughly understood by the analyst assigned to perform it. Technicians should be completley trained and should fully understand all the assignments of their job before being given new responsibilities. All analysts and laboratory personnel must be thoroughly instructed in basic laboratory analytical and safety procedures.

The following guidelines apply to the basic skill levels required by laboratory personnel:

+ The analyst should understand when and under what conditions samples should be settled, agitated, pipetted, etc., before the sample is removed from the original container.

+ Laboratory personnel responsible for analytical work must be familiar with the proper care and use of volumetric glassware.

+ Analysts using any of the balances must be familiar with the proper care and use of the balance.

+ All laboratory personnel must be familiar with the proper glassware cleaning procedures.

+ Instrumentation should be cleaned and operated only by authorized personnel.

+ all laboratory personnel must be acquainted with normal laboratory safety percautions.

X. MICROBIOLOGY

The general aspects of the Quality Assurance program discussed in Section VII are applicable to microbiology work. However, because known values can not be applied to biological work, it is imperative that careful and continuous control be exerted over sampling, personne, analytical methodology, materials, supplies, and equipment.

Specific procedures to insure that samples, reagents, and equipment are not contaminated are discussed in the specific bacteriological procedures in the Laboratory Procedures Manual. Stock reagents should be treated according to the guidelines discussed in Section VI.

The following logs should be maintained for the bacteriology laboratory. Examples of these logs are included in Appendix 2.

+ Record the lot number, date, sterilization time, and temperature, final pH, and technician's name for each batch of sterilized media.

+ Record the lot number and date of receipt for each lot of membrane filters.

+ Record the lot number and date of receipt for each lot of sterile funnels.

Bacteriological records must be retained for three years.

APPENDIX 1

MAINTENANCE SCHEDULES

Maintenance Schedule

Equipment	Maintenance	Frequency
Incubator		
Total Coliform (1)	Alcohol Sterilization	1/month
Fecal Coliform (1)	Alcohol Sterilization	1/month
UV Sterilizer (1)	Alcohol wipe down	1/month
Autoclave (1)	Clean, general	1/6 months
Pumps/Fans		
Air Compressor (1)	Check oil level	1/week
	Drain water	1/week
	Check belt tension (1/2 in)	1/month
	Clean air filter	1/week
Vacuum Pumps (2)	Check oil level	1/week
	Clean filters	1/week
Composite Sampler (1)	Check batteries	after each use
	Check & clean tubing &	
		after each use
[illegible]	[illegible]	ach use
E[illegible]		[illegible]ths
Fume Hood Fans (3)	Lubricate & clean	1/month
Mill	Clean & Lubricate	1/week
Stirrers		
Flash Point	Check oil & clean	1/month
Magnetic	Wipe clean	after each use
t Plates ( )	Wipe clean	after each use
	Remove from hood	daily
	Check wiring	1/month
Kjeldhal Heaters	Check wiring	1/month
Variacs	Wipe clean	after each use
	Remove from hood	daily
	Check wiring	1/month
Ovens (2)	Clean	1/month
Muffle Furnace	Clean	1/month
	Check wiring	1/month
Water Bath	Clean	after each use
Shaker Bath	Clean	after each use
	Check shaker alignment	
Utilities		
Air Lines	Check for leaks & clean filters	1/month
Vacuum Lines	Check for leaks	1/month
Deionized Water	Check for leaks	1/week
Fume Hoods	Wipe down with wet cloth	1/month

APPENDIX 2

LOG SHEETS

AUTOCLAVE LOG SHEET

ITEMS STERILIZED	DATE	TIME AT TEMP	SLOW EXHAUST	TEMP SETTING	MAX TEMP	MAX PRES	OPERATOR

DEIONIZED WATER LOG SHEET

MONTH	DATE	pH	COND	STD PLATE	CHLORINE	ANALYST
JAN						
FEB						
MAR						
APR						
MAY						
JUN						
JUL						
AUG						
SEP						
OCT						
NOV						
DEC						

DILOG

pH CALIBRATION LOG SHEET

DATE	STANDARDS	EXPIRATION	ANALYST

PHLOG

STANDARD LOG
TABLE OF CONTENTS

DATE	COMPOUND OR MIXTURE	PAGE

TOCORG

CONCENTRATED STOCK STANDARDS
LOG SHEET

CODE _____ DATE ___/___/___ CHEMIST/TECHNICIAN _____
COMPOUND_____ LOT NUMBER_____ PURITY _____%

Final Gross Weight _____gm Dilution Volume _____ml
Tare Weight _____gm Concentration* _____
Net Weight _____gm Solvent _____

CODE _____ DATE ___/___/___ CHEMIST/TECHNICIAN _____
COMPOUND_____ LOT NUMBER_____ PURITY _____%

Final Gross Weight _____gm Dilution Volume _____ml
Tare Weight _____gm Concentration* _____
Net Weight _____gm Solvent _____

CODE _____ DATE ___/___/___ CHEMIST/TECHNICIAN _____
COMPOUND_____ LOT NUMBER_____ PURITY _____%

Final Gross Weight _____gm Dilution Volume _____ml
Tare Weight _____gm Concentration* _____
Net Weight _____gm Solvent _____

CODE _____ DATE ___/___/___ CHEMIST/TECHNICIAN _____
COMPOUND_____ LOT NUMBER_____ PURITY _____%

Final Gross Weight _____gm Dilution Volume _____ml
Tare Weight _____gm Concentration* _____
Net Weight _____gm Solvent _____

CODE _____ DATE ___/___/___ CHEMIST/TECHNICIAN _____
COMPOUND_____ LOT NUMBER_____ PURITY _____%

Final Gross Weight _____gm Dilution Volume _____ml
Tare Weight _____gm Concentration* _____
Net Weight _____gm Solvent _____

CODE _____ DATE ___/___/___ CHEMIST/TECHNICIAN _____
COMPOUND_____ LOT NUMBER_____ PURITY _____%

Final Gross Weight _____gm Dilution Volume _____ml
Tare Weight _____gm Concentration* _____
Net Weight _____gm Solvent _____

---

* Concentration = (Net Weight) x (Purity) / Dilution Volume

CSS

INTERMEDIATE STANDARDS

LOG SHEET

CODE _____ DATE __/__/__ CHEMIST/TECHNICIAN _____ SOLVENT _____

COMPOUND	CODE OF PARENT STANDARD	CONC OF PARENT STANDARD	ALIQUOT VOLUME ML	DILUTION VOLUME ML	FINAL CONC

CODE _____ DATE __/__/__ CHEMIST/TECHNICIAN _____ SOLVENT _____

COMPOUND	CODE OF PARENT STANDARD	CONC OF PARENT STANDARD	ALIQUOT VOLUME ML	DILUTION VOLUME ML	FINAL CONC

CODE _____ DATE __/__/__ CHEMIST/TECHNICIAN _____ SOLVENT _____

COMPOUND	CODE OF PARENT STANDARD	CONC OF PARENT STANDARD	ALIQUOT VOLUME ML	DILUTION VOLUME ML	FINAL CONC

WORKING STANDARDS
LOG SHEET

CODE _____ DATE __/__/__ CHEMIST/TECHNICIAN _____ SOLVENT _____

COMPOUND	CODE OF PARENT STANDARD	CONC OF PARENT STANDARD	ALIQUOT VOLUME ML	DILUTION VOLUME ML	FINAL CONC

CODE _____ DATE __/__/__ CHEMIST/TECHNICIAN _____ SOLVENT _____

COMPOUND	CODE OF PARENT STANDARD	CONC OF PARENT STANDARD	ALIQUOT VOLUME ML	DILUTION VOLUME ML	FINAL CONC

CODE _____ DATE __/__/__ CHEMIST/TECHNICIAN _____ SOLVENT _____

COMPOUND	CODE OF PARENT STANDARD	CONC OF PARENT STANDARD	ALIQUOT VOLUME ML	DILUTION VOLUME ML	FINAL CONC

COLUMN EVALUATION DATA

Column _____
Position _____
Packing _____
Theoretical Plates _____
Septum Changed _____
Inlet Temp _____
Detector Temp _____
Oven Temp _____
Column Flow _____
Detector Purge _____
Analyst _____
Date _____
Comments _____
_____
_____

Column _____
Position _____
Packing _____
Theoretical Plates _____
Septum Changed _____
Inlet Temp _____
Detector Temp _____
Oven Temp _____
Column Flow _____
Detector Purge _____
Analyst _____
Date _____
Comments _____
_____
_____

Column _____
Position _____
Packing _____
Theoretical Plates _____
Septum Changed _____
Inlet Temp _____
Detector Temp _____
Oven Temp _____
Column Flow _____
Detector Purge _____
Analyst _____
Date _____
Comments _____
_____
_____

Column _____
Position _____
Packing _____
Theoretical Plates _____
Septum Changed _____
Inlet Temp _____
Detector Temp _____
Oven Temp _____
Column Flow _____
Detector Purge _____
Analyst _____
Date _____
Comments _____
_____
_____

Column _____
Position _____
Packing _____
Theoretical Plates _____
Septum Changed _____
Inlet Temp _____
Detector Temp _____
Oven Temp _____
Column Flow _____
Detector Purge _____
Analyst _____
Date _____
Comments _____
_____
_____

Column _____
Position _____
Packing _____
Theoretical Plates _____
Septum Changed _____
Inlet Temp _____
Detector Temp _____
Oven Temp _____
Column Flow _____
Detector Purge _____
Analyst _____
Date _____
Comments _____
_____
_____

APPENDIX 3

CHAIN OF CUSTODY DOCUMENT

CHAIN OF CUSTODY RECORD

General Engineering Laboratories
1313 Ashley River Road
Charleston, South Carolina 29407

PAGE ___ of ___

CLIENT NAME

COLLECTED BY

SAMPLE ANALYSIS (x)

F - filtered P - preserved

SAMPLE ID	DATE	TIME	comp	grab	well	SAMPLE LOCATION	# of Containers	pH, Sp. Cond.	TOC (F P)	TOX	Cl, Fl, SO4 (F)	NITRATES (F P)	VOC	METALS (F P)	PESTICIDE	HERBICIDE	PHENOL (P)	ACID/B/N Ext	COLIFORM (P)	CYANIDE (P)	(F P)	(F P)	(F P)	REMARKS

Relinquished by:	Date	Time	Received by:	Relinquished by:	Date	Time	Received by:

Relinquished by:	Date	Time	Received by lab by:	Date	Time	Remarks

APPENDIX 4

EPA RECOMMENDED HOLDING TIMES AND PRESERVATION REQUIREMENTS

SAMPLE PRESERVATION, HOLDING TIME AND ANALYTICAL PROCEDURES

Parameter	Bottle	Preservative	Vol ml	Holding Time	Analytical Method(1)
Wet Chemistry					
Acidity	plastic	4°C	50	14 D	A-305.1
Alkalinity	plastic	4°C	100	14 D	A-310.2
BOD	plastic	4°C	1000	48 H	B-543-549
Chlorides	plastic	none	100	28 D	A-325.3
COD	plastic	4°C, H_2SO_4(pH≤2)	50	28 D	B-550-554
Color	plastic	4°C	50	48 H	B-64
Conductivity	plastic	4°C	25	28 D	A-120.1
Cyanides	plastic	4°C,NaOH(pH≥12)	500	14 D	A-335.1&2
Dissolved Oxygen	in-situ	none	–	on site	A-360.1
Fluoride	plastic	none	50	28 D	B-387-390
Hardness	plastic	HNO_3(ph≤2)	100	6 M	A-130.2
Nitrogen					
Ammonia	plastic	4°C,H_2SO_4(pH≤2)	500	28 D	B-418
Nitrate/Nitrite	plastic	4°C,H_2SO_4(pH≤2)	150	28 D	A-365.2
Kjeldahl	plastic	4°C,H_2SO_4(pH≤2)	500	28 D	A-354.1
pH	plastic	none	50	on site	A-150.1
Phenols	glass	4°C,H_2SO_4(pH≤2)	500	28 D	A-420.1
Phosphorus					
Total	plastic	4°C,H_2SO_4(pH≤2)	50	28 D	A-365.2
Ortho	plastic	filter,4°C	50	48 H	A-365.2
Oil & Grease	glass	4°C,H_2SO_4(pH≤2)	1000	28 D	B-502B
Solids					
Filterable (Dissolved)	plastic	4°C	100	48 H	A-160.1
Settleable	plastic	4°C	100	48 H	A-160.5
Non-Filterable (Suspended)	plastic	4°C	100	7 D	A-160.2
Total	plastic	4°C	100	7 D	A-160.3
Sulfates	plastic	4°C	100	28 D	A-375.4
Surfactants	plastic	4°C	400	48 H	A-425.1
Turbidity	plastic	4°C	50	48 H	B-64
Bacteriological					
Coliform					
Fecal	plastic	4°C,$Na_2S_2O_3$(2ml)	100	6 H	B-909C
Total	plastic	4°C,$Na_2S_2O_3$(2ml)	100	6 H	B-909
Metals					
Total	plastic	4°C,HNO_3(pH≤2)	500	6 M	A-200-289
Dissolved	plastic	filter,4°C,HNO_3 (pH≤2)	500	6 M	A-200-289
Chromium (+6)	plastic	4°C	200	24 H	A-600/4
Mercury	glass	HNO_3(pH≤2)	100	28 D	A-245.1

SAMPLE PRESERVATION, HOLDING TIME AND ANALYTICAL PROCEDURES
(CONTINUED)

Parameter	Bottle	Preservative	Vol ml	Holding Time	Analytical Method(1)
Organics					
Priority Pollutants					
Chlorinated Phenoxy Acid Herbicides	glass	4°C	1000	40 D	B-509-A
Halocarbons	glass	$Na_2S_2O_3$ (10 mg/40 ml)	500	14 D	A-601
Purgeable Aromatics	glass	$Na_2S_2O_3$ (10 mg/40 ml)	500	14 D	A-602
Phenols (2)	glass	4°C,$Na_2S_2O_3$ (10 mg/40 ml)	1000	40 D	A-604
Pesticides, PCB, Phthalates, & Organophosphates (2)	glass	4°C	1000	40 D	A-608
Chlorinated Hydrocarbons (2)	glass	4°C	1000	40 D	A-612
TOC	glass	4°C,H_2SO_4	125	28 D	B-418B,421
TOX	glass	4°C	250	14 D	C-9020

(1) A = Methods for Chemical Analysis of Water and Wastes, EPA-600/4-79-020, March 1983
B = Standard Methods for the Examination of water and Wastewater, 14th Ed., 1975 C = Test Methods for Evaluating Solid Waste, EPA-SW-846, July 1982

(2) Samples must be extracted within 7 days. The extract can be held 40 days.

SAMPLING REPORT - NAVAL AIR STATION MEMPHIS

MILLINGTON, TENNESSEE

Prepared by

Southern Division
Naval Facilities Engineering Command

11 August 1988

Prepared by:

Robert W. Moser, PE

Robert W. Moser

Reviewed by:

James Malone, PE

J. B. Malone

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LIST OF FOOTNOTE REFERENCES

(1) 100% ADDITIONAL SAMPLING REPORT - NAS MEMPHIS (NORTHSIDE STORM DRAIN) Prepared by Environmental & Safety Designs, Inc. August 9, 1988

(2) INITIAL ASSESSMENT STUDY OF NAVAL AIR STATION MEMPHIS, MILLINGTON, TENNESSE, NEESA 13-038, NOVEMBER 1983

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1.0 INTRODUCTION

"Environmental and Safety Designs (EnSafe) was contracted by Southern Division Naval Facilities Engineering Command to investigate certain uncontroled hazardous waste disposal sites located at Naval Air Station (NAS) Memphis. The investigation was designed to identify possible contamination at the following Navy locations:

Site 1.) Soils adjacent to a 60" RCP (4' sections) storm sewer from its outfall and continuing upstream a distance of 660 linear feet. The site received approximately 17,000 gallons/day of cyanide electroplating waste daily from the fifties to the seventies.

Site 2.) An outside storage yard which stored lead acid batteries and gasoline, and;

Site 3.) An area adjacent to an existing storm sewer manhole located immediately west of 7th Avenue and south Casablanca street, near the former electroplating shop. The location of these site is shown on Figure 1." 1

The investigation was conducted in order to determine the proper handling of any contaminated soils within the limits of the Navy's Military Construction (MILCON) Project No. 283, SHIPBOARD AIRCRAFT CRASH CREW LIVE FIRE TRAINING FACILITY. The location of this facility and the location of the sites investigated are shown on Figure 1.

Sites 1, 2, and 3 are solid waste management units (SWMU) that have been identified in the Hazardous Solid Waste Amendments Permit No. TN 002, dated 15 September 1986. Site 1 of this report is SWMU site - N-121 Plating Shop Ditch. Site 2 of this report is SWMU site 40 -Salvage Yard No. 1. Site 3 of this report is associated with SWMU site 3 - N-121 Plating Shop Dry well. A RCRA Facility Investigation Work Plan was submitted to both the state of Tennessee and EPA region IV in April 1987. We have been waiting for EPA's comments on the work plan since then. In June of 1988 we could not wait any longer, so we proceeded to investigate the three sites. If we can not award the below MILCON project this September 1988, we could lose the project.

2.0 MILCON PROJECT NO. 283

This project's primary facility consists of a concrete simulated flight deck for aircraft crash and rescue crew firefighting training. The primary facility will be underlined with a 40 mil impervious material. Support facilities will include an asphalt road which will circle the primary facility.

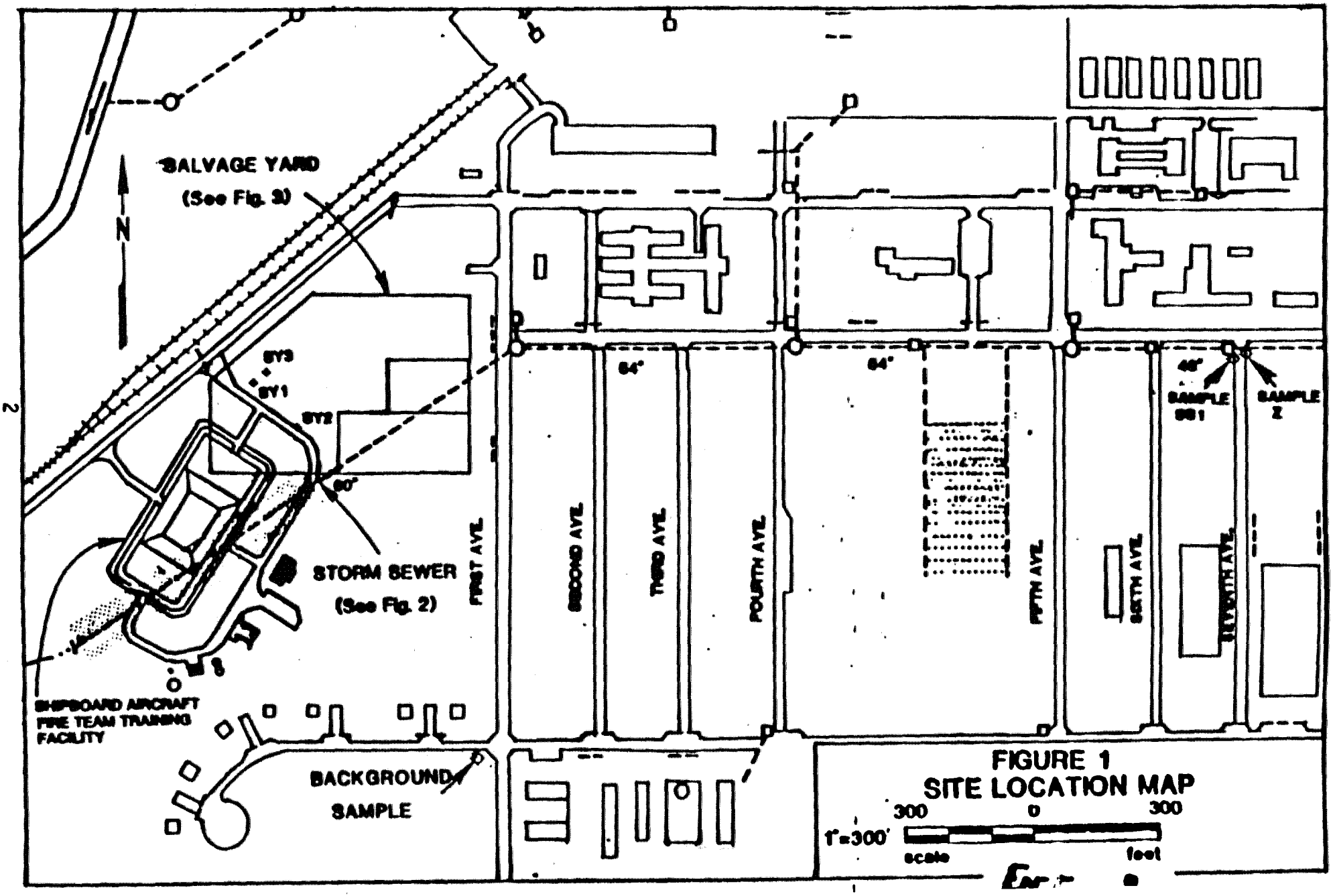


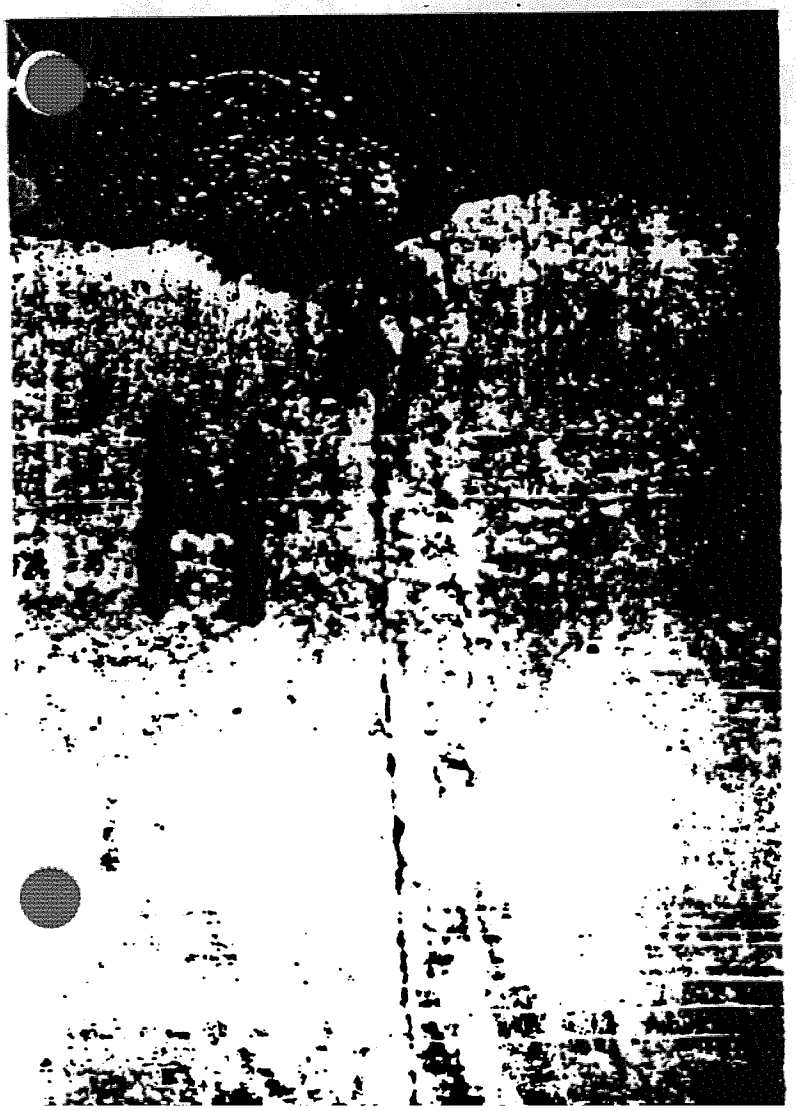
FIGURE 1
SITE LOCATION MAP

Currently there is not a facility of this type for a Navy aircraft crash and salvage crew to train under live fire conditions. This project was developed from the findings of the investigation into the problems associated with extinguishing the catastrophic fire onboard the USS NIMITZ. Investigators discovered that the current level of training for aircraft crash crews was inadequate because no facilit exist where an aircraft crash crew can receive live fire training. This project will enable a team to receive live firefighting training with the unique hazards associated with shipboard aircraft firefighting. This team training will develop confidence in the crew's ability to extinguish large, complex shipboard aircraft deck fires, thus potentially saving thousands of lives aboard our ships.

3.0 SAMPLING RATIONALE

"The sampling target for site 1 was to sample soils surrounding the storm sewer at all defective joints. An internal inspection of the sewer was performed by Industrial Clean-up Inc. (ICI) and all suspect joints were marked and recorded (Table 1). Photographs of the joints are located in Appendix A. All joint locations were then transposed to the ground surface measured from the outfall. Sampling was performed by drilling to depths of 0-1 feet, 1-3 feet, and 3-5 [illegible] Two additional borings were taken at [illegible] depth interval [illegible] from the [illegible] the system. [illegible] of the 0-1 foot samples were analyzed for [illegible] Toxicity Metals (EPA METHOD SW-846) and Total Cyanide." 1

"Site 2, the salvage yard, was visually inspected and monitored using a hNu photoionization detector. The visual inspection of the property indicated widespread discoloration of surface soils on the site. Consequently, three composite samples were collected from areas that showed staining or discoloration on the surface. An organic vapor background concentration of 0.1 ppm was established using the hNu and at sampling location SY1 there was a slight deflection to 0.3ppm. Sample locations SY2 and SY3 were determined by staining only. Composite samples were collected at each of these locations from depths of 0-1 feet, 1-3 feet, and 3-5 feet below the surface. Samples collected from the 0-1, and 1-3 foot level were analyzed for Total Petroleum Hydrocarbons and Total Lead." 1 Samples collected from the 1-3 foot level were also analyzed for EP Toxicity Lead and BTX.

During the field investigation site 2 was found to be covered with a good growth of grass. The grass had to be cut so that the salvage yard could be visually inspected. Asphalt was detected at the surface of the salvage yard and appeared to be fine millings. The boring logs are provided in appendix C.

"The sampling target for site 3 was the joint nearest the storm sewer manhole as shown on the attached location map (Figure 1). A composite sample was taken from a boring at depths 0-1 foot, 1-3 feet, and 3-5 feet below the pipe's invert. The storm sewer samples (from the 0-1 feet below the invert) were also analyzed for EP Toxicity Metals and Total Cyanide." 1