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REVISED FINAL WORK PLAN FOR FACILITY INVESTIGATION NSA PANAMA CITY FL
3/1/1998
E.C. JORDAN CO.

TI-45-Revised Final
Work Plan RCRA Facility
Investigation

U.S. DEPARTMENT OF THE NAVY
NAVAL COASTAL SYSTEMS CENTER
PANAMA CITY, FLORIDA

UIC N61331

REVISED FINAL WORK PLAN

RCRA FACILITY INVESTIGATION

CONTRACT NO. N62467-87-C-0025

PREPARED FOR

SOUTHERN DIVISION
NAVAL FACILITIES ENGINEERING COMMAND
2155 EAGLE DRIVE
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EXECUTIVE SUMMARY

The Resource Conservation and Recovery Act (RCRA) corrective action program is designed to evaluate the potential for release of hazardous waste from Solid Waste Management Units (SWMU) and to implement corrective actions as necessary. The program applies to all operating, closed, or closing RCRA facilities and consists of the RCRA Facility Assessment (RFA), the RCRA Facility Investigation (RFI), and corrective measures. E.C. Jordan (Jordan), under contract No. N62467-87-C-0025 is providing services to the Department of the Navy, Naval Facilities Engineering Command, Southern Division in support of their compliance with Hazardous and Solid Waste Amendment (HSWA) Permit (RCRA Permit No. FL8 170 002 792) requirements for Naval Coastal Systems Center (NCSC), Panama City, Florida. Jordan has prepared this RFI Work Plan based on the results of the RFA conducted in 1987. The objective of the RFI is to determine whether any of the SWMUs or areas of concern (AC) identified during the RFA are releasing hazardous constituents to the environment.

The RFI will investigate 7 of the 12 SWMUs and 2 of the 3 ACs that were identified during the RFA. Methods of exploration to be used during the RFI include soil borings, monitoring wells, aquifer testing, sediment sampling, and soil gas testing. A horizontal and elevational survey of all new and existing monitoring wells and a Health and Environmental Assessment will be conducted in addition to the exploration program.

Monitoring well clusters consisting of shallow, intermediate, and deep wells will be used at SWMU #2 (former landfill), AC #1 (old fire training area No. 1), and AC #2 (oil contamination area) to assess the vertical and horizontal extent of contamination. Soil boring grids will be used at SWMU #2 and AC #2 for delineating plumes of contamination. Intermediate depth monitoring wells will be used at SWMU #5 (paint shop cleaning area), and SWMU #9 (old fire training area No. 2) to evaluate whether contamination exists at these sites. Sediment samples will be collected at SWMU #3 and SWMU #4 (landfills). An ash sample will be collected from SWMU #8, the classified documents incinerator.

Jordan will prepare a Draft RFI Report that includes a review, evaluation, and summary of the data generated during the RFI. The Navy's comments will be discussed and incorporated into a Draft Final Report that will be submitted to the U.S. Environmental Protection Agency (USEPA) and the Florida Department of Environmental Regulation (FDER) for their review. Subsequent to the comments meeting with these agencies, Jordan will publish a Final RFI Report.

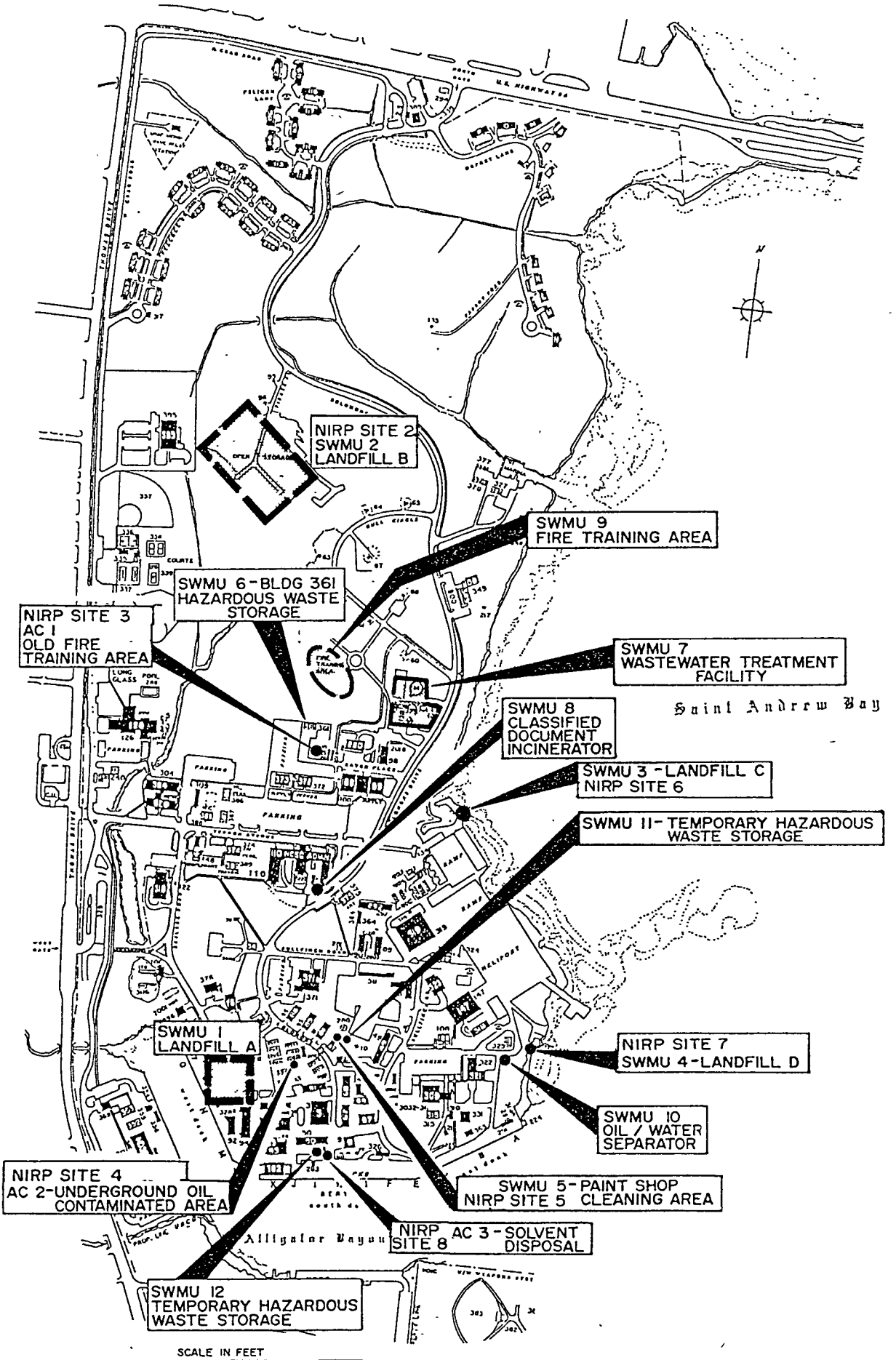
1.0 INTRODUCTION

The Resource Conservation and Recovery Act (RCRA) corrective action program is designed to evaluate the potential for release of hazardous wastes and hazardous constituents to the environment at RCRA facilities and, as necessary, implement corrective actions. Under the broad authority of the 1984 Hazardous and Solid Waste Amendments (HSWA), the program was extended to cover all past waste management practices at RCRA facilities. The RCRA corrective action program applies to all operating, closed, or closing RCRA facilities and consists of three phases:

- RCRA Facility Assessment (RFA) study identifies existing or potential releases of contamination from Solid Waste Management Units (SWMUs) that require additional investigation;
- RCRA Facility Investigation (RFI) study characterizes the nature and extent of releases; and
- Corrective Measures Study (CMS) identifies the types of remedial alternatives available, feasibility of alternatives, and provides engineering design of alternative selected.

E.C. Jordan Co. (Jordan) is providing consulting services to the Department of the Navy, Naval Facilities Engineering Command, Southern Division (SDIV) in support of their compliance with HSWA Permit (No. FL8 170 002 792) requirements for the Naval Coastal Systems Center (NCSC) at Panama City, Florida. As part of this service, Jordan was authorized in June 1987 to conduct an RFA at NCSC and develop an RFI Work Plan for the units requiring additional investigation. The RFA for NCSC consisted of a preliminary review (PR) of available information supplied by NCSC, SDIV, and the Florida Department of Environmental Regulation (FDER). In addition to the PR, a visual site inspection (VSI) was conducted on June 23 and 24, 1987, by Jordan and NCSC personnel. In July 1987, a Draft Final RFA Report was submitted to SDIV, U.S. Environmental Protection Agency (USEPA), and FDER for review. Based on the comments received during this review, a Final RFA Report was prepared and submitted in October 1987.

The Final RFA Report presented information on waste generation, handling and processing that had occurred or is occurring at NCSC. The report identified 12 SWMUs and three Areas of Concern (AC) where past or current practices may have impacted the environment. The locations of the SWMUs and ACs identified in the RFA are shown in Figure 1-1. Based upon a review of information derived during the PR, VSI, and documents provided by the Navy, each site was evaluated with regard to a potential for a release to the environment. A summary of the release potentials is presented in Table 1-1.



LEGEND

SWMU - SOLID WASTE MANAGEMENT UNIT
AC - AREAS OF CONCERN

E.C. JORDAN CO. ENGINEERS & SCIENTISTS	LOCATION OF SOLID WASTE MANAGEMENT UNITS AND AREAS OF CONCERN	
U.S. DEPT. OF NAVY NAVAL COASTAL SYSTEMS CENTER PANAMA CITY, FLORIDA	5330-01	FIGURE 1-1

TABLE 1-1
SUMMARY OF RELEASE INFORMATION
RCRA FACILITY INVESTIGATION
NAVAL COASTAL SYSTEMS CENTER
PANAMA CITY, FLORIDA

SWMU No.	NIRP site	Description	Ground-water	Surface water	Air	Soil	Subsurface gas	Action
1	1	Landfill A	P	P	NE	P	NE	RFI
2	2	Landfill B	D	NE	NE	D	NE	RFI
3	6	Landfill C	NE	NE	NE	NE	NE	RFI
4	7	Landfill D	NE	NE	NE	NE	NE	RFI
5	5	Paint equipment cleaning area	P	NE	NE	E	NE	RFI
6		RCRA haz. waste storage area	NE	NE	NE	NE	NE	No action
7		Wastewater treatment facility	NE	P	NE	NE	NE	No action
8		Classified documents incinerator	NE	NE	NE	NE	NE	RFI
9		Old fire training area No. 2	E	NE	NE	E	NE	RFI
10		Oil/water separator	P	P	NE	P	NE	No action
11		Temporary haz. waste storage (Bldg. 84)	NE	P	NE	NE	NE	Preventative measures
12		Temporary hazourdous waste storage (Bldg. 40)	NE	P	NE	NE	NE	Bldg removed 1988

AC No.	NIRP site	Description	Ground-water	Surface water	Air	Soil	Subsurface gas	Action
1	3	Old fire training area No. 1	D	NE	NE	D	NE	RFI
2	4	Underground oil contaminated area	D	D	NE	D	NE	RFI
3	8	Solvent disposal (Bldg. 40)	NE	NE	NE	NE	NE	No action

NE - Not expected
P - Potential
E - Expected
D - Documented

Of the 15 sites studied during the RFA, Jordan recommended 6 sites for additional study under a RCRA Facility Investigation. These sites are:

- SWMU #1 - Landfill A, Original Disposal Area,
- SWMU #2 - Landfill B, Burn and Landfill Area,
- SWMU #5 - Paint Equipment Cleaning Area,

- SWMU #9 - Old Fire Training Area No. 2,
- AC #1 - Old Fire Training Area, and
- AC #2 - Underground Oil Contaminated Area.

In addition, the two temporary hazardous waste storage units (SWMU #11 and SWMU #12) were recommended for the installation of measures to prevent a release to the environment. SWMU #12 was removed from NCSC in 1988.

Upon review of the Draft Final RFA Report by both the USEPA and the FDER, three additional sites were added to the RCRA Facility Investigation. The sites are:

- SWMU #3 - Landfill C, Burn and Disposal Area,
- SWMU #4 - Landfill D, Filled Gully, and
- SWMU #8 - Classified Documents Incinerator.

Presented in this Work Plan is a description of the activities necessary to conduct the RCRA Facility Investigations at nine sites within the boundaries of NCSC Panama City, Florida. Background information for the NCSC Panama City facility is presented in Section 2.0. The field activities, Health and Environmental Assessment (HEA), well survey, laboratory program, the RFI Report, and the schedule are presented in subsequent sections.

1.1 PURPOSE. The purpose of conducting the RFI at NCSC Panama City is to evaluate and characterize any releases from the SWMUs and ACs that were identified as requiring further evaluation during the RCRA Facility Assessment. Data from the RFI will be used in developing any necessary remedial alternatives for the CMS or for directing further investigations, as appropriate.

1.2 WORK PROGRAM OVERVIEW. In June 1987 Jordan was contracted by SDIV (Contract No. N62467-89-C-0025) to develop the Work Program for a RCRA Facility Investigation. The RCRA Facility Investigation Work Program consists of the preparation of a Work Plan and the appendices to the Work Plan including the Sampling and Analysis Plan (SAP), the Health and Safety Plan (HASP), the Data Management Plan (DMP), and the Project Management Plan (PMP).

The objective of the field program for the proposed RFI is three-fold. First, it is intended to characterize the horizontal and vertical extent of groundwater contamination in the unconfined aquifer migrating from known contaminated sites (SWMU #1, SWMU #2, AC #1, and AC #2). Secondly, it is intended to yield data that will be used to verify the existence of contamination at SWMU #3, SWMU #4, and SWMU #9. Lastly, ancillary goals include delineating known source areas (SWMU #2, SWMU #5, SWMU #8, SWMU #9, AC #1, and AC #2); defining baseline (background) chemical concentrations in soils; developing a database of soil and aquifer chemical and physical properties that influence contaminant transport; and evaluating potential subsurface gas sources (SWMU # 2).

It is the goal of the field and laboratory program to supply sufficient data on those sites included under the Navy's Installation Restoration Program (IRP) so that work can begin on the CMS phase of the program. To this end, a Health and Environmental Assessment is also proposed in the Work Plan. For those sites undergoing verification of contamination, the intent of the field program is to provide a database that will support recommendations for exclusion of the site from additional work under the draft HSWA permit or provide a framework for the development of a Work Plan for the next phase of the RCRA Corrective Action activities.

1.2.1 Work Plan. The Work Plan presents the scope of work and schedule associated with the field and laboratory programs proposed for the RCRA Facility Investigation and the program for the Health and Environmental Assessment. There are six major tasks within the scope of work which are briefly reviewed in this section.

Task 1 - Exploration and Sampling Program. The exploration and sampling program for each SWMU or AC is described in Section 3.4. Activities included in the program are as follows:

- boring and soil sampling,
- monitoring well installation,
- subsurface gas screening,
- sediment sampling,
- ash sampling,
- groundwater sampling,
- water level measuring, and
- aquifer testing.

Task 2 - Well Survey. This task includes the survey program required for horizontal and elevational location of monitoring wells relative to existing NCSC datum. The objective of the survey program is to horizontally locate monitoring wells for future reference and to provide the data necessary for piezometric surface mapping to assess groundwater flow direction and seepage velocities.

Task 3 - Health and Environmental Assessment. In conjunction with the program for the RFI, an HEA will be conducted at NCSC. This assessment will establish the baseline risk associated with the solid waste management units, evaluate the conditions at NCSC, and identify potential effects of these conditions on public health and the environment. The HEA will evaluate whether or not a risk may be associated with the SWMUs and ACs located on the facility and will be used as a basis for comparison with the anticipated impact of corrective measures, should they be required. The HEA is described in Section 4.0.

Task 4 - Analytical Program. The analytical program is described in detail in the Sampling and Analysis Plan (SAP) which is included as Appendix A to the Work Plan. Parameters and analytical methods to be used for analysis of samples of each medium are identified in this task.

Task 5 - RFI Report.

Draft Report. Presented in Section 6.1 of the Work Plan is a description of the Draft RFI report. The Draft Report will describe the characteristics of each site evaluated. Based on the evaluation of these characteristics, conclusions will be drawn and recommendations made to conduct either additional phases of investigation, if necessary, or develop remedial alternatives for the Corrective Measures study.

Draft Final Report. Presented in Section 6.2 of the Work Plan is the process for the review of the Draft Report preparation of the Draft Final Report. This process includes meeting with the Navy and the preparation of the Draft Final Report.

1.2.2 Field Operations Plans. The Field Operations Plans (FOP) for the NCSC RFI include the SAP, the HASP, the DMP, and the PMP. The FOPs are included as appendices to the RFI Work Plan and described individually in the following sections.

1.2.2.1 Sampling and Analysis Plan. Included in the SAP are the E.C. Jordan Co. Standard Operating Procedures (SOP), the Quality Assurance Project Plan (QAPP), and detailed descriptions of the sampling procedures to be performed at each SWMU and AC. The SAP is included as Appendix A to the Work Plan.

1.2.2.2 Health and Safety Plan. The Health and Safety Plan (HASP) presented in Appendix B describes Jordan's health monitoring and safety training program and the site-specific health and safety requirements for conducting the field operations of the Remedial Investigation. The HASP also will include a presentation of the training experience for all personnel scheduled to work at NCSC.

1.2.2.3 Project Management Plan. The PMP (Appendix C) was developed to present Jordan's overall management approach to the RFI at NCSC Panama City. Also included in the PMP are the schedule for the project and a description of the logistical approach to the project. Qualifications of key Jordan personnel responsible for directing and conducting the RFI are also presented in the PMP.

1.2.2.4 Data Management Plan. Presented in the DMP are the RFI data processing procedures, report processing procedures, project file requirements, and progress reporting procedures and documents. The formats to be used in presentation of the data and the data reduction procedures are also discussed in the DMP. The DMP is presented in Appendix D.

2.0 BACKGROUND INFORMATION

2.1 NAVAL COASTAL SYSTEMS CENTER FACILITY DESCRIPTION. The Naval Coastal Systems Center (NCSC) Panama City, Florida is a major Navy research and development facility. NCSC is located on St. Andrew Bay in Bay County, Florida (Figure 2-1). It is situated approximately 103 miles east of Pensacola, 98 miles west of Tallahassee, and 7 miles west of Panama City, Florida. NCSC is bounded by U.S. Highway 98 to the north, St. Andrew Bay to the east, State Road 392B (Magnolia Beach Road) to the south, and State Road 392 (Thomas Drive) to the west.

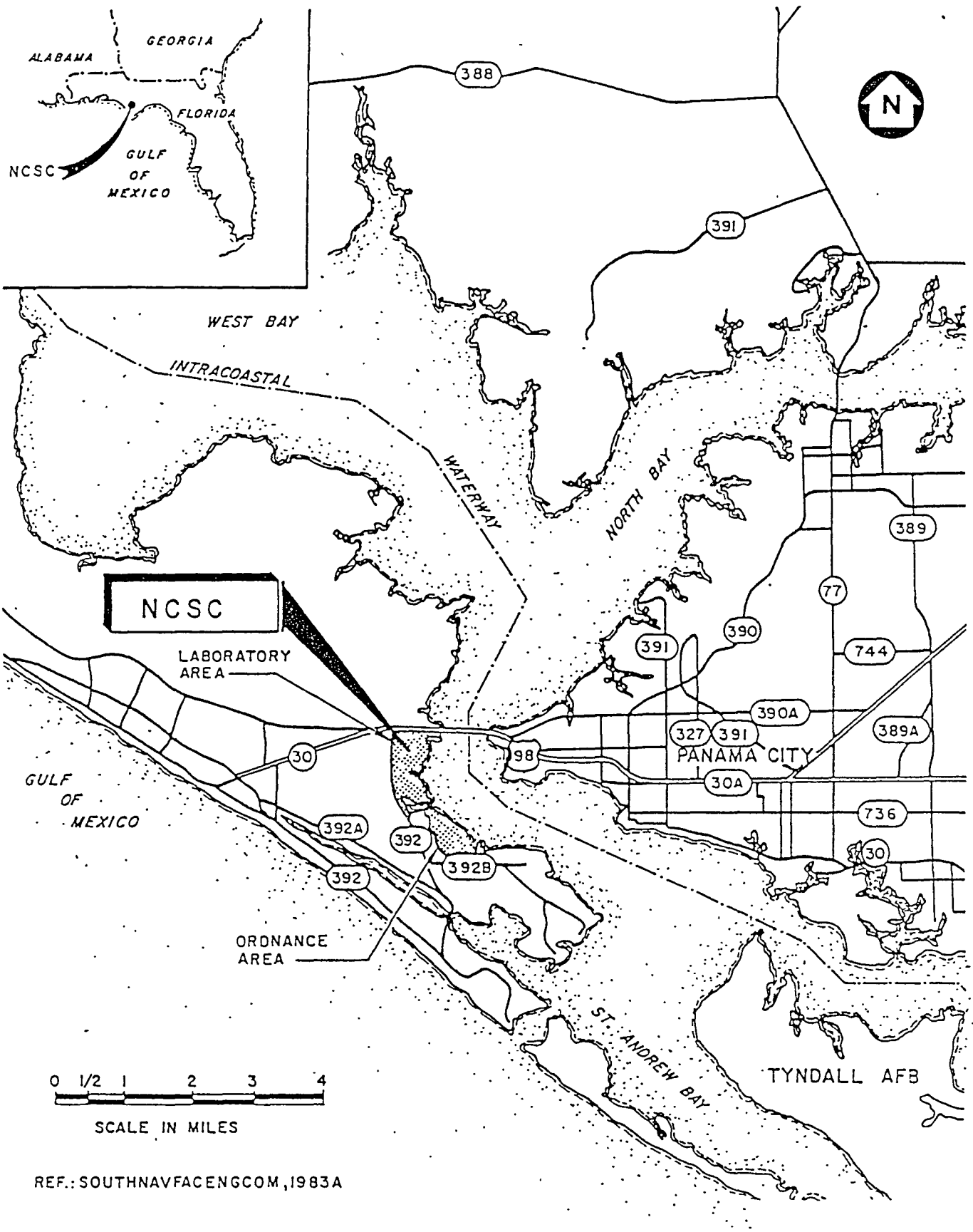
NCSC consists of two operational areas that encompass 657 acres. The laboratory area, situated north of Alligator Bayou (an inlet to St. Andrew Bay), covers approximately 350 acres and houses research facilities and various support activities and tenants. The ordnance area, south of Alligator Bayou, is approximately 300 acres in extent and is used primarily for ordnance storage and limited research.

2.2 ENVIRONMENTAL SETTING.

2.2.1 Physiography and Climate. NCSC is located in the Flat-wood Forest Physiographic Subdivision of the Gulf Coastal Lowlands Physiographic Division. The Flat-wood Forest is covered with pines in areas where it has not been cleared. It is well drained except for some low-lying swampy areas near bays, which become inundated during periods of extended rainfall.

The land surface in Bay County varies from slightly rolling to flat and has an elevation of less than 70 feet above mean sea level (MSL). Topography is the result of the buildup of ancient marine terraces due to isostatic sea level changes. Elevations at NCSC range from 0 to 17 feet above MSL and are indicative of the Silver Bluff Terrace (0 to 10 feet above MSL) and the Pamlico Terrace (0 to 25 feet above MSL). Terrace breaks are difficult to discern in this area; therefore, the two terrace systems are often paired for purposes of identification.

NCSC is located in a humid, subtropical climate, characterized by mild winters and hot, humid summers. The average yearly temperature is 66.9 degrees Fahrenheit, varying from an average of 53 degrees Fahrenheit in January to an average of 82 degrees Fahrenheit in July. NCSC is located in a low-lying area near the Gulf of Mexico; therefore, the diurnal effects of land-sea breezes obviate temperature extremes. It is particularly breezy in the summer because of the temperature differential between the land and sea. The relative humidity is 55 to 67 percent in the early afternoon and 82 to 88 percent in the evening. Heavy fog is present 20 to 30 percent of the year, generally forming late at night and dissipating after sunrise. Thunderstorms are frequent in the spring and summer.



REF.: SOUTHNAVFACENGCOM, 1983A

E.C. JORDAN CO. ENGINEERS & SCIENTISTS	NCSC SITE VICINITY
U.S. DEPT. OF NAVY NAVAL COASTAL SYSTEMS CENTER PANAMA CITY, FLORIDA	5330-01 FIGURE 2-1

Hurricanes are also encountered in this area. The hurricane season extends from June 1 to November 30, with the greatest frequency of storms occurring in August and September. The estimated chance of hurricane force winds occurring during the season is approximately 1 in 12. Tornadoes and windstorms (58 mph or more) also occur periodically. The prevailing wind direction varies monthly and the mean wind speed ranges from 5 to 9 knots. The average yearly rainfall is 55.2 inches, with a seasonal peak occurring in July (9.82 inches average). The driest month occurs in October (2.90 inches average).

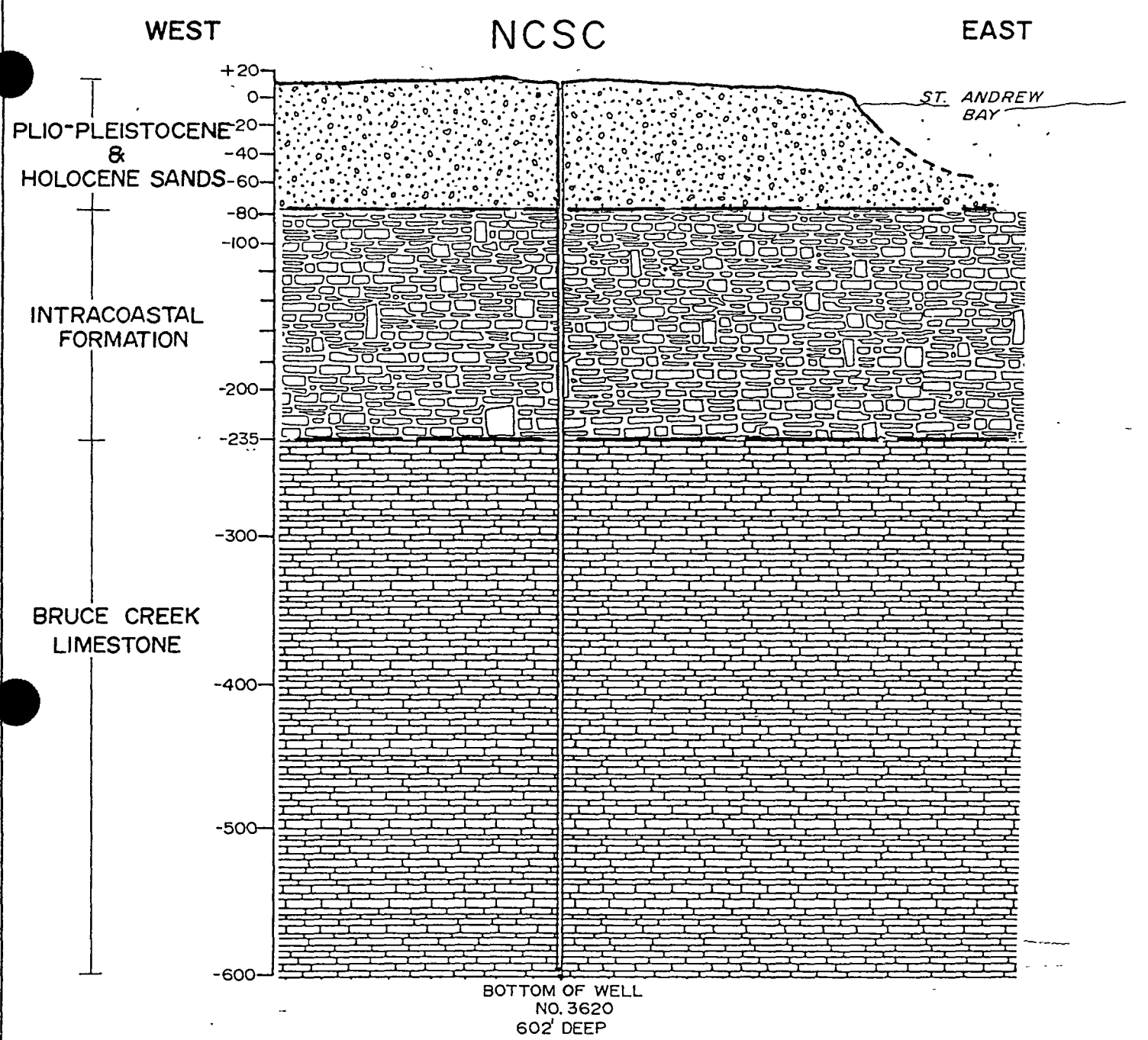
2.2.2 Stratigraphy and Structure. Surficial deposits at NCSC are Pleistocene to Recent coastal plain sediments of marine and estuarine origin. They are predominantly comprised of quartz sands. They vary in thickness from 70 to 100 feet in Bay County and are approximately 100 feet in thickness at NCSC. An interpretative geologic cross section of the geology beneath NCSC is presented in Figure 2-2. Stratigraphic nomenclature for the geologic formations in Bay County, Florida, is presented in Figure 2-3.

The upper 50 feet of sediments at NCSC consist of fine sands. Dominant surface soils that have developed from these surficial deposits include the Mandarin, Rutledge, Osier, Arents, and Leon soil series (Naval Facilities Engineering Command, 1982). These soil series range from very poorly drained sands, sandy clay loams and organic soils, in the low lying areas, to well drained sands on high ridges of the Coastal Plain.

The Intracoastal Formation underlies the Pleistocene to Recent sediments at NCSC (Figure 2-2). This formation is late Middle Miocene to late Pliocene in Bay County. It is olive green, consists of sand and poorly consolidated limestone, is highly fossiliferous, and contains phosphorite. This formation is approximately 150 feet thick at NCSC.

The Bruce Creek Formation underlies the Intracoastal Formation in Bay County. It consists of white to light yellow-gray, moderately indurated granular to calcarentic limestone. It may possess up to 20 percent quartz sands, is fossiliferous, and contains minor amounts of phosphorite, glauconite, and pyrite. This formation is absent in the northeastern corner of Bay County and increases in thickness, up to about 300 feet, near the coast. It is Miocene or younger in age and is approximately 300 feet thick under NCSC.

Suwannee Limestone and limestones of the Ocala Group probably underlie the Bruce Creek Formation. Wells have not been drilled to sufficient depths at NCSC to confirm their presence. However, it is inferred from boring logs for deep wells from surrounding areas that they are present (Schmidt and Clark, 1980). The Suwannee Limestone consists of light gray to yellow-gray limestone, is fossiliferous, and is locally dolomitized. It is Oligocene in age and has a thickness of 70 to 100 feet in the vicinity of NCSC.



SOURCE: SCHMIDT & CLARK, 1980;
BARR & WAGNER, 1981;
ESE, 1986

NOTE: AREAL EXTENT OF SPECIFIC STRATIGRAPHY INFERRED FROM GEOLOGIC LOG OF WELL NO. 3620

LEGEND

- UNDIFFERENTIATED GRAVELS, QUARTZ SANDS, AND CLAYEY SANDS.
- SANDY, CLAYEY LIMESTONE
- LIMESTONE OF THE FLORIDAN AQUIFER

E.C. JORDAN CO. ENGINEERS & SCIENTISTS	EAST-WEST GEOLOGIC CROSS SECTION OF NCSC	
U.S. DEPT. OF NAVY NAVAL COASTAL SYSTEMS CENTER PANAMA CITY, FLORIDA	5330-01	FIGURE 2-2

ERA	PERIOD	EPOCH	ROCK UNITS OR FORMATIONS, AND DESCRIPTIONS		APPROXIMATE DEPTH (FEET BELOW) (GROUND SURACE)
CENOZOIC	QUATERNARY	RECENT	UNDIFFERENTIATED QUARTZ SANDS		
		PLEISTOCENE			100
	NEOGENE		UNDIFFERENTIATED CLAYEY SANDS AND GRAVELS		
		PLIOCENE	INTRACOASTAL FORMATION	GRAY-OLIVE GREEN, SANDY, ARGILLACIOUS, POORLY CONSOLIDATED VERY MICRO-FOSSILIFEROUS CALCARENITE	
		UPPER			200
		MIDDLE MIOCENE	BRUCE CREEK LIMESTONE	WHITE TO LIGHT YELLOW, MODERATELY INDURATED, GRANULAR LIMESTONE	
		LOWER			550
	PALEOGENE	OLIGOCENE	SUWANNEE LIMESTONE	LIGHT GRAY TO YELLOW GRAY, DOLOMITIC LIMESTONE, OFTEN HIGHLY ALTERED, SUCROSIC, ALTERED FOSSIL TYPES	
					650
		EOCENE	OCALA LIMESTONE	LIGHT ORANGE TO WHITE, HIGH POROSITY LIMESTONES; SMALL AMOUNTS OF SAND AND CHERT; GLAUCONITE IN LOWER FACIES ABUNDANT MICRO-FOSSILS	
			VARIOUS LIMESTONE FORMATIONS		
		PALEOCENE			1050
PALEOZOIC	MESOZOIC	UPPER CRETACEOUS	VARIOUS SEDIMENTARY ROCK UNITS		
		LOWER			
		JURASSIC			
		TRIASSIC			
		CAMBRIAN	QUARTZITE/META-ARKOS		>11,000
PRE-CAMBRIAN			GRANITE	"BASEMENT"?	

E.C. JORDAN CO.
ENGINEERS & SCIENTISTS

STRATIGRAPHIC NOMENCLATURE FOR THE GEOLOGIC FORMATIONS IN BAY COUNTY, FL

U.S. DEPT. OF NAVY
NAVAL COASTAL SYSTEMS CENTER
PANAMA CITY, FLORIDA

5330-01

FIGURE 2-3

Limestones of the Ocala Group underlie the Suwannee Limestone (Figure 2-2). The limestone is divided into an upper and a lower facies. The lower facies is a light orange to white limestone with high porosity, calcite cement, some glauconite and sand, and is highly fossiliferous. The upper facies is similar but glauconite is rare and chert is more common. The Ocala Limestone is of Eocene age, thickens toward the coast, and lies about 650 to 700 feet below the surface. It is approximately 400 feet thick below NCSC.

Older Cenozoic (i.e., Paleocene) and Mesozoic sedimentary rocks probably underlie the site, but an exact description is not possible because they have not been encountered during previous drilling episodes in the NCSC area. Although such rocks are known to exist at depth throughout the Panhandle, the formations vary in composition and lateral extent.

Cambrian quartzite/meta-arkos and Precambrian granite (basement) underlie the younger sedimentary deposits. These occur at depths greater than 11,000 feet below the surface.

Bay County is located on the western flank of the Apalachicola Embayment, which is the main structural feature influencing the deposition of sediments found in the subsurface. The axis of this shallow basin is generally northeast to southwest; it is narrowest in the northeast and widens to the south and southwest. The areal extent of the basin increases with depth; therefore, indicating a long, continued development. Correspondingly, the older rocks (Paleogene and Mesozoic) are thicker than the younger deposits (Quaternary and Neogene) because they have had continuous deposition for a longer time period.

2.2.3 Hydrology.

2.2.3.1 Surface Water. NCSC is located on the western shore of St. Andrew Bay, which borders the facility to the east. There are several small streams onsite. The streams in the northern part of the site flow to the east and northeast through channelized tributaries and those in the southern part of the site flow through a tributary system towards four freshwater ponds located in the west central part of NCSC. The two largest ponds, adjacent to Alligator Bayou, are 0.5 and 1.2 acres in extent. Their water levels are maintained by control structures leading to Alligator Bayou. The bayou is tidally influenced and flows in an easterly-northeasterly direction. There is a small tidal inlet north of the Hovercraft Landing Pad that drains into St. Andrew Bay. Low-lying areas tend to be swampy.

St. Andrew Bay, to the east of NCSC, is a marine body that discharges southward into the Gulf of Mexico. Wave action within the bay is generally limited to short period wind waves with heights less than 1 foot. Wave heights of 2 to 4 feet may be attained during severe storms. The mean tidal range at NCSC is 1.3 feet, and the tides are generally diurnal. The local tidal amplitudes are small and very susceptible to wind and weather modification.

2.2.3.2 Groundwater. Groundwater occurs in three aquifers at NCSC: the surficial aquifer, the secondary artesian aquifer, and the Floridan aquifer system.

The surficial aquifer is composed of highly permeable quartz sands with scattered lenses of clayey sands and sandy clays. It ranges in thickness from 65 to 140 feet. The depth to the water table ranges from 0 to 9 feet below land surface (BLS), and varies 3 to 5 feet periodically due to changes in rainfall. Groundwater flow direction within this aquifer at NCSC generally follows local topography. Onsite flow is primarily towards the discharge areas of St. Andrew Bay and Alligator Bayou, to the east and south (Figure 2-4 and 2-5).

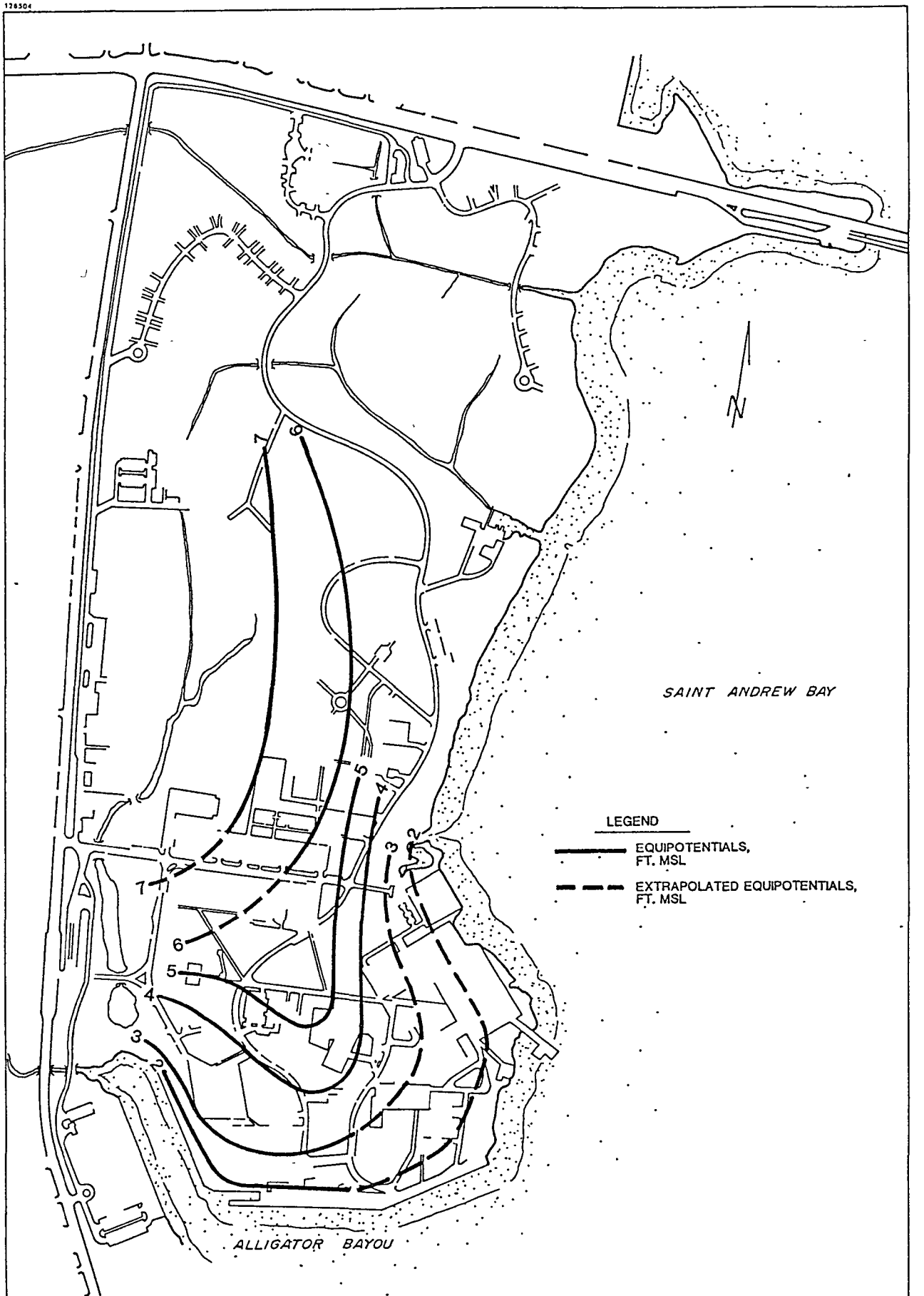
The shallow water-table aquifer at NCSC, where most of the contaminant migration would be expected to take place, is primarily composed of quartz sand and gravel with few clay sand, sandy clay loams, and organic soils. The quartz sands are only very slightly soluble; therefore, the mineral content of the water-table aquifer is low with the exception of iron. The shallow aquifer contains high levels of iron, making the groundwater slightly acidic. Depending on the type of contamination present, the high iron content may contribute to the precipitation of some contamination out of the groundwater, hence retarding the transport of contaminants.

The secondary artesian aquifer underlies the water table aquifer and is composed of isolated sand and shell beds and discontinuous limestone lenses that range from 10 to 25 feet in thickness within the Intracoastal Formation. Clay and low permeability limestone bound these more permeable lenses, confining the water in them and producing artesian conditions.

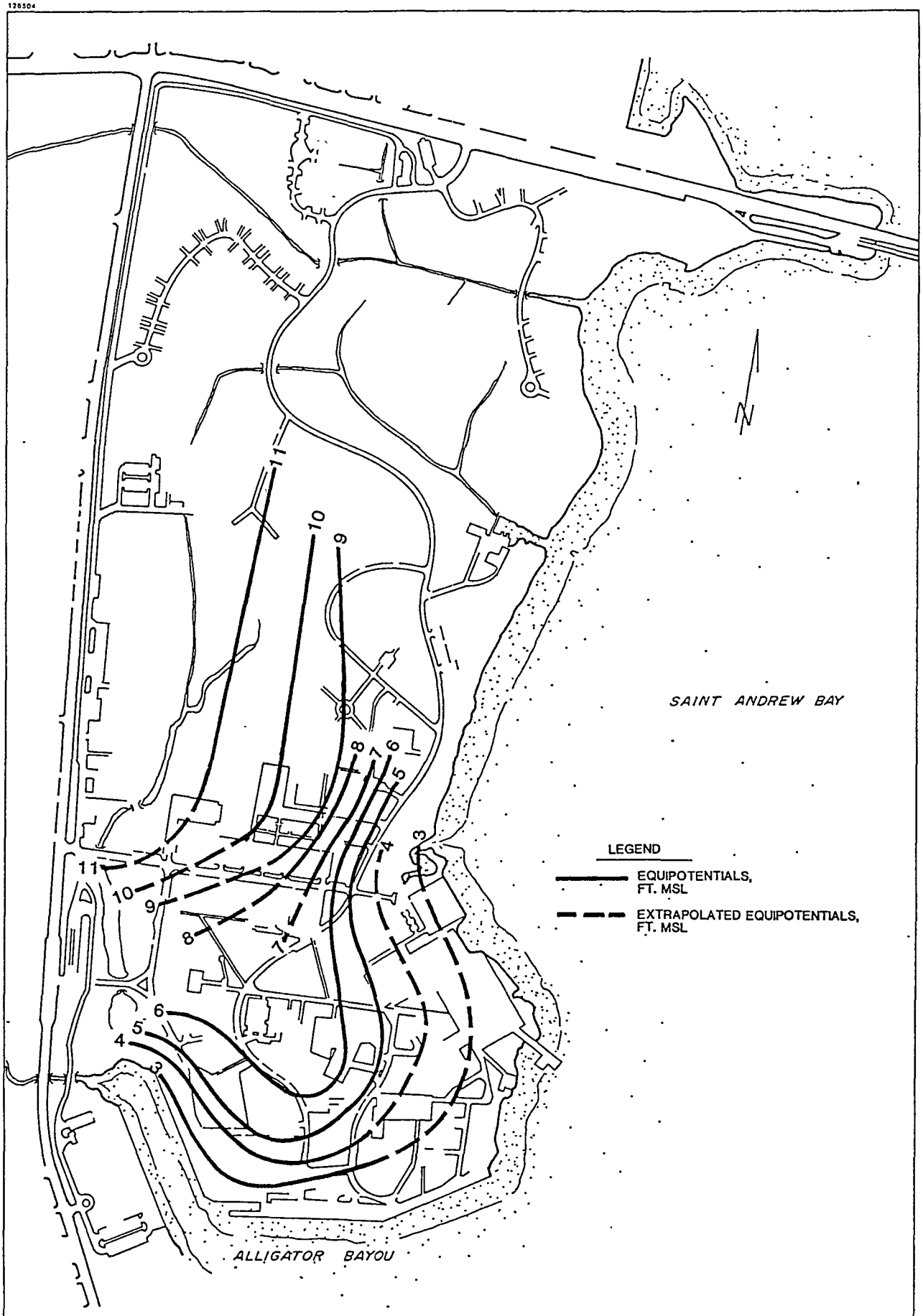
The Floridan aquifer system is separated from the overlying aquifers by semi-confining beds within the Intracoastal Formation. It is hydraulically connected with overlying strata in this area. At NCSC, the aquifer consists of the lower permeable beds of the Intracoastal Formation, the Bruce Creek Formation, the Suwannee Limestone, and the limestones of the Ocala Group. It is composed of limestones and dolomites, its upper units lie about 250 feet below sea level at NCSC, and it is approximately 1,100 feet thick (Forster 1965; 1972). Groundwater flow within the aquifer is southwesterly toward the Gulf of Mexico.

Recharge is predominantly a result of local rainwater infiltration. Some recharge to the Floridan aquifer system occurs from north of Bay County. Water entering surface outcrops of limestone in Washington, Holmes, and Jackson Counties and in southern Alabama travels down-dip, providing regional recharge. However, the majority of recharge to the Floridan aquifer system in this area is probably a result of seepage from overlying formations.

The two major aquifer systems at NCSC are the surficial aquifer and the Floridan aquifer system. The secondary artesian aquifer does not produce sufficient water locally to make it a worthwhile water source. The Floridan aquifer system yields up to 500 gallons per minute in wells. However, the water is generally hard and has a high pH. Groundwater hardness, pH, calcium, magnesium, sulfate, chloride, nitrate, and dissolved solids increase in the down-dip direction toward the coast. Analysis of the quality of water in the Floridan aquifer system at NCSC shows dissolved solids greater than 500 parts per million (ppm), hardness greater than 180 ppm, chloride greater than 100 ppm, and a fluoride concentration ranging from 0.5 to 1.5 ppm (Johnson and Associates, 1985).



E.C. JORDAN CO. ENGINEERS & SCIENTISTS	PIEZOMETRIC SURFACE MAP FOR NCSC 30,31 OCTOBER, 1986	
U.S. DEPT. OF NAVY NAVAL COASTAL SYSTEMS CENTER PANAMA CITY, FLORIDA	5330-01	FIGURE 2.4



E.C. JORDAN CO. ENGINEERS & SCIENTISTS	PIEZOMETRIC SURFACE MAP FOR NCSC 19 AUGUST, 1987	
U.S. DEPT. OF NAVY NAVAL COASTAL SYSTEMS CENTER PANAMA CITY, FLORIDA	5330-01	FIGURE 2.5

The groundwater quality in the surficial aquifer exhibits a high iron content (unsuitable for domestic use) and is acidic and corrosive (pH of 5.5 to 6.5). Laboratory analysis of the groundwater at NCSC shows dissolved solids ranging from 200 to 300 milligrams per liter (mg/l), hardness ranging from 150 to 200 mg/l, a chloride concentration less than 50 mg/l, and fluoride ranging from 0.5 to 1.5 mg/l (Johnson and Associates, 1985).

NCSC changed its primary source of potable water from onsite groundwater wells to municipal surface water in October 1970. This was done to avoid saltwater intrusion into the aquifer due to excessive pumping. Water is now supplied by the Bay County Water System, which obtains water from Deer Point Lake (located 9 miles northeast of NCSC).

There are still wells onsite that are used for potable and nonpotable water supply. Two low capacity surficial aquifer wells, approximately 100 feet deep, are located 150 to 250 feet south of the southern shore of Alligator Bayou and are used for drinking water supply. There are four operative Floridan aquifer system wells located at Buildings 10, 101, 281, and 394. The well at Building 10 has not been used for 13 years. The well at Building 101 is actively maintained for emergencies. It can be used, if required, to maintain water pressure in the water tower, for fire fighting, and as a potable water supply (with the use of a temporary chlorinator at the discharge point). The well is flushed every 2 months and periodically sampled for coliform bacteria. The well at Building 281 is capable of delivering emergency water, but is not flushed or sampled. The well near the housing area at Building 394 is used to provide water for air conditioning and heating pumps and discharges into the residential area through heat pump sprinkler systems.

There are other Floridan aquifer system wells located in the vicinity of NCSC. There are two large capacity wells for public use located at Long Beach Resort (3 miles west of NCSC), three at West Panama Beach (10 miles northwest of NCSC), and two at Lynn Haven (7.5 miles northeast of NCSC). There are two smaller wells located in a campground and trailer park 2 miles north of NCSC that are used for potable water and a swimming pool.

2.3 PREVIOUS INVESTIGATIONS. In compliance with the Superfund Amendments and Reauthorization Act (SARA) and Section 120 of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), a Naval Facilities Engineering Command Interim Policy, dated April 23, 1987, stated that all future Navy restoration program methodology and terminology will conform to that used by the USEPA. In addition, to ensure consistency among the agencies within the Department of Defense, the Navy has renamed its Navy Assessment and Control of Installation Pollutants (NACIP) program to the Navy Installation Restoration Program (IRP). The discussion in this section conforms to this directive and appropriate USEPA and IRP terms are used in place of the NACIP program headings used in the two previous reports (ESE, 1987; Johnson and Associates, 1985).

The NCSC Panama City is included in the Navy's IRP. IRP was established to identify the presence of suspected contamination at Navy and Marine Corps lands

resulting from past operations and, if needed, to institute procedures to bring about corrective remedial measures. The IRP is implemented in five parts:

- preliminary assessment (PA),
- site inspection (SI),
- remedial investigation (RI),
- feasibility study (FS), and
- remedial actions (RA).

The PA for NCSC was conducted by C.C. Johnson & Associates, Inc. (Johnson and Associates), and a report (Johnson and Associates, 1985) was submitted to the Naval Energy and Environmental Support Activity (NEESA) in September 1985. The PA report contains background information on chemicals that were used at NCSC and on specific sites where chemical wastes are known to have been stored or disposed of or where such activities are suspected to have occurred. Eight sites were identified in the PA report as past disposal sites or areas of environmental concern. As part of the PA, a two-step Confirmation Study Ranking System (CSRS), developed by NEESA (NEESA Document 20.2-042, *Confirmation Study Ranking System*), was used to evaluate each site for its potential hazard to human health and to the environment. The first step, using a flowchart developed around the type of waste, type of contamination, and site hydrogeology, delineated sites that pose a potential threat to human health or the environment. The second step numerically scored the sites from 0 to 100. Scoring reflects the characteristics of the wastes, the potential migration pathways from the site, and possible contaminant receptors. On the basis of this scoring, seven sites were selected by the Navy for an Expanded Site Inspection (ESI) study, formerly termed a Confirmation Study, to determine if contamination exists and to determine if contaminant migration pathways exist.

An ESI was performed on the seven sites recommended in the PA and a report, developed by Environmental Science and Engineering, Inc. (ESE), was submitted to Southern Division, Naval Facilities Engineering Command, in May 1987 (ESE, 1987). Of the seven sites studied, ESE recommended that a remedial investigation (RI) be performed at three sites (SWMU #2, AC #1, and AC #2), a closure plan be developed for three others (SWMU #1, SWMU #3, and SWMU #5) and the seventh site needed no further action (AC #3).

3.0 RCRA FACILITY INVESTIGATION

The Scope of Work for the RCRA Facility Investigation has been developed based on Jordan's review of both the PA and the ESI reports for NCSC; a review of available information from other studies; USEPA comments; FDER comments; a site reconnaissance conducted by Jordan on June 23 and 24, 1987; and discussions with U.S. Navy officials.

3.1 DATA QUALITY OBJECTIVES. Data Quality Objectives (DQO) were developed to reflect the different uses of the data collected during the RFI. Data quality is the degree of certainty with respect to precision, accuracy, reproducibility, completeness, and comparability of a database. The DQOs are both qualitative and quantitative specifications for the quality of data required to support RCRA Corrective Action activities at NCSC Panama City. These activities include the field screening, characterization, and the health and environmental assessment phases of the RFI. The DQOs also support decisions made in the evaluation and selection of corrective measures during the Corrective Measures Study.

The NIRP has adopted three quality assurance (QA) levels that provide guidelines for analysis. These levels are based on the type of site undergoing the investigation, the level of accuracy and precision required, and the intended use of the data. USEPA guidelines for Level I, Field Screening, and Level II, Field Analysis, are included for completeness in addressing the DQOs.

Based on the guidelines provided in the *Sampling and Chemical Analysis Quality Assurance Requirements for the Navy Installation Restoration Program* (1988), Level C Quality Control will be used in analyzing samples collected during the RFI at NCSC Panama City. Level C QC, similar to EPA level III, is required for a site near a populated area, not on the National Prority List (NPL), and not likely to be undergoing litigation. Higher level QC documentation will be retained and provided by the laboratory at a later date, if required. Laboratory requirements are specified in the SAP, which is included as Appendix A, Table C-1, pages 11 through 13, of this Work Plan.

3.2 TECHNICAL APPROACH AND METHODOLOGY.

3.2.1 Methods of Exploration. This section describes the methods to be used in the proposed exploration program at NCSC. The program includes soil borings, monitoring well installation, sediment sampling, aquifer testing, water level measurements, and subsurface gas testing.

3.2.1.1 **Soil Borings.** Soil borings will be advanced using hollow stem auger. Lithologic and stratigraphic information will be obtained from soil samples collected using a split-spoon sampler. Laboratory methods, analytes, sampling methods, sampling protocol, and laboratory protocol for this program are included in the SAP (Appendix A).

3.2.1.2 **Monitoring Well Installation.** Monitoring wells will be installed in most of the completed soil borings for the purpose of monitoring groundwater quality and assessing the direction and flux of groundwater flow in the shallow aquifer. The total depth of soil drilling is estimated to be 950 linear feet. The installation of monitoring wells will comply with the following:

- 40 Code of Federal Regulations (CFR) and 265 Subpart F;
- *Groundwater Monitoring Guide*, NEESA 20.2-013A;
- Chapter 40 A-3, Florida Administrative Code (FAC); and
- *Specifications for Groundwater Monitoring Well Installation and Sampling* provided by Southern Division (SDIV) of Naval Facilities Engineering Command.

Section 2.2.2 of the Appendix A Sampling and Analysis Plan details the typical monitoring well installation at NCSC. Monitoring well identifications are provided in Table 3-1.

TABLE 3-1
MONITORING WELL IDENTIFICATION
RCRA FACILITY INVESTIGATION
NCSC, PANAMA CITY

SWMU number	NIRP site number	Former well number	New well number
1	1	PCY-1-X	PCY-1-XX
2	2	PCY-2-X	PCY-2-XX
3	6	PCY-6-X	[1]PCY-3-X
4	7		
5	5	PCY-5-X	PCY-5-X
6		--	--
7		--	--
8		--	--
9		--	PCY-9-XX
10		--	--
11		--	--
12		--	--

AC number	NIRP site number	Former well number	New well number
1	3	PCY-3-X	PCY-13-XX
2	4	PCY-4-X	PCY-14-XX
3	8	PCY-8-X	[1]PCY-15-X

[1]No new wells are proposed for this site, only the well number of the existing well is changed.

NOTE: X and XX refer to specific well identifiers; for example, PCY-14-1S.

3.2.1.3 Aquifer Testing. Subsequent to monitoring well installation and well development, short-term pump tests will be conducted to determine the hydraulic

properties of the surficial aquifer. At single well locations in-situ, rising head tests will be used.

Data obtained from pump tests and rising head tests will provide information on the hydraulic conductivity of the aquifer tested. Coupled with water level observations, the data will be used to determine hydraulic gradients and groundwater flow direction and rate.

3.2.1.4 **Water Level Measurements.** Static water level measurements will be taken in all wells and plotted to map the potentiometric surface of the shallow aquifer. Additionally, Jordan will take measurements in four monitoring wells located at progressively greater distances from St. Andrew Bay to assess tidal effects on the groundwater table at NCSC. A specific program is presented in the SAP (Appendix A).

3.2.1.5 **Subsurface Gas Testing.** Subsurface gas testing will be conducted at former Landfill B (SWMU #2) at NCSC Panama City. Initial screening will be conducted using a methane sensitive instrument such as an organic vapor analyzer (OVA) with and without a carbon filter. Site specific soil gas testing procedures are included in the SAP (see Appendix A).

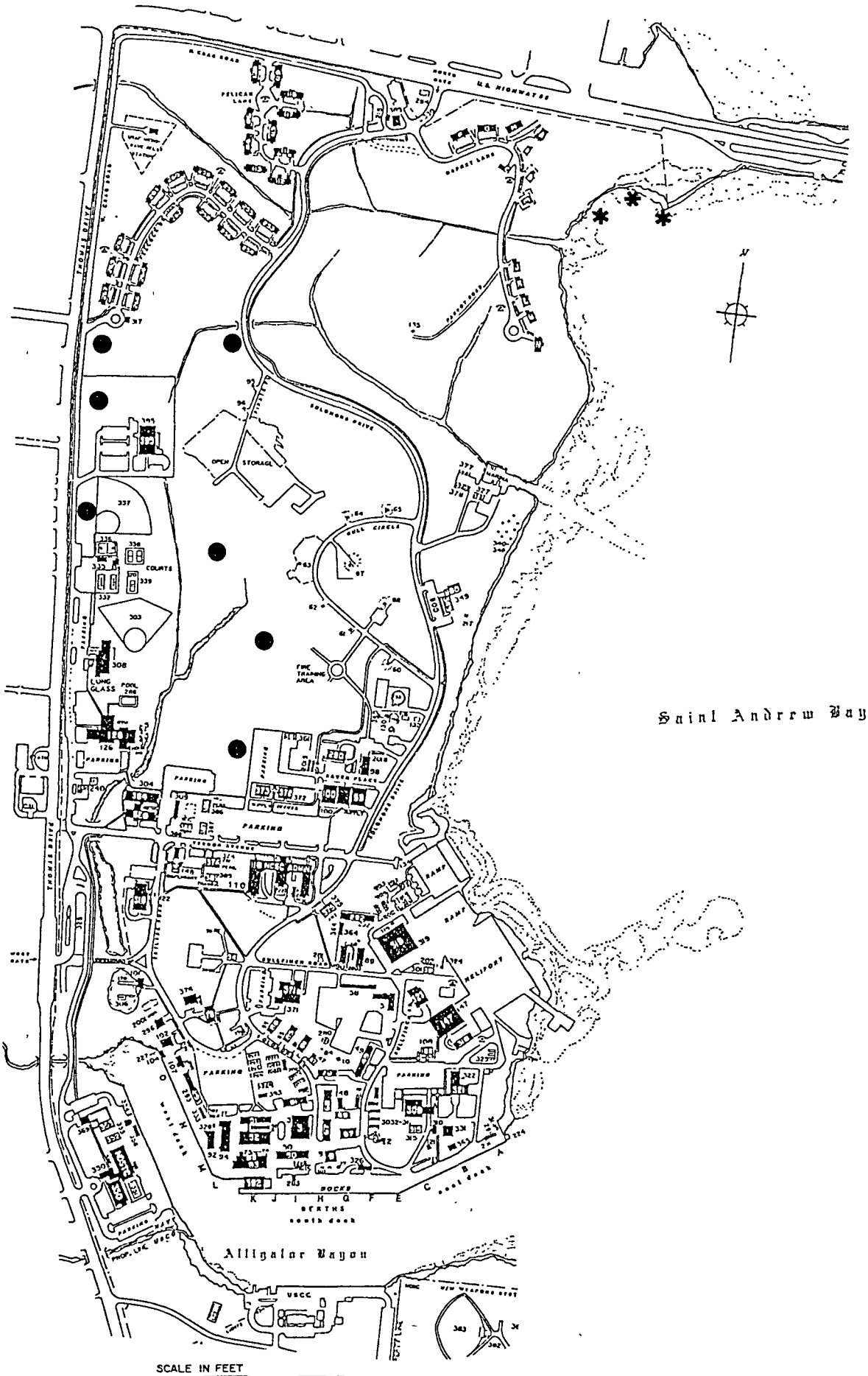
3.2.1.6 **Air Sampling.** In accordance with the EPA RFI guidance, air releases from SWMUs are assessed at the facility boundary. SWMU #9, the classified documents incinerator, is the only SWMU with an air release. No measurable impact is expected at the facility boundary from SWMU #9; therefore, air sampling will not be conducted during the RFI at NCSC Panama City.

3.3 PRELIMINARY ACTIVITIES. Preliminary activities to be conducted prior to the field work include securing subcontractors to perform the monitoring well installations and well measuring point survey; arranging for the acquisition of necessary permits and other authorizations; conducting a reconnaissance of the sites to determine logistics and meet with NCSC personnel to make access and security arrangements (i.e., location of exploration, decontamination stations, etc.); mobilizing equipment and supplies at NCSC Panama City; and briefing field personnel on site history, health and safety requirements, and field procedures.

3.4 TASK 1 - EXPLORATION AND SAMPLING PROGRAM. The following sections contain information regarding the collection of background samples and site-specific exploration and sampling programs. A summary of the background information precedes the proposed exploration program for each site.

3.4.1 Background Samples. Seven background soil samples will be collected from the areas identified in Figure 3-1. Background samples will be analyzed for the contaminants of concern as specified in the SAP (Appendix A). In addition, background samples will be analyzed for those soil physical and chemical properties that control contaminant transport (i.e., cation exchange capacity, percentage organic carbon, bulk density, etc.) as specified in the SAP.

Three background sediment samples will be collected in an area east of the married officers' housing area. This area was selected as representative of background conditions for NCSC because it is an undeveloped section of the activity, and is located away from any SWMUs or ACs. Background sediment samples will be analyzed for chemicals of concern that might be emanating from SWMU #3 and SWMU #4 as described in the SAP.



E.C. JORDAN CO.
ENGINEERS & SCIENTISTS

APPROXIMATE LOCATION OF BACKGROUND SAMPLES

U.S. DEPT. OF NAVY
NAVAL COASTAL SYSTEMS CENTER
PANAMA CITY, FLORIDA

5330-01

FIGURE 3-1

3.4.2 SWMU # 1 - Landfill A, Original Disposal Area.

3.4.2.1 Environmental Setting. Groundwater elevations measured in monitoring wells within the vicinity of Landfill A indicate that the groundwater flow direction is southwest towards Alligator Bayou. The water table lies within 2 to 3 feet of ground surface over most of the site (ESE, 1987).

Soils beneath SWMU #2 are anticipated to be quartz sands. The geology is expected to be similar to that shown in Figure 2-2. Specific information on the soils and geology will be collected during the RFI Field Program.

Landfill A borders on Alligator Bayou; however, current releases of contaminants to the Bayou are expected to be small due to the age of the fill material and type of operation (i.e., burning of combustibles) during its active life.

The disposal area is located beneath land surface and most of the area is paved. Therefore, no significant releases to the atmosphere are expected from SWMU #1.

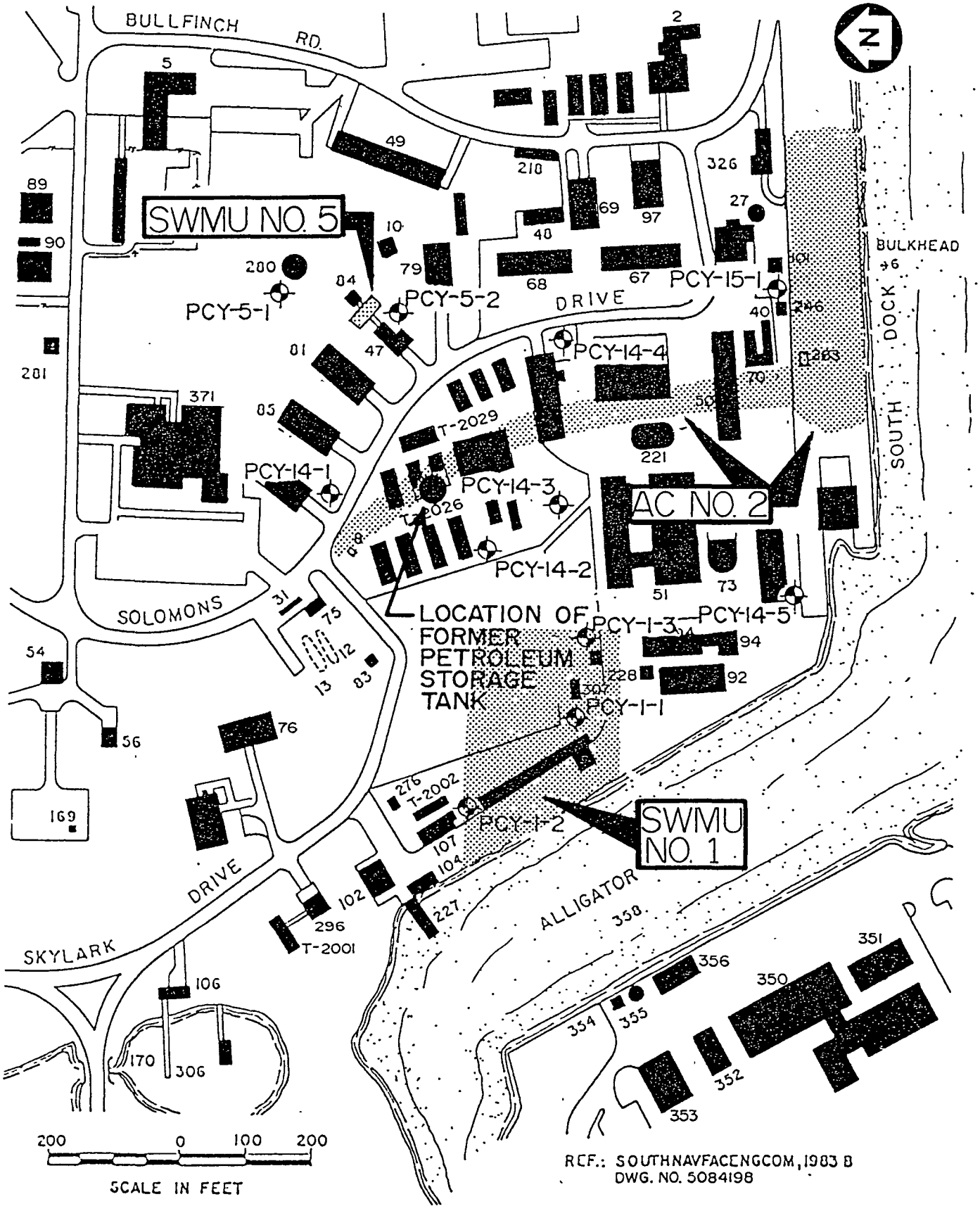
3.4.2.2 Source Characterization. Landfill A encompasses about 1 acre along the edge of Alligator Bayou near the present location of Buildings 77, 293, and 333 (Figure 3-2). The disposal area was originally a marshy depression along the shore of Alligator Bayou. That part of the site nearest the Bayou is currently underneath the concrete deck of the facility's west dock. It is unknown whether wastes in this part of the area were moved during dock construction in the early 1950s or during reconstruction in the late 1970s. Construction of the dock and other structures has resulted in the paving of much of the disposal area.

NCSC used SWMU #1 from about 1945 to 1953 for general waste disposal and the burning of combustible waste. Details of the burning operation are unknown. During its period of operation, the site was the principal disposal area for the entire facility and received nearly all wastes generated by NCSC. In addition to general household waste, food waste, scrap metal, and lumber, wastes received included small quantities of paint, paint thinner, solvents (acetone, methyl ethyl ketone, dry cleaning solvent, trichloroethylene, and CRC-336) in cans ranging in sizes from 4 ounces to 5 gallons, and lead battery acid. Bilge water and waste oil were poured on the ground and burned.

3.4.2.3 Release Characterization. Due to the downgradient position of SWMU #1 to AC #2 (Underground Oil Contamination Area) this site is being included in the investigation program for AC #2. Information on the installation of new monitoring wells and the analytical program for this SWMU can be found in the SAP.

3.4.3 SWMU #2 - Landfill B, Burn and Landfill Area.

3.4.3.1 Environmental Setting. Based on observations made during the RFA, groundwater flow direction in the vicinity of Landfill B is anticipated to be easterly towards an unnamed stream located north of Solomons Drive. Based upon the anticipated flow direction, the proposed monitoring well installation program is designed to yield information on contaminant migration downgradient from SWMU #2 and from each of the five disposal areas associated with the site.



REF.: SOUTHNAVFACENGCOM, 1983 B
DWG. NO. 5084198

E.C. JORDAN CO. ENGINEERS & SCIENTISTS	APPROXIMATE LOCATIONS OF SWMU NO. 1 SWMU NO. 5, & AC NO. 2	
U.S. DEPT. OF NAVY NAVAL COASTAL SYSTEMS CENTER PANAMA CITY, FLORIDA	5330-01	FIGURE 3-2

Soils in the area of the SWMU #2 were found to be fine to medium quartz sands from the surface to at least 25 feet (ESE, 1987). It is anticipated that the quartz sands make up the top 70 to 100 feet in this area. Geology beneath the site is anticipated to be similar to that shown on Figure 2-2. A more detailed geologic description will be contained in the RFI Report.

An ephemeral drainage system exists within the vicinity of SWMU #2. Surface water drainage from the northern part of SWMU #2 flows overland to the north, then east to St. Andrew Bay (less than 1,100 feet away). Surface drainage from the southern part of the site is southerly to a series of unnamed ponds that drain into Alligator Bayou. The eastern boundary of the site is approximately 1,100 feet from St. Andrew Bay; the southern boundary is about 600 feet from an unnamed stream.

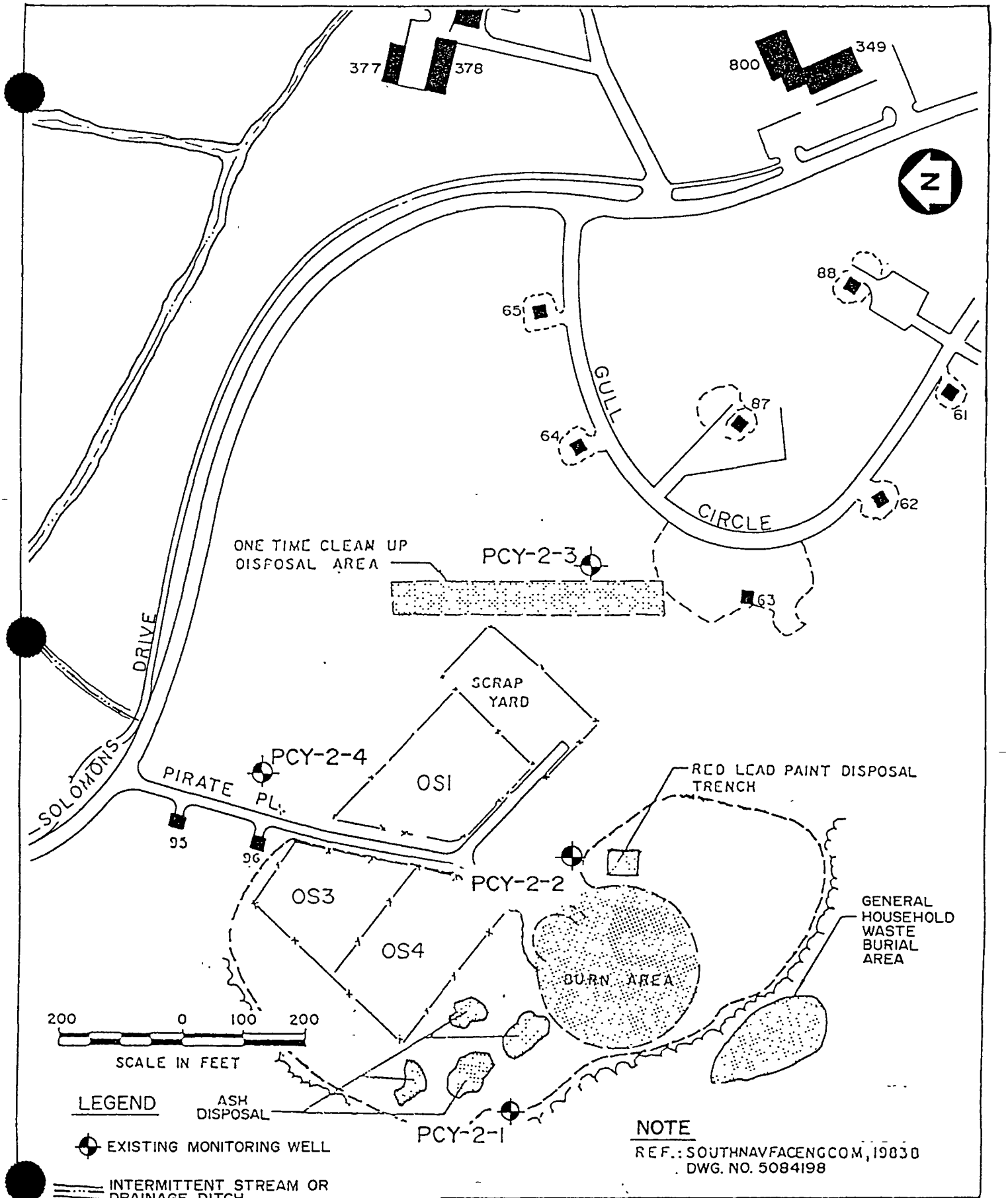
At present, significant ground cover, high infiltration rates, and a lack of a discrete channel system within the site boundaries indicate that surface runoff is not significant. Because SWMU #2 is a former disposal area and landfill, an air release would not be expected.

3.4.3.2 **Source Characterization.** SWMU #2 occupies approximately 11 acres around Pirate Place (Figure 3-3). This landfill was the largest and longest operating disposal area on the facility. Within the confines of SWMU #2, five areas have been delineated where landfill operations have occurred. These areas include the burn area, the ash disposal area, the household garbage (wet garbage) disposal area, the red lead paint disposal area, and the one-time, base cleanup disposal area.

The red lead paint disposal area was used for the burial of 2 to 4 tons of red lead paint in 1946 or 1947. A trench, which was approximately 100 feet long and 8 feet deep, was bulldozed and 5-gallon paint cans were deposited, compacted, and covered with earth. Several more feet of fill were then placed over the trench (Johnson and Associates, 1985).

In an area to the east of the present open storage area, wastes from a one-time "base cleanup" operation were disposed of sometime between 1970 and 1975. Trenches approximately 100 feet long by 10 feet wide by 8 feet deep were used to bury materials. The wastes reportedly included general trash, drums and cans reportedly containing paints, oils, and solvents (trichloroethylene, methyl ethyl ketone, and acetone), scrap lumber, and construction rubble. Based on the size of the trenches, a maximum of 800 cubic yards of materials could have been disposed of during this operation (Johnson and Associates, 1985).

Major landfill operations began around 1957 when the site was used as a general disposal and burn area and continued until the early 1970s. Industrial refuse from base operations was collected on a daily basis and piled in the burn area. Burning took place about once every 6 months by pouring about 10 gallons of gasoline around the edge of the pile and igniting it. Also, any 55-gallon drum brought to the site had its contents poured on the ground prior to burning. Non-combustible materials were buried along with the ash in trenches excavated by bulldozers. The excavated material was then used as cover. It was reported that some scrap metal salvage occurred prior to burial. Household garbage (from the living quarters) was buried separately in an area south and west of Pirate Place (Johnson and Associates, 1985).



E.C. JORDAN CO. ENGINEERS & SCIENTISTS	APPROXIMATE LOCATION OF SWMU NO. 2	
U.S. DEPT. OF NAVY NAVAL COASTAL SYSTEMS CENTER PANAMA CITY, FLORIDA	5330-01	FIGURE 3-3

Wastes disposed of in SWMU #2 reportedly included: household garbage, tires, wooden crates and pallets, scrap lumber, tree limbs, metal shavings, conduit, rope, paint cans and drums (mostly empty or with residues), paint thinners, waste oil solvents (trichloroethylene, dry cleaning solvent, methyl ethyl ketone, and acetone), mineral spirits, alcohol, hydraulic fluids, and bilge water.

3.4.3.3 Release Characterization. The exploration program at SWMU #2 will include the installation of six monitoring wells and the collection of 22 soil samples and 10 groundwater samples.

To delineate the vertical and horizontal extent of groundwater contamination, an additional six monitoring wells will be installed (Figure 3-4). Monitoring well numbers, descriptions, and the rationale for locations are as follows.

- PCY-2-1S will be a shallow monitoring well located adjacent to PCY-2-1, which is the intermediate screened well of the well pair. This well cluster is west of the ash disposal area and the burn area and is anticipated to be upgradient of SWMU 2 and, therefore, will provide background data.

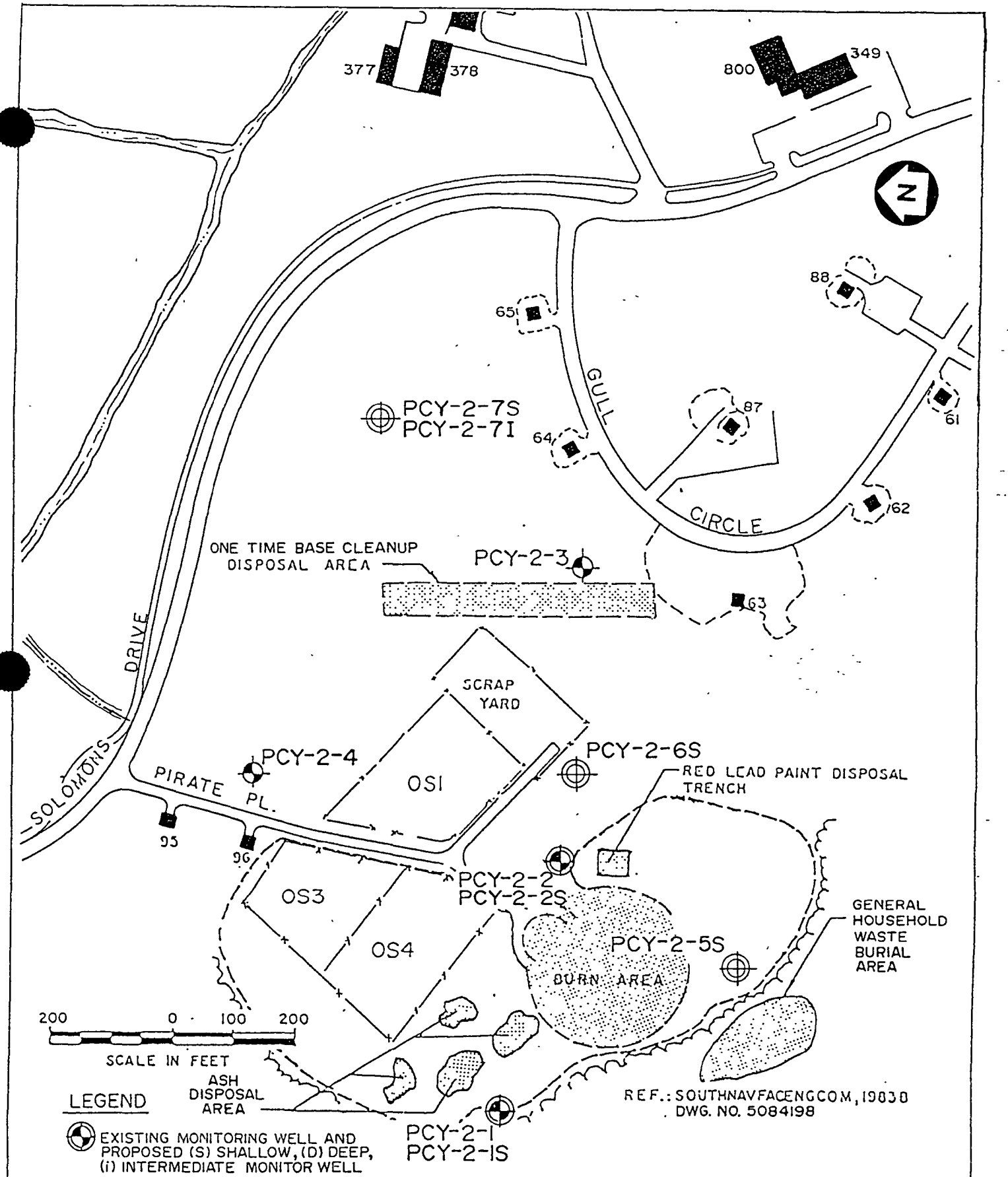
- PCY-2-2S will be a shallow monitoring well clustered with the intermediate well PCY-2-2. This well pair is north of the red lead paint disposal area and is anticipated to be downgradient of the burn area and the household waste disposal area and upgradient of the one-time base cleanup disposal area. This well pair will provide data on groundwater quality downgradient of the burn area and household waste disposal area.

- PCY-2-5S will be a shallow monitoring well located south of the burn area and is anticipated to be downgradient of the general household waste disposal area. This well will provide groundwater quality data downgradient of the household waste disposal area.

- PCY-2-6S will be a shallow monitoring well located east of the burn area and is anticipated to be downgradient of the burn area and the red lead paint disposal area and upgradient of the one-time cleanup disposal area. This well will be used to intercept any contaminant plume emanating from the two source areas.

- PCY-2-7S and PCY-2-7I will be shallow and intermediate monitoring wells located east to northeast of the one-time base cleanup disposal area and are anticipated to be downgradient of this disposal area. Data derived from this well pair will be used to monitor the vertical and horizontal extent of any plume migrating from the one-time base cleanup disposal area.

Subsequent to monitoring well installation and development, a groundwater sample will be collected from each monitoring well and will be submitted for laboratory chemical analysis. Specific methods and parameters of analysis are discussed in the SAP.



E.C. JORDAN CO. ENGINEERS & SCIENTISTS		APPROXIMATE LOCATION OF PROPOSED MONITORING WELLS SWMU NO.2
U.S. DEPT. OF NAVY NAVAL COASTAL SYSTEMS CENTER PANAMA CITY, FLORIDA	5330-01	FIGURE 3-4

Water level measurements coupled with aquifer test results will be used to assess groundwater flow direction and seepage velocities in the vicinity of SWMU #2. Due to its location in the vicinity of soils exhibiting oil stains, a split-spoon soil sample from monitoring well PCY-2-6S will be collected just above the water table and submitted to the laboratory for chemical analysis. Additionally, 21 soil samples will be collected to identify source area and approximate extent of soil contamination. The approximate location of the soil explorations are presented in Figure 3-5. The grid pattern for sample stations is based upon a block-centered nodal grid with 100-ft spacing. Exact positions or sample stations will be defined by field conditions but will conform to the general pattern established in Figure 3-6. Individual samples will be identified by their grid position (i.e., A1, B7, etc.).

The partitioning of soil samples by suspected source areas is:

- four samples (A1, B1, C1, and D1) in the one-time base cleanup disposal area;
- four samples (B3, C2, C3, and D3) in the surface soil stained area;
- nine samples (C4, C5, C6, D4, D5, D6, E4, E5, and E6) in the burn area; and
- four samples (A6, A7, B6, and B7) in the ash disposal area.

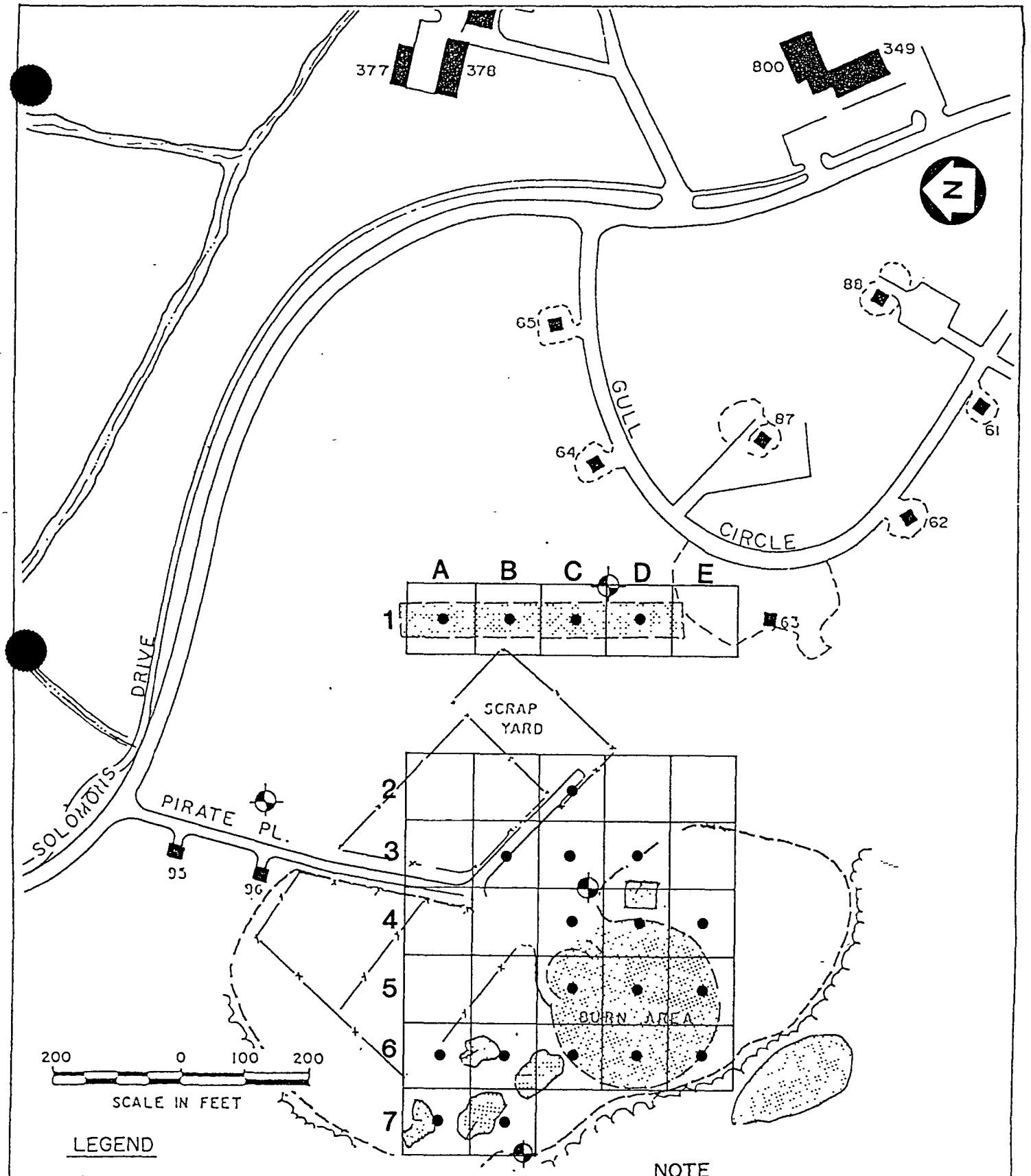
A soil gas screening survey will be conducted in the vicinity of the general household waste burial area. The intent of this survey is to determine if methane gas is being generated from the putrescible wastes buried here. The survey will consist of comparing values obtained from both an organic vapor analyzer and a photoionization meter. The program is detailed in the SAP.

3.4.4 SWMU #3 - Landfill C, Burn and Disposal Area.

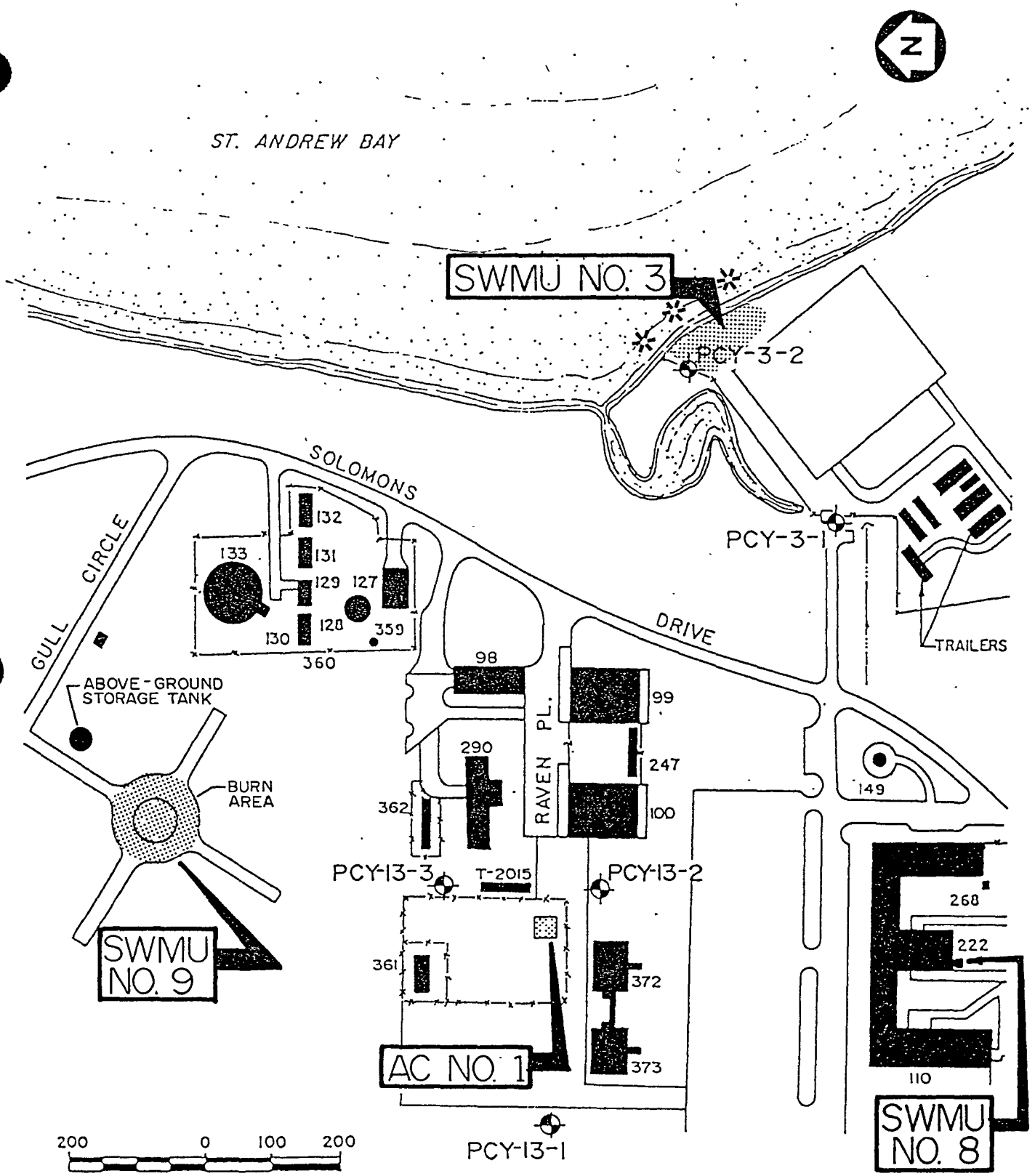
3.4.4.1 Environmental Setting. Groundwater in the vicinity of SWMU #3 probably exists above a saltwater interface. The direction of contaminant transport within the unconfined aquifer should then be southward along the shoreline of St. Andrew Bay. The soils beneath SWMU #3 are anticipated to be quartz sands. The geology in this area is anticipated to be similar to that presented in Figure 2-2. SWMU #3 borders directly on St. Andrew Bay. Transport of possible contaminants is expected to be by both erosional processes and in the surface water. Direction of transport is southward along the shoreline of St. Andrew Bay.

3.4.4.2 Source Characterization. The location of SWMU #3 is presented on Figure 3-6. This landfill is located northeast of the Amphibious Assault Landing Craft area (Building 319) on the beach of St. Andrew Bay. It was the second landfill area used on the activity. The site was approximately 150 feet by 50 feet by 12 feet deep.

The landfill operated from about 1953 to 1959. Two to three truck loads (12 to 16 cubic yards per truck) of wastes were brought to the site daily. Burning took place about once a month. Bulldozers were used to push the piles together to a height of about 25 feet. The piles were doused with gasoline and ignited. The ash piles were then covered with sand (Johnson and Associates, 1985).



E.C JORDAN CO. ENGINEERS & SCIENTISTS	APPROXIMATE LOCATIONS FOR SOIL SAMPLING PROGRAM SWMU NO. 2	
U.S. DEPT. OF NAVY NAVAL COASTAL SYSTEMS CENTER PANAMA CITY, FLORIDA	5330-01	FIGURE 3-5



REF.: SOUTHNAVFACENGCOM, 1983 B
DWG. NO. 5084198

EXISTING MONITORING WELL

SEDIMENT SAMPLING LOCATION

E.C. JORDAN CO. ENGINEERS & SCIENTISTS	APPROXIMATE LOCATION OF SWMU NO. 3, SWMU NO. 9, SWMU NO. 8, & AC NO. 1	
U.S. DEPT. OF NAVY NAVAL COASTAL SYSTEMS CENTER PANAMA CITY, FLORIDA	5330-01	FIGURE 3-6

The types of wastes included general household garbage, scrap lumber and metal, tree limbs, paint thinner and solvent cans (containing methyl ethyl ketone, acetone, trichloroethylene, and xylene), waste oil (possibly transformer oil containing polychlorinated biphenyls), and bilge water. Most of the cans were empty or contained residues (Johnson and Associates, 1985). Jordan personnel observed several cans and other debris during the visual site inspection.

3.4.4.3 Release Characterization. Due to the proximity of SWMU #3 to St. Andrew Bay, it is not feasible to install a downgradient monitoring well within the surficial aquifer. Instead, the exploration program at SWMU #3 will consist of the collection of three sediment samples (see Figure 3-6). If possible, water samples will be collected from seeps entering St. Andrew Bay. Specific methods and parameters to be analyzed for are discussed in the SAP.

3.4.5 SWMU #4 - Landfill D, Filled Gully

3.4.5.1 Environmental Setting. Groundwater data at SWMU #4 are lacking, however, it is believed that the surficial aquifer exists above the saltwater interface. The depth to groundwater is expected to be within 3 feet of the land surface. Flow direction is anticipated to be towards the south along St. Andrew Bay.

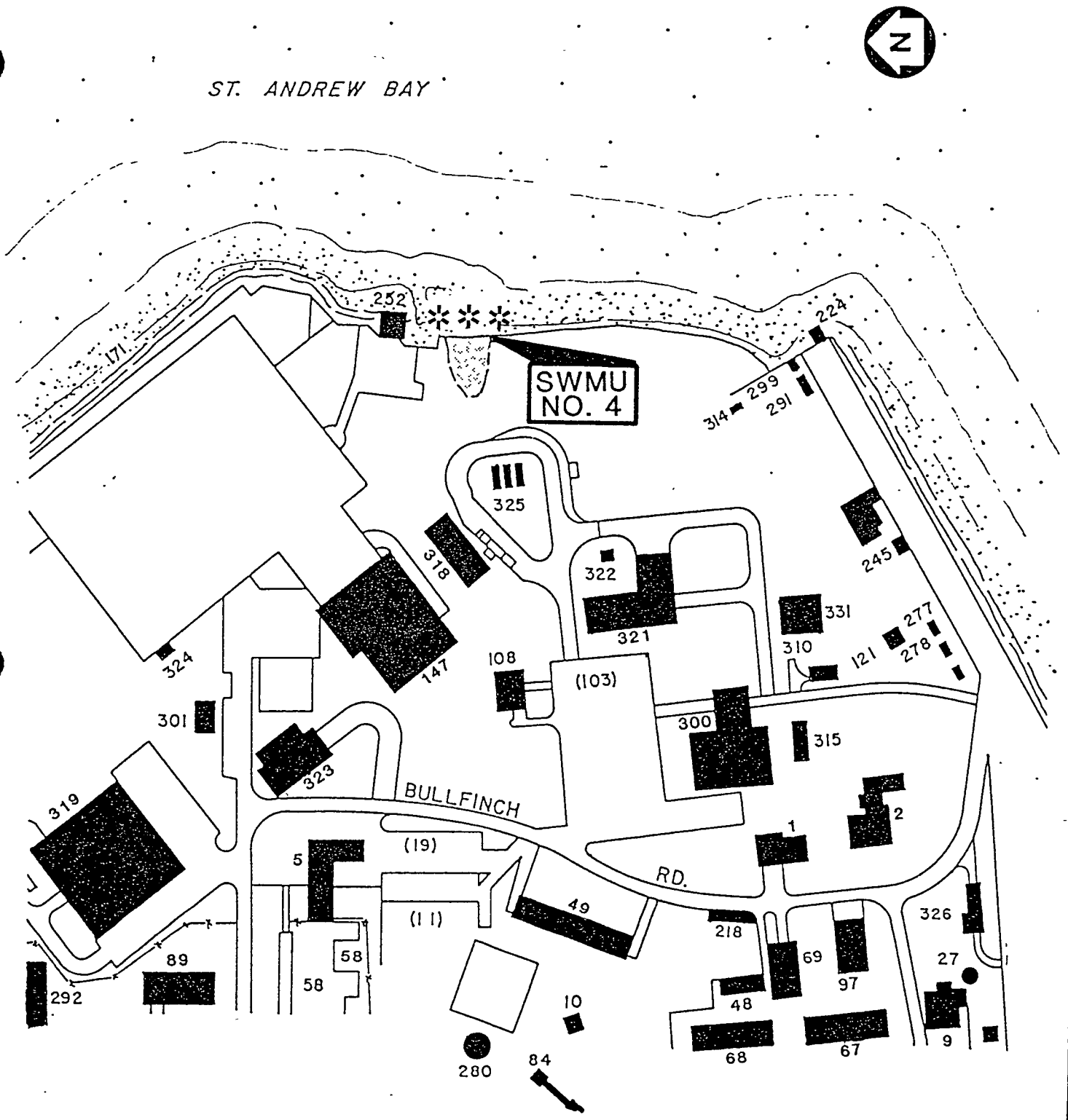
The soils beneath SWMU #4 are anticipated to be fine- to medium-grain quartz sands. The lithology in the area of SWMU #4 is expected to be similar to that shown in Figure 2-2.

SWMU #4 was originally a surface water drainage ravine discharging to St. Andrew Bay. Based on the type of waste disposed of and the lack of fill materials it is expected that SWMU #4 still receives surface water runoff from the surrounding area. The runoff is anticipated to flow beneath the waste and either infiltrate through the soils to groundwater or discharge to St. Andrew Bay.

3.4.5.2 Source Characterization. SWMU #4 is located along St. Andrew Bay (Figure 3-7). The landfill, covering less than $^1/_4$ acre, was originally a ravine into which concrete blocks, pieces of broken concrete and hardened asphalt, tires, and other inert materials were disposed of between 1954 and 1958. Because no records were kept, exact quantities and types of materials landfilled at SWMU #4 are unknown.

3.4.5.3 Release Characterization. The exploration program for SWMU #4 will consist of the collection of three sediment samples (see Figure 3-7) and, if possible, water samples from seeps emanating from the site. Methods of analysis and analytical parameters are described in the SAP.

As with SWMU #3, it is difficult to locate a downgradient monitoring well due to the proximity of the landfill to St. Andrew Bay.



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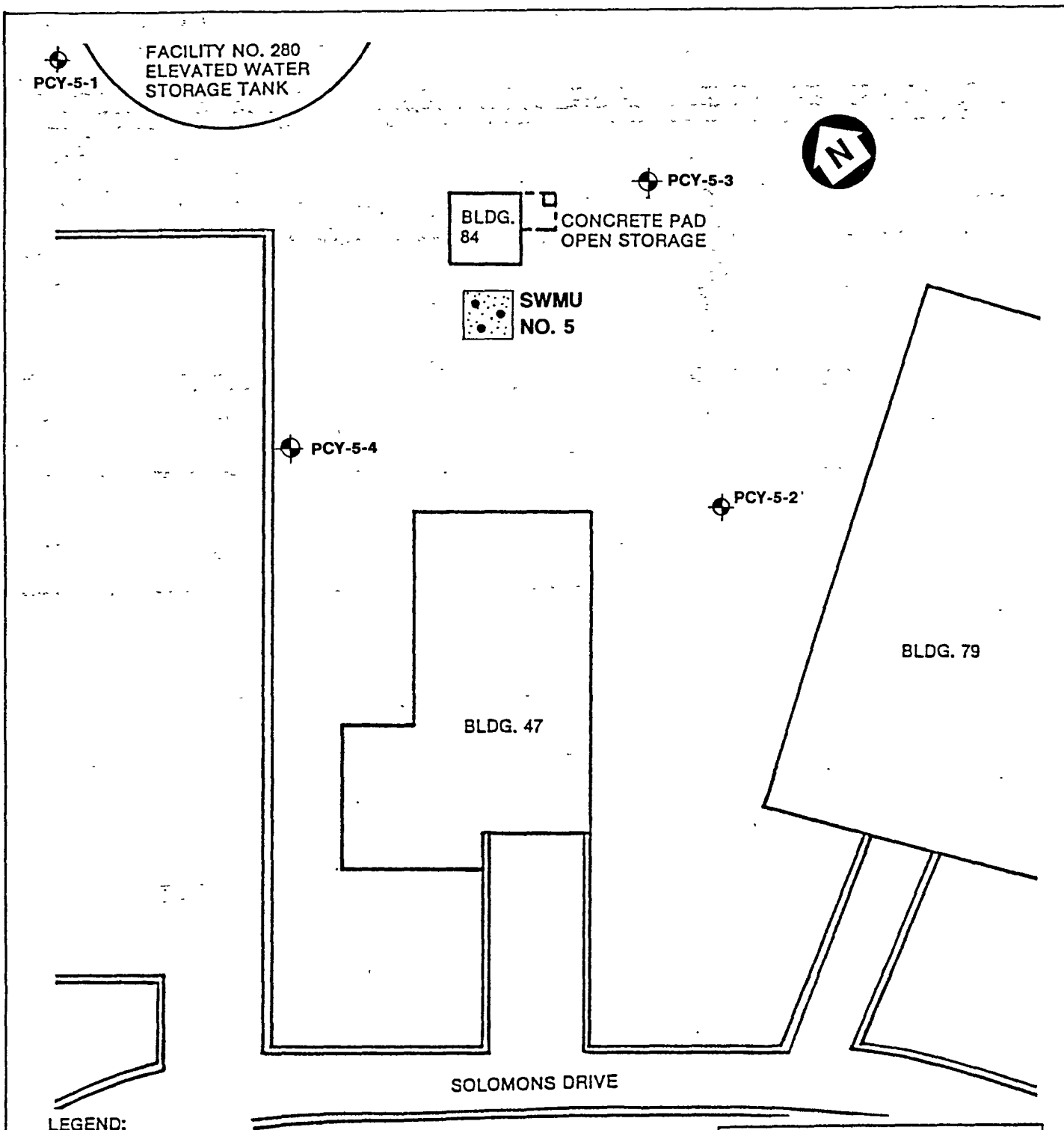
SCALE IN FEET

REF.: SOUTHNAVFACENGCOM, 1983 B
DWG. NO. 5084198

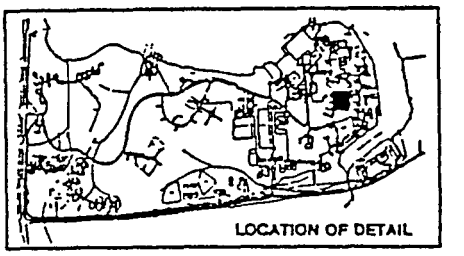
✲ SEDIMENT SAMPLING LOCATION

E.C JORDAN CO. ENGINEERS & SCIENTISTS	APPROXIMATE LOCATION OF SWMU NO. 4
U.S. DEPT. OF NAVY NAVAL COASTAL SYSTEMS CENTER PANAMA CITY, FLORIDA	TASK 5330-01
	FIGURE 3-7



LEGEND:

- MONITOR WELL
- PROPOSED HAND AUGER SOIL SAMPLING LOCATION
- SAND PIT



SOURCE: ESE 1987

0 25 50

SCALE IN FEET

E.C. JORDAN CO. ENGINEERS & SCIENTISTS	APPROXIMATE LOCATIONS FOR SOIL SAMPLING PROGRAM SWMU NO. 5	
U.S. DEPT. OF NAVY NAVAL COASTAL SYSTEMS CENTER PANAMA CITY, FLORIDA	5330-01	FIGURE 3-7A

3.4.6 SWMU #5 - Paint Equipment Cleaning Area

3.4.6.1 **Environmental Setting.** Groundwater flow direction in the vicinity of SWMU #5 is south to southwest towards Alligator Bayou. The water table occurs approximately 3 to 4 feet BLS. Soils in the area of SWMU #5 are anticipated to be fine- to medium-grain quartz sands to a depth of 70 to 100 feet BLS.

Surface runoff from storm events in the vicinity of the site is collected in stormwater drainage systems that discharge into Alligator Bayou.

3.4.6.2 **Source Characterization.** SWMU #5 (see Figure 3-2) is located behind the Paint Shop (Building 47) and is estimated to have been approximately 100 square feet in size. The site is the former location of a sand pit used to clean painting equipment. This operation took place from at least the early 1950s to 1979. Brushes and other painting equipment were cleaned with mineral spirits, methyl ethyl ketone, acetone, or paint thinner. Paint and cleaning wastes were poured directly onto the ground. A project undertaken in 1979 to prevent further use of the sand pit provided a concrete brush cleaning pad with spill containment adjacent to Building 84. The original sand pit used for disposal has since been paved with asphalt. Although an ESI was conducted at SWMU #5, the data are inconclusive. Surface soils samples were obtained outside the area of the sand pit and the residual levels of cleaning solvents in the source area are unknown. Groundwater levels indicate that the downgradient monitoring well (PCY-5-2) may not be situated in a position to monitor any existing contaminant plume.

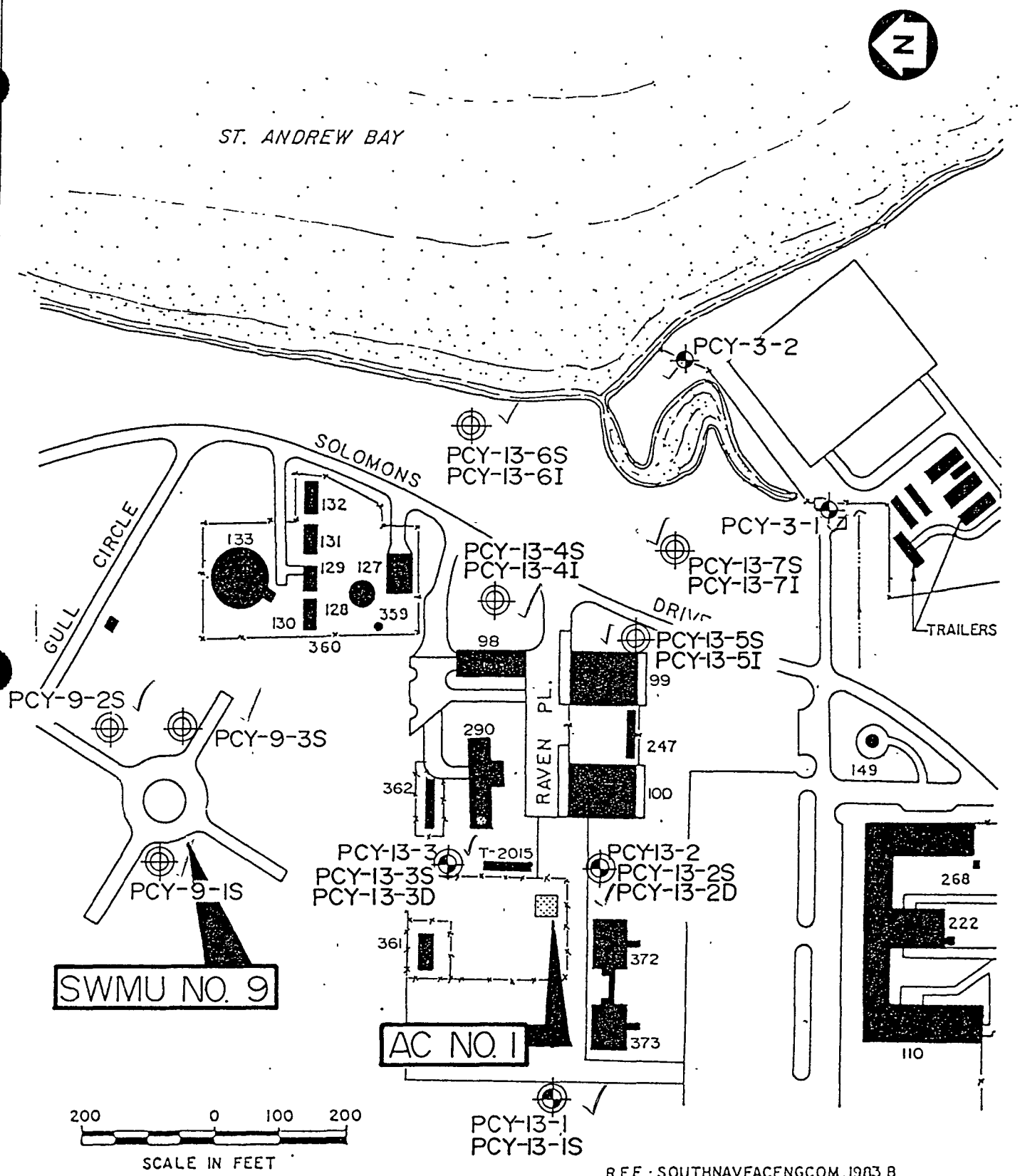
3.4.6.3 **Release Characterization.** The exploration program at SWMU #5 will consist of the collection of three soils samples, the installation of two shallow monitoring wells, and sampling of the two existing wells PCY-5-1 and PCY-5-2 and the two new monitoring wells. Soil samples will be obtained within the sand pit area at a depth just above the water table using a hand auger. The specific methods and parameters of analysis are discussed in the SAP.

3.4.7 SWMU #8 - Classified Documents Incinerator

3.4.7.1 **Environmental Setting.** The geology in the area is expected to be similar to the other areas of NCSC and is depicted on Figure 2-2. Groundwater in the area is expected to occur at 5 to 8.5 feet BLS and flows to the southeast at approximately 0.36 feet per day (ESE, 1987). The possibility exists that ash could enter surface water via stormwater runoff from the incinerator area. Because hazardous materials are not disposed of in the incinerator, contamination is not expected.

The classified documents incinerator releases exhaust to air via a stack. This exhaust is released under FDER Permit No. A003-34959. Release of hazardous constituents is not expected as only paper and small amounts of photographic material are incinerated in this unit.

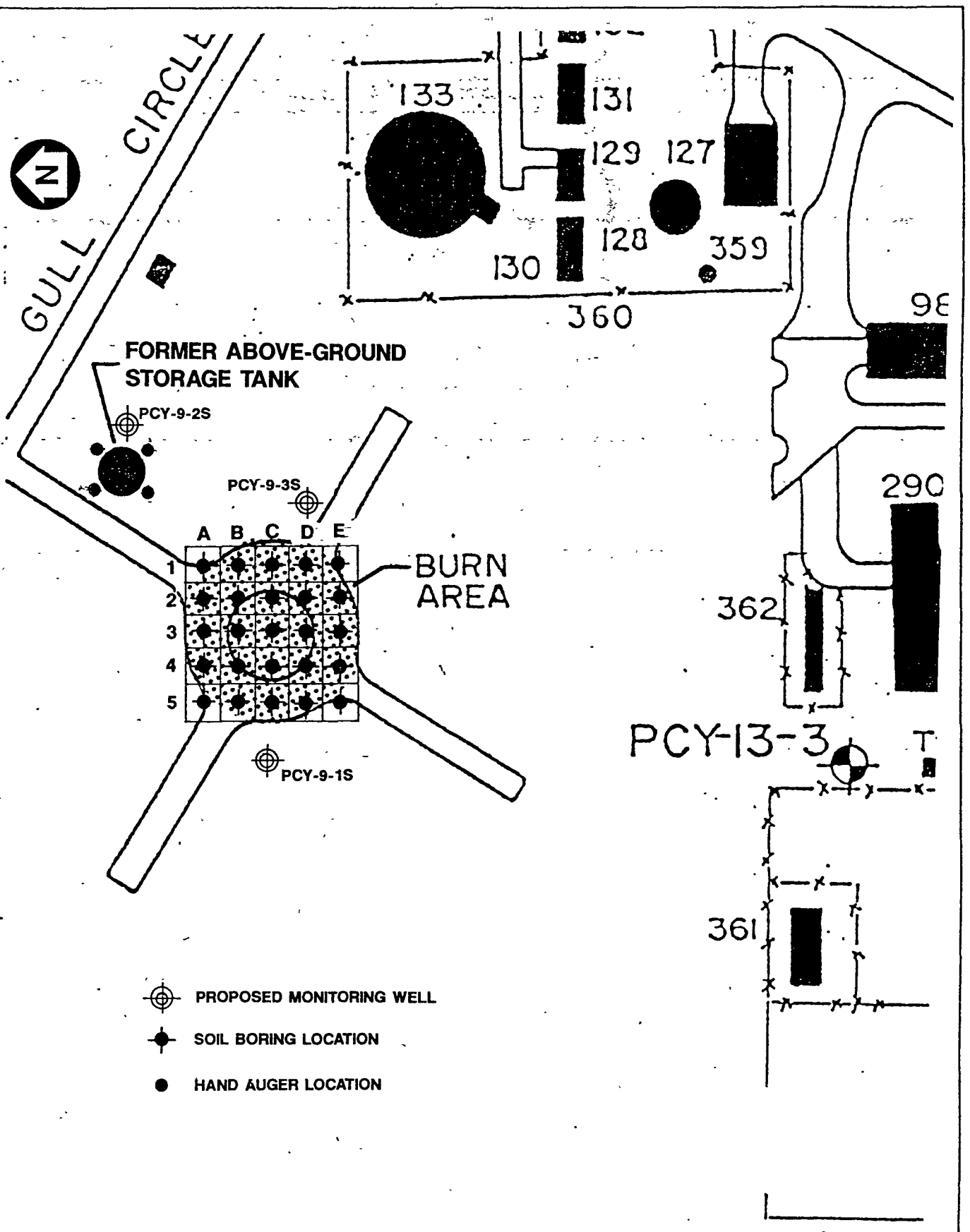
3.4.7.2 **Source Characterization.** Prior to October 1987, NCSC operated a natural gas fired, solid waste incinerator used exclusively for the destruction of classified materials (see Figure 3-7). The incinerator capacity was 300 pounds and was operated twice weekly. Burn time was approximately 8 hours per burn.



REF.: SOUTHNAVFACENGCOM, 1983 B
DWG. NO. 5084198

- EXISTING MONITORING WELL
- EXISTING MONITORING WELL AND PROPOSED (S) SHALLOW, (D) DEEP, (I) INTERMEDIATE MONITORING WELL
- PROPOSED MONITORING WELL

E.C. JORDAN CO. ENGINEERS & SCIENTISTS	APPROXIMATE LOCATIONS OF PROPOSED MONITORING WELLS SWMU NO. 9 & AC NO. 1	
U.S. DEPT. OF NAVY NAVAL COASTAL SYSTEMS CENTER PANAMA CITY, FLORIDA	5330-01	FIGURE 3-8



E.C. JORDAN CO. ENGINEERS & SCIENTISTS		APPROXIMATE LOCATIONS OF PROPOSED MONITORING WELLS AND SOIL SAMPLES SWMU NO. 9
U.S. DEPT. OF NAVY NAVAL COASTAL SYSTEMS CENTER PANAMA CITY, FLORIDA	5330-01	FIGURE 3-8A

The current incinerator is similar to the old one except it has a capacity of 1,000 pounds per burn. Operation of the incinerator occurs once per week. The material disposed of in the solid waste incinerator consists primarily of paper documents. However, some photographs and negatives are also destroyed. The incinerator is regulated under FDER Permit No. A003-34959.

3.4.7.3 Release Characterization. The exploration program at SWMU #8 will consist of the collection of one ash sample for extraction procedure (EP) toxicity testing to determine if the ash is considered hazardous.

3.4.8 SWMU #9 - Old Fire Training Area No. 2

3.4.8.1 Environmental Setting. Highly permeable soils underlie the fire training area, possibly allowing the migration of unburned fuel and solvents into the surficial aquifer. As previously discussed in Section 2.2.3.2, the possibility exists that the surficial and the Floridan aquifers are hydraulically connected, therefore contamination of the Floridan aquifer system is possible from this SWMU. The geology beneath this SWMU is expected to be similar to that shown in Figure 2-2.

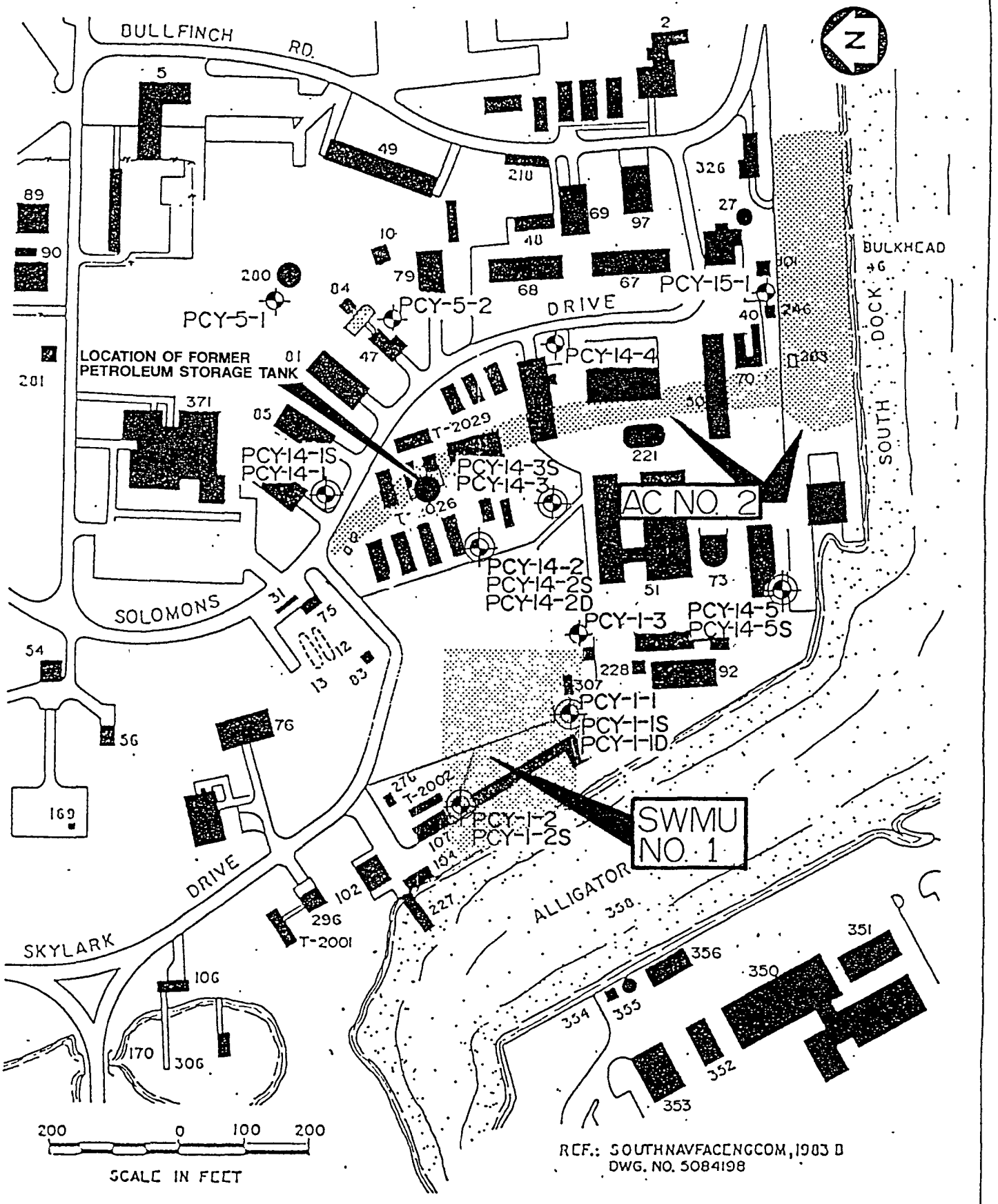
Surface drainage in the area flows to the east. Fuels and solvents used for practice fires could migrate to St. Andrew Bay during rain events. Live fire training has been discontinued;therefore, the possibility of surface water contamination from this SWMU is reduced.

Volatilization of fuels and solvents used in fire training was possible during practice sessions. Particulate material was also released during these practices. The release of hazardous materials depended on the waste products used as fuels for the practice fires.

3.4.8.2 Source Characterization. The old fire training area No. 2 is located southwest of Gull Circle (Figure 3-8). Fire training commenced at the facility in 1980, but live fire training was suspended in 1986. Currently, only smoke training occurs at the facility.

The facility consists of two mobile homes used in smoke training and two dumpsters and a trash pile that were used during live fire training. In addition, a 4,500-gallon, aboveground fuel storage tank was formerly located northeast of the burn area. Fuels used during fire training consisted of water contaminated JP-5 helicopter fuel, diesel, and gasoline. According to NCSC personnel, it is probable that small quantities of flammable waste solvents were also used. Although records were not kept, it is estimated that between 100 and 150 gallons of waste fuels were burned per fire training exercise and that 18 to 20 training events took place annually (Johnson and Associates, 1985).

3.4.8.3 Release Characterization. The exploration program at SWMU #9 will consist of the installation of 3 shallow monitoring wells, and the collection of 30 soil samples and 3 groundwater samples for laboratory analysis. The approximate locations of wells are presented in Figure 3-8.



EC JORDAN CO. ENGINEERS & SCIENTISTS	APPROXIMATE LOCATION OF PROPOSED MONITORING WELLS SWMU NO. 1 & AC NO. 2	
U.S. DEPT. OF NAVY NAVAL COASTAL SYSTEMS CENTER PANAMA CITY, FLORIDA	5330-01	FIGURE 3-9

The intent of the exploration program at SWMU #9 is to verify the existence of contaminants in soil within the burn area and around the former 4,500-gallon aboveground fuel storage tank and groundwater within the surficial aquifer underlying the training area.

The rationale for the placement of monitoring wells at SWMU #9 is as follows.

- PCY-9-1S will be a shallow monitoring well located upgradient of the burn area and will yield data on background groundwater quality.
- PCY-9-2S will be a shallow monitoring well located downgradient of the aboveground fuel storage tank. Its purpose is to provide information of groundwater quality downgradient of the storage tank.
- PCY-9-3S will be a shallow monitoring well located downgradient of the burn area. This well will provide data on groundwater chemistry downgradient of the burn area.

In addition to the installation and sampling of three monitoring wells, the program at SWMU #9 will consist of collecting 30 soils samples for laboratory analysis. Five soil samples will be collected in the vicinity of the aboveground fuel tank at a depth just above the water table. The remaining 25 samples will be collected within the burn area. Sampling stations will be established at 25-foot intervals throughout a 100-foot by 100-foot sampling area. Samples from the burn area that are to be submitted to the laboratory are described in the SAP. The intent here is to delineate the extent of the source area.

3.4.9 AC #1 - Old Fire Training Area No. 1

3.4.9.1 Environmental Setting. Groundwater occurs at about 5 to 8 feet BLS in the area near AC #1. Monitoring wells installed around the site during the Confirmation Study (ESE, 1987) indicate evidence of a release to groundwater. A strong petroleum odor was noted in two of three wells and subsequent groundwater analysis for volatile organic compounds and metals indicates elevated levels of benzene (3.6 ug/l), ethylbenzene (29 ug/l), toluene (68 ug/l), trichlorofluoromethane (21 ug/l), and methyl isobutyl ketone (16 ug/l) in well PCY-3-3 (ESE, 1987). Of the three wells sampled, the downgradient well (PCY-3-3) generally contained higher contaminant levels for most of the parameters identified. Based on these results, former operations at the fire training area have resulted in groundwater contamination by petroleum products. Because the area has been paved, stormwater runoff should not cause surface water contamination. Because groundwater is known to be contaminated and moving towards St. Andrew Bay and Alligator Bayou, discharge into surface water is possible.

3.4.9.2 Source Characterization. Fire fighting training occurred approximately once a month in an unlined pit of approximately 500 square feet, located about 140 feet west of Building 100 and approximately 700 feet from St. Andrew Bay (Figure 3-8). The site was used for fire fighting training from the mid-1950s to late 1970 when the new facility off Gull Circle was constructed. The site was paved with asphalt in 1978 when Open Storage Area 2 was constructed.

During the period of operation, diesel fuel, oily bilge water, water contaminated fuels, paints, and paint thinners were poured onto the ground and ignited. Reportedly, about eight or nine 55-gallon drums of wastes were burned during each training exercise and about 45 to 50 drums of material were burned annually (Johnson and Associates, 1985).

3.4.9.3 Release Characterization. The exploration program at AC #1 will consist of the incremental installation of 13 monitoring wells and the collection of 3 soil samples and 16 groundwater samples.

It is anticipated that groundwater flow direction in the vicinity of AC #1 is east to east-northeast towards St. Andrew Bay. As such, most of the proposed wells lie between St. Andrew Bay and AC #1 and are intended to yield information on the vertical and horizontal extent of contamination emanating from the Old Fire Training Area. Because the horizontal distribution of the plume is still unknown, wells will be installed incrementally. Initially, nine wells (PCY-13-1S, PCY-13-2S, PCY-13-2D, PCY-13-3S, PCY-13-3D, PCY-13-4S, PCY-13-4I, PCY-13-5S, and PCY-13-5I) will be installed and sampled. Once analytical results are received and evaluated, an additional four wells (PCY-13-6S, PCY-13-6I, PCY-13-7S, and PCY-13-7I) will be installed. If contamination is not detected in the wells farthest downgradient, additional wells will be placed closer to the source then the previously installed wells, but if the wells farthest downgradient exhibit contamination, the additional wells will be positioned farther away from the source than the farthest downgradient wells. Of the 13 monitoring wells, 7 will be shallow wells, 4 will be intermediate wells, and 2 will be deep wells. The rationale for each well is as follows.

- PCY-13-1S will be a shallow monitoring well clustered with the existing, intermediate monitoring well PCY-3-1. This well pair is believed to be upgradient of AC #1 and will provide information on the vertical distribution of background groundwater quality.

- PCY-13-2S and PCY-13-2D will be shallow and deep monitoring wells clustered with the existing, intermediate well PCY-3-2. This well cluster is located southeast of the site and will provide information on the vertical extent of the plume emanating from the site.

- PCY-13-3S and PCY-13-3D are shallow and deep monitoring wells to be clustered with the existing, intermediate monitoring well PCY-3-3. This well cluster is northeast of AC #1 and will yield information of the vertical extent of the plume.

- PCY-13-4S and PCY-13-4I are shallow and intermediate monitoring wells located northeast of the site. The intent of these wells is to identify whether the transverse edge of the shallow and intermediate depth plume has migrated to this position.

- PCY-13-5S and PCY-13-5I are shallow and intermediate monitoring wells located southeast of the site. As with the PCY-3-4 well cluster, the intent of this cluster is to define whether the transverse edge of the shallow and intermediate depth plume has migrated to this position.

- PCY-13-6S and PCY-13-6I compose a shallow and intermediate monitoring well pair to be placed downgradient of the source based on contaminant findings in the nine initially installed wells. The intent of this well pair is to delineate the downgradient reach of the shallow and intermediate depth plumes.

- PCY-13-7S and PCY-13-7I compose a shallow and intermediate well pair to be placed downgradient of the source based on contaminant findings in the nine initially installed wells. The intent of this well pair is to delineate the downgradient reach of the shallow and intermediate depth plumes.

Subsequent to monitoring well installation, a groundwater sample will be collected from each monitoring well and will be submitted for laboratory chemical analysis. Specific methods and parameters of analysis are discussed in the SAP.

Water level readings observed in the monitoring wells, coupled with aquifer testing, will allow for an assessment of the groundwater flow rate and direction in the vicinity of AC #1.

Three soil samples will be obtained from the unlined pit using a hand auger. These samples will be used to characterize the source area (i.e., the unlined pit) and provide information on the variation of soil chemistry.

3.4.10 AC #2 - Underground Oil Contaminated Area

3.4.10.1 Environmental Setting. The groundwater flow direction is southwest to south towards Alligator Bayou. The water table ranges from 5 to 8.5 feet BLS. No impermeable layer is known to exist beneath the area to prevent migration of contaminants into the unconfined surficial aquifer. Elevated levels of polynuclear aromatic compounds were found in samples collected from the area of AC #2 (ESE, 1987). Other compounds detected in various wells included ethylbenzene, toluene, lead, and mercury. Soils in the area are expected to be fine- to medium-grained quartz sands. The lithology is expected to be similar to that presented in Figure 2-2.

3.4.10.2 Source Characterization. This site (Figure 3-9) is the location of a former aboveground 10,000-barrel petroleum product storage tank (No. 11), its associated distribution and supply lines, and an area under south dock contaminated by a break in the off-loading oil supply line. Construction of the storage tank, which was 24 feet tall and 55 feet in diameter, was completed in 1943. The tank received diesel fuel from barges at the south dock fuel off-loading station and distributed it, by pipeline, to other vessels moored at fueling stations along the dock. Numerous small leaks from the tank (mostly at seams) reportedly occurred before and after its rehabilitation in 1957. According to an Environmental Pollution Control Proposed Project Report (Naval Facilities Engineering Command, 1977), 50,000 gallons of diesel oil were lost from the system in 1953. The exact location of the leak and whether the underground pipeline was involved are unknown.

In 1957 the tank was restored, including complete dismantling, cleaning and reassembly of the tank using new bolts and gaskets. The replacement gasket allowed the tank to be used for storage of gasoline and aviation fuel as well as diesel fuel oil. During rehabilitation, the tank bottom was found to be badly deteriorated and replacement of 28 bottom plates was required. Reportedly, the tank continued to leak following rehabilitation and its associated piping was in poor condition. According to NCSC personnel, the tank was used for waste oil storage for several years prior to its removal in 1975.

During the mid 1960s, the oil supply line between the dock and the storage tank ruptured and an estimated 10,000 gallons of oil collected under the south dock. Following the leak, seepage of diesel oil through the south dock's steel bulkhead to Alligator Bayou was noted. Reportedly, the dock's steel bulkhead had numerous small pits and holes. During periods of low tide, the elevation of the floating oil layer beneath the dock was low enough to allow oil to escape to Alligator Bayou through the holes in the bulkhead.

3.4.10.3 **Release Characterization.** The exploration program at AC #2 will consist of 8 soil borings completed with monitoring wells, 30 soil samples, and 19 groundwater samples.

It is anticipated that groundwater flow direction in the vicinity of the former petroleum product storage tank is radial towards west and south dock. The proposed monitoring well installation program (see Figure 3-9) takes this into consideration as well as the location of existing monitoring wells. As such, all new wells will be nested with existing monitoring wells. The rationale for each well cluster is as follows.

- PCY-14-1S will be a shallow monitoring well to be installed adjacent to the existing, intermediate monitoring well PCY-14-1. It is believed that this well cluster is upgradient of the former storage tank and will provide upgradient groundwater quality data for AC #2. Background groundwater quality data will be collected from well PCY-5-1.

- PCY-14-2S and PCY-14-2D will comprise the shallow and deep members of a well cluster associated with the existing intermediate monitoring well PCY-14-2. It is anticipated that this well cluster is located immediately downgradient of the former storage tank and will provide information on the vertical distribution of contaminants emanating from the old tank area.

- PCY-14-3S will be a shallow monitoring well to be nested with the existing, intermediate well PCY-14-3. It is anticipated that this well cluster is downgradient of the former storage tank and will yield information on the vertical and lateral extent of groundwater contamination.

- PCY-14-5S will be a shallow monitoring well nested with the existing, intermediate well PCY-14-5. This well cluster is located along the western edge of south dock and is anticipated to be near the transverse edge of the plume emanating from the former storage tank.

- PCY-1-1S and PCY-1-1D will comprise the shallow and deep monitoring wells clustered with the existing, intermediated well PCY-1-1. It is anticipated that this well cluster is downgradient of the former storage tank and will provide information on the longitudinal and vertical extent of contaminants emanating from the area of the former storage tank.

- PCY-1-2S will be a shallow monitoring well clustered with the existing, intermediate well PCY-1-2. It is anticipated that this well cluster is located along the transverse edge of the plume and will supply information on the lateral dispersion of the plume.

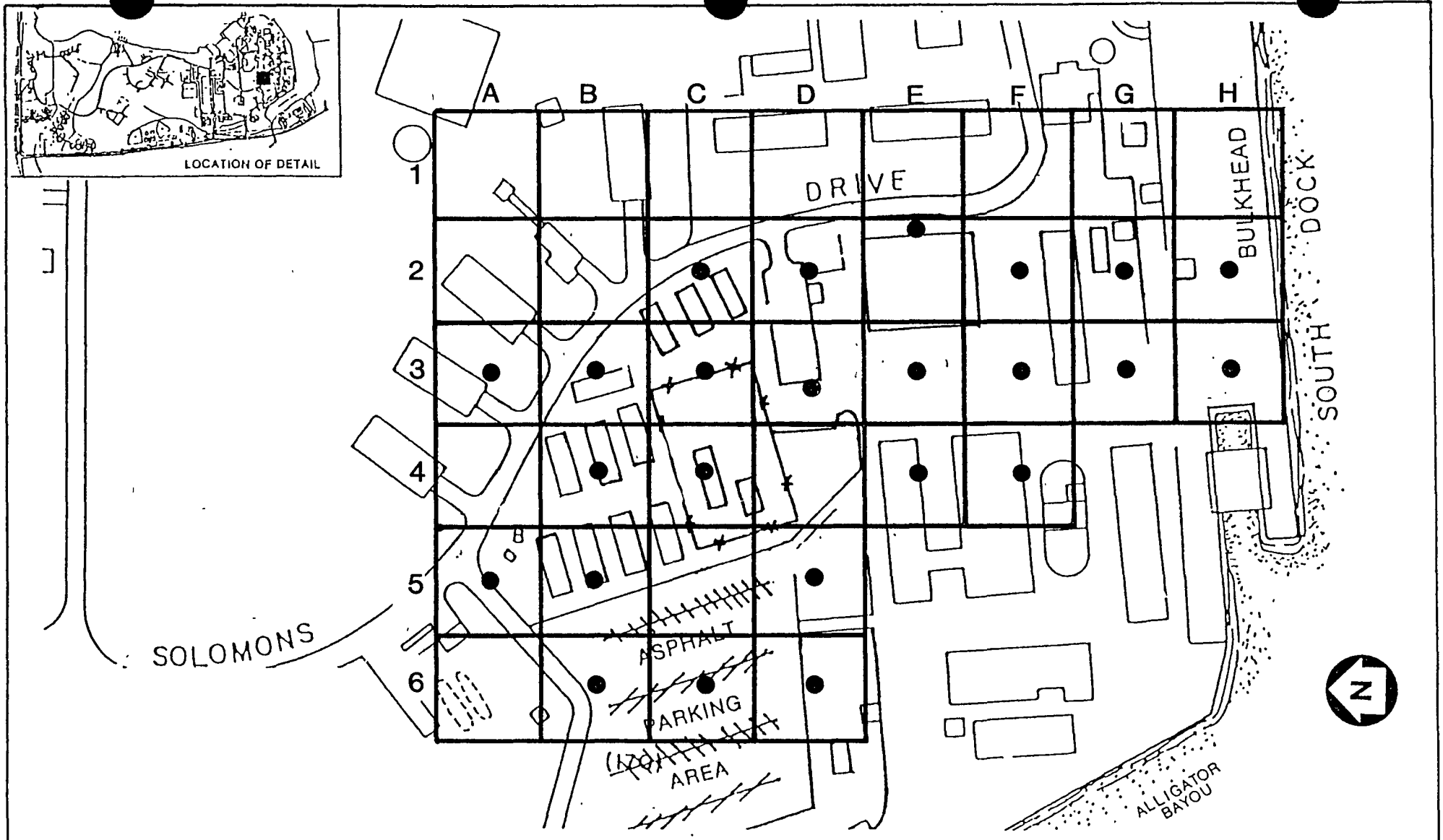
Subsequent to monitoring well installation, a groundwater sample will be collected from each monitoring well and will be submitted for laboratory chemical analysis. The specific methods and parameters of analysis are discussed in the SAP. In addition to the proposed wells, groundwater samples will be collected from the existing wells in the site vicinity. These wells are PCY-1-1, PCY-1-2, PCY-1-3, PCY-14-1, PCY-14-2, PCY-14-3, PCY-14-4, PCY-14-5, PCY-5-1, PCY-5-2, and PCY-15-1. Groundwater samples collected from existing wells will be obtained from the bottom 5 feet of screen by the use of a packer.

Water level readings observed in the monitoring wells coupled with aquifer testing will allow an assessment of the groundwater flow rate and direction in the vicinity of AC #2.

One soil sample will be collected from the deepest soil boring for each well cluster and for isolated borings in the unsaturated soils above the groundwater table and will be submitted for laboratory chemical analysis. In addition to the 6 soil samples collected during monitoring well installation, 24 samples will be collected in accordance to the grid system displayed in Figure 3-10. Samples will be obtained just above the water table using a hand auger.

3.5 Task 2 - WELL SURVEY

The elevation and horizontal location of all monitoring wells will be surveyed by a Florida-registered land surveyor. Elevations of both the top of the riser and the ground surface will be measured to the nearest 0.01 feet and referenced to NCSC datum. The elevational survey is necessary to develop piezometric surface maps and to determine groundwater flow direction.



E.C. JORDAN CO. ENGINEERS & SCIENTISTS	APPROX. LOCATIONS OF SOIL SAMPLING STATIONS AC #2
U.S. DEPT. OF NAVY NAVAL COASTAL SYSTEMS CENTER PANAMA CITY, FLORIDA	5330-01 FIGURE 3-10

4.0 TASK 3 - POTENTIAL RECEPTORS AND THE HEALTH AND ENVIRONMENTAL ASSESSMENT

4.1 IDENTIFICATION OF POTENTIAL RECEPTORS. This section describes, in general, the types of data to be collected to describe human populations and ecosystems that may be potential receptors of contamination emanating from the SWMUs and ACs at NCSC Panama City.

The identification of potential receptors will be based upon information obtained from a records search of appropriate NCSC files; a search of pertinent state and Federal records, statutes, and documents; appropriate interviews with Naval and state personnel; and a visual survey of the SWMUs and ACs by a qualified public health scientist.

4.1.1 Human Receptors.

4.1.1.1 **Current and Potential Future Uses of Groundwater.** The following information will be collected with regard to groundwater uses:

- location of groundwater users of the surficial aquifer, secondary artesian aquifer, and Floridan aquifer system including withdrawal and discharge wells within a 1-mile radius of each SWMU and AC;
- classification of the groundwater aquifers under state of Florida Administrative Code, Chapter 17-3; and
- identification of the types of use of groundwater.

4.1.1.2 **Current and Potential Future Uses of Surface Water.** General descriptions of surface water bodies on NCSC are described in general in Section 2.2.6.1 and include the Gulf of Mexico, St. Andrew Bay, small streams, four freshwater ponds and Alligator Bayou. The current and potential future uses of the surface water bodies will be described including possible domestic, municipal, recreational, agricultural, industrial, and environmental uses. The information will be obtained by contacting local and state agencies and base personnel.

4.1.1.3 **Use and Access to the Facility.** Uses of land on, or adjacent to the facility will be described as well as the type and number of people who have access to the land(s). Information to be collected includes, but is not limited to, recreation, hunting, residential, and commercial uses. Any zoning of lands will be reported. The relationship between population locations and prevailing wind direction will also be predicted. Information on access to SWMUs and ACs will be obtained from base personnel. Use of lands on base will be determined from NCSC files and personnel interviews. Use of lands outside the base will be determined by obtaining information from local land planning agencies.

4.1.1.4 **Demographic Profile.** A demographic profile of populations who use or have access to the facilities and the adjacent land(s) will be compiled. The profile will include age, sex, sensitive subgroups (e.g. schools or nursing homes), and other factors as appropriate. The profile will be compiled from information available from NCSC concerning personnel and on-base housing areas.

Off-base demographic information will be obtained from local census sources.

4.1.2 Environmental Receptors. Environmental receptors include aquatic and terrestrial wildlife species that may be exposed to contamination emanating from the facilities. In order to accurately assess environmental receptors a biological field investigation will be conducted. The technical aspects of the field investigation are fully described in the SAP (see Appendix A).

The goal of the biological field investigation is to collect information from the field required to conduct the environmental assessment part of the Health and Environmental Assessment (HEA). The methods used in the field are according to those outlined in *Ecological Assessment at Hazardous Waste Sites: A Field and Labortory Reference* (EPA/600/3-89/-13). The objectives of the biological investigation include:

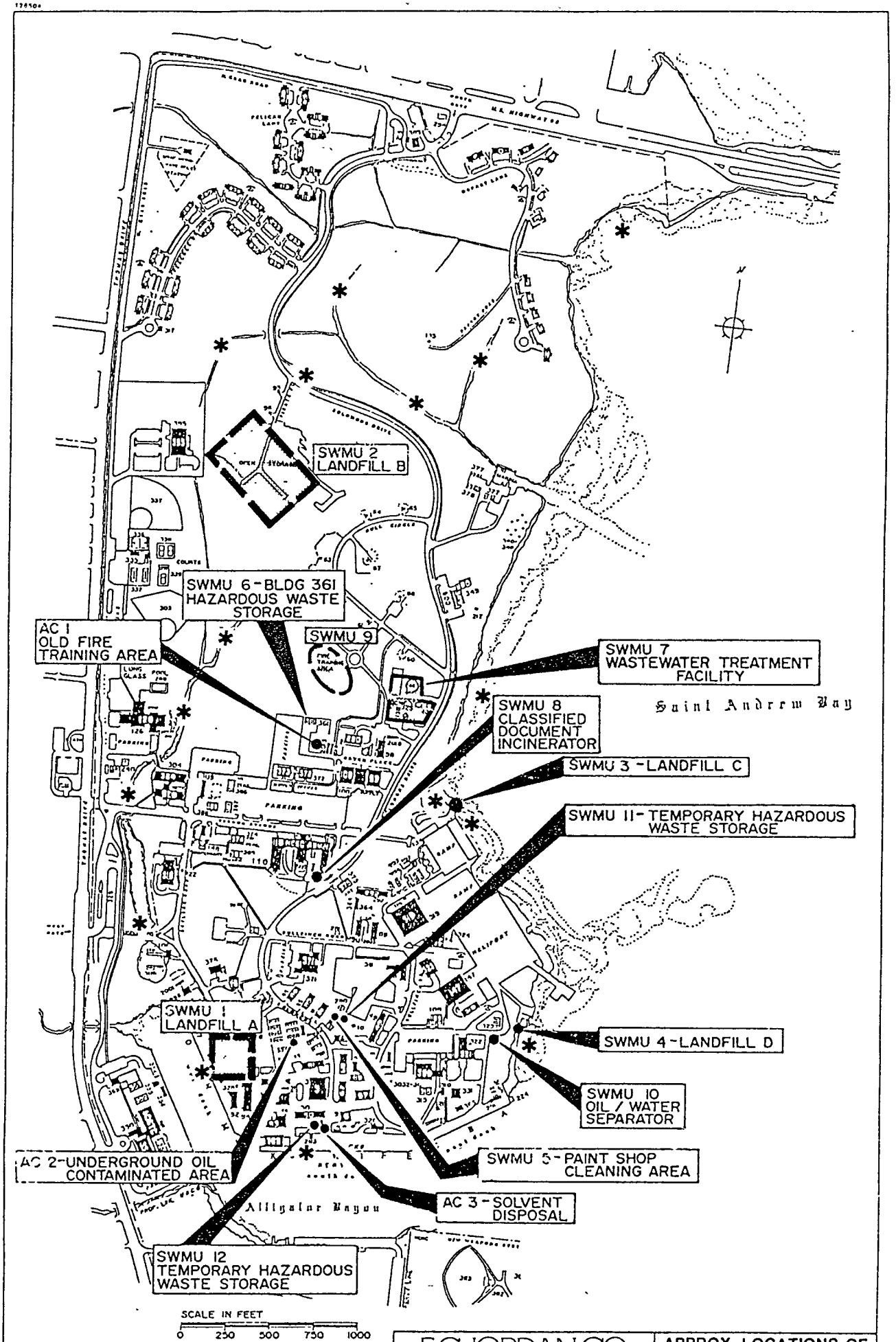
- identification of basic environmental characteristics,
- identification of important aquatic and terrestrial organisms (receptors),
- identification of areas of contamination and ecological effects, and
- estimation of the magnitude and variation of toxic effects.

4.1.2.1 **Survey of Aquatic Biota**. The biota of surface water bodies on, adjacent to, or affected by each of the facilities will be characterized. Aquatic biota include amphibians, fish, invertebrates, plants, and algae. Aquatic biota will be sampled from surface water potentially impacted by contaminated releases. The sampling will be conducted by field biologists. The survey is designed to collect as many species as possible. Sampling will be by dredge, net seines, minnow traps, dip net, kick net, and hand collection.

Sixteen aquatic survey stations will be established at the locations shown in Figure 4-1. At each station, aquatic flora and fauna will be collected and identified. Terrestrial vegetation around each biological sampling station will also be noted along with the physical characteristics of the site location. At each station, one sediment sample will be collected for submittal to the laboratory for chemical analysis. At those stations not on St. Andrew Bay, a surface water sample will also be collected. Specific parameters to be analyzed for are discussed in the SAP (see Appendix A).

Additional biomonitoring methods (e.g., bioassays) may be employed if extensive soil, sediment, or surface water contamination is measured at any SWMU. Possible implementation of biomonitoring is discussed in the SAP (see Appendix A).

4.1.2.2 **Survey of Terrestrial Biota and Plants**. The terrestrial biota inhabiting the facility and lands adjacent to it will be characterized. Terrestrial biota include birds, reptiles, invertebrates, amphibians, and mammals. Information on habitats collected during the biological characterization will aid in identifying species that may be susceptible to exposures to contaminants.



LEGEND

SWMU - SOLID WASTE MANAGEMENT UNIT
AC - AREAS OF CONCERN
* SAMPLING STATION

E.C. JORDAN CO.
ENGINEERS & SCIENTISTS

APPROX. LOCATIONS OF BIOLOGICAL SAMPLING STATIONS

U.S. DEPT. OF NAVY
NAVAL COASTAL SYSTEMS CENTER
PANAMA CITY, FLORIDA

5330-00

FIGURE 4-1

4.1.2.3 Description of Ecosystems. Ecosystems present at, or adjacent to, NCSC will be described based upon the results of the aquatic and terrestrial survey and other available information. The ecosystem descriptions will include identification of possible food webs that will aid in assessment of possible food chain transport of contamination.

Identification of wetland habitats will be included in this part of the receptor survey. The wetlands assessment will include descriptions of the wetland areas; their classification according to state, federal, and local regulations; and their functional attributes.

4.1.2.4 Identification of Rare, Endangered, or Threatened Species and Sensitive Habitats. Any rare, endangered, or threatened species on, near the SWMUs, or potentially affected by contamination from the SWMUs will be described. Rare, endangered, and threatened species are protected by the U.S. Fish and Wildlife Service under the Endangered Species Act of 1973. The state of Florida also protects a number of wildlife species under its Endangered and Threatened Species Act of 1977.

Bioassessment Methods. Bioassessment methods will be used on a site-specifc basis to identify areas of contamination and ecological effects and to estimate the magnitude and variation of toxic effects.

Bioassessment methods include quantitative surveys, bioassays, and tissue residue analyses. Quantitative surveys of vegetation, aquatic macroinvertebrate populations, and fish populations help to define areas of contamination with ecological effects. Bioassays expose organisms to contaminated media from the site(s) in order to estimate the magnitude of toxic effects. Tissue residue analyses of aquatic or terrestrial organisms provide information on exposures for the organisms themselves and human consumers.

The sampling of aquatic biota for tissue analyses will be dependent upon the results of the sampling program in Section 3.2. If inorganic or organic constituents having bioaccumulative potential are measured in sediments or the water column, sampling and analyses of aquatic species may be implemented. Tissue analyses of aquatic species would provide exidence of bioaccumulative potential and potential exposures via consumption for humans.

4.2 HEALTH AND ENVIRONMENTAL ASSESSMENT (HEA)

4.2.1 Constituents of Concern. Constituents of concern will be determined after a review of the analytical data collected during the exploration and sampling program (Section 3.2). Constituents of concern will be equivalent to the chemicals detected in soils, sediments, surface water and groundwater. Inorganic chemicals will be considered to be "of concern" if they exceed background levels as determined for the site and the particular medium.

Bioassessment Methods. Bioassessment methods will be used on a site-specifc basis to identify areas of contamination and ecological effects and to estimate the magnitude and variation of toxic effects.

Bioassessment methods include quantitative surveys, bioassays, and tissue residue analyses. Quantitative surveys of vegetation, aquatic macroinvertebrate populations, and fish populations help to define areas of contamination with ecological effects. Bioassays expose organisms to contaminated media from the site(s) in order to estimate the magnitude of toxic effects. Tissue residue analyses of aquatic or terrestrial organisms provide information on exposures for the organisms themselves and human consumers.

4.2.2 Human Health Assessment

4.2.2.1 Exposure Assessment.

Identification of Exposure Routes. Potential routes of exposure for human receptors are listed by medium of exposure in Table 4-1. Exposure routes will be selected for each of the SWMUs based upon the identified constituents of concern and the extent of contaminant release into environmental media (groundwater, surface water, soils, sediments, and biota).

TABLE 4-1
POTENTIAL EXPOSURE ROUTES FOR HUMAN RECEPTORS
RCRA FACILITY INVESTIGATION

Medium of Exposure	Exposure Route
Soil	• Ingestion • Direct contact
Groundwater	• Ingestion of drinking water • Direct contact • Inhalation of volatiles during domestic use
Air	• Inhalation of vapors from contaminated soils, surface waters, or groundwater
Subsurface gas	• Inhalation of vapors from contaminated soils
Surface waters	• Ingestion of drinking water • Direct contact • Consumption of contaminated biota
Sediments	• Direct contact • Ingestion of contaminated biota

Estimation of Exposure Point Concentrations. The concentrations of a constituent measured in environmental media at different locations will be presented and averaged to provide an estimate of mean exposures for contamination in surface water, soils, groundwater (ingestion only), sediments (ingestion only), and air. The highest contaminant concentrations measured will provide an estimate of worst case exposures.

For contaminants in sediments, exposures will be estimated by predicting the partitioning of the chemical between the solid and dissolved phases. Exposures will be equivalent to the amount of chemical in the dissolved phase. Predictions will be according to the equilibrium partitioning (EP) theory approach for hydrophobic organics and other valid approaches for specific metals.

Exposures to groundwater contamination via effluent seepage to surrounding surface water will be predicted based upon the extent of the release, the potential rate of migration of the release, and general release characteristics as well as the potential for dilution in the surface water body.

4.2.2.2 Human Health Toxicity Assessment.

Exposure-Limit Criteria. EPA exposure-limit criteria are levels of contaminants in a medium that present an unacceptable risk to a receptor under certain intake assumptions. The criteria are derived based upon intake assumptions and risk-based adverse contaminant levels (dose-response levels). Possible adverse contaminant levels or dose response values include:

- Risk-Specific Doses (RSDs) based on Carcinogen Potency Factors,
- Carcinogen Slope Factor (CSF),
- Maximum Contaminant Levels (MCLs),
- Drinking Water Health Advisories,
- National Academy of Sciences Advisories,
- World Health Organization Advisories,
- Florida Water Quality Standards,
- Florida Ambient Air Quality Criteria,
- National Ambient Air Quality Standards, and
- any other relevant criteria.

Exposure limit criteria will be derived for surface water, soils, sediments, air, and groundwater as they pertain to each individual SWMU. Intake assumptions for the exposure-limit criteria will be based upon EPA guidance. USEPA's Integrated Risk Information System (IRIS) will be the primary source of dose response information.

For chemicals and other parameters for which no dose response values are available, the chronic, subchronic, acute, and carcinogenic effects will be characterized by a literature search. Documents that will be searched include:

- Health and Environmental Effects Profiles (HEEPs),
- Health Effects Assessment (HEA) documents, and
- Health and Environmental Effects Documents (HEEDs).

Toxicity Profiles. Toxicity profiles will be brief and describe short- and long-term effects associated with exposures to the respective constituents of concern.

4.2.2.3 Risk Assessment

Comparison of Predicted Exposures with Criteria. The predicted exposure point concentrations (Section 4.2.2.2) for selected exposure routes (Section 4.2.2.1) will be compared with the exposure-limit criteria in Section 4.2.2.2. Exceedance of the criteria implies a potential risk.

Evaluation of Risks for Chemical Mixtures. Total potential human health risks associated with each exposure route will be determined by comparing the total exposure concentrations of chemicals from Section 4.2.2.2 with dose response values from Section 4.2.2.1. The evaluation will integrate total potential exposures in oral, dermal, and inhalation routes from contaminant(s) in groundwater, soil, surface water, sediments, and air.

4.2.3 Environmental Assessment

4.2.3.1 Exposure Assessment

Identification of Exposure Routes. Potential routes of exposure for environmental receptors are listed by medium of exposure in Table 4-2. Exposure routes will be selected for each of the SWMUs based upon the identified constituents of concern and the extent of contaminant release into environmental media (groundwater, surface water, soils, and sediments).

Estimation of Exposure Point Concentrations. Estimation of exposure point concentrations will be the same as described for the human health assessment. Expression of exposure concentrations will include uncertainty analyses.

4.2.3.2 Toxicity Assessment

Ecological Criteria. Criteria protective of aquatic organisms are available in the form of:

- Ambient Water Quality Criteria,
- Florida Water Quality Standards, and
- Interim Sediment Quality Criteria (SQC).

These criteria are levels of contaminants in surface water or sediments that are protective of chronic or acute toxic effects to aquatic life. The SQC are site specific based upon the organic carbon content of the sediments.

Available and applicable criteria for constituents of concern will be calculated and summarized. Where criteria are not available, dose-response information will be collected and used to derive protective levels. The dose-response information for aquatic and terrestrial organisms and constituents of concern will be summarized in Section 4.3.2.2. Where possible, uncertainty associated with dose-response levels (including criteria) will be expressed by equation.

TABLE 4-2
POTENTIAL EXPOSURE ROUTES FOR ENVIRONMENTAL RECEPTORS
RCRA FACILITY INVESTIGATION

Medium of exposure	Route of exposure	Populations exposed
Soil	Dermal contact with contaminated soil or organic matter.	Burrowing mammals, reptiles, amphibians, invertebrates, and dust-bathing birds.
Soil	Ingestion of contaminated soil or organic matter.	Earthworms and insects.
Soil	Consumption of animals that have contact with contaminated soil or matter.	Predatory and omnivorous mammals, birds, reptiles, and amphibians; insects.
Soil/air	Inhalation of vapors from contaminated soil or organic matter.	All terrestrial animals.
Surface water	Dermal contact with contaminated water.	Fish, terrestrial animals, reptiles, and amphibians; invertebrate larvae.
Surface water	Ingestion of contaminated water.	Most terrestrial animals and fish (via gills).
Sediments	Dermal contact with or ingestion of contaminated sediments or organic matter.	Aquatic invertebrates
Sediments	Ingestion of sediment dwelling aquatic invertebrates.	Fish.
Surface water & sediments	Ingestion of fish contaminated as above.	Predatory fish, reptiles, birds, and mammals.

In addition to numeric criteria, qualitative criteria will be assessed including:

- presence of sensitive ecosystems;
- presence of rare, endangered, or threatened species;
- important exposure routes not addressed by quantitative criteria; and
- presence of chemicals that cause secondary ecological effects (alter pH, dissolved oxygen, or change habitat).

Bioassessment Results. Results of bioassessment methods employed at any of the sites will be presented in this section. The results may include those of quantitative benthos sampling, sediment or aquatic bioassays, soil bioassays, vegetative sampling, or tissue residue analyses.

Quantitative benthos, fish, or vegetative sampling results will help to define areas of contamination where ecological effects are occurring. Results of bioassays (soil, sediment, and surface water) and tissue residue analyses provide information on the magnitude and variation of toxic effects associated with contaminant exposure.

Toxicity Profiles. The toxicity profiles will provide information on the long- and short-term effects of the constituents of concern upon aquatic and terrestrial wildlife. Information on species that are particularly sensitive to respective contaminants will be included as part of the profile as well as a compilation of data on the tendency of respective contaminants to bioconcentrate in biota and biomagnify within food chains.

4.2.3.3 Risk Assessment

Comparison of Predicted Exposures with Criteria. A joint probability analyses procedure will be used to compare predicted exposures with dose-response values for respective chemicals. The analyses will be used for sediment and surface water exposures and will provide probability based risk estimates.

Risks for soil exposures will be evaluated by comparing dose-response levels with exposure estimates.

Evaluation of Risks for Chemical Mixtures. Total potential ecological risks associated with each exposure route will be determined in theory by comparing the total exposure concentrations of chemicals with dose-response values. The evaluation will integrate total potential exposures to contaminant(s) in groundwater, surface water, and sediments. If bioassay results are available these will provide a direct measure of toxic effects associated with chemical mixtures in a particular medium.

5.0 TASK 4 - ANALYTICAL PROGRAM

Details of the analytical program for the RFI at NCSC Panama City are included in the SAP (see Appendix A).

6.0 TASK 5 - RFI REPORT

6.1 DRAFT REPORT. To meet the objective of the RCRA Facility Investigation, Jordan will review and summarize the data developed during the investigation and will assess the vertical and horizontal extent of contamination emanating from the sites. As part of this assessment, Jordan will assemble the necessary information to characterize the source areas and the groundwater hydrology in the vicinity of each site. These characteristics include:

- site geology,
- site hydrogeology,
- site hydrology,
- presence and concentration of contaminants, and
- evaluation of contaminant concentrations relative to state and Federal regulatory criteria.

This information will be used to ascertain transport mechanisms that will aid in the predicting of contaminant migration through time.

Based upon the results and conclusions drawn from the analysis, Jordan will make one or more of the following recommendations for each of the sites studied:

- investigate further under a Phase 2 RCRA Facility Investigation,
- conduct a risk assessment to develop appropriate action levels, or
- develop remedial alternatives and conduct a CMS.

The information and evaluation will be compiled into the Draft RFI Report, which will be submitted to SDIV and NCSC for their review and comment.

6.2 DRAFT FINAL REPORT. Subsequent to the Navy's review of the Draft RFI Report, a meeting will be held at NCSC Panama City, Florida to discuss written comments provided by the Navy. The purpose of this meeting will be to finalize changes to the Draft Report. A Draft Final RFI Report will subsequently be completed by Jordan following this meeting. The Draft Final Report will be submitted to the FDER and USEPA for review and comment. Upon the Navy's receipt of review comments from the USEPA and the FDER, Jordan will address the review comments and prepare the Final RFI Report. The Final RFI Report will be prepared under a subsequent contract amendment, based on the magnitude of the USEPA and FDER review comments.

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LIST OF ACRONYMS

AFFF	Aqueous Film Forming Foam
AIMD	Aircraft Intermediate Maintenance Department
ARAR	Applicable or Relevant and Appropriate Requirement
ATSDR	Agency for Toxic Substances and Disease Registry: a branch of the Centers for Disease Control that is responsible for preparing health assessments at sites.
AWQC	Ambient Water Quality Criteria
BLS	Below Land Surface
CAA	Clean Air Act
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980, also known as Superfund. Amended in 1986 by the Superfund Amendments and Reauthorization Act (SARA).
CIP	Caucus Inorganic Protocol
CLP	Contract Laboratory Program
CO	Corporate Officer
COP	Caucus Organic Protocol
CRL	Central Regional Laboratory
CRP	Community Relations Plan
CSF	Carcinogen Slope Factor
CWA	Clean Water Act
DFM	Diesel Fuel Marine
DMP	Data Management Plan
DQO	Data Quality Objectives: statements that specify the data needed to support decisions regarding remedial response activities.
EIC	Engineer in Charge
EMSL-LV	Environmental Monitoring Systems Laboratory, Las Vegas
EPIC	Environmental Photographic Interpretation Center

LIST OF ACRONYMS (Continued)

ERA	Expedited Response Action
ESE	Environmental Science and Engineering, Inc.
ESI	Expanded Site Investigation
FDER	Florida Department of Environmental Regulation
FIT	Field Investigation Team
FS	Feasibility Study
FSP	Field Sampling Plan: defines in detail the sampling and data gathering activities to be used at a site (see SAP).
GAC	Granulated Activated Carbon
GC	Gas Chromatograph
gpm	Gallons per minute
GSE	Ground Support Equipment
HASO	Health and Safety Officer
HASP	Health and Safety Plan
HEA	Health Effects Assessment
HEED	Health and Environmental Effects Document
HEEP	Health and Environmental Profile
HSWA	Hazardous and Solid Waste Amendments of 1984 to the Resource Conservation and Recovery Act.
IAS	Initial Assessment Study
IRP	Installation Restoration Program
IRIS	Integrated Risk Information System
Lead Agency	The agency, either the USEPA, Federal agency, or appropriate State agency having primary responsibility and authority for planning and executing the remediation at a site.

LIST OF ACRONYMS (Continued)

MCL	Maximum Contaminant Level: established under the Safe Drinking Water Act.
MCLG	Maximum Contaminant Level Goal: established under the Safe Drinking Water Act.
mg/l	Milligrams per liter
mg/kg	Milligrams per kilogram
MIBK	Methyl-isobutyl ketone
MPRSA	Marine Protection Research and Sanctuaries Act
MSL	Mean sea level
NAAQS	National Ambient Air Quality Standards
NCP	National Oil and Hazardous Substances Contingency Plan
NCSC	Naval Coastal Systems Center
NEPA	National Environmental Policy Act
NGVD	National Geodetic Vertical Datum of 1929
NIOSH	National Institute for Occupational Safety and Health
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List: a list of sites identified for remediation under CERCLA.
NSC	Naval Supply Center
O&M	Operation and Maintenance
OMD	Operations Maintenance Division
OMS	Operations Maintenance Service
OSHA	Occupational Safety and Health Administration
OSWER	Office of Solid Waste and Emergency Response

LIST OF ACRONYMS (Continued)

OWTP	Oily Waste Treatment Plant
PCB	Polychlorinated biphenyl
PHE	Public Health Evaluations
PM	Program Manager
PrM	Project Manager
PRP	Potentially responsible Party
q_1*	Cancer potency factor: the lifetime cancer risk for each additional mg/kg body weight per day of exposure.
QA	Quality Assurance
QAPP	Quality Assurance Project Plan: a plan that describes protocols necessary to achieve the data quality objectives defined for an RI (see SAP).
QC	Quality Control
RAS	Routine Analytical Services
RCRA	Resource Conservation and Recovery Act of 1976, as amended
RD	Remedial Design
RFA	RCRA Facility Assessment
RfD	The reference dose (RfD) is an estimate (with uncertainty spanning perhaps an order of magnitude) of a daily exposure to the human population (including sensitive subgroups) that is likely to be without appreciable risk of deleterious effects during a lifetime.
RFI	RCRA Facility Investigation
RI/FS	Remedial Investigation/Feasibility Study
ROD	Record of Decision: documents selection of cost-effective Superfund-financed remedy.
RSD	Risk-Specific Dose

LIST OF ACRONYMS (Continued)

SAP	Sampling and Analysis Plan: consists of a Quality Assurance Project Plan (QAPP) and a Field Sampling Plan (FSP).
SARA	Superfund Amendments and Reauthorization act of 1986 (see CERCLA).
SAS	Special Analytical Services
SDWA	Safe Drinking Water Act
SOUTHDIV-FACENGCOM	Southern Division Naval Facilities Engineering Command
SI	Site Inspection
SIMA	Shore Intermediate Maintenance Activity
SITE	Superfund Innovative Technology Evaluation
SMP	Site Management Plan
SOP	Standard Operating Procedures
SOW	Statement of Work
SPHEM	Superfund Public Health Evaluation Manual
SUBSHIPS	Supervisor of Shipbuilding
SWDA	Solid Waste Disposal Act
SWMU	Solid Waste Management Unit
TAT	Technical Assistance Team
TBC	To be considered
TCL	Target Compound List
TD	Technical Director
TDM	Technical Directive Memorandum
TRB	Technical Review Board
TSCA	Toxic Substances Control Act

LIST OF ACRONYMS (Continued)

USDA	U.S. Department of Agriculture
USEPA	U.S. Environmental Protection Agency
WPRR	Work Plan Revision Request

TABLE 4-2
POTENTIAL EXPOSURE ROUTES FOR ENVIRONMENTAL RECEPTORS
RCRA FACILITY INVESTIGATION

Medium of exposure	Route of exposure	Populations exposed
Soil	Dermal contact with contaminated soil or organic matter.	Burrowing mammals, reptiles, amphibians, invertebrates, and dust-bathing birds.
Soil	Ingestion of contaminated soil or organic matter.	Earthworms and insects.
Soil	Consumption of animals that have contact with contaminated soil or matter.	Predatory and omnivorous mammals, birds, reptiles, and amphibians; insects.
Soil/air	Inhalation of vapors from contaminated soil or organic matter.	All terrestrial animals.
Surface water	Dermal contact with contaminated water.	Fish, terrestrial animals, reptiles, and amphibians; invertebrate larvae.
Surface water	Ingestion of contaminated water.	Most terrestrial animals and fish (via gills).
Sediments	Dermal contact with or ingestion of contaminated sediments or organic matter.	Aquatic invertebrates
Sediments	Ingestion of sediment dwelling aquatic invertebrates.	Fish.
Surface water & sediments	Ingestion of fish contaminated as above.	Predatory fish, reptiles, birds, and mammals.

TABLE 4-1
POTENTIAL EXPOSURE ROUTES FOR HUMAN RECEPTORS
RCRA FACILITY INVESTIGATION

Medium of Exposure	route
Soil	• Ingestion • Direct contact
Groundwater	• Ingestion of drinking water • Direct contact • Inhalation of volatiles during domestic use
Air	• Inhalation of vapors from contaminated soils, surface waters, or groundwater
Subsurface gas	• Inhalation of vapors from contaminated soils
Surface waters	• Ingestion of drinking water • Direct contact • Consumption of contaminated biota
Sediments	• Direct contact • Ingestion of contaminated biota

TABLE 1-1
SUMMARY OF RELEASE INFORMATION
RCRA FACILITY INVESTIGATION
NAVAL COASTAL SYSTEMS CENTER
PANAMA CITY, FLORIDA

SWMU NO.	NIRP site	Description	Ground-water	Surface water	Air	Soil	Subsurface gas	Action
1	1	Landfill A	P	P	NE	P	NE	RFI
2	2	Landfill B	D	NE	NE	D	NE	RFI
3	6	Landfill C	NE	NE	NE	NE	NE	RFI
4	7	Landfill D	NE	NE	NE	NE	NE	RFI
5	5	Paint equipment cleaning area	P	NE	NE	E	NE	RFI
6		RCRA haz. waste storage area	NE	NE	NE	NE	NE	No action
7		Wastewater treatment facility	NE	P	NE	NE	NE	No action
8		Classified documents incinerator	NE	NE	NE	NE	NE	RFI
9		Old fire training area No. 2	E	NE	NE	E	NE	RFI
10		Oil/water separator	P	P	NE	P	NE	No action
11		Temporary haz. waste storage (Bldg. 84)	NE	P	NE	NE	NE	Preventative measures
12		Temporary hazourdous waste storage (Bldg. 40)	NE	P	NE	NE	NE	Bldg removed 1988
Areas of concern								
1	3	Old fire training area	D	NE	NE	D	NE	RFI
2	4	Underground oil contaminated area	D	D	NE	D	NE	RFI
3	8	Solvent disposal (Bldg. 40)	NE	NE	NE	NE	NE	No action

NE - Not expected
P - Potential
E - Expected
D - Documented