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INITIAL ASSESSMENT STUDY NCBC GULFPORT MS

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ENVIRODYNE ENGINEERS, INC

JULY, 1985

INITIAL ASSESSMENT STUDY OF NAVAL CONSTRUCTION BATTALION CENTER GULFPORT, MISSISSIPPI

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NAVAL ENERGY AND ENVIRONMENTAL SUPPORT ACTIVITY

Port Hueneme, California 93043

INITIAL ASSESSMENT STUDY
NAVAL CONSTRUCTION BATTALION CENTER
GULFPORT, MISSISSIPPI

UIC: N62604

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NAVY ASSESSMENT AND CONTROL
OF INSTALLATION POLLUTANTS DEPARTMENT
Naval Energy and Environmental Support Activity
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NEPSS

Naval
Environmental
Protection
Support
Service

FOREWORD

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

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

A Confirmation Study, Phase II of the NACIP Program, is recommended for six sites identified during the IAS. Southern Division of the Naval Facilities Engineering Command (SOUTHNAVFACENGCOM) will assist NCBC Gulfport in implementing the recommendations.

Questions regarding this report should be referred to the Naval Energy and Environmental Support Activity, Code 112N at AUTOVON 360-3351, FTS 799-3351, or commercial 805-982-3351. Questions concerning confirmation work or other follow-on efforts should be referred to SOUTHNAVFACENGCOM, 114, at AUTOVON 794-5510, FTS 679-5510, or commercial 803-743-5510.

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EXECUTIVE SUMMARY

This report presents the results of an Initial Assessment Study (IAS) conducted at the Naval Construction Battalion Center (NCBC), Gulfport, Mississippi. The purpose of an IAS is to identify and assess sites posing a potential threat to human health or the environment due to contamination from past hazardous substance disposal operations.

Based on historical data, aerial photographs, field inspections and personnel interviews, nine potentially contaminated sites were identified at NCBC Gulfport. Each of the sites was evaluated with regard to contamination characteristics, migration pathways and pollutant receptors.

The major pathways for migration from potentially contaminated sites at NCBC Gulfport include erosion, surface runoff and ground water movement through the surficial aquifer to receiving waters of Canal 1, the catfish ponds, and various drainage ditches. The regional movement of the surficial aquifer is toward the Mississippi Sound, less than two miles south of the installation. Aquatic organisms in these receiving waters and the animals that rely on these areas for feeding and water are potential receptors. The catfish ponds are stocked with channel catfish and fished by installation personnel. The Mississippi Sound is classified as a recreation area.

The study concludes that six of the sites warrant futher investigation under the Naval Assessment and Control of Installation Pollutants (NACIP) Program, to assess potential long-term impacts. A confirmation study, including actual sampling and monitoring of the sites, is recommended to confirm or deny the existence of the suspected contamination and to quantify the extent of any problems which may exist. The six sites recommended for confirmation are listed below in order of priority.

1) Site 5, Heavy Equipment Training Area Landfill
2) Site 6, Fire Fighting Training Area
3) Site 4, Golf Course Landfill
4) Site 3, Northwest Landfill/Burning Pit
5) Site 1, Disaster Recovery Disposal Area
6) Site 2, World War II Landfill

Confirmation studies at these sites will determine whether a threat to human health or the environment exists, the extent of contamination, and the potential for contaminant migration.

ACKNOWLEDGEMENTS

The Initial Assessment Study team expresses its thanks for the support, assistance and cooperation provided by personnel at Southern Division, Naval Facilities Engineering Command (SOUTHNAVFACENGCOM); Naval Energy and Environmental Support Activity (NEESA); and Naval Construction Battalion Center (NCBC), Gulfport, Mississippi. Without their support, the Initial Assessment Study at the NCBC Gulfport could not have been successfully completed. In particular, the team acknowledges the effort provided by the following people:

Jim Cluff, Environmental Coordinator, NCBC Gulfport

Sonny Chestnut, Southern Division, Naval Facilities Engineering Command

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CHAPTER 1. INTRODUCTION

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

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

1.1.2 Navy Program. The Navy manages its part of the program, the Navy Assessment and Control of Installation Pollutants (NACIP) Program, in three phases. Phase one, the Initial Assessment Study (IAS), identifies disposal sites and contaminated areas caused by past hazardous substance storage, handling or disposal practices at naval activities. These sites are then individually evaluated with respect to their potential threat to human health or to the environment. Phase two, the Confirmation Study, verifies or characterizes the extent of contamination present and provides additional information regarding migration pathways. Phase three, Remedial Action, provides the required corrective measure to mitigate or eliminate confirmed problems.

1.2 AUTHORITY. The Chief of Naval Operations (CNO) initiated the NACIP program in OPNAVNOTE 6240 of 11 September 1980, superseded by OPNAVINST 5090.1 of 26 May 1983. Naval Facilities Engineering Command (NAVFACENGCOM), manages the program within the existing structure of the Naval Environmental Protection Support Service (NEPSS), which is administered by the Naval Energy and Environmental Support Activity (NEESA). NEESA conducts the program's first phase, the IAS, in coordination with NAVFACENGCOM Engineering Field Divisions (EFDs). Activities are selected for an IAS by CNO, based on recommendations by NAVFACENGCOM, the EFDs and NEESA. Approval of the Naval Construction Battalion Center (NCBC) Gulfport, Mississippi for an IAS is contained in CNO letter ser 451/3U392444 of July 1983.

1.3 SCOPE.

1.3.1 Past Operations. The NACIP program focuses attention on past hazardous substance storage, use and disposal practices on Navy property. Current practices are regularly surveyed for conformity to state and federal regulations and, therefore, are not included in the scope of the NACIP program. The IAS addresses operational non-hazardous disposal and storage areas only if they were hazardous waste disposal or storage areas in the past. Current operations are investigated solely to determine what types and quantities of chemicals or other materials were used and what disposal methods were practiced.

1.3.2 Results. If necessary, an IAS recommends mitigating actions to be performed by the activity or EFD, or recommends Confirmation Studies to be administered by the EFD under the NACIP program. Based on these recommendations, NAVFACENGCOM schedules Confirmation Studies for those sites which have been determined by scientific and engineering judgment to be potential hazards to human health or to the environment.

1.4 INITIAL ASSESSMENT STUDY.

1.4.1 Records Search. The IAS begins with an investigation of activity records followed by a records search at various government agencies including EFDs, national and regional archives and records centers, and U.S. Geological Survey offices. In this integral step, study team members review records to assimilate information about the activity's past missions, industrial processes, waste disposal records, and known environmental contamination. Examples of records include activity master plans and histories, environmental impact statements, cadastral records, and aerial photographs. Appendix A lists agencies contracted during this study.

1.4.2 On-Site Survey. After the records search, the study team conducts an on-site survey to complete documentation of past operations and disposal practices and to identify potentially-contaminated areas. With the assistance of an activity point-of-contact, the team inspects the activity during ground and aerial tours, and interviews long-term employees and retirees. The on-site survey for NCBC Gulfport was conducted from 5-9 October 1984; information in this report is current as of those dates.

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

1.4.3 Confirmation Study Ranking System. With information collected during the study, team members evaluate each site for its potential hazard to human health or to the environment. A two-step Confirmation Study Ranking System (CSRS) developed at NEESA is used to systematically evaluate the relative severity of potential problems. The two steps of the CSRS are a flow- chart and a numerical ranking model. The first step is a flowchart based on type of waste, containment, and hydrogeology. This step eliminates innocuous sites from further consideration. If the flowchart indicates a site poses a potential threat to human health or to the environment, the second step, the model, is applied. This model assigns a numerical score from 0 to 100 to each site. The score reflects the characteristics of the waste, the potential migration pathways from the site, and possible contaminant receptors on and off the activity.

1.4.4 Site Ranking. After scoring a site, engineering judgment is applied to determine the need for a Confirmation Study or for immediate mitigating action. At sites recommended for further work, CSRS scores are used to rank the sites in a prioritized list for scheduling projects. For a more detailed description, refer to NEESA 20.2-042, Confirmation Study Ranking System.

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

1.5 CONFIRMATION STUDY. Generally, the EFD conducts the Confirmation Study in two phases - verification and characterization. In the verification phase, short-term analytical testing and monitoring determines whether specific toxic and hazardous materials, identified in the IAS, are present in concentrations considered to be hazardous. Normally, the IAS recommends verification phase sampling and monitoring. The design of the characterization phase usually depends on results form the verification phase. If required, a characterization phase, using longer-term testing and monitoring, provides more detailed information concerning the horizontal and veritical distribution of contamination migrating from sites, as well as site hydrogeology. If sites reauire remedial actions or additional monitoring programs, the Confirmation Study recommendations include the necessary planning information for the work, such as design parameters.

1.6 IAS REPORT CONTENTS. In this report, the significant findings and conclusions from the IAS are presented in Chapter 2. Recommendations are presented in Chapter 3. Chapter 4 describes general activity information, history, biology and physical features. Chapters 5 through 8 trace the use of chemicals and hazardous materials from storage and transfer, through manufacturing and operations, to waste processing and disposal. The latter chapters provide detailed documentation to support the findings, conclusions and recommendations in Chapters 2 and 3. A general location map for NCBC Gulfport is shown in Figure 1-1.

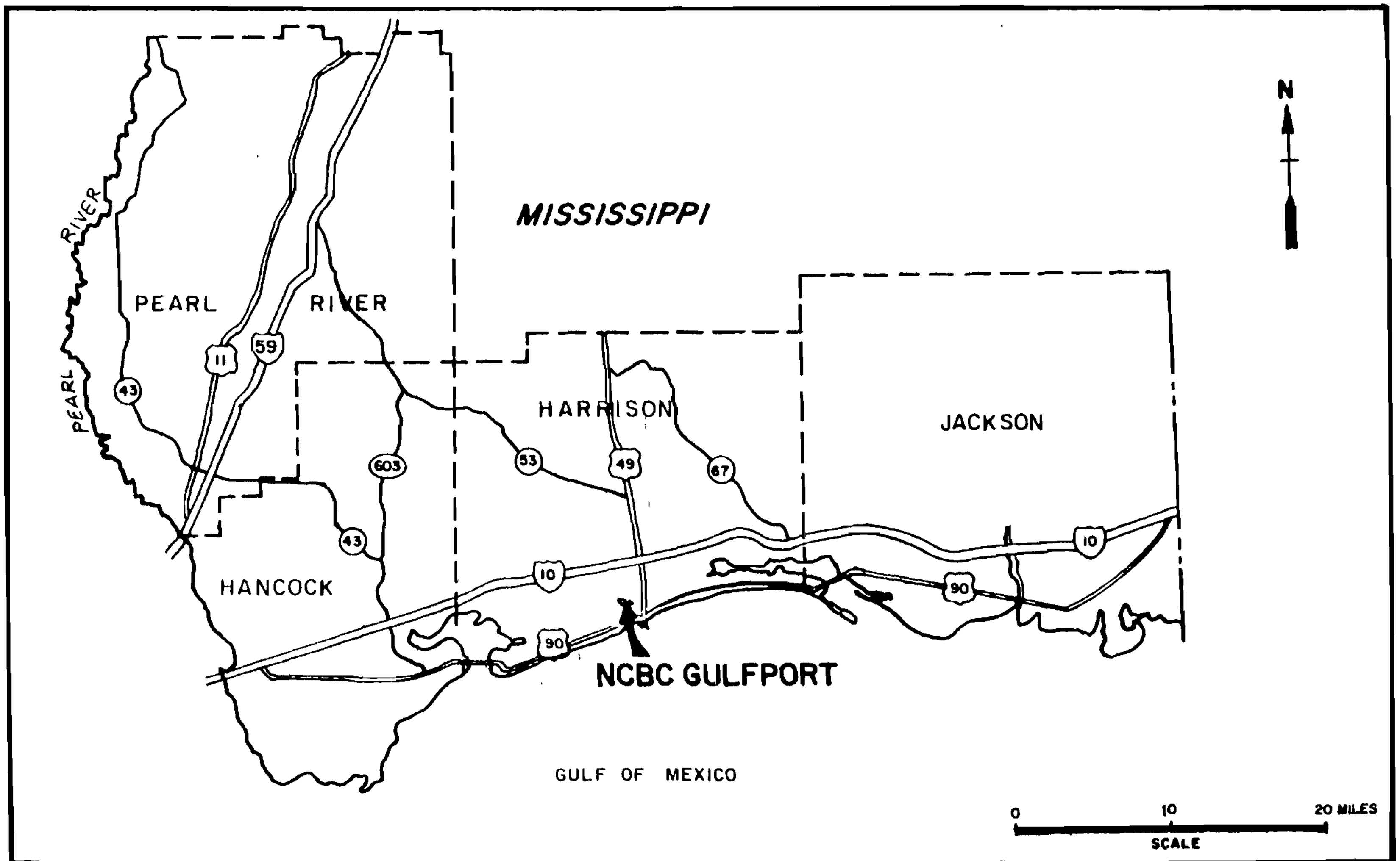


FIGURE 1-1

Location Map

INITIAL ASSESSMENT STUDY
NAVAL CONSTRUCTION
BATTALION CENTER
GULFPORT

CHAPTER 2. SIGNIFICANT FINDINGS AND CONCLUSIONS

2.1 INTRODUCTION. This chapter summarizes significant findings and conclusions developed as a result of the Initial Assessment Study (IAS) for Naval Construction Battalion Center (NCBC) Gulfport, Mississippi. Information presented in this chapter is based on a review of available data, the results of the on-site survey, and interviews with current and long-term personnel. In the first part of this chapter, the potential for contaminant migration and receptors for NCBC Gulfport are summarized. The remainder of the chapter summarizes disposal operations at each of the nine identified disposal sites and presents conclusions as to whether the sites pose a potential threat to human health or the environment and warrant confirmation studies.

2.2 POTENTIAL FOR CONTAMINANT MIGRATION. A contaminant migration pathway at NCBC Gulfport is ground water movement through the unconfined surficial aquifer. The surficial aquifer occurs at or near the surface and is composed of unconsolidated deposits of sand and clayey sands that overlie confining clayey units. Thickness of the surficial aquifer varies, depending on the presence of clayey confining units. Based on the logs of existing wells at NCBC Gulfport, the surficial aquifer ranges from 15 to 45 feet thick and is underlain by a layer of clay ranging from 28 to 197 feet thick. The surficial aquifer is recharged primarily from local rainfall.

Contaminants may easily enter the surficial aquifer due to its close proximity to the land surface and the rapid permeability of the soils common throughout the area. Contaminant movement through the surficial aquifer would be primarily lateral because vertical movement is impeded by underlying clayey sediments. The general direction of ground water movement is from topographic highs to areas of natural discharge such as ditches and canals. The direction of regional ground water movement is to the south toward the Mississippi Sound. Ground water velocity in the surficial aquifer, as estimated from the Darcy equation, is on the order of 60 to 260 feet per year. Thus, contaminants entering the surficial ground water may readily enter nearby discharge areas such as ditches and canals.

The surficial aquifer is not used as a water source in the area of NCBC Gulfport. Therefore, no direct impacts to water supplies are anticipated. There are no wells tapping the surficial aquifer at NCBC Gulfport.

Although ground water movement in the surficial aquifer is primarily lateral, due to underlying clayey sediments, there is some potential for vertical contaminant migration to underlying artesian aquifers. The uppermost artesian aquifer is at a depth of approximatly 100 feet. The potential for contaminant migration from the surficial aquifer to underlying aquifers would depend on the continuity and thickness of the confining clay lenses in the area.

General studies of the underlying Miocene aquifer system suggest these Miocene aquifers may be hydraulically connected. Thus, if contaminants migrate from the surficial aquifer to the first underlying Miocene aquifer, there is a potential for further downward migration into other underlying aquifers. Potable water is obtained from these Miocene aquifers beginning at a depth of approximately 700 feet. There are five on-base water supply wells ranging in depth from 722 to 1,196 feet. Wells to the south of NCBC Gulfport, which is the direction of ground water movement in the Miocene aquifer system, could also potentially be impacted through vertical contaminant migration. The velocity in the Miocene aquifers, as estimated from the Darcy equation, is on the order of 9 to 56 feet per year.

Contaminant migration by surface waters is also a potential pathway at NCBC Gulfport. Numerous ditches and a canal occur at the installation. Contaminants could enter these surface waters by direct surface runoff or through ground water discharge of the surficial aquifer. Contaminants entering surface waters could migrate off-base to Turkey Creek.

2.3 POTENTIAL CONTAMINANT RECEPTORS. Because the surficial aquifer at NCBC Gulfport is not used, no direct impact to water sources is anticipated. Contaminants entering the surficial aquifer could migrate to the south and potentially discharge to the Mississippi Sound which is located less than two miles from the installation. The Mississippi Sound is classified as recreational. There is some potential for contamination of the underlying Miocene aquifer system which could impact potable water supplies on-base and off-base to the south.

Contaminants migrating to receiving waters, such as ditches and Canal 1, would primarily impact aquatic wildlife inhabiting the waters and predators, such as wading birds, that depend on these areas for feeding. Contaminants entering surface waters could also migrate off-base to Turkey Creek through Canal 1 and adversely impact aquatic wildlife.

The catfish ponds, which are located in close proximity to two of the landfills (Sites 1 and 2), could also serve as a discharge area for contaminated surficial ground water. These three ponds are stocked with channel catfish and are fished by base personnel.

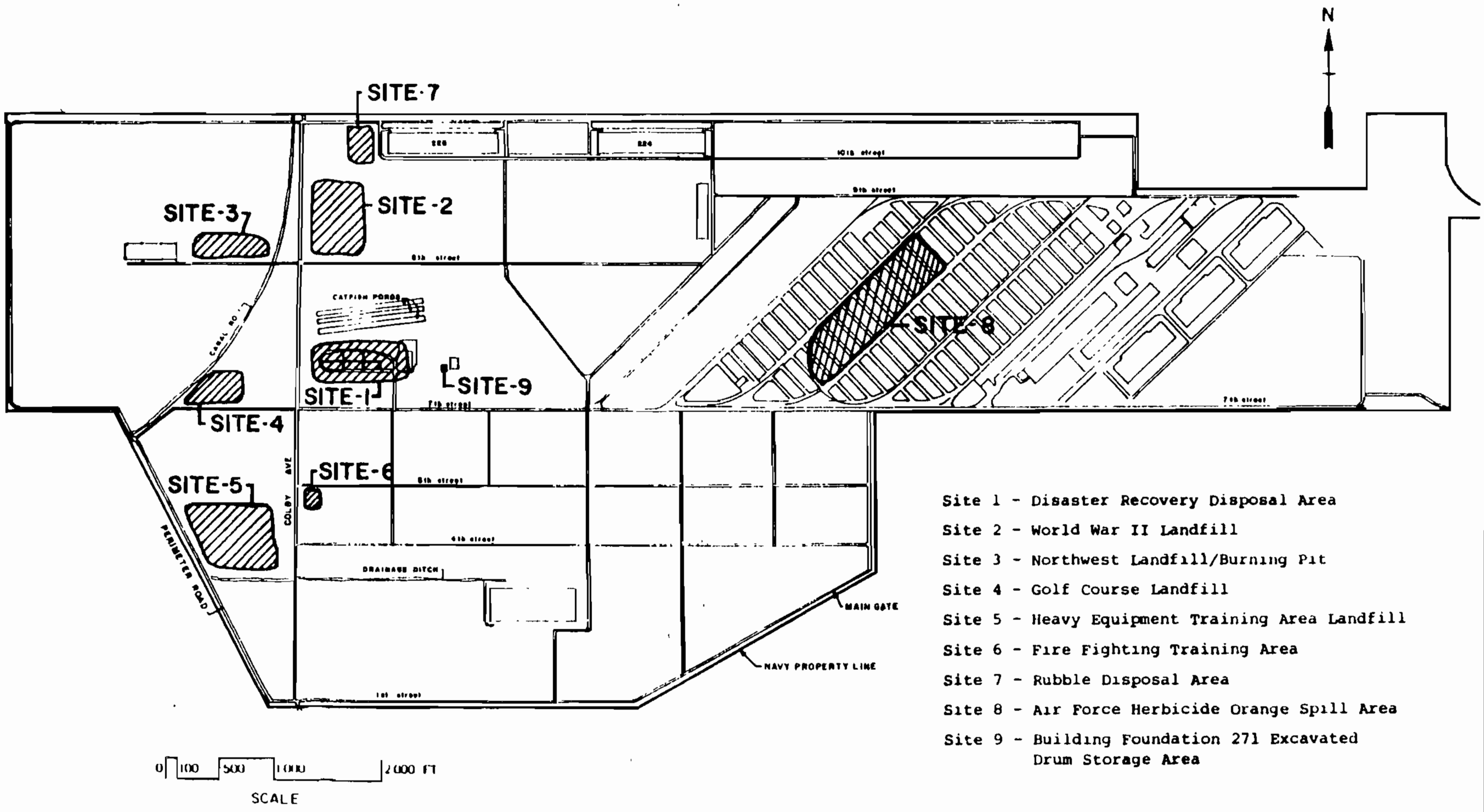
2.4 SITES RECOMMENDED FOR CONFIRMATION STUDY. Of the nine disposal and spill sites identified at NCBC Gulfport, six are recommended for confirmation studies. Figure 2-1 shows the location of these sites. Table 2-1 summarizes the findings of the disposal and spill sites. Detailed descriptions of each of these sites can be found in Chapter 8.

2.4.1 Site 1, Disaster Recovery Disposal Area. Site 1 is a nine acre landfill, located between 7th Street and the catfish ponds, at the site of the current mock disaster recovery training village. The landfill was operated from 1942 to 1948, during which time it was the primary disposal area for chemical wastes generated at the installation. The disposal operation consisted of burying the waste, much of which was reportedly in 55-gallon drums, in trenches.

Wastes reportedly disposed at the site include paints, oils, solvents, paint strippers and cleaning compounds. Waste paints disposed at the site are suspected to contain cadmium, chromium and lead.

In the early part of 1984, four or five drums were uncovered during repair operations on a water line in the southwestern portion of the site. Analytical results from a sample of the drum contents indicated xylene, toluene and 1,2 dichloroethane.

The primary pathway for contaminant migration at the site is ground water movement through the surficial aquifer. Portions of the waste are in direct contact with the surficial ground water. Thus, there is a high potential for



Site 1 - Disaster Recovery Disposal Area
Site 2 - World War II Landfill
Site 3 - Northwest Landfill/Burning Pit
Site 4 - Golf Course Landfill
Site 5 - Heavy Equipment Training Area Landfill
Site 6 - Fire Fighting Training Area
Site 7 - Rubble Disposal Area
Site 8 - Air Force Herbicide Orange Spill Area
Site 9 - Building Foundation 271 Excavated Drum Storage Area

Figure 2-1

WASTE DISPOSAL SITES

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Table 2-1

Past Disposal Sites at NCBC Gulfport

Site No.	Site Name	Map Location	Period of Operation	Waste Types	Estimated Total Quantities	Sources*
Sites Recommended for Confirmation Studies:						
1	Disaster Recovery Disposal Area	F-9	1942-1948	Paints, oils, solvents, paint strippers and cleaning compounds	unknown	Public work shops, supply
2	World War II Landfill	B/C-8	1942-1948	General refuse, paints, oils, solvents, paint strippers, and cleaning compounds	unknown	Dumpsters throughout NCBC
3	Northwest Landfill/ Burning Pit	D-8	1948-1966	Solid waste, oils, fuels, paints, paint strippers, solvents, and cleaning compounds	30,000 tons of solid waste, unknown quantities of other liquid wastes; 130,000 gallons of flammable liquids burned in pit	All NCBC industrial operations
4	Golf Course Landfill	G-6	1966-1972	Solid waste, oils, fuels, paints, paint strippers, solvents, and cleaning compounds	16,000 tons of solid waste; unknown quantities of other liquid wastes	All NCBC industrial operations
5	Heavy Equipment Training Area Landfill	K-6/7	1972-1976	Refuse and tree clippings, DDT, paints, oils, solvents, paint strippers and cleaning compounds	6,000 cubic yards of solid waste; 50 to 100 drums of DDT	All NCBC industrial operations
6	Fire Fighting Training Area	K/J-8	1966-1975	Waste fuels, oils, solvents, paint and paint strippers	500,000 gallons	CED, 20th NCR, NCTC, Public works shops
Sites Not Recommended for Confirmation Studies:						
7	Rubble Disposal Area	A/B-9	1978-1984	Concrete, lumber, scrap metal and similar inert materials	unknown	Construction and building demolition debris
8	Air Force Herbicide Orange Spill Area	E-21	1968-1977	Herbicide Orange	Spillage from storage of 15,400 55-gallon drums at site	Air Force
9	Building Foundation 271 Excavated Drum Storage Area	F-11	1984	Toluene, xylene and 1,2-dichloroethane	Four or five 55-gallon drums	Excavated from Site 1

[illegible]ED - Construction Equipment Department; NCR - Naval Construction [illegible]ent; NCTC - Naval Construction Training Center.

contaminant migration at the site. Ground water movement of the surficial aquifer is primarily to the south. However, there may be a localized ground water gradient toward the catfish ponds immediately north of the site. The catfish ponds are fished by base personnel. Contaminants migrating south through the surficial aquifer could ultimately discharge into the Mississippi Sound, approximately two miles away, which is used recreationally.

Based on the types of wastes disposed at Site 1, the high potential for contaminant migration, and the presence of receptors, a confirmation study is recommended.

2.4.2 Site 2, World War II Landfill. Site 2 is an 11 acre landfill located between 8th and 11th Streets. Site 2 was operated from 1942 to 1948, during which time it was the primary disposal area for general refuse generated at the installation. The disposal operation consisted of burning combustible materials in a structure formerly located at the northern end of the site. The ash, along with the non-combustible material, was then pushed to the southern end of the site and buried in trenches.

The majority of the waste disposed at the site was general refuse and inert material such as paper, cardboard, wood and garbage. Liquid wastes such as paints, paint thinners, solvents, oils and fuels were reportedly disposed at the site. Because much of the waste was burned at the site, flammable liquids and materials disposed at the site were probably incinerated. Products of incomplete combustion might exist at the site. Paints disposed at the site are suspected to contain cadmium, chromium and lead.

The primary pathway for contaminant migration at the site is ground water movement through the surficial aquifer. Portions of the waste are in direct contact with the surficial ground water. Thus, there is a high potential for contaminant migration at the site. Ground water movement of the surficial aquifer is primarily in a southerly direction at the site. The catfish ponds to the south of the site are potential ground water discharge areas. The catfish ponds are fished by base personnel. Contaminants migrating further south through the surficial aquifer could ultimately discharge into the Mississippi Sound, approximately 2.2 miles away, which is used recreationally.

Based on the types of wastes disposed at Site 2, the potential for contaminant migration and the presence of receptors, a confirmation study is recommended.

2.4.3 Site 3, Northwest Landfill/Burning Pit. Site 3 encompasses approximately 3.5 acres and is located at the northwest corner of the intersection of 8th Street and Canal 1. The site was operated as a landfill from 1948 to the mid-1960s. There was also a fire fighting training burning pit at the site which was used from the mid-1950s until 1966. During the time period the landfill was operational, virtually all the solid waste and some of the liquid and chemical waste generated at the installation was disposed at the site. The landfill was a trench and fill operation with daily burning of wastes. Waste fuel, oil, solvents, paint and paint thinners from throughout the installation were also transported to the burning pit in bowsers or 55-gallon drums. During a practice burn, the waste liquids were drained into the unlined pit and ignited. The fires were extinguished with a biodegradable and non-toxic protein foaming agent and water.

An estimated 130,000 gallons of waste fuels, oils, solvents [methyl ethyl ketone (MEK), toluene and xylene], paints and paint thinners were burned at the site during fire fighting training exercises. In addition, an estimated 30,000 tons of solid waste, including additional liquid wastes, were disposed at the landfill.

Most of the wastes disposed at the landfill were burned. In addition, most of the flammable liquids burned during fire fighting training exercises were consumed by fire. However, some residual flammable liquids remained following practice burns and products of incomplete combustion may exist at the landfill. Waste paints disposed at the site could contain cadmium, chromium and lead. The fuels disposed at the site could also contain lead.

The primary pathway for contaminant migration at the site is ground water movement through the surficial aquifer. Portions of the wastes are in direct contact with the surficial ground water. Thus, there is a potential for contaminant migration at the site. The regional surficial ground water gradient is toward the south to the Mississippi Sound, which is located about 2.2 miles south of the site. However, there may be a localized ground water gradient toward the Canal and ditch which border the site. There were also signs of surface erosion at the site. Surface drainage from the site is into the ditch and Canal 1. Aquatic wildlife inhabiting the ditch and Canal 1 could be adversely impacted. Contaminants migrating to the south could discharge into the Mississippi Sound which is used recreationally. Contaminants entering Canal 1 could also migrate off-base to Turkey Creek.

Based on the types of wastes disposed at Site 3, the potential for contaminant migration and the presence of receptors, a confirmation study is recommended.

2.4.4 Site 4, Golf Course Landfill. Site 4 is a four acre landfill located at the Golf Course, and is immediately northeast of the intersections of 7th Street and Canal 1. The landfill was operated from 1966 to 1972, during which time it was the only operating landfill at the installation. The landfill was a trench and fill operation with daily burning of wastes. Virtually all the solid waste and some liquid and chemical wastes generated at the installation were disposed at the site.

A worst-case estimate indicated as much as 200,000 gallons of waste liquids were disposed at the site. Waste liquids disposed at the site reportedly included fuels, oils, solvents (MEK, toluene, xylene), paints and paint thinners. In addition, an estimated 16,000 tons of solid waste was disposed at the landfill. Because much of the waste was burned at the site, flammable liquids and materials disposed at the site were probably incinerated. Products of incomplete combustion may exist at the site. In the latter operational years of the site, drummed liquid wastes were reportedly buried intact in trenches. Also disposed at the site is building demolition debris resulting from Hurricane Camille. Waste paints disposed at the site could contain cadmium, chromium and lead.

The primary pathway for contaminant migration at the site is ground water movement through the surficial aquifer. Portions of the waste are in direct contact with the surficial ground water. Thus, there is a potential for contaminant migration at the site. The regional surficial ground water gradient is to the south, toward the Mississippi Sound about two miles from the site.

However, there may be a localized ground water gradient toward Canal 1, which borders the site on the west. Aquatic wildlife inhabiting the canal would be adversely impacted and contaminants could also migrate off-base through the canal to Turkey Creek. Contaminants migrating to the south could discharge into the Mississippi Sound which is used recreationally.

Based on the types of wastes disposed at Site 4, the potential for contaminant migration and the presence of receptors, a confirmation study is recommended.

2.4.5 Site 5, Heavy Equipment Training Area Landfill. Site 5 is an 8.5 acre landfill located approximately 200 feet west of the intersection of 4th Street and Colby Avenue, in an area currently used for heavy equipment training. The landfill was operated from 1972 until 1976. During this time, this site was the only operating landfill at the installation. However, the majority of solid waste generated at the installation was being disposed off-base by a private contractor. The landfill was a trench and fill operation with no burning.

Fifty to 100 55-gallon drums of liquid dichlorodiphenyltrichloroethane (DDT) were reportedly buried in the southern portion of the site along with at least 12 pounds of powdered DDT. Liquid wastes from the shops were also reportedly disposed at the site. These liquid wastes included fuels, oils, solvents, (MEK, toluene, xylene), paints and paint thinners. In addition, an estimated 6,000 cubic yards of solid waste was disposed at the landfill.

The primary pathway for contaminant migration at the site is ground water movement through the surficial aquifer. Portions of the waste are in direct contact with the surficial ground water. Thus, there is a potential for contaminant migration at the site. The regional surficial ground water gradient is toward the south to the Mississippi Sound, which is about 1.7 miles south of the site. However, there may be localized ground water discharge to the perimeter ditch which borders the site on the south and west. There was also evidence of surface erosion along the southern boundary of the site. Contaminants migrating by surface erosion would also end up in the perimeter ditch which empties into Canal 1. Contaminants could adversely impact aquatic wildlife in the ditches and canal, and could migrate off-base through the canal to Turkey Creek. Contaminants migrating to the south could discharge into the Mississippi Sound which is used recreationally.

Based on the types of waste disposed at Site 5, the potential for contaminant migration and the presence of receptors, a confirmation study is recommended.

2.4.6 Site 6, Fire Fighting Training Area. Site 6 is located east of Colby Avenue, midway between 4th and 5th Streets. The site consisted of two unlined burning pits in a grassed area. One of the pits was approximately 50 feet by 35 feet and 4 to 5 feet deep, while the other pit was approximately 40 feet by 25 feet and 6 feet deep. The burning pits were used from 1966 to 1975 for fire fighting training. Waste liquids from the shops were taken to the site in bowsers or 55-gallon drums. In addition, waste fuels from Keesler Air Force Base, the Air National Guard and Pascagoula Shipyard were used at the site. The waste liquids were drained into the burning pits and ignited. The fires were extinguished with a biodegradable and non-toxic protein foaming agent.

An estimated 500,000 gallons of waste liquids were burned at the site. Waste liquids disposed at the site included fuels, oils, solvents (xylene, Stoddard, toluene, MEK), paints and paint thinners. Waste paints disposed at the site are suspected to contain cadmium, chromium and lead. Waste fuels disposed at the site could contain lead.

Most of the waste liquids burned during drills were consumed by fire. However, some residual flammable liquids remained following burns. There were reports that following heavy rains, waste liquids sometimes overflowed the pits and entered a drainage ditch to the immediate west. This ditch drains north into Canal 1, which drains off-base to Turkey Creek.

The pits have been covered with soil and the primary pathway for contaminant migration at the site is ground water movement through the surficial aquifer. The regional surficial ground water gradient is toward the south to the Mississippi Sound, which is located about 1.7 miles south of the site. However, there may be a localized ground water gradient toward the ditch to the immediate west of the site. Aquatic wildlife inhabiting the drainages could be adversely impacted. In addition, contaminants entering the drainage ditch could migrate off-base. Contaminants migrating to the south could discharge into the Mississippi Sound which is used recreationally.

Based on the types of waste disposed at Site 6, the potential for contaminant migration and the presence of receptors, a confirmation study is recommended.

2.5 SITES NOT RECOMMENDED FOR CONFIRMATION STUDY. Three of the nine potentially contaminated sites are not recommended for confirmation studies. Significant findings for these sites are summarized in Table 2-1 and the site locations are shown in Figure 2-1. Detailed descriptions of each of these sites can be found in Chapter 8.

2.5.1 Site 7, Rubble Disposal Area. Site 7 is a three acre rubble disposal area located south of 11th Street and approximately 200 feet west of Building 225. Site 7 was operated from 1978 to 1984. Wastes disposed at the site include concrete, lumber, scrap metal, and similar inert materials. In the southeastern portion of the site, tree clippings, sawdust, lumber and concrete are aboveground. The remainder of the rubble is buried just below the surface. The source of much of the waste disposed at the site was construction and building demolition debris. There were no reports or evidence of hazardous wastes being disposed at the site.

Because the materials disposed at the site are inert wastes, the site is not a source of potential surface or ground water contamination. No confirmation study is recommended.

2.5.2 Site 8, Air Force Herbicide Orange Spill Area. Site 8 is located at open storage areas 56 through 67, between Goodier and Greenwood Avenues. Site 8 covers approximately 13 acres and was used from 1968 to 1977 to store approximately 15,400 drums of Herbicide Orange. Substantial leakage of Herbicide Orange did occur at the site prior to its removal and at-sea incineration in 1977. An extensive environmental monitoring program conducted by the Air Force has indicated the site and surrounding area is contaminated with 2,3,7,8-tetrachlorodibenzo-p-dioxin (dioxin), the primary contaminant of concern at the site. Soil samples from the site indicate dioxin at concentrations of 100 to 500 parts per billion (ppb), while sediment samples from the drainageways receiving runoff from the site contained low (0 to 5 ppb) concentrations of dioxin. Tissue samples from organisms in the drainageways also contained low (0 to 10 ppb) concentrations of dioxin.

The U. S. Air Force has already documented that there is contamination at the site and is committed to undertaking remedial action at the site. Therefore, this site is not recommended for a confirmation study.

2.5.3 Site 9, Building Foundation 271 Excavated Drum Storage Area. Site 9 is located on the concrete foundation of Building 271, immediately west of Building 281. Four or five 55-gallon drums were uncovered in the early part of 1984 during repair operations on a water line in the southwestern portion of Site 1. These drums were transferred to the concrete foundation for interim storage until analysis could be performed on the contents. A subsequent analysis indicated the waste was in fact hazardous. The most significant results were that the waste contained toluene, xylene and 1,2-dichloroethane, as well as low levels of arsenic and lead.

Because the material has already been shown to contain hazardous waste, a confirmation study is not necessary.

CHAPTER 3. RECOMMENDATIONS

3.1 INTRODUCTION. This chapter presents the recommended actions for the potentially contaminated sites at Naval Construction Battalion Center (NCBC) Gulfport, Mississippi. Based on the significant findings and conclusions developed in Chapter 2, six sites are recommended for confirmation studies under phase two of the Naval Assessment and Control of Installation Pollutants (NACIP) program. The two-step Confirmation Study Ranking System (CSRS), developed by Naval Energy and Environmental Support Activity (NEESA), was used to systematically evaluate the relative severity of potential problems. The results of the CSRS and a summary of actions for the sites recommended for confirmation studies are listed in Table 3-1. The confirmation study recommendations are designed to first verify the presence of contamination. The verification phase is for one year. However, if contamination is detected at a site after the first quarterly sampling effort, further characterization to determine the extent of contamination can proceed immediately.

3.2 CONFIRMATION STUDY RECOMMENDATIONS. This section contains the detailed recommendations for the six sites recommended for confirmation studies.

3.2.1 Site 1, Disaster Recovery Disposal Area. It is recommended that four surficial monitoring wells be installed at Site 1. Two monitoring wells to the south of the site are positioned to detect contaminant migration towards the Mississippi Sound, while the two monitoring wells to the north of the site are positioned to detect migration toward the three catfish ponds. The proposed monitoring well locations are shown in Figure 3-1.

Type of Samples:	Ground Water
Ground Water Monitoring Wells:	Four
Sampling Frequency:	Quarterly for one year
Number of Samples:	16
Testing Parameters:	Scan gas chromatograph (GC)/flame ionization detector (FID) with capillary column for methyl ethyl ketone (MEK), toluene, xylene trichloroethylene; chemical oxygen demand (COD); total organic carbon (TOC); total organic halogens (TOX); cadmium, chromium, lead; oil and grease; specific conductance; pH

Remarks: The monitoring wells should be completed a minimum of 15 feet into the surficial aquifer, if possible, and screened from two feet above the water level to the bottom of the wells. Well locations and elevations should be surveyed, and water levels taken prior to sampling.

3.2.2 Site 2, World War II Landfill. It is recommended that two surficial monitoring wells be installed downgradient (south) of Site 2 to detect contaminant migration towards the Mississippi Sound. In addition, two sediment samples from the catfish ponds are recommended, as well as one surface water sample from the ponds. The ponds are downgradient of the site and may

Table 3-1

Summary of Confirmation Study Recommendations
Study Number 064

Site No.	Site Identification	CSRS Score	No. of Wells	No. and Type of Samples	Frequency	Testing Parameters
64-1	Disaster Recovery Disposal Area	24	4	16 Ground water	Quarterly*	See Note 1
64-2	World War II Landfill	18	2	8 Ground water	Quarterly*	See Note 1
				4 Surface water	Quarterly*	See Note 1
				2 Sediment	One time only	See Note 1, except water level
64-3	Northwest Landfill/ Burning Pit	24	3	12 Ground water	Quarterly*	See Note 2
				4 Surface water	Quarterly*	See Note 2
				1 Sediment	One time only	See Note 2, except water level
64-4	Golf Course Landfill	30	3	12 Ground Water	Quarterly*	See Note 2
				4 Surface Water	Quarterly*	See Note 2
				1 Sediment	One time only	See Note 2, except water level
64-5	Heavy Equipment Training Area Landfill	33	3	12 Ground water	Quarterly*	See Note 2
				4 Surface Water	Quarterly*	See Note 2
				2 Sediment	One time only	See Note 2, except water level
64-6	Fire Fighting Training Area	26	1	4 Ground Waters	Quarterly*	See Note 1
				4 Surface Water	Quarterly*	See Note 1
				1 Sediment	One time only	See Note 1, except water level
	Background Well	-	1	4 Ground Water	Quarterly*	See Note 2

*Quarterly for the first year. If contamination is detected at a site after the first quarter of the sampling effort, further characterization to determine the extent of contamination can proceed immediately.

Note 1: Scan gas chromatography (GC)/flame ionization detector (FID) with capillary column for methyl ethyl ketone (MEK), toluene, trichloroethylene and xylene; COD; TOC; TOX; cadmium, chromium, lead; oil and grease; specific conductance; pH; water level.

Note 2: Scan GC/FID with capillary column for MEK, toluene, [illegible]chloroethylene and xylene; Scan GC/ECD for pesticides; COD; TOC; TOX; cadmium, ch[illegible]ium, lead; [illegible] and grease; specific conductance; pH; water level.

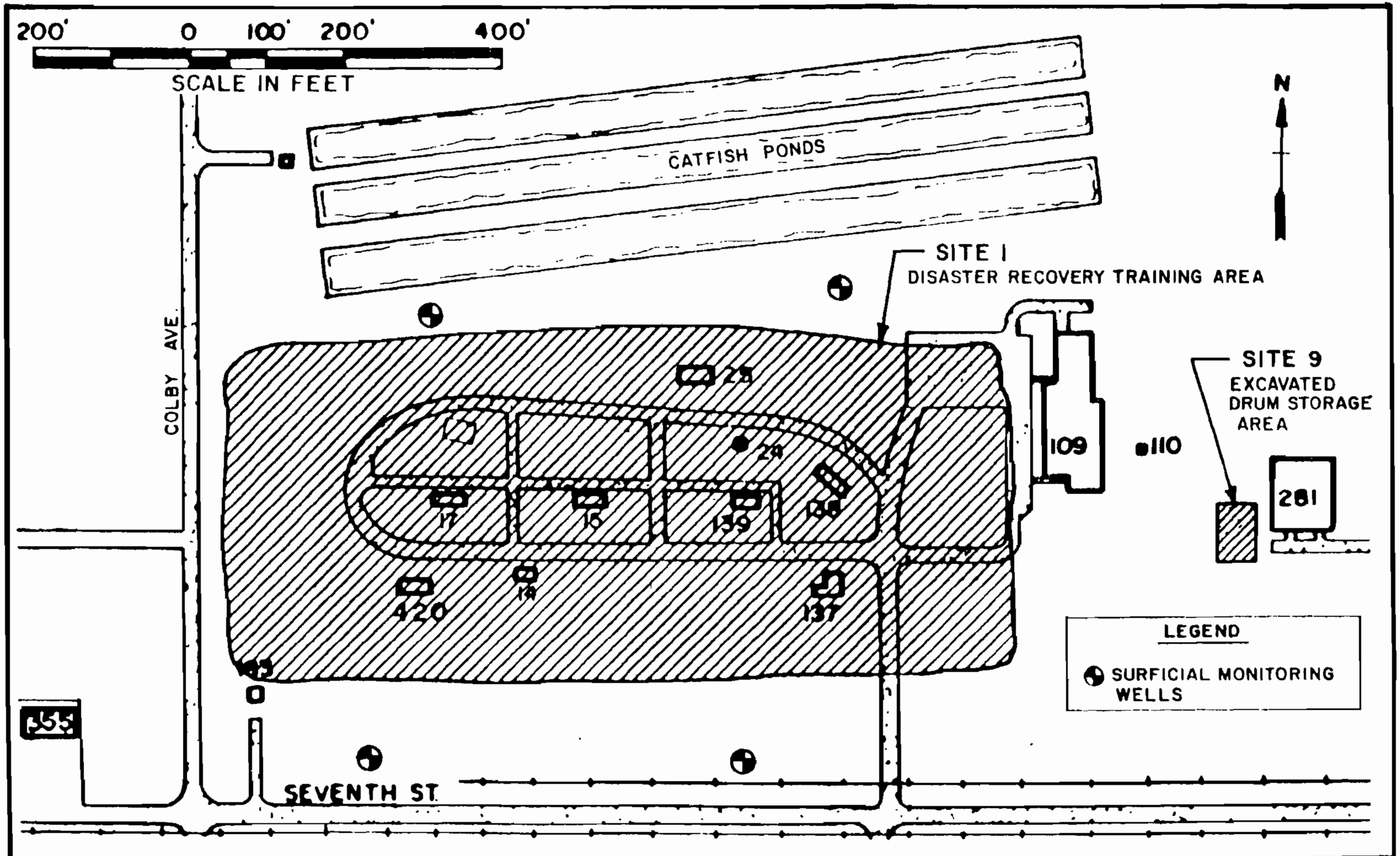

FIGURE 3-1
Site 1
Recommended Sampling Locations

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NAVAL CONSTRUCTION
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receive surficial ground water discharge. These ponds are stocked with channel catfish and are fished by base personnel. The proposed sampling locations are shown in Figure 3-2.

Type of Samples:	Ground water, sediment and surface water
Ground Water Monitoring Wells:	Two
Sampling Frequency:	Ground water: Quarterly for one year Sediment: One time only Surface water: Quarterly for one year
Number of Samples:	Ground water: Eight Sediment: Two Surface water: Four
Testing Parameters:	Ground water: Scan GC/FID with capillary column for MEK, toluene, xylene and trichloroethylene; COD; TOC; TOX; cadmium, chromium, lead; oil and grease; specific conductance; pH

Remarks: Sediment samples should be obtained from the southern-most and northern-most ponds. Eighteen inch sediment cores should be taken from the ponds and composited into two samples as indicated on Figure 3-2. A grab surface water sample should be taken from various places in the ponds and composited into one sample. The wells should be completed a minimum of 15 feet into the surficial aquifer, if possible, and screened from two feet above the water level to the bottom of the wells. Well locations and elevations should be surveyed, and water levels taken prior to sampling.

3.2.3 Site 3, Northwest Landfill/Burning Pit. It is recommended that two surficial monitoring wells be installed downgradient (south) of Site 3 to detect contaminant migration toward the Mississippi Sound. One upgradient monitoring well is also recommended. In addition, one surface water and one sediment sample from Canal 1 are recommended to determine if contaminants have migrated to the canal. The proposed sampling locations are shown in Figure 3-3.

Type of Samples:	Ground water, sediment and surface water
Ground Water Monitoring Wells:	Three
Sampling Frequency:	Ground water: Quarterly for one year Sediment: One time only Surface water: Quarterly for one year
Number of Samples:	Ground water: 12 Surface water: Four Sediment: One
Testing Parameters:	Scan GC/FID with capillary column for MEK, toluene, trichloroethylene and xylene; scan GC/Electron Capture Device (ECD) for pesticides; COD; TOC; TOX; pH; cadmium, chromium, lead; oil and grease; specific conductance

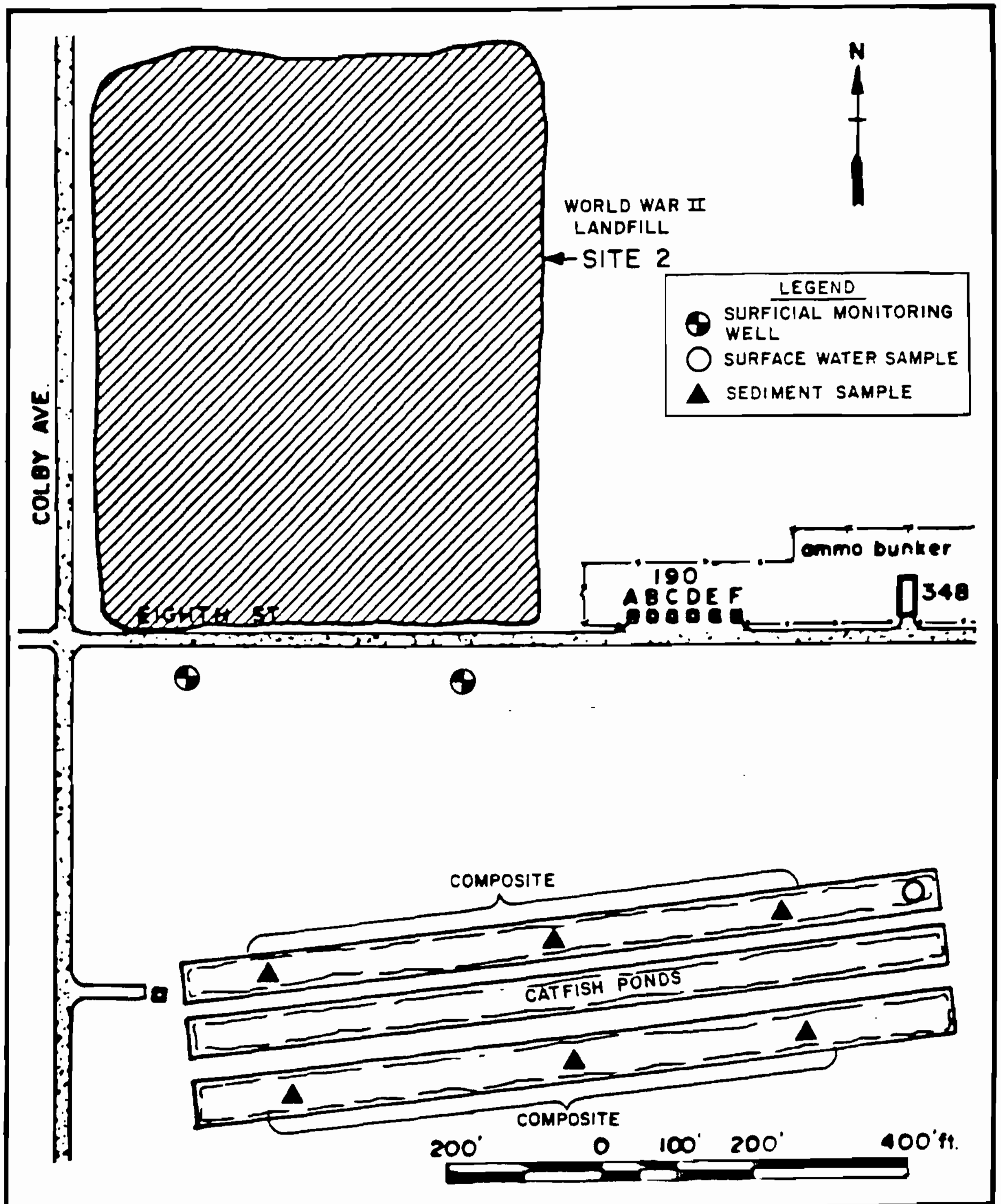

FIGURE 3-2

Site 2 Recommended Sampling Locations

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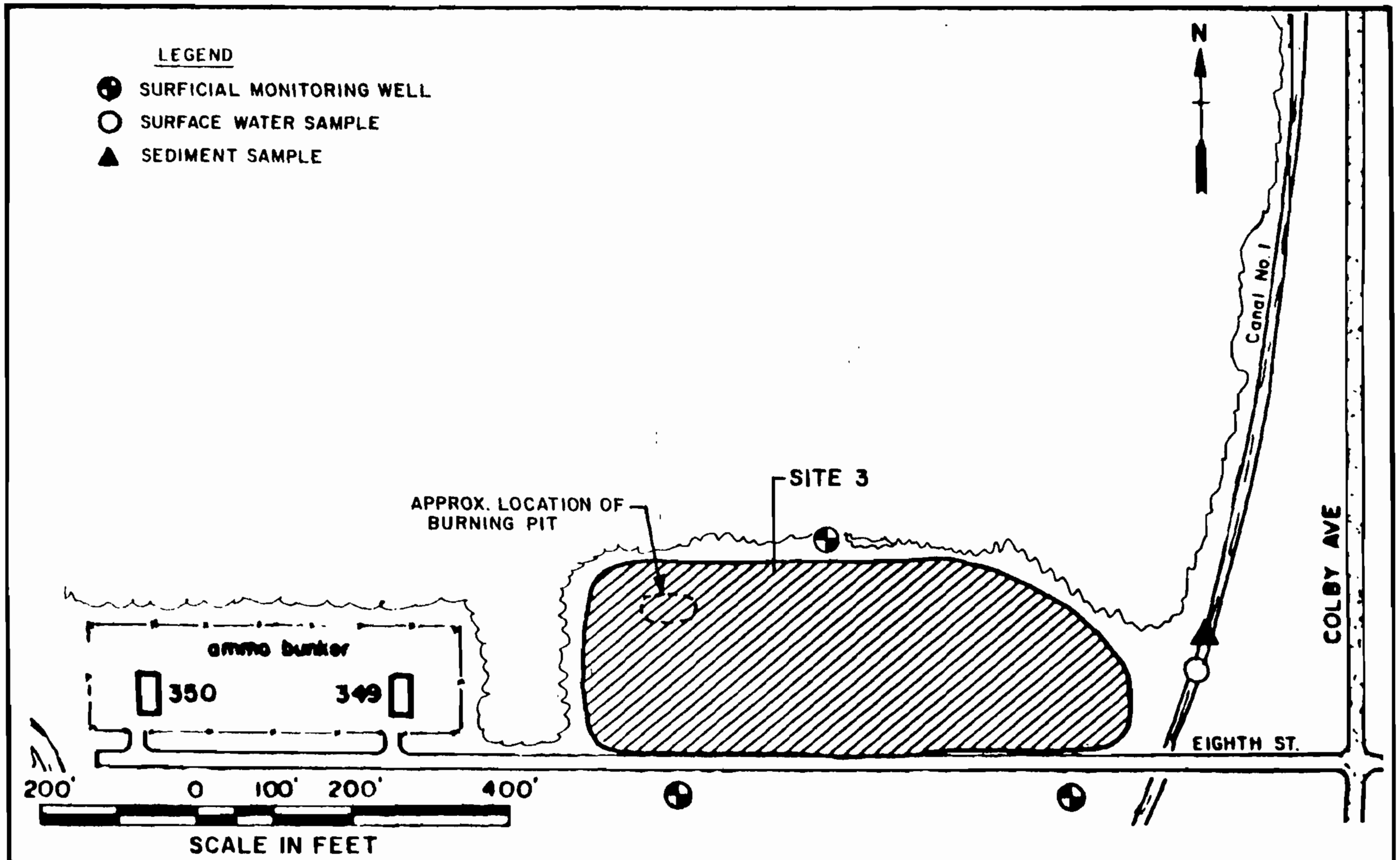

FIGURE 3-3
Site 3
Recommended Sampling Locations

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Remarks: The monitoring wells should be completed a minimum of 15 feet into the surficial aquifer, if possible, and screened from two feet above the water level to the bottom of the wells. Well locations and elevations should be surveyed and water levels taken prior to sampling. An 18 inch sediment core should be taken from Canal 1 and composited into one sample.

3.2.4 Site 4, Golf Course Landfill. It is recommended that two surficial monitoring wells be installed downgradient (south) of Site 4 to detect contaminant migration toward the Mississippi Sound. One upgradient well is also recommended. In addition, one surface water and one sediment sample from Canal 1 are recommended to determine if contaminants have migrated to the canal. The proposed sampling locations are shown in Figure 3-4.

Type of Samples:	Ground water, sediment and surface water
Ground Water Monitoring Wells:	Three
Sampling Frequency:	Ground water: Quarterly for one year Sediment: One time only Surface water: Quarterly for one year
Number of Samples:	Ground water: 12 Surface water: Four Sediment: One
Testing Parameters:	Scan GC/FID with capillary column for MEK, toluene, xylene and trichloroethylene; scan GC/ECD for pesticides; COD; TOC; TOX; pH; cadmium, chromium, lead; oil and grease; specific conductance

Remarks: The monitoring wells should be completed a minimum of 15 feet into the surficial aquifer, if possible, and screened from two feet above the water level to the bottom of the wells. Well locations and elevations should be surveyed and water levels taken prior to sampling. An 18 inch sediment core should be taken from Canal 1 and composited into one sample.

3.2.5 Site 5, Heavy Equipment Training Area Landfill. It is recommended that three surficial monitoring wells be installed at Site 5. Two of the wells are positioned to detect contaminant migration toward the Mississippi Sound and another to detect possible contaminant migration to the west. In addition, one surface water and two sediment samples from the drainage ditch are recommended to determine if contaminants have migrated to the drainageway to the south and west of the site. The proposed sampling locations are shown in Figure 3-5.

Type of Samples:	Ground water, sediment and surface water
Ground Water Monitoring Wells:	Three
Sampling Frequency:	Ground water: Quarterly for one year Surface water: Quarterly for one year Sediment: One time only

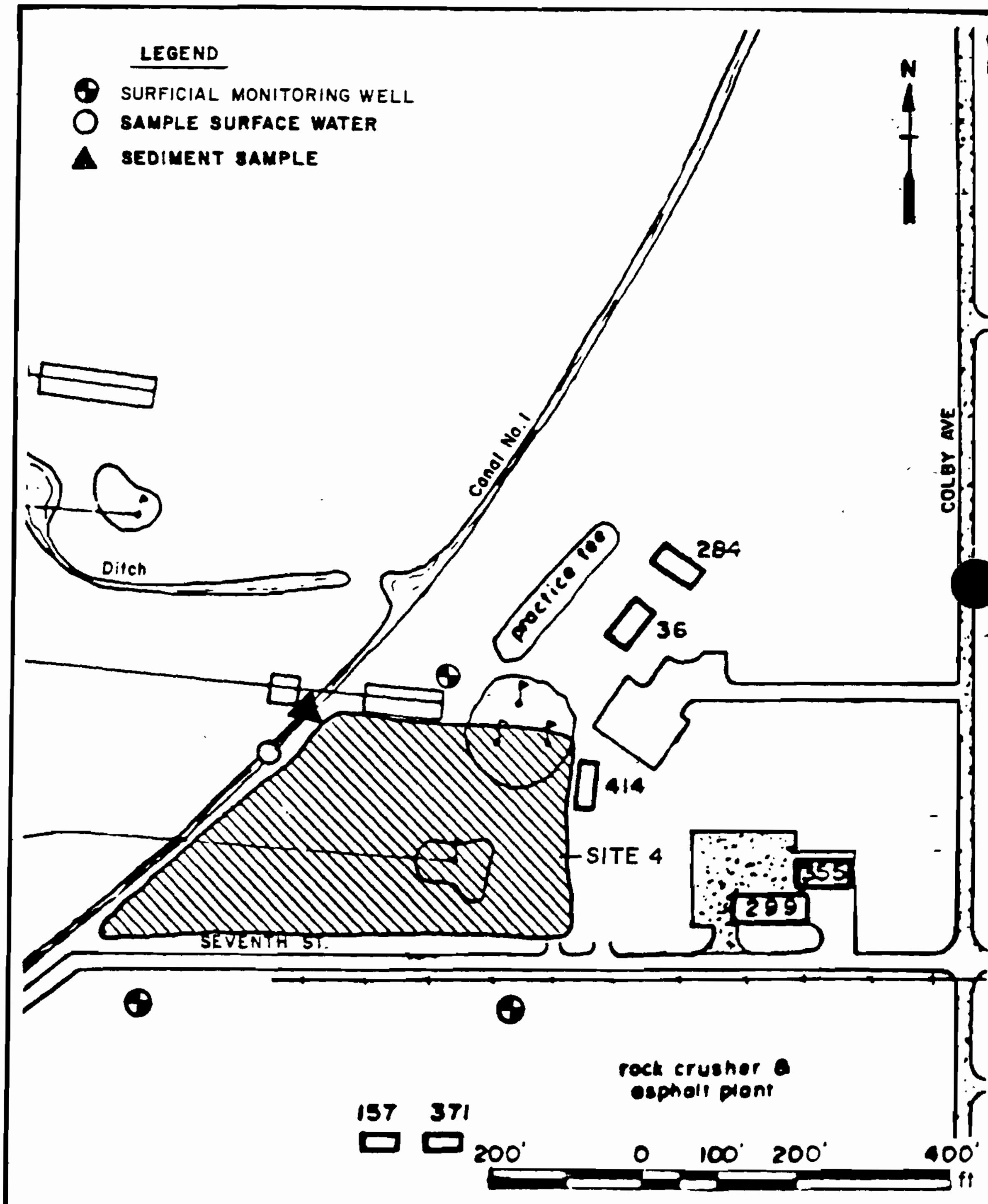

FIGURE 3-4

Site 4
Recommended
Sampling Locations

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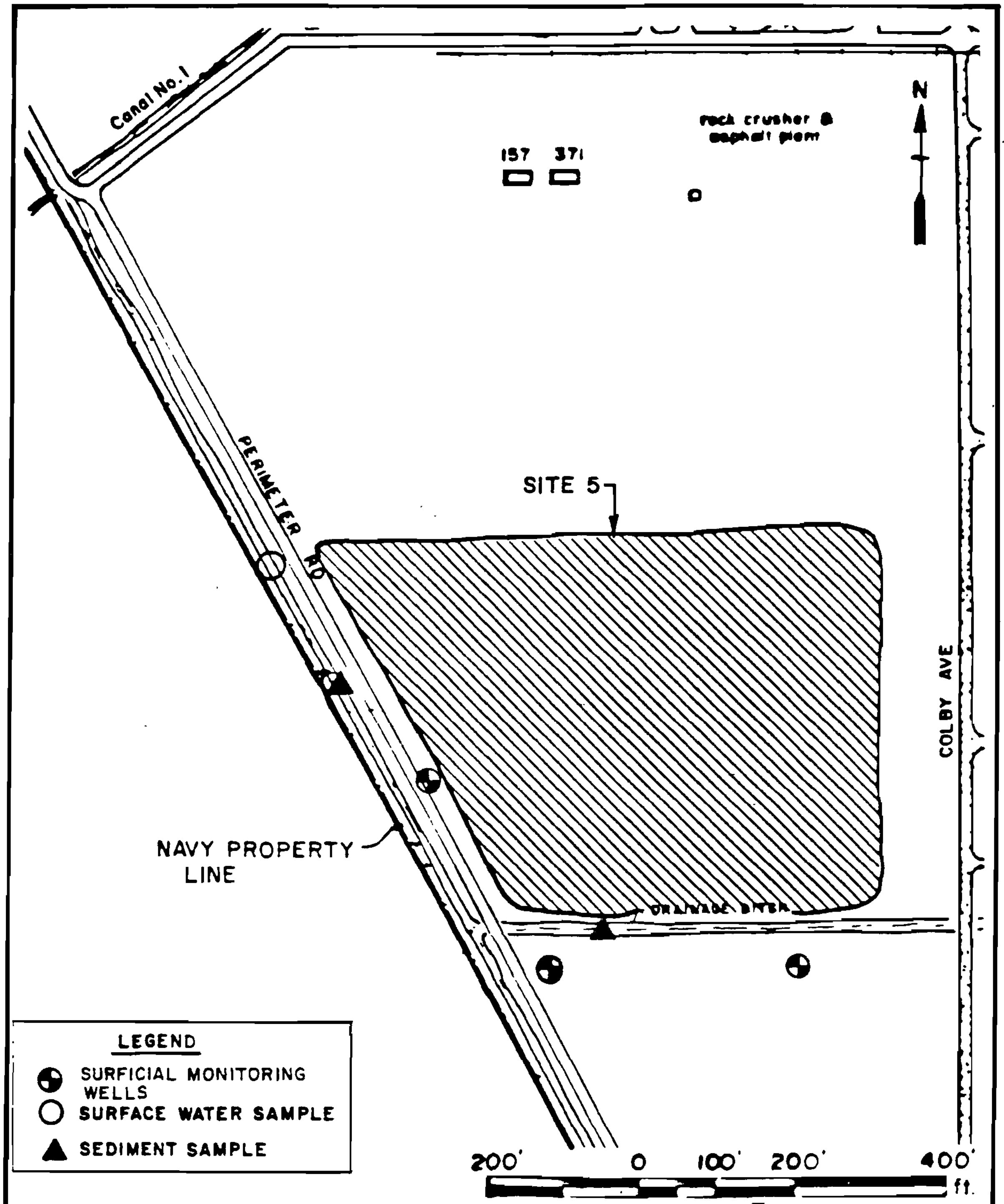

FIGURE 3-5

Site 5
Recommended
Sampling Locations

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Number of Samples:	Ground water: 12 Sediment: Two Surface water: Four
Testing Parameters:	Scan GC/FID with capillary column for MEK, toluene, trichloroethylene, xylene; scan GC/ECD for pesticides (specifically DDT); COD; TOC; TOX; cadmium, chromium, lead; oil and grease; specific conductance; pH

Remarks: The monitoring wells should be completed a minimum of 15 feet into the surficial aquifer, if possible, and screened from two feet above the water level to the bottom of the wells. Well locations and elevations should be surveyed and water levels taken prior to sampling. An 18 inch sediment core should be taken from the drainageway to the south of the site and composited into one sample. Another 18 inch sediment core should be taken from the drainageway to the west of the site and composited into one sample.

3.2.6 Site 6, Fire Fighting Training Area. It is recommended that one surficial monitoring well be installed downgradient (south) of Site 6 to detect contaminant migration toward the Mississippi Sound. In addition, one surface water and one sediment sample from the drainage ditch to the west of the site are recommended. The proposed sampling locations are shown in Figure 3-6.

Type of Samples:	Ground water, sediment and surface water
Ground Water Monitoring Wells:	One
Sampling Frequency:	Ground water: Quarterly for one year Sediment: One time only Surface water: Quarterly for one year
Number of Samples:	Ground water: Four Sediment: One Surface water: Four
Testing Parameters:	Scan GC/FID with capillary column for MEK, toluene, xylene and trichloroethylene; COD; TOC; TOX; cadmium, chromium, lead; oil and grease; specific conductance; pH

Remarks: The monitoring well should be completed a minimum of 15 feet into the surficial aquifer, if possible, and screened from two feet above the water level to the bottom of the well. Well locations should be surveyed and water levels taken prior to sampling. An 18 inch sediment core should be taken from the drainageway and composited into one sample.

3.2.7 Background Monitoring Well. It is recommended that one background surficial aquifer monitoring well be installed in the northwestern portion of the installation as indicated in Figure 3-7.

Type of Samples:	Ground water
Ground Water Monitoring Wells:	One

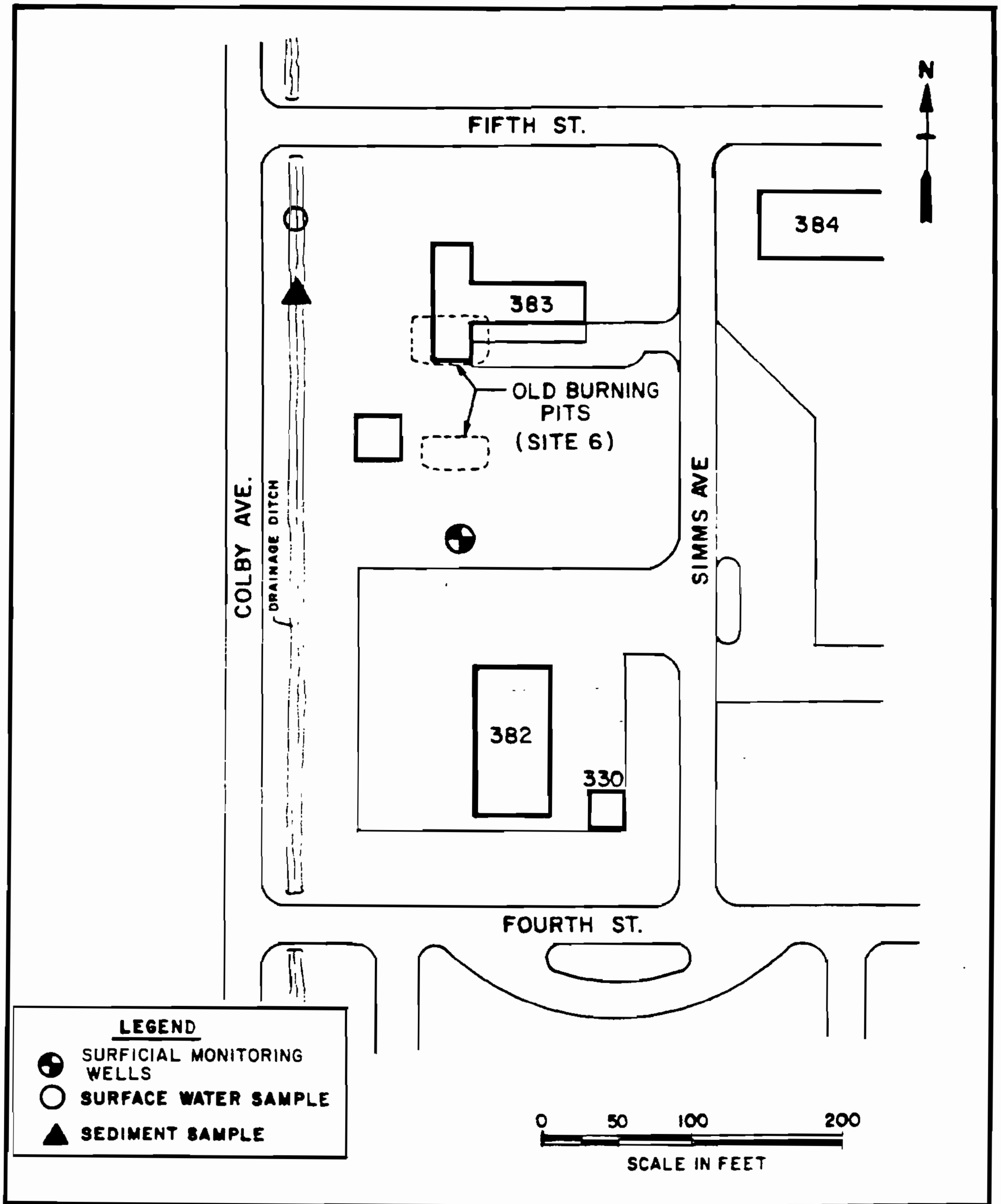

FIGURE 3-6

Site 6 Recommended Sampling Locations

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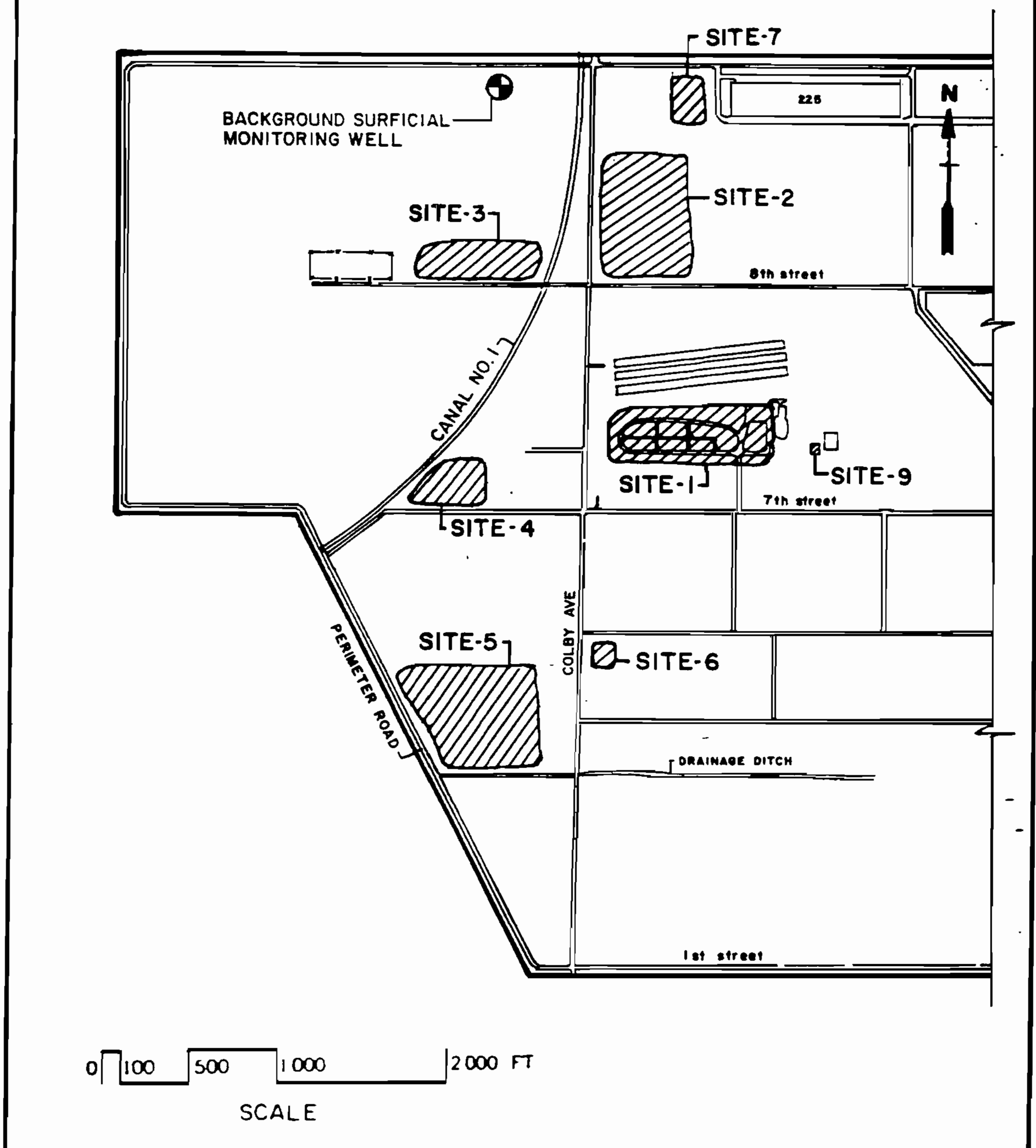

FIGURE 3-7

Recommended Background Monitoring Well

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Sampling Frequency:	Quarterly
Number of Samples:	Four
Testing Parameters:	Scan GC/FID with capillary column for MEK, toluene, trichloroethylene and xylene; scan GC/ECD for pesticides; COD; TOC; TOX; pH; cadmium, chromium, lead; oil and grease; specific conductance;

Remarks: The monitoring well should be completed a minimum of 15 feet into the aquifer and screened from two feet above the water level to the bottom of the wells. The well location should be surveyed and water levels taken prior to sampling.

3.3 OTHER RECOMMENDATIONS. All nine sites identified in this study should be documented and labeled on future installation maps.

3.3.1 Site 7, Rubble Disposal Area. No confirmation study is recommended. In addition to this site being identified on future installation maps, it is also recommended that "No Dumping" signs be posted to discourage unauthorized future disposal at the site.

3.3.2 Site 8, Air Force Herbicide Orange Spill Area. The presence of dioxin contamination at this site has been verified by studies conducted by the Air Force. A NACIP confirmation study is not necessary because confirmation and cleanup are being conducted by the Air Force. Further studies are not recommended.

3.3.3 Site 9 Building Foundation 271 Excavated Drum Storage Area. The excavated 55-gallon drums have been shown to contain hazardous waste. Because NCBC has implemented immediate remedial measures at this site, further studies are not recommended.

CHAPTER 4. BACKGROUND

4.1 GENERAL. The Naval Construction Battalion Center (NCBC) Gulfport, Mississippi is located along the Mississippi Gulf Coast, approximately midway between Mobile, Alabama and New Orleans, Louisiana within the city limits of Gulfport. A general location map of the area is shown in Figure 4-1.

NCBC Gulfport is situated on a tract of land covering approximately 1,100 acres. The facility is about 1.5 miles inland from Mississippi Sound and the port of Gulfport, in the northwest portion of the city. This site was selected in the early stages of World War II because of the opportunity the Gulf Coast offered for an uncongested deep-water port to serve the Caribbean area. Figure 4-2 shows the layout of the NCBC.

4.1.1 Tenant/Host Relationships. The primary missions of NCBC are the support of five battalions of the Naval Construction Force (NCF) and the storage and maintenance of Pre-positioned War Reserve Material Stock. NCF support consists of both homeport services and deployed support. Secondary missions are tenant support and services to other activities in the region. The command relationships are illustrated in Figure 4-3.

NCBC's assigned population is roughly 5,500 persons (military, civilian personnel and dependents). The average on-board population is approximately 4,000 since, typically, two battalions are in deployment status. Tenants comprise 23 percent of the average on-board population. The Naval Construction Training Center is the largest tenant with 13 percent of the on-board personnel. The organizational structure at NCBC, Gulfport is presented in

Figure 4-4. A listing of the host commands and tenant activities is presented below along with a brief summary of its mission or service.

Twentieth Naval Construction Regiment (20th NCR) is responsible for ensuring maximum effectiveness of all Atlantic units of the NCF while secondarily serving as a personnel receiving and separating activity.

Naval Mobile Construction Battalions are the established units of the Naval operational forces and are components of the NCF. It provides military construction support to forces in military operations and construction services for base facilities. Additionally, the battalions conduct defensive operations as required by the circumstances of the deployment situation.

Naval Construction Training Center administers courses and special training programs assigned by the Chief of Naval Education and training to train enlisted and officer personnel to prepare them in their designated specialties.

Commander, Naval Construction Battalions, United States Atlantic Fleet-Equipment Office, is the overall manager of construction, automotive and material handling equipment assigned to the command and is responsible for establishing policies and procedures to ensure maximum effectiveness.

Naval and Marine Corps Reserve Center's mission is to manage assigned resources and to advise, assist, and support all assigned Naval Reserve units and reservists.

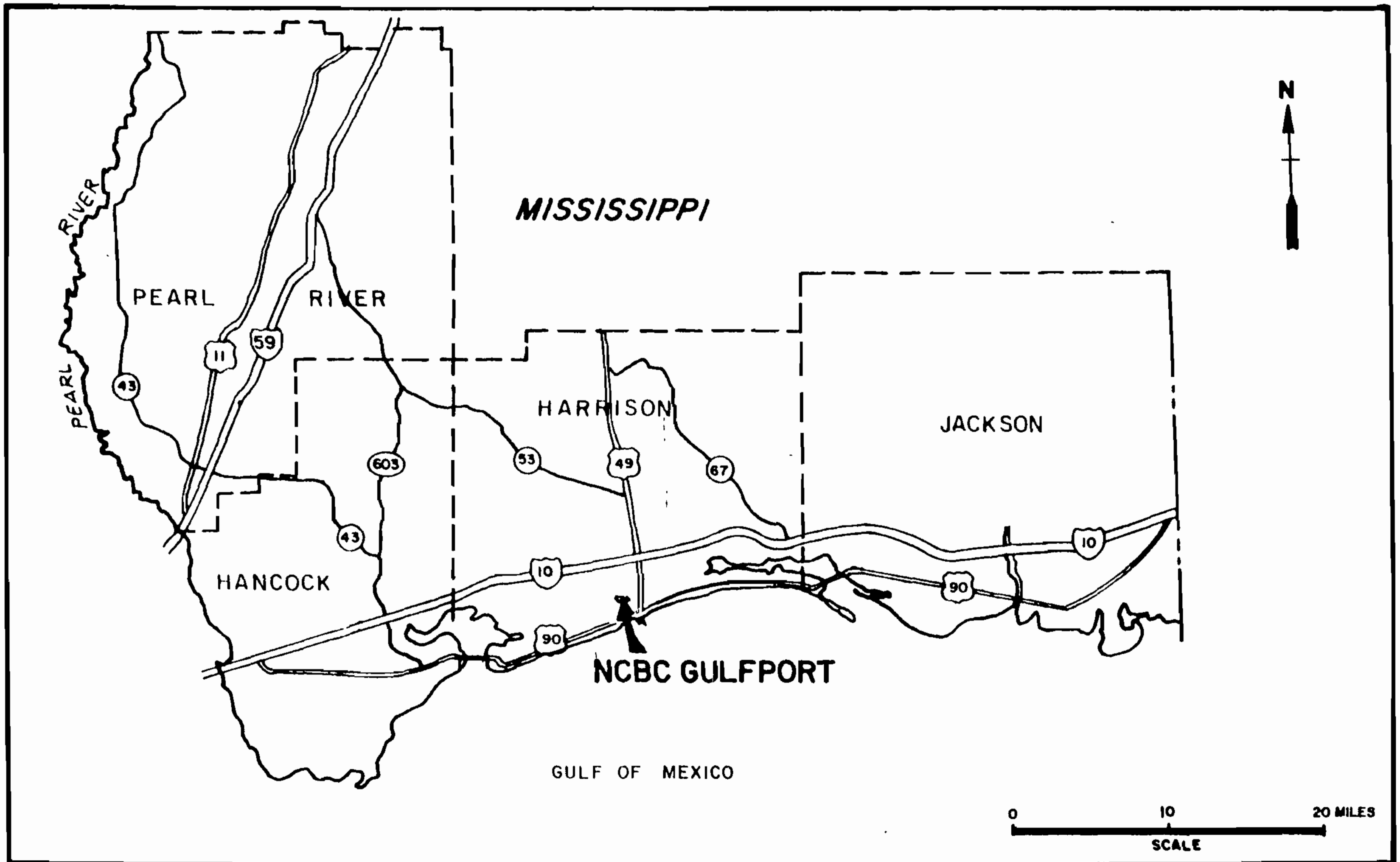

FIGURE 4-1

Location Map

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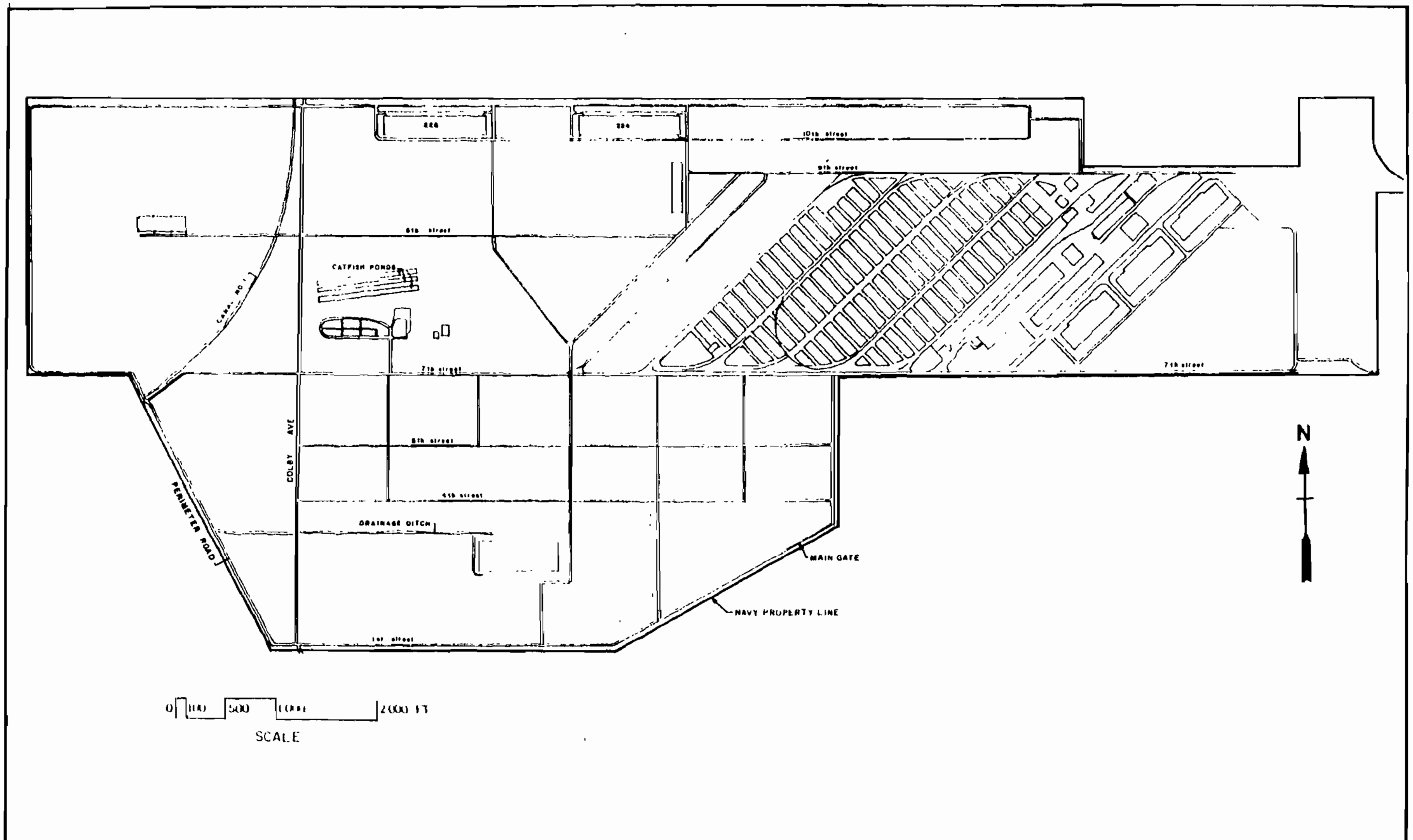

Figure 4-2

INSTALLATION MAP

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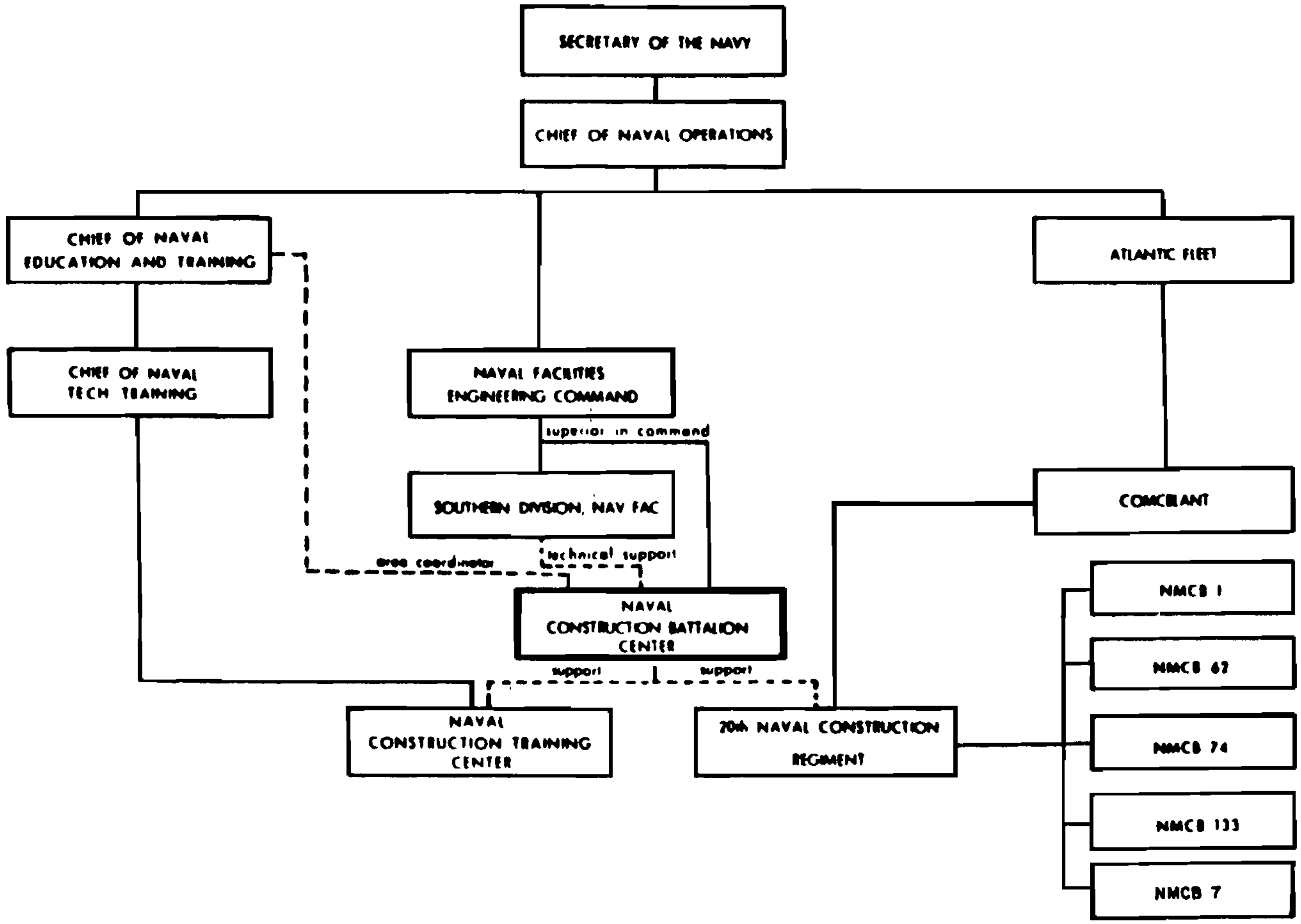

FIGURE 4-3

Chain of Command

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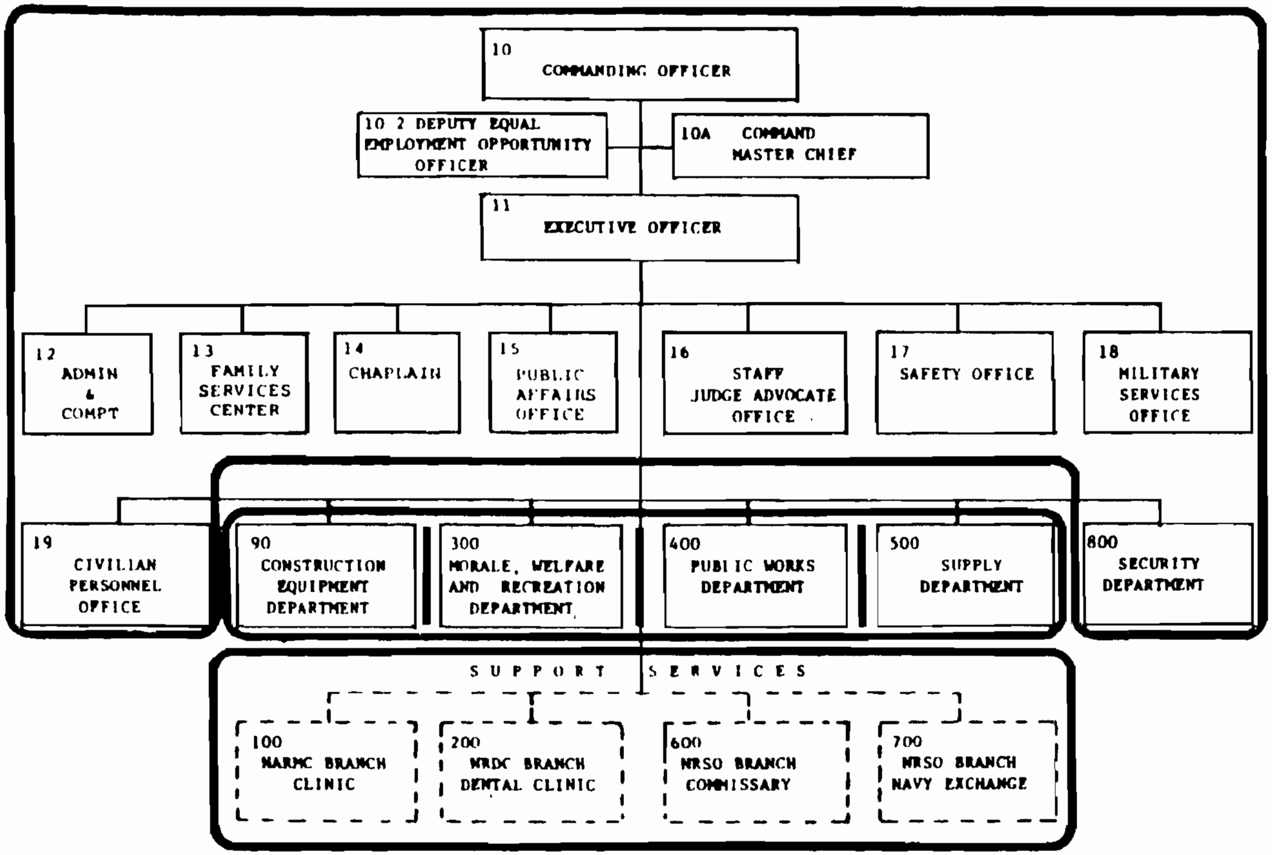

FIGURE 4-4
Organization/Functional Groupings

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United States Marine Corps Reserve Center, Inspector-Instructor Staff, Detachment, Company A supervises, instructs, and assists the Reserve Unit in maintaining a continuous state of readiness for immediate mobilization.

Naval Investigative Services provides investigative and intelligence support to military activities within the 14 southern counties of Mississippi and acts as primary liaison to state and local law enforcement agencies.

Navy Campus for Achievement functions as the education advisor to military commands and personnel.

United States Coast Guard Reserve's mission is training reserve personnel to perform their port security duty in the event of mobilization, while simultaneously providing assistance to regular components.

Navigation Aids Support Unit provides portable precision electronic navigational aids to designated Navy-wide activities.

SOUTHNAVFACENGCOM ROICC maintains liaison with EFD and the PWD or A/E firm in preparation of plans and specifications on projects for which authority has been assigned.

Navy Publications and Printing Service is tasked with providing a staging area for the assembly of technical manuals.

Personnel Support Activity Detachment provides pay/personnel and transportation support to all naval activities from Pascagoula to Bay St. Louis, Mississippi.

Navy Exchange offers a convenient and reliable source from which authorized patrons may obtain, at the lowest practical cost, articles and services.

Commissary Store supplies provisions at the lowest practical price in a facility designed and operated to conform to the standards used in commercial food stores.

Naval Hospital, Pensacola Branch Clinic, Gulfport is responsible for planning, coordinating, and directing the functions of the clinic along with providing limited medical care for sick and injured personnel.

Naval Regional Dental Clinic, Branch Dental Clinic, Gulfport conducts complete dental services to shore activities and units of the operating forces.

4.1.2 Adjacent Land Use. The lands immediately surrounding the NCBC are predominatly residential. Some wooded areas are to the northwest which consists of open pine forest and deciduous hardwoods associated with a natural drainage, Turkey Creek; low density housing and areas utilized for silviculture are scattered thoughout. Mississippi Sound lies approximately 1.1 miles to the south of the property.

Similar to other coastal areas, the highest population density and development occurs near the coastline. Approximately 68 percent of Harrison County's population occurs along the coastal area between the Mississippi

Sound and Interstate Highway 10, 4.5 miles to the north (Mississippi AWPCC, 1978a). The cities of Gulfport, Biloxi, Long Beach and Pass Christian lie within this coastal zone.

The NCBC is situated within Gulfport with the City of Long Beach abutting its western property line. Biloxi, the county's largest city, lies approximately seven miles to the east. The town of Pass Christian is situated seven miles to the west.

Gulfport has a municipal airport used for daily commercial jet flights and as a National Guard training center. It also has the only State-owned port used by numerous ocean-going freighters. Ships with drafts in excess of 30 feet can use the port (Soil Conservation Services, 1975).

An old public landfill (Section 4.6) is located on the east side of Canal Road, approximately 0.8 miles north of the NCBC property line. This represents a potential source of off-base ground water contamination that could impact on-base water supplies.

Off-base impacts from on-base sources (Section 4.6) would be primarily associated with drainage ditches or canals that could carry contaminants off Navy property. In addition, off-base wells to the south, that tap the Miocene aquifer system, could be impacted.

4.2 HISTORY. NCBC Gulfport dates back to June 2, 1942, and was originally called Camp Hollyday. The Gulfport area was chosen for establishment of the camp because of its uncongested deep-water port which the Navy needed to serve the Caribbean area. The moderate semi-tropical climate of the area also allowed outloading and training of personnel on a year-around basis.

Initially, the facility was established as an Advanced Base Depot. An Armed Guard School and Cooks and Bakers School were added in November 1942. During this time, millions of tons of supplies and equipment were stored at the camp and shipped to all areas for military operations. In 1944, the mission changed from a receiving facility to a United States Naval Training Center. Continuing realignments of the center created a single command of the Naval Training Center and the Advanced Base Depot.

Temporary facilities for each of the battalions were provided in units consisting of barracks, headquarters, a mess and storage. The rapid growth was accomplished by using a simple gridiron system and constructing buildings of framed construction. Reportedly, at times during World War II, as many as 25,000 Naval personnel were stationed at the center, living in wooden barracks, tents and Quonset huts. In 1945, the depot became the United States Naval Storehouse and in 1946 the training center was decommissioned. Two years later the station became a custodian of certain national stockpile materials, and in 1952 other organizational changes were made; the Naval Storehouse was disestablished. On February 26, 1952, it was replaced by the Advanced Base Supply Depot, Naval Construction Equipment Depot, and a Naval Construction Battalion Center. In July 1953, the NCBC Gulfport was established by absorbing the two depots. Base on-board population decreased from the early 1950's to 1966.

Commitments for construction forces in southeast Asia led way to an increased mission in 1966, and the center expanded to include homebase battalion support functions. After 20 inactive years NCBC Gulfport was forming, staging, training, and homeporting two mobile construction battalions. The 20th NCR was established on April 11, 1966. Presently, five construction battalions (1, 7, 62, 74 and 133), under the command of the 20th NCR, are based at Gulfport. These four "Seabee" battalions average approximately 750 personnel each and are deployed on a rotational schedule.

Hurricane Camille had a devastating effect on the installation in August 1969, and since that time many new buildings have been constructed. New structures are of permanent masonry construction rather than wood. In July of 1974, the Naval Construction Training Center, now the largest tenant, was established at NCBC. The Commander, Construction Battalion Atlantic Fleet, Detachment Gulfport, was established in October 1974.

4.3 LEGAL ACTIONS. There are no reported legal actions concerning contamination incidents at NCBC Gulfport.

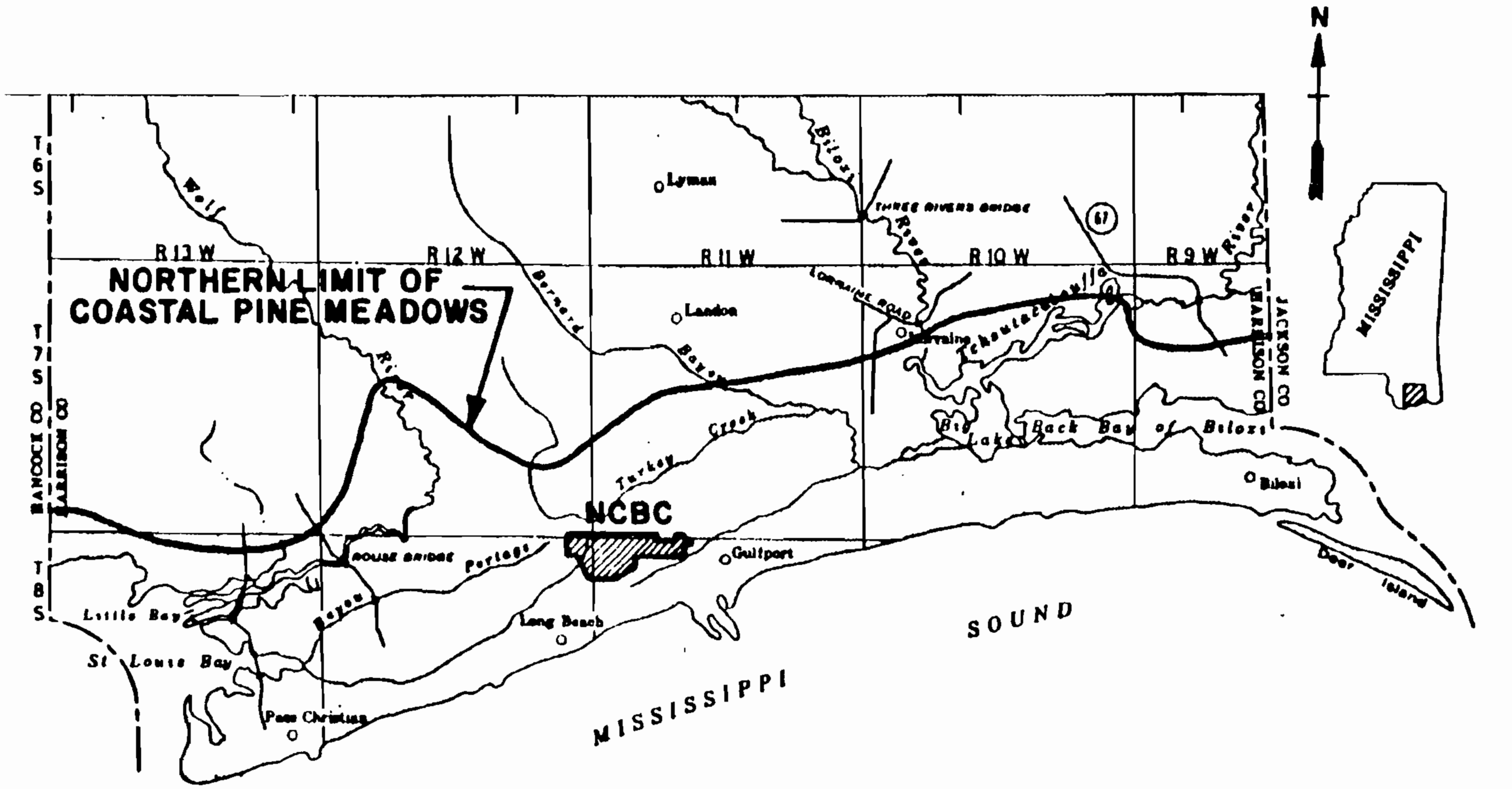
4.4 BIOLOGICAL FEATURES.

4.4.1 Ecosystems. The NCBC lies within the physiographic province called the Coastal Pine Meadows (see Figure 4-5). Historically, this region can be characterized as a flat and local swampy belt that meanders along the Gulf coast, typically ranging from 5 to 15 miles in width, and 5 to 30 feet above sea level. Ground water lies near the surface throughout this region, occasionally pooling in depressions during the rainy season. Marshes and swamps associated with this region follow lines roughly parallel with the coast. Salt water marshes associated with the Pearl and Pascagoula Rivers border this particular region to the west and east. Near to the coast are vegetated remnants of former beach dunes which vary in height from 10 to 20 feet (Lowe, 1921). The vegetation typical of this land-form is an open growth of pine with an understory characteristic of bogs and pine savannas.

The natural drainages of this coastal area are considered to be tortuous and slow flowing with sandy bottoms and clear, amber-colored waters (Lowe, 1921). These habitat types are characterized below.

4.4.1.1 Pine Savannas. The area in which the NCBC and the City of Gulfport are now situated was previously typified throughout by a number of pine species: the longleaf pine (Pinus palustris), loblolly pine (Pinus taeda) and slash pine (Pinus elliotti). A number of other tree species could be found in some of the drier areas: water oak (Quercus nigra), live oak (Quercus virginiana), turkey oak (Quercus leaevis), magnolia (Magnolia grandiflora), sourwood (Oxydendrum arboreum), and leatherwood (Cyrilla racemiflora). The shores of creeks and low, wet depressions typically harbored the following: water tupelo (Nyssa aquatica), gallberry (Ilex spp.), saw palmetto (Serenoa repens), titi (Cliftonia monophylla), bald cypress (Taxodium distichum), and southern white-cedar (Chamaecyparis thyoides) (Lowe, 1921).

Today, the remaining natural areas within the confines of the NCBC consists of 401 areas of planted slash pine with the western portion of the property retaining many of the original characteristics of the area (flat and swampy), and a number of the original species constituents. Vegetation chracteristic of disturbed sites has invaded the understory of most of the wooded areas. Noted among the species presently inhabiting the pine areas at the NCBC were: sweet gallberry (Ilex coriacea), southern magnolia (Magnolia grandiflora), tallowtree (Sapium sebiferum), morning glory (Ipomea sp.), fennel (Eupatorium



SOURCE: ADAPTED FROM WISEMAN, 1984

FIGURE 4-5

Coastal Pine Meadows of Harrison County

INITIAL ASSESSMENT STUDY NAVAL CONSTRUCTION BATTALION CENTER GULFPORT

spp.) and golden rod (Solidago spp.). Where standing water persists, bald cypress (Taxodium distichum) and willow (Salix spp.) were periodically found growing in association with the slash pine stands.

A remnant of a small stand of oak trees occurred near the western side of property on one of the better drained areas. Live oak (Quercus virginiana) and water oak (Quercus nigra) were the most conspicuous species with occasional tallow trees occurring among them. Fennel and greenbriar (Smilax sp.) were a constituent of the ground cover, while ressurrection fern (Polypodium polypodioides) was growing epiphytically on a number of oak limbs. Elsewhere, occurences of smaller oak trees were scattered.

Due to recent activities, some areas are presently predominated by species characteristic of disturbed areas. Fennel, golden rod, morning glory, poison ivy (Toxicodendron radicans), poison sumac (Toxicodendron vernix) and rattlebox (Sesbania sp.) were quite common.

A list of common species expected to occur in the Coastal Pine Meadows near the NCBC is provided in Table 4-1.

4.4.1.2 Natural and Artifical Aquatic Environments. There are no natural drainage systems, such as creeks, present on the Navy property, though most areas drain off-base. Turkey Creek represents the closest natural drainage system, lying approximately 2,000 feet north of the NCBC property line, which would receive base runoff. This creek is classified by the State of Mississippi as Fish and Wildlife, which is defined as a water for the propogation and management of fish and wildlife. The vegetation associated with Turkey Creek is typical for the region. Some of the more common hardwood species include; titi (Cyrilla racemiflora), black titi (Cliftonia monophylla), red bay (Persea palustris), red maple (Acer rubrum), tupelo gum (Nyssa aquatica), bald cypress (Toxodium distichum) and willow (Salix spp.) (Lowe, 1921).

Man-made lakes and drainage ditches at the NCBC are habitat for a number of species. As these areas appear to be periodically maintained, most of the wetlands vegetation associated with their borders tend to remain artifical or at early successional stages. Some of the plant species found in or adjacent to the environment at the Navy property include: rattlebox (Sesbania sp.), cattail (Typha sp.), morning glory (Ipomea sp.), unidentified pipewort (Eriocaulon spp.), pennywort (Hydrocotyle sp.), willow (Salix sp.), and unidentified grasses. A rare plant, Lilaeopsis carolinensis, was also observed inhabiting some of the grassed ditches during the on-site investigation.

4.4.1.3 Fauna. It was reported that turkey, deer, fox and skunk occasionally are sighted just off Navy property. Two interviewees stated that an alligator inhabits one of the golf course lakes.

The NCBC lakes and sewage lagoons are maintained for recreational fishing. These are presently stocked with largemouth bass, bluegill, redear sunfish and channel catfish (SOUTHNAVFACENGCOM, 1984).

During the Initial Assessment Study (IAS) on-site survey, a number of species (or evidence of them) were observed. Several turtles were seen in association with a number of the drainage ditches and the reclaimed sewage lagoons. The great egret and cattle egret were found to use the aquatic habitats for

Table 4-1

Representative Plant Species from the Mississippi Coastal Pine Meadows Region

Scientific Name	Common Name
Cliftonia monophylla	Black Titi
Cyrilla racemiflora	Titi
Eriocaulon decangulare	Pipewort
Eriocaulon septangulare	Pipewort
Gaylussacia dumosa	Dwarf Huckleberry
Ilex glabra	Gallberry
Ilex vomitoria	Yaupon
Magnolia grandiflora	Magnolia
Nyssa aquatica	Water Tupelo
Osmanthus americanus	Wild Olive
Oxydendrum arboreum	Sourwood
Persea palustris	Red Bay
Pinguicula lutea	Yellow Butterwort
Pinus elliottii	Slash Pine
Pinus palustris	Longleaf Pine
Pinus taeda	Loblolly Pine
Pogonia divaricata	Spreading Pogonia
Polygala cymosa	Pine-barren Milkwort
Polygala lutea	Yellow Milkwort
Polygala nane	Dwarf Milkwort
Quercus laevis	Turkey Oak
Quercus laurifolia	Laurel Oak
Quercus virginiana	Live Oak
Rhexia blabella	Deer Grass
Rhexia stricta	Swamp Meadow Beauty
Sarracenia rubra	Sweet Pitcher Plant
Sarracenia flava	Trumpet-leaf
Xyris torta	Yellow-eyed grass

Source: Adapted from Lowe, 1921.

foraging. Raccoon tracks were found at various locations on the NCBC, particularly near the aquatic habitats. Rabbit scat was common in the wooded areas suggesting that at least one species of rabbit is present in moderate numbers on the Navy property.

The Gulf area has a distinct strand of flora containing a number of tropical and subtropical species (Lowe, 1921) which provide a diverse and suitable habitat for a number of fauna. A list of representative species for the Coastal Pine Meadows of Mississippi is provided in Tables 4-2 through 4-5.

4.4.2 Endangered, Threatened and Rare Species. The U.S. Fish and Wildlife Service (USFWS) through the U.S. Endangered Species Act of 1973 (16 USC 1531) and the Mississippi Department of Wildlife Conservation through the Non-Game and Endangered Species Act (Section 49-5-101 through 119, Mississippi Code of 1972) have each promulgated a list of biota legally protected in the State of Mississippi. Respectively, these are: the List of Endangered and Threatened Wildlife and Plants (50 CFR 17.11 and 17.12), and the Official State List of Endangered Vertebrates (Public Notice No. 2408). Presently, the State of Mississippi has no official State list for protected plant species.

The Mississippi Natural Heritage Program (NHP), an affiliate of the Mississippi Department of Wildlife Conservation (MDWC), has "compiled a data base that is the most complete, single source of information about Mississippi's rare, threatened, endangered or otherwise significant plants, animals, plant communities and natural features" (Wiseman, 1984). Thoough the complete inventory of species is currently not assigned a legal status, the Program is recognized statewide and given consideration.

The status designations, applied to the species in Sections 4.4.2.1 and 4.4.2.2, are defined by the NHP as follows:

Endangered - A species which is in danger of extinction throughout all, or a significant portion, of its range in the state due to: 1) destruction, drastic modification or severe curtailment of habitat; 2) its overutilization for commercial or sporting purposes; 3) effect of disease or pollution; or 4) other natural or manmade factors.

Threatened - A species which may become endangered within the foreseeable future in all, or a significant portion, of its range in the state for the same reasons as set out above for endangered species.

Rare - A rare species is one that, although not presently threatened with extinction, is in such small numbers throughout its range in Mississippi, it may be threatened or endangered if its environment worsens. Close watch of its status is necessary.

4.4.2.1 Fauna. There are 20 species of animals in Mississippi listed as endangered or threatened by the USFWS. Of these, five are recorded from the Coastal Pine Meadows of Harrison County. The MDWC has classified a total of 39 species of animals as endangered statewide. Of these, three species in addition to the five accounted for in the federal listing are known from the region. The NHP presently lists 110 species as endangered, threatened or rare. The data base of the NHP indicates nine other species, in addition to those considered by the USFWS and the MDWC, are known from the Coastal Pine Meadows. The 17 species under consideration are discussed briefly below (see

Table 4-2

Representative Fish Species from the Mississippi Coastal Pine Meadows Region

Scientific Name	Common Name
Ammocrypta beani	Naked Sand Darter
Elassoma zonatum	Banded Pygmy Sunfish
Erimyzon tenuis	Sharpfin Chubsucker
Etheostoma fusiforme	Swamp Darter
Etheostoma stigmaeum	Speckled Darter
Etheostoma zonale	Banded Darter
Fundulus notti	Starhead Topminnow
Fundulus pulvereus	Bayou Killifish
Gambusia affinis	Mosquitofish
Gobionellus shufeldti	Freshwater Goby
Ictalurus natalis	Yellow Bullhead
Ictalurus punctatus	Channel Catfish
Lepisosteus oculatus	Spotted Gar
Lepomis macrochirus	Bluegill
Lepomis microlophus	Redear Sunfish
Lepomis punctatus	Spotted Sunfish
Micropterus punctulatus	Spotted Bass
Micropterus salmoides	Largemouth Bass
Notropis longirostris	Longnose Shiner
Notropis venustus	Blacktail Shiner
Percina nigrofasciata	Blackbanded Darter
Percina sciera	Dusky Darter

Table 4-3

Representative Herpetofauna from the Mississippi Coastal Pine Meadows Region

Scientific Name	Common Name
Agkistrodon piscivorus	Cottonmouth
Ambystoma cingulatum	Flatwoods Salamander
Ambystoma talpoideum	Mole Salamander
Anolis carolinensis	Green Anole
Chelydra serpentina	Common Snapping Turtle
Chrysemys scripta	Pond Slider
Coluber constrictor	Southern Black Racer
Desomognathus auriculatus	Southern Dusky Salamander
Diadophis punctatus	Ringneck Snake
Elaphe guttata	Corn Snake
Eumeces fasciatus	Five-lined Skink
Gastrophryne carolinensis	Eastern Narrow-mouthed Toad
Graptemys kohni	Mississippi Map Turtle
Hyla cinerea	Green Treefrog
Hyla femorlis	Pine Woods Tree Frog
Kinosternon subrubrum	Mississippi Mud Turtle
Nerodia sipedon	Water Snake
Rana grylio	Pig Frog
Rana utricularia	Southern Leopard Frog
Scaphiopus holbrooki	Eastern Spadefoot Toad
Sceloporus undulatus	Southern Fence Lizard
Sistrurus miliarius	Pygmy Rattlesnake
Sternotherus odoratus	Stinkpot
Terrrapene carolina	Box Turtle
Thamnophis sirtalis	Garter Snake

Table 4-4

Representative Bird Species from the
Mississippi Coastal Pine Meadows Region

Scientific Name	Common Name
Agelaius phoeniceus	Red-winged Blackbird
Bubulcus ibis	Cattle Egret
Butorides striatus	Green Heron
Cardinalis cardinalis	Northern Cardinal
Casmerodius albus	Great Egret
Chordeiles minor	Common Nighthawk
Colinus virginianus	Common Bobwhite
Corvus brachyrhynchus	American Crow
Cyanocitta cristata	Blue Jay
Dendroica dominica	Yellow-throated Warbler
Falco sparverius	American Kestrel
Gallinula chloropus	Common Moorhen
Hydranassa tricolor	Louisiana Heron
Larus delawarensis	Ring-billed Gull
Megaceryle alcyon	Belted Kingfisher
Melanerpes carolinus	Red-bellied Woodpecker
Meleagris gallopavo	Turkey
Mimus polyglottos	Northern Mockingbird
Pandion haliaetus	Osprey
Passer domesticus	House Sparrow
Quiscalus quiscula	Common Grackle
Rallus elegans	King Rail
Stelgidopteryx ruficollis	Rough-winged Swallow
Sterna fosteri	Foster's Tern
Sturnella magna	Eastern Meadowlark
Thryothorus ludovicianus	Caroline Wren
Tyrannus tyrannus	Eastern Kingbird
Zenaida macroura	Mourning Dove

Table 4-5

Representative Mammals from the
Mississippi Coastal Pine Meadows Region

Scientific Name	Common Name
Lutra canadensis	River Otter
Lynx rufus	Bobcat
Mephitis mephitis	Striped Skunk
Mustela vison	Mink
Neotoma floridana	Eastern Woodrat
Odocoileus virginianus	Whitetail Deer
Ondatra zibethica	Muskrat
Oryzomys palustris	Rice Rat
Peromyscus gossypinus	Cotton Mouse
Procyon lotor	Raccoon
Rattus rattus	Black Rat
Reithrodontomys humulis	Eastern Harvest Mouse
Sciurus carolinensis	Eastern Gray Squirrel
Sciurus niger	Eastern Fox Squirrel
Sigmodon hispidus	Cotton Rat
Spilogale putorius	Spotted Skunk
Sylvilagus aquaticus	Swamp Rabbit
Sylvilagus floridanus	Eastern Cottontail
Urocyon cineroargenteus	Gray Fox

Table 4-6). The parenthetical references following "USFWS" in the text below identify the most recent data that the notice or rule-making action concerning each species appeared in the Federal Register.

The western subspecies of Atlantic sturgeon (Acipenser oxyrhynchus desotoi) is confined to the northeastern Gulf of Mexico, where it ranges from the Mississippi Delta in Louisiana east to the Suwannee River in Florida. Records indicate that it once occurred as far south as Tampa Bay (Lee, 1980). Spawning takes place in the fresh water of some of the major coastal rivers. Distribution maps indicate that the Pearl and Pascagoula River systems are utilized by this species. The MDWC has a records of the Atlantic sturgeon from the Mississippi Sound near Gulfport. The sturgeon feeds on insects, crustaceans, mollusks, annelids, and occasionally small fishes. The sturgeon numbers have been greatly depleted throughout most of its range and is now relatively common in only a few areas. The MDWC and the Natural Heritage Program lists the Atlantic sturgeon as an endangered species. The NCBC does not provide habitat for this species, however, surface drainage from the area may ultimately be received by the Mississippi Sound.

Striped bass (Morone saxatilis) has a historic range from the St. Lawrence River south to the St. Johns River in northern Florida. A disjunct population occurs along the coast of the Gulf of Mexico from the Suwannee River in Florida west to Lake Pontchartrain in Louisiana. This fish has been introduced into lakes and impoundments throughout the United States. The striped bass is important to the sport and commercial fisheries. Spawning occurs in the spring in upstream portions of rivers above tidal influence. Distribution maps indicate the striped bass uses a number of drainage systems in Mississippi, including those associated with the Bay of Biloxi. The adult fish prey on fish and large crustaceans (Lee, 1980). The NHP presently categorizes this species as rare. The NCBC does not provide habitat for this species, however, surface drainage from the area may ultimately be received by the Mississippi Sound.

The American alligator (Alligator mississippiensis) inhabits a wide variety of brackish and fresh water habitats throughout much of the southeast United States. It is able to tolerate man-altered habitats, often occuring in lakes or canals in the middle of most urbanized settings. The alligator is an opportunistic feeder, but typically consumes fish, birds and reptiles. Nesting begins in the late spring with the female constructing a mound nest of vegetation near to a body of water. The numbers of alligators have been increasing since it has become legally protected (McDiarmid, 1978). The USFWS (48 FR 46336; October 12, 1983) classifies the alligator as an endangered species in Mississippi. The MDWC and NHP also consider the alligator as endangered. It was reported by interviewees during the IAS that at least one alligator inhabits the lakes at the NCBC golf course.

The scarlet snake (Cemophora coccinea) ranges from southern New Jersey south to Florida and west to extreme eastern Texas. Typically, this species is found in or near sandy, loamy soils suitable for burrowing. It is also found in logs and beneath bark. The scarlet snake preys upon small mice and lizards and occasionally smaller snakes. Snake eggs are also eaten. The NHP considers this species to be rare. This species could potentially inhabit the wooded portions of the NCBC property.

The southern hognose snake (Heterodon simus) is found from southeast North Carolina to central Florida and west to southern Mississippi. They are known

Table 4-6

List of Endangered, Threatened and Rare Animal Species Of The Coastal Pine Meadows Region

Scientific Name	Common Name	USFWS	State	NHP
Mammals:				
Sorex longirostris	Southeastern Shrew			R
Trichechus mantus	West Indian Manatee	E	E	E
Birds:				
Charadrius alexandrinus	Snowy Plover		E	R
Egretta rufescens[a]	Reddish Egret			R
Haematopus palliatus	American Oystercatcher			R
Haliaeetus leucocephalus	Bald Eagle	E	E	E
Laterallus jamaicensis[a]	Black Rail			R
Pelecanus occidentalis	Brown Pelican	E	E	E
Sterna antillarum	Least Tern			R
Reptiles and Amphibians:				
Alligator mississippiensis[b]	American Alligator	E	E	E
Cemophora coccinea	Scarlet Snake			R
Heterodon simus	Southern Hognose Snake		E	E
Lampropeltis triangulum elapsoides	Scarlet Kingsnake			R
Lepidochelys kempi	Atlantic Ridley Turtle	E	E	E
Rhainaea flavilata	Yellow-lipped Snake			R
Fish:				
Acipenser oxyrhynchus	Atlantic Sturgeon		E	E
Morone saxtilis	Striped Bass			R

[a]Reported to occur within a three mile radius of NCBC.
[b]Reported to be on NCBC property.

USFWS - U.S. Fish and Wildlife Service
NHP - Missippi Natural Heritage Program
E - Endangered
T - Threatened
R - Rare

to inhabit sandy woods, fields and groves, dry river flood plains, and hardwood hammocks. The hognose snake uses its snout for burrowing and digging for toads, its favored prey. The MDWC and NHP has this species listed as endangered. This species may find appropriate habitat in the wooded portions of the NCBC property.

The scarlet kingsnake (Lampropeltis triangulum elapsoides) ranges from North Carolina to south Florida and west to the Mississippi River. It commonly occurs in pine woodlands, but it is seldom seen due to its secretive habits of hiding beneath bark or logs; it is most often seen at night or after heavy rains. It preys on a variety of food items; small snakes, lizards, young mice, small fish, insects and earthworms. The NHP lists the scarlet kingsnake as a rare species. This species may find appropriate habitat in the wooded portions of the NCBC property.

The Atlantic Ridley turtles (Lepidochelys kempi) are restricted as adults to the Gulf of Mexico. The immature animals have been collected along the eastern coast of North America. Nesting takes place solely on a 10 mile stretch of beach in the State of Tamaulipas, Mexico. The Ridley turtle is primarily a bottom feeder, with food consisting of snails, clams and occasionally marine plants. Reasons for the decline of this species include excessive collection and high predation of eggs, slaughter of adults, and drowning by entrapment in shrimp nets. The NHP has a record of this sea turtle occurring in the Mississippi Sound. The USFWS (35 FR 18320; December 2, 1970), MDWC and NHP categorize the Ridley turtle as an endangered species. This species is not expected to frequent the Sound, thus it is unlikely it would be affected by potential surficial run-off from the NCBC which could reach the Sound.

The yellow-lipped (or pine woods) snake (Rhadinaea flavilata) is found along a narrow coastal strip from North Carolina to eastern Louisiana and southwards into peninsular Florida. The yellow-lipped snake is found in damp woodlands, chiefly pine flatwoods; it is occasionally found in hardwood hammocks. It is most commonly located under bark and in rotting pine logs and stumps. This species primarily feeds upon small frogs and lizards. The NHP currently lists the yellow-lipped snake as rare. The wooded portions of the NCBC provide potential habitat for this species.

The Caribbean subspecies of the snowy plover (Charadrius alexandrius) is found along the Gulf coast from Texas to Florida. The snowy plover requires expansive open, dry, sandy beaches for breeding as well as both dry and tidally inundated sand flats for foraging. They feed on a variety of prey including insects, worms, crustaceans, and small mollusks. The nest is constructed on open, dry white sand. The eggs, usually three, are deposited in a shallow depression lined with bits of shell. Man's increasing utilization of this species' specialized habitat has brought about its decline in numbers (Kale, 1978). The records of the NHP indicate the snowy plover is currently found on the barrier islands of Harrison County, but it could occur along the beaches of the mainland. The MDWC categorizes the snow plover as endangered while the NHP currently has it listed as rare. This species would not find suitable habitat at the NCBC.

The reddish egret (Dichromanassa rufescens) ranges from the Gulf coast of the United States to the West Indies, and as far west as the Pacific coast of Mexico. The reddish egret inhabits coastal tidal flats, salt marshes, shores and lagoons, feeding in the surrounding shallows on small fish. The reddish egret was once prized by plume hunters nearly a century ago and was almost extirpated. Today the species is uncommon in the United States. Texas and Florida harbor the largest populations of this egret with only scattered reports elsewhere (Kale, 1978). However, the NHP has a verified record of a reddish egret occuring within three miles of the NCBC. The NHP considers this species rare. Habitat is available at the NCBC for the reddish egret.

The American oystercatcher (Haematopus palliatus) breeds along the coast from Long Island to the Gulf coast states, Mexico, and northern South America. This shorebird is found on broad, open coastal beaches, mudflats and spoil islands. Though it will feed on crustaceans and marine worms, it is specialized for feeding on mollusks, particularly oysters. It nests on sandy shores, constructing a shallow depression in the sand above the high water mark. Increases in human recreation along beaches and development of shoreline property have caused the numbers of this species to decline (Kale, 1978). The NHP categorizes the American oystercatcher as rare in Mississippi. This species would not be found on the NCBC property.

The southern bald eagle (Haliaeetus leucocephalus) formerly ranged throughout North America. It is now gone, as a nesting species, from much of the interior United States and is reduced in numbers along most coastal areas. This predator is most often associated with the coast, lakes and river banks where it nests and feeds. Fish, waterbirds and turtles comprise the bulk of its diet. Nesting failure due to DDT and destruction of coastal habitat have led to the diminution of its numbers in the southeast (Kale, 1978). The bald eagle is categorized as an endangered species by the MDWC, NHP and USFWS (43 FR 6233; February 14, 1978). A USFWS range mapping indicates bald eagle nesting territories along the Back Bay of Biloxi, a potential final receptor for run-off from the NCBC.

The black rail (Laterallus jamaicensis) breeds along the coast from Massachusetts south to Florida, and locally inland to Iowa and Kansas. It winters along the southern coast of the United States. Typically, this species inhabits salt marshes with low-growing vegetation, but it is also known from freshwater marshes and meadows. NHP reports a sighting of a black rail on the beach within three miles of the NCBC. Isopods, insects and spiders are the primary food items in the diet of this rail. Due to its secretive habits, little is known about this species, including its exact distribution (Kale, 1978). The NHP considers this species to be rare. The appropriate habitat for this species is not present at the NCBC property.

The eastern brown pelican (Pelecanus occidentalis carolinensis) can be found along the eastern seaboard from North Carolina through the Gulf states into Central and South America. Nesting colonies occur along the coast, usually on mangrove islands or undisturbed fringe areas. The brown pelican preys exclusively on fish, usually feeding in shallow estuarine waters. Though seemingly common along the shore, they are sensitive to some forms of water pollution (pesticides) (Kale, 1978). The USFWS (35 FR 8495; June 2, 1970) categorizes this species as endangered, but it is anticipated that the brown pelican will soon be removed from the federal listing. The MDWC and NHP currently consider the brown pelican to be an endangered species. Due to NCBC's proximity to the Gulf, this species may occasionally be observed.

The least tern (Sterna albiforns) is listed as rare by NHP. The subspecies S. a. antillarum is known from coastal Louisiana to Florida and northwards in coastal habitats as far north as Maine. Although the preferred natural habitat is coastal beaches and sand dunes, this tern is opportunistic a will readily utilize manmade habitats, often nesting on gravel roof tops a spoil banks. These shore birds prey on small bait fish (Kale, 1978). Due t NCBC's proximity to the Gulf, this species may occasionally be observed.

The southeastern shrew (Sorex longirostris) occurs throughout the southeastern United States and some portions of the Midwest. Distribution maps indicate that this species occurs in extreme northeastern Mississippi, however, the NHP has a recent (1978) record of the southeastern shrew from the Coastal Pine Meadow of Harrison County. This shrew can tolerate a variety of habitats, including open fields, swamp forests and moist flood plain forests. Their prey are primarily insects and worms. Due to its limited presence, the NHP categorizes the southeastern shrew as a rare species. This species could possibly occur in the wooded areas of the NCBC.

The manatee's (Trichechus manatus) distribution in the United States is primarily limited to the waters surrounding peninsular Florida. Sightings of the manatee along the northen shores of the Gulf of Mexico are uncommon, however, the NHP has records indicating that the species is an occasional resident of the Gulfport area. This aquatic mammal is stricly herbivorous, feeding on plants in the water and along the shoreline. The USFWS (35 FR 8495; June 2, 1970), MDWC and NHP consider the manatee as an endangered species.

4.4.2.2 Flora. Neither the USFWS nor MDWC list any endangered or threatened plant species which occur in the State of Mississippi. There are 221 species of plants listed as either endangered, threatened or rare by the NHP. A computer search of their data base (Wiseman, 1984) indicates that 16 of these species have been recorded in the Coastal Pine Meadows of Harrison County (see Table 4-7). At least one of these (Lilaeopsis carolinensis) was found at the NCBC during the on-site survey. These 16 species are discussed below.

The spreading pogonia (Cleistes divaricata) has its distribution in the eastern United States, ranging from Delaware south to northern peninsular Florida and westward to southeastern Texas; additional occurrences are known from Kentucky and Tennessee. This terrestrial orchid prefers the habitats afforded by pine savannas and flatwoods, bogs, swamps, and along stream banks (Godfrey and Wooten, 1979). The NHP considers this plant to be rare in Mississippi. This species could potentially be found at the NCBC.

The balsamscale (Elyonurus tripsacoides) is a perennial grass found in pine savannas and flatwoods or low wet prairies. It is usually found in association with sandy peat or marly soils. It ranges in the United States along the coastal plain from Florida to Texas (Godfrey and Wooten, 1979). The NHP considers the balsamscale to be a rare species. This grass could potentially be found at the NCBC.

The green fly orchid (Epidendrum conopseum) though uncommon, is found from Georgia to Mississippi. An epiphytic plant, it can be found growing on a variety of trees in swamps and forests (Radford, 1968). This orchid is known from the Coastal Pine Meadows area of Harrison County and is listed as rare by the NHP. It is not expected that this species would be found on the NCBC. A species of pipewort (Eriocaulon lineare) typically ranges from the coastal plains of North Carolina south to Florida and west to Alabama. The NHP has a record of this species from the Coastal Pine Meadows of Harrison County. Sandy or peaty lake shores, margins of pineland ponds, ditches and savannas

Table 4-7

List of Endangered, Threatened and Rare Plant Species of the Coastal Pine Meadows Region

Scientific Name	Common Name	NHP	USFWS/State
Plants:			
Cleistes divaricata	Spreading Pogonia	R	None
Elyonurus tripsacoides	Balsam scale	R	
Epidendrum conopseum	Green Fly Orchid	R	
Eriocaulon lineare	Pipewort	R	
Gaylussacia frondosa	Dangleberry	R	
Lilaeopsis carolinensis[a,b]	Parsley	R	
Paspalum monostachym	Paspalum	R	
Petalostemum gracile	Prairie Clover	R	
Pinguicula primuliflora	Butterwort	R	
Plantanthera blephariglottis	Large White Fringed-Orchid	R	
Plantanthera cristata	Crested Fringed-Orchid	R	
Polanisia tenuifolia	Clammy-Weed	R	
Polygala hookeri	Milkwort	R	
Quercus myrtifolia	Murtle Oak	R	
Rhynchospora macra	Beak Rush	R	
Spiranthes longilabris	Giant Spiral-Orchid	R	

[a]Reported to occur within a three mile radius of NCBC.
[b]Reported to be on NCBC property.

USFWS - U.S. Fish and Wildlife Service
NHP - Mississippi Natural Heritage Program
E - Endangered
T - Threatened
R - Rare

comprise the variety of wetland habitats in which this species is found (Godfrey and Wooten, 1979). The NHP categorizes E. lineare as a rare species. This species could occur in the wetland areas of the NCBC.

The dangleberry (Gaylussacia frondosa) occurs from New Hampshire southward to central Florida and west to southern Mississippi. The variety of plants from south Georgia, Florida and Mississippi tend to be of a smaller stature than those found to the north. The dangleberry is known to occur in a number of habitats: well-drained to moist weedlands and thickets, bottomland woodlands, poorly drained to well-drained pinelands, sphagnous bogs, shrub-tree bogs or bays (Godfrey and Wooten, 1981). This species is considered rare by the NHP. This species could occur on the NCBC.

A member of the parsley family (Lilaeopsis carolinensis) ranges along the coastal plain from Virginia south to northern Florida and west to Louisiana. Often growing in thick, tangled mats, this plant can be found growing in fresh shallow water pools, marshes, swamps and ditches usually near or on muddy shores (Godfrey and Wooten, 1981). NHP records indicate this species has been found within a three mile radius of the NCBC. During the IAS on-site survey, L. carolinensis was seen growing in association with some of the drainage ditches on the NCBC property. This wetland species is listed as rare by the NHP.

A grass species (Paspalum monostachyum) is found in the southeast United States from southern Florida west to Louisiana and Texas. This plant is found in association with wet prairies and marshes, seasonally wet depressions in pinelands and adjacent ditches and roadsides (Godfrey and Wooten, 1979). The NHP considers this grass to be rare. This species could occur at the NCBC.

The prairie-clover (Petalostemum gracile) can be found growing along the coastal plain from Georgia and north Florida westward to Mississippi. This perennial herb is generally found in those areas of pine savannas and flatwoods that are seasonally wet. Slopes with sufficient moisture due to seepage will provide suitable habitat as well (Godfrey and Wooten, 1981). The prairie-clover is assigned the rare status by NHP. This species could occur at the NCBC.

A species of butterwort (Pingquicula primuliflora) is limited in distribution to the western Florida panhandle, southwestern Georgia, southern Alabama and Mississippi. Its habitat requirements seem to be fairly specific. It can be found in shallow, usually flowing water of springy areas, boggy banks of small streams, swamps, and on rare occasions, in ditches with flowing water. Dense to partial shade seems to be an additional requirement of this species (Godfrey and Wooten, 1981). This species of butterwort is categorized as rare by the NHP. The habitat required of this species does not appear to be available at the NCBC.

The large white fringed-orchid (Plantanthera blephariglottis) ranges widely, being found in regions of the northeast as well as along the coastal plains from Virginia south to Florida and westward to Texas. This terestrial orchid favors the wetland habitats afforded by marshes, meadows and depressions in pine savannas and flatwoods (Godfrey and Wooten, 1979). The large white fringed-orchid is considered rare by the NHP. This species could potentially occur at the NCBC.

The crested fringed-orchid (Plantanthera cristata) can be found in suitable habitat from eastern Massachusetts southward to central Florida and westward to southeast Texas. Inland, the species is known from Arkansas and Tennessee. The crested fringed-orchid can be found growing in a variety of wetland areas: bogs, meadows, pine savannas and flatwoods, along streams in woods, borders of cypress swamps and depressions (Godfrey and Wooten, 1979). This orchid is categorized as rare by the NHP. This species could potentially inhabit the NCBC.

The clammyweed (Polanisia tenuifolia) is typically found on sand dunes and open wooded dunes. It apparently is seldom found with other plants. The NHP has one record of this species for Harrison County occurring on Cat Island. For the entire state, all occurrences are reported from the barrier islands (Wiseman, 1985). Thus, the clammyweed is considered a rare species by the NHP. This species would not be found at the NCBC.

The milkwort (Polygala hookeri) is limited in the coastal plain from southeastern North Carolina to the Florida panhandle westward to Mississippi. Pine savannas and flatwoods provide suitable habitat for this species (Godfrey and Wooten, 1981). The milkwort is presently listed at rare by the NHP. This species could potentially occur at the NCBC.

The myrtle oak (Quercus myrtifolia) is known from extreme southern South Carolina to south Florida. It also narrowly fringes the Gulf coast westward to Mississippi. This small tree often forms a shrub thicket in areas where dry sandy ridges or sand dunes prevail (Little, 1980). The myrtle oak is presently considered as a rare species by NHP. This species' habitat is limited at the NCBC and probably does not occur on the property.

The beak rush (Rhynchospora macra) can be found in bogs and wet pine savannas and flatwoods from Georgia and the Florida panhandle westward to the eastern portions of Texas (Godfrey and Wooten, 1979). This wetland species is presently listed as rare by the NHP. This species could potentially occur at the NCBC.

The giant spiral orchid (Spiranthes longilabris) ranges along the coastal plain from North Carolina to south Florida and westward to the southeastern region of Texas. This species can be found in a variety of wetland habitats: wet pine savannas and flatwoods, swamps, marshes, wet praries and sandy bogs (Godfrey and Wooten, 1979). The NHP categorizes the giant spiral orchid as a rare species. This species could potentially occur at the NCBC.

4.5 PHYSICAL FEATURES

4.5.1 Climatology. The humid temperate to subtropical climate of the Gulfport area is influenced by the Gulf of Mexico to the south and the land mass to the north. Along the coast, the relative humidity monthly means range from 80 percent in January to a low of 72 percent in October. Fog is relatively common, particularly between the months of November and April (Mississippi AWPCC, 1976). In a typical year, the county receives slightly less than two-thirds of the possible sunshine (Soil Conservation Service, 1975). Warm temperatures can be expected beginning in May and continuing into September. Temperatures of 90°F or higher have occurred at Gulfport as early as May 4th (1951) and as late as October 16th (1947); the annual mean number of days with such temperatures is 66 (Soil Conservation Service, 1975). At the NCBC, the annual maximum temperature normal is 77.5°F (see Table 4-8). October through April is relatively mild with temperatures usually above

Table 4-8

Monthly Normals of Temperature and Precipitation for the
Gulfport Naval Construction Batallion Center

Temperature Normals (DEG F)*													
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Max	61.0	64.1	70.0	77.5	84.2	89.8	91.2	90.9	87.6	80.0	70.0	63.6	77.5
Min	42.2	44.2	50.8	59.1	65.6	71.3	73.2	72.7	69.1	58.0	49.1	44.2	58.3
Mean	51.6	54.2	60.4	68.3	74.9	80.6	82.2	81.8	78.4	69.1	59.6	53.9	67.9
Precipitation Normals (inches)*													
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
	5.23	4.98	5.41	5.33	4.95	4.64	7.13	5.77	7.23	2.98	3.81	5.39	62.85

*Values are based on records for the 30-year period 1951-1981, inclusive.

Source: Adapted from National Oceanic and Atmospheric Administration, 1982 freezing during the day (Gulf Regional Planning Commission, 1980). Temperatures of 32°F or lower have occurred at Gulfport as early in fall as November 3rd (1966, 27°) and as late as March 27th (1955, 27°F). The annual mean number of days in which the temperature is at or below freezing is 16 days (Soil Conservation Service, 1975). The annual minimum temperature normal for the NCBC is 58.3°F (see Table 4-8).

Annual rainfall averages 60 inches along the Mississippi coastline. Records from the NCBC indicate that September is the wettest month while October is the driest (See Table 4-8). There is an average of 60 to 80 thunderstorms per year with occasional torrential rains yielding 12 inches in a 24-hour period (Gulf Regional Planning Commission, 1980). Normally, winter storms are cold and rainy; years may go by with no snowfall or amounts to small to measure (Soil Conservation Service, 1975). Monthly precipitation normals for the NCBC are included in Table 4-8.

The mean annual pan evaporation for the Mississippi coastal area is 48 inches with the average May to October evaporation equal to 66 percent of the total (Christmas, 1973). The prevailing winds are from the south during the spring and early summer, from the east during the late summer, and from the north the remainder of the year (Mississippi AWPCC, 1976). Wind speeds are generally under 10 miles per hour. Wind speeds of 45 miles per hour or more recur approximately every two years (Soil Conservation Service, 1975).

Tropical storms or hurricanes occasionally pass through the Gulfport area inflicting wind and flood damage. The most notable in recent years was Hurricane Camille (1969) which had a 23 foot tidal surge. This storm has been estimated to have a recurrence period of 170 years (Mississippi AWPCC, 1978a).

4.5.2 Topography. Harrison County contains two physiographic regions of the East Gulf Coastal Plain. The Coastal Pine Meadows Region, which encompasses the NCBC, extends from the shoreline fifteen to twenty miles inland and is basically flat with a slight upward sloping to the north. It is at this somewhat ill-defined boundary that an undulating area of rolling hills known as the Longleaf Pine Hills Region begins. Elevation differences in this area may vary as much as 150 feet between stream-beds and ridgetops (Mississippi AWPCC, 1978a).

Most of Harrison County is gently rolling terrain with well established stream valleys. The drainage pattern is dendritic. Elevations range from sea level on the coast to 230 feet above sea level in the north-central part of the county (Newcome, 1968). At the NCBC, elevations typically range from 20 to 35 feet above sea level. The average elevation is about 23 feet above sea level and there is little topographic relief except near the bauxite piles which are approximately 70 feet above sea level (SOUTHNAVFACENGCOM, 1984a).

Harrison County lies within the 1,560 square mile Coastal Streams Basin which is mainly bounded by the Pearl River Basin to the west, the Pascagoula River Basin to the north and east, and the Gulf of Mexico to the south (Mississippi AWPCC, 1976). Most of the NCBC is located within the 76 square mile Bernard Bayou wastershed, a tributary to Biloxi Bay. The watershed area is bounded by the Biloxi River watershed on the north and east, by the Wolf River watershed to the west, and by coastal areas adjacent to the Mississippi Sound on the south (Gulf Coast Regional Planning Commission, 1980). Named tributaries include Brickyard Bayou and Turkey Creek. Section 4.5.5.1 provides detailed information concerning surface drainage patterns at the NCBC.

4.5.3 Geology. The Late Tertiary Gulf Coast Geosyncline is the primary geologic feature in the area. This downward flexure of the earth's crust originates approximately 100 miles into the Gulf of Mexico with the axis oriented in an east to west direction (Garner Russell, 1977). The major axis of the geosyncline approximately parallels the Louisiana coastline (Newcome, 1968). The trough created by the geosyncline has been filled with river and stream sediments flowing into the Gulf of Mexico during the past 15 million years (Garner Russell, 1977).

4.5.3.1 Stratigraphy. The geologic sequences found in southern Mississippi are illustrated in Table 4-9. A description of the various geologic formations, in descending order, are as follows.

4.5.3.1.1 The alluvium is of Holocene age and composed of deposits of chert and quartz gravels and sands grading up into sandy clays and silt. In and near tidal marshes, much organic debris has accumulated (Brown, 1944).

4.5.3.1.2 The terrace deposits are of Pleistocene age and consist of sand and gravel with pebbles of quartz and brown chert. Chert pebbles are less abundant and quartz more abundant than the older underlying sediments of the Citronelle Formation (Brown, 1944).

4.5.3.1.3 The Citronelle Formation consists of sediments of Pliocene age, chiefly non-marine, that occur near the seaward margin of the Gulf Coastal Plain, extending from a short distance east of the western boundary of Florida westward to Texas (Boswell, 1979). The formation disconformably rests on the beveled clays and silts of the Graham Ferry and Pascagoula Formations.

The Citronelle Formation is composed mostly of quartz sand, chert gravel, and lenses and layers of clay, in proportions that vary from place to place; however, the percentage of gravel decreases southward. Erosion during the Pleistocene and Holocene has reduced the areal extent of the formation and has left a southward-thickening wedge of highly dissected and discontinuous ridgeforming strata. Only along the Gulf Coast and in the Louisiana border counties of southwestern Mississippi does the Citronelle Formation have continuity into the subsurface. At Gulfport, the base of the formation is approximately 100 feet below National Geodetic Vertical Datum (NGVD) of 1929 (Boswell, 1979). Figure 4-6 provides a mapping of the Citronelle Formation in the Gulfport area.

4.5.3.1.4 The Graham Ferry Formation is a series of deltaic sediments of Pliocene age located below the Citronelle Formation and above the Pascagoula Formation. The formation consists of silty clay and shale, sand, silty sand and gravelly sand and gravel in heterogeneous deltaic masses. The formation consists of both continental and marine beds (Brown, 1944).

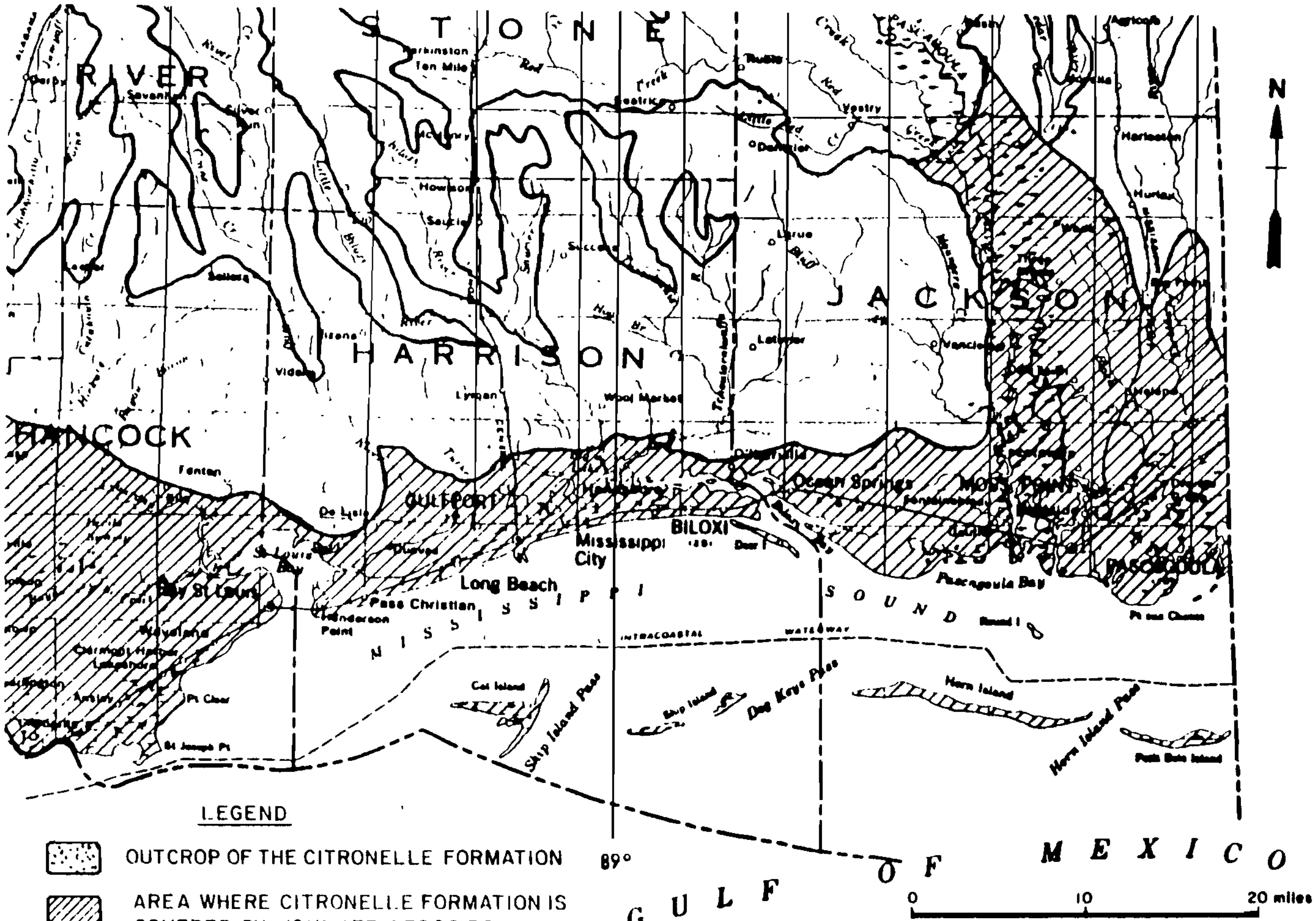
4.5.3.1.5 The Pascagoula Formation consists of sediments of Miocene age located below the Graham Ferry Formation and above the Hattiesburg Formation. The formation consists of clay and shale, generally blue-green, silt, sandy shale, grey and green sand, grey and silty clay and dark sandy gravel

Table 4-9

Generalized Stratigraphic Column for Southern Mississippi

Era	System	Series	Stratigraphic Unit	Thickness (feet)
Cenozoic	Quaternary	Holocene	Alluvium	0-80
		Pleistocene	Terrace Deposits	0-100
			Citronelle	0-100
	Tertiary	Pliocene	Graham Ferry	0-200
		Miocene	Pascagoula	0-1000
			Hattiesburg	0-400
			Catahoula	500-900

Source: Shows, 1970



LEGEND

OUTCROP OF THE CITRONELLE FORMATION

AREA WHERE CITRONELLE FORMATION IS COVERED BY YOUNGER DEPOSITS

SOURCE:
BOSWELL, 1979

FIGURE 4-6

Map of the Citronelle formation in Harrison County area

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containing numerous grains and pebbles of polished black chert. The formation is mostly of deltaic or estuarine origin and the brackish water clam is a characteristic fossil of the formation (Brown, 1944).

4.5.3.1.6 The Hattiesburg Formation consists of sediments of Miocene age located below the Pascagoula Formation and above the Catahoula Formation. The stratigraphic base of the formation is arbitrary. The formation consists of gray-green and blue-green shale and clay which are mostly carbonaceous and non-calcareous (Brown, 1944).

4.5.3.1.7 The Catahoula Formation consists of sediments of early Miocene age located below the Hattiesburg Formation. The top of the formation is an arbitrary boundary. The formation consists of shale, sandy shale, sand, clay and silt, and gravelly sands containing black chert (Brown, 1944).

4.5.4 Soils. Two soil associations (or map units) constitute the NCBC soils, the Smithton-Plummer association and the Atmore-Harleston-Plummer association. The descriptions given below are from the Soil Survey of Harrison County, Mississippi (Soil Conservation Service, 1975).

The southeastern portion of the property is typified by the Smithton-Plummer association. This assoication is on broad flats and in drainageways and depressional areas in the southern part of the county. The areas are about one-fourth mile to more than one mile wide, several miles long, and irregular. Several areas of better drained soils are on low ridges. Most areas in this association are flooded or have water standing on the surface for long periods. This association makes up about 10 percent of the county. It is about 60 percent Smithton soils, 30 percent Plummer soils, and 10 percent Hyde and Poarch soils. Smithton soils are poorly drained. They have a fine sandy loam surface layer and subsoil. Plummer soils are also poorly drained and have a thick loamy sand surface layer and a sandy loam subsoil.

The Atmore-Harleston-Plummer association typifies the majority of the Navy property. This association is on broad nearly level flats that are broken by scattered drainageways and numerous low ridges where the soils are gently sloping. It is in the southern part of the county. Many of the ridges are narrow, and most are less than one-fourth mile wide. This association makes up about four percent of the county. It is about 55 percent Atmore soils, 15 percent Harleston soils, 5 percent Plummer soils, and 25 percent Latonia, Poarch, Ocilla, and Escambia soils. Atmore soils are on the broad flats and in drainageways and depressional areas. They are poorly drained and have a silt loam surface layer and a subsoil that is silt loam in the upper part and becomes clayey with depth. Harleston soils are on the low ridges. They are moderately well drained and have a fine sandy loam surface layer and subsoil. The Plummer soils are poorly drained and have a thick loamy sand surface layer and a sandy loam subsoil.

The specific soil constituents of the NCBC are shown in detail in Figure 4-7. The characteristics of each of soil type are provided in Table 4-10.

4.5.5 Hydrology.

4.5.5.1 Surface Water. Surface runoff at the NCBC is conveyed off base by a system of drainage ditches and storm sewers. Figure 4-8 shows the general drainage patterns at the NCBC, and Figure 4-9 provides a map of surrounding

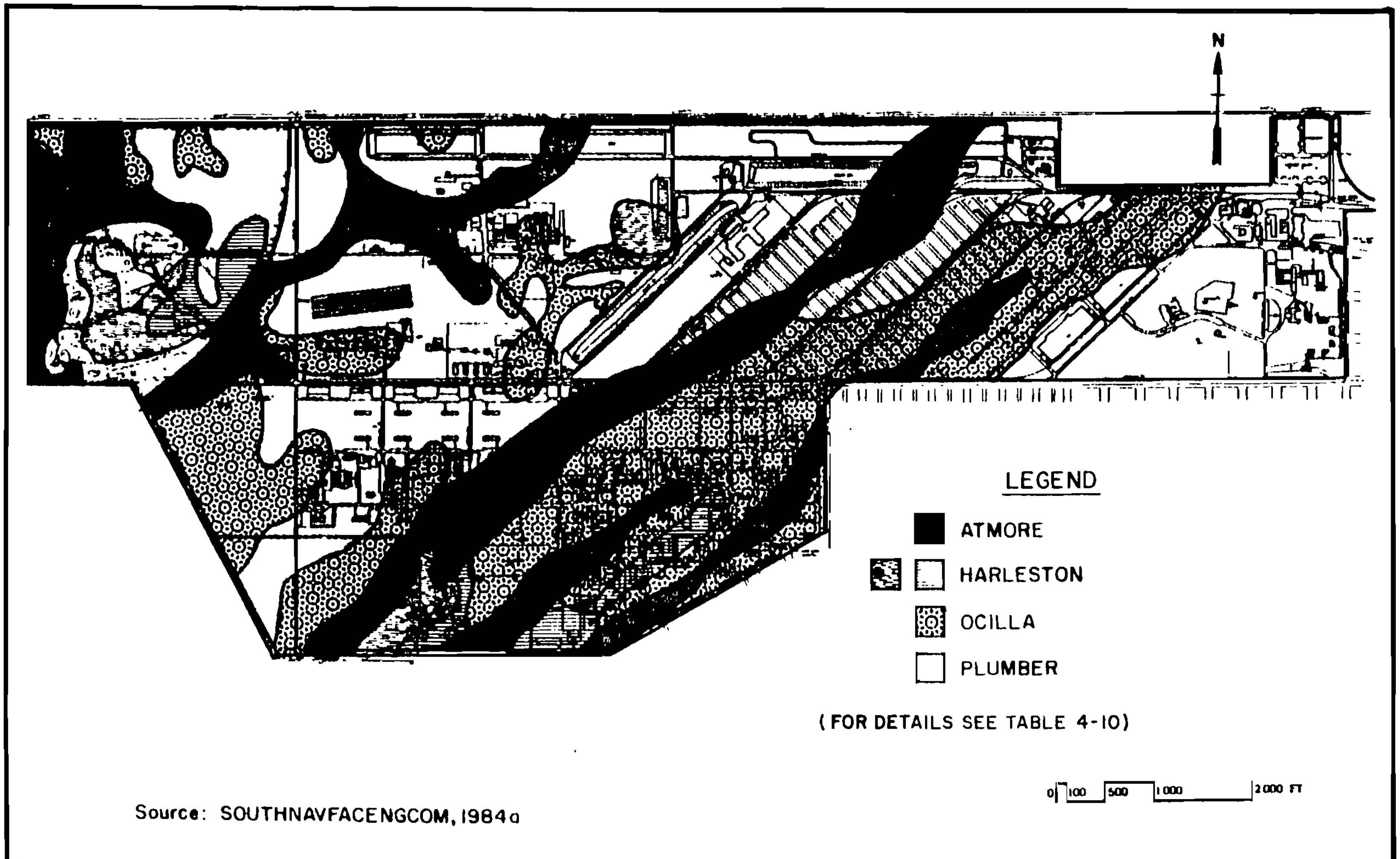

FIGURE 4-7

General Soils Map

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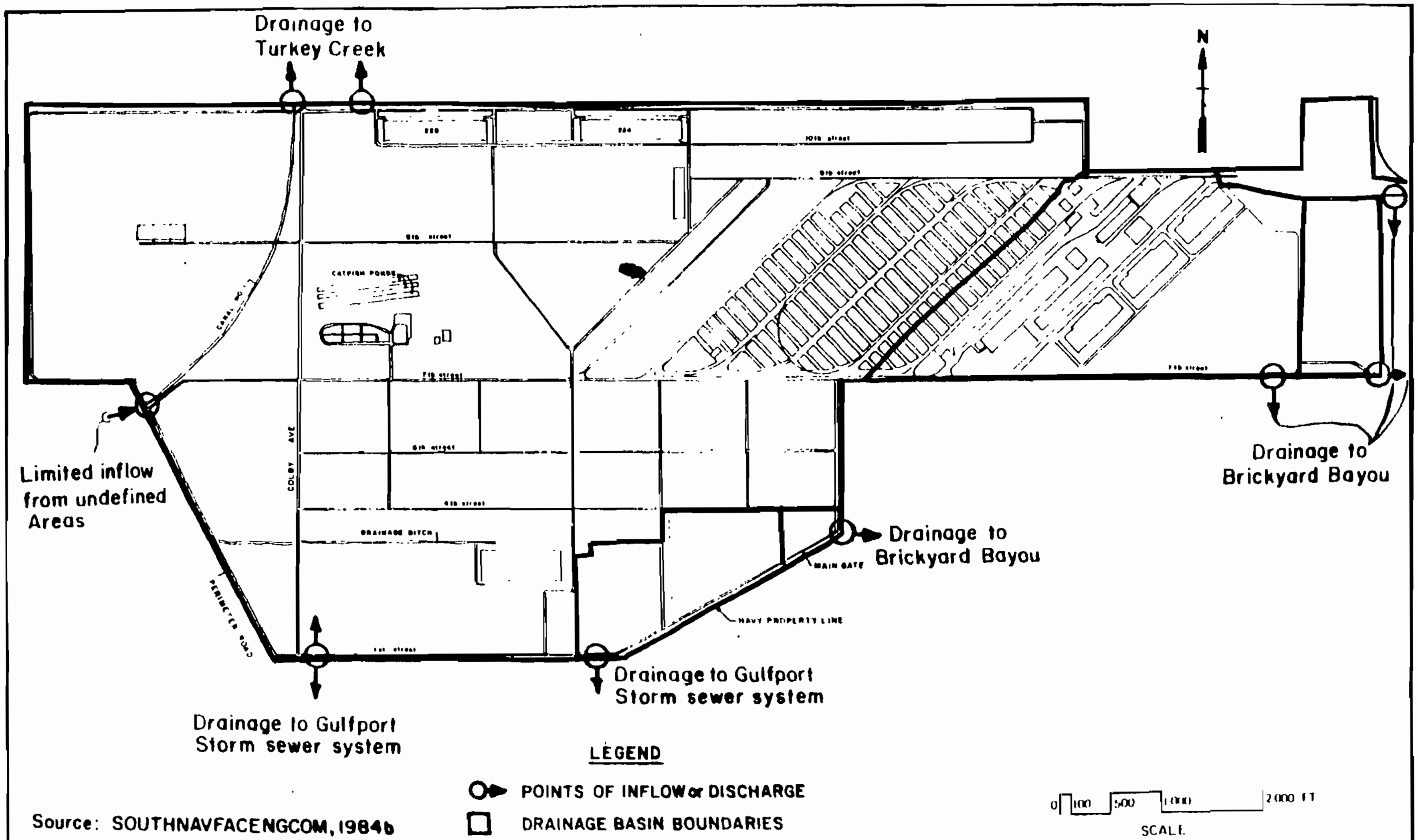
Table 4-10

Characteristics of Soil Types Occuring at the NCBC, Gulfport, Mississippi

Soil Series & Map Symbols	Depth to Seasonal High Water Table (In.)	Depth from Surface (In.)	Classification USDA Texture	Permeability (In. per hour)	Available Water Capacity (In. per inch of soil depth)	Shrink Well Potential	Erosion Hazard
Atmore: AT	(a)	0-39	Silt Loam	0.63-2.00	0.18-0.24	Low	Slight
		39-51	Loam	0.63-2.00	0.12-0.18	Low	
		51-59	Clay	0.06-0.20	0.10-0.18	Med	
		59-78	Clay Loam	0.20-0.63	0.12-0.20	Low	
Harleston: HIA, HIB	18-24	0-43	Fine Sandy Loam	0.63-2.00	0.10-0.15	Low	Slight
		43-58	Sandy Clay Loam	0.63-2.00	0.10-0.15	Low	
		58-98	Fine Sandy Loam	0.63-2.00	0.10-0.15	Low	
Ocilla: OC	0-15	0-21	Loamy Sand	2.00-6.30	0.60-0.10	Low	Slight
		21-67	Sandy Loam	0.63-2.00	0.10-0.14	Low	
Plummer: PM	0-15	0-43	Loamy Sand	2.00-6.30	0.05-0.10	Low	Slight
		43-64	Sandy Loam	0.63-2.00	0.10-0.15	Low	
		64-72	Loamy Sand	6.3-20.00	0.05-0.10	Low	

[a] Water table at or near the surface during winter and spring

Source: Adapted from Soil Conservtion Service, 1975



Source: SOUTHNAVFACENGCOM, 1984b

FIGURE 4-8

Surface Drainage

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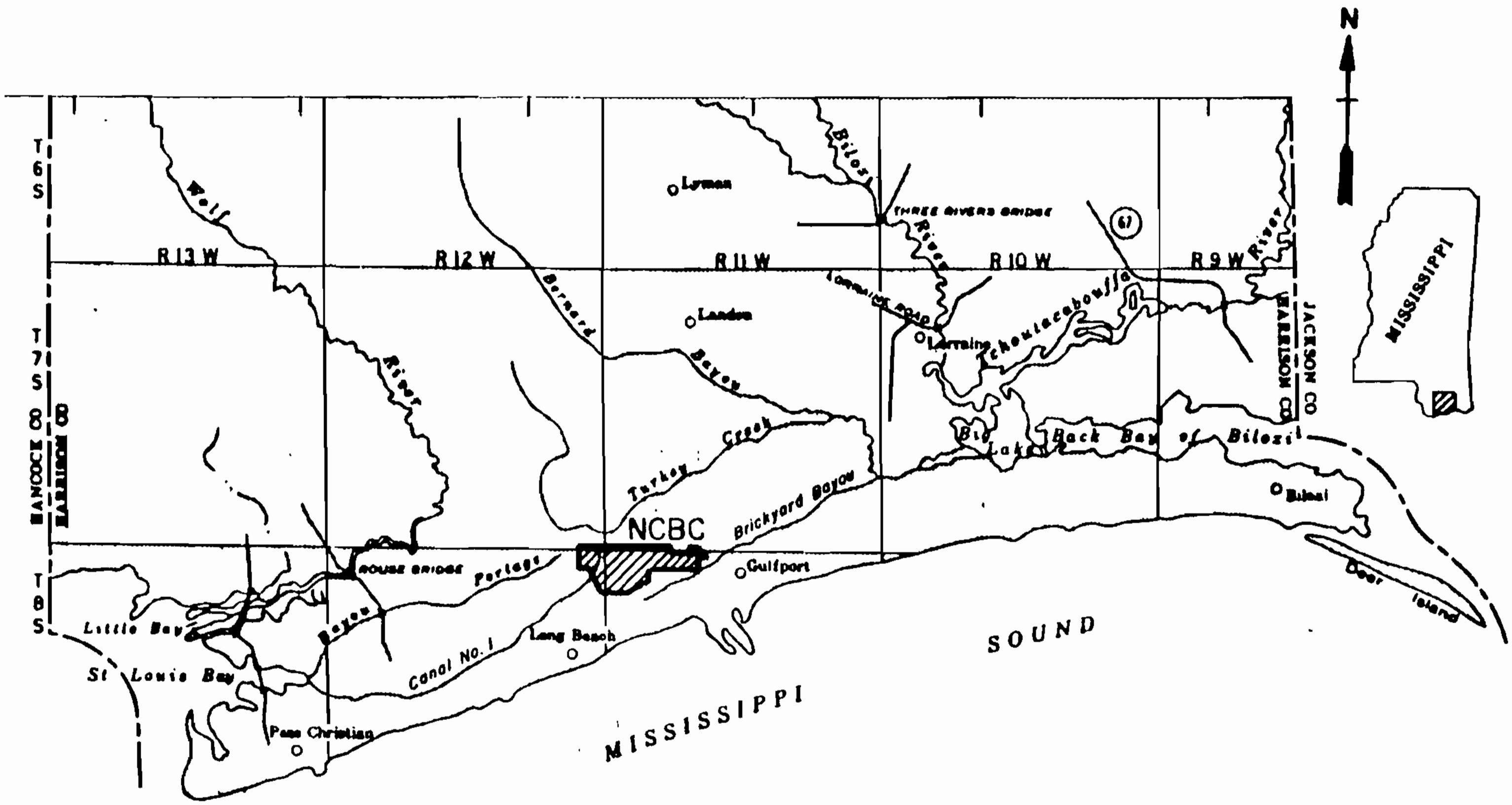

SOURCE: ADAPTED FROM NEWCOME, 1968

FIGURE 4-9

The NCBC and surrounding Surface Waters

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surface waters. The entire base, with an average elevation of about 23 feet above sea level, is above the 100 year flood elevation (SOUTHNAVFACENGCOM, 1984a).

The majority of the NCBC drains into Canal Number 1, which is the major on-site drainage conveyance channel at the NCBC. On Navy property, this canal drains north to Turkey Creek which discharges eastward in succession to Bernard Bayou, Big Lake, the Back Bay of Biloxi, and ultimately to the Mississippi Sound and the Gulf of Mexico. Outside of Navy property, and southwest of the NCBC, Canal Number 1 flows west to Johnson Bayou and St. Louis Bay. The eastern portion of the NCBC drains to Brickyard Bayou, which drains east to Bernard Bayou, with ultimate discharge to the Gulf of Mexico as previously described. Certain areas in the southern portion of the NCBC drain south into the City of Gulfport storm sewer system with ultimate discharge to the Mississippi Sound and the Gulf of Mexico.

Biloxi Bay is classified as Shellfish Harvesting while the Mississippi Sound is classified as Recreational. These classifications represent the two highest uses of surface waters, since these activities represent an important segment of the Coast's economy. Those water bodies classified as shellfish harvesting are primarily for propogation and harvesting of shellfish for sale and use as a food product. The remaining receiving waters which accept surface drainage from the NCBC are all classified as Fish and Wildlife (Mississippi AWPCC, 1978b).

Water quality problems identified in Brickyard Bayou and Turkey Creek include depressed dissolved oxygen concentrations, bacterial contamiation and high nitrogen and phosphorus concentrations. These problems have been attributed primarily to inadequately treated sewage discharges, such as septic tank drainage, and urban runoff (Mississippi AWPCC, 1976).

The water quality in Bernard Bayou has been severely degraded as evidenced by high temperatures, high BOD concentrations, erratic dissolved oxygen concentrations, excessive nitrogen and phosphorus concentrations, high coliform concentrations and sediment samples containing significant concentrations of volatile solids and heavy metals. The degradation of Bernard Bayou has been attributed to discharges of inadequately treated municipal, industrial, and private wastewater, urban runoff, garbage and trash dumps along the banks of the stream and poor aeration (Mississippi AWPCC, 1976).

High fecal coliform densities have been a problem in the Mississippi Sound. This problem has been attributed to inadequate municipal and private sewage treatment plants, extensive unsewered areas and urban runoff (Mississippi AWPCC, 1976).

At the NCBC, four ponds comprising a total area of 10 acres are managed as a recreational fish resource. Three one-acre reclaimed sewage ponds, with an average depth of three feet, are stocked with channel catfish. A seven acre pond, located at the the golf course and approximately five feet deep, is managed for largemouth bass, bluegill, redear sunfish and channel catfish. The golf course pond is also used for irrigation of the golf course (SOUTHNAVFACENGCOM, 1984a).

4.5.5.2 <u>Ground Water</u>. Due to difficulties in identifying and tracing the various geologic divisions (Section 4.5.5.1) into the subsurface for geohydrologic purposes, the ground water in southern Mississippi has been divided into two major systems. The shallowest system being the Citronelle Formation, followed by the Miocene aquifer system which consists of the Pliocene Graham Ferry Formation and the Miocene sequence of the Pascagoula Formation, Hattiesburg Formation and the Catahoula Sandstone. These two aquifer systems are vaguely defined and it is not always clear whether water bearing formations in a given area belong to the Citronelle or Miocene aquifer systems. As a general guide to the ground water in the Gulfport area, the surficial aquifer can be considered to consist of younger deposits which overlay the Citronelle Formation, with the first underlying artesian aquifer being part of the Citronelle Formation and deeper underlying aquifers being part of the Miocene aquifer system (Boswell, 1985).

4.5.5.2.1 Three well logs at the NCBC (NCBC Public Works Drawing No. 10-51) indicate that the surficial aquifer at the NCBC consists of sands and sand and gravel ranging from 13 to 45 feet in thickness, which are underlain by a layer of clay ranging in thickness from 28 to 197 feet. These surficial sands represent younger deposits which overlie the Citronelle Formation along the Mississippi Coast (Figure 4-6) and possibly upper portions of the Citronelle Formation.

At the NCBC, localized ground water flow in the surficial aquifer is from topographic highs to areas of discharge such as nearby drainage ditches or canals. The regional ground water gradient is southward to the Mississippi Sound.

There are no published detailed investigations or mappings of the surficial aquifer in the Gulfport area. Currently, the United States Geological Survey Office in Jackson, Mississippi is conducting a surficial ground water study which covers the northern part of Gulfport as the southern limit of the study. However, no reports have been published yet (Boswell, 1985).

4.5.5.2.2 The Citronelle Formation is composed mostly of quartz sand, chert gravel, and lenses and layers of clay, in proportions that vary from place to place, as described in Section 4.5.3.1 (Boswell, 1979). The Citronelle deposits generally cover the surface of southern Mississippi (Figure 4-6) (Shows, 1970). The formation which is highly dissected by streams in its area of outcrop, makes up many discontinuous and hydrologically independent water-bearing units or aquifers (Boswell, 1979). The formation varies from 80 to 100 feet in thickness, unless the unit is missing due to erosion. The slope of the Citronelle deposits is generally toward the south at 6 to 25 feet per mile (Shows, 1970). At Gulfport, the Citronelle is covered by younger deposits and the base of the formation is about 100 feet below the 1929 NGVD (Boswell, 1979).

The Citronelle Formation is very permeable and readily receives and transmits water from precipitation. Water infiltrates to the water table and then either moves laterally to valley walls to be discharged by springs and seeps or continues downward into underlying Miocene aquifers (Section 4.5.5.2.2). Where the underlying units are permeable sand, a large part of the water may continue downward and where underlying clays predominate, most of the water moves laterally to discharge points. The Citronelle Formation functions as a principal source of the water that sustains the low flow of many streams. Because of this drainage effect, only a part of the permeable sand and gravel in the Citronelle is saturated. The saturated zone thickens Southward as the unit thickens. In the extreme southern part of Mississippi, many sand beds are completely saturated and, in some places, confined (Boswell, 1979). Well logs at the NCBC (NCBC Public Works Drawing No. 10-51) indicate that the Citronelle aquifer is probably confined within the area of the base. Free flowing conditions have been encountered during well drilling at NCBC as described in Section 4.5.3.3. Water levels in the Citronelle aquifers change seasonally. The highest levels occur in the spring as a result of the rains and from reduced evapotranspiration during the winter and early spring (Boswell, 1979).

The hydraulic gradient in the Citronelle aquifer, in areas where it is unconfined, can be roughly approximated by assuming that it corresponds to the slope of the deposits, which varies from 6 to 25 feet per mile. The Citronelle aquifer has an average hydraulic conductivity of about 150 feet per day (Newcome, 1975). Applying Darcy's law and assuming a hydraulic gradient of 6 to 25 feet per mile, the rate of regional ground water flow in the Citronelle aquifer ranges from about 60 to 260 feet per year toward the south.

Water from the Citronelle aquifer is generally good for most purposes. The water typically has a low pH, is soft to moderately hard and the mineral content is low (Shows, 1970). The water has dissolved solids of less than 1,000 milligrams per liter (mg/l) except in small areas along the Gulf Coast where saltwater has intruded from estuarine streams, or from the Mississippi Sound (Boswell, 1979).

The Citronelle Formation is the shallowest significant source of ground water in much of southern Mississippi. A large number of domestic wells and a few municipal wells are completed in the Citronelle aquifer in southern Mississippi (Shows, 1970). In the coastal lowlands, wells are drilled several hundred feet below the Citronelle aquifer for the large natural flows that can be obtained from the Miocene aquifers (Boswell, 1979). This is the case at the NCBC where all water supply wells tap the Miocene aquifer system, as described in Section 4.5.5.3.

4.5.5.2.3 The Miocene sequence in southern Mississippi has been subdivided by some workers into the Pascagoula Formation, Hattiesburg Formation and Catahoula Sandstone (Section 4.5.3) from youngest to oldest, but these divisions cannot be reliably identified or traced in the subsurface. Likewise, a unit at the top in the coastal counties has been identified as Pliocene in age on the basis of fossil evidence and assigned the name Graham Ferry Formation. Again, the unit cannot be distinguished from the next lower formation by lithological, geophysical, or hydrological means. Consequently, all the material between the Citronelle Formation, a blanket deposit of Pliocene age, and the base of the Catahoula Sandstone is herein considered to compose the Miocene aquifer system (Newcome, 1975).

The Miocene aquifers in the coastal counties consist of thick beds of sand or gravel separated by clay layers (Shows, 1970). These water bearing sands, or aquifers occur irregularly through the Miocene sequence and are composed chiefly of clear quartz sand and are tan or light gray. There are no thick consistently traceable clay beds (Newcome, 1968).

Because of the lenticularity of the sand beds, the sand intervals do not extend very far laterally (Newcome, 1975). Both the bed thickness and the grain size vary considerably within short distances which is a characteristic effect of deltaic and estuarine deposition. Many beds are more than 100 feet thick (Newcome, 1968). At any site, multiple aquifers or zones of sand are likely to occur and many of these are hydraulically connected (Newcome, 1975). The number of major aquifers underlying the coast has not yet been established, but water bearing units probably underlie most of the coastal area (Gulf Regional Planning Commission, 1980). Electric logs of oil tests at 11 sites in Harrison County indicate the presence of up to 11 fresh-water sand intervals at a given site (Newcome, 1968). At the NCBC, well logs of three of the water supply wells (Wells L160, L161 and L162) indicate the presence of six to seven beds of sand in the upper part of the Miocene aquifer system, which differ in elevation and thickness among the three sites. This information is summarized in Table 4-11. Further details on the wells, including their location, is provided in Section 4.5.5.3.

The Miocene aquifers are recharged by rainfall directly on the outcrops to the north of the coastal areas, by infiltration from overlying surficial deposits (Citronelle Formation and younger sediments), and by interaquifer movement through the clay and silt beds that separate sand units. In Harrison County, the sand beds or lenses are sufficiently interconnected hydraulically to permit interflow but not to create a pressure common to all the aquifers (Newcome, 1968). Water levels in the Miocene aquifer system are declining regionally at a rate of one to two feet per year. Near centers of heavy pumping, the annual decline is much greater (Newcome, 1975). In the Gulfport area, current water levels in the 600-900 feet zone of the Miocene aquifer system range from approximately 40 to 50 feet below ground (Boswell, 1984). At the NCBC the static water levels in the water supply wells L160, L161, and L162 (Table 4-11) when first installed in 1942, were from 14 to 15 feet above ground. The water level in Well L160 was measured in November of 1965 at one foot above the land surface (Newcome, 1968). Well A, another water supply well installed in 1978, had a static level of minus 39 feet below ground.

Water movement is gulfward, in the direction of the regional formation dip towards areas of artificial discharge (pumping) or natural discharge (upward leakage or to the sea). The potentiometric surface slopes at a low rate, probably less than five feet per mile (ft/mile) except near pumping centers (Newcome, 1975). Pumping tests in the Gulfport area indicate that hydraulic conductivities in the Miocene aquifers range from about 195 to 1,200 gallons per day per square foot (Newcome, 1968). Applying Darcy's law and assuming a hydraulic gradient of five feet per mile, the rate of ground water flow ranges from about 9 to 56 feet per year.

Fresh water is available from the Miocene aquifers wherever the system occurs. However, in much of southern Mississippi, the lower part of the Miocene series contains saline water (Newcome, 1975). Figure 4-10 provides a map of the altitude of the base of the fresh groundwater. In the Gulfport area, the base of the fresh ground water is approximately 2,500 feet below sea level.

The quality of the water in the Miocene aquifers is generally good, the only substantial problem being excessive iron in places. In many, if not most, of the high-iron situations the acidic nature of the water probably is responsible for corrosion of iron fittings and the consequent inclusion of the occurrence of acidic water. The water is almost exclusively a soft, sodium bicarbonate type and is markedly uniform aerially and stratigraphically (Newcome, 1975).

Table 4-11

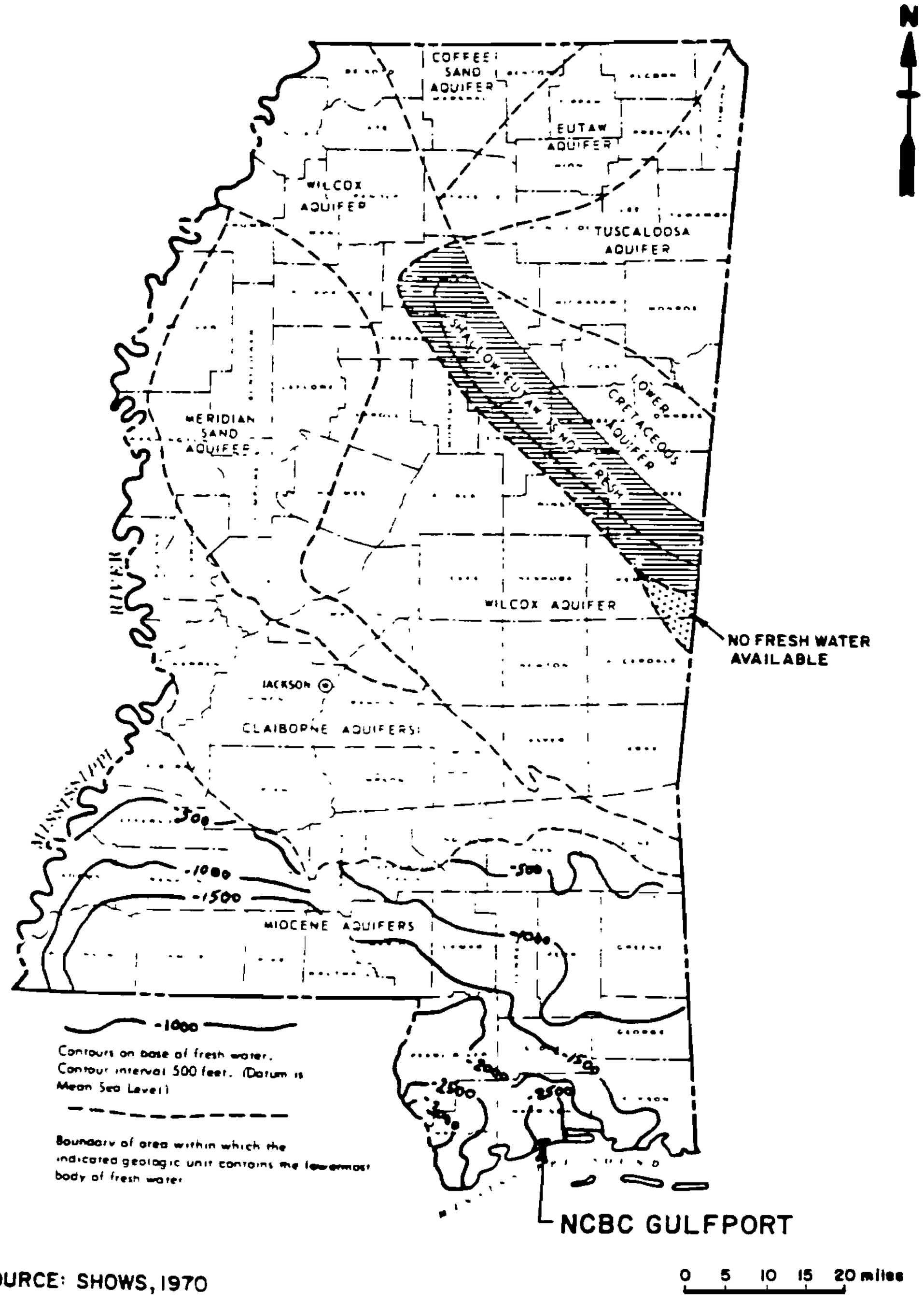
Sand Beds in Miocene Aquifer System at NCBC

Well L160 Well Finished: 8/31/42 Ground Elevation: 23.0' Total Log Depth: 1230' Static Head: 15' above ground			Well L161 Well Finished: 7/13/42 Ground Elevation: 29.0' Total Log Depth: 1288' Static Head: 14' above ground			Well L162 Well Finished: 12/30/42 Ground Elevation: 27.5' Total Log Depth: 1304' Static Head: 15' above ground		
Material	Depth Interval (Below MSL)	Thickness (ft)	Material	Depth Interval (Below MSL)	Thickness (ft)	Material	Depth Interval (Below MSL)	Thickness (ft)
Fine Sand St.	202-213	11	Fine Blue Sand	281-299	18	Fine Sand and Sand	214.5-300.5	86
Fine Sand St.	236-261	25	Sand	393-408	15	Fine Sand	572.5-610.5	38
Sand	713-731	18	Sand	459-480	21	Sand	644.5-732.5*	88
Fine Sand and Sand	847-893	46	Fine Loose Sand and Sand	658-696	38	Sand	779.5-812.5	33
Fine Sand and Sand	1091-1013*	22	Fine Sand	744-756	12	Sand	860.5-905.5	45
Sand	1150-1171*	21	Fine Sand	783-821*	38	Fine Sand St.	954.5-992.5	38
			Sand	1177-1193	16	Sand	1231.5-1251.5	20

*Sand interval in which well screen is set.

Note: Only layers composed of sand indicated (e.g. sandy clays and sandy shales not included). Materials between sand layers consist primarily of clays, sandy clays, and sandy shale.

Source: NCBC Public Works Drawing No. 10-52.



SOURCE: SHOWS, 1970

FIGURE 4-10

Base of Fresh-Water in Mississippi

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Because of its thickness, aerial extent and permeability, the Miocene aquifer system is the largest potential source of ground water supplies in Mississippi. The Miocene aquifer system is currently tapped for slightly more than one-fourth of the ground water withdrawn in Mississippi for uses other than irrigation (Newcome, 1975). All of the water supply wells at the NCBC tap the Miocene aquifer system, as described in Section 4.5.5.3.

4.5.5.3 Water Supply. All of the water utilized at the NCBC is obtained from on-site wells. Table 4-12 provides an inventory of the Navy wells and of nearby municipal water supply wells off Navy property. Figure 4-11 indicates the locations of the various wells.

The NCBC potable water supply system consists of five wells (Wells L160, L161, L162, A and B) that tap the Miocene aquifer system and two 500,000 gallon storage tanks. The five wells range in depth from 722 to 1,196 feet and have a combined capacity of approximtely 3,600 gallons per minute (gpm). Water from the wells is used for potable, industrial, fire fighting and recreational purposes. The only treatment consists of chlorination. The City of Gulfport's municipal water system provides a back-up water supply to NCBC Gulfport.

In addition to the potable water supply wells, there is a 500 foot deep Miocene aquifer well (Well 1) used for process water by the asphalt plant. Another well (Well 2) located at the golf course has been used intermittently since 1971 to replenish water at the golf course lake. Water from the lake is used to irrigate the golf course. The well is approximately 450 feet deep and taps the Miocene aquifer system.

Practice well drilling is carried out on a regular basis by the Naval Construction Training Center in an area approximately 300 yards north of the heavy equipment training area landfill (Site 5). About five wells are drilled per year at a depth of from 85 to 100 feet. The wells, which probably tap the confined Citronelle aquifer, are reportedly free flowing and, after drilling, the wells are pulled and collapsed.

The majority of the municipalities in the state, including all of those on the Gulf Coast, rely on ground water for their public water supplies (Peat, Marwick, Mitchell and Company, 1978). Most major supply wells along the coast tap aquifers that are 600 to 1,200 feet deep. Near the coast, almost all residents are on municipal supplies (Boswell, 1984). In the interior of Harrison County, aquifers may exist at any depth within the fresh-water zone, depending upon the location (Newcome, 1968).

The City of Gulfport utilizes a total of 12 wells for its potable water supply, which vary in depth from approximately 750 to 1,000 feet. These wells provide approximately 3.5 million gallons per day of water to the city, and chlorination is the only treatment provided (Mitchell, 1984). Six of the wells (Wells C, D, E, G, L17 and L15) are located near the NCBC (Table 4-12 and Figure 4-11).

The City of Long Beach utilizes four wells (Wells 01, 0175, L5 and F) for its potable water supply, which vary in depth from 873 to 926 feet (Campton 1984).

4.6 MIGRATION POTENTIAL. For purposes of clarity, accuracy and consistency, when discussing migration pathways at the NCBC, ground water aquifers will be

Table 4-12

Well Inventory of the NCBC and Nearby Municipal Wells[a]

Well Designation	Owner	Year Drilled	Depth (ft.)	Casing Diameter (inches)	Screen Length (ft.)	Water Level [ft, above (+) or below (-)] Land Surface	Water Level Date of Measurement	Discharge (GPM)
L160[b]	NCBC	1942	1,196	10,6	29	+1	Nov/1965	600
L161[b]	NCBC	1942	850	10,6	30	+14	1942	500
L162[b]	NCBC	1943	757	10,6	60	+15	1943	500
A	NCBC	1978	746	16,10	40	-39	1978	1000
B	NCBC	1978	722	16,10	70	-	-	1000
1	NCBC	1969-1972?	500	4	-	-	-	-
2	NCBC	1971	450(app)	4	-	-	-	-
L15[b]	Gulfport	1963	752	24,16,10	63	-19	Aug/1964	960
L17[b]	Gulfport	1952	848	18,10	80	-8	Mar/1966	500
C	Gulfport	-	-	-	-	-	-	1000
D	Gulfport	-	-	-	-	-	-	700
E	Gulfport	-	-	-	-	-	-	400
G	Gulfport	-	-	-	-	-	-	800
L5[b]	Long Beach	1958	880	10,6	80	-6	1964	500
01[b]	Long Beach	1963	926	12,8	60	+3	May/1964	585
0175[b]	Long Beach	-	880	-	-	-	-	1000
F	Long Beach	-	873	-	-	-	-	900

[a]Nearby wells listed are municipal water supply wells which are currently in use. All wells in table, except wells 1 and 2, are used for potable water supply.
[b]United States Geological Survey well designation number.

Source: Newcome, 1968; Campton, 1984; Mitchell, 1984.

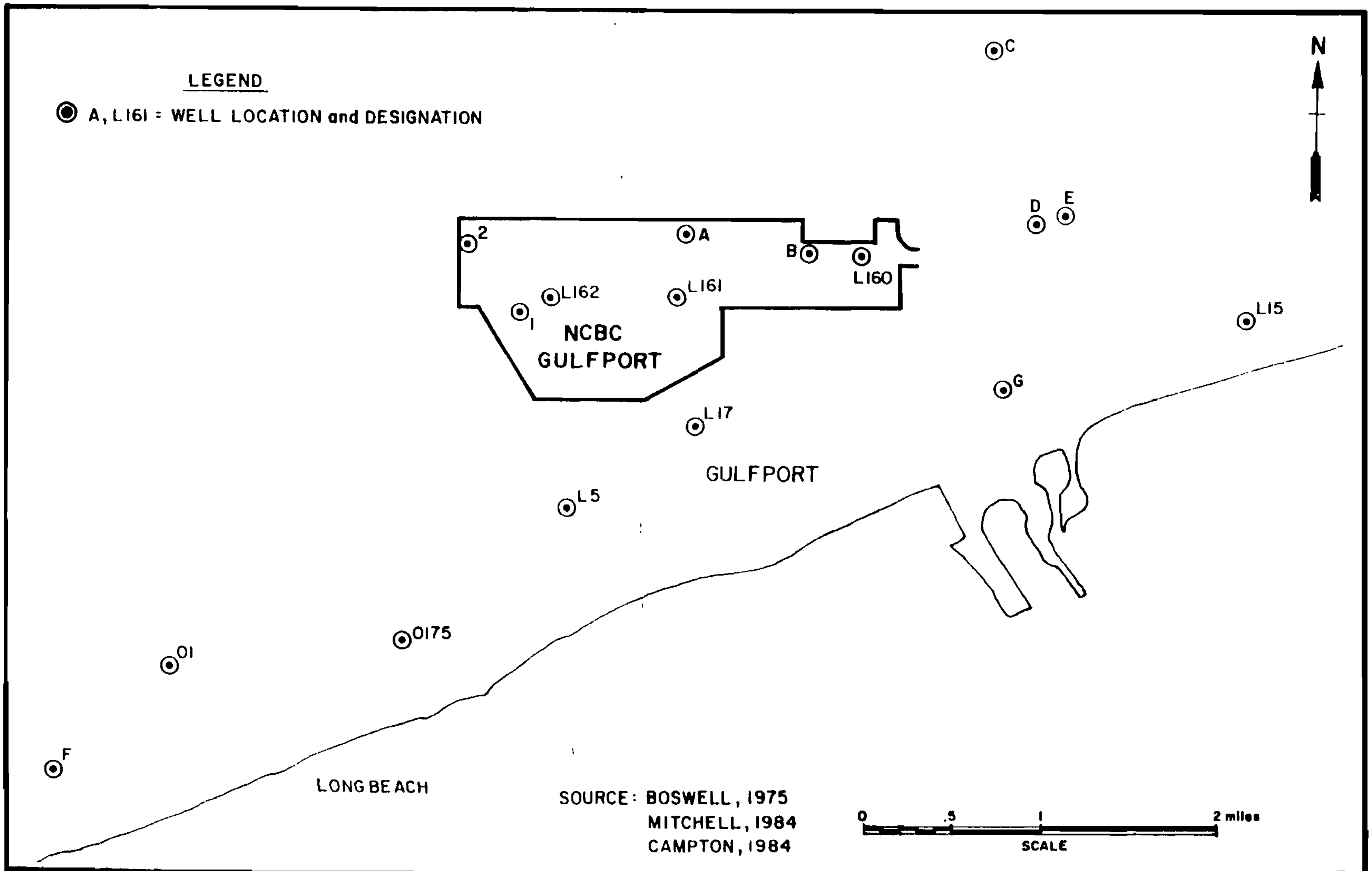

FIGURE 4-11

Well Location Map
NCBC and nearby areas

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generally referred to as the surficial aquifer and underlying artesian aquifers. In cases where deep wells obviously tap the Miocene aquifer system, they will be identified as such. The major migration pathways from sites of potential contamination at the NCBC include surface runoff, and ground water movement in the surficial aquifer to nearby receiving waters, such as ditches and canals.

Contaminant migration by the surface runoff pathway could occur in areas where the source of contamination is at or near the surface or where erosion problems expose previously buried materials, thereby allowing direct contact with surface runoff.

Many of the potential contamination sites drain to receiving ditches which are adjacent to or in close proximity to the site. This allows relatively direct access of potential contaminants from the ditches to receiving waters, such as Canal Number 1 and Turkey Creek.

Impacts to the ditches on the base would primarily be limited to the aquatic wildlife inhabiting the waters and predators such as raccoons and wading birds that depend on these areas for feeding. In addition, Lilaeopsis carolinensis, a type of parsley, is listed as a rare plant species by the MDWC and has been found in drainage ditches at the NCBC during the IAS on-site survey. There is little human contact with these areas since they are used for drainage conveyance, and thus they are relatively isolated from the areas of normal base activities.

Contaminants from potential sites may easily enter the surficial aquifer due to its close proximity to the land surface and the moderate to rapid surficial permeability of the soils found in the area. In certain instances, buried materials were reported to be in direct contact with the surficial ground water.

Ground water movement in the surficial aquifer is primarily lateral because vertical movement is impeded by underlying clayey sediments. The general direction of local ground water movement in the surficial aquifer is from topographic highs to areas of natural discharge such as ditches and canals. The general direction of regional ground water movement is to the south toward the Mississippi Sound.

The hydraulic conductivity of the surficial aquifer in the Gulfport area is probably similar to that of the Citronelle aquifer and on the order of about 150 feet per day. This high hydraulic conductivity indicates that contaminated ground water may readily enter or recharge nearby ditches and canals. Actual ground water velocities in the surficial aquifer will depend on local ground water gradients. Specific information on ground water levels at the NCBC is lacking. However, ground water flow in the surficial aquifer at the NCBC can be assumed to be on the order of the previously estimated rate for the Citronelle aquifer (Section 4.5.5.2.2), about 60 to 260 feet per year. These estimates can be refined during the confirmation phase of the study.

As previously discussed for surface runoff migration patterns, potential impacts at the NCBC would be primarily limited to the aquatic wildlife and vegetation associated with these ditches which intercept contaminated ground water. In addition, the old sewage lagoons, which are currently stocked with catfish and are used for recreational fishing by base personnel, might intercept ground water from potential contamination sites at NCBC. This may occur by regional ground water flow from a potential contamination site north of the lagoons or by localized ground water flow from a potential contamination site immediately south of the lagoons. The catfish in the lagoons may accumulate contaminants potentially present in the water and bottom substrates. Predators utilizing this area for foraging such as wading birds may be impacted through further bio-accumulation. Fishing activities at the lagoons allow the potential for direct human contact.

Since there are no wells at the NCBC which tap the surficial aquifer, no direct impacts to water supplies are anticipated. However, although ground water movement in the surficial aquifer is primarily lateral due to underlying clayey sediments, there is some potential for contaminant migration from the surficial aquifer to underlying artesian aquifers. Due to the limited amount of information available regarding potentiometric levels in the numerous underlying artesian aquifers at the NCBC, it is not possible to accurately determine the hydraulic potential for downward migration.

General studies suggest that many of the multiple aquifers may be hydraulically connected. Thus, if contaminants migrate from the surficial aquifer to the first underlying artesian aquifer, there is a potential for further downward migration into other underlying aquifers. Practice well drilling tests in one area of the NCBC at depths of from 85 to 100 feet, indicate that the first artesian aquifer is free flowing. This indicates that the hydraulic gradient in this area is upward between the first artestian aquifer and the underlying surficial aquifer. Downward migration within this area is unlikely. Likewise, the static level in a deeper artesian aquifer at a different site at the NCBC in 1978 was about 39 feet below ground surface. Since the NCBC is relatively flat, this indicates a downward gradient between the first artesian aquifer and the deep artesian aquifer. The varying extent and thickness of the numerous underlying sand and clay beds add additional complexity to the ground water system, which may vary considerably from site to site. Thus, generalizations are difficult and site specific studies will be required to better determine the actual potential for downward migration from the surficial aquifer to underlying artesian aquifer systems. The potential for contaminant migration from the surficial aquifer to the potable wells at the NCBC, which tap deeper aquifers in the Miocene aquifer system, would depend on the cone of infuence of the wells, the ground water gradient at the site, the continuity and thickness of the clay lenses in the area and the degree of interconnection of the aquifers.

The potential off-base impacts from sources of contamination at the NCBC would be primarily associated with drainage ditches or canals that could carry contaminants off Navy property. Surface receiving waters are not a source of potable water for the area. Nearby receiving waters which receive surface drainage from potential contamination sites at the NCBC include Canal Number 1 and Turkey Creek, which are both classified as Fish and Wildlife areas. Aquatic wildlife inhabiting these waters and the predators that depend on these waters for feeding may be impacted. However, Turkey Creek has water quality problems, such as depressed dissolved oxygen levers, high coliform concentrations, which have been primarily attributed to urban runoff and to septic tank drainage. Thus these waters and their wildlife are currently impacted by off-base sources. Human contact with these waters is probably limited.

Although ground water contamination on Navy property would be primarily limited to the surficial aquifer, there is, as previously discussed, the potential for migration to underlying artesian aquifers. Thus, impacts to municipal off-base water supply wells, which tap the Miocene aquifer system at a depth of from approximately 750 feet to 930 feet, are possible. However, only those wells in the general direction of ground water flow (south) would receive any ground water recharge from on base areas.

Any potential contamination of on-base areas from off-base sources would be primarily limited to ground water movement, because there is little surface drainage from off-base areas into the NCBC. Because ground water movement in the underlying artesian aquifers is from north to south, any impact to on-base water supplies would be limited to potential areas of ground water contamination located north of the NCBC.

A potential area of surficial ground water contamination in the immediate vicinity of the base is an old, City of Gulfport, sanitary landfill which is located approximately 0.8 miles north of the NCBC. The landfill was used sporadically since 1969 primarily for the disposal of rubble, and in 1980, debris from hurricane Frederic was disposed of there. Although potentially contaminated ground water from the site would primarily move toward Turkey Creek, downward migration into the underlying artesian aquifer is possible. Thus, potable wells at the NCBC could be impacted. Currently, municipal wastes from the City of Gulfport and Harrison County are taken to a landfill in Jackson County for disposal.

CHAPTER 5. WASTE GENERATION

5.1 GENERAL. Naval Construction Battalion Center (NCBC) Gulfport's primary functions have basically remained unchanged since the facility was constructed in the early 1940s. The center provides support for the deployment and homeport phases of the Naval Construction Forces. These responsibilities include storing, preserving and shipping capabilities for advanced base and mobilization stocks along with training of existing and new personnel in the various skills required by a Naval Mobile Construction Battalion (NMCB).

This chapter presents a discussion of the facilities which have a potential for generating hazardous wastes. Past operations are described as completely as possible, and more recent information is provided to strengthen the understanding of past waste generation practices.

5.2 INDUSTRIAL OPERATIONS. The industrial departments and tenant activities on-base that were or continue to be the major generators of hazardous wastes include the Construction Equipment Department (CED), Twentieth Naval Construction Regiment (20th NCR), Naval Construction Training Center (NCTC) and the Public Works Department (PWD). A description of each of the operations along with dates and locations of the specific activity are presented in the subsequent paragraphs. Tables present the types and estimated quantities of wastes generated by the individual shops. Additionally, the tables include information on the period of generation, along with the treatment and disposal methods.

5.2.1 Construction Equipment Department. The CED has performed all levels of vehicle and equipment maintenance through the efforts of vehicle maintenance shops, a paint shop, a battery shop, sandblasting facilities and washracks since the mid-1950s. Operations include everything from routine maintenance of the PWD vehicles to engine overhauls, transmission rebuilding, sandblasting, body work and painting of equipment returned from overseas deployment. The CED is also responsible for the preservation of Pre-position War Reserve Material Stock (PWRMS) and the periodic surveillance of equipment stored in the warehouses. On average, CED services some 3,500 pieces of equipment annually.

The CED shops occupied a number of prefabricated buildings from the 1950s until 1979. In 1979, all of the various shops were moved to their present facility, occupying Buildings 399 and 400.

The CED has always used a wide variety of lubricating oils, hydraulic fluids, parts cleaning solvents, preservatives, paints and thinners to accomplish the services of the department. Prior to the mid-1970s, the waste liquids were poured into waste oil bowsers located adjacent to the shops. Bowsers were subsequently transported to the fire fighter areas (Sites 3 and 6) for training drills or on occasion to one of the on-base landfills (Sites 4 and 5). Since the mid-1970s, liquid wastes have been collected for eventual off-base disposal. A summary of waste generation for CED is presented in Table 5-1.

5.2.1.1 Vehicle Maintenance Shops. Vehicle maintenance was primarily performed in Building 240 until 1979. When the facility was moved in 1979 to Building 400, maintenance operations were divided into three areas, Shops A, B and C. Shop A is responsible for most of the PWRMS operations and performs

Table 5-1

Construction Equipment Department Waste Generation Rates

Waste Source	Waste Type	Estimated Waste Generation Rate (gallons per year*)	Period of Generation	Treatment/Disposal Location[a]
Vehicle Maintenance Shops	Parts Cleaning Solvent (Stoddard)	3,000	1956-1976	WOB/FFTA (3,6)[b]; OBL (4,5)
		3,000	1976-1979	WOB/RBC
	PD-680, Type I	2,500	1979-1983	UWOT/RBC
	PD-680, Type II	2,200	1983-1984	RBC
	Waste Oils	15,000	1956 1976	WOB/FFTA (3,6); OBL (4,5)
		12,000	1976-1979	WOB/RBC
		9,000	1979-1984	UWOT/RBC
	Waste Fuels (diesel, MOGAS)	1,000	1956-1976	WOB/FFTA (3,6); OBL (4,5)
		500	1976-1979	WOB/RBC
		500	1979-1984	FB/reused
	Safety Solvent	300	1979-1983	UWOT/RBC
		300	1983-1984	RBC
Paint Shop	Paint Thinners (MEK, toluene, xylene, naphtha)	500	1956-1976	WOB/FFTA (3,6); OBL (4,5)
		350	1976-1983	WPC/RBC
		300	1983-1984	Drums/RBC, DPDO
	Waste Paints	150	1956-1976	WOB/FFTA (3,6); OBL (4,5)
		100	1976-1983	WPC/RBC
		60	1983-1984	Drums/RBC, DPDO
Battery Shop	Sulfuric Acid, Electrolyte	2,000	1956-1979	Dilution/SS
		1,500	1979-1984	Neutralization in battery sink/SS
	Battery Cases	600(each)	1956-1984	Salvage, DPDO
Sandblasting	Blasting Grit	120 tons/yr	1956-1979	Roads, grounds and OBL (3,4,5)
	Black Beauty	110 tons/yr	1979-1984	PWD storage pile and OBL (7)
Washracks	Steam Cleaning Detergent	500	1956-1975	Dilution/storm sewer
		500	1975-1979	Dilution/SS
		500	1979-1984	Grease and oil separator/SS
	Oily Wastes	1,000	1979-1984	Grease and oil separator/RBC

*Estimated waste generation rates in gallons per year unless other noted.

[a]WOB - Waste Oil Bowser; FFTA - Fire Fighting Training Area; RBC - Removed by Contractor; OBL = On-Base Landfills; UWOT - Underground Waste Oil Tank; SS - Sanitary Sewer; FB - Fuel Bowser.

[b]Numbers in parentheses are Site Numbers.

most of the surveillance work. Shop B conducts overhaul, repairs and inspections of the larger equipment such as the tractors, dump trucks, cranes, etc., while Shop C focuses on maintenance of the smaller construction equipment and station vehicles such as fork lifts and pick-up trucks.

Each of the three shops generate waste dry cleaning solvent from parts cleaning along with mixed oils and fluids. Since 1979, shop wastes have been temporarily stored in underground waste oil tanks until they are picked up by a contractor.

5.2.1.2 Paint Shop. Equipment painting operations were conducted in and around Buildings 106, 108 and 297 until 1979. No spray booths were in service at the old facilities. Painting was performed within a warehouse or out on a pad. The new paint spray operation in Buildng 400 has two large 20 feet by 60 feet long booths containing dry filter systems. The filters are changed routinely by the PWD and disposed in a dumpster. Prior to 1979, a vehicle undercoating station associated with the department was located at Building 220. This operation is now located next to the spray booths in Building 400.

The paint shop consumes about 250 gallons of paint per month, primarily green enamel. However, less than 15 gallons of paint are disposed each month from the cleaning of spray guns and pots.

5.2.1.3 Battery Shop. Battery filling, cleaning and charging operations were initially performed in Building 298. These activities were moved with the other CED operations to Building 400 in 1979. Prior to 1979, waste battery acid was diluted and poured into the sanitary sewer. The new facility uses a neutralization unit prior to sewer disposal. Batteries which can no longer be serviced are sent to DPDO for salvage.

5.2.1.4 Sandblasting. Vehicle sandblasing was performed in Buildings 271 and 281 until the new facility was constructed. Since 1979, the CED sandblasting operations have been performed in Building 399 which contains two bays. Waste sand was hauled to the PWD storage piles and, in turn, used for fill material.

5.2.1.5 Vehicle Washracks. The CED operated two vehicle/equipment steam washracks at Buidings 236 and 268. The wastewater generated by this equipment was discharged to the storm drains until the mid to late 1970s when connections to the sanitary sewer were completed. The Building 400 washrack wastewater passes through an oil/water separator prior to discharge to the sanitary sewer. Oily wastes collected by the unit are routinely pumped out by a contractor for off-base disposal.

5.2.2 Twentieth Naval Construction Regiment. The 20th NCR is responsible for ensuring maximum effectiveness of all Atlantic fleet units of the Naval Construction Forces (NCF) while homeported at NCBC Gulfport. Operational and material readiness is achieved in part by performing routine and special maintenance of some 175 pieces of Civil Engineering Support Equipment (CESE) assigned to the Regiment. These duties have remained relatively unchanged since the Regiment was established at Gulfport in 1966.

The 20th NCR's equipment maintenance operations were first located in Building 290. In 1979, they moved to Buildings 105, 106, 107, 108 and 240 (the old CED shops). These metal buildings house the Woodworking Shop (Building

105), Central Tool Room (Building 106), Material Liaison Office (Building 107), Paint Shop (Building 108), and the Vehicle/Equipment Maintenance Shop (Building 240).

Daily maintenance operations have always generated a variety of waste lube oils, hydraulic fluids and parts cleaning solvents during the course of mechanical equipment repairs. Waste generation for the 20th NCR is given in Table 5-2.

5.2.3 Naval Construction Training Center. The NCTC provides technical training to Seabees in all of their specialty fields through the activities of four companies (Alpha, Bravo, Charlie and Delta). The Alpha Company trains mechanics, and the Bravo Company teaches electronics. The Charlie Company runs schools to train students in the various building trades, and the Delta Company conducts training functions for special services. The Construction Training Unit (CTU) was the predecessor of NCTC and began operations in the mid-1960s. The NCTC replaced the CTU in 1974 to continue training functions for Seabees.

Being a training operation, NCTC does not generate a significant amount of hazardous waste. The types of wastes primarily generated by the training and maintenance operations include parts cleaning solvents, waste oils, and dead vehicle batteries. A summary table presenting NCTC's past waste generation practices is given in Table 5-3.

5.2.3.1 Alpha Company. The Alpha Company provides training for Construction Mechanics (CM) and Equipment Operators (EO) for the heavy civil engineering vehicles (bulldozers, scrapers, cranes, draglines and well drilling rigs). The rock crusher and asphalt plants are used periodically to train personnel to operate these facilities. Expertise in engine chassis repair and overhaul is obtained through a number of applied instruction classes.

A series of buildings (378 through 381) are used for the applied instruction classes. The CM-Gas Engine Shop is located in Building 378 and the CM-Diesel Shop is in Building 379. The Auto and Heavy Chassis Shops are located in Building 380 and 381. Buildings 242 and 357 are associated with vehicle maintenance for NCTC. Building 242, used to store electrolyte solution, is also used by personnel to perform maintenance services on the batteries. The crusher and asphalt plants are located on the western portion of the base.

Alpha Company generates small amounts of dry cleaning solvents which are used during the course of vehicle repairs and training sessions. Waste oils are also generated during vehicle maintenance. Additionally, the rock crusher and asphalt plants use PD-680 (approximately 200 gallons per year) to wipe-down equipment and remove accumulation of grease and oil. The solvent is allowed to evaporate and, therefore, does not generate any waste. It was also reported that diesel fuel was used for wiping down equipment at the plant prior to 1980.

5.2.3.2 Bravo Company. The Bravo Company trains its personnel to be Construction Electricians (CE) and Utilitiesmen (UT). They gain experience in these areas by working on plumbing, boilers, air conditioning units, generators, water treatment package plants and pumps. The company's electrical cable splicing lab is housed in Building 388. Most of the UT school classes are conducted in Building 162. Training associated with the water treating plant is performed in Building 384.

Table 5-2

20th Naval Construction Regiment Waste Generation Rates

Waste Source	Waste Type	Estimated Waste Generation Rate (gallons per year*)	Period of Generation	Treatment/Disposal Location[a]
Vehicle Maintenance Shops	Parts Cleaning Solvent (Stoddard)	400	1966-1976	WOB/FFTA[b] (6); OBL (4,5)
	PD-680, Type I	500	1976-1979	WOB/RBC
		500	1979-1983	WOB/CED WOT/RBC
	PD-680, Type II	300	1983-1984	Drums/RBC
	Waste Oils	6,000	1966-1976	WOB/FFTA (6)
		6,000	1976-1979	WOB/RBC
		6,000	1979-1983	WOB/CED WOT/RBC
		5,300	1983-1984	Drums/RBC
Paint Shop	Mixed Paint Thinners (MEK, toluene, xylene, naphtha, etc.)	100	1966-1976	WOB/FFTA (6); OBL (4,5)
		60	1976-1979	WOB/RBC
		60	1979-1983	WOB/CED WOT/RBC
	Mixed Paint Wastes (lacquer, enamel)	50	1966-1976	WOB/FFTA (6); OBL (4,5)
		30	1976-1979	WOB/RBC
		30	1979-1983	WOB/CED WOT/RBC
Battery Shop	Sulfuric Acid, Electrolyte	500	1966-1979	Dilution/SS
		500	1979-1984	NT/RBC
	Battery Cases	250	1966-1979	Pallets/Salvage, DPDO
Sandblasting	Blasting Grit	6 tons/yr	1966-1983	Roads, grounds, PWD pile, OBL (4,5,7)

*Estimated waste generation rates in gallons per year unless other noted.
[a]WOB - Waste Oil Bowser; FFTA - Fire Fighting Training Area; RBC - Removed by Contractor; OBL = On-Base Landfills; WOT - Waste Oil Tank; SS - Sanitary Sewer; NT - Neutralization Tank.
[b]Numbers in parentheses are Site Numbers.

Table 5-3

Naval Construction Training Center Waste Generation Rates

Waste Source	Waste Type	Estimated Waste Generation Rate (gallons per year*)	Period of Generation	Treatment/Disposal Location[a]
Vehicle Maintenance Shops	Parts Cleaning Solvent (Stoddard)	300	1966-1976	WOB/FFTA (6)[b]; OBL (4,5)
	PD-680, Type I	300	1976-1983	WOB/RBC
	PD-680, Type II	300	1983-1984	Drums/RBC
	Waste Oils	200	1966-1976	WOB/FFTA (6); OBL (4,5)
		200	1976-1983	WOB/RBC
		200	1983-1984	Drums/RBC
	Battery Cases	100	1966-1984	Pallet/Salvage, DPDO
	Sulfuric Acid,	80	1966-1983	Dilution/SS
	Electrolyte	80	1983-1984	Neutralization/SS
CM Training Shops	Dry Cleaning Solvent	200	1966-1976	WOB/FFTA (6); OBL (4,5)
	(Stoddard)	60	1976-1979	WOB/RBC
	PD-680, Type I	200	1976-1983	WOB/RBC
	PD-680, Type II	200	1983-1984	Drums/RBC
	Waste Oils	100	1966-1976	WOB/FFTA (6); OBL (4,5)
		100	1976-1983	WOB/RBC
		100	1983-1984	Drums/RBC
Cable Splicing	Old Lead Splices	1,000 lbs/yr	1966-1976	OBL/DPDO (4,5)
			1976-1984	Salvage/DPDO

*Estimated waste generation rates in gallons per year unless other noted.
[a]WOB - Waste Oil Bowser; FFTA - Fire Fighting Training Area; RBC - Removed by Contractor; WOT - Waste Oil Tank; SS - Sanitary Sewer; NT - Neutralization Tank; OBL - On-Base Landfill.
[b]Numbers in parentheses are Site Numbers.

Cable splicing generates waste lead splices which are mainly sent to DPDO for salvage. Some of these splices were reportedly put into dumpsters and landfilled on-base from time to time until 1976. The UT school consumes a few pounds per month of a wide variety of chemicals such as sodium sulfite, sodium hydroxide, ferric chloride, aluminum sulfate and potassium chromate. These chemicals are used for water analyses and water purification. Discharge of these wastes is routinely made to the sanitary sewer.

5.2.3.3 Charlie Company. Charlie Company runs its schools to train Builders (BU), Steelworkers (SW) and Engineering Aids (EA) to perform assigned projects requiring carpenters, masons, roofers, steelworkers, draftsmen, and surveyors. Classroom and applied instructions are conducted in Buildings 311 and 344. This company did not generate any hazardous wastes.

5.2.3.4 Delta Company. Specialty instructions for disaster recovery, oil spill control and safety programs are conducted by the Delta Company. The Delta Company's Disaster Recovery Division has conducted classroom instruction in Building 109 since 1969. Applied instructions, however, are performed in the mock village adjacent to the building.

The only chemical warfare agents (irritants) reportedly used over the years at NCBC Gulfport were tear gas and chlorobenzylidenemalononitrile (CS). Both tear gas capsules and grenades (approximately 8 and 2 per month, respectively) were used in demonstrations. Several decontamination agents were also used from time to time during training exercises. These included supertropical bleach (STB) and DANC (tetrachloroethylene and dichloro-dimethylhydantoin). STB is a white powder containing about 30 percent available chlorine, which can be used either as a dry mix or a slurry to decontaminate exterior surfaces. The use of these agents was discontinued in the mid-1970s. Subsequent demonstrations have been performed with only water applied by sprayers to building walls.

5.2.4 Supply Department Material Packing and Preservation Section. This section of the Supply Department's Material Division performs preservation and packing operations on a wide variety of small items not handled by CED. Surface preparations and coatings are applied to items pulled from warehouse stocks for surveillance or those being prepared for shipment overseas. These items include hand tools, machinery, metal hardware, auto parts and small vehicle accessories. Several large dip tanks (4 foot by 4 foot by 8 foot) are used for the removal of grease, rust, paint and/or previously applied surface preservation coatings. An average of approximately 8,000 items are processed by the section monthly.

The preservation unit was located in Building 198 from the early 1950s until 1969 when hurricane Camille destroyed the structure. The unit was moved to a new warehouse following Camille, Building 320, where it still operates. The processes used in the operation include dip tanks containing phosphoric acid solution, an alkaline solution tank, and cleaning solvents for the removal of light preservatives. Built-up grease is removed in the vapor degreasing unit. The rust proofing of metal before painting and/or preservation operations generated several types of wastes which are summarized in Table 5-4.

5.2.5 Public Works Department. The PWD is comprised of five divisions including Administrative, Maintenance Control, Engineering, Maintenance and Planning. Of these, the Maintenance Division is responsible for nearly all

Table 5-4

Packing/Preservation Waste Generation Rates

Waste Source	Waste Type	Estimated Waste Generation Rate (gallons per year*)	Period of Generation	Treatment/Disposal Location[a]
Acid Tank	Phosphoric Acid Solution	900	1953-1969	Dilution/storm sewer
		600	1969-1976	Dilution/SS
		300	1976-1982	Neutralization, dilution/SS
		200	1982-1984	Drummed/DPDO
	Acid Sludge	30	1953-1969	Hauled/PIL (3,4)[b]
		20	1969-1976	Hauled/PIL (4,5)
		10	1976-1982	Drummed/DPDO
		5	1982-1984	Drummed/DPDO
Caustic Tank	Sodium Hydroxide Solution	900	1953-1969	Dilution/storm sewer
		600	1969-1976	Dilution/SS
		300	1976-1982	Neutralization, dilution/SS
		200	1982-1984	Drummed/DPDO
	Caustic Sludge	30	1953-1969	Hauled/PIL (3,4)
		20	1969-1976	Hauled/PIL (4,5)
		10	1976-1980	Drummed/DPDO
		5	1980-1984	Drummed/DPDO
Vapor Degreaser	Trichloroethylene	300	1953-1976	Redistilled/reused
		200	1976-1984	Drummed/DPDO
	Tetrachloroethylene	100	1980-1984	Drummed/DPDO
	Degreaser Sludge	10	1953-1976	Hauled/PIL (3,4,5)
		5	1976-1980	Drummed/DPDO
		3	1980-1984	Drummed/DPDO
Parts Cleaning Tank	Dry Cleaning Solvent (Stoddard)	300	1953-1976	Drummed/FFTA (3,6); OBL (4,5)
		300	1976-1980	Drummed/DPDO
	PD-680, Type I	200	1980-1983	Drummed/DPDO
	PD-680, Type II	100	1983-1984	Drummed/DPDO
Paint Spraying	Mineral Spirits, Paint Thinner	100	1953-1976	Drummed/FFTA (3,6); OBL (4,5)
		100	1976-1984	Drummed/DPDO
	MEK	100	1943-1976	Drummed/FFTA (3,6); OBL (1,2,4,5)

*Estimated waste generation rates in gallons per year unless other noted.
[a]WOB - [redacted]te Oil Bowser; FFTA - Fire Fighting Training Area; [redacted] - Removed by Contractor; OBL = On-Base Landfills; [redacted]
WOT - [redacted]te Oil Tank; SS - Sanitary Sewer; PIL - Poured in [redacted]fill.
[b][redacted]

of the hazardous wastes generated by the PWD. The Maintenance Division, being relatively small at NCBC Gulfport, performs minor operational maintenance on department vehicles and minor repairs to base facilities. These activities are conducted through the efforts of the Emergency Services Branch, Building Trades Branch, Utilities Branch and/or the General Services/ Transportation Branch. Most of the major repairs required on PWD vehicles are performed by CED. Likewise, any significant maintenance or repairs required on the buildings are performed through outside contracts.

During World War II, each of the original six battalion areas provided complete unit integrity and exclusive use of separate shop facilities. These PWD shops occupied Buildings 30 through 33 in Construction Battalion (CB) Area I, Buildings 50 through 53 in CB Area II, Buildings 70 through 73 in CB Area III, Buildings 120 and 121 in CB Area IV, Buildings 140 and 141 in CB Area V, and Buildings 160 and 161 in CB Area VI. Following World War II, PWD primarily provided caretaker status of base facilities until the mid-1950s.

Waste cleaning solvents, waste oils, paints and thinner are generated by the PWD. A summarization of these waste is given in Table 5-5.

5.2.5.1 Maintenance Shops. The Maintenance Shop was located in Building 266 from 1957 until 1974 when it was moved. The operation was relocated to a newly constructed facility in 1974, Building 370, were it remains. This building has areas designated for the Carpenter Shop, Sheetmetal Shop, Electrical Shop and Plumbing Shop.

The maintenance areas share a 50 gallon solvent parts cleaning tank. The tank is reportedly cleaned out about once every year. The waste solvent is poured into a waste oil bowser prior to disposal. Freon is used to degrease small compressor components but this material quickly evaporates. Vacuum pump oil is consumed at a rate of about 50 gallons per year. Table 5-5 provides a summary for the wastes generated by the PWD Maintenance Shops.

5.2.5.2 Transportation Shop. The shop is located in Building 28 and provides personnel for the PW vehicles. The shop also provided heavy equipment operators for the station landfills until the mid-1970s when the last base landfill was closed. The shop itself is not involved in the generation of hazardous wastes, however, the personnel haul hazardous materials and wastes in certain instances.

5.2.5.3 Paint Shop. The paint shop, Building 270, employs several painters to primarily conduct interior painting projects for base facilities. The paint shop generates relatively small quantities of wastes. Prior to about 1982, the shop employed four full-time painters and consumed approximately 200 gallons of paint monthly. Since then, these activities have consumed between 50 to 100 gallons of latex paint each month. Typically, excess paint is used for the next job. The paint thinners or mineral spirits used to clean out paint brushes and rollers following projects requiring oil based paints, are disposed in a waste barrel outside the building. This material is allowed to evaporate.

5.2.5.4 Pest Control Shop. The PWD Pest Control Shop provides pest management services for the entire base including the station's golf course. The operation was located in Building 218 from the mid-1950s until 1969 when it was moved to Building 266. The shop remained there until Building 421 was completed in 1981. The shop continues to operate from Building 421.

Table 5-5

Public Works Department Waste Generation Rates

Waste Source	Waste Type	Estimated Waste Generation Rate (gallons per year*)	Period of Generation	Treatment/Disposal Location[a]
Maintenance Shop	Dry Cleaning Solvent	100	1957-1974	WOB/FFTA (3,6)[b]; OBL (4,5)
	PD-680, Type I	50	1974-1984	WOB/RBC
	Waste Oil	100 50	1957-1974 1974-1984	WOB/FFTA (3,6); OBL (4,5) WOB/RBC
	Scrap Metal	insufficient data	1957-1974	Salvage/DPDO
	Sulfuric Acid, Electrolyte	10 5	1957-1974 1974-1984	Diluted/SS CED neutralization/SS

*Generation Rate in gallons per year unless otherwise noted.
[a]WOB - Waste Oil Bowser; FFTA - Fire Fighting Training Area; RBC - Removed By Contractor; SS - Sanitary Sewer; OBL = On-Base Landfills.
[b]Numbers in parentheses are Site Numbers.

The shop generates primarily empty containers and out-of-date pesticides. Since the early 1970s, liquid pesticide containers have been triple rinsed, punctured to make then unusable, and placed in a dumpster for burial in an on-base landfill (Sites 3, 4 and 5). Prior to the early 1970s, unrinsed pesticide containers were likely disposed at the landfills. Crushed drums which contained 10 percent sodium arsonite, used for termites were, reportedly buried at Site 3. These drums were rinsed prior to diposal. The rinsate is either used for makeup water or applied to the job site. The containers for dry pesticides, such as bags and fiber drums, are also made unusable by crushing or tearing, and placed into a dumpster. During this same time period the out-of-date pesticides have been sent to DPDO for disposal off-base. The annual application rates for the pesticides used during 1973 and 1980 are presented in Table 5-6 for comparison purposes.

5.2.6 Fire Fighting Training. The fire fighter training operations were conducted at two different locations at NCBC Gulfport. These areas were used under the direction of the Fire Department to train recruits in fire service. Typically, liquid wastes generated by on-base shop operations were transported to the training area, floated on water in the earthen pits, ignited and extinguished.

The older fire fighter training area (Site 3) was located next to the old pistol range (northwest of Colby and Eighth Street) from the early 1950s until the mid-1960s. This pit was approximately 15 feet by 25 feet and 4 feet deep. Training drills were conducted, at most, about every two weeks for several hours and consumed approximately 500 gallons of liquid wastes per session. Water was used to extinguish these fires.

Because of the escalation of activities overseas during the mid-1960s, the fire fighter training operations were moved to a new location. In 1966, two new earthen pits (Site 6) were dug at the southeast corner of Colby and Fifth Street. The north pit was roughly 35 feet by 50 feet and 5 feet deep while the south pit was somewhat smaller, 25 feet by 40 feet. Rain water which accumulated in the pits between sessions could be drawn off through drain lines positioned near the bottom of each pit. The drain pipes discharged into an adjacent storm ditch.

Training sessions were conducted much more frequently during the period 1967 through 1971 when the fire department supervised training for the Direct Procurement Petty Officer (DPPO) Program. During this time period, both pits were routinely used, reportedly several times each week. At the beginning of each drill, about one foot of water was pumped into the pit. Next, about 500 gallons of liquid wastes from drums, a bowser or the fire department's tanker truck were poured into each of the pits. The material was then ignited, allowed to burn for several minutes, extinguished and reignited at 15 to 20 minute intervals until it could no longer be lighted. During most of the sessions, the two pits would be alternately used to allow the pits to cool. The actual drill would last for about two to three hours. The majority of the fires were extinguished with water pumped at a flowrate of 125 gallons per minute (gpm), but some protein foam, dry chemical agents (potassium chloride and sodium bicarbonate) and aqueous film forming foam (AFFF) were used on occasion. From 1972 through 1975, training exercises were once again reduced to one or two sessions each month.

Flammable waste liquids generated by the on-base shops (CED, NCTC, 20th NCR, PWD, etc.) were routinely transported to the training areas (Sites 3 and 6).

Table 5-6

Pesticide Usage Comparison

Pesticide	Target Pest	Amount Applied 1973	1980
Anticoagulant Baits, 0.025% (Warfarin)	Mice	20 pounds	-
Baygon Solution, 0.5%	Roaches	-	100 gallons
Chlordane Emulsion, 2.0%	Ants	400 gallons	-
Chlordane Granules, 10%	Ants	-	1,200 pounds
2,4-D Emulsion	Grass Weeds	500 pounds	-
Diazinon Emulsion, 0.5%	Roaches	500 gallons	200 gallons
Dursban Emulsion, 0.5%	Roaches	-	400 gallons
Ficam, 76%	Roaches	-	10 pounds
Malathion Solution, 6.0%	Mosquitos	900 gallons	800 gallons
Monuron (MCM)	Grass Weeds	2,700 pounds	-
Mineral Oil Solution, 100% (Diesel)	Mosquitos	100 gallons	-
Naled Solution, 0.8% (Dibrom)	Mosquitos	1,200 gallons	-

These wastes probably included motor oil, dry cleaning solvents, MEK, toluene, mineral spirits, paints and thinners among others. The wastes were temporarily stored at the training area in 55-gallon drums, waste oil bowsers or the fire department's tanker truck. In addition, waste liquids from various off-base locations were collected by station personnel and imported to NCBC Gulfport to support fire training operations during the late 1960s and early 1970s. These wastes possibly included contaminated AVGAS, JP-5, other waste fuels, waste oils and smaller amounts of solvents and thinners. Estimated quantities of wastes used for fire training exercises are shown in Table 5-7.

5.2.7 Marine Corps Vehicle Maintenance Facility. The Marine reserve inspection/instruction (I&I) detachment of Company A performs equipment maintenance and repairs for assigned vehicles. The primary vehicle used by the detachment is the amphibious (AMTRAK) ship-to-shore LVT P-7s. Specific maintenance and repairs conducted by the unit include equipment lubrication, electronic component repairs, machinery cleaning and touch-up painting.

The shop has been located in Building 299 since the late 1960s. This shop generates few hazardous wastes. A solvent bath containing PD-680 (Stoddard solvent type of dry cleaning solution) is used for removing grease from parts. The tank holds about 25 to 30 gallons of liquid and is reportedly changed annually. The spent solvent and sludge is poured into the oily waste tank located near the shop. A few spray cans of 1,1,1-trichloroethane are also used each month to clean electrical components. These cans are placed in a dumpster for off-base disposal. Table 5-8 provides a breakdown on the estimated quantities and disposition of these wastes.

5.2.8 Reserve Naval Mobile Construction Battalion Equipment Shop. The Reserve NMCB unit conducts vehicle maintenance operations similar to those of the 20th NCR, except on a much smaller scale. Operations primarily involve routine maintenance such as oil changes and minor vehicle repairs on the unit's trucks and heavy equipment.

The shop has been located in Building 298 since about 1980. The solvent tank used for parts cleaning contains PD-680. Reportedly, the contents of this tank are changed about every six months. The waste solution is placed in a drum for storage prior to off-base disposal. Table 5-8 presents a summary of the types and quantities of waste generated by this operation.

5.2.9 Navigation Aids Support Unit. The Navigation Aids Support Unit (NAVAIDS) is responsible for providing portable precision electronic navigational equipment to support Navy-wide activities. The operations performed at NCBC Gulfport include the repair and maintenance of the electronic instruments, along with repair of the unit's vehicles and support equipment such as tents, sleeping bags and stoves.

The unit has been stationed at NCBC Gulfport since 1979 and occupies Buildings 101, 102 and 406. Building 101 contains the Engineering Shop which generates waste oil during equipment oil changes along with waste batteries and electrolyte. The shop also has a solvent cleaning tank containing 1,1,1-trichloroethane. The tank is reportedly cleaned out about once a year. The waste is disposed off-base by a contractor. The life support and electronic equipment repairs are conducted in Building 201. Spray cans of 1,1,1-trichloroethane are used in the cleaning of electronic components. This material quickly evaporates. Table 5-8 presents a summary of the types and quantities of waste generated by this operation.

Table 5-7

Fire Fighting Training Area Waste Generation Rates

Waste Source	Waste Type	Estimated Waste Generation Rate* (gallons per year)	Period of Generation	Treatment/Disposal Location**
Pistol Range Pit (Site 3)	Mixed Flammable Waste	12,000	1953-1966	Burned; partially combusted hydrocarbon residual/TP
Pole Field Pits (Site 6)	Mixed Flammable Waste	100,000	1967-1971	Burned; partially combusted hydrocarbon residual/TP
		12,000	1971-1975	Burned; partially combusted hydrocarbon residual/TP
	Protein Foaming Agents	2,500	1967-1971	Burned; partially combusted hydrocarbon residual/TP
	Dry Chemical	2,000	1967-1971	Burned; partially combusted hydrocarbon residual/TP
	Aqueous Film Forming Foam (AFFF)	500	1971-1975	Burned; partially combusted hydrocarbon residual/TP

*Quantity used for fire drills.
**TP - Training Pit.

Table 5-8

Waste Generation Rates

Waste Source	Waste Type	Estimated Waste Generation Rate (gallons per year*)	Period of Generation	Treatment/Disposal Location**
Marine Vehicle Maintenance	Dry Cleaning Solvent (Stoddard)	50	1960s-1976	WOT/FFTA (Site 6)
	PD-680, Type I	30	1976-1984	WOT/RBC
RNMCB Equipment Shop	PD-680, Type I	60	1980-1984	WOB/RBC
NAVAIDS	1,1,1-Trichloroethane	50	1979-1984	WOB/RBC
	Waste Oil	360	1979-1984	WOB/RBC
	Battery Cases	50(each)	1979-1984	DPDO
	Sulfuric Acid, Electrolyte	50	1979-1984	Neutralized/SS
Photo Lab	Developer	500	1960s-1984	SS
	Fixer	250	1960s-1984	SS
	Waste Film/Paper	insufficient data	1960s-1975	Dumpster/OBL (Sites 4 and 5)
		insufficient data	1975-1984	Dumpster/RBC
Medical Clinic	X-Ray Fixer	360	1968-1970s	SS
		360	1970s-1984	Recovery Unit/SS
	X-Ray Developer	360	1968-1970s	SS
		360	1970s-1984	Recovery Unit/SS
	Silver Sludge	10	1970s-1984	Recovery Unit/DPDO
Dental Clinic	X-Ray Fixer	60	1968-1970s	SS
		60	1970s-1984	DPDO
	X-Ray Developer	60	1968-1984	SS
	Mercury Amalgam	10 lbs	1968-1984	DPDO
Auto Hobby Shop	Waste Oil	200	1968-1976	WOB/FFTA (Site 6)
		100	1976-1984	Drums/RBC
	Dry Cleaning Solvent (PD-680)	50	1976-1984	Drums/RBC

*Generation rates in gallons per year unless otherwise noted.
**WOT - Waste Oil Tank; FFTA - Fire Training Area; RBC - Removed by Contractor; WOB - Waste Oil Bowser; SS - Sanitary Sewer; OBL - On-Base Landfill;

5.2.10 Photo Lab. The photo lab performs general black and white photographic processing and enlarging along with color slide productions. The lab was located in Building 280 from the mid-1960s to the mid-1970s. The lab was then moved to Building 50 where it continues to operate.

Wastewater (approximately 200 gallons per day) from photo processing contains a variety of weak chemical solutions including developers and fixers. These wastes are generated from spent baths and film rinse tank overflows. Until recently, these wastes were discharged directly to the sanitary sewer. The wastes now pass through a silver recovery unit. Waste generation is summarized in Table 5-8.

5.2.11 Medical and Dental Clinics.

5.2.11.1 Medical Clinic. The dispensary is devoted to handling out-patient and emergency clinic services primarily for active duty personnel. Cases requiring surgical operations are referred to an off-base medical center. The dispensary, located in Building 295, was constructed in 1968. Building 87 acted as the dispensary during World War II. The X-ray fixer and developer generated by this operation are disposed through the DPDO office. Prior to the 1970s, the laboratory wastewater (200 gallons per day) was discharged directly to the sanitary sewer. Subsequently, this wastewater was passed through a silver recovery unit prior to sanitary sewer discharge. Waste syringes are sent to DPDO to be autoclaved. Table 5-8 summarizes waste generation for the dispensary.

5.2.11.2 Dental Clinic. The clinic provides dental care for personnel on-base and to such other personnel as may be authorized to receive dental treatment. This clinic consists of three oral hygiene and preventive dentistry rooms, one each prosthetic and oral diagnosis treatment rooms, and six general operatories. This facility is located in the base dispensary, Building 295. The dental clinic was also established in 1968.

Waste mercury amalgam, lead and film are sent to the DPDO facility for precious metals recovery. Wastewater from the clinic is discharged to the sanitary sewer. Waste generation is summarized in Table 5-8.

5.2.12 Automotive Hobby Shop. The shop provides general repair and engine overhaul stalls and machine shop services to assigned NCBC Gulfport personnel. It also provides an Automotive Resale Store. The shop uses two small solvent tanks to clean up greasy automative parts. Prior to 1977, the shop was located in Building 4. The new shop is located in Building 397.

Shop operations generate waste oil, lubricants and parts cleaning solvents produced during the course of minor repair activities. Shop waste generation is presented in Table 5-8.

5.3 ORDNANCE OPERATIONS. The 20th NCR's Military Training Department stores and handles all small arms and ammunition used by the battalions. They are responsible for the acquisition, storage, maintenance, security and distribution of ordnance used by the units. Small arms training exercises are conducted off-base. There are no explosive ordnance disposal teams at NCBC Gulfport. Ordnance requiring destruction must be transported off-base for detonation. The only operations performed at NCBC Gulfport are rifle and gun cleaning. Weapons are cleaned at the Armory, Building 291. This facility was constructed in 1967.

The waste weapons cleaning solvents (PD-680 and bore cleaner) are each generated at a rate of approximately 50 gallons per year. These wastes are poured into drums and transported to the 20th NCR shop area, Building 240, for disposal off-base with other wastes.

6.0 MATERIAL HANDLING: STORAGE AND TRANSPORTATION

6.1 GENERAL. The Naval Construction Battalion Center (NCBC) Gulfport was established during World War II as a training base for Seabees and a storage site for millions of tons of war material. Today the base is home to the Twentieth Naval Construction Regiment (20th NCR), Naval Construction Training Center (NCTC) and some 20 other tenant commands and organizations. The base encompasses approximately 1,100 acres of land and has over 260 buildings containing a total of over 2,870,000 square feet of floor space. Relevant information pertaining to past activities involving the storage and transportation of hazardous materials and waste is discussed in this chapter.

6.2 STORAGE. Storage is a major responsibility of the NCBC. All of the installation's warehousing capabilities combine to total more than 30 acres of covered, secure and protected area. In addition to warehouse storage, the center also maintains approximately 100 acres of open storage. Base storage assets are given in Table 6-1.

6.2.1 Petroleum, Oil and Lubricants. NCBC Gulfport stores gasoline, diesel fuel, and kerosene for use on the base. Fuel storage for ships or aircraft is not provided at NCBC Gulfport. Annual fuel consumption is approximately 140,000 gallons of motor gasoline (MOGAS) and 150,000 gallons of diesel. Additionally, annual exchange sales of MOGAS are about 700,000 gallons. The base fuel storage facilities are listed in Table 6-2.

6.2.2 Public Works Department (PWD) Pesticides. Pesticides used for base-wide activities have been stored at several locations. Prior to 1981, pesticide materials were stored in Building 266. Following the completion of the new pesticide control facility in 1981, all pesticides were stored in the Pesticide Shop, Building 421. The inventory of pesticide control materials presented in Table 6-3 represents what was normally kept on hand by the PWD to meet its needs.

6.2.3 Air Force Herbicides. Four military herbicides were stored for various lengths of time at NCBC. These herbicides were code named Herbicide Orange, Orange II, Blue and White. Herbicides Blue and White were intermittently stored at NCBC during 1968 and 1969. However, all stores of these materials were shipped to South Vietnam. The herbicide inventory that underwent long-term storage was comprised of Herbicide Orange (approximately 13,855 drums) and Orange II (1,545 drums).

Herbicide Orange was a reddish-brown to tan colored liquid, soluble in diesel fuel and organic solvents, but insoluble in water. One gallon of Herbicide Orange theoretically contained 4.21 pounds of the active ingredient of 2,4-dichlorophenoxy acetic acid (2,4-D) and 4.41 pounds of the active ingredient of 2,4,5-trichlorophenoxy acetic acid (2,4,5-T). Herbicide Orange was formulated to contain a 50:50 mixture of the n-butyl esters of 2,4-D and 2,4,5-T. The percentages of the formulation typically were:

n-butyl ester of 2,4-D	49.49
free acid of 2,4-D	0.13
n-butyl ester of 2,4,5-T	48.75
free acid of 2,4,5-T	1.00
inert ingredients (butyl alcohol and ester moieties)	0.63

Table 6-1

Base Storage Facilities

Use	Area (square feet)
Open Storage	4,711,680
Cold Storage	6,922
Controlled Humidity	575,200
Public Works Storage	16,264
General Storage Shed	4,040
General Warehouses	561,818
Hazardous/Flammable Storage	4,000

Table 6-2

Fuel Storage Facilities

Location	Product	Capacity (gal)	Type*	Time Period
Building 157 (NCTC)	Diesel	10,000	AG	1969-1984
Building 220 (Gov't Vehicle Service Station)	MOGAS	10,000	UG	1952-1977
	MOGAS	10,000	UG	1952-1977
	Diesel	5,000	UG	1952-1977
	Kerosene	1,000	AG	1952-1977
Building 283 (Navy Exchange Service Station)	MOGAS	10,000	UG	1967-1971
	Diesel	10,000	UG	1967-1971
Building 340 (Navy Exchange Service Station)	MOGAS	10,000	UG	1971-1984
	MOGAS	10,000	UG	1971-1984
Building 398 (Gov't Vehicle Service Station)	MOGAS	5,000	UG	1977-1984
	MOGAS	10,000	UG	1977-1984
	MOGAS	10,000	UG	1977-1984
	Diesel	25,000	UG	1977-1984
	Diesel	25,000	UG	1977-1984
Building 400 (CED)	2 Fuel	10,000	UG	1979-1984

Note: *Above ground = AG
Underground = UG

Table 6-3

Typical Pesticide Inventory

Pesticide	Quantity
Insecticides:	
Allethrin, 2.5% Aerosol, 12 ounce	32 each
Carbaryl, 80% Wettable Powder (WP)	60 pounds
Chlordane, 5% Dust	1 pound
Chlordane, 10% Dust	100 pounds
Chlordane, 72% Emmulsifiable Concentrate (EC)	93 gallons
Diazinon, 2% Dust	12 pounds
Diazinon, 48.2% EC	7 gallons
Dichlorvos, 0.04% Fly Bait	4 pounds
Dichlorvos, 0.5%; Pyrethrum, 0.04% Oil Solution (OS)	1 gallon
Dichlorvos, 23.2% EC	2 gallons
Dieldrin, 15% EC	2 gallons
Dimethoate, 23.4% EC	2.5 pints
Dursban, 0.5% Granules	80 pounds
Dursban, 23.5% EC	2 gallons
Ficam, 76% WP	66 ounces
Malathion, 57% EC	11 gallons
Malathion, 95% Conc.	40 gallons
Naled, 85% Conc.	3 gallons
Petroleum oil, 80% EC	1 gallon
Petroleum oil, 97% EC	1 gallon
Propoxur, 1% OS	14 gallons
Propoxur, 2% Bait	30 pounds
Propoxur, 13.9% EC	2 gallons
Pyrethrum, 1% OS	4 gallons
Rotenone, 0.12%; Pyrethrum, 0.05% Aero, 16 ounce (Wasp Freeze)	12 each
Herbicides:	
Bromacil, 80% WP	35 pounds
Glyphosate, 41% EC (Round-Up)	10 gallons
2,4-D, 4 lb/gal, A.E., Amine salt	16 gallons
Miscellaneous:	
Anticoagulant, 0.005% Bait	12 pounds
Anticoagulant, 0.025% Bait	1 pound
Anticoagulant, 0.2% Tracking powder	12 pounds
Anticoagulant, 0.5% Conc.	4 pounds
Glue, rodent	2 gallons
Repellent, bird (Roost-No-More), 14 ounce Aero	3 each
Repellent, bird (Roost-No-More), 10.5 ounce Tubes	16 each

Orange II was a formulation similar to Herbicide Orange with the only difference being the substitution of the isooctyl ester of 2,4,5-T for the n-butyl ester of 2,4,5-T. The physical, chemical and toxicological properties of Orange II were similar to those of Herbicide Orange. Orange II was produced solely by one chemical company (Young 1979).

The outside areas numbered 56 through 67 (approximately 13 acres) were used for storage of these materials. To provide good drainage, 2 inch by 6 inch dunnage (creosote treated timbers) was laid on a hard surface. The drums were positioned horizontally with the bung closure pointing outward, stacked in double rows, three high, in pyramidal fashion. The number of drums in each single row, bottom to top, was 55, 54 and 53. There was an 18 inch walking space between each double row to allow for inspection of the bungs. Drums were inspected and moved or redrummed as required. After prolonged storage, bung seal leaks and some rusting of the drums resulted in leaking of herbicide on the ground of the open storage area. The quantity of herbicide which leaked from the drums was not recorded. These materials were stored from 1968 until July of 1977 when all of the herbicide stock was transported and disposed off-base by the Air Force.

6.2.4 <u>Polychlorinated Biphenyl Filled Transformers</u>. NCBC's eight pad mounted PCB (askarel) filled transformers are listed in Table 6-4. Public Works personnel indicated that all the transformers were leak-free. However, the transformer located outside Building 322 had a one quart leak in 1977. This transformer was inspected and soil samples taken from the area next to it. Soil samples were collected during a sampling and analysis program to determine the extent of contamination. The contaminated material was removed and disposed off-base.

6.2.5 <u>Asbestos</u>. Until early 1984, the General Services Administration (GSA) stored about 94,000 burlap bags (9,000,000 pounds) of amosite asbestos (used for insulating buildings) in Building 225. There had been no receipt or shipment of the material since 1966. No incidents pertaining to storage of this material were reported. In 1983, a contract was awarded for rebagging and transport of the asbestos off-base to another GSA facility.

6.2.6 <u>Bauxite Ore Piles</u>. Following World War II, the center became the custodian of about 2 million tons of bauxite (a red clay colored ore used to make aluminum) given to the United States for payment of a war debt. Initially there were a number of storage piles of ore in the northwestern portion of NCBC. By the mid-1970s, only two large piles, covering 24 acres and containing approximately 1 million tons, remained on base. This ore is still stored at NCBC. No incidents were reported except for an occassional dust nuissance within the confines of the base.

6.2.7 <u>Salvage Yard</u>. A storage and scrap yard was located in a fenced open area adjacent to the wastewater treatment plant (base coordinate system location: D-11). Materials such as scrap metals, 55 gallon drums and automotive parts, were stored here prior to sale to scrap dealers. This area was in use from the 1950's until it was closed in the early 1970s. The scrap metal was subsequently sent to the off-base DPDO facility for resale.

6.2.8 <u>CED Oil Yard</u>. A temporary storage area for petroleum, oils and lubricants (POLs), used routinely by CED, was located between Building 281 and 282. This drum storage area was used by CED until 1979. When CED moved

Table 6-4

PCB Transformer Inventory

Location	Serial Number	Quantity (kg)
Building 365	2-55732	1,500
Building 343	72V7434	2,315
Building 367	2-56833	2,215
Building 356	72V3598	1,020
Building 319	6859604	1,000
Building 320	12CD-1482	2,250
Building 322	W246736	1,000
Building 339	71V6224	1,100

their operation to the new facility (Building 400) the "Oil Yard" was relocated to an open area directly northeast of the new facility. Reportedly both of these areas were operated similarily. Several hundred 55 gallon drums of POLs where kept on hand to meet the needs of the department. Drums were placed horizontally on racks in several long rows and segregated by material category (motor oils, lubricants, preservation agents, cleaners, etc.). Table 6-5 presents an inventory of what was actually on-hand during the survey. However, it is considered typical of the types and quantities of materials generally stored by CED.

6.2.9 Chemical/Flammable Materials. The Supply Department's Chemical/Flammable Materials storage area is located in Building 292. This 4,000 square foot building was constructed in 1967 for temporary storage of these materials prior to distribution to the shops. One to five gallon containers of materials were stored in the building while larger containers (55 gallon drums) were stored outside.

6.2.10 Hazardous Waste Storage. Hazardous wastes are temporarily stored (less than 90 days) in 55 gallon drums at the individual shop responsible for generating the particular waste. The wastes are segregated by type of material and picked up by the off-base DPDO facility for disposal. Potentially hazardous wastes such as oils and cleaning solvents are handled by contractors for reclaiming and reprocessing.

6.3 TRANSPORTATION.

6.3.1 Supply Transport. Hazardous materials and POL products in cans or drums, purchased by Supply, are delivered to the Stock Receiving Facility (Building 320) prior to storage or distribution. Products are distributed to the shop areas on demand.

6.3.2 Waste Transport. The collection and transportation of wastes generated on-base were the responsibility of the PWD Transportation Shop until the early 1970s. This responsibility included the collection of dumpsters around the base for transport to the various disposal sites discussed in Chapter 8. Some collections were made on a scheduled basis, while others were conducted on an as needed basis. By 1972, collection, transportation and disposal were accomplished in three ways: by contract, by the City of Gulfport, and by PWD personnel. The PWD staff collected litter barrels, GI cans, ground litter, and tree cuttings which were transported to the base's sanitary landfill (Site 5). Wastes generated by the various shop operations were picked up and hauled by private contractors to an off-base landfill. This procedure continued until the mid 1970s when the base landfill (Site 5) was officially closed. All subsequent refuse collection activities were performed under contract for off-base disposal.

Petroleum wastes, collected in shop oil bowsers, were routinely hauled to the fire fighter areas (Sites 3 and 6) for use in training sessions. During the height of the Vietnam conflict (about 1968-1971), waste fuels from off-base activities were transported to NCBC by base personnel to supplement the high demand for flammable wastes needed to conduct fire training drills. The fuel was hauled using a 6,000 gallon tanker truck. After the demand for these wastes subsided, the practice of collecting off-base waste fuel was discontinued. Since the mid 1970s, excess base-generated petroleum wastes have been collected by a contractor for reclaiming. Prior to about 1982, waste solvents, paints, thinners, etc., were combined with the oily wastes. This

Table 6-5

CED Oil Yard Inventory

Substance	Quantity (55-gallon drums)
OE/HDO-10	9
OE/HDO-30	4
P-14	four 5-gallon cans
XP-500 Undercoating (Kendell Protective Coating-Vg Based)	8
XP-700-Corrosion Prevention Compound	2
80W90	6
Antifreeze	17
Steam Soap	5
10W30	10
140W	4
P-21	9
P-19	3
P-10	9
P-9	2
P-1	16
Mineral Spirits	8
Alcohol	2
10W40	13
2110 TH	9
C2-Hydo Transmission Fluid	6
105-Compressor Oil	1
ARMONY 47-Heat Transfer Oil	4
T-4	7
T-6-Automatic Transmission Fluid	7
Rock Drill	2
Hi-Range	3
Grease	6
Safety Solvent	3

practice was stopped and the wastes have since been segregated. Solvents are pumped directly from the parts cleaning tanks by a contractor for off-base reprocessing.

6.4 ORDNANCE. The center uses several magazines for storage of small munitions. The magazines, built in the 1940s for storing high explosives, small arms and pyrotechnics, are located in the northwestern portion of the base (base coordinate system locations: D-10, 11 and 12). Information gathered during the IAS survey did not indicate any disposal of ordnance during past operations. No detonation of ordnance has occurred on-base. Explosives with large safety distance requirements were stored off-base. No ordnance is stored in magazines 349 and 350 during peace-time. These would be activated for ordnance storage during national emergencies. Table 6-6 presents a summary of magazine use and assigned capacity.

Table 6-6

Ordnance Storage Magazines

Magazine Number	Use	Assigned Capacity (pounds)
190 A	Smokeless Powder and Projectiles	1,000
190 B	Small Arms	unlimited
190 C	Empty	-
190 D	Empty	-
190 E	Pyrotechnics	1,000
190 F	Empty	-
191	Pyrotechnics Small Arms	5,000 unlimited
192	Small Arms	unlimited
348	Small Arms	unlimited
349	Empty	-
350	Empty	-

CHAPTER 7. WASTE PROCESSING

7.1 GENERAL. Historically, the primary waste processing activities performed at Naval Construction Battalion Construction (NCBC) Gulfport have included the treatment of sewage generated by the various base operations and the burning of refuse collected in on-base dumpsters. Several waste processing activities of lesser significance include the recycling of scrap metal, waste oil reclaiming and the reprocessing of spent cleaning solvents.

7.2 SEWAGE TREATMENT. NCBC does not currently treat any of its sewage generated on-base. The Public Works Department (PWD) did, however, operate the Center's treatment plant from the early 1940s until 1978. In 1978, the plant was shutdown when an interceptor sewer that connects the base to the city's system was completed. This treatment facility was designed to treat approximately 1.5 million gallons per day (MGD) but typically handled about 0.45 MGD. Sanitary wastes were discharged by three pumping stations to two Imhoff tanks operated in parallel. The tank effluent discharged to a fixed nozzle slag rock trickling filter. The tank sludge was pumped to drying beds. The dried sludge was hauled to the on-base landfills (Sites 2, 3, 4 and 5). The treated wastewater was discharged to three one-acre polishing ponds connected in series. The final pond discharged into the Colby Avenue drainage ditch which emptied off-base to the north into Turkey Creek.

7.3 REFUSE BURNING. NCBC disposed of all refuse and other burnable materials by burning at the various disposal locations discussed in Chapter 8. In addition to domestic solid wastes, unknown volumes of waste oils, old paints and various other industrial wastes were occasionally thrown in the dumpster and burned at the landfills. The burning practices established in the 1940s ceased in the early 1970s. Thereafter, the solid waste was hauled off-base by contractor for disposal in privately owned landfills.

7.4 RECYCLING. The major recycling efforts conducted at the base have been with scrap metal and cardboard. Scrap metal is collected at various shops and other locations on-base. Until the early 1970s, this material was hauled to the base salvage yard and sold to scrap dealers. Since then, the material has been routinely picked up by the regional Defense Property Disposal Office (DPDO) and taken to their facility for sale to scrap metal dealers. The cardboard waste is recovered at the Commissary store and mess hall by a contractor and sold to a paper stock broker.

7.5 WASTE OILS/SOLVENTS. Waste oil reclaiming efforts extend back to the early 1970s. Waste oil generated on-base at the vehicle maintenance shops is collected by a contractor and hauled to a reclaiming facility. Until approximately two years ago, the waste oil solution also contained cleaning solvents, waste paint, thinners, etc., which were poured into the holding tanks or bowsers. These wastes have now been segregated from the waste oil. A contractor was hired to provide solvent processing services for the parts cleaning tanks. This contractor pumps the waste solvent from the units and replaces it with fresh solvent. The waste solvent is hauled off-base for reprocessing and reuse. The waste paint and thinners are poured into drums for off-base disposal.

CHAPTER 8. DISPOSAL SITES AND POTENTIALLY CONTAMINATED AREAS

8.1 GENERAL. Nine potentially contaminated areas were identified at the Naval Construction Battalion Center (NCBC) Gulfport during this study. This chapter contains a detailed discussion on each of the identified disposal sites. Information presented was obtained during the on-site survey, interviews with current and long-term personnel, and a review of available records. Table 8-1 summarizes the information collected on these sites.

8.2 SITE 1, DISASTER RECOVERY DISPOSAL AREA. Site 1 is located between 7th Street and the catfish ponds, at the site of the current mock disaster recovery training village (base coordinate system location: F-9). The site covers an area approximately 400 feet by 1,000 feet, encompassing 9 acres. The location and aerial extent of the site are shown in Figure 8-1.

The site was used from 1942 to 1948 as a landfill. It was reported that this site was the primary disposal area for chemical wastes generated at the installation during its six years of operation. These chemical wastes were generated mainly by public works shops or the Supply Department. Many of the wastes were reportedly containerized in 55-gallon drums. The disposal operation consisted of burying the wastes in trenches. These trenches were reportedly greater than eight feet deep and had standing water. Thus, the wastes disposed at the site were in direct contact with the surficial ground water.

Chemical wastes reportedly disposed at the site include paints, solvents [Stoddard, xylene, toluene, methyl ethyl ketone (MEK), trichloroethylene], oils, paint strippers and cleaning compounds. Paints commonly used at NCBC contained cadmium, chromium and lead. Therefore, those metals are suspected to be present at the site.

In the early part of 1984, four or five buried drums were uncovered during repair operations on a water line in the southwestern portion of the site. The drums were almost totally deteriorated but contained a tar-like substance which had a very strong odor (much like burnt plastic). A sample of the material was found by the Southern Division, Naval Facilities Engineering Command (SOUTHNAVFACENGCOM) to contain grease and oil. A subsequent analysis indicated that the material contained xylene, toluene and 1,2-dichloroethane, as well as low levels of arsenic and lead. The excavated drums are currently being stored on the concrete foundation pad of Building 271 (Site 9), which is to the east of Site 1.

The majority of surface runoff drains to on-site shallow grassed ditches which drain in a westerly direction to a partially concrete-lined ditch that borders the site on the west. This ditch drains north into Canal 1 with eventual discharge to Turkey Creek. A small portion of the northeast corner of the site may drain north via a grassed ditch into the catfish ponds. There were no signs of surface erosion or exposed materials at the site.

The site is characterized by planted pines and maintained grass areas surrounding the roads and buildings associated with Disaster Recovery Training. A strip of pine woods with hardwood undergrowth fringes the site to the north and west, while to the south is an open grass area.

Table 8-1

Past Disposal Sites at NCBC Gulfport

Site No.	Site Name	Map Location	Period of Operation	Waste Types	Estimated Total Quantities	Sources*
1	Disaster Recovery Disposal Area	F-9	1942-1948	Paints, oils, solvents, paint strippers and cleaning compounds	unknown	Public work shops, supply
2	World War II Landfill	B/C-8	1942-1948	General refuse, paints, oils, solvents, paint strippers, and cleaning compounds	unknown	Dumpsters throughout NCBC
3	Northwest Landfill/ Burning Pit	D-8	1948-1966	Solid waste, oils, fuels, paints, paint strippers, solvents, and cleaning compounds	30,000 tons of solid waste, unknown quantities of other liquid wastes; 130,000 gallons of flammable liquids burned in pit	All NCBC industrial operations
4	Golf Course Landfill	G-6	1966-1972	Solid waste, oils, fuels, paints, paint strippers, solvents, and cleaning compounds	16,000 tons of solid waste; unknown quantities of other liquid wastes	All NCBC industrial operations
5	Heavy Equipment Training Area Landfill	K-6/7	1972-1976	Refuse and tree clippings, DDT, paints, oils, solvents, paint strippers and cleaning compounds	6,000 cubic yards of solid waste; 50 to 100 drums of DDT	All NCBC industrial operations
6	Fire Fighting Training Area	K/J-8	1966-1975	Waste fuels, oils, solvents, paint and paint strippers	500,000 gallons	CED, 20th NCR, NCTC, Public works shops
7	Rubble Disposal Area	A/B-9	1978-1984	Concrete, lumber, scrap metal and similar inert materials	unknown	Construction and building demolition debris
8	Air Force Herbicide Orange Spill Area	E-21	1968-1977	Herbicide Orange	Spillage from storage of 15,400 55-gallon drums at site	Air Force
9	Building Foundation 271 Excavated Drum Storage Area	F-11	1984	Toluene, xylene and 1,2-dichloroethane	Four or five 55-gallon drums	Excavated from Site 1

CED - Construction Equipment Department; NCR - Naval Construction [illegible]ment; NCTC - Naval Construction Training Center.

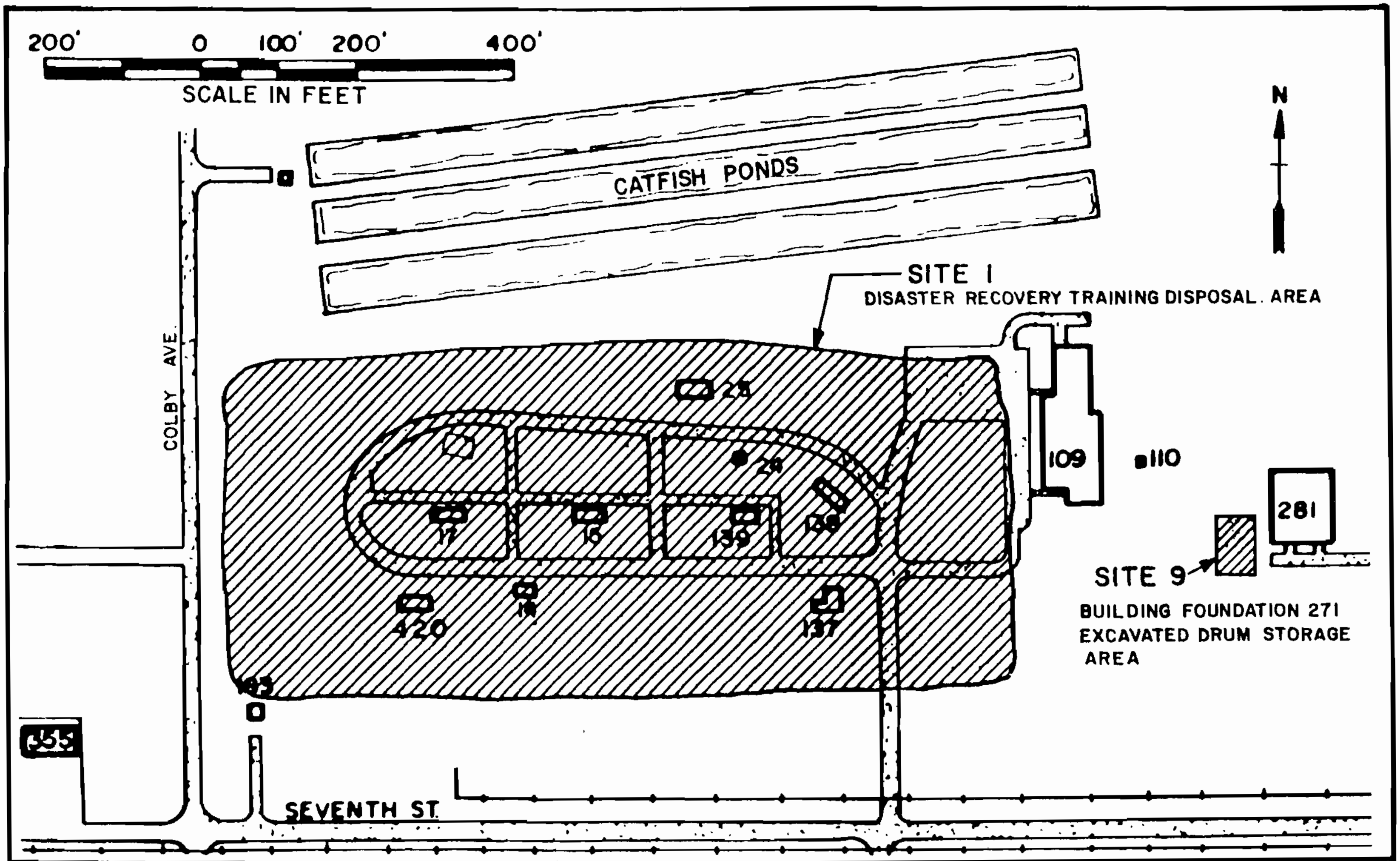

FIGURE 8-1

Waste Disposal Sites 1 and 9

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8.3 SITE 2, WORLD WAR II LANDFILL. Site 2 is located along the east side of Colby Avenue between 8th and 11th streets (base coordinate system location: B/C-8). The site covers an area approximately 600 feet by 800 feet, encompassing 11 acres. The location and aerial extent of the site are shown in Figure 8-2.

The site was used from 1942 to 1948 as a landfill. The site was reportedly used for disposal of general refuse generated at the installation during the World War II period. The disposal operation consisted of the burning of the combustible materials in a structure formerly located at the north end of the site. The ash along with the non-combustible material was then pushed to the southern end of the site were burial was done.

The wastes were buried in trenches that were greater than eight feet deep and typically had standing water. Thus, the wastes disposed at the site were in direct contact with the surficial ground water. Once wastes were disposed in a trench, it was covered with soil.

The majority of the waste disposed at the site was general refuse and inert material such as paper, cardboard, wood and garbage. Liquid wastes such as paints, paint thinners, solvents, oils and fuels were also reportedly disposed at the site. Paints commonly used at NCBC contained cadmium, chromium and lead. Therefore, those metals are suspected to be present at the site.

The site is relatively flat. Any runoff leaving the site probably drains toward a ditch which borders the site on the west. This ditch drains north into Canal 1 which eventually discharges to Turkey Creek off-base.

A planted pine forest now occupies the site. Immediately east of a former drainage ditch, which seems to form the eastern border of the landfill, the understory changes, becoming markedly less dense. This difference is probably attributable to the soils being disturbed during the landfill operation (west of the ditch) and not as a result of some form of soil contamination.

8.4 SITE 3, NORTHWEST LANDFILL/BURNING PIT. Site 3 is located at the northwest corner of the intersection of 8th Street and Canal 1 (base coordinate system location: D-8). The site covers an area approximately 650 feet by 240 feet, encompassing 3.5 acres. The location and aerial extent of the site are shown in Figure 8-3.

The site was used as a landfill from 1948 to the mid-1960s. There was also a burning pit at the site from the mid-1950s until the mid-1960s which was used for fire fighting training.

During the time period that the landfill was operational, virtually all the solid waste and some of the chemical and liquid waste generated at the installation was disposed at the landfill. Dumpsters stationed throughout the installation were picked up by public works and disposed at the landfill. In addition, the Construction Equipment Department (CED) and public works shops disposed of their own wastes directly at the landfill.

The landfill was a trench and fill operation. The trenches were approximately six to eight feet deep with as much as a foot of standing water. Thus, the wastes disposed at the site were in direct contact with the surficial

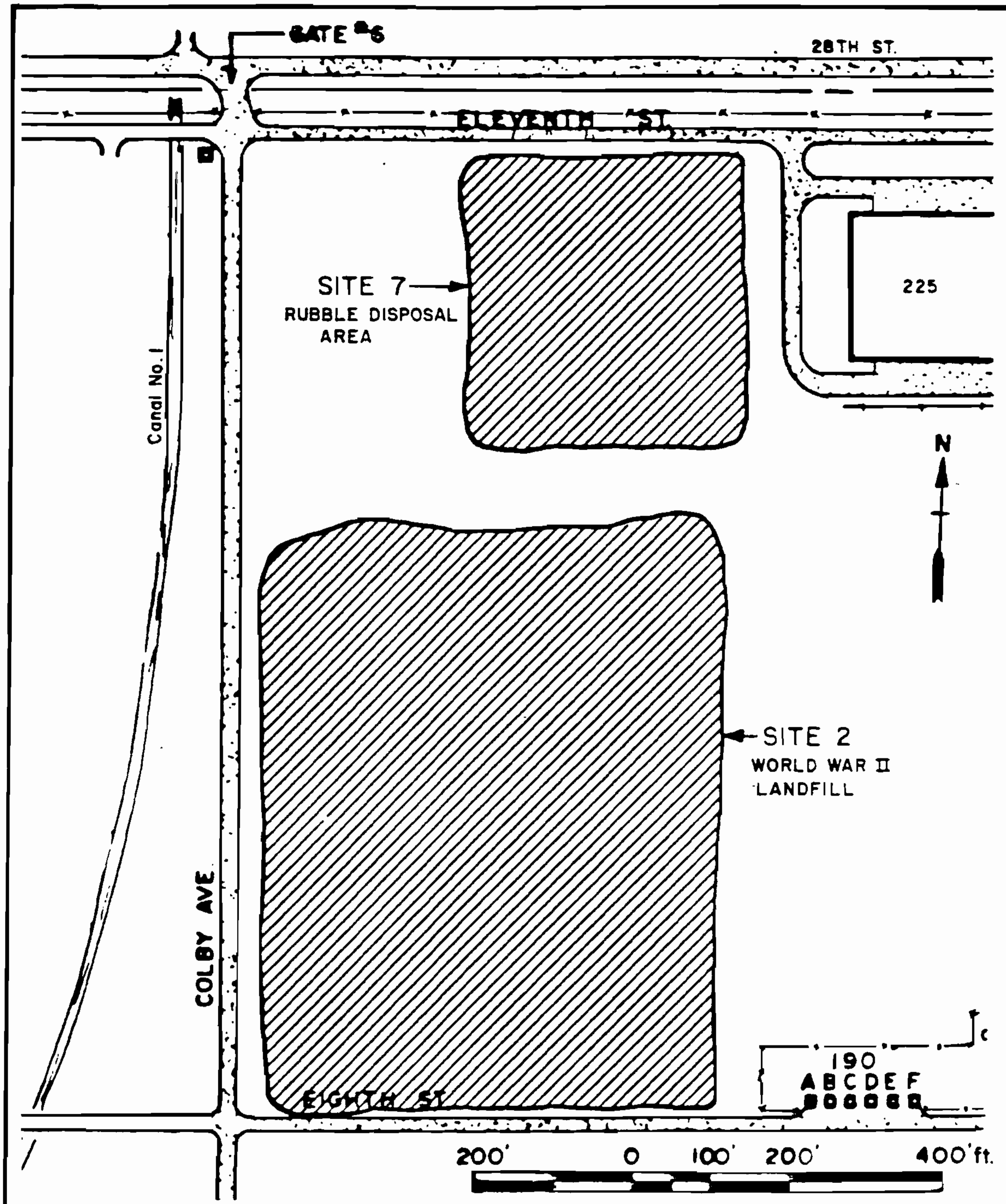

FIGURE 8-2

Waste Disposal Sites 2 and 7

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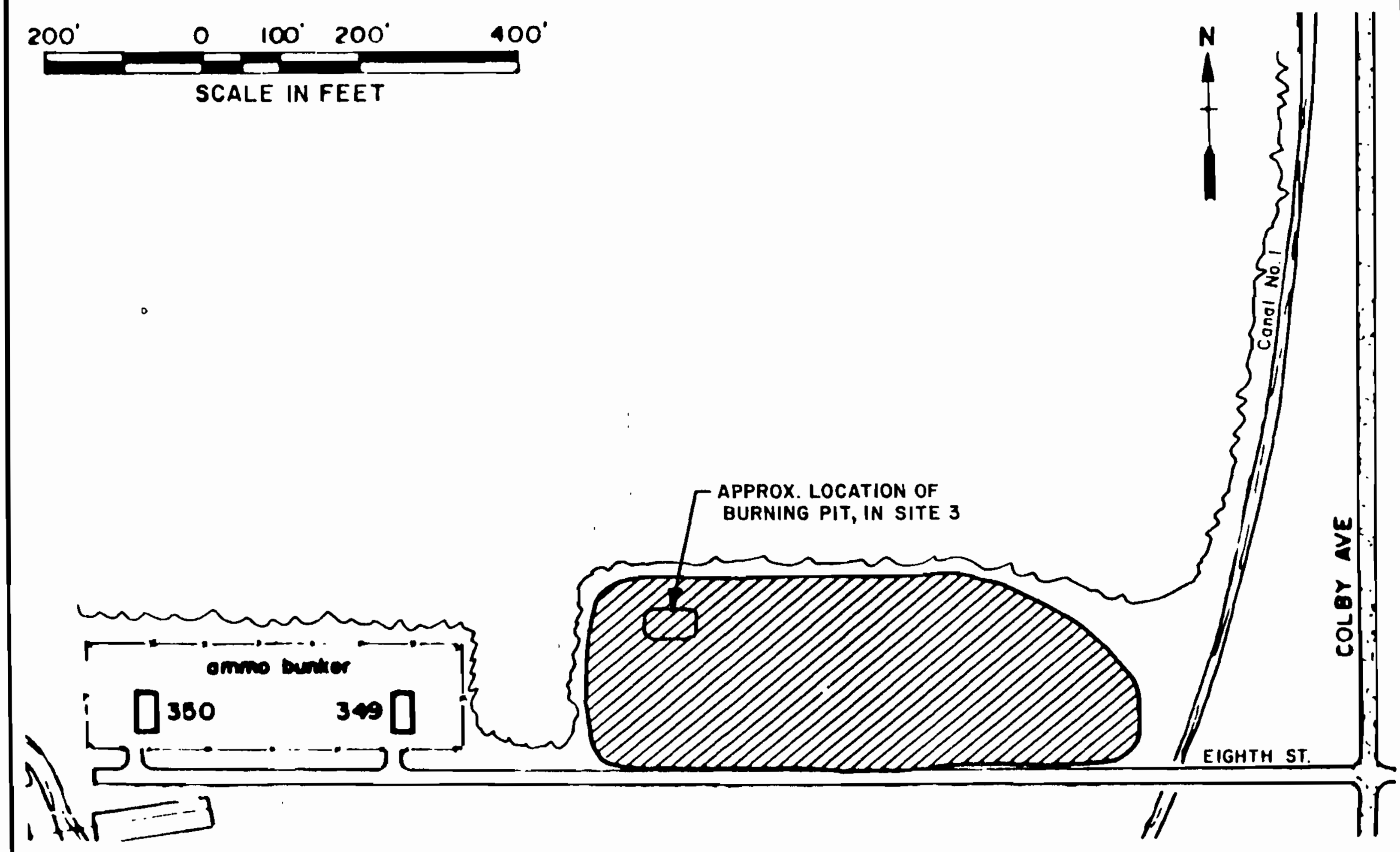

FIGURE 8-3

Site 3 Northwest Landfill and Burning Pit

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ground water. Burning was done daily at the landfill. Wastes brought to the site were placed on the ground and diesel fuel used to ignite them. After the wastes were burned, the ash and remaining material was pushed into the trenches and covered with soil.

From 1948 to the early 1950s (approximately a five year period), the installation was basically on caretaker status and little waste was generated. During this time period, it is estimated that approximately 250 tons of solid waste was disposed annually at the site (based on assumption that one ton per day was disposed at the site). For the remaining operational period of the site, it is estimated that roughly 2,300 tons of solid waste was disposed annually at the site (SOUTHNAVFACENGCOM, 1976). Over the entire period of time that the landfill was operated, this amounts to an estimated 30,000 tons of solid waste disposed at the site.

Liquid wastes generated by CED and public works shops during maintenance and repair activities were also disposed at the landfill. These wastes included fuels, oils, solvents (Stoddard, xylene, toluene, MEK), paints and paint strippers. Table 8-2 summarizes the estimated waste liquid quantities generated during the operational period of the site. The vast majority of these liquid wastes were burned during fire fighting training activities. However, some of these wastes were reportedly disposed at the landfill. Because no records were kept on disposal activities, a more exact quantification of the liquid wastes disposed at the site is not possible.

Crushed drums of 10 percent sodium arsenite, which was used to treat termites, are also reportedly buried at the site. The drums were rinsed prior to disposal. Crushed pesticide cans are also disposed at the site. The pesticide cans were also reportedly rinsed prior to disposal.

Because much of the waste was burned at the site, flammable liquids and materials disposed at the site were probably incinerated. Products of incomplete combustion may exist at the site.

From the mid-1950s to 1966, there was a burning pit located in the northwestern portion of the site used for fire fighting training. The pit was approximately 25 feet by 15 feet by 4 feet deep and unlined. Typically, waste liquids were taken from the shops and transported to the site in bowsers or 55-gallon drums.

Burns were conducted at the pit once or twice per month. The flammable liquids were drained into the pit and set afire. There was typically one to two feet of water in the pits upon which the flammable liquid was poured. The fires were surpressed with a protein foaming agent or water fog.

Approximately 1,000 gallons of waste fuels, oils, solvents, paints and paint thinners were burned at the site monthly. Over the time period the burning pit was operational, it is estimated that 130,000 gallons of flammable liquids were burned at the site. The vast majority of the flammable liquid wastes generated at the shops were burned at this site. It is not possible to accurately estimate what portion of the flammable liquids was consumed by burning or volatilization and what portion percolated into the surrounding ground. However, based on accounts of fire station personnel, some residual liquids did remain following practice burns. Waste paints disposed at the site could contain cadmium, chromium and lead.

Table 8-2

Wastes Potentially Disposed at the Northwest Landfill, Site 3

Waste Type	Total Estimated Quantity Disposed	Source	Comments
Solid Waste	30,000 tons	All NCBC operations	Wastes from dumpsters throughout NCBC
Spent Solvents (Stoddard, PD-680, toluene, MEK)	30,000 gallons*	CED, Public works	Much of this waste burned during fire fighting training
POL Wastes	160,000 gallons*	CED, Public works	Much of this waste burned during fire fighting training
Waste Paint	2,500 gallons*	CED, Public works	Much of this waste burned during fire fighting training
Paint Thinners	5,000 gallons*	CED	Much of this waste burned during fire fighting training
Pesticide Cans and Bags	unknown	Public works, pesticide shop	Empty drums of 10% sodium arsenite buried; empty 5-gallon cans of other pesticides buried

*This represents the total quantity generated during the operational period of the site. Some unknown portion of this total quantity was disposed at the site. This number provides a worst-case assumption.

Following closure of the site in 1965, the pit was filled with soil. There is no longer any indication of the pit at the site. The site drains to a small ditch which borders the site on the south, and Canal 1 which borders the site on the east. The ditch drains into Canal 1, which drains off Navy property to Turkey Creek.

There were signs of surface erosion at the southeast corner of the site. The ditch and canal both had significant sediment deposition. There was also a pink liquid noticeable on the water surface of Canal 1. There was evidence of fairly recent disposal operations at the site including empty lube oil drums, an area of residual fuel approximately 25 feet by 25 feet, pieces of metal siding, and bags of fertilizer.

8.5 SITE 4, GOLF COURSE LANDFILL. Site 4 is located at the golf course, immediately northeast of the intersection of 7th Street and Canal 1 (base coordinate system location: G-6). The site is trapazoidal in shape and encompasses an area of approximately 4 acres. The location and aerial extent of the site are shown in Figure 8-4.

The site was used from approximately 1966 to 1972 as a landfill. During this time period, it was the only operating landfill at the installation. Virtually, all the solid waste and some of the liquid and chemical wastes generated at the installation were disposed at the site. Dumpsters stationed throughout the installation were picked up by public works and disposed at the landfill. In addition, CED, public works, Naval Construction Training Center (NCTC) and Twentieth Naval Construction Regiment (20th NCR) took their own wastes directly to the landfill.

The landfill was a trench and fill operation. Trenches ran east to west and were approximately 8 feet wide, 6 to 8 feet deep, and 200 feet long. Typically, there was standing water as much as a foot deep in the trenches. Thus, wastes were in direct contact with the surficial ground water.

Wastes brought to the site were placed on the ground and diesel fuel was used to ignite them. After the wastes were burned, the ash and remaining material was pushed into the trenches and covered with soil.

Approximately 2,300 tons of solid waste was disposed at the landfill annually (SOUTHNAVFACENGCOM, 1976). Over the period of time that the landfill was operational, an estimated 16,000 tons of solid waste was disposed at the site. Also disposed at the site was all the installation debris resulting from hurricane Camille. Many of the older wooden buildings were destroyed during hurricane Camille in 1969 and this rubble is buried at the site.

Liquid wastes generated by CED, NCTC, 20th NCR and public works shops during maintenance and repair activities were also disposed at the site. These wastes included fuels, oils, solvents (Stoddard, xylene, toluene, MEK), paints and paint strippers. Table 8-3 summarizes the estimated waste liquid quantities generated during the operational period of the site. The vast majority of these liquid wastes were burned during fire fighting training activities. However, some of these wastes were reportedly disposed at the landfill. Because no records were kept on disposal activities, a more exact quantification of the liquid wastes disposed at the site is not possible.

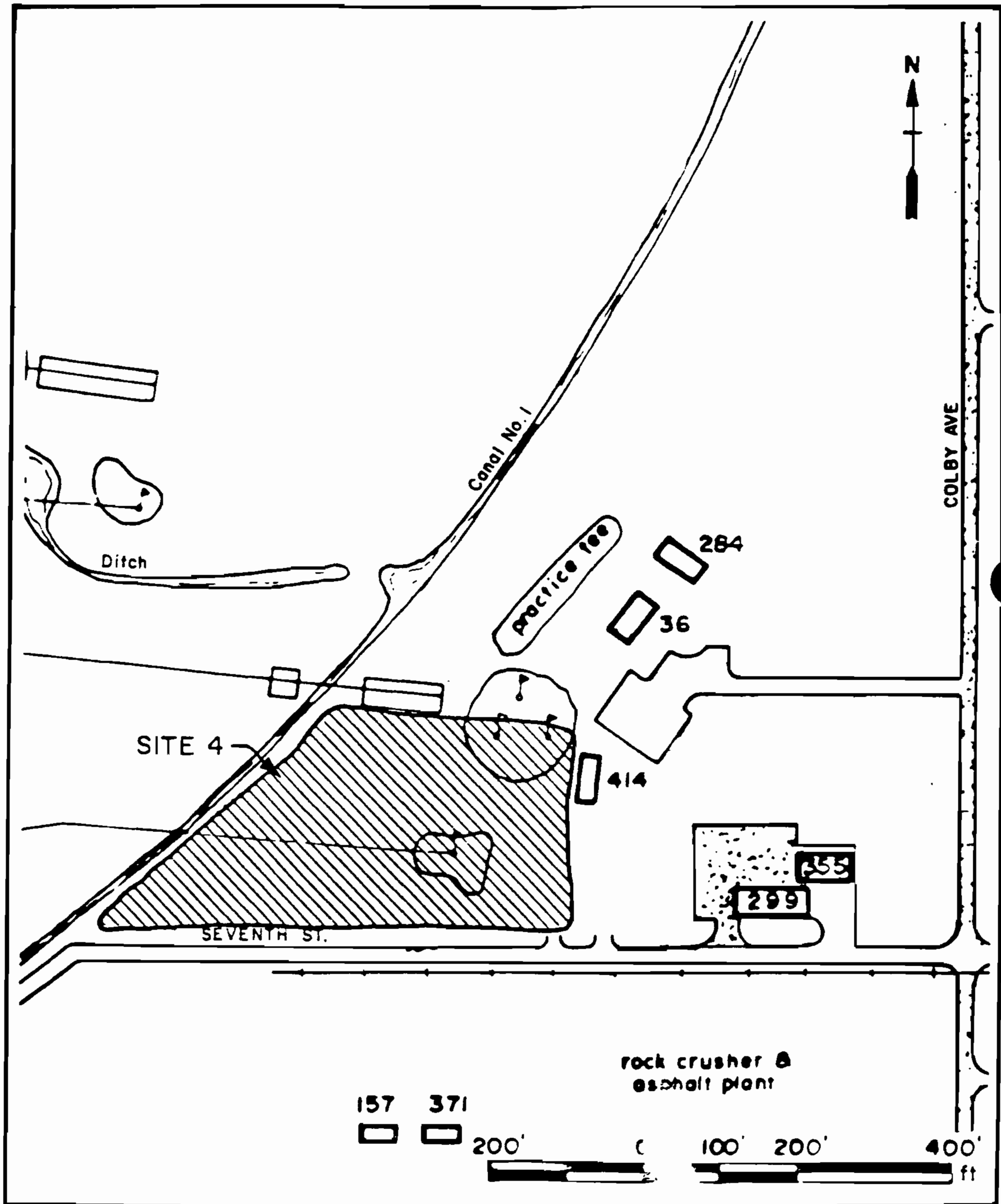

FIGURE 8-4

Site 4
Golf Course Landfill

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Table 8-3

Wastes Potentially Disposed at the Golf Course Landfill, Site 4

Waste Type	Total Estimated Quantity Disposed	Source	Comments
Solid Waste	16,000 tons	All NCBC operations	Wastes from dumpsters throughout NCBC
Spent Solvents (Stoddard, PD-680, toluene, MEK)	40,000 gallons*	CED, Public works, NCTC, 20th NCR, Marines	Much of this waste burned during fire fighting training
POL Wastes	160,000 gallons*	CED, 20th NCR, NCTC	Much of this waste burned during fire fighting training
Waste Paint	2,000 gallons*	CED, Public works, 20th NCR	Much of this waste burned during fire fighting training
Paint Thinners	4,000 gallons*	CED, 20th NCR	Much of this waste burned during fire fighting training
Building Demolition Debris	unknown	NCBC Buildings	Installation debris resulting from Hurricane Cammille

*This represents the total quantity generated during the operational period of the site. Some unknown portion of this total quantity was disposed at the site. This number provides a worst-case assumption.

Because much of the waste was burned at this site, flammable liquids and materials disposed at the site were probably incinerated. Products of incomplete combustion may exist. However, in the latter years the site was used, it was reported that drums of liquid waste were buried intact instead of being crushed and burned. Waste paints disposed at the site could contain cadmium, chromium and lead.

Following closure of the site in 1972, approximately ten feet of fill was placed over the site. There is no evidence of past waste disposal practices at the site. The site generally drains to Canal 1 which borders the site on the west. Canal 1 drains north off Navy property to Turkey Creek.

8.6 SITE 5, HEAVY EQUIPMENT TRAINING AREA LANDFILL. Site 5 is located approximately 200 feet west of the intersection of 4th Street and Colby Avenue, in an area currently being used for heavy equipment training (base coordinate system location: K-6/7). The site is trapazoidal in shape and encompasses an area of approximately 8.5 acres. The location and aerial extent of the site are shown in Figure 8-5.

The site was used for approximately a four year period from 1972 to 1976. During this time period, it was the only operating landfill at the installation. However, the majority of the solid waste generated at the installation was being disposed off-base by a private contractor. Solid waste was disposed at the site through public works. In addition, CED, NCTC, 20th NCR and public works took their own wastes directly to the landfill.

The landfill was a trench and fill operation. Trenches ran north to south and were approximately eight feet wide and six to eight feet deep. Typically, there was standing water as much as a foot deep in the trenches. Thus, wastes were in direct contact with the surficial ground water. Waste brought to the site were disposed directly into trenches. There was no burning of wastes at the site.

Approximately 1,500 cubic yards of solid waste was disposed at the landfill annually (SOUTHNAVFACENGCOM, 1972). This included mainly trash, refuse from the reserve barracks, and tree cutting (SOUTHNAVFACENGCOM, 1972). Over the time period that the landfill was operational, this amounts to an estimated 6,000 cubic yards of solid waste disposed at the site.

Liquid wastes generated by CED, NCTC, 20th NCR and public works shops during maintenance and repair activities were also disposed at the site. These wastes included fuels, oils, solvents (Stoddard, xylene, toluene, MEK), paints and paint strippers. Table 8-4 summarizes the estimated waste liquid quantities generated during the operational period of the site. The vast majority of the liquid wastes were burned during fire fighting training activities. However, some of these wastes were reportedly disposed at the landfill. There were reports of a dump truck load of paint being disposed at the site and bowsers of oil being drained at the site. Because no records were kept of disposal activities at the site, a more exact quantification of the liquid wastes disposed at the site is not possible.

Also reportedly disposed in the southern portion of the site were 50 to 100 drums of liquid dichlorodiphenyltrichloroethane (DDT) and boxes of powder containing DDT. The drums were believed to have been buried at the site in the mid-1970s. At least some of these drums leaked during the disposal operation and an attempt was reportedly made to seal the drums in clay.

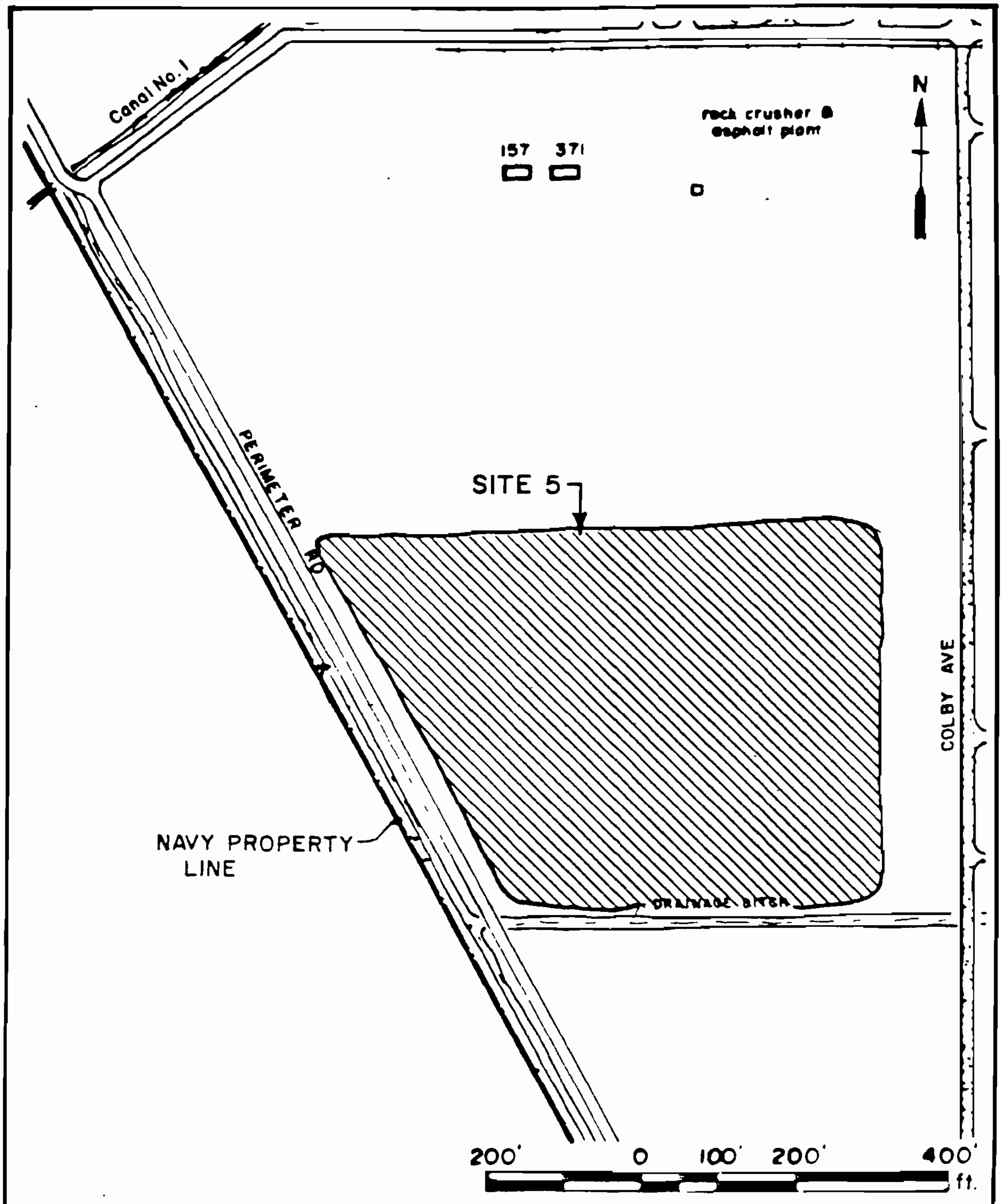

FIGURE 8-5

Site 5
Heavy Equipment
Training Area Landfill

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Table 8-4

Wastes Potentially Disposed at the Heavy Equipment Training Area Landfill, Site 5

Waste Type	Total Estimated Quantity Disposed	Source**	Comments
Solid Waste	6,000 cubic yards	Barrels, public works	Mainly litter, refuse from reserve barracks and tree cutting
Spent Solvents (Stoddard, PD-680, toluene, MEK)	16,000 gallons*	CED, Public works, NCTC, 20th NCR, Marines	Much of this waste burned during fire fighting training
POL Wastes	90,000 gallons*	CED, 20th NCR, NCTC, Public works	Much of this waste burned during fire fighting training or salvaged by private contractor
Waste Paint	1,200 gallons*	CED, 20th NCR	Much of this waste burned during fire fighting training
Paint Thinners	2,500 gallons*	CED, 20th NCR	Much of this waste burned during fire fighting training
DDT	50-100 drums of liquid DDT and at least 12 pounds of powdered DDT	unknown	At least 24 eight ounce boxes of powdered DDT were disposed at the site

*This represents the total quantity generated during the operational period of the site. Some unknown portion of this total quantity was disposed at the site. This number provides a worst-case assumption.
**CED - Construction Equipment Department; NCR - Naval Construction Regiment; NCTC - Naval Construction Training Center; NCBC - Naval Construction Battalion Center.

Soon after the landfill was closed and began being used as a heavy equipment training area, powdered DDT was also discovered at the site. While excavating a ditch at the site, a bulldozer operator encountered what he believed was DDT-contaminated water. Approximately one month later in the same general area, labeled boxes of powder containing DDT were uncovered. These boxes were approximately eight ounces in size. From descriptions, it sounds as if the boxes were DDT dusting kits used by personnel on deployment as insect repellant. There were at least 24 of the boxes observed in the ditch which would amount to at least 12 pounds of powder DDT. The DDT was left at the site and covered with soil.

The source of the drums of liquid and powdered DDT is not known. However, the most likely explanation of its origin is that it was probably brought back to NCBC by one of the battalions when it returned from deployment. The DDT was not from the pesticide shop.

In the late 1970s, a four to six foot cap of soil was placed over top of the landfill. This was done because the area was being used for heavy equipment training. Without the soil cap, the buried wastes were continually being uncovered during training exercises.

A perimeter ditch along the south and west borders of the site convey any runoff from the site toward the northwest into Canal 1, which is located approximately 800 feet northwest of the site. A weir at the southeast corner of the site drains the eastern portion of the site south into the perimeter ditch.

There were significant signs of erosion at the site, especially along the perimeter ditch. There was also evidence of exposed material at the site including scrap metal, wood and plastic. Presently the site is extensively used as a heavy equipment training area so no vegetation has been able to establish itself.

8.7 SITE 6, FIRE FIGHTING TRAINING AREA. Site 6 is located east of Colby Avenue approximately midway between 4th and 5th Streets (base coordinate system location: K/J-8). The site consisted of two burning pits. One of the pits was approximately 50 feet by 35 feet and four to 5 feet deep, while the other pit was approximately 40 feet by 25 feet and 6 feet deep. The location of the site is shown in Figure 8-6.

The site was used from 1966 until about 1975 as a training area for fire fighting. Typically, waste liquids were taken from CED, NCTC, 20th NCR and public works shops and transported to the site in bowsers or 55-gallon drums. These waste liquids were either stored in the bowsers or transferred to a 6,000 gallon tanker truck until a burn. Flammable liquids were also obtained from Keesler Air Force Base, the Air National Guard, and Pascagoula Shipyard to be used at the site.

From 1966 through about 1967, burns were conducted once or twice per month at the site. For the four year period from 1968 through 1971, use of the site was greatly increased due to training classes associated with the Vietnam War. During this four year period, burns were conducted once or twice per week at the site. From 1972 through 1975, training exercises were once again reduced to one or two burns per month.

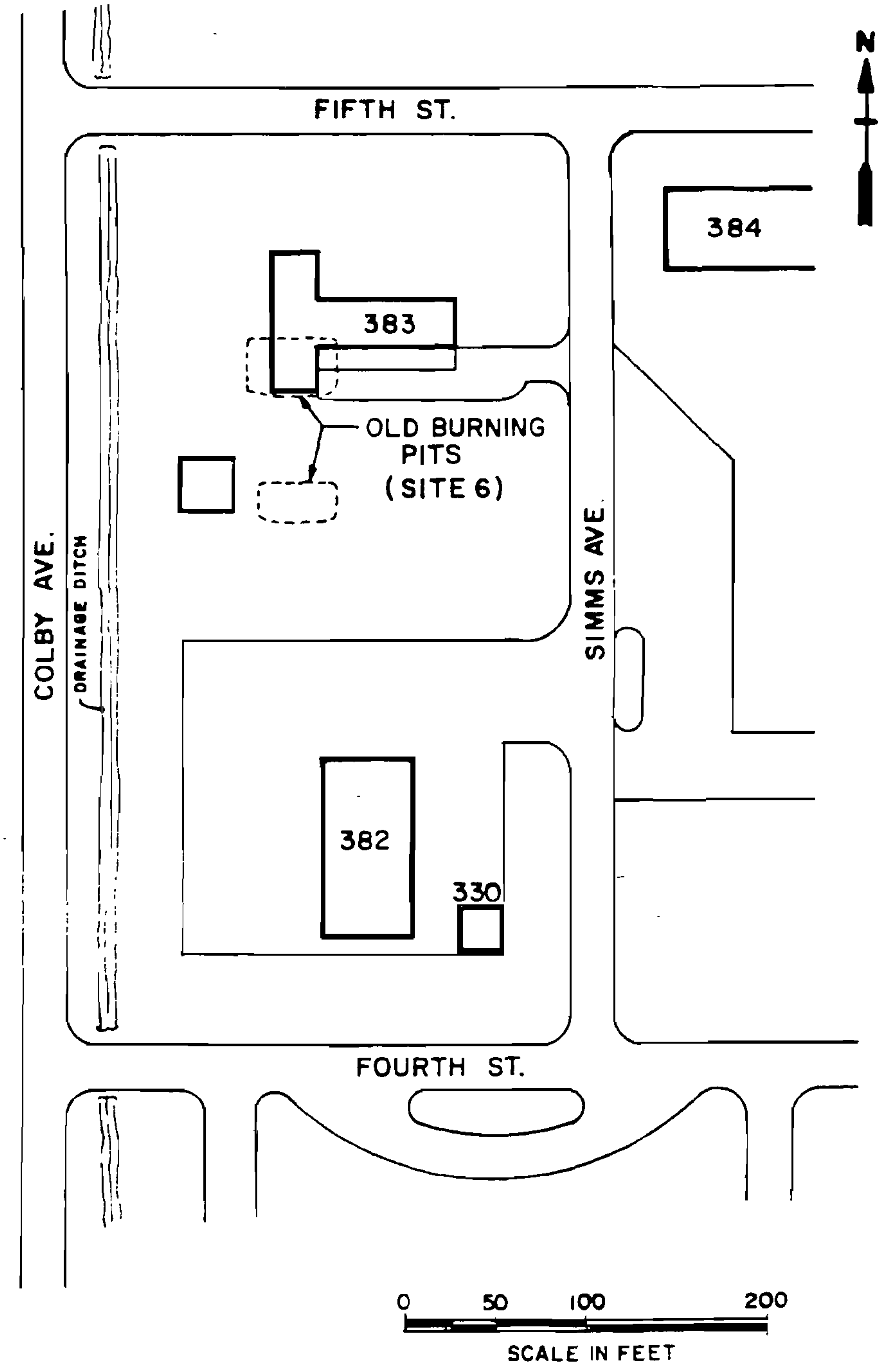

FIGURE 8-6

Site 6 Fire Fighting Training Area

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The flammable liquids were drained into one or both of the pits and set afire. There was typically one to two feet of water in the pits upon which the flammable liquid was poured. The fires were surpressed with a protein foaming agent or water fog. A burn would last three to four minutes. After the fire was extinguished, it was continually restarted and put out until the flammable liquid had essentially burned off to the water level and would no longer ignite. The pits were often used in an alternating fashion.

Approximately 2,000 gallons of waste fuels, oils, solvents (Stoddard, xylene, toluene, MEK), paints, paint thinners and cleaning compounds were burned weekly at the site from 1968 through 1971. During the other periods, approximately 1,000 gallons of flammable liquids were burned at the site monthly. Thus, over the entire time period the fire fighting training area was operational, it is estimated that 500,000 gallons of flammable liquids were burned at the site. The vast majority of the flammable liquids generated at CED, NCTC, public works and 20th NCR were burned at the site. Table 8-5 summarizes the estimated waste liquid quantities generated at the installation during the operational period of the site.

It is not possible to accurately estimate what portion of the flammable liquids was consumed by burning or volatilization and what portion percolated into the surrounding ground. However, based on accounts of fire station personnel, some residual flammable liquid did remain following practice burns. There were reports that following heavy rains waste liquids would sometimes overflow from the pits. Waste paints disposed at the site could contain cadmium, chromium and lead.

Following closure of the site in 1975, the burning pits were filled with soil. This area is now used for pole climbing training. The location of the pits is no longer distinguishable at the site. Building 383 is located where one of the burning pits used to be (Figure 8-6).

The site drains toward a grassed ditch which borders the site to the west. This ditch drains north into Canal 1 and off Navy property with eventual discharge to Turkey Creek. There were no signs of significant surface erosion at the site. A maintained grass area typifies the vegetation at the site. The soil is exposed in many areas. However, this condition is attributable to the training activity conducted at the area.

8.8 SITE 7, RUBBLE DISPOSAL AREA. Site 7 is located south of 11th Street and approximately 200 feet east of Building 225 (base coordinate system location: A/B-9). The site covers an area approximately 375 feet by 350 feet, encompassing three acres. The location and aerial extent of the site are shown in Figure 8-2.

The site was used as a rubble disposal area from 1978 to 1984. Most of the rubble is buried just below the surface at the site. However, in the southeastern portion of the site, rubble is evident aboveground. Wastes buried at the siteinclude concrete, lumber, scrap metal and similar inert materials. In the southeastern portion of the site, tree clippings, sawdust, lumber and concrete are aboveground. The source of much of the waste disposed at the site was construction and building demolition debris. There were no reports or evidence of hazardous waste being disposed at the site.

Table 8-5

Waste Liquids Potentially Burned at the Fire Fighting Training Area, Site 6

Waste Type	Total Estimated Quantity Disposed	Source
Spent Solvents (Stoddard, PD-680, toluene, MEK)	40,000 gallons	CED, Public works, [illegible] 20th NCR,
POL Wastes	325,000 gallons	CED, 20th NCR, NCTC, Public works
Waste Paint	3,000 gallons	CED, 20th NCR
Paint Thinners	6,000 gallons	CED, 20th NCR

The site primarily drains to vegetated ditches which border the site on the east and north. Drainage from these ditchesmay cross north under the perimeter road and immediately into a tributary of Turkey Creek or enter Canal 1 to the west of the site. Canal 1 drains north off Navy property into Turkey Creek. There was some evidence of erosion along the southern and western edges of the site. Vegetation at the site is scant due primarily to recent activity.

8.9 SITE 8, AIR FORCE HERBICIDE ORANGE SPILL AREA. Site 8 is located at Open Storage Area 56 through 67, between Goodier and Greenwood Avenues (base coordinate system location: E-21). The site covers an area approximately 400 feet by 1,425 feet, encompassing 13 acres. The location and aerial extent of the site are shown in Figure 8-7.

The site was used from 1968 to 1977 as a long-term storage area for Herbicide Orange and Orange II. The herbicide was formulated to contain a 50:50 mixture of 2,4-dichlorophenoxy acetic acid (2,4-D) and 2,4,5-trichlorophenoxy acetic acid (2,4,5-T). The herbicide was the property of the U.S. Air Force. Stock piles were beginning to accumulate in Vietnam, so the Air Force arranged with NCBC Gulfport for storage of the herbicide originally intended to be shipped to Vietnam. It was stored at the site in 55-gallon drums. To provide adequate drainage for the storage area, two by six creosoted lumber was laid on the ground surface and drums, positioned horizontally with the bung closure pointing outward, were stacked in double rows, three high, in pyramidal fashion. The number of drums in each single row, bottom to top, was 55, 54 and 53. An 18 inch walking space was left between each double row to allow inspection of the bungs. There were approximately 15,400 drums stored at the site.

After prolonged storage, bung seal leaks and rusting of the drums resulted in Herbicide Orange leaking on the ground of the open storage area. Leakage became such a problem that in 1972, a program was initiated to re-drum the entire inventory of 15,400 drums. Following this, and until the drums were removed from the site in 1977, the drums were routinely inspected and redrummed as required. The quantity of Herbicide Orange spilled at the site is not known, however, given the fact that the entire inventory required redrumming, significant quantitites can be assumed to have leaked. During the summer of 1977, the entire inventory of Herbicide Orange was removed from the site and incinerated at sea. The drums were also disposed off-base by the Air Force.

The primary contaminant of concern at the site is 2,3,7,8-tetrachlorodibenzo-p-dioxin (dioxin). The Air Force is involved in an extensive environmental monitoring program at the site and has been since 1977. Soil, water, sediment and tissue samples have been taken from the site and the drainageways receiving runoff from the site. Soil samples from the storage area indicated dioxin at concentrations of 100 to 500 parts per billion (ppb). Sediment samples from the drainageways receiving runoff from the site contained low (0 to 5 ppb) levels of dioxin, and tissue samples from organisms in the drainageways also contained low (0 to 10 ppb) levels of dioxin. Water samples were negative for dioxin at a detection level of 0.02 ppb.

A report prepared by the Air Force's Occupational and Environmental Health Laboratory which discusses the history of the site and summarizes the sampling performed at the site through 1979 is included as Appendix B (Air

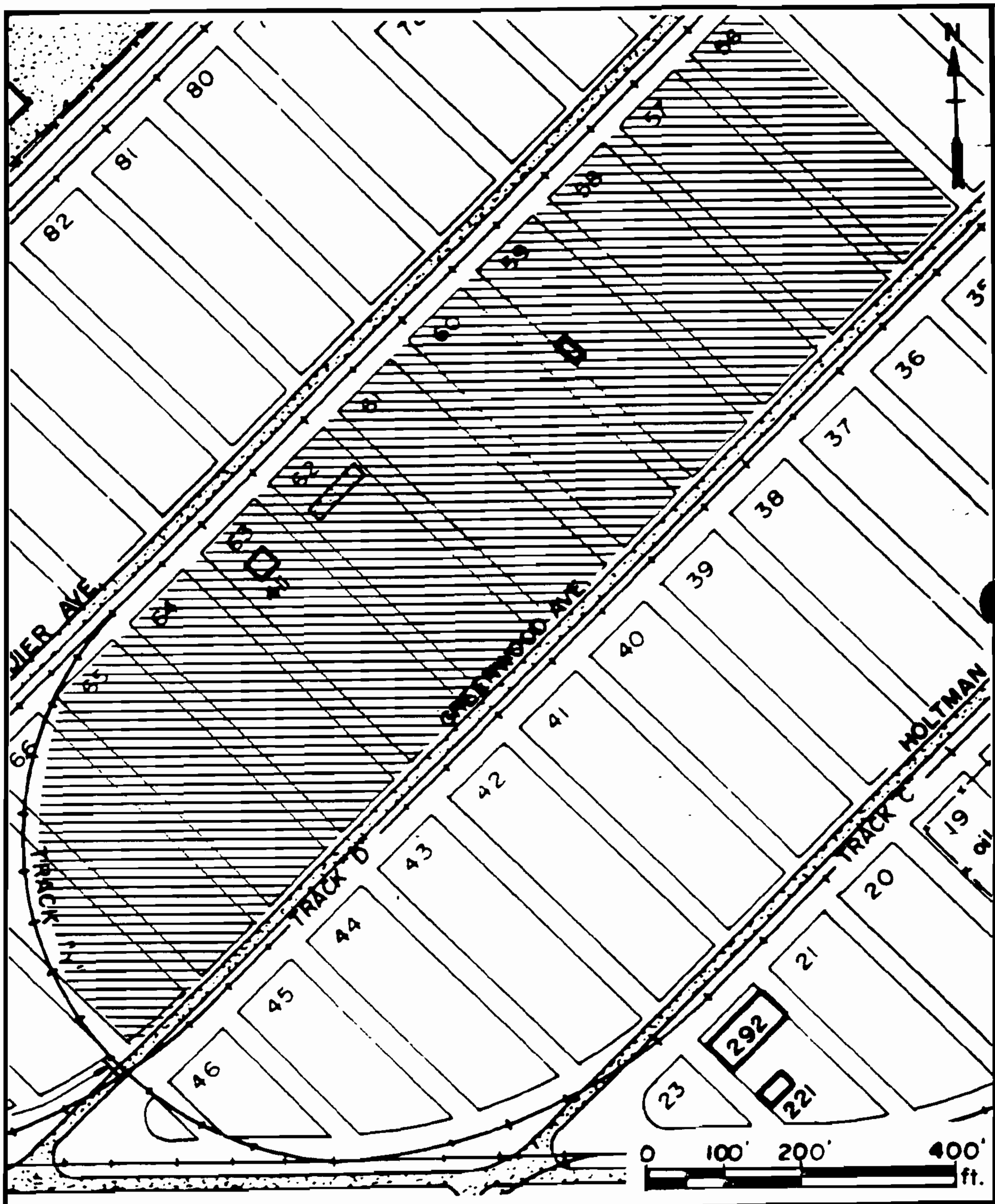

FIGURE 8-7
SITE 8
Air Force Herbicide Orange Storage Area

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Force, 1979). Results of the sampling conducted at the site from January 1980 to February 1985 is contained in Appendix C along with a site map showing sampling locations (Air Force, 1985a).

Dioxin is insoluble in water and the primary pathway for it to migrate off-site is through the erosion of contaiminated soil particles. In order to prevent potentially contaminated soil particles from migrating off-site, the Air Force modified the surface drainage at the site in 1980. Ditches on the site were lined with gravel, and gravel dikes were erected prior to the ditches exiting the site to trap sediments.

In the 1940s when the installation was established, the soil at th site was treated with cement and compacted, creating a 6 to 12 inch layer of hardened, stabilized soil. Studies undertaken by the Air Force have indicated that the hardened, stabilized soil has, for the most part, prevented the downward migration of dioxin at the site. Soil contamination at the site is primarily limited to the upper few inches of soil.

The Air Force is currently involved in a study to evaluate two technologies for decontaminating the dioxin contaminated soils at the site (Air Force, 1985b). One of the technologies being evaluated is thermal pyrolysis of the soil and destruction of the dioxin in a high temperature (4000°F) electric reactor. The other technology being evaluated is thermal desorption followed by ultraviolet light destruction of the dioxin. The goal of each technology is to reduce the level of dioxin to less than one ppb.

8.10 SITE 9, BUILDING FOUNDATION 271 EXCAVATED DRUM STORAGE AREA. Site 9 is located on the concrete foundation of Building 271, immediately west of Building 281 (base coordinate system location: F-11). The concrete foundation covers an area 50 feet by 75 feet. The location and aerial extent of the site are shown in Figure 8-8.

Four or five 55-gallon drums were uncovered in the early part of 1984 during repair operation on a water line in the southwestern portion of Site 1. These drums were transferred to the concrete foundation for interim storage until an analysis could be performed on the drum contents. A sample of the material was found by SOUTHNAVFACENGCOM to contain grease and oil. A subsequent analysis indicated that the material contained xylene, toluene and 1,2-dichloroethane, as well as low levels of arsenic and lead. The complete analytical results are contained in Appendix D.

The concrete pad is bermed on three sides. The drums are almost totally deteriorated, but the drum contents have a tar-like consistency which had a very strong odor (much like burnt plastic). There was no evidence of erosion of the waste material away from the concrete pad.

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APPENDIX A

GOVERNMENT AGENCIES CONTACTED FOR THE INITIAL ASSESSMENT STUDY AT NCBC GULFPORT

Naval Energy and Environmental Support Activity, Port Hueneme, CA.

NAVFAC Command Historian, Naval Construction Battalion Center, Port Hueneme, CA.

Ordnance Environmental Support Office, Indian Head, MD.

Navy Historical Center, Navy Yard, Washington, DC.

Naval Aviation History Office, Washington Navy Yard, Washington, DC.

National Archives, Navy and Old Army Branch, Washington, DC.

National Records Center, General Archives, Suitland, MD.

Naval Facilities Engineering Command Headquarters, Alexandria, VA.

Naval Air Systems Command, Alexandria, VA.

DOD Explosives Safety Board, Alexandria, VA.

U.S. Geological Survey, Reston, VA.

Naval Sea Systems Command, Alexandria, VA.

Naval Facilities Engineering Command, Southern Division, South Carolina, Environmental Branch, Applied Biology Branch, Facilities Planning Branch, Natural Resources Branch, Real Estate Branch, Utilities Branch.

Soil Conservation Service, Gulfport, MS.

APPENDIX B

HERBICIDE ORANGE SITE TREATMENT AND ENVIRONMENTAL MONITORING

Report OEHL TR-79-169

HERBICIDE ORANGE SITE TREATMENT AND ENVIRONMENTAL MONITORING

SUMMARY REPORT AND RECOMMENDATIONS FOR NAVAL CONSTRUCTION BATTALION CENTER GULFPORT MISSISSIPPI

November 1979

Approved for public release; distribution unlimited

USAF Occupational and Environmental Health Laboratory
Aerospace Medical Division (AFSC)
Brooks Air Force Base, Texas 78235

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HERBICIDE ORANGE SITE TREATMENT AND ENVIRONMENTAL MONITORING

SUMMARY REPORT AND RECOMMENDATIONS

FOR

NAVAL CONSTRUCTION BATTALION CENTER
GULFPORT MS

November 1979

Prepared for

AIR FORCE LOGISTICS COMMAND
WRIGHT-PATTERSON AFB OH

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	6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s): Alvin L. Young, Major, USAF; Charles E. Thalken, Lieutenant Colonel, USAF, VC; William J. Cairney, Major, USAF, BSC	8. CONTRACT OR GRANT NUMBER(s)
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aquatic studies; bioaccumulation; biodegradation of herbicides; biodegradation of TCDD; chlorinated phenols; ecological effects; 2,4-dichlorophenoxyacetic acid (2,4-D); environmental monitoring; herbicides; Herbicide Orange; dioxin; Orange; phenoxy herbicides; PACER HO

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Environmental surveys of the soils, plants and the aquatic system in and around a 12-acre Herbicide Orange storage area at Gulfport MS were conducted from 1970 through 1979. The major objectives of the surveys were to (1) determine the magnitude of Herbicide Orange contamination on the storage area; (2) determine the fate of the phenoxy herbicides 2,4-D and 2,4,5-T, their phenolic degradation products and TCDD in soils of the storage area; (3) monitor movements of residues from the storage area into adjacent water, sediments and biological organisms; and (4) recommend managerial techniques for minimizing the impact

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19.
soil microbial studies
TCDD
2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD)
2,4,5-trichlorophenoxyacetic acid (2,4,5-T)

20.
of the herbicides and TCDD residues on the ecology and human populations adjacent or near the storage area. High levels of TCDD (e.g., 100-200 parts per billion [ppb]) were associated with spill sites on the herbicide storage area. Sediment samples from the storage area contained 2.7 to 3.6 ppb TCDD and biological organisms closely associated with the sediment contained 0.14 to 7.2 ppb TCDD. Water samples collected in the same area were negative for TCDD at a detection level of 0.02 ppb. Two of five off-base samples were positive for TCDD (a crayfish and a sediment sample both contained 0.02 ppb TCDD). The primary recommendation is that the 12-acre Herbicide Orange storage area be left undisturbed permitting the continuation of "natural" degradation of the herbicides and TCDD. It is recommended that the area be restricted and that efforts be immediately undertaken to minimize future erosion of contaminated soil into the ditches. The prevention of soil and silt movement from the area may be accomplished by stabilizing the ditch banks, constructing silt catchments within the ditches and constructing a silt retaining pond prior to the stream leaving the NCBC.

SUMMARY*

PURPOSE

The report was prepared to present senior Air Force leaders the latest available data in the continuing environmental monitoring studies of a 12-acre storage area on the Naval Construction Battalion Center (NCBC), Gulfport MS. The area had been used for the long-term storage of approximately 840,000 gallons of Herbicide Orange from mid-1968 to mid-1977.

BASIC HISTORY

Since 1970, various Air Force and contract laboratories have been conducting environmental surveys and analyses of the soils, plants, and the aquatic system in and around the Herbicide Orange storage area. As some leaking became evident and as more information became available on the toxic contaminant 2,3,7,8-tetrachlorodibenzo-ρ-dioxin (TCDD) contained in the herbicide, more extensive monitoring programs were conducted. The entire inventory was redrummed in 1972 and checked for leaks continuously thereafter. In the summer of 1977, the herbicide was transferred to a specially equipped ship and destroyed by at-sea incineration during Project PACER HO. The Air Force Plan and the EPA permits for the disposal of the herbicide committed the Air Force to a follow-on storage site reclamation and environmental monitoring program. The major objectives of this program were to (1) determine the magnitude of Herbicide Orange contamination in the storage area:

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*Updated to include data received 3 Dec 1979 subsequent to report preparation.

(2) determine the soil persistence of the pheonxy herbicides 2,4-dichl phenoxyacetic acid (2,4-D) and 2,4,5-T, their phenolic degradation products and TCDD in soils of the storage area; (3) monitor for potent movement of residues from the storage area into adjacent water, sedime and biological organisms; and (4) recommend managerial techniques for minimizing any impact of the herbicides and TCDD residues on the ecolo and human populations adjacent or near the storage area.

STORAGE SITE CONTAMINATION AND FATE

The monitoring approach used to determine storage site contaminat consisted of analyzing soil samples selected from 42 different sites w the storage area. Sampling points were selected in groups depending u whether a spill of the herbicide had occurred in that area or not. Pre studies had shown that residue did not appreciably move within the soil or significantly penetrate the impervious concrete-stabilized harc located approximately six inches below the soil surface. Soil samples were also analyzed for microorganisms.

The results indicated that approximately 15% of the 12-acre site significantly contaminated with Herbicide Orange and TCDD. Levels of 2,4-D and 2,4,5-T in the samples, which were greater than 100,000 parts per million (ppm) in July 1977, have decreased to one-third that level 16 months. Data from spill sites monitored for this same time period also suggested that TCDD levels are decreasing but at a slower rate. T soil penetration of the herbicides was low while penetration of TCDD wa negligible. Sterilization of the soil did not occur; rather, certain m flora proliferated under high levels of herbicides.

RESIDUE MOVEMENT INTO ADJACENT AREAS

To monitor for potential movement of residue from the storage area, soil and biological samples were collected from the drainage ditch directly adjacent to the site. A November 1978 analysis of this nearby on-base drainage ditch found positive TCDD residues [0.14-3.6 parts per billion (ppb)]. The TCDD movement was presumably caused through soil erosion from the annual (Jan-June) heavy rain season (approximately 60 in). Drainage ditches carry heavy rain from the storage site and other parts of the base into Long Beach Canal #1, approximately 9,000 feet from the site. The canal runs from the city of Long Beach through the base carrying municipal surface drainage, and until July 1978, carried treated sewage materials. The canal eventually runs into Turkey Creek approximately 12,000 feet from the storage site. Due to the November 1978 findings, further samples were collected at varying distances from the site in January, February, and June 1979. Following extensive and difficult analyses in contract laboratories, the results were received in September, November, and December 1979. The results confirmed the November 1978 data and indicated slightly higher levels (sediment levels of 1.7-3.6 ppb and biological levels of 0.14-7.2 ppb). Water samples collected in the same area were negative for TCDD at a detection level of 0.02 ppb. TCDD appears to move only as a part of soil sediment. Sediment and biological samples taken downstream at 3,000, 7,000, 9,000 and 12,000 feet from the site indicated that some TCDD residue was now present but at very low levels. A crayfish collected at 9,000 feet and numerous fish collected at 12,000 feet were analyzed with .032 ppb the highest level detected. This figure of .032 ppb is three times lower than the Food and Drug

Administration suggested maximum permissible level of 0.1 ppb. With present "state-of-the-art" detection limits, readings as low as these in biological samples have only been considered reliable in recent months.

RECOMMENDATIONS

To control the now verifiable but very low levels of residue, the report recommends the following actions:

- Stabilize drainage ditch banks to prevent water erosion during heavy seasonal rainstorms.

- Construct siltation traps in the drainage system allowing for greater silt catchment prior to drainage water leaving the base.

- Leave the storage area in its present undisturbed state and continue to limit access so that the "natural" degradation of the herbicide and its TCDD continue to occur.

- Allow the continued growth of native vegetation in the contaminated storage area and drainage ditches since this plant community inhibits water erosion.

- Continue sampling to ensure that preventive actions do control contamination.

- Develop follow-on reserach to determine possible methods for returning the storage area to full and beneficial use.

PREFACE

This technical report represents the culmination of a two-year environmental monitoring program of an area previously used for the long-term storage of Herbicide Orange at the Naval Construction Battalion Center. The study was conducted by personnel of the United States Air Force Occupational and Environmental Health Laboratory, Brooks Air Force Base, Texas and the United States Air Force Academy, Department of Chemistry and Biological Science, USAF Academy, Colorado.

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INTRODUCTION

During the summer of 1977 the United States Air Force (USAF) disposed of 2.22 million gallons of Herbicide Orange by high temperature incineration at sea. This operation, Project PACER HO, was accomplished under the very stringent criteria set forth in an U.S. Environmental Protection Agency (EPA) ocean dumping permit. Among the numerous conditions of this EPA-approved disposal operation was the requirement for the USAF to conduct extensive environmental and occupational monitoring of the land-transfer/loading operations, shipboard incineration operations and subsequent storage site reclamation and environmental monitoring. Details of the proposed site monitoring programs were documented in April 1977 by the Air Force Logistics Command (AFLC) in a programming plan for the disposal of Herbicide Orange (1). In this plan, AFLC proposed that soil samples from the storage sites at both the Naval Construction Battalion Center (NCBC), Gulfport MS, and Johnston Island (JI), Pacific Ocean, be collected and analyzed for Herbicide Orange after the completion of transfer operations. These analyses were to aid in the establishment of a schedule for future monitoring. The site monitoring program would be flexible to requirements generated by construction of any facility on the storage site and would be concluded upon mutual agreement of all agencies involved.

In July 1977, following the completion of the PACER HO dedrumming and subsequent site clean-up operations at NCBC, the USAF Occupational and Environmental Health Laboratory (USAF OEHL) initiated an extensive site monitoring program. The objectives of this program were:

1. To determine the magnitude of Herbicide Orange contamination on the storage site.

2. To determine the soil persistence of the two phenoxy herbicides contained in Herbicide Orange and a dioxin contaminant 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD).

3. To monitor for any movement of residues from the site into adjacent water, sediments and biological organisms.

4. To recommend techniques for managing the storage area with the ultimate goal of returning the area to full beneficial unrestricted use.

HISTORICAL BACKGROUND (GENERAL)

In April 1970, the Secretaries of Agriculture; Health, Education and Welfare; and the Interior, jointly announced the suspension of certain uses of the herbicide 2,4,5-trichlorophenoxyacetic acid (2,4,5-T). These suspensions resulted from published studies indicating that 2,4,5-T was a teratogen. Subsequent studies revealed that the teratogenic effects had resulted from a toxic contaminant in the 2,4,5-T, identified as 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD). Subsequently, the Department of Defense suspended the use of Herbicide Orange [a mixture of 2,4,5-T and 2,4-dichlorophenoxyacetic acid (2,4-D)] in South Vietnam. At the time of the suspension, the Air Force had an inventory of 1.37 million gallons of Herbicide Orange in South Vietnam and 0.85 million gallons at the Naval Construction Battalion Center, Gulfport MS. In September 1971, the Department of Defense directed that the Herbicide Orange in South Vietnam be returned to the United States and that the entire 2.22 million gallons be disposed of in an environmentally safe and efficient manner.

The 1.37 million gallons were moved from South Vietnam to Johnston Island, Pacific Ocean, for storage in April 1972.

HISTORICAL BACKGROUND (NCBC)

Craig (2), in a historical review of herbicides for Southeast Asia noted that the storage of Herbicide Orange became an item of significant importance with the temporary suspension placed on all uses of Herbicide Orange by the Assistant Secretary of Defense on 15 April 1970. Prior to 1970, shipments of herbicides into and out of the Mobile Outport and the Naval Construction Battalion Center were handled in a routine manner.

As the herbicide inventory began to accumulate in Southeast Asia, the San Antonio Air Logistics Center, Directorate of Fuels (SA ALC/SF), Kelly AFB TX, discontinued shipments from the port of embarkation to Southeast Asia in 1968 to avoid exposing large quantities of herbicides to possible damage by enemy action. The SA ALC then had to determine disposition of the product at the port and that scheduled for delivery. Rather than return the product to the manufacturer and suspend delivery to the port, SA ALC decided to arrange for the product to be temporarily placed in storage. Since the Mobile Outport, Mobile AL, was routinely used as the port of embarkation for herbicides, this was the logical place for the temporary storage. It was anticipated at that time that the storage period would be about six months. Herbicides were sent to the Mobile Detachment for storage between April and June 1968, and were removed from storage between September and December 1968. Except for one shipment to Southeast Asia during September 1968, herbicides removed from this storage site were used only to fill equipment test requirements at Eglin AFB FL.

On 26 June 1968 an Interservice Support Agreement was made by and between SA ALC and NCBC, to provide services related to receiving and storing approximately 50,000 18-gauge, 55-gallon drums of herbicide. The agreement was effective for the two-year period 1 July 1968 - 1 July 1970. It was to be reviewed annually by both parties. Input of herbicides to Gulfport began in July 1968. Additional Interservice Support Agreements were made in 1970 and 1972.

Storage was considered a better alternative than the return to the manufacturer where storage charges would have been more expensive. The NCBC agreed to receive and store the drums of herbicide and remove from storage quantities of drums as designated by SA ALC while SA ALC agreed to provide personnel in support of this operation. This was modified in July 1968 to reimburse NCBC for material and supervisory personnel salaries.

The Gulfport outside storage area was about two miles from the docks, with convenient access to the railroads. It was fenced and isolated from public traffic. The NCBC provided surveillance personnel as well as a controlled access. It was planned and set up for long-term storage. To provide good drainage, 2 x 6-inch dunnage (creosoted lumber) was laid on a hard surface and drums, positioned horizontally with the bung closure pointing outward, were stacked in double rows, three high, in pyramidal fashion. The number of drums in each single row, bottom to top, was 55, 54, and 53. To allow inspection of the bungs, there was an 18-inch walking space between each double row.

NCBC was the only Continental United States (CONUS) storage facility used during the last half of FY69 and through FY70. The Mobile Outport intransit storage facility was not used after December 1968 when the last drums of herbicide were moved to NCBC. At the end of FY70 there were 833,855 gallons of Herbicide Orange in storage at NCBC. Except for a small quantity stored at Eglin AFB FL for test purposes, Gulfport was the CONUS storage point.

A few damaged drums were received at NCBC with leaks around the bung closures because the seals had vibrated loose. In such cases the producer was notified to supply new bung closures. NCBC personnel took the corrective action. Usually the leaks could be stopped by removing the cover and tightening the bung or replacing the bung gasket.

When damaged leaking drums were spotted while in storage, they were redrummed by the people on duty. It was discovered that a herbicide moistened area usually appeared on the drum two or three weeks before noticeable loss occurred, and the contents could be saved by transferring it to a new drum when the damp area was noted.

In May 1971, during an inspection of the inventory, it was noted that deterioration of some of the drums had required NCBC personnel to redrum the product. As drums were removed from the stacks, indications of additional leaking drums became apparent. Previously, leaking had been attributed to breakdown of the bung seals used in the drum closures or an occasional seam leak. Now there were indications of leaks starting in the drum surfaces. During 1972, military personnel moved, inspected, and redrummed as required, the entire inventory of approximately 15,400 drums. Thereafter, an intensive drum surveillance program was initiated in which all drums were routinely inspected and moved or redrummed as required. The drum surveillance program was continued until May 1977 when Project PACER HO began.

The observations in 1971 and 1972 that drums were deteriorating prompted AFLC to task the USAF Environmental Health Laboratory (EHL/K), Kelly AFB TX and the Department of Chemistry and Biological Sciences (USAF/DFCBS), USAFA CO, to undertake a cursory chemical and biological monitoring program of the storage site. A review of these efforts is provided in a subsequent section of this report.

DESCRIPTION OF HERBICIDE INVENTORY

Four military herbicides were stored for various lengths of time at NCBC. These herbicides were code-named Herbicides Orange, Orange II, Blue and White. Herbicides Blue and White were intermittently stored at NCBC during 1968 and 1969. However, all stores of these materials were shipped to South Vietnam. Since these two herbicides (Blue and White) were only briefly stored at NCBC, site monitoring programs did not include these materials. The herbicide inventory that underwent long-term storage was comprised of primarily Herbicide Orange (approximately 13,855 drums) and a relatively small quantity of Orange II (1,545 drums).

Young, et al. (8) have described these herbicides.

1. Herbicide Orange

Orange was a reddish-brown to tan colored liquid, soluble in diesel fuel and organic solvents, but insoluble in water. One gallon or Orange theoretically contained 4.21 pounds (lb) of the active ingredient of 2,4-D and 4.41 lb of the active ingredient of 2,4,5-T. Orange was formulated to contain a 50:50 mixture of the n-butyl esters of 2,4-D and 2,4,5-T. The percentages of the formulation typically were:

n-butyl ester of 2,4-D	49.49
free acid of 2,4-D	0.13
n-butyl ester of 2,4,5-T	48.75
free acid of 2,4,5-T	1.00
inert ingredients (e.g., butyl alcohol and ester moieties)	0.63

2. Herbicide Orange II

Orange II was a formulation similar to Orange with the only difference being the substitution of the isooctyl ester of 2,4,5-T for the n-butyl ester of 2,4,5-T. The physical, chemical, and toxicological properties of Orange II were similar to those of Orange. Orange II was produced solely by one chemical company.

A detailed analyses of the inventory of Herbicide Orange and Orange II stored at NCBC was prepared in 1975 by Hughes, et al. (4) and Fee, et al (3). A summary of manufacturers and TCDD contents is presented in Table 1.

SUMMARY OF EARLY ENVIRONMENTAL MONITORING PROGRAMS

As early as 1970 the Air Force was expressing its concern about the possible adverse environmental impact of the storage of Herbicide Orange at NCBC, Gulfport MS. Environmental scientists from Eglin AFB visited the storage site at the request of SA ALC/SF and conducted an environmental survey of the plant and aquatic animal community in and around the herbicide storage site. No significant environmental problems were noted at that time.

In 1972, members of the USAF Environmental Health Laboratory, Kelly AFB TX (EHL/K), conducted an environmental survey of the storage area and also found no significant environmental problems.

TABLE 1. Identification Data on Herbicide Orange Stocks Stored at the Naval Construction Battalion Center, Gulfport MS[a]

Manufacturer	Transportation Control No. (TCN) [b]	Analysis Sequence No.	Total Number of Drums with Same TCN	*TCDD[c] (ppm)
Hercules Co	9464 8156 0001	8	500	<0.05
Hercules Co	9464 8192 001	14	2,152	NA[d]
Diamond Co	FY9461 7165 0001AA	18	60	14.2[e]
Diamond Co	FY9461 8156 001AA	11	421	8.62[f]
Thompson Hayward Co	9463 8155 X032	1	1,546	0.32
Dow Chemical Co	9463 8155 X052	10	6,976	0.12
Thompson Co	9463 7184 X011	3	46	NA
Thompson Co	9463 8155 X012	5	808	0.17
Monsanto Co	FY9463 7163 X0001XX	4	563	NA
Monsanto Co	FY9463 8183 X002XX	6	2,185	7.62
			15,257	

[a]SOURCE: Fee, et al. (3).

[b]Each separate purchase of herbicide was designated by a separate TCN

[c]Tetrachlorodibenzo-p-dioxin (TCDD) content. Results reported in this column are the average of six samples collected from six different barrels of Herbicide Orange having the same TCN.

[d]Not Analyzed.

[e]Average value of five samples: 12, 17, 12, 15, 15. Other sample value was 0.07 with rechecks.

[f]Average value of four samples: 8.0, 8.1, 8.7, and 9.7. Other two samples each averaged <0.05 with rechecks.

*On the basis of 280 samples of Herbicide Orange taken from the Gulfport inventory, the weighted mean concentration of TCDD was 2.06 ppm.

In July 1974, members from the USAF Academy Department of Chemistry and Biological Sciences conducted an extensive survey and ecological assessment of the herbicide storage area and collected soil, water, and biological samples. There was considerable evidence of herbicide contamination within the storage area itself (i.e., visual evidence of leaks and spills on the soil); however, there was no evidence that any of the material had been carried from the storage area by the surface drainage system. Soil samples collected between the stored drums, on the banks of the drainage system and silt deposits at various points in the drainage ditches had no detectable levels of herbicide at the 1 part per million (ppm) level. One soil sample was taken only six feet from the drums where prior leakage had been detected as evidenced by discoloration of the soil surface. Water samples from the drainage ditches had no detectable levels of herbicide at the 50 parts per billion (ppb) level. One of the water samples did, however, contain hydrocarbon residues apparently from washing operations in the area. The presence of the fuel in the water gave the stream an oily appearance which may have lead some people to conclude that a herbicide residue was present.

The biologicals (frogs, tadpoles, minnows) that were collected were not analyzed because there was no evidence that the aquatic drainage system was contaminated at that time. Upon gross examination no abnormalities were seen in any of these aquatic specimens.

A complete survey of the flora surrounding the storage area was also completed during the July 1974 visit by the USAF Academy personnel. Plant damage of a herbicidal-nature (twisting and bending of leaves and stems) was noted on two plant species as far as 85 yards west (downwind) of the drum storage site.

In December of 1974 Dow Chemical Interpretive Analytical Services reported the first known TCDD positive soil sample from between the rows of barrels on the storage site. Two soil samples were analyzed. One sample had nondetectable levels at a detection limit of 4 parts per trillion (ppt) while the second soil sample was positive for TCDD at 15 ppt.

During the period of August 1974 to October 1976 representatives of the EHL/K made 11 trips to the Naval Construction Battalion Center to monitor pilot plant activities, drum rinse studies and conduct environmental monitoring including the collection of water samples from the herbicide storage area drainage ditches. Water sample values for 2,4-D had a range of average mean value of 0.15 ppb to 409.4 ppb; the 2,4,5-T range of average mean values for water was 0.3 ppb to 519.4 ppb and a 1976 TCDD positive sample that had an average mean value of 7.7 ppt. Sediment samples collected from the drainage area contained 2,4-D in a range of average mean values of 0.04 ppm to 0.24 ppm; the 2,4,5-T range of average mean values for sediment was 0.04 ppm to 0.42 ppm. All sediment samples for TCDD were negative; however, the analytical laboratory could not establish a level of detection for TCDD because of interferences.

In the October 1976 report it was noted that of the 26 water samples analyzed, 13 were reported as containing more than 10 ppb herbicide. However, at the base discharge sample point leading off base, there were no water samples analyzed that exceeded this lower detection limit of 10 ppb. Also, of the 23 water samples that were analyzed for TCDD, there was only one that had a positive reading and that sample was collected near the storage area. Samples collected further downstream had no detectable TCDD. The detection limit in these samples was 0.01 ppb. These results indicated that although some herbicide was entering the drainage system, it was not leaving the base and most likely was being held in the bottom sediments of the drainage ditch system.

Visual observations of the drainage ditch system indicated that there were no deleterious effects being exerted on the biotic community and that fish, frogs, snakes and other normal fauna and flora seemed to flourish.

Only two of the sediment samples analyzed exceeded 1 ppm herbicide. These samples were collected near the storage area. The sediment samples collected near the base discharge point never exceeded the 1 ppm herbicide level and no TCDD was ever detected in any of these sediment samples. However, the analytical laboratory could not establish a level of detection for TCDD because of interferences.

Soil sample data in October 1976 was not sufficient to make an interpretation as to the degree of severity of the herbicide contamination of the soil.

Recommendations from the October 1976 EHL/K report were:

1. The levels of Herbicide Orange (HO) in the ambient air were not high enough to create any concern about any on- or off-base exposure. This was also borne out by the biomonitoring that had been performed during the Agent Chemical Inc (ACI) operation at NCBC. If the TCDD analytical results were viewed as upper limits, as suggested by the analytical laboratory [Wright State University (WSU)], then there was no need for concern.

2. There was no indication of any off-base discharge of TCDD in the water or sediment samples.

3. Quarterly environmental monitoring surveys should be continued.

4. There is need for a comprehensive sampling program of the soil in the HO storage area to permit a better evaluation of the degree and extent of contamination by both HO and TCDD.

In January 1976, members from the USAF Academy, Department of Chemistry and Biological Sciences, conducted an extensive aquatic and soil survey of the herbicide storage area. During this survey, many soil, sediment and biological samples were collected from throughout the storage area and the surface drainage system. These samples were frozen and archived as baseline samples should the need arise to evaluate similar types of samples during or after the dedrumming operation. Selected samples from this collection were later analyzed in 1978. Data from these samples are incorporated into the Results and Discussion Section of this report.

USAF OEHL SITE MONITORING PROTOCOL

Four problem areas were apparent in the design of a study:

1. Over 25 individual chemical components in Herbicide Orange had been identified [Hughes, et al. (4)]. Should or could a monitoring program include all of these components? The low percentage in content of most of these components combined with their known low toxicity and/or rapid biodegradability (e.g., butanol, toluene and xylene) suggested that only the principle herbicides (acid and ester formulations of 2,4-D and 2,4,5-T), their major breakdown products (di- and trichlorophenol) and TCDD should be followed.

2. What criteria should be used to determine the number and location of sampling sites on an area of approximately 12 acres? Spills, due to handling of the drums during dedrum operations (during and prior to PACER HO) or to leakage (prior to PACER HO), could have occurred almost anywhere on the storage area over the eight-year period. Certainly, the persistence and fate of individual herbicides, phenols or dioxin might be determined if a technique could be used to determine old spills from new spills.

3. What factors associated with the actual storage area at NCBC will have influenced the penetration of herbicides/TCDD into the soil profile? This problem would certainly influence the depth of sampling that would be required.

4. In an "ideal" monitoring program, some method would be required to determine a minimum level of residue that could be considered biologically and ecologically acceptable, i.e., a "no significant effect" residue level. Should this no effect level be based upon soil micro-organisms, surface vegetation or some other criterion?

Previous environmental studies in 1974 and 1976 by Young, (9), and Young, et al. (10), showed that movement of the herbicide components of Herbicide Orange and the TCDD contaminant was low, suggesting that both lateral movement and soil penetration of the water-insoluble Herbicide and TCDD would be minimal. Thus, surface sampling, e.g., the top three inches (8 cm) of soil, should constitute the primary sampling depth.

As noted above, the depth of routine sampling was of major concern in designing the residue monitoring program. Young, et al. (10) had shown that neither the herbicide components of Orange nor the TCDD had appreciably moved in the soil during biodegradation studies at Eglin AFB FL or the AFLC Test Range Complex, Hill AFB UT. However, these studies had involved soils treated with herbicides by using a hand sprayer and at concentrations great below those encountered in spills. Certainly some of the spills that had occurred at NCBC were "old" spills and the effects of time (years) on these spills was essentially unknown. Another factor in sampling depth was that the soil in the outdoor storage areas of NCBC had been treated in the 1940s with cement and compacted (1). This treatment had created a 6-12 inch cm) layer of hardened stabilized soil. This "hardpan" was relatively impervious to water and presumably herbicide; however, in 1977, the hardpan was 3 to 6 inches (8-15 cm) below surface due to the addition of soil and gravel during the intervening years. This upper layer of soil was primarily sandyloam in texture. Selected sites where heavy spills had apparently occurred had also been treated with a 2 inch (5 cm) layer of oyster shells. All of these factors influenced the decision to select only one depth as the primary sampling depth which was the top three inches (8 cm).

In July 1977, a preliminary sampling study was initiated. This consisted of assessing the heterogenity of the soils on the sites and the heterogenity of the herbicide concentrations. Twelve sites were selected for sampling; six were in areas of obvious spills and six in areas that showed no spill. Not only were the spills discernible by sight but also by smell. Winston and Ritty (7) had previously found that the olfactory senses can detect a butyl ester formulation of 2,4,5-T at levels of 0.4 ppb. The results of this first sampling after PACER HO are shown in Table 2. Significant concentrations of herbicides, phenols and TCDD were detected in soils from spill sites. The variation in concentrations and in the portion of acids to esters suggested that the spills were from different time periods. Accordingly, a more extensive protocol was proposed for future sampling.

1978 PROTOCOL

The sites selected within the storage area for monitoring of residue were determined by whether a spill had occurred or not occurred at that specific location. The basis for determining a spill was whether a herbicide stain was discernible (heavy, light, absent) and whether a herbicide odor was detectable (strong, mild, absent). Thus, within the Storage Area numerous locations were found that had a heavy stain and strong odor (labeled H/H, presumably representing a recent spill); a light stain and

TABLE 2. Concentration parts per million, of total herbicides, total phenols, and TCDD in 12 soil samples collected July 1977 from the Herbicide Orange Storage Area, Naval Construction Battalion Center, Gulfport MS[a]

Location		Total Herbicides[b] (ppm)	Total Phenols[c] (ppm)	TCDD (ppm)
Spill Sites[d]				
1		51,600	87	0.1090
3		132,400	109	0.6310
5		37,350	166	ND(0.0084)[g]
8		34,840	96	0.1900
10		117,060	303	0.0185
11		95,000	NA[e]	NA
	Mean =	78,040	152(5)[f]	0.2371(4)
		± 42,395	± 90	± 0.2718
No Spill Sites[d]				
2		34.3	0.7	NA
4		15.2	0.2	NA
6		0.9	0.1	NA
7		22.0	0.6	NA
9		8.4	0.2	NA
12		4.4	0.2	NA
		14.2	0.3	
		± 12.4	± 0.2	

[a]Analysis by the Flammability Research Center, The University of Utah, Salt Lake City UT. Air Force Contract No. 561178C0062. Report submitted 17 May 1979.

[b]Total herbicides refers to concentrations of acid and all esters detected of 2,4-D and 2,4,5-T.

[c]Total phenols refers to concentrations of dichlorophenol and trichlorophenol.

[d]The sample consisted of a cube (3x3x3 inches) of soil removed from the center of an area designated spill or no spill.

[e]NA = Not Analyzed.

[f]( ) refers to number of samples included in obtaining the means and standard deviation.

[g]ND = Not Detected at the detection limit specified in parenthesis.

mild odor (labeled L/L, presumably representing an older spill); and no stain and no odor (labeled O/O, presumably representing an uncontaminated area). Fourteen replications of each treatment were then randomly selected to represent the storage area (thus a total of 42 permanently marked sampling locations). Twelve of these locations had been tentatively located and marked on 28 July 1977 with the remaining 30 located and marked on 17 January 1978 with sampling being conducted on these dates, as well as 6 November 1978. In collecting the soil samples, a 3-inch square was marked, 6 inches away from the site marker pin. At each sampling time, soil was taken from a different "point of the compass" with reference to the marker pin to insure a fresh and undisturbed profile. At the designated site, a 3x3x3-inch cube of soil was removed with a ceramic spatula which was rinsed with acetone between uses to prevent carryover of residue and microorganisms. Wherever possible, sediment samples were collected from the drainage ditches in a similar manner.

CHEMICAL ANALYSES

Each soil sample consisted of approximately 200 grams and was placed into new glass jars (400 ml) appropriately labeled and transported to the laboratory where they were uniformly mixed and subsampled. The subsample used for chemical analysis was immediately frozen. The remaining sample was used for microbial studies (see Microbial Analyses). All soil samples collected from NCBC in July 1977, January 1978 or November 1978 were submitted for chemical analyses to the Flammability Research Center, University of Utah, Salt Lake City UT. Each soil sample was analyzed for the esters and acids of 2,4-D and 2,4,5-T. In addition, each sample was analyzed for di- and trichlorophenols (intermediate degradation products of 2,4-D and

2,4,5-T) and selected samples analyzed for TCDD. A brief description of the method employed in the analyses has been published (5).

MICROBIAL ANALYSES

Subsamples of all soils were sent to the Department of Chemistry and Biological Sciences, USAF Academy CO for microbial analyses. All samples were analyzed for total populations of actinomycetes, fungi and bacteria. In addition, key species presumably responding to the presence of herbicides were identified. The method employed in the microbial analyses has been previously described by Young (9). It was hoped that quantitative and qualitative studies of the microorganisms from each of the treatment classes used in association with residue data would permit an establishment of a no effect level.

RESULTS AND DISCUSSIONS OF HERBICIDE AND MICROBIAL DATA

A summary of the analytical results for the 42 sites sampled in January and November 1978 is shown in Table 3. A statistically significant decrease in the levels of total herbicides and total phenols was found to occur between the two dates. There was also a downward trend in TCDD levels, but it was not statistically different (P.05). This trend in decreasing levels of TCDD (as well as in herbicides and phenols) is even more pronounced when the July 1977 data (Table 2) are compared to the 1978 data (Table 3). Unfortunately, because of differences in site delineation between 1977 and 1978, data for spills vs no spills between the two years cannot be "paired" and statistically analyzed. Nevertheless, the data suggest that TCDD may be degrading within the time period of this study (18 months).

Data on the soil penetration of the herbicides, phenols, and TCDD are shown in Table 4. This site (site 17) was a site where a herbicide spill

TABLE 3. Mean concentrations, parts per million, of total phenols and TCDD in soils collected in January and November 1978 from selected sites on the Herbicide Orange Storage Area, Naval Construction Battalion Center, Gulfport MS[a]

Location	Number of Sites Sampled[b]	Total Herbicides (ppm)[c]	Total Phenols (ppm)[d]	TCDD (ppm)
"No" Spills (O/O)[e]				
Jan 78	14	32α[f]	3.5α	ND[g](4)
Nov 78	14	3β[f]	0.4β	NA[h]
"Old" Spills (L/L)				
Jan 78	14	1,202α	86α	0.0364[i](3)
Nov 78	14	492β	23β	0.0438(3)
"New" Spills (H/H)				
Jan 78	14	51,285α	437α	0.2064(10)α
Nov 78	14	30,005β	253β	0.1444(11)α

[a]Samples analyzed by the Flammability Research Center, The University Of Utah, Salt Lake City UT. Air Force Contract No. 561178C0062. Reports submitted 17 May 1979 and 7 November 1979.

[b]Each soil sample consisted of a cube of soil (3x3x3 inches) removed adjacent to a designated marker.

[c]Total herbicides refers to the concentration of acid and all esters of both 2,4-D and 2,4,5-T.

[d]Total phenols refers to total concentration of both dichlorophenol and trichlorophenol.

[e]The coding O/O, L/L and H/H are described in the text.

[f]Means within columns within subtitles followed by the same letters are not significantly different at the 0.05 probability level. For the statistical analyses, the Wilcoxon Paired-Sample Test was used. A test for a one-tailed hypothesis with paired samples was used in the procedure for nonparametric data since it could not be assumed that the levels of residue detected were from a normal distribution and it was expected that the residues would decrease with time. See Reference 11.

[g]ND=Not Detected; the number of samples analyzed is in parentheses. The detection limit was generally 0.0002 ppm (200 ppt).

[h]NA=Not Analyzed.

[i]The number within parentheses refers to number of positive samples used in calculations of the means. In L/L sites, the other 11 samples were either ND or not analyzed; in H/H sites the remaining samples were ND.

TABLE 4. **Penetration of herbicides, phenols and TCDD in soil collected June 1979 from a site (Number 17, H/H) where a herbicide spill occurred in 1977 on the Herbicide Orange Storage Area, Naval Construction Battalion Center, Gulfport MS[a]**

Description of Site[b]	Soil Depth (Inches)	Total Herbicides (ppm)[c]	Total Phenols (ppm)[d]	TCDD (ppm)
Surface Layer	0-3	61,650	365	0.325
Above Hardpan	3-6	34,690	95	0.340
Within Hardpan	6-9	1,620	48	0.021
Within Hardpan	9-15	322	11	ND[e]

[a]Samples analyzed by the Flammability Research Center, The University of Utah, Salt Lake City UT. Air Force Contract No. 561178C0062. Report submitted 7 November 1979.

[b]See text for description of Hardpan.

[c]Total herbicides refers to concentration of acid and all esters of both 2-4D and 2,4,5-T.

[d]Total phenols refers to total concentration of both dichlorophenol and trichlorophenol.

[e]Not Detected. The detection limit was 0.00048 ppm (480 ppt) for this sample.

had occurred during the PACER HO Operation in June 1977. The soil core was collected in June 1979; thus, a period of at least two years had elapsed from date of spill to date of sampling. A decrease in concentration of residue occurred with depth. The hardpan (soil stabilized with cement at least 30 years earlier) was relatively impervious to any residues, despite the high annual rainfall (60 inches) received in this geographic location. These data suggest that soil penetration of residue as a route for contamination of subsurface water will be negligible.

Some additional observations of the residue data that may influence future monitoring programs concern the nature of the remaining residues. Although most of the sites, where high levels of residues have been found, have been associated with a spill of Herbicide Orange, two of the sites contain significant levels of the isooctyl esters of 2,4-D and 2,4,5-T. These data suggest that Orange II was spilled at these sites rather than Orange. Whereas the butyl esters of 2,4-D and 2,4,5-T have rapidly hydrolyzed in the soil, the data from Orange II sites show little or no degradation of the isooctyl esters over the two-year period, especially the isooctyl esters of 2,4,5-T. In addition, in these two sites detailed studies of the residue indicate the presence of an apparently very stable isooctyl ether of 2,4,5-trichlorophenol. Unpublished data by Arnold* of the studies on soils treated with Orange II in 1972 and collected six years later, have shown negligible degradation in the isooctyl ether of 2,4,5-trichlorophenol. The stability of this ether has permitted its use in confirming the actual concentration of herbicide in the soil at the time of treatment. It may be possible to use this "marker" ether to date selected spills at NCBC.

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*E.L. Arnold, August 1979. Analysis of Herbicide Orange Components in Selected Soil Samples. USAFSAM/NGP, Brooks AFB TX. Report submitted to USAF OEHL.

Data from the microbial analyses of soil samples collected from the storage area in July 1977 and January and November 1978 are shown in Tables 5 and 6. Although the biological activity was high in all three treatment areas (O/O, L/L, and H/H) trends in populations were discernible. The July 1977 data in Table 5 indicate the impact that activities associated with Project PACER HO may have had on the storage area. During PACER HO, not only did personnel and vehicular traffic disturb the entire site, but when the operation was complete, the site was leveled and a layer of oyste shells was placed in selected sites where spills of herbicide and fuel oil had occurred. The bacteria were especially affected; note that the July 1977 levels in either no spill or new spill sites were much lower tha the other two dates. However, these data may also reflect both an effect of PACER HO and a lag-phase effect in the adaptation of the bacteria t herbicide. The highest levels of bacteria were found in highly herbicide-contaminated sites (January 1978). Of the several bacterial genera isolat and identified, Psuedomonas spp. predominated in samples with the highest levels of herbicides.

Levels of fungi decreased both with time and herbicide concentration. Only 50 percent of the H/H sites in January or November 1978 had detectable levels of fungi, and then, as noted in Table 6, they were not always of genera found in O/O or control soils. Proliferation of certain organisms could indicate their ability to metabolize or co-metabolize herbicide or herbicide degradation products or it could indicate elimination or inhibition of natural competitors. Specific metabolic activity studies using the predominant organisms would be necessary to determine their exact role (if any) in biodegradation.

TABLE 5. Microbial population levels (number of organisms per gram of soil) in soils collected in July 1977, January and November 1978 from selected sites on the Herbicide Orange Storage Area, Naval Construction Battalion Center, Gulfport MS[a]

Location	Number of Sites	Bacteria, $\times 10^7$	Fungi, $\times 10^5$
"No" Spills (O/O)[b]			
Jul 77	6	29.7	29.6 (5)[c]
Jan 78	14	45.6	7.8
Nov 78	14	40.2	6.2
Old Spills (L/L)			
Jan 78	14	41.8	10.2 (8)
Nov 78	14	36.3	4.2 (8)
New Spills (H/H)			
Jul 77	6	15.4	28.6 (5)
Jan 78	14	49.4	7.7 (7)
Nov 78	14	34.6	6.1 (7)
Control[d]			
Jan 78	1	38	3.0
Nov 78	1	35	3.2

[a]Microbial analyses conducted by Department of Chemistry and Biological Sciences, USAF Academy CO. Final report received August 1979.

[b]The coding O/O, L/L and H/H are described in text.

[c]The number within parentheses refers to number of samples where colonies could be counted. Fungi in soils contaminated with herbicide frequently showed no growth after 7 days or growth was random.

[d]Control taken in open grassy area one mile from Storage Area.

TABLE 6. Fungal genera found in soils collected from selected sites in 1977 and 1978 on and off the Herbicide Orange Storage Area, Naval Construction Battalion Center, Gulfport MS[a]

Predominant Genera	Off-Site Control	On Site		
		O/O	L/L	H/H[b]
Aspergillus spp.	X	X		
Penicillium spp.	X	X	X	X
Cunninghamella spp.	X	X		
Zygorhynchus sp.	X	X		
Alternaria sp.	X	X		
Mycelial Molds			X	X
Candida spp.	X	X		
Rhodotorula sp.	X	X	X	
Geotrichum sp.			X	X
Trichoderma spp.	X	X	X	
Mucor spp.	X		X	X
Rhizopus sp.	X	X		
Absidia sp.	X	X		

[a] Microbial analyses conducted by Department of Chemistry and Biological Sciences, USAF Academy CO. Final report received August 1979.

[b] The coding O/O, L/L and H/H refer to no spill (O/O), old spill (L/L) and new spill (H/H) and are further described in text.

AQUATIC SYSTEM MONITORING FOR TCDD RESIDUE, 1977-1979

The extreme toxicity associated with 2,3,7,8-TCDD (Reference 8) and its occurrence as a contaminant in 2,4,5-T (and hence Herbicide Orange) dictated that it must be the focus of any residue monitoring study. The location of the NCBC in relation to the major population center of Gulfport MS and to the associated aquatic system is shown in Figure 1. Previous ecological studies on the environmental fate of TCDD by Young (9) and Young, et al. (10) suggested that aquatic drainage systems could be contaminated by water erosion of soil particles containing TCDD. The herbicide storage area is drained by a series of small ditches that connect into a single ditch immediately adjacent to the area. This larger ditch is fed by other small ditches as it transverses the property of the NCBC. In an effort to obtain baseline data on TCDD in this aquatic system, archived biological samples (collected in the immediate storage area and frozen in January 1976) were analyzed in November 1978 and found positive for TCDD residue. Thereafter, additional environmental samples were collected in January, February and June 1979 at varying distances downstream from the storage area. These designated Aquatic Sampling Sites are shown in Figure 2. Aquatic Site III was located at the NCBC perimeter. Aquatic Site IV was at a culvert discharge from the drainage ditch into Long Beach Canal Number 1. Aquatic Sampling Site V was at the confluence of the canal and Turkey Creek. The analytical results from some of these environmental samples were received in September and November 1979.

A summary of all available TCDD residue data for the aquatic system draining from the storage area is shown in Table 7. It should be again noted that TCDD data in Tables 2, 3 and 4 are presented as parts per million (ppm). Aquatic monitoring studies detected residue levels in

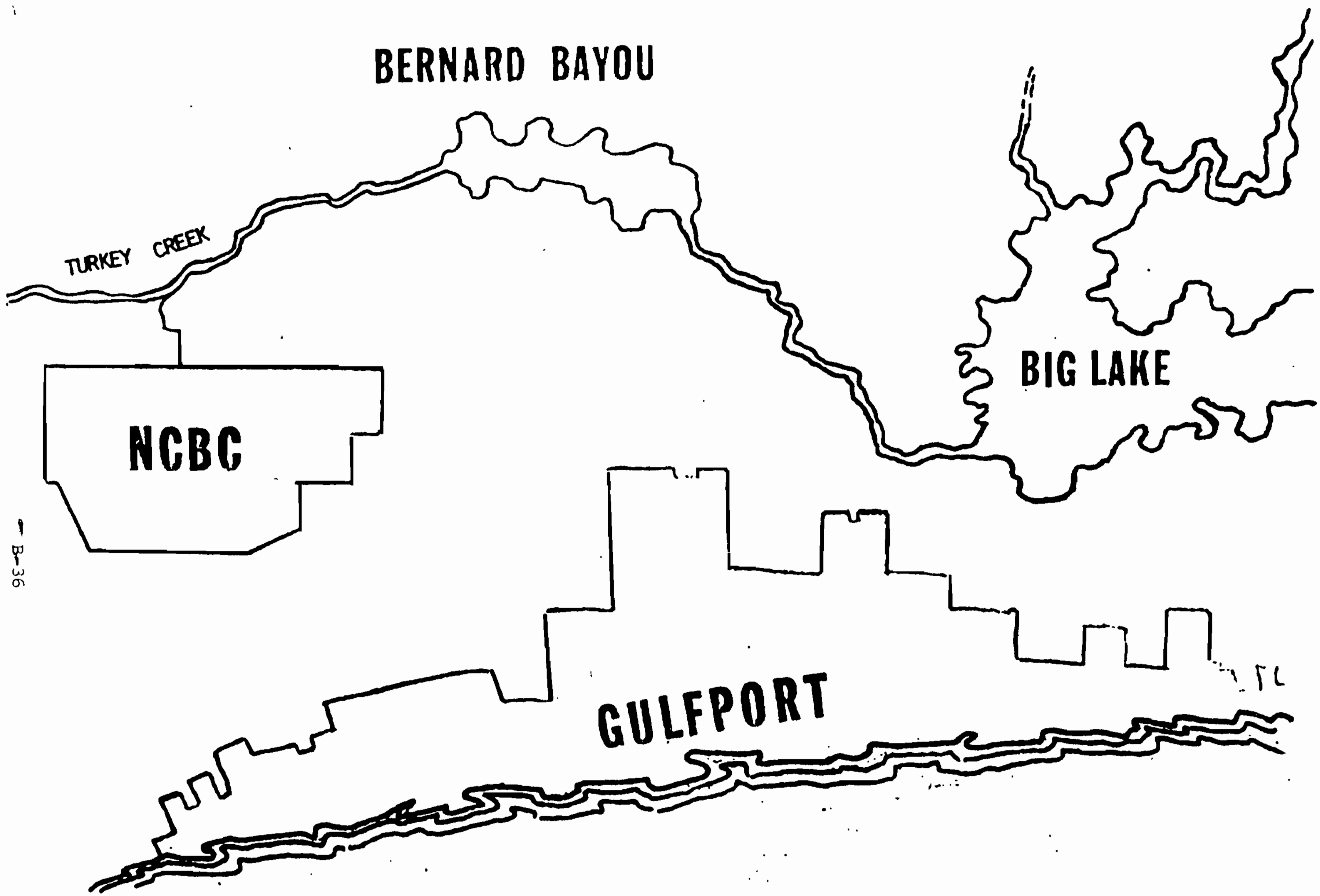

Figure 1. A map of the Gulfport MS area showing the relationship of the Naval Construction Battalion Center (NCBC) to the major population center and associated aquatic system.

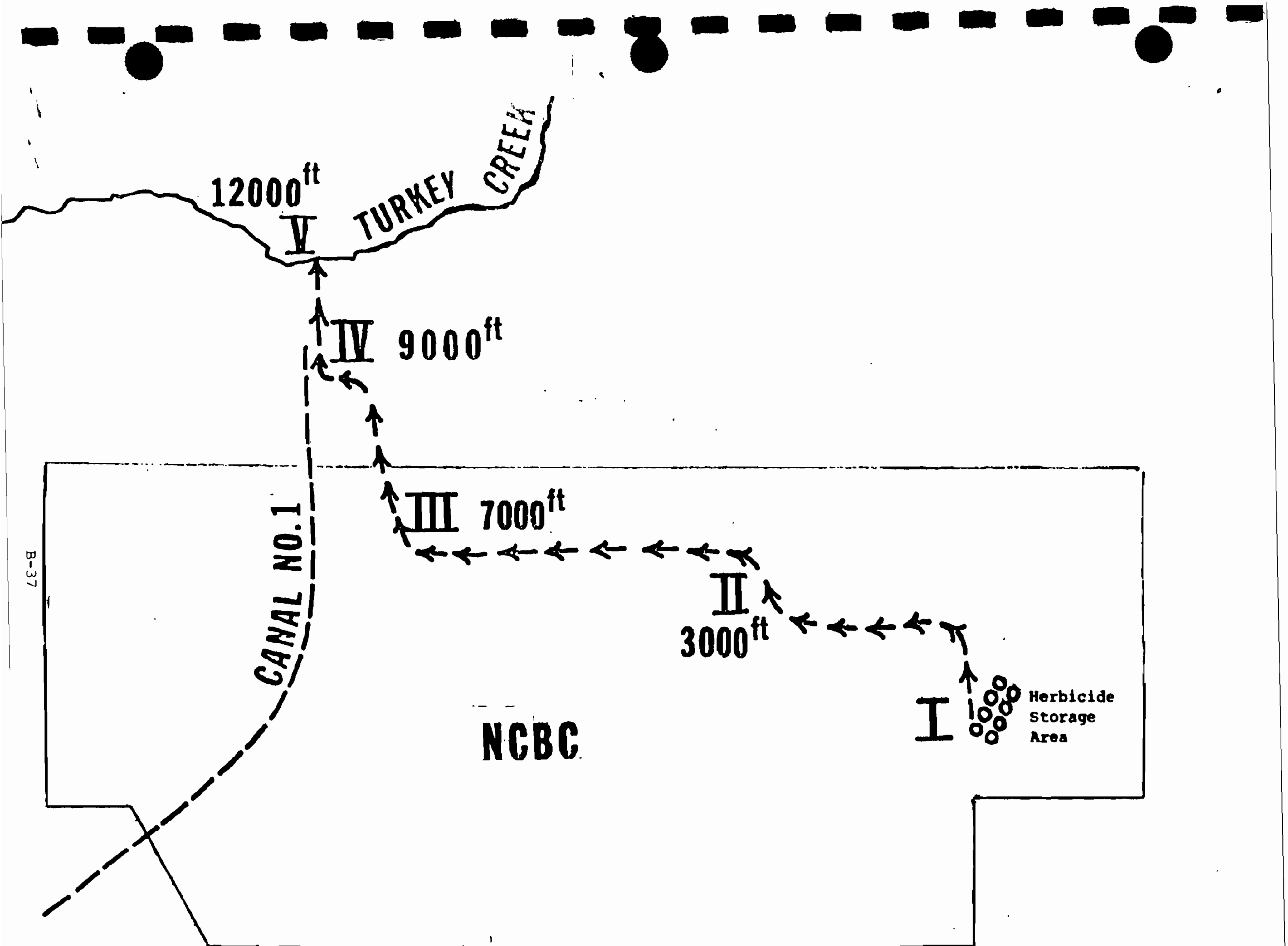

Figure 2. Locations of the aquatic sampling sites in relation to the Herbicide storage area on the Naval Construction Battalion Center (NCBC).

TABLE 7. Summary of results (parts per billion) for TCDD residue studies in water, sediments and biological organisms associated with drainage from the Herbicide Orange storage area, Naval Construction Battalion Center, Gulfport MS[a]

Aquatic Sampling Site	Distance from Storage Area (Feet)	Water (ppb)	Maximum Concentration in Sediments (ppb)	Biologicals (ppb)
I	Immediate Area	ND[b]	3.6	0.14-3.5;[c] 1.6 -7.2
II	3,000	NA[d]	ND	0.2-2.2
III	7,000	NA	0.01	0.045[e]
IV	9,000	NA	0.02	0.02[f]
V	12,000	NA	ND	ND[g]

[a]The analyses for TCDD were conducted by the University of Nebraska, Mass Spectrometry Laboratory, Lincoln NE, under Air Force Contract No. F0561178C0063 and the University of Utah, Salt Lake City UT, under Air Force Contract No. 561178C0062. Reports submitted 6 September 1979 from the University of Nebraska and 17 May 1979 and 7 November 1979 from the University of Utah.

[b]ND = Not Detected. Detection limit varied with the sample. All water samples were analyzed by the University of Utah and the detection limit was 0.02 ppb. Sediment samples from Sites I, II and V were analyzed by the University of Utah by low resolution GC-MS where the detection limit was 0.5 ppb. Sediment samples from Sites III and IV were analyzed by the University of Nebraska by high resolution GC-MS where the detection limit was 0.005 ppb. All biological samples were analyzed by the University of Nebraska and the detection limit ranged from approximately 0.05 to 0.005 ppb.

[c]First sample set collected in January 1976 and analyzed and reported in January 1979; second sample set collected in January 1979 and reported in September 1979.

[d]NA = Not Analyzed.

[e]This value is an average for a single biological, a crayfish, which was analyzed twice. The mean detection limit was 0.01 ppb.

[f]This value was for a single biological, a crayfish, which was analyzed twice. The mean detection limit was 0.008 ppb.

[g]A single biological sample, a composite of mosquitofish, was analyzed three times. The sample was considered negative at a mean detection limit of 0.007 ppb.

parts per billion (ppb) and parts per trillion (ppt). Thus, the average mean level of TCDD in storage site soils (spills) in July 1977 was 237 ppb (0.237 ppm, see Table 2); 206 ppb in January 1978 and 144 ppb in November 1978 (see Table 3). Data in Table 7 in very low parts per billion are two orders of magnitude below levels in the storage area soils.

Water Samples - Surface Drainage System Herbicide Storage Area

A total of 61 surface drainage system water samples were collected (Aquatic Sampling Site I) during the history of the project. One sample collected in 1976 was positive at an average mean value of 7.7 ppt TCDD. All remaining samples were negative for TCDD at detection limits ranging from 5-37 ppt.

Water Samples - Potable Water System and Wells on the NCBC

A total of 36 potable water system and well water samples taken during the history of the project have contained no detectable levels of TCDD at detection levels as low as 10 ppt.

Sediment Samples

Two of eight sediment samples collected (Aquatic Sampling Site I) in the immediate surface drainage system of the herbicide storage area in June 1979 were positive for TCDD at levels of 2.7 ppb and 3.6 ppb. Of the remaining six samples, five contained no detectable TCDD at a detection limit of 2 ppb. The sixth sample contained no TCDD at a 37 ppb detection limit. The maximum positive value for this location is shown in Table 7.

Two sediment samples have been collected from Aquatic Sampling Site II. These samples were collected in June 1979 and were found negative for TCDD at a detection limit of 0.5 ppb.

Two sediment samples have been collected from Aquatic Sampling Site III (located at the NCBC perimeter). One of these samples was collected in February 1979; the other in June 1979. The June sample (data reported in November 1979) was negative for TCDD at a detection limit analysis of 0.5 ppb [low resolution Gas Chromatography-Mass Spectrometry (GC-MS)], while the February sample (data reported in September 1979) was positive for TCDD at a level of 0.01 ppb (high resolution GC-MS analysis). The datum from the February sample is reported in Table 7.

One sediment sample collected in February 1979 off-base, 9,000 feet from the herbicide storage area (Aquatic Sampling Site IV), in the drainage system leading away from the herbicide storage area and the NCBC, was positive for TCDD at 0.02 ppb with a lower detection limit of 0.01 ppb (report received September 1979). One additional sample collected from the same area (Aquatic Sampling Site IV), in June 1979 contained no detectable TCDD, when the detection limit was 0.5 ppb (report received November 1979).

A single sediment sample was collected from Aquatic Sampling Site V. The sample was collected in June 1979 and analyzed by low resolution GC-MS. The sample was found negative for TCDD at 0.5 ppb.

Biological Samples

Aquatic biological samples (snails, fish, tadpoles, crayfish, and insects) collected over the past three years from the drainage ditch serving the immediate herbicide storage area (Aquatic Sampling Site I), contained TCDD levels that ranged between 0.14 ppb and 7.2 ppb (Table 7).

Aquatic biological samples (snails, tadpoles, fish and crayfish) collected over the past three years from the drainage ditch 3,000 feet downstream from the herbicide storage area (Aquatic Sampling Site II), contained TCDD levels that ranged between 0.2 ppb and 2.2 ppb. A large crayfish was collected in January 1979 and the muscle tissue and intestine were separately analyzed. The intestine was found to contain 1.1 ppb TCDD, while the muscle tissue contained 0.07 ppb TCDD.

A crayfish sample collected in February 1979, 7,000 feet downstream from the herbicide storage area (Aquatic Sampling Site III), just before the drainage system exited the NCBC property, contained 0.045 ppb TCDD.

A crayfish sample collected in February 1979, 9,000 feet downstream from the herbicide storage area (Aquatic Sampling Site IV), off-base in the drainage system serving NCBC was found to contain 0.02 ppb TCDD.

A mosquitofish sample collected in February 1979, 12,000 feet downstream from the herbicide storage area (Aquatic Sampling Site V), in the off-base drainage system, contained no detectable TCDD at a detection limit of 10 ppt.

CONCLUSIONS

Environmental studies of an area on the Naval Construction Battalion Center, previously used for the storage of Herbicide Orange from mid-1968 through mid-1977 were conducted during the period 1970 through 1979. The following are conclusions from those studies:

1. Approximately 1-2 acres of the 12-acre area are contaminated with Herbicide Orange and its associated dioxin.

2. Levels of 2,4-D and 2,4,5-T herbicides in selected samples from the top three inches of soil profile were greater than 100,000 ppm (mean 78,040 ppm) in 1977, but rapidly decreased to one-third that level in 18 month

3. No accurate estimate of TCDD persistence is possible from these studies. However, data from spill sites monitored for 18 months suggest that TCDD levels are decreasing.

4. Soil penetration of the herbicides was low while soil penetratio of TCDD was very low but measurable.

5. Soil sterilization did not occur as a result of Herbicide Orange contamination.

6. Proliferation of certain microflora occurred under high levels of herbicide (specifically members of the fungal order Mucorales, white non-sporulating mutants, soil yeasts, and Pseudomonas spp.)

7. Yeast and Pseudomonas spp. predominate in samples with highest levels of herbicide.

8. Proliferation of certain organisms could indicate:

   a. Ability to metabolize HO or degradation products.

   b. Ability to co-metabolize HO or degradation products.

   c. Elimination/inhibition of natural competitors.

9. The low solubility of TCDD in water would suggest that its solubility in water alone could not account for the levels of TCDD found in the drainage ditch sediment.

10. The movement of TCDD from the storage sites is primarily through soil erosion, especially that caused by water.

11. Organisms that come into direct and intimate contact with TCDD-contaminated soil generally become contaminated themselves. (A wide variety of organisms have been examined.)

12. TCDD was found in a crayfish collected on base 3,000 feet downstream from the storage site. Levels in the intestine were 1.1 ppb, levels in muscle tissue were only 0.07 ppb. Movement of contaminated soil from the storage area downstream may have resulted in the contamination of crayfish. However, crayfish are highly mobile and may have migrated from the storage area to the point of capture.

13. TCDD was found in two samples (1 sediment and 1 biolcgical) collected off-base of NCBC. Although the levels of TCDD were extremely low (20 parts per trillion in each sample), it is apparent that some contamination from the storage area has occurred. Contamination from the storage area is not yet extensive and can be controlled.

RECOMMENDATIONS

The principle recommendation for management of the 12-acre area at the Naval Construction Battalion Center, formerly used as a storage area for Herbicide Orange, is that the area be left undisturbed permitting the continuation of "natural" degradation of the herbicides and TCDD. Specific recommendations to prevent further movement of contaminated soil from the area include:

1. Limiting access to the storage area and preventing motor vehicle traffic from crossing the area and potentially "tracking" TCDD-contaminated soil particles to other parts of the installation.

2. Preventing water erosion wherever possible by stabilizing the drainage ditch banks with concrete or asphalt material. The ditch banks should be slightly elevated on the contour to allow pooling of water from the storage area prior to entering the ditch creating an initial siltation catchment. The ditches should be allowed to have plant growth in them to slow the movement of water and allow for more silt catchment. In several places along the ditch drainage system concrete dams should be constructed to slow water movement and provide a wide shallow overflow (in effect creating small siltation ponds in the ditch drainage system).

3. Constructing one or two larger siltation ponds in the draina system prior to the drainage water leaving the base.

4. Allowing native vegetation to invade the storage area and establish a plant community to help prevent both wind and water erosion.

5. Developing a research protocol to determine possible methods for returning the storage area to full beneficial use. This protocol might include techniques to:

a. decontaminate TCDD-laden soils.

b. increase TCDD degradation rates.

c. characterize the distribution and effects of TCDD in the aquatic environment.

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ADDENDUM

Additional residue data from selected biological samples collected June 1979 were received 3 December 1979. These data are shown in Table A-1. These data offer additional support of the previous conclusion, that TCDD from the Herbicide Orange storage area is present in selected biological samples obtained outside the boundary of the Naval Construction Battalion Center.

TABLE A-1. Summary of results (parts per billion) for TCDD residue in biological organisms collected June 1979 from the drainage system associated with the Herbicide Orange storage area, Naval Construction Battalion Center, Gulfport MS[a]

Aquatic Sampling Site	Distance from Storage Area	Nature of Sample	Concentration of TCDD (ppb)	Detection Limit (ppb)
II	3,000	Composite: Crayfish/Fish[b]	0.175[c]	0.035
III	7,000	Composite: Crayfish/Fish	0.088[d]	0.010
		Turtle (Fat)	ND[e]	0.035
IV	9,000	Composite: Crayfish/Fish	0.031[f]	0.017
V	12,000	Composite: Crayfish/Fish	0.020	0.008
		Frog (whole body)	0.006	0.005

[a] The analyses for TCDD were conducted by the University of Nebraska, Mass Spectrometry Laboratory, Lincoln NE, under Air Force Contract No. F056118C0063. Report submitted 3 December 1979.

[b] This composite sample and subsequent composite samples in this table consisted of mosquitofish and small crayfish.

[c] Average of three analyses.

[d] Average of two analyses.

[e] ND = not detected.

[f] Average of two analyses.

APPENDIX C

HERBICIDE ORANGE MONITORING
PROGRAM ADDENDUM 1

ESL-TR-83-56

HERBICIDE ORANGE MONITORING PROGRAM - ADDENDUM I

ALBERT N. RHODES

MAY 1985

ADDENDUM REPORT

JANUARY 1980 - FEBRUARY 1985

APPROVED FOR PUBLIC RELEASE; DISTRIBUTION UNLIMITED

ENGINEERING & SERVICES LABORATORY
AIR FORCE ENGINEERING & SERVICES CENTER
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PREFACE

This report is Addendum I of ESL-TR-83-56 Herbicide Orange Monitoring Program. Addendum I contains Herbicide Orange data from Eglin AFB, Florida, Naval Construction Battalion Center, Gulfport, Mississippi, and Johnston Island, Pacific Ocean. Environmental samples were collected by personnel from the Air Force Occupational and Environmental Health Laboratory (OEHL) and the Air Force Engineering and Services Center, Engineering and Services Laboratory (ESL) from July 1977 through February 1985. Technical efforts were conducted solely by ESL from January 1980 through February 1985 under JON 19002031, PE 62601F. AFESC/RDVW Project Officer was 2nd Lt Albert N. Rhodes.

This report was prepared to make all ESL Herbicide Orange data available to the public. These data may be useful to the scientific community for decision making and problem solving when faced with similar contaminants. No recommendations or conclusions are made in this report.

This report has been reviewed by the Public Affairs Office (PA) and is releasable to the National Technical Information Service (NTIS). At NTIS it will be available to the general public, including foreign nationals.

This technical report has been reviewed and is approved for publication.

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LIST OF ABBREVIATIONS

ppb	PARTS PER BILLION
ppm	PARTS PER MILLION
ppq	PARTS PER QUADRILLION
ppt	PARTS PER TRILLION
BE	BUTYL ESTERS
C-52A	TEST RANGE C-52A, EGLIN AFB
CAL	CALIFORNIA ANALYTICAL LABORATORIES
DCP	DICHLOROPHENOL
DS	DRAINAGE SYSTEM
DW	DOWNWIND OF STORAGE SITE
EAFB	EGLIN AFB, FLORIDA
ESL	ENGINEERING AND SERVICES LABORATORY
FL	FENCELINE
G1	GRID ONE
HS 7	HARDSTAND SEVEN, EGLIN AFB
HpCDD	HEPTACHLORODIBENZO-p-DIOXINS, ALL ISOMERS
HpCDF	HEPTACHLORODIBENZO-p-FURANS, ALL ISOMERS
HxCDD	HEXACHLORODIBENZO-p-DIOXINS, ALL ISOMERS
HxCDF	HEXACHLORODIBENZO-p-FURANS, ALL ISOMERS
JI	JOHNSTON ISLAND
NCBC	NAVAL CONSTRUCTION BATTALION CENTER, GULFPORT, MISSISSIPPI
ND	NONDETECTABLE AT SPECIFIED DETECTION LIMITS
NR	INTERNAL STANDARD WAS NOT RECOVERABLE
OCDD	OCTACHLORODIBENZO-p-DIOXIN
OCDF	OCTACHLORODIBENZO-p-FURAN
OEHL	AIR FORCE OCCUPATIONAL AND ENVIRONMENTAL HEALTH LABORATORY
OS	OCEAN SEDIMENT
PCDD	PENTACHLORODIBENZO-p-DIOXINS, ALL ISOMERS
PCDF	PENTACHLORODIBENZO-p-FURANS, ALL ISOMERS
Q1	QUADRANT ONE
Q2	QUADRANT TWO
Q3	QUADRANT THREE
Q4	QUADRANT FOUR
SS	STORAGE SITE
TCDD	TETRACHLORODIBENZO-p-DIOXINS, ALL ISOMERS UNLESS SPECIFIED
TCDF	TETRACHLORODIBENZO-p-FURANS, ALL ISOMERS UNLESS SPECIFIED
TCP	TRICHLOROPHENOL
TH	TEST HOLE
UOU	UNIVERSITY OF UTAH, FLAMMABILITY RESEARCH CENTER
UW	UPWIND OF STORAGE SITE
WSU	BREHM LABORATORY, WRIGHT STATE UNIVERSITY
2,3,7,8-TCDD	2,3,7,8-TETRACHLORODIBENZO-p-DIOXIN
2,4-D	2,4-DICHLOROPHENOXYACETIC ACID
2,4,5-T	2,4,5-TRICHLOROPHENOXYACETIC ACID

SECTION IV

HERBICIDE ORANGE DATA

NAVAL CONSTRUCTION BATTALION CENTER

GULFPORT, MISSISSIPPI

LOCATION & DATE	SAMPLING LAB	SAMPLE DESCRIPTION	2,4-D (ppm)	2,4,5-T (ppm)	2,3,7,8-TCDD (ppb)	ANALYT. LAB
NCBC SS 1						
JUL 77	OEHL	SOIL	10500	6120	109	UOU
JAN 78	OEHL	SOIL	5920	6460	328	UOU
NOV 78	OEHL	SOIL	4050	19600	198	UOU
SEP 80	OEHL	SOIL			178	WSU
MAY 81	ESL	SOIL			123	WSU
		SOIL			134	WSU
		SOIL	280	200	190	CAL
		SOIL	760	1100	170	CAL
NOV 81	ESL	SOIL	130	200	240	CAL
		SOIL			154	WSU
APR 82	ESL	SOIL			130	WSU
		SOIL	22	74	176	CAL
NOV 82	ESL	SOIL			176	WSU
NCBC SS 2						
JUL 77	OEHL	SOIL	8.2	20.3	NO DATA	UOU
JAN 78	OEHL	SOIL	0.8	0.4	NO DATA	UOU
NOV 78	OEHL	SOIL	1.4	2.8	NO DATA	UOU
NCBC SS 3						
JUL 77	OEHL	SOIL	13100	13900	631	UOU
JAN 78	OEHL	SOIL	ND-0.1	0.6	4.8	UOU
NOV 78	OEHL	SOIL	1.5	0.3	2.2	UOU
NCBC SS 4						
JUL 77	OEHL	SOIL	7.4	6.6	NO DATA	UOU
JAN 78	OEHL	SOIL	0.1	0.8	NO DATA	UOU
NOV 78	OEHL	SOIL	1.2	4.8	NO DATA	UOU
NCBC SS 5						
JUL 77	OEHL	SOIL	7810	3600	ND-8.4	UOU
JAN 78	OEHL	SOIL	6120	18500	ND-2.0	UOU
NOV 78	OEHL	SOIL	805	2340	ND-38.7	UOU
SEP 80	OEHL	SOIL			2.6	UOU
NOV 81	ESL	SOIL	600	2000	0.1	CAL
		SOIL			1.5	WSU
APR 82	ESL	SOIL			2.5	WSU
		SOIL	330	1640	2.4	CAL
NOV 82	ESL	SOIL			2	WSU
NCBC SS 6						
JUL 77	OEHL	SOIL	0.3	0.4	NO DATA	UOU
JAN 78	OEHL	SOIL	2.7	3.4	NO DATA	UOU
NOV 78	OEHL	SOIL	3.6	1.4	NO DATA	UOU
NCBC SS 7						
JUL 77	OEHL	SOIL	9	11.5	NO DATA	UOU
JAN 78	OEHL	SOIL	570	1110	ND-5.0	UOU
NOV 78	OEHL	SOIL	3.1	4.8	NO DATA	UOU
NCBC SS 8						
JUL 77	OEHL	SOIL	674	369	190	UOU
JAN 78	OEHL	SOIL	0.2	0.5	4.6	UOU
NOV 78	OEHL	SOIL	0.6	0.4	5.2	UOU

NCBC SS 9						
JUL 77	OEHL	SOIL	2.9	5.4	NO DATA	UOU
JAN 78	OEHL	SOIL	0.3	0.2	NO DATA	UOU
NOV 78	OEHL	SOIL	0.4	0.4	NO DATA	UOU
NCBC SS 10						
JUL 77	OEHL	SOIL	2140	1420	18.5	UOU
JAN 78	OEHL	SOIL	4370	1730	42	UOU
NOV 78	OEHL	SOIL	719	2860	24.2	UOU
NCBC SS 11						
JAN 78	OEHL	SOIL	8.8	19.6	NO DATA	UOU
NOV 78	OEHL	SOIL	0.9	2.6	NO DATA	UOU
NCBC SS 12						
JUL 77	OEHL	SOIL	2.0	2.2	NO DATA	UOU
JAN 78	OEHL	SOIL	0.6	0.4	ND-.2	UOU
NOV 78	OEHL	SOIL	0.2	0.6	NO DATA	UOU
SEP 80	ESL	SOIL			0.65	WSU
MAY 81	ESL	SOIL	ND-.01	ND-.013	0.007	CAL
		SOIL	ND-1.0	ND-.1	ND-.01	CAL
		SOIL			0.05	WSU
		SOIL			0.04	WSU
NOV 81	ESL	SOIL			0.09	WSU
APR 82	ESL	SOIL			0.14	WSU
		SOIL			ND-.1	[illegible]
NOV 82	ESL	SOIL			0.25	[illegible]
NCBC SS 13						
JAN 78	OEHL	SOIL	7.2	6.4	NO DATA	UOU
NOV 78	OEHL	SOIL	2.6	4.2	NO DATA	UOU
NCBC SS 14						
JAN 78	OEHL	SOIL	1420	3790	100	UOU
NOV 78	OEHL	SOIL	29.6	40.2	105	UOU
NCBC SS 15						
JAN 78	OEHL	SOIL	0.9	1.2	NO DATA	UOU
NOV 78	OEHL	SOIL	0.2	0.3	NO DATA	UOU
NCBC SS 16						
JAN 78	OEHL	SOIL	6950	11800	442	UOU
NOV 78	OEHL	SOIL	7920	20300	198	UOU
NCBC SS 17						
JAN 78	OEHL	SOIL	31000	22500	510	UOU
NOV 78	OEHL	SOIL	29100	50300	508	UOU
JUN 79	OEHL	SOIL	27000	32900	325	UOU
SEP 80	ESL	SOIL			421	WSU
MAY 81	ESL	SOIL			160	WSU
		SOIL			227	WSU
		SOIL	5600	3200	97	CAL
		SOIL	4400	4200	200	CAL
NOV 81	ESL	SOIL			168	WSU

		SOIL	1200	1700	260	CAL
APR 82	ESL	SOIL			337	WSU
		SOIL	796	2770	271	CAL
NOV 82	ESL	SOIL			184	CAL
NCBC SS 18						
JAN 78	OEHL	SOIL	112	0.5	ND-.02	UOU
NOV 78	OEHL	SOIL	1.8	2.6	NO DATA	UOU
NCBC SS 19						
JAN 78	OEHL	SOIL	7530	14400	130	UOU
NOV 78	OEHL	SOIL	6760	13000	119	UOU
NCBC SS 20						
JAN 78	OEHL	SOIL	21000	53000	1	UOU
NOV 78	OEHL	SOIL	45200	3.7	NO DATA	UOU
NCBC SS 21						
JAN 78	OEHL	SOIL	0.8	2.7	NO DATA	UOU
NOV 78	OEHL	SOIL	1	2.6	NO DATA	UOU
NCBC SS 22						
JAN 78	OEHL	SOIL	2680	10300	ND-2.0	UOU
NOV 78	OEHL	SOIL	6690	33700	ND-18	UOU
NCBC SS 23						
JAN 78	OEHL	SOIL	0.3	0.1	NO DATA	UOU
NOV 78	OEHL	SOIL	0.4	1	NO DATA	UOU
NCBC SS 24						
JAN 78	OEHL	SOIL	4010	ND-2.0	NO DATA	UOU
NOV 78	OEHL	SOIL	1690	1840	ND-12.8	UOU
NCBC SS 25						
JAN 78	OEHL	SOIL	0.7	0.5	NO DATA	UOU
NOV 78	OEHL	SOIL	1.1	3.6	NO DATA	UOU
NCBC SS 26						
JAN 78	OEHL	SOIL	11400	30500	11	UOU
NOV 78	OEHL	SOIL	8840	2970	14	UOU
NCBC SS 27						
JAN 78	OEHL	SOIL	871	660	130	UOU
NOV 78	OEHL	SOIL	359	266	29	UOU
NCBC SS 28						
JAN 78	OEHL	SOIL	0.5	0.6	NO DATA	UOU
NOV 78	OEHL	SOIL	0.3	0.6	NO DATA	UOU
NCBC SS 29						
JAN 78	OEHL	SOIL	46.4	79.8	ND-4.0	UOU
NOV 78	OEHL	SOIL	0.7	2	NO DATA	UOU

NCBC SS 30			3530	8790	240	UOU
JAN 78	OEHL	SOIL	2610	8770	222	UOU
NOV 78	OEHL	SOIL				
NCBC SS 31			200	698	ND-2.0	UOU
JAN 78	OEHL	SOIL	384	504	NO DATA	UOU
NOV 78	OEHL	SOIL				
NCBC SS 32			1.3	6.2	NO DATA	UOU
JAN 78	OEHL	SOIL	6.7	34.9	NO DATA	UOU
NOV 78	OEHL	SOIL				
NCBC SS 33			5.7	3.4	NO DATA	UOU
JAN 78	OEHL	SOIL	0.3	0.7	NO DATA	UOU
NOV 78	OEHL	SOIL				
NCBC SS 34			117	494	ND-8.0	UOU
JAN 78	OEHL	SOIL	3.3	6	NO DATA	UOU
NOV 78	OEHL	SOIL				
NCBC SS 35			50.6	175	ND-340	UOU
JAN 78	OEHL	SOIL	5	15.6	NO DATA	UOU
NOV 78	OEHL	SOIL				
NCBC SS 36			23.1	55.8	ND-10	U[illegible]
JAN 78	OEHL	SOIL	1.1	3.9	NO DATA	U[illegible]
NOV 78	OEHL	SOIL				
NCBC SS 37			1490	7850	ND-8.0	UOU
JAN 78	OEHL	SOIL	1470	5820	21.8	UOU
NOV 78	OEHL	SOIL				
NCBC SS 38			1320	6120	ND-11	UOU
JAN 78	OEHL	SOIL	859	4160	24.2	UOU
NOV 78	OEHL	SOIL				
NCBC SS 39			6.1	15.6	ND-40	UOU
JAN 78	OEHL	SOIL	0.5	2.2	NO DATA	UOU
NOV 78	OEHL	SOIL				
NCBC SS 40			40.8	128	ND-3.0	UOU
JAN 78	OEHL	SOIL	0.3	0.7	NO DATA	UOU
NOV 78	OEHL	SOIL				
NCBC SS 41			5030	6800	230	UOU
JAN 78	OEHL	SOIL	5790	13900	251	UOU
NOV 78	OEHL	SOIL			193	WSU
SEP 80	ESL	SOIL	3400	2100	80	CAL
MAY 81	ESL	SOIL	2700	1600	180	CAL
		SOIL			54	WSU
		SOIL			165	WSU
		SOIL	600	1100	140	CAL
NOV 81	ESL	SOIL			123	WSU
		SOIL	110	570	150	CAL
APR 82	ESL	SOIL				

		SOIL			249	WSU
NOV 82	ESL	SOIL			164	WSU
NCBC SS 42						
JAN 78	OEHL	SOIL	0.6	2.5	NO DATA	UOU
NOV 78	OEHL	SOIL	0.3	NO DATA	NO DATA	UOU
NCBC SS 43						
JAN 78	OEHL	SOIL	9.2	15.7	ND-43	UOU
NOV 78	OEHL	SOIL	2270	6860	5.9	UOU
NCBC SS 44						
JAN 78	OEHL	SOIL	12	30.5	NO DATA	UOU
NOV 78	OEHL	SOIL	3510	7470	9.1	UOU
NCBC DS 1						
SEP 80	ESL	SEDIMENT			0.74	WSU
		BIOLOGICAL(FISH)			2.17	WSU
MAY 81	ESL	SEDIMENT			1.15	WSU
		BIOLOGICAL(COMPOSITE)			1.2	WSU
NOV 81	ESL	SEDIMENT			2.2	WSU
		BIOLOGICAL(FROG)			0.53	WSU
APR 82	ESL	SEDIMENT			0.48	WSU
		BIOLOGICAL(NOT SPECIFIED)			0.57	WSU
		BIOLOGICAL(TURTLE LIVER)			0.57	WSU
		BIOLOGICAL(TURTLE VISCERA)			0.24	WSU
		BIOLOGICAL(TURTLE MUSCLE)			0.08	WSU
NOV 82	ESL	SEDIMENT			1.5	WSU
		BIOLOGICAL(COMPOSITE)			0.9	WSU
APR 83	ESL	BIOLOGICAL(FISH)			2	WSU
MAR 84	ESL	SUSPENDED SEDIMENT			10.6	WSU
		WATER			ND-30ppq	WSU
NCBC DS 2						
SEP 80	ESL	SEDIMENT			0.31	WSU
		SEDIMENT			0.34	WSU
		BIOLOGICAL(TADPOLE)			0.37	WSU
		BIOLOGICAL(FISH)			11.6	WSU
		BIOLOGICAL(TURTLE LIVER)			2.49	WSU
		BIOLOGICAL(TURTLE MUSCLE&BONE)			0.36	WSU
MAY 81	ESL	SEDIMENT			0.16	WSU
		BIOLOGICAL(FISH)			0.6	WSU
NOV 81	ESL	SEDIMENT			1.2	WSU
		BIOLOGICAL(TADPOLE)			0.26	WSU
		BIOLOGICAL(CRAYFISH)			0.07	WSU
		BIOLOGICAL(FISH)			0.52	WSU
APR 82	ESL	SEDIMENT			0.14	WSU
		BIOLOGICAL(TADPOLE)			0.06	WSU
		BIOLOGICAL(NOT SPECIFIED)			0.62	WSU
NOV 82	ESL	SEDIMENT			0.18	WSU
		BIOLOGICAL(COMPOSITE)			0.41	WSU
		BIOLOGICAL(TURTLE LIVER)			0.61	WSU
		BIOLOGICAL(TURTLE ADIPOSE)			0.07	WSU
		BIOLOGICAL(TURTLE MUSCLE)			0.05	WSU

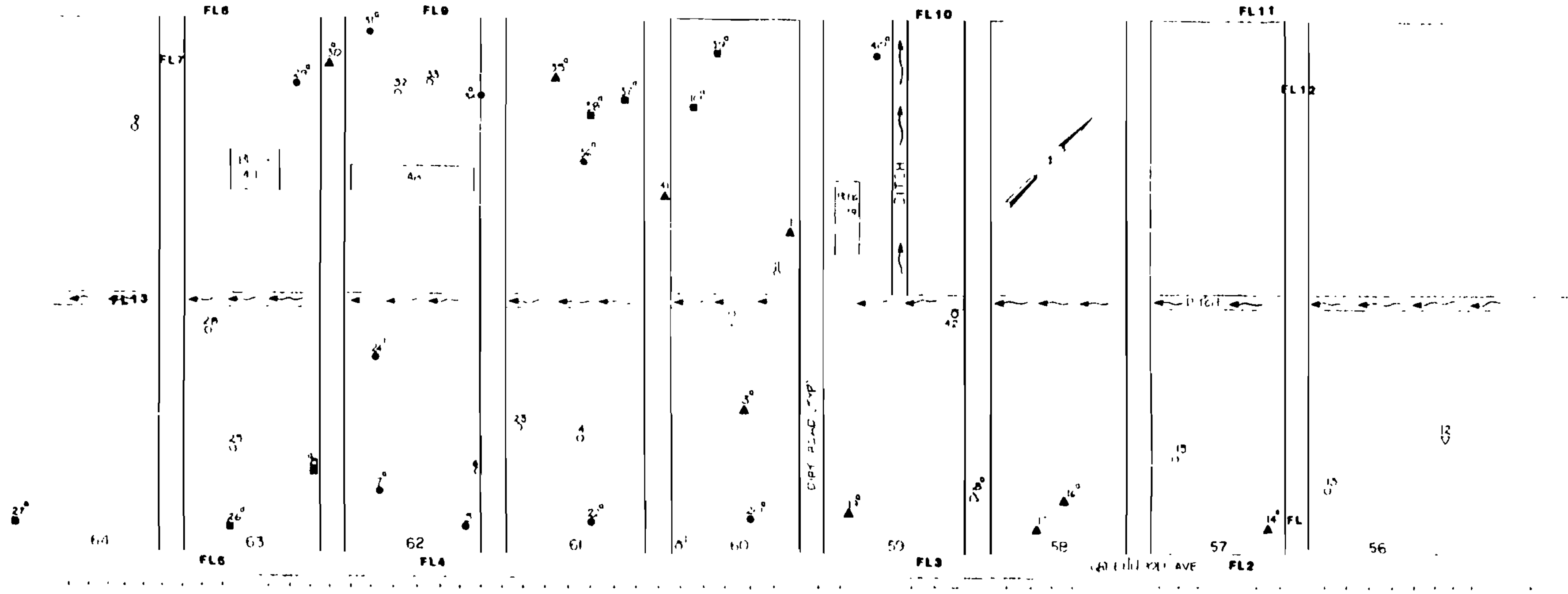
APR 83	ESL	BIOLOGICAL(COMPOSITE)	0.4	WSU
MAR 84	ESL	SEDIMENT	0.15	WSU
		WATER	ND-50ppq	WSU
		BIOLOGICAL(COMPOSITE)	0.39	WSU
NCBC DS 3				
SEP 80	ESL	SEDIMENT	0.02	WSU
		BIOLOGICAL(FROG)	0.01	WSU
APR 82	ESL	SEDIMENT	ND	WSU
		BIOLOGICAL(NOT SPECIFIED)	ND	WSU
NOV 82	ESL	SEDIMENT	ND	WSU
		BIOLOGICAL(TURTLE LIVER)	1.32	WSU
		BIOLOGICAL(TURTLE ADIPOSE)	4.4	WSU
		BIOLOGICAL(MUSCLE)	0.06	WSU
APR 83	ESL	BIOLOGICAL(CRAYFISH)	0.23	WSU
MAR 84	ESL	SEDIMENT	0.07	WSU
		WATER	ND-80ppq	WSU
		BIOLOGICAL(FISH)	0.9	WSU
NCBC DS 4				
SEP 80	ESL	SEDIMENT	0.07	WSU
		BIOLOGICAL(TURTLE LIVER)	0.06	WSU
		BIOLOGICAL(TURTLE ADIPOSE)	0.32	WSU
		BIOLOGICAL(TURTLE MUSCLE)	0.02	WSU
MAY 81	ESL	SEDIMENT	ND	WSU
NOV 81	ESL	SEDIMENT	ND	[illegible]
		BIOLOGICAL(FISH)	ND	[illegible]
APR 82	ESL	SEDIMENT	ND	WSU
		BIOLOGICAL(FISH)	0.07	WSU
		BIOLOGICAL(CRAYFISH)	0.29	WSU
NOV 82	ESL	SEDIMENT	ND	WSU
		BIOLOGICAL(FISH)	0.04	WSU
APR 83	ESL	BIOLOGICAL(FISH)	0.18	WSU
MAR 84	ESL	SEDIMENT	ND	WSU
		WATER	ND-50ppq	WSU
		BIOLOGICAL(CRAYFISH)	0.11	WSU
NCBC DS 5				
SEP 80	ESL	SEDIMENT	0.01	WSU
MAY 81	ESL	SEDIMENT	ND	WSU
NOV 81	ESL	SEDIMENT	0.03	WSU
		BIOLOGICAL(FISH)	0.02	WSU
NOV 82	ESL	SEDIMENT	ND	WSU
		BIOLOGICAL(COMPOSITE)	0.05	WSU
APR 83	ESL	BIOLOGICAL(COMPOSITE)	0.1	WSU
MAR 84	ESL	SEDIMENT	ND	WSU
		WATER	ND-55ppq	WSU
		BIOLOGICAL(CRAYFISH)	0.05	WSU
NCBC DS 6				
SEP 80	ESL	SEDIMENT	ND	WSU
		BIOLOGICAL(FISH)	0.11	WSU
		BIOLOGICAL(TURTLE LIVER)	0.12	WSU
		BIOLOGICAL(TURTLE ADIPOSE)	0.88	WSU

		BIOLOGICAL(TURTLE MUSCLE)	0.05	WSU
MAY 81	ESL	SEDIMENT	0.03	WSU
		SEDIMENT	0.02	WSU
		BIOLOGICAL(FISH)	0.09	WSU
NOV 81	ESL	SEDIMENT	0.04	WSU
		BIOLOGICAL(CRAYFISH)	0.04	WSU
APR 82	ESL	SEDIMENT	ND	WSU
		BIOLOGICAL(NOT SPECIFIED)	0.02	WSU
NOV 82	ESL	SEDIMENT	0.12	WSU
		BIOLOGICAL(COMPOSITE)	0.1	WSU
		BIOLOGICAL(FISH)	0.24	WSU
APR 83	ESL	BILOGICAL(CRAYFISH)	0.02	WSU
MAR 84	ESL	SEDIMENT	0.08	WSU
		WATER	ND-90ppq	WSU
NCBC DS 7				
SEP 80	ESL	SEDIMENT	0.19	WSU
		BIOLOGICAL(FISH)	0.05	WSU
MAY 81	ESL	SEDIMENT	0.08	WSU
		SEDIMENT	0.09	WSU
		BIOLOGICAL(FISH)	0.05	WSU
NOV 81	ESL	SEDIMENT	ND	WSU
		BIOLOGICAL(FISH)	0.07	WSU
APR 82	ESL	SEDIMENT	ND	WSU
		BIOLOGICAL(CRAYFISH)	0.04	WSU
		BIOLOGICAL(FISH)	0.04	WSU
NOV 82	ESL	SEDIMENT	0.03	WSU
		BIOLOGICAL(FISH)	0.13	WSU
		BIOLOGICAL(FISH)	0.07	WSU
APR 83	ESL	BIOLOGICAL(FISH)	0.03	WSU
MAR 84	ESL	SEDIMENT	0.01	WSU
		WATER	ND-40ppq	WSU
		SUSPENDED SEDIMENT	0.15	WSU
		BIOLOGICAL(FISH)	0.07	WSU
NCBC DS 8				
SEP 80	ESL	SEDIMENT	0.01	WSU
APR 82	ESL	SEDIMENT	0.04	WSU
		BIOLOGICAL(CRAYFISH)	0.05	WSU
NOV 82	ESL	SEDIMENT	0.02	WSU
		BIOLOGICAL(CRAYFISH)	0.03	WSU
APR 83	ESL	BIOLOGICAL(CRAYFISH)	0.3	WSU
MAR 84	ESL	SEDIMENT	ND	WSU
		SUSPENDED SEDIMENT	0.15	WSU
		WATER	ND-50ppq	WSU
		BILOGICAL(CRAYFISH)	0.02	WSU

NCBC DS 9				
SEP 80	ESL	SEDIMENT	0.04	WSU
NOV 81	ESL	SEDIMENT	ND	WSU
		BIOLOGICAL((FISH)	ND	WSU
NOV 82	ESL	SEDIMENT	ND	WSU
		BIOLOGICAL(COMPOSITE)	ND	WSU
APR 83	ESL	BIOLOGICAL(FISH)	ND	WSU
MAR 84	ESL	SEDIMENT	ND	WSU
		SEDIMENT	ND	WSU
		SUSPENDED SEDIMENT	0.3	WSU
		WATER	ND-30ppq	WSU
NCBC DS 10				
		NO DATA		
NCBC DS 11				
MAR 84	ESL	SEDIMENT	ND	WSU
		SEDIMENT	ND	WSU
		WATER	ND-30ppq	WSU
NCBC DS 12				
MAR 84	ESL	SEDIMENT	ND	WSU
		SEDIMENT	ND	WSU
		WATER	ND-30ppq	WSU
NCBC DS 13				
MAR 84	ESL	SEDIMENT	ND	WSU
		SEDIMENT	0.02	WSU
NCBC DS 14				
MAR 84	ESL	SEDIMENT	ND	WSU
		SEDIMENT	ND	WSU
		SEDIMENT	ND	WSU
		SUSPENDED SEDIMENT	0.45	WSU
		WATER	ND-40ppq	WSU

SECTION VII

SITE MAPS



TCDD CONCENTRATION IN PARTS PER BILLION	
○ NO DATA	● 1 TO 10
□ <0.01 ND	■ 10 TO 100
△ 0.01 TO 0.1	▲ 100 TO 500
▽ 0.1 TO 1	

ᵃ SAMPLES COLLECTED IN 1977-78 AND ANALYZED BY THE UNIVERSITY OF UTAH; ALL OTHER SAMPLES COLLECTED IN 1980-82 AND ANALYZED BY WRIGHT STATE UNIVERSITY AND CALIFORNIA ANALYTICAL LABORATORY

Figure 4. Herbicide Orange Storage Site, Naval Construction Battalion Center, Gulfport MS

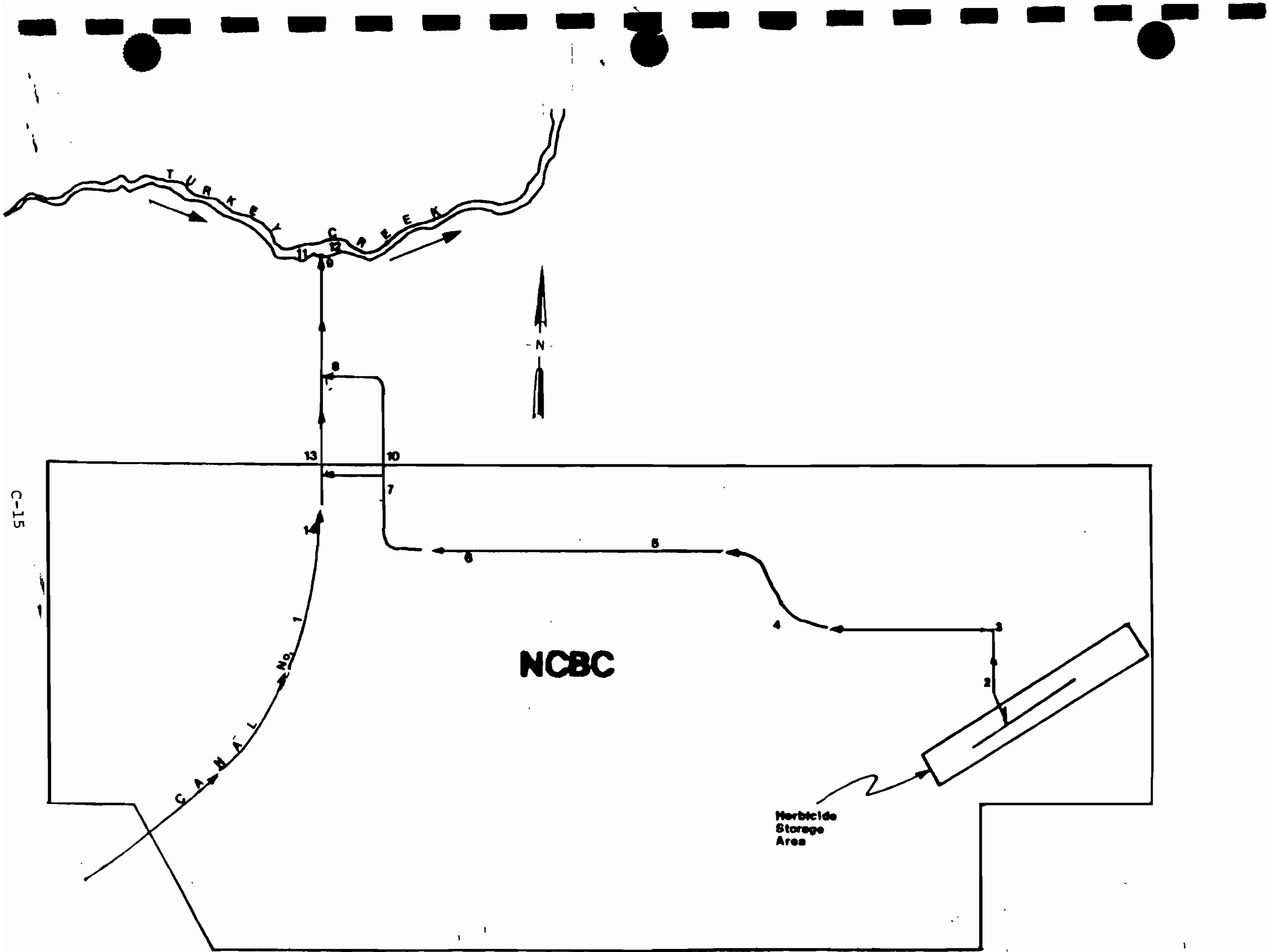
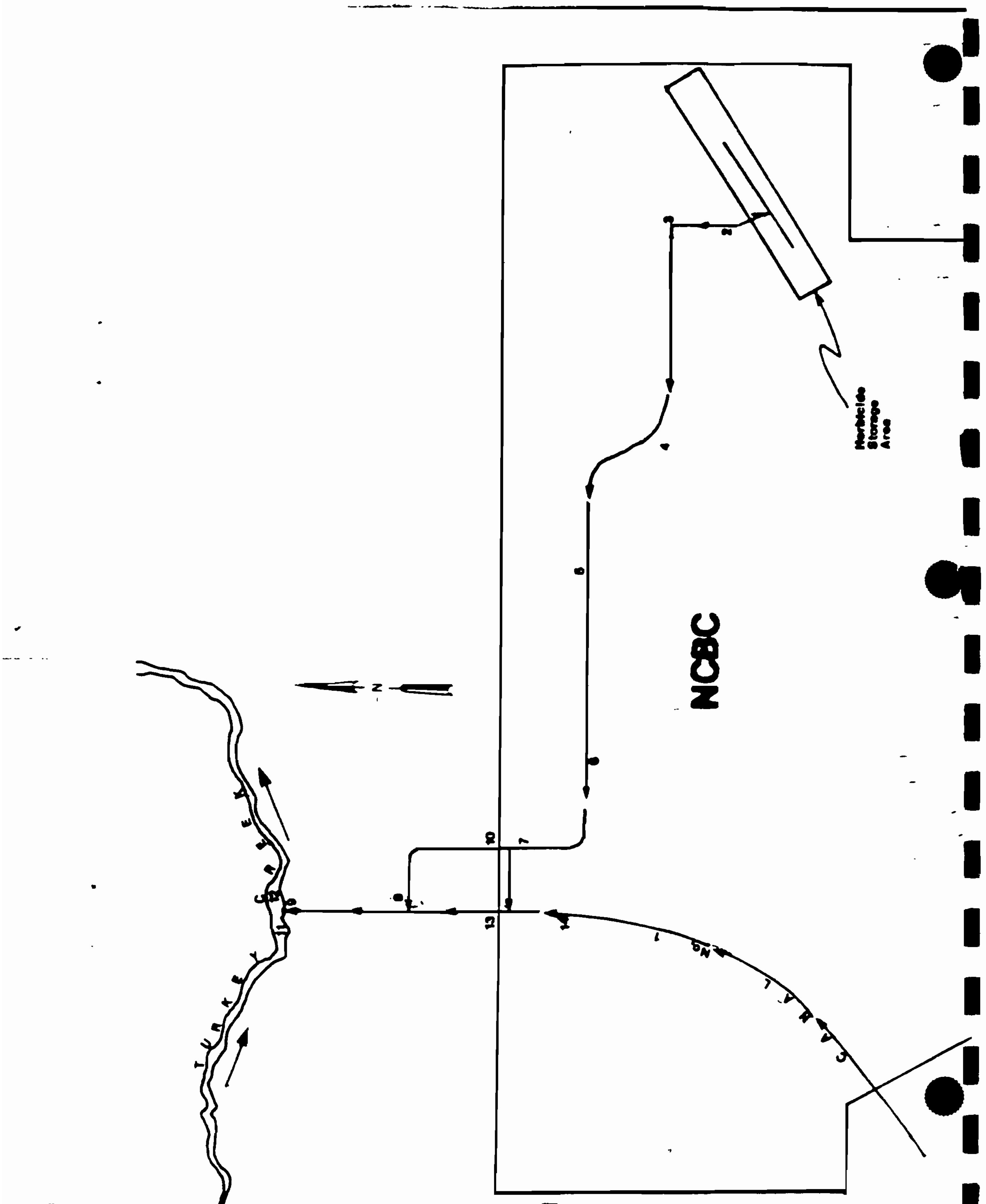


Figure 5. Storage Site Drainage System. NCBC


NCBC
Herbicide Storage Area
TURKEY CREEK
CANAL No 1
N

APPENDIX D

ANALYTICAL RESULTS FROM

DRUMS STORED AT SITE 9