DEPARTMENT OF THE AIR FORCE
HEADQUARTERS 49TH FIGHTER WING (ACC)
HOLLOMAN AIR FORCE BASE, NEW MEXICO

U.S. AIR FORCE
1947 - 1997

30 JUN 1997

MEMORANDUM FOR NEW MEXICO ENVIRONMENT DEPARTMENT
Attn: Mr. Cornelius Amindyas
Hazardous & Radioactive Materials Bureau
P.O. Box 26110
Santa Fe NM 87502

JUL 1997 RECEIVED

FROM: 49 CES/CEV
550 Tabosa Avenue
Holloman AFB NM 88330-8458

SUBJECT: Final Characterization Summary and No Further Action (NFA) Documentation

1. Attached please find the Final Characterization Summary and NFA Documentation for Solid Waste Management Unit (SWMU) 139, Lake Holloman, and SWMU 140, Lake Stinky. SWMUs 139 and 140 were investigated in conjunction with the sewage lagoons (Ponds A-G). These SWMUs are similar to Pond G in that they are critical habitat for migratory waterfowl in southern New Mexico. Any type of intervention (i.e., dredging) would result in much greater harm to the ecosystem as compared to the potential effect of any contaminant present at these SWMUs. Holloman AFB (HAFB) conducted an in-depth ecological risk assessment for these SWMUs and found no threat to any native species. As such, HAFB is recommending NFA for these SWMUs to ensure they remain beneficial habitat for migratory waterfowl.

2. If you have any questions regarding these work plans or require additional information, please contact Warren Neff at (505) 475-5395.

Howard E. Moffitt
HOWARD E. MOFFITT
Deputy Base Civil Engineer

Attachment:
Final Characterization Summary and No Further Action (NFA) Documentation

LIBRARY COPY

Headquarters, Air Combat Command
Langley Air Force Base,
Virginia

Final

Characterization Summary and No Further Action (NFA) Documentation

SWMUs 139 (Lake Holloman and the Ditch) and 140 (Lake Stinky)

June 1997

49th FIGHTER WING

49 CES/CEV
Holloman Air Force Base,
New Mexico

DCN: 97-670-008-19

CHARACTERIZATION SUMMARY AND NO FURTHER ACTION (NFA) DOCUMENTATION

SWMUS 139 (LAKE HOLLOMAN AND THE DITCH) AND 140 (LAKE STINKY)

FINAL

Prepared for:

49 CES/CEV
Holloman Air Force Base, NM

and

HQ ACC CES/ESVR
Langley Air Force Base, VA

Prepared by:

Foster Wheeler Environmental Corporation
143 Union Blvd., Suite 1010
Lakewood, Colorado 80203
303/988-2202

Radian International LLC
8501 North MoPac Boulevard
Austin, Texas 78720-1088
512/454-4797

Under Contract No. DACW45-94-D-0003

U.S. Army Corps of Engineers
Omaha District
Omaha, Nebraska

June 1997

TABLE OF CONTENTS

Page

EXECUTIVE SUMMARY ES-1

1 INTRODUCTION 1-1

1.1 Objective 1-1
1.2 Regulatory Background 1-1
1.3 Organization of Site Closeout Report 1-2

2 DESCRIPTION OF SWMUs 2-1

2.1 Holloman AFB Mission 2-1
2.2 Location of Holloman AFB 2-1
2.3 Physical Description of SWMUs 139 and 140 2-3
2.3.1 SWMU 139—Lake Holloman and the Ditch 2-3
2.3.2 SWMU 140—Lake Stinky 2-3
2.4 Physiography 2-3
2.5 Geology 2-3
2.6 Hydrology 2-5
2.6.1 Surface Water 2-5
2.6.2 Groundwater 2-9
2.7 Groundwater Quality 2-13

3 INVESTIGATION RESULTS 3-1

3.1 Summary of Previous Investigations 3-1
3.2 Summary of Results and Current Conditions 3-1
3.2.1 Sludge 3-1
3.2.2 Soil 3-1
3.2.3 Surface Water 3-6
3.2.4 Groundwater 3-6
3.3 Summary of Risk Assessment Results 3-6
3.3.1 Human Health Risks 3-6
3.3.2 Ecological Risks 3-6

4 EVALUATION OF EFFECTS ON BIOLOGICAL RESOURCES 4-1

4.1 Habitats 4-1
4.1.1 Upland Grassland 4-1
4.1.2 Brackish Marshes 4-2
4.1.3 Playas 4-2
4.1.4 Riparian Habitat 4-2
4.1.5 Surface Water Habitat 4-3

TABLE OF CONTENTS (Continued)

Page

4.1.5.1 Lake Holloman 4-3
4.1.5.2 Lake Stinky 4-4
4.2 Threatened, Endangered, and Sensitive Species 4-5
4.3 Discussion 4-5

5 NO FURTHER ACTION RECOMMENDATION 5-1

6 REFERENCES 6-1

APPENDIX A: Analytical Summary of Investigations at SWMUs 139 and 140

APPENDIX B: List of Historical Reports for SWMUs 139 and 140

LIST OF FIGURES

Page

ES-1 Location of SWMUs 139 and 140 at Holloman AFB E-2

2-1 Location of Holloman AFB 2-2

2-2 Location of SWMUs 139 and 140 2-4

2-3 Stratigraphic Fence Diagram 2-6

2-4 Site Stratigraphy 2-7

2-5 Location of Jurisdictional and Constructed Wetlands Near SWMUs 139 and 140 2-8

2-6 Potentiometric Groundwater Surface Map (August 1996) for the Former Sewage Lagoons and SWMUs 139 and 140 2-11

3-1 Sampling Locations at Lake Holloman and the Ditch (SWMU 139) and Lake Stinky (SWMU 140) 3-2

3-2 Sampling Locations at the Ditch (part of SWMU 139) 3-3

LIST OF TABLES

Page

3-1 Summary of Primary Investigations and Historical Reports For SWMU 139 (Lake Holloman and the Ditch) and SWMU 140 (Lake Stinky) 3-4

4-1 Threatened, Endangered, and Sensitive Species of Birds 4-6

4-2 Threatened, Endangered, and Sensitive Mammal, Fish, and Plant Species 4-8

ACRONYMS

ACC	Air Combat Command
AFB	Air Force Base
bgl	Below ground level
BLM	Bureau of Land Management
CFR	Code of Federal Regulations
DoD	Department of Defense
DRMO	Defense Reutilization Marketing Office
EA	Environmental Assessment
EPA	U.S. Environmental Protection Agency
ERA	Ecological Risk Assessment
FONPA	Finding of no practicable alternative
FONSI	Finding of no significant impact
GAF	German Air Force
HHSs	Human Health Standards
HSWA	Hazardous and Solid Waste Amendments
MCLs	Maximum Contaminant Levels
NEPA	National Environmental Policy Act
NFA	No Further Action
NM	New Mexico
NMED	New Mexico Environment Department
NPDES	National Pollutant Discharge Elimination System
PCBs	Polychlorinated biphenyls
RCRA	Resource Conservation and Recovery Act
RFA	RCRA Facility Assessment
RFI	RCRA Facility Investigation
SMCLs	Secondary Drinking Water Maximum Contaminant Levels
SWMU	Solid Waste Management Unit
TDS	Total Dissolved Solids
TSDF	Treatment, storage, or disposal facility
USACE	U.S. Army Corps of Engineers
USAF	United States Air Force
USFWS	U.S. Fish and Wildlife Service
USGS	United States Geological Survey
UTL	Upper tolerance limit
WQCC	Water Quality Control Commission
WWTP	Wastewater Treatment Plant

PURPOSE OF DOCUMENT

A. The *Characterization Summary and No Further Action (NFA) Documentation for SWMUs 139 (Lake Holloman and the Ditch) and 140 (Lake Stinky),* presents the relevant information to support the no further action (NFA) determination for SWMU 139 (Lake Holloman and the earthen ditch carrying discharge from Lagoon G to Lake Holloman) and SWMU 140 (Lake Stinky) at Holloman Air Force Base (AFB), New Mexico. This document describes the SWMUs and the surrounding areas, summarizes the results of the investigations that have been conducted, demonstrates that the conditions at the SWMUs have been well characterized and that no further investigation is needed, and presents the justification for no further action. This document was prepared for, and in cooperation with, the Base Civil Engineer Environmental Office: 49 CES/CEV, 550 Tabosa Avenue, Holloman AFB, NM 88330-8458, phone 505/475-3931.

B. Appendix A to this report presents a summary of the analytical results for all surface water, sludge, soil, and groundwater data obtained from SWMUs 139 and 140 between 1990 and 1994.

C. This report summarizes all previous reports that have been prepared for the investigation and assessment of SWMUs 139 and 140. A discussion of the previous reports that pertain to these SWMUs is presented in Section 3. The more recent reports include the following:

- August 1992, *Site Characterization Report, Sewage Lagoons and Lakes Investigation, Holloman Air Force Base, NM.*
- December 1993, *Phase 2—RCRA Facility Investigation Report for Lakes Holloman and Stinky, Sewage Lagoons and Lakes Investigation, Holloman Air Force Base, NM.*
- November 1995, *Technical Memorandum, 1994 Site Investigation, Lake Holloman, Lake Stinky, and the Ditch, Holloman Air Force Base, NM.*
- March 1996, *Risk Assessment Addendum, Sewage Lagoons Closure Project, Holloman Air Force Base, NM.*
- June 1996, *Biological Resources Report, Sewage Lagoons Closure Project, Holloman Air Force Base, NM.*

EXECUTIVE SUMMARY

This document presents information that supports the no further action (NFA) determination for Solid Waste Management Unit (SWMU) 139 (Lake Holloman, which includes the earthen ditch carrying discharge from lagoon G to Lake Holloman) and SWMU 140 (Lake Stinky) at Holloman Air Force Base (AFB), New Mexico. These SWMUs have been investigated under the Hazardous and Solid Waste Amendments (HSWA) corrective action program because they are listed in Table 1 of the HSWA portion of the Base's Resource Conservation and Recovery Act (RCRA) Part B permit. Because these SWMUs previously received water from the former sewage lagoons, site-specific investigations were conducted in coordination with the sewage lagoons investigations and not with other SWMUs listed in Table 1 of the HSWA permit.

SWMUs 139 and 140 are located in the southwestern corner of Holloman AFB as shown in Figure ES-1. SWMU 139 (Lake Holloman) is an unlined, 166-acre lake that was formed by constructing a nonengineered dam to collect wastewater effluent. Until July 1996, the former wastewater treatment system consisted of the headworks, which included a grit chamber and a pump station, and the former sewage lagoons. The treated effluent from the last lagoon (Pond G) flowed via an earthen ditch, which is part of SWMU 139, to Lake Holloman. Because of seasonal low evaporation, water from SWMU 139 occasionally overflows into SWMU 140 (Lake Stinky). Lake Stinky is a natural playa lake that periodically contains water during the winter, but any surface water eventually dissipates through evaporation and infiltration.

Extensive investigations have been performed to determine the nature and extent of the constituents in the sludge, soil, surface water, and groundwater in SWMUs 139 and 140. Between 1990 and 1994, several investigations were conducted in and around SWMUs 139 and 140. The analyses of sludge and soil samples for Appendix IX constituents have indicated low levels of organochlorine pesticide and metal constituents, and analyses of groundwater samples for Appendix IX constituents have shown very low levels of organochlorine pesticides.

In addition to the investigations, studies have been performed to ensure that the approach to closeout will enable the area to remain a viable natural resource. The results of risk assessments conducted for SWMUs 139 and 140 indicate there is no need to remediate the SWMUs. No unacceptable risks to human health were reported, and no unacceptable ecological risks to native species such as waterfowl were determined for the SWMUs.

The evaluation of biological resources also showed there is no need to remediate these SWMUs. The evaluation indicated that any actions such as dredging the SWMUs would adversely affect the existing ecosystem because the disturbances could have a greater negative impact than the low levels of constituents that are present.

On the basis of the results of the investigations, the risk assessment, and the biological resources evaluation, no further action is recommended for SWMUs 139 and 140. After this report is submitted to EPA Region VI and the New Mexico Environment Department (NMED) under HSWA, Holloman AFB will prepare and submit a Class 3 RCRA permit modification to remove SWMUs 139 and 140 from the Base's HSWA permit.

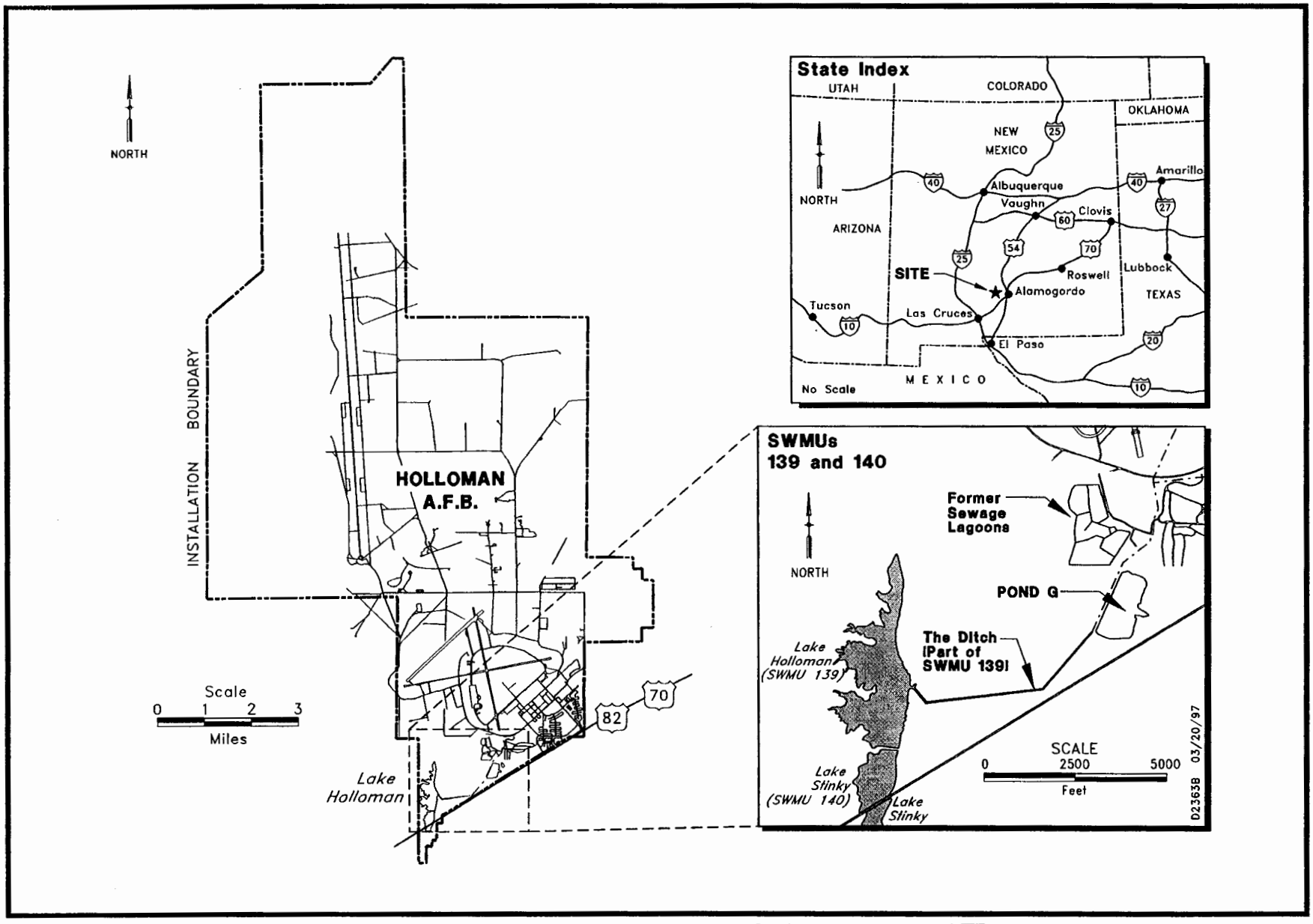

Figure ES-1. Location of SWMUs 139 and 140 at Holloman AFB

Section 1
INTRODUCTION

1.1 Objective

The primary objective of this document is to present the relevant information that supports the no further action (NFA) determination for the following two solid waste management units (SWMUs): SWMU 139 (Lake Holloman, which includes the earthen ditch carrying discharge from lagoon G to Lake Holloman) and SWMU 140 (Lake Stinky) at Holloman Air Force Base (AFB), New Mexico. This document provides a description of the SWMUs and the surrounding areas, summarizes the results of previous investigations that have been conducted at these SWMUs, demonstrates that the conditions at the SWMUs have been well characterized, and presents the justification for the NFA determination for the SWMUs.

1.2 Regulatory Background

Holloman AFB operates an on-site storage facility for currently generated hazardous wastes. This facility, which stores wastes for greater than 90 days and is considered a treatment, storage, or disposal facility (TSDF), is permitted under a Resource Conservation and Recovery Act (RCRA) permit. Because of the permitted facility, Holloman AFB is subject to the RCRA corrective action program. The Hazardous and Solid Waste Amendments (HSWA) portions of Holloman AFB's RCRA Part B TSDF permit require the Base to investigate several of the SWMUs identified in the 1988 RCRA facility assessment (RFA). The units listed in Tables 1, 2, and 3 of the HSWA permit must each comply with a schedule for implementing the corrective action program. SWMU 139 (Lake Holloman, which includes the earthen ditch carrying discharge from lagoon G to Lake Holloman) and SWMU 140 (Lake Stinky) are listed in Table 1 of the HSWA permit and, therefore, require investigation under the HSWA corrective action program. Because these SWMUs formerly received water from the sewage lagoons, site-specific investigations were conducted in coordination with the sewage lagoons investigations and not with other SWMUs listed in Table 1 of the HSWA permit.

In 1994, the New Mexico Environment Department (NMED) and the U.S. Environmental Protection Agency (EPA) Region VI confirmed that SWMUs 139 and 140 would be regulated as SWMUs under the HSWA program. In a letter to NMED, EPA Region VI stated that as far as it could determine hazardous wastes have never been managed at SWMUs 139 and 140; therefore, the sites fail the criteria for RCRA units and they are subject to HSWA authority under EPA (David Neleigh, personal communication, 4 April 1994). Also, in a letter to Holloman AFB, NMED stated that SWMUs 139 and 140 would be regulated by EPA Region VI under the HSWA program (Barbara Hoditschek, personal communication, 6 April 1994). Although NMED has recently received the authority to run the HSWA program in New Mexico, EPA Region VI has maintained a technical review function for the HSWA program as part of a work share agreement with NMED.

Other regulatory issues affecting the SWMUs include those listed below. Lake Holloman and Lake Stinky are "waters of the United States" as defined in 40 CFR 122.2. Also, as discussed in Section 2, many portions of the ditch are jurisdictional wetlands, and other portions of the ditch will become part of the constructed wetlands that are being developed as part of the new wastewater treatment system. In all, there are approximately 300 acres of jurisdictional waters in the area. Because Holloman AFB discharges storm water and treated wastewater to these jurisdictional waters, the Base has submitted a National Pollutant

Discharge Elimination System (NPDES) permit application to EPA Region VI.

1.3 Organization of Site Closeout Report

This SWMU closeout report consists of six sections including this introduction. Section 2 describes SWMUs 139 and 140 including the environmental setting, physical descriptions of the SWMUs, and the hydrology of the area. Section 3 presents a summary of the investigations that have been conducted at the lakes and the ditch. The summary includes a discussion of the sludge, soil, surface water, and groundwater sampling that has been conducted at SWMUs 139 and 140, as well as a summary of the risk assessments that have been conducted. Section 4 presents an evaluation of effects on biological resources that are present at SWMUs 139 and 140. Section 5 discusses the justification for an NFA determination for the SWMUs. Section 6 lists all the reports and references that are referred to in this document.

Appendix A contains a summary of the analytical results from the investigations at SWMUs 139 and 140. Appendix B presents a list of reports that pertain to the SWMUs.

Section 2
DESCRIPTION OF SWMUs

Section 2 discusses the mission, location, and environmental setting of Holloman AFB, in addition to describing SWMUs 139 and 140.

2.1 Holloman AFB Mission

The host organization of Holloman AFB is the 49th Fighter Wing, whose mission as part of Air Combat Command (ACC) is to support national security objectives worldwide with F-117 stealth fighters and HH-60 helicopters. The helicopters are associated with the 48th Rescue Squadron. Additionally, the wing provides fighter fundamentals training using T-38 and AT-38 aircraft to U.S. and selected allied nation air crews. Training in F-4 aircraft is provided to the German Air Force (GAF). The Base has also constructed support facilities for the GAF PA-200 Tornado fighter bombers. The 49th Material Maintenance Group deploys worldwide to provide physical infrastructure to remote air bases.

Over 30 tenant organizations are present on base, including the 46th Test Group, the Army Air Operations Directorate, Primate Research Lab (operated by the Coulston Foundation), and the Defense Reutilization Marketing Office (DRMO).

The 46th Test Group sponsors a variety of activities, including operating a variety of test bed aircraft and operating the 10-mile-long high speed test track. The test track is used for ground testing ejection seats, missiles, and other defense activities. Army Air operates aircraft in support of White Sands Missile Range located to the north and west of Holloman AFB. The Primate Research Lab, formerly operated by New Mexico State University, is now privately operated by the Coulston Foundation and performs medical research. DRMO is directly responsible for operating the Holloman AFB treatment, storage, and disposal facility.

2.2 Location of Holloman AFB

Holloman AFB is situated in south-central New Mexico (see Figure 2-1), in the northwest central portion of Otero County. The Main Base occupies about 60,000 acres including lands around Lakes Holloman and Stinky that were recently transferred from the Bureau of Land Management (BLM). The main cantonment area is located in the northeast quarter of Section T.17S, R.8E. The High Speed Test Track extends northward into T.15S. The Base is situated approximately 7 miles west of Alamogordo, New Mexico, the only town of appreciable size within 50 miles of the Base. The remote location and the large Department of Defense (DoD) presence (White Sands Missile Range, Fort Bliss, and Holloman AFB) have helped Holloman AFB to avoid many problems (e.g., encumbered air space and urban encroachment) associated with other bases.

The desert terrain of the area surrounding Holloman AFB has limited development in the immediate vicinity of the Base. There are no farming operations, residential communities, or large industrial operations located adjacent to the Base. Future land use in the area is not expected to differ significantly from current land use. Holloman AFB is an active military installation and is expected to remain active for the foreseeable future. No transfer of military property to the public domain is anticipated. Public access to the Base is restricted.

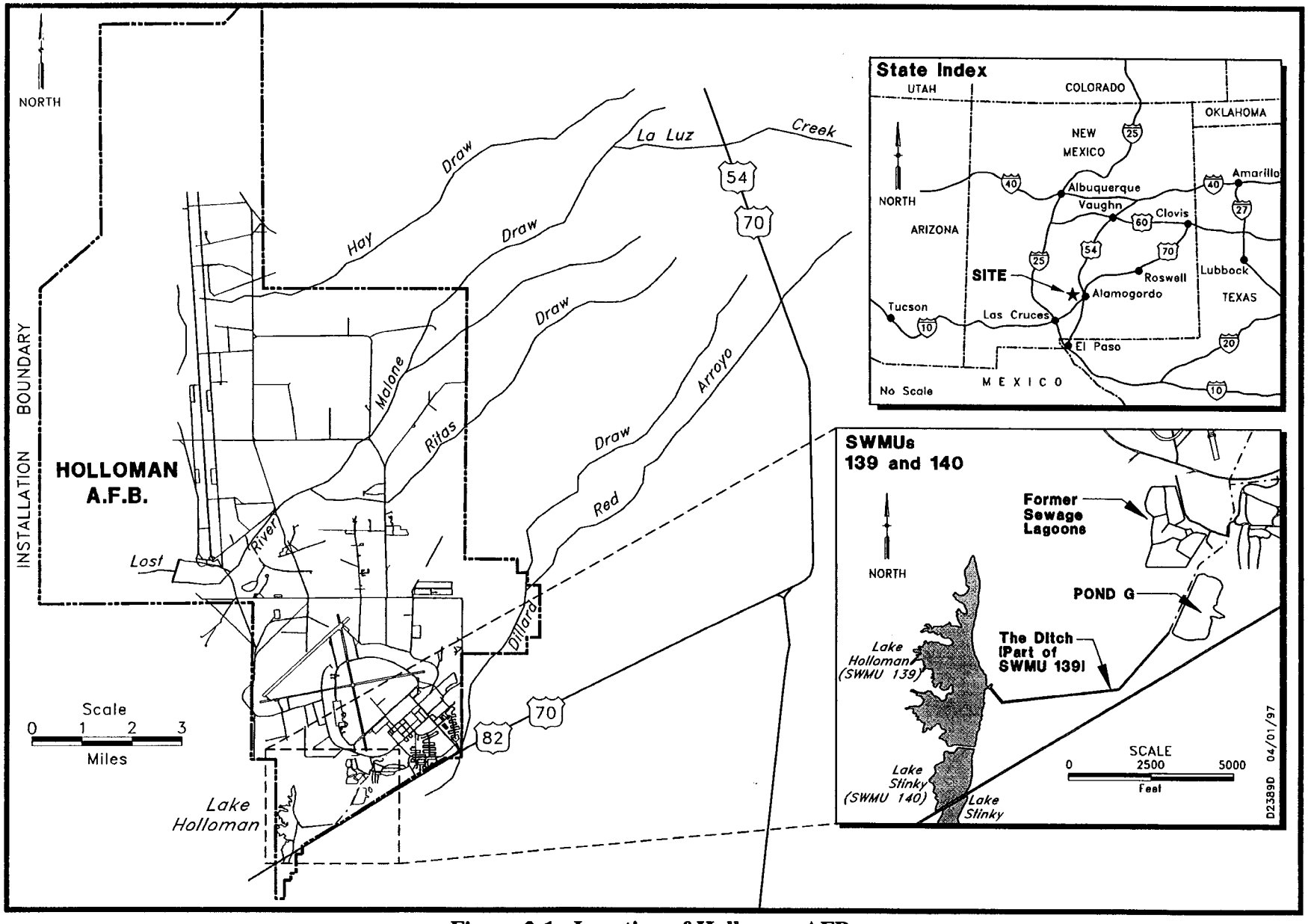

Figure 2-1. Location of Holloman AFB

2.3 Physical Description of SWMUs 139 and 140

As illustrated in Figure 2-2, SWMUs 139 and 140 are located in the southwestern corner of the Base. Until July 1996, the former wastewater treatment plant (WWTP) treated approximately 1.4 million gal. of residential and industrial wastewater per day, and it discharged the treated water into seven aeration/evaporation lagoons. The discharge from the last sewage lagoon (Pond G) flowed via an open ditch to Lake Holloman.

The sewage lagoons were taken out of service in July 1996, and Ponds A through F are being closed. Pond G will remain open and will periodically receive water from the new WWTP to preserve the wildlife habitat. This is required as a condition for a finding of no significant impact (FONSI) in the environmental assessment for the new wastewater treatment plant.

2.3.1 SWMU 139—Lake Holloman and the Ditch

Lake Holloman is an impoundment of a natural playa that was formed by constructing a nonengineered dam to collect wastewater effluent. It also collects a significant amount of surface water drainage from the Main Base, runoff from the surrounding water shed, and some groundwater discharge. It has a capacity of 379 million gal. The original dam was constructed in 1964 and upgraded to the present size in 1968. The 166-acre lake was intended to be the final impoundment for evaporation; however, because of seasonal low evaporation and increased wastewater generation from Base activities, water from Lake Holloman occasionally overflows into Lake Stinky (SWMU 140). The water level is controlled primarily by evaporation, groundwater infiltration, and overflow into Lake Stinky.

The earthen ditch passes along the west side of Pond G, and ultimately extends to Lake Holloman. Discharge from Pond G flows into the ditch at a point near the southwest corner of Pond G. The portion of the ditch between the Pond G discharge and Lake Holloman is included as part of SWMU 139. Upstream of SWMU 139, the ditch receives surface water drainage from the Base.

2.3.2 SWMU 140—Lake Stinky

Lake Stinky is a natural playa lake that periodically contains water during the winter. It receives water from Lake Holloman by persistent seepage through the earthen dam that separates the two lakes and, periodically, by overflow through the spillway of the dam. Lake Stinky has a capacity of about 227 million gal. However, any surface water in Lake Stinky eventually dissipates through evaporation and infiltration.

2.4 Physiography

Holloman AFB is located in the Tularosa Basin. The basin is approximately 120 miles long and 35 miles wide, extending from the southern end of Chupadera Mesa almost to the Texas Border. In the vicinity of the Base, the Tularosa Basin is bound 8 miles to the east by the Sacramento Mountains and 20 miles to the west by the San Andres Mountains.

Elevations within the Tularosa Basin range from 4400 ft above mean sea level (ft-msl) at the northeast corner to 3900 ft-msl in the southwest corner, sloping downward to the southwest. Elevations at the Base range from approximately 4000 to 4200 ft-msl, excluding Tularosa Peak. Elevations in the Sacramento Mountains reach 12,000 ft-msl and range from 7000 to 9000 ft-msl within the San Andres Mountains.

2.5 Geology

The soils in the area are either Holloman-Gypsum Land-Yesum, Complex, or Mead silty clay loam soil. The Mead silty clay loam is found in low-lying areas, is less permeable, and some-

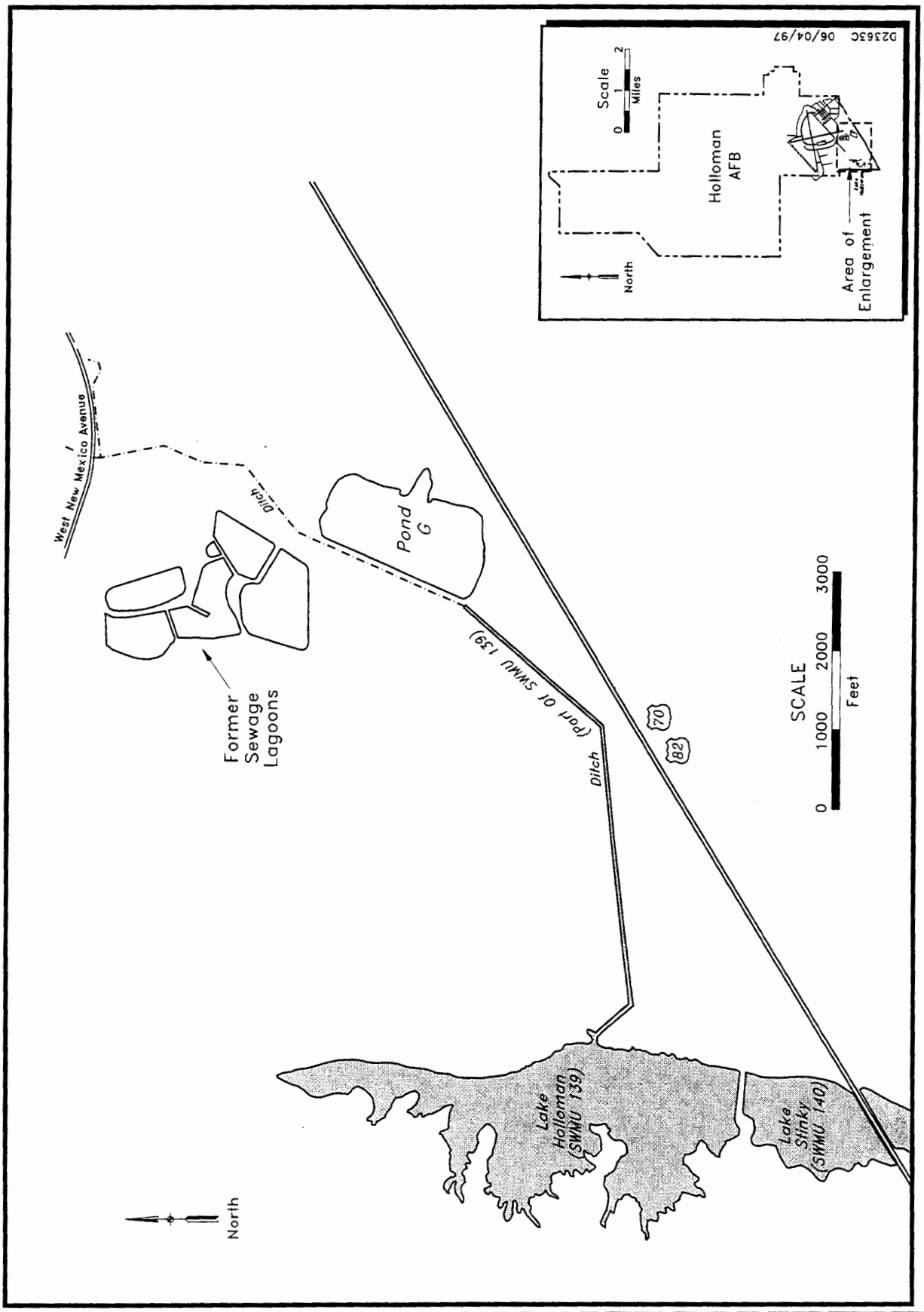

Figure 2-2. Location of SWMUs 139 and 140

times is associated with wetlands as described in *Soil Survey of Otero County, New Mexico* (USDA Soil Conservation Service, 1981).

Figures 2-3 and 2-4 illustrate and describe, respectively, the general stratigraphy of the area where SWMUs 139 and 140 are located. The sediments consist of sand, silt, and clay, and are subdivided into six very broadly definable units that appear to be continuous across the site (Figure 2-4). This interpretation is supported by available data; however, irregularities exist on a smaller scale because of the discontinuous nature of alluvial and lacustrine deposits.

2.6 Hydrology

2.6.1 Surface Water

Holloman AFB is located in the Tularosa Basin, which is a closed basin with no surface water drainage. The little surface water that is present within the basin is lost either to evaporation or infiltration. Lake Lucero, which is approximately 20 miles southwest of the Base, is the lowest point in the basin. It has no direct surface water connection with the east side of the Tularosa basin, which includes the Base.

As shown in Figure 2-1, the Base is crossed by several southwest-trending "arroyos," or intermittent stream beds, including Lost River (the largest), Dillard Draw, Malone Draw, Ritas Draw, and Hay Draw. Most of the arroyos terminate in the gypsum dune fields located in the western portion of the Base. Exceptions are the Lost River and Dillard Draw. The Lost River continues into the larger dunes of White Sands National Monument before it terminates. The river is fed by groundwater seeps and springs resulting from the LaLuz Creek/Fresnal Canyon Watershed. It appears and disappears along its course as groundwater adds to and evapotranspiration and infiltration recapture the river's volume. Within the Base's boundaries, there is a very low volume of water in the Lost River. Dillard Draw terminates in a series of small lakes that originally included the Lake Holloman/Lake Stinky playa. The presence of the Base and U.S. Highway 70 has modified these patterns.

Most drainage from the Main Base (developed portion) runs off through a drainage ditch that begins near West New Mexico Avenue and passes to the west of Pond G. Other Base drainage flows to Dillard Draw and to undrained depressions, some of which are jurisdictional wetlands (see Figure 2-5). As part of a new wastewater treatment system, the Base is constructing 120 acres of new wetlands west of Pond G, as shown in Figure 2-5. The Base has already begun installing water control structures and dikes for the wetlands. Part of the ditch has been incorporated into the constructed wetlands. The portion of the ditch west of Pond G, which previously diverted water out of jurisdictional wetlands, has been blocked off, whereas the portion of the ditch that enters Lake Holloman will carry water from the constructed wetlands to Lake Holloman. The Base has submitted a discharge plan for the constructed wetlands to the New Mexico Groundwater Protection and Remediation Bureau. The plan, which is applicable to the parts of the wetlands that are not "waters of the United States," is currently being processed.

Lake Holloman is a playa lake and is considered "waters of the United States" as defined in 40 CFR 122.2. Holloman AFB submitted a NPDES permit application in 1991, and a revised NPDES permit application in 1995 to reflect the realignment of the Base in 1992 and the final design and construction of the new wastewater treatment plant, which began operating in July 1996.

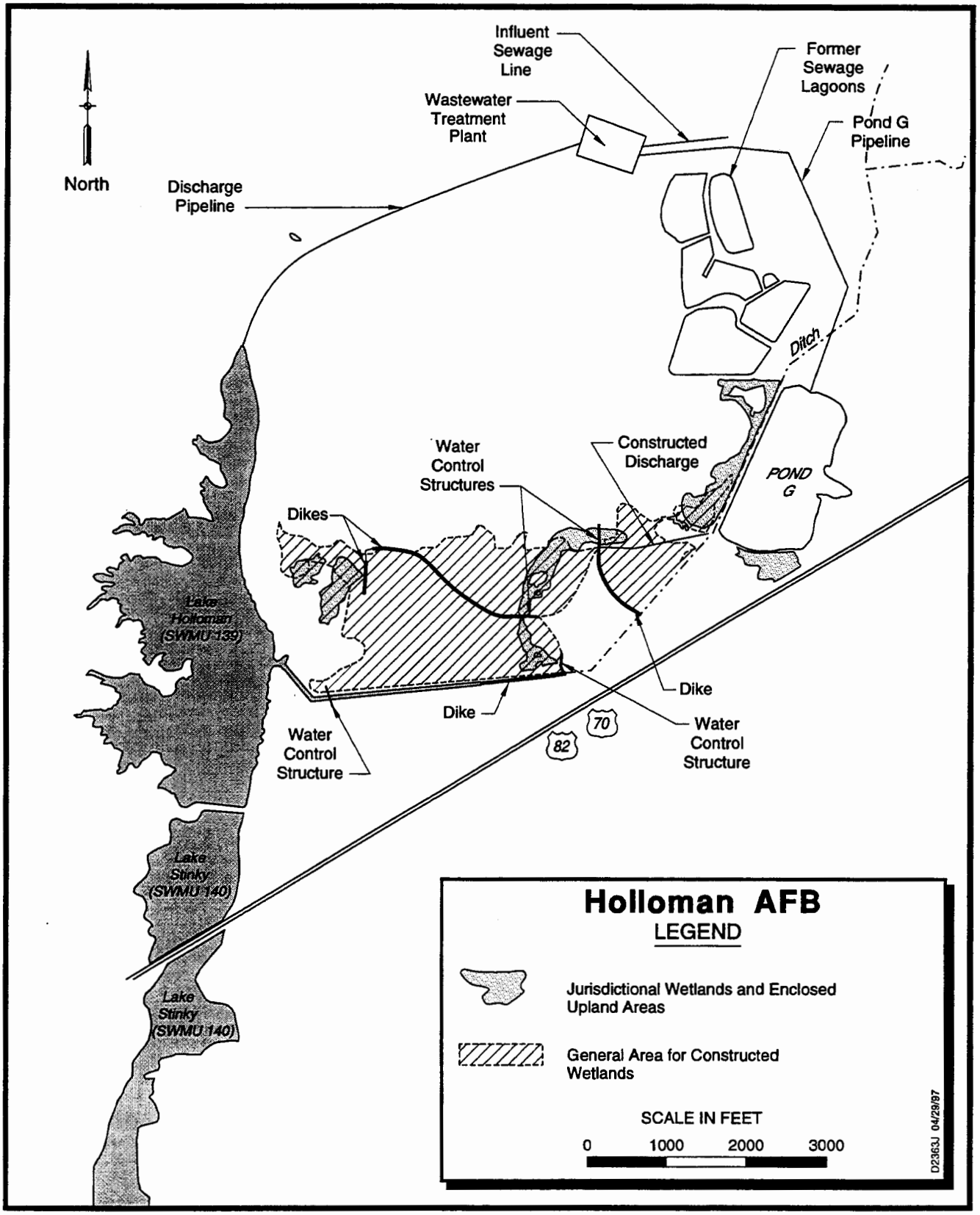

Figure 2-5. Location of Jurisdictional and Constructed Wetlands Near SWMUs 139 and 140

A study conducted in 1996 by the U.S. Army Corps of Engineers (USACE) identified 867.88 acres and 36,890 linear ft of jurisdictional waters on Holloman AFB. A large portion of the jurisdictional waters (approximately 300 acres) are in the area of Lake Holloman, Lake Stinky, and Pond G. The study noted that Lake Holloman, Lake Stinky, and Pond G, as well as the nearby wetlands, are important habitat to shorebirds, wading birds, and waterfowl (USACE, 1996).

It should be noted that jurisdictional waters of the United States are regulated under the Clean Water Act Sections 401 and 404, Executive Order 11988 (Floodplain Management), Executive Order 11990 (Protection of Wetlands), and by the NMED Surface Water Quality Board (USACE, 1996). Any remedial actions in waters of the United States or wetlands would require a Section 404 permit from the USACE under the Clean Water Act, an environmental assessment (EA) under the National Environmental Policy Act (NEPA), a Section 7 consultation under the Endangered Species Act, and a finding of no practicable alternative (FONPA) under Executive Order 11990 signed by the Secretary of the Air Force.

2.6.2 Groundwater

Groundwater occurs under unconfined conditions in the unconsolidated bolson deposits beneath Holloman AFB. The primary source of recharge for groundwater in the bolson aquifer is percolation of rainfall and stream runoff through the coarse, unconsolidated alluvial fan deposits located near the base of the mountains upgradient of Holloman AFB. Groundwater discharge occurs through evapotranspiration, springs or seeps along steep-sided arroyos, or into closed playa lakes such as Lake Lucero, the regional groundwater discharge area.

Regional groundwater flows toward Lake Lucero. Local groundwater flow is seasonally variable and is affected by the relationship between the water table elevation and the elevation of the bottom of the local arroyo channels. In the southeastern portion of the Base, regional groundwater flows to the southwest, following the Dillard Draw surficial drainage system. In the northern portion of the Base, groundwater flows to the west, following the Ritas Draw, Malone Draw, and Lost River drainages.

The groundwater elevation at the sewage lagoons, Lake Holloman (SWMU 139), and Lake Stinky (SWMU 140) was surveyed in March, April, and August 1993 to determine seasonal variation associated with precipitation and evaporation rates at Holloman AFB (Radian, 1993b). As part of that survey, surface water elevations were measured in Ponds A, D, and G and in Lakes Holloman (SWMU 139) and Stinky (SWMU 140) to provide data necessary to characterize local relationships between surface water and groundwater. Additional water level measurements were taken in August 1996, and a groundwater contour map that shows the groundwater elevations as of that time is presented in Figure 2-6.

Near the former wastewater treatment facility, the depth to groundwater ranges from approximately 2 ft below ground level (bgl) near the lagoons and the ditch to approximately 20 ft bgl near Lake Holloman (SWMU 139) and Lake Stinky (SWMU 140). Under an average hydraulic gradient of 0.003, the groundwater flows consistently from northeast to southwest. However, surface water in the unlined lakes causes groundwater mounding. Immediately to the east of Lakes Holloman and Stinky, groundwater flows toward the southeast if the elevation of Lake Holloman surface water higher than the water table, which occurs most of the time. Note that the groundwater contours and

[This page intentionally left blank.]

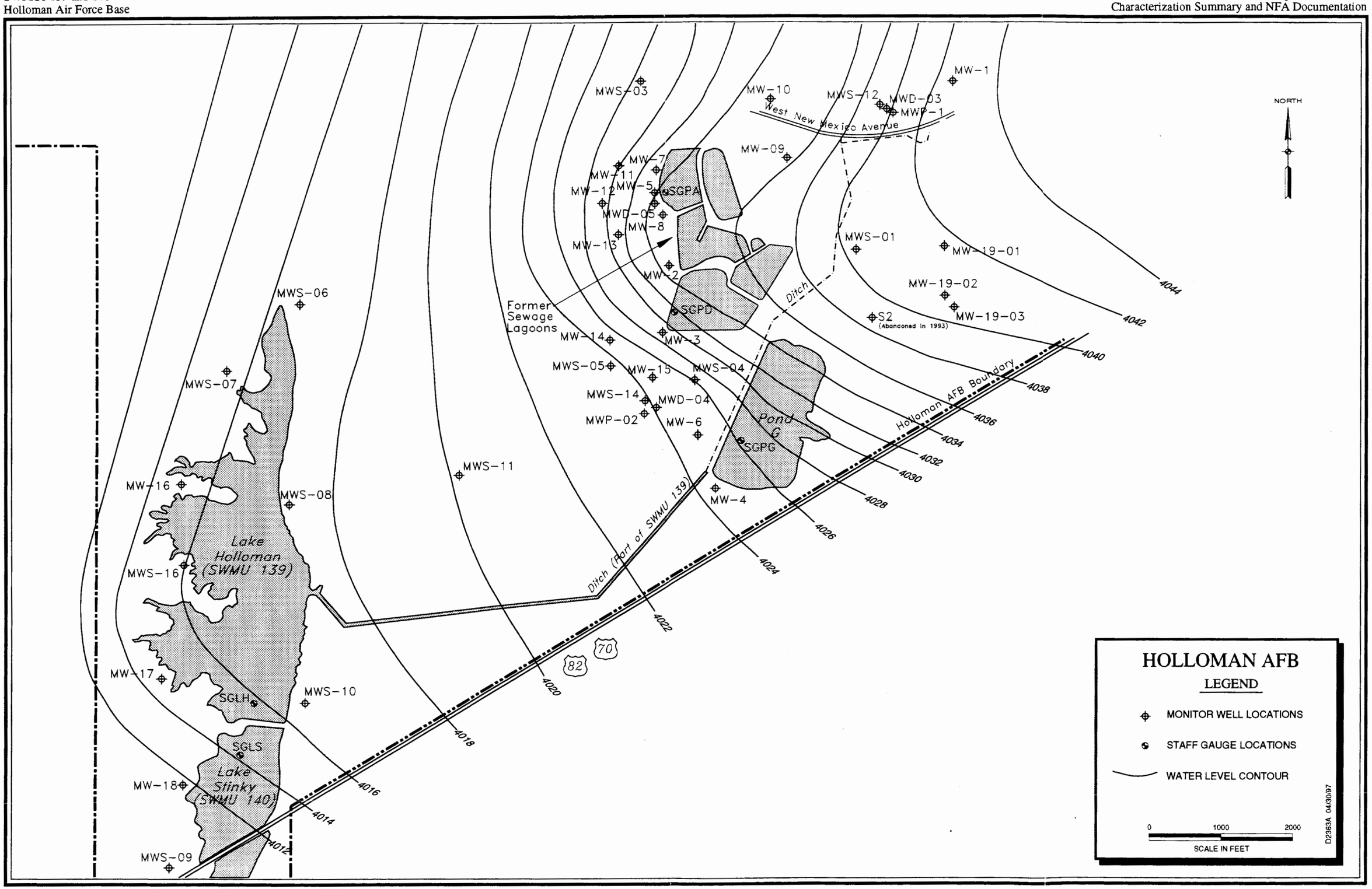

Figure 2-6. Potentiometric Groundwater Surface Map (August 1996) for the Former Sewage Lagoons and SWMUs 139 and 140

flow direction will change after the former sewage lagoons are closed and the water control structures and dikes are installed for the constructed wetlands.

2.7 Groundwater Quality

Groundwater directly upgradient of the Base (approximately 10 miles) at the recharge zone at the foot of LaLuz canyon is slightly saline, with total dissolved solids (TDS) concentrations ranging from 1000 to 3000 mg/L. However, groundwater becomes progressively more mineralized as it flows downgradient toward the interior of the basin. This decrease in water quality can be attributed to slow groundwater migration from recharge to discharge areas and the presence of readily soluble minerals in the bolson sediments. TDS concentrations exceed 100,000 mg/L in groundwater in some portions of the Tularosa Basin (USGS, 1985).

The groundwater beneath Holloman AFB is designated as unfit for human consumption based on New Mexico Water Quality Control Commission Regulations (NM WQCC 82-1, as amended through August 18, 1991 Parts 3-100 through 3-103), because it exceeds New Mexico Human Health Standards (HHSs) for TDS and sulfate. Average values of other groundwater quality parameters measured at Holloman AFB (chloride, fluoride, and nitrate-nitrite) also exceed HHSs and, except for fluoride, also exceed federal primary and secondary drinking water maximum contaminant levels (MCLs; SMCLs). Water quality parameters reflect the fact that the groundwater in this area is not potable under natural conditions.

The EPA's 1986 *Guidelines for Groundwater Classification Under the EPA Groundwater Protection Strategy* classify the groundwater beneath Holloman AFB as a Class III B aquifer. Class III groundwater, characterized by having a TDS concentration greater than 10,000 mg/L, is not considered a source or a potential source of drinking water. Class III B groundwater is characterized by a low degree of interconnection to adjacent surface waters or groundwater of a higher class. The average measured TDS value of groundwater at Holloman AFB is greater than 10,000 mg/L (Radian, 1992). Because the Tularosa Basin is a closed basin, its groundwater does not discharge or connect to any adjacent aquifers. Adjacent surface waters include groundwater surfacing in Malone Draw and Lakes Holloman and Stinky. The TDS concentration in Lake Holloman ranges from a winter low of 12,400 mg/L to a summer high of 17,000 mg/L (Cole et al., 1981); therefore, groundwater at Holloman AFB is not interconnected with surface water of a higher class. In a 1993 investigation, TDS concentrations were found to range from 11,000 to 12,000 mg/L in Lake Holloman and were 14,000 mg/L in Lake Stinky (Radian, 1993b).

Section 3
INVESTIGATION RESULTS

Between 1990 and 1994, several investigations were conducted in and around SWMUs 139 and 140 that provide insight into the nature and extent of constituents at the SWMUs. These investigations have analyzed the soil, sludge, surface water, and groundwater, and have been used to evaluate the human health and ecological risks associated with the SWMUs. Section 3 summarizes the results of these investigations and provides the basis for the NFA determination for SWMUs 139 and 140. Figures 3-1 and 3-2 show the sampling locations at these SWMUs. Appendix A of this report contains a summary of the median and maximum concentrations of constituents detected in soil, sludge, surface water, and groundwater samples collected from SWMUs 139 and 140 between 1990 and 1994.

3.1 Summary of Previous Investigations

Table 3-1 provides a chronological summary of the investigative activities for SWMUs 139 and 140. Where applicable, emphasis is placed on 1) the objective of the investigation, 2) the results and conclusions, and 3) any recommendations stemming from the sampling event. In particular, the significance of each sampling event is presented with regard to the constituents detected and how the findings contribute to the NFA determination for the SWMUs. Additional information may be obtained from the documents cited in the table. Other reports that pertain to SWMUs 139 and 140 are listed in Table B-1 in Appendix B of this report.

3.2 Summary of Results and Current Conditions

The subsections below summarize the investigation results for each medium at SWMUs 139 and 140. The discussions focus primarily on the most recent results in order to clearly describe the current conditions at the SWMUs.

3.2.1 Sludge

Sludge is present only in Lake Holloman (SWMU 139). The results of the 1994 investigation showed that the concentrations of metal constituents in the sludge in SWMU 139 were below 350 mg/kg (equivalent to 350 parts per million, or ppm). The metal constituents with the highest detections were barium (348 mg/kg), vanadium (135 mg/kg), and zinc (118 mg/kg). As a point of comparison, the concentrations of all metal constituents were below the concentrations for land applied sludge listed in 40 CFR 503.13.

Chlordane and 4,4'-DDD were detected at concentrations above their reporting limits in a sample (16-LH) from the area where the ditch discharges into Lake Holloman. However, the maximum concentrations of these constituents were below 0.4 mg/kg. Also the concentrations of 4,4'-DDD decreased by about a factor of two from 1992 to 1994. None of the sludge samples collected from Lake Holloman in 1994 contained concentrations of 4,4'-DDE or 4,4'-DDT above the respective reporting limits.

3.2.2 Soil

For SWMU 139, no metal constituents in 1994 soil samples collected from beneath Lake Holloman exceeded the background upper tolerance limits (UTLs). Several metal constituents in soil samples from the ditch exceeded the background UTLs. Also, several metal constituents in soil samples collected from SWMU 140 slightly exceeded the background UTLs. However, none of the metal constituents in any area pose unacceptable risk.

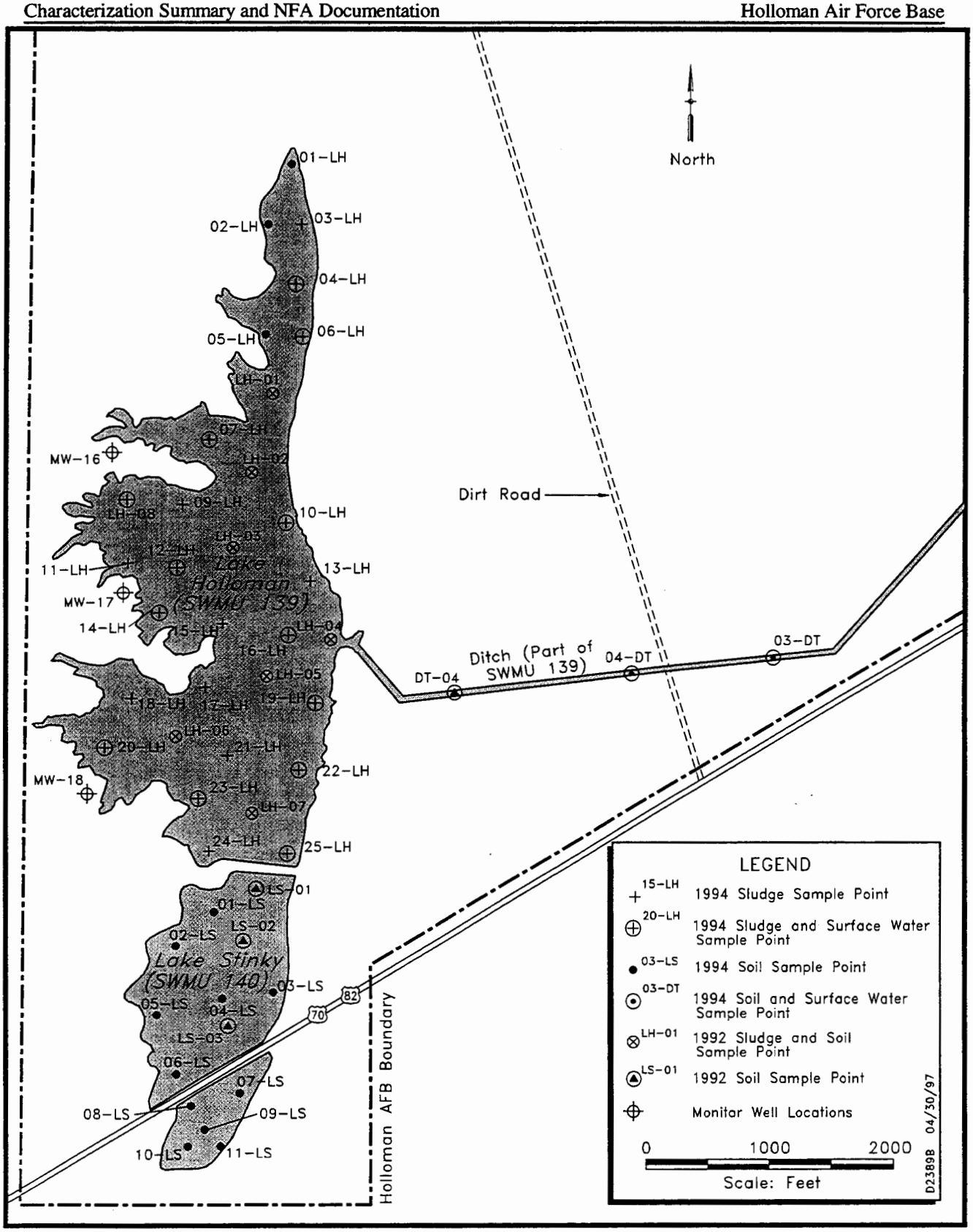

Figure 3-1. Sampling Locations at Lake Holloman and the Ditch (SWMU 139) and Lake Stinky (SWMU 140)

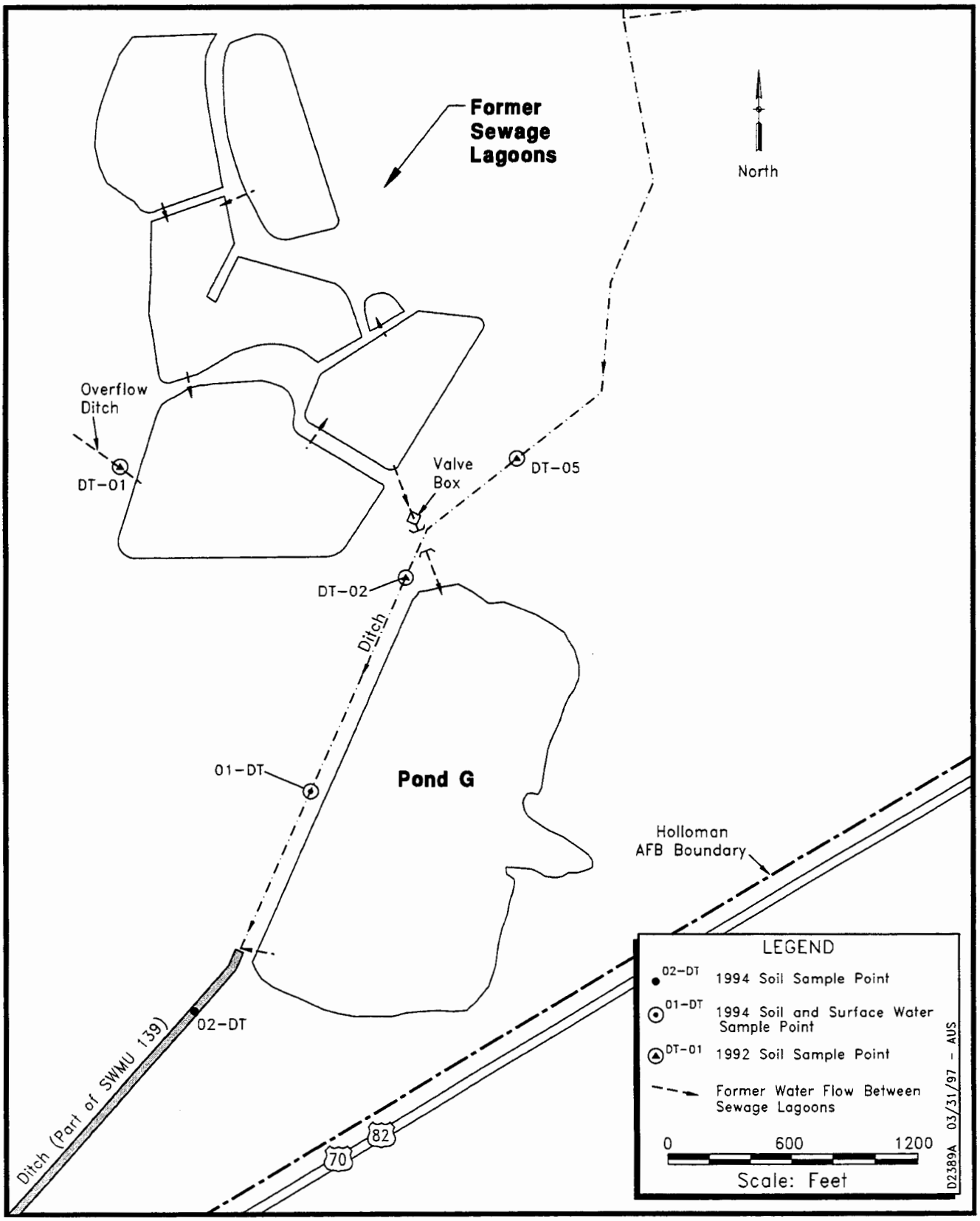

Figure 3-2. Sampling Locations at the Ditch (part of SWMU 139)

Table 3-1
Summary of Primary Investigations and Historical Reports For SWMU 139 (Lake Holloman and the Ditch) and SWMU 140 (Lake Stinky)

REPORT TITLE	SCOPE AND OBJECTIVES	RESULTS
Site Characterization Report, Sewage Lagoons and Lakes Investigation (Radian, 1992)	• Conducted Phase 1 RCRA Facility Investigation (RFI) for SWMUs 139 and 140 in February and March 1992. • Defined the nature of the constituents in the SWMUs. • Collected and analyzed sludge and soil samples for Appendix IX constituents.	The results of the Phase 1 RFI indicated that the only significant constituents in the sludge and/or soil in SWMUs 139 and 140 were organochlorine pesticide and metal constituents at low concentrations.
Draft Final Phase 2 - RCRA Facility Investigation Report for Lakes Holloman and Stinky, Sewage Lagoons and Lakes Investigation (Radian, 1993c)	• Conducted a Phase 2 RFI to determine whether the uppermost groundwater aquifer hydraulically downgradient of SWMUs 139 and 140 had been affected by the low levels of constituents detected in the soil and sludge at those SWMUs in the Phase 1 RFI. • Analyzed the groundwater for Appendix IX constituents.	The only significant constituents detected in the groundwater were organochlorine pesticides at very low concentrations. No metal constituents were determined to have affected the groundwater. It was concluded that additional monitor wells were not required at these SWMUs.
Holloman Risk Assessments, Sewage Lagoons and Lakes Investigation (Radian, 1993d)	• Conducted separate risk assessments for each of the former sewage lagoons and SWMUs 139 and 140. • Evaluated current and potential future effects on human health and the environment.	The report initially indicated some human health risk for SWMUs 139 and 140. However, the 1994 investigation demonstrated that the tentatively identified constituents that drove risk are not actually present at the SWMUs. Also, the metal constituents that caused potential risk are at concentrations below the background levels.
Draft Preliminary Survey of Contaminants Present in Biota, Pore-Water, and Sediments at the Holloman Air Force Base Waste Water Treatment Facility (USFWS, 1994)	• USFWS collected sediment, surface water, and biological samples from the sewage lagoons and SWMU 139 in 1991. • Objective was to determine whether migratory birds were being exposed to any organic or inorganic constituents. • Analyzed the samples for heavy metals and metalloids, organochlorine pesticide and PCBs, polycyclic aromatic hydrocarbons, aliphatic hydrocarbons, and certain dioxin and furan compounds.	The results of the tissue sample analyses indicated low concentrations of constituents. Although the sediment samples indicated some potential for adverse biological effects, no evaluation was performed to determine the bioavailability of the constituents. The report was never finalized.

Table 3-1
(Continued)

REPORT TITLE	SCOPE AND OBJECTIVES	RESULTS
Technical Memorandum, 1994 Site Investigation, Lake Holloman, Lake Stinky, and the Ditch (Radian and Foster Wheeler, 1995c)	• Defined the nature and extent of constituents in SWMUs 139 and 140. • Collected sludge and soil samples from Lake Holloman. • Collected soil samples from Lake Stinky and the ditch (no sludge was present). • Analyzed all samples for organochlorine pesticides and metals.	Low levels of organochlorine pesticide and metal constituents were detected in the sludge in Lake Holloman and the soil in the ditch. The concentrations of DDD in these media decreased by about a factor of two between 1992 and 1994. No pesticides exceeded their reporting limits in the soil in Lakes Holloman or Stinky, and no metals exceeded their background UTLs in the soil from Lake Holloman.
Risk Assessment Addendum, Sewage Lagoons Closure Project (Radian and Foster Wheeler, 1996b)	• The objective was to update the risk values for human health using the data collected during 1994 investigation. • Conducted a new ecological risk assessment using biological tissue samples collected in 1993.	The report indicated no unacceptable human health risks for SWMUs 139 and 140. No unacceptable risks to native species were indicated in the ecological risk assessment.
Biological Resources Report, Sewage Lagoons Closure Project (Radian and Foster Wheeler, 1996a)	• Describes the effects of potential closure alternatives on the ecosystem provided by the former sewage lagoons and SWMUs 139 and 140. • Describes 21 animal and two plant species that are either threatened, endangered, or sensitive and could be present in the area.	The report concluded that Pond G and SWMUs 139 and 140 are ecologically valuable areas that should remain open. It also indicated that wetlands should be constructed to replace the six former sewage lagoons that will be closed.

The 1994 results indicate that no pesticide constituents are present at concentrations above their reporting limits in either Lake Holloman (SWMU 139) or Lake Stinky (SWMU 140). For the ditch, the maximum concentrations of 4,4'-DDD (0.14 mg/kg) and chlordane (0.15 mg/kg) exceeded the reporting limits. However, the maximum detection of 4,4'-DDD decreased by about a factor of three from 1992 to 1994. It is likely that the constituent was carried to the ditch in storm water runoff from the Base and did not originate from the former sewage lagoons or the former wastewater treatment system. The 1994 investigation showed that 4,4'-DDE and 4,4'-DDT are not present in the ditch at concentrations above their respective reporting limits.

3.2.3 Surface Water

The results of the 1990 surface water sampling at SWMUs 139 and 140 indicated that low concentrations of metal constituents (other than the naturally occurring elements calcium, magnesium, and sodium) were present in the surface water. The TDS concentration in the surface water in SWMUs 139 and 140 was found to be greater than 10,000 mg/L (the maximum concentration was 14,000 mg/L). Only one organic constituent (methoxychlor) was detected at a concentration above its reporting limit in the 1990 sampling event.

3.2.4 Groundwater

Very low concentrations of organochlorine pesticides were detected in the groundwater in the SWMUs 139 and 140 area during the 1993 Phase 2 RCRA facility investigation (RFI). No metal constituents were determined to have affected the groundwater. Because the Phase 2 RFI clearly defined the nature of the constituents in the groundwater, it was concluded that additional monitor wells were not required. It has also been determined that continued groundwater monitoring is not necessary for these SWMUs.

3.3 Summary of Risk Assessment Results

The 1996 risk assessment addendum (Radian and Foster Wheeler, 1996b) updated the human health evaluation of the 1993 risk assessment and completely reassessed the ecological risks. Therefore, this section presents the risk assessment findings for SWMUs 139 and 140 as evaluated in the 1996 addendum.

3.3.1 Human Health Risks

The exposure pathways evaluated for SWMUs 139 and 140 include 1) current/future recreational hunters at SWMUs 139 and 140, and 2) future beef consumer at SWMU 140. All of the human health risks calculated for SWMUs 139 and 140 were below or within the acceptable risk range of 10^{-4} to 10^{-6} specified in the National Contingency Plan and the preamble to RCRA Subpart S.

3.3.2 Ecological Risks

The potential for adverse ecological effects was evaluated using a combination of actual biological tissue sample data collected from SWMUs 139 and 140 and basic uptake modeling from lower trophic levels to higher trophic levels. Adverse effects were defined as attributes that may threaten the survivorship and productivity of the aquatic food chain.

Tissue samples were collected from one duck flying over Pond G and four black-necked stilts collected from near Pond C. Concentrations of 4,4'-DDE in the body-burden analyses indicated a potential adverse effect to mallards, and black-necked stilts. A literature search indicated that "waterfowl carcass concentrations similar to those reported for Holloman AFB would not be expected to be related to, nor cause, concentrations in eggs that could be considered detrimental to reproductive success." (Foster Wheeler, 1996).

The risk resulting from modeling constituents through the food chain was acceptable (i.e.,

the ecological quotient was less than 1.0) in the indicator species (mallards, killdeer, and mergansers). For SWMU 139, no adverse effects were indicated for Lake Holloman. Body-burden analyses of tissues from non-native mosquito fish collected from the ditch indicated a potential for adverse effects owing to the presence of 4,4'-DDD, 4,4'-DDE, and 4,4'-DDT in the tissue. Note that mosquito fish, which are not a native species, were introduced into Pond G and the ditches to control mosquito populations. This species was evaluated because it is a food source for mergansers, which are native species. The uptake modeling indicated the constituent concentrations in the mosquito fish tissues caused no risks to the mergansers. Fish were not evaluated at Lake Stinky (SWMU 140) because there typically is not enough water to support them.

Note that DDT, which was formerly used for mosquito control, is no longer used at the Base. Also, none of the sludge or soil samples collected in 1994 at SWMUs 139 and 140 contained concentrations of DDT or DDE above the reporting limits. Furthermore, the maximum concentration of DDD in the ditch decreased by a factor of three from 1992 to 1994. Therefore, even though the ecological risk assessment indicated there may be some potential risk from these constituents in the ditch, the concentrations of the constituents appear to have already decreased to a level that does not threaten the survivorship or productivity of aquatic food chains.

On the basis of the risk assessment results, there is no need to remediate SWMUs 139 or 140. The only constituents causing potential ecological risk were DDE and DDT, which are no longer present at SWMUs 139 and 140 in concentrations above the reporting limit, and DDD, which is naturally attenuating.

Section 4
EVALUATION OF EFFECTS ON BIOLOGICAL RESOURCES

SWMU 139 (Lake Holloman and the ditch), SWMU 140 (Lake Stinky), Pond G, and the nearby jurisdictional and constructed wetlands comprise a unique ecosystem in south central New Mexico. These systems are supported primarily by treated wastewater effluent and base storm water runoff. In addition, the dynamics of the system are driven by the climatic conditions of rain and drought.

A variety of animal species, including threatened, endangered, and sensitive species, have become dependent on this ecosystem, including SWMUs 139 and 140, for habitat and food. In particular, water birds are dependent on this system. The presence of this large expanse of water in a desert location attracts migrating birds and other animals. The low water levels tend to provide shoreline to species using the lakes. Lakes Holloman and Stinky are, therefore, recognized by federal and state agencies as a high visibility natural area and a valuable bird viewing area. Since this system has become an important habitat area for a variety of bird species, the USFWS has developed a management plan in cooperation with the Mesilla Audubon Society for the constructed wetlands and lakes. The plan will be monitored by the New Mexico Natural Heritage Program by performing monthly or quarterly observations. These observations include collecting invertebrates for population studies and performing bird counts. The plan will be adapted as data is obtained and evaluated.

A *Biological Resources Report* (Radian and Foster Wheeler, 1996a) was prepared previously for the sewage lagoons and lakes, and provides the descriptions of threatened and endangered species that have either been sighted or may be attracted to the SWMUs 139 and 140 area. Please refer to that report for specific information about these species.

Section 4 describes the habitats in and around SWMUs 139 and 140 and identifies these threatened and endangered and some sensitive species that may be attracted to these habitats. It also provides assessments concerning the effects of constituents detected in SWMUs 139 and 140 to these identified species.

4.1 Habitats

The USAF (1995) identified five site-specific habitat types in and around SWMUs 139 and 140 at Holloman AFB: 1) upland grassland, 2) brackish marshes/wetlands, 3) playas, 4) riparian habitat, and 5) surface water habitat. The descriptions for each of these habitat types are described in this subsection. The SWMUs physically include all these habitats except the upland grasslands. As many as 72% of the bird species that occur in New Mexico have been observed within or near the SWMUs 139 and 140 area (Hubbard, 1970).

4.1.1 Upland Grassland

Well-drained upland areas are dominated by upland (or gypsum) grassland. Alkali sacaton (*Sporobolus airoides*) is the dominant grass in the gypsum grassland community. Fluffgrass (*Erioneuron pulchellum*) and neally dropseed (*Sporobolus nealleyi*) are common associate grasses. Shrubs include four-wing saltbush (*Aatriplex canescens*), creosote bush, and tarbush (*Flourensia cernua*). Cacti and yuccas are widely scattered throughout the gypsum grassland community. Common cacti include walkingstick cholla (*Opuntia imbricata*) and plains prickly pear (*Opuntia phaeacantha*). Soaptree yucca (*Yucca elata*) is also present. Vegetation is sparse, espe-

cially in the very highly saline soils near SWMUs 139 and 140.

Common species observed during surveys of this area include turkey vulture (*Cathartes aura*), American kestrel (*Falco sparverius*), red-tailed hawk (*Buteo jamaicensis*), northern harrier (*Circus cyaneus*), mourning dove (*Zenaida macroura*), greater roadrunner (*Geococcyx californianus*), cactus wren (*Campylorrhynchus brunneicapillus*), black-throated sparrow (*Amphispiza bilineata*), western meadowlark (*Sturnella neglecta*), and Scott's oriole (*Icterus parisorum*).

4.1.2 Brackish Marshes

Brackish marshes/wetlands, consisting of both jurisdictional and constructed wetlands, exist in a number of locations near SWMUs 139 and 140 (Figure 2-5). Water levels in these areas fluctuate seasonally with changes in rainfall, evaporation, and inflow of treated wastewater. The lower portion of the marsh tends to be dominated by desert saltgrass (*Distichlis spicata var. stricta*), with a few scattered Chinese tamarisk (*Tamarix chinensis*) and patches of alkali sacaton in the drier, higher areas.

Just east of Lake Holloman, more limited wetland areas are found at points along the ditch, as well as in an abandoned borrow pit north of Lake Holloman, and along the boundaries of Lake Holloman and Lake Stinky. Many of these areas are not perennially inundated. Chinese tamarisk is dominant in these areas.

4.1.3 Playas

The area south of Lake Holloman includes Lake Stinky (SWMU 140), which is an extensive playa. Playas are depressional areas in the central portions of closed drainage basins that receive surface water flow from surrounding areas. Fine-grained sediments, mostly silt and clay, with some sand, are deposited in thin horizontal layers after heavy rains. Water infiltration is slow, and shallow standing water may remain for several weeks after heavy rains. Playas may contain a higher diversity of range grasses and shrubs because of the stability of the silt and clay soils. However, playas are subject to additional vegetational losses through soil compaction and salinization.

Lake Holloman was a natural playa lake that was dammed to hold storm water and treated wastewater from Holloman AFB. Lake Stinky represents a remnant of the original playa that existed in the project area prior to the construction of the wastewater treatment system. Persistent seepage from Lake Holloman is sufficient to maintain limited surface water at the north end of Lake Stinky, as well as a community of wetland vegetation (tamarisk and saltgrass) at the base of the dam separating Lake Stinky from Lake Holloman. Desert saltgrass and alkali sacaton are dominant along the edge of the playa. During most years, total annual discharge to Lake Holloman is sufficient to result in overflow to Lake Stinky. On these occasions Lake Stinky extends south from the dam through culverts underneath U.S. Highway 70/82. The majority of the area south of this highway is a playa that is devoid of vegetation.

4.1.4 Riparian Habitat

Riparian areas (e.g., ditches, rivers, arroyos, and stream banks) are dominated by a variety of shrubs and a few low stands of trees. Extensive thickets of tamarisk line the ditches and wet areas. Saltbush and baccharis (*Baccharis pteronioides*) are scattered along the shore around Lake Holloman and Lake Stinky. Riparian drainages carved in the sandy-gravelly soils provide habitat for a greater diversity of plant species than do adjacent upland areas. Consequently, these habitats support a greater diversity of wildlife species throughout the year. The food and cover provided by vegetation along these

long, narrow drainages are important to numerous wildlife species because the drainages cross a variety of different habitats. Wildlife use riparian/arroyo areas as travel lanes (corridors) through their ranges.

Neotropical shorebirds and songbirds use shoreline and riparian habitats at Lakes Holloman and Stinky, and they use the riparian habitat along the ditch during migration and for nesting. On the basis of surveys conducted in June 1994, four neotropical birds use shoreline and riparian habitats in the SWMUs 139 and 140 area for nesting. These birds are the American avocet (*Recurvirostra americana*) along the lake shorelines and green heron (*Butorides caerulea*), western kingbird (*Tyrannus verticalis*), and the blue grosbeak (*Guiraca caerulea*) in the riparian habitat along the ditch. The only neotropical migrants observed were several flycatchers (*Empidona sp.*) and a Wilson's warbler (*Wilsonia canadensis*).

The ditch, which is part of SWMU 139, is unlined with somewhat steep edges and receives discharge from the base storm water sewer system. Water is present in the ditch at all times. In the northern part of the ditch, vegetation is limited to tamarisk and upland grass species. Bulrush (*Scirpus maritimus*) is also abundant along part of the ditch. The banks of the ditch are somewhat eroded in some areas, allowing for discharge of water into adjacent marshlands. In these areas, saltgrass is the dominant species. This part of the stream also has an abundant population of non-native mosquito fish, although they may be there as a result of wash-out from Pond G rather than being a self-sustaining population.

4.1.5 Surface Water Habitat

According to Mr. Gordon Ewing of the Mesilla Valley Audubon Society, three distinct habitats associated with the surface water in and around SWMUs 139 and 140 include 1) saline ponds, 2) salt flats and beaches, and 3) emergent wetlands.

Lake Holloman can be considered a saline pond, as well as nearby Pond G (not under evaluation in this report); ducks and wading birds inhabit these water bodies. The fringes of Lake Holloman and most of Lake Stinky can be considered salt flats/beaches. Shorebirds, including the snowy plover, use these water bodies. The area below Pond G (approximately 60 to 85 acres) can be considered emergent wetlands (irregularly to permanently flooded wetlands, usually dominated by perennial herbaceous hydrophytes). Many birds inhabit this area. Mr. Ewing also pointed out that 40 to 50 species of birds can be seen in the area almost any day of the year.

4.1.5.1 Lake Holloman

Lake Holloman (SWMU 139) is a 166-acre brackish impoundment and is the largest single body of open water in this ecosystem. It receives storm water and treated wastewater effluent from Holloman AFB. The lake has the capacity to hold 379 million gal. of water. The water level is controlled mainly by evaporation, groundwater infiltration, and overflow into Lake Stinky (SWMU 140).

A field sampling study of the biota was performed in 1993 (Radian, 1993d). The results of this study are described as follows. The high nutrient levels of the lake result in an abundance of algae and bacteria, which attracts insect populations. Dragonfly larvae, damselfly larvae, beetles, and corixids were also observed during a site investigation. Mosquito fish (*Gambusia affinis*) were found in areas where grass was overhanging the water. The bottom of the lake (depths from 4 ft to 9 ft) was covered with a layer of bacterial/algal ooze that was devoid of macroscopic life. Benthic organisms began to

appear at a depth of about 3 ft where the ooze began to thin out. A population of chironomids was found in hand-dredged samples taken from 1 to 3 ft of water. In the shallow north end of the lake, dense algal mats covered the bottom and, after towing a skid dredge for about 500 ft, it was filled with algae and contained only 15 chironomid larvae.

Cole et al. (1981) described Lake Holloman as hypereutrophic on the basis of the level of primary productivity. (The improved quality of effluent discharged from the new wastewater treatment plant will eventually result in some productivity loss of the lake.) In this study, zoobenthos, phytoplankton, zooplankton, and fish (mosquito fish) were collected. The most common birds collected were coots, phalaropes, ruddy ducks, northern shovelers, and avocets. Eared grebes, pied-billed grebes, least sandpipers, killdeer, and yellow legs also were observed. The stomach contents of birds feeding mostly at Lake Holloman consisted of benthic macroinvertebrates almost exclusively. Few piscivorous birds were observed routinely using Lake Holloman, with egrets being the most obvious. Dahl (1991) also described Lake Holloman as a highly productive brackish lake that was often turbid from dense growths of phytoplankton. In this study, zooplankton was abundant throughout the lake, whereas zoobenthos was abundant in shallow areas only.

The high productivity of the lake, as well as the insect population, attracts numerous shorebirds and waterfowl to the lake. Mallards (*Anas platyrhynchos*), Northern shovelers (*Anas clypeata*), blue-winged teal (*Anas discors*), lesser scaup (*Aythya affinis*), ring-necked ducks (*Aythyacollaris*), and ruddy ducks (*Oxyura jamaicensis*) were the most common duck species observed (USAF, 1995). Ducks were observed nesting in adjacent grasslands during April 1992 and May 1994 surveys; snowy plovers (*Charadrius alexandrinus nivosus*) and American avocets were observed at Lake Holloman and Lake Stinky during May and June 1994 surveys. A variety of fish-eating species (e.g., black tern, belted kingfisher, green heron) is also present, presumably attracted by the presence of the mosquito fish. The lake is also used by large numbers of migrant Wilson's phalaropes (*Phalaropus tricolor*).

Algal blooms during warm weather result in anoxic conditions. During this time, mosquito fish are unable to survive in the lake. It is assumed that the lake is restocked with mosquito fish by the storm water drainage ditch or Pond G. Because of the steep bank on the east side of Lake Holloman and fluctuating water levels, there is no extensive wetland vegetation. Along the west edge, the lake has a gentle slope that allows for the growth of wetland vegetation, and some pockets of tamarisk and saltgrass have been established.

4.1.5.2 Lake Stinky

Lake Stinky (SWMU 140) is a natural playa lake (a depressional area) that is frequently flooded and just as frequently nearly dry. It receives water from Lake Holloman by persistent seepage through the earthen dam that separates the lakes, or, periodically, by lake overflow through the spillway of the dam. The lake has the capacity to hold 227 million gal. of water. Lake Stinky is split by U.S. Highway 82/70 and forms two ecologically distinct lakes connected by a culvert under the highway.

Observations recorded on March 9, 1993 (Radian, 1993d) show the north portion of Lake Stinky to be 20 to 24 in. deep with a soft, sludgy bottom overlaid with algal/bacterial mats. Widgeon grass was present in sparse clumps; benthic organisms were present at very low populations. The few fish (*Gambusia affinis*) observed in the north part of Lake Stinky were

probably fugitives from Lake Holloman and not a resident population. Only a few (four or five) fish were caught in dip nets along the entire northwest shoreline in prime *Gambusia* habitat.

The southern portion of Lake Stinky has a hard, sandy bottom. On March 3, 1993, the lake had a plankton population much like Lake Holloman's, but somewhat less dense. Widgeon grass was beginning to grow in isolated strands on the bottom, and algal mats were present in places on the bottom. On March 24, 1993, the plankton noted on March 3 were replaced almost entirely by a population of ostracods (seed shrimp), which were distributed throughout the water column, lake bottom, and widgeon grass. Widgeon grass was growing in isolated strands and small clumps, with very little or no algae present. On April 5, 1993, south Lake Stinky was similar in appearance, with widgeon grass much more widespread, moving from the deeper water into shallower areas along the shore. A few bright red copepods with egg sacs were noted in shallow water near the shore.

Lake Stinky is good shorebird habitat, and the fluctuating water level and salt keep vegetation from invading the mud flats of the playa. Snowy plovers, avocets, black-necked stilts, and killdeer nest around Lake Stinky (Ewing, 1993). Lake Stinky is more actively used by snowy plovers for nesting than is Lake Holloman because of the increased shoreline habitat.

4.2 Threatened, Endangered, and Sensitive Species

A list of bird species was compiled based on a year (1994) of monthly field observations by the New Mexico Natural Heritage Program and recorded observations by the Mesilla Valley Audubon Society. In addition, threatened, endangered, or sensitive mammal, fish and plant species that may occur in or near SWMUs 139 and 140 were also selected by the Base biologist, Dr. Hildy Riser, for evaluation. These animal and plant species are believed to represent the threatened, endangered, and sensitive species that may visit SWMUs 139 and 140 or their surrounding areas. Tables 4-1 and 4-2 list these species and the potential effects that may occur from the current conditions at SWMUs 139 and 140. The *Biological Resources Report* (Radian and Foster Wheeler, 1996a) discusses these species in greater detail.

4.3 Discussion

This section discusses the potential effects of the current conditions at SWMUs 139 and 140 on threatened, endangered, and sensitive species. The objective of this section is to assess whether the constituents detected in SWMUs 139 and 140 would adversely affect their populations. Lake Holloman and, to a lesser extent, Lake Stinky, have been discussed in detail in several documents, including a limnology study (Weigmann and Hayes, 1981) and an unpublished thesis (Dahl, 1991). For further discussion of the aquatic characteristics and foraging behavior of migrating birds at Lake Holloman, the reader is referred to these references.

For SWMUs 139 and 140, 21 animal and two plant species were selected to determine whether the current conditions would result in the loss of sensitive habitat for endangered, threatened, and sensitive species. Of the 23 species assessed, only 8 have actually been sighted in or near the SWMUs, and 3 of these occur only as migrants. The remaining 15 species were assessed, since they are either listed or are candidates for listing, or because the area in or around SWMUs 139 and 140 may provide the proper habitat or forage for the species (5 of these 15 occur at other areas on the Base). Tables 4-1 and 4-2 summarized species occurrence and potential effects of the detected constituents.

Table 4-1
Threatened, Endangered, and Sensitive Species of Birds

Species	Occurrence in New Mexico	Occurrence at Holloman AFB/Potential Occurrence at SWMUs 139 and 140	Potential Habitat Use at SWMUs 139 and 140	Potential Effects from Current Conditions	Federal Status[a]	State Status[a]
Aplomado Falcon	One sighting in 1952 near Deming, NM; One sighting in 1994 near Tularosa, NM.	Not observed./Low to moderate potential since forage is present.	Migrant/resident	No adverse effects	Endangered	Endangered
Baird's Sparrow	Occurs as a migrant and possibly as a wintering bird. Most records are from fall migration.	Not observed./Low potential of occurring since this bird may migrate through the area; however, it prefers areas of dense vegetation of medium to tall height.	Migrant/winter resident	No adverse effects	Category 2	Threatened
Bald Eagle	May be present in areas where there is open water and large dead trees for roosting.	Observed./Moderate potential since forage is present.	Winter resident/migrant	No adverse effects	Endangered	Endangered
Burrowing Owl	Breeds from Canada's southern prairie provinces south to southern California and Texas. Winters in southwestern states.	Not observed./Moderate potential of occurring since grassland habitat is present and the owl has been sighted on Base <1 mi. away.	Resident breeder	No adverse effects	Category 2	None
Ferruginous Hawk	Sighted occasionally throughout the year in Otero County.	Observed./Moderate to high potential of occurring as migrants.	Winter resident/migrant	No adverse effects	Category 2	None
Interior Least Tern	Breeds near Bitter Lakes N.W.R. on the Pecos River in NM. It is a rare vagrant at the Holloman lakes.	Not observed./Low to moderate potential of occurring at the lakes during migration since wetland habitat is available.	Migrant	No adverse effects	Endangered	Endangered
Loggerhead Shrike	Population is stable in NM, though declining elsewhere.	Observed./High potential of occurring since habitat and food source are available.	Resident breeder/migrant	No adverse effects	Category 2	None
Neotropic (Olivaceous) Cormorant	Breeds and is a variable resident in southern NM.	Not observed./Low potential of occurring; may occur as a vagrant.	Migrant	No adverse effects	None	Threatened

Table 4-1
(Continued)

Species	Occurrence in New Mexico	Occurrence at Holloman AFB/Potential Occurrence at SWMUs 139 and 140	Potential Habitat Use at SWMUs 139 and 140	Potential Effects from Current Conditions	Federal Status[a]	State Status[a]
Northern Goshawk	Breeds in southern NM.	Observed./Low potential of occurring since suitable nesting habitat is not present at lakes.	Migrant	No adverse effects	Category 2	None
Peregrine Falcon	Migrant and wintering peregrines use low elevation wetland habitats, especially where there are shorebirds and waterfowl.	Observed./High potential of occurring; has been sighted.	Migrant	No adverse effects	Endangered	Endangered
Southwestern Willow Flycatcher	Occurs throughout the Southwest as a migrant and/or nester.	Not observed./Low potential of occurring since potentially suitable habitat (tamarisk thickets) is present.	Resident/migrant	No adverse effects	PE	Threatened
Western Snowy Plover	Breeds in NM, including Holloman AFB.	Observed./High probability of occurring; has been sighted.	Resident breeder/migrant	No adverse effects	Category 2	None
White-Faced Ibis	Isolated breeding colonies occur in NM and it occurs statewide during migration and in wetland habitats. It is a regular migrant in the spring and fall at the lakes.	Observed./High potential of occurring; has been sighted.	Migrant	No adverse effects	Category 2	None
Whooping Crane	Winter in Bosque del Apache National Wildlife Refuge, NM.	Not observed./Low potential of occurring because of close proximity of wintering grounds.	Migrant	No adverse effects	Endangered	Endangered

[a] Federal and state status as of May 1995.

Note: PE=Federally proposed endangered; E=Federally endangered; Category 1=Federal candidate under review; Category 2=Federal candidate under review; however, there is not enough information available to make a decision.

By focusing on endangered, threatened, and sensitive species, the evaluation in this report should be conservative and result in the protection of the ecosystem as a whole. As noted in these tables, no adverse effects are expected to result to these species under the current conditions. In some cases, owing to the addition of constructed wetlands near SWMUs 139 and 140, conditions are expected to improve because of the increase of available wetland and shoreline habitat that will provide food or cover for these species.

For waterfowl migrating through south-central New Mexico, Lake Holloman provides a major permanent body of water that has a high productivity, primarily consisting of zooplankton and phytoplankton (Weigmann and Hayes, 1981). In the diurnal foraging behavior study, it was determined that if northern shovelers feed on both zooplankton and phytoplankton, productivity at Lake Holloman may be sufficient to support these birds. In the same study, it was concluded that ruddy ducks and coots were probably not using Lake Holloman as a primary foraging ground, but that they must go elsewhere for food (it was also reported that variation in surface water area, shoreline development, and percent basin slope had little effect on duck use). Alterations in water levels that decrease shorelines may affect species that forage along the edges of the lakes.

It is in the best interest of the species to maintain the current water levels and water quality. Alterations in lake morphology and in water quality would probably result in a shift in the types of species present in the area. Although this is not clearly an adverse effect, it may result in the loss of certain species such as the snowy plover, which rely on the lower water levels and shoreline habitat at Lake Stinky.

Part of the ditch has been incorporated into the constructed wetlands. The portion of the ditch west of Pond G, which previously diverted water out of jurisdictional wetlands, has been blocked off. The portion of the ditch that enters Lake Holloman will carry water from the constructed wetlands (after completion) to Lake Holloman. The ditch provides riparian habitat surrounded by tamarisk thickets that provide the type of habitat used by southwestern willow flycatchers. Because this riparian habitat is unique to the area, it is important to preserve the southern portion of the ditch. This area may be enhanced with native species, such as cottonwood and willows, if possible, to provide additional habitat for songbirds. Tamarisk will not be planted, since it is not native to the area and has a very high rate of evapotranspiration.

Any actions such as dredging Lake Holloman would result in the removal of plants and animals (invertebrates) living in the sediments, as well as associated nutrients. Plant and invertebrate populations inhabiting Lake Holloman would have to be reestablished, and it is unknown how long it would take for the lake to return to suitable avian habitat. This action is expected to adversely affect the wildlife utilizing this lake for forage or cover.

SWMUs 139 and 140 provide sensitive habitat to some of the bird species and also support associated wetlands. Although the sludge in SWMUs 139 and 140 contains constituents at low levels, as discussed in Section 3.3, a risk assessment has determined that there is no unacceptable risk (Radian and Foster Wheeler, 1996b). Dredging SWMUs 139 and 140 would result in the removal of the low concentrations of constituents in the sludge, however, it would also disturb the plant and animal life in them that support the ecosystem.

Section 5
NO FURTHER ACTION RECOMMENDATION

SWMUs 139 and 140 (and parts of the ditch) are waters of the United States, and as such are important to the natural resources in the area. The results of previous investigations and studies, which have been summarized in the previous sections of this report, indicate that the potential for adverse effects at these SWMUs is minimal. Therefore, NFA is appropriate for SWMUs 139 and 140.

Extensive investigations have determined the nature and extent of the constituents in SWMUs 139 and 140. Analyses of sludge and soil samples for Appendix IX constituents have indicated low levels of organochlorine pesticide and metal constituents. Analyses of groundwater samples for Appendix IX constituents have shown very low levels of organochlorine pesticides.

On the basis of the risk assessment results, there is no need to remediate SWMUs 139 and 140. As discussed in Section 3.3, no unacceptable risks to human health were reported. Also, no unacceptable ecological risks to native species were determined for the SWMUs.

The evaluation of biological resources also showed there is no need to remediate these SWMUs. The evaluation indicated that any actions such as dredging the SWMUs would adversely affect the existing ecosystem because it would destroy the habitat. Dredging would remove the plants and animals (invertebrates) living in the sediment, as well as associated nutrients. Plant and invertebrate populations inhabiting the SWMUs would have to be reestablished, and it is unknown how long it would take for the area to return to suitable avian habitat. Dredging would adversely affect the wildlife using these areas for forage or cover, and would serve no added benefit to the survivorship of the current ecosystem. Also, any remedial actions in waters of the United States would require a Section 404 permit under the Clean Water Act.

On the basis of the results of the investigations, the risk assessment, and the biological resources evaluation, NFA is recommended for SWMUs 139 and 140. After this report is submitted to EPA Region VI and NMED under HSWA, Holloman AFB will prepare and submit a Class 3 RCRA permit modification to remove SWMUs 139 and 140 from the Base's HSWA permit.

Section 6
REFERENCES

Cole, Richard A., et al, 1981. *Limnology of a Shallow Brackish Hypereutrophic Reservoir in Southern New Mexico*. Las Cruces, NM: New Mexico State University.

Dahl, Ann Louise, 1991. Diurnal Foraging of Selected Migrating Birds on a Hypereutrophic Lake. Unpublished master's thesis. Las Cruces, NM: New Mexico State University

Ewing, G.J., 1993. Letter to Dr. Fred Fisher (Holloman AFB). April 7, 1993.

Foster Wheeler Environmental Corporation, 1996. Letter from Dr. Fred Applehans (Foster Wheeler Environmental Corporation) to Dr. Fred Fisher (Holloman AFB). April 22, 1996.

Hoditschek, Barbara, 1994. Personal communication.

Hubbard, J.P., 1970. *Checklist of the Birds of New Mexico*. New Mexico Ornithological Society Publication 3:180.

Neleigh, David, 1994. Personal communication.

Radian Corporation, 1990. *Draft Quality Control Summary Report (A-E QCSR) for Sewage Lagoon Surface Water Sampling*. Austin, Texas.

Radian Corporation, 1991a. *Conceptual Plan for Sludge and Soil Sampling, Sewage Lagoon Investigation*. Austin, Texas.

Radian Corporation, 1991b. *Risk Assessment for the Sewage Lagoon System*. Austin, Texas.

Radian Corporation, 1992. *Site Characterization Report, Sewage Lagoons and Lakes Investigation*. Austin, Texas.

Radian Corporation, 1993a. *Chemical Data Aquisition Plan, Sewage Lagoons and Lakes Investigation, Holloman AFB, NM*. Austin, Texas.

Radian Corporation, 1993b. *Draft Final Phase 1—Groundwater Assessment Monitoring Report for the Sewage Lagoons and Lakes Investigation, Holloman AFB, NM*. Austin, Texas.

Radian Corporation, 1993c. *Draft Final Phase 2— RCRA Facility Investigation Report for Lakes Holloman and Stinky, Sewage Lagoons and Lakes Investigation, Holloman AFB, NM*. Austin, Texas.

Radian Corporation, 1993d. *Holloman AFB Risk Assessment, Sewage Lagoons and Lakes Investigation*. Austin, Texas.

Radian Corporation, 1993e. *Draft Final Sampling and Quality Control Summary Report (A-E SQCSR) Sewage Lagoons and Lakes Investigation, Holloman AFB, NM.* Austin, Texas.

Radian Corporation, 1994. *Conceptual Plan for Additional Sampling, Sewage Lagoons and Lakes Investigation, Holloman AFB, NM.* Austin, Texas.

Radian Corporation and Foster Wheeler Environmental Corporation, 1995a. *Project Assessment Report, Sewage Lagoons Closure Project, Holloman AFB, NM.* Austin, Texas.

Radian Corporation and Foster Wheeler Environmental Corporation, 1995b. *Site Characterization Report, Sewage Lagoons Closure Project, Holloman AFB, NM.* Austin, Texas.

Radian Corporation and Foster Wheeler Environmental Corporation, 1995c. *Technical Memorandum, 1994 Site Investigation, Lake Holloman, Lake Stinky, and the Ditch, Holloman AFB, NM.* Austin, Texas.

Radian International and Foster Wheeler Environmental Corporation, 1996a. *Biological Resources Report, Sewage Lagoons Closure Project, Holloman AFB, NM.* Austin, Texas.

Radian International and Foster Wheeler Environmental Corporation, 1996b. *Risk Assessment Addendum, Sewage Lagoons Closure Project, Holloman AFB, NM.* Austin, Texas.

United States Air Force (USAF), 1995. *Environmental Assessment, Wastewater Treatment Plant for Holloman AFB, NM,* Holloman AFB, NM.

United States Army Corps of Engineers (USACE), 1996. *Delineations of Jurisdictional Waters of the United States and Wetlands on Holloman Air Force Base, New Mexico.*

United States Department of Agriculture Soil Conservation Service, 1981. *Soil Survey of Otero County, New Mexico.*

United States Environmental Protection Agency, 1986. *Guidelines for Groundwater Classification Under the EPA Groundwater Protection Strategy.*

United States Fish and Wildlife Service (USFWS), 1994. *Draft Preliminary Survey of Contaminants Present in Biota, Pore-Water, and Sediments at the Holloman AFB WWTF.*

United States Geological Survey, 1985. *Hydrologic Data on the Shallow Bolson Fill Near the Sewage Lagoons and Lake Holloman, Holloman Air Force Base, Alamogordo, New Mexico.*

Weigmann, Diana L. and M. Hayes, 1981. *A Limnological Study of Lake Holloman (Southcentral New Mexico) With Management Recommendations for Multiple Use.* A Final Completion Report to the Bureau of Land Management for Contract No. NM-910-CTO-7. Completed by the Department of Fishery & Wildlife Sciences, Las Cruces, NM: New Mexico State University.

APPENDIX A

Appendix A

Analytical Summary of Investigations at SWMUs 139 and 140

This appendix summarizes the analytical results from all surface water, sludge, soil, and groundwater investigations conducted at SWMUs 139 and 140 between 1990 and 1994. Tables A-1 through A-4 present an analytical summary of the investigations conducted at SWMU 139 (Lake Holloman and the ditch) and SWMU 140 (Lake Stinky). Figures A-1 and A-2 show the location of sludge, soil, surface water and groundwater samples collected from the SWMUs.

Each table provides the frequency of detection, the median concentration, the maximum reporting limit (RL), the maximum concentration, and the sample location, along with year, for maximum detections. Analytical flags are also presented with the data. The flags may vary depending on the laboratory used, and therefore a summary of the analytical flags is presented below:

1990 Sampling Event

B	=	Parameter was also detected in the blank sample; result is uncorrected
C	=	Confirmed on second column or by GC/MS
G	=	Indicates an estimated GC value due to interference
J	=	Result is less than the method specified detection limit. These results should be considered approximate.
@	=	Result is less than five times the method detection limit. Studies have shown that the uncertainty of the analysis will increase exponentially as the MDL is approached. These results should be considered approximate.
X	=	Not confirmed on second column

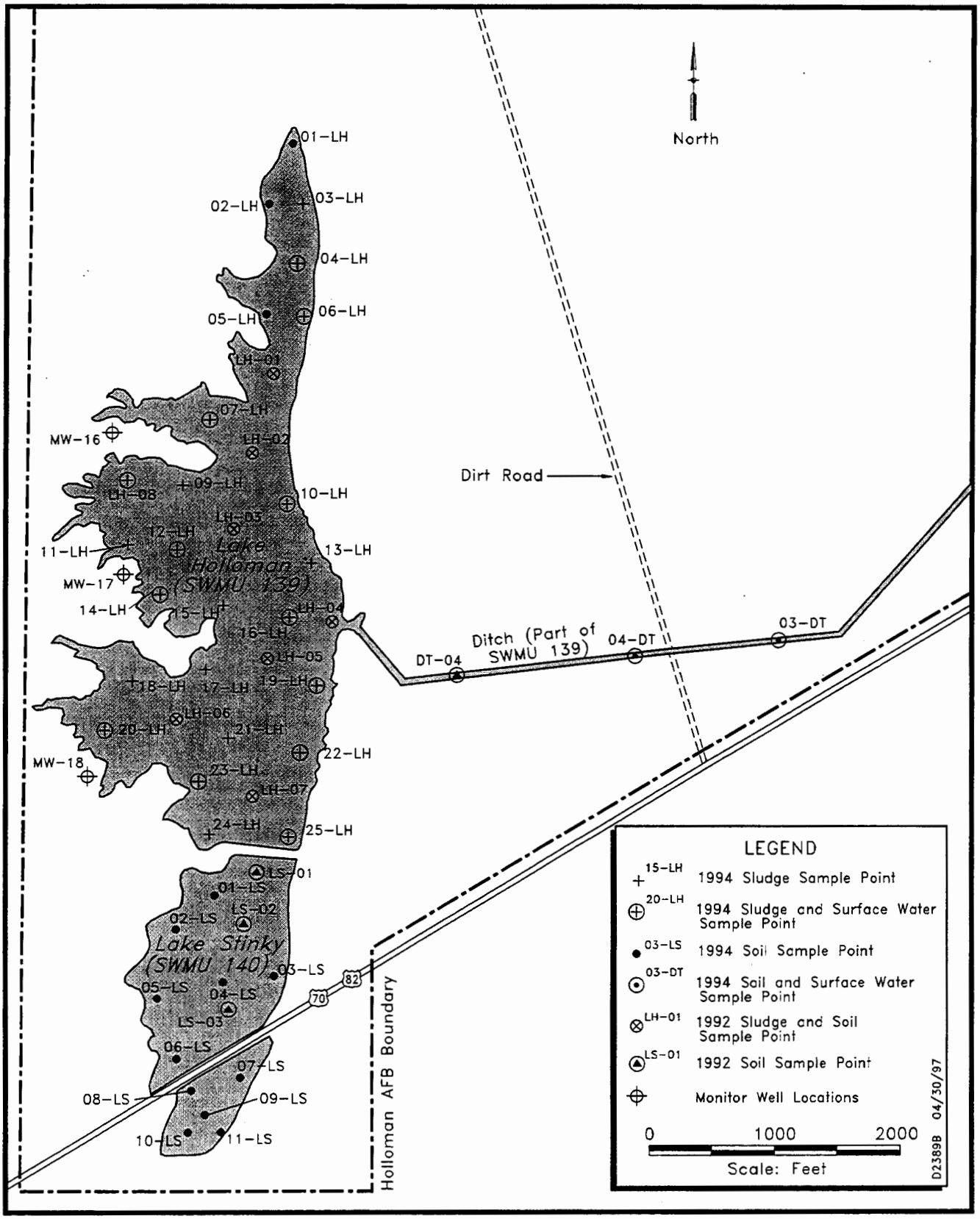

Figure A-1. Sampling Locations at Lake Holloman and the Ditch (SWMU 139) and Lake Stinky (SWMU 140)

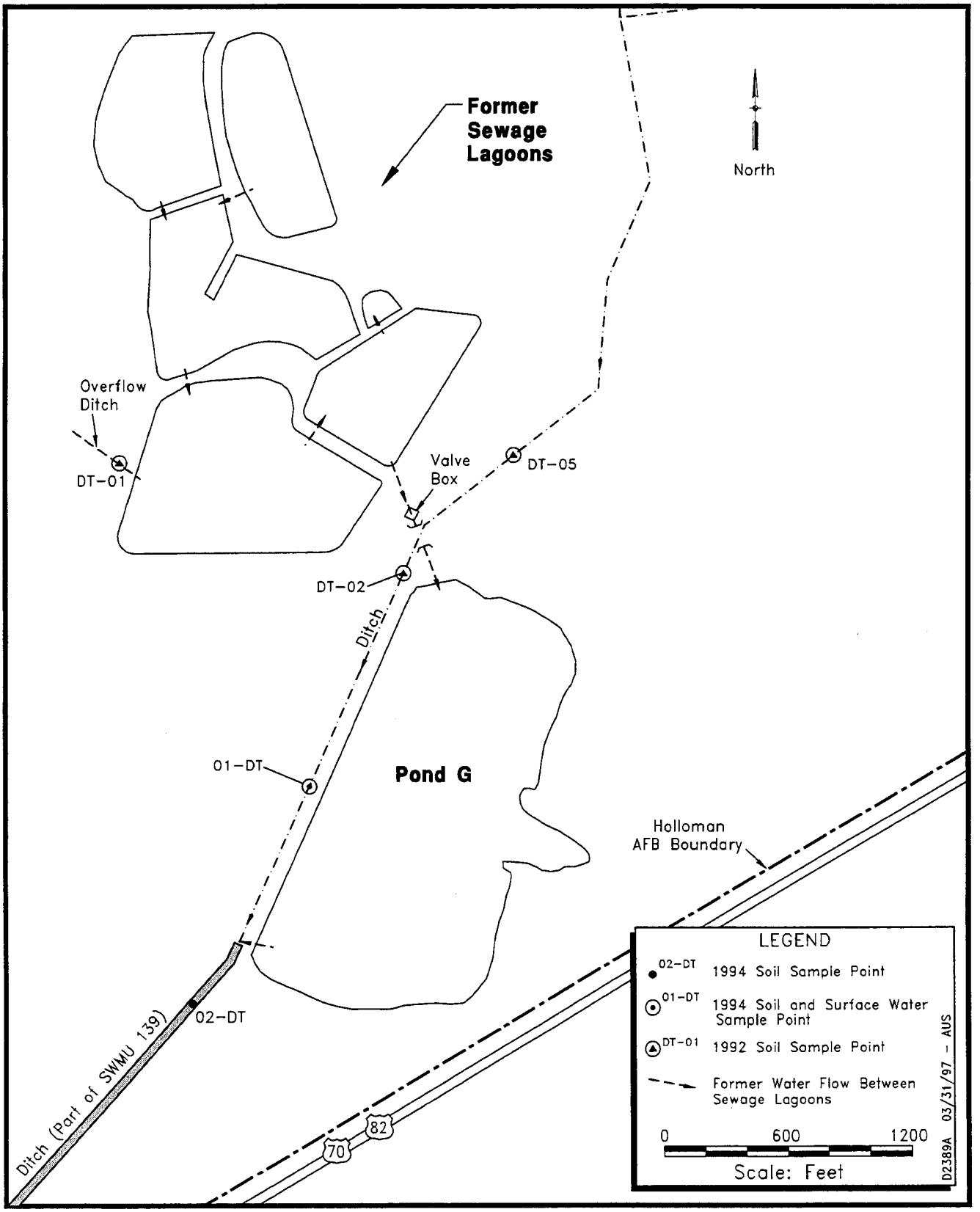

Figure A-2. Sampling Locations at the Ditch (part of SWMU 139)

1992 and 1993 Sampling Events

X	=	Qualitative confirmation of analyte on both columns. Quantification differed by a factor of two or more between columns. Value determined by the first column is reported.
@	=	Measured result is less than five times the detection limit
C	=	Presence and quantitation of the analyte confirmed by second column analysis
D	=	Secondary dilution required for this analyte
J	=	Detected below the method detection limit
B	=	Analyte detected in laboratory blank analysis, no blank subtraction performed
G	=	Indicates an estimated GC value due to interference

1994 Sampling Event

T	=	Primary column concentration is the preferred result
V	=	Second column concentration is the preferred result
J	=	Result is less than the reporting limit

Although the 1993 investigation focused on biological sampling, surface water and sediment samples were collected from the SWMUs. Sampling consisted of single surface water samples from each SWMU. The sediment samples were collected from the near surface sediment (upper few inches of sludge) to compare the constituents found in the benthic organisms with their immediate environment. These sediment samples are included with the sludge samples in the analytical summary tables, and can be identified by those maximum sludge concentrations noted with a [93] sampling date. The location of sediment and surface water samples collected in 1993 are not identified in Figures A-1 and A-2 due to their composite nature.

The data set for the median and maximum concentrations included detected, non-detect, and J-flagged data (concentrations below the reporting limit). J-flagged data are counted as "hits" or detections in the summary tables even though they are below the reporting limit. Reporting limits vary for each constituent between samples due to matrix interferences. For example, some samples were diluted and therefore would have a higher reporting limit than those that were not diluted. The median concentration is derived by ordering the values reported for each constituent in a particular media and SWMU in descending order and then identifying that value that is in the middle. For example if there were 5 samples collected, the 3rd value in descending order would be the median. If there are 6 samples, the median value would be the average of the 3rd and 4th value in descending order. In some cases the median value is below the reporting limit. If a median or maximum value is nondetect, the value is reported as less than the reporting limit (i.e., <0.5 means that the constituent was not detected and the reporting limit was 0.5). In some cases, the median or maximum value may be a flagged value that is less than the reporting limit (i.e., J flagged data), in this case the value will be reported as the flagged value (e.g., 0.045J means that 0.045 is a value that is less than the reporting limit).

Table A-1
Analytical Summary for Lake Holloman (SWMU 139)

Analyte	Surface Water					Sludge					Soils				
	Hits	Median	Max RL	Maximum	Location	Hits	Median	Max RL	Maximum	Location	Hits	Median	Max RL	Maximum	Location
Total Organic Carbon (mg/L or mg/kg)															
Total organic carbon	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1/1	2900	1100	2900 @	LH-06 [92]
E130.2 - Hardness (mg/L or mg/kg)															
Hardness, as CaC03	3/3	4700	250	4800	LH-03 [93]	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
E160.1 - Total Dissolved Solids (mg/L or mg/kg)															
Total dissolved solids	3/3	11000	10	12000	LH-01 [93]	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
E239.1 - Organic Lead (mg/L or mg/kg)															
Lead (organic)	5/5	0.16	NA	0.35 @	H-5 [90]	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
MRI-SOP - Kepone (mg/L or mg/kg)															
Kepone	NA	NA	NA	NA	NA	0/13	<0.07	0.07	ND	NA	1/2	<0.0435	0.07	<0.07	NA
SW6010 - Metals (mg/L or mg/kg)															
Barium	5/5	0.039	NA	0.042 @	H-3 [90]	29/29	57.5	15	348	04LH [94]	12/12	61.5	5.3	110	LH-05 [92]
Beryllium	NA	NA	NA	NA	NA	9/29	<0.68	3	3.5	04LH [94]	0/12	<0.785	1.1	ND	NA
Boron	5/5	0.33	NA	0.36 @	H-2 [90]	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Cadmium	NA	NA	NA	NA	NA	1/29	<1.7	7.4	<7.4	NA	0/12	<1.95	2.6	ND	NA
Calcium	5/5	850	NA	880	H-3 [90]	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chromium	0/5	<0.004	0.004	ND	NA	24/29	5 @	15	40.7	04LH [94]	7/12	<4.2	5.3	8.3 @	LH-05 [92]
Cobalt	NA	NA	NA	NA	NA	18/29	3.4	15	54	04LH [94]	3/12	<3.9	5.3	5.7 @	LH-07 [92]
Copper	0/5	<0.005	0.005	ND	NA	25/29	7.6	30	38 @	LH-03 [92]	3/12	<7.85	11	<11	NA
Iron	2/5	<0.013	0.013	1.7	H-3 [90]	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Magnesium	5/5	540	NA	570	H-3 [90]	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Table A-1
(Continued)

Analyte	Surface Water					Sludge					Soils				
	Hits	Median	Max RL	Maximum	Location	Hits	Median	Max RL	Maximum	Location	Hits	Median	Max RL	Maximum	Location
Manganese	5/5	0.053	NA	0.06	H-3 [90]	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Nickel	NA	NA	NA	NA	NA	20/29	7.6 J	36.7	38.5	04LH [94]	1/12	<8.05	12.6	<12.6	NA
Potassium	4/4	34	NA	36	H-1 [90]	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Silicon	5/5	12	NA	15	H-1 [90]	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Silver	NA	NA	NA	NA	NA	10/29	<3.4	15	<15	NA	0/12	<3.9	5.3	ND	NA
Sodium	5/5	1700	NA	1800	H-1 [90]	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Thallium	NA	NA	NA	NA	NA	4/22	<2.6	9.2	<9.2	NA	1/3	<1.4	3.2	<3.2	NA
Vanadium	1/5	0.003	0.003	0.0043 @	H-3 [90]	28/29	12.2	30	135	04LH [94]	10/12	<8.65	11	19 @	LH-05 [92]
Zinc	5/5	0.011	NA	0.029 @	H-3 [90]	29/29	18 @	30	118	04LH [94]	12/12	13.5	11	29 @	LH-05 [92]
SW7060 - Arsenic (mg/L or mg/kg)															
Arsenic	5/5	0.0076	NA	0.0088 @	H-5 [90]	28/29	1.3	4.9	5.9 @	LH-05 [92]	12/12	2.05	2	4 @	LH-06 [92]
SW7421 - Lead (mg/L or mg/kg)															
Lead	5/19	<0.2	0.5	<0.5	NA	27/29	3.5 J	22.1	37	LH-04 [92]	12/12	2.15	7.2	<7.2	NA
SW7470 - Mercury (mg/L)															
Mercury	5/5	0.0002	NA	0.0003 @	H-1 [90]	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
SW7471 - Mercury (mg/L or mg/kg)															
Mercury	NA	NA	NA	NA	NA	0/29	<0.24	0.92	ND	NA	2/12	<0.0695	0.16	0.53	LH-06 [92]
SW7740 - Selenium (mg/L or mg/kg)															
Selenium	0/5	<0.004	0.004	ND	NA	8/29	<1.9	4.6	<4.6	NA	5/12	<0.57	3.2	<3.2	NA

Table A-1
(Continued)

Analyte	Surface Water					Sludge					Soils				
	Hits	Median	Max RL	Maximum	Location	Hits	Median	Max RL	Maximum	Location	Hits	Median	Max RL	Maximum	Location
SW8080 - Organochlorine Pesticides and PCBs (µg/L or µg/kg)															
alpha-BHC	3/8	<0.15	1	<1	NA	8/29	<4.2	40	<40	NA	4/12	<1.5	16	<16	NA
delta-BHC	0/3	<0.0095	0.0095	ND	NA	5/29	<4.7	120	7000 CD	LH-07 [92]	6/12	<2.55	16	4200 XD	LH-07 [92]
gamma-BHC	1/8	<0.45	3	<3	NA	3/29	<4.3	40	<40	NA	8/12	4.75 @	16	25 X@	LH-07 [92]
Chlordane	0/5	<14	14	ND	NA	13/22	7.6 J	77	360	16LH [94]	0/3	<4.8	27	ND	NA
alpha-Chlordane	0/3	<0.0095	0.0095	ND	NA	1/7	<5.5	8	59 C	LH-04 [92]	0/9	<1.5	16	ND	NA
gamma-Chlordane	0/3	<0.0095	0.0095	ND	NA	6/7	<8	8	75 C	LH-04 [92]	0/9	<1.5	16	ND	NA
4,4'-DDD	1/3	<0.0095	0.0095	<0.0095	NA	20/29	3VJ	77	600 C	LH-04 [92]	3/12	<1.45	16	<16	NA
4,4'-DDE	0/8	<0.45	3	ND	NA	20/29	3.9 J	77	<77	NA	2/12	1.5	16	<16	NA
4,4'-DDT	1/3	<0.019	0.019	<0.019	NA	3/29	<8.4	77	<77	NA	0/12	<3	32	ND	NA
Dieldrin	1/3	<0.0095	0.0095	0.011 X@	LH-03 [93]	14/29	<5.6	77	110 X	LH-02 [92]	0/12	<1.5	16	ND	NA
Endosulfan Sulfate	1/3	<0.048	0.048	<0.048	NA	0/29	<8.9	77	ND	NA	0/12	<7.1	79	ND	NA
Endrin Aldehyde	1/3	<0.019	0.019	<0.019	NA	0/29	<8.4	77	ND	NA	1/12	<3	32	<32	NA
Endrin ketone	1/5	<1	1	<1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Heptachlor	0/3	<0.0095	0.0095	ND	NA	1/29	<4.3	40	<40	NA	1/12	<1.55	16	<16	NA
Isodrin	0/3	<0.0095	0.0095	ND	NA	2/29	<8	77	9900 X	LH-06 [92]	1/12	<1.5	16	42 X@	LH-07 [92]
Methoxychlor	3/8	<7.5	10	50	H-2 [90]	0/29	<34	400	ND	NA	0/12	<7.55	79	ND	NA
SW8240 - Volatile Organic Compounds (µg/L or µg/kg)															
Acetone	NA	NA	NA	NA	NA	2/7	<11000	16000	<16000	NA	5/9	<140	160	170 @	LH-07 [92]
Carbon disulfide	NA	NA	NA	NA	NA	2/7	<530	800	<800	NA	1/9	<7.6	7.8	16 @	LH-04 [92]
Methyl ethyl ketone	NA	NA	NA	NA	NA	1/7	<11000	16000	<16000	NA	1/9	<150	160	<160	NA

Table A-1
(Continued)

Analyte	Surface Water					Sludge					Soils				
	Hits	Median	Max RL	Maximum	Location	Hits	Median	Max RL	Maximum	Location	Hits	Median	Max RL	Maximum	Location
Methylene chloride	NA	NA	NA	NA	NA	1/7	<530	800	<800	NA	9/9	14	7.8	33 @	LH-07 [92]
Toluene	NA	NA	NA	NA	NA	0/7	<530	800	ND	NA	8/9	0.42 J	7.8	<7.8	NA
SW8270 - Semivolatile Organic Compounds (mg/L or mg/kg)															
Butylbenzylphthalate	1/5	<0.02	0.02	0.042 @	H-3 [90]	0/7	<5.3	7.9	ND	NA	0/9	<1.5	1.6	ND	NA
Dibutylphthalate	1/5	<0.02	0.02	0.02 J	H-3 [90]	0/7	<5.3	7.9	ND	NA	0/9	<1.5	1.6	ND	NA
Diethylphthalate	1/5	<0.02	0.02	<0.02	NA	0/7	<5.3	7.9	ND	NA	0/9	<1.5	1.6	ND	NA
bis(2-Ethylhexyl) phthalate	4/5	0.01	0.02	0.069 @B	H-3 [90]	3/7	<5.3	7.9	28 @	LH-05 [92]	4/9	<1.4	1.6	<1.6	NA
Molecular sulfur	NA	NA	NA	NA	NA	1/1	5	NA	5	LH-01 [92]	5/5	46	NA	100	LH-05 [92]
SW9012 - Total Cyanide (mg/L or mg/kg)															
Cyanide	NA	NA	NA	NA	NA	6/7	1.7 @	4.7	120	LH-02 [92]	8/9	1.3	0.37	11	LH-05 [92]
SW9030 - Sulfides (mg/L or mg/kg)															
Sulfide	NA	NA	NA	NA	NA	7/7	830	190	2700	LH-05 [92]	6/9	100 @	39	360	LH-07 [92]

[a] Heptachlor epoxide data was questionable since it was only detected on one of two columns using a GC methodology. Therefore, this constituent was resampled in the 1994 investigation and any sample that was detected on one column only was reanalyzed using a GC/MS methodology to determine if heptachlor epoxide was present. In all cases, no heptachlor epoxide was detected using the GC/MS methodology. Holloman AFB has verified that no heptachlor epoxide is present.

Table A-1
(Continued)

NOTES:

Hits = Frequency of detection (i.e. 1/15 means 1 out of 15 samples reported a detected concentration)
Max RL = Maximum reporting limit.
NA = Not applicable, or not analyzed
ND = Not detected
[90] = Year that the sample reporting the maximum value was collected
< = Value reported after < is the reporting limit

Legend for Analytical Flags varies with each year of sampling as shown below.

1990 Sampling Event

@ - Result is less than five times the method detection limit. Studies have shown that the uncertainty of the analysis will increase exponentially as the MDL is approached. These results should be considered approximate
B - Parameter was also detected in the blank sample; result is uncorrected
C - Confirmed on second column or by GC/MS
J - Result is less than the method specified detection limit. These results should be considered approximate.
X - Not confirmed on second column

1992 and 1993 Sampling Events

@ - Measured result is less than five times the detection limit
B - Analyte detected in laboratory blank analysis, no blank subtraction performed
C - Presence and quantitation of the analyte confirmed by second column analysis
D - Secondary dilution required for this analyte
J - Detected below the method detection limit
X - Qualitative confirmation of analyte on both columns. Quantification differed by a factor of two or more between columns. Value determined by the first column is reported.

1994 Sampling Event

J - Result is less than the reporting limit
V - Second column concentration is the preferred result

Table A-2
Analytical Summary for Ditch (Included in SWMU 139)

Analyte	Surface Water					Soils				
	Hits	Median	Max RL	Maximum	Location	Hits	Median	Max RL	Maximum	Location
E130.2 - Hardness (mg/L or mg/kg)										
Hardness, as CaC03	1/1	2100	120	2100	DT-02 [93]	NA	NA	NA	NA	NA
E160.1 - Total Dissolved Solids (mg/L or mg/kg)										
Total dissolved solids	1/1	4900	10	4900	DT-02 [93]	NA	NA	NA	NA	NA
SW6010 - Metals (mg/L or mg/kg)										
Antimony	NA	NA	NA	NA	NA	1/15	<43	53	96	DT-05 [93]
Barium	NA	NA	NA	NA	NA	15/15	76	5.3	123	01DT [94]
Beryllium	NA	NA	NA	NA	NA	6/15	<0.85	1.1	1.1 @	02DT [94]
Cadmium	NA	NA	NA	NA	NA	1/15	<2	2.6	<2.6	NA
Chromium	NA	NA	NA	NA	NA	11/15	11 @	5.3	40.8	01DT [94]
Cobalt	NA	NA	NA	NA	NA	9/15	<4.9	5.3	7.3 @	DT-03 [92]
Copper	NA	NA	NA	NA	NA	8/15	<9.8	11	28	01DT [94]
Nickel	NA	NA	NA	NA	NA	7/15	<9.8	12.7	19 @	DT-03 [92]
Silver	NA	NA	NA	NA	NA	3/15	<4	5.3	<5.3	NA
Thallium	NA	NA	NA	NA	NA	2/5	<1.4	12	<12	NA
Tin	NA	NA	NA	NA	NA	1/15	<240	320	<320	NA
Vanadium	NA	NA	NA	NA	NA	11/15	22.9	11	34.1	01DT [94]
Zinc	NA	NA	NA	NA	NA	12/15	33.8	11	80.5	01DT [94]
SW7060 - Arsenic (mg/L or mg/kg)										
Arsenic	NA	NA	NA	NA	NA	14/15	2.2	2.3	14	DT-05 [93]

Table A-2
(Continued)

Analyte	Surface Water					Soils				
	Hits	Median	Max RL	Maximum	Location	Hits	Median	Max RL	Maximum	Location
SW7421 - Lead (mg/L or mg/kg)										
Lead	0/3	<0.02	0.5	ND	NA	14/15	7.4	15.9	120	DT-05 [92]
SW7471 - Mercury (mg/L or mg/kg)										
Mercury	NA	NA	NA	NA	NA	3/15	<0.071	0.28	0.54	DT-02 [92]
SW7740 - Selenium (mg/L or mg/kg)										
Selenium	NA	NA	NA	NA	NA	4/15	<0.58	1.6	7.1	DT-05 [93]
SW7841 - Thallium (mg/L or mg/kg)										
Thallium	NA	NA	NA	NA	NA	1/11	<0.54	0.73	<0.73	NA
SW8080 - Organochlorine Pesticides and PCBs (µg/L or µg/kg)										
Aldrin	0/1	<0.0099	0.0099	ND	NA	3/15	<1.5	55	<55	NA
alpha-BHC	1/1	0.0078 JX	0.0099	<0.0099	NA	1/15	<1.5	55	<55	NA
beta-BHC	0/1	<0.0099	0.0099	ND	NA	1/15	<1.6	55	<55	NA
delta-BHC	0/1	<0.0099	0.0099	ND	NA	13/15	47 X	55	880 X	DT-05 [92]
gamma-BHC	0/1	<0.0099	0.0099	ND	NA	5/15	<1.8	55	<55	NA
Chlordane	NA	NA	NA	NA	NA	1/4	<5.2	19	150	01DT [94]
alpha-Chlordane	0/1	<0.0099	0.0099	ND	NA	4/11	<1.4	55	<55	NA
gamma-Chlordane	0/1	<0.0099	0.0099	ND	NA	4/11	1.4	55	62 @	DT-05 [93]
4,4'-DDD	0/1	<0.0099	0.0099	ND	NA	11/15	2.7 C@	55	350 C	DT-05 [92]
4,4'-DDE	0/1	<0.0099	0.0099	ND	NA	10/15	2.1 C@	55	81 @	DT-05 [93]
4,4'-DDT	0/1	<0.02	0.02	ND	NA	6/15	3.1 C@	110	180 @	DT-05 [93]
Dieldrin	1/1	0.011 X@	0.0099	0.011 X@	DT-02 [93]	1/15	<1.5	55	<55	NA

Table A-2
(Continued)

Analyte	Surface Water					Soils				
	Hits	Median	Max RL	Maximum	Location	Hits	Median	Max RL	Maximum	Location
Endosulfan Sulfate	0/1	<0.05	0.05	ND	NA	1/15	<7	280	<280	NA
Endrin	0/1	<0.0099	0.0099	ND	NA	1/15	<1.5	55	<55	NA
Endrin Aldehyde	0/1	<0.02	0.02	ND	NA	1/15	<3.1	110	<110	NA
Heptachlor epoxide	0/1	<0.0099	0.0099	ND	NA	1/15	<1.5	55	12000 X	DT-05 [93]
Isodrin	1/1	0.0061 J	0.0099	<0.0099	NA	2/15	<1.5	55	55 XD@	DT-05 [92]
Methoxychlor	0/1	<0.05	0.05	ND	NA	1/15	<7.3	280	<280	NA
SW8240 - Volatile Organic Compounds (µg/L or µg/kg)										
Acetone	NA	NA	NA	NA	NA	3/10	<135	180	<180	NA
Carbon disulfide	NA	NA	NA	NA	NA	1/10	<7.15	9.2	72	DT-04 [92]
Methyl ethyl ketone	NA	NA	NA	NA	NA	1/10	<140	180	<180	NA
Toluene	NA	NA	NA	NA	NA	3/10	<6.8	9.2	<9.2	NA
SW8270 - Semivolatile Organic Compounds (mg/L or mg/kg)										
Benzo(b)fluoranthene	NA	NA	NA	NA	NA	2/11	<1.4	5.6	<5.6	NA
Benzo(k)fluoranthene	NA	NA	NA	NA	NA	2/11	<1.4	5.6	<5.6	NA
Chrysene	NA	NA	NA	NA	NA	1/11	<1.4	5.6	<5.6	NA
Cyclohexenone	NA	NA	NA	NA	NA	2/2	1.075	NA	1.2	DT-01 [92]
bis(2-Ethylhexyl)phthalate	NA	NA	NA	NA	NA	10/11	0.39 J	5.6	<5.6	NA
Fluoranthene	NA	NA	NA	NA	NA	1/11	1.4	5.6	<5.6	NA
Molecular sulfur	NA	NA	NA	NA	NA	1/1	12	NA	12	DT-05 [93]
Pyrene	NA	NA	NA	NA	NA	1/11	<1.4	5.6	<5.6	NA

Table A-2
(Continued)

Analyte	Surface Water					Soils				
	Hits	Median	Max RL	Maximum	Location	Hits	Median	Max RL	Maximum	Location
SW9012 - Total Cyanide (mg/L or mg/kg)										
Cyanide	NA	NA	NA	NA	NA	6/10	0.76 @	0.6	16	DT-01 [92]
SW9030 - Sulfides (mg/L or mg/kg)										
Sulfide	NA	NA	NA	NA	NA	6/10	83.5 @	42	390	DT-05 [92]

[a] Heptachlor epoxide data was questionable since it was only detected on one of two columns using a GC methodology. Therefore, this constituent was resampled in the 1994 investigation and any sample that was detected on one column only was reanalyzed using a GC/MS methodology to determine if heptachlor epoxide was present. In all cases, no heptachlor epoxide was detected using the GC/MS methodology. Holloman AFB has verified that no heptachlor epoxide is present.

NOTES:

Hits = Frequency of detection (i.e. 1/15 means 1 out of 15 samples reported a detected concentration)
Max RL = Maximum reporting limit.
NA = Not applicable, or not analyzed
ND = Not detected
[90] = Year that the sample reporting the maximum value was collected
< = Value reported after < is the reporting limit

Legend for Analytical Flags varies with each year of sampling as shown below.

1990 Sampling Event

@ - Result is less than five times the method detection limit. Studies have shown that the uncertainty of the analysis will increase exponentially as the MDL is approached. These results should be considered approximate
C - Confirmed on second column or by GC/MS
J - Result is less than the method specified detection limit. These results should be considered approximate.
X - Not confirmed on second column

1992 and 1993 Sampling Events

@ - Measured result is less than five times the detection limit
C - Presence and quantitation of the analyte confirmed by second column analysis
D - Secondary dilution required for this analyte
J - Detected below the method detection limit
X - Qualitative confirmation of analyte on both columns. Quantification differed by a factor of two or more between columns. Value determined by the first column is reported.

1994 Sampling Event

J - Result is less than the reporting limit

Table A-3
Analytical Summary for Lake Stinky (SWMU 140)

Analyte	Surface Water					Soils				
	Hits	Median	Max RL	Maximum	Location	Hits	Median	Max RL	Maximum	Location
Total Organic Carbon (mg/L or mg/kg)										
Total organic carbon	NA	NA	NA	NA	NA	4/4	6900	1100	11000	LS-03 [92]
E130.2 - Hardness (mg/L or mg/kg)										
Hardness, as CaCO3	3/3	5600	250	5700	LS-01 [93]	NA	NA	NA	NA	NA
E160.1 - Total Dissolved Solids (mg/L or mg/kg)										
Total dissolved solids	2/2	14000	10	14000	LS-01 [93]	NA	NA	NA	NA	NA
SW6010 - Metals (mg/L or mg/kg)										
Barium	NA	NA	NA	NA	NA	19/19	60	4.9	95	LS-03 [92]
Beryllium	NA	NA	NA	NA	NA	5/19	0.64	0.98	0.69	11LS [94]
Cadmium	NA	NA	NA	NA	NA	2/19	<1.6	2.4	<2.4	NA
Chromium	NA	NA	NA	NA	NA	17/19	4.9	4.9	12.7	11LS [94]
Cobalt	NA	NA	NA	NA	NA	14/19	2.8	4.9	6.2	11LS [94]
Copper	NA	NA	NA	NA	NA	13/19	7.8	9.8	9	11LS [94]
Nickel	NA	NA	NA	NA	NA	13/19	6.8	13.2	14.5	11LS [94]
Thallium	NA	NA	NA	NA	NA	1/13	<1.5	9	< 9	NA
Vanadium	NA	NA	NA	NA	NA	18/19	11	9.8	30.5	11LS [94]
Zinc	NA	NA	NA	NA	NA	19/19	19.3	9.8	40	LS-05 [93]
SW7060 - Arsenic (mg/L or mg/kg)										
Arsenic	NA	NA	NA	NA	NA	19/19	2.2	2.1	4.7 @	LS-03 [92]
SW7421 - Lead (mg/L or mg/kg)										
Lead	NA	NA	NA	NA	NA	16/19	3	13.5	<13.5	NA

Table A-3
(Continued)

Analyte	Surface Water					Soils				
	Hits	Median	Max RL	Maximum	Location	Hits	Median	Max RL	Maximum	Location
SW7740 - Selenium (mg/L or mg/kg)										
Selenium	NA	NA	NA	NA	NA	5/19	<0.65	3.3	<3.3	NA
SW7841 - Thallium (mg/L or mg/kg)										
Thallium	NA	NA	NA	NA	NA	2/8	<0.525	0.66	<0.66	NA
SW8080 - Organochlorine Pesticides and PCBs (µg/L or µg/kg)										
Aldrin	1/2	<0.0173	0.095	<0.095	NA	6/19	<2.2	16	21 X@	LS-05 [93]
alpha-BHC	2/2	0.055	0.095	0.1 X@	LS-01 [93]	11/19	<0.84	16	<16	NA
beta-BHC	0/2	<0.0523	0.095	ND	NA	1/19	<2.6	16	<16	NA
delta-BHC	0/2	<0.0523	0.095	ND	NA	5/19	<2.6	16	3400 X	LS-03 [92]
gamma-BHC	1/2	<0.0524	0.095	<0.095	NA	13/19	<2.3	16	35 C@	LS-02 [92]
4,4'-DDD	1/2	<0.0263	0.095	<0.095	NA	3/19	<4.5	16	<16	NA
4,4'-DDT	0/2	<0.1045	0.19	ND	NA	3/19	<4.5	33	<33	NA
Dieldrin	1/2	<0.053	0.095	0.011 X@	LS-02 [93]	5/19	4.2 J	16	<16	NA
Endosulfan I	1/2	<0.0368	0.095	<0.095	NA	0/19	<2.5	16	ND	NA
Endrin	0/2	<0.0523	0.095	ND	NA	5/19	<4.5	16	<16	NA
Endrin Aldehyde	1/2	<0.034	0.19	<0.19	NA	1/19	<4.9	33	<33	NA
Heptachlor	0/2	<0.0523	0.095	ND	NA	4/19	<2.2	16	<16	NA
Heptachlor epoxide	1/2	<0.0138	0.095	<0.095	NA	2/19	<2.6	16	6300 G	LS-05 [93]
Isodrin	1/2	<0.0318	0.095	<0.095	NA	1/19	<5	17	<17	NA

Table A-3
(Continued)

Analyte	Surface Water					Soils				
	Hits	Median	Max RL	Maximum	Location	Hits	Median	Max RL	Maximum	Location
SW8140 - Parathion (µg/L or µg/kg)										
Parathion	NA	NA	NA	NA	NA	1/8	<100	240	<240	NA
SW8150 - Chlorinated Herbicides (µg/L or µg/kg)										
2,4,5-T	NA	NA	NA	NA	NA	1/8	<28.5	34	<34	NA
SW8240 - Volatile Organic Compounds (µg/L or µg/kg)										
Acetone	NA	NA	NA	NA	NA	4/8	<220	3400	<3400	NA
CarbonDisulfide	NA	NA	NA	NA	NA	2/8	<10.6	170	<170	NA
Methyl ethyl ketone	NA	NA	NA	NA	NA	2/8	<140	3400	<3400	NA
Methylene chloride	NA	NA	NA	NA	NA	4/8	<8.15	170	<170	NA
Toluene	NA	NA	NA	NA	NA	4/8	<4.35	170	<170	NA
Trichloroethene	NA	NA	NA	NA	NA	1/8	<7.55	170	<170	NA
Xylenes	NA	NA	NA	NA	NA	2/8	<6.95	170	<170	NA
SW8270 - Semivolatile Organic Compounds (mg/L or mg/kg)										
Cyclohexenone	NA	NA	NA	NA	NA	1/1	1	NA	1	LS-01 [92]
bis(2-Ethylhexyl)pthalate	NA	NA	NA	NA	NA	4/8	<0.515	1.7	3.9 @	LS-01 [92]
Molecular sulfur	NA	NA	NA	NA	NA	5/5	92	NA	210	LS-03 [92]
SW9012 - Total Cyanide (mg/L or mg/kg)										
Cyanide	NA	NA	NA	NA	NA	5/8	1.92	0.4	11	LS-02 [92]
SW9030 - Sulfides (mg/L or mg/kg)										
Sulfide	NA	NA	NA	NA	NA	5/9	35	42	540	LS-03 [92]

Table A-3
(Continued)

[a] Heptachlor epoxide data was questionable since it was only detected on one of two columns using a GC methodology. Therefore, this constituent was resampled in the 1994 investigation and any sample that was detected on one column only was reanalyzed using a GC/MS methodology to determine if heptachlor epoxide was present. In all cases, no heptachlor epoxide was detected using the GC/MS methodology. Holloman AFB has verified that no heptachlor epoxide is present.

NOTES:

Hits = Frequency of detection (i.e. 1/15 means 1 out of 15 samples reported a detected concentration)
Max RL = Maximum reporting limit.
NA = Not applicable, or not analyzed
ND = Not detected
[90] = Year that the sample reporting the maximum value was collected
< = Value reported after < is the reporting limit

Legend for Analytical Flags varies with each year of sampling as shown below.

<u>1990 Sampling Event</u>
@ - Result is less than five times the method detection limit. Studies have shown that the uncertainty of the analysis will increase exponentially as the MDL is approached. These results should be considered approximate
C - Confirmed on second column or by GC/MS
G - Indicates an estimated GC value due to interference
J - Result is less than the method specified detection limit. These results should be considered approximate.
X - Not confirmed on second column

<u>1992 and 1993 Sampling Events</u>
@ - Measured result is less than five times the detection limit
C - Presence and quantitation of the analyte confirmed by second column analysis
G - Indicates and estimated GC value due to interference
J - Detected below the method detection limit
X - Qualitative confirmation of analyte on both columns. Quantification differed by a factor of two or more between columns. Value determined by the first column is reported.

<u>1994 Sampling Event</u>
J - Result is less than the reporting limit

Table A-4
Analytical Summary for Groundwater

Analyte	Hits	Median	Max RL	Maximum	Location
E130.2 - Hardness (mg/L)					
Hardness, as CaC03	2/3	3800	250	7300	MW-16 [93]
E160.1 - Total Dissolved Solids (mg/L)					
Total dissolved solids	3/3	18000	10	24000	MW-17 [93]
SW6010 - Metals (mg/L)					
Antimony	1/3	<0.785	1	<1	NA
Barium	3/3	0.28	0.01	0.58	MW-16 [93]
Beryllium	3/3	0.0021 @	0.002	0.0036 @	MW-16 [93]
Cadmium	2/3	0.0165 @	0.005	0.019 @	MW-17 [93]
Chromium	3/3	0.017 @	0.01	0.043 @	MW-16 [93]
Cobalt	3/3	0.0042 J	0.01	0.04 @	MW-16 [93]
Copper	1/3	<0.017	0.02	<0.02	NA
Nickel	2/3	0.012 @	0.02	<0.02	NA
Thallium	3/3	0.22 @	0.1	0.3 @	MW-17 [93]
Tin	1/3	<0.33	0.6	<0.6	NA
Vanadium	3/3	0.03 @	0.02	0.091 @	MW-16 [93]
Zinc	3/3	0.057 @	0.02	0.16	MW-16 [93]
SW7060 - Arsenic (mg/L)					
Arsenic	2/3	<0.016	0.016	0.032 @	MW-16 [93]
SW7421 - Lead (mg/L)					
Lead	1/3	<0.01	0.006	0.014 @	MW-16 [93]
SW7470 - Mercury (mg/L)					
Mercury	2/3	0.00003 J	0.00036	<0.00036	NA
SW7740 - Selenium (mg/L)					
Selenium	1/3	<0.0115	0.01	0.013 @	MW-17 [93]
SW7841 - Thallium (mg/L)					
Thallium	3/3	0.0014 J	0.02	<0.02	NA
SW8080 - Organochlorine Pesticides and PCBs (µg/L)					
Aldrin	2/3	0.0135 @	0.0095	0.014 @	MW-17 [93]
alpha-BHC	2/3	0.023 G@	0.0095	0.051	MW-16 [93]
beta-BHC	3/3	0.012 X@	0.0095	0.027 @	MW-16 [93]
delta-BHC	2/3	0.035	0.0095	0.049 G	MW-16 [93]
gamma-BHC	3/3	0.016 @	0.0095	0.02 G@	MW-16 [93]
alpha-Chlordane	1/3	<0.00895	0.0095	<0.0095	NA
gamma-Chlordane	3/3	0.0132 X@	0.0095	0.014 @	MW-16 [93]
4,4'-DDD	3/3	0.016 X@	0.0095	0.022 X@	MW-16 [93]

Table A-4
(Continued)

Analyte	Hits	Median	Max RL	Maximum	Location
4,4'-DDE	3/3	0.015 @	0.0095	0.015 @	MW-16 [93]
4,4'-DDT	1/3	0.0096 JX	0.019	<0.019	NA
Dieldrin	3/3	0.018 @	0.0095	0.029 X@	MW-16 [93]
Endosulfan I	2/3	<0.0095	0.0095	0.03 X@	MW-16 [93]
Endosulfan II	2/3	0.013 J	0.029	<0.029	NA
Endosulfan Sulfate	2/3	0.0105 J	0.048	<0.048	NA
Endrin	3/3	0.0083 JX	0.0095	0.011 X@	MW-16 [93]
Endrin Aldehyde	1/3	0.012 JX	0.019	<0.019	NA
Heptachlor	3/3	0.036 @	0.0095	0.036 X@	MW-16 [93]
Heptachlor epoxide	3/3	0.022 X@	0.0095	0.023 X@	MW-17 [93]
Isodrin	3/3	0.015 X@	0.0095	0.018 X@	MW-17 [93]
Kepone (Mirex)	3/3	0.75 G	0.0095	0.99 X	MW-18 [93]
SW8270 - Semivolatile Organic Compounds (mg/L)					
bis(2-Ethylhexyl)phthalate	3/3	0.0023 J	0.0096	<0.0096	NA
SW9012 - Total Cyanide (mg/L)					
Cyanide	2/3	0.004 @	0.01	<0.01	NA
SW9030 - Sulfides (mg/L)					
Sulfide	1/3	<0.67	1	<1	NA

Hits = Frequency of detection (i.e. 1/15 means 1 out of 15 samples reported a detected concentration)
Max RL = Maximum reporting limit
NA = Not applicable, or not analyzed
[92] = Year that the sample reporting the maximum value was collected
< = Value reported after < is the reporting limit

Legend for Analytical Flags:
X - Qualitative confirmation of analyte on both columns. Quantification differed by a factor of two or more between columns. Value determined by the first column is reported.
@ - Measured result is less than five times the detection limit
J - Detected below the method detection limit
G - Indicates an estimated GC value due to interference.

APPENDIX B

List of Historical Reports for SWMUs 139 and 140

Table B-1
List of Historical Reports For
SWMUs 139 (Lake Holloman and the Ditch) and 140 (Lake Stinky)

Report Title	Description	Author and Date
Draft Quality Control Summary Report (A-E QCSR) for Sewage Lagoon Surface Water Sampling at Holloman Air Force Base, NM	This report presents the results of surface water samples collected in October 1990 from the sewage lagoons and lakes.	Radian, December 1990
Risk Assessment for the Sewage Lagoon System	This preliminary assessment evaluated the risks for the sewage lagoon system as a whole.	Radian, February 1991b
Site Characterization Report, Sewage Lagoons and Lakes Investigation	This report presents the Appendix IX analytical results of sludge and soil collected in the Ponds C, D, E, G, the ditch, and Lakes Holloman and Stinky during the Spring of 1992.	Radian, August 1992
Draft Final Chemical Data Acquisition Plan (CDAP)	This plan presents the sampling scheme for the 1993 investigation. The appendix presents the results of the 8080 geoprobe analyses.	Radian, January 1993a
Draft Final Sampling and Quality Control Summary Report (A-E SQCSR) Sewage Lagoons and Lakes Investigation	This report contains analytical results for 8080 geoprobe water samples, and inorganic results for background soils and groundwater samples. It also contains results for inorganic analyses for soils, surface water, and groundwater; and organic analyses for soils, surface water and groundwater collected from the sewage lagoons and lakes. In addition, it presents the results of biota samples collected from sewage lagoons and Lake Holloman.	Radian, October 1993e
Holloman Risk Assessment, Sewage Lagoons and Lakes Investigation	Separate risk assessments for each of the former sewage lagoons and SWMUs 139 and 140 were conducted. Vol. II, Appendix B to this report presents the analytical data collected in previous investigations of the sewage lagoons. Appendix M describes the biota sampling event.	Radian, November 1993d
Draft Final Phase 2 - RCRA Facility Investigation Report for Lakes Holloman and Stinky	This report contains data evaluation criteria, conclusions and recommendations for groundwater monitoring results from wells downgradient of SWMUs 139 and 140.	Radian, December 1993c

Table B-1
(Continued)

Report Title	Description	Author and Date
Preliminary Survey of Contaminants Present in Biota, Pore-Water, and Sediments at the Holloman Air Force Base Waste Water Treatment Facility	During the summer of 1991, USFWS collected eleven sediment, 1 surface water, and 35 biological samples in the sewage lagoons and SWMU 139 (Lake Holloman). Samples were analyzed for heavy metals and metalloids, organochlorine pesticide and PCBs, polycyclic aromatic hydrocarbons, aliphatic hydrocarbons, and certain dioxin and furan compounds. Results and conclusions are presented in this report.	USFWS, January 1994
Conceptual Plan for Additional Sampling Sewage Lagoons and Lakes Investigation	This plan describes the proposed sampling procedures to identify the extent of constituents in the sewage lagoons and SWMUs 139 and 140.	Radian, January 1994
Project Assessment Report, Sewage Lagoons and Lakes Closure Project	This report provides historical background of regulatory issues, and investigations from the early 1980s through 1995.	Radian and Foster Wheeler, March 1995a
Site Characterization Report, Sewage Lagoons Closure Project	This report provides results and conclusions of data collected from the sewage lagoons during 1994 and 1995. Describes trend in data from previous investigations.	Radian and Foster Wheeler, June 1995b
Technical Memorandum, 1994 Site Investigation, Lake Holloman, Lake Stinky, and the Ditch	This document presents the results and conclusions of data collected from SWMUs 139 and 140 in the 1994 investigation.	Radian and Foster Wheeler, November 1995c
Risk Assessment Addendum, Sewage Lagoons Closure Project	The risk assessment addendum updates risk values for human health using the data collected during 1994 and 1995. It completely reevaluates the ecological risk assessment using biological sample data.	Radian and Foster Wheeler, March 1996
Biological Resources Report, Sewage Lagoons Closure Project	This report describes the effects that different closure alternatives could have on the ecosystem provided by the sewage lagoons and SWMUs 139 and 140.	Radian and Foster Wheeler, June 1996