

INSTALLATION RESTORATION PROGRAM
PHASE I: RECORDS SEARCH
ELLSWORTH AFB
SOUTH DAKOTA

Prepared For

United States Air Force
STRATEGIC AIR COMMAND
Deputy Chief of Staff
Engineering and Services
Offutt AFB, Nebraska 68113

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TABLE OF CONTENTS

	<u>Page</u>
LIST OF FIGURES	-iv-
LIST OF TABLES	-vi-
EXECUTIVE SUMMARY	-1-
SECTION 1 INTRODUCTION	1-1
Background and Authority	1-1
Purpose and Scope	1-2
Methodology	1-5
SECTION 2 INSTALLATION DESCRIPTION	2-1
Location, Size, and Boundaries	2-1
Base History	2-5
Organization and Mission	2-7
SECTION 3 ENVIRONMENTAL SETTING	3-1
Climate	3-1
Geography	3-3
Topography	3-3
Drainage	3-5
Surface Soils	3-9
Geology	3-13
Regional Geology	3-13
Stratigraphy and Distribution	3-15
Structural Geology	3-21
Hydrology	3-21
Ground-Water Resources	3-22
Study Area Ground-Water Use	3-27
Base Water Supplies	3-28
Ground-Water Quality	3-28
Surface Water Resources	3-31
Surface Water Quality Monitoring	3-33
Threatened and Endangered Species	3-33
Summary of Environmental Setting	3-38
SECTION 4 FINDINGS	4-1
Installation Hazardous Waste Activity Review	4-1
Industrial Operations (Shops)	4-2
Waste Accumulation and Storage Areas	4-11
Pesticide Utilization	4-11
Fuels Management	4-13
Spills and Leaks	4-15
Fire Protection Training	4-21

TABLE OF CONTENTS
(Continued)

	<u>Page</u>
SECTION 4 FINDINGS (Continued)	
Installation Waste Disposal Methods	4-21
Landfills	4-23
Hardfill Disposal Areas	4-28
Sanitary Sewage System	4-28
Industrial Sewer System	4-30
Explosive Ordnance Disposal Area	4-31
Incinerators	4-33
Low-Level Radioactive Waste Burial Sites	4-33
Oil/Water Separators	4-33
Remote Facilities Review	4-36
PM-1/Sundance Site	4-36
Missile Launch Facilities, and	4-37
Launch Control Facilities	
Evaluation of Past Disposal Activities and	4-42
Facilities	
Sites Eliminated from Further Evaluation	4-42
Sites Evaluated Using HARM	4-44
SECTION 5 CONCLUSIONS	5-1
Fire Protection Training Area	5-1
Spill Site No. 9	5-3
(Auto Hobby Shop Heating Fuel)	
Landfill No. 3	5-3
Landfill No. 1	5-4
Spill Site No. 7 (Pump House No. 6)	5-5
Landfill No. 6	5-5
Landfill No. 2	5-6
Low-Level Radioactive Waste Burial Sites	5-6
Landfill No. 5	5-7
Landfill No. 4	5-8
Spill Site No. 1 (Pump House No. 7)	5-8
Spill Site No. 3 (Hydrant Line Leaks)	5-9
Spill Site No. 2 (LF C-9 Coolant Spill)	5-9
Spill Site No. 5 (LF C-11 Coolant Spill)	5-9
Spill Site No. 6 LF N-10 Coolant Spill)	5-10
Spill Site No. 4 (Pramitol Spill at EOD Area)	5-10
SECTION 6 RECOMMENDATIONS	6-1
Phase II Monitoring Recommendations	6-1
Fire Protection Training Area	6-3
Spill Site No. 9	6-11
(Auto Hobby Shop Heating Fuel)	

TABLE OF CONTENTS
(Continued)

	<u>Page</u>
SECTION 6 RECOMMENDATIONS (Continued)	
Landfill No. 3	6-11
Landfill No. 1	6-12
Spill Site No. 7 (Pump House No. 6)	6-12
Landfill No. 6	6-12
Landfill No. 2	6-12
Low-Level Radioactive Waste Burial Sites	6-13
Landfill No. 5	6-13
Landfill No. 4	6-13
Spill Site No. 1 (Pump House No. 7)	6-14
Spill Site No. 3 (Hydrant Line Leaks)	6-14
Spill Site No. 2 (LF C-9), No. 3 (LFC-4), and No. 6 (LF N-10)	6-14
(Spill Site No. 4 (EOD Pramitol Spill))	6-15
APPENDIX A BIOGRAPHICAL DATA	
APPENDIX B LIST OF INTERVIEWEES AND OUTSIDE AGENCY CONTACTS	
APPENDIX C TENANT ORGANIZATIONS AND MISSIONS	
APPENDIX D SUPPLEMENTAL BASE FINDINGS INFORMATION	
APPENDIX E MASTER LIST OF SHOPS	
APPENDIX F PHOTOGRAPHS	
APPENDIX G USAF INSTALLATION RESTORATION PROGRAM HAZARD ASSESSMENT RATING METHODOLOGY	
APPENDIX H SITE HAZARD ASSESSMENT RATING FORMS	
APPENDIX I GLOSSARY OF TERMINOLOGY AND ABBREVIATIONS	
APPENDIX J REFERENCES	
APPENDIX K INDEX OF REFERENCES TO POTENTIAL CONTAMINATION SITES AT ELLSWORTH AFB	

LIST OF FIGURES

<u>No.</u>	<u>Title</u>	<u>Page</u>
1	Sites of Potential Environmental Contamination - Main Base	-6-
2	Sites of Potential Environmental Contamination - Missile Facilities	-7-
1.1	U.S. Air Force Installation Restoration Program	1-3
1.2	Records Search Flow Chart	1-7
2.1	Regional Location Map	2-2
2.2	Area Location	2-3
2.3	Installation Site Plan	2-4
2.4	44th Strategic Missile Wing Flight Locations	2-6
3.1	Major Physiographic Divisions of South Dakota	3-4
3.2	Storm Drainage Map	3-7
3.3	Badlands Air Force Range Drainage	3-8
3.4	PM-1/Sundance Site Drainage	3-10
3.5	Soils	3-11
3.6	Badlands Air Force Range Soils	3-14
3.7	Geologic Map of South Dakota	3-17
3.8	Test Location L-1 Boring Log	3-18
3.9	Test Location Boring Log	3-19
3.10	Study Area Well Locations	3-29
3.11	Surface Water Quality Monitoring Locations	3-34
3.12	PM-1/Sundance Site Vicinity Sampling Stations	3-35
3.13	PM-1/Sundance Site Remote Sampling Locations	3-36

LIST OF FIGURES
(Continued)

<u>No.</u>	<u>Title</u>	<u>Page</u>
4.1	Major Liquid Fuels Storage Areas	4-14
4.2	Spill and Leak Areas - Main Base	4-17
4.3	Spill and Leak Areas - Missile Facilities	4-18
4.4	Fire Protection Training Area	4-22
4.5	Landfill Sites	4-24
4.6	Hardfill Disposal Areas	4-29
4.7	EOD - Munitions Residual Burial Pit	4-32
4.8	Low Level Radioactive Waste Sites - Main Base	4-34
4.9	PM-1 Study Area After Burial	4-38
4.10	PM-1 Floor Plan	4-39
4.11	Cross Section of Primary Building After Burial	4-40
6.1	Sites of Potential Environmental Contamination - Main Base	6-9
6.2	Sites of Potential Environmental Contamination - Missile Facilities	6-10

LIST OF TABLES

<u>No.</u>	<u>Title</u>	<u>Page</u>
1	Sites Evaluated Using the Hazard Assessment Rating Methodology	-8-
3.1	Climatological Data	3-2
3.2	Ellsworth Air Force Base Soils	3-12
3.3	Study Area Geologic Units	3-16
3.4	Logs of Base Wells 1 and 2	3-25
3.5	Ellsworth AFB Well Data	3-30
3.6	Study Area Surface Water Use Classifications in South Dakota	3-32
3.7	PM-1/Sundance Site Environmental Quality Monitoring Stations	3-37
4.1	Industrial Operations (Shops)	4-4
4.2	Waste Accumulation Areas	4-12
4.3	Spill and Leak Area Information Summary	4-16
4.4	Summary of Landfill Disposal Sites	4-25
4.5	Low-Level Radioactive Waste Burial Sites	4-35
4.6	Summary of Flow Chart Logic for Areas of Initial Health, Welfare, and Environmental Concern at Ellsworth AFB	4-43
4.7	Summary of HARM Scores for Potential Contamination Sites at Ellsworth AFB	4-45
5.1	Sites Evaluated Using the Hazard Assessment Rating Methodology	5-2
6.2	Recommended List of Analytical Parameters for Phase II IRP at Ellsworth AFB	6-7

EXECUTIVE SUMMARY

The Department of Defense (DOD) has developed a program to identify and evaluate past hazardous material disposal sites on DOD property, to control the migration of hazardous contaminants, and to control hazards to health or welfare that may result from these past disposal operations. This program is called the Installation Restoration Program (IRP). The IRP has four phases consisting of Phase I, Installation Assessment/Records Search; Phase II, Confirmation/Quantification; Phase III, Technology Base Development; and Phase IV, Remedial Actions. Engineering-Science was retained by the United States Air Force to conduct the Phase I, Initial Assessment/Records Search for Ellsworth Air Force Base (AFB) under Contract No. F08637 84 R0040.

INSTALLATION DESCRIPTION

Ellsworth AFB is located in western South Dakota, approximately 11 miles east of Rapid City, north of Interstate 90. The main base consists of approximately 4,858 acres comprised of runways and airfield operations, industrial areas, housing and recreational facilities. The base is bordered on the north, south, and west by open land while the east is bordered by residential and commercial areas. Remote installation facilities include the Badlands Air Force Range (2,487 acres) the South Nike Academic Annex (11 acres), three family housing annexes (11 to 17 acres), three communications facilities (each less than 2 acres), a nuclear decommissioning site (less than 1 acre), and 165 Minuteman Missile Launch Facilities and Launch Control Facilities (21,677 acres owned, leased, or easement).

The base was officially activated in July 1942, and began operations in September 1942, as Rapid City Army Air Base. In 1947, when the Air Force became a separate operating branch, the base name was modified to Rapid City AFB. The base was renamed Ellsworth AFB in June 1953, in memory of Brigadier General Richard Ellsworth.

The base mission, through its early years, was the training of crews for the B-36 and B-52 bomber. In October 1960, the 850th Strategic Missile Squadron was activated at Ellsworth AFB and assigned with Titan I Missiles. The 44th Strategic Missile Wing was established in January 1962, and became active in October 1963, with 15 Minuteman Intercontinental Ballistic Missile flights. Today, the 44th Strategic Missile Wing continues as the host wing at Ellsworth AFB.

ENVIRONMENTAL SETTING

The environmental setting data reviewed for this investigation identified the following points relevant to Ellsworth AFB:

- o The mean annual precipitation at Ellsworth AFB is 16.9 inches and the net annual precipitation is calculated to be minus 24 inches. The mean annual precipitation at Badlands Air Force Range is 16 inches; net annual precipitation is calculated to be minus 24 inches. The average annual precipitation received in the vicinity of the PM-1/Sundance Site is 20 inches; the calculated net annual precipitation is minus 21 inches.
- o Flooding is not known to be a problem at any of the installations investigated under the scope of this study; no wetlands exist on any of the facilities.
- o Ellsworth AFB surface soils are generally fine-grained and possess low permeabilities in the upper sections of their profiles, but may be underlain by higher permeability sand and gravel zones. The Badlands Air Force Range surface materials are principally clays and silts of the White River Group (eighty percent of the installation's land area); permeable wind-blown sand, sandy terrace deposits and alluvium are present at land surface in the remaining portion of the Range. The surface soils present at the PM-1/Sundance Site are typically clayey or clayey and gravelly residuum having low permeabilities. Bedrock underlies the residuum at shallow depths.

- o An ephemeral shallow aquifer exists at or near ground surface at Ellsworth AFB (older alluvium). It probably contains ground water seasonally and discharges to local surface waters. The aquifers of regional significance at Ellsworth AFB consist of bedrock units present at depths of 1700 feet below land surface or greater. The regionally significant aquifers beneath the base are effectively sealed from installation surface activities by substantial sequences of shale, sandstone, limestone, siltstone, etc. Ground water contained in the regional aquifers exists under very strong artesian pressures.
- o Shallow unconsolidated aquifers exist at the Badlands Air Force Range. Ground water occurs in these hydrogeologic units under water table conditions, usually at depth of 100 feet or less below land surface.
- o A shallow aquifer is not known to exist at the PM-1/Sundance Site. The underlying bedrock may contain ground water locally in secondary openings, but is not considered to be a dependable source of water supplies. Most of the PM-1/Sundance Site is paved, precluding the generation of contaminated leachate and any possible contaminant migration to an aquifer beneath the facility.
- o Ellsworth AFB and surrounding areas obtain their potable water supplies from the Rapid City municipal distribution system. The city uses surface water, shallow and deep aquifers to obtain its water supplies. The base maintains wells finished into deep aquifers on a standby basis. The town of Box Elder and numerous consumers near the base use their own individual wells to obtain needed water supplies. It is believed that all of the wells presently in use near Ellsworth AFB are finished into deep aquifers, at least 1700 feet below ground surface. Surface water (probably augmented by shallow aquifer seasonal discharge) is utilized for livestock watering and irrigation purposes by consumers located west, north and east of the base.
- o It is unlikely that any water resources are currently in use to serve human populations near the Badlands AFB or the PM-1/-

Sundance Site. The Range is a restricted area with no resident population and is located in a remote section of Shannon County. The PM-1/Sundance Site is situated on a mountain top in a national forest, six miles northwest of the town of Sundance, in Crook County, Wyoming. Its remote setting isolates the site from disturbance.

- o The streams existing on Ellsworth AFB are classified as ephemeral streams; they contain water only when sufficient runoff is available to support flow. The White River, a perennial stream transects a segment of the Badlands Air Force Range. No surface waters exist at the PM-1/Sundance Site.
- o A review of base historical surface water quality monitoring data indicates several incidences of noncompliance with the NPDES permit stipulations due to periodically high oil and grease and fecal coliform levels. All the incidences of non-compliance have been as a result of sewage treatment plant discharges.
- o A review of the annual PM-1/Sundance Site monitoring program data (1969 to date) indicates that there have been no changes in radionuclide levels in surface water, ground water or soil samples collected.
- o No rare and endangered species are known to be residents at any of the installations investigated under the scope of this study, however, several such mammals and birds are known to be occasional transients and could be present at any or all of the installations at any time.

METHODOLOGY

During the course of this project, interviews were conducted with installation personnel (past and present) familiar with past waste disposal practices; file searches were performed for past hazardous waste activities; interviews were held with local, state and federal agencies; and field surveys were conducted at suspected past hazardous waste activity sites.

FINDINGS AND CONCLUSIONS

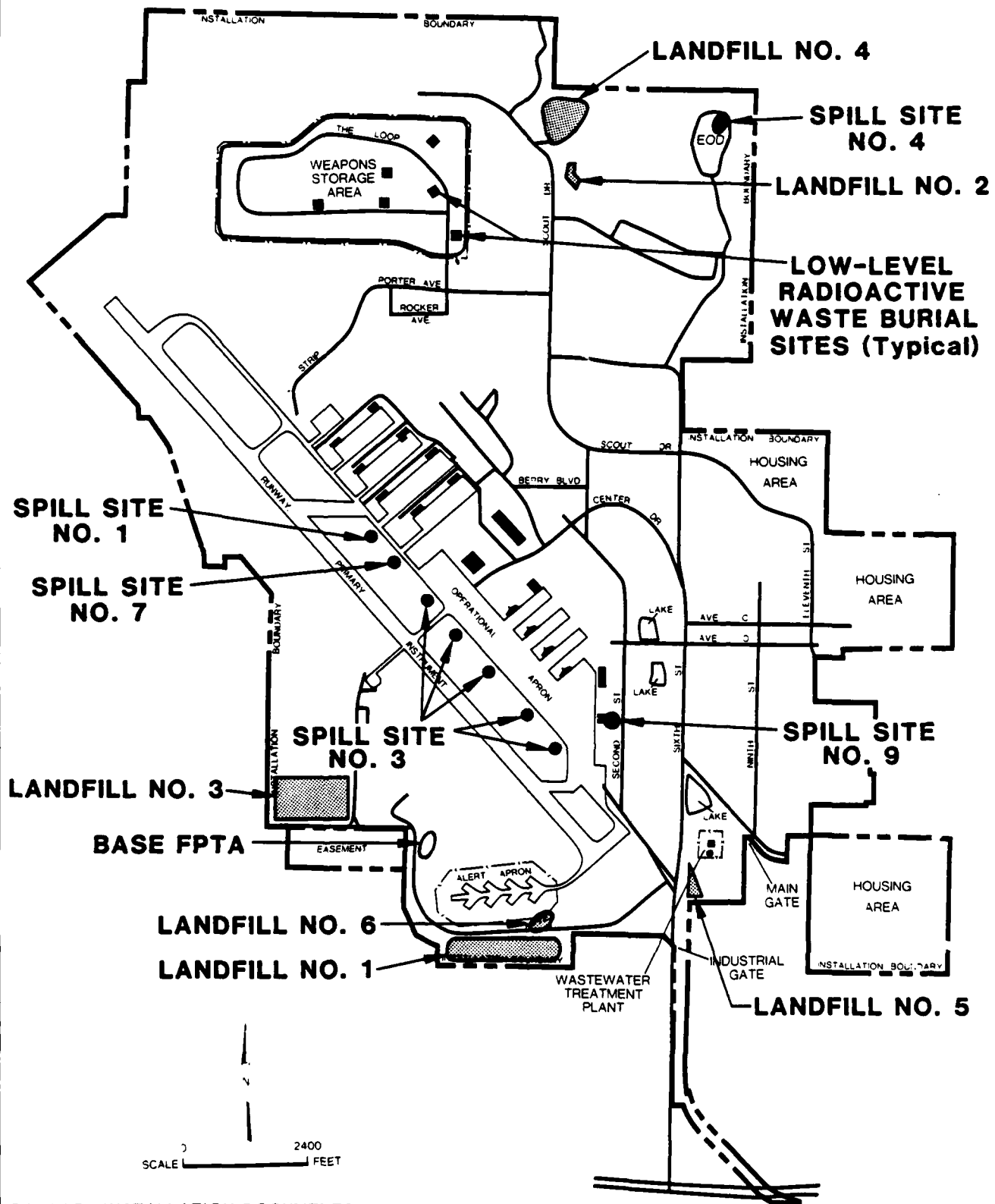
Sixteen sites were identified as potentially containing hazardous contaminants and having the potential for contaminant migration resulting from past activities. Thirteen of these sites are located at the main base and are shown on Figure 1. Figure 2 shows the location of the three missile launch facilities where the potential for contamination exists. These sites have been assessed using a Hazard Assessment Rating Methodology (HARM) which takes into account factors such as site characteristics, waste characteristics, potential for contaminant migration and waste management practices. The rating system is designed to indicate the relative need for followup investigation. The results of the HARM assessments are presented in Table 1.

RECOMMENDATIONS

The recommended Phase II activities for the sixteen sites identified as potentially containing hazardous contaminants and having the potential for contaminant migration are summarized below. The Phase II program may be expanded to define the extent and type of contamination if the initial monitoring reveals contamination.

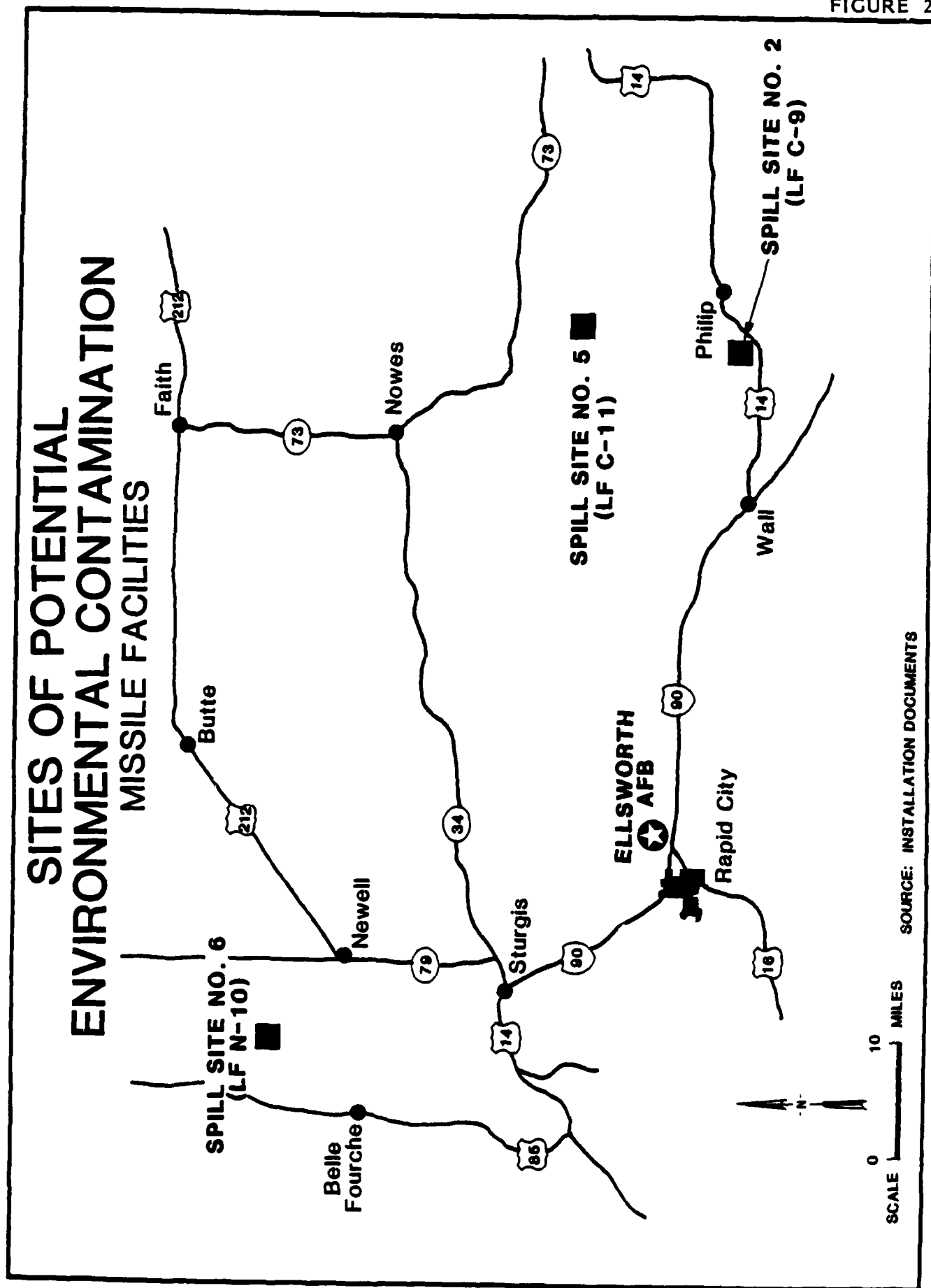
- o Fire Protection Training Area.
Conduct three borings and analyze soil samples from the borings. Also, collect and analyze three sediment samples from the 001 discharge pond.
- o Spill Site No. 9 (Auto Hobby Shop Heating Fuel).
Conduct a geophysical study and install and sample one background and two downgradient wells.
- o Landfill No. 3.
Conduct a geophysical study and install and sample one background and eight downgradient wells.
- o Landfill No. 1.
Conduct a geophysical study and install and sample one background and ten downgradient wells.

ELLSWORTH AFB SITES OF POTENTIAL ENVIRONMENTAL CONTAMINATION MAIN BASE



SOURCE: INSTALLATION DOCUMENTS

FIGURE 2



SOURCE: INSTALLATION DOCUMENTS

TABLE 1
SITES EVALUATED USING THE
HAZARD ASSESSMENT RATING METHODOLOGY
ELLSWORTH AFB

Rank	Site	Operation Period	Harm Score ¹
1.	Fire Protection Training Area	1942 - Present	66
2.	Spill Site No. 9 (Auto Hobby Shop Heating Fuel)	Discovered 1985	65
3.	Landfill No. 3	1965 - 1976	62
4.	Landfill No. 1	1940's - 1964	59
5.	Spill Site No. 7 (Pump House No. 6)	1984	56
6.	Landfill No. 6	1962 - 1965	49
7.	Landfill No. 2	1964 - 1965	48
8.	Low-Level Radioactive Burial Sites	1952 - 1962	46
9.	Landfill No. 5	1960 - 1980	46
10.	Landfill No. 4	1940's - Present	44
11.	Spill Site No. 1 (Pump House No. 7)	1972	43
12.	Spill Site No. 3 (Hydrant Line Leaks)	Early 1970 - 1974	43
13.	Spill Site No. 2 (LF C-9 Coolant Spill)	1977	40
14.	Spill Site No. 5 (LF C-11 Coolant Spill)	1983	40
15.	Spill Site No. 6 (LF N-10 Coolant Spill)	1983	40
16.	Spill Site No. 4 (EOD Pramitol Spill)	1982	34

¹ This ranking was performed according to the Hazard Assessment Rating Methodology (HARM) described in Appendix G. Individual rating forms are in Appendix H.

- o Spill Site No. 7 (Pump House No. 6).
Conduct five borings and analyze soil samples from the borings.
- o Landfill No. 6.
Conduct a geophysical study and monitor as part of Landfill No. 1.
- o Landfill No. 2.
Conduct a geophysical study and install and sample one background and two downgradient wells.
- o Low-Level Radioactive Waste Burial Site.
Conduct a geophysical study to locate the solid waste disposal box and check for radioactivity. Check the status of the tank liquids and, if present, sample.
- o Landfill No. 5.
Conduct a geophysical study and install and sample one background and two downgradient wells.
- o Landfill No. 4.
Conduct a geophysical study and install and sample one background and two downgradient wells.
- o Spill Site No. 1 (Pump House No. 7).
Conduct three borings and analyze soil samples from the borings.
- o Spill Site No. 3 (Hydrant Line Leaks).
Install a monitoring well downgradient of each pump house (No. 1 through No. 5) transfer line and sample the ground water.
- o Spill Site No. 2 (LF C-9 Coolant Spill).
Conduct three borings and analyze soil samples from the borings.

- o Spill Site No. 5 (LF C-11 Coolant Spill).
Conduct three borings and analyze soil samples from the borings.
- o Spill Site No. 6 (LF N-10 Coolant Spill).
Conduct three borings and analyze soil samples from the borings.
- o Spill Site No. 4 (EOD Pramitol Spill)
Collect and analyze soil samples at 10 locations to a depth of 3 and 6 inches.

SECTION 1
INTRODUCTION

BACKGROUND AND AUTHORITY

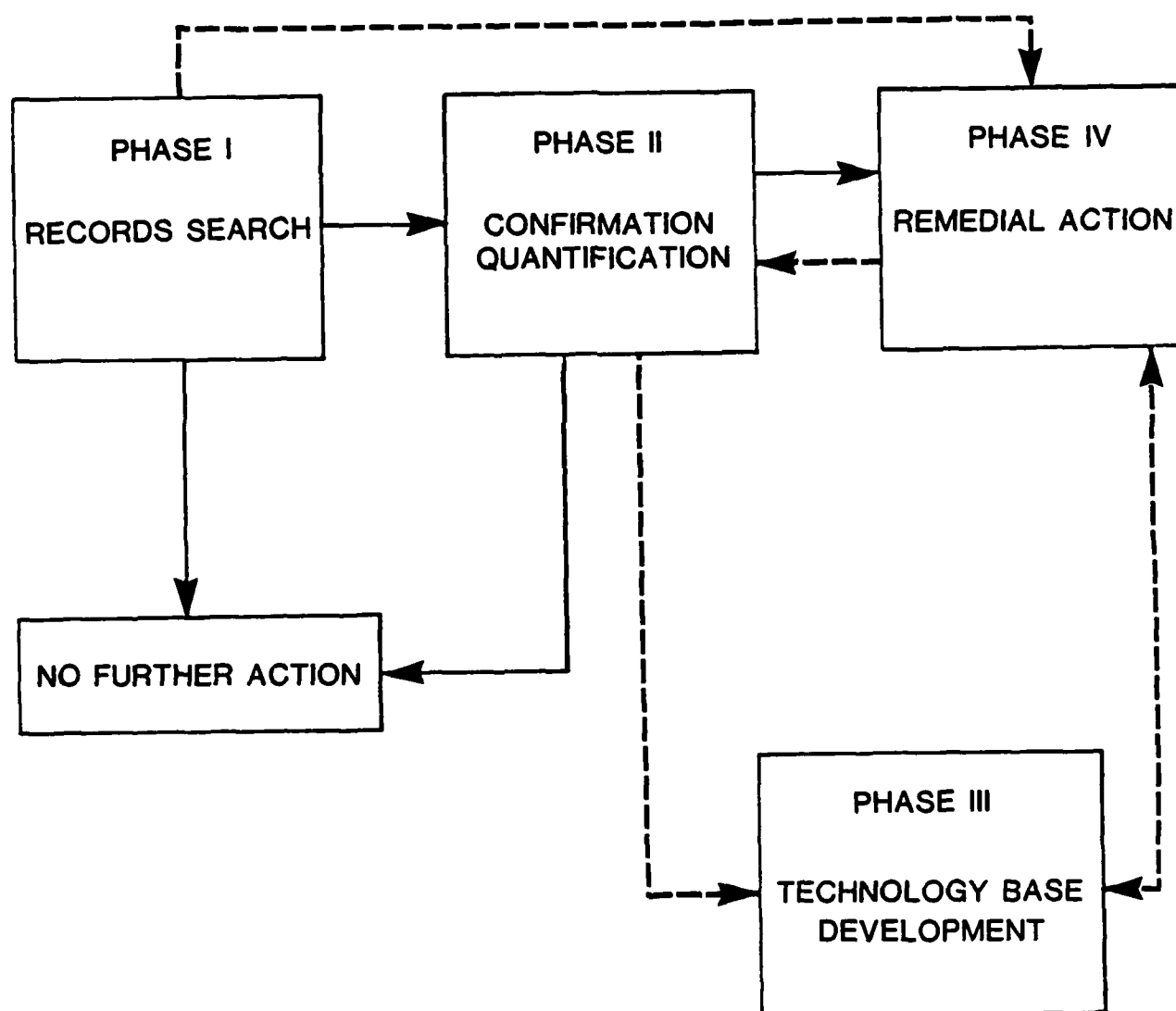
The United States Air Force, due to its primary mission of defense of the United States, has long been engaged in a wide variety of operations dealing with toxic and hazardous materials. Federal, state, and local governments have developed regulations that require disposers of waste to identify the locations and contents of past disposal sites and take action to eliminate hazards in an environmentally responsible manner. The primary Federal legislation governing disposal of hazardous waste is the Resource Conservation and Recovery Act (RCRA) of 1976, as amended. Under Section 6003 of the Act, Federal agencies are directed to assist the Environmental Protection Agency (EPA) and under Section 3012, state agencies are required to inventory past disposal sites, and Federal agencies are required to make the information available to the requesting agencies. To assure compliance with these hazardous waste regulations, the Department of Defense (DOD) developed the Installation Restoration Program (IRP). The current DOD IRP policy is contained in Defense Environmental Quality Program Policy Memorandum (DEQPPM) 81-5, dated 11 December 1981 and implemented by Air Force message dated 21 January 1982. DEQPPM 81-5 reissued and amplified all previous directives and memoranda on the Installation Restoration Program. DOD policy is to identify and fully evaluate suspected problems associated with past disposal practices of hazardous waste and resulting contamination, and to control hazards to health and welfare that resulted from these past practices. The IRP is the basis for response actions on Air Force installations under the provisions of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980, clarified by Executive Order 12316. CERCLA is the primary legislation governing remedial action at past hazardous waste disposal sites.

PURPOSE AND SCOPE

The IRP is a four-phased program (Figure 1.1) designed to assure that identification, confirmation/ quantification, and remedial actions are performed in a timely and cost-effective manner. Each phase is briefly described below:

- o Phase I - Installation Assessment/Records Search - The purpose of Phase I is to identify and prioritize those past disposal sites that may pose a hazard to public health or the environment as a result of contaminant migration to surface or ground waters, or have an adverse effect by its persistence in the environment. In this phase it is determined whether a site requires further action to confirm an environmental hazard or whether it may be considered to present no hazard. If a site requires immediate remedial action, such as removal of abandoned drums, the action can proceed directly to Phase IV. Phase I is a basic background document for the Phase II study.
- o Phase II - Confirmation/Quantification - The purpose of Phase II is to define and quantify, by preliminary and comprehensive environmental and/or ecological survey, the presence or absence of contamination, the extent of contamination, waste characterization (when required by the regulatory agency), and to identify sites or locations where remedial action is required in Phase IV. Research requirements identified during this phase will be included in the Phase III effort of the program.
- o Phase III - Technology Base Development - The purpose of Phase III is to develop a sound data base upon which to prepare a comprehensive remedial action plan. This phase includes implementation of research requirements and technology for objective assessment of adverse effects. A Phase III requirement can be identified at any time during the program.
- o Phase IV - Operations/Remedial Actions - The purpose of Phase IV includes the preparation and implementation of a remedial action plan.

U.S. AIR FORCE INSTALLATION RESTORATION PROGRAM



SOURCE: AFESC

Engineering-Science was retained by the United States Air Force to conduct the Phase I Records Search at Ellsworth Air Force Base (AFB) under Contract No. F08637-84-R0040. This report contains a summary and an evaluation of the information collected during Phase I of the IRP and recommended follow-on actions. The approximate land areas included as part of the Ellsworth AFB study is as follows:

Main Base	4858 Acres
Badlands Air Force Range	2487 Acres
Minuteman Launch and Launch Control Facilities	21,677 Acres (including leases and easements)
South Nike Academic Annex	7 Acres
South Nike Family Housing Annex No. 3	11 Acres
East Nike Family Housing Annex No. 2	11 Acres
West Nike Family Housing Annex No. 4	17 Acres
West Communications Transmitter	2 Acres
Terry Peaks Radio Relay Facility	<1 Acre
Wall Relay Building	<1 Acre
PM-1/Sundance Site	<1 Acre

The activities performed as a part of the Phase I study scope included the following:

- Review of site records
- Interviews with personnel familiar with past generation and disposal activities
- Survey of types and quantities of wastes generated
- Determination of current and past hazardous waste treatment, storage, and disposal activities
- Description of the environmental setting at the base
- Review of past disposal practices and methods
- Reconnaissance of field conditions
- Collection of pertinent information from federal, state and local agencies

- Assessment of the potential for contaminant migration
- Development of recommendations for follow-on actions

Engineering-Science performed the on-site portion of the records search during April 29 - May 3, 1984. The following team of professionals were involved:

- E. J. Schroeder, P.E., Environmental Engineer and Project Manager, 18 years of professional experience.
- J. R. Absalon, Hydrogeologist, 11 years of professional experience.
- J. P. McAuliffe, Environmental Engineer, 3 years of professional experience.
- J. E. Menard, Environmental Engineer, 4 years of professional experience.

More detailed information on these four individuals is presented in Appendix A.

METHODOLOGY

The methodology utilized in the Ellsworth AFB Records Search began with a review of past and present industrial operations conducted at the installation. Information was obtained from available records such as shop files and real property files, as well as interviews with 60 past and present base employees from various operating areas. Those interviewed included current and past personnel associated with civil engineering, fuels management, roads and grounds maintenance, fire protection, real property, history, and the various shops. A listing of interviewee positions with approximate years of service is presented in Appendix B.

Concurrent with the employee interviews, the applicable federal, state and local agencies were contacted for pertinent study area related environmental data. The agencies contacted are listed in Appendix B.

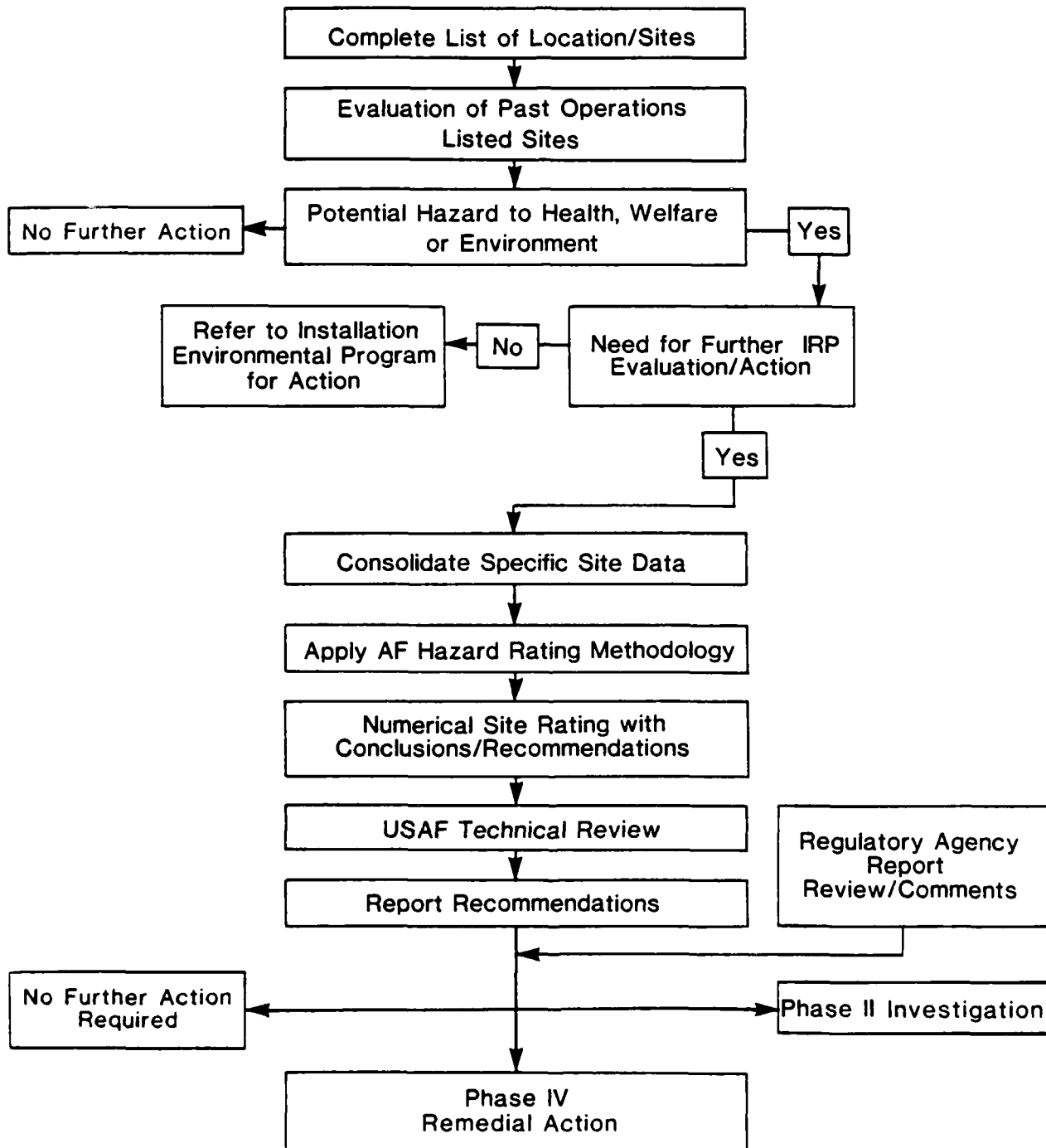
The next step in the activity review was to identify all sources of hazardous waste generation and to determine the past management practices regarding the use, storage, treatment, and disposal of hazardous materials from the various sources on the base. Included in this part of the activities review was the identification of all known past disposal sites and other possible sources of contamination such as spill areas.

A ground tour and an overflight of the identified sites were made by the Engineering-Science Project Team to gather site-specific information including: (1) general observations of existing site conditions; (2) visual evidence of environmental stress; (3) presence of nearby drainage ditches or surface waters; and (4) visual inspection of these water bodies for any obvious signs of contamination or leachate migration.

A decision was then made, based on all of the above information, whether a potential hazard to health, welfare or the environment exists at any of the identified sites using the flow chart shown in Figure 1.2. If no potential existed, the site received no further action. For those sites where a potential hazard was identified, a determination of the need for IRP evaluation/action was made by considering site-specific conditions. If no further IRP evaluation was determined necessary, but the site potentially could create an environmental problem in the future, then the potential problem was referred to the installation environmental program for appropriate action. If a site warranted further investigation, it was evaluated and rated using the Hazard Assessment Rating Methodology (HARM). The HARM score is a resource management tool which indicates the relative potential for adverse effects on health or the environment at each site evaluated.

FIGURE 1.2

PHASE I INSTALLATION RESTORATION PROGRAM
RECORDS SEARCH FLOW CHART



Source: AFESC

SECTION 2
INSTALLATION DESCRIPTION

LOCATION, SIZE, AND BOUNDARIES

Ellsworth AFB is located in western South Dakota, approximately 11 miles east of Rapid City, north of Interstate 90 (Figure 2.1). The base is located on the border of Pennington and Meade Counties, just north of the Box Elder corporate limits (Figure 2.2). On the north, south, and west, the base is bordered by open land, while the east is bordered by residential and commercial areas. The main base site comprises approximately 4,858 acres (see Figure 2.3). Remote installation (satellite) facilities consist of the following government owned land (see Figures 2.1 and 2.2):

- o Badlands Air Force Range, 2,487 acres owned.
- o South Nike Academic Annex, 7 acres owned and 1 acre lease or easement.
- o South Nike Family Housing Annex No. 3, 11 acres owned and 8 acres lease or easement.
- o East Nike Family Housing Annex No. 2, 11 acres owned and 27 acres lease or easement.
- o West Nike Family Housing Annex No. 4, 17 acres owned and 24 acres lease or easement.
- o West Communications Annex, 2 acres owned and 10 acres lease or easement.
- o Terry Peak Radio Relay Facility, 0.62 acres owned.
- o Wall Relay Building, less than 1 acre (no land owned).
- o PM-1/Sundance Site, 0.34 acre (650 acres lease or easement).
- o Minuteman Launch and Launch Control Facilities, 21,677 acres owned, lease, and easement.

FIGURE 2.1

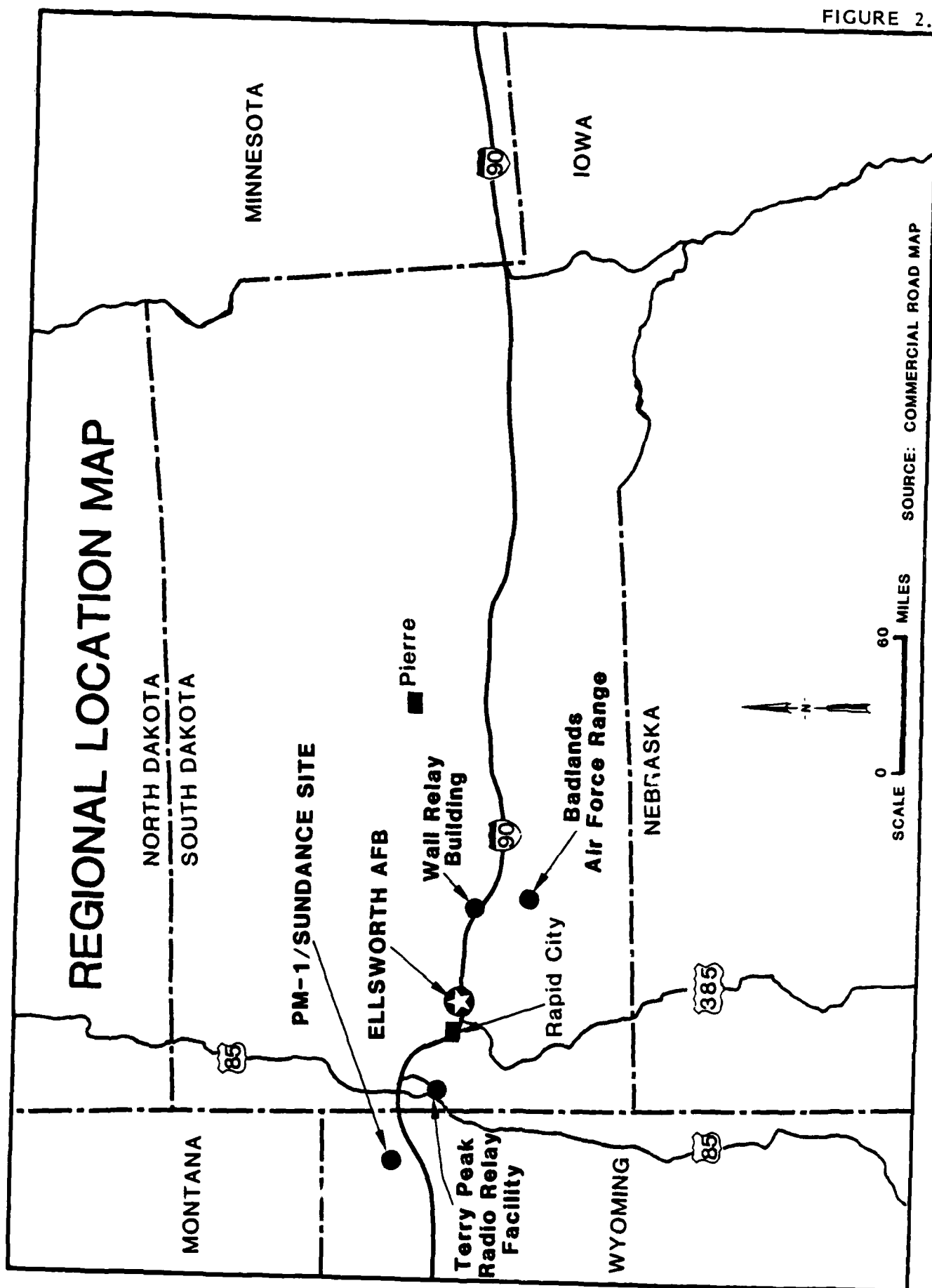
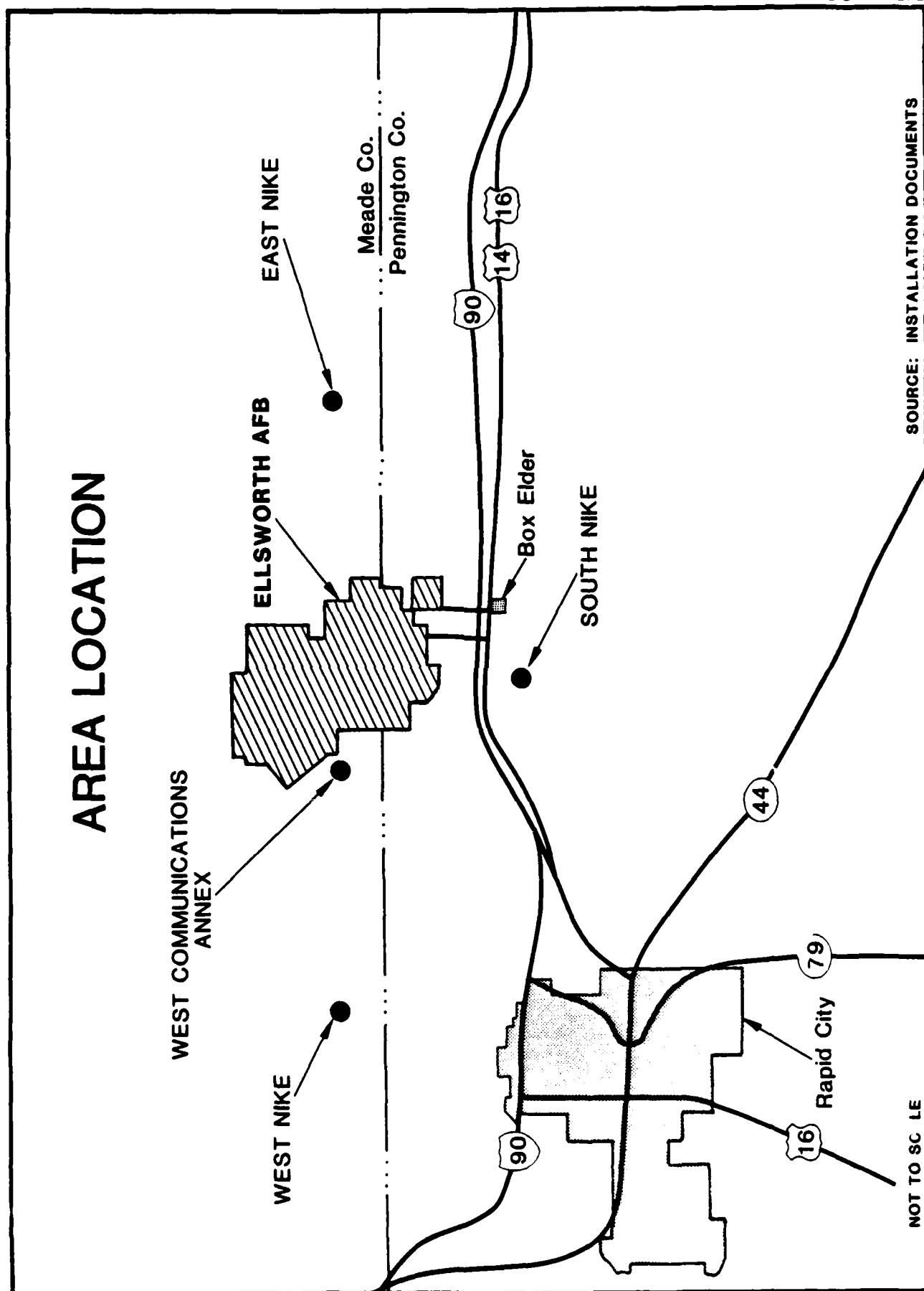


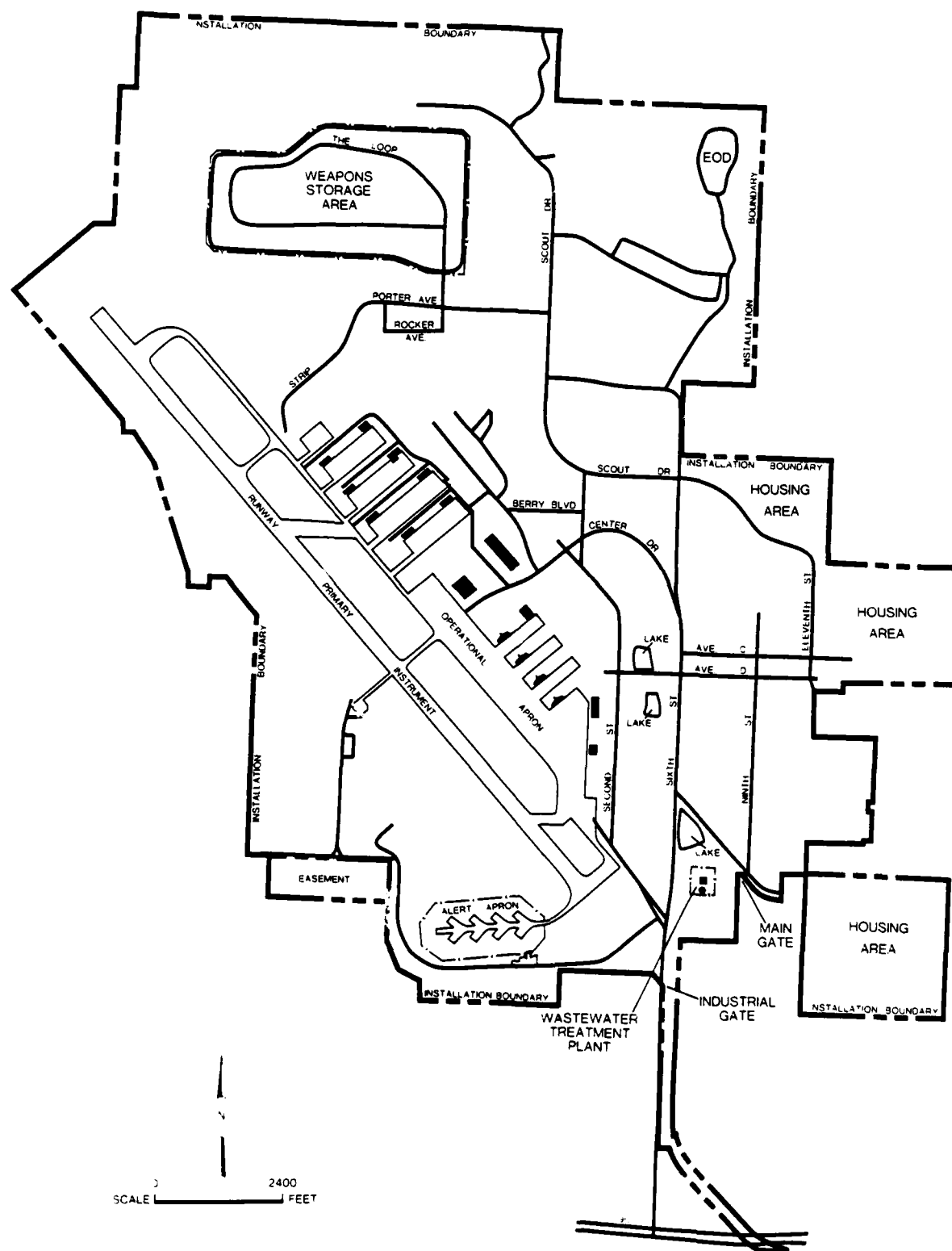
FIGURE 2.2



SOURCE: INSTALLATION DOCUMENTS

FIGURE 2.3

ELLSWORTH AFB INSTALLATION SITE PLAN



SOURCE: INSTALLATION DOCUMENTS

The 150 Minuteman II Intercontinental Ballistic Missile (ICBM) Launch Facilities (LF) and 15 Launch Control Facilities (LCF) are located to the north and east of Ellsworth AFB. The total acreage associated with the LF and LCF including U.S. government-owned, leased, and easement land is 21,677 acres. The acreage is spread over a land area of approximately 13,500 square miles within a hundred mile radius of the base.

The missile LF and LCF are arranged in 15 flights (A-O) with an alphanumeric code as follows: A-1 indicated the LCF for Flight A, A-2 through A-11 are the associated LF. The same numerical designation holds for Flights B through O. The 15 Minuteman flight locations are shown on Figure 2.4.

BASE HISTORY

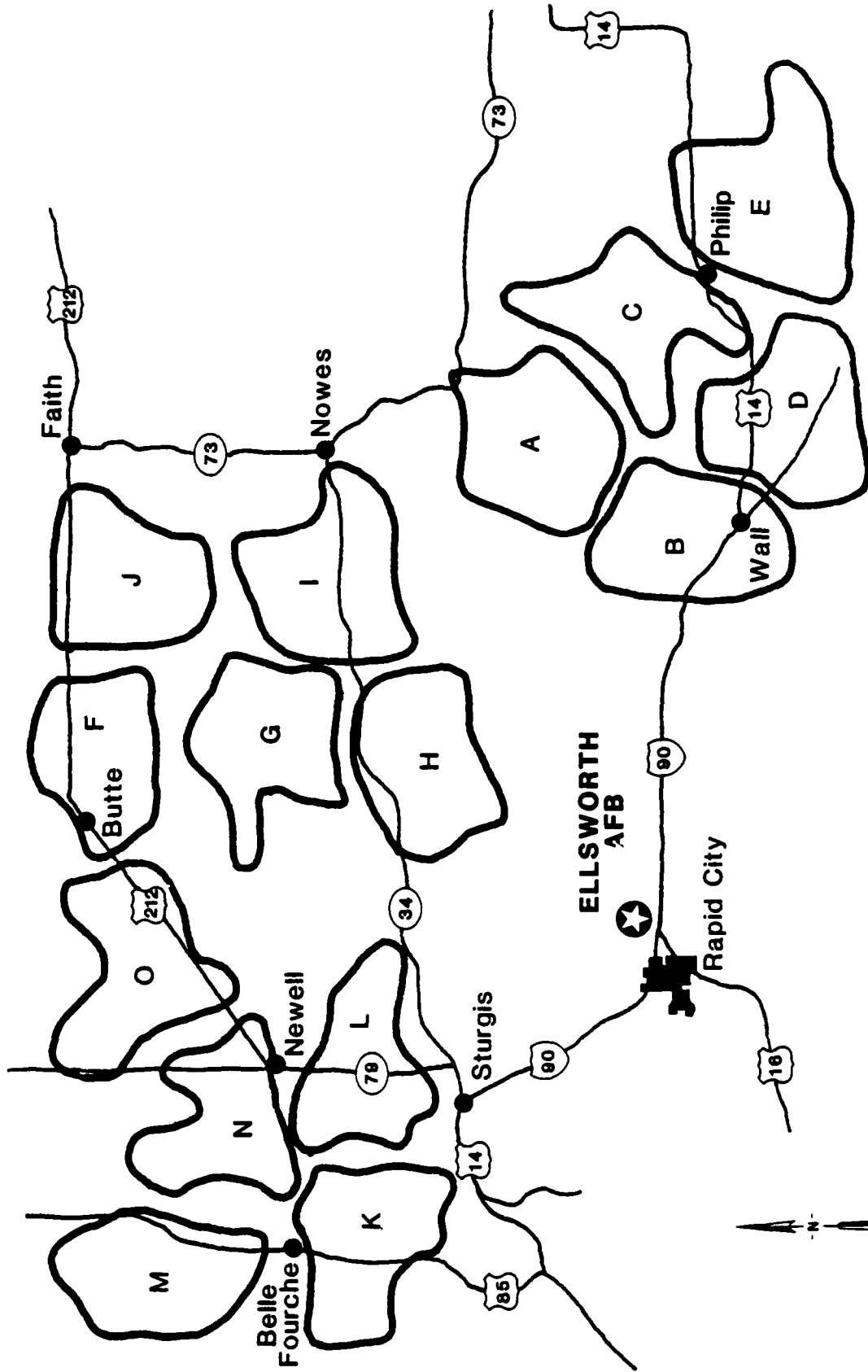
The base was officially activated July 1942, and began operations in September 1942, as Rapid City Army Air Base for Training of B-17 "Flying Fortress" Bomber Crews. Following World War II, the base mission was the training of weather reconnaissance squadrons until September 1946, when it went inactive. The base resumed activities in March 1947, with the assignment of the 28th Bombardment Wing under the 15th Air Force Insignia.

In September 1947, when the Air Force became a separate operating branch, the base was renamed Rapid City AFB and became a permanent installation in 1948. The base was renamed Ellsworth AFB in June 1953, in memory of Brigadier General Richard Ellsworth. The base continued its bomber mission and in 1957, the 28th Bombardment Wing received its first intercontinental all-jet B-52 bombers to replace the existing B-36.

Between 1956 and 1959, the U.S. Army constructed and controlled four Nike Missile sites, located to the north, south, east and west of Ellsworth AFB. The sites consisted of housing and administration facilities in addition to missile facilities. Once the facilities had become obsolete in 1964, Ellsworth AFB obtained the housing areas at the four sites and the administration buildings at the South Nike Site. The remaining facilities were declared excess, for disposal, by the Army.

FIGURE 2.4

44TH STRATEGIC MISSILE WING FLIGHT LOCATIONS



SOURCE: INSTALLATION DOCUMENTS

The North Nike family housing was transferred to the Bureau of Indian Affairs in 1972.

Between 1952 and 1962, the Atomic Energy Commission operated at what was then known as Rushmore Air Force Station under the jurisdiction of the Air Material Command. That facility is now the Base Weapons Storage Area.

Prior to 1968, Ellsworth AFB also provided logistical support to three sites operated under the command of the 10th Air Force, and located near Gettysburg, South Dakota; Sundance, Wyoming; and Miles City, Montana. The sites were deactivated in 1968 and disposed of, excepting a portion of Sundance, in 1970. The remainder of the Sundance site, except for the radioactive burial area, was disposed of in January, 1974. The radioactive burial area has remained Air Force property.

In October 1960, the 850th Strategic Missile Squadron was activated and assigned with Titan I Missiles, to the 28th Bombardment Wing at Ellsworth. The Titan I Missiles were deactivated in March 1965, following the establishment of the Minuteman Missiles. The Titan missile sites were disposed of between 1965 and 1978.

The 44th Strategic Missile Wing (SMW) was established in January 1962, and became operational in October 1963 with 15 Minuteman ICBM flights. The Minuteman I Missiles were updated and modified between October 1971 and April 1973. Today, the 44th Strategic Missile Wing (SMW) continues as the host wing at Ellsworth AFB.

ORGANIZATION AND MISSION

The primary mission at Ellsworth AFB is to provide operational and maintenance facilities for both aircraft and Minuteman missiles of the Strategic Air Command. The host organization is the 44th SMW with 150 missiles of the LGB-30F Minuteman ICBM weapon system. The 28th Bombardment Wing, also under the jurisdiction of the 4th Air Division, operates B-52 bombers of the 77th Bombardment Squadron, KC-135 Stratotankers of the 28th Air Refueling Squadron, and EC-135 aircraft of the 4th Airborne Command and Control Squadron. The 44th Combat Support Group maintains the base in support of the 44th SMW. The USAF Hospital Ellsworth provides health care to the base personnel and their families.

The tenant organizations at Ellsworth AFB are listed below. Descriptions of the major tenant organizations and their missions are presented in Appendix C.

Army and Air Force Exchange Service

Air Force Audit Agency, Area Audit Office

Air Force Institute of Technology

American Red Cross

Defense Investigative Service

Defense Property Disposal Office (DPDO)

Detachment 15, 3904th Management Engineering Squadron

Air Force Commissary Service

Detachment 17, 9th Weather Squadron

Detachment 1302, 13th District Air Force Office of Special Investigations

Detachment 2, 37th Aerospace Rescue and Recovery Squadron

409th Field Training Detachment

2148th Information Systems Squadron

64th Flying Training Wing

NCO Leadership School

USAF Trial Judiciary

SECTION 3

ENVIRONMENTAL SETTING

The environmental setting of Ellsworth AFB and the remote sites are described in this section with the primary emphasis directed toward the identification of features or conditions that may facilitate the generation and migration of hazardous waste related contamination off-base. A discussion of the environmental setting at the main base is presented first, followed by a description of the satellite facilities. Environmentally sensitive conditions pertinent to this study are summarized at the end of the section.

CLIMATE

Temperature, precipitation, snowfall and other relevant climatic data furnished by Detachment 17, 9th Weather Squadron, Ellsworth AFB, SD are listed on Table 3.1. The period of record is 43 years. The mean annual precipitation is 16.9 inches at the base. The net annual precipitation is calculated to be minus 24 inches, based on National Oceanographic and Atmospheric Administration (NOAA) information (NOAA, 1983). The net annual precipitation is an estimate of the amount of meteoric water potentially available for infiltration into the subsurface and does not consider evapotranspiration, which varies seasonally. Net precipitation is equal to total precipitation minus evaporation. The infiltration potential for Ellsworth AFB is considered to be minimal. The one-year, twenty-four hour rainfall value for the study area is 1.6 inches, which has been interpolated from charts published by the US Department of Commerce, Weather Bureau (1961). This figure suggests that a slight potential for the development of erosion exists.

The study area experiences a semi-arid type of climate, influenced by Black Hills weather patterns. The summers are warm and dry; winters tend to be cold. The warmest months are June to September; the coldest include November through March. Precipitation occurs primarily in the spring and summer months of July and August.

TABLE 3.1
CLIMATOLOGICAL DATA

M O N T H	Temperature (°F)				Precipitation (In)				Snowfall (In)		Surface Winds		
	Mean		Extreme		Monthly		24 Hrs		Monthly		Prevailing Direction	Mean Speed (kt)	
	Max	Min	Max	Min	Mean	Max	Min	Max					
JAN	31	11	21	69	-25	.5	1.7	#	1.2	5	19	NNW	9
FEB	36	16	26	72	-23	.6	2.2	#	1.0	7	20	NNW	9
MAR	42	22	33	32	-18	1.0	3.1	.1	2.2	9	29	NNW	10
APR	56	34	45	87	5	1.9	5.6	#	1.8	7	43	NNW	10
MAY	67	45	56	97	20	3.1	9.8	.2	3.1	1	7	NNW	9
JUN	76	54	65	106	31	3.2	7.7	.8	3.3	#	6	NNW	8
JUL	86	61	74	111	42	2.1	5.7	#	3.2	0	0	S	7
AUG	84	60	72	107	40	1.5	4.1	.1	1.3	0	0	S	7
SEP	74	49	62	123	19	1.1	3.0	#	1.9	#	2	NNW	8
OCT	62	39	51	74	13	.9	3.5	#	2.1	2	8	NNW	8
NOV	46	26	36	77	-14	.6	2.3	.1	1.1	5		NNW	7
DEC	37	16	28	74	-24	.4	1.1	#	.5	5	11	NNW	8
ANN	58	36	47	111	-25	16.9	2.8	#	3.3	41	43	NNW	8

Indicates trace amount

Period of Record: 1939-1982

Source: Detachment 17, 9th Weather Squadron, Ellsworth AFB, SD

The average annual precipitation value for the Badlands Air Force Range is reported to be 16 inches (NOAA, 1983). The calculated net precipitation is minus 24 inches for the Range. The one-year, twenty-four hour rainfall figure is reported to be 1.75 inches (US Department of Commerce, Weather Bureau, 1961).

The average annual precipitation received at the PM-1/Sundance Site is reported to be 20 inches (NOAA, 1983). The calculated annual net precipitation is minus 21 inches. The Station's one-year, twenty-four hour rainfall value is reported to be 1.5 inches (US Department of Commerce, Weather Bureau, 1961).

GEOGRAPHY

Ellsworth AFB is located on the Missouri Plateau subdivision of the Great Plains Physiographic Province (Trimble, 1980). The Great Plains region is characterized as a semi-arid grassland of nearly level to rolling topography interrupted by occasional hills. Dissection may be prominent along upland margins and adjacent to stream valleys.

The Badlands Air Force Range is located in the Badlands subdivision of the Great Plains Physiographic Province. The Badlands are gently rolling to nearly vertical in appearance and have formed due to the extensive, rapid erosion of soft fine-grained underlying materials.

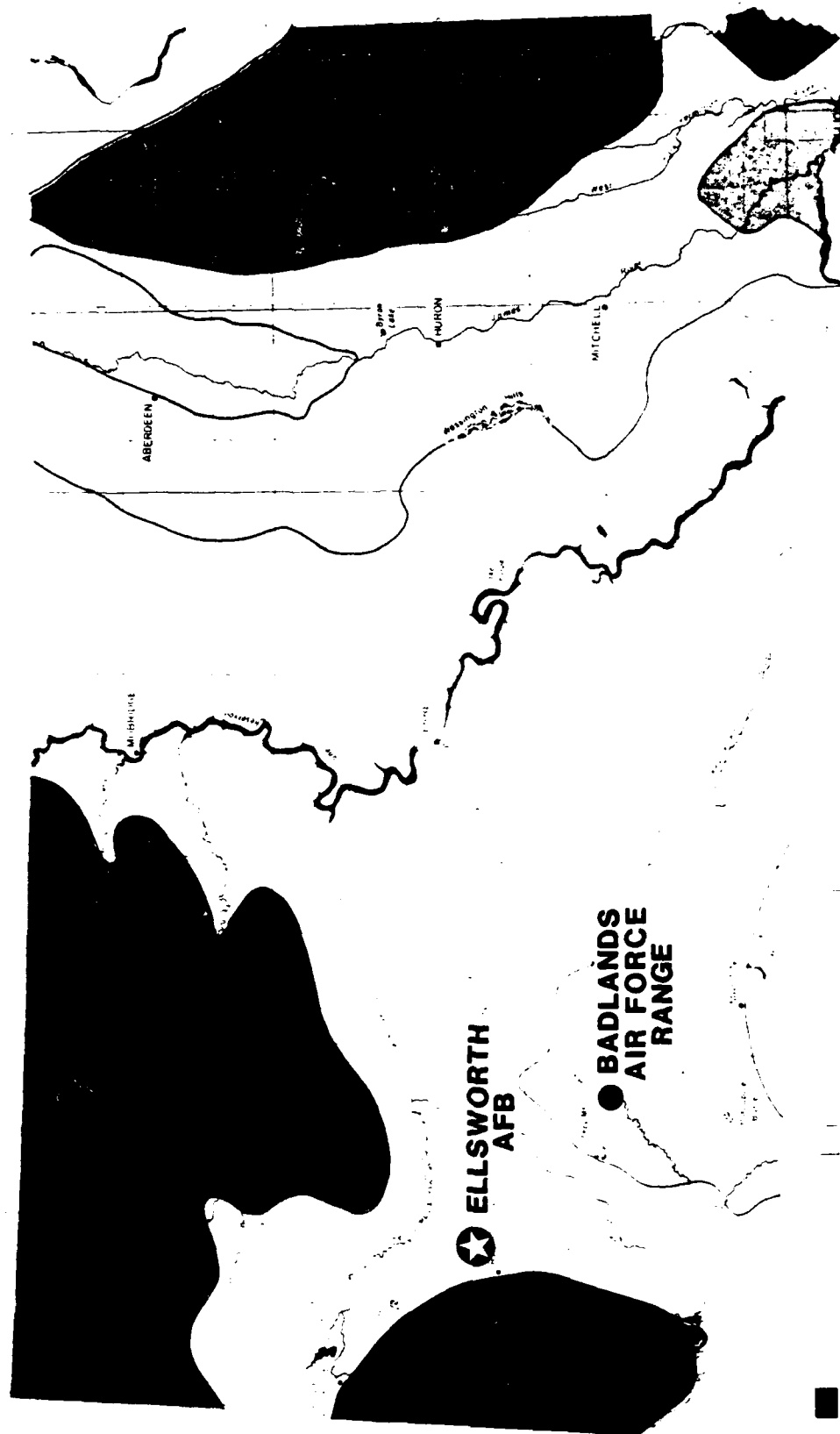
The PM-1/Sundance Site is located on Warren Peaks in the Black Hills subdivision of the Great Plains Physiographic Province. The PM-1/Sundance study area is characterized by steep, mountainous terrain framed by well-incised valleys.

Study area physiographic divisions are illustrated on Figure 3.1.

Topography

The land surface of the base is nearly level to gently sloping. North of the Weapons Storage Area (WSA), the land surface drops abruptly to the valley floor below. The section of the base generally south of the main installation slopes southward toward the stream valley of Box Elder Creek. The highest elevation reported on base is 3371.68 feet, National Geodetic Vertical Datum of 1929 (NGVD), which occurs on the table some one thousand feet west of the WSA. The lowest elevation noted on base is 3040 feet, NGVD, along the Government Railroad access south of Interstate Route 90. The maximum relief noted on base is

MAJOR PHYSIOGRAPHIC DIVISIONS OF SOUTH DAKOTA



NOTE: THE PM-1/SUNDANCE SITE IS LOCATED IN WYOMING,
ABOUT EIGHTY MILES NORTHWEST OF ELLSWORTH AFB.

SOURCE: SOUTH DAKOTA GEOLOGICAL SURVEY, UNDATED

approximately two hundred feet and occurs north of the WSA, where the upland platform descends to the valley of Elk Creek and its tributaries. Relief on the order of forty feet occurs on the south end of the installation along the eroded drainage path alignments extending south to Box Elder Creek.

The highest elevation recorded on the Badlands Air Force Range is 2700 feet, NGVD, which is located on the west border of the Range, near the center of Section 36, Township 43 North, Range 42 West. The lowest elevation is 2420 feet, NGVD, which is located along the White River alignment in the northeast quadrant of the Range in Section 28, Township 43 North, Range 41 West. Maximum relief on the order of 180 feet occurs between the White River channel and the promontory located near the center of Section 33, Township 43 North, Range 41 West.

The PM-1/Sundance site is located on a nearly level overlook on Warren Peaks in the Bear Lodge Mountains of the Black Hills National Forest. A US Geological Survey benchmark located on the site is reported to be 6656 feet above Mean Sea Level (MSL). The site has been graded within its 3.48-acre limits to facilitate construction. Beyond the perimeter fence, the landscape drops precipitously into the valleys below. Maximum relief in the area is estimated to be on the order of 800 feet, measured between the station location and Jim Wayne Canyon one mile west of the installation.

Drainage

The drainage of Ellsworth AFB land areas is accomplished by overland flow of runoff to ditches, drain tiles and a storm drainage system. Drainage from the base is directed to local streams via drainage ditches exiting the base. Runoff generated at the extreme north end of the installation flows generally northward to Elk Creek via eight unnamed tributaries, all of which are ephemeral streams. Runoff generated in the central, west, east and south sections of the base is directed in a generally southward direction to Box Elder Creek via six unnamed tributaries, all of which are ephemeral streams. Ephemeral streams contain water only when sufficient runoff is available to support flow. Typically, these streams conduct water during or immediately following precipitation events.

The storm drainage system at Ellsworth AFB consists of subsurface storm water drainage lines and open channels. Runoff is collected into four major drainage areas which are designated in accordance with their assigned NPDES numbers. The major drainage areas include:

- o 001 Drains the central runway area and the six northern fuel pump stations.
- o 002 Drains the southern runway, southern shops, alert apron and a portion of the industrial sewer.
- o 003 Drains the northern runway area and the northern shops.
- o 011 Drains the north central section of the base, including the support administration and CE buildings. Also drains the south central section of the installation, including the base lakes.

Drainage area 001 has been equipped with an oil/water separator since 1974. Oil/water separators were installed for surface water quality maintenance in 1977 at discharges 002 and 003. Drainage area 011 is a series of small base lakes. All the man-made drainage improvements direct flow to Box Elder Creek.

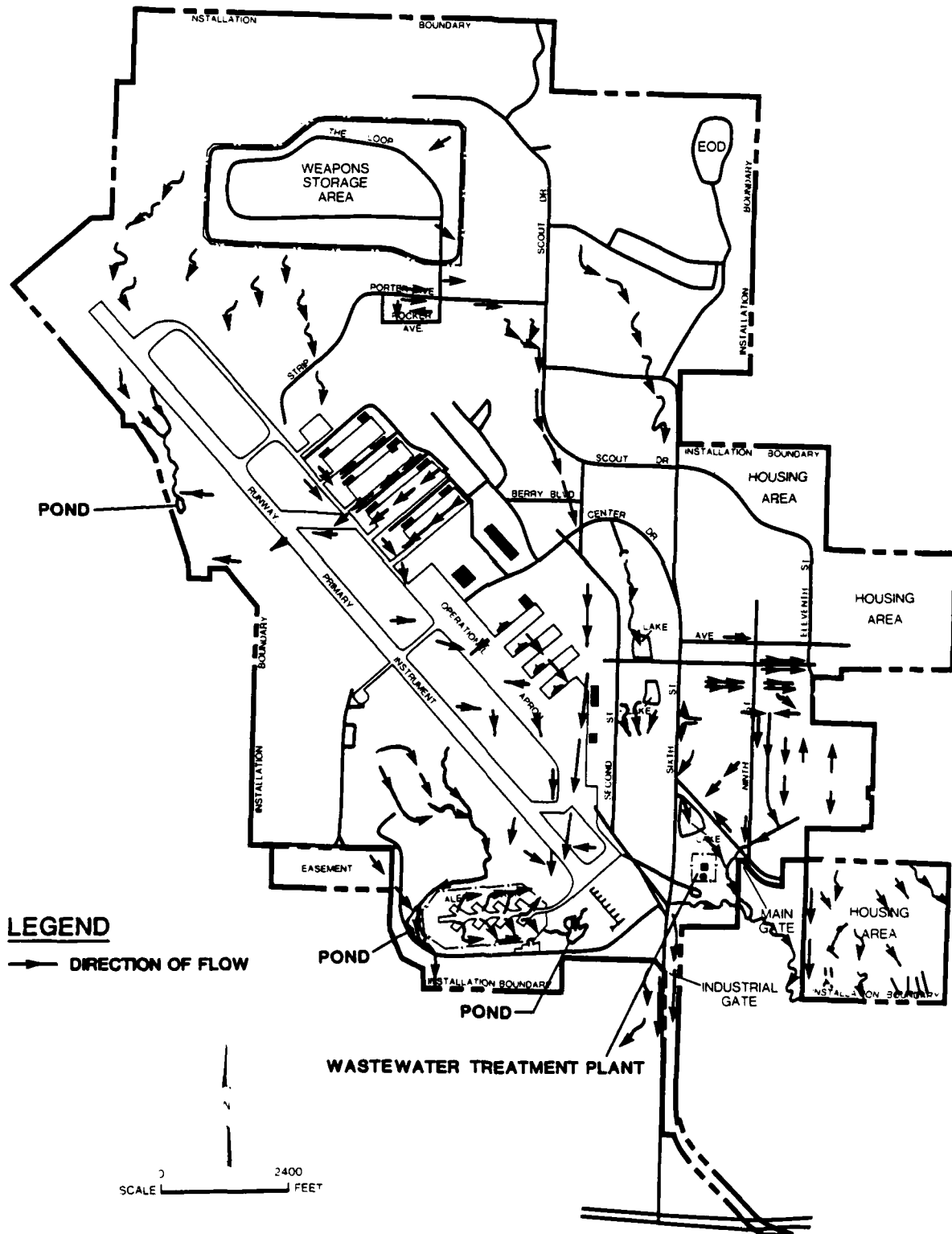
Figure 3.2 illustrates the principle drainage features of Ellsworth AFB. Flooding is not known to be a problem at the base. No wetlands exist on the installation.

The drainage of the Badlands Air Force Range is accomplished by overland flow to ditches and local streams. All Range drainage is directed to the White River. Figure 3.3 depicts the major drainage features of the Badlands Air Force Range. Flooding is not known to be a problem at the range; no wetlands exist on the facility.

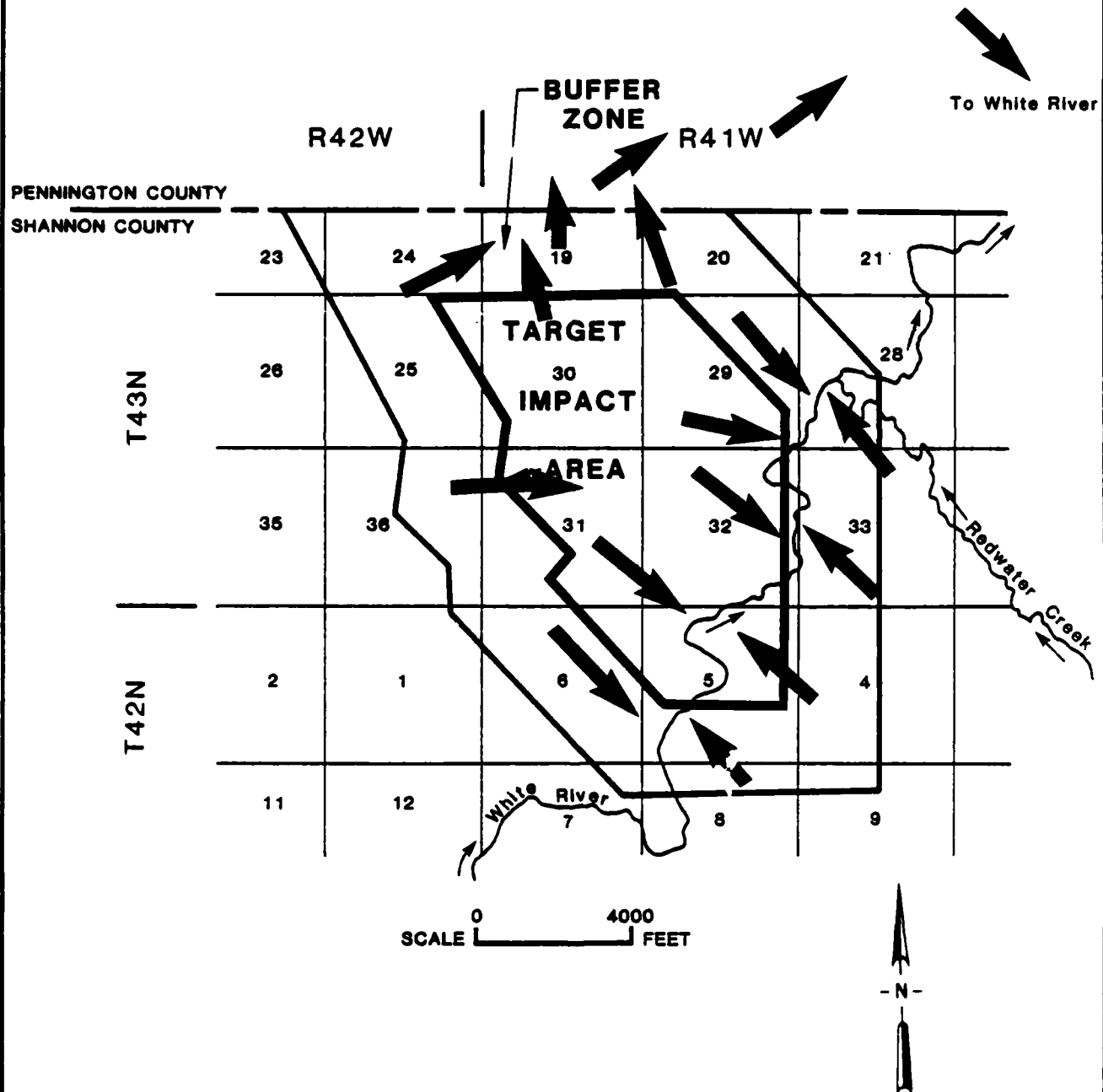
The drainage of the PM-1/Sundance site is accomplished by overland flow from the installation, downslope to adjacent segments of the Black Hills National Forest. There are no operative drainage structures on the Station. According to contour data reported on the Sundance, Wyoming 15 Minute Quadrangle Topographic Map (US Geological Survey,

FIGURE 3.2

ELLSWORTH AFB STORM DRAINAGE MAP



BADLANDS AIR FORCE RANGE DRAINAGE



SOURCE: INSTALLATION DOCUMENTS

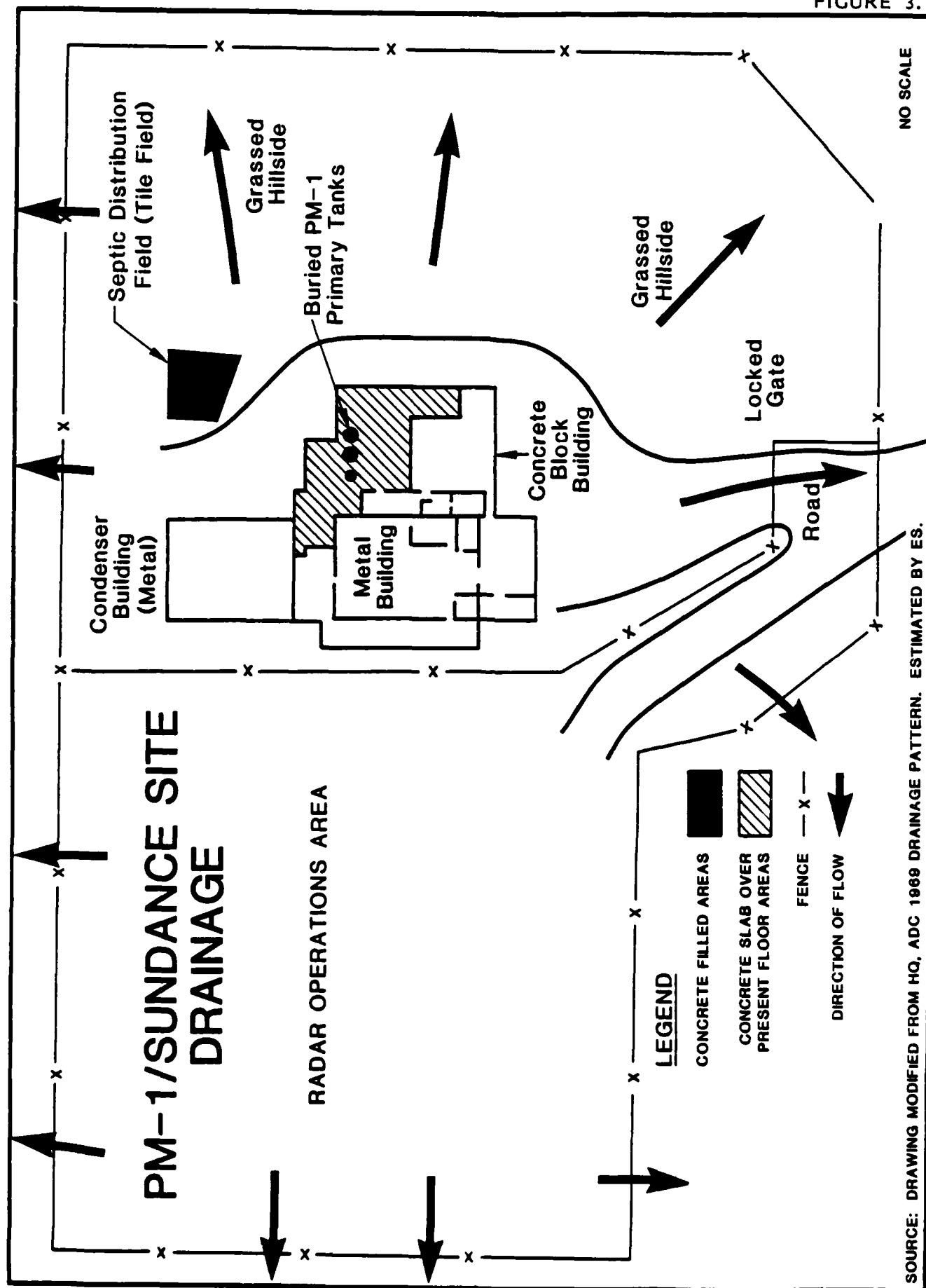
1958), most runoff originating from the site appears to be directed northwest to Lytle Creek, westward to the unnamed stream in Jim Wayne Canyon, southward to the unnamed streams in Bear Den Canyon and Jim Wayne Canyon and northeast to the unnamed tributary of Beaver Creek. Figure 3.4 illustrates the surface drainage features at PM-1/Sundance Site. Flooding is not a problem at the site; no wetlands are present at the facility.

Surface Soils

The surface soils of Ellsworth AFB have been reported by the USDA, SCS (1978) and by Boline (1985). Eleven soil types have been identified on the installation. The distribution of base soil units is illustrated on Figure 3.5. Their principle characteristics relative to this study are summarized on Table 3.2. The modern soils of Ellsworth AFB have developed in colluvium (materials that have been transported downslope due to gravity and/or the influence of unchannelized water flow), alluvium (materials transported by channelized water flow, resulting in stratification, grain size sorting, etc.) or in residuum (soils that have developed in place by the weathering of underlying bedrock). The typical base soil profile is some sixty inches thick and consists of generally low permeability clays which tend to promote rapid runoff. These modern soils may be underlain locally by high permeability sands and gravels. One soil unit mapped on base, Borrow Pit, is not so much a discrete soil type, but rather is a condition. Sand and gravel deposits in such areas have been excavated. Because the native soils in this area have been altered or removed locally, it is not possible to estimate their properties. The distribution of base soil units present in Meade County was originally plotted by the Soil Conservation Service on aerial imagery dated 1974.

Three major soil associations have been identified on the Badlands Air Force Range (USDA, SCS, 1971). The Tuthill-Richfield Association consists of nearly level to undulating, well-drained, deep loamy silty soils occurring on table lands and terraces. The unit is reported to be underlain by stratified sand and gravel. The association has formed in old alluvium. Locally, the unit has been modified in its upper profile by windblown fine sand and silt. Shallow ground water may be present in the unit seasonally. The Valentine-Anselmo Association occurs on

FIGURE 3.4



SOURCE: DRAWING MODIFIED FROM HQ, ADC 1869 DRAINAGE PATTERN. ESTIMATED BY ES.

FIGURE 3.5

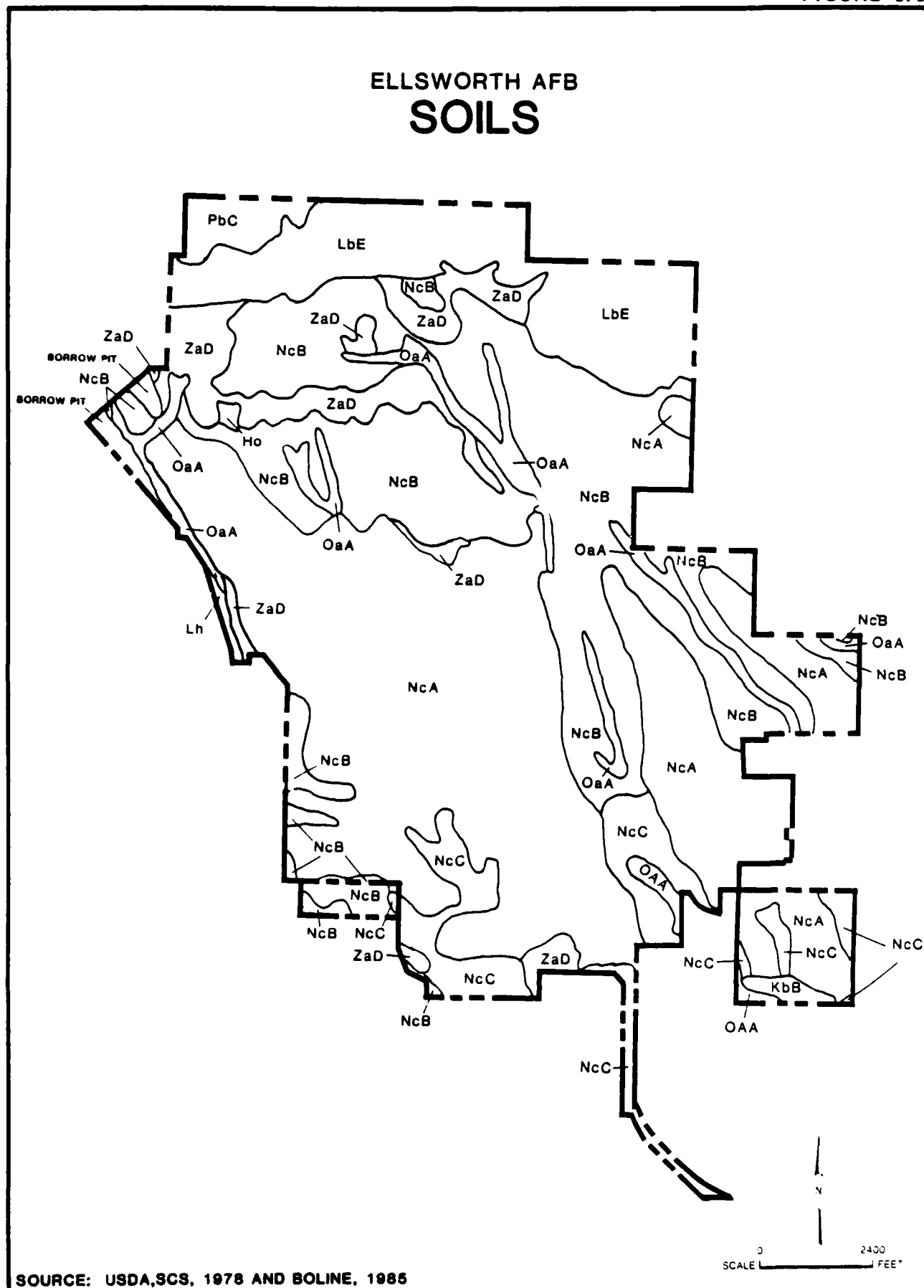


TABLE 3.2
ELLSWORTH AIR FORCE BASE SOILS

Map Symbol (Figure 3.5)	Unit Description (Major Fraction)	USDA Texture (Major Fraction)	Thickness (Inches)	Unified Classification (Major Fraction)	Permeability (Inches/Hour)	Parent Material	Potential Construction Constraints
BP	Borrow Pit	Variable	—	Properties not	estimated	—	Unknown
Ho	Hoven silt loam	Silt loam, silty clay, clay, clay loam.	60	ML, CL, CH, MH	<0.06 - 2.0	Colluvium	Severe. Subject to flooding.
KbB	Kyle clay, 2 to 6 per cent slopes	Clay	60	CH, MH	<0.06	Residuum	None
Lbe	Lisnas clay, 15 to 40 per cent slopes	Clay, silty clay, weathered bedrock.	60	CH, MH	<0.2	Residuum	None
Lh	Lohmiller and Glenberg soils, channelized	Silty clay loam, sandy loam, loam.	60	CL, CH, SH, SM-SC	0.06 - 6.0	Recent alluvium	Severe. Subject to flooding.
NcA	Nunn clay loam, 0 to 2 per cent slopes	Clay loam, clay, loam, gravelly sandy loam.	60	CL, CH, SC, SM-SC	0.2 - 2.0	High terrace alluvium	None
NcB	Nunn clay loam, 2 to 6 per cent slopes	Clay loam, clay, loam, gravelly sandy loam.	60	CL, CH, SC, SM-SC	0.2 - 2.0	High terrace alluvium	None
NcC	Nunn clay loam, 6 to 9 per cent slopes	Clay loam, clay, loam, gravelly sandy loam.	60	CL, CH, SC, SM-SC	0.2 - 2.0	High terrace alluvium	None
OaA	Onita clay loam, 0 to 4 per cent slopes	Clay loam, silty clay loam, silty clay, silt loam.	60	ML, CL, CH	0.2 - 2.0	Colluvium	Severe. Subject to flooding.
PbC	Pierre clay, 6 to 15 per cent slopes.	Clay, bedrock.	60	CH, MH	<0.06	Residuum	None
Zad	Zigweid-Nihill complex, 6 to 15 per cent slopes.	Clay loam, gravelly loam.	60	CL, SH, GM, GM-SC, SM-SC	0.6 - 6.0	Up and alluvium	None

Source: USDA, SCS, 1978 and Roline, 1985

Unified System Classifications: ML: low plasticity silt; CL: low plasticity clay; MH: high plasticity silt; CH: high plasticity clay;
SM: silty sand; SC: clayey sand; GM: silty gravel.

The unit Borrow Pit, indicates a disturbed area where soil characteristics can not be determined.

rolling, excessively well-drained uplands and consists of deep sandy soils that have formed in sandy alluvium that has been mixed and re-deposited by wind. Shallow ground water may be present in this unit seasonally. The third unit present at the Range is the Badlands Association which occurs on mesas, escarpments, valley walls, buttes and tablelands. The unit consists of clayey and loamy soils. The unit probably lacks a shallow water table due to its fine-grained character which promotes rapid runoff and its relatively high topographic position on the landscape. The distribution of the soil associations mapped on the Range is shown on Figure 3.6.

The Grizzly-Virkula Complex is reported to be the dominant soil association present at the PM-1/Sundance Site (USDA, SCS, 1983). The complex occurs on 15 to 60 per cent slopes in Crook County, Wyoming. It consists of loam, silt loam, clay loam and clay in a sixty-inch thick profile. It possesses a gravelly clay loam substratum which has developed in residuum, weathered from the underlying igneous and metamorphic bedrock. It exhibits a generally slow permeability (0.06 inches per hour) in the clayey upper extent of its profile and a rapid permeability (6.0 inches per hour) in its gravelly subsoil. The unit experiences rapid runoff characteristics and is susceptible to erosion. Much of the site's land areas has been paved, which precludes infiltration and promotes rapid runoff.

GEOLOGY

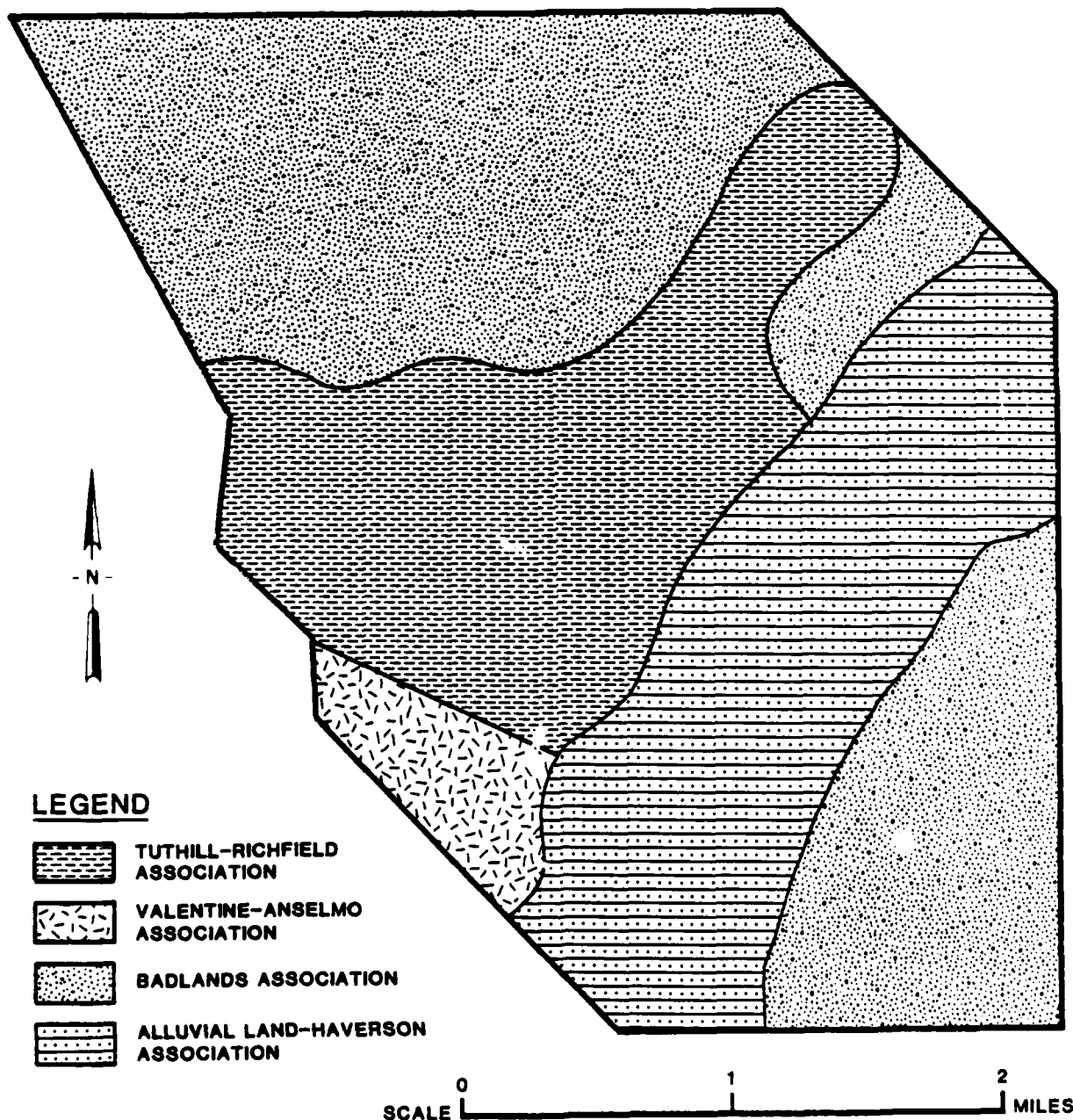
Information describing the geology of Ellsworth AFB and its satellite facilities has been reported by several authors, most notably Mapel, et al., 1959; SDGS, 1964; Ellis and Adolphson, 1971; Petsch, 1972; Hodson, et al., 1973; McGregor and Cattermole, 1973; Kleinkopf and Redden, 1975; USGS, et al., 1975 and Trimble, 1980. Additional information has been obtained from interviews with US Geological Survey and South Dakota Geological Survey scientists. A brief overview of the available information with pertinent comments is included in the following discussion.

Regional Geology

Geologic units ranging in age from Cretaceous to Quaternary have been identified as significant to subsurface investigations in the

FIGURE 3.6

BADLANDS AIR FORCE RANGE SOILS



SOURCE: USDA, SCS 1971

Ellsworth AFB study area. They repose on a PreCambrian surface that dips eastward with respect to Rapid City. The major bedrock units consist primarily of shale, sandstone, siltstone and limestone. Table 3.3 lists the principle geologic units in chronological order.

Stratigraphy and Distribution

The surface distribution of major geologic units is presented as Figure 3.7, which has been modified from US Geological Survey, et al. (1975). Generally, the geology of Ellsworth AFB is dominated by the Upper Cretaceous age Pierre Shale, a dark gray, noncalcareous shale which weathers to a plastic brown and olive-brown clay. Bentonite (a clay which swells upon hydration) beds averaging one foot thick are common through the shale. The Pierre Shale is reported to be 860 feet thick at Ellsworth AFB well number 1. The Pierre Shale is overlain by a thin veneer of older alluvium ranging in thickness from ten to thirty feet thick. The topographic expression of the older alluvium is that of terraces and upland interstream areas standing many tens of feet above modern stream channels. The alluvium consists of stratified deposits of clay, clayey sand and gravel, well-graded gravel, silty sand and sand. Some boulders and cobbles may be present. The alluvium tends to be somewhat finer-grained in its upper extent and its basal segment is coarser. The character of the unconsolidated alluvium is illustrated by Figures 3.8 and 3.9, the drilling logs of two representative installation test borings. The borings encountered either weathered shale or unweathered shale at the termination of drilling.

The geology of the Badlands Air Force Range is dominated by Tertiary to Quaternary age consolidated and unconsolidated units. These units include, from oldest to youngest:

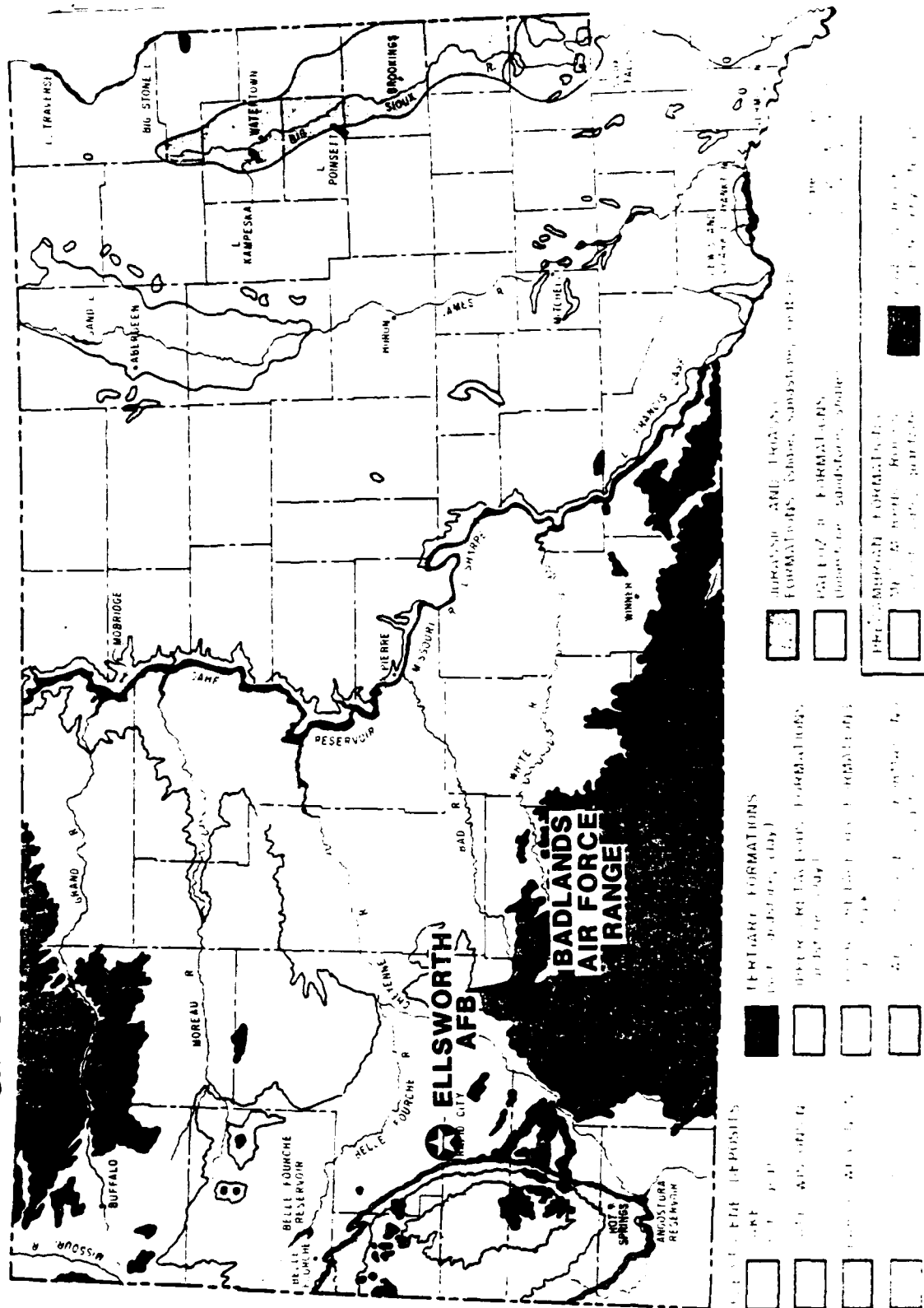
- o The White River Group. The White River Group consists of two divisions, the Chadron Formation (lower) and the Brule Formation (upper). The Chadron Formation consists of bentonite and siltstone with discontinuous limestone and sandstone beds. The Brule Formation includes sandy clay and silt. Locally, channel sandstone and conglomerate may occur. The White River Group reaches a maximum thickness on the order of six hundred

TABLE 3.3
Study Area Geologic Units

			Rock unit	Maximum thickness (feet)	Age estimates commonly used for boundaries (in million years)
CENOZOIC	Quaternary	Holocene	Stream and lake sediments		
		Pleistocene	Glacial deposits and stream and lake sediments	800	
	Tertiary	Pliocene	Ogallala Formation	300	1.5-2
			Batesland Formation	60	ca. 7
		Miocene	Rosebud Formation	250	
			Harrison Formation		
			Monroe Creek Formation	600	
			Sharps Formation		
		Oligocene	White River Group	800	25 (Oligocene)
			Chadron Formation		38 (Eocene)
		Paleocene	Tongue River Formation		54 (Eocene)
			Fort Union Group	1000	54 (Paleocene)
MESOZOIC	Cretaceous	Upper	Ludlow Formation	65	
			Hell Creek Formation	400	
			Montana Group		
			Ros Hills Formation	400	
			Pierre Shale	3000	
			Niobrara Formation	220	
		Colorado Group	Carlisle Shale	550	
			Greenhorn Limestone	360	
			Beile Fourche Shale	450	
		Lower	Mowry Shale	250	
			Newcastle Sandstone	100	
			Skull Creek Shale	250	
	Jurassic	Upper	Inyan Kara Group	150	
			Lakota Formation	550	136
			Morrison Formation	350	
			Sundance Formation	740	
		Middle	River Formation	125	
			Gypsum Spring Formation	200	
			Triassic		190-195
			Speers Formation	775	225
PALEOZOIC	Permian		Minnekahta Limestone	40	
			Opeche Shale	125	
			Minnetonka Formation	1400	280
	Pennsylvanian		(Big Snowy Group)	100	320
			(Kibbey Sandstone)		
			(Charles Formation)	550	
	Mississippian	(Madison Group)	(Mission Canyon Limestone)	1300	
			(Lodgepole Limestone)		
			Englewood Formation	70	345
	Devonian		Three Forks Shale		
			(Bird Bear Formation)		
			(Duerow Formation)	600	
			(Souris River Formation)		
			(Interlake Group)		395
	Silurian		(Stony Mountain Formation)		
			(Red River Formation) or Whitehead Dolomite	600	430-440
			Winnipeg Formation	180	
	Ordovician		Deadwood Formation	600	ca. 500
			Sioux Quartzite	5000	570
PRECAMBRIAN			Metasediments, metavolcanics, metagabbro, granite, and granite gneiss where exposed. Largely granite and granite gneiss in subsurface. Formation names in use apply only to small areas	At least 60,000	3000

Source: U S Geological Survey, et al., 1975

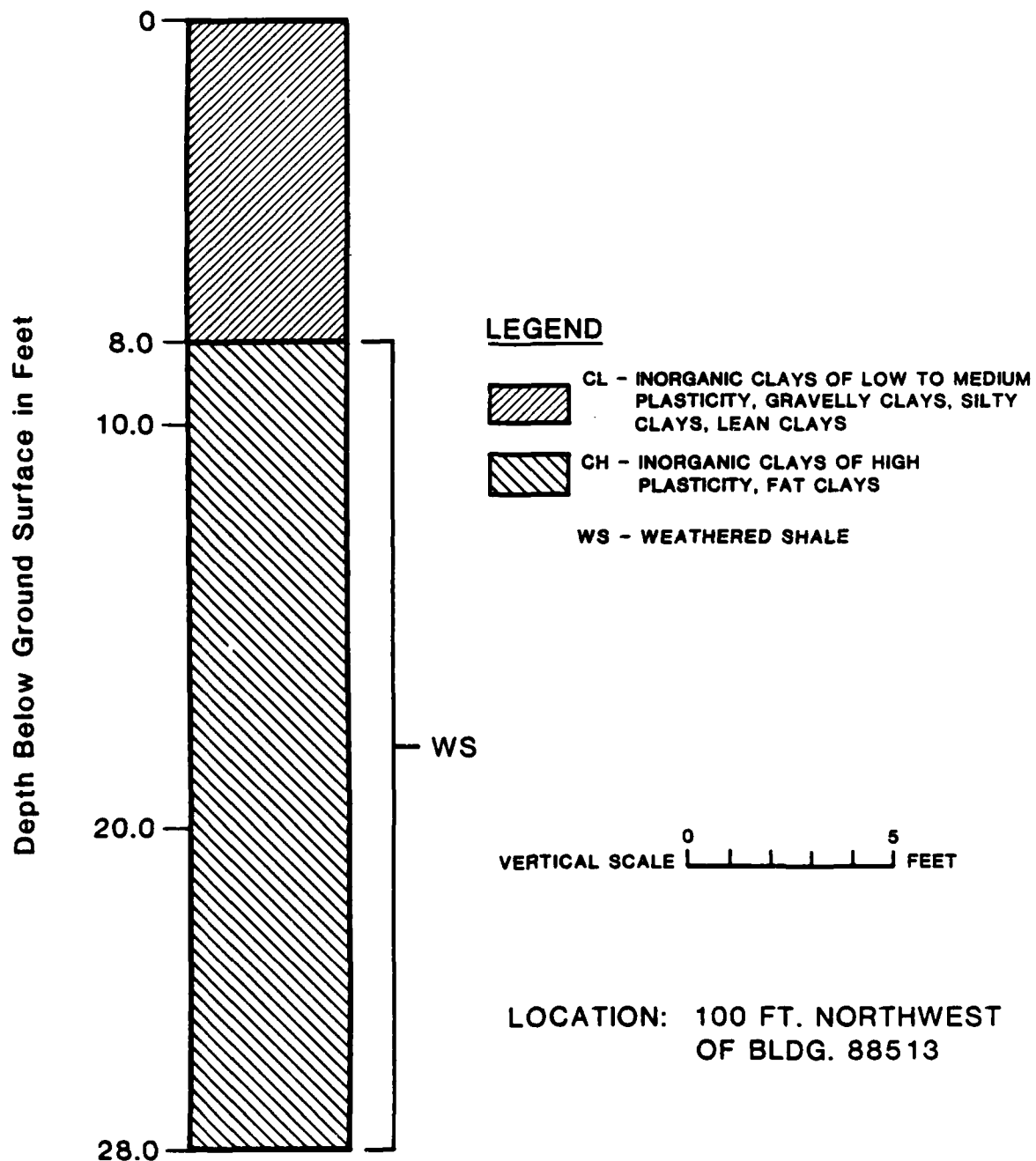
GEOLOGIC MAP OF SOUTH DAKOTA



SOURCE: SOUTH DAKOTA GEOLOGICAL SURVEY, 1964

FIGURE 3.7

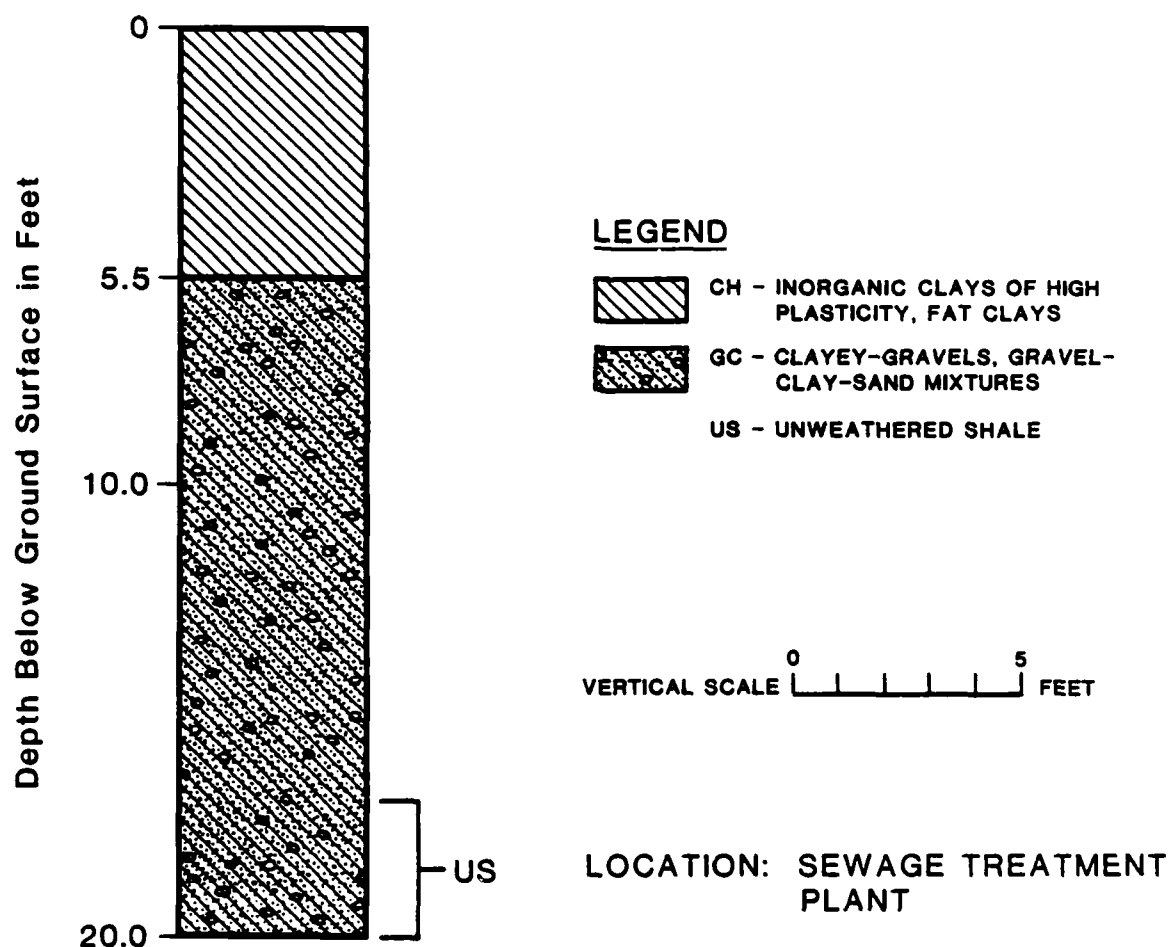
ELLSWORTH AFB
TEST LOCATION L-1
(Elev. 3,295 ft. (approx.))



SOURCE: INSTALLATION DOCUMENTS

ELLSWORTH AFB
TEST LOCATION 0-1

Elev. 3,114 ft. (approx.)



SOURCE: INSTALLATION DOCUMENTS

feet and is exposed by erosion to form such topographic features as the steep fluted cliffs, gradual slopes, tables, bluffs and knolls common to the Badlands Area. Approximately eighty percent of the Range's land areas is underlain by this unit.

- o Wind-blown sand deposits. Quaternary-age wind-blown sand deposits consisting of fine to medium-grained quartz sand occur in the southwest section of the Range. The unit has a reported maximum thickness of some two hundred feet. Topographically, it forms gently rolling hills.
- o Terrace deposits. Quaternary-age terrace deposits consisting of clay, silt and fine sand occupy the isolated terraces and benches which occur parallel to and above the modern stream channel of the White River. The unit is reported to be sixty feet thick at its maximum extent and may include a clayey and sandy gravel accumulation marking its basal section, especially along the White River.
- o Flood plain alluvium. Flood plain alluvium occurs in or immediately proximate to the channels of most modern streams in sequence consists of clay, silt and fine sand. The lower segment may include discontinuous clayey and sandy gravel beds. The unit has a reported maximum thickness of forty feet. The alluvium forms the level zones parallel to modern stream channels and is usually less than one-half mile in width.

The geology of the PM-1/Sundance Site is generally dominated by PreCambrian-age igneous and metamorphic rocks consisting of granite, gneiss and schist. These rocks are crop out in the Bear Lodge Mountains as a result of the intrusion of igneous materials such as monzonite and syenite and the erosion of the (formerly) overlying younger geologic units. The rocks are exposed along many of the steep slopes in the PM-1/Sundance Site and may be locally mantled by a thin veneer of

residual soil which has formed in place as a result of the weathering of the underlying parent bedrock.

Structural Geology

The major structural geologic feature of the study areas is the Black Hills uplift, an elliptically shaped dome 125 miles long and 45 miles wide (USGS, 1975). The Black Hills were formed by the combination of structural uplift and broad warping of the major geologic units present. Subsequent erosion has exposed the central crystalline rocks and has sculpted the remaining sedimentary rocks to form the modern landscape of the area.

Ellsworth AFB is located east of the Rapid City area, on the extreme eastern flanks of the Black Hills uplift. The rocks in the base study area generally dip east to northeast as a result of the uplift. The principle bedrock geologic unit present at the base, the Pierre Shale is not known to be faulted or otherwise disrupted in the immediate project area.

The Badlands Air Force Range is located in an area where relatively flat-lying Tertiary and younger geologic units occur. The Brule Formation may be fractured locally, but is generally considered to be continuous at the Range. The Chadron Formation is not known to be disrupted by faulting, fracturing or other geologic discontinuities.

The PM-1/Sundance Site is located on Warren Peaks in the Bear Lodge Mountains of the Black Hills National Forest. The site is situated on a section of exposed PreCambrian crystalline rock. The crystalline rocks are reported to be disrupted locally by faults, fissures, fractures and jointing. The discontinuities are prominent near ground surface and become less apparent with increasing depth.

HYDROLOGY

Study area hydrologic information has been reported by Porter and O'Brien, Inc., 1961; La Rocque, 1966; Adolphson and Ellis, 1969; Ellis and Adolphson, 1971; Hodson, et al., 1973; US Geological Survey, et al., 1975; Mancini, 1976; USAF, 1977 and Wells, 1982. Additional information has been obtained from interviews with two US Geological Survey Water Resources Division scientists and a South Dakota Geological Survey geologist.

Ground-Water Resources

Precipitation is the primary source of ground-water recharge in the project area. Although most rainfall is lost as evapotranspiration or as runoff directed to local surface waters, a small amount is able to infiltrate downward until it reaches a level in the unconsolidated deposits (surface soils) where all available voids between soil particles are water-filled. In the case of consolidated (rock) aquifers, the infiltrating water fills the fissures, fractures, bedding planes, solution channels and other secondary openings that may be present. Water contained in these void spaces is termed ground water and is constantly in motion. Ground water tends to move from points where it enters the subsurface, recharge areas, where water levels are highest, to discharge areas where local water levels are lowest. A review of available data, topographic maps, surface water information and site inspections suggest that Ellsworth AFB, Badlands Air Force Range and the PM-1/Sundance Site are probably located in the recharge zones of the uppermost aquifers present. Ground water moving from the recharge zone may flow into hydraulically communicating hydrogeologic units, recharging them, or may be directed to local surface waters as base flow (that portion of stream flow contributed by ground water discharge). The actual directions of flow, flow velocities, etc., for each water-bearing unit present on an installation must be treated as an individual case. The following discussion describes the significant properties of the water-bearing units considered to be relevant to this investigation.

Ellsworth AFB is located in a section of South Dakota where ground water may occur in either shallow or deep hydrogeologic units. The shallow water-bearing units present in the study area include modern alluvium and the older alluvium described in the subsection GEOLOGY. The modern alluvium consists of silt, sand and gravel, whose distribution is limited to the flood plains and near stream areas of Elk, Box Elder and Rapid Creeks. The modern alluvium does not occur on Ellsworth AFB or its satellite facilities. The older alluvium consists of stratified deposits of clay, clayey sand and gravel, well-graded gravel, silty sand and sand. The older alluvium ranges in thickness from ten to thirty feet at the base and directly overlies bedrock. The alluvium is recharged by rainfall. It probably contains ground water in its basal

section just above the bedrock surface seasonally. It is assumed that ground water present in the unit flows across the alluvium/ bedrock interface following local topography until it is discharged as base flow to local streams or infiltrates into lower strata. The alluvium may provide some discharge to the ponds located on base. During the Phase I IRP site inspection conducted 29 April - 3 May 1985, springs were visible emanating from the alluvium below the base of the northeast installation landfill (Landfill No. 4) at approximate elevation 3150 feet, NGVD.

Several deep aquifers are known to exist in the study area. These hydrogeologic units consist of consolidated bedrock and exist at great depth below ground surface at Ellsworth AFB. The bedrock units are separated from ground surface by some two thousand feet of low permeability shale, sandstone and limestone. The deep aquifers of regional significance present in the Ellsworth AFB study area include the Fall River and Lakota Formations of the Lower Cretaceous Inyan Kara Group and the Pahasapa Limestone of the Mississippian Madison Group. At base well number 1, the Fall River Formation, principally a sandstone, is present at a depth of 2140 feet below ground surface. It is immediately underlain by the Lakota Formation, also a sandstone, at a depth of 2190 feet. The units are likely in hydraulic communication and form a single aquifer some 300 feet thick beneath the base and proximate environs. The units probably receive recharge west of the installation where it may occur at or near ground surface along the east margin of the Black Hills uplift. Ground water occurs in these units under strong artesian conditions. Base static water levels ranged from 351 to 560 feet below ground surface in wells 3, 4 and 5, finished into the Fall River and Lakota Formations. It is assumed that ground-water is directed downdip (eastward) with respect to Ellsworth AFB. The Fall River and Lakota aquifers are subjected to extensive use in the study area.

The Pahasapa Limestone of the Madison Group is an aquifer of regional significance which underlies Ellsworth AFB at a depth of 4200 feet below ground surface (measured at base well number 1). It is separated from the overlying Fall River and Lakota aquifers by some 2000 feet of shale, limestone and sandstone. This unit probably receives most of its recharge west of the base where it occurs at or near ground

surface along the east margin of the Black Hills uplift. Ground water occurs in the Pahasapa under strong artesian pressures. Base well number 1, finished into the Pahasapa, indicated that the potentiometric level was 543 feet below grade. It is assumed that ground-water flow in the Pahasapa is directed downdip (eastward) with respect to Ellsworth AFB. The Pahasapa is subjected to limited use in the study areas because of its great depth and the subsequent costs of constructing wells into it.

Table 3.4, the logs of installation wells 1 and 2, describe the major hydrogeologic units present beneath the base and their stratigraphic relationships.

Four hydrogeologic units have been identified at the Badlands Air Force Range and correspond to the geologic formations described in the subsection GEOLOGY. All of the Range hydrogeologic units occur at or near ground surface and include the following:

- o The White River Group. The White River Group includes two major divisions, the Brule Formation (upper section) and the Chadron Formation (lower) whose combined maximum thickness is some six hundred feet. The unit's distribution encompasses eighty percent of the Range land area. The Chadron Formation consists of relatively continuous bentonitic clay and siltstone beds. It is therefore considered to be nearly impermeable and is not a source of water supplies. The upper White River Group unit, the Brule Formation, consists of sandy clay and silt with limited sandstone and conglomerate deposits. Locally, channel sand accumulations may occur. The unit may contain ground water in locally fractured clay and silt zones, or in the isolated channel sand beds. The Brule Formation is recharged by precipitation. Discharge is directed downdip, usually corresponding to local topography. A few isolated springs have been mapped in this unit throughout the general study area. The springs may run dry during the late summer to winter months, suggesting that the Brule may only contain ground water locally on a seasonal basis.

TABLE 3.4
LOGS OF BASE WELLS 1 AND 2

	WELL #1		WELL #2	
	THICKNESS	DEPTH	THICKNESS	DEPTH
Elev ref point, MSL	3194 feet		3210 feet	
<u>UPPER CRETACEOUS</u>				
Pierre & Niobrara Formations	860	860	820	820
Carlile Shale	360	1220	330	1150
Greenhorn Limestone	130	1350	150	1300
Graneros Formation				
Belle Fourche Shale	520	1870	530	1830
Newcastle Sandstone	20	1890	20	1850
Lower Shale	250	2140	255	2105
Fall River (Dakota) Sandstone	50	2190	50	2155
<u>LOWER CRETACEOUS</u>				
Fuson & Lakota Formations	250	3440	255	2410
<u>JURASSIC</u>				
Morrison, Unkpapa, Sundance Formation	560	3000	610	3020
<u>TRIASSIC-PERMIAN</u>				
Spearfish Formation	385	3385	340	3360
<u>PERMIAN</u>				
Minnekahta Limestone	45	3450	40	3400
Opeche Shale	130	3560	120	3520
<u>PENNSYLVANIAN</u>				
Minnelusa Formation	640	4200	645	4165
<u>MISSISSIPIAN</u>				
Pahasapa (Madison) Limestone	445	4645	484	4645

Source: Installation Documents

- o Wind-blown sand deposits. The distribution of this unit is limited to the southwest quadrant of the Range. The sand deposits consist of quartz sand reaching a maximum thickness of some two hundred feet. Ground water is usually present at the base of the sand, just above local bedrock (White River Group). The unit is recharged by precipitation; discharge is directed downslope to communicating hydrogeologic units. Springs may form at the base of the sand deposits, along White River Group contacts.
- o Terrace deposits. The terrace deposits occur as isolated clay, silt and sand terraces and benches above modern stream channels in the study area. Ground water may be present in the terrace deposits where they extend to elevations below the water table present in adjacent alluvium or where the water table is perched on underlying bedrock (White River Group). The terrace deposits are recharged by either precipitation or flow from communicating hydrogeologic units. In the study area, the terrace deposits are likely in hydraulic communication with the proximate flood plain alluvium of the White River and other major streams.
- o Flood plain alluvium. The flood plain alluvium occurs in the channels and adjacent areas of modern streams. It consists of clay, silt and sand in its upper extent and may include locally occurring clayey gravel beds in the lower portions of the sequence. The flood plain alluvium is the most prolific water-bearing unit present at the Range. It is reported to be a dependable source of water throughout the year where it occurs near major streams. Recharge is provided by precipitation, stream flow and by discharge from communicating hydrogeologic units such as the terrace deposits. Water levels in the alluvium respond quickly to changes in study area stream flow.

The PM-1/Sundance Site is underlain by a single hydrogeologic unit, PreCambrian igneous and metamorphic rocks. These materials consist

primarily of granite, gneiss and schist that has been disrupted locally due to faults, fissures, fracturing and jointing. This unit is reported to contain modest amounts of ground water in the secondary openings where it is exposed at land surface. Ground water may not be present in the unit locally. The unit depends upon precipitation for recharge. It is believed that little recharge is directed into the PreCambrian rocks at the PM-1 Sundance site, as most of the area is paved, resulting in increased runoff and little opportunity for infiltration of rainfall to occur. Ground water that does accumulate in the unit discharges to local springs, seeps and streams that radiate outward from the base of Warren Peaks several hundred feet below the site.

Study Area Ground-Water Use

Ground-water resources provide most of the water supplies required by municipal, industrial, domestic and agricultural consumers in the study area. The Rapid City municipal distribution system obtains its water supplies from two deep high-capacity wells finished into the bottom of the Minnelusa Formation and the upper Madison Group (Pahasapa Limestone), three shallow wells finished into the alluvium of Rapid Creek and from a surface water intake on Rapid Creek. Two reservoirs are utilized to maintain storage capacity and flow. The Town of Box Elder obtains its water resources entirely from a municipal distribution system based on four wells. Three of the wells are finished into the Inyan Kara Group (Fall River and Lakota Formations) at depths of 2000 feet or more, and one well has been completed into the Madison Group (Pahasapa Limestone) at a depth of 4180 feet below grade.

Some subdivisions and individual homes or farms near the base also use wells to obtain water resources to meet their needs. It is reported that these individual consumers likely depend on wells completed into the Inyan Kara Group at depths of at least 1700 feet or more below land surface. A few farms bordering Ellsworth AFB are reported to use ponds to provide water for livestock. The ponds have been created by damming local drainage alignments to impound runoff. A few of the ponds located north of the base in topographically low positions may also receive seasonal discharge from the older alluvium overlying bedrock at Ellsworth AFB.

The Badlands Air Force Range is located in a relatively isolated section of Shannon County, South Dakota. There are no records to indicate that any water resources have been developed for use in the immediate vicinity of the Range and is not likely due to the isolation of the area.

No water resources are known to have been developed for any type of use in the immediate vicinity of the PM-1/Sundance Site. The site has been closed for several years. Its location in the Black Hills National Forest and its physical setting on Warren Peaks preclude such development.

Base Water Supplies

Ellsworth Air Force Base and other major study area consumers obtain their water supplies from the Rapid City municipal distribution system. The city furnishes ample quantities of good quality water. The quality of base water supplies is monitored by the Ellsworth AFB Bioenvironmental Engineering Section.

In past years, Ellsworth AFB obtained its water supplies from its own wells. A total of five deep wells have been installed into deep bedrock aquifers at the base. Wells 1, 2 and 3 are no longer serviceable. Wells 4 and 5 are inactive and are considered to be "standby" status for use in emergencies. The locations of Ellsworth AFB and study area water wells are illustrated on Figure 3.10. Installation well construction data is summarized on Table 3.5.

The Badlands Air Force Range has no permanent party assigned to it and therefore has no requirement for water resources. No wells or other developed water resources are located on the Range or known to be located in the areas immediately adjacent to it. The PM-1/Sundance Site has been closed for several years. No wells or other water resources have been developed in the PM-1/Sundance Site study area.

Ground-Water Quality

Information describing the quality of study area ground-water resources has been obtained from US Geological Survey, et al, 1975; Wells, et al., 1979 and Larson and Daddow, 1984. Generally, the quality of ground water obtained from study area aquifers is highly variable and may be quite poor locally. In South Dakota, ground water obtained from alluvial aquifers in Meade County or surficial aquifers in Shannon

FIGURE 3.10

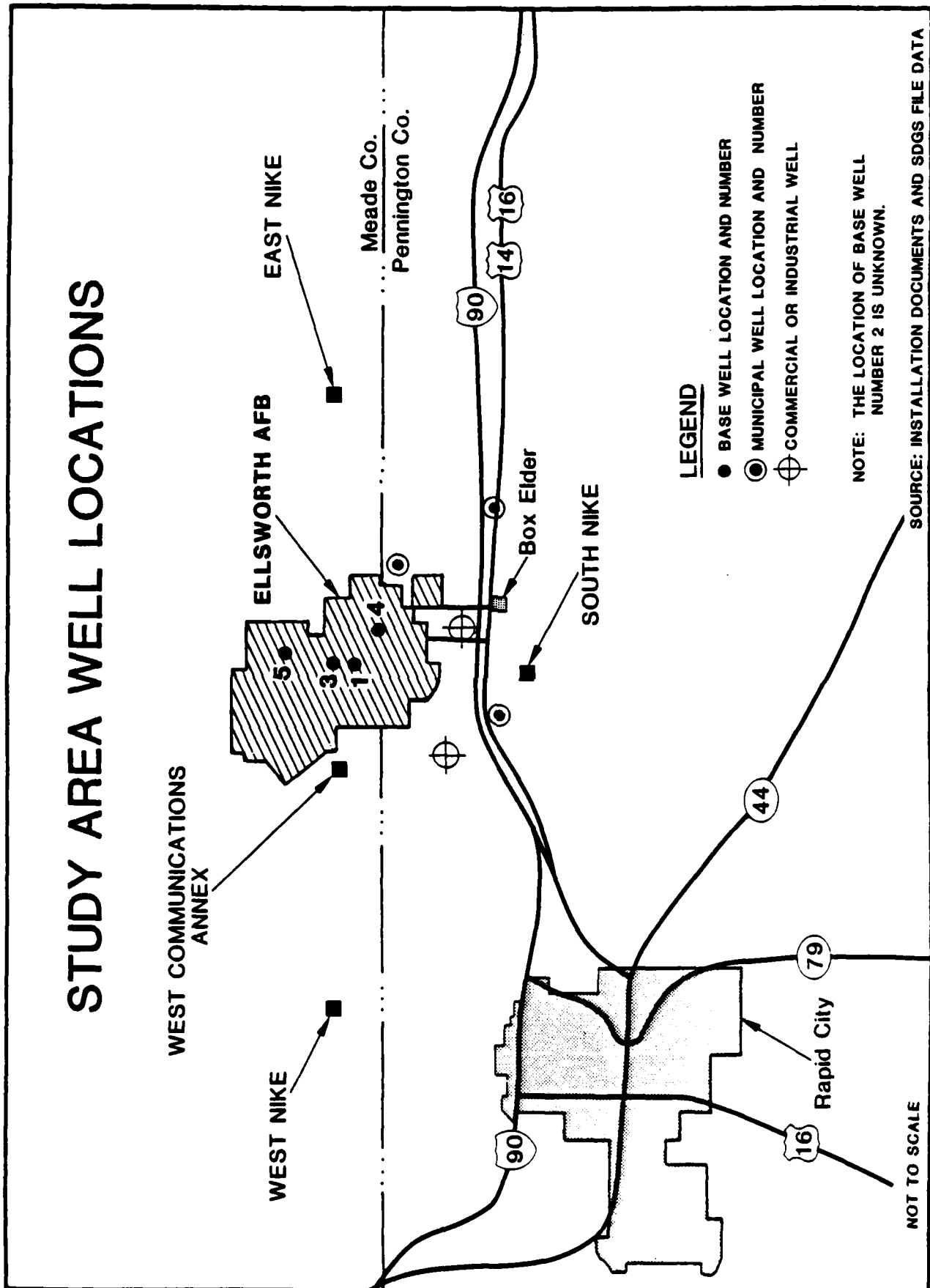


TABLE 3.5
ELLSWORTH AFB WELL DATA

Well No.	Location (Building)	Diameter (Inches)	Depth (Feet)	Static Level (Feet Below Grade)	Yield (gpm)	Aquifer	Remarks
1	920	9	4645	543	427	Pahasapa	Inactive
2	*	9	4645	*	*	Pahasapa	Capped
3	1120	9-5/8	2506	351	333	Lakota	Inactive
4	1808	8-5/8	2382	560	200	Lakota	Inactive
5	88625	12-3/4	2492	367	250	Lakota	Inactive

Source: Installation Documents

*Note: No additional data was available to describe base well number 2.

County is typically described as good. Ground water obtained from the deep bedrock aquifers in the Rapid City area may be high in hardness and heavy metals concentrations. Wells completed into the bedrock aquifers of Crook County, Wyoming may produce water of either acceptable or marginal quality.

Surface Water Resources

Ellsworth AFB is located in the Missouri River Basin of southwest South Dakota. Most installation drainage is directed southward to unnamed tributaries of Box Elder Creek which extend onto the base. The unnamed tributaries are considered to be ephemeral streams, that is they contain water only when sufficient runoff is available to support flow. Box Elder Creek is considered to be a perennial stream. A small amount of surface drainage originating from the extreme north section of the base is directed to Elm Creek via several ephemeral streams. Elm Creek is considered to be a perennial stream.

Surface drainage originating from within the boundaries of the Badlands Air Force Range is directed to the White River, a perennial stream via Redwater Creek and several unnamed tributaries of the White River. All of the White River tributaries extending through the Range are ephemeral streams. Table 3.6 summarizes the designated water uses permitted by the State of South Dakota for streams either crossing or receiving drainage from installation incorporated within the scope of this investigation.

Surface water runoff originating from the PM-1/Sundance Site study area is directed downslope to the several small streams which extend outward in a radial pattern from the base of Warren Peaks. The State of Wyoming (Wyoming Department of Environmental Quality, 1983) has designated all of the surface existing within the limits of national parks as Class I Waters. Class I Waters are those surface waters in which no quality degradation is permitted and only discharges from dams are allowed. The natural character of the Class I Waters must be preserved. The streams receiving surface drainage from PM-1/Sundance Site include Lytle Creek, an unnamed tributary of Beaver Creek and the unnamed streams in Bear Den Canyon and Jim Wayne Canyon.

TABLE 3.6
STUDY AREA SURFACE WATER USE CLASSIFICATIONS IN
SOUTH DAKOTA

Designated Use	Surface Water		
	Box Elder Creek	Elm Creek	White River
Farm/range irrigation	X	X	X
Wildlife Propagation	X	X	X
Livestock Watering	X	X	X
Warm water permanent fish life propagation		X	
Warm water semi-permanent fish life propagation			X
Limited contact recreation		X	X

Source: South Dakota Department of Water and Natural Resources, 1984

Note: Applicable to the stream segment receiving base runoff or discharge.

Surface Water Quality Monitoring

Routine surface water quality monitoring is conducted on Ellsworth AFB at the general locations depicted on Figure 3.11, in accordance with the provisions of the base National Permit Discharge Elimination System (NPDES) permit. The permit requires water quality monitoring for oil and grease and surfactants at all monitoring locations. In addition, monitoring for fecal coliform bacteria is required at the sewage treatment plant outfall (monitoring point number 005). A review of base historical water quality monitoring data (December 1982 - December 1984) indicates that NPDES permit noncompliance events have occurred at site 005 due to excessive oil and grease and fecal coliform concentrations. Base surface water monitoring data is summarized in Appendix D, Table D.4.

No permanent structures or facilities exist at the Badlands Air Force Range. Because of the lack of activity that might create runoff or pollution problems, no surface water quality monitoring is performed at the Range.

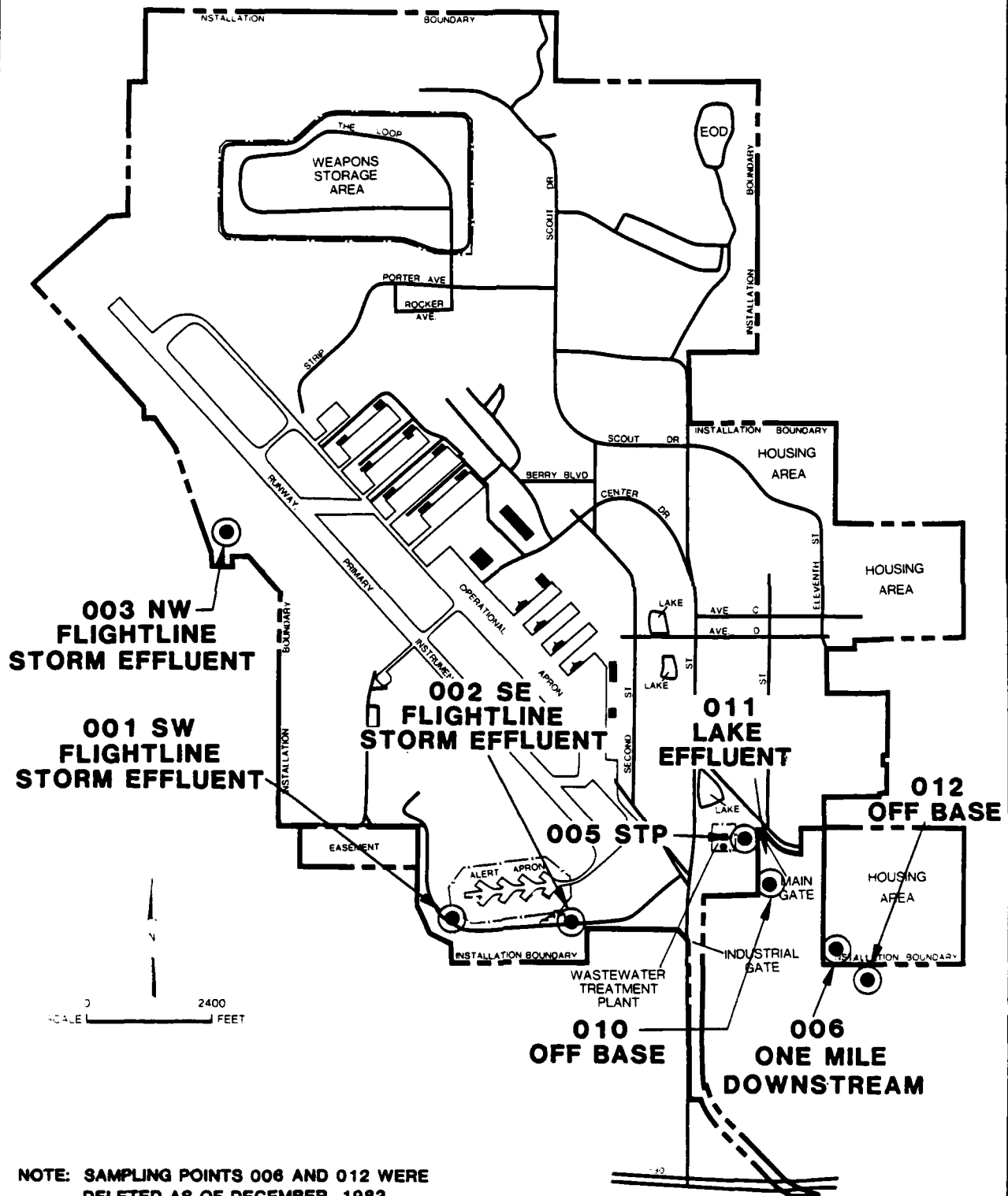
Surface water, ground water and soil quality monitoring has been conducted routinely in the vicinity of the PM-1/Sundance Site since the closure of the radar site in 1969. Sampling and analysis has been performed annually by OEHL, Brooks AFB, Texas, for gross Beta, total gamma and selected radionuclides. Annual sample collection is now shared by OEHL, Brooks AFB, Texas, and the Bioenvironmental Engineering Section, Ellsworth AFB, SD. A review of historical and current reports documenting the PM-1/Sundance Site environmental quality monitoring program indicate that no change in local conditions has occurred. The locations of water and soil monitoring stations relative to the PM-1/Sundance Site are illustrated on Figure 3.12 (soil locations) and Figure 3.13 (water sampling locations). Currently utilized PM-1/Sundance Site sampling stations are listed on Table 3.7. There is no environmental quality monitoring performed at the other remote sites.

THREATENED AND ENDANGERED SPECIES

The land area of Ellsworth AFB includes some 4858 acres of which approximately 1952 acres is classified as unimproved land. At present, 1081 acres is outleased and the remaining 871 acres are utilized as

FIGURE 3.11

ELLSWORTH AFB SURFACE WATER QUALITY MONITORING LOCATIONS



SOURCE: INSTALLATION DOCUMENTS

FIGURE 3.12

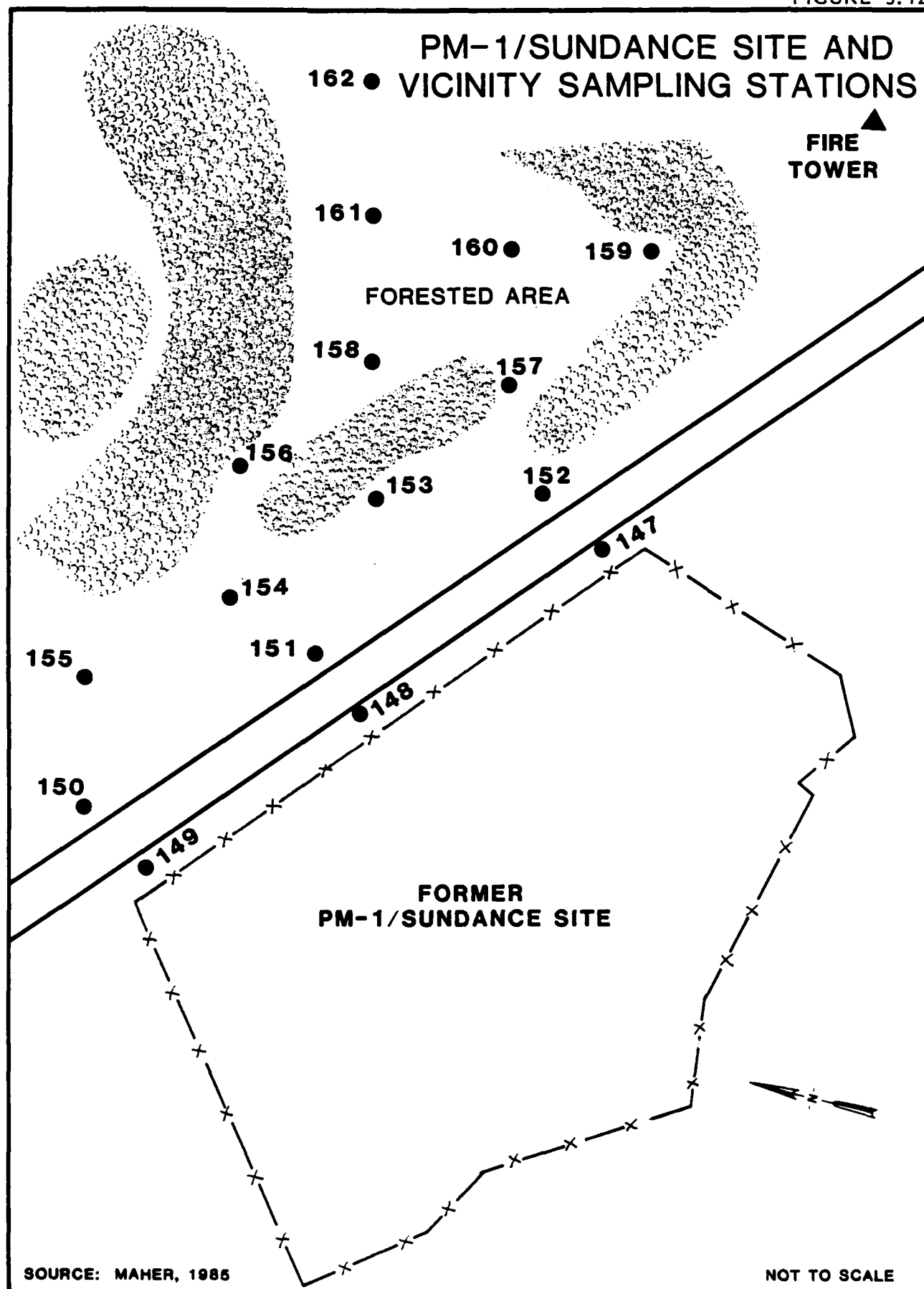


FIGURE 3.13

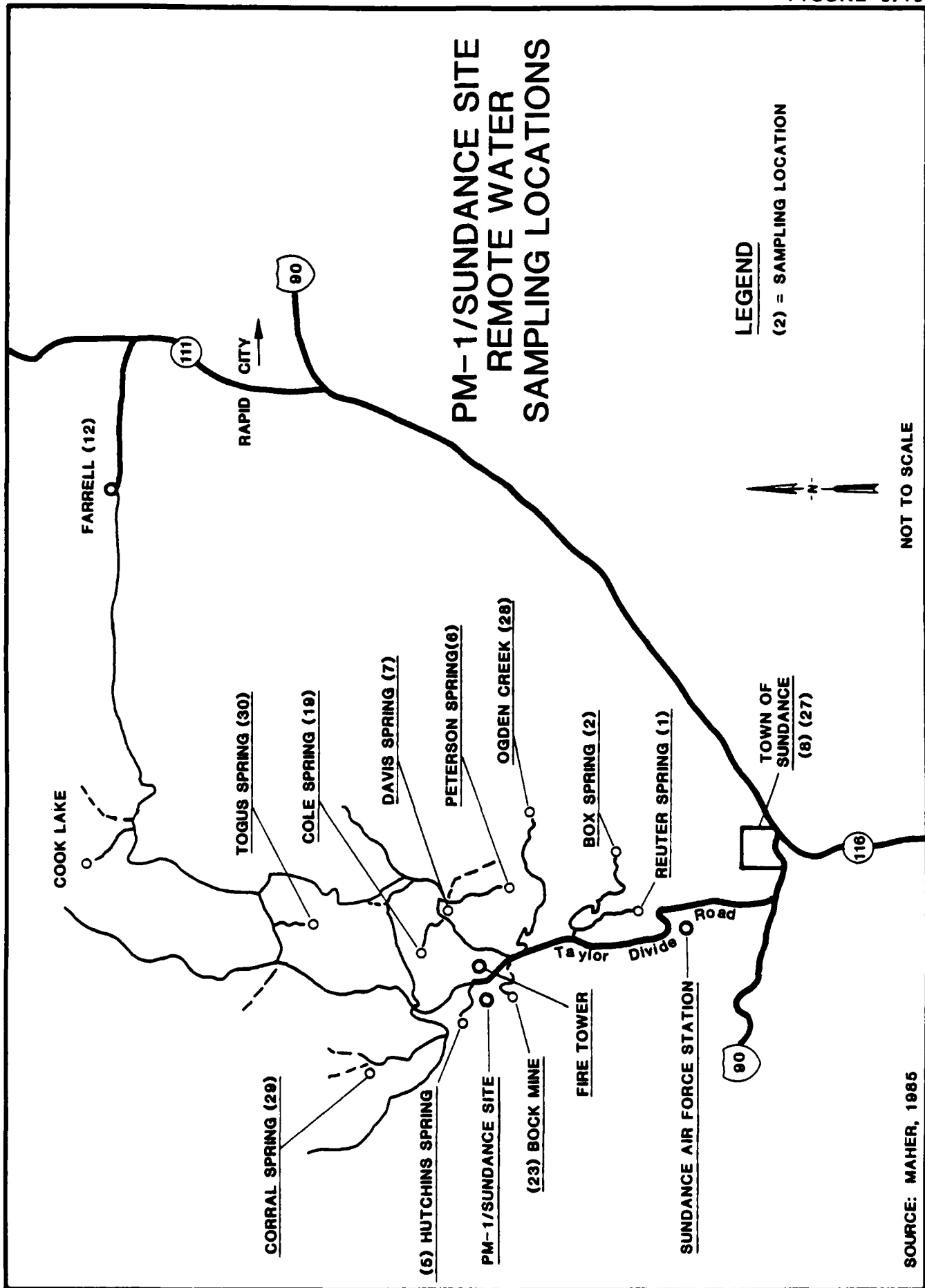


TABLE 3.7
PM-1/SUNDANCE SITE ENVIRONMENTAL QUALITY MONITORING STATIONS

Sampling Point Number	Name/Identifier	Media	Analytes
1	Reuter Spring	Ground Water	Gross Beta
2	Box Spring	Ground Water	Gross Beta
5	Hutchins Spring	Ground Water	Gross Beta
6	Peterson Spring	Ground Water	Gross Beta
7	Davis Spring	Ground Water	Gross Beta
8	Sundance Well	Ground Water	Gross Beta
19	Cole Spring	Ground Water	Gross Beta
23	Bock Mine	Surface Water	Gross Beta
27	Sundance Soil	Soil	Gross Beta, Total gamma, radionuclides
27	Sundance Well	Ground Water	Gross Beta
28	Ogden Creek	Surface Water	Gross Beta
30	Togus Spring	Ground Water	Gross Beta
30	Togus Spring Vicinity	Soil	Gross Beta, Total gamma, radionuclides
147	Northeast Slope	Soil	Gross Beta, Total gamma, radionuclides
148	Northeast Slope	Soil	Gross Beta, Total gamma, radionuclides
149	Northeast Slope	Soil	Gross Beta, Total gamma, radionuclides
150	Northeast Slope	Soil	Gross Beta, Total gamma, radionuclides
151	Northeast Slope	Soil	Gross Beta, Total gamma, radionuclides
152	Northeast Slope	Soil	Gross Beta, Total gamma, radionuclides
153	Northeast Slope	Soil	Gross Beta, Total gamma, radionuclides
154	Northeast Slope	Soil	Gross Beta, Total gamma, radionuclides
155	Northeast Slope	Soil	Gross Beta, Total gamma, radionuclides
156	Northeast Slope	Soil	Gross Beta, Total gamma, radionuclides
157	Northeast Slope	Soil	Gross Beta, Total gamma, radionuclides
158	Northeast Slope	Soil	Gross Beta, Total gamma, radionuclides
159	Northeast Slope	Soil	Gross Beta, Total gamma, radionuclides
160	Northeast Slope	Soil	Gross Beta, Total gamma, radionuclides
161	Northeast Slope	Soil	Gross Beta, Total gamma, radionuclides
162	Northeast Slope	Soil	Gross Beta, Total gamma, radionuclides

Source: Maher, 1985

pasture. The unimproved acreage is considered to be mixed prairie grassland and provides suitable habitat for a variety of small animals and birds.

No threatened or endangered species of plants or animals are known to be residence at Ellsworth AFB (Ellsworth AFB, 1971; USAF, 1977; and HQ SAC, 1985), however, several species of mammals and birds may occur in the study area at any time and could be transients at the installation. These potential transients include:

- o Black-footed ferret
- o Swift fox
- o American peregrine falcon
- o Arctic peregrine falcon
- o Bald eagle
- o Whooping crane

The transients listed above may also be present within the limits of the Badlands Air Force Range or the PM-1/Sundance Site at any time. It is not known if any or all of the species listed above is a resident of the Ellsworth AFB satellite facilities.

SUMMARY OF ENVIRONMENTAL SETTING

The environmental setting data reviewed for this investigation indicate that the following elements are relevant to the evaluation of past hazardous waste management practices at Ellsworth AFB and its satellite facilities:

- o The mean annual precipitation at Ellsworth AFB is 16.9 inches and the net annual precipitation is calculated to be minus 24 inches. The mean annual precipitation at Badlands Air Force Range is 16 inches; net annual precipitation is calculated to be minus 24 inches. The average annual precipitation received in the vicinity of the PM-1/Sundance Site is 20 inches; the calculated net annual precipitation is minus 21 inches.

- o Flooding is not known to be a problem at any of the installations investigated under the scope of this study; no wetlands exist on any of the facilities.
- o Ellsworth AFB surface soils are generally fine-grained and possess low permeabilities in the upper sections of their profiles, but may be underlain by higher permeability sand and gravel zones. The Badlands Air Force Range surface materials are principally clays and silts of the White River Group (eighty percent of the installation's land area); permeable wind-blown sand, sandy terrace deposits and alluvium are present at land surface in the remaining portion of the Range. The surface soils present at the PM-1/Sundance Site are typically clayey or clayey and gravelly residuum having low permeabilities. Bedrock underlies the residuum at shallow depths.
- o An ephemeral shallow aquifer exists at or near ground surface at Ellsworth AFB (older alluvium). It probably contains ground water seasonally and discharges to local surface waters. The aquifers of regional significance at Ellsworth AFB consist of bedrock units present at depths of 1700 feet below land surface or greater. The regionally significant aquifers beneath the base are effectively sealed from installation surface activities by substantial sequences of shale, sandstone, limestone, siltstone, etc. Ground water contained in the regional aquifers exists under very strong artesian pressures.
- o Shallow unconsolidated aquifers exist at the Badlands Air Force Range. Ground water occurs in these hydrogeologic units under water table conditions, usually at depth of 100 feet or less below land surface.
- o A shallow aquifer is not known to exist at the PM-1/Sundance Site. The underlying bedrock may contain ground water locally in secondary openings, but is not considered to be a dependable

source of water supplies. Most of the PM-1/Sundance Site is paved, limiting the recharge by precipitation of an aquifer beneath the facility.

- o Ellsworth AFB and surrounding areas obtain their potable water supplies from the Rapid City municipal distribution system. The city uses surface water, shallow and deep aquifers to obtain its water supplies. The base maintains wells finished into deep aquifers on a standby basis. The town of Box Elder and numerous consumers near the base use their own individual wells to obtain needed water supplies. It is believed that all of the wells presently in use near Ellsworth AFB are finished into deep aquifers, at least 1700 feet below ground surface. Surface water (probably augmented by shallow aquifer seasonal discharge) is utilized for livestock watering and irrigation purposes by consumers located west, north and east of the base.
- o It is unlikely that any water resources are currently in use to serve human populations near the Badlands AFB or the PM-1/Sundance Site. The Range is a restricted area with no resident population and is located in a remote section of Shannon County. The PM-1/Sundance Site is situated on a mountain top in a national forest, six miles northwest of the town of Sundance, in Crook County, Wyoming. Its remote setting isolates the site from disturbance.
- o The streams existing on Ellsworth AFB are classified as ephemeral streams; they contain water only when sufficient runoff is available to support flow. The White River, a perennial stream transsects a segment of the Badlands Air Force Range. No surface waters exist at the PM-1/Sundance Site.
- o A review of base historical surface water quality monitoring data indicates incidences of noncompliance with the NPDES

permit stipulations due to periodically high oil and grease and fecal coliform levels. All the incidences of non-compliance have been as a result of sewage treatment plant discharges.

- o A review of the annual PM-1/Sundance Site monitoring program data (1969 to date) indicates that there have been no changes in radionuclide levels in surface water, ground water or soil samples collected.
- o No rare and endangered species are known to be residents at any of the installations investigated under the scope of this study, however, several such mammals and birds are known to be occasional transients and could be present at any or all of the installations at any time.

It may be seen from these key environmental factors that potential pathways facilitating the migration of hazardous-waste related contamination exist. Hazardous waste constituents present at ground surface could be potentially mobilized to local surface waters via runoff or by direct infiltration into the surface soils followed by subsequent discharge to local surface waters. In no event is it likely that surface contaminants could conceivably migrate into the regional aquifers underlying the installation at great depth.

SECTION 4

FINDINGS

This section summarizes the hazardous wastes generated by installation activities, identifies hazardous waste accumulation and disposal sites located on the installation, and evaluates the potential environmental contamination from hazardous waste sites. Past waste generation and disposal methods were reviewed to assess contamination potential at Ellsworth AFB. The information for the satellite facilities is presented in a latter portion of this section.

INSTALLATION HAZARDOUS WASTE ACTIVITY REVIEW

A review was made of past and present installation activities that resulted in generation, accumulation and disposal of hazardous wastes. Information was obtained from files and records, interviews with past and present installation employees and site inspections.

The sources of hazardous waste at Ellsworth AFB are grouped into the following categories:

- o Industrial Operations (Shops)
- o Waste Accumulation and Storage Areas
- o Pesticide Utilization
- o Fuels Management
- o Spills and Leaks
- o Fire Protection Training

The subsequent discussion addresses only those wastes generated at Ellsworth AFB which are either hazardous or potentially hazardous. Potentially hazardous wastes are grouped with and referenced as "hazardous wastes" throughout this report. A hazardous waste, for this report,

is defined by, but not limited to, the Resource Conservation and Recovery Act (RCRA) and the Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA). Compounds such as polychlorinated biphenyls (PCB) which are listed in the Toxic Substances Control Act (TSCA) are also considered hazardous. For the purposes of this study, waste petroleum products such as contaminated fuels, waste oils and waste nonchlorinated solvents are also included in the "hazardous waste" category.

No distinction is made in this report between "hazardous substances/materials" and hazardous wastes". A potentially hazardous waste is one which is suspected of being hazardous although insufficient data are available to fully characterize the material.

Industrial Operations (Shops)

Information on industrial operations at Ellsworth AFB were obtained from installation files and interviews. This information obtained was used to determine which operations handle hazardous materials and which ones generate hazardous wastes. The Bioenvironmental Engineering Section (BES) provided a listing of industrial shops as well as individual shop files indicating past hazardous materials utilization and hazardous material handling practices. Summary information on all installation shops is provided as Appendix E, Master List of Shops.

The eleven main units involved in the handling of hazardous materials at Ellsworth AFB are listed below:

- o 44 Combat Support Group
- o 28 Organizational Maintenance Squadron
- o 44 Transportation Squadron
- o 44 Supply Squadron
- o 28 Avionics Maintenance Squadron
- o 28 Munitions Maintenance Squadron
- o USAF Hospital, Ellsworth
- o 44 Field Missile Maintenance Squadron
- o 28 Field Maintenance Squadron
- o Detachment 2, 37 Aerospace Rescue and Recovery
- o 44 Civil Engineering Squadron

For the shops identified as potential hazardous waste generators, personnel were interviewed to determine the types and quantities of materials handled and present and past disposal methods. This information is summarized in Table 4.1.

Since the reactivation of the base, and its transfer to the Air Force in 1947, industrial shops have supported aircraft and missile missions and performed general base maintenance. Expansion has occurred since then and some shops are no longer in their original locations. Hazardous waste generation and disposal practices for the base from its onset to the mid-seventies are not well documented. Information obtained from interviews with personnel who had been at the base during this period was used in developing the time lines in Table 4.1.

The shops at Ellsworth AFB generate primarily waste oils, solvents (including paint thinners and strippers), contaminated jet fuels and acidic and basic cleaning solutions.

Prior to 1980, waste oils and solvents (paint thinners and strippers) were generally not segregated, but mixed in drums and either sent to the DPDO Holding Facility for temporary storage or to the Fire Protection Training Area (FPTA) to be burned in fire training exercises. From the DPDO Holding Facility, drums were removed to an off-base facility by contract, retrieved for fire training exercises, or, if no other disposal arrangements could be made, sent to an on-base landfill. Since 1980, these wastes have been disposed of off-base by contract through DPDO.

Small amounts of oils and solvents from individual shops have occasionally been discharged to the industrial sewer as shown in Table 4.1. The industrial sewer system is described in a later subsection. Prior to approximately 1976, the waste oils separated from the industrial treatment system were sent to the base landfill. Since 1976, these waste oils have been removed and disposed of off-base by contract.

Before 1970, contaminated jet fuels were sent to the DPDO Holding Facility and disposed of along with the other liquid wastes as described above. After 1970, contaminated fuels were separated in bowlers, sent to the Fuels Lab for testing, and either reused on-base or sent to the FPTA.

TABLE 4.1
INDUSTRIAL OPERATIONS (Shops)
Waste Management

1 of 7

SHOP NAME	LOCATION (BLDG. NO.)	WASTE MATERIAL	WASTE QUANTITY	METHOD(S) OF TREATMENT, STORAGE & DISPOSAL 1950 1960 1970 1980
44 COMBAT SUPPORT GROUP				
PHOTO /GRAPHICS	7506	DEVELOPER & FIXER	57 GALS. /MO.	1951 SANITARY SEWER SILVER RECOVERY / SANITARY SEWER 1973
		BLEACH SOLUTION	5 GALS. /MO.	SANITARY SEWER
		DIAZO SOLUTION	1 GAL. /MO.	SANITARY SEWER
PHOTO HOBBY SHOP	4610	DEVELOPER & FIXER	1/2 GAL. /MO.	SILVER RECOVERY /SANITARY SEWER 1978
		BLEACH SOLUTION	1/3 GAL. /MO.	SILVER RECOVERY /SANITARY SEWER
AUTO HOBBY SHOP	4610	SOLVENTS	10 GALS. /MO.	1952 OBC
		WASTE OIL	100 GALS. /MO.	CONTRACT DISPOSAL /FPTA OBC
28TH ORGANIZATIONAL MAINTENANCE SQUADRON				
WHEEL & TIRE	410	PD 680	50 GALS. /MO.	1954 DPDO
		PAINT STRIPPER (ETHANOLA MINE, ETHYLENE DIAMINE)	75 GALS. /MO.	DPDO OVS /INDUSTRIAL SEWER 1981
WASH RACK	7621	DEGREASER (SOAP)	100 GALS. /MO.	OVS INDUSTRIAL SEWER

KEY

— CONFIRMED TIME FRAME DATA BY SHOP PERSONNEL
- - - ESTIMATED TIME FRAME DATA BY SHOP PERSONNEL

DPDO DEFENSE PROPERTY DISPOSAL OFFICE
OVS OIL/WATER SEPARATOR
OBC DISPOS L, TREATMENT OR REUSE OFF BASE BY CONTRACT

TABLE 4.1 (CONT'D) INDUSTRIAL OPERATIONS (Shops)

Waste Management

2 of 7

SHOP NAME	LOCATION (BLDG. NO.)	WASTE MATERIAL	WASTE QUANTITY	TREATMENT, STORAGE & DISPOSAL 1950 1960 1970 1980	METHOD(S) OF
44TH TRANSPORTATION SQUADRON	7616	ANTIFREEZE	25 GALS. /MO.	1952	INDUSTRIAL SEWER
		WASTE OIL	40 GALS. /MO.		OBC
		SOLVENT	20 GALS. /MO.		OBC
		WASTE OIL	25 GALS. /MO.		DPDO /FPTA
	605	HYDRAULIC FLUIDS	80 GALS. /MO.		DPDO /FPTA
		SOLVENT	20 GALS. /MO.	1955	OWS /INDUSTRIAL SEWER
	102	WASTE OIL	150 GALS. /MO.		DPDO /FPTA
		CLEANING SOLUTION (PARCHEM)	45 GALS. /MO.		OWS /INDUSTRIAL SEWER
		SODIUM HYDROXIDE	40 GALS. /MO.		NEUTRALIZED TO INDUSTRIAL SEWER
		BRAKE FLUID	2 GALS. /MO.		DPDO
44TH SUPPLY SQUADRON	7616	TRANSMISSION FLUID	30 GALS. /MO.		OWS /INDUSTRIAL SEWER
					DPDO /FPTA
		FUEL	500 GALS. /MO.		RECOVERED /FPTA

KEY

— CONFIRMED TIME FRAME DATA BY SHOP PERSONNEL
 - - - ESTIMATED TIME FRAME DATA BY SHOP PERSONNEL

DPDO DEFENSE PROPERTY DISPOSAL OFFICE
 FPTA FIRE PROTECTION TRAINING AREA
 OWS OIL/WATER SEPARATOR
 OBC DISPOSAL, TREATMENT OR REUSE OFF BASE BY CONTRACT

TABLE 4.1 (CONT'D)
INDUSTRIAL OPERATIONS (Shops)
Waste Management

3 of 7

SHOP NAME	LOCATION (BLDG. NO.)	WASTE MATERIAL	WASTE QUANTITY	METHOD(S) OF TREATMENT, STORAGE & DISPOSAL 1950 1960 1970 1980
28TH AVIONICS MAINTENANCE SQUADRON	PMEL 106	CESIUM 137	1 PELLET /YR.	1956 OBC
		PLUTONIUM 239	1 PELLET /YR.	OBC
		MERCURY	5 MI/MO.	DPDO
	7503	PD 680	40 GALS. /MO.	1953 FPTA DPDO
		HYDRAULIC FLUID	40 GA' S. /MO.	FPTA DPDO
28TH MUNITIONS MAINTENANCE SQUADRON	7239	PD 680	1 2 GALS. /MO.	DPDO 1977 DISCONTINUED USE
		HYDRAULIC FLUID	40 GALS. /MO.	INDUSTRIAL SEWER 1969 DPDO
	7240	SOLVENT	10 GALS. /MO.	INDUSTRIAL SEWER 1976 DPDO
				INDUSTRIAL SEWER DPDO

KEY

— CONFIRMED TIME FRAME DATA BY SHOP PERSONNEL
- - - - - ESTIMATED TIME FRAME DATA BY SHOP PERSONNEL

DPDO DEFENSE PROPERTY DISPOSAL OFFICE
FPTA FIRE PROTECTION TRAINING AREA
OWS OIL/WATER SEPARATOR
OBC DISPOSAL, TREATMENT OR REUSE OFF BASE BY CONTRACT

TABLE 4.1 (CONT'D)
INDUSTRIAL OPERATIONS (Shops)

Waste Management

4 of 7

SHOP NAME	LOCATION (BLDG. NO.)	WASTE MATERIAL	WASTE QUANTITY	TREATMENT, STORAGE & DISPOSAL 1950 1960 1970 1980	METHOD(S) OF
USAF HOSPITAL, ELLSWORTH MEDICAL X RAY DENTAL CLINIC	6000	DEVELOPER	40 GALS. /MO.		SILVER RECOVERY/SANITARY SEWER 1959 SANITARY SEWER 1981
	6000	DEVELOPER	5 GALS. /MO.		SILVER RECOVERY/SANITARY SEWER SANITARY SEWER 1980
44TH FIELD MISSILE MAINTENANCE SQUADRON FACILITIES MAINTENANCE/PERIODIC INSP. TEAM POWER, REFRIGERATION, ELECTRIC PNEUDRAULICS	7504	WASTE OIL	100 GALS. /MO.		1960 DPDO/FPTA 1980 DPDO
	7504	SODIUM CHROMATE	55 GALS. /MO.		SANITARY SEWER DPDO 1979 1984
	7504	HYDRAULIC OIL	15 GALS. /MO.		INDUSTRIAL SEWER DPDO 1979 1984
		CONTAMINATED FUEL	10 GALS. /MO.		MIXED WITH WASTE ENGINE OIL IN FUEL MAINTENANCE
28TH FIELD MAINTENANCE SQUADRON ELECTRIC SHOP AEROSPACE GROUND EQUIPMENT	410	ACID	80 GALS. /MO.		1954 NEUTRALIZED TO SANITARY SEWER
	410	WASTE OIL	100 GALS. /MO.		DPDO/FPTA DPDO
		SOLVENT	100 GALS. /MO.		DPDO/FPTA DPDO

KEY

— CONFIRMED TIME FRAME DATA BY SHOP PERSONNEL
- - - - - ESTIMATED TIME FRAME DATA BY SHOP PERSONNEL

DPDO DEFENSE PROPERTY DISPOSAL OFFICE
FPTA FIRE PROTECTION TRAINING AREA

TABLE 4.1 (CONT'D)
INDUSTRIAL OPERATIONS (Shops)
Waste Management

5 of 7

SHOP NAME	LOCATION (BLDG. NO.)	WASTE MATERIAL	WASTE QUANTITY	TREATMENT, STORAGE & DISPOSAL 1950 1960 1970 1980	METHOD(S) OF
28TH FIELD MAINTENANCE SQUADRON (CONT'D.)					
CORROSION CONTROL	7778	SOLVENTS	110 GALS./MO.		1958 DISCHARGE ON GROUND DPDO 1980
		PAINT STRIPPER	50 GALS./MO.		OWS/INDUSTRIAL SEWER 1976 DPDO
NON DESTRUCTIVE INSPECTION	305	PD 680	8 GALS./MO.		1972 DPDO
		FIXER & DEVELOPER	5 GALS./MO.		SENT TO PHOTO LAB FOR SILVER RECOVERY/SANITARY SEWER
		DYE	5 GALS./MO.		DPDO
		EMULSIFIER	5 GALS./MO.		DPDO
NON POWERED AGE	DOCK 62	SOLVENTS	1 GAL./MO.		1955 EVAPORATED DPDO 1982
		HYDRAULIC FLUID	100 GALS./MO.		DPDO/FPTA 1980
		WASTE OIL	75 GALS./MO.		DPDO/FPTA DPDO
PNEUDRAULICS	410	WASTE OIL/HYDRAULIC FLUID	25 GALS./MO.		1954 OWS/INDUSTRIAL SEWER DPDO 1982
			30 GALS./MO.		OWS/INDUSTRIAL SEWER DPDO
MACHINE SHOP	410	WASTE CUTTING OIL (WATER SOLUBLE)	5 GALS./MO.		INDUSTRIAL SEWER

KEY
— CONFIRMED TIME FRAME DATA BY SHOP PERSONNEL
- - - - - ESTIMATED TIME FRAME DATA BY SHOP PERSONNEL

DPDO DEFENSE PROPERTY DISPOSAL OFFICE
OWS OIL/WATER SEPARATOR
FPTA FIRE PROTECTION TRAINING AREA

TABLE 4.1 (CONT'D)
INDUSTRIAL OPERATIONS (Shops)
Waste Management

SHOP NAME	LOCATION (BLDG. NO.)	WASTE MATERIAL	WASTE QUANTITY	METHOD(S) OF TREATMENT, STORAGE & DISPOSAL 1950 1960 1970 1980
28TH FIELD MAINTENANCE SQUADRON (CONT'D)				
JET ENGINE REPAIR	601	CARBON REMOVER	60 GALS. /MO.	1942 ----- DPDO /FPTA ----- 1980 DPDO
SMALL ENGINE REPAIR	601	SOLVENT	55 GALS. /MO.	----- DPDO /FPTA ----- DPDO
		CARBON REMOVER	55 GALS. /MO.	----- DPDO /FPTA ----- DPDO
		CALIBRATION FLUID	55 GALS. /MO.	----- DPDO /FPTA ----- DPDO
DETACHMENT 2, 37TH AEROSPACE RESCUE & RECOVERY				
HELICOPTER MAINTENANCE	7244	WASTE FUEL	100 GALS. /MO.	1956 ----- DPDO /FPTA ----- 1980 DPDO
		SOLVENT	25 GALS. /MO.	----- DPDO /FPTA ----- DPDO
		WASTE OIL	100 GALS. /MO.	----- DPDO /FPTA ----- DPDO
44TH CIVIL ENGINEERING SQUADRON				
ENTOMOLOGY	8118	OUTDATED PESTICIDES	VARIES	1952 ----- LANDFILL ----- 1976 OBC
		WASH WATER	80 GALS. /MO.	----- INDUSTRIAL SEWER -----
	88408	SLUDGE FROM TANK CLEANING	10 GALS. /MO.	----- BURIED NEAR TANK ----- 1979 DPDO
		SPENT FUEL FILTERS (Weathered)	VARIES	----- LANDFILL ----- OBC
PAINT SHOP	1911	SPENT SOLVENT	10 GALS. /MO.	1955 SANITARY SEWER, LANDFILL ----- DPDO

KEY

----- CONFIRMED TIME FRAME DATA BY SIOP PERSONNEL
----- ESTIMATED TIME FRAME DATA BY SIOP PERSONNEL

DPDO DEFENSE PROPERTY DISPOSAL OFFICE
FPTA FIRE PROTECTION TRAINING AREA
OBC DISPOSAL, TREATMENT OR REUSE OFF BASE BY CONTRACT

INDUSTRIAL OPERATIONS (Shops)

Waste Management

7 of 7

SHOP NAME	LOCATION (BLDG. NO.)	WASTE MATERIAL	WASTE QUANTITY	TREATMENT, STORAGE & DISPOSAL 1950 1960 1970 1980	METHOD(S) OF
POWER PRODUCTION	8115	ACID	2 GALS. /MO.		1958 NEUTRALIZED TO SANITARY SEWER
REFRIGERATION	8115	SPENT SOLVENT	2 GALS. /MO.		SANITARY SEWER
INTERIOR ELECTRIC	8115	LUBRICATING OIL	10 GALS. /MO.		1980 DPDO /FPTA DPDO
EXTERIOR ELECTRIC	8115	USED BATTERIES	5 BATTERIES/MO.		OBC
		PCB'S	10 GALS. /MO.		DPDO

KEY

— CONFIRMED TIME FRAME DATA BY SHOP PERSONNEL
 - - - - - ESTIMATED TIME FRAME DATA BY SHOP PERSONNEL

DPDO DEFENSE PROPERTY DISPOSAL OFFICE
 FPTA FIRE PROTECTION TRAINING AREA
 OBC DISPOSAL, TREATMENT OR REUSE OFF BASE BY CONTRACT

Waste acidic and alkaline solutions are neutralized prior to disposal in the industrial or sanitary sewerage system. Small amounts of these solutions are discharged directly to the sewerage system.

Waste Accumulation and Storage Areas

Wastes generated on-base and from operations off-base have been accumulated in drums in on-base storage areas. Currently, there are designated areas, both indoors and outdoors, that each serve a number of the shops. These areas are listed in Table 4.2. Inspection of these areas showed only minimal leakage, and no significant environmental contamination is associated with these storage areas.

The DPDO (formerly base salvage) has coordinated accumulation and disposal of drummed waste at the base. Prior to 1982, drummed waste was stored at the Holding Facility on Landfill No. 3, on the southwest side of the base. Many drums were stored for a long period of time and some leakage occurred. Although not confirmed, it is speculated that prior to 1964, drums were also stored at Landfill No. 1, south of the alert apron.

The current drum storage area was constructed in 1982 south of the DPDO facility. The area is fenced and has a concrete base and dike with a drain to the sanitary sewerage system. The drain was plugged in 1984. Drums are stored on pallets in the area until removed by a contractor for off-base disposal.

DPDO also temporarily stores PCB transformers at their facility prior to off-site disposal. No known PCB spills or accidents have occurred on the base.

Pesticide Utilization

The Entomology Shop in the Civil Engineering Squadron is responsible for pesticide management at Ellsworth AFB. All pesticides are stored in the Entomology Shop and applied by personnel from the shop. A pesticide inventory list is presented in Appendix D, Table D.1. All pesticide containers are triple rinsed prior to being removed from the base by contractors. The rinsate is stored in a 300 gallon tank and used in making new pesticide solutions. For the past five years, outdated pesticides have been sent off-base for disposal by contractors. Equipment is washed after pesticide application and the water flushed down the industrial drain. Small spills are either flushed with water

TABLE 4.2
WASTE ACCUMULATION AND STORAGE AREAS

Location	Facility Description	Materials Stored
South of Bldg. 410	Outside, fenced with concrete pad.	Waste Oils, Solvents
Dock 83, Corrosion Control	Inside, with drain to OWS/industrial sewer.	Solvents
North of Bldg. 410	Outside, fenced with concrete pad and dike.	Waste Oils, Solvents
Bldg. 7504, Pride Hanger	Inside, diked.	Sodium Chromate
Northeast of Bldg. 102	Outside, asphalt, not diked.	Anti-freeze, Solvents, Waste Oils
West of Bldg. 7504	Inside, locked, temporary storage building.	Waste Fuels
North of Bldg. 8117	Outside, asphalt, not diked.	Waste Fuels
South of Bldg. 1801, DPDO	Outside, fenced and diked.	Waste Oils, Solvents, PCB's

SOURCE: Base Personnel

into the industrial drain or absorbant is used to collect the spill. The absorbant is disposed of in the dumpster for off-base disposal.

Prior to off-site refuse disposal in 1976, outdated pesticides were probably landfilled on-base. Contaminated rinsewaters, if not recycled, were disposed of in the industrial sewer.

Fuels Management

Ellsworth AFB fuels management system includes substantial quantities of jet fuel (JP-4) and smaller quantities of motor vehicle fuel (MOGAS), heating fuel oil, diesel fuel, and JP-5. A listing of the current storage facilities, their locations and quantities, are identified in Table D.2.

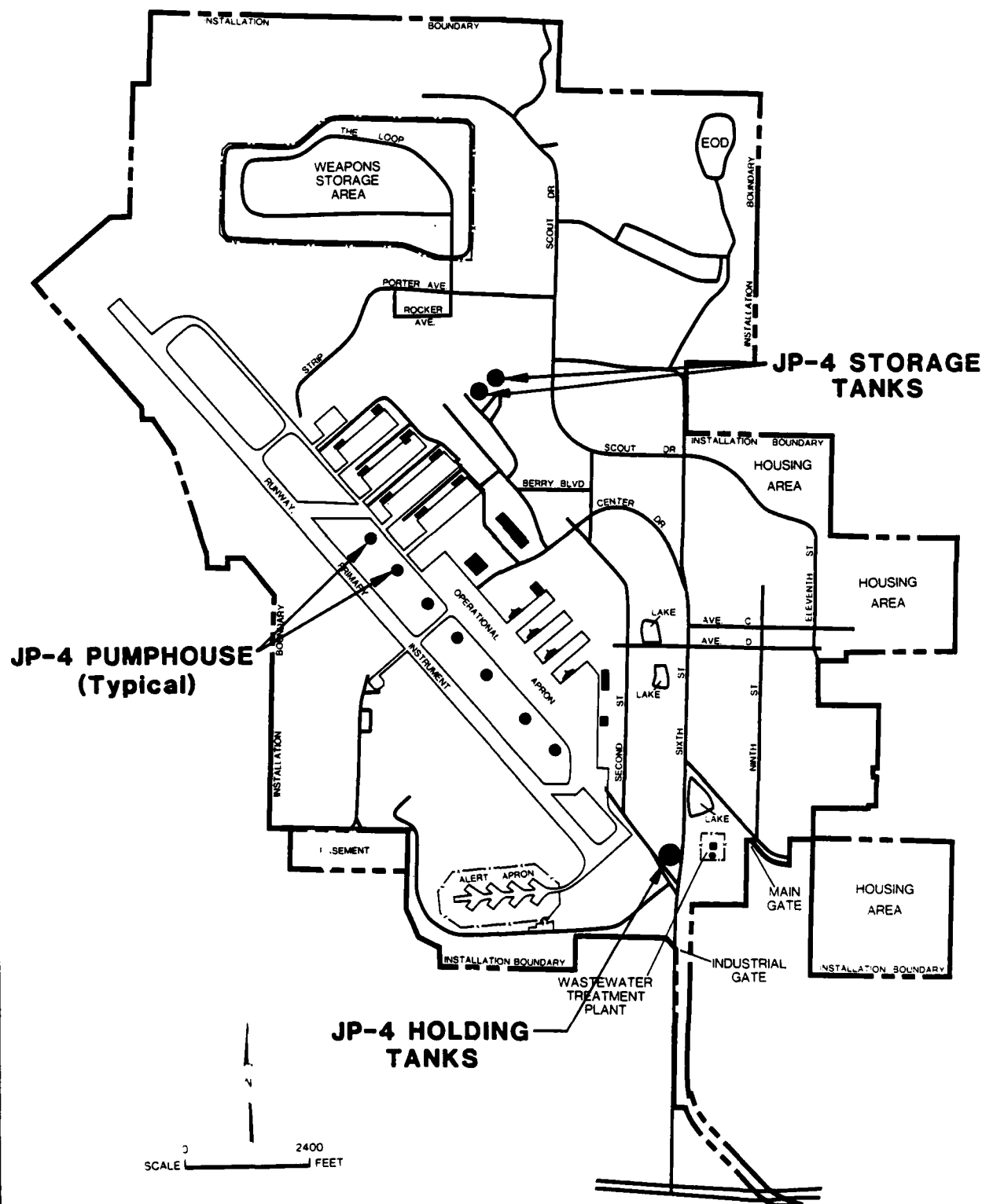
The majority of JP-4 is delivered to base primarily through a six inch contractor owned fuel pipeline. JP-4 can also be delivered by truck and rail car if necessary. The JP-4 is initially held in three tanks, located at the south end of the runway. Two of the tanks (Facility 1706 and 1710) are 840,000 gallon underground tanks and the third (Facility 1708) a 420,000 gallon aboveground tank. From these tanks, the JP-4 is pumped to forty-two 25,000 gallon underground tanks which are located at pump houses 1-7, along the operational apron, and to two aboveground storage tanks (Facility 8216 and 8212) which are located north of the shops. The two north tanks, having a combined capacity of 3,780,000 gallons, are then also used to supply the 42 pump house tanks. JP-4 is pumped from the 42 tanks to the hydrant system which services the flightline. The underground lines and tanks have cathodic protection to reduce corrosion, and are hydrostatically tested for leaks on a regular basis by Liquid Fuels Management. Fuel is trucked to alert apron and the backside of the operational apron. The primary fuel storage areas are shown in Figure 4.1.

MOGAS, unleaded MOGAS, and diesel fuel are stored at a number of locations (see Table D.2), and are all delivered by truck. JP-5, used occasionally as a backup heating fuel, is stored in a 260,000 gallon aboveground storage tank (Facility 88471) and is delivered and dispersed by truck.

Approximately 120 underground fuel oil tanks ranging in size from 500 to 15,000 gallons are located around base for backup power generation and heating purposes. These tanks were visually inspected in 1985

FIGURE 4.1

ELLSWORTH AFB MAJOR LIQUID FUELS STORAGE AREAS



by Civil Engineering, Heating Maintenance, and no tanks appeared to be leaking.

The JP-4 tanks are cleaned about once every three years. Since 1979, the sludge has been placed in drums and sent to DPDO for disposal. Prior to 1979, the sludge, 100 to 200 gallons per year, was spread within one of the aboveground storage tank diked areas, allowed to dry, and buried at a corner of the dike.

Used fuel filters have been air dried and then placed in the base trash for disposal.

Spills and Leaks

A number of significant spill and leak events have occurred at Ellsworth AFB. The available written history of spills and leaks at Ellsworth AFB prior to 1980 is quite limited; therefore, the information on these events is primarily the result of personnel interviews with present and past base employees. A spill and leak information summary is presented in Table 4.3, and the locations are shown in Figures 4.2 and 4.3. The events are described below.

Spill Site No. 1 (B-52 Crash at Pump House 7)

In 1972, a B-52 bomber on a training exercise left the runway and crashed into Pump House 7. Two of the plane's engines remained intact and two were destroyed. Although the plane's tanks were probably not full at the time of the crash, the maximum spill volume would have amounted to the 50,000 gallon capacity of the aircraft minus what was lost as a result of the fuel fire. No JP-4 was reported to have been lost from the pump house. The fuel was washed into the infield during the firefighting operation. There is no visual evidence of surface contamination at Spill Site No. 1.

Spill Site No. 2 (Coolant Spill at LF C-9)

In July 1977, approximately 50 gallons of missile launch facility (LF) coolant containing hexavalent sodium chromate and dimethoxane additive was pumped to the surface and discharged from LF C-9. The coolant ran off the LF and into a county road drainage ditch adjacent to the LF. No cleanup action was reportedly undertaken.

Spill Site No. 3 (Pump Houses 1,2,3,4, and 5 Hydrant Lines)

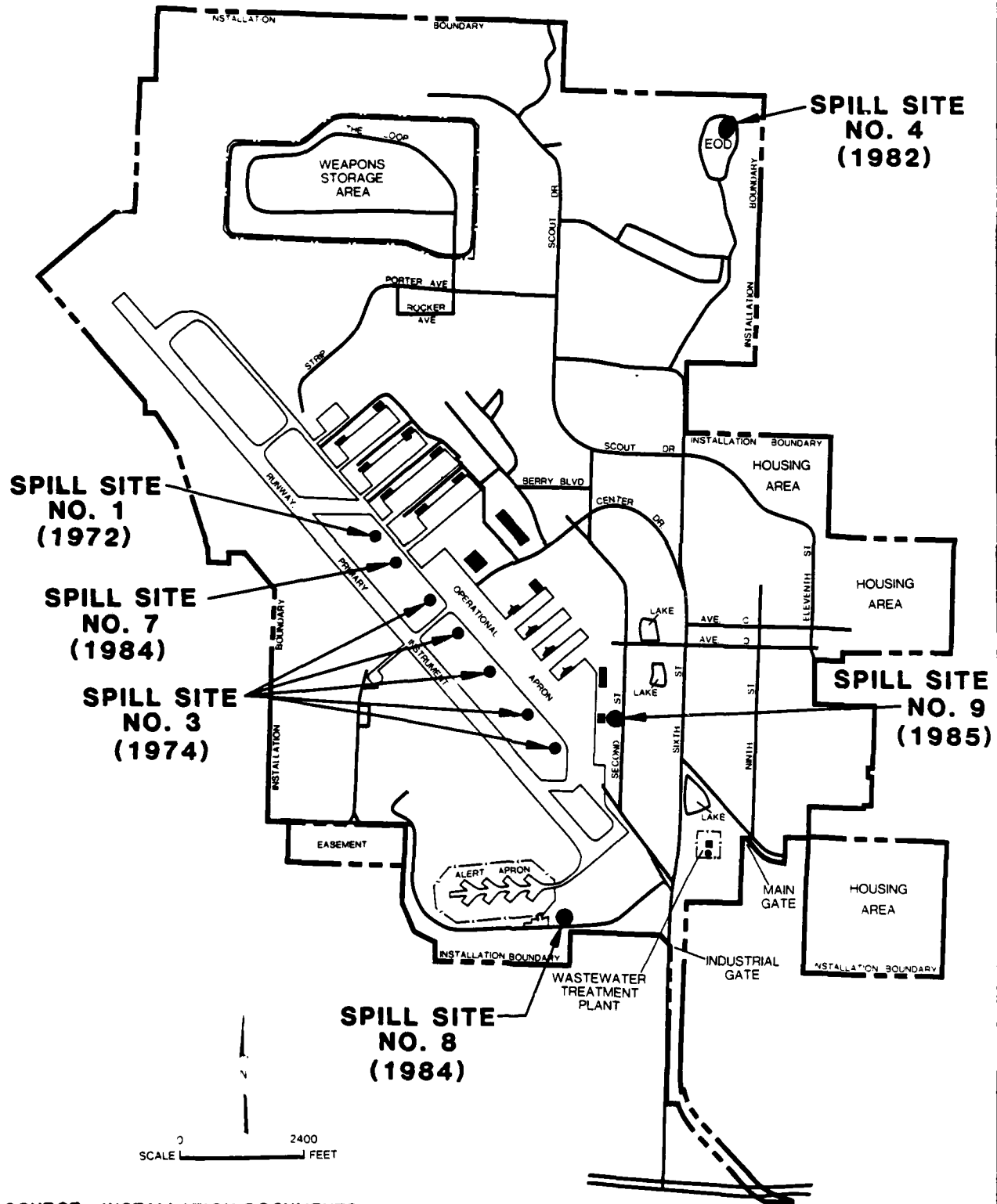
Spill Site No. 3 involves the fourteen old aluminum hydrant lines leading from pump houses 1 through 5 to the aircraft. Each of the pump

TABLE 4.3
SPILL AND LEAK AREA INFORMATION SUMMARY

Spill Site No.	Spill Description	Spill Date	Type of Waste Spilled	Approximate Quantity of Waste Spilled	Extent of Cleanup
1	B-52 Crash at Pump House 7	1972	JP-4	Quantity onboard minus burned fuel	Fuel washed into infield, drain to oil/water separator 001.
2	Sodium Chromate Spill at LF C-9	July 1977	LF Coolant	50 gallons	None.
3	Pump Houses 1-5 Aluminum Hydrant Lines	Early 1970's to 1974	JP-4	Unknown	Underground lines replaced from Pump Houses to the aircraft connections.
4	Pramitol Spill at EOD Area	May 1982	Prometone Herbicide (Pramitol 25E)	100 gallons	Soil removed to Landfill No. 3 June 1982, dams constructed June, 1983.
5	Sodium Chromate Spill at LF C-11	Jan. 1983	LF Coolant	100 gallons	Soil rototilled and left in place.
6	Sodium Chromate Spill at LF N-10	Aug. 1983	LF Coolant	100 gallons	Soil removed, returned to base, placed in Landfill No. 3.
7	JP-4 Spill at Pump House 6	Feb. 1984	JP-4	12,000 gallons	Washed into infield and to oil/water separator 001.
8	Calcium Hydroxide Precipitate at Oil/Water Separator 002	1984	Unknown	Unknown	Washed to oil/water separator 002.
9	Old Auto Hobby Shop Heating Fuel Tank	Discovered 1985	Heating Oil	Unknown	Abandoned tanks and contaminated soil to be removed as part of active project.

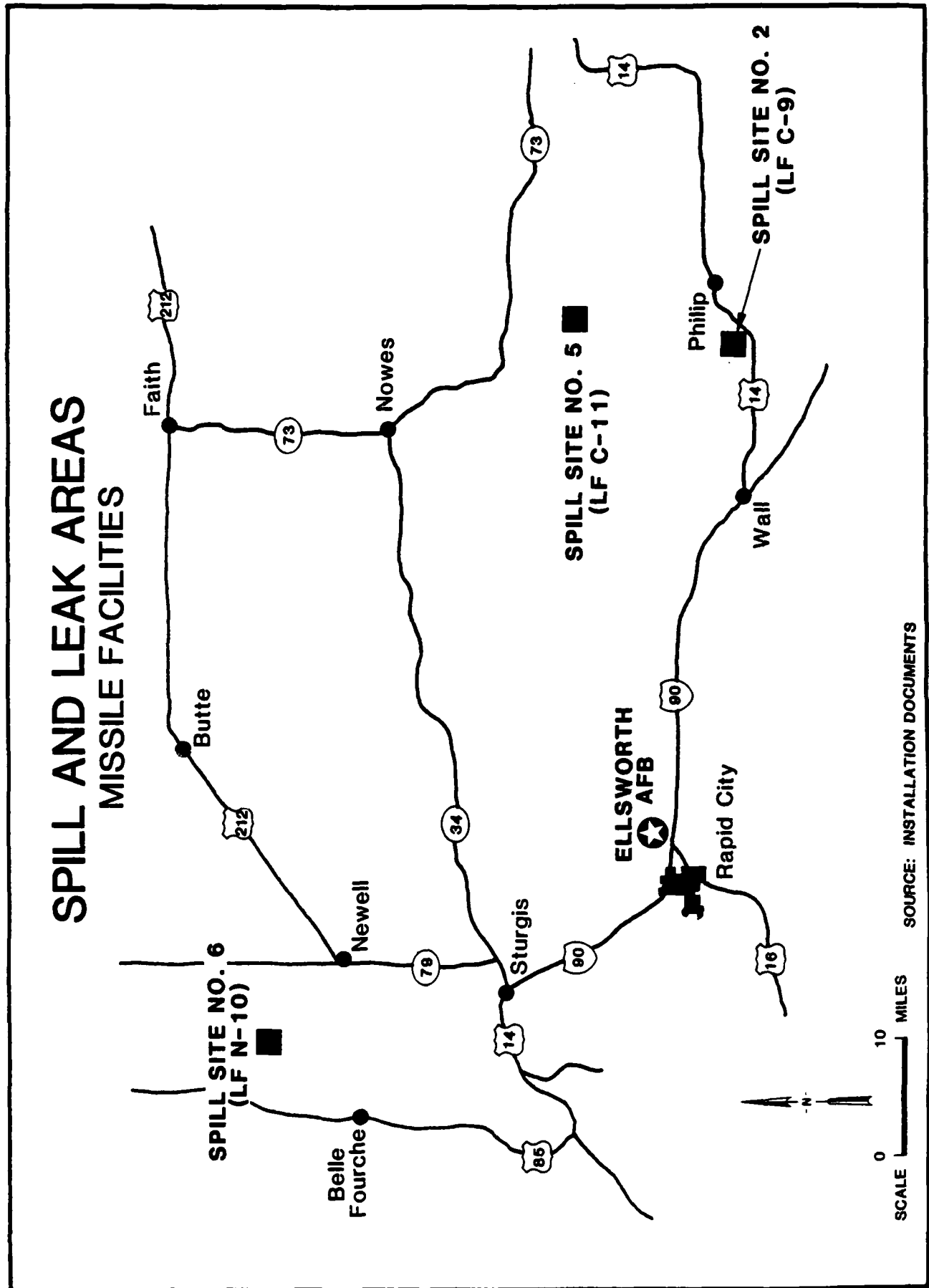
FIGURE 4.2

ELLSWORTH AFB SPILL AND LEAK AREAS MAIN BASE



SOURCE: INSTALLATION DOCUMENTS

FIGURE 4.3



SOURCE: INSTALLATION DOCUMENTS

houses had three underground fuel lines (excluding Pump House 5 which had two), which ran to the apron. Historically, these lines were routinely pressurized about three times a week for approximately two hours, and would have been empty the remainder of the time. In 1974, following a SAC memo regarding similar lines, they were pressure tested and found to be leaking. The aluminum lines were subsequently replaced with steel pipe. No estimate of the leak volume is available.

Spill Site No. 4 (Pramitol Spill at EOD Area)

In May 1982, 100 gallons (20 five-gallon cans) of concentrated Pramitol 25E soil sterilant was dumped at a high point in the northern part of the EOD area. Approximately 200 cubic yards of the Pramitol contaminated soil was excavated and removed to Landfill No. 3 in June 1982. In June 1983, the Pramitol was found to be leaching from the EOD areas as indicated by dead grass in the ravines that drain the area. At this time, several dams were constructed of the native soil to prevent migration of the Pramitol. The remedial measures have not been totally effective in eliminating the Pramitol migration.

Prometone, the active ingredient in Pramitol, is generally considered low in toxicity to animals (acute oral LD₅₀, rate = 2,980 mg/kg) and people. At normal application rates, less than 50% of the applied prometone is generally expected to persist after six months; however, its persistence in the environment can be extended due to low organic soils, higher pH soils, low rainfalls, low temperatures, and high application concentrations.

Spill Site No. 5 (Coolant Spill at LF C-11)

In January 1983, approximately 100 gallons of missile coolant containing hexavalent sodium chromate and dimethoxane additive was discharged from the sump onto the ground outside LF C-11. Soil samples were taken to define the extent of contamination. All of the spill material apparently remained on the LF. The contaminated soil was rototilled for the purpose of aeration and left in place.

Spill Site No. 6 (Coolant Spill at LF N-10)

Again in August 1983, approximately 100 gallons of coolant was discharged from LF N-10. The coolant drained approximately 35 feet off the LF onto the adjacent farmland. The discolored soil located on the adjacent farmland was excavated, returned to base, and placed in Land-

fill No. 3 in a trench lined with plastic. The LF soil was left in place.

Spill Site No. 7 (JP-4 Spill at Pump House 6)

In February 1984, approximately 12,000 gallons of JP-4 overflowed a tank at Pump House 6 when a cutoff valve failed. The JP-4 spilled onto the ground surrounding the pump house. Water was used to wash the spill across the infield into a storm drain, and eventually to oil/water separator 001. Only about 500 gallons of JP-4 were reported to have reached the separator. Some of the JP-4 likely evaporated prior to reaching the oil/water separator approximately 1.5 miles away. However, the rate of volatilization would have been reduced by the cold February temperatures. Although the ground may have been frozen, some JP-4 would also have infiltrated as it crossed the infield. There was no visual evidence of surface contamination.

Spill Site No. 8 (Calcium Hydroxide Precipitate)

Spill Site No. 8 involved the formation of a white precipitate behind the oil/water separator 002 in 1984. Analysis of the precipitate by the USAF OEHL revealed that it was primarily calcium hydroxide. It is speculated that the precipitate was formed by a combination of aircraft cleaner washed off the flightline with the liquid held behind the oil/water separator. Due to the nonharmful nature of the precipitate, no potential for contamination exists.

Spill Site No. 9 (Old Auto Hobby Shop Heating Fuel Tank)

Heating fuel oil has apparently leaked from a tank at the Old Auto Hobby Shop. The abandoned tank and contaminated soil were discovered in 1985 while borings were being completed for construction of the new jet engine test stand. Soil and water samples have been collected to determine the horizontal extent of the contamination. The tank was abandoned and is scheduled to be removed prior to construction of the new building.

Miscellaneous Small Spill Areas

Numerous small spills of fuel and oil were also reported to have occurred at the base. These spills generally have occurred in paved areas, and have been washed to the storm drainage system and to oil/water separators. Therefore, no environmental contamination is associated with these spills.

Fire Protection Training

The fire department at Ellsworth AFB has operated one FPTA during the entire period of base operation. This area is located northwest of the alert apron, east of Bismark Road, as shown in Figure 4.4. Fire extinguishing agents have included AFFF, halon, protein-foams, CO₂, dry chemicals, and chlorobromomethane.

Prior to 1972, drummed waste oils and solvents and contaminated oils and fuels were routinely delivered to the FPTA. As many as two burns per day may have been practiced during the summer. Each burn utilized approximately 1,000 to 2,000 gallons of waste. The fuel for the burn was dumped into the pit until the soil became saturated. No pre-wetting was used.

In 1972, the FPTA was upgraded. The upgrade consisted of scraping back the original pit to form a larger area, constructing a dike around the pit, and installing a 20,000 gallon aboveground storage tank and a 1,000 gallon underground tank. Fuel from the storage tank is supplied to the pit via four underground lines. Since 1972, burns have generally been limited to 200 to 300 gallons, with approximately 10,000 to 15,000 gallons of fuel burned annually.

Since 1984, the FPTA has burned only clean JP-4. Between 1974 and 1984, an effort was made to burn primarily contaminated JP-4. Recently, the practice of pre-wetting the burn area has also been introduced.

It is reported that prior to 1972, discharges of fuel and erosion of contaminated soil occurred from the FPTA into the discharge ditch south of the FPTA. No surface contamination is now apparent between the FPTA and the downgradient discharge ditch and pond. Due to the nature of the operations at the FPTA, fuels and waste residuals have likely seeped into the ground creating a potential for contamination.

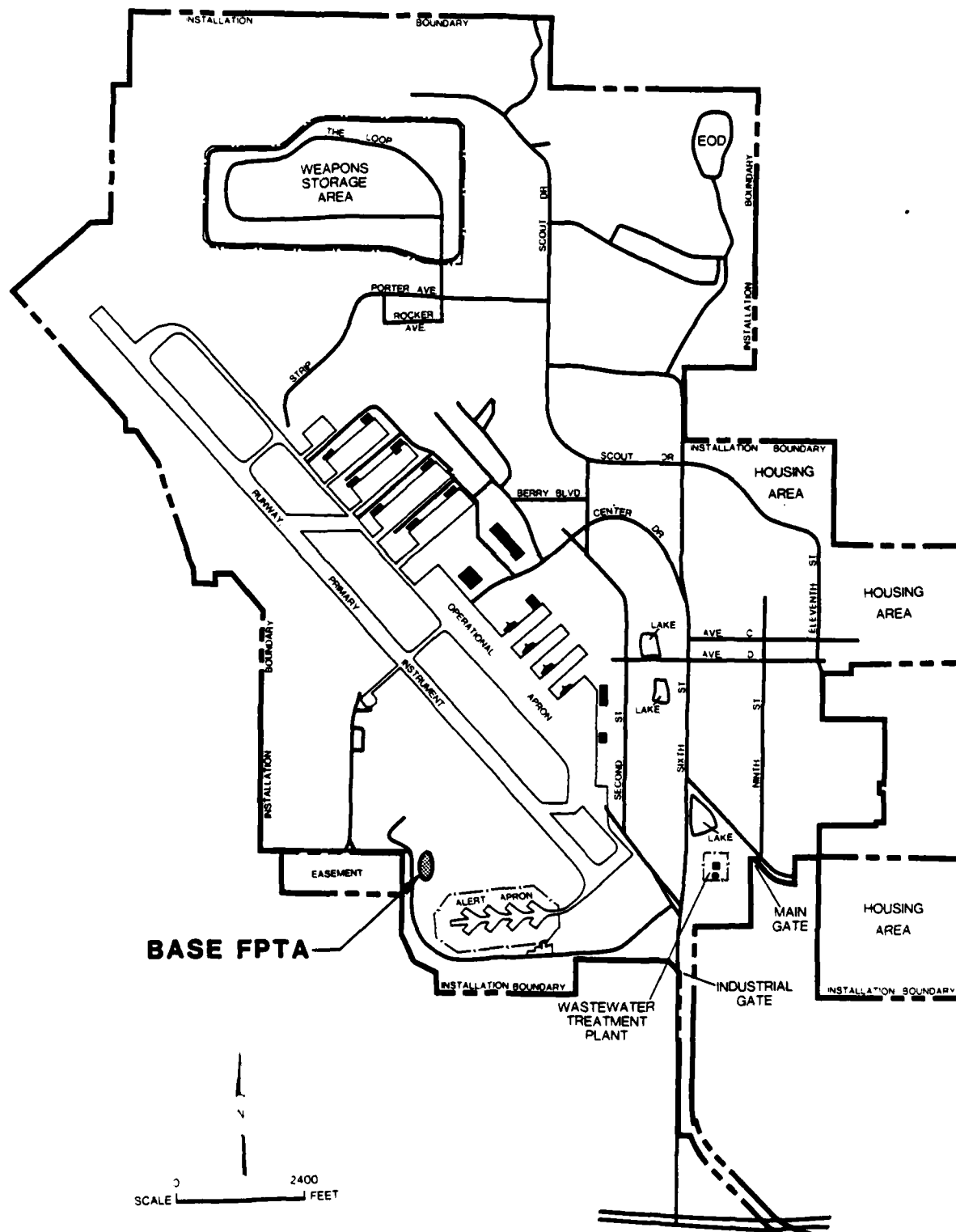
INSTALLATION WASTE DISPOSAL METHODS

The facilities at Ellsworth AFB, which have been used for the management and disposal of waste, can be categorized as follows:

- o Landfills
- o Hardfill Disposal Areas
- o Sanitary Sewer System

FIGURE 4.4

ELLSWORTH AFB FIRE PROTECTION TRAINING AREA



SOURCE: INSTALLATION DOCUMENTS

- o Industrial Sewer System
- o Explosive Ordnance Disposal Area
- o Incinerators
- o Low-Level Radioactive Waste Burial Sites
- o Oil/Water Separators

Landfills

Since October 1976, all solid waste generated on Ellsworth AFB and the military and family housing areas, has been disposed of by contract at an off-base sanitary landfill. Prior to 1976, wastes from the base were collected by civil engineering personnel and placed in an on-base landfill. The volume of loose refuse collected on-base is estimated at 200 to 300 cubic yards per day. Drums and cans of waste liquids and paints are also reported to have been included in the general refuse sent to the on-base landfills. Waste oil, fuel or solvents were sometimes used to help burn the trash in the landfill.

The solid wastes generated from the family housing areas have always been removed and disposed off-base by contract. The compacted refuse collected from these locations is estimated at 500 cubic yards per week. Although this refuse should have gone to an off-base landfill, it was reportedly often dumped in the base landfill. The non-hazardous solid wastes from the missile sites is transported to an off-base sanitary landfill by contract.

On-base landfills at Ellsworth AFB have been used for disposal of nonhazardous solid wastes and some industrial waste materials. Landfills have been operated in the past at six locations, as shown in Figure 4.5. A summary of the pertinent information associated with these landfills is presented in Table 4.4.

Landfill No. 1

Landfill No. 1 was operated from the early 1940's until 1964 and is located south of Bismark Road between the 001 and 002 discharge ditches. The landfill was likely active from the time that the base began operation in 1942. However, much of the refuse generated through approximately 1956 would have been burned in the on-base incinerator with the incinerator ash being sent to Landfill No. 1. This area also functioned as the base salvage yard during this time and it is speculated that

FIGURE 4.5

ELLSWORTH AFB LANDFILL SITES

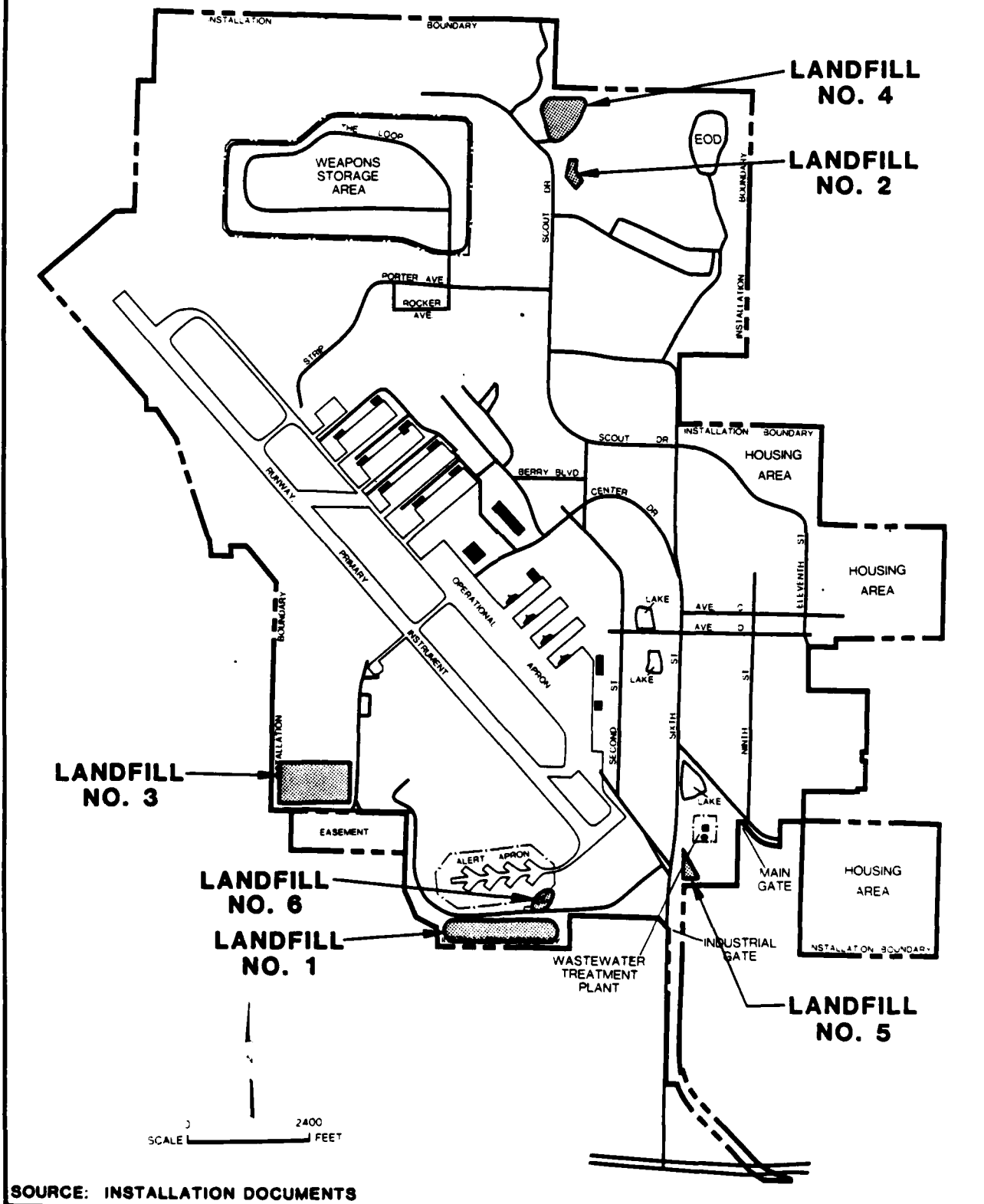


TABLE 4.4
SUMMARY OF LANDFILL DISPOSAL SITES

Landfill Designation	Operation Period	Approximate Size (Acres)	Type of Waste	Method of Operation	Closure Status	Surface Drainage
No. 1 South	1940's-1964	20	General Refuse (including some shop wastes)	Trench and fill, burning and cover, some dumping over bank	Primarily closed w/cover, open field, some exposed refuse charges to Box Elder Creek	South, combining w/001 and 002 discharges to Box Elder Creek
No. 2	1964-1965	1 (est.)	General Refuse (including some shop wastes)	Trench and fill, burning and cover	Closed, mostly covered, presently horse pasture	North, off-base
No. 3	1965-1976	40	General Refuse (including some shop wastes)	Trench and fill, some burning and cover	Primarily closed and covered, one active trench	West, off-base and 001 discharge to Box Elder Creek
No. 4	1940's-Present	10	Hardfill, Construction Rubble, General Refuse (including some shop wastes)	Fill into pit and over bank	Active hardfill and construction rubble disposal	North, off-base
No. 5	1960-1980	3	Hardfill, Construction Rubble, General Refuse (including some shop wastes)	Fill along bank	Closed, grass covered	011 discharge to Box Elder Creek
No. 6	1962-1965	0.5 (est.)	Hardfill, Construction Rubble, General Refuse (including some shop wastes)	Fill into ditch	Alert area, recreation facility parking lot	002 discharge to Box Elder Creek

SOURCE: Engineering-Science

waste oil, solvent, and fuel drums may have been stored on the landfill. Following the shut down of the incinerator, this landfill received all the base's solid wastes, the sludge and oil from the industrial sewer system, and presumably some of the wastes from the shops. There was one verbal report that a sign indicating a radioactive hazard has previously been posted at this landfill. This report was not substantiated by base records or other interviews. The operating method was trench and fill with burning of the refuse. Some refuse was also pushed over the west and south banks of the landfill and is still visible. The remainder of the site is covered with a soil layer and fairly heavy vegetation. Due to the close proximity of the site to the base boundary and the 001 and 002 discharge ditches, and the unknown nature of the wastes disposed of at the site, the potential for contamination does exist.

Landfill No. 2

Landfill No. 2 was operated in 1964 and 1965, and is located east of Northern Scout Drive, south of the active landfill area. The site was only active for a little over a year due to difficulties in containing the refuse. The operation was trench and fill with daily burning of combustible refuse, including shop wastes, in a separate burning pit. Although some refuse is visible, the landfill is generally covered with soil and sparse vegetation and currently used as a horse pasture. Due to the nature of the wastes disposed of at this site, the potential for contamination exists.

Landfill No. 3

Landfill No. 3 was operated from 1965 until 1976 and is located in the southwest corner of the base. The landfill was operated as a trench and fill operation with burning for only the first few years. Refuse was hauled to the landfill at a rate of approximately 300 cubic yards per day, five days per week. Refuse consisted of general base garbage as well as liquid and paint wastes from the shops and sludge and oils from the industrial sewer system.

The southwest corner of the landfill also served as a waste oil and fuel storage area until approximately 1982. A waste oil disposal pit is also reported to have been operated for about a year during the mid-1970's in the southwest corner of this landfill. Approximately one hundred 55-gallon drums of waste oil and diesel fuel are reported to

have been dumped into this gravel filled pit. The landfill has also been used for the disposal of sodium chromate and prometone contaminated soils as described above under Spills and Leaks. Except for one open trench, this site is covered with soil and has a heavy vegetative cover. This open trench is currently being used for disposal of construction demolition debris. Due to the nature of the wastes disposed of at Landfill No. 3, the potential for contamination exists.

Landfill No. 4

Landfill No. 4 was operated from the 1940's to the present and is located at the northern end of Scout Drive, just south of the base boundary. The site's primary function is, and has been, the disposal of construction demolition and hardfill materials. However, reports and visual observations have confirmed that this site has been used in the past for general refuse and drum disposal. The method of operation was first to fill in the old gravel pit and later to dump the fill over the bank. The lower levels of material are covered with vegetation; however, the active fill area has very steep side slopes and no vegetative cover. Due to the nature of the wastes, the present state of the fill, and the close proximity to the base boundary, the potential for contamination exists at Landfill No. 4.

Landfill No. 5

Landfill No. 5 was active from 1960 to 1980, and is located east of the railroad tracks running parallel to Sixth Street, just north of the Industrial Gate. Again, this area was used primarily for construction demolition and hardfill material, but general refuse was reported to have been dumped frequently in this area. This landfill has also been used for the disposal of dried sewage sludge from the base wastewater treatment plant. Due to the uncontrolled nature of this operation, and the frequency of unauthorized dumping, it is likely that shop wastes were disposed of in this landfill. The fill was initially placed along the bank to help control erosion of the railroad and later expanded to the east. The area has been graded, covered, and vegetated; however, it is still used for stockpiling of sludge from the Wastewater Treatment Plant. Due to reports of unauthorized dumping at this site, the potential for contamination exists.

Landfill No. 6

Landfill No. 6 was active from approximately 1962 to 1965, and was located between the alert apron and Bismark Road in the area of the present alert area recreation facility parking lot. The area was initiated and operated as a fill area for the parking lot with the fill dumped between the alert apron and the road. General refuse including shop waste was reportedly dumped into this area. The area has been covered with clean fill and paved for a parking lot. No visual signs of the dumping operation exist. Due to the reports of unauthorized dumping, and the location of this site in close proximity to the 002 discharge point, the potential for contamination exists.

Hardfill Disposal Areas

There are two major areas at Ellsworth AFB in addition to Landfills 4, 5, and 6, that have been used for disposal of construction rubble, brush and other hardfill. These major hardfill areas are identified in Figure 4.6. Based on interviews conducted with base personnel, a review of file information and visual observations made during the site visit, there is no evidence of any hazardous waste disposal associated with these hardfill areas.

Hardfill No. 1 is located along the 001 drainage ditch, north of alert apron. Although the construction rubble is visible, parts of the site are covered with vegetation. Hardfill No. 2 is located on the western base boundary, north of oil/water separator 003. The construction rubble is exposed and no significant vegetation growth is present.

Landfill No. 4 on the north end of Scout Drive is currently the designated base hardfill.

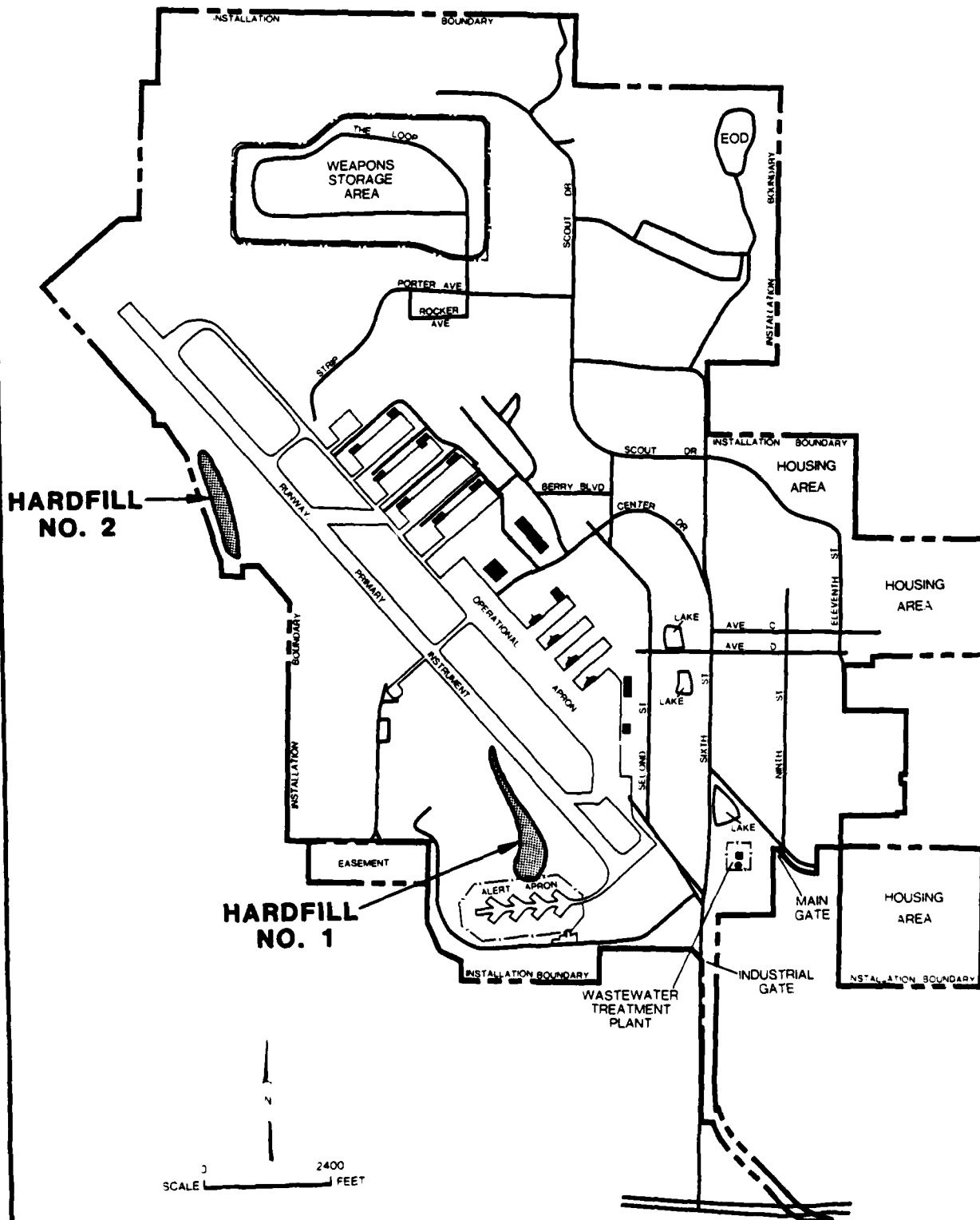
Sanitary Sewer System

Most sanitary wastewater from Ellsworth AFB is treated at the base Wastewater Treatment Plant which is located east of Sixth Street, north of the Industrial Gate. The original plant was constructed in 1942 and was upgraded in 1984. The treatment plant now consists of pretreatment for grease and grit removal, primary settling basin, a trickling filter, secondary settling basin, and three sludge digestors.

A large portion of the sewage flow is generated by the housing areas, including Capehart, Skyway and Shell, and the base administration buildings. Sewage from Renal Heights enters the Box Elder system for

FIGURE 4.6

ELLSWORTH AFB HARDFILL DISPOSAL AREAS



SOURCE: INSTALLATION DOCUMENTS

treatment. Less than five percent of the flow may originate from flightline activities such as washracks and industrial drains. The sewage collection system is primarily 8 to 18 inches vitrified clay pipe with a series of low lift pump stations.

The digested sludge is placed in sludge drying beds. The dried sludge is then stockpiled at a rate of approximately 500 pounds per day in an area south of the treatment plant on Landfill No. 5. The stockpiled sludge has, in the past, been used on- and off-base for lawn fertilizer and fill material. The sludge has also been used as fill around the treatment plant and placed in Landfill No. 5 which is just south of the treatment plant. A contract has recently (June 1985) been implemented for regular sludge removal to an off-base location.

Prior to 1976, oil and grease scums (300 - 400 lbs/day) were disposed of by base personnel in the base landfill. These are now removed off-base by contract.

The wastewater treatment plant effluent is designated NPDES discharge point 005. The effluent eventually flows to Box Elder Creek, a tributary of the Cheyenne River.

Although the vast majority of the base facilities are served by the wastewater treatment plant, a few remote buildings have septic tanks, and tile leach fields. The leach fields appear to all be used for sanitary discharges. These facilities are listed in Appendix D, Table D.3.

There is no evidence to indicate that past septic tank or treatment plant practices pose a potential for contamination.

Industrial Sewer System

In addition to the sanitary sewer system, an industrial sewer serves the flightline shops and pump houses. The system has two primary branches with one serving the buildings along the operational apron and taxiways 10 and 11 and the second branch serving pump houses 1 through 7.

The branch draining the operational apron shops receives flows from the wash racks and other industrial sewer drains. Between 1948 and 1972, this branch flowed to the old Building 3015, which was located north of the wastewater treatment plant, for grit and oil removal. Upon entering Building 3015, ferric sulfate was added to the wastewater to

aid in oil and particulate removal. The oil was removed to a waste holding tank, and then taken to the base landfill at approximately 300 to 400 gallons per week. Particulates were sent to sludge drying beds. The effluent then flowed to Building 3016 for pH adjustment before it was discharged into the creek to the east. The solids from the industrial drying beds were also removed to the base landfill. In 1972, this branch of the system was altered so that the industrial sewage would flow to old Building 3015 for oil separation and then into the sanitary system.

In 1984, the new Building 3015 was constructed on the site of the old Building 3015. The new Building 3015 also serves to separate oil and remove grit from the industrial sewer which services the buildings along the operational apron. Approximately 1,000 to 1,500 gallons of oil per month are removed from this separator and taken off-base by contract. Following this separator, the industrial sewage combines with the sanitary sewage and flows to the treatment plant.

The waste oils from the industrial treatment system were removed and disposed of off-base by contract starting in approximately 1976.

The branch of this industrial sewer, which drains Pump Houses 1 through 7, primarily drained wash water used for cleaning the pump houses and small fuel leaks that occur within the pump houses. This branch of the industrial sewer enters the storm sewer which runs to the oil/water separator 002.

The disposal of waste oils and sludges from the industrial sewer system was discussed under the subsection on landfills. There is no evidence of further significant contamination from past operations of the industrial sewer system.

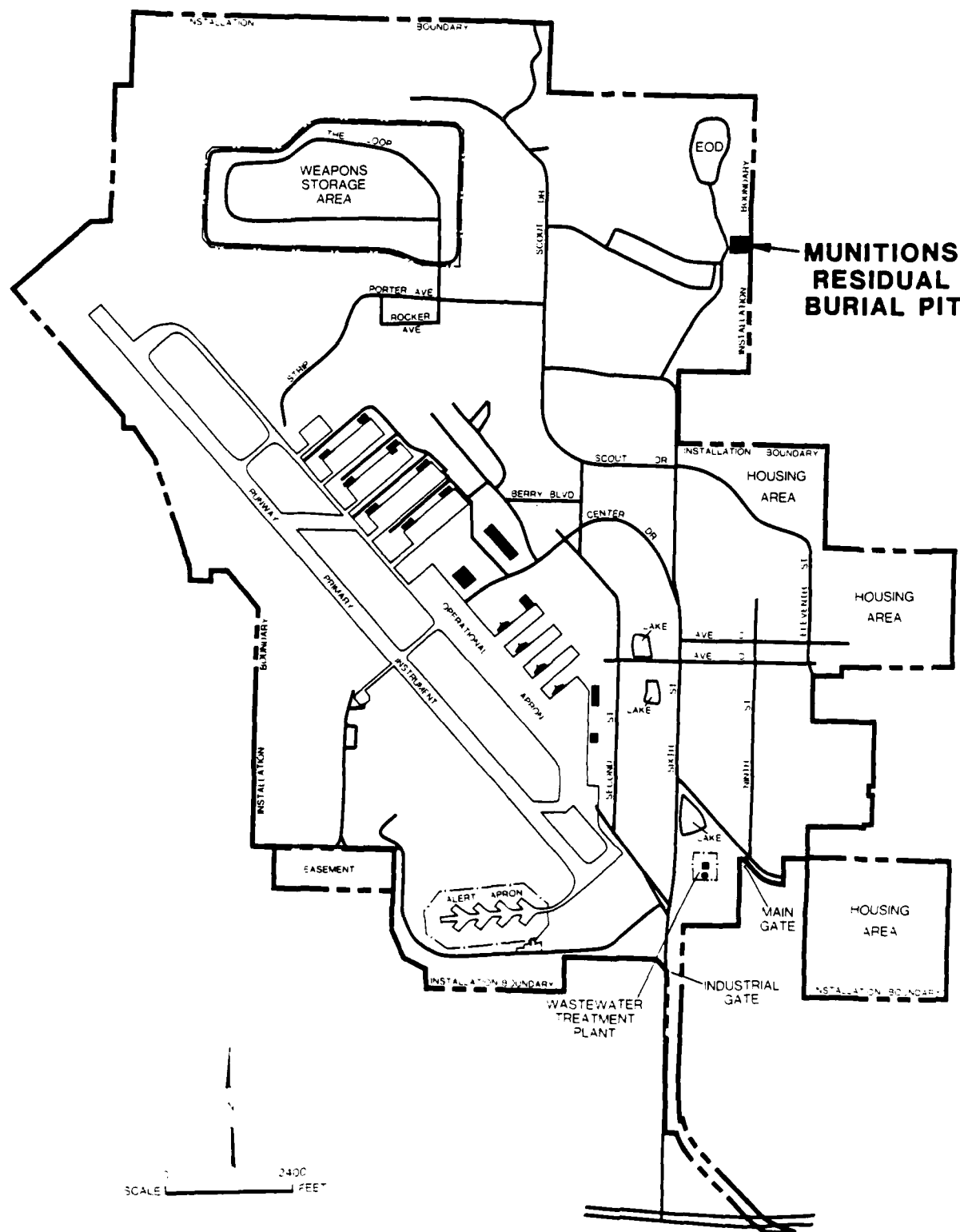
Explosive Ordnance Disposal Area

The Explosive Ordnance Disposal (EOD) area at Ellsworth AFB is located at the far northeast corner of the base, beyond the rifle range.

The EOD area consists of a large deserted area for detonation of active explosives and a "burn kettle" for incineration of small arms ammunition. The "burn kettle" residue and expended fast start cartridges are disposed in a munitions residual burial pit located approximately 2,000 feet south of the EOD area and east of the rifle range, as shown in Figure 4.7. This pit is approximately 30 feet by 20 feet in

FIGURE 4.7

ELLSWORTH AFB EOD - MUNITIONS RESIDUAL BURIAL PIT



SOURCE: INSTALLATION DOCUMENTS

area and about 15 feet deep. One pit is currently in operation although several other pits used in the past have been filled and covered.

Incinerators

Three incinerators have been used at Ellsworth AFB for waste disposal. Prior to approximately 1956, an incinerator was operated for the disposal of general refuse including housing and paper wastes. The incinerator was located just south of the existing Wastewater Treatment Plant. The ash from this incinerator was reportedly disposed of at Landfill No. 1.

Currently, two incinerators are operated on base. The first incinerator, Facility 4304, was constructed in 1979 and is operated by the 44th Combat Support Group for the destruction of classified documents. The second, Facility 4303, was constructed in 1980, and is used for the burning of pathological, laboratory, and other hospital wastes. The ash from both these incinerators is disposed of with the base refuse.

Low-Level Radioactive Waste Burial Sites

Seven potential low-level radioactive waste burial sites have been identified at Ellsworth AFB. The sites are located within the Weapons Storage Area operated by the 28th Munitions Maintenance Squadron, as shown in Figure 4.8.

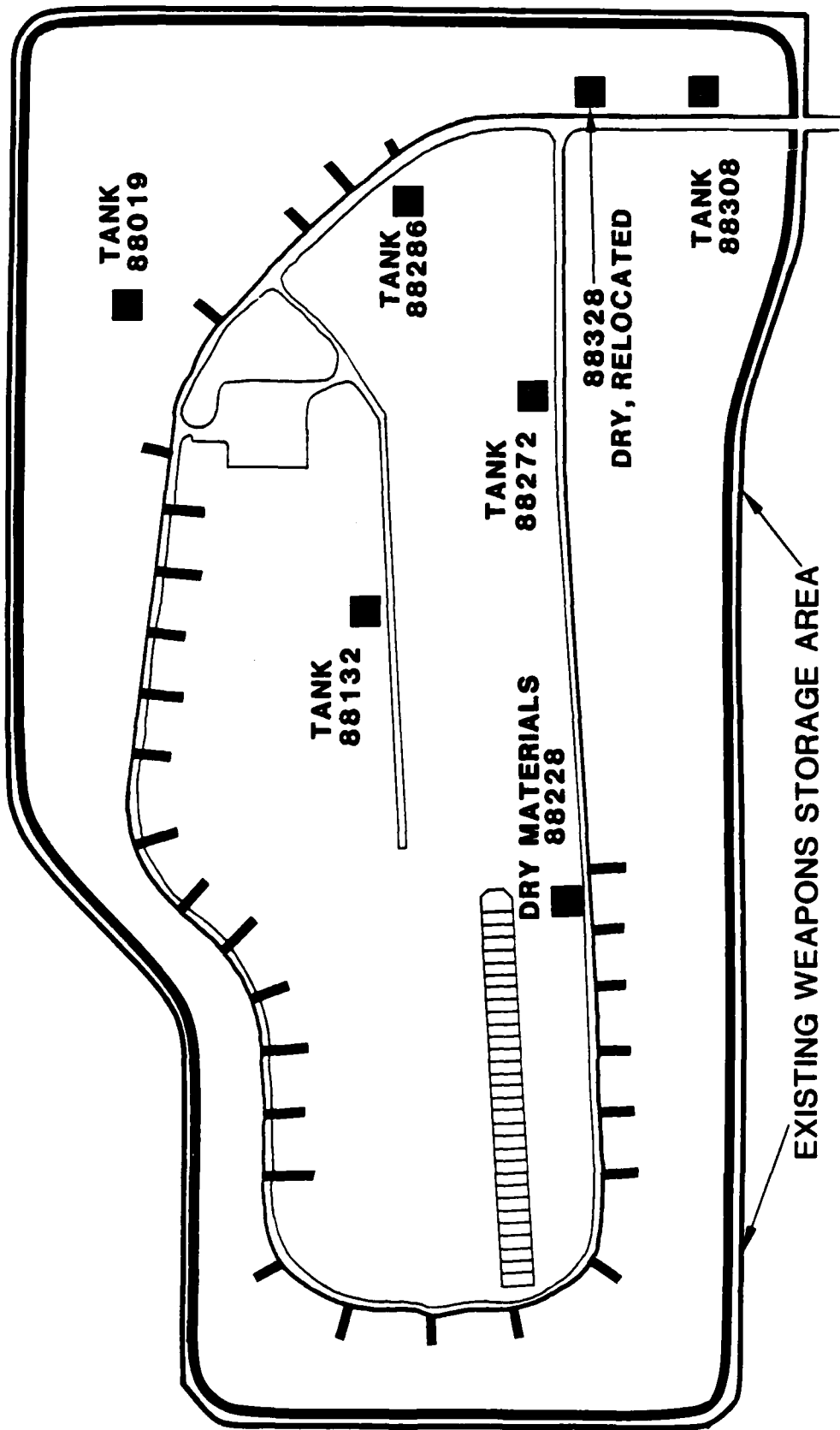
The wastes were generated between 1952 and 1962 when the Atomic Energy Commission was operating the Rushmore Air Force Station (this area is now the Weapons Storage Area). Five of the seven burial sites are underground tanks and contained liquid wastes. The other two were dry waste burial areas. Details on the seven burial sites are given in Table 4.5.

The dry material, now all stored at Facility 88228, is assumed to be an accumulation of rags, gloves, aprons, etc. In 1972, following testing, the liquid that was stored in the five tanks was deemed safe for discharge. However, no records of the actual discharge have been found.

Oil/Water Separators

There are several areas on base currently served by oil/water separators or oil interceptors. Appendix D, Table D.5 lists the location of these devices. Oil separators and interceptors are used in areas which have large quantities of waste liquids that may contain oils

ELLSWORTH AFB MAIN BASE LOW LEVEL RADIOACTIVE WASTE SITES



SCALE 0 600 FEET

FIGURE 4.8

TABLE 4.5
LOW-LEVEL RADIOACTIVE WASTE BURIAL SITES

Facility No.	Facility Description	Min. Depth of Cover (ft)	Status of Facility
88019	1000 gal Underground Tank	4	Tank abandoned, waste status unknown.
88132	1000 gal Underground Tank	4	Tank abandoned, waste status unknown.
88272	1000 gal Underground Tank	4	Tank abandoned, waste status unknown.
88286	1500 gal Underground Tank	4	Tank abandoned, waste status unknown.
88308	5000 gal Underground Tank	5	Tank abandoned, waste status unknown.
88328	Probably Shallow Trenches for Dry Materials	Unknown	Relocated to 88228 in 1956.
88228	3/4" Plywood Box (6'x6'x10') for Dry Materials	Unknown	In place, no designation of area.

SOURCE: Base Documents

and grease. These devices are serviced periodically by a contractor who removes and disposes of the material off-base. Water layers from the separators/interceptors are discharged to the sanitary sewer, industrial sewer or storm sewer.

REMOTE FACILITIES REVIEW

A review of files and records and interviews with present and past base employees were performed to identify past activities at remote base facilities which could have resulted in the disposal of hazardous waste. Because of the nature of the activities conducted at the West Communications Annex, the Terry Peak Relay Facility, and the Wall Relay Building, namely routine maintenance of communication equipment, none of these annexes were found to have significant waste generation or disposal activities, past or present.

The South, East, and West Nike Family Housing Annexes currently controlled by the Air Force each consist of Family Housing and necessary operating facilities, including sewage lagoons. The South Nike Site also includes the Ellsworth Academic Annex. Sight visits or helicopter overflights were conducted at the Nike housing and academic annexes. Since these buildings have always been used as housing or administration facilities, there are no hazardous waste activities associated with the current housing and academic annexes.

The Badlands Air Force Range currently consists of approximately 2,487 acres. Although inactive, live munitions are still found on the range. A helicopter overflight of the range was conducted during the base visit. No records, reports, or visual evidence was found to suspect that any hazardous wastes disposal activities may have occurred at the Badlands Air Force Range.

PM-1/Sundance Site

A small nuclear power plant was utilized at the PM-1/Sundance Site during the period February 1962 to April 1968 to provide electric power to the adjacent radar facility operated by 731st Radar Squadron, Aerospace Defense Command. Manpower support was furnished by Sundance Air Force Station, Wyoming. The site is located six miles northwest of Sundance, Crook County, Wyoming in Section 20, Township 52 North, Range 63 West of the sixth Principal Meridian. The PM-1/Sundance Site is

situated on Warren peak along the Taylor Divide of the Bear Lodge Mountains of the Black Hills National Forest. Figure 4.9 depicts the general features of the site. Figure 4.10 is a general floor plan of the power plant.

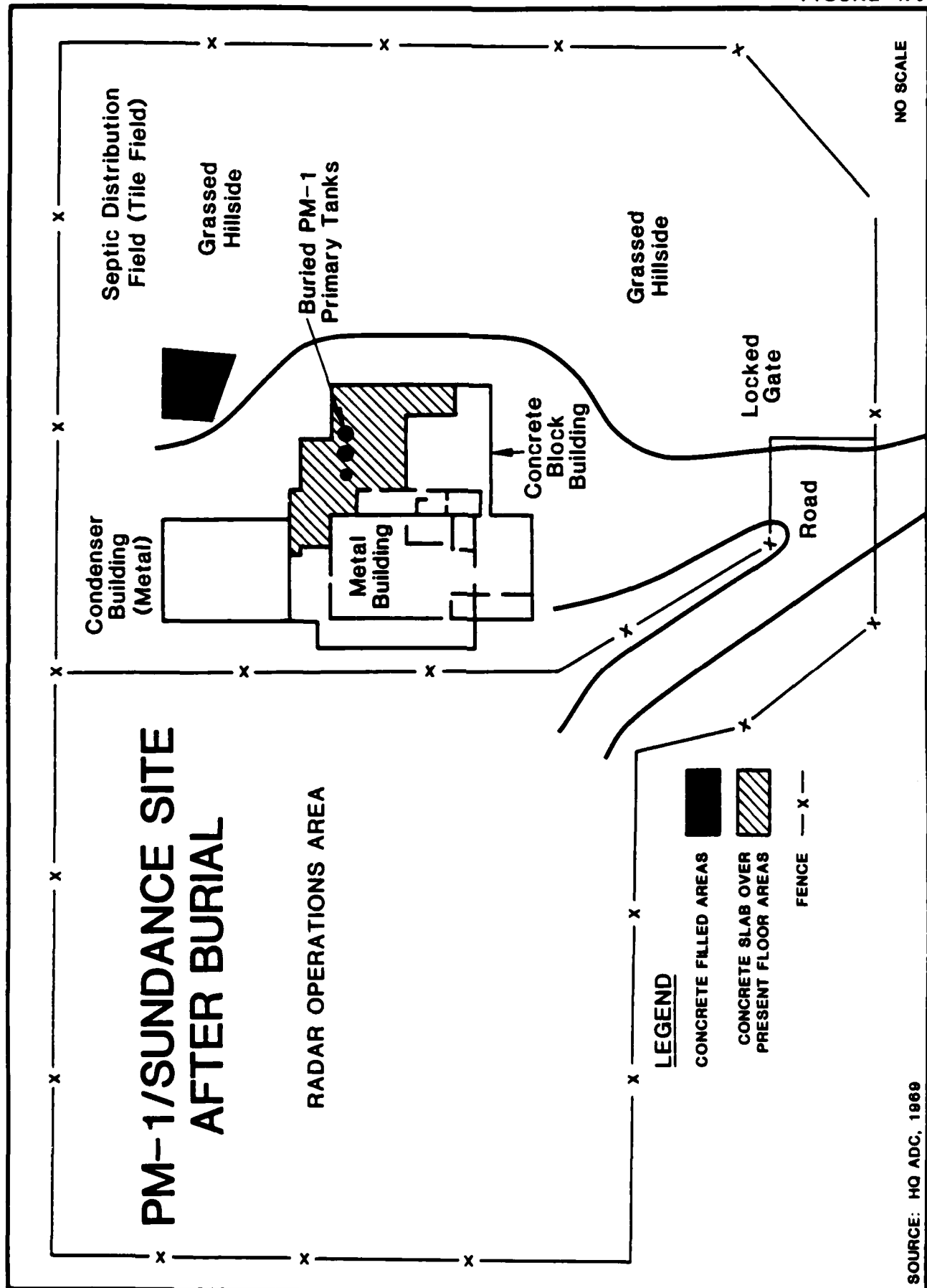
After site shutdown in 1968, formal plans were prepared for the decommissioning and dismantling effort (HQ ADC, 1968). The decommissioning and dismantling took place during the spring, 1969, and the site's final inspection occurred in September, 1969. The dismantling effort included the removal of spent fuel and coolant from the site, removal of all primary structures to ground level, placing all radioactive debris in the primary building, grouting up all remaining tanks, pipelines and the reactor pressure vessel and by capping the primary building with a cast-in-place concrete slab twelve inches thick, rebarricaded into the backfilled structure. Figure 4.11 is a cross section of the primary building after burial. Additional closure work included the site security fencing and filling, grading and grassing of all undeveloped slopes.

During its operation, thirty-six sampling points were established around the site to provide continuous environmental quality surveillance. Following closure, an environmental sampling plan was formulated to insure that no contaminants were migrating from the closed site. Many of the same sampling points used during the operational phase were maintained as sampling stations during the closure period. Sampling was conducted twice annually for the first two years of the closure period (1969-1970) by USAF/OEHL. Annual sampling has been conducted by USAF/OEHL from 1971 to date. The sampling stations currently utilized by the USAF to monitor site environmental quality are shown on Figures 3.12 and 3.13. There has never been any evidence of contaminant migration emanating from the closed PM-1/Sundance Site. Current plans require that the annual environmental quality monitoring program be continued through 2044. Table 3.7 summarized the monitoring points currently employed to test environmental quality relative to the PM-1/Sundance Site.

Missile, Launch Facility, and Launch Control Facility Maintenance

The LCF and LF sites contain materials which are potentially hazardous to the environment. These materials are described in the following paragraphs.

FIGURE 4.9



SOURCE: HQ ADC, 1969

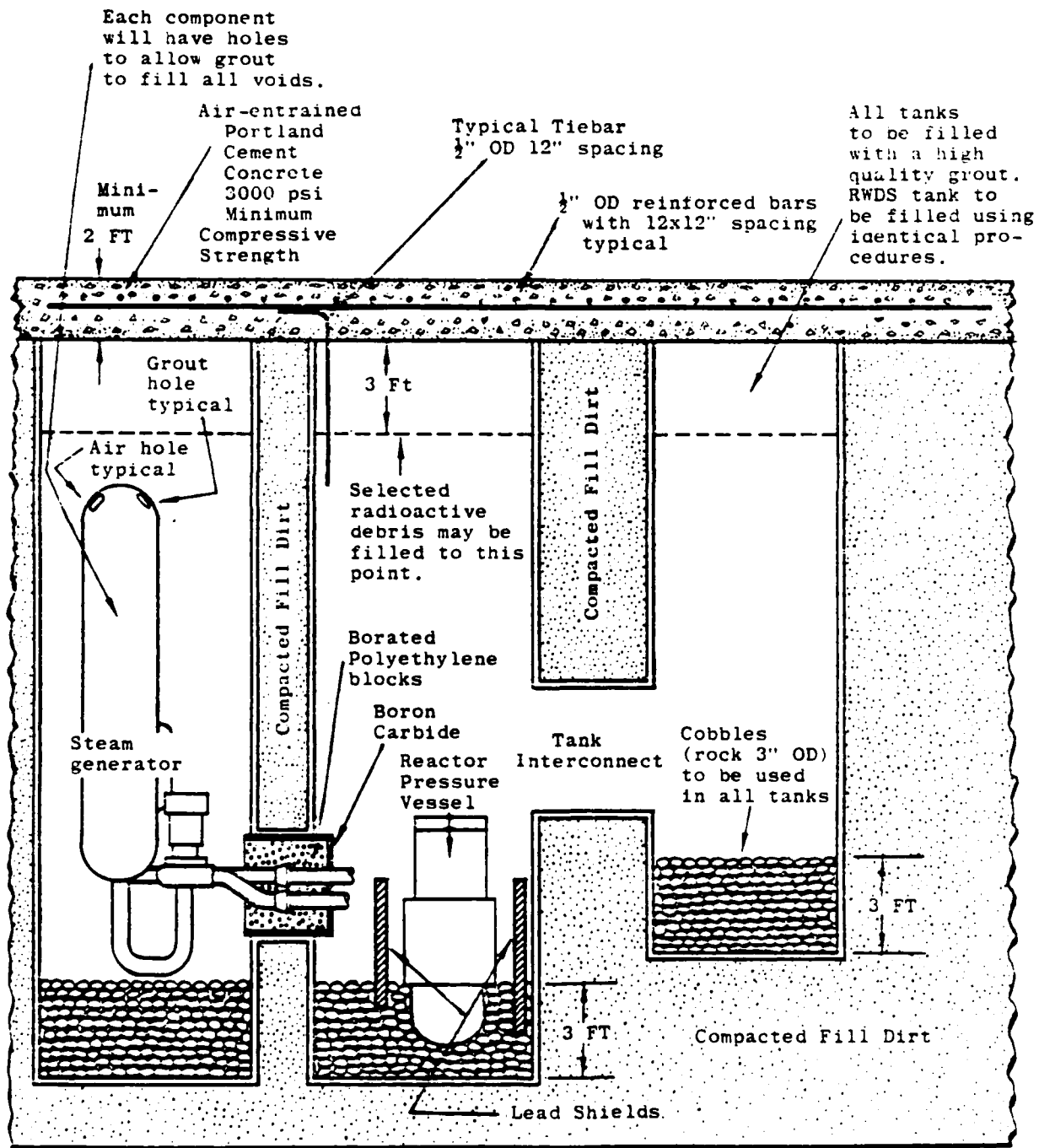
PM-1/SUNDANCE SITE

POWER PLANT FLOOR PLAN



PM-1/SUNDANCE SITE

CROSS SECTION OF POWER PLANT AFTER BURIAL



SOURCE: HQ ADC, 1968

A main diesel fuel tank which holds 12,000 gallons of fuel is located 60 feet underground at each LCF site. The support building at each LCF has a diesel tank which contains 2,500 gallons of fuel. The main diesel tank feeds a "day tank" which holds 165 gallons of fuel and is located in the equipment bay.

An aboveground tank at each LCF holds 2,000 gallons of MOGAS. A lube oil tank which contains 65 gallons of 30 weight oil is located near the generator. Ethylene glycol is used as a coolant and Freon 502 and Freon 12 are used as refrigerants at the LCF sites. Methyl ethyl ketone (MEK) and PD-680 are used to clean the diesel fuel filters on the generators.

At the LF sites, a main diesel fuel tank has a capacity of 2,500 gallons and a "day tank" holds 312 gallons. The missiles themselves are propelled with solid fuel which is not loaded or handled at these facilities. A sodium chromate solution (1.62 gm sodium chromate per liter of coolant) with a dimethoxane additive (1 gm dimethoxane per liter of coolant) is used in the missile guidance system for cooling; the cooling system on each missile holds 150 gallons of the solution. A lube oil tank near the generator holds 60 gallons of 30-weight oil. In addition, Freon 502, MEK, and PD-680 are used for the same purposes as at LCF sites. Batteries located at both LCF and LF sites are alkaline electrolyte nickel-cadmium batteries containing potassium hydroxide (KOH). Twelve lead acid batteries are located in the launchers at each site.

At each LCF and LF a sump pump is located at the base of the underground facility to collect ground-water seepage. At the LCF sites, the sump discharges into a series of sewage lagoons on the LCF grounds. The first sewage lagoon is about fifty feet in diameter and has a depth of about five feet. The second lagoon is approximately fifty by forty feet. The lagoons are unlined and have an overflow pipe. In addition, sewage from the support building is discharged into the lagoon.

At LF sites, the sump discharge pipe is about five feet from the launch support building; the discharge runs directly onto the gravel covering the ground.

Interviews with on-base personnel and helicopter overflights of selected LF and LCF sites were performed to determine the potential

environmental impact of activities at typical sites. Helicopter overflights were conducted at LCF D-1, LF D-7, LF D-8, and LF D-9.

Sodium chromate coolant leaks have been reported at several of the LF sites. The small spills are cleaned up by maintenance personnel with the contaminated cleaning material being drummed and returned to base. A larger spill would be washed into the sump and the sump discharge collected manually into drums for return to base. Sodium chromate contaminated materials are disposed of off-base by contract. Three large leaks in the coolant system, two of which have resulted in the discharge of approximately 100 gallons of the sodium chromate coolant, and the third resulting in a 50 gallon discharge, have been reported. These incidents are described above under spills and leaks.

Other potential areas of contamination for both LCF and LF sites are the aboveground graveled areas, which are routinely sprayed with a herbicide. However, since the herbicide is biodegradable and non-persistent, no potential for contamination is believed to exist.

EVALUATION OF PAST DISPOSAL ACTIVITIES AND FACILITIES

Review of past waste generation and management practices at Ellsworth AFB has resulted in identification of 22 sites and/or activities which were considered as areas of concern for potential contamination and migration of contaminants. These sites are listed in Table 4.6.

Sites Eliminated from Further Evaluation

Hardfill No. 1 located along the 001 drainage ditch north of the alert apron, and Hardfill No. 2 located along the bank north of oil/water separator 003, are not considered for further action. No evidence was found to indicate that hazardous materials were placed in either of these two hardfill sites.

No evidence was found in regard to the Wastewater Treatment Plant which indicated any potential health or environmental risks. The sludge was either used as fill or fertilizer or placed in Landfill No. 5. The sludges and waste oils from the industrial sewer system were placed in the base landfills which are to be evaluated further.

TABLE 4.6
SUMMARY OF FLOW CHART LOGIC FOR AREAS OF INITIAL HEALTH,
WELFARE, AND ENVIRONMENTAL CONCERN AT ELLSWORTH AFB

Site	Potential Hazard to Health, Welfare or Environment	Need for Further IRP Evaluation/ Action	HARM Rating
1. Spill Site No. 1 (Pump House No. 7)	Yes	Yes	Yes
2. Spill Site No. 2 (LF C-9 Coolant Spill)	Yes	Yes	Yes
3. Spill Site No. 3 (Hydrant Line Leaks)	Yes	Yes	Yes
4. Spill Site No. 4 (EOD Pramitol Spill)	Yes	Yes	Yes
5. Spill Site No. 5 (LF C-11 Coolant Spill)	Yes	Yes	Yes
6. Spill Site No. 6 (LF N-10 Coolant Spill)	Yes	Yes	Yes
7. Spill Site No. 7 (Pump House No. 6)	Yes	Yes	Yes
8. Spill Site No. 8 (002 Separator Precipitate)	No	No	No
9. Spill Site No. 9 (Auto Hobby Shop Heating Fuel)	Yes	Yes	Yes
10. Fire Protection Training Area	Yes	Yes	Yes
11. Landfill No. 1	Yes	Yes	Yes
12. Landfill No. 2	Yes	Yes	Yes
13. Landfill No. 3	Yes	Yes	Yes
14. Landfill No. 4	Yes	Yes	Yes
15. Landfill No. 5	Yes	Yes	Yes
16. Landfill No. 6	Yes	Yes	Yes
17. Hardfill No. 1	No	No	No
18. Hardfill No. 2	No	No	No
19. Wastewater Treatment Plant	No	No	No
20. Industrial Treatment System	No	No	No
21. Explosive Ordnance Disposal Area	No	No	No
22. Low-Level Radioactive Waste Burial Sites	Yes	Yes	Yes

The explosive ordnance disposal area is not suspected of containing any hazardous materials. Wastes sent to this area should be primarily in an inert form and pose no environmental threat.

The spill into the oil/water separator 002 which led to the formation of the calcium hydroxide precipitate does not warrant further IRP investigation. Due to the nature of the material, no potential for contamination was expected.

Sites Evaluated Using HARM

The remaining 16 sites identified in Table 4.7 were evaluated using the Hazard Assessment Rating Methodology. The HARM process takes into account characteristics of potential receptors, waste characteristics, pathways for migration, and specific characteristics of the site related to waste management practices. Results of the HARM analysis for the sites are summarized in Table 4.7.

The procedures used in the HARM system are outlined in Appendix G and the specific rating forms for the 16 sites at Ellsworth AFB are presented in Appendix H. The HARM system is designed to indicate the relative need for follow-on action. Photographs of these sites are included in Appendix F.

TABLE 4.7
SUMMARY OF HARM SCORES FOR POTENTIAL CONTAMINATION SITES AT ELLSWORTH AFB

Rank	Site	Receptor Subscore	Waste Charac- teristics Subscore	Pathways Subscore	Waste Management Factor	HARM Score
1	Fire Protection Training Area	40	100	56	1	66
2	Spill Site No. 9 (Auto Hobby Shop Heating Fuel)	48	48	100	1	65
3	Landfill No. 3	43	100	42	1	62
4	Landfill No. 1	51	70	56	1	59
5	Spill Site No. 7 (Pump House No. 6)	40	80	48	1	56
6	Landfill No. 6	51	40	56	1	49
7	Landfill No. 2	43	60	42	1	48
8	Low-Level Radioactive Burial Site	46	50	42	1	46
9	Landfill No. 5	51	40	48	1	46
10	Landfill No. 4	41	50	42	1	44
11	Spill Site No. 1 (Pump House No. 7)	40	40	48	1	43
12	Spill Site No. 3 (Hydrant Line Leaks)	40	40	48	1	43
13	Spill Site No. 2 (LF C-9 Coolant Spill)	18	60	42	1	40
14	Spill Site No. 5 (LF C-11 Coolant Spill)	18	60	42	1	40
15	Spill Site No. 6 (LF N-10 Coolant Spill)	18	60	42	1	40
16	Spill Site No. 4 (EOD Parmitol Spill)	41	20	42	1	34

SOURCE: Engineering-Science

SECTION 5

CONCLUSIONS

The goal of the IRP Phase I study is to identify sites where there is potential for environmental contamination resulting from past waste disposal practices and to assess the probability of contamination migration from these sites. The conclusions given below are based on field inspections; review of records and files; review of the environmental setting; interviews with base personnel, past employees and local, state and federal government employees; and assessments using the HARM system. Table 5.1 contains a list of the potential contamination sources identified at Ellsworth AFB and a summary of the HARM scores for those sites. Only potential contamination sources identified in Section 4 and determined to warrant further instructions are presented here.

FIRE PROTECTION TRAINING AREA

The current FPTA located northwest of the alert apron, has been used during the entire period of base operation. Prior to 1972, waste oils, fuels and solvents were routinely delivered to the FPTA. As many as two burns (1,000 to 2,000 gallons per burn) per day may have been practiced during the summer. The fuel was dumped into the pit with no pre-wetting. In 1972, the FPTA was upgraded by scraping back the original pit to form a larger diked area and installing a storage tank and underground supply lines. Since 1972, burns have generally been limited to 200 to 300 gallons with a total of 10,000 to 15,000 gallons of fuel burned annually. Between 1974 and 1984, an effort was made to burn primarily contaminated JP-4; however, other waste fuels, oils and solvents were also burned. Only clean JP-4 has been burned since 1984.

The site is underlain by primarily clay loam and gravelly sandy loam alluvial soils possessing low to moderate permeabilities. Surface drainage from the site is directed in a generally southward direction to

TABLE 5.1
SITES EVALUATED USING THE
HAZARD ASSESSMENT RATING METHODOLOGY
ELLSWORTH AFB

Rank	Site	Operation Period	Harm ¹ Score
1.	Fire Protection Training Area	1942 - Present	66
2.	Spill Site No. 9 (Auto Hobby Shop Heating Fuel)	Discovered 1985	65
3.	Landfill No. 3	1965 - 1976	62
4.	Landfill No. 1	1940's - 1964	59
5.	Spill Site No. 7 (Pump House No. 6)	1984	56
6.	Landfill No. 6	1962 - 1965	49
7.	Landfill No. 2	1964 - 1965	48
8.	*Low-Level Radioactive Burial Sites	1952 - 1962	46
9.	*Landfill No. 5	1960 - 1980	46
10.	*Landfill No. 4	1940's - Present	44
11.	Spill Site No. 1 (Pump House No. 7)	1972	43
12.	Spill Site No. 3 (Hydrant Line Leaks)	Early 1970 - 1974	43
13.	Spill Site No. 2 (C-9 LF Coolant Spill)	1977	40
14.	Spill Site No. 5 (C-11 LF Coolant Spill)	1983	40
15.	Spill Site No. 6 (N-10 LF Coolant Spill)	1983	40
16.	Spill Site No. 4 (EOD Pramitol Spill)	1982	31

¹ This ranking was performed according to the Hazard Assessment Rating Methodology (HARM) described in Appendix G. Individual rating forms are in Appendix H.

Box Elder Creek via several unnamed tributaries. The clay, sand and gravel overburden ranges in thickness from ten to thirty feet and directly overlies bedrock (Pierre Shale) which is generally impermeable. Seasonal ground water may occur in the basal sections of the alluvium, above the bedrock. Ground-water flow probably follows the bedrock surface. Discharge to local streams is likely.

A significant potential for contamination exists at this site and a follow on investigation is warranted. This site received a HARM score of 66.

SPILL SITE NO. 9 (AUTO HOBBY SHOP HEATING FUEL)

An abandoned heating fuel oil tank and contaminated soil were discovered in 1985 while borings were being completed for construction of the new jet engine test stand. Soil samples have been collected to determine the horizontal extent of contamination.

Most of the area over this site is paved with asphalt. The site is underlain by primarily clay loam and gravelly sandy loam alluvial soils possessing low to moderate permeabilities. Surface drainage from the site is directed in a generally southward direction to Box Elder Creek via several unnamed tributaries. The clay, sand and gravel overburden ranges in thickness from ten to thirty feet and directly overlies bedrock (Pierre Shale) which is generally impermeable. Seasonal ground water may occur in the basal sections of the alluvium, above the bedrock. Ground-water flow probably follows the bedrock surface and probable discharges to local streams.

There is a potential for contamination associated with this site and a follow on investigation is warranted. This site received a HARM score of 65.

LANDFILL NO. 3

Landfill No. 3 was the operating base landfill from approximately 1965 until 1976, and is located in the southwest corner of the base. Wastes disposed of during this time included general base refuse, liquid and paint wastes from the shops, and sludge and oils removed from the industrial sewer system. A waste oil disposal pit located in the southwest corner of the landfill was used to dump liquid waste for about a

year in the mid 1970's. Prior to 1982, a holding area for drums of waste oils and solvents from the shops was located in the southwest area of the landfill. Landfill No. 3 was also used in 1982 and 1983 for the disposal of soils contaminated with Pramitol and launch facility sodium chromate coolant. A trench is currently open at the landfill and appears to be accepting construction debris.

The landfill is closed with a soil and grass cover. The site is underlain by primarily clay loam and gravelly sandy loam alluvial soils possessing low to moderate permeabilities. Surface drainage from the site is directed in a generally southward direction to Box Elder Creek via several unnamed tributaries. The clay, sand and gravel overburden ranges in thickness from ten to thirty feet and directly overlies bedrock (Pierre Shale) which is generally impermeable. Seasonal ground water may occur in the basal sections of the alluvium, above the bedrock. Ground-water flow probably follows the bedrock surface. Discharge to local streams is likely.

This site has a potential for environmental contamination and a follow on investigation is warranted. This site received a HARM score of 62.

LANDFILL NO. 1

Landfill No. 1, located south of the alert apron, was the first base landfill and operated until approximately 1964. A variety of wastes were disposed of at the landfill including general base refuse, incinerator ash, sludge and oil from the industrial sewer system, and presumably some of the shop liquid wastes. The method of operation was generally trench and fill with burning; however, some refuse was pushed over the south and west banks and is still visible.

The landfill is closed with a soil and grass cover. The site is underlain by primarily clay loam and gravelly sandy loam alluvial soils possessing low to moderate permeabilities. Surface drainage from the site is directed in a generally southward direction to Box Elder Creek via several unnamed tributaries. The clay, sand and gravel overburden ranges in thickness from ten to thirty feet and directly overlies bedrock (Pierre Shale) which is generally impermeable. Seasonal ground water may occur in the basal sections of the alluvium, above the

bedrock. Ground-water flow probably follows the bedrock surface. Discharge to local streams is likely.

The site has a potential for contamination and a follow on investigation is warranted. The site recieved a HARM score of 59.

SPILL SITE NO. 7 (PUMP HOUSE NO. 6)

In February 1984, approximately 12,000 gallons of JP-4 overflowed a tank at Pump House No. 6 as a result of a cut-off valve failure. The JP-4 was washed across the infield, into a storm drain, and eventually to oil/water separator 001. Approximately 500 gallons of fuel was reported to have reached the separator. The remainder of the fuel likely evaporated or infiltrated the infield soils.

The area of the spill has a grass cover and no signs of vegetative stress have been noted. The site is underlain by primarily clay loam and gravelly sandy loam alluvial soils possessing low to moderate permeabilities. Surface drainage from the site is directed in a generally southwest direction to Box Elder Creek via several unnamed tributaries. The clay, sand and gravel overburden ranges in thickness from ten to thirty feet and directly overlies bedrock (Pierre Shale) which is generally impermeable. Seasonal ground water may occur in the basal sections of the alluvium, above the bedrock. Ground-water flow probably follows the bedrock surface and discharges to local streams.

There is a potential for contamination associated with this spill and a follow on investigation is recommended. This site received a HARM score of 56.

LANDFILL NO. 6

Landfill No. 6 was located at the current site of the alert apron recreation facility parking lot. The area was operated primarily as a hardfill area between approximately 1962 and 1965. However, general refuse, including liquid waste (waste oil, fuel and solvents), was reportedly dumped into the fill area.

The landfill is closed and has a grass cover. The site is underlain by primarily clay loam and gravelly sandy loam alluvial soils possessing low to moderate permeabilities. Surface drainage from the site is directed in a generally southward direction to Box Elder Creek

via several unnamed tributaries. The clay, sand and gravel overburden ranges in thickness from ten to thirty feet and directly overlies bedrock (Pierre Shale) which is generally impermeable. Seasonal ground water may occur in the basal sections of the alluvium, above the bedrock. Ground-water flow probably follows the bedrock surface. Discharge to local streams is likely.

The site has a potential for contamination and a follow on investigation is warranted. This site received a HARM score of 49.

LANDFILL NO. 2

Landfill No. 2 which is located at the north end of the base, just south of the active landfill area, was operated for just over a year in the mid-1960's (1964-1965). The trench and fill operation also included a burning pit for combustible materials, including waste liquids from the shops (waste oil, fuel and solvents).

The landfill is closed and mostly covered with soil and grass. The site is underlain by primarily clayey residual soils possessing low permeabilities which tend to promote runoff. Surface drainage from the site is directed in a northward direction toward Elk Creek via several unnamed tributaries. The clayey soil overburden ranges in thickness from ten to twenty feet and directly overlies bedrock (Pierre Shale) which is generally impermeable. Seasonal ground water may occur at the overburden/bedrock interface. Ground-water flow probably follows the bedrock surface. Discharge to local streams is likely.

This site has the potential for contamination and a follow on investigation is warranted. This site received a HARM score of 48.

LOW-LEVEL RADIOACTIVE WASTE BURIAL SITES

Seven potential low-level radioactive waste burial sites were located within the existing WSA. The wastes were generated between 1952 and 1962 by the Atomic Energy Commission at what was then known as Rushmore Air Force Station. Five of the burial sites are underground tanks (1,000 to 5,000 gallons). Although the liquid wastes were deemed safe for discharge in 1972, there are no records indicating disposal took place. The present status of the tanks are unknown. The other two burial sites, dry material storage areas, have been combined into one site.

The site is underlain by primarily clay loam and gravelly sandy loam alluvial soils possessing low to moderate permeabilities. Surface drainage from the site is directed in a generally southward direction to Box Elder Creek via several unnamed tributaries. The clay, sand and gravel overburden ranges in thickness from ten to thirty feet and directly overlies bedrock (Pierre Shale) which is generally impermeable. Seasonal ground water may occur in the basal sections of the alluvium, above the bedrock. Ground-water flow probably follows the bedrock surface. Discharge to local streams is likely.

These sites have a potential for environmental contamination and follow on investigations are warranted. These sites received a HARM score of 46.

LANDFILL NO. 5

Landfill No. 5, located just north of the Industrial Gate, was used primarily for construction demolition and hardfill material. However, general refuse was reportedly frequently dumped in this site. Due to the uncontrolled nature of this operation, and the frequency of unauthorized dumping, it is likely that shop wastes were disposed of in this landfill. This area has also received sludge from the base sanitary wastewater treatment plant.

The site is closed and has been graded, covered and vegetated. The site is underlain by primarily clay loam and gravelly sandy loam alluvial soils possessing low to moderate permeabilities. Surface drainage from the site is directed in a generally southward direction to Box Elder Creek via several unnamed tributaries. The clay, sand and gravel overburden ranges in thickness from ten to thirty feet and directly overlies bedrock (Pierre Shale) which is generally impermeable. Seasonal ground water may occur in the basal sections of the alluvium, above the bedrock. Ground-water flow probably follows the bedrock surface. Discharge to local streams is likely.

This site has a potential for contamination and a follow on investigation is warranted. This site received a HARM score of 46.

LANDFILL NO. 4

The active hardfill area, just east of Scout Drive on the north end of the base, is identified as Landfill No. 4. Although the primary function of the site is, and has been, the disposal of construction demolition and hardfill materials, reports and visual observations have confirmed that this site has been used in the past for general refuse and drum disposal. This area has been operated as a fill operation and has very steep side slopes.

Part of this site is closed with a cover and vegetation and part of the site is still open. The site is underlain by primarily clayey residual soils possessing low permeabilities which tend to promote runoff. Surface drainage from the site is directed in a northward direction toward Elk Creek via several unnamed tributaries. The clayey soil overburden ranges in thickness from ten to twenty feet and directly overlies bedrock (Pierre Shale) which is generally impermeable. Seasonal ground water may occur at the overburden/bedrock interface. Groundwater flow probably follows the bedrock surface. Discharge to local streams is likely.

This site has a potential for contamination and a follow on investigation is warranted. This site received a HARM score of 44.

SPILL SITE NO. 1 (PUMP HOUSE NO. 7)

In 1972, a B-52 bomber left the runway and crashed into Pump House No. 7. The spilled JP-4 was washed into the infield during the fire fighting operation. Some of the fuel evaporated and some infiltrated into the soil.

The site is underlain by primarily clay loam and gravelly sandy loam alluvial soils possessing low to moderate permeabilities. Surface drainage from the site is directed in a generally southward direction to Box Elder Creek via several unnamed tributaries. The clay, sand and gravel overburden ranges in thickness from ten to thirty feet and directly overlies bedrock (Pierre Shale) which is generally impermeable. Seasonal ground water may occur in the basal sections of the alluvium, above the bedrock. Groundwater flow probably follows the bedrock surface. Discharge to local streams is likely.

This site has a potential for contamination and a follow on investigation is warranted. This site received a HARM score of 43.

SPILL SITE NO. 3 (HYDRANT LINE LEAKS)

Fourteen aluminum hydrant lines that lead from Pump Houses 1 through 5 to the aircraft were found to be leaking in 1974. No estimate of the fuel lost is available. However, these lines were routinely pressurized about three times per week for approximately two hours, and would have remained empty the remainder of the time.

The site is underlain by primarily clay loam and gravelly sandy loam alluvial soils possessing low to moderate permeabilities. Surface drainage from the site is directed in a generally southward direction to Box Elder Creek via several unnamed tributaries. The clay, sand and gravel overburden ranges in thickness from ten to thirty feet and directly overlies bedrock (Pierre Shale) which is generally impermeable. Seasonal ground water may occur in the basal sections of the alluvium, above the bedrock. Ground-water flow probably follows the bedrock surface. Discharge to local streams is likely.

This site has the potential for environmental contamination and a follow on investigation is recommended. This site received a HARM score of 43.

SPILL SITE NO. 2 (C-9 LF COOLANT SPILL)

In July 1977, approximately 50 gallons of missile launch facility (LF) coolant containing hexavalent sodium chromate and dimethoxane additive was pumped to the surface and discharged from LF C-9 onto the ground and flowed to the adjacent county road drainage ditch. No clean-up action was undertaken. This site has a potential for environmental contamination and a follow on investigation is warranted. This site received a HARM score of 40.

SPILL SITE NO. 5 (C-11 LF COOLANT SPILL)

In January 1983, approximately 100 gallons of coolant was discharged from C-11 LF onto the ground. The launch facility soil was rototilled and left in place. There is a potential for environmental contamination at this site and a follow on investigation is warranted. This site received a HARM score of 40.

SPILL SITE NO. 6 (N-10 LF COOLANT SPILL)

In August, 1983, approximately 100 gallons of coolant was discharged from N-10 LF onto the ground and the adjacent property. The discolored soil was removed from the adjacent farmland and disposed of at Landfill No. 3. Contaminated soil at the LF was left in place. This site has a potential for environmental contamination and a follow on investigation is warranted. This site received a HARM score of 40.

SPILL SITE NO. 4 (PRAMITOL SPILL AT EOD AREA)

In May 1982, 100 gallons of concentrated Pramitol 25E herbicide was dumped in the EOD area. Although 200 cubic yards of contaminated soil was removed following the spill, the Pramitol was again found to be leaching from the EOD area in June 1983. At this time, several large dams were constructed of the native material to control the migration of Pramitol off-base. Visual indications are that the Pramitol is still leaching from the EOD area. The persistence of the Pramitol is likely extended by the high application concentration, low soil organic content, high soil pH, and low rainfall.

The site is underlain by primarily clayey residual soils possessing low permeabilities which tend to promote runoff. Surface drainage from the site is directed in a northward direction toward Elk Creek via several unnamed tributaries. The clayey soil overburden ranges in thickness from ten to twenty feet and directly overlies bedrock (Pierre Shale) which is generally impermeable. Seasonal ground water may occur at the overburden/bedrock interface. Ground-water flow probably follows the bedrock surface. Discharge to local streams is likely.

Due to the apparent persistence of the Pramitol, there is a potential for environmental contamination and a follow on investigation is recommended. The site received a HARM score of 34.

SECTION 6

RECOMMENDATIONS

Sixteen sites were identified at Ellsworth AFB as having the potential for environmental contamination. These sites have been evaluated and rated using the HARM system which assesses their relative potential for contamination and provides the basis for determining the need for additional PHASE II IRP investigations. All of the sixteen sites have sufficient potential to create environmental contamination and warrant Phase II investigations.

PHASE II MONITORING RECOMMENDATIONS

The recommendations in this section are made to further assess the potential for environmental contamination from waste disposal areas at Ellsworth AFB. The recommended actions are generally one time sampling programs to determine if contamination does exist at the site. If contamination is identified, the sampling program may need to be expanded to further define the extent of contamination. Of the sixteen sites recommended for further actions, eight are previous spill or leak areas. There are also six former landfill areas, the FPTA and a low-level radioactive waste burial site recommended for further IRP action.

The hydrogeologic conditions present at each waste disposal facility are entirely site-specific due to variations in geology, topography, land use modifications, etc. These natural conditions or man-made changes in the local environmental setting must be clearly understood in order to design an effective ground-water quality monitoring system. At present, these site-specific conditions existing at Ellsworth AFB IRP sites are unknown. Soil test borings and temporary observation wells may be employed to obtain site-specific information. A systematic, more efficient and cost-effective approach would be to utilize geophysical

techniques to obtain local subsurface information. Electrical resistivity (ER) and electromagnetic conductivity (EM) are geophysical instruments that employ indirect measurement technologies to collect data describing subsurface material electrical properties. They respond to changes or contrasts in either the horizontal or vertical planes which may be correlated to direct sampling methods, such as test borings. Both methods may be utilized in situations if local geology permits, to determine stratigraphic changes, depth to ground water, aquifer thickness and contaminated zones if sufficient contrast exists. ER may be employed in more complicated terrains or in situations where deep contamination is suspected. Wells may then be installed systematically, in zones selected by the geophysical techniques. This approach to monitoring program design significantly reduces both costs and schedules.

The use of geophysical techniques at waste disposal facilities has been well documented in the technical literature (Benson, et. al., 1984). A USEPA guidance manual describes the capabilities and limitations of electrical resistivity at waste disposal facilities and is applicable to the probable conditions that may be encountered at Ellsworth AFB (USEPA, 1978). Other geophysical methodologies can be utilized for specialized purposes; for example, a metal detector may be used in shallow settings to locate buried ferrous materials and the magnetometer may be utilized to locate either buried objects or disturbed zones (backfilled trenches or pits) in shallow and deep settings.

The hydrogeologic setting at Ellsworth AFB consists of a shallow, ephemeral unconsolidated aquifer composed of mixed alluvium and a very deep bedrock aquifer. The shallow unconsolidated aquifer contains seasonally-recharged ground water locally under water table (unconfined) conditions in its lower extent, just above the bedrock surface. Ground water contained in the shallow unit probably flows along the path(s) defined by the bedrock upper surface. The shallow unconsolidated aquifer occurs at ground surface and is capable of furnishing water to local farmers for domestic or livestock watering purposes at sites set topographically lower than Ellsworth AFB (especially the area north of the installation). It is believed that the shallow water-bearing unit provides at least some discharge to the many small ponds located on the base, where it is ten to thirty feet thick. This shallow aquifer may be

an important receptor of migrating contamination and should be considered as a candidate for ground-water quality monitoring. Because the shallow unconsolidated unit is largely undefined at Ellsworth AFB (for example, ground-water flow directions and velocities are unknown), site-specific hydrogeologic studies must be performed at each waste disposal facility to determine if the aquifer is present, well placement, screen depths, etc.

The shallow unit is underlain at great depth (1700 feet) by a regionally-significant bedrock aquifer. The bedrock aquifer is the principle source of ground water in the study area. It is separated from ground surface by substantial sequences of nearly impermeable shale, limestone, etc. Ground water occurs in the deep unit under strong artesian (confined) pressure. The deep aquifer is not a candidate for ground-water quality monitoring.

Following geophysical surveys, the proper placement of additional soil borings and/or ground-water quality monitoring wells can be determined. Those sites with a potential for ground-water contamination will be monitored with 4-inch diameter wells consisting of Schedule 40 PVC with solid casing and machine slotted screen. Well screens should be installed to permit sampling of the uppermost aquifer's complete saturated thickness. Well depth should be determined by site geophysics. If the initial ground-water samples indicate contamination, additional wells may be required. The number of wells may be reduced if the geophysical techniques are successful in identifying subsurface plumes. The recommended monitoring program is summarized in Table 6.1 and 6.2 and discussed below for each site. Figures 6.1 and 6.2 locate the sites proposed for Phase II monitoring.

FIRE PROTECTION TRAINING AREA

At the FPTA test borings are recommended to a depth of ten feet at three or more locations within the diked area. Samples should be taken at the surface and two foot intervals or in areas of obvious visual contamination. An Organic Vapor Analyzer (OVA) or similar instrument should be used during the boring procedure. Selected samples, in particular those with high OVA readings, should be analyzed for the parameters listed in Table 6.2, List A. Additionally, three sediment

TABLE 6.1
RECOMMENDED MONITORING PROGRAM FOR PHASE II IRP
AT ELLSWORTH AFB

Site Name	Rating Score	Recommended Monitoring	Sample Analysis List	Comments
Fire Protection Training Area	66	Conduct 3 borings to 10 feet with sampling at the surface and at 2 foot intervals. Analyze samples with high Organic Vapor Analyzer (OVA) readings. Collect and analyze 3 sediment samples from the OOI discharge pond.	A	If sampling indicates contamination, additional soil borings and wells may be necessary to assess the extent of contamination.
Spill Site No. 9 (Auto Hobby Shop Heating Fuel)	65	Geophysical study to determine extent of contamination and to aid in placement of wells, install and sample 1 background well and 2 downgradient wells.	B	If sampling indicates contamination, continue monitoring. Additional wells and soil borings may be necessary to assess the extent of contamination.
Landfill No. 3	62	Geophysical study to determine extent of the fill and to aid in placement of wells; install and sample 1 background wells and 8 downgradient wells.	A	If sampling indicates contamination, continue monitoring. Additional wells and soil borings may be necessary to assess the extent of contamination.
Landfill No. 1	59	Geophysical study to determine extent of the fill and to aid in placement of wells; install and sample 1 background wells and 10 downgradient wells.	A+E Includes Landfill No. 6.	Monitoring at Landfill No. 1 includes Landfill No. 6. If sampling indicates contamination, continue monitoring. Additional wells and soil borings may be necessary to assess the extent of contamination.
Spill Site No. 7 (Pump House No. 6)	56	Conduct 5 borings, 2 at the Pump House and 3 in the infield to 6 feet with sampling at the surface and at 2 foot intervals. Analyze samples with high OVA readings.	B	If sampling indicates contamination, additional soil borings and wells may be necessary to assess the extent of contamination.

1 Refer to Table 6.2

TABLE 6.1 (Continued)
RECOMMENDED MONITORING PROGRAM FOR PHASE II IRP
AT ELLSWORTH AFB

Site Name	Rating Score	Recommended Monitoring	Sample Analysis List	Comments
Landfill No. 6	49	Geophysical study to aid in determining the extent of the fill. Due to the close proximity of Landfill No. 1, the wells and sampling points for Landfill No. 1 should be positioned to include the Landfill No. 6 area.	A	If sampling indicates contamination, continue monitoring. Additional wells and soil borings may be necessary to assess the extent and source of contamination.
Landfill No. 2	48	Geophysical study to determine extent of the fill and to aid in placement of wells, install and sample 1 background well and 2 downgradient wells.	A	If sampling indicates contamination, continue monitoring. Additional wells and soil borings may be necessary to assess the extent of contamination.
Low-Level Radioactive Waste Burial Site	46	Geophysical study to locate solid waste disposal box; check for radioactivity. Check the status of the liquids and, if present, sample contents of tanks for radioactivity and Total Organic Carbon (TOC).	E+P	If sampling indicates contamination, further monitoring may be necessary prior to disposal and closure.
Landfill No. 5	46	Geophysical study to determine extent of the fill and to aid in placement of wells; install and sample 1 background well and 2 downgradient wells.	A	If sampling indicates contamination, continue monitoring. Additional wells and soil borings may be necessary to assess the extent of contamination.
Landfill No. 4	44	Geophysical study to determine extent of the fill and to aid in placement of wells; install and sample 1 background well and 2 downgradient wells.	A	If sampling indicates contamination, continue monitoring. Additional wells and soil borings may be necessary to assess the extent of contamination.

1 Refer to Table 6.2.

TABLE 6.1 (Continued)
RECOMMENDED MONITORING PROGRAM FOR PHASE II IRP
AT ELLSWORTH AFB

Site Name	Rating Score	Recommended Monitoring	Sample Analysis List	Comments
Spill Site No. 1 (Pump House No. 7)	43	Conduct 3 soil borings to 6 feet with sampling at the surface and at 2 foot intervals. Analyze samples which have high OVA readings.	B	If sampling indicates contamination, additional soil borings and wells may be necessary to assess the extent of contamination.
Spill Site No. 3 (Hydrant Line Leaks)	43	Install a monitoring well downgradient of each pump house (No. 1 through No. 5) transfer line.	B	If sampling indicates contamination, additional soil borings and wells may be necessary to assess the extent of contamination.
Spill Site No. 2 (LF C-9 Coolant Spill)	40	Conduct 3 borings to 10 feet with sampling and analysis at 1 foot intervals for the first 2 feet, and at 2 foot intervals for the remaining 8 feet.	C	If sampling indicates contamination, additional soil borings may be necessary to assess the extent of contamination.
Spill Site No. 5 (LF C-11 Coolant Spill)	40	Conduct 3 borings to 10 feet with sampling and analysis at 1 foot intervals for the first 2 feet, and at 2 foot intervals for the remaining 8 feet.	C	If sampling indicates contamination, additional soil borings may be necessary to assess the extent of contamination.
Spill Site No. 6 (LF N-10 Coolant Spill)	40	Conduct 3 borings to 10 feet with sampling and analysis at 1 foot intervals for the first 2 feet, and at 2 foot intervals for the remaining 8 feet.	C	If sampling indicates contamination, additional soil borings may be necessary to assess the extent of contamination.
Spill Site No. 4 (EOD Pramitol Spill)	34	Collect and analyze soil samples at 10 locations to a depth of 3 and 6 inches.	D	If sampling indicates unacceptable contamination, additional soil samples may be necessary to assess the extent of contamination.

¹ Refer to Table 6.2

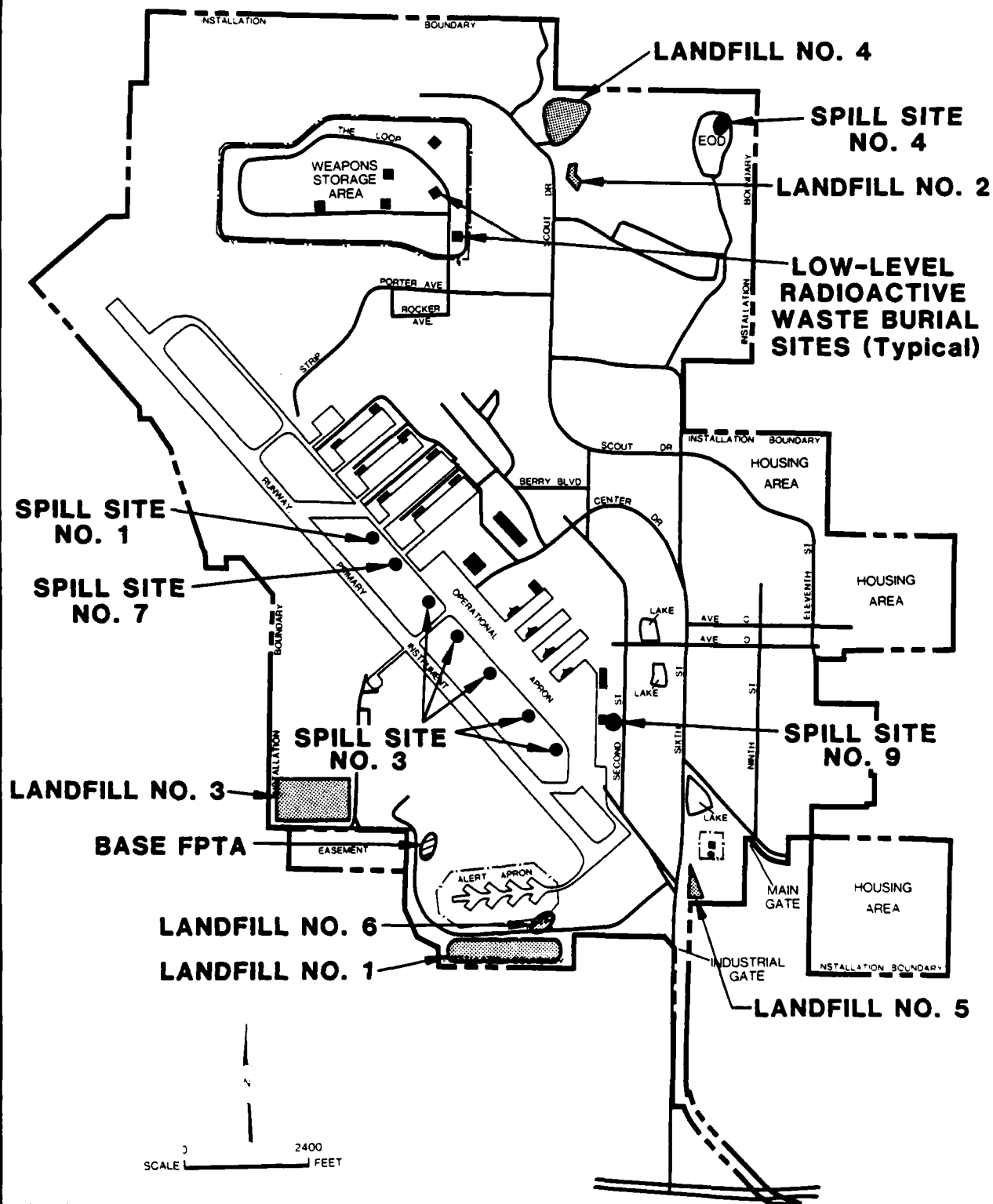
TABLE 6.2
RECOMMENDED LIST OF ANALYTICAL PARAMETERS FOR PHASE II IRP
AT ELLSWORTH AFB

<u>LIST A</u>	<u>Methods</u>	
	<u>Water Analysis</u>	<u>Soil Analysis</u>
pH (Water Samples Only)	EPA 150.1	No Soils
Total Dissolved Solids (Water Samples Only)	EPA 160.1	No Soils
Oil and Grease	EPA 413.2	EPA 3550, then EPA 413.2
Volatile Organics	EPA 624	SW 8240
EP Toxicity (Soil Samples Only)	No Waters	40 CFR 261.24
Sulfate	EPA 375.2	No Soils
Chloride	EPA 325.3	No Soils
Lead	EPA 239.1	No Soils
Cadmium	EPA 213.1	No Soils
Nickel	EPA 249.1	No Soils
Chromium	EPA 218.1	No Soils
Silver	EPA 272.1	No Soils
Iron	EPA 236.1	No Soils
Manganese	EPA 243.1	No Soils
Copper	EPA 220.1	No Soils
Zinc	EPA 289.1	No Soils
<u>LIST B</u>		
Oil and Grease	EPA 413.2	EPA 3550, then EPA 413.2
Volatile Organics	EPA 624	SW 8240
<u>LIST C</u>		
Hexavalent Chromium	No Waters	SW 7196
Total Chromium	No Waters	SW 7190
Dimethoxane	No Waters	SW 8270
<u>LIST D</u>		
pH	No Waters	SW 9040
Prometone	No Waters	SW 8270

TABLE 6.2 (continued)
RECOMMENDED LIST OF ANALYTICAL PARAMETERS FOR PHASE II IRP
AT ELLSWORTH AFB

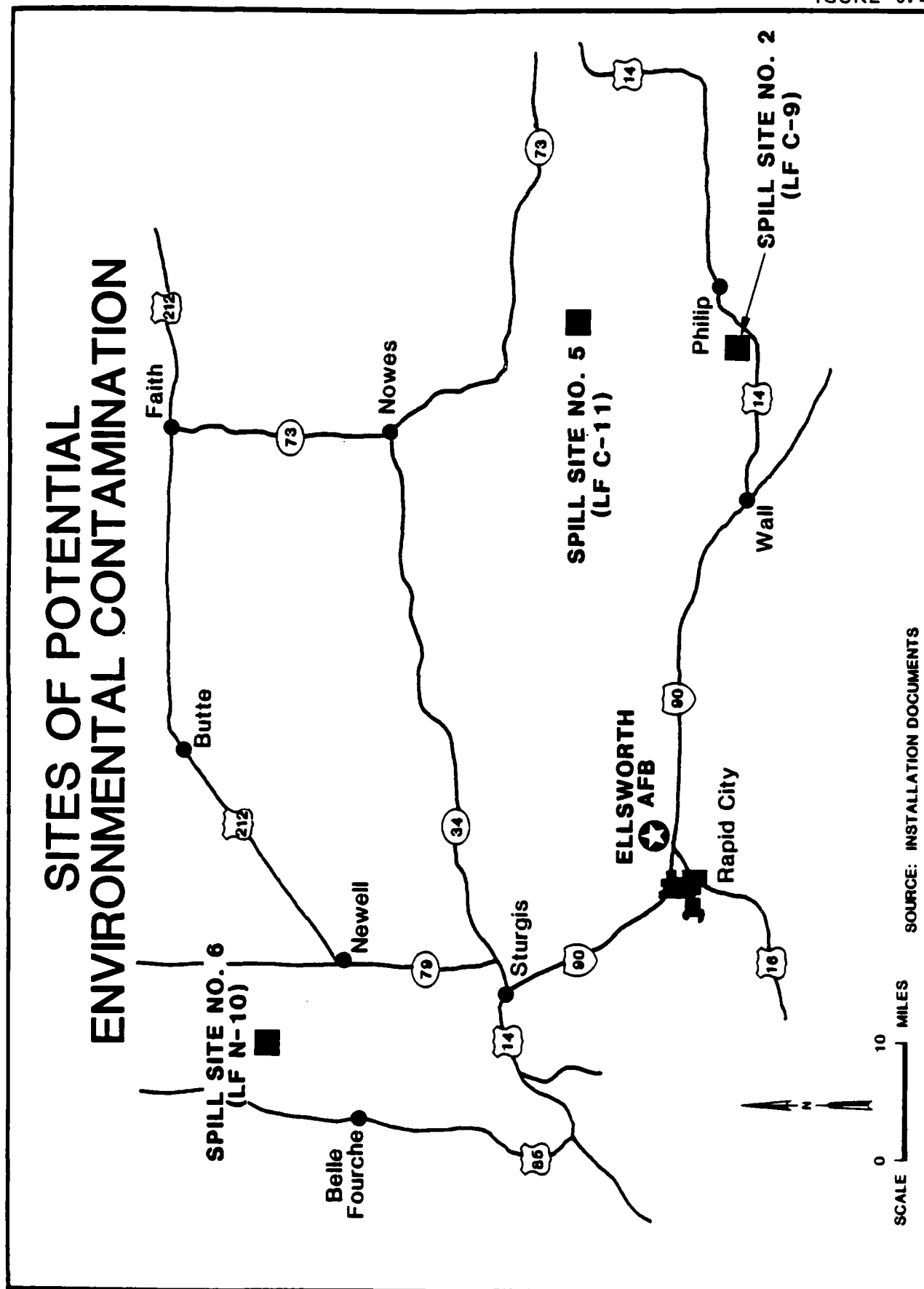
<u>LIST E</u>	<u>Methods</u>	
	<u>Water Analysis</u>	<u>Soil Analysis</u>
Radioactivity (Water Samples Only)	Gross Alpha-Beta and High Resolu- tion Gamma Ray Spectroscopy	No Soils
<u>List F</u>		
Total Organic Carbon (Water Samples Only)	EPA 415.1	No Soils
Sources: EPA 600/4-79-020 EPA SW-846 2nd Ed. EPA 600/4-82-057		

ELLSWORTH AFB SITES OF POTENTIAL ENVIRONMENTAL CONTAMINATION MAIN BASE



SOURCE: INSTALLATION DOCUMENTS

FIGURE 6.2



SOURCE: INSTALLATION DOCUMENTS

samples should be collected from the 001 discharge to monitor the effect of runoff from the FPTA. One upgradient sample should be collected upstream of the FPTA, and the other two samples should be collected from the 001 discharge pond. These sediment samples should also be analyzed for the parameters in Table 6.2, List A.

SPILL SITE NO. 9 (AUTO HOBBY SHOP HEATING FUEL)

At Spill Site No. 9 heating fuel oil was discovered during borings for the construction of the new jet engine test cell. The leak apparently originated from an underground tank at the old auto hobby shop. Prior to construction of the new jet engine test cell, the old tank and the contaminated soils in the construction area are to be removed.

Since a shallow perched water table has been reported in this area, it is recommended that a geophysical study be conducted to determine the extent of contaminant migration and aid in the placement of one background and two downgradient monitoring wells. The wells should be constructed such that the surface of the perched water table intersects the well screens so that the floating contaminants can be sampled. The estimated well depth is 30 feet. The ground-water samples should be analyzed for the parameters listed in Table 6.2, List B.

LANDFILL NO. 3

Landfill No. 3, located west of the FPTA, was not only used as a landfill for various wastes, but was also the site of a waste oil disposal pit and a waste oil and solvent drum holding area. Geophysical studies are recommended to determine the horizontal and vertical extent of the landfill and specific hydrogeologic conditions of the site. A ground-water quality monitoring system, consisting of one background well and one downgradient monitoring well for each 250 feet of "downgradient" frontage should be installed. An estimated 9 wells, 30 feet deep will be required to monitor Landfill No. 3. The ground-water samples should be analyzed for the parameters listed in Table 6.2, List A.

LANDFILL NO. 1

Landfill No. 1 is located south of the alert apron. Prior to the initiation of field activities, a surface radioactive survey should be performed. Geophysics are recommended to determine the horizontal and vertical extent of the landfill and the local subsurface conditions. The geophysical information will be used to assist in placing the monitoring wells. The monitoring system should consist of one upgradient well and one downgradient well for each 250 feet of "downgradient" frontage. An estimated 10 wells, 30 feet deep may be required to monitor this site. Well installation should be performed as previously noted. The ground-water samples should be analyzed for the parameters listed in Table 6.2, List A and E.

SPILL SITE NO. 7 (PUMP HOUSE NO. 6)

Spill Site No. 7 was the result of an estimated 12,000 gallons of JP-4 overflowing a tank during filling at Pump House No. 6. The spill was washed across the infield to the storm drain.

Two borings are recommended at the Pump House and three in the infield, between the Pump House and the storm sewer. The borings should be to a depth of six feet with samples collected at the surface and at two foot intervals. An OVA meter should be utilized while advancing the borings. Selected soil samples, in particular those with high OVA readings, should be analyzed for the parameters listed in Table 6.2, List B.

LANDFILL NO. 6

Landfill No. 6 is located between the Alert Apron and Bismark Road. A geophysical study should be utilized to aid in determining the location and extent of the fill. However, due to the close proximity of Landfill No. 1, the wells and sampling points for Landfill No. 1 should be positioned to include Landfill No. 6.

LANDFILL NO. 2

At Landfill No. 2, located south of the active hardfill area, geophysics should be utilized to determine the location and extent of the fill, locate leachate plumes, and aid in the placement of monitoring

wells. A monitoring system consisting of one upgradient well and two downgradient wells is recommended. The estimated depth is 30 feet. These wells should be constructed as discussed above. The ground-water samples should be analyzed for the parameters shown in Table 6.2, List A.

LOW-LEVEL RADIOACTIVE WASTE BURIAL SITES

A geophysical study may be utilized to help locate the solid waste disposal box. The area should then be designated and monitored for radioactivity. A well or test pit adjacent to the solid waste disposal box may be required to effectively check for radioactivity. The tanks should be checked to determine if they contain any materials. If so, it should be sampled and analyzed for radioactivity and Total Organic Carbon. If the liquid is determined to be contaminated, additional testing should be done to determine the integrity of the tanks.

LANDFILL NO. 5

Landfill No. 5 is located just south of the waste water treatment plant. Geophysical studies are recommended to determine the extent of the site and aid in the placement of the monitoring wells. The recommended monitoring system consists of one upgradient well and two downgradient well. These wells should be constructed as discussed above. The estimated depth of the wells is 30 feet. The ground-water samples should be analyzed for the parameters shown in Table 6.2, List A.

LANDFILL NO. 4

Landfill No. 4, located at the north end of the base, is the existing hardfill area. Site-specific hydrogeologic conditions should be established, using geophysics, followed by installation of a ground-water quality monitoring system including one background well and at least two downgradient wells. The estimated depth of the wells is 30 feet. The samples should be analyzed for the parameters listed in Table 6.2, List A.

SPILL SITE NO. 1 (PUMP HOUSE NO. 7)

Spill Site No. 1 was the result of a B-52 Bomber crash at Pump House No. 7 in 1972. Three soil borings on the infield side of the pump house are recommended. The borings should be to a depth of six feet with sampling at the surface and at two foot intervals. Selected samples, in particular those with high OVA readings, should be analyzed for the parameters identified in Table 6.2, List B.

SPILL SITE NO. 3 (HYDRANT LINE LEAKS)

Spill Site No. 3 is the result of leaks, discovered in 1974, from the aluminum hydrant lines at Pump Houses 1 through 5. Since the old lines were located under the operational apron, ground-water monitoring should be done downgradient of each pump house (No. 1 through 5) transfer line. The ground-water samples should be analyzed for the parameters listed in Table 6.2, List B.

SPILL SITE NO. 2 (LF C-9), NO. 3 (LF C-11) AND NO. 6 (LF N-10)

Discharges of the coolant containing sodium chromate and dimethoxane additives from the launch facility sumps onto the ground have occurred as listed below:

- o Spill Site No. 2, July 1977, at LF C-9
- o Spill Site No. 5, January 1983, at LF C-11
- o Spill Site No. 6, August 1983, at LF N-10

Since no remediation was performed at LF C-9 the effectiveness of the remediation activities at LF C-11 and N-10 is not known. The potential for contamination exists at these sites and further investigation is recommended. Three soil borings to a depth of ten feet are recommended at each of the launch facilities. Sample locations should be selected in areas of suspected contamination. Sampling and analysis should be done at one foot intervals for the first two feet, and at two foot intervals for the remaining eight feet. The soil samples should be analyzed for the parameters listed in Table 6.2, List C.

EOD PRAMITOL SPILL (SP-4)

Spill SP-4 occurred in May 1982 at the EOD and involved the dumping of 100 gallons of Pramitol 25E herbicide (prometone is the active ingredient). Since the Pramitol has appeared to persist in the EOD area and remedial efforts have not been completely effective, the potential for contamination still exists and further investigation is recommended. The recommended investigation consists of the collection of soil samples to a depth of three and six inches at a minimum of ten locations. Sample locations should be selected in the field to define the extent of contamination. The soil samples should be analyzed for the parameters listed in Table 6.2, List D.

TABLE OF CONTENTS
APPENDICES

	<u>Page No.</u>
APPENDIX A BIOGRAPHICAL DATA	
E. J. Schroeder	A-1
J. G. Menard	A-3
J. R. Absalon	A-5
J. P. McAuliffe	A-7
APPENDIX B LIST OF INTERVIEWEES AND OUTSIDE AGENCY CONTACTS	
List of Interviewees	B-1
Outside Agency Contacts	B-4
APPENDIX C TENANT ORGANIZATIONS AND MISSIONS	C-1
APPENDIX D SUPPLEMENTAL BASE FINDINGS INFORMATION	D-1
APPENDIX E MASTER LIST OF SHOPS	
44th Combat Support Group	E-1
28th Organizational Maintenance Squadron	E-2
44th Transportation Squadron	E-2
44th Supply Squadron	
28th Bombardment Wing	E-3
28th Avionics Maintenance Squadron	E-3
28th Munitions Maintenance Squadron	E-3
USAF Hospital Ellsworth	E-4
44th Field Missile Maintenance Squadron	E-5
28th Field Maintenance Squadron	E-5
2148 Information Systems Squadron	E-6
44th Organizational Missile Maintenance Squadron	E-7
Detachment 2, 37th Aerospace Rescue & Recovery	E-7
44th Civil Engineering Squadron	E-8
APPENDIX F PHOTOGRAPHS	F-1
APPENDIX G USAF INSTALLATION RESTORATION PROGRAM	G-1
HAZARD ASSESSMENT RATING METHODOLOGY	
APPENDIX H SITE HAZARD ASSESSMENT RATING FORMS	
Fire Protection Training Area	H-1
Spill Site No. 9 (Auto Hobby Shop Heating Fuel)	H-3
Landfill No. 3	H-5
Landfill No. 1	H-7
Spill Site No. 7 (Pump House No. 6)	H-9
Landfill No. 6	H-9
Landfill No. 2	H-13
Level Radioactive Waste Burial Site	H-15
Landfill No. 5	H-17
Landfill No. 4	H-19
Spill Site No. 1 (Pump House No. 7)	H-21
Spill Site No. 3 (Hydrant Line Leaks)	H-23

TABLE OF CONTENTS
APPENDICES
(Continued)

APPENDIX H (CONTINUED)

Spill Site No. 2 (LF C-9 Coolant Spill)	H-25
Spill Site No. 5 (LC C-11 Coolant Spill)	H-27
Spill Site No. 6 (LF N-10 Coolant Spill)	H-29
Spill Site No. 4 (EOD Pramital Spill)	H-31

APPENDIX I	GLOSSARY OF TERMINOLOGY AND ABBREVIATIONS	I-1
------------	---	-----

APPENDIX J	REFERENCES	J-1
------------	------------	-----

APPENDIX K	INDEX OF REFERENCES TO POTENTIAL CONTAMINATION SITES AT ELLSWORTH AFB	K-1
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APPENDIX A
BIOGRAPHICAL DATA

Biographical Data

ERNEST J. SCHROEDER

Environmental Engineer

Manager, Solid and Hazardous Waste Dept.

PII Redacted

Education

B.S. in Civil Engineering, 1966, University of Arkansas,
Fayetteville, Arkansas

M.S. in Sanitary Engineering, 1967, University of Arkansas,
Fayetteville, Arkansas

Professional Affiliations

Registered Professional Engineer (Arkansas No. 3259, Georgia
No. 10618, and Texas No. 33556)

Water Pollution Control Federation

American Academy of Environmental Engineers

Honorary Affiliations

Chi Epsilon

Experience Record

1967-1976 Union Carbide Technical Center, Engineering Department,
South Charleston, West Virginia (1967-1968). Project
Engineer. Responsible for environmental protection
engineering projects for various organic chemicals and
plastics plants.

Union Carbide Corporation, Environmental Protection
Department, Texas City, Texas (1969-1975). Project
Engineer and Engineering Supervisor. Responsible for
various aspects of plant pollution abatement programs,
including preparation of state and federal permits for
wastewater treatment activities, operations represen-
tative on \$8 million regional wastewater treatment
project (process design, detailed design, construction
and startup), and supervisor for operation of waste-
water collection and treatment facilities.

Union Carbide Corporation, Environmental Protection
Project Engineer, Toronto, Ontario, Canada (1975-1976).
Responsible for the environmental permitting and
engineering design of waste treatment systems
associated with a new refinery.

Ernest J. Schroeder (Continued)

1976-Date Engineering-Science, Inc., Project Manager (1976-1978).
Engineering and project management of various
industrial wastewater and hazardous waste projects.

Engineering-Science, Inc., Manager of the Industrial
Waste Group in the Atlanta, Georgia office (1978-1980).
Responsible for the supervision of industrial waste
project managers and project engineers and the manage-
ment of industrial waste studies conducted in the
office. Also directly involved in project management
consulting with clients on environmental studies and
environment assessment projects, e.g., project manager
for several spill control and wastewater treatability
projects and for a third-party EIS for a new phosphate
mine in Florida.

Engineering-Science, Inc., Manager of Solid and
Hazardous Waste Group in the Atlanta, Georgia office
(1980-date). Responsible for the supervision of solid
and hazardous waste project managers and project
engineers and the management of solid and hazardous
waste projects in the office. Project activities have
included permit and regulatory assistance, environ-
mental audits, waste management program development,
delisting partitions, ground-water monitoring, landfill
evaluations, landfill closure design, hazardous waste
management, waste inventory, waste recovery/recycle
evaluation, waste disposal alternative evaluation,
transportation evaluation, and spill control and
countermeasure planning, HRS evaluations, preparation
of remedial investigations and feasibility studies, and
design and construction supervision for hazardous waste
site cleanup.

Project Manager for fourteen Phase I Installation
Restoration Program projects for the U.S. Air Force.
The objective of this program is to audit past hazard-
ous waste disposal practices that could result in
migration of contaminants and recommend priority sites
requiring further investigation. Also conducted
environmental audits (air, water and solid waste) at
ten industrial facilities. Project manager for a
contamination assessment and hazardous waste site
cleanup conducted for an industrial client as part of a
consent decree agreement. Project manager for site
investigation and contamination assessment projects at
multiple hazardous waste sites in the northeast. Pro-
ject manager for preparation of two Remedial Investi-
gation/Feasibility Studies.

Biographical Data

Jennifer Gredell Menard
Environmental Engineer

PII Redacted



Education

B.A. in Biochemistry, 1981, Rice University, Houston, Texas
M.S.C.E. in Civil Engineering, 1982, University of Colorado,
Boulder, Colorado

Professional Affiliations

American Society of Civil Engineers

Experience Record

1980-1981	Research Assistant, Rice University, Houston, Texas. Participated in a senior honors research program investigating microbial DNA control mechanisms.
1980-1981	Undergraduate Research Assistant, University of Texas Health Science Center, Houston, Texas. Designed and conducted an independent research project to develop a strain of yeast for protein extraction.
1981-1982	Research Assistant, University of Colorado, Boulder, Colorado. Investigated performance of a rapid infiltration sewage land treatment system. Responsibilities included analysis of influent and effluent water samples for 5-day biological oxygen demand, total organic carbon, total and fecal coliform bacteria, and pH.
1983-1984	Environmental Quality Specialist, Texas Department of Water Resources. Responsible for monitoring and reporting industries' compliance with Federal (RCRA) and State hazardous waste regulations, investigation of requests for assistance from the public and other agencies, emergency response, and preliminary hazardous waste permit application review.
1985-Date	Environmental Engineer, Engineering-Science, Inc. Involved in studies concerning the fate and effect of pollutants from acid mine drainage discharges.

Jennifer Gredell Menard (Continued, Page 2)

Publications

Gredell, Jennifer A. 1981. Rapid Infiltration Treatment of Selected Pollutants. M.S. Thesis, University of Colorado, Boulder, Colorado.

Biographical Data

JOHN R. ABSALON
Hydrogeologist

PII Redacted

Education

B.S. in Geology, 1973, Upsala College, East Orange, New Jersey

Professional Affiliations

Certified Professional Geologist (Indiana No. 46) (Virginia No. 241)
Association of Engineering Geologists
Geological Society of America
National Water Well Association

Experience Record

- 1973-1974 Soil Testing Incorporated-Drilling Contractors, Seymour, Connecticut. Geologist. Responsible for the planning and supervision of subsurface investigations supporting geotechnical, ground-water contamination, and mineral exploitation studies in the New England area. Also managed the office staff, drillers, and the maintenance shop.
- 1974-1975 William F. Loftus and Associates, Englewood Cliffs, New Jersey. Engineering Geologist. Responsible for planning and management of geotechnical investigations in the northeastern U.S. and Illinois. Other duties included formal report preparation.
- 1975-1978 U.S. Army Environmental Hygiene Agency, Fort McPherson, Georgia. Geologist. Responsible for performance of solid waste disposal facility siting studies, non-complying waste disposal site assessments, and ground-water monitoring programs at military installations in the southeastern U.S., Texas, and Oklahoma. Also responsible for operation and management of the soil mechanics laboratory.
- 1978-1980 Law Engineering Testing Company, Atlanta, Georgia. Engineering Geologist/Hydrogeologist. Responsible for the project supervision of waste management, water quality assessment, geotechnical, and hydrogeologic studies at commercial, industrial, and government facilities. General experience included planning and management of several ground-water monitoring programs,

John R. Absalon (Continued)

development of remedial action programs, and formulation of waste disposal facility liner system design recommendations. Performed detailed ground-water quality investigations at an Air Force installation in Georgia, a paper mill in southwestern Georgia, and industrial facilities in Tennessee.

1980-Date Engineering-Science. Hydrogeologist. Responsible for supervising efforts in waste management, solid waste disposal, ground-water contamination assessment, leachate generation, and geotechnical and hydrogeologic investigations for clients in the industrial and governmental sectors. Performed geologic investigations at twelve Air Force bases and other industrial sites to evaluate the potential for migration of hazardous materials from past waste disposal practices. Conducted RCRA ground-water monitoring studies for industrial clients and evaluated remedial action alternatives for a county landfill in Florida. Conducted quality management, hydrogeologic and ground-water quality programs for the pulp and paper industry at several mills located in the Southeast United States.

Publications and Presentations

Eleven presentations and/or papers in technical publications or conferences dealing with geology, ground water, and waste disposal/-ground water interaction.

Biographical Data

JOHN P. MCAULIFFE

Environmental Engineer

PII Redacted



Education

M.S. in Civil and Environmental Engineering, 1982, Clarkson College of Technology, Potsdam, NY
B.S. in Civil and Environmental Engineering, 1981, Clarkson College of Technology, Potsdam, NY (Graduated with Distinction)

Professional Affiliations

Engineer-in-training, New York State
Water Pollution Control Federation

Honorary Affiliations

Chi Epsilon
Tau Beta Pi

Experience Record

1981-1982	Clarkson College of Technology, Potsdam, New York. Research/Teaching Assistant. Conducted biological assays and chemical characterizations on Lake Erie Tributary sediments to evaluate changes in the availability of phosphorus due to exposure to anaerobic conditions. Responsibilities included compiling data and formulating conclusions for submittal to the U.S. Army Corps of Engineers and preparation of Masters Thesis. Teaching responsibilities included preparation of course materials and assisting with laboratory classes.
1982-1985	O'Brien & Gere Engineers, Inc., Syracuse, New York. Environmental Engineer. As a project engineer, performed environmental engineering on a variety of projects involving hazardous waste site investigations and remediation designs, groundwater contamination investigations and remediation designs, and industrial/municipal wastewater treatment studies. Specific projects included:

John P. McAuliffe (Continued)

engineering support for litigative defense in a CERCLA (Superfund) lawsuit at four Central Indiana industrial waste sites; design and implementation of preliminary remedial measures at two Superfund sites; remedial investigation/feasibility study at Central New York Superfund site; site remediation programs at seven New York State PCB disposal sites; coordination of an industrial wastewater characterization study; and design and permits for water treatment plant sludge disposal facility.

1985-Present Engineering-Science, Inc., Syracuse, NY. Environmental Engineer. Project Engineer responsible for various activities within the hazardous waste field. Primary responsibilities have included preliminary field investigations (Phase II) conducted for the New York State Department of Environmental Conservation at ten inactive hazardous waste disposal sites, and a remedial investigation and feasibility study conducted for the New York State Department of Environmental Conservation on a contaminated public water supply well.

APPENDIX B
LIST OF INTERVIEWEES AND
OUTSIDE AGENCY CONTACTS

TABLE B.1
LIST OF INTERVIEWEES
ELLSWORTH AFB

Position	Years of Service at this Installation
1. Civilian, Plumbing Shop Work Leader	17
2. Civilian, Sanitation Foreman	23
3. Civilian, Wastewater Plant Operator	17
4. Civilian, General and Civil Pavements Engineer	3
5. Civilian, Liquid Fuels Maintenance Supervisor	22
6. Civilian, Assistant Fire Chief	15
7. Civilian, Fire Chief	6
8. NCOIC, Base Fuels Management	2
9. Civilian, Crash Truck Crew Chief (Retired for 14 years)	19
10. Civilian, Deputy Chief of Operations	19
11. Civilian, Equipment Operator	27
12. Civilian, Refuse Collection/Erosion Control Foreman (Retired for 9 years)	27
13. Civilian, Instrumentation and Control Foreman	35
14. Civilian, Museum Curator (Retired)	9
15. Civilian, CE Customer Service Chief	30
16. Civilian, Equipment Shop Mechanic	23
17. NCOIC, EOD Superintendent	7
18. NCOIC, 28th Bombardment Wing Historian	3
19. Officer, Environmental Engineer	1
20. Officer, Bioenvironmental Engineer, Former OIC	3
21. Civilian, Realty Officer	20
22. Airman, Real Property Office	2
23. Civilian, Judge Advocate	2
24. Civilian, Engineering Branch Chief	7

TABLE B.1
(Continued)
LIST OF INTERVIEWEES
ELLSWORTH AFB

Position	Years of Service at this Installation
25. Civilian, Photo Shop Supervisor	11
26. Civilian, Graphics Shop Supervisor	12
27. NCOIC, Reprographics Shop Supervisor	3
28. NCOIC, Small Arms Training Manager	1
29. Civilian, Photo Hobby Shop Supervisor	3
30. Civilian, DPDO Manager	19
31. NCOIC, AGE Shop Supervisor	1
32. NCOIC, Corrosion Control Shop Supervisor	9
33. NCOIC, Non-Destructive Inspection Supervisor	6
34. NCOIC, Non-Powered AGE Supervisor	1
35. NCOIC, Pneudraulics Supervisor	3
36. NCOIC, Machine Shop Supervisor	10
37. NCOIC, Small Engine Repair Superivsor	3
38. NCOIC, PREL Shop Supervisor	2
39. NCO, Facilities Maintenance Shop Worker	1
40. NCOIC, Medical X-ray Supervisor	4
41. NCOIC, Dental Clinic Supervisor	3
42. NCOIC, Weapons Release Supervisor	1 1/2
43. NCOIC, Equipment Maintenance Supervisor	1
44. NCOIC, Re-Entry Vehicle Maintenance Supervisor	1
45. NCO, Conventional Maintenance Shop Worker	1
46. NCOIC, PME Lab Chief	2
47. NCOIC, Fire Control Supervisor	12
48. NCOIC, Bomb-Nav/Photo Shop Chief	14
49. NCO, Fuels Lab Assistant	1
50. NCOIC, Fuels Lab Chief	1
51. NCOIC, Fuels Distribution Shop Chief	1
52. NCOIC, Helicopter Maintenance Supervisor	5
53. NCO, Entomology Shop Worker	2

TABLE B.1
(Continued)
LIST OF INTERVIEWEES
ELLSWORTH AFB

Position	Years of Service at this Installation
54. Civilian, Pavement Grounds and Chief	19
55. Airman, Bioenvironmental Engineering Staff	3
56. Airman, Bioenvironmental Engineering Staff	1
57. NCOIC, Life Support Supervisor	8
58. NCOIC, OMS Wash Rack Supervisor	3
59. OIC, Bioenvironmental Engineering	1
60. NCOIC, Bioenvironmental Engineering	1

TABLE B.2
OUTSIDE AGENCY CONTACTS

Kimball E. Goddard, Hydrologist
US Geological Survey, Water Resources Division
Federal Building, Room 250
515 Ninth Street
Rapid City, SD 57701
605/342-6812

Rodger A. Kruger, Assistant Water Superintendent
Rapid City Water Department
22 Main Street
Rapid City, SD 57701
605/394-4162

Richard Bretts, Geologist
South Dakota Geological Survey
36 East Chicago
Rapid City, SD 57701
605/394-2229

Gary Stephenson, Regional Administrator
Gene Nelson, Environmental Analyst
Black Hills Regional Office
South Dakota Department of Water and Natural Resources
36 East Chicago
Rapid City, SD 57701
605/394-2385

William Hager, Engineer
Office of Air Quality and Solid Waste
South Dakota Department of Water and Natural Resources
Joe Foss Building
Pierre, SD 575-1
605/773-3153

John Wagner, Technical Supervisor
Water Quality Division
Wyoming Department of Environmental
Herschler Building
Cheyenne, WY 82002
307/777-7354

Hugh W. Lowham, Chief, Hydrologic Investigations Section
US Geological Survey Water Resources Division
Federal Building
2120 Capitol Avenue
Cheyenne, WY 82003
307/772-2722

Robert Burn, Chief, Permits Section
Barbara Hanson, Environmental Protection Specialist
US Environmental Protection Agency, Region 8 (8WMC)
1860 Lincoln Street
Denver, CO 80295
303/293-1587

John Giedt, Chief
Radiation Control Branch
US Environmental Protection Agency, Region 8 (8 HWM-RP)
1860 Lincoln Street
Denver, CO 80295
303/293-1515

John M. Boline, Technician
US Department of Agriculture, Soil Conservation Service
Federal Building
515 Ninth Street, Room 226
Rapid City, SD 57701
605/343-1643

Gary Sanborn, Liaison Officer
US Nuclear Regulatory Commission
611 Ryan Plaza Drive, Suite 1000
Arlington, TX 76011
817/860-8267

Allen Richardson, Chief
Guides and Criteria Branch
Office of Radiation Programs
US Environmental Protection Agency (ANR-460C)
Washington, DC 20460
703/557-8224

APPENDIX C
TENANT MISSIONS - ELLSWORTH AFB

APPENDIX C
TENANT MISSIONS - ELLSWORTH AFB

ARMY AND AIR FORCE EXCHANGE SERVICE (AAFES)

The AAFES mission is to provide services for authorized patrons.

AIR FORCE AUDIT AGENCY, AREA AUDIT OFFICE (AFAA)

The AFAA mission is to assist Air Force managers in accomplishing their missions in the most economical and effective manner possible.

AIR FORCE INSTITUTE OF TECHNOLOGY (AFIT)

The AFIT mission is to provide graduate education through the University of South Dakota to the missile combat crew members of the 44th SMW.

AMERICAN RED CROSS

The mission of the American Red Cross is to verify emergency situations in the serviceman's home community pertaining to the need for the serviceman to be granted emergency leave, to provide welfare and recreational services for military personnel and their dependents, and to provide financial assistance to serviceman and their dependents when they qualify under Red Cross policy.

DEFENSE INVESTIGATIVE SERVICE (DIS)

The mission of DIS is to provide the Department of Defense with a single personnel security investigative service. DIS will conduct task force operations, crime prevention surveys, special investigations under the direction of the Secretary of Defense, etc.

DEFENSE PROPERTY DISPOSAL OFFICE (DPDO)

The DPDO mission is to reutilize, transfer, donate, and dispose of excess, surplus, and scrap property generated by the Department of Defense.

DETACHMENT 15, 3904TH MANAGEMENT ENGINEERING SQUADRON

The Management Engineering Squadron mission is to provide management advisory and manpower services to SAC Units.

AIR FORCE COMMISSARY SERVICE (AFCOMS)

The AFCOMS mission is to provide food service to all personnel on-base.

DETACHMENT 17, 9TH WEATHER SQUADRON

The mission of the 9th Weather Squadron, Detachment 17 is to provide meteorological support as required by the base and off-base military units. Also, provide forecasting and observing services in support of the Air Weather Service Global Weather concept and the unique missions of the various organizations assigned to the base.

DETACHMENT 1302, 13TH DISTRICT AIR FORCE OFFICE OF SPECIAL INVESTIGATIONS, (OSI)

The OSI mission involves investigative activity IAW AFR 23-18 in support of Air Force activities, to include: (a) criminal, counter-terrorism, internal security, and special investigative services investigations; (b) personal protective services and operations; (c) collection and reporting of information pertinent to base security and resource protection; and (d) counterintelligence services and support.

DETACHMENT 2, 37TH AEROSPACE RESCUE AND RECOVERY SQUADRON, (ARRS)

The primary mission of the ARRS is to provide support for the 44th Strategic Missile Wing. This support varies from routine daily missile crew changes to providing security surveillance for movement of Class A resources, emergency parts delivery, distinguished visitor transportation, and emergency disaster response operations.

409TH FIELD TRAINING DETACHMENT (ATC)

The 409th Field Training Detachment mission is to provide job-orientated System, associates and aircrew familiarization training on B-52, EC/KC-135, weapon systems, and associated aerospace ground equipment to the 28th Bombardment Wing, other SAC bases and major command

bases possessing similar equipment. In addition, the Field Training Detachment is responsible for providing OJT Advisory Assistance to all agencies at Ellsworth AFB and a five state area around South Dakota.

2148TH INFORMATION SYSTEMS SQUADRON

The Communications Squadron mission is to provide air traffic control, post attack command and control systems, and communication electronic services at Ellsworth AFB.

64TH FLYING TRAINING WING

The Flying Training Wing provides continuing training for pilots and co-pilots stationed at Ellsworth AFB.

NCO LEADERSHIP SCHOOL

The Leadership School mission is to provide non-commissioned officers further training in areas of personnel management.

USAF TRIAL JUDICIARY

The Trial Judiciary provides defense counsel to eligible personnel.

APPENDIX D
SUPPLEMENTAL BASE FINDINGS INFORMATION

TABLE D.1
PESTICIDE INVENTORY - 1985
ELLSWORTH AFB

Trade Name	Concentration (%)
Dunsbar M	40.8
Ficam W	76.0
Malathion	91.0
Cyanogas	42.0
Fumi-toxin	55.0
Warfain	0.0025
Dd-Tox 4B	48.2
Chema-gro	15.0 gran.
D-Tox 4E	48.2
Diazinon Dust	2-3
Sevin	80.0

SOURCE: Base Documents

TABLE D.2
FUEL STORAGE TANKS - ELLSWORTH AFB

Facility No.	Facility Description	Product	Capacity (gallons)	Description
1706	Tank 13A	JP-4 (Jet Fuel)	840,000	Underground
1710	Tank 13B	JP-4 (Jet Fuel)	840,000	Underground
1708	Tank 14	JP-4 (Jet Fuel)	420,000	Aboveground, diked
6900	FPTA	Burn Fuels	20,000	Aboveground
		Burn Fuels	1,000	Underground
8216	Tank 15	JP-4 (Jet Fuel)	1,470,000	Aboveground, diked
8212	Tank 16	JP-4 (Jet Fuel)	2,310,000	Aboveground, diked
88471	Reserve Tank	JP-5	260,000	Aboveground, diked
1709	Tanks 4-5	De-Icing Fluid	2 each 20,000	Aboveground, diked
	Tanks	Tar	2 each 20,000	Aboveground, diked
	Tanks 1-3	MOGAS, Regular	3 each 20,000	Aboveground, diked
	Tanks 6-8	Fuel Oil	2 each 20,000	Aboveground, diked
7315	Pump House 1	JP-4 (Jet Fuel)	6 each 25,000	Underground
7311	Pump House 2	JP-4 (Jet Fuel)	6 each 25,000	Underground
7309	Pump House 3	JP-4 (Jet Fuel)	6 each 25,000	Underground
7305	Pump House 4	JP-4 (Jet Fuel)	6 each 25,000	Underground
7303	Pump House 5	JP-4 (Jet Fuel)	6 each 25,000	Underground
7265	Pump House 6	JP-4 (Jet Fuel)	6 each 25,000	Underground
7245	Pump House 7	JP-4 (Jet Fuel)	6 each 25,000	Underground
102	Vehicle Maint.	MOGAS	1 each 12,000	Underground
		Unleaded MOGAS	1 each 5,000	Underground
		Diesel	1 each 2,000	Underground
906	AGE Parking	MOGAS	1 each 1,500	Underground
		MOGAS	1 each 2,500	Underground
		JP-4 (Jet Fuel)	1 each 2,000	Underground
4704	BX Station	MOGAS	4 each 10,000	Underground
88412	Inactive	MOGAS	1 each 8,000	Underground
7146	Run-up Shop	Unleaded MOGAS	1 each 4,000	Underground
2801	Former BX Station (Tanks Used by OMS)	JP-4 (Tested, for AGE use)	2 each 2,500	Underground
		JP-4 (Tested, for Recycle)	2 each 2,500	Underground

SOURCE: Ellsworth AFB, SPCC Plan, January, 1985

TABLE D.3

FACILITIES SERVED BY SEPTIC TANKS - ELLSWORTH AFB

Facility No.	Facility Description
5202	Visitor Center
7432	Bomber Alert Area Recreation Facility
6908	Inactive Warehouse and Office Space
6922	Navigational Aide Facility - Receiver Building
6925	Old Munition Storage - Office Building
7911	Radio Equipment Shelter
9014	Dog Kennels and Training Area
88554	Inactive Vehicle Heated Parking
7140	Security Police Facilities
No Number	Old Aero Club Facility

SOURCE: Installation Drawings

TABLE D.5
FACILITIES SERVED BY OIL/WATER SEPARATORS - ELLSWORTH AFB

Facility No.	Facility Description	Area Served
7622	Fuel Cell Repair	Inside Dock 21
7616	Refueling Maintenance	East Half Dock 42
3015	Industrial Waste Treatment Bldg.	Industrial Sewer System
102	Service Station (Vehicle Maint. Portion)	Inside of Station
7235	Supply Dry Storage	Inside Storage Area
2801	Service Station	Inside Maintenance Stalls
7237	Missile Wing Vehicle Washing	Inside Entire Facility
8117	Vehicle Maintenance	Inside Station & Wash Rack
7239	Corrosion Control Dock	Inside Dock 83
7506	Fire Station	Inside of Station
88149	Integrated Maintenance Facility	
605	Heavy Equipment Maintenance	
7499	Discharge 001	Corresponding Discharge Area
7440	Discharge 002	Corresponding Discharge Area
7118	Discharge 003	Corresponding Discharge Area

SOURCE: Ellsworth AFB, SPCC Plan, January, 1985.

NPDES

	Dec '82	Jan '83	Feb '83	Mar '83	Apr '83	May '83	June '83	July '83	August '83	Sept '83
Site:										
11 D+G	.6	<.1	.7	<.3	.5	.5	<.3	<.3	.5	.5
surf	.2	.1	.3	.2	<.1	<.1	<.1	<.1	.1	.1
21 D+G	<.3	<.1	1.3	2.1	3.4	1.3	<.3	.4	.5	<.3
surf.	.2	.1	.9	.4	.3	<.1	<.1	<.1	.1	<.1
31 D+G	NO	NO	NO	NO	<.3	<.3	NO	.4	.4	NO
surf.	Flow	Flow	Flow	Flow	.1	<.1	Flow	<.1	<.1	Flow
41 D+G	2.2	5.6	2.8	6.6	29.6	8.8	2.8	1.6	5.5	1.8
chrom./chrom.	<.50	<.50	<.50	<.50	<.50	<.50	<.50	<.50	<.50	<.50
NO ₃ Fecals	25	17.4	16	300	341	250	303	78	20	252
51 D+G	5.8	7.2	23.2	2.5	41.6	2.1	1.8	.4	1.5	.3
surf.	2.1	.3	3.7	.3	2.2	.1	.2	<.1	.1	<.1
61 D+G	12.6	13.4	35.2	5.4	36.0	.5	4.4	1.2	.4	1.5
surf.	1.8	.3	3.0	.5	3.0	<.1	.3	.1	<.1	.2
71 D+G	5.9	3.9	<.3	.5	<.3	.7	.5	.4	<.3	6.9
surf	1.9	.3	.6	<.1	<.1	<.1	<.1	<.1	<.1	.2
81 D+G	<.3	<.3	26.4	2.9	24.8	1.3	1.7	1.5	1.2	.3
surf	<.1	<.1	4.4	.2	2.3	.1	.2	.1	.1	<.1
91										
101										
111										
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471										
481										
491										
501										

GENERAL PURPOSE (105' X 8")

3134

APPENDIX E
MASTER LIST OF INDUSTRIAL SHOPS

APPENDIX E
MASTER LIST OF INDUSTRIAL SHOPS

Name	Present Location (Bldg. No.)	Handles Hazardous Materials	Generates Hazardous Wastes	Waste Management Practices
44th Combat Support Group				
Photo/Graphics	7506	Yes	Yes	Silver Recovery and Sanitary Sewer
Photo Hobby Shop	4610	Yes	Yes	Silver Recovery, and Sanitary Sewer (thru photo shop)
Auto Hobby Shop	4610	Yes	Yes	Stored In Underground Tank, Removed Off-Base By Contract
Ceramics & Lapidary	4610	Yes	No	---
Wood Hobby Shop	4610	No	No	---
Reprographics	7810	Yes	No	---
Small Arms Training	9017	Yes	No	---

APPENDIX E
MASTER LIST OF INDUSTRIAL SHOPS
(Continued)

Name	Present Location (Bldg. No.)	Handles Hazardous Materials	Generates Hazardous Wastes	Waste Management Practices
28th Organizational Maintenance Squadron				
Wheel and Tire	410	Yes	Yes	DPDO, OWS to Industrial Sewer
Repair and Reclamation	7624	Yes	No	---
Bomber Phase Docks	7230/7222	Yes	No	---
Tanker Phase Dock	7248	Yes	No	---
Support Branch	7262	Yes	No	---
Wash Rack	7621	Yes	Yes	OWS to Industrial Sewer
44th Transportation Squadron				
Packing and Crating	7510	Yes	No	---
Refueling Maintenance	7616	Yes	Yes	Drummed for Removal Off-Base by Contract
Heavy Vehicle Maintenance	605	Yes	Yes	DPDO
General Purpose Vehicle Maintenance	102	Yes	Yes	Drummed for Removal Off-Base by Contract, DPDO, OWS to Industrial Sewer

APPENDIX E
MASTER LIST OF INDUSTRIAL SHOPS
(Continued)

Name	Present Location (Bldg. No.)	Handles Hazardous Materials	Generates Hazardous Wastes	Waste Management Practices
44th Supply Squadron				
Fuels Lab	7616	Yes	Yes	Recovered, FPTA
Fuels Distribution	7616	Yes	No	
28th Bombardment Wing				
Life Support	605	Yes	No	---
28th Avionics Maintenance Squadron				
Precision Measurement Equipment Lab	106	Yes	Yes	Removed Off-Base by Contract
Fire Control	7503	Yes	Yes	DPDO
Air Flight Control Instrument Shop	7503	Yes	No	---
Bomb-Nav/Photo	7503	Yes	No	---
Doppler/Radio	7503	Yes	No	---
Electronic Counter- Measures Branch	7503	Yes	No	---
Nav-Aids	7503	Yes	No	---
PACCS Branch	7503	Yes	No	---

APPENDIX E
MASTER LIST OF INDUSTRIAL SHOPS
(Continued)

Name	Present Location (Bldg. No.)	Handles Hazardous Materials	Generates Hazardous Wastes	Waste Management Practices
28th Munitions Maintenance Squadron				
Weapons Release	Dock 83 7239	Yes	Yes	Industrial Sewer
Equipment Maintenance	Dock 82 7240	Yes	Yes	DPDO
Weapons Plant 2	88240	Yes	No	---
Reentry Vehicle Maintenance	88031	Yes	No	---
Conventional Maintenance	88144	Yes	No	---
Explosive Ordnance Disposal	88307	Yes	No	---
USAF Hospital				
Physiological Training Unit	6000	Yes	No	---
Central Sterile Supply	6000	Yes	No	---
Laboratory	6000	Yes	No	---
Medical X-Ray	6000	Yes	Yes	Silver Recovery to Sanitary Sewer
Dental Clinic	6000	Yes	Yes	Silver Recovery to Sanitary Sewer
Surgery	6000	Yes	No	---
Pharmacy	6000	Yes	No	---

APPENDIX E
MASTER LIST OF INDUSTRIAL SHOPS
(Continued)

Name	Present Location (Bldg. No.)	Handles Hazardous Materials	Generates Hazardous Wastes	Waste Management Practices
44th Field Missile Maintenance Squadron				
Facilities Maintenance	7504	Yes	Yes	DPDO
Power, Refridgeration, Electric	7504	Yes	Yes	DPDO
Mechanical	7504	No	No	---
Corrosion Control	7504	Yes	No	---
Pneudraulics	7504	Yes	Yes	DPDO
Electronics Lab	7504	No	No	---
28th Field Maintenance Squadron				
Survival Equipment	909	Yes	No	---
Electric Shop	410	Yes	Yes	Neutralized to Sanitary Sewer
Aerospace Ground Equipment Repair	410	Yes	Yes	DPDO
Environmental Systems	410	Yes	No	---
Corrosion Control	Dock 83 7239	Yes	Yes	DPDO

APPENDIX E
MASTER LIST OF INDUSTRIAL SHOPS
(Continued)

Name	Present Location (Bldg. No.)	Handles Hazardous Materials	Generates Hazardous Wastes	Waste Management Practices
28th Field Maintenance Squadron (Continued)				
Fuel System Repair	Dock 21 7622	Yes	No	---
Non-Destructive Inspection	905	Yes	Yes	DPDO, Silver Recovery, Sanitary Sewer
Non-Powered AGE	Dock 62 7260	Yes	Yes	DPDO
Pneudraulics	410	Yes	Yes	DPDO
Machine Shop	410	Yes	Yes	Industrial Sewer
Test Cell	7140	Yes	No	---
Jet Engine Repair	601	Yes	Yes	DPDO
Small Engine Repair	601	Yes	Yes	DPDO
Welding	410	Yes	No	---
Structural Repair	410	Yes	No	---
2148 Information Systems Squadron				
Cable Maintenance Shop	4304	Yes	No	---
Radar Maintenance	6927	Yes	No	---
Nav-Aids Maintenance	6927	Yes	No	---

APPENDIX E
MASTER LIST OF INDUSTRIAL SHOPS
(Continued)

Name	Present Location (Bldg. No.)	Handles Hazardous Materials	Generates Hazardous Wastes	Waste Management Practices
2148 Information Systems Squadron (Continued)				
Hardened Ant. Maintenance	7235	Yes	No	---
ATC Radio Maintenance	7207	Yes	No	---
Weather Maintenance	7506	Yes	No	---
Intra Base Radio- Maintenance	7235	Yes	No	---
Missile Radio Maintenance	4304	Yes	No	---
AFSATCOM Maintenance	4304	Yes	No	---
SACCS Maintenance	4304	Yes	No	---
44th Organizational Missile Maintenance Squadron				
Missile Handling Teams	7107	No	No	---
Missile Mechanical	7504	No	No	---
Electro-Mechanical	7504	No	No	---
Detachment 2, 37th Aerospace Rescue & Recovery				
Helicopter Maintenance	7244/ Dock 80	Yes	Yes	DPDO

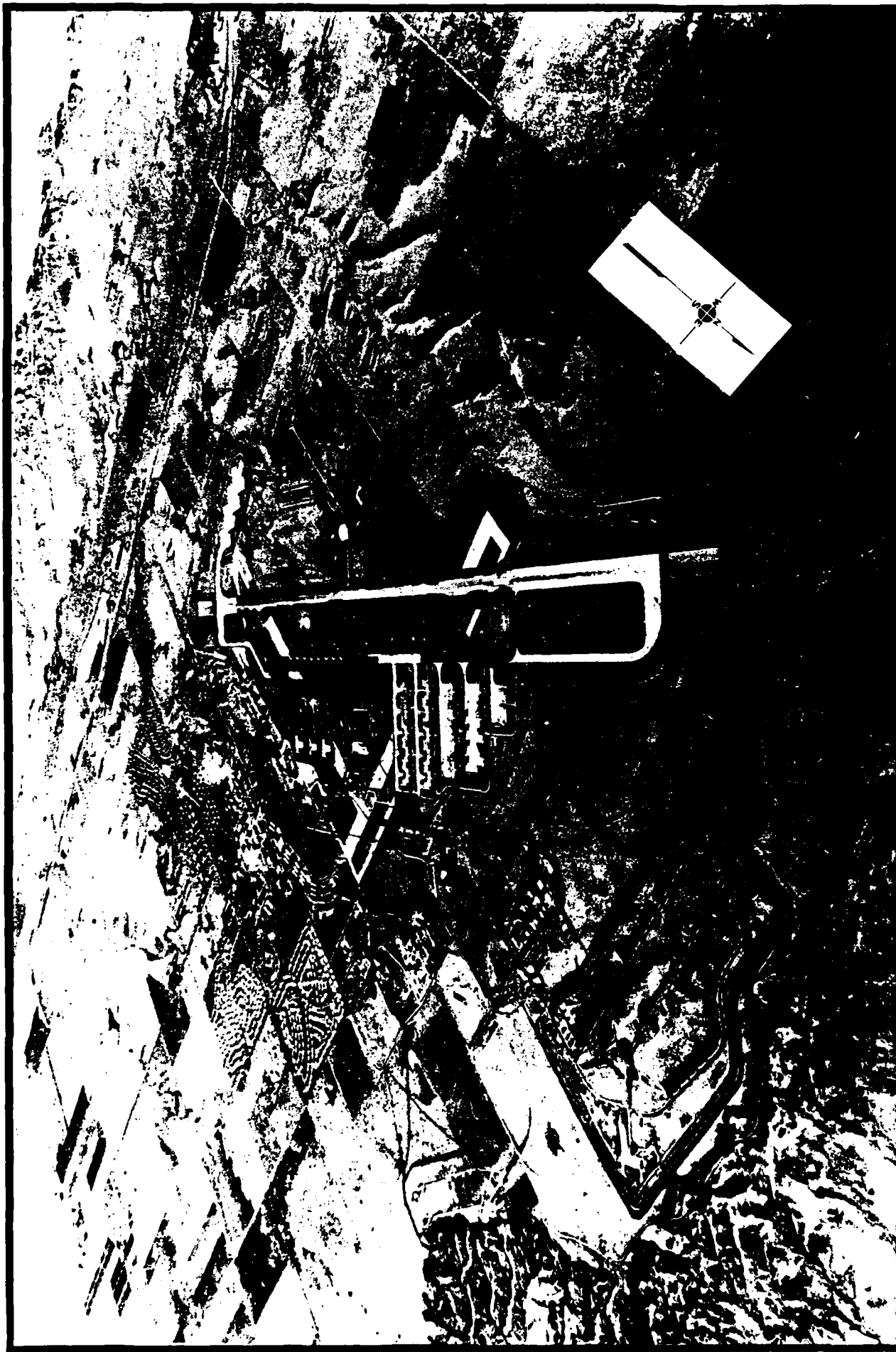
APPENDIX E
MASTER LIST OF INDUSTRIAL SHOPS
(Continued)

Name	Present Location (Bldg. No.)	Handles Hazardous Materials	Generates Hazardous Wastes	Waste Management Practices
44th Civil Engineering Squadron				
Plumbing Shop	8115	Yes	No	---
Carpentry Shop	8115	Yes	No	---
Entomology	8118	Yes	Yes	Disposed of Off-Base by Contract, Industrial Sewer
Sheet Metal/Welding	8115	Yes	No	---
Sewage Treatment Plant	3005	Yes	No	---
Liquid Fuels Maintenance	88408	Yes	Yes	DPDO, Disposed of Off-Base by Contract
Paint Shop	88408	Yes	Yes	DPDO
Power Production	8115	Yes	Yes	Neutralized to Sanitary Sewer, Sanitary Sewer
Grounds and Pavement	88411	Yes	No	---
Heating Plant Maintenance Shop	8115	Yes	No	---
Drafting Section	8201	No	No	---
Heating Operations	8115	No	No	---
Refrigeration	8115	Yes	Yes	DPDO
Interior Electric	8115	Yes	Yes	DPDO, Disposed of Off-Base by Contract

APPENDIX E
MASTER LIST OF INDUSTRIAL SHOPS
(Continued)

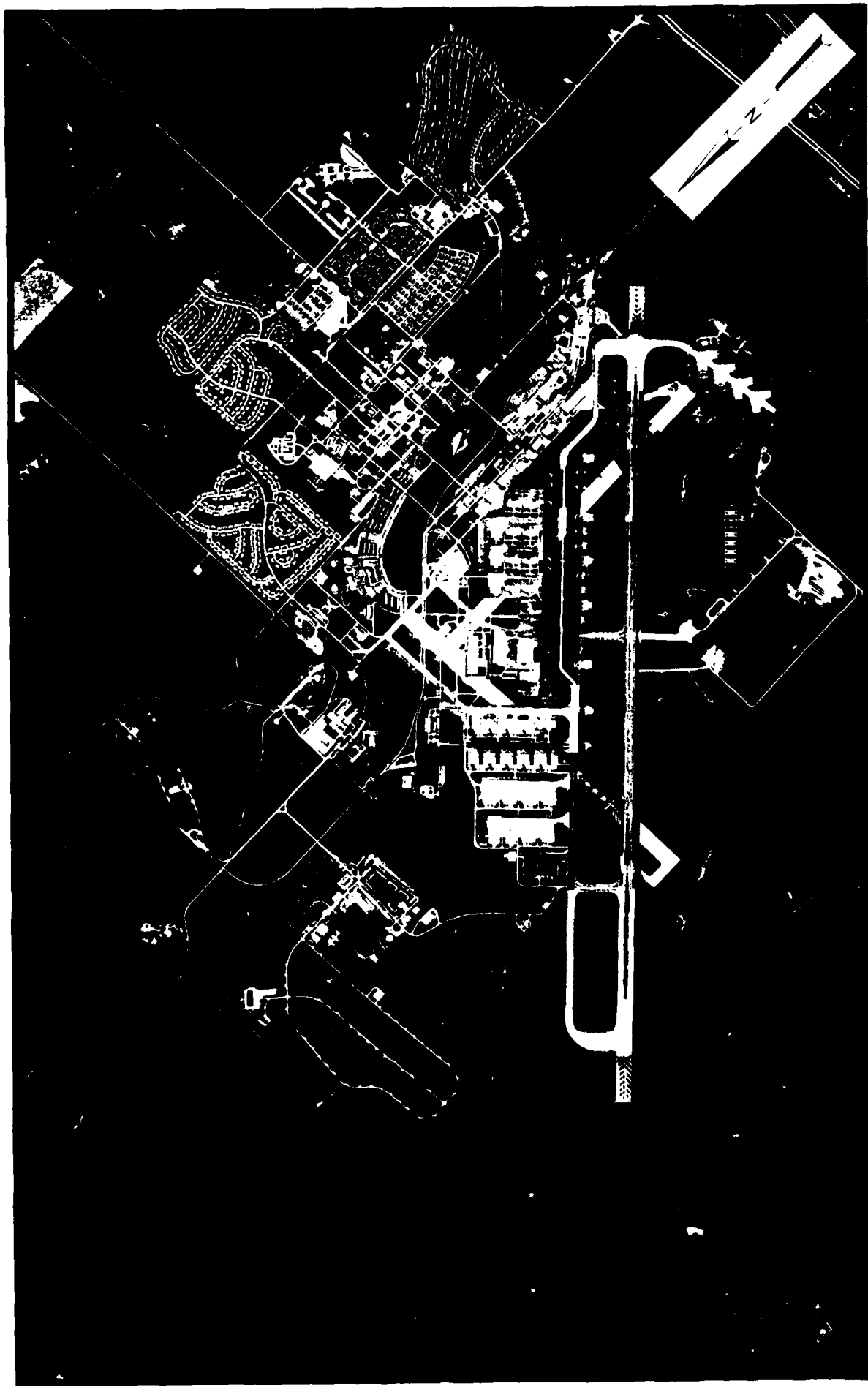
Name	Present Location (Bldg. No.)	Handles Hazardous Materials	Generates Hazardous Wastes	Waste Management Practices
Exterior Electric	8115	Yes	Yes	DPDO
Fire Station	7506	Yes	No	---

APPENDIX F
PHOTOGRAPHS



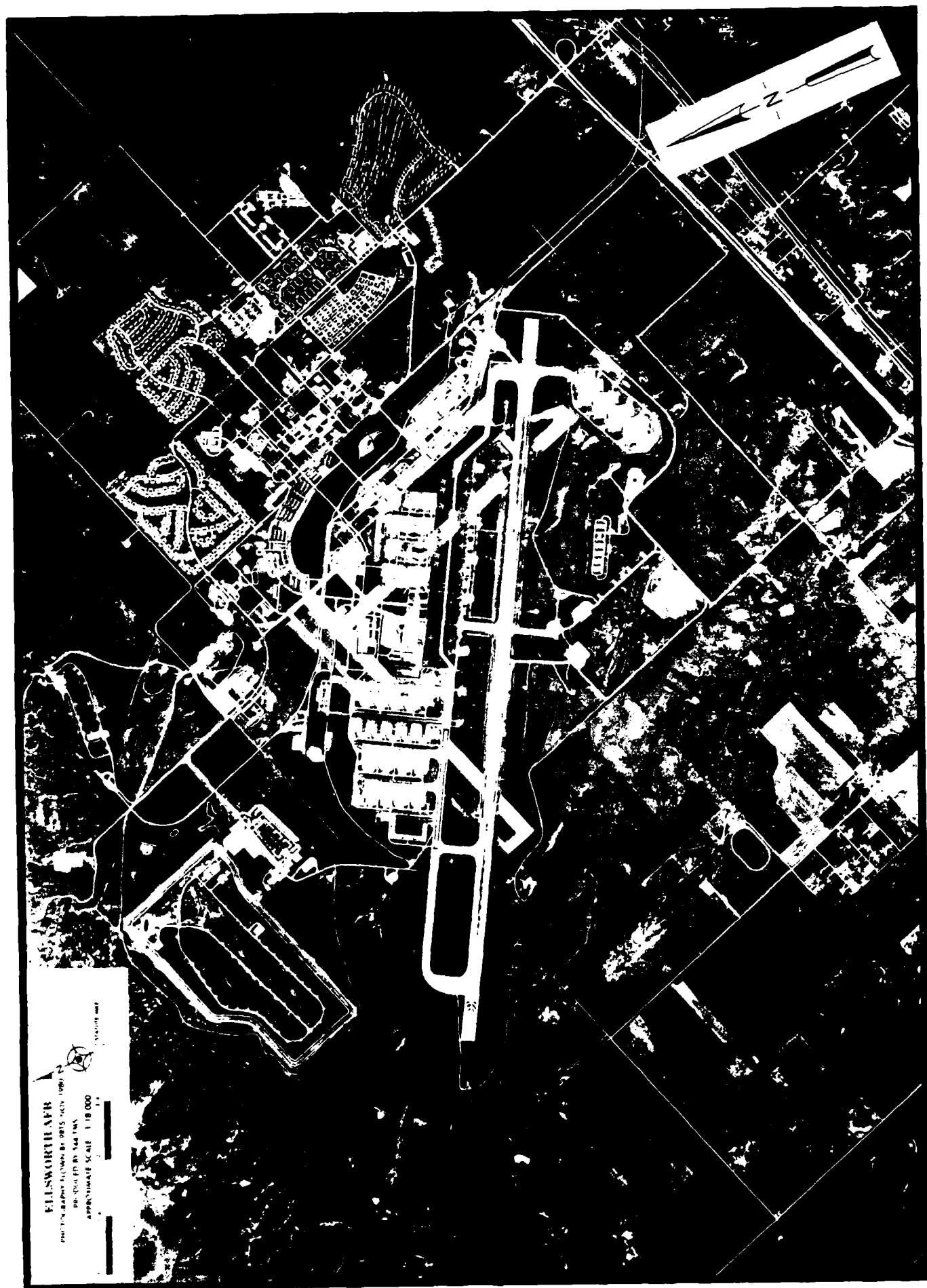
DECEMBER 1965

ELLSWORTH AFB



JUNE 1972

ELLSWORTH AFB



NOVEMBER 1980

ELLSWORTH AFB

ELLSWORTH AFB

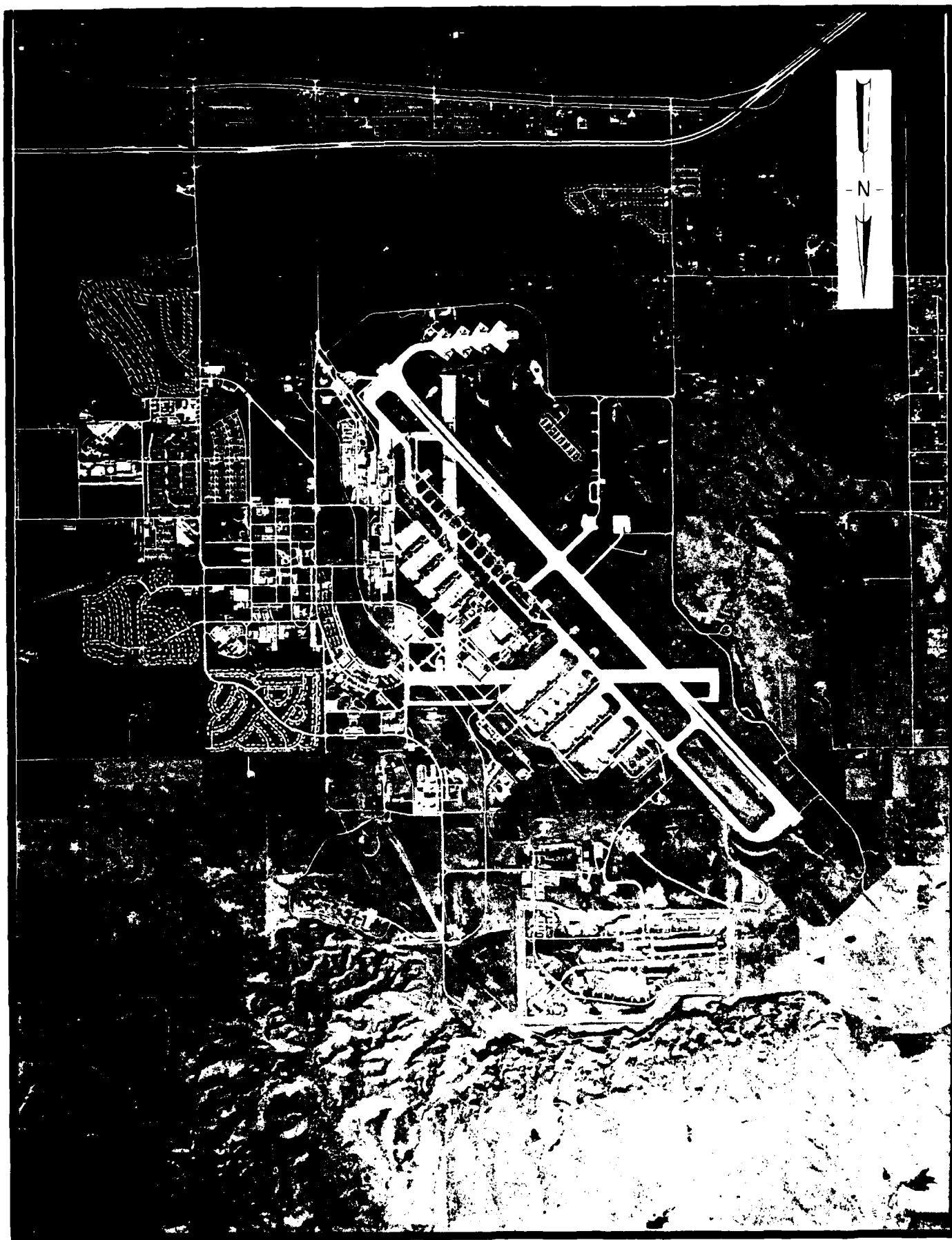
PHOTOGRAPHED BY 0075 ACN 1080

DEVELOPED BY 544 TMA

APPROXIMATE SCALE 1:18,000

1:18,000

1:18,000



OCTOBER 22, 1983

ELLSWORTH AFB

ELLSWORTH AFB



Fire Protection Training Area

ELLSWORTH AFB

LANDFILL NO.6



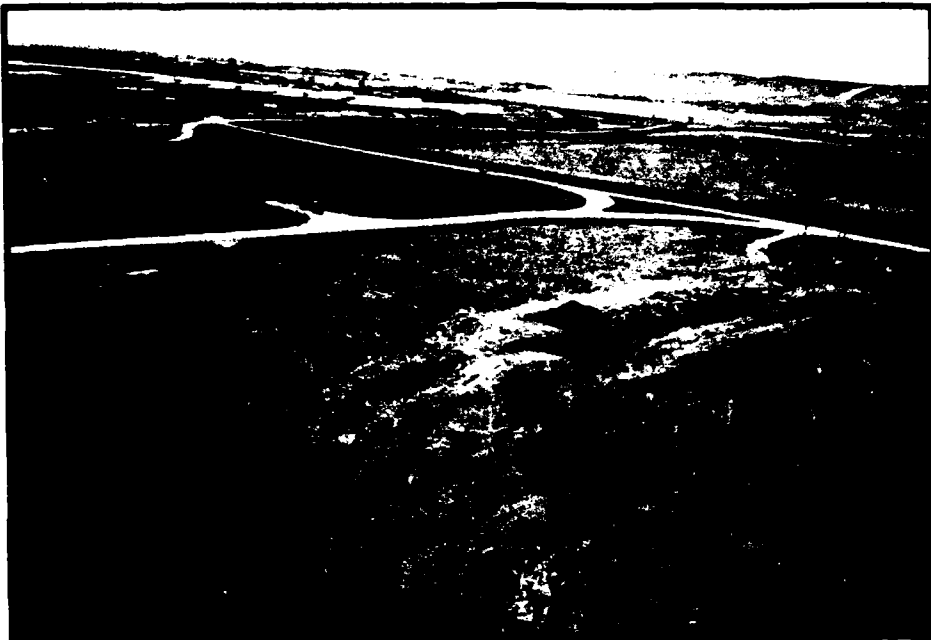
Landfill No. 1 (in foreground)
Landfill No. 6 (in background)

ELLSWORTH AFB



Landfill No. 2
(south of active hardfill)

ELLSWORTH AFB

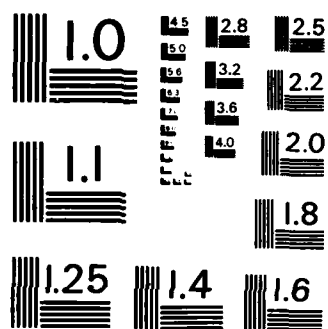


Landfill No. 3



Landfill No. 3

ML



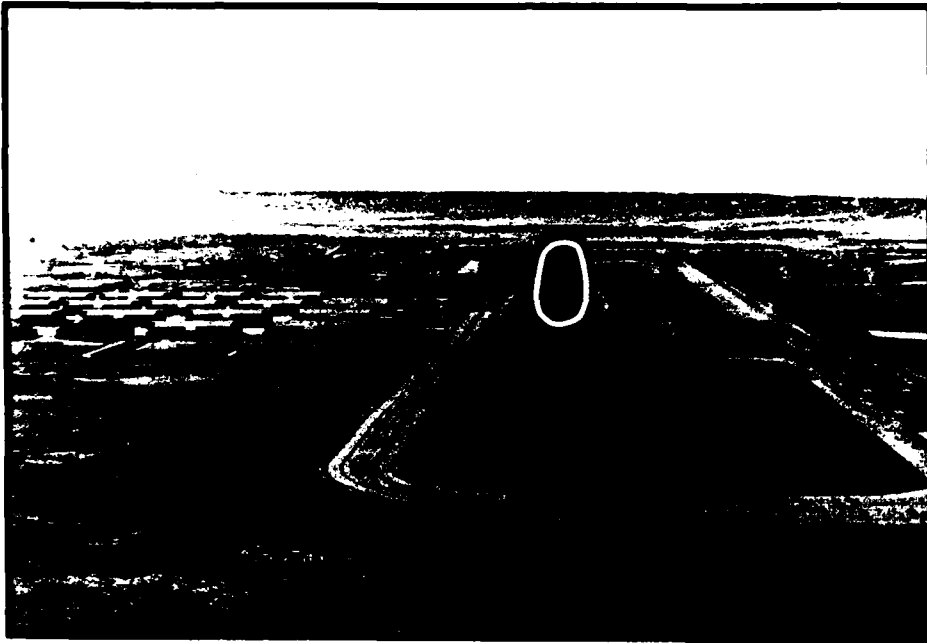
MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

ELLSWORTH AFB



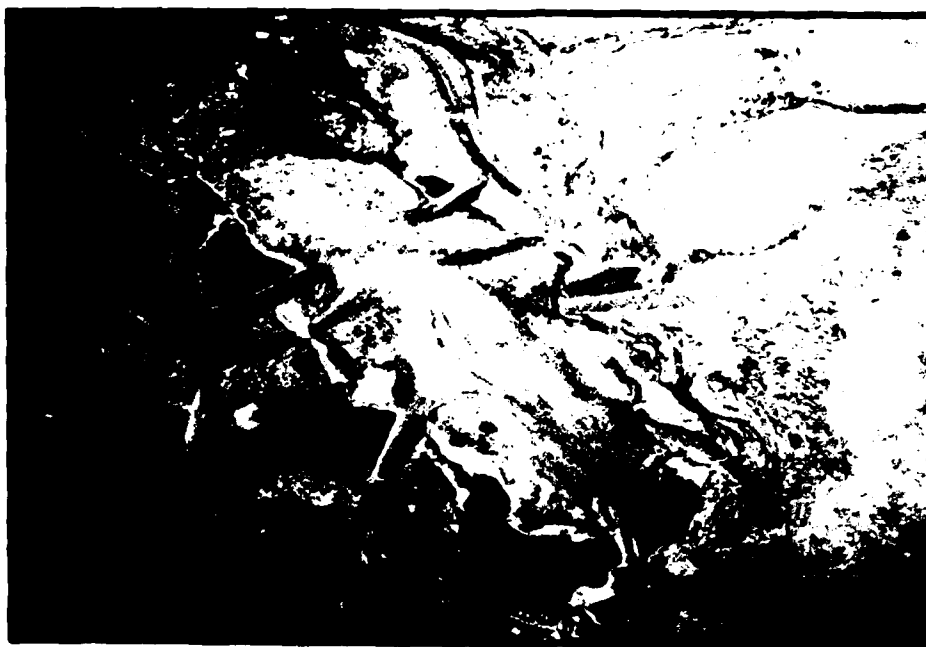
Landfill No. 4

ELLSWORTH AFB



Pumphouses 1-7 at Far End of Infield
(Spill Site Nos. 1, 3 and 7)

ELLSWORTH AFB



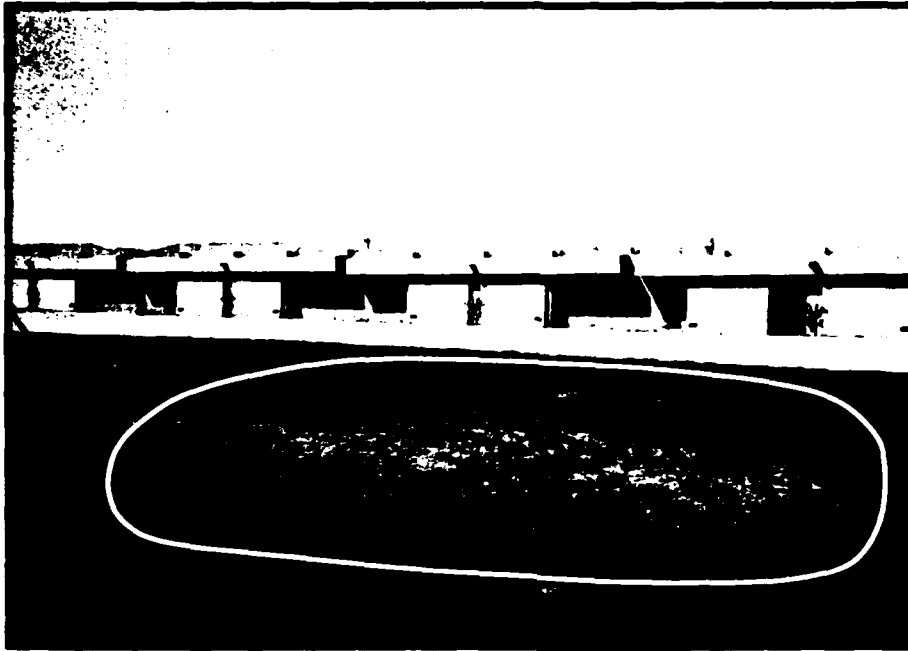
Spill Site No. 4
(EOD Pramitol Spill)

ELLSWORTH AFB

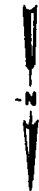


Launch Facility - Typical
(Spill Site Nos. 2,5 and 6)

ELLSWORTH AFB



Solid Material, Low-Level Rad Waste
Burial Site, Facility 88328



Tank, Low-Level Rad Waste Burial Site,
Facility 88286 (typical)

APPENDIX G

USAF INSTALLATION RESTORATION PROGRAM
HAZARD ASSESSMENT RATING METHODOLOGY

APPENDIX G

USAF INSTALLATION RESTORATION PROGRAM HAZARD ASSESSMENT RATING METHODOLOGY

BACKGROUND

The Department of Defense (DOD) has established a comprehensive program to identify, evaluate, and control problems associated with past disposal practices at DOD facilities. One of the actions required under this program is to:

"develop and maintain a priority listing of contaminated installations and facilities for remedial action based on potential hazard to public health, welfare, and environmental impacts." (Reference: DEQPPM 81-5, 11 December 1981).

Accordingly, the United States Air Force (USAF) has sought to establish a system to set priorities for taking further actions at sites based upon information gathered during the Records Search phase of its Installation Restoration Program (IRP).

The first site rating model was developed in June 1981 at a meeting with representatives from USAF Occupational and Environmental Health Laboratory (OEHL), Air Force Engineering and Services Center (AFESC), Engineering-Science (ES) and CH2M Hill. The basis for this model was a system developed for EPA by JRB Associates of McLean, Virginia. The JRB model was modified to meet Air Force needs.

After using this model for 6 months at over 20 Air Force installations, certain inadequacies became apparent. Therefore, on January 26 and 27, 1982, representatives of USAF OEHL, AFESC, various major commands, Engineering-Science, and CH2M Hill met to address the inadequacies. The result of the meeting was a new site rating model designed to present a better picture of the hazards posed by sites at Air Force installations. The new rating model described in this presentation is referred to as the Hazard Assessment Rating Methodology.

PURPOSE

The purpose of the site rating model is to provide a relative ranking of sites of suspected contamination from hazardous substances. This model will assist the Air Force in setting priorities for follow-on site investigations and confirmation work under Phase II of the IRP.

This rating system is used only after it has been determined that (1) potential for contamination exists (hazardous wastes present in sufficient quantity), and (2) potential for migration exists. A site can be deleted from consideration for rating on either basis.

DESCRIPTION OF MODEL

Like the other hazardous waste site ranking models, the U.S. Air Force's site rating model uses a scoring system to rank sites for priority attention. However, in developing this model, the designers incorporated some special features to meet specific DOD program needs.

The model uses data readily obtained during the Records Search portion (Phase I) of the IRP. Scoring judgments and computations are easily made. In assessing the hazards at a given site, the model develops a score based on the most likely routes of contamination and the worst hazards at the site. Sites are given low scores only if there are clearly no hazards at the site. This approach meshes well with the policy for evaluating and setting restrictions on excess DOD properties.

As with the previous model, this model considers four aspects of the hazard posed by a specific site: the possible receptors of the contamination, the waste and its characteristics, potential pathways for waste contaminant migration, and any efforts to contain the contaminants. Each of these categories contains a number of rating factors that are used in the overall hazard rating.

The receptors category rating is calculated by scoring each factor, multiplying by a factor weighting constant and adding the weighted scores to obtain a total category score.

The pathways category rating is based on evidence of contaminant migration or an evaluation of the highest potential (worst case) for contaminant migration along one of three pathways. If evidence of contaminant migration exists, the category is given a subscore of 80 to 100 points. For indirect evidence, 80 points are assigned and for direct evidence, 100 points are assigned. If no evidence is found, the highest score among three possible routes is used. These routes are surface water migration, flooding, and ground-water migration. Evaluation of each route involves factors associated with the particular migration route. The three pathways are evaluated and the highest score among all four of the potential scores is used.

The waste characteristics category is scored in three steps. First, a point rating is assigned based on an assessment of the waste quantity and the hazard (worst case) associated with the site. The level of confidence in the information is also factored into the assessment. Next, the score is multiplied by a waste persistence factor, which acts to reduce the score if the waste is not very persistent. Finally, the score is further modified by the physical state of the waste. Liquid wastes receive the maximum score, while scores for sludges and solids are reduced.

The scores for each of the three categories are then added together and normalized to a maximum possible score of 100. Then the waste management practice category is scored. Sites at which there is no containment are not reduced in score. Scores for sites with limited containment can be reduced by 5 percent. If a site is contained and well managed, its score can be reduced by 90 percent. The final site score is calculated by applying the waste management practices category factor to the sum of the scores for the other three categories.

HAZARD ASSESSMENT RATING METHODOLOGY FLOW CHART

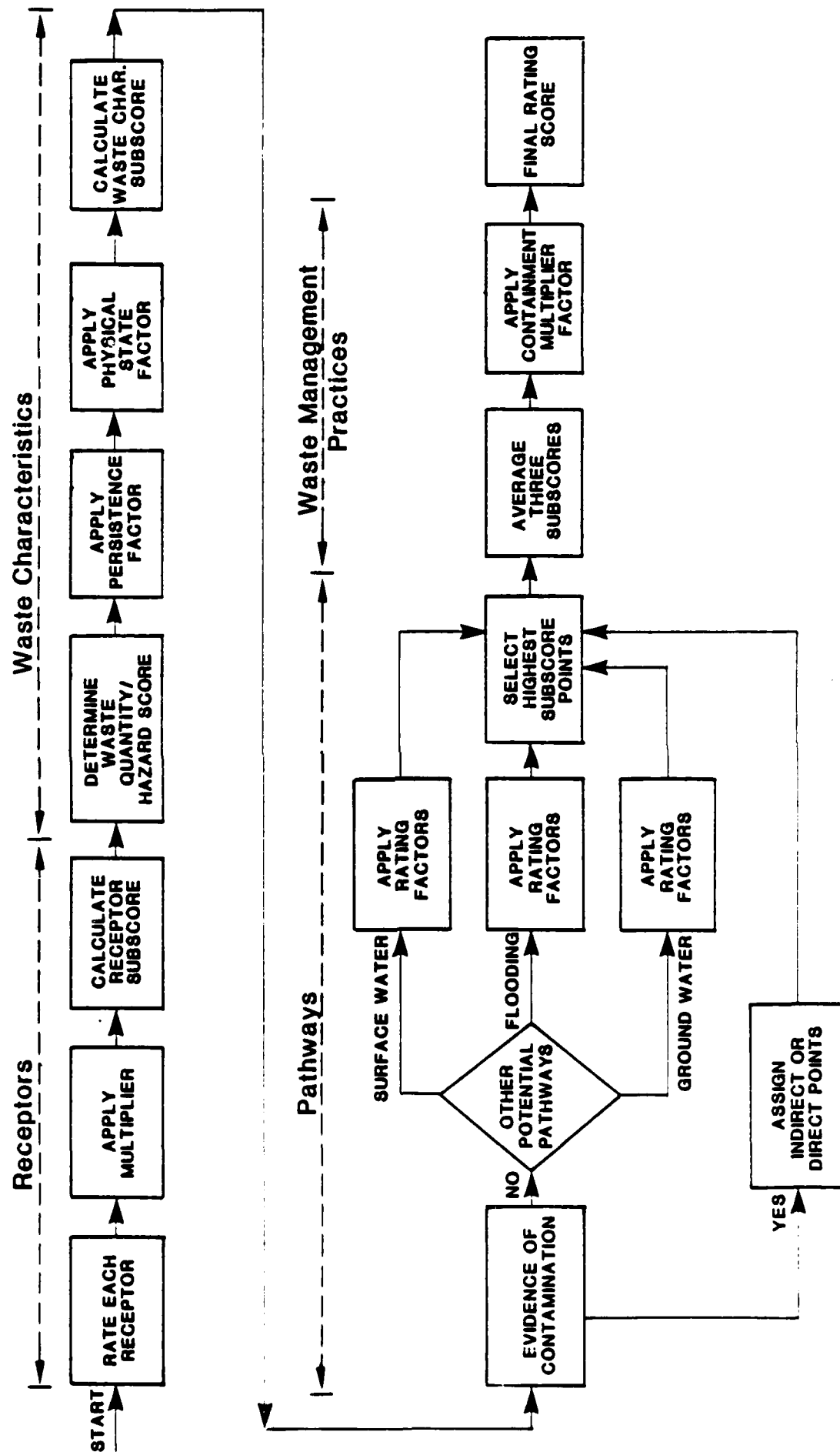


FIGURE 2 HAZARD ASSESSMENT RATING METHODOLOGY FORM

Page 1 of 2

NAME OF SITE _____
 LOCATION _____
 DATE OF OPERATION OR OCCURRENCE _____
 OWNER/OPERATOR _____
 COMMENTS/DESCRIPTION _____
 SITE RATED BY _____

I. RECEPTORS

Rating Factor	Factor Rating (0-3)	Multiplier	Factor Score	Maximum Possible Score
A. Population within 1,000 feet of site		4		
B. Distance to nearest well		10		
C. Land use/zoning within 1 mile radius		3		
D. Distance to reservation boundary		6		
E. Critical environments within 1 mile radius of site		10		
F. Water quality of nearest surface water body		6		
G. Ground water use of uppermost aquifer		9		
H. Population served by surface water supply within 3 miles downstream of site		6		
I. Population served by ground-water supply within 3 miles of site		6		

Subtotals _____

Receptors subscore (100 X factor score subtotal/maximum score subtotal)

II. WASTE CHARACTERISTICS

A. Select the factor score based on the estimated quantity, the degree of hazard, and the confidence level of the information.

1. Waste quantity (S = small, M = medium, L = large) _____

2. Confidence level (C = confirmed, S = suspected) _____

3. Hazard rating (H = high, M = medium, L = low) _____

Factor Subscore A (from 20 to 100 based on factor score matrix)

B. Apply persistence factor

Factor Subscore A X Persistence Factor = Subscore B

_____ X _____ = _____

C. Apply physical state multiplier

Subscore B X Physical State Multiplier = Waste Characteristics Subscore

_____ X _____ = _____

III. PATHWAYS

- | Rating Factor | Factor Rating (0-3) | Multiplier | Factor Score | Maximum Possible Score |
|---------------|---------------------|------------|--------------|------------------------|
|---------------|---------------------|------------|--------------|------------------------|
- A. If there is evidence of migration of hazardous contaminants, assign maximum factor subscore of 100 points for direct evidence or 80 points for indirect evidence. If direct evidence exists then proceed to C. If no evidence or indirect evidence exists, proceed to B.

Subscore _____

- B. Rate the migration potential for 3 potential pathways: surface water migration, flooding, and ground-water migration. Select the highest rating, and proceed to C.

1. Surface water migration

Distance to nearest surface water		8		
Net precipitation		6		
Surface erosion		8		
Surface permeability		6		
Rainfall intensity		8		

Subtotals _____

Subscore (100 X factor score subtotal/maximum score subtotal) _____

2. Flooding

Subscore (100 x factor score/3) _____

3. Ground-water migration

Depth to ground water		8		
Net precipitation		6		
Soil permeability		3		
Subsurface flows		8		
Direct access to ground water		8		

Subtotals _____

Subscore (100 x factor score subtotal/maximum score subtotal) _____

C. Highest pathway subscore.

Enter the highest subscore value from A, B-1, B-2 or B-3 above.

Pathways Subscore _____

IV. WASTE MANAGEMENT PRACTICES

- A. Average the three subscores for receptors, waste characteristics, and pathways.

Receptors	_____
Waste Characteristics	_____
Pathways	_____

Total _____ divided by 3 =

Gross Total Score _____

- B. Apply factor for waste containment from waste management practices

Gross Total Score X Waste Management Practices Factor = Final Score

_____ X _____ = _____

TABLE 1
HAZARD ASSESSMENT RATING METHODOLOGY GUIDELINES

I. RECEPTORS CATEGORY	Rating Factors	Rating Scale Levels			Multiplier
		0	1	2	3
A. Population within 1,000 feet (includes on-base facilities)	Population within 1,000 feet (includes on-base facilities)	0	1 - 25	26 - 100	Greater than 100
	Distance to nearest water well	Greater than 3 miles	1 to 3 miles	3,001 feet to 1 mile	0 to 3,000 feet
	Land Use/zoning (within 1 mile radius)	Completely remote (zoning not applicable)	Agricultural	Commercial or Industrial	Residential
	Distance to installation boundary	Greater than 2 miles	1 to 2 miles	1,001 feet to 1 mile	0 to 1,000 feet
	Critical environments (within 1 mile radius)	Not a critical environment	Natural areas	Pristine natural areas; minor wetlands; preserved areas; presence of economically important natural resources susceptible to contamination.	Major habitat of an endangered or threatened species; presence of recharge area; major wetlands.
F. Water quality/use designation of nearest surface water body	Water quality/use designation of nearest surface water body	Agricultural or Industrial use.	Recreation, propagation and management of fish and wildlife.	Shellfish propagation and harvesting.	Potable water supplies
	Ground-Water use of uppermost aquifer	Not used, other sources readily available.	Commercial, industrial, or irrigation, very limited other water sources.	Drinking water, municipal water available.	Drinking water, no municipal water available; commercial, industrial, or irrigation, no other water source available.
II. Population served by aquifer supplies within 3 miles of site	Population served by surface water supplies within 3 miles downstream of site	0	1 - 50	51 - 1,000	Greater than 1,000
	Population served by aquifer supplies within 3 miles of site	0	1 - 50	51 - 1,000	Greater than 1,000

TABLE 1 (Continued)
HAZARD ASSESSMENT RATING METHODOLOGY GUIDELINES

II. WASTE CHARACTERISTICS

A-1 Hazardous Waste Quantity

- S - Small quantity (<5 tons or 20 drums of liquid)
M - Moderate quantity (5 to 20 tons or 21 to 85 drums of liquid)
L - Large quantity (>20 tons or 85 drums of liquid)

A-2 Confidence Level of Information

C - Confirmed confidence level (minimum criteria below)

S - Suspected confidence level

- o Verbal reports from interviewer (at least 2) or written information from the records.

- o No verbal reports or conflicting verbal reports and no written information from the records.

- o Knowledge of types and quantities of wastes generated by shops and other areas on base.

- o Logic based on a knowledge of the types and quantities of hazardous wastes generated at the base, and a history of past waste disposal practices indicate that these wastes were disposed of at a site.

- o Based on the above, a determination of the types and quantities of waste disposed of at the site.

A-3 Hazard Rating

Hazard Category	Rating Scale Levels			
	0	1	2	3
Toxicity	Sax's Level 0	Sax's Level 1	Sax's Level 2	Sax's Level 3
Ignitability	Flash point greater than 200°F	Flash point at 140°F to 200°F	Flash point at 80°F to 140°F	Flash point less than 80°F
Radioactivity	At or below background levels	1 to 3 times back-ground levels	3 to 5 times back-ground levels	Over 5 times back-ground levels

Use the highest individual rating based on toxicity, ignitability and radioactivity and determine the hazard rating.

Hazard Rating	Points
High (H)	3
Medium (M)	2
Low (L)	1

HAZARD ASSESSMENT RATING METHODOLOGY GUIDELINES

II. WASTE CHARACTERISTICS (Continued)

Waste Characteristics Matrix

Point Rating	Hazardous Waste Quantity	Confidence Level of Information	Hazard Rating
100	L	C	H
80	L	C	M
	M	C	H
70	L	S	H
60	S	C	H
	M	C	M
50	L	S	M
	L	C	L
	M	S	H
	S	C	M
40	S	S	H
	M	S	M
	M	C	L
	L	S	L
30	S	C	L
	M	S	L
	S	S	M
20	S	S	L

Notes:

For a site with more than one hazardous waste, the waste quantities may be added using the following rules:

- o Confirmed confidence levels (C) can be added
- o Suspected confidence levels (S) can be added
- o Confirmed confidence levels cannot be added with suspected confidence levels

Waste Hazard Rating

- o Wastes with the same hazard rating can be added
- o Wastes with different hazard ratings can only be added in a downgrade mode, e.g., MCH + SCH = LCH if the total quantity is greater than 20 tons.

Example: Several wastes may be present at a site, each having an MCH designation (60 points). By adding the quantities of each waste, the designation may change to LCH (80 points). In this case, the correct point rating for the waste is 80.

B. Persistence Multiplier for Point Rating

Multiply Point Rating
From Part A by the Following

Persistence Criteria	Multiply Point Rating
Metals, polycyclic compounds, and halogenated hydrocarbons	1.0
Substituted and other ring compounds	0.9
Straight chain hydrocarbons	0.8
Easily biodegradable compounds	0.4

C. Physical State Multiplier

Multiply Point Total From
Parts A and B by the Following

Physical State	Multiply Point Total From
Liquid	1.0
Soluble	0.75
Solid	0.50

TABLE 1 (Continued)

HAZARD ASSESSMENT RATING METHODOLOGY GUIDELINES

III. PATHWAYS CATEGORY

A. Evidence of Contamination

Direct evidence is obtained from laboratory analyses of hazardous contaminants present above natural background levels in surface water, ground water, or air. Evidence should confirm that the source of contamination is the site being evaluated.

Indirect evidence might be from visual observation (i.e., leachate), vegetation stress, sludge deposits, presence of taste and odors in drinking water, or reported discharges that cannot be directly confirmed as resulting from the site, but the site is greatly suspected of being a source of contamination.

B-1 POTENTIAL FOR SURFACE WATER CONTAMINATION

Rating Factor	Rating Scale Levels			Multiplier
	0	1	2	3
Distance to nearest surface water (includes drainage ditches and storm sewers)	Greater than 1 mile	2,001 feet to 1 mile	501 feet to 2,000 feet	0 to 500 feet
Net precipitation	Less than -10 in.	-10 to +5 in.	+5 to +20 in.	Greater than +20 in.
Surface erosion	None	Slight	Moderate	Severe
Surface permeability	0% to 15% clay (>10 ⁻² cm/sec)	15% to 30% clay (10 ⁻² to 10 ⁻³ cm/sec)	30% to 50% clay (10 ⁻³ to 10 ⁻⁴ cm/sec)	Greater than 50% clay (<10 ⁻⁴ cm/sec)
Rainfall intensity based on 1 year 24-hr rainfall	<1.0 inch	1.0-2.0 inches	2.1-3.0 inches	>3.0 inches

B-2 POTENTIAL FOR FLOODING

Floodplain	Beyond 100-year floodplain	In 25-year floodplain	In 10-year floodplain	Floods annually	1
Depth to ground water	Greater than 500 ft	50 to 500 feet	11 to 50 feet	0 to 10 feet	8
Net precipitation	Less than -10 in.	-10 to +5 in.	+5 to +20 in.	Greater than +20 in.	6
Soil permeability	Greater than 50% clay (>10 ⁻² cm/sec)	30% to 50% clay (10 ⁻² to 10 ⁻³ cm/sec)	15% to 30% clay (10 ⁻³ to 10 ⁻⁴ cm/sec)	0% to 15% clay (<10 ⁻⁴ cm/sec)	8
Subsurface flows	Bottom of site greater than 5 feet above high ground-water level	Bottom of site occasionally submerged	Bottom of site frequently submerged	Bottom of site located below mean ground-water level	8
Direct access to ground water (through faults, fractures, faulty well construction, abandoned trenches, etc.)	No evidence of risk	Low risk	Moderate risk	High risk	11

B-3 POTENTIAL FOR GROUND-WATER CONTAMINATION

Depth to ground water	Greater than 500 ft	50 to 500 feet	11 to 50 feet	0 to 10 feet	8
Net precipitation	Less than -10 in.	-10 to +5 in.	+5 to +20 in.	Greater than +20 in.	6
Soil permeability	Greater than 50% clay (>10 ⁻² cm/sec)	30% to 50% clay (10 ⁻² to 10 ⁻³ cm/sec)	15% to 30% clay (10 ⁻³ to 10 ⁻⁴ cm/sec)	0% to 15% clay (<10 ⁻⁴ cm/sec)	8
Subsurface flows	Bottom of site greater than 5 feet above high ground-water level	Bottom of site occasionally submerged	Bottom of site frequently submerged	Bottom of site located below mean ground-water level	8
Direct access to ground water (through faults, fractures, faulty well construction, abandoned trenches, etc.)	No evidence of risk	Low risk	Moderate risk	High risk	11

TABLE 1 (Continued)
HAZARD ASSESSMENT RATING METHODOLOGY GUIDELINES

IV. WASTE MANAGEMENT PRACTICES CATEGORY

A. This category adjusts the total risk as determined from the receptors, pathways, and waste characteristics categories for waste management practices and engineering controls designed to reduce this risk. The total risk is determined by first averaging the receptors, pathways, and waste characteristics subscores.

B. WASTE MANAGEMENT PRACTICES FACTOR

The following multipliers are then applied to the total risk points (from A):

<u>Waste Management Practice</u>	<u>Multiplier</u>
No containment	1.0
Limited containment	0.95
Fully contained and in full compliance	0.10

Guidelines for fully contained:

Landfills:

- o Clay cap or other impermeable cover
- o Leachate collection system
- o Liners in good condition
- o Adequate monitoring wells

Surface Impoundments:

- o Liners in good condition
- o Sound dikes and adequate freeboard
- o Adequate monitoring wells

Spills:

- o Quick spill cleanup action taken
- o Contaminated soil removed
- o Soil and/or water samples confirm total cleanup of the spill

Fire Protection Training Areas:

- o Concrete surface and berms
- o Oil/water separator for pretreatment of runoff
- o Effluent from oil/water separator to treatment plant

General Note: If data are not available or known to be complete the factor ratings under items I-A through I, III-B-1 or III B-3, then leave blank for calculation of factor score and maximum possible score.

APPENDIX H
INDEX FOR HAZARDOUS ASSESSMENT
METHODOLOGY FORMS

Fire Protection Training Area	H-1
Spill Site No. 9 (Auto Hobby Shop Heating Fuel)	H-3
Landfill No. 3	H-5
Landfill No. 1	H-7
Spill Site No. 7 (Pump House No. 6)	H-9
Landfill No. 6	H-11
Landfill No. 2	H-13
Low-Level Radioactive Burial Sites	H-15
Landfill No. 5	H-17
Landfill No. 4	H-19
Spill Site No. 1 (Pump House No. 7)	H-21
Spill Site No. 3 (Hydrant Line Leaks)	H-23
Spill Site No. 2 (C-9 LF Coolant Spill)	H-25
Spill Site No. 5 (C-11 LF Coolant Spill)	H-27
Spill Site No. 6 (N-10 LF Coolant Spill)	H-29
Spill Site No. 4 (EOD Pramitol Spill)	H-31

HAZARD ASSESSMENT RATING METHODOLOGY FORM

Name of site: Fire Protection Training Area

Locations: North of Alert Apron, east of Bismark Road

Date of Operation: Late 1940's to present

Owner/Operator: Ellsworth AFB

Comments/Description: Approximately 2 acres, all types of liquids fuels

Site Rated by: J.R.Absalon; J.P.McAuliffe; J.Menard; E.J.Schroeder

I. RECEPTORS

Rating Factor	Factor Rating (0-3)	Multiplier	Factor Score	Maximum Possible Score
A. Population within 1,000 feet of site	1	4	4	12
B. Distance to nearest well	3	10	30	30
C. Land use/zoning within 1 mile radius	2	3	6	9
D. Distance to installation boundary	2	6	12	18
E. Critical environments within 1 mile radius of site	0	10	0	30
F. Water quality of nearest surface water body	0	6	0	18
G. Ground water use of uppermost aquifer	1	9	9	27
H. Population served by surface water supply within 3 miles downstream of site	0	6	0	18
I. Population served by ground-water supply within 3 miles of site	3	6	18	18

Subtotals

79

180

Receptors subscore (100 x factor score subtotal/maximum score subtotal)

44

II. WASTE CHARACTERISTICS

A. Select the factor score based on the estimated quantity, the degree of hazard, and the confidence level of the information.

- | | |
|--|---------------|
| 1. Waste quantity (small, medium, or large) | L = large |
| 2. Confidence level (confirmed or suspected) | C = confirmed |
| 3. Hazard rating (low, medium, or high) | H = high |

Factor Subscore A (from 20 to 100 based on factor score matrix) 100

B. Apply persistence factor

Factor Subscore A x Persistence Factor = Subscore B

$$100 \times 1.00 = 100$$

C. Apply physical state multiplier

Subscore B x Physical State Multiplier = Waste Characteristics Subscore

$$100 \times 1.00 = 100$$

III. PATHWAYS

- A. If there is evidence of migration of hazardous contaminants, assign maximum factor subscore of 100 points for direct evidence or 80 points for indirect evidence. If direct evidence exists then proceed to C. If no evidence or indirect evidence exists, proceed to B.

Subscore 0

- B. Rate the migration potential for 3 potential pathways: surface water migration, flooding, and ground-water migration. Select the highest rating and proceed to C.

Rating Factor	Factor Rating (0-3)	Multiplier	Factor Score	Maximum Possible Score
1. Surface Water Migration				
Distance to nearest surface water	3	8	24	24
Net precipitation	0	6	0	18
Surface erosion	2	8	16	24
Surface permeability	2	6	12	18
Rainfall intensity	1	8	8	24
Subtotals			60	108
Subscore (100 x factor score subtotal/maximum score subtotal)				56
2. Flooding				
	0	1	0	3
Subscore (100 x factor score/3)				0
3. Ground-water migration				
Depth to ground water	3	8	24	24
Net precipitation	0	6	0	18
Soil permeability	2	8	16	24
Subsurface flows	1	8	8	24
Direct access to ground water	0	8	0	24
Subtotals			48	114
Subscore (100 x factor score subtotal/maximum score subtotal)				42

- C. Highest pathway subscore.

Enter the highest subscore value from A, B-1, B-2 or B-3 above.

Pathways Subscore 56

IV. WASTE MANAGEMENT PRACTICES

- A. Average the three subscores for receptors, waste characteristics, and pathways.

Receptors	44
Waste Characteristics	100
Pathways	56
Total	199

divided by 3 =

66 Gross total score

- B. Apply factor for waste containment from waste management practices.

Gross total score x waste management practices factor = final score

66 x 1.00 =

66
FINAL SCORE

HAZARD ASSESSMENT RATING METHODOLOGY FORM

Name of site: Spill Site No. 9 (Auto Hobby Shop Heating Fuel)
 Location: Old Auto Hobby Shop
 Date of Operation: Discovered 1985
 Owner/Operator: Ellsworth AFB
 Comments/Description: Soil found contaminated with heating fuel

Site Rated by: J.R.Absalon ; J.P.McAuliffe ; J.Menard ; E.J.Schroeder

I. RECEPTORS

Rating Factor	Factor Rating (0-3)	Multiplier	Factor Score	Maximum Possible Score
A. Population within 1,000 feet of site	2	4	8	12
B. Distance to nearest well	3	10	30	30
C. Land use/zoning within 1 mile radius	3	3	9	9
D. Distance to installation boundary	2	6	12	18
E. Critical environments within 1 mile radius of site	0	10	0	30
F. Water quality of nearest surface water body	0	6	0	18
G. Ground water use of uppermost aquifer	1	9	9	27
H. Population served by surface water supply within 3 miles downstream of site	0	6	0	18
I. Population served by ground-water supply within 3 miles of site	3	6	18	18
Subtotals			86	180
Receptors subscore (100 x factor score subtotal/maximum score subtotal)				<u>48</u>

II. WASTE CHARACTERISTICS

A. Select the factor score based on the estimated quantity, the degree of hazard, and the confidence level of the information.

- | | |
|--|---------------|
| 1. Waste quantity (small, medium, or large) | S = small |
| 2. Confidence level (confirmed or suspected) | C = confirmed |
| 3. Hazard rating (low, medium, or high) | H = high |

Factor Subscore A (from 20 to 100 based on factor score matrix) 60

B. Apply persistence factor

Factor Subscore A x Persistence Factor = Subscore B

$$60 \times 0.80 = 48$$

C. Apply physical state multiplier

Subscore B x Physical State Multiplier = Waste Characteristics Subscore

$$48 \times 1.00 = \underline{\underline{48}}$$

III. PATHWAYS

- A. If there is evidence of migration of hazardous contaminants, assign maximum factor subscore of 100 points for direct evidence or 80 points for indirect evidence. If direct evidence exists then proceed to C. If no evidence or indirect evidence exists, proceed to B.

Subscore 100

- B. Rate the migration potential for 3 potential pathways: surface water migration, flooding, and ground-water migration. Select the highest rating and proceed to C.

Rating Factor	Factor Rating (0-3)	Multiplier	Factor Score	Maximum Possible Score
1. Surface Water Migration				
Distance to nearest surface water	2	8	16	24
Net precipitation	0	6	0	18
Surface erosion	2	8	16	24
Surface permeability	2	6	12	18
Rainfall intensity	1	8	8	24
Subtotals			52	108
Subscore (100 x factor score subtotal/maximum score subtotal)				48
2. Flooding	0	1	0	3
Subscore (100 x factor score/3)				0
3. Ground-water migration				
Depth to ground water	3	8	24	24
Net precipitation	0	6	0	18
Soil permeability	2	8	16	24
Subsurface flows	1	8	8	24
Direct access to ground water	0	8	0	24
Subtotals			48	114
Subscore (100 x factor score subtotal/maximum score subtotal)				42

- C. Highest pathway subscore.

Enter the highest subscore value from A, B-1, B-2 or B-3 above.

Pathways Subscore 100

IV. WASTE MANAGEMENT PRACTICES

- A. Average the three subscores for receptors, waste characteristics, and pathways.

Receptors	48
Waste Characteristics	48
Pathways	100
Total	196

divided by 3 =

65 Gross total score

- B. Apply factor for waste containment from waste management practices.

Gross total score x waste management practices factor = final score

65 x 1.00 =

65
FINAL SCORE

HAZARD ASSESSMENT RATING METHODOLOGY FORM

Name of site: Landfill No. 3

Location: West of EPTA

Date of Operations: 1965 to 1976

Owner/Operator: Ellsworth AFB

Comments/Description: Approximately 40 acres, base refuse, oil disposal pit, contaminated soils

Site Rated by: J.R.Absalon; J.P.McAuliffe; J.Menard; E.J.Schroeder

I. RECEPTORS

Rating Factor	Factor Rating (0-3)	Multiplier	Factor Score	Maximum Possible Score
A. Population within 1,000 feet of site	1	4	4	12
B. Distance to nearest well	2	10	20	30
C. Land use/zoning within 1 mile radius	3	3	9	9
D. Distance to installation boundary	3	6	18	18
E. Critical environments within 1 mile radius of site	0	10	0	30
F. Water quality of nearest surface water body	0	6	0	18
G. Ground water use of uppermost aquifer	1	9	9	27
H. Population served by surface water supply within 3 miles downstream of site	0	6	0	18
I. Population served by ground-water supply within 3 miles of site	3	6	18	18

Subtotals		70	180
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Receptors subscore (100 x factor score subtotal/maximum score subtotal)	43
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II. WASTE CHARACTERISTICS

A. Select the factor score based on the estimated quantity, the degree of hazard, and the confidence level of the information.

- | | |
|--|---------------|
| 1. Waste quantity (small, medium, or large) | L = large |
| 2. Confidence level (confirmed or suspected) | C = confirmed |
| 3. Hazard rating (low, medium, or high) | H = high |

Factor Subscore A (from 20 to 100 based on factor score matrix) 100

B. Apply persistence factor

Factor Subscore A x Persistence Factor = Subscore B

100	x	1.00	=	100
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C. Apply physical state multiplier

Subscore B x Physical State Multiplier = Waste Characteristics Subscore

100	x	1.00	=	100
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III. PATHWAYS

A. If there is evidence of migration of hazardous contaminants, assign maximum factor subscore of 100 points for direct evidence or 80 points for indirect evidence. If direct evidence exists then proceed to C. If no evidence or indirect evidence exists, proceed to B.

Subscore 0

B. Rate the migration potential for 3 potential pathways: surface water migration, flooding, and ground-water migration. Select the highest rating and proceed to C.

Rating Factor	Factor Rating (0-3)	Multiplier	Factor Score	Maximum Possible Score
1. Surface Water Migration				
Distance to nearest surface water	1	8	8	24
Net precipitation	0	6	0	18
Surface erosion	2	8	16	24
Surface permeability	2	6	12	18
Rainfall intensity	1	8	8	24
Subtotals			44	108
Subscore (100 x factor score subtotal/maximum score subtotal)				41
2. Flooding				
	0	1	0	3
Subscore (100 x factor score/3)				0
3. Ground-water migration				
Depth to ground water	3	8	24	24
Net precipitation	0	6	0	18
Soil permeability	2	8	16	24
Subsurface flows	1	8	8	24
Direct access to ground water	0	8	0	24
Subtotals			48	114
Subscore (100 x factor score subtotal/maximum score subtotal)				42

C. Highest pathway subscore.

Enter the highest subscore value from A, B-1, B-2 or B-3 above.

Pathways Subscore 42

IV. WASTE MANAGEMENT PRACTICES

A. Average the three subscores for receptors, waste characteristics, and pathways.

Receptors	43	
Waste Characteristics	100	
Pathways	42	
Total	185	divided by 3 =
		62 Gross total score

B. Apply factor for waste containment from waste management practices.

Gross total score x waste management practices factor = final score

62 x 1.00 = 62
FINAL SCORE

H-6

HAZARD ASSESSMENT RATING METHODOLOGY FORM

Name of site: Landfill No. 1

Location: South of Alert Apron and Bismark Road

Date of Operation: 1940's to 1964

Owner/Operator: Ellsworth AFB

Comments/Description: Approximately 20 acres , all base refuse

Site Rated by: J.R.Absalon ; J.P.McAuliffe ; J.Menard ; E.J.Schroeder

I. RECEPTORS

Rating Factor	Factor Rating (0-3)	Multi- plier	Factor Score	Maximum Possible Score
A. Population within 1,000 feet of site	2	4	8	12
B. Distance to nearest well	3	10	30	30
C. Land use/zoning within 1 mile radius	3	3	9	9
D. Distance to installation boundary	3	6	18	18
E. Critical environments within 1 mile radius of site	0	10	0	30
F. Water quality of nearest surface water body	0	6	0	18
G. Ground water use of uppermost aquifer	1	9	9	27
H. Population served by surface water supply within 3 miles downstream of site	0	6	0	18
I. Population served by ground-water supply within 3 miles of site	3	6	18	18

Subtotals			92	180
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Receptors subscore (100 x factor score subtotal/maximum score subtotal)				<u>51</u>
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II. WASTE CHARACTERISTICS

A. Select the factor score based on the estimated quantity, the degree of hazard, and the confidence level of the information.

- | | |
|--|---------------|
| 1. Waste quantity (small, medium, or large) | L = large |
| 2. Confidence level (confirmed or suspected) | S = suspected |
| 3. Hazard rating (low, medium, or high) | H = high |

Factor Subscore A (from 20 to 100 based on factor score matrix) 70

B. Apply persistence factor

Factor Subscore A x Persistence Factor = Subscore B

70	x	1.00	=	70
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C. Apply physical state multiplier

Subscore B x Physical State Multiplier = Waste Characteristics Subscore

70	x	1.00	=	<u>70</u>
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III. PATHWAYS

- A. If there is evidence of migration of hazardous contaminants, assign maximum factor subscore of 100 points for direct evidence or 80 points for indirect evidence. If direct evidence exists then proceed to C. If no evidence or indirect evidence exists, proceed to B.

Subscore 0

- B. Rate the migration potential for 3 potential pathways: surface water migration, flooding, and ground-water migration. Select the highest rating and proceed to C.

Rating Factor	Factor Rating (0-3)	Multi- plier	Factor Score	Maximum Possible Score
1. Surface Water Migration				
Distance to nearest surface water	3	8	24	24
Net precipitation	0	6	0	18
Surface erosion	2	8	16	24
Surface permeability	2	6	12	18
Rainfall intensity	1	8	8	24
Subtotals			60	108
Subscore (100 x factor score subtotal/maximum score subtotal)				56
2. Flooding				
	0	1	0	3
Subscore (100 x factor score/3)				0
3. Ground-water migration				
Depth to ground water	3	8	24	24
Net precipitation	0	6	0	18
Soil permeability	2	8	16	24
Subsurface flows	1	8	8	24
Direct access to ground water	0	8	0	24
Subtotals			48	114
Subscore (100 x factor score subtotal/maximum score subtotal)				42

- C. Highest pathway subscore.

Enter the highest subscore value from A, B-1, B-2 or B-3 above.

Pathways Subscore 56

IV. WASTE MANAGEMENT PRACTICES

- A. Average the three subscores for receptors, waste characteristics, and pathways.

Receptors 51
 Waste Characteristics 70
 Pathways 56
 Total 177 divided by 3 =

59 Gross total score

- B. Apply factor for waste containment from waste management practices.

Gross total score x waste management practices factor = final score

59 x 1.00 =

59
 FINAL SCORE

HAZARD ASSESSMENT RATING METHODOLOGY FORM

Name of site: Spill Site No. 7 (Pump House No. 6)

Location: Pump House No. 6

Date of Operation: February 1984

Owner/Operator: Ellsworth AFB

Comments/Description: 12,000 gallons of JP - 4

Site Rated by: J.R.Absalon ; J.P.McAuliffe ; J.Menard ; E.J.Schroeder

I. RECEPTORS

Rating Factor	Factor Rating (0-3)	Multi- plier	Factor Score	Maximum Possible Score
A. Population within 1,000 feet of site	1	4	4	12
B. Distance to nearest well	2	10	20	30
C. Land use/zoning within 1 mile radius	3	3	9	9
D. Distance to installation boundary	2	6	12	18
E. Critical environments within 1 mile radius of site	0	10	0	30
F. Water quality of nearest surface water body	0	6	0	18
G. Ground water use of uppermost aquifer	1	9	9	27
H. Population served by surface water supply within 3 miles downstream of site	0	6	0	18
I. Population served by ground-water supply within 3 miles of site	3	6	18	18

Subtotals			72	180
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Receptors subscore (100 x factor score subtotal/maximum score subtotal)				40
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II. WASTE CHARACTERISTICS

A. Select the factor score based on the estimated quantity, the degree of hazard, and the confidence level of the information.

- | | |
|--|---------------|
| 1. Waste quantity (small, medium, or large) | L = large |
| 2. Confidence level (confirmed or suspected) | C = confirmed |
| 3. Hazard rating (low, medium, or high) | H = high |

Factor Subscore A (from 20 to 100 based on factor score matrix) 100

B. Apply persistence factor

Factor Subscore A x Persistence Factor = Subscore B

100	x	0.80	=	80
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C. Apply physical state multiplier

Subscore B x Physical State Multiplier = Waste Characteristics Subscore

80	x	1.00	=	80
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III. PATHWAYS

A. If there is evidence of migration of hazardous contaminants, assign maximum factor subscore of 100 points for direct evidence or 80 points for indirect evidence. If direct evidence exists then proceed to C. If no evidence or indirect evidence exists, proceed to B.

Subscore 0

B. Rate the migration potential for 3 potential pathways: surface water migration, flooding, and ground-water migration. Select the highest rating and proceed to C.

Rating Factor	Factor Rating (0-3)	Multi- plier	Factor Score	Maximum Possible Score
1. Surface Water Migration				
Distance to nearest surface water	2	8	16	24
Net precipitation	0	6	0	18
Surface erosion	2	8	16	24
Surface permeability	2	6	12	18
Rainfall intensity	1	8	8	24
Subtotals			52	108
Subscore (100 x factor score subtotal/maximum score subtotal)				48
2. Flooding				
	0	1	0	3
Subscore (100 x factor score/3)				0
3. Ground-water migration				
Depth to ground water	3	8	24	24
Net precipitation	0	6	0	18
Soil permeability	2	8	16	24
Subsurface flows	1	8	8	24
Direct access to ground water	0	8	0	24
Subtotals			48	114
Subscore (100 x factor score subtotal/maximum score subtotal)				42

C. Highest pathway subscore.

Enter the highest subscore value from A, B-1, B-2 or B-3 above.

Pathways Subscore 48

IV. WASTE MANAGEMENT PRACTICES

A. Average the three subscores for receptors, waste characteristics, and pathways.

Receptors	48	
Waste Characteristics	80	
Pathways	48	
Total	168	divided by 3 =
		56 Gross total score

B. Apply factor for waste containment from waste management practices.

Gross total score x waste management practices factor = final score

56	x	1.00	=	56
				FINAL SCORE

HAZARD ASSESSMENT RATING METHODOLOGY FORM

Name of site: Landfill No. 6
 Location: Alert Apron Recreation Facility
 Date of Operation: 1962 to 1965
 Owner/Operator: Ellsworth AFB
 Comments/Description: Approximately 1/2 acre, hardfill, base refuse

Site Rated by: J.R.Absalon ; J.P.McAuliffe ; J.Menard ; E.J.Schroeder

I. RECEPTORS

Rating Factor	Factor Rating (0-3)	Multiplier	Factor Score	Maximum Possible Score
A. Population within 1,000 feet of site	2	4	8	12
B. Distance to nearest well	3	10	30	30
C. Land use/zoning within 1 mile radius	3	3	9	9
D. Distance to installation boundary	3	6	18	18
E. Critical environments within 1 mile radius of site	0	10	0	30
F. Water quality of nearest surface water body	0	6	0	18
G. Ground water use of uppermost aquifer	1	9	9	27
H. Population served by surface water supply within 3 miles downstream of site	0	6	0	18
I. Population served by ground-water supply within 3 miles of site	3	6	18	18

Subtotals 92 180

Receptors subscore (100 x factor score subtotal/maximum score subtotal) 51

II. WASTE CHARACTERISTICS

A. Select the factor score based on the estimated quantity, the degree of hazard, and the confidence level of the information.

- | | |
|--|---------------|
| 1. Waste quantity (small, medium, or large) | S = small |
| 2. Confidence level (confirmed or suspected) | S = suspected |
| 3. Hazard rating (low, medium, or high) | H = high |

Factor Subscore A (from 20 to 100 based on factor score matrix) 40

B. Apply persistence factor

Factor Subscore A x Persistence Factor = Subscore B

40 x 1.00 = 40

C. Apply physical state multiplier

Subscore B x Physical State Multiplier = Waste Characteristics Subscore

40 x 1.00 = 40

III. PATHWAYS

A. If there is evidence of migration of hazardous contaminants, assign maximum factor subscore of 100 points for direct evidence or 80 points for indirect evidence. If direct evidence exists then proceed to C. If no evidence or indirect evidence exists, proceed to B.

Subscore 0

B. Rate the migration potential for 3 potential pathways: surface water migration, flooding, and ground-water migration. Select the highest rating and proceed to C.

Rating Factor	Factor Rating (0-3)	Multiplier	Factor Score	Maximum Possible Score
1. Surface Water Migration				
Distance to nearest surface water	3	8	24	24
Net precipitation	0	6	0	18
Surface erosion	2	8	16	24
Surface permeability	2	6	12	18
Rainfall intensity	1	8	8	24
Subtotals			68	108
Subscore (100 x factor score subtotal/maximum score subtotal)				56
2. Flooding				
	0	1	0	3
Subscore (100 x factor score/3)				0
3. Ground-water migration				
Depth to ground water	3	8	24	24
Net precipitation	0	6	0	18
Soil permeability	2	8	16	24
Subsurface flows	1	8	8	24
Direct access to ground water	0	8	0	24
Subtotals			48	114
Subscore (100 x factor score subtotal/maximum score subtotal)				42

C. Highest pathway subscore.

Enter the highest subscore value from A, B-1, B-2 or B-3 above.

Pathways Subscore 56

IV. WASTE MANAGEMENT PRACTICES

A. Average the three subscores for receptors, waste characteristics, and pathways.

Receptors	51
Waste Characteristics	40
Pathways	56
Total	147

divided by 3 =

49 Gross total score

B. Apply factor for waste containment from waste management practices.

Gross total score x waste management practices factor = final score

49 x 1.00 =

49
FINAL SCORE

HAZARD ASSESSMENT RATING METHODOLOGY FORM

Name of site: Landfill No. 2

Location: East of Northern Scout Drive , south of active hardfill area

Date of Operation: 1964 to 1965

Owner/Operator: Ellsworth AFB

Comments/Description: Approximately 1 acre , all base refuse

Site Rated by: J.R.Absalon ; J.P.McAuliffe ; J.Menard ; E.J.Schroeder

I. RECEPTORS

Rating Factor	Factor Rating (0-3)	Multi- plier	Factor Score	Maximum Possible Score
A. Population within 1,000 feet of site	0	4	0	12
B. Distance to nearest well	3	10	30	30
C. Land use/zoning within 1 mile radius	3	3	9	9
D. Distance to installation boundary	2	6	12	18
E. Critical environments within 1 mile radius of site	0	10	0	30
F. Water quality of nearest surface water body	0	6	0	18
G. Ground water use of uppermost aquifer	1	9	9	27
H. Population served by surface water supply within 3 miles downstream of site	0	6	0	18
I. Population served by ground-water supply within 3 miles of site	3	6	18	18

Subtotals			78	180
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Receptors subscore (100 x factor score subtotal/maximum score subtotal)				43
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II. WASTE CHARACTERISTICS

A. Select the factor score based on the estimated quantity, the degree of hazard, and the confidence level of the information.

- | | |
|--|---------------|
| 1. Waste quantity (small, medium, or large) | S = small |
| 2. Confidence level (confirmed or suspected) | C = confirmed |
| 3. Hazard rating (low, medium, or high) | H = high |

Factor Subscore A (from 20 to 100 based on factor score matrix) 60

B. Apply persistence factor

Factor Subscore A x Persistence Factor = Subscore B

60	x	1.00	=	60
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C. Apply physical state multiplier

Subscore B x Physical State Multiplier = Waste Characteristics Subscore

60	x	1.00	=	60
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III. PATHWAYS

A. If there is evidence of migration of hazardous contaminants, assign maximum factor subscore of 100 points for direct evidence or 80 points for indirect evidence. If direct evidence exists then proceed to C. If no evidence or indirect evidence exists, proceed to B.

Subscore 0

B. Rate the migration potential for 3 potential pathways: surface water migration, flooding, and ground-water migration. Select the highest rating and proceed to C.

Rating Factor	Factor Rating (0-3)	Multiplier	Factor Score	Maximum Possible Score
1. Surface Water Migration				
Distance to nearest surface water	1	8	8	24
Net precipitation	0	6	0	18
Surface erosion	2	8	16	24
Surface permeability	2	6	12	18
Rainfall intensity	1	8	8	24
Subtotals			44	100
Subscore (100 x factor score subtotal/maximum score subtotal)				41
2. Flooding				
	0	1	0	3
Subscore (100 x factor score/3)				0
3. Ground-water migration				
Depth to ground water	3	8	24	24
Net precipitation	0	6	0	18
Soil permeability	2	8	16	24
Subsurface flows	1	8	8	24
Direct access to ground water	0	8	0	24
Subtotals			48	114
Subscore (100 x factor score subtotal/maximum score subtotal)				42

C. Highest pathway subscore.

Enter the highest subscore value from A, B-1, B-2 or B-3 above.

Pathways Subscore 42

IV. WASTE MANAGEMENT PRACTICES

A. Average the three subscores for receptors, waste characteristics, and pathways.

Receptors 43

Waste Characteristics 60

Pathways 42

Total 145 divided by 3 =

48 Gross total score

B. Apply factor for waste containment from waste management practices.

Gross total score x waste management practices factor = final score

48 x 1.00 =

48
FINAL SCORE

HAZARD ASSESSMENT RATING METHODOLOGY FORM

Name of site: Low - Level Radioactive Waste Burial Site

Location: Weapons Storage Area

Date of Operation: 1952 to 1962

Owner/Operator: Ellsworth AFB

Comments/Description: 5 tanks and a solid disposal area

Site Rated by: J.R.Absalon ; J.P.McAuliffe ; J.Menard ; E.J.Schroeder

I. RECEPTORS

Rating Factor	Factor Rating (0-3)	Multiplier	Factor Score	Maximum Possible Score
A. Population within 1,000 feet of site	1	4	4	12
B. Distance to nearest well	3	10	30	30
C. Land use/zoning within 1 mile radius	3	3	9	9
D. Distance to installation boundary	2	6	12	18
E. Critical environments within 1 mile radius of site	0	10	0	30
F. Water quality of nearest surface water body	0	6	0	18
G. Ground water use of uppermost aquifer	1	9	9	27
H. Population served by surface water supply within 3 miles downstream of site	0	6	0	18
I. Population served by ground-water supply within 3 miles of site	3	6	18	18

Subtotals	82	180
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Receptors subscore (100 x factor score subtotal/maximum score subtotal)	46
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II. WASTE CHARACTERISTICS

A. Select the factor score based on the estimated quantity, the degree of hazard, and the confidence level of the information.

- | | |
|--|---------------|
| 1. Waste quantity (small, medium, or large) | L = large |
| 2. Confidence level (confirmed or suspected) | C = confirmed |
| 3. Hazard rating (low, medium, or high) | L = low |

Factor Subscore A (from 20 to 100 based on factor score matrix) 50

B. Apply persistence factor

Factor Subscore A x Persistence Factor = Subscore B

50	x	1.00	=	50
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C. Apply physical state multiplier

Subscore B x Physical State Multiplier = Waste Characteristics Subscore

50	x	1.00	=	50
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III. PATHWAYS

A. If there is evidence of migration of hazardous contaminants, assign maximum factor subscore of 100 points for direct evidence or 80 points for indirect evidence. If direct evidence exists then proceed to C. If no evidence or indirect evidence exists, proceed to B.

Subscore 0

B. Rate the migration potential for 3 potential pathways: surface water migration, flooding, and ground-water migration. Select the highest rating and proceed to C.

Rating Factor	Factor Rating (0-3)	Multiplier	Factor Score	Maximum Possible Score
1. Surface Water Migration				
Distance to nearest surface water	1	8	8	24
Net precipitation	0	6	0	18
Surface erosion	2	8	16	24
Surface permeability	2	6	12	18
Rainfall intensity	1	8	8	24
Subtotals			44	108
Subscore (100 x factor score subtotal/maximum score subtotal)				41
2. Flooding				
	0	1	0	3
Subscore (100 x factor score/3)				0
3. Ground-water migration				
Depth to ground water	3	8	24	24
Net precipitation	0	6	0	18
Soil permeability	2	8	16	24
Subsurface flows	1	8	8	24
Direct access to ground water	0	8	0	24
Subtotals			48	114
Subscore (100 x factor score subtotal/maximum score subtotal)				42

C. Highest pathway subscore.

Enter the highest subscore value from A, B-1, B-2 or B-3 above.

Pathways Subscore 42

IV. WASTE MANAGEMENT PRACTICES

A. Average the three subscores for receptors, waste characteristics, and pathways.

Receptors 46

Waste Characteristics 50

Pathways 42

Total 138 divided by 3 =

46 Gross total score

B. Apply factor for waste containment from waste management practices.

Gross total score x waste management practices factor = final score

46 x 1.00 =

46
FINAL SCORE

HAZARD ASSESSMENT RATING METHODOLOGY FORM

Name of site: Landfill No. 5

Location: North of Industrial Gate , east of Sixth Street

Date of Operation: 1968 to 1988

Owner/Operator: Ellsworth AFB

Comments/Description: Approximately 3 acres , hardfill , general refuse , sewage sludge

Site Rated by: J.R.Absalon ; J.P.McAuliffe ; J.Menard ; E.J.Schroeder

I. RECEPTORS

Rating Factor	Factor Rating (0-3)	Multi- plier	Factor Score	Maximum Possible Score
A. Population within 1,000 feet of site	2	4	8	12
B. Distance to nearest well	3	10	30	30
C. Land use/zoning within 1 mile radius	3	3	9	9
D. Distance to installation boundary	3	6	18	18
E. Critical environments within 1 mile radius of site	0	10	0	30
F. Water quality of nearest surface water body	0	6	0	18
G. Ground water use of uppermost aquifer	1	9	9	27
H. Population served by surface water supply within 3 miles downstream of site	0	6	0	18
I. Population served by ground-water supply within 3 miles of site	3	6	18	18

Subtotals	92	180
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Receptors subscore (100 x factor score subtotal/maximum score subtotal)	51
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II. WASTE CHARACTERISTICS

A. Select the factor score based on the estimated quantity, the degree of hazard, and the confidence level of the information.

- | | |
|--|---------------|
| 1. Waste quantity (small, medium, or large) | S = small |
| 2. Confidence level (confirmed or suspected) | S = suspected |
| 3. Hazard rating (low, medium, or high) | H = high |

Factor Subscore A (from 20 to 100 based on factor score matrix) 40

B. Apply persistence factor

Factor Subscore A x Persistence Factor = Subscore B

40	x	1.00	=	40
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C. Apply physical state multiplier

Subscore B x Physical State Multiplier = Waste Characteristics Subscore

40	x	1.00	=	40
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III. PATHWAYS

A. If there is evidence of migration of hazardous contaminants, assign maximum factor subscore of 100 points for direct evidence or 80 points for indirect evidence. If direct evidence exists then proceed to C. If no evidence or indirect evidence exists, proceed to B.

Subscore 0

B. Rate the migration potential for 3 potential pathways: surface water migration, flooding, and ground-water migration. Select the highest rating and proceed to C.

Rating Factor	Factor Rating (0-3)	Multiplier	Factor Score	Maximum Possible Score
1. Surface Water Migration				
Distance to nearest surface water	2	8	16	24
Net precipitation	0	6	0	18
Surface erosion	2	8	16	24
Surface permeability	2	6	12	18
Rainfall intensity	1	8	8	24
Subtotals			52	108
Subscore (100 x factor score subtotal/maximum score subtotal)				48
2. Flooding				
	0	1	0	3
Subscore (100 x factor score/3)				0
3. Ground-water migration				
Depth to ground water	3	8	24	24
Net precipitation	0	6	0	18
Soil permeability	2	8	16	24
Subsurface flows	1	8	8	24
Direct access to ground water	0	8	0	24
Subtotals			48	114
Subscore (100 x factor score subtotal/maximum score subtotal)				42

C. Highest pathway subscore.

Enter the highest subscore value from A, B-1, B-2 or B-3 above.

Pathways Subscore 48

IV. WASTE MANAGEMENT PRACTICES

A. Average the three subscores for receptors, waste characteristics, and pathways.

Receptors	51	
Waste Characteristics	48	
Pathways	48	
Total	139	divided by 3 =
		46

Gross total score

B. Apply factor for waste containment from waste management practices.

Gross total score x waste management practices factor = final score

46 x 1.00 = 46
FINAL SCORE

HAZARD ASSESSMENT RATING METHODOLOGY FORM

Name of site: Landfill No. 4

Location: North end of base , east of Scout Drive

Date of Operation: 1940's to present

Owner/Operator: Ellsworth AFB

Comments/Description: Approximately 10 acres , hardfill , base refuse , drums

Site Rated by: J.R.Absalon ; J.P.McAuliffe ; J.Menard ; E.J.Schroeder

I. RECEPTORS

Rating Factor	Factor Rating (0-3)	Multi- plier	Factor Score	Maximum Possible Score
A. Population within 1,000 feet of site	0	4	0	12
B. Distance to nearest well	2	10	20	30
C. Land use/zoning within 1 mile radius	3	3	9	9
D. Distance to installation boundary	3	6	18	18
E. Critical environments within 1 mile radius of site	0	10	0	30
F. Water quality of nearest surface water body	0	6	0	18
G. Ground water use of uppermost aquifer	1	9	9	27
H. Population served by surface water supply within 3 miles downstream of site	0	6	0	18
I. Population served by ground-water supply within 3 miles of site	3	6	18	18

Subtotals	74	180
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Receptors subscore (100 x factor score subtotal/maximum score subtotal)	41
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II. WASTE CHARACTERISTICS

A. Select the factor score based on the estimated quantity, the degree of hazard, and the confidence level of the information.

- | | |
|--|---------------|
| 1. Waste quantity (small, medium, or large) | S = small |
| 2. Confidence level (confirmed or suspected) | C = confirmed |
| 3. Hazard rating (low, medium, or high) | H = high |

Factor Subscore A (from 20 to 100 based on factor score matrix)	50
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B. Apply persistence factor

Factor Subscore A x Persistence Factor = Subscore B

50	x	1.00	=	50
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C. Apply physical state multiplier

Subscore B x Physical State Multiplier = Waste Characteristics Subscore

50	x	1.00	=	50
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Name of Site: Landfill No. 4

Page 2 of 2

III. PATHWAYS

A. If there is evidence of migration of hazardous contaminants, assign maximum factor subscore of 100 points for direct evidence or 80 points for indirect evidence. If direct evidence exists then proceed to C. If no evidence or indirect evidence exists, proceed to B.

Subscore 0

B. Rate the migration potential for 3 potential pathways: surface water migration, flooding, and ground-water migration. Select the highest rating and proceed to C.

Rating Factor	Factor Rating (0-3)	Multiplier	Factor Score	Maximum Possible Score
1. Surface Water Migration				
Distance to nearest surface water	1	8	8	24
Net precipitation	0	6	0	18
Surface erosion	2	8	16	24
Surface permeability	2	6	12	18
Rainfall intensity	1	8	8	24
Subtotals			44	100
Subscore (100 x factor score subtotal/maximum score subtotal)				41
2. Flooding				
	0	1	0	3
Subscore (100 x factor score/3)				0
3. Ground-water migration				
Depth to ground water	3	8	24	24
Net precipitation	0	6	0	18
Soil permeability	2	8	16	24
Subsurface flows	1	8	8	24
Direct access to ground water	0	8	0	24
Subtotals			48	114
Subscore (100 x factor score subtotal/maximum score subtotal)				42
C. Highest pathway subscore.				
Enter the highest subscore value from A, B-1, B-2 or B-3 above.				
Pathways Subscore			42	

IV. WASTE MANAGEMENT PRACTICES

A. Average the three subscores for receptors, waste characteristics, and pathways.

Receptors	41
Waste Characteristics	50
Pathways	42
Total	133

divided by 3 =

44 Gross total score

B. Apply factor for waste containment from waste management practices.

Gross total score x waste management practices factor = final score

44 x 1.00 =

44
FINAL SCORE

HAZARD ASSESSMENT RATING METHODOLOGY FORM

Name of site: Spill Site No. 1 (Pump House No. 7)

Location: Pump House No. 7

Date of Operation: 1972

Owner/Operator: Ellsworth AFB

Comments/Description: Spill of onboard fuel minus burned fuel

Site Rated by: J.R.Absalon ; J.P.McAuliffe ; J.Menard ; E.J.Schroeder

I. RECEPTORS

Rating Factor	Factor Rating (0-3)	Multi- plier	Factor Score	Maximum Possible Score
A. Population within 1,000 feet of site	1	4	4	12
B. Distance to nearest well	2	10	20	30
C. Land use/zoning within 1 mile radius	3	3	9	9
D. Distance to installation boundary	2	6	12	18
E. Critical environments within 1 mile radius of site	0	10	0	30
F. Water quality of nearest surface water body	0	6	0	18
G. Ground water use of uppermost aquifer	1	9	9	27
H. Population served by surface water supply within 3 miles downstream of site	0	6	0	18
I. Population served by ground-water supply within 3 miles of site	3	6	18	18
Subtotals			72	180
Receptors subscore (100 x factor score subtotal/maximum score subtotal)				<u>40</u>

II. WASTE CHARACTERISTICS

A. Select the factor score based on the estimated quantity, the degree of hazard, and the confidence level of the information.

- | | |
|--|---------------|
| 1. Waste quantity (small, medium, or large) | S = small |
| 2. Confidence level (confirmed or suspected) | C = confirmed |
| 3. Hazard rating (low, medium, or high) | H = high |

Factor Subscore A (from 20 to 100 based on factor score matrix) 50

B. Apply persistence factor

Factor Subscore A x Persistence Factor = Subscore B

$$50 \times 0.80 = 40$$

C. Apply physical state multiplier

Subscore B x Physical State Multiplier = Waste Characteristics Subscore

$$40 \times 1.00 = \underline{\underline{40}}$$

III. PATHWAYS

- A. If there is evidence of migration of hazardous contaminants, assign maximum factor subscore of 100 points for direct evidence or 80 points for indirect evidence. If direct evidence exists then proceed to C. If no evidence or indirect evidence exists, proceed to B.

Subscore 0

- B. Rate the migration potential for 3 potential pathways: surface water migration, flooding, and ground-water migration. Select the highest rating and proceed to C.

Rating Factor	Factor Rating (0-3)	Multi- plier	Factor Score	Maximum Possible Score
1. Surface Water Migration				
Distance to nearest surface water	2	8	16	24
Net precipitation	0	6	0	18
Surface erosion	2	8	16	24
Surface permeability	2	6	12	18
Rainfall intensity	1	8	8	24
Subtotals			52	108
Subscore (100 x factor score subtotal/maximum score subtotal)				48
2. Flooding				
	0	1	0	3
Subscore (100 x factor score/3)				0
3. Ground-water migration				
Depth to ground water	3	8	24	24
Net precipitation	0	6	0	18
Soil permeability	2	8	16	24
Subsurface flows	1	8	8	24
Direct access to ground water	0	8	0	24
Subtotals			48	114
Subscore (100 x factor score subtotal/maximum score subtotal)				42

- C. Highest pathway subscore.

Enter the highest subscore value from A, B-1, B-2 or B-3 above.

Pathways Subscore 48

IV. WASTE MANAGEMENT PRACTICES

- A. Average the three subscores for receptors, waste characteristics, and pathways.

Receptors 40
Waste Characteristics 40
Pathways 48
Total 128 divided by 3 =

43 Gross total score

- B. Apply factor for waste containment from waste management practices.

Gross total score x waste management practices factor = final score

43 x 1.00 =

43
FINAL SCORE

HAZARD ASSESSMENT RATING METHODOLOGY FORM

Name of site: Spill Site No. 3 (Hydrant Line Leaks)

Location: Pump Houses 1 - 5

Date of Operation: 1974

Owner/Operator: Ellsworth AFB

Comments/Description: Aluminum hydrant lines leaking, replaced in 1974

Site Rated by: J.R.Absalon ; J.P.McAuliffe ; J.Menard ; E.J.Schroeder

I. RECEPTORS

Rating Factor	Factor Rating (0-3)	Multiplier	Factor Score	Maximum Possible Score
A. Population within 1,000 feet of site	1	4	4	12
B. Distance to nearest well	2	10	20	30
C. Land use/zoning within 1 mile radius	3	3	9	9
D. Distance to installation boundary	2	6	12	18
E. Critical environments within 1 mile radius of site	0	10	0	30
F. Water quality of nearest surface water body	0	6	0	18
G. Ground water use of uppermost aquifer	1	9	9	27
H. Population served by surface water supply within 3 miles downstream of site	0	6	0	18
I. Population served by ground-water supply within 3 miles of site	3	6	18	18
Subtotals			72	180
Receptors subscore (100 x factor score subtotal/maximum score subtotal)				40

II. WASTE CHARACTERISTICS

A. Select the factor score based on the estimated quantity, the degree of hazard, and the confidence level of the information.

- | | |
|--|---------------|
| 1. Waste quantity (small, medium, or large) | M = medium |
| 2. Confidence level (confirmed or suspected) | S = suspected |
| 3. Hazard rating (low, medium, or high) | H = high |

Factor Subscore A (from 20 to 100 based on factor score matrix) 50

B. Apply persistence factor

Factor Subscore A x Persistence Factor = Subscore B

$$50 \times 0.80 = 40$$

C. Apply physical state multiplier

Subscore B x Physical State Multiplier = Waste Characteristics Subscore

$$40 \times 1.00 = 40$$

III. PATHWAYS

- A. If there is evidence of migration of hazardous contaminants, assign maximum factor subscore of 100 points for direct evidence or 80 points for indirect evidence. If direct evidence exists then proceed to C. If no evidence or indirect evidence exists, proceed to B.

Subscore 0

- B. Rate the migration potential for 3 potential pathways: surface water migration, flooding, and ground-water migration. Select the highest rating and proceed to C.

Rating Factor	Factor Rating (0-3)	Multiplier	Factor Score	Maximum Possible Score
1. Surface Water Migration				
Distance to nearest surface water	2	8	16	24
Net precipitation	0	6	0	18
Surface erosion	2	8	16	24
Surface permeability	2	6	12	18
Rainfall intensity	1	8	8	24
Subtotals			52	108
Subscore (100 x factor score subtotal/maximum score subtotal)				48
2. Flooding				
	0	1	0	3
Subscore (100 x factor score/3)				0
3. Ground-water migration				
Depth to ground water	3	8	24	24
Net precipitation	0	6	0	18
Soil permeability	2	8	16	24
Subsurface flows	1	8	8	24
Direct access to ground water	0	8	0	24
Subtotals			48	114
Subscore (100 x factor score subtotal/maximum score subtotal)				42

C. Highest pathway subscore.

Enter the highest subscore value from A, B-1, B-2 or B-3 above.

Pathways Subscore 48

IV. WASTE MANAGEMENT PRACTICES

- A. Average the three subscores for receptors, waste characteristics, and pathways.

Receptors	40
Waste Characteristics	40
Pathways	48
Total	128

divided by 3 =

43 Gross total score

- B. Apply factor for waste containment from waste management practices.

Gross total score x waste management practices factor = final score

43 x 1.00 =

43
FINAL SCORE

HAZARD ASSESSMENT RATING METHODOLOGY FORM

Name of site: Spill Site No. 2 (LF C-9 Coolant Spill)
 Location: Launch Facility C - 9
 Date of Operation: July 1977
 Owner/Operator: Ellsworth AFB
 Comments/Description: Discharge off launch facility, no cleanup

Site Rated by: J.R. Absalon ; J.P. McAuliffe ; J. Menard ; E.J. Schroeder

I. RECEPTORS

Rating Factor	Factor Rating (0-3)	Multiplier	Factor Score	Maximum Possible Score
A. Population within 1,000 feet of site	0	4	0	12
B. Distance to nearest well	0	10	0	30
C. Land use/zoning within 1 mile radius	0	3	0	9
D. Distance to installation boundary	3	6	18	18
E. Critical environments within 1 mile radius of site	0	10	0	30
F. Water quality of nearest surface water body	0	6	0	18
G. Ground water use of uppermost aquifer	1	9	9	27
H. Population served by surface water supply within 3 miles downstream of site	0	6	0	18
I. Population served by ground-water supply within 3 miles of site	1	6	6	18
Subtotals			33	180
Receptors subscore (100 x factor score subtotal/maximum score subtotal)				<u>18</u>

II. WASTE CHARACTERISTICS

A. Select the factor score based on the estimated quantity, the degree of hazard, and the confidence level of the information.

1. Waste quantity (small, medium, or large) S = small
 2. Confidence level (confirmed or suspected) C = confirmed
 3. Hazard rating (low, medium, or high) H = high

Factor Subscore A (from 20 to 100 based on factor score matrix) 60

B. Apply persistence factor

Factor Subscore A x Persistence Factor = Subscore B

$$60 \quad \times \quad 1.00 \quad = \quad 60$$

C. Apply physical state multiplier

Subscore B x Physical State Multiplier = Waste Characteristics Subscore

$$60 \quad \times \quad 1.00 \quad = \quad \underline{\underline{60}}$$

III. PATHWAYS

A. If there is evidence of migration of hazardous contaminants, assign maximum factor subscore of 100 points for direct evidence or 80 points for indirect evidence. If direct evidence exists then proceed to C. If no evidence or indirect evidence exists, proceed to B.

Subscore 0

B. Rate the migration potential for 3 potential pathways: surface water migration, flooding, and ground-water migration. Select the highest rating and proceed to C.

Rating Factor	Factor Rating (0-3)	Multiplier	Factor Score	Maximum Possible Score
1. Surface Water Migration				
Distance to nearest surface water	0	8	0	24
Net precipitation	0	6	0	18
Surface erosion	2	8	16	24
Surface permeability	2	6	12	18
Rainfall intensity	1	8	8	24
Subtotals			36	108
Subscore (100 x factor score subtotal/maximum score subtotal)				33
2. Flooding	0	1	0	3
Subscore (100 x factor score/3)				0
3. Ground-water migration				
Depth to ground water	3	8	24	24
Net precipitation	0	6	0	18
Soil permeability	2	8	16	24
Subsurface flows	1	8	8	24
Direct access to ground water	0	8	0	24
Subtotals			48	114
Subscore (100 x factor score subtotal/maximum score subtotal)				42

C. Highest pathway subscore.

Enter the highest subscore value from A, B-1, B-2 or B-3 above.

Pathways Subscore 42

IV. WASTE MANAGEMENT PRACTICES

A. Average the three subscores for receptors, waste characteristics, and pathways.

Receptors	18
Waste Characteristics	60
Pathways	42
Total	120

divided by 3 =

40 Gross total score

B. Apply factor for waste containment from waste management practices.

Gross total score x waste management practices factor = final score

40 x 1.00 =

40
FINAL SCORE

HAZARD ASSESSMENT RATING METHODOLOGY FORM

Name of site: Spill Site No. 5 (LF C-11 Coolant Spill)

Location: Launch Facility C - 11

Date of Operation: January 1983

Owner/Operator: Ellsworth AFB

Comments/Description: Soil rototilled and left in place

Site Rated by: J.R.Absalon ; J.P.McAuliffe ; J.Menard ; E.J.Schroeder

I. RECEPTORS

Rating Factor	Factor Rating (0-3)	Multi- plier	Factor Score	Maximum Possible Score
A. Population within 1,000 feet of site	0	4	0	12
B. Distance to nearest well	0	10	0	30
C. Land use/zoning within 1 mile radius	0	3	0	9
D. Distance to installation boundary	3	6	18	18
E. Critical environments within 1 mile radius of site	0	10	0	30
F. Water quality of nearest surface water body	0	6	0	18
G. Ground water use of uppermost aquifer	1	9	9	27
H. Population served by surface wa supply within 3 miles downstream of site	0	6	0	18
I. Population served by ground-water supply within 3 miles of site	1	6	6	18
Subtotals			33	180
Receptors subscore (100 x factor score subtotal/maximum score subtotal)				<u>18</u>

II. WASTE CHARACTERISTICS

A. Select the factor score based on the estimated quantity, the degree of hazard, and the confidence level of the information.

- | | |
|--|---------------|
| 1. Waste quantity (small, medium, or large) | S = small |
| 2. Confidence level (confirmed or suspected) | C = confirmed |
| 3. Hazard rating (low, medium, or high) | H = high |

Factor Subscore A (from 20 to 100 based on factor score matrix) 60

B. Apply persistence factor

Factor Subscore A x Persistence Factor = Subscore B

$$60 \quad \times \quad 1.00 \quad = \quad 60$$

C. Apply physical state multiplier

Subscore B x Physical State Multiplier = Waste Characteristics Subscore

$$60 \quad \times \quad 1.00 \quad = \quad \underline{\underline{60}}$$

III. PATHWAYS

- A. If there is evidence of migration of hazardous contaminants, assign maximum factor subscore of 100 points for direct evidence or 80 points for indirect evidence. If direct evidence exists then proceed to C. If no evidence or indirect evidence exists, proceed to B.

Subscore 0

- B. Rate the migration potential for 3 potential pathways: surface water migration, flooding, and ground-water migration. Select the highest rating and proceed to C.

Rating Factor	Factor Rating (0-3)	Multiplier	Factor Score	Maximum Possible Score
1. Surface Water Migration				
Distance to nearest surface water	0	8	0	24
Net precipitation	0	6	0	18
Surface erosion	2	8	16	24
Surface permeability	2	6	12	18
Rainfall intensity	1	8	8	24
Subtotals			36	108
Subscore (100 x factor score subtotal/maximum score subtotal)				33
2. Flooding				
	0	1	0	3
Subscore (100 x factor score/3)				0
3. Ground-water migration				
Depth to ground water	3	8	24	24
Net precipitation	0	6	0	18
Soil permeability	2	8	16	24
Subsurface flows	1	8	8	24
Direct access to ground water	0	8	0	24
Subtotals			48	114
Subscore (100 x factor score subtotal/maximum score subtotal)				42

- C. Highest pathway subscore.

Enter the highest subscore value from A, B-1, B-2 or B-3 above.

Pathways Subscore 42

IV. WASTE MANAGEMENT PRACTICES

- A. Average the three subscores for receptors, waste characteristics, and pathways.

Receptors	18
Waste Characteristics	60
Pathways	42
Total	120

divided by 3 =

40 Gross total score

- B. Apply factor for waste containment from waste management practices.

Gross total score x waste management practices factor = final score

40 x 1.00 =

40
FINAL SCORE

HAZARD ASSESSMENT RATING METHODOLOGY FORM

Name of site: Spill Site No. 6 (LF N-10 Coolant Spill)

Location: Launch Facility N - 10

Date of Operation: August 1983

Owner/Operator: Ellsworth AFB

Comments/Description: Stained soil removed from adjacent property

Site Rated by: J.R.Absalon ; J.P.McAuliffe ; J.Menard ; E.J.Schroeder

I. RECEPTORS

Rating Factor	Factor Rating (0-3)	Multiplier	Factor Score	Maximum Possible Score
A. Population within 1,000 feet of site	0	4	0	12
B. Distance to nearest well	0	10	0	30
C. Land use/zoning within 1 mile radius	0	3	0	9
D. Distance to installation boundary	3	6	18	18
E. Critical environments within 1 mile radius of site	0	10	0	30
F. Water quality of nearest surface water body	0	6	0	18
G. Ground water use of uppermost aquifer	1	9	9	27
H. Population served by surface water supply within 3 miles downstream of site	0	6	0	18
I. Population served by ground-water supply within 3 miles of site	1	6	6	18
Subtotals			33	180
Receptors subscore (100 x factor score subtotal/maximum score subtotal)				<u>18</u>

II. WASTE CHARACTERISTICS

A. Select the factor score based on the estimated quantity, the degree of hazard, and the confidence level of the information.

- | | |
|--|---------------|
| 1. Waste quantity (small, medium, or large) | S = small |
| 2. Confidence level (confirmed or suspected) | C = confirmed |
| 3. Hazard rating (low, medium, or high) | H = high |

Factor Subscore A (from 20 to 100 based on factor score matrix) 60

B. Apply persistence factor

Factor Subscore A x Persistence Factor = Subscore B

$$60 \quad \times \quad 1.00 \quad = \quad 60$$

C. Apply physical state multiplier

Subscore B x Physical State Multiplier = Waste Characteristics Subscore

$$60 \quad \times \quad 1.00 \quad = \quad \underline{\underline{60}}$$

III. PATHWAYS

- A. If there is evidence of migration of hazardous contaminants, assign maximum factor subscore of 100 points for direct evidence or 80 points for indirect evidence. If direct evidence exists then proceed to C. If no evidence or indirect evidence exists, proceed to B.

Subscore 0

- B. Rate the migration potential for 3 potential pathways: surface water migration, flooding, and ground-water migration. Select the highest rating and proceed to C.

Rating Factor	Factor Rating (0-3)	Multiplier	Factor Score	Maximum Possible Score
1. Surface Water Migration				
Distance to nearest surface water	0	8	0	24
Net precipitation	0	6	0	18
Surface erosion	2	8	16	24
Surface permeability	2	6	12	18
Rainfall intensity	1	8	8	24
Subtotals			36	108
Subscore (100 x factor score subtotal/maximum score subtotal)				33
2. Flooding	0	1	0	3
Subscore (100 x factor score/3)				0
3. Ground-water migration				
Depth to ground water	3	8	24	24
Net precipitation	0	6	0	18
Soil permeability	2	8	16	24
Subsurface flows	1	8	8	24
Direct access to ground water	0	8	0	24
Subtotals			48	114
Subscore (100 x factor score subtotal/maximum score subtotal)				42

- C. Highest pathway subscore.

Enter the highest subscore value from A, B-1, B-2 or B-3 above.

Pathways Subscore 42

IV. WASTE MANAGEMENT PRACTICES

- A. Average the three subscores for receptors, waste characteristics, and pathways.

Receptors	18
Waste Characteristics	60
Pathways	42
Total	120

divided by 3 =

40 Gross total score

- B. Apply factor for waste containment from waste management practices.

Gross total score x waste management practices factor = final score

40 x 1.00 =

40
FINAL SCORE

HAZARD ASSESSMENT RATING METHODOLOGY FORM

Name of site: Spill Site No. 4 (EOD Pramitol Spill)

Location: EOD Area

Date of Operation: May 1982

Owner/Operator: Ellsworth AFB

Comments/Description: 100 gallons of Pramitol

Site Rated by: J.R.Absalon ; J.P.McAuliffe ; J.Menard ; E.J.Schroeder

I. RECEPTORS

Rating Factor	Factor Rating (0-3)	Multiplier	Factor Score	Maximum Possible Score
A. Population within 1,000 feet of site	0	4	0	12
B. Distance to nearest well	2	10	20	30
C. Land use/zoning within 1 mile radius	3	3	9	9
D. Distance to installation boundary	3	6	18	18
E. Critical environments within 1 mile radius of site	0	10	0	30
F. Water quality of nearest surface water body	0	6	0	18
G. Ground water use of uppermost aquifer	1	9	9	27
H. Population served by surface water supply within 3 miles downstream of site	0	6	0	18
I. Population served by ground-water supply within 3 miles of site	3	6	18	18

Subtotals	74	180
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Receptors subscore (100 x factor score subtotal/maximum score subtotal)	41
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II. WASTE CHARACTERISTICS

A. Select the factor score based on the estimated quantity, the degree of hazard, and the confidence level of the information.

- | | |
|--|---------------|
| 1. Waste quantity (small, medium, or large) | S = small |
| 2. Confidence level (confirmed or suspected) | C = confirmed |
| 3. Hazard rating (low, medium, or high) | M = medium |

Factor Subscore A (from 20 to 100 based on factor score matrix)	50
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B. Apply persistence factor

Factor Subscore A x Persistence Factor = Subscore B

50	x	0.40	=	20
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C. Apply physical state multiplier

Subscore B x Physical State Multiplier = Waste Characteristics Subscore

20	x	1.00	=	20
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III. PATHWAYS

- A. If there is evidence of migration of hazardous contaminants, assign maximum factor subscore of 100 points for direct evidence or 80 points for indirect evidence. If direct evidence exists then proceed to C. If no evidence or indirect evidence exists, proceed to B.

Subscore 0

- B. Rate the migration potential for 3 potential pathways: surface water migration, flooding, and ground-water migration. Select the highest rating and proceed to C.

Rating Factor	Factor Rating (0-3)	Multi- plier	Factor Score	Maximum Possible Score
1. Surface Water Migration				
Distance to nearest surface water	1	8	8	24
Net precipitation	0	6	0	18
Surface erosion	2	8	16	24
Surface permeability	2	6	12	18
Rainfall intensity	1	8	8	24
Subtotals			44	108
Subscore (100 x factor score subtotal/maximum score subtotal)				41
2. Flooding				
	0	1	0	3
Subscore (100 x factor score/3)				0
3. Ground-water migration				
Depth to ground water	3	8	24	24
Net precipitation	0	6	0	18
Soil permeability	2	8	16	24
Subsurface flows	1	8	8	24
Direct access to ground water	0	8	0	24
Subtotals			48	114
Subscore (100 x factor score subtotal/maximum score subtotal)				42

C. Highest pathway subscore.

Enter the highest subscore value from A, B-1, B-2 or B-3 above.

Pathways Subscore 42

IV. WASTE MANAGEMENT PRACTICES

- A. Average the three subscores for receptors, waste characteristics, and pathways.

Receptors	41
Waste Characteristics	20
Pathways	42
Total	103

divided by 3 =

34 Gross total score

- B. Apply factor for waste containment from waste management practices.

Gross total score x waste management practices factor = final score

34 x 1.00 =

34
FINAL SCORE

APPENDIX I
GLOSSARY OF TERMINOLOGY AND ABBREVIATIONS

APPENDIX I
GLOSSARY OF TERMINOLOGY AND ABBREVIATIONS

ACFT MAINT: Aircraft Maintenance.

ADC: Aerospace Defense Command.

AEC: Atomic Energy Commission.

AF: Air Force.

AFB: Air Force Base.

AFFF: Aqueous Film Forming Foam, a fire extinguishing agent. AFFF concentrates include fluorinated surfactants plus foam stabilizers diluted with water to a 3 to 6% solution.

AFRCE: Air Force Regional Civil Engineer.

AFS: Air Force Station.

AFSC: Air Force Systems Command.

Ag: Chemical symbol for silver.

AGE: Aerospace Ground Equipment.

Al: Chemical symbol for aluminum.

ALC: Air Logistics Center.

ALLUVIUM: Materials eroded, transported and deposited by streams.

AMS: Avionics Maintenance Squadron

ANG: Air National Guard.

ANTICLINE: A fold in which layered strata are inclined down and away from the axes.

AROMATIC: Description of organic chemical compounds in which the carbon atoms are arranged into a ring with special electron stability associated. Aromatic compounds are often more reactive than non-aromatics.

ARTESIAN: Ground water contained under hydrostatic pressure.

AQUICLUDE: Poorly permeable formation that impedes ground-water movement and does not yield to a well or spring.

AQUIFER: A geologic formation, group of formations, or part of a formation that is capable of yielding water to a well or spring.

AQUITARD: A geologic unit which impedes ground-water flow.

AREFG: Air Refueling Group.

As: Chemical Symbol for arsenic.

ASC: Audiovisual Service Center.

ATC: Air Training Command.

AVGAS: Aviation Gasoline.

Ba: Chemical symbol for barium.

BEDROCK: Any solid rock exposed at the surface of the earth or overlain by unconsolidated material.

BEE: Bioenvironmental Engineer.

BES: Bioenvironmental Engineering Section.

BIOACCUMULATE: Tendency of elements or compounds to accumulate or build up in the tissues of living organisms when they are exposed to these elements in their environments, e.g., heavy metals.

BIODEGRADABLE: The characteristic of a substance to be broken down from complex to simple compounds by microorganisms.

BOWSER: A portable tank, usually under 200 gallons in capacity.

BX: Base Exchange.

CaCO_3 : Chemical symbol for calcium carbonate.

Cd: Chemical symbol for cadmium.

CE: Civil Engineering.

CERCLA: Comprehensive Environmental Response, Compensation and Liability Act.

CES: Civil Engineering Squadron.

CIRCA: About; used to indicate an approximate date.

CLOSURE: The completion of a set of rigidly defined functions for a hazardous waste facility no longer in operation.

CN: Chemical symbol for cyanide.

COD: Chemical Oxygen Demand, a measure of the amount of oxygen required to oxidize organic and oxidizable inorganic compounds in water.

COE: Corps of Engineers.

COLLUVIUM: Sediments that have moved down slope primarily under the influence of gravity or as periodic, unchanneled flow. It frequently includes large boulders or other fragments which contrast this material to alluvium, material deposited by channelized flow which results in some degree of sorting according to particle size.

CONFINED AQUIFER: An aquifer bounded above and below by impermeable strata or by geologic units of distinctly lower permeability than that of the aquifer itself.

CONFINING UNIT: An aquitard or other poorly permeable layer which restricts the movement of ground water.

CONTAMINATION: The degradation of natural water quality to the extent that its usefulness is impaired; there is no implication of any specific limits since the degree of permissible contamination depends upon the intended end use or uses of the water.

CPM: Counts per minute (alpha radiation measurement).

Cr: Chemical symbol for chromium.

CSG: Combat Support Group.

Cu: Chemical symbol for copper.

CURIE: Unit for measuring radioactivity. One curie is the quantity of any radioactive isotope undergoing 3.7×10^{10} disintegrations per second.

DEQPPM: Defense Environmental Quality Program Policy Memorandum

DET: Detachment.

DISPOSAL FACILITY: A facility or part of a facility at which hazardous waste is intentionally placed into or on land or water, and at which waste will remain after closure.

DISPOSAL OF HAZARDOUS WASTE: The discharge, deposit, injection, dumping, spilling, or placing of any hazardous waste into or on land or water so that such waste or any constituent thereof may enter the environment or be emitted into the air or discharged into any waters, including ground water.

DOD: Department of Defense.

DOWNGRAIENT: In the direction of decreasing hydraulic static head; the direction in which ground water flows.

DPDO: Defense Property Disposal Office, previously included Redistribution and Marketing (R&M) and Salvage. The name has recently been changed to Defense Reutilization and Marketing Agency.

DUMP: An uncovered land disposal site where solid and/or liquid wastes are deposited with little or no regard for pollution control or aesthetics; dumps are susceptible to open burning and are exposed to the elements, disease vectors and scavengers.

EFFLUENT: A liquid waste discharge from a manufacturing or treatment process, in its natural state, or partially or completely treated, that discharges into the environment.

ELECTRICAL RESISTIVITY (ER): Specialized equipment designed to produce an electrical current through subsurface geologic strata. The instrument and the technique permit the operator to examine conditions at specific depths below land surface. Subsurface contrasts indicative of specific geologic or hydrologic conditions may be obtained through correlation of the ER data with known site information such as that provided by test borings or well construction logs.

EOD: Explosive Ordnance Disposal.

EP: Extraction Procedure, the EPA's standard laboratory procedure for leachate generation.

EPA: U.S. Environmental Protection Agency.

EPHEMERAL: Short-lived or temporary.

EPHEMERAL AQUIFER: A water-bearing zone typically located near the surface which normally contains water seasonally.

EROSION: The wearing away of land surface by wind, water, or chemical processes.

ES: Engineering-Science, Inc.

FAA: Federal Aviation Administration.

FACILITY (As Applied to Hazardous Wastes): Any land and appurtenances thereon and thereto used for the treatment, storage and/or disposal of hazardous wastes.

FAULT: A fracture in rock along which the adjacent rock surfaces are differentially displaced.

Fe: Chemical symbol for iron.

FLOOD PLAIN: The lowland and relatively flat areas adjoining inland and coastal areas of the mainland and off-shore islands, including, at a minimum, areas subject to a one percent or greater chance of flooding in any given year.

FLOW PATH: The direction or movement of ground water as governed principally by the hydraulic gradient.

FMMS: Field Missile Maintenance Squadron.

FMS: Field Maintenance Squadron.

FPTA: Fire Protection Training Area.

FTA: Fire Training Area.

GC/MS: Gas chromatograph/mass spectrophotometer, a laboratory procedure for identifying unknown compounds.

GEOPHYSICS: (Geophysical survey) the use of one or more geophysical instruments or methods to measure specific properties of the earth's subsurface through indirect means. Geophysical equipment may include electrical resistivity, geiger counter, magnetometer, metal detector, electromagnetic conductivity, magnetic susceptibility, etc. Geophysics seeks to provide specific measurements of the earth's magnetic field, the electrical properties of specific geologic strata, radioactivity, etc.

GLACIAL TILL: Unsorted and unstratified drift consisting of clay, sand, gravel and boulders which is deposited by or underneath a glacier.

GROUND WATER: Water beneath the land surface in the saturated zone that is under atmospheric or artesian pressure.

GROUND-WATER RESERVOIR: The earth materials and the intervening open spaces that contain ground water.

HALF-LIFE: The time required for half the atoms present in radioactive substance to disintegrate.

HALOGEN: The class of chemical elements including fluorine, chlorine, bromine, and iodine.

HARDFILL: Disposal sites receiving construction debris, wood, miscellaneous spoil material.

HARM: Hazard Assessment Rating Methodology.

HAZARDOUS SUBSTANCE: Under CERCLA, the definition of hazardous substance includes:

1. All substances regulated under Paragraphs 311 and 307 of the Clean Water Act (except oil);
2. All substances regulated under Paragraph 3001 of the Solid Waste Disposal Act;
3. All substances regulated under Paragraph 112 of the Clean Air Act;

4. All substances which the Administrator of EPA has acted against under Paragraph 7 of the Toxic Substance Control Act;

5. Additional substances designated under Paragraph 102 of CERCLA.

HAZARDOUS WASTE: As defined in RCRA, a solid waste, or combination of solid wastes, which because of its quantity, concentration, or physical, chemical or infectious characteristics may cause or significantly contribute to an increase in mortality or an increase in serious, irreversible, or incapacitating reversible illness; or pose a substantial present or potential hazard to human health or the environment when improperly treated, stored, transported, or disposed of, or otherwise managed.

HAZARDOUS WASTE GENERATION: The act or process of producing a hazardous waste.

HEAVY METALS: Metallic elements, including the transition series, which include many elements required for plant and animal nutrition in trace concentrations but which become toxic at higher concentrations.

Hg: Chemical symbol for mercury.

HQ: Headquarters.

HYDROCARBONS: Organic chemical compounds composed of hydrogen and carbon atoms chemically bonded. Hydrocarbons may be straight chain, cyclic, branched chain, aromatic, or polycyclic, depending upon arrangement of carbon atoms. Halogenated hydrocarbons are hydrocarbons in which one or more hydrogen atoms has been replaced by a halogen atom.

INCOMPATIBLE WASTE: A waste unsuitable for commingling with another waste or material because the commingling might result in generation of extreme heat or pressure, explosion or violent reaction, fire, formation of substances which are shock sensitive, friction sensitive, or otherwise have the potential for reacting violently, formation of toxic dusts, mists, fumes, and gases, volatilization of ignitable or toxic chemicals due to heat generation in such a manner that the likelihood of contamination of ground water or escape of the substance into the environment is increased, any other reaction which might result in not meeting the air, human health, and environmental standards.

INFILTRATION: The movement of water through the soil surface into the ground.

IRP: Installation Restoration Program.

ISOPACH: Graphic presentation of geologic data, including lines of equal unit thickness that may be based on confirmed (drill hole) data or indirect geophysical measurement.

ISOTOPE: Two or more species of atoms of the same chemical element, with the same atomic number and place in the periodic table, and nearly identical chemical properties, but with different atomic mass numbers

and different physical properties; an example may be the radioactive isotope - Carbon (12) and Carbon-14.

JP-4: Jet Propulsion Fuel Number Four; contains both kerosene and gasoline fractions.

JP-5: Jet Propulsion Fuel Number Five; consists of high boiling kerosene fractions.

LANDFILL: A land disposal site used for disposing solid and semi-solid materials. May refer either to a sanitary landfill or dump.

LEACHATE: A solution resulting from the separation or dissolving of soluble or particulate constituents from solid waste or other man-placed medium by percolation of water.

LEACHING: The process by which soluble materials in the soil, such as nutrients, pesticide chemicals or contaminants, are washed into a lower layer of soil or are dissolved and carried away by water.

LENTICULAR: A bed or rock stratum or body that is lens-shaped.

LINER: A continuous layer of natural or man-made materials beneath or on the sides of a surface impoundment, landfill, or landfill cell which restricts the downward or lateral escape of hazardous waste, hazardous waste constituents or leachate.

LITHOLOGY: The description of the physical character of a rock.

LOESS: An essentially unconsolidated unstratified calcareous silt; commonly homogeneous, permeable and buff to gray in color.

m: Milli (10^{-3}).

MAGNETOMETER (MG): A device capable of measuring localized variations in the earth's magnetic field that may be due to disturbed areas such as backfilled trenches, buried objects, etc. Measurements may be obtained at points located on a grid pattern so that the data can be contoured, revealing the location, size and intensity of the suspected anomaly.

MAINT: Recording System Maintenance.

MEK: Methyl Ethyl Ketone.

METALS: See "Heavy Metals".

MGD: Million Gallons per Day.

MIBK: Methyl Isobutyl Ketone.

MICRO: 1×10^{-6} .

ug/l: Micrograms per liter.

mg/l: Milligrams per liter.

MOA: Military Operating Area.

MOGAS: Motor gasoline.

Mn: Chemical symbol for manganese.

MONITORING WELL: A well used to measure ground-water levels and to obtain ground-water samples for water quality analyses. As distinguished from observation wells, monitoring wells are often designed for longer term operations. They are constructed of materials for the site-specific climatic, hydrogeologic and contaminant conditions.

MSL: Mean Sea Level.

MUNITION ITEMS: Munitions or portions of munitions having an explosive potential.

MUNITIONS RESIDUE: Non-explosive segments of waste munitions (i.e., bomb casings).

MWR: Morale Welfare and Recreation.

NCO: Non-commissioned Officer.

NCOIC: Non-commissioned Officer In-Charge.

NDI: Non-destructive Inspection.

NET PRECIPITATION: The amount of annual precipitation minus annual evaporation.

NGVD: National Geodetic Vertical Datum of 1929. A national datum system, tied to Mean Sea Level, but referenced primarily to land-based benchmarks.

Ni: Chemical symbol for nickel.

NOAA: National Oceanic and Atmospheric Administration.

NON-CALCAREOUS: Not bearing calcium carbonate (CaCO_3) a characteristic mineral of marine paleoenvironment.

NPDES: National Pollutant Discharge Elimination System.

OBSERVATION WELL: An informally designed cased well, open to a specific geologic unit or formation, designed to allow the measurement of physical ground-water properties within the zone or unit of interest. Observation wells are designed to permit the measurement of water levels and in-situ parameters such as ground-water (flow velocity and flow direction). Not to be confused with a monitoring well, a well designed to permit accurate ground-water quality monitoring. Monitoring wells are constructed of materials compatible with site-specific climatic, hydro-

geologic and contaminant conditions. monitoring well installation and construction is planned to have minimal impacts on apparent ground-water quality and will often be for longer term operation compared with observation wells.

OEHL: USAF Occupational and Environmental Health Laboratory.

OIC: Officer-In-Charge.

OMMS: Organizational Missile Maintenance Squadron.

OMS: Organizational Maintenance Squadron.

OPNS: Operations.

ORGANIC: Being, containing or relating to carbon compounds, especially in which hydrogen is attached to carbon.

OSI: Office of Special Investigations.

O&G: Symbols for oil and grease.

OUT CROP: Zone or area of exposure where a geologic unit or formation occurs at or near land surface. "Outcrop area" is an important factor in hydrogeologic studies as this zone usually corresponds to the point where significant recharge occurs. When this term is used as an intransitive verb: "Where the unit crops out....."

OXIDIZER: Material necessary to support combustion of fuel.

Pb: Chemical symbol for lead.

PCB: Polychlorinated Biphenyl; liquids used as a dielectrics in electrical equipment.

PD-680: Cleaning solvent; petroleum distillate, Stoddard solvent.

PERCHED WATER TABLE: A water table above a relatively impermeable zone underlain by unsaturated rocks of sufficient permeability to allow ground-water movement.

PERCOLATION: Movement of moisture by gravity or hydrostatic pressure through interstices of unsaturated rock or soil.

PERMEABILITY: The relative rate of water flow through a porous medium. The USDA, Soil Conservation Service describes permeability qualitatively as follows:

very slow	<0.06	inches/hour
slow	0.06 to 0.2	inches/hour
moderately slow	0.2 to 0.6	inches/hour
moderate	0.6 to 2.0	inches/hour
moderately rapid	2.0 to 6.0	inches/hour
rapid	6.0 to 20	inches/hour
very rapid	>20	inches/hour

PERSISTENCE: As applied to chemicals, those which are very stable and remain in the environment in their original form for an extended period of time.

PESTICIDE: An agent used to destroy pests. Pesticides include such specialty groups as herbicides, fungicides, insecticides, etc.

pH: Negative logarithm of hydrogen ion concentration.

pico: 10^{-12}

PL: Public Law.

PMEL: Precision Measurement Equipment Lab.

POL: Petroleum, Oils and Lubricants.

POLLUTANT: Any introduced gas, liquid or solid that makes a resource unfit for a specific purpose.

POLYCYCLIC COMPOUND: All compounds in which carbon atoms are arranged into two or more rings, usually aromatic in nature.

POTENTIALLY ACTIVE FAULT: A fault along which movement has occurred within the last 25-million years.

POTENTIOMETRIC SURFACE: The imaginary surface to which water in an artesian aquifer would rise in tightly screened wells penetrating it.

ppb: Parts per billion by weight.

ppm: Parts per million by weight.

PRECIPITATION: Rainfall.

PROPELLANT: fuels, oxidizers and monopropellants.

QUATERNARY MATERIALS: The second period of the Cenozoic geologic era, following the Tertiary, and including the last 2-3 million years.

QAE: Quality Assurance Evaluator.

RCRA: Resource Conservation and Recovery Act.

RECEPTORS: The potential impact group or resource for a waste contamination source.

RECHARGE AREA: A surface area in which surface water or precipitation percolates through the unsaturated zone and eventually reaches the zone of saturation. Recharge areas may be natural or manmade.

RECHARGE: The addition of water to the ground-water system by natural or artificial processes.

RESISTIVITY: See Electrical Resistivity

RIPARIAN: Living or located on a riverbank.

SAC: Strategic Air Command.

SANITARY LANDFILL: A land disposal site using an engineered method of disposing solid wastes on land in a way that minimizes environmental hazards.

SATURATED ZONE: That part of the earth's crust in which all voids are filled with water.

SAX'S TOXICITY: A rating method for evaluating the toxicity of chemical materials.

SCS: U.S. Department of Agriculture Soil Conservation Service.

SEISMICITY: Pertaining to earthquakes or earth vibrations.

SLUDGE: The solid residue resulting from a manufacturing or wastewater treatment process which also produces a liquid stream. The residue which accumulates in liquid fuel storage tanks.

SOLE SOURCE: As in aquifer. The only source of potable water supplies of acceptable quality available in adequate quantities for a significant population. Sole source is a legal term which permits use control of the aquifer by designated regulatory authorities.

SMART: Structural maintenance and repair team.

SOLID WASTE: Any garbage, refuse, or sludge from a waste treatment plant, water supply treatment, or air pollution control facility and other discarded material, including solid, liquid, semi-solid, or contained gaseous material resulting from industrial, commercial, mining, or agricultural operations and from community activities, but does not include solid or dissolved materials in domestic sewage; solid or dissolved materials in irrigation return flows; industrial discharges which are point source subject to permits under Section 402 of the Federal Water Pollution Control Act, as amended (86 USC 880); or source, special nuclear, or by-product material as defined by the Atomic Energy Act of 1954 (68 USC 923).

SPILL: Any unplanned release or discharge of a hazardous waste onto or into the air, land, or water.

STORAGE OF HAZARDOUS WASTE: Containment, either on a temporary basis or for a longer period, in such a manner as not to constitute disposal of such hazardous waste.

STP: Sewage Treatment Plant.

SUPS: Supply Squadron.

TASS: Tactical Air Support Squadron.

TCA: 1,1,1,-Tetrachloroethane.

TCE: Trichloroethylene, a solvent and suspected carcinogen.

TDS: Total Dissolved Solids.

TOC: Total Organic Carbon.

TOXICITY: The ability of a material to produce injury or disease upon exposure, ingestion, inhalation, or assimilation by a living organism.

TRANS: Transportation Squadron.

TRANSMISSIVITY: The rate at which water is transmitted through a unit width of aquifer under a unit hydraulic gradient.

TREATMENT OF HAZARDOUS WASTE: Any method, technique, or process including neutralization designed to change the physical, chemical, or biological character or composition of any hazardous waste so as to neutralize the waste or so as to render the waste nonhazardous.

TS: Transportation Squadron.

TSD: Treatment, storage or disposal sites/methods.

UPGRADIENT: In the direction of increasing hydraulic static head; the direction opposite to the prevailing flow of ground-water.

US: United States.

USAF: United States Air Force.

USAFSS: United States Air Force Security Service.

USDA: United States Department of Agriculture.

USFWS: United States Fish and Wildlife Service.

USGS: United States Geological Survey.

WATER TABLE: Surface of a body of unconfined ground water at which the pressure is equal to that of the atmosphere.

WWTP: Wastewater Treatment Plant.

Zn: Chemical symbol for zinc.

APPENDIX J
REFERENCES

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REFERENCES

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APPENDIX K
SITES EVALUATED USING
HAZARD ASSESSMENT RATING METHODOLOGY
ELLSWORTH AFB

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Rank	Site	References [Page No's]
1.	Fire Protection Training Area	5, 6, 8, 4-21, 4-22, 4-43, 4-45, 5-1, 5-2, 6-3, 6-4, 6-9, F-5, H-1, H-2
2.	Spill Site No. 9 (Auto Hobby Shop Heating Fuel)	5, 6, 8, 4-16, 4-17, 4-20, 4-43, 4-45, 5-2, 5-3, 6-4, 6-9, 6-11, H-3, H-4
3.	Landfill No. 3	5, 6, 8, 4-24, 4-25, 4-26, 4-43, 4-45, 5-2, 5-3, 6-4, 6-9, 6-11, F-8, H-5, H-6
4.	Landfill No. 1	5, 6, 8, 4-23, 4-24, 4-25, 4-43, 4-45, 5-2, 5-4, 6-4, 6-9, 6-12, F-6, H-7, H-8
5.	Spill Site No. 7 (Pump House No. 6)	6, 8, 9, 4-16, 4-17, 4-20, 4-43, 4-45, 5-2, 5-5, 6-4, 6-9, 6-12, F-10, H-9, H-10
6.	Landfill No. 6	6, 8, 9, 4-24, 4-25, 4-28, 4-43, 4-45, 5-2, 5-5, 6-5, 6-9, 6-12, F-6, H-11, H-12
7.	Landfill No. 2	6, 8, 9, 4-24, 4-25, 4-26, 4-43, 4-45, 5-2, 5-6, 6-5, 6-9, 6-12, F-2, H-13, H-14
8.	*Low-Level Radioactive Burial Sites	6, 8, 9, 4-33, 4-34, 4-35, 4-43, 4-45, 5-2, 5-6, 6-5, 6-9, 6-13, F-13, H-15, H-16
9.	*Landfill No. 5	6, 8, 9, 4-24, 4-25, 4-27, 4-43, 4-45, 5-2, 5-7, 6-5, 6-9, 6-13, H-17, H-18
10.	*Landfill No. 4	6, 8, 9, 4-24, 4-25, 4-27, 4-43, 4-45, 5-2, 5-8, 6-5, 6-9, 6-13, F-9, H-19, H-20

APPENDIX K
(Continued)
SITES EVALUATED USING THE
HAZARD ASSESSMENT RATING METHODOLOGY
ELLSWORTH AFB

Rank	Site	References [Page No's]
11.	Spill Site No. 1 (Pump House No. 7)	6, 8, 9, 4-15, 4-16, 4-17, 4-43, 4-45, 5-2, 5-8, 6-6, 6-9, 6-14, F-10, H-21, H-22
12.	Spill Site No. 3 (Hydrant Line Leaks)	6, 8, 9, 4-15, 4-16, 4-17, 4-43, 4-45, 5-2, 5-9, 6-6, 6-9, 6-14, F-10, H-23, H-24
13.	Spill Site No. 2 (C-9 LF Coolant Spill)	7, 8, 9, 4-15, 4-16, 4-18, 4-43 4-45, 5-2, 5-9, 6-6, 6-10, 6-14, F-12, H-25, H-26
14.	Spill Site No. 5 (C-11 LF Coolant Spill)	7, 8, 10, 4-16, 4-17, 4-19, 4-43, 4-45, 5-2, 5-9, 6-6, 6-10, 6-14, F-12, H-27, H-28
15.	Spill Site No. 6 (N-10 LF Coolant Spill)	7, 8, 10, 4-16, 4-18, 4-19, 4-43, 4-45, 5-2, 5-10, 6-6, 6-10, 6-14, F-12, H-29, H-30
16.	Spill Site No. 4 (EOD Pramitol Spill)	6, 8, 10, 4-16, 4-17, 4-19, 4-43, 4-45, 5-2, 5-10, 6-6, 6-9, 6-15, F-11, H-31, H-32

¹ This ranking was performed according to the Hazard Assessment Rating Methodology (HARM) described in Appendix G. Individual rating forms are in Appendix H.

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