SITE INVESTIGATION REPORT FOR IRP SITES NO. 25 AND NO. 26

VOLUME I

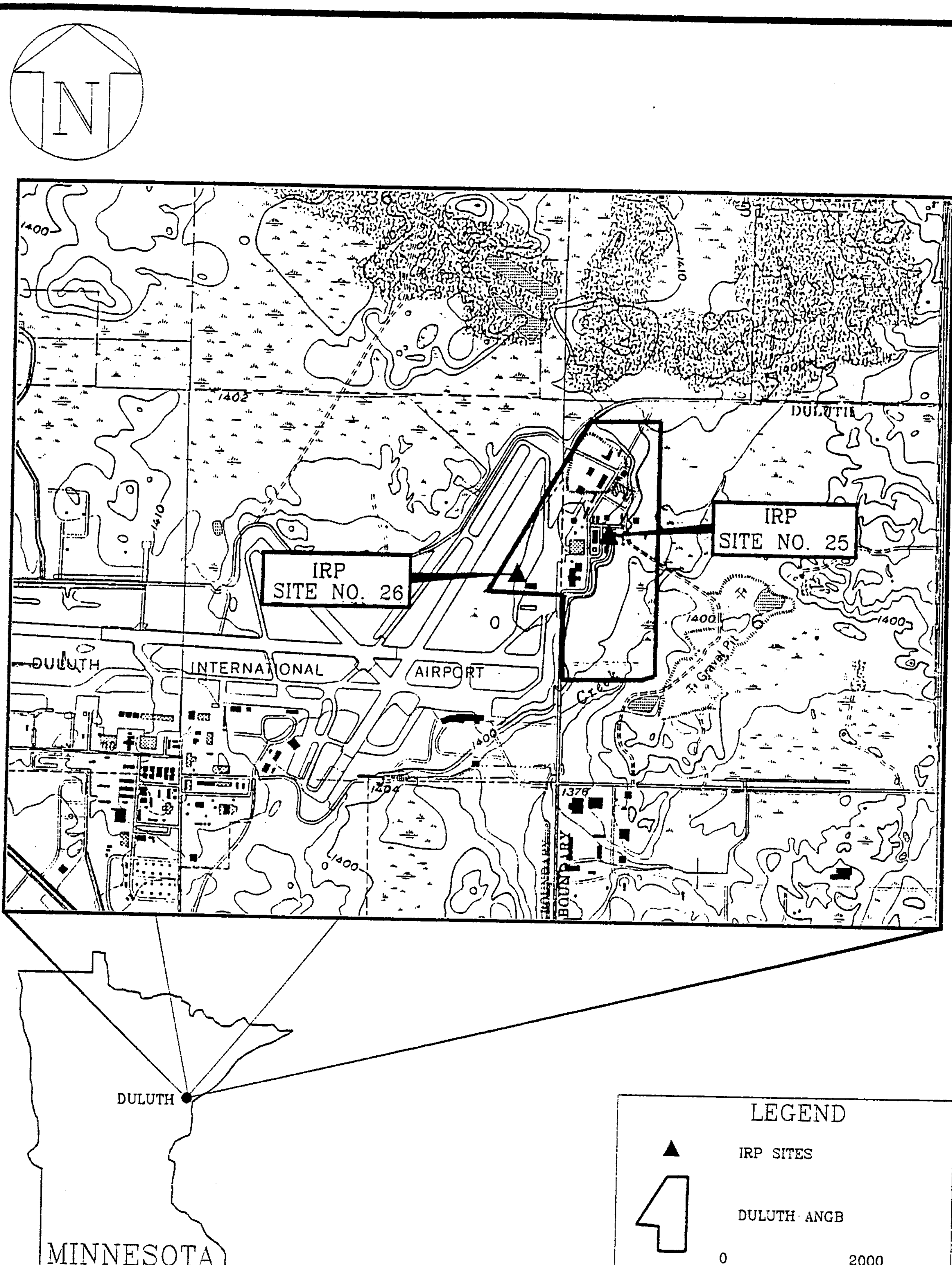
148th FIGHTER WING
MINNESOTA AIR NATIONAL GUARD
DULUTH AIR NATIONAL GUARD BASE
DULUTH, MINNESOTA

JUNE 1996

AIR NATIONAL GUARD

Prepared For

HQ ANG/CEVR
ANDREWS AFB, MARYLAND



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Prepared By

Operational Technologies Corporation
4100 N.W. Loop 410, Suite 230
San Antonio, Texas 78229-4253
(210) 731-0000

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Site Investigation Report for IRP Sites No. 25 and No. 26, 148th Fighter Wing, Duluth Air National Guard Base, Duluth, MN, Volume I, Executive Summary and Sections 1 through 7. This is the first volume of a four volume site investigation report. This investigation involves two sites; site 25 -- Old Motor Pool area, and site 26 -- Ramp Disposal Area. Soil and groundwater contamination above state action levels were found at site 25; no significant contamination was found at site 26. Site 25 cleanup will be included in the scheduled cleanup of site 21.

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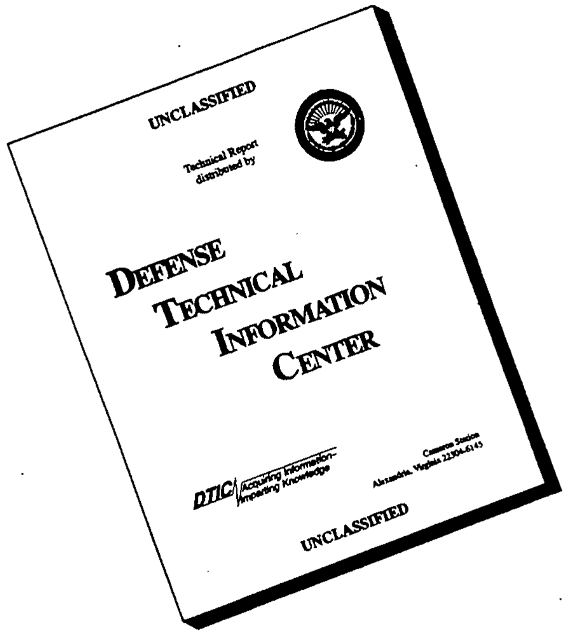

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LIST OF ACRONYMS

ANG	Air National Guard
ANGB	Air National Guard Base
ARAR	Applicable or Relevant and Appropriate Requirement
ASTM	American Society for Testing and Materials
BH	Borehole
Bldg.	Building
BLS	Below Land Surface
BTEX	Benzene, Toluene, Ethylbenzene, and Xylenes
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
DD	Decision Document
DERP	Defense Environmental Restoration Program
DNR	Department of Natural Resources
DoD	Department of Defense
EM	Environmental Management Office
EO	Executive Order
° F	Degrees Fahrenheit
ft/ft	feet per feet
FS	Feasibility Study
FW	Fighter Wing
gal.	gallon(s)
GC	Gas Chromatograph
gpd/ft^2	gallons per day per square feet
HQ ANG/CEVR	Headquarters, Air National Guard/Installation Restoration Branch
HRL	Health Risk Limit
HSA	Hollow-stem auger
I	Hydraulic Gradient
IAP	International Airport
ID	Inside Diameter
IRP	Installation Restoration Program
ITTS	Imhoff Tank Treatment System
JP-4	Jet Propulsion Fuel - 4
LEL	Lower explosive limit
LTM	Long-term monitoring
MCL	Maximum Contaminant Level
MCLG	Maximum Contaminant Level Goals
MDH	Minnesota Department of Health
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
MOGAS	Motor Vehicle Gasoline
MPCA	Minnesota Pollution Control Agency
MW	Monitoring Well
NCP	National Oil and Hazardous Substance Pollution Contingency Plan

LIST OF ACRONYMS

NFA	No Further Action
NGVD	National Geodetic Vertical Datum of 1929
NOAA	National Oceanic and Atmospheric Administration
NPL	National Priorities List
OpTech	Operational Technologies Corporation
PA	Preliminary Assessment
PAH	Polyaromatic Hydrocarbons
PID	Photoionization Detector
PPE	Personal protective equipment
ppm	parts per million
PVC	Polyvinyl chloride
QA/QC	Quality Assurance/Quality Control
RA	Remedial Action
RCRA	Resource Conservation and Recovery Act
RD	Remedial Design
RFI	RCRA Facility Investigation
RI	Remedial Investigation
RI/FS	Remedial Investigation/Feasibility Study
SARA	Superfund Amendments and Reauthorization Act of 1986
SI	Site Investigation
SMA	Sensitive Management Areas
SPL	Southern Petroleum Laboratories
SVOC	Semivolatile Organic Compounds
μg/kg	micrograms per kilogram
μg/L	micrograms per Liter
USCS	Unified Soil Classification System
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
UST	Underground Storage Tank
VOA	Volatile Organic Analysis
VOC	Volatile Organic Compounds
WMA	Wildlife Management Area

SITE INVESTIGATION REPORT FOR IRP SITES NO. 25 AND NO. 26
EXECUTIVE SUMMARY

This Site Investigation (SI) Report presents the results of investigation activities conducted at the 148th Fighter Wing, Duluth Air National Guard Base (ANGB), Duluth, Minnesota (Inside Front Cover Figure) (hereafter referred to as the Base). A Preliminary Assessment (PA) of the Duluth ANGB was conducted by Operational Technologies Corporation (OpTech) in February 1993, and finalized in August 1993. Information obtained through interviews, review of Base records, and field observations resulted in the identification of two potentially contaminated disposal and/or spill sites. These sites are identified as Installation Restoration Program (IRP) Site No. 25 (Old Motor Pool Area) and IRP Site No. 26 (Ramp Disposal Area).

Headquarters Air National Guard/Installation Restoration Branch (HQ ANG/CEVR) contracted Operational Technologies Corporation to prepare an SI Work Plan and conduct an SI at IRP Sites No. 25 and No. 26. This investigation was conducted as outlined in the SI Work Plan, which was submitted to and approved by HQ ANG/CEVR and the Minnesota Pollution Control Agency in April 1995.

IRP Site No. 25 includes the old motor pool compound and two adjacent locations of related motor pool activities: (a) a 1,000-gallon (gal.) unleaded gasoline underground storage tank (UST) (removed), formerly located across the street at the corner of Building (Bldg.) 231; and (b) the motor pool floor drains outfall, which runs east to southeast from the fenced compound into an adjacent marshy area.

The old motor pool compound encompasses Bldg. 240 (vehicle maintenance and refueling bays) and Bldg. 242 (vehicle maintenance). USTs associated with the old motor pool area consisted of:

- Two side-by-side 10,000-gal. steel USTs were formerly located in front of (west of) former Bldg. 239; the northern tank contained motor vehicle gasoline (MOGAS) and the southern tank contained diesel fuel. Both tanks have been removed.

- A 500-gal. waste solvent UST located just inside the fence in the southeast corner of the old motor pool area. This UST has also been removed.

- An unleaded gasoline UST and dispenser system (1,000-gal.). This tank, which was located adjacent to Bldg. 231, was the main source for unleaded gasoline on the Base when the motor pool was active. This tank has also been removed.

A Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) of IRP Site No. 21 was conducted in 1992 and 1994. IRP Site No. 21 is located directly downgradient from IRP Site No. 25. Based on this investigation, the activities at IRP Site No. 25 are the source of the benzene, toluene, ethylbenzene, and xylene (BTEX) contamination in soil at IRP Site No. 21. Due to the close geographic proximity of IRP Sites No. 21 and No. 25, and due to the similar contaminants existing at both these sites, these should be considered as one operable unit in Remedial Actions.

The non-paved area west of the aircraft ramp and Bldg. 500 is designated IRP Site No. 26. Reportedly, waste fuel from aircraft operations was stored in 55-gal. drums along the ramp in the 1960s and 1970s. Additionally, small amounts of waste fuel from aircraft were disposed by dumping them in the dirt along the edge of the ramp. As a result, the soil was reportedly discolored (i.e., black) along the ramp edge, according to former aircraft maintenance personnel. Undated aerial photography of the ramp area was viewed in civil engineering. Staining is visible in the aircraft parking area adjacent to Bldg. 500. An apparent 55-gal. drum is visible off the ramp in the grassy area west of Bldg. 500.

Potential contaminants at IRP Site No. 25 include waste oil, organic solvents, and petroleum motor fuels. Potential contaminants at IRP Site No. 26 include waste jet propulsion fuel-4 (JP-4). The actual quantity of releases at the sites are unknown.

Site Investigation field activities included drilling soil borings, installing monitoring wells, collecting soil and groundwater samples for chemical analyses, collecting water level data, and conducting slug tests. Additional soil samples were collected at IRP Site No. 26 for geotechnical analysis. Soil samples were collected for laboratory analyses and for characterizing site geology and subsurface soil conditions. Monitoring wells were installed to obtain groundwater samples for laboratory analyses and to determine hydrogeologic evaluation of the hydrologic unit. These analytical results were used to define the vertical and horizontal extent of contamination.

Thirteen soil borings were drilled and three monitoring wells were installed at IRP Site No. 25. Soil and groundwater samples were analyzed for volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), cadmium, chromium, lead, mercury, and nickel.

Six soil borings were drilled and three monitoring wells were installed at IRP Site No. 26. Soil samples were analyzed for VOCs, SVOCs, cadmium, chromium, and lead. Groundwater samples were analyzed for VOCs and SVOCs.

Conclusions based on the SI are reported as follows:

IRP Site No. 25 – Old Motor Pool Area

- BTEX was detected at a maximum concentration of 1,300 parts per million (ppm) from soil samples collected from soil borings located near the former 10,000-gal. diesel and MOGAS USTs. SVOCs of the naphthalene and phenol groups were detected at a maximum concentration of 14 ppm in soil samples collected from these soil borings.

- BTEX and SVOCs were detected in the groundwater sample collected from the monitoring well 025-003MW located downgradient from the former 10,000-gal. diesel and MOGAS USTs. Phenol was detected at a concentration of 51 micrograms per liter (μg/L) in groundwater samples collected from monitoring wells 025-001MW and 025-002MW. 1,2-dicholorethane was detected in the groundwater sample collected from the monitoring well located downgradient from the former 500-gal. waste solvent UST. Benzene, ethylbenzene, xylenes (total), and 1,2-dichloroethane were detected at concentrations of 2,600 μg/L, 1,300 μg/L, 1,450 μg/L, and 11 μg/L, respectively, exceeding the Minnesota Department of Health Health Risk Limits (HRLs) of 5 μg/L, 700 μg/L, 1,000 μg/L, and 4 μg/L, respectively.

- There is no contamination associated with the 1,000-gal. UST of Bldg. 231 and low level fuel-related soil contamination around the 500-gal. waste solvent UST.

- Soil contamination is primarily confined to an area around the 10,000-gal. diesel and MOGAS USTs only.

- There is no soil and groundwater contamination from chlorinated compounds.

- The main site contamination is BTEX. The only non-fuel compound is an SVOC, 4-methylphenol, in groundwater.

- Site soil and groundwater are adequately defined and no additional data is required for this site.

- In accordance with the SI Work Plan approved in April 1995, soil and groundwater samples were not analyzed for TPH gasoline range organics/diesel range organics. However, at the subsequent request of the MPCA, existing field screening data from this investigation and previous investigations at IRP Site No. 21 were incorporated into this report to provide additional information on petroleum waste constituents. These data, in addition to that data generated during the CMS phase of the investigation to be conducted in conjunction with IRP Site No. 21, will aid in more fully delineating the areal extent of both soil and groundwater contamination. See Figures 5.6 and 5.7, respectively, for plots of GC and PID data.

IRP Site No. 26 – Ramp Disposal Area

- Three polyaromatic hydrocarbons (PAHs) were detected at low levels in a near-surface soil sample from a soil boring located near the ramp.

- No VOCs or SVOCs were detected in the groundwater samples.

- There is no significant soil and groundwater contamination at the site.

- There is no soil and groundwater contamination from chlorinated compounds.

- Site soil and groundwater is fully defined and no additional data is required for this site.

Recommendations based on the SI are reported as follows:

IRP Site No. 25 – Old Motor Pool Area

- Due to the close geographic proximity of IRP Sites No. 21 and No. 25, and due to the similar contamination existing at both sites, IRP Site No. 25 should be remediated concurrently with IRP Site No. 21.

IRP Site No. 26 – Ramp Disposal Area

- No additional investigation is required and remedial action is not recommended. A Decision Document (DD) should be prepared to close out this site.

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SECTION 1.0 INTRODUCTION

This Site Investigation (SI) Report presents the results of investigation activities conducted at the 148th Fighter Wing (FW), Duluth Air National Guard Base (ANGB) (hereinafter referred to as Base), Duluth, Minnesota (Inside Front Cover Figure). A Preliminary Assessment (PA) of the 148th FW, Duluth ANGB was conducted by Operational Technologies Corporation (OpTech) in February 1993, and finalized in August 1993. Information obtained through interviews, review of Base records, and field observations resulted in the identification of two potentially contaminated disposal and/or spill sites. These sites are identified as Installation Restoration Program (IRP) Site No. 25 (Old Motor Pool Area) and IRP Site No. 26 (Ramp Disposal Area) as indicated on Figure 1.1.

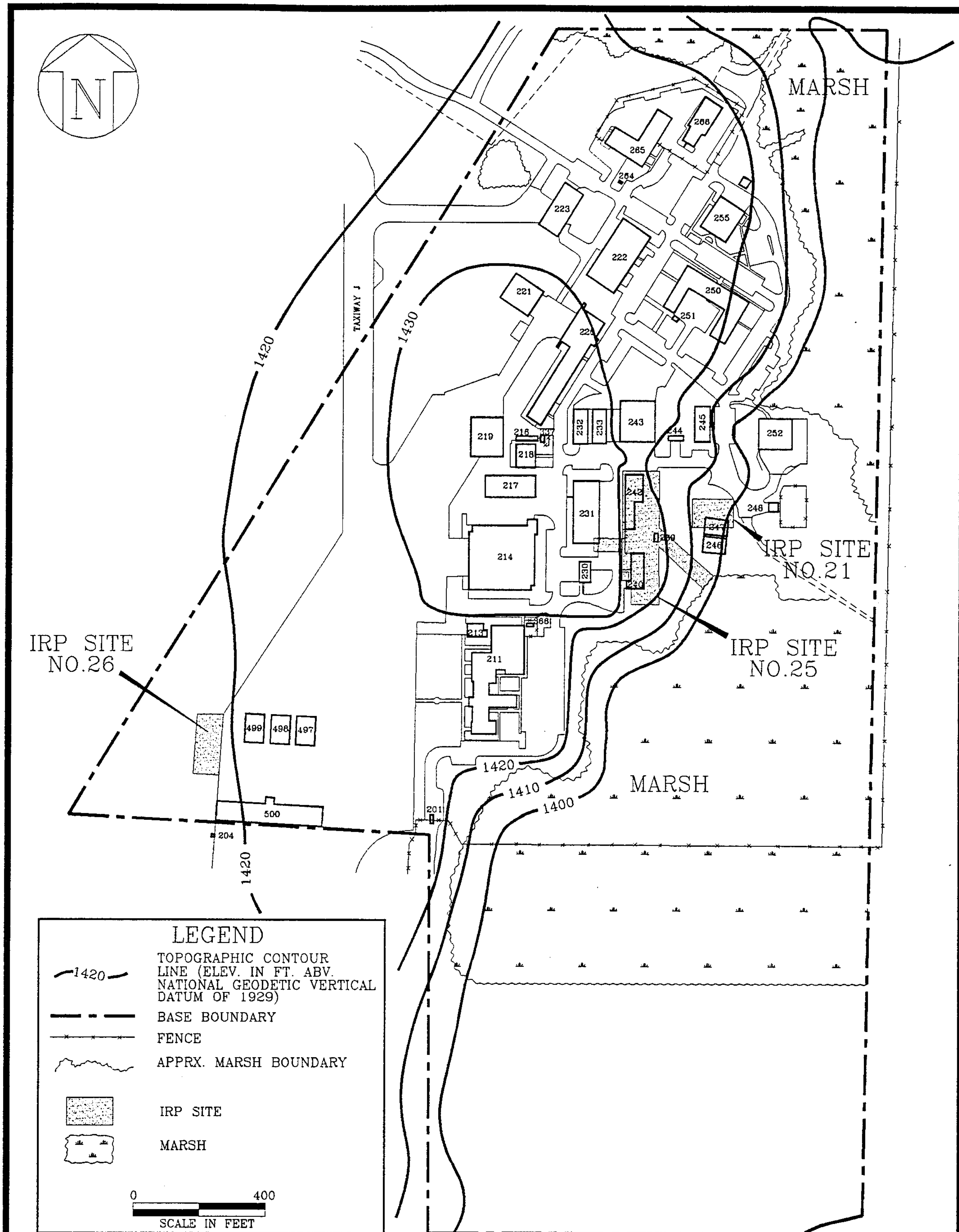
Headquarters Air National Guard/Installation Restoration Branch (HQ ANG/CEVR) contracted OpTech to prepare an SI Work Plan and conduct an SI at IRP Sites No. 25 and No. 26. This investigation was conducted as outlined in the SI Work Plan, which was submitted to and approved by HQ ANG/CEVR and the Minnesota Pollution Control Agency (MPCA) in April 1995.

The word "contamination" as used in this SI Report, is any substance introduced into the environment as a result of man's activities and does not necessarily imply a health risk.

Potential contaminants at IRP Site No. 25 include waste oil, organic solvents, and petroleum motor fuels. Potential contaminants at IRP Site No. 26 include waste fuels (JP-4). The actual quantity of releases at the sites are unknown.

1.1 INSTALLATION RESTORATION PROGRAM

The Defense Environmental Restoration Program (DERP) was established in 1984 to promote and coordinate efforts for the evaluation and cleanup of contamination at Department of Defense (DoD) installations. On 23 January 1987, Presidential Executive Order (EO) 12580 assigned specific responsibility to the Secretary of Defense for carrying out the DERP within the overall framework of the Superfund Amendments and Reauthorization Act of 1986 (SARA) and the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980. The IRP was established under DERP to identify, investigate, and clean up contamination at DoD installations. The IRP focused on cleanup of contamination associated with past DoD activities to ensure that threats to public health were minimized and natural resources were restored for future use. Within the Air National Guard, HQ ANG/CEVR manages the IRP.



SOURCE: OpTech, 1993.

FIGURE 1.1 DULUTH\SITE	LOCATION OF IRP SITES NO.25 AND NO.26 Duluth Air National Guard Base Duluth, Minnesota	OPTECH OPERATIONAL TECHNOLOGIES CORPORATION DECEMBER 1995

The IRP is divided into six phases as illustrated in Figure 1.2, and defined and described in the following subsections.

1.1.1 Preliminary Assessment

The PA process consists of personnel interviews, a records search, and a site visit designed to identify and evaluate past disposal and/or spill sites that might pose a potential and/or actual hazard to public health, public welfare, or the environment. Previously undocumented information is obtained through the interview process. The records search focuses on obtaining useful information from aerial photographs; installation plans; facility inventory documents; lists of hazardous materials used; subcontractor reports; correspondence; Material Safety Data Sheets; Federal/State agency scientific reports and statistics; Federal administrative documents; Federal/State records on endangered species, threatened species, and critical habitats; documents from local government offices; and numerous standard reference sources.

1.1.2 Site Investigation

The SI phase consists of field activities designed to confirm the presence or absence of contamination at the potential sites identified in the PA or during non-related IRP investigations, and to provide data needed to reach a decision point for the site. The activities undertaken during the SI generally fall into three distinct categories: screening, confirmation, and optional activities.

Screening Activities

Screening activities are conducted prior to drilling activities to gather preliminary data on each site. Screening activities may include the use of such tools as a magnetometer survey to locate underground lines, tanks, and utilities; soil gas surveys for developing the optimum number and location of soil borings needed to delineate soil contamination, and to be used as a guide in the selection of monitoring well locations; or the installation of a piezometer network in order to determine groundwater flow direction prior to installation of any groundwater monitoring wells.

Confirmation Activities

Confirmation activities include drilling soil borings and/or installing monitoring wells; specific media sampling; and laboratory analyses to confirm either the presence or

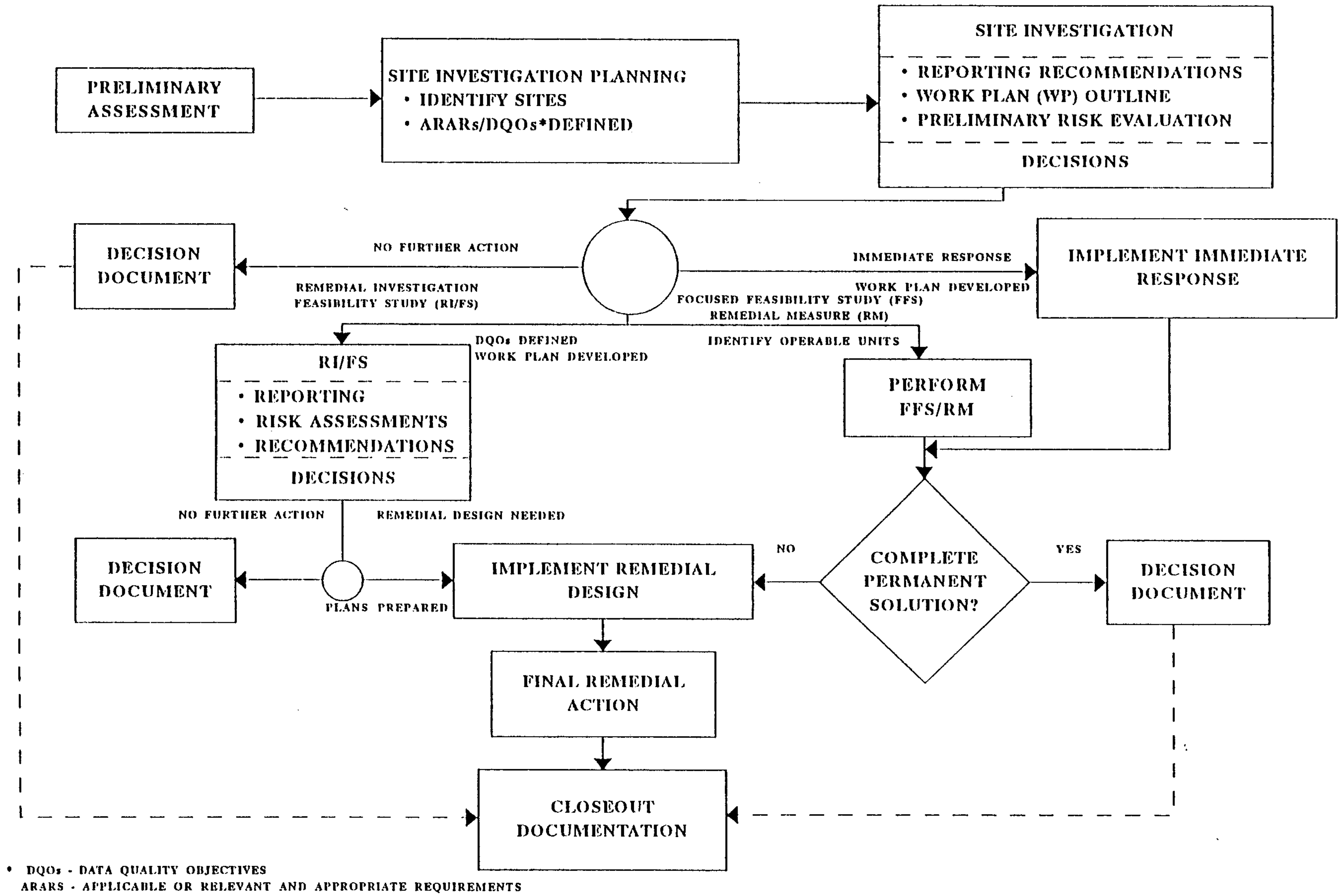


FIGURE 1.2

FORMS\LANDSCAP

FLOW OF INSTALLATION RESTORATION PROGRAM TASKS
Duluth Air National Guard Base
Duluth, Minnesota

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DECEMBER 1995

absence of contamination, levels of contamination, and the potential for contaminant migration. Information obtained during the subsurface investigation is also utilized to define the installation and site hydrology, geology, and soil characteristics.

Optional Activities

Optional activities are used if additional data are needed to reach a decision point for a site, such as no further IRP action is warranted, prompt removal of contaminants is necessitated, or further IRP work is required. Optional activities may include increasing the number of soil gas sampling points or the number of soil borings and/or monitoring wells to be drilled.

The general approach for the design of the SI activities is to sequence the field activities so that data are acquired and used as the field investigation progresses. This is done in order to determine the absence or presence of contamination in a relatively short period of time, optimize data collection and data quality, and to keep costs to a minimum. Information, data, and analytical results obtained from the SI field investigation will support the selection of one of the following decisions:

No Further Action (NFA) – Investigation did not indicate harmful levels of contamination that pose a significant threat to human health or the environment. Therefore, no further IRP action is warranted and a Decision Document (DD) will be prepared to close out the site.

Immediate cleanup/remedial activities – Investigation indicates that the site poses an immediate threat to public health or the environment. Therefore, prompt removal of contaminants or measures to reduce contaminant levels to an acceptable limit is warranted.

Remedial Investigation/Feasibility Study (RI/FS) – Investigation indicates further IRP work is required and the next phase of the IRP needs to be implemented. The RI is described more fully in the following subsection.

1.1.3 Remedial Investigation

The objectives of the RI are to determine the nature and extent of contamination at a site, determine the nature and extent of the threat to human health and the environment, and to provide a basis for determining the types of response actions to be considered (Decision Document, Feasibility Study, Remedial Design, Remedial Action).

The RI consists of field activities designed to quantify and identify the potential contaminant, the extent of the contaminant plume, and the pathways of contaminant migration. Field activities may include drilling soil borings and/or installing monitoring wells, and the collection and analysis of water, soil, and/or sediment samples. Careful documentation and quality control procedures in accordance with CERCLA/SARA guidelines ensure the validity of data. Hydrogeologic studies are conducted to determine the underlying strata, groundwater flow rates, and direction of contaminant migration.

A baseline risk assessment may be conducted which provides an evaluation of the potential threat to human health in the absence of remedial action. The assessment provides the basis for determining whether remedial action is necessary, justification for performing remedial actions, and what imminent and substantial endangerment to public health or the environment exists.

1.1.4 Feasibility Study

Based on results of the RI, the baseline risk assessment, and a review of State and Federal regulatory requirements, an FS will be prepared to develop, screen, and evaluate alternatives for remediation of groundwater and/or soil contamination at the subject sites. The overall objective of the FS is to provide information necessary for remedial alternatives development. The FS is conducted to support selection of a remedy that is: protective of human health and the environment; attains applicable or relevant and appropriate requirements (ARARs); satisfies the preference for treatment that significantly and permanently reduces toxicity, mobility, or volume of hazardous constituents as a principal element; and is cost-effective.

Activities associated with the FS include the following:

- Development of alternatives;
- Preliminary screening of remedial alternatives;
- Detailed analysis of alternatives;
- Comparative analysis of alternatives; and
- The creation of an FS Report.

The end result of the FS is the selection of the most appropriate remedial action with concurrence by State and/or Federal regulatory agencies.

1.1.5 Remedial Design

The Remedial Design (RD) involves formulation and approval of the engineering designs required to implement the selected remedial action identified in the FS.

1.1.6 Remedial Action

The Remedial Action (RA) is the actual implementation of the remedial alternative. It refers to the accomplishment of measures to eliminate the hazard or, at a minimum, reduce it to an acceptable limit. Covering a landfill with an impermeable cap, pumping and treating contaminated groundwater, installing a new water distribution system, and *in-situ* biodegradation of contaminated soils are examples of remedial measures that might be selected. In some cases, after the RAs have been completed, a long-term monitoring (LTM) system may be installed as a precautionary measure to detect contaminant migration or to document the efficiency of remediation.

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SECTION 2.0 FACILITY BACKGROUND INFORMATION

2.1 FACILITY DESCRIPTION

Duluth ANGB is located at the Duluth International Airport, within the City of Duluth. Duluth is in St. Louis County in northeastern Minnesota (Inside Front Cover Figure). The airport encompasses an estimated 2,000 acres of relatively flat terrain. The base is the home of the 148th FW, whose mission is to maintain air sovereignty, provide atmospheric attack warning and assessment, and support the air defense of its assigned airspace according to applicable plans and directives.

The Duluth International Airport encompasses a 2,000-acre area. According to the Economic Resource Impact Statement FY 91 (1992), the 148th FW uses 18.85 acres owned by the U. S. Air Force and leases 61.9 acres from the City of Duluth and 137.5 acres from the State of Minnesota in the northeastern quadrant of the airport facility (OpTech, 1993).

The Duluth ANGB area is 10 to 20 feet higher than the terrain to the east and south of the base. Topography to the east of the base is more pronounced, as the elevated hill drops off sharply to an area of a marshy area which drains into the nearby Miller Creek. The elevation of the base is approximately 1,420 feet above the National Geodetic Vertical Datum of 1929 (NGVD). The center of the Duluth ANGB is located at approximately 46° 50' 42" north longitude by 92° 10' 21" west latitude (OpTech, 1993).

The base is connected to the City of Duluth public water system. The City Water System intake is located in Lake Superior, nearly 10 miles south of the base. The water system serves the Duluth metropolitan area, a population of approximately 105,000 (1990 U. S. Census Data) (OpTech, 1993).

All sewage is conveyed off the base through the City of Duluth sanitary sewer system. The base previously used an Imhoff Tank Treatment System (ITTS) for the processing of base sewage. Built in 1949 by the U. S. Army Corps of Engineers, the ITTS was abandoned in 1969 when the City of Duluth sanitary sewer line was constructed. The subsurface utility lines for IRP Sites No. 25 and No. 26 are presented in Figures 2.1 and 2.2, respectively (OpTech, 1993).

The full-time population of Duluth ANGB is 182 personnel and includes 25 officers, 100 enlisted personnel, and 57 State employees. An additional 932 traditional Guardsmen add to the base

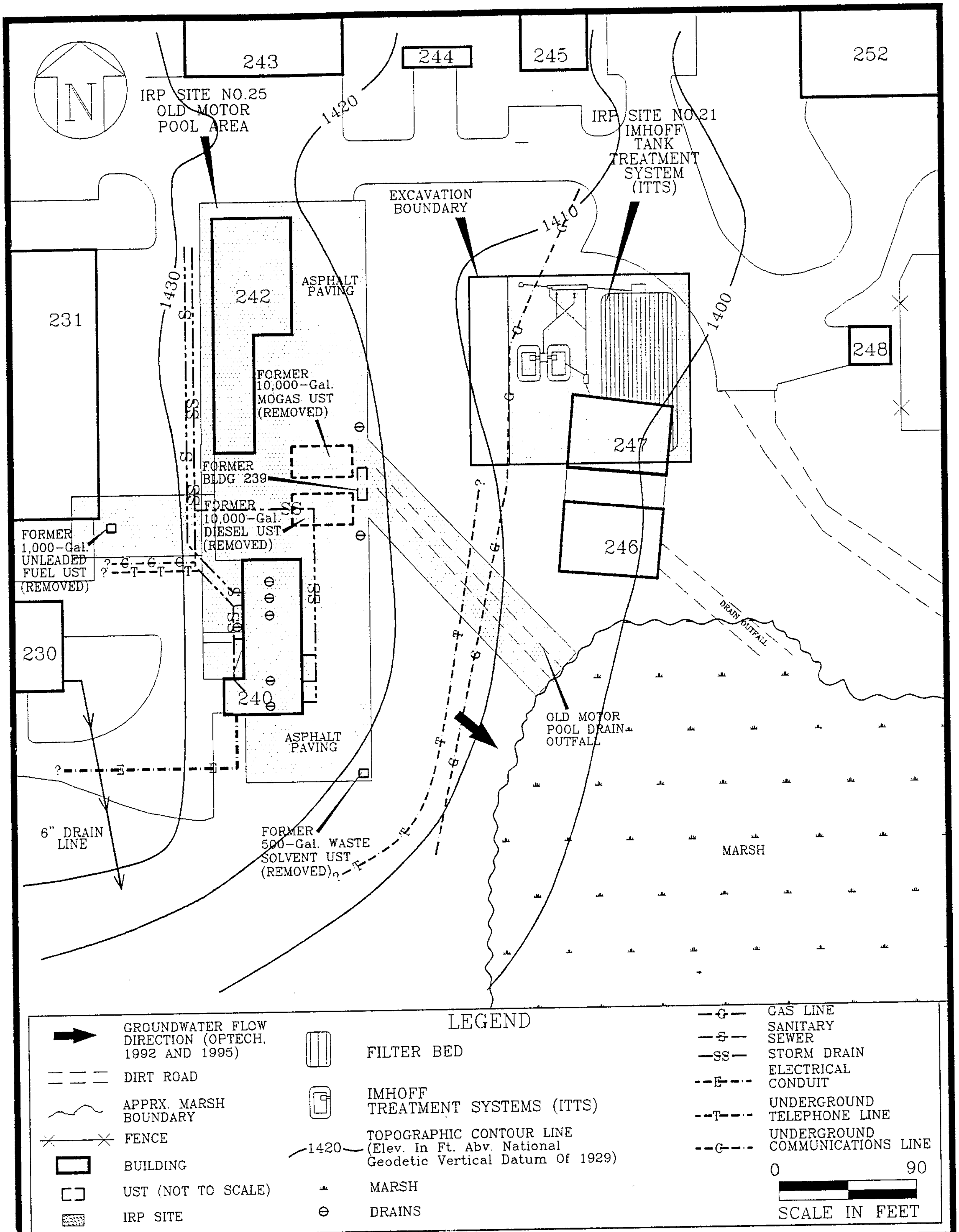

FIGURE 2.1

DULUTH\SITE2521

SUBSURFACE UTILITY LINES AND USTs IN VICINITY OF IRP SITE NO.25, OLD MOTOR POOL AREA
Duluth Air National Guard Base
Duluth, Minnesota

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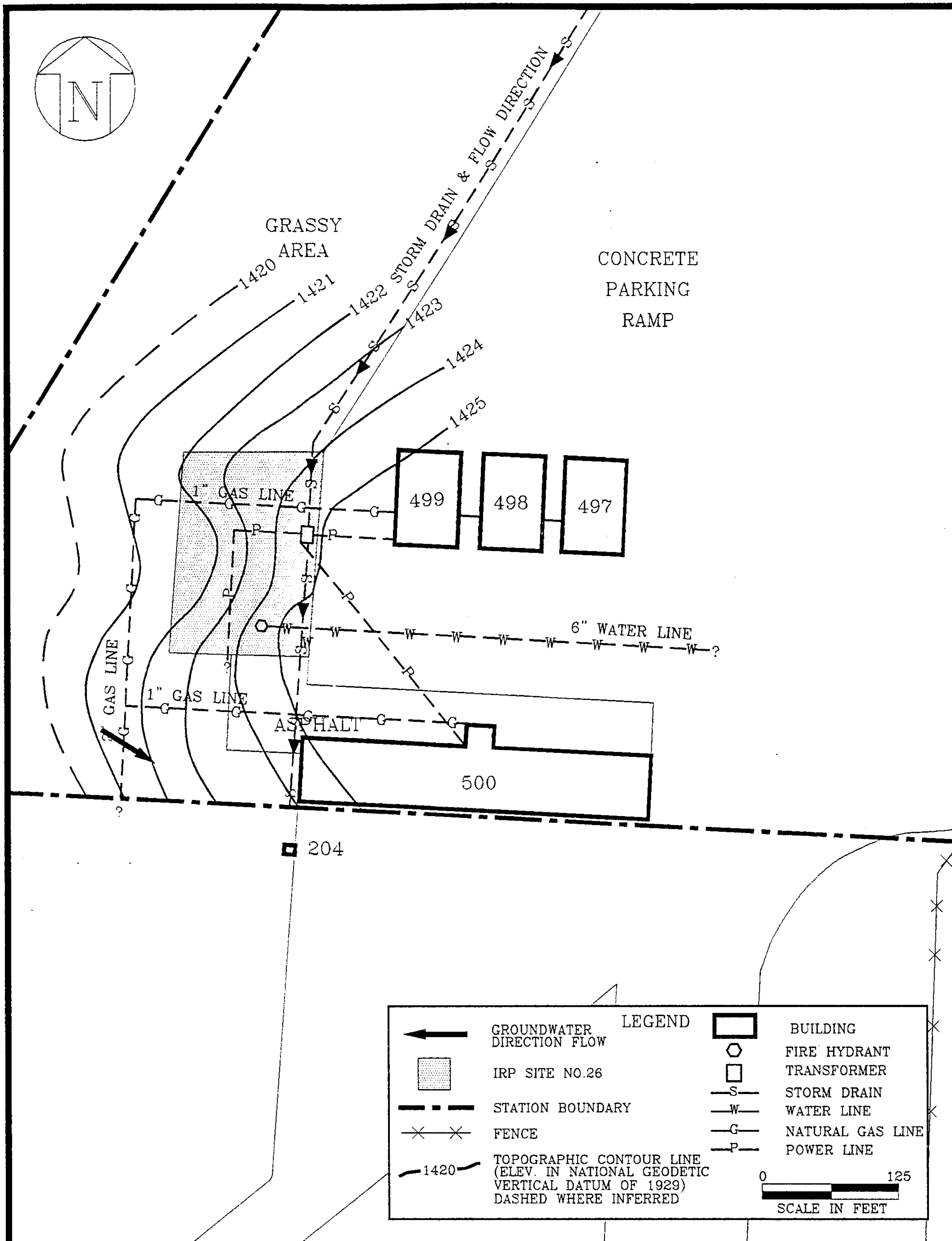

FIGURE 2.2

DULUTH\SITE-26

SUBSURFACE UTILITY LINES IN VICINITY OF IRP SITE NO.26, RAMP DISPOSAL AREA

Duluth Air National Guard Base
Duluth, Minnesota

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population on drill weekends. Additionally, Duluth ANGB serves a significant retiree population, totaling 604 personnel (OpTech, 1993).

In support of a variety of base operational mission requirements, Duluth ANGB currently possesses nine underground storage tanks (USTs) installed between 1952 to 1986. Table 2.1 is an inventory listing of all USTs and other underground sumps, separators, and tanks on the base. The locations of the USTs at IRP Site No. 25 are presented in Figure 2.1.

The population density surrounding the base is low. Privately owned residences are scattered throughout the area surrounding the base.

Land use in the vicinity of the airport includes public lands used for Duluth International Airport operations, commercial and light industrial activities, and low-density residential living.

Northeast of the airport, land has been used by the Western Lake Superior Sanitary District as a landfill. Agricultural land usage within a 10-mile radius of the base is very light. There are less than 25 isolated farms that produce milk or raise beef or sheep for commercial production. Additionally, seven farms within 10 miles of the base raise crops (i.e., hay). Twelve farms are engaged in commercial horticulture (i.e., fruits, vegetables) (OpTech, 1993).

2.1.1 Base History

In September 1948, the 179th Fighter Interceptor Squadron, Minnesota Air National Guard, was established at the Duluth Airport. The first aircraft flown by the 179th Fighter Interceptor Squadron was an F51D. The mission of the squadron was as an interceptor role between 1948-1954. Shortly thereafter, construction of the present Duluth ANGB was begun. The 179th was activated during the Korean War for a period of 21 months. In July 1954, the Squadron transitioned to F-94A/B Starfire aircraft. For the next two years, the unit earned first place in all-weather gunnery competitions. The 179th upgraded to the superior F-94C Starfire in April 1957, and the unit received the prestigious Winston P. Wilson Award as the outstanding Air National Guard all-weather interceptor unit. In July 1959 the unit converted to the F-89J Scorpion (Engineering-Science, Inc., 1982).

In July 1960 the unit was redesignated the 148th Fighter Group under the U. S. Air Force Air Defense Command. From 1967 to 1971 the unit flew the F-102 Delta Dagger. For the following five years, they flew the F-101 Voodoo. In 1976, the 148th Fighter Group was

Table 2.1
Underground Storage Tank and Structure Inventory
148th FW, Duluth ANGB, Duluth, Minnesota

Tank No.	Bldg. No.	Capacity (gal.)	Product	Construction	Year Installed	Protection (Intnl/Extnl)	Current Status
001	123	6,000	Fuel oil	Steel w/asphalt	1961	Unlined/coated	Active
002	126	500	Fuel oil	Steel w/asphalt	1966	Unlined/coated	Active
003	126	580	Drain water	Steel w/asphalt	1966	Unlined/none	Active
004	119	750	JP-4	Steel w/asphalt	1959	Unlined/coated	Empty (Temp out of svc)
005	385	1,500	Fuel oil	Steel w/asphalt	1971	Unlined/coated	Removed 10/27/94
006	230	15,000	Fuel oil	Steel w/asphalt	1948	Unlined/coated	Removed 10/21/94
007	500	10,000	Fuel oil	Steel w/asphalt	1952	Unlined/coated	Removed 08/15/91
008	219	1,000	Sanitary Sewer Settling Tank	Steel w/asphalt	1980	Unlined/coated	Removed 05/01/95
009	219	2,000	Waste oil	Steel w/asphalt	1980	Unlined/coated	Removed 05/01/95
010	245	1,000	Fuel oil	Steel w/asphalt	1966	Unlined/coated	Removed 09/28/94
011	231	1,000	Gasoline	Steel w/asphalt	1949	Unlined/coated	Removed 09/27/94
012	239	10,000	Gasoline	Steel w/asphalt	1964	Unlined/coated	Removed 09/16/94
013	239	10,000	Diesel	Steel w/asphalt	1977	Unlined/coated	Removed 09/26/94
014	240	500	Solvent	Steel w/asphalt	1960	Unlined/coated	Removed 09/27/94
015	255	100	Fuel oil	Steel w/asphalt	1983	Unlined/coated	Removed 09/28/94
016	219	250	Sanitary separator	Concrete	1980	Unlined/none	Abandoned in Place 04/26/95
017	520	1,000	Fuel oil	Steel w/asphalt	1986	Unlined/anode	Removed 10/03/94

Table 2.1 (Concluded)
Underground Storage Tank and Structure Inventory
148th FW, Duluth ANGB, Duluth International Airport, Duluth, Minnesota

Tank No.	Bldg. No.	Capacity (gal.)	Product	Construction	Year Installed	Protection (Intnl/Extnl)	Current Status
018	521	4,000	Fuel oil	Steel w/asphalt	1986	Unlined/anode	Removed 10/03/94
019	123	675	Septic	Concrete	1961	Unlined/none	Active
020	125	750	Septic	Concrete	1972	Unlined/none	Active
021	500	500	Gasoline	Steel w/asphalt	1952	Unlined/coated	Removed
022	219	550	Detergent	Fiberglass	1980	Unlined/none	Abandoned in Place 01/11/95
023	222	300	Waste oil	Painted steel	1989	Unlined/in vault	Active
024	521	2,000	Septic	Concrete	1959	Unlined/none	Active
025	223	100	Fuel oil	Steel w/asphalt	1984	Unlined/none	Removed 09/28/94
026	223	150	Infl trap	Concrete	1984	Unlined/none	Removed 10/17/94
027	223	1,500	Sewer	Concrete	1984	Unlined/none	Active
028	252	1,000	Sewer	Concrete	1983	Unlined/none	Active
029	264	10,000	Unleaded gas	Fiberglass	1986	Unlined/none	Removed 10/21/94
030	264	10,000	Diesel	Fiberglass	1986	Unlined/none	Removed 10/21/94
031	264	10,000	Diesel	Fiberglass	1986	Unlined/none	Removed 10/21/94
032	265	500	JP-4	Fiberglass	1986	Unlined/none	Removed 10/05/94
033	265	500	Waste oil	Fiberglass	1986	Unlined/none	Removed 04/17/95
034	265	500	Reclaimed oil	Fiberglass	1986	Unlined/none	Removed 10/05/94

gal. – gallons.
Infl – Influent.
Extnl – External.
Intnl – Internal.
JP-4 – Jet Fuel No. 4.

svc – service.
temp – temporarily.
Source: Environmental Coordinator, Duluth ANGB, MN.
Source: Preliminary Assessment, OpTech, 1993.

redesignated the 148th Tactical Reconnaissance Group and assigned the RF-4C aircraft. The unit received the Air Force Outstanding Unit Award in 1979 (Engineering-Science, Inc., 1982).

October 1983 was a benchmark month as the unit transitioned back into the air defense mission with the arrival of the F-4D Phantom and a new name: the 148th Fighter Interceptor Group. A second Air Force Outstanding Unit Award was received in February 1988. In July 1990, the unit received its first of 18 authorized F-16 Falcon aircraft, which continue to be the primary mission aircraft today. The unit was redesignated under the new Air Combat Command in June 1992 with the reorganization of the U. S. Air Force (Engineering-Science, Inc., 1982). On 1 October 1995, the unit was redesignated the 148th FW.

2.1.2 Previous Investigations

A PA was conducted at the 148th FW, Duluth ANGB, by OpTech in February 1993, and finalized in August 1993. Information obtained through interviews, review of base records, and field observations resulted in the identification of two potentially contaminated disposal and/or spill sites. These sites are identified as IRP Site No. 25 (Old Motor Pool Area) and IRP Site No. 26 (Ramp Disposal Area) as indicated on Figures 2.1 and 2.2, respectively. A Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) was conducted by OpTech at IRP Site No. 21, the Imhoff Tank Treatment System, in August 1992 and in July 1994. IRP Site No. 21 is located approximately 75 feet downgradient hydraulically and topographically from IRP Site No. 25.

2.2 INSTALLATION RESTORATION PROGRAM SITE DESCRIPTIONS

As a result of interviews, base records, and the field survey, two sites on Duluth ANGB were identified as potentially contaminated. Figures 2.1 and 2.2 present schematics of each site.

2.2.1 Installation Restoration Program Site No. 25 – Old Motor Pool Area

IRP Site No. 25 (Figure 2.1) includes the old motor pool compound and two adjacent locations of related motor pool activities: a 1,000-gallon (gal.) unleaded gasoline UST (removed), formerly located across the street at the corner of Building (Bldg.) 231, and the motor pool floor drains outfall, which runs east to southeast from the fenced compound into an adjacent marshy area. The old motor pool compound encompasses Bldg. 240 (vehicle maintenance and refueling bays) and Bldg. 242 (vehicle maintenance). Two side-by-side 10,000-gal. steel USTs were formerly located in front of (west of) former Bldg. 239; the northern tank contained motor vehicle gasoline (MOGAS) and the southern tank contained diesel fuel. Both tanks have been removed. A 500-gal. waste solvent UST was also located just inside the fence in the southeast corner of the old motor pool area. This UST was also removed in 1994.

An RFI of IRP Site No. 21 was conducted in 1992 and 1994. IRP Site No. 21 is located directly downgradient from IRP Site No. 25. Based on this investigation, the activities at IRP Site No. 25 are the source of the benzene, toluene, ethylbenzene, and xylene (BTEX) contamination in soil at IRP Site No. 21. Due to the close geographic proximity of IRP Sites No. 25 and No. 21 and due to the similar contaminants existing at both these sites, these should be considered as one operable unit in Remedial Actions.

Across the street from the motor pool compound an unleaded gasoline UST and dispenser system at Bldg. 231 was the main source for unleaded gasoline on the base when the motor pool was active. This tank was also removed in 1994.

The motor pool floor drains outfall serves not only the floor drains within Bldg. 240, but also two open drains on the paved surface within the compound (Figure 2.1). Historically, spilled motor pool products were washed down the drains and flowed downhill into an adjacent marsh area. Information from interviews confirmed that the drain flowed underground from the motor pool and then emerged halfway down the hill to the east of the motor pool area. The open drain is visible on an undated aerial photograph (identified as 1975 ± 1 year by civil engineering personnel). With construction projects on-base, the drain was eventually covered over as a road was built at the bottom of the hill. Personnel who have worked at the base for many years reported occasional sightings of black substances emitting from the motor pool drains outfall in the adjacent marshy area. Figure 2.1 is representative of the location of the drain outfall in relation to the edge of the marsh during the time the old motor pool was in use. The effluent would have directly entered the marsh from the outfall pipe. After the old motor pool was closed, the area to the east of the outfall was filled in. The outfall location is now separated from the marsh by the previously mentioned road to the east.

2.2.2 Installation Restoration Program Site No. 26 – Ramp Disposal Area

The non-paved area west of the aircraft ramp and Bldg. 500 is designated IRP Site No. 26 (Figure 2.2). Reportedly, waste fuel from aircraft operations was stored in 55-gal. drums along the ramp in the 1960s and 1970s. Additionally, small amounts of waste fuel from aircraft were disposed of by dumping them in the dirt along the edge of the ramp. As a result, the soil was reportedly discolored (i.e., black) along the ramp edge, according to former aircraft maintenance personnel.

Undated aerial photography of the ramp area was viewed in civil engineering. Aircraft on the ramp were identified as F-101s and F-102s. Staining is visible in the aircraft parking area adjacent to Bldg. 500. An apparent 55-gal. drum is visible off the ramp in the grassy area west of the building.

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SECTION 3.0 ENVIRONMENTAL SETTING

The Duluth ANGB is located at the Duluth International Airport in St. Louis County, Minnesota. The Base is situated within the North Shore Highland section of the Superior Upland physiographic province, a dissected plateau with varied relief and prominent escarpments. Regional elevations in the North Shore Highland section generally range from 900 feet above the NGVD, overlooking Lake Superior west to Duluth, to 1,500 feet above NGVD at the Canadian border, approximately 150 miles north of Duluth (U. S. Geological Survey, 1981).

In the area of the Duluth ANGB, physiography is the result of Pleistocene glaciation. Locally, relief may be distinct due to glaciation features such as kames, kettles, moraines, and marshes. The glaciated terrain near the Base is characterized by poor drainage, irregular, low relief, and numerous shallow lakes and bogs occupying low areas. Although the altitude of the Base is approximately 1,420 feet above NGVD, to the east of the Base the land surface drops off abruptly across the City of Duluth to Lake Superior, to an altitude of approximately 602 feet above NGVD.

Minnesota has a predominantly continental climate, modified somewhat by the presence of Lake Superior. Duluth averages 143 days between the last occurrence of freezing in mid-May and the first freeze in early October. At the Duluth International Airport, the average first and last occurrences of freezing are late September and late May, giving an average freeze-free period of 123 days. Summers are mild, with the normal daily maximum for June, July, and August near 72 degrees Fahrenheit (° F). The highest recorded temperature was 106° F, which occurred 13 July 1936 (National Oceanic and Atmospheric Administration (NOAA), 1988).

Minnesota's winters are cold with the maximum daily temperature remaining below freezing for an average of 108 days per year. The lowest temperature on record at Duluth is -41° F, which occurred on 2 January 1885 (NOAA, 1988).

Precipitation is well distributed throughout the year. The mean annual precipitation is 28.49 inches. Maximum precipitation occurs from May through September. The mean annual snowfall is 76.9 inches, and the greatest snow depth record is 121 inches, which occurred during the winter of 1968-69 (Table 3.1). The maximum annual precipitation is 39.61 inches in the Duluth International Airport area. The two-year 24-hour rainfall level is 2.5 inches (NOAA, 1988).

Table 3.1
Climate Data for Duluth International Airport
148th FW, Duluth ANGB, Duluth, Minnesota

Month	Temperature		Rainfall[1]		Snowfall[2]		Wind	
	Mean Max (° F)	Mean Min (° F)	Mean (in)	Max (in)	Mean (in)	Max (in)	Mean Speed[3](mph)	Direction[4]
Jan	17.0	-0.5	1.11	4.70	16.8	46.8	11.7	NW
Feb	21.5	3.5	0.93	2.37	11.5	31.5	11.3	NW
Mar	32.5	15.8	1.64	5.12	13.7	45.5	11.9	WNW
Apr	47.1	29.4	2.17	5.84	6.4	31.5	12.7	NW
May	59.4	39.2	3.09	7.67	0.8	8.1	11.8	E
Jun	69.0	48.0	3.95	8.04	T[5]	T	10.6	E
Jul	75.5	54.9	3.76	8.48	0.0	0.0	9.6	WNW
Aug	73.3	54.0	3.47	10.31	T	T	9.5	E
Sep	64.0	46.0	3.31	6.61	T	0.7	10.5	WNW
Oct	52.6	36.1	2.24	7.53	1.3	8.1	11.3	WNW
Nov	35.6	21.9	1.68	5.01	10.9	37.7	11.8	WNW
Dec	22.3	6.9	1.13	3.70	15.4	44.3	11.3	NW
Annual	47.5	29.6	28.49	39.61	76.9	121.0	11.2	WNW

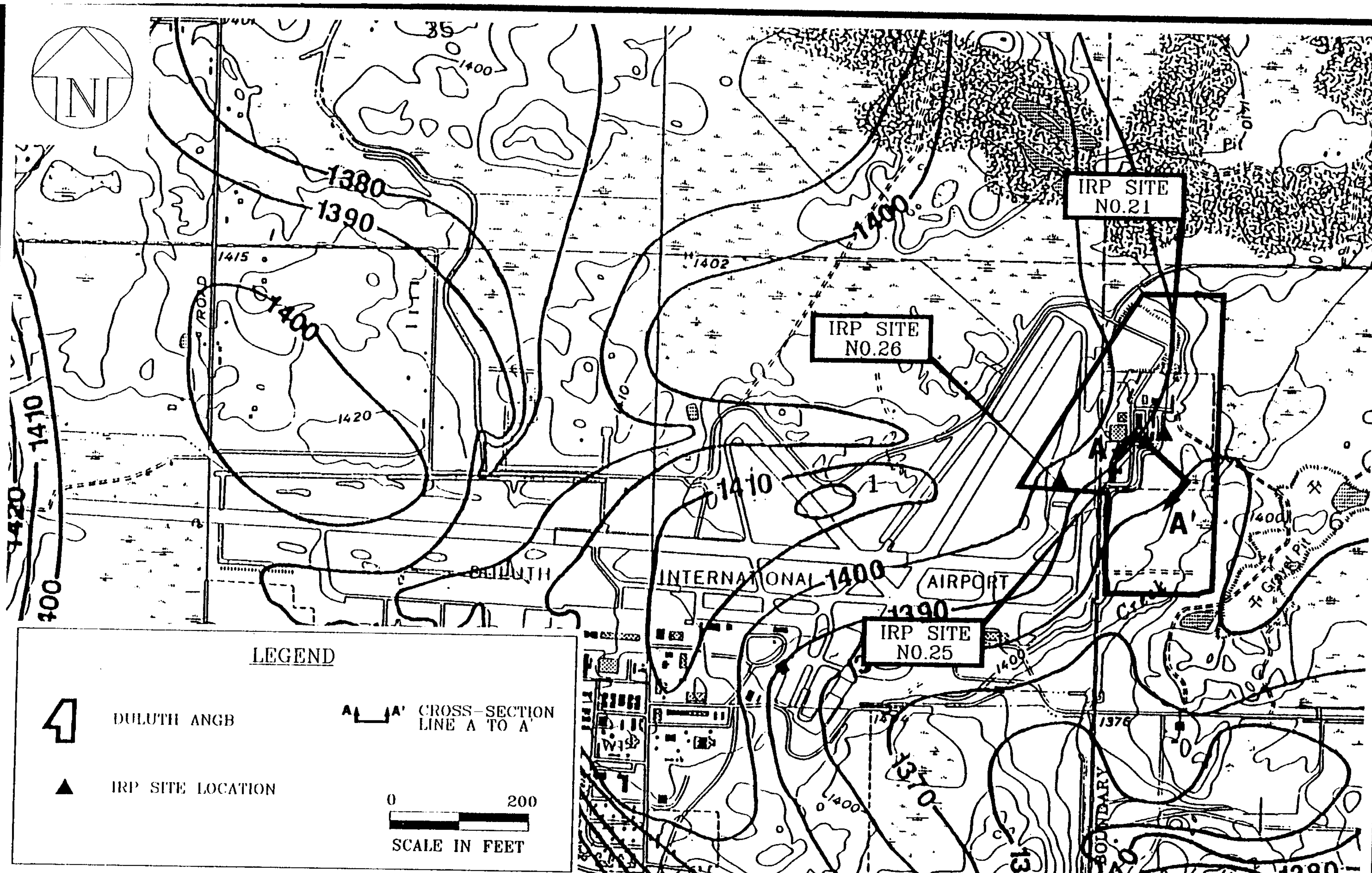
[1]Period of record of means: 1904-1987.
[2]Period of record of means: 1944-1987.
[3]Length of record is 38 years.
[4]Direction data through 1963.
[5]Trace.

in – inches.
° F – Degrees Fahrenheit.
mph – miles per hour.
Source: National Oceanic and Atmospheric Administration, 1988.

During construction of Duluth ANGB, the land was subjected to extensive cut and fill operations, affecting both topography and drainage. Pre-existing boggy areas were filled in, small knobs were lowered or removed, and drainage channels created or relocated to direct runoff site. Both of the sites identified during the PA are located in structural fill or otherwise disturbed ground.

3.1 LOCAL AND REGIONAL GEOLOGY

Duluth lies on the southern margin of the Superior Province of the Canadian Shield (Medaris, 1983). This is a large region of Precambrian sedimentary and igneous rocks that have been metamorphosed and deformed. The area is underlain by crystalline bedrock, the Duluth Gabbro, belonging to the Duluth Complex (Figure 3.1). This bedrock is composed of various



SOURCE: GEOLOGY MODIFIED FROM ROGERS (1982), BASE FROM USGS DULUTH HEIGHTS, MN, 1:24,000 QUADRANGLE. INTERNAL DRAFT, SITE 10 RI, ENGINEERING SCIENCE, 1992

FIGURE 3.1

DULUTH/SI-197/TOPO

BEDROCK CONTOUR MAP OF THE DULUTH INTERNATIONAL AIRPORT AREA

Duluth Air National Guard Base
Duluth, Minnesota

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intrusive igneous rocks which contain a large portion of the heavier elements such as calcium, iron, and magnesium. These igneous rocks have been categorized on the basis of whether they are layered or massive, contain intrusions of other material, or contain predominant amounts of particular minerals.

The Precambrian bedrock of the Duluth area and northern Minnesota in general, has been scoured by glaciers of Pleistocene age which removed younger rock units overlying the Precambrian surface (Medaris, 1983). During the last glacial period, the late Wisconsin Superior lobe, removed any evidence of earlier glaciation and deposited a veneer of glacial till, a red soil which varies from clay to silt, overlying the bedrock (Figures 3.2 and 3.3). Other soil types are loam, sandy loam, and sand.

Structurally, the Duluth Complex is located on the western limb of the Superior Syncline, the axis of which corresponds roughly to the axis of Lake Superior. At the airport, the base of the syncline dips irregularly toward Lake Superior. Lake Superior itself covers 32,000 square miles and its floor is over 700 feet below NGVD. The depth of the lake is caused by glacial scouring, down-faulting, and the incomplete rebound from the depression due to the thick ice load (Shimer, 1972).

Duluth ANGB is underlain by the Duluth gabbro, which consists of dark gray, medium- to coarse-grained olivine gabbro. Olivine is a rock-forming silicate mineral which contains iron and magnesium. Gabbro is a dark-colored intrusive rock which contains silicate minerals consisting of calcium, magnesium, and iron, as well as other rock forming silicate minerals.

The gabbro is a heavy, dense, crystalline rock having essentially no pore spaces, but containing zones which are fractured. These zones can be closely spaced, but frequently can be miles or even tens of miles apart.

The overlying glacial till in the area of the Base is composed of low to moderately permeable unstratified sands, silts, and clays with boulders and cobble inclusions. Locally occurring pockets of peat are found within the till. The till is unconsolidated and ranges in thickness from 10 to over 60 feet.

CENOZOIC	QUATERNARY	PLEISTOCENE	GLACIAL TILL
PROTEROZOIC	AMERICAN		DULUTH GABBRO

SOURCE: ENGINEERING SCIENCE, 1990

FIGURE 3.2

DULUTH\SI-197\STRTGPHC

GENERALIZED STRATIGRAPHIC COLUMN IN THE DULUTH ANGB AREA
Duluth Air National Guard Base
Duluth, Minnisota

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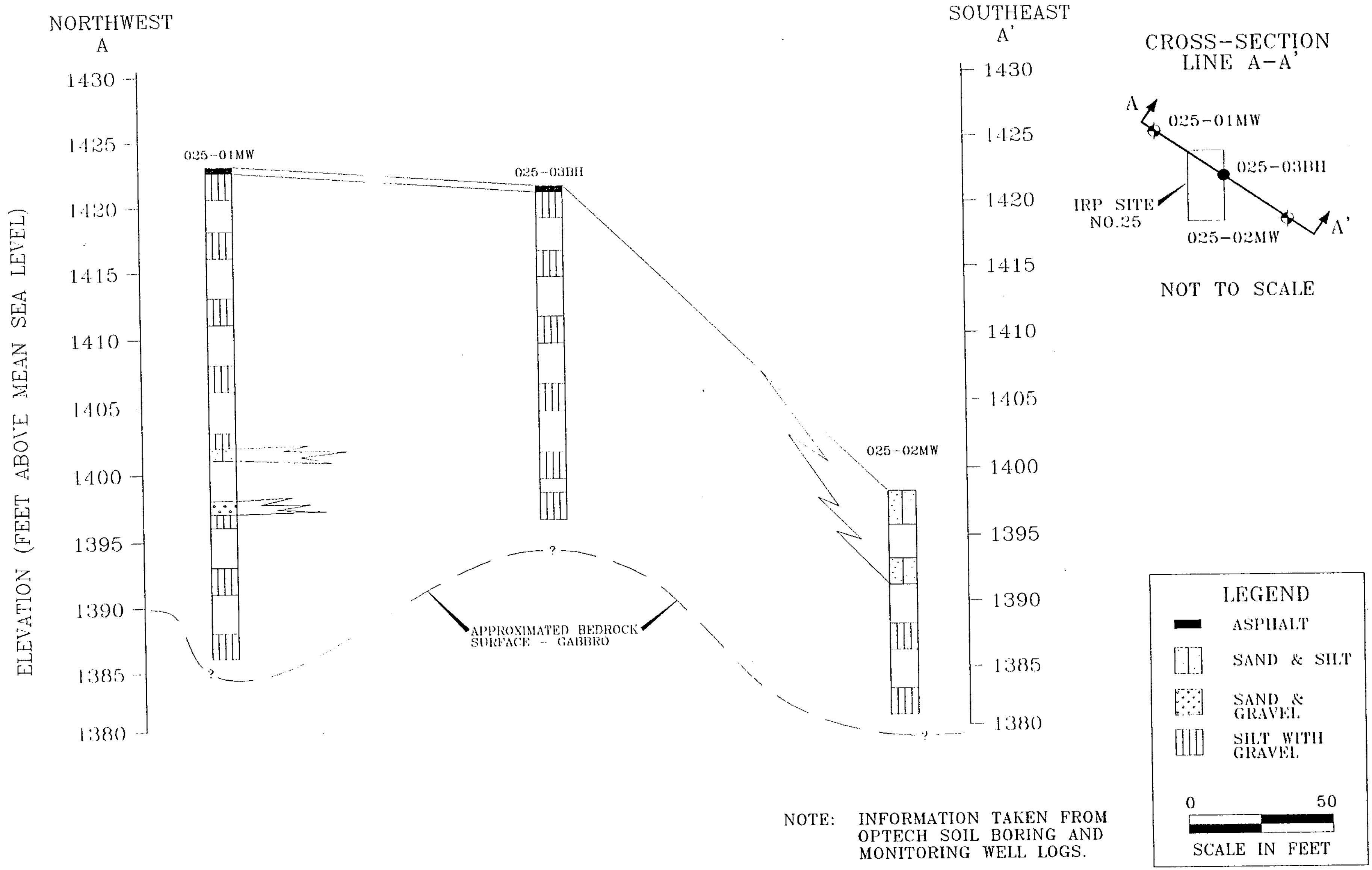
MAY 1996



NOTE: INFORMATION TAKEN FROM OPTECH SOIL BORING AND MONITORING WELL LOGS.

FIGURE 3.3

DULUTH\SI-197\AA-CROSS

GEOLOGIC CROSS-SECTION ACROSS DULUTH ANGB AREA

Duluth Air National Guard Base
Duluth, Minnesota

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3.1.1 Soils

In terms of surface soils, the Duluth office of the U. S. Soil Conservation Service (Diers, 1993) noted that the Duluth ANGB falls within the Highland Moraine soil area, which is made up of five major surface soil groups as follows (Figure 3.4):

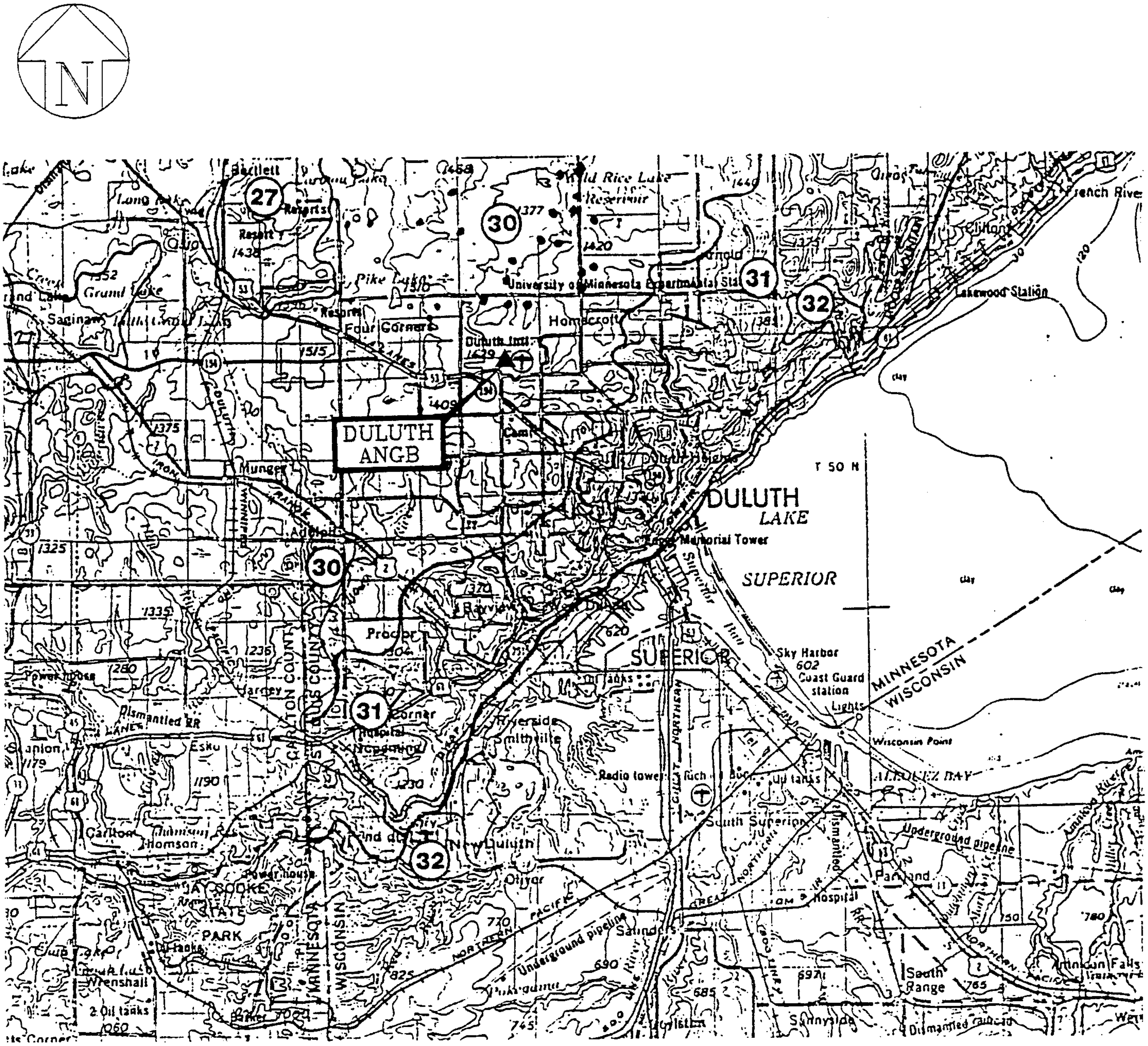
- Ahmeek: The Ahmeek series consists of well- and moderately-well drained soils formed in a loamy mantle and firm glacial till on uplands. The surface layer is a very dark brown silt loam 2 inches thick. The subsurface layer is dark grayish brown silt loam 2 inches thick. The subsoil is dark brown silt loam in the upper 10 inches and reddish brown fine sandy loam in the lower 19 inches. The substratum is reddish brown fine sandy loam.

- Hermantown: The Hermantown series consists of deep, somewhat poorly drained soils that formed in loamy mantle and dense glacial till on uplands. The surface layer is very dark brown silt loam 4 inches thick. The subsurface layer is grayish brown mottled silt loam 6 inches thick. The upper subsoil is brown mottled fine sandy loam 5 inches thick. The lower subsoil is reddish brown mottled fine sandy loam 21 inches thick. The underlying material is dark reddish brown dense sandy loam and gravelly sandy loam.

- Twig: The Twig series consists of very poorly drained soils formed in organic material and the underlying glacial till on uplands. The surface layer is black sapric material 3 inches thick. The next layer is dark reddish brown sapric material 5 inches thick. The next layer is reddish brown hemic material 4 inches thick. The next layer is black silt loam 8 inches thick. The next layer is dark gray loam 6 inches thick. The subsoil is gray and reddish brown fine sandy loam 22 inches thick. The substratum is fine sandy loam.

- Cathro: The Cathro series, low precipitation, consists of very deep, very poorly drained soils formed in deposits of herbaceous organic material over loamy sediments in depressions on glacial moraines, till plains, and lake plains. The surface is black mucky peat and muck 23 inches thick. The substratum is grayish brown sandy loam.

- Rifle: Rifle series consists of very poorly drained soils formed in herbaceous organic deposits in bogs and depressional areas within lake, outwash, and till



LEGEND

(27)	CLOQUET	-ON FLATS, SIDESLOPES AND SUMMITS
	EMMERT	-ON SIDESLOPES AND SUMMITS OF ESKERS
	OESTERLE	-ON FLATS AND IN DRAINAGEWAYS
	NEWSON	-ON FLATS AND IN SHALLOW DEPRESSIONS
	MARKEY	-IN SHALLOW BOGS AND ALLUVIAL CHANNELS
	RIFLE	-IN DEEP BOGS
(30)	AHMEEK	-ON SIDESLOPES AND SUMMITS
	HERMANTOWN	-ON FLATS AND IN SHALLOW DRAINAGEWAYS
	TWIG	-IN SHALLOW DEPRESSIONS
	CATHRO	-IN SHALLOW BOGS
	RIFLE	-IN DEEP BOGS
(31)	FINLAND	-ON SIDESLOPES AND SUMMITS
	BARTO	-ON SIDESLOPES AND SUMMITS
	HERMANTOWN	-ON FLATS AND IN SHALLOW DRAINAGEWAYS
	TWIG	-IN SHALLOW DEPRESSIONS
	CATHRO	-IN SHALLOW BOGS
	RIFLE	-IN DEEP BOGS
	BEDROCK EXPOSED AT THE SURFACE	
(32)	ONTONAGON	-FLATS AND SIDESLOPES
	BERGLAND	-DRAINAGEWAYS AND SHALLOW DEPRESSIONS

0 20000
SCALE IN FEET

SOURCE: DULUTH HEIGHTS, MINNESOTA, 1953, REVISED 1993

FIGURE 3.4

DULUTH/SI-197/SOILMAP

SOIL MAP OF DULUTH ANGB AREA

Duluth Air National Guard Base
Duluth, Minnesota

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plains. The surface soil is yellowish brown and black peat 4 inches thick. The underlying material is black and dark reddish brown mucky peat.

In general, Ahmeek is found on sideslopes and summits, Hermantown is found on flats and in shallow drainageways, Twig in shallow depressions, Cathro in shallow bogs, and Rifle is found in deep bogs.

Permeabilities of the respective soil groups in the Duluth area are shown in Table 3.2.

Table 3.2
Soil Group Permeability
148th FW, Duluth ANGB, Duluth, Minnesota

Soil Type	Depth in Inches	USCS Classification	Permeability (Inches/hour)
Ahmeek	2 - 14	SM, SM-SC, ML, CL-ML	0.6 - 2.0
Hermantown	4 - 15	SM, SC-SM, ML, CL-ML	0.6 - 2.0
Twig	12 - 20	OL, CL, CL-ML	0.06 - 0.6
Cathro	0 - 11	PT	0.2 - 6.0
Rifle	0 - 4	PT	0.2 - 6.0

Source: Soil Interpretation Records, Soil Conservation Service, Duluth, MN, Diers, February 1993.
CL – Inorganic clays of low to medium plasticity.
ML – Silt and fire sands.
USCS – Unified Soil Classification System.
OL – Organic clays.
PT – Peat.
SC – Clayey sands.
SM – Silty sands.

3.1.2 Hydrogeology

Two hydrogeologic units underlie the airport area, the Duluth Gabbro (bedrock), and the unconsolidated glacial materials that overlie the bedrock. Limited groundwater is present in fracture zones in the bedrock. The overlying glacial drift, consists of unsorted, non-stratified till, 10 to 60 feet thick, within which groundwater occurs in limited quantities in water conditions 5 to 15 feet below the surface. In this unit, groundwater flow characteristics are controlled by the amount of clay in the drift and the topography of the bedrock.

The hydraulic head in the bedrock near the airport is similar to that in the overlying glacial drift while the bedrock's permeability is generally much lower than the overlying sediments (Engineering Science, 1990). Although the two units are hydraulically interconnected, most flow occurs in the more conductive glacial drift. The principal flow path of groundwater in the area is direct recharge from ground surface to the shallow water table in the glacial drift, then horizontal flow in the water table to discharge in local streams and ponds. Throughout the area of the Base, the shallow groundwater table provides discharge to streams and their tributaries. The water table is also continuous with marsh and bog areas where the water is at or above the ground surface.

Lindholm, et.al., (1979) reports that yields are generally less than 25 gal. per minute for glacial tills and less than 5 gal. per minute for the bedrock. The glacial drift, however, is used in rural areas for farm and domestic use by low production, hand-dug or shallow-drilled wells. When the till is used as a source of water, the wells are dug open-end, and, where the gabbro is used as a source, the wells are completed as an open hole. In both cases, the lower parts of the wells themselves are used as reservoirs.

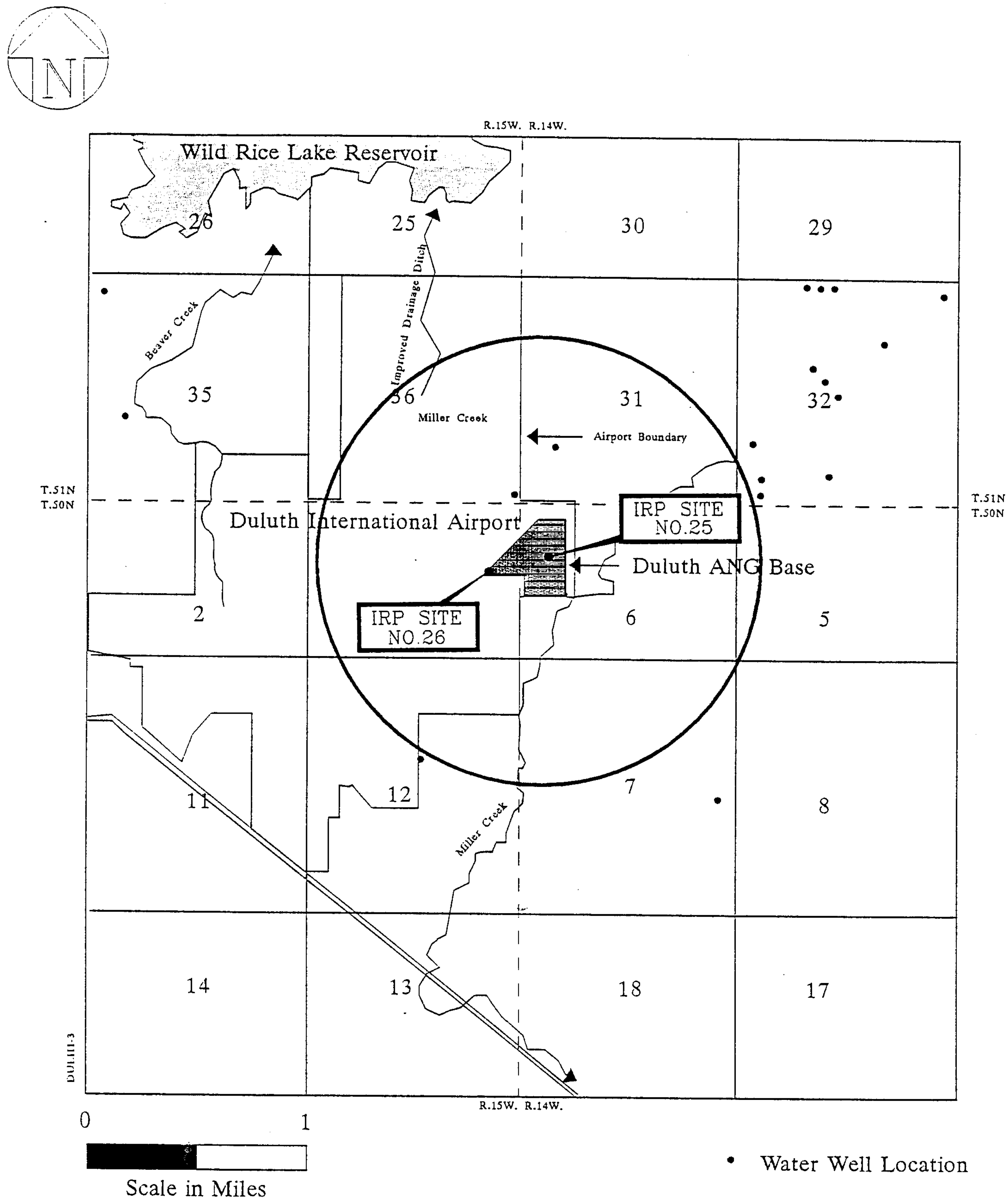
According to Lindholm, et.al., (1979), the dissolved solids concentrations in glacial drift and bedrock aquifers in the eastern part of the watershed is less than 250 milligrams per liter (mg/L). In general, bedrock aquifer water is bicarbonate type in nature in the State (details provided in Lindholm, et.al., 1979).

As shown in Figure 3.5, private water wells are located in the vicinity of the Duluth International Airport and the Duluth ANGB. Private wells in Figure 3.5 are for domestic use except one well located in Section 12, Range 15W, Township 50N. This well is classified as a commercial well (details provided in OpTech, 1993 PA Report).

3.1.3 Surface Water

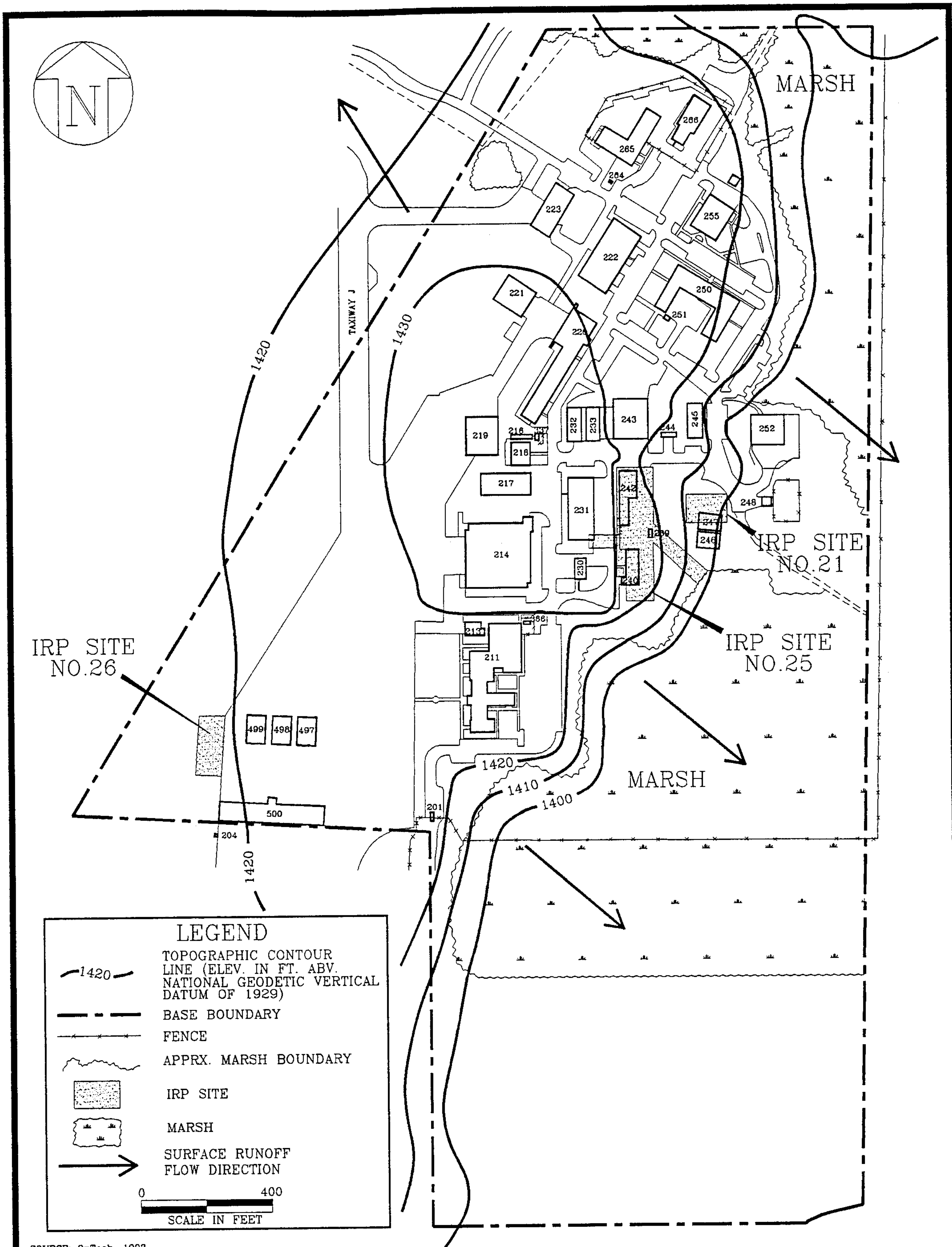
Surface water drainage at the Duluth ANGB is part of the St. Louis Watershed of the Great Lakes Basin (Olcott, et al., 1978) (Figure 3.6). The southeastern corner of the watershed, north of the St. Louis River, is drained by several small creeks, which flow southeastwardly and join the St. Louis River near its mouth. The remainder of the watershed north of the river drains to the southwest and the smaller streams and tributaries join the St. Louis River along it upper extent. The St. Louis River is the largest river to flow into Lake Superior from Minnesota.

The Duluth International Airport is drained mainly by a large north-south drainage ditch flowing northward and eventually into the Wild Rice Lake (Figure 3.7). The lake drains into the Beaver River and then the Cloquet River, which joins the St. Louis River approximately 19 miles west of the airport. Because of its location on the eastern portion of the airport, Duluth ANGB drains eastward into Miller Creek (Figures 3.6 and 3.7). Miller Creek flows southeastward and joins the St. Louis River at St. Louis Bay.



SOURCE: PRELIMINARY ASSESSMENT, OPTECH, 1993

FIGURE 3.5 DULUTH\SI-197\WWLOCATN	WATER WELL LOCATIONS WITHIN ONE-MILE RADIUS OF IRP SITES NO.25 AND NO.26 Duluth Air National Guard Base Duluth, Minnesota	OPTECH OPERATIONAL TECHNOLOGIES CORPORATION MAY 1996



SOURCE: OpTech, 1993.

FIGURE 3.6

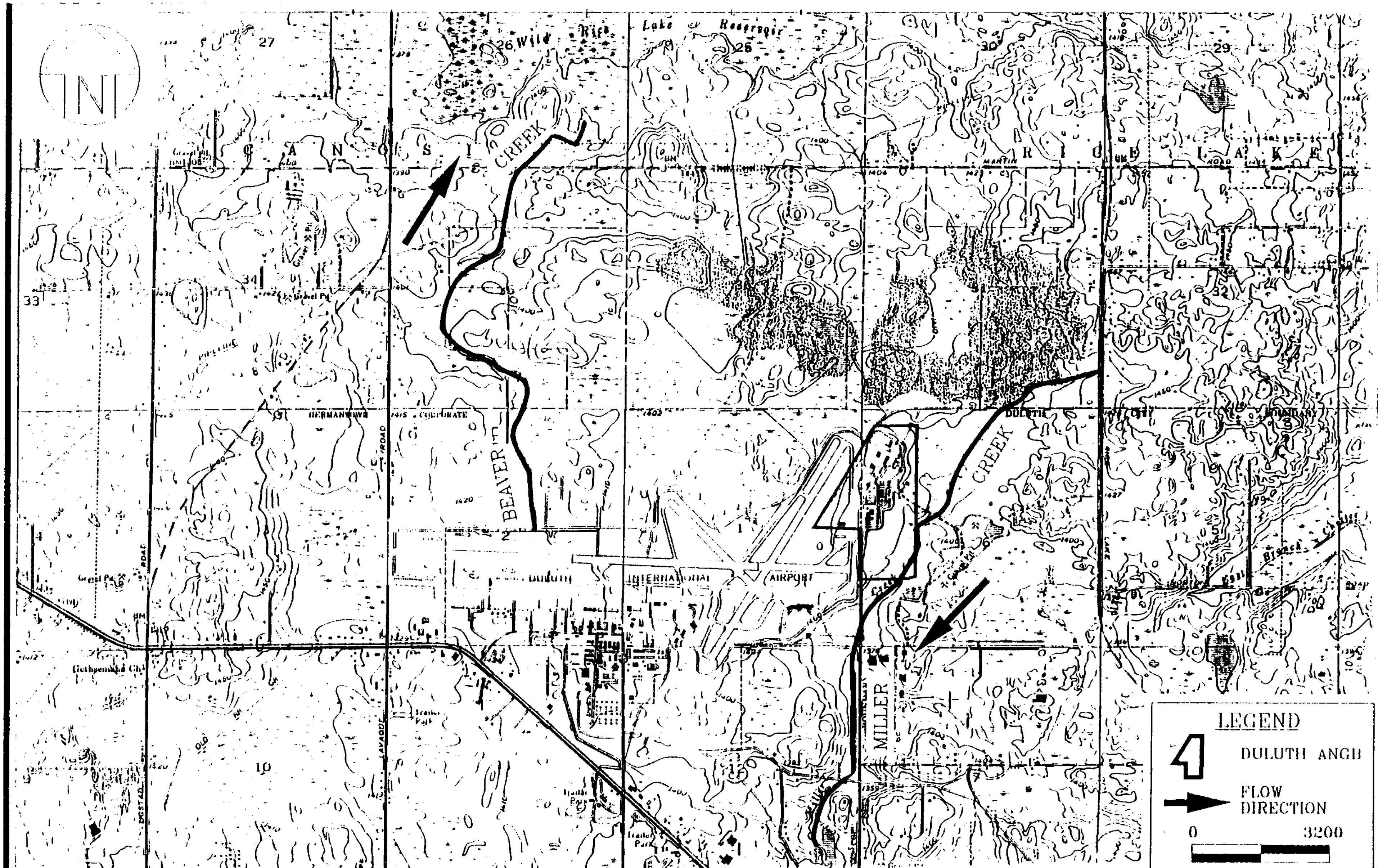
DULUTH\SITE

SURFACE DRAINAGE MAP

Duluth Air National Guard Base
Duluth, Minnesota

OPTECH OPERATIONAL TECHNOLOGIES CORPORATION

DECEMBER 1995



SOURCE: MODIFIED FROM USGS DULUTH HEIGHTS, MN. 1:24,000 QUADRANGLE 1953, REVISED 1993.

FIGURE 3.7

DULUTH/SI-197/WATERSHD

WATERSHED SURROUNDING
DULUTH AIR NATIONAL GUARD BASE
Duluth Air National Guard Base
Duluth, Minnesota

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Stream flow varies during the year, with the highest flows in April and May, resulting from snow melt and spring rains. Stream flow then recedes through the summer, increasing only temporarily due to occasional periods of stormwater runoff. Flow increases slightly as evapotranspiration losses diminish in the fall. During winter, stream flow is sustained by groundwater discharge and recedes slowly until March, when accumulated snow begins to melt.

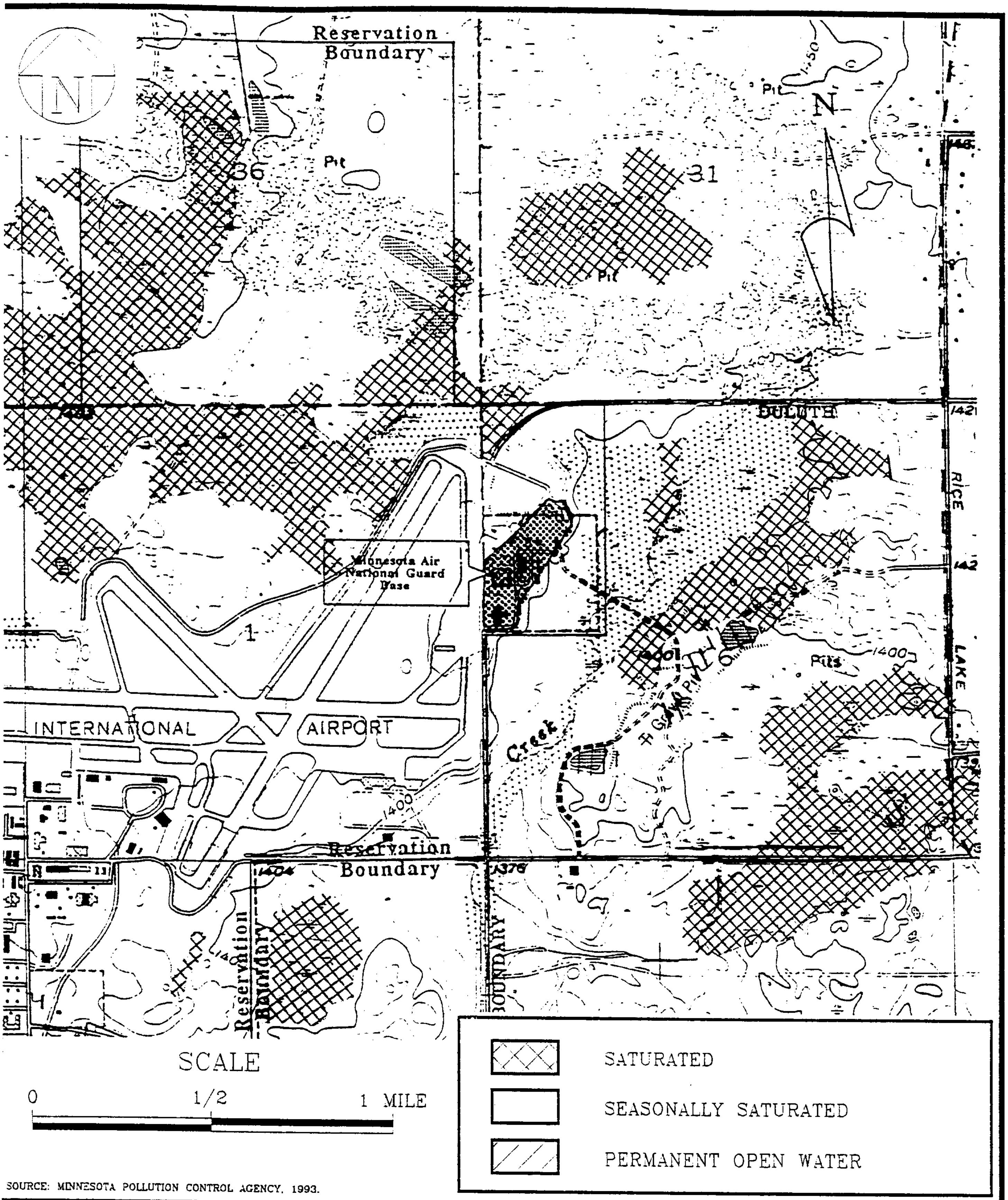
There are hundreds of surface water bodies surrounding the Duluth ANGB, consisting of wooded bogs, wetlands, and small ponds. Figure 3.7 details the abundant surface water bodies in the vicinity of Duluth ANGB.

3.1.4 Critical Habitats/Endangered or Threatened Species

The classifications of the marshes and wetlands located in the vicinity of the Base are presented on Figure 3.8. The marsh, located east of IRP Site No. 25 and draining into Miller Creek, is seasonally saturated. Marshes located northwest and less than 0.5 miles from IRP Site No. 26 are saturated all year. Approximately 4.1 miles northwest of Duluth ANGB and 1.25 miles northwest of Wild Rice Lake is the Canosia Wildlife Management Area (WMA) (Figure 3.9). Owned by the Minnesota Department of Natural Resources (DNR), the Canosia WMA is a State-managed area that contains one endangered species, the osprey (*Pandion Haliaetus*) (Minnesota DNR, 1979).

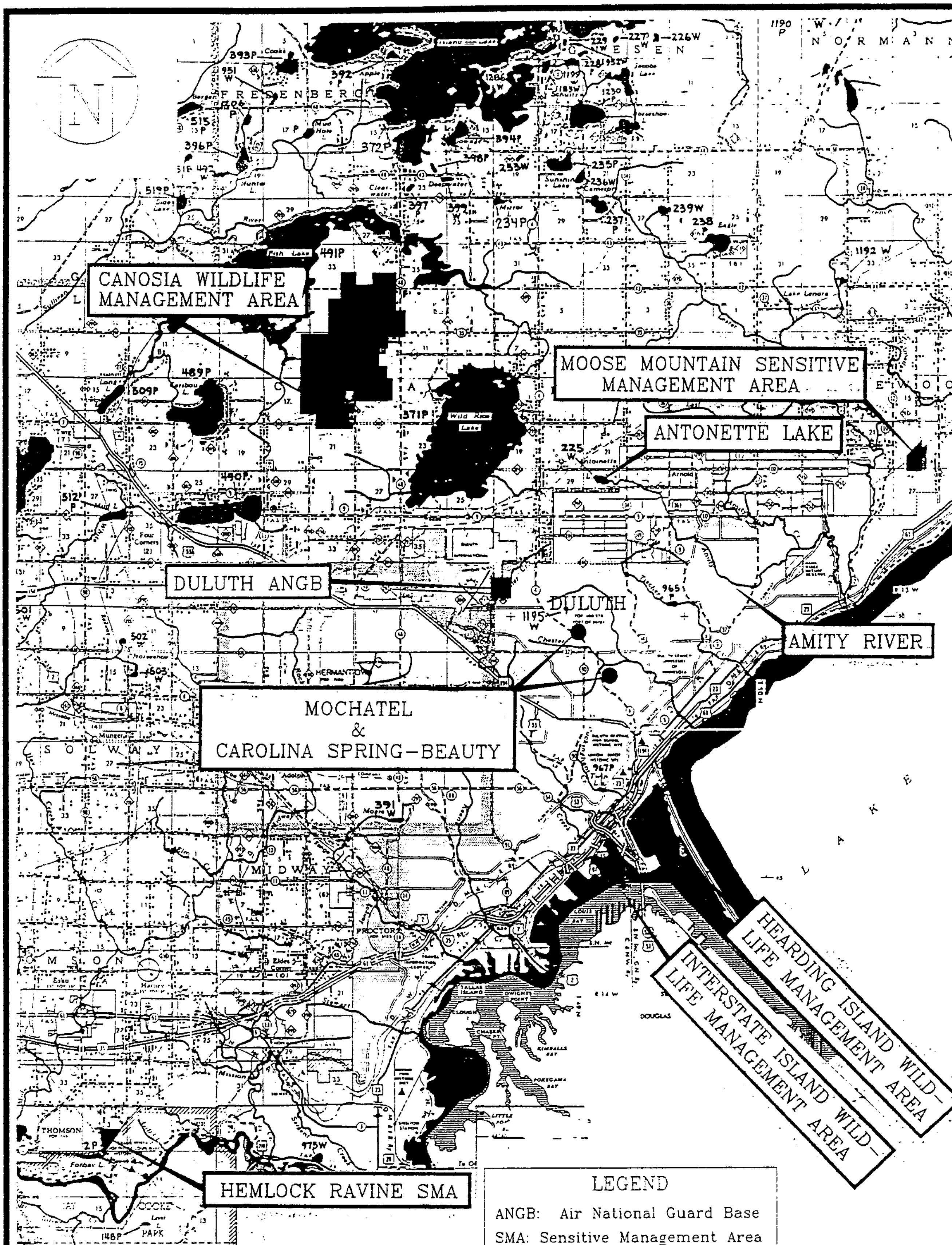
According to the Minnesota Natural Heritage Database (1993), ospreys were using the Canosia WMA as a nesting ground in 1991. The State of Minnesota DNR classifies various lakes and wetlands as Protected Waters or Wetlands and strictly controls any projected modifications of water courses, currents, or cross sections of these protected areas. All lakes over 10 acres in size are automatically protected, as are all Type 3 (inland shallow fresh marshes), Type 4 (inland deep fresh marshes), and Type 5 (inland open fresh water) wetlands, all trout streams, and all major rivers in Minnesota. Miller Creek, which the eastern portion of Duluth ANGB drains into, is a State-designated trout stream. Wild Rice Lake (Figure 3.9), located 2.5 miles north of Duluth ANGB, is formally classified by the Minnesota DNR as a Protected Water. Similarly, Antoinette Lake, located 2.75 miles northeast of the Base, is classified as a Protected Water. Antoinette Lake serves as the headwaters for the Amity River, which flows southeast into Lake Superior.

Within Minnesota, the Moschatel (*Adoxa Moschatellina*) and the Carolina Spring-Beauty (*Clatonia Caroliniana*) are endangered plant species (Coffin and Pfannmuller, 1988). Both have been observed in two areas near the Base; 1.5 miles and 2.1 miles southeast of Duluth ANGB



SOURCE: MINNESOTA POLLUTION CONTROL AGENCY, 1993.

FIGURE 3.8 DULUTH\WETLAND	WETLAND CLASSIFICATIONS ADJACENT TO DULUTH AIR NATIONAL GUARD BASE Duluth Air National Guard Base Duluth, Minnesota	OPTECH OPERATIONAL TECHNOLOGIES CORPORATION MAY 1996



SOURCE: OPTECH, 1993 AND U.S. DEPARTMENT OF TRANSPORTATION 1989

FIGURE 3.9	SENSITIVE HABITATS/WATERS NEAR DULUTH ANG BASE	OPTECH OPERATIONAL TECHNOLOGIES CORPORATION
DULUTH\DULIII-4	Duluth Air National Guard Base Duluth, Minnesota	DECEMBER 1995

(Figure 3.9). Of note, observations of both plant species were last made in 1940 (Moschatel) and 1944 (Carolina Spring-Beauty in the vicinity of Duluth ANGB).

Figure 3.9 also includes Sensitive Management Areas (SMAs) and other WMAs in the vicinity of Duluth ANGB (Saffon, 1993). The region falls within a major flyway for migrant birds; traditional wildlife areas that support regional bird migrations are protected.

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SECTION 4.0 FIELD PROGRAM

The purpose of this SI is to confirm, through field activities, the presence or absence of contamination at IRP Site No. 25, Old Motor Pool Area and at IRP Site No. 26, Ramp Disposal Area, and, if contamination is identified, to attempt to determine the areal extent and concentration of the contamination in order to provide data needed to reach a decision for the sites. This section describes the field activities performed during the SI to accomplish the above objectives, and the methodologies used to conduct these activities. The field investigation at the Duluth ANGB commenced on 2 May 1995 and was completed on 20 May 1995.

4.1 SUMMARY

The field investigation at the Duluth ANGB incorporated the use of soil borings and monitoring wells. Soil borings were drilled to obtain soil samples for laboratory analyses. Sample results were used to determine contaminant concentrations and to delineate vertical and horizontal extent of soil contamination at the sites, and to evaluate the potential for contaminant impact to groundwater. Monitoring wells were installed to obtain groundwater samples for laboratory analyses and obtain data for hydrogeologic characterization of the hydrologic unit. The soil boring and monitoring well locations for IRP Sites No. 25 and No. 26 are presented in Figures 4.1 and 4.2, respectively.

4.2 BACKGROUND

An evaluation of the significance of environmental contaminant concentrations is typically based on a comparison of the levels observed to known background conditions and regulatory-based standards, where applicable. Sampling of soil at background locations is conducted to determine naturally occurring concentration levels and contaminant or chemical concentrations already existing in the area due to general environmental conditions. Establishing soil background conditions is necessary for risk assessment, establishing cleanup criteria, and making decisions on further site actions. Background levels for soil and groundwater were determined during a previous investigation (Engineering-Science, 1990), and these background levels are used for the SI.

4.3 DEVIATIONS FROM THE SITE INVESTIGATION WORK PLAN

There were deviations from the SI Work Plan noted. However, in no way did any of the changed procedures or protocols prevent accomplishing the overall objectives of the SI.

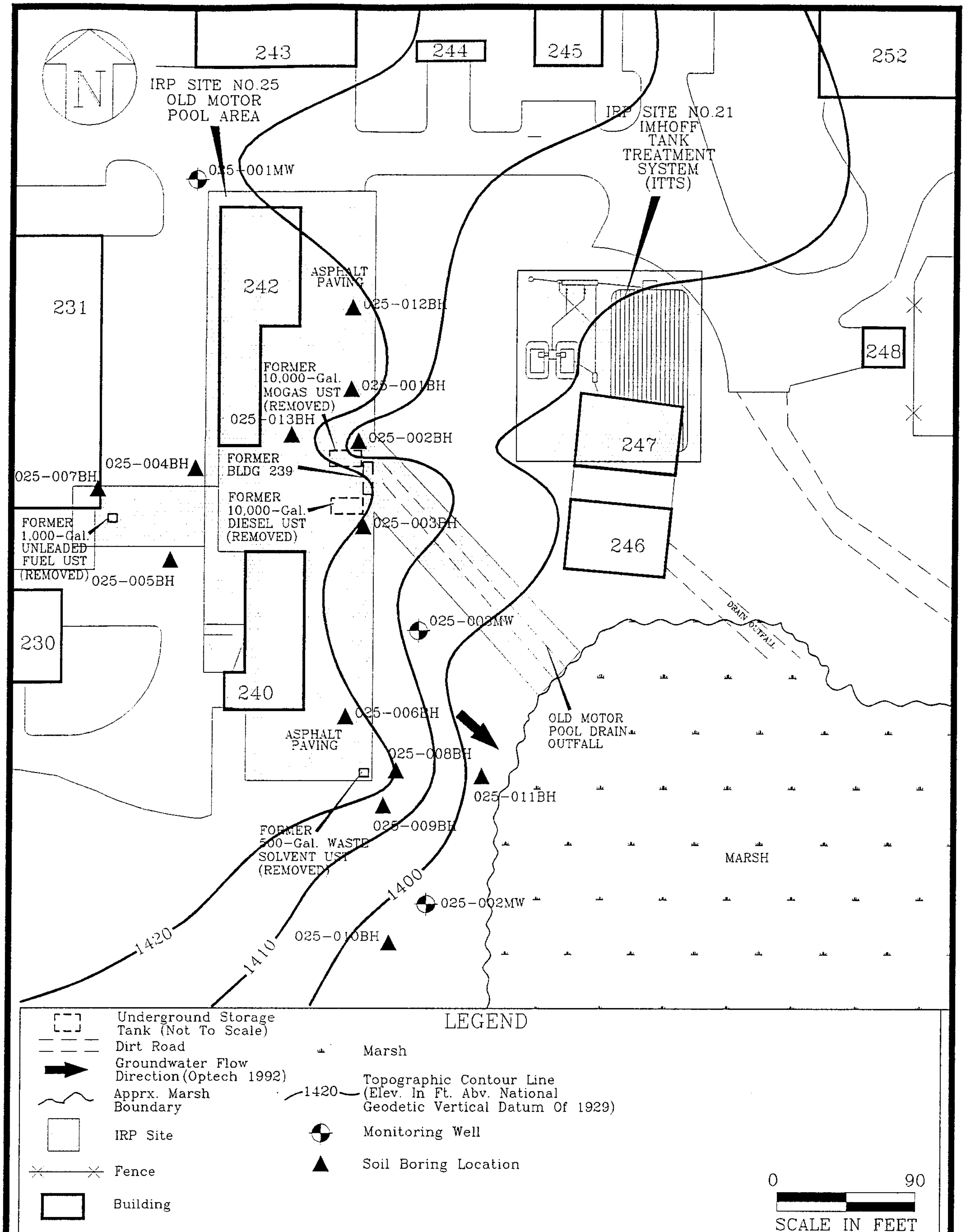

FIGURE 4.1

DULUTH\SITE2521

SOIL BORING AND MONITOR
WELL LOCATIONS IRP SITE NO.25,
OLD MOTOR POOL AREA
Duluth Air National Guard Base
Duluth, Minnesota

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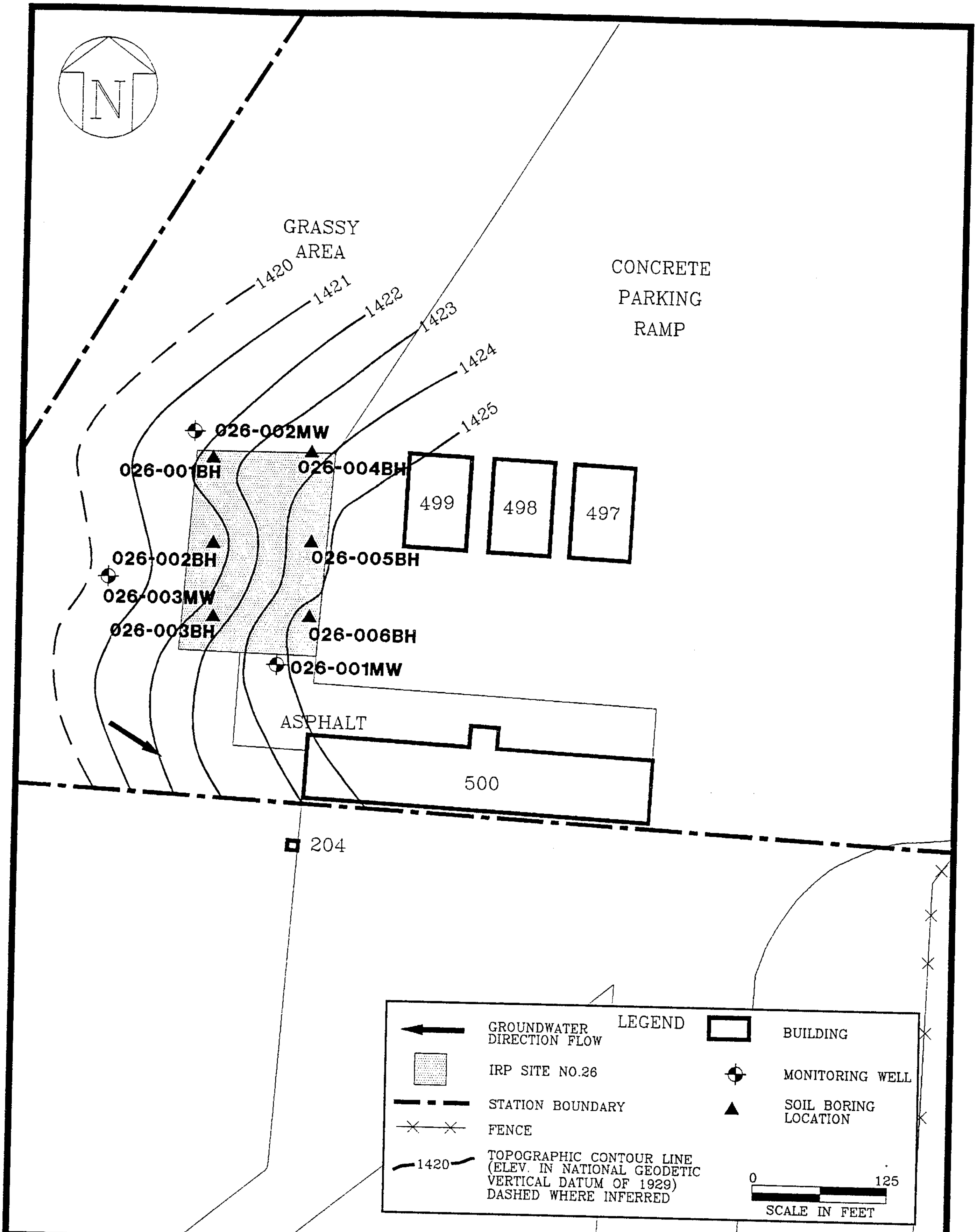

FIGURE 4.2

DULUTH\SITE-26

SOIL BORING AND MONITOR WELL LOCATIONS IRP SITE NO.26, RAMP DISPOSAL AREA
Duluth Air National Guard Base
Duluth, Minnesota

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The deviations from the SI Work Plan and the rationale for the changes are described as follows:

- American Society of Testing and Materials (ASTM) Type II reagent water was not used to rinse equipment during the decontamination procedure, as outlined in Section 6.2 of the SI Work Plan. ASTM Type I water was used in its place. To insure the use of ASTM Type I water would not affect analytical results, three field blanks of the water were submitted during field work and analyzed for all target analytes. The analytical results of these field blanks confirmed target analytes were not present in the ASTM Type I water used to decontaminate equipment or for rinseate blank collection.

- The SI Work Plan specified that a polyvinylchloride (PVC) slug be used in conducting slug tests. An acrylic slug was used in lieu of the PVC slug. This change did not affect the results of the slug tests or the SI.

- At the request of the 148th FW Base Civil Engineer, monitoring well 025-001MW was not constructed as specified in the SI Work Plan. The concrete base was not set below the frost line.

- The SI Work Plan stated that photographs would be taken showing purged well water in a clear jar against a white background. These photographs were not taken during the SI, but the Site Manager noted the actual conditions of the development and purge water in her field book.

- Due to the high water table, the construction of monitoring wells 026-003MW and 025-002MW deviated from the design given in the SI Work Plan. Monitoring well 026-003MW has only 1.5 feet of sand pack above the screen rather than the 2.0 feet of sand pack specified in the SI Work Plan. Both monitoring wells have only 1.5 feet of bentonite slurry rather than the 2.0 feet specified in the SI Work Plan. These changes will not affect the function of the monitoring wells or adversely affect the results of the SI.

4.4 FIELD SCREENING ACTIVITIES

During sampling of soil borings, the air around the sampler was monitored with a Thermal Instrument Determinator photoionization detector (PID) immediately upon opening the split-spoon sampler (to maximize the detection of volatiles). Soil was then field screened using a Photovac 10S Plus Portable Gas Chromatograph (GC). The soil samples collected were placed in plastic bags, and the PID used to conduct ambient temperature headspace analysis for photoionization compounds. All PID readings are indicated on the boring logs included in Appendix A, Boring Logs. The Portable GC, calibrated to screen for BTEX, was used to detect the presence of these compounds in the headspace from the soil samples collected. Headspace analysis was used to provide immediate information as to the level of photoionizable compounds in the borehole. Data obtained from the field GC and PID will supplement analytical laboratory data. Field GC data is summarized in Subsections 5.2.2 and 5.3.2, Field GC Screening Results, and included in Appendix B, Field Gas Chromatography Screening Results.

4.5 CONFIRMATION ACTIVITIES

American Engineering Testing, Inc., Duluth, Minnesota was retained as the drilling contractor for drilling soil borings and installing monitoring wells. The drilling contractor mobilized personnel and equipment that met or exceeded HQ ANG/CEVR, MPCA, and other relevant regulatory requirements.

Southern Petroleum Laboratories (SPL), Houston, Texas, was retained to perform sample analyses. Provisions were made to ensure samples were properly stabilized, preserved, and labeled (including chain-of-custody) prior to shipment to the laboratory.

RREM, Inc., Duluth, Minnesota, was retained as the surveying contractor. The site boundaries, buildings, parking areas, soil boring locations, and monitoring well locations were surveyed. The land surface elevations of each borehole are shown on the borehole logs included in Appendix G, Survey Report. The land surface elevations of each monitoring well are shown on the monitoring well logs included in Appendix C, Monitoring Well Construction Logs.

4.5.1 Soil Borings

Soil borings were drilled to obtain soil samples for laboratory analyses for defining the vertical and horizontal extent of any existing soil contamination at the site. Soil samples were also used for determining site geology and subsurface soil characteristics.

A total of 19 soil borings were drilled for data collection. All work was performed in a manner consistent with the HQ ANG/CEVR approved SI Work Plan. Soil test borings were drilled to the depth where groundwater was encountered. Two borings were terminated before groundwater was encountered when high PID and Lower explosive level (LEL) readings were noted in the workers' breathing zones. All borings were drilled using hollow-stem auger (HSA) methods.

4.5.1.1 Hollow-Stem Auger Drilling Method

The HSA drilling method employs a hollow helical steel drill tool that is rotated to advance the boring and lift formation materials (cuttings) to the surface. The flights for the HSA are welded onto steel pipe and a cutter head is attached to the lead (bottom) auger to cut the hole. During drilling, a center bit is inserted into the hollow area of the cutter head that prevents cuttings from re-entering the hollow portion of the auger. Generally, the center bit is flush with or extends no more than 1/2 foot below the cutter head. The center bit connects through the auger by small diameter drill rods and is attached to the top-head drive unit of the drill rig. The top-head drive is powered by a truck-mounted engine that mechanically rotates the entire flight of augers. The hollow opening allows the insertion of sampling tools (i.e., split-spoon sampler) with the augers in place to prevent caving of the borehole.

A 24-inch carbon steel California-style sampler equipped with four 6-inch sleeves was used for collecting soil samples for laboratory analyses. The sampler was decontaminated and new sleeves inserted before each sampling event.

Auger flights, drill rig(s), and tools were thoroughly steam-cleaned in the designated decontamination area south of Bldg. 246 before initial use, after the completion of each borehole, and at the end of each day.

Borehole abandonment activities conformed to applicable Minnesota requirements. HSA borings were backfilled with cement/bentonite grout immediately after sampling to prevent downward migration of contaminants through the open borehole. All borings were grouted from the bottom of the borehole to the surface using a tremie pipe. The cement grout consisted of a mixture of portland cement, ASTM C-150, and water in the proportion of not more than seven gallons of clean water per bag of cement (one cubic foot or 94 pounds). Additionally, a three percent by weight volume of bentonite powder was added to the mixture. All borings were clearly marked or guarded at all times until backfilled. Soil boring locations and ground elevations were determined by a professional surveyor.

4.5.2 Monitoring Wells

The groundwater investigation consisted of the installation of six monitoring wells. Monitoring wells were used to determine groundwater contamination and obtain data for hydrogeologic characterization of the aquifer.

Monitoring wells were installed by a qualified well driller using HSA drilling methods, as previously described in Subsection 4.5.1.1. Soil samples were collected at each five-foot interval for geologic classification and field screening for contaminants. All monitoring wells were constructed in accordance with the Minnesota Department of Health (MDH) well standards. Well permits were obtained from the MDH prior to installation of the monitoring wells. Additionally, well variances were retained from the MDH prior to the installation of the flush surface mount monitoring wells.

Monitoring wells were constructed of two-inch ID, flush threaded, PVC casing and screens meeting State of Minnesota well construction standards, and had a bottom cap. The monitoring wells were constructed using a 10-foot, 2-inch diameter continuous slot PVC pipe with a PVC solid riser pipe. Screen slot size is 0.010 inch. The top of the screen was placed at least approximately one foot above the water table. The well head has a vented cap. In choosing both depth and length of the well screens, annual fluctuation of the water table was taken into consideration. Certified pre-cleaned and pre-wrapped riser and screen was used for well construction. Monitoring well construction data are presented in Table 4.1. A monitoring well construction log was prepared for each monitoring well installed during the SI (Appendix C, Monitoring Well Construction Logs).

The well annulus at the screen was sand-packed from 0.5 feet below the bottom of the screen to 2 feet above the top of the well screen by the tremie pipe method, using Red Flint 45/55 bagged silica sand. A two-foot bentonite slurry seal, surface mixed, was placed above the sand pack. The sand pack and screen size were designed such that the screen will not become plugged and that sand free water will be produced. The annulus around the casing and above the slurry seal was filled with cement/bentonite grout after the well was set in the borehole to prevent the flow of any contaminated water along the casing.

A total of four monitoring wells at IRP Sites No. 25 and No. 26 were completed by finishing the casing approximately 2-1/2 feet above the top of the borehole (Table 4.1) and two monitoring wells were completed by flush surface mount (025-001MW and 026-001MW). Base Civil Engineering personnel were contacted to determine which wells would be completed with

Table 4.1
Monitoring Well Construction Data IRP Sites No. 25 and No. 26
148th FW, Duluth ANGB, Duluth, Minnesota

Monitoring Well ID	Total Depth of Borehole (ft BLS)	Surface Elevation (ft above NGVD)	Top of Casings Elevation (ft above NGVD)	Screened Interval (ft BLS)
IRP Site No. 25				
025-001MW	39.8	1,422.59	1,422.56	29.4 - 39.4
025-002MW	16	1,397.83	1,400.21	5 - 15
025-003MW	21	1,402.71	1,405.32	9.7 - 19.7
IRP Site No. 26				
026-001MW	26	1,424.69	1,424.62	14.2 - 24.2
026-002MW	20	1,421.90	1,424.28	9.4 - 19.4
026-003MW	15.5	1,420.44	1,422.90	5.5 - 15.5

IRP – Installation Restoration Program.
BLS – Below Land Surface.
NGVD – National Geodetic Vertical Datum of 1929.
ID – Identification.
ft – feet.
MW – Monitoring Wells.

a flush mount and which would be completed aboveground. For aboveground completion, a protective steel riser pipe equipped with a locking cap was set in a concrete pad set around the well casing. Both the MDH unique well number, as well as the IRP well number, were permanently marked on the locking cap. The concrete pad was built up around the riser pipe in a three-foot-square and was sloped away from the riser pad to aid in runoff. All risers were secured with keyed-alike stainless-steel plastic coated locks. All lock keys were given to the 148th FW/Environmental Management Office (EM). The riser pipe was painted dark brown.

Three 4-inch diameter steel guard posts filled with concrete were placed around the protective steel riser pipe. All guard posts were painted dark brown. The bases for the guard posts were set into concrete below the frost line in order to prevent frost heave.

Monitoring wells completed by flush surface mount were flush with the land surface. The casing was cut two to three inches below land surface and fitted with a protective locking lid consisting of a cast-iron valve box assembly. The valve box was placed in the center of the hole with the top just above the ground surface. Concrete was placed around the value box and sloped to divert drainage. The valve box was recessed to prevent snowplow damage. The well head was fitted with a watertight compression casing cap to prevent infiltration of surface water. The well number was clearly marked on the valve box lid and well casing. All well assemblies were secured with keyed-alike stainless-steel plastic coated locks. All well lock keys and copies of all well installation and registration paperwork were provided to the 148th FW on-site representative.

4.5.3 Specific Media Sampling

This subsection summarizes the analytical program followed for soil samples collected during the SI to determine the nature, magnitude, and extent of contamination detected at the sites. Also included in this subsection is a brief discussion of quality assurance/quality control (QA/QC) procedures followed during the field sampling activities.

4.5.3.1 Soil

Past activities at IRP Site No. 25 indicate that suspected contamination consists primarily of waste solvents, diesel fuels, MOGAS fuels, and unleaded fuels. Therefore, the primary analytical program of the SI focused on the detection of volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), cadmium, chromium, nickel, mercury, and lead. To comply with MPCA requirements, and to fulfill the requirements of the SI, soil samples were analyzed for VOCs by United States Environmental Protection Agency, (USEPA) Method SW8240; for SVOCs by USEPA Method SW8270; and for nickel and cadmium by USEPA Method SW6010, for lead by USEPA Method SW7421, for chromium by USEPA Method SW7196, and for mercury by USEPA Method SW7470. Table 4.2 summarizes the analytical program at this site. The soil sampling program is presented in Table 4.3.

Past activities at IRP Site No. 26 indicate that suspected contamination consists primarily of waste JP-4 fuel. Therefore, the primary analytical program of the SI focused on the detection of VOCs, SVOCs, cadmium, chromium, and lead. To comply with MPCA requirements, and to fulfill the requirements of the SI, soil samples were analyzed for VOCs using USEPA Method SW8240; for SVOCs using USEPA Method SW8270, for cadmium using USEPA Method SW6010, for chromium using USEPA Method SW7196 and for lead using USEPA Method SW7421. Table 4.2 summarizes the analytical program at this site. The soil sampling program is presented in Table 4.4.

4.5.3.2 Groundwater

Groundwater samples collected at IRP Site No. 25 were analyzed for VOCs using USEPA Method SW8010/8020; for SVOCs using USEPA Method SW8270; for cadmium and nickel

Table 4.2
Summary of the Analytical Program
148th FW, Duluth ANGB, Duluth, Minnesota

Site No.	Matrix	Field Parameters	Lab Parameters	Analytic Methods	Investigative Samples	Number of Field QA/QC Samples: Trip Blanks	Equipment Rinseate Blanks	Field Blanks	Field Duplicate	MS/MSD	Matrix Totals
25	Soil	Soil Gas Screening using Determinator PID Field GC Soil Classification	VOCs	SW 8240[a]	19	3*[b]	2*	2*[c]	2	1	22
			SVOCs	SW 8270[a]	19		2*	2*[c]	2	1	22
			Lead	SW 7421[a]	19		2*	2*[c]	2	1	22
			Cadmium	SW 6010[a]	19		2*	2*[c]	2	1	22
			Chromium	SW 7196[a]	19		2*	2*[c]	2	1	22
			Nickel	SW 6010[a]	19		2*	2*[c]	2	1	22
			Mercury	SW 7470[a]	19		2*	2*[c]	2	1	22
	Groundwater	Temperature pH Specific Conductance Turbidity	VOCs	SW 8010/8020[a]	3	1*[b]	1*	1*[c]	1	NA	4
			SVOCs	SW 8270[a]	3		1*	1*[c]	1		4
			Lead	SW 7421[a]	3		1*	1*[c]	1		4
			Cadmium	SW 6010[a]	3		1*	1*[c]	1		4
			Chromium	SW 7196[a]	3		1*	1*[c]	1		4
			Nickel	SW 6010[a]	3		1*	1*[c]	1		4
			Mercury	SW 7470[a]	3		1*	1*[c]	1		4
26	Soil	Soil Gas Screening using Determinator PID Field GC Soil Classification	VOCs	SW 8240[a]	12	1*[b]	2*	2*[c]	2	1	15
			SVOCs	SW 8270[a]	12		2*	2*[c]	2	1	15
			Lead	SW 7421[a]	12		2*	2*[c]	2	1	15
			Cadmium	SW 6010[a]	12		2*	2*[c]	2	1	15
			Chromium	SW 7196[a]	12		2*	2*[c]	2	1	15
	Groundwater	Temperature pH Specific Conductance Turbidity	VOCs	SW 8260[a]	3	1*[b]	1*	1*[c]	1	NA	4
			SVOCs	SW 8270[a]	3		1*	1*[c]	1		4

* – Trip, Equipment Rinseate and Field Blanks are not counted in Matrix Totals.
VOCs – Volatile Organic Compounds.
SVOCs – Semivolatile Organic Compounds.
QA/QC – Quality Assurance/Quality Control.
PID – Photoionization Detector.
GC – Gas Chromatograph.
[a]United States Environmental Protection Agency, 1986.
[b]One Trip Blank per cooler.
[c]Field blank samples consist of the potable water source and Type I reagent-grade water used during the decontamination procedures. These field blanks are representative of activities at IRP Sites No. 25 and No. 26 during the same event.
NA – Not Applicable.
MS/MSD – Matrix Spike/Matrix Spike Duplicate.

Table 4.3
Soil Sampling Program for IRP Site No. 25
148th FW, Duluth ANGB, Duluth, Minnesota

Borehole Number	Sample Depth (ft BLS)	Additional Samples
025-001BH	6.5 - 7	
025-002BH	11.5 - 12	
025-003BH	11 - 12	
025-003BH	11 - 12	Duplicate
025-004BH	11.5 - 12	
025-004BH	19.5 - 20	
025-005BH	11.5 - 12	
025-006BH	21.5 - 22	
025-007BH	11.5 - 12	
025-008BH	10.5 - 11	
025-008BH	14.5 - 15	
025-009BH	11 - 12	
025-009BH	11 - 12	Duplicate
025-009BH	14 - 14.5	MS/MSD
025-009BH	14.5 - 15	
025-010BH	2 - 2.5	
025-010BH	6 - 6.5	
025-011BH	2 - 2.5	
025-011BH	6.5 - 7	
025-012BH	11.5 - 12	
025-012BH	19.5 - 20	
025-013BH	11.5 - 12	

ft BLS – feet Below Land Surface.
BH – Borehole.
MS/MSD – Matrix Spike/Matrix Spike Duplicate.

using USEPA Method SW6010, for chromium using USEPA Method SW7196, for mercury using USEPA Method SW7470, and for lead using USEPA Method SW7421.

Groundwater samples collected at IRP Site No. 26 were analyzed for VOCs using USEPA Method SW8260 and for SVOCs using USEPA Method SW8270. A summary of the analytical program for both sites is presented in Table 4.2.

4.5.3.3 Quality Control of Field Sampling

Field duplicate samples, equipment rinseate blanks, field blanks, trip blanks, and matrix spike/matrix spike duplicate samples were submitted to the analytical laboratory for assessment of the quality of data resulting from the field sampling program. Field and trip blank samples were analyzed to check for procedural contamination and ambient conditions at the site that may have caused sample contamination. Duplicate samples were submitted to provide a quality assurance check on analytical procedures and results. The number of field QA/QC samples collected at IRP Sites No. 25 and No. 26 is presented in Table 4.2.

Table 4.4
Soil Sampling Program for IRP Site No. 26
148th FW, Duluth ANGB, Duluth, Minnesota

Borehole Numbers	Sample Depth (ft BLS)	Additional Sample
026-001BH	2 - 2.5	
026-001BH	9.0 - 9.5	MS/MSD
026-001BH	9.5 - 10	
026-002BH	2 - 2.5	
026-002BH	6.5 - 7	
026-003BH	1.5 - 2	DUP
026-003BH	2 - 2.5	
026-003BH	6.5 - 7	
026-004BH	2 - 2.5	
026-004BH	9.5 - 10	DUP
026-005BH	1.5 - 2	
026-005BH	2 - 2.5	
026-005BH	9.5 - 10	
026-006BH	2 - 2.5	

ft BLS – feet Below Land Surface.
MS/MSD – Matrix Spike/Matrix Spike Duplicate.
DUP – Field Duplicate.
BH – Borehole.

The rate of quality control sampling was set at one field duplicate, one field blank, and one equipment rinseate blank for every 10 or fewer investigative soil samples, and one field duplicate, one equipment rinseate blank, and one field blank for every 10 or fewer investigative water samples. One VOC analysis trip blank, consisting of distilled, de-ionized, ultra pure water, was included along with each shipment of samples. One matrix spike/matrix spike duplicate was collected for every 20 or fewer investigative soil samples. Matrix samples provide information about the effect of the sample matrix on the analytical methodology.

4.5.3.4 Soil Sample Preservation

Soil samples submitted for laboratory analysis were collected with a California-style split-spoon sampler equipped with four 6-inch long, 2.5-inch diameter brass sleeves. Immediately upon removal from the sampler, the sleeve ends were covered with a Teflon™ barrier, aluminum foil, and fitted with a plastic cap. Prepared samples were placed within two sealed zip-lock plastic bag and immediately placed in the ice chest.

4.5.3.5 Aqueous Sample Preservation

Groundwater samples submitted for laboratory analyses were collected with a decontaminated Teflon™ bailer and new monofilament line (a new line was used for each well). Equipment blanks and field blanks were collected as aqueous samples.

VOC samples were preserved with no more than 2 drops of a 1:1 solution of hydrochloric acid per 40-milliliter, Teflon™-lined, glass Volatile Organic Analysis (VOA) vial having a Teflon™-lined lid. SVOC samples were stored without preservatives in 1-liter amber glass bottles having Teflon™-lined lids. Total recoverable metal samples were stored in a 1/2-liter high-density polyethylene bottle with a Teflon™-lined lid, and preserved at a pH of less than 2 with a solution of 1:1 nitric acid. Prepared samples were placed in a sealed zip-lock plastic bag and immediately placed in the ice chest.

4.6 HYDROGEOLOGIC CHARACTERIZATION

Water level measurements were collected to determine the direction of groundwater movement. The hydraulic gradient (I) was calculated based on the potentiometric surface maps interpreted from the water level data.

Hydraulic conductivity was estimated by conducting rising head slug tests in all monitoring wells. Slug tests were performed on 18-20 May 1995. Each test was performed by placing a solid acrylic "slug" into the well to displace a known volume of groundwater. After displaced groundwater levels restabilized within the well the slug was retrieved rapidly from the monitoring well and the rate of the respondent water level rise within the well was recorded by measuring water pressure transients using a transducer interfaced with an automatic data logger.

Slug test data was analyzed by the Bouwer and Rice Method (Bouwer and Rice, 1976) as presented in Geraghty & Miller, Inc., (1994) "AQTESOLV" Version 2.0 computer program. The method is applicable to determining values of hydraulic conductivity in unconfined aquifers. A detailed description of the method is provided in Appendix E, Aquifer Slug Test.

A summary of the results from the tests is presented in Section 5.0. The slug test data and analyses are presented in Appendix E.

4.7 INVESTIGATION DERIVED WASTE

During the SI, a certain amount of waste material (personal protective equipment (PPE), drill cuttings, decontamination water, and purge water) were produced as a result of investigative activities. Drill cuttings were produced during the drilling of soil borings. Drill cuttings were preliminarily characterized by monitor for organic vapor emissions with a PID and screened with a portable GC. All soil cuttings were drummed in steel, plastic-lined 55-gal. drums at the time of drilling.

Miscellaneous derived wastes (e.g., gloves, Visqueen™ sheeting, and wipes) which came in contact with drill cuttings having PID readings less than 100 parts per million (ppm) when field-screened were disposed of in a general refuse container.

Purge water and decontamination water were collected in steel, plastic-lined 55-gal. drums. Purge water was segregated by monitoring well. Proper management and disposal of water will be determined after sampling has been completed and laboratory analyses results have been obtained.

All drums were properly marked to indicate their contents, the collection date, contractor's name and telephone number, and borehole identification number. The final disposition of drummed materials is discussed in Appendix H, Site Investigation Derived Waste Management.

SECTION 5.0 INVESTIGATIVE FINDINGS

5.1 BACKGROUND

Background sampling was not conducted during the SI at Duluth ANGB, as per the HQ ANG/CEVR approved SI Work Plan. Background levels for soil and groundwater were determined during a previous investigation (Engineering-Science, Inc., 1990), and these background levels will be used for the SI.

5.2 IRP SITE NO. 25 INVESTIGATIVE FINDINGS

Thirteen soil boring locations were drilled to obtain soil samples for laboratory analyses and for characterizing site geology and subsurface soil conditions. Three monitoring wells were installed to obtain groundwater samples for laboratory analyses and to determine hydrogeologic evaluation of the hydrologic unit. The analytical results of these soil and groundwater samples were used to define the vertical and horizontal extent of contamination. Soil boring and monitoring well locations are shown on Figure 4.2.

5.2.1 Geologic and Hydrogeologic Investigative Results

Geologic information obtained from soil boring and boreholes drilled for the monitoring wells were used to describe the subsurface geology. Lithologic logs are presented in Appendix A, Boring Logs. Temperature, pH, and specific conductance measurements were collected during the sampling event and are presented in Table 5.1. The water level data that were collected prior to slug testing were used to interpret the potentiometric surface maps to determine the direction of groundwater movement at IRP Site No. 25. The slug test results were used for the analysis to determine the hydraulic conductivity of the hydrologic unit in the vicinity of the screened interval. A summary of the water level data and slug test data are also presented in Table 5.1. The slug test data and analysis are presented in Appendix E, Aquifer Slug Test Data.

5.2.1.1 Site Geology

Unconsolidated glacial till overlies the gabbro bedrock and consists of silt, clay, sand, pebbles, gravel, and mixtures of these components in layers and lenses of varying vertical and horizontal extents. The three geologic cross sections depicting the subsurface geology at IRP Site No. 25 are indexed in Figure 5.1 and are presented as Figures 5.2, 5.3, and 5.4. The upper 10-foot interval is representative of a fill material consisting of silt with trace to some sand and trace to

Table 5.1
Measurements for Groundwater Sampling Collected from IRP Site No. 25 on 18 May 1995 and 19 May 1995
148th FW, Duluth ANGB, Duluth, Minnesota

Monitoring Well	Temp (° C)	pH	Specific Conductivity (µS/cm)	Depth to Water (feet BLS)	Water Table (feet NGVD)	Hydraulic Conductivity (gpd/ft²)
025-001MW	9	7.74	802	22.64	1,399.92	10.9
025-002MW	NA	NA	NA	7.32	1,392.89	9.26
025-003MW	6	6.61	1,413	10.92	1,394.40	3.28

° C – Degrees Centigrade.
µS/cm – micro-Siemens per centimeter.
IRP – Installation Restoration Program.
BLS – Below Land Surface.
NGVD – National Geodetic Vertical Datum of 1929.
gpd/ft² – gallons per day per square foot.

little gravel. The unconsolidated material observed below 10 feet BLS was representative of the glacial till consisting of predominantly silt with trace to little sand and little to some gravel. The clasts size of the sand ranged from fine- to medium-grained and for the gravel ranged from granule to boulder. A sand and gravel layer was observed at approximately 25 feet BLS during drilling the borehole for monitoring well 025-001MW. A peat layer was encountered at approximately 20 feet BLS during drilling of the borehole for monitoring well 025-003MW.

5.2.1.2 Site Hydrogeology

Groundwater occurs in the unconsolidated glacial till and was encountered from approximately 5 to 35 feet BLS during drilling operations. The hydrologic unit was observed to be unconfined; however, heterogenous nature of the lenticular stratigraphy and discontinuous layers of intermixed clays, silts, sands, and gravels produces semi-confined conditions within the hydrologic unit. Also, based on the grain size analysis, silt and fine sand comprise 52% of the total component of samples in certain intervals of the stratigraphic column.

The potentiometric surface map is presented as Figure 5.5. The direction to groundwater movement at IRP Site No. 25 is to the southeast. The average I in the vicinity of IRP Site No. 25 was calculated to be 0.02 feet per feet (ft/ft), based on information from the potentiometric surface map.

The hydraulic conductivity values were computed from Bouwer and Rice (1976) method using the AQTESOLV 2.0 Version computer program (Geraghty & Miller, Inc., 1994). The hydraulic conductivity values are only representative of the 10-foot screened interval. The average

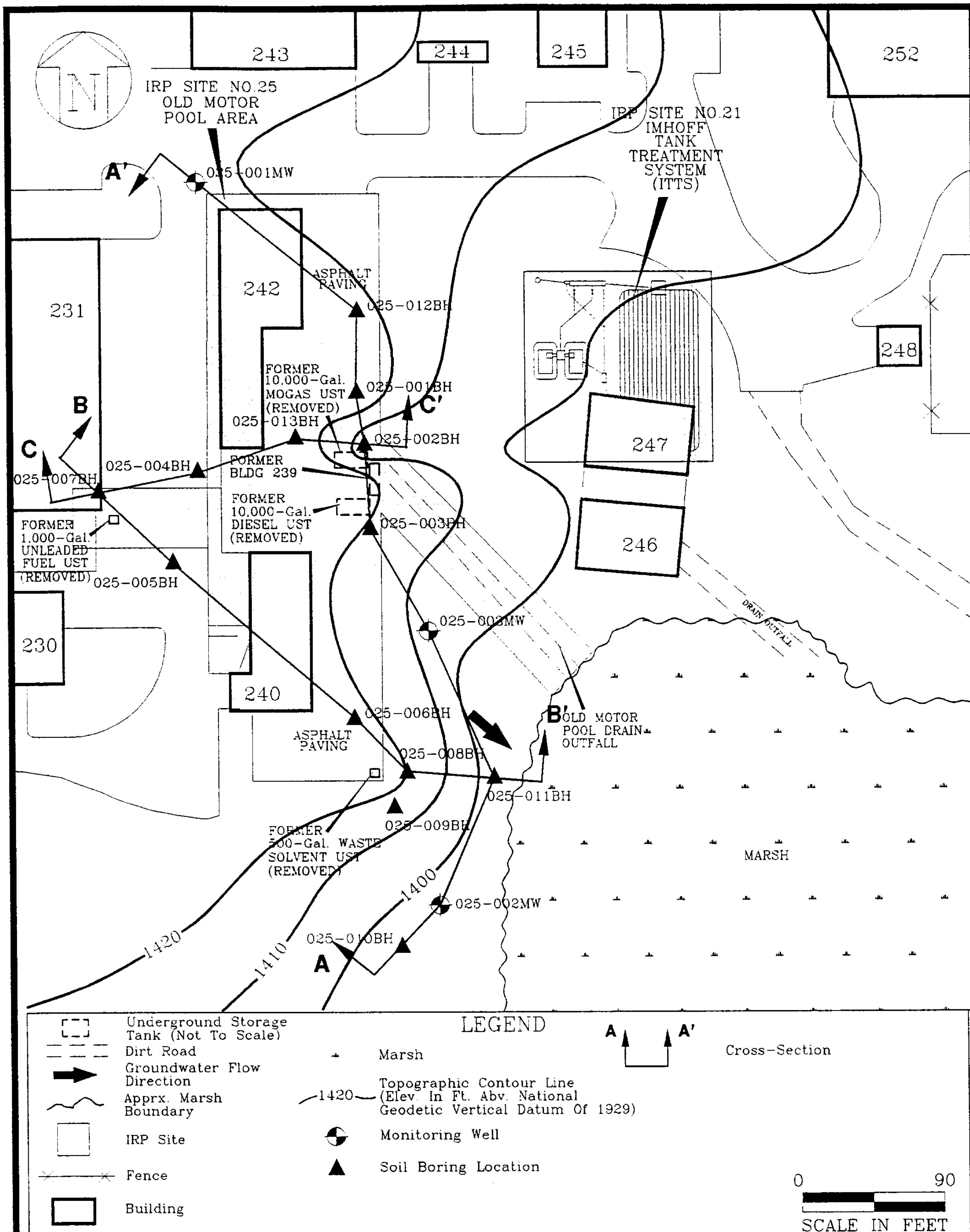

FIGURE 5.1

DULUTH\SITE2521

HYDROGEOLOGIC CROSS-SECTIONS
LOCATION MAP IRP SITE NO.25,
OLD MOTOR POOL AREA
Duluth Air National Guard Base
Duluth, Minnesota

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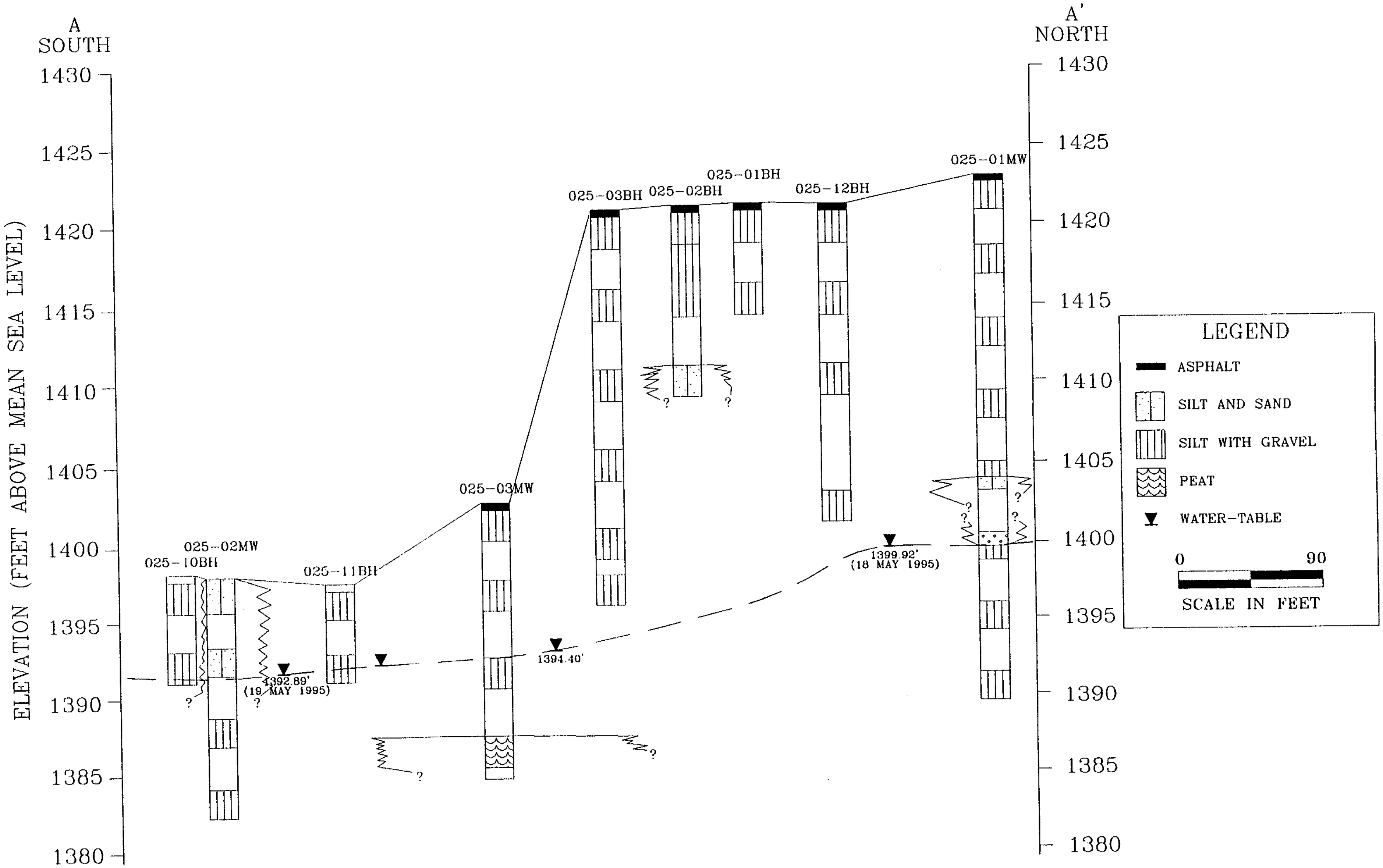

FIGURE 5.2

DULUTH\CROSSA-A

HYDROGEOLOGIC CROSS-SECTION A-A'
IRP SITE NO.25
Duluth Air National Guard Base
Duluth, Minnesota

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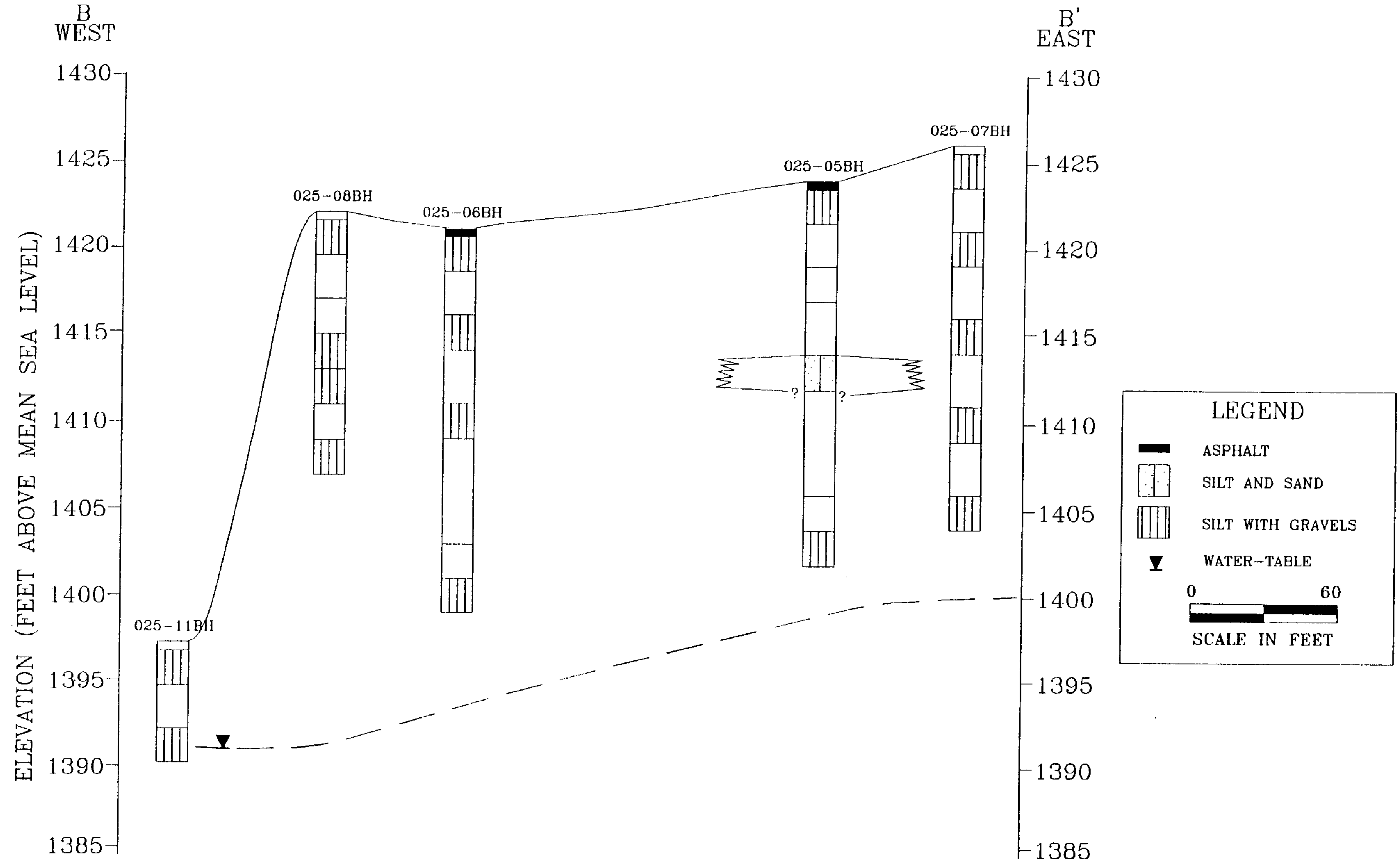

FIGURE 5.3

DULUTH\CROSSB-B

HYDROGEOLOGIC CROSS-SECTION B-B'
IRP SITE NO.25
Duluth Air National Guard Base
Duluth, Minnesota

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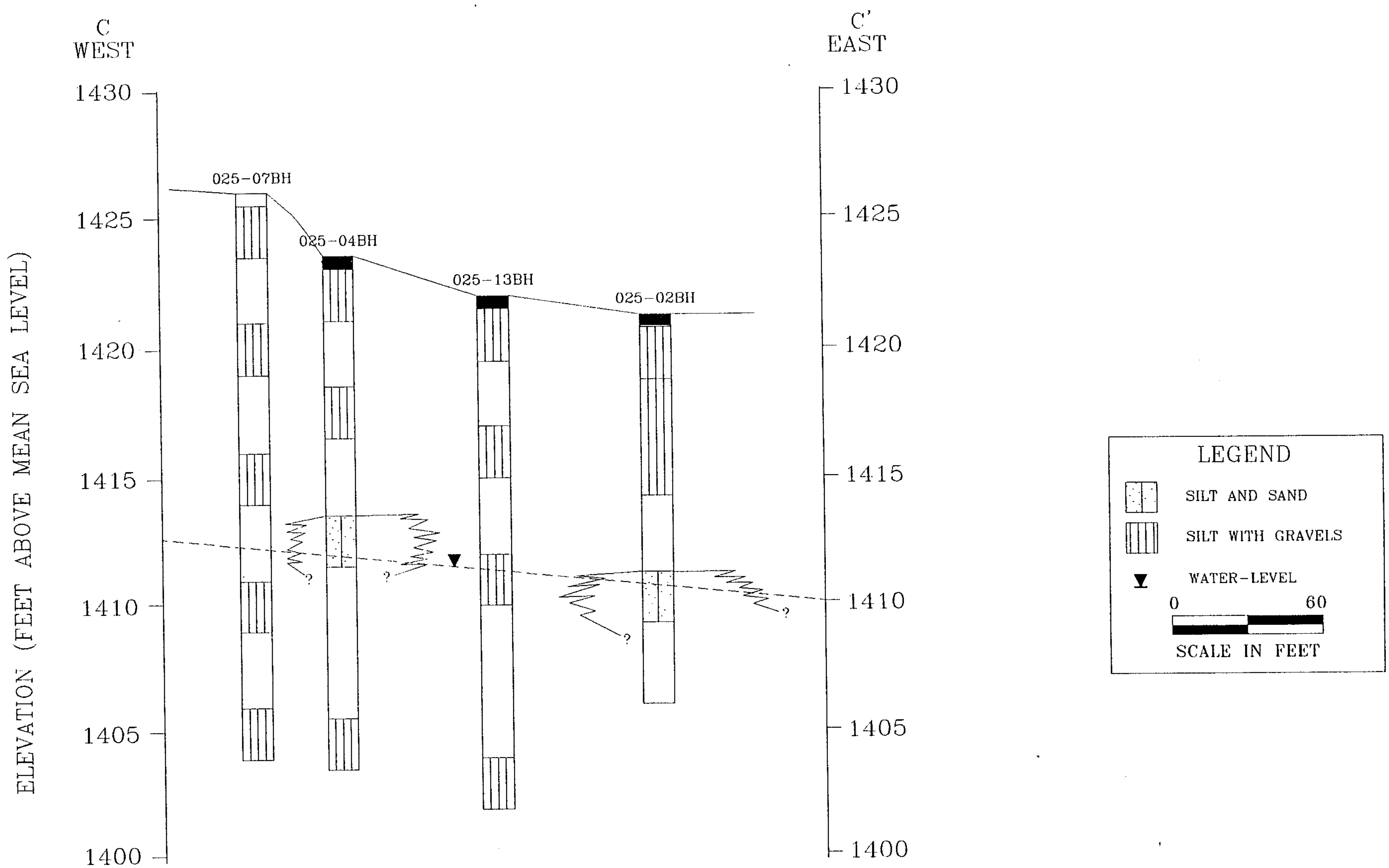

FIGURE 5.4

DULUTH\CROSSC-C

GEOLOGIC CROSS-SECTION C-C'
IRP SITE NO.25
Duluth Air National Guard Base
Duluth, Minnesota

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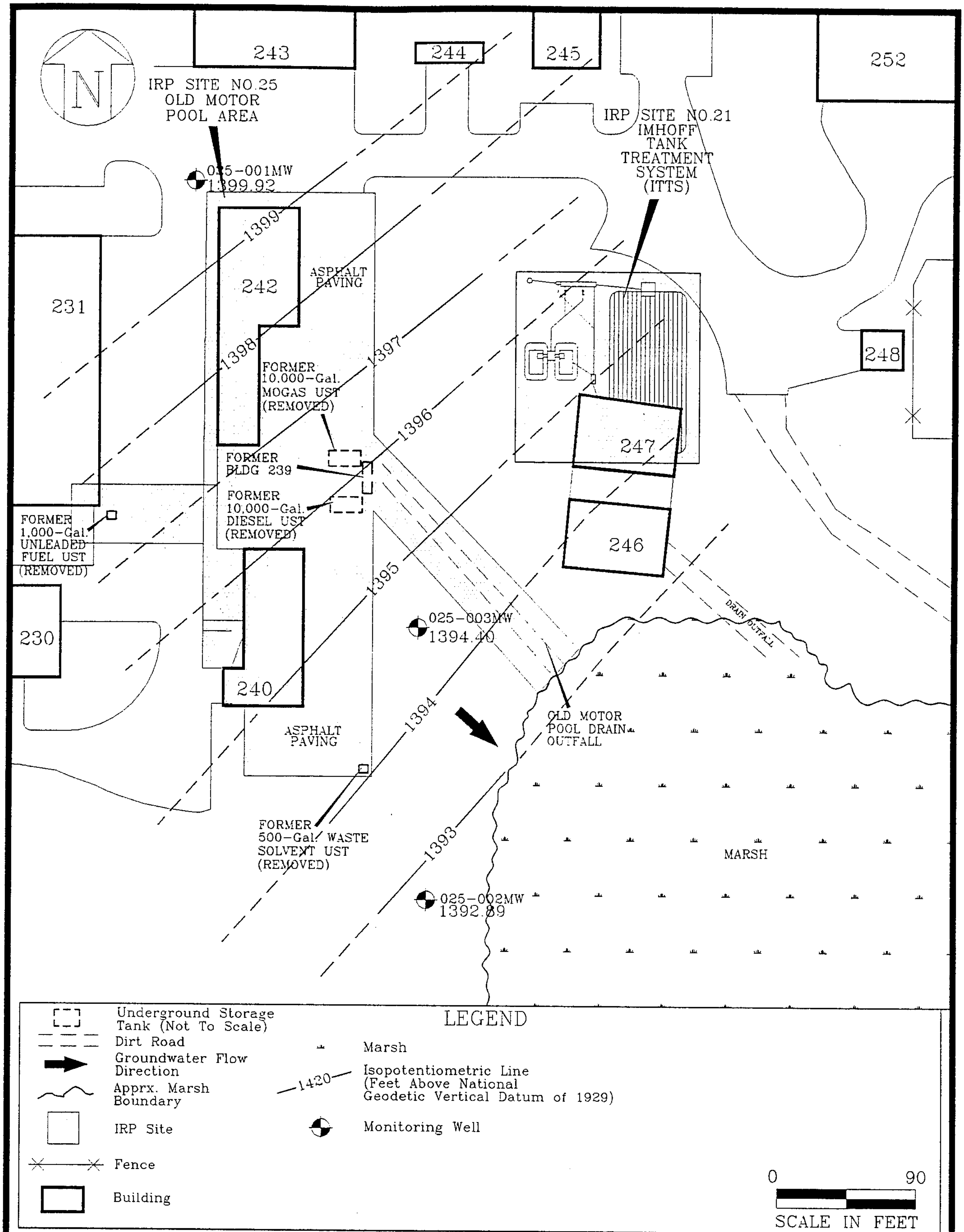

FIGURE 5.5

GROUNDWATER POTENTIOMETRIC SURFACE MAP 18 AND 19 MAY 1995 AT IRP SITE NO.25
Duluth Air National Guard Base
Duluth, Minnesota

DULUTH\SITE2521

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hydraulic conductivity was calculated to be 7.81 gallons per day per square foot (gpd/ft^2). The hydrologic unit effective porosity is estimated to be 20 percent (Fetter, 1980).

Using these values the average groundwater flow velocity was calculated to be about 38 feet per year. The average groundwater flow velocity was derived from the equation:

$$V = .134 \frac{KI}{n}$$

V = velocity, in feet per day;
K = average horizontal hydraulic conductivity, in gpd/ft^2;
I = average hydraulic gradient, in feet per foot;
n = aquifer net effective porosity, no dimensions; and
0.134 = conversion factor of gallons to cubic feet.

The following values were used:

K = 7.81 gpd/ft^2, based on the aquifer slug tests (Appendix E);
I = 0.02, as measured from Figure 5.5; and
n = 0.2.

Localized groundwater flow velocities may vary substantially from the average value due to the heterogeneous nature of the glacial till. Within the till, groundwater flow velocities may be greater in sand lenses and less in clay lenses.

5.2.2 Field Gas Chromatograph and Photoionization Detector Screening Results

Soil samples were collected from every 5-foot interval from the 13 soil borings and 3 boreholes of the monitoring wells at the site. Three groundwater samples were also collected from the three monitoring wells. These soil and groundwater samples were screened for BTEX using the field gas chromatograph (GC), and Table 5.2 summarizes the maximum concentrations detected in the samples. The field GC screening results are presented in Appendix C, and PID readings are included on the boring logs in Appendix A. At the request of MPCA, GC and PID data from this investigation and previous investigations conducted at the adjacent Site No. 21 (the abandoned ITTS) was plotted. Isoconcentration maps depicting these GC and PID results are presented on Figures 5.6 and 5.7, respectively.

Table 5.2
Maximum Gas Chromatograph Concentrations Detected in Soil and Groundwater Samples at IRP Site No. 25
148th FW, Duluth ANGB, Duluth, Minnesota

Compound	Maximum Concentration Detected in Soil Samples (ppm)	Maximum Concentration Detected in Groundwater Samples (ppm)
Benzene	5,800	1.92
Toluene	613	0.93
Ethylbenzene	25	0.31
M,P-Xylene	387	1.40
O-Xylene	180	1.09

ppm – parts per million.
GC – Gas Chromatograph.
IRP – Installation Restoration Program.

5.2.2.1 Soil – Field Gas Chromatograph Results

Benzene, toluene, ethylbenzene, m,p-xylene, and o-xylene were detected, with maximum concentrations of 5,800 parts per million (ppm), 263 ppm, 25.5 ppm, 205 ppm, and 114 ppm, respectively, in the soil sample collected from soil boring 025-002BH. The field GC screening results are presented in Appendix B.

5.2.2.2 Groundwater – Field Gas Chromatograph Results

Benzene was detected in two groundwater samples, with a maximum concentration of 1.92 ppm detected in the groundwater sample collected from monitoring well 025-003MW. Toluene, ethylbenzene, m,p-xylene, and o-xylene were detected in one groundwater sample collected from monitoring well 025-003MW at concentrations of 0.930 ppm, 0.318 ppm, 1.40 ppm, 1.09 ppm, respectively. The field GC screening results are presented in Appendix B.

5.2.3 Nature and Extent of Soil Contamination

Nineteen investigative soil samples were collected for laboratory analyses from 13 soil boring locations at IRP Site No. 25. Soil samples were collected from 12 May 1995 to 16 May 1995. Soil borings were drilled to depths ranging from 7 to 22 feet BLS. The analytical program is presented in Table 4.1, and the sampling intervals submitted for laboratory analyses are presented in Table 4.2 in Section 4.0. A summary of laboratory results for all analyses is presented in Appendix K, Summary of Analytical Results for Soil and Groundwater Samples.

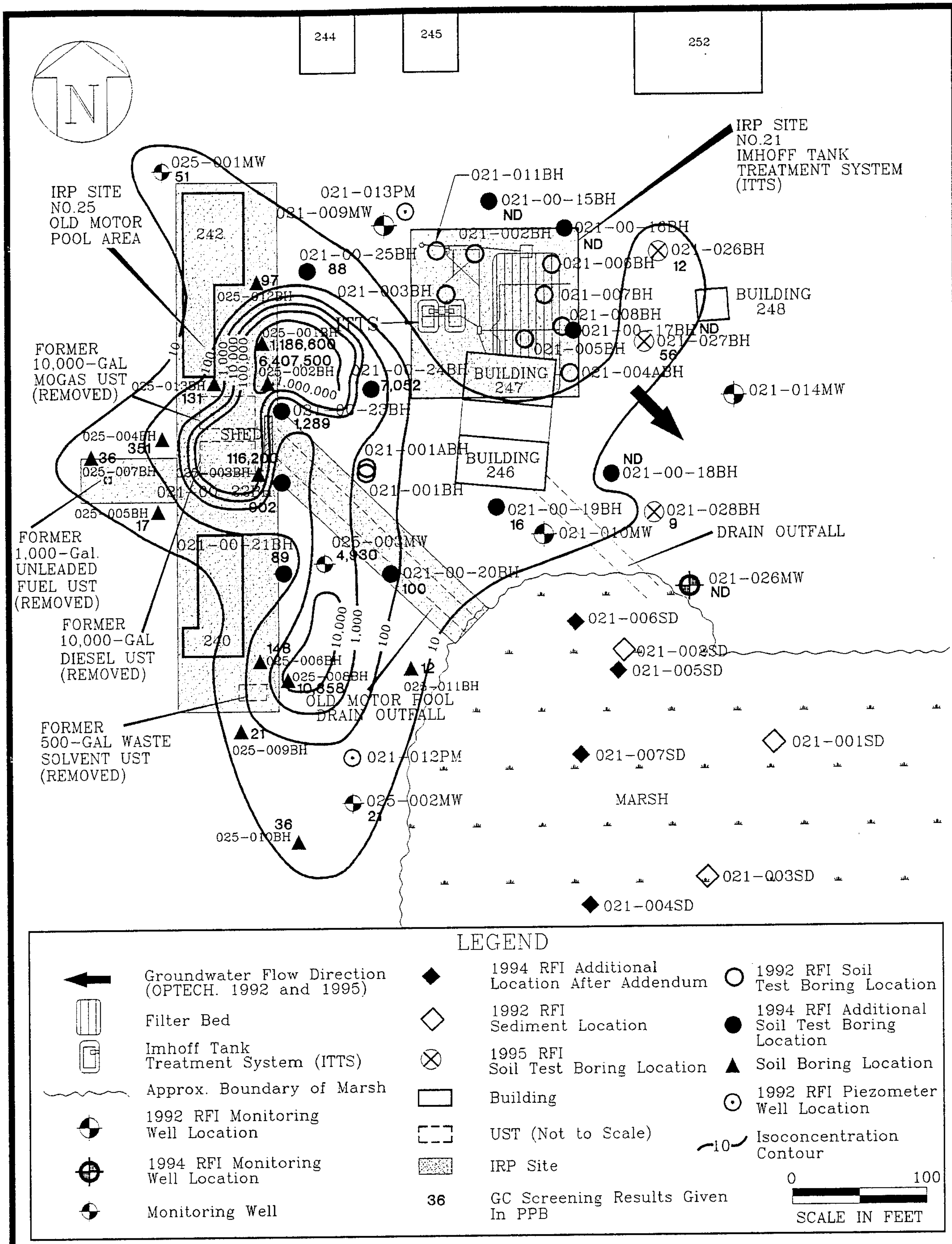

FIGURE 5.6

DULUTH\GC-PID

GC SCREENING RESULTS AT IRP SITES NO. 21 AND NO. 25
Duluth Air National Guard Base
Duluth, Minnesota

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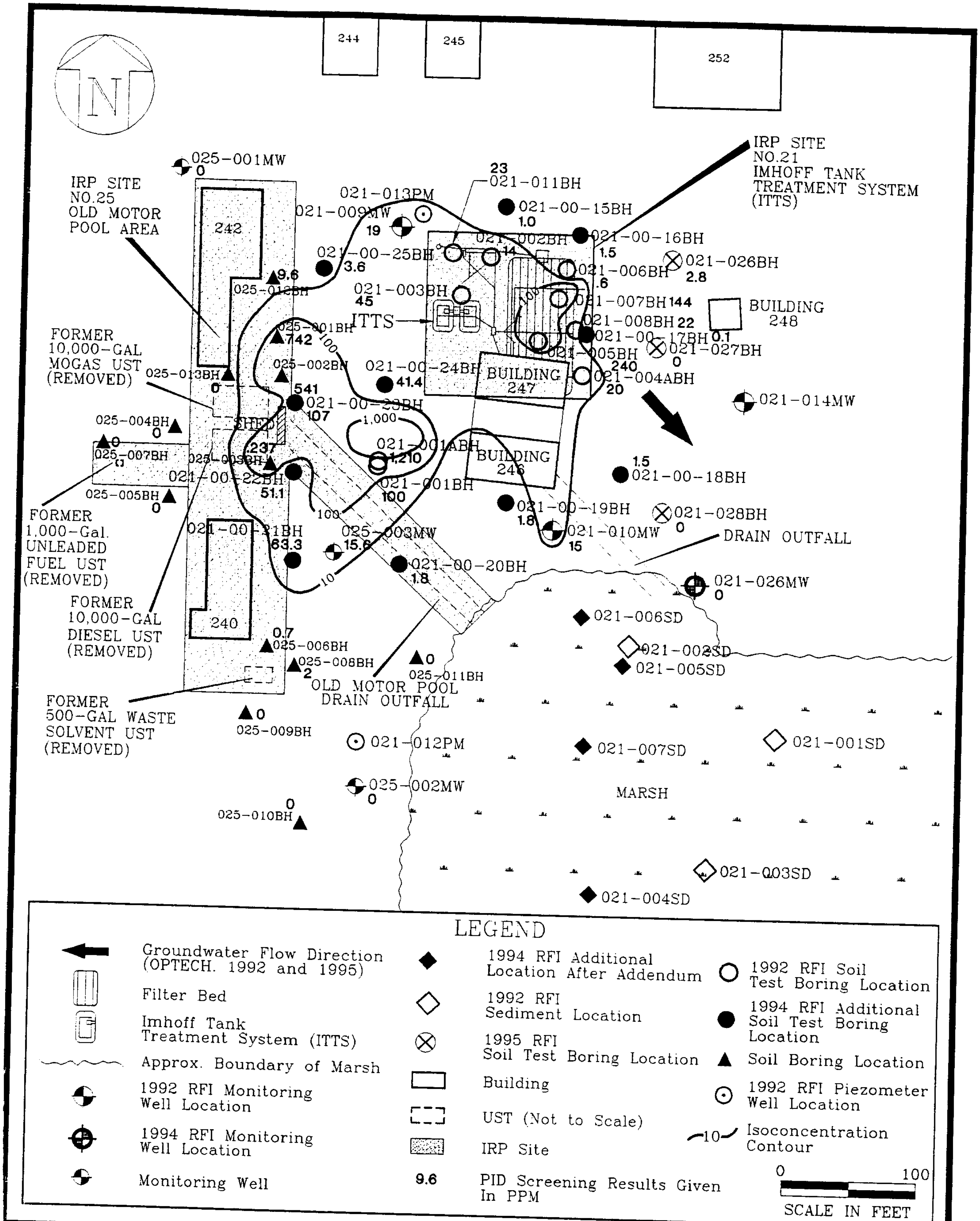

FIGURE 5.7

DULUTH\GC-PID

PID SCREENING RESULTS AT IRP SITES NO. 21 AND NO. 25
Duluth Air National Guard Base
Duluth, Minnesota

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QA/QC samples were collected during the SI. A summary of the analytical results are presented in Appendix L, Summary of the Analytical Results for the QA/QC Samples. The analytical results for the duplicates are presented in the tables in this subsection with the original result. An evaluation of the analytical data is presented in Appendix L. Holding times were not exceeded for any soil samples. Chloroform, methylene chloride, and di-n-butylphthalate were detected at the detection limit in the equipment rinseate and field blanks. These compounds are known laboratory contaminants.

VOCs and SVOCs detected in soil samples collected from IRP Site No. 25 are presented in Figure 5.8. VOCs detected in soil samples collected from IRP Site No. 25 are summarized in Table 5.3. BTEX was detected in the soil samples collected at IRP Site No. 25. Benzene was detected only in soil samples collected from soil borings 025-001BH (6.5- to 7-foot interval), 025-002BH (11.5- to 12-foot interval), and 025-012BH (11.5- to 12-foot interval) at concentrations of 84,000 micrograms per kilogram (μg/kg), 1,700 μg/kg, and 29 μg/kg, respectively. Only xylenes (total) were detected in soil samples collected from soil borings 025-006BH, 025-008BH, 025-009BH, 025-010BH, 025-011BH, and 025-012BH at concentrations ranging from 5 μg/kg to 230 μg/kg. BTEX was detected in soil samples from soil borings located upgradient from the Imhoff Tank Treatment System at IRP Site No. 21 during the RFI (OpTech, 1994). The isoconcentration map of BTEX detected in soil at IRP Sites No. 21 and No. 25 is presented as Figure 5.9.

Table 5.3
Volatile Organic Compounds Detected in Soil Samples Collected at IRP Site No. 25
148th FW, Duluth ANGB, Duluth, Minnesota

Soil Boring/Interval (feet BLS)	VOCs (μg/kg)			
	Benzene	Ethylbenzene	Toluene	Total Xylenes
025-001BH 6.5 - 7	84,000	140,000	460,000	680,000
025-002BH 11.5 - 12	1,700	9,700	26,000	52,000
025-003BH 11 - 12	25U	120	25U	800
025-003BH 11 - 12 (DUP)	1,200U	5,300	1,200U	29,000
025-006BH 21.5 - 22	5U	5U	5U	5
025-008BH 14.5 - 15	5U	30	29	230
025-009BH 14 - 14.5	5U	5U	5U	8
025-010BH 6 - 6.5	5U	7	17	5
025-011BH 6.5 - 7	5U	5U	5U	6
025-012BH 11.5 - 12	29	5U	8	11

VOCs – Volatile Organic Compounds.
IRP – Installation Restoration Program.
μg/kg – micrograms per kilograms.
BH – Borehole.
DUP – Field Duplicate.
BLS – Below Land Surface.
U – Compound analyzed for but not detected.

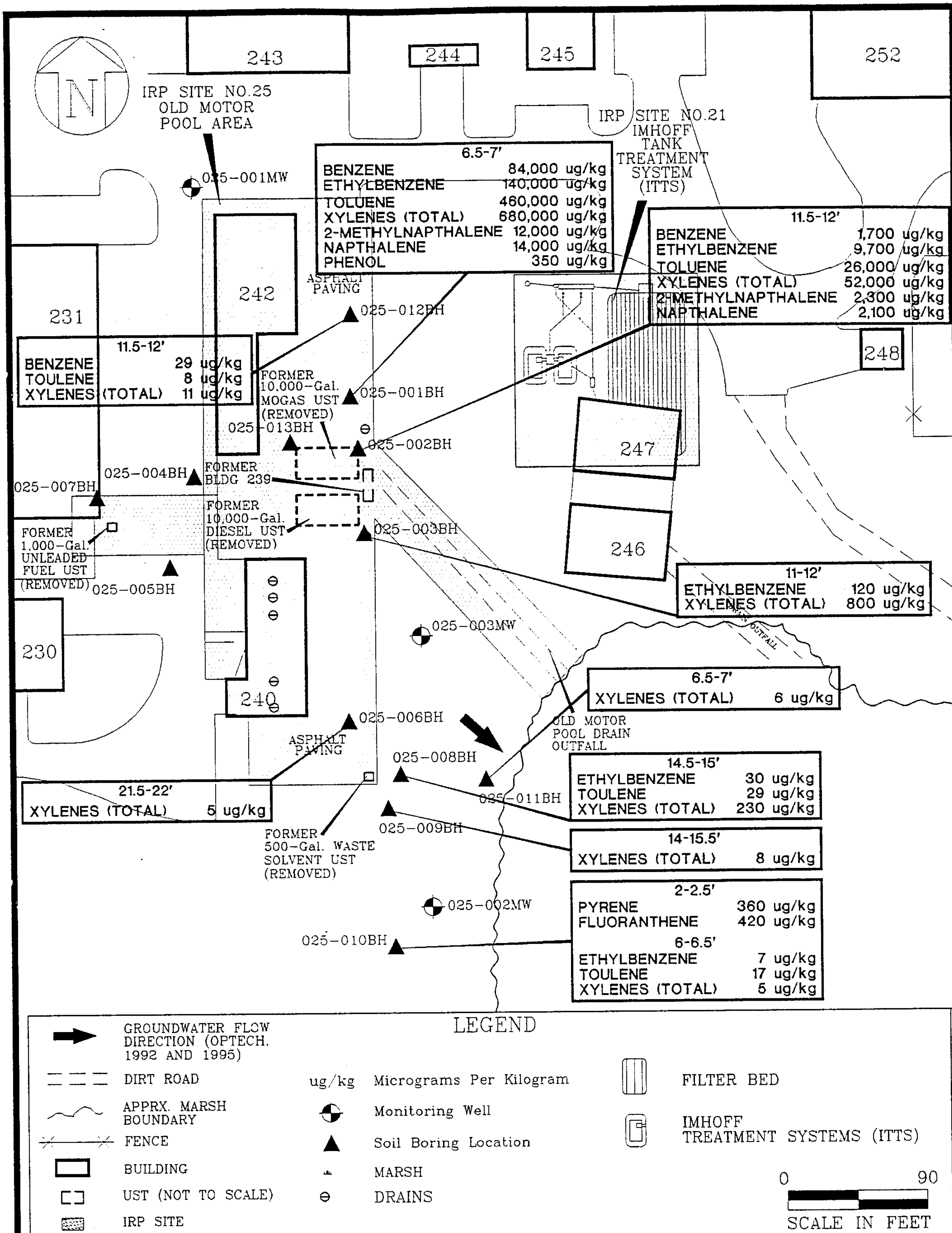

FIGURE 5.8

VOCs AND SVOCs DETECTED IN SOIL SAMPLES COLLECTED FROM OLD MOTOR POOL AREA
Duluth Air National Guard Base
Duluth, Minnesota

DULUTH\SITE2521

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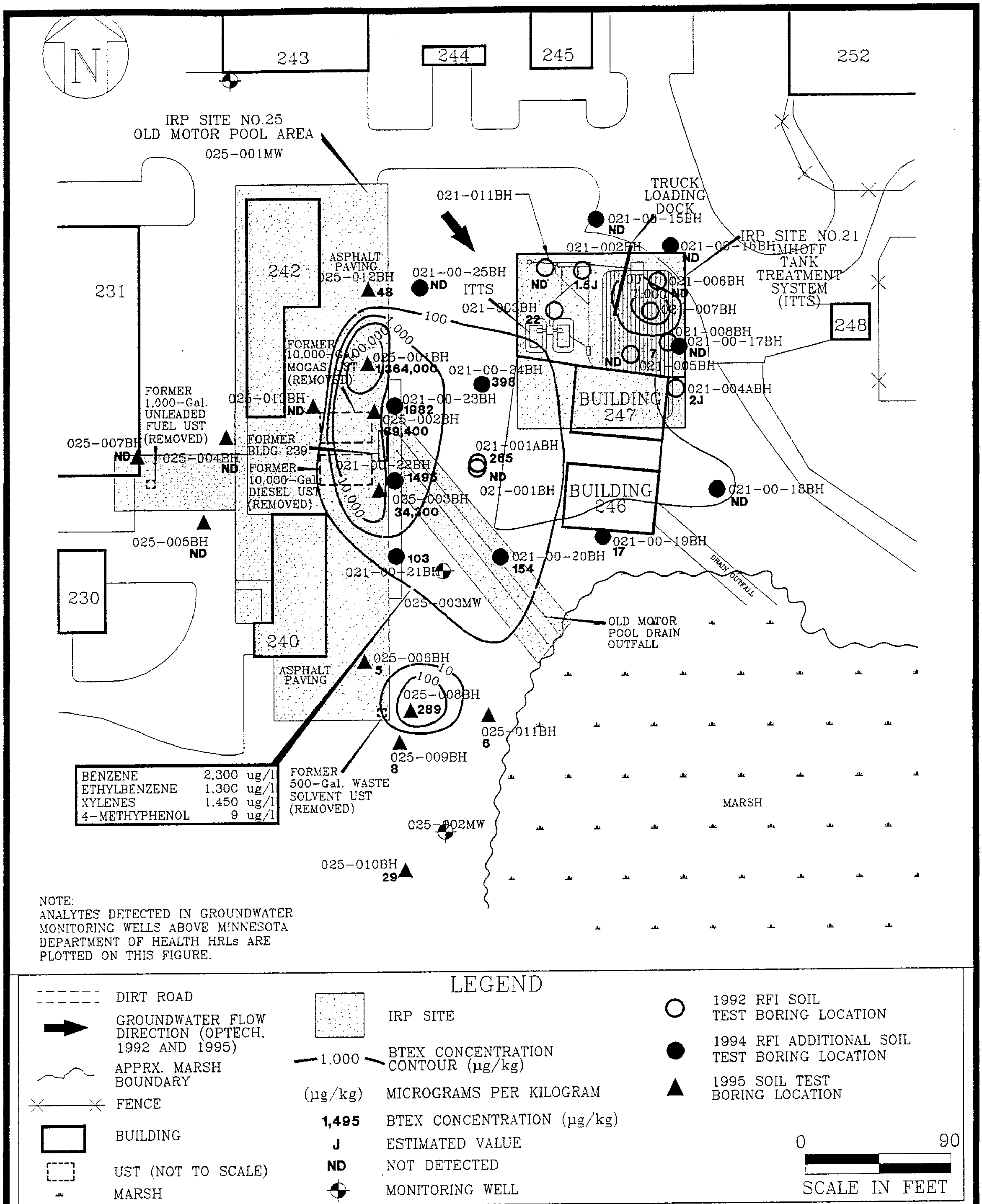

FIGURE 5.9

ISOCONCENTRATION MAP OF BTEX CONTAMINATION IN SOIL AT IRP SITES NO.21 AND NO.25
Duluth Air National Guard Base
Duluth, Minnesota

DULUTH\SI-2521

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MAY 1996

SVOCs detected in soil samples collected from IRP Site No. 25 are presented in Table 5.4. SVOCs of the naphthalene and phenol groups were detected in soil samples collected from soil borings 025-001BH, 025-002BH, and 025-003BH, located near the former 10,000-gal. diesel and MOGAS USTs. Two polyaromatic hydrocarbons (PAHs), pyrene and fluoranthene, were detected in a near-surface soil sample collected from soil boring 025-010BH.

Table 5.4
Semivolatile Organic Compounds Detected
in Soil Samples Collected at IRP Site No. 25
148th FW, Duluth ANGB, Duluth, Minnesota

SVOCs (μg/kg)	Soil Boring/Interval (feet BLS)			
	025-001BH 6.5 - 7	025-002BH 11.5 - 12	025-003BH 11 - 12 DUP	025-010BH 2 - 2.5
2-Methylnaphthalene	12,000	2,300	330	330U
Naphthalene	14,000	2,100	330U	330U
Phenol	350	330U	330U	330U
Pyrene	330U	330U	330U	360
Fluoranthene	330U	330U	330U	420

SVOCs – Semivolatile Organic Compounds.
μg/kg – micrograms per kilogram.
BLS – Below Land Surface.
DUP – Field Duplicate.
IRP – Installation Restoration Program.
BH – Borehole.
U – Compound analyzed for but not detected.

Metals detected in soil samples at IRP Site No. 25 are presented in Table 5.5. Cadmium, chromium, nickel, and lead were all detected in soil samples. Cadmium, chromium, and lead concentrations were less than background levels observed at Duluth ANGB and all metals concentrations were less than observed range of background levels for soil in the eastern U. S.

5.2.4 Nature and Extent of Groundwater Contamination

Three investigative groundwater samples were collected for laboratory analyses from three monitoring wells at IRP Site No. 25. Groundwater samples were collected from 18 May 1995 to 19 May 1995. A complete listing of laboratory results for all analyses is given in Appendix K, Summary of the Analytical Results of the Soil and Groundwater Samples.

QA/QC samples were collected during the SI. A summary of the analytical results are presented in Appendix L, Summary of the Analytical Results for the QA/QC Samples. The analytical results for the duplicate are presented in the tables in this subsection with the original result.

Table 5.5
Metals Detected in Soil Samples Collected at IRP Site No. 25
148th FW, Duluth ANGB, Duluth, Minnesota

Soil Boring/Interval (feet BLS)	Metals (mg/kg)			
	Cadmium	Chromium	Nickel	Lead
Observed Range of Background Concentrations of Soils in eastern U. S.[1]	NA	1 - 1,000	> 5 - 700	< 10 - 300
Maximum Background Levels Observed at Duluth ANGB[2]	13.6	42.2	NA	9.9
025-001BH 6.5 - 7	0.4U	9	25	3.2
025-002BH 11.5 - 12	0.4U	6	21	1.7
025-003BH 11 - 12 DUP	0.5	11	26	2.6
025-003BH 11 - 12	0.4U	15	22	3.0
025-004BH 11.5 - 12	0.5U	9	17	2.0
025-004BH 19.5 - 20	0.5U	18	23	4.5
025-005BH 11.5 - 12	0.5U	6	17	1.9
025-006BH 21.5 - 22	0.5U	16	18	7.6
025-007BH 11.5 - 12	0.5U	6	16	6.1
025-008BH 10.5 - 11	0.5U	18	26	4.60
025-008BH 14.5 - 15	0.5U	12	27	6.8
025-009BH 11 - 12 DUP	0.5U	24	22	5.8
025-009BH 11 - 12 DUP	0.5U	18	19	5.5
025-009BH 14 - 14.5	0.5U	17	18	3.8
025-010BH 2 - 2.5	0.5U	15	20	4.6
025-010BH 6 - 6.5	0.5U	19	25	3.6
025-011BH 2 - 2.5	0.5U	19	21	5.2
025-011BH 6.5 - 7	0.5U	17	18	6.3
025-012BH 11.5 - 12	0.5U	11	15	4.3
025-012BH 19.5 - 20	0.5U	13	9	5.3
025-013BH 11.5 - 12	0.5U	6	16	3.2

IRP – Installation Restoration Program.
mg/kg – milligrams per kilogram.
BLS – Below Land Surface.
U. S. – United States.
ANGB – Air National Guard Base.
NA – Not Available.

[1]Shacklette, Hansford T. et al., 1984.
[2]Engineering-Science, Inc., 1990.
DUP – Field Duplicate.
BH – Borehole.
ND – Not Detected.

An evaluation for the analytical data is also presented in Appendix L. Holding times were not exceeded for any groundwater samples.

VOCs detected in groundwater samples collected from IRP Site No. 25 are presented in Table 5.6. BTEX was detected in the groundwater samples collected from monitoring wells 025-002MW and 025-003MW. Benzene, ethylbenzene, and xylenes (total) concentrations detected in the groundwater sample from monitoring well 025-003MW exceeded the MDH Health Risk Limits (HRLs). 1,2-Dichloroethane was detected in the groundwater sample collected from monitoring well 025-002MW at a concentration of 11 micrograms per liter (μg/L), exceeding the MDH HRL of 4 μg/L.

SVOCs detected in groundwater samples collected from IRP Site No. 25 are presented in Table 5.6. Only 4-methylphenol concentrations detected in the groundwater sample from monitoring well 025-003-MW-GW01 exceed the MDH HRLs. Most of the SVOCs were detected in the groundwater sample collected from monitoring wells were below the MDH HRLs.

Metals detected in the groundwater samples collected from IRP Site No. 25 are presented in Table 5.6. Chromium, nickel, and lead were detected in groundwater samples at concentrations less than MDH HRLs and/or Federal maximum contaminant levels (MCLs).

5.3 IRP SITE NO. 26 INVESTIGATIVE FINDINGS

Six soil boring locations were drilled to obtain soil samples for laboratory analyses and for characterizing site geology and subsurface soil conditions. Three monitoring wells were installed to obtain groundwater samples for laboratory analyses and to determine hydrogeologic evaluation of the hydrologic unit. The analytical results of these soil and groundwater samples were used to define the vertical and horizontal extent of contamination. Soil boring and monitoring well locations are shown on Figure 4.2.

5.3.1 Geologic and Hydrogeologic Investigative Results

Geologic information obtained from soil boring and boreholes drilled for the monitoring wells were used to describe the subsurface geology. Lithologic logs are presented in Appendix A, Boring Logs. Temperature, pH, and specific conductance measurements were collected during the sampling event and are presented in Table 5.7. The water level data that were collected prior to slug testing were used to interpret the potentiometric surface maps to determine the direction of groundwater movement at IRP Site No. 26. The slug test results were used for the analysis to determine the hydraulic conductivity of the hydrologic unit in the vicinity of the

Table 5.6
Analytes Detected in Groundwater Samples Collected at IRP Site No. 25
148th FW, Duluth ANGB, Duluth, Minnesota

Parameter (μg/L)	Monitoring Well				ARARs
	025-001-MW-GW01	025-002-MW-GW1	025-003-MW-GW01	025-003-GW01 (Duplicate)	
Benzene	1U	1	2,600	2,300	5 (MCLs)
Ethylbenzene	1U	1U	1,300	1,300	700 (MCLs, HRL)
Toluene	1U	1U	570	540	1,000 (MCLs, HRL)
Xylenes (Total)	1U	1U	1,450	1,390	1,000 (MCLs, HRL)
			VOCs		
1,2-Dichloroethane	1U	11	25U	25U	4 (HRL)
			SVOCs		
4-Methylphenol	5U	5U	9	8	3 (HRL)
Naphthalene	5U	5U	75	51	300 (HRL)
Phenol	51	51	15	12	4,000 (HRL)
			Metals		
Chromium	0.036	0.011	0.015	0.019	4 (HRL)
Lead	0.008	0.004U	0.005	0.007	15 (tap water)
Nickel	0.07	0.03	0.03	0.04	100 (HRL)

IRP – Installation Restoration Program.
μg/L – micrograms per liter.
MW – Monitoring Well.
GW – Groundwater.
ARARs – Applicable or Relevant and Appropriate Requirements.
U – Compound analyzed for but not detected.
VOCs – Volatile Organic Compounds.
SVOCs – Semivolatile Organic Compounds.
MCLs – Maximum Contaminant Levels.
HRL – Health Risk Limit.
NA – Not Available.

Table 5.7
Measurements for Groundwater Sampling Collected from IRP Site No. 26 on 20 May 1995
148th FW, Duluth ANGB, Duluth, Minnesota

Monitoring Well	Temp (° C)	pH	Specific Conductance (μS/cm)	Depth to Water (feet BLS)	Water Table (feet NGVD)	Hydraulic Conductivity (gpd/ft²)
026-001MW	7	7.41	485	17.03	1,407.59	102
026-002MW	6	7.13	260	9.50	1,414.78	315
026-003MW	6	6.95	382	7.36	1,415.54	15.5

IRP – Installation Restoration Program.
° C – Degrees Centigrade.
BLS – Below Land Surface.
gpd/ft² – gallons per day per square foot.
NGVD – National Geodetic Vertical Datum of 1929.
μS/cm – micro-Siemens per centimeter.

screened interval. A summary of the water level data and slug test data are also presented in Table 5.7. The slug test data and analysis are presented in Appendix E, Aquifer Slug Test Data. Two soil samples were collected for geotechnical analysis, grain-size distribution, coefficient of permeability, pH, and cation exchange capacity. The geotechnical results are presented in Table 5.8.

Table 5.8
Geotechnical Results for IRP Site No. 26
148th FW, Duluth ANGB, Duluth, Minnesota

Analysis	026-002MW 0.5' – 2.5'		026-003MW 15' – 17'	
Grain-Size Distribution	Size	Percentages	Size	Percentages
	Clay	4	Clay	5
	Silt/Fine Sand	42	Silt/Fine Sand	70
	Medium Sand	18	Medium Sand	13
	Coarse Sand	7	Coarse Sand	5
	Fine Gravel	29	Fine Gravel	7
Coefficient of Permeability at cm/sec 20° C (vertical hydraulic conductivity)	1.10×10^{-3}		3.55×10^{-6}	
pH	6.56		7.54	
Cation Exchange Capacity meg/100 grams	127		45.6	

IRP – Installation Restoration Program.
MW – Monitoring Well.
cm/sec – centimeters per second.
° C – Degrees Centigrade.

5.3.1.1 Site Geology

Unconsolidated glacial till overlies the gabbro bedrock and consists of silt, clay, sand, pebbles, gravel, and mixtures of these components in layers and lenses of varying vertical and horizontal extents. The three geologic cross sections depicting the subsurface geology at IRP Site No. 26 are indexed in Figure 5.10 and are presented as Figures 5.11, 5.12, and 5.13. The upper 10-foot interval is representative of a fill material consisting of silt with trace to some sand and trace to little gravel. The unconsolidated material observed below 10 feet BLS was representative of the glacial till consisting of predominantly silt with trace to little sand and little to some gravel. The clasts size of the sand ranged from fine- to medium-grained and for the gravel ranged from granule to boulder. Sand and gravel layers were observed at approximately 20 feet BLS at monitoring wells 026-001MW and 026-002MW, and at 5 feet BLS during drilling borehole at monitoring well 026-003MW.

5.3.1.2 Site Hydrogeology

Groundwater occurs in the unconsolidated glacial till and was encountered from approximately 5 to 17 feet BLS during drilling operations. The hydrologic unit was observed to be unconfined; however, heterogenous nature of the lenticular stratigraphy and discontinuous layers of intermixed clays, silts, sands, and gravels produces semi-confined conditions within the hydrologic unit.

The potentiometric surface map is presented as Figure 5.14. The direction to groundwater movement at IRP Site No. 26 is to the southeast. The average hydraulic gradient (I) in the vicinity of IRP Site No. 26 was calculated to be 0.03 feet per feet (ft/ft) based on information from the potentiometric surface map.

The hydraulic conductivity values were computed from Bouwer and Rice (1976) method using the AQTESOLV 2.0 Version computer program (Geraghty & Miller, Inc., 1994). The hydraulic conductivity values are only representative of the 10-foot screened interval. The average hydraulic conductivity was calculated to be 144 gpd/ft^2. The hydrologic unit effective porosity is estimated to be 20 percent (Fetter, 1980).

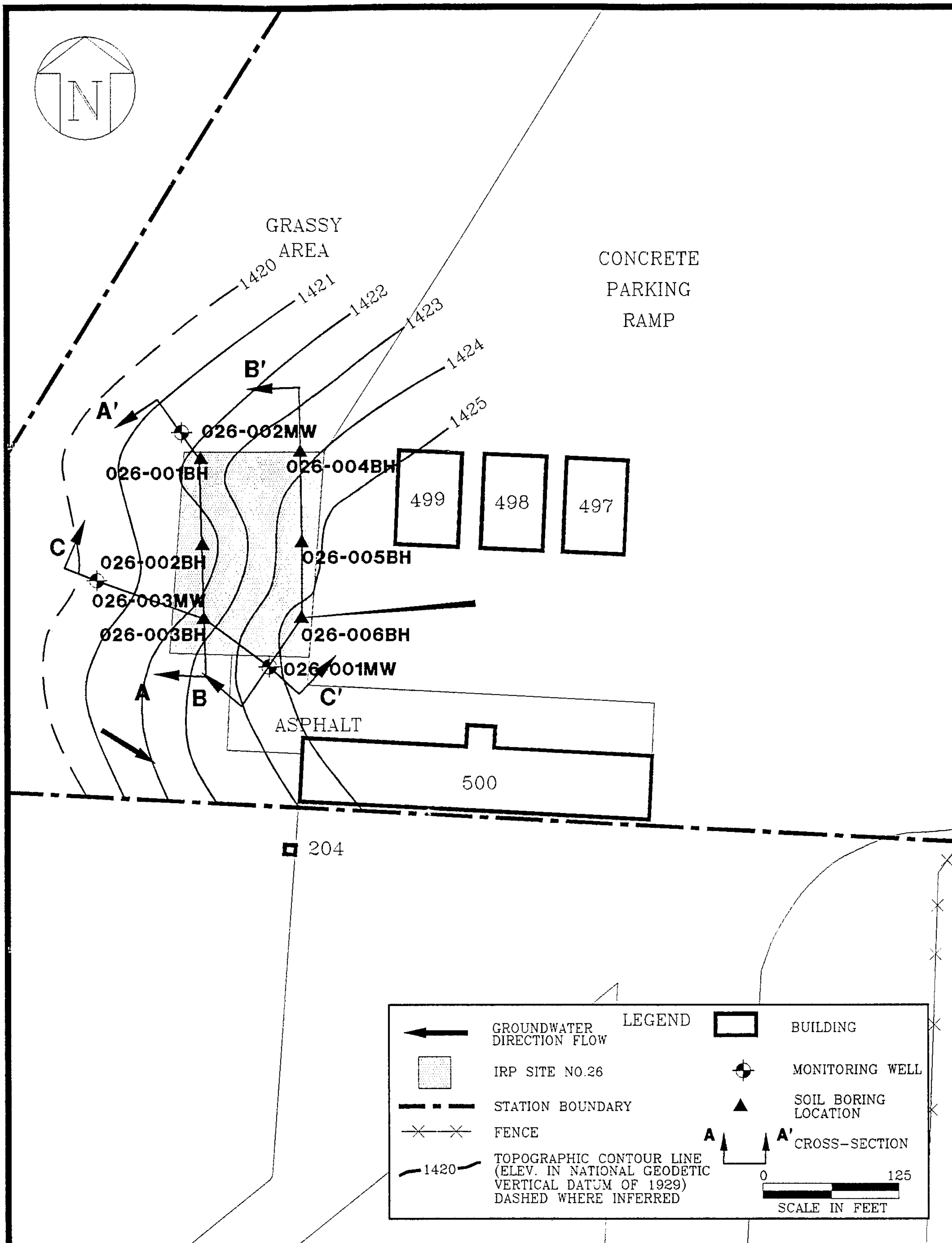

FIGURE 5.10

DULUTH\SITE-26

HYDROGEOLOGIC CROSS-SECTION LOCATION MAP
IRP SITE NO.26
Duluth Air National Guard Base
Duluth, Minnesota

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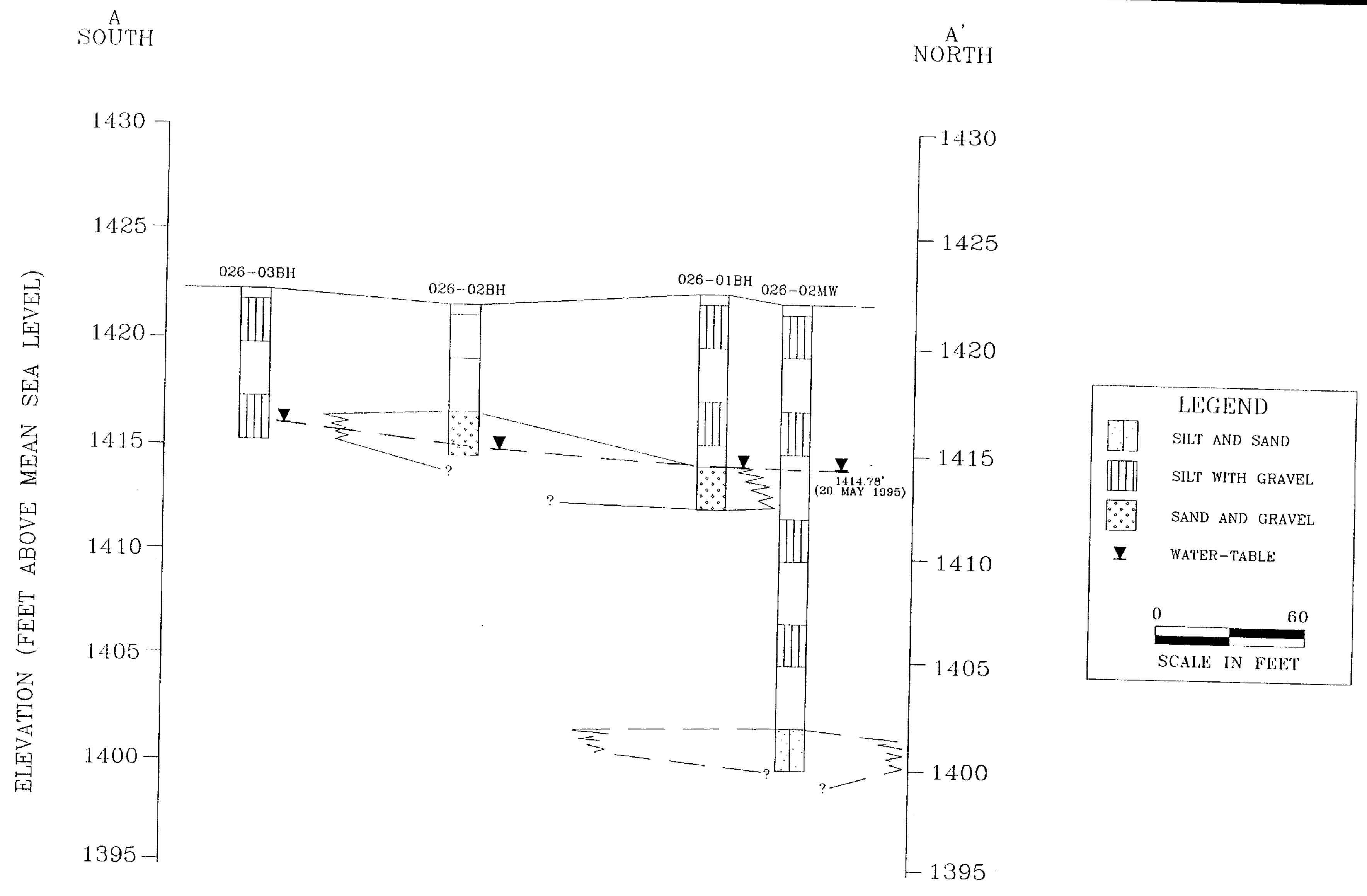

FIGURE 5.11

DULUTH\A-ACROSS

HYDROGEOLOGIC CROSS-SECTION A-A'
IRP SITE NO.26
Duluth Air National Guard Base
Duluth, Minnesota

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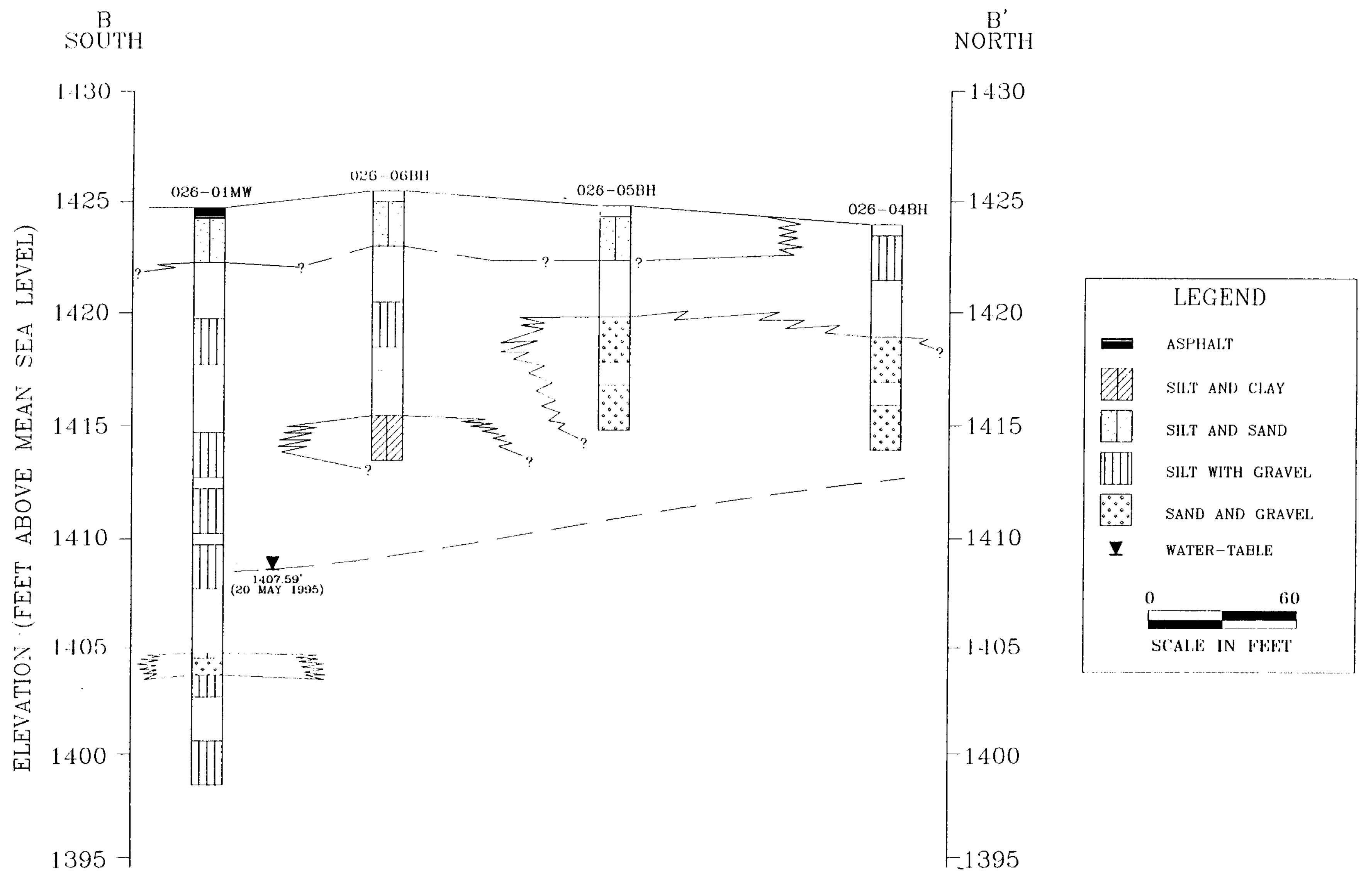

FIGURE 5.12

DULUTH\B-BCROSS

HYDROGEOLOGIC CROSS-SECTION B-B'
IRP SITE NO.26
Duluth Air National Guard Base
Duluth, Minnesota

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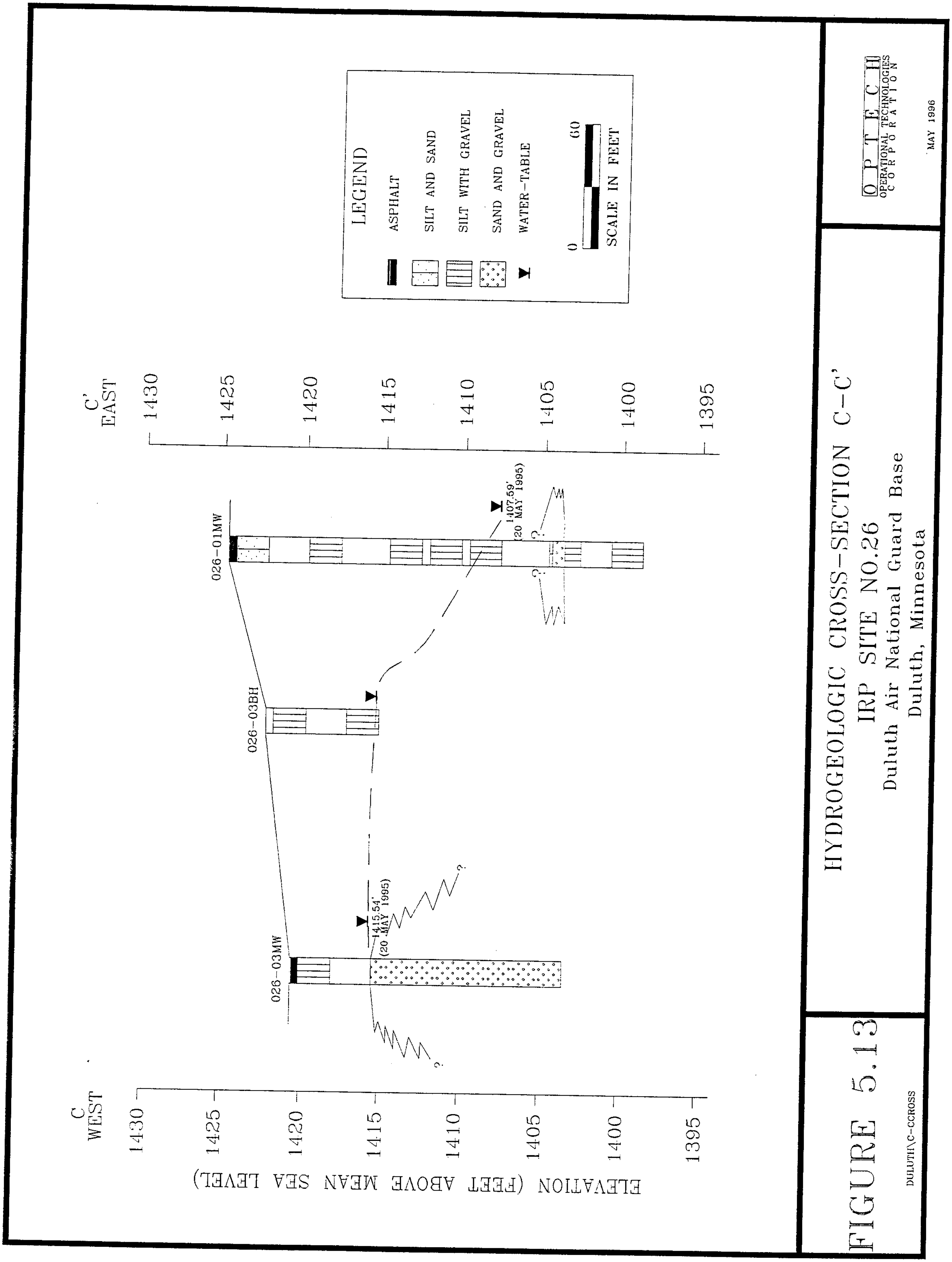
C WEST
C' EAST
ELEVATION (FEET ABOVE MEAN SEA LEVEL)
1430
1425
1420
1415
1410
1405
1400
1395
026-03MW
026-03BH
026-01MW
1415.54' (20 MAY 1995)
1407.59' (20 MAY 1995)
LEGEND
ASPHALT
SILT AND SAND
SILT WITH GRAVEL
SAND AND GRAVEL
WATER-TABLE
0
60
SCALE IN FEET
OPTECH
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MAY 1996
HYDROGEOLOGIC CROSS-SECTION C-C'
IRP SITE NO.26
Duluth Air National Guard Base
Duluth, Minnesota
FIGURE 5.13
DULUTH\C-CCROSS

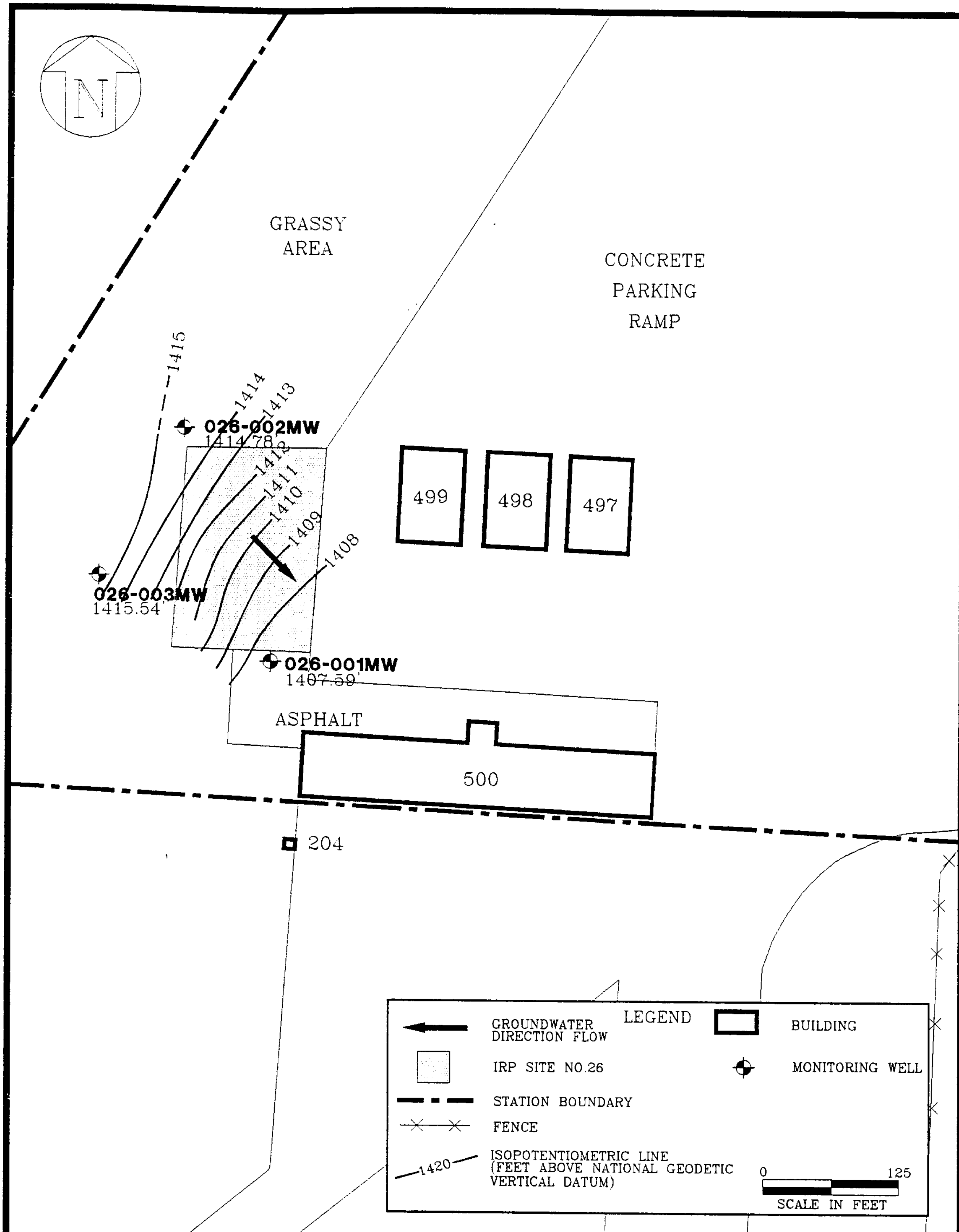

FIGURE 5.14

DULUTH\SITE-26

GROUNDWATER POTENTIOMETRIC SURFACE MAP 20 MAY 1995 AT IRP SITE NO.26
Duluth Air National Guard Base
Duluth, Minnesota

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MAY 1996

Using these values the average groundwater flow velocity was calculated to be about 1,050 feet per year. The average groundwater flow velocity was derived from the equation:

$$V = .134 \frac{KI}{n}$$

V = velocity, in feet per day;
K = average horizontal hydraulic conductivity, in gpd/ft^2;
I = average hydraulic gradient, in feet per foot;
n = aquifer net effective porosity, no dimensions; and
0.134 = conversion factor of gallons to cubic feet.

The following values were used:

K = 144 gpd/ft^2, based on the aquifer slug tests (Appendix E);
I = 0.03, as measured from Figure 5.5; and
n = 0.2.

Localized groundwater flow velocities may vary substantially from the average value due to the heterogeneous nature of the glacial till. Within the till, groundwater flow velocities may be greater in sand lenses and less in clay lenses.

5.3.2 Field Gas Chromatograph Screening Results

Soil samples were collected from six soil borings and three boreholes of the monitoring wells at the site. Three groundwater samples were collected from the three monitoring wells. These soil and groundwater samples were screened for BTEX using the field GC. Table 5.9 summarizes the maximum concentrations detected in both soil and groundwater samples. The field GC screening results are presented in Appendix C.

5.3.2.1 Soil – Field Gas Chromatograph Results

Benzene was detected with a maximum concentration of 0.011 ppm detected in soil sample collected from soil boring 026-004BH. Toluene was detected with a maximum concentration of 0.006 ppm detected in a soil sample collected from the borehole of monitoring well

Table 5.9
Maximum Gas Chromatograph Concentrations Detected in Soil and Groundwater Samples at IRP Site No. 26
148th FW, Duluth ANGB, Duluth, Minnesota

Compound	Maximum Concentration Detected in Soil Samples (ppm)	Maximum Concentration Detected in Groundwater Samples (ppm)
Benzene	0.011	0.01
Ethylbenzene	0.006	0.003
m, p-Xylene	0.017	ND
o-Xylene	0.026	ND
Toluene	0.006	0.002

GC – Gas Chromatograph.
IRP – Installation Restoration Program.
ppm – parts per million.
ND – Not Detected.

026-001MW. Ethylbenzene was detected with a maximum concentration of 0.006 ppm detected a soil sample collected from the borehole of monitoring well 026-003MW. M,P-xylene was detected with a maximum concentration of 0.017 ppm detected in a soil sample collected from soil boring 026-001BH. O-xylene was detected with a maximum concentration of 0.026 ppm detected in soil sample collected from soil boring 026-001BH. The field GC screening results are presented in Appendix C.

5.3.2.2 Groundwater – Field Gas Chromatograph Results

Benzene was detected in two groundwater samples, with a maximum concentration of 0.010 ppm detected in a groundwater sample collected from monitoring well 026-001MW. Toluene and ethylbenzene were detected in one groundwater sample collected from the monitoring well 026-001MW with concentrations of 0.002 ppm and 0.003 ppm, respectively. M,P-xylene and O-xylene were not detected in groundwater samples. The field GC screening results are presented in Appendix C.

5.3.3 Nature and Extent of Soil Contamination

Fourteen investigative soil samples were collected for laboratory analyses from six soil boring locations at IRP Site No. 26. Soil samples were collected from 3 May 1995 to 5 May 1995. Soil borings were drilled to a depths ranging from 7 to 12 feet BLS. Monitoring well construction data is presented in Table 4.1 and the sampling intervals submitted for laboratory analysis are presented in Table 4.3 in Section 4.0. A complete listing of laboratory results for all analyses is given in Appendix K, Summary of Analytical Results for Soil and Groundwater Samples.

QA/QC samples were collected during the SI. A summary of the analytical results are presented in Appendix L, Summary of the Analytical Results for the QA/QC Samples. The analytical results for the duplicate are presented in the tables in this subsection with the original result. An evaluation for the analytical data is also presented in Appendix L. Holding times were not exceeded for any soil samples. Chloroform, methylene chloride, and 4-chloro-3-methylphenol were detected in equipment rinseate and field blank samples. These are typical laboratory contaminants and are not considered to represent site conditions.

The analytes detected in the soil samples are presented in Table 5.10. VOC toluene was detected at a concentration of 7 μg/kg, slightly exceeding the detection limit of 5 μg/kg in a duplicate soil sample of near-surface soil samples collected from soil boring 026-005BH. This VOC was not detected in the original sample. The SVOCs detected in soil samples collected from IRP Site No. 26 are presented in Figure 5.15. Three SVOCs, PAHs, were only detected in a near-surface soil sample collected from soil boring 026-006BH. Both these soil boring locations are located near the ramp. Chromium and lead concentrations were detected below background levels.

5.3.4 Nature and Extent of Groundwater Contamination

Since no VOCs and SVOCs were detected in any of the groundwater samples collected at IRP Site No. 26, groundwater has not been impacted by chemicals at the site (Table 5.11).

5.4 INVESTIGATION DERIVED WASTE DISPOSITION

Details for the investigation derived waste disposition for the soil cuttings and purge water contained at IRP Sites No. 25 and No. 26 are provided in Appendix H.

Table 5.10
Analytes Detected in Soil Samples Collected at IRP Site No. 26
148th FW, Duluth ANGB, Duluth, Minnesota

	VOCs (μg/kg)	SVOCs (μg/kg)			Metals (mg/kg)	
Soil Boring	Toluene	Fluoranthene	Phenanthrene	Pyrene	Chromium	Lead
026-001BH 2 - 2.5	5U	330U	330U	330U	13	2.8
026-001BH 9.5 - 10	5U	330U	330U	330U	10	2.4
026-001BH 9.5 - 10 (DUP)	5U	330U	330U	330U	6	2.5
026-002BH 2 - 2.5	5U	330U	330U	330U	3.1	3.2
026-002BH 6.5 - 7	5U	330U	330U	330U	3.8	1.5
026-003BH 1.5 - 2.5	5U	330U	330U	330U	18	5.9
026-003BH 1.5 - 2.5 (DUP)	5U	330U	330U	330U	6	3.2
026-003BH 6.5 - 7	5U	330U	330U	330U	3.2	4.6
026-004BH 2 - 2.5	5U	330U	330U	330U	9	5.3
026-004BH 9.5 - 10	5U	330U	330U	330U	7	2.5
026-005BH 2 - 2.5 (DUP)	7	330U	990U	990U	8	4.2
026-005BH 2 - 2.5	5U	330U	330U	330U	7	4.6
026-005BH 9.5 - 10	5U	330U	330U	330U	3	2.4
026-006BH 2 - 2.5	5U	870	800	710	5	2.4
026-006BH 11.5 - 12	5U	330U	330U	330U	4	2.6

VOCs – Volatile Organic Compounds.
SVOCs – Semivolatile Organic Compounds.
IRP – Installation Restoration Program.
μg/kg – micrograms per kilogram.
mg/kg – milligrams per kilogram.
BH – Borehole.
DUP – Field Duplicate.
U – Compound analyzed for but not detected.

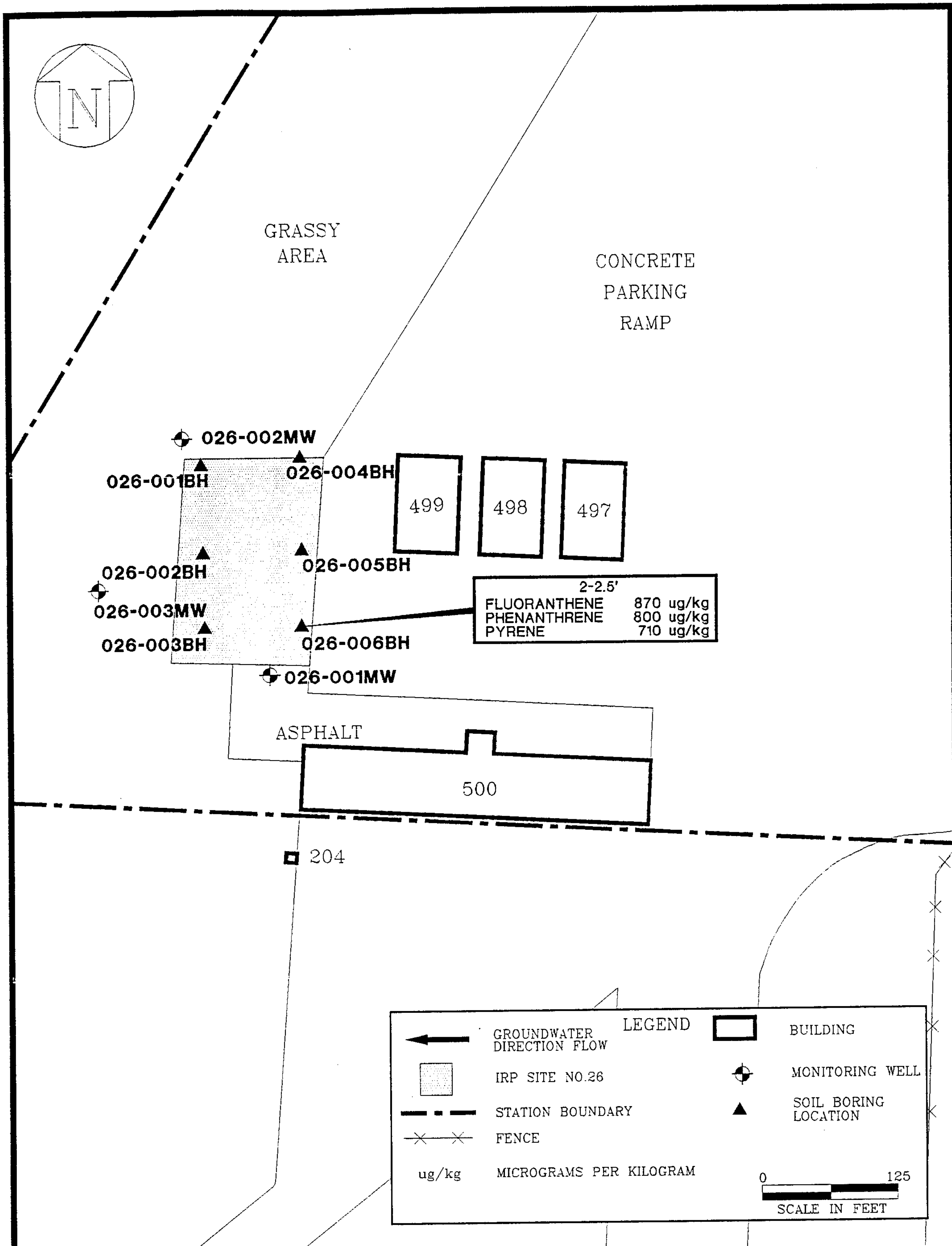

FIGURE 5.15

DULUTH\SITE-26

SVOCs DETECTED IN SOIL SAMPLES COLLECTED FROM IRP SITE NO.26
Duluth Air National Guard Base
Duluth, Minnesota

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MAY 1996

Table 5.11
Analytes Detected in Groundwater Samples Collected at IRP Site No. 26 on 18 May 1995
148th FW, Duluth ANGB, Duluth, Minnesota

Parameter (μg/L)	Monitoring Wells				ARARs
	026-001-MW-GW	026-002MW-GW	026-003MW-GW	Duplicate	
Benzene	0.01	0.001	ND	ND	NA
Ethylbenzene	0.003	ND	ND	ND	NA
Toluene	0.002	ND	ND	ND	NA
Xylenes (total)	ND	ND	ND	ND	NA
VOCs					
VOCs	ND	ND	ND	ND	NA
SVOCs					
Phenol	51	51	51	NA	4,000 (HRL)

IRP – Installation Restoration Program.
MW – Monitoring Well.
GW – Groundwater.
ARARs – Applicable or Relevant and Appropriate Requirements.
ND – Non-Detect.
NA – Not Applicable.
VOCs – Volatile Organic Compounds.
SVOCs – Semivolatile Organic Compounds.
HRL – Health Risk Limit.
μg/L – micrograms per liter.

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SECTION 6.0 CONCLUSIONS AND RECOMMENDATIONS

6.1 CONCLUSIONS

Conclusions based on the SI are reported as follows:

6.1.1 IRP Site No. 25 – Old Motor Pool Area

- BTEX was detected at a maximum concentration of 1,300 ppm from soil samples collected from soil borings located near the former 10,000-gal. diesel and MOGAS USTs. SVOCs of the naphthalene and phenol groups were detected at a maximum concentration of 14 ppm in soil samples collected from these soil borings.

- BTEX and SVOCs were detected in the groundwater sample collected from monitoring well 025-003MW located downgradient from the former 10,000-gal. diesel and MOGAS USTs. Phenol was detected at a concentration of 51 μg/L in groundwater samples collected form monitoring wells 025-001MW and 025-002MW. 1,2-dicholorethane was detected in the groundwater sample collected from the monitoring well 025-002MW located downgradient from the former 500-gal. waste solvent UST. Benzene, ethylbenzene, xylenes (total), and 1,2-dichloroethane, were detected at concentrations of 2,600 μg/L, 1,300 μg/L, 1,450 μg/L, and 11 μg/L, respectively, exceeding the MDH HRLs of 5 μg/L, 700 μg/L, 1,000 μg/L, and 4 μg/L, respectively.

- There is no contamination associated with the 1,000-gal. UST of Bldg. 231 and low level fuel-related soil contamination around the 500-gal. waste solvent UST.

- Soil contamination is primarily confined to an area around the 10,000-gal. diesel and MOGAS USTs.

- There is no soil and groundwater contamination from chlorinated compounds.

- The main site contamination is BTEX. The only non-fuel compound is an SVOC, 4-methylphenol, in groundwater.

- Site soil and groundwater are adequately defined and no additional data is required for this site.

- In accordance with the SI Work Plan approved in April 1995, soil and groundwater samples were not analyzed for TPH gasoline range organics/diesel range organics. However, at the subsequent request of the MPCA, existing field screening data from this investigation and previous investigations at IRP Site No. 21 were incorporated into this report to provide additional information on petroleum waste constituents. These data, in addition to that data generated during the CMS phase of the investigation to be conducted in conjunction with IRP Site No. 21, will aid in more fully delineating the areal extent of both soil and groundwater contamination. See Figures 5.6 and 5.7, respectively, for plots of GC and PID data.

6.1.2 IRP Site No. 26 – Ramp Disposal Area

- VOC toluene was detected at a concentration of 7 μg/kg, slightly exceeding the detection limit of 5 μg/kg in a duplicate soil sample but were not detected in the original sample. Three PAHs were detected at low levels in a near-surface soil sample from a soil boring located near the ramp.

- No VOCs or SVOCs were detected in the groundwater samples.

- There is no significant soil and groundwater contamination at the site.

- There is no soil and groundwater contamination from chlorinated compounds.

- Site soil and groundwater is fully defined and there is no additional data is required for this site.

6.2 RECOMMENDATIONS

Recommendations based on the SI are reported as follows:

6.2.1 IRP Site No. 25 – Old Motor Pool Area

- Due to the close geographic proximity of IRP Sites No. 21 and No. 25 and due to the similar contamination existing at both sites, IRP Site No. 25 should be remediated concurrently with IRP Site No. 21.

6.2.2 IRP Site No. 26 – Ramp Disposal Area

- No additional investigation is required and remedial action is not recommended. A DD should be prepared to close out this site.

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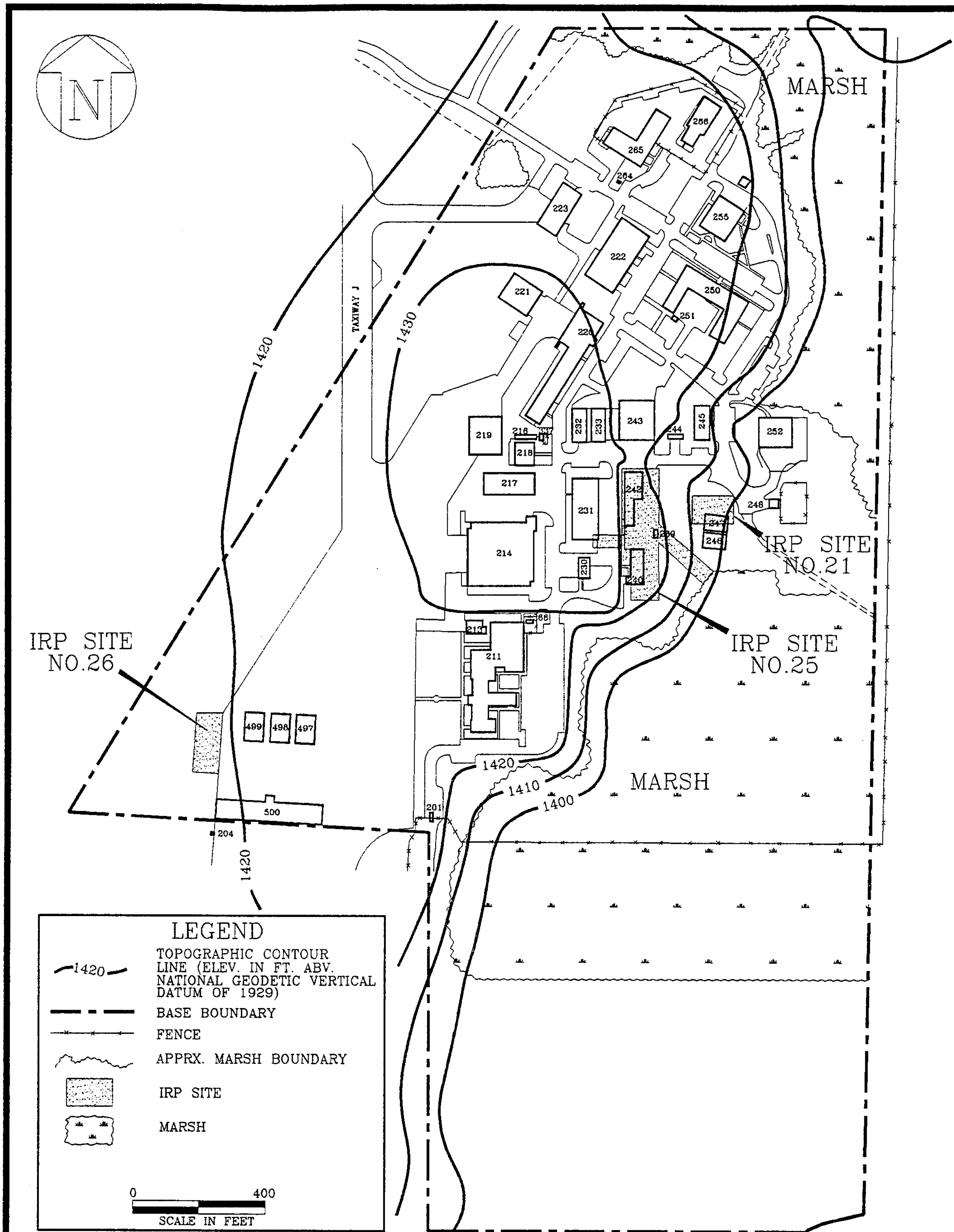

SOURCE: OpTech, 1993.

INSIDE BACK COVER

DULUTH\SITE

LOCATION OF IRP SITES NO.25 AND NO.26

Duluth Air National Guard Base
Duluth, Minnesota

OPTECH
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DECEMBER 1995