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Agency

Office of
Emergency and
Remedial Response

EPA/ROD/R01-93/083
September 1993

EPA

Superfund Record of Decision:

Pease Air Force Base (Operable Unit 1), NH

50272-101

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15. Supplementary Notes

PB94-963703

16. Abstract (Limit: 200 words)

The 23-acre Pease Air Force Base (Operable Unit 1) site is part of the 4,300-acre inactive Air Force base located in Newington and Portsmouth, Rockingham County, New Hampshire. Land use in the area is predominantly commercial and residential, with wetlands and woodlands located onsite. Current land use at the site is institutional, agricultural, abandoned land, and unoccupied residential. There are three wetlands areas on and adjacent to the site, and many of the 3,700 dwellings located within a 1-mile radius of Pease Air Force Base (AFB) have wells and/or springs located on their associated properties. While the Town of Newington has a large number of private wells, the vast majority of Portsmouth residences are serviced by municipal water only. From 1951 to 1991, the site was used as a military installation by the U.S. Navy and Air Force. During its history, Pease AFB was the home of the 100th and the 509th Bombardment Wings, whose mission was to maintain a combat-ready force capable of long-range bombardment operations. The New Hampshire Air National Guard currently is stationed at the air field area and uses some of the facilities. Over time, various quantities of fuels, oils, solvents, lubricants, and protective coatings were used at the base, and releases of contaminants into the environment occurred. Zone 1

(See Attached Page)

17. Document Analysis a. Descriptors

Record of Decision - Pease Air Force Base (Operable Unit 1), NH
First Remedial Action
Contaminated Media: soil, sediment, debris, gw
Key Contaminants: VOCs (benzene), other organics (PAHs), metals (arsenic, chromium, lead)

b. Identifiers/Open-Ended Terms

c. COSATI Field/Group

18. Availability Statement	19. Security Class (This Report) None	21. No. of Pages 190
	20. Security Class (This Page) None	22. Price

(See ANSI-Z39.18) *See Instructions on Reverse* OPTIONAL FORM 272 (4-77) (Formerly NTIS-35) Department of Commerce

Abstract (Continued)

encompasses six areas of concern: LF-2, LF-3, LF-4, LF-5 (the source area OU for the Landfill-5 area), the Bulk Fuel Storage Area, and the Paint Can Disposal Area. The 23-acre LF-5 area was used from 1964 to 1979 as the base's primary landfill for domestic and industrial refuse. Types of waste disposed of in LF-5 include waste oil and solvents, paints, paint strippers and thinners, pesticide containers, and empty cans. A small drum staging area located at the southern entrance to the landfill was used for the temporary storage of drums encountered onsite, miscellaneous soil, and metals. In addition, the landfill received an estimated 20,000 gallons of sludge from the base industrial wastewater treatment plant, which may have contained TCE residues, grass clippings, wood chips, miscellaneous soil, and concrete rubble. There are several surface water pathways that channel surface runoff away from the LF-5 area toward the Piscataqua River. Surface drainage from LF-2 and LF-4, other inactive landfills in the vicinity, as well as from a portion of LF-5, flows into ditches located on both sides of the Railway Ditch and leads to a swampy area. A portion of LF-5's surface runoff enters directly into Flagstone Brook and flows north into the Piscataqua River. Site contamination has severely affected surface waters and sediment due to overland flow and ground water discharge. In 1983, an onsite investigation was conducted in three stages at the Pease site as part of the Department of Defense's Installation Restoration Program (IRP). The first stage revealed elevated contamination levels in soil and debris in the LF-5 area and, in 1987, the second stage identified 5- and 55-gallon drums in the LF-5 area as a potential threat to human health and the environment. In 1991, as part of the third stage of the investigation, 54 85-gallon overpacks containing drums and waste material and more than 2,000 empty, crushed drums were removed and disposed of offsite. Based on the Phase II IRP investigation, a total of 20 sites at Pease AFB will be investigated further. Studies conducted during the RI determined that previous improper landfilling operations have caused contamination of native soil and that burned refuse now is in contact with ground water and fractured bedrock. In 1993, EPA determined that two other landfills in Zone 1 (LF-2 and LF-4) should be considered concurrently with LF-5. This ROD addresses onsite contaminated soil, sediment, debris, and ground water in the LF-2, LF-4, and LF-5 areas, as OU1. Future RODs will address ground water contamination in Zone 1 and sediment contamination in Flagstone Brook, onsite drainage ditches, and associated wetlands, if necessary. The primary contaminants of concern affecting the soil, sediment, debris, and ground water are VOCs, including benzene; other organics, including PAHs; and metals, including arsenic, chromium, and lead.

The selected remedial action for this site includes excavating, dewatering, and consolidating 221,500 yd^3 of landfill soil and debris that would still be in contact with ground water after capping; consolidating any soil and waste materials from LF-2 and LF-4 on LF-5; backfilling the excavated area with clean fill to a level at least 2 feet above the natural ground water table after capping, and placing excavated waste above the clean fill; excavating and consolidating 3,200 yd^3 of sediment from the Railway Ditch that contain contaminants exceeding site-specific cleanup goals; utilizing erosion control measures during sediment excavation and transporting excavated sediment to a central staging area for thickening; dewatering and bulking excavated material, as required, and disposing of excavated sediment onsite on LF-5; capping LF-5 after consolidation of all waste and soil with a 1,200,000 ft^2 RCRA-approved composite barrier cap; installing a passive gas collection system to capture and vent landfill gases; treating ground water extracted during dewatering process onsite using multi-media filtration, ion exchange, and activated carbon adsorption; discharging the treated ground water to the onsite wastewater treatment facility; disposing of all treatment residuals including concentrated salt solution, iron sludge, and spent activated carbon offsite; restoring any affected wetlands, as needed; monitoring soil gas, ground water, and air; and implementing institutional controls, including deed restrictions, and site access restrictions such as fencing. The estimated present worth cost for this remedial action is $23,992,000, which includes an estimated present worth O&M cost of $6,629,721 for 30 years.

EPA/ROD/R01-93/083
Pease Air Force Base (Operable Unit 1), NH
First Remedial Action

Abstract (Continued)

PERFORMANCE STANDARDS OR GOALS:

Chemical-specific ground water cleanup goals are based on health and ecological risk-based concentrations for soil and solid waste in the LF-5 area and health-based concentrations for Railway Ditch sediment, and include arsenic 50 ug/l, benzene 5 ug/l, lead 15 ug/l, and TCE 5 ug/l for ground water; arsenic 0.508 mg/kg and lead 0.065 mg/kg for soil and debris; and arsenic 33 mg/kg, lead 35 mg/kg, and total PAHs 4 mg/kg for sediment.

Record of Decision
For A
Source Area Remedial Action
At
Landfill 5 (OU1)

Pease Air Force Base, NH

September 1993

Prepared for:

Headquarters Air Force Base Disposal Agency (HQ AFBDA)
The Pentagon, Washington, DC 20330

Air Force Center for Environmental Excellence
Base Closure Division (AFCEE/ESB)
Brooks Air Force Base, TX 78235-5328

Prepared by:

Roy F. Weston, Inc.
1 Weston Way
West Chester, PA 19380-1499

LANDFILL 5
RECORD OF DECISION

TABLE OF CONTENTS

TABLE OF CONTENTS
(Continued)

TABLE OF CONTENTS
(Continued)

LIST OF TABLES

LIST OF FIGURES

DECLARATION

SITE NAME AND LOCATION

Pease Air Force Base (PAFB), Landfill 5, New Hampshire

STATEMENT OF BASIS AND PURPOSE

This decision document presents a selected source control remedial action designed to provide containment of landfill wastes at Landfill 5, Pease AFB, NH. This decision document was developed in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act as amended by the Superfund Amendments and Reauthorization Act of 1986, and, to the extent practicable, the National Contingency Plan. Through this document the Air Force plans to remedy the threat to human health, welfare or the environment posed by contaminated soil, debris, and sediment associated with Landfill 5. Contaminated groundwater, surface water, and additional sediment associated with Landfill 5 will be addressed in the Zone 1 FS. This decision is based on the Administrative Record for the site. The Administrative Record for the site is located at the Information Repository in Building 43 at Pease International Tradeport (formerly Pease AFB, New Hampshire). The Administrative Record Index as applies to Landfill 5 may be found in Appendix D.

The State of New Hampshire Department of Environmental Services (NHDES) and the U.S. Environmental Protection Agency (USEPA) concur with the selected remedy.

ASSESSMENT OF THE SITE

Actual or threatened releases of hazardous substances from Landfill 5, if not addressed by implementing the response action selected in this Record of Decision (ROD), may present an imminent and substantial endangerment to public health, welfare, or the environment.

DESCRIPTION OF THE SELECTED REMEDY

This action addresses the principal threat posed by Landfill 5 by preventing endangerment of public health,, welfare, or the environment by implementation of this ROD which calls for consolidation and containment of landfill wastes.

The selected remedy includes excavation and consolidation, above the groundwater table, of saturated Landfill 5 debris and construction of a cap over Landfill 5. It is also proposed that all soil and debris from Landfills 2 and 4 would be excavated and transported to Landfill 5 for consolidation and used as subgrade fill material prior to capping of Landfill 5. A final decision under CERCLA for Landfills 2 and 4 will be required prior to implementation of the proposed consolidation plan. The selected remedy also includes extraction of groundwater to facilitate excavation of saturated landfill debris, treatment of the groundwater in an on-site mobile treatment system and discharge of treated groundwater to the base wastewater treatment facility.

The selected remedy is expected to prevent the potential for direct contact between contaminated landfill soils/debris and human and ecological receptors, and to minimize contaminant leaching to sediments and surface waters of Flagstone Brook and Railway Ditch and to groundwater.

The treatment processes used to treat groundwater extracted during construction dewatering will ultimately be selected by the remedial contractor providing the mobile treatment system. Technologies considered in the Feasibility Study include carbon adsorption, ion exchange and multi-media filtration.

The preferred discharge method for the treated water is to the base wastewater treatment facility. Coordination with the City of Portsmouth as the current operator, would be required prior to discharge. Treated water will meet the pretreatment criteria established by the City of Portsmouth. Ultimate discharge will be to the Great Bay via a National Pollutant Discharge Elimination System (NPDES) permit.

As part of Landfill 5 closure the Air Force will submit a monitoring program for approval by the NHDES and the USEPA. The purpose of the monitoring program is to verify the effectiveness of the containment system.

STATUTORY DETERMINATIONS

The selected source control remedy is protective of human health and the environment, complies with federal and state requirements, that are legally applicable or relevant and appropriate to the remedial action, is cost effective and uses permanent solutions. Treatment is not the principal element of the source control alternative because treatment of landfill debris is not practical or cost-effective given the size and heterogeneity of the landfill contents. The selected source control remedy may however involve treatment of groundwater extracted during construction dewatering, which should remove much of the contaminants currently present in groundwater. Because this remedy will result in hazardous substances remaining on site, a review will be conducted by the USAF, the USEPA, and the NHDES within five years after landfill closure to ensure that the remedy is providing adequate protection of human health and the environment. This review will be conducted at least every five years as long as hazardous substances remain on site above health-based cleanup levels.

The foregoing represents the selection of a remedial action by the United States Air Force and the U.S. Environmental Protection Agency, Region I, with concurrence of the New Hampshire Department of Environmental Services.

Concur and recommended for immediate implementation:

By: _[signature]_ Date: 9/24/93

JAMES F. BOATRIGHT
Deputy Assistant Secretary of the Air Force
(Installations)

By: _[signature]_ Date: 9-27-93
Paul G. Keough

Title: Acting Regional Administrator, USEPA

I. SITE NAME, LOCATION, AND DESCRIPTION

Pease AFB is a National Priorities List site consisting of numerous areas of contamination. This ROD addresses source area contamination at Landfill-5 (LF-5). LF-5 encompasses approximately 23 acres in the northern section of Pease AFB. Records indicate that LF-5 was used continuously from 1964 to 1975 as the primary base landfill, although some disposal occurred as late as 1979. Domestic and industrial refuse reportedly disposed of in the landfill includes waste oils and solvents, paints, paint strippers and thinners, pesticide containers and empty cans and drums. In addition, the landfill received sludge from the base industrial wastewater treatment plant. LF-5 has been investigated under the Air Force Installation Restoration Program (IRP). Results of the investigation indicate that sediments, surface water, soil and groundwater have been impacted by activities at LF-5.

The 4,365-acre Pease Air Force Base (AFB) is located in the towns of Portsmouth and Newington, Rockingham County, New Hampshire (approximately 3 miles northwest of the City of Portsmouth). As shown in Figure 1, Pease AFB is located on a peninsula bounded on the west and southwest by Great Bay; on the northwest by Little Bay; and on the north and northeast by the Piscataqua River. The base is situated in the approximate center of the peninsula.

At the beginning of World War II, an airport at the current Pease AFB location was used by the U.S. Navy. The Air Force assumed control of the site in 1951, and construction of the present facility was completed in 1956. During its history, Pease AFB has been the home of the 100th Bombardment Wing and the 509th Bombardment Wing whose mission was to maintain a combat-ready force capable of long-range bombardment operations. Over time, various quantities of fuels, oils, solvents, lubricants, and protective coatings were used at the base, and releases of contaminants into the environment occurred.

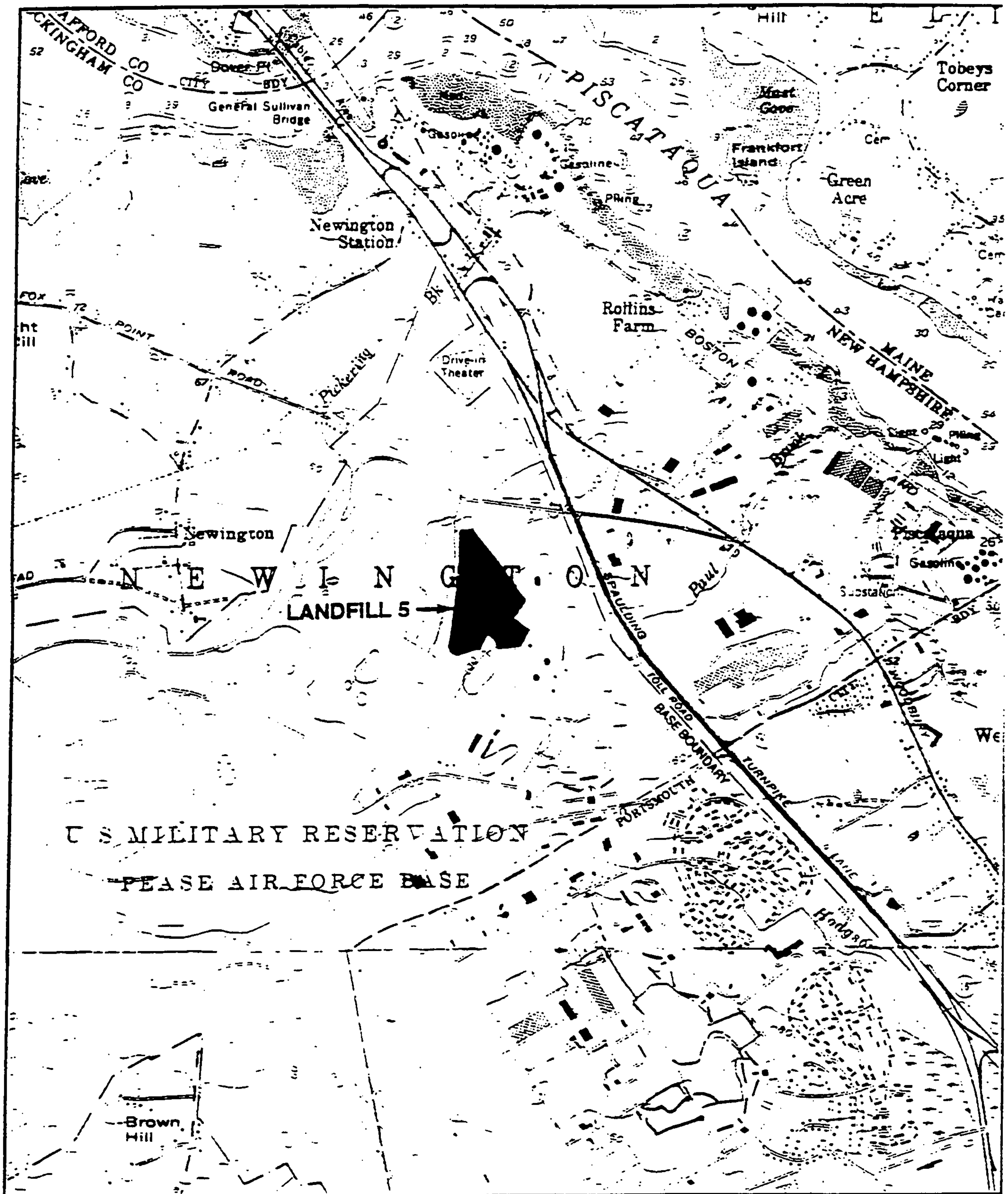
The New Hampshire Air National Guard (NHANG) relocated the 157th Military Airlift Group (MAG) from Grenier Field at Manchester, NH, to Pease AFB in 1966. The mission of the group was changed in 1975, when it was designated as the 157th Air Refueling Group.

In December 1988, Pease AFB was selected as one of 86 military installations to be closed by the Secretary of Defense's Commission on Base Realignment and Closure. The base was closed as an active military reservation on 31 March 1991. The New Hampshire Air National Guard remains at the airfield and will use some of the existing facilities. The remainder of the reservation will be divided between the State of New Hampshire's Pease Development Authority (PDA), the Department of the Interior, and the USAF.

Land use in the vicinity of LF-5 varies. LF-5 is bordered by Merrimac Drive to the north, an abandoned railroad bed to the east; Flagstone Brook to the west; and a Bulk Fuel Storage Area (BFSA) to the southeast (see Figure 2). Zone features near LF-5 include Landfill-2 (LF-2) to the northeast; Landfill-3 (LF-3) to the east; the BFSA to the southeast; a Paint Can Disposal Area (PCDA) to the south; the Air National Guard's (NHANG) North Ramp to the west; and Landfill-4 (LF-4) to the northwest (see Figure 1). LF-2, LF-3, LF-4, LF-5, and the PCDA are inactive disposal areas located within restricted access areas. The BFSA is still used by the NHANG for bulk fuel storage. The NHANG uses the north ramp for large aircraft maintenance and as a temporary staging area. Undeveloped land is located along the western boundary of LF-5.

A portion of the site located at the southern entrance of LF-5 was used as a temporary staging area for drums that were removed from the eastern area of LF-5 in the fall of 1989. This area continues to be used to temporarily store drummed solids and liquids generated during investigation activities conducted as part of the basewide Installation Restoration Program (IRP). Stored drummed solids and liquids are eventually disposed of off-base.

Off-base, a commercial and residential area is located along Spaulding Turnpike, approximately 1,000 feet northeast of the Pease AFB eastern boundary and approximately 1,500 feet north of LF-5. An abandoned outdoor theater and a water supply booster station are located approximately 150 feet north of the Pease AFB boundary. A small shop and a shopping mall are located on the eastern side of Spaulding Turnpike.



NORTH

500 0 250500 1000 2000

SCALE IN FEET

Base Map Source:
Detail area from USGS 7.5 min. series, Portsmouth, NH - ME Quadrangle, dated 1956, PR 1981 and 1988

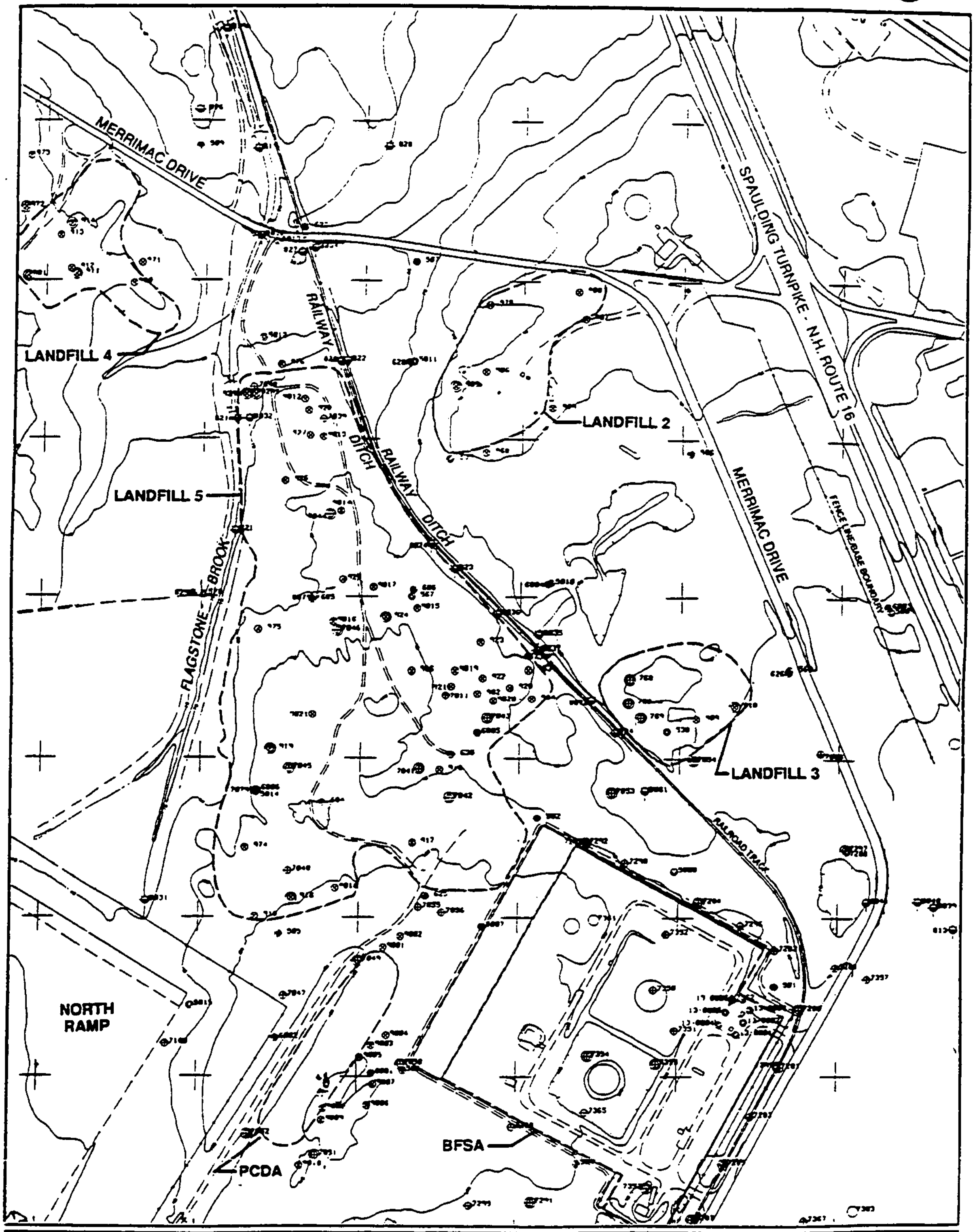
Map Area

Pease AFB

Landfill 5 (LF-5) Area
Stage 4, Record of Decision
Pease Air Force Base, New Hampshire

FIGURE 1
GENERAL LAND USE MAP

LSRCCA01(USGS)-4-93



LEGEND:

WELLS/BORINGS

- Staff gage
- Piezometer
- Piezometer/soil boring
- Monitor well(Overburden)
- Monitor well(Bedrock)
- Surface soil sample
- Test pit
- Soil boring
- Seep
- Surface contour/elevation(FT/MSL) 10 foot interval
- Roads (asphalt/paved)
- Other roads and trails
- Buildings
- Fence

NORTH

SCALE IN FEET

Base Map Source:
Detail area of photogrammetric compilation of PAFB from aerial photography dated 11/23/87

Map Area

Pease AFB

NOTE:

Landfill 5 (LF-5) Area
Stage 4, Record of Decision
Pease Air Force Base, New Hampshire

FIGURE 2
LANDFILL 5 (LF-5) SITE MAP

There are approximately 3,700 dwellings within a 1-mile radius of Pease AFB. Based on water usage surveys conducted in 1988 and 1992 and on available U.S. Geological Survey (USGS) and New Hampshire Department of Environmental Services (NHDES) information, it was determined that a number of these dwellings have wells and or springs located on their associated properties. The Town of Newington in particular has a large number of private wells. The vast majority of Portsmouth residences surveyed are serviced by town water only. A complete compilation of area springs and wells for Pease AFB, based on information available to date can be found in the Pease AFB Off-Base Well Inventory Letter Report (F-518). Information is presented in tabular form in Tables 1 through 7 of the Letter Report. Well location maps are provided as attachments to the report.

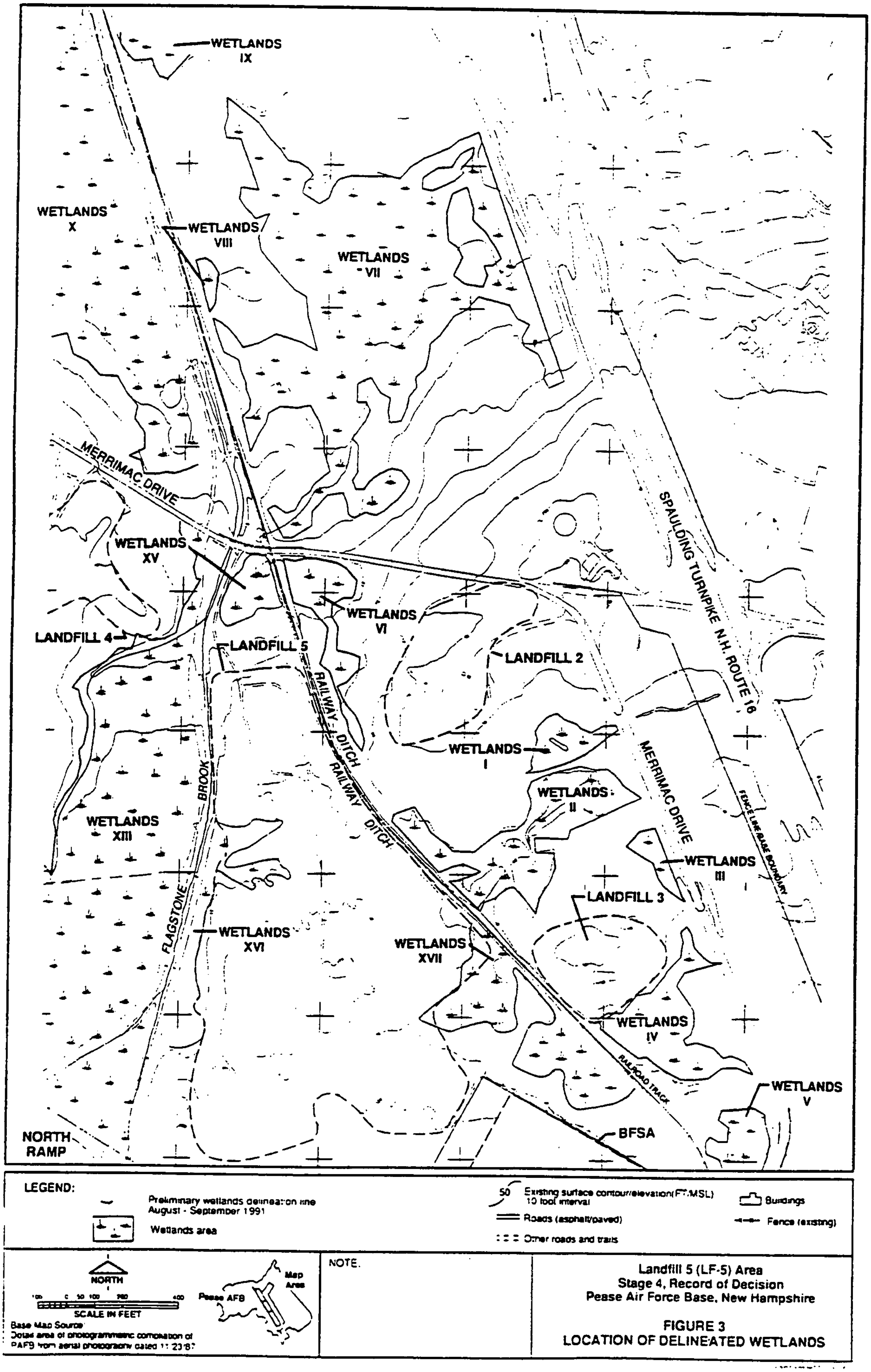
Pease AFB is located on a peninsula within the Piscataqua River drainage basin (see Figure 1). Drainage is radially away from the peninsula, into Great Bay toward the west, Little Bay to the northwest and north, and the Piscataqua River to the east. Little Bay flows into the Piscataqua River at the northern end of the peninsula. Great Bay, Little Bay, and the Piscataqua River are all tidally influenced. Consequently, these bodies of water are subject to semidiurnal water-level variations.

There are several surface water pathways that channel surface runoff away from the LF-5 area toward the Piscataqua River (see Figure 2). Surface drainage from LF-2, and portions of LF-3 and LF-5, flows into ditches located on both sides of the railway spur (collectively known as the Railway Ditch), which subsequently flows north and enters a swampy area east of the railroad tracks. The Railway Ditch eventually joins with Flagstone Brook, approximately 3,000 feet north of LF-5.

A portion of LF-5's surface runoff flows directly into Flagstone Brook, which flows north through a series of weirs and empties into the Piscataqua River near the General Sullivan Bridge. The total drainage area of the stormwater collection system within the headwaters of Flagstone Brook is approximately 78 acres, which includes a number of industrial areas of the base. Below the confluence of the eastern and western branches, Flagstone Brook flows north along the western edge of LF-5. Surface runoff seeps from LF-5 discharge directly into Flagstone Brook.

In addition to the Railway Ditch and Flagstone Brook, several wetland areas exist in the LF-5 vicinity. On and immediately adjacent to the landfill are three wetlands: Wetlands XV, XVI, and XVII (see Figure 3). Wetlands XVI drains to Flagstone Brook and Wetlands XV and XVII drain to the Railway Ditch. East of the landfill, between the railroad and Merrimac Drive, are Wetlands I, II, III, IV, V, and VI. Wetlands I, III, IV, and V drain toward Merrimac Drive, and Wetlands II and VI drain to the Railway Ditch. North of the landfill, there are several wetlands associated with the Railway Ditch and Flagstone Brook. Wetlands VII and VIII are associated with the Railway Ditch until it reaches Wetlands IX and joins Flagstone Brook through a culvert under the railroad. Wetlands X is located north of LF-5 and west of Flagstone Brook and has no identified surface water connection to Flagstone Brook. However, subsurface flow may exist under the roadbed. West of the landfill, Wetlands XIII is immediately adjacent to Flagstone Brook and a portion of it flows into Flagstone Brook near its conjunction with Merrimac Drive. It is not known if LF-5 is within a 100-year flood plain, since flood plain location maps were not available for Pease AFB.

A more complete description of the site can be found in the Stage 3C Landfill-5 Remedial Investigation (RI) Report (F-500).



NOTE.

Landfill 5 (LF-5) Area
Stage 4, Record of Decision
Pease Air Force Base, New Hampshire

FIGURE 3
LOCATION OF DELINEATED WETLANDS

II. SITE HISTORY AND ENFORCEMENT ACTIVITIES

A. Site Use and Response History

Records indicate that LF-5 was used continuously from 1964 to 1975 as the primary base landfill, although some disposal occurred as late as 1979. Domestic and industrial refuse reportedly disposed of in the landfill includes waste oils and solvents, paints, paint strippers and thinners, pesticide containers, and empty cans and drums. In addition, the landfill received an estimated 20,000 gallons of sludge from the base industrial wastewater treatment plant. Sludge from the base wastewater treatment facility, which may have contained trichloroethylene (TCE) residues, grass clippings, wood chips, miscellaneous soils, and concrete rubble, was temporarily stored at the landfill pending ultimate disposal. As previously discussed, a small drum staging area used for temporary storage of drums encountered on-base, miscellaneous soils, and metals is located at the southern landfill entrance. Based on aerial photographs, this area may have been a drum storage area as early as 1960.

One method of landfilling used between 1964 and 1975 was trenching. Based on review of aerial photographs and other information, trenches were constructed 15 to 20 feet wide, 150 to 300 feet long, and 6 to 8 feet deep (or to bedrock). The trenches were then filled with refuse and covered with local fill. Today, the settled trenches appear to cover about one-third of the 23-acre landfill. The trenches are located in the north-central, central, and southwestern portions of the landfill. Surface filling or backfilling was also a major landfilling technique used at LF-5. The fill between the trench areas was probably emplaced using these methods.

In 1983, an IRP Phase I Problem Identification/Records Search was conducted at Pease AFB. The study identified LF-5 as a potential source for the release of contaminants into the environment. In response to this finding, a pre-survey was conducted to obtain sufficient information for use in the planning of a more detailed study. The pre-survey was completed in 1984. Based on the pre-survey, Remedial Investigations (RIs) were conducted in accordance with the Comprehensive Environmental Response, Compensation, and Liability

Act (CERCLA), as amended by the Superfund Amendments and Reauthorization Act (SARA) of 1986, at LF-5 and at 18 other IRP sites at Pease AFB. The investigations were conducted in three stages between 1984 and 1991.

During Stage 2 of the investigation (October 1987 through May 1989) 5- and 55-gallon drums were identified in LF-5. Because these drums were determined to present a potential threat to human health and the environment, fast-track remedial action was initiated. Drum removal was completed during Stage 3 RI field activities. The RI field work was completed in October 1991. During drum removal, 54 85-gallon overpacks containing drums and waste material and over 2,000 empty, crushed drums were removed and disposed of at a licensed off-base disposal facility.

To date, LF-5 RI activities have included geophysical surveys, sampling of surface and subsurface soils, test pit investigations, sampling of groundwater beneath and surrounding LF-5, sampling of sediments and surface water in Flagstone Brook and the Railway Ditch, a wetlands determination in the area of LF-5, and measurement of groundwater levels and hydraulic gradients at LF-5. Table 1 provides a summary of RI activities performed to date.

A more detailed description of the LF-5 site history can be found in the RI in Subsection 2.1.

B. Enforcement History

The enforcement history at LF-5 is summarized as follows:

- In 1976, the Department of Defense (DOD) devised a comprehensive Installation Restoration Program (IRP) to assess and control environmental contamination that may have resulted from past operations and disposal practices at DOD facilities.
- In 1983, an IRP Phase I Problem Identification/Records Search was conducted at Pease AFB. As a result, a total of 18 IRP sites were identified and 16 were recommended for follow-on investigations (Phase II).

Table 1

Summary of Site Investigations, LF-5 and Vicinity, Pease AFB, NH

Date	Activity	Sampling Points	Purpose
Stage 1			
11/84	Surface water sampling	SW-2,3,4,6,7,8,9[a]	Evaluate surface water for TOX, TOC, O&G, cyanide, phenols, metals, and lindane.
11/84-2/85	Monitor well installation and development	502 (RFW-2) 505 (RFW-5)	Establish groundwater monitoring points upgradient of LF-5.
3/85	Surface water sampling	SW-2,3,4,6,7,8,9[a]	Evaluate surface water for TOX, TOC, O&G, cyanide, phenols, metals, and lindane.
3/85-4/85	Groundwater sampling (round 1)	502, 505	Evaluate groundwater for TOX, TOC, O&G, cyanide (502 and 505), phenols, metals, and lindane (505 only).
4/85-5/85	Groundwater sampling (round 2)	502, 505	Same as round 1.
5/85	Surveying	502, 505	Determine elevations and locations.
8/85-9/85	Surface water resampling	SW-2,3,4,6,7,8,9[a]	Re-evaluate surface water for cyanide, O&G, and lindane because holding times were exceeded.
8/85-9/85	Groundwater resampling	502, 505	Re-evaluate groundwater for phenols, cyanide, and lindane because holding times were exceeded.
8/85-9/85	Slug test	502	Determine hydraulic conductivity.

Date	Activity	Scope	Purpose	Report
Stage 2				
10/87-1/88	Aerial photograph review	Photographs from 1952, 1960, and 1976	Evaluate areal extent of LF-5.	ITR No. 1[b]
10/87-1/88	Magnetometer survey	25- x 50-foot grid 10- x 10-foot subgrids	Evaluate areas of buried ferrous material (i.e., drums).	ITR No. 1[b]

Table 1

Summary of Site Investigations
LF-5 and Vicinity
Pease AFB, NH
(Continued)

Date	Activity	Scope	Purpose	Report
Stage 2 (continued)				
10/87-1/88	GPR survey	10- x 10-foot subgrids	Verify anomalous magnetometer readings.	ITR No. 1[b]
Begin 11/87	Water level measurements (quarterly)	Stage 1 wells, Stage 2 wells, piezometers, gages as installed	Evaluate hydrologic characteristics.	ITR No. 1[b]
12/87	Survey	Monitor wells 502 and 505	Establish locations and elevations.	ITR No. 1[b]
3/88-4/88	Test pit excavation	15 pits: 915 to 929	Investigate magnetic and GPR anomalies; determine depth and character of fill.	ITR No. 2[c]
3/88-4/88	Piezometer installation	In test pits 919, 920, 924, 929 (north), and 929 (south)	Obtain water level measurements.	ITR No. 2[c]
4/88	Staff gage installation	818 to 824	Obtain water level measurements; establish surface water and sediment sampling locations.	ITR No. 2[c]
4/88-5/88	Survey	Test pits, borings, gages, and piezometers	Determine elevations and locations.	ITR No. 2[c]
9/88-10/88	Bedrock well installation and development	604, 605, 606	Evaluate bedrock water quality.	ITR No. 3[d]
10/88	Test pit excavation	974, 975, 976	Evaluate refuse type and saturated thickness.	ITR No. 3[d]
11/88-12/88	Survey	Monitor wells and test pits	Determine elevations and locations.	ITR No. 3[d]

Table 1

Summary of Site Investigations
LF-5 and Vicinity
Pease AFB, NH
(Continued)

Date	Activity	Scope	Purpose	Report
Stage 2 (continued)				
11/88	Surface water and sediment sampling	818 to 824	Evaluate surface water for VOCs, SVOCs, pesticides/PCBs, herbicides, total metals, and cyanide. Evaluate sediment for VOCs, SVOCs, pesticides/PCBs, metals, herbicides, and TPHs.	ITR No. 4[c]
11/88	Minirate pumping test	604	Estimate hydraulic conductivity.	ITR No. 4[c]
11/88-12/88	Round 1 groundwater sampling	604, 605, 606	Evaluate groundwater for VOCs, SVOCs, pesticides/PCBs, herbicides, dissolved metals, common anions, total hardness, and nitrate/nitrite.	ITR No. 4[c]
5/89	Surface water and sediment sampling	818 to 824	Evaluate surface water for VOCs, pesticides/PCBs, total metals, BOD, and ammonia/nitrogen. Evaluate sediment for cyanide.	ITR No. 4[c]

Date	Activity	Scope	Purpose
Stage 3			
9/89	Sediment and surface water sampling	10 locations (818 to 824, 826 to 828)	Evaluate surface water quality and measure its potential effect on macroinvertebrate populations.
10/89	Overburden well installation	567, 568	Evaluate overburden groundwater quality.
10/89-1/90	Drum removal IRM	One-acre tract. Southeastern section of landfill.	IRM performed to remove possible contaminant source.
11/89-12/89	Bedrock well installation	625 to 630	Evaluate bedrock groundwater quality.

Table 1

Summary of Site Investigations LF-5 and Vicinity Pease AFB, NH (Continued)

Date	Activity	Scope	Purpose
Stage 3 (continued)			
11/89-4/90	Column leaching test	405, 406, 407, 408	Evaluate effect of soil contamination on groundwater quality.
2/90	Minirate pumping tests	625, 627 to 630	Evaluate aquifer characteristics.
3/90, 10/90, 6/91, 8/91, 10/91	Groundwater sampling	See groundwater analyte summary table (Appendix A).	Characterize bedrock and overburden groundwater quality in the LF-5 area.
9/90	Overburden well installation	578	Evaluate overburden groundwater quality west of LF-5. Paired with bedrock well 629 to calculate vertical hydraulic gradient.
5/91	Test pit excavation	9001 to 9010	Delineate potential PCE source upgradient of LF-5.
5/91	Landfill cover soil sampling	32 locations (336 to 367) 200- x 200-ft grid	Characterize landfill cover material to assess air, direct contact, and surface runoff pathways.
5/91-6/91	Borehole permeability tests	7039 to 7048	Further delineate landfill solid waste and establish permeability values in the underlying material.
5/91-7/91	Bedrock well installation	6003 to 6006	Evaluate bedrock water quality in/near LF-5.
5/91-7/91	Overburden well installation	5007, 5008, 5015	Delineate PCE plume area.
5/91-7/91	Overburden well installation	5009 to 5011, 5014	Monitor overburden water quality. Paired with bedrock wells to calculate vertical hydraulic gradient.
5/91-7/91	Overburden well installation	5012, 5013	Monitor water quality hydraulically downgradient of the northern trench area.
5/91-7/91	Bedrock well installation	6001, 6002	Evaluate bedrock water quality upgradient of LF-5. Delineate potential PCE source.

Table 1

**Summary of Site Investigations
LF-5 and Vicinity
Pease AFB, NH
(Continued)**

Date	Activity	Scope	Purpose
Stage 3 (continued)			
6/91	Sediment and surface water sampling	18 locations (818 to 824, 826 to 828, 8031 to 8038)	Evaluate surface water quality and measure its potential effect on macroinvertebrate populations.
6/91, 10/91	Wetlands delineation	In and adjacent to LF-5	Identify wetlands areas.
7/91	Pumping test	48-hour test on well 630	Estimate hydraulic conductivity within the landfill.
9/91	Test pit excavation and soil sampling	9012 to 9021	Characterize LF-5 soil and debris.
9/91	TCLP analyses	Railway Ditch sediments Test pits	Evaluate leachability of soil and sediments.
10/91	Sediment and surface water sampling	Five locations (8061, 8072 to 8074, 8079)	Further delineate known contamination.

[a]Corresponds to surface water sampling points 824, 823, 822, 821, 820, 819, and 818, as shown in Figure 2.1-1 in F-500.
[b]F-452.
[c]F-453.
[d]F-458.
[e]F-459.

- In 1984, Phase II (Problem Confirmation and Quantification) was initiated via conducting a presurvey to obtain sufficient information to plan a more detailed study. Based on the presurvey results, LF-5 and 19 other IRP sites (three areas were dropped and four areas were added as IRP sites) were recommended for further study and were entered into the RI/FS process (F-447).

- In October 1987, the Air Force initiated a second part of the Phase II study (Stage 2). At this point, the IRP approach was adjusted to be consistent with the U.S. Environmental Protection Agency's (EPA) Remedial Investigation/ Feasibility Study (RI/FS) terminology and philosophy. Stage 2 field activities were concluded in May 1989.

- Following groundwater analyses in Phase II (Stage 2), five sites were identified for initiation of interim remedial measures (IRMs). LF-5 was among these sites, due to the presence of buried drums in the landfill and due to high contaminant levels in LF-5 soils and groundwater (F-455).

- On 14 July 1989, Pease AFB was proposed for addition to the National Priorities List (NPL). The effective date of addition was February 1990.

- In 1990, a Technical Review Committee (TRC) was established to facilitate communication and coordination among various agencies and the public concerning Pease AFB IRP activities. The TRC assists in keeping the local community apprised of investigative/remedial actions and findings at Pease AFB. The TRC is comprised of individuals representing the Air Force; NHDES; EPA; PDA; the Towns of Newington, Greenland, and Portsmouth; and a community representative. TRC meetings are held monthly.

- On 24 April 1991, the U.S. Air Force, EPA, and NHDES signed a Federal Facilities Agreement (FFA) establishing the protocol and timetable for conducting the RI/FS and Remedial Design/Remedial Action (RD/RA) processes at Pease AFB.

- In October 1991 (Stage 3), a drum removal IRM was conducted at LF-5. During field activities 54 85-gallon overpacks containing drums, waste materials, and over 2,000 empty, crushed drums were removed and disposed of at an off-base, licensed facility (F-463).

As part of the timetable established in the FFA, the U.S. Air Force, in an effort to streamline activities, designed a basewide strategy plan for conducting an RI/FS investigation. This strategy plan grouped the numerous sites into seven zones. The zones were delineated based on hydrogeological similarities, analytical results, geographical location, surface features, and types of source areas contained within the zones. RI/FS reports have been or will be prepared for each zone. As noted for Stage II, prior to inclusion of Pease AFB on the NPL, five sites, including LF-5, were on an accelerated RI/FS approach because of the potential threat they posed to human health and the environment. The U.S. Air Force, EPA, and NHDES agreed that the source area RI/FS reports, as well as the remedial actions at these sites, would continue on an accelerated track toward source area cleanup, independent of the zones in which they were contained.

- In April 1992, the U.S. Air Force submitted a Draft Final RI Report for LF-5 (F-500).
- In August 1992, the U.S. Air Force submitted a Draft Final FS for LF-5 (F-494).

III. COMMUNITY PARTICIPATION

Throughout the site's history, the community has been actively involved. EPA, NHDES, and the U.S. Air Force have kept the community and other interested parties apprised of site activities through informational meetings, fact sheets, press releases, public meetings, and TRC meetings.

During January 1991, the U.S. Air Force released a community relations plan, which outlined a program to address community concerns and keep citizens informed about and involved in remedial activities. This plan was updated and released in the summer of 1993.

Numerous fact sheets have been released by the U.S. Air Force throughout the IRP program at Pease AFB. These fact sheets are intended to keep the public and other concerned parties apprised of developments and milestones in the Pease IRP. The fact sheets released to date that concern LF-5 are summarized as follows:

Fact Sheet	Release Date
Pease AFB Installation Restoration Program Update	October 1991
Pease AFB Installation Restoration Program Update	December 1992
Proposed Plan for Landfill-5 Source Area	January 1993
Revised Proposed Plan for Landfill-5 Source Area	July 1993

In addition to the fact sheets, a number of public meetings have been held concerning the remediation of LF-5. On 14 November 1991 an IRP update public meeting was held and on 12 January 1993 an IRP public workshop and meeting was conducted to provide the public with information on the status of the IRP at Pease AFB. On 27 January 1993 the U.S. Air Force conducted a public hearing and information session for the LF-5 Proposed Plan, during which oral comments on the Proposed Plan were received. A transcript of oral comments received during this meeting and U.S. Air Force response to comments are included in the attached Responsiveness Summary (Appendix C). In addition, a public comment period for the Proposed Plan was conducted between 14 January and 13 February 1993. Responses to written comments received during this period are also included in Appendix C.

TRC meetings have been held on a monthly basis since 1990 (see Subsection II.B). Through these meetings, lines of communication among the public and the various lead agencies have been kept open.

On 5 August 1993, the U.S. Air Force conducted a public hearing and information session for the Revised Proposed Plan for LF-5 during which comments on the Proposed Plan were received. A transcript of comments received during this meeting and the U.S. Air Force response to comments are included in the attached Responsiveness Summary (Appendix C). In addition, a public comment period for both the Revised Proposed Plan for Landfill-5 and the Proposed Plan for Landfills-2 and -4 was held from 20 July to 19 August 1993. Responses to written comments received during that period are also included in Appendix C.

A complete information repository, containing documents relating to the Pease AFB IRP, is maintained at Pease AFB in Building 43. An administrative record pertaining to the Pease AFB IRP is located in Building 43 of Pease AFB. An index of the administrative record is maintained in the EPA Region I Headquarters.

IV. SCOPE AND ROLE OF OPERABLE UNIT OR RESPONSE ACTION

Zone 1 encompasses six areas of concern, including the source area operable unit for LF-5. Other areas of concern include LF-2, LF-3, and LF-4, the BFSA, and the PCDA. The remedy presented in this Record of Decision (ROD) provides for source control at LF-5. Remediation at a Superfund site typically involves activities to remove or isolate contaminant source materials in conjunction with activities that mitigate migration of contamination through groundwater, surface water, and/or air pathways. This ROD addresses only source control measures. Management of contaminant migration will be addressed in a separate ROD for Zone 1, which is scheduled for completion in September 1994.

Source materials at LF-5 have been identified as landfill soil and solid wastes, landfill surficial soils, and sediment in the Railway Ditch and associated wetlands. Although sediment in Flagstone Brook may represent an additional source, contaminants present in this medium may be directly related to runoff from other sources and, therefore, are addressed in the Zone 1 Draft FS, which was completed in August 1993, rather than in the LF-5 source control FS. Groundwater and surface water are not considered source materials, however, remedial action objectives (RAOs) and cleanup goals have been established for these media, as well as for the source materials, since they will be affected by source control activities.

Subsequent to the completion and public review of the original Proposed Plan for LF-5, it was proposed that two additional source areas, LF-2 and LF-4, be excavated (in their entirety) and consolidated on LF-5. The volume increase of materials consolidated on LF-5 would total approximately 76,320 cubic yards (yd^3). The two landfills, which are adjacent to (in the case of LF-2) or within 200 feet (in the case of LF-4) of LF-5, cover a total area of approximately 12 acres. The materials in LF-2 and LF-4 are mainly soil and debris as with LF-5. In keeping with the public's desire to consolidate landfill materials wherever possible to provide for more available land whose future use is not restricted, it was determined that consolidation of LF-2 and LF-4 onto LF-5 would be the best strategy in terms of meeting the public's requests. Because LF-2 and LF-4 are part of the Zone 1 operable unit, consolidation of LF-2 and LF-4 onto LF-5 will be addressed in the Zone 1 Proposed Plan and ROD. A final decision under CERCLA will be required prior to implementation of the LF-2 and LF-4 excavation and consolidation plan.

The selected source control remedy for LF-5, as described in the Proposed Plan, was developed by combining components of different source control technologies to aid in obtaining a comprehensive approach for site source area remediation. In summary, the remedy provides for:

- Excavation and consolidation of selected sediments on the existing landfill.
- Excavation of soil and debris in LF-2 and LF-4 and consolidation on LF-5 (not included in the original LF-5 Proposed Plan but added in the revised Proposed Plan).
- Excavation of soil and solid wastes predicted to be below the water table after capping and placement of excavated material on the existing landfill. Dewatering of areas requiring excavation, on-site treatment of the extracted groundwater, and discharge to the local publicly-owned treatment works (POTW) may be necessary.
- Regrading and capping of the existing landfill.
- Conducting long-term environmental monitoring and placement of institutional controls.

The remedial action addresses the following primary risks and principal threats to human health and the environment posed by the site:

- Risks posed to ecological receptors from direct contact with, or ingestion of, sediment in the Railway Ditch and associated wetlands containing contaminants in excess of concentrations that may present a risk.
- Risks posed to humans from direct contact with, or ingestion of, contaminated soils or debris that may present a health risk.

- Risks posed to ecological receptors from direct contact with, or ingestion of, soil or debris containing contaminants in excess of concentrations that may present health risks.

- Migration of contaminants from soil or debris within the LF-5 source area into the groundwater, which may inhibit attainment of the groundwater RAOs for Zone 1.

- Migration of contaminants from soil or debris within the LF-5 source area into surface water, including wetlands, which may inhibit attainment of the surface water ROAs for Zone 1.

The selected source control remedy will complete the mitigation of the site risks related to source areas as described in Subsection 1.6 of the LF-5 FS (F-494).

V. SUMMARY OF SITE CHARACTERISTICS

Subsections 1.3 and 1.4 of the FS contain an overview of the RI. Based on the results of the RI, a working conceptual model was developed that incorporates all known data concerning LF-5 and vicinity, including geological, hydrological, analytical, field measurements, and visual observations. The salient points of the model are summarized as follows:

- Several primary, discrete contaminant source areas exist within LF-5.
- Landfill operations have caused the excavation of native soils down to bedrock in places; consequently, buried refuse is in direct contact with groundwater and weathered and fractured bedrock.
- Contaminated soil is a likely source for some of the contaminants that have been observed in other matrices in the LF-5 area.
- An enhanced groundwater recharge area for LF-5 and its vicinity overlaps the central trench area.
- Groundwater within LF-5 is contaminated with halogenated volatile organic compounds (VOCs), aromatic VOCs, and semivolatile compounds (SVOCs); metals; and pesticides. The concentrations of a few of these substances exceed federal and state standards.
- Aromatic and halogenated VOCs are discharged from groundwater to surface water in the Railway Ditch and Flagstone Brook.
- A groundwater plume containing VOCs (halogenated) is migrating from LF-5.
- The extent of the halogenated VOC plume east of the Railway Ditch is known; the downgradient limit coincides with wells 5009 and 6003.
- Surface water and sediment in Flagstone Brook appear to be affected by other sources in addition to LF-5.
- Surface water and sediment in the Railway Ditch appear to be significantly affected by LF-5.

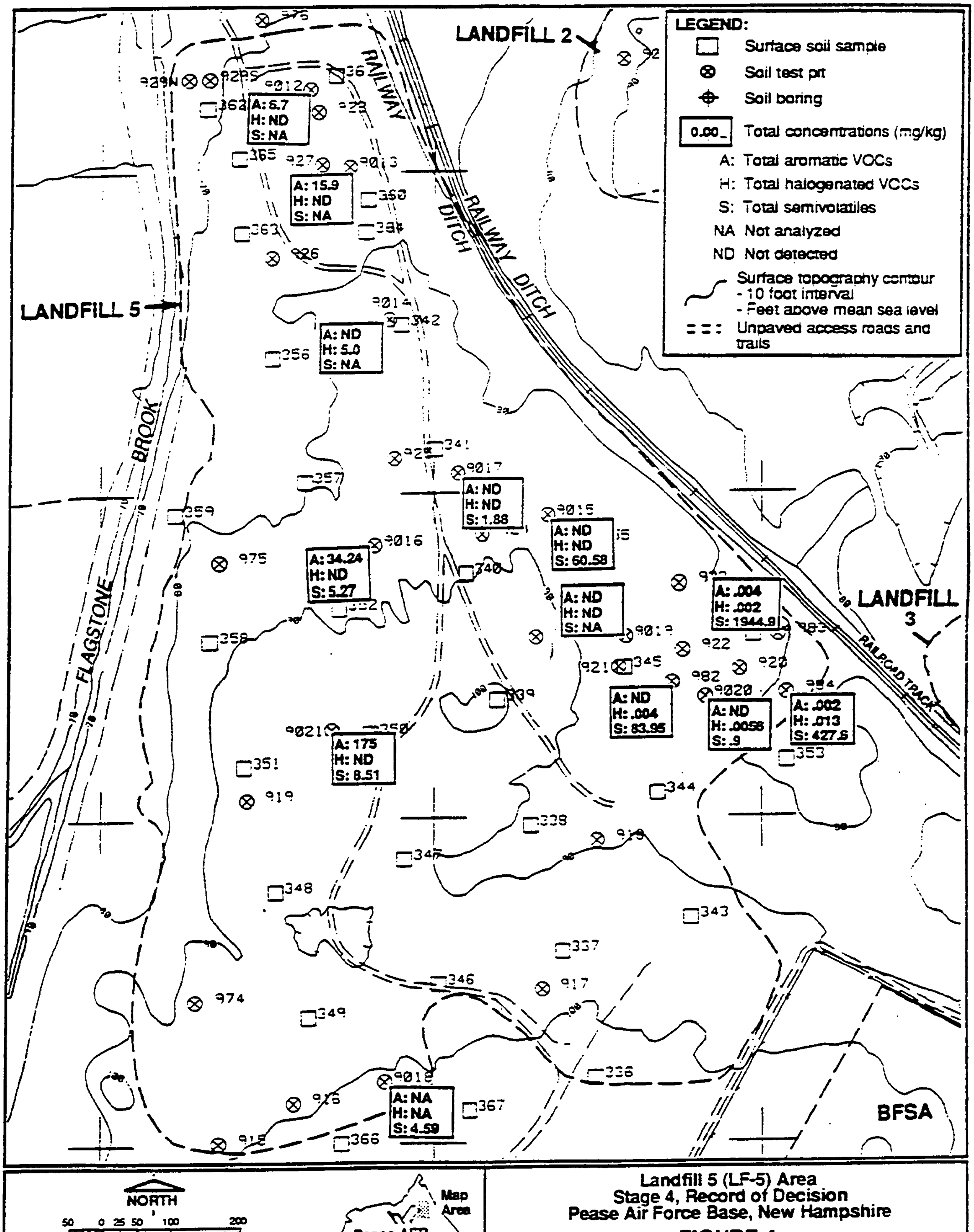
The results of the RI as conceptualized are discussed in more detail in the subsections that follow.

A. Subsurface Soils and Solid Waste

Source characterization at LF-5 included the collection and analysis of subsurface soil and solid waste samples. Subsurface soils refer to material collected at a depth of 2 feet or greater. All subsurface soil samples were collected from the landfill over a period of 4 years. Samples were obtained from approximately 30 test pits and several samples were collected during drum removal operations. Figure 4 depicts the distribution of organics in subsurface soils in and adjacent to LF-5. Major findings of the analyses of all test pit soil samples are summarized as follows:

- The highest total SVOCs were detected within the drum removal area.
- The highest total VOCs were detected in soils collected near the central trench area. Total xylenes were the largest component [33 milligrams/kilogram (mg/kg)] of the total aromatic VOCs. 1,4-Dichlorobenzene (DCB) was detected in soil from the southwestern corner of the central trench area at a concentration of 0.140 mg/kg.
- Low concentrations of total aromatics were detected in test pit soils collected from the northern trench area.
- TCE was detected in soils from test pit 9014 at a concentration of 0.005 mg/kg.
- Arsenic was detected above the background concentrations in the sample from test pit 9018. The copper background concentration was exceeded in samples from test pit 9013. Zinc concentrations exceeded the background concentration in samples from test pits 983, 9013, 9015, 9016, and 9018.
- Cadmium concentrations exceeded the background concentrations in samples from test pits 9013, 9016, and 9021. The mercury background concentration was exceeded in samples from test pits 9016 and 9017. Lead concentrations exceeded the background concentration in samples from test pits 982, 983, 984, and 9016. The nickel background concentration was exceeded in the sample from test pit 9015.

Soil samples from test pits 9016 and 9020 were also subjected to the Toxicity Characteristic Leaching Procedure (TCLP). Leachate was analyzed for VOCs, SVOCs, metals, pesticides, and herbicides. Laboratory data indicate that no TCLP regulatory limits were exceeded.



Base Map Source:
Detail area of photogrammetric compilation of PAFB from aerial photography dated 11/23/87.

Landfill 5 (LF-5) Area
Stage 4, Record of Decision
Pease Air Force Base, New Hampshire

FIGURE 4
DISTRIBUTION OF ORGANICS IN SUBSURFACE SOILS

L5RODA04/SSTPITS-4/93

Contaminants in subsurface soils at LF-5 are of concern since they are, in some landfill areas, in contact with groundwater and have the potential to migrate from the site via this medium.

B. Surface Soils

A total of 32 landfill surface soil samples (336 through 367) were collected from a depth of 0 to 2 feet to characterize the landfill cover soil. Surficial (0 to 2 feet) test pit samples were also used to describe the landfill cover soils. Figure 5 depicts the distribution of organics in surface soils in and adjacent to LF-5. The results of the laboratory analyses may be summarized as follows:

- Aromatic and halogenated VOCs were detected at low concentrations in soils collected from all areas of the landfill. The highest concentrations were detected in soils from test pit 983 and soil sample 357.

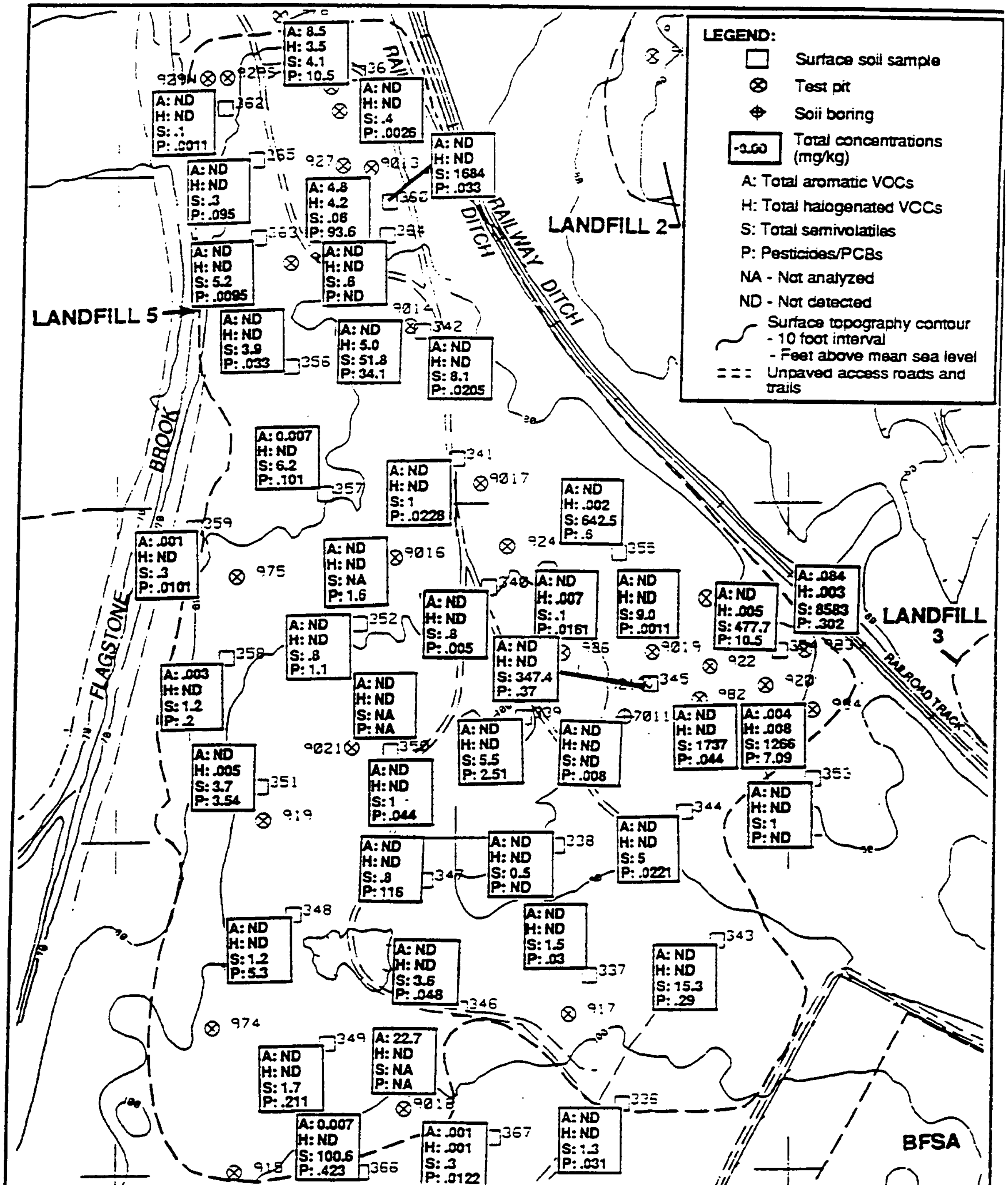
- SVOCs were detected in all soil samples. From areas outside the drum removal area, total concentrations ranged from 0.06 mg/kg (9013) to 1,684 mg/kg (360). Most of the highest total SVOCs were detected in soil samples collected from the drum removal area (345, 354, and 355) and test pits from the drum removal area (982, 983, and 984).

- Polynuclear aromatic hydrocarbons (PAHs) (e.g., chrysene) were most often detected in soil from the drum removal area.

- The highest concentrations of total petroleum hydrocarbons (TPHs) were detected in the samples from location 364 (2,500 mg/kg) from the northern trench area and location 345 (2,200 mg/kg) from the drum removal area.

- Pesticides were detected in most of the surface soil samples. Both heptachlor and dieldrin were elevated in the sample from location 354 (drum removal area), and dieldrin was detected in the sample from locations 366 and 984.

- Most of the samples that contained metals that exceeded the background concentrations were collected from the drum removal area and the northern trench area. Table 2 includes a summary of locations and concentrations that have metals concentrations that exceed background in surface soils at LF-5.



NORTH

SCALE IN FEET

Base Map Source: Detail area of photogrammetric compilation of PAFB from aerial photography dated 11/23/87.

Map Area

Pease AFB

Landfill 5 (LF-5) Area
Stage 4, Record of Decision
Pease Air Force Base, New Hampshire

FIGURE 5
DISTRIBUTION OF ORGANICS IN SURFACE SOILS

L5RODA05/SSTPITS-4/93

Table 2

Summary of Elevated Metals Concentrations in Soil
LF-5, Stage 3, Pease AFB, NH

Compound	As	B	Ba	Cr	Cu	Mn	Na	Ni	Pb	V	Zn	Hg	Cd	Se
Background concentration[a] (mg/kg)	25.2	67.3	262	49.4	54.3	1,020	366	70.5	54.0	150	219	1.2	6.7	1.4
Northern trench area	365s (28.6) 364s (dup.) (35.1)		364s (4,430)	364s (dup.) (54.0J)	9012s (215J) 364s (dup.) (55.7) 9013d (133J)	362s (1,080J)			364s (159) 9013s (75.5) 9012s (193) 360s (81.2)		9012s (259J) 364s (962J) 9013d (362J)		9012s (11.9J) 9013s (9.0) 9013d (13.5J)	
Drum removal area		364s (195)			354s (130J)		983s (2,560)		354s (55.8J) 982d (86.5) 983d (74.1) 984d (71.6)		983d (333)			
Other areas	9018d (37.8)				352s (65.8J)			9015d (86.5)	342s (120J) 349s (54J) 357s (67.7J) 358s (78.6J) 9016d (114)		9015d (246J) 9016d (491) 9018d (258J)	9016d (2.9) 9017d (1.6)	9021d (19.9J) 9016d (11.4)	9013s (8.1)

[a]Background concentrations were established in both a letter report dated 4 December 1991 and a letter included in Appendix G in P-500.
s = Sample collection depth was 0 to 2 feet.
d = Sample collection depth was >2 feet.
(28.6) = Concentration (mg/kg).
364 = Sample location.
Note: The common mineral-forming minerals aluminum and silicon are not included.

- One surface soil sample (9013) was subjected to TCLP. Leachate from the test was analyzed for VOCs, SVOCs, metals, pesticides, and herbicides. Preliminary laboratory data indicate that TCLP regulatory limits were not exceeded.

Contaminants in surface soils at LF-5 are of concern because of the potential for direct human and ecological receptor contact with these soils and the potential for contaminants in surface soils to migrate to surrounding surface water bodies and wetlands.

C. **Surface Water and Sediments**

The LF-5 surface drainage system consists of two main drainage channels. The first, Flagstone Brook, has its headwaters at the North Ramp and flows northward forming the western boundary of LF-5. The second, the Railway Ditch, flows northward along the eastern border of LF-5, eventually joining Flagstone Brook, approximately 3,000 feet north of LF-5. Flagstone Brook eventually drains to the Piscataqua River to the east of Pease AFB.

Nine surface water/sediment stations were sampled to characterize Flagstone Brook, while 15 stations were sampled to determine the impact of LF-5 on the Railway Ditch. Sampling results and data interpretation are discussed in Subsection 4.5 of the Zone 1 Draft Final RI (F-500). The sampling history of all LF-5 surface waters and sediment stations is summarized in Appendix B of that document. Figures 6 and 7 present the distribution of organics in LF-5 surface waters and sediments, respectively.

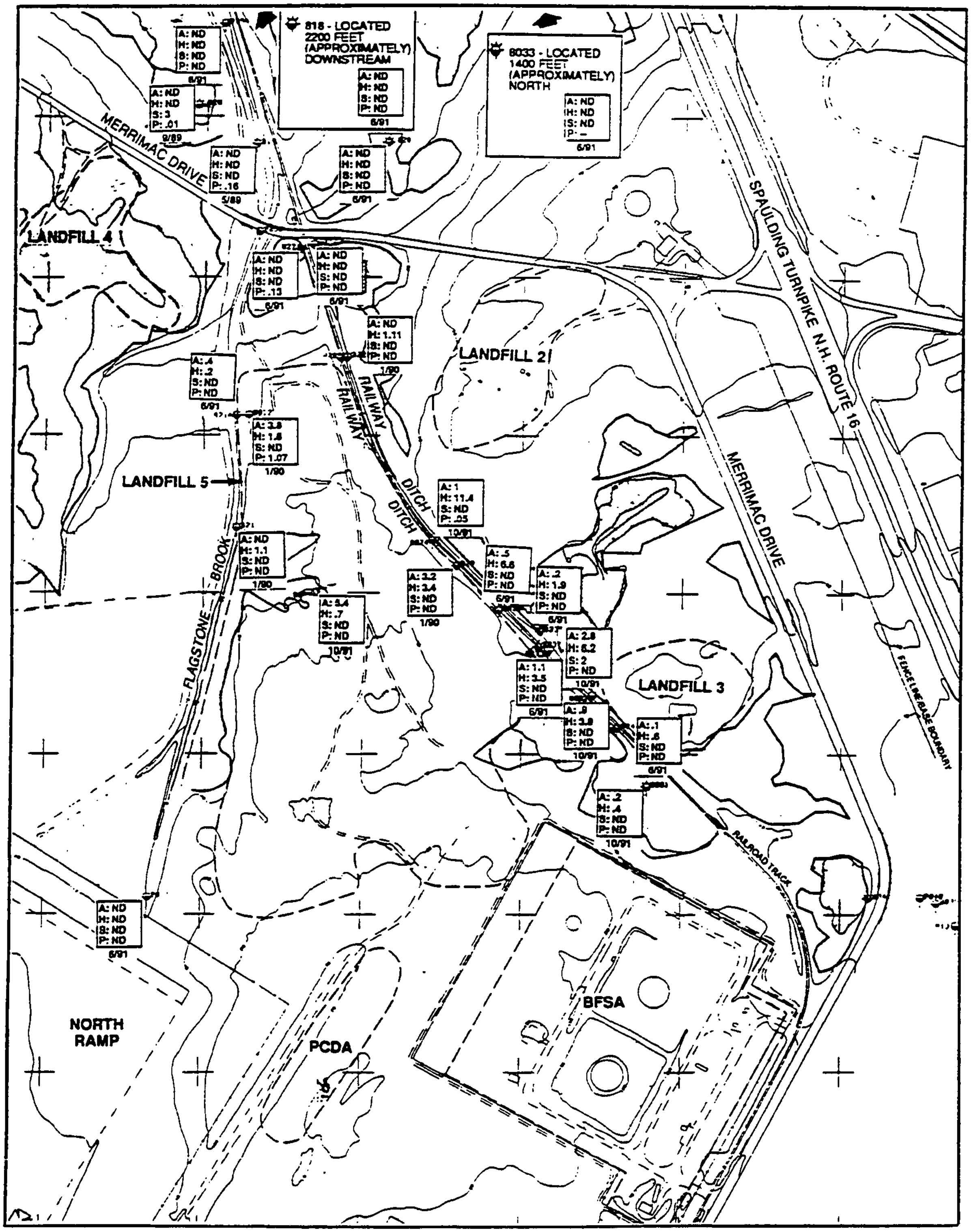
Tetrachloroethene (PCE) is the only VOC confirmed in the surface waters of Flagstone Brook at concentrations greater than 1 microgram per liter ($\mu g/L$). This sample was collected at station 821 during the January 1990 sampling round. No SVOCs were detected in the Flagstone Brook surface waters. The pesticide DDT and its metabolite DDE were the only pesticides confirmed in Flagstone Brook surface waters; these two compounds were detected at concentrations of 0.14 $\mu g/L$ and 0.2 $\mu g/L$, respectively, at station 819 during the May 1989 sampling round. Polychlorinated biphenyls (PCBs) were not detected at any location.

The highest concentrations of aromatic VOCs and SVOCs in the Flagstone Brook watershed were detected at seeps 8079 and 826, respectively. Total aromatic VOCs were detected at 54 μg/L for station 8079 during the October 1991 sampling round, and the SVOC 4-methylphenol was detected at 3.0 μg/L for station 826 during the September 1989 sampling round.

DDT (station 819) was the only organic compound detected in the Flagstone Brook watershed that exceeded ambient water quality criteria (AWQC) (0.001 μg/L).

VOCs were not detected in any of the sediment samples taken in Flagstone Brook; however, VOCs were detected in seep sediments. The VOCs detected in sediments were chlorobenzene (0.07 mg/kg) and 1,4-DCB (0.002 mg/kg) at seep 8079. SVOCs have been detected in the sediments of all but two of the stations (stations 821 and 821A) in the Flagstone Brook watershed. Stations 8031 and 8032 had the highest total sediment SVOC concentrations, 3.07 mg/kg and 2.48 mg/kg, respectively. The greatest contributors to the total SVOC concentrations at all stations were PAHs. It is important to note that the highest total SVOC concentration was reported for station 8031, which is upgradient from LF-5. This implies that sources other than LF-5 are contributing SVOCs and possibly other contaminants to surface water and sediments in the Flagstone Brook drainage.

Pesticides/PCBs were detected in the sediments at six stations in the Flagstone Brook drainage. The highest total pesticide/PCB concentration was detected at the upgradient station (8031) and was based on a single hit of 1.00 mg/kg for heptachlor epoxide. Other pesticides/PCBs observed in Flagstone Brook drainage sediments, and the number of stations at which they were reported include: 4,4′-DDT (4), 4,4′-DDE (3), gamma-chlordane (1), and Aroclor-1260 (1).



LEGEND:

- Staff gage
- Surface water/sediment sampling location
- Seep
- Preliminary delineated wetlands

0.00 Total concentrations (µg/l)

A: Total aromatic VOCs

H: Total halogenated VOCs

S: Total semivolatiles

P: Pesticides/PCBs

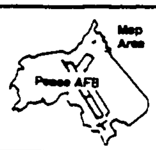
ND Not detected

- 50 Surface contour/elevation (FT/MSL) 10 foot interval
- Roads (asphalt/paved)
- Other roads and trails
- Buildings
- Fence

Samples collected on dates as noted beneath concentrations.

NORTH

SCALE IN FEET



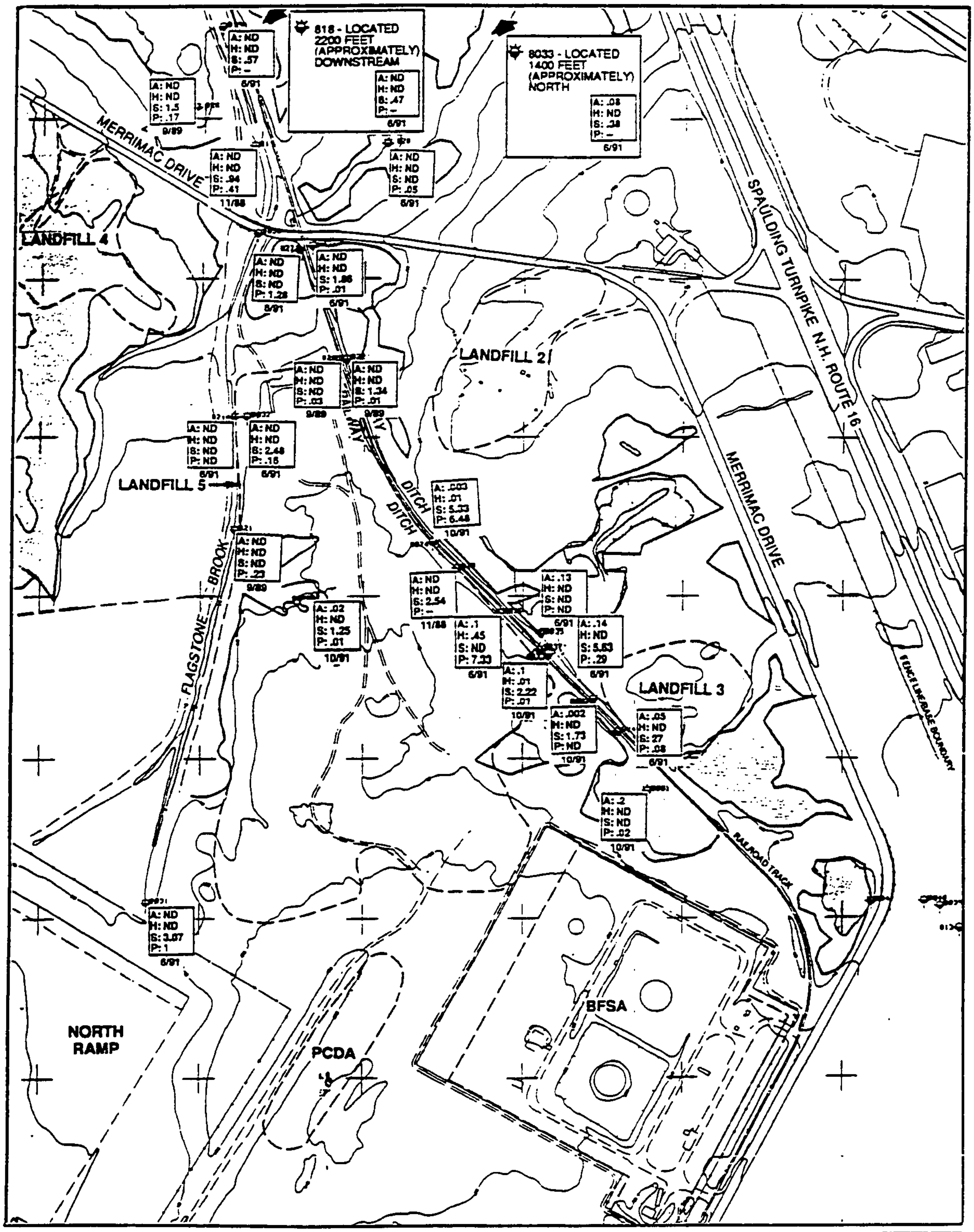
Base Map Source: Detail area of photogrammetric compilation of PAFB from aerial photography dated 11/23/87

NOTE:

Landfill 5 (LF-5) Area
Stage 4, Record of Decision
Pease Air Force Base, New Hampshire

FIGURE 6

DISTRIBUTION OF ORGANICS IN SURFACE WATER



LEGEND:

- Staff gage
- Surface water/sediment sampling location
- Seep
- Preliminary delineated wetlands

0.00 Total concentrations (µg/kg)

A: Total aromatic VOCs
H: Total halogenated VOCs
S: Total semivolatiles
P: Pesticides/PCBs
ND Not detected

50 Surface contour/elevation (FT/MSL) 10 foot interval

Roads (asphalt/paved)
Other roads and trails
Buildings
Fence

Samples collected on dates as noted beneath concentrations.

NORTH
SCALE IN FEET
Base Map Source:
Detail area of photogrammetric compilation of PAFB from aerial photography dated 23/87

Map Area
Pease AFB

NOTE:

Landfill 5 (LF-5) Area
Stage 4, Record of Decision
Pease Air Force Base, New Hampshire

FIGURE 7
DISTRIBUTION OF ORGANICS IN SEDIMENTS

Inorganic concentrations in surface waters in the Flagstone Brook drainage were compared with the State of New Hampshire freshwater chronic criteria for the protection of aquatic life, when available. Metals for which criteria are hardness- or pH-dependent have been adjusted assuming hardness of 20 mg/L and pH of 6.5. The state AWQC for seven inorganics were exceeded at one or more stations in the Flagstone Brook drainage. Zinc concentrations at stations 819, 819A, 826, 8031, and 8079 exceeded the state AWQC (0.027 mg/L). The state AWQC for iron (1.0 mg/L) was exceeded at stations 819, 826, 8031, and 8079; and the state AWQC for lead (0.000041 mg/L) was exceeded at three stations (826, 8031, and 8079). The four other compounds that exceeded surface water criteria and the number of stations are beryllium (1), copper (2), nickel (1), and thallium (1).

Inorganic sediment concentrations in the Flagstone Brook drainage were compared to concentrations at upgradient station 8031. Station 8031 had the highest detected concentrations of barium (445 mg/kg) and chromium (91.9 mg/kg) in sediments when compared to other Flagstone Brook drainage samples. In general, inorganic sediment concentrations did not exceed the upgradient sample by more than an order of magnitude, the exceptions being mercury and beryllium, which were not detected at station 8031. Mercury was identified in a duplicate sample taken at station 8032 (0.15 mg/kg) in June 1991. Beryllium was identified at stations 819A (0.27 mg/kg) and 8079 (0.41 mg/kg) during June and October 1991 sampling, respectively. The only other compound that exceeded the upgradient concentration by more than an order of magnitude was aluminum, which was detected at station 826 (20,800 mg/kg) in a sample collected in September 1989.

Aromatic and halogenated VOCs were detected in surface water at nine stations in the Railway Ditch during the 1991 field investigations at LF-5 (see Figure 7). Aromatic VOCs detected included chlorobenzene, benzene, toluene, ethylbenzene, trimethylbenzene, and butylbenzene. Chlorobenzene was the most frequently detected and also showed the highest concentration of 2.0 μg/L at station 8073. Halogenated VOCs were detected at the same stations where aromatic VOCs were present. Halogenated VOC contaminants included PCE, TCE, trans- and cis-1,2-dichloroethene (DCE), 1,1-DCA, 1,4-DCB, and 1,2-DCB. TCE, cis-1,2-DCE, 1,1-dichloroethane (DCA), and 1,4-DCB were the dominant halogenated

VOCs present in Railway Ditch surface water. TCE was detected at the highest concentration (9 μg/L at station 8074). No aromatic or halogenated VOCs were detected in surface water downstream of station 827. The area of aromatic/halogenated VOC surface water contamination extends from staff gage 8061 downstream to station 820/822.

No SVOCs were detected in surface water sampled from the Railway Ditch. The pesticide DDT and its metabolite 4,4'-DDD were detected in surface water collected from four Railway Ditch stations (820, 827, 828, and 8074). The highest concentrations of DDT and 4,4'-DDD in surface water were detected at staff gage 820. No herbicides or PCBs were detected in Railway Ditch surface waters.

Aromatic VOCs were detected in sediments at nine stations in the Railway Ditch during the 1991 field investigations at LF-5 (see Figure 7). Aromatic VOCs detected included chlorobenzene, 1,2-DCB, methylene chloride, 2-butanone, toluene, and acetone; 2-butanone had the highest detected concentration of 0.2 mg/kg at station 8061. Halogenated VOCs were detected in sediment at three stations in the Railway Ditch and included 1,2-DCE, TCE, and 1,1-DCA. The aromatic VOC 1,2-DCE was detected in the highest concentration at station 8036 (0.45 mg/kg). Aromatic VOCs were detected in sediments in the upper Railway Ditch from staff gage 8061 downstream to station 8074, while halogenated VOCs were detected at stations 8074, 8036, and 8073. No VOCs were detected in sediments sampled below station 8074.

SVOCs were detected in sediments sampled at eight stations in the Railway Ditch. Phenanthrene, fluoranthene, and pyrene were the most common SVOCs out of a total of 15 SVOC compounds detected. The highest SVOC concentration detected in Railway Ditch sediments was a 27-mg/kg concentration of benzoic acid at station 824. SVOCs were detected throughout the Railway Ditch system from station 824 downstream to station 8033.

Pesticides were detected in sediments at 10 stations in the Railway Ditch. DDT was the most widely distributed pesticide in the Railway Ditch sediments and was detected at six stations. The DDT metabolites 4,4-DDE and 4,4-DDD were both detected at seven stations in the Railway Ditch. The highest sediment concentration of pesticide (DDT) was detected at station 8036. No herbicides or PCBs were detected in Railway Ditch sediments.

Inorganic concentrations detected in surface waters of the Railway Ditch drainage were compared with the State of New Hampshire freshwater chronic criteria for the protection of aquatic life. State AWQC for five inorganics were exceeded at one or more stations in the Railway Ditch drainage. Arsenic concentrations at stations 8036, 8037, and 8073 exceeded the state AWQC (0.048 mg/L). State AWQC for copper (0.003 mg/L) was exceeded at stations 8035 and 8061. A total of 10 stations (820, 823, 827, 8035, 8036, 8037, 8061, 8072, 8073, and 8074) exceeded the state AWQC for iron (1.0 mg/L). Lead concentrations at seven stations (820, 822, 8035, 8036, 8061, 8072, and 8073) exceeded the state AWQC (0.00041 mg/L), and the state AWQC for zinc (0.027 mg/L) was exceeded at stations 8035, 8036, 8037, and 8061.

Railway Ditch sediment concentrations of inorganics were compared to the upgradient station on Flagstone Brook (8031). Inorganics concentrations in Railway Ditch sediments that were one order of magnitude greater in concentration than those detected at station 8031 are described as follows. Eight sediment inorganics were one order of magnitude greater in concentration than those detected at station 8031. These included: arsenic at seven stations, iron at one station, lead at two stations, calcium at three stations, cobalt at one station, potassium at one station, manganese at six stations, and silicon at eight stations. Four inorganics (beryllium, selenium, silver, and thallium) detected in Railway Ditch sediments were not detected at station 8031.

Potential pathways by which contaminants have entered Flagstone Brook and the Railway Ditch include overland flow (erosion) and groundwater discharge. The PAHs and pesticides observed in sediments are transported via erosion of LF-5 soils. VOCs detected in the Railway Ditch surface waters reflect contaminated groundwater discharge. The relative absence of VOCs in Flagstone Brook surface waters may result from dilution, losses due to volatilization, or a smaller contaminant load migrating westward, as opposed to eastward toward the Railway Ditch.

Halogenated VOCs in Railway Ditch waters have been determined to have originated from three separate source locations in the vicinity of LF-5; the central trench area (chlorobenzene, 1,4-DCB, and C-1,2-DCE), the southern trench area (PCE), and an area south of the landfill near the PCDA.

Based on sampling results in Flagstone Brook and the Railway Ditch, it is estimated that approximately 3,000 yd^3 of Railway Ditch sediments will require remediation.

D. Groundwater

During the LF-5 characterization, 38 groundwater sample locations were tested for VOCs with varied frequency. Both aromatic and halogenated VOCs have been detected on- and off-site. However, the off-site aromatic VOCs have been detected in wells 502 and 5008. Well 5008 is downgradient of both LF-5 and the BFSA.

All of the groundwater samples collected from monitor wells installed within the established LF-5 boundary have contained VOCs. Outside the landfill boundary, halogenated VOCs were detected in samples collected from five wells located east of the southern section of LF-5 (502, 538, 568, 626, and 6003); and one well located northeast of the landfill (5011). Figure 8 depicts the distribution of the concentrations of total halogenated VOCs, total aromatic VOCs, and total SVOCs for each well.

The highest concentrations of total aromatic VOCs (primarily benzene, chlorobenzene, and 1,4-DCB) and SVOCs are typically detected in groundwater collected from wells near the central trenches (567, 603, 604, 605, and 6005).

The highest concentrations of halogenated VOCs, primarily TCE and PCE, in groundwater are hydraulically downgradient of the southeastern corner of LF-5, but low concentrations have been detected in samples from one well, located adjacent to the central portion of the southern boundary, during three separate sampling events. Low concentrations of dichlorinated alkenes and alkanes cis-1,2-DCE, 1,1-DCA, and 1,2-DCA are present across the landfill, but the higher concentrations (>5 μg/L) are restricted to the southeastern region of LF-5. The highest detected concentrations of total SVOCs and total aromatic VOCs have been in the central trench area (605 and 606); benzene has repeatedly exceeded the Federal Maximum Contaminant Level (MCL) of 5 μg/L in samples collected from one well (5014) in this area. No other final or proposed MCLs have been exceeded for aromatic VOCs or SVOCs at LF-5. The MCLs for TCE (5 μg/L) and vinyl chloride (2 μg/L) have been exceeded in groundwater samples collected from well 502, and the MCL for PCE (5 μg/L) has been exceeded in all samples from wells 502 and 538.

Groundwater samples collected from 38 wells in and around LF-5 have been analyzed for pesticides. Low concentrations (below quantitation limits) of either delta-BHC, endosulfan I, or 4,4'-DDD have been detected in groundwater samples collected from three of the wells (605, 606, and 629). The two samples containing endosulfan I were collected from wells located downgradient of the central trench area (605 and 606). The concentrations present are not above any existing federal or state criteria. No herbicides have been detected in groundwater samples collected from the wells in and around LF-5.

A total of 96 groundwater samples collected from 38 wells were analyzed for dissolved metals. Table 3 summarizes those wells at which dissolved metal concentrations have exceeded background. Iron and manganese were consistently present at concentrations above established background concentrations near the central trench area (wells 567, 604, 605, 606, 630, 6005, and 6006). In all wells in which dissolved manganese concentrations exceeded the background concentrations, aromatic VOCs were detected. A similar correlation exists with dissolved iron except in wells 508 and 5010, which do not contain VOCs. The majority of the metals concentrations that were present in elevated concentrations were located in wells near the central trenches.

Dissolved arsenic was detected above the background concentration (50 μg/L) in seven wells; six of these wells are located near the central trenches (567, 605, 630, 6005, and 6006) and the seventh (501) is located downgradient of the BFSA. Dissolved arsenic was detected

Table 3

Locations of Elevated Dissolved Metals Concentrations in Groundwater
LF-5, Stage 3, Pease AFB, NH

Parameter:	As	Fe	Mn	Mg	Si	Co	Ti	B	K	Al	Na	Ni
Background concentration (μg/L)	50	1,090	59.7	41,300	13,400	50	200	163	12,900	439	8,800	100
Locations	501 (2/5) 567 (3/3) 5014 (1/1) 6006 (1/1) 605 (4/4) 606 (4/4) 630 (3/3)	5010 (1/1) 501 (5/5) 567 (3/3) 604 (4/4) 605 (4/4) 606 (4/4) 630 (3/3) 5014 (1/1) 6005 (1/1) 6006 (1/1)	*	567 (2/3)	5010 (1/1) 567 (1/3) 605 (2/3) 606 (2/4)	606 (2/4) 5014 (1/1)	501 (1/5) 567 (1/3) 604 (1/4) 605 (1/4) 606 (1/4) 630 (1/3)	5008 (1/1) 501 (1/4) 567 (1/3) 605 (2/4) 606 (2/4) 630 (1/3)	567 (1/3) 606 (4/4)	508 (1/2)	5010 (1/1)	606 (1/4)

(2/4) = Number of times above background/number of times analyzed.
*All the wells within the landfill have concentrations that exceed the background concentration.

at lower concentrations in wells that are hydraulically upgradient of the trench area (502 and 505), and in well 629.

Contaminant migration in groundwater beneath and adjacent to LF-5 is discussed in detail in Subsections 5.2 and 5.3 of the Zone 1 Draft Final RI (F-500). The salient points of the discussion are presented in the paragraphs that follow.

Six potential groundwater contaminant migration pathways exist at LF-5. The six pathways are overburden and bedrock groundwater pathways to the north, east, and west of LF-5.

The bedrock and overburden water-bearing zones within LF-5 are intimately interconnected hydraulically. Excavating and landfilling activities resulted in removal of much of the relatively low-permeability Marine Clay and Silt (MCS) and Glacial Till (GT) units, that, in many other areas, act as an aquitard between the bedrock and overburden aquifers. Consequently, low-permeability material, which would otherwise separate groundwater in the overburden from groundwater in the weathered bedrock, is only sporadically present throughout LF-5. The observed contaminant distributions within LF-5 are consistent with the single hydraulic unit model.

Groundwater beneath LF-5 is recharged primarily from the south, although a local groundwater mound, which acts as an enhanced recharge zone, has developed in the central trench area. The center of this recharge zone is located north of well 604 (see Figure 8).

The location of this recharge zone coincides with an area characterized by elevated concentrations of several aromatic and halogenated VOCs. A north/south-trending groundwater divide transects this recharge zone along an axis through test pits 925, 927, and 928, and bedrock wells 604 and 605. Groundwater (bedrock and overburden) flows radially away from the recharge area and then joins the dominant flow pattern toward Flagstone Brook to the west and the Railway Ditch to the east.

Hydraulic gradients across LF-5 indicate that groundwater flows toward both the Railway Ditch and Flagstone Brook, thereby resulting in discharge from the water table to surface water. Although the Railway Ditch was not flowing during the September 1989 surface water sampling event, it appears to be a perennial stream because flow has been noted during all previous and subsequent sampling rounds. Organic contaminants present in surface water samples from staff gages along the Railway Ditch are the same as found in groundwater at LF-5. Although groundwater is also discharging into Flagstone Brook, with the exception of a small amount of PCE in one of four surface water samples collected at staff gage 821, there is a relative absence of contaminants detected in surface water samples. The relative absence of contaminants in Flagstone Brook may result from dilution, because of its relatively high discharge, contaminant losses resulting from aeration and volatilization, and/or it may be a reflection of a relatively smaller contaminant load migrating westward rather than eastward toward the Railway Ditch.

E. Wetlands

In addition to the Railway Ditch and Flagstone Brook, several wetlands areas exist in the LF-5 vicinity. On and immediately adjacent to the landfill are three wetlands: Wetlands XV, XVI, and XVII (see Figure 3). Wetlands XVI drains to Flagstone Brook and Wetlands XV and XVII drain the Railway Ditch. East of the landfill, between the railroad and Merrimac Drive, are Wetlands I, II, III, IV, V, and VI. Wetlands I, III, IV, and V drain toward Merrimac Drive, and Wetlands II and VI drain to the Railway Ditch. North of the landfill, there are several wetlands associated with the Railway Ditch and Flagstone Brook. Wetlands VII and VIII are associated with the Railway Ditch until it reaches Wetlands IX and joins Flagstone Brook through a culvert under the railroad. Wetlands X is located north of LF-5 and west of Flagstone Brook and has no identified surface water connection to Flagstone Brook. However, subsurface flow may exist under the roadbed. West of the landfill, Wetlands XIII is immediately adjacent to Flagstone Brook and a portion of it flows into Flagstone Brook near its conjunction with Merrimac Drive. More detailed information pertaining to the wetlands in the LF-5 vicinity is presented in the Wetlands Delineation Report in Appendix M of the LF-5 RI (F-500).

Based on wetland area surface soil and sediment sampling results that were available during preparation of the FS, it was assumed that sediment in Wetlands VI and XV, located outside the northern boundary of the landfill on either side of the Railway Ditch and south of Merrimac Drive, would require remediation. The estimated volumes of sediment in Wetlands VI and XV that may require remediation are 4,200 yd^3 and 2,400 yd^3, respectively. However, it should be noted that these volumes were conservatively estimated assuming that the entire wetlands will require sediment excavation. While sediment samples from the portions of these wetlands immediately adjacent to the Railway Ditch contained contaminant concentrations exceeding the No Observable Adverse Biological Effects Levels (ER-Ms), published by the National Oceanic and Atmospheric Administration (NOAA) samples were not collected from these wetlands at locations farther away from the Railway Ditch so there are no data to suggest that remediation of the entire wetlands is necessary. Confirmational sampling has been conducted in these wetlands to confirm whether sediment removal is necessary. Remedial volumes resulting from the sampling results will be confirmed prior to implementation of remedial action. Excavation will be avoided, wherever possible, to avoid the adverse long-term effects of wetlands destruction.

VI. SUMMARY OF SITE RISKS

A Risk Assessment (RA) was performed to estimate the probability and magnitude of potential adverse human health and environmental effects from exposure to contaminants associated with the Site. The public health risk assessment followed a four-step process:

1. Contaminant identification, which identified those hazardous substances which, given the specifics of the site, were of significant concern.
2. Exposure assessment, which identified actual or potential exposure pathways, characterized the potentially exposed populations, and determined the extent of possible exposure.
3. Toxicity assessment, which considered the types and magnitude of adverse health effects associated with exposure to hazardous substances.
4. Risk characterization, which integrated the three earlier steps to summarize the potential and actual risks posed by carcinogenic risks.

The results of the baseline human health and ecological risk assessments for Pease AFB are discussed in the subsections that follow.

A. Human Health Risk Assessment

A total of 75 contaminants of concern, listed in Tables 4 through 12, were selected for evaluation in the human health risk assessment. These contaminants constitute a representative subset of the more than 98 contaminants identified at the site during the RI. The 75 contaminants of concern were selected to represent potential site-related hazards based on toxicity, concentration, frequency of detection, mobility, and persistence in the environment. A summary of the health effects of each of the contaminants of concern can be found in Subsection 6.3.2 and Appendix L.4 of the LF-5 Draft Final RI (F-500).

Table 4

Chemicals of Concern in Main Soils[a]
LF-5, Pease AFB, NH

Chemical	Frequency of Detection[b]	Range of Sample Quantitation Limits (mg/kg)	Range of Averaged (Detected) Concentrations[c] (mg/kg)	Mean Concentration[d] (mg/kg)	Upper 95% Confidence Limit of the Mean (mg/kg)
Organics					
Aroclor-1242	2/33	0.045-9.1	1.6-5.3	0.43	1.0
Aroclor-1248	3/33	0.045-9.1	0.82-3.4	0.39	0.88
Bis(2-ethylhexyl) phthalate	27/33	0.45-15	0.055-1.0(1.1)	0.66	1.0
4,4'-DDD	8/33	0.009-1.8	0.003-0.23	0.062	0.13
4,4'-DDE	14/33	0.014-1.8	0.001-0.71	0.085	0.25
4,4'-DDT	23/33	0.009-0.41	0.002-3.4	0.18	0.66
Dibenzofuran	7/33	0.35-2.4	0.055-30	0.56	1.0
1,4-Dichlorobenzene	2/31	0.35-15	0.057-0.11	0.42[d]	0.64[d]
Dieldrin	5/33	0.[illegible]9-1.8	0.009-0.24	0.068	0.15
Di-n-butyl phthalate	6/33	0.35-15	0.039-0.084	0.40[e]	0.68[e]
2-Methylnaphthalene	3/33	0.35-2.4	0.29-8.9	0.39	0.57
Naphthalene	6/33	0.35-2.4	0.10-34	0.54	0.97
PAHs					
Acenaphthene	8/33	0.35-2.4	0.037-52	0.74	1.6
Acenaphthylene	2/33	0.35-15	0.096-0.20	0.42[d]	0.62[d]
Anthracene	12/33	0.35-2.4	0.045-85	0.95	2.5
Benzo(a)anthracene	22/33	0.35-2.4	0.042-130	1.6	5.7
Benzo(a)pyrene	21/33	[illegible].35-2.4	0.040-110	1.4	4.4
Benzo(b)fluoranthene	22/33	0.36-2.4	0.041-100	1.5	4.7
Benzo(g,h,i)perylene	10/34	0.35-2.4	0.20-110	1.3	3.2
Benzo(k)fluoranthene	21/33	0.36-2.4	0.036-82	1.2	3.3
Chrysene	25/33	0.36-2.4	0.040-120	1.7	6.3

Table 4

Chemicals of Concern in Main Soils[a]
LF-5, Pease AFB, NH
(Continued)

Chemical	Frequency of Detection[b]	Range of Sample Quantitation Limits (mg/kg)	Range of Averaged (Detected) Concentrations[c] (mg/kg)	Mean Concentration[d] (mg/kg)	Upper 95% Confidence Limit of the Mean (mg/kg)
Organics (continued)					
Dibenzo(a,h)-anthracene	8/33	0.35-2.4	0.082-23	0.51	0.88
Fluoranthene	28/33	0.36-2.4	0.045-200	2.7	12.5
Fluorene	7/33	0.35-2.4	0.075-62	0.77	1.7
Indeno(1,2,3-cd)-pyrene	10/33	0.35-2.4	0.17-87	1.1	2.6
Phenanthrene	16/33	0.35-2.4	0.048-240	2.4	10
Pyrene	28/33	0.36-0.45	0.048 (0.040) - 210	2.4	10
Pentachlorophenol	4/33	1.8-76	0.093-0.94	1.8[e]	2.8[e]
Inorganics					
Arsenic	36/36	1.0[f]	4.0-28.6	9.7	11
Cadmium	4/36	1.7-7.6	2.0-11.9	1.7	2.1
Copper	36/36	3.0[f]	6.8-215	23	28
Lead	33/36	9-15	7.1-193	37	49
Manganese	36/36	1.0[f]	105-1,080	333	388
Mercury	8/34	0.11-0.28	0.14-0.81	0.13	0.17
Zinc	32/36	15-34	25-259	68	89

[a]The listed chemicals were selected as chemicals of concern for both the human health and ecological risk assessments.
[b]Number of sampling locations at which the chemical was detected compared with the total number of sampling locations.
[c]If the minimum or maximum detected concentration differed from the respective minimum or maximum averaged concentration, the detected concentration is given in parentheses.
[d]Mean was calculated for the averaged concentrations using the minimum variance unbiased estimation approach for lognormally distributed data (F-230).
[e]Exceeds the maximum detected concentration.
[f]Sample quantitation limits were unavailable. Method detection limit is indicated (F-484).

Table 5

Chemicals of Concern in Hot Spot Soils — Drum Removal Area[a] LF-5, Pease AFB, NH

Chemical	Frequency of Detection[b]	Range of Sample Quantitation Limits (mg/kg)	Range of Averaged (Detected) Concentrations[c] (mg/kg)	Mean Concentration[d] (mg/kg)	Upper 95% Confidence Limit of the Mean (mg/kg)
Organics					
alpha-Chlordane	2/6	0.23-13	0.011-1.7	2.6[e]	15,953[e]
gamma-Chlordane	1/6	0.23-13	1.7	1.5	28[e]
4,4′-DDD	5/6	2.2	0.021(0.011)-0.67	0.37	39[e]
4,4-DDE	2/6	0.0046-2.1	0.15-0.26	0.15	0.46[e]
4,4′-DDT	4/6	0.0046-0.20	0.16-6.0	1.9	19,411[e]
Dibenzofuran	6/6	0.35-2.4[f]	0.38(0.093)-110	37	87,005[e]
Dieldrin	2/6	0.046-2.6	1.5-1.5	0.57	65[e]
Heptachlor	2/6	0.023-1.0	0.15-0.16	0.09	0.42[e]
2-Methylnaphthalene	5/6	19	0.18(0.039)-41	19	27,715[e]
Naphthalene	5/6	19	0.18(0.054)-64	27	95,617[e]
PAHs					
Acenaphthene	6/6	0.33[f]	0.69(0.19)-190	67	113,721[e]
Anthracene	6/6	0.33[f]	1.1(0.30)-220	90	75,800[e]
Benzo(a)anthracene	6/6	0.33[f]	2.3(0.77)-890	242	568,196[e]
Benzo(a)pyrene	6/6	0.33[f]	1.7(0.55)-750	199	633,285[e]
Benzo(b)fluoranthene	6/6	0.33[f]	1.7(0.61)-610	182	394,218[e]
Benzo(g,h,i)perylene	5/6	19	1.1(0.41)-120	45	6,712[e]
Benzo(k)fluoranthene	6/6	0.33[f]	1.5(0.47)-300	129	86,233[e]
Chrysene	6/6	0.33[f]	2.1(0.74)-910	239	724,126[e]
Dibenzo(a,h)-anthracene	5/6	0.38-19	0.38-88	28	16,408[e]
Fluoranthene	6/6	0.33[f]	4.2(1.5)-1,300	379	505,372[e]
Fluorene	6/6	0.33[f]	0.59(0.15)-200	69	218,424[e]

Table 5

Chemicals of Concern in Hot Spot Soils — Drum Removal Area[a]
LF-5, Pease AFB, NH
(Continued)

Chemical	Frequency of Detection[b]	Range of Sample Quantitation Limits (mg/kg)	Range of Averaged (Detected) Concentrations[c] (mg/kg)	Mean Concentration[d] (mg/kg)	Upper 95% Confidence Limit of the Mean (mg/kg)
Organics (continued)					
Indeno(1,2,3-cd)-pyrene	5/6	19	1.0(0.39)-190	60	27,942[e]
Phenanthrene	6/6	0.33[f]	3.7(1.2)-1,200	326	429,142[e]
Pyrene	6/6	0.33[f]	61-1,400	354	509,661[e]
Toluene	2/5	0.006-0.007	0.007(0.004)-0.082	0.014	2.2[e]
Inorganics					
Boron	1/3	17-23	18.9	13	64[e]
Copper	6/6	3.0[f]	14.8(13.9)-130	31	140[e]
Lead	6/6	20[f]	5.1-55.8	23	108[e]
Mercury	2/4	0.11-0.22	0.29-0.34	0.18	0.90[e]

[a]The listed chemicals were selected as chemicals of concern for both the human health and ecological risk assessments.
[b]Number of sampling locations at which the chemical was detected compared with the total number of sampling locations.
[c]If the minimum or maximum concentration differed from the minimum or maximum averaged concentration, the detected concentration is given in parentheses.
[d]Mean was calculated for the averaged concentration using the minimum variance unbiased estimation approach for lognormally distributed data (F-230).
[e]Exceeds maximum detected and/or averaged concentration.
[f]Sample quantitation limits were unavailable. The method detection limit is indicated (F-484).

Table 6

Chemicals of Concern in Hot Spot Soils — Staged UST Location[a]
LF-5, Pease AFB, NH

Chemical	Range of Averaged (Detected) Concentrations[b]
Organics	
Bis(2-ethylhexyl) phthalate	0.24 (0.21-0.27)
Di-n-butyl phthalate	0.048 (0.043-0.052)
PAHs	
Benzo(a)pyrene	0.066 (0.065-0.066)
Chrysene	0.049 (0.048-0.049)
Fluoranthene	0.059 (0.058-0.060)
Pyrene	0.078 (0.071-0.084)
Inorganics	
Arsenic	35.1[c] (6.2-35.1)
Barium	8,200[c] (4,430-8,200)
Boron	309 (195-422)
Cadmium	2.4 (2.2-2.5)
Chromium	54.0[c] (21.0-54.0)
Lead	187 (159-214)
Zinc	1,690[c] (962-1,690)

[a]The listed chemicals were selected as chemicals of concern for both the human health and ecological risk assessments.

[b]The range represents the analytical results of duplicate samples from one sampling location (364). The arithmetic mean of the samples is presented, unless otherwise indicated, and the results of the duplicate samples are given in parentheses. Because there is only one sampling location, an upper 95% confidence limit of the mean was not calculated.

[c]The higher reported value is indicated instead of the mean because the relative percent difference of the concentrations for the duplicate samples exceeded the criterion (i.e., 50%).

Table 7

Chemicals of Concern in Groundwater[a] — LF-5, Pease AFB, NH

Chemical	Frequency of Detection[b]	Range of Sample Quantitation Limits (μg/L)	Range of Averaged (Detected) Concentrations[c] (μg/L)	Mean Concentration[d] (μg/L)	Upper 95% Confidence Limit of the Mean (μg/L)
Organics					
Acetone	1/9	10	46	9.6	18
Benzene	9/27	0.7-10	0.35(0.30)-12 (14)	1.5	2.4
Bis(2-ethylhexyl) phthalate	8/25	10-11	1.0-8.3(11)	5.0	5.5
n-Butylbenzene	3/25	1.0	0.45(0.40)-2.0	0.57	0.67
sec-Butylbenzene	8/25	1.0	0.30(0.40)-3.0	0.76	0.98
Chlorobenzene	11/37	1.0-1.2	0.30-66(80)	5.7	9.9
Chloroethane	3/27	2.0-3.0	1.3(1.0)-2.5(3.0)	1.3	1.4
4-Chloro-3-methylphenol	9/25	10-11	2.5(2.0)-10(11)	5.6	6.1
1,2-Dichloro-benzene	8/27	0.6-2.0	0.30(0.20)-12(32)	1.2	2.0
1,4-Dichloro-benzene	11/27	0.6-1.0	0.20-28(38)	6.4	9.5
Dichlorodifluoro-methane	4/27	2.0-9.0	3.9(2.0)-13(23)	3.2	4.0
1,1-Dichloroethane	5/27	0.4-1.0	0.32(0.50)-14(15)	1.3	2.2
1,2-Dichloroethane	4/27	0.20-1.0	0.26(0.10)-1.4(2.2)	0.37	0.44
cis-1,2-Dichloroethene	7/27	0.5-1.0	0.30(0.10)-8.6(22)	0.82	1.4
Diethyl phthalate	9/25	10-11	3.7(1.0)-8.3(11)	5.2	5.6
Dimethyl phthalate	4/25	10-11	1.0-8.0(11)	5.2	5.6
Di-n-butyl phthalate	4/25	10-11	3.2(2.0)-8.3(11)	5.4	5.7
Ethyl ether	2/9	2.0	2.0-19(40)	3.1	6.9
Isopropyl-benzene	8/24	1.0	0.50-2.0	0.72	0.87

Table 7

Chemicals of Concern in Groundwater[a]
LF-5, Pease AFB, NH
(Continued)

Chemical	Frequency of Detection[b]	Range of Sample Quantitation Limits (µg/L)	Range of Averaged (Detected) Concentrations[c] (µg/L)	Mean Concentration[d] (µg/L)	Upper 95% Confidence Limit of the Mean (µg/L)
Organics (continued)					
2-Methyl-naphthalene	2/25	7.0-11	8.0(11)-8.3(11)	5.4	5.7
Naphthalene	4/25	7.0-11	3.8(1.0)-8.3(11)	5.3	5.6
PAHs Fluoranthene	3/25	10-11	3.3(1.0)-8.3(11)	5.3	5.7
n-Propylbenzene	8/25	1.0	0.20-3.0	0.67	0.85
Tetrachloro-ethene	6/27	0.2-1.0	0.30-21(56)	1.8	3.3
Trichloroethene	6/27	0.6-1.0	0.43(0.51)-27(46)	1.6	3.4
1,2,4-Trimethyl-benzene	5/24	1.0	0.10-4.0	0.64	0.90
Xylenes (total)	3/17	1.6-2.0	1.6(2.0)-2.6(5.7)	1.2	1.4
Inorganics					
Arsenic (filtered) (total)	13/27 13/19	5-7.5 5-7.4	3.4(5.0)-153(194) 5.0-353	30 65	46 101
Boron (filtered) (total)	24/26 20/20	100 100[e]	67(100)-305(340) 100-269	117 133	139 154
Cobalt (filtered) (total)	4/27 6/20	40-45 40	27(40)-80 40(10)-114(127)	24 34	28 45
Iron (filtered) (total)	22/27 20/20	40-291 40[e]	31(42)-55,300(64,800) 1,620-173,000	8,047 40,281	12,933 55,640
Manganese (filtered) (total)	23/27 20/20	10-19 10[e]	10(12)-5,268(6,260) 33-4,370(4,780)	842 1,470	1,262 2,005
Nickel (filtered) (total)	27/27 20/20	10[e] 10[e]	15-82(122) 15-433	25 63	30 99
Selenium (filtered) (total)	4/27 2/19	5.0 5.0-7.5	3.8(5.0)-5.0 5.0(1.3)-5.0	2.8 2.9	3.0 3.2

Table 7

Chemicals of Concern in Groundwater[a]
LF-5, Pease AFB, NH
(Continued)

Chemical		Frequency of Detection[b]	Range of Sample Quantitation Limits (µg/L)	Range of Averaged (Detected) Concentrations[c] (µg/L)	Mean Concentration[d] (µg/L)	Upper 95% Confidence Limit of the Mean (µg/L)
Inorganics (continued)						
Silicon	(filtered)	25/26	4,820	3,450(3,570)-24,850(24,900)	8,980	11,022
	(total)	20/20		4,630-95,700	21,306	29,389
Silver	(filtered)	5/27	18-30	17(30)-30	15	17
	(total)	5/20	30	23(7.5)-30	18	21
Thallium	(filtered)	8/27	10-200	41(10)-215(589)	60	82
	(total)	2/19	10	10-10	5.5	6.2

[a]Selected as chemicals of concern for the human health risk assessment only.
[b]Number of wells at which the chemical was detected compared with the total number of wells.
[c]If the minimum or maximum detected concentration differed from the minimum averaged concentration, the detected concentration is given in parentheses.
[d]Arithmetic mean, based on averaged concentrations.
[e]Sample quantitation limits were unavailable. The method detection limit is indicated (F-484).

Table 8

Chemicals of Concern in Surface Water — Flagstone Brook[a]
LF-5, Pease AFB, NH

Chemical	Frequency of Detection[b]	Range of Sample Quantitation Limits (μg/L)	Range of Averaged (Detected) Concentrations[c] (μg/L)	Mean Concentration[d] (μg/L)	Upper 95% Confidence Limit of the Mean (μg/L)
Organics					
Chlorobenzene	1/5	1.0-1.3	0.40	0.53[e]	0.61[e]
4,4'-DDD	1/5	0.07-0.10	0.022 (0.01)	0.039[e]	0.051[e]
4,4'-DDE	1/5	0.07-0.10	0.013 (0.020)	0.038[e]	0.053[e]
4,4'-DDT	1/5	0.07-0.10	0.073 (0.14)	0.050	0.063
1,4-Dichlorobenzene	1/4	0.50-1.0	0.20	0.31[e]	0.42[e]
Lindane	1/5	0.033-0.05	0.020	0.021[e]	0.025[e]
Tetrachloroethene	1/5	0.20-1.0	0.35 (1.1)	0.38[e]	0.50[e]
Inorganics					
Aluminum	1/5	200	765 (1,050)	233	516
Ammonia[f]	2/3	0.10	0.075-0.095	0.13[e]	0.25[e]
Barium	2/5	50	51 (100)-62 (104)	38	55
Boron	3/5	100	80 (123) - 130 (210)	79	111
Copper	1/5	10-30	24 (34)	12	20
Iron	5/5	0.04[g]	260 (286) - 2,750 (4,480)	995	1,950
Zinc	5/5	0.01[g]	7.7 (12)-146	48	102

[a]Unless otherwise indicated, the chemical was selected as a chemical of concern for both the human health and ecological risk assessments.
[b]Number of sampling locations at which the chemical was detected compared with the total number of sampling locations.
[c]If the minimum or maximum detected concentration differed from the respective minimum or maximum averaged concentration, the detected concentration is given in parentheses.
[d]Arithmetic mean based on the averaged concentrations.
[e]Exceeds the maximum detected and/or averaged concentration.
[f]Selected as a chemical of concern for the ecological risk assessment only.
[g]Sample quantitation limits were not available. The method detection limit is indicated (F-484).

Table 9

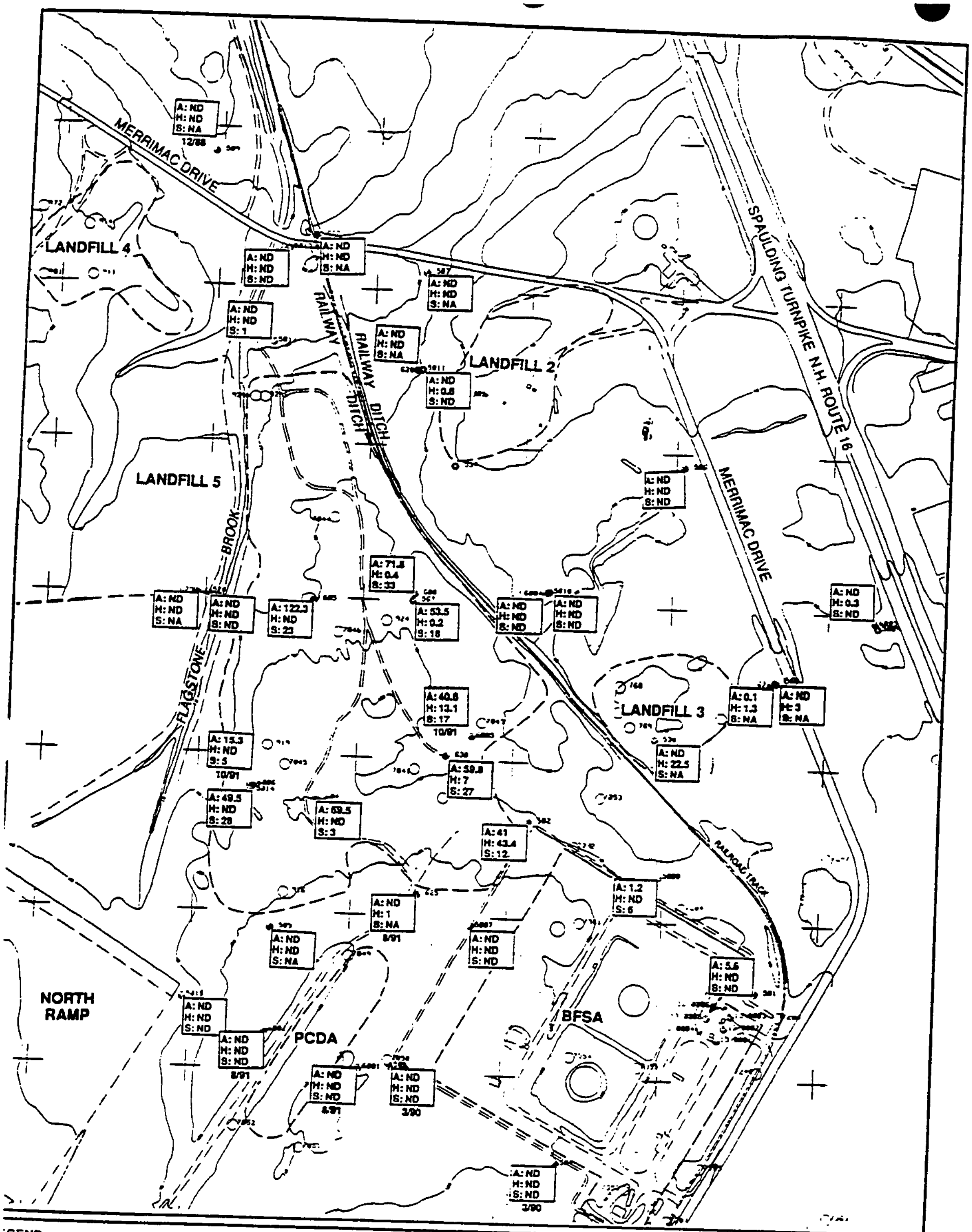
Chemicals of Concern in Surface Water — Railway Ditch[a] LF-5, Pease AFB, NH

Chemical	Frequency of Detection[b]	Range of Sample Quantitation Limits (μg/L)	Range of Averaged (Detected) Concentrations[c] (μg/L)	Mean Concentration[d] (μg/L)	Upper 95% Confidence Limit of the Mean (μg/L)
Organics					
Chlorobenzene	11/15	1.0-1.1	0.10-2.0	0.81	1.0
4,4'-DDD	4/14	0.077-0.11	0.03 (0.02) - 0.17 (0.31)	0.064	0.084
4,4'-DDT	2/14	0.077-0.11	0.088 (0.16) - 0.55 (1.4)	0.088	0.15
1,4-Dichlorobenzene	8/15	0.5-1.0	0.25 (0.30)-2.0	0.68	0.94
1,1-Dichloroethane	6/15	0.4-1.0	0.20-2.0	0.53	0.73
cis-1,2-Dichloroethene	11/15	0.67-1.0	0.20-2.0	0.59	0.79
Trichloroethene	8/15	0.60-1.0	0.20-9.0	1.2	2.2
Inorganics					
Aluminum	10/15	200	211-12,467 (37,200)	1,299	2,732
Ammonia[e]	2/4	0.10	0.15-0.27	0.13	0.25
Arsenic	12/15	5.0	4.4 (5.2)-850	84	183
Barium	6/15	50	35-339 (968)	55	92
Boron	11/15	100	106-227 (351)	126	153
Copper	4/15	10-30	11-102 (287)	15	27
Iron	14/15	169	409-220,483 (658,000)	24,669	50,739
Lead	10/15	3.0-5.0	3.1 (3.7)-96 (280)	14	25
Manganese	15/15	10[f]	72 (35) - 10,897 (31,500)	2,014	3,234
Mercury[f]	1/15	0.1-0.2	0.23 (0.55)	0.077	0.099
Nickel	4/15	15-16	9.6 (15.7)-54 (154)	15	21
Thallium	3/15	10-73	37 (90) - 1,417 (4,240)	118	282
Zinc	12/15	10-13	15 (14)-328 (974)	56	94

Table 9

Chemicals of Concern in Surface Water — Railway Ditch[a]
LF-5, Pease AFB, NH
(Continued)

[a]Unless otherwise indicated, the chemical was selected as a chemical of concern for the human health and ecological risk assessments.
[b]Number of sampling locations at which the chemical was detected compared with the total number of sampling locations.
[c]If the minimum or maximum detected concentration differed from the respective minimum or maximum averaged concentration, the detected concentration is given in parentheses.
[d]Arithmetic mean based on the averaged concentrations.
[e]Selected as a chemical of concern for the ecological risk assessment only.
[f]Sample quantitation limits were unavailable. Method detection limit is indicated (F-484).



GEND:

- Staff gage
- Monitor well (Bedrock)
- Monitor well (Overburden)
- Monitor well (Hybrid)
- Piezometer

0.00 Total concentrations (µg/l)

A: Total aromatic VOCs
H: Total halogenated VOCs
S: Total semivolatiles
NA Not analyzed
ND Not detected

Samples collected in 5/91 except as noted.

50 Surface contour/elevation (FT/MSL) 10 foot interval

Roads (asphalt/paved)

Other roads and trails

Buildings

Fence

NORTH

SCALE IN FEET

Map Source: area of photogrammetric compilation of from aerial photography dated 11/23/87

Map Area

Pease AFB

Landfill 5 (LF-5) Area
Stage 4, Record of Decision
Pease Air Force Base, New Hampshire

FIGURE 8
DISTRIBUTION OF ORGANICS IN GROUNDWATER

Table 10

Chemicals of Concern in Sediment — Flagstone Brook[a]

Chemical	Frequency of Detection[b]	Range of Sample Quantitation Limits (mg/kg)	Range of Averaged (Detected) Concentrations[c] (mg/kg)	Mean Concentration[d] (mg/kg)	Upper 95% Confidence Limit of the Mean (mg/kg)
Organics					
4,4'-DDD	4/5	0.020-0.035	0.009 (0.005)-0.21	0.069	7.5[e]
4,4'-DDE	3/5	0.018-0.035	0.021-0.12	0.036	0.57[e]
4,4'-DDT	2/5	0.018-0.085	0.020-0.035	0.023	0.087[e]
Inorganics					
Antimony	2/5	1.7-26.7	2.5 (2.2)-5.9 (2.5)	6.8[e]	155[e]
Boron	3/5	15.8-26.7	4.8 (2.7)-6.1 (5.2)	7.4[e]	13[e]
Cadmium	1/5	0.5-2.7	1.2	0.90	3.2[e]
Lead	5/5	19	7.95 (6.4)-63.1	36	371[e]
Selenium	1/5	0.17-1.2	0.95[j]	0.55	4.9[e]
Thallium	1/5	0.13-26.7	9.6 (19.2)	11	23,900,000[e]

[a]Selected as a chemical of concern for both the human health and ecological risk assessments.
[b]Number of sampling locations at which the chemical was detected compared with the total number of sampling locations.
[c]If the minimum or maximum detected concentration differed from the respective minimum or maximum averaged concentration, the detected concentration is given in parentheses.
[d]Mean was calculated for the averaged concentrations using the minimum variance unbiased estimation approach for lognormally distributed data (F-230).
[e]Exceeds the maximum detected concentration.

Table 11

Chemicals of Concern in Sediment — Railway Ditch[a]

Chemical	Frequency of Detection[b]	Range of Sample Quantitation Limits (mg/kg)	Range of Averaged (Detected) Concentrations[c] (mg/kg)	Mean Concentration[d] (mg/kg)	Upper 95% Confidence Limit of the Mean (mg/kg)
Organics					
Acetone	3/15	0.013-1.4	0.029-0.20	0.073	0.21[e]
Benzoic acid	4/13	1.8-16	0.12-14 (27)	3.5	16
Bis(2-ethylhexyl) phthalate	6/14	0.36-7.4	0.18-0.49	0.60[e]	0.83[e]
2-Butanone	3/15	0.13-0.77	0.019-0.20	0.024	0.041
alpha-Chlordane[f]	1/15	0.097-4.8	0.11	0.39[e]	1.0[e]
gamma-Chlordane[f]	1/14	0.097-4.8	0.078	0.28[e]	0.67[e]
4,4'-DDD	8/15	0.022-0.55	0.0038 (0.0017)-3.1 (4.9)	0.68	14[e]
4,4'-DDE	10/15	0.022-0.55	0.0029-0.28	0.079	0.31[e]
4,4'-DDT	9/14	0.022-0.55	0.0074-3.9 (10)	1.1	62[e]
1,4-Dichlorobenzene	3/14	0.36-7.4	0.14-0.76	0.64	1.1[e]
1,2-Dichloroethene (total)	3/15	0.006-0.068	0.007-0.45	0.019	0.058
PAHs					
Acenaphthene	3/15	0.106-7.4	0.26-0.67	0.37	0.56
Acenaphthylene	2/15	0.136-7.4	0.42-0.79	0.41	0.61
Benzo(a)-anthracene	13/15	0.40-7.4	0.0097 (0.0062)-0.53 (0.59)	0.27	0.91[e]
Benzo(a)pyrene	12/15	0.0072-7.4	0.0049-0.36	0.25	1.2[e]
Benzo(b)-fluoranthene	12/15	0.0055-7.4	0.039 (0.0082)-0.66 (0.76)	0.39	1.7[e]
Benzo(g,h,i)-perylene	8/15	0.023-7.4	0.020 (0.007)-0.26	0.25	0.83[e]
Benzo(k)-fluoranthene	12/15	0.0053-7.4	0.0094 (0.0033)-0.46 (0.76)	0.25	0.96[e]

Table 11

Chemicals of Concern in Sediment — Railway Ditch[a] (Continued)

Chemical	Frequency of Detection[b]	Range of Sample Quantitation Limits (mg/kg)	Range of Averaged (Detected) Concentrations[c] (mg/kg)	Mean Concentration[d] (mg/kg)	Upper 95% Confidence Limit of the Mean (mg/kg)
PAHs (continued)					
Chrysene	13/15	0.40-7.4	0.036 (0.010)-0.53 (0.58)	0.30	0.63[e]
Dibenzo(a,h)-anthracene	3/15	0.0018-7.4	0.0041-0.090	0.37[e]	6.2[e]
Fluoranthene	3/15	0.40-7.4	0.087 (0.020)-0.94 (1.4)	0.44	0.90
Indeno(1,2,3-c,d)-pyrene	9/15	0.013-7.4	0.028 (0.011)-0.25	0.27[e]	0.94[e]
Phenanthrene	8/15	0.084-7.4	0.044 (0.030)-0.25 (1.4)	0.22	0.41[e]
Pyrene	12/15	0.082-7.4	0.094 (0.019)-0.84 (0.94)	0.38	0.80
Inorganics					
Antimony	3/15	0.0021-0.26	8.5-24 (35)	18	45[e]
Arsenic	14/15	8.2	8.0 (4.8)-800	95.6	341
Boron	8/15	23-264	8.9-75	29	48
Cobalt	13/15	13-53	8.7 (7.2)-57	18	25
Iron	15/15	4[f]	9,340 (8,970)-195,000	35,400	57,400
Lead	15/15	38	13 (10)-621	106	271
Manganese	15/15	1.0[f]	185 (97)-8,430	2,610	6,650
Nickel	14/15	66	18 (15)-79	34	41
Zinc	15/15	23	25-409	113	190

[a]Unless otherwise indicated, the chemical was selected as a chemical of concern for both the human health and ecological risk assessments.
[b]Number of sampling locations at which the chemical was detected compared with the total number of sampling locations.
[c]If the minimum or maximum detected concentration differed from the respective minimum or maximum averaged concentration, the detected concentration is given in parentheses.
[d]Mean was calculated for the averaged concentrations using the minimum variance unbiased estimation approach for lognormally distributed data (F-230).
[e]Exceeds the maximum detected and/or averaged concentration.
[f]Sample quantitation limits were unavailable. The method detection limit is indicated (F-484).

Table 12

Summary of Chemicals of Concern by Medium[a]
LF-5, Pease AFB, NH

Chemical	Soil (Main)	Soil (Drum Excavation Area)	Soil (UST Location)	Groundwater	Surface Water—Flagstone Brook	Surface Water—Railway Ditch	Sediment—Flagstone Brook	Sediment—Railway Ditch
Organics								
Acetone				x				x
Aroclor-1242	x							
Aroclor-1248	x							
Benzene				x				
Benzoic acid								x
Bis(2-ethylhexyl) phthalate	x		x	x				x
2-Butanone								x
n-Butylbenzene				x				
sec-Butylbenzene				x				
alpha-Chlordane		x						x[b]
gamma-Chlordane		x						x[b]
Chlorobenzene				x	x	x		
Chloroethane				x				
4-Chloro-3-methyl phenol				x				
4,4′-DDD	x	x			x	x	x	x
4,4′-DDE	x	x			x		x	x
4,4′-DDT	x	x			x	x	x	x
Dibenzofuran	x	x						
1,2-Dichlorobenzene				x				
1,4-Dichlorobenzene	x			x	x	x		x
Dichlorodifluoromethane				x				
1,1-Dichloroethane				x		x		
1,2-Dichloroethene				x[c]		x[c]		x[d]
Dieldrin	x	x						
Diethyl phthalate				x				

Table 12

Summary of Chemicals of Concern by Medium[a]
LF-5, Pease AFB, NH
(Continued)

Chemical	Soil (Main)	Soil (Drum Excavation Area)	Soil (UST Location)	Groundwater	Surface Water—Flagstone Brook	Surface Water—Railway Ditch	Sediment—Flagstone Brook	Sediment—Railway Ditch
Dimethyl phthalate				x				
Di-n-butyl phthalate	x		x	x				
Ethyl ether				x				
Heptachlor		x						
Isopropyl benzene				x				
Lindane					x			
2-Methylnaphthalene	x	x		x				
Naphthalene	x	x		x				
PAHs								
Acenaphthene	x	x						
Acenaphthylene	x							x
Anthracene	x	x						x
Benzo(a)anthracene	x	x						
Benzo(a)pyrene	x	x	x					x
Benzo(b)fluoranthene	x	x						x
Benzo(g,h,i)perylene	x	x						x
Benzo(k)fluoranthene	x	x						x
Chrysene	x	x	x					x
Dibenzo(a,h)anthracene	x	x						x
Fluoranthene	x	x	x	x				x
Fluorene	x	x						x
Indeno(1,2,3-c,d)pyrene	x	x						
Phenanthrene	x	x						x
Pyrene	x	x	x					x
Pentachlorophenol	x							x

Table 12

Summary of Chemicals of Concern by Medium[a]
LF-5, Pease AFB, NH
(Continued)

Chemical	Soil (Main)	Soil (Drum Excavation Area)	Soil (UST Location)	Groundwater	Surface Water—Flagstone Brook	Surface Water—Railway Ditch	Sediment—Flagstone Brook	Sediment—Railway Ditch
n-Propylbenzene				x				
Tetrachloroethene				x	x			
Toluene		x						
Trichloroethene				x		x		
1,2,4-Trimethylbenzene				x				
Xylenes				x				
Inorganics								
Aluminum					x	x		
Ammonia					x[b]	x[b]		
Antimony							x	x
Arsenic	x		x	x		x		x
Barium			x		x	x		
Boron		x	x	x	x	x	x	x
Cadmium	x		x				x	
Chromium			x					
Cobalt				x				x
Copper	x	x			x	x		
Iron				x	x	x		x
Lead	x	x	x			x	x	x
Manganese	x			x		x		x
Mercury	x	x				x		
Nickel				x		x		x
Selenium				x			x	
Silicon				x				
Silver				x				

Table 12

Summary of Chemicals of Concern by Medium[a]
LF-5, Pease AFB, NH
(Continued)

Chemical	Soil (Main)	Soil (Drum Excavation Area)	Soil (UST Location)	Groundwater	Surface Water—Flagstone Brook	Surface Water—Railway Ditch	Sediment—Flagstone Brook	Sediment—Railway Ditch
Thallium				x		x	x	
Zinc	x				x	x		x

[a]An "x" indicates that the chemical was selected as a chemical of concern for both the human health and ecological risk assessments, unless otherwise indicated.
[b]Selected as a chemical of concern for the ecological risk assessment only.
[c]Cis-isomer.
[d]Data were for "total" isomers (i.e., cis- and trans-).

The potential human health effects associated with exposure to the contaminants of concern were estimated quantitatively through the development of several hypothetical exposure pathways. These pathways were developed to reflect the potential for exposure to hazardous substances based on the present uses, potential future uses, and location of the site.

LF-5 is the largest of the landfills within Zone 1 and is located in the center of the zone. LF-5 currently is not used. The only site being used within Zone 1 is Site 13, the BFSA. It is assumed that future land use within Zone 1 will be restricted to prohibit building construction on the landfills, which includes LF-5. The areas within the zone that are currently or have previously been used for industrial purposes are assumed to have an industrial future use potential. However, areas adjacent to the landfills could be future residential areas, particularly in the northern, eastern, and western portions of the zone.

Two surface water bodies, Flagstone Brook and the Railway Ditch, are associated with LF-5. These surface waters may potentially be affected by site contaminants through groundwater discharge and overland flows. Flagstone Brook and the Railway Ditch have no current uses. It is possible, however, that if residential development were to occur in Zone 1 in the future, these surface waters could be used for recreational activities (e.g., wading).

Groundwater is not currently used on or immediately downgradient of the site. However, it is possible that in the future the groundwater may be used on the base for industrial purposes (i.e., drinking water, showering, process water) or, if residences were to be built within Zone 1, for domestic use. As such, human health risks due to exposure to groundwater at LF-5 were evaluated in the LF-5 RA included in the LF-5 FS (F-494). While future groundwater use is evaluated in the RA, it is most likely that current off-base public water supply sources would be used. Groundwater is currently used for domestic purposes by local off-base residents. An extensive survey of private wells has given no indication that groundwater contaminants associated with LF-5 have affected private wells.

The following is a brief summary of the exposure pathways evaluated. A more thorough description can be found in Subsection 6.3.1 of the RA (Subsection 6.3.1 of the RI). Only source control remedial actions are considered in this ROD. Groundwater remedial actions will be addressed in the Zone 1 FS, scheduled for completion in September 1993.

Only one current exposure pathway was evaluated, based on current land use scenarios. The current on-site maintenance worker was assumed to be exposed to contaminants via: 1) incidental soil ingestion, and 2) dermal contact with soil. In each case, the exposure frequency was assumed to be 250 days/year for a duration of 25 years. For ingestion, rates of 7.8 mg/day for the main landfill, 3.1 mg/day for the drum removal area, and 1.6 mg/day for the staged underground storage tank (UST) area were assumed. The drum removal area and staged UST area are locations on the landfill that were identified as hot spots and were consequently evaluated separately in the RA because of the type and concentrations of contaminants in these areas.

Future use exposure pathways evaluated were as follows:

- <u>Soil</u> — Future maintenance worker (same exposure parameters as current maintenance worker).

- <u>Surface water</u> — There are two potentially exposed populations:

    - Future Zone 1 resident — This scenario assumes exposure via dermal contact (wading) at a rate of 1 hour/event at a frequency of 75 events per year for Flagstone Brook and 25 events/year for the Railway Ditch, all over a period of 30 years.

    - Future Zone 1 recreational user — This scenario assumes the same exposure rate, frequency, and duration as the residential scenario.

- <u>Sediment</u> — Again, both future residential and recreational users are evaluated. In each case, both incidental ingestion and dermal contact were assumed to occur at a rate of 6.25 mg/day (both Flagstone Brook and the Railway Ditch) at frequencies of 75 events/year and 25 events/year for Flagstone Brook and the Railway Ditch, respectively. In each instance, an exposure duration of 30 years was assumed.

Summaries of exposure parameters for each pathway evaluated are presented in Table 13 (i.e., exposure frequency, exposure duration, etc.). For each pathway evaluated, an average

Table 13

Summary of Exposure Parameters
LF-5, Pease AFB, NH

Exposure Route/Receptor	Parameter		Reference
All exposure routes	Averaging time — noncarcinogenic risk	Exposure duration (years) x 365 days/year.	F-171
	Averaging time — carcinogenic risk	70 years x 365 days/year.	F-171
	Body weight	70 kg.	F-202
Groundwater ingestion — adult resident	Ingestion rate	2 liters/day.	F-202
	Exposure frequency	350 days/year.	F-202
	Exposure duration	30 years.	F-202
Noningestion groundwater uses — adult resident	Exposure equivalent	2 liters/day.	F-197
	Other parameters	Same as groundwater ingestion route.	
Incidental soil ingestion — maintenance worker	Ingestion rate	7.8 mg/day (7.8E-06 kg/day) for the main landfill, based on an estimated 1.25 hours of exposure per day and an ingestion rate of 50 mg/8-hour workday. 3.1 mg/day (3.1E-06 kg/day) for the drum removal area, based on an estimated 0.5 hour of exposure per day and an ingestion rate of 50 mg/8-hour workday. 1.6 mg/day (1.6E-06 kg/day) for the staged UST location, based on an estimated 0.25 hours/day and an ingestion rate of 50 mg/8-hour workday.	F-202 (daily ingestion rate)
	Exposure frequency	250 days/year.	F-202
	Exposure duration	25 years.	F-202

Table 13

Summary of Exposure Parameters
LF-5, Pease AFB, NH
(Continued)

Exposure Route/Receptor	Parameter		Reference
Dermal contact with soil — maintenance worker	Surface area	1,000 cm² (one-half of the mean hand and forearm surface area of adult males).	F-133; F-176
	Adherence factor	5E-07 kg/cm².	F-176
	Other parameters	Same as incidental soil ingestion route.	
Dermal contact with surface water — adult resident/recreational user	Surface area	6,300 cm² (based on mean leg and feet surface area of adults).	F-103
	Exposure time	1 hour/event for Flagstone Brook and the Railway Ditch.	Estimated, site-specific
	Exposure frequency	75 events/year for Flagstone Brook (estimated). 25 events/year for the Railway Ditch (estimated).	F-197 (75 events total/year)
	Exposure duration	30 years.	F-202
Incidental sediment ingestion — adult resident/recreational user	Ingestion rate	6.25 mg/day (6.25E-06 kg/day) for Flagstone Brook and the Railway Ditch, based on an estimated 1 hour of exposure per day and a consumption of 100 mg/16 waking hours (based on the daily soil ingestion rate).	F-202 (daily soil ingestion rate)
	Exposure frequency	75 events/year for Flagstone Brook (estimated). 25 events/year for the Railway Ditch (estimated).	F-197 (75 events total/year)
	Exposure duration	30 years.	F-202

Table 13

Summary of Exposure Parameters
LF-5, Pease AFB, NH
(Continued)

Exposure Route/Receptor	Parameter		Reference
Dermal contact with sediment — adult resident/recreational user	Skin surface area	1,000 cm^2.	F-176
	Sediment-to-skin adherence factor	5E-07 kg/cm^2 (assumed to be the same as soil).	F-176
	Other parameters	Same as incidental sediment ingestion exposure route.	

and a reasonable maximum exposure estimate was generated corresponding to exposure to the average and the maximum concentration detected in that particular medium.

Excess lifetime cancer risks were determined for each exposure pathway by multiplying the exposure level with the chemical-specific cancer factor. Cancer potency factors have been developed by EPA from epidemiological or animal studies to reflect a conservative "upper bound" of the risk posed by potentially carcinogenic compounds; i.e., the true risk is unlikely to be greater than the risk predicted. The resulting risk estimates are expressed in scientific notation as a probability (e.g., 1×10^{-6} for 1/1,000,000) and indicate (using this example), that an average individual is not likely to have greater than a one-in-one-million chance of developing cancer over 70 years as a result of site-related exposure as defined for the compound at the stated concentration. Current EPA practice considers carcinogenic risks to be additive when assessing exposure to a mixture of hazardous substances.

The hazard index was also calculated for each pathway as EPA's measure of the potential for noncarcinogenic health effects. A hazard quotient is calculated by dividing the exposure level by the reference dose (RfD) or other suitable benchmark for noncarcinogenic health effects for an individual compound. Reference doses have been developed by EPA to protect sensitive individuals over the course of a lifetime and they reflect a daily exposure level that is likely to be without an appreciable risk of an adverse health effect. RfDs are derived from epidemiological or animal studies and incorporate uncertainty factors to help ensure that adverse health effects will not occur. The hazard quotient is often expressed as a single value (e.g., 0.3) indicating the ratio of the stated exposure as defined to the reference dose value (in this example, the exposure as characterized is approximately one-third of an acceptable exposure level for the given compound). The hazard quotient is only considered additive for compounds that have the same or similar toxic endpoint and the sum is referred to as the hazard index (HI). (For example, the hazard quotient for a compound known to produce liver damage should not be added to a second whose toxic endpoint is kidney damage.)

Calculated risks for each individual chemical of concern for each exposure pathway evaluated are presented in Appendix L.7 of the RA. A summary of additive chemical risks for each pathway evaluated is presented in Table 14 of this ROD. The conclusions of the human health risk assessment are summarized in the paragraphs that follow.

For the main landfill soils, the cancer risks ranged from 1×10^{-5} to 9×10^{-4}. The chemicals contributing most of the risk were PAHs ($>10^{-4}$). Aroclor-1242, Aroclor-1248, dieldrin, and arsenic each posed a risk of $>10^{-6}$. The cancer risks posed by contact with hot spot soils was 5×10^{-7} for the staged UST location and ranged from 1×10^{-3} to 4×10^{-3} for the drum removal area. PAHs contributed most of the risk for the drum removal area ($>10^{-4}$), followed by dieldrin ($>10^{-6}$). There was no apparent risk of noncancer health effects posed by contact with either main landfill or hot spot soils. The hazard indices for soil were below 1 at all exposure concentrations.

Cancer risks based on future groundwater use ranged from 6×10^{-6} to 3×10^{-3} based on filtered samples and 1×10^{-3} to 7×10^{-3} based on unfiltered (total) samples. Arsenic posed the highest risk ($>10^{-4}$). Benzene, bis-(2-ethylhexyl) phthalate (DEHP), 1,4-dichlorobenzene, 1,2-dichloroethane, tetrachloroethene, and trichloroethene each posed greater than a 10^{-6} risk. The total hazard indices ranged from 30 to 100 based on filtered samples, and from 10 to 40 based on unfiltered samples. Arsenic and thallium had hazard indices that exceeded 10; manganese had a hazard index that exceeded 1. Thallium was detected in unfiltered samples only during one sampling round. The presence of thallium could not be confirmed during subsequent sampling rounds.

The cancer risks posed by surface water contact were minimal, ranging from 9×10^{-10} to 5×10^{-8} for Flagstone Brook, and from 1×10^{-9} to 8×10^{-8} for the Railway Ditch. The hazard indices for both surface waters were below the criterion of 1.

The cancer risks posed by contact with sediment in Flagstone Brook were minimal, ranging from 2×10^{-10} to 3×10^{-9}. The cancer risks posed by contact with sediment in the Railway Ditch ranged from 2×10^{-7} to 4×10^{-6}. Arsenic was the only chemical of concern that

Table 14

Summary of Total Lifetime Cancer Risks and Hazard Indices

Medium	RME	Total Lifetime Cancer Risk[a,b]			Total Hazard Index[a,c]		
		Mean	Upper 95 Percent Confidence Limit	Maximum	Mean	Upper 95 Percent Confidence Limit	Maximum
Main soils	Current or future maintenance worker	1E-05	4E-05	9E-04	1E-02	2E-02	2E-01
Hot spot soils — drum removal area	Current or future maintenance worker	1E-03	4E-03	4E-03	2E-01	6E-01	6E-01
Hot spot soils — staged UST location	Current or future maintenance worker	5E-07	NA	NA	7E-03	NA	NA
Groundwater[d]	Future resident	6E-04 (filtered) 1E-03 (total)	1E-03 (filtered) 2E-03 (total)	3E-03 (filtered) 7E-03 (total)	3E+01 (filtered) 1E+01 (total)	4E+01 (filtered) 1E+01 (total)	1E+02 (filtered) 4E+01 (total)
Surface water — Flagstone Brook	Current maintenance worker	9E-10	1E-09	1E-09	9E-06	1E-05	1E-05
	Future resident/-recreational user	4E-08	5E-08	5E-08	4E-04	4E-04	5E-04
Surface water — Railway Ditch	Current maintenance worker	1E-09	2E-09	5E-09	1E-05	2E-05	6E-05
	Future resident/-recreational user	2E-08	3E-08	8E-08	1E-04	2E-04	8E-04
Sediment — Flagstone Brook	Current maintenance worker	2E-10	5E-10	5E-10	2E-04	3E-04	3E-04

Table 14

Summary of Total Lifetime Cancer Risks and Hazard Indices (Continued)

Medium	RME	Total Lifetime Cancer Risk[a,b]			Total Hazard Index[a,c]		
		Mean	Upper 95 Percent Confidence Limit	Maximum	Mean	Upper 95 Percent Confidence Limit	Maximum
	Future resident/-recreational user	1E-09	4E-09	3E-09	2E-03	4E-03	4E-03
Sediment — Railway Ditch	Current maintenance worker	2E-07	5E-07	9E-07	8E-04	2E-03	5E-03
	Future resident/-recreational user	7E-07	2E-06	4E-06	3E-03	1E-02	2E-02

NA = Not applicable.
[a]Values are rounded to one significant number.
[b]Maximum cancer risk at hazardous waste sites are regulated in the range of 1E-06 to 1E-04 (10^{-6} to 10^{-4}). Risks of less than 1E-06 (10^{-6}) are generally not of concern.
[c]A hazard index of one (1E+00) or greater is usually considered the benchmark of potential concern.
[d]"Filtered" and "total" values are based on inorganics data for filtered and unfiltered (total) samples, respectively.

posed greater than a 10^{-6} risk. The hazard indices for sediment from both Flagstone Brook and the Railway Ditch were below the criterion of 1.

B. Ecological Risk Assessment

The objectives of the ecological risk assessment were to identify and estimate the potential ecological impacts associated with the chemicals of concern at LF-5, Pease AFB. The assessment focused on the potential impacts of chemicals of concern found in the soil, surface waters, and sediments to terrestrial and aquatic flora and fauna that inhabit or are potential inhabitants of the site, including Flagstone Brook and the Railway Ditch.

The species evaluated and their relevant exposure pathways are listed as follows:

White-Tailed Deer

- Incidental ingestion of soil.
- Ingestion of vegetation (browse).
- Ingestion of surface water.

Shrew

- Incidental ingestion of soil.
- Ingestion of soil invertebrates (earthworms).

Robin

- Ingestion of soil invertebrates (earthworms).
- Ingestion of surface water.

Earthworm

- Ingestion/absorption of soil.

Aquatic Biota

- Direct contact with surface water.
- Direct contact with sediments.

Terrestrial Plants

- Direct contact with soil.

Although wildlife present at LF-5 may be exposed to chemicals of concern through the dermal absorption and inhalation routes, there is little scientific information available with which to assess these types of exposures; therefore, these routes of exposure were not evaluated in the RA. It was assumed that exposure to terrestrial wildlife primarily occurs when the animals feed in those areas affected by site contamination. For this assessment, avian and mammalian species with the greatest potential for exposure were selected for evaluation of exposure. Species selected were representative of major foraging guilds and trophic levels that are present at LF-5. Although amphibians and reptiles are important components of this ecosystem, sufficient exposure and toxicity data were not available for their evaluation. However, a brief discussion of potential sensitivity of these phylogentic groups to environmental perturbations were included in the uncertainty analysis. An ecological inventory of Pease AFB by the New Hampshire Natural Heritage program did not identify any threatened, endangered, or species of special concern at LF-5.

The aquatic life inhabiting Flagstone Brook and the Railway Ditch was described in Section 3 of the RI. The transport and fate of chemicals migrating from the site via surface water runoff, groundwater discharge, or air transport of dust or vapors may potentially result in the exposure of flora and fauna that inhabit these surface waters. NHDES has adopted many of the AWQC developed by EPA for the protection of 95% of all aquatic life, including fish, aquatic invertebrates, and plants. Comparisons of surface water concentrations with the New Hampshire AWQC for the protection of freshwater aquatic life were used to assess the likelihood of adverse effects to aquatic life. Where AWQC were not available for contaminants of concern, toxicity values were developed from toxicological data in the literature. Where possible, the lowest observed effect level (LOEL) for a species similar to those reported in Flagstone Brook or the Railway Ditch was used.

During the FS, in order to assess potential adverse effects to aquatic life from exposure to sediments, chemicals of concern identified in the sediments of Flagstone Brook and the Railway Ditch were compared with biological effect levels developed by NOAA. The biological effect level used in this assessment was an environmental Effect Range-Low (ER-L) value, which is a concentration that is the lower tenth percentile of a range of sediment concentrations in which biological effects have been observed. Whenever an ER-L was not available for an organic nonpolar chemical, interstitial water concentrations were estimated using the equilibrium partitioning (EP) approach and compared to AWQC or toxicity data.

Since completion of the LF-5 Draft Final FS (F-494), it has been determined via review of RA protocols, review of characterization study results for Pease AFB, RI/FS experience at other sites, and discussions with EPA Region I representatives that ER-Ls are unrealistically conservative. Consequently a revised approach to selecting cleanup goals for organic compounds in sediments was instituted at Pease. Rather than using ER-Ls as cleanup goals for organics in sediments, the EP method was used to calculate sediment cleanup goals. Under this method the cleanup goal for a specific organic compound in sediment would be set at that compound concentration in sediment which would not partition to the pore water at a concentration exceeding an established AWQC or other toxicity value. Cleanup goals established for organic contaminants in sediments, as presented in this ROD, may be revised prior to remediation. Cleanup goals for metals in sediments will continue to be ER-Ls.

In addition to the comparisons just described, a qualitative evaluation of the benthic community sampling results was presented in Subsection 3.5.3 of the RI and will be summarized in the paragraphs that follow.

The distribution and composition of vegetative communities observed at LF-5 were described in Subsection 3.5.1 of the RI. A direct comparison of soil concentrations with available phytotoxicity data was used to qualitatively assess potential adverse effects on vegetation.

There is currently no EPA guidance for quantitatively evaluating potential adverse effects to plants growing in contaminated soils. Based on a visual inspection of plants grown at LF-5, no signs of phytotoxic effects (i.e., necrosis, chlorosis, or stunted growth) were observed. New Hampshire and EPA AWQC provide protection for 95% of all aquatic life, including plants. Therefore, potential toxicity to aquatic plants was not evaluated separately, but was taken into account in the comparison of surface water concentrations to the New Hampshire and EPA AWQC. In the case of rooted or emergent aquatic plants, sufficient toxicity data were not available, and therefore, rooted and emergent aquatic plants were not evaluated in the RA.

The results of the environmental evaluation indicate chemicals of concern identified in the surface soils, surface waters, and sediments at LF-5 may adversely affect selected target species and aquatic life. In general, the chemicals of concern, by medium, that contributed most to the total hazard indices were as follows:

- Soil — Pesticides, benzo(a)pyrene, lead, and zinc.
- Surface waters — Aluminum, copper, iron, lead, zinc, and DDT.
- Sediments — Arsenic, DDT, DDD, DDE, alpha-chlordane, gamma-chlordane, and lead.

Total hazard indices, for target species, based on average and maximum exposure concentrations ranged from 2.76 (deer; hot spot) for average exposure concentrations to 2.86×10^4 (masked shrew; hot spot) for maximum exposure concentrations. The hazard indices for LF-5 surface water evaluations, average and maximum concentrations, ranged from 1.47 (Flagstone Brook; acute criteria) to 2,810 (Railway Ditch; chronic criteria), respectively. The hazard indices calculated for the LF-5 sediment evaluation ranged from 77.4 (Flagstone Brook; average concentration) to 12,800 (Railway Ditch maximum concentration).

Macrobenthos population analyses were also conducted in Flagstone Brook and the Railway Ditch to provide information in support of the ecological risk assessment for LF-5. Results of the community analyses are discussed in the paragraphs that follow. A total of 1,626 benthic macroinvertebrates representing 47 taxa were collected in 20 samples from in and adjacent to Flagstone Brook stations 8031, 821, 819, and 818. Information on taxa and pollution tolerance values were used to calculate biotic indices for each of the taxa encountered.

The one-way analysis of variance (ANOVA) statistical method was performed on the data set to determine whether a significant difference in the total number of organisms and total number of taxa existed between sampling stations. The data show a downstream increase in the total number of taxa while the total number of individuals exhibits no significant increase.

Index values were computed for each sample data set from Flagstone Brook. A general trend was observed in the biotic index for Flagstone Brook. At station 8031, the biotic index of 3.1 is indicative of fair water quality. The next station downstream, station 821, had the highest biotic index value (3.8), which is indicative of poor water quality, while biotic index values at stations 819 (3.2) and 818 (2.7) exhibited an improvement in water quality downstream of LF-5. The lowest biotic index value was observed at station 818, which is indicative of good water quality. This corroborates the diversity, evenness, and community similarity data that indicate a downstream improvement in water quality below LF-5.

For the Railway Ditch, a total of 218 benthic macroinvertebrates representing 22 taxa were collected from three stations (826, 826, and 828). Stations 827 and 828 were located in the Railway Ditch, and station 826 was located as a control point west of Flagstone Brook. Station 826 was located in a stream similar in size and characteristics to the Railway Ditch stations for use as a control or reference station to compare surface water, sediment, and macrobenthos data. The control station (826) had the most taxa (13) and the largest number of individuals (190) of the three stations sampled. Stations located downstream of LF-5 exhibited a decrease in the total number of taxa in comparison to station 826.

Additionally, downstream stations had lower total numbers of individuals in comparison to station 826.

A one-way ANOVA was performed on the quantitative data set to determine whether a significant difference in total number of individuals and total number of taxa existed between each sampling station. The results of this statistical analysis indicated that station 826 (control) had significantly more organisms and taxa than either of the two stations located in the Railway Ditch (827 and 828). There were no statistical differences between the two downstream stations with respect to either the number of organisms or the number of taxa.

Station 826, the control station, had a biotic index value of 3.4, which is indicative of fair to poor water quality, while stations 827 and 828 had index values indicative of good water quality. The two downstream stations had similar biotic index values, diversities, and species composition and are different from the community at station 826.

Actual or threatened releases of hazardous substances from this site, if not addressed by implementing the response action selected in this ROD, may present an imminent and substantial endangerment to public health, welfare, or the environment. However, remediation of LF-5 soils and sediments under the ROD will serve to eliminate LF-5 as a source of contamination, thereby reducing the threat of endangerment. Additionally, Zone 1 groundwater remediation, which is to be addressed in the Zone 1 Draft Final FS (completed in August 1993) will reduce contaminant mobility such that future human health and ecological risks via exposure to groundwater and surface water at and around LF-5 will be reduced to acceptable levels.

VII. DEVELOPMENT AND SCREENING OF ALTERNATIVES

A. Statutory Requirements/Response Objectives

Section 121 of CERCLA establishes several statutory requirements and preferences, including: remedial actions must be protective of human health and the environment; remedial actions, when complete, must comply with all federal and more stringent state environmental standards, requirements, criteria, or limitations, unless a waiver is invoked; the remedial action selected must be cost-effective and utilize permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable; and a preference for remedies in which treatment that permanently and significantly reduces the volume, toxicity, or mobility of the hazardous substances is a principal element over remedies not involving such treatment. Response alternatives were developed to be consistent with these mandates.

Based on preliminary information relating to types of contaminants, environmental media of concern, and potential exposure pathways, RAOs were developed to aid in the development and screening of alternatives. These RAOs were developed to mitigate existing and future potential threats to public health and the environment via source control. These response objectives for sediment were:

- To protect ecological receptors from direct contact with, or ingestion of, sediment containing contaminants in excess of concentrations that may present a health risk (total hazard index greater than 1).
- To protect human receptors from direct contact with, or ingestion of, sediment containing contaminants in excess of concentrations that may present a health risk (total cancer risk greater than 10^{-4} and a total hazard index greater than 1).

Because contaminants in sediment in Flagstone Brook may be originating from upgradient locations, including the North Ramp, remediation of Flagstone Brook sediments will not be addressed in this ROD, but will be addressed in the Zone 1 ROD, as appropriate.

The response objectives for landfill soil and solid wastes were the following:

- To protect humans from direct contact with, or ingestion of, contaminated soils or debris that may present a health risk (total cancer risk greater than 10^{-4} or a total hazard index greater than 1).

- To protect ecological receptors from direct contact with, or ingestion of, soil or debris containing contaminants in excess of concentrations that may present health risks (total hazard index greater than 1).

- To reduce the migration of contaminants from soil or debris into the groundwater, which may inhibit attainment of the groundwater RAOs for Zone 1.

- To reduce the migration of contaminants from soil or debris into surface water, which may inhibit attainment of the surface water RAOs for Zone 1.

The source control response objective for groundwater and surface water was the following:

- To reduce the migration of contaminants from sediments and landfill soil and solid wastes within the LF-5 source area, which may inhibit attainment of the groundwater and surface water remedial objectives for Zone 1.

The remedial response objectives for mitigation of contaminant migration will be addressed in the Zone 1 FS and its subsequent ROD.

B. Technology and Alternative Development and Screening

CERCLA and the National Contingency Plan (NCP) set forth the process by which remedial actions are evaluated and selected. In accordance with these requirements, a range of alternatives was developed for LF-5.

With respect to source control, the RI/FS developed a range of alternatives in which treatment that reduces the toxicity, mobility, or volume (TMV) of the hazardous substances is a principal element. This range included an alternative that removes or destroys hazardous substances to the maximum extent feasible, eliminating or minimizing to the degree possible the need for long-term management. This range also included alternatives that treat the principal threats posed by the site but vary in the degree of treatment employed and the quantities and characteristics of the treatment residuals and untreated waste that must be managed; alternatives that involve little or no treatment but provide protection through engineering or institutional controls; and a no action alternative.

VIII. DESCRIPTION OF ALTERNATIVES

The information presented in the LF-5 Draft Final RI was used to prepare an FS. The FS provides a screening of 13 source control remedial alternatives. Five alternatives passed through the screening process and were retained for detailed evaluation.

This section provides a narrative summary of each alternative evaluated. A detailed tabular assessment of each alternative can be found in Table 5.3-1 of the FS.

A. Source Control Alternatives Analyzed

The source control alternatives analyzed for the site include:

- Alternative SC-1: No Action/Institutional Controls (considered as a baseline requirement by CERCLA).
- Alternative SC-2A: Sediment and Landfill Consolidation, Landfill Capping, and Potential On-site Construction Dewatering, Treatment, and Disposal.
- Alternative SC-3A: Sediment Consolidation, Landfill Capping, and On-site Landfill Waste Dewatering, Treatment, and Disposal.
- Alternative SC-4D: Sediment and Landfill Consolidation, Hot Spot Thermal Treatment On-site, Landfill Capping, and Potential On-site Construction Dewatering, Treatment, and Disposal.
- Alternative SC-5A: Sediment and Landfill Waste On-site RCRA Landfilling and Potential On-site Construction Dewatering, Treatment, and Disposal.

<u>Alternative SC-1 — No Action/Institutional Controls</u>

This alternative was evaluated in detail in the FS to serve as a baseline for comparison with the other remedial alternatives under consideration. Under this alternative, no treatment or containment of disposal areas would occur. This alternative does include fencing and deed restrictions for the property, and also includes a long-term monitoring program. This alternative would not meet the source control remedial objectives for the site.

Estimated time for design and construction: 2 months
Estimated period for operation: 30 years
Estimated capital cost: $174,400
Estimated operation and maintenance cost (net present worth): $2,948,315
Estimated total cost (net present worth): $3,123,000

Alternative SC-2A — Sediment and Landfill Consolidation, Landfill Capping, and On-site Groundwater Treatment and Disposal for Construction Dewatering

This alternative involves excavation and consolidation of: 1) sediments containing contaminants at levels in excess of established treatment goals, and 2) landfill debris and contaminated soils that would otherwise remain in contact with groundwater after landfill capping. During excavation, air emissions would be controlled with synthetic covers, such as geomembranes. Also during construction, the excavation would be dewatered via a system of advancing well points. Extracted groundwater would be treated in an on-site mobile unit to meet site-specific groundwater treatment goals (either risk-based, or based on federal/state groundwater MCLs). These goals will be met via multimedia filtration, ion exchange, and activated carbon adsorption. Treated water would be discharged to the local POTW via existing sewer lines. Therefore, treated water would meet Federal Clean Water Act (CWA, 40 CFR 403) pretreatment standards for discharge to a POTW. In addition, the treated water would meet New Hampshire pretreatment standards, per Env-Ws 900, Part 904.07, as well as requirements imposed by the local POTW. Following consolidation, the landfill would be capped with a composite-barrier-type cap. A security fence and deed restrictions would be used to prevent unauthorized access and future activities that could compromise the composite-barrier cap integrity.

Based on the MODFLOW model, approximately 53,500 yd^3 of saturated landfill material would require consolidation. The total excavated volume is estimated at 145,500 yd^3. Additionally, sampling results suggest that a total sediment volume of 9,600 yd^3 would require consolidation. The additional LF-2/LF-4 debris, which will also be consolidated on LF-5 (see Sections IV and XII), would increase the total excavated volume by approximately 76,320 yd^3. This is an increase of greater than 100% in volume. However, when this volume is partially used to fill the excavation at LF-5, and partially spread over an area of

28 acres on top of LF-5, cap design and final grading are unaffected. Additional volumes from LF-2/LF-4 and additional costs (if any) associated with placement of LF-2/LF-4 soils and debris on LF-5 are discussed in the Proposed Plan for LF-2/LF-4 completed in July 1993.

Risks posed by exposure to contaminated sediments, soils, and debris would be eliminated as soon as the cap is in place. This would also minimize the potential for LF-5 to act as a source of surface water and groundwater contamination by reducing the mobility of contaminants in the landfill materials and sediments. All soil, sediment, and air applicable or relevant and appropriate requirements (ARARs) would be met.

Treatment residuals, including concentrated salt solution and iron sludge, would be disposed of off-site. Spent activated carbon would be transported off-site for regeneration or disposal.

For implementation of Alternative SC-2A, acquisition of approvals from and coordination with the New Hampshire Wetlands Board and NHDES would be required. Quarterly air monitoring and bi-annual groundwater modelling would be required. Per CERCLA guidance, the monitoring is estimated to continue for a period of 30 years (for costing purposes), with the understanding that continued monitoring or other remedial actions subsequent to the 30-year period, are the responsibility of the Air Force. Five-year reviews to assess performance of the containment system would also be needed.

Estimated time for design and construction: 1 year
Estimated time of operation: 30 years
Estimated capital cost: $17,362,700
Estimated operation and maintenance cost (net present worth): $6,629,721
Estimated total cost (net present worth): $23,992,000

Alternative SC-3A — Excavation and Consolidation of Sediments on Landfill, Landfill Capping, and On-site Landfill Waste Dewatering, Treatment, and Disposal

Under Alternative SC-3A, excavation and placement of an estimated 9,600 yd^3 of contaminated sediments and regrading and capping the existing landfill would occur as described for Alternative SC-2A. No landfill excavation would be performed; however, landfill debris would be dewatered. Dewatering would occur such that the post-capping water table would be lowered to a level 2 feet below the debris. This difference would minimize some of the short-term impacts associated with landfill excavation; however, it would require long-term groundwater extraction and possibly treatment in order to keep the waste dewatered. The dewatering strategy is based on water-table elevations predicted by the MODFLOW model. The dewatering system would consist of six extraction wells and a collection trench. The combined groundwater extraction rate for the six wells is expected to average 45 gallons per minute (gpm). The bottom of the collection trench would be set at 80 feet above mean sea level (MSL).

The extracted groundwater would be treated via lime precipitation and carbon adsorption. Flow rates to the treatment system would average 45 gpm, with a maximum anticipated flow rate of 60 gpm. The treatment system would be enclosed to prevent freezing during winter months. Treated effluent would be discharged to the local POTW, as specified for Alternative SC-2A.

Residuals generated from the groundwater treatment system include spent carbon (it is anticipated that two 2,200-pound units would be employed in series), and approximately 11.25 tons per year of hydroxide/carbonate sludge. Treatability studies would be required for verification of these residuals amounts. It is anticipated that the sludge will pass the Toxicity Characteristic Leaching Procedure (TCLP) tests; however, dewatered sludge would have to be analyzed to verify this, in accordance with the Resource Conservation and Recovery Act (RCRA). Sludge would be disposed of off-site in accordance with state and federal regulations. Spent carbon would be regenerated off-site.

Treated water would meet the standards for discharge to the local POTW, as described for Alternative SC-2A. Long-term monitoring of on-site groundwater would continue for an estimated 30 years, as for Alternative SC-2A, with the same provisions for extended monitoring or remedial actions, as necessary. As with Alternative SC-2A, institutional controls such as fencing and deed restrictions, would be necessary. Monitoring of groundwater levels within the landfill would be required to ensure that the dewatering system was maintaining water levels beneath the waste material.

Estimated time for design and construction: 1 year
Estimated period for operation: 30 years
Estimated capital cost: $13,084,000
Estimated operation and maintenance cost (net present worth): $10,916,337
Estimated total cost (net present worth): $24,000,000

<u>**Alternative SC-4D — Sediment and Landfill Consolidation, Hot Spot Thermal Treatment On-site, Landfill Capping, and Potential On-site Construction Dewatering, Treatment, and Disposal**</u>

Under this alternative, excavation and consolidation of sediments and landfill debris predicted to be below the water table would be conducted in the same manner as for Alternative SC-2A. The volumes of sediment and landfill material excavated and consolidated would be 9,600 yd^3 and 53,500 yd^3, respectively. Details on consolidating, regrading, and capping of the existing landfill as well as environmental monitoring and placement of institutional controls would be the same as for Alternative SC-2A. Groundwater collected during construction dewatering would be treated and discharged to the local POTW as with Alternative SC-2A. The same type and amount of treatment residuals would be produced and these would be disposed of off-site as described for Alternative SC-2A. Treatment goals and ARARs are expected to be met as with Alternative SC-2A, and the same long-term monitoring requirements as for Alternative SC-2A are anticipated.

The only significant difference in the activities posed in Alternative SC-4D versus Alternative SC-2A is the thermal treatment of hot spot soils and the placement of treated residuals back into the landfill. The hot spot soils to be treated include several areas in the drum disposal area which, after drum and tank removal operations, were found to contain high concentrations of contaminants of concern, most notably PAHs. Thermal treatment has been proposed for these soils to reduce the overall toxicities and quantities of LF-5 contaminants.

For treatment, the Low Temperature Thermal Treatment system (LT^3®) or its equivalent would be used. As part of the LT^3 process, during soil excavation, field screening would be conducted to determine whether elevated PAH levels remain. Additionally, periodic TCLP analyses of the contaminated soil would be performed to ensure that RCRA LDRs would be met. It is possible that by the time remediation is initiated, the final rule for contaminated soils will become final. In this instance, thermal treatment would be the only LDR compliance necessary. Otherwise, a treatability variance from EPA may be required such that existing LDR treatment standards can be satisfied. Currently, treatment goals are based on current hot spot data and a projected removal efficiency of 95% for the LT^3 system. Treatability studies may be required if a more accurate removal efficiency is required. If LF-5 receives a CAMU designation (see Sections IV, IX, and X), LDRs would not apply to this alternative.

Air monitoring would be required throughout hot spot soils excavation and treatment activities, as would institutional controls for minimization of short-term human health risks posed during excavation. Following treatment, TCLP soil analyses would be conducted on the residuals to ensure that metals have not been concentrated or their solubilities changed such that TCLP criteria are exceeded. If TCLP criteria are exceeded, pozzalonic stabilization of residuals will be performed prior to landfilling in order to reduce contaminant leachability (mobility).

Estimated time for design and construction: 2 years
Estimated period for operation: 30 years
Estimated capital cost: $23,526,400
Estimated operation and maintenance cost (net present worth): $6,605,687
Estimated total cost (net present worth): $30,132,000

<u>**Alternative SC-5A — Sediment and Landfill Waste On-site RCRA Landfilling and Potential On-site Construction Dewatering and Disposal**</u>

In this alternative, all of the landfilled solid waste would be excavated and placed into a secure RCRA Subtitle C landfill on-site. Sediment excavation activities, on-site treatment of groundwater for construction dewatering, and environmental monitoring would be performed as described for Alternative SC-2A.

The facility would be designed to hold, at a minimum, the 251,000 yd^3 of solid waste estimated to be landfilled. In addition, the facility should have the capacity to hold an estimated 70,000 yd^3 of soil from below the existing waste deposits, and an estimated 19,000 yd^3 of thickened sediments, plus an allowance of 17,000 yd^3 for intermediate cover soil. The new landfill would be constructed to RCRA Subtitle C standards. It would have a double-composite bottom liner system, providing for leachate collection and leak detection. A perimeter containment berm, constructed of selected earthen materials, would define the lateral limits of the lined facility. On completion of filling, the landfill would be capped with a multilayered composite final cover system, such as that described for Alternative SC-2A. The maximum elevation of the new landfill would be 140 (±) feet MSL, based on a contained volume of about 390,000 yd^3 (including 150,000 yd^3 of excavated material). This elevation would be approximately 40 feet above the maximum elevation of the present site. To achieve that height, the sides of the landfill would rise at a slope not exceeding 3:1 (horizontal:vertical) to about elevation 130. Above elevation 130, top slopes would be at a minimum of 20:1 (5%). Construction of the RCRA Subtitle C landfill, including dewatering, excavation, stockpiling filling, grading, liner and leachate collection systems, waste placement and compaction, and composite cap construction, would be expected to require approximately 2 years.

Leachate generated from the landfill would be collected in a wet well and would be pumped into an aboveground storage system. Off-site treatment and disposal of leachate will be performed, as required. Eventually the leachate could be processed through a groundwater treatment plant constructed on the base. Leachate generation has been estimated at between 1,400 and 2,100 gallons per day (gpd) based on a preliminary evaluation of the proposed landfill conditions. It has been assumed that the leachate would be treated off-base for the first 5 years of operation and at a plant constructed on the base after that time.

Similar to Alternatives SC-2A and SC-4D, groundwater extracted during construction dewatering would be treated on-site with a mobile treatment plant. In this alternative, the mass of contaminants treated would be greater than for Alternatives SC-2A and SC-4D since more extensive dewatering would be conducted. Ion-exchange salt solution and iron sludge from the mobile treatment plant would be disposed of off-site. Activated carbon used in the groundwater treatment plant (GWTP) would be transported off-site for regeneration. No residuals associated with soil handling and capping activities are expected to be produced. It was assumed that 0.5% of the landfill material would require off-site treatment to comply with ARARs: all other waste materials would be incorporated into the RCRA Subtitle C landfill.

Risks to human and ecological receptors via exposure to the waste materials, sediment, and surface soils would be minimized under this alternative. Containment of waste materials in the lined facility and collection of leachate for off-site treatment would eliminate potential contributions to groundwater that would exist for all other alternatives. This alternative may help achieve groundwater ARARs more quickly than Alternatives SC-1, SC-2A, SC-3A, and SC-4D because of the complete isolation of source contaminants and a reduction in the volume of contaminated groundwater present at the site that would be effected during construction dewatering activities.

As in the previous capping alternatives (SC-2A, SC-3A, and SC-4D), indirect treatment of the landfilled material would occur through natural biotransformation and desorption processes within the landfill. These processes may reduce the toxicity of the waste materials. In contrast to the previous capping alternatives, however, contaminants leached from soil and debris by water infiltrating the cap would be collected and treated off-site, thereby reducing the TMV of contaminated leachate.

Predicted air emissions from the landfill are expected to be less than EPA's proposed action level of 150 mg/year (above which active control of emissions is required), but air monitoring would be conducted to ensure compliance with federal and state requirements for hazardous and toxic air pollutants.

Monitoring of the volume of leachate generated from the bottom collection system of the landfill would evaluate the effectiveness of the inner geomembrane liner. Groundwater quality monitoring around the landfill for conventional leachate parameters would be used to evaluate the entire landfill's containment effectiveness. Periodic sampling and analysis of groundwater around LF-5 for conventional leachate parameters would be conducted as part of the long-term groundwater monitoring program. This program would evaluate the effectiveness of the RCRA cell in containing site contaminants.

Coordination and consultation with NHDES would be required for this alternative. Acceptance by the Waste Management Division would be expected. Coordination and consultation with the New Hampshire Wetlands Board would be expected because of activities in and around wetland areas. It is also expected that consultation with the Water Supply and Pollution Control Division of NHDES would be required concerning the effluent discharge from the GWTP. Consultation and coordination with the Air Resources Division of NHDES may also be required because of potential odor and particulate emissions from the excavation areas and stockpiled waste materials.

Estimated time for design and construction: 2 years
Estimated period for operation: 30 years
Estimated capital cost: $28,813,600
Estimated operation and maintenance cost (net present worth): $11,461,724
Estimated total cost (net present worth): $40,275,000

IX. SUMMARY OF THE COMPARATIVE ANALYSIS OF ALTERNATIVES

Section 121(b)(1) of CERCLA presents several factors that must be considered when assessing alternatives. Building on these specific statutory mandates, the NCP articulates nine evaluation criteria to be used in assessing the individual remedial alternatives.

A detailed analysis was performed on the alternatives using the nine evaluation criteria in order to select a site remedy. The following is a summary of the comparison of each alternative's strengths and weaknesses with respect to the nine evaluation criteria. These criteria are summarized as follows:

Threshold Criteria

The two threshold criteria described must be met in order for the alternatives to be eligible for selection in accordance with the NCP.

1. Overall protection of human health and the environment addresses whether or not a remedy provides adequate protection and describes how risks posed through each pathway are eliminated, reduced, or controlled through treatment, engineering controls, or institutional controls.

2. Compliance with ARARS addresses whether or not a remedy will meet all of the ARARs of other federal and state environmental laws and/or provide grounds for invoking a waiver.

Primary Balancing Criteria

The following five criteria are utilized to compare and evaluate the elements of one alternative to another that meet the threshold criteria.

3. Long-term effectiveness and permanence address the criteria that are utilized to assess alternatives for the long-term effectiveness and permanence they afford, along with the degree of certainty that they will prove successful.

4. Reduction of toxicity, mobility, or volume through treatment addresses the degree to which alternatives employ recycling or treatment that reduces toxicity, mobility, or volume, including how treatment is used to address the principal threats posed by the site.

5. Short-term effectiveness addresses the period of time needed to achieve protection and any adverse impacts on human health and the environment that may be posed during the construction and implementation period, until cleanup goals are achieved.

6. Implementability addresses the technical and administrative feasibility of a remedy, including the availability of materials and services needed to implement a particular option.

7. Cost includes estimated capital and operation and maintenance (O&M) costs, as well as present-worth costs.

Modifying Criteria

The modifying criteria are used on the final evaluation of remedial alternatives generally after public comments on the RI/FS and Proposed Plan are received.

8. State acceptance addresses the state's position and key concerns related to the preferred alternative and other alternatives, and the state's comments on ARARs or the proposed use of waivers.

9. Community acceptance addresses the public's general response to the alternatives described in the Proposed Plan and RI/FS report. Community acceptance of both the original and the revised Proposed Plans for LF-5 was evaluated based on written comments and verbal comments received in public meetings during the public comment period.

Detailed tabular assessments of each alternative according to the threshold and balancing criteria can be found in Tables 5.2-1 through 5.2-6 of the FS.

Following the detailed analysis of each individual alternative, a comparative analysis, focusing on the relative performance of each analysis against the threshold and balancing criteria, was conducted. This comparative analysis can be found in Table 15.

Table 15

Summary of Detailed Alternatives Evaluation[a]
LF-5, Pease AFB, NH

Remedial Alternative	Short-Term Effectiveness Ranking	Long-Term Effectiveness Training	Reduction in TMV Ranking	Implementability Ranking	Protection of Human Health and Environment Ranking	Compliance with ARARs Ranking	Cost Analysis[b] (Sensitivity Analysis)[c] (in $1,000)
SC-1 No Action/Institutional Controls.	AB	C	C	A	C	BC	3,123
SC-2 Sediment and Landfill Consolidation, Landfill Capping, and On-Site Groundwater Treatment and Disposal for Construction Dewatering.	B	B	BC	AB	AB	AB	23,992 (22,687 to 25,779)
SC-3A Sediment Consolidation, Landfill Capping, and On-Site Groundwater Treatment and Disposal to Dewater Landfill Waste.	AB	B	B	AB	AB	AB	24,000 (21,658 to 24,961)
SC-4D Sediment and Landfill Consolidation, Hot Spot Soil Thermal Treatment On-Site, and On-Site Groundwater Treatment and Disposal for Construction Dewatering.	B	B	AB	B	AB	AB	30,132 (29,315 to 34,266)
SC-5A Sediment and Landfill Waste On-Site RCRA Landfilling and Disposal for Construction Dewatering.	B	AB	B	B	A	A	40,275 (36,629 to 47,601)

a. The ranking system is defined as follows:
   A. The alternative meets the intent of the criterion.
   B. The alternative partially meets the intent of the criterion.
   C. The alternative does not meet the intent of the criterion.
   AB. The alternative was ranked between A and B.
   BC. The alternative was ranked between B and C.
b. Estimated costs represent the 30-year present worth cost.
c. The sensitivity analysis costs represent the upper and lower limits of the 50% confidence interval.

The following subsection presents the nine criteria, including the two modifying criteria not discussed in the FS, a brief narrative summary of the alternatives, and the strengths and weaknesses according to the detailed and comparative analysis.

A. Overall Protection of Human Health and the Environment

In the long term, Alternative SC-1 would minimize the exposure of humans and large animals to landfill soil, solid wastes, and surrounding sediment by restricting site access and development. However, site worker and small animal exposure would not be mitigated. In addition, contaminant leaching to groundwater would continue, thereby, allowing human exposure via potential groundwater use as well as through recreational uses of drainage channels to which a portion of groundwater and overland flows discharge. The continued leaching of contaminants would also affect wetlands habitats at LF-5.

Alternatives SC-2A, SC-3A, SC-4D, and SC-5A would achieve overall protection of human and ecological receptors from contaminated soils and sediments. These four alternatives would also contribute to attainment of overall Zone 1 groundwater and surface water objectives. For each of the four alternatives, protection of human and ecological receptors from surface water contaminants is expected over the long term, due to elimination of leachate and contaminated sediments as sources. Alternative SC-5A would further reduce the potential for contaminant migration to groundwater and surface water over that of the other alternatives by encasing all landfill wastes in a RCRA cell. Over the short term, groundwater use restrictions would be necessary to mitigate risks associated with groundwater use in the early stages of remediation.

B. Compliance with ARARs

Complete ARAR compliance would not be attained for Alternative SC-1 due to the lack of remediation planned for that alternative. Of the three types of ARARs (location-specific, action-specific, and contaminant-specific), location-specific ARARs are the only ARARs for which compliance would be attained.

Alternatives SC-2A, SC-3A, SC-4D, and SC-5A would all be expected to achieve compliance with location- and action-specific ARARs. For contaminant-specific ARARs, all four alternatives would meet soil, sediment, and air ARARs.

C. Long-Term Effectiveness and Permanence

The deed restrictions and site access restrictions in Alternative SC-1 would reduce, but would not prevent, human contact with contaminated soils, sediments, surface water, and groundwater. Exposures to ecological receptors would not be mitigated. In addition, no reduction in contaminant TMV would be achieved. Therefore, continued human and ecological receptor exposure is expected over the long term.

For Alternatives SC-2A, SC-3A, SC-4D, and SC-5A, significant risk reduction is achieved by eliminating dermal and ingestion exposure routes (both human and ecological receptors) to contamination in site soils and sediments from LF-2, LF-4, and LF-5. For all four alternatives, it is expected that long-term reliability would be enhanced via periodic inspections, and management and monitoring for a period of 30 years (this time-frame is typically chosen for costing purposes). For Alternative SC-3A, it is assumed that groundwater would require treatment for a period of 30 years to maintain long-term effectiveness.

Additionally, pursuant to the requirements of CERCLA 120(h)(3)(B)(ii), should any additional remedial actions be required (including continued monitoring) either during or subsequent to the 30-year time period, the Air Force will be responsible for implementation of these actions, regardless of when the need arises. This ensured the long-term effectiveness of Alternatives SC-2A, SC-3A, SC-4D, and SC-5A subsequent to the 30-year monitoring and treatment periods described.

There exists a potential for future receptor exposures to site contaminants due to failure of the containment strategy-cap failure for Alternatives SC-2A, SC-3A, SC-4D, and SC-5A. Each source control alternative would contribute to attainment of overall Zone 1 objectives for groundwater and surface water.

D. Reduction of Toxicity, Mobility, or Volume Through Treatment

Alternative SC-1 would not reduce the TMV of contaminants through treatment because the alternative does not provide for treatment.

Each of the remaining alternatives, Alternatives SC-2A, SC-3A, SC-4D, and SC-5A would provide for some degree of reduction in TMV, but would not significantly reduce TMV as a principal element of the remedy. All four alternatives would reduce TMV for groundwater currently in contact with solid waste. This would serve to reduce the mobility of soil contaminants in LF-2, LF-4, and LF-5. In the case of Alternative SC-5A, which provides for on-site RCRA landfilling of contaminated soils and sediments, reduction in the mobility of soil contaminants would be significantly increased over the other three alternatives. For Alternative SC-4D, reduction of the TMV of hot spot soils via thermal treatment (LT^3) would be achieved.

All four alternatives (SC-2A, SC-3A, SC-4D, and SC-5A) involve on-site groundwater treatment, which constitutes irreversible treatment. All four alternatives will produce groundwater treatment residuals (either concentrated ion salt solution, iron sludge and spent carbon, or carbonate and metal hydroxide sludge and spent carbon). In each case, off-site disposal/regeneration is expected. Thermal treatment residuals (Alternative SC-4D) would be tested for TCLP criteria and to determine the percent contaminant destruction achieved prior to placement back in the excavation.

E. Short-Term Effectiveness

Implementation of Alternative SC-1 would not be expected to have significant impacts on the community. In addition, impacts to workers would not be expected, and use of personal protective equipment (PPE) would minimize potential impacts during fence and wall installation and water sampling activities. Minor environmental impacts would be possible during implementation, and would be mitigated via use of erosion control measures. The total time for implementation of Alternative SC-1 is estimated to be 2 months.

Each of the four remaining alternatives (SC-2A, SC-3A, SC-4D, and SC-5A) would result in potential community and worker exposure to emissions generated during remedial activities (landfill excavation — Alternatives SC-2A, SC-4D, SC-5A; thermal treatment — Alternative SC-4D; groundwater treatment — Alternative SC-3A). These impacts would be minimized using engineering controls and site-specific health and safety procedures. Sediment excavation and landfill dewatering during implementation of Alternatives SC-2A, SC-4D, and SC-5D could impact wetlands environments at LF-5. Long-term groundwater extraction during implementation of Alternative SC-3A could result in even greater impacts. Landfill capping could compound the effect by reducing groundwater recharge in the area (Alternatives SC-2A, SC-3A, and SC-4D). Installation of a RCRA landfill (Alternative SC-5A) could further exacerbate the problem. In all cases, wetlands mitigation may be performed as part of remedial activities.

F. Implementability

Alternative SC-1, with its minimal construction activities, is easily constructed and is not hindered by site conditions. Monitoring and maintenance activities would be easily performed. Composite barrier cap construction, as planned for Alternatives SC-2A, SC-3A, and SC-4D, is a proven and well-known technology. Site conditions are not expected to inhibit construction. Composite-barrier caps are considered reliable engineering controls. Cap construction would have to be limited to warmer months, and modeling would be required to better predict the post-capping water table elevation. More comprehensive modelling and pilot-scale treatability studies would likely be required for Alternative SC-3A due to the expected long-term groundwater pumping and on-site treatment planned. Thermal treatment (Alternative SC-4D) is a proven and well-known technology and should not be adversely impacted by site conditions. However, there would be some difficulties associated with materials handling and low throughput rates due to potentially high soil moisture content. Construction of a RCRA landfill (Alternative SC-5A) is a proven and well-known technology. However, site conditions, such as bedrock and water table elevation, actual volume of wastes to be landfilled, and the necessity to import construction fill material could hinder construction. As with Alternatives SC-2A and SC-4D, groundwater treatment for construction dewatering is a well known and reliable technology that is not difficult to implement.

All five alternatives (SC-1, SC-2A, SC-3A, SC-4D, and SC-5A) would potentially require acquisition of permits/approvals for implementation. In addition, all alternatives would require some degree of monitoring and maintenance activities. In each case, the activities are easily performed.

G. Cost

The estimated present worth value of each alternative and the options are as follows:

Alternative		Capital Costs	O&M	Present Worth
SC-1	No action, institutional controls.	$174,000	$2,948,315	$3,123,000
SC-2A	Sediment/landfill consolidation, capping, on-site groundwater treatment and disposal for dewatering.	$17,362,700	$6,629,721	$23,992,000
SC-3A	Sediment consolidation, landfill capping, on-site groundwater treatment and disposal to lower water table below solid waste.	$13,084,000	$10,916,337	$24,000,000
SC-4D	Sediment/landfill consolidation, hot spot thermal treatment, landfill capping, on-site groundwater treatment and disposal for construction dewatering.	$23,526,400	$6,605,687	$30,132,000

Alternative		Capital Costs	O&M	Present Worth
SC-5D	Sediment/landfill waste on-site RCRA landfilling, on-site groundwater treatment and disposal for construction.	$28,813,600	$11,461,724	$40,275,000

H. State Acceptance

NHDES has been involved in the environmental activities at Pease AFB since the mid-1980s, as summarized in Section II of this document. The RI was performed as an Air Force lead, with state and EPA oversight, in accordance with the FFA. NHDES has reviewed this document and concurs with the selected remedy. A copy of the Declaration of Concurrence is attached as Appendix B.

I. Community Acceptance

The comments received during the public comment periods and the public hearings on both the original and revised LF-5 Proposed Plans are summarized in the attached document entitled "The Responsiveness Summary" (Appendix C). The selected remedy has been modified from that presented in the original Proposed Plan based on public comment, as described in Section X.

X. THE SELECTED REMEDY

The selected remedy is comprehensive in that it provides for source control and reduction of exposure to site contaminants via containment, and it also contributes to attainment of overall Zone 1 objectives (to be presented at a later date in the Zone 1 FS) of migration control for surface water and groundwater.

The selected remedy, Alternative SC-2A, involves excavation and consolidation of sediments, which contain levels of contamination in excess of selected cleanup levels, on LF-5. Landfill debris from LF-5 that was predicted to be saturated after capping (as determined via MODFLOW modelling) would also be excavated and consolidated on LF-5. In addition, LF-2 and LF-4 soil and debris would be excavated and consolidated on LF-5 (see Sections IV and XII). However, since LF-2 and LF-4 are part of the Zone 1 operable unit, final decision under the Zone 1 ROD will be required prior to implementation of the proposed excavation and consolidation plan for LF-2 and LF-4. Following consolidation, the landfill would be covered with a composite-barrier type cap to prevent water infiltration. During construction, in order to facilitate excavation, groundwater would be collected and treated in a temporary on-site mobile system. Discharge of treated water to Flagstone Brook was specified in the original Proposed Plan. Based on public comment to the original Proposed Plan, this strategy was revised to specify discharge to the local POTW via the sanitary sewer.

A. Methodology for Cleanup Level Determination

Cleanup levels have been selected for each medium of concern at LF-5. Cleanup levels have been established for chemicals of concern identified in the risk assessment section of the LF-5 Draft Final RI Report and for contaminants detected at levels exceeding ARARs or risk-based concentrations.

The approach used to determine risk-based concentrations is consistent with the approach used to evaluate human health risk in the risk assessment section of the LF-5 Draft Final RI Report (F-500). This approach was originally presented in a protocols document submitted to EPA Region I and NHDES. This document was subsequently amended and a revised version was resubmitted.

Risk-based concentrations were derived for the chemicals of concern in each medium, based on the most reasonable maximally exposed human receptor (current or future) for the medium. The chemicals of concern include those substances that were identified as chemicals of concern in the risk assessment section of the LF-5 Draft Final RI Report (F-500). In addition, risk-based concentrations were derived for a few chemicals that were not selected as chemicals of concern in the RA, but whose maximum reported concentration exceeded one or more ARAR.

Risk-based concentrations were derived for each noncarcinogenic chemical in a medium based on a goal of a hazard index of 1. For each carcinogenic chemical, the concentrations were derived based on a goal of 10^{-6} (1-in-1 million) lifetime cancer risk, with the following exceptions. Some chemicals, although categorized by EPA as carcinogens, are not considered to be carcinogenic through all exposure routes. For example, several metals, including cadmium, chromium (VI), and nickel, are not classified as carcinogens through the oral exposure route. Therefore, in deriving risk-based concentrations for a given medium, if a carcinogenic chemical was not considered to be carcinogenic through the applicable exposure routes, the risk-based concentration for the chemical was based on a hazard index of 1 (i.e., noncarcinogenic risk).

Cleanup levels were selected after comparing maximum contaminant concentrations detected for each contaminant of concern in each medium with appropriate chemical-specific ARARs, human health, and, if applicable, ecological risk-based concentrations.

In general, where ARARs were available and deemed appropriate, the ARARs were selected as cleanup levels. Where ARARs were not available, or if the basis on which the ARAR was established was not consistent with LF-5 exposure scenarios, a risk-based concentration was selected as the cleanup goal. When ARARs were selected as the cleanup goal a human health risk was calculated for the ARAR concentration. Cleanup levels were not established for chemicals detected at maximum concentrations that were lower than appropriate ARARs or risk-based concentrations.

Cleanup levels for the various contaminated media at LF-5 are summarized in the subsections that follow.

B. Groundwater Cleanup Levels/Treatment Goals

The selected remedy for LF-5 does not address groundwater beneath and in the vicinity of LF-5. Contamination in groundwater will be addressed in the Zone 1 FS, Proposed Plan, and ROD. However, the LF-5 source control remedy would be expected to contribute to attainment of the Zone 1 objectives and cleanup goals via removal of contaminant sources and would facilitate the implementation of potential groundwater actions that will be evaluated during the Zone 1 RI/FS process. For the purposes of this ROD, the Zone 1 cleanup levels are to be considered (TBC) guidelines for treatment of groundwater extracted for construction dewatering purposes. Treatment requirements established in the state, federal, and local POTW pretreatment standards will serve as ARARs.

Table 16 presents ARARs, risk-based concentrations, maximum average detected concentrations in groundwater, and selected cleanup levels for contaminants detected in groundwater. The cleanup levels were calculated using the Zone 1 objectives for groundwater.

C. Landfill Soil and Solid Waste Cleanup Levels

Table 17 presents human health and ecological risk-based concentrations, maximum detected concentrations, and selected cleanup levels for contaminants detected in soils in the landfill, including the hot spots. Cleanup levels were established for 22 contaminants in the landfill (excluding hot spot soils) detected at concentrations exceeding either human health or ecological risk-based concentrations. The majority of cleanup goals were

Table 16

Zone 1 Cleanup Goal Selection — Groundwater
LF-5, Pease AFB, NH

Compound	Potential ARARs (µg/L)					Risk-Based Concentration (µg/L)[f]		Maximum Detected Concentration	Cleanup Goal
	MCL[a]	MCLG[b]	NHDPHS[c]	RCRA[d]	Lifetime Health Advisory[e]	Hazard Index	Cancer Risk	Total (µg/L)[g]	(µg/L)
Organics[g]									
Acetone			7.00E+02	4.00E+03		3.65E+03		4.60E+01	NA
Benzene	5.00E+00 •	0.00E+00	5.00E+00				1.47E+00	1.40E+01	5.00E+00
Bis(2-ethylhexyl) phthalate	4.00E+00 •	6.00E+00		3.00E+00			6.08E+00	1.10E+01	6.00E+00
n-Butylbenzene						NTV		2.00E+00	NTVA
sec-Butylbenzene						1.46E-02		3.00E+00	NA
Chlorobenzene	1.00E+02	1.00E+02	1.00E+02	7.00E+02		1.46E+02		8.00E+01	NA
Chloroethane						NTV		3.00E+00	NTVA
4-Chloro-3-methylphenol						NTV		1.00E+01	NTVA
1,2-Dichlorobenzene	6.00E+02	6.00E+02	6.00E+02		6.00E+02	1.01E+03		3.20E+01	NA
1,4-Dichlorobenzene	7.50E+01	7.50E+01	7.50E+01		7.50E+01		1.77E+00	3.80E+01	NA
Dichlorodifluoromethane			1.00E+03	7.00E+03	1.00E+03	1.46E+03		2.30E+01	NA
1,1-Dichloroethane[h]			8.10E+01			1.83E+03		1.50E+01	NA
1,2-Dichloroethane	5.00E+00	0.00E+00	5.00E+00	5.00E+00			4.68E-01	2.20E+00	NA
cis-1,2-Dichloroethene	7.00E+01	7.00E+01	7.00E+01		7.00E+01	3.65E+02		2.20E+01	NA
Diethyl phthalate		5.00E+03 p		3.00E+04		2.92E+04		1.10E+01	NA
Dimethyl phthalate						3.65E+04		1.10E+01	NA
Di-n-butyl phthalate		3.00E+02 p		4.00E+03		3.65E+03		1.10E+01	NA
Ethyl ether						3.65E+03		4.00E+01	NA
Fluoranthene						1.46E+03		1.10E+01	NA
Isopropylbenzene						8.91E+01		2.00E+00	NA
2-Methylnaphthalene						1.24E+01		1.10E+01	NA
Naphthalene			2.00E+01		2.00E+01	1.24E+01		1.10E+01	NA
n-Propylbenzene						NTV		3.00E+00	NTVA
Tetrachloroethene	5.00E+00 •	0.00E+00	5.00E+00	7.00E-01			1.61E+00	5.60E+01	5.00E+00
Trichloroethene	5.00E+00 •	0.00E+00	5.00E+00				3.04E+00	4.60E+01	5.00E+00
1,2,4-Trimethylbenzene						1.98E+01		4.00E+00	NA
Vinyl chloride	2.00E+00 •	0.00E+00	2.00E+00				2.24E-02	8.10E+00	2.00E+00
Xylenes (total)	1.00E+04	1.00E+04	1.00E+04	7.00E+04	1.00E+04	3.01E+03		5.70E+00	NA
Inorganics[g]									
Arsenic	5.00E+01 •		5.00E+01		5.00E+01		4.87E-02	3.53E+02	5.00E+01
Boron			6.20E+02		6.20E+02	3.29E+03		2.69E+02	NA
Cobalt						NTV		1.27E+02	NTVA
Iron						NTV		1.73E+05	NTVA
Lead[h]	1.50E+01 •	0.00E+00	1.50E+01			1.06E+01		6.70E+01	1.50E+01
Manganese						3.65E+03 •		4.78E+03	3.65E+03
Nickel[i]	1.00E+02 •	1.00E+02		7.00E+02	1.00E+02	7.30E+02		4.33E+02	1.00E+02
Selenium	5.00E+01	5.00E+01	5.00E+01			1.83E+02		5.00E+00	NA

Table 16

Zone 1 Cleanup Goal Selection — Groundwater
LF-5, Pease AFB, NH

Compound	Potential ARARs (µg/L)					Risk-Based Concentration (µg/L)[f]		Maximum Detected Concentration	Cleanup Goal
	MCL[a]	MCLG[b]	NHDPHS[c]	RCRA[d]	Lifetime Health Advisory[e]	Hazard Index	Cancer Risk	Total (µg/L)[g]	(µg/L)
Inorganics[#] (continued)									
Silicon						NTV		9.57E+04	NTVA
Silver			5.00E+01	5.00E+01	1.00E+02	1.10E+02		3.00E+01	NA
Thallium	2.00E+00 •	5.00E-01	5.00E-01			2.56E+00		1.00E+01	2.00E+00

(a) MCL = Maximum Contaminant Level, May 1992.
(b) MCLG = Maximum Contaminant Level Goal, May 1992.
(c) NHDPHS = New Hampshire Department of Public Health Services, June 5, 1992.
(d) RCRA = RCRA Corrective Action Levels (40 CFR 264.521 (a) (2)(i-iv) Appendix A)
(e) Lifetime Health Advisory, April 1992.
(f) Unless otherwise indicated, risk-based concentrations are based on a hazard index of one for noncarcinogens and a 10^{-6} cancer risk for carcinogens. Calculations are based on the exposure scenario and assumptions presented in Subsection 2.3 and F-500.
(g) Maximum detected concentrations were taken from the risk assessment section of the LF-5 Draft Final RI Report (F-500).
(h) Although categorized as a carcinogen, in the absence of slope factors the risk-based concentration was based on noncarcinogenic risk.
(i) Although categorized as a carcinogen, the chemical is not considered carcinogenic through the applicable exposure routes.
• = Value used to select cleanup goal.
p = Proposed standard
NTV = A risk-based concentration was not calculated due to the unavailability of the applicable toxicity value.
NTVA = No applicable toxicity value or ARAR.
NA = ARAR or risk-based concentration exceeds maximum detected concentration.
# = Parameter list is based on contaminants in groundwater in vicinity of Landfill 5.

Table 17

Site-Specific Cleanup Goal Selection -- Landfill Soil and Solid Waste LF-5, Pease AFB, NH

Main Soils	Risk-Based Concentration[a] (mg/kg) Hazard Index	Cancer Risk	Ecological Risk-Based Concentrations (mg/kg)[b]	Maximum Detected Concentration (mg/kg)[c]	Cleanup Goal (mg/kg)
Organics					
Aroclor-1242		1.36E+00	1.63E-03 *	5.30E+00	1.63E-03
Aroclor-1248		1.36E+00	1.63E-03 *	3.40E+00	1.63E-03
Bis(2-ethylhexyl)phthalate		7.93E+01	4.00E-01 *	1.10E+00	4.00E-01
4,4'-DDD		4.36E+01	2.76E-01	2.30E-01	NA
4,4'-DDE		3.08E+01	3.40E-02 *	7.10E-01	3.40E-02
4,4'-DDT		3.08E+01	1.30E-03 *	3.40E+00	1.30E-03
Dibenzofuran	1.67E+03		NTV	3.00E+01	NTVA
1,4-Dichlorobenzene		4.63E+01	2.20E+03	1.10E-01	NA
Dieldrin		6.94E-02	1.38E-04 *	2.40E-01	1.38E-04
Di-n-butyl phthalate	3.74E+05		7.34E+02	8.40E-02	NA
2-Methylnaphthalene	1.59E+03		2.17E+01	8.90E+00	NA
Naphthalene	1.59E+03		2.73E+02	3.40E+01	NA
PAHs					
Acenaphthene	1.87E+05		1.94E+02	5.20E+01	NA
Acenaphthylene	1.25E+04		1.26E+03	2.00E-01	NA
Anthracene	9.35E+05		2.96E+03	8.50E+01	NA
Benzo(a)anthracene		7.59E-01 *	2.50E+00	1.30E+02	7.59E-01
Benzo(b)fluoranthene		7.59E-01 *	7.89E+02	1.00E+02	7.59E-01
Benzo(k)fluoranthene		7.59E-01 *	1.01E+03	8.20E+01	7.59E-01
Benzo(g,h,i)perylene	1.25E+04		1.05E+03	1.10E+02	NA
Benzo(a)pyrene		7.59E-01	7.00E-02 *	1.10E+02	7.00E-02
Chrysene		7.59E-01 *	1.48E+03	1.20E+02	7.59E-01
Dibenzo(a,h)anthracene		7.59E-01 *	1.26E+03	2.30E+01	7.59E-01
Fluoranthene	1.25E+05		2.78E+02	2.00E+02	NA
Fluorene	1.25E+05		1.39E+02	6.20E+01	NA
Indeno(1,2,3-cd)pyrene		7.59E-01 *	6.00E+02	8.70E+01	7.59E-01
Phenanthrene	1.25E+04		2.33E+00 *	2.40E+02	2.33E+00
Pyrene	9.35E+04		1.53E+02 *	2.10E+02	1.53E+02
Pentachlorophenol		9.25E+00	6.13E-02 *	9.40E-01	6.13E-02
Inorganics					
Arsenic		2.10E+01	5.08E-01 *	2.86E+01	5.08E-01
Cadmium[d]	1.70E+04		5.18E-02 *	1.19E+01	5.18E-02
Copper	4.85E+05		2.14E+00 *	2.15E+02	2.14E+00
Lead[e]	1.27E+04		6.50E-02 *	1.93E+02	6.50E-02
Manganese	1.31E+06		3.33E+04	1.08E+03	NA
Mercury	3.93E+03		2.00E-02 *	8.10E-01	2.00E-02
Zinc	2.62E+06		8.43E-02 *	2.59E+02	3.43E-02

(a) Unless otherwise indicated, risk-based concentrations are based on a hazard index of one for noncarcinogens and a 10^{-6} cancer risk for carcinogens. Calculations are based on the exposure scenario and assumptions presented in Subsection 2.3 in F-500.
(b) Ecological risk-based concentrations were developed based on the exposure scenarios and assumptions presented in Subsection 2.3 in E-429 (F-500).
(c) Maximum detected concentrations were taken from the risk assessment section of the LF-5 Draft Final RI Report (F-500).
(d) Although categorized as a carcinogen, the chemical is not considered to be carcinogenic through the applicable exposure routes.
(e) Although categorized as a carcinogen, in the absence of slope factors the risk-based concentration was based on noncarcinogenic risk.
NA = Not applicable, risk-based concentrations exceed maximum detected concentration.
NTV = A risk-based concentration was not calculated because of the unavailability of the applicable toxicity value.
NTVA = No applicable toxicity value or ARAR.
* = Value used to select cleanup goal.

Table 17

Site-Specific Cleanup Goal Selection
Landfill Soil and Solid Waste
LF-5, Pease AFB, NH
(Continued)

Hot Spot Soils - Drum Removal Area	Risk-Based Concentration[a] Hazard Index	Risk-Based Concentration[a] Cancer Risk	Ecological Risk-Based Concentrations (mg/kg)[b]	Maximum Detected Concentration (mg/kg)[c]	Cleanup Goal (mg/kg)
Organics					
alpha-Chlordane		8.49E+00	4.00E-01 *	1.70E+00	4.00E-01
gamma-Chlordane		8.49E+00	3.17E-03 *	1.70E+00	3.00E-03
4,4'-DDD		4.60E+01	2.77E-01 *	6.70E-01	2.77E-01
4,4'-DDE		3.25E+01	3.40E-02 *	2.60E-01	3.40E-02
4,4'-DDT		3.25E+01	1.00E-03 *	6.00E+00	1.00E-03
Dibenzofuran	1.70E+03			1.10E+02	NA
Dieldrin		7.07E-02	1.38E-04 *	1.50E+00	1.38E-04
Heptachlor		2.51E-01	9.79E-03 *	1.60E-01	9.79E-03
2-Methylnaphthalene	1.62E+03		2.17E+01 *	4.10E+01	2.17E+01
Naphthalene	1.62E+03 *		2.73E+02	6.40E+01	NA
PAHs					
Acenaphthene	2.18E+05 *		1.94E+02	1.90E+02	NA
Anthracene	1.09E+06 *		5.02E+03	2.20E+02	NA
Benzo(a)anthracene		8.86E-01 *	2.50E+00	8.90E+02	8.86E-01
Benzo(b)fluoranthene		8.86E-01 *	7.88E+02	6.10E+02	8.86E-01
Benzo(k)fluoranthene		8.86E-01 *	1.01E+03	3.00E+02	8.86E-01
Benzo(g,h,i)perylene	1.45E+04 *		1.05E+03	1.20E+02	NA
Benzo(a)pyrene		8.86E-01	7.00E-02 *	7.50E+02	7.00E-02
Chrysene		8.86E-01 *	1.48E+03	9.10E+02	8.86E-01
Dibenzo(a,h)anthracene		8.86E-01 *	1.26E+03	8.80E+01	8.86E-01
Fluoranthene	1.45E+05		2.79E+02 *	1.30E+03	2.79E+02
Fluorene	1.45E+05 *	*	1.39E+02	2.00E+02	NA
Indeno(1,2,3-cd)pyrene		8.86E-01 *	6.00E+02	1.90E+02	8.86E-01
Phenanthrene	1.45E+04		2.33E+00 *	1.20E+03	2.33E+00
Pyrene	1.09E+05		1.53E+02 *	1.40E+03	1.53E+02
Toluene	8.08E+04 *		1.33E+00	8.20E-02	NA
Inorganics					
Boron	2.97E+06		5.99E+00 *	1.89E+01	5.99E+00
Copper	1.22E+06		2.15E+00 *	1.30E+02	2.15E+00
Lead[e]	3.19E+04		6.53E-02 *	5.58E+01	6.53E-02
Mercury	9.89E+03		2.00E-02 *	3.40E-01	2.00E-02

(a) Unless otherwise indicated, risk-based concentrations are based on a hazard index of one for noncarcinogens and a 10^{-6} cancer risk for carcinogens. Calculations are based on the exposure scenario and assumptions presented in Subsection 2.3 in F-500.
(b) Ecological risk-based concentrations were developed based on the exposure scenarios and assumptions presented in Subsection 2.3 in F-500.
(c) Maximum detected concentrations were taken from the risk assessment section of the LF-5 Draft Final RI Report (F-500).
(d) Although categorized as a carcinogen, the chemical is not considered to be carcinogenic through the applicable exposure routes.
(e) Although categorized as a carcinogen, in the absence of slope factors the risk-based concentration was based on noncarcinogenic risk.
NA = Not applicable. risk-based concentrations exceed maximum detected concentration.
* = Value used to select cleanup goal.

Table 17

Site-Specific Cleanup Goal Selection
Landfill Soil and Solid Waste
LF-5, Pease AFB, NH
(Continued)

Hot Spot Soils – Staged UST Location	Risk-Based Concentration[a]		Ecological Risk-Based Concentrations (mg/kg)[b]	Maximum Detected Concentration (mg/kg)[c]	Cleanup Goal (mg/kg)
	Hazard Index	Cancer Risk			
Organics					
Bis(2-ethylhexyl) phthalate		8.12E+01	NC	2.70E-01	NA
Di-n-butyl phthalate	4.01E+05		NC	5.20E-02	NA
PAHs					
Benzo(a)pyrene		9.35E-01	NC	6.60E-02	NA
Chrysene		9.35E-01	NC	4.90E-02	NA
Fluoranthene	1.54E+05		NC	6.00E-02	NA
Pyrene	1.15E+05		NC	8.40E-02	NA
Inorganics					
Arsenic		1.02E+02	NC	3.51E+01	NA
Barium	4.47E+06		NC	8.20E+03	NA
Boron	5.75E+06		NC	4.22E+02	NA
Cadmium[d]	8.30E+04		NC	2.50E+00	NA
Chromium (III)[e]	6.39E+07		NC	5.40E+01	NA
Chromium (VI)[d,f]	3.19E+05		NC	5.40E+01	NA
Lead[g]	6.17E+04		NC	2.14E+02	NA
Zinc	1.28E+07		NC	1.69E+03	NA

(a) Cancer risk is calculated for carcinogens; a hazard index is calculated for noncarcinogens. Calculations are based on the exposure scenario and assumptions presented in Subsection 2.3 in F-500.
(b) Ecological risk-based concentrations were developed based on the exposure scenarios and assumptions presented in Subsection 2.3 in F-500.
(c) Maximum detected concentrations were taken from the risk assessment section of the LF-5 Draft Final RI Report (F-500). The maximum represents the highest analytical result of duplicate samples from one sampling location.
(d) Although categorized as a carcinogen, the chemical is not considered to be carcinogenic through the applicable exposure routes.
(e) Chromium is assumed to be present totally as chromium (III).
(f) Chromium is assumed to be present totally as chromium (VI).
(g) Although categorized as a carcinogen, in the absence of slope factors, the risk-based concentration was based on noncarcinogenic risk.
NA = Not applicable, risk-based concentrations exceed maximum detected concentrations.
* = Value used to select cleanup goal.
NC = As discussed in the risk assessment section of the LF-5 Draft Final RI Report (F-500), ecological risk-based concentrations were not evaluated for the staged UST hot spot.

ecological risk-based concentrations. Ecological risk-based concentrations were developed as described in Subsection 2.3 of the LF-5 FS. Cleanup goals were also established for contaminants in the drum removal area hot spot soils. Again, most of the cleanup goals were ecological risk-based concentrations. Drum removal area hot spot contaminants for which cleanup levels were established include seven pesticides, one SVOC, 10 PAHs, and four metals. Cleanup levels were not established for any contaminants in the staged UST location hot spot.

D. Sediment Cleanup Levels

Table 18 presents human health risk-based concentrations, maximum concentrations detected in sediment, and TBC criteria that were used in determining ecological risks. These TBC criteria are the NOAA biological effects levels (ER-Ls) established by Technical Memorandum NOS OMA 52, March 1990. While NOAA sediment guidelines are not enforceable and, consequently, are not considered ARARs, they appear to be appropriate toxicity benchmark values and were used in deriving ecological risk-based cleanup levels. In all cases, these TBCs were selected as sediment cleanup goals. As a result, cleanup goals were established for five pesticides, seven PAHs, and five metals in the Railway Ditch, and for three pesticides and two metals in Flagstone Brook. As described in Subsection 2.1 of the LF-5 Draft Final FS, remediation of sediment in Flagstone Brook will be an objective of the Zone 1 remedy. It should be noted that DDE, DDD, and DDT were detected in most sediment samples collected at Pease AFB and may be indicative of background levels. Human health risk-based concentrations were typically orders of magnitude greater than the NOAA criteria and were not used to select cleanup goals. As shown in Table 2.4-2 of the FS, there are no human health risks associated with these ecologically based TBC sediment criteria.

Table 18

Zone 1 Cleanup Goal Selection for the Railway Ditch and Flagstone Brook — Sediment LF-5, Pease AFB, NH

Railway Ditch	TBC Criteria[a] (mg/kg)		Risk-Based Concentration[b] (mg/kg) Hazard Index	Risk-Based Concentration[b] (mg/kg) Cancer Risk	Maximum Detected Concentration (mg/kg)[c]	Cleanup Goal (mg/kg)
Organics						
Acetone			3.99E+05		2.00E-01	NA
Benzoic Acid			1.60E+07		2.70E+01	NA
Bis(2-ethylhexyl) phthalate				6.65E+02	4.90E-01	NA
2-Butanone			1.99E+05		2.00E-01	NA
alpha-Chlordane	5.00E-04	•		6.83E-01	1.10E-01	5.00E-04
gamma-Chlordane	5.00E-04	•		6.83E+01	7.80E-02	5.00E-04
4,4'-DDD	2.00E-03	•		3.70E+02	4.90E+00	2.00E-03
4,4'-DDE	2.00E-03	•		2.61E-02	2.80E-01	2.00E-03
4,4'-DDT	1.00E-03	•		2.61E-02	1.00E+01	1.00E-03
1,4-Dichlorobenzene				3.88E+02	7.60E-01	NA
1,2-Dichloroethene (total)[d]			3.99E+04		4.50E-01	NA
PAHs						
Acenaphthene	1.50E-01	•	1.96E+06		6.70E-01	1.50E-01
Acenaphthylene			1.31E+05		7.90E-01	NA
Benzo(a)anthracene	2.30E-01	•		6.64E+00	5.90E-01	2.30E-01
Benzo(b)fluoranthene				6.64E+00	7.60E-01	NA
Benzo(k)fluoranthene				6.64E+00	7.60E-01	NA
Benzo(g,h,i)perylene			1.31E+05		2.60E-01	NA
Benzo(a)pyrene	4.00E-01			6.64E+00	3.60E-01	NA
Chrysene	4.00E-01	•		6.64E+00	5.80E-01	4.00E-01
Dibenzo(a,h)anthracene	6.00E-02	•		6.64E+00	9.00E-02	6.00E-02
Fluoranthene	6.00E-01	•	1.31E+06		1.40E+00	6.00E-01
Indeno(1,2,3-cd)pyrene				6.64E+00	2.50E-01	NA
Phenanthrene	2.25E-01	•	1.31E+05		1.40E+00	2.25E-01
Pyrene	3.50E-01	•	9.81E+05		9.40E-01	3.50E-01
Total PAHs[e]	4.00E+00	•	1.31E+05	6.64E+00	3.89E+00[f]	4.00E+00
Inorganics						
Antimony	2.00E+00	•	6.54E+04		3.50E+01	2.00E+00
Arsenic	3.30E+01	•		2.18E+02	8.00E+02	3.30E+01
Boron			1.47E+07		7.45E+01	NA
Cobalt			NTV		5.74E+01	NTVA
Iron			NTV		1.95E+05	NTVA
Lead[g]	3.50E+01	•	1.58E+05		6.21E+02	3.50E+01
Manganese			1.64E+07		8.43E+03	NA
Nickel[h]	3.00E+01	•	3.27E+06		7.92E+01	3.00E+01
Zinc	1.20E+02	•	3.27E+07		4.09E+02	1.20E+02
Flagstone Brook						
Organics						
4,4'-DDD	2.00E-03	•		1.23E+02	2.10E-01	2.00E-03
4,4'-DDE	2.00E-03	•		1.87E+03	1.20E-01	2.00E-03
4,4'-DDT	1.00E-03	•		1.87E+03	3.50E-02	1.00E-03
Total PAHs[e]	4.00E+00	•	4.36E-04	2.21E+00	1.11E+00[f]	NA
Inorganics						
Antimony	2.00E+00	•	2.18E+04		2.50E+00	2.00E+00
Boron			4.91E+06		5.20E+00	NA
Cadmium[h]	5.00E+00		7.09E+04		1.20E+00	NA
Lead[g]	3.50E+01	•	5.27E+04		6.31E+01	3.50E+01
Selenium			2.73E+05		9.50E-01	NA
Thallium			3.82E+03		1.92E+01	NA

(a) NOAA Biological Effect Levels (ER-L), NOAA Technical Memorandum, NOS OMA 52, March 1990.
(b) Unless otherwise indicated, risk-based concentrations are based on a hazard index of one for noncarcinogens and a 10^{-6} cancer risk for carcinogens. Calculations are based on the exposure scenarios and assumptions presented in Subsection 2.3 in F-500.
(c) Maximum detected concentrations were taken from the risk assessment section of the LF-5 Draft Final RI Report (F-500).
(d) The risk number for 1,2-dichloroethene is based on the RfD of the cis isomer.
(e) Risk numbers for total PAHs are based on the RfD for naphthalene and the slope factor for benzo(a)pyrene.
(f) Maximum detected total PAH concentration is a sum of individual maximum detected PAH concentrations including naphthalene which by itself is not a chemical of concern.
(g) Although categorized as a carcinogen, in the absence of a slope factor, the risk-based concentration was based on noncarcinogenic risk.
(h) Although categorized as a carcinogen the chemical is not considered to be carcinogenic through the applicable exposure routes.
NA – ARAR or risk-based concentration exceeds maximum detected concentration.
NTV – A risk-based concentration was not calculated due to the unavailability of the applicable toxicity value.
NTVA – No applicable toxicity value or ARAR.
• = Value used to select cleanup goal.

E. Surface Water Cleanup Levels

Table 19 presents ecological risk-based ARARs, human health risk-based concentrations, maximum detected concentrations, and cleanup levels for contaminants detected in surface water in the Railway Ditch. The cleanup goals were derived to satisfy the Zone 1 Railway Ditch RAOs. As discussed previously, the LF-5 source control remedy would be expected to contribute to attainment of the Zone 1 objectives and cleanup goals. All cleanup goals were based on New Hampshire surface water standards that are protective of aquatic life. Chronic criteria were used to evaluate ecological risks in the baseline RA and therefore, are selected as the applicable ARARs for Zone 1. Cleanup levels were established for one pesticide, 10 metals in the Railway Ditch, and one pesticide and four metals in Flagstone Brook. Human health risks associated with Zone 1 ARAR concentrations selected as cleanup goals are presented in Table 2.4-7 of the LF-5 Draft Final FS. As shown in the table, cancer risks greater than 10^{-6} exist due to the use of ARARs as cleanup goals for DDT, 1,4-dichlorobenzene, and TCE. The maximum residual cancer risk was for TCE (2.15×10^{-5}). No excess noncancer human health risks would result.

F. Description of Remedial Components

The chosen LF-5 remedy, whose main remedial goal is source control, will involve the following key components:

- Excavation and consolidation of Railway Ditch sediments that contain contaminants at concentrations exceeding site-specific cleanup goals. A mobile laboratory will be on-site to confirm the removal of contaminated material. The excavated material will be dewatered and bulked, if necessary, and consolidated on LF-5.

- Landfill debris that would still be in contact with groundwater after capping will be excavated and consolidated on dry locations on the landfill prior to capping. The excavation will be backfilled with clean fill to a level at least 2 feet above the natural groundwater table after capping and excavated waste will be placed above the clean fill.

Table 19

Zone 1 Cleanup Goal Selection for the Railway Ditch — Surface Water LF−5, Pease AFB, NH

Railway Ditch	ARARs (µg/L) NH[a]	ARARs (µg/L) FAWQC[b]	Risk−Based Concentration (µg/L)[c] Based on Hazard Index	Risk−Based Concentration (µg/L)[c] Based on Cancer Risk	Maximum Detected Concentration (µg/L)	Cleanup Goal (µg/L)
Organics						
Chlorobenzene	5.00E+01		6.12E+04		2.00E+00	NA
4,4'−DDD				1.58E+01	3.10E−01	NA
4,4'−DDT	1.00E−03 *			1.12E+01	1.40E+00	1.00E−03
1,4−Dichlorobenzene	7.63E+02 [d,e]			1.95E+02	2.00E+00	NA
1,1−Dichloroethane[f]			1.05E+06		2.00E+00	NA
cis−1,2−Dichloroethene	1.16E+04 [d,g]	1.16E+04 [d,g]	6.01E+05		2.00E+00	NA
Trichloroethene	2.19E+04 [d]			1.02E+03	9.00E+00	NA
Inorganics						
Aluminum	8.70E+01 *		NC		3.72E+04	8.70E+01
Ammonia	2.20E+03 [h]	2.20E+03 [h]	NC		2.70E−01	NA
Arsenic (V)	4.80E+01 *		NC		8.50E+02	4.80E+01
Barium				NC	9.68E+02	NCA
Boron					3.51E+02	NCA
Cadmium[j]	9.71E−01 [i] *	9.71E−01 [i]	NC		8.70E+00	9.71E−01
Copper	9.98E+00 [i] *	9.98E+00 [i]			2.87E+02	9.98E+00
Iron	1.00E+03 *	1.00E+03	NC		6.58E+05	1.00E+03
Lead	2.47E+00 [i] *	2.47E+00 [i]	NC		2.80E+02	2.50E+00
Manganese					3.15E+04	NCA
Mercury[j]	1.20E−02 *	1.20E−02	NC		5.50E−01	1.20E−02
Nickel	1.33E+02 [i]	1.33E+02 [i]	NC		1.54E+02	1.33E+02
Thallium	4.00E+01 [d] *	4.00E+01 [d]	NC		4.24E+05	4.00E+01
Zinc	8.96E+01 [i] *	8.96E+01 [i]	NC		9.74E+02	9.00E+01

(a) NH = State of New Hampshire Water Quality Criteria for Toxic Substances − Protection of Aquatic Life (freshwater chronic criteria), April 1990.
(b) FAWQC = Federal Ambient Water Quality Criteria for protection of aquatic life (freshwater chronic criteria), EPA, 1991.
(c) Unless otherwise indicated, risk−based concentrations are based on a hazard index of one and a 10^{-6} cancer risk for carcinogens. Calculations are based on scenarios and assumptions presented in Subsection 2.3 in F−500.
(d) Value presented is the Lowest Observed Effect Level (LOEL).
(e) Value is for total dichlorobenzenes.
(f) Although categorized as a carcinogen, in the absence of a slope factor, the risk−based concentration is based on noncarcinogenic risk.
(g) Value is freshwater acute criterion for total dichloroethenes.
(h) Values presented are for a temperature of 14°C and a pH of 7.3 in Railway Ditch.
(i) Chronic criterion based on a measured hardness of 82 mg/L as $CaCO_3$ for Railway Ditch.
(j) Although categorized as a carcinogen, the chemical is not considered to be carcinogenic through the applicable exposure route.
NC = Not calculated. Chemical is not of concern to human health through the surface water pathway.
NCA = Risk−based levels were not calculated and no applicable ARARs are available.
NA = Not applicable. ARARs and/or risk−based concentration exceed maximum detected concentration.
* = Value used to select cleanup goal.

- The LF-5 debris excavation area will be dewatered, as necessary, during the excavation process (i.e., the groundwater table will be artificially lowered rendering the area to be excavated dry). Any groundwater extracted as part of the dewatering process will be treated in an on-site mobile treatment unit to meet site-specific groundwater treatment objectives. Treated groundwater will be discharged to the local POTW via the sanitary sewer.

- Soil and waste materials from LF-2 and LF-4 will be consolidated on LF-5. A final decision under CERCLA for LF-2 and LF-4 will be required prior to implementation of the proposed consolidation plan for LF-2 and LF-4.

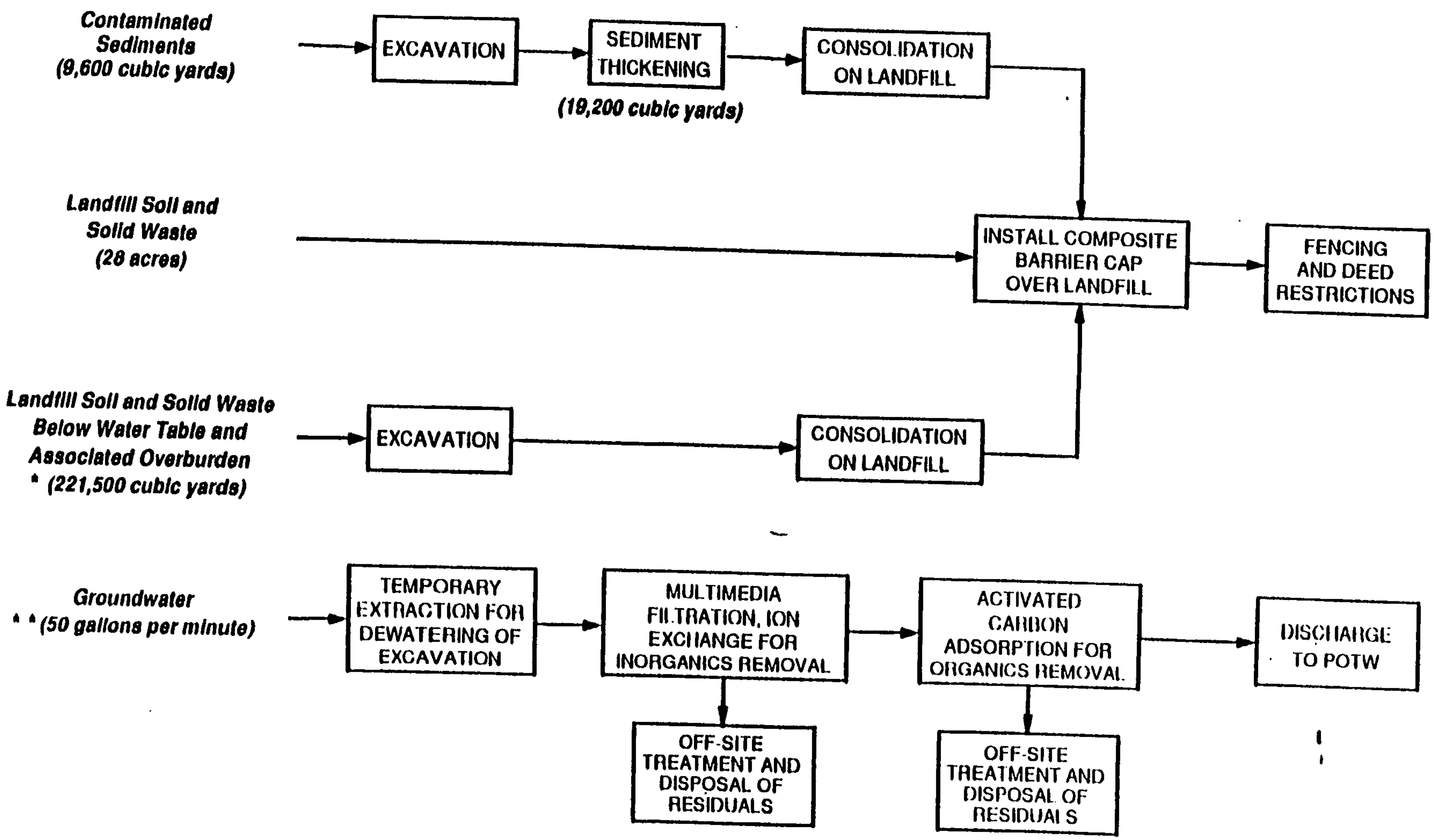
- Following consolidation of all wastes, including material from LF-2 and LF-4, the landfill will be capped with a composite barrier cap, which will meet performance standards required in a RCRA cap. As part of the cap construction, a passive gas collection system will be installed to capture and vent landfill gases. It is estimated the cap will cover the entire landfill, an area of approximately 1.2 million square feet. Deed restrictions will be imposed to restrict future construction activities that could violate the integrity of the cap.

- The remedial action will be monitored to ensure that the integrity of the cap is maintained as well as monitoring groundwater elevation to ensure that the waste material remains dry.

- Five-year reviews would be required as part of the environmental monitoring program. The 5-year reviews would assess the performance of the containment system and make recommendations, as appropriate, regarding additional remedial action.

Figure 9 provides a remedial process flow sheet for the selected remedy that depicts the elements described. Detailed descriptions of the various components follow.

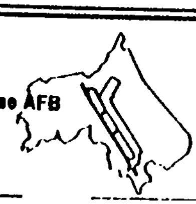
Sediment excavation and consolidation on LF-5 would be performed in a phased approach. Sediments would first be excavated and placed on compacted soils adjacent to the Railway Ditch. These activities will be conducted in accordance with the requirements of Env-Ws 415. During excavation, silt fences, hay bales, and other erosion control measures would be used for control or erosion and runoff. Following excavation, the sediments would be transported to a central staging area for thickening. Thickening would involve mixing the sediments with sandy soil in a 1:1 ratio. The use of heavy equipment and engineering controls, such as containment, during thickening would be facilitated by the installation of



NOTE:

* Includes LF-2 and LF-4 materials

* * Extraction rate could vary if dewatering of LF-2 and LF-4 materials is included in the LF-5 remedial strategy.



Landfill 5(LF-5) Area
Stage 4, Record of Decision
Pease Air Force Base, New Hampshire

FIGURE 9
REMEDIAL PROCESS FLOW SHEET FOR ALTERNATIVE 2A

a concrete pad within the staging area. Following thickening, sediments would be placed on LF-5 for compaction, along with excavated landfill debris, prior to landfill regrading and capping.

As described in Section VII of this ROD, it is anticipated that 3,200 yd^3 of sediments from the Railway Ditch will be excavated and consolidated, according to the method presented previously. In addition, it is currently believed that a total of 6,600 yd^3 of sediments from two site wetlands may require similar remediation. During remedial design, available data (including additional Stage 4 data) will be used to refine this estimate, as well as to determine the potential for and magnitude of harmful environmental effects resulting from wetlands excavation. During remedial design, it will be determined whether excavation in a particular wetland would result in more harm to the ecosystem and greater human health risks than can be justified by the expected contaminant reduction.

Since excavation would result in destruction of portions of the affected wetlands, excavation will be avoided wherever possible. The remedial design also will include wetlands restoration or formation of new wetlands, as necessary.

Currently, restoration of the Railway Ditch following excavation is not anticipated. The ditch will likely be allowed to stabilize and revegetate naturally. The necessity for immediate stabilization and revegetation will be reevaluated, if during remedial design, it becomes apparent that regrading and capping actions at LF-5 would adversely impact the ditch.

This alternative also involves excavation and consolidation of landfill soil and debris predicted to be in contact with groundwater or within 2 feet above the groundwater table as it would exist following capping of LF-5. Available groundwater elevation data were used in conjunction with the MODFLOW model to predict what portion of landfill soils would require excavation under this scenario. All excavated materials would initially be stockpiled within a bermed area atop the landfill. The MODFLOW model estimates the volume of excavated soil and debris at a total of 145,500 yd^3, approximately 92,000 yd^3 of which represents unsaturated materials that are to be returned to the landfill following placement of clean fill to 2 feet above the water table. The remaining 33,500 yd^3 would be consolidated on the landfill. Material from LF-2 and LF-4 will also be consolidated on LF-5 prior to capping. The quantities of this material were estimated to be approximately 76,320 cubic yards from LF-2 and LF-4 combined. Consolidation of this additional material onto LF-5 is not expected to significantly change the cap design criteria originally presented in the FS.

During excavation/consolidation activities, erosion runoff and odor and particulate emissions would be controlled via the use of a temporary runoff detention basin adjacent to the stockpile, and placement of geomembranes on the stockpile and sideslopes of the excavation areas. Continuous on-site air monitoring will also be conducted during excavation.

Construction activities during landfill debris excavation and consolidation may be facilitated via dewatering of the excavation below the static water table. A system of well points would be installed, which would allow groundwater extraction at an average rate of approximately 50 gpm. Following extraction, groundwater would be treated in a mobile on-site unit composed of multimedia filtration, ion exchange, and activated carbon adsorption units. Runoff from the stockpile would also be treated in the mobile unit.

Treated effluent would comply with MCLs and federal, state, and local requirements for discharge to a POTW. As such, treated water will be: 1) discharged to the local POTW via sanitary sewer lines, or 2) used for site dust control (see Figure 9, for a schematic).

Subsequent to consolidation of sediments and landfill materials on LF-5, the landfill would be capped with a composite barrier that would meet RCRA performance standards. The cap would consist of the following (from bottom to top):

- A subbase/gas ventilation layer, consisting of a 12-inch lift of sandy soils placed on a graded and compacted 12-inch layer of intermediate soil overlying the landfill. Decomposition gases would be vented via passive gas vents constructed of perforated and solid-walled plastic pipe. The vents would be installed at 200-foot intervals through the final cover and linked to the sand subbase layer, which would aid in the interception and transmission of gases to the vents. A geotextile would overlie the sand layer and would serve as a bedding layer for the overlying composite barrier.

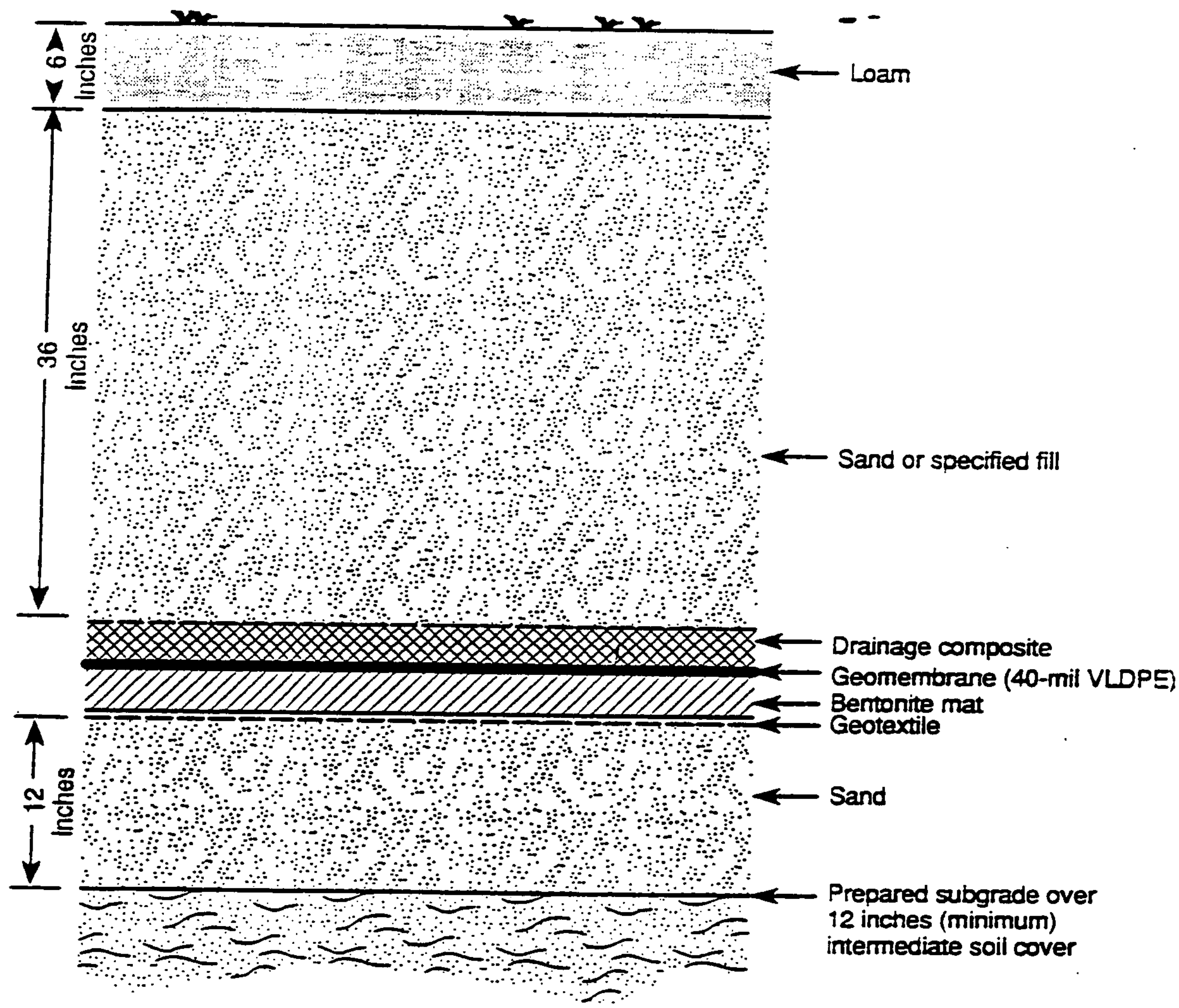
- A composite barrier layer, consisting of a clay mat overlain by a 40-mil, very low density polyethylene (VLDPE) geomembrane. The clay mat would be composed of bentonite clay bonded to a geomembrane or a geotextile.

- A drainage composite layer, composed of a single-layer high-density polyethylene (HDPE) drainage net with a nonwoven needle-punched geotextile. This layer would allow for water percolation, while preventing cover soil intrusion.

- A protective cover layer, comprised of a minimum of 36 inches of drainage sand and 6 inches of mulched, seeded topsoil. This layer would provide protection against erosion and frost penetration.

The drainage composite layer and its underlying geomembrane would be terminated in a perimeter anchor trench. The trench would be fitted with a subdrain of perforated plastic piping embedded in crushed stone. An estimated 18,000 yd^3 of perimeter landfill materials adjacent to the Railway Ditch and Flagstone Brook would be excavated and regraded to allow for appropriate construction of the anchor trench, drainage, access, and setbacks from site waterways. Figure 10 provides a schematic of the final cover system for the barrier cap at LF-5.

The composite-barrier cap system would cover an estimated 28 acres. Final grading prior to capping would result in a minimum slope of 5% on top, and a maximum of 33% sideslope. Figure 11 depicts proposed final grades for the landfill barrier cap. Subsidence of the landfill surface would be monitored annually. Final grading may be contoured to blend with the surrounding topography. This grading will be presented in the remedial design.



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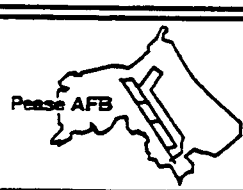

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Landfill 5(LF-5) Area
Stage 4, Record of Decision
Pease Air Force Base, New Hampshire

FIGURE 10
DETAIL OF TYPICAL FINAL COVER SYSTEM
LANDFILL BARRIER CAP

In addition, plans exist for construction of a North Ramp access road, by the PDA, which will traverse a portion of the LF-5 cap. The Air Force has worked and will work with the PDA in coordinating the design and construction activities for the cap and the access road. A figure depicting the planned layout of the access road can be found in the remedial design of Drawing No. 1, sheet 1 of 6, entitled "North Apron Access Road — Conceptual Design," by Hoyle and Tanner Associates.

As with excavation activities, capping may result in destruction of wetlands adjacent to LF-5. (Potentially impacted wetlands are shown in Figure 12.) Mitigation of capped wetlands will involve construction of wetlands in non-wetlands areas. Appropriate wetlands reconstruction plans will be based on a wetlands function and value assessment conducted prior to commencement of construction activities.

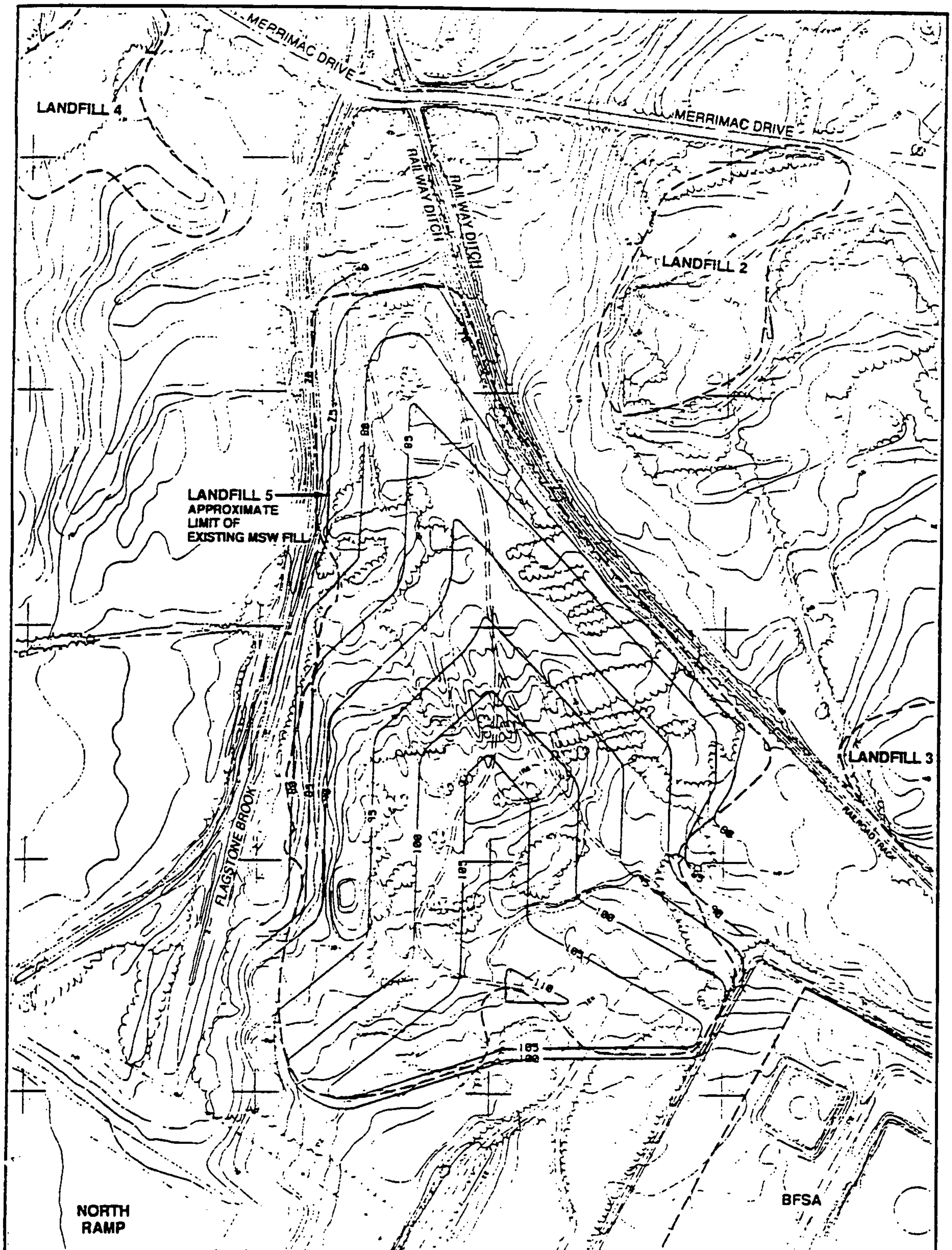
Groundwater will be monitored via sampling and analysis on a semiannual basis for an assumed duration of 30 years. This duration is typically assumed for costing purposes, per CERCLA guidance. As stated in Section IX, any future additional actions found to be necessary, regardless of when, will be conducted by the Air Force. Analysis would likely include VOCs, SVOCs, metals, nitrate, sulfate, chemical oxygen demand (COD), and other selected inorganics. In addition, pesticides and phenols would be monitored bi-annually. It is anticipated that surface water at LF-5 will undergo the same sampling regimen as groundwater, with the addition of biannual PCB analyses. Sediments would be analyzed semiannually for SVOCs and annually for VOCs, pesticides/PCBs, metals, sulfate, nitrate, and other inorganics. Sediments would be tested for phenols biannually. As with groundwater, surface water and sediment monitoring may continue for a period of 30 years. Specifics of the groundwater, surface water, and sediment monitoring programs will be finalized during remedial design.

In addition to monitoring of ambient air at three stations on the landfill (upwind, downwind, central), soil gas monitoring along the LF-5 periphery would be conducted to monitor gas buildup beneath the cap. Approximately eight intermediate soil vents would be installed at locations between passive gas vents. In all cases, samples would be analyzed for methane and VOCs over a period of 30 years, unless annual evaluations of the monitoring program indicate that a change in the program is necessary.

Five-year reviews of the containment system would be required for performance assessment and possible reevaluation and adjustments to the remediation program.

Prior to implementation of Alternative SC-2A, pre-design studies would be required to more accurately determine design parameters. These studies would include:

- Wetlands sampling for more accurate determination of design excavation volumes.
- Additional groundwater modeling to more closely define the depth of the water table following capping.
- Modeling of erosion/runoff from the cap to determine whether restoration of Flagstone Brook or the Railway Ditch (stabilization and revegetation) would be necessary.
- Evaluation of sampling results for LF-2 and LF-4 to determine additional consolidated soil and debris volumes in the event that they are consolidated on LF-5.
- Groundwater treatability studies for determination of mobile treatment unit design parameters.



LEGEND:

— 100 — Proposed final grade - landfill barrier cap (approximate) - FT-MSL - 5 foot interval

– – – Existing limit of MSW fill (approximate)

50 Existing surface contour/elevation (FT MSL) - 2 foot interval

Roads (asphalt/paved)

Other roads and trails

Buildings

Fence (existing)

Marshy areas

Tree line

NOTE:
The grades shown represent covering of the debris and soils from LF-5 and the sediments from Flagstone Brook and the Railway Ditch, only. Additional landfill materials from LF-2 and LF-4 will also be consolidated on LF-5 (total additional volume of approximately 76,000 cubic yards). The deposition of LF-6 (Zone 4) materials is still under consideration. Consolidation on LF-5 is a possibility. A revised figure will be incorporated once final design parameters are etsablish

NORTH

SCALE IN FEET

Pease AFB

Map Area

Landfill 5 (LF-5) Area
Stage 4, Record of Decision
Pease Air Force Base, New Hampshire

FIGURE 11

XI. STATUTORY DETERMINATION

The remedial action selected for implementation at Pease AFB site is consistent with CERCLA and, to the extent practicable, the NCP. The selected remedy is protective of human health and the environment, attains ARARs or invokes appropriate waivers, and is cost-effective. The selected remedy does not satisfy the statutory preference for treatment that permanently and significantly reduces the mobility, toxicity, or volume of hazardous substances as a principal element. Additionally, the selected remedy utilizes alternative treatment technologies and resource recovery technologies to the maximum extent practicable.

A. The Selected Remedy is Protective of Human Health and the Environment

The remedy at this site will permanently reduce the risks posed to human health and the environment by eliminating, reducing, or controlling exposures to human and environmental receptors through treatment, engineering controls, and institutional controls; more specifically:

- Excavation and consolidation of contaminated landfill soils and debris and contaminated sediments on LF-5, thereby eliminating leaching for contaminants to groundwater and reducing receptor exposure via containment.
- Dewatering of landfill soils and debris during construction and treatment of water to reduce toxicity prior to discharge to a local POTW.
- Capping of landfill to prevent water infiltration and reduce volume of leachate produced, and further reducing receptor exposure to contaminants.
- Deed restrictions to prevent future construction that may pose a threat to cap integrity, thereby maintaining contaminant containment.

Moreover, the selected remedy will achieve potential human health risk levels that attain the 10^{-4} to 10^{-6} incremental cancer risk range and a level protective of noncarcinogenic endpoints, and will comply with ARARs and other TBC criteria.

B. The Selected Remedy Attains ARARs

The selected remedy will attain all of the substantive, non-procedural requirements of federal and state ARARs. ARARs for LF-5 are set forth in Table 20 contained in Appendix E of this document, which contains a complete list of ARARs including the regulatory citation, and a brief summary of the requirement, and the action to be taken to attain the requirement.

The ARARs identified for LF-5 include:

<u>Chemical-Specific ARARs</u>

There were no chemical specific ARARs identified for the LF-5 selected remedy.

<u>Location-Specific ARARs</u>

- Fish and Wildlife Coordination Act (FWCA)
- Executive Order 11990 (40 CFR 6, Appendix A), Protection of Wetlands
- Floodplains Executive Order 11888 Minimization Of Flood Impacts And Protection of Beneficial Value of Floodplains
- Clean Water Act, Section 404 (40 CFR 230; 33 CFR 320-330), Prohibition of Wetland Filling
- State of New Hampshire Administrative Code Env-Ws 415 - Rules To Prevent Pollution From Activities In Or Near State Surface Waters
- State of New Hampshire Administrative Code Env-Wt 300, 400, 600 - Criteria And Conditions For Fill And Dredging In Wetlands

<u>Action-Specific ARARs</u>

- RCRA - Releases From solid Waste Management Units
- RCRA - Closure and Post Closure
- RCRA - Preparedness and Prevention
- RCRA - Contingency Plan and Emergency Procedures

- RCRA - Requirements for Tank Systems
- RCRA - Use and Management of Containers
- RCRA - Temporary Storage of Hazardous Soils
- RCRA - Requirements for Equipment Leaks At TSDFs
- RCRA - Design and Operating Requirements for Waste Piles and Landfills
- CWA - Pretreatment Standards for POTW Discharge
- New Hampshire Rules for Identification and Listing of Hazardous Waste
- New Hampshire Standards for Owners and Operators of Hazardous Waste Facilities
- New Hampshire Pretreatment Standards
- New Hampshire Terrain Alteration Requirements
- New Hampshire Ambient Air Limits for Toxic Air Pollutants
- New Hampshire Fugitive Dust Control Requirements

Policies, Guidelines and Criteria To Be Considered

In addition, the following policies, criteria, and guidelines (to be considered, or "TBCs") will be considered during the implementation of the remedial action:

- EPA Risk Reference Doses
- NOAA Technical Memorandum NOS OMA 52
- EPA Carcinogen Assessment Group Potency Factors
- Federal Groundwater Protection Strategy
- RCRA - Proposed Air Pollutant Emission Standards For Owners and Operators of TSDFs
- CAA - Proposed Performance Standards for NMOC Emissions at New and Existing Municipal Solid Waste Landfill

- CERCLA Off-Site Disposal Policy

Table 20 included in Appendix A provides a complete listing of the ARARs and TBCs for Alternative SC-2A, including regulatory citations, requirement synopsis, actions to be taken to attain the requirements, and determinations as to whether the requirements represent ARARs or TBCs.

The following narrative presents a summary of some of the key ARARs and their applicability to the selected remedy.

Federal and State Water Quality Criteria

The preferred option for discharge of treated groundwater collected during construction dewatering is to the base wastewater treatment plant. Under this option, discharge limits would be based on factors regulated by the POTW's NPDES permit, pretreatment regulations, and water pollution control laws, which are discussed under action-specific ARARs. Because final discharge from the POTW would be to Great Bay, federal and New Hampshire Water Quality Criteria are ultimately applicable to this discharge option.

Pretreatment standards are being developed with the City of Portsmouth who is the current operator of the plant. Both the Pretreatment Standards and CWA NPDES will be attained upon successful establishment of pretreatment standards for discharge from the on-site mobile groundwater treatment system.

Federal and State Air Quality Regulations

The technologies proposed in the selected remedy will not create any new sources of air emissions. Therefore, many federal and state regulations governing air quality do not apply to the selected remedy. The only air quality standards that are applicable are particulate standards promulgated under the Clean Air Act and New Hampshire Ambient Air Quality Standards. The particulate standard would apply to remedial construction activities associated with cap installation. These standards would be attained through monitoring and, if necessary, use of dust suppression techniques or engineering controls. Potential emissions from the closed landfill would be in compliance with Performance Standards for Nonmethane Organic Compounds for new and existing municipal landfills as specified under the Clean Air Act.

State Location-Specific Regulations

All of the location-specific ARARs that apply to the selected remedy are based on the close proximity of the site to Flagstone Brook and Railway Ditch. New Hampshire Environmental Regulations provides that removal of soils or other activities conducted adjacent to streams must not cause unreasonable soil erosion, cause unreasonable harm to significant wildlife habitats, unreasonably interfere with natural water flow, lower water quality, or unreasonably cause or increase flooding. Additionally, NHDES regulations provides standards for erosion control and soil excavation. Implementation of the selected remedy would not impact the drainage or natural flow of Flagstone Brook and Railway Ditch. Erosion control measures will be employed during construction to minimize soil/sediment from entering Flagstone Brook or Railway Ditch.

Federal and State Hazardous Waste Regulations

The applicability of RCRA and New Hampshire Hazardous Waste Regulations depends on whether the wastes are RCRA hazardous wastes as defined under these regulations. To date, there is no information available (i.e., manifests) to indicate that RCRA-regulated materials were disposed of at LF-5. However, because toxic constituents are present in the waste materials and groundwater at LF-5 many portions of the federal and state hazardous waste regulations are relevant and appropriate to the selected remedy.

RCRA General Facility Standards, Preparedness and Prevention, and Contingency Plan and Emergency Procedures will be attained during operation of the mobile groundwater treatment system. The facility will be designed, maintained, constructed, and operated to minimize the possibility of an unplanned release that could threaten human health or the environment. During remedial construction, safety and communication equipment will be installed at the site, and local authorities will be familiarized with site operations. Contingency plans will be developed and implemented during site work and treatment system operation. A program will be developed for handling storage, and recordkeeping in accordance with New Hampshire Hazardous Management Rules.

A post closure monitoring program will be developed for LF-5 in accordance with RCRA Releases from Solid Waste Management Units and Closure and Post-Closure regulations.

During treatment of contaminated groundwater collected during construction dewatering, sludges containing some toxic constituents will be produced. A component of groundwater treatment includes laboratory analysis of this sludge, including Toxicity Characteristic Leachate Procedure (TCLP) testing. If the sludge fails TCLP testing, this material will be considered hazardous. As a characteristic hazardous waste, RCRA regulations including Land Disposal Restrictions, will apply and the sludge will be treated and disposed of in a RCRA Subtitle C facility.

Because toxic constituents are present on site, OSHA regulations protecting worker health and safety at hazardous waste sites are applicable to the implementation and long-term operation of the selected remedy. Site workers will have completed training requirements and will have appropriate health and safety equipment on site. Contractors and subcontractors working on site will follow health and safety procedures.

Although LF-5 may take material from LF-2 and LF-4 as subgrade fill, it is not necessary for LF-5 to obtain a permit under the New Hampshire Hazardous Waste Rules or other New Hampshire regulations. Landfills 2, 4, and 5 are all part of a single National Priorities List site, Pease Air Force Base, (55 Federal Register 6154, February 21, 1990), and therefore the activities can be viewed as taking place on site. Moreover, if Landfills 2, 4, and 6 are viewed as separate facilities, CERCLA § 104(d)(4) allows the lead agency broad discretion to treat non-contiguous facilities as one site for the purpose of taking response action, including where the sites, as here, are related based on geography or on the basis of waste treatment compatibility. See 55 Federal Register 8690 (March 8, 1990).

C. The Selected Remedial Action is Cost-Effective

In the judgment of the Air Force, the selected remedy is cost effective (i.e., the remedy affords overall effectiveness proportional to its costs). Once alternatives that were protective of human health and the environment and that either attain, or, as appropriate, waive ARARs were identified, the overall effectiveness of each alternative was evaluated by assessing the relevant three criteria—long-term effectiveness and permanence; reduction in TMV through treatment; and short-term effectiveness. The relationship of the overall effectiveness of these remedial alternatives was determined to be proportional to their costs.

A summary of the costs associated with each of the source control remedies follows. All costs are presented in net present worth costs.

Alternative		Capital Costs	O&M	Present Worth
SC-1	No action, institutional controls.	$174,000	$2,948,315	$3,123,000
SC-2A	Sediment/landfill consolidation, capping, on-site groundwater treatment and disposal for dewatering.	$17,362,700	$6,629,721	$23,992,000
SC-3A	Sediment consolidation, landfill capping, on-site groundwater treatment and disposal to lower water table below solid waste.	$13,084,000	$10,916,337	$24,000,000
SC-4D	Sediment/landfill consolidation, hot spot thermal treatment, landfill capping, on-site groundwater treatment and disposal for construction dewatering.	$23,526,400	$6,605,687	$30,132,000
SC-5D	Sediment/landfill waste on-site RCRA landfilling, on-site groundwater treatment and disposal for construction.	$28,813,600	$11,461,724	$40,275,000

Four of the alternatives are protective and attain ARARs: SC-2A, SC-3A, SC-4D, and SC-5A. Comparing these alternatives, the selected alternative, SC-2A, combines the most cost-effective remedial alternative components that were evaluated. The remedy provides a degree of protectiveness proportional to its costs. Alternative SC-5A is 40% more costly than Alternative SC-2A, without providing a commensurate increase in protectiveness. While Alternative SC-4D considers the EPA preference for a treatment component via thermal treatment of hot spot soils, it is 20% more costly and does not provide an increased degree of protectiveness over Alternative SC-2A, since Alternative SC-2A prevents receptor access to and migration of hot spot contaminants. Alternative SC-3A, like Alternative SC-2A involves the construction of a cap over the landfill and landfill debris dewatering. However, Alternative SC-3A would provide for reduction of contaminant migration via artificial lowering of the water table to a level below in-site debris. In contrast, Alternative SC-2A would reduce migration of contaminants by placing landfill debris on top of the landfill at least 2 feet above the water table. Each would achieve the same degree of protectiveness, but Alternative SC-2A would do so at a slightly lower cost. Additionally, while the costs for Alternative SC-2A and Alternative SC-3A are very nearly the same, it must be remembered that all present worth costs were calculated assuming a 30-year project life. In reality, the pump-and-treat component of SC-3A would have to continue indefinitely to provide long-term effectiveness. In addition, continuous pumping of the aquifer beneath LF-5 could adversely affect wetlands in the area by removing an important source of recharge. Additionally, contaminant migration mitigation is addressed in the Zone 1 Draft FS, which was completed in August 1993. Alternative SC-1 (no-action) does not meet all ARARs and is not sufficiently protective of human health and the environment.

A summary of costs for key elements of the selected source control remedy follows. All costs are net present worth.

Component of Remedy	Present Worth ($)
Landfill excavation/consolidation	$4,334,050
Sediment excavation/consolidation	539,175
Groundwater dewatering system	651,000
Mobile groundwater treatment system	332,610
Composite barrier cap installation	6,215,160
O&M	5,290,669
Miscellaneous	6,629,721
TOTAL	$23,992,000 (rounded)

O&M includes groundwater, surface water, sediment and air monitoring, 5-year SARA review, surveying and subsidence monitoring, replacement costs for fencing and monitor wells, and access restrictions. Miscellaneous includes mobilization and health and safety costs, contingency costs, and additions and modifications to monitoring systems.

D. The Selected Remedy Utilizes Permanent Solutions and Alternative Treatment or Resource Recovery Technologies to the Maximum Extent Practicable

Once those alternatives that attain or, as appropriate, waive ARARs and that are protective of human health and the environment were identified, the Air Force identified which alternative utilizes permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable. This determination was made by deciding which one of the identified alternatives provides the best balance of trade-offs among alternatives in terms of: 1) long-term effectiveness and permanence; 2) reduction of toxicity, mobility, or volume through treatment; 3) short-term effectiveness; 4) implementability; and 5) cost. The balancing test emphasized long-term effectiveness and permanence and the reduction of TMV through treatment; and considered the preference for treatment as a principal element, the bias against off-site land disposal of untreated waste, and community and state acceptance. The selected remedy provides the best balance of trade-offs among the alternatives.

Alternatives SC-3A, SC-4D, and SC-5A all out rank Alternative SC-2A based on emphasis on reduction of TMV through treatment. In addition, both Alternatives SC-3A and SC-4D place greater emphasis on the preference for treatment as a principal element. However, the costs for Alternatives SC-4D and SC-5A exceed those for Alternative SC-2A by 20 and 40%, respectively. As described, implementation of the treatment portion of Alternative SC-3A extends the remedial action beyond the 30-year time frame allotted for costing purposes, and may adversely impact wetlands at LF-5 via dewatering of a wetland recharge area. In addition, implementation of remediation will further address the reduction of TMV and EPA preference for treatment. Alternative SC-1 contains no provision for reduction in TMV or for consideration of the statutory preference for treatment as a component of remediation.

E. The Selected Remedy Does Not Satisfy the Preference for Treatment which Permanently and Significantly Reduces the Toxicity, Mobility, or Volume of the Hazardous Substances as a Principal Element

The principal element of the selected source control remedy is the containment of waste in LF-5. The principal element of the Zone 1 remedial alternative is management of contaminant migration via groundwater and surface waters. Together, these elements address the primary threat at the site, namely, direct contact with contaminants in landfill soil and debris and migration of this contamination to groundwater and surface waters.

Treatment is not the principal element of the selected source control alternative because treatment of landfill debris is not practical or cost-effective given the size and heterogeneity of the landfill contents. The selected source control remedy may, however, involve treatment of groundwater extracted during construction dewatering, which should remove much of the contaminants currently present in groundwater.

XII. DOCUMENTATION OF SIGNIFICANT CHANGES

The LF-5 Draft Final FS (F-494) was completed in August 1992. The original Proposed Plan for LF-5 was completed in January 1993. This Proposed Plan documented the U.S. Air Force's selected remedy for source control at LF-5. During the public comment period (14 January through 13 February 1993) and public hearing (27 January 1993) that followed the public expressed a preference for consolidating as many Pease landfills as possible in one area, so as to minimize the total acreage of land that would be designated as having restricted use. In addition, several other concerns were raised regarding the selected remedy, such as disposal of treated groundwater from construction dewatering in Flagstone Brook.

In response to public input, the U.S Air Force completed a revised Proposed Plan for LF-5 source control, which included as a remedial component, the potential consolidation of LF-2 and LF-4 onto LF-5. This revised Proposed Plan for LF-5 was completed in July 1993 and public comment period for the Revised Proposed Plan was held from 20 July to 19 August 1993. The following paragraphs describe changes to the selected remedy and other minor changes that occurred following issuance of the original Proposed Plan for LF-5.

One modification involves the potential consolidation of materials from two other Zone 1 landfills (LF-2 and LF-4) onto LF-5. The change would result in: 1) an increase in the total volume of landfill soil and debris to be consolidated (an additional 76,320 yd^3), 2) possible changes in the final height and grading of the landfill prior to capping, 3) possible impacts to additional Zone 1 wetlands already expected to be impacted, and 4) increased short-term risks associated with soil inhalation, due to the increased time for and extent of excavation. These changes would be expected to be small in comparison with the entire scope of LF-5 remedial actions and are not expected to significantly alter the cap design criteria presented in the LF-5 FS. These changes would not be expected to adversely impact the overall ranking of Alternative SC-2A as the preferred alternative. Sections VIII, IX, and X provide further detail on the potential impacts of adding LF-2 and LF-4 remediation to the scope of Alternative SC-2A.

Consolidation of LF-2 and LF-4 onto LF-5 is the preferred alternative in part due to public comments on the original Proposed Plan for LF-5. These comments expressed a desire for consolidation of as many landfills as possible in order to retain more land at Pease AFB for unrestricted development. The remedial action was also selected due to its relative ease of implementation, and due to the resulting closure of both LF-2 and LF-4 that would result. Excavation and consolidation of LF-2 and LF-4 onto LF-5 is not evaluated in an FS as is the typical practice. Instead, the Air Force's plans to implement this remedy will be outlined in the Proposed Plan and Record of Decision for Zone 1. A final decision under CERCLA will be required prior to implementation of the proposed excavation and consolidation plan for LF-2 and LF-4.

A second modification involves disposal of treated groundwater from construction dewatering. Based on public comments received on the original Proposed Plan, discharge of treated groundwater extracted during construction dewatering will be to the sanitary sewer rather than Flagstone Brook.

Since issuance of the revised Proposed Plan for Landfill-5, there have been no significant modifications to the LF-5 selected remedy. Public comments and comments from EPA and NHDES pertaining to the specifics of the LF-2/LF-4 remedy are addressed in this ROD.

XIII. STATE ROLE

The NHDES reviewed the various alternatives and has indicated its support for portions of the selected remedy. The state has also reviewed the RI, RA, and FS to determine if the selected remedy is in compliance with applicable or relevant and appropriate state environmental laws and regulations. The NHDES, as a party to the FFA, concurs with the selected remedy for the Pease AFB site. A copy of the declaration of concurrence is attached as Appendix B.

XIV. ACRONYMS/REFERENCES

LIST OF ACRONYMS

AALs	Ambient Air Limits
AFB	Pease Air Force Base
AFCEE/ESB	Air Force Center for Environmental Excellence
ANOVA	analysis of variance
ARARs	Applicable or Relevant and Appropriate Requirements
AWQC	Ambient Water Quality Criteria
BAT	Best Available Technology
BCT	Best Conventional Technology
BFSA	Bulk Fuel Storage Area
BMP	Best Management Practices
CAA	Clean Air Act
CAMU	Corrective Action Management Unit
c-1,2-DCE	cis-1,2-dichloroethylene
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CO	carbon monoxide
COD	chemical oxygen demand
CWA	Clean Water Act
CZMA	Coastal Zone Management Act
DCA	1,1-dichloroethane
DCB	1,4-dichlorobenzene
DCE	1,2-dichloroethylene
DEHP	bis(2-ethylhexyl) phthalate
DOD	Department of Defense
DOT	Department of Transportation
DRE	destruction and removal efficiency
DRED	Department of Resources and Development
EP	equilibrium partitioning
EPA	U.S. Environmental Protection Agency
ER-L	Effect Range-Low
ER-M	Effect Range-Medium
ESA	Endangered Species Act
FFA	Federal Facilities Agreement
FR	Federal Registry
FWCA	Fish and Wildlife Coordination Act
gpd	gallons per day
gpm	gallons per minute
GPR	ground penetrating radar
GWTP	groundwater treatment plant
HCl	hydrochloric acid
HI	hazard index
HMTA	Hazardous Materials Transportation Act
HQ AFBDA	Headquarters Air Force Base Disposal Agency

LIST OF ACRONYMS
(Continued)

IRM	Interim Remedial Measures
IRP	Installation Restoration Program
LDRs	Land Disposal Restrictions
LT^3	Low Temperature Thermal Treatment
MCL	Maximum Contaminant Level
MCLG	Maximum Contaminant Level Goal
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
MSL	mean sea level
NAAQS	National Ambient Air Quality Standards
NCP	National Contingency Plan
NESHAP	National Emission Standards for Hazardous Air Pollution
NHANG	New Hampshire Air National Guard
NHCAR	New Hampshire Code of Administrative Rules
NHDES	New Hampshire State Department of Environmental Services
NHPA	National Historic Preservation Act
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
NSPS	New Source Performance Standards
NSDWS	National Secondary Drinking Water Standards
O&G	oil and grease
O&M	operation and maintenance
OSHA	Occupational Safety and Health Act
PAHs	polynuclear aromatic hydrocarbons
PCBs	polychlorinated biphenyls
PCDA	Paint Can Disposal Area
PCE	tetrachloroethene
PCSs	potential (groundwater) contaminant sources
PDA	Pease Development Authority
POHC	principal organic hazardous constituent
POTW	publicly owned treatment works
PPE	personal protective equipment
RA	Risk Assessment
RAO	remedial action objective
RCRA	Resource Conservation and Recovery Act
RD/RA	Remedial Design/Remedial Action
RfD	reference dose
RI/FS	Remedial Investigation/Feasibility Study
RI	Remedial Investigation
ROD	Record of Decision
RSA	Revised Statute Annotated
SARA	Superfund Amendments and Reauthorization Act
SCOPE	Seacoast Citizens Overseeing Pease Environment

LIST OF ACRONYMS
(Continued)

SDWA	Safe Drinking Water Act
SMCL	Secondary Maximum Contaminant Level
SVOCs	semivolatile organic compounds
TBC	treated as to be considered
TCE	trichloroethylene
TCLP	Toxicity Characteristic Leaching Procedure
TMB	trimethyl benzene
TMV	toxicity, mobility, or volume
TPHs	total petroleum hydrocarbons
TRC	Technical Review Committee
TSCA	Toxic Substances Control Act
TSD	treatment, storage, and disposal (facility)
μg/kg	micrograms per kilogram
μg/L	micrograms per liter
UIC	underground injection control
USC	United States Code
USCA	United States Code Annotated
UST	underground storage tank
VLDPE	very low density polyethylene
VOCs	volatile organic compounds
WHPA	Wellhead Protection Area

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APPENDIX A

ARARS FOR THE LANDFILL 5 SELECTED REMEDY (ALTERNATIVE SC-2A)

Table 20

ARARs for Alternative SC-2A - Sediment and Landfill Consolidation; Landfill Capping; On-Site Groundwater Treatment and Disposal for Construction Dewatering LF-5, Pease AFB, NH

Media	Requirement	Requirement Synopsis	Action To Be Taken To Attain Requirements	Status
	CHEMICAL SPECIFIC			
Groundwater, surface water, sediment, soil	FEDERAL-EPA Risk Reference Doses (RfDs)	RfDs are dose levels developed based on the noncarcinogenic effects and are used to develop hazard indices. A hazard index of less than or equal to 1 is considered acceptable.	EPA RfDs have been used to characterize risks due to exposure to contaminants in groundwater, surface water, sediment, and soils. See Subsection 1.7 and 2.3 (F-494).	TBC
Sediment	FEDERAL-NOAA Technical Memorandum NOS OMA 52	Reference doses for various contaminants in sediments and their potential effects on biota exposed to the contaminants.	Were considered when selecting sediment clean-up levels. See Table 2.4-1 (F-494).	TBC
Sediment, soil	FEDERAL-EPA Carcinogen Assessment Group Potency Factors	Potency factors are developed by the EPA from Health Effects Assessments or evaluation by the Carcinogenic Assessment Group and are used to develop excess cancer risks. A range of 10^{-4} to 10^{-7} is considered acceptable.	EPA Carcinogenic Potency Factors have been used to compute the individual incremental cancer risk resulting from exposure to site contamination. See Subsection 1.7 and 2.3 (F-494).	TBC
	LOCATION SPECIFIC			
Floodplains	Floodplains Executive Order (EO 11888)	Federal Agencies are required to reduce the risk of flood loss, to minimize impact of floods, and to restore and preserve the natural and beneficial value of floodplains.	No floodplain has been identified. Moreover, work to be done under remedial action would not permanently affect any floodplain which may be identified.	Applicable
Wetlands	Wetlands Executive Order (EO 11990)	Under this order, federal agencies are required to minimize the destruction, loss or degradation of wetlands, and beneficial values of wetlands.	The Remedial Action will address impacts to identified wetlands. Remedial activities will minimize harm to the wetlands to the extent possible.	Applicable

Table 20

ARARs for Alternative SC-2A - Sediment and Landfill Consolidation; Landfill Capping; On-Site Groundwater Treatment and Disposal for Construction Dewatering LF-5, Pease AFB, NH (Continued)

Media	Requirement	Requirement Synopsis	Action To Be Taken To Attain Requirements	Status
Wetlands	FEDERAL-CWA 404, Section 404(b)(i) Guidelines for Specification of Disposal Sites for Dredged or Fill Material 40 CFR Part 230	Contains requirements for discharge of dredge or fill material, including that no discharge is permitted if there is a practicable alternative to the proposed discharge which would have a less adverse impact on the aquatic ecosystem, and that no discharge permitted unless appropriate and practicable steps are taken to minimize potential adverse impacts on the aquatic ecosystem.	The range of alternatives evaluated were those which best meet the project purpose of minimizing leaching of contaminants from source area soils into groundwater and surface water. All of the alternatives have similar adverse impacts on the Landfill 5 wetlands. However, the selected alternative had the least adverse impact. Remedial activities will be designed to minimize potential adverse affects on the aquatic ecosystem. Any wetlands adversely affected will be restored or replaced.	Applicable
Soil	FEDERAL-Groundwater Protection Strategy	EPA's strategy for protecting groundwater in the 1990's outlines policy and implementation principles intended to protect the nations groundwater resources.	EPA's general policy for protecting groundwater has been taken into consideration when selecting soil clean-up goals. See Table 2.4-4 and Table 5.2-3 (F-494).	TBC
Wetlands, Rivers	FEDERAL-16 USC 661 et. seq., Fish and Wildlife Coordination Act	Requires Federal agencies to take into consideration the effect that water-related projects will have upon fish and wildlife. Requires consultation with Fish and Wildlife Service and the State to develop measures to prevent, mitigate, or compensate for project-related losses to fish and wildlife.	Relevant federal agencies will be contacted to help analyze impacts of remedial action on fish and wildlife in Flagstone Brook, and in the wetlands in and around Flagstone Brook and the Railway Ditch and to develop measures to prevent, mitigate, and compensate for adverse impacts.	Applicable

Table 20

ARARs for Alternative SC-2A - Sediment and Landfill Consolidation; Landfill Capping; On-Site Groundwater Treatment and Disposal for Construction Dewatering LF-5, Pease AFB, NH (Continued)

Media	Requirement	Requirement Synopsis	Action To Be Taken To Attain Requirements	Status
Wetlands, Rivers	STATE-RSA 485:A-17 NH Admin. Code Env-Ws 415, Rules Relative to Prevention of Pollution from Dredging, Filling, Mining, Transporting, Construction	Establish criteria for conducting any activity in or near state surface waters which significantly alters terrain or may otherwise adversely affect water quality, impede natural runoff or create unnatural runoff. Activities within the scope of these provisions include excavation, dredging, filling, mining and grading of topsoil in or near wetland areas.	Sediment excavation plans and cap installation will meet substantive requirements of these NHDES rules prior to initiation.	Applicable
Wetlands, Rivers	STATE-RSA 482-A, NH Admin. Code Env-Wt 300, 400, 600, New Hampshire Criteria and Conditions for Fill and Dredging in Wetlands	Regulate filling and other activities in or adjacent to wetlands, and establish criteria for the protection of wetlands from adverse impacts on fish, wildlife, commerce and public recreation.	Proposed work in the wetlands in and adjacent to the Site 5 Landfill will be reviewed by the Wetlands Board and will comply with state wetland protection requirements.	Applicable
Groundwater	<u>ACTION SPECIFIC</u> FEDERAL-RCRA 40 CFR Sections 264.90 - 264.101 (Subpart F). Releases from Solid Waste Management Units. Identifies procedures to be followed to ensure that groundwater standards are met.	General facility requirements for groundwater monitoring at affected facilities and general requirements for corrective action programs if required at regulated facilities.	Groundwater monitoring will be conducted in accordance with these requirements. See Appendix F (F-94).	Relevant & Appropriate
	FEDERAL-RCRA 40 CFR Sections 264.110-264.120 (Subpart G) Closure and Post Closure Disposal Units - Requirements for closing the landfill and routine monitoring of the groundwater around the landfill for a period of up to 30 years after closure of the landfill.	Owners or operators of a landfill must develop and submit plans which identify the activities which will be performed to close (i.e., cap) the landfill and the activities which will be conducted during the post closure period.	The landfill will be closed in manner consistent with these regulations.	Relevant & Appropriate

Table 20

ARARs for Alternative SC-2A - Sediment and Landfill Consolidation; Landfill Capping; On-Site Groundwater Treatment and Disposal for Construction Dewatering
LF-5, Pease AFB, NH
(Continued)

Media	Requirement	Requirement Synopsis	Action To Be Taken To Attain Requirements	Status
	FEDERAL-RCRA 40 CFR Part 264.30-37 (Subpart C) Preparedness and Prevention	Identifies requirements which must be met during design, construction, and operation of TSD facilities to minimize possibility of fires, explosions or unplanned releases of waste.	Activities such as on-site recontouring, cap construction and design, construction, and operation of an on-site groundwater treatment system will comply with all portions of this requirement.	Relevant & Appropriate
	FEDERAL-RCRA 40 CFR Part 264.50-264.56 (Subpart D) Contingency Plan and Emergency Procedures	Identifies the requirements which must be addressed in a contingency plan. Each TSD facility must have a contingency plan which identifies all procedures to be followed in the event of fire, explosion or a planned release from a facility.	Construction and operation of an on-site groundwater treatment system will comply with all portions of this requirement.	Relevant & Appropriate
Hazardous Waste	FEDERAL-RCRA 40 CFR Sections 264.190-198 (Subpart J) Requirements for the design, installation and operation of any tanks or tank systems which are used to store or treat hazardous liquids or sludges.	Tanks or tank systems which are to be used to temporarily store hazardous liquids or as part of a treatment system for hazardous liquids or sludges must be designed, installed and operated in accordance with the RCRA standards.	Tanks used in the on-site groundwater treatment system will comply with these regulations.	Applicable
Hazardous Waste	FEDERAL-RCRA 40 CFR 264.170-178 (Subpart I), Use and Management of Containers	Contains requirements for use and management of containers holding hazardous substances.	Any containers which are uncovered by recontouring will meet the requirements of this regulation. Any containers used to store treatment sludges, "hot spot" waste, or treatment filters will also meet these requirements.	Applicable
Soils, Sediments	FEDERAL-RCRA 40 CFR Sections 264.250-264.259 (Subpart L)	General design and operation requirements for temporary storage of hazardous soils. Locations must have an impermeable liner and materials stored in piles must be free of standing liquid.	Waste piles used for temporary storage of excavated landfill debris or sediment that are not located on the existing landfill will comply with these requirements.	Applicable

Table 20

ARARs for Alternative SC-2A - Sediment and Landfill Consolidation; Landfill Capping; On-Site Groundwater Treatment and Disposal for Construction Dewatering LF-5, Pease AFB, NH (Continued)

Media	Requirement	Requirement Synopsis	Action To Be Taken To Attain Requirements	Status
Air	FEDERAL-RCRA 40 CFR Part 264, Appendix BB	Contains air pollutant emission standards for equipment leaks at hazardous waste treatment, storage and disposal facilities (TSDFs). Contains design specifications and requirements for monitoring for leak detection. It is applicable to equipment that contains or contacts hazardous wastes with organic concentrations of at least 10 per cent by weight, and relevant and appropriate if less than 10 percent.	Equipment used in remedial activities will meet the design specifications, and will be monitored for leaks.	Applicable, or relevant and appropriate depending on total organics concentration
Air	FEDERAL-RCRA 40 CFR Part 264, Appendix CC--proposed	Contains proposed air pollutant emission standards for owners and operators of TSDFs using tanks, surface impoundments and containers to manage hazardous wastes. Specific organic emissions controls would have to be installed if volatile organic concentrations equal or are greater than 500 ppmw.	Required emissions controls will be installed.	TBC
Air	FEDERAL-RCRA 40 CFR 264.251(j) (Subparts L) and 40 CFR 264.301(j) (Subpart N)	Contains design and operating requirements for waste piles and landfills.	If waste piles or the landfill contains particulate matter that may be subject to wind dispersal, it will be covered or otherwise managed to control wind dispersal.	Applicable
Air	FEDERAL-Clean Air Act 40 CFR Part 60, (Subpart WWW--proposed), Performance Standards for nonmethane organic compounds (NMOCs) emissions.	Contains proposed performance standard for NMOC emissions from landfill gases at new municipal solid waste landfills. A control device would be used to reduce the NMOC's in the collected gas by 98 weight percent.	The requirements of this proposed regulation will be met for NMOC's at Landfill 5.	TBC

Table 20

ARARs for Alternative SC-2A - Sediment and Landfill Consolidation; Landfill Capping; On-Site Groundwater Treatment and Disposal for Construction Dewatering LF-5, Pease AFB, NH (Continued)

Media	Requirement	Requirement Synopsis	Action To Be Taken To Attain Requirements	Status
Water	FEDERAL-CWA 40 CFR Part 403 EPA Pretreatment Standards	Standards to be followed in establishing pretreatment effluent discharge limits for pollutants which will be discharged to a publicly owned treatment works.	Discharge to wastewater treatment plant will meet the pretreatment requirements of the Clean Water Act.	Applicable
Hazardous Waste	CERCLA Off-Site Disposal Policy - OSWER Directive 9834.11, 11/13/87	This policy requires off-site receiving facility to be in compliance with all permits and with applicable state and federal requirements.	The off-site receiving facility will have to be licensed and in compliance with permits and with applicable state and federal requirements before any material from Landfill 5 is taken off-site.	TBC
Hazardous Waste	STATE-NH Admin. Code Env-Wm 400-404 Identification and Listing of Hazardous Waste	Requirements for the identification and listing of hazardous waste.	Residue from groundwater treatment will be analyzed and identified to determine if it is hazardous prior to any action that involves treatment or disposal.	Applicable
Hazardous Waste	STATE-NH Admin. Code Env 353, 701-705, 707, 708, 709 Standards for Owners and Operators of Hazardous Waste Facilities	General requirements for owners or operators of hazardous waste sites or treatment facilities, including closure of hazardous waste facilities.	All remedial activities will comply with the substantive provision of state hazardous waste regulations. If any state standard under these regulations is more stringent than RCRA standard, then the more stringent state standard will control. Since these state regulations address and incorporate by reference many of the RCRA hazardous waste regulations, see the actions to be taken under specific RCRA regulations listed above.	Relevant & Applicable

Table 20

ARARs for Alternative SC-2A - Sediment and Landfill Consolidation; Landfill Capping; On-Site Groundwater Treatment and Disposal for Construction Dewatering LF-5, Pease AFB, NH (Continued)

Media	Requirement	Requirement Synopsis	Action To Be Taken To Attain Requirements	Status
Water	STATE-NH Admin. Code Env-Ws 900 Part 904.07 Pretreatment Standards	This regulation establishes guidelines for those wastes which are prohibited from being introduced to a publicly owned treatment works (POTW). Sewer use ordinances passed by the town owning the POTW may contain standards equal to or more stringent than Env-Ws 904.07. RSA 485-A:5, IV authorizes the state to enforce local pretreatment standards which have been previously approved by the state.	Remedial activities discharging to wastewater treatment plant must comply with pretreatment standards.	Applicable
	STATE-RSA 495-A:17 and NH Admin. Code Env-Ws 415 Terrain Alteration	Establishes criteria to control erosion and run-off for any activity that significantly alters the terrain.	Sediment excavation and cap installation will comply with these requirements. Such actions will be coordinated with the NHDES.	Applicable
Air	STATE-NH Admin. Code Env-A 1300 Toxic Air Pollutants	Established Ambient Air Limits (AALs) to protect the public from concentrations of pollutants in ambient air that may cause adverse health effects.	Release of contaminants to the air from any on-site remedial activities will not result in exceedence of the respective AAL, if one exists. Emissions from the landfills passive gas collection system are not expected to result in exceedence of these standards. Proposed air emissions will be coordinated with the Air Resources Division.	Applicable

Table 20

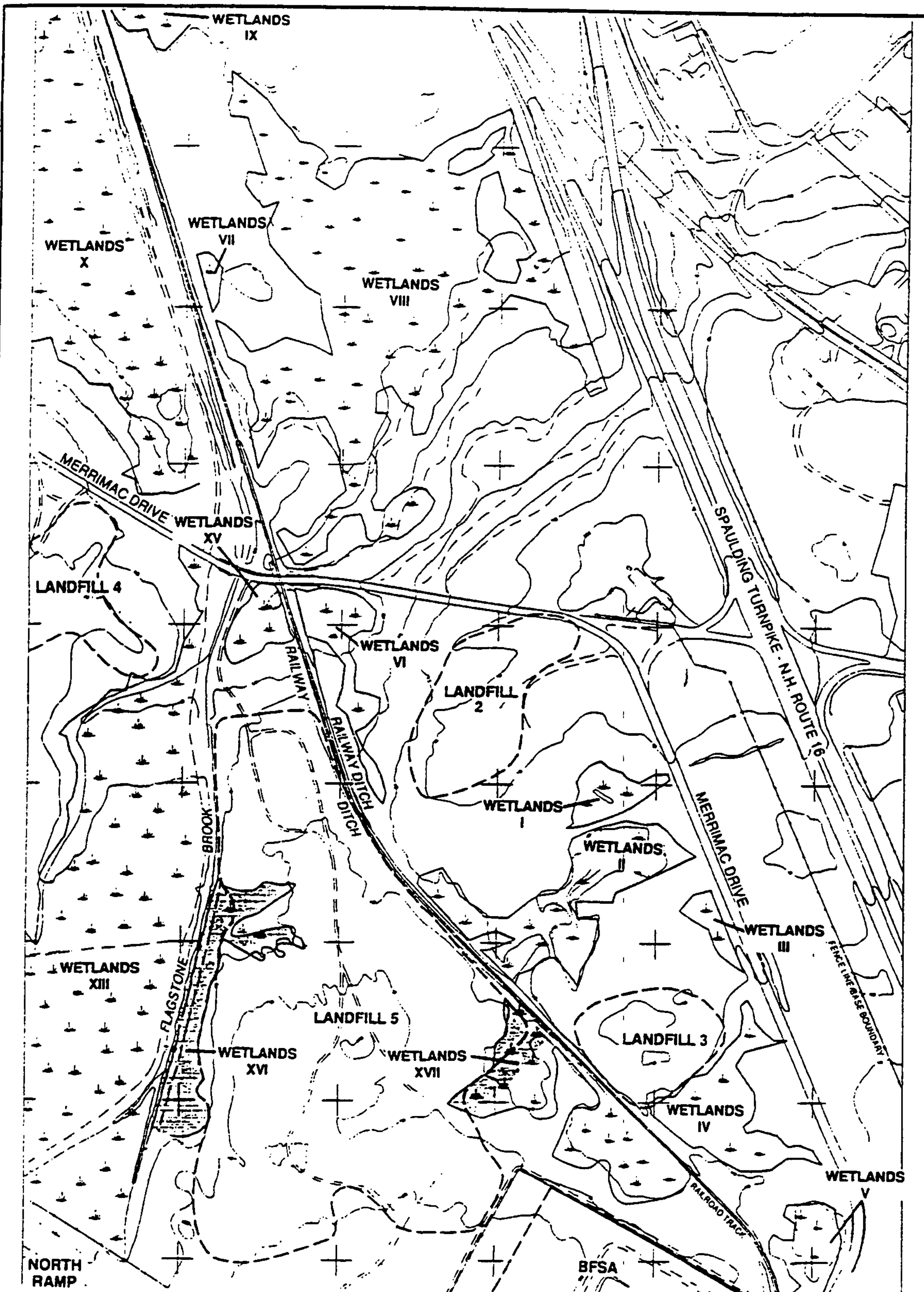
ARARs for Alternative SC-2A - Sediment and Landfill Consolidation; Landfill Capping; On-Site Groundwater Treatment and Disposal for Construction Dewatering LF-5, Pease AFB, NH (Continued)

Media	Requirement	Requirement Synopsis	Action To Be Taken To Attain Requirements	Status
Air	STATE-NH Admin. Code Env-A 300 Ambient Air Quality Standards	Establishes primary and secondary levels for eight air contaminants (particulate matter, sulfur dioxide, carbon monoxide, nitrogen dioxide, ozone, hydrocarbons, fluorides, and lead).	These ambient air levels will be incorporated with Federal NAAQs to establish target levels which may not be exceeded due to air emissions from on-site activities, including excavation and groundwater treatment. Proposed air emissions will be coordinated with Air Resources Division.	Applicable
Air	STATE-NH Admin. Code Env-1002 Fugitive Dust Control	Requires precautions to prevent, abate, and control fugitive dust during specified activities, including excavation, construction, and bulk hauling.	Precautions to control fugitive dust emissions will be required during sediment excavation, and cap installation activities. These precautions will be included in the remedial design.	Applicable

APPENDIX B

DECLARATION OF CONCURRENCE

TO BE PROVIDED



LEGEND:

- Preliminary wetlands delineation line August - September 1991
- Wetlands area
- Wetlands area potentially impacted by landfill barrier cap.
- 50 Existing surface contour/elevation(FT/MSL) 10 foot interval
- Roads (asphalt/paved)
- Other roads and trails
- Buildings
- Fence (existing)

NORTH

SCALE IN FEET

Pease AFB

Map Area

Base Map Source

Landfill 5 (LF-5) Area
Stage 4, Record of Decision
Pease Air Force Base, New Hampshire

FIGURE 12
WETLANDS POTENTIALLY IMPACTED BY

State of New Hampshire
DEPARTMENT OF ENVIRONMENTAL SERVICES
6 Hazen Drive, P.O. Box 95, Concord, NH 03302-0095
603-271-3503 FAX 603-271-2867
TDD Access: Relay NH 1-800-735-2964

September 16, 1993

Mr. Alan P. Babbitt
Deputy for Hazardous Materials and Waste;
Deputy Assistant Secretary of the Air Force
(Environment, Safety and Occupational Health)
Suite 5C866, Pentagon
Washington, D.C. 20330-1660

RE: Site 5 Source Area Record of Decision
Pease Air Force Base Superfund Site
Pease Air Force Base, New Hampshire

Subject: Declaration of Concurrence

Dear Mr. Babbitt:

The New Hampshire Department of Environmental Services (NHDES) has reviewed the September 1993 Record of Decision (ROD) regarding source control remedial actions at Site 5 - Landfill 5 at the Pease Air Force Base Superfund Site located in Newington and Portsmouth, New Hampshire. Management of contaminant migration will be addressed in the Zone 1 ROD. The source control action consists of a multi-component approach for the containment of contaminant source materials as outlined in the following:.

I. Excavation and consolidation of selected Railway Ditch sediments on the existing landfill.

II. Excavation of soil and solid wastes in Landfills 2 and 4 and consolidation on Landfill 5.

III. Excavation of soil and solid wastes predicted to be below the water table after capping and placement of excavated material on the existing landfill. Dewatering of areas requiring excavation, on-site treatment of the extracted groundwater and discharge to the local wastewater treatment plant may be necessary. Treated effluent will also be used for site dust control.

IV. Regrading and capping of the landfill with a composite cap. The cap will consist of the following (from top to bottom):

- A protective cover layer, comprised of a minimum of 36 inches of drair sand and 6 inches of mulched, seeded topsoil.

- A drainage composite layer, composed of a single-layer high-den polyethylene (HPDE) drainage net with a nonwoven needle-punci geotextile. The drainage composite layer and the underlying geomembra will be terminated in a perimeter anchor trench fitted with a subdrain perforated plastic pipe embedded in crushed stone.

- A composite barrier layer, consisting of a clay mat overlain by a 40-mil, ve low density polyethylene (VLDPE) geomembrane. The clay mat will t composed of bentonite clay bonded to geomembrane or a geotextile.

- A 12-inch subbase gas ventilation layer with gas vents overlain with geotextile to serve as a bedding layer for the overlying composite barrier.

V. Destruction of wetlands will require the construction of appropriate wetlands, basec on a functional evaluation and assessment of wetlands prior to commencement o construction activities, in non-wetland areas.

VI. Placement of institutional controls. Deed restrictions will be imposed to restrict future activities that could violate the integrity of the cap.

VII. Conducting long-term environmental monitoring to ensure the integrity of the cap is maintained and ensure the waste material remains dry.

Based upon its review, NHDES has determined the source area remedial action is consistent with, or exceeds, applicable or relevant and appropriate state standards. NHDES, as a party to the Pease Air Force Base Federal Facility Agreement and acting as agent for the State of New Hampshire, concurs with the selected remedial action. This concurrence is based upon the State's understanding that:

A. NHDES will continue to participate in the Pease Air Force Base Federal Facility Agreement and in the review and approval of the Zone 1 ROD, remedial design and action documents, and the following Landfill 5 operational designs and monitoring plans:

- The capping system;
- The gas management system and post-closure landfill gas monitoring plan;
- The landfill settlement monitoring system and monitoring plan;

- The stormwater management (drainage) system as typically incorporated into landfill closure plans through issuance of a Significant Alteration-of-Terrain Permit;
- The groundwater and surface water monitoring system;
- Long-term operation and maintenance plan; and
- Post closure access control systems.

B. The purpose of the NHDES' closure standards is to ensure, "...all facilities shall be closed in a manner that does not endanger public health or adversely affect the environment and which minimizes the potential for accidents that could lead to personal injury or property damage" (Env-Wm 312.01). NHDES' Landfill Capping System Standards (Env-Wm 2505.10) require landfill capping systems be designed to, "...reduce leachate generation by limiting to the extent practicable precipitation and surface water infiltration of the waste, through placement of low-permeability cover materials over the landfilled areas". The low permeability barrier shall, "minimize the infiltration of water into underlying wastes so as to limit continued leachate production and the associated adverse impacts to the quality of groundwater and surface waters; and consist of a geomembrane with a minimum thickness of 40 mils or a low permeability soil, or admixture". NHDES' solid waste closure requirements are primarily performance based and as such, provide a degree of flexibility in allowing capping systems which will provide functionally equivalent protection of human health and the environment.

The composite cap, specified by the USEPA, is a RCRA Subtitle C (hazardous waste) type closure cap which exceeds the specifications used at most municipal solid waste landfills (RCRA Subtitle D) in New Hampshire. Although RCRA C type wastes were found within a portion of the landfill during Stage 2 investigations, a drum removal action was completed in January of 1990. Subsequent test pit excavations indicate Landfill 5 is primarily a solid waste landfill which contains some hazardous waste constituents typically found in a municipal solid waste landfill.

The environmental impact from Landfill 5 wastes is similar to the impact associated with a typical municipal solid waste landfill and would otherwise be closed under the NHDES' solid waste regulations.

C. The excavation and subsequent consolidation of soil and solid waste, in order to remove waste from contact with groundwater, is an accepted source control action. The discharge of treated groundwater, extracted during excavation dewatering activities, from a mobile on-site treatment unit to the base sewer will require the development of discharge limits in coordination with the City of Portsmouth (operator of the base wastewater treatment plant) in order to ensure compliance with the existing National Pollution Discharge Elimination System permit, pretreatment regulations and water pollution control laws.

D. Any wetlands adversely impacted by the source control action will be restored, subject to the provisions of RSA 482-A and Env-Wt 100 through Wt 800.

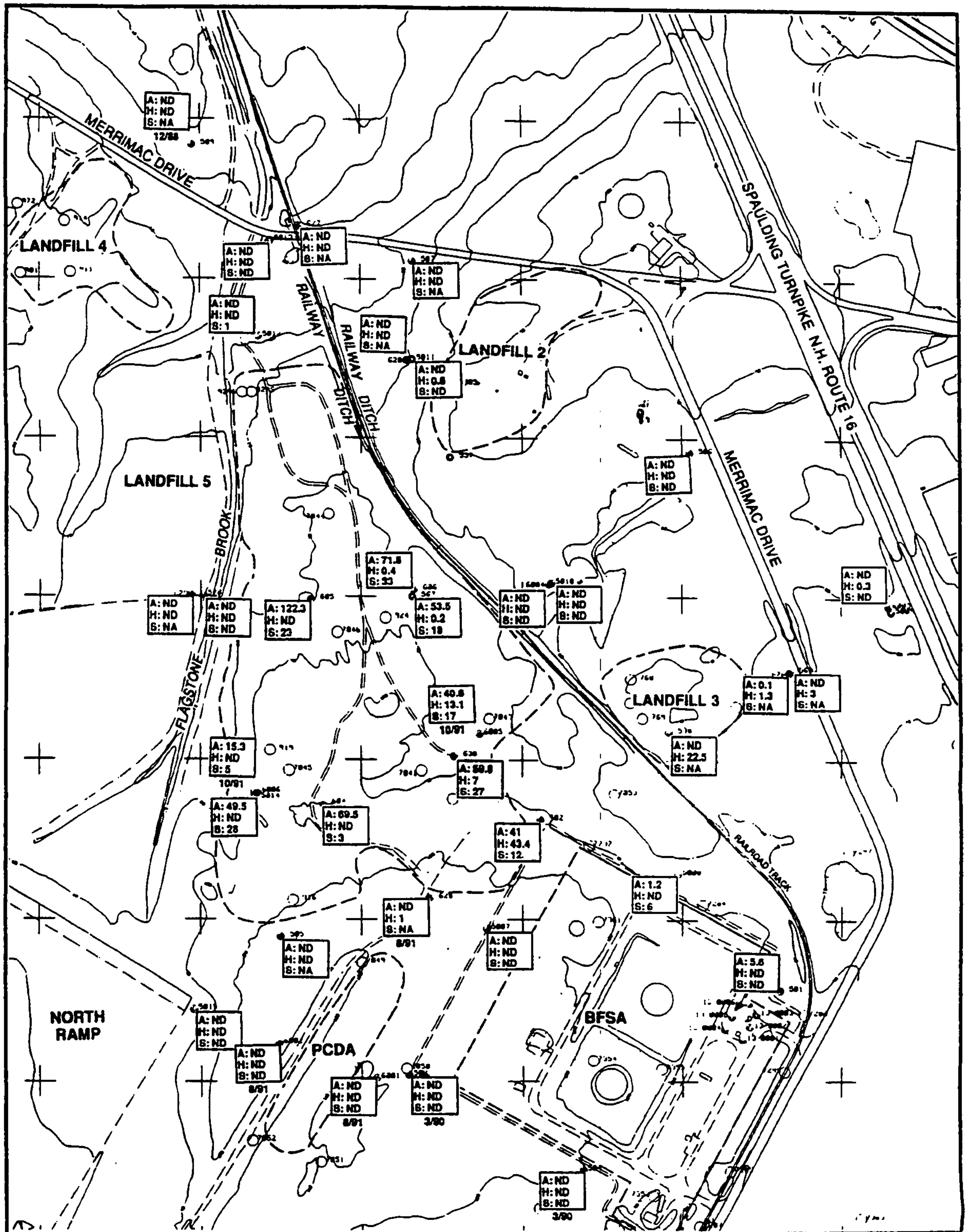
E. The Pease Development Authority (PDA) plans to construct an access road to the North Ramp, adjacent to Landfill 5. The Air Force and the PDA will coordinate the consolidation and the design and construction of the landfill cap and access road to ensure the integrity of the cap and capping systems.

F. Long-term monitoring will be necessary in order to determine the effectiveness of the source control action. Long-term monitoring of the management of contaminants in groundwater will be addressed in the Zone 1 ROD. The frequency and location of water quality monitoring is determined on a site specific basis and is typically required tri-annually until a baseline condition is established. A comprehensive, detailed review will be conducted by the Air Force, the USEPA and the NHDES within five years after remediation to ensure the remedy provided adequate protection of human health and the environment.

Sincerely,

Robert W. Varney
Commissioner

cc: Philip J. O'Brien, Ph.D., Director, NHDES-WMD
Carl W. Baxter, P.E., NHDES-WMEB
Richard H. Pease, P.E., NHDES-WMEB
Martha A. Moore, Esq., NHDOJ-PDA
Michael J. Daly, EPA
Arthur L. Ditto, P.E., AFBDA
James Snyder, AFCEE



LEGEND:

- Staff gage
- Monitor well (Bedrock)
- Monitor well (Overburden)
- Monitor well (Hybrid)
- Piezometer

0.00 Total concentrations (µg/l)

A: Total aromatic VOCs
H: Total halogenated VOCs
S: Total semivolatiles
NA Not analyzed
ND Not detected

Samples collected in 6/91 except as noted.

50 Surface contour/elevation(FT/MSL) 10 foot interval

Roads (asphalt/paved)

Other roads and trails

Buildings

Fence

NORTH

100 0 50 100 200 300 400

SCALE IN FEET

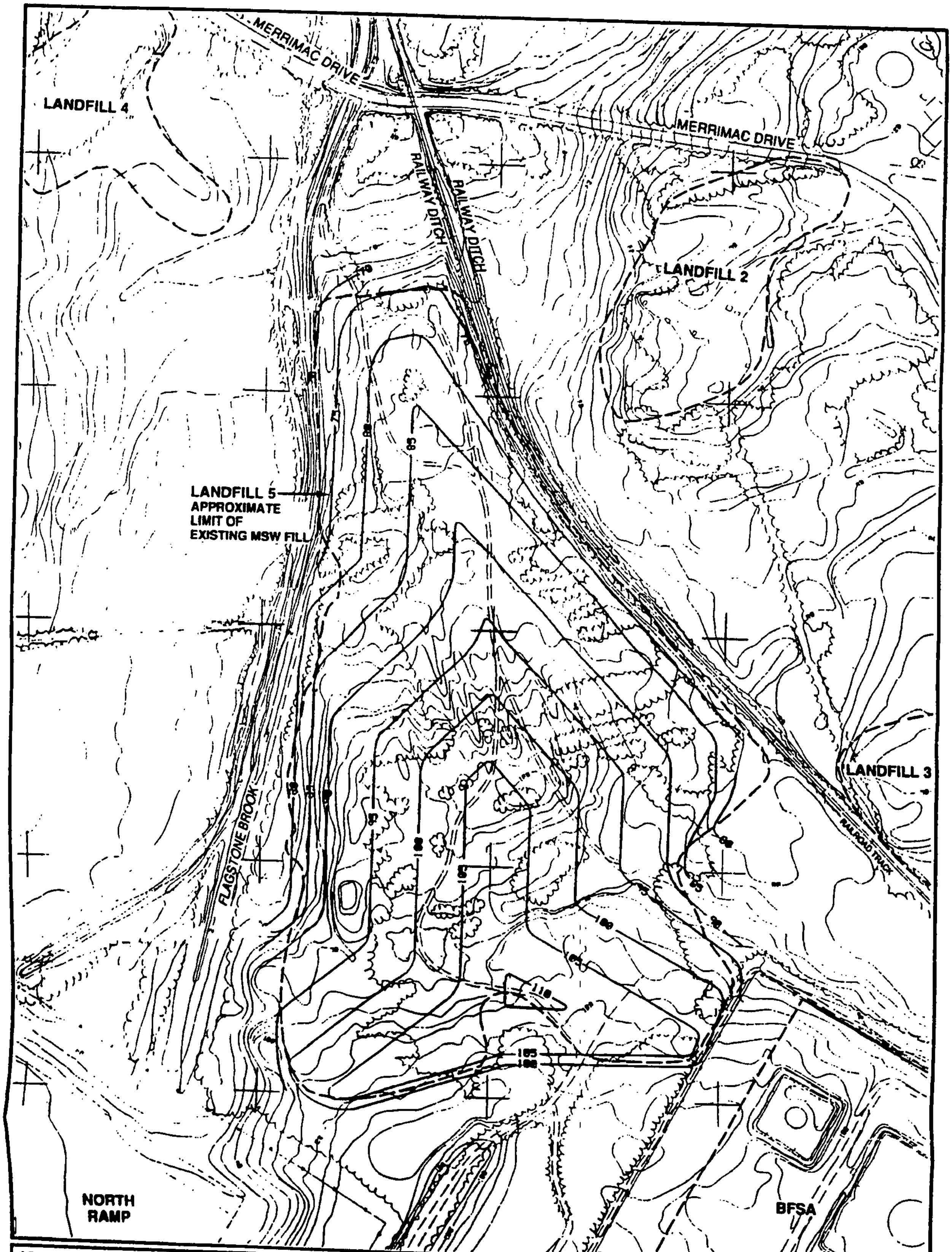
Base Map Source:
Detail area of photogrammetric compilation of PAFB from aerial photography dated 11/23/87

Map Area

Pease AFB

Landfill 5 (LF-5) Area
Stage 4, Record of Decision
Pease Air Force Base, New Hampshire

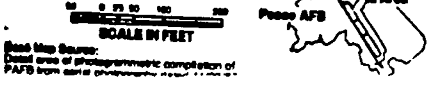
FIGURE 8
DISTRIBUTION OF ORGANICS IN GROUNDWATER



LEGEND:

- —100— Proposed final grade - landfill barrier cap (approximate) - FT/MSL - 5 foot interval
- — — — Existing limit of MSW fill (approximate)
- 50 Existing surface contour/elevation (FT/MSL) - 2 foot interval
- Roads (asphalt/paved)
- Other roads and trails
- Buildings
- Fence (existing)
- Marshy areas
- Tree line

NOTE:
The grades shown represent covering of the debris and soils from LF-5 and the sediments from Flagstone Brook and the Railway Ditch, only. Additional landfill materials from LF-2 and LF-4 will also be consolidated on LF-5 (total additional volume of approximately 76,000 cubic yards). The deposition of LF-6 (Zone 4) materials is still under consideration. Consolidation on LF-5 is a possibility. A revised figure will be incorporated once final design parameters are establish



Base Map Source:
Detail area of photogrammetric compilation of PAFB from aerial photography dated ...

Landfill 5 (LF-5) Area
Stage 4, Record of Decision
Pease Air Force Base, New Hampshire

FIGURE 11
PROPOSED FINAL GRADES LANDFILL ...