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September 1991

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Superfund Record of Decision:

Fort Dix Landfill, NJ

50272-101

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15. Supplementary Notes

16. Abstract (Limit: 200 words)

The 126-acre Fort Dix Landfill site is an inactive landfill located in the southwest section of the U.S. Army Fort Dix Military Reservation, Pemberton Township, Burlington County, New Jersey. The site is surrounded by military housing developments, a hardwood swamp, and a densely vegetated hardwood forest. The site is bordered by Cannon Run Stream, located on the east side of the landfill, and an unnamed stream located northwest of the landfill. From 1950 until its closure in 1984, the site was used and operated by the Fort Dix Military Reservation to dispose of various wastes including household waste from the military base, paints, thinners, demolition debris, ash, and solvents. From 1968 to 1984, McGuire Air Force Base also used the landfill for waste disposal. Landfilling operations consisted of excavating a series of parallel trenches and filling with waste materials. Waste disposal began at the northern portion of the landfill in 1950 and proceeded in a southerly direction to the southern boundary of the landfill. In addition to the landfill, during 1982, the Army used a pit in the southwestern area of the site to dispose of mess hall grease and degreasing agents. A 1982 State investigation revealed ground water contamination beneath the site that had resulted from landfill leachate. This

(See Attached Page)

17. Document Analysis a. Descriptors

Record of Decision - Fort Dix Landfill, NJ
First Remedial Action - Final
Contaminated Media: soil, debris
Key Contaminants: VOCs (benzene, toluene), other organics (PAHs), metals (chromium, lead)

b. Identifiers/Open-Ended Terms

c. COSATI Field/Group

18. Availability Statement	19. Security Class (This Report) None	21. No. of Pages 104
	20. Security Class (This Page) None	22. Price

Abstract (Continued)

Record of Decision (ROD) addresses final source control at the site; however, if additional investigations reveal significant increases in unacceptable risk to human health and the environment, then additional remedial actions will be proposed. The primary contaminants of concern affecting the soil and debris are VOCs including benzene and toluene; other organics including PAHs; and metals including chromium and lead.

The selected remedial action for this site includes capping the 50-acre southern portion of the landfill with a clay or geomembrane cap; developing a soil erosion and sediment control plan; long-term ground water, surface water, and air monitoring; and implementing institutional controls including deed, land, and ground water use restrictions, and site access restrictions such as fencing. The estimated capital cost for this remedial action is $12,600,000, with an annual O&M cost of $218,900 for the first 2 years and $199,900 for years 3-30.

PERFORMANCE STANDARDS OR GOALS: Not applicable.

ROD FACT SHEET

SITE

Name	Fort Dix Landfill
Location/State	Pemberton Township, New Jersey
EPA Region	II
HRS Score (date)	37.40
NPL Rank (date)	67 for Federal Facilities (8-30-90)

ROD

Date Signed	9-24-91
Remedy	Landfill Cap & 30 years of groundwater monitoring
Capital Cost	$12,600,000
O & M/year	$ 199,900

LEAD

Enforcement, EPA		
Primary contact	Paul G. Ingrisano	(212) 264-6609
Secondary contact	Robert J. Wing	(212) 264-8670
Main PRP(s)	U.S. Army	
PRP Contact	Lt. Colonel Donnie L. Henley	(609) 562-3255

WASTE

Type and media:	The groundwater and surface water are contaminated with various volatile organic compounds as well as, heavy metals including manganese, lead, and cadmium.
Origin	On-site waste disposal.
Est. quantity	126 acres

OCT 0 3 1991

Donnie L. Henley
Lieutenant Colonel, Engineer
Director of Engineering and Housing
Department of the Army
Headquarters, U.S. Army Training
Center and Fort Dix
Fort Dix, New Jersey 08640-5501

Dear Lieutenant Colonel Henley:

Enclosed is the final copy of the Record of Decision (ROD) for the Fort Dix Landfill which was signed by the Deputy Regional Administrator on September 24, 1991.

Please note that, as required by the Interagency Agreement (IAG), within twenty-one (21) days of issuance of the ROD for the Fort Dix Landfill, the Army shall propose deadlines for the submission of the Remedial Design and Remedial Action Workplans in accordance with Part XIII (Deadlines) of the IAG.

We ask that the Army place copies of this letter declaring that the ROD has been signed, together with the ROD itself, on file at the information repositories which the Army is maintaining for this site.

If you have any questions concerning this matter, please contact me at (212) 264-6609.

Sincerely yours,

Paul G. Ingrisano
Project Manager
Federal Facilities Section

Enclosure

cc: Secretary L.D. Walker, U.S. Army
General J.P. Herrling, Fort Dix
L. Barb, U.S. Army
D. Felder, Fort Dix
E. Kauffman, USATHAMA
A. D. Gupta, Baltimore District, COE
N. Hubler, Philadelphia District, COE
C. Shah, Law Environmental, Inc.
K. Walters, Advanced Sciences, Inc.
L. Miller, NJDEPE
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bcc: V. Pitruzzello, PSB, w/o encl
R. Wing, PSB, w/o encl
R. Hargrove, EIB, w/encl
D. Mellot, ORC, w/encl
P. Ingrisano, PSB, w/o encl
M. Margetts-Jaeger, OEP, w/encl
P. Moss, PSB, w/encl ✓
L. Richman, NJSB2, w/encl
L. Elson, EPA-HQ, w/encl

RECORD OF DECISION

FORT DIX LANDFILL

FORT DIX MILITARY RESERVATION

PEMBERTON TOWNSHIP
BURLINGTON COUNTY, NEW JERSEY

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SECTION 1

DECLARATION STATEMENT

1.1 SITE NAME AND LOCATION

Fort Dix Landfill
Fort Dix Military Reservation
Pemberton Township
Burlington County, New Jersey

1.2 STATEMENT OF BASIS AND PURPOSE

This decision document presents the selected remedial action for the Fort Dix Landfill in Pemberton Township, Burlington County, New Jersey, developed in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 as amended by the Superfund Amendments and Reauthorization Act of 1986 (CERCLA), 42 U.S.C. Section 9601, et seq., and, to the extent practicable, the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), 40 CFR Part 300. This decision is based on the administrative record for this site.

The State of New Jersey concurs with the selected remedy.

1.3 ASSESSMENT OF THE SITE

Actual or threatened releases of hazardous substances from this site, 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.

1.4 DESCRIPTION OF THE SELECTED REMEDY

The selected remedial alternative for the Fort Dix Landfill site is essentially a source control action that will reduce the amount of contamination being introduced into the ground water. It consists of covering the southernmost 50 acres of the landfill with a low-permeability cap, while undertaking actions consistent with State solid waste landfill closure requirements and Resource Conservation and Recovery Act (RCRA) guidance. Monitoring will also be conducted during the design phase and will include the following:

1. Collect and analyze sediment samples at the point where Cannon Run discharges into the North Branch of Rancocas Creek;

2. Perform standard bioassay testing for freshwater species on samples collected from a piezometer, a proposed monitoring well, and surface water along Cannon Run;

3. Conduct air sampling for volatile organic analysis; and,

4. Sample newly installed and selected existing monitoring wells for chemical analysis.

A long-term monitoring program (30 years) will also be implemented as part of this action to detect changes in ground water, surface water, and air quality. These data will be reviewed, as they are collected so that, if significant degradation in the quality of these media is noted that produces an unacceptable risk, then further action can be initiated. Unacceptable risk will be determined through a revision of the latest risk assessment, using the most recent total volume of data. Risk assessments will use EPA guidance and policy effective at the time of the review. The information obtained during the monitoring program in items 1-4 above will be used in the three year post-closure review. The effectiveness of the selected remedy will be reevaluated no less often than three years after commencement of remedial action and at least every five years thereafter as required under CERCLA.

Land Disposal Restrictions (LDRs) are not applicable to this action because the landfill will be capped and placement will not occur.

The major components of the selected remedial alternative are:

1. Installation of a cap on the southern 50 acres of the landfill that will consist of vegetative, drainage, and low-permeability layers. Two feet of final cover will be maintained on the remaining portion of the landfill which will not receive the cap. The final cover requirements will be developed in consultation with the New Jersey Department of Environmental Protection (NJDEP) and the U.S. Environmental Protection Agency (EPA).

2. Installation of a landfill gas venting and air monitoring system (to determine if methane gas and volatile organic compounds (VOCs) emissions require treatment).

3. Installation of a chain-link fence around the perimeter of the landfill to restrict access to the site.

4. Implementation of landfill closure requirements in accordance with New Jersey Administrative Code (NJAC) 7:26-2A et seq. and RCRA guidance.

5. Long-term ground water, surface water, and air monitoring (30 years) pursuant to the New Jersey State closure requirements. A yearly statistical analysis will be performed on the chemical analysis results to determine the trend of the overall contamination levels.

6. Long-term operation and maintenance (O&M) to provide inspection of and repairs to the landfill cap.

7. Institutional controls in the form of deed and water use restrictions on future uses of the landfill and ground water in the immediate vicinity of the landfill.

8. Development and implementation of a soil erosion and sediment control plan consistent with the Soil Erosion and Sediment Control Act Regulations of 1975, NJSA 4:24-40 et seq., and NJAC 2:90-1.1 et seq.

9. Using the data obtained in the monitoring program, the risk assessment will be reviewed and subsequently revised if the trend shows significant changes in water quality. These reviews and revisions will occur no less often than three years after commencement of remedial action and every five years thereafter. Any changes in actual exposure scenarios will be addressed in the revised risk assessments. Risk assessments will use EPA guidance and policy effective at the time of the review.

10. If significant increases in unacceptable risk to human health and the environment are determined in the revised risk assessments, additional remedial actions will be proposed.

1.5 DECLARATION

The selected remedy is protective of human health and the environment, complies with Federal and State requirements that are legally applicable or relevant and appropriate (ARARs) to the remedial action, and is cost-effective. This remedy utilizes permanent solutions and alternative treatment technologies, to the maximum extent practicable for this site. Because treatment of the potential threats at the site was not found to be practicable, this remedy does not satisfy the statutory preference for treatment as a principal element of the remedy.

Because this remedy will result in hazardous substances remaining on-site above health-based levels, a review will be conducted within three years, then every five years after commencement of remedial action to ensure that the remedy continues to provide adequate protection of human health and the environment.

8/14/91
Date

Lewis D. Walker
Lewis D. Walker
Deputy Assistant Secretary
of the Army
Environment, Safety &
Occupational Health

9/24/91
Date

William [signature]
Constantine Sidamon-Eristoff
Regional Administrator
Region II
U.S. Environmental Protection
Agency

(fort_dix/98)

SECTION 2

DECISION SUMMARY

2.1 SITE NAME, LOCATION, AND DESCRIPTION

The Fort Dix Landfill is located in the southwest section of the U.S. Army's (Army) Fort Dix Military Reservation in Pemberton Township, Burlington County, New Jersey (see figure 1). The Fort Dix Landfill covers approximately 126 acres and is located about 2,200 feet from the post boundary (see figure 2). The site is surrounded by Pointville Road to the north, Juliustown-Browns Mills Road to the east, Pemberton-Browns Mills Road to the south, and Pipeline Road to the west. Two streams flow near the landfill. Cannon Run, located on the east side of the landfill, flows south into the North Branch of Rancocas Creek. An unnamed stream, located northwest of the landfill, flows to the west into the North Branch of Rancocas Creek. A swamp that drains into Budds Run (and eventually into the North Branch of Rancocas Creek) is located to the west of Pipeline Road. The terrain is gradually sloping towards the south, from a topographic elevation of approximately 160 feet above Mean Sea Level (MSL) at the northern portion of the landfill to approximately 75 feet above MSL towards the swampy area to the south of the landfill.

The area immediately surrounding the landfill consists of a hardwood swamp and densely vegetated hardwood forest. Unauthorized recreational activities such as dirtbiking and hunting take place throughout the year, although access to the landfill is restricted by road gates, boulders (at dirt road entrances), and military police patrols. Three military housing subdivisions are located beyond this forested area to the north of the landfill (Kennedy Courts, Laurel Housing, and Garden Terrace). The Fort Dix Elementary School is also located to the north of the landfill (see figure 3). The town of Browns Mills is immediately to the east of the military reservation. To the south of the Fort Dix Landfill are two abandoned farms, approximately 12 homes, several county buildings, the county hospital, and the Burlington County Juvenile Detention Center and

Shelter. Pemberton Township municipal buildings, sewage disposal plant, public water supply wells, and several homes are located to the southwest of the landfill. The public water supply wells identified are located within three miles to the southwest of the landfill boundary.

The Fort Dix site is located within the Protection Area of the New Jersey Pinelands.

The site area lies within the Atlantic Coastal Plain physiographic province, which is characterized by a southeasterly dipping wedge of unconsolidated sediments consisting of clays, silts, sands, and gravels that thicken in a seaward direction. The Cretaceous and Tertiary age sediments that overlie the bedrock strike northeast-southwest and dip gently to the southeast between 10 and 60 feet per mile.

An understanding of the subsurface geology of the site is necessary to evaluate any potential ground water contamination, its directions and speed of travel, and its impact on the environment.

The thickness of the unconsolidated sediments at the site is approximately 1,200 feet; however, only the upper few hundred feet are important to this study. The underlying sediments are effectively sealed off by relatively impermeable formations of fine-grained silts and clay.

The subsurface geological formations under the site include the following:

- The Cohansey Sand, the uppermost formation, which outcrops at the site, was observed to range from 15 to 90 feet in thickness within the site
- The Kirkwood Formation, which outcrops south and southwest of the landfill and east of the landfill along Cannon Run, was observed to be 25 to 50 feet thick at the site
- The Manasquan Formation, which outcrops near the town of Browns Mills, was observed to be 10 to 20 feet thick
- The Vincentown Formation, which is poorly developed at the site, was observed to be 17 to 23 feet thick

- The Hornerstown and Navesink Formations, ranging from 12 to 30 feet thick and 12 to 22 feet thick, respectively

The Cohansey and Kirkwood Formations form a single unconfined aquifer at the site. Ground water flow in this aquifer is to the south and southwest toward Cannon Run and the marsh, where it discharges at the surface.

The underlying Manasquan, Hornerstown, and Navesink Formations form a confining layer that limits ground water flow downward from the landfill site.

The Cohansey and Kirkwood Formations were estimated to have horizontal hydraulic conductivities (a measure of the ease with which ground water can flow through the formation) of 25 feet per day and five feet per day, respectively. These aquifers discharge into Cannon Run and the marsh.

The vertical conductivity of the confining layer -- consisting of the Manasquan, Hornerstown, and Navesink Formations -- was estimated to be approximately 0.0001 feet per day, indicating that this layer forms a barrier to the downward flow of ground water from the landfill site.

2.2 SITE HISTORY AND ENFORCEMENT ACTIVITIES

The Fort Dix Landfill has been in operation since 1950; it was officially closed on July 6, 1984. Prior to landfill development, the area was used for Army training. Between 1950 and 1984, the landfill was used and operated by the Fort Dix Military Reservation. McGuire Air Force Base also used the landfill from 1968 until it was closed. Access to the landfill was not controlled until 1980; therefore, records of disposal practices, waste types, and quantities are incomplete. However, wastes that have been reportedly disposed of at the landfill include domestic waste (household waste from the military base), paints and thinners, demolition debris, ash, and solvents. The final filled area is approximately 126 acres.

Landfill operations consisted of excavating a series of parallel trenches to a depth of approximately 10 feet below grade. The trenches were then filled with waste materials and covered with about two feet of native soils that were originally removed during excavation. In general, trench excavation and waste disposal began at the northern portion of the landfill (in the 1950's) and preceded in a southerly direction to the landfill's southern boundary as of July 6, 1984 (see figure 4). After 1969, landfill capacity was increased by depositing wastes to an elevation of approximately 10 feet above grade, therefore doubling the depth of wastes disposed of in each trench.

In addition to the landfill, a pit in the southwest area of the site (see figure 2) was reported by the Army to be used for an estimated period of four months in 1982 to dispose of mess hall grease and grease trap cleansers. The pit covered approximately one-half acre to a depth of six feet. Disposal into the grease pit was discontinued in October 1982. The type of grease trap cleansers has not been confirmed, although Army contacts have stated that degreasers were not used. Prior to disposal at the grease pit, mess hall grease was disposed of throughout the landfill.

Older portions of the landfill were revegetated with ash and pine trees, while the newer portions of the landfill were left to naturally revegetate. These portions of the landfill are either covered by high grass, low vegetation, or are bare. Newer sections of the landfill where refuse was disposed of at elevations above the original grade suffer from extensive soil erosion and washouts, where waste materials (e.g., tires) are exposed. Along the eastern portion of the landfill (trenched from approximately 1960 to 1970), large metal and concrete objects were exposed along the perimeter of the landfill and appear to have been filled into the wetlands of Cannon Run. These materials are now partially covered with natural organic detritus. Two feet of final cover will be maintained on the remaining portion of the landfill which will not receive the cap.

In 1979 and 1982, a series of ground water monitoring wells (LF series wells on figure 5) were installed around the perimeter of the landfill. Reports indicated that VOCs were detected in many of the ground water samples taken in 1982. The major VOCs that exceeded the NJDEP ground water limits were methylene chloride and trichloroethylene. In December 1983, eight additional ground water monitoring wells (MW well series in figure 5) were installed to further define ground water contamination. Eleven wells were installed in May 1984 as part of a ground water investigation performed by the U.S. Army Engineers Waterways Experiment Station (WES series wells in figure 5). VOCs and heavy metals were detected in the ground water samples collected from wells located immediately to the south, southeast, and southwest of the landfill. These compounds included methylene chloride, di- and trichloroethane, tri- and tetrachloroethylene, methyl ethyl ketone, methyl isobutyl ketone, mercury, cadmium, and other heavy metals.

An interim New Jersey Pollutant Discharge Elimination System (NJPDES) permit was issued for the Fort Dix Landfill on May 29, 1984. Since that time, quarterly sampling of "LF" monitoring wells continues to be performed by various laboratories to satisfy the landfill NJPDES permit. On July 6, 1984, the Army ceased the disposal of waste at the landfill in compliance with the landfill closure date. The landfill was ranked for inclusion on the National Priority List (NPL) on September 14, 1984. On October 15, 1984, 32 Federal facilities sites, including the Fort Dix Landfill, were proposed in the Federal Register for addition to the NPL.

On September 16, 1985, the Army entered into an Administrative Consent Order (ACO) with NJDEP and EPA. The ACO required the Army to conduct a Remedial Investigation/Feasibility Study (RI/FS) and to implement the selected remedial alternative approved by NJDEP and EPA.

The Fort Dix Landfill was placed on the NPL in July 1987.

2.3 HIGHLIGHTS OF COMMUNITY PARTICIPATION

The RI and FS reports and Proposed Plan (PRAP) for the Fort Dix Landfill site were released to the public in April 1990. These documents were made available to the public in both the administrative record and at three information repositories:

- Fort Dix Environmental Resources Branch
  Building 5512
  Texas Avenue
  Fort Dix, New Jersey

- Burlington County Library
  Browns Mills Branch
  348 Lakehurst Road
  Browns Mills, New Jersey

- New Jersey Department of Environmental Protection
  Division of Hazardous Site Mitigation
  Bureau of Community Relations
  401 East State St.
  Trenton, New Jersey

The notice of availability for these documents was published in the Burlington County Times on April 26, 1990. A public comment period was held from April 25, 1990, through May 25, 1990. In addition, a public meeting was held on May 7, 1990. At this meeting, representatives from the Army formally presented the findings of the RI and FS and answered questions about environmental conditions at the site and the remedial alternatives under consideration. Representatives from EPA and NJDEP were also present to answer questions. A response to the comments received during this period is included in the Responsiveness Summary which is part of this ROD. This decision document presents the selected remedial action for the Fort Dix Landfill Site, in Pemberton Township, New Jersey, chosen in accordance with CERCLA, and, to the extent practicable, the NCP. The decision for this site is based upon the administrative record.

2.4 SCOPE AND ROLE OF RESPONSE ACTION

The selected remedial alternative for the Fort Dix Landfill site is a source control action that will reduce the amount of contamination being introduced to the ground water. The RI was designed to characterize contaminant migration from the landfill through the implementation of a series of field investigations. The FS report presents a complete description and evaluation of the alternatives.

A long-term monitoring program (30 years) will be implemented as part of the selected remedial action to detect changes in ground water, surface water, and air quality.

If significant degradation in the quality of these media is noted that produces an unacceptable risk, then further action will be initiated. Unacceptable risk will be determined through a revision of the latest risk assessment, using the most recent total volume of data. Risk assessments will use EPA guidance and policy effective at the time of the review. The effectiveness of the remedial action will be evaluated no less often than three years after commencement of remedial action and at least every five years thereafter as required by CERCLA.

2.5 SITE CHARACTERISTICS

As a result of the Army's extensive RI at this site, the nature and extent of contamination has been characterized in sufficient detail to conduct a FS. The following is a summary of this characterization.

As part of the scoping for the RI, two suspected sources of contamination were identified for investigation. These areas were the landfill and the grease pit. The grease pit was evaluated through the analysis of soil samples while the investigation of the landfill focused on characterizing contaminant migration from the landfill through ground water monitoring and surface water and sediment sampling.

The analyses of subsurface soil samples from the grease pit were comparable to subsurface soil samples taken to determine background or "natural" conditions, indicating that the grease pit is not currently a source of contamination, although it may have been in the past.

Ground water in the shallow aquifer comprised of the Cohansey and Kirkwood Formations immediately (approximately within 300 feet) to the south and southwest of the landfill contained levels of VOCs and metals above background and/or in excess of MCLs. These VOCs included, but were not limited to, vinyl chloride, benzene, trichloroethylene, tetrachloroethylene, 2-butanone, and toluene. In addition, inorganic compounds (cadmium, calcium, chromium, cobalt, iron, magnesium, manganese, mercury, nickel, and sodium) were found at levels above background in these wells.

There was no evidence of organic contaminant migration in the shallow aquifer beyond 300 feet to the south/southwest of the landfill. The review of the ground water data collected between November 1982 and January 1986 indicated that the number of and concentration of VOCs declined substantially during the period of sampling events.

Magnesium, potassium, sodium, calcium, chloride, nitrate, and total dissolved solids were detected at levels above background in monitoring well LF-11 (southeast of the landfill). These constituents may be attributed to landfill leachate flowing into Cannon Run.

Low levels of trichloroethylene (TCE) were detected in well CDM-6, located southwest of the landfill and screened in the Vincentown aquifer. Additional field investigations were performed to identify the contaminant source and consistency of contaminant concentration. Samples from three other wells did not indicate the presence of TCE. The six sets of data from CDM-6 indicate a decreasing trend to the lowest level in the spring of 1989.

The landfill as a source of TCE in the Vincentown aquifer is questionable because no other characteristics of the contaminant plume are evident in ground water samples collected from the Vincentown aquifer. In addition, subsurface soil samples collected from the Manasquan Formation (the confining unit) at the location of well CDM-6 did not indicate contaminant migration to or through this aquitard.

Further investigation of contamination detected in this aquifer is being conducted separately from landfill activities by the U.S. Army Toxic and Hazardous Materials Agency.

Soil screening for volatile organic vapors indicated no significant VOC contamination within subsurface soils at any of the CDM borehole locations.

Ammonia, iron, magnesium, and calcium were found to increase as the surface water sample locations approach the landfill. Beryllium, iron, and mercury were detected above the State surface water criteria. Remedial criteria for these contaminants have been established in table 1. The long-term monitoring program (30 years) will help determine if these contaminants are reaching the remedial criteria once the cap is in place. Geophysical investigations and chemical analyses of ground water, surface water, and sediment samples indicate that a plume of contaminated ground water in the shallow aquifer is emanating from the southern portion of the landfill. However, no contaminants from the landfill were detected in the sediment, surface water or ground water samples taken downgradient of the area immediately to the south of the landfill that is recharged by the contaminated ground water. Natural mechanisms (such as adsorption, dispersion, and volatilization) may be dissipating contaminant concentrations in these media to undetectable levels in the vicinity of the landfill.

Organic compounds were detected in only one sample from Cannon Run, a leachate soil sample from the central eastern boundary of the landfill. Two polynuclear aromatic hydrocarbons detected in this sample may be related to early landfill practices of disposal of coal ash and refuse burning. Pesticides such as DDT, were also detected in this sample, and may be the result of an accumulation of spraying around Fort Dix. DDT was used at Fort Dix in the 1950s and 1960s, although no records of usage or disposal have been found. This information was provided by interviews with facility personnel.

VOCs were detected at extremely low concentrations at several gas vents and monitoring well sampling locations. Most of these compounds were also detected in either field, trip, or method blanks and were determined to be unrelated to environmental conditions at the landfill.

A summary of contaminants detected in water, soil, and air samples is presented in tables 1, 2 and 3. Sample locations can be found in figures 5, 6 and 7.

The major routes of migration of site contaminants is via precipitation and subsequent formation and infiltration of leachate to ground water. They move in the same direction as the shallow ground water to local discharge areas along Cannon Run to the southeast and to the swamp to the southwest of the landfill. Other potential routes of migration include transport to Cannon Run via erosion and runoff and volatilization.

2.6 SUMMARY OF SITE RISKS

During the RI/FS, an analysis was conducted to determine the potential for any impact to public health and the environment which might result if the contamination associated with the Fort Dix Landfill were not controlled in an acceptable manner. This analysis of potential detriment to human health or the environment, if no remediation is conducted, is commonly called a baseline risk assessment. In conducting this assessment, the focus was on the human health and environmental effects that could result from exposure to contaminants associated with the landfill in various environmental media (air, surface water, sediments, soil, and ground water).

During the evaluation of site risks, chemicals that were detected in the ground water, surface water, sediment, grease pit, subsurface soil and air samples were screened to select indicator chemicals for the Fort Dix Landfill site. These chemicals were selected as those most representative of site conditions and as those expected to contribute the greatest risks to human health and the environment. The indicator chemicals for the site are 1,2-dichloroethane, benzene, vinyl chloride, trichloroethylene, tetrachloroethylene, chlorobenzene, 2-butanone, toluene, trans-1,2-dichloroethylene, bis(2-ethylhexyl)phthalate, 1,4-dichlorobenzene, 1,1,1-trichloroethane, ethylbenzene, nickel, mercury, cadmium, zinc, chromium, and manganese. EPA has classified the indicator chemicals as the following based on EPA's Weight-of-Evidence Categories for Potential carcinogens:

- o Benzene and vinyl chloride are classified as Group A, human carcinogens

- o Trichloroethylene, 1,2-dichloroethane, tetrachloroethylene, bis-(2-ethylhexyl) phthalate are classified as Group B2, probable human carcinogens (based on animal carcinogenicity, yet inadequate evidence of human carcinogenicity)
- o 1,4-dichlorobenzene is classified as Group C, possible human carcinogen (based on limited evidence of carcinogenicity in animals)

The remaining indicator chemicals are considered to be noncarcinogens by EPA.

Human Health Risks

The human health exposure pathways that were analyzed for current use of the Fort Dix Landfill included:

- o Inhalation of VOCs in the ambient atmosphere
- o Direct contact with soils including dermal absorption of and incidental ingestion of soil contaminants
- o Direct contact with surface water in the swampy area west of the landfill and inhalation of VOCs
- o Direct contact with contaminants predicted to be present in the North Branch of Rancocas Creek

Under present conditions, exposure to ground water in the Cohansey-Kirkwood formation was not considered to be a complete pathway because private wells are currently not in the path of the landfill plume. In addition, the probability of future development of water supplies in the Cohansey-Kirkwood formation in the path of the landfill plume is unlikely because of the characteristics of the aquifer in this area.

Exposure to soil is of greatest concern with young children because of their increased tendency to ingest soil. In addition, it is possible for children to gain access to the landfill. Children have been seen playing on and around the landfill. Thus, young children were used to represent the exposed population for most of the pathways.

The concentrations of the selected chemicals of concern at potential exposure points were estimated for each public health exposure pathway. These "exposure point concentrations" along with assumptions concerning the exposed populations, the rate of exposure, the duration of exposure, and the level of exposure were used in the calculation of chronic daily intakes. For potential carcinogenic compounds, the lifetime exposure durations for the selected chemicals of concern were developed to provide the upper-bound cancer risk estimates. For chronic noncarcinogenic effects, the time period used was the actual period of exposure. The daily intake was expressed in terms of the concentration of the contaminant per unit of body weight over the duration of the event (mg/kg/day).

The carcinogenic risks and noncarcinogenic hazards were calculated using the carcinogenic potency factors and reference doses (RfDs) shown in tables 4 and 5, respectively. Cancer potency factors (CPF) have been developed by EPA's Carcinogenic Assessment Group for estimating excess lifetime cancer risks associated with exposure to potentially carcinogenic chemicals. CPFs express carcinogenic potency in terms of lifetime cancer risks per $mg/kg/day^{-1}$ and are estimated upper 95-percent confidence limits of the carcinogenic potency of a chemical. The carcinogenic risk was developed using the following equation:

$$\text{Risk} = (\text{LADE} \times \text{CPF})$$

Because the CPF expresses the lifetime risk, the Lifetime Average Daily Exposure (LADE) was calculated by averaging the estimated chronic daily intake by the years of exposure over a 70-year lifetime. The total estimated carcinogenic risk for each pathway was estimated by summing the individual carcinogenic risks. The results of this characterization provided the upper-bound estimate of the potential carcinogenic risk per pathway. The term "upper bound" reflects the conservative estimate of the risks calculated from the CPF. Use of this approach makes the underestimation of the actual cancer risk highly unlikely. These total risks were used in the development of the aggregate risk for total ingestion, inhalation, and dermal exposures.

The hazard index (HI) provides a useful reference point for gauging the potential significance of multiple contaminant exposures within a single medium or across media. Noncarcinogenic risks are assessed using a HI approach. RfDs developed by EPA are estimates of daily exposure levels for humans which are thought to be safe over a lifetime (including sensitive individuals). Estimated intakes of chemicals are compared with the RfD to derive the hazard quotient for the contaminant in the particular media. The HI is obtained by adding the hazard quotients for all compounds across all media. A HI greater than one indicates that potential exists for noncarcinogenic health effects to occur as a result of site-related exposures. The chronic daily intakes for noncarcinogens were developed by dividing the daily intake by one year of exposure. The RfDs shown in table 5 were used to calculate the potential hazards posed by the noncarcinogenic compounds.

A comparison was made between the projected chronic intake and the acceptable intake for chronic exposure for noncarcinogens and between calculated risks and target risks for potential carcinogens. Each exposure pathway was examined individually to estimate the potential health effects that would result from the exposure to the selected indicator chemicals. The health risks from each pathway were then summed to allow for a complete evaluation of the potential risks and hazards that would be associated with the Fort Dix Landfill and the surrounding area in the absence of remediation.

EPA has proposed that remediation should occur when the excess cancer risk exceeds the acceptable range. The acceptable risk range for carcinogens is defined as an excess cancer risk posed to a population of from 1×10^{-4} to 1×10^{-6}. This is interpreted as the probability that one additional case of cancer in a population of ten thousand (10^4) to one million (10^6) is expected to occur as a result of exposure to compounds associated with a site. For noncarcinogens, where the sum of expected dose/RfD ratios exceeds one, observed concentrations pose unacceptable risks of exposure.

A summary of current site risks can be found in table 7. It was determined that the inhalation of VOCs detected in the ambient air would not pose a significant risk to human health under both the most probable and vorst case scenarios. The scenarios developed used source concentrations and represented the exposures that could reasonably be expected to exist during the spring and fall. The risks to the surrounding community vould be expected to be significantly lover than the estimated source risks due to the distance to the nearest homes and the heavy vegetation surrounding the site.

Direct contact and incidental ingestion of soils vould not present a risk to human :ealth under the vorst case conditions. For the most probable conditions, it vas determined that this pathvay vas incomplete and vould not present a risk to human health.

Because the calculated risk numbers in table 7 are less than the EPA risk range of $1x10^{-4}$ to $1x10^{-6}$, direct contact vith contaminants in the svamp vould not pose a risk to human health. It vas also determined that the inhalation of VOCs vould not pose a risk to human health. Risks posed by the svamp vould be limited to individuals having access to the svamp and vould not extend to the surrounding community. No significant risks vould be posed by periodic svimming in the North Branch of Rancocas Creek.

The sum of all estimated most probable cases for carcinogenic risks under a present use scenario for the four pathvays vould be eight additional cancer cases in a billion (10^9) people. The vorst case, or more conservative estimate, predicts an excess cancer risk of one in ten million (10^7). Hovever, MCL's vere exceeded in the Cohansey aquifer, thereby varranting a remedy other than no action.

Although future use of the landfill site vas not expected to result in any additional exposure pathvays, three additional pathvays that may be of concern in the future vere analyzed: (1) the construction of a surface vater intake on the North Branch of Rancocas Creek; (2) the use of the Vincentovn aquifer dovngradient of the landfill; and, (3) the use of the Cohansey aquifer dovngradient of the landfill.

Exposure to water from the North Branch of Rancocas Creek may be associated with a 5×10^{-7} to 4×10^{-9} cancer risk using conservative assumptions. A total estimated cancer risk for the 1989 Vincentown scenario (based on 1989 data) would be 1×10^{-7}. Total risks of 5×10^{-7} and 8×10^{-6} were estimated for the most probable and the worst cases Vincentown scenarios, respectively.

Another possible future use is the construction of an on-site potable water well screened in the Cohansey aquifer. The estimated risks associated with the ingestion of water within the plume found in the Cohansey aquifer range from 2×10^{-3} to 6×10^{-6}. The future site risks are presented in table 8.

Under the current worst case conditions, the cancer risks associated with the Fort Dix Landfill were at the lower end of the EPA risk range, while the most probable case predicted the risk to be well below this range. Based on the assumptions used in the risk assessment, noncarconogenic hazards were predicted not to present a human health hazard under the evaluated current and future (Rancocas Creek and Vincentown aquifer only) case scenarios. Under future use conditions, however, the worst-case cancer risk is above the EPA risk range. Furthermore, Federal or State drinking water standards (MCL's) were exceeded for vinyl chloride, 1,2-dichloroethane, trichloroethylene, benzene, tetrachloroethylene, methylene chloride and trans-1,2-dichloroethylene.

Environmental Risks

The environmental assessment conducted as part of the RI determined that contamination of the surface water and sediments of the swamp and Cannon Run was limited to low concentrations of VOCs (swamp area only) and metals. The concentrations of aluminum, calcium, iron, magnesium, manganese, potassium and zinc were higher than would typically be expected, with iron detected above the ambient water quality criteria. However, significant impacts to wildlife and vegetation were not expected to occur and any impacts to the biotic communities would be limited to areas where the volatiles and/or metals were detected above the ambient water quality criteria.

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.

2.7 DESCRIPTION OF ALTERNATIVES

The alternatives presented in the PRAP were developed based upon a screening of possible remedial technologies, compliance of the alternatives with ARARs and the ability of the alternatives to satisfy the remedial objectives summarized below:

- To prevent contaminants that migrate from the landfill from affecting drinking water supplies of the local population
- To prevent landfill contaminant migration/exposure via Cannon Run and Budds Run (swamp) from restricting State-designated down-stream surface water uses on the North Branch of Rancocas Creek (i.e., fishing, swimming, and future water supply)
- To protect people who perform military-related or unauthorized recreational activities on the Fort Dix property from potentially harmful effects due to the landfill
- To satisfy all appropriate local, State and Federal requirements for proper landfill closure
- To prevent significant adverse environmental impacts on the surrounding flora and fauna caused by contaminant release from the Fort Dix Landfill
- To satisfy all site-specific ARARs as practicable

The remedial alternatives addressed both source control and plume mitigation technologies. Excavation of the landfill material, including the destruction of the wastes by incineration or other treatment technologies, and its disposal off-site in a secure commercial landfill, or re-disposal on-site in a lined landfill, was eliminated early in the screening process as a result of excessive cost, potential short-term impacts on human health, and limited additional long-term benefit in comparison to other alternatives.

During development of remedial alternatives, it was determined that installation of a low-permeability cap over only the southernmost 50 acres of the landfill should be evaluated because the older portions of the landfill are believed to be exhausted of any hazardous leachable material. The age of the landfill sections, the method of waste material placement in the landfill, and a thorough review of present and historical ground water quality records for the northern portions of the landfill indicated that capping of the entire landfill is not necessary. In addition, a well established tree, shrub, and grass cover exists on the older portions of the landfill. Maintenance of the existing vegetative cover is believed to be more beneficial to the environment than installation of a low-permeability cap over this older portion of the landfill.

Therefore, seven remedial alternatives were evaluated that would further protect public health and the environment from the contamination identified by the RI. The characteristics of each alternative are summarized in table 9. Remedial alternatives were evaluated based on the nine criteria identified in the FS report and summarized in section 2.8 of this ROD. CERCLA requires that each selected site remedy be protective of human health and the environment, comply with ARARs, utilize permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable, and be cost-effective. The engineering controls, institutional controls, quantity of wastes handled, and implementation requirements for each alternative were discussed in detail in the FS and its addendum. Each of these seven alternatives are summarized below. The construction cost, O&M costs, and the estimated time for completion for each alternative are shown in table 6.

Alternative 1 - No Remedial Action

The no remedial action alternative is defined as closure of the Fort Dix Landfill in accordance with NJAC 7:26-2A et seq., except that the final cover system would not include a low-permeability geomembrane and/or clay cap. Other closure improvements such as surface grading and revegetation (where insufficient vegetation currently exists), stormwater and erosion controls, gas monitoring and controls, and perimeter fencing would be constructed under this alternative. Components of this alternative are presented in figure 8.

The development and implementation of a closure and post-closure plan as defined by NJAC 7:26-2A.9 et seq., would also be included and is required for landfill closure. The plan would consist of both a closure and post-closure care plan and financial plan.

In addition, the existing ground water and surface water monitoring program (under NJPDES) would be expanded to include more sampling points and more analytical parameters.

Alternative 2 - Cap and Monitor

Alternative 2 involves landfill closure (as described in alternative 1 above), installation of a low-permeability cap over the southern 50 acres of the landfill (the newer portion of the landfill), and an expanded monitoring program (see figure 9). The partial cap will serve to reduce the amount of contamination being introduced to the aquifer system. The cap will consist of a multilayer cover system as required by RCRA and NJDEP regulations. The three-layer cover system will include an upper vegetative layer, underlain by a drainage layer, over a low-permeability layer (either clay or geomembrane). A typical closure cap detail is presented in figure 10. This alternative also includes institutional controls in the form of deed and water use restrictions on future uses of the landfill and ground water in the immediate vicinity of the landfill.

A closure and post-closure care plan will be prepared and will include the following activities: construction of a final cover (capping and vegetation), construction of structures to control surface water runon and runoff, installation of a landfill gas monitoring and control system, installation of a facility access control system, and implementation of measures to ensure the site is compatible with the surrounding area. A financial plan will also be developed and implemented.

Monitoring of ground water and surface water will continue until remedial criteria are met as set forth in table 1, or alternatively it is determined that further remedial action is necessary, but in either case long-term ground water and surface water monitoring will continue for 30 years under the post-closure plan.

Alternative 3A - Ground Water Pumping and On-site Treatment

Alternative 3A consists of collection of ground water immediately downgradient of the landfill using extraction wells, on-site treatment, and reinjection of the treated ground water into the shallow aquifer, in conjunction with landfill closure in accordance with RCRA and NJDEP regulations and monitoring as described in alternative 2. Contaminated ground water would be pumped out south of the landfill, treated, pumped to the north of the landfill, and then reinjected upgradient of the capped area. This alternative would flush out, treat, and clean up contaminants in the saturated zone at the site, and isolate any wastes above the water table. Since the ground water is a potential future source of drinking water in the area, it would be treated to meet drinking water and ground water standards. The treated effluent will meet NJPDES requirements. A general layout of alternative 3A is presented on figure 11.

A system of 11 extraction wells would be installed to a depth of 30 feet to the southwest of the landfill. Each well would be pumped at a rate of 10 gallons per minute, for a total of 110 gallons per minute to be extracted, treated, and reinjected. A total of 30 injection wells would be installed to the northwest of the capped portion of the landfill. The ground water treatment processes used in the preliminary design, presented in figures 12, 13, and 14, include unit processes grouped into the following nine process system design modules:

- Module I - preliminary treatment (iron removal)
- Module II - VOC stripping
- Module III - semivolatile organic compound removal by granular activated carbon adsorption (GAC), ion exchange, and pH

adjustment for sodium concentration, reduction, and neutralization

- o Module IV - sludge and backwash handling
- o Module V - lime slurry preparation
- o Module VI - polymer and potassium permanganate ($KMNO_4$) solution preparation
- o Module VII - carbon storage and transfer
- o Module VIII - ion exchange regeneration and pH adjustment
- o Module IX - utilities (plant water, power, compressed air, heat)

Pilot testing would be required prior to final design of the treatment system. Additional long-term monitoring (30 years) would be required to determine the efficiency of the treatment unit and to determine if additional treatment for air pollution control and sludge disposal would be required.

Alternative 3B - Ground Water Pumping and Off-site Treatment

Alternative 3B consists of collecting ground water downgradient of the landfill through interceptor wells, transmission of the ground water to an off-site facility for treatment and disposal, along with landfill closure in accordance with RCRA and NJDEP regulations as described in alternative 2. Contaminated water would be pumped by a system of 11 interceptor wells located to the southwest of the landfill to on-site storage, and then transported by tanker truck to an off-site facility where it would be treated to meet NJPDES requirements. An estimated volume of 150,000 gallons per day of ground water would require transportation and treatment. Collected ground water would be held in storage facilities with at least three days of storage capacity to allow the water to be sampled and tested daily prior to its transport. Pretreatment of ground water for iron prior to transportation may be necessary. Alternative 3B is presented on figure 15.

Alternative 3D - Partial Ground Water Pumping and On-site Treatment

This alternative is similar to alternative 3A; the landfill would be closed in accordance with RCRA and NJDEP regulations, and interceptor wells would be used to capture contaminated ground water, which would be treated on-site, pumped to the northwest of the landfill, and reinjected upgradient of the capped area. Since the ground water is a potential future source of drinking water in the area, it would be treated to meet drinking water and ground water standards. The treated effluent would meet NJPDES requirements. The intent of this alternative would focus on the cleanup of the inorganic plume alone, which is smaller in area than the organic plume. Although treatment for VOCs would be required for extracted ground water, some of the organic plume would not be collected but rather would be allowed to discharge eventually to the surface water bodies and volatilize through natural processes.

Four interceptor wells located immediately to the southwest of the landfill would extract a total of approximately 40 gallons per minute and send it to a treatment system consisting of the following principal components:

- Metals removal by chemical precipitation, coagulation, and sedimentation
- VOC removal by air stripping
- Sludge and backwash handling

A schematic flowsheet for this proposed treatment system is presented in figure 16, although final design would depend on a treatability study.

The treated water would be pumped to the northwest of the capped area of the landfill for reinjection through a system of approximately eight wells.

Alternative 4A - Ground Water Interception and On-site Treatment

This alternative consists of landfill closure with a low-permeability cap in accordance with RCRA and NJDEP regulations (as presented in alternative 2), a downgradient drainage trench or French drain to intercept the observed contaminant plume, an on-site treatment facility (as described in alternative 3A), and upgradient injection of treated water. This alternative was developed to accomplish the same purpose as alternative 3A, to flush out leachable wastes in the saturated zone and treat the contaminated water. Since the ground water is a potential future source of drinking water in the area, it would be treated to meet drinking water and ground water standards. The treated effluent would meet NJPDES requirements. The downgradient drainage trench replaces the interceptor wells described in alternative 3A.

The downgradient drainage trench would be excavated to a depth of 30 feet immediately to the southwest of the site. A geotextile filter, crushed stone bedding and envelope, and a perforated pipe about 8 to 12 inches in diameter would be installed in the trench, which would then be backfilled to grade. The filter fabric would be tested for compatibility with the contaminated ground water. Contaminated ground water would be collected by gravity. Because pumping would not be necessary, this plume extraction alternative would require a minimum amount of energy.

On-site treatment and discharge of the collected ground water would be the same as described in alternative 3A. This alternative is presented in figure 17.

Alternative 4B - Ground Water Interception and Off-site Treatment

Alternative 4B consists of collection of ground water downgradient of the landfill using an interceptor trench, off-site treatment to meet NJPDES requirements and disposal of the ground water (as with alternative 3B), and landfill closure in accordance with RCRA and NJDEP regulations as described in alternative 2. This alternative is presented on figure 18.

2.8 SUMMARY OF COMPARATIVE ANALYSIS OF ALTERNATIVES

The alternative preferred by the Army, NJDEP, and EPA for implementation at the Fort Dix Landfill is alternative 2, closure with a low-permeability cap over the southern 50 acres of the landfill, and an expanded ground water monitoring program. Based on current information, this alternative provides the best balance among the nine criteria that EPA uses as a means of alternative evaluation.

The alternative evaluation and comparative analysis have been made in accordance with the revised NCP (March 8, 1990). This section provides a summary of the nine criteria and a comparative analysis of the remedial alternatives to each of the criteria. The nine criteria are described below.

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

- Compliance with ARARs addresses whether or not a remedy meets Federal and State environmental statutes and/or provides grounds for invoking a waiver.

- Long-term effectiveness and permanence refers to the ability of a remedy to maintain reliable protection of human health and the environment over time once cleanup goals have been met. It also addresses the magnitude and effectiveness of the measures that may be required to manage the risk posed by treatment residuals and/or untreated wastes.

- Reduction of toxicity, mobility or volume of contaminants addresses the anticipated performance of the remedy with respect to these parameters.

- Short-term effectiveness addresses the period of time needed to achieve protection, and any adverse effects on human health and the environment that may be posed during the construction and implementation period of the alternative.

- Implementability is the technical and administrative feasibility of a remedy, including the availability and performance of materials and services needed to implement the remedy.

- Cost includes estimated capital, O&M costs, and net present worth costs.

- State acceptance indicates whether, based on its review of the RI/FS and Proposed Plan, the State concurs with, opposes, or has no comment on the preferred alternative.

- Community acceptance indicates whether the public concurs with, opposes, or has no comment on the preferred alternative as reflected in the public comments received on the RI/FS report and the PRAP.

The comparative analysis, which identifies the relative advantages and disadvantages of each alternative under each evaluation criterion, is presented below.

Overall Protection of Human Health and the Environment

The baseline risk assessment determined that the landfill does not present significant risks and hazards to human health and the environment under the known site use conditions. Each of the alternatives, including no action, incorporates features to protect human health and the environment. These are described below.

- o Opportunity for direct contact with soils would be reduced by construction of a fence.
- o Surface grading would control runoff and erosion of soils.
- o Based on water level elevations and water quality data south of the landfill, the exposure pathway for ground water is currently incomplete.
- o Surface water and sediments pose no significant risk through direct contact or ingestion exposures, and contaminant concentrations would continue to decrease through natural attenuation.
- o Existing institutional controls would prevent future use of ground water from within the area of the contaminated ground water plume.
- o Gaseous emissions from the landfill pose no significant risk.
- o Monitoring of ground water, surface water, and air quality will provide sufficient advance notice of adverse changes from existing conditions to allow determination of need for additional remedial actions, and their implementation before significant exposures could occur.

In each alternative, except Alternative 1 - no action, construction and maintenance of a low-permeability cap would reduce leachate formation by limiting the infiltration of rain water through the landfill and, subsequently, the rate of contaminant discharge to ground water and surface water. The cap also would minimize the incidence of soil transport by erosion, and reduce the opportunity for direct contact by covering soils and fill material that may be contaminated.

The ground water interceptor and treatment systems proposed for alternatives 3A, 3B, 4A, and 4B would capture a significant portion of the contaminant plume exiting the landfill, reducing the total contaminant load that may discharge to surface water. The interceptor system proposed for alternative 3D would provide a smaller capture zone than the systems evaluated for the other alternatives, and would allow most of the ground water plume to discharge to surface water.

None of the ground water treatment alternatives would provide any additional public health benefit over landfill closure with monitoring (the selected remedy) because existing conditions currently do not pose a significant risk to human health and the environment and the low-permeability cap should significantly reduce the generation of leachate discharging to the ground water.

Compliance with ARARs

Each of the seven alternatives was estimated to achieve chemical-specific, location-specific, and action-specific ARARs for ground water quality and surface water quality, based on existing conditions and the expectation that no future releases would occur. The ground water and surface water quality standards are based on State and Federal MCL's for drinking water, State ground water and surface water quality criteria, Federal water quality criteria, and NJPDES requirements. The location-specific ARARs, including the E.O. 11990 "Protection of Wetlands", New Jersey Freshwater Wetlands Act (NJAC 7:7A-1.1), E.O. 11988 "Floodplain Management", and Section 7 of the Endangered Species Act, will be addressed in the design documents for the selected alternative. Any activities in the floodplain of Cannon Run will be designed in accordance with the Flood Hazard Area Control Act Regulations (NJAC 7:13-1.1 et seq.) for stream encroachment.

Each alternative, except alternative 1, would meet landfill closure requirements under RCRA and NJDEP regulations, and would satisfy NJPDES requirements. No action is not an appropriate alternative because of the ACO and RCRA closure requirements for the landfill. Therefore, it will not be considered further in this analysis as an option. The soil erosion and sediment control plan and the gas venting system will conform to requirements within the Soil Erosion and Sediment Control Act of 1975 (NJSA 4:24-40 et seq., and the regulations NJAC 2:90-1.1 et seq.), and Air Pollution Control Regulations (NJAC 7:27-1 et seq.).

The alternatives incorporating ground water treatment are expected to meet NJDEP requirements for air emissions and NJPDES requirements for either reinjection of treated effluent or its acceptance at a publicly-owned treatment works. The operation of the on-site treatment system would comply with RCRA requirements.

Location-specific and action-specific "to be considered" (TBC) goals identified for the Fort Dix site include State endangered plant/animal habitat species and well drilling, sealing, and pump installation requirements. Although potentially threatened species or habitats were identified within one mile of the site, the Fort Dix Landfill is not impacting these areas. Well drilling, sealing, and pump installations will be addressed in the design documents and will be conducted in accordance with the New Jersey requirements for all actions.

Long-Term Effectiveness and Permanence

The technologies employed by each of the alternatives historically have shown high reliability, with proper maintenance.

Under present site conditions (table 7) the total risk to human health under a worst-case scenario is $1x10^{-7}$. Because this number is less than the acceptable risk range, current exposure to the site is not expected to pose a significant risk. The estimated cancer risk under future ground water use, however, is greater than the acceptable range and may pose a significant risk.

None of the alternatives provides a permanent remedy, and reviews of the performance of the remedy will be needed no less often than three years after commencement of remediation and every five years thereafter, as required under CERCLA. It is unlikely that Fort Dix, knowing the risks that could result from the consumption of this water, would construct a well for drinking water purposes either through or in the plume associated with the landfill. In addition, it is unlikely that NJDEP would approve of a well permit application for a water supply well in this area. As long as Fort Dix maintains control of the landfill, the possibility of constructing a well on-site is minimal. This aquifer will continue to be monitored and appropriate remedial action will be implemented if needed.

Alternative 1 provides no controls for contaminant migration. Contaminants would continue to migrate from the landfill to ground water, and subsequently to surface water.

Alternative 2 is a relatively simple remedy to operate and maintain. Performance of the cap, passive venting system, and monitoring system are reliable with proper maintenance. Monitoring would continue until the remedial criteria for ground water and surface water are met as set forth in table 1, or alternatively it is determined that further remedial action is necessary, but in either case long-term ground water and surface water monitoring will continue for 30 years under the post-closure plan. If significant increases in unacceptable risk to human health and the environment are determined in the revised risk assessments, additional remedial action will be proposed. Unacceptable risk will be determined through a revision of the latest risk assessment, using the most recent total volume of data. Risk assessments will use EPA guidance and policy effective at the time of review. Once additional remedial action is deemed necessary, clean-up goals for the ground water and surface water will be based on chemical specific ARARs. Institutional controls (i.e., technical and/or administrative restrictions placed by the Federal and/or State agencies) on land use can be maintained as long as the Army retains control over the landfill. Land use restrictions currently in place could be altered through legislative action or the public review process, but should be reliable at least through the planning period for the remedial action.

Water use restrictions, if enforced properly through local, state, and federal agencies, should also be reliable.

The ground water interception and treatment components of the other alternatives are expected to be short-term actions (10-year planning period), and provide no additional benefit toward long-term effectiveness because remedial criteria are expected to be met within the same time frame as in alternative 2.

Current risks and hazards to human health at the site are below EPA's risk range. The alternatives 2, 3A, 3B, 3D, 4A and 4B would act to minimize these risks even further, while Alternative 1 to a lesser degree, would act to minimize some of these risks. To minimize any future risk and to evaluate the ground water, surface water, and air quality, these three media would be monitored under all alternatives.

Reduction of Toxicity, Mobility, or Volume through Treatment

Under CERCLA, remedies that use treatment to permanently and significantly reduce the toxicity, mobility, or volume of contaminants are to be given preference over remedies that do not. However, full compliance with this criterion is impractical at the Fort Dix Landfill, where the contaminated volume is large and contaminant concentrations are believed to be low.

Each of the alternatives selected for detailed evaluation in this report would allow this potential source of contamination to remain.

Alternative 2, and each of the remedial actions incorporating ground water treatment, reduces the rate of contaminant migration to surface water, and the volume of the leachate generated, by reducing the infiltration of rain water through the landfill. Treatment of the ground water is currently not necessary for protection of human health or the environment, and treatment of the landfill contents is not practical.

Treatment of the ground water would reduce the toxicity of the present-day plume, and would reduce the total amount of contaminants-eventually discharged to surface water. Under existing site conditions, ground water treatment is not expected to yield significant benefit over landfill capping alone, because the amount of contamination discharging to surface water is small and the contamination appears to be dissipating through natural processes. Contaminants currently discharging to surface water bodies do not present a threat to human health or the environment.

Alternatives 3A and 4A provide treatment to the maximum practical extent, but would produce residues (alkaline iron sludge and spent activated carbon) that would require off-site disposal or additional treatment. Alternative 3D would treat a smaller volume of ground water (50 instead of 220 gallons per minute), but would produce a smaller amount of sludge for disposal, and no spent carbon. Alternatives 3B and 4B are similar to alternatives 3A and 4A, respectively, but provide for off-site treatment of the ground water.

Short-Term Effectiveness

Because volatile organics and particulate matter could be released into the atmosphere during the installation of the landfill cap, contingency plans and monitoring plans for construction will be developed under the design-stage documents to minimize risks to on-site workers or to the community. Risks to the community will decrease as attenuation decreases contaminant concentrations. Worker protection will be maintained by monitoring to detect deviations from expected conditions, and use of engineering controls, including respiratory or dermal protection, if needed.

No significant adverse impacts are expected from the short-term operation of any of these alternatives except 3B and 4B. Engineering controls will be used to control surface runoff and minimize erosion, and suppress dust generated during construction.

Construction and maintenance of the low-permeability cap, under each of the alternatives except "no remedial action," will significantly reduce the rate of leachate formation and subsequent contaminant loading to ground water and surface water. Alternatives 3A, 3B, 4A, and 4B will significantly reduce the total contaminant loading to surface water by intercepting the contaminant plume exiting the landfill. However, the increase in truck traffic associated with the off-site transport of ground water under alternatives 3B and 4B constitutes an undesirable short-term impact. Under alternative 3D, most of the contaminant plume would be allowed to discharge. Alternative 2 would allow all of the plume to discharge to surface water, but at a much lower rate than alternative 1, "no remedial action." As there is no significant risk to public health or threat to the environment under current conditions, the differences in the rate or quantity of contaminants discharged is not a critical factor in remedy selection. Contaminant concentrations are low and may be dissipating to undetectable levels through natural processes.

Implementability

Excluding consideration of "no remedial action", Alternative 2 would be the most simple to construct, and its O&M would be the most straightforward.

Construction and operation of alternatives 3A, 3B, and 3D would be more complex, as there would be more components to construct and operate, but still would be fairly straightforward. Conventional treatment processes would be used, and equipment specialists and materials are available.

Alternatives 4A and 4B would be somewhat more difficult to implement. Construction of the trench would require dewatering, and the collected water would have to be treated for disposal. During operation an estimated 50 trips per day of trucks of 6,000-gallon capacity would be required to transport ground water offsite for treatment. Over time the interceptor trench may experience clogging or structural failure, and its repair or replacement would be as difficult and costly as its construction.

Each alternative includes a monitoring program that would provide notice of deviations from expected environmental conditions or failure of the remedy with sufficient advance notice to determine whether additional remedial actions are warranted, and allow their implementation before significant exposures can occur. If additional actions are warranted, any of the alternative remedies could be augmented by additional remedial actions (e.g. extended cap, additional capture wells, changes to treatment process) without interfering with the existing remedy.

Under each alternative, NJDEP approval through NJPDES would be needed to incorporate additional ground water monitoring wells, and monitoring at surface water discharge points. Should land use and water use restrictions be necessary they will be arrived at through consultation with EPA, NJDEP, and the Army.

Under alternatives 3A, 3D, and 4A, NJDEP approval will be needed for air stripper emissions and effluent reinjection. Off-site disposal of treatment residues may become more difficult as disposal regulations and capacity limitations become more restrictive.

Under alternatives 3B and 4B, a Significant Indirect User permit and approval from the Mount Holly Utilities Authority will be needed for ground water to be received at the Mount Holly treatment plant. The facility management has stated its willingness to accept ground water from the site for treatment.

Costs

Alternative 2 has the lowest total project and operating costs of all the alternatives, except "no remedial action." Construction of the cap is the most expensive component of any of the remedies, but its annual maintenance cost is the lowest.

Alternative 3D has the next lowest total project cost of the alternatives, but offers no significant benefit over alternative 2. It has the next lowest annual O&M costs, about 40 percent of those for alternative 3A or 4A, but would be much less effective in intercepting contaminants before discharge.

The total project costs of alternatives 3A, 3B, 4A, and 4B are comparable, with 3A being the least expensive. Annual costs for 3A and 4A are similar, as are annual costs for 3B and 4B. Annual costs for these alternatives are several times greater than for the other alternatives. A summary of costs for each alternative is presented in tables 6, 11 and 12.

State Acceptance

The New Jersey State Department of Environmental Protection concurs with the selected remedy.

Community Acceptance

Public comments on the Proposed Plan are addressed in the Responsiveness Summary.

2.9 SELECTED REMEDY

The Army, EPA, and NJDEP have evaluated the remedial alternatives in accordance with Section 121(b) of CERCLA and Section 300.432 of the NCP, and have selected alternative 2 as the preferred remedial action for the landfill based on the findings of the RI/FS.

The selected remedy for the Fort Dix Landfill, alternative 2, is landfill closure with a low-permeability cap and an expanded environmental monitoring program subject to EPA approval. This provides a landfill closure plan in accordance with NJAC 7:26-2A et seq. The preferred remedy includes but is not limited to:

1. Installation of a cap on the southern 50 acres of the landfill that will consist of vegetative, drainage, and low-permeability layers. Two feet of final cover will be maintained on the remaining portion of the landfill which will not receive the cap. The final cover requirements will be developed in consultation with NJDEP and EPA.

2. Installation of a landfill gas venting and air monitoring system (to determine if methane gas and VOC emissions require treatment).

3. Installation of chain-link fence around the perimeter of the landfill to restrict access to the site.

4. Implementation of landfill closure requirements in accordance with NJAC 7:26-2A et seq., and RCRA guidance.

5. Long-term ground water, surface water, and air monitoring (30 years) pursuant to the New Jersey State closure requirements. A yearly statistical analysis will be performed on the chemical analysis results to determine the trend of the overall contamination levels.

6. Long-term O&M to provide inspection of and repairs to the landfill cap.

7. Institutional controls in the form of deed and water use restrictions on future uses of the landfill and ground water in the immediate vicinity of the landfill.

8. Development and implementation of a soil erosion and sediment control plan in accordance with the Soil Erosion and Sediment Control Act Regulations of 1975, NJSA 4:24-40 et seq., and NJAC 2:90-1.1 et seq.

9. Using the data obtained in the monitoring program, the risk assessment will be reviewed and subsequently revised if the trend shows significant changes in water quality. These reviews and revisions will occur no less often than three years after commencement of remedial action and every five years thereafter. Any changes in actual exposure scenarios will be addressed in the revised risk assessments. Risk assessments will use EPA guidance and policy effective at the time of the review.

10. If significant increases in unacceptable risk to human health and the environment are determined in the revised risk assessments, additional remedial actions will be proposed.

In addition, monitoring will be conducted during the design phase that will include the following:

1. Collect and analyze sediment samples at the point where Cannon Run discharges into the North Branch of Rancocas Creek;

2. Perform standard bioassay testing for freshwater species on samples collected from a piezometer, a proposed monitoring well, and surface water along Cannon Run;

3. Conduct air sampling for volatile organic analysis; and,

4. Sample newly installed and selected existing monitoring wells for chemical analysis.

This alternative is protective of human health and the environment, complies with ARARs, and is cost-effective. A list of ARARs for this alternative is set forth in table 10. Labor, materials, and methodologies are available for implementation of this alternative. Short-term risks associated with alternative 2 are construction-related and can be minimized. The low-permeability cap effectively reduces the amount of infiltration and leachate generated by the landfill, provides a protective layer that reduces potential impacts to the environment and public health, and costs less than the other "action" alternatives.

As with all of the alternatives, a long-term environmental monitoring plan (30 years) would be developed as part of landfill closure to monitor the effectiveness of the remedy in protecting the environment and public health. The results of the environmental monitoring would be reviewed by the Army, EPA, and NJDEP. Based on the results of this monitoring, additional remedial actions may be required as appropriate.

Treatment of the ground water is currently not necessary for protection of human health or the environment. Treatment of the landfill contents is not practical as described in the FS (i.e., the contaminated volume is large and, based on the historical and RI data, the contaminant concentrations are believed to be low). Recent guidance on remedy selection under CERCLA indicates that treatment need not be considered under these circumstances. LDR are not applicable to this action because the landfill will be capped and placement will not occur.

2.10 STATUTORY DETERMINATIONS

The primary responsibility of the Army and EPA at Federal Facility Superfund sites is to undertake remedial actions that achieve protection of human health and the environment. In addition, section 121 of CERCLA establishes several other statutory requirements and preferences. These specify that when complete, the selected remedial action for this site must comply with applicable or relevant and appropriate environmental standards established under Federal and State environmental laws unless a statutory waiver is justified. The selected remedy also must be cost-effective and utilize permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable. Finally, the statute includes a preference for remedies that employ treatment that permanently and significantly reduce the volume, toxicity, or mobility of hazardous wastes as their principal element.

Protection of Human Health and the Environment

Because it would include fencing, capping, monitoring, landfill gas venting, and deed restrictions, the selected remedy would be protective of human health and the environment. How the selected remedy will address each potential exposure pathway is presented below.

Air. Following installation of the 50-acre cap, and revegetation of the capped areas, exposure pathways involving air transport of contaminated particulates would no longer be complete. Those areas to the north of the proposed cap, which are not heavily vegetated, would be covered with clean soil and revegetated to maintain at least two feet of clean soil over the landfilled material. The vegetation should reduce the erosion of the surface and the transport of soils as fugitive dusts. Restricted site access would also reduce the potential for exposure at the older sections of the landfill.

Methane, other gaseous components of anaerobic degradation, and VOCs would be released to the atmosphere from the passive gas-venting system installed as part of closure. However, the emission of VOCs is not expected to present a threat to public health under known site conditions. In addition, the air monitoring program would be used to evaluate the effectiveness of the system and to predict impacts to on-site workers and the surrounding community.

Soils. Placement of the cap over the newer sections of the landfill would cover any contaminated soils or waste materials present at the surface of the landfill. As long as the integrity of the cap is maintained, the exposure pathway of direct contact with contaminated soil or waste materials would be eliminated. In addition, the construction of the fence around the landfill to restrict site access also would limit opportunities for contact with on-site soils. Grading of the site and construction of the cap would reduce or eliminate hazards associated with erosion or washout of on-site soils, and the exposure of refuse and construction materials. Construction of the cap would, therefore, prevent the landfill from presenting a risk to human health and the environment by eliminating the exposure pathways involving direct contact with contaminated soils, or their transport in surface runoff.

Ground Water. Capping the landfill would significantly reduce the rate of migration of contaminants to the ground water. If the landfill does not continue to act as a source, the reduction in infiltration caused by the cap would allow an eventual improvement of ground water quality.

The composition of the landfill materials was not investigated during the RI. However, inferences can be made regarding the likelihood of future releases based on the information that is available. Because disposal practices were controlled from 1980 until disposal activities ceased, it is believed that drummed wastes are absent from the area identified as the most likely source of the contaminant plume. Soils and fill materials have been washed by infiltrating precipitation for up to 40 years, which would be sufficient to remove most of the leachable waste material. Moreover, there has been no evidence of episodic releases since ground water monitoring was initiated in 1979. For these reasons, it is believed that significant releases are not likely to occur at any future time.

Potential exposure pathways for ground water are considered to be incomplete under existing conditions. Institutional controls restricting the use of on-site ground water would be needed to prevent exposure to contaminated ground water through future uses. Existing controls should be adequate for this purpose. The purpose of the monitoring program is to determine if further action at the Fort Dix landfill is needed.

Surface Water. The construction of the landfill cap would not directly eliminate the existing contaminant plumes, or the transport of drainable wastes (if present) from the landfill into the ground water flow field.

However, the cap would reduce the amount of leachate generated by reducing the amount of infiltration. The baseline risk assessment determined that periodic contact with surface water and sediments in the swamp and Cannon Run would not pose a significant health risk to children playing in that area, under existing conditions. Surface water quality should improve over time with the installation of the cap, with resulting reductions in estimated risk.

Leachate seepage from the landfill will be significantly reduced through capping, and fencing will restrict access to those sections of Cannon Run immediately adjacent to potential seeps. The potential health risks associated with exposure to contaminants in Cannon Run are not significant under known conditions, and would be reduced to even lower levels by these remedial measures.

Biological Community. Construction of a fence around the site and sections of Cannon Run would decrease the likelihood of domestic or wild animals coming in contact with contaminated soil or ingesting contaminated plants. However, fencing the site will make the landfill a less viable habitat for larger animals.

Continuation of contaminant discharge to either the swamp or Cannon Run may result in adverse impacts to aquatic life, vegetation, and wildlife that use these areas as a water source. However, it is expected that the adverse effects would be minimal, considering the nature and levels of the contaminants detected in the ground water and the history of improved water quality.

Compliance with ARARs

The selected alternative consists of closure of the Fort Dix Landfill in accordance with NJDEP and RCRA regulations, along with a sampling program to monitor changes in ground water, surface water, and air quality. This alternative would also include a closure and post-closure plan as defined by NJAC 7:26-2A.9 et seq. Monitoring of ground water and surface water will continue until remedial criteria are met as set forth in table 1, or alternatively it is determined that further remedial action is necessary. The soil erosion and sediment control plan and the gas venting system will conform to requirements within the Soil Erosion and Sediment Control Act of 1975 (NJSA 4:24-40 et seq. and the regulations NJAC 2:90-1.1 et seq.), and Air Pollution Control Regulations (NJAC 7:27-1 et seq.). Any activities in the flood plain of Cannon Run will be designed in accordance with the Flood Hazard Area Control Act Regulations (NJAC 7:13-1.1 et seq.) for stream encroachment.

A health and safety program for the installation and maintenance of the landfill closure elements and monitoring program would be established in compliance with the National Institute for Occupational Safety and Health and the Occupational Safety and Health Administrations.

Location-specific ARARs, including the E.O. 11990 "Protection of Wetlands", New Jersey Fresh Water Wetlands Act (NJAC 7:7A-1.1), E.O. 11988 "Floodplain Management", and Section 7 of the Endangered Species Act will be addressed in the design documents for the selected alternative.

Location-specific and action-specific TBCs identified for the Fort Dix site include State endangered plant/animal habitat species and well drilling, sealing, and pump installation requirements. Although potentially threatened species or habitats were identified within one mile of the site, the Fort Dix Landfill does not impact these areas. Well drilling, sealing, and pump installations will be addressed in the design documents and will be conducted in accordance with the New Jersey requirements for all actions.

Cost Effectiveness

The selected remedy is cost-effective because it has been determined to provide overall effectiveness proportioned to its costs (present worth = $14.5 million). Tables 11 and 12 compare estimated costs affiliated with each component of all alternatives. The selected remedy has significantly lower capital and O&M costs than all of the other "action" alternatives.

Utilization of Permanent Solutions and Alternative Treatment Technologies or Resource Recovery Technologies to the Maximum Extent Practicable

The Army, EPA, and NJDEP have determined that the selected remedy represents the maximum extent to which permanent solutions and treatment technologies can be utilized in a cost-effective manner.

Based upon the information presented, the selected remedy will protect ground water quality by reducing infiltration and leachate production. It provides the best balance among all nine evaluation criteria, with the following being the most important considerations for the site:

1. Compliance with State and Federal ARARs for solid waste landfill closure
2. Availability of equipment and materials
3. Cost of construction, O&M
4. Elimination of rain water infiltration and, thus, reduction in the volume of leachate released to the ground water
5. Continued monitoring to ensure the remedy continues to be protective of human health and the environment

Preference for Treatment as a Principal Element

The selected remedy does not satisfy the statutory preference for treatment because treatment is impractical. The remedy does not include treatment of any contaminated matrix. Treatment of the source of contamination (the landfill itself) is technically impracticable because of the large volume of material, the expected heterogeneity of the material, and the low contaminant concentrations believed to be present. The feasibility of treating isolated, heavily contaminated areas cannot be evaluated because the nature and extent of contamination within the fill area has not been quantified.

None of the ground water treatment alternatives would provide any additional public health benefit over landfill closure with monitoring (the selected remedy) because existing conditions currently do not pose a significant risk to human health and the environment and the low-permeability cap should significantly reduce the generation of leachate discharging to the ground water. The monitoring program that will be implemented as part of this action will better define the nature and extent of contamination (organic and inorganic) and detect changes in ground water, surface water, and air quality. These data will be reviewed as they are collected, so that if significant degradation in the quality of these media is noted, then further action can be initiated. Unacceptable risk will be determined through a revision of the latest risk assessment, using the most recent total volume of data. Risk assessments will use EPA guidance and policy effective at the time of the review. Also, the effectiveness of the selected remedy will be reevaluated no less often than three years after commencement of remedial action and at least every five years thereafter as required under CERCLA.

(fort_dix/101)

ATTACHMENT 1 FIGURES

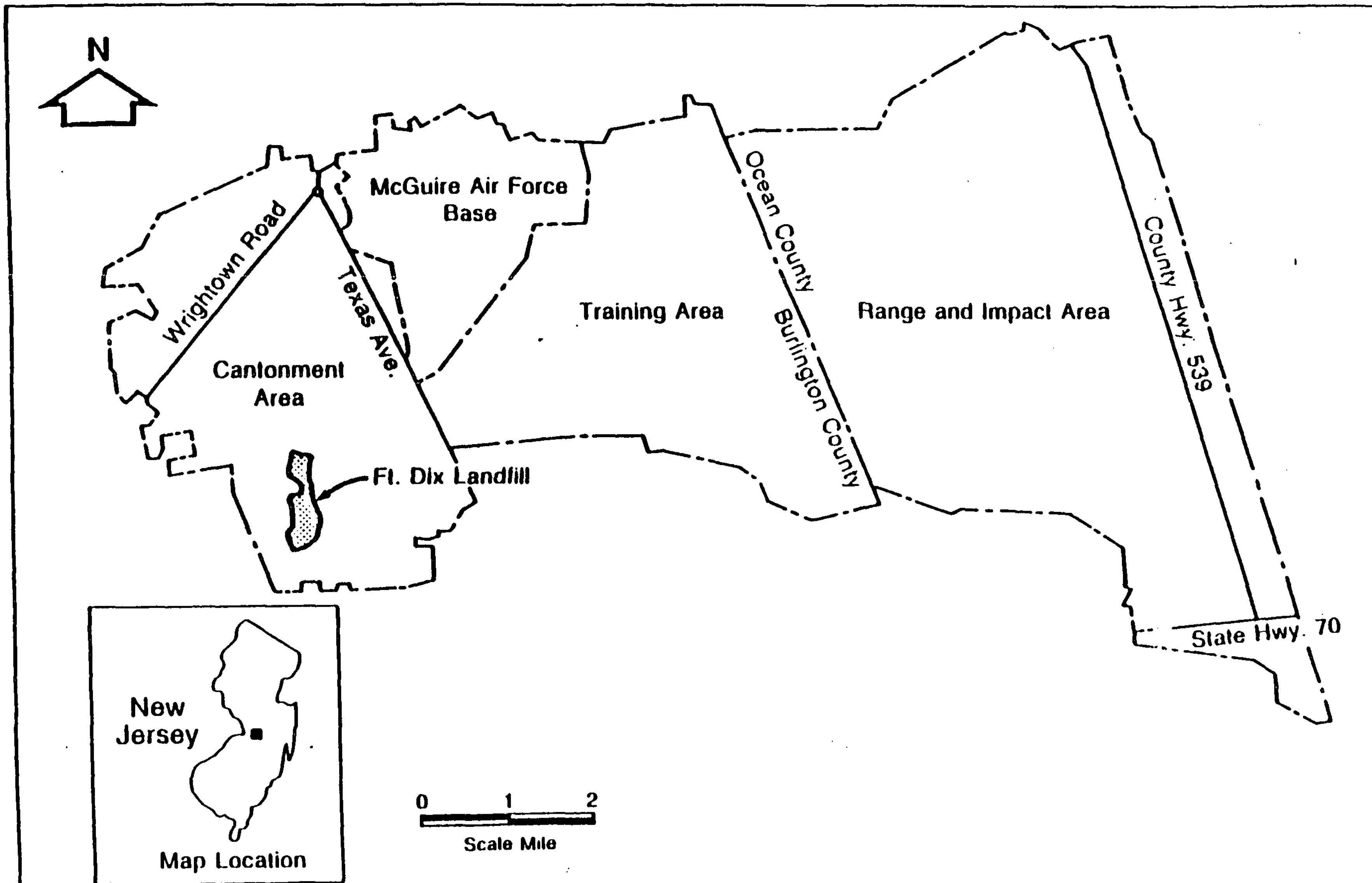

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Figure 1

General Location Map

Fort Dix Sanitary Landfill

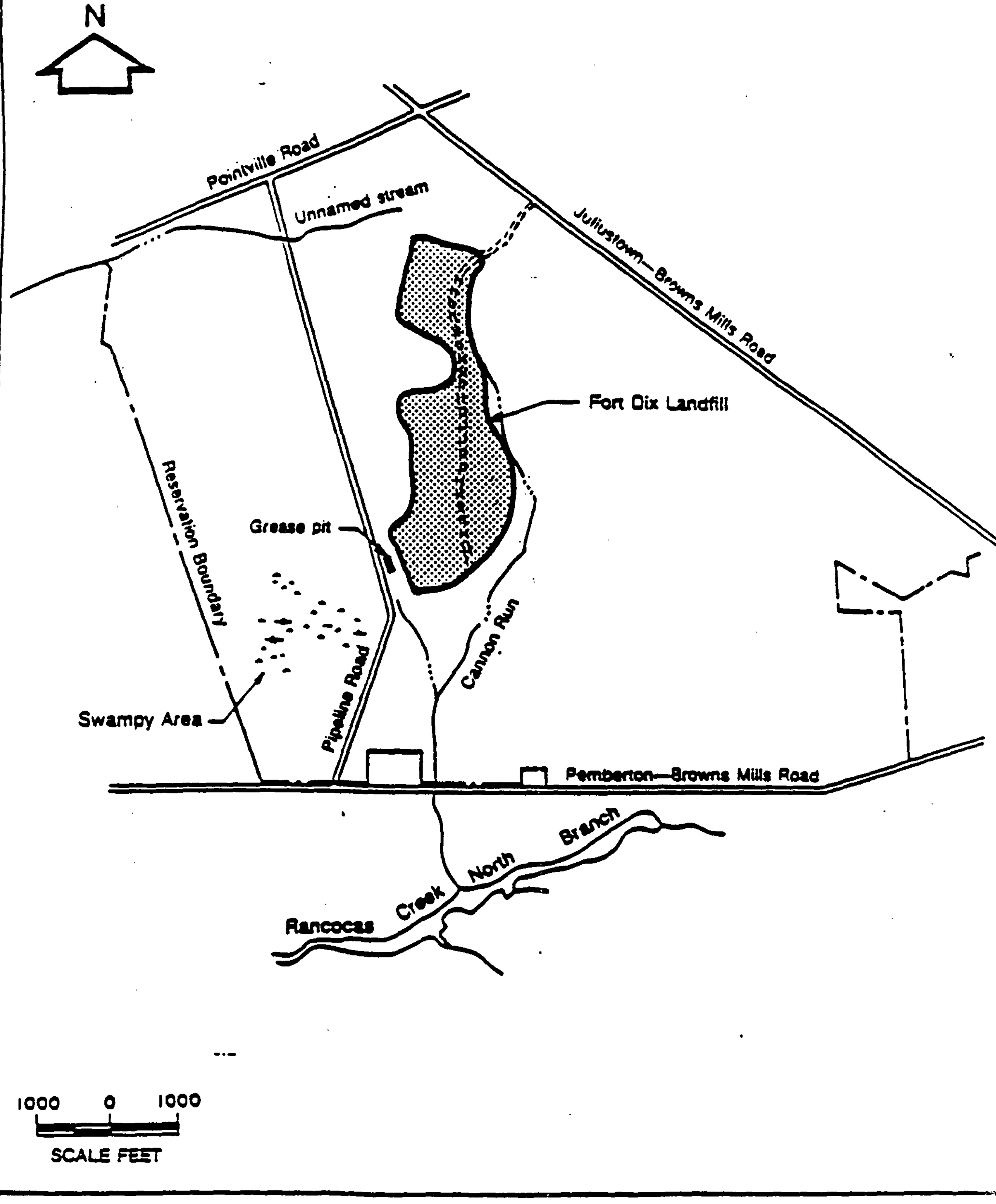

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Figure 2

Site Location Map

Fort Dix Sanitary Landfill

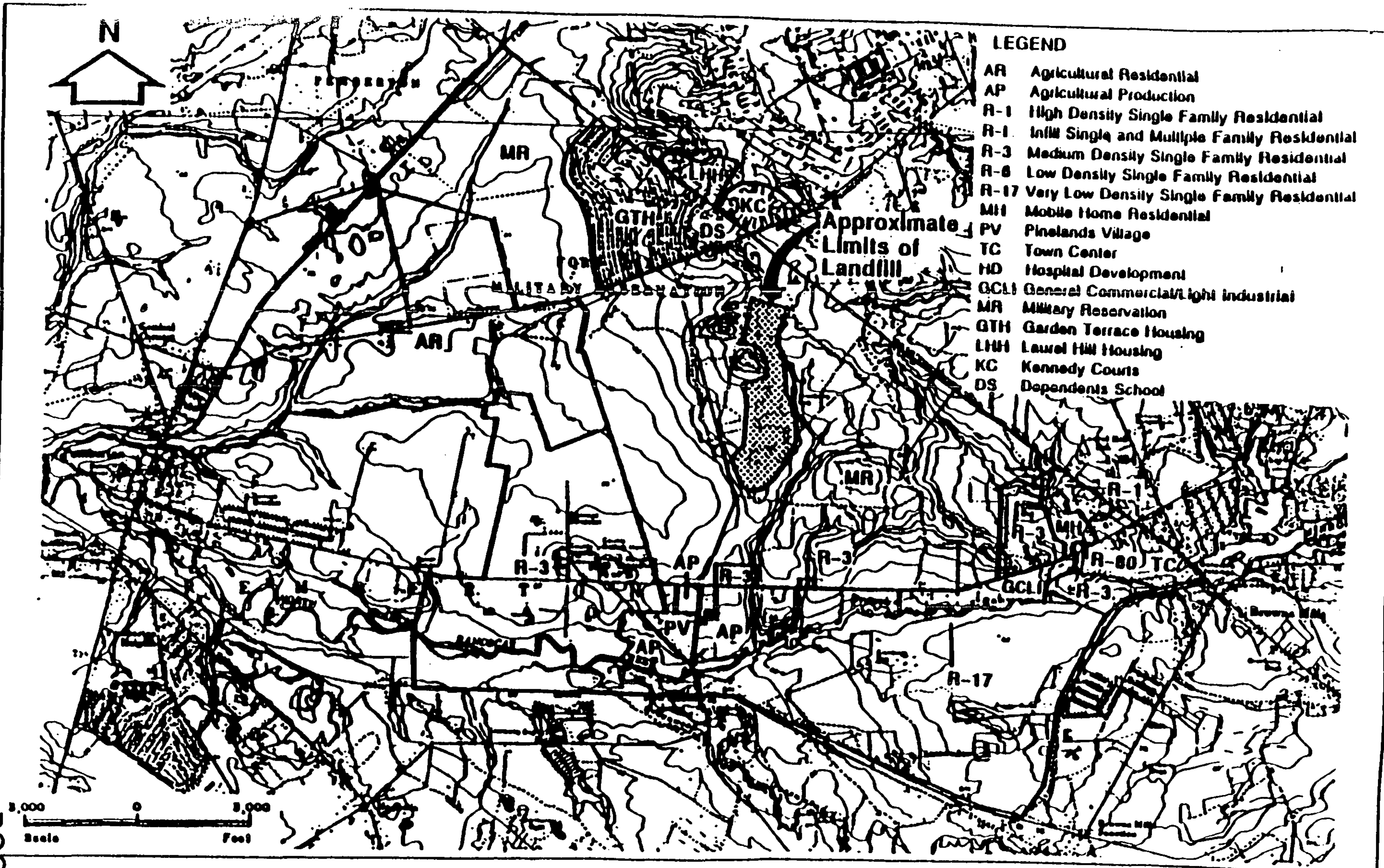

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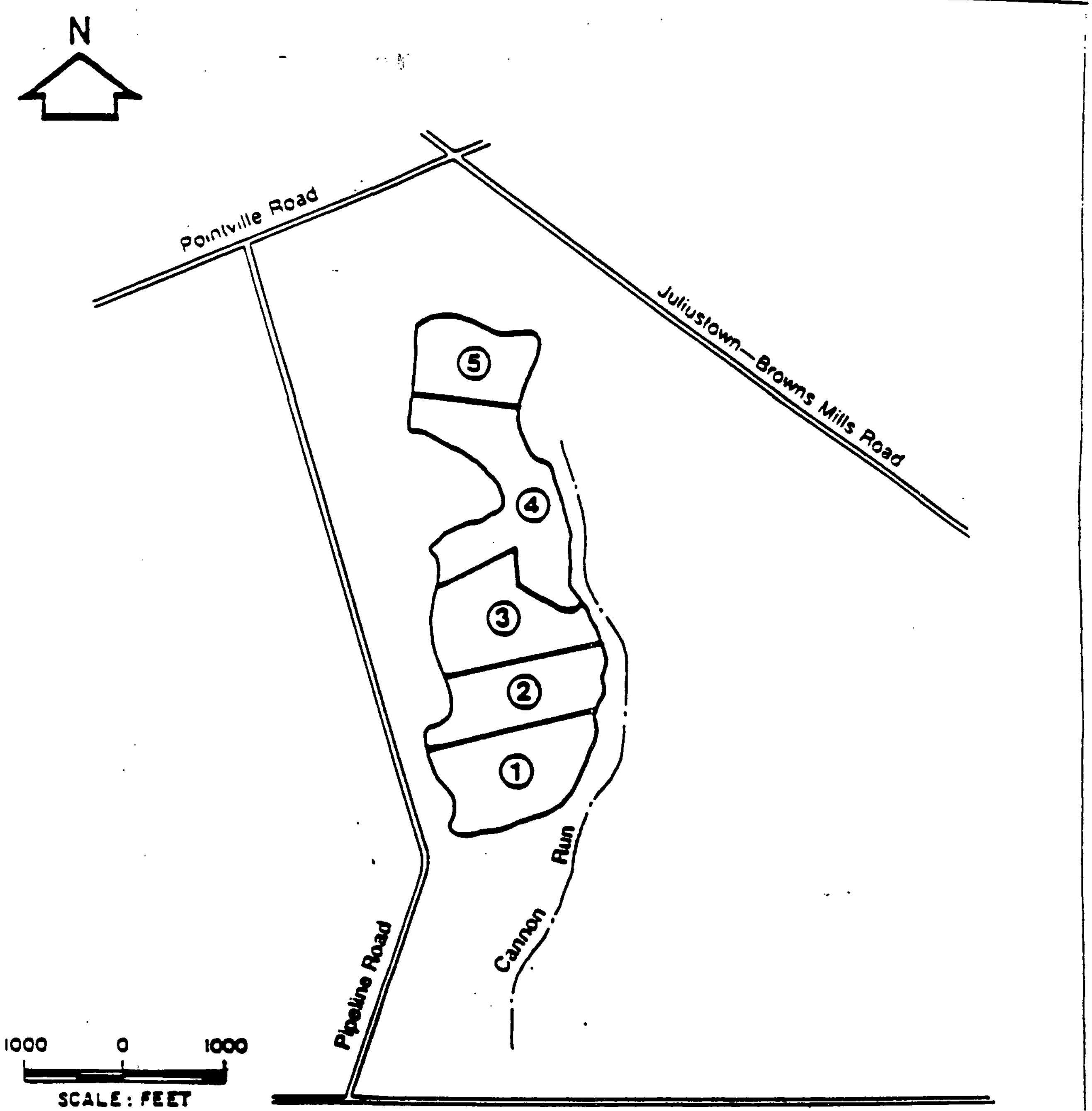
Figure 3

Land Use Map

Fort Dix Sanitary Landfill



Key:

1. Material Filled Between 1974–1984
2. Material Filled Between 1970–1974
3. Material Filled Between 1963–1970
4. Material Filled Between 1956–1963
5. Material Filled Before 1956

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Figure 4
Fort Dix Landfill Development Progression
Fort Dix Sanitary Landfill

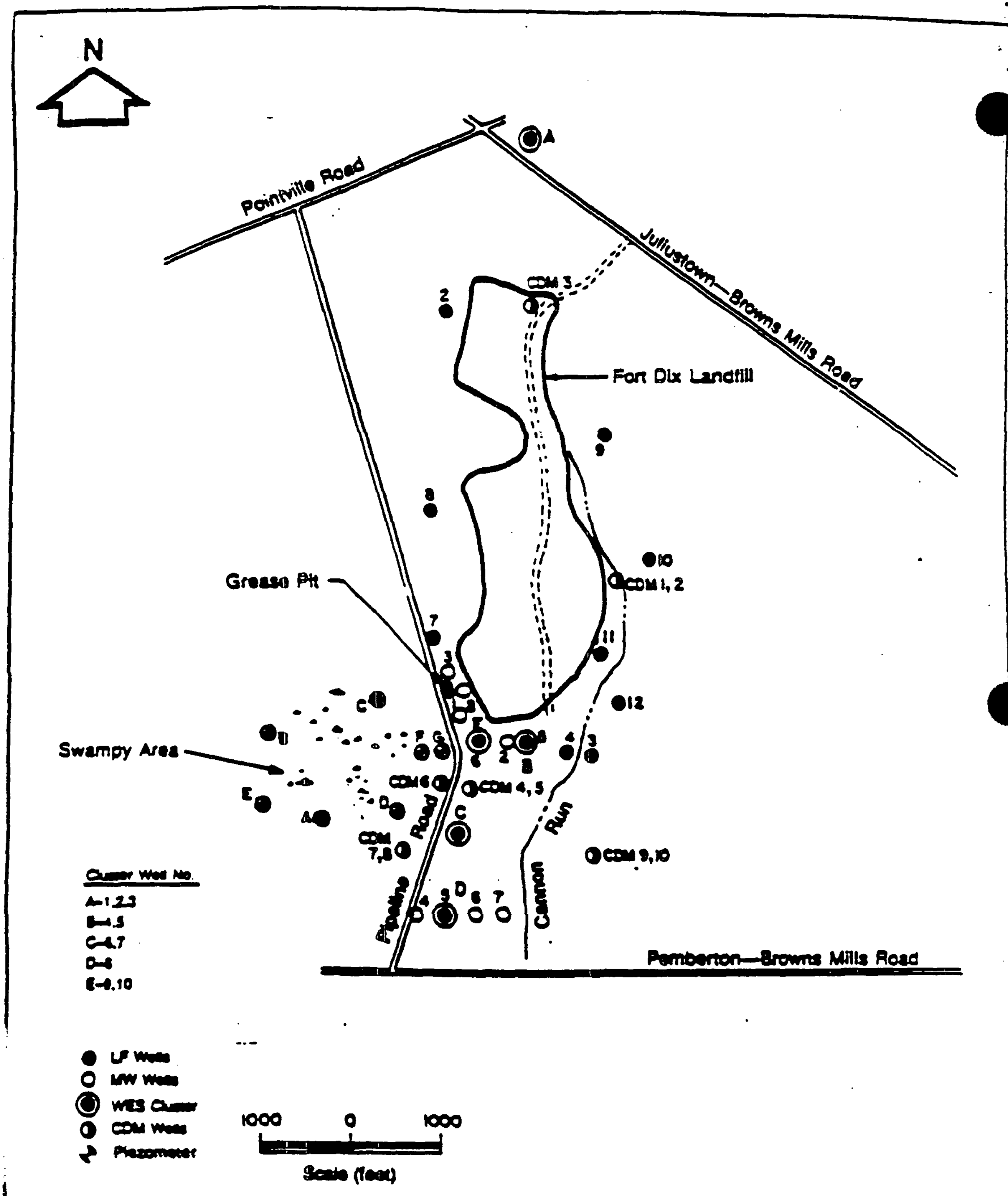

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Figure 5

Monitoring Well and Piezometer Locations

Fort Dix Sanitary Landfill

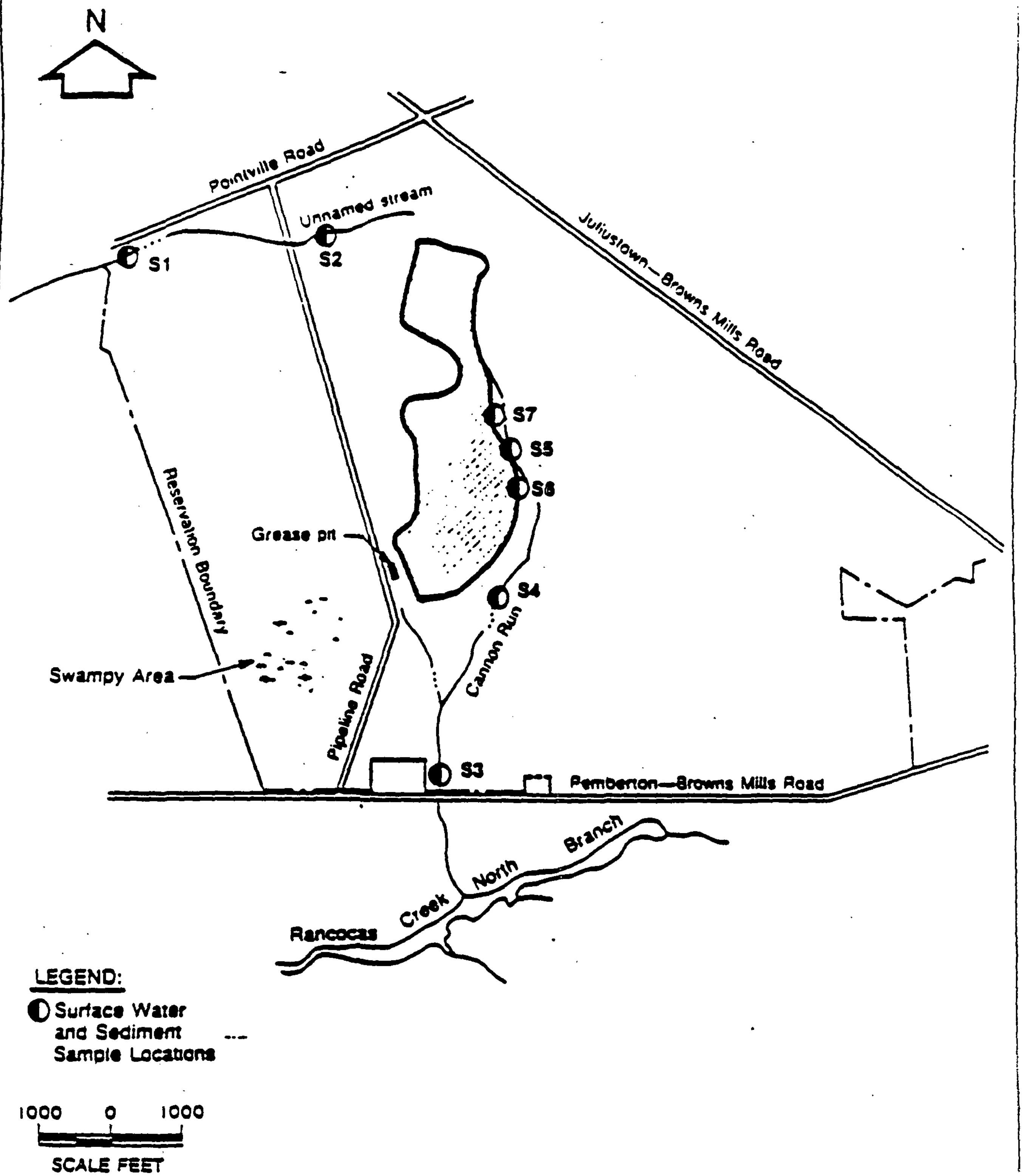

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Figure 6

Surface Water, Sediment and Leachate Sample Locations

Fort Dix Sanitary Landfill

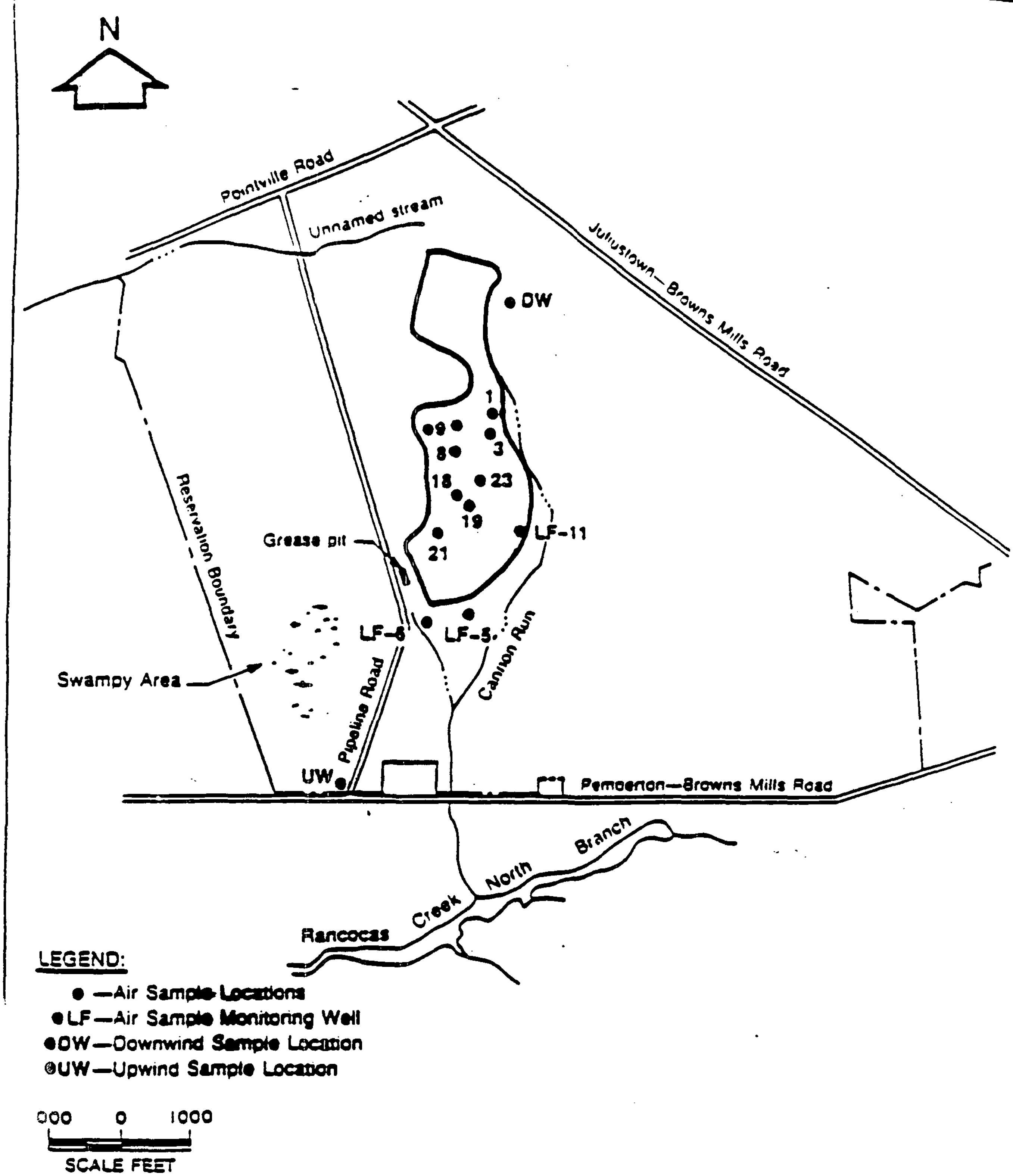

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Figure 7

Air Sample Locations

Fort Dix Sanitary Landfill

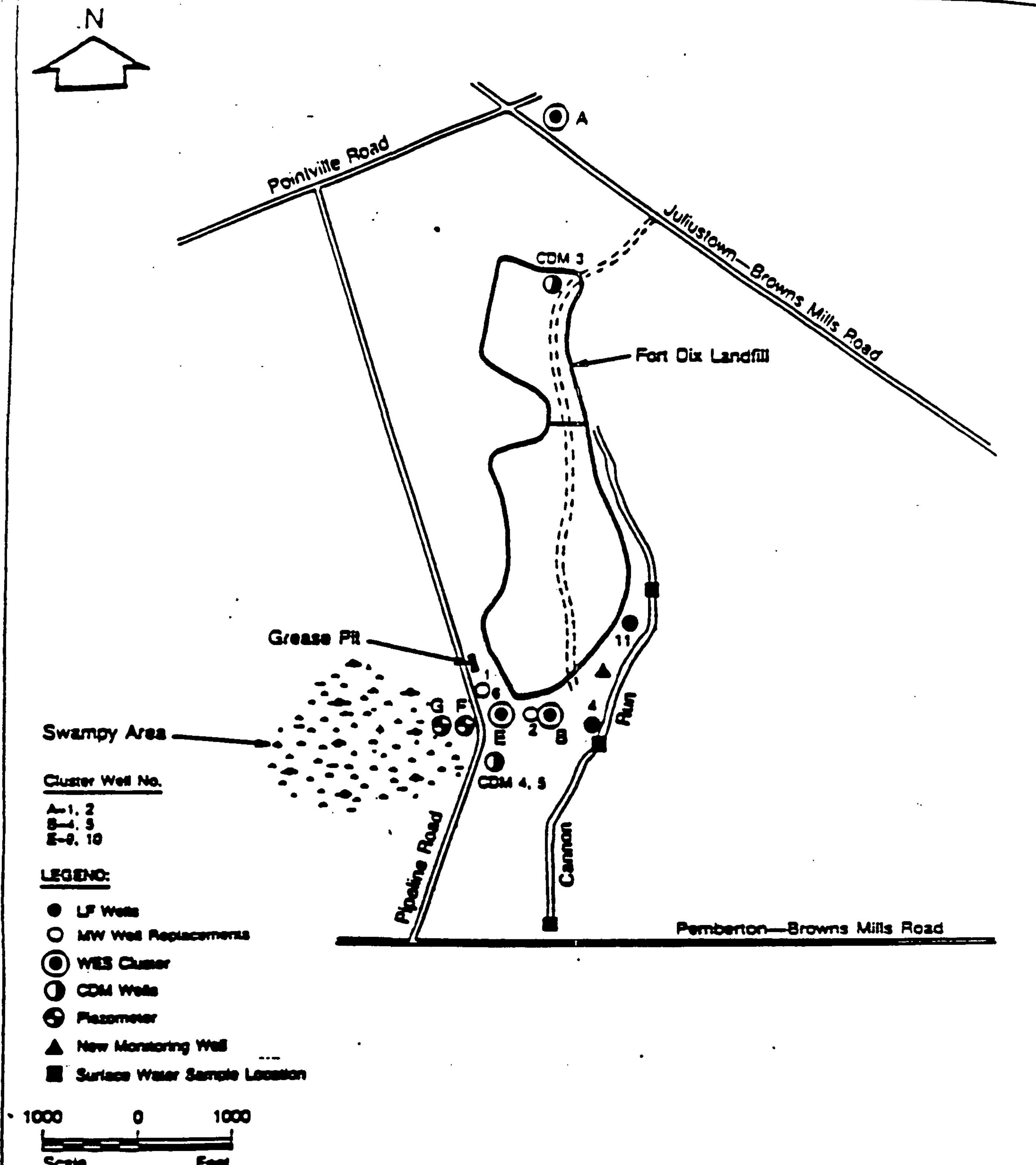

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Figure

Alternative
No Action

Fort Dix Sanitary Landfill

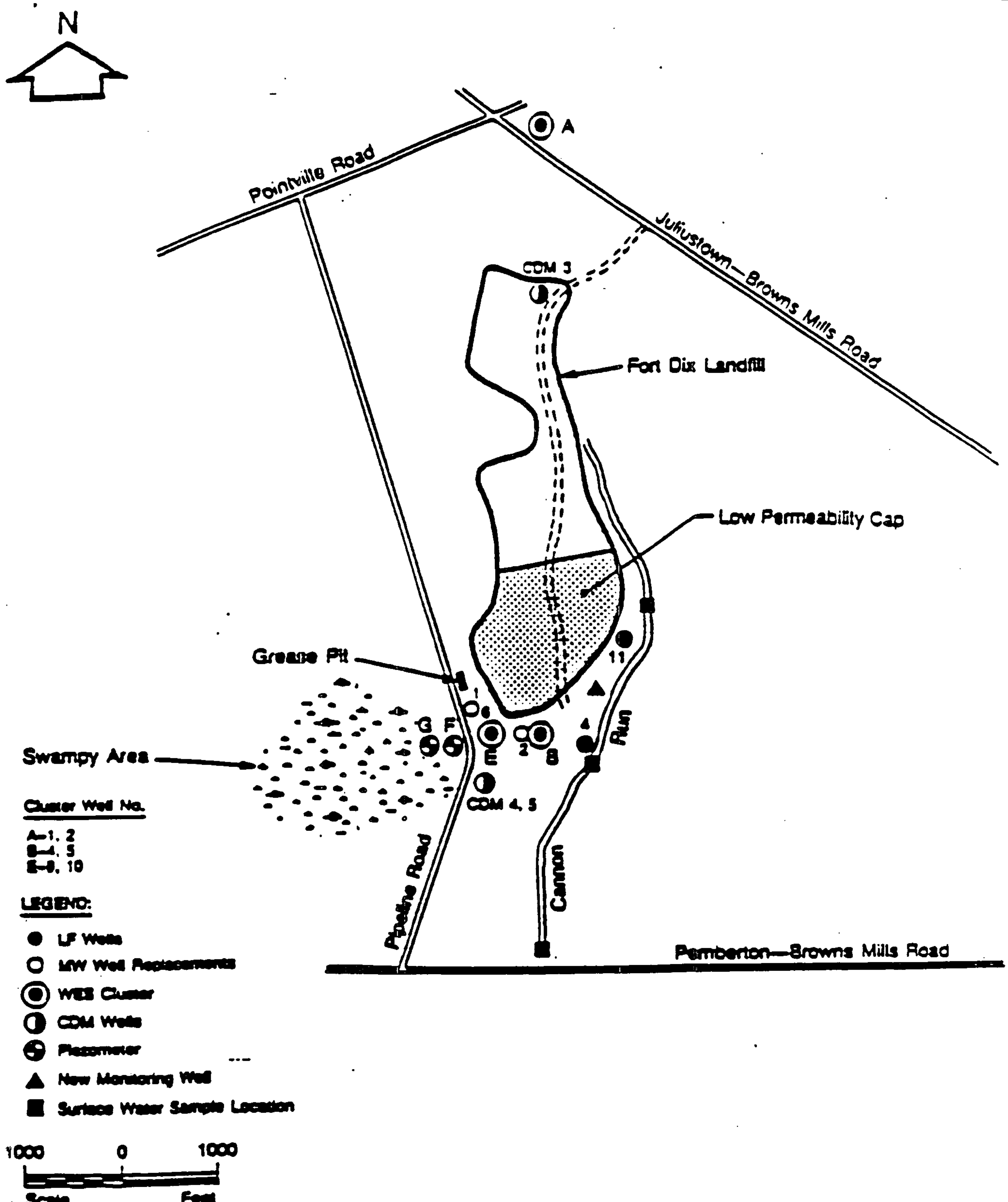

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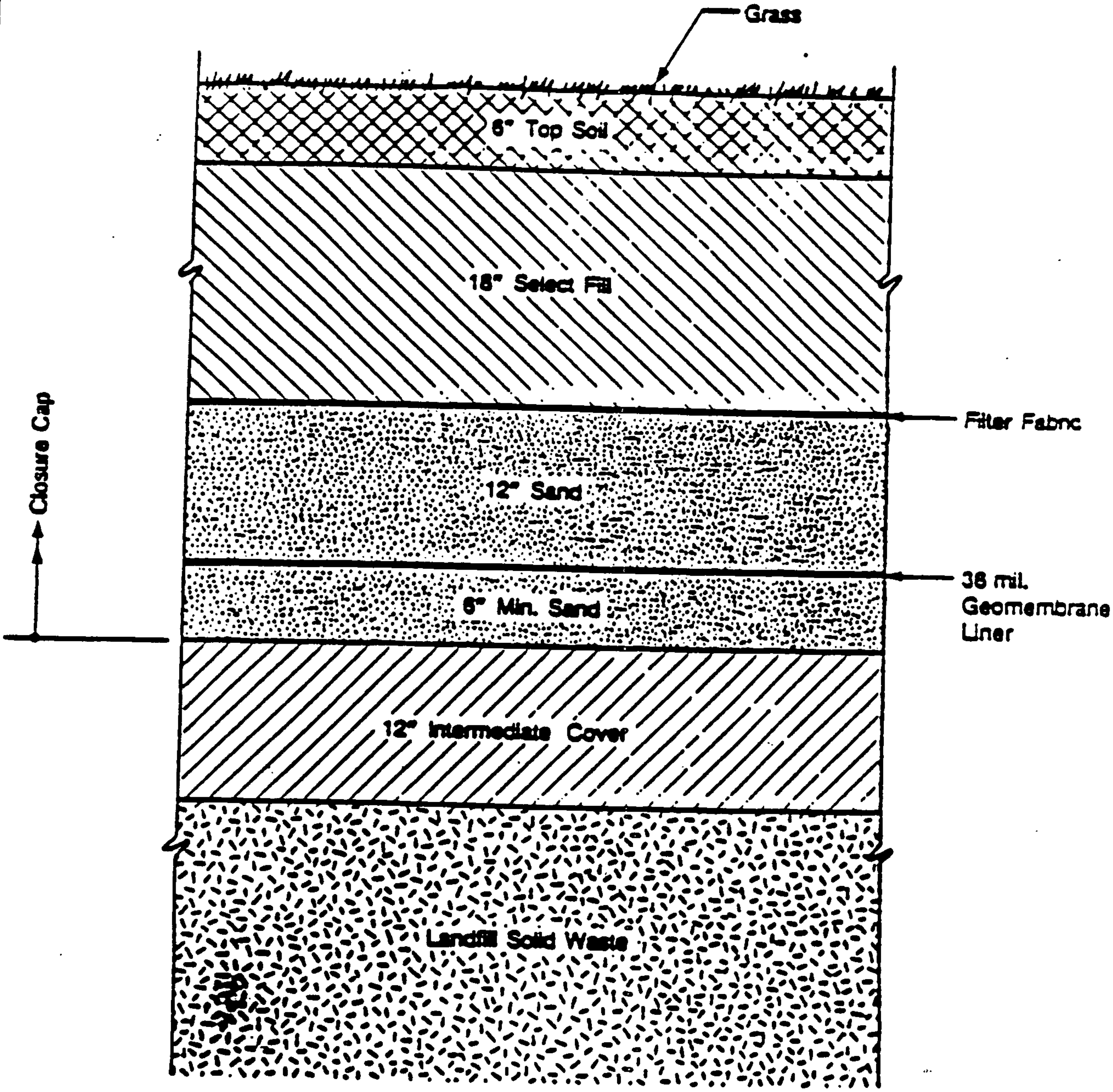
Figure 9

Alternative 2
Landfill Closure

Fort Dix Sanitary Landfill



Not to scale

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Figure 1

Typical Closure Cap Detail
Side Slopes <7 %

Fort Dix Sanitary Landfill

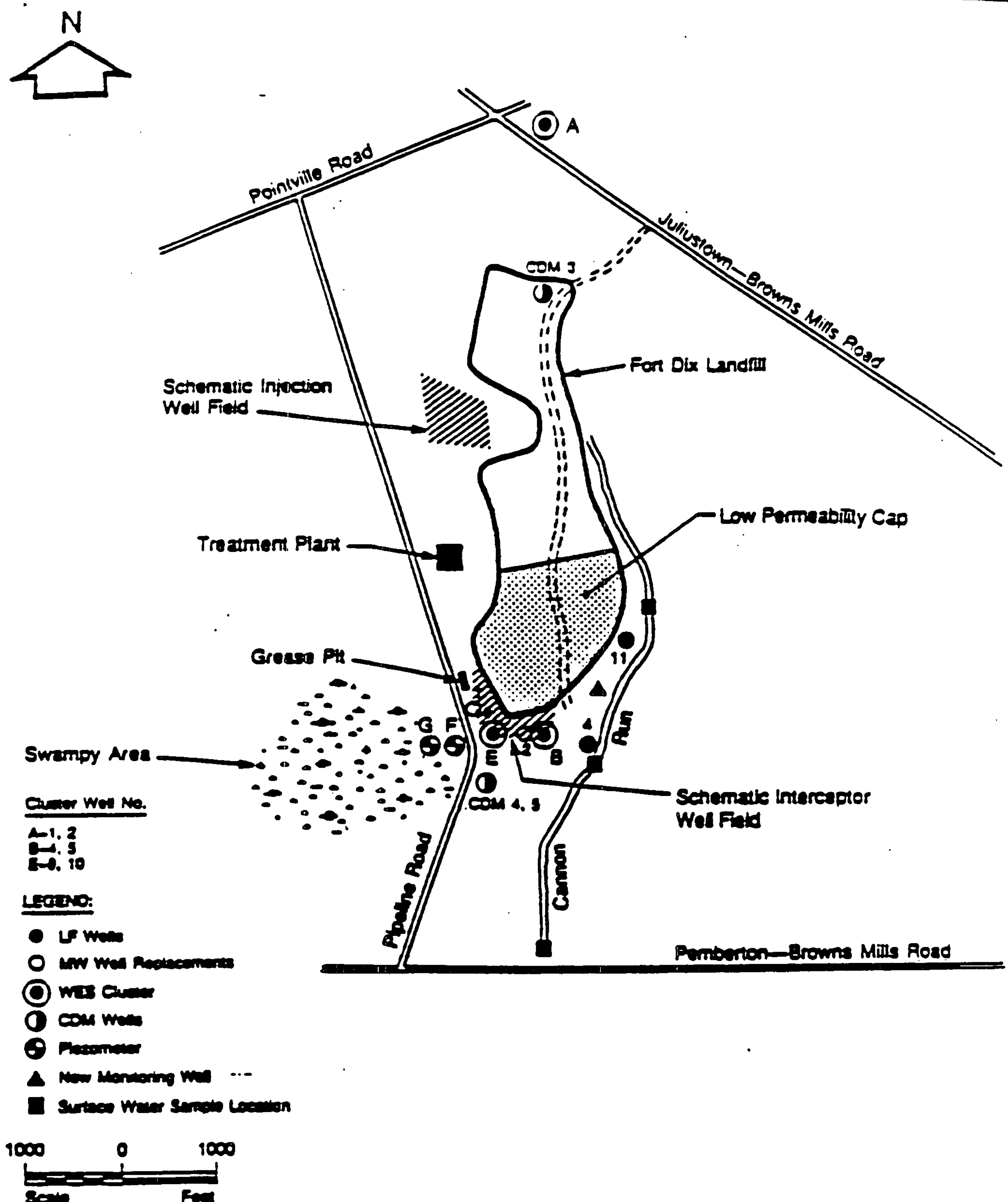

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Figure 11

Alternative 3A

Plume Pumping, Treatment and Reinjection

Fort Dix Sanitary Landfill

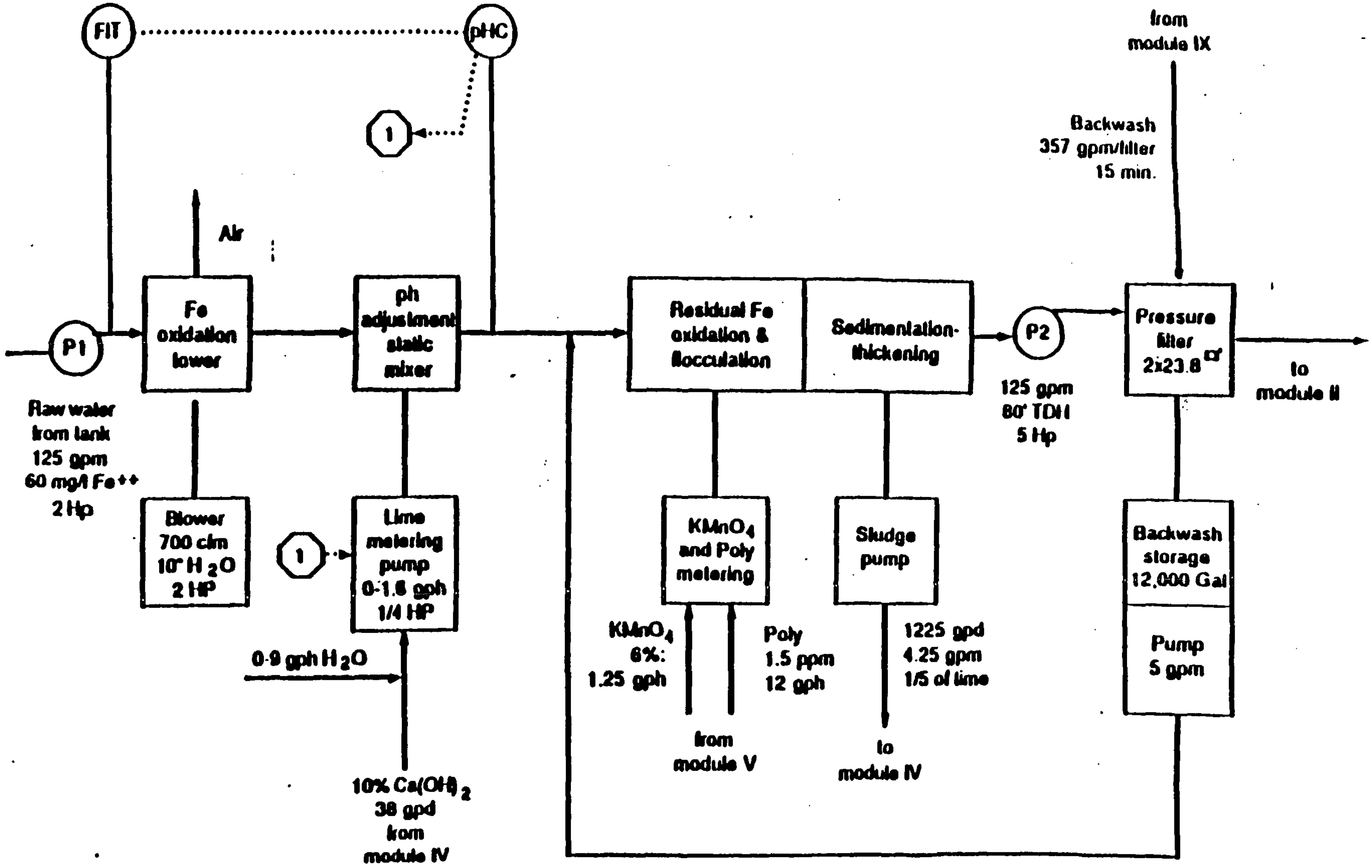

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Figure 12

Treatment Process Schematic
Module I

Fort Dix Sanitary Landfill

OFF GAS: (391-50) mg/l x 8.34 x 0.16 = .512 ppd in 3340 ACFM x 1440 = 4.81 x 10^{6} ACF

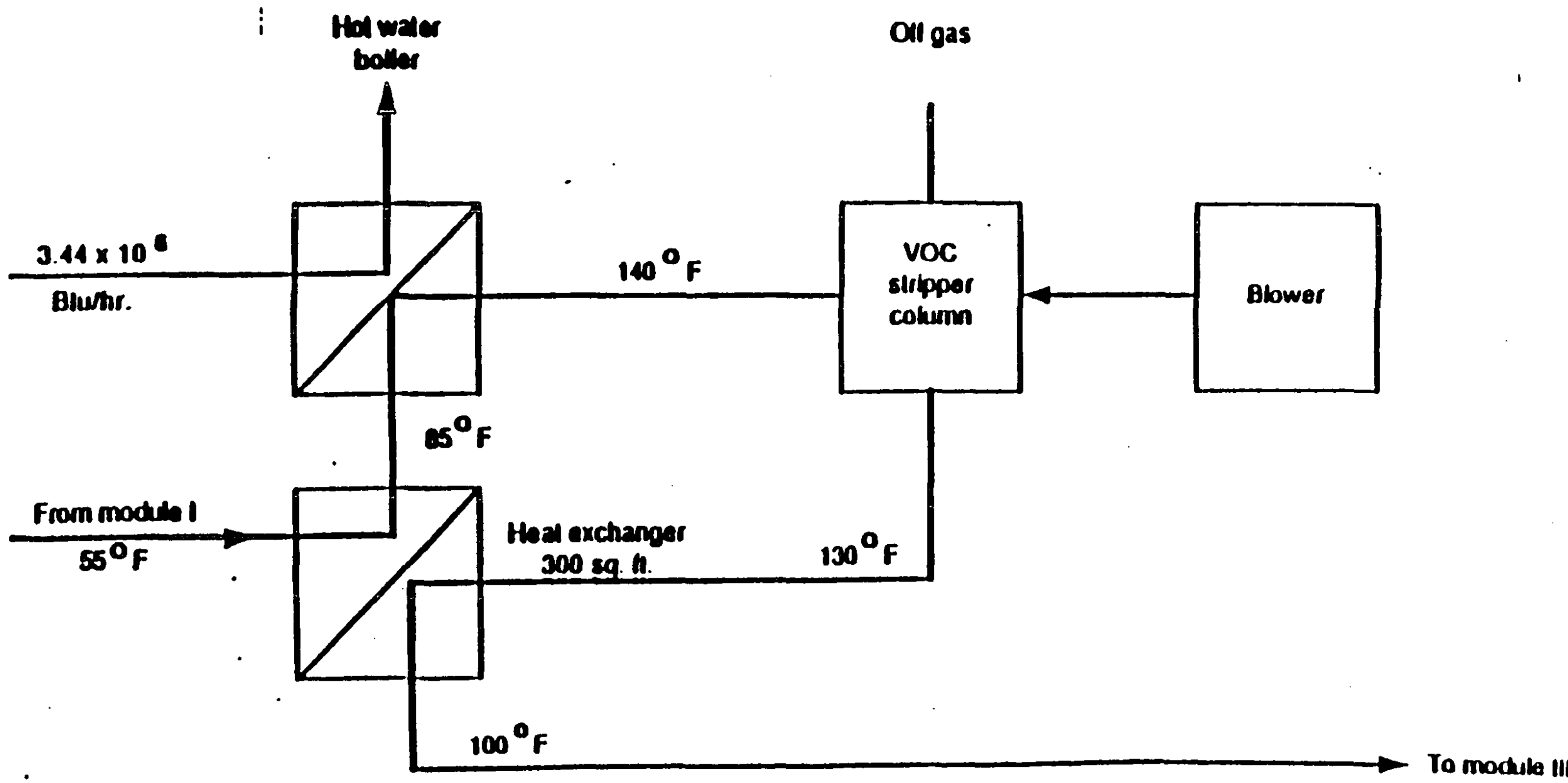

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Figure 13

Treatment Process Schematic
Module II

Fort Dix Sanitary Landfill

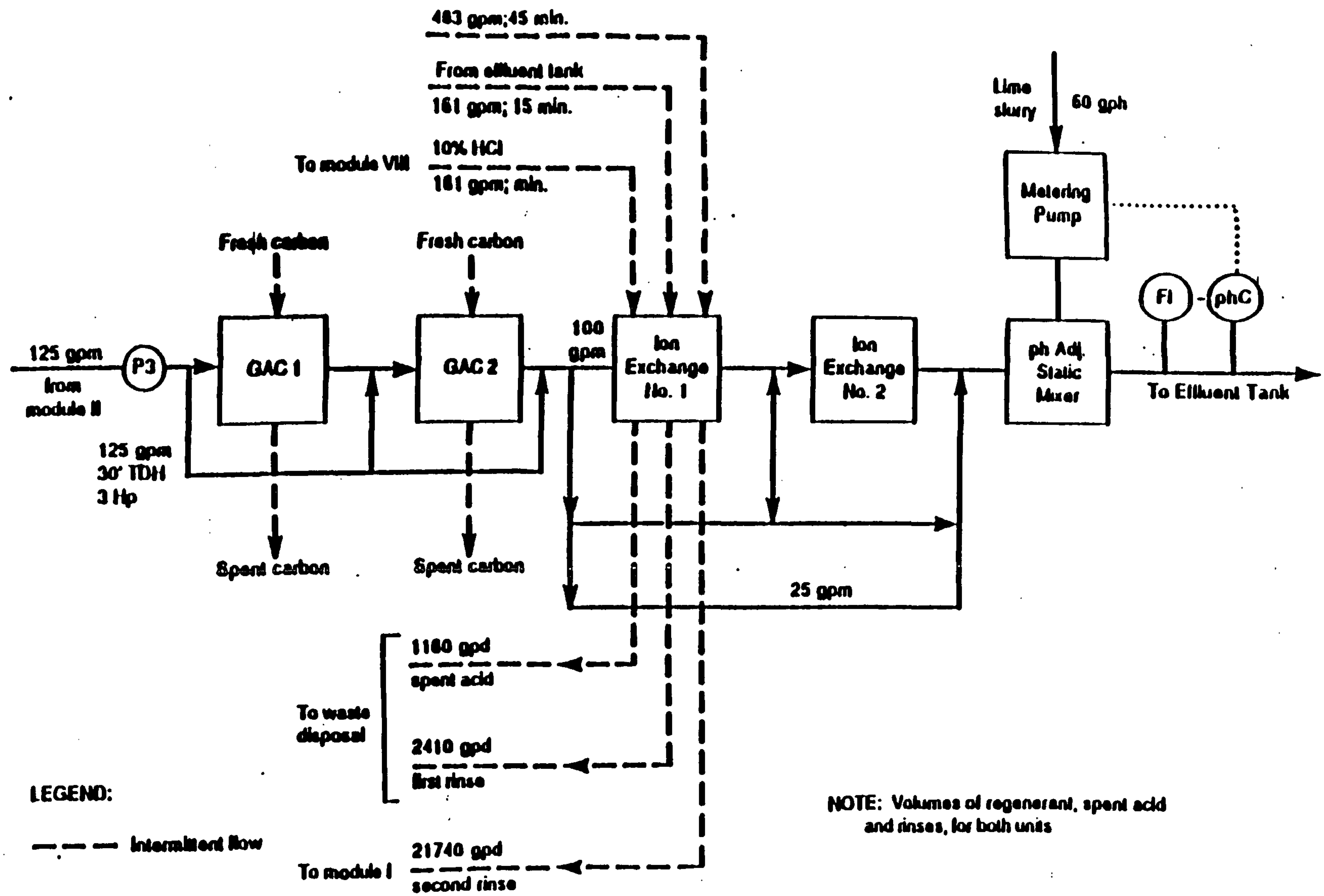

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Figure 14

Treatment Process Schematic
Module III

Fort Dix Sanitary Landfill

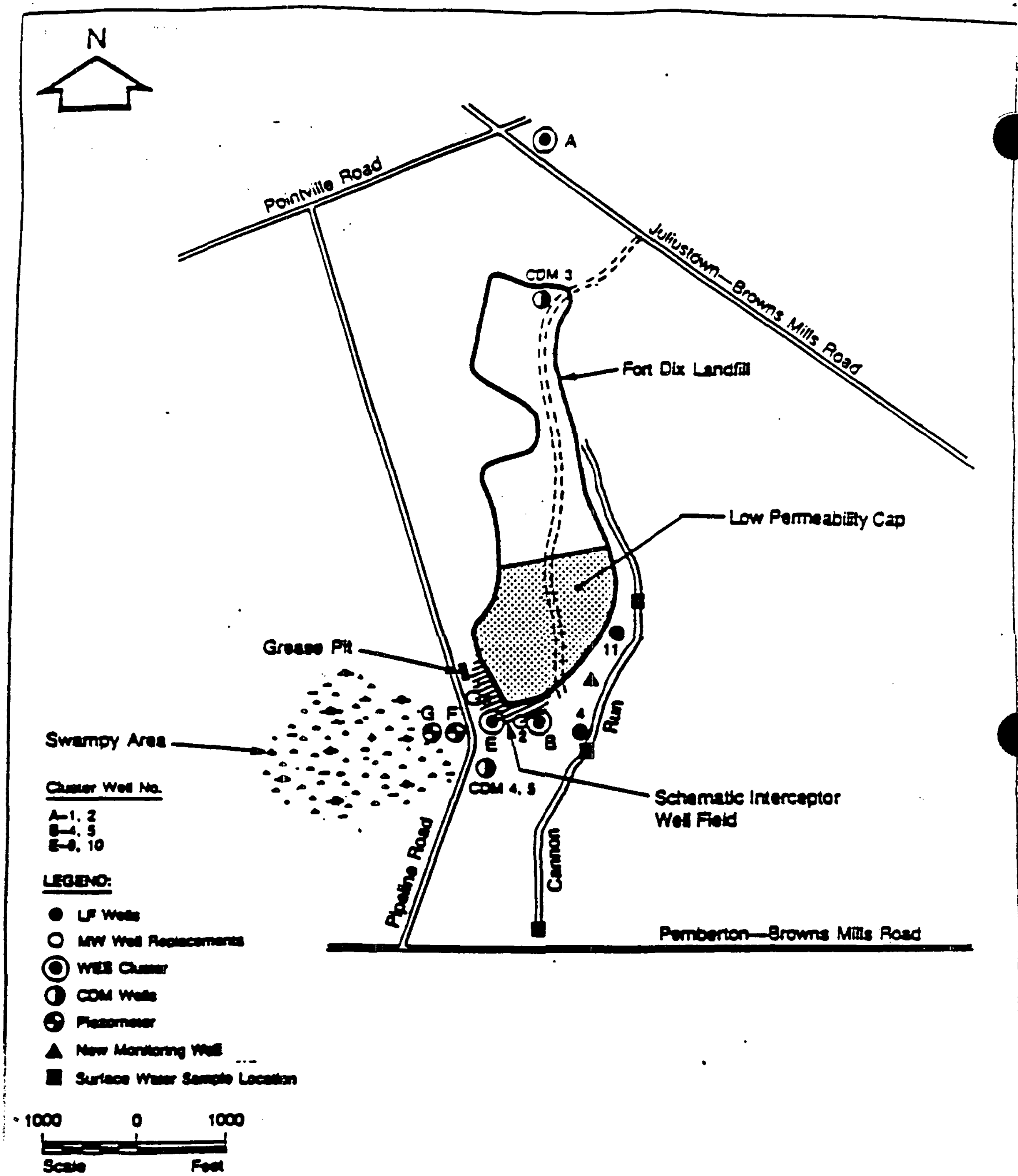

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Figure 15
Alternative 3B
Plume Pumping, Treatment and Offsite Discharge
Fort Dix Sanitary Landfill

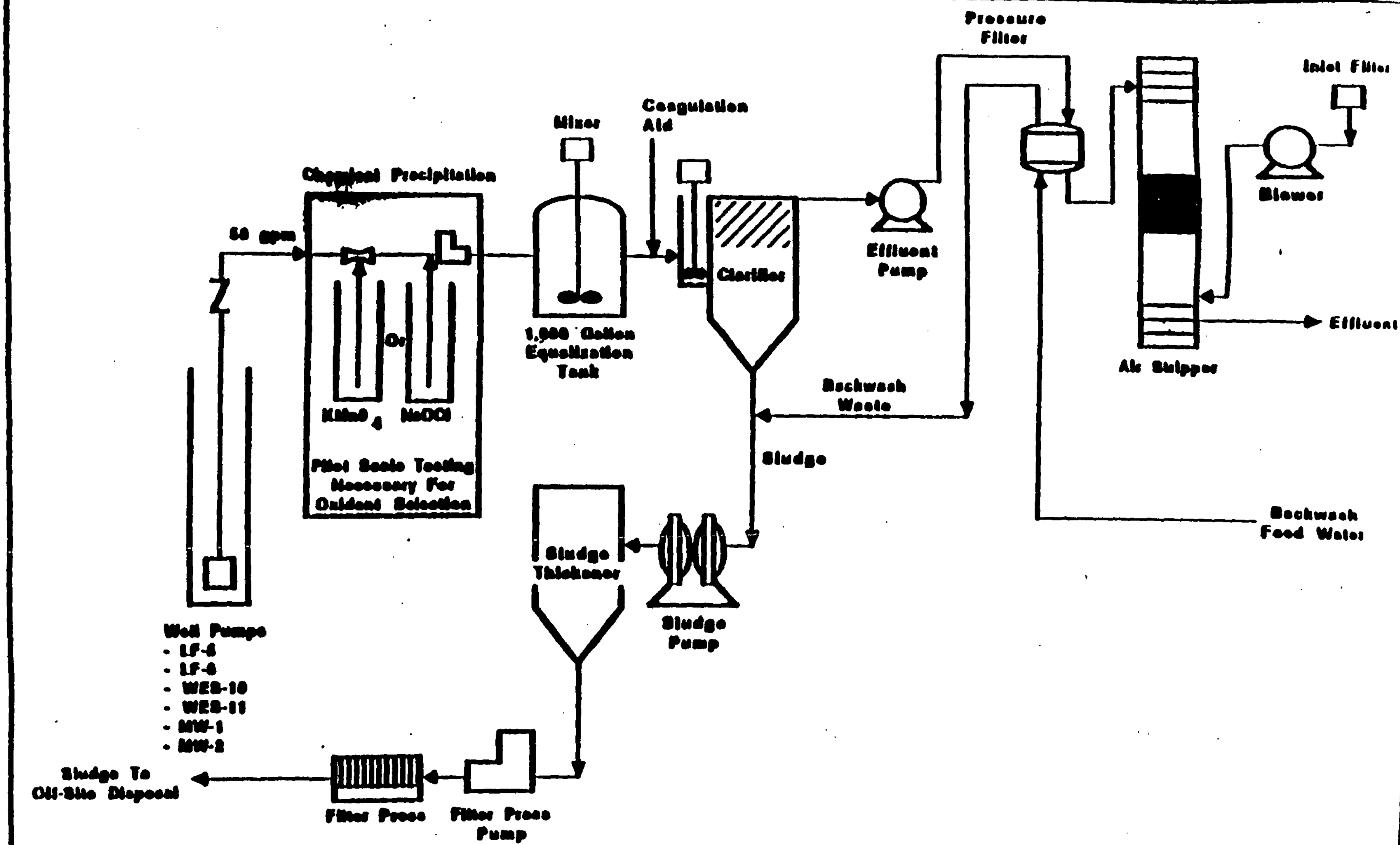

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Figure 16
Alternative 3D
Localized Plume Pumping with onsite Treatment, Injection, and Landfill Closure
Fort Dix Sanitary Landfill

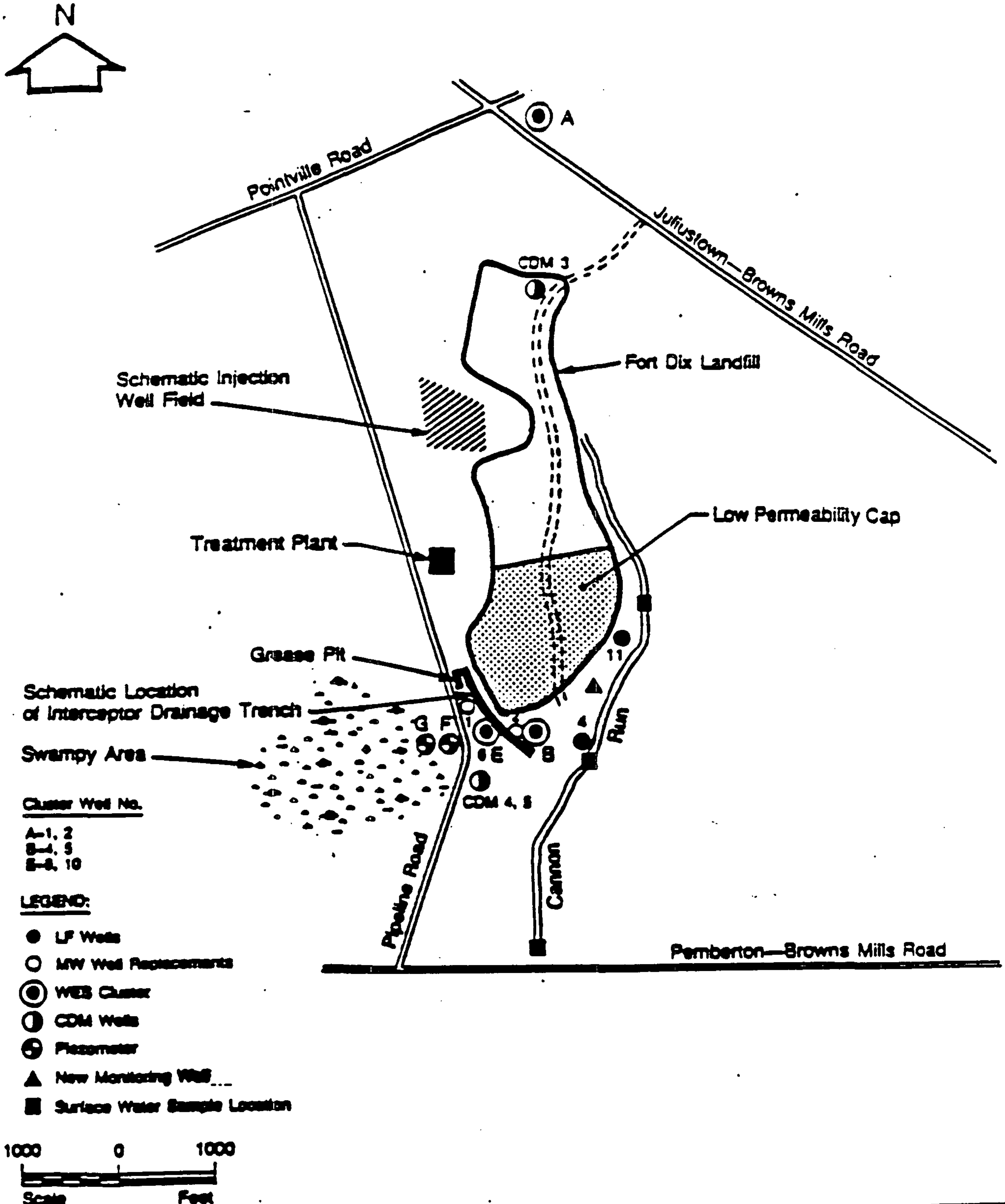

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Figure 17
Alternative 4A
Interceptor Drains,
Treatment and Reinjection
Fort Dix Sanitary Landfill

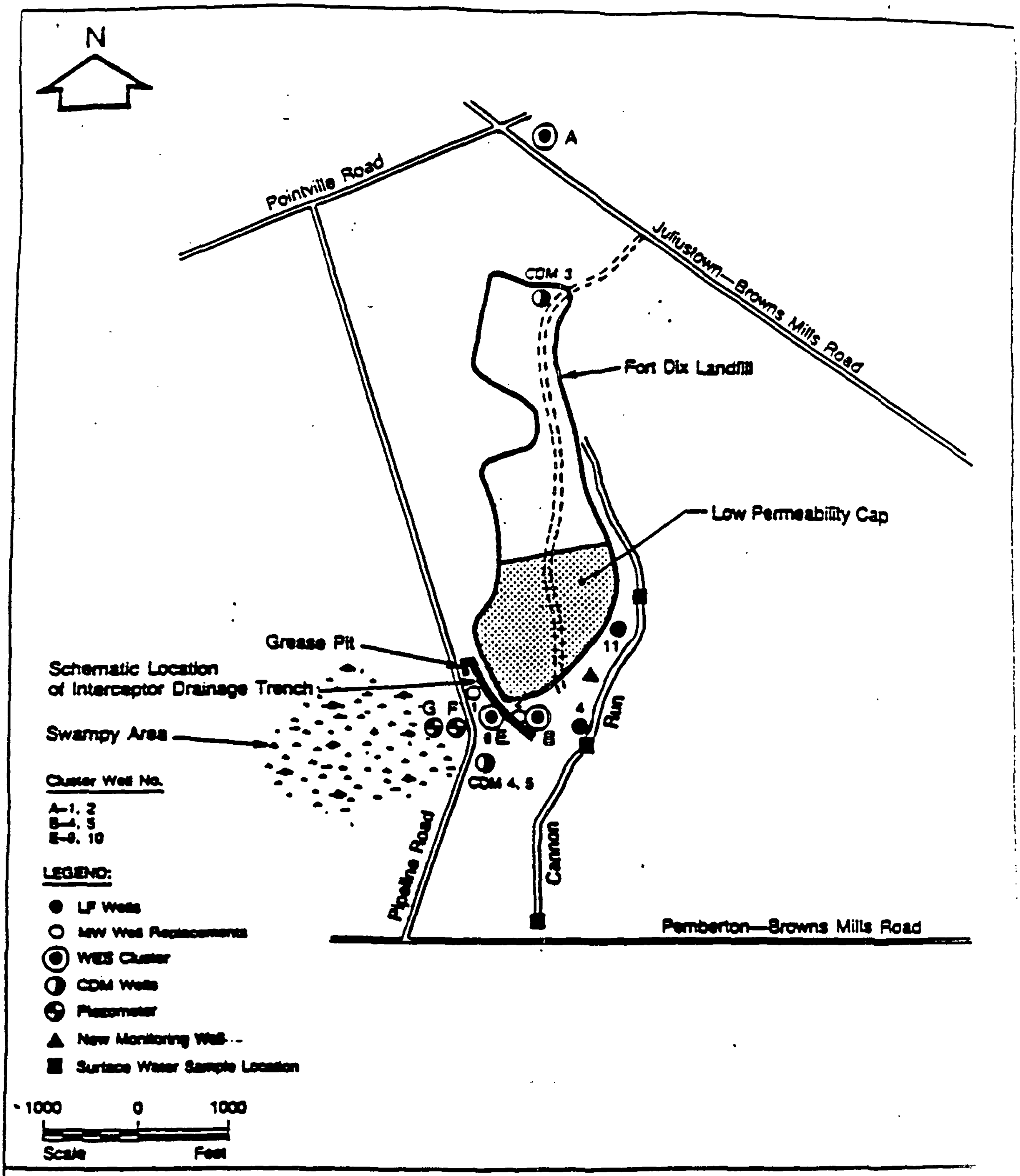

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Figure
Alternative
Interception Drai.
Treatment and Discharg
Fort Dix Sanitary Landfi

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ATTACHMENT 2 TABLES

TABLE 1

SUMMARY OF CONTAMINANTS DETECTED IN GROUND WATER
SURFACE WATER IN CANNON RUN
AND SWAMP WATER TABLE SAMPLES

Organic Chemicals	Ground Water: Frequency of detection	Ground Water: Maximum concentration (ug/l)	Ground Water: Geometric mean (ug/l)	Remedial Criteria*: MCL[e] (ug/l)	Remedial Criteria*: NJ[f] MCL (ug/l)	Remedial Criteria*: GW2[g] (ug/l)
Volatiles:						
Vinyl chloride	3/37	22	7.7	2	2*	
Chloroethane	6/37	17	7.1			
Methylene chloride	3/37	110B[c]	71.3		2*	
Acetone	6/37	3,400B	340			
1,1-Dichloroethane	7/37	49	5.2			
trans-1,2-Dichloroethylene	6/37	13	7.5		10*	
1,1-Dichloroethylene	0/37	ND	ND	7	2*	
1,2-Dichloroethane	2/37	20J[d]	17.3	5	2*	
2-Butanone	4/37	5,600B	600			
1,1,1-Trichloroethane	3/37	24	12.9	200	26*	
1,2-Dichloropropane	3/37	3J	1.4			
Trichloroethylene	10/37	18	3.9	5	1*	
Benzene	6/37	12	5.3	5	1*	
4-Methyl-2-pentanone	4/37	210J	80			
Tetrachloroethylene	4/37	17J	4.2		1*	
Toluene	5/37	100	7.9			
Ethyl benzene	6/37	16	5.1			
Total xylenes	6/37	34	7.4		44*	
Acid, Base/Neutral:						
1,4-Dichlorobenzene	1/37	3J	3	75*		
4-Methylphenol	3/37	270J	23.5			
Isophorone	17/37	16	6.2			
Benzoic acid	3/37	890J	58.1			
Napthalene	4/37	15J	6.0			
Diethylphthalate	6/37	49J	27.01			
bis(2-Ethylhexyl) phthalate	23/37	17	4.7			
Di-n-butylphthalate	1/37	2J	2			

TABLE 1
(continued)

SUMMARY OF CONTAMINANTS DETECTED IN GROUND WATER
AND SURFACE WATER

Organic Chemcials	Surface Water from Cannon Run: Frequency of detection	Surface Water from Cannon Run: Maximum concentration (ug/l)	Surface Water from Cannon Run: Geometric mean (ug/l)	Remedial Criteria*: $FW2^h$ (ug/l)	Remedial Criteria*: $FWQC^i$ (ug/l)
Volatiles:					
Vinyl chloride	0/7	ND^b	ND		2^{*K}
Methylene chloride	0/7	ND	ND		4.7^{*jK}
Acetone	0/7	ND	ND		
Chloroethane	0/7	ND	ND		
1,1-Dichloroethane	0/7	ND	ND		
trans-1,2-dichloroethylene	0/7	ND	ND		700^{*j}
1,1-Dichloroethylene	0/7	ND	ND		0.057^{*jK}
1,2-Dichloroethane	0/7	ND	ND		0.38^{*jK}
2-Butanone	0/7	ND	ND		
1,1,1-Trichloroethane	0/7	ND	ND		$3{,}100^{*j}$
1,2-Dichloropropane	0/7	ND	ND		
Trichloroethylene	0/7	ND	ND		2.7^{*K}
Benzene	0/7	ND	ND		1.2^{*jK}
4-Methyl-2-pentanone	0/7	ND	ND		
Tetrachloroethylene	0/7	ND	ND		$.8^{*}$
Toluene	0/7	ND	ND		$10{,}000^{*j}$
Ethyl benzene	0/7	ND	ND		$3{,}100^{*j}$
Total xylenes	0/7	ND	ND		
Acid, Base/Neutrals:					
1,4-Dichlorobenzene	0/7	ND	ND		400^{*}
4-Methylphenol	0/7	ND	ND		
Isophorone	3/7	5J	2.7		
Benzoic acid	0/7	ND	ND		
Naphthalene	0/7	ND	ND		
Diethylphthalate	0/7	ND	ND		$23{,}000^{*j}$
bis(2-Ethylhexyl) phthalate	2/7	4J	3.5		1.8^{*jK}
Di-n-butylphthalate	0/7	ND	ND		2700^{*j}

TABLE 1
(continued)

SUMMARY OF CONTAMINANTS DETECTED IN GROUND WATER,
SURFACE WATER IN CANNON RUN,
AND SWAMP WATER TABLE SAMPLES

	Swamp Water Table			Remedial Criteria*	
Organic Chemcials	Frequency of detection	Maximum concentration (ug/l)	Geometric mean (ug/l)	FW2 (ug/l)	FWQC (ug/l)
Volatiles:					
Vinyl chloride	0/6	ND[b]	ND	2^{*K}	
Methylene chloride	2/6	110	69		4.7^{*jK}
Acetone	0/6	ND	ND		
Chloroethane	1/6	12	12		
1,1-Dichloroethane	1/6	12	12		
trans-1,2-dichloroethylene	1/6	1J	1	700^{*j}	
1,1-Dichloroethylene	1/6	1J	1J		0.057^{*jK}
1,2-Dichloroethane	0/6	ND	ND		0.38^{*jK}
2-Butanone	0/6	ND	ND		
1,1,1-Trichloroethane	1/6	8	8	$3,100^{*j}$	
1,2-Dichloropropane	0/6	ND	ND		
Trichloroethylene	1/6	2J	2		2.7^{*K}
Benzene	0/6	ND	ND		1.2^{*jK}
4-Methyl-2-pentanone	1/6	93	93		
Tetrachloroethylene	0/6	ND	ND		$.8^{*}$
Toluene	0/6	ND	ND	$10,000^{*j}$	
Ethyl benzene	0/6	ND	ND	$3,100^{*j}$	
Total xylenes	0/6	1J	1J		
Acid, Base,/Neutrals:					
1,4-Dichlorobenzene	0/6	ND	ND	400^{*}	
4-Methylphenol	0/6	ND	ND		
Isophorone	0/6	ND	ND		
Benzoic acid	1/6	21	21		
Naphthalene	0/6	ND	ND		
Diethylphthalate	1/6	9	9	$23,000^{*j}$	
bis(2-Ethylhexyl) phthalate	0/6	ND	ND		1.8^{*jK}
Di-n-butylphthalate	0/6	ND	ND	2700^{*j}	

TABLE 1
(continued)

SUMMARY OF CONTAMINANTS DETECTED IN GROUND WATER
AND SURFACE WATER

Inorganics	Ground water			Remedial Criteria*
	Frequency of detection	Maximum concentration (ug/l)	Geometric[a] mean (ug/l)	GW2 (ug/l)
Aluminum	37/39	52,240	940	
Barium	24/39	551	178.5	1000*
Beryllium	9/39	3.2	0.3	
Cadmium	14/39	10.2	4.9	10*
Calcium	24/39	38,210	6,149	
Chromium	33/39	197	16	50*
Cobalt	18/39	86	8.5	
Copper	28/39	89	12.3	1000*
Iron	39/39	285,000	3,222	300*
Lead	21/39	114	19.5	50*
Magnesium	39/39	90,510	4,218	
Manganese	38/39	4,626	69	50*
Mercury	8/39	16.8	3.9	2*
Nickel	6/39	146	34	
Potassium	25/39	26,230	3,122	
Silver	1/39	2.4	2.4	50*
Sodium	24/39	237,000	10,759	50,000*
Tin	3/39	26	24.6	
Vanadium	22/39	239.5	11.2	
Zinc	39/39	910	36.7	5,000*

TABLE 1
(continued)

SUMMARY OF CONTAMINANTS DETECTED IN GROUND WATER
AND SURFACE WATER

	Surface water from Cannon Run			Remedial Criteria*	
Inorganics	Frequency of detection	Maximum concentration (ug/l)	Geometric mean[a] (ug/l)	FW2 (ug/l)	FWQC (ug/l)
Aluminum	6/7	982	152.9		
Barium	7/7	81	48.2	1000*	
Beryllium	3/7	0.2	0.2		.0076*K
Cadmium	0/7	ND	ND	10	10*j
Calcium	7/7	38,280	20,863.6		
Chromium	1/7	3	3.5	50*	(Cr^{+6})170[j]; (CR^{+3}) 33,000[j]
Cobalt	0/7	ND	ND		
Copper	2/7	4	3.5		1,300*j
Iron	7/7	17,100	515.5		
Lead	0/7	ND	ND	50	50*
Magnesium	7/7	6,094	4,688.2		
Manganese	7/7	173	61.6		50*L
Mercury	1/7	0.4	0.4	2	.14*
Nickel	0/7	ND	ND		510*j
Potassium	7/7	5,658	3,971.7		
Silver	3/7	2.5	2.2	50*	91[j]
Sodium	7/7	9,908	7,591.7		
Tin	0/7	ND	ND		
Vanadium	3/7	4.2	4		
Zinc	7/7	21	8.8		

TABLE 1
(continued)

SUMMARY OF CONTAMINANTS DETECTED IN GROUND WATER
AND SURFACE WATER

	Swamp Water Table			Remedial Criteria*	
Inorganics	Frequency of detection	Maximum concentration (ug/l)	Geometric mean[a] (ug/l)	FW2 (ug/l)	FWQC (ug/l)
Aluminum	6/6	2,221	551		
Barium	6/6	138	72	1000*	
Beryllium	3/6	0.8	0.6		.0076*K
Cadmium	0/6	ND	ND	10	10*
Calcium	6/6	16,060	3,272		
Chromium	6/6	11	7	50*	(CR+6)170j;(Cr+3)33,000j
Cobalt	1/6	9	9		
Copper	6/6	15	5		1,300*j
Iron	6/6	129,000	3,164		
Lead	5/6	11	8	50	50*
Magnesium	5/6	14,840	2,165		
Manganese	6/6	865	51		50*
Mercury	0/6	ND	ND	2	.14*
Nickel	0/6	ND	ND		510*j
Potassium	6/6	5,305	3,972		
Silver	6/6	5.5	4.6	50*	91j
Sodium	6/6	23,390	4,624		
Tin	0/6	ND	ND		
Vanadium	5/6	10	7		
Zinc	6/6	13,380	10,026		

[a]Only the detected values of the contaminant were used in the calculation of the geometric mean. When the concentration was detected only in one sample, the measured concentration was used to represent both the maximum concentration and the geometric mean concentration.

[b]ND = Not detected at the detection limit.

[c]B = Found in blank; use as estimated value.

[d]J = Estimated value.

e = Office of Drinking Water, USEPA, Drinking Water Regulations and Health Advisories, April 1990 (Federal Drinking Water MCL's).

f = NJAC 7:10-16.7(a).

g = NJAC 7:9-6.6(b), Ground Water Quality Criteria.

h = NJAC 7:9-4.1 et seq., Surface Water Quality Standards.

i = 40 CFR Part 131, Federal Water Quality Criteria, June 15,1990.

j = Criteria revised to reflect current agency RFDs, as contained in the Integrated Risk Information System (IRIS).

K = Criteria based on carcinogenicity (10^{-6} risk).

TABLE 2

SUMMARY OF CONTAMINANTS DETECTED IN GREASE PIT, SUBSURFACE SOIL, AND SEDIMENT SAMPLES

Contaminant	Grease pit: Frequency of detection	Grease pit: Maximum concentration (ug/kg)	Grease pit: Geometric[a] mean (ug/kg)
Volatiles:			
Methylene chloride	0/15	ND[b]	ND
Acetone	0/15	ND	ND
Carbon disulfide	0/15	ND	ND
2-Butanone	0/15	ND	ND
Trichloroethylene	0/15	ND	ND
Benzene	0/15	ND	ND
Toluene	0/15	ND	ND
Chlorobenzene	0/15	ND	ND
Chloroethane	0/15	ND	ND
Total xylenes	0/15	ND	ND
Acid, base/neutrals:			
1,3-Dichlorobenzene	1/15	130	130
1,4-Dichlorobenzene	0/15	ND	ND
Di-n-butyl phthalate	7/15	400	267
bis(2-Ethylhexyl) phthalate	4/15	440J[c]	256
Fluoranthene	0/15	ND	ND
Benzo(b)fluoranthene	0/15	ND	ND
Benzoic acid	1/15	1,000J	1,000
Pesticides:			
4,4'-DDT	0/15	ND	ND
4,4'-DDE	0/15	ND	ND
4,4'-DDD	0/15	ND	ND

(FD1/6)

TABLE 2
(continued)

SUMMARY OF CONTAMINANTS DETECTED IN GREASE PIT, SUBSURFACE SOIL, AND SEDIMENT SAMPLES

	Subsurface soil		
Contaminant	Frequency of detection	Maximum concentration (ug/kg)	Geometric[a] mean (ug/kg)
Volatiles:			
Methylene chloride	0/4	ND	ND
Acetone	1/4	170B[d]	170
Carbon disulfide	2/4	26	7
2-Butanone	0/4	ND	ND
Trichloroethylene	1/4	3J	3
Benzene	0/4	ND	ND
Toluene	3/4	10	4
Chlorobenzene	0/4	ND	ND
Chloroethane	0/4	ND	ND
Total xylenes	0/4	ND	ND
Acid base/neutrals:			
1,3-Dichlorobenzene	0/4	ND	ND
1,4-Dichlorobenzene	0/4	ND	ND
Di-n-butyl phthalate	0/4	ND	ND
bis(2-Ethylhexyl) phthalate	3/4	480J	322
Fluoranthene	0/4	ND	ND
Benzo(b)fluoranthene	0/4	ND	ND
Benzoic acid	0/4	ND	ND
Pesticides:			
4,4'-DDT	0/4	ND	ND
4,4'-DDE	0/4	ND	ND
4,4'-DDD	0/4	ND	ND

TABLE 2
(continued)

SUMMARY OF CONTAMINANTS DETECTED IN GREASE PIT, SUBSURFACE SOIL, AND SEDIMENT SAMPLES

Contaminant	Cannon Run sediments: Frequency of detection	Maximum concentration (ug/kg)	Geometric mean[a] (ug/kg)
Volatiles:			
Methylene chloride	0/8	ND	ND
Acetone	1/8	320B	320
Carbon disulfide	0/8	ND	ND
2-Butanone	1/8	88B	88
Trichloroethylene	0/8	ND	ND
Benzene	1/8	11	11
Toluene	0/8	ND	ND
Chlorobenzene	1/8	28	28
Chloroethane	0/8	ND	ND
Total xylenes	0/8	ND	ND
Acid base/neutrals:			
1,3-Dichlorobenzene	0/8	ND	ND
1,4-Dichlorobenzene	1/8	790	790
Di-n-butyl phthalate	1/8	240J	240
bis(2-Ethylhexyl) phthalate	5/8	1,600	284
Fluoranthene	1/8	1,500	1,500
Benzo(b)fluoranthene	1/8	1,100	1,100
Benzoic acid	0/8	ND	ND
Pesticides:			
4,4'-DDT	1/8	120J	120
4,4'-DDE	3/8	180J	13
4,4'-DDD	2/8	270J	52

(FD1/6)

TABLE 2
(continued)

SUMMARY OF CONTAMINANTS DETECTED IN GREASE PIT, SUBSURFACE SOIL, AND SEDIMENT SAMPLES

Contaminant	Swamp sediments: Frequency of detection	Swamp sediments: Maximum concentration (ug/kg)	Swamp sediments: Geometric[a] mean (ug/kg)
Volatiles:			
Methylene chloride	1/4	10	10
Acetone	0/4	ND	ND
Carbon disulfide	0/4	ND	ND
2-Butanone	R	R	R
Trichloroethylene	0/4	ND	ND
Benzene	1/4	6	6
Toluene	4/4	57	23
Chlorobenzene	1/4	7	7
Chloroethane	1/4	7J	7
Total xylenes	1/4	7J	7
Acid base/neutrals:			
1,3-Dichlorobenzene	0/4	ND	ND
1,4-Dichlorobenzene	0/4	ND	ND
Di-n-butyl phthalate	1/4	2,100	2,100
bis(2-Ethylhexyl) phthalate	1/4	290J	290J
Fluoranthene	0/4	ND	ND
Benzo(b)fluoranthene	0/4	ND	ND
Benzoic acid	0/4	ND	ND
Pesticides:			
4,4'-DDT	3/4	340	160
4,4'-DDE	4/4	1,100	352
4,4'-DDD	4/4	7,900	1,650

TABLE 2
(continued)

SUMMARY OF CONTAMINANTS DETECTED IN GREASE PIT, SUBSURFACE SOIL, AND SEDIMENT SAMPLES

Metal	Grease pit Frequency of detection	Maximum Concentration (mg/kg)	Geometric[a] Mean (mg/kg)
Aluminum	16/16	5,558	2,047
Arsenic	1/16	7	7
Barium	9/16	13	8.0
Beryllium	16/16	0.7	0.5
Calcium	0/16	ND	ND
Chromium	16/16	18	11.8
Cobalt	16/16	2	2.0
Copper	3/16	2	2.0
Iron	16/16	9,129	4,760
Magnesium	14/16	766	227.3
Manganese	16/16	48	13.7
Mercury	0/16	ND	ND
Nickel	0/16	ND	ND
Potassium	16/16	1,989	1,730
Silver	8/16	2.7	1.8
Sodium	16/16	479	385.6
Vanadium	16/16	18.2	11.3
Zinc	16/16	20	9.7

TABLE 2
(continued)

SUMMARY OF CONTAMINANTS DETECTED IN GREASE PIT, SUBSURFACE SOIL, AND SEDIMENT SAMPLES

	Subsurface soil		
Metal	Frequency of detection	Maximum concentration (mg/kg)	Geometric[a] mean (mg/kg)
Aluminum	4/4	6,400	5,339
Arsenic	0/4	ND	ND
Barium	0/4	R[e]	R
Beryllium	4/4	0.9	0.77
Calcium	4/4	113,400	46,448
Chromium	4/4	29	20.6
Cobalt	4/4	8	5.6
Copper	3/4	10	5.3
Iron	4/4	20,122	15,391
Lead	3/4	6.8	5.2
Magnesium	4/4	4,513	3,440
Manganese	4/4	99	64.1
Mercury	0/4	ND	ND
Nickel	4/4	33	22
Potassium	4/4	8,520	7,489
Silver	2/4	5.4	2.5
Sodium	4/4	599	375
Vanadium	4/4	12.7	8.5
Zinc	4/4	66	62

TABLE 2
(continued)

SUMMARY OF CONTAMINANTS DETECTED IN GREASE PIT,
SUBSURFACE SOIL, AND SEDIMENT SAMPLES

Metal	Cannon Run sediments: Frequency of detection	Cannon Run sediments: Maximum concentration (mg/kg)	Cannon Run sediments: Geometric[a] mean (mg/kg)
Aluminum	R	R	R
Arsenic	0/8	ND	ND
Barium	7/8	35	5.1
Beryllium	8/8	0.3	0.1
Calcium	R	R	R
Chromium	5/8	10	4.3
Cobalt	8/8	7	2.3
Copper	5/8	27	3.4
Iron	8/8	131,306	2,356.3
Magnesium	4/8	274	85.9
Manganese	8/8	90	5.1
Mercury	0/8	ND	ND
Nickel	0/8	ND	ND
Potassium	8/8	3,358	1,284.2
Silver	5/8	3	2.4
Sodium	R	R	R
Vanadium	7/8	185	5.4
Zinc	R	R	R

TABLE 2
(continued)

SUMMARY OF CONTAMINANTS DETECTED IN GREASE PIT, SUBSURFACE SOIL, AND SEDIMENT SAMPLES

	Swamp sediments		
Metal	Frequency of detection	Maximum concentration (mg/kg)	Geometric[a] mean (mg/kg)
Aluminum	4/4	5,895	4,961
Arsenic	0/4	ND	ND
Barium	4/4	77	69
Beryllium	4/4	0.9	0.6
Calcium	4/4	2,894	1,339
Chromium	4/4	26	19
Cobalt	0/4	ND	ND
Copper	4/4	18	13
Iron	4/4	10,491	6,027
Magnesium	4/4	750	533
Manganese	4/4	31	21
Mercury	3/4	0.4	0.3
Nickel	0/4	ND	ND
Potassium	4/4	3,429	2,781
Silver	0/4	ND	ND
Sodium	4/4	381	169
Vanadium	4/4	28.8	22.9
Zinc	4/4	127	86

[a]Only the detected values of the contaminant were used in the calculation of the geometric mean. When the concentration was detected only in one sample, the measured concentration was used to represent both the maximum concentration and the geometric mean concentration.

[b]ND = Contaminant was analyzed for but not detected in samples at the detection limit.

[c]J = Estimated value.

[d]B = Found in blank; use as estimated value.

[e]R = Compound was analyzed but did not pass QA/QC requirements.

TABLE 3

CONCENTRATIONS OF CONTAMINANTS IN AIR SAMPLES

Chemical	Upwind/downwind samples: Frequency of detection	Upwind/downwind samples: Maximum concentration (mg/m^3)	Upwind/downwind samples: Geometric mean (mg/m^3)	Vent samples: Frequency of detection	Vent samples: Maximum concentration (mg/m^3)	Vent samples: Geometric mean (mg/m^3)
Methylene chloride	1/4	$3.3x10^{-5}$J[a]	$3.3x10^{-5}$	1/11	$2.8x10^{-4}$J	$2.8x10^{-4}$
trans-1,2-Dichloroethylene	0/4	ND[b]	ND	1/11	$5.9x10^{-5}$J	$5.9x10^{-5}$
1,1-Dichloroethane	0/4	ND	ND	2/11	$5.1x10^{-5}$J	$2.4x10^{-5}$
1,1,1-Trichloroethane	1/4	$1.5x10^{-3}$J	$1.5x10^{-3}$	4/11	$8.5x10^{-4}$J	$2.3x10^{-4}$
Trichloroethylene	0/4	ND	ND	2/11	$4.2/10^{-4}$J	$2.3x10^{-4}$
Benzene	0/4	ND	ND	2/11	$4.9x10^{-5}$J	$4.2x10-^{5}$
Tetrachloroethylene	3/4	$6.5x10^{-5}$J	$4.3x10^{-5}$	11/11	$1.2x10^{-2}$	$4.2x10^{-4}$
Toluene	0/4	ND	ND	3/11	$2.5x10^{-2}$	$2.9x10^{-3}$
Chlorobenzene	0/4	ND	ND	1/11	$1.2x10^{-3}$J	$1.2x10^{-3}$
Ethylbenzene	2/4	$1.6x10^{-3}$J	$3.3x10^{-4}$	6/11	$2.0x10^{-1}$	$3.2x10^{-3}$

[a]J Estimated value.

[b]ND Contaminant was analyzed for but not detected in samples at the detection limit.

(FD1/24)

TABLE 4

Health Effect Criteria for Chemicals of Concern
At the Fort Dix Site -- Potential Carcinogens

Chemical	EPA/CAG Potency Factor[a] (mg/kg/day)$^{-1}$ Oral	Inhalation	Weight of Evidence[b]	
Benzene	2.9E-02	2.9E-02	A	A
bis(-Ethylhexyl) phthalate	1.4E-02	--[cd]	B2	D
1,4,-Dichlorobenzene	2.2E-02[e]	--[c]	B2	B2
1,1-Dichlorethane	9.1E-02	--	C	C
1,2-Dichloroethane	9.1E-02	9.1E-02	B2	B2
Tetrachloroethane	1E-02	--[cf]	B2	B2
1,1,1-Trichloroethane	[g]	g.1E-09[g]	D[g]	D/C[g]
Trichloroethylene	1.1E-02	1.3E-02	B2	B2
Vinyl chloride	2.3	2.9E-01	A	A

[a]Source of potency factor: EPA Intergrated Risk Information System as of June 7, 1989.

[b]EPA weight of evidence classification scheme

[c]-- = Criterion has not been developed for this chemical and route of exposure.

[d]NA = Not applicable. Exposure via this route was not quantitatively evaluated.

[e]Source of potency factor for 1,4-dichlorobezene: Draft Toxicological Profile for 1,4-Dichlorobenzene (ATSDR/EPA, 1987).

[f]Oral carcinogenic potency factor was used to assess inhalation exposure.

[g]EPA has classified 1,1,1-trichloroethane as D, not classifiable as a human carcinogen. However, NJDEP classifies 1,1,1-trichloroethane as a class C carcinogen for inhalation.

(FT DIX2/6)NY-GMO

TABLE 5

Health Effects Criteria for Chemicals of Concern
At the Fort Dix Site -- Noncarcinogens

Chemical	Oral		Inhalation	
	RfD	Source[a]	RfD	Source[a]
Organics:				
Benzene	b	b	b	b
bis(2-Ethylhexyl) phthalate	2.0E-02	IRIS	--[c]	--
2-Butanone	3.0E-02	IRIS	2.4E-02	HA
Chlorobenzene	3.0E-02	HEA	5.0E-03	HEA
1,4-Dichlorobenzene	1.1E-02	HA	--	--
1,1-Dichloroethane	1.0E-01	HEA	1.0E-01	HEA
1,2-Dichloroethane	b	b	b	b
1,2-Dichloroethylene(trans)	2.0E-02	IRIS	--	--
Ethylbenzene	1E-01	IRIS	--	--
Tetrachloroethylene	1.0E-02	IRIS	1.9E-02	HA
Toluene	3.0E-01	PHE	2.9E-01	HA
1,1,1-Trichloroethane	9E-02	IRIS	--	--
Trichloroethylene	1.1E-02	IRIS	1.3E-02	IRIS
Vinyl chloride	b	b	b	b
Inorganics:				
Cadmium	5.0E-4	HA	NA[d]	NA
Chromium	5.0E-03 1.0E+0	IRIS[e] IRIS	NA	NA
Manganese	2.2E-01	HEA	NA	NA
Mercury	3.0E-04	PHE	NA	NA
Nickel	2.0E-02	IRIS	NA	NA
Zinc	2.E-01	HEA	NA	NA

TABLE 5
(continued)

Health Effects Criteria For Chemicals of Concern
At the Fort Dix Site -- Noncarcinogens

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[a]Source: IRIS as of 6/8/89
HA = Health Advisories (EPA 1985)
PHE = Superfund Public Health Manual (EPA 1986)
HEA = Health Effects Assessments (EPA 1984)

[b]RfDs have not been calculated because of the potential nature of the carcinogenic response.

c---Criterion have not been developed for this chemical and this route of exposure.

[d]NA = Not applicable. Exposure via this route was not quantitatively evaluated.

[e]5.0E-03 is the value for chromium II
1.0E+0 is the value for chromium III

TABLE 6

FORT DIX LANDFILL SUPERFUND SITE

COST SUMMARY[a]

	Alternatives	Estimated construction cost	Operation and maintenance cost	Total project cost[b]	Implementation time (years)
1.	No remedial action with monitoring	6.6	1.4	8.0	0.5
2.	Landfill closure with monitoring program	12.6	1.9	14.5	1.5
3A.	Ground water pumping and onsite treatment with ground water injection	16.6	9.8	26.4	2.0
3B.	Ground water pumping and offsite treatment	13.5	16.7	30.2	2.0
3D.	Partial ground water pumping and onsite treatment with ground water injection	13.7	4.1	17.8	2.0
4A.	Ground water interception and onsite treatment with ground water injection	21.3	9.0	30.3	2.0
4B.	Ground water interception and offsite treatment	18.2	16.0	34.2	2.0

NOTE:

[a]Costs are presented in millions of dollars

[b]A 30-year landfill post-closure care period and 10-year ground water withdrawal and treatment period were used to develop the total project cost.

(fort_dix/96)

TABLE 7

SUMMATION OF TOTAL ESTIMATED RISKS FOR THE PRESENT SITE USE EXPOSURE PATHWAYS
(Present Site Use)

Exposure Pathway	Exposure Route	Total Estimated Risk: Most Probable	Total Estimated Risk: Worst Case
Air: Volatiles	Inhalation	1×10^{-10}	2×10^{-9}
		1×10^{-10}	2×10^{-9}
Soils:	Ingestion	0 (3×10^{-10})[a]	2×10^{-8}
	Inhalation	Incomplete	Incomplete
	Dermal Absorption	0 (8×10^{-11})	8×10^{-11}
		0 (4×10^{-10})	2×10^{-8}
Surface Water: Swamp	Ingestion	Incomplete	Incomplete
	Inhalation	7×10^{-9}	6×10^{-8}
	Dermal Absorption-surface water	3×10^{-10}	4×10^{-9}
	Dermal Absorption-sediments	7×10^{-11}	2×10^{-9}
		7×10^{-9}	7×10^{-8}
Surface Water: Swimming	Ingestion	6×10^{-12}	7×10^{-10}
	Inhalation	Negligible	Negligible
	Dermal Absorption	7×10^{-12}	7×10^{-10}
		1×10^{-11}	1×10^{-9}
Total Risks: All Pathways		8×10^{-9}	1×10^{-7}

[a] The most probable case risks would be zero as the pathway was assumed to be incomplete. Average worst case risks are presented in the parentheses.

(DPS02/25)NY

TABLE 8

SUMMATION OF TOTAL ESTIMATED CANCER RISKS FOR THE POTENTIAL FUTURE SITE USE EXPOSURE PATHWAYS

(Future Site Use)

Exposure Scenario	Total Estimated Risk	
	Most Probable	Worst Case
1. Rancocas Creek	4×10^{-9}	5×10^{-7}
2. Vincentown Aquifer	5×10^{-7}	8×10^{-4}
3. Cohansey Aquifer	6×10^{-6}	2×10^{-3}

TABLE 9

CHARACTERISTICS OF THE REMEDIAL ACTION ALTERNATIVES

Alternative number	Landfill cap	Monitoring program	Plume abatement	Onsite treatment and disposal	Offsite treatment and disposal
1	No	Yes	No	No	No
2	Yes	Yes	Yes	No	No
3A	Yes	Yes	Interceptor wells	Yes	No
3B	Yes	Yes	Interceptor wells	No	Yes
3D	Yes	Yes	Interceptor wells (partial)	Yes	No
4A	Yes	Yes	Interceptor trench	Yes	No
4B	Yes	Yes	Interceptor trench	No	Yes

(fort_dix/62)

TABLE 10

FORT DIX SANITARY LANDFILL
ARARs

FEDERAL	STATE
<u>Contaminant-Specific</u>	<u>Contaminant-Specific</u>
SAFE DRINKING WATER ACT (SDWA) o National Primary Drinking Water Standards, 40 CFR Part 141	SDWA MCLs, NJAC 7:10-1 et seq. Ground Water Quality Standards, NJAC 7:9-6.6 (b) Surface Water Quality Criteria, NJAC 7:9-4.1 et seq.
CLEAN WATER ACT (CWA) o Water Quality Criteria, 40 CFR Part 131	
<u>Location-Specific</u>	<u>Location-Specific</u>
Executive Order 11990 "Protection of Wetlands" Executive Order 11988 "Floodplain Management" Endangered Species Act, 16 USC 1531 Clean Water Act, Section 404, 40 CFR 230	Flood Hazard Area Regulations, NJAC 7:13-1 et seq. Fresh Water Wetlands Protection Act Rules, NJAC 7:7A-1.1 et seq.
<u>Action-Specific</u>	<u>Action-Specific</u>
Resource Conservation and Recovery Act, 40 CFR Part 264	CLOSURE AND POST-CLOSURE o Hazardous Waste Regulations, NJAC 7:26-1 et seq. o Non-Hazardous Waste Regulations, NJAC 7:26-1 et seq. o Soil Erosion and Sediment Control Act Regulations, NJAC 2:90-1.1 et seq.
CLEAN WATER ACT (CWA) o Disposal of Dredged and Fill Material, 40 CFR 230	
CLEAN AIR ACT (CAA), 42 U.S.C. 7401 et seq.	AIR POLLUTION CONTROLS o Air Pollution Control, NJAC 7:27-1 et seq.
OTHERS o Occupational Safety and Health Act (OSHA), 29 U.S.C. 651-678	HAZARDOUS WASTE FACILITIES o Requirements for Ground Water Monitoring, NJAC 7:26-9 et seq.
	EMERGENCY RESPONSE ACTIONS o Notice of Release of Hazardous Substances to Atmosphere and Water Pollution Control, NJSA 26:2C-19
	OTHER o Noise Control Act NJSA 13:1G-1 et seq. o Noise Pollution, NJAC 7:29-1 et seq.

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TABLE 11

ESTIMATED CAPITAL COSTS OF ALTERNATIVES

Component	Alternative 1	Alternative 2	Alternative 3A	Alternative 3B	Alternatve 3D	Alternative 4A	Alternati 4B
Landfill closure	$4,900,000	$9,300,000	$9,300,000	$9,300,000	$9,300,000	$9,300,000	$9,300,0
Additional monitoring wells	25,000	25,000	25,000	25,000	25,000	25,000	25,0
Extraction wells and piping	-	-	200,000	180,000	80,000	-	
Injection wells and piping	-	-	220,000	-	50,000	220,000	
Downgradient trench	-	-	-	-	-	3,700,000	3,700,0
Ground water treatment	-	-	2,600,000	-	690,000	2,600,000	
Storage and transfer to offsite treatment	-	-	-	460,000	-	-	460,0
Subtotal (rounded)	4,900,000	9,300,000	12,300,000	10,000,000	10,100,000	15,800,000	13,500,0
Engineering and contingencies (35 percent)	1,700,000	3,300,000	4,300,000	3,500,000	3,600,000	5,500,000	4,700,0
Total	$6,600,000	$12,600,000	$16,600,000	$13,500,000	$13,700,000	$21,300,000	$18,200,0

TABLE 12

ESTIMATED ANNUAL O&M COSTS OF ALTERNATIVES

Component	Alternative 1	Alternative 2	Alternative 3A	Alternative 3B	Alternative 3D	Alternative 4A	Alternative 4B
Post-closure care with cap	-	$84,900	$84,900	$84,900	$84,900	$84,900	$84,900
Post-closure care without cap	31,500	-	-	-	-	-	-
Ground and surface water monitoring	115,000[1]	115,000[1]	115,000[1]	115,000[1]	115,000[1]	115,000[1]	115,000[1]
Extraction and/or injection wells	-	-	137,000	120,000	41,800	17,000	-
Downgradient trench	-	-	-	-	-	15,500	15,500
Ground water treatment	-	-	1,265,000[2]	-	369,400	1,265,000[2]	-
Storage and transfer to offsite treatment	-	-	-	20,000	-	-	20,000
Offsite treatment	-	-	-	2,143,000	-	-	2,143,000
Total	$146,500	$199,900	$1,601,900	$2,482,900	$611,100	$1,497,400	$2,378,400

[1] $134,000 a year for the first two years.

[2] First-year cost; annual cost in years 2-5 about $72,000 less and annual cost in years 6-10 ranges from about $175,000 less (year 6) to about $569,000 less (year 10) mainly because of reduced chemical and carbon regeneration costs.

ATTACHMENT 3 RESPONSIVENESS SUMMARY

I. Introduction

In accordance with EPA's Community Relations policy and guidance, the Army held a public comment period from April 25, 1990 to May 25, 1990, to solicit comments on remedial alternatives for the Fort Dix Landfill site. As part of the selection process, the Army published a PRAP describing the Army's and EPA's preferred alternative and issued a public notice announcing a public meeting.

The Army, in conjunction with the EPA and NJDEP, held the public meeting to present the PRAP on May 7, 1990 at the New Hanover Township Municipal Building in Cookstown. Approximately 18 people attended the meeting, including representatives of Federal, State, and local public agencies, and from local newspapers. No members of the general public attended the public meeting. Copies of the PRAP were distributed at the meeting and were available in three information repositories.

The Army presented a brief overview of the Fort Dix Landfill site, the decision-making process, the findings of the RI/FS and the preferred alternative. Comments from the meeting attendees were then received by the Army. No comments were received by the Army, other than those presented at the public meeting, during the public comment period.

The purpose of the Responsiveness Summary is to document the Army's responses to comments and questions raised during the public comment period.

II. Response to Comments

1. When the results of the risk assessment were being presented, clarification as to what the computation 10^{-10} means was requested.

<u>Response</u>: The value of 10^{-10} represents one additional cancer risk in ten billion people exposed to certain environmental conditions.

2. Definition of what a filter fabric is as part of the landfill cap was requested.

Response: Filter fabric is a permeable material often used between layers of material of different grain sizes to prevent mixing of finer material with the layer of coarser material.

The effectiveness of the coarser layer used as a water drainage layer in the landfill cap may be reduced by the clogging of pores by finer material if a filter fabric or a filter layer is not present. Filter fabrics can also help to minimize internal erosion and settlement as a result of fines movement within the cap.

3. A request for clarification was made concerning Table 5-1 of the presentation given at the public meeting, which states that plume abatement is part of alternative 2.

Response: Alternative 2 does not include abatement of the ground water plume directly. However, ground water monitoring and evaluation of the remedial action at least every five years are included in alternative 2 which could trigger an active ground water treatment approach if deemed necessary.

4. A review of the remaining steps in the process to implementing the proposed remedial action was requested.

Response: After the public comment period is over a response to all public concerns will be prepared and incorporated into a document called a Record of Decision (ROD). The ROD will outline the alternative that was chosen, and the basis upon which it was selected over the other alternatives. The Deputy Assistant Secretary of the Army and the EPA Regional Administrator will sign the ROD. Once the ROD has been finalized, the Army will initiate the design and construction of the selected remedial action.

5. Has additional technical information been made available to the public other than what was presented at the public meeting?

Response: Other technical information concerning the Fort Dix Landfill is available for public review at the following three repositories.

- Fort Dix Environmental Resources Branch
  Building 5512
  Texas Avenue
  Fort Dix, New Jersey

- Burlington County Library
  Browns Mills Branch
  348 Lakehurst Road
  Browns Mills, New Jersey

- New Jersey Department of Environmental Protection
  Division of Hazardous Site Mitigation
  Bureau of Community Relations
  401 East State Street
  Trenton, New Jersey

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ATTACHMENT 4 NJDEP LETTER OF CONCURRENCE WITH THE RECORD OF DECISION

DEPARTMENT OF ENVIRONMENTAL PROTECTION
JUDITH A. YASKIN, COMMISSIONER
CN 402
TRENTON, N.J. 08625-0402
(609) 292-2885
Fax: (609) 984-3962

29 JUN 1990

Mr. Joseph Haug
USATC and Fort Dix
Fort Dix Environmental Branch
ATZD-EH
Fort Dix, NJ 08640-5500

Dear Mr. Haug:

Re: Draft Record of Decision
Fort Dix NPL Landfill
Pemberton Township, Burlington County, New Jersey

This is to formally notify you that New Jersey Department of Environmental Protection has reviewed the enclosed Draft Record of Decision for the above referenced site and concurs with the recommended remedy providing the enclosed comments are incorporated in the final Record of Decision. This remedy will consist of the following components:

- Landfill Closure
- Perimeter Fencing
- Deed Restrictions
- Storm Water and Erosion Control
- Air, Surface Water and Ground Water Monitoring

New Jersey fully appreciates the importance of the Record of Decision in the cleanup process and will continue to take all reasonable steps to ensure that the State's commitments in this area are met.

Sincerely,

Judith A. Yaskin
Commissioner

Enclosure

c: With Enclosure:
[redacted]
Ali Alavi, USATHAMA

Without Enclosure:
Constantine Sidamon-Eristoff, Regional Administrator/USEPA