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U.S. DEPARTMENT OF THE NAVY

INSTALLATION RESTORATION PROGRAM

NAVAL AIR STATION, BRUNSWICK

BRUNSWICK, MAINE

FOCUSED FEASIBILITY STUDY

SITES 1 AND 3

CONTRACT: N62472-84-C-1108

E. C. JORDAN PROJECT NO. 4607-57

OCTOBER 1991

FEASIBILITY STUDY
SITES 1 AND 3
NAVAL AIR STATION BRUNSWICK

Prepared for:

U.S. Department of the Navy
Northern Division
Naval Facilities Engineering Command
Contract N62472-84-C-1108

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Project No. 4607-57

OCTOBER 1991

W0019126.M80

BRUNSWICK NAVAL AIR STATION
FOCUSED FEASIBILITY STUDY SITES 1 AND 3

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GLOSSARY OF ACRONYMS AND ABBREVIATIONS

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1.0 INTRODUCTION

The Naval Air Station at Brunswick (NAS Brunswick) is located south of the Androscoggin River between Brunswick and Bath, Maine. The NAS is an active base owned and operated by the federal government through the Department of the Navy. This facility is currently participating in the Navy's Installation Restoration Program (IRP). In 1987, the U.S. Environmental Protection Agency (USEPA) placed NAS Brunswick on the National Priorities List (NPL), and in 1990 a Federal Facility Agreement (FFA) among the Navy, the USEPA, and the Maine Department of Environmental Protection (MEDEP) was established. This FFA identifies timetables and deadlines for the completion of a Remedial Investigation and Feasibility Study (RI/FS) at NAS Brunswick.

An Initial Assessment Study (IAS) was performed on nine sites at NAS Brunswick by Roy F. Weston, Inc. (R.F. Weston) in 1983. This study recommended further investigation at seven of the nine sites.

In 1984, E.C. Jordan Co. (Jordan) was contracted by the Navy to perform a Pollution Abatement Confirmation (PAC) Study, and in 1987, to conduct a complete RI/FS on seven sites identified during the IAS and PAC study. Based on further information, two additional sites, Sites 11 and 13, were added to the RI/FS program in 1989 and a third site, Site 14 was included in 1990. Sites 5 and 6, initially identified in the IAS were brought back into the RI/FS program in 1989. A total of 13 sites are currently part of the RI/FS program, as follows:

- Site 1 Orion Street Landfill - North
- Site 2 Orion Street Landfill - South
- Site 3 Hazardous Waste Burial Area
- Site 4 Acid/Caustic Pit
- Site 5 Orion Street Asbestos Disposal Site
- Site 6 Sandy Road Rubble and Asbestos Disposal Site
- Site 7 Old Acid/Caustic Pit
- Site 8 Perimeter Road Disposal Site
- Site 9 Neptune Drive Disposal Site
- Site 11 Fire Training Area and
- Site 12 Explosive Ordnance Dump Training Area

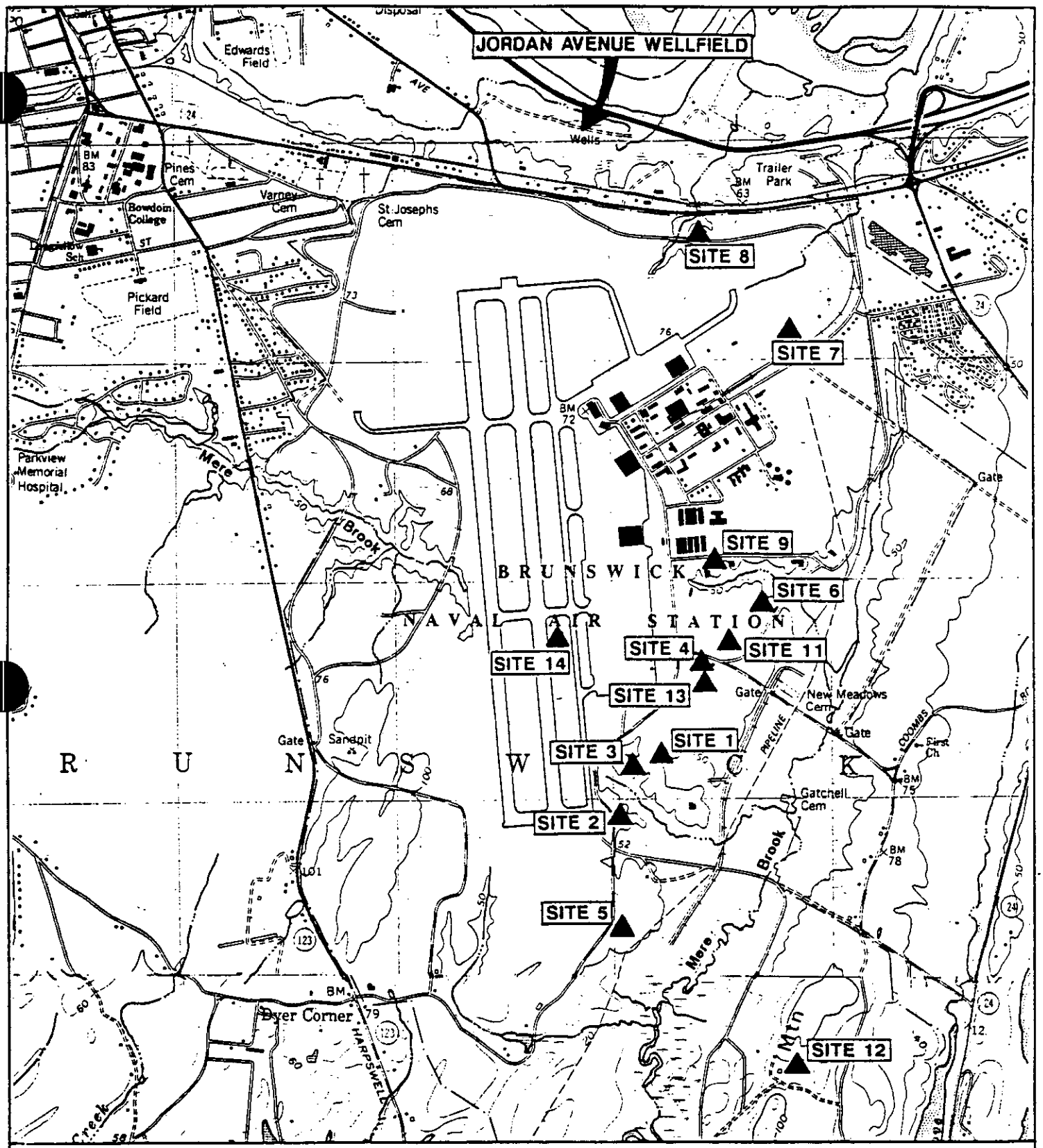
- Site 13 Defense Reutilization and Marketing Office
- Site 14 Old Dump No. 3

Site locations are shown in Figure 1-1. In August 1990, Jordan submitted both a Draft Final RI and Phase I FS report to the Navy. These reports included Sites 1, 2, 3, 4, 7, 8, 9, 11, and 13. The RI report described the field sampling investigations, geology, hydrogeology, and presented contamination and risk assessments; the Phase I FS report identified the remedial action objectives, and developed and screened remedial actions for each site. In April 1991, Jordan submitted a Draft Supplemental RI report and a Draft Supplemental Phase I FS report. The Supplemental RI report included initial studies at Sites 5, 6, 12, and 14, and additional studies at Sites 8, 9, and 11. The Supplemental Phase I FS report provided remedial action objectives and developed and screened remedial alternatives for Sites 5, 6, and 12.

Because the Navy is committed to providing a timely response to environmental contamination at NAS Brunswick, a strategy was developed to expedite the RI/FS process. This strategy involves separating the 13 sites into "operable units" and establishing separate timetables for the completion of the Final FS reports and Records of Decision. The Navy has identified Sites 1 and 3, Site 8, and the Eastern Plume (i.e., contaminated groundwater originating from Sites 4, 11, and 13) as three distinct operable units and believes the remedial process can be initiated for these sites.

This report is submitted in support of the Navy's overall strategy for remediation at NAS Brunswick and completes the Focused Feasibility Study (FFS) for the Orion Street Landfill - North (i.e., Site 1) and the Hazardous Waste Disposal Area (i.e., Site 3). This approach enables the Navy to proceed with developing remedial strategies for two well-defined sites at NAS Brunswick. This report was conducted in accordance with the Superfund Amendments and Reauthorization Act of 1986 (SARA), the National Oil and Hazardous Substance Pollution Contingency Plan (NCP) (USEPA, 1990), and USEPA guidance (USEPA, 1988), and fulfills part of the requirements established in the Agreement. It consists of the detailed evaluation and comparative analysis of the remedial alternatives developed and screened for Sites 1 and 3 and presented in the Phase I FS.

The report is organized as follows. Section 2.0 of this report summarizes the site history and response objectives; Section 3.0 evaluates each alternative in accordance



SOURCE: U.S.G.S. QUADRANGLES, BRUNSWICK, AND ORRS ISLAND, ME., 1984, 1978. 7.5 MINUTE SERIES.

QUADRANGLE LOCATION

SCALE IN FEET

0 2,000 4,000

Drawn By:	Date: 4/91
Checked By:	Date: 4/91

E.C. JORDAN CO. CONSULTING ENGINEERS	SITE LOCATION MAP
INSTALLATION RESTORATION PROGRAM NAVAL AIR STATION BRUNSWICK, MAINE	SITE 1 & 3 FFS
	4607-57 FIGURE 1-1

with the criteria set in the NCP, and contains a general description of and cost estimate for each remedial action; Section 4.0 provides a comparative summary of the alternatives.

2.0 SUMMARY OF RESPONSE OBJECTIVES AND REMEDIAL ALTERNATIVES DEVELOPED FOR SITES 1 AND 3

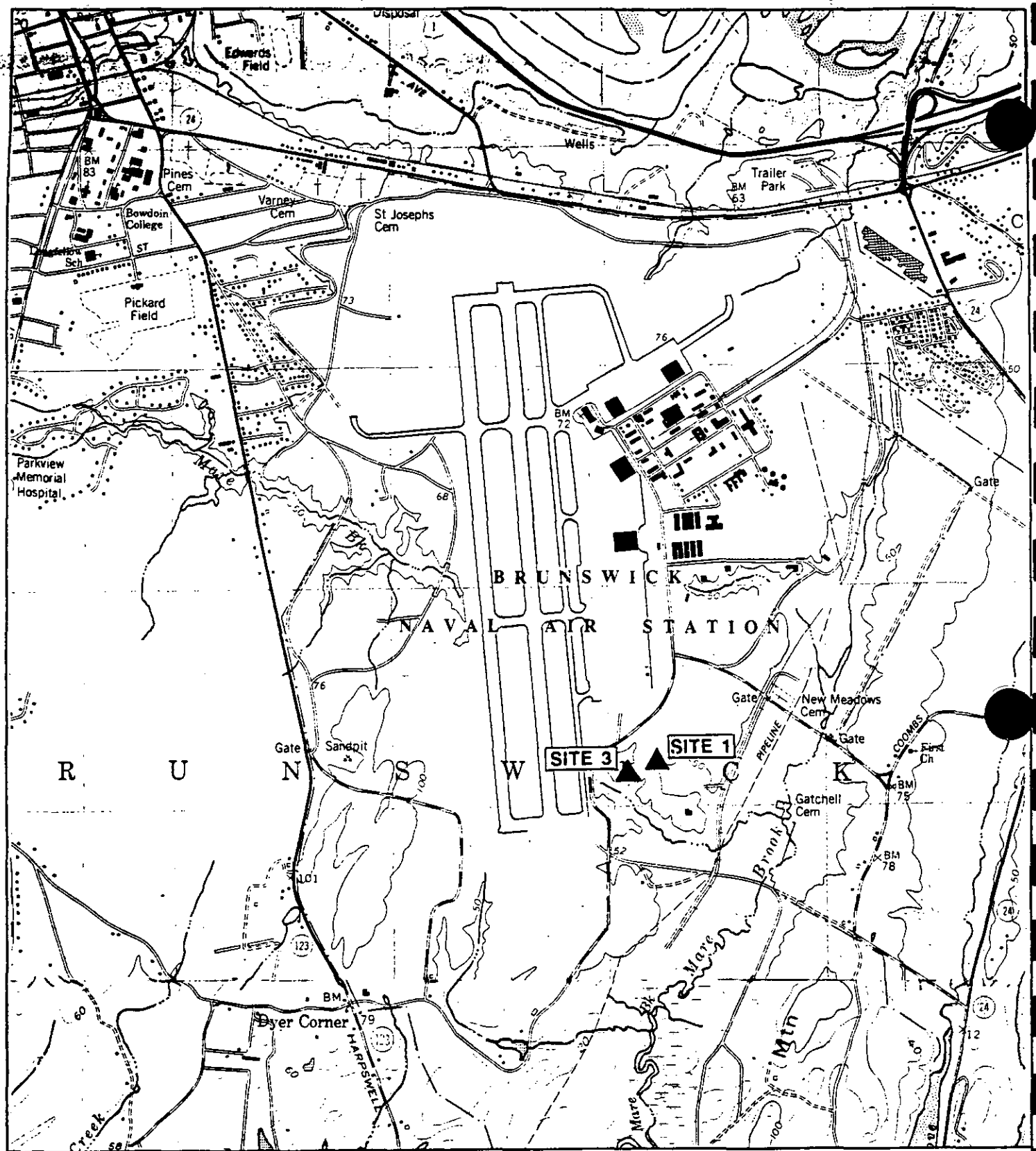
This section summarizes the contamination assessment, Applicable or Relevant and Appropriate Requirements (ARARs) response objectives, and remedial alternatives developed for Sites 1 and 3 that were presented in the Draft Final RI and Phase I FS reports (E.C. Jordan Co., 1990a,b). The RI and FS reports contain more detailed information including the site history, hydrology, geology, and contamination evaluation. Summaries of the groundwater, surface water, sediment, leachate and soil data are presented in Appendix E.

2.1 SUMMARY OF CONTAMINATION

Sites 1 and 3 are located within a restricted area in the central portion of NAS Brunswick (Figure 2-1). Historical records indicate that the Site 1 landfill was used from 1955 to 1975. Material reportedly disposed of in this landfill included garbage, food waste, refuse, waste oil, solvents, pesticides, petroleum products, paint wastes, aircraft and automobile parts, and unknown chemicals.

Site 3 is defined as the area across from Site 1, adjacent to the access road into the Weapons Compound (Figure 2-2). Historical information reports that Site 3 operated as a disposal area from 1960 to 1973. Wastes disposed of at this site included solvents, paints, and isopropyl alcohol. No waste material was observed at Site 3 and only low level soil contamination (i.e., 1.1 milligram per kilogram (mg/kg) chlordane, see Appendix E) was detected. Although Site 3 was originally believed to be a separate disposal area from Site 1, field sampling activities did not show a clear delineation between these two sites.

Based on the proximity of the two sites, common historical land use, and hydrogeologic characteristics, the impacts of past disposal practices from Sites 1 and 3 cannot be distinguished. Therefore, these areas of contamination are combined and discussed as one site. Test pit information and field sampling results were used to estimate the combined size of the landfills at 12 acres. The waste is estimated based on test pit data and boring logs. The waste in the trench area is approximately 20 feet in the deepest areas with the depth of waste decreasing to the east and west. An average depth of 15 feet was assumed for an approximate combined refuse



SOURCE: U.S.G.S. QUADRANGLES, BRUNSWICK, AND ORRS ISLAND, ME., 1984, 1978, 7.5 MINUTE SERIES.

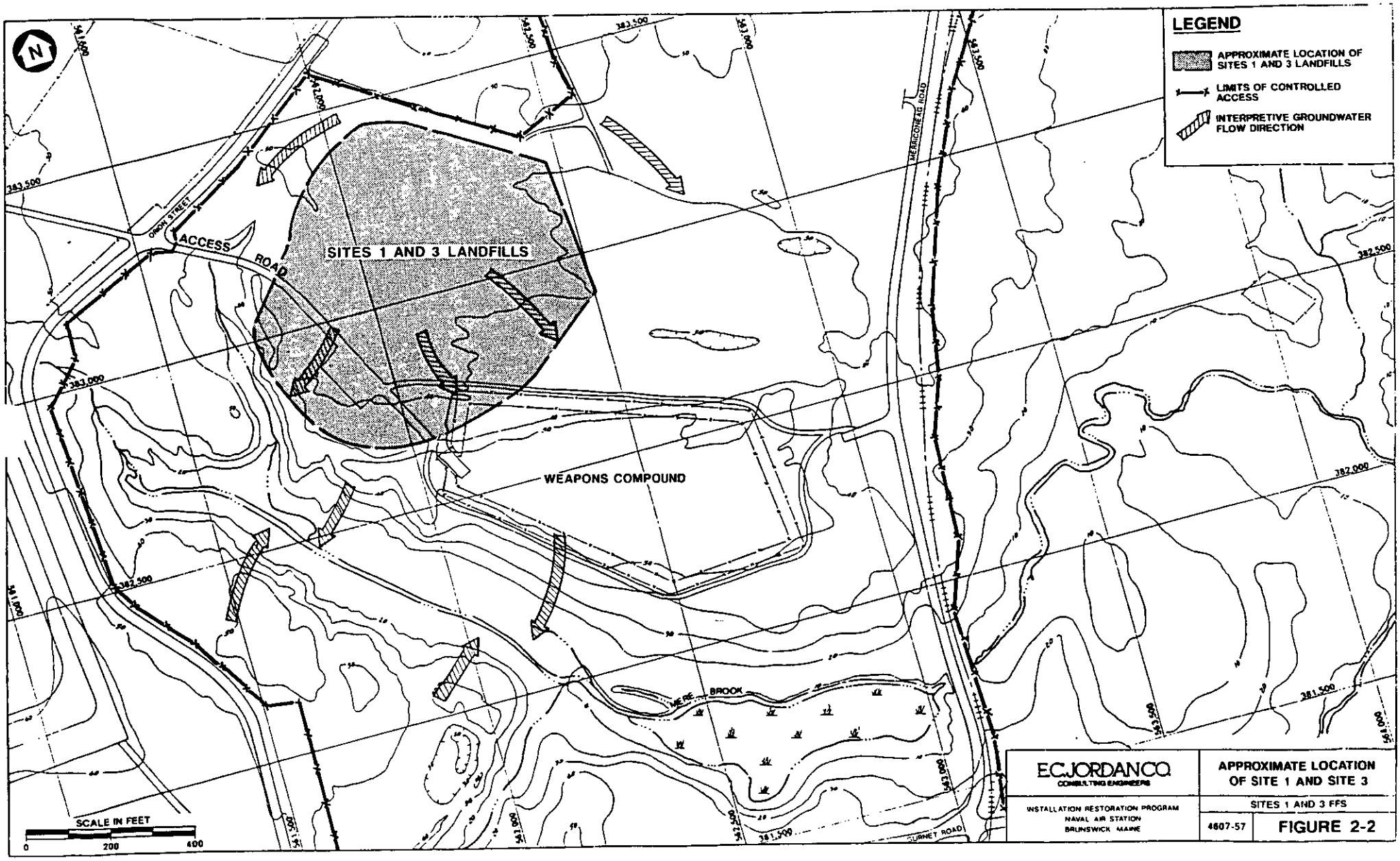
QUADRANGLE LOCATION

N

SCALE IN FEET

0 2000 4000

E.C. JORDAN CO. CONSULTING ENGINEERS	SITE LOCATION MAP
INSTALLATION RESTORATION PROGRAM NAVAL AIR STATION BRUNSWICK, MAINE	SITES 1 AND 3 FFS
	4607-57 FIGURE 2-1


LEGEND
APPROXIMATE LOCATION OF SITES 1 AND 3 LANDFILLS
LIMITS OF CONTROLLED ACCESS
INTERPRETIVE GROUNDWATER FLOW DIRECTION
SITES 1 AND 3 LANDFILLS
ACCESS ROAD
ORION STREET
WEAPONS COMPOUND
MERRIMONEAG ROAD
MERE BROOK
BURNETT ROAD
383,500
383,000
382,500
382,000
381,500
SCALE IN FEET
0
200
400
EC JORDAN CO.
CONSULTING ENGINEERS
INSTALLATION RESTORATION PROGRAM
NAVAL AIR STATION
BRUNSWICK MAINE
APPROXIMATE LOCATION OF SITE 1 AND SITE 3
SITES 1 AND 3 FFS
4607-57
FIGURE 2-2

volume of 300,000 cubic yards (cy) for Sites 1 and 3 (E.C. Jordan Co., 1990a and 1990b).

Environmental contamination was observed in several media at Sites 1 and 3, including soils, groundwater, leachate/sediment, and surface water/sediment. Contaminants detected above background levels include polycyclic aromatic hydrocarbons (PAHs) and pesticides in soil; volatile organic compounds (VOCs) and inorganic compounds in groundwater; inorganic compounds, VOCs, and semivolatile organic compounds (SVOCs) in leachate; and inorganic compounds in surface water. The source area for this contamination is considered to be the landfill located north and west of the Weapons Compound. No single, well-defined source of contamination has been identified in the landfill.

Inorganic concentrations in Mere Brook are effected by discharge of groundwater and leachate seeps emanating from Sites 1 and 3 (E.C. Jordan Co., 1990a). However upgradient of Sites 1 and 3, (e.g., SW-316 and SW-317, see Appendix E) concentrations of iron and zinc in Mere Brook are observed at levels that exceed their respective Ambient Water Quality Criteria (AWQC). Iron concentrations ranged from 1,300 to 4,830 (SW-316, see Appendix E) micrograms per liter (μg/L) and 519 to 1,300 μg/L (SW-317, see Appendix E), for sampling Rounds I through IV. The chronic AWQC value for iron is 1,000 μg/L. Zinc concentrations also exceeded the chronic AWQC at these two upgradient sampling locations and ranged from 22 to 58 μg/L (average 35 μg/L; SW-316, see Appendix E), and from 31 to 152 μg/L (average 51 μg/L; SW-317, see Appendix E). The AWQC for zinc in based on water hardness as expressed in milligrams per liter (mg/L) $CaCO_3$. Hardness, as $CaCO_3$ was not measured, however estimated values, based on calcium and magnesium concentrations in Mere Brook range from 36 to 54 mg/L. This range corresponds to a range in the chronic AWQC for zinc of 9.7 to 13.8 μg/L.

The concentrations of iron and zinc at SW-316 and SW-317 do not represent true background values for Mere Brook as storm sewer drainage from the runway area discharges to the brook in the vicinity of SW-316 and SW-317 (E.C. Jordan Co., 1990a and Appendix E). Actual background values for iron and zinc in Mere Brook are given by surface water sampling locations BK-1 and BK-2 which are located along Mere Brook west of the runways, upgradient of the runway storm sewer discharge (E.C. Jordan Co., 1990a and Appendix E). Iron concentrations at these locations range from 349 to 395 μg/L, while zinc was not detected. Therefore, iron and zinc concentrations at SW-316 and SW-317 are impacted by the storm sewer

discharge, and significant impact from Sites 1 and 3 along Mere Brook is only observed at SW-122 where 7,060 μg/L iron is reported (see Appendix E). Calcium, manganese, sodium and magnesium concentrations are all significantly elevated at this sampling location which is directly downgradient from the predicted groundwater discharge zone (see Figure 6-27, E.C. Jordan Co., 1990a, and Appendix E). Concentrations of iron and zinc in Mere Brook both upgradient and downgradient of SW-122 are at levels consistent or lower than that observed at SW-316 and SW-317 (see Appendix E).

2.2 Summary of Baseline Risk Assessments

The human health and ecological risks associated with contaminant exposure at Sites 1 and 3 were evaluated and presented in Appendix Q of the RI report (E.C. Jordan Co., 1990a). The results of these risk assessments are summarized in the following subsections.

2.2.1 Human Health Risk Assessment

Human health risks were evaluated based on potential contaminant exposure under both current (including worker exposure) and future land-use (e.g., residential) scenarios. Because access to these sites is currently controlled, long-term repetitive exposure to soils, sediments, and surface water is not considered likely. Exposure to groundwater is also not considered likely as this area of the NAS is serviced by a public water supply system. In addition, the Navy can implement institutional controls to restrict current and future land use in this area. There were no exposure routes considered to present a risk to human health under present land-use conditions. However, because the role of the baseline risk assessment is to address risks associated with the site in the absence of any remedial action, including institutional controls, potential risks under a future residential scenario were also estimated.

Human health risks are associated with exposure to groundwater under a future land-use scenario. Concentrations of some contaminants detected in groundwater from monitoring wells placed within and immediately downgradient of the landfill area exceed state guidelines and federal drinking water standards. These contaminants are listed in Table 2-1. Although groundwater beneath the site is not currently and likely will never be used for potable purposes, human health risks associated with

TABLE 2-1
CHEMICAL-SPECIFIC ARARS, CRITERIA, ADVISORIES, AND GUIDANCE

REMEDIAL INVESTIGATION
NAS BRUNSWICK

MEDIA	REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	CONSIDERATION IN THE RI/FS
GROUNDWATER/ SURFACE WATER				
Federal	SDWA - MCLs (40 CFR 141.11 - 141.16)	Relevant and Appropriate	MCLs have been promulgated for several common organic and inorganic contaminants. These levels regulate the concentration of contaminants in public drinking water supplies, but may also be considered relevant and appropriate for groundwater aquifers used for drinking water.	To assess the potential risks to human health due to consumption of groundwater, contaminant concentrations were compared to their MCLs.
	SDWA - MCLGs (40 CFR 141.50 - 141.51)	Relevant and Appropriate	MCLGs are health-based criteria. As promulgated under SARA, MCLGs are to be considered for drinking water sources. MCLGs are available for several organic and inorganic contaminants.	The 1990 National Contingency Plan states that non-zero MCLGs are to be used as goals. Contaminant concentrations in groundwater were compared to their MCLGs.
	RCRA - Subpart F Groundwater Protection Standards, Alternate Concentration Limits (40 CFR 264.94)	Relevant and Appropriate	This requirement outlines standards, in addition to background concentrations and MCLs, to be used in establishing clean-up levels for remediating groundwater contamination.	These requirements may be relevant and appropriate if certain conditions relating to transport and exposure are met.
	Federal AWQC	Relevant and Appropriate	Federal AWQC include (1) health-based criteria developed for 95 carcinogenic and noncarcinogenic compounds and (2) water quality parameters. AWQC for the protection of human health provide levels for exposure from drinking water and consuming aquatic organisms, and from consuming fish alone. Remedial actions involving contaminated surface water or groundwater must consider the uses of the water and the circumstances of the release or threatened release; this determines whether AWQC are relevant and appropriate.	This requirement will be complied with when determining clean-up levels or potential discharge limits for treated groundwater.

continued

TABLE 2-1
CHEMICAL-SPECIFIC ARARS, CRITERIA, ADVISORIES, AND GUIDANCE

REMEDIAL INVESTIGATION
NAS BRUNSWICK

MEDIA	REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	CONSIDERATION IN THE RI/FS
Federal Guidance and Criteria To Be Considered	USEPA Risk Reference Doses (RfDs)	To Be Considered	RfDs are considered the levels unlikely to cause significant adverse health effects associated with a threshold mechanism of action in human exposure for a lifetime.	USEPA RfDs are used to characterize risks due to noncarcinogens in various media.
	USEPA Carcinogen Assessment Group Carcinogenic Potency Factors (CPFs)	To Be Considered	Carcinogenic effects present the most up-to-date information on cancer risk potency derived from USEPA's Carcinogen Assessment Group.	USEPA CPFs are used to compute the individual incremental cancer risk resulting from exposure to certain compounds.
State	Maine Drinking Water Rules (10-144A CMR Chapters 231-233)	Relevant and Appropriate	Maine's Primary Drinking Water Standards are equivalent to federal MCLs. When state levels are more stringent than federal levels and have been legally and consistently applied, the state levels may be used.	Primary drinking water standards will be used to set clean-up levels.
	Maine Regulations Relating to Water Quality Criteria for Toxic Pollutants (MEDEP Regs, Chapter 584)	Applicable	This rule limits the concentrations of certain materials allowed in Maine waters to prevent the occurrence of pollutants in toxic amounts as required by state and federal law. Except if naturally occurring, ambient levels of toxic pollutants shall not exceed the Clean Water Act AWQC. Where AWQC do not exist, the Board of Environmental Protection shall adopt site-specific numerical criteria.	These standards will be attained when determining clean-up levels or potential discharge limits.

continued

TABLE 2-1
CHEMICAL-SPECIFIC ARARS, CRITERIA, ADVISORIES, AND GUIDANCE

REMEDIAL INVESTIGATION
NAS BRUNSWICK

MEDIA	REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	CONSIDERATION IN THE RI/FS
State Criteria and Guidance To Be Considered	Rules Relating to Testing of Private Water Systems for Potentially Hazardous Contaminants (10-144A CMR Chapter 233, Appendix C)	To Be Considered	Appendix C outlines Maximum Exposure Guidelines (MEGs) for organic and inorganic compounds. MEGs include health advisories, which are maximum allowable concentrations of specific contaminants in drinking water.	MEGs will be considered for chemical compounds for which there are no promulgated standards.
AIR				
Federal	Clean Air Act - National Primary and Secondary Ambient Air Quality Standards (40 CFR 50)	Applicable	Primary ambient air quality standards define levels of air quality to protect public health. Secondary ambient air quality standards protect public welfare from known or anticipated adverse effects from pollutants.	Particulate standard for matter less than 10 microns is 150 $\mu g/m^3$, 24-hour average concentration.
Federal Criteria and Guidance To Be Considered	Control of Air Emissions from Superfund Air Strippers at Superfund Groundwater Sites (OSWER Directive 9355.D-28)	To Be Considered	Controls on air strippers at sites located in attainment areas can be based on state ARARs, risk management, guidelines, and other requirements of CERCLA Section 121.	NAS Brunswick is located in a Class II area. Controls on air strippers will be determined by the system's performance and ability to attain state ARARs, criteria, and guidance.
State	Establishment of Air Quality Regions (38 MRSA, Section 583; MEDEP Regs, Chapter 114)	Relevant and Appropriate	The Metropolitan Portland Air Quality Region is Class II.	Remedial actions should not result in the degradation of air quality classification.

continued

TABLE 2-1
CHEMICAL-SPECIFIC ARARS, CRITERIA, ADVISORIES, AND GUIDANCE

REMEDIAL INVESTIGATION
NAS BRUNSWICK

MEDIA	REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	CONSIDERATION IN THE RI/FS
	Maine Ambient Air Quality Standards (38 MRSA, Section 584; MEDEP Regs, Chapter 110)	Applicable	This Chapter establishes ambient air quality standards that are maximum levels of a particular pollutant permitted in the ambient air.	Standards for specific contaminants include: (1) particulate matter-150 $\mu g/m^3$, 24-hour average concentration; (2) hydrocarbons-160 $\mu g/m^3$, 3-hour period; (3) lead-1.5 $\mu g/m^3$, 24-hour period; (4) total chromium-0.3 $\mu g/m^3$, 24-hour period; and (5) photochemical oxidants-160 $\mu g/m^3$, 24-hour period.

NOTES:

ARAR = Applicable or Relevant and Appropriate Requirement
AWQC = Ambient Water Quality Criteria
CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act
CFR = Code of Federal Regulations
CMR = Code of Maine Rules
CPF = carcinogenic potency factor
FS = feasibility study
MCL = Maximum Contaminant Level
MCLG = Maximum Contaminant Level Goal
MEG = Maximum Exposure Guidelines
MEDEP = Maine Department of Environmental Protection
MRSA = Maine Revised Statues Annotated
NAS = Naval Air Station
OSWER = Office of Solid Waste and Emergency Response
RI = remedial investigation
RCRA = Resource Conservation and Recovery Act
RfD = reference dose
SARA = Superfund Amendments and Reauthorization Act
SDWA = Safe Drinking Water Act
USEPA = U.S. Environmental Protection Agency
$\mu g/m^3$ = micrograms per cubic meter

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exposure to groundwater were considered. (A summary of the groundwater data are presented in Appendix E.)

Carcinogenic risks in excess of 10^{-6} and noncarcinogenic risks greater than a Hazard Index (HI) of 1.0 were associated with exposure to certain contaminants detected in groundwater beneath Sites 1 and 3. No risk estimates exceeded the 10^{-4} risk level. The contaminants of concern in groundwater include arsenic, vinyl chloride, methylene chloride, 1,2-dichloroethylene (DCE), chromium, lead, and nickel. 1,1-Dichloroethane was originally listed as a contaminant of concern. However, because it was detected at concentrations less than its risk reference dose [0.1 milligram per kilogram per day (mg/kg-day) or 3.5 mg/L assuming a 70 kg adult ingests 2 liters of water per day], it has been eliminated as a containment of concern.

Human health risks associated with long term repetitive dermal contact and incidental ingestion of soil were also evaluated under a future residential scenario. The carcinogenic risks associated with this scenario were $3x10^{-6}$ and attributed almost entirely to the presence of PAHs. (E.C. Jordan Co., 1990a). This estimate is at the lower end of the risk range of 10^{-4} to 10^{-6} and is considered to be conservative as is does not account for any decrease in contaminant concentrations that will result from natural degradation and dispersion processes. Based on the results of this evaluation, no remedial action objectives were developed for soil contaminants. (A summary of the soil data are presented in Appendix E.)

Based on the results of the risk assessment, remedial action objectives were developed to eliminate, reduce, or control risks to human health from future potential exposure through ingestion of groundwater. The Target Cleanup Levels for the contaminants of concern are proposed at Chemical Specific, ARARs (e.g., Maximum Contaminant Levels [MCL], Maximum Contaminant Level Goal [MCLG]) or appropriate risk-based levels (e.g., carcinogenic risk of 10^{-6} or HI of 1.0). A range of remedial alternatives were developed that include maintaining controlled access to and land-use at the site to limit contaminant exposure, and diverting groundwater flow around the landfill to reduce leachate and contaminant concentrations in groundwater. The remedial action objectives are discussed in more detail in Subsection 2.4.

2.2.2 Ecological Risk Assessment

Ecological risks associated with contaminant exposure at Sites 1 and 3 focused on the Mere Brook Beaver Marsh and were estimated using a food-web analysis (E.C. Jordan Co., 1990a). According to this analysis, exposure to mercury in soil and sediment around the leachate seeps at Sites 1 and 3 may cause chronic impacts to some terrestrial receptors. Soil organisms such as earthworms and other invertebrates with a small home range (e.g., small birds and rodents) might receive the greatest exposure because a large proportion of their diet consists of organisms inhabiting the contaminated area. Organisms with a large home range (e.g., hawks and foxes) are expected to receive smaller exposures because most of their diet consists of organisms inhabiting uncontaminated areas. Deer and other herbivores, that have a large home range, are not expected to be adversely affected by contamination in this area. It is not possible to quantify population-level effects of this exposure because the boundaries and densities of wildlife populations at NAS Brunswick are not known. No chronic or acute ecological effects were estimated based on exposure to other contaminants detected within the Mere Brook ecosystem including polychlorinated biphenyls (PCBs) and dichlorodiphenyltrichloroethane (DDT). These contaminants were not present at concentrations considered to present an ecological risk (E.C. Jordan Co., 1990a). (A summary of the surface water and sediment data are presented in Appendix E.)

Zinc and iron were detected in the surface water of Mere Brook in excess of their respective AWQC. AWQC are contaminant concentrations in surface water considered to be protective of aquatic organisms.

Based on the results of the ecological risk assessment, remedial action objectives were developed to reduce exposure to or contaminant concentrations in surface water and leachate sediments around Mere Brook. Surface water Target Clean-up Levels for iron and zinc were proposed at the contaminants' AWQC; leachate sediment Target Clean-up Levels for mercury were derived based on the food-web analysis. The derivation of these clean-up levels is described in Subsection 2.4.2. A range of remedial alternatives were developed to reduce contaminant concentrations in the leachate sediment and surface water. These include diverting groundwater flow around the landfill and collecting and treating contaminated groundwater prior to its discharge to Mere Brook.

As discussed in Section 1.0, a separate evaluation of the remedial alternatives proposed for Site 2 is being conducted. This evaluation includes a discussion of the possible impacts of Site 2 on the Mere Brook Beaver Marsh. Any remedial alternative proposed for this site, will be consistent with achieving the remedial action objectives for Sites 1 and 3.

2.3 IDENTIFICATION OF APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

ARARs are federal and state public health and environmental requirements and guidelines used to (1) evaluate the appropriate extent of site cleanup, (2) define and formulate remedial action alternatives, and (3) govern implementation and operation of the selected action.

2.3.1 Definition of ARARS

To properly consider ARARs and to clarify their function in the RI/FS and remedial response processes, the NCP define two ARAR components: (1) applicable requirements, and (2) relevant and appropriate requirements. These definitions are discussed in the following paragraphs.

Applicable requirements are those federal and state requirements that would be legally applicable, either directly or as incorporated by a federally authorized state program. Requirements that specifically address, and have jurisdiction over, a given situation are considered "applicable requirements." An example of an applicable requirement is the use of MCLs for a site where groundwater contamination enters a public water supply.

Relevant and appropriate requirements are those federal and state requirements that, while not legally "applicable," can be applied if the decision-maker's best professional judgement determines that site circumstances are sufficiently similar to those situations that are covered and use of the requirement makes good sense. Relevant and appropriate requirements are intended to have the same weight and consideration as applicable requirements.

The term "relevant" was included so that a requirement initially screened as non-applicable because of jurisdictional restrictions would be reconsidered and, if

appropriate, be included as an ARAR for the site. For example, MCLs would be relevant an appropriate requirements at a site where groundwater contamination could affect a potential (rather than actual) drinking water source.

Other requirements to be considered (TBCs) are federal and state nonpromulgated advisories or guidelines that are not legally binding and do not have the status of potential ARARs. However, if there are no specific ARARs for a chemical or site condition, or if existing ARARs are not deemed sufficiently protective, then guidance or advisory criteria should be identified and used to ensure public health and environmental protection.

2.3.2 Identification of ARARs

Under the description of ARARs set forth in the NCP, state and federal environmental requirements must be considered. These requirements include ARARs that are:

- location-specific (i.e., pertain to existing site features),
- chemical-specific (i.e., govern the level or extent of site remediation), and
- action-specific (i.e., pertain to proposed site remedies and govern implementation of the selected site remedy).

2.3.2.1 Chemical-Specific ARARs. Chemical-specific ARARs are usually health- or risk-based standards limiting the concentration of a chemical found in or discharged to the environment. They govern the extent of site remediation by providing either actual clean-up levels, or the basis for calculating such levels. For example, groundwater standards may provide necessary clean-up goals for site with contaminated groundwater. Chemical-specific ARARs for the site may also be used to indicate acceptable levels of discharge in determining treatment and disposal requirement, and to assess the effectiveness of future remedial alternative. Table 2-2 provides a list and synopsis of potential chemical-specific ARARs.

2.3.2.2 Location-Specific ARARs. Location-specific ARARs govern natural site feature (e.g., wetland, floodplains, and sensitive ecosystems) and manmade feature (e.g., existing landfills, disposal areas, and places of historical or archeological

TABLE 2-2
CHEMICAL-SPECIFIC ARARS, CRITERIA, ADVISORIES, AND GUIDANCE FOR SITES 1 AND 3

FOCUSED FEASIBILITY STUDY
NAS BRUNSWICK

MEDIA	REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	CONSIDERATION IN THE RI/FS
GROUNDWATER/SURFACE WATER				
Federal	SDWA - MCLs (40 CFR 141.11 - 141.16)	Relevant and Appropriate	MCLs have been promulgated for several common organic and inorganic contaminants. These levels regulate the concentration of contaminants in public drinking water supplies, but may also be considered relevant and appropriate for groundwater aquifers used for drinking water.	To assess the potential risks to human health due to consumption of groundwater, contaminant concentrations were compared to their MCLs.
	SDWA - MCLGs (40 CFR 141.50 - 141.51)	Relevant and Appropriate	MCLGs are health-based criteria to be considered for drinking water sources as a result of SARA. MCLGs are available for several organic and inorganic contaminants.	The 1990 National Contingency Plan states that non-zero MCLGs are to be used as goals. Contaminant concentrations in groundwater were compared to their MCLGs.
	RCRA - Subpart F Groundwater Protection Standards, Alternative Concentration Limits (40 CFR 264.94)	Relevant and Appropriate	This requirement outlines standards, in addition to background concentrations and MCLs, to be used in establishing clean-up levels for remediating groundwater contamination.	These requirements may be relevant and appropriate if certain conditions relating to transport and exposure are met.
	Federal AWQC	Relevant and Appropriate	Federal AWQC are health-based criteria developed for carcinogenic and noncarcinogenic compounds and parameters. AWQC for the protection of human health provide levels for exposure from drinking water and consuming aquatic organisms, and from consuming fish alone. Remedial actions involving contaminated surface water or groundwater must consider the uses of the water and the circumstances of the release or threatened release; this determines whether AWQC are relevant and appropriate.	This requirement will be complied with when determining clean-up levels or potential discharge limits for treated groundwater.
Federal Guidance and Advisories To Be Considered	USEPA Risk Reference Doses (RfDs)	To Be Considered	RfDs are considered the levels unlikely to cause significant adverse health effects associated with a threshold mechanism of action in human exposure for a lifetime.	USEPA RfDs are used to characterize risks due to noncarcinogens in various media.
	USEPA Carcinogen Assessment Group Carcinogenic Potency Factors (CPFs)	To Be Considered	Carcinogenic effects present the most up-to-date information on cancer risk potency derived from USEPA's Carcinogen Assessment Group.	USEPA CPFs are used to compute the individual incremental cancer risk resulting from exposure to certain compounds.

(continued)

TABLE 2-2
CHEMICAL-SPECIFIC ARARS, CRITERIA, ADVISORIES, AND GUIDANCE FOR SITES 1 AND 3

FOCUSED FEASIBILITY STUDY
NAS BRUNSWICK

MEDIA	REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	CONSIDERATION IN THE RI/FS
GROUNDWATER/SURFACE WATER (continued)				
State	Maine Drinking Water Rules (10-144A CMR Chapters 231-233)	Relevant and Appropriate	Maine's Primary Drinking Water Standards are equivalent to federal MCLs. Maine MEGs have been promulgated for several contaminants. When state levels are more stringent than federal levels and have been legally and consistently applied, the state levels may be used.	Primary drinking water standards will be used to set clean-up levels.
	Maine Standards for Classification of Minor Drainages (38 MRSA, Chapter 3, Section 468)	Applicable	Mere Brook is classified as a Class B water under the state water quality standards.	Remedial actions should not result in the degradation of water quality classification.
	Maine Regulations Relating to Water Quality Criteria for Toxic Pollutants (MEDEP Regulations, Chapter 584)	Applicable	This rule limits the concentrations of certain materials allowed in Maine waters to prevent the occurrence of pollutants in toxic amounts as required by state and federal law. Except if naturally occurring, ambient levels of toxic pollutants shall not exceed the Clean Water Act AWQC. Where AWQC do not exist, the Board of Environmental Protection shall adopt site-specific numerical criteria.	These standards will be attained when determining clean-up levels or potential discharge limits.
AIR				
Federal	Clean Air Act - National Primary and Secondary Ambient Air Quality Standards (40 CFR 50)	Applicable	Primary ambient air quality standards define levels of air quality to protect public health. Secondary ambient air quality standards protect public welfare from known or anticipated adverse effects from pollutants.	Particulate standard for matter less than 10 microns is 150 $\mu g/m^3$, 24-hour average concentration.

(continued)

TABLE 2-2
CHEMICAL-SPECIFIC ARARS, CRITERIA, ADVISORIES, AND GUIDANCE FOR SITES 1 AND 3

FOCUSED FEASIBILITY STUDY
NAS BRUNSWICK

MEDIA	REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	CONSIDERATION IN THE RI/FS
Federal Criteria and Guidance To Be Considered	Control of Air Emissions from Superfund Air Strippers at Superfund Groundwater Sites (OSWER Directive 9355.D-28)	To Be Considered	Controls on air strippers at sites located in attainment areas can be based on state ARARs, risk management, guidelines, and other requirements of CERCLA Section 121.	NAS Brunswick is located in a Class II area. Controls on air strippers will be determined by the system's performance and ability to attain state ARARs, criteria, and guidance.
State	Classification of Air Quality Control Regions (38 MRSA Chapter 4, Section 583-B; MEDEP Regs, Chapter 114)	Relevant and Appropriate	The Metropolitan Portland Air Quality Region is Class II.	Remedial actions should not result in the degradation of air quality classification.
	Incinerator Particulate Emission Standards (MEDEP Regs, Chapter 104)	Applicable	Establishes limitations on the amount of particulate matter allowed to be emitted from several categories and sizes of incinerators, as well as a limitation on the capacity of emission from all incinerators.	These limits will be addressed if an on-site incinerator is proposed.
	Maine Ambient Air Quality Standards (MEDEP Regs, Chapter 110)	Applicable	This Chapter establishes ambient air quality standards that are maximum levels of a particular pollutant permitted in the ambient air.	The standard for particulate matter is 150 $\mu g/m^3$, 24-hour average concentration.
	Maine Emission License Regulations (38 MRSA Chapter 4, Section 590; MEDEP Regs, Chapter 115)	Applicable	These requirements specify who must obtain an air emissions license, application information, and standards and criteria that must be met.	New sources must be in compliance with all applicable emissions limitations under the Clean Air Act. Emissions of pollutants with no standards should not exceed interim guideline values.

(continued)

TABLE 2-2
CHEMICAL-SPECIFIC ARARS, CRITERIA, ADVISORIES, AND GUIDANCE FOR SITES 1 AND 3

FOCUSED FEASIBILITY STUDY
NAS BRUNSWICK

NOTES:

ARAR = Applicable or Relevant and Appropriate Requirement
AWQC = Ambient Water Quality Criteria
CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act
CFR = Code of Federal Regulations
CMR = Code of Maine Rules
CPF = carcinogenic potency factor
FS = feasibility study
MCL = Maximum Contaminant Level
MCLG = Maximum Contaminant Level Goal
MEG = Maximum Exposure Guidelines
MEDEP = Maine Department of Environmental Protection
MRSA = Maine Revised Statues Annotated
NESHAP = National Emission Standards for Hazardous Air Pollutants
OSWER = Office of Solid Waste and Emergency Response
ppm = parts per million
RI = remedial investigation
RCRA = Resource Conservation and Recovery Act
RfD = reference dose
SARA = Superfund Amendments and Reauthorization Act
SDWA = Safe Drinking Water Act
USEPA = U.S. Environmental Protection Agency
$\mu g/m^3$ = micrograms per cubic meter

significance). These ARARs generally place restrictions on the concentration of hazardous substances or the conduct of activities solely based on the site's particular characteristic or location. Table 2-3 provides a list and synopses of potential location-specific standards.

2.3.2.3 Action-Specific ARARs. Action-Specific ARARs are usually technology- or activity-based limitations that control actions at hazardous waste sites. After remedial alternatives are developed, action-specific ARARs pertaining to proposed site remedies provide a basis for assessing the feasibility and effectiveness of the remedies. For example, these action-specific ARARs may include hazardous waste transportation and handling requirements, air and water emissions standards, and Resource Conservation and Recovery Act (RCRA) landfilling and treatment requirements.

Table 2-4 lists regulations identified as potential ARARs for the possible remedial alternatives. Major requirements that must be attained are discussed in the following paragraphs. Action-specific ARARs for each remedial alternative that passes initial screening will be discussed during the detailed analysis of those remedial alternatives retained after screening.

There are a number of federal and state regulations that govern facility standards and actions conducted at hazardous waste sites. This group of general action-specific ARARs would apply to all of the proposed remedial alternatives, except No Action. RCRA General Facility Standards (40 CFR 264.10 - 264.18), Preparedness and Prevention (40 CFR 264.30 - 264.37), Contingency Plan and Emergency Procedures (40 CFR 364.50 - 364.56) would apply to any remedial action conducted at NAS Brunswick. The Maine Hazardous Waste Management Rules (MEDEP Regulations, Chapters 800-802, 850, 851, 853-857) supplement the RCRA general standards; therefore, would also apply. These regulations outline requirements for general operation and maintenance, safety, and emergency procedures for hazardous waste treatment facilities and remedial actions.

Occupational Safety and Health Administration (OSHA) requirements promulgated under General Facility Standards (29 CFR 1910), Safety and Health Standards (29 CFR 1926), and Recordkeeping, Reporting, and Related Regulations (29 CFR 1904) would apply to all worker activities conducted during remediation. OSHA regulations include health and safety standards for federal services contracts, record

TABLE 2-3
LOCATION-SPECIFIC ARARS, CRITERIA, ADVISORIES, AND GUIDANCE FOR SITES 1 AND 3

FOCUSED FEASIBILITY STUDY
NAS BRUNSWICK

MEDIA	REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	CONSIDERATION IN THE RI/FS
WETLANDS				
Federal	CWA Section 404	Applicable	Section 404 of the CWA regulates the discharge of dredged or fill material into U.S. waters, including wetlands. The purpose of Section 404 is to ensure that proposed discharges are evaluated with respect to impact on the aquatic ecosystem. If a remedial alternative involves dredged or fill material discharge to a wetland, a permit must be obtained from the U.S. Army Corps of Engineers.	During the identification, screening, and evaluation of alternatives, the effects on wetlands are evaluated.
	Guidelines for Specification of Disposal Sites for Dredged or Fill Materials (40 CFR 230)	Applicable	These guidelines maintain that no dredged or fill material discharge will be permitted if there is a practicable alternative with less impact to the aquatic ecosystem. Discharge will also not be permitted unless steps are taken to minimize potential adverse impacts, or if it will cause or contribute to significant degradation of U.S. waters.	If a remedial alternative involves discharging dredged or fill material to a wetland, potential short- or long-term effects must be determined, based on various physical, chemical, and biological parameters. Effects on human use characteristics such as aesthetics and recreation also need to be addressed.
	Fish and Wildlife Coordination Act (16 U.S.C. 661)	Applicable	This act requires that any federal agency proposing to modify a body of water must consult with the U.S. Fish and Wildlife Service, National Marine Fisheries Service, and other related state agencies.	Notification is not required for actions taken on-site at a CERCLA site. However, actions will be taken to minimize impacts to wetlands.
FLOODPLAINS	RCRA - Location Standards (40 CFR 264.18)	Relevant and Appropriate	A facility located in a 100-year floodplain must be designed, constructed, operated, and maintained to prevent washout of any hazardous wastes by a 100-year flood.	The impact of hazardous constituents on the affected surface waters must be considered during remedial actions.

(continued)

TABLE 2-3
LOCATION-SPECIFIC ARARS, CRITERIA, ADVISORIES, AND GUIDANCE FOR SITES 1 AND 3

FOCUSED FEASIBILITY STUDY
NAS BRUNSWICK

MEDIA	REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	CONSIDERATION IN THE RI/FS
WETLANDS/FLOODPLAINS				
	40 CFR Part 6, Appendix A	Applicable	Sets forth USEPA policy for carrying out the provisions of the Wetlands Executive Order (EO 11990) and Floodplains Executive Order (EO 11988). Under this order, federal agencies are required to minimize the destruction, loss, or degradation of wetlands, and preserve and enhance natural and beneficial values of wetlands; and minimize potential harm to or within floodplains and to avoid the long- and short-term adverse impact with modifications to floodplains.	This requirement will be considered during the development of alternatives. If no practical alternative exists, potential harm must be minimized and action taken to restore the natural and beneficial values of the wetland or floodplain.
State	Maine Natural Resources Protection Act (38 MRSA, Section 480-A through S)	Applicable	This act outlines requirements for certain activities adjacent to any freshwater wetland greater than 10 acres or with an associated stream, brook, or pond or adjacent to a coastal wetland. The activities must not unreasonably interfere with certain natural features, such as natural flow or quality of any waters, nor harm significant aquatic habitat, freshwater fisheries, or other aquatic life.	Remedial activities regulated under this act must meet activity standards. Substantive requirements of these regulations must be met by any action taken within 100 feet of a wetland or stream.
	Natural Resources Protection Act, Permit by Rule Standards (MEDEP Regs, Chapter 305)	Applicable	This rule outlines prescribed standards for specific activities that may take place in or adjacent to wetlands and water bodies.	Proposed activities involving disturbance of soil material and discharge of treatment water, within 100 feet of the normal high water line, would be designed to incorporate all applicable standards.
	Maine Hazardous Waste Management Rules (06-096 CMR 800-802, 850, 851, 853-857)	Applicable	These rules correspond to RCRA hazardous waste requirements and outline the criteria for the siting of a new facility. No portion of a treatment facility may be located within a wetland or within 300 feet of any 100-year floodplain. These rules supplement RCRA hazardous waste regulations.	The siting rules will be considered when selecting a location if an on-site treatment facility is proposed that would handle hazardous waste.

(continued)

TABLE 2-3
LOCATION-SPECIFIC ARARS, CRITERIA, ADVISORIES, AND GUIDANCE FOR SITES 1 AND 3

FOCUSED FEASIBILITY STUDY
NAS BRUNSWICK

MEDIA	REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	CONSIDERATION IN THE RI/FS
MERE BROOK				
State	Maine Standards for Classification of Minor Drainages (38 MRSA, Chapter 3, Section 468)	Applicable	Mere Brook is classified as a Class B water under the state water quality standards. Class B waters are defined as suitable for drinking water (after treatment), fishing, recreation in and on the water, and as habitat for fish and other aquatic life.	Remedial actions should not result in the degradation of water quality classification.
	Maine Natural Resources Protection Act (38 MRSA, Section 480-A through S)	Applicable	A permit application must be submitted and approved by the Maine Bureau of Land Quality Control and Section 480-D performance standards met when conducting activities adjacent to any freshwater wetland greater than 10 acres or with an associated stream, brook, or pond.	Remedial activities regulated under this act must meet activity standards developed by the Maine Bureau of Land Quality Control.
	Maine Water Pollution Control Law: Solid Waste Disposal Areas; Location (38 MRSA, Chapter 3, Article 2, Section 421)	Applicable	No boundary of any public or private solid waste disposal area shall lie closer than 300 feet to any classified body of surface water; also known as the Three-Hundred-Foot Law.	During the development of alternatives, effects on the surface waters will be evaluated.
OTHER NATURAL RESOURCES				
Federal	Endangered Species Applicable Act	Applicable	This act requires action to avoid jeopardizing the continued existence of listed endangered or threatened species or notification of their habitat.	Endangered or threatened species in the site area will be identified. Activities must not impact such species.
State	Maine Standards for Classification of Groundwater (38 MRSA, Chapter 3, Section 470)	Applicable	This law requires the classification of the state's groundwater to protect, conserve, and maintain groundwater resources in the interest of the health, safety, and general welfare of the people of the state.	Under the Maine standards, groundwater is classified as GW-A.

(continued)

TABLE 2-3
LOCATION-SPECIFIC ARARS, CRITERIA, ADVISORIES, AND GUIDANCE FOR SITES 1 AND 3

FOCUSED FEASIBILITY STUDY
NAS BRUNSWICK

MEDIA	REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	CONSIDERATION IN THE RI/FS
OTHER NATURAL RESOURCES (continued)				
	Maine Site Location of Development Law and Regulations (38 MRSA Sections 481-490; MEDEP Regs, Chapters 371-377)	Applicable	This act and regulations govern drilling for natural resources and includes hazardous activities that consume, generate, or handle hazardous wastes and oil. Activities cannot adversely affect existing uses, scenic character, or natural resources in the municipality or neighboring municipality.	Remedial alternatives will be developed considering these regulations. A permit will not be required if the activity is on-site.
	Maine Solid Waste Management Rules: Landfill Disposal Facilities (38 MRSA, Section 1301 et seq.; MEDEP Regs, Chapters 400-406)	Applicable	These regulations outline landfill siting requirements including minimum distances to aquifers, bedrock, and geologic faults.	The standards outlined in this requirement will be incorporated into the design of any remedial alternative proposing construction of a land disposal facility.
	Maine Inland Fisheries and Wildlife Laws and Regulations (12 MRSA Chapter 713, Section 7751)	Applicable	The state of Maine has authority to research, list, and protect any species deemed endangered or threatened. These species are listed as either endangered or threatened in the state regulations. The Maine Department of Inland Fisheries and Wildlife has also developed the following administrative categories for species not considered endangered or threatened but considered important for research and further evaluation: Maine Watch List, Special Concern List, and Indeterminate Category. The Department determines appropriate use(s) of various habitats on a case-by-case basis. The Maine lists may differ from the federal lists of endangered species.	Endangered or threatened species in the site area will be identified. Activities must not impact an endangered or threatened species.

(continued)

TABLE 2-3
LOCATION-SPECIFIC ARARS, CRITERIA, ADVISORIES, AND GUIDANCE FOR SITES 1 AND 3

FOCUSED FEASIBILITY STUDY
NAS BRUNSWICK

MEDIA	REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	CONSIDERATION IN THE RI/FS
State Guidance To Be Considered	Town Shoreland Zoning Ordinances and State Minimum Guidelines	To Be Considered	These minimum guidelines and town ordinances apply to activities proposed within 200 feet of a high-water mark of a stream or other body of water.	These guidelines will be considered in the siting of treatment facilities during the development and evaluation of remedial alternatives.
	Maine Critical Areas Program and Maine Natural Heritage Program	To Be Considered	These state programs issue policies and regulations governing special habitats or communities.	Where such special areas exist, these state programs will become involved in the project and/or permit review process.
	Maine Critical Areas Act (5 MRSA 3310 through 3316)	To Be Considered	This nonregulatory legislation allows Maine agencies such as the Critical Areas Program and the Natural Heritage Areas Program to identify, research, and protect critical areas and endangered or threatened plants.	Where such special areas exist, these state programs will become involved in the project and/or permit review process.

TABLE 2-4
LOCATION-SPECIFIC ARARS, CRITERIA, ADVISORIES, AND GUIDANCE

REMEDIAL INVESTIGATION
NAS BRUNSWICK

MEDIA	REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	CONSIDERATION IN THE RI/FS
WETLANDS				
Federal	CWA Section 404	Applicable	Section 404 of the CWA regulates the discharge of dredged or fill material into U.S. waters, including wetlands. The purpose of Section 404 is to ensure that proposed discharges are evaluated with respect to impact on the aquatic ecosystem. If a remedial alternative involves dredged or fill material discharge to a wetland, a permit must be obtained from the U.S. Army Corps of Engineers.	During the identification, screening, and evaluation of alternatives, the effects on wetlands are evaluated.
	U.S. Army Corps of Engineers Permit Program Regulations (33 CFR 320-330)	Applicable	These regulations prescribe the statutory authorities, and general and special policies and procedures applicable to the review of applications for Department of Army permits for controlling certain activities in U.S. waters including discharge of dredged or fill material.	To obtain a Department of Army permit, it must be shown (1) dredging and filling of the wetlands will cause minimal adverse impacts, (2) a less environmentally damaging alternative does not exist, and (3) the project is in the overall public interest.
	Guidelines for Specification of Disposal Sites for Dredged or Fill Materials (40 CFR 230)	Applicable	These guidelines maintain that no dredged or fill material discharge will be permitted if there is a practicable alternative with less impact to the aquatic	

TABLE 2-4
LOCATION-SPECIFIC ARARS, CRITERIA, ADVISORIES, AND GUIDANCE

REMEDIAL INVESTIGATION
NAS BRUNSWICK

MEDIA	REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	CONSIDERATION IN THE RI/FS
WETLANDS				
Federal	CWA Section 404	Applicable	Section 404 of the CWA regulates the discharge of dredged or fill material into U.S. waters, including wetlands. The purpose of Section 404 is to ensure that proposed discharges are evaluated with respect to impact on the aquatic ecosystem. If a remedial alternative involves dredged or fill material discharge to a wetland, a permit must be obtained from the U.S. Army Corps of Engineers.	During the identification, screening, and evaluation of alternatives, the effects on wetlands are evaluated.
	U.S. Army Corps of Engineers Permit Program Regulations (33 CFR 320-330)	Applicable	These regulations prescribe the statutory authorities, and general and special policies and procedures applicable to the review of applications for Department of Army permits for controlling certain activities in U.S. waters including discharge of dredged or fill material.	To obtain a Department of Army permit, it must be shown (1) dredging and filling of the wetlands will cause minimal adverse impacts, (2) a less environmentally damaging alternative does not exist, and (3) the project is in the overall public interest.
	Guidelines for Specification of Disposal Sites for Dredged or Fill Materials (40 CFR 230)	Applicable	These guidelines maintain that no dredged or fill material discharge will be permitted if there is a practicable alternative with less impact to the aquatic ecosystem. Discharge will also not be permitted unless steps are taken to minimize potential adverse impacts, or if it will cause or contribute to significant degradation of U.S. waters.	If a remedial alternative involves discharging dredged or fill material to a wetland, potential short- or long-term effects must be determined, based on various physical, chemical, and biological parameters. Effects on human use characteristics such as aesthetics and recreation also need to be addressed.
	Fish and Wildlife Coordination Act (16 U.S.C. 661)	Applicable	This act requires that any federal agency proposing to modify a body of water must consult with the U.S. Fish and Wildlife Service, National Marine Fisheries Service, and other related state agencies.	Notification is not required for actions taken on-site at a CERCLA site. However, actions will be taken to minimize impacts to wetlands.
FLOODPLAINS	RCRA - Location Standards (40 CFR 264.18)	Relevant and Appropriate	A facility located in a 100-year floodplain must be designed, constructed, operated, and maintained to prevent washout of any hazardous wastes by a 100-year flood.	The impact of hazardous constituents on the affected surface waters must be considered during remedial actions.

continued

TABLE 2-4
LOCATION-SPECIFIC ARARS, CRITERIA, ADVISORIES, AND GUIDANCE

REMEDIAL INVESTIGATION
NAS BRUNSWICK

MEDIA	REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	CONSIDERATION IN THE RI/FS
WETLANDS/FLOODPLAINS				
	40 CFR Part 6, Appendix A	Applicable	Sets forth USEPA policy for carrying out the provisions of the Wetlands Executive Order (EO 11990) and Floodplains Executive Order (EO 11988). Under this order, federal agencies are required to minimize the destruction, loss, or degradation of wetlands, and preserve and enhance natural and beneficial values of wetlands; and minimize potential harm to or within floodplains and to avoid the long- and short-term adverse impact with modifications to floodplains.	This requirement will be considered during the development of alternatives. If no practical alternative exists, potential harm must be minimized and action taken to restore the natural and beneficial values of the wetland or floodplain.
State	Maine Natural Resources Protection Act (38 MRSA, Section 480-A through S)	Applicable	This act outlines requirements for certain activities adjacent to any freshwater wetland greater than 10 acres or with an associated stream, brook, or pond or adjacent to a coastal wetland. The activities must not unreasonably interfere with certain natural features, such as natural flow or quality of any waters, nor harm significant aquatic habitat, freshwater fisheries, or other aquatic life.	Remedial activities regulated under this act must meet activity standards. Substantive requirements of these regulations must be met by any action taken within 100 feet of a wetland or stream.
	Natural Resources Protection Act, Permit by Rule Standards (MEDEP Regs, Chapter 305)	Applicable	This rule outlines prescribed standards for specific activities that may take place in or adjacent to wetlands and water bodies.	Proposed activities involving disturbance of soil material and discharge of treatment water, within 100 feet of the normal high water line, would be designed to incorporate all applicable standards.
	Maine Hazardous Waste Management Rules (MEDEP Regs, Chapters 800-802, 850, 851, 853-857)	Applicable	These rules correspond to and supplement RCRA hazardous waste requirements and outline the criteria for the siting of a new facility. No portion of a treatment facility may be located within a wetland or within 300 feet of any 100-year floodplain.	The siting rules will be considered when selecting a location if an on-site treatment facility is proposed that would handle hazardous waste.

continued

TABLE 2-4
LOCATION-SPECIFIC ARARS, CRITERIA, ADVISORIES, AND GUIDANCE

REMEDIAL INVESTIGATION
NAS BRUNSWICK

MEDIA	REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	CONSIDERATION IN THE RI/FS
MERE BROOK				
State	Maine Standards for Classification of Minor Drainages (38 MRSA, Section 468)	Applicable	Mere Brook is classified as a Class B water under the state water quality standards. Class B waters are defined as suitable for drinking water (after treatment), fishing, recreation in and on the water, and as habitat for fish and other aquatic life.	Remedial actions should not result in the degradation of water quality classification.
	Maine Natural Resources Protection Act (38 MRSA, Section 480-A through S)	Applicable	A permit application must be submitted and approved by the Maine Bureau of Land Quality Control and Section 480-D performance standards met when conducting activities adjacent to any freshwater wetland greater than 10 acres or with an associated stream, brook, or pond.	Remedial activities regulated under this act must meet activity standards developed by the Maine Bureau of Land Quality Control.
	Maine Water Pollution Control Law: Solid Waste Disposal Areas; Location (38 MRSA, Section 421)	Applicable	No boundary of any public or private solid waste disposal area shall lie closer than 300 feet to any classified body of surface water; also known as the Three-Hundred-Foot Law.	During the development of alternatives, effects on the surface waters will be evaluated.
OTHER NATURAL RESOURCES				
Federal	Endangered Species Applicable Act	Applicable	This act requires action to avoid jeopardizing the continued existence of listed endangered or threatened species or notification of their habitat.	Endangered or threatened species in the site area will be identified. Activities must not impact such species.
State	Maine Standards for Classification of Groundwater (38 MRSA, Section 470)	Applicable	This law requires the classification of the state's groundwater to protect, conserve, and maintain groundwater resources in the interest of the health, safety, and general welfare of the people of the state.	Under the Maine standards, groundwater is classified as GW-A.

continued

TABLE 2-4
LOCATION-SPECIFIC ARARS, CRITERIA, ADVISORIES, AND GUIDANCE

REMEDIAL INVESTIGATION
NAS BRUNSWICK

MEDIA	REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	CONSIDERATION IN THE RI/FS
	Maine Site Location Development Law and Regulations (38 MRSA Sections 481-490; MEDEP Regs, Chapters 371-377)	Applicable	This act and regulations govern drilling for natural resources and includes hazardous activities that consume, generate, or handle hazardous wastes and oil. Activities cannot adversely affect existing uses, scenic character, or natural resources in the municipality or neighboring municipality.	Remedial alternatives will be developed considering these regulations. A permit will not be required if the activity is on-site.
	Maine Solid Waste Management Rules: Landfill Disposal Facilities (38 MRSA, Section 1301 et seq.; MEDEP Regs, Chapters 400-406)	Applicable	These regulations outline landfill siting requirements including minimum distances to aquifers, bedrock, and geologic faults.	The standards outlined in this requirement will be incorporated into the design of any remedial alternative proposing construction of a land disposal facility.
	Maine Inland Fisheries and Wildlife Laws and Regulations (12 MRSA Chapter 713, Section 7751)	Applicable	The state of Maine has authority to research, list, and protect any species deemed endangered or threatened. These species are listed as either endangered or threatened in the state regulations. The Maine Department of Inland Fisheries and Wildlife has also developed the following administrative categories for species not considered endangered or threatened but considered important for research and further evaluation: Maine Watch List, Special Concern List, and Indeterminate Category. The Department determines appropriate use(s) of various habitats on a case-by-case basis. The Maine lists may differ from the federal lists of endangered species.	Endangered or threatened species in the site area will be identified. Activities must not impact an endangered or threatened species.
State Guidance and Criteria To Be Considered	Town Shoreland Zoning Ordinances and State Minimum Guidelines	To Be Considered	These minimum guidelines and town ordinances apply to activities proposed within 200 feet of a high-water mark of a stream or other body of water.	These guidelines will be considered in the siting of treatment facilities during the development and evaluation of remedial alternatives.

continued

TABLE 2-4
LOCATION-SPECIFIC ARARS, CRITERIA, ADVISORIES, AND GUIDANCE

REMEDIAL INVESTIGATION
NAS BRUNSWICK

MEDIA	REQUIREMENT	STATUS	REQUIREMENT SYNOPSIS	CONSIDERATION IN THE RI/FS
	Maine Critical Areas Program and Maine Natural Heritage Program	To Be Considered	These state programs issue policies and regulations governing special habitats or communities.	Where such special areas exist, these state programs will become involved in the project and/or permit review process.
	Maine Critical Areas Act (5 MRSA 3310 through 3316)	To Be Considered	This nonregulatory legislation allows Maine agencies such as the Critical Areas Program and the Natural Heritage Areas Program to identify, research, and protect critical areas and endangered or threatened plants.	Where such special areas exist, these state programs will become involved in the project and/or permit review process.

Notes:

ARAR = Applicable or Relevant and Appropriate Requirements
CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act
CFR = Code of Federal Regulations
CWA = Clean Water Act
EO = Executive Order
MRSA = Maine Revised Statutes Annotated
MEDEP = Maine Department of Environmental Protection
NAS = Naval Air Station
RI/FS = Remedial Investigation/Feasibility Study
RCRA = Resource Conservation and Recovery Act
USC = United States Code

keeping and reporting, and requirements such as safety equipment and procedures to be followed during site remediation.

Because of the volume of waste material, source removal has not been considered as a feasible alternative. Therefore, in each of the proposed alternatives, hazardous contaminants would remain on-site following implementation of the remedial alternative. Under SARA, continued groundwater monitoring and five year site reviews would be required. Groundwater monitoring would be conducted on a [quarterly basis]. During the five year site reviews laboratory data would be assessed and the effectiveness of the chosen alternative would be reevaluated

2.4 Summary of Remedial Action Objectives: Sites 1 and 3

Remedial action objectives for Sites 1 and 3 include media-specific goals established to provide an adequate level of protection to human and ecological receptors. These goals are to eliminate, reduce or control exposure to contaminants and can be achieved by either reducing exposure (e.g., capping contaminated areas or limiting access) or reducing contaminant concentrations in the media of concern (USEPA, 1988). The critical routes of exposure at Sites 1 and 3 include future potential ingestion of groundwater (human receptors) and direct contact with surface water and ingestion of leachate sediment (ecological receptors). Target Cleanup Levels are developed to reduce contaminant concentrations in groundwater, leachate sediment and surface water to levels considered protective of human or ecological receptors. These cleanup levels were based on current and assumed future land use at these sites and are set at either a chemical-specific ARAR (e.g., MCL or AWQC) or a residual risk level adopted from USEPA guidelines and the NCP (USEPA, 1988 and 1990).

USEPA guidance and the NCP state that the total incremental carcinogenic risk for an individual resulting from exposure at a hazardous waste site should be between 10^{-4} and 10^{-6}. The 10^{-6} risk level and HI of 1.0 is suggested by the USEPA as the point of departure for developing remediation goals for carcinogenic and noncarcinogenic compounds, respectively. However, the agency recognizes that the final cleanup of a site may not achieve this risk level (USEPA, 1990). Factors that may warrant selection of an alternative risk level include the technical limitations of the remedial alternative, the ability to monitor and control movement of contaminants, and background contaminant concentrations (USEPA, 1990). These

factors will be considered in setting the final Target Clean-up Levels for Sites 1 and 3. However, the initial proposed Target Cleanup Levels are set at either chemical-specific ARARs (e.g., MCLs) or a residual risk level of 10^{-6} or HI of 1.0.

2.4.1 Human Health Target Clean-up Levels

Target Clean-up Levels for the contaminants of concern in groundwater were set at either the chemical-specific ARAR (e.g., MCL) or developed based on exposure and risk considerations. Risk-based Target Clean-up Levels were developed for individual compounds for which there are no promulgated standards and based on a residual carcinogenic risk level of 10^{-6} or noncarcinogenic HI of 1.0. This approach results in the residual carcinogenic risk being between the 10^{-4} and 10^{-6} risk range and noncarcinogenic risk at an HI of 1.0 for individual compounds with different toxicity endpoints. The Target Clean-up Levels for the contaminants of concern in groundwater are listed in Table 2-5.

2.4.2 Ecological Target Clean-up Levels

Ecological Target Clean-up Levels for contaminants in leachate seep and surface water were set at chemical-specific ARARs (e.g., AWQC) or risk-based levels. For zinc and lead (e.g., surface water contaminants), the Target Clean-up Levels were the AWQC; for soil/sediment contaminants (e.g., mercury) the clean-up levels were based on assumed exposure and risk conditions. Mercury was the only contaminant identified in the baseline risk assessment as presenting a potential risk to terrestrial receptors. Mercury was selected as a contaminant of concern because of its propensity to bioaccumulate and biomagnify in food chains. Other contaminants (e.g., VOCs and inorganic metals) do not exhibit the same behavior and were, therefore, not considered to present a risk to terrestrial receptors (E.C. Jordan Co., 1990). The Target Clean-up Level for mercury of 1 mg/kg was developed using the same food-web analysis as in the baseline risk assessment. This model estimates the bioaccumulation of contaminants within a food web and can be used to estimate an acceptable soil/sediment concentration that is protective of higher trophic level organisms. Ecological Target Clean-up Levels are presented in Table 2-5.

2.4.3 Remedial Action Objectives

Remedial action objectives have been proposed to minimize the human health and ecological risks associated with exposure to contaminated groundwater and leachate

TABLE 2-5
POTENTIAL ACTION-SPECIFIC APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

REMEDIAL INVESTIGATION
NAS BRUNSWICK

REQUIREMENT	REQUIREMENT SYNOPSIS	CONSIDERATION IN THE RI/FS
Federal		
RCRA - General Facility Standards (40 CFR 264.10-264.18)	General facility requirements outline general waste analysis, security measures, inspections, and training requirements.	Any facilities will be constructed, fenced, posted, and operated in accordance with this requirement. All workers will be properly trained.
RCRA - Preparedness and Prevention (40 CFR 264.30-264.37)	This regulation outlines requirements for safety equipment and spill-control for hazardous waste facilities. Part of the regulation includes a requirement that facilities be designed, maintained, constructed, and operated to minimize the possibility of an unplanned release that could threaten human health or the environment.	Safety and communication equipment will be installed at the site; local authorities will be familiarized with site operations.
RCRA - Contingency Plan and Emergency Procedures (40 CFR 264.50-264.56)	This regulation outlines the requirements for emergency procedures to be used following explosions, fires, etc.	Plans will be developed and implemented during site work including installation of monitoring wells, and implementation of site remedies. Copies of the plans will be kept on-site.
RCRA - Releases from Solid Waste Management Units (40 CFR 264.90-264.109)	This regulation details groundwater monitoring requirements for hazardous waste treatment facilities. The regulation outlines general groundwater monitoring standards, as well as standards for detection monitoring, compliance monitoring, and corrective action monitoring.	General groundwater monitoring standards should be addressed as part of any proposed alternative. The need for any of the specific monitoring programs will depend on whether source materials are removed, treated, or left in place.
RCRA - Closure and Post-closure (40 CFR 264.110-264.120)	This regulation details general requirements for closure and post-closure of hazardous waste facilities, including installation of a groundwater monitoring program.	Those parts of the regulation concerned with long-term monitoring and maintenance of the site will be considered during remedial design.
RCRA - Waste Piles (40 CFR 264.250-264.269)	This regulation details procedures, operating requirements, and closure and post-closure for waste piles. If removal or decontamination of all contaminated subsoils is not possible, closure and post-closure requirements for landfills must be attained.	According to RCRA, waste piles used for treatment or storage of noncontainerized accumulation of solid, nonflowing hazardous waste may comply with either the waste pile or landfill requirements. The temporary storage of solid waste on-site, therefore, must comply with one or the other subpart.
RCRA - Landfills (40 CFR 264.300-264.339)	This regulation details the design, operation, monitoring, inspection, recordkeeping, closure, and permit requirements for a RCRA landfill. Two liners must be installed to prevent groundwater contamination. A leachate collection system must be placed above and between the liner systems.	Disposal of contaminated materials from NAS Brunswick must be to a facility that complies with all relevant and appropriate RCRA landfill regulations, including closure and post-closure.

continue

TABLE 2-5
POTENTIAL ACTION-SPECIFIC APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

REMEDIAL INVESTIGATION
NAS BRUNSWICK

REQUIREMENT	REQUIREMENT SYNOPSIS	CONSIDERATION IN THE RI/FS
RCRA - Incinerators (40 CFR 264.340-264.599)	This regulation specifies the performance standards, operating requirements and monitoring, inspection, and closure guidelines of any incinerator burning hazardous waste.	On-site thermal treatment must comply with the appropriate requirements specified in this subpart of RCRA.
RCRA - Miscellaneous Units (40 CFR 264.600-264.999)	These standards are applicable to miscellaneous units not previously defined under existing RCRA regulations. Subpart X outlines performance requirements that miscellaneous units be designed, constructed, operated, and maintained to prevent releases to the subsurface, groundwater, surface water, and wetlands that may have adverse effects on human health and the environment.	The design of proposed treatment alternatives, not specifically regulated under other subparts of RCRA, will address the means of preventing the release of hazardous constituents and prevent further impact on the environment.
RCRA Land Disposal Restrictions (40 CFR 268)	Land disposal of RCRA hazardous wastes is restricted without specified treatment. It must be determined that the waste, beyond a reasonable doubt, meets the definition of one of the specified restricted wastes and the remedial action must constitute "placement" for the land disposal restrictions to be considered applicable. For each hazardous waste, the LDRs specify that the waste must be treated either by a treatment technology or to a concentration level prior to disposal in a RCRA Subtitle C permitted facility.	If it is determined that hazardous materials located at NAS Brunswick are considered wastes subject to the LDRs, the hazardous materials will be handled and treated in compliance with these regulations.
OSHA - General Industry Standards (29 CFR Part 1910)	These regulations specify the 8-hour time-weighted average concentration for various organic compounds. Training requirements for workers at hazardous wastes operations are specified in 29 CFR 1910.120.	Proper respiratory equipment will be worn if it is impossible to maintain the work atmosphere below the concentration. Workers performing activities would be required to have completed specific training requirements.
OSHA - Safety and Health Standards (29 CFR Part 1926)	This regulation specifies the type of safety equipment and procedures to be followed during site remediation.	All appropriate safety equipment will be on-site. In addition, safety procedures would be followed during on-site activities.
OSHA - Recordkeeping, Reporting, and Related Regulations (29 CFR 1904)	This regulation outlines the recordkeeping and reporting requirements for an employer under OSHA.	These requirements apply to all site contractors and subcontractors, and must be followed during all site work.
CWA - NPDES Regulations (40 CFR Parts 122, 125)	This requirement implements the NPDES program that specifies the applicable effluent standards, monitoring requirements, and standard and special conditions for direct discharge.	Both on- and off-site discharges from CERCLA sites to surface waters are required to meet the substantive CWA NPDES requirements, including discharge limitations, monitoring requirements, and best management practices. Permits will be required for off-site discharges.

continued

TABLE 2-5
POTENTIAL ACTION-SPECIFIC APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

REMEDIAL INVESTIGATION
NAS BRUNSWICK

REQUIREMENT	REQUIREMENT SYNOPSIS	CONSIDERATION IN THE RI/FS
Underground Injection Control Program (40 CFR 144, 146, 147, 1000)	These regulations outline minimum program and performance standards for underground injection programs. Technical criteria and standards for siting, operation and maintenance, and reporting and recordkeeping as required for permitting are set forth in Part 146.	Discharge of treated groundwater, by well injection, must be in accordance with all the criteria and standards in these federal regulations, as well as meet all state Underground Injection Control Program requirements. Treated groundwater must meet all SDWA standards prior to well injection.
CWA - Pretreatment Standards for POTW Discharge (40 CFR Part 403)	This regulation specifies pretreatment standards for discharges to a POTW. If treated groundwater is discharged to a POTW, the POTW must have mechanisms available to meet the requirements of the National Pretreatment Program - Introduction of Pollutants which cause pass through or interference are prohibited. Discharges must also comply with any local POTW regulations. If hazardous waste is discharged to the POTW, the POTW may be subject to RCRA permit-by-rule.	If treated groundwater is discharged to a POTW, the discharge must meet all discharge limitations imposed by the POTW.
RCRA - Standards Applicable to Generators of Hazardous Waste (40 CFR Part 262)	This requirement sets standards for generators of hazardous waste that address (1) accumulating waste, (2) preparing hazardous waste for shipment, and (3) preparing the uniform hazardous waste manifest. These requirements are integrated with DOT regulations.	If any alternative proposes shipping wastes off-site, the material must be shipped in proper containers that are accurately marked and labeled, and the transporter must display proper placards. All waste shipments must be accompanied by an appropriate manifest.
DOT Rules for Transportation of Hazardous Materials (49 CFR Parts 107, 171.1-172.558)	This regulation outlines procedures for the packaging, labeling, manifesting, and transporting of hazardous materials.	Contaminated materials will be packaged, manifested, and transported to a licensed off-site disposal facility in compliance with these regulations.
CWA - Regulations on Disposal Site Determinations Under the CWA (40 CFR 231)	These regulations apply to all existing, proposed, or potential disposal sites for discharges of dredged or fill material into U.S. waters, which include wetlands.	The dredged or fill material should not be discharged unless it can be demonstrated that such a discharge will not have an unacceptable impact on the wetlands.
State		
Maine Landfill Disposal Regulations (MEDEP Regs, Chapter 401)	These regulations outline the permitting requirements for waste disposal by landfill. Chapter 401 specifies closure and post-closure maintenance requirements.	Design of a cover system would have to meet minimum standards and specifications (401.7[c]). Institutional controls would need to include providing appropriate record information to the Registry of Deeds (401.7[f]).
Management, Testing, and Disposal of Special Wastes (MEDEP Regs, Chapter 405)	Section 405.4 sets forth requirements that apply to the storage and disposal of asbestos wastes.	These requirements apply to alternatives that propose removing wastes or leaving the wastes in place. Site restrictions and monitoring requirements would need to be included in these types of alternatives.

continue

TABLE 2-5
POTENTIAL ACTION-SPECIFIC APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

REMEDIAL INVESTIGATION
NAS BRUNSWICK

REQUIREMENT	REQUIREMENT SYNOPSIS	CONSIDERATION IN THE RI/FS
Maine Rules to Control the Subsurface Discharge of Pollutants by Well Injection (MEDEP Regs, Chapter 543)	This regulation prohibits the injection of hazardous waste into or above water-bearing formations via a new Class IV well. The subsurface discharge into or through a Class IV well that would cause or allow the movement of fluid into an underground source of drinking water that may result in a violation of any Maine Primary Drinking Water Standard, or which may otherwise adversely affect public health, is prohibited.	The groundwater must be treated to a target clean-up level less than or equal to the Maine MEGs to be recharged to the aquifer.
Maine Hazardous Waste Management Rules (MEDEP Regs, Chapters 800-802, 850, 851, 853-857)	The rules provide a comprehensive program for handling, storage, and recordkeeping at hazardous waste facilities. They supplement the RCRA regulations.	Because these requirements supplement RCRA hazardous waste regulations, they must also be considered.
Maine Emission License Regulations (38 MRSA, Section 585, 590; MEDEP Regs, Chapter 115)	These requirements specify who must obtain an air emissions license, application information, and standards and criteria that must be met.	New sources must be in compliance with all applicable emissions limitations under the Clean Air Act. Emissions of pollutants with no standards should not exceed interim guidelines values.
Maine Incinerator Particulate Emission Standard (38 MRSA Section 600; MEDEP Regs, Chapter 104)	Establishes limitations on the amount of particulate matter allowed to be emitted from each of several categories and sizes of incinerators, and on the capacity of emissions from all incinerators.	The thermal treatment technology must comply with the applicable emissions standard.
Maine Growth Offset Regulations (38 MRSA, Section 590; MEDEP Regs, Chapter 113)	This rule applies to new licenses for facilities in non attainment areas. They require Reasonably Available Control Technology (RACT) or better for the base case emission, and offset reductions from other facilities.	RACT will be considered for air treatment if applicable.
Maine Water Pollution Control Law: Conditions of Licenses (38 MRSA, Section 414-A)	Regulates the discharge of any pollutants. Specifies that the discharge, either by itself or combined with other discharges, will not lower the quality of any classified body of water below such classification. The discharge will be subject to effluent limitations that require application of the best practicable treatment.	The effluent water from on-site activities should receive the best practicable treatment before discharge.
Maine Water Pollution Control Law: Certain Deposits and Discharges Prohibited (38 MRSA, Section 420)	No person, firm, corporation, or other legal entity shall place, deposit, discharge, or spill mercury or toxic or hazardous substances, either directly or indirectly, into the inland groundwater or surface waters, tidal waters, on the ice, or on the banks thereof, so that the same may flow or be washed into such waters, or in such manner that the drainage therefrom may flow into such waters.	Best Management Practices will be used when handling wastes.

continued

TABLE 2-5
POTENTIAL ACTION-SPECIFIC APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

REMEDIAL INVESTIGATION
NAS BRUNSWICK

REQUIREMENT	REQUIREMENT SYNOPSIS	CONSIDERATION IN THE RI/FS
State Guidance and Criteria To Be Considered		
MEDEP, Bureau of Water Quality Control, Policy Number 10, "The Discharge of Hazardous Substances to Groundwaters of the State"	The Bureau will deny applications for waste discharge licenses for the discharge to groundwaters of substances designated by the Board to be hazardous when such substances are present in concentrations exceeding groundwater levels which occur naturally in the area. Exemption may be granted if the groundwater is treated to reduce the concentrations of pollutants discharged to below the level considered safe for drinking water.	At least the minimum level of groundwater treatment would be required to provide adequate protection if no other means of disposal is feasible.

NOTES:

AHERA	=	Asbestos Hazard Emergency Response Act
CAA	=	Clean Air Act
CERCLA	=	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	=	Code of Federal Regulations
CMR	=	Code of Maine Regulations
CWA	=	Clean Water Act
DOT	=	Department of Transportation (U.S.)
FS	=	feasibility study
MEDEP	=	Maine Department of Environmental Protection
MEG	=	Maximum Exposure Guidelines
MRSA	=	Maine Revised Statutes Annotated
NAS	=	Naval Air Station
NESHAP	=	National Emission Standards for Hazardous Air Pollutants
NPDES	=	National Pollutant Discharge Elimination System
OSHA	=	Occupational Safety and Health Administration
POTW	=	publicly owned treatment works
RACT	=	Reasonably Available Control Technology
RI	=	remedial investigation
RCRA	=	Resource Conservation and Recovery Act
SDWA	=	Safe Drinking Water Act
$\mu g/m^3$	=	micrograms per cubic meter
VOC	=	volatile organic compound

NOTES:

AHERA	=	Asbestos Hazard Emergency Response Act
CAA	=	Clean Air Act
CERCLA	=	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	=	Code of Federal Regulations
CMR	=	Code of Maine Regulations
CWA	=	Clean Water Act
DOT	=	Department of Transportation (U.S.)
FS	=	feasibility study
MEDEP	=	Maine Department of Environmental Protection
MEG	=	Maximum Exposure Guidelines
MRSA	=	Maine Revised Statutes Annotated
NAS	=	Naval Air Station
NESHAP	=	National Emission Standards for Hazardous Air Pollutants
NPDES	=	National Pollutant Discharge Elimination System
OSHA	=	Occupational Safety and Health Administration
POTW	=	publicly owned treatment works
RACT	=	Reasonably Available Control Technology
RI	=	remedial investigation
RCRA	=	Resource Conservation and Recovery Act
SDWA	=	Safe Drinking Water Act
$\mu g/m^3$	=	micrograms per cubic meter
VOC	=	volatile organic compound

soil/sediment. The objective of groundwater remediation is to reduce contaminant concentrations to levels considered protective of human health. The objective of leachate soil/sediment remediation is to reduce mercury contamination to levels considered protective of higher trophic organisms.

General response actions that may be employed to satisfy these remedial action objectives range from minimal action including institutional controls to limit access to this site, containment actions such as slurry walls and caps to reduce the amount of contaminated groundwater and leachate discharging to Mere Brook and groundwater extraction to limit the migration of contaminated groundwater.

Remedial action objectives were not developed to specifically reduce zinc and iron concentrations in the surface water of Mere Brook. However, remedial actions taken to reduce the generation of leachate and contaminated groundwater will effectively reduce the impact of Sites 1 and 3 on the water quality of Mere Brook. Iron and zinc were detected at elevated concentrations upgradient of the site at the Mere Brook culvert outfall, indicating that other nonpoint source discharges of these contaminants are contributing to the levels currently detected in Mere Brook. Therefore, specific remedial actions taken to reduce levels of zinc and iron would not provide a permanent remedy. In addition, possible remedial alternatives (e.g., surface water diversion and treatment) may cause significant irreversible damage to the ecosystem. The remedial alternatives developed to reduce the amount of contaminated groundwater and leachate generated will result in a decrease in the amount of zinc and iron discharging to Mere Brook. However, because zinc and iron concentrations upgradient of the site currently exceed their respective AWQC, these contaminants may not decrease to levels considered protective of the environment. A stormwater runoff characterization study is being conducted by the Base and will address the impacts of base operations across NAS Brunswick. However, because this study addresses ongoing activities of the base, it is not part of this investigation.

Remedial action objectives and general response actions for Sites 1 and 3 are presented in Table 2-6.

2.5 SUMMARY OF REMEDIAL ALTERNATIVES

Six remedial alternatives were described and presented in the Phase I FS (E.C. Jordan Co., 1990b). These alternatives were developed to achieve the remedial

TABLE 2-6
REMEDIAL ACTION OBJECTIVES AND GENERAL RESPONSE ACTIONS:
SITES 1 AND 3

FOCUSED FEASIBILITY STUDY
NAS BRUNSWICK

MEDIUM (receptor)	REMEDIAL ACTION OBJECTIVE	GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY
Groundwater (Human)	Protection of Human Health: Reduce VOC concentrations in groundwater to MCLs or levels considered protective of human health (e.g., MCLGs or RfDs). Ingestion of groundwater is the route of exposure.	* No Action Monitoring Institutional Actions	Institutional Controls Natural Flushing
		* Containment	Slurry Wall Cap
		* Groundwater Treatment Extraction Treatment	Treatment Technologies UV/Ozone UV/Peroxide Air Stripping
Leachate Soils/Sediment (Ecological)	Protection of Environment: Reduce mercury concentrations in leachate soils/sediments to levels considered protective of ecological receptors. Ingestion of soils/sediment and contaminated prey is route of exposure.	* No Action Monitoring Institutional Actions	Institutional Controls Natural Flushing
		* Containment	Slurry Wall Cap
		* Groundwater Treatment	Treatment Technologies UV/Ozone UV/Peroxide Air Stripping
Surface Water (Ecological)	Protection of Environment: Reduce iron and zinc concentrations is Mere Brook to AWQC.	No Action specific to surface water. However, response actions for groundwater and leachate will reduce the discharge of iron and zinc to Mere Brook.	

NOTES:
MCL = Maximum Contaminant Level
MCLG = Maximum Contaminant Level Goal
RfD = reference dose
UV = ultraviolet
VOC = volatile organic compound

action objectives developed for contamination at Sites 1 and 3 and include the following:

- No Action
- Containment/Slurry Wall
- Passive Groundwater Collection/Treatment
- Cap/Groundwater Extraction/Treatment
- Cap/Passive Groundwater Collection/Treatment
- Source Removal/Incineration/Groundwater Extraction/Treatment

The first five alternatives focus on limiting exposure to contaminants through institutional controls or containment, or reducing the toxicity, mobility, or volume of contaminants through treatment. Waste material would not be removed from the site under these alternatives. The last alternative involves removal and complete destruction of the waste material.

Each alternative was screened in the Phase I FS based on the clean-up standards described in Section 121 of SARA and the NCP (E.C. Jordan Co., 1990b). The objective of the screening process was to eliminate from further consideration any alternative(s) that have significant effectiveness, implementability, or cost disadvantages, while still preserving a range of remedial options.

The first five alternatives listed above were retained for detailed evaluation. The source removal alternative was eliminated, because excavation and handling of the estimated 300,000 cy of waste from the landfill was believed to be cost prohibitive and more hazardous than leaving it in place. The alternatives were reevaluated during detailed analysis, and another alternative was added. The No Action Alternative developed in the Phase I FS is now referred to as the Minimal Action Alternative, because the alternative involves institutional controls and environmental monitoring. A true No Action Alternative, requiring no action in excess of the security measures already in place at the site, is evaluated in this FFS. This alternative was included because current land use and security measures at Sites 1 and 3 are effective at limiting access and potential contaminant exposure at this site. These alternatives provide a range of remedial actions consistent with the USEPA guidance and NCP (USEPA 1988 and 1990b).

Section 3.0 describes and evaluates the six alternatives. Section 4.0 provides a comparative analysis of the alternatives relative to one another.

3.0 DETAILED EVALUATION OF REMEDIAL ALTERNATIVES

This section presents the detailed analysis of the six remedial alternatives for Sites 1 and 3. This analysis presents the relevant information that allows decision-makers to select a site remedy. The detailed analysis of each alternative includes the following:

- detailed descriptions and specification of each remedial alternative with emphasis on application of the various technologies as components in the alternative
- detailed analysis of each alternative against the nine evaluation criteria outlined in the NCP (USEPA, 1990)

This section presents the assessment of the individual alternatives against each evaluation criterion. Section 4.0 presents a comparative analysis of the six alternatives and identifies the relative advantages and disadvantages among them.

In this section, the six remedial alternatives summarized in Table 3-1 are described and then evaluated according to the first seven criteria listed in Table 3-2. Typically, the state acceptance criterion is not addressed until comments on the RI/FS and proposed plan are received from the state. The State is a party to the FFA and has had the opportunity to review and comment on this FFS. Similarly, community acceptance is addressed upon receipt of public comments on the RI/FS and proposed plan (USEPA, 1990).

A detailed description of the technologies or processes used is provided for each alternative. Where appropriate, the description includes preliminary site layouts, process flow diagrams, preliminary design calculations, sizing of key components, and a discussion of the limitations, assumptions, and uncertainties associated with each alternative. These descriptions are only intended to provide a conceptual design of each alternative. This description is followed by the criteria evaluation process. The alternatives are compared relative to these criteria in Section 4.0.

TABLE 3-1
SUMMARY OF REMEDIAL ALTERNATIVES: SITES 1 AND 3

FOCUSED FEASIBILITY STUDY
NAS BRUNSWICK

ALTERNATIVE	COMPONENTS
1,3-A: No Action	No additional remedial actions
1,3-B: Minimal Action	Institutional controls and deed restrictions Environmental monitoring
1,3-C: Containment	Cap Subsurface hydraulic barrier Groundwater extraction wells Water treatment Discharge of treated water Institutional controls and deed restrictions Environmental monitoring
1,3-D: Passive Groundwater Collection/Treatment	Passive groundwater collection Water treatment Discharge of treated water Institutional controls and deed restrictions Environmental monitoring
1,3-E: Cap/Groundwater Extraction/Treatment	Cap Groundwater extraction wells Water treatment Discharge of treated water Institutional controls and deed restrictions Environmental monitoring
1,3-F: Cap/Passive Groundwater Collection/ Treatment	Cap Passive groundwater collection Water treatment Discharge of treated water Institutional controls and deed restrictions Environmental monitoring

TABLE 3-2
CRITERIA FOR COMPARATIVE ANALYSIS OF ALTERNATIVES: SITES 1 AND 3

FOCUSED FEASIBILITY STUDY
NAS BRUNSWICK

CRITERIA	DESCRIPTION
Overall Protection of Human Health and the Environment	Describes how each alternative, as a whole, protects and maintains protection of human health and the environment.
Compliance with ARARs	Describes how the alternative complies with chemical-, location-, and action-specific ARARs, or other criteria, advisories, and guidance.
Long-term Effectiveness and Permanence	Evaluates the effectiveness of alternatives in protecting human health and the environment after response objectives have been met, in terms of the magnitude of residual risk and the adequacy and reliability of controls.
Reduction of Toxicity, Mobility, or Volume through Treatment	Evaluates the treatment technologies used by the degree of expected reduction in toxicity, mobility, or volume of hazardous material. This criterion also evaluates the irreversibility of the treatment process and the type and quantity of residuals remaining after treatment.
Short-term Effectiveness	Examines the impacts on the community, workers, and the environment during construction and implementation. Estimates the time until the remedial action objectives are met.
Implementability	Assesses the ability to construct and operate the technology; the reliability of the technology; the ease of undertaking additional remedial actions; and the ability to monitor the effectiveness of the remedy. Administrative feasibility is addressed in terms of the ability to obtain approvals from other agencies. This criterion also evaluates the availability of required resources, such as equipment, facilities, specialists, and capacity.

TABLE 3-2
CRITERIA FOR COMPARATIVE ANALYSIS OF ALTERNATIVES: SITES 1 AND 3

FOCUSED FEASIBILITY STUDY
NAS BRUNSWICK

CRITERIA	DESCRIPTION
Cost	Evaluates the capital and operation and maintenace costs of each alternative, and provides an estimate of the total present worth cost of each alternative.
State Acceptance *	Evaluates the technical and administrative issues and concerns the state may have.
Community Acceptance *	Evaluates the issues and concerns the public may have.

NOTES:
* This criterion will be addressed once comments on the FFS and proposed plan have been received.
ARARs = Applicable or Relevant and Appropriate Requirements
FFS = Focused Feasibility Study

3.1 ALTERNATIVE 1,3-A: NO ACTION

Alternative 1,3-A was developed to comply with the NCP and to compare to other corrective action alternatives. This alternative would not meet the remedial action objectives because it does not involve reduction or containment of leachate or groundwater treatment. Target levels would not be met.

Although this alternative does not involve implementing remedial actions, controls, or monitoring, exposure to site contaminants is limited by virtue of the sites' location. Because Sites 1 and 3 are located within the fenced area near the Weapons Compound, they are accessible only to authorized personnel. Armed guards patrol the sites and observe the area from the central control tower to enforce security at the Weapons Compound. At Site 3, signs are posted warning of pesticides buried in the area.

3.1.1 Overall Protection of Human Health and the Environment

This alternative would provide no additional protection to human or ecological receptors over baseline conditions. Because the No Action Alternative is not intended to meet remedial action objectives, exposure to contaminated sediment at the leachate seeps and/or contaminated groundwater would result in risks exceeding state and federal guidance. Minimal improvements to human health and the environment would result after decades of natural degradation and dispersion processes act on the contaminated media. However, it cannot be assumed that contaminant levels in leachate, sediment, and groundwater would decrease to levels considered protective of human and ecological receptors.

3.1.2 Compliance with ARARS

The No Action Alternative would not comply with chemical-specific ARARs and guidance. MCLs, MCLGs, AWQC, and sediment to be considered (TBC) are the clean-up standards proposed for groundwater, surface water, and sediment associated with the leachate seeps, respectively. Under this alternative, contaminant concentrations in these media would continue to exceed Target Clean-up Levels.

Because no remedial actions would be implemented, action- or location-specific ARARs would not be triggered.

3.1.3 Long-term Effectiveness and Permanence

This alternative is intended to provide a baseline for comparison to the other alternatives, and not to meet the remedial action objectives. The No Action Alternative would not reduce human health or environmental risks posed by contaminants in the media of concern at Sites 1 and 3.

Because no action would be taken to reduce groundwater contamination or leachate generation, contaminant levels in surface water and sediments and soils near the leachate seeps would not be expected to decrease in the near future. Contamination reduction would occur over the time required for natural groundwater flow to flush contaminants from the waste and surrounding fill and natural soils. The actual time required for this to happen is unknown due to the heterogeneity of materials buried in the landfills. The exact location and size of the source of chlorinated solvents contributing to groundwater contamination has not been characterized.

Security measures are expected to continue for as long as the NAS is active; however, permanent protection against exposure cannot be relied upon. It is likely that remedial actions would be required in the future.

3.1.4 Reduction of Toxicity, Mobility, or Volume

Treatment processes would not be employed to address site contamination. Therefore, no reduction in toxicity, mobility, or volume of contaminated groundwater or leachate would be achieved.

3.1.5 Short-term Effectiveness

The No Action Alternative would not involve any remedial construction or invasive activities. Therefore, no adverse impacts to workers, the public, or the environment would occur.

3.1.6 Implementability

This alternative would be easy to implement. Implementation of this alternative would not interfere with possible future remedial actions such as pump and treat, containment, or source removal.

3.1.7 Cost

Capital, indirect, and operation and maintenance costs are not incurred for this alternative.

3.2 ALTERNATIVE 1,3-B: MINIMAL ACTION

Alternative 1,3-B is a Minimal Action Alternative, consisting of the following components:

- institutional controls and deed restrictions
- environmental monitoring

This alternative would not meet remedial action objectives because it does not involve reduction or containment of leachate or groundwater treatment. Target levels would not be met; however, institutional actions and deed restrictions would reduce the possibility of exposure to contaminated media. A long-term environmental monitoring program would be implemented because contaminants would remain in place, untreated. Collected data would be evaluated during the five-year site reviews mandated by SARA and described in the Agreement. These programs are described in detail in the following paragraphs.

Institutional Controls and Deed Restrictions. In addition to the security measures described in Subsection 3.1 already in place, warning signs would be posted around the landfill area and near leachate seeps. Restrictions on future development would be incorporated into the property deed to limit land use should the base be decommissioned. The mechanism for implementing these institutional controls will be addressed in the Record of Decision (ROD) for the remedial actions at Sites 1 and 3.

Environmental Monitoring. Under the Minimal Action Alternative, an environmental monitoring program would be implemented at Sites 1 and 3. The objective of environmental monitoring would be to evaluate whether dispersion and natural attenuation are reducing contaminant concentrations in groundwater, surface water, leachate seeps, and sediment. A typical monitoring plan developed and described in this FFS is suggested for cost estimating purposes only. The final,

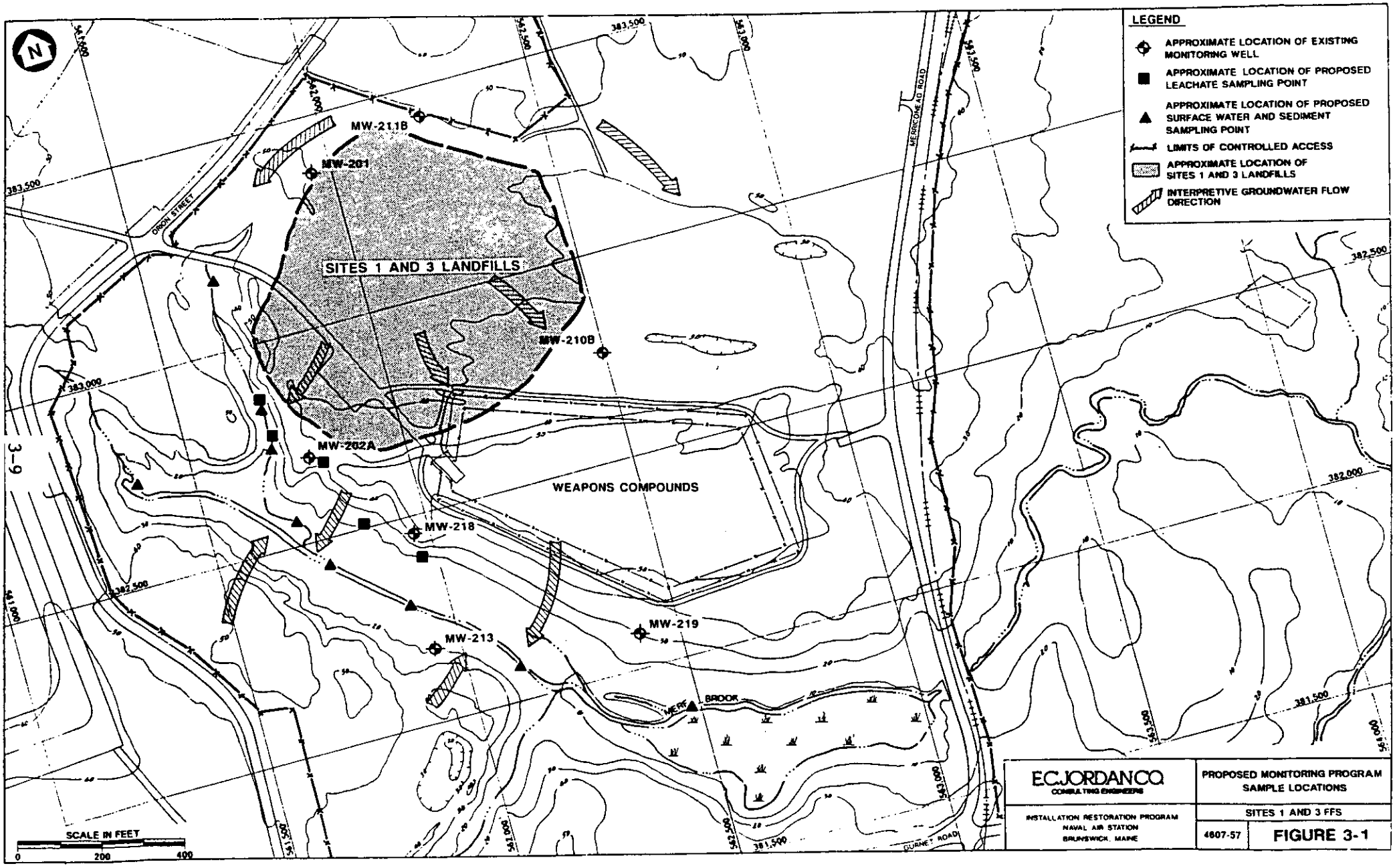
detailed monitoring plan would be developed during Remedial Design and submitted for regulatory agency review, comment, and approval prior to implementation.

This plan would involve the routine, periodic sampling of groundwater, surface water (i.e., Mere Brook), leachate seeps, and sediment. All samples would be analyzed for Target Compound List (TCL) VOCs, SVOCs, pesticides/PCBs and inorganics, as was done in the RI. Seven existing monitoring wells were proposed for sampling to provide information on contaminant movement, attenuation, and dispersion in groundwater. Two upgradient wells (i.e., MW-201 and MW-211B) and five downgradient wells (i.e., MW-202A, MW-210B, MW-213, MW-218, and MW-219) were selected. Figure 3-1 shows the locations of these wells. The upgradient wells would provide information on the background levels of contamination entering Sites 1 and 3. The downgradient wells would monitor groundwater quality and potential impacts of leachate from the landfills and ensure that the plume is not migrating beneath the brook (i.e., MW-213). Over time, the data would provide information on the dispersion and degradation of contaminants in groundwater.

Five leachate seep sampling locations were chosen to correspond roughly with leachate sampling points LT-301, LT-302, LT-303, LT-304, and LT-305 sampled during the RI (see Figure 3-1). Two of these points would be located downgradient of MW-202A and MW-218.

Nine locations would be sampled for surface water and sediment in Mere Brook (see Figure 3-1). Five would be located directly downgradient of the leachate sampling points. Two surface water and sediment samples would be collected from locations upstream of leachate sampling points, corresponding roughly with SW-318 and SW-317 sampled during the RI. Finally, two surface water and sediment locations would be sampled downstream of the leachate sampling points. These locations would correspond roughly with the RI sampling points SW-122 and SW-115. Data generated from these sampling events would provide information on potential contaminant migration, the accumulation or attenuation of contaminants sorbed onto sediment, and the discharge of contaminated groundwater to Mere Brook.

For the first two years, sampling would be done quarterly to increase the data base on contaminant concentrations and distribution. After the third year, sampling would occur annually. The Agreement, consistent with the NCP, requires a five-year site review for sites at which wastes have not been permanently treated, to assure that human health and the environment are being protected. The purpose of the five-


LEGEND
APPROXIMATE LOCATION OF EXISTING MONITORING WELL
APPROXIMATE LOCATION OF PROPOSED LEACHATE SAMPLING POINT
APPROXIMATE LOCATION OF PROPOSED SURFACE WATER AND SEDIMENT SAMPLING POINT
LIMITS OF CONTROLLED ACCESS
APPROXIMATE LOCATION OF SITES 1 AND 3 LANDFILLS
INTERPRETIVE GROUNDWATER FLOW DIRECTION
N
MW-211B
MW-201
SITES 1 AND 3 LANDFILLS
MW-210B
MW-202A
WEAPONS COMPOUNDS
MW-218
MW-213
MW-219
MERRY BROOK
ORION STREET
MERRICONEAG ROAD
DURANT ROAD
383,500
383,000
382,500
382,000
381,500
541,000
542,000
542,500
543,000
543,500
544,000
544,500
545,000
SCALE IN FEET
0
200
400
ECJORDANCO
CONSULTING ENGINEERS
INSTALLATION RESTORATION PROGRAM
NAVAL AIR STATION
BRUNSWICK, MAINE
PROPOSED MONITORING PROGRAM
SAMPLE LOCATIONS
SITES 1 AND 3 FFS
4607-57
FIGURE 3-1

year review would be to organize, analyze, and present all data gathered during sampling events in report format. The review would make a recommendation regarding future remedial actions at the site. This recommendation could be to continue environmental monitoring and five-year reviews, to pump and treat the groundwater, or to implement a source removal remedial action.

3.2.1 Overall Protection of Human Health and the Environment

This alternative would provide no additional protection to human or ecological receptors over baseline conditions. Because the Minimal Action Alternative is not intended to meet the remedial response objectives, exposure to contaminated sediment at the leachate seeps and/or contaminated groundwater would result in risks exceeding state and federal guidance. Minimal improvements to human and ecological receptors would result after decades of natural degradation and dispersion processes act on contaminated media. However, because the source is not well-defined and potentially large, it cannot be assumed that contaminant levels in leachate, sediment associated with leachate seeps, and groundwater would decrease to levels considered protective of human and ecological receptors in the near future.

3.2.2 Compliance with ARARs

The Minimal Action Alternative does not comply with chemical-specific ARARs and guidance. MCLs, MCLGs, AWQC, and sediment TBC are the clean-up standards proposed for groundwater, surface water, and sediment associated with the leachate seeps, respectively. Under this alternative, contaminant concentrations in these media would continue to exceed Target Clean-up Levels.

Because remedial actions would not be implemented, action- or location-specific ARARs would not be triggered. The Minimal Action Alternative would not comply with the goals or intent of SARA and the NCP, which state that the preferred alternative is one that permanently reduces toxicity, mobility, or volume of hazardous contaminants and minimizes risk to human health and the environment.

Because hazardous contaminants would remain on-site following implementation of this remedial alternative, a site review would be performed every five years pursuant to SARA and outlined in the Agreement. All site activities, including monitoring, would be carried out pursuant to Occupational Safety and Health Administration (OSHA) standards (29 CFR 1904, 1910, and 1926).

3.2.3 Long-term Effectiveness and Permanence

The Minimal Action Alternative would not reduce public health or environmental risks posed by contaminants in the media of concern at Sites 1 and 3. This alternative would not meet the remedial action objectives. Environmental monitoring and five-year reviews would provide data and interpretation of the degradation, dispersion, and movement of contaminants in groundwater and Mere Brook. Because groundwater flowing to the south discharges to Mere Brook, it would not be expected to migrate off base and enter a drinking water aquifer. For purposes of analysis in this FFS, the environmental monitoring program is considered for 30 years. However, this could conceivably extend for a longer period. Wells would be repaired or decommissioned and replaced if they were to be damaged and could not be sampled.

Because no action would be taken to reduce groundwater contamination or leachate generation, contaminant levels in surface water and sediments and soils near the leachate seeps would not be expected to decrease in the near future. Any reduction in contamination would occur only over the time required for natural groundwater flow to flush contaminants from the waste and surrounding fill and natural soils. The actual time required for this to happen is unknown due to the heterogeneity of materials buried in the landfills. There is no discrete point source of chlorinated solvents in the landfills; rather, a widespread but sporadically distributed source contributing to groundwater contamination.

3.2.4 Reduction of Toxicity, Mobility, or Volume

Treatment processes would not be employed to address site contamination. Therefore, no reduction in toxicity, mobility, or volume of contaminated groundwater or leachate would be achieved.

3.2.5 Short-term Effectiveness

The Minimal Action Alternative would not involve any remedial construction or invasive activities. Therefore, adverse impacts to workers, the public, or the environment would not occur. Workers involved in monitoring activities would have to be trained in health and safety for work at hazardous waste sites. Proper personal protective equipment and safe work practices would minimize the possibility of chemical exposure or injury.

3.2.6 Implementability

Because existing wells are proposed to be sampled as part of the environmental groundwater monitoring program, difficulties associated with construction would not be expected for the Minimal Action Alternative. Environmental monitoring and analysis procedures for groundwater, surface water, sediment, and seeps samples are well developed and widely used at many hazardous waste sites. Therefore, technical problems are not expected to limit the implementability of this alternative. Implementation of this alternative would not interfere with possible future remedial actions such as pump and treat, containment, or source removal.

The proposed monitoring plan would need to be submitted for regulatory agency review and approval prior to implementation. Coordination between the party responsible for carrying out monitoring activities and officials at NAS Brunswick would be required for individuals to gain safe and legal access to sampling locations near Sites 1 and 3. These activities would be carried out on a regular, periodic basis, so obtaining passes for work at NAS Brunswick should not present difficulty. For security reasons, sampling would not be conducted within the Weapons Compound. The five-year review would be conducted jointly by the Navy, MEDEP, and USEPA.

Because environmental monitoring is a well-developed and widely available technique, several contractors would be able to provide competitive bids for required services.

3.2.7 Cost

The cost estimate for Alternative 1,3-B is summarized in Table 3-3. Supporting information is provided in Appendix A. The capital cost of this alternative is estimated to be $10,000 and includes the cost of installing 15 warning signs placed at intervals around the landfill and leachate seeps to deter human contact with contaminated media and a site survey. Indirect costs associated with implementing the institutional controls are expected to be minimal and have been estimated at 10 percent of the capital cost of the alternative.

Annual monitoring costs constitute the bulk of the total cost of this alternative. These costs include sampling personnel labor costs and equipment rental costs, expendable items such as gloves and sample packing material, containers for water and soil samples, laboratory analytical costs, and other costs such as transportation

TABLE 3-3
ALTERNATIVE 1,3-B: MINIMAL ACTION
COST SUMMARY

FOCUSED FEASIBILITY STUDY
NAS BRUNSWICK

	COST	PRESENT WORTH (1)
CAPITAL COSTS		
Institutional Controls		
Warning Signs	$2,000	
Deed Restrictions		
Survey	$8,000	
Total Capital Costs:	$10,000	$10,000
INDIRECT COSTS		
Legal, Administrative, and Permitting		
(@ 5% of Capital Cost)	$500	
Services During Construction		
(@ 5% of Capital Cost)	$500	
Total Indirect Costs:	$1,000	$1,000
ANNUAL MONITORING COSTS (2)		
Labor	$4,700	
Equipment	$600	
Expendables	$600	
Containers	$1,200	
Transportation and Other Direct Costs	$400	
Analysis	$45,200	
Total Sampling Cost Per Episode	$53,000	
Total Annual Monitoring Costs:		
First 2 Years (4 Episodes Per Year)	$212,000	$380,000
Remaining 28 Years (1 Episode Per Year)	$53,000	$408,000
Five-Year Review (6 Reviews Planned)	$63,000	$157,000
SUBTOTAL		$956,000
Contingency (@ 20%)		$191,000
TOTAL COST		$1,147,000

NOTES:
(1) Discount rate of 10% is used for annual costs.
(2) Cost for each line item is per sampling episode.
(3) Costs are rounded to the nearest $1,000.

19126.1&3

and per diem expenses for sampling personnel, and telephone and computer charges. The present-worth cost of monitoring, based on a 10 percent discount rate, is estimated at $788,000, which accounts for four sampling episodes per year for the first two years and annual sampling thereafter. Monitoring is assumed to continue for 30 years for cost-estimating purposes; however, this time frame will be continually reevaluated during the five-year site review. An estimate of the cost of this review, provided in Table 3-3, is expected to be approximately $63,000 every five years. The cost of the review assumes that the data collected over the five-year period would be validated (Level D) and a report would be produced.

A contingency of 20 percent of the present-worth cost of the alternative is added to account for unforeseen circumstances that may increase the estimated cost.

The total present-worth cost of the Minimal Action Alternative, based on a 10 percent discount rate, is $1,147,000. This cost is an estimate and is believed to be within the +50 percent to -30 percent range for FS cost estimates (USEPA, 1988). This cost may increase as labor rates and costs of laboratory analysis of samples increase over the 30-year period.

3.3 ALTERNATIVE 1,3-C: CONTAINMENT

Alternative 1,3-C is made up of source area containment technologies, in addition to the institutional controls and monitoring program described for Alternative 1,3-B. A short-term groundwater pump-and-treat system is included to remove groundwater trapped in the waste by the cap and slurry wall. The components of this alternative are:

- cap
- subsurface hydraulic barrier (i.e., slurry wall)
- groundwater extraction wells
- water treatment
- discharge of treated water
- institutional controls and deed restrictions
- environmental monitoring

Alternative 1,3-C was developed as an alternative to minimize the migration of contaminants from the landfill area by reducing the amount of water flowing through

the buried waste. Groundwater flow modeling has indicated that a cap and slurry wall will depress the groundwater table to approximately 6 to 8 feet below its current level within 1 to 2 years and 8 to 11 feet below its current level within 5 to 10 years (see Appendix B). A review of historical water levels at the site indicates that seasonal groundwater variations are less than 1 foot (fall versus spring measurements). This slight fluctuation is not expected to influence the effectiveness of this alternative.

After the slurry wall is in place, an extraction well system would be installed to remove the contaminated volume of groundwater remaining beneath the landfill. This component was added in response to regulatory comments on the Draft FFS. The hydraulic effects of an extraction well system would serve to lower groundwater beneath the landfill and shorten the time to dewater the waste. The combination of the cap, slurry wall, and extraction system would reduce groundwater contact with the waste (see Appendix B) and thereby lower contaminant concentrations in groundwater, and in Mere Brook surface waters and sediments where leachate seeps and groundwater discharge have degraded these media.

The Containment Alternative, as it was developed in the Phase I FS, consists of a low-permeability cap over Sites 1 and 3, a slurry wall upgradient of the cap, and an interceptor trench upgradient of the slurry wall to divert clean groundwater around the landfill and into Mere Brook so that high hydrostatic pressures or overtopping of the slurry wall would not occur (E.C. Jordan Co., 1990b). The interceptor trench was conceptualized to channel water around the slurry wall. However, the relatively high horizontal hydraulic conductivity of the natural sands at the site (ranging from $1x10^{-4}$ to $2x10^{-3}$ centimeters per second [cm/sec]) (E.C. Jordan Co., 1990a) is similar to the conductivity that could be achieved in a man-made drain. A computer simulation of groundwater flow for the slurry wall scenario showed that the groundwater table remained at least 10 feet below the top of the upgradient side of the slurry wall without an interceptor trench to channel the water (see Appendix B). Therefore, the design of an upgradient interceptor trench was not considered necessary and will not be explored further in this FFS. The monitoring program described in this subsection was designed, in part, to monitor the effectiveness of the slurry wall. If it is determined that it is not performing to specifications, additional remedial actions may be required.

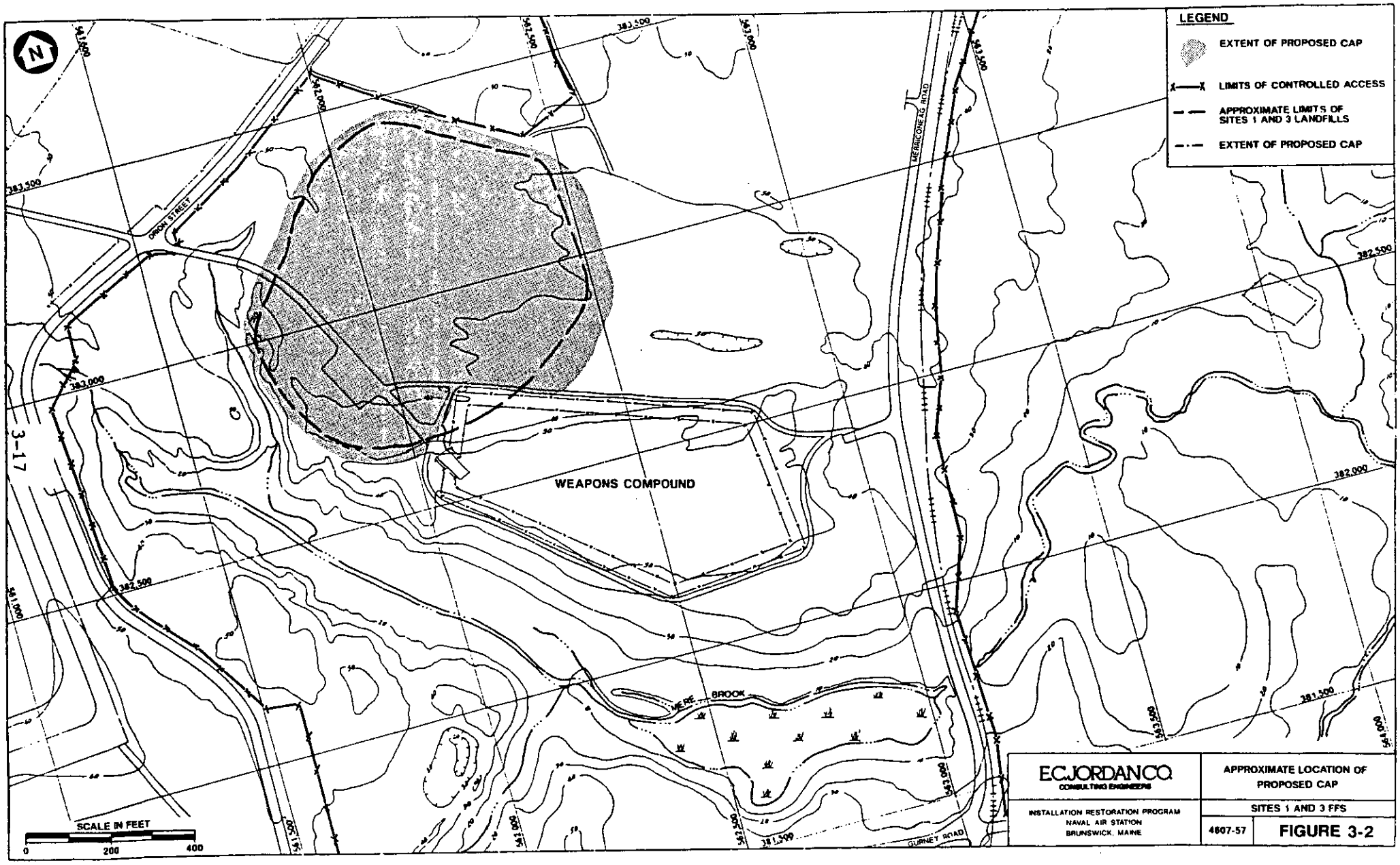
Because the waste would not be removed, an environmental monitoring program would be required as part of this alternative. In addition to current access

restrictions imposed on this area, restrictions would be included in the property deed to prevent future site development and prevent disturbance of the cap should the base be decommissioned. A detailed description of each major component of Alternative 1,3-C follows.

Cap. The purpose of the cap is to cover landfilled waste materials at Site 1 and contaminated soils at Site 3 to reduce leachate production. The cap would cover approximately 11.6 acres, encompassing most of the area designated as Sites 1 and 3. The 11.6 acre cup would cover approximately 9.7 of the 10.0 acres designated as Sites 1 and 3. The remaining 0.3 acre area was not assumed to be covered because it is within the weapons compound. Although waste has been uncovered within the confines of the Weapons Compound, much of this is assumed to have been hauled away during construction when the area was expanded. Only a small area within the Weapons Compound is believed to contain waste and computer simulations of groundwater flow contours with a cap during model set-up did not show a difference between the effects of a cap including or excluding the area within the Weapons Compound. Therefore, succeeding discussions will refer to a cap that does not encroach upon this area for security reasons. Figure 3-2 shows the areal extent of the proposed cover system.

No evidence of waste was found in test pits excavated at Site 3, and contaminants detected in soil samples from this part of the site are relatively immobile in subsurface soils and present at low concentrations (i.e., maximum concentration 1.1 mg/kg chlordane) (see Section 6.5.3 of the Draft Final RI, E.C. Jordan, 1990a). The proximity of Site 3 to the steep bank of Mere Brook makes a complete cover system over the entire site infeasible. There is no evidence of disposal in or along the banks of Site 3; this area comprises natural undisturbed soils. The disposal area of Site 3 would be capped as identified in Figure 3-2.

The landfill cover would be designed to follow RCRA guidance as described in the USEPA document, "Final Covers on Hazardous Waste Landfills and Surface Impoundments" (USEPA, 1989) and sound engineering design practices. USEPA guidance suggests a cover system composed of a vegetative top cover layer, a drainage layer, a bottom hydraulic barrier, and a landfill gas venting system. According to RCRA guidance, the hydraulic barrier can be either a 2-foot recompacted clay layer or a combined system of a 2-foot recompacted clay layer overlain by a synthetic membrane at least 20 mils thick. The cap described in this


LEGEND
EXTENT OF PROPOSED CAP
LIMITS OF CONTROLLED ACCESS
APPROXIMATE LIMITS OF SITES 1 AND 3 LANDFILLS
EXTENT OF PROPOSED CAP
WEAPONS COMPOUND
ORION STREET
MERRICONEAG ROAD
MERE BROOK
GURNET ROAD
SCALE IN FEET
0
200
400
383,500
383,000
382,500
382,000
381,500
561,000
561,500
562,000
562,500
563,000
563,500
564,000
ECJORDANCO
CONSULTING ENGINEERS
INSTALLATION RESTORATION PROGRAM
NAVAL AIR STATION
BRUNSWICK, MAINE
APPROXIMATE LOCATION OF PROPOSED CAP
SITES 1 AND 3 FFS
4607-57
FIGURE 3-2

alternative, and used for cost estimating purposes, is the latter composite cover system.

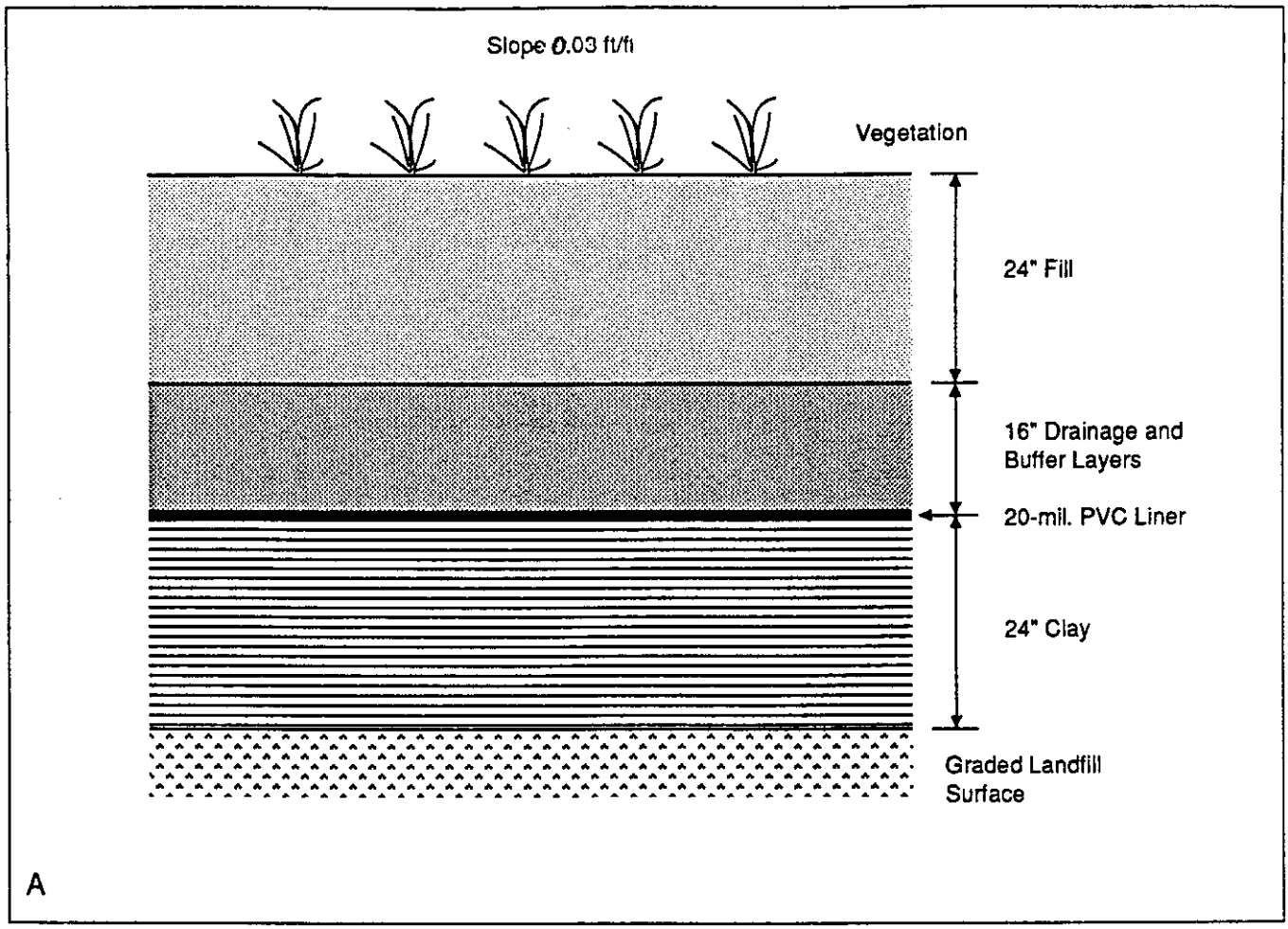
A polyvinyl chloride (PVC) geomembrane is proposed due to its physical properties and the lack of surficial leachate seeps and deposits of waste materials at the site which could come in contact with the geomembrane. Final selection of geomembrane material type and thickness would be included in the final design phase of the remedial process.

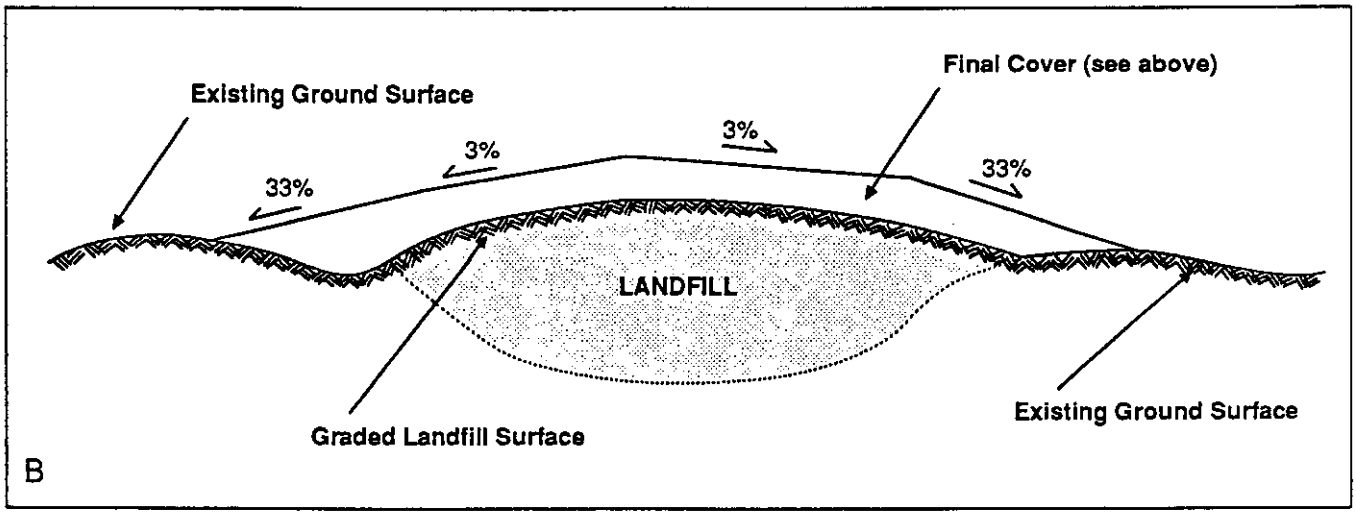
Before construction, the area would be surveyed to layout the exact locations of the cap and slurry wall. Underground utilities would need to be identified and possibly relocated before construction activities commence.

A clay source would need to be located and its suitability evaluated for use in a low-permeability cap. Approximately 37,000 cy of clay would be required. It is expected that a source could be found within 10 miles of the base. Mining of the clay would require a permit from the Maine Division of Site Location. When a clay source is located, a clay borrow study would determine whether the clay is suitable for a low-permeability cap. The following tests are required by the State of Maine:

- grain size analyses (one test per 500 cy of clay)
- Atterberg limits (one test per 5,000 cy of clay)
- permeability testing (one test per 500 cy of clay)
- Proctor testing (one test per 1,000 cy of clay)

Before the clay is excavated and hauled to the site, Site 1 would be graded and clean fill would be applied to achieve an adequate surface water drainage slope for the cover system. The hydraulic barrier (consisting of 24 inches of clay constructed in three lifts, and a 20-mil PVC liner) with an average permeability of $1x10^{-7}$ cm/sec, would be constructed above the fill soils. A 16-inch-thick drainage layer, consisting of granular material exhibiting a saturated hydraulic conductivity of at least $1x10^{-2}$ cm/sec, would be placed above the barrier. A 24-inch-thick layer of fill would overlie the drainage layer and would be vegetated to help prevent erosion of the cap material. A cross section of the cap is shown in Figure 3-3. The cap would be constructed in sections rather than by layers; the PVC and drainage layers would be placed before the entire clay layer is completed to prevent the clay from drying out. Caps are often constructed in sections to protect the overall integrity of the cap from desiccation or puncture.





Not To Scale

E.C.JORDAN CO. CONSULTING ENGINEERS	RCRA GUIDANCE FINAL COVER SYSTEM	
INSTALLATION RESTORATION PROGRAM NAVAL AIR STATION BRUNSWICK, MAINE	SITES 1 AND 3 FFS	
	4607-57	FIGURE 3-3

9110049D

Due to the proximity of the weapons compound and potential for explosion hazard, a gas venting system may be necessary to limit landfill gas migration to the surrounding sandy soils. A gas venting system can readily be designed into the final cover system. Gas vents are typically installed several feet into the waste materials and spaced one per acre over the cover systems. These vents may be constructed of 6-inch diameter pipe which is perforated below the hydraulic barrier. Anti-seep collars would be installed on the vent pipe within the hydraulic barrier layer and the geomembrane would be attached to the vent by a pipe boot. Perforated lateral piping may be installed beneath the hydraulic barrier layer within the existing cover and/or fill soils and connected to the vent to increase the effectiveness of the vents. The design of the gas venting system would occur during the final design of the cap. Cost estimates for this system were not included, however, the additional cost is not expected to be significant.

During cap construction, testing would be required for quality control. Density and moisture content could be determined in situ using a nuclear densimeter. This would be performed continually by the contractor during clay placement. The contractor's measurements would be confirmed by construction monitoring personnel at a frequency of five tests per acre per lift. Also, samples taken from the cap (five Shelby tubes per acre) would be tested to verify the $1x10^{-7}$ cm/sec permeability requirement.

The geomembrane and clay layer would need to be located at a depth of approximately 40 inches below the surface of the cap to protect the clay layer from the effects of freeze-thaw weathering cycles. Because the depth of the drainage layer and fill layer would not be sufficient to place the clay below the local frost zone penetration depth of 40 inches, a buffer layer at least 4 inches thick would need to be placed between the clay and the drainage layers. Adjacent layers of granular soil materials (i.e., drainage layer, fill layer, and buffer layer) would either be separated by geotextile fabric or be designed to meet granular soil filter criteria to prevent clogging of the soil layers. These specific design issues would be studied during the final remedial design phase and an appropriate system would be selected. The availability and cost of the material would be considered in the final design process.

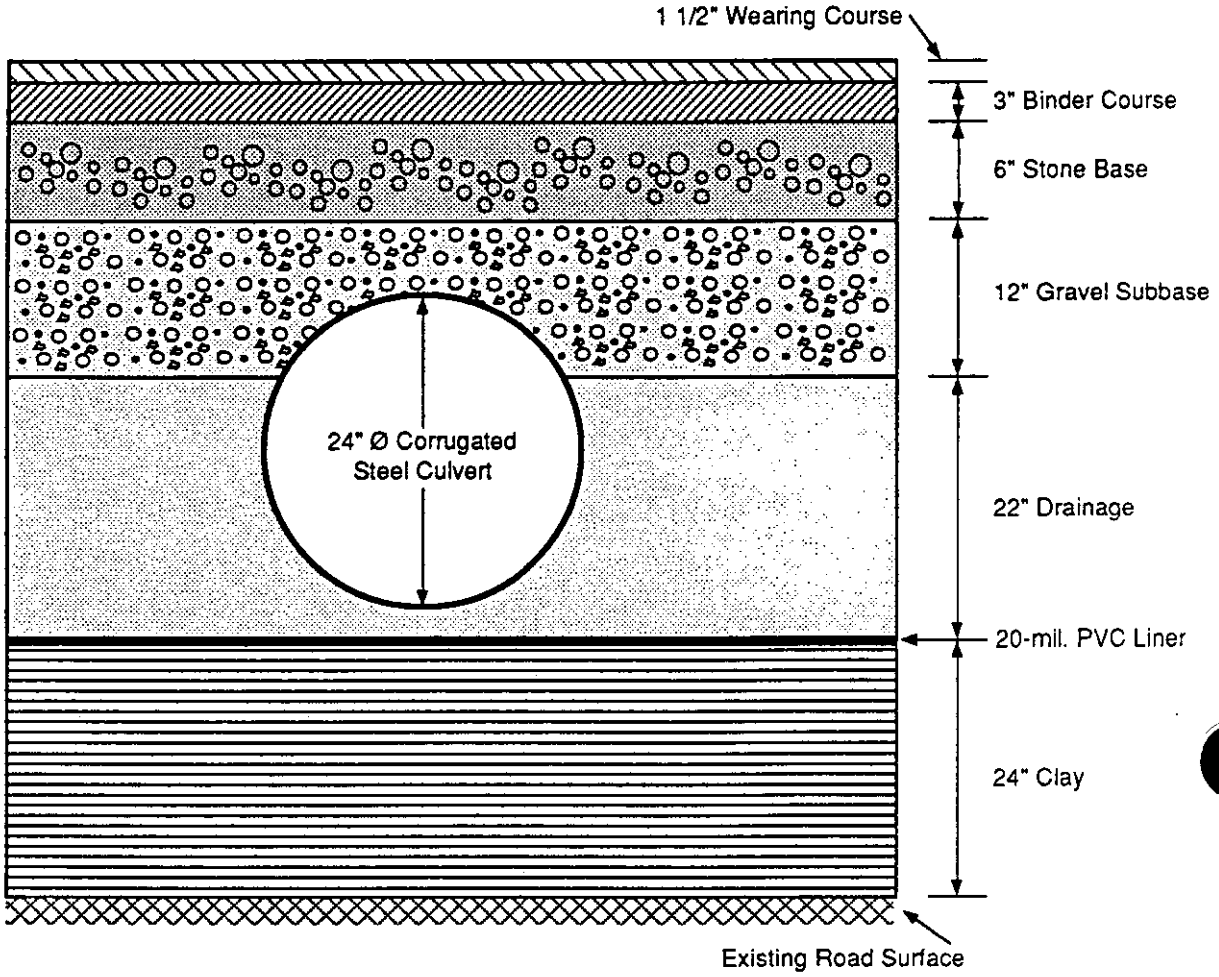
Final grade of the cap surface would be approximately 3 percent and sideslope would be approximately 33 percent. Figure 3-3 shows a cross-section of the final grade of the cap. Surface water drainage would be directed off the cap to the south and east consistent with existing topography. Extra fill material may be necessary to achieve

final grade and promote drainage. The cover would be vegetated to minimize erosion.

Part of the existing access road and parking lot would be covered by the cap and would need to be replaced. Following placement of the clay and drainage layers, a 12-inch-deep gravel subbase, 6-inch-deep stone base, and pavement would be replaced (Figure 3-4). For cost estimating purposes, it was assumed that three 24-inch-diameter culverts installed beneath the proposed road would be adequate to promote drainage of runoff from the parking lot and road and prevent it from ponding or infiltrating the cap. A drainage plan would be included as part of the final design. This will include the exact size, number, and location of the culverts to be installed beneath the proposed road.

The cover system would require little maintenance. Periodic post-closure inspections would be conducted to check for burrow holes created by animals, cracking, or subsidence. If the holes are believed deep enough to penetrate the liner, the cap may need to be reconstructed in that area. Cracking and subsidence of the cap are not expected because the proposed cap is over a relatively flat area. The grass would be mowed and reseeded as necessary. Periodic inspections and mowing could be performed by base personnel as part of the normal maintenance routine for the secured area. Inspection and maintenance of the cap system would be addressed in the operations and maintenance plan which would be developed by the Navy and reviewed and approved by appropriate regulatory agencies at the time of remedial design.

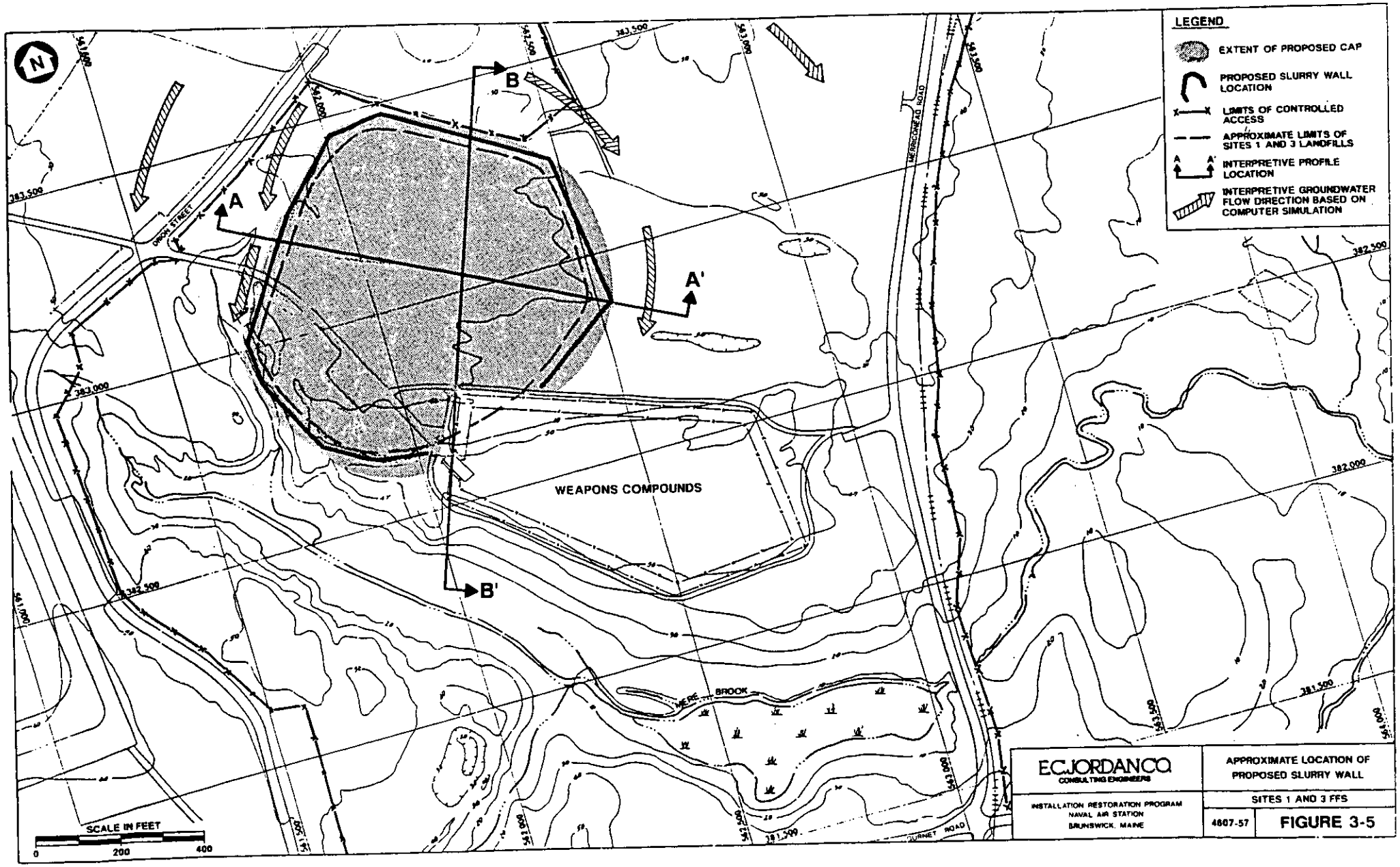
Subsurface Hydraulic Barrier. To redirect clean groundwater around the site, a slurry wall approximately 2,300 feet long would be constructed outside the limits of waste, as defined by the RI test pit program (Figure 3-5). Computer modeling has shown that this proposed location would intercept groundwater flow and redirect it around the landfill to discharge to Mere Brook (see Appendix B). The slurry wall would be keyed into the natural clay layer beneath the site. Geotechnical borings conducted prior to design would supplement information gathered from RI geologic borings and would be used to determine the actual location of the slurry wall. Figures 3-6 and 3-7 show cross-sections of existing site geology, limits of waste, and groundwater table interpreted from RI test pits and borings. The cross-sections also show the proposed location of the slurry wall and expected groundwater levels based on computer modeling. The final location of the slurry wall would be outside the limits of waste.

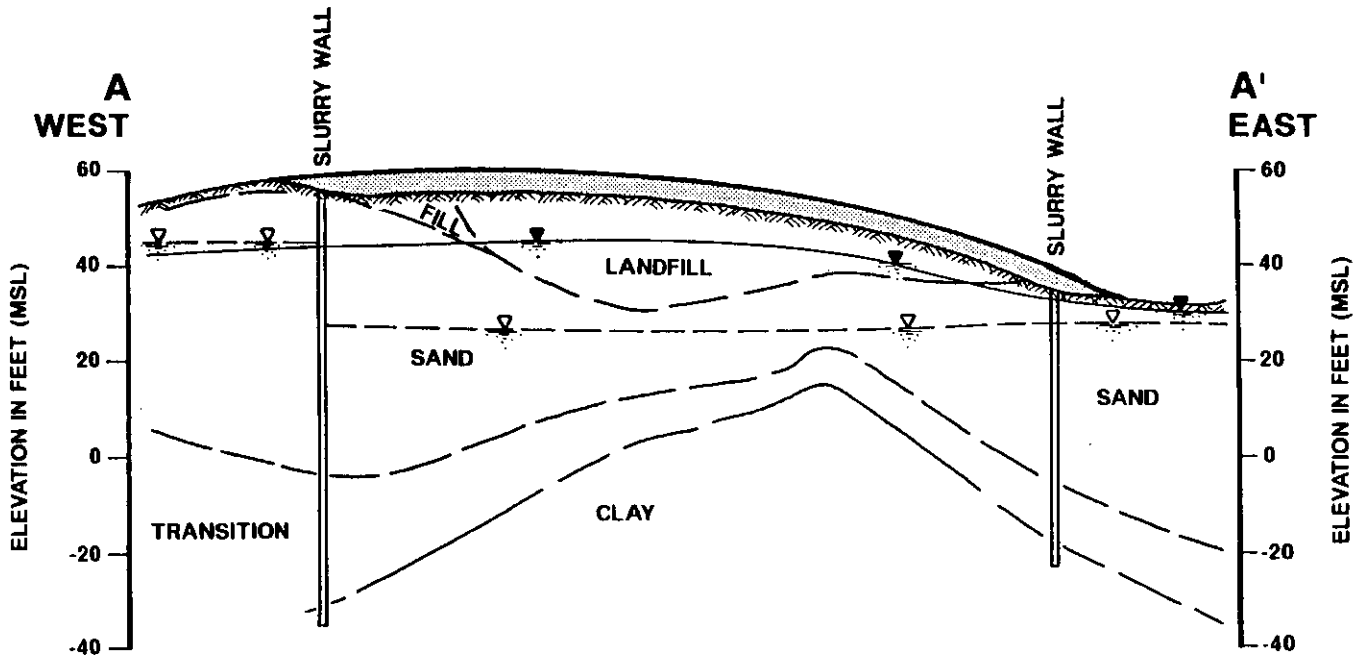


NOT TO SCALE

E.C.JORDAN CO. CONSULTING ENGINEERS	FINAL COVER SYSTEM ACCESS ROAD REPLACEMENT	
INSTALLATION RESTORATION PROGRAM NAVAL AIR STATION BRUNSWICK, MAINE	SITES 1 AND 3 FFS	
	4607-57	FIGURE 3-4

9102087D/4607-57


LEGEND
EXTENT OF PROPOSED CAP
PROPOSED SLURRY WALL LOCATION
LIMITS OF CONTROLLED ACCESS
APPROXIMATE LIMITS OF SITES 1 AND 3 LANDFILLS
INTERPRETIVE PROFILE LOCATION
INTERPRETIVE GROUNDWATER FLOW DIRECTION BASED ON COMPUTER SIMULATION
N
A
A'
B
B'
WEAPONS COMPOUNDS
MERE BROOK
MERRICONEAG ROAD
ORION STREET
BURNET ROAD
383,500
383,000
382,500
382,000
381,500
541,000
542,000
543,000
544,000
545,000
SCALE IN FEET
0
200
400
ECJORDANCO
CONSULTING ENGINEERS
INSTALLATION RESTORATION PROGRAM
NAVAL AIR STATION
BRUNSWICK, MAINE
APPROXIMATE LOCATION OF PROPOSED SLURRY WALL
SITES 1 AND 3 FFS
4607-57
FIGURE 3-5



LEGEND

- WATER LEVEL DATA FROM OCT. 1989
- INTERPRETIVE GROUNDWATER TABLE BASED ON COMPUTER SIMULATION
- PROPOSED CAP

GEOLOGIC DESCRIPTIONS:

SAND - TAN TO LIGHT BROWN FINE SAND, TRACE TO LITTLE MEDIUM SAND, TRACE SILT, POORLY GRADED, LOOSE TO MEDIUM DENSE, DRY TO SATURATED, SLIGHTLY STRATIFIED WITH DEPTH.

TRANSITION - BROWN TO GRAY FINE SAND AND SILTY, FINE SAND, TRACE CLAY, STRATIFIED WITH SILT AND CLAY LENSES, POORLY GRADED, NON TO SLIGHTLY PLASTIC, SOFT IN PLACES, SATURATED.

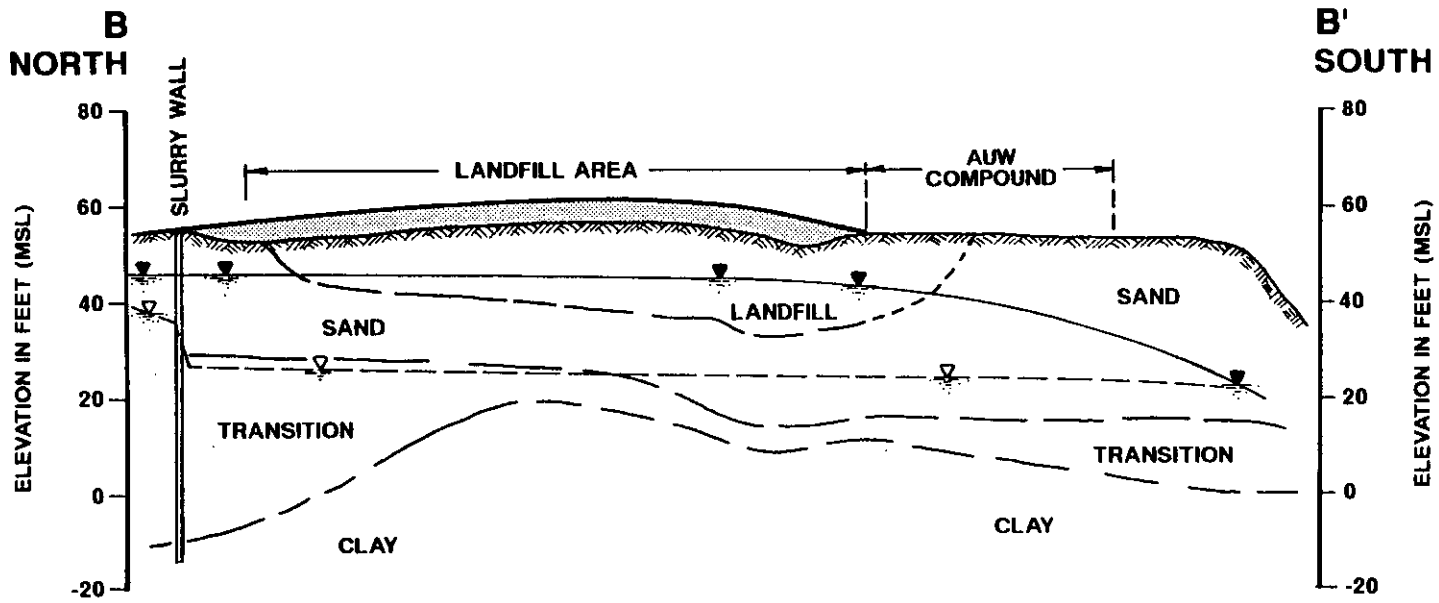
CLAY: - GRAY, SILTY CLAY TO CLAYEY SILT (ROCK FLOUR), MEDIUM TO HIGH PLASTICITY, VERY SOFT, SATURATED.

SCALE IN FEET

0 200 400

VERTICAL EXAGGERATION 5:1

E.C. JORDAN CO. CONSULTING ENGINEERS	GEOLOGIC CROSS SECTION A-A' FOR PROPOSED SLURRY WALL
INSTALLATION RESTORATION PROGRAM NAVAL AIR STATION BRUNSWICK, MAINE	SITES 1 AND 3 FFS
	4607-57 FIGURE 6



LEGEND

WATER LEVEL DATA FROM OCT. 1989

INTERPRETIVE GROUNDWATER TABLE BASED ON COMPUTER SIMULATION

PROPOSED CAP

GEOLOGIC DESCRIPTIONS:

SAND - TAN TO LIGHT BROWN FINE SAND, TRACE TO LITTLE MEDIUM SAND, TRACE SILT, POORLY GRADED, LOOSE TO MEDIUM DENSE, DRY TO SATURATED, SLIGHTLY STRATIFIED WITH DEPTH.

TRANSITION - BROWN TO GRAY FINE SAND AND SILTY, FINE SAND, TRACE CLAY, STRATIFIED WITH SILT AND CLAY LENSES, POORLY GRADED, NON TO SLIGHTLY PLASTIC, SOFT IN PLACES, SATURATED.

CLAY: - GRAY, SILTY CLAY TO CLAYEY SILT (ROCK FLOUR), MEDIUM TO HIGH PLASTICITY, VERY SOFT, SATURATED.

SCALE IN FEET

0 200 400

VERTICAL EXAGGERATION 5:1

E.C. JORDAN CO. CONSULTING ENGINEERS	GEOLOGIC CROSS SECTION B-B' FOR PROPOSED SLURRY WALL
INSTALLATION RESTORATION PROGRAM NAVAL AIR STATION BRUNSWICK, MAINE	SITES 1 AND 3 FFS
	4607-57 FIGURE 3-7

9107023T

To prevent desiccation of the slurry wall (resulting in decreased effectiveness), the slurry wall would be installed prior to completion of the cap, so the cap could be extended over the top of the wall. Because the cap would be constructed in sections, these activities could be implemented concurrently.

Before wall installation, a compatibility study would be conducted to determine the strength and consolidation properties of the underlying clay. Information from borings logged during the RI would be supplemented by additional geotechnical borings prior to design. Testing would include Atterberg limits, permeability, and hydrometer analyses to determine grain size and analyses to determine the natural moisture content. The proper slurry mix can be designed to match the permeability of the underlying clay, to provide a good seal between the two. Other tests should also be performed prior to construction. Chemical analysis of the proposed source of mixing water should be conducted to confirm its compatibility with the bentonite. Also, testing of the effect of contaminated groundwater on the bentonite and backfill mix should be conducted to determine if contaminants in the water could degrade the slurry wall. This test can take several months to complete.

The slurry wall would be keyed approximately 3 to 5 feet into the natural clay formation beneath the aquifer to prevent groundwater flow beneath the wall. The clay layer at Site 1 is found at varying depths along the length of the proposed barrier, ranging from approximately 28 to 62 feet below ground surface (bgs). Additional geotechnical borings would be required to more accurately map the location of the clay layer beneath the site. Visual observation of the cuttings excavated during construction would indicate when the clay layer is reached.

Conventional excavators are limited to a 45-foot excavation depth; however, equipment is available to excavate to depths greater than 60 feet (e.g., clamshells). Several contractors, including S.M.W. Seiko, Inc., of Redwood City, California, and Geo-Con, Inc., of Pittsburgh, Pennsylvania, have equipment that can install deep slurry walls. Methods employed by these two contractors are explained here as examples of different available methods.

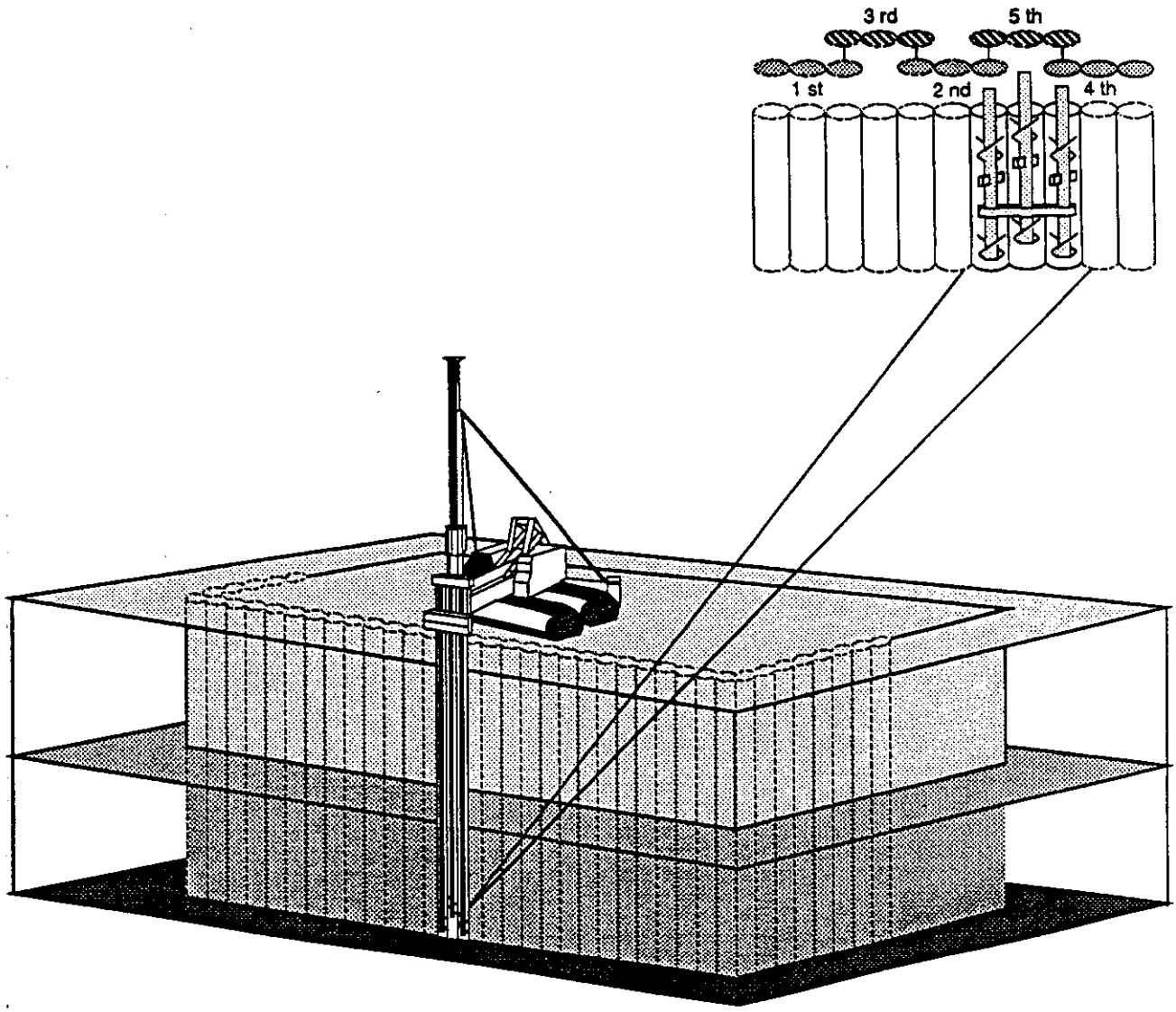
S.M.W. Seiko uses their patented Soil-Cement Mixed-in-Place Wall (S.M.W.) technique to construct slurry walls up to a 200-foot depth. This technique uses multiaxis augers and mixing paddles to construct overlapping soil-cement columns. The overlapping augers break up the soil. Cement grout is pumped into the boring through the auger shafts. The grout is mixed with the soil in situ by the auger flights

and mixing paddles. Each three-column segment is overlapped with the subsequent segment. The result is a continuous wall, with permeability ranging from $1x10^{-6}$ to $1x10^{-7}$ cm/sec (Taki and Yang, 1989). This method is advantageous for very deep walls or when excavating through hazardous material; however, the slurry mix is difficult to control in-situ, and it is difficult to ascertain whether the wall has been adequately keyed into clay. Figure 3-8 is a conceptual diagram of this type of structure.

Geo-Con is capable of installing slurry walls to depths of approximately 70 feet. At a Superfund site in Michigan, Geo-Con installed a deep soil-bentonite slurry wall around a landfill to prevent leachate migration. Geo-Con excavated the 70-foot-deep trench using a long-stick hydraulic excavator. In this process, a 2-to-4-foot-wide trench is excavated while a bentonite-water slurry is pumped into the excavation. The slurry provides enough pressure on the walls that shoring is unnecessary. The trench is backfilled with a soil-bentonite mixture (which is mixed with a bulldozer adjacent to the trench) as the excavation progresses so the water-bentonite slurry is displaced into the newly excavated portion of the trench. These walls typically have permeabilities ranging from $1x10^{-6}$ to $1x10^{-9}$ cm/sec. Backfilling with material with a high percentage of fines can achieve lower permeability coefficients. Borings in the vicinity of the proposed slurry wall show that soils below 40 feet bgs may be suitable for use in the soil-bentonite slurry wall material because the soil contains moderately plastic fines at these depths.

For a soil-bentonite slurry wall, the construction area would have to be graded to nearly level to prevent slurry and backfill flow and to keep the trench walls from collapsing. A level grade could be achieved by constructing the wall in sections, such that the work area at each section is stepped to a different grade than the adjacent section. To construct a continuous wall, the excavation of each new section would overlap the previous section.

Quality control during installation would include daily testing of the bentonite-water slurry (or cement grout), and testing of the in-place soil-bentonite mixture. The required tests would depend on the installation method used. Post-construction testing would require permeability testing two-and-a-half months after completion. A properly constructed slurry wall requires no maintenance. The environmental monitoring program would be able to evaluate the slurry wall's continued effectiveness.



TECHNICAL DATA

Wall Thickness: 20" to 36" by design
Maximum Wall Depth: Greater than 200 feet
Permeability (K): Approaching 10^{-8} cm/sec
Strength: 50 to 3,000 psi depending on subsurface conditions
Acceptable Soil Conditions: Clay to gravel and cobbles
Production Rate: 1,000 to 1,500 ft^2 per 8-hour shift

Not To Scale

Source: S.M.W. Seiko, Inc.

E.C.JORDAN CO. CONSULTING ENGINEERS	SLURRY WALL S.M.W. TECHNIQUE
INSTALLATION RESTORATION PROGRAM NAVAL AIR STATION BRUNSWICK, MAINE	SITES 1 AND 3 FFS
	4607-57 FIGURE 3-8

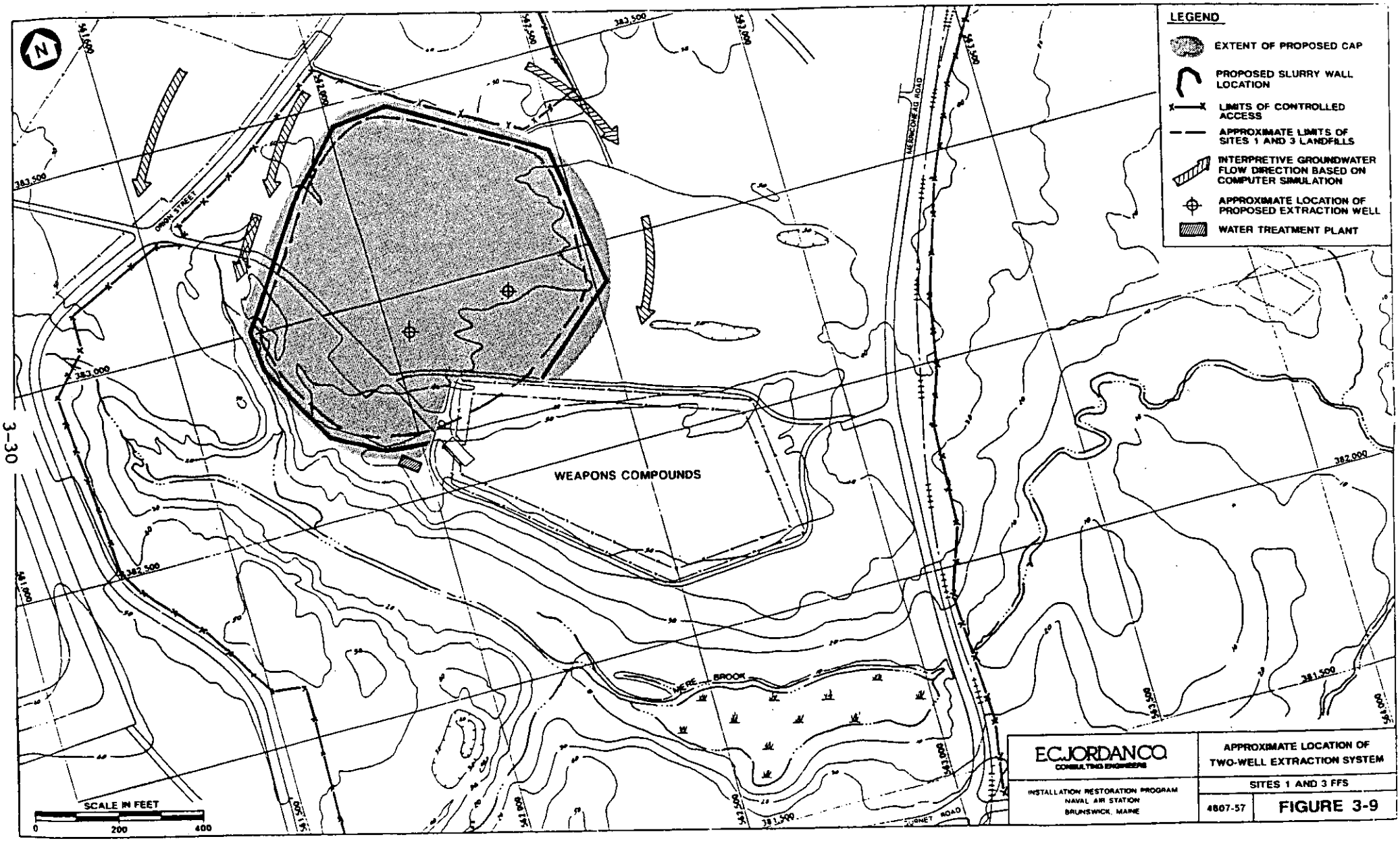
9102073D

Groundwater Extraction Wells. To facilitate the collection of the volume of contaminated groundwater remaining beneath the landfill following installation of the slurry wall, an extraction well system would be installed. The volume of contaminated water remaining within the landfill area (i.e., one pore volume) is estimated to be approximately 16 million gallons (see Appendix D). Using a Theis analysis, it is estimated that two extraction wells yielding approximately 40 gallons per minute (gpm) per well could be installed at the site to remove the pore volume of groundwater associated with the landfill. However, based on the data generated during the design phase modeling program, it may be necessary to install more than two extraction wells. These extraction wells would pump at lower flow rates than assumed here, to ensure sustainable flow rates. The exact number and location of the wells would be determined during remedial design. Actual pumping rates would be determined by pumping tests conducted after well installation.

The wells would be drilled to the underlying clay surface, estimated at a depth of approximately 40 feet bgs. The average depth clay in this portion of the landfill is estimated at approximately 40 feet bgs. Two 6-inch diameter wells with 30-foot screens would be installed in the borings. It is estimated that the entire aquifer saturated thickness would be intercepted by the screens. The boreholes would be backfilled and sealed with bentonite. Protective casings would be installed and cemented in place. Each well would contain a submersible pump capable of extracting groundwater at a rate of up to 60 gpm. The protective casings would not penetrate the hydraulic barrier layer. However, the well risers would and the geomembrane would be sealed to the risers using a geomembrane pipe boot. This well design has been assumed to estimate the cost of this alternative. The location of the extraction wells are presented in Figure 3-9.

Several piezometers would be installed in conjunction with the extraction well program to evaluate the hydraulic performance of the extraction well system. Piezometers would provide water level information during the pumping of extraction wells which is needed to estimate aquifer transmissivity, storage coefficients, and substainable yields. The piezometers would be located both in the direction of and perpendicular to groundwater flow. The piezometers could be monitored after the pumps are shut off to determine the effectiveness of the containment system in keeping water out of the waste.

Pumping tests would be monitored by an In-situ Hermit 2000 multiple transducer/data logger. To evaluate drawdown in the sandpack surrounding


LEGEND
EXTENT OF PROPOSED CAP
PROPOSED SLURRY WALL LOCATION
LIMITS OF CONTROLLED ACCESS
APPROXIMATE LIMITS OF SITES 1 AND 3 LANDFILLS
INTERPRETIVE GROUNDWATER FLOW DIRECTION BASED ON COMPUTER SIMULATION
APPROXIMATE LOCATION OF PROPOSED EXTRACTION WELL
WATER TREATMENT PLANT
WEAPONS COMPOUNDS
ORION STREET
MERRICONEAG ROAD
MERE BROOK
HARNET ROAD
383,500
383,000
382,500
382,000
381,500
541,000
541,500
542,000
542,500
543,000
543,500
544,000
544,500
545,000
SCALE IN FEET
0
200
400
ECJORDANCO
CONSULTING ENGINEERS
INSTALLATION RESTORATION PROGRAM
NAVAL AIR STATION
BRUNSWICK, MAINE
APPROXIMATE LOCATION OF TWO-WELL EXTRACTION SYSTEM
SITES 1 AND 3 FFS
4807-57
FIGURE 3-9

extraction wells, a 1-inch diameter PVC piezometer would be installed in the filter pack of each well. The piezometers would be attached to the riser using a stainless steel clap, and would be vertically positioned within the borehole to provide water-level information in the filter pack during pumping tests. Two types of aquifer testing would be performed in the site: (1) step-drawdown tests; and (2) constant discharge tests. Step-drawdown tests would provide data on well efficiency, contaminant capture, localized aquifer properties, and short-term well yields. Constant-discharge tests would be used to evaluate drawdown effects, recharge boundaries, and large-scale aquifer properties that would influence long-term contaminant-capture efficiency and operation of the groundwater extraction system. Based on these calculations, estimated flow rates, and analytical models presented in Appendix D, it is estimated that one pore volume may be removed in approximately 142 days (based on an estimated 78 gpm pumping rate). This time estimate would increase if the pumping rate was decreased. It should be noted that the time estimates are based on several assumed variables, in particular the fraction of organic carbon (f_{oc}) values, and that actual cleanup times may be considerably longer.

Water Treatment. Treatment of the water removed from the contained landfill area would be required, because the water would contain VOCs in excess of state and federal standards for discharge. It is assumed for cost estimating purposes that the pump-and-treat system would operate for one year at 78 gpm.

Several groundwater treatment options were considered to reduce VOC contamination, including air stripping and ultraviolet (UV)/oxidation (using either hydrogen peroxide [H_2O_2] or ozone [O_3] as an oxidant). These systems would be designed to remove VOCs and would be preceded by pretreatment for the removal of inorganic compounds, such as iron, which could interfere with the VOC treatment process. Discharge of treated water is assumed to be upgradient recharge; however, other options are described and evaluated in this section.

Two water treatment technologies retained after the screening of alternatives are air stripping and UV/oxidation. Both technologies are effective in treating VOCs; however, because the concentrations of iron and manganese exceed 1 mg/L, pretreatment may be required. When groundwater containing dissolved iron and manganese contacts air, the metals oxidize to a less soluble form and precipitate out of solution. This precipitate can foul the packing material in the air stripper or the UV lamps in the UV/oxidation reactor vessel, reducing the efficiency of the

treatment systems and increasing costs. The need for pretreatment would be confirmed by treatability testing.

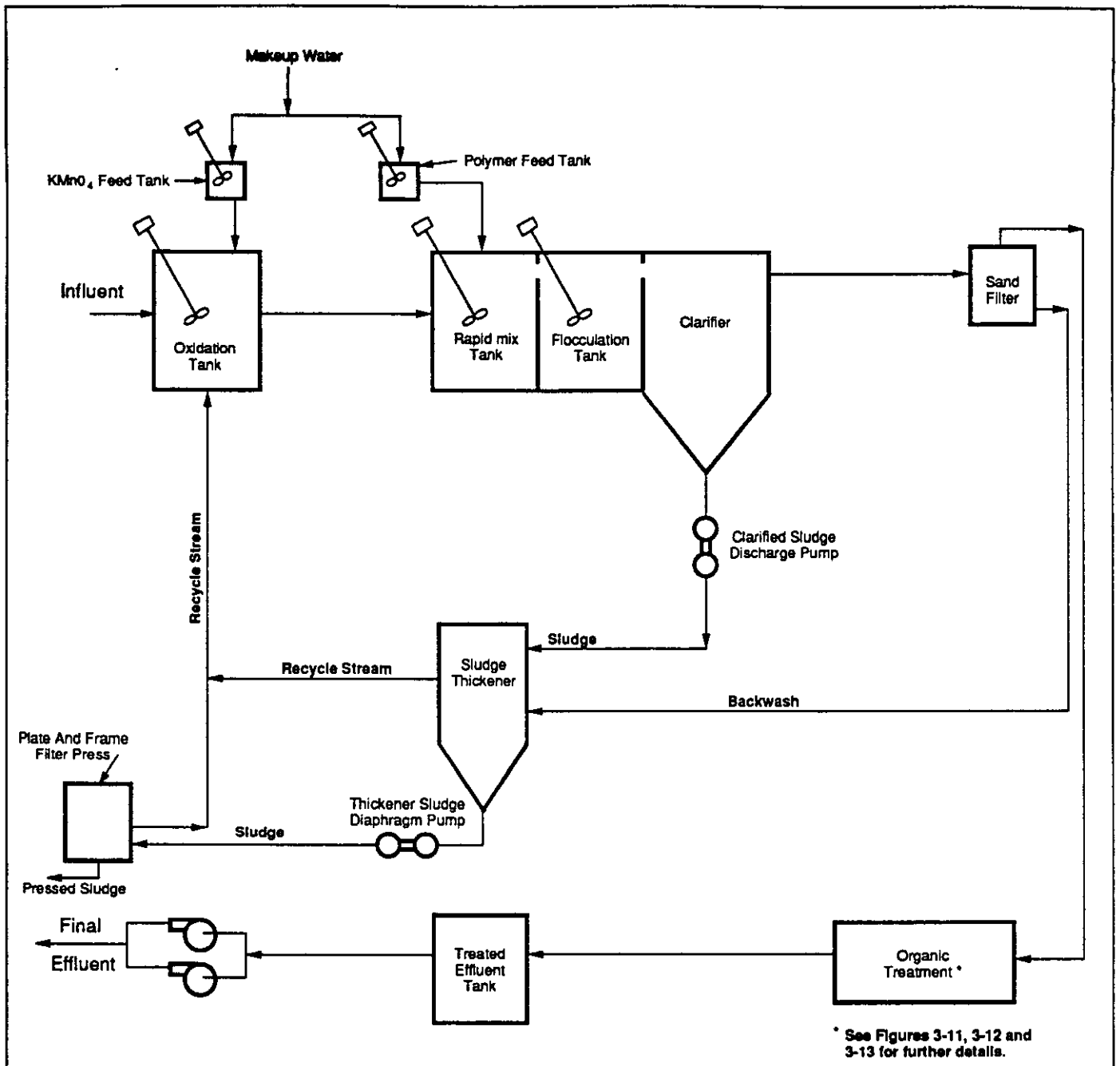
Pretreatment of the raw water, if necessary, would involve the following processes:

- oxidation
- flocculation
- clarification
- filtration

A schematic flow diagram of the pretreatment process is shown in Figure 3-10. This system was developed for cost estimating purposes and designed to remove primarily iron and manganese. However, the final pretreatment system would be designed to remove all inorganic compounds to the appropriate discharge limits (i.e., MCLs or NPDES limits) or concentrations that would not interfere with VOC treatment. A treatability test would be conducted prior to final design to ensure proper removal efficiency and/or the need for any modifications, in the pretreatment process.

The first step in pretreatment would be to oxidize iron and manganese to their insoluble forms. These analytes are the primary inorganic contaminants of concern and will be removed during pretreatment to prevent clogging or fouling of the VOC treatment. Potassium permanganate ($KMnO_4$) was assumed as the oxidizing agent in the preliminary design for pretreatment. The added manganese in $KMnO_4$ would be the oxidizing agent as it is reduced from the +VII oxidation state to the +IV oxidation state. Dissolved iron would be oxidized from the relatively soluble +II state to the more insoluble +III state. Dissolved manganese would be oxidized from the +II state to the more insoluble +IV state. The precipitates would be ferric hydroxide ($Fe(OH)_3$) and manganese dioxide (MnO_2).

A polymer would be rapidly mixed with effluent from the oxidation tank. This mixture would then be slowly mixed in a flocculation tank to promote the agglomeration of suspended particles. Flocculated effluent would discharge to a clarifier for particle settling. The clarifier allows for a sufficient residence time to allow particles to settle and collect in the sludge zone. The clarified effluent would be removed from the tank and filtered to remove remaining suspended solids prior to VOC treatment (air stripping or UV/oxidation).



Not To Scale

E.C.JORDAN CO. CONSULTING ENGINEERS	PROCESS FLOW DIAGRAM FOR WATER TREATMENT
INSTALLATION RESTORATION PROGRAM NAVAL AIR STATION BRUNSWICK, MAINE	SITES 1 AND 3 FFS
	4607-57 FIGURE 3-10

9102101D/4607-57

TABLE 3-4
INFLUENT AND EFFLUENT CONCENTRATIONS FOR
METALS PRETREATMENT, AIR STRIPPING , AND UV/H202

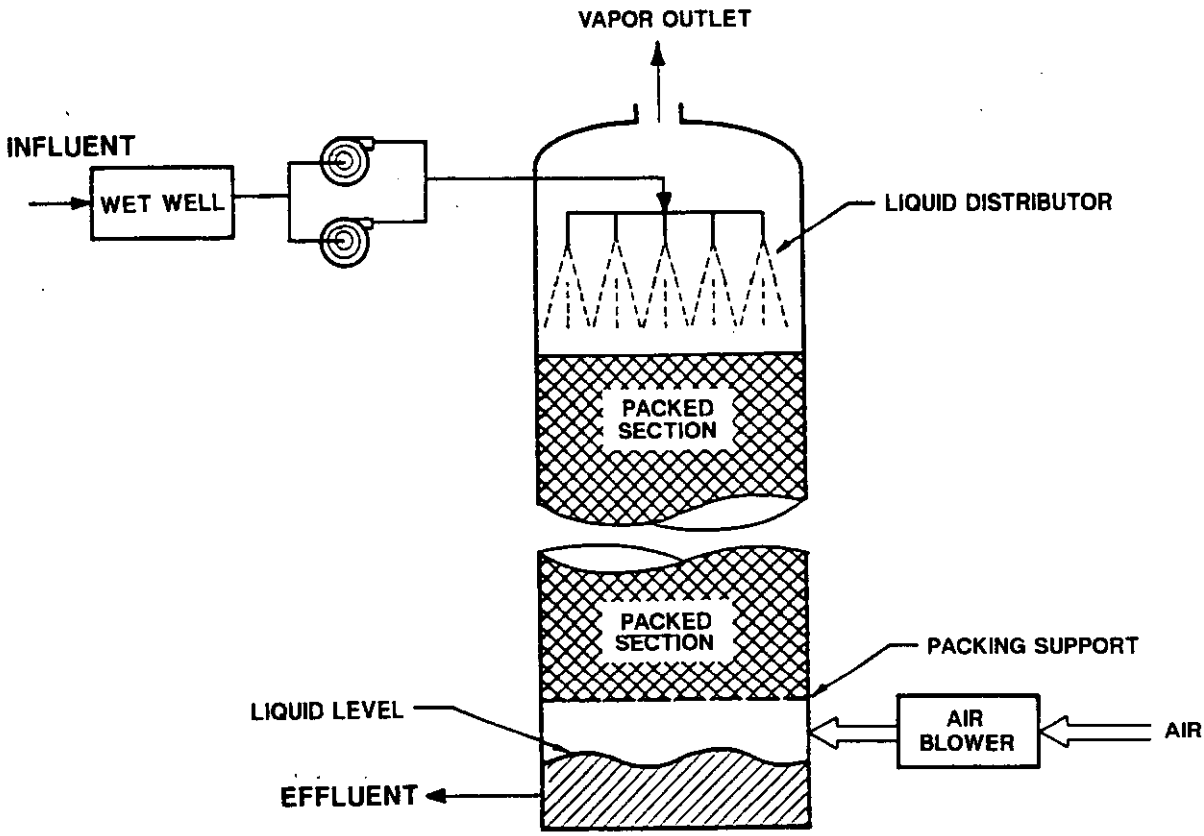
FOCUSED FEASIBILITY STUDY
NAS BRUNSWICK

Contaminant	Assumed Influent Conc.	Estimated Effluent Concentration		Calculated Percent Removal	
		Air Stripping	UV/H2O2	Air Stripping	UV/H2O2
Vinyl Chloride	180	1.3	0.2	99.28	99.9
Chloroethane	25	0.2	0.0	99.20	99.9
Methylene Chloride	460	2.3	0.5	99.50	99.9
1,1-DCE	9	0.1	0.0	98.89	99.9
1,2-DCE	60	0.9	0.1	98.50	99.9
1,1-DCA	38	0.7	0.0	98.16	99.9
Chlorobenzene	32	1.0	0.0	96.88	99.9
Chloroform	17	0.4	0.0	97.65	99.9
Benzene	6	0.1	0.0	98.33	99.9
Toluene	380	42.8	0.4	88.74	99.9
Ethyl Benzene	200	5.4	0.2	97.30	99.9
Xylenes	660	17.3	0.7	97.38	99.9
Pretreatment Metals		Oxidation/Settling		Oxidation/Settling	
Iron	286,000	--------	100	--------	99.97
Manganese	4,710	--------	100	--------	97.88

NOTES:
All concentrations are given in micrograms per liter.

Effluent concentrations for airstripping were determined using the Airstrip Version 1.1 computer model.

For UV/H2O2, percent removals are assumed to be 99.9%. The actual value would depend on UV intensity, contact time, and oxidant dose. These parameters would be optimized during bench and pilot scale testing prior to full scale operation. The actual required removal percentage and the operating parameters would be determined in the pilot and bench scale studies.



NOT TO SCALE

E.C.JORDAN CO. CONSULTING ENGINEERS	AIR STRIPPING TOWER
INSTALLATION RESTORATION PROGRAM NAVAL AIR STATION BRUNSWICK, MAINE	SITES 1 AND 3 FFS
	4607-57 FIGURE 3-11

Sludge from the clarifier would be thickened in a gravity thickener to a concentration of approximately 2 percent solids. The supernatant from the thickener would be recycled to the headworks. The thickened sludge would then be dewatered to approximately 30 percent solids in a plate and frame filter press. The filtrate would be added to the recycle stream. Dewatered sludge would be collected and tested to determine its regulatory status and proper disposal options for off-site disposal. For cost estimating purposes, it was assumed that the sludge would be shipped out of state for disposal as a hazardous waste.

A treatability test would be performed prior to the final design of the pretreatment system. If other inorganics such as arsenic and lead are present above their respective discharge limits, modifications to the system will be made. This may include adding pretreatment steps such as the addition of time to reduce arsenic and lead levels to below their discharge limits.

After pretreatment, the water would be treated to remove or reduce all VOCs. Air stripping and UV/oxidation are the process options for VOC removal that were retained after alternative screening. Air stripping is a method frequently used to remove VOCs from groundwater and is effective for removing the contaminants of concern: vinyl chloride, 1,2-DCE, and methylene chloride. During the process, contaminated water contacts large volumes of clean air. Contaminated water enters the top of the air stripping tower and trickles down through the packing material, while air enters at the bottom. The contaminants are transferred from the liquid phase to the gas phase and carried off with the effluent air. Table 3-4 presents the assumed influent and estimated effluent concentrations for organic and inorganic compounds for pretreatment, air stripping, and UV/oxidation treatment technologies.

Design of the column is essentially dictated by the column fluid dynamics and the desired removal efficiencies for the compounds of concern. A computer program (i.e., Airstrip), which models the dynamics of the air stripping process, was used as part of the preliminary design effort. Results obtained from this model are in Appendix C. The design calls for an 18-foot-high by 2-foot-diameter column with plastic packing material. The design flow rate is 78 gpm based on groundwater modeling. Several vendors can custom design a tower if a standard-sized tower does not meet design specifications. Figure 3-11 is a cross section of a typical packed air stripping tower.

An estimated 1.9 lb/day of total VOCs would be expected from air stripper emissions at Sites 1 and 3. Off-gas treatment of these emission may not be required to achieve federal guidelines. This emission rate was calculated based on preliminary design parameters for the air stripping unit (i.e., water and air flow rates and initial concentrations) and the maximum concentration of VOCs detected in the landfill area. Guidance from USEPA's Office of Solid Waste and Emergency Response on air emissions from air strippers at Superfund sites suggests that "sources most in need of controls are those with an actual emissions rate in excess of...15 lb/day...of total VOCs" (USEPA, 1989).

Emissions from the air stripper may not attain the state ambient air guidelines. Estimates of VOC emissions indicate that vinyl chloride, methylene chloride, and other VOCs may be released from the air stripper in excess of their respective guidelines. A vapor phase carbon (VPC) adsorption unit was evaluated as a technology for off-gas treatment. Vendor information indicates a usage rate of 8,000 lb/day of VPC for contaminants in the air effluent and the associated flow rates if controls had to be placed on air stripper emissions. This extremely high usage rate is due to the fact that both methylene chloride and vinyl chloride do not adsorb well to activated carbon. The other VOCs would be effectively removed by the VPC. Off-gas incineration is another treatment option for air-stripping that may be effective at treating vinyl chloride. However, this technology cannot be used at Sites 1 and 3 because of the sites' proximity to the Weapons Compound.

The actual emissions would have to be determined if air stripping were implemented. A treatability study would be completed prior to designing the full-scale air stripping system. The study would determine whether pretreatment is required and provide more accurate air emission concentrations. This information would be used to determine if Maine state guidelines would be exceeded and the need for off-gas treatment.

Another process option suitable for organics treatment at Sites 1 and 3 is UV/oxidation. This process option destroys organic compounds in water through chemical oxidation enhanced by exposure to UV light. Reagents used with UV/oxidation include O_3 and H_2O_2. Under these conditions, O_3 and H_2O_2 are rapidly converted to hydroxyl radicals. In addition, organic molecules absorb energy from the UV light, promoting reactions with hydroxyl radicals. The combined effects of UV light and concentrated hydroxyl radicals synergistically promote rapid breakdown of organic molecules. In the oxidation process, organic contaminants are

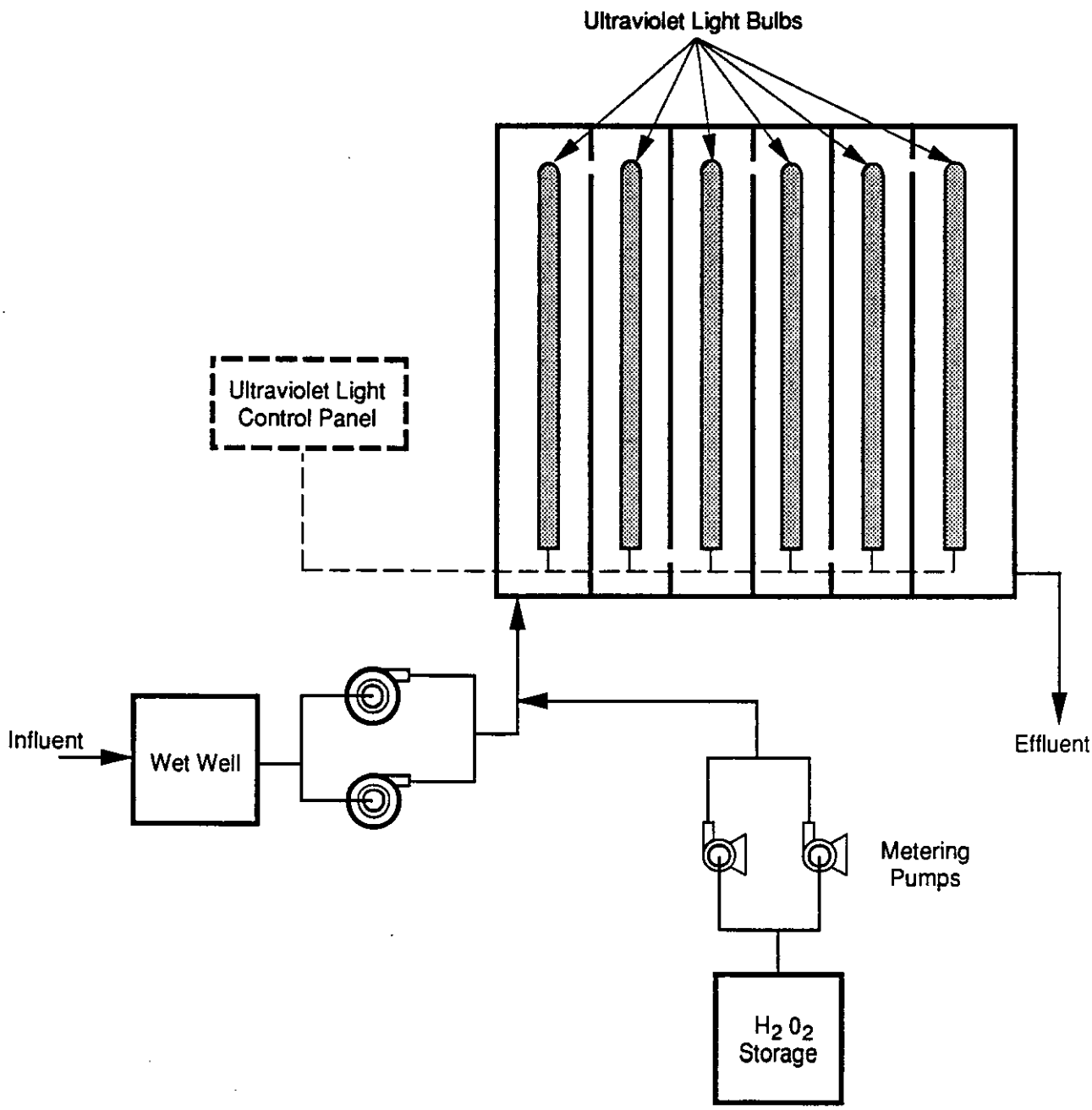
broken down into simpler, non-hazardous substances such as carbon dioxide, water, salts, acetone, sulfates, nitrates, and organic and inorganic acids. Some of these by-products have discharge requirements (e.g., acetone, sulfates, nitrates), that would need to be met if this treatment technology is chosen. A treatability test would provide information on the compounds and concentrations likely to be present in the effluent.

UV/oxidation occurs in a stainless steel chamber containing vertically or horizontally mounted UV lamps. A typical reaction vessel has six chambers designed to provide intimate contact between the oxidant and the water while in the presence of UV light.

The process is the same for either oxidant; however, each is introduced into the system differently. H_2O_2 is metered in water solution into the wastestream before entering the reactor. Introduction of O_3 differs in that it must be generated on-site and diffused directly into each chamber. O_3 is a highly reactive and unstable gas and UV/O_3 systems are equipped with a catalytic destructor to remove residual O_3 prior to release to the atmosphere. Cooling water and a cooling tower are required to cool the cells in the ozone generator. Figures 3-12 and 3-13 are schematic diagrams of the two process options.

For preliminary design and cost estimating purposes, a flow rate of 78 gpm was used to size the reactor vessels for both the UV/O_3 and UV/H_2O_2 systems with assumed detention times of 50 and 67 minutes, respectively, based on vendor information. Because O_3 is a stronger oxidant than H_2O_2, it would require a shorter residence time. The preliminary design for the UV/O_3 system includes the following items: UV reactor with generator, cooling tower, wet well, process pumps, and level controls. For the UV/H_2O_2 system, the preliminary design includes these components: UV reactor, wet well, process pumps, level controls, metering pumps, and H_2O_2 storage (see Table 3-4 for the assumed influent and estimated effluent concentrations for inorganic and organic compounds treated with UV/oxidation).

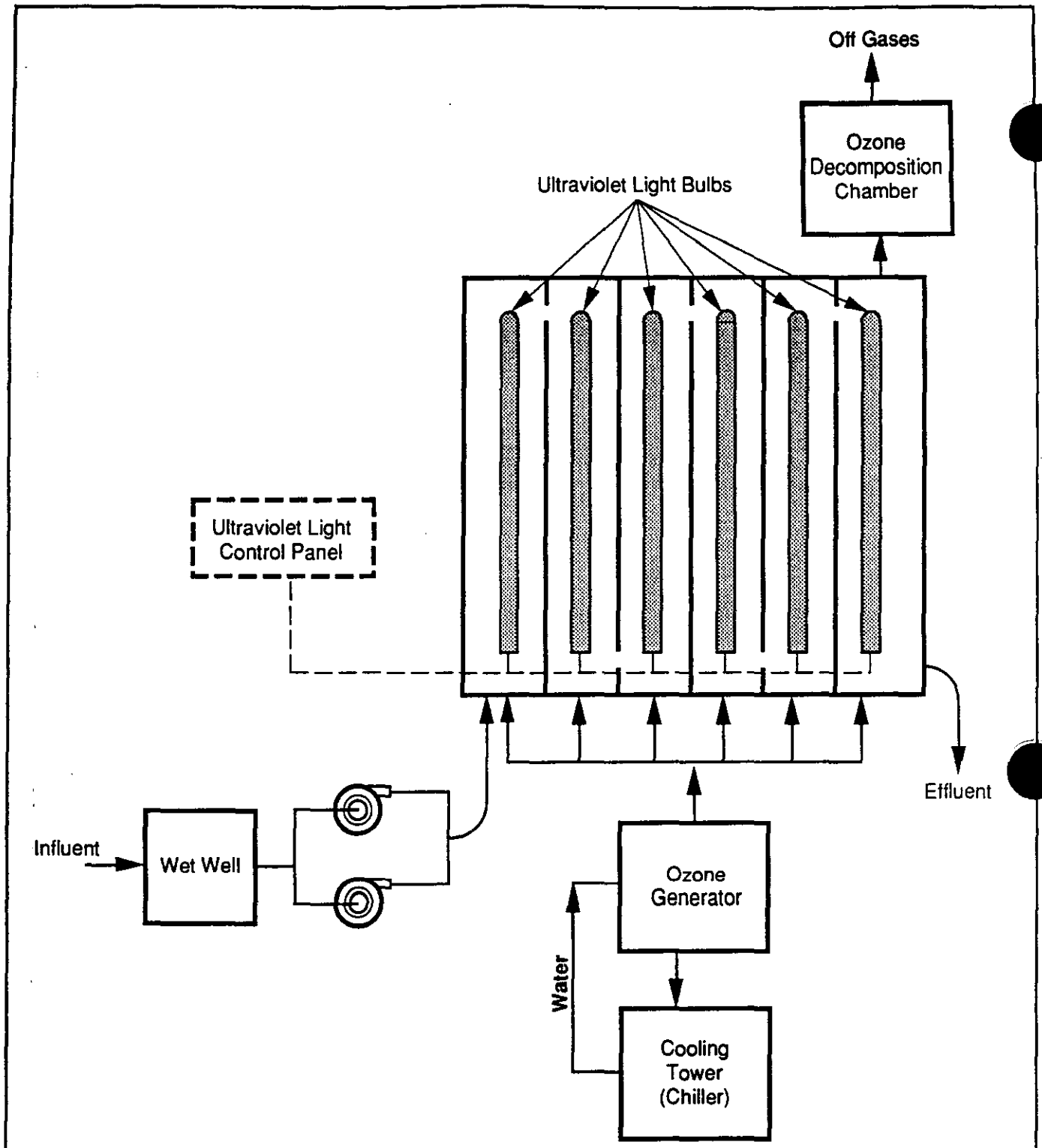
Treatability studies would be required before any full-scale design of a UV/oxidation system. Bench- and pilot-scale tests for all the water treatment processes (i.e., pretreatment, air stripping, UV/O_3, and UV/H_2O_2) would be conducted concurrently. These studies would determine which process option, UV/O_3 or UV/H_2O_2, would provide better, more cost-effective treatment for the given conditions at Sites 1 and 3. Treatability tests would provide information on the by-products created, the need



Not To Scale

EC JORDAN CO. CONSULTING ENGINEERS	ULTRAVIOLET/PEROXIDE REACTOR
INSTALLATION RESTORATION PROGRAM NAVAL AIR STATION BRUNSWICK, MAINE	SITES 1 AND 3 FFS
	4607-57 FIGURE 3-12

9102099D/4607-57



Not To Scale

E.C. JORDAN CO. CONSULTING ENGINEERS	ULTRAVIOLET/OZONE REACTOR	
INSTALLATION RESTORATION PROGRAM NAVAL AIR STATION BRUNSWICK, MAINE	SITES 1 AND 3 FFS	
	4607-57	FIGURE 3-13

9102097D/4607-57

for polishing the treated water with activated carbon, and approximate process costs and operating conditions. Each of the three VOC treatment options will be evaluated and their effectiveness assessed by treatability tests before one is selected.

Discharge of Treated Water. Several options are available for discharge of treated water:

- surface water (e.g., Mere Brook)
- groundwater (e.g., infiltration)
- Brunswick Sewer District's Publicly Owned Treatment Works (POTW)
- Town of Brunswick storm sewer system

Discharge to surface water would involve piping treated water from the treatment facility to the brook. The outfall would be constructed to reduce the velocity of water exiting the pipe to minimize scouring of the streambed. Discharge to surface water would require compliance with effluent discharge permit limits. Permits issued under Section 402 of the Clean Water Act may include permit limits based on effluent limitation guidelines, water quality criteria, or best professional judgement, whichever is more stringent. These discharge requirements may be more stringent than MCLs or proposed risk-based target levels, on which the preliminary design of the treatment system was based. Therefore, the final treatment plant design may need to be modified to meet the discharge limits. Effluent monitoring would be conducted and would include compliance monitoring for the applicable discharge permit.

Disposal of treated water by groundwater recharge could be accomplished by methods such as irrigation, rapid infiltration, or reinjection. Upgradient recharge has been considered for preliminary treatment plant design and cost considerations; however, the other methods may also be viable options for discharge of treated water.

Irrigation is often used for watering crops or lawns. Large land areas would be required to implement this option. Also, the water would need to be stored in the winter when irrigation is not feasible. Assuming that irrigation is not possible for five months out of the year, and assuming a constant flow rate of 78 gpm, approximately 17 million gallons of water would need to be stored. Storage of this volume of water would require at least 3 acres of land for siting tanks.

Rapid infiltration involves discharging water into a shallow basin upgradient of the site, and allowing the water to pass through natural soils to the water table. The size of the basin is determined by the rate at which the water can move through the soil. Infiltration tests would be required before siting or designing an infiltration system. The vertical conductivity of soil upgradient of Site 1 is calculated to be between 0.06 and 1 foot per day, assuming 5-to-1 horizontal to vertical anisotropy in the conductivity due to the stratified nature of the natural soils. The horizontal hydraulic conductivity for sand and silt strata observed at Sites 1 and 3 is estimated to be between 0.29 and 5.1 feet per day (E.C. Jordan Co., 1990a). The estimated vertical conductivities would result in hydraulic loading rates between 0.4 and 7.6 gallons per day (gpd) per square foot.

The infiltration basin must be sized to allow for infiltration at the same rate as effluent is produced, that is, 78 gpm or 112,300 gpd, to prevent significant ponding of water. To accommodate this flow given the expected hydraulic loading rates, the basin would need to be between 0.33 and 6 acres. Recharge of treated water upgradient of the landfill may influence local water levels and hydraulic gradients. Induced infiltration may result in groundwater mounding which would alter flow directions. Groundwater mounding may also increase hydraulic gradients and seepage velocities within the landfill area. If actual vertical conductivities are low and a large area is required for the infiltration basin, rapid infiltration may not be a viable option for discharge. Infiltration of water over the 6-acre area is likely to influence groundwater flow patterns over a larger area than that part of the aquifer associated with Sites 1 and 3. This basin is not expected to have a significant impact to groundwater flow within the Eastern Plume area. Computer modeling could be used to predict these effects if infiltration is considered further.

Freezing is not expected to create technical difficulties if rapid infiltration is used. Water would enter the basin at a temperature greater than 32 degrees Fahrenheit, so the incoming water would likely melt any ice that may have had the chance to form. Sand beds operated year-round at the Lake George Treatment Plant in upstate New York did not encounter problems due to freezing conditions (USEPA, 1979).

If infiltration is considered infeasible, another groundwater discharge alternative is reinjection, where water would be directly introduced into the aquifer through wells upgradient of the landfill. The effects of discharge of groundwater upgradient of both the landfill and Eastern Plume will be evaluated as part of the design phase

modeling efforts. It is anticipated that up to eight injection wells receiving a total of 78 gpm would be required to discharge treated water. Eight extraction wells, pumping at relatively low flow rates, were considered to be necessary to passively collect groundwater and enhance the flushing of the landfill waste materials. An analysis, assuming fewer extraction wells, indicated that higher flow rates at each well location would lower groundwater to levels below the waste. The exact number and location of these wells would be determined during remedial design. The hydraulic effects described previously for the infiltration basin would be similar if reinjection wells were employed.

Another option for discharge is piping the water approximately 1 mile to tie into the base sanitary sewer system. The Navy would need to obtain permission from the Brunswick Sewer District to discharge treated effluent to the system. Discharge limits would be set such that the POTW would not exceed its discharge permit limits or the standards set within its permit for land application of sludge. The additional 78 gpm (0.11 million gallons per day [mgd]) flow rate would not cause the POTW to exceed its capacity. The design flow rate is 3.85 mgd. Average flows are currently 2.8 mgd, or about 73 percent of capacity (Appendix C). The cost of discharging treated water to the POTW cannot be estimated because pretreatment requirements are not known. However, there would be a fee for the increased flow.

Treated effluent could possibly be discharged to one of the many storm sewer lines that collect runoff from the base. These lines discharge to streams; therefore, the effluent may be required to meet the same water quality standards as for direct discharge to surface water. This method would need to be approved by the appropriate parties prior to implementation (Appendix C).

Institutional Controls and Deed Restrictions. This alternative requires institutional controls and deed restrictions to prevent future use of the landfill or groundwater. As described in Subsection 3.1, security is strictly enforced at Sites 1 and 3 because these sites are within the fenced area near the Weapons Compound. At Site 3, signs are posted warning of pesticides buried in the area. Additional warning signs would be posted around the landfill area and near leachate seeps. Restrictions on future development would be incorporated into the property deed to limit land use should the base be decommissioned. The mechanism for implementing these institutional controls will be placed in the ROD for the remedial actions at Sites 1 and 3.

Environmental Monitoring. The proposed environmental monitoring program for the Containment Alternative would be very similar to that discussed under Alternative 1,3-B, the Minimal Action Alternative. As stated, this monitoring plan has been developed for cost-estimating purposes only. In addition to sampling for environmental contamination, periodic site inspections would be conducted to evaluate the condition of the cap and determine if leachate seeps still exist after the groundwater table has been lowered. Groundwater monitoring data would provide chemical and water level information that could be used to determine if the cap and slurry wall are effectively maintaining the groundwater table below the level of waste in the landfill.

Five-year reviews would be required as part of the environmental monitoring program for the Containment Alternative. In addition to making recommendations regarding future remedial actions, the five-year reviews would assess the performance of the containment system.

3.3.1 Overall Protection of Human Health and the Environment

This alternative would provide an increased level of protection to human and ecological receptors over baseline conditions. The clay cap and slurry wall would effectively reduce the amount of water infiltrating and passing through the waste material. This reduction would decrease the amount of contaminated groundwater generated and discharged either at the leachate seeps or to Mere Brook. In addition, the extraction and treatment systems would remove the volume of contaminated water remaining beneath the cap and treat this water to the appropriate discharge requirements (i.e., MCLs or NPDES concentrations). It is estimated that 142 to 370 days (based on pumping rates between 78 and 30 gpm) would be required to treat the residual groundwater.

Institutional controls would be required during the time that contaminant concentrations in groundwater remain in excess of the proposed Target Clean-up Level. These controls would be aimed at limiting contaminant exposure by restricting groundwater usage in this area. Because this area of NAS Brunswick is currently serviced by a public water supply, it is unlikely that groundwater would be used for potable purposes. In addition, institutional controls would be required to limit future land use of the capped area.

This alternative is expected to provide a permanent reduction in contaminant concentrations in groundwater, surface water, and sediments at the leachate seeps. If air stripping is selected as the groundwater treatment technology, off-gas treatment using VPC would be required. However, even with VPC, emissions of vinyl chloride and methylene chloride may exceed the state ambient air guidelines.

To ensure protection of human health, the Navy will conduct a risk assessment at the five-year review. If the risks do not fall within the target risk range specified in the NCP (i.e., 10^{-4} to 10^{-6}) the Navy will consider the need for additional remedial actions.

3.3.2 Compliance with ARARs

To meet chemical-specific ARARs, contaminant concentrations in groundwater must not exceed the MCLs, MCLGs, or TBCs. As part of this alternative, groundwater beneath the capped area would be extracted and treated to the appropriate discharge levels. This alternative would decrease the amount of contaminated groundwater discharging to Mere Brook. However, due to contribution of upgradient non-point sources of iron and zinc, the chemical-specific ARARs for these metals may not be attained (see Section 2.1).

Other chemical-specific ARARs include state and federal air regulations such as the total suspended particulate standards identified under the Clean Air Act (CAA) (40 CFR 129), and Maine regulations concerning the Protection and Improvement of Air (38 M.R.S.A. Chapter 4). These regulations would be attained during construction activities by controlling fugitive dust emissions. Hazardous air emissions during construction activities are not expected because invasive work (e.g., construction of slurry wall) would not occur in the landfill area. If air stripping is considered for groundwater treatment, this would create a point source of air emissions. The State's guidance on the Protection and Improvement of Air and Ambient Air Quality Standards would be relevant and appropriate to the point source emission from the air stripper.

There are a number of action-specific ARARs that potentially apply to most of the proposed alternatives. The general action-specific requirements that apply to most remedial construction activities were identified and discussed in Subsection 2.3.2.3 RCRA General Facility Standards (40 CFR 264.10 - 264.18), Preparedness and Prevention (40 CFR 264.30 - 264.37), Contingency Plan and Emergency Procedures

(40 CFR 364.50 - 364.56) would apply to the capping alternative. Maine Hazardous Waste Management Rules (MEDEP Regulations, Chapters 800-802, 850, 851, 853-857) supplement the RCRA general standards; therefore, would also apply. OSHA requirements promulgated under General Facility Standards (29 CFR 1910), Safety and Health Standards (29 CFR 1926), and Recordkeeping, Reporting, and Related Regulations (29 CFR 1904) would apply to all worker activities conducted during remediation. Attainment of these ARARs was discussed in Subsection 2.3.2.3.

Action-specific ARARs that would govern Alternative 1,3-C include RCRA Landfill requirements (40 CFR 264.300 - 264.339). The landfill cover system would be designed to meet RCRA standards under this regulation. The cap would provide long-term minimization of migration of rainwater through the closed landfill, promote drainage, reduce erosion, and accommodate settling. The cover system would be inspected concurrently with the proposed annual monitoring activities and repairs would be made, as necessary.

If during construction of the cover system contaminated material were encountered and required excavation, RCRA requirements for Waste Piles (40 CFR 264.250 - 264.269) would apply. Attainment of this ARAR would be achieved through engineered controls of erecting either a cover, or liner and berm system, to prevent erosion or migration of waste materials. The waste material would be disposed beneath the cap in compliance with Land Disposal Requirements or transported off-site to a hazardous waste facility.

Sludge generated during the pretreatment of groundwater would be analyzed using the Toxicity Characteristic Leachate Procedure (TCLP). If the sludge failed TCLP it would require treatment prior to disposal in a compliant RCRA Subtitle C landfill. Action-specific ARARs that would apply to the transport of the sludge or possible waste material include: Department of Transportation (DOT) Rules for Transportation of Hazardous Materials (49 CFR Part 107, 191.1-172.558). Under this requirement the sludge would be manifested and transported by a USEPA-licensed hazardous waste hauler.

If the treated water is to be discharged to Mere Brook or the storm sewers, federal and state water regulations pertaining to discharge requirements and water quality standards would apply. Treated groundwater would have to comply with the limits set under the Clean Water Act National Pollutant Discharge Elimination System (NPDES) permit program (40 CFR Parts 122 and 125), and Maine Regulations

relating to Water Quality Criteria (MEDEP Regulations, Chapter 584) and Antidegradation (38 MRSA Section 464(4)). NPDES requirements and the Maine Antidegradation statute set the requirements that discharge waters must meet. However, these requirements are stated as limits and restrictions for various pollutants that will be incorporated into the final discharge permits. The regulations do not provide promulgated standards outlining allowable concentrations of contaminants in discharge waters. NPDES discharge limits may be established from effluent guidelines, AWQC, best available treatment technology or best professional judgement. The limits of the Antidegradation policy and corresponding discharge licensing regulations allow the state to set site-specific discharge limits for new or increased discharges to surface water. The policy addresses drainage areas of water sources, discharges that cause waters to be unsuitable for the designated use of their class, pH, color, and temperature of the receiving waters (Verrill and Dana, 1990).

A definitive evaluation of whether these discharge options will attain the action-specific ARARs cannot be made at this time because the terms of the final discharge permit will be based on site-specific considerations and set by regulatory agencies in consideration of CWA, NPDES, and state requirements. Final discharge standards cannot be predicted since they are established through a process that evaluates broad requirements that will address the resources attributed and related to Mere Brook.

If treated water is to be discharged to the Brunswick POTW, pretreatment standards under the federal CWA would apply (40 CFR Part 403). CWA Section 307(b) authorized the National Pretreatment Program to regulate the introduction of pollutants from nondomestic sources into POTWs. The goal of the program is to prevent discharges into POTWs that would interfere with the operation, pass through, or be incompatible with the POTW. Because the water to be discharged to the POTW would be treated (both to remove metals and VOCs) it is unlikely this discharge would interfere with current operations at the POTW.

One alternative for discharge of treated groundwater would be injection to the subsurface. Underground discharge is regulated by both federal and state Underground Injection Control (UIC) Programs. The federal UIC regulations (40 CFR 144, 146, 147, 1000) set forth minimum standards and criteria for well injection. Treated groundwater would have to meet SDWA standards prior to underground injection. The federal rules also outline criteria for siting of injection wells, operation and maintenance, and reporting and recordkeeping. The Maine Rules to Control the Subsurface Discharge of Pollutants by Well Injection (MEDEP Regs,

Chapter 543) would require treated groundwater to meet drinking water standards prior to subsurface discharge.

If construction of the slurry wall requires excavation and movement of soil within 100 feet of Mere Brook, the MEDEP Natural Resource Protection Act (Chapter 305) would apply. This location-specific ARAR sets forth standards for activities conducted adjacent to a stream to ensure that disturbed soil is stabilized in order to prevent erosion of the stream bank and siltation of the water. If remedial construction activities cannot be conducted in accordance with these standards, a permit would be required.

Because hazardous contaminants would remain on-site following implementation of this remedial alternative, a site review would be performed every five years pursuant to SARA and outlined in the FFA. All site activities, including monitoring, would be carried out pursuant to OSHA standards (29 CFR 1904, 1910, and 1926).

3.3.3 Long-term Effectiveness and Permanence

Groundwater modeling results indicate that construction of a cap over wastes and a slurry wall located north, west and east of Sites 1 and 3 would likely lower the groundwater table an estimated 6 to 8 feet, within 1 to 2 years and 8 to 11 feet within 5 to 10 years. A review of test pit and boring data collected during the RI and the groundwater modeling conducted for the FS indicates that in all cases where trash was encountered in explorations, the proposed slurry wall would lower the groundwater to below the level of the deepest waste encountered. Appendices B and E contain the information used in this analysis. Clean water would be diverted around the refuse by the slurry wall and would discharge to Mere Brook. The cap is expected to reduce the production of leachate by reducing infiltration into the refuse to approximately 0.5 inches per year.

Containment of the waste is expected to reduce the total flux of contaminants leaching to the groundwater and discharging to Mere Brook. Surface water contamination is expected to decrease over time due to the expected overall reduction of contaminant mass in groundwater discharging to the brook. As discussed, the time required to remediate the groundwater flow system beneath the landfill is estimated to range from 142 to 370 days. These time estimates are discussed in more detail in Appendix D.

Environmental monitoring, site inspections, and five-year reviews would assess the long-term performance of the system at reducing groundwater table elevations and eventually reducing the concentrations of contaminants in groundwater discharging to Mere Brook. It is assumed, for cost-estimating purposes, that the present monitoring well network would be sufficient to monitor the long term performance of this alternative. The final monitoring plan would be developed during Remedial Design and may include additional well locations and/or piezometers. Maintenance of the cap (i.e., maintenance of the vegetation to minimize erosion, and patching if necessary) would be required to ensure its efficiency at reducing infiltration.

Water levels measured during the groundwater monitoring program would provide information on the effectiveness of the slurry wall. Additional remedial actions may be required if the monitoring program indicates that the slurry wall is not performing to specifications. Monitoring of the cap and slurry wall would therefore be required indefinitely. Engineering controls would also be used to minimize fugitive dust and particulate monitoring will be performed during all invasive remedial activities. This monitoring will ensure that workers and/or the community are not at risk from potential contaminant exposure.

The slurry wall is proposed to be placed outside the limits of the waste. However, in certain areas (e.g., near the weapons compound) this may not be possible. Geotechnical borings would be collected prior to the final design of the slurry wall to determine if waste material would be encountered. If encountered, proper real-time monitoring would be required during the construction of the slurry wall to ensure worker and community safety.

This alternative would meet the remedial action objectives because the slurry wall would contain the waste and the extraction wells would collect contaminated groundwater and leachate before it migrates from the landfill and discharges to Mere Brook. Collected water would then be pretreated to remove metals and treated to remove VOCs. The water would be treated to meet the discharge requirements for all constituents. Treatability testing would determine the most effective of the three process options for VOC treatment (i.e., air stripping, UV/O_3, or UV/H_2O_2). It would also determine the proper pretreatment and operating procedures for the chosen process option. Air-stripping is a well-developed and reliable technology for removing VOCs from water and UV/oxidation has been shown to destroy VOCs. All treatment options may require pretreatment which would produce a sludge requiring disposal. The nature and volume of the sludge would be determined at the

time of treatability testing for proper disposal. Sampling of the chosen treatment system's influent and effluent would be performed to ensure adequate system performance. Environmental monitoring and five-year reviews would assess the effectiveness of the collection system in capturing contaminated water.

3.3.4 Reduction of Toxicity, Mobility, or Volume

This alternative includes a groundwater treatment component which reduces the toxicity, mobility, and volume of contaminants. By isolating the source using a low-permeability cap and slurry wall, and pumping and treating the remaining water from the waste, this alternative would reduce the volume of contaminated water migrating from the source area. The proposed groundwater treatment technologies (e.g., ultraviolet/oxidation) provide permanent reduction in the toxicity of the contaminants detected beneath Sites 1 and 3. However, air stripping treatment technology may not be effective at reducing vinyl chloride or methylene chloride concentrations. These compounds are not readily absorbed to VPC and therefore would be released to the environment.

Metals pretreatment would produce a higher volume wastestream because additional chemicals would be introduced to enhance oxidation and flocculation. The mobility of the metals would be slightly reduced, because metals in the precipitated form (i.e., $Fe(OH)_3$, MnO_2, and other metal oxides or hydroxides) are less soluble. The proposed pretreatment process would produce a sludge containing iron and manganese. A treatability test would be conducted prior to final design and determine the need for the removal of additional metals (i.e., arsenic, and lead). The toxicity of the metal sludge would also be evaluated using the TCLP as part of the treatability test.

Treatability tests would be required to evaluate the effectiveness of the organics treatment systems in reducing contaminant toxicity; however, it is expected that the UV/oxidation treatment processes would reduce the toxicity of contaminants by destroying the VOCs through chemical oxidation. If air stripping were employed, the contaminants would be transferred from the liquid to the vapor phase. Off-gas treatment using VPC may be required to reduce concentrations of VOCs in the air stream. However, two contaminants, vinyl chloride and methylene chloride, are not effectively adsorbed to carbon and therefore may not be captured by the VPC.

The toxicity and volume of the source material would not be reduced under this alternative. The mobility of the contamination would, however, be reduced by lowering of the groundwater table to below the majority of waste.

3.3.5 Short-term Effectiveness

Remedial construction activities are not likely to adversely affect the public or base personnel. Initial grading of the cap area and excavation of the slurry wall trench are not expected to encounter or expose waste; however, drilling extraction wells may produce hazardous cuttings. A Health and Safety Plan (HASP) would be developed to describe proper procedures if waste material is exposed. The greatest potential threat to the public from construction-related activities would be due to fugitive dust created during site preparation. Ambient air monitoring for respirable dust would be conducted during remedial construction. Provisions for dust suppression, if levels exceed 150 $\mu g/m^3$, would be developed and included in the HASP. Engineered controls for dust suppression are readily available and could be easily implemented if necessary.

An increase in truck traffic on and near NAS Brunswick would be expected due to the hauling of materials for cap construction (e.g., clay, fill, and PVC). Trucks would be covered to minimize the possibility of lost material onto roadways and generation of dust.

Workers would have to be trained in health and safety practices for work at a hazardous waste site. An appropriate HASP would be followed to minimize risks to workers during remedial construction. Although most of the work should not require levels of protection greater than Level D, the HASP would outline situations when an upgrade of personal protective equipment would be necessary. Preconstruction sampling would identify waste that may potentially be encountered. Hazards associated with heavy equipment use can be minimized by maintaining safe working conditions. An open trench method for construction of the slurry wall would pose a safety hazard to workers and site trespassers. These risks would be minimized by fencing around the open excavation and proper site security.

Significant impacts to the environment are not expected. Some trees would need to be removed to implement this alternative, but wildlife habitat near the site would not be affected. The slurry wall and treatment facility would be located to minimize impacts to Mere Brook and the associated wetlands in this area. Upgradient

recharge or discharge to the POTW is not expected to have any adverse effects on the environment. Discharge to Mere Brook or the sewer system would be designed to mitigate physical or chemical impacts on aquatic receptors.

Estimated time for construction activities is four months. This includes mobilization, construction of the groundwater extraction and treatment system, slurry wall and cap, and demobilization. The time required to achieve groundwater remedial action objectives is estimated to be between 142 and 370 days.

3.3.6 Implementability

Capping, slurry walls, groundwater extraction wells, and water treatment are well-developed technologies for landfill containment and groundwater remediation, and have been used at a number of Superfund sites. Construction techniques used for these technologies are not expected to be difficult to implement. Underground utilities may require rerouting before excavation or drilling of the trench for the slurry wall and construction of the cap. Placement and compaction of the clay cap must be carried out in lifts to ensure that the proper moisture/density relationship and, consequently, low permeability, is achieved. Solvent seaming of the PVC liner during placement involves time-consuming vacuum testing and quality control procedures to ensure the effectiveness of the seams. Mixing ponds, approximately 100 square feet in area, would be required at various points along the slurry wall trench to mix the soil and bentonite. Extra clearing and grubbing may be required for these mixing areas. Compatibility testing of the water and bentonite slurry should be performed prior to construction, to ensure that contaminated water would not degrade the slurry.

Environmental monitoring would provide necessary data to assess the performance of the slurry wall and cap system over an extended period. A more detailed evaluation of the implementability of environmental monitoring was presented in Subsection 3.2.6. The following monitoring parameters would provide data to adequately characterize the performance of the containment system: groundwater elevations; contaminant concentrations in groundwater, surface water, leachate seeps, and sediment; and the existence and location of leachate seeps. Additional remedial actions may be necessary if the system does not lower the water table enough to eliminate leachate seeps discharging to Mere Brook. Should source removal be necessary, the entire cap would require removal prior to source removal operations.

Identification of a suitable clay source and permitting for removal of clay at the clay borrow site can be costly and time consuming. Often, these borrow sites are situated in wetlands areas and removal of the clay is considered strip mining. Potential clay sources will be identified during the design and construction phases of this program. Coordination would be required among officials at NAS Brunswick and construction contractors and environmental monitoring personnel to ensure that access to the secured area can be obtained for both long- and short-term activities associated with this alternative. For security reasons, construction activities would not take place within the Weapons Compound. Although waste may extend to the northwestern corner of the Weapons Compound, remedial construction would not be implemented in this area, as discussed. Some long-term activities, such as groundskeeping, could be carried out by NAS Brunswick personnel.

The unit operations and processes involved in the pretreatment of groundwater for iron and manganese removal, oxidation, precipitation, clarification, and filtration, are all well developed and reliable, and are commonly used in industrial and municipal wastewater treatment applications. Treatability studies would determine proper chemicals and their dosages, retention times, pumping and piping design, and other parameters to optimize the system. The sludge generated from pretreatment would probably require disposal at a RCRA-permitted facility. The availability and capacity of waste disposal facilities would have to be investigated before implementing this alternative.

Air stripping and VPC are widely used and reliable techniques for removing VOCs from contaminated water. However, because vinyl chloride and methylene chloride concentrations may exceed Maine ambient air guidelines, this treatment technology may not be feasible. Ultrox International is currently participating in the USEPA's Superfund Innovative Technology Evaluation (SITE) program with their UV/oxidation technology. This technology was field-demonstrated at the Lorentz Barrel and Drum Site in San Jose, California, where it was shown to effectively destroy VOCs through chemical oxidation. Solarchem currently has 15 full-scale UV/oxidation units operating throughout the United States and Canada treating industrial wastewater and contaminated groundwater. Vendors are available to perform bench- and pilot-scale treatability tests to determine the optimal UV light intensity, O_3 or H_2O_2 supply, and residence times to meet effluent standards, as well as the effectiveness of the system in reducing the concentration of contaminants of concern in the water.

Off-gas treatment of emissions from an air stripper would be limited to VPC. Off-gas incineration could not be used because of the proximity of this site to the Weapons Compound Area. Because vinyl chloride and methylene chloride are not effectively removed by VPC, these compounds may be present in air emissions at concentrations exceeding Maine ambient air guidelines. Therefore, the air stripping technology may be difficult to implement at this site.

For surface water, storm sewer, or POTW discharge, treating the water to drinking water standards may not be adequate. Water quality criteria and permit requirements may be more stringent, especially with regard to certain compounds that have not been identified as contaminants of concern. Permit and discharge limitations are developed on a site-specific basis and address specific attributes of the receiving waters or facility. Whether these requirements are more stringent than drinking water standards cannot be evaluated at this time. These compounds may not be hazardous to human health, but may pose a risk to aquatic life. If any of these discharge options is chosen, design of the treatment system may need to be modified to meet the discharge limits. Treatability tests would indicate the levels and concentrations of contaminants in the treated effluent that could be achieved by the treatment technologies considered in this FFS. This information would be evaluated during the discharge and permitting process to determine if the remedy can attain discharge requirements.

Upgradient recharge and discharge to the POTW are technically feasible. If infiltration tests indicate that vertical conductivities are low in the proposed infiltration area north of the landfill, reinjection wells would be installed to discharge treated water if upgradient recharge is chosen.

Contractors to perform the construction services required for this alternative are available and several would be contacted for competitive bidding on the request for proposal. Contractors would have to demonstrate qualifications for work at hazardous waste sites prior to competitive bidding.

3.3.7 Cost

The cost estimate for Alternative 1,3-C is summarized in Tables 3-5, 3-6, and 3-7. Supporting information is in Appendix A. An estimate of the costs of all the various water treatment options is included in these tables. For preliminary design and costing purposes it was assumed the water would be pumped at a rate of 78 gpm,

TABLE 3-5
ALTERNATIVE 1,3-C: CONTAINMENT/
GROUNDWATER EXTRACTION/AIR STRIPPING
COST SUMMARY

FOCUSED FEASIBILITY STUDY
NAS BRUNSWICK

	COST	PRESENT WORTH (1)
CAPITAL COSTS		
Cap		
Clay Borrow Study	$17,000	
Survey	$9,000	
Site Preparation	$43,000	
Materials	$1,105,000	
Construction QC Testing	$19,000	
Replacement of Road and Parking Lot	$40,000	
Site Manager	$40,000	
Slurry Wall (2)		
Compatibility Study	$4,000	
Mobilization	$30,000	
Installation	$828,000	
Post-construction Testing	$4,000	
Site Manager	$30,000	
Groundwater Extraction Wells		
Pumping Tests	$23,000	
Mobilization	$10,000	
Decontamination	$2,000	
Piezometers	$4,000	
Well Materials and Installation*	$11,000	
Disposal of Excavated Material*	$300,000	
Groundwater Collection		
Pumps	$5,000	
Piping	$40,000	
Water Treatment		
Treatability Tests*	$52,000	
Building	$165,000	
Utilities	$51,000	
Pretreatment*	$394,000	
Air Stripping*	$44,000	
Discharge		
Pumps	$4,000	
Piping	$16,000	
Reinjection	$161,000	
Institutional Controls		
Warning Signs	$2,000	
Total Capital Costs:	$3,453,000	$3,453,000
INDIRECT COSTS		
Health and Safety		
(@ 25% of Construction and Treatment Costs)(3)	$200,000	
Legal, Administrative, and Permitting		
(@ 5% of Capital Cost)	$173,000	
Engineering (@ 10% of Capital Cost)	$345,000	
Services During Construction		
(@ 5% of Capital Cost)	$173,000	
Total Indirect Costs:	$891,000	$891,000

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TABLE 3-5
ALTERNATIVE 1,3-C: CONTAINMENT/
GROUNDWATER EXTRACTION/AIR STRIPPING
COST SUMMARY

FOCUSED FEASIBILITY STUDY
NAS BRUNSWICK

	COST	PRESENT WORTH (1)
ANNUAL OPERATING COSTS		
Labor	$117,000	$117,000
Pretreatment Chemicals	$84,000	$84,000
Electricity	$35,000	$35,000
Sludge Disposal	$247,000	$247,000
Maintenance	$40,000	$40,000
Environmental Monitoring		
First 2 Years (4 Episodes Per Year)	$212,000	$380,000
Remaining 28 Years (1 Episode Per Year)	$53,000	$408,000
Effluent Monitoring	$7,000	$7,000
Air Monitoring	$12,000	$12,000
Total Operating Costs:		$1,330,000
Five-Year Review (6 Reviews Planned)	$63,000	$157,000
SUBTOTAL		$5,831,000
Contingency (@ 20%)		$1,166,000
TOTAL COST		$6,997,000

NOTES:
(1) Discount rate of 10% is used over 30 years for environmental monitoring costs.
(2) Mobilization and installation costs quoted by S.M.W. Seiko.
(3) Activities requiring Health and Safety training or equipment are marked with an asterisk.
(4) Costs are rounded to the nearest $1,000.

TABLE 3-6
ALTERNATIVE 1,3-C: CONTAINMENT/
GROUNDWATER EXTRACTION/UV/H2O2
COST SUMMARY

FOCUSED FEASIBILITY STUDY
NAS BRUNSWICK

	COST	PRESENT WORTH (1)
CAPITAL COSTS		
Cap		
Clay Borrow Study	$17,000	
Survey	$9,000	
Site Preparation	$43,000	
Materials	$1,105,000	
Construction QC Testing	$19,000	
Replacement of Road and Parking Lot	$40,000	
Site Manager	$40,000	
Slurry Wall (2)		
Compatibility Study	$4,000	
Mobilization	$30,000	
Installation	$828,000	
Post-construction Testing	$4,000	
Site Manager	$30,000	
Groundwater Extraction Wells		
Pumping Tests	$23,000	
Mobilization	$10,000	
Decontamination	$2,000	
Piezometers	$4,000	
Well Materials and Installation*	$11,000	
Disposal of Excavated Material*	$300,000	
Groundwater Collection		
Pumps	$5,000	
Piping	$40,000	
Water Treatment		
Treatability Tests*	$52,000	
Building	$230,000	
Utilities	$51,000	
Pretreatment*	$394,000	
UV/H2O2*	$360,000	
Discharge		
Pumps	$4,000	
Piping	$16,000	
Reinjection	$161,000	
Institutional Controls		
Warning Signs	$2,000	
Total Capital Costs:	$3,834,000	$3,834,000
INDIRECT COSTS		
Health and Safety		
(@ 25% of Construction and Treatment Costs)(3)	$279,000	
Legal, Administrative, and Permitting		
(@ 5% of Capital Cost)	$192,000	
Engineering (@ 10% of Capital Cost)	$383,000	
Services During Construction		
(@ 5% of Capital Cost)	$192,000	
Total Indirect Costs:	$1,046,000	$1,046,000

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TABLE 3-6
ALTERNATIVE 1,3-C: CONTAINMENT/
GROUNDWATER EXTRACTION/UV/H2O2
COST SUMMARY

FOCUSED FEASIBILITY STUDY
NAS BRUNSWICK

	COST	PRESENT WORTH (1)
ANNUAL OPERATING COSTS		
Labor	$117,000	$117,000
Pretreatment Chemicals	$84,000	$84,000
Peroxide	$6,000	$6,000
Electricity	$100,000	$100,000
Sludge Disposal	$247,000	$247,000
Maintenance	$59,000	$59,000
Environmental Monitoring		
First 2 Years (4 Episodes Per Year)	$212,000	$380,000
Remaining 28 Years (1 Episode Per Year)	$53,000	$408,000
Effluent Monitoring	$7,000	$7,000
Total Operating Costs:		$1,408,000
Five-Year Review (6 Reviews Planned)	$63,000	$157,000
SUBTOTAL		$6,445,000
Contingency (@ 20%)		$1,289,000
TOTAL COST		$7,734,000

NOTES:
(1) Discount rate of 10% is used over 30 years for environmental monitoring costs.
(2) Mobilization and installation costs quoted by S.M.W. Seiko.
(3) Activities requiring Health and Safety training or equipment are marked with an asterisk.
(4) Costs are rounded to the nearest $1,000.

TABLE 3-7
ALTERNATIVE 1,3-C: CONTAINMENT/
GROUNDWATER EXTRACTION/UV/O3
COST SUMMARY

FOCUSED FEASIBILITY STUDY
NAS BRUNSWICK

	COST	PRESENT WORTH (1)
CAPITAL COSTS		
Cap		
Clay Borrow Study	$17,000	
Survey	$9,000	
Site Preparation	$43,000	
Materials	$1,105,000	
Construction QC Testing	$19,000	
Replacement of Road and Parking Lot	$40,000	
Site Manager	$40,000	
Slurry Wall (2)		
Compatibility Study	$4,000	
Mobilization	$30,000	
Installation	$828,000	
Post-construction Testing	$4,000	
Site Manager	$30,000	
Groundwater Extraction Wells		
Pumping Tests	$23,000	
Mobilization	$10,000	
Decontamination	$2,000	
Piezometers	$4,000	
Well Materials and Installation*	$11,000	
Disposal of Excavated Material*	$300,000	
Groundwater Collection		
Pumps	$5,000	
Piping	$40,000	
Water Treatment		
Treatability Tests*	$52,000	
Building	$200,000	
Utilities	$51,000	
Pretreatment*	$394,000	
UV/O3*	$430,000	
Discharge		
Pumps	$4,000	
Piping	$16,000	
Reinjection	$161,000	
Institutional Controls		
Warning Signs	$2,000	
Total Capital Costs:	$3,874,000	$3,874,000
INDIRECT COSTS		
Health and Safety		
(@ 25% of Construction and Treatment Costs)(3)	$297,000	
Legal, Administrative, and Permitting		
(@ 5% of Capital Cost)	$194,000	
Engineering (@ 10% of Capital Cost)	$387,000	
Services During Construction		
(@ 5% of Capital Cost)	$194,000	
Total Indirect Costs:	$1,072,000	$1,072,000

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TABLE 3-7
ALTERNATIVE 1,3-C: CONTAINMENT/
GROUNDWATER EXTRACTION/UV/O3
COST SUMMARY

FOCUSED FEASIBILITY STUDY
NAS BRUNSWICK

	COST	PRESENT WORTH (1)
ANNUAL OPERATING COSTS		
Labor	$117,000	$117,000
Pretreatment Chemicals	$84,000	$84,000
Electricity	$128,000	$128,000
Sludge Disposal	$247,000	$247,000
Maintenance	$61,000	$61,000
Environmental Monitoring		
First 2 Years (4 Episodes Per Year)	$212,000	$380,000
Remaining 28 Years (1 Episode Per Year)	$53,000	$408,000
Effluent Monitoring	$7,000	$7,000
Total Operating Costs:		$1,432,000
Five-Year Review (6 Reviews Planned)	$63,000	$157,000
SUBTOTAL		$6,535,000
Contingency (@ 20%)		$1,307,000
TOTAL COST		$7,842,000

NOTES:
(1) Discount rate of 10% is used over 30 years for annual costs.
(2) Mobilization and installation costs quoted by S.M.W. Sciko.
(3) Activities requiring Health and Safety training or equipment are marked with an asterisk.
(4) Costs are rounded to the nearest $1,000.

treated to drinking water standards and the effluent discharged upgradient through reinjection. The actual cost of this alternative is, therefore, dependent upon these assumptions.

The capital cost of this alternative includes the cost of clearing, grading, and surveying the site, locating a clay source, constructing the cap and slurry wall, installing the groundwater extraction wells, constructing the water treatment facility, and installing warning signs. The water treatment component includes costs for bench-scale treatability testing, treatment equipment, building construction and utilities hookup for the building. The discharge component includes pumps, piping, and installing reinjection wells. The total capital cost for this alternative is estimated to be $3,453,000, $3,834,000, and $3,874,000 for air stripping, UV/H_2O_2, and UV/O_3, respectively. Other indirect costs associated with implementing these construction activities have been estimated at $891,000, $1,046,000, and $1,072,000 for the three treatment options.

The cap and slurry wall are not expected to require long-term maintenance activities more than annual site inspections and periodic mowing and reseeding of the cap as necessary. Operating costs for the water treatment process have been estimated for one year. In each case, water treatment includes pretreatment for inorganics as well as the particular VOC treatment option. Operating costs include labor, pretreatment chemicals and disposal of metal sludge, electricity (for operating pumps and lighting in the building), and equipment maintenance (assumed to be 5 percent of the capital costs). For the UV/H_2O_2 option, an additional $6,000 per year would be spent on H_2O_2. Electrical costs are higher for the UV/oxidation options than for air stripping. High power requirements for the UV/O_3 option are due to on-site production of O_3. Annual environmental monitoring costs are described in Subsection 3.2.7 for Alternative 1,3-B. The present-worth cost of environmental monitoring is estimated at $788,000, which accounts for four sampling episodes per year for the first two years and annual sampling thereafter. Effluent monitoring and air monitoring (for the air stripper only) have been estimated for water treatment, but actual costs may differ depending on discharge and emission requirements. Monitoring is assumed to continue for 30 years for cost estimating purposes; however, this time frame will be continually reevaluated during the five-year site reviews. An estimate of the cost of this review is provided, and is expected to be approximately $63,000 every five years.

A contingency of 20 percent of the present-worth cost of the alternative is added to account for unforeseen circumstances that may increase the estimated cost.

The total present-worth cost of the Containment Alternative is $6,997,000 for air stripping, $7,734,000 for UV/H_2O_2, and $7,842,000 for UV/O_3. These costs are estimates and are believed to be within the +50 percent to -30 percent range for FS cost estimates (USEPA, 1988). These costs are sensitive to the proximity of a suitable clay source. Transportation costs can substantially influence the cost of the clay. Also, because the cost estimate is based on a quote from only one slurry wall vendor, the actual cost of slurry wall construction may vary from that in Tables 3-5 through 3-7.

If it is determined that vapor phase treatment is needed for air emissions, air stripping may be infeasible, because it would add $7.3 million per year in carbon costs alone (based on an estimate of 8,000 lb/day carbon usage and $2.50/lb to regenerate the carbon) and may not achieve the Maine ambient air guidelines for vinyl chloride and methylene chloride. Additional costs for meeting stricter effluent discharge requirements may be incurred depending on the discharge method chosen. The frequency of sampling and type of analysis would be dictated by effluent discharge requirements.

Discharge costs are also sensitive to the method used. Upgradient reinjection using wells was estimated to cost $181,000. If rapid infiltration were used, costs could range from $3,000 to $52,000, depending on the size of the basin needed to accept the 78 gpm flow rate. The size, in turn, would be based on vertical hydraulic conductivities measured during predesign infiltration testing. The cost of the other discharge options (i.e., surface water, sanitary sewer, or storm sewer) cannot be estimated at this time because discharge permit requirements have not yet been determined. The Brunswick Sewer District currently charges $3.00 per 100 cubic feet (748 gallons) of water for use of the sanitary sewer system.

The choice of the water treatment technology to be designed and implemented should not be based only on cost considerations, but on the technology's performance as indicated by treatability test results. The cost of the treatability tests given in Tables 3-5, 3-6, and 3-7 includes bench-scale testing of pretreatment methods, air stripping, UV/H_2O_2, and UV/O_3.

If this alternative is chosen for the remediation of Sites 1 and 3, it is possible that the groundwater extracted from the landfills could be combined and treated with water at another location on base (i.e., the Eastern Plume). This scenario is considered feasible because of the low flow rate (e.g., 30 gpm) and short duration (e.g.,

370 days) that could be used to effectively pump the contained volume of water. If the water were to be treated to remove VOCs with water from the Eastern Plume, the inorganic compounds (principally iron and manganese) would most likely need to be removed. A treatability test would determine the need for pretreatment and levels of inorganic compounds that would not interfere with the remedial actions at the Eastern Plume (E.C. Jordan Co., 1991). In this scenario, groundwater would be pretreated on site and piped to an existing treatment plant for VOC removal.

As a sensitivity analysis, the cost of pretreating the water on-site and piping to an existing facility was estimated. This cost does not include VOC treatment or discharge of water, because these activities may occur at another site on base. The pretreatment requirements for this alternative are the same as described earlier in this subsection. The cost backup for this sensitivity analysis is provided in Appendix A. The total present worth cost of this alternative, including an on-site water pretreatment facility and piping costs, is estimated to be approximately $5,672,000.

3.4 ALTERNATIVE 1,3-D: PASSIVE GROUNDWATER COLLECTION/TREATMENT

Alternative 1,3-D is a Passive Groundwater Collection and Treatment option, consisting of the following components:

- passive groundwater collection
- water treatment
- discharge of treated water
- institutional controls and deed restrictions
- environmental monitoring

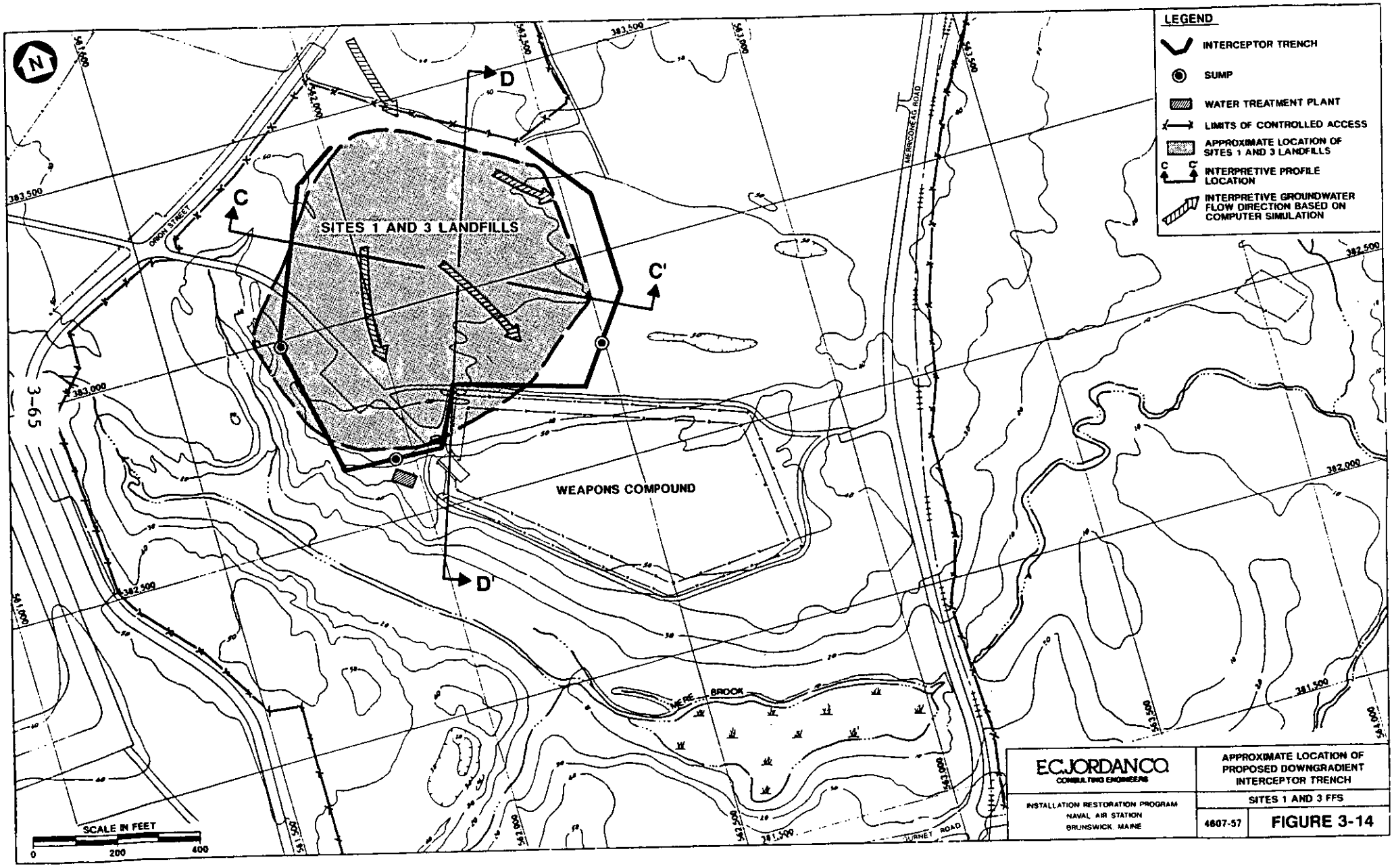
This alternative would collect and treat groundwater until Target Clean-up Levels are achieved. Collecting and treating the groundwater before it discharges to Mere Brook would reduce the amount of leachate entering the stream, and, over time, reduce the impact of contaminated groundwater on the stream environment. Because this alternative does not include containment or removal of the source, groundwater would have to be collected and treated until natural flushing remediates the source of contamination.

Groundwater would be removed using a passive collection system installed downgradient of the site. The water would be collected and transported by gravity flow through a perforated pipe or high-permeability medium, discharging to sumps. The water would then be pumped from the sumps and piped to a treatment plant located south of the landfill and west of the Weapons Compound (Figure 3-14).

Another option is to actively collect groundwater using a system of pumping wells. Although a Groundwater Extraction and Treatment Alternative was not developed in the Phase I FS for Sites 1 and 3 (E.C. Jordan Co., 1990b), active collection is analyzed within this subsection as a variation of the Passive Groundwater Collection and Treatment Alternative. A complete description of the extraction well system and pumping scheme is presented in Subsection 3.5 for Alternative 1,3-E, Cap, Groundwater Extraction, and Treatment.

As discussed in Subsection 3.3, air stripping and UV/oxidation (using either H_2O_2 or O_3 as an oxidant) were groundwater treatment options considered to reduce VOC contamination. These systems would be designed to remove VOCs and would be preceded by pretreatment for the removal of inorganic compounds, such as iron, which could interfere with the VOC treatment process. Discharge of treated water is assumed to be upgradient recharge; however, other options were described and evaluated in Subsection 3.3. An environmental monitoring program like that recommended for Alternative 1,3-B would be instituted as part of this alternative, and deed restrictions would apply if the base were decommissioned. Each component is described in the following paragraphs.

Passive Groundwater Collection. The trench described in the Phase I FS was to be constructed along the streambank where leachate discharges (a distance of approximately 500 feet) (E.C. Jordan Co., 1990b). Computer simulations were run and used to locate the area that would best capture the contaminated groundwater and not interfere with the water balance between the aquifer and Mere Brook. From these models, it was determined that the best capture of groundwater from the landfill site would be achieved by siting the trench as shown in Figure 3-14 (see also Appendix B). The trench was located to encompass the contaminated groundwater plume identified at the site. This configuration would intercept groundwater flowing to the west, south, and east of the landfill. To limit the migration of contaminants from the source, the trench would be located closer to the source than originally planned. This location would not create a significant backflow of water from the stream to the trench, thereby minimizing any impacts to Mere Brook. The total


LEGEND
INTERCEPTOR TRENCH
SUMP
WATER TREATMENT PLANT
LIMITS OF CONTROLLED ACCESS
APPROXIMATE LOCATION OF SITES 1 AND 3 LANDFILLS
C C'
INTERPRETIVE PROFILE LOCATION
INTERPRETIVE GROUNDWATER FLOW DIRECTION BASED ON COMPUTER SIMULATION
SITES 1 AND 3 LANDFILLS
WEAPONS COMPOUND
D
D'
C
C'
ORION STREET
MERRIDONEAG ROAD
MERE BROOK
HURNET ROAD
383,500
383,000
382,500
382,000
381,500
541,000
541,500
542,000
542,500
543,000
543,500
544,000
SCALE IN FEET
0
200
400
ECJORDANCO
CONSULTING ENGINEERS
INSTALLATION RESTORATION PROGRAM
NAVAL AIR STATION
BRUNSWICK, MAINE
APPROXIMATE LOCATION OF PROPOSED DOWNGRADIENT INTERCEPTOR TRENCH
SITES 1 AND 3 FFS
4607-57
FIGURE 3-14

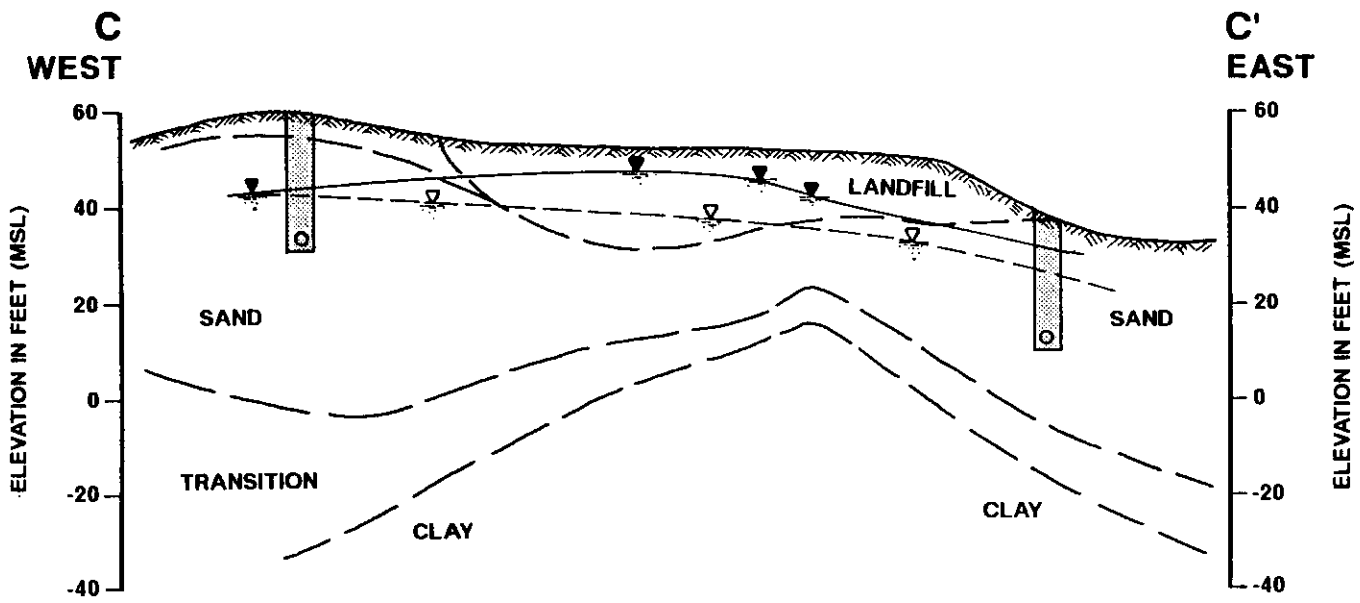
length of the trench is estimated to be about 2,300 feet, and the depth of the trench was assumed to be 35 feet bgs in the computer model. The depth of the trench was estimated based on data collected from monitoring wells sampled during the RI (E.C. Jordan Co., 1990a). The data shows that the plume is located in the shallow groundwater, at a depth of up to 25 to 30 feet bgs. The actual location of the trench would be based on modeling and confirmed using geotechnical borings and other field information collected during the predesign phase of this process. Figures 3-15 and 3-16 show cross-sections transecting Sites 1 and 3 as shown in Figure 3-14.

Although the trench may collect some water from its downgradient side, these flows are not expected to significantly affect the transfer of water between the aquifer and the brook or have any adverse effect on stream flows. If, after implementing the alternative, too much water flows from the stream to the trench, a vertical barrier may need to be constructed between the trench and the stream.

The sequence for construction of the interceptor trench would require that sumps be constructed before the trench is excavated to dewater the immediate area to prevent flooding of the excavation. The water, which may be contaminated, would be pumped to the treatment plant prior to discharge. Sumps can be constructed of PVC, polyethylene, or concrete. The perforated sump barrel would be wrapped in a geofabric to collect groundwater in addition to the interceptor trench (Figure 3-17). The sump could be installed to a depth of approximately 30 feet using standard well drilling methods. Temporary casing could be set as the borehole is advanced, and a brine mixture with a polymeric drilling additive could be pumped into the borehole to prevent caving (Gilbert and Gress, 1987). Alternatively, the hole could be excavated using a backhoe. The sump would be lowered into the hole and grouted into place. The hole would be backfilled with washed sand and gravel, and the casing removed (if the hole were drilled). A submersible pump and controls would then be installed.

Several methods for trench excavation, water collection, and backfilling are available. Trenching, water collection, and backfilling methods used by two different contractors were investigated for comparison in the detailed evaluation: Industrial Builders, Inc., of Fargo, North Dakota, and Geo-Con, Inc., of Pittsburgh, Pennsylvania. These methods are described in the following paragraphs.

Industrial Builders has equipment that can excavate, lay pipe, and backfill a trench in one pass. The excavator can dig to a depth of 24 feet bgs; however, it can reach



LEGEND

- WATER LEVEL DATA FROM OCT. 1989
- SIMULATED GROUNDWATER TABLE
- INTERCEPTOR TRENCH PLACED AS DEEP AS 25 FEET BELOW GROUND SURFACE
- INTERCEPTER TRENCH BACKFILL

GEOLOGIC DESCRIPTIONS:

SAND - TAN TO LIGHT BROWN FINE SAND, TRACE TO LITTLE MEDIUM SAND, TRACE SILT, POORLY GRADED, LOOSE TO MEDIUM DENSE, DRY TO SATURATED, SLIGHTLY STRATIFIED WITH DEPTH.

TRANSITION - BROWN TO GRAY FINE SAND AND SILTY, FINE SAND, TRACE CLAY, STRATIFIED WITH SILT AND CLAY LENSES, POORLY GRADED, NON TO SLIGHTLY PLASTIC, SOFT IN PLACES, SATURATED.

CLAY: - GRAY, SILTY CLAY TO CLAYEY SILT (ROCK FLOUR), MEDIUM TO HIGH PLASTICITY, VERY SOFT, SATURATED.

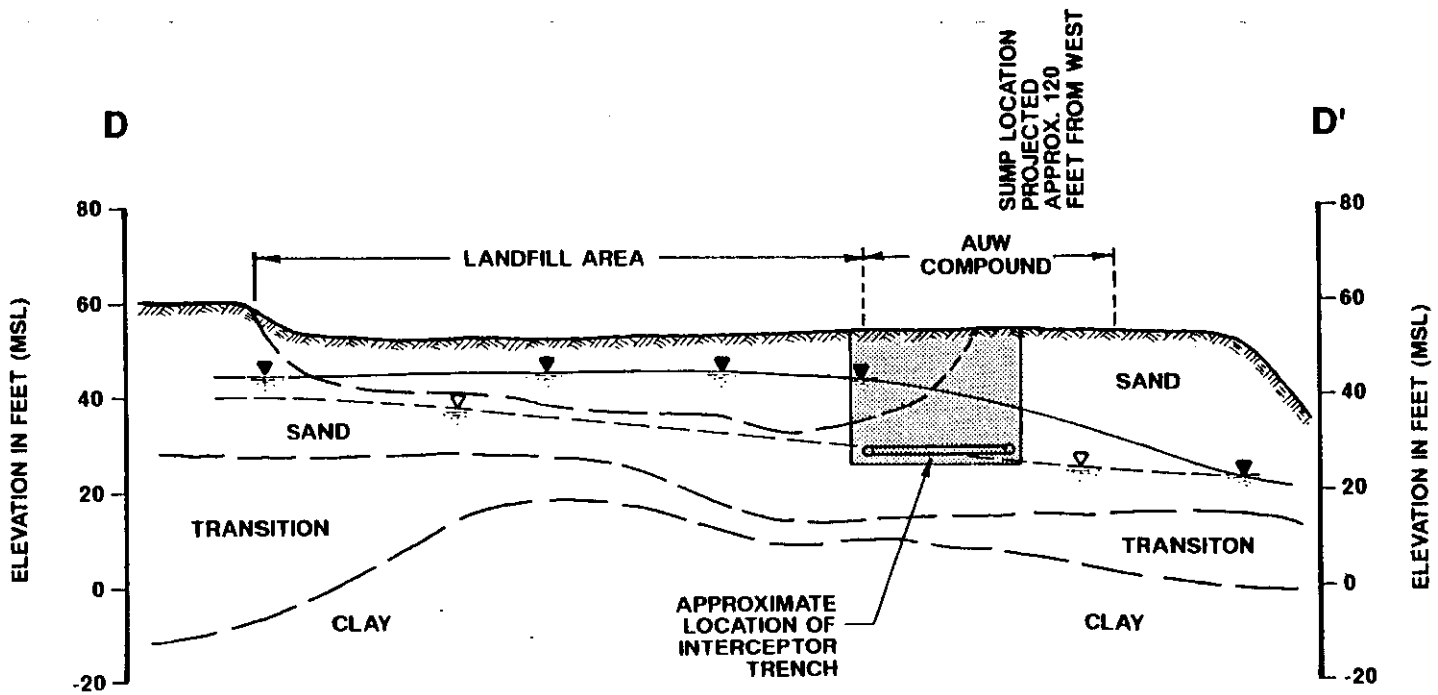
SCALE IN FEET

0 200 400

VERTICAL EXAGGERATION 5:1

E.C. JORDAN CO. CONSULTING ENGINEERS	GEOLOGIC CROSS SECTION C-C' FOR PROPOSED INTERCEPTER TRENCH
INSTALLATION RESTORATION PROGRAM NAVAL AIR STATION BRUNSWICK, MAINE	SITES 1 AND 3 FFS
	4607-57 FIGURE 3-15

9107023T



LEGEND

- WATER LEVEL DATA FROM OCT. 1989
- SIMULATED GROUNDWATER TABLE
- INTERCEPTER TRENCH BACKFILL

GEOLOGIC DESCRIPTIONS:

SAND - TAN TO LIGHT BROWN FINE SAND, TRACE TO LITTLE MEDIUM SAND, TRACE SILT, POORLY GRADED, LOOSE TO MEDIUM DENSE, DRY TO SATURATED, SLIGHTLY STRATIFIED WITH DEPTH.

TRANSITION - BROWN TO GRAY FINE SAND AND SILTY, FINE SAND, TRACE CLAY, STRATIFIED WITH SILT AND CLAY LENSES, POORLY GRADED, NON TO SLIGHTLY PLASTIC, SOFT IN PLACES, SATURATED.

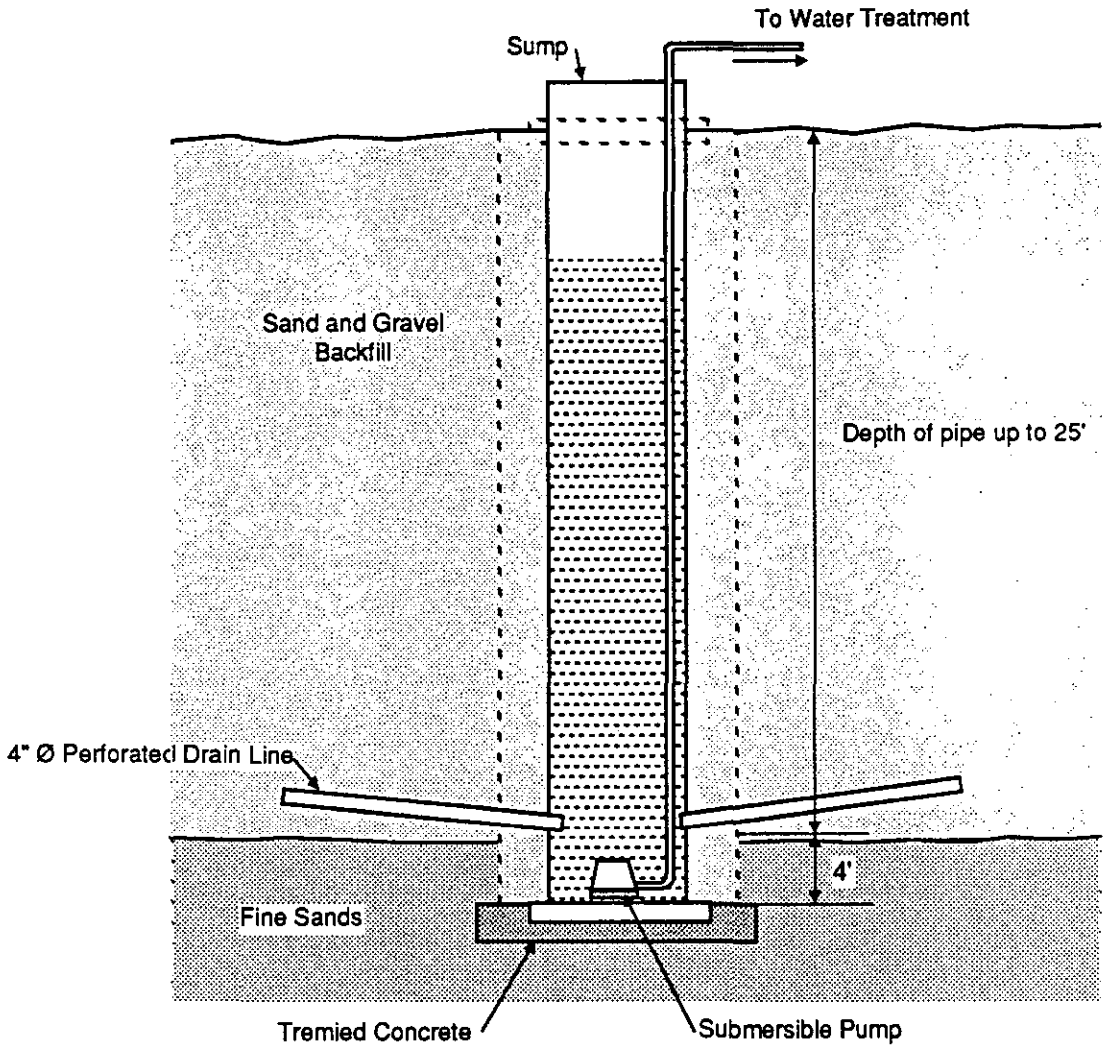
CLAY: - GRAY, SILTY CLAY TO CLAYEY SILT (ROCK FLOUR), MEDIUM TO HIGH PLASTICITY, VERY SOFT, SATURATED.

SCALE IN FEET

0 200 400

VERTICAL EXAGGERATION 5:1

E.C.JORDAN CO. CONSULTING ENGINEERS	GEOLOGIC CROSS SECTION D-D' FOR PROPOSED INTERCEPTER TRENCH
INSTALLATION RESTORATION PROGRAM NAVAL AIR STATION BRUNSWICK, MAINE	SITES 1 AND 3 FFS
	4607-57 FIGURE 3-16



Source: Modified from "Groundwater Monitoring Review," Spring 1987.

Not To Scale

EC JORDAN CO. CONSULTING ENGINEERS	PROFILE OF PROPOSED DOWNGRADIENT TRENCH
INSTALLATION RESTORATION PROGRAM NAVAL AIR STATION BRUNSWICK, MAINE	SITES 1 AND 3 FFS
	4607-57 FIGURE 3-17

9102089D

deeper if a shallow trench is excavated first, and the deeper trench excavated from the floor of that trench. The estimated depth of the collection trench is approximately 35 feet bgs, which is below the level of waste in the landfill. The trench would intercept groundwater flow from the top of the water table to approximately 12 feet below the water. Contaminated groundwater deeper than 12 feet would be collected as well, because water is drawn into the pipe from all directions (Gilbert and Gress, 1987).

The width of the trench using the Industrial Builders excavator is only 10 inches, reducing the amount of excavated soil to be disposed of and aggregate to be backfilled. For cost estimating purposes, it was assumed that a 4-inch diameter perforated pipe (wrapped in a geofabric to prevent clogging by silt) would need to be installed at a slope of at least 0.008 feet per foot for gravity flow to three sumps, spaced evenly along the length of the trench (see Figure 3-14 and Appendix C).

An alternative method used by Geo-Con is very similar to Geo-Con's slurry wall installation technique described in Alternative 1,3-C. The maximum depth of a trench installed by Geo-Con is 65 feet. The depth is limited by the type of excavating equipment Geo-Con typically uses. Using this method, a 2- to 4-foot wide trench would be excavated, and a biopolymer slurry used (instead of a water-bentonite slurry) to support the excavation, eliminating the hazard of an open trench. The biopolymer is sensitive to temperature; warm water cannot be used to mix slurry. Environmental conditions, such as the chemistry of the groundwater, may affect the slurry; however, chemical compatibility tests can be conducted prior to construction. The pH and viscosity must be monitored continually during use to ensure the slurry's effectiveness. This technique has been used for constructing interceptor trenches to collect contaminated groundwater at several sites in California, Colorado, and Texas.

The excavation would be continually backfilled with gravel or sand to provide a highly permeable medium for water collection. This method relies on the permeability of the gravel to channel water flow instead of perforated pipe. The trench may need to be lined with a geofabric to prevent clogging by fines. The grain-size analysis of natural soils at this depth indicates up to 48 percent passing a 200 sieve. As described, water would flow to sumps for removal.

If the biopolymer slurry were used, it would need to be removed when the trench is backfilled. The slurry can be biodegraded to a less viscous sugar-water solution when

enzymes are added. This solution can be easily pumped and disposed of when installation is complete. The trench could be flushed with H_2O_2 to kill excess bacteria, if necessary, and the liquid pumped into holding tanks before disposal. (The biopolymer would degrade naturally within two weeks, and bacterial growth would eventually decrease without addition of H_2O_2). The resulting fluid would be nonhazardous and would not have to be disposed of as a hazardous waste. It is possible that the H_2O_2 would oxidize the iron in the groundwater, if it were used to reduce bacteria in the trench. The iron precipitate could cause clogging of the trench.

The downgradient trench would intercept an estimated 15,000 cubic feet of water per day (78 gpm), which would be pumped approximately 200 feet to the water treatment plant described in the following paragraphs.

Water Treatment. Water pumped from the passive groundwater collection system would be piped to the water treatment system described and evaluated in Subsection 3.3 for Alternative 1,3-C. Treatment would include pretreatment to remove metals followed by organics treatment by air stripping or UV/oxidation with either H_2O_2 or O_3.

Discharge of Treated Water. Treated effluent would be discharged by any of the four methods described for Alternative 1,3-C (Subsection 3.3). For preliminary design and cost estimating purposes water is assumed to be discharged to groundwater upgradient of the landfills by reinjection

Institutional Controls and Deed Restrictions. As described in Subsection 3.2 for Alternative 1,3-B, warning signs would be installed to supplement existing institutional controls. Deed restrictions would be enacted if the property is sold to prevent future use of the site and thereby reduce the potential for exposure to site contaminants. The mechanism for implementing these institutional controls will be addressed in the ROD for remedial actions at Sites 1 and 3.

Environmental Monitoring. The environmental monitoring program for the passive downgradient interceptor trench alternative would be very similar to that discussed under Alternative 1,3-B, the Minimal Action Alternative. However, environmental monitoring would also determine the effectiveness of the interceptor trench at capturing contaminated water by analyzing water quality downgradient of the trench. Environmental monitoring would also include relative air monitoring during the

construction of the interceptor trench. Site inspections would determine the location of leachate seeps and proper sampling locations, if they exist at all after the groundwater has been intercepted. Monitoring of the treatment system effluent would also be conducted and include compliance monitoring for the applicable discharge permit.

As in the other alternatives, five-year reviews would be required as part of the environmental monitoring program under this alternative. In addition to making recommendations regarding future remedial actions, the five-year review would assess how well the collection and treatment system performs. If the treatment system were adequately treating the groundwater contamination, it is unlikely that any further remedial action would be recommended.

3.4.1 Overall Protection of Human Health and the Environment

This alternative would provide an increased level of protection to human and ecological receptors over baseline conditions. The passive (or active) groundwater collection and treatment system would be designed to effectively capture and treat contaminated groundwater before it discharges to Mere Brook. In addition, both the concentration of contaminants in the leachate seeps and the volume of the seeps are expected to decrease over time as a result of groundwater collection. Because this alternative does not remove or treat waste material in the landfill, it would rely on natural flushing, degradation, or dispersion to reduce contaminant concentrations in the source area. Groundwater treatment would be required to ensure that remedial action objectives are met. It is estimated to take between 18 and 73 years to achieve Target Clean-up levels. The effects of upgradient reinjection or discharge on the interceptor trench will be evaluated as part of the design phase modeling program if this alternative is selected.

Institutional controls would be required during the time that contaminant concentrations were in excess of the proposed Target Clean-up Levels. These controls would be aimed at limiting contaminant exposure by restricting groundwater usage in this area. Because this portion of the NAS is serviced by a public water supply, it is unlikely that inadvertent exposure to groundwater would occur. To ensure protection of human health, the Navy will conduct a risk assessment at the five-year review. If the risks do not fill between the target risk range specified in the NCP (i.e., 10^{-4} to 10^{-6}), the Navy will consider the need for additional remedial actions.

3.4.2 Compliance with ARARs

Chemical-specific ARARs for groundwater would be achieved under this alternative. Collection and treatment of contaminated groundwater would continue until the MCL, MCLGs, or TBCs are achieved. Water would be treated to meet federal and state requirements for discharge of treated water. Since this alternative relies on natural degradative processes, the time required to achieve Target Clean-up Levels is significantly longer than alternatives that contain the waste and divert groundwater around the landfill. This alternative would decrease the amount of contaminated groundwater discharging to Mere Brook. However, due to contribution of upgradient non-point sources of iron and zinc, the chemical-specific ARARs for these metals may not be attained (see Section 2.1).

Other chemical-specific ARARs include state and federal air regulations including the total suspended particulate standards identified under the CAA (40 CFR 129) and Maine regulations concerning the Protection and Improvement of Air (38 M.R.S.A. Chapter 4). These regulations would be attained during construction activities by controlling fugitive dust emissions. In addition, if air stripping is considered for groundwater treatment, the state's guidance on the Protection and Improvement of Air and Ambient Air Quality Standards would be relevant and appropriate.

The general facility and operation action-specific ARARs presented in Subsection 2.3.2.3 would apply to this alternative. These include: RCRA General Facility Standards (40 CFR 264.10 - 264.18), Preparedness and Prevention (40 CFR 264.30 - 264.37), Contingency Plan and Emergency Procedures (40 CFR 364.50 - 364.56). Maine Hazardous Waste Management Rules (MEDEP Regulations, Chapters 800-802, 850, 851, 853-857) supplement the RCRA general standards; therefore, would also apply. OSHA requirements promulgated under General Facility Standards (29 CFR 1910), Safety and Health Standards (29 CFR 1926), and Recordkeeping, Reporting, and Related Regulations (29 CFR 1904) would apply to all worker activities conducted during remediation. Attainment of these ARARs was discussed in Subsection 2.3.2.3.

Sludge generated during the pretreatment of groundwater would be analyzed using the TCLP. If the sludge failed TCLP it would require treatment prior to disposal in a compliant RCRA Subtitle C landfill. Action-specific ARARs that would apply to the transport of the sludge or possible waste material include: Department of

Transportation (DOT) Rules for Transportation of Hazardous Materials (49 CFR Part 107, 191.1-172.558). Under this requirement the sludge would be manifested and transported by a USEPA-licensed hazardous waste hauler.

If construction of the interceptor trench or treatment plant requires excavation and movement of soil within 100 feet of Mere Brook, the MEDEP Natural Resource Protection Act (Chapter 305) would apply. This location-specific ARAR sets forth standards for activities conducted adjacent to a stream to ensure that disturbed soil is stabilized in order to prevent erosion of the stream bank and siltation of the water. If remedial construction activities cannot be conducted in accordance with these standards, a permit would be required.

The ARARs pertaining to discharge requirements for treated groundwater are presented in Subsection 3.3.2. Because hazardous contaminants will remain on-site following implementation of this remedial alternative, a site review will be performed every five years pursuant to SARA and outlined in the FFA. All site activities, including monitoring, would be carried out pursuant to OSHA standards (29 CFR 1904, 1910 and 1926).

3.4.3 Long-term Effectiveness and Permanence

The Passive Groundwater Collection and Treatment Alternative would not prevent contaminants from leaching into the groundwater at Sites 1 and 3. However, the interceptor trench would be designed to capture the water before it discharges to Mere Brook. Both the concentration of contaminants in the leachate seeps and the volume of the seeps would decrease over time as a result of the passive groundwater collection trench. Based on analytical models presented in Appendix D, it is estimated that natural flushing through the landfill wastes may achieve acceptable source concentrations in approximately 18 to 73 years. It should be noted that these flushing estimates are based on several assumed variables, particularly f_{oc}, and that actual flushing time requirements may be considerably longer. The physical collection of contaminated groundwater would prevent contamination from reaching the seep points. Decreased hydraulic gradients (as indicated by computer simulation) in the vicinity of the leachate seeps would decrease their flow rate. Because contaminated water would not reach Mere Brook, contaminant concentrations in surface water, sediments, and soils near leachate seeps at Mere Brook would be expected to decrease over time due to natural attenuation.

The long-term effectiveness of this alternative relies on natural flushing of contaminants from the site. The time required to remove the source of groundwater contamination is estimated to be between 18 and 73 years. Because the volume of waste and the amount of hazardous materials buried in the landfill are not accurately known, the time to achieve Target Clean-up Levels cannot be more accurately estimated.

Discharge of treated water upgradient by infiltration is not expected to affect the flushing process; however, it is conceivable that this could influence gradients and flow directions, and perhaps contaminant fate and transport processes. Groundwater mounding may also increase hydraulic gradients and seepage velocities within the landfill area. This may not allow for sufficient residence times between groundwater and contaminated soils, thereby reducing the efficiency of flushing through the landfill. Any other discharge alternative would not have an effect on the long-term effectiveness and permanence of the alternative.

This alternative would meet the remedial action objectives because the downgradient interceptor trench or extraction wells would collect contaminated groundwater and leachate before it migrates from the landfill and discharges to Mere Brook. Collected water would then be pretreated to remove metals and treated to remove VOCs. The water would be treated to meet discharge requirements for all constituents. Once Target Clean-up levels are achieved, the treatment would be considered permanent because all parts of the landfill would be flushed of contaminants. Treatability testing would determine the most effective of the three process options for VOC treatment (i.e., air stripping, UV/O_3, or UV/H_2O_2). It would also determine the proper pretreatment and operating procedures for the chosen treatment option. Air-stripping is a well-developed and reliable technology for removing VOCs from water. However, contaminant concentrations in the effluent air may exceed state ambient air guidelines even using VPC treatment. UV/oxidation has been shown to destroy VOCs. All treatment options may require pretreatment which would produce a sludge requiring disposal. The nature and volume of the sludge would be determined at the time of treatability testing for proper disposal. Sampling of the chosen treatment system's influent and effluent would be performed to ensure adequate system performance. Environmental monitoring and five-year reviews would assess the effectiveness of the collection system in capturing contaminated water. Monitoring wells downgradient of the interceptor trench and on the opposite side of Mere Brook would provide information to assess the effectiveness of the interceptor trench and passage of

contaminated groundwater beneath Mere Brook. Section 3.4.6 contains additional information regarding monitoring parameters.

3.4.4 Reduction of Toxicity, Mobility, or Volume

By collecting and treating groundwater immediately downgradient of the source before discharging to Mere Brook, contaminant toxicity and mobility would be reduced. Because the interceptor trench would also draw in some uncontaminated water from the downgradient side of the trench, the volume of contaminated water to be treated would be greater, although more dilute.

Metals pretreatment would produce a higher volume wastestream because additional chemicals would be introduced to enhance oxidation and flocculation. The mobility of the metals would be slightly reduced, because metals in the precipitated form (i.e., $Fe(OH)_3$, MnO_2, and other metal oxides or hydroxides) are less soluble. Toxicity of the metal sludge would be evaluated using the TCLP.

Treatability tests would be required to evaluate the effectiveness of the organics treatment systems in reducing contaminant toxicity; however, it is expected that the UV/oxidation treatment processes would reduce the toxicity of contaminants by destroying the VOCs through chemical oxidation. If air stripping were employed, the contaminants would be transferred from the liquid to the vapor phase. Off-gas treatment using VPC may be required to reduce contaminant concentrations in the air emissions. However, two contaminants, vinyl chloride and methylene chloride, are not effectively adsorbed to carbon and therefore may not be captured by VPC.

There is no proposed treatment of source materials as part of this alternative. Natural flushing of groundwater through the waste material will result in an increase in the volume and mobility of source contaminant; however, the toxicity of the source contaminants would be reduced.

3.4.5 Short-term Effectiveness

Implementation of the passive collection and treatment alternative would not result in any significant short-term adverse impacts to the public. The biopolymer that Geo-Con, Inc., would use for trench stabilization may cause foul odors. The gel-like fluid has a high biological oxygen demand because the biopolymer is made of degradable carbohydrates. Biodegradation of the fluid can cause odors. Before

pumping from the trench, hydrogen peroxide is added to stop bacterial growth and the resulting odor problems. The resulting fluid is not regulated under the Toxic Substances Control Act or RCRA.

Workers would be required to have OSHA health and safety training for work at a hazardous waste site. An appropriate HASP would be followed to minimize risks to workers during remedial construction. The HASP would outline situations when an upgrade from Level D protective equipment would be necessary. This may be possible because a portion of the interceptor trench would be constructed in areas known to contain waste along the northwestern corner of the Weapons Compound. Personal protective equipment would minimize the possibility of exposure to contamination. Engineering controls would be employed and particulate monitoring would occur during all remedial activities at the site.

Hazards associated with open trenches and the use of heavy equipment can be mitigated by implementing sound safety practices. Fencing and security would help to minimize these hazards. Industrial Builders' method of trench installation would not involve leaving an open trench, minimizing the associated risks.

Treatment plant operators would also have to be trained in health and safety practices to work at the site, because exposure to hazardous contaminants while working in the plant is possible. To minimize this possibility, the operators would be required to follow a HASP. Workers involved in environmental site monitoring would also be required to follow a HASP to ensure their safety.

Significant impacts to the environment are not expected. Some trees would require removal for implementation of this alternative. The trench would be located in an area that does not interfere with the water balance of Mere Brook. The treatment system would be designed to mitigate chemical and physical impacts to aquatic life if the water is to be discharged to the storm sewer system or directly to Mere Brook. Upgradient recharge or discharge to the POTW are not expected to have adverse effects on public health or the environment.

The estimated time for construction activities is four months. This includes mobilization, construction of the interceptor trench, construction of the treatment plant, and demobilization. However, due to uncertainties associated with the volume and exact nature of the source material, the time for flushing to be achieved is estimated to be between 18 and 73 years. Treatment would have to continue until

contaminant concentrations in groundwater reach target levels. Once this had been verified by results of the monitoring program, the treatment would be considered complete.

Because this alternative does not include a cap, Sites 1 & 3 would be considered an "insecure" landfill and would need to be considered for proper closure under Maine Solid Waste regulations.

3.4.6 Implementability

Construction of interceptor trenches can be very difficult due to the need for excavation shoring. However, both Geo-Con and Industrial Builders have developed innovative techniques for trench installation (as discussed previously in this section). Construction techniques used for these technologies are not expected to encounter major difficulties in the implementation of this alternative at this site. Underground utilities may require rerouting before excavation of the interceptor trench. For Industrial Builders' trenching equipment, which excavates, lays pipe, and backfills in a single pass, removal of large boulders may be necessary prior to trench excavation. Geo-Con's biopolymer slurry method of excavation support may present problems because the biopolymer slurry is very sensitive to temperature and environmental conditions and would require monitoring of pH and viscosity to ensure its effectiveness. Also, flushing the trench with H_2O_2 could produce an iron precipitate which could decrease the permeability of the backfill material. Well installation is a common technique, and would be easily implemented if an extraction well system were employed in place of an interceptor trench.

The implementability issues described for groundwater treatment and discharge for Alternative 1,3-C pertain to this alternative and are discussed in Subsection 3.3.6.

Environmental monitoring would provide the necessary data to assess the performance of the interceptor trench and the treatment processes over an extended period. A more detailed evaluation of the implementability of environmental monitoring is presented in Subsection 3.2.6. The following monitoring parameters would provide adequate information to characterize the performance of the interceptor trench and treatment system: groundwater elevations; contaminant concentrations in groundwater, surface water, leachate seeps, treated effluent, and sediment; and the existence and location of leachate seeps. Effluent monitoring would also be required and include compliance monitoring for the applicable

discharge permit. Additional remedial actions would be necessary if the system did not eliminate leachate seeps discharging to Mere Brook or properly treat groundwater to effluent standards (treatability studies should minimize this possibility). Should containment or source removal be necessary, the existing interceptor trench would not inhibit future remedial actions.

Coordination among officials at NAS Brunswick and parties responsible for construction activities, treatment plant operation, and environmental monitoring would be required to ensure that access clearance is obtained for both long- and short-term activities associated with this alternative. For security reasons, no construction activities would take place within the Weapons Compound. Long-term activities such as treatment plant operation could be carried out by NAS Brunswick personnel and would not require extensive coordination for site access. The permitting process for discharge of treated water may be extensive.

Contractors to perform the construction services required under this alternative are available and several would be contacted for competitive bidding on the request for proposal. Contractors would have to demonstrate qualifications for work at hazardous waste sites prior to competitive bidding.

3.4.7 Cost

The cost estimate for Alternative 1,3-D is summarized in Tables 3-8, 3-9, and 3-10. Supporting information is in Appendix A. An estimate of the cost of all of the various water treatment options is included in these tables. For preliminary design and cost estimating purposes, it was assumed the water would be treated to drinking water standards and the effluent could be discharged upgradient through reinjection.

The capital cost of this alternative includes the cost of clearing, grading, and surveying the site, constructing the downgradient interceptor trench, pumping and piping the water to the treatment plant and installing warning signs, in addition to water treatment and discharge. The water treatment component includes costs for bench-scale treatability testing, treatment equipment, building construction, and utilities hookup for the building. The discharge component includes pumps, piping and installing reinjection wells. The total capital cost for this alternative is estimated to be $2,289,000, $2,670,000, and $2,710,000, for air stripping, UV/H_2O_2, and UV/O_3, respectively. Other indirect costs associated with implementing these alternatives

TABLE 3-8
ALTERNATIVE 1.3-D:
PASSIVE GROUNDWATER COLLECTION/AIR STRIPPING
COST SUMMARY

FOCUSED FEASIBILITY STUDY
NAS BRUNSWICK

	COST	PRESENT WORTH (1)
CAPITAL COSTS		
Downgradient Trench (2)		
Survey	$8,000	
Site Preparation	$10,000	
Trench Installation*	$575,000	
Disposal of Excavated Material*	$753,000	
Replacement of Road	$5,000	
Site Manager	$3,000	
Groundwater Collection		
Pumps	$6,000	
Piping	$40,000	
Water Treatment		
Treatability Tests*	$52,000	
Building	$165,000	
Utilities	$51,000	
Pretreatment*	$394,000	
Air Stripping*	$44,000	
Discharge		
Pumps	$4,000	
Piping	$16,000	
Reinjection	$161,000	
Institutional Controls		
Warning Signs	$2,000	
Total Capital Costs:	$2,289,000	$2,289,000
INDIRECT COSTS		
Health and Safety (@ 25% of Construction and Treatment Costs)(3)	$455,000	
Legal, Administrative, and Permitting (@ 5% of Capital Cost)	$114,000	
Engineering (@ 10% of Capital Cost)	$229,000	
Services During Construction (@ 5% of Capital Cost)	$114,000	
Total Indirect Costs:	$912,000	$912,000

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TABLE 3-8
ALTERNATIVE 1,3-D:
PASSIVE GROUNDWATER COLLECTION/AIR STRIPPING
COST SUMMARY

FOCUSED FEASIBILITY STUDY
NAS BRUNSWICK

	COST	PRESENT WORTH (1)
ANNUAL OPERATING COSTS		
Labor	$117,000	$1,103,000
Pretreatment Chemicals	$84,000	$792,000
Electricity	$31,000	$292,000
Sludge Disposal	$247,000	$2,328,000
Maintenance	$39,000	$368,000
Environmental Monitoring		
First 2 Years (4 Episodes Per Year)	$212,000	$380,000
Remaining 28 Years (1 Episode Per Year)	$53,000	$408,000
Effluent Monitoring	$7,000	$66,000
Air Monitoring	$12,000	$113,000
Total Operating Costs:		$5,850,000
Five-Year Review (6 Reviews Planned)	$63,000	$157,000
SUBTOTAL		$9,208,000
Contingency (@ 20%)		$1,842,000
TOTAL COST		$11,050,000

NOTES:
(1) Discount rate of 10% is used over 30 years for annual costs.
(2) Trench installation cost quoted by Industrial Builders, Inc., based on a depth of 25 feet.
(3) Activities requiring Health and Safety training or equipment are marked with an asterisk.
(4) Costs are rounded to the nearest $1,000.

TABLE 3-9
ALTERNATIVE 1,3-D:
PASSIVE GROUNDWATER COLLECTION/UV/H2O2
COST SUMMARY

FOCUSED FEASIBILITY STUDY
NAS BRUNSWICK

	COST	PRESENT WORTH (1)
CAPITAL COSTS		
Downgradient Trench (2)		
Survey	$8,000	
Site Preparation	$10,000	
Trench Installation*	$575,000	
Disposal of Excavated Material*	$753,000	
Replacement of Road	$5,000	
Site Manager	$3,000	
Groundwater Collection		
Pumps	$6,000	
Piping	$40,000	
Water Treatment		
Treatability Tests*	$52,000	
Building	$230,000	
Utilities	$51,000	
Pretreatment*	$394,000	
UV/H2O2*	$360,000	
Discharge		
Pumps	$4,000	
Piping	$16,000	
Reinjection	$161,000	
Institutional Controls		
Warning Signs	$2,000	
Total Capital Costs:	$2,670,000	$2,670,000
INDIRECT COSTS		
Health and Safety		
(@ 25% of Construction and Treatment Costs)(3)	$534,000	
Legal, Administrative, and Permitting		
(@ 5% of Capital Cost)	$134,000	
Engineering (@ 10% of Capital Cost)	$267,000	
Services During Construction		
(@ 5% of Capital Cost)	$134,000	
Total Indirect Costs:	$1,069,000	$1,069,000

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TABLE 3-9
ALTERNATIVE 1,3-D:
PASSIVE GROUNDWATER COLLECTION/UV/H2O2
COST SUMMARY

FOCUSED FEASIBILITY STUDY
NAS BRUNSWICK

	COST	PRESENT WORTH (1)
ANNUAL OPERATING COSTS		
Labor	$117,000	$1,103,000
Pretreatment Chemicals	$84,000	$792,000
Peroxide	$6,000	$57,000
Electricity	$97,000	$914,000
Sludge Disposal	$247,000	$2,328,000
Maintenance	$58,000	$547,000
Environmental Monitoring		
First 2 Years (4 Episodes Per Year)	$212,000	$380,000
Remaining 28 Years (1 Episode Per Year)	$53,000	$408,000
Effluent Monitoring	$7,000	$66,000
Total Annual Operating Costs:		$6,595,000
Five-Year Review (6 Reviews Planned)	$63,000	$157,000
SUBTOTAL		$10,491,000
Contingency (@ 20%)		$2,098,000
TOTAL COST		$12,589,000

NOTES:
(1) Discount rate of 10% is used over 30 years for annual costs.
(2) Trench installation cost quoted by Industrial Builders, Inc., based on a depth of 25 feet.
(3) Activities requiring Health and Safety training or equipment are marked with an asterisk.
(4) Costs are rounded to the nearest $1,000.

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TABLE 3-10
ALTERNATIVE 1,3-D:
PASSIVE GROUNDWATER COLLECTION/UV/O3
COST SUMMARY

FOCUSED FEASIBILITY STUDY
NAS BRUNSWICK

	COST	PRESENT WORTH (1)
CAPITAL COSTS		
Downgradient Trench (2)		
Survey	$8,000	
Site Preparation	$10,000	
Trench Installation*	$575,000	
Disposal of Excavated Material*	$753,000	
Replacement of Road	$5,000	
Site Manager	$3,000	
Groundwater Collection		
Pumps	$6,000	
Piping	$40,000	
Water Treatment		
Treatability Tests*	$52,000	
Building	$200,000	
Utilities	$51,000	
Pretreatment*	$394,000	
UV/O3*	$430,000	
Discharge		
Pumps	$4,000	
Piping	$16,000	
Reinjection	$161,000	
Institutional Controls		
Warning Signs	$2,000	
Total Capital Costs:	$2,710,000	$2,710,000
INDIRECT COSTS		
Health and Safety		
(@ 25% of Construction and Treatment Costs)(3)	$551,000	
Legal, Administrative, and Permitting		
(@ 5% of Capital Cost)	$136,000	
Engineering (@ 10% of Capital Cost)	$271,000	
Services During Construction		
(@ 5% of Capital Cost)	$136,000	
Total Indirect Costs:	$1,094,000	$1,094,000

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TABLE 3-10
ALTERNATIVE 1,3-D:
PASSIVE GROUNDWATER COLLECTION/UV/O3
COST SUMMARY

FOCUSED FEASIBILITY STUDY
NAS BRUNSWICK

	COST	PRESENT WORTH (1)
ANNUAL OPERATING COSTS		
Labor	$117,000	$1,103,000
Pretreatment Chemicals	$84,000	$792,000
Electricity	$125,000	$1,178,000
Sludge Disposal	$247,000	$2,328,000
Maintenance	$60,000	$566,000
Environmental Monitoring		
First 2 Years (4 Episodes Per Year)	$212,000	$380,000
Remaining 28 Years (1 Episode Per Year)	$53,000	$408,000
Effluent Monitoring	$7,000	$66,000
Total Operating Costs:		$6,821,000
Five-Year Review (6 Reviews Planned)	$63,000	$157,000
SUBTOTAL		$10,782,000
Contingency (@ 20%)		$2,156,000
TOTAL COST		$12,938,000

NOTES:
(1) Discount rate of 10% is used over 30 years for annual costs.
(2) Trench installation cost quoted by Industrial Builders, Inc.
(3) Activities requiring Health and Safety training or equipment are marked with an asterisk.
(4) Costs are rounded to the nearest $1,000.

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have been estimated at $912,000, $1,069,000, and $1,094,000 for the three treatment options.

Operating costs for this alternative include labor, pretreatment chemicals and disposal of metal sludge, electricity (for operating the pumps and lighting in the building), equipment maintenance (assumed to be 5 percent of the capital costs per year), environmental monitoring costs as described in Subsection 3.2.7 for Alternative 1,3-B, effluent monitoring, and air monitoring for the air stripping option. The total present-worth operating cost is approximately $5,850,000, $6,595,000, and $6,821,000 for the three treatment options. Monitoring and operation of the treatment plant are assumed to continue for 30 years for cost estimating purposes; however, treatment could continue for a longer period. Although the time to achieve remedial action objectives cannot be accurately estimated at this time, the long-term monitoring and five-year site reviews will determine when treatment can be terminated. The cost of the site review is estimated to be $63,000 every five years.

A contingency of 20 percent of the present-worth cost of the alternative is added to account for unforeseen circumstances that may increase the estimated cost.

The total present-worth cost of the Passive Groundwater Collection and Treatment Alternative is $11,050,000, $12,589,000, and $12,938,000 for air stripping, UV/H_2O, and UV/O_3, respectively. These costs are estimates and are believed to be within the +50 percent to -30 percent range for FS cost estimates (USEPA, 1988). These costs are sensitive to the length of time it will take to meet the response objectives. Also, because the cost estimate was based on a quote from only one interceptor trench contractor (i.e., Industrial Builders), the actual cost of trench construction may be different. If extraction wells are used to collect the water, the present worth cost of this alterative would be $9,871,000.

If it is determined that vapor phase treatment is needed for air emissions, air stripping may be infeasible, because it would add $7.3 million per year in carbon costs alone (based on an estimate of 8,000 lb/day carbon usage and $2.50/lb to regenerate the carbon) and may not achieve the Maine State guidelines for vinyl chloride and methylene chloride. Additional costs for meeting stricter effluent discharge requirements may be incurred depending on the discharge method chosen. The frequency of sampling and type of analysis would be dictated by effluent discharge requirements.

The choice of the water treatment technology to be designed and implemented should not be based only on cost considerations, but on the technology's performance as indicated by treatability test results. The cost of the treatability tests given in Tables 3-8, 3-9, and 3-10 includes bench-scale testing of pretreatment methods, air stripping, UV/H_2O_2, and UV/O_3.

3.5 ALTERNATIVE 1,3-E: CAP/GROUNDWATER EXTRACTION/TREATMENT

Alternative 1,3-E combines containment with active groundwater collection and treatment. These components are outlined below:

- cap
- groundwater extraction wells
- water treatment
- discharge of treated water
- institutional controls and deed restrictions
- environmental monitoring

This alternative includes a multilayer cap to reduce infiltration and prevent exposure to the landfill contents. It meets remedial action objectives by pumping and treating contaminated groundwater before it reaches human or aquatic receptors. In addition, the alternative includes deed restrictions and an environmental monitoring program because the wastes are not being removed from the site.

Each component of this alternative, except the groundwater extraction system, has been described in preceding subsections. These discussions will be referenced in the following paragraphs where applicable.

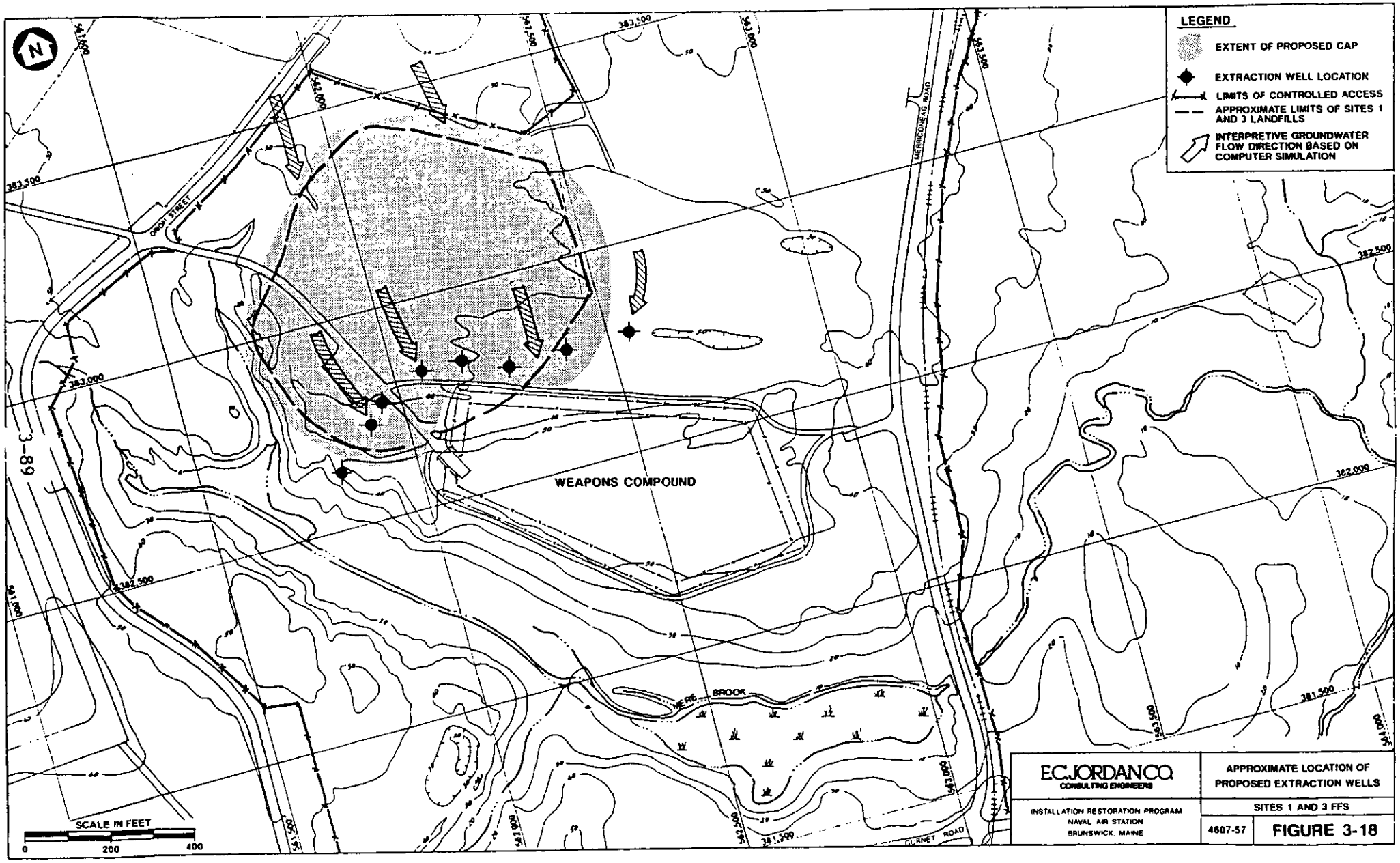
Cap. The cover system evaluated in Subsection 3.3 for Alternative 1,3-C is also part of Alternative 1,3-E. The cap would consist of a clay layer, synthetic liner, drainage layer, and vegetative cover, as recommended in RCRA guidance (see Figure 3-3). A soil cover system may also be appropriate for this alternative. Unlike Alternative 1,3-C, where the objective was to isolate the waste material, this alternative relies on natural flushing and degradative processes to reduce contaminant concentrations in the waste. Therefore, a low-permeability cap is not considered necessary and a soil cover system may be as effective. However, a soil cover may not comply with RCRA requirements. The cover system described in

Alternative 1,3-C and recommended in RCRA guidance was assumed in this Alternative for cost estimating purposes. The cap would cover the area shown in Figure 3-2.

Groundwater Extraction Wells. The downgradient extraction system was designed based on computer modeling of the hydrogeologic system with the cap in place. The proposed extraction system is a network of eight wells placed approximately 150 feet apart as shown in Figure 3-18. The extraction wells are located to capture groundwater flowing downgradient of Sites 1 and 3 before it discharges to Mere Brook. The number and location of wells is provided for cost-estimating purposes only. The final number and location of wells and piezometers would be determined during remedial design.

As described for Alternative 1,3-C, the borings would be drilled to the underlying clay surface, estimated at a depth of approximately 40 feet bgs. The average depth clay in this portion of the landfill is estimated at approximately 40 feet bgs. Eight 6-inch diameter wells with 30-foot screens would be installed in the borings. It is estimated that the entire aquifer-saturated thickness would be intercepted by the screens. The boreholes would be backfilled and sealed with bentonite. Protective casings would be installed and cemented in place. Each well would contain a submersible pump capable of extracting groundwater at a rate of up to 30 gpm. The protective casings would not penetrate the hydraulic barrier layer. However, the well risers would and the geomembrane would be sealed to the risers using a geomembrane pipe boot. This well design has been assumed for cost estimating purposes.

The pumping scheme evaluated in the model involved increased pumping rates from the western wells to the eastern wells, because natural groundwater gradients and flow rates are higher to the southeast. The three westernmost wells would pump water at a rate of approximately 4 gpm; the three center wells at 9 gpm; and the two easternmost wells at 10 gpm and 29 gpm, respectively. Final pumping rates at each well would be based on a pumping test conducted at each well after installation. The combined groundwater extraction rate for this system, which is similar to the interceptor trench extraction rate, would be approximately 78 gpm. This pumping scenario would provide sufficient groundwater drawdowns in each extraction well to capture groundwater migrating from the site.


LEGEND
EXTENT OF PROPOSED CAP
EXTRACTION WELL LOCATION
LIMITS OF CONTROLLED ACCESS
APPROXIMATE LIMITS OF SITES 1 AND 3 LANDFILLS
INTERPRETIVE GROUNDWATER FLOW DIRECTION BASED ON COMPUTER SIMULATION
WEAPONS COMPOUND
MERE BROOK
MERRIDONEAG ROAD
GURNET ROAD
383,500
383,000
382,500
382,000
381,500
561,000
562,000
562,500
563,000
563,500
564,000
SCALE IN FEET
0
200
400
N
ECJORDANCO
CONSULTING ENGINEERS
INSTALLATION RESTORATION PROGRAM
NAVAL AIR STATION
BRUNSWICK, MAINE
APPROXIMATE LOCATION OF PROPOSED EXTRACTION WELLS
SITES 1 AND 3 FFS
4607-57
FIGURE 3-18

Up to twelve piezometers would be installed in conjunction with the extraction well program to evaluate the hydraulic performance of the extraction well system. Piezometers would provide water level information during the pumping of extraction wells which is needed to estimate aquifer transmissivity, storage coefficients, and substainable yields. The piezometers would be located both in the direction of and perpendicular to groundwater flow.

Pumping tests would be monitored by an In-situ Hermit 2000 multiple transducer/data logger. To evaluate drawdown in the sandpack surrounding extraction wells, a 1-inch diameter PVC piezometer would be installed in the filter pack of each well. The piezometers would be attached to the riser using a stainless steel clamp, and would be vertically positioned within the borehole to provide water-level information in the filter pack during pumping tests. Two types of aquifer testing would be performed in the site: (1) step-drawdown tests; and (2) constant-discharge tests. Step-drawdown tests would provide data on well efficiency, contaminant capture, localized aquifer properties, and short-term well yields. Constant-discharge tests would be used to evaluate drawdown effects, recharge boundaries, and large-scale aquifer properties that would influence long-term contaminant-capture efficiency and operation of the groundwater extraction system.

The description of this component differs from that given in the Phase I FS. Instead of lowering the water table below the waste, the objective of this pumping scheme is to draw water through the waste and thereby flush contaminants from the source in a more timely and cost-effective manner. By flushing groundwater through the landfill wastes, the source of VOCs in groundwater will, over time, be remediated and eventually the pumps could be shut off. However, the time required to achieve remedial action objectives is not expected to be appreciably reduced by active removal of groundwater as compared to the passive interceptor trench system described in Subsection 3.4 (e.g., 18 to 73 years; see Appendix D).

Water Treatment. Water pumped from the extraction wells would be piped to the water treatment system described and evaluated in Subsection 3.3 for Alternative 1,3-C. Treatment would include pretreatment to remove metals followed by organics treatment by air stripping or UV/oxidation with either H_2O_2 or O_3.

Discharge of Treated Water. Treated effluent could be discharged by any of the four methods described for Alternative 1,3-C. For preliminary design and cost-estimating purposes, water is assumed to be discharged to groundwater upgradient of the

landfills by reinjection. The effects of groundwater recharge on the extraction well system will be evaluated as part of the design phase modeling effort, if this alternative is selected.

Institutional Controls and Deed Restrictions. As described in Subsection 3.2 for Alternative 1,3-B, signs would be installed and deed restrictions implemented to supplement existing institutional controls to prevent future use of the site, and thereby reduce the potential for exposure to site contaminants. The mechanism for implementing these institutional controls will be addressed in the ROD for remedial actions at Sites 1 and 3.

Environmental Monitoring. The environmental monitoring program for Alternative 1,3-E would be similar to that described for Alternative 1,3-D. The program would be used to determine the effectiveness of the extraction wells at capturing contaminated water and the cap's ability to reduce water infiltration into the waste. Site inspections would determine if leachate seeps are still entering the stream and would visually check the condition of the cover system.

Five-year reviews would be conducted to evaluate the performance of the collection and treatment systems and recommend further action, if necessary.

3.5.1 Overall Protection of Human Health and the Environment

This alternative would provide an increased level of protection to human and ecological receptors over baseline conditions. The groundwater extraction and treatment system would effectively capture and treat contaminated groundwater before it discharges to Mere Brook. The clay cap would reduce the amount of infiltration passing through the waste. This reduction would decrease the amount of contaminated groundwater generated and treated. The concentration of contaminants in the leachate seeps and the volume of the seeps would also decrease over time as a result of the groundwater extraction system.

Because this alternative would not remove or treat waste material in the landfill, it would rely on natural flushing, degradation, or dispersion to reduce contaminant concentrations in groundwater. Therefore, continual treatment of groundwater would be required to ensure that remedial action objectives are met. It is estimated to take between 18 and 73 years to achieve Target Clean-up Levels.

To ensure protection of human health, the Navy will conduct a risk assessment of the five year review. If the risks do not fall within the target risk range or specified in the CNP (i.e., 10^{-4} to 10^{-6}), the Navy will consider the need for additional remedial actions.

3.5.2 Compliance with ARARs

Chemical-specific ARARs for groundwater would be achieved under this alternative. Collection and treatment of contaminated groundwater would continue until the MCL, MCLGs, or TBCs are achieved. Water would be treated to meet federal and state requirements for discharge of treated water. This alternative would decrease the amount of contaminated groundwater discharging to Mere Brook. However, due to contribution of upgradient non-point sources of iron and zinc, the chemical-specific ARARs for these metals may not be attained (see Section 2.1).

Other chemical-specific ARARs include state and federal air regulations including the total suspended particulate standards identified under the CAA (40 CFR 129), and the Maine regulations concerning the Protection and Improvement of Air (38 M.R.S.A. Chapter 4). These regulations would be attained during construction activities by controlling fugitive dust emissions. In addition, if air stripping is considered for groundwater treatment, the state's guidance on the Protection and Improvement of Air and Ambient Air Quality Standards would be relevant and appropriate.

Action-specific ARARs include federal and state regulations pertaining to hazardous waste operations (RCRA 40 CFR 264; MEDEP Chapters 800-802, 850, 851, 853-857). These regulations would be used as standards during remedial design to ensure compliance.

The landfill cover system would be designed to meet RCRA guidance (USEPA, 1989). The cap would minimize migration of contaminants, promote drainage, minimize erosion of the cover, and accommodate settling. The cover system would be monitored and repaired as necessary.

The sludge generated during pretreatment of the groundwater would be tested before disposal. If the sludge was determined to be hazardous it would be treated to ensure that contaminant levels would not exceed allowable leachate concentrations in an

extract sample using the TCLP. After treatment, the sludge would be disposed of in a RCRA-compliant facility.

Action-specific ARARs also include federal and state regulations pertaining to discharge requirements. The requirements for discharge of treated water for this alternative are the same as those discussed in Subsection 3.3.2.

If construction of the cap or groundwater treatment plant requires excavation and movement of soil within 100 feet of Mere Brook, the MEDEP Natural Resource Protection Act (Chapter 305) would apply. This location-specific ARAR sets forth standards for activities conducted adjacent to a stream to ensure that disturbed soil is stabilized in order to prevent erosion of the stream bank and siltation of the water. If remedial construction activities cannot be conducted in accordance with these standards, a permit will be obtained.

All OSHA requirements regulating worker safety and employee records must be followed during site work. OSHA regulations include health and safety standards for federal service contracts, recordkeeping and reporting, and requirements such as safety equipment and procedures to be followed during site remediation. Because hazardous contaminants would remain on-site following implementation of this remedial alternative, a site review would be performed every five years pursuant to SARA and outlined in the Agreement. All site activities, including monitoring, would be carried out pursuant to OSHA standards (29 CFR 1904, 1910, and 1926).

3.5.3 Long-term Effectiveness and Permanence

The cap would reduce infiltration through the contaminated material and into groundwater and improve surface runoff. However, a significant amount of groundwater would still flow through waste buried at Sites 1 and 3. Contaminated water would be collected by the extraction wells, pretreated to remove iron and manganese, and treated to remove VOCs. Concentrations of contaminants in surface water and soil and sediments near leachate seeps would decrease over time due to natural attenuation because contaminants would no longer discharge to the stream. Based on analytical models presented in Appendix D, it is estimated that natural flushing through the landfill wastes may achieve acceptable source concentrations in approximately 18 to 73 years. It should be noted that these flushing estimates are based on several assumed variables, particularly f_{oc}, and that actual flushing time requirements may be considerably longer. Contamination in the seeps and the

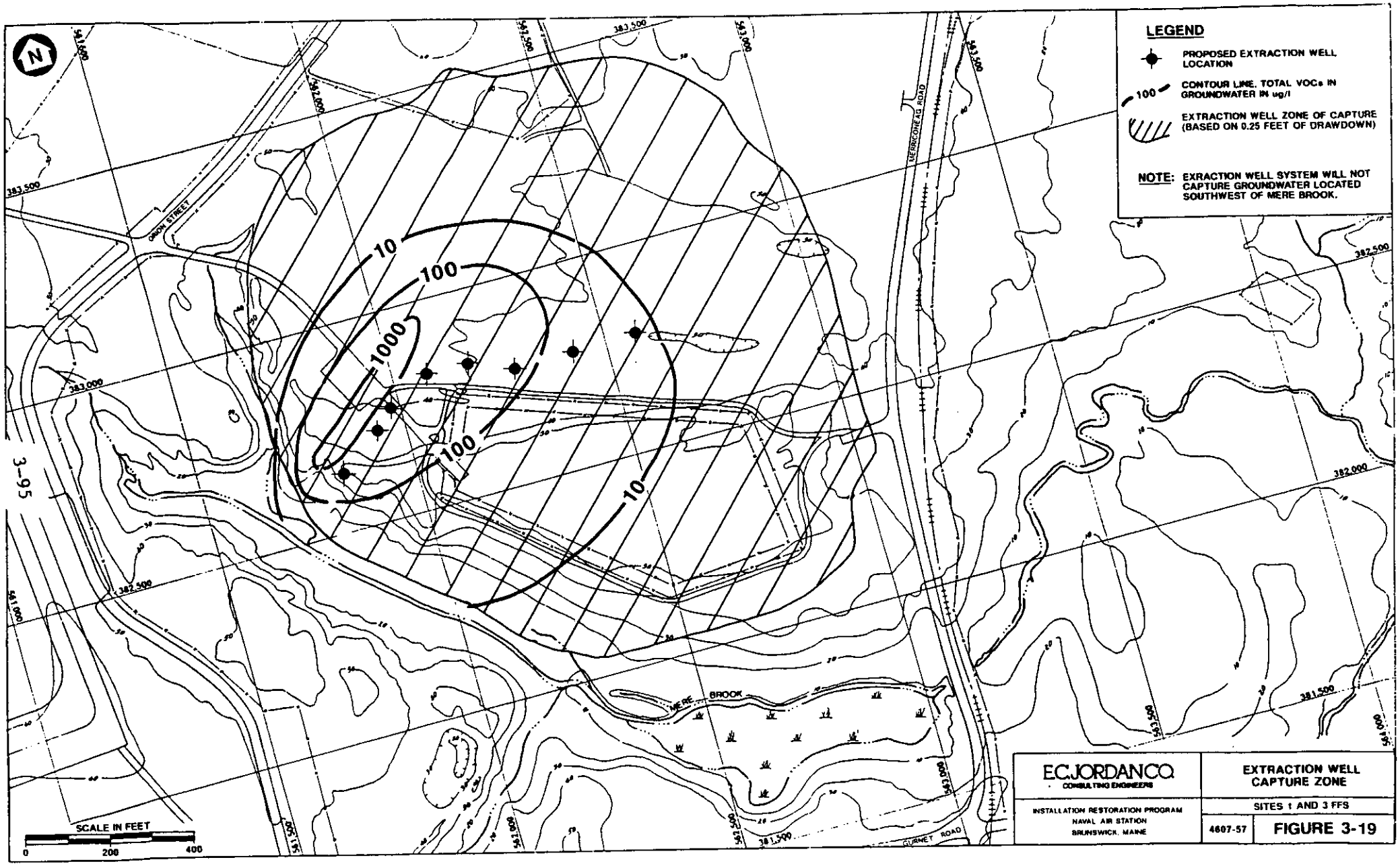
volume of the seeps would both decrease due to the physical collection of contaminated water and the decreased hydraulic gradients near the seeps.

Due to uncertainties associated with the volume and exact nature of the source material, the time for flushing can only be estimated. This alternative would require between 18 and 73 years, similar to the time required for Alternative 1,3-D. Because recharge from this area is relatively small compared to the amount of groundwater flowing beneath the capped area, the overall volume of water to be collected and treated would not be greatly reduced by the cap and is similar to that estimated for Alternative 1,3-D. Treatment would have to continue until contaminant concentrations in groundwater reached target levels. Once this had been verified by results of the monitoring program, pumping could be discontinued.

Discharge of treated water upgradient by infiltration is not expected to enhance the flushing process. Because of the local groundwater mounding observed in the landfill area, some of the water discharged upgradient may flow radially from the recharge area and not flush through the source. In addition, recharging the water upgradient may increase the velocity of water flowing through the waste, and decrease the amount of time the water is in contact with the waste. Contaminants may not have sufficient opportunity to partition to the liquid phase. Any other discharge alternative would not have an effect on the long-term effectiveness and permanence of the alternative.

This alternative would meet the remedial action objectives because extraction wells would be designed to capture all contaminated groundwater and leachate before the water discharges to Mere Brook. Environmental monitoring and five-year reviews would assess the effectiveness of the extraction wells in capturing contaminated water and the removal of contaminants of concern by the treatment system. The pumping scheme described above is expected to optimize removal of contaminated water migrating from the site. Pump tests would be conducted to gather information on aquifer characteristics to refine the pumping plan. Figure 3-19 shows the expected zone of capture of the proposed extraction wells relative to the plume (as defined by RI data) based on computer modeling. Note that interpretive concentration contours shown on this figure are for current conditions (i.e., before pumping begins).

Treatability testing would determine the most appropriate process option for organics removal or destruction given the conditions at Sites 1 and 3. The chosen process option would effectively remove or destroy all contaminants to levels considered


LEGEND
PROPOSED EXTRACTION WELL LOCATION
100
CONTOUR LINE, TOTAL VOCs IN GROUNDWATER IN ug/l
EXTRACTION WELL ZONE OF CAPTURE (BASED ON 0.25 FEET OF DRAWDOWN)
NOTE: EXRACTION WELL SYSTEM WILL NOT CAPTURE GROUNDWATER LOCATED SOUTHWEST OF MERE BROOK.
10
100
1000
100
10
UNION STREET
MERRICONEAG ROAD
MERE BROOK
GURNET ROAD
383,500
383,000
382,500
382,000
381,500
541,500
542,000
542,500
543,000
543,500
544,000
SCALE IN FEET
0
200
400
E.C.JORDAN CO.
CONSULTING ENGINEERS
INSTALLATION RESTORATION PROGRAM
NAVAL AIR STATION
BRUNSWICK, MAINE
EXTRACTION WELL CAPTURE ZONE
SITES 1 AND 3 FFS
4607-57
FIGURE 3-19

protective of human health and the environment. Air stripping is a well-developed and reliable technology for removing VOCs from water. However, off-gas treatment, such as VPC, may not be effective at reducing vinyl chloride and methylene chloride emissions to levels below the Maine ambient air guidelines. UV/oxidation has been demonstrated to destroy VOCs. Both treatment technologies require pretreatment which would produce a sludge requiring disposal. The expected nature and volume of the sludge would be determined at the time of treatability testing for disposal purposes. Sampling of the chosen treatment system's influent and effluent streams would be performed to ensure adequate system performance.

3.5.4 Reduction of Toxicity, Mobility, or Volume

By extracting and treating groundwater before discharging to Mere Brook, contaminant toxicity and mobility would be reduced. Similar to Alternative 1,3-D, the extraction wells would also draw in uncontaminated water, decreasing the concentration but increasing the volume of contaminated water to be treated.

Metals pretreatment would produce a concentrated sludge as described for Alternative 1,3-D. Precipitated metal oxides or hydroxides would be less mobile than the dissolved phase. Toxicity of the metal sludge would be evaluated using the TCLP, and it would be properly disposed of.

It is expected that the treatment processes would be able to reduce the toxicity, mobility, and volume of contaminants in groundwater to meet target levels or discharge standards. As described, air stripping would transfer contaminants from the liquid to the vapor phase. Many of these contaminants would be absorbed into carbon as part of off-gas treatment. However, vinyl chloride and methylene chloride are not effectively adsorbed by VPC and could be released to the air.

There is no proposed treatment of source material as part of this alternative. Natural flushing of the waste will increase the volume and mobility of source contaminants, however, the toxicity of the source material would be reduced.

3.5.5 Short-term Effectiveness

The short-term effectiveness of the cap, treatment, and environmental monitoring components of the alternative were discussed in Subsections 3.3.5, 3.4.5, and 3.2.5, respectively.

Construction of extraction wells would not be expected to expose the public to any site-related hazards. An appropriate HASP would have to be followed to address risks that might be encountered during construction of extraction wells. Some of the proposed wells would be located at points known to have waste buried beneath the surface. Drilling through this contaminated material would increase the possibility of worker exposure to site contamination. Therefore, proper safety practices would have to be carried out as described in the HASP to mitigate this exposure. In addition, the drill cuttings will be screened, and if determined to be contaminated will be managed and disposed of properly.

Significant impacts to the environment are not expected. Some trees would require removal for the construction of the cap. The treatment system would be designed to mitigate chemical and physical impacts to aquatic life if the water is to be discharged to the storm sewer system or directly to Mere Brook. Measures will be taken to reduce the impacts of potential increased flow in Mere Brook or on the habitat of resident aquatic species. Upgradient infiltration or discharge to the POTW are not expected to have adverse effects on public health or the environment.

The estimated time for construction of this alternative is six months. This includes mobilization, construction of the groundwater treatment system, cap, extraction well installation, pump tests, treatment building construction, and demobilization. However, because of uncertainties associated with the volume and exact nature of the source material, the time for flushing to be achieved is estimated to range from 18 to 73 years. Treatment would have to continue until contaminant concentrations in the groundwater reach target levels. Once this is verified by the results of the monitoring program, treatment would be considered complete.

3.5.6 Implementability

The implementability of the cap, treatment, discharge, and environmental monitoring components of this alternative has been discussed for other alternatives. Therefore, a discussion of the implementability of each of these components will not be repeated. The cap is discussed in Subsection 3.3.6. The implementability of the treatment systems and discharge options is presented in Subsection 3.4.6. Subsections 3.2.6, 3.3.6, and 3.4.6 contain discussions on the implementability of environmental monitoring.

The construction techniques used to install extraction wells are not expected to impose constraints upon the implementability of this alternative. These techniques are well developed and reliable and have been used at several Superfund site remedial actions. Contractors to perform the construction services required under this alternative are available and several would be contacted for competitive bidding on the request for proposal. Contractors would have to demonstrate qualifications for work at hazardous waste sites prior to competitive bidding if a potential for exposure is determined to exist.

Coordination among officials at NAS Brunswick and parties responsible for construction and monitoring activities would be required to ensure that access clearance is obtained. For security reasons, no construction activities or well installation would take place within the Weapons Compound. The permitting process for discharge of treated water could be extensive. Underground utilities would require relocation before construction activities to ensure they would not be damaged. Treatability testing would be required before designing a water treatment system to determine whether treatment technologies could treat the water to meet discharge limits.

3.5.7 Cost

The cost estimate for Alternative 1,3-E is summarized in Tables 3-11, 3-12, and 3-13. Supporting information is provided in Appendix A. An estimate of the cost of all of the various water treatment and discharge options is included in these tables. For preliminary design and cost estimating purposes, it was assumed that the water would be treated to drinking water standards, and the effluent could be discharged through upgradient reinjection.

The capital cost of this alternative includes the cost of clearing, grading, and surveying the site, locating a clay source, constructing the cap, installing the extraction wells and piezometers, pumping and piping the water to the treatment plant, and installing warning signs, in addition to water treatment and discharge. The water treatment component includes costs for bench-scale treatability testing, treatment equipment, building construction, and utilities hookup for the building. The discharge component includes pumps, piping, and installing reinjection wells. The total capital cost using air stripping, UV/H_2O_2, and UV/O_3 is estimated to be $2,731,000, $3,112,000, and $3,152,000, respectively. Other indirect costs associated

TABLE 3-11
ALTERNATIVE 1,3-E:
CAP/GROUNDWATER EXTRACTION/AIR STRIPPING
COST SUMMARY

FOCUSED FEASIBILITY STUDY
NAS BRUNSWICK

	COST	PRESENT WORTH (1)
CAPITAL COSTS		
Cap		
Clay Borrow Study	$17,000	
Survey	$8,000	
Site Preparation	$43,000	
Materials	$1,105,000	
Construction QC Testing	$19,000	
Replacement of Road and Parking Lot	$40,000	
Site Manager	$40,000	
Groundwater Extraction Wells		
Pumping Tests	$93,000	
Mobilization	$10,000	
Decontamination	$8,000	
Piezometers	$10,000	
Well Materials and Installation*	$42,000	
Disposal of Excavated Material*	$360,000	
Groundwater Collection		
Pumps	$7,000	
Piping	$40,000	
Water Treatment		
Treatability Tests*	$52,000	
Building	$165,000	
Utilities	$51,000	
Pretreatment*	$394,000	
Air Stripping*	$44,000	
Discharge		
Pumps	$4,000	
Piping	$16,000	
Reinjection	$161,000	
Institutional Controls		
Warning Signs	$2,000	
Total Capital Costs:	$2,731,000	$2,731,000
INDIRECT COSTS		
Health and Safety		
(@ 25% of Construction and Treatment Costs)(2)	$223,000	-
Legal, Administrative, and Permitting		
(@ 5% of Capital Cost)	$137,000	
Engineering (@ 10% of Capital Cost)	$273,000	
Services During Construction		
(@ 5% of Capital Cost)	$137,000	
Total Indirect Costs:	$770,000	$770,000

19126.1&3

TABLE 3-11
ALTERNATIVE 1,3-E:
CAP/GROUNDWATER EXTRACTION/AIR STRIPPING
COST SUMMARY

FOCUSED FEASIBILITY STUDY
NAS BRUNSWICK

	COST	PRESENT WORTH (1)
ANNUAL OPERATING COSTS		
Labor	$117,000	$1,103,000
Pretreatment Chemicals	$84,000	$792,000
Electricity	$54,000	$509,000
Sludge Disposal	$247,000	$2,328,000
Maintenance	$41,000	$387,000
Environmental Monitoring		
First 2 Years (4 Episodes Per Year)	$212,000	$380,000
Remaining 28 Years (1 Episode Per Year)	$53,000	$408,000
Effluent Monitoring	$7,000	$66,000
Air Monitoring	$12,000	$113,000
Total Operating Costs:		$6,086,000
Five-Year Review (6 Reviews Planned)	$63,000	$157,000
SUBTOTAL		$9,744,000
Contingency (@ 20%)		$1,949,000
TOTAL COST		$11,693,000

NOTES:
(1) Discount rate of 10% is used over 30 years for annual costs.
(2) Activities requiring Health and Safety training or equipment are marked with an asterisk.
(3) Costs are rounded to the nearest $1,000.

TABLE 3-12
ALTERNATIVE 1,3-E:
CAP/GROUNDWATER EXTRACTION/UV/H2O2
COST SUMMARY

FOCUSED FEASIBILITY STUDY
NAS BRUNSWICK

	COST	PRESENT WORTH (1)
CAPITAL COSTS		
Cap		
Clay Borrow Study	$17,000	
Survey	$8,000	
Site Preparation	$43,000	
Materials	$1,105,000	
Construction QC Testing	$19,000	
Replacement of Road and Parking Lot	$40,000	
Site Manager	$40,000	
Groundwater Extraction Wells		
Pumping Tests	$93,000	
Mobilization	$10,000	
Decontamination	$8,000	
Piezometers	$10,000	
Well Materials and Installation*	$42,000	
Disposal of Excavated Material*	$360,000	
Groundwater Collection		
Pumps	$7,000	
Piping	$40,000	
Water Treatment		
Treatability Tests*	$52,000	
Building	$230,000	
Utilities	$51,000	
Pretreatment*	$394,000	
UV/H2O2*	$360,000	
Discharge		
Pumps	$4,000	
Piping	$16,000	
Reinjection	$161,000	
Institutional Controls		
Warning Signs	$2,000	
Total Capital Costs:	$3,112,000	$3,112,000
INDIRECT COSTS		
Health and Safety		
(@ 25% of Construction and Treatment Costs)(2)	$302,000	
Legal, Administrative, and Permitting		
(@ 5% of Capital Cost)	$156,000	
Engineering (@ 10% of Capital Cost)	$311,000	
Services During Construction		
(@ 5% of Capital Cost)	$156,000	
Total Indirect Costs:	$925,000	$925,000

19126.1&3

TABLE 3-12
ALTERNATIVE 1,3-E:
CAP/GROUNDWATER EXTRACTION/UV/H2O2
COST SUMMARY

FOCUSED FEASIBILITY STUDY
NAS BRUNSWICK

	COST	PRESENT WORTH (1)
ANNUAL OPERATING COSTS		
Labor	$117,000	$1,103,000
Pretreatment Chemicals	$84,000	$792,000
Peroxide	$6,000	$57,000
Electricity	$120,000	$1,131,000
Sludge Disposal	$247,000	$2,328,000
Maintenance	$61,000	$575,000
Environmental Monitoring		
First 2 Years (4 Episodes Per Year)	$212,000	$380,000
Remaining 28 Years (1 Episode Per Year)	$53,000	$408,000
Effluent Monitoring	$7,000	$66,000
Total Operating Costs:		$6,840,000
Five-Year Review (6 Reviews Planned)	$63,000	$157,000
SUBTOTAL		$11,034,000
Contingency (@ 20%)		$2,207,000
TOTAL COST		$13,241,000

NOTES:
(1) Discount rate of 10% is used over 30 years for annual costs.
(2) Activities requiring Health and Safety training or equipment are marked with an asterisk.
(3) Costs are rounded to the nearest $1,000.

TABLE 3-13
ALTERNATIVE 1,3-E:
CAP/GROUNDWATER EXTRACTION/UV/O3
COST SUMMARY

FOCUSED FEASIBILITY STUDY
NAS BRUNSWICK

	COST	PRESENT WORTH (1)
CAPITAL COSTS		
Cap		
Clay Borrow Study	$17,000	
Survey	$8,000	
Site Preparation	$43,000	
Materials	$1,105,000	
Construction QC Testing	$19,000	
Replacement of Road and Parking Lot	$40,000	
Site Manager	$40,000	
Groundwater Extraction Wells		
Pumping Tests	$93,000	
Mobilization	$10,000	
Decontamination	$8,000	
Piezometers	$10,000	
Well Materials and Installation*	$42,000	
Disposal of Excavated Material*	$360,000	
Groundwater Collection		
Pumps	$7,000	
Piping	$40,000	
Water Treatment		
Treatability Tests*	$52,000	
Building	$200,000	
Utilities	$51,000	
Pretreatment*	$394,000	
UV/O3*	$430,000	
Discharge		
Pumps	$4,000	
Piping	$16,000	
Reinjection	$161,000	
Institutional Controls		
Warning Signs	$2,000	
Total Capital Costs:	$3,152,000	$3,152,000
INDIRECT COSTS		
Health and Safety		
(@ 25% of Construction and Treatment Costs)(2)	$320,000	
Legal, Administrative, and Permitting		
(@ 5% of Capital Cost)	$158,000	
Engineering (@ 10% of Capital Cost)	$315,000	
Services During Construction		
(@ 5% of Capital Cost)	$158,000	
Total Indirect Costs:	$951,000	$951,000

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TABLE 3-13
ALTERNATIVE 1,3-E:
CAP/GROUNDWATER EXTRACTION/UV/O3
COST SUMMARY

FOCUSED FEASIBILITY STUDY
NAS BRUNSWICK

	COST	PRESENT WORTH (1)
ANNUAL OPERATING COSTS		
Labor	$117,000	$1,103,000
Pretreatment Chemicals	$84,000	$792,000
Electricity	$148,000	$1,395,000
Sludge Disposal	$247,000	$2,328,000
Maintenance	$63,000	$594,000
Environmental Monitoring		
First 2 Years (4 Episodes Per Year)	$212,000	$380,000
Remaining 28 Years (1 Episode Per Year)	$53,000	$408,000
Effluent Monitoring	$7,000	$66,000
Total Operating Costs:		$7,066,000
Five-Year Review (6 Reviews Planned)	$63,000	$157,000
SUBTOTAL		$11,326,000
Contingency (@ 20%)		$2,265,000
TOTAL COST		$13,591,000

NOTES:
(1) Discount rate of 10% is used over 30 years for annual costs.
(2) Activities requiring Health and Safety training or equipment are marked with an asterisk.
(3) Costs are rounded to the nearest $1,000.

with implementing these construction activities have been estimated at $770,000, $925,000, and $951,000.

Operating costs for this alternative include labor, pretreatment chemicals and disposal of metal sludge, electricity (for operating the pumps and lighting in the building), equipment maintenance (assumed to be 5 percent of the capital costs per year), environmental monitoring costs as described in Subsection 3.2.7 for Alternative 1,3-B, effluent monitoring, and air monitoring for the air stripping option. Total present-worth operating cost is $6,086,000, $6,840,000, and $7,066,000 for air stripping UV/H_2O_2, and UV/O_3, respectively. Monitoring and operation of the treatment plant are assumed to continue for 30 years for cost-estimating purposes; however, treatment could continue for a longer time period. Although the time to achieve remedial action objectives cannot be accurately estimated now, the long-term monitoring and five-year site reviews will determine when treatment can be terminated. The cost of the site review is estimated to be $63,000 every five years.

A contingency of 20 percent of the present-worth cost of the alternative is added to account for unforeseen circumstances that may increase the estimated cost.

The total present-worth cost of the Cap, Groundwater Extraction, and Treatment Alternative is $11,693,000, $13,241,000, and $13,591,000 for air stripping, UV/H_2O_2, and UV/O_3, respectively. These costs are estimates and are believed to be within the +50 percent to -30 percent range for FS cost estimates (USEPA, 1988). These costs are sensitive to the time it will take to meet response objectives. Also, the capital cost is sensitive to the location of the clay source relative to the base; clay cost depends heavily on transportation costs. If VPC is needed, air stripping may not be a cost-effective alternative because of the high carbon usage costs. Additional costs for meeting effluent discharge requirements may be incurred depending on the discharge method chosen. The frequency of sampling and type of analysis would be dictated by effluent discharge requirements.

The choice of the water treatment technology to be designed and implemented should not be based only on cost considerations, but on the technology's performance as indicated by treatability test results. The cost of the treatability tests given in Tables 3-11, 3-12, and 3-13 includes bench-scale testing of pretreatment methods, air stripping, UV/H_2O_2, and UV/O_3.

3.6 ALTERNATIVE 1,3-F: CAP/PASSIVE GROUNDWATER COLLECTION/TREATMENT

Alternative 1,3-F is a variation of Alternatives 1,3-D and 1,3-E, incorporating both source control and groundwater treatment components, as follows:

- cap
- passive groundwater collection
- water treatment
- discharge of treated water
- institutional controls and deed restrictions
- environmental monitoring

This alternative is the same as Alternative 1,3-E in that it includes a cap to reduce infiltration and prevent contact with wastes and provides a means for groundwater collection and treatment. Unlike Alternative 1,3-E, it incorporates passive groundwater collection (an interceptor trench) rather than active extraction (a system of pumping wells). Deed restrictions would be enacted to limit future land use, and an environmental monitoring and review program would be implemented. Because each component of this alternative has been described in detail in preceding subsections, they will be briefly outlined here with reference to earlier discussion.

Cap. A multilayer cover system would encompass the 11.6-acre area as shown in Figure 3-2. The cap construction and testing requirements are given in Subsection 3.3 for Alternative 1,3-C and Subsection 3.5 for Alternative 1,3-E.

Passive Groundwater Collection. The 2,300-foot downgradient interceptor trench would be located as shown in Figure 3-14. Details of sump construction, trenching, and backfilling are described in Subsection 3.4 for Alternative 1,3-D.

Water Treatment. A description of the design of the treatment system (inorganics pretreatment and organics removal) is found in Subsection 3.3 for Alternative 1,3-C. This discussion evaluates several treatment options and provides process flow and schematic diagrams (see Figures 3-10 through 3-13).

Discharge of Treated Water. Treated effluent could be discharged by any of the four methods described in Subsection 3.3 for Alternative 1,3-C. For preliminary design and cost-estimating purposes, water is assumed to be discharged upgradient of the landfill.

Institutional Controls and Deed Restrictions. As described in Subsection 3.2 for Alternative 1,3-B, warning signs would be installed and deed restrictions implemented to supplement existing institutional controls to prevent future use of the site and thereby reduce the potential for exposure to site contaminants. The mechanism for implementing these institutional controls will be addressed in the ROD for remedial actions at Sites 1 and 3.

Environmental Monitoring. The environmental monitoring program for the passive downgradient interceptor trench and cap alternative would be very similar to that discussed in Subsection 3.4 for Alternative 1,3-D, the passive downgradient collection trench alternative. As in the other alternatives, five-year reviews would be required as part of the environmental monitoring program for this alternative.

3.6.1 Overall Protection of Human Health and the Environment

This alternative would provide an increased level of protection to human and ecological receptors over baseline conditions. The cap and passive groundwater collection and treatment system would effectively capture and treat contaminated groundwater before it discharges to Mere Brook. The clay cap would reduce the amount of infiltration passing through the waste, which would decrease the amount of contaminated groundwater generated. The concentration of contaminants in the leachate seeps and the volume of the seeps would also decrease as the contaminated groundwater would be captured in the passive collection system.

Because this alternative would not remove or treat waste in the landfill, it would rely on natural flushing, degradation, or dispersion to reduce contaminant concentrations in groundwater. Therefore, continual treatment of groundwater would be required for an estimated 18 to 73 years to ensure that remedial action objectives are met.

To ensure protection of human health, the Navy will conduct a risk assessment at the five year review. If the risks do not fall within the target risk range as specified in the NCP (i.e., 10^{-4} to 10^{-6}), the Navy will consider the need for additional remedial actions.

3.6.2 Compliance with ARARs

Chemical-specific ARARs for groundwater would be achieved under this alternative. Collection and treatment of contaminated groundwater would continue until the

MCL, MCLGs, or TBCs are achieved. Water would be treated to meet federal and state requirements for discharge of treated water. This alternative would decrease the amount of contaminated groundwater discharging to Mere Brook. However, due to contribution of upgradient non-point sources of iron and zinc, the chemical-specific ARARs for these metals may not be attained (see Section 2.1).

Other chemical-specific ARARs include state and federal air regulations including the total suspended particulate standards identified under the CAA (40 CFR 129), and the Maine regulations concerning the Protection and Improvement of Air (38 M.R.S.A. Chapter 4). These regulations would be attained during construction activities by controlling fugitive dust emissions. In addition, if air stripping is considered for groundwater treatment, the state's guidance on the Protection and Improvement of Air and Ambient Air Quality Standards would be relevant and appropriate.

Action-specific ARARs include federal and state regulations pertaining to hazardous waste operations (RCRA 40 CFR 264; MEDEP Chapters 800-802, 850, 851, 853-857). These regulations would be used as standards during remedial design to ensure compliance.

The landfill cover system would be designed to meet RCRA guidelines (USEPA, 1985). The cover system would be monitored and repaired as necessary.

Sludge generated during the pretreatment of groundwater would be tested before disposal. If the sludge was determined to be hazardous it would be treated to ensure that contaminant levels would not exceed allowable leachate concentrations in an extract sample using the TCLP. After treatment, the sludge would be disposed of in a RCRA-compliant facility.

The requirements for discharge of treated water under this alternative are the same as those discussed in Subsection 3.3.2.

If construction of the cap or groundwater treatment plant requires excavation and movement of soil within 100 feet of Mere Brook, the MEDEP Natural Resource Protection Act (Chapter 305) would apply. The location-specific ARAR sets forth standards for activities conducted adjacent to a stream to ensure that disturbed soil is stabilized in order to prevent erosion of the stream bank and siltation of the water.

If remedial construction activities cannot be conducted in accordance with these standards, a permit will be obtained.

All OSHA requirements regulating worker safety and employee records must be followed during site work. OSHA regulations include health and safety standards for federal service contracts, recordkeeping and reporting, and requirements such as safety equipment and procedures to be followed during site remediation. Because hazardous contaminants would remain on-site following implementation of this remedial alternative, a site review would be performed every five years pursuant to SARA and outlined in the Agreement. All site activities, including monitoring, would be carried out pursuant to OSHA standards (29 CFR 1904, 1910, and 1926).

3.6.3 Long-term Effectiveness and Permanence

The cap would reduce infiltration through the contaminated material and into groundwater and improve surface runoff. However, a significant amount of groundwater would still flow through wastes buried at Sites 1 and 3. Contaminated water would be collected by the interceptor trench, pretreated to remove iron and manganese, and treated to remove organics. Concentrations of contaminants in surface water and soil and sediments near leachate seeps would decrease over time due to natural attenuation because contaminants would no longer discharge to the stream. Contamination in the seeps and the volume of the seeps would both decrease due to the physical collection of contaminated water and the decreased hydraulic gradients near the seeps.

Due to uncertainties associated with the volume and exact nature of the source material, the time for flushing to be achieved is estimated to range from 18 to 73 years, as discussed in Subsection 3.5.3 for Alternative 1,3-E. Treatment would have to continue until contaminant concentrations in groundwater reached target levels. Once this had been verified by results of the monitoring program, treatment could be discontinued.

The long-term effectiveness and permanence of the treatment and discharge options have been discussed for the other water treatment alternatives.

3.6.4 Reduction of Toxicity, Mobility, or Volume

The reduction in toxicity, mobility, and volume of contaminants afforded by this alternative is the same as discussed in Subsection 3.5.4 for Alternative 1,3-E. Collecting groundwater immediately downgradient of the source would reduce contaminant toxicity and mobility in groundwater and in Mere Brook but would increase the volume of water to be treated. There is no proposed treatment of source material as part of this alternative.

As discussed, the water treatment system would ultimately reduce the toxicity, mobility, and volume of contaminants in the water, but may increase toxicity, mobility, and volume of contaminants in the wastestreams (e.g., clarifier sludge or air from the stripping tower).

3.6.5 Short-term Effectiveness

The short-term effectiveness for each component of this alternative (i.e., cap, downgradient interceptor trench, treatment, and environmental monitoring) was discussed for the other alternatives. These components have been combined from Alternatives 1,3-B, 1,3-C, and 1,3-D to form Alternative 1,3-F. Therefore, a discussion of the short-term effectiveness of these components will not be repeated. The cap was discussed in Subsection 3.3.5 for Alternative 1,3-C. Short-term effectiveness for the interceptor trench, treatment, and discharge was discussed in Subsection 3.4.5 for Alternative 1,3-D. Environmental monitoring was discussed in Subsection 3.2.5 for Alternative 1,3-B.

The main issues discussed in these subsections are the need for workers trained in health and safety practices, increased truck traffic on and near NAS Brunswick, and the possibility of intrusive work into contaminated zones. For more detail on these short-term effectiveness issues, refer to the subsections listed above.

3.6.6 Implementability

Each component of this alternative (i.e., cap, downgradient interceptor trench, treatment, and environmental monitoring) has been discussed for other alternatives. Therefore, a discussion of the implementability of each component will not be repeated. The cap was discussed in Subsection 3.3.6. The implementability of the interceptor trench and treatment was presented in Subsection 3.4.6.

Subsections 3.2.6, 3.3.6, and 3.4.6 discuss the implementability of environmental monitoring as it applies to alternatives from which the elements of Alternative 1,3-F have been combined.

To reiterate important implementability concerns, construction would not be implemented in the northwestern corner of the Weapons Compound. Underground utilities would require relocation prior to construction activities to ensure they would not be damaged. Treatability testing would be required before designing a water treatment system to ensure that the technology will be able to meet effluent discharge limits. The approval process for discharge of treated water may limit the options available for discharge. Coordination with the base would be required for short-term construction activities and long-term monitoring and maintenance requirements.

3.6.7 Cost

The cost estimate for Alternative 1,3-F is summarized in Tables 3-14, 3-15, and 3-16. Supporting information is provided in Appendix A. An estimate of the cost of all of the various water treatment and discharge options is included in these tables. For preliminary design and cost estimating purposes, it was assumed the water would be treated by air stripping to drinking water standards and the effluent could be discharged through upgradient reinjection.

The capital cost of this alternative includes the cost of clearing, grading, and surveying the site, locating a clay source, constructing the cap, installing the trench, pumping and piping the water to the treatment plant, and installing warning signs, in addition to water treatment and discharge. The water treatment component includes costs for bench-scale treatability testing, pretreatment and equipment, building construction, and utilities hookup for the building. The discharge component includes pumps, piping, and installing reinjection wells. The total capital cost using air stripping, UV/H_2O_2, and UV/O_3 is estimated to be $3,544,000, $3,925,000, and $3,965,000, respectively. Other indirect costs associated with implementing these construction activities have been estimated at $1,163,000, $1,319,000, and $1,344,000.

Operating costs for this alternative include labor, pretreatment chemicals and disposal of metal sludge, electricity (for operating the pumps and lighting in the building), equipment maintenance (assumed to be 5 percent of the capital costs per

TABLE 3-14
ALTERNATIVE 1,3-F:
CAP/PASSIVE GROUNDWATER COLLECTION/AIR STRIPPING
COST SUMMARY

FOCUSED FEASIBILITY STUDY
NAS BRUNSWICK

	COST	PRESENT WORTH (1)
CAPITAL COSTS		
Cap		
Clay Borrow Study	$17,000	
Survey	$9,000	
Site Preparation	$43,000	
Materials	$1,105,000	
Construction QC Testing	$19,000	
Replacement of Road and Parking Lot	$45,000	
Site Manager	$40,000	
Downgradient Trench (2)		
Trench Installation*	$575,000	
Disposal of Excavated Material*	$753,000	
Site Manager	$3,000	
Groundwater Collection		
Pumps	$6,000	
Piping	$40,000	
Water Treatment		
Treatability Tests*	$52,000	
Building	$165,000	
Utilities	$51,000	
Pretreatment*	$394,000	
Air Stripping*	$44,000	
Discharge		
Pumps	$4,000	
Piping	$16,000	
Reinjection	$161,000	
Institutional Controls		
Warning Signs	$2,000	
Total Capital Costs:	$3,544,000	$3,544,000
INDIRECT COSTS		
Health and Safety		
(@ 25% of Construction and Treatment Costs)(3)	$455,000	
Legal, Administrative, and Permitting		
(@ 5% of Capital Cost)	$177,000	
Engineering (@ 10% of Capital Cost)	$354,000	
Services During Construction		
(@ 5% of Capital Cost)	$177,000	
Total Indirect Costs:	$1,163,000	$1,163,000

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TABLE 3-14
ALTERNATIVE 1,3-F:
CAP/PASSIVE GROUNDWATER COLLECTION/AIR STRIPPING
COST SUMMARY

FOCUSED FEASIBILITY STUDY
NAS BRUNSWICK

	COST	PRESENT WORTH (1)
ANNUAL OPERATING COSTS		
Labor	$117,000	$1,103,000
Pretreatment Chemicals	$84,000	$792,000
Electricity	$31,000	$292,000
Sludge Disposal	$247,000	$2,328,000
Maintenance	$39,000	$368,000
Environmental Monitoring		
First 2 Years (4 Episodes Per Year)	$212,000	$380,000
Remaining 28 Years (1 Episode Per Year)	$53,000	$408,000
Effluent Monitoring	$7,000	$66,000
Air Monitoring	$12,000	$113,000
Total Operating Costs:		$5,850,000
Five-Year Review (6 Reviews Planned)	$63,000	$157,000
SUBTOTAL		$10,714,000
Contingency (@ 20%)		$2,143,000
TOTAL COST		$12,857,000

NOTES:
(1) Discount rate of 10% is used over 30 years for annual costs.
(2) Trench installation cost quoted by Industrial Builders, Inc.
(3) Activities requiring Health and Safety training or equipment are marked with an asterisk.
(4) Costs are rounded to the nearest $1,000.

TABLE 3-15
ALTERNATIVE 1,3-F:
CAP/PASSIVE GROUNDWATER COLLECTION/UV/H2O2
COST SUMMARY

FOCUSED FEASIBILITY STUDY
NAS BRUNSWICK

	COST	PRESENT WORTH (1)
CAPITAL COSTS		
Cap		
Clay Borrow Study	$17,000	
Survey	$9,000	
Site Preparation	$43,000	
Materials	$1,105,000	
Construction QC Testing	$19,000	
Replacement of Road and Parking Lot	$45,000	
Site Manager	$40,000	
Downgradient Trench (2)		
Trench Installation*	$575,000	
Disposal of Excavated Material*	$753,000	
Site Manager	$3,000	
Groundwater Collection		
Pumps	$6,000	
Piping	$40,000	
Water Treatment		
Treatability Tests*	$52,000	
Building	$230,000	
Utilities	$51,000	
Pretreatment*	$394,000	
UV/H2O2*	$360,000	
Discharge		
Pumps	$4,000	
Piping	$16,000	
Reinjection	$161,000	
Institutional Controls		
Warning Signs	$2,000	
Total Capital Costs:	$3,925,000	$3,925,000
INDIRECT COSTS		
Health and Safety		
(@ 25% of Construction and Treatment Costs)(3)	$534,000	
Legal, Administrative, and Permitting		
(@ 5% of Capital Cost)	$196,000	
Engineering (@ 10% of Capital Cost)	$393,000	
Services During Construction		
(@ 5% of Capital Cost)	$196,000	
Total Indirect Costs:	$1,319,000	$1,319,000

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TABLE 3-15
ALTERNATIVE 1,3-F:
CAP/PASSIVE GROUNDWATER COLLECTION/UV/H2O2
COST SUMMARY

FOCUSED FEASIBILITY STUDY
NAS BRUNSWICK

	COST	PRESENT WORTH (1)
ANNUAL OPERATING COSTS		
Labor	$117,000	$1,103,000
Pretreatment Chemicals	$84,000	$792,000
Peroxide	$6,000	$57,000
Electricity	$97,000	$914,000
Sludge Disposal	$247,000	$2,328,000
Maintenance	$58,000	$547,000
Environmental Monitoring		
First 2 Years (4 Episodes Per Year)	$212,000	$380,000
Remaining 28 Years (1 Episode Per Year)	$53,000	$408,000
Effluent Monitoring	$7,000	$66,000
Total Operating Costs:		$6,595,000
Five-Year Review (6 Reviews Planned)	$63,000	$157,000
SUBTOTAL		$11,996,000
Contingency (@ 20%)		$2,399,000
TOTAL COST		$14,395,000

NOTES:
(1) Discount rate of 10% is used over 30 years for annual costs.
(2) Trench installation cost quoted by Industrial Builders, Inc.
(3) Activities requiring Health and Safety training or equipment are marked with an asterisk.
(4) Costs are rounded to the nearest $1,000.

TABLE 3-16
ALTERNATIVE 1,3-F:
CAP/PASSIVE GROUNDWATER COLLECTION/UV/O3
COST SUMMARY

FOCUSED FEASIBILITY STUDY
NAS BRUNSWICK

	COST	PRESENT WORTH (1)
CAPITAL COSTS		
Cap		
Clay Borrow Study	$17,000	
Survey	$9,000	
Site Preparation	$43,000	
Materials	$1,105,000	
Construction QC Testing	$19,000	
Replacement of Road and Parking Lot	$45,000	
Site Manager	$40,000	
Downgradient Trench (2)		
Trench Installation*	$575,000	
Disposal of Excavated Material*	$753,000	
Site Manager	$3,000	
Groundwater Collection		
Pumps	$6,000	
Piping	$40,000	
Water Treatment		
Treatability Tests*	$52,000	
Building	$200,000	
Utilities	$51,000	
Pretreatment*	$394,000	
UV/O3*	$430,000	
Discharge		
Pumps	$4,000	
Piping	$16,000	
Reinjection	$161,000	
Institutional Controls		
Warning Signs	$2,000	
Total Capital Costs:	$3,965,000	$3,965,000
INDIRECT COSTS		
Health and Safety		
(@ 25% of Construction and Treatment Costs)(3)	$551,000	
Legal, Administrative, and Permitting		
(@ 5% of Capital Cost)	$198,000	
Engineering (@ 10% of Capital Cost)	$397,000	
Services During Construction		
(@ 5% of Capital Cost)	$198,000	
Total Indirect Costs:	$1,344,000	$1,344,000

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TABLE 3-16
ALTERNATIVE 1,3-F:
CAP/PASSIVE GROUNDWATER COLLECTION/UV/O3
COST SUMMARY

FOCUSED FEASIBILITY STUDY
NAS BRUNSWICK

	COST	PRESENT WORTH (1)
ANNUAL OPERATING COSTS		
Labor	$117,000	$1,103,000
Pretreatment Chemicals	$84,000	$792,000
Electricity	$125,000	$1,178,000
Sludge Disposal	$247,000	$2,328,000
Maintenance	$60,000	$566,000
Environmental Monitoring		
First 2 Years (4 Episodes Per Year)	$212,000	$380,000
Remaining 28 Years (1 Episode Per Year)	$53,000	$408,000
Effluent Monitoring	$7,000	$66,000
Total Operating Costs:		$6,821,000
Five-Year Review (6 Reviews Planned)	$63,000	$157,000
SUBTOTAL		$12,287,000
Contingency (@ 20%)		$2,457,000
TOTAL COST		$14,744,000

NOTES:
(1) Discount rate of 10% is used over 30 years for annual costs.
(2) Trench installation cost quoted by Industrial Builders, Inc.
(3) Activities requiring Health and Safety training or equipment are marked with an asterisk.
(4) Costs are rounded to the nearest $1,000.

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year), environmental monitoring costs as described in Subsection 3.2.7 for Alternative 1,3-B, effluent monitoring, and air monitoring for the air stripper option. Total present-worth operating cost is approximately $5,850,000, $6,595,000, and $6,821,000 for air stripping, UV/H_2O_2, and UV/O_3, respectively. Monitoring and operation of the treatment plant are assumed to continue for 30 years for cost estimating purposes; however, treatment could to continue for a longer time period. Although the time to achieve response objectives cannot be accurately predicted now, the long-term monitoring and five-year site reviews will determine when treatment can be terminated. The cost of the site review is estimated to be $63,000 every five years.

A contingency of 20 percent of the present-worth cost of the alternative is added to account for unforeseen circumstances that may increase the estimated cost.

The total present-worth cost of the Cap, Passive Groundwater Collection, and Treatment Alternative is $12,857,000, $14,395,000 and $14,744,000 for air stripping, UV/H_2O, and UV/O_3, respectively. These costs are estimates and are believed to be within the +50 percent to -30 percent range for FS cost estimates (USEPA, 1988). These costs are sensitive to the length of time it will take to meet the response objectives. Also, the capital cost is sensitive to the location of the clay source relative to the base; clay cost depends heavily on transportation costs. If VPC is needed, the annual cost of carbon would make air stripping infeasible. Additional costs for meeting effluent discharge requirements may be incurred depending on the discharge method chosen. The frequency of sampling and type of analysis would be dictated by effluent discharge requirements.

The choice of the water treatment technology to be designed and implemented should not be based only on cost considerations, but on the technology's performance as indicated by treatability test results. The cost of the treatability tests given in Tables 3-14, 3-15, and 3-16 includes bench-scale testing of pretreatment methods, air stripping, UV/H_2O_2, and UV/O_3.

4.0 COMPARATIVE ANALYSIS OF ALTERNATIVES

The comparative analysis evaluates the relative performance of each alternative using the criteria upon which the detailed analysis of alternatives was conducted. The purpose of the comparative analysis is to identify the advantages and disadvantages of the alternatives relative to one another to aid in the selection of a remedy for Sites 1 and 3. The following subsections highlight differences between the alternatives for each criterion. The criteria analysis is summarized in Table 4-1.

4.1 OVERALL PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT

All the remedial alternatives, except the No Action and Minimal Action Alternatives, would provide an increased level of protection to human and ecological receptors. The No Action and Minimal Action Alternatives were not designed to achieve the remedial action objectives. Alternatives 1,3-C, 1,3-D, 1,3-E, and 1,3-F include containment, collection and/or treatment components that would effectively reduce contaminant concentrations in groundwater and leachate sediments. Because none of the alternatives include source removal, they all would rely on natural attenuation and degradation processes to assist in reducing contaminant levels in the groundwater and Mere Brook. However, because Alternative 1,3-C lowers groundwater below the level of waste, less contaminated groundwater is generated and a smaller volume of water requires treatment. The time required to achieve the remedial action objectives is shortest for Alternative 1,3-C (142 to 370 days). Because Alternatives 1,3-D; 1,3-E; and 1,3-F all rely on natural flushing and degradative processes, the time to achieve remedial response actions for these Alternatives are all estimated to be between 18 and 73 years.

4.2 COMPLIANCE WITH ARARS

The No Action and Minimal Action Alternatives were not designed to achieve the remedial action objectives and, therefore, would not comply with chemical-specific ARARs. Groundwater treatment by air stripping and off-gas treatment (VPC), a technology considered for Alternatives 1,3-C, 1,3-D, 1,3-E, and 1,3-F, may not attain the chemical-specific ARARs for air emissions of vinyl chloride or methylene chloride. All other VOCs are expected to be effectively removed using VPC. If

TABLE 4-1
SUMMARY OF COMPARATIVE ANALYSIS OF ALTERNATIVES: SITES 1 AND 3

FOCUSED FEASIBILITY STUDY
NAS BRUNSWICK

CRITERION	1,3-A NO ACTION	1,3-B MINIMAL ACTION	1,3-C CONTAINMENT;GROUNDWATER EXTRACTION AND TREATMENT
Overall Protection of Human Health and the Environment			
How risks are eliminated, reduced, or controlled.	Remedial action objectives would not be achieved because no action is taken to reduce, contain or treat groundwater or leachate.	Remedial action objectives would not be achieved because no action is taken to reduce, contain or treat groundwater or leachate.	Cap would decrease infiltration and slurry wall would divert clean groundwater around source area reducing the amount of contaminated water and leachate. Groundwater would be extracted and treated to meet discharge requirements.
Short-term or cross-media impact.	No short-term or cross- media impacts are associated with this alternative. There are no current (i.e., short-term) human exposures to groundwater. Ecological receptors at risk from exposure to leachate.	No short-term or cross- media impacts are associated with this alternative. There are no current (i.e., short-term) human exposures to groundwater. Ecological receptors at risk from exposure to leachate.	No short-term impacts. Slurry wall would be constructed in uncontaminated areas. Ground-water treatment may include air stripping, whereby contaminants would be transferred from water to air. Off-gas treatment would be required.

TABLE 4-1
SUMMARY OF COMPARATIVE ANALYSIS OF ALTERNATIVES: SITES 1 AND 3

FOCUSED FEASIBILITY STUDY
NAS BRUNSWICK
(continued)

	1,3-D PASSIVE GROUNDWATER COLLECTION AND TREATMENT	1,3-E CAP WITH GROUNDWATER EXTRACTION AND TREATMENT	1,3-F CAP WITH PASSIVE GROUNDWATER EXTRACTION AND TREATMENT
Overall Protection of Human Health and the Environment			
How risks are eliminated, reduced, or controlled.	Groundwater would be collected downgradient of source area and treated to meet discharge requirements. Leachate generation would be reduced by passive collection system.	Sites 1 and 3 would be capped and groundwater extracted and treated to meet discharge requirements. Leachate would be reduced by capturing groundwater before migrating from source area.	Sites 1 and 3 would be capped and groundwater extracted and treated to meet discharge requirements. Leachate would be reduced by capturing groundwater. before migrating from source area.
Short-term or cross-media impact.	No short-term impacts. The collection/treatment system would be located to minimize impact to environment. Construction may occur in contaminated areas. Groundwater treatment may include air stripping, whereby contaminants would be transferred from water to air. Off-gas treatment would be required.	No short-term impacts. The extraction/treatment system would be located to minimize impact to environment. Groundwater treatment may include air stripping, whereby contaminants would be transferred from water to air. Off-gas treatment would be required.	No short-term impacts. The collection/treatment system would be located to minimize impact to environment. Groundwater treatment may include air stripping, whereby contaminants would be transferred from water to air. Off-gas treatment would be required.

TABLE 4-1
SUMMARY OF COMPARATIVE ANALYSIS OF ALTERNATIVES: SITES 1 AND 3

FOCUSED FEASIBILITY STUDY
NAS BRUNSWICK

CRITERION	1,3-A NO ACTION	1,3-B MINIMAL ACTION	1,3-C CONTAINMENT;GROUNDWATER EXTRACTION AND TREATMENT
Compliance with ARARs			
Chemical-specific ARARs	Would not comply.	Would not comply.	142 to 370 days would be required to extract and treat one pore volume of contaminated groundwater to MCLs or discharge requirements. Potential air emissions would be treated to meet ARARs.
Location-specific ARARs	Not applicable.	Not applicable.	Location of slurry wall, cap and treatment facility would comply with Maine's Natural Resource Protection Act or permit would be obtained.
Action-specific ARARs	No action is taken, therefore not applicable.	No action is taken, therefore not applicable.	Would comply with all ARARs. MCLs, MCLGs, and AWQCs are ARARs. Maine MEGs are TBCs. No sediment ARARs.
Criteria, advisories, and guidances	MCLs, MCLGs, and AWQCs are ARARs. Maine MEGs are TBCs. No sediment ARARs.	MCLs, MCLGs, and AWQCs are ARARs. Maine MEGs are TBCs. No sediment ARARs.	

TABLE 4-1
SUMMARY OF COMPARATIVE ANALYSIS OF ALTERNATIVES: SITES 1 AND 3

FOCUSED FEASIBILITY STUDY
NAS BRUNSWICK
(continued)

	1,3-D PASSIVE GROUNDWATER COLLECTION AND TREATMENT	1,3-E CAP WITH GROUNDWATER EXTRACTION AND TREATMENT	1,3-F CAP WITH PASSIVE GROUNDWATER EXTRACTION AND TREATMENT
Compliance with ARARs			
Chemical-specific ARARs	Would achieve MCLs in 18 to 73 years. Potential air emissions would be treated to achieve ARARs.	Would achieve MCLs in 18 to 73 years. Potential air emissions would be treated to achieve ARARs.	Would achieve MCLs in 18 to 73 years. Potential air emissions would be treated to achieve ARARs.
Location-specific ARARs	Location of trench and treatment facility would comply with Maine's Natural Resource Protection Act or permit would be obtained.	Location of cap and treatment facility would comply with Maine's Natural Resource Protection Act or permit would be obtained.	Location of cap and treatment facility would comply with Maine's Natural Resource Protection Act or permit would be obtained.
Action-specific ARARs Criteria, advisories, and guidances	Would comply with all ARARs. MCLs, MCLGs, and AWQCs are ARARs. Maine MEGs are TBCs. No sediment ARARs.	Would comply with all ARARs. MCLs, MCLGs, and AWQCs are ARARs. Maine MEGs are TBCs. No sediment ARARs.	Would comply with all ARARs. MCLs, MCLGs, and AWQCs are ARARs. Maine MEGs are TBCs. No sediment ARARs.

TABLE 4-1
SUMMARY OF COMPARATIVE ANALYSIS OF ALTERNATIVES: SITES 1 AND 3

FOCUSED FEASIBILITY STUDY
NAS BRUNSWICK

CRITERION	1,3-A NO ACTION	1,3-B MINIMAL ACTION	1,3-C CONTAINMENT;GROUNDWATER EXTRACTION AND TREATMENT
Long-term Effectiveness and Permanence			
Magnitude of residual risk	Long-term risk would remain as source would continue to leach contaminants to groundwater and leachate seeps.	Long-term risk would remain as source would continue to leach contaminants to groundwater and leachate seeps.	Test pitting and groundwater modeling data indicate that groundwater would be lowered to below level of buried waste at every location where it was encountered. Residual risk would be minimal. Groundwater would be diverted around source area and contaminated groundwater would be extracted and treated to appropriate discharge requirements. Cap would reduce infiltration.

TABLE 4-1
SUMMARY OF COMPARATIVE ANALYSIS OF ALTERNATIVES: SITES 1 AND 3

FOCUSED FEASIBILITY STUDY
NAS BRUNSWICK
(continued)

	1,3-D PASSIVE GROUNDWATER COLLECTION AND TREATMENT	1,3-E CAP WITH GROUNDWATER EXTRACTION AND TREATMENT	1,3-F CAP WITH PASSIVE GROUNDWATER EXTRACTION AND TREATMENT
Long-term Effectiveness and Permanence			
Magnitude of residual risk	Residual risks would decrease with time. Passive collection of contaminanted groundwater, relies on natural degredative processes for contaminant reduction in source area. Leachate generation would decrease.	Residual risks would decrease with time as flushing and natural degredative processes reduce contaminant loading to groundwater. Groundwater extraction would prevent contaminant migration.	Residual risks would decrease with time as flushing and natural degredative processes reduce contaminant loading to groundwater. Groundwater extraction would prevent contaminant migration.

TABLE 4-1
SUMMARY OF COMPARATIVE ANALYSIS OF ALTERNATIVES: SITES 1 AND 3

FOCUSED FEASIBILITY STUDY
NAS BRUNSWICK

CRITERION	1,3-A NO ACTION	1,3-B MINIMAL ACTION	1,3-C CONTAINMENT;GROUNDWATER EXTRACTION AND TREATMENT
Adequacy of controls	Not applicable; no controls taken. However, current security practices limit access to the site.	Land use restrictions would prevent the use of contaminated groundwater and the development of the landfill area. However, the source area would continue to leach contaminants to the groundwater.	The slurry wall would effectively clean groundwater around the source area and the extraction and treatment system would reduce contaminant levels in groundwater. Test pitting and groundwater modeling information indicate that groundwater will not remain in contact with buried waste at all locations where it is located. The cap would adequately reduce infiltration and leaching in the vadose zone. Land use restrictions would be required to limit future development of capped area and the use of groundwater.

TABLE 4-1
SUMMARY OF COMPARATIVE ANALYSIS OF ALTERNATIVES: SITES 1 AND 3

FOCUSED FEASIBILITY STUDY
NAS BRUNSWICK
(continued)

	1,3-D PASSIVE GROUNDWATER COLLECTION AND TREATMENT	1,3-E CAP WITH GROUNDWATER EXTRACTION AND TREATMENT	1,3-F CAP WITH PASSIVE GROUNDWATER EXTRACTION AND TREATMENT
Adequacy of controls	Groundwater collection and treatment would prevent contaminated groundwater from discharging to Mere Brook. Land use restrictions would prevent the use of contaminated groundwater during treatment and future development of landfill areas.	Extraction wells would effectively contain groundwater and limit discharge to Mere Brook. The cap would decrease infiltration, however, the majority of water entering the landfill is from upgradient flow. Therefore, the cap would provide minimal improvement in quantity of waste and time to treat. Land use restrictions would prevent the use of contaminated groundwater and future development in the capped area.	Passive collection system would reduce leachate and groundwater discharge to Mere to Mere Brook. The cap would decrease infiltration, however, the majority of water entering the landfill is from upgradient flow. Therefore, the cap would provide minimal improvement in quantity of waste and time to treat. Land use restrictions would prevent the use of contaminated groundwater and future development in the capped area.

TABLE 4-1
SUMMARY OF COMPARATIVE ANALYSIS OF ALTERNATIVES: SITES 1 AND 3

FOCUSED FEASIBILITY STUDY
NAS BRUNSWICK

CRITERION	1,3-A NO ACTION	1,3-B MINIMAL ACTION	1,3-C CONTAINMENT;GROUNDWATER EXTRACTION AND TREATMENT
Reliability of controls	Land use restrictions can reliably be enforced on base. Land use restrictions would be unreliable if the base were decommissioned.	Institutional controls and land use restrictions are reliable as long as the base is in operation.	Pilot and bench scale treatability tests would help to optimize the final design for groundwater treatment. Cap and slurry walls are reliable technologies.
Reduction of Mobility, Toxicity, or Volume			
Treatment process and remedy	No treatment employed. Source would be remediated only by rainwater infiltration, biodegradation, and volatilization.	No treatment employed. Source would be remediated only by rainwater infiltration, biodegradation, and volatilization.	Groundwater extraction and treatment via air stripping or UV/oxidation. Off-gascap and slurry treatment would be required for air stripping. Cap and slurry wall would significantly reduce volume of contaminanted groundwater and leachate generated . No flushing of waste would occur.

TABLE 4-1
SUMMARY OF COMPARATIVE ANALYSIS OF ALTERNATIVES: SITES 1 AND 3

FOCUSED FEASIBILITY STUDY
NAS BRUNSWICK
(continued)

	1,3-D PASSIVE GROUNDWATER COLLECTION AND TREATMENT	1,3-E CAP WITH GROUNDWATER EXTRACTION AND TREATMENT	1,3-F CAP WITH PASSIVE GROUNDWATER EXTRACTION AND TREATMENT
Reliability of controls	Pilot and bench scale treatability tests would help optimize the final design of water treatment system. The passive collection system is reliable and easily constructed, however, maintenace, if necessary, would be difficult.	Pilot and bench scale treatability tests would help to optimize the final design for groundwater treatment.	Pilot and bench scale treatability tests would help to optimize the final design for groundwater treatment. The passive collection system is reliable and easily constructed, however, maintenance, if necessary, would be difficult.
Reduction of Mobility, Toxicity, or Volume			
Treatment process and remedy	Groundwater extraction and treatment via air stripping or UV/oxidation. Off-gas treatment would be required for air stripping. The passive collection system will reduce amount of leachate, however does not reduce the amount of contaminated groundwater generated. Natural flushing of buried wastes	Groundwater extraction and treatment via air stripping or UV/oxidation. Off-gas treatment would be required for air stripping. The passive collection system will reduce amount of leachate, however does not reduce the amount of contaminated groundwater generated. Natural	Passive groundwater collection/ treatment via air stripping or UV/oxidation. Off-gas treatment would be required for air stripping. Groundwater collection system will reduce amount of leachate generated. Natural flushing of buried wastes would occur.

TABLE 4-1
SUMMARY OF COMPARATIVE ANALYSIS OF ALTERNATIVES: SITES 1 AND 3

FOCUSED FEASIBILITY STUDY
NAS BRUNSWICK

CRITERION	1,3-A NO ACTION	1,3-B MINIMAL ACTION	1,3-C CONTAINMENT;GROUNDWATER EXTRACTION AND TREATMENT
Amount of hazardous material destroyed or treated	None. Natural degradation processes would cause decrease in contaminant concentrations. No source material would be treated.	None. Natural degradation processes would cause decrease in contaminant concentrations. No source material would be treated.	16 million gallons of contaminated groundwater would be treated. over approximately 142 days at a flow rate of 78 gpm. No source material would be treatd.
Reduction in mobility, toxicity, or volume through treatment	None. Applies to treatment alternatives.	None. Applies to treatment alternatives.	Would achieve significant and permanent reduction in toxicity, mobility, and volume of VOCs and inorganic compounds in groundwater.
Irreversibility of treatment	Not applicable. Applies to treatment alternatives.	Not applicable. Applies to treatment alternatives.	Groundwater treatment technologies are irreversible. No source treatment.

TABLE 4-1
SUMMARY OF COMPARATIVE ANALYSIS OF ALTERNATIVES: SITES 1 AND 3

FOCUSED FEASIBILITY STUDY
NAS BRUNSWICK
(continued)

	1,3-D PASSIVE GROUNDWATER COLLECTION AND TREATMENT	1,3-E CAP WITH GROUNDWATER EXTRACTION AND TREATMENT	1,3-F CAP WITH PASSIVE GROUNDWATER EXTRACTION AND TREATMENT
	would occur.	flushing of waste would occur.	
Amount of hazardous material destroyed or treated	Aminimum of 740 million gallons of water would be treated at a flow rate of 78 gpm for a minimum of 18 years. Contamination in the source would be reduced.	Aminimum of 740 million gallons of water would be treated at a flow rate of 78 gpm for a minimum of 18 years. Contamination in the source would be reduced.	Aminimum of 740 million gallons of water would be treated at a flow rate of 78 gpm for a minimum of 18 years. Contamination in the source would be reduced.
Reduction in mobility, toxicity, or volume through treatment	Will achieve significant and permanent reduction in toxicity, and mobility of contaminated groundwater. Will not significantly change volume of contaminated groundwater over Minimal Action. Contaminants in groundwater captured and destroyed in treatment process.	Will achieve significant and permanent reduction in toxicity, and mobility of contaminated groundwater. Will not significantly change volume of contaminated groundwater over Minimal Action. Contaminants in groundwater captured and destroyed in treatment process.	Will achieve significant and permanent reduction in toxicity, and mobility of contaminated groundwater. Will not significantly change volume of contaminated groundwater over Minimal Action. Contaminants in groundwater captured and destroyed in treatment process.
Irreversibility of treatment	Groundwater treatment technologies are irreversible. No source treatment.	Groundwater treatment technologies are irreversible. No source treatment.	Groundwater treatment technologies are irreversible. No source treatment.

TABLE 4-1
SUMMARY OF COMPARATIVE ANALYSIS OF ALTERNATIVES: SITES 1 AND 3

FOCUSED FEASIBILITY STUDY
NAS BRUNSWICK

CRITERION	1,3-A NO ACTION	1,3-B MINIMAL ACTION	1,3-C CONTAINMENT;GROUNDWATER EXTRACTION AND TREATMENT
Type and quantity of residual	Not applicable. Applies to treatment alternatives.	Not applicable. Applies to treatment alternatives.	Metal sludge would be generated during pretreatment. Treated groundwater would be discharged. Approximately 16 million gallons of water to be treated and discharged.
Short-term Effectiveness			
Protection of community during remedial actions	No impact to community.	No impact to community.	Air emission controls would be required for groundwater treatment if air stripping is retained. However, vinyl chloride and methylene chloride may exceed Maine Guideline values. Minimal risks during installation of slurry wall, cap, or treatment facility.
Protection of workers during remedial actions	Not Applicable. No action taken as part of this alternative.	Workers performing monitoring tasks would be required to follow HASP.	Minimal risk because no invasive actions would occur in contaminated areas. Workers required to follow HASP.

TABLE 4-1
SUMMARY OF COMPARATIVE ANALYSIS OF ALTERNATIVES: SITES 1 AND 3

FOCUSED FEASIBILITY STUDY
NAS BRUNSWICK
(continued)

	1,3-D PASSIVE GROUNDWATER COLLECTION AND TREATMENT	1,3-E CAP WITH GROUNDWATER EXTRACTION AND TREATMENT	1,3-F CAP WITH PASSIVE GROUNDWATER EXTRACTION AND TREATMENT
Type and quantity of residual	Metal sludge would be generated during pretreatment. Treated groundwater would be discharged. Greater than 610 million gallons of water to be treated and discharged.	Metal sludge would be generated during pretreatment. Treated groundwater would be discharged. Greater than 610 million gallons of water to be treated and discharged.	Metal sludge would be generated during pretreatment. Treated groundwater would be discharged. Greater than 610 million gallons of water to be treated and discharged.
Short-term Effectiveness			
Protection of community during remedial actions	Air emission controls would be required for groundwater treatment if air stripping is retained. However, vinyl chloride and methylene chloride may exceed Maine Guideline values. Minimal risks during installation of trench or treatment facility.	Air emission controls would be required for groundwater treatment if air stripping is retained. However, vinyl chloride and methylene chloride may exceed Maine Guideline values. Minimal risks during installation of cap, extraction and treatment facility.	Air emission controls would be required for groundwater treatment if air stripping is retained. However, vinyl chloride and methylene chloride may exceed Maine Guideline values. Minimal risks during installation of cap, extraction and treatment facility.
Protection of workers during remedial actions	Some risk because construction of trench is in potentially contaminated area. Workers required to follow HASP.	Minimal risks because little invasive work. All workers required to follow HASP.	Some risk because construction of trench is in potentially contaminated area. Workers required to follow HASP.

TABLE 4-1
SUMMARY OF COMPARATIVE ANALYSIS OF ALTERNATIVES: SITES 1 AND 3

FOCUSED FEASIBILITY STUDY
NAS BRUNSWICK

CRITERION	1,3-A NO ACTION	1,3-B MINIMAL ACTION	1,3-C CONTAINMENT;GROUNDWATER EXTRACTION AND TREATMENT
Environmental impacts	Contaminated groundwater would continue to discharge to Mere Brook. Leachate seeps would not be remediated.	Contaminated groundwater would continue to discharge to Mere Brook. Leachate seeps would not be remediated.	Minimal impacts (i.e., tree removal) during construction of wells, treatment plant, cap and slurry wall. Minimal environmental impacts associated with groundwater discharge to surface water and no environmental impacts associated with POTW discharge.
Time until remedial action objectives are achieved	Would not meet remedial action objectives.	In excess of 75 years because source of contamination would remain. Time to achieve MCLs is function of natural degredative processes.	142 to 370 days required to pump and treat groundwater.

TABLE 4-1
SUMMARY OF COMPARATIVE ANALYSIS OF ALTERNATIVES: SITES 1 AND 3

FOCUSED FEASIBILITY STUDY
NAS BRUNSWICK
(continued)

	1,3-D PASSIVE GROUNDWATER COLLECTION AND TREATMENT	1,3-E CAP WITH GROUNDWATER EXTRACTION AND TREATMENT	1,3-F CAP WITH PASSIVE GROUNDWATER EXTRACTION AND TREATMENT
Environmental impacts	Minimal impacts (i.e., tree removal) during construction of trench,and treatment plant. Minimal environmental impacts associated with groundwater discharge to surface water and no environmental impacts associated with POTW discharge.	Minimal impacts (i.e., tree removal) during construction of wells, treatment plant, and cover/cap system. Minimal environmental impacts associated with groundwater discharge to surface water and no environmental impacts associated with POTW discharge.	Minimal impacts (i.e., tree removal) during construction of wells, treatment plant, trench, and cover/cap system. Minimal environmental impacts associated with groundwater discharge to surface water and no environmental impacts associated with POTW discharge.
Time until remedial action objectives are achieved	Between 18 and 73 years required to pump and treat groundwater.	Between 18 and 73 years required to pump and treat groundwater.	Between 18 and 73 years required to pump and treat groundwater.

TABLE 4-1
SUMMARY OF COMPARATIVE ANALYSIS OF ALTERNATIVES: SITES 1 AND 3

FOCUSED FEASIBILITY STUDY
NAS BRUNSWICK

CRITERION	1,3-A NO ACTION	1,3-B MINIMAL ACTION	1,3-C CONTAINMENT;GROUNDWATER EXTRACTION AND TREATMENT
Implementability			
Ability to construct technology	Not Applicable.	Monitoring wells easily installed, if required.	Monitoring wells and extraction wells easily installed. Treatment plant easily constructed. Air stripper delivered prefabricated to site. UV/Oxidation simple to construct. Cap will require some site preparation but easy to construct.
Reliability of technology	Not Applicable.	Environmental monitoring is reliable.	Groundwater treatment is reliable. Treatment designed to met MCLs. However, may be more difficult if discharge permits are more stringent than MCLs. Caps and slurry walls are reliable.

TABLE 4-1
SUMMARY OF COMPARATIVE ANALYSIS OF ALTERNATIVES: SITES 1 AND 3

FOCUSED FEASIBILITY STUDY
NAS BRUNSWICK
(continued)

	1,3-D PASSIVE GROUNDWATER COLLECTION AND TREATMENT	1,3-E CAP WITH GROUNDWATER EXTRACTION AND TREATMENT	1,3-F CAP WITH PASSIVE GROUNDWATER EXTRACTION AND TREATMENT
Implementability			
Ability to construct technology	Monitoring wells, cap and down-gradient trench easily installed. Treatment plant easily constructed. Air stripper delivered prefabricated to site. UV/Oxidation simple to construct.	Monitoring wells and extraction wells easily installed. Treatment plant easily constructed. Air stripper delivered prefabricated to site. UV/Oxidation simple to construct. Cap will require some site preparation but easy to construct.	Monitoring wells and down- gradient trench easily installed. Treatment plant easily constructed. Air stripper delivered prefabricated to site. UV/Oxidation simple to contruct. Cap will require some site preparation but easy to construct.
Reliability of technology	Groundwater treatment is reliable. Treatment designed to met MCLs. However, may be more difficult if discharge permits are more stringent than MCLs. Downgradient trench is reliable.	Groundwater treatment is reliable. Treatment designed to met MCLs. However, may be more difficult if discharge permits are more stringent than MCLs. Caps are reliable.	Groundwater treatment is reliable. Treatment designed to met MCLs. However, may be more difficult if discharge permits are more stringent than MCLs. Caps are reliable.

TABLE 4-1
SUMMARY OF COMPARATIVE ANALYSIS OF ALTERNATIVES: SITES 1 AND 3

FOCUSED FEASIBILITY STUDY
NAS BRUNSWICK

CRITERION	1,3-A NO ACTION	1,3-B MINIMAL ACTION	1,3-C CONTAINMENT;GROUNDWATER EXTRACTION AND TREATMENT
Ease of undertaking additional remedial action, if necessary	Not Applicable.	Easy to undertake. Additional monitoring wells could easily be installed. Additional remedial controls could easily be constructed.	Additional remedial actions would be required if slurry wall fails. Additional extraction wells could be installed and water treated in the original treatment plant. Unlikely that cap would fail, easy to maintain and repair.
Monitoring considerations	No monitoring proposed as part of this alternative.	Migration of the plume would be monitored. Surface water would be monitored to determine impact of groundwater discharge and leachate seeps. No influent or effluent monitoring required.	Groundwater monitoring would be required to ensure slurry wall is functioning and groundwater is being extracted. Influent and effluent concentrations of groundwater at the treatment plant would be monitored as well as air emissions from air stripper.

TABLE 4-1
SUMMARY OF COMPARATIVE ANALYSIS OF ALTERNATIVES: SITES 1 AND 3

FOCUSED FEASIBILITY STUDY
NAS BRUNSWICK
(continued)

	1,3-D PASSIVE GROUNDWATER COLLECTION AND TREATMENT	1,3-E CAP WITH GROUNDWATER EXTRACTION AND TREATMENT	1,3-F CAP WITH PASSIVE GROUNDWATER EXTRACTION AND TREATMENT
Ease of undertaking additional remedial action, if necessary	Easy to undertake. Additional remedial actions could be implemented. Extraction wells, cap or slurry wall could easily be constructed, if required.	Easy to undertake. Additional remedial actions could be implemented. Extraction wells, or slurry wall could be easily constructed, if required.	Easy to undertake. Additional remedial actions could be implemented. Extraction wells, or slurry wall could be easily constructed, if required.
Monitoring considerations	Migration of the plume would be monitored to verify that collection system is adequately capturing the plume before dischare to Mere Brook. The influent and effluent concentrations of groundwater at the treatment plant would be monitored as well as air emissions from air stripper.	Migration of the plume would be monitored to verify that collection system is adequately capturing the plume before dischare to Mere Brook. The influent and effluent concentrations of groundwater at the treatment plant would be monitored as well as air emissions from air stripper.	Migration of the plume would be monitored to verify that collection system is adequately capturing the plume before dischare to Mere Brook. The influent and effluent concentrations of groundwater at the treatment plant would be monitored as well as air emissions from air stripper.

TABLE 4-1
SUMMARY OF COMPARATIVE ANALYSIS OF ALTERNATIVES: SITES 1 AND 3

FOCUSED FEASIBILITY STUDY
NAS BRUNSWICK

CRITERION	1,3-A NO ACTION	1,3-B MINIMAL ACTION	1,3-C CONTAINMENT;GROUNDWATER EXTRACTION AND TREATMENT
Coordination with other agencies	No monitoring proposed as part of this alternative. Minimal coordination required.	Coordination with NAS Brunswick personnel required for a long period of time for monitoring groundwater, surface water and leachate.	Coordination with NAS Brunswick personnel required for a long period of time for monitoring of groundwater. Coordination with city of Brunswick for POTW discharge.
Availability and capacity of treatment, storage, and disposal services	None required.	None required.	Availability of landfills permitted to accept the metals pretreatment sludge would be required at the time of remedial design.
Availability of technologies, equipment, and specialists	None required.	Drilling and construction contractors, monitoring equipment and personnel, and labs are available.	Drilling and construction contractors, monitoring equipment and personnel, and labs are available. Air strippers are commercially available. UV/Oxidation available through several vendors.

TABLE 4-1
SUMMARY OF COMPARATIVE ANALYSIS OF ALTERNATIVES: SITES 1 AND 3

FOCUSED FEASIBILITY STUDY
NAS BRUNSWICK
(continued)

	1,3-D PASSIVE GROUNDWATER COLLECTION AND TREATMENT	1,3-E CAP WITH GROUNDWATER EXTRACTION AND TREATMENT	1,3-F CAP WITH PASSIVE GROUNDWATER EXTRACTION AND TREATMENT
Coordination with other agencies	Coordination with NAS Brunswick personnel required for long period of time to monitoring groundwater. Coordination with city of Brunswick for POTW discharge.	Coordination with NAS Brunswick personnel required for a long period of time for monitoring of groundwater. Coordination with city of Brunswick for POTW discharge.	Coordination with NAS Brunswick personnel required for a long period of time for monitoring of groundwater. Coordination with city of Brunswick for POTW discharge.
Availability and capacity of treatment, storage, and disposal services	Availability of landfills permitted to accept the metals pretreatment sludge would be required at the time of remedial design.	Availability of landfills permitted to accept the metals pretreatment sludge would be required at the time of remedial design.	Availability of landfills permitted to accept the metals pretreatment sludge would be required at the time of remedial design.
Availability of technologies, equipment, and specialists	Drilling and construction contractors, monitoring equipment and personnel, and labs are available. Air strippers are commercially available. UV/Oxidation available through several vendors. Trench system easily installed by contractors.	Drilling and construction contractors, monitoring equipment and personnel, and labs are available. Air strippers are commercially available. UV/Oxidation available through several vendors. Cap system easily installed by contractors.	Drilling and construction contractors, monitoring equipment and personnel, and labs are available. Air strippers are commercially available. UV/Oxidation available through several vendors. Cap system and downgradient trench easily installed by contractors.

TABLE 4-1
SUMMARY OF COMPARATIVE ANALYSIS OF ALTERNATIVES: SITES 1 AND 3

FOCUSED FEASIBILITY STUDY
NAS BRUNSWICK

CRITERION	1,3-A NO ACTION	1,3-B MINIMAL ACTION	1,3-C CONTAINMENT;GROUNDWATER EXTRACTION AND TREATMENT
Capital Costs	None	$10,000	Air Stripping: $3,453,000 UV/H2O2: $3,834,000 UV/O3: $3,874,000
Operation and Maintenance Costs	None	$788,000	Air Stripping: $1,330,000 UV/H2O2: $1,408,000 UV/O3: $1,432,000
Total Present Worth	None	$1,147,000	Air Stripping: $6,997,000 UV/H2O2: $7,734,000 UV/O3: $7,842,000

TABLE 4-1
SUMMARY OF COMPARATIVE ANALYSIS OF ALTERNATIVES: SITES 1 AND 3

FOCUSED FEASIBILITY STUDY
NAS BRUNSWICK
(continued)

	1,3-D PASSIVE GROUNDWATER COLLECTION AND TREATMENT	1,3-E CAP WITH GROUNDWATER EXTRACTION AND TREATMENT	1,3-F CAP WITH PASSIVE GROUNDWATER EXTRACTION AND TREATMENT
Capital Costs	Air Stripping: $2,289,000 UV/H2O2: $2,670,000 UV/O3: $2,710,000	Air Stripping: $2,731,000 UV/H2O2: $3,112,000 UV/O3: $3,152,000	Air Stripping: $3,544,000 UV/H2O2: $3,925,000 UV/O3: $3,965,000
Operation and Maintenance Costs	Air Stripping: $5,850,000 UV/H2O2: $6,595,000 UV/O3: $6,821,000	Air Stripping: $6,086,000 UV/H2O2: $6,840,000 UV/O3: $7,066,000	Air Stripping: $5,850,000 UV/H2O2: $6,595,000 UV/O3: $6,821,000
Total Present Worth	Air Stripping: $11,050,000 UV/H2O2: $12,589,000 UV/O3: $12,938,000	Air Stripping: $11,693,000 UV/H2O2: $13,241,000 UV/O3: $13,591,000	Air Stripping: $12,857,000 UV/H2O2: $13,395,000 UV/O3: $14,744,000

VPC is not used as part of off-gas treatment, other VOCs in addition to vinyl chloride and methylene chloride may exceed their respective guidelines. Groundwater treatment employing UV/oxidation is a contained system that would attain chemicals specific ARARs for groundwater and air. Alternatives 1,3-C; 1,3-D; 1,3-E; and 1,3-F would all decrease the amount of contaminated groundwater discharging to Mere Brook. However, due to contribution of upgradient non-point sources of iron and zinc, the chemical-specific ARARs for these metals may not be attained (see Section 2.1). All other chemical-specific ARARs would be achieved by these alternatives.

The design of the remedy for the site would be based on location- and action-specific ARARs to ensure compliance with these regulations. The final treatment standards for groundwater would be based on achieving discharge requirements. In addition, all work conducted at the site would be in accordance with OSHA requirements.

4.3 Long-Term Effectiveness and Permanence

Neither the No Action nor the Minimal Action Alternative would meet remedial action objectives. The site would continue to pose a risk to both human health and the environment until natural attenuation reduced contaminant levels in the leachate and brook. Although current institutional controls effectively limit human contact with contaminants, these restrictions may not be enforced if NAS Brunswick is decommissioned. Environmental monitoring and site reviews would evaluate the effectiveness of natural attenuation in reducing contaminant concentrations; future remedial actions may be recommended.

The Containment Alternative (i.e., Alternative 1,3-C) is estimated to meet remedial action objectives in one to two years. This alternative substantially reduces water contact with the waste thereby shutting off the source of groundwater contamination. Because this alternative incorporates a groundwater extraction and treatment component, the volume of contaminated water remaining beneath the cap is removed and treated, preventing the discharge of this slug of water to the brook. This alternative relies on natural attenuation, dispersion, or degradation to reduce contaminant concentrations in the brook after the remedial action has been implemented. The cap and slurry wall are expected to be effective in diverting rainfall and groundwater flow away from the waste, and reducing the amount of contaminated groundwater generated. However, if these controls fail, the potential

for groundwater and leachate contamination exists because the contaminant source has not been remediated.

The other three groundwater treatment alternatives (i.e., Alternatives 1,3-D, 1,3-E, and 1,3-F) would meet remedial action objectives for groundwater because the water would be collected and treated before it could migrate from the source area. Each treatment option is considered to provide a permanent remedy and is estimated to take between 18 and 73 years to achieve Target Clean-up Levels.

4.4 Reduction Of Toxicity, Mobility, Or Volume

This criterion is relevant only for treatment alternatives. The No Action and Minimal Action Alternatives do not reduce the toxicity, mobility, or volume of contaminants or contaminated media. All four of the water treatment alternatives would reduce the toxicity, mobility, and volume of contaminants in groundwater. The volume of water to be treated is smallest for Alternative 1,3-C. It is estimated that 16 million gallons would remain below the landfill after the cap and slurry wall are installed. The other alternatives rely on natural flushing to decrease contaminant concentrations. A significantly greater volume of water would require treatment for these alternatives. This volume is estimated to be greater than 610 million gallons. The anticipated reduction of toxicity and mobility by the several pretreatment and organic treatment processes is evaluated in Subsection 3.3.4. The evaluation will not be repeated here, because it is the same regardless of the treatment alternative selected. The groundwater treatment technology will be chosen following treatability tests, which will evaluate the effectiveness of each treatment option.

4.5 Short-Term Effectiveness

Implementing either the No Action or Minimal Action Alternative would not result in additional adverse impacts on the public or the environment than already exist at Sites 1 and 3. For the other alternatives, impacts to the public would result from increased truck traffic as cap, slurry wall, trenching or drilling equipment and materials are transported to the site.

Impacts on the environment during remedial activities include the removal of trees during site preparation prior to installing the cap, slurry wall, trench, or infiltration

basin; or increased flows in streams where the discharge of treated water may occur. However, these components would be designed to have minimal impact on the environment. Preliminary groundwater modeling has been used to site the downgradient trench in an area that would not interfere with the water balance of Mere Brook.

Impacts to workers implementing remedial actions as part of 1,3-C, 1,3-D, 1,3-E, and 1,3-F would be mitigated by the use of appropriate personal protective equipment and clothing and by following safe work practices, as outlined in a HASP. These would be minimal to workers implementing the environmental monitoring programs as part of Alternatives 1,3-A and 1,3-B because no invasive work would be required.

4.6 IMPLEMENTABILITY

All the alternatives presented in this FFS are implementable, although obtaining access to the secured area to conduct monitoring or remedial actions would require coordination with personnel responsible for base security. Each of the technologies described are well developed and widely available.

If it is determined that additional remedial actions are necessary in the future, the cap in Alternatives 1,3-C, 1,3-E, and 1,3-F may need to be removed.

Although water treatment is technically feasible, discharge permit requirements for the effluent may be difficult to achieve if the water is discharged to a surface water or sewer system, because the effluent limits may be lower than drinking water standards. If infiltration is chosen as the discharge method, large areas of land may be needed for the infiltration basin.

4.7 COST

With the exception of the No Action Alternative, the alternative cost estimates are a combination of costs estimated for each component. Each remedial alternative includes as a component the cost of the institutional controls and environmental monitoring program given for Alternative 1,3-B, Minimal Action.

The least expensive alternative is clearly the No Action Alternative, estimated to cost nothing, because it would not require any additional controls or monitoring. The Minimal Action Alternative is expected to cost approximately $1.1 million. The Containment Alternative is also relatively inexpensive at approximately $7.0 to $7.8 million, depending on the water treatment process used. A sensitivity analysis showed that pretreating the groundwater to remove inorganic compounds and piping the water to a treatment facility for the Eastern Plume would cost approximately $6.1 million.

For Alternatives 1,3-C, 1,3-D, 1,3-E, and 1,3-F, the costs of the three different types of organic treatment processes were compared. Although cost estimates for the three types of treatment may differ by up to approximately $1.9 million within the same alternative, the water treatment technology should not be chosen based on cost.

The cost of three flushing alternatives only differ by approximately 10 percent, even though they offer varying degrees of containment (i.e., cap or no cap) and different systems for groundwater collection (i.e., downgradient interceptor trench or extraction wells). Table 2 in Appendix A presents a cost comparison conducted for Alternative 1,3-D. Table 2 shows a $1.2 million difference in the total present worth cost of the alternative due to the lower capital cost of installing eight extraction wells instead of a 2,300-foot-long interceptor trench. The difference is also evident when comparing Alternatives 1,3-E and 1,3-F, because these alternatives only differ in the type of collection system used. However, over a longer period of time than the 30-year period evaluated, the pumping well alternative may be more expensive due to higher operation and maintenance costs.

Because the total cost of the groundwater collection and treatment alternatives is so similar, the alternatives should not be compared to one another based on cost; but instead, they should be compared on the basis of their effectiveness in meeting response objectives, compliance with federal and state ARARs, and the relative ease of implementing the alternative within the constraints imposed by the sites' location.

ARAR	Applicable or Relevant and Appropriate Requirements
AWQC	Ambient Water Quality Criteria
bgs	below ground surface
CAA	Clean Air Act
CFR	Code of Federal Regulations
cm/sec	centimeters per second
CWA	Clean Water Act
cy	cubic yard
DCE	dichloroethylene
FFS	Focused Feasibility Study
f_{oc}	fraction of organic carbon
gpd	gallons per day
gpm	gallons per minute
HASP	Health and Safety Plan
HI	Hazard Index
H_2O_2	hydrogen peroxide
$KMnO_4$	potassium permanganate
lb/day	pound per day
MCL	Maximum Contaminant Level
MCLG	Maximum Contaminant Level Goal
MEDEP	Maine Department of Environmental Protection
mgd	million gallons per day
NAS	Naval Air Station
NCP	National Oil and Hazardous Substance Pollution Contingency Plan
NPDES	National Pollutant Discharge Elimination System
OSHA	Occupational Safety and Health Administration

O_3	ozone
PAC	Pollution Abatement Confirmation
POTW	publicly owned treatment works
PVC	polyvinyl chloride
RCRA	Resource Conservation and Recovery Act
RI/FS	Remedial Investigation and Feasibility Study
ROD	Record of Decision
SARA	Superfund Amendments Reauthorization Act
SITE	Superfund Innovative Technology Evaluation
S.M.W.	Soil-Cement Mixed-in-Place Wall
SVOC	semivolatile organic compound
TBC	to be considered
TCL	Target Compound List
TCLP	Toxicity Characteristic Leachate Procedure
USEPA	U.S. Environmental Protection Agency
UV	ultraviolet
VOC	volatile organic compound
VPC	vapor phase carbon

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SUPPORTING INFORMATION AND CALCULATIONS FOR COST ESTIMATES

TABLE 1
SENSITIVITY ANALYSIS
ALTERNATIVE 1,3-C: CONTAINMENT/
GROUNDWATER EXTRACTION/PRETREATMENT
COST SUMMARY

FOCUSED FEASIBILITY STUDY
NAS BRUNSWICK

	COST	PRESENT WORTH (2)
CAPITAL COSTS (1)		
Cap		
Clay Borrow Study	$17,000	
Survey	$9,000	
Site Preparation	$43,000	
Materials	$1,105,000	
Construction QC Testing	$19,000	
Replacement of Road and Parking Lot	$40,000	
Site Manager	$40,000	
Slurry Wall (3)		
Compatibility Study	$4,000	
Mobilization	$30,000	
Installation	$828,000	
Post-construction Testing	$4,000	
Site Manager	$30,000	
Groundwater Extraction Wells		
Pumping Tests	$23,000	
Mobilization	$10,000	
Decontamination	$2,000	
Piezometers	$4,000	
Well Materials and Installation*	$11,000	
Disposal of Excavated Material*	$300,000	
Groundwater Collection		
Pumps	$5,000	
Piping	$88,000	
Water Treatment		
Treatability Tests*	$6,000	
Building	$56,000	
Utilities	$51,000	
Pretreatment*	$230,000	
Institutional Controls		
Warning Signs	$2,000	
Total Capital Costs:	$2,957,000	$2,957,000
INDIRECT COSTS		
Health and Safety		
(@ 25% of Construction and Treatment Costs)(4)	$137,000	
Legal, Administrative, and Permitting		
(@ 5% of Capital Cost)	$148,000	
Engineering (@ 10% of Capital Cost)	$296,000	
Services During Construction		
(@ 5% of Capital Cost)	$148,000	
Total Indirect Costs:	$729,000	$729,000

TABLE 1
SENSITIVITY ANALYSIS
ALTERNATIVE 1,3-C: CONTAINMENT/
GROUNDWATER EXTRACTION/PRETREATMENT
COST SUMMARY

FOCUSED FEASIBILITY STUDY
NAS BRUNSWICK

	COST	PRESENT WORTH (2)
ANNUAL OPERATING COSTS		
Labor	$117,000	$203,000
Pretreatment Chemicals	$32,000	$56,000
Electricity	$17,000	$30,000
Sludge Disposal	$95,000	$165,000
Maintenance	$22,000	$38,000
Environmental Monitoring		
First 2 Years (4 Episodes Per Year)	$212,000	$380,000
Remaining 28 Years (1 Episode Per Year)	$53,000	$408,000
Total Operating Costs:		$1,280,000
Five-Year Review (6 Reviews Planned)	$63,000	$157,000
SUBTOTAL		$5,123,000
Contingency (@ 20%)		$1,025,000
TOTAL COST		$6,148,000

NOTES:

(1) VOC treatment and water discharge costs are not included in this estimate. Water would be piped off-site for further treatment.

(2) Discount rate of 10% over 2 years is used for annual costs, with the exception of environmental monitoring (30 years).

(3) Mobilization and installation costs quoted by S.M.W. Seiko.

(4) Activities requiring Health and Safety training or equipment are marked with an asterisk.

(5) Costs are rounded to the nearest $1,000.

TABLE 2
SENSITIVITY ANALYSIS
ALTERNATIVE 1,3-D:
GROUNDWATER EXTRACTION/AIR STRIPPING
COST SUMMARY

FOCUSED FEASIBILITY STUDY
NAS BRUNSWICK

	COST	PRESENT WORTH (1)
CAPITAL COSTS		
Survey	$8,000	
Groundwater Extraction Wells		
Pumping Tests	$93,000	
Mobilization	$10,000	
Decontamination	$8,000	
Piezometers	$10,000	
Well Materials and Installation*	$42,000	
Disposal of Excavated Material*	$360,000	
Groundwater Collection		
Pumps	$7,000	
Piping	$40,000	
Water Treatment		
Treatability Tests*	$52,000	
Building	$165,000	
Utilities	$51,000	
Pretreatment*	$394,000	
Air Stripping*	$44,000	
Discharge		
Pumps	$4,000	
Piping	$16,000	
Reinjection	$161,000	
Institutional Controls		
Warning Signs	$2,000	
Total Capital Costs:	$1,467,000	$1,467,000
INDIRECT COSTS		
Health and Safety		
(@ 25% of Construction and Treatment Costs)(2)	$223,000	
Legal, Administrative, and Permitting		
(@ 5% of Capital Cost)	$73,000	
Engineering (@ 10% of Capital Cost)	$147,000	
Services During Construction		
(@ 5% of Capital Cost)	$73,000	
Total Indirect Costs:	$516,000	$516,000
ANNUAL OPERATING COSTS		
Labor	$117,000	$1,103,000
Pretreatment Chemicals	$84,000	$792,000
Electricity	$54,000	$509,000
Sludge Disposal	$247,000	$2,328,000
Maintenance	$41,000	$387,000
Environmental Monitoring		
First 2 Years (4 Episodes Per Year)	$212,000	$380,000
Remaining 28 Years (1 Episode Per Year)	$53,000	$408,000
Effluent Monitoring	$7,000	$66,000
Air Monitoring	$12,000	$113,000
Total Operating Costs:		$6,086,000
Five-Year Review (6 Reviews Planned)	$63,000	$157,000

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SUBTOTAL	$8,226,000
Contingency (@ 20%)	$1,645,000
TOTAL COST	$9,871,000

NOTE:

(1) Discount rate of 10% is used over 30 years for annual costs.

(2) Activities requiring Health and Safety training or equipment are marked with an asterisk.

(3) Costs are rounded to the nearest $1,000.

TABLE 3
COST ESTIMATE: ENVIRONMENTAL MONITORING*

ITEM	UNIT COST	UNITS	QUANTI	TOTAL COST
LABOR				
Technical	$50	hour	87	$4,350
Professional	$65	hour	6	$390
TOTAL				$4,740
EQUIPMENT				
Water level meter	$5	each	1	$5
Peristaltic pump	$34	each	1	$34
Submersible pump	$88	each	1	$88
Battery chargers	$5.40	each	2	$11
Bailers	$11	each	7	$76
pH/cond. meter	$99	each	2	$198
Gravity corer	$45	each	1	$45
Split spoon	$54	each	1	$54
PI meter	$67	each	1	$67
Port generator	$36	each	1	$36
TOTAL				$613
EXPENDABLES				
Preservative kit	$10	each	1	$10
DI water	$1	gal	50	$50
Dis. filters	$15	each	10	$150
H&S Level D	$120	LS	1	$120
Sprayers	$7	each	4	$28
Filament tape	$8	roll	2	$16
2" tape	$6	roll	2	$12
Bubble pack	$0.20	foot	307.5	$62
Plastic sheeting	$24	each	1	$24
SS spoons	$7	each	9	$63
SS spatulas	$1	each	9	$9
Nitrile gloves	$2	pair	4	$7
Disposable gloves	$0.50	pair	50	$25
Ice	$1.30	lb	6	$8
TOTAL				$584
CONTAINERS				
40 ml vials	$3.50	each	50	$175
1 L amber glass	$5.00	each	100	$500
1 L plastic	$3.50	each	25	$88
4 oz glass	$5.00	each	96	$480
TOTAL				$1,243
TRANSPORTATION & ODCs				
Econoline van	$75	each	2	$150
Per diem	$10	person	8	$80
Computer time	$60	LS	1	$60
Telephone	$10	LS	1	$10
Xerox	$25	LS	1	$25
Misc. costs	$50	LS	1	$50
TOTAL				$375
ANALYSIS				
Groundwater, leachate, surface water				
VOA	$195	sample	32	$6,240
SVOA	$370	sample	30	$11,100
Pest/PCB	$195	sample	30	$5,850
Inorganic	$272	sample	30	$8,160
Sediment				
VOA	$205	sample	13	$2,665
SVOA	$380	sample	13	$4,940
Pest/PCB	$205	sample	13	$2,665
Inorganic	$272	sample	13	$3,536
TOTAL				$45,156

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FIVE YEAR REVIEW				
Data validation	$6,600	episode	5	$33,000
Report production	$30,000	LS	1	$30,000
TOTAL				$63,000
SIGNS	$100	sign	15	$2,000

Note:

* Cost per episode

COST ESTIMATE: CAP

ITEM	UNIT COST	UNITS	QUANTITY	TOTAL COST
CLAY BORROW STUDY				
Atterbergs	$65	test	5	$325
Grain size	$50	test	50	$2,500
Permeability	$225	test	50	$11,250
Proctors	$125	test	24	$3,000
Report preparation	$50	hour	5	$250
TOTAL				$17,325
SURVEY				
Base map	$7,500	map	1	$7,500
Layout:cap & slurry wall or trench	$600	day	2	$1,200
TOTAL				$8,700
SITE PREPARATION				
Clear and grub site	$6,000	acre	2	$12,000
Grading	$2,581	acre	12	$30,976
TOTAL				$42,976
CAP MATERIALS*				
Clay	$12	cy	37,429	$449,152
PVC	$0.45	sf	505,296	$227,383
Sand drainage	$6.50	cy	18,715	$121,645
Buffer layer	$6.50	cy	6,238	$40,548
Fill	$6.50	cy	37,429	$243,291
Seed, fertilizer, mulch	$2,000	acre	11.6	$23,200
TOTAL				$1,105,220
CONSTRUCTION QC TESTING				
Nuclear densometer	$80	day	80	$6,400
Tube opening	$50	tube	37	$1,850
Permeability	$225	test	37	$8,325
Seam testing (PVC)	$100	sample	26	$2,562
TOTAL				$19,137
REPLACEMENT OF ROAD AND PARKING LOT*				
Subbase (12" gravel)	$4.10			
Base (6" stone)	$5.10			
Pavement base (3")	$5.70			
Wearing course (1.5")	$3.20			
Total pavement cost	$18.10	sy	2000	$36,200
Culverts (3)	$30	ft	120	$3,600
TOTAL				$39,800
MANPOWER**				
Site manager	$50	hr	800	$40,000

Notes:

* Material costs include transportation to the site and labor costs for laying the material.

** Assumes a 10-hour day for 80 days.

TABLE 5
COST ESTIMATE: SLURRY WALL

ITEM	UNIT COST	UNITS	QUANTITY	TOTAL COST
COMPATIBILITY STUDY				
Tube opening	$50	tube	10	$500
Atterbergs	$65	test	10	$650
Grain size (hydrometer)	$100	test	10	$1,000
Permeability	$225	test	10	$2,250
TOTAL				$4,400
MOBILIZATION	$30,000	LS		$30,000
SURVEY (included with cap estimate)				
SITE PREPARATION (included with cap estimate)				
INSTALLATION*				
TOTAL	$8	sf	103500	$828,000
POST-CONSTRUCTION TESTING				
Permeability	$225	test	16	$3,600
MANPOWER				
Site manager	$50	hour	600	$30,000

Notes:

* Cost includes equipment, materials, operators, excavation, and testing. Unit cost quoted by S.M.W. Seiko, Inc.

TABLE 6
COST ESTIMATE: 2 EXTRACTION WELLS

ITEM	UNIT COST	UNITS	QUANTITY	TOTAL COST
PUMPING TESTS				
Equip. and mat'ls	$8,000	well	2	$16,000
Labor	$60	manhour	120	$7,200
TOTAL				$23,200
MOBILIZATION	$10,000	LS	1	$10,000
DECONTAMINATION				
Well materials	$1,000	well	2	$2,000
Rig and equipment	$325	rig	1	$325
TOTAL				$2,325
WELLS				
40', 6" diameter wells	$1,800	LS	2	$3,600
30' st. steel screens	$50	LF	60	$3,000
10' st. steel well riser	$40	LF	20	$800
Filter pack	$85	well	2	$170
Bentonite seal	$75	well	2	$150
Caps	$100	well	2	$200
Locking covers	$100	well	2	$200
Labor	$60	manhour	40	$2,400
TOTAL				$10,520
PIEZOMETERS				
Installation	$20	ft	120	$2,400
Split spoons	$20	spoon	16	$320
PVC tube	$1	ft	120	$120
Transducers	$1,000	week	1	$1,000
TOTAL				$3,840
PUMPS				
Submersible pumps	$2,500	LS	2	$5,000
DISPOSAL*				
Drill and trench cuttings	$400	ton	750	$300,000
O&M (ANNUAL COSTS):				
Electricity	$0.10	kWh	65350	$6,535
Maintenance				
(Assume 5% of cap. cost)				$968
TOTAL				$7,503

Note:

* Assumes 1 cy = 1.5 tons, includes transportation and disposal at a RCRA Subtitle C facility.

TABLE 7
COST ESTIMATE: 8 EXTRACTION WELLS

ITEM	UNIT COST	UNITS	QUANTITY	TOTAL COST
PUMPING TESTS				
Equip. and mat'ls	$8,000	well	8	$64,000
Labor	$60	manhour	480	$28,800
TOTAL				$92,800
MOBILIZATION	$10,000	LS	1	$10,000
DECONTAMINATION				
Well materials	$1,000	well	8	$8,000
Rig and equipment	$325	rig	1	$325
TOTAL				$8,325
WELLS				
40', 6" diameter wells	$1,800	LS	8	$14,400
30' st. steel screens	$50	LF	240	$12,000
10' st. steel well riser	$40	LF	80	$3,200
Filter pack	$85	well	8	$680
Bentonite seal	$75	well	8	$600
Caps	$100	well	8	$800
Locking covers	$100	well	8	$800
Labor	$60	manhour	160	$9,600
TOTAL				$42,080
PIEZOMETERS				
Installation	$20	ft	360	$7,200
Split spoons	$20	spoon	48	$960
PVC tube	$1	ft	360	$360
Transducers	$1,000	week	1	$1,000
TOTAL				$9,520
PUMPS				
Submersible pumps	$880	LS	8	$7,040
DISPOSAL*				
Drill and trench cuttings	$400	ton	900	$360,000
O&M (ANNUAL COSTS):				
Electricity	$0.10	kWh	261398	$26,140
Maintenance				
(Assume 5% of cap. cost)				$2,932
TOTAL				$29,072

Note:

* Assumes 1 cy = 1.5 tons, includes transportation and disposal at a RCRA Subtitle C facility.

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TABLE 8
COST ESTIMATE: DOWNGRADIENT TRENCH

ITEM	UNIT COST	UNITS	QUANTITY	TOTAL COST
SURVEY				
Base map	$7,500	LS	1	$7,500
Layout: trench only	$600	day	1	$600
TOTAL				$8,100
SITE PREPARATION				
Demo pavement	$3.50	sy	300	$1,050
Clear and grub site	$6,000	acre	1	$6,000
Grading (1 acre @ 1-ft depth)	$1.60	cy	1613	$2,581
TOTAL				$9,631
TRENCH INSTALLATION*				
TOTAL	$250	ft	2300	$575,000
PUMPS				
Well pump	$2,000	LS	3	$6,000
DISPOSAL**				
Excavated material	$400	ton	1883	$753,200
REPLACEMENT OF ROAD				
Subbase (12" gravel)	$4.10			
Base (6" stone)	$5.10			
Pavement base (3")	$5.70			
Wearing course (1.5")	$3.20			
TOTAL	$18.10	sy	300	$5,430
MANPOWER				
Site manager	$50	hour	50	$2,500
O&M (ANNUAL)				
Electricity	$0.10	kWh	32675	$3,268
Pump replacement (5%)				$50
TOTAL				$3,318

Notes:

* Cost includes mobilization/demobilization, equipment, operators, sump, trenching and drain, backfill material, and filter material. Unit cost quoted by Industrial Builders, Inc.

** Assumes 1 cy = 1.5 tons, includes transportation and disposal at a RCRA Subtitle C facility.

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TABLE 9
COST ESTIMATE: WATER TREATMENT - 78 GPM

ITEM	UNIT COST	UNITS	QUANTITY	TOTAL COST
CAPITAL COSTS:				
TREATABILITY TESTS:				
Equipment				
Peristaltic pump	$35	week	1.4	$50
Hach DR 2000	$35	week	1.4	$50
Portable mixer	$20	week	1.4	$29
30 gal tank	$10	week	1.4	$14
pH/ORP meter	$15	week	1.4	$21
Weighing scale	$5	week	1.4	$7
Glass beakers	$5	week	1.4	$7
Silicone tubing	$1	foot	25	$25
Balance	$95	week	1.4	$136
UV/ox reactor	$150	week	1.4	$214
Air stripper	$15	week	1.4	$21
Stirrer	$25	week	1.4	$36
Drying oven	$20	week	1.4	$29
Field GC	$344	day	12	$4,128
Trailer	$110	month	1	$110
Total equipment				$4,877
Expendables	$1,035	LS	1	$1,035
Labor	$65	hour	513	$33,345
ODCs	$2,685	LS	1	$2,685
Analysis				
Organic	$175	sample	11	$1,925
Inorganic	$272	sample	3	$816
Total analytical				$2,741
UV/O3 testing by subctr	$3,000	sample	1	$3,000
Report preparation	$60	hour	80	$4,800
TOTAL				$52,483
PRETREATMENT				
Oxidation tank	$3,000	LS	1	$3,000
KMnO4 tank	$5,000	LS	1	$5,000
Polymer feed	$6,000	LS	1	$6,000
Sludge thickener	$90,000	LS	1	$90,000
Clarifier	$43,000	LS	1	$43,000
Filter press	$100,000	LS	1	$100,000
Sand filter	$32,500	LS	1	$32,500
Air compressor	$4,000	LS	1	$4,000
ORP controls	$3,000	LS	1	$3,000
Mixers	$250	LS	4	$1,000
Diaphragm pump (sludge)	$2,000	LS	4	$8,000
KMnO4 pump	$1,000	LS	2	$2,000
Process pump	$2,000	LS	2	$4,000
Final effluent tank	$6,000	LS	1	$6,000
Level controls	$2,500	LS	2	$5,000
Timer & proc. controls	$5,000	LS	2	$10,000
Piping (interior)	$8	ft	625	$5,000
Dumpster	$1,000	LS	1	$1,000
Installation (20% of cap. cost)				$65,700
TOTAL				$394,200
AIR STRIPPING				
Air Stripper w/blower	$20,000	LS	1	$20,000
Wetwell	$2,000	LS	2	$4,000
Process pumps	$2,000	LS	4	$8,000
Level controls	$2,500	LS	2	$5,000
Installation (20% of cap. cost)				$7,400
TOTAL				$44,400
UV/H2O2				
UV reactor	$280,000	LS	1	$280,000

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Wetwell	$2,000	LS	1	$2,000
Process pumps	$2,000	LS	2	$4,000
Level control	$2,500	LS	1	$2,500
Metering pumps	$675	LS	2	$1,350
H2O2 storage	$10,000	LS	1	$10,000
Installation (20% of cap. cost)				$59,970
TOTAL				$359,820
UV/O3				
UV reactor w/generator	$341,000	LS	1	$341,000
Wetwell	$2,000	LS	1	$2,000
Process pumps	$2,000	LS	2	$4,000
Level control	$2,500	LS	1	$2,500
Cooling tower (chiller)	$9,000	LS	1	$9,000
Installation (20% of cap. cost)				$71,700
TOTAL				$430,200
PIPING				
From coll. to treatment	$40	ft	1000	$40,000
BUILDING				
Pretreatment	$50	sf	2500	$125,000
Air stripping	$50	sf	800	$40,000
UV/H2O2	$50	sf	2100	$105,000
UV/O3	$50	sf	1500	$75,000
UTILITIES				
Phone & elec. hookup	$10	ft	1000	$10,000
Circuit breaker	$10,000	LS	1	$10,000
Transformer (150 kVa)	$7,500	LS	1	$7,500
Water hookup (4" dia.)	$20	ft	1000	$20,000
Septic tank (2000 gal)	$1,000	LS	1	$1,000
Leaching chamber	$400	LS	5	$2,000
TOTAL				$50,500
O&M (ANNUAL COSTS):				
PRETREATMENT				
Chemicals				
polymer	$3.00	lb	683	$2,049
KMnO4	$1.20	lb	68494	$82,193
Electricity	$0.10	kWh	140675	$14,068
Sludge disposal	$325.00	ton	760	$247,000
TOTAL				$345,309
AIR STRIPPING				
Electricity	$0.10	kWh	108540	$10,854
TOTAL				$10,854
UV/H2O2				
Chemicals	$0.45	gal	13672	$6,152
Electricity	$0.10	kWh	761430	$76,143
TOTAL				$82,295
UV/O3				
Electricity	$0.10	kWh	1040620	$104,062
TOTAL				$104,062
MANPOWER*				
TOTAL	$40.00	hr	2920	$116,800
MAINTENANCE				
(Assume 5% of capital costs for each process)				
Pretreatment				$30,485
Air stripping				$4,220
UV/H2O2				$23,241
UV/O3				$25,260

EFFLUENT MONITORING				
Report preparation	$20	hour	12	$240
ODCs	$30	LS	12	$360
Analysis				
Organic	$175	sample	12	$2,100
Inorganic	$272	sample	12	$3,264
Trip blanks	$175	sample	6	$1,050
Total analytical				$6,414
TOTAL				$7,014
AIR MONITORING				
Air stripper off-gas	$3,000	round	4	$12,000

Notes:

* Manpower includes two people (health and safety trained) at $20 per hour.
The treatment plant would operate 365 days per year for the duration of treatment.

TABLE 10
COST ESTIMATE: PRETREATMENT - 30 GPM

ITEM	UNIT COST	UNITS	QUANTITY	TOTAL COST
CAPITAL COSTS:				
TREATABILITY TESTS:				
Equipment				
pH/ORP meter	$15	week	1	$15
Glass beakers	$5	week	1	$5
Stirrers	$25	week	1	$25
Other misc. equipment	$50	week	1	$50
Total equipment				$95
Expendables	$100	LS	1	$100
Labor	$60	hour	84	$5,040
ODCs	$138	LS	1	$138
Analysis				
Inorganic	$272	sample	4	$1,088
TOTAL				$6,461
PRETREATMENT				
Oxidation tank	$2,000	LS	1	$2,000
KMnO4 tank	$3,000	LS	1	$3,000
Polymer feed	$6,000	LS	1	$6,000
Sludge thickener	$25,000	LS	1	$25,000
Clarifier	$35,000	LS	1	$35,000
Filter press	$54,000	LS	1	$54,000
Sand filter	$25,000	LS	1	$25,000
Air compressor	$4,000	LS	1	$4,000
ORP controls	$3,000	LS	1	$3,000
Mixers	$250	LS	4	$1,000
Diaphragm pump (sludge)	$1,500	LS	4	$6,000
KMnO4 pump	$1,000	LS	2	$2,000
Process pump	$1,750	LS	2	$3,500
Final effluent tank	$2,000	LS	1	$2,000
Level controls	$2,500	LS	2	$5,000
Timer & proc. controls	$5,000	LS	2	$10,000
Piping (interior)	$6	ft	625	$3,750
Dumpster	$1,000	LS	1	$1,000
Installation (20% of cap. cost)				$38,250
TOTAL				$229,500
PIPING				
From coll. to pretreatment	$40	ft	1100	$44,000
From pretreat.to VOC treat	$40	ft	1100	$44,000
TOTAL				$88,000
BUILDING				
Temp. structure w/ concrete pad	$25	sf	2250	$56,250
UTILITIES				
Phone & elec. hookup	$10	ft	1000	$10,000
Circuit breaker	$10,000	LS	1	$10,000
Transformer (150 kVa)	$7,500	LS	1	$7,500
Water hookup (4" dia.)	$20	ft	1000	$20,000
Septic tank (2000 gal)	$1,000	LS	1	$1,000
Leaching chamber	$400	LS	5	$2,000
TOTAL				$50,500
O&M (ANNUAL COSTS):				
PRETREATMENT				
Chemicals				
polymer	$3.00	lb	263	$789
KMnO4	$1.20	lb	26344	$31,613
Electricity	$0.10	kWh	107985	$10,798

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Sludge disposal	$325.00	ton	292	$94,900
TOTAL				$138,100
MANPOWER*				
TOTAL	$40.00	hr	2920	$116,800
MAINTENANCE				
(Assume 5% of capital costs)				
Pretreatment				$21,213

Notes:

* Manpower includes two people (health and safety trained) at $20 per hour.
The treatment plant would operate 365 days per year for the duration of treatment.

TABLE 11
COST ESTIMATE: UPGRADIENT DISCHARGE

ITEM	UNIT COST	UNITS	QUANTI	TOTAL COST
PIPING				
2.5" PVC	$12	ft	1300	$15,600
PUMPS				
5 hp	$2,000	pump	2	$4,000
INFILTRATION:				
0.33-acre:				
SITE PREPARATION				
Clearing and grubbin	$6,000	acre	0.33	$1,980
Grading/berms	$2,600	acre	0.33	$858
OUTFALL CONSTRUCTION				
Riprap	$75	sy	1	$75
TOTAL (0.33-acre)				$2,913
2.3-acre:				
SITE PREPARATION				
Clearing and grubbin	$6,000	acre	2.3	$13,800
Grading/berms	$2,600	acre	2.3	$5,980
OUTFALL CONSTRUCTION				
Riprap	$75	sy	1	$75
TOTAL (2.3-acre)				$19,855
6-acre:				
SITE PREPARATION				
Clearing and grubbin	$6,000	acre	6	$36,000
Grading/berms	$2,600	acre	6	$15,600
OUTFALL CONSTRUCTION				
Riprap	$75	sy	1	$75
TOTAL (6-acre)				$51,675
O&M (ANNUAL COSTS):				
Electricity	$0.10	kWh	32675	$3,268
Maintenance				
(Assume 5% of cap. cost)				$984
TOTAL				$4,251
REINJECTION WELLS:				
PUMPING TESTS				
Equip. and mat'ls	$8,000	well	8	$64,000
Labor	$60	manhour	480	$28,800
TOTAL				$92,800
MOBILIZATION	$10,000	LS	1	$10,000
DECONTAMINATION				
Rig and equipment	$325	rig	1	$325
WELLS				
60', 6" diameter wells	$2,700	LS	8	$21,600
50' st. steel screens	$50	LF	400	$20,000
10' st. steel well riser	$40	LF	80	$3,200
Filter pack	$100	well	8	$800
Bentonite seal	$90	well	8	$720
Caps	$100	well	8	$800
Locking covers	$100	well	8	$800
Labor	$60	manhour	160	$9,600
TOTAL				$57,520
TOTAL (Reinj. wells)				$160,645

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O&M (ANNUAL COSTS):			
Electricity	$0.10 kWh	32675	$3,268
Maintenance			
(Assume 5% of cap. cost)			$3,856
TOTAL			$7,124

C-E Environmental, Inc.

261 Commercial Street/P.O. Box 7050
Portland, Maine 04112
(207) 775-5401 Telex 94-4329

TELEPHONE MEMORANDUM

PROJECT NO. 4607-57 DATE: 1/30/91

CLIENT: Dept of Navy

PROJECT DESCRIPTION: NAS Brunswick sites 1, 3 FFS

BETWEEN: Tony Delano (FCJ)

AND: Kent Sand - Industrial Builders, Fargo N.D 701-282-4977

SUBJECT: Cost estimate for the construction of an interceptor trench

DISCUSSION: I spoke to Kent Sand of Industrial Builders for a cost estimate of constructing an interceptor trench 2,000 ft long and 6-25 ft deep in fine sand. He gave me an estimate of $250/ft. This price would include mobilization, demobilization, installation of sump, drain and filter material, and equipment. This would not include above- or below-ground obstructions which could slow the construction process. It would not include pumps, pumping, discharge and associated piping. Material excavated from the trench would not be disposed of by Industrial Builders and would have to taken by somebody else.

DISTRIBUTION:

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TELEPHONE MEMORANDUM

1 of 2

PROJECT NO. 4607-57 DATE: 1/30/91

CLIENT: US Navy

PROJECT DESCRIPTION: NAS Brunswick sites 1, 3 FFS

BETWEEN: Tony Delano

AND: Taki Osamu (SMW Seiko, Inc 415-591-9646

SUBJECT: Cost estimate for construction of a cutoff wall

DISCUSSION: I spoke to Taki Osamu at SMW Seiko about a cost estimate for the construction of a vertical hydraulic barrier to groundwater flow. The site-specific information I gave him was for a wall 1900' long to be constructed in fine sands, the depth of the wall would be 28'-62' bgs (avg depth 45 ft) and a permeability of 10^{-7} cm/sec if it could be attained. He said that 10^{-6} cm/s would be easy to get but 10^{-7} cm/s would be substantially more difficult for our soil type. The wall itself would cost \$6-\$8 /sf. This cost includes: machinery, materials, operators, labor, excavation and testing. It would not include the disposal of spoils. A mobilization/demobilization charge of \$100,000 would be required as SMW Seiko is based in Redwood City, CA. An additional (\$20,000 - \$30,000 would be required for

DISTRIBUTION:

TELEPHONE MEMORANDUM (Cont.)

SHEET 2 OF 2

PROJECT NO. 4607-57 DATE: 1/30/90

SUBJECT: Construction Costs for Slurry wall ~~co~~ at NAS Bonsurzk Sites 1,3 FFS

DISCUSSION:

Health and Safety considerations according to Taki. He also said that the schedule would require 60 working days for the construction of the wall itself with an additional 10 days for mobilization and demobilization. These numbers are based on a construction rate of 1500 sq ft/day of cutoff wall.

PROJECT	COMP. BY	JOB NO.
NAS BRUNSWICK SITES 1 & 3 FFS UPGRADIENT RECHARGE	CW	4607-57
	CHK. BY RR	DATE 4/2/91

UPGRADIENT DISCHARGE OF TREATED WATER

2 OPTIONS:

1) PASSIVE INFILTRATION USING INFILTRATION BASIN (LEACHFIELD)

2) REINJECTION USING WELLS

ASSUMPTIONS:

1) WATER TREATED TO MEET DRINKING WATER STANDARDS (MCLS) AS REQUIRED BY MEDEP CHAPTER 543.

2) WATER WOULD BE PIPED TO WOODED AREA NORTH OF LANDFILL SHOWN ON MAP, ASSUME 1300 FT OF PIPE.

3) FOR INFILTRATION BASIN:
   A) NO PONDING OF WATER WOULD OCCUR, NO FREEZING IN WINTER
   B) 5:1 HORIZONTAL TO VERTICAL ANISOTROPY OF SOILS (DUE TO SILT LAYERS WITHIN SAND)
   THEREFORE, USING A RANGE OF HORIZONTAL CONDUCTIVITIES 0.29 FT/DAY TO 5.1 FT/DAY, ESTIMATE K_V = 0.058 TO 1.02 FT/DAY.

4) FOR REINJECTION WELLS:
   A) SATURATED THICKNESS IS GREATER UPGRADIENT, SO AQUIFER SHOULD BE ABLE TO ACCEPT 78 GPM WITHOUT PRESSURIZING WELLS

5) INTRODUCING WATER UPGRADIENT WILL NOT INFLUENCE GRADIENTS, CAPTURE ZONES OR FLOW DIRECTIONS.
   (NOTE THAT THIS ASSUMPTION IS UNLIKELY AND WILL NEED TO BE REVISITED DURING DESIGN PHASE)

PROJECT	COMP. BY	JOB NO.
NAS BRUNSWICK SITES 1 & 3 FFS UPGRADIENT RECHARGE	CLS	4607-57
	CHK. BY MR	DATE 4/2/91

TRANSPORTATION OF WATER TO DISCHARGE LOCATION:

1300 FT OF PIPE

USE 2½" ϕ STEEL OR PVC
VELOCITY 5.3 FPS (STEEL), 6 FPS PVC
FRICTION HEAD 8.4 FT/100 FT (STEEL), 5.4 FT/100 FT (PVC)
ASSUME HEAD LOSS IN FITTINGS, ENTRANCE/EXIT IS NEGLIGIBLE COMPARED TO FRICTION LOSS
FRICTION LOSS:
STEEL: 1300 × 8.4/100 FT = 109 FT
PVC: 1300 × 5.4/100 FT = 70 FT

ABOVE VALUES FROM PERMUTIT "WATER AND WASTE TREATMENT DATA BOOK"

ASSUME 20 FT STATIC HEAD (ELEVATION DIFFERENCE)
TOTAL HEAD, USING 20% SAFETY FACTOR:
STEEL: 154 FT
PVC: 108 FT

PUMPS:
ONLY NEED ONE BUT HAVE AN EXTRA ONE FOR BACKUP
USING PUMP CURVES FOR GOULDS PUMPS:
78 GPM
1750 RPM
STEEL PIPE: 1½ × 3-13 MT 7.5 HP PUMP
PVC PIPE: 1 × 2-10MT 5 HP PUMP
USE DUCTILE IRON PUMP W/ NONASBESTOS PACKING MATERIAL
HORIZONTAL MOUNT (MOTOR & PUMP) W/ COMMON BASEPLATE

COSTS:
COST OF PIPE (TRENCHED APPROX. 5 FT BELOW GROUND)
STEEL: $15/FT ≅ $20,000
PVC: $11/FT ≅ $15,000
COST OF PUMP
MFR QUOTE APPROX. $2000/PUMP (EITHER)

TOTAL COST OF DISTRIBUTION SYSTEM: $19,000 – $24,000

O&M COSTS:
ELECTRICITY (10¢/KWH): $3,300/YR TO $5,000/YR
EQUIP. REPLACEMENT/MAINTENANCE: $200/YR
$3,500/YR TO $5,200/YR

PROJECT	COMP. BY	JOB NO.
NAS BRUNSWICK SITES 1 & 3 FFS UPGRADIENT RECHARGE	CLS	4607-57
	CHK. BY PM	DATE 4/2/91

REV. 7/10/91 CLS

INFILTRATION BASIN:

ASSUME TWO SIZES:
1/3 ACRE (CORRESPONDING TO K_v = 1.02 FT/DAY)
6 ACRE (CORRESPONDING TO K_v = 0.058 FT/DAY)

NEED TO CLEAR, GRADE SITE, CONSTRUCT BERMS, CONSTRUCT OUTFALL

SITE PREPARATION COSTS:
CLEARING & GRUBBING: $6,000/ACRE
GRADING/BERMS: $2,600/ACRE
OUTFALL:
RIPRAP (< 30" ϕ): $75/SQ YD. (18" THICK) (ASSUME 1 SQ. YD.)

COST*:
1/3-ACRE AREA: $3,000
6-ACRE AREA: $52,000

ASSUME MAINTENANCE COSTS ARE NEGLIGIBLE

REINJECTION WELLS:

ASSUME 8 WELLS RECEIVING TOTAL OF 78 GPM:

6" ϕ WELLS (60 FT)	$2,700 LS	=	$21,600
STEEL SCREENS (50 FT)	$50/FT	=	$20,000
STEEL RISERS (10 FT)	$40/FT	=	$3,200
FILTER PACK	$100/WELL	=	$800
BENTONITE SEAL	$90/WELL	=	$720
CAPS	$100/WELL	=	$800
LOCKING COVERS	$100/WELL	=	$800
LABOR	$60/MNHR	=	$38,400
PUMPING TESTS	$8,000/WELL	=	$64,000
MOBILIZATION			$10,000 ← IF NOT INSTALLED ON THE SAME SCHEDULE AS EXTRACTION WELLS
DECONTAMINATION OF RIG			$325
			$160,045

ASSUME MAINTENANCE COSTS ARE NEGLIGIBLE

* ADDITIONAL COSTS WOULD BE INCURRED FOR HYDROGEOLOGIC TESTING PRIOR TO DESIGN FOR EITHER SYSTEM

GROUNDWATER FLOW MODEL SIMULATIONS FOR EVALUATION OF REMEDIAL ALTERNATIVES

B.1 INTRODUCTION

An RI conducted at NAS Brunswick Sites 1 and 3 indicated that past chemical releases adversely affected downgradient groundwater quality, and that chemicals also appear in leachate seeps in the vicinity of Mere Brook. This appendix presents an overview of the groundwater flow model used to support the evaluation of remedial alternatives for Sites 1 and 3. The principal objectives of the groundwater modeling effort were to simulate and evaluate alternatives to (1) eliminate the contribution of the landfill source to the downgradient seeps; (2) lower the groundwater beneath the landfill to a level below the bottom of the landfill waste; and/or (3) capture groundwater flow potentially migrating from Sites 1 and 3. Currently, the landfill waste materials are 8 to 10 feet into the water table.

The groundwater modeling effort involved the following components:

- model conceptualization
- selection of a model code
- calibration of model to observed conditions
- evaluation of various remedial alternatives

B.2 HYDROGEOLOGIC OVERVIEW

The hydrogeology of Sites 1 & 3 has been assessed with stratigraphic information, hydraulic conductivity data, and water levels obtained from 44 test borings and monitoring wells installed at the site. A complete discussion and presentation of all hydrogeologic and chemical data is included in the August 1990 Draft Final RI Report and the April 1991 Draft Supplemental RI Report (E.C. Jordan). Groundwater at the Sites 1 & 3 areas flows within an unconfined aquifer system which is primarily composed of medium to fine sands which grade into stratified silt and sand strata. These soils overlie a Presumpscot clay unit which is estimated to range from 20 to 60 feet in thickness. Permeability tests conducted on Shelby tube samples obtained from this clay unit indicate a hydraulic conductivity on the order of 10^{-7} cm/sec. This unit is considered to be a confining layer for the shallow groundwater flow system, based on the observed thickness of the clay unit and its low hydraulic conductivity. Upward vertical gradients of approximately .06 ft/ft were observed in the vicinity of MW-210 and no chemicals have been detected in two bedrock wells installed in the vicinity of the site (MW-210A and MW-211A). Given

the high horizontal hydraulic conductivity in the sandy soils relative to the estimated low hydraulic conductivity for the clay unit, groundwater flow at the site is expected to be primarily horizontal with very little vertical leakage through the clay. The topography of the clay surface is varied and was characterized through a Piezometric Cone Penetrometer Test (PCPT) survey and the test boring program. The groundwater contaminant plume is approximately 20 feet thick and is restricted to the upper unconfined aquifer system.

Groundwater flow direction at the site is largely controlled by Mere Brook which is a deeply incised stream located approximately 300 feet downgradient of the site. Mere Brook is considered to be a gaining stream in the vicinity of the site and has been observed to be flowing throughout the year. The shallow groundwater flow system discharges to Mere Brook based on vertical gradients observed in the vicinity of the brook, construction of vertical flow nets through the site, and data collected from seepage meters and steambed piezometers. Further, water level data collected south of the brook indicate flow northward to the brook (i.e., the shallow groundwater north of the brook does not pass beneath it). An analysis of this data indicate that upward gradients exist beneath Mere Brook and that the stream gains from groundwater discharge seepage throughout its length. Stream gauging data collected at the site indicate that the drainage system has a total discharge of about 3.73 cubic feet per second (cfs). This discharge rate is based on rates obtained at MB-1 (2.8 cfs) and at MS-4 (0.93 cfs). Based on the location of these sample stations, and the range of discharge rates observed at these stations, the total discharge for the area was based on a comparison of discharge rates at MB-1 and MS-4. This discharge rate is the result of surface water flow from small tributaries; groundwater discharge from stream bank seeps; and groundwater discharge through upward seepage from underlying sediments. During periods of minimal precipitation, all three of these pathways would be expected to represent groundwater discharge within the watershed. Discharge data and results are discussed in detail in the April 1991 Draft Supplemental RI Report (E.C. Jordan).

The shallow groundwater system generally flows to the south, toward Mere Brook, however a localized groundwater mound apparently exists north of the landfill resulting in some groundwater flow to the southeast and southwest as well, but again toward the meandering Mere Brook. Horizontal hydraulic gradients at the site range form 0.01 to 0.03 foot/foot. Downward vertical gradients within the shallow aquifer range from 0.05 to 0.07 foot/foot in the vicinity of the landfill. Upward vertical gradients exist in the vicinity of Mere Brook and range from 0.1 to 0.3 foot/foot.

Hydraulic conductivities at the site range from 0.18 to 49 feet per day (ft/day) with the average hydraulic conductivity for the site estimated from this data to be 2.0 feet/day. Based on the average hydraulic conductivity, an estimated effective porosity of 0.25, and an average gradient of 0.03 ft/ft, groundwater seepage velocities at the site are estimated to be approximately 90 feet/year.

Hydraulic conductivities for stream bottom sediments, calculated from data from seepage meters and stream piezometers installed in Mere Brook, were estimated to range from 10^{-5} to 10^{-7} cm/sec, and the thickness of the river bottom sediment was observed to be approximately 3 feet. The site receives approximately 41 inches of rainfall per year. Given the relatively highly permeable sands at the site, and based on an assumed infiltration rate of 45% for permeable sands (Caswell, 1987), a recharge rate of 18 inches/year is estimated for the site. Water level measurements obtained in the fall (November, 1988) and in the spring (April, 1989), which are estimated to represent high and low groundwater conditions, indicate that seasonal groundwater fluctuations in the vicinity of the site are generally less than 0.5 feet.

B.3 CONCEPTUAL FLOW MODEL

A conceptual groundwater flow model was developed for Sites 1 and 3 based on the current understanding of the hydrogeologic conditions at these sites and the objectives of the model study. The groundwater flow system at Sites 1 and 3 was conceptualized as a single layer system with groundwater flowing within a sand and silt transitional unit. As discussed in the August 1990 and April 1991 E.C. Jordan RI reports, the geology at the sites 1 & 3 area consists of sands over stratified silts. As discussed in these reports, the stratigraphy above the Presumpscot clay is considered a single aquifer unit, but, because of different physical properties, may be separated into sand and transitional members. In the vicinity of the sites 1 & 3 area, the transition member consists of stratified silts and is very thin. The sand component of the overburden comprises the bulk of the aquifer and is the unit which the various remedial alternatives would impact. For these reasons, and because the clay unit is relatively impermeable, the modeled system was conceptualized as a single layer system. This is also consistent with the intended simulations for conceptual design evaluation of wells and slurry walls in that the wells are considered to be fully penetrating and the slurry wall would be keyed into the Presumpscot clay unit. As discussed in Section B.2, the saturated thickness of the shallow aquifer system is dependant on the topography of the underlying Presumpscot clay formation,

and groundwater flowing beneath Sites 1 & 3 is interpreted to discharge to Mere Brook. The site area is recharged by upgradient groundwater flow and an assumed uniform distribution of infiltration of precipitation over the area.

B.4 Selection Of The Model Code

Selection of a groundwater model numerical code was based on several considerations: the code must have the ability to include as boundary or initial conditions all significant hydrogeologic influences, be well accepted and documented, and be readily available for use by others (in the public domain). It is for these reasons that USEPA favors models by the U.S. Geological Survey (USGS), and has issued guidance for modeling that encourages model selection based on the criteria cited above. Further, it was believed that a numerical model could more adequately represent the individual and combined effects of the remedial alternatives under consideration than could an analytical model(s). Jordan considered several possible candidate models and selected the USGS code MODFLOW (McDonald and Harbaugh, 1989) as a model that would best evaluate groundwater conditions and satisfy the above criteria. The positive aspects of this selection included the model's potential for three dimensionality, variety of boundary condition modules, ability to express variability in thickness of aquifer/aquitard units, and acceptance by the modeling community.

MODFLOW is a finite difference numerical model that provides the essential features needed for the alternatives evaluation. The following sections of this appendix describe the configuration of the model and the basis for selection of model parameter input values.

B.5 Model Grid

Figure B-1 shows the initial discretization for the model. Model elements are smallest in the areas where the drains, wells, and/or slurry wall were being considered. The entire model domain covers about 90 acres and consists of one layer that corresponds to the water table aquifer above the clay. This layer is discretized (subdivided) into 24 rows and 29 columns.

B.6 INITIAL MODEL INPUTS

Several input parameters are required for the MODFLOW numerical model simulation and include boundary conditions, hydraulic conductivity values, aquifer bottom elevation if simulating a water table aquifer, river fluxes, and recharge rates. These input parameters are discussed in general terms in section B.2 and specifically addressed in terms of the model simulation within this section.

Given the rapid response of the aquifer to stresses (i.e., relatively high hydraulic conductivities, and the expected long-term nature of the potential remedial actions), steady-state conditions were assumed for the model during most calibration and simulation model runs.

The basic module file for MODFLOW includes a designation of which nodes are active or constant heads. The values for constant head boundaries were specified for active nodes on the eastern, western, and southern sides of the model grid. Constant head values were interpolated for the model grid boundaries from an interpretive groundwater surface contour map considered to represent average annual conditions. This groundwater surface contour map is shown in Figure B-1.

Boundary Conditions. Based on a review of the groundwater flow regime at the site, boundary conditions were selected and input into the model. The western, eastern, and southern edges of the model were input as constant head boundaries. The northern portion of the grid area was specified as a general head boundary. Figure B-3 illustrates the grid cells for which each type of boundary condition was specified. Constant head boundaries are comprised of constant head cells for which the head is specified in advance, typically based on an overlay of the interpreted groundwater contour surface on the model grid area. Constant head values remain at the specified value through all time steps of the computer simulation. Constant head values input into this model are based on the overlay of observed groundwater flow contours on the model grid area (Figure B-1). The general head boundary specified for the northern model grid boundary provides for greater control in simulating the flux of groundwater through this area of the model, especially under stressed aquifer conditions. The hydrogeologic characterization at the site indicates that a significant portion of the groundwater flow through the site is due to flow from areas north of the site (see Figure B-1). The selected parameter values controlling the flux across the boundary that were initially input into the model were based on interpreted groundwater head values located 250 feet north of the model grid area,

which flow through materials that have hydraulic conductivities ranging from 21 to 34 ft/day (which is consistent with the observed hydraulic conductivity range discussed in Section B.2), and mass balance considerations relative to the amount of recharge assumed for the model. A hydraulic conductivity of 21 ft/day was assigned to the area north of the modeled area, and corresponding to columns 1-7 and 24-29. A hydraulic conductivity of 34 ft/day was also assigned to the area north of modeled area, and corresponds to the general head boundary specified for columns 8-23. The specification of a higher hydraulic conductivity values in the above areas is inferred from the presence of a groundwater mound north of the landfill site and the need for higher flow rates in this area to attempt to provide a closer match to the observed conditions.

Hydraulic Conductivity Inputs. Based on in situ permeability tests conducted in monitoring wells at NAS Brunswick an average hydraulic conductivity of 21 ft/day was specified over the entire model grid area. This constant hydraulic conductivity value, combined with the varying thickness of the aquifer as defined by the top of clay, result in variable aquifer transmissivities over the modeled area. Although the average hydraulic conductivity for the site as estimated through slug tests is approximately 2.0 ft/day, a higher hydraulic conductivity value was input to the model to achieve an acceptable calibration. This situation relative to a higher bulk aquifer hydraulic conductivity versus slug testing results is common, and models often require an upward revision of slug testing results during calibration. The hydraulic conductivity used in the model is still within the range of hydraulic conductivity values estimated by the slug test analysis.

Within the MODFLOW model, vertical gradients can only be simulated with a multi-layer configuration. Given the hydrogeologic interpretations for this site, and the anticipation of essentially horizontal flow to the various proposed remedial alternative controls, a single layer model with no vertical anisotropy is considered to provide for acceptable representation of the aquifer conditions. No vertical anisotropy was, or could be, assigned to the model.

Aquifer Thickness. The thickness of the single layer model was based on the observed depth of a Presumpscot clay layer, which is interpreted to be an aquiclude to significant vertical groundwater flow occurring in the upper sand and silt soils. Figure B-2 illustrates the clay surface elevation (feet above mean sea level) which was input into the model as the bottom elevation of layer 1. This allows the model to calculate a varying transmissivity based on the hydraulic conductivity and the

calculated saturated thickness. The saturated thickness of the aquifer is estimated to vary between 20 and 50 feet. The bottom of the aquifer was equated to the top of clay surface contour map presented in the April 1991 Supplemental RI Report (E.C. Jordan). The model grid is considered to be block-centered, which means that the groundwater head value calculated for each model block or element is calculated at a point (node) at the center of the block.

River Fluxes. A river package, which is similar to other general flow boundary condition simulators, was used to simulate groundwater interactions with Mere Brook. As discussed earlier, the shallow groundwater flow system is interpreted to discharge to Mere Brook which flows year round. The model calculates flow out of or into the stream as a function of a driving head (the difference in river stage and groundwater head) and resistance of some confining stream bed layer. A 3-foot sediment thickness was input based on estimated sediment thickness values observed during the Mere Brook seepage meter and stream piezometer study. Hydraulic conductivities calculated from seepage meters and stream piezometers were estimated to range from 10^{-5} to 10^{-7} cm/sec. These values are considered to be conservatively low and were varied during model calibration through the specification of a conductance term in the river module package of MODFLOW. The final value input into the model was 4.0×10^{-5} cm/sec (.11 ft/day). This value is consistent with the hydraulic conductivity value ranges observed throughout the NAS Brunswick site. Calculated river conductance terms resulted in only two values depending on the sizes of river simulation blocks: 183 square feet per day (ft^2/day) (100 by 50 foot nodes); and 366 ft^2/day (100 by 100 foot nodes). The model elements representing the stream are shown in Figure B-3.

Recharge Rates. A uniform recharge rate of 18 inches per year (.0041 ft/day) was input to the model grid area. As discussed in Section B.2, this recharge rate of .0041 ft/day was based on an annual rainfall figure of 41 inches/year and an assumed infiltration rate of 45% for permeable sand deposits. Constant-head boundaries and river package nodes do not accept recharge. This amount of recharge is probably conservatively high with respect to expected flow rates to drains or other simulated groundwater control mechanisms.

B.7 CALIBRATION

Several model inputs required adjustment during model calibration. These model inputs primarily included the refinement of the aquifer thickness and the adjustment of hydraulic conductivity values. Several runs were also necessary to calibrate the general-head boundary package to simulate the groundwater mounding which apparently exists beneath the landfill.

After varying parameter values through approximately 33 MODFLOW model runs, the model calculated head values were considered a reasonable match to an interpretive groundwater contour map generated for the site based on water level measurements in the monitoring wells, and with respect to interpreted flow directions and mass balances.

The primary difference between the groundwater surface contour map and the final steady-state groundwater surface contour map is the groundwater mounding which is interpreted to occur within the northern portions of the landfill (i.e., the 46 and 44 MSL groundwater contour lines). Although the water level measurements obtained at monitoring wells in this area suggest a groundwater mound, the actual existence of this hydrogeologic feature is questionable. It may be a reflection of localized semi-confined conditions. In either case, the simulated groundwater surface contours represent the best match to the observed contours, within the acceptable range of hydrogeologic parameters available for input. The numerical simulation could be made to better fit the interpreted groundwater measurements, however, that would involve adjusting hydraulic conductivity values in a manner inconsistent with the observed conditions.

The computed head values matched the observed head values reasonably well, with the exception of the area associated with the interpreted groundwater mound in the northern portion of the model grid area. In evaluating the calibrated model the hydrogeologic parameters which were considered to be most accurate for comparison of modeled and observed conditions, and determined to be most critical in the modeled system included the mass balance or measured flux of the system, groundwater flow directions, and hydraulic gradients. As discussed above, the hydrogeologic model inputs have been adjusted in a manner consistent with the observed site conditions. Various parameters, specifically aquifer thickness and hydraulic conductivity, could be altered to allow for a closer match between observed/computed head values and thereby reflect to a greater extent the

groundwater mounding interpreted to exist at the site. However it is important to note that if a model's structure ignores important sources, geologic heterogeneities, or physical processes, calibration is reduced to a fitting exercise that forces available inputs to compensate for an improper formulation (National Research Council, 1990). This numerical model has been properly formulated and calibrated within the range of acceptable input values.

The hydraulic gradients compare well; .01 ft/ft to .03 ft/ft for the observed groundwater contour map, and .01 ft/ft to .02 ft/ft for the simulated groundwater contour map. The groundwater flow directions also compare well, with both the interpreted observed and simulated contour maps indicating groundwater flow to the southeast and the calculated mass balance (total in) was estimated at 83,000 ft^3/day and the modeled mass balance (total out) was 78,054 ft^3/day. This mass balance comparison (total in vs. total out) is within approximately 6% which is considered to be within an acceptable range for a calibrated model. The modeled mass balance closely matches values estimated from site data of the overall groundwater flux.

The final calibration run is considered to be in good agreement with the observed flow system and is expected to provide for a reasonably accurate and comparative simulation of the various remedial alternatives. It should be noted that a numerical simulation provides for a more accurate and detailed evaluation of alternatives than could be accomplished using analytical solutions. Given that the purpose of the model is to evaluate the relative effectiveness of the various remedial alternatives, and not provide actual design information, the numerical model is considered to be adequately calibrated for the intended purposes of the modeling. The final steady-state calibration run is presented in Figure B-4. At this point, the model was considered adequate to perform the simulations planned to evaluate potential feasibility study alternatives as applied to groundwater.

Model Limitations. The groundwater flow model was developed and implemented to provide for a comparative evaluation of remedial alternatives as part of the Focussed Feasibility Study process. It is not intended to provide for information required as part of the detailed design process. Given the purposes of the modeling effort, several simulation aspects of a numerical model study were not performed. These include validation analysis, sensitivity analysis, error analysis, and a post-audit evaluation. The model was properly constructed and utilized to provide for an initial screening of remedial alternatives.

While the model reasonably represents the shallow aquifer, there are aspects of the model which limit its accuracy and which should be considered when applying and interpreting model results. These limitations concern mainly the simplification of the system as 1-layered, simplified boundary conditions, and the absence of detailed validation. While these limit the model from application to detailed design, these limitations are not considered to detrimentally affect the usefulness of the model as a screening tool for comparison and evaluation of identified remedial alternatives at the conceptual stage. These limitations of the model are discussed in the following paragraphs.

The simplification of the aquifer as a one-layer system does not permit considerations of vertical gradients nor of variations of hydraulic conductivity with depth. This limits detailed examination of the interaction of the effectiveness of drains and wells with depth, and also may limit the ability of the model to simulate the interpreted presence of a mound within the model area.

The simplification of the boundary conditions were accepted as reasonable representations base on current knowledge and the screening level nature of the model. However, for a more accurate representation, it would be better to consider a more regional model to identify more accurate representations for the boundaries, particularly the choices for constant head boundaries. In evaluating the effect of the proposed remedial measures, however, it did not appear that there were any significant boundary effects as a result of the simulated stresses. The model limits also prohibit assessment of potential interactions with potential remedial actions for the Eastern Plume. This interaction, however, will be addressed in the design level model for site groundwater remediation.

No formal validation on the model was performed except for simple mass balance calculations. Little data exist for validation other than for stream flow data which were useful in establishing baseflow information. The inclusion of this level of analysis will have its greatest effect on the determination of a more accurate value for hydraulic conductivity for the site. This will be important in determining design flow rates. The effect on expected flows will generally be linear with hydraulic conductivity and will affect most remedial measures proportionately with respect to flows. Variations in hydraulic conductivity could bias decisions between active and passive systems based on power and size requirements to achieve pumping removal rates.

B.8 Evaluation Of Remedial Alternatives

The groundwater flow simulations performed to evaluate remedial alternatives were accomplished using the final calibrated model (which can be considered the no action or minimal action condition). The following groundwater flow conditions were then simulated by adding simulated drains, restricting recharge over areas, or by assigning low hydraulic conductivity values to elements representing barriers:

- Alternative 1,3-C: Containment (Cap and Subsurface Hydraulic Barrier)
- Alternative 1,3-D: Passive Groundwater Collection/Treatment (Downgradient Trench)
- Alternative 1,3-E: Cap/Groundwater Extraction/Treatment (Cap and Downgradient Extraction Wells)
- Alternative 1,3-F: Cap/Passive Groundwater Collection/Treatment (Cap and Downgradient Trench)

B.8.1 Alternative 1,3-C

Modeling this alternative involved the simulation of a clay cap and an upgradient slurry wall. The clay cap was simulated in the model by reducing recharge over the proposed cap area to values typical of a clay cap. This area of reduced recharge indirectly simulates the presence of a clay cap. The alternative also includes the extraction of one pore volume of water from beneath the cap area at a rate of about 80 gpm. This component of the alternative was not included as part of this modeling effort. It should be noted that this groundwater extraction will lower the groundwater levels within the landfill boundaries in a shorter time frame than that presented for just a slurry wall and cap. Since the barrier wall essentially surrounds the site, the extraction of this groundwater volume is not expected to have a significant impact on Mere Brook. The clay cap was simulated at Sites 1 and 3 over the area shown in Figure B-5. The proposed clay cap was designed to reduce groundwater recharge through the cap to 0.5 inches per year or 0.00011 ft/day. This recharge rate was specified for nodes indicated in Figure B-5, as opposed to the 18 inches per year over the remainder of the model.

A slurry wall was simulated in the model to evaluate the effects that diversion of upgradient flows around the landfill would have on groundwater levels beneath the landfill. The nodes for which the slurry wall was specified are shown in Figure B-5. The slurry wall was conceptualized as horse-shoe shaped, surrounding the landfill area with the exception of that part within the Weapons Compound. The slurry wall simulated for Alternative 1,3-C was configured in this manner to prevent groundwater flow, which would be deflected by this slurry wall, from flowing around the slurry wall and affecting the southern portion of the landfill area. It should be noted that slurry walls have been installed at the depths required at this site. Several contractors have equipment that can install deep slurry walls and these methods are described in more detail in Section 3.3 of this report. Given the feasibility of slurry wall construction to the clay surface, a single layer simulation is considered appropriate to evaluate this component of the alternative. The hydraulic conductivity of the slurry wall was assumed to be 0.003 ft/day ($1x10^{-6}$ cm/sec). Figure B-6 illustrates the effect a slurry wall would have on groundwater flow directions and levels within the modeled area. This figure also reflects the effect a landfill cap (simulated by reduced rechange) will have on the system. Based on computed head values in the calibration model run, and computed head values generated from this scenario, groundwater levels beneath the landfill are expected to decrease by 8 to 10 feet. This would result in groundwater levels at, or near, the bottom of the landfill waste.

The model simulates a slurry wall as the entire thickness of the model node, which is unrealistic. Therefore, factors of 16 or 33 (depending on the node size of either 50 or 100 feet wide) were factored into the slurry wall hydraulic conductivity values to account for a typical slurry wall construction thickness of 3 feet, and thus allow an appropriate groundwater flux to occur through the wall. That is, the hydraulic conductivity for slurry wall modes represent the composite for 3 feet of low hydraulic conductivity slurry and 47 feet of sand for a 50 foot wide grid node. This amount of seepage is still considered to be relatively small.

B.8.2 Alternative 1,3-D

A trench downgradient of the landfill was simulated in the model to evaluate the effect of a passive drain (operating by gravity) on groundwater flow at the site. The MODFLOW drain package was used to simulate a passive drain immediately downgradient of the landfill. The nodes for which the drain package was specified are shown in Figure B-7. A drain conductance value was derived and input into the

nodes specified for the downgradient trench. A check on this drain conductance value was performed using the equation Q=KiA where:

Q = flow in cubic feet per day (ft^3/day)
K = hydraulic conductivity (estimated at 21 ft/day)
i = hydraulic gradient (calculated at 0.03 ft/ft)
A = area of groundwater discharge (estimated at 29,250 ft^2)

This calculated volumetric flowrate of 18,400 ft^3/day of groundwater through the model compared well with the mass balance output for runs with a drain package conductance value of 100 ft^2/day.

Based on this calculation for this alternative, approximately 0.184 x 10^5 ft^3/day is estimated to flow from Sites 1 and 3. Figure B-7 illustrates the effect of a passive downgradient trench on groundwater flow directions and levels within the modeled area. Based on computed head values in the calibration model run, and computed head values generated from the passive collection trench run, groundwater beneath the landfill is expected to decrease by 2 to 4 feet. The passive groundwater trench would be collecting groundwater migrating from Sites 1 and 3. The volumetric budget for the final trench alternative model run indicates the trench would collect approximately 80 gpm. Given that this alternative, as well as Alternatives 1,3E and 1,3F, will collect groundwater passively under natural flowrates. Surface water flow in Mere Brook is not expected to be significantly impacted. A comparison of heads associated with the modeled river nodes for both the calibration run, and these alternatives runs, indicate that only relatively small head changes in Mere Brook would occur (less than a 1-foot difference). Nodes associated with Mere Brook did not go dry in any of the alternative simulations.

B.8.3 Alternative 1,3-E

The third alternative evaluated as part of the model study consisted of a landfill cap and a downgradient extraction well system. To provide the most effective groundwater flushing of the landfill wastes, it was determined that the extraction well system would capture groundwater downgradient of the landfill, but would not lower water levels beneath the landfill wastes. This would ensure that groundwater would continue to flush contaminants from the source area. Otherwise, whenever the wells were turned off, groundwater would rise up into the waste again, and could resume the leaching of contaminants into the groundwater.

Eight extraction wells were simulated at the locations shown in Figure B-8. The computed volumetric budget discharge rates associated with the passive downgradient trench were utilized as a guideline in estimating extraction well rates. A total of approximately 80 gpm would be extracted from the system. The groundwater model reflects that transmissivity is greater in the southeastern portion of the landfill area. Therefore, extraction wells in this portion of the system were simulated with pumping rates higher than those in wells in the southwestern portion of the extraction system. Pumping rates from west to east ranged from 4 to 29 gpm. Based on this model simulation, this extraction well system would lower groundwater beneath the landfill approximately 3 to 5 feet.

B.8.4 Alternative 1,3-F

This model evaluation involved the simulation of the effects of a landfill cap and a passive downgradient trench. Alternative 1,3-F would both minimize recharge to the landfill wastes and collect groundwater downgradient of the Sites 1 and 3 landfill. The trench would collect groundwater passively and only lower groundwater by 2 to 4 feet beneath the landfill. This passive system would also permit groundwater to flush through the landfill wastes. The head distribution for this simulation is similar to that modeled in Alternative 1,3-D and is shown in Figure B-9.

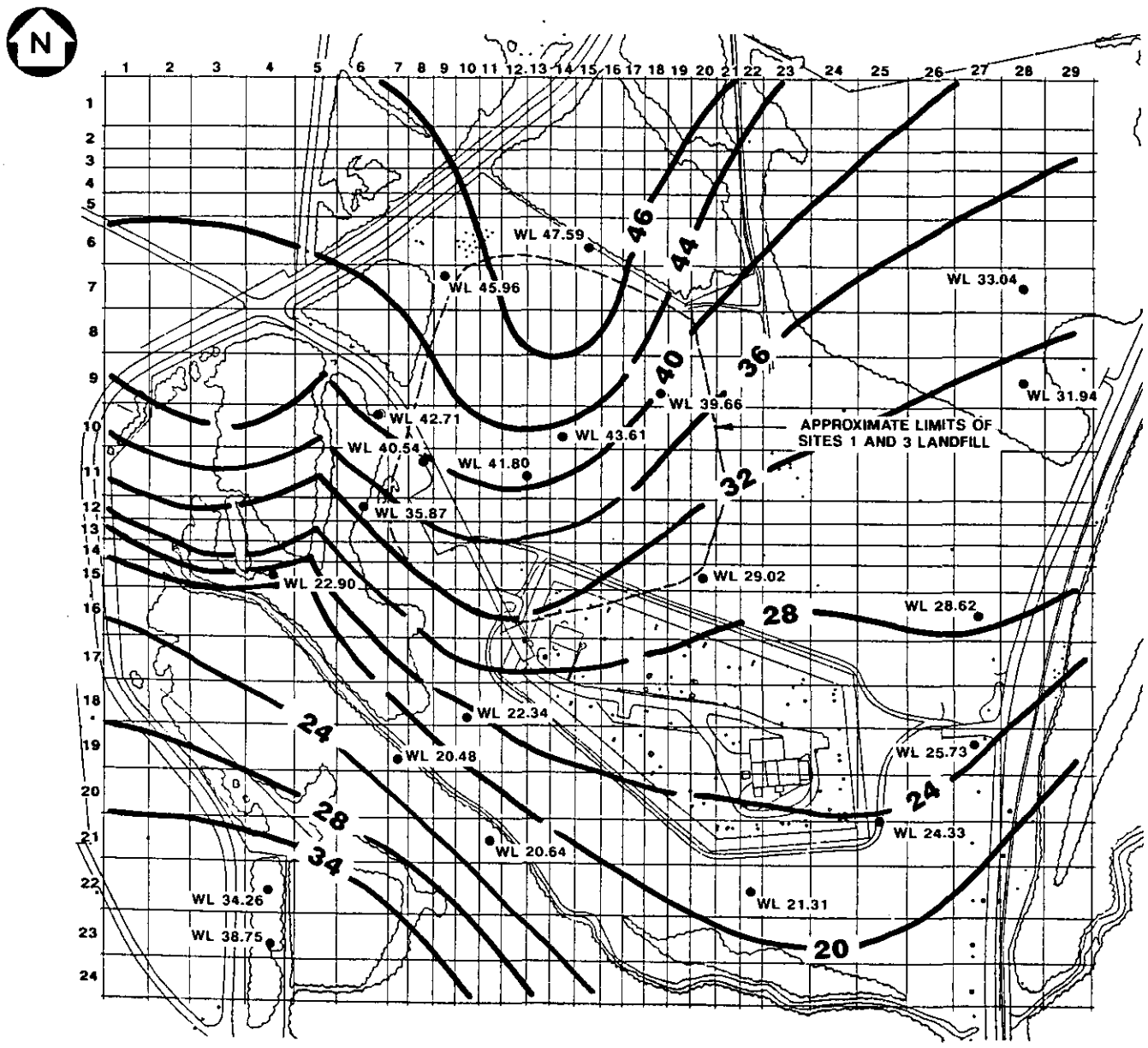
B.9 SUMMARY

The MODFLOW model developed for Sites 1 and 3 reasonably represents the behavior of the shallow aquifer at these sites. The groundwater gradients, flow directions, hydraulic conductivity, and mass balances simulated in the model all reasonably match with field data and observed hydraulic conditions. Within the recognized limitations of the model, it was then used as a screening tool to compare and evaluate conceptual designs for identified remedial alternatives. The flow model was used to simulate remedial alternatives involving: a landfill cap/slurry wall (Alternative 1,3-C); a passive downgradient drain (Alternative 1,3-D); a landfill cap/downgradient extraction well system (Alternative 1,3-E); and a landfill cap/passive downgradient trench (Alternative 1,3-F). Information from the simulations was used to estimate flow required to establish containment and collection, and to judge the probable relative effectiveness of proposed groundwater remedial alternatives.

Caswell, B.C. 1987 Groundwater Handbook for the State of Maine. Maine Geological Survey, Department of Conservation. Bulletin 39, second edition.

MacDonald, M.G. and A.W. Harbaugh. 1988. A Modular Three-dimensional Finite-difference Groundwater Flow Model. U.S. Geological Survey, National Center, Reston, VA.

National Research Council. 1989. Groundwater Models: Scientific and Regulatory Applications. National Academy Press, Washington, D.C. pp. 229.



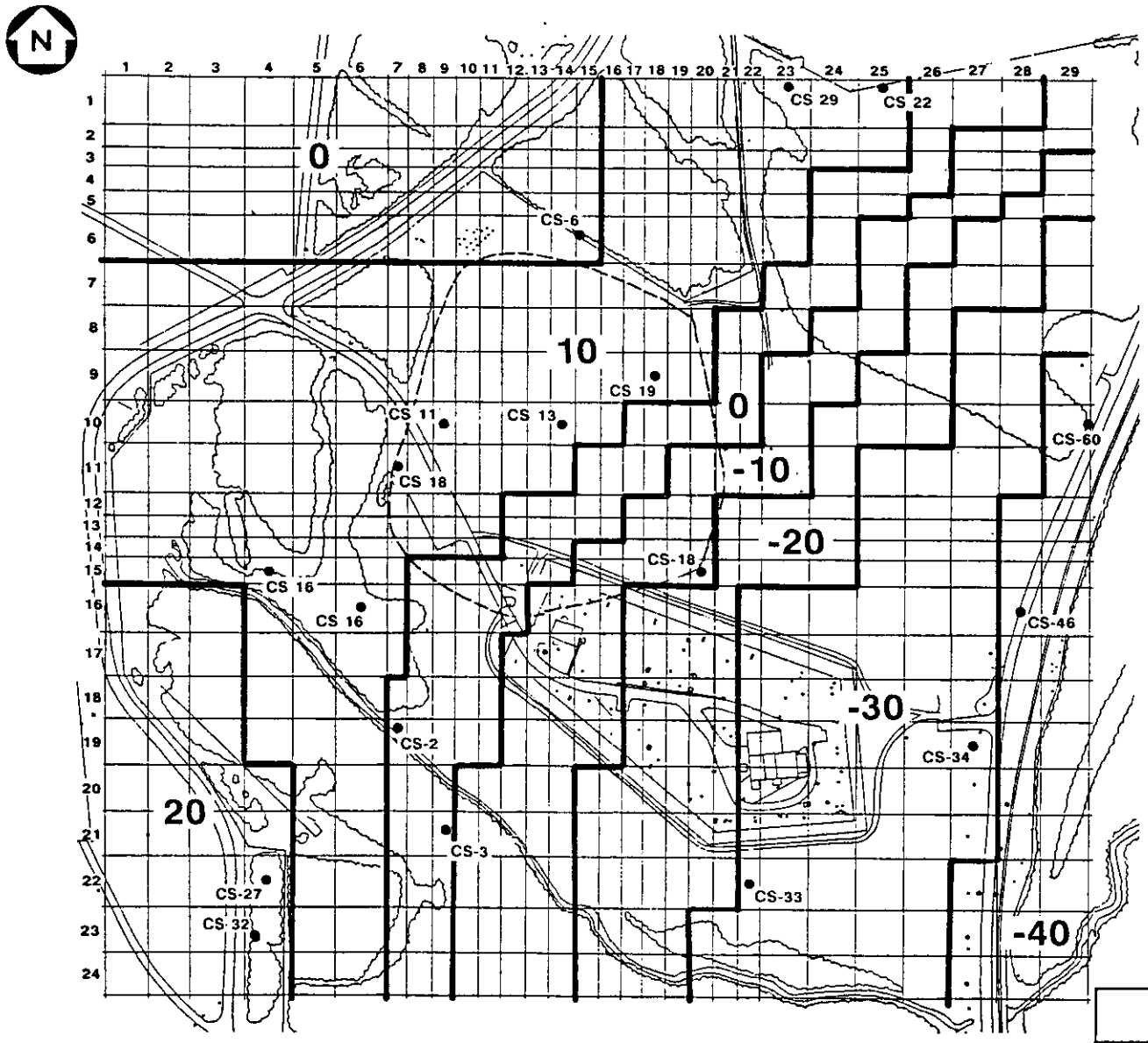
LEGEND

-34- INTERPRETIVE GROUNDWATER SURFACE CONTOUR (10/24/89)

● WL 25.73 WATER LEVEL MEASURED ON 10/24/89

COMPLETE GROUNDWATER SURFACE CONTOUR MAP SHOWN IN FIGURE 6-2 OF THE AUGUST 1990 DRAFT FINAL RI REPORT (E.C. JORDAN)

E.C. JORDAN CO. CONSULTING ENGINEERS	MODEL GRID AREA SITES 1 & 3 MODFLOW SIMULATION
INSTALLATION RESTORATION PROGRAM NAVAL AIR STATION BRUNSWICK, MAINE	FIGURE B-1



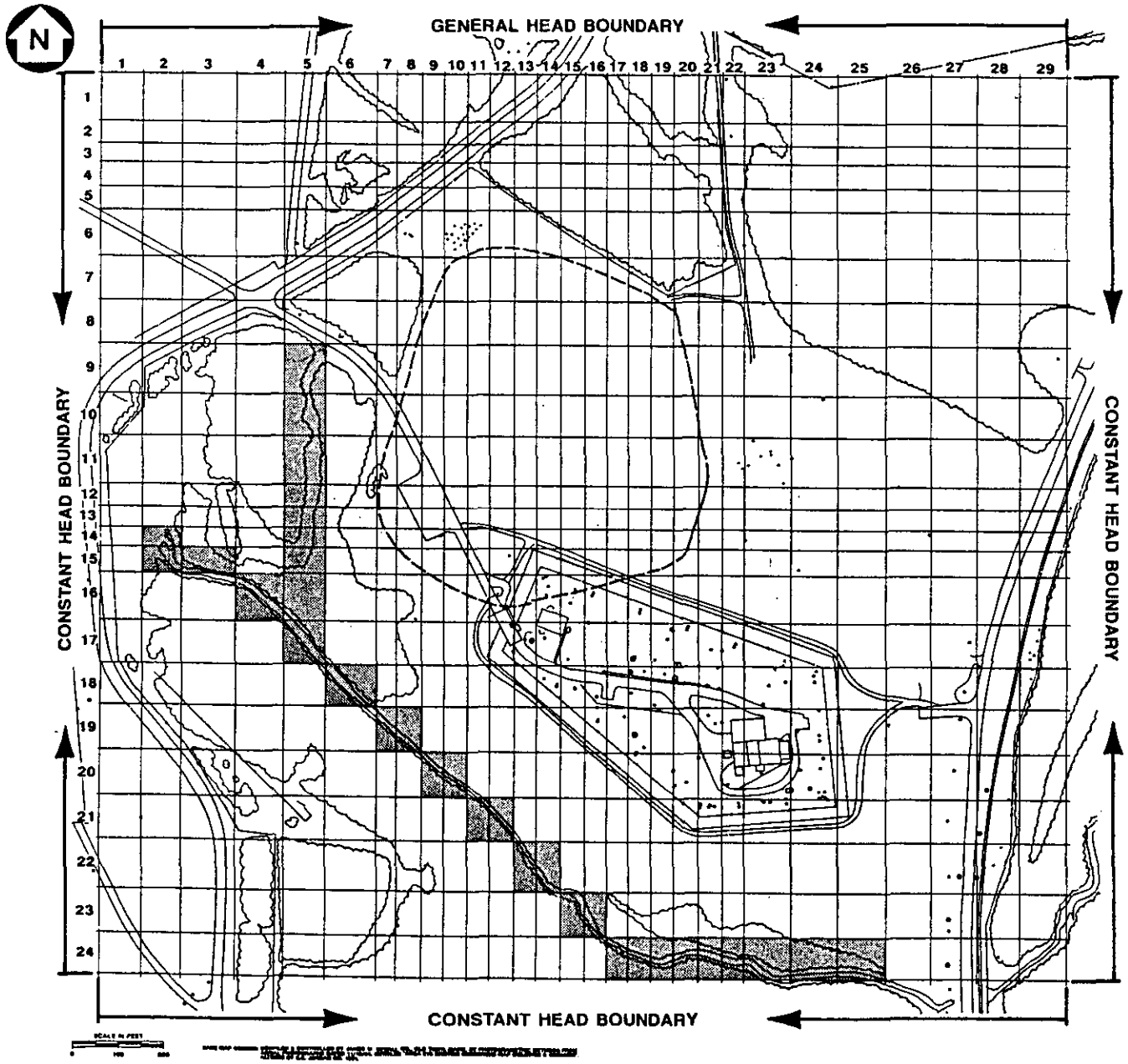
LEGEND

● CS-34 — ELEVATION OF CLAY SURFACE IN FEET MSL

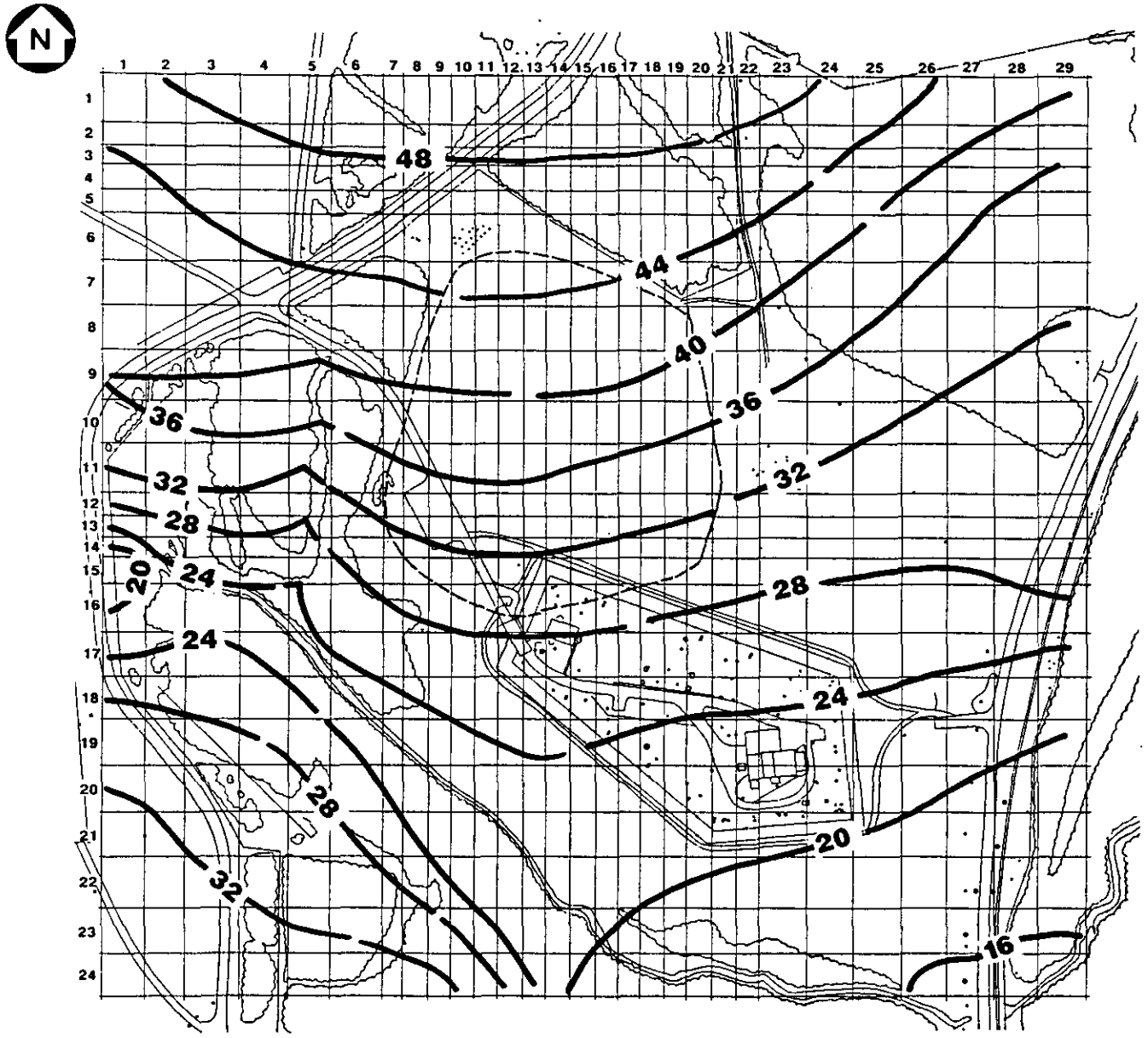
COMPLETE TOP OF CLAY SURFACE CONTOUR MAP SHOWN IN FIGURE 8-8 OF THE APRIL 1991 DRAFT SUPPLEMENTAL RI REPORT (E.C. JORDAN).

NOTE:
NUMBER REPRESENTS ELEVATION IN FEET ABOVE MEAN SEA LEVEL.

E.C. JORDAN CO. CONSULTING ENGINEERS	TOP OF CLAY SURFACE (FEET, MSL) SITES 1 AND 3 MODFLOW SIMULATION
INSTALLATION RESTORATION PROGRAM NAVAL AIR STATION BRUNSWICK, MAINE	SITES 1 AND 3 FFS
	4607-57 FIGURE B-2



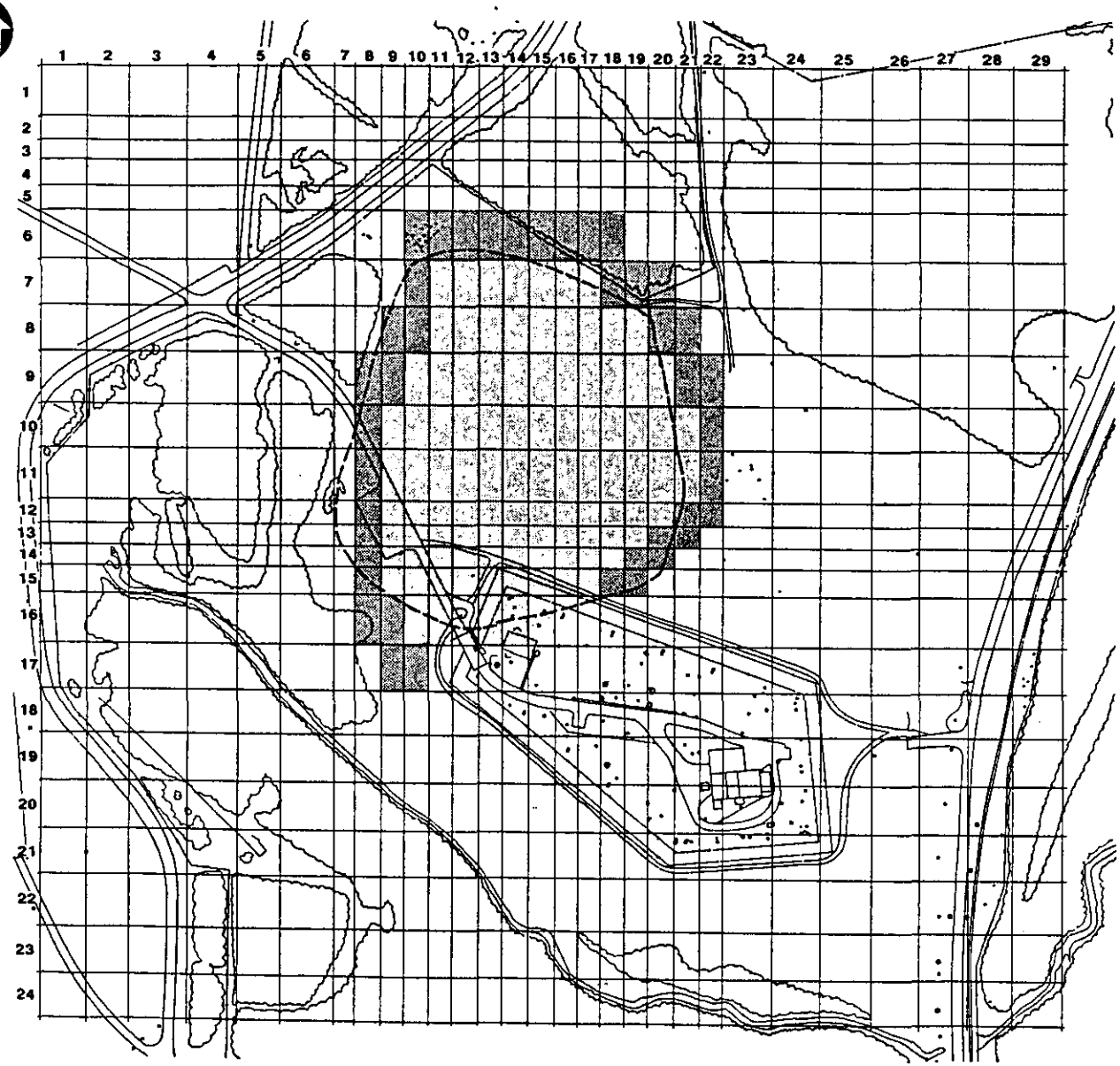
E.C. JORDAN CO.	RIVER BLOCK MATRIX SITES 1 & 3 MODFLOW SIMULATION
INSTALLATION RESTORATION PROGRAM NAVAL AIR STATION BRUNSWICK, MAINE	FIGURE B-3



LEGEND

20 — INTERPRETIVE GROUNDWATER SURFACE CONTOUR BASED ON COMPUTED HEAD VALUES

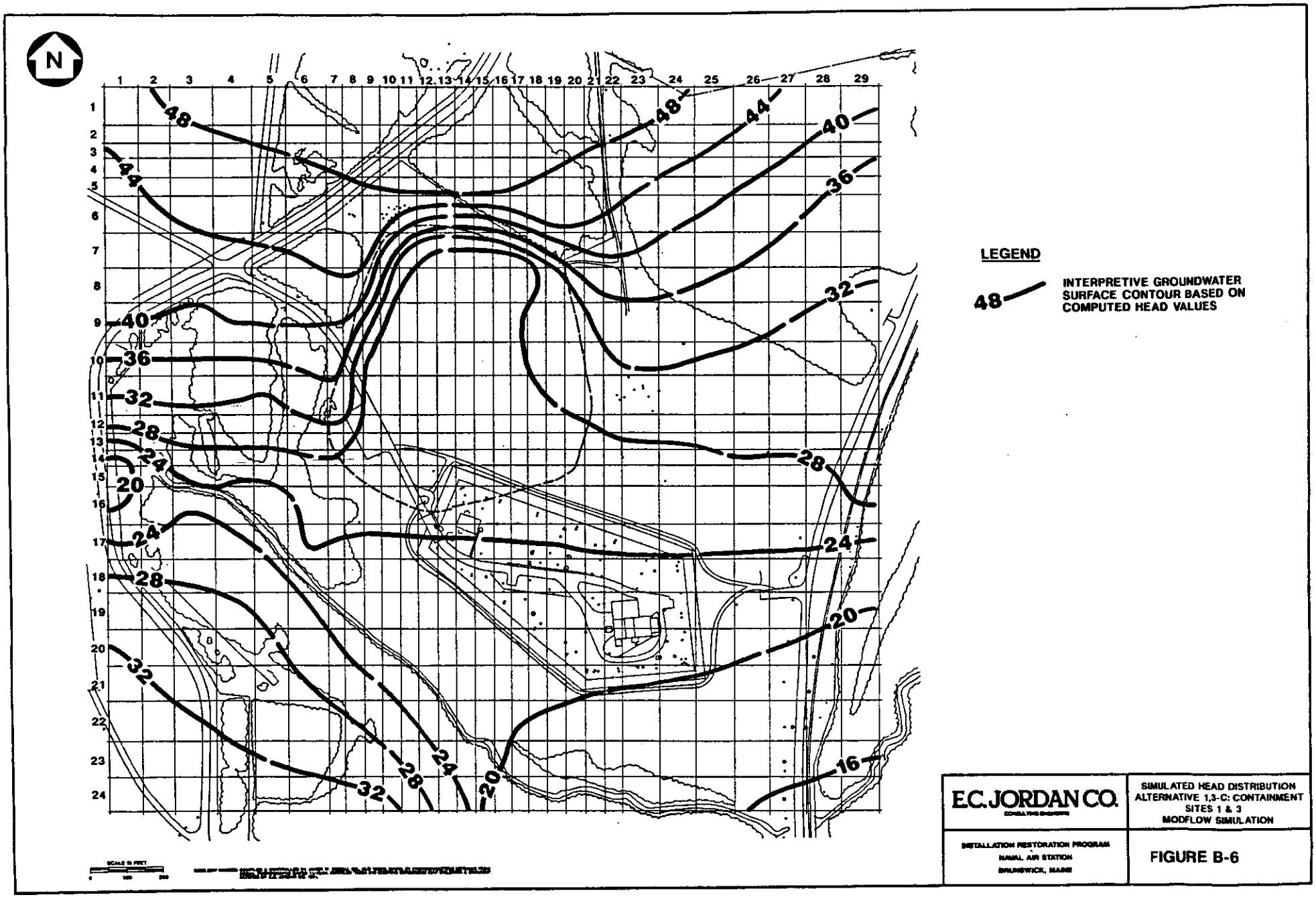
E.C. JORDAN CO. CONSULTING ENGINEERS	FINAL CALIBRATION RUN SITES 1 & 3 MODFLOW SIMULATION
INSTALLATION RESTORATION PROGRAM NAVAL AIR STATION BRUNSWICK, MAINE	FIGURE B-4

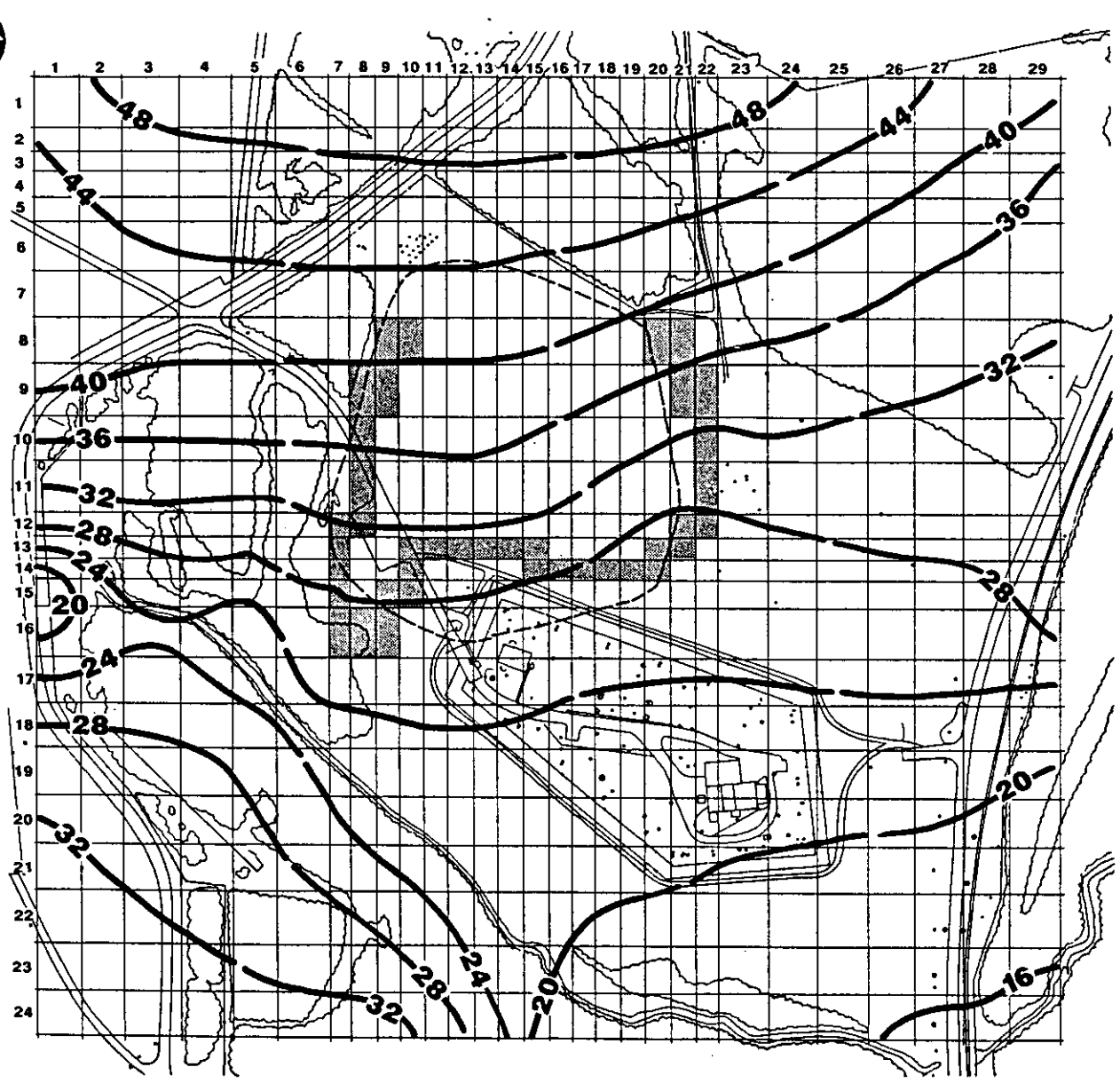


LEGEND

- LANDFILL CAP NODES
- BARRIER WALL NODES

E.C. JORDAN CO. CONSULTING ENGINEERS	MODEL NODES SPECIFIED FOR LANDFILL CAP AND BARRIER WALL, SITES 1 & 3 MODFLOW SIMULATION
INSTALLATION RESTORATION PROGRAM NAVAL AIR STATION BRUNSWICK, MAINE	FIGURE B-5


N
LEGEND
48 INTERPRETIVE GROUNDWATER SURFACE CONTOUR BASED ON COMPUTED HEAD VALUES
E.C. JORDAN CO.
SIMULATED HEAD DISTRIBUTION
ALTERNATIVE 1,3-C: CONTAINMENT
SITES 1 & 3
MODFLOW SIMULATION
INSTALLATION RESTORATION PROGRAM
NAVAL AIR STATION
BRUNSWICK, MAINE
FIGURE B-6

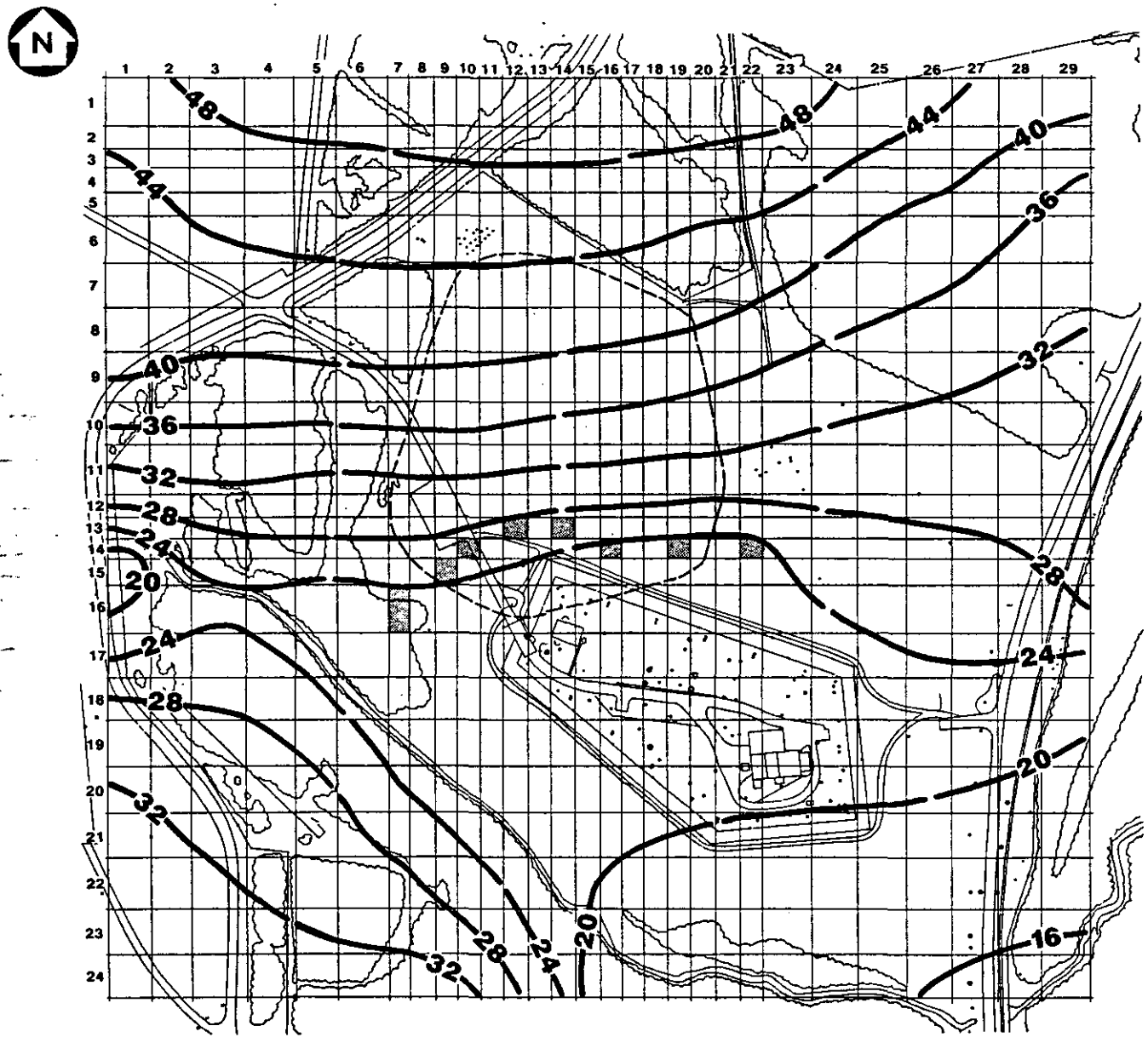


LEGEND

28 — INTERPRETIVE GROUNDWATER SURFACE CONTOUR BASED ON COMPUTED HEAD VALUES

NODES SPECIFIED FOR DRAIN PACKAGE

E.C. JORDAN CO. CONSULTING ENGINEERS	SIMULATED HEAD DISTRIBUTION ALTERNATIVE 1,3-D: PASSIVE GROUNDWATER COLLECTION SITES 1 & 3 MODFLOW SIMULATION
INSTALLATION RESTORATION PROGRAM NAVAL AIR STATION BRUNSWICK, MAINE	FIGURE B-7

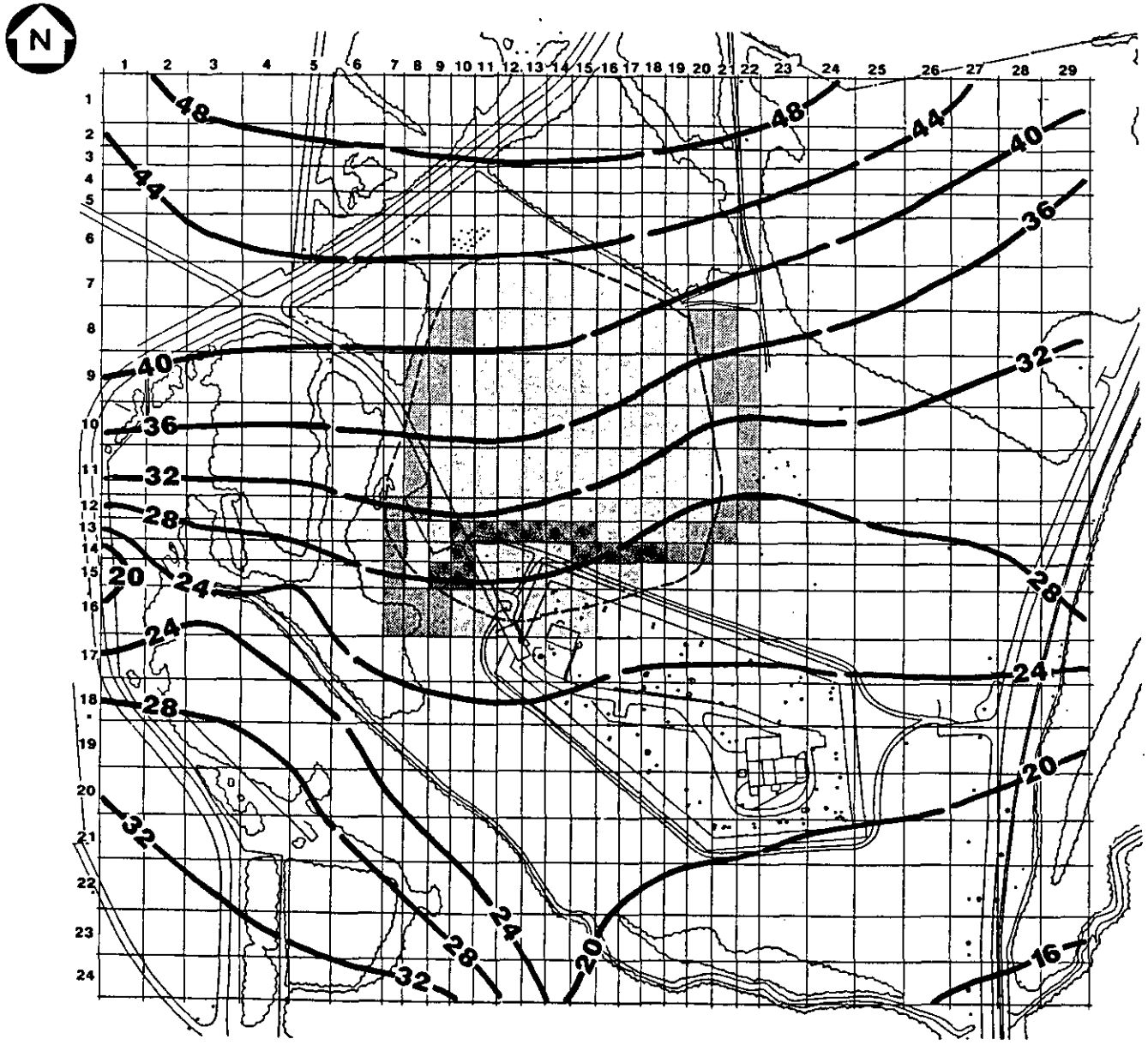


LEGEND

20 — INTERPRETIVE GROUNDWATER SURFACE CONTOUR BASED ON COMPUTED HEAD VALUES

EXTRACTION WELL NODES

E.C. JORDAN CO.	SIMULATED HEAD DISTRIBUTION ALTERNATIVE 1,3-E: CAP/GROUNDWATER EXTRACTION SITES 1 & 3 MODFLOW SIMULATION
INSTALLATION RESTORATION PROGRAM NAVAL AIR STATION BRUNSWICK, MAINE	FIGURE B-8



LEGEND

20 — INTERPRETIVE GROUNDWATER SURFACE CONTOUR BASED ON COMPUTED HEAD VALUES

SPECIFIED NODES FOR DRAIN PACKAGE

SPECIFIED NODES FOR LANDFILL CAP

E.C. JORDAN CO. CONSULTING ENGINEERS	SIMULATED HEAD DISTRIBUTION ALTERNATIVE 1,3-F: CAP/ PASSIVE GROUNDWATER COLLECTION SITES 1 & 3 MODFLOW SIMULATION
INSTALLATION RESTORATION PROGRAM NAVAL AIR STATION BRUNSWICK, MAINE	FIGURE B-9

PRELIMINARY DESIGN INFORMATION AND CALCULATIONS

******* A N A L Y S I S O F S T R I P P I N G T O W E R *******

PROJECT : BNAS DATE : 1/9/1991

ENGINEER : RBP PAGE : 1/2

PHYSICAL CONSTANTS

Design temperature	:	50.0 degrees F.
Density of water	:	62.4 lb/ft^3
Density of air	:	0.0778 lb/ft^3
Viscosity of water	:	8.80E-04 lb/ft.s
Viscosity of air	:	1.16E-05 lb/ft.s
Surface tension of water	:	74 dyne/cm
Atmospheric pressure	:	1.00 atm

CONTAMINANT PROPERTIES

Name	:	Vinylchloride
Molecular weight	:	62.5 g/mol
Boiling point	:	9 degrees F.
Molal volume at boiling point	:	0.0653 L/mol
Henry's Constant	:	3.40000
Enthalpy upon dissolution in water	:	3800 cal/mol
Molecular diffusivity in air	:	1.20E-04 ft^2/s
Molecular diffusivity in water	:	8.95E-09 ft^2/s

PACKING PROPERTIES

Name	:	Jaeger Tripacks
Packing Material	:	Plastic
Nominal Size	:	1.00 inch
Specific Area	:	84.7 ft^2/ft^3
Critical surface tension	:	33 dyne/cm
Packing depth	:	15.0 ft
Air friction factor	:	28

13

******* A N A L Y S I S O F S T R I P P I N G T O W E R *******

PROJECT : BNAS DATE : 1/9/1991

ENGINEER : RBP PAGE : 2/2

LOADING RATES

Water mass loading rate	:	3.5 lb/ft^2.s	*
Air mass loading rate	:	0.430 lb/ft^2.s	*
Water volumetric loading rate	:	24.79 gpm/ft^2	*
Air volumetric loading rate	:	2479 gpm/ft^2	*
Air pressure gradient	:	0.685 " H2O/ft	#
Volumetric air/water ratio	:	100.0	
Stripping factor	:	200.1	

MASS TRANSFER PARAMETERS

Percentage of packing area wetted	:	46.5 %	
Wetted packing area	:	39.4 ft^2/ft^3	*
Transfer rate constant in water	:	0.000463 ft/s	
Transfer rate constant in air	:	0.080884 ft/s	
Overall transfer rate constant	:	0.000462 ft/s	
Overall mass transfer coefficient	:	0.0182 1/s	
NTU	:	4.9422	
HTU	:	3.0351 ft	

CONTAMINANT REMOVAL

Influent concentration	:	180.0 ug/L	
Effluent concentration	:	1.3 ug/L	
Fraction removed	:	99.3 %	
Mass of contaminant removed	:	0.05318 lb/ft^2.day	*
Concentration in airstream	:	0.00470 mg/ft^2.ft^3	

* Expressed per unit of stripping tower cross-sectional area
\# Expressed per unit of tower length

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***** C-E Environmental, Inc. *****

******* A N A L Y S I S O F S T R I P P I N G T O W E R *******

PROJECT : BNAS DATE : 1/9/1991

ENGINEER : RBP PAGE : 1/2

PHYSICAL CONSTANTS

Design temperature	:	50.0 degrees F.
Density of water	:	62.4 lb/ft^3
Density of air	:	0.0778 lb/ft^3
Viscosity of water	:	8.80E-04 lb/ft.s
Viscosity of air	:	1.16E-05 lb/ft.s
Surface tension of water	:	74 dyne/cm
Atmospheric pressure	:	1.00 atm

CONTAMINANT PROPERTIES

Name	:	Dichloromethane
Molecular weight	:	84.9 g/mol
Boiling point	:	104 degrees F.
Molal volume at boiling point	:	0.0714 L/mol
Henry's Constant	:	0.08400
Enthalpy upon dissolution in water	:	3620 cal/mol
Molecular diffusivity in air	:	1.07E-04 ft^2/s
Molecular diffusivity in water	:	8.48E-09 ft^2/s

PACKING PROPERTIES

Name	:	Jaeger Tripacks
Packing Material	:	Plastic
Nominal Size	:	1.00 inch
Specific Area	:	84.7 ft^2/ft^3
Critical surface tension	:	33 dyne/cm
Packing depth	:	15.0 ft
Air friction factor	:	28

******* A N A L Y S I S O F S T R I P P I N G T O W E R *******

PROJECT : BNAS DATE : 1/9/1991

ENGINEER : RBP PAGE : 2/2

LOADING RATES

Water mass loading rate	:	3.5 lb/ft^2.s	*
Air mass loading rate	:	0.430 lb/ft^2.s	*
Water volumetric loading rate	:	24.79 gpm/ft^2	*
Air volumetric loading rate	:	2479 gpm/ft^2	*
Air pressure gradient	:	0.685 " H2O/ft	#
Volumetric air/water ratio	:	100.0	
Stripping factor	:	5.1	

MASS TRANSFER PARAMETERS

Percentage of packing area wetted	:	46.5 %	
Wetted packing area	:	39.4 ft^2/ft^3	*
Transfer rate constant in water	:	0.000451 ft/s	
Transfer rate constant in air	:	0.075179 ft/s	
Overall transfer rate constant	:	0.000403 ft/s	
Overall mass transfer coefficient	:	0.0159 1/s	
NTU	:	4.3099	
HTU	:	3.4804 ft	

CONTAMINANT REMOVAL

Influent concentration	:	460.0 ug/L	
Effluent concentration	:	11.6 ug/L	
Fraction removed	:	97.5 %	
Mass of contaminant removed	:	0.13343 lb/ft^2.day	*
Concentration in airstream	:	0.01179 mg/ft^2.ft^3	

* Expressed per unit of stripping tower cross-sectional area
\# Expressed per unit of tower length

GEO·CON INC.
GEOTECHNICAL CONTRACTING

October 15, 1990

Ms. Kristie Tschudy
E. C. Jordan
P. O. Box 7050
Portland, ME 04112

Dear Ms. Tschudy:

Thank you for your interest in Geo-Con's new deep drainage trench technique using bio-degradable polymers (B-P). A technical brief describing this technique is attached for your review.

The B-P deep drainage technique is a method of installing a groundwater collection system, without driving sheet pilings and installing numerous well points. The B-P trench system uses the slurry cut-off wall excavation technique, but utilizes a bio-degradable polymer in lieu of the bentonite slurry normally associated with slurry cut-off wall systems. The bio-degradable polymer keeps the trench open while the drainage system is installed. After drainage system installation, the bio-polymer is bio-degraded into a sugar-water solution and disposed of into municipal sewers (after confirmation tests provide a contaminate free solution).

The B-P trench system is a fast, economical method of groundwater collection. If you have any questions, please feel free to contact the nearest Geo-Con regional office as listed below.

Thank you for your interest in Geo-Con, Inc.

Sincerely,

GEO-CON, INC.

Richard W. Hanford, P.E.
Sales and Marketing Manager

RWH/ja

Attachment

P.O. Box 17380 · Pittsburgh, PA 15235 · Tel (412)856-7700 · FAX (412)373-3357

Texas Office (817)383-1400
California Office (408)453-3587

Florida Office (813)647-5888
New Jersey Office (609)848-2220

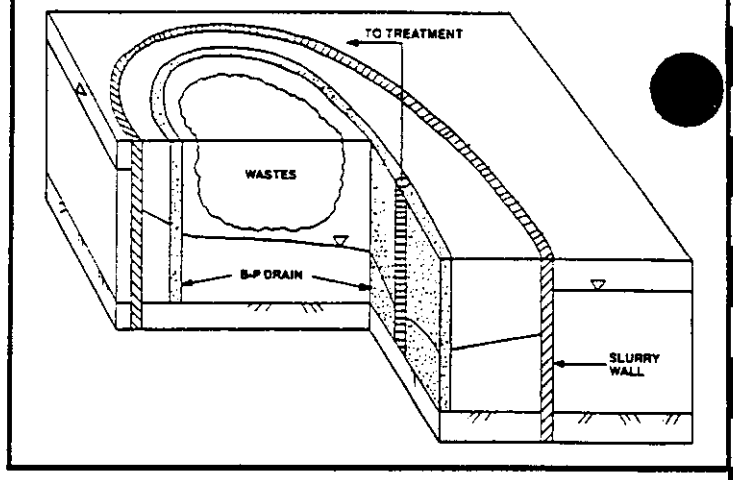
DEEP DRAINAGE TRENCHES BY THE BIO-POLYMER SLURRY TRENCH METHOD

Technical Brief

Bio-Polymer Slurry Drainage Trench

Bio-Polymer Slurry Drainage Trenches (B-P Drain) are narrow, vertical trenches filled with permeable materials that act as interceptor drains or extraction trenches for the collection or removal of groundwater and groundwater-borne pollutants. B-P Drains are constructed using the slurry trench technique with a biodegradable carbohydrate instead of bentonite as the active ingredient in the water-based trenching slurry. The principal advantages of B-P Drains are their high groundwater transmissivity, rapid installation sequence, superior safety environment for workers, and relatively greater depth capability.

Schematic of Typical Bio-Polymer Slurry Drainage Trench



APPLICATIONS

The first productive use of a B-P Drain was in the 1970's in Europe for the interception of groundwater near unstable highway slopes. It was found that a B-P Drain could effectively lower in-situ pore pressures by transmitting groundwater around the unstable slopes without the need for extensive dewatering, mass excavation and structural bracing.

In the United States, there has been a growing need for deep Drainage trenches to collect contaminated groundwater for treatment and disposal. Often these drains must be very deep and operated for extended periods in congested areas. Recent advances in the slurry trench equipment and biodegradable slurry additives have made the use of this technology both practical and cost-effective. B-P Drains are now economically competitive on projects where mass excavation, sheeted excavations and/or well points would have previously been used. Some recommended applications are to:

- stabilize earthen slopes,
- intercept contaminated groundwater plumes,
- collect contaminated groundwater inside of waste containment landfills,
- transmit groundwater around work areas,
- hydraulically isolate lagoons or holding ponds.

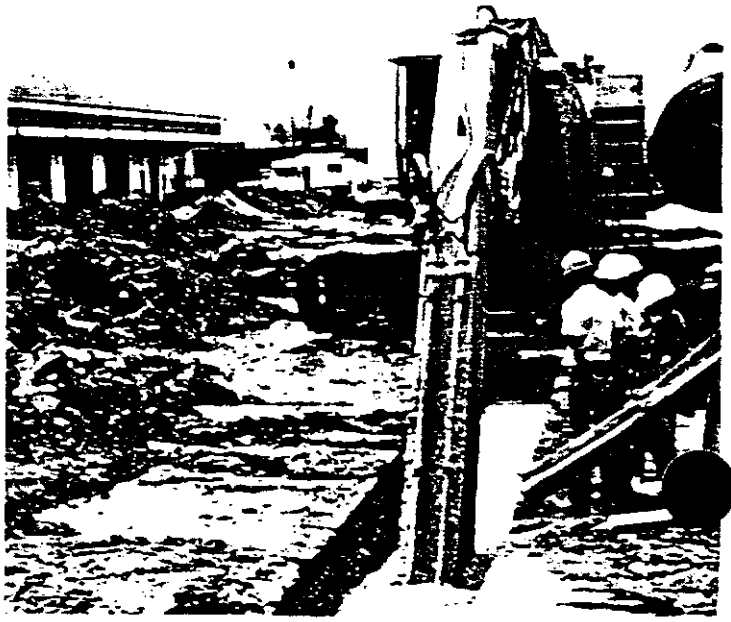
The B-P Drain installation combines the continuity and storage capacity of an interceptor pipe-drain with the ease of installation and depth capability of a deep well system.

CONSTRUCTION

The construction sequence for the B-P Drain is similar to that used for slurry cut-off walls except that 1) permeable materials such as gravel or sand are used for the trench backfill, and 2) a biodegradable slurry is used in lieu of a bentonite clay slurry to support the excavation without the use of lateral bracing.

B-P slurry trenches are installed by excavating a narrow trench (2 - 4 ft. wide) while simultaneously pumping in a biodegradable slurry and maintaining the level near the surface and above the surrounding groundwater table. The trench is then backfilled with permeable materials to form the permanent drainage system.

The critical ingredient in B-P Drain is the biodegradable slurry. The active ingredient in the slurry is a natural bio-polymer which yields a psuedo-plastic fluid when slurried with water. A properly controlled and modified slurry will remain effective for one to two weeks before reverting back to water. Specially modified slurry mixing equipment is



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T-SW-02-87

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used to blend the bio-polymer, additives and water into an effective trenching slurry. Monitoring of the pH and viscosity of the slurry is required to maintain the stability of the slurry and thus the trench during excavation.

Once the trench is open and supported with slurry, a variety of permeable materials may be placed through the slurry into the trench. The simplest system is to fill the trench with gravel or a sand filter and grade the trench bottom to a collection point. In difficult soil, vertically graded filters may be tremied into the trench or filter fabrics sunk into the trench to resist invasion of soil into the drainage system. Well casings can be easily placed into the trench during excavation to provide groundwater extraction capabilities.

When the trench is completed, the remaining bio-polymer slurry is broken or converted back to water and a minute amount of natural sludstuff (residual bio-polymer) which is quickly consumed by soil organisms. The breaking of the bio-polymer is accomplished either by natural enzymes in the soil or by the addition of a breaker solution. Once the slurry has been broken, the native soil formation surrounding the trench assumes its original hydraulic conductivity in a short time.

DESIGN

The incorporation of a B-P Drain into any project requires a working knowledge of both the strengths and limitations of the technique. The primary design considerations for a B-P Drain are hydraulic conductivity, clogging resistance, collection and disposal options, slurry compatibility, and project application.

Hydraulic conductivity and clogging resistance are critical factors which are usually evaluated based on filter criteria with the surrounding soil and the required permeability of the drain. Typically a well-graded but freely draining sand or stone is used as the backfill. In difficult applications it may be necessary to incorporate a woven geotextile to the face of the trench to minimize the migration of fine soil particles into the drain.

Usually a collection point or extraction well is installed to collect groundwater. The groundwater can then be transmitted to an on-site treatment or storage facility. Well spacing, screen openings and casing dimensions are sized based on the filter material and performance expectations.

In order to have an effective slurry, it is necessary to have a reliable water source for slurry mixing. The fresh slurry may be preserved and modified with slurry additives for successful trenching and later broken with other additives. In general, a properly controlled slurry will be resistant to most saline or contaminated groundwater, though the slurry's effective lifetime may be shortened by some environmental factors such as temperature and soil-water chemistry.

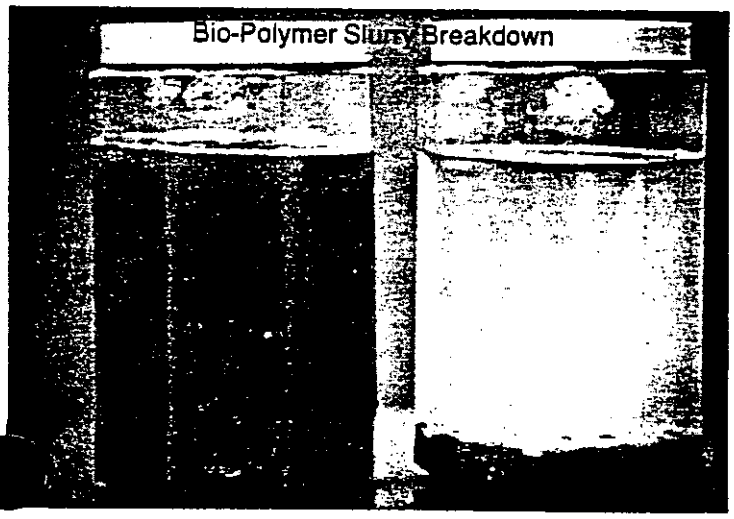
Well installation

Typically, drainage trenches for waste containment are installed on the down-gradient side of waste containments. For stabilizing slopes, the drain is installed up-gradient of the slope. Pairs of drainage trenches may be installed on both sides of a contaminated zone to act as a recharge and collection system. A comprehensive understanding of groundwater patterns and the purpose of the drain is required for each project. In most cases, the depth of the drain is designed to intercept groundwater well below seasonal fluctuations. Drains may be installed to collect all contaminated groundwater by extending the drain as deep as a natural aquiclude. In other cases, the groundwater sink created by the drain can be used to create a flow toward the well thus minimizing both the length and depth of the drain. B-P Drains may be combined with slurry walls to both contain and collect groundwater.

This type of system has obvious construction advantages as well as optimum flexibility in modifying groundwater patterns for the designer.

CONCLUSION

Deep drainage trenches can be installed by the bio-polymer slurry trench method and are gaining recognition for use in slope stability and pollution control. This technique offers a cost-effective solution to many construction and design problems for drain installation. The economy and flexibility of the technique are being utilized on an increasing number of projects.



Active slurry

Slurry shortly after addition of breaker solution

C-E Environmental, Inc.

261 Commercial Street/P.O. Box 7050
Portland, Maine 04112
(207) 775-5401 Telex 94-4329

TELEPHONE MEMORANDUM

PROJECT NO. 4607-57 DATE: Feb. 11, 1991

CLIENT: Navy

PROJECT DESCRIPTION: NAS Brunswick - Sites 1 + 3 FFS

BETWEEN: Christine Sawicki

AND: C. B. Osgood, Brunswick Public Works Dept. 1-725-6654

SUBJECT: Discharge of treated water to storm sewer system

DISCUSSION: Stormwater from the base is piped across the base and discharges to a stream near Rt. 24 and Coombs Rd. The water is not treated. Mr. Osgood seemed very skeptical about discharging treated landfill leachate to the storm sewers. He said we would need to get an effluent discharge permit and clear it through several town offices (Public Works, Planning Board, Codes Office). Effluent would need to be tested to ensure discharge requirements are met.

Would need to talk to John Foster (Director, DPW) to find out if 0.11 mgd flowrate is acceptable.

DISTRIBUTION:

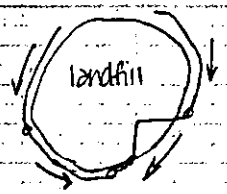
Beth Ryan
Tony Delano

PROJECT	COMP. BY	JOB NO.
Passive Groundwater Collection System Pipe slope and diameter (revised)	CRS	6836-02
	CHK. BY: BN	DATE: 6/25/91

Reference: "Recommended Standards for Sewage Works" 1978
Recommended minimum velocity to prevent siltation in pipe = 2.0 fps
Maximum = 15 fps

Design flow 15,000 ft^3/day = 0.17 cfs total flow

Assume 3 sumps along a 2,400 ft length (approximate)



Therefore, each section of pipe would pick up 1/4 of the total flow, or 0.043 cfs ✓

Assume pipe will flow half full → Q = 50% of Q_{full}
V = 100% of V_{full}

Use Mannings eqn. for pipe flowing full

$$V = \frac{1.49 \cdot R^{0.66} \cdot S^{0.5}}{n} = \frac{Q}{A} = \frac{Q}{\pi D^2/4} \quad \text{(fps)}$$

n = 0.013 for PVC pipe

$$R = \frac{A}{P} = \frac{\pi D^2}{4} \cdot \frac{1}{\pi D} = \frac{D}{4} \quad \text{(ft)}$$

S = slope (ft/ft)

For a V_{full} = 2 fps, and 2" pipe, slope = 0.02 ft/ft (minimum)

check:

$$Q_{full} = V_{full} \cdot A$$

$$= 2 \text{ fps} \cdot \frac{\pi (0.17 \text{ ft})^2}{4} = 0.047 \text{ cfs}$$ (would flow close to full in 2" pipe)

$Q_{50\%}$ = 0.023 cfs

For V_{full} = 2 fps, 4" pipe, slope = 0.008 ft/ft (minimum)

check:

$$Q_{full} = V_{full} \cdot A$$

$$= 2 \text{ fps} \cdot \frac{\pi (0.33)^2}{4} = 0.17 \text{ cfs}$$

$Q_{50\%}$ = 0.087 cfs

To be conservative, use 4" pipe at slope of at least 0.008 ft/ft

Over 600 ft pipe length, ~5 ft vertical elev. difference

C-E Environmental, Inc.

261 Commercial Street/P.O. Box 7050
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(207) 775-5401 Telex 94-4329

TELEPHONE MEMORANDUM

PROJECT NO. 4607-57 DATE: Feb. 11, 1991

CLIENT: Navy

PROJECT DESCRIPTION: NAS Brunswick - Sites 1 + 3 FFS

BETWEEN: Christine Sawicki

AND: Lenny Blanchette, Brunswick Sewer District 1-729-0148

SUBJECT: Discharge of treated water to the sewer system

DISCUSSION: Mr. Blanchette was not sure if the treatment plant could take the treated water because they are not supposed to accept anything but sanitary sewage. We would need to submit a proposal to them and go through a permitting process with the DEP.

The treatment plant currently receives wastewater from the Naval Air Station. The water is metered, so they would have to pay for additional flow.

Currently, the plant is operating at about 73 percent of their design capacity of 3.85 mgd. Average flows are 2.8 mgd. Our additional flowrate would be 0.11 mgd, bringing them up to 76 percent of capacity.

DISTRIBUTION:

Beth Ryan HP-3
Tony Delano HP-3

GROUNDWATER CLEAN-UP TIME ESTIMATES FOR LANDFILL WASTES: ALTERNATIVE 1,3-D AND 1,3-E

GROUNDWATER CLEANUP TIME ESTIMATES FOR LANDFILL WASTES ALTERNATIVES 1,3D AND 1,3E

Pore Volume Estimate--Alt. 1,3C

Sites 1&3 Area:

600 FT X 600 FT X 24 FT = 8640000 FT^3

or:

64,800,000 gallons @ 25% porosity - 16.2 million gallons

One can derive an equation to estimate the cleanup time, t_f, required for lowering groundwater concentrations at sites 1&3 site based on an initial concentration of C_o to a final concentration C_f. A volume of soil having an areal extent, A, and thickness L, is leached primarily by horizontal percolation of groundwater moving through the waste at a velocity V_x. A mass balance for the removal of contaminant from the volume is:

$$\frac{dM_w}{dt} = -V_w C_\ell$$

where: M_w = the mass of contaminant adhered to the soil

V_w = the volumetric flow rate of groundwater through the contaminated soil volume.

C_ℓ = the concentration of the contaminant in groundwater leaving the volume

This assumes that the initial mass of contaminant is nearly all on the soil, that chemical equilibria are established during time of travel, and that the volume is a uniform aquifer, all simplifying, but reasonable, assumptions.

M_w is the concentration on the soil, C_w, times the mass of soil, M_o, or:

$$M_w = M_o C_w = ALp\ (1-n) C_w$$

where: A = the cross area of the contaminated volume normal to the groundwater flow

L = the length of the volume in the direction of flow

p = the density of the soil taken as 2.65 kg/l (SEAM)

n = the porosity of the soil

Assume linear partitioning so that:

$$C_w = K_d \cdot C\ell = f_{oc} \cdot K_{oc}\ C_\ell$$

where: f_{oc} = the fraction of organic carbon

K_{oc} = the organic carbon partition coefficient

The volumetric flowrate, V_w, is also the seepage velocity, V_x, times the area (pore fraction), or

$$V_w = AnV_x$$

Substituting these expressions into the differential equation gives:

$$\frac{dc_w}{dt} = -\frac{AnV_xC_w}{ALp(n-n)f_{oc}\ K_{oc}}$$

or:

$$\frac{dCw}{C_w} = -\frac{nV_x\ dt}{Lp(1-n)f_{oc}\ K_{oc}}$$

or, solving for t_f,

$$t_f = -(Lp[1-n]f_{oc}\ K_{oc})\ (\ln[C_f/C_o])\ /\ (nV_x)$$

Note also that for linear partitioning, the ratio C_f/C_o is also the ratio of the final groundwater concentration to the initial, and that $-\ln(C_fC_o) = +\ln(C_o/C_f)$.

If 800 feet is used as an approximate longitudinal length of the landfill wastes, the average darcian seepage velocity nV_x is 90 ft/year, linear partitioning is assumed with an f_oc ranging from .005 to .02, a bulk density p(1-n) of 1.6 kg/ℓ, K_{oc} of 57 ℓ/kg for vinyl chloride, 180 mg/ℓ as a maximum concentration in groundwater, and 2 ug/ℓ is taken as the MCL, then:

$$t_f = \frac{f_oc\ K_{oc}\ L\ p(1-n)}{nV_x}\ \ln\ C_o/C_f$$

$$t_f = \frac{(.005)\ 57\ \ell/kg)\ (1.6\ kg/\ell)\ (800\ ft)}{90\ ft/year}\ \ln\frac{180}{2}$$

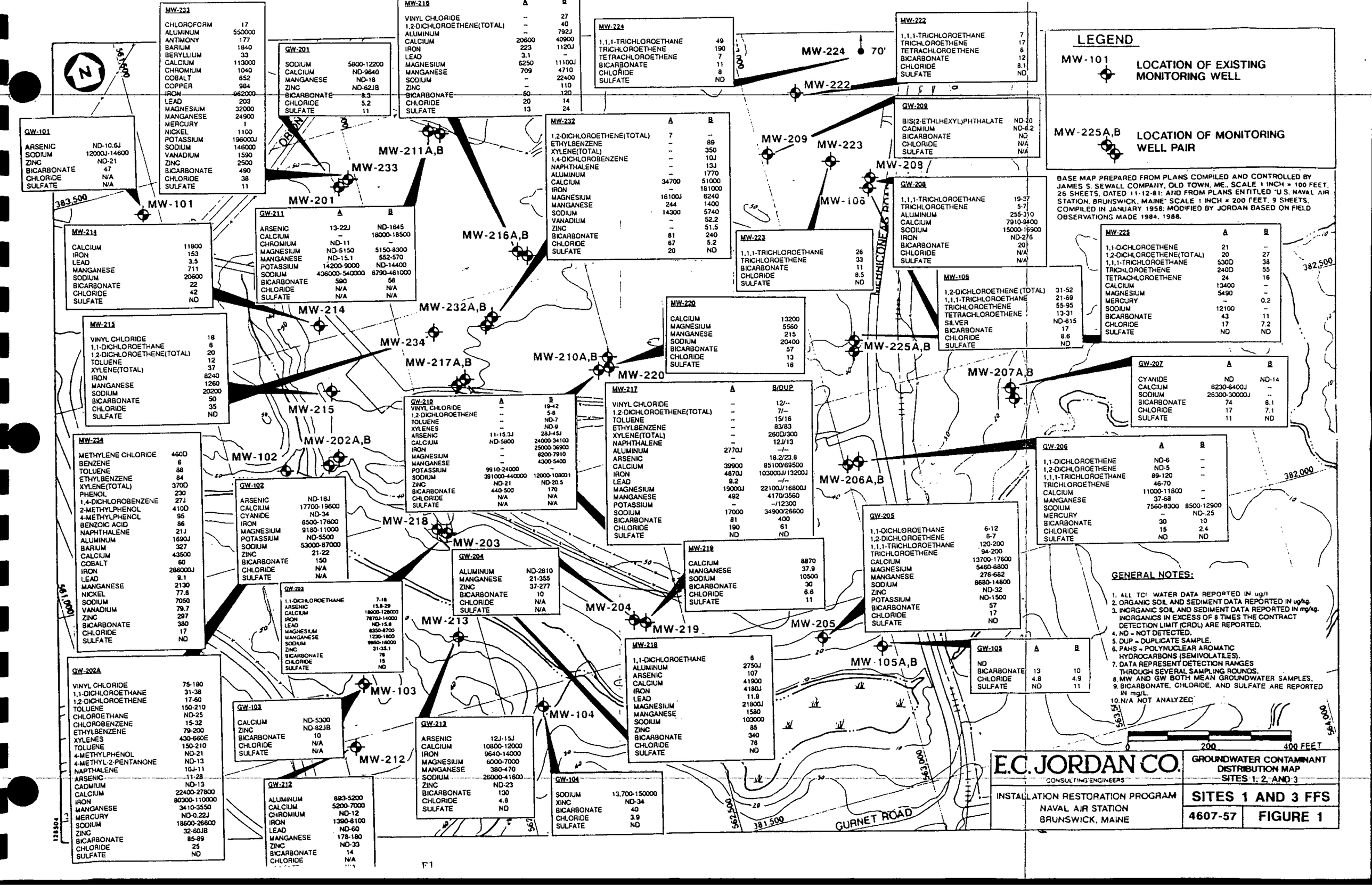
$$t_f = 4.05\ \ln\ \frac{180}{5} \qquad T_f = 18.2\ \text{years}$$

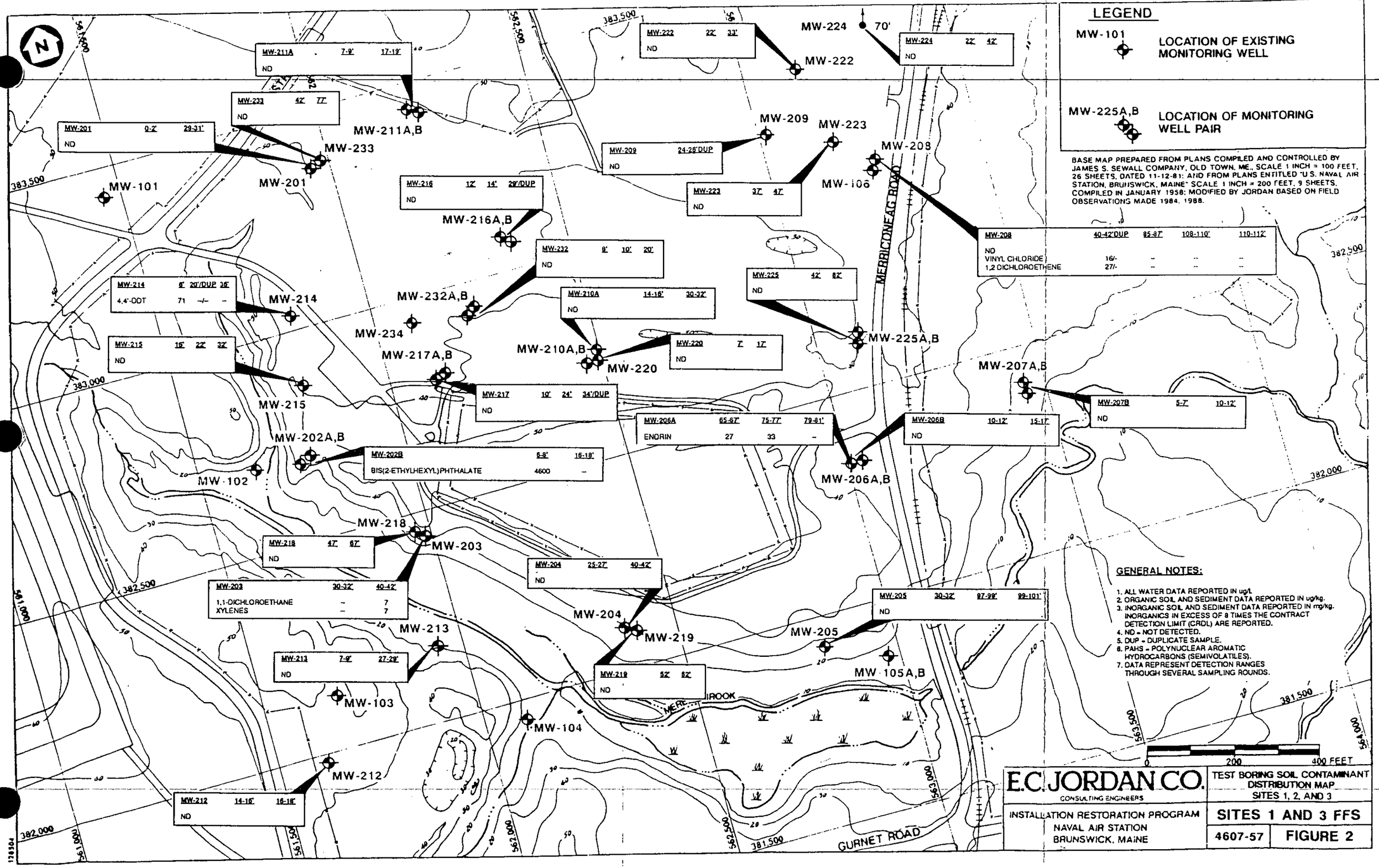
$$t_f = \frac{(.02)\ (57\ \ell/kg)\ (1.6\ kg/\ell)\ (800\ ft)}{90\ ft/year}\ \ln\frac{180}{2}$$

$$t_f = 16.2\ \ln\frac{180}{2} \qquad T_f = 72.8\ \text{years}$$

For both alternative 1,3D and 1,3E the time for the landfill wastes to be flushed is expected to range from 18 to 73 years. This range of cleanup time is primarily a result of the potential variability in estimated f_{oc} values at the site. Inefficiencies of flushing and heterogeneities in the actual aquifer system will probably cause longer removal times than those estimated in this calculation.

SUMMARY OF SAMPLING DATA


MW-233
CHLOROFORM 17
ALUMINUM 550000
ANTIMONY 177
BARIUM 1840
BERYLLIUM 33
CALCIUM 113000
CHROMIUM 1040
COBALT 652
COPPER 984
IRON 962000
LEAD 203
MAGNESIUM 32000
MANGANESE 24900
MERCURY 1
NICKEL 1100
POTASSIUM 196000J
SODIUM 146000
VANADIUM 1590
ZINC 2500
BICARBONATE 490
CHLORIDE 38
SULFATE 11
GW-201
SODIUM 5800-12200
CALCIUM ND-9640
MANGANESE ND-18
ZINC ND-62JB
BICARBONATE 8.3
CHLORIDE 5.2
SULFATE 11
MW-216 A B
VINYL CHLORIDE -- 27
1,2-DICHLOROETHENE(TOTAL) -- 40
ALUMINUM -- 792J
CALCIUM 20600 40900
IRON 223 1120J
LEAD 3.1 --
MAGNESIUM 6250 11100J
MANGANESE 709 4710
SODIUM -- 22400
ZINC -- 110
BICARBONATE 50 120
CHLORIDE 20 14
SULFATE 13 24
MW-224
1,1,1-TRICHLOROETHANE 49
TRICHLOROETHENE 190
TETRACHLOROETHENE 7
BICARBONATE 11
CHLORIDE 8
SULFATE ND
MW-222
1,1,1-TRICHLOROETHANE 7
TRICHLOROETHENE 17
TETRACHLOROETHENE 6
BICARBONATE 12
CHLORIDE 8.1
SULFATE ND
LEGEND
MW-101 LOCATION OF EXISTING MONITORING WELL
MW-225A,B LOCATION OF MONITORING WELL PAIR
BASE MAP PREPARED FROM PLANS COMPILED AND CONTROLLED BY JAMES S. SEWALL COMPANY, OLD TOWN, ME., SCALE 1 INCH = 100 FEET, 26 SHEETS, DATED 11-12-81; AND FROM PLANS ENTITLED "U.S. NAVAL AIR STATION, BRUNSWICK, MAINE" SCALE 1 INCH = 200 FEET, 9 SHEETS, COMPILED IN JANUARY 1958; MODIFIED BY JORDAN BASED ON FIELD OBSERVATIONS MADE 1984, 1988.
GW-101
ARSENIC ND-10.6J
SODIUM 12000J-14600
ZINC ND-21
BICARBONATE 47
CHLORIDE N/A
SULFATE N/A
MW-232 A B
1,2-DICHLOROETHENE(TOTAL) 7 --
ETHYLBENZENE -- 89
XYLENE(TOTAL) -- 350
1,4-DICHLOROBENZENE -- 10J
NAPHTHALENE -- 13J
ALUMINUM -- 1770
CALCIUM 34700 51000
IRON -- 181000
MAGNESIUM 16100J 6240
MANGANESE 244 1400
SODIUM 14300 5740
VANADIUM -- 52.2
ZINC -- 51.5
BICARBONATE 81 240
CHLORIDE 67 5.2
SULFATE 20 ND
GW-209
BIS(2-ETHLHEXYL)PHTHALATE ND-20
CADMIUM ND-6.2
BICARBONATE ND
CHLORIDE N/A
SULFATE N/A
GW-208
1,1,1-TRICHLOROETHANE 19-37
TRICHLOROETHENE 5-7
ALUMINUM 255-310
CALCIUM 7910-9400
SODIUM 15000-16900
IRON ND-276
BICARBONATE 20
CHLORIDE N/A
SULFATE N/A
MW-223
1,1,1-TRICHLOROETHANE 26
TRICHLOROETHENE 33
BICARBONATE 11
CHLORIDE 8.5
SULFATE ND
MW-106
1,2-DICHLOROETHENE (TOTAL) 31-52
1,1,1-TRICHLOROETHANE 21-69
TRICHLOROETHENE 55-95
TETRACHLOROETHENE 13-31
SILVER ND-615
BICARBONATE 17
CHLORIDE 8.6
SULFATE ND
MW-225 A B
1,1-DICHLOROETHENE 21 --
1,2-DICHLOROETHENE(TOTAL) 20 27
1,1,1-TRICHLOROETHANE 530D 38
TRICHLOROETHENE 240D 55
TETRACHLOROETHENE 24 16
CALCIUM 13400 --
MAGNESIUM 5490 --
MERCURY -- 0.2
SODIUM 12100 --
BICARBONATE 43 11
CHLORIDE 17 7.2
SULFATE ND ND
MW-214
CALCIUM 11800
IRON 153
LEAD 3.5
MANGANESE 711
SODIUM 20600
BICARBONATE 22
CHLORIDE 42
SULFATE ND
GW-211 A B
ARSENIC 13-22J ND-1645
CALCIUM -- 18000-18500
CHROMIUM ND-11 --
MAGNESIUM ND-5150 5150-8300
MANGANESE ND-15.1 552-570
POTASSIUM 14200-9000 ND-14400
SODIUM 436000-540000 6790-461000
BICARBONATE 590 56
CHLORIDE N/A N/A
SULFATE N/A N/A
MW-220
CALCIUM 13200
MAGNESIUM 5560
MANGANESE 215
SODIUM 20400
BICARBONATE 57
CHLORIDE 13
SULFATE 16
MW-215
VINYL CHLORIDE 18
1,1-DICHLOROETHANE 8
1,2-DICHLOROETHENE(TOTAL) 20
TOLUENE 12
XYLENE(TOTAL) 37
IRON 8240
MANGANESE 1260
SODIUM 20200
BICARBONATE 50
CHLORIDE 35
SULFATE ND
GW-210 A B
VINYL CHLORIDE -- 19-42
1,2-DICHLOROETHENE -- 5-8
TOLUENE -- ND-7
XYLENES -- ND-9
ARSENIC 11-15.3J 28J-45J
CALCIUM ND-5800 24000-34100
IRON -- 25000-36900
MAGNESIUM -- 6200-7910
MANGANESE -- 4300-5400
POTASSIUM 9910-24000 --
SODIUM 391000-440000 12000-108001
ZINC ND-21 ND-20.5
BICARBONATE 440-500 170
CHLORIDE N/A N/A
SULFATE N/A N/A
MW-217 A B/DUP
VINYL CHLORIDE -- 12/--
1,2-DICHLOROETHENE(TOTAL) -- 7/--
TOLUENE -- 15/16
ETHYLBENZENE -- 83/83
XYLENE(TOTAL) -- 260D/300
NAPHTHALENE -- 12J/13
ALUMINUM 2770J --/--
ARSENIC -- 18.2/23.8
CALCIUM 39900 85100/69500
IRON 4870J 103000J/13200J
LEAD 9.2 --/--
MAGNESIUM 19000J 22100J/16800J
MANGANESE 492 4170/3560
POTASSIUM -- --/12300
SODIUM 17000 34900/26600
BICARBONATE 81 400
CHLORIDE 190 61
SULFATE ND ND
GW-207 A B
CYANIDE ND ND-14
CALCIUM 6230-6400J --
SODIUM 26300-30000J --
BICARBONATE 74 8.1
CHLORIDE 17 7.1
SULFATE 11 ND
MW-234
METHYLENE CHLORIDE 460D
BENZENE 6
TOLUENE 88
ETHYLBENZENE 84
XYLENE(TOTAL) 370D
PHENOL 230
1,4-DICHLOROBENZENE 27J
2-METHYLPHENOL 410D
4-METHYLPHENOL 95
BENZOIC ACID 86
NAPHTHALENE 21J
ALUMINUM 1690J
BARIUM 327
CALCIUM 43500
COBALT 60
IRON 286000J
LEAD 9.1
MANGANESE 2130
NICKEL 77.8
SODIUM 7050
VANADIUM 79.7
ZINC 297
BICARBONATE 380
CHLORIDE 17
SULFATE ND
GW-102
ARSENIC ND-18J
CALCIUM 17700-19600
CYANIDE ND-34
IRON 8500-17600
MAGNESIUM 9180-11000
POTASSIUM ND-5500
SODIUM 53000-87000
ZINC 21-22
BICARBONATE 150
CHLORIDE N/A
SULFATE N/A
GW-206 A B
1,1-DICHLOROETHENE ND-6 --
1,2-DICHLOROETHENE ND-5 --
1,1,1-TRICHLOROETHANE 89-120 --
TRICHLOROETHENE 46-70 --
CALCIUM 11000-11800 --
MANGANESE 37-68 --
SODIUM 7560-8300 8500-12900
MERCURY -- ND-.25
BICARBONATE 30 10
CHLORIDE 15 2.4
SULFATE ND ND
GW-204
ALUMINUM ND-2810
MANGANESE 21-355
ZINC 37-277
BICARBONATE 10
CHLORIDE N/A
SULFATE N/A
MW-219
CALCIUM 8870
MANGANESE 37.9
SODIUM 10500
BICARBONATE 30
CHLORIDE 6.6
SULFATE 11
GW-205
1,1-DICHLOROETHANE 6-12
1,2-DICHLOROETHENE 6-7
1,1,1-TRICHLOROETHANE 120-200
TRICHLOROETHENE 94-200
CALCIUM 13700-17600
MAGNESIUM 5460-6800
MANGANESE 276-682
SODIUM 8680-14800
ZINC ND-32
POTASSIUM ND-1500
BICARBONATE 57
CHLORIDE 17
SULFATE ND
GENERAL NOTES:
1. ALL TCL WATER DATA REPORTED IN ug/l
2. ORGANIC SOIL AND SEDIMENT DATA REPORTED IN ug/kg.
3. INORGANIC SOIL AND SEDIMENT DATA REPORTED IN mg/kg. INORGANICS IN EXCESS OF 8 TIMES THE CONTRACT DETECTION LIMIT (CRDL) ARE REPORTED.
4. ND = NOT DETECTED.
5. DUP = DUPLICATE SAMPLE.
6. PAHS = POLYNUCLEAR AROMATIC HYDROCARBONS (SEMIVOLATILES).
7. DATA REPRESENT DETECTION RANGES THROUGH SEVERAL SAMPLING ROUNDS.
8. MW AND GW BOTH MEAN GROUNDWATER SAMPLES.
9. BICARBONATE, CHLORIDE, AND SULFATE ARE REPORTED IN mg/L.
10. N/A NOT ANALYZED
GW-202A
VINYL CHLORIDE 75-180
1,1-DICHLOROETHANE 31-38
1,2-DICHLOROETHENE 17-60
TOLUENE 150-210
CHLOROETHANE ND-25
CHLOROBENZENE 15-32
ETHYLBENZENE 79-200
XYLENES 430-660E
TOLUENE 150-210
4-METHYLPHENOL ND-21
4-METHYL-2-PENTANONE ND-13
NAPTHALENE 10J-11
ARSENIC 11-28
CADMIUM ND-13
CALCIUM 22400-27800
IRON 80300-110000
MANGANESE 3410-3550
MERCURY ND-0.22J
SODIUM 18600-26600
ZINC 32-60JB
BICARBONATE 85-89
CHLORIDE 25
SULFATE ND
GW-203
1,1-DICHLOROETHANE 7-18
ARSENIC 15.8-29
CALCIUM 18900-128000
IRON 7870J-14000
LEAD ND-15.6
MAGNESIUM 6350-8700
MANGANESE 1230-1800
SODIUM 9950-16000
ZINC 31-35.1
BICARBONATE 78
CHLORIDE 15
SULFATE ND
MW-218
1,1-DICHLOROETHANE 6
ALUMINUM 2750J
ARSENIC 107
CALCIUM 41900
IRON 4180J
LEAD 11.8
MAGNESIUM 21800J
MANGANESE 1580
SODIUM 103000
ZINC 85
BICARBONATE 340
CHLORIDE 76
SULFATE ND
GW-105 A B
ND
BICARBONATE 13 10
CHLORIDE 4.8 4.9
SULFATE ND 11
GW-103
CALCIUM ND-5300
ZINC ND-82JB
BICARBONATE 10
CHLORIDE N/A
SULFATE N/A
GW-213
ARSENIC 12J-15J
CALCIUM 10800-12000
IRON 9640-14000
MAGNESIUM 6000-7000
MANGANESE 380-470
SODIUM 26000-41600
ZINC ND-23
BICARBONATE 130
CHLORIDE 4.8
SULFATE ND
GW-104
SODIUM 13,700-150000
XINC ND-34
BICARBONATE 40
CHLORIDE 3.9
SULFATE ND
GW-212
ALUMINUM 893-5200
CALCIUM 5200-7000
CHROMIUM ND-12
IRON 1390-6100
LEAD ND-60
MANGANESE 178-180
ZINC ND-33
BICARBONATE 14
CHLORIDE N/A
MW-224
70'
MW-222
MW-209
MW-223
MW-208
MW-106
MW-225A,B
MW-207A,B
MW-206A,B
MW-205
MW-105A,B
MW-211A,B
MW-233
MW-201
MW-101
MW-216A,B
MW-214
MW-232A,B
MW-234
MW-217A,B
MW-210A,B
MW-220
MW-215
MW-202A,B
MW-102
MW-218
MW-203
MW-204
MW-219
MW-213
MW-103
MW-104
MW-212
383,500
382,500
382,000
381,500
541,000
540,000
562,500
563,000
563,500
GURNET ROAD
0 200 400 FEET
E.C. JORDAN CO.
CONSULTING ENGINEERS
INSTALLATION RESTORATION PROGRAM
NAVAL AIR STATION
BRUNSWICK, MAINE
GROUNDWATER CONTAMINANT DISTRIBUTION MAP
SITES 1, 2, AND 3
SITES 1 AND 3 FFS
4607-57
FIGURE 1



E.C. JORDAN CO.
CONSULTING ENGINEERS

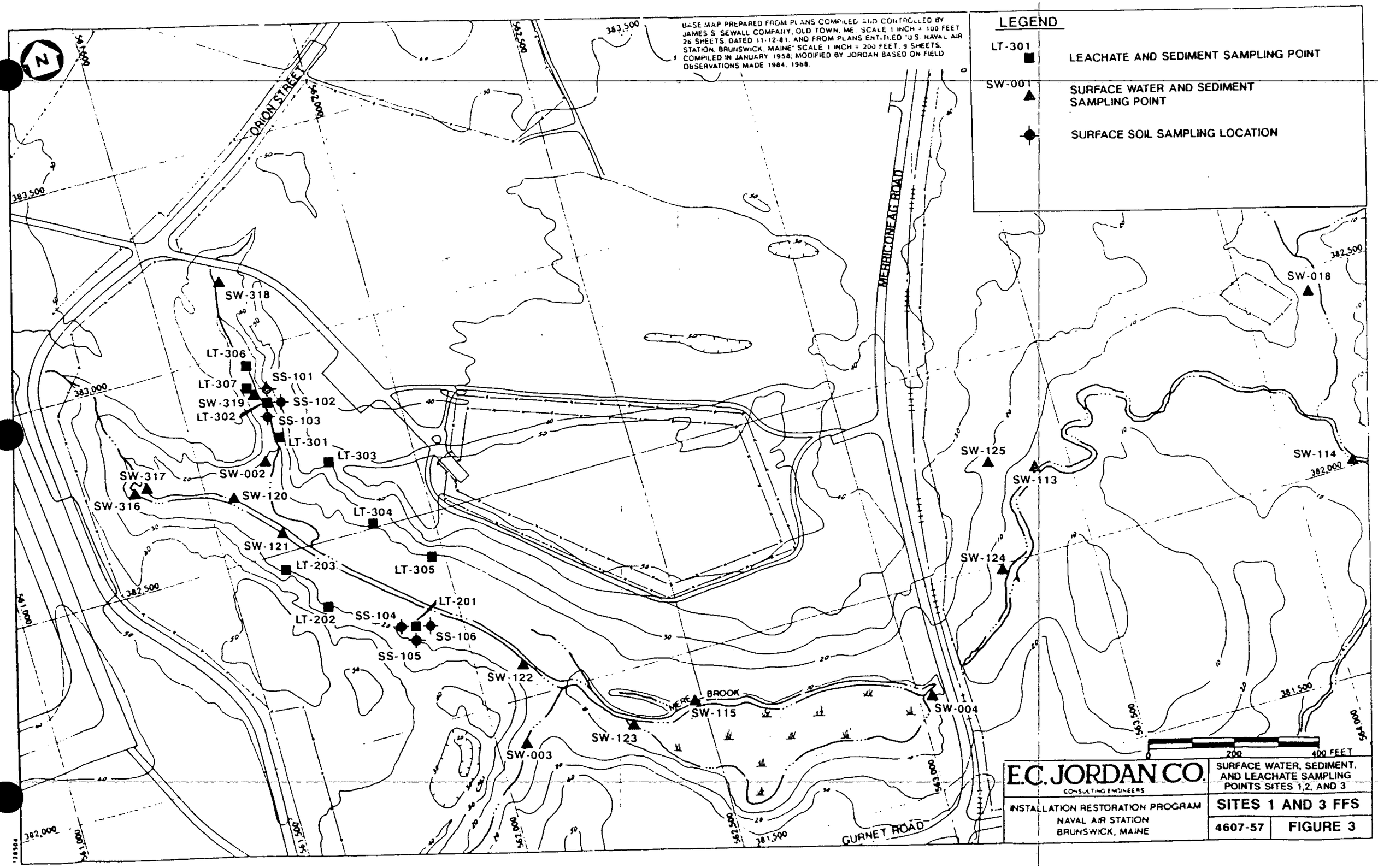
TEST BORING SOIL CONTAMINANT DISTRIBUTION MAP
SITES 1, 2, AND 3

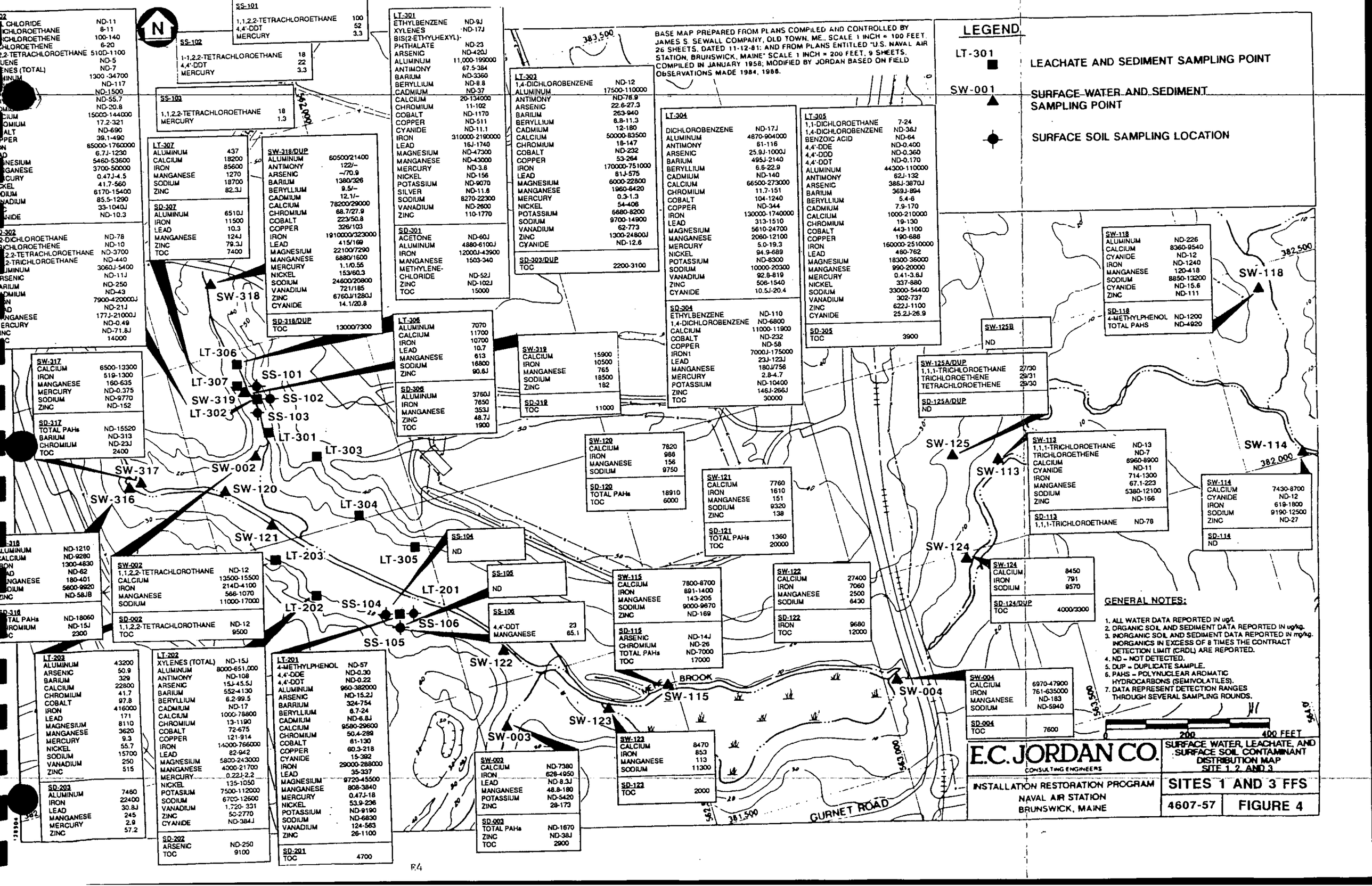
INSTALLATION RESTORATION PROGRAM
NAVAL AIR STATION
BRUNSWICK, MAINE

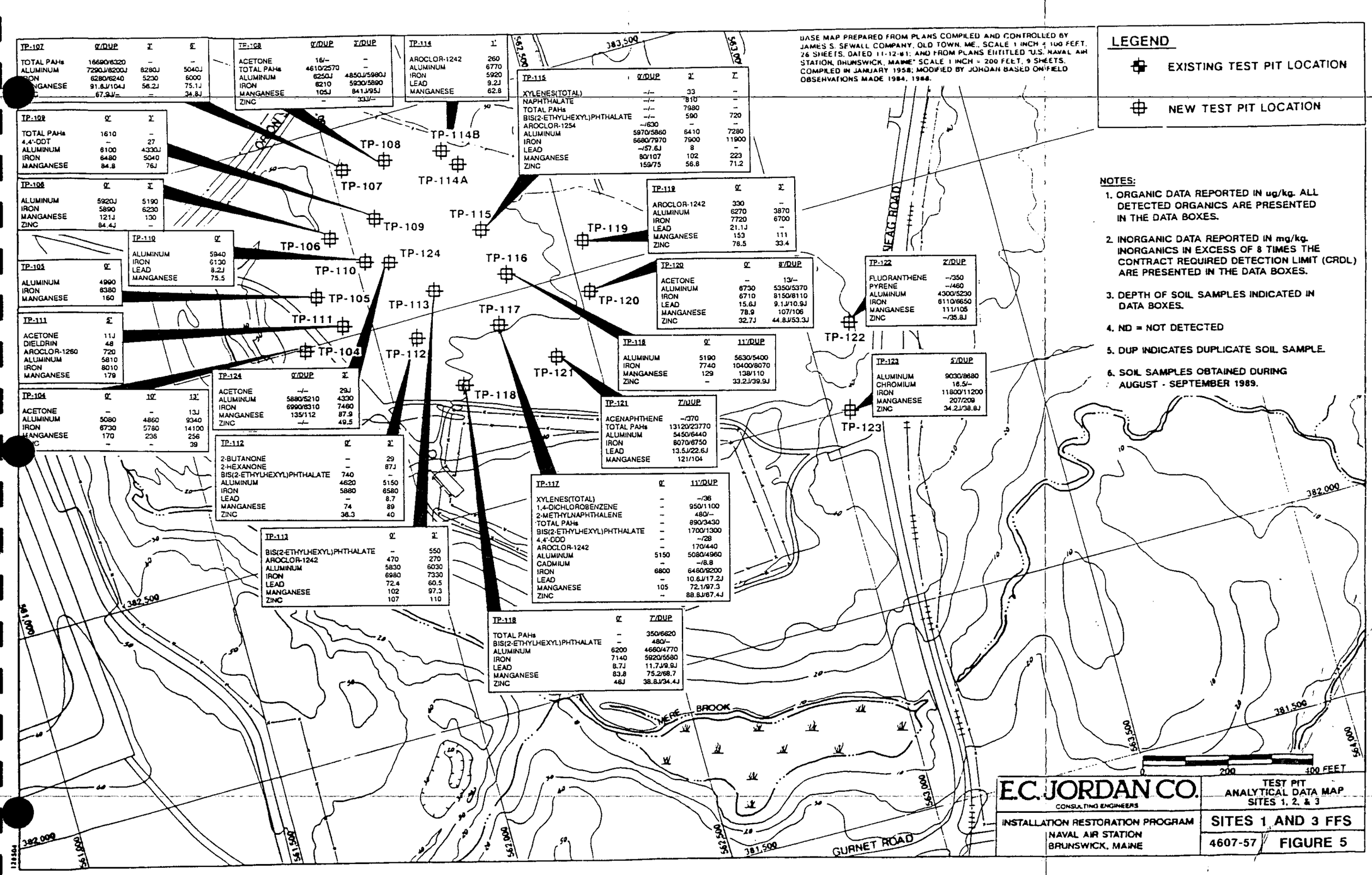
SITES 1 AND 3 FFS

4607-57 FIGURE 2

128504


BASE MAP PREPARED FROM PLANS COMPILED AND CONTROLLED BY JAMES S. SEWALL COMPANY, OLD TOWN, ME. SCALE 1 INCH = 100 FEET 26 SHEETS. DATED 11-12-81. AND FROM PLANS ENTITLED "U.S. NAVAL AIR STATION, BRUNSWICK, MAINE" SCALE 1 INCH = 200 FEET, 9 SHEETS. COMPILED IN JANUARY 1958; MODIFIED BY JORDAN BASED ON FIELD OBSERVATIONS MADE 1984, 1988.
LEGEND
LT-301 LEACHATE AND SEDIMENT SAMPLING POINT
SW-001 SURFACE WATER AND SEDIMENT SAMPLING POINT
SURFACE SOIL SAMPLING LOCATION
ORION STREET
MERRICONEAG ROAD
GURNET ROAD
MERE BROOK
SW-318
LT-306
LT-307
SS-101
SW-319
SS-102
LT-302
SS-103
LT-301
LT-303
SW-002
SW-317
SW-316
SW-120
LT-304
SW-121
LT-203
LT-305
LT-201
LT-202
SS-104
SS-106
SS-105
SW-122
SW-115
SW-123
SW-003
SW-004
SW-125
SW-113
SW-124
SW-018
SW-114
383,500
383,000
382,500
382,000
381,500
541,000
542,000
542,500
543,000
543,500
544,000
0 200 400 FEET
E.C. JORDAN CO.
CONSULTING ENGINEERS
INSTALLATION RESTORATION PROGRAM
NAVAL AIR STATION
BRUNSWICK, MAINE
SURFACE WATER, SEDIMENT, AND LEACHATE SAMPLING POINTS SITES 1,2, AND 3
SITES 1 AND 3 FFS
4607-57
FIGURE 3


N
BASE MAP PREPARED FROM PLANS COMPILED AND CONTROLLED BY JAMES S. SEWALL COMPANY, OLD TOWN, ME., SCALE 1 INCH = 100 FEET, 26 SHEETS, DATED 11-12-81; AND FROM PLANS ENTITLED "U.S. NAVAL AIR STATION, BRUNSWICK, MAINE" SCALE 1 INCH = 200 FEET, 9 SHEETS, COMPILED IN JANUARY 1958; MODIFIED BY JORDAN BASED ON FIELD OBSERVATIONS MADE 1984, 1986.
LEGEND
LT-301 LEACHATE AND SEDIMENT SAMPLING POINT
SW-001 SURFACE WATER AND SEDIMENT SAMPLING POINT
SURFACE SOIL SAMPLING LOCATION
SS-101
1,1,2,2-TETRACHLOROETHANE 100
4,4'-DDT 52
MERCURY 3.3
SS-102
1-1,2,2-TETRACHLOROETHANE 18
4,4'-DDT 22
MERCURY 3.3
SS-103
1,1,2,2-TETRACHLOROETHANE 18
MERCURY 1.3
LT-301
ETHYLBENZENE ND-9J
XYLENES ND-17J
BIS(2-ETHYLHEXYL)-PHTHALATE ND-23
ARSENIC ND-420J
ALUMINUM 11,000-199000
ANTIMONY 67.5-384
BARIUM ND-3360
BERYLLIUM ND-8.8
CADMIUM ND-37
CALCIUM 20-134000
CHROMIUM 11-102
COBALT ND-1170
COPPER ND-511
CYANIDE ND-11.1
IRON 310000-2190000
LEAD 16J-1740
MAGNESIUM ND-47300
MANGANESE ND-43000
MERCURY ND-3.8
NICKEL ND-156
POTASSIUM ND-9070
SILVER ND-11.6
SODIUM 8270-22300
VANADIUM ND-2600
ZINC 110-1770
SD-301
ACETONE ND-60J
ALUMINUM 4880-6100J
IRON 12000J-43900
MANGANESE 1503-340
METHYLENE-CHLORIDE ND-52J
ZINC ND-102J
TOC 15000
LT-303
1,4-DICHLOROBENZENE ND-12
ALUMINUM 17500-110000
ANTIMONY ND-78.9
ARSENIC 22.6-27.3
BARIUM 263-940
BERYLLIUM 6.8-11.3
CADMIUM 12-180
CALCIUM 50000-83500
CHROMIUM 18-147
COBALT ND-232
COPPER 53-264
IRON 170000-751000
LEAD 81J-575
MAGNESIUM 6000-22800
MANGANESE 1960-6420
MERCURY 0.3-1.3
NICKEL 54-406
POTASSIUM 6680-8200
SODIUM 9700-14900
VANADIUM 62-773
ZINC 1300-24800J
CYANIDE ND-12.6
SD-303/DUP
TOC 2200-3100
LT-304
DICHLOROBENZENE ND-17J
ALUMINUM 4870-904000
ANTIMONY 61-116
ARSENIC 25.9J-1000J
BARIUM 495J-2140
BERYLLIUM 6.6-22.9
CADMIUM ND-140
CALCIUM 66500-273000
CHROMIUM 11.7-151
COBALT 104-1240
COPPER ND-344
IRON 130000-1740000
LEAD 313-1510
MAGNESIUM 5610-24700
MANGANESE 2060-12100
MERCURY 5.0-19.3
NICKEL 94.9-689
POTASSIUM ND-8300
SODIUM 10000-20300
VANADIUM 92.8-819
ZINC 506-1540
CYANIDE 10.5J-20.4
SD-304
ETHYLBENZENE ND-110
1,4-DICHLOROBENZENE ND-6800
CALCIUM 11000-11900
COBALT ND-232
COPPER ND-58
IRON1 7000J-175000
LEAD 23J-123J
MANGANESE 180J/756
MERCURY 2.8-4.7
POTASSIUM ND-10400
ZINC 146J-266J
TOC 30000
LT-305
1,1-DICHLOROETHANE 7-24
1,4-DICHLOROBENZENE ND-36J
BENZOIC ACID ND-64
4,4'-DDE ND-0.400
4,4'-DDD ND-0.360
4,4'-DDT ND-0.170
ALUMINUM 44300-110000
ANTIMONY 62J-132
ARSENIC 386J-3870J
BARIUM 369J-894
BERYLLIUM 5.4-6
CADMIUM 7.9-170
CALCIUM 1000-210000
CHROMIUM 19-130
COBALT 443-1100
COPPER 190-686
IRON 160000-2510000
LEAD 480-762
MAGNESIUM 18300-36000
MANGANESE 990-20000
MERCURY 0.41-3.6J
NICKEL 337-880
SODIUM 33000-54400
VANADIUM 302-737
ZINC 622J-1100
CYANIDE 25.2J-26.9
SD-305
TOC 3900
LT-307
ALUMINUM 437
CALCIUM 18200
IRON 85600
MANGANESE 1270
SODIUM 18700
ZINC 82.3J
SD-307
ALUMINUM 6510J
IRON 11500
LEAD 10.3
MANGANESE 124J
ZINC 79.3J
TOC 7400
SW-318/DUP
ALUMINUM 60500/21400
ANTIMONY 122/--
ARSENIC --/70.9
BARIUM 1380/326
BERYLLIUM 9.5/--
CADMIUM 12.1/--
CALCIUM 78200/29000
CHROMIUM 68.7/27.9
COBALT 223/50.8
COPPER 326/103
IRON 1910000/323000
LEAD 415/169
MAGNESIUM 22100/7290
MANGANESE 6880/1600
MERCURY 1.1/0.55
NICKEL 153/60.3
SODIUM 24600/20800
VANADIUM 721/185
ZINC 6760J/1280J
CYANIDE 14.1/20.8
SD-318/DUP
TOC 13000/7300
LT-306
ALUMINUM 7070
CALCIUM 11700
IRON 10700
LEAD 10.7
MANGANESE 613
SODIUM 16800
ZINC 90.6J
SD-306
ALUMINUM 3760J
IRON 7650
MANGANESE 353J
ZINC 48.7J
TOC 1900
SW-319
CALCIUM 15900
IRON 10500
MANGANESE 765
SODIUM 18500
ZINC 182
SD-319
TOC 11000
SW-317
CALCIUM 6500-13300
IRON 519-1300
MANGANESE 160-635
MERCURY ND-0.375
SODIUM ND-9770
ZINC ND-152
SD-317
TOTAL PAHs ND-15520
BARIUM ND-313
CHROMIUM ND-23J
TOC 2400
SW-316
ALUMINUM ND-1210
CALCIUM ND-9280
IRON 1300-4830
LEAD ND-62
MANGANESE 180-401
SODIUM 5600-9920
ZINC ND-58JB
SD-316
TOTAL PAHs ND-18060
CHROMIUM ND-15J
TOC 2300
SW-002
1,1,2,2-TETRACHLOROTHANE ND-12
CALCIUM 13500-15500
IRON 214D-4100
MANGANESE 566-1070
SODIUM 11000-17000
SD-002
1,1,2,2-TETRACHLOROTHANE ND-12
TOC 9500
SW-120
CALCIUM 7820
IRON 988
MANGANESE 156
SODIUM 9750
SD-120
TOTAL PAHs 18910
TOC 6000
SW-121
CALCIUM 7760
IRON 1610
MANGANESE 151
SODIUM 9320
ZINC 138
SD-121
TOTAL PAHs 1360
TOC 20000
SS-104
ND
SS-105
ND
SS-106
4,4'-DDT 23
MANGANESE 65.1
SW-115
CALCIUM 7800-8700
IRON 891-1400
MANGANESE 143-205
SODIUM 9000-9870
ZINC ND-169
SD-115
ARSENIC ND-14J
CHROMIUM ND-26
TOTAL PAHs ND-7000
TOC 17000
SW-122
CALCIUM 27400
IRON 7060
MANGANESE 2500
SODIUM 6430
SD-122
IRON 9680
TOC 12000
SW-118
ALUMINUM ND-226
CALCIUM 8360-9540
CYANIDE ND-12
IRON ND-1240
MANGANESE 120-418
SODIUM 8850-13200
CYANIDE ND-15.6
ZINC ND-111
SD-118
4-METHYLPHENOL ND-1200
TOTAL PAHS ND-4920
SW-125B
ND
SW-125A/DUP
1,1,1-TRICHLOROETHANE 27/30
TRICHLOROETHENE 29/31
TETRACHLOROETHENE 29/30
SD-125A/DUP
ND
SW-113
1,1,1-TRICHLOROETHANE ND-13
TRICHLOROETHENE ND-7
CALCIUM 6960-8900
CYANIDE ND-11
IRON 714-1300
MANGANESE 67.1-223
SODIUM 5380-12100
ZINC ND-166
SD-113
1,1,1-TRICHLOROETHANE ND-78
SW-114
CALCIUM 7430-8700
CYANIDE ND-12
IRON 619-1800
SODIUM 9190-12500
ZINC ND-27
SD-114
ND
SW-124
CALCIUM 8450
IRON 791
SODIUM 9570
SD-124/DUP
TOC 4000/3000
SW-004
CALCIUM 6970-47900
IRON 761-635000
MANGANESE ND-183
SODIUM ND-5940
SD-004
TOC 7600
LT-203
ALUMINUM 43200
ARSENIC 50.9
BARIUM 329
CALCIUM 22800
CHROMIUM 41.7
COBALT 97.8
IRON 416000
LEAD 171
MAGNESIUM 8110
MANGANESE 3620
MERCURY 9.3
NICKEL 55.7
SODIUM 15700
VANADIUM 250
ZINC 515
SD-203
ALUMINUM 7480
IRON 22400
LEAD 30.8J
MANGANESE 245
MERCURY 2.9
ZINC 57.2
LT-202
XYLENES (TOTAL) ND-15J
ALUMINUM 8000-651,000
ANTIMONY ND-108
ARSENIC 15J-45.5J
BARIUM 552-4130
BERYLLIUM 6.2-99.5
CADMIUM ND-17
CALCIUM 1000-78800
CHROMIUM 13-1190
COBALT 72-675
COPPER 121-914
IRON 14000-766000
LEAD 82-942
MAGNESIUM 5800-243000
MANGANESE 4000-21700
MERCURY 0.22J-2.2
NICKEL 135-1050
POTASSIUM 7500-112000
SODIUM 6700-12600
VANADIUM 1.720-331
ZINC 50-2770
CYANIDE ND-384J
SD-202
ARSENIC ND-250
TOC 9100
LT-201
4-METHYLPHENOL ND-57
4,4'-DDE ND-0.30
4,4'-DDT ND-0.22
ALUMINUM 960-382000
ARSENIC ND-15.2J
BARRIUM 324-754
BERYLLIUM 8.7-24
CADMIUM ND-6.8J
CALCIUM 9580-29600
CHROMIUM 50.4-289
COBALT 61-130
COPPER 60.3-218
CYANIDE 15-392
IRON 29000-288000
LEAD 35-337
MAGNESIUM 9720-45500
MANGANESE 808-3840
MERCURY 0.47J-18
NICKEL 53.9-236
POTASSIUM ND-9190
SODIUM ND-6830
VANADIUM 124-563
ZINC 26-1100
SD-201
TOC 4700
SW-003
CALCIUM ND-7380
IRON 626-4950
LEAD ND-8.3J
MANGANESE 48.8-180
POTASSIUM ND-5420
ZINC 28-173
SD-003
TOTAL PAHs ND-1670
ZINC ND-38J
TOC 2900
SW-123
CALCIUM 8470
IRON 853
MANGANESE 113
SODIUM 11300
SD-123
TOC 2000
SW-318
LT-306
LT-307
SW-319
LT-302
SS-101
SS-102
SS-103
LT-301
LT-303
SW-317
SW-002
SW-316
SW-120
LT-304
SW-121
LT-203
LT-305
LT-201
LT-202
SS-104
SS-106
SS-105
SW-122
SW-115
SW-123
SW-003
SW-004
SW-125
SW-113
SW-124
SW-114
SW-118
NEW BROOK
GURNET ROAD
383,500
382,500
382,000
381,500
563,000
564,000
GENERAL NOTES:
1. ALL WATER DATA REPORTED IN ug/L
2. ORGANIC SOIL AND SEDIMENT DATA REPORTED IN ug/kg.
3. INORGANIC SOIL AND SEDIMENT DATA REPORTED IN mg/kg. INORGANICS IN EXCESS OF 8 TIMES THE CONTRACT DETECTION LIMIT (CRDL) ARE REPORTED.
4. ND - NOT DETECTED.
5. DUP - DUPLICATE SAMPLE.
6. PAHS - POLYNUCLEAR AROMATIC HYDROCARBONS (SEMIVOLATILES).
7. DATA REPRESENT DETECTION RANGES THROUGH SEVERAL SAMPLING ROUNDS.
0 200 400 FEET
E.C. JORDAN CO.
CONSULTING ENGINEERS
INSTALLATION RESTORATION PROGRAM
NAVAL AIR STATION
BRUNSWICK, MAINE
SURFACE WATER, LEACHATE, AND SURFACE SOIL CONTAMINANT DISTRIBUTION MAP
SITE 1, 2, AND 3
SITES 1 AND 3 FFS
4607-57
FIGURE 4



BASE MAP PREPARED FROM PLANS COMPILED AND CONTROLLED BY JAMES S. SEWALL COMPANY, OLD TOWN, ME., SCALE 1 INCH = 100 FEET, 26 SHEETS, DATED 11-12-81; AND FROM PLANS ENTITLED "U.S. NAVAL AIR STATION, BRUNSWICK, MAINE" SCALE 1 INCH = 200 FEET, 9 SHEETS, COMPILED IN JANUARY 1958; MODIFIED BY JORDAN BASED ON FIELD OBSERVATIONS MADE 1984, 1988.

LEGEND

EXISTING TEST PIT LOCATION

NEW TEST PIT LOCATION

NOTES:

1. ORGANIC DATA REPORTED IN ug/kg. ALL DETECTED ORGANICS ARE PRESENTED IN THE DATA BOXES.
2. INORGANIC DATA REPORTED IN mg/kg. INORGANICS IN EXCESS OF 8 TIMES THE CONTRACT REQUIRED DETECTION LIMIT (CRDL) ARE PRESENTED IN THE DATA BOXES.
3. DEPTH OF SOIL SAMPLES INDICATED IN DATA BOXES.
4. ND = NOT DETECTED
5. DUP INDICATES DUPLICATE SOIL SAMPLE.
6. SOIL SAMPLES OBTAINED DURING AUGUST - SEPTEMBER 1989.

TP-107	0'/DUP	3'	5'
TOTAL PAHs	16690/8320	–	–
ALUMINUM	7290J/8200J	8280J	5040J
IRON	6280/6240	5230	6000
MANGANESE	91.8J/104J	56.2J	75.1J
ZINC	67.9J/–	–	34.8J

TP-108	0'/DUP	3'/DUP
ACETONE	16/–	–
TOTAL PAHs	4610/2570	–
ALUMINUM	6250J	4850J/5980J
IRON	6210	5930/5890
MANGANESE	105J	841J/95J
ZINC	–	33J/–

TP-114	1'
AROCLOR-1242	260
ALUMINUM	6770
IRON	5920
LEAD	9.2J
MANGANESE	62.8

TP-115	0'/DUP	3'	7'
XYLENES(TOTAL)	–/–	33	–
NAPHTHALATE	–/–	810	–
TOTAL PAHs	–/–	7980	–
BIS(2-ETHYLHEXYL)PHTHALATE	–/–	590	720
AROCLOR-1254	–/630	–	–
ALUMINUM	5970/5860	6410	7280
IRON	6680/7970	7900	11900
LEAD	–/57.6J	8	–
MANGANESE	80/107	102	223
ZINC	159/75	56.8	71.2

TP-109	0'	3'
TOTAL PAHs	1610	–
4,4'-DDT	–	27
ALUMINUM	6100	4330J
IRON	6480	5040
MANGANESE	84.8	76J

TP-108	0'	3'
ALUMINUM	5920J	5190
IRON	5890	6230
MANGANESE	121J	130
ZINC	84.4J	–

TP-110	0'
ALUMINUM	5940
IRON	6130
LEAD	8.2J
MANGANESE	75.5

TP-105	0'
ALUMINUM	4990
IRON	6380
MANGANESE	160

TP-111	5'
ACETONE	11J
DIELDRIN	48
AROCLOR-1260	720
ALUMINUM	5810
IRON	8010
MANGANESE	179

TP-104	0'	10'	13'
ACETONE	–	–	13J
ALUMINUM	5080	4860	9340
IRON	6730	5780	14100
MANGANESE	170	236	256
ZINC	–	–	39

TP-124	0'/DUP	3'
ACETONE	–/–	29J
ALUMINUM	5880/5210	4330
IRON	6990/8310	7460
MANGANESE	135/112	87.9
ZINC	–/–	49.5

TP-112	0'	3'
2-BUTANONE	–	29
2-HEXANONE	–	87J
BIS(2-ETHYLHEXYL)PHTHALATE	740	–
ALUMINUM	4620	5150
IRON	5880	6580
LEAD	–	8.7
MANGANESE	74	89
ZINC	38.3	40

TP-113	0'	3'
BIS(2-ETHYLHEXYL)PHTHALATE	–	550
AROCLOR-1242	470	270
ALUMINUM	5830	6030
IRON	6980	7330
LEAD	72.4	60.5
MANGANESE	102	97.3
ZINC	107	110

TP-119	0'	3'
AROCLOR-1242	330	–
ALUMINUM	6270	3870
IRON	7720	6700
LEAD	21.1J	–
MANGANESE	153	111
ZINC	78.5	33.4

TP-120	0'	8'/DUP
ACETONE	–	13/–
ALUMINUM	6730	5350/5370
IRON	6710	8150/8110
LEAD	15.6J	9.1J/10.9J
MANGANESE	78.9	107/106
ZINC	32.7J	44.8J/53.3J

TP-122	2'/DUP
FLUORANTHENE	–/350
PYRENE	–/460
ALUMINUM	4300/5230
IRON	6110/6650
MANGANESE	111/105
ZINC	–/35.8J

TP-116	0'	11'/DUP
ALUMINUM	5190	5630/5400
IRON	7740	10400/8070
MANGANESE	129	138/110
ZINC	–	33.2J/39.9J

TP-123	5'/DUP
ALUMINUM	9030/8680
CHROMIUM	16.5/–
IRON	11800/11200
MANGANESE	207/209
ZINC	34.2J/38.8J

TP-121	7'/DUP
ACENAPHTHENE	–/370
TOTAL PAHs	13120/23770
ALUMINUM	5450/6440
IRON	8070/6750
LEAD	13.5J/22.6J
MANGANESE	121/104

TP-117	0'	11'/DUP
XYLENES(TOTAL)	–	–/36
1,4-DICHLOROBENZENE	–	950/1100
2-METHYLNAPHTHALENE	–	480/–
TOTAL PAHs	–	890/3430
BIS(2-ETHYLHEXYL)PHTHALATE	–	1700/1300
4,4'-DDD	–	–/28
AROCLOR-1242	–	170/440
ALUMINUM	5150	5080/4960
CADMIUM	–	–/8.8
IRON	6800	6460/9200
LEAD	–	10.6J/17.2J
MANGANESE	105	72.1/97.3
ZINC	–	88.8J/67.4J

TP-118	0'	7'/DUP
TOTAL PAHs	–	350/6620
BIS(2-ETHYLHEXYL)PHTHALATE	–	480/–
ALUMINUM	6200	4660/4770
IRON	7140	5920/5580
LEAD	8.7J	11.7J/9.9J
MANGANESE	83.8	75.2/68.7
ZINC	46J	38.8J/34.4J

E.C. JORDAN CO.
CONSULTING ENGINEERS

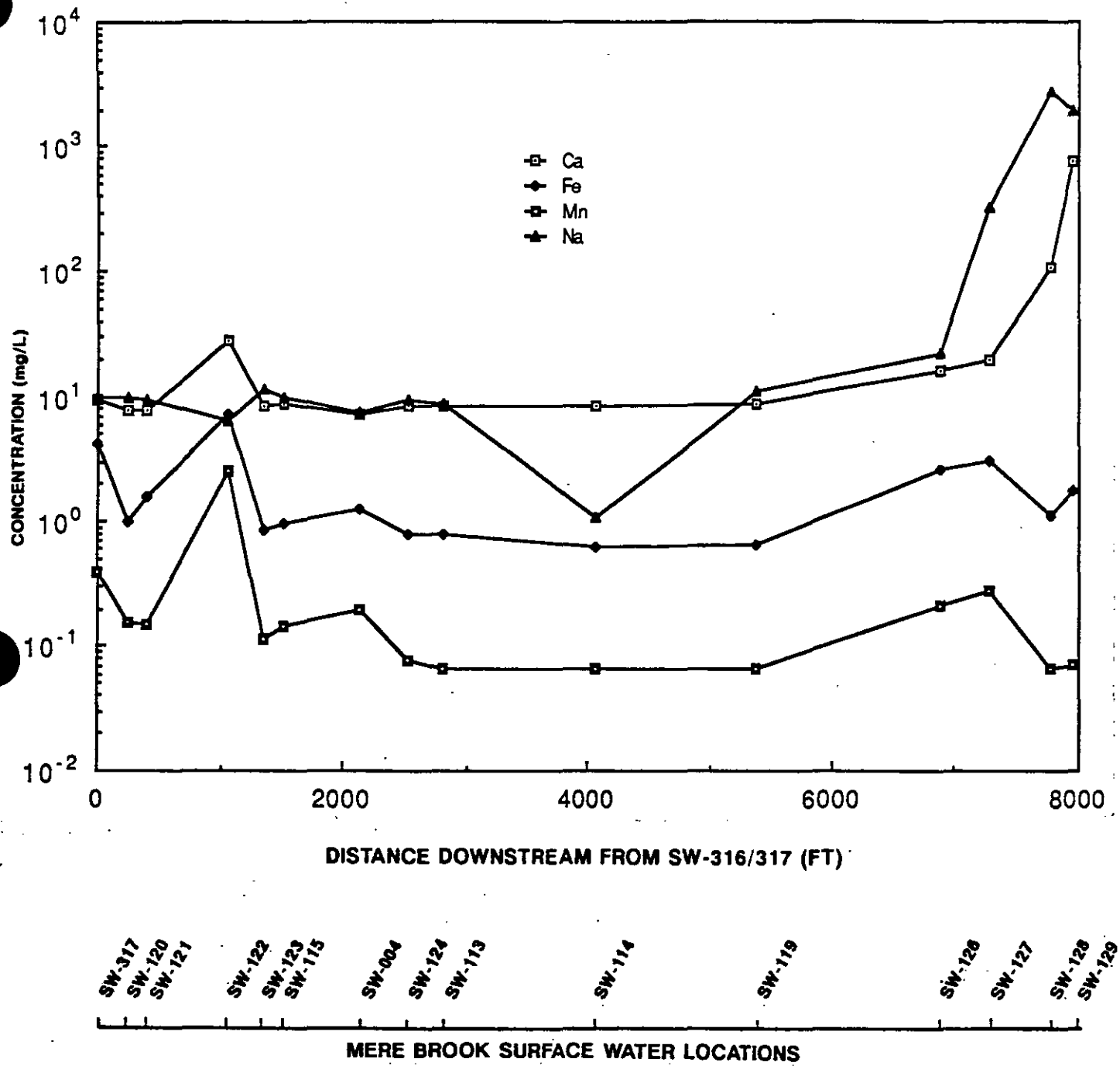
INSTALLATION RESTORATION PROGRAM
NAVAL AIR STATION
BRUNSWICK, MAINE

TEST PIT
ANALYTICAL DATA MAP
SITES 1, 2, & 3

SITES 1 AND 3 FFS

4607-57 FIGURE 5

INORGANICS IN MERE BROOK



NOTE: DATA IS FROM ROUND 4 SAMPLING EPISODE

EC JORDAN CO. CONSULTING ENGINEERS	INORGANICS IN MERE BROOK SURFACE WATER
INSTALLATION RESTORATION PROGRAM NAVAL AIR STATION BRUNSWICK, MAINE	SITES 1 AND 3 FFS
	4607-41 FIGURE 6

RESPONSE TO REGULATORY AND TECHNICAL REVIEW COMMITTEE COMMENTS

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION I
J.F. KENNEDY FEDERAL BUILDING, BOSTON, MASSACHUSETTS 02203-2211

August 11, 1991

Mr. James Shafer (Code 1421)
Northern Division
Naval Facilities Engineering Command
U.S. Naval Base, Bldg. 77 Low
Philadelphia, PA 19112-5094

Subj: U.S. EPA Comments
Draft Final Focused Feasibility Study
Site 8
Naval Air Station Brunswick
Brunswick, Maine

Dear Jim:

The United States Environmental Protection Agency (EPA) has received and reviewed the document entitled "Draft Final Focused Feasibility Study (FFS) - Site 8" dated August 1991. Attachment I to this letter contains comments pertaining to this document.

As has been conveyed to the Navy, EPA cannot concur with the proposed target clean-up level of 18 ppm for carcinogenic PAHs as outlined in the report. The Navy has agreed to discuss this issue further at a meeting on October 3, 1991 at 1:00 PM. EPA recommends that we discuss any other outstanding issues pertaining to Site 8 at this time.

Please contact me at (617)573-5785 to discuss any of the comments provided further.

Sincerely,

Meghan F. Cassidy

Meghan F. Cassidy
Remedial Project Manager

Enclosures

cc: Eileen Curry/NASB
Mel Dickenson/EC Jordan
Ted Wolfe/ME DEP
Ann Johnson/SAIC
Mary Jane O'Donnell/US EPA
Jui-yu Hsieh/US EPA
Bob DiBiccaro/US EPA

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ATTACHMENT I

The comments provided below pertain to the report entitled "Draft Final Focused Feasibility Study, Site 8" (August 1991). The report was submitted by the U.S. Department of the Navy for the Naval Air Station Brunswick in Brunswick, Maine.

SECTION 2.0 - SUMMARY OF RESPONSE OBJECTIVES AND REMEDIAL ALTERNATIVES

1. Page 2-4, Paragraph 3: The response to comments states that a maximum concentration of 0.008 mg/kg of DDT was detected in the soils however, this paragraph indicates that the maximum concentration was 0.08 mg/kg. Clarify this discrepancy. Also clarify what Hazard Index associated with the correct value is.

2. Page 2-5, Paragraph 1: Summarize the history of cadmium detection in the text.

3. Page 2-6, Paragraph 3: This paragraph states that "remedial action objectives were developed to reduce exposure to or concentrations of cyanide, aluminum, iron and lead in surface water." However, this directly contradicts paragraph 4 on page 2-13 and paragraph 2.4.3 on page 2-29.

4. Page 2-11, Table 2-2: This table states that Maine MEGs have been promulgated, and are Relevant and Appropriate. Maine MEGs have not been promulgated and therefore should have a status of To Be Considered.

5. Page 2-13, Paragraph 4: This paragraph states that concentrations of lead, iron and cyanide exceed AWQC in surface water. However, this FFS does not address surface water. EPA considers AWQC as ARARs and cannot concur with a remedy which will not attain ARARs or will not meet the criteria for an ARAR waiver. Further discussion regarding this issue is needed.

6. Page 2-13, Paragraph 6: Clarify in the text why the surface water bodies of the western drainage area only would be regulated by ARARs that pertain to streams and wetlands.

7. Page 2-25, Paragraph 2: When commenting on the Draft Focused Feasibility Study for Site 8, EPA stated that background levels for PAHs must be calculated for Site 8 soils specifically. This apparently was not done since the text as presented in the draft final report still refers to background samples taken at Sites 1 and 3. The Navy <u>must</u> present background levels calculated using Site 8 soil information. Given the information provided, the target clean-up level of 18 ppm for carcinogenic PAHs is not appropriate. EPA will not concur on a target clean-up level for carcinogenic PAHs until such time that all of the requested information is provided.

8. Page 2-26, Table 2-5: Some of the exposure assumptions used to derive the clean-up level for Site 8 are different from the exposure assumptions used in the risk assessment as shown in Appendix Q of the RI report. The different assumptions used in Appendix Q are:

Amount of soil ingested: 0.1 g/day
Amount of soil contacted: 0.5 g/day
Exposure frequency: 8 days/year
Fraction of carcinogenic PAH absorbed dermally: 20%

An explanation of these differences or a correction is required before EPA can concur on any target clean-up level.

9. Page 2-27, Table 2-6: The following corrections to the table should be made.

   a. Use equal signs (=) instead of hyphens (-) in equations on lines 1, 2 and 3.

   b. In the bottom equation, the unit listed on the right is not equal to the unit on the left.

   c. Recalculate the target clean-up level if the exposure assumptions are incorrect.

10. Page 2-29, Paragraph 3: This paragraph does not agree with paragraph 3 on page 2-6 which states that remedial action objectives were developed for surface water. Further, as stated in comment No. 5 above the exceedance of AWQC must be discussed further.

SECTION 3.0 - DETAILED EVALUATION OF REMEDIAL ALTERNATIVES

11. In the ARAR discussion for each alternative, the report states that there are no chemical specific and no location specific ARARs for Site 8 (in connection with PAH). However, chemical specific and location specific ARARs in connection with iron, lead, cyanide and aluminum have not been addressed.

12. Page 3-1, Paragraph 3: EPA recommends that this paragraph include a statement stating that "The State is a party to a Federal Facility Agreement and has had the opportunity to review and comment on this FFS."

13. Page 3-23, Paragraph 5: This paragraph states that there is little expected difference in the overall protection of human health between this alternative (Alternative 8-D) and Alternative 8-C. The text should include language to explain why this is true.

APPENDIX C

Response to EPA Comments Dated June 17, 1991

Section 2.0 - Summary of Response Objectives and Remedial Alternatives

14. Page C-16, Response 9. Indicate whether the sum of all DDT positive detects was divided by the total number of DDT samples or all positive detect samples. Also, include a reference to the DDT detection limit.

15. Page C-16, Response 12. Jordan's response to this comment is analogous to Response 11. A discussion of the location of background samples for total and carcinogenic PAHs is included in the narrative. However, the referenced PAH concentration range of 1.8 to 21.9 mg/kg has been changed to 1.97 to 7.35 mg/kg. Explain this change.

16. Page C-16, Response 13. This comment has not been addressed. Provide information on how the PAH concentrations in surface water/sediment samples were compared to surface soils. Also, provide a rationale why test pits in the vicinity of Site 8, which exhibited no detectable concentrations of PAHs, are not considered background.

17. Page C-16, Response 14. A specific discussion concerning an ARAR waiver as they relate to Ambient Water Quality Criteria should be presented in Section 2.4.2 (Page 2-29).

18. Page C-16, Response 15. This comment appears to have been addressed, but a reference to the location of the background iron and aluminum concentrations is needed in the text.

Section 3.0 - Detailed Evaluation of Remedial Alternatives

19. Page C-18, Response 33. A statement indicating that local governments will cooperate with the Navy in the implementation of deed restrictions should be included in Paragraph 5 on Page 3-9.

20. Page C-19, Response 49. A reference to a nearby monitoring well would provide a more definitive location of the steep bank, since Figure 3-6 does not show topographic contours.

21. Page C-19, Response 50. Stabilization agent information can be obtained from EPA references and other professional publications and should be provided in the text.

22. Page C-19, Response 56. Provide a statement as to whether the stabilized soil that has failed the TCLP or other tests can be subjected to further on-site treatment rather than disposing of material off site as indicated in Figure 3-5 on Page 3-20.

23. Page C-20, Response 57. The leachate controls should be referenced in Paragraph 2 on Page 3-24.

Section 4.0 - Comparative Analysis of Alternatives

24. Page C-20, Response 64. State in Paragraph 1 on Page 4-3 that leachate controls are required for Alternative 8D.

RESPONSE TO COMMENTS, SITES 1 AND 3 DRAFT FINAL FFS, JULY 1991

EPA COMMENTS; ATTACHMENT I

COMMENT NO. RESPONSE

1. The modeling presented in the report has been used to evaluate various remedial alternatives and is not intended to be used at the design level. Future groundwater modeling for pre-design and design efforts will be coordinated with the EPA.

2. A deed restriction cannot appropriately be placed on the subject Navy lands. A limitation placed on title is a property disposal action that needs to be conducted through the General Service Administration authority. Many of the lands held by the Navy for government do not have deeds. The instrument of title in many cases is a court order in condemnation proceeding.

   However, there are certain actions that the Navy can take that will accomplish the same fundamental purpose of the proposed restriction on title. These actions include:

   1. Institutional controls can be made part of the remedial action. Such controls, when made part of the ROD, are enforceable in the same manner as any other ROD requirements.

   2. 42 USC 6920(h) requires the federal government to covenant in any deed of transfer that all remedial action has been taken.

   3. In the event that the Navy seeks to excess the subject property, the Navy can request and urge GSA to place the appropriate restrictions on title prior to disposal of the property to any party outside of the federal government.

   As discussed with the USEPA and MEDEP the following language has been included in the text: "The mechanism for implementing these institutional controls will be addressed in the ROD for remedial actions at Sites 1 and 3."

3. Deed/Land restrictions will include specific controls for maintenance and construction activities and future land use to ensure that these activities will not interfere

with the selected remedy.

As discussed with the USEPA and MEDEP the following language has been included in the text: "The mechanism for implementing these institutional controls will be addressed in the ROD for remedial actions at Sites 1 and 3."

4. The evaluation criterion "Reduction in toxicity, mobility or volume" is applied to the TREATMENT of source or contaminated media. Because the proposed remedial alternatives did not include treatment of the source material a discussion of MTV was not included. However, a discussion of MTV was included for the treatment of contaminated groundwater extracted/captured from beneath the landfill.

   A statement or discussion of the MTV of the source material has been included in the text. However, contrary to the comment, there would be a reduction in toxicity of the source contaminants, for those alternatives relying on natural flushing of the source area to achieve target cleanup levels. Natural flushing will, however, result in an increase in volume and mobility of source contaminants.

5. Two types of off-gas treatment were considered in the Sites 1 and 3 FFS: off-gas incineration and vapor phase activated carbon. Costs were not included for either of these technologies because they were not considered to be implementable at this site. Placing an ignition source (i.e., off-gas incineration treatment) in close proximity to the Weapons Compound would pose a significant safety hazard. Therefore, this technology was not considered in the costing of the alternative. Methylene chloride and vinyl chloride are not readily adsorbed by activated carbon. However, costs for these technologies have been developed in the revised report.

6. Page 2-33, Table 2-6: The estimate of a 78 gpm extraction rate (or flow into the drain system) is based on an hydrologic data obtained at the site. This rate is based on the equation Q = KIA; where Q is the flow rate, K is the average hydraulic conductivity value, I is the average hydraulic gradient, and A is the average cross-sectional area through which groundwater flows at the site. If the actual flow rates at the site are higher than this value, the alternative costs will be increased and this statement has been included in the text. A sensitivity analysis of various pumping rates on the cost of each alternative was not conducted and

is not considered necessary for the selection of a remedial alternative.

7. The discussion of the contamination at Sites 1 and 3 references the RI and Supplemental RI document. However, the figures, summarizing the contamination at the site, and presented in the RI reports have been included in Appendix E of the revised Draft Final FFS.

ATTACHMENT II

1. Page 2-3, Figure 2-2: The Figure 2-2 used in the Draft Final FFS was incorrect. A revised figure showing the extent of the site, including a portion of the Weapons Compound, has been be provided.

2. Page 2-4, Paragraph 3: The sampling locations have been identified in a figure presented in Appendix E.

3. Page 2-8, Paragraph 3: The reference to lead was in error. The sentence should read "Surface water Target Clean-up Levels for iron and zinc...".

4. Page 2-30, Table 2-5: The notation "proposed" for cis and trans 1,2-DCE has been deleted.

5. Page 2-31 and 2-32: The Navy believes that subsequent to remedial actions at Sites 1 and 3 the groundwater and seeps discharging to Mere Brook will be consistent with AWQC ARARs. The brook upgradient of Sites 1 and 3 currently exceeds the AWQC ARARs, and would continue to exceed these values subsequent to remedial actions at Sites 1 and 3. This has been discussed in the revised text. The Stormwater and Runoff Characterization study is not being preformed under the ongoing work associated with the past disposal sites. Reference to the stormwater study has been omitted from the text.

6. Page 2-33, Table 2-6: Although no direct general response action is proposed for surface water, the proposed actions for groundwater and leachate will have an indirect impact on the water quality of Mere Brook. The potential sources for surface water contamination in the brook are groundwater and seeps and these media have specific response actions. This has been included in the text.

7. Page 3-1, Paragraph 3: The sentence has been

revised as suggested.

8. Page 30-8, Paragraph 1: The distribution of specific monitoring wells for the monitoring plan was developed for cost estimating purposes as indicated in the text. The monitoring plan for Sites 1 and 3 will be developed and appropriately reviewed by the regulatory agencies. No change to the text.

9. Page 3-15, Paragraph 4: The text has been modified to reflect that monitoring "would be required".

10. Page 3-16, Paragraph 2: A value of 7.4 acres was based on the area of Sites 1 and 3 where trash/waste was observed in the test pits. This value was used for cost estimating purposes. The actual area to be capped may range from 7 to 10 acres and will be determined during the remedial design, and falls within the -30/+50 percent range required for cost estimates in an FS. The text has been revised to reflect these assumptions.

11. Page 3-16, Paragraph 3: The text references the specific section of the Draft Final RI report where the list of contaminants can be found. The figures presented in the RI reports identifying the contamination at this site have been provided in the revised Draft Final FFS.

12. Page 3-16, Paragraph 4: The statement "and sound engineering design practices" has been added to the text.

13. Page 3-16, Paragraph 4: The text has been modified as suggested in this comment.

14. Page 3-16, Paragraph 5: As stated in the text, the final selection of the geomembrane material type and thickness would be included in the final design phase of the remedial process. Therefore, a discussion of the merits of VLDPE is not warranted in this text. No change to the text.

15. Page 3-18, Paragraph 4: The text has been modified as suggested in the comment.

16. Page 3-13, Paragraph 4: The recommendations of EPA will be considered during the final design of the cap system. the cap design described in the text is preliminary and conceptual in nature and was developed for cost estimating purposes. No chnage to the text.

17. Page 3-19, Figure 3-3: The slope of 0.003 ft/ft

has been changed to 0.03 ft/ft.

18. Page 3-20, Paragraph 1: As stated in the text, the actual design of the gas venting system would occur during the final design of the cap. The discussion in the text was for informational purposed only, and was purposely generic in nature. The issues relating to the specific design of a gas venting system will be addressed during final design. A sentence has been added to the text indicating that the gas venting system would not significantly change the cost of this alternative.

19. Page 3-20, Paragraph 4: A cross section of the final grade of the cap has been provided.

20. Page 3-20, Paragraph 5: The text has been modified to more clearly state why three 24" diameter culverts were considered necessary to carry runoff from the cap under the roadway. This number and size was selected for cost estimating purposes only and was assumed to be adequately sized to handle the amount of runoff from the capped area. The final design plan would contain the assumptions and calculations needed to accurately size the culverts to actually be used.

21. More information on the hydrologic evaluation and surface soil erosion has been provided.

22. A 100-year flood water surface does exist in the vicinity of Sites 1 and 3, but the surface remains within the steep confines of Mere Brook. (See Flood Boundary and Floodual Map - Town of Brunswick, Cumberland County Panel 15 of 35. FEMA) No change to the text.

23. Page 3-22: The purpose of removing the groundwater remaining beneath the landfill (as part the containment alternative) is to both decrease the time required to lower the groundwater to levels below the waste and minimize groundwater impacts to Mere Brook. Groundwater will be extracted at the maximum flow rates achievable at the site. An interceptor trench is a passive collection system and would not remove groundwater at maximum flow rates. Various monitoring wells, or "well-points", will be evaluated at part of the more extensive computer modeling study.

24. Page 3-22, Paragraph 4; The cap will extend over the slurry wall. Figure 3-5 presents the proposed locations of the cap and slurry; the actual locations would be determined using information gathered during the pre-design activities (i.e., geotechnical borings) and supplemented by the information gathered during the past

RI activities.

25. Page 3-23, Figure 3-5: As stated above in 24, the cap will extend over the slurry wall. Figure 3-5 has been revised to show the proposed locations as described in the text.

26. Page 3-22, Paragraph 5: Geotechnical testing of the underlying clay would include natural moisture content. This item was omitted from the text and has been included.

27. Page 3-26, Paragraph 1: The text has been modified to state that testing "should be conducted".

28. Page 3-26, Paragraph 1: The last sentence of the paragraph has been deleted.

29. Page 3-28, Paragraph 4: The pore volume estimate of 16 million gallons is detailed in Appendix D, first paragraph. This Appendix is referenced in the text as appropriate.

30. Page 3-31, Paragraph 1: The removal of one pore volume is expected to remove the majority of the groundwater contaminant mass present beneath the landfill. Due to the relatively impermeable nature of the landfill cap and slurry wall, it was estimated that it may take up to 6 years for an additional pore volume to build up beneath the landfill area. The purpose of removing the groundwater remaining beneath the landfill (as part of the containment alternative) is to both decrease the time required to lower the groundwater levels below the waste and minimize groundwater impacts to Mere Brook. Only Alternatives 1,3-D, 1,3-E, and 1,3-F flush the landfill wastes due to the fact that the landfill wastes remain in contact with the groundwater. Reference to "cleanup" has been omitted. The paragraph refers to the time required to remove one pore volume of water (i.e., 16 million gallons).

31. Page 3-32, Paragraph 1: The pretreatment system was designed to reduce inorganic concentrations to levels that would not interfere with the performance of the VOC treatment system. It was also recognized that the pretreatment system could be modified, if appropriate, to reduce inorganic concentrations to the target clean-up levels. Because the discharge levels (or target clean-up levels) have not been finalized, it is not possible to determine the effectiveness of the proposed pretreatment system. The results of the proposed treatability test

will provide additional information that will determine the need to modify the pretreatment system. The text has been revised to reflect these objectives.

32. Page 3-32, Paragraph 2: The removal of iron and manganese has been proposed for purposes of pretreatment only, to prevent problems associated with precipitation of these metals in the organics treatment process. The pretreatment system presented in the FFS was designed for cost estimating purposes only and was not designed to reduce lead and arsenic levels. These compounds were sporadically detected at levels above their MCLs. However, they were not detected with the frequency and magnitude as the other compounds of concern. Treatability tests would be conducted using water generated in a pumping test to simulate full scale treatment. The concentrations of contaminants in this groundwater are expected to be indicative of a the full scale treatment system. The need to treat for arsenic and lead would be based on the results of the treatability tests. The pretreatment process would be modified and additional chemicals (such as lime) may be required if these inorganics are determined to present a risk to human heath or the environment. This has been included in the text.

33. Page 3-12. Paragraph 3: The strict definitions of coagulation and flocculation are not clear in the literature. Some definitions state that flocculation is a part of coagulation which occurs at the end of the process. Others state that these are two separate processes. The reason for these discrepancies stems from the fact that these processes are not well understood.

The polymer would be metered into solution and pumped into the rapid mix tank to provide a complete mixing of the polymer and the effluent from the oxidation tank. This mixture would then be slowly mixed to promote coagulation. Particle destabilization and agglomeration would occur in this tank. The agglomerated effluent would then pass on to a clarifier for particle settling. The text has been clarified to more accurately describe this process.

34. Page 3-32, Paragraph 4: The disposal requirements for the sludge generated during pretreatment would be determined as it is produced. The sludge would be tested for characteristics of hazardous waste and disposed of accordingly. Treatability testing would provide a good indication of the possible characteristics of the sludge generated during full scale operations. If hazardous, the actual disposal location would be determined during

remedial design. For cost estimating purposes, it was assumed that the sludge would be shipped out-of-state for disposal as a hazardous waste. The text has been modified to clearly state this.

35. Page 3-40, Last paragraph: This typographical error has been corrected.

36. Page 3-42, Paragraph 1: A figure illustrating the proposed infiltration location was not included due to a lack of hydrological data throughout the area north of the landfill site. Additional hydrologic data will be collected during the design phase of the project to support the location and size of the infiltration area. No change to the text.

37. Page 3-42, Paragraph 3: No flushing of waste materials is proposed as part of Alternative 1,3-C. The text has been changed to reflect this. The effect of any mounding on the slurry wall will be evaluated as part of the modeling and design phase of the project.

38. Page 3-42, Paragraph 3: The basis behind the selection of eight extraction wells has been discussed in the text.

39. Page 3-42: The Navy will contact the Wastewater Management Section at EPA regarding the option of discharging treated effluent with stormwater to streams. No change to the text.

40. Page 3-45, Paragraph 3: Reference to the Maine Interim Ambient Air Guidelines was included in the discussion of ARARs in response to the May 21, 1991 letter from the MEDEP to the Navy. The Interim Ambient Air Guidelines were provided to the Navy with guidance that these values were the "maximum allowable emission from off-gas treatment of contaminated groundwater" (i.e., air stripping).

    Interim Ambient Air Guidelines apply to point source air emissions. Because air stripping is the only proposed alternative with a technology that would be considered a point emission source, the Interim Ambient Air Guidelines apply only to air stripping.

    This is a point that should not impact the implementability of any alternative.

41. Page 3-45, Paragraph 3: The text has been modified as suggested in the comment.

42. Page 3-45, Paragraph 3: Inspections of the landfill cap

could be performed concurrently with the proposed monitoring program activities. The text has been modified to clearly state this.
The text will be modified accordingly.

43. Page 3-45, Paragraph 4: State requirements have been reviewed to identify any potential requirements for the permitting or licensing with regard to the removal and transportation of sludge. New text has been included to indicate whether, or not, state permitting or licensing is required.

44. Page 3-46, Paragraph 2: The text has been modified to reflect this comment. The establishment of NPDES discharge limits will be clarified and additional information provided regarding the Maine Antidegradation Policy.

45. Page 3-46, Paragraph 1: Text has been included that specifies the chemical- and action-specific ARARs pertaining to discharge of treated groundwater back to the underlying aquifer. The ARARs currently being considered will address upgradient infiltration and groundwater quality standard (MCLs).

46. Page 3-47, Paragraph 3: The slurry wall would be installed around the limits of the landfills. Additional geotechnical borings collected during the pre-design would provide the information necessary to delineate the limits of waste. For security reasons, the slurry wall would not be constructed in any part of the Weapons Compound. The text has been modified to state this.

47. Page 3-47, Paragraph 3: The assumptions used to estimate 0.5 inches of infiltration a year are provided in Appendix B.

48. Page 3-49, Paragraph 2: As stated above in Comment 32, treatability studies would determine the need for additional pretreatment steps other than potassium permanganate. These could include lime if the removal of lead and arsenic is required. The text has been clarified to state that the proposed pretreatment system would produce a sludge containing iron and manganese and that treatability tests would more accurately determine the composition of this sludge.

49. Page 3-50, Paragraph 4: The estimated time for construction presented in this paragraph includes the construction and installation of the groundwater extraction and treatment systems. This has been clarified in the text.

50. Page 3-51, Paragraph 3: Potential clay sources will be identified during in the design and construction phases of the program. No change to the text.

51. Page 3-51, Paragraph 3: Time estimates for the clay borrow study will be provided in the design and construction phases of the project. No change to the text.

52. Page 3-54, Table 3-5: a). Labor costs are included in costs given for cap constructions. The cost backup information in Appendix A contains this information.

b). The construction of the slurry wall and environmental monitoring would be conducted by contractors who have demonstrated that their employees meet the requirements of OSHA for working at hazardous waste sites. A cost for health and safety has been included in the cost estimate even though the slurry wall would not be constructed in areas of waste.

c). The response to Comment Number 5 under Attachment I above describes why costs for off-gas treatment were not included. As stated in comment number 5, these costs have been provided in the revised text.

d). Costs include the collection and analysis of air stripper off-gas samples but not ambient air samples at the fence line for compliance with MEDEP emissions standards. An air monitoring plan very similar to the one presented in the Sites 1 and 3 FFS was approved by the MEDEP for the Tex Tech site in North Monmouth, Maine.

53. Page 3-61, Paragraph 4: The text has been revised to indicate that the treatment and/or discharge of water may occur at another location on-base.

54. Page 3-64, Paragraph 2: The depth of the trench is estimated to be 35 feet below ground surface. The text has been changed.

55. Page 3-64, Paragraph 2: The actual location of the trench would be based on modeling and confirmed using geotech borings. This statement will be added to the text.

56. Page 3-64, Paragraph 2: The depth of the trench is estimated to be 35 feet below ground surface. The text has been changed.

57. Page 3-65, Figure 3-15. As discussed in the text, the purpose of the trench is to passively collect groundwater

flowing from the site and promote the natural flushing of the landfill waste materials. This will allow for the removal of the landfill wastes as a source to groundwater over time. No change to the text.

58. Page 3-69, Paragraph 3: Additional details regarding the design of the trench have been included in the text. The trench design will be discussed in detail in the design document. The pumping rate of 78 gpm was based on calculations described in response to Comment 6 in Attachment I.

59. Page 3-68, Paragraph 3: As discussed in the text, groundwater is estimated to be 25 to 30 feet below ground surface. The trench depth is estimated to be 35 feet below ground surface. The text has been changed to reflect this.

60. Page 3-70, Paragraph 1: The effects of upgradient reinjection on the interceptor trench will be evaluated as part of the modeling and design phase of the project if this alternative is selected. No change to the text.

61. Page 3-70, Paragraph 3: The costs for alternatives involving the installation of the trench include health and safety costs associated with real-time air monitoring. The text has been modified to state this.

62. Page 3-70, Paragraph 3: The text has been clarified to state that the effluent monitoring refers to treatment system effluent.

63. Page 3-71, Paragraph 4: The text includes a discussion of the ARARs that apply to Mere Brook.

64. Page 3-74, Paragraph 1: A reference to Section 3.4.6 has been included. The downgradient wells in the monitoring program would provide information on the groundwater quality downgradient of the interceptor prior to discharge to Mere Brook and across the brook to determine if it is migrating beneath the brook.

65. Page 3-86, Paragraph 3: The word "could" has been changed to "would".

66. Page 3-86, Paragraph 3: The range of pumping rates is a reflection of the range of transmissivities observed throughout the site. The depth to clay beneath the site (Figure B-2) accounts for the range of aquifer thickness (and therefore transmissivities) observed at the site.

78. Page 4-3, Table 4-1, Action-specific ARARs for Alternatives 1,3-C, 1,3-D, 1,3-E and 1,3-F: A discussion of the AWQCs has been provided. See also response to comment 5 Attachment II.

79. Page 4-3 , Table 4-1, Alternative 1,3-C: The time frame provided in the Table has been clarified to indicate the time to extract one pore volume.

80. Page 4-4, table 4-1, Adequacy of controls for Alternative 1,3-C: The statement has been clarified as suggested in the comment.

81. Page 4-10, Paragraph 1: ARAR requirements for UV/oxidation has been clarified.

82. Page 4-11, Paragraph 4: The sentence has been modified as suggested in the comment.

83. Page 4-11, Paragraph 4: The sentence has been modified as suggested in the comment.

84. Page 4-13, Paragraph 2: Table 2 in Appendix A has been referenced in the cost comparison of Alternative 1,3-D.

67. Page 3-87, Figure 3-18: The impact of the extraction wells in the western and southwestern side of the landfill will be reexamined and the location of extraction wells in this area will be adjusted if necessary.

68. Page 3-88, Paragraph 4: The effects of groundwater recharge on the aquifer flow patterns and the extraction well system will be evaluated as part of the design study if this remedy is selected. This is primarily due to the fact that the final location of groundwater reinjection wells or an infiltration system will be based on data collected north of the landfill as part of the design study which will be submitted to agencies for review and comment. No change to the text.

69. Page 3-89, Paragraph 1: The text has been revised to state that an environmental monitoring program similar to that described for Alternative 1,3-D would be most applicable.

70. Page 3-90, Paragraph 3: The reference has been corrected to read "USEPA, 1989".

71. Page 3-92, Paragraph 3: The text has been modified as suggested in the comment.

72. Page 3-94, Paragraph 4: The text has been modified as suggested in the comment.

73. Page 3-94, Paragraph 5: The sentence has been changed to state " Measures will be taken to reduce the impacts of potential increased flow in Mere Brook on the habitat of resident aquatic species."

74. Page 3-94, Paragraph 6: The estimated time for construction for this alternative is one year and includes the construction of the treatment system. The text has been revised to describe this.

75. Pages 4-2 through 4-9, Table 4-1: Table 4-1 has been printed in larger font.

76. Page 4-3, Table 4-1: A sentence has been added that addresses the ARARs and Mere Brook.

77. Page 4-3, Table 4-1: Set back requirements has been clarified.

STATE OF MAINE
Department of Environmental Protection

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207 289-7688

JOHN R. McKERNAN, JR.
GOVERNOR

DEAN C. MARRIOTT
COMMISSIONER

September 9, 1991

Mr. James Shafer
Department of the Navy, Northern Division
Naval Facilities Engineering Command
Building 77-L
Philadelphia Naval Shipyard
Philadelphia, PA 19112-5094

Re: Naval Air Station Brunswick, Draft Final Focused Feasibility Study Site 8, August, 1991, by E.C. Jordan Co.

Dear Mr. Shafer:

The Maine Department of Environmental Protection (MEDEP) has completed its review of the Draft Final Focused Feasibility Study Site 8, which was submitted to the MEDEP by E.C. Jordan Co. on August 12, 1991 on behalf of the U.S. Department of the Navy for the Naval Air Station Brunswick (NASB) Site.

The MEDEP believes that the alternatives presented in the Draft Final Focused Feasibility Study for Site 8 have been appropriately carried forward for consideration. The MEDEP has raised concerns in previous correspondence and phone conversations regarding the target clean-up level for carcinogenic PAHs at this site. These concerns have not been addressed to the satisfaction of the MEDEP in this Draft Final Focused Feasibility Study.

General Comments:

The scope of the remediation effort for Alternatives 8-B, C, and D depend on the extent of soil contamination being considered for remediation. As previously stated, the MEDEP believes the proposed 18 ppm carcinogenic PAH clean up level is excessive. The MEDEP will not concur with this proposed level. Discussions are necessary concerning this matter.

The Site 8 location could have future development potential should the operational status of NASB change. Although its use as a site of residential development is questionable, it can not be ruled out. Any surrounding residential and or commercial development may result in unrestricted access by some individuals. The threat of long term exposure exists.

The acceptable target clean up level for carcinogenic PAHs in areas of potential residential development is 1 ppm. This clean up level is based on the maximum plausible exposure assumptions and the 10^{-5} risk level.

The MEDEP believes that the exposure assumptions utilized in the risk based calculations have been underestimated. This concern was previously raised in the June 27, 1991 correspondence regarding the Draft Focused Feasibility Study. Further more, adequate calculations of background carcinogenic PAH levels at Site 8 have not been presented. Such calculations were requested in the June 27, 1991 correspondence.

The establishment of target clean up levels must depend on a combination of factors including future potential development and access, risk generated exposures, present background PAH levels, and consistency with other PAH target clean up levels at NASB.

Specific Comments:

Page	Section	Comments

2-11, table 2-2, Chemical Specific ARARs: The Requirement Synopsis for the Maine Drinking Water Rule includes an inaccurate description of the MEGs. This inaccuracy has been noted and discussed during previous conversations and correspondence regarding other sites at NASB. A chemical specific ARARs table was not included in the previous Draft Focused Feasibility Study for this site. All documents which present ARARs must be corrected to the satisfaction of the MEDEP.

2-25, section 2.4.1, Human Health Clean-up Levels: The MEDEP believes that the proposed 18 ppm PAH target clean-up level for this site is excessive if based on a future scenario that allows repeated exposure. A residential risk scenario does not appear to have been developed or presented as requested. Furthermore, the 18 ppm PAH target clean up level at Site 8 is not consistent with the 3-4 ppm PAH target clean up level proposed by the Navy for Site 9 in the Draft Final Phase 1 Feasibility Study Development and Screening of Alternatives dated August, 1990.

Adequate calculation of background carcinogenic PAH levels at Site 8 were not presented as requested. Remedial efforts will be centered on soil contaminated areas at Site 8. Discussions of background contamination in "sediment samples upstream of Sites 1 and 3 within the facility" have no relevancy to specific Site 8 conditions. A background soil PAH concentration should be calculated using data available from site 8 including numerous non-detect readings. A base wide background PAH calculation should be made utilizing all analytical PAH data, including non-detect readings.

2-26, table 2-5, Exposure Assumptions: Following consultation with the Maine State Toxicologist, the MEDEP believes that the exposure assumptions at Site 8 have been underestimated. The dermal exposure should be increased from 1.0 grams/event to 3.0 grams/event The ingestion exposure should be increased from 0.05 grams/event to 0.1 grams/event. (The comment letter of June 27th inadvertently suggested an increase from 0.5 gram/event to 1.0 gram/event. This error was brought to the attention of NORDIV in a subsequent phone conversation.)

While the exposure parameter utilized a specific age group, and may be consistent with USEPA guidance, it is doubtful that repetitive exposure to surface soils and sediment will be limited to only the 7-12 age group. The population assumption does not consider children older than 12 years who could also come in contact with the site. The exposed population should also include children in the 13-18 age group. Therefore, consideration should be given to an expanded exposure duration.

Recalculation of the target clean-up level using the increased exposure assumptions results in a target clean-up level of approximately 3 ppm. The MEDEP believes that 3 ppm is appropriate for this site.

3-8, figure 3-1, Alternative 8B: The delineated area of contamination will change with a lowering of the target clean up level. Installation of fencing will depend on the area to be remediated. The fenced area will need to be expanded. An additional area beyond that identified in this report will be necessary. Additional costs will need to be calculated for the cost summary in Table 3-4, page 3-11.

3-13, figure 3-2, Alternative 8-C: The delineated area of contamination will change with a lowering of the target clean up level.

3-17, Table 3-5, Alternative 8-C, Cost Summary: Capital costs will increase with an increased amount of cover material.

3-21, figure 3-6, Alternative 8-D: The delineated area of contamination will change with a lowering of the target clean up level.

3-24, section 3.4.3, Cost: Adjustments in the cost analysis should be made.

C-27, Response # 4 to MEDEP comments: While the exposure scenarios developed for Site 8 may have been presented in both the Preliminary Risk Assessment and the Draft Final RI, review of MEDEP comments letters for these reports and their drafts show that the MEDEP did not necessarily accept these reports as written.

In the February 8, 1990 MEDEP comment letter concerning the Preliminary Risk Assessment, the MEDEP neither approved nor disapproved of the document. The MEDEP did raise concerns that too few risk estimates were presented.

The May 17, 1991 MEDEP correspondence regarding the Draft RI Report specifically disapproved of the report. The MEDEP stated that "concerns expressed in the Risk Assessment regarding PAHs... at Site 8 do not seem to be reflected in discussions included in the RI". The MEDEP raised questions concerning the amount, frequency, and length of exposure.

The October 10, 1990 MEDEP comment letter regarding the Draft Final RI Report stated that "the DEP continues to have concerns regarding both the RI and the RA (Risk Assessment) Reports". The Risk Assessment was <u>conditionally approved</u> provided that MEDEP comments be addressed. Many comments were repeated from the May 17th letter since MEDEP concerns were not addressed in the Draft Final Report.

As a result of Response #4 the MEDEP reexamined the Risk Assessment portion of the Draft Final RI. The Summary on page Q-78, Appendix Q, Volume 4 of the Draft Final RI states that "lifetime exposure to contaminants in soils at Site 8 are associated with carcinogenic risks ranging from 8.6×10^{-5} to 1.9×10^{-4}. The Risks are essentially attributable to carcinogenic PAHs. For the realistic worst case the risk estimate is above USEPA target risk range.....".

All involved parties must discuss and resolve issues relating to the target clean up levels at Site 8 prior to issuing a Draft Proposed Plan for Site 8

If you have any concerns or questions regarding these comments, please contact me at (207) 289-2651.

Sincerely,

Ted Wolfe

Ted Wolfe
Division of Site Investigation and Remediation
Bureau of Hazardous Materials and Solid Waste Control

cc: Michael Barden, MEDEP
Sam Butcher, Harpswell Representative
Meghan Cassidy, EPA
Eileen Curry, NASB
Mel Dickenson, E.C. Jordan/ABB Environmental
Donald Gerrish, Town of Brunswick
Marianne Hubert, MEDEP
Loukie Lofchie, BACSE
Denise Messier, ME DEP
Susan Weddle, Community Representative

A:DFFFS8

DEP COMMENTS
DRAFT FINAL FFS SITES 1 AND 3

General Comments:

1. The Navy will give proper consideration to State TBCs in the Remedial Action Objectives Section. The clean-up level for vinyl chloride will be consistent with the USEPA range of 10^{-4} to 10^{-6} as discussed with the State on August 28, 1991.

2. The proposed pretreatment system was designed to remove iron and manganese to eliminate problems associated with precipitation in the organics treatment system. It is anticipated, based on the range and frequency of detection, that the other inorganic compounds would be treated to levels at or below their respective MCLs. The need for additional steps for the removal of these inorganics would be determined through treatability testing. The pretreatment process would be modified to achieve target cleanup levels, if necessary. The text will be modified to reflect these concerns.

3. The Navy recognizes the States concerns regarding long-term remedial objectives. The NCP has established criteria that result in overall protection of human health and the environment and the achievement of chemical, location, and action-specific ARARs. The Navy has used this guidance in developing and evaluating the remedial alternatives for Sites 1 and 3.

4. The Navy recognizes the States concerns for Alternative 1,3-C. This alternative does not permanently reduce the volume, toxicity or mobility of the waste material however, it is consistent with containment alternatives for landfill sites. The large volume makes permanent treatment of the source material impractical and inhomogeneity of the waste material. The containment alternative would be monitored as described in the FFS, and as mandated in the NCP, if the remedial action objectives were not being met a new alternative would be implemented.

   Maintenance of extraction wells will be addressed in a separate O&M plan for the selected remedy.

5. The Navy recognizes the States concerns with air stripping and has recommended U/V oxidation as the treatment option in the Draft Proposed Plan.

6. The four discharge options discussed in the Site 1 and 3 document present potential means to dispose treated groundwater. The Navy recognizes the States concerns with regard to these discharge options and agrees with the State

that the POTW is the most viable option. If the POTW is not feasible the Navy will consider a combination of infiltration and discharge to surface water.

7. The Navy agrees with the State that the most realistic estimate on flushing times is probably closer to the upper end of the predicted range, and O&M costs may increase with time. As indicated in the FFS report a small portion of the landfill, along the weapons compound, will not be included in the system and may require closure under MEDEP Solid Waste Regulations. Health and Safety of construction workers would be addressed in work plans for trench construction.

8. The Navy recognizes the States input concerning Alternative 1,3-E. However, the long-term treatment and volume of water to be treated may exclude the POTW as a viable discharge option.

9. The Navy recognizes the States input concerning Alternative 1,3-F. However, the long-term treatment and volume of water to be treated may exclude the POTW as a viable discharge option.

Specific Comments

1. Page 2-30, Table 2-5: Risk calculated have been presented to the State (August 22, 1991 meeting) that indicate that the 2 ppb clean-up level for vinyl chloride is protective of human health, and does fall within the 10^{-4} to 10^{-6} range specified in the NCP. Upon the completion of the final remedy, the Navy will **reevaluate the total site risk**, and undertake further remedial action if the excess cancer risk is found to be outside the upper limit specified in the NCP. This has been included in the text.

2. Page 3-34, Section 3.3: U/V Oxidation will be included in the Proposed plan for Sites 1 and 3.

3. Page 3-41, Section 3.3: Discussions concerning the effects of recharge of treated water upgradient of the landfill will be discussed in the design study document. The volume of water needing treatment in Alternatives D, E, and F may be altered based on the information developed as part of the design study.

4. Page 3-42, Section 3.3: The effects of the discharge of groundwater upgradient of the site on the eastern plume will be evaluated as part of additional modeling conducted at Sites 1 and 3 and the Eastern Plume. The modelings will be conducted during the pre-design portion of the project.

5. As agreed, the Navy will conduct a risk assessment at the 5-

year review. If the risks do not fall within the NCP range, then additional remedial action may be necessary. This has been included in the text.

6. Pages 3-44 tp 3-47, Section 3.3.2: a) The small amount of waste that could remain in contact with the ground water would have little impact on groundwater quality. The two wells designed to remove the pore volume of groundwater downgradient of the slurry wall could continue to remove this small amount of water.

   b) If the remedy does not perform according to the ROD, the Navy will propose modifications to the EPA and MEDEP to remedy the problems.

   c) Containment alternatives, by definition, do not permanently reduce source contamination. The containment is appropriate for landfill sites where the volume and nature of wastes preclude cost-effective and timely treatment. However, of all the alternatives, Alternative 1,3-C will achieve the Target Clean-up Levels in the shortest amount of time (less than 2 years). The other alternatives rely on natural flushing to permanently reduce source contamination, however, the time to achieve Target Clean-up Levels is significantly greater and ranges from 18 to 73 years.

7. Page 3-47, Section 3.3.3: The groundwater table would be lowered 6 to 8 feet within 1 to 2 years and 8 to 11 feet within 5 to 10 years. The text has been revised to accurately state this.

   A review of the test pit and boring information gathered in the RI and the groundwater modeling done for the FS showed that the in all cases where trash was encountered in explorations, the proposed slurry wall in Alternative 1,3-C would lower the groundwater to below the level of the waste encountered. The text has been revised to state this and backup information will be provided if necessary.

8. Pages 3-75 & 3-76, Section 3.4.5: Because this alternative does not include a cap, it would be considered an "unsecured" landfill and would need to be considered for proper closure under MEDEP Solid Waste Regulations. This will be added to the text.

9. Table 4-1, Compliance with ARARs:

   a) Due to a formatting error, the text addressing chemical-specific TBCs was listed under Action-specific ARARs. This has been corrected.

b) This alternative would not attain ARARS IF it fails and if the extraction well could not be activated to minimize migration of the contaminated groundwater. However, it has been designed based on sound engineering practices and will be monitored regularly to ensure compliance with response objectives. The CERCLA process allows numerous opportunities (i,e, 5-year reviews) to monitor and modify remedial alternatives should they fail to attain and maintain the response objectives.

c) The text has been changed to reflect that this alternative would not comply with MEDEP Soil Waste ARARs because the landfill would be "unsecured".

10. Table 4-1, Long Term Effectiveness and Permanence:

a) Magnitude of Residual Risk: The response to comment number 7 adequately addresses this issue.

b) Adequacy of Controls: The response to comment number 7 adequately addresses the issue of water remaining in contact with waste. The table will be revised to address the considerations in this comment.

c) Reliability of Control: Maintenance would be difficult if necessary. The table will be modified to address this.

11. Table 4-11, Reduction of Mobility, Toxicity, or Volume: The table has been modified as suggested in the comment.