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Alternatives Array Document

for

Soils Operable Unit
Naval Industrial Reserve Ordnance Plant
Fridley, Minnesota

Southern Division
Naval Facilities Engineering Command
Contract Number N62472-90-D-1298
Contract Task Order 0179

November 1994

Halliburton NUS
CORPORATION

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ALTERNATIVES ARRAY DOCUMENT
FOR
SOILS OPERABLE UNIT
NAVAL INDUSTRIAL RESERVE ORDNANCE PLANT
FRIDLEY, MINNESOTA

COMPREHENSIVE LONG-TERM
ENVIRONMENTAL ACTION NAVY (CLEAN) CONTRACT

Submitted to:
Southern Division
Environmental Branch Code 18
Naval Facilities Engineering Command
2155 Eagle Drive, P.O. Box 190010
North Charleston, South Carolina 29419-9010

Submitted by:
Halliburton NUS Corporation
993 Old Eagle School Road, Suite 415
Wayne, Pennsylvania 19087-1710

CONTRACT NUMBER N62472-90-D-1298
CONTRACT TASK ORDER 0179

NOVEMBER 1994

SUBMITTED BY:

RICHARD M. NINESTEEL, P.E.
PROJECT MANAGER
HALLIBURTON NUS CORPORATION
PITTSBURGH, PENNSYLVANIA

APPROVED FOR SUBMISSION BY:

JOHN J. TREPANOWSKI, P.E.
PROGRAM MANAGER
HALLIBURTON NUS CORPORATION
WAYNE, PENNSYLVANIA

PREPARED BY:

LINDA E. HICKEN, P.E.
SENIOR PROJECT MANAGER
RMT, INC.
MADISON, WISCONSIN

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Section 1
INTRODUCTION

This focused Alternatives Array Document (AAD) identifies possible remedial alternatives that are applicable to the Soils Operable Unit (Soils OU) at the Naval Industrial Reserve Ordnance Plant (NIROP) in Fridley, Minnesota. This report has been based upon the results of the Remedial Investigation (RI) Report dated September 1993 and numerous regulatory summaries and guidance documents published by the Minnesota Pollution Control Agency (MPCA), the United States Environmental Protection Agency (USEPA), and other technical resources. The intent of the focused AAD has been discussed with representatives of the United States Navy, the USEPA, and the MPCA, and includes the identification of Applicable or Relevant and Appropriate Requirements (ARARs), the development of the basis for cleanup goals, and a review of the remedial technologies used in presumptive remedies for volatile organic compounds (VOCs) in soils. This AAD includes the following major sections:

1. INTRODUCTION - presents the report organization and objectives
2. SITE BACKGROUND - summarizes the site conditions and previous investigations
3. REMEDIAL ACTION OBJECTIVES - focuses on the areas of the site where action is needed
4. IDENTIFICATION OR APPLICABLE AND OR RELEVANT AND APPROPRIATE REQUIREMENTS - incorporates both federal ARARs and a preliminary list of state ARARs
5. DISCUSSION OF PRESUMPTIVE REMEDIES - presents a brief description of the four presumptive remedies applicable to sites with predominantly VOC–impacted soils

RMT, Inc. (RMT), of Madison, Wisconsin, has been retained by Halliburton NUS, a U.S. Department of the Navy contractor, to prepare this document and the subsequent detailed Feasibility Study (FS), Proposed Plan (PP), and Record of Decision (ROD). This AAD is the first deliverable document required by the negotiated Federal Facilities Agreement (FFA) after approval of the RI Report.

Section 2
SITE BACKGROUND

2.1 Site Setting

The NIROP Fridley is owned by the Navy and operated by Armament Systems Division of United Defense LD (United Defense), formerly Northern Ordinance Division of FMC Corporation. The plant has produced naval guns since 1941 and has expanded into the production of guided missile launching systems, torpedo tubes, and hydraulic and electric power drive and control systems.

The NIROP Fridley is located on the southernmost tip of Anoka County. The plant is situated approximately one-quarter mile east of the Mississippi River and less than 1 mile south of Interstate 694. The plant is bordered on the west by East River Road and on the east by the Burlington Northern railyard. The government-owned, contractor-operated portion of the plant encompasses 83 acres. The remainder of the facility is owned and operated by United Defense, and encompasses approximately 55 acres.

The NIROP Fridley and adjacent properties to the north, east, and south are zoned heavy industrial. The Anoka County Riverfront Regional Park is located between East River Road and the Mississippi River (west of the site). The park is a day-use recreation facility on the river's edge, consisting of approximately 60 acres.

Fridley's population was estimated at 28,000 residents in 1990. Anoka County's population, according to 1990 estimates, was 244,000 people. The NIROP Fridley is located near the northern boundary of the metropolitan statistical area (as defined by the U.S. Bureau of Census) for Minneapolis-St. Paul, Minnesota. The area was estimated to contain a population of 2,350,000 people in 1990 (Rand McNally, 1992).

Two significant waterways are in the vicinity of the site: the Mississippi River, approximately 700 feet to the west, and Rice Creek, approximately 2 miles to the north. The Mississippi River provides active recreational opportunities for boaters and anglers as well as passive recreation because of its aesthetics and historical significance. The river also serves as a source of

public and private drinking water. Water intake for the City of Minneapolis Waterworks facility is located approximately 2,000 feet south (downstream) of NIROP Fridley's southern property line.

The NIROP Fridley is situated over a sand and gravel aquifer that is capable of yielding significant quantities of water for residential or municipal supplies. The aquifer is generally restricted to the Mississippi River Valley.

The soil at the NIROP site is developed on glacial-fluvial deposits that resulted from deposition in a fluvial (river) environment during higher stages of the Mississippi River during glacial melting. The glacial-fluvial deposits occurring at the site consist primarily of coarse sand, fine to medium sand, and some gravelly sand. Discontinuous layers of silt and clay occur at some locations. These unconsolidated deposits are up to 150 feet thick in the vicinity of the site (Envirodyne, 1983). Generally, sand in the study area is classified as poorly graded sand (SP) under the Unified Soil Classification System (USCS). The bedrock unit immediately underlying most of the Quaternary deposits at the site is the St. Peter Sandstone. Successive units underlying the St. Peter Sandstone are the Prairie du Chien Group and the Jordan, St. Lawrence, Franconia, and Ironton/Galesville Sandstones. On a portion of the site, the St. Peter sandstone has been removed by erosion and the first bedrock encountered below the unconsolidated deposits is the Prairie du Chien Group. Area geology and groundwater use are discussed in detail in Section 5 of the RI report for the groundwater operable unit prepared by RMT (1987a).

The climate in the area of the site is characterized by warm summers with average temperatures ranging from the upper 70s°F to the low 80s°F, with moderate rainfall averaging about 17 inches per year. Winter temperatures average between 3°F and 7°F for January and February. Precipitation during the months of October through April averages about 9 inches. Temperature extremes for the area range from - 34° to 104°F (Envirodyne, 1983). Wind directions vary throughout the year. Northwesterly winds prevail from November through April; southeasterly winds are dominant in May, June, August, and October; and southerly winds dominate in July and September. Wind speeds are fairly constant throughout the year, averaging 10.5 miles per hour (Envirodyne, 1983).

2.2 Chronological Summary of Site Activities To Date

A summary of the various investigation and remedial site activities that have occurred at the NIROP Fridley property follows. More details regarding the results of any of these activities are available in reports referenced in the RI document and elsewhere.

Summary of Activities - NIROP Fridley, Minnesota	
Date	Event
Overall Site	
March 1981	Initial sampling initiated
March 1982	Began investigation of North Study Area
June 1983	Completion of Initial Assessment Study (Envirodyne Engineers, Inc., 1983)
	Initiation of U.S. Corps of Engineers (USACE) conductivity study
November 1983	First drum removal action by Chemical Waste Management (43 drums removed)
September 1986	Final report of the hazardous waste clean-up (RMT, 1986)
Groundwater Operable Unit	
Late 1986	Initiation of groundwater RI activities (RMT)
June-July 1988	Completion of Groundwater RI Report and Addendum (RMT, 1988a)
July 1988-August 1988	Completion of FS Report and Addendum for Groundwater (RMT, 1988c and 1988d)
September 1990	Issuance of ROD for the Groundwater Operable Unit
September 1992	Start-up of groundwater recovery system
December 1992	90-day Determination Document (RMT, 1992c)
June 1994	Submittal of Proposed Workplan for upgrading groundwater recovery system (RMT, 1994)
Soils Operable Unit	
November 1987	Pore gas survey to evaluate shallow VOC impacts (RMT, 1988b)
October-November 1990	Initial soil investigation consisting of 55 soil borings
February 1991	Quality control summary report and technical memorandum (RMT, 1991a and 1991b)
August 1991	Historical aerial photograph review to identify other areas for investigation
November 1991	Discovery of soil contamination near hazardous materials storage building on southwestern side of facility.
Soils Operable Unit (continued)	
January 1992	Final RI Workplan (RMT, 1992a)
January 1992	Final Quality Assurance Plan Approved (RMT, 1992b)
June 1992	RI field investigation to define nature and extent of soil contamination and on-site removal action of 31 drums and 900 yards of soil
September 1993	Final RI Report (RMT, 1993)

2.3 Summary of the Soil OU RI Results

The most recent soil investigation as reported in the RI consisted of evaluating the extent of contamination in 11 areas and in establishing site-specific background concentrations at unimpacted locations in the NIROP Fridley area. Figure 1 shows the location of the 11 areas of investigation.

The investigation consisted of the advancement of over 100 soil borings extended to various depths, the excavation of 12 test pits at focused locations, and the analyses of hundreds of samples for various constituents. On the basis of these data and those from previous investigations, it was concluded that there was only slight or not significant soil contamination, in six of the areas studied (A-1, B-1, B-2, E-1, E-2, and F-1). Two areas (D and F-2) had moderate impacts, and three areas (A-2, A-3, and A-4) were found to have significant soil contamination.

A shallow zone (approximately 3 to 7 feet below ground surface) of highly variable fine-grain soil underlies much of Area A3 and the west-central part of Area A4. Figure 2 shows the location of this fine-grained layer.

VOCs represent the most significant type of chemical contamination associated with the areas where the fine-grained layer exists. Based on analytical results collected during the soils RI, it appears that no significant or consistent vertical trends in the VOC concentrations are associated with the fine-grained soil. In general, similar concentrations were detected in shallow soils (0 to 5 feet deep) located within and above the fine-grained soil interval, in intermediate soils (6 to 12 feet deep), and in the deep soils (13 to 20 feet deep) beneath the fine-grained interval. Table 1 shows the vertical extent of contamination in borings advanced through the fine-grained layer. The effectiveness of the selected remediation technology for removing contaminants from this fine-grained material will be addressed in the FS.

The primary chemicals of concern in soils at NIROP Fridley are chlorinated VOCs. This is consistent with the findings associated with the groundwater OU. Some pesticides were identified in surficial soil, likely attributable to on-site maintenance activities. Semivolatile

AREA D
(SEE FIGURE 4-9 FOR
AREA D BORING LOCATIONS)

AREA B
(SEE FIGURE 4-8 FOR
AREA B BORING LOCATIONS)

AREA E
(SEE FIGURE 4-11 FOR
AREA E BORING LOCATIONS)

AREA A
(SEE FIGURE 4-3 FOR
AREA A BORING LOCATIONS)

AREA F
(SEE FIGURE 4-12 FOR
AREA F BORING LOCATIONS)

AREA B2
AREA B1
AREA A3
AREA A4
AREA A2
AREA A1
AREA E1
AREA E2
AREA F1
AREA F2

NIROP

EAST RIVER ROAD

MISSISSIPPI RIVER

FRIDLEY MUNICIPAL WELL 13

23-S
15-S
5-PC
1-I
10-D
21-S
2-I
3-PC
4-S
3-D
AT-1
22-S
9-S
14-D
5-I
1-D
1-S
20-S
BG-02
14-S
10-I
5-D
7-S
12-D
8-S
3-I
3-S
FMC-33
2-PC
BG-01
13-S
BG-05
AT-4
BG-03
16-S
11-D
AT-5
14-I
17-D
9-D
19-S
BG-04
1-PC
2-S
2-D
AT-3
26-S
15-D
15-I
AT-2
23-S
6-D
11-S
8-D
18-S
4-I
10-S
6-S
4-D
4-PC
5-S
12-S
BG-08
13-D
25-S
BG-09
BG-10
17-S
7-D
16-D
27-S
16-I
BG-06
BG-07

LEGEND

- EXISTING PAVED ROAD
- EXISTING UNPAVED ROAD
- EXISTING BUILDING
- EXISTING FENCE
- 800 — EXISTING 5' CONTOUR
- EXISTING 1' CONTOUR
- x 865.1 — EXISTING SPOT ELEVATION
- TREES AND / OR BRUSH
- EDGE OF WATER
- WET AREA
- 1-S — WATER TABLE OBSERVATION WELL IN UNCONSOLIDATED SEDIMENTS
- 1-I — INTERMEDIATE DEPTH PIEZOMETER IN UNCONSOLIDATED SEDIMENTS
- 1-D — DEEP PIEZOMETER IN UNCONSOLIDATED SEDIMENTS
- 1-PC — BEDROCK PIEZOMETER
- AT-1 — PRODUCTION WELL
- MUNICIPAL WELL
- BG-2 — BACKGROUND SOIL BORING COMPLETED DURING RI INVESTIGATION
- APPROXIMATE NIROP PROPERTY LINE
- APPROXIMATE FMC PROPERTY LINE
- APPROXIMATE BNR PROPERTY LINE
- APPROXIMATE BOUNDARY OF THE RI INVESTIGATED SUBSURFACE SOILS FOR AREAS A, B, D, E, AND F

SCALE: 1 = 200'
0 200 400 800 FEET

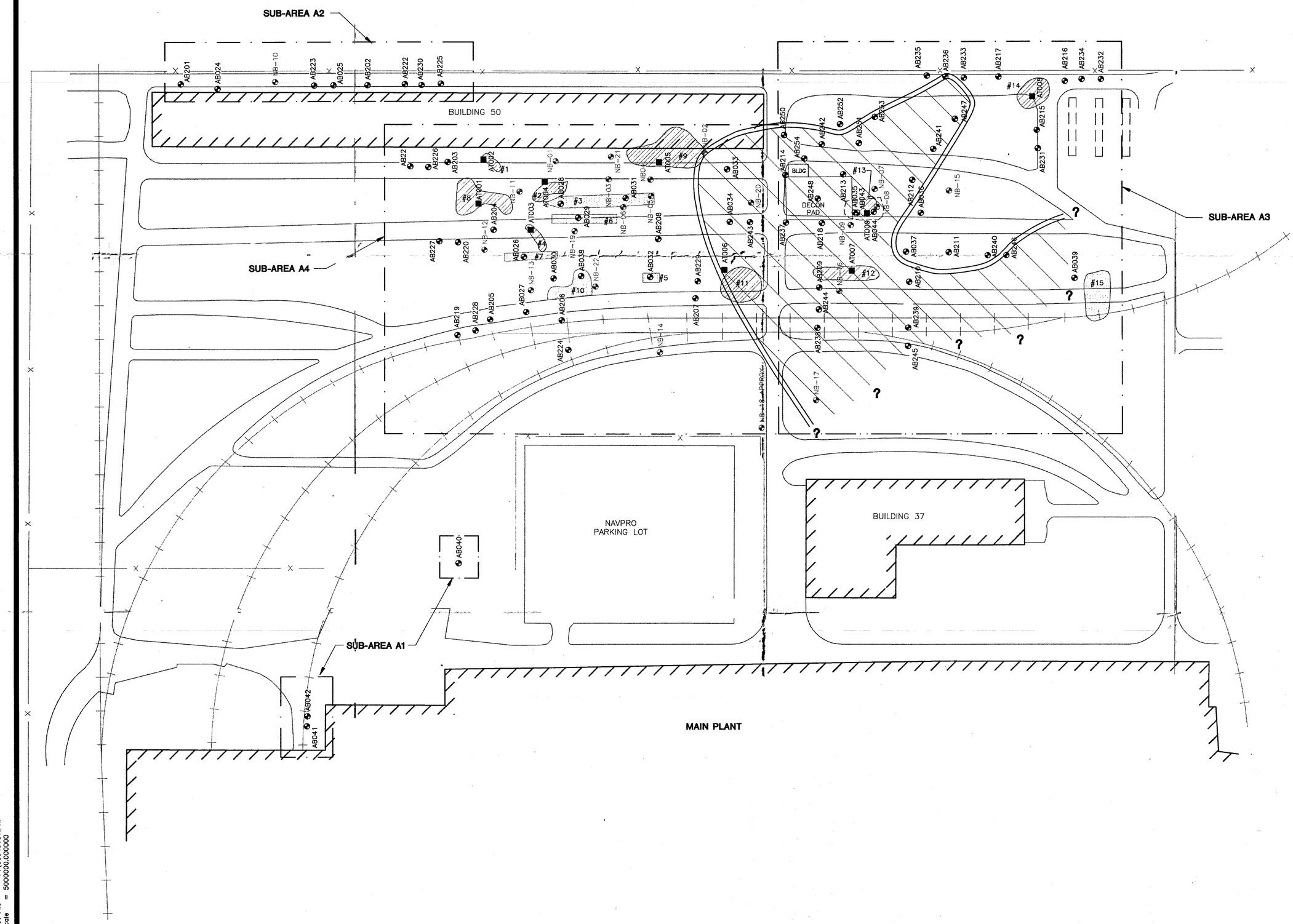
NO.	BY	DATE	REVISION	APP'D.
3.				
2.				
1.				

PROJECT :
REMEDIAL INVESTIGATION
NIROP - FRIDLEY, MINNESOTA

SHEET TITLE :
FACILITY MAP, AREAS OF INVESTIGATION
AND BACKGROUND SOIL BORING LOCATIONS

DRAWN BY: BLG MDD	SCALE : 1"=200'	PROJ . NO . 3094.01
CHECKED BY:		DRWG . NO .
APPROVED BY:	DATE PRINTED :	SHEET FIGURE 1
DATE : AUGUST 1994		

RMT INC
744 Heartland Trail
P.O. Box 8923
Madison, WI 53708
Phone: 608-831-4444



LEGEND

- BUILDING
- PAVED ROAD
- RAILROAD
- FENCELINE
- 2-PC — MONITORING WELL LOCATION & NUMBER
- AT25 — TEST PIT COMPLETED DURING THE RI INVESTIGATION–1992
- AB03 — BORING COMPLETED DURING THE RI INVESTIGATION–1992
- #2 — EXCAVATED CONDUCTIVITY ANOMALIES (SEE NOTE 3 BELOW)
- #5 — UNEXCAVATED CONDUCTIVITY ANOMALIES
- SHALLOW (3'–7') FINE GRAINED SOIL UNIT (ML, CL, SC, SM) (NOT FILL)

NOTES

1. BASE MAP SOURCE: U.S. ARMY CORPS OF ENGINEERS, DRAWING CODE XF 215–30–01, PREPARED BY DYNAMIC INTERNATIONAL INC., ROCKVILLE, MD, AUGUST 1983.
2. SEE FIGURE 3–1 FOR AREA A LOCATION.
3. LOCATIONS OF ALL 20 ANOMALIES ARE INCLUDED IN APPENDIX C.
4. DASHED LINE AROUND AT009 REPRESENTS APPROXIMATE TOTAL EXTENT OF THE REMOVAL AREA.

N

0 50 100
SCALE: 1"=50

NO.	BY	DATE	REVISION	APP'D.
3.				
2.				
1.				

PROJECT: **NIROP**

SHEET TITLE: **AREA A - SHALLOW FINE-GRAINED SOIL UNIT LOCATION MAP**

DRAWN BY: BLG,MDD	SCALE: 1"=50'	PROJ. NO. 3094.01
CHECKED BY:		FILE NO. 30940101
APPROVED BY:	DATE PRINTED:	**FIGURE 2**
DATE: AUGUST 1994		

RMT INC.
744 Heartland Trail
P.O. Box 8923
Madison, WI 53708–8923
Phone: 608–831–4444

Drawing File = H:\3094_01\30940101
Plot File = P:\30940101.PRF
Scale = 5000000.000000

TABLE 1

CONCENTRATION OF TOTAL VOCs ABOVE, THROUGH, AND BELOW THE FINE GRAIN SOIL LAYER

Boring Number	VOC Concentration in Shallow (1' - 5') Soils[a] (ppm)	VOC Concentration in Intermediate (6' - 12') Soils[b] (ppm)	VOC Concentration in Deep (13' - 20') Soils[c] (ppm)
AB 033	3.2	10.4	19.6
AB 034	28.7	25.4	3.9
AB 243	142	63	47
AB 237	38.6	79.3	31.5
AB 214	195	306	63
AB 254	81	65	42.1
AB 248	70	178	63.8
AB 218	97	182	280
AB 238	2.7	2.8	13.4
AB 244	2.2	5.1	45.6
AB 242	127	50.7	26.7
AB 213	51	10	22.6
AB 251	26.6	100	32.6
AB 239	10	5.3	16.2
AB 212	216	142	113
AB 241	75	88	32.4
AB 247	23	21	11.8
AB 210	6.1	21.6	19

a VOC contamination in Shallow (1' - 5') soils - Figure 4-3 of RMT's Remedial Investigation Report for the Soils Operable Unit, NIROP Fridley, Minnesota.

b VOC contamination in Intermediate (6' - 12') soils - Figure 4-4 of RMT's Remedial Investigation Report for the Soils Operable Unit, NIROP Fridley, Minnesota.

c VOC contamination in Deep (13' - 20') soils - Figure 4-4 of RMT's Remedial Investigation Report for the Soils Operable Unit, NIROP Fridley, Minnesota.

organic compounds (SVOCs) were quantified in some surface and intermediate depths, along with isolated metals and constituents above background levels. There were also two smaller areas where low to moderate concentrations of petroleum-based hydrocarbons were identified. Concentrations reported were variable depending upon the depth and type of constituents. VOCs were generally quantified in the range of low parts per billion to high parts per billion. SVOCs had similar variability, while metals and pesticide concentrations remained near levels commonly found in off-site soil samples. The depths of soil contamination varied in the three areas of greatest impact.

In area A-2, which is approximately 0.6 acres in size, the concentrations of VOCs were highest in shallow layers and decreased with depth in the sandy subsurface soil. Pesticides and metals were also detected in higher concentrations in the surface samples. Approximately half of area A-3 (Area A-3 is approximately 4.1 acres) was contaminated with VOCs. The depth varied with location. The mid-depth (6 to 12 feet below ground surface) concentrations were highest, where drums had been disposed in trenches. Otherwise, the highest concentrations were again present in the shallow sampling interval. A-4 (approximately 3.4 acres) had widespread contamination from VOCs. The horizontal distribution of contamination was generally consistent in the three depth ranges. SVOCs were also somewhat distributed over depth, while the metals and pesticides were generally limited to surficial soil with no evidence of vertical migration. More details of these results are available in the RI Report (RMT, 1993).

2.4 Summary of Baseline Risk Assessment

The data used to calculate the baseline risk assessment were taken from the USEPA-approved databases and the maximum on-site parameter concentrations, and therefore are likely to provide an overestimation of the actual hazard and risk. Under current land use scenarios, two exposure pathways were identified. These were: 1) incidental ingestion, dermal adsorption and inhalation of soil particulates, and 2) inhalation of VOCs by workers in subsurface structures such as tunnels and basements, through pore gas migration. The estimated site risk for both pathways was calculated to be less than Minnesota guidelines (1×10^{-5} cancer risk) or the hazard index (HI) level of concern (HI = 1).

For the future land use scenario, the site was divided into two areas on which a home could potentially be built. These two areas included a residence in either sub-areas A2, A3, and A4 (areas of highest impacts), or the areas outside of sub-areas A2, A3, and A4.

Under the future land use scenario, the estimated site risk (associated with carcinogens) for a hypothetical resident in sub-areas A2, A3, and A4 was found to be 4×10^{-3}, which is above the 10^{-5} acceptable risk level. The site risk is primarily associated with the inhalation of soil pore gas, specifically of tetrachloroethylene (PCE) and trichloroethylene (TCE), that could infiltrate through soil into the basement of a home constructed on the site. The risk associated with a home built outside of sub-areas A2, A3, and A4 was calculated at 6×10^{-4}, which is also greater than the acceptable level. TCE and PCE in soil pore gas were the two factors that drove this risk value.

Under the future land use scenario, the hazard (associated with noncarcinogens) to a hypothetical future resident in sub-areas A2, A3, and A4 was found to be 6.0, which is greater than the level of concern of 1.0. The primary contributors to hazard in these sub-areas were ethylbenzene and toluene measured in the soil pore gas and, secondarily, manganese in soil. The estimated hazard for a resident located outside of sub-areas A2, A3, and A4 was 0.4, which is below the level of concern of 1.0.

Section 3
REMEDIAL ACTION OBJECTIVES

On the basis of the nature and extent of soil contamination at the NIROP Fridley, the remedial objectives were established. As stated in Subsection 9.2 of the RI Report for the Soils OU, dated September 1993, these remedial objectives are as follows:

- To minimize/control risks and hazards associated with the migration of volatilized gases through soil pores
- To minimize/control risks and hazards associated with direct contact, ingestion, and inhalation of near-surface soil

An additional objective for this focused AAD is as follows:

- To minimize/control risks and hazards associated with the migration of volatile compounds to the groundwater via leaching

The basic focus of the remedial activities will be to control the potential migration of compounds from the unsaturated soil into the groundwater and to reduce soil pore gas concentrations to levels that would not pose an unacceptable health risk in future land use scenarios. These two objectives require the remedy to be focused upon the reduction of VOC concentrations.

The secondary focus of remedial activities is associated with minimizing or controlling the contact with near surface soil that contains concentrations of SVOCs, pesticides, and metals above background levels. These constituents have not migrated vertically and do not pose a current site risk above acceptable levels. Under a future (residential) land use scenario, SVOCs and metals pose an unacceptable risk or hazard in sub-areas A2, A3, and A4. Modifications to an overall site remedy may be needed to address the control of these constituents. If metals, pesticides, and SVOCs are found to be at unacceptable concentrations as a result of previous disposal activities at NIROP, they will be addressed in the FS.

Section 4
IDENTIFICATION OF ARARs

4.1 Introduction

The assessment of ARARs is an integral part of the remediation process mandated under the Comprehensive Environmental Response, Compensation and Liability Act, and the Superfund Amendments and Reauthorization Act (42 U.S.C. § 9601-9675)(1991). As the preamble of CERCLA states, the purpose of the law is "to provide for liability, compensation, cleanup, and emergency response for hazardous substances released into the environment and the cleanup of inactive hazardous waste disposal sites." In addressing hazardous substances and sites, CERCLA provides that on-site remedial actions must meet the standards and criteria that are otherwise legally applicable to the substance, pollutant, or contaminant or that are relevant and appropriate under the circumstances (42 U.S.C. § 9621[d][2][a]) (1991).

Guidance for assessing and selecting ARARs is provided in the U.S. Environmental Protection Agency's (USEPA's) manual "CERCLA Compliance With Other Laws" (USEPA, 1988) and "CERCLA Compliance With Other Laws Manual: Part II, Clean Air Act and Other Environmental Statutes and State Requirements" (USEPA, 1989). These guidance documents were used to identify potential federal ARARs. Information from the MPCA and the Minnesota Department of Health was also obtained to identify potential state ARARs.

CERCLA remedial actions may trigger several different types of requirements or ARARs. These are organized into three categories: chemical-specific, action-specific, and location-specific. However, these categories are not always mutually exclusive and there may be some overlap. Chemical-specific ARARs are numeric requirements typically based on health- or risk-based values for different chemical substances (USEPA, 1988). Action-specific ARARs are usually technology- or activity-based requirements or limitations (USEPA, 1988). Location-specific ARARs are requirements or limitations based on the physical setting of the site.

In order to be classified as an ARAR, a requirement must be **applicable** or **relevant and appropriate**. As defined in the National Contingency Plan (NCP), **applicable** requirements are "those cleanup standards, standards of control, and other substantive requirements, criteria, or

limitations promulgated under federal environmental or state environmental or facility siting laws that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance found at a CERCLA site" (40 CFR § 300.5)(1991). Relevant and appropriate requirements are "those cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under federal environmental or state environmental or facility siting laws that, while not "applicable" to a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site, address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well suited to the particular site" (40 CFR § 300.5)(1991).

In either case, an applicable or a relevant and appropriate requirement for on-site remedial action must be substantive. Compliance with administrative requirements is not mandated for on-site actions (USEPA, 1988). Administrative requirements are those procedures "that facilitate the implementation of the substantive requirements of a statute or regulation" (USEPA, 1988). For example, CERCLA specifically exempts on-site actions from federal, state, and local permitting requirements (42 USC § 9621[e][1])(1991). Furthermore, only those state requirements that are more stringent than federal requirements are ARAR (40 CFR § 300.5) (1991). "More stringent" would also necessarily include those state laws or programs that have no federal counterpart as "they add to the federal law requirements that are specific to the environmental conditions in the State" (USEPA, 1989). State requirements must be adopted by formal means (i.e., promulgated) and generally acceptable (i.e., not just to Superfund sites, but to all circumstances addressed in the requirement (42 USC § 9621[d][2][C][iii][I]) (1991).

Finally, there is a category of requirements called "To Be Considered" (TBC) guidance that may appear in this section. These are guidelines or advisories that are issued by the federal or state government, but which are neither legally binding nor promulgated (USEPA, 1988). However, these guidelines may be used when they are necessary to ensure protection of public health and the environment **and** when they have not been superseded (USEPA, 1988). If no ARARs address a particular circumstance at a CERCLA site, then TBCs can be used to establish remedial guidelines or targets. Even when TBCs are used, the requirements

imposed on the remedy, including cost-effectiveness, still apply (55 *Fed. Reg.* 8745, March 8, 1990).

This section presents the potential ARARs identified for the Soils OU at the NIROP Fridley facility. Contaminated soils and potential DNAPLs under the buildings at NIROP are separated into Operable Unit 3 (OU3) and are not addressed in this AAD. Chemical-specific, action-specific, and location-specific ARARs are primarily identified for both federal and state interpretation. Potential federal ARARs are discussed first, followed by a discussion of potential state ARARs.

4.2 Federal and State ARARs

Table 2 presents the potential chemical-specific, action-specific, and location-specific ARARs for the Soils OU. To meet ARARs for the Soils OU, presumptive remedies for CERCLA sites with VOCs were considered. Presumptive remedies are preferred technologies for common categories of sites, based on historical patterns of remedy selection and EPA's scientific and engineering evaluation of performance date on technology implementation. The primary objective of the presumptive remedies is to address VOC contaminated soil in order to minimize impacts to groundwater and surface water. To this end, the chemical-specific ARARs include groundwater maximum contaminant levels (MCLs), MCL goals, and surface water quality standards. Surface water quality standards are included for the state of Minnesota because the Mississippi River is used for drinking water purposes and the groundwater from the site discharges to the river. Soil cleanup levels for lead are identified, but likely do not apply because lead is not a contaminant of concern at the site.

Action-specific ARARs are based on the remedial alternatives under consideration. The presumptive remedies for the site include the following:

- Soil vapor extraction (SVE) with treatment of the vapor (i.e., in-place treatment)
- Thermal desorption of soil and replacement in the excavation (i.e., on-site treatment and clean closure)
- Incineration conducted either on- or off-site

TABLE 2

POTENTIAL FEDERAL AND STATE CHEMICAL-, ACTION-, AND LOCATION-SPECIFIC ARARs
NIROP - FRIDLEY, MINNESOTA

Pathway	Requirement	Prerequisite(s)	Citation	Comments
Chemical-Specific ARARs				
Groundwater[5]	Safe Drinking Water Act (SDWA) Maximum Contaminant Levels (MCLs) for 75 compounds, radioactivity, bacteria, and turbidity, which are enforceable for public drinking water systems.	Public water systems defined as piped water serving at least 25 persons.	40 CFR 141.11 through 141.16	Relevant and appropriate under current land use conditions (i.e., the groundwater at the site is not used for drinking purposes). Relevant and appropriate under future land use scenario for groundwater used as drinking water.
	SDWA MCL Goals for 75 compounds, radioactivity, bacteria, and turbidity.		40 CFR 141.50 through 141.51	To be considered. MCL goals are non-enforceable for public drinking water systems.
	Hazardous substance concentrations in the aquifer should not exceed the Minnesota health risk limits (HRLs) for drinking water.	Groundwater concentrations at drinking water wells exceed the HRLs.	Minnesota Groundwater Protection Act, 1989.	Relevant and appropriate under current land use conditions (i.e., the groundwater at the site is not used for drinking purposes). Applicable under future land use scenario for groundwater used as drinking water.
Surface Water	Water quality standards must be achieved to protect humans, aquatic life, or wildlife.	Discharges of groundwater or surface water run-off from the site to water bodies exceed the water quality standards.	Clean Water Acts 303 and 304. Minnesota Rules Ch. 7050, Standards for the Protection of the Quality and Purity of the Waters of the State.	Relevant and appropriate if groundwater or surface water run-off from the site discharges to water bodies and exceeds the water quality standards.
Soil	Surficial soil remediation must achieve cleanup level for lead of less than 100 parts per million (ppm) for the top 2 cm in bare soil.	Bare soil on residential property or playground contains lead and is remediated.	Minnesota Rules pt. 4761.0100 and 4761.0300, Subpart 4	Relevant and appropriate under current land use conditions (i.e., the soil is not used as residential property or a playground) if lead concentrations exceed 100 ppm in surficial soil. Applicable under future land use scenario if lead concentrations exceed 100 ppm in surficial soil.

TABLE 2

POTENTIAL FEDERAL AND STATE CHEMICAL-, ACTION-, AND LOCATION-SPECIFIC ARARs
NIROP - FRIDLEY, MINNESOTA

Pathway	Requirement	Prerequisite(s)	Citation	Comments
Action-Specific ARARs				
SVE with Treatment of Vapor (i.e., in-place treatment)	Air emissions must achieve compliance with air quality standards.	Major stationary source as defined in 40 CFR Section 52.21(b)(1)(i)(a).	National Ambient Air Quality Standards (NAAQS)[1] 40 CFR 52 and 40 CFR 61	Relevant and appropriate for criteria pollutants related to the site. Attainment of NAAQS is only required for "major sources." In general, emissions from CERCLA activities are not expected to qualify as "major sources."[2]
	Engineering control measures must be used to control the release of VOCs and particulates.	Emission of VOCs from a stationary source or group of stationary sources that have the potential to emit 100 tons per year of VOCs or 10 tons per year of any hazardous pollutant. Emission of particulates from thermal desorbers are limited to a 25 lb/yr threshold.	Minnesota Statue Chapter 7007	Applicable for remedial alternatives that release VOCs in excess of the air emission standards.[6]
	Disposal of treatment residuals (e.g., spent carbon) must comply with RCRA land disposal requirements.	Treatment residuals are determined to be a RCRA hazardous waste and are land disposed.	40 CFR 268	Applicable if treatment residuals are hazardous and land disposed.
	Transportation of hazardous waste or treatment residuals off-site must meet the requirements of Minnesota Statues, Sections 221.033, 221.034, and 221.035.	Waste/Treatment Residuals are hazardous as defined in Minnesota Statutes 116.06, Subdivision 13.	Minnesota Regulation Ch. 7045.0371	Applicable if hazardous waste or treatment residuals are transported off-site.[6]
Thermal Desorption of Soil and Replacement in the Excavation (i.e., on-site treatment and clean closure)	Air emissions must achieve compliance with air quality standards.	Major stationary source as defined in 40 CFR Section 52.21(b)(1)(i)(a).	National Ambient Air Quality Standards (NAAQS)[1] 40 CFR 52 and 40 CFR 61	Relevant and appropriate for criteria pollutants related to the site. Attainment of NAAQS is only required for "major sources." In general, emissions from CERCLA activities are not expected to qualify as "major sources."[2]
	Thermal desorption must comply with RCRA removal, storage, and treatment requirements.	Excavated soil is determined to be a RCRA hazardous waste.	40 CFR 264	Applicable if excavated soil is determined to be a RCRA hazardous waste.[3]
	Best management practices (i.e., sediment and erosion controls) for surface water control measures must be used during soil excavation.	Construction activities disturb greater than 5 acres of total land area.	40 CFR 122	Applicable if the total area of soil excavation is greater than 5 acres. Relevant and appropriate if less than 5 acres is disturbed.

TABLE 2

POTENTIAL FEDERAL AND STATE CHEMICAL-, ACTION-, AND LOCATION-SPECIFIC ARARs
NIROP - FRIDLEY, MINNESOTA

Pathway	Requirement	Prerequisite(s)	Citation	Comments
	Engineering control measures must be used to control the release of VOCs and particulates.	Emission of VOCs from a stationary source or group of stationary sources that have the potential to emit 100 tons per year of VOCs or 10 tons per year of any hazardous pollutant. Emission of particulates from thermal desorbers are limited to a 25 lb/yr threshold.	Minnesota Statue Chapter 7007	Applicable for remedial alternatives that release VOCs in excess of the air emission standards.[6]
	Transportation of hazardous waste or treatment residuals off-site must meet the requirements of Minnesota Statues, Sections 221.033, 221.034, and 221.035.	Waste/Treatment Residuals are hazardous as defined in Minnesota Statutes 116.06, Subdivision 13.	Minnesota Regulation Ch. 7045.0371	Applicable if hazardous waste or treatment residuals are transported off-site.[6]
Incineration Conducted Either On- or Off-Site	Air emissions must achieve compliance with air quality standards.	Major stationary source as defined in 40 CFR Section 52.21(b)(1)(i)(a).	National Ambient Air Quality Standards (NAAQS)[1] 40 CFR 52 and 40 CFR 61	Relevant and appropriate for criteria pollutants related to the site. Attainment of NAAQS is only required for "major sources." In general, emissions from CERCLA activities are not expected to qualify as "major sources."[2]
	Incineration must comply with RCRA removal, treatment, transportation requirements (if conducted off-site), and land disposal regulations (if a RCRA hazardous waste).	Excavated soil is determined to be a RCRA hazardous waste.	40 CFR 264.271 and 264.60	Applicable if excavated soil is determined to be a RCRA hazardous waste.[3]
	Incineration must meet RCRA performance standards and monitoring requirements.	Excavated soil is determined to be a RCRA hazardous waste.	40 CFR 264.340 through 40 CFR 264.345	Applicable if excavated soil is determined to be a RCRA hazardous waste.[3]
	Best management practices (i.e., sediment and erosion controls) for surface water control measures must be used during soil excavation.	Construction activities disturb greater than 5 acres of total land area.	40 CFR 122	Applicable if the total area of soil excavation is greater than 5 acres. Relevant and appropriate if less than 5 acres is disturbed.
	Engineering control measures must be used to control the release of VOCs and particulates.	Emission of VOCs from a stationary source or group of stationary sources that have the potential to emit 100 tons per year of VOCs or 10 tons per year of any hazardous pollutant. Emission of particulates from thermal desorbers are limited to a 25 lb/yr threshold.	Minnesota Statue Chapter 7007	Applicable for remedial alternatives that release VOCs in excess of the air emission standards.[6]

TABLE 2

POTENTIAL FEDERAL AND STATE CHEMICAL-, ACTION-, AND LOCATION-SPECIFIC ARARs
NIROP - FRIDLEY, MINNESOTA

Pathway	Requirement	Prerequisite(s)	Citation	Comments
	Transportation of hazardous waste or treatment residuals off-site must meet the requirements of Minnesota Statues, Sections 221.033, 221.034, and 221.035.	Waste/Treatment Residuals are hazardous as defined in Minnesota Statutes 116.06, Subdivision 13.	Minnesota Regulation Ch. 7045.0371	Applicable if hazardous waste or treatment residuals are transported off-site.[6]
Location-Specific ARARs				
Within 100-year floodplain	Facility to be designed, constructed, operated, and maintained to avoid washout during flooding.	Remediation activities that involve treatment, storage, or disposal of RCRA hazardous waste.	40 CFR 264.18(b)	Applicable if the excavated soil is determined to be a RCRA hazardous waste and the material is treated, stored, or disposed within the 100-year floodplain.[4]
Within floodplain	Avoid adverse effects, minimize potential impacts, and preserve natural beneficial value of floodplain.	Action that will occur in a floodplain.	Protection of floodplains, 40 CFR 6, Appendix A	Applicable if a floodplain area exits at or near the site that will be affected by the remediation.[4]
	Storage of potentially hazardous materials and actions that cause pollution of waters are prohibited. The action must also comply with local ordinances.	Action undertaken in floodplain as defined in MS 103F.111, Subd. 4 and 5.	Minnesota Statute 103F.101-.165 and 6120.5000-.6200.	Relevant and appropriate if a floodplain area exists at or near the site that will be affected by the remediation.[4]
Within area affecting national wild, scenic, or recreational river	Avoid taking or assisting in action that will have direct adverse effect on wild, scenic, or recreational river.	Activities that affect or may affect any of the rivers specified in Section 1276(a).	Scenic Rivers Act (16 USC 1271 et seq. Section 7(a); 40 CFR 6.302(e)	Applicable if national wild, scenic, or recreational rivers are located at or near the site that will be affected by the remediation[4].

NOTES:

1 All of the Clean Air Act ARARs that have been established by the Federal Government may be covered by matching state regulations. The State may have the authority to manage these programs through the approval of its implementation plans (40 CFR 52 Subpart G).

2 CERCLA Compliance with Other Laws Manual: Part II. Clean Air Act and Other Environmental Statutes and State Requirements, EPA 540/G-89/009.

3 The classification of the contaminated soil as a solid or hazardous waste is unknown at this time. If the soil is determined to be a RCRA hazardous waste, thermal desorption and incineration treats hazardous waste to BDAT levels; therefore, there is no land disposal restrictions for residuals.

4 Appropriate agencies will be contacted to determine if floodplain areas or national wild, scenic, or recreational river areas exist that could potentially be affected by remediation.

5 The State of Minnesota MCLs for drinking water supply are identical to the federal MCLs and thus are not listed because they are not more stringent. The State incorporated the National Primary Drinking Water Regulations (Code of Federal Regulations, Title 40, Parts 141 and 142.40 to 142.64) into the Rules of the Minnesota Department of Health Governing Public Water Supplies, Parts 4720.0200 to 4720.3970.

6 Minnesota has state statutes for air emission standards and the removal, storage, treatment, and disposal of RCRA hazardous waste that parallel the federal regulations.

These presumptive remedies are listed in Table 2 with their respective action-specific ARARs identified. National Ambient Air Quality Standards (NAAQSs) are relevant and appropriate for air emissions resulting from the CERCLA remedial actions. USEPA guidance (USEPA, 1989) interprets CERCLA activities as non-major sources of air emissions, and the NAAQSs are, therefore, not considered applicable.

Action-specific state ARARs identified beyond the federal regulations included VOC air emission requirements, particulate emission requirements, and off-site transportation of hazardous waste (if appropriate).

One of the unknowns at the NIROP site is the classification of the contaminated soil as a solid or hazardous waste. In-place treatment through SVE would not trigger any of the potential RCRA removal, treatment, storage, transportation, or disposal requirements with the possible exception of the vapor treatment residuals (e.g., spent carbon) if the material was tested and found to be hazardous.

Ex-Situ treatment of the soil through thermal desorption or incineration must comply with RCRA removal, storage, and treatment requirements if the excavated soil is determined to be hazardous. In addition, off-site transportation of the untreated hazardous soil must also comply with appropriate RCRA requirements. Once the soil is treated, RCRA land disposal restrictions for the residuals (e.g., ash) would not apply because thermal desorption and incineration are considered best demonstrated available technologies (BDATs) (USEPA, 1989).

Best management practices for the control of surface water would also be applicable for the excavation of the soil (required under thermal desorption and incineration actions).

The potential location-specific ARARs identified include the protection of flood plains and national wild, scenic, or recreational rivers. In order for the location-specific ARARs to be applicable, the following conditions must be met:

1. Flood plain or recreational river environments exist at or near the site.
2. The remedial action could adversely affect the flood plain or river environment.

Remedial actions that involve the treatment, storage, or disposal of RCRA hazardous waste (e.g., excavated soil determined to be hazardous) and that are conducted within the 100-year flood plain must also be designed and maintained to avoid washout during flooding. Wetlands, endangered species, and national historical features were determined not to be present at the site during the RI, and are, therefore, not listed in Table 2.

4.3 To Be Considered Standards

Table 3 presents the "To Be Considered" standards applicable to OU2 soils. The "To Be Considered" standards are administered on a site-specific basis using information collected during the remedial investigation (RI). Cleanup goals for VOCs will be determined during the feasibility study using the Minnesota Pollution Control Agency's Soil Leaching Model and information presented in the Baseline Risk Assessment (RMT, 1993) for OU2 soils.

TABLE 3

TO BE CONSIDERED SOIL CLEANUP CRITERIA

Requirement	Prerequisite(s)	Citation	Comments
Lead cleanup goals of 400 ppm for Superfund sites. This goal was set for unrestricted land use.	Soil contains lead and is remediated.	Minnesota Department Health Uptake/Biokinetic model for unrestricted land use.	To be considered if lead concentrations exceed the recommended guidance levels.
Soil cleanup objectives for VOCs could consider levels developed using Minnesota's leaching model that attempts to set soil cleanup levels protective of groundwater.	Completed migration pathways exist for soil contaminants.	Minnesota Pollution Control Agency Procedures for Establishing Soil Cleanup Levels, Version 1.	To be considered in establishing soil cleanup levels.

Section 5
DEVELOPMENT OF CLEANUP GOALS

5.1 Introduction

Site-specific cleanup goals are a critical portion of the overall assessment of remedial actions for the NIROP Fridley site. However, since neither federal nor state ARARs exist for soil, the development of cleanup goals will require a thorough assessment of TBC requirements and site-specific conditions. This process should involve cooperation between all parties and will take time to complete. Therefore, these goals will be incorporated into the draft FS for the NIROP Fridley Soils OU. This AAD discusses site-specific and technical factors that should be considered during the goal development process.

5.2 Site-Specific Considerations

5.2.1 Groundwater Quality

The most critical issue at the NIROP Fridley is associated with groundwater protection. The Navy acknowledges that the soils of OU2 may be a source of contamination to the aquifer. The soil RI identified three areas, totaling approximately 4 acres in size with moderate solvent impacts, as having a reasonable potential to impact the groundwater. However, given the relative mass of contaminants already detected in groundwater, this unsaturated soil may not be the only source of chlorinated VOCs to the groundwater. Therefore, extremely stringent soil cleanup criteria may not be effective in protecting groundwater, and could influence the selection of the most cost-effective remedy for the soil.

5.2.2 Soil Conditions

Although soil in the unsaturated zone predominantly consists of poorly and well-graded sands, there are some areas of finer-grained silts and clays. This fine-grained soil does not release constituents to the groundwater in the same manner as the sandy soil. However, in spite of the heterogeneity of the soils, a single numeric cleanup goal will be proposed in the FS for OU2 soils at the NIROP.

5.3 Technical Issues

5.3.1 Leaching Models

The use of leaching models in conjunction with groundwater standards has been considered for the development of soil standards in many areas of the United States. This approach involves predicting the release of contaminants into infiltrating water and the subsequent migration of that water into the underlying groundwater system. The actual contaminant transport phenomenon is complex and includes relative rates of adsorption and desorption; separate phase movement; concentration levels; volatilization considerations, etc.

The proposed Minnesota Leaching Model will be considered in developing cleanup goals at the NIROP Fridley. Since this model is not a specific ARAR, its applicability and appropriateness must be considered carefully in light of both technical and site-specific issues. An evaluation of the Minnesota Leaching Model will be performed during preparation of the FS.

5.3.2 Risk-Based Goals

Another approach to establishing cleanup goals is to apply risk factors associated with concentrations in the soil, and determine the site-specific risks to populations under the exposure scenarios. This approach has also been applied frequently and is utilized in Minnesota for setting cleanup goals for certain exposure pathways. The application of these procedures involves a reverse calculation assuming a safe level of risk, and distribution of that risk over the number of constituents that contribute to the overall condition. The criteria for distribution of the risk would need to be determined when developing goals based upon the risk assessment approach.

5.3.3 Performance-Based Goals

Another alternative approach would be to identify appropriate remedial technologies and then establish performance standards. This process is most applicable for in-place remedies or bioremediation systems that are implemented over longer periods of time. The goals are then specific to the migration potential associated with the site-

specific conditions. The challenge, then, lies in selecting technically appropriate remedies and in optimizing operations to achieve maximum treatment efficiency.

Section 6
DISCUSSION OF PRESUMPTIVE REMEDIES

6.1 General Discussion of Presumptive Remedies

On the basis of site characteristics, and consistent with USEPA direction and guidance, the Presumptive Remedy approach will be used as a basis for identifying remedial options for constituents of concern in Soils OU2. The EPA directive, "Presumptive Remedies: Site Characterization and Technology Selection for CERCLA Sites With Volatile Organic Compounds in Soils," was used as a guide. TCE, PCE, ethylbenzene, and toluene, contaminants found at the NIROP Fridley, are listed as typical VOCs, that can be addressed using the Presumptive Remedy approach.

The Presumptive Remedies (in addition to the no-action alternative) presented and discussed below include SVE, thermal desorption, and incineration. As stated in the directive, one of these Presumptive Remedies is expected to be used for all VOC sites except under unusual circumstances. These circumstances may include the presence of other non-VOC compounds that are not addressed effectively by the Presumptive Remedies, such as metals. The action to address these circumstances may differ from the action for the majority of the contaminated soil on-site. This exceptional soil (contaminated with non-VOCs) will be discussed briefly in this focused AAD, and then will be addressed specifically in the FS.

The following section will describe and provide a discussion of the three Presumptive Remedies listed in the EPA directive referenced above, as well as of the no-action alternative. Discussion of the technologies will be limited to the effectiveness, implementability, and relative cost of the remedies.

6.2 No-Action Alternative

6.2.1 Description

As a basis of comparison against other alternatives, the National Contingency Plan (NCP) (40 CFR pt. 300, 430[e][6]) requires that a "no action" alternative be considered. No active remedial options are included in this alternative. This alternative consists of

no remedial activities in conjunction with periodic monitoring of VOC concentrations in OU2 soils.

6.2.2 Effectiveness

This alternative does not provide an effective means of reaching the remedial action objectives. Some attenuation of contaminants may occur due to migration (leaching) or natural biodegradation, for example, but no means of measuring the effectiveness of these processes exist for this alternative.

6.2.3 Implementability

This alternative, as described above, is currently being implemented at the site.

6.2.4 Relative Cost

This is a no-cost alternative when only short-term costs are considered. Long-term liability costs are difficult to estimate.

6.3 Soil Vapor Extraction

6.3.1 Description

This technology is known in the industry by various names, including SVE, vacuum extraction, soil venting, *in-situ* volatilization, and enhanced volatilization. In this report, the term SVE will be applied.

SVE is the process by which volatile compounds are removed from soil (*in-situ*, typically) through the use of drawn air currents. Volatile organic compounds are removed by mechanically drawing or venting air through the soil matrix. Air flow is produced by applying a vacuum in the unsaturated zone, typically through a series of screened or slotted pipes installed vertically or horizontally. A vacuum is developed by a mechanical device such as a vacuum pump or blower.

In the unsaturated zone, contaminant-free air displaces contaminated soil vapor, and the decreased pressure in the soil matrix causes free-phase and dissolved-phase VOCs to evaporate. These contaminant vapors flow through manifold piping to the

vacuum pump and are either exhausted to the atmosphere or are recovered via off-gas treatment, such as granular activated carbon, thermal oxidation, or an air biofilter system.

Air samples are collected periodically from the exhaust side of the vacuum pump, and are analyzed to provide data that are used to assess system efficiency. Main system components for a SVE system include the following:

- A vacuum pump or blower
- Vapor extraction wells or points, manifolded to the vacuum pump
- An off-gas treatment system (if necessary), such as a granular activated carbon, thermal oxidation, or air biofilter system
- Control panel and miscellaneous air flow meters, pressure gauges, control valves, and sampling ports to facilitate air flow and assess system efficiency
- Clean air injection wells placed in the vicinity of the SVE wells (optional, depending upon site conditions)

6.3.2 Effectiveness

The effectiveness of SVE technology depends partially on the physical properties of the contaminant compounds, the physical components of the soil, and the characteristics of the system.

Generally, compounds with higher vapor pressure and lower solubility in water are more efficiently removed or stripped via SVE. Henry's Law constant, which is a measure of the equilibrium distribution between air and dilute solutions, is typically used as an indicator of strippability, also. Compounds with a Henry's Law constant greater than .001 atm. m^3/mole are considered to be easily stripped, while a Henry's Law constant of less than .0001 atm. m^3/mole indicates that it would be very difficult to strip the compound. TCE has a Henry's Law constant of .00918, indicating that it is very strippable. In fact, all VOCs of potential concern for gas phase migration at this site have Henry's Law constants above .001.

Soil factors that impact the effectiveness of SVE include water content, porosity, permeability, and grain size.

Porosity and permeability are particularly important factors in establishing the effectiveness of a SVE system. These properties are used to estimate air flow and pressure drop in the soil matrix. They are used along with field test data to proceed with the system design process. Soil grain size, directly related to soil permeability, is also an important factor. Increased fine-grained (clay) content decreases the soil's permeability, and therefore inhibits volatilization. SVE has been successful for remediation in an unsaturated zone containing highly permeable sandy soil with little or no clay. In soil with low porosity, additional time is needed to establish the pressure gradient required to enhance volatilization.

Water content influences the rate of volatilization by affecting the rates at which chemicals can diffuse through the unsaturated zone. An increase in the soil's water content will decrease the rate at which volatile compounds are transported out of the soil via vapor diffusion.

Soil conditions at NIROP Fridley are generally suitable for SVE technology. Soil in the areas of interest is classified as poorly to well graded sand with a low organic content. The fine grain soil layer is not expected to effect the performance of SVE. The relatively permeable soils at NIROP will allow for the passage of air to provide controlled treatment pathways. Low organic content ensures minimal adsorption of VOCs to the soil, in turn making it less difficult to remove the contamination via stripping. The SVOCs may be reduced in concentration by a combination of volatilization and biodegradation enhanced by the availability of oxygen in the air stream induced by SVE. Metals will not be treated effectively by this technology.

The depth of the contamination can also impact the effectiveness of this technology, depending on the site's surface conditions. Extremely shallow contamination (1 to 5 feet below grade) may require covering or capping the area with a liner or pavement to prevent vertical short circuiting of air at the surface.

Removal performance for VOCs under ideal conditions can be as high as 99 percent, but is typically in the range of 85 to 99 percent.

6.3.3 Implementability

Much of the information necessary for successful implementation of a SVE system is obtained from field test data. Design considerations such as vapor extraction well spacing and depth, mechanical equipment selection and sizing, and control system requirements and off-gas treatment requirements are among the major parameters affecting implementation.

SVE systems may require off-gas treatment, such as a granular activated carbon, thermal oxidation, or biofilter system. Systems that do not require treatment of the off-gas waste stream produce little or no by-products or wastes requiring disposal, with the exception of the liquid collected in condensation or air/water separation tanks. Disposal options may be required if granular activated carbon is used for treatment. Spent carbon would need to be regenerated or disposed in an approved landfill.

Permits from government and regulatory agencies, such as building and land use permits or air emissions permits, may be required.

Some shallow soil contamination exists at this site. Because current surface conditions are mainly gravel areas crossed with unpaved roads and railroad spurs, with few structures, the site may require localized covering, as with an impermeable liner or with pavement, to enhance system effectiveness.

Minimal disruption to NIROP operations associated with SVE system installation and operation is expected. Vacuum piping would be connected to SVE wells below the surface, and these lines would be installed in shallow trenches (3 to 4 feet deep), running back to a permanent system building.

SVE will require more time to achieve remedial action objectives than the other Presumptive Remedies presented. It is anticipated that the system would require 2 to

3 years or more to reach the objectives. The other *ex-situ* technologies could conceivably be completed in a single construction season.

A SVE system is currently installed at the site in Area D, northeast of the main plant building. This system, installed as part of RCRA closure activities, has operated successfully in similar soil conditions at similar depths and on similar constituents as with these areas of interest.

6.3.4 Relative Cost

The unit cost for SVE is relatively low as compared to the other Presumptive Remedies. Remediation unit costs would range from $10 to $150 per ton of contaminated soil (USEPA, 1993b).

6.4 Thermal Desorption

6.4.1 Description

Thermal desorption is an *ex-situ* process that uses either direct or indirect heat exchange to vaporize organic contaminants from soil. Air, combustion gas, or inert gas is used as the transfer medium for the vaporized components. Thermal desorption should not be confused with incineration, since volatilization, not the decomposition of organic contaminants, is the desired result, although some decomposition may occur during the process.

Thermal desorption systems are physical separation systems (as are SVE systems) and will typically be used in conjunction with follow-on treatment technologies to address vapors in the off-gas waste stream.

The soil is excavated and stockpiled, and fed into the desorption unit where it is heated to a target temperature in the range of 200°F to 1,000°F. The VOC contaminants are vaporized and transferred to the off-gas waste stream. The vapors in the waste stream are then treated directly or condensed before treatment. Vapor or liquid treatment options would include granular activated carbon and thermal oxidation. The treated soil can be used as backfill following confirmation analysis.

The following types of thermal desorption units exist:

1. The rotary dryer or rotary drum type unit uses a rotating drum that is either heated indirectly or into which hot gases are directed with a blower. The ability to rapidly exchange heat allows relatively high processing rates in the range of 5 to 55 tons per hour.

2. The thermal screw unit uses hollow augers to transport soil through an enclosed, heated trough. Hot oil or steam is circulated through the augers to indirectly heat the soil. These units are relatively simple to operate and generally generate a reduced amount of fines and dust. Processing rates are relatively low to medium and range from 3 to 13 tons per hour.

3. Vapor extraction systems mix hot gases directly with the soil to volatilize the contaminants. Hot gases are injected into the unit through a series of gas jets at a rate sufficient to fluidize the feed material soil. Processing rates are medium to relatively high and range from 10 to 73 tons per hour.

4. Distillation chambers are a series of cylindrical chambers (typically 3 to 5) that are heated externally to successively increasing temperatures. This allows the vaporization, condensation, and recovery of specific contaminants from each temperature range. Augers convey the soil through each chamber, and a nitrogen sweep gas is used to transport the volatilized contaminants. The processing rate for this type of unit ranges from 1 to 17 tons per hour.

6.4.2 Effectiveness

The primary technical factors affecting thermal desorption performance are contaminant characteristics; properties of the soil, including moisture and organic content; the total residence time; and the maximum desorber bed temperature achieved.

Soil composition may also have an impact on the cost effectiveness of thermal desorption from a material preparation perspective. Consolidated material larger than approximately 1.5 inches on any edge may restrict the passages in some units, and can also result in uneven heating of the material. Processing rates may be decreased as a result, and the larger rejected objects may require additional handling and treatment.

Successful treatability tests have demonstrated the effectiveness of this technology for the removal of VOCs, SVOCs, PCBs, pesticides, and volatile metals. Inorganic

constituents or nonvolatile metals, however, will probably not be removed effectively by this technology, and will remain as a process residual. Removal performance for VOCs ranges from 95 to 99 percent. Efficiencies for other treated constituents can be considerably less. This technology appears to be effective for the treatment of the majority of contaminated soil at the NIROP Fridley. Both the major contaminants at the site and many of the minor contaminants can be effectively treated using thermal desorption.

6.4.3 Implementability

The results of treatability studies should be combined with other data such as contaminant and soil characteristics to determine the overall implementability of thermal desorption to the site. Thermal desorption may only be applicable to some areas of a site. Separate characterizations should be done on distinctly different areas in order that they can be addressed properly in a treatability study.

Thermal desorption can be accomplished on-site using trailer-mounted mobile units, or by transporting the soil off-site to a fixed facility. Mobile units are commercially widely available, and are typically more cost effective when compared with a fixed facility due to vendor competition and spared soil transportation costs.

Excavation is required with this technology. At the NIROP Fridley, the total quantity of soil requiring treatment and the potential disruption of normal plant operations may limit the use of this technology to selected areas. In addition, excavation can trigger consideration of hazardous waste requirements since some on-site soil may be considered hazardous waste by either listing or characteristic classification.

All thermal desorption systems require treatment of off-gas and residuals. Off-gas will require particulate (dust) removal as well as a removal system for the vaporized organic contaminants. Particulate removal can be accomplished by conventional equipment, such as cyclone dust collectors, wet scrubbers, or fabric filters. These collected particulates can be reprocessed in the thermal desorption unit. Vaporized organic contaminants can be condensed and passed through granular activated

carbon, or may be destroyed by the use of an off-gas combustion chamber or thermal oxidation unit.

Air emission permits may be required for the operation of a thermal desorption unit. Chemical-specific thermal treatment permits from the EPA or the MPCA (e.g., for PCBs or chlorinated compounds) may also be required. This technology is used routinely in Minnesota for the removal of petroleum hydrocarbon–contaminated soils, but permit problems may be encountered when the technology is applied to chlorinated VOCs.

6.4.4 Relative Cost

The costs of remediation for thermal desorption fall between the other two Presumptive Remedies. Unit costs for thermal desorption range from approximately $200 to $300 per ton (USEPA, 1993b).

6.5 Incineration

6.5.1 Description

Decomposition of contaminants is the desired result in the use of incineration. An *ex-situ* technology, incineration is used for the destruction of several forms of waste utilizing temperatures ranging from 800°F to 4,500°F, depending on the type of incinerator and contaminant. Several types of incineration technologies exist to address these wastes. In this report, the discussion will focus on the two types of incineration technologies that are typically best suited and commercially available for addressing contaminated soil. These two types are rotary kiln technology and fluidized bed technology.

Rotary kiln incinerators are generally lined cylindrical shells (oxidation chambers) mounted at an incline and rotated to facilitate gravity feeding of the soil material. A burner located either at the front or at the rear of the oxidation chamber provides heat, and combustion air is fed through dedicated ducts or from a supplemental fuel burner. Residence time and mixing with combustion air is controlled by the speed of rotation.

Operating temperatures typically range from 1,450°F to 2,900°F. Ash is withdrawn from the rear of the oxidation chamber, and off-gas is typically drawn through a scrubbing system prior to discharge.

Fluidized bed technology uses inert granular material, such as sand, for heat transfer and waste agitation. A typical fluidized bed utilizes a lined vessel in which the inert material is kept in turbulent motion by fluidizing air at a temperature ranging from 800°F to 1,500°F. Bed temperatures are limited by the softening point of the inert material, which is approximately 1,600°F for sand. Contaminated soil and auxiliary fuel are injected radially in proportionally small amounts and are mixed to facilitate heat transfer to the soil material. The material combusts and returns energy to the bed. Residual ash is removed from the base of the bed, and fine particulate is collected via a cyclone and/or a filter in the flue gas treatment unit.

6.5.2 Effectiveness

Incineration is a proven technology for the destruction and disposal of any form of hazardous waste material which is at all combustible. Unlikely candidates for successful destruction include noncombustibles such as heavy metals, high moisture content wastes, and the general group of materials having a high inorganic content. Incineration is capable of VOC removal/destruction performance of greater than 99 percent, and destruction of other organic compounds is also highly efficient. The only constituents that would remain to be managed are the metallic residuals in the ash.

6.5.3 Implementability

Ensuring sufficient air (oxygen) and air flow for proper combustion of target contaminants and heat of combustion are major design considerations of the incinerator.

Incinerators are commercially available as mobile units for on-site use or at fixed facilities for off-site treatment. The decision to utilize mobile or fixed units should be based on factors such as cost, availability of utilities (electricity and water), and

permitting requirements. Fixed units will require obtaining permits, which is a lengthy and costly process for the owner. The permitting process for a mobile unit may be less severe, depending on state and local requirements.

Excavation is required with this technology. At the NIROP Fridley, the total quantity of soil requiring treatment and the potential disruption of normal plant operations may limit the use, if at all, at selected areas. In addition, excavation can trigger consideration of hazardous waste requirements, since some on-site soil may be considered hazardous waste by either listing or characteristic classifications.

Disposal of residuals, if not considered a hazardous waste, can be done on-site, by using it as backfill material. It must otherwise be disposed in an approved landfill. Air pollution control equipment may also generate wastes, such as sludge and/or scrubber wastewater, which must be addressed.

It is anticipated that, if incineration is selected for use at this site, it would be utilized for only a limited quantity of soil requiring special considerations. For this reason, an off-site, fixed incineration facility would be used.

Due to possible concern over the production of dioxins from the thermal treatment of chlorinated compounds, the MPCA may not approve this technology at this site because chlorinated VOCs are the dominant constituents being treated.

6.5.4 Relative Cost

Incineration costs are high relative to other Presumptive Remedies. Costs for remediation range from $200 to $1,700 per ton (USEPA, 1993b).

6.6 Summary

Following consideration of the three Presumptive Remedies in terms of effectiveness, implementability, and cost, it is evident that no single alternative will address all constituents of concern—VOCs, SVOCs, and metals—effectively at this site.

Implementation of SVE would be the least difficult and least costly of the three Presumptive Remedies, but is most effective for treatment of VOCs. Effectiveness for SVOCs is lower and metals are not treated by this technology.

Thermal desorption would require excavation prior to treatment and may have significant permitting concerns in Minnesota regarding thermal treatment of chlorinated VOCs. Costs for this alternative would fall in between SVE and incineration, but while it would be effective for treatment of VOCs and SVOCs, metals would not be addressed.

Incineration would have essentially the same implementability concerns as thermal desorption, but it is the most costly of the three Presumptive Remedies. It would be effective for treatment of VOCs and SVOCs, but metals would remain as residual in the ash.

As stated in Section 3, focused modifications to an overall site remedy may be needed to address control of all constituents of concern in a cost-effective manner. These modifications may include: further evaluation of the risk management associated with non-VOC constituents; or perhaps the integration of multiple remedial alternatives, including removal or institutional controls. Discussion of these modifications will be included in the FS.

Section 7

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