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NIROP FRIDLEY
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Focused Feasibility Study
for
Operable Units 2 and 3

Naval Industrial Reserve Ordnance Plant
Fridley, Minnesota

Southern Division
Naval Facilities Engineering Command
Contract Number N62467-94-D-0888
Contract Task Order 0003

June 2000

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Project Number 6966

Commander
Department of the Navy
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Reference: CLEAN Contract Number N62467-94-D-0888
Contract Task Order 0057

Subject: Naval Industrial Reserve Ordnance Plant, Fridley, Minnesota
Feasibility Study

Dear Mr. Sanders:

Please find enclosed one copy of the recently revised Feasibility Study Report for Operable Units 2 and 3 for NIROP Fridley. While an FS for OU2 and OU3 was previously distributed, the Partnering Team has revised plans, resulting in the February 2000 FS being obsolete. Now, soil only is addressed in the FS and groundwater contamination identified during the investigation is being addressed as an Explanation of Significant Difference (ESD) to the existing OU1 ROD.

If you have any questions, feel free to call me at (412) 921-8216.

Sincerely,

Mark Sladic, P.E.
Task Order Manager

MS/kf

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060009/P

FOCUSED FEASIBILITY STUDY
FOR
OPERABLE UNITS 2 AND 3

NAVAL INDUSTRIAL RESERVE ORDNANCE PLANT
FRIDLEY, MINNESOTA

COMPREHENSIVE LONG-TERM
ENVIRONMENTAL ACTION NAVY (CLEAN) CONTRACT

Submitted to:
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North Charleston, South Carolina 29406

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JUNE 2000

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LIST OF ACRONYMS AND ABBREVIATIONS

AOC	area of concern
ARAR	Applicable or Relevant and Appropriate Requirement
AS/SVE	air sparging/soil vapor extraction
bgs	below ground surface
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
cfs	cubic foot/feet per second
CLEAN	Comprehensive long-term Environmental Action Navy
COC	chemical of concern
COPC	chemical of potential concern
CSF	Cancer Slope Factor (USEPA)
CTO	Contract Task Order
CWA	Clean Water Act
DCA	dichloroethane
DCE	dichloroethene
DNAPL	dense non-aqueous phase liquid
DPT	direct-push technology
FFA	Federal Facilities Agreement
FIG	Franconia/Ironton/Galesville aquifer
FS	Feasibility Study
ft	foot/feet
ft^2	square foot/feet
GAC	granular activated carbon
GOCO	government-owned contractor-operated
gpm	gallons per minute
HI	hazard index
HQ	hazard quotient
HRL	Health Risk Limit (MPCA)
HRV	Health Risk Value (MPCA)
IAS	Initial Assessment Study
MCES	Metropolitan Council Environmental Service
MCL	Maximum Contaminant Level (USEPA)
mg/kg	milligram per kilogram
mg/L	milligram per liter
µg/kg	microgram per kilogram

µg/L	microgram per liter
MHF	Mount Simon/Hinckley/Fond du Lac aquifer
MPCA	Minnesota Pollution Control Agency
msl	mean sea level
NACIP	Navy Assessment and Control of Installation Pollutants
NAVFACENGCOM	Naval Facilities Engineering Command
Navy	Department of the Navy
NCP	National Contingency Plan
NEESA	Navy Energy and Environmental Support Activity
NIROP Fridley	Naval Industrial Reserve Ordnance Plant, Fridley, Minnesota
NOD	Northern Ordnance Division
NPDES	National Pollutant Discharge Elimination System
NPL	National Priority List
O&M	operation and maintenance
ORP	oxidation/reduction potential
OSHA	Occupational Safety and Health Act
OU	operable unit
PAH	polynuclear aromatic hydrocarbon
PCBs	polychlorinated biphenyls
PCE	tetrachloroethene
PCJ	Prairie du Chien/Jordan aquifer
PPE	personal protection equipment
PRAP	Proposed Remedial Action Plan
PVC	polyvinyl chloride
RAB	Restoration Advisory Board
RAGS	Risk Assessment Guidance for Superfund
RCRA	Resource Conservation and Recovery Act
RD/RA	Remedial Design/Remedial Action
RfD	Reference Dose (USEPA)
RI	Remedial Investigation
ROD	Record of Decision
SARA	Superfund Amendment and Reauthorization Act
SDWA	Safe Drinking Water Act
SDS	State Disposal System
SMCL	Secondary Maximum Contaminant Level (U.S. EPA)
SOUTHDIV	Southern Division (U.S. Navy)
SPECAP	specific capacity (test)
STP	sewage treatment plant

SVOC	semivolatile organic compound
TAL	Target Analyte List
TBC	to be considered (criterion)
TCA	trichloroethane
TCE	trichloroethene
TCL	Target Compound List
TCLP	Toxicity Characteristic Leaching Procedure
TOC	total organic carbon
TtNUS	Tetra Tech NUS, Inc.
USACE	U.S. Army Corps of Engineers
USEPA	United States Environmental Protection Agency
UDLP	United Defense Limited Partnership
USGS	U.S. Geological Survey
UV	ultraviolet
VLS	vertical launching system
VOC	volatile organic compound

EXECUTIVE SUMMARY

INTRODUCTION

This document presents the Focused Feasibility Study (FS) Report for Operable Units (OUs) 2 and 3, Naval Industrial Reserve Ordnance Plant, Fridley, Minnesota (NIROP Fridley). The report has been prepared by Tetra Tech NUS, Inc., (TtNUS) for the Southern Division (SOUTHDIV) Naval Facilities Engineering Command (NAVFAC) under the Navy Comprehensive Long-Term Environmental Action Navy (CLEAN) Program, Contract Number N62467-94-D-0888, Contract Task Order (CTO) 0003.

SCOPE

The Focused FS addresses OU2 and OU3, which consist of all soil at NIROP Fridley. The groundwater at the facility, categorized as OU1, was addressed separately under the OU1 ROD in 1990 and the associated Explanation of Significant Differences and Minor Changes (TtNUS, 2000).

This Focused FS is slightly different than a typical FS because no active treatment alternatives are required for the continued non-residential use of OU2 and OU3 soil. Based on the Remedial Investigation (RI) results, there are no contaminants of concern (COCs) in the surface soil and only one COC, chromium, in the subsurface soil (TtNUS, 1999). Because the classification of chromium as a COC was based on a single detection, chromium does not constitute a significant contamination problem in the soil at NIROP Fridley. Consequently, an active treatment technology is not warranted. However, institutional controls focused on restricting access and future property use may be required. While the RI was adequate for determining if large-scale contamination sources are present, plant closure activities are continuing around the facility and could result in the discovery of spatially localized minor sources of contamination. Institutional controls will protect potential future receptors from these contaminated areas. Based on this information and prior consent of the Minnesota Pollution Control Agency (MPCA) and U.S. Environmental Protection Agency (USEPA), the Focused FS will develop and evaluate only two alternatives, no action and institutional controls, as opposed to a typical FS that would evaluate multiple treatment alternatives.

FACILITY DESCRIPTION

NIROP Fridley is located on the southernmost tip of Anoka County, Minnesota. The plant is situated approximately 1/4 mile east of the Mississippi River and less than one mile south of Interstate 694. The plant is currently active and consists of 80.35 acres of government-owned land; approximately 50 acres are paved or covered with buildings. The plant is bordered on the east by the Burlington Northern rail

yard, on the north by various industrial facilities, on the south by United Defense Limited Partnership (UDLP) property, and on the west by East River Road. The 46-acre area adjacent to the southern border of the site is owned by UDLP, the NIROP [government-owned, contractor-operated (GOCO)] operator, and is designated USEPA Superfund Site Number 17 on Update 6 of the National Priority List (NPL). The area within a 3-mile radius of NIROP Fridley includes parts of Minneapolis/St. Paul, New Brighton, St. Anthony, and most of Fridley and Brooklyn Center.

PLANT CLOSURE ACTIVITIES

Although the RI results indicate that active treatment of soil is not required, the human health risk assessments were based on current industrial land use scenarios at NIROP Fridley. Plant closure activities, which may involve machinery, equipment, and concrete removal, are conducted on a continual basis at NIROP Fridley. There is a potential for these on-going activities to uncover spatially localized, minor areas of contamination that were not explicitly identified in the risk assessments. The Navy is expected to sell the plant to a private owner, which may accelerate closure-type activities. This Focused FS will evaluate institutional controls as a means for ensuring protection against unforeseen contamination.

EVALUATION OF HUMAN HEALTH RISKS

OU2 Soil

According to the Supplemental RI (TtNUS, 1999), all OU2 soil risks were within acceptable limits with the exception of two: a hazard quotient (HQ) for trichloroethene (TCE) of 0.64 and a hazard quotient for arsenic of 0.203. Both hazard quotients were generated under the major-infrequent construction worker scenario and exceeded the MPCA acceptable level of 0.2. However, after evaluation, TCE and arsenic were not retained as COCs.

TCE was only detected in 11 of 38 soil samples. The maximum detection of 48.1 mg/kg was used in the calculation of the hazard quotient. The second highest detected concentration of TCE was 0.044 mg/kg, which is one thousand times lower than the maximum detection. Using 0.044 mg/kg to generate the hazard quotient results in a value of 0.001, which is also extremely low. As a result, it does not appear as though TCE is a primary concern at the site. The hazard quotient for arsenic, 0.203, only slightly exceeds the acceptable level of 0.2. As a result, arsenic also is not a primary concern at the site.

OU3 Soil

The human health risk assessment indicated that all risks for OU3 soil were within acceptable limits, with the exception of a cumulative hazard index (HI) equivalent to 2.9. The hazard index of 2.9 exceeded the USEPA and MPCA acceptable level of 1.0 and was driven by arsenic, chromium, copper, and mercury. Individual hazard quotients for arsenic (HQ = 0.3), hexavalent chromium (HQ = 1.35), copper (HQ = 0.23), and mercury (HQ = 0.46) also exceeded the MPCA acceptable level of 0.2. The highest concentrations of the four inorganics exceeded the mean, and each inorganic was detected in a different plant area. However, after evaluation, only chromium in the former East Plating Shop was retained as a COC.

Lead was not considered as a COC since it only slightly exceeded its state reference value (SRV) in one sample and was detected at low concentrations in the remaining samples. Arsenic was not considered a COC since the HQ only slightly exceeded the MPCA acceptable level of 0.2, was less than the USEPA acceptable level of 1.0, and was detected at low concentrations across the site. Copper was not considered a COC since the HQ only slightly exceeded the MPCA acceptable level of 0.2, was less than the USEPA acceptable level of 1.0, and was detected at low concentrations across the site. Mercury was not considered a COC since the HQ was less than the USEPA acceptable level of 1.0 and was infrequently detected at low concentrations across the site.

Although chromium was retained as a COC, the Focused FS will not address this chemical with active treatment alternatives because the maximum detected concentration did not exceed the remediation level.

REMEDIAL ACTION OBJECTIVES

The following remedial action objective was developed for the Focused FS:

Protect human health and the environment against unforeseen soil contamination that may be uncovered during plant closure activities.

REMEDIAL ACTION ALTERNATIVES

Two remedial action alternatives were developed to address OU2 and OU3 soil:

- Alternative 1 – No Action
- Alternative 2 – Institutional Controls

The following paragraphs briefly describe these alternatives.

Alternative 1 – No Action

The no action alternative is required under CERCLA regulations to provide a baseline for comparison to other response actions. The no action alternative involves taking no remedial actions to address the contaminated media. This includes no active treatment, institutional controls, or monitoring programs.

Alternative 2 – Institutional Controls

Alternative 2 incorporates deed restrictions, an access guarantee, and a sump and drywell investigation as institutional controls.

The deed restrictions will prohibit future residential development of the NIROP Fridley facility. Residential development would involve concrete removal and other invasive construction activities that could potentially expose spatially localized, minor areas of contamination. In addition, the USEPA has expressed concern about potential vapor infiltration into basements of residential housing units, if constructed. In addition to prohibiting residential development, the restrictions will prohibit the installation of wells in the Quaternary aquifer zone and the potable and non-potable use of groundwater from the Quaternary aquifer zone. Although the Focused FS addresses soil contamination, these groundwater restrictions were included in the event that contaminants leach from the soil and affect groundwater quality. The deed restrictions will be implemented in writing via land deeds for the facility. Periodic site inspections will be conducted to ensure that the deed restrictions are implemented over time.

The access guarantee involves a modification to the deed that will guarantee the Navy access to the land for environmental investigation, remediation, or other corrective action. This guarantee will become effective once the Navy has transferred ownership of the property. In the event that additional contamination is discovered, the Navy will be guaranteed the right to conduct the necessary investigation and remediation, thereby reducing the potential for contaminant exposure.

The sump and drywell investigation will consist of a visual inspection of key sumps and drywells within the main plant building. (Drywells are holes in the ground where wastes were discharged.) The investigation will be focused in areas where specific contamination is present at greater than average concentrations. If the sumps and drywells contain visual signs of contamination, the Navy will conduct the appropriate remediation. This remediation may involve the removal of contaminated material or the repair, sealing, or removal of the sump or drywell.

1.0 INTRODUCTION

This Focused Feasibility Study (FS) Report for Operable Units (OUs) 2 and 3, Naval Industrial Reserve Ordnance Plant Fridley, Minnesota (NIROP Fridley), has been prepared by Tetra Tech NUS, Inc. (TtNUS) for the Southern Division (SOUTHDIV) Naval Facilities Engineering Command (NAVFAC) under the Navy Comprehensive Long-Term Environmental Action Navy (CLEAN) Program, Contract Number N62467-94-D-0888, Contract Task Order (CTO) 0003. Activities associated with the Focused FS have been conducted in accordance with the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) [40 Code of Federal Regulations (CFR) 300.430]. The NCP guidelines, which dictate the FS process, were promulgated under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), commonly referred to as Superfund, and amended by the Superfund Amendments and Reauthorization Act (SARA). NIROP Fridley was placed on the Superfund National Priorities List (NPL) on November 21, 1989. In March 1991, a Federal Facilities Agreement (FFA) was established among the Department of the Navy (Navy), the US Environmental Protection Agency (USEPA), and the Minnesota Pollution Control Agency (MPCA).

The primary purpose of the FS report is to establish remediation levels and remedial action objectives; screen remediation technologies; assemble, evaluate, and compare remedial action alternatives; and propose a final remedial action plan. The USEPA document entitled Conducting Remedial Investigations and Feasibility Studies Under CERCLA (USEPA, 1988) provided guidance during the preparation of this report.

1.1 SCOPE AND ORGANIZATION OF REPORT

1.1.1 Scope

The Focused FS addresses OU2 and OU3, which consist of all soil at NIROP Fridley. The groundwater at the facility, categorized as OU1, was addressed separately under the OU1 ROD in 1990 and the associated Explanation of Significant Differences and Minor Changes (TtNUS, 2000).

This Focused FS is slightly different than a typical FS because no active treatment alternatives are required for the continued non-residential use of OU2 and OU3 soil. Based on the RI results, there are no contaminants of concern (COCs) in the surface soil and only one COC, chromium, in the subsurface soil (TtNUS, 1999). Because the classification of chromium as a COC was based on a single detection, chromium does not constitute a significant contamination problem in the soil at NIROP Fridley. Consequently, an active treatment technology is not warranted. However, institutional controls focused on restricting access and future property use may be required. While the RI was adequate for determining if

large-scale contamination sources are present, plant closure activities are continuing around the facility and could result in the discovery of spatially localized minor sources of contamination. Institutional controls will protect potential receptors from these contamination sources. Based on this information and prior consent of the MPCA and USEPA, the Focused FS will develop and evaluate only two alternatives, no action and institutional controls, as opposed to a typical FS that would evaluate multiple treatment alternatives.

1.1.2 Organization

The Focused FS is organized into five sections. Section 1.0 is an introduction, which presents the scope and organization of the report, the site background, and the results of the OU3 RI. Section 2.0 presents the remediation levels, remedial action objectives, and general response actions. Section 2.0 also presents the applicable and relevant or appropriate requirements (ARARs). Section 3.0 contains the screening of remediation technologies and process options. Section 4.0 presents the assembly of remedial action alternatives, and Section 5.0 presents the detailed analysis of alternatives.

1.2 SITE BACKGROUND

The subsections that follow present background information pertinent to NIROP Fridley. This information includes a facility description, a facility history, a summary of previous environmental investigations, and a description of the sanitary sewer system.

1.2.1 Facility Description

NIROP Fridley is located on the southernmost tip of Anoka County, Minnesota. The plant is situated approximately ¼ mile east of the Mississippi River and less than 1 mile south of Interstate 694 (Figure 1-1).

The site is currently active and consists of 80.35 acres of government-owned land; approximately 50 acres are paved or covered with buildings. The plant is bordered on the east by the Burlington Northern rail yard, on the north by various industrial facilities, on the south by United Defense Limited Partnership (UDLP) property, and on the west by East River Road. The 46-acre area adjacent to the southern border of the site is owned by UDLP, the NIROP [government-owned, contractor-operated (GOCO)] operator, and is designated USEPA Superfund Site Number 17 on Update 6 of the NPL (RMT, July 1995). The area within a 3-mile radius of the NIROP site includes parts of Minneapolis/St. Paul, New Brighton, St. Anthony, and most of Fridley and Brooklyn Center.

1.2.2 Facility History

NIROP Fridley dates back to 1940 when Northern Pump Company negotiated with the Navy for the construction of a new manufacturing plant on approximately 80.35 acres of land situated in the northern portion of the Minneapolis-St. Paul metropolitan area (Envirodyne, June 1983). Northern Pump had been under contract to the Navy throughout the 1930s. These defense contracts eventually reached a level where Northern Pump's existing plant in Minneapolis was inadequate. When Northern Pump received a contract from the Navy to produce 100 five-inch gun mounts, a move to a new manufacturing plant was needed (Envirodyne, June 1983).

The arrangement to construct the new plant was unique in that the plant was partially owned by the government and partially by Northern Pump Company. NIROP Fridley was the GOCO facility. The site chosen for the plant was a cornfield just north of the Minneapolis city limits, within the city of Fridley. The new plant was completed in just 60 days with machinery, office equipment, and records moved intact by flat car from the old plant. By January 1941, the plant was in full production (Envirodyne, June 1983). The general layout of the site is shown on Figure 1-2.

In June 1942, Northern Pump Company established Northern Ordnance, Incorporated, as an operating subsidiary to conduct the government portion of Northern Pump's business. Thereafter, the facility was often referred to as Northern Ordnance, Inc. and later as Northern Ordnance Division (NOD) (Envirodyne, June 1983).

On January 31, 1964, Northern Ordnance was acquired from Northern Pump Company by FMC Corporation (FMC). Northern Ordnance was assigned divisional status within FMC's Ordnance Group (Envirodyne, June 1983). In 1994, FMC Corporation and Harsco Corporation formed UDLP, and the Armament Systems Division of UDLP currently operates the facility.

Production at the NIROP facility began in January 1941. During World War II, the plant was operated in two 12-hour shifts, 365 days a year, to produce gun mounts. A production level of about 150 single gun mounts and 20 twin gun mounts per month was eventually reached. During the height of the war, 11,400 people were employed at the plant. By the end of the war, more than 6,000 gun mounts had been produced, and the plant received awards annually from 1941 through 1946 from the Navy for meritorious production (Envirodyne, June 1983).

Following the end of the war, production of gun mounts dropped substantially, and the workforce at the plant was reduced to its pre-war level of less than 1,000 employees. The plant undertook various overhaul projects for the Navy and designed a new, dual-purpose, 5-inch, 54-caliber, single gun mount, the Mark 42. This was one of the first fully automated gun mounts in the world. Production of the Mark 42

commenced in 1948 and was the major production activity at the plant for the next 10 years (Envirodyne, June 1983).

During the 1950s, the Navy had demand for new and advanced missile launching systems. Northern Ordnance responded to this need by producing the first automatic guided missile launching system in the world in 1956, the Mark 4. Other missile launching systems, the Mark 7, Mark 10, Mark 13, Mark 22, and Mark 26, were also produced at the plant. These were all highly reliable shipboard systems designed to store, transfer, warm up, position, and launch the missiles. All of these systems were designed for the "3-T Missiles": Talos, Terrier, and Tarter (Envirodyne, June 1983). During this same period, a series of torpedo launching tubes, the Mark 23, Mark 24, and Mark 25, were produced at the plant (Envirodyne, June 1983).

After FMC Corporation's takeover of Northern Ordnance in 1964, the plant continued to produce gun mounts and advanced missile launching systems. However, there was a shift toward smaller, lighter systems. The plant produced a 5-inch, 54-caliber gun mount, the Mark 45, which was the smallest and lightest 5-inch gun mount in the world. This gun mount was used on the Navy's latest cruisers and destroyers. The Mark 75, which was a fast firing 76-millimeter, 62-caliber gun mount, was also produced at the plant (Envirodyne, June 1983).

The guided missile launching systems that were produced at the plant in the 1970s and 1980s, the Mark 13, the Mark 26, and the Mark 41 Vertical Launching Systems (VLS), were designed for the Navy's newer, smaller class ships. However, today, the mainstay of the Navy's launching platform is the MK41 VLS.

There were no major functional changes in the industrial operations at NIROP since the plant was constructed in 1941, although some of the operations were modernized or relocated. The processing, assembly, and manufacturing operations associated with the facility include plating, welding, heat treating, machining, and foundry. Testing facilities currently at NIROP include an electronics laboratory, a metallurgical laboratory, hydraulic test bays, and shock/vibration test equipment (Envirodyne, June 1983). These areas are shown on Figure 1-3.

The plant layout consists of 29 avenues that run west to east and north to south. Broadway is the main north-south avenue; it is located in the center of the plant. East of Broadway, building columns are numbered from 1E to 21E; to the west, columns are numbered from 1W to 29W. The Navy-owned portion of the plant extends from Fifth Avenue to the north wall of the main building.

NIROP Fridley has previously stored and disposed of industrial wastes, scrap materials, drummed wastes, and chemicals at the facility. The following paragraphs discuss the former chemical and waste disposal, storage, and removal practices.

In 1975, an estimated 150 55-gallon drums of industrial waste were removed from NIROP. Prior to disposal, such waste material was collected and stored at a central waste storage area located outside, near the northeastern corner of NIROP. The area consisted of a 30-foot by 30-foot asphalt and concrete pad graded toward the middle that drained to a dry well that could be pumped if a spill occurred (Envirodyne, June 1983).

Two trenches were excavated at NIROP for waste disposal purposes in 1972 in the area north of the main plant building. The trenches were used on a one-time basis. Each trench was approximately 10 feet wide and 8 to 10 feet deep, with a combined length of 75 to 100 feet. Between 50 and 100 drums containing wastes were placed into the trenches on their sides, stacked two or three deep, and covered with excavated soils. The material potentially disposed in the drums included waste oil, plating sludge, cleaning solvent, and degreasing solvent (Envirodyne, June 1983).

During the late 1960s or early 1970s, two borrow pits were used one time only for the disposal of drummed wastes on the northeastern portion of NIROP: one near the railroad gate and the other near the first railroad switch. Each of the pits was approximately 8 feet deep and irregularly shaped and contained about 25 barrels holding the same types of wastes as those disposed in the trenches. In addition to the barrels, the disposal pits contained miscellaneous construction debris, such as metal scraps, lumber, and concrete (Envirodyne, June 1983).

Through various geophysical and remote sensing techniques, nine areas were selected for excavation based on their likelihood for containing drummed wastes in the northern portion of the outside property. These areas were excavated in the fall of 1983 and the spring of 1984. Forty-three excavated drums and 1,200 cubic yards of underlying soil were found to contain volatile organic compounds (VOCs), polychlorinated biphenyls (PCBs), oil and grease, pesticides, and metal-bearing wastes. The drums and contaminated soil were disposed of at a USEPA-approved landfill (RMT, February 1997).

Based on the results of a geophysical investigation conducted in 1995, a total of twenty-three 55-gallon drums and 12 smaller containers were found in the north 40 area. These drums were excavated during a removal action conducted in April through June 1996. Eleven drums were determined to be nonhazardous, 11 drums contained contaminated soil, one drum contained hazardous waste, four 1-gallon containers were determined to be nonhazardous, and eight quart-sized containers contained ingredients such as brake fluid and paint thinner. The nonhazardous containers were disposed as scrap metal by the UDLP metal recycling program, and their soil contents were placed in roll-offs for disposal as Special Waste [materials containing volatiles but having Toxic Characteristic Leaching Procedure (TCLP) results below hazardous levels, as mandated in 40 CFR 261]. The remaining 13 drums and eight containers, and their contents, were sampled for disposal and sent to Emelle, Alabama for disposition and

subsequent incineration at Port Arthur, Texas. In addition, approximately 100 cubic yards of soil and debris consisting of trash, scrap metal, tires, construction and demolition rubble, metal casting waste, equipment parts, and cast concrete structures were removed and disposed as nonhazardous waste (Morrison Knudsen Corp., December 1996).

Large quantities of sand are consumed in the casting process at NIROP. Foundry core butts contain mostly sand with minor amounts of metal and resin or binders. Most foundry core butt disposal operations occurred off Navy property. However, it was reported that core butts were disposed in the northern portion of NIROP on a very limited basis. An analysis of the foundry sand, both before and after use, was performed in November 1978. This analysis did not show any hazardous materials (Envirodyne, June 1983).

In 1972, with the approval of the MPCA, foundry sand was used as one of the fill materials to raise the elevation of the land west of the site, in an area that is now part of the Anoka County Park.

A large storage lot and scrap yard was maintained at the northern end of the facility after the plant was built in the early 1940s. A wide variety of scrap metal parts was found in the yard. Items include old gun barrels, cranes, machining jigs, and gun mounts (Envirodyne, June 1983). The area has since been cleaned and is relatively barren.

In the location now occupied by the existing hazardous materials storage building, a metal shavings and milling waste loading area existed where the wastes were loaded for removal from the plant.

Plating chemical storage, oil/solvent storage, and cyanide storage areas were located on the western end of the plant on 22nd and 23rd Avenues. Cyanide was stored in this area from 1973 to 1988. Flammable materials were stored in the oil/solvent storage area until 1991.

Prior to the late 1980s, the plant used five interim storage areas, A through D. Storage Areas A, B, B', C, and D have been closed in accordance with MPCA and USEPA procedures.

1.2.3 Previous Environmental Investigations

The NIROP Fridley site is divided into three operable units: OU1 addresses groundwater; OU2 addresses soil contamination outside the footprint of the building; and OU3 originally addressed only soil contamination under the footprint of the building. In a letter dated August 30, 1995, the MPCA requested that OU2 be incorporated into OU3 and that contamination sources (e.g., DNAPLs) within the saturated zone be added to OU3. The MPCA believed that the best course of action for the site would be to proceed with a more holistic approach to investigation and remediation. The Navy agreed to this

approach. Therefore, OU3 now includes all sources in the unsaturated and saturated soil zones for remedy selection.

Previous investigations have identified COCs for OU1 and OU2. COCs identified for OU1 (groundwater) include trichloroethene (TCE), tetrachloroethene (PCE), and 1,2-dichloroethene (1,2-DCE) (RMT, July 1988). COCs identified for OU2 include toluene, carcinogenic polyaromatic hydrocarbons (PAHs), ethylbenzene, TCE, PCE, 1,2-DCE, 1,1-dichloroethene (1,1-DCE), 1,1,1-trichloroethane (TCA), and 1,1-dichloroethane (1,1-DCA) (MPCA, January 1995). The following paragraphs and Table 1-1 are chronological summaries of events that have occurred at the NIROP facility since 1940.

In September 1980, Navy officials implemented the nationwide Navy Assessment and Control of Installation Pollutants (NACIP) program to identify and control environmental contamination from past waste management and disposal practices (USEPA, March 1991).

In March 1981, an anonymous telephone call to the MPCA led to the discovery of CERCLA hazardous substance TCE in the three NIROP Fridley water supply wells finished in the Prairie du Chien/Jordan Dolomite aquifer. These on-site water supply wells were shut down on April 24, 1981. The groundwater from NIROP Fridley flows west/southwest and enters the Mississippi River. Sampling at the City of Minneapolis Mississippi River water intake plant also revealed measurable concentrations of TCE. The city of Minneapolis draws its municipal water from the Mississippi River approximately 2,000 feet downstream from the NIROP site (USEPA, March 1991).

The Navy Energy and Environmental Support Activity (NEESA) initiated an Initial Assessment Study (IAS) in June 1983. The IAS report (Envirodyne, June 1983) determined that drummed wastes had occasionally been buried in trenches or pits 8 to 10 feet below the surface in the northern portion of NIROP Fridley and that the area beneath the NIROP Fridley production building might be contributing to groundwater contamination. The exact location of the buried wastes was not recorded. As a result of the IAS recommendations, the Navy contracted with the U.S. Army Corps of Engineers (USACE), Omaha District, to continue investigations (USEPA, March 1991).

Cleanup activities involved excavation of nine areas that contained 43 drums and 1,200 cubic yards of underlying soils. The 43 drums and 1,200 cubic yards of underlying soils were found to contain VOCs, PCBs, oil and grease, pesticides, and metal-bearing wastes. The excavated materials were disposed at a USEPA-approved landfill (USEPA, March 1991).

Four phases of groundwater monitoring well installation were initiated in June 1983. The network consists of 53 monitoring wells. Shallow, intermediate, and deep monitoring wells were installed in the unconsolidated aquifer underlying NIROP Fridley. Monitoring wells were also installed in the Prairie du

Chien/Jordan Dolomite aquifer, which underlies the unconsolidated aquifer under NIROP Fridley. The objective of the monitoring well network is to determine the physical and chemical characteristics of the unconsolidated and Prairie du Chien/Jordan Dolomite aquifers underlying NIROP and adjacent areas (USEPA, March 1991).

The OU1 Remedial Investigation Report (RMT, June 1987) was issued in June 1987 in partial fulfillment of an MPCA Request for Response Action issued to the Navy in May 1984. The purpose of the report was to use existing information to evaluate the impacts of past disposal practices on subsoil and groundwater. The report included evaluations of the eight sampling rounds and the no-action alternative. Results of the RI confirmed earlier findings that groundwater was contaminated with VOCs (primarily TCE) and that groundwater flow was primarily to the southwest toward the Mississippi River.

To address the need for further information defining the nature and extent of contamination, the Navy issued a Conceptual Work Plan for Additional Investigations in June 1987. Implementation of the Conceptual Work Plan was completed between November 1987 and March 1988. The work consisted of installing and sampling 16 new groundwater monitoring wells, testing soil pore gas, installing two shallow aquifer pumping wells, and sampling two storm sewers. The results of these investigations were included in the addendum to the RI Report issued for groundwater (OU1) in July 1988 (USEPA, March 1991).

RMT conducted a soil pore gas survey at the site to screen and identify areas of potential VOC-contaminated soil that might be contributing to groundwater contamination. The results were included in the A-E Quality Control Summary Report for the Soil Gas Survey (RMT, February 1988) and concluded that the following three contiguous areas had the greatest concentrations in the pore space of the near-surface soils:

- Former disposal trench
- Permanent decontamination pad
- New water main trench area

The OU1 FS Report (RMT, July 1988) was issued in July 1988. Based on the initial screening of alternatives, three remedial alternatives were recommended for detailed evaluations and comparison. These alternatives consisted of two source-control alternatives and an alternative addressing management of contaminant migration (USEPA, March 1991).

In August 1988, an Addendum to the FS Report (RMT, August 1988) for OU1 was issued. This report accounted for the changes found in the Addendum to the RI Report and recommended a pumping and treating remedial action that was to be implemented in two phases (USEPA, March 1991).

On February 8, 1989, the Navy held the initial Technical Review Committee (TRC) meeting at NIROP Fridley. TRC membership included representatives from the following: USEPA, MPCA, U.S. Navy, Corps of Engineers, Anoka County (Minnesota), city of Fridley, FMC Corp., Metropolitan Waste Control Commission, Minnesota Department of Natural Resources, and RMT, Inc. The committee periodically met at NIROP Fridley to review progress of the RI/FS and later the Remedial Design/Remedial Action (RD/RA) (USEPA, March 1991).

Hazardous Waste Storage Area C, located on NIROP Fridley, was used for hazardous waste storage and was addressed by FMC Corporation, a Navy contractor. Soil in the storage area was remediated under the hazardous waste permit that was issued to FMC Corporation and the Navy pursuant to Minnesota Rules Ch. 7045. The closure plan and schedule in the permit required the removal and disposal of contaminated soil beneath the storage area. During April 1989, approximately 317 tons of contaminated soil and debris were excavated and disposed from Hazardous Waste Storage Area C. No soil outside the perimeter of Hazardous Waste Storage Area C was removed.

The Navy held a public information meeting to discuss the preferred alternative for groundwater remediation on May 22, 1989 (USEPA, March 1991).

On July 14, 1989, NIROP Fridley was proposed for placement on the NPL (54 Fed. Reg. 29820, July 14, 1989) (USEPA, March 1991).

On July 31, 1989, the U.S. Navy established a Public Information Repository for documents relating to NIROP Fridley. The repository was initially located at the Anoka County Branch Library, 410 N.E. Mississippi Street, Fridley, Minnesota. The Transcript of Proceedings from the Public Forum held on May 22, 1989 was placed in the Information Repository at the Anoka County Branch Library, Fridley, Minnesota (USEPA, March 1991). The entire Public Information Repository is now maintained at NIROP.

On November 21, 1989, NIROP Fridley was placed on the NPL (USEPA, March 1991) after receiving an HRS score of 28.5 or greater. Initial discovery/notification documented a release of VOCs into the groundwater beneath NIROP (USEPA, March 1991).

On May 1, 1990, the Proposed Plan for groundwater remediation was made available to the public by placing a copy in the Public Information Repository. Prior to and on May 1, 1990, a notice of the commencement of a public comment period was published in local newspapers. Members of the public were notified of a 30-day period in which they could provide oral or written comments to the USEPA or Navy concerning the Proposed Plan. A public meeting was held on May 9, 1990 in Fridley, Minnesota, during which representatives of the Navy, USEPA, and MPCA answered questions and solicited both

written and oral comments from members of the public. The public comment period continued until May 30, 1990 (USEPA, March 1991).

A CERCLA ROD (USEPA, June 1986) was signed for OU1 groundwater remediation on September 28, 1990. The Navy entered into an FFA with the USEPA and the MPCA in March 1991.

On April 16, 1995, the first NIROP Fridley Restoration Advisory Board (RAB) meeting was held. The RAB was the expansion of the TRC with the addition of community members. The mission of the RAB is to establish and maintain a forum for the exchange of information, in an open and constructive atmosphere, concerning restoration activities at NIROP Fridley and to provide advice/comment on such activities.

Initial investigative activities related to environmental issues at NIROP Fridley began in 1981. After an initial assessment and focused drum removal action, the site issues were divided into three operable units. OU1 addressed the groundwater beneath the site. The RI/FS and ROD are complete, and long-term operation and maintenance of the selected remedy is under way. The selected remedy includes installation and operation of groundwater containment and recovery wells, with a two-phased plan for disposal of the groundwater from the well system.

Under Phase I, the contaminated groundwater from the containment and recovery well system was discharged directly to the existing sanitary sewer system for treatment at the local wastewater treatment facility. Under Phase II, design and construction for a groundwater treatment system was completed to permit discharge of treated groundwater to the Mississippi River via an NPDES storm sewer discharge.

A groundwater extraction (and containment) system has been constructed based on design documents approved by the USEPA Region V and the MPCA. A pumping capacity test was performed during construction at each of the four extraction wells and included groundwater sampling and analysis. The results indicated that groundwater pretreatment was required prior to discharge to the sanitary sewer to meet discharge limits. Therefore, a pretreatment system was also constructed at NIROP as part of the original facilities, for use during the interim Phase I discharge to the sanitary sewer.

The groundwater extraction system and pretreatment facilities began operating in September 1992. During the first 90 days of recovery system operation, data were collected to determine whether hydraulic containment of contaminated groundwater from the site was achieved. This determination was summarized in a document that was sent to the USEPA and MPCA in December 1992 (RMT, December 1992) for review and approval. In that document, it was concluded that one or more additional groundwater extraction wells would be needed to achieve effective hydraulic containment. A work plan for upgrading the original groundwater extraction system was prepared (RMT, January 1995) and approved by the USEPA and the MPCA. As provided in that Work Plan, two additional extraction wells were

constructed and placed into operation in June 1995. The combined groundwater extraction system, consisting of six extraction wells, is currently in operation.

The concentrations of TCE and other VOCs in the combined discharge from the extraction wells have decreased significantly since startup of the system in 1992. The concentrations decreased to levels where pretreatment of the groundwater was not necessary to comply with the Metropolitan Council Environmental Service (MCES) discharge permit limits. With the approval of the MCES, the pretreatment system was shut down in March 1995. The combined flow from the extraction well system was discharged directly to the sanitary sewer without pretreatment from March 1995 (RMT, April 1996) until completion of Phase II in November 1998.

As specified in the FFA (USEPA, March 1991), an Annual Monitoring Report was submitted by the Navy to the USEPA and the MPCA in October 1995 (RMT, October 1995) to satisfy the requirement that an annual evaluation of the effectiveness of the groundwater extraction system be performed. The upgraded extraction well system flow rate is high enough to substantially improve the capture zone coverage over the pre-upgrade conditions, although the combined flow rate from the six wells is slightly less than the target flow rate [660 gallons per minute (gpm)] (RMT, October 1995). It was recommended that efforts be made to achieve sustainable pumping rates that total approximately 660 gpm so that the extraction well system will continue to effectively control the contaminant plume. The MPCA suspended review of the report pending receipt of particle tracking modeling output figures. The results of particle tracking are key to determining capture effectiveness. The Navy is required by the MPCA to modify the Evaluation of Groundwater Containment System Effectiveness Report (RMT, October 1995) to adequately indicate the capture effectiveness of the groundwater system and accurately locate the capture boundary. Determining capture effectiveness is a prerequisite to starting the Phase II design phase.

An Annual Monitoring Report for 1995 Groundwater Extraction and Pretreatment System (RMT, April 1996) was submitted to the USEPA and MPCA in April 1996, as specified in the FFA, to fulfill the requirements for submittal of data and information describing operation, maintenance, and monitoring of the groundwater extraction and pretreatment system from startup (September 1992) through 1995. Additional Annual Monitoring Reports have been issued each year since.

OU2 addresses the unsaturated soil outside the building footprint area. The OU2 RI has been completed. A Draft FS for OU2 was submitted to the USEPA and MPCA for review (RMT, 1995). It was agreed that OU2 would be combined with OU3 for remedy selection purposes and, therefore, the OU2 FS was finalized, but remedy selection was postponed until the OU3 evaluation was complete.

The final operable unit, OU3, was defined to address sources in the unsaturated and saturated zones at NIROP Fridley. Final revisions for the OU3 RI have been submitted to the USEPA and MPCA for review

(TtNUS, 1999). Efforts to address OU3 initially began in August 1995. Due to the size of the NIROP main building and limited understanding of past operations that could have released TCE into the environment, a site evaluation was conducted for OU3, and the Site Evaluation Report (Brown & Root Environmental, September 1995) was prepared to present the findings. The site evaluation consisted of a site visit, records search, and a personnel interview survey at the NIROP main building. The primary objective of the site evaluation was to identify sites that could have been sources of potential TCE releases to the soil beneath the main building. The Site Evaluation Report (Brown & Root Environmental, September 1995) described and located 59 areas that were considered potential sources of TCE contamination within specific industrial operations. In addition, the sanitary and storm sewer systems were considered potential source areas for contamination. Nine additional potential areas of concern (AOCs 60-68), which were identified during the site evaluation but not included in the Site Evaluation Report because they were not suspected sources of TCE contamination, were added later. In addition, the locations of several previously identified AOCs were modified. An updated list of AOCs, updated AOC locations, and a description of each newly identified AOC was issued (Brown & Root Environmental, February 1996). The list of AOCs was further modified (Brown & Root Environmental, January 1997) to include seven additional AOCs (AOCs 69-75).

1.2.4 OU1 Remedy

OU1 consists of groundwater at the facility. During previous investigations, it was determined that this groundwater is contaminated with VOCs in the shallow and intermediate portions of the Quaternary aquifer zone. In particular, TCE accounted for over ninety percent of the total VOCs and was detected at levels exceeding the Federal MCL. To address this contamination with a remedy, an OU1 ROD was signed on September 28, 1990 by members of the Navy, USEPA, and MPCA. The selected remedy included a groundwater recovery and treatment system for the purpose of downgradient containment along the southwestern portion of NIROP Fridley. The system began operation in September 1992. Figure 1-4 shows the location of the original four recovery wells and on-site treatment plant. Wells AT-2 and AT-4 are shallow wells screened in the upper portion of the Quaternary aquifer zone. Well AT-1A is an intermediate well screened in the intermediate portion of the Quaternary aquifer zone and well AT-3A is a deep well screened in the deep portion of the Quaternary aquifer zone.

In 1995, the recovery well system was upgraded with the installation of one intermediate recovery well (AT-5A) and one deep recovery well (AT-5B) in the UDLP parking lot, approximately 400 feet southeast of existing well AT-3A. Figure 1-4 depicts the locations of these wells. Well AT-5A was installed in the lower portion of the unconfined sand and gravel aquifer with a screened interval from 36 to 66 feet bgs, above a clay layer encountered at approximately 71 feet bgs. Well AT-5B was installed into the lower semi-confined aquifer beneath the clay layer, with a screened interval from 101 to 136 feet bgs. Two wells were

installed instead of a single well to enhance the ability of the recovery system to capture contaminated groundwater located above and below the clay layer, especially at the southern edge of the plume.

During the RI (TtNUS, 1999), groundwater risks at NIROP Fridley exceeded acceptable limits under the future potable use scenario. During the 1999 Annual Monitoring Report (AMR), the effectiveness of the existing recovery and treatment system was re-evaluated and suggestions for improvement were made. The improvements were documented in three small reports that modify the remedy outlined in the OU1 ROD (1990). These reports are an Explanation of Significant Differences (ESD) for groundwater at Anoka County Park, an ESD for groundwater involving source area recovery well, and Minor Changes for the groundwater recovery and treatment system (TtNUS, 2000).

The ESD for groundwater at Anoka County Park includes treatment of VOC contamination in the park that is not captured by the existing recovery system. Figure 1-4 identifies the location of Anoka County Park. The Navy, USEPA, and MPCA agreed that park contamination should be addressed with some form of active treatment to protect the Mississippi River, which is located downgradient. Enhanced bioremediation was ultimately selected as the most appropriate treatment technology.

The second ESD includes a source area recovery well to collect TCE-contaminated groundwater in the vicinity of the former East Plating Shop. This area of contamination is not captured by the existing recovery system, yet it has not dissipated or migrated over time. As a result, the Navy, USEPA, and MPCA agreed to install one additional recovery well in the area and to connect that recovery well to the existing on-site treatment plant.

The Minor Changes involve modifications to alter and enhance the performance of the existing recovery system and the abandonment of service wells. The recovery system upgrades include:

- Discontinue the operation of AT-1A and AT-4, which are performing below acceptable levels and are not cost-effective under current conditions.

- Install a new shallow well in the high permeability material (e.g., sand, gravel) on the southwest side of the NIROP plant. Figure 1-4 depicts the approximate location of this well.

- Install a new well in the shallow/intermediate monitored interval in the south-central side of the NIROP plant (near the center of the TCE plume) where it can reduce the concentrations in the source area and quicken the overall recovery of TCE. Figure 1-4 depicts the approximate location of this well.

- Increase the pumping rate of AT-5A in the shallow and intermediate zones because most of the contamination is located in these zones, and some may be moving southwestward between wells AT-2 and AT-3A.

- Other adjustments to the recovery system, as they are identified.

The service well abandonment will include grouting of two service water wells, NIROP-2 (Navy-2) and NIROP-3 (Navy-3), which are located within the facility. The wells tap into the Prairie du Chien/Jordan aquifer, which underlies the Quaternary aquifer zone, and date back to the 1940s when they were used to supply NIROP with potable and industrial water. Detection of TCE in the Prairie du Chien/Jordan aquifer led to shut down of these wells in 1981. Although the wells are not currently in service and NIROP obtains all water from the city, the wells may act as conduits for the migration of contamination. As a result, the wells will be permanently abandoned according to State of Minnesota well code regulations.

The OU1 ROD, ESDs, and Minor Changes constitute a remedy that addresses all OU1 groundwater contamination. As a result, the purpose of this Focused FS is to address soil (OU2 and OU3), not groundwater (OU1).

1.3 OU3 REMEDIAL INVESTIGATION RESULTS

This section summarizes various aspects of the OU3 RI including field investigations, the physical characteristics of the study area, the nature and extent of contamination, and the human health risk assessment.

1.3.1 Field Investigations

Surface and subsurface RI activities took place from June 25, 1997 through March 25, 1998. Figure 1-5 depicts the OU3 RI sampling locations. The RI field event was divided into two phases, Phase I and Phase II, based on the sample collection techniques that were employed.

Phase I involved the collection of surface and subsurface soil samples and shallow groundwater samples. Phase I activities took place from June 25, 1997 through October 3, 1997. The soil sampling in Phase I was performed to (1) identify chemicals of potential concern (COPCs); (2) determine the concentration and general location of the COPCs; (3) evaluate the potential human health risk; (4) quantify the potential for migration of the COPCs to groundwater; and (5) identify conditions that are indicative of the presence of free-product source areas. To achieve this task, a total of 48 soil borings were installed using direct-push techniques (DPT). Each of these borings was then converted to temporary groundwater monitoring wells. Background soil samples were also collected during this investigation phase. Background

samples were collected at 10 locations using a stainless-steel hand auger to supplement background samples collected during the OU2 RI.

Phase II involved the collection of additional geologic data and installation of permanent monitoring wells using the Rotosonic drilling methodology, collection of groundwater samples from these newly installed monitoring wells, aquifer testing, and groundwater level measurements. Phase II activities took place from October 3, 1997 through March 25, 1998. Six new permanent monitoring well clusters were installed. Each well cluster consisted of three permanent monitoring wells: one shallow well screened in the upper portion of the unconfined aquifer, one intermediate well screened in the lower portion of the unconfined aquifer, and one deep well screened in the upper confined aquifer (totaling 18 wells).

The OU3 RI also included field activities that were conducted at the former East Plating Shop in April 1995. At that time, the East Plating Shop was being renovated, allowing access to this area for environmental sampling. The East Plating Shop Soil and Groundwater Investigation included the installation of seven borings and three temporary wells. Figure 1-6 shows the East Plating Shop sampling locations.

1.3.2 Physical Characteristics of the Study Area

The physical characteristics of the study area include topography, surface water hydrology, regional hydrogeology and water usage, local geology, and local hydrogeology.

1.3.2.1 Topography

The ground surface in the vicinity of the NIROP facility is generally flat, sloping very slightly from the east toward the west and southwest. The ground surface to the east and southeast of the East River Road (west of NIROP) decreases sharply as the flat alluvial terrace at 835 feet (National Geodetic Vertical Datum) meets the elevation of the Mississippi River at approximately 802 feet above mean sea level (msl). The ground surface at the NIROP Fridley facility itself, however, is very flat. The elevation across the site is approximately 834 feet above msl. The elevation of the NIROP plant concrete floor is approximately 834.8 feet msl. Slopes throughout the site are five percent or less (Envirodyne, June 1983).

1.3.2.2 Surface Water Hydrology

NIROP is situated on an alluvial terrace east of the Mississippi River. Much of this very flat surface is covered by buildings and pavement. Runoff from these hard-surfaced areas is collected by a series of

storm sewers that discharge into the Mississippi River, located approximately 800 feet west of the plant boundary (Envirodyne, June 1983).

The soils are very sandy and highly permeable. As such, and because of the flat topography, essentially all the precipitation falling on these areas either infiltrates into the ground or is evaporated. There is little to no runoff from these areas, and no significant water courses, either perennial or intermittent, are present on the site (Envirodyne, June 1983).

The Mississippi River in the vicinity of the site flows to the south, where it is joined by the Minnesota River at a point approximately 15 river miles downstream from NIROP. At the U.S. Geological Survey (USGS) gaging station near Anoka (upstream from NIROP), the Mississippi River has had an average discharge of approximately 7,600 cubic feet per second (cfs) (Envirodyne, June 1983) and has an approximate stage elevation of 802 feet msl (USGS 7.5 minute Quad).

1.3.2.3 Regional Hydrogeology and Water Usage

At NIROP, four aquifers (or aquifer zones) underlie the site as identified by the Minnesota Geological Survey (University of Minnesota, 1979). These aquifers consist of (from shallow to deep) the shallow Quaternary aquifer zone, the Prairie du Chien/Jordan aquifer (PCJ), the Franconia/Ironton/Galesville (FIG) aquifer, and the Mount Simon/Hinckley/Fond du Lac (MHF) aquifer (Envirodyne, June 1983).

The shallow Quaternary aquifer zone is comprised of the unconsolidated Quaternary deposits overlying bedrock in the region. It is referred to here as an aquifer zone because it consists of a poorly defined unconfined and a confined (or semi-confined) aquifer. The depth to the potentiometric surface in the Quaternary aquifer zone ranges from approximately 18 to 34 feet, depending upon precipitation levels and pumping wells. Groundwater flow in the Quaternary and the PCJ aquifers is generally toward the south and southwest and discharges into the Mississippi River (Work Plan, Brown & Root Environmental, 1997).

As mapped by Kanivetsky (University of Minnesota, 1979), the Quaternary aquifer at the NIROP is capable of a sustained yield of 100 to 500 gpm to a properly developed well. The Quaternary aquifer, though capable of yielding fairly high quantities of water to wells, is not commonly used for water supply purposes. It is easily contaminated due to relatively shallow depth from ground surface, and water of good quality and even higher yields is commonly available at comparable cost in the underlying PCJ aquifer (Envirodyne, June 1983).

Under the northern and eastern portions of NIROP, the PCJ (approximately 130 to 400 feet bgs) is confined by the lower portion of the St. Peter Sandstone. Under the southwestern part of the NIROP facility, the St. Peter Sandstone is fully eroded, and the PCJ exists as an unconfined (or semi-confined)

aquifer. Where this occurs, the PCJ and the Quaternary aquifer may act as a single, hydraulically connected unit (Envirodyne, June 1983). Wells tapping the PCJ aquifer typically yield 500 to 1,000 gpm (University of Minnesota, 1978).

The PCJ aquifer is used for water supply purposes in the immediate vicinity of the NIROP. There are two wells at the plant that tap this aquifer (NIROP-2 and NIROP-3). These wells date back to the 1940s and were used to supply potable and industrial water for NIROP. The average pumping rate for these wells was 760 gpm. TCE contamination problems led to the shutdown of these wells in April 1981. There is also a well just south of the Navy Property, within the main industrial building, that taps the PCJ aquifer (FMC-1). This well was also shut down in April 1981 because of TCE contamination. The well was re-opened in August 1981 and was intermittently used for non-contact cooling water for the NIROP facility until it was shut down again in June 1983 (Envirodyne, June 1983). Currently, all water used at the NIROP Fridley is obtained from the city. The city of Fridley has a well just beyond the northwestern corner of the NIROP (Fridley-13) that taps the PCJ and is used for municipal water supply on a standby basis. This well dates back to 1970. It has a gas-powered pump and is used during power outages and during periods of peak demand. TCE has not been detected in well Fridley-13. The total population served by groundwater within a 3-mile radius of the NIROP is 29,000 residents (RMT, November 1995). Several other water supply wells in the general vicinity of the NIROP are believed to tap the PCJ aquifer (Envirodyne, June 1983). There are no groundwater supply wells or users downgradient of NIROP Fridley between the facility and the Mississippi River (RMT, November 1995).

The MHF and the FIG are both confined aquifers. Because of the depths of these aquifers (greater than 400 feet bgs), they are not used for water supply purposes in the immediate vicinity of the NIROP. The MHF, however, is used rather extensively as a water supply source north of the site, where it is more shallow (Envirodyne, June 1983).

1.3.2.4 Local Geology

The OU3 RI field event focused on the unconsolidated deposits within the boundaries of the NIROP Plant. The unconsolidated overburden exists from the ground surface down to the top of the Ordovician age bedrock. The overburden ranges from 98.6 to 136.7 feet thick in the vicinity of the NIROP facility. Generally, from ground surface to approximately 45 to 50 feet bgs, the subsurface material is predominantly medium to coarse sand and fine sand with very few discontinuous clay layers. The thicknesses of these discontinuous clay layers in this interval range from 1 to 17 feet. Below an approximate depth of 50 feet bgs to the top of bedrock (i.e., 98.6 to 136.7 feet bgs), the presence and thickness of the very fine grained material increase significantly in the central, western, and southwestern portions of the site whereas in the northern, eastern, and southeastern portions of the site, this material is very thin or is nonexistent. The thickness of the very fine grained material layers within this interval in the

central, western, and southwestern portions of the site range from 1 to 45 feet, and in the north, east, and southeast, the thickness ranges from 1 to 4 feet. The St. Peter Sandstone is present as the surficial bedrock in all areas of the site, with the exception of the south-central portion of the site where the Shakopee Dolomite (Prairie du Chien Group) is present. Within the project area, the St. Peter Sandstone ranges in thickness from 17 to 62.4 feet. The top of the St. Peter Sandstone is typically moderately to highly weathered.

1.3.2.5 Local Hydrogeology

The hydrogeology within the vicinity of the NIROP facility is consistent with the regional hydrogeology where four aquifers (or aquifer zones) govern groundwater movement through the subsurface. These aquifers are (from shallow to deep) the shallow Quaternary aquifer zone, the PCJ aquifer, the FIG aquifer, and the MHF aquifer. The OU3 RI was primarily concerned with the hydrogeology of the Quaternary aquifer zone.

The Quaternary aquifer as defined by the University of Minnesota (1979) is referred to here as an aquifer zone because it consists of two poorly defined aquifers. Each of these two aquifers, namely the shallow unconfined aquifer that overlies a locally deep confined (or semi-confined) aquifer, varies significantly in thickness and hydraulic connection throughout the site. The shallow unconfined aquifer ranges in thickness between 41 and 93 feet, and the deeper confined (or semi-confined) aquifer ranges in thickness between 19 and 55 feet. The unconfined aquifer has been defined by the installation of shallow wells (S) in the upper portion of the unconfined aquifer and intermediate wells (I) installed in the lower portion of the unconfined aquifer; the deep confined (or semi-confined) aquifer has been defined by deep wells (D). The two aquifer zones are separated by material having a low permeability (often referred to as an aquitard or confining unit) that varies significantly in thickness and horizontal extent.

The thickness of the aquitard ranges between 0 and 36 feet. It appears that the aquitard is the thickest and fairly laterally continuous in the central, western, and southwestern portions of the site. However, in the northern, eastern, and southeastern portions of the site, the aquitard is very thin or is nonexistent. In these areas, the deep aquifer may no longer be confined but is semi-confined or even unconfined, thus having some direct hydraulic connection with the overlying shallow unconfined aquifer. The importance of these fine-grained interbeds or aquitards is that they may impede or redirect the natural vertical migration of fluids in the aquifer. Downward migration of DNAPLs such as TCE can be redirected by the low permeability layers, even against the natural direction of groundwater flow.

The horizontal groundwater flow direction across the facility in the Quaternary aquifer zone is generally toward the south and southwest and discharges into the Mississippi River. Figures 1-7 and 1-8 illustrate the potentiometric surfaces for the shallow and deep aquifers, respectively, based upon measurements

taken on July 7, 1998 (USGS, 1998). As both figures illustrate, the natural groundwater flow direction at the site is altered significantly by the remedial wells (i.e., AT-1A, AT-2, AT-5 on Figure 1-7, and AT-3A and AT-5B on Figure 1-8) actively pumping in both aquifer zones. On both Figures 1-7 and 1-8, a cone of depression is evident at wells 1-IS and 10-D, respectively. At the present time it is unknown why this phenomenon is occurring because no pumping wells exist at this location.

Horizontal Hydraulic Gradient

As expected, due to the cones of depression created by the actively pumping remedial wells, the horizontal hydraulic gradient is greater in the southern and southwestern portions of the site than in the north and northeast where few pumping wells are active. Average gradients for the entire site were 0.00503 and 0.00689 for the shallow unconfined and the deep confined aquifers, respectively.

Vertical Hydraulic Gradient

Wells located in the northern and northeastern portions of the site had an upward hydraulic gradient (or upward potential groundwater flow) that ranged from 0.0022 to 0.0096. This upward hydraulic gradient may be an indication of confining pressure on the underlying deep aquifer and/or of recharge to the shallow aquifer. However, in well clusters in the southern and southwestern portions of the site, which are directly affected by the remedial extraction wells, a downward hydraulic gradient is present that ranged from 0.0007 to 0.0676. Exceptions to the general rule include well cluster 30 on the eastern side of the Plant and cluster 26-S and 15D on the southwestern side of the facility. Well cluster 30 has a downward hydraulic gradient of 0.0105, which is likely due to extraction well AT-1A, located nearby. Well cluster 26-S and 15D has an upward hydraulic gradient of 0.0030, which may be indicative of confining pressure on the underlying deep aquifer and/or of recharge to the shallow aquifer and ultimately the Mississippi River.

Specific Capacity Results

The transmissivity, hydraulic conductivity, and specific capacity (SPECAP) range from 3.3 to 26,012 feet^2/day, 0.651 to 364.22 feet/day, and 0.0221 to 21.42 gallons per minute/feet (gpm/feet), respectively, for the unconfined aquifer. The transmissivity, hydraulic conductivity, and SPECAP range from 24.35 to 903.9 feet^2/day, 1.40 to 288.06 feet/day, and 4.71×10^{-2} to 8.82 gpm/feet, respectively, for the deep confined aquifer. The aquifers appear to have similar characteristics, with the shallow unconfined aquifer having slightly higher values (but within the same order of magnitude). Only the transmissivity is significantly higher between the two aquifers, which is probably due to the fact that the unconfined aquifer is significantly thicker than the deep confined aquifer.

Groundwater Flow Velocity

Based upon the calculated hydraulic gradients and average hydraulic conductivities and an assumed porosity of 0.3, horizontal linear groundwater velocities were also calculated for each of the two aquifers at the site. As expected, due to the increased hydraulic gradient created by the actively pumping remedial wells, the horizontal groundwater velocities are greater in the south and southwest portions of the site than in the north and northeast where few pumping wells are active. Average velocities for the entire site were 1.139 feet/day and 0.8 feet/day for the shallow unconfined and the deep confined aquifers, respectively.

1.3.3 Nature and Extent of Contamination

The following paragraphs briefly describe the nature and extent of contamination at NIROP Fridley as determined during the OU3 RI. Tables 1-2, 1-3, and 1-4 summarize the analytical results for soil, unfiltered groundwater, and filtered groundwater, respectively.

- Several VOCs, primarily chlorinated hydrocarbons, aromatic compounds, and ketones, were detected in surface (0 to 4 feet bgs), shallow subsurface (4 to 12 feet bgs), and deep subsurface (greater than 12 feet bgs) soil samples. Relative detection frequencies for VOCs were similar among surface, shallow subsurface, and deep subsurface soil samples. However, no consistent pattern of concentrations was evident among the three categories of soil samples. Concentrations of 1,1-DCA and carbon disulfide were at the same order of magnitude for all three categories of soil samples. The maximum concentration of 1,1,1-TCA was detected in a surface soil sample. Maximum concentrations of 1,2-DCE (total), ethylbenzene, toluene, and xylenes were detected in shallow subsurface soil samples. Maximum concentrations of styrene, PCE, and TCE were detected in deep subsurface soil samples. Maximum concentrations of TCE and PCE in all three categories of soil samples were detected in samples collected from the former East Plating Shop, indicating the possible presence of a "hot spot" of TCE and PCE in this area.

- Several semivolatile organic compounds (SVOCs), primarily PAHs, were sporadically detected in surface and shallow subsurface soil samples. With few exceptions, concentrations and detection frequencies of SVOCs in surface soil samples exceeded those reported for shallow subsurface soil samples. Concentrations of PAHs in shallow subsurface soil samples ranged from 11 µg/kg to 2,300 µg/kg, and concentrations of PAHs in surface soil samples ranged from 10 µg/kg to 5,600 µg/kg.

- Aroclor 1016 and Aroclor 1254 were detected in one and two surface soil samples, respectively, at concentrations ranging from 150 µg/kg to 290 µg/kg. No other PCBs were detected in any of the soil samples.

- All 22 Target Analyte List (TAL) metals and cyanide were detected in surface soil samples, and cyanide and all but two TAL metals were detected in the shallow subsurface soil samples. Concentrations and detection frequencies of metals detected in surface and shallow subsurface samples were very similar. A majority of the metals was frequently detected (i.e., in greater than 90 percent of the samples). Concentrations of most metals and cyanide exceeded background concentrations in one or more soil samples. Of the deep subsurface soil samples, only the seven samples collected from the former East Plating Shop were analyzed for metals and cyanide. Seventeen metals and cyanide were detected in the deep soil samples, with concentrations of 13 of these metals and cyanide exceeding background.

- The maximum detected concentrations of all chemicals in soil were less than the MPCA State Reference Values (SRVs) for industrial exposures with the exception of lead in one surface soil sample and chromium in one subsurface soil sample.

- Based upon the field screening tests and analytical results, it is unlikely that non-aqueous phase liquids (NAPLs) are present in any of the subsurface soil sample locations.

- Chlorinated hydrocarbons were the primary chemicals detected in groundwater samples. TCE was detected most frequently and at the greatest concentrations in shallow, intermediate, and deep groundwater samples. Concentrations of TCE in groundwater samples ranged from 0.6 µg/L to 140,000 µg/L. The maximum concentration of TCE was detected in a shallow groundwater sample collected from monitoring well GW-01, located in the East Plating Shop. Review of the data collected from the six shallow, six intermediate, and six deep permanent wells, however, indicates that the greatest VOC concentrations are generally associated with the intermediate wells.

- Concentrations of TCE in shallow and intermediate groundwater samples and 1,2-DCE in shallow groundwater samples from wells located in the former East Plating Shop exceeded 1 percent of their solubility limits, indicating that potential DNAPL is present in the local vicinity of these wells.

- Several soil sampling locations were purposely located where impacts from releases from the sanitary or storm sewers could be observed, if present. There were no significant findings at these locations.

1.3.4 Human Health Risk Assessment

As part of the OU3 RI, a human health risk assessment was prepared following MPCA risk assessment protocol and using spreadsheets provided by MPCA. The USEPA Risk Assessment Guidance for Superfund (RAGS) Part D Standardized Planning, Reporting, and Review of Superfund Risk Assessments (USEPA, 1989) was not followed, as agreed upon between USEPA Region V and MPCA. The risk

assessment only evaluated exposures to soil by industrial workers and construction workers. OU3 groundwater analytical results were compared to MPCA health-based criteria. Exposures to OU2 soil were evaluated in the Supplemental RI Report (TtNUS, 1999). The following sections summarize the risk assessment results for soil and groundwater.

Since the area targeted in the OU3 investigation is either under roof or paved, the area is not conducive for wildlife. Within the OU3 investigation area, there are no known grass areas. The area is a fenced, highly industrialized area. The majority of the area is paved and subject to regular vehicular traffic. Therefore, the lack of suitable habitat makes it unlikely that terrestrial receptors, if any, will actually be impacted, and an ecological risk assessment was not conducted.

1.3.4.1 Soil

Table 1-5 presents the chemicals of potential concern in soil that were evaluated during the risk assessment. The risk assessment considered exposures to industrial workers, major-infrequent construction workers, and minor-frequent construction workers. Potential exposure pathways for all receptors included incidental ingestion of soil, dermal contact with soil, and inhalation of fugitive dust and volatile compounds.

Table 1-6 presents a summary of the cancer risks and hazard indices for soil that exceeded the acceptable limits.

For the typical industrial worker exposed to surface soil, the cumulative cancer risk estimate was 3.5×10^{-6}, which is within the acceptable range of 1×10^{-4} to 1×10^{-6}. All hazard indices (HIs) for the target endpoints were within the acceptable level of 1.0, and all individual hazard quotients (HQs) were below the acceptable level of 0.2.

For the major-infrequent construction worker, the cumulative cancer risk estimate was 2.1×10^{-6}, which is within the acceptable range of 1×10^{-4} to 1×10^{-6}. The cumulative hazard index was 2.9, which exceeds the acceptable limit of 1.0. Individual hazard quotients for arsenic (HQ = 0.3), chromium VI (HQ = 1.35), copper (HQ = 0.23), and mercury (HQ = 0.46) exceeded the acceptable level of 0.2. However, as detailed in the risk assessment, a hazard index of greater than 0.2 would be associated with only one or two of the arsenic, copper, and chromium detections. A hazard index greater than 0.2 would be associated with nine mercury samples. (Note: 113 soil samples were analyzed for metals.) Additionally, the hazard quotient for chromium was developed assuming that all chromium was present in the hexavalent state. However, it should be noted that hexavalent chromium was detected infrequently (3 of 50 soil samples, only) in surface and subsurface soil.

For the minor-frequent construction worker, the cumulative cancer risk estimate was 3.6×10^{-6}, which is within the acceptable range of 1×10^{-4} to 1×10^{-6}. The cumulative hazard index was also below the acceptable level of 1.0. All individual hazard quotients were below 0.2.

The human health risk assessment addressed potential direct contact with contaminated soil within the top 12 feet. No potential exposures were identified for soil at depths beyond 12 feet, therefore no risks were calculated for potential exposures to soil greater than 12 feet bgs. Concentrations of all chemicals in soil samples collected at depths beyond 12 feet were less than MPCA SRVs for industrial exposures with the exception of TCE in one soil sample (SB-07, 12 to 16 feet) collected at the former East Plating Shop. The boring logs suggest that this sample was collected from within the saturated zone, consequently this sample may be more representative of groundwater contamination than soil contamination.

Chemicals of Concern

Table 1-7 presents the chemicals of concern in soil that were retained based on the risk assessment results. As shown, chromium in subsurface soil was the only chemical retained as a COC. No chemicals were retained as COCs in surface soil. Although the maximum detected concentration of lead exceeded the MPCA SRV for industrial exposures and the hazard quotients for arsenic, copper, and mercury exceeded the acceptable level under the major-infrequent construction worker scenario, these chemicals were not retained as COCs for the following reasons:

- Lead was detected in 111 of 113 surface and subsurface soil samples. The maximum detected lead concentration of 733 mg/kg slightly exceeded the MPCA SRV of 700 mg/kg for industrial exposures. The concentration of lead in all but one of the remaining samples was below the OSWER screening level of 400 mg/kg for residential exposures. Therefore, lead is not considered as a COC since it only slightly exceeded its SRV in one sample and was detected at low concentrations in the remaining samples.

- The HQ of 0.3 for exposure to arsenic in surface and subsurface soil by a major infrequent construction worker slightly exceeded the MPCA acceptable level of 0.2 but was less than the USEPA acceptable level of 1.0. Exposures to arsenic in soil by the industrial worker and minor frequent construction worker were within acceptable levels. Arsenic was only detected in two samples at concentrations above background. Concentrations of arsenic in 111 of 113 would result in HQs of less than 0.2. Therefore, arsenic is not considered a COC since the HQ only slightly exceeded the MPCA acceptable level of 0.2, was less than the USEPA acceptable level of 1.0, and was detected at low concentrations across the site.

- The HQ of 0.23 for exposure to copper in surface and subsurface soil by a major infrequent construction worker slightly exceeded the MPCA acceptable level of 0.2 but was less than the USEPA acceptable level of 1.0. Exposures to copper in soil by the industrial worker and minor frequent construction worker were within acceptable levels. Concentrations of copper in 112 of 113 would result in an HQ of less than 0.2. Therefore, copper is not considered a COC since the HQ only slightly exceeded the MPCA acceptable level of 0.2, was less than the USEPA acceptable level of 1.0, and was detected at low concentrations across the site.

- The HQ of 0.46 for exposure to mercury in surface and subsurface soil by a major infrequent construction worker exceeded the MPCA acceptable level of 0.2 but was less than the USEPA acceptable level of 1.0. Exposures to mercury in soil by the industrial worker and minor frequent construction worker were within acceptable levels. Mercury was only detected in 18 of 113 surface and subsurface soil samples. Therefore, mercury is not considered a COC since the HQ was less than the USEPA acceptable level of 1.0 and was infrequently detected at low concentrations across the site.

Although chromium was retained as a COC, it may not present a significant contamination problem at NIROP Fridley. The risk assessment generated a *hexavalent* chromium HQ, in accordance with the MPCA guidelines, that exceeded the acceptable level of 0.2. Because hexavalent chromium analyses were not conducted, this HQ was calculated using a maximum detected *total* chromium concentration. If the maximum detected chromium concentration was evaluated as *trivalent* chromium, the HQ would not exceed the MPCA acceptable level of 0.2. As a result, the hazard index of 2.9 appears to overestimate the risk associated with chromium in soil.

1.3.4.2 Groundwater

On-site groundwater is not currently used as a potable water supply at NIROP Fridley nor is it expected to be used in the future because a public water supply is available. According to MPCA, the city of Minneapolis has developed plans to use bedrock aquifer groundwater downgradient of NIROP as a backup water supply for Minneapolis, but decided not to install the water supply because of groundwater contamination from NIROP. For the risk assessment, a screening evaluation of the risks associated with potable use of the groundwater was performed using an MPCA spreadsheet. The spreadsheet evaluates exposures to groundwater by comparing maximum detected concentrations in unfiltered samples to MPCA Health Risk Limits (HRLs) and Health Risk Values (HRVs), and USEPA Maximum Contaminant Levels (MCLs). Also, the evaluation included a "mixture" evaluation as required by the Minnesota Rule. Table 1-8 presents the chemicals of potential concern that were included in the screening evaluation. The maximum detected concentrations of compounds in unfiltered groundwater were used in the analysis.

Cancer risks and hazard indices were generated for the upper portion of the unconfined aquifer, the lower portion of the unconfined aquifer, and the deep aquifer. Table 1-9 presents a summary of these risks.

In the upper portion of the unconfined aquifer, the cumulative cancer risk estimate was 5.0×10^{-2}, which exceeds the USEPA acceptable range of 1×10^{-4} to 1×10^{-6} and the MPCA acceptable level of 1×10^{-5}. Arsenic, 1,1-DCE, methylene chloride, pentachlorophenol, PCE, TCE, and vinyl chloride were the main contributors to the cancer risk. The cumulative HI calculated per target endpoint exceeds 1.0 for the cardiovascular or blood system, central or peripheral nervous system, kidneys, and gastrointestinal system or liver. 1,1-DCA, 1,1-DCE, cis 1,2-dichloroethene (cis 1,2-DCE), ethylbenzene, 1,1,1-TCA, cobalt, cyanide, manganese, and thallium were the main contributors to the HI.

In the lower portion of the unconfined aquifer, the cumulative cancer risk estimate was 2.1×10^{-2}, which exceeds the USEPA acceptable range of 1×10^{-4} to 1×10^{-6} and the MPCA acceptable level of 1×10^{-5}. Arsenic, TCE, and vinyl chloride were the main contributors to the cancer risk. The cumulative HI calculated per target endpoint exceeds 1.0 for the cardiovascular or blood system, central or peripheral nervous system, and gastrointestinal system or liver. 1,1-DCE, cis 1,2-DCE, and manganese were the main contributors to the HI.

In the deep aquifer, the cumulative cancer risk estimate was 5.2×10^{-5}, which is within the USEPA acceptable range of 1×10^{-4} to 1×10^{-6}, but exceeds the MPCA acceptable level of 1×10^{-5}. PCE and TCE were the main contributors to the cancer risk. The cumulative HI calculated per target endpoint exceeded 1.0 for the central or peripheral nervous system. Manganese was the main contributor to the HI.

Table 1-10 presents the chemicals of concern in groundwater that were retained based on the risk assessment results.

A groundwater remedy is currently underway to address the VOC contamination and unacceptable risks (see Section 1.2.4). The OU1 ROD, signed in 1990, specified a groundwater recovery and treatment system that began operation in 1992. In 1995, the system was initially upgraded with the two additional pumping wells. In 2000, the system will be upgraded under an ESD to the ROD and an additional source recovery well will be installed in the vicinity of the former East Plating Shop. In addition, an ESD was issued to implement enhanced bioremediation of groundwater contamination in Anoka County Park. As a result, this Focused FS does not develop and evaluate remedial alternatives for groundwater.

TABLE 1-1

CHRONOLOGICAL SUMMARY OF EVENTS
FOCUSED FEASIBILITY STUDY FOR OPERABLE UNITS 2 AND 3
NIROP FRIDLEY, MINNESOTA

Date	Event
1940 - 1941	Naval ordnance manufacturing facility was constructed.
1947	U.S. Navy purchased what is now the Federally owned portion of NIROP.
1942 - 1964	Northern Ordnance, Inc., a subsidiary of Northern Pump Company, operated the naval ordnance manufacturing complex.
1964	FMC Corporation purchased the southern portion of the manufacturing facility property from Northern Pump Company.
Early 1970s	Limited disposal at NIROP of paint sludge and chlorinated solvents in pits and trenches was performed.
1980	
September	U.S. Navy implemented the NACIP program to identify and control environmental contamination from past use and disposal practices.
1981	
March	Anonymous phone call to the MPCA regarding disposal practices at the FMC-operated facility.
March 16 - April 23	Three production wells at the site were sampled by the MPCA. Analysis results showed 0.035 to 0.200 milligrams per liter (mg/L) of TCE detected (RMT, July 1988).
April 24	Wells FMC-1 and NIROP -2 and -3 were discontinued for drinking water usage. Well FMC-1 was intermittently used for process cooling water until June 1983.
December 31	TCE was detected at 0.0012 mg/L at the Minneapolis water supply intake. Earlier in 1981, TCE was detected at unquantifiable levels during four sample rounds.
	Storm sewer outfalls were sampled for several constituents. Quantifiable levels of volatiles were detected in the sanitary sewer and at National Pollutant Discharge Elimination System (NPDES) outfall 20200.
	The site was divided into the North Study area (government-owned property) and South Study Area (FMC-owned property) for additional investigations by Hickok and Associates (Hickok, 1981).
1982	
March 31	Investigation of the North Study area began.
1983	
May	U.S. Navy authorized the Installation Restoration (IR) Program.
June	Initial Assessment Study (IAS) for the NIROP site was completed by Envirodyne Engineers (June 1983).
	As a result of the IAS, the U.S. Army Corps of Engineers (USACE) was assigned to manage site remediation. The Corps installed 33 monitoring wells on and around the site over the next 3 years.

TABLE 1-1

CHRONOLOGICAL SUMMARY OF EVENTS
FOCUSED FEASIBILITY STUDY FOR OPERABLE UNITS 2 AND 3
NIROP FRIDLEY, MINNESOTA

Date	Event
1983 - 1984	
November 18, 1983 – March 1984	Approximately 1,200 cubic yards of soil considered hazardous and 43 drums were excavated from the North 40 area and disposed of at an off-site Resource Conservation and Recovery Act (RCRA)-permitted facility. Samples were analyzed from the soils at the base of each excavation. Trenches 3, 6, and 7 showed greater than 1 mg/L total volatiles. Cost: $460,000 Chemical Waste Management Corporation/$20,000 Corps of Engineers (RMT, Sept 1996)
May 22, 1984	The MPCA issued a Request for Response Action at the site to the U.S. Navy and FMC Corporation.
1983 - 1986	Eight rounds of groundwater sampling were completed. The last round was conducted in November 1986 by RMT, Inc. (RMT).
1986	
June	RMT, Inc. was retained by the USACE to complete the Remedial Investigation/Feasibility Study for OU1 (groundwater).
	FMC established an agreement with the MPCA to pump contaminated groundwater until total volatile levels in certain wells were less than 0.270 mg/L. Pumped water was discharged to the Pig's Eye Wastewater Treatment Plant.
1987	
March	All use of trichloroethene at NIROP was discontinued. 1,1,1-Trichloroethane was put into use in place of trichloroethene.
June	Remedial Investigation Report (RMT, June 1987) issued for OU1.
September	During excavation of an on-site utility trench, a strong odor was detected in the trench by construction workers. Soil exposed during the excavation was later monitored by MPCA using an HNu photoionization detector (PID). The trench is along the northern property line of NIROP.
	An anonymous phone call to FMC directed the MPCA's attention to a potential hazardous waste site in the vicinity of the Dealers Manufacturing facility, located approximately 1,000 feet to the east of NIROP.
November	Results of soil pore gas survey included in the A-E Quality Control Summary Report for the Soil Gas Survey (RMT, February 1988).
1988	
July	Feasibility Study Report (RMT, July 1988) issued for OU1.
1989	
February 8	The U.S. Navy established the Technical Review Committee (TRC) for the project and convened the first meeting. TRC meetings were held every three months until the beginning of the RAB.
May 22	Public meeting to present the RI/FS is held in Fridley, Minnesota.
July 14	NIROP listed as a proposed site on the NPL by the USEPA.
July 31	Public Repository is established at Anoka County Branch Library, 410 N. E. Mississippi St., Fridley, MN.

TABLE 1-1

CHRONOLOGICAL SUMMARY OF EVENTS
FOCUSED FEASIBILITY STUDY FOR OPERABLE UNITS 2 AND 3
NIROP FRIDLEY, MINNESOTA

Date	Event
November 21	NIROP listed as a final site on NPL by USEPA.
1990	
May1	Navy issues final Proposed Plan for groundwater remediation after review by the MPCA and the USEPA.
May 9	Public meeting to present the Proposed Plan is held in Fridley, Minnesota.
May 1 - May 30	Public comment period for the proposed groundwater remedial action is held.
September	A Record of Decision (ROD) was signed for OU1 by the Navy, the MPCA, and the USEPA. A groundwater pump-and-treat alternative was the alternative selected in the ROD.
October - November	Fifty-five soil borings were advanced to assess the extent of soil contamination in four specific areas (background area, North 40 area, Hazardous Waste Storage Area C, and the southeast area near Well 9-S). The North 40 area included 22 soil borings to investigate potential soil contamination due to past disposal practices, the locations of former Hazardous Waste Storage Area C included 28 soil borings to investigate potential soil contamination associated with the storage area, and the Southeast Area included four soil borings to attempt to delineate the source(s) of volatiles reported in groundwater monitoring wells in the area. The results reported the highest concentrations of volatiles, up to 62,000 micrograms per kilogram (μg/kg), from near the decontamination pad (RMT, February 1991).
1991	
March	Federal Facility Agreement (USEPA, March 1991) issued for NIROP Fridley.
August	An initial aerial photographic review was conducted by RMT staff that included photographs spanning the period from 1945 to 1977.
	The installation of four groundwater recovery and containment wells, as well as additional groundwater monitoring wells, was completed in late 1991 for OU1.
December	A second review of the aerial photographs, including additional photographs, was performed jointly by representatives of the Navy, the USEPA, the MPCA, FMC, and RMT. As a result of the review and subsequent discussions, additional areas of investigation were included as part of the OU2 Remedial Investigation.
May	Community Relations Plan issued.
1992	
January	A Remedial Action Work Plan (RMT, January 1992) was issued for OU2. The RI of the soils operable unit addresses soil contamination in the unsaturated zone (i.e., above the water table) in areas of NIROP Fridley that are not covered by buildings or other surface structures. The scope of the soil RI was intended to investigate potential outdoor sources that may contribute to groundwater contamination.
June 22 – June 28	In the North 40 area, a total of 31 drums were excavated, sampled, and overpacked, and the drums, along with approximately 900 cubic yards of soil and debris, were removed from the excavation. Excavated drums were disposed of via incineration at a USEPA Superfund RCRA-licensed facility. Associated debris (screened material) was disposed of at a sanitary landfill or a RCRA-secure landfill according to analytical results. Removal was performed by Bay West, Inc. and managed by UDLP. Cost: $163,157 (Removal Action File, July 1992)

TABLE 1-1

CHRONOLOGICAL SUMMARY OF EVENTS
FOCUSED FEASIBILITY STUDY FOR OPERABLE UNITS 2 AND 3
NIROP FRIDLEY, MINNESOTA

Date	Event
August 20	Emergency Removal Operation (Bay West, August 1992) report was issued that discussed the investigation of the North 40 area.
September	The groundwater recovery system was completed and monitoring for OU1 began. Acquisition date of Bldg 52 was Jan 1, 1992; Cost: $173,900; Contract N0002493E8521. Acquisition date of Bldg 53 was Jan 1, 1992; Cost: $1,426,100; Contract: N0002493E8521.
December	A 90-Day Determination Document (RMT, December 1992) was prepared that evaluated the effectiveness of the OU1 recovery system's operation over the first few months.
1993	
September	A Remedial Investigation Report (RMT, September 1993) was issued for OU2. Results indicated that volatile, semivolatile, pesticide, hydrocarbon, and metal contamination was present in the soils at several locations.
1994	
September	Results of East Plating Shop soil sampling were issued to the Southern Division of the Naval Facilities Engineering Command (NAVFACENGCOM) in a letter report (Bay West, September 1994). Two soil borings were completed, and several metals and cyanide were identified at concentrations greater than background levels determined during the OU2 RI.
1995	
March	A Work Plan (Halliburton NUS, March 1995) was issued for the East Plating Shop. Proposed field activities for the soil and groundwater investigation included the installation of six soil borings and three temporary monitoring wells.
April 16	First NIROP Fridley Restoration Advisory Board meeting was held.
April 1 – May 4	MK added extraction wells AT-5A and AT-5B to the GTWF to improve hydraulic containment of the GWTF. Cost: $615,104; Contract: N62467-93-D-1106 D.O. 14
May	Results of East Plating Shop soil and groundwater investigation were issued (Halliburton NUS, May 1995). The report identified soil and groundwater contamination under the East Plating Shop. TCE was the primary contaminant found. Other volatile organic compounds, including 1,1,1-trichloroethane (TCA), acetone, styrene, and metals such as chromium, lead, and cyanide, were detected at concentrations greater than background levels determined during the OU2 RI.
June	Thirty former areas of concern, located within the NIROP facility, were identified on a Solid Waste Management Unit (SWMU) map (UDLP, June 1995).
September	Results of a site evaluation conducted at the NIROP facility in August 1995 were presented in the Site Evaluation Report (Brown & Root Environmental, September 1995). Fifty-nine areas of concern, the sanitary sewer system, and the storm sewer system were identified as potential areas requiring further investigation.

TABLE 1-1

CHRONOLOGICAL SUMMARY OF EVENTS
FOCUSED FEASIBILITY STUDY FOR OPERABLE UNITS 2 AND 3
NIROP FRIDLEY, MINNESOTA

Date	Event
1996	
February	Revisions to the Final Site Evaluation Report (Brown & Root Environmental, September 1995) identified nine additional potential areas of concern (AOCs 60-68) which were identified but not previously reported because they were not suspected sources of TCE contamination.
April 22 – June 4	MK conducted a North 40 drum removal Action. 23 drums and 12 smaller containers were removed as well as 100 cy of soil. Cost: $706,670; Contract: N62467-93-D-1106 D.O. 14
1997	
June	The Final Field Sampling Plan for OU3 RI/FS (Brown & Root Environmental) was issued.
June 25, 1997 - March 25, 1998	Phases I and II of the field investigation for OU3 as part of the RI/F activities were completed.
February	Updated and issued Community Relations Plan.
July	The Work Plan for Operable Unit 3 Remedial Investigation/Feasibility Study (Brown & Root Environmental) was issued.
September 22, 1997 – January 13, 1998	Phase I of MK contract to construct GWTF (outside portion of work). Cost: $1,291,628; Contract: N62467-93-D-1106 D.O. 039
1998	
March 30, 1998- November 14, 1998	Phase II of MK contract to construct GWTF (inside portion of work). Cost: $3,204,359; Contract: N62467-93-D-1106 D.O. 042
August	The OU3 RI Report, Rev. 0 (TtNUS) was issued.
November	Community Relations Plan updated and issued.
1999	
August	The OU3 RI Report, final Rev. 1 (TtNUS), was issued.
September	Community Relations Plan was updated and issued.
2000	
September	Upgrade of the extraction well hydraulic containment system. Cost: $1,300,000
September	Anoka County Park Removal Action. Cost: $1,400,000

TABLE 1-2

SUMMARY OF SOIL ANALYTICAL RESULTS
FOCUSED FEASIBILITY STUDY FOR OPERABLE UNITS 2 AND 3
NIROP FRIDLEY, MINNESOTA

Analyte	Surface Soil (<4 Feet)[1]			Subsurface Soil (4 to 12 Feet)[2]			Subsurface Soil (>12 Feet)[3]		
	Frequency of Detection[4]	Concentration Range[5]	Location of Maximum Detection	Frequency of Detection[4]	Concentration Range[5]	Location of Maximum Detection	Frequency of Detection[4]	Concentration Range[5]	Location of Maximum Detection
Volatile Organic Compounds (ug/kg)									
1,1,1-Trichloroethane	4/57	1-56	003-SB-058-01	3/73	1-2	003-SB-035-02/ 003-SB-054-02	1/97	4	003-SB-058-05-BR
1,1,2-Trichloroethane	0/57	ND[5]	ND	2/73	8-9	SB-02-0406	0/97	ND	ND
1,1-Dichloroethane	1/57	2-9	003-SB-058-01	2/73	1-11	003-SB-032-03	1/97	1	003-SB-023-15-BR
1,2-Dichloroethene (total)	4/57	3-15	003-SB-073-01	4/73	1-15000	003-SB-032-03	15/97	1-290	003-SB-32D-08
2-Butanone	32/57	1-190	003-SB-30D-01	37/73	1-210	003-SB-29D-01	61/97	1-370	003-SB-28D-08
2-Hexanone	3/57	1-26	003-SB-P11-01-D	6/73	1-4	003-SB-037-03	4/97	3-16	003-SB-33D-11
4-Methyl-2-pentanone	30/57	1-120	003-SB-30D-01	47/73	1-150	003-SB-028-02	59/97	2-260	003-SB-32D-04
Acetone	28/57	3-770	003-SB-32D-01	38/73	3-1700	003-SB-032-03	55/97	4-1000	003-SB-32D-07
Benzene	0/57	ND	ND	2/73	1-24	003-SB-032-03	0/97	ND	ND
Bromomethane	1/57	2	003-SB-054-01	3/73	1-2	003-SB-063-03	0/97	ND	ND
Carbon Disulfide	8/57	1-13	003-SB-029-01	4/73	5-14	003-SB-054-02	11/97	1-18	003-SB-31D-12
Chlorobenzene	0/57	ND	ND	0/73	ND	ND	1/97	1	003-SB-P06-05-BR
Chloromethane	0/57	ND	ND	0/73	ND	ND	1/97	1	SB-06-1214
Ethylbenzene	4/57	1-10	003-SB-32D-01	5/73	4-720	003-SB-032-03	11/97	9-34	003-SB-29D-06
Styrene	3/57	4-33	003-SB-32D-01	2/73	1-54	003-SB-29D-01	12/97	10-72	003-SB-29D-06
Tetrachloroethene	9/57	1-90	SB-02-0204	9/73	1-760	SB-02-0406	5/97	1-3800	SB-07-1416
Toluene	21/57	1-14	003-SB-039-01	31/73	1-1000	003-SB-032-03	43/97	1-24	003-SB-28D-11
Trichloroethene	24/57	1-640	SB-01-0001	20/73	1-1100	SB-03-1012/ SB-05-1012	37/97	1-100000	SB-07-1416
Xylenes, Total	19/57	1-45	003-SB-32D-01	30/73	1-7300	003-SB-032-03	50/97	1-120	003-SB-29D-06
Semivolatile Organic Compounds (ug/kg)									
2-Methylnaphthalene	4/55	12-1000	003-SB-028-01	5/58	13-720	003-SB-032-03	0/7	ND	ND
4-Chloro-3-methylphenol	0/55	ND	ND	1/58	11000	003-SB-032-03	0/7	ND	ND
4-Methylphenol	0/55	ND	ND	0/58	ND	ND	1/7	320	SB-07-1416
Acenaphthene	8/55	11-650	003-SB-028-01	1/58	59	003-SB-054-02	0/7	ND	ND
Acenaphthylene	2/55	19-760	003-SB-017-01	1/58	20	003-SB-054-02	0/7	ND	ND
Anthracene	9/53	20-640	003-SB-017-01	3/57	12-510	003-SB-032-03	0/5	ND	ND
Benzo(a)anthracene	14/53	11-3500	003-SB-P03-01	3/57	18-280	003-SB-054-02	0/5	ND	ND
Benzo(a)pyrene	13/53	15-1700	003-SB-017-01	3/57	11-190	003-SB-054-02	0/5	ND	ND
Benzo(b)fluoranthene	13/53	12-3600	003-SB-P03-01	3/57	14-230	003-SB-054-02	0/5	ND	ND
Benzo(g,h,i)perylene	13/53	12-820	003-SB-P03-01	2/57	18-150	003-SB-054-02	0/5	ND	ND
Benzo(k)fluoranthene	14/53	14-1300	003-SB-017-01	3/57	15-190	003-SB-054-02	0/5	ND	ND
Bis(2-Ethylhexyl)phthalate	10/53	17-1200	SB-02-0204-D	13/57	16-4400	SB-02-0406	4/5	45-210	SB-07-1416
Butylbenzyl Phthalate	1/53	16	003-SB-P06-01	2/57	110-3600	003-SB-032-03	0/5	ND	ND
Carbazole	7/53	16-530	003-SB-P03-01	1/57	67	003-SB-054-02	0/5	ND	ND

TABLE 1-2

SUMMARY OF SOIL ANALYTICAL RESULTS
FOCUSED FEASIBILITY STUDY FOR OPERABLE UNITS 2 AND 3
NIROP FRIDLEY, MINNESOTA

Analyte	Surface Soil (<4 Feet)[1]			Subsurface Soil (4 to 12 Feet)[2]			Subsurface Soil (>12 Feet)[3]		
	Frequency of Detection[4]	Concentration Range[5]	Location of Maximum Detection	Frequency of Detection[4]	Concentration Range[5]	Location of Maximum Detection	Frequency of Detection[4]	Concentration Range[5]	Location of Maximum Detection
Chrysene	15/53	11-1700	003-SB-017-01	4/57	13-240	003-SB-054-02	0/5	ND	ND
Di-n-butyl phthalate	3/53	13-28	003-SB-017-01	4/57	15-140	SB-02-0406	1/5	43	SB-07-1416
Di-n-octyl phthalate	2/53	12-40	003-SB-073-01	1/57	84	003-SB-030-02	0/5	ND	ND
Dibenzo(a,h)anthracene	9/53	11-400	003-SB-017-01	1/57	50	003-SB-054-02	0/5	ND	ND
Dibenzofuran	3/53	11-250	003-SB-017-01	2/57	41-78	SB-02-0406	0/5	ND	ND
Fluoranthene	18/53	10-5600	003-SB-017-01	6/57	12-840	003-SB-054-02	0/5	ND	ND
Fluorene	8/53	15-760	003-SB-028-01	1/57	44	003-SB-054-02	0/5	ND	ND
Indeno(1,2,3-cd)pyrene	12/53	15-1100	003-SB-P03-01	2/57	20-120	003-SB-054-02	0/7	ND	ND
Naphthalene	2/55	55-78	003-SB-P03-01	4/58	56-2300	003-SB-032-03	0/5	ND	ND
Pentachlorophenol	0/53	ND	ND	1/57	50	003-SB-054-02	0/5	ND	ND
Phenanthrene	12/53	29-5000	003-SB-P03-01	7/57	23-570	003-SB-054-02	0/5	ND	ND
Phenol	2/55	45-54	003-SB-046-01-D	1/58	120	003-SB-058-03	0/7	ND	ND
Pyrene	19/53	12-4800	003-SB-P03-01	7/57	11-590	003-SB-054-02	0/5	ND	ND
Polychlorinated Biphenyls (ug/kg)									
Aroclor-1016	1/51	150	003-SB-030-01	0/55	ND	ND	0/4	ND	ND
Aroclor-1254	2/51	230-290	003-SB-050-01-D	0/55	ND	ND	0/4	ND	ND
Inorganics (mg/kg)									
Aluminum	55/55	498-7830	003-SB-037-01-D	58/58	1090-7090	003-SB-035-02	7/7	1700-5450	SB-01-1416
Antimony	5/49	2.8-3.4	003-SB-017-01	0/51	ND	ND	0/7	ND	ND
Arsenic	52/55	0.42-13.8	003-SB-071-01	48/58	0.25-13.6	003-SB-032-03	7/7	0.46-2.8	SB-07-1416
Barium	55/55	7.3-201	SB-03-0001	57/58	5.4-70.4	003-SB-032-03	3/7	12-55.2	SB-01-1416
Beryllium	34/55	0.07-0.7	003-SB-058-01	35/58	0.05-0.44	003-SB-035-02	5/7	0.17-0.23	SB-01-1416
Cadmium	3/55	0.46-0.75	003-SB-035-01	1/58	0.38	003-SB-039-03	0/7	ND	ND
Calcium	55/55	768-34100	003-SB-028-01	58/58	791-46500	003-SB-038-03	7/7	3490-31900	SB-07-1416
Chromium	55/55	3.6-91	003-SB-036-01	54/58	3.7-618	SB-02-0406	2/7	12.7-15.9	SB-01-1416
Cobalt	52/55	2.4-10.4	003-SB-058-01-D	55/58	1.6-11.4	003-SB-P09-03	7/7	2.2-5.4	SB-07-1416
Copper	50/55	0.8-1360	003-SB-035-01	52/58	0.69-57.7	SB-07-0406	5/7	4.8-11.8	SB-01-1416
Cyanide	2/55	1.1-90.4	SB-02-0204-D	2/58	140-148	SB-07-0406	1/7	2.9	SB-01-1416
Hexavalent Chromium	3/17	2-6	003-SB-035-01	0/18	ND	ND	NA[7]	NA	NA
Iron	55/55	2430-48400	003-SB-017-01	58/58	3400-23300	003-SB-032-03	7/7	3920-11100	SB-01-1416
Lead	55/55	1.6-733	003-SB-017-01	56/58	0.88-515	SB-07-0406	7/7	1.1-5.2	SB-07-1416
Magnesium	55/55	153-14100	003-SB-035-01	58/58	286-20000	003-SB-038-03	7/7	1480-11400	SB-01-1416
Manganese	55/55	31.2-2490	SB-03-0001	58/58	35.2-1180	003-SB-055-02	7/7	79.7-406	SB-07-1416
Mercury	9/55	0.05-0.19	003-SB-013-01	8/58	0.06-0.32	003-SB-013-02	0/7	ND	ND
Nickel	51/55	4.9-33.5	003-SB-035-01	52/58	3.6-24.7	003-SB-P09-03	1/7	20.5	SB-01-1416
Potassium	55/55	147-1130	003-SB-037-01	58/58	154-1350	003-SB-035-02	7/7	198-1130	SB-07-1416
Selenium	1/47	0.8-1.3	003-SB-058-01	1/49	0.4	003-SB-004-03	0/7	ND	ND

TABLE 1-2

SUMMARY OF SOIL ANALYTICAL RESULTS
FOCUSED FEASIBILITY STUDY FOR OPERABLE UNITS 2 AND 3
NIROP FRIDLEY, MINNESOTA

Analyte	Surface Soil (<4 Feet)[1]			Subsurface Soil (4 to 12 Feet)[2]			Subsurface Soil (>12 Feet)[3]		
	Frequency of Detection[4]	Concentration Range[5]	Location of Maximum Detection	Frequency of Detection[4]	Concentration Range[5]	Location of Maximum Detection	Frequency of Detection[4]	Concentration Range[5]	Location of Maximum Detection
Sodium	54/55	36.7-364	003-SB-028-01	50/58	41.9-487	003-SB-068-03	4/7	81.8-337	SB-07-1416
Thallium	4/53	0.18-0.24	003-SB-047-01	0/56	ND	ND	0/7	ND	ND
Vanadium	55/55	2-35.6	003-SB-058-01-D	58/58	4.9-35.3	003-SB-032-03	7/7	9.4-23.4	SB-01-1416
Zinc	51/55	7.9-479	003-SB-035-01	52/58	8.7-207	003-SB-028-02	5/7	11.6-29.5	SB-07-1416
Miscellaneous (mg/kg)									
Total Organic Carbon	12/12	740-19000	003-SB-016-01	13/13	480-2200	003-SB-004-03	NA	NA	NA
pH	14/14	6.85-11.51	SB-01-0001	7/7	5.63-9.24	SB-01-0608	7/7	7.55-8.66	SB-07-1416

1 Includes samples:

003-SB-003-01	003-SB-023-01	003-SB-037-01-D	003-SB-063-01	003-SB-P04-01	SB-01-0001
003-SB-004-01	003-SB-026-01	003-SB-038-01	003-SB-068-01	003-SB-P05-01	SB-01-0001-D
003-SB-004-01-D	003-SB-027-01	003-SB-039-01	003-SB-070-01	003-SB-P06-01	SB-02-0001
003-SB-006-01	003-SB-028-01	003-SB-046-01	003-SB-071-01	003-SB-P07-01	SB-02-0204
003-SB-007-01	003-SB-029-01	003-SB-046-01-D	003-SB-073-01	003-SB-P08-01	SB-02-0204-D
003-SB-008-01	003-SB-030-01	003-SB-047-01	003-SB-074-01	003-SB-P09-01	SB-03-0001
003-SB-013-01	003-SB-032-01	003-SB-050-01	003-SB-074-01-D	003-SB-P09-01-D	SB-04-0001
003-SB-015-01	003-SB-033-01	003-SB-050-01-D	003-SB-30D-01	003-SB-P10-01	SB-05-0001
003-SB-015-01-D	003-SB-034-01	003-SB-054-01	003-SB-32D-01	003-SB-P10-01-D	SB-06-0002
003-SB-016-01	003-SB-035-01	003-SB-055-01	003-SB-P01-01	003-SB-P11-01	
003-SB-017-01	003-SB-036-01	003-SB-058-01	003-SB-P02-01	003-SB-P11-01-D	
003-SB-018-01	003-SB-037-01	003-SB-058-01-D	003-SB-P03-01	003-SB-P12-01	

2 Includes samples:

003-SB-003-02	003-SB-027-03	003-SB-039-03	003-SB-074-03	003-SB-P06-02-BR	SB-05-1012
003-SB-004-03	003-SB-028-02	003-SB-046-03	003-SB-28D-01	003-SB-P06-03	SB-06-0608
003-SB-006-03	003-SB-029-02	003-SB-047-03	003-SB-29D-01	003-SB-P07-03	SB-07-0406
003-SB-007-02	003-SB-030-02	003-SB-050-02	003-SB-31D-01	003-SB-P08-03	
003-SB-007-03	003-SB-030-03	003-SB-054-02	003-SB-31D-02	003-SB-P09-02	
003-SB-008-02	003-SB-032-03	003-SB-055-02	003-SB-33D-01	003-SB-P09-03	
003-SB-013-02	003-SB-033-03	003-SB-055-03	003-SB-33D-02	003-SB-P10-03	
003-SB-015-03	003-SB-034-03	003-SB-058-02	003-SB-P01-02	003-SB-P11-03	

2 Includes samples: (continued)

003-SB-016-03	003-SB-035-02	003-SB-058-03	003-SB-P01-03-BR	003-SB-P12-03
003-SB-017-03	003-SB-036-02	003-SB-063-03	003-SB-P02-02	SB-01-0608
003-SB-018-02	003-SB-036-03	003-SB-068-03	003-SB-P02-03	SB-02-0406
003-SB-023-03	003-SB-037-02	003-SB-070-03	003-SB-P03-03	SB-02-0608

TABLE 1-2

SUMMARY OF SOIL ANALYTICAL RESULTS
FOCUSED FEASIBILITY STUDY FOR OPERABLE UNITS 2 AND 3
NIROP FRIDLEY, MINNESOTA

Analyte	Surface Soil (<4 Feet)[1]			Subsurface Soil (4 to 12 Feet)[2]			Subsurface Soil (>12 Feet)[3]		
	Frequency of Detection[4]	Concentration Range[5]	Location of Maximum Detection	Frequency of Detection[4]	Concentration Range[5]	Location of Maximum Detection	Frequency of Detection[4]	Concentration Range[5]	Location of Maximum Detection
003-SB-026-03	003-SB-037-03		003-SB-071-03		003-SB-P04-03		SB-03-1012		
003-SB-027-02	003-SB-038-03		003-SB-073-03		003-SB-P05-02		SB-04-1012		
3 Includes samples:									
003-SB-007-05-BR	003-SB-28D-04		003-SB-29D-11		003-SB-31D-08		003-SB-32D-12		003-SB-P06-05-BR
003-SB-007-11-BR	003-SB-28D-05		003-SB-29D-12		003-SB-31D-09		003-SB-32D-12-D		003-SB-P06-07-BR
003-SB-023-05-BR	003-SB-28D-06		003-SB-29D-13		003-SB-31D-09-D		003-SB-32D-13		003-SB-P09-05-BR
003-SB-023-15-BR	003-SB-28D-07		003-SB-29D-14		003-SB-31D-10		003-SB-33D-03		003-SB-P09-09-BR
003-SB-027-05-BR	003-SB-28D-08		003-SB-30D-02		003-SB-31D-11		003-SB-33D-04		003-SB-P12-05-BR
003-SB-027-06-BR	003-SB-28D-09		003-SB-30D-03		003-SB-31D-12		003-SB-33D-05		003-SB-P12-11-BR
003-SB-030-04-BR	003-SB-28D-10		003-SB-30D-04		003-SB-31D-13		003-SB-33D-06		SB-01-1416
003-SB-036-05-BR	003-SB-28D-10-D		003-SB-30D-05		003-SB-32D-02		003-SB-33D-06-D		SB-03-1214
003-SB-036-05-BR-D	003-SB-28D-11		003-SB-30D-06		003-SB-32D-02-D		003-SB-33D-07		SB-04-1214
003-SB-036-07-BR	003-SB-29D-02		003-SB-30D-07		003-SB-32D-03		003-SB-33D-08		SB-05-1315
003-SB-037-05-BR	003-SB-29D-03		003-SB-30D-08		003-SB-32D-04		003-SB-33D-09		SB-06-1214
003-SB-037-10-BR	003-SB-29D-04		003-SB-30D-09		003-SB-32D-05		003-SB-33D-10		SB-07-1416
003-SB-055-05-BR	003-SB-29D-05		003-SB-30D-10		003-SB-32D-05-D		003-SB-33D-11		SB-07-2830
003-SB-058-05-BR	003-SB-29D-06		003-SB-31D-03		003-SB-32D-06		003-SB-33D-12		
003-SB-058-05-BR-D	003-SB-29D-06-D		003-SB-31D-04		003-SB-32D-07		003-SB-P01-05-BR		
003-SB-058-15-BR	003-SB-29D-07		003-SB-31D-05		003-SB-32D-08		003-SB-P01-09-BR		
003-SB-063-04-BR	003-SB-29D-08		003-SB-31D-05-D		003-SB-32D-09		003-SB-P02-05-BR		
003-SB-063-14-BR	003-SB-29D-09		003-SB-31D-06		003-SB-32D-10		003-SB-P02-05-BR-D		
003-SB-28D-03	003-SB-29D-10		003-SB-31D-07		003-SB-32D-11		003-SB-P02-15-BR		

4 Frequency of detection determined considering a duplicate pair as one sample.
5 Concentration range determined considering duplicate sample results as individual data points.
6 Not Detected.
7 Not Analyzed.

TABLE 1-3

SUMMARY OF GROUNDWATER ANALYTICAL RESULTS - UNFILTERED
FOCUSED FEASIBILITY STUDY FOR OPERABLE UNITS 2 AND 3
NIROP FRIDLEY, MINNESOTA

Analyte	Shallow Wells[1]			Intermediate Wells[2]			Deep Wells[3]		
	Frequency of Detection[4]	Concentration Range[5]	Location of Maximum Detection	Frequency of Detection[4]	Concentration Range[5]	Location of Maximum Detection	Frequency of Detection[4]	Concentration Range[5]	Location of Maximum Detection
Volatile Organic Compounds (ug/L)									
1,1,1-Trichloroethane	22/57	0.2-690	003-TW-033-01	0/6	ND[6]	ND	0/6	ND	ND
1,1,2-Trichloroethane	4/57	0.2-1	003-TW-033-01	0/6	ND	ND	0/6	ND	ND
1,1-Dichloroethane	39/57	0.2-110	003-TW-017-01	5/6	2.4-17	003-MS-30I-01	1/6	0.9	003-MS-28D-01
1,1-Dichloroethene	37/57	0.2-380	003-TW-033-01	5/6	0.9-13	003-MS-32I-01	1/6	0.3	003-MS-28D-01
1,2-Dichloroethane	6/57	0.3-8.2	003-TW-033-01	1/6	1.7	003-MS-30I-01	0/6	ND	ND
1,2-Dichloroethene (total)	3/3	100-12000	GW-01	NA[7]	NA	NA	NA	NA	NA
2-Butanone	1/3	270	GW-02-D	R[8]	R	R	R	R	R
Acetone	1/5	0.2	003-TW-070-01	R	R	R	R	R	R
Benzene	1/57	0.2	003-TW-017-01	0/6	ND	ND	0/6	ND	ND
Carbon Disulfide	1/57	31	GW-02-D	0/6	ND	ND	0/6	ND	ND
Chloroform	1/57	0.7	003-TW-039-01	0/6	ND	ND	0/6	ND	ND
Chloromethane	7/57	0.2-0.5	003-MS-30S-01	3/6	0.3-1.2	003-MS-33I-01	3/6	0.2-0.6	003-MS-31D-01
cis-1,2-dichloroethene	42/54	0.2-1500	003-TW-017-01	5/6	5-580	003-MS-33I-01	6/6	1.2-11	003-MS-28D-01
Ethylbenzene	4/57	0.2-820	003-TW-P04-01	2/6	0.2-0.3	003-MS-33I-01/ 003-MS-33I-01-D	0/6	ND	ND
M+p-Xylenes	4/54	0.5-780	003-TW-P04-01	2/6	0.2-0.7	003-MS-33I-01	0/6	ND	ND
Methylene Chloride	1/57	640	003-TW-P10-01	0/6	ND	ND	0/6	ND	ND
o-Xylene	4/54	0.3-750	003-TW-P04-01	1/6	0.3-1	003-MS-33I-01-D	0/6	ND	ND
Tetrachloroethene	28/57	0.2-160	GW-01	3/6	3.8-6.8	003-MS-33I-01	4/6	0.3-22	003-MS-33D-01
Toluene	5/57	0.4-240	003-TW-P10-01	2/6	0.6-1.6	003-MS-33I-01	1/6	0.2	003-MS-28D-01
Trans-1,2-dichloroethene	36/54	0.2-1900	003-TW-P10-01	4/6	0.7-1400	003-MS-32I-01-D	4/6	0.3-1.6	003-MS-32D-01
Trichloroethene	54/57	0.6-140000	GW-01	5/6	150-59000	003-MS-33I-01	6/6	0.7-61	003-MS-28D-01
Vinyl Chloride	13/57	0.2-40	003-TW-P09-01	4/6	0.4-9.5	003-MS-33I-01-D	0/6	ND	ND
Semivolatile Organic Compounds (ug/L)									
2,4-Dimethylphenol	2/57	3-5	GW-01	0/6	ND	ND	0/6	ND	ND
2-Methylnaphthalene	1/57	2	003-TW-026-01	0/6	ND	ND	0/6	ND	ND
2-Methylphenol	1/57	2	GW-01	0/6	ND	ND	0/6	ND	ND
4-Chloro-3-methylphenol	1/57	9	003-TW-032-01	0/6	ND	ND	0/6	ND	ND
4-Methylphenol	1/57	11	GW-01	0/6	ND	ND	0/6	ND	ND
Bis(2-Ethylhexyl)phthalate	4/57	1	003-TW-023-01/ 003-TW-036-01/ 003-TW-P01-01/ 003-TW-P12-01	0/6	ND	ND	0/6	ND	ND

TABLE 1-3

SUMMARY OF GROUNDWATER ANALYTICAL RESULTS - UNFILTERED
FOCUSED FEASIBILITY STUDY FOR OPERABLE UNITS 2 AND 3
NIROP FRIDLEY, MINNESOTA

Analyte	Shallow Wells[1]			Intermediate Wells[2]			Deep Wells[3]		
	Frequency of Detection[4]	Concentration Range[5]	Location of Maximum Detection	Frequency of Detection[4]	Concentration Range[5]	Location of Maximum Detection	Frequency of Detection[4]	Concentration Range[5]	Location of Maximum Detection
Butylbenzyl Phthalate	7/57	1-6	003-TW-008-01	0/6	ND	ND	0/6	ND	ND
Di-n-butyl phthalate	3/57	1	003-TW-006-01/ 003-TW-P02-01/ 003-TW-P08-01	0/6	ND	ND	1/6	1	003-MS-28D-01
Di-n-octyl phthalate	1/57	1	003-TW-070-01	0/6	ND	ND	0/6	ND	ND
Diethyl Phthalate	1/57	1	003-TW-032-01	0/6	ND	ND	0/6	ND	ND
Naphthalene	2/57	1-120	003-TW-026-01	0/6	ND	ND	0/6	ND	ND
Pentachlorophenol	2/57	1-3	003-TW-026-01	0/6	ND	ND	0/6	ND	ND
Phenol	3/57	5-10	GW-01	1/6	1	003-MS-33I-01-D	0/6	ND	ND
Inorganics (ug/L)									
Aluminum	25/57	25.3-19400	GW-01	1/6	567-712	003-MS-33I-01-D	1/6	36.3	003-MS-29D-01
Arsenic	19/57	1-11	GW-01	3/6	1.4-9.4	003-MS-32I-01-D	0/6	ND	ND
Barium	57/57	12.7-380	GW-01	6/6	7.3-89.7	003-MS-32I-01-D	6/6	27.9-64.5	003-MS-29D-01
Beryllium	7/57	0.3-0.7	003-TW-036-01	0/6	ND	ND	0/6	ND	ND
Calcium	57/57	50500-265000	003-TW-004-01	6/6	56600-375000	003-MS-31I-01	6/6	114000-202000	003-MS-30D-01
Chromium	45/57	6.4-286	GW-01	5/6	11.7-26.7	003-MS-31I-01	4/6	6.5-16.2	003-MS-30D-01
Cobalt	12/57	5.9-57.3	003-TW-036-01	0/6	ND	ND	0/6	ND	ND
Copper	15/57	3-172	GW-01	1/6	5.7	003-MS-28I-01	0/6	ND	ND
Cyanide	4/54	5.9-291	GW-01	2/6	7-8.6	003-MS-33I-01-D	2/6	6-9	003-MS-32D-01
Iron	55/57	515-27000	GW-01	6/6	2830-11000	003-MS-28I-01	6/6	465-2830	003-MS-31D-01
Lead	14/57	0.8-17.7	003-TW-036-01	0/6	ND	ND	1/6	1.7	003-MS-33D-01
Magnesium	57/57	10500-81900	003-TW-004-01	6/6	32000-110000	003-MS-31I-01	6/6	43000-63800	003-MS-30D-01
Manganese	56/57	19.5-3200	003-TW-018-01	6/6	251-1760	003-MS-31I-01	6/6	167-566	003-MS-30D-01
Mercury	2/57	0.21-0.26	003-TW-007-01	2/6	0.2-0.57	003-MS-33I-01-D	0/6	ND	ND
Nickel	26/57	5.1-87.9	003-TW-036-01	1/6	5.2	003-MS-33I-01	0/6	ND	ND
Potassium	57/57	1660-9430	GW-01	6/6	2630-4260	003-MS-28I-01	6/6	2290-3200	003-MS-31D-01
Selenium	21/51	1.9-142	003-TW-036-01	0/6	ND	ND	0/6	ND	ND
Sodium	57/57	5080-107000	003-TW-047-01	6/6	5690-132000	003-MS-33I-01-D	6/6	11600-29400	003-MS-31D-01
Thallium	3/57	1.1-2.2	003-MS-29S-01	0/6	ND	ND	0/6	ND	ND
Vanadium	14/57	2.1-53.9	GW-01	1/6	3.1	003-MS-32I-01-D	0/6	ND	ND
Zinc	17/57	13.5-159	GW-01	5/6	7.6-229	003-MS-29I-01	2/6	20.3-27.7	003-MS-28D-01

TABLE 1-3

SUMMARY OF GROUNDWATER ANALYTICAL RESULTS - UNFILTERED
FOCUSED FEASIBILITY STUDY FOR OPERABLE UNITS 2 AND 3
NIROP FRIDLEY, MINNESOTA

Analyte	Shallow Wells[1]			Intermediate Wells[2]			Deep Wells[3]		
	Frequency of Detection[4]	Concentration Range[5]	Location of Maximum Detection	Frequency of Detection[4]	Concentration Range[5]	Location of Maximum Detection	Frequency of Detection[4]	Concentration Range[5]	Location of Maximum Detection
1 Includes samples:									
003-MS-28S-01	003-TW-013-01		003-TW-030-01-D		003-TW-047-01-D		003-TW-074-01		003-TW-P10-01
003-MS-29S-01	003-TW-015-01		003-TW-032-01		003-TW-050-01		003-TW-P01-01		003-TW-P10-01-D
003-MS-30S-01	003-TW-016-01		003-TW-033-01		003-TW-054-01		003-TW-P02-01		003-TW-P11-01
003-MS-31S-01	003-TW-017-01		003-TW-034-01		003-TW-055-01		003-TW-P03-01		003-TW-P12-01
003-MS-32S-01	003-TW-018-01		003-TW-035-01		003-TW-058-01		003-TW-P04-01		GW-01
003-MS-33S-01	003-TW-023-01		003-TW-036-01		003-TW-063-01		003-TW-P05-01		GW-02
003-TW-003-01	003-TW-026-01		003-TW-037-01		003-TW-068-01		003-TW-P06-01		GW-02-D
003-TW-004-01	003-TW-027-01		003-TW-038-01		003-TW-070-01		003-TW-P06-01-D		GW-03
003-TW-006-01	003-TW-028-01		003-TW-039-01		003-TW-071-01		003-TW-P07-01		
003-TW-007-01	003-TW-029-01		003-TW-046-01		003-TW-073-01		003-TW-P08-01		
003-TW-008-01	003-TW-030-01		003-TW-047-01		003-TW-073-01-D		003-TW-P09-01		
2 Includes samples:									
003-MS-28I-01	003-MS-30I-01		003-MS-32I-01		003-MS-33I-01				
003-MS-29I-01	003-MS-31I-01		003-MS-32I-01-D		003-MS-33I-01-D				
3 Includes samples:									
003-MS-28D-01	003-MS-30D-01		003-MS-32D-01						
003-MS-29D-01	003-MS-31D-01		003-MS-33D-01						

4 Frequency of detection determined considering a duplicate pair as one sample.
5 Concentration range determined considering duplicate sample results as individual data points.
6 Not Detected.
7 Not Analyzed.
8 All results for this parameter in these samples were rejected during data validation.

TABLE 1-4

SUMMARY OF GROUNDWATER ANALYTICAL RESULTS - FILTERED
FOCUSED FEASIBILITY STUDY FOR OPERABLE UNITS 2 AND 3
NIROP FRIDLEY, MINNESOTA
PAGE 1 OF 2

Analyte	Shallow Wells[1]			Intermediate Wells[2]			Deep Wells[3]		
	Frequency of Detection[4]	Concentration Range[5]	Location of Maximum Detection	Frequency of Detection[4]	Concentration Range[5]	Location of Maximum Detection	Frequency of Detection[4]	Concentration Range[5]	Location of Maximum Detection
INORGANICS (UG/L)									
Aluminum	1/57	196-370	GW-02-F	0/6	ND[6]	ND	0/6	ND	ND
Arsenic	17/57	1-22.9	003-TW-034-F1	3/6	1.1-8.9	003-MS-32I-F1-D	0/6	ND	ND
Barium	55/57	14.7-147	GW-01-F	5/6	30.3-90	003-MS-32I-F1-D	6/6	26.8-63.9	003-MS-29D-F1
Beryllium	7/57	0.3-0.4	003-TW-023-F1	0/6	ND	ND	0/6	ND	ND
Calcium	57/57	48100-265000	003-TW-004-F1	6/6	48300-371000	003-MS-31I-F1	6/6	117000-210000	003-MS-30D-F1
Chromium	41/57	5.9-20.1	003-MS-31S-F1	5/6	9.4-22	003-MS-31I-F1	6/6	6.8-18.2	003-MS-30D-F1
Cobalt	16/57	2.2-13.1	003-TW-038-F1	0/6	ND	ND	0/6	ND	ND
Copper	5/57	3.3-23.6	GW-01-F	0/6	ND	ND	0/6	ND	ND
Iron	54/57	348-17700	003-TW-P12-F1	6/6	1380-8990	003-MS-32I-F1-D	6/6	171-2510	003-MS-30D-F1
Lead	2/57	1.1-1.2	003-TW-073-F1	0/6	ND	ND	0/6	ND	ND
Magnesium	57/57	10100-81200	003-TW-004-F1	6/6	30600-109000	003-MS-31I-F1	6/6	43900-66300	003-MS-30D-F1
Manganese	57/57	3.8-2920	003-TW-018-F1	6/6	212-1740	003-MS-31I-F1	6/6	157-588	003-MS-30D-F1
Mercury	0/57	ND	ND	2/6	0.2-0.44	003-MS-28I-F1	0/6	ND	ND
Nickel	27/57	4.1-33.7	003-TW-016-F1	0/6	ND	ND	0/6	ND	ND
Potassium	57/57	1700-5930	003-TW-004-F1	6/6	2620-4280	003-MS-28I-F1	6/6	2310-3130	003-MS-31D-F1
Selenium	20/54	10.3-131	003-TW-036-F1	1/6	5.1	003-MS-32I-F1	0/6	ND	ND
Sodium	57/57	5460-110000	003-TW-047-F1	6/6	5790-129000	003-MS-33I-F1-D	6/6	12100-29600	003-MS-32D-F1
Thallium	3/57	1-1.9	003-TW-027-F1	0/6	ND	ND	0/6	ND	ND
Vanadium	7/57	2-4	003-TW-P06-F1-D	1/6	3.4	003-MS-33I-F1	0/6	ND	ND
Zinc	5/57	7.5-43.9	003-TW-006-F1	2/6	28.7-87.8	003-MS-29I-F1	1/6	17.7	003-MS-29D-F1

1 Includes samples:

003-MS-28S-F1	003-TW-003-F1	003-TW-015-F1	003-TW-027-F1	003-TW-033-F1
003-MS-29S-F1	003-TW-004-F1	003-TW-016-F1	003-TW-028-F1	003-TW-034-F1
003-MS-30S-F1	003-TW-006-F1	003-TW-017-F1	003-TW-029-F1	003-TW-035-F1
003-MS-31S-F1	003-TW-007-F1	003-TW-018-F1	003-TW-030-F1	003-TW-036-F1
003-MS-32S-F1	003-TW-008-F1	003-TW-023-F1	003-TW-030-F1-D	003-TW-037-F1
003-MS-33S-F1	003-TW-013-F1	003-TW-026-F1	003-TW-032-F1	003-TW-038-F1

TABLE 1-4

SUMMARY OF GROUNDWATER ANALYTICAL RESULTS - FILTERED
FOCUSED FEASIBILITY STUDY FOR OPERABLE UNITS 2 AND 3
NIROP FRIDLEY, MINNESOTA

1 Includes samples: (continued)

003-TW-039-F1	003-TW-058-F1	003-TW-074-F1	003-TW-P06-F1-D	003-TW-P12-F1
003-TW-046-F1	003-TW-063-F1	003-TW-P01-F1	003-TW-P07-F1	GW-01-F
003-TW-047-F1	003-TW-068-F1	003-TW-P02-F1	003-TW-P08-F1	GW-02-F
003-TW-047-F1-D	003-TW-070-F1	003-TW-P03-F1	003-TW-P09-F1	GW-02-F-D
003-TW-050-F1	003-TW-071-F1	003-TW-P04-F1	003-TW-P10-F1	GW-03-F
003-TW-054-F1	003-TW-073-F1	003-TW-P05-F1	003-TW-P10-F1-D	
003-TW-055-F1	003-TW-073-F1-D	003-TW-P06-F1	003-TW-P11-F1	

2 Includes samples:

003-MS-28I-F1	003-MS-32I-F1
003-MS-29I-F1	003-MS-32I-F1-D
003-MS-30I-F1	003-MS-33I-F1
003-MS-31I-F1	003-MS-33I-F1-D

3 Includes samples:

003-MS-28D-F1	003-MS-31D-F1
003-MS-29D-F1	003-MS-32D-F1
003-MS-30D-F1	003-MS-33D-F1

4 Frequency of detection determined considering a duplicate pair as one sample.
5 Concentration range determined considering duplicate sample results as individual data points.
6 Not Detected.

TABLE 1-5

CHEMICALS OF POTENTIAL CONCERN (COPCs)
SURFACE AND SUBSURFACE SOIL
FOCUSED FEASIBILITY STUDY FOR OPERABLE UNITS 2 AND 3
NIROP FRIDLEY, MINNESOTA

Chemical	Surface Soil (<4 Feet)	Subsurface Soil (4 to 12 Feet)	Subsurface Soil (>12 Feet)
Volatile Organic Compounds			
1,1,1-Trichloroethane	X	X	X
1,1,2-Trichloroethane		X	
1,1-Dichloroethane	X	X	X
1,1-Dichloroethene			
1,2-Dichloroethane			
1,2-Dichloroethene (total)	X	X	X
2-Butanone	X	X	X
2-Hexanone	X	X	X
4-Methyl-2-pentanone	X	X	X
Acetone	X	X	X
Benzene		X	
Bromomethane	X	X	
Carbon Disulfide	X	X	X
Chlorobenzene			X
Chloroform			
Chloromethane			X
cis-1,2-dichloroethene			
Ethylbenzene	X	X	X
Methylene Chloride			
Styrene	X	X	X
Tetrachloroethene	X	X	X
Toluene	X	X	X
Trans-1,2-dichloroethene			
Trichloroethene	X	X	X
Vinyl Chloride			
Xylenes, Total	X	X	X
Semivolatile Organic Compounds			
2,4-Dimethylphenol			
2-Methylnaphthalene	X	X	
2-Methylphenol			
4-Chloro-3-methylphenol		X	
4-Methylphenol			X
Acenaphthene	X	X	
Acenaphthylene	X	X	
Anthracene	X	X	
Benzo(a)anthracene	X	X	
Benzo(a)pyrene	X	X	
Benzo(b)fluoranthene	X	X	
Benzo(g,h,i)perylene	X	X	
Benzo(k)fluoranthene	X	X	
Bis(2-Ethylhexyl)phthalate	X	X	X
Butylbenzyl Phthalate	X	X	
Carbazole	X	X	
Chrysene	X	X	
Di-n-butyl phthalate	X	X	X
Di-n-octyl phthalate	X	X	
Diethyl Phthalate			
Dibenzo(a,h)anthracene	X	X	
Dibenzofuran	X	X	
Fluoranthene	X	X	
Fluorene	X	X	
Indeno(1,2,3-cd)pyrene	X	X	
Naphthalene	X	X	
Pentachlorophenol		X	
Phenanthrene	X	X	
Phenol	X	X	
Pyrene	X	X	
Polychlorinated Biphenyls			
Aroclor-1016	X		

TABLE 1-5

CHEMICALS OF POTENTIAL CONCERN (COPCs)
SURFACE AND SUBSURFACE SOIL
FOCUSED FEASIBILITY STUDY FOR OPERABLE UNITS 2 AND 3
NIROP FRIDLEY, MINNESOTA

Chemical	Surface Soil (<4 Feet)	Subsurface Soil (4 to 12 Feet)	Subsurface Soil (>12 Feet)
Aroclor-1254	X		
Inorganics			
Aluminum	X	X	X
Antimony	X		
Arsenic	X	X	X
Barium	X	X	X
Beryllium	X	X	X
Cadmium	X	X	
Calcium	X	X	X
Chromium	X	X	X
Cobalt	X	X	X
Copper	X	X	X
Cyanide	X	X	X
Hexavalent Chromium	X		
Iron	X	X	X
Lead	X	X	X
Manganese	X	X	X
Manganese	X	X	X
Mercury	X	X	
Nickel	X	X	X
Potassium	X	X	X
Selenium	X	X	
Sodium	X	X	X
Thallium	X		
Vanadium	X	X	X
Zinc	X	X	X

Notes:
In accordance with MPCA guidance any chemical detected in at least one sample is consider
An X indicates that the chemical was retained as a chemical of potential concern.

TABLE 1-6

SUMMARY OF CANCER RISKS AND HAZARD INDICES
SURFACE AND SUBSURFACE SOIL
FOCUSED FEASIBILITY STUDY FOR OPERABLE UNITS 2 AND 3
NIROP FRIDLEY, MINNESOTA

Receptor (1)	Cancer Risk	Chemicals with Cancer Risks $>10^{-4}$	Chemicals with Cancer Risks $>10^{-5}$	Chemicals with Cancer Risks $>10^{-6}$	Hazard Index	Chemicals with HI > 0.2
Industrial Workers	3.5E-06	--	--	Arsenic	< 0.10	--
Major Infrequent Construction Worker	2.1E-06	--	--	--	2.9	Arsenic, Total Chromium (2), Copper, Mercury
Minor Frequent Construction Worker	3.6E-06	--	--	Arsenic, Benzo(a)pyrene	0.046	--

Notes:

1 - Risks for industrial workers and minor frequent construction workers are based on site wide UCL concentration. Risks to major infrequent construction worker are based on maximum detected concentration in soil.

2 - Total chromium was evaluated as hexavalent chromium.

TABLE 1-7

CHEMICALS OF CONCERN (COCs)
SURFACE AND SUBSURFACE SOIL
FOCUSED FEASIBILITY STUDY FOR OPERABLE UNITS 2 AND 3
NIROP FRIDLEY, MINNESOTA

Chemical	Surface Soil (<4 Feet)	Subsurface Soil (4 to 12 Feet)	Receptor	Rationale
Metals				
Chromium		X	Industrial Worker	Exceeds SRV
		X	Major Infrequent Construction Worker	HQ > 0.2
		X	Minor Frequent Construction Worker	HQ > 0.2

Notes:
Chemicals retained as COCs for soil are those chemicals with cancer risks greater than 1×10^{-5}, HQs greater than 0.2, or a maximum detected contration greater than it's respective MPCA SRV.
An X indicates chemical is retained as a chemical of concern.

TABLE 1-8

CHEMICALS OF POTENTIAL CONCERN (COPCs)
GROUNDWATER
FOCUSED FEASIBILITY STUDY FOR OPERABLE UNITS 2 AND 3
NIROP FRIDLEY, MINNESOTA

Chemical	Shallow Groundwater	Intermediate Groundwater	Deep Groundwater
Volatile Organic Compounds			
1,1,1-Trichloroethane	X		
1,1,2-Trichloroethane	X		
1,1-Dichloroethane	X	X	X
1,1-Dichloroethene	X	X	X
1,2-Dichloroethane	X	X	
1,2-Dichloroethene (total)	X		
2-Butanone	X		
2-Hexanone			
4-Methyl-2-pentanone			
Acetone	X		
Benzene	X		
Bromomethane			
Carbon Disulfide	X		
Chlorobenzene			
Chloroform	X		
Chloromethane	X	X	X
cis-1,2-dichloroethene	X	X	X
Ethylbenzene	X	X	
Methylene Chloride	X		
Styrene			
Tetrachloroethene	X	X	X
Toluene	X	X	X
Trans-1,2-dichloroethene	X	X	X
Trichloroethene	X	X	X
Vinyl Chloride	X	X	
Xylenes, Total	X	X	
Semivolatile Organic Compounds			
2,4-Dimethylphenol	X		
2-Methylnaphthalene	X		
2-Methylphenol	X		
4-Chloro-3-methylphenol	X		
4-Methylphenol	X		
Acenaphthene			
Acenaphthylene			
Anthracene			
Benzo(a)anthracene			
Benzo(a)pyrene			
Benzo(b)fluoranthene			
Benzo(g,h,i)perylene			
Benzo(k)fluoranthene			
Bis(2-Ethylhexyl)phthalate	X		
Butylbenzyl Phthalate	X		
Carbazole			
Chrysene			
Di-n-butyl phthalate	X		X
Di-n-octyl phthalate	X		
Diethyl Phthalate	X		
Dibenzo(a,h)anthracene			
Dibenzofuran			
Fluoranthene			
Fluorene			
Indeno(1,2,3-cd)pyrene			
Naphthalene	X		
Pentachlorophenol	X		
Phenanthrene			
Phenol	X	X	
Pyrene			
Polychlorinated Biphenyls			
Aroclor-1016			

TABLE 1-8

CHEMICALS OF POTENTIAL CONCERN (COPCs)
GROUNDWATER
FOCUSED FEASIBILITY STUDY FOR OPERABLE UNITS 2 AND 3
NIROP FRIDLEY, MINNESOTA

Chemical	Shallow Groundwater	Intermediate Groundwater	Deep Groundwater
Aroclor-1254			
Inorganics			
Aluminum	X	X	X
Antimony			
Arsenic	X	X	
Barium	X	X	X
Beryllium	X		
Cadmium			
Calcium	X	X	X
Chromium	X	X	X
Cobalt	X		
Copper	X	X	
Cyanide	X	X	X
Hexavalent Chromium			
Iron	X	X	X
Lead	X		X
Manganese	X	X	X
Manganese	X	X	X
Mercury	X	X	
Nickel	X	X	
Potassium	X	X	X
Selenium	X		
Sodium	X	X	X
Thallium	X		
Vanadium	X	X	
Zinc	X	X	X

Notes:
In accordance with MPCA guidance any chemical detected in at least one sample is consider
An X indicates that the chemical was retained as a chemical of potential concern.

TABLE 1-9

SUMMARY OF CANCER RISKS AND HAZARD INDICES
GROUNDWATER
FOCUSED FEASIBILITY STUDY FOR OPERABLE UNITS 2 AND 3
NIROP FRIDLEY, MINNESOTA

Aquifer	Exposure Scenario	Cancer Risk	Chemicals with Cancer Risks $> 10^{-4}$	Chemicals with Cancer Risks $>10^{-5}$ and £ 10^{-4}	Chemicals with Cancer Risks ³ 10^{-6} and £ 10^{-5}	Chemicals with HI > 1.0
Upper Portion, Unconfined Aquifer	Potable Use	5.0E-02	Methylene Chloride, PCE, TCE, Vinyl Chloride, Arsenic	1,2-DCA, Beryllium	Pentachlorophenol	1,1-DCA, 1,1-DCE, cis-1,2-DCE, trans-1,2 DCE, Ethylbenzene, 4-Methylphenol, 1,1,1-TCA, Cobalt, Cyanide, Manganese, Selenium, Thallium, Vanadium
Lower Portion, Unconfined Aquifer	Potable Use	2.1E-02	TCE, Vinyl Chloride, Arsenic	- -	1,2-DCA, PCE	1,1-DCE, cis-1,2-DCE, trans-1,2-DCE, Manganese
Deep Aquifer	Potable Use	5.2E-05	- -	PCE, TCE	- -	Manganese

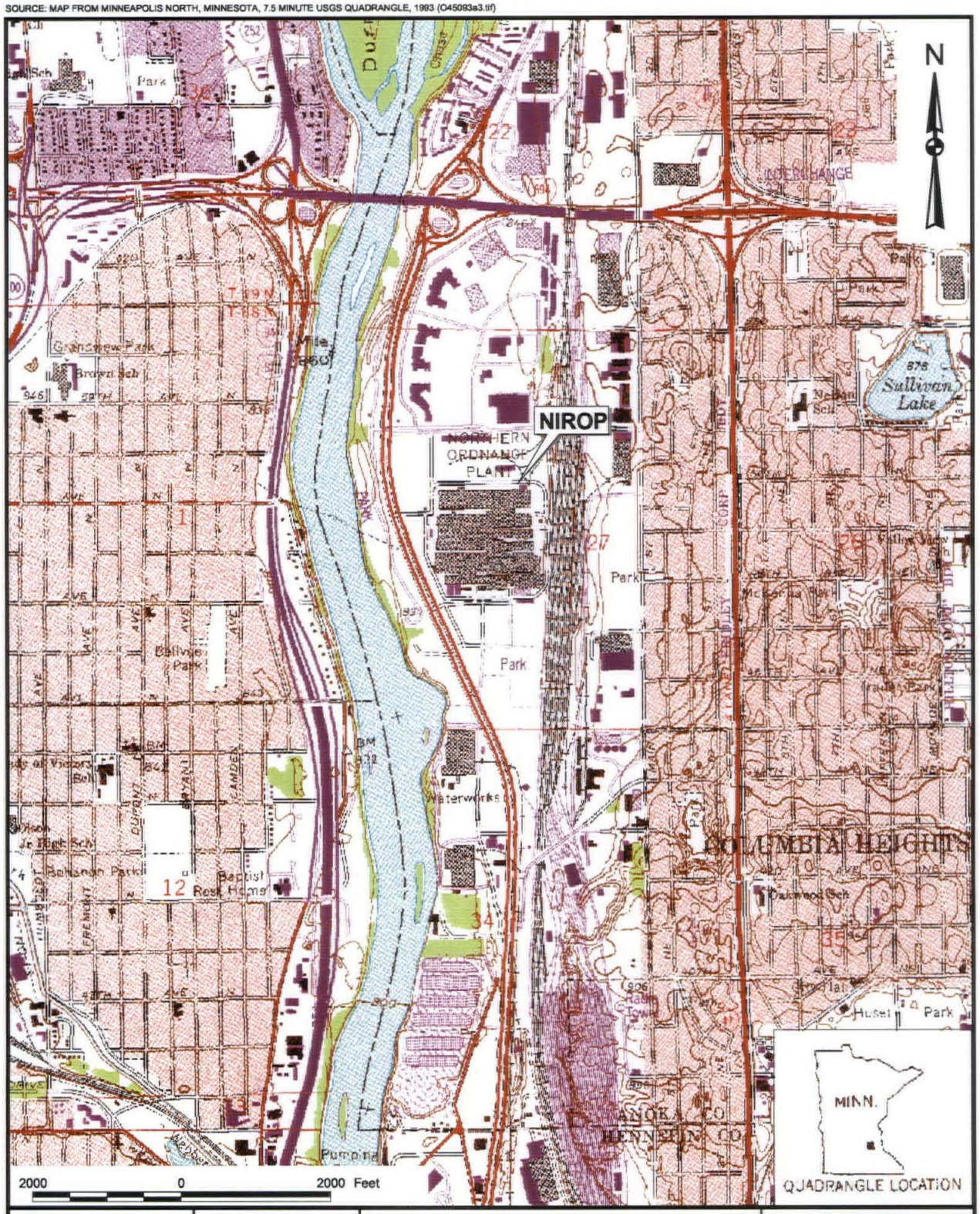
TABLE 1-10

CHEMICALS OF CONCERN (COCs)
GROUNDWATER
FOCUSED FEASIBILITY STUDY FOR OPERABLE UNITS 2 AND 3
NIROP FRIDLEY, MINNESOTA

Chemical	Shallow Groundwater	Intermediate Groundwater	Deep Groundwater
Volatile Organic Compounds			
1,1,1-Trichloroethane	X		
1,1-Dichloroethane	X		
1,1-Dichloroethene	X	X	
1,2-Dichloroethane	X		
cis-1,2-dichloroethene	X	X	
Ethylbenzene	X		
Methylene Chloride	X		
Tetrachloroethene	X		X
Trans-1,2-dichloroethene	X	X	
Trichloroethene	X	X	X
Vinyl Chloride	X	X	X
Semivolatile Organic Compounds			
4-Methylphenol	X		
Inorganics			
Aluminum	X	X	
Beryllium	X		
Chromium	X		
Cobalt	X		
Cyanide	X		
Iron	X	X	X
Manganese	X	X	X
Selenium	X		
Thallium	X		
Vanadium	X		

Notes:
An X indicates that the chemical was retained as a chemical of concern.
The chemicals of concern are those chemicals with maximum detected concentrations which exceed MPCA Health Risk Limits, Health Risk Values, and EPA Maximum Contaminant Levels.

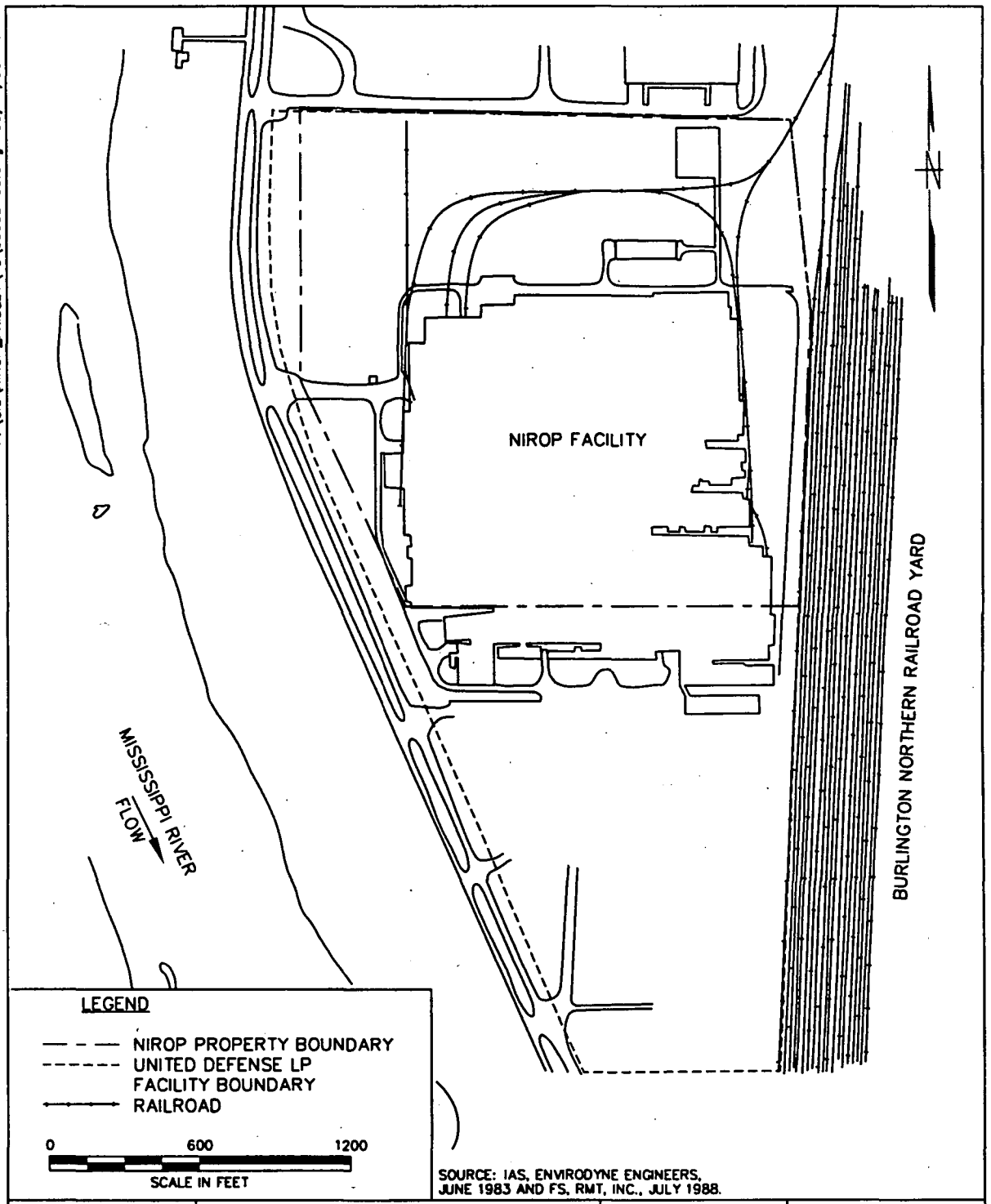
SOURCE: MAP FROM MINNEAPOLIS NORTH, MINNESOTA, 7.5 MINUTE USGS QUADRANGLE, 1993 (O45093a3.tif)



DRAWN BY D. PERRY	DATE 12-AUG-98	SITE LOCATION MAP FOCUSED FEASIBILITY STUDY FOR OPERABLE UNITS 2 AND 3 NAVAL INDUSTRIAL RESERVE ORDNANCE PLANT FRIDLEY, MINNESOTA	CONTRACT NUMBER —
CHECKED BY	DATE		APPROVED BY — DATE —
COST/SCHEDULE-AREA			APPROVED BY — DATE —
SCALE AS NOTED			DRAWING NO. FIGURE 1-1 / REV 0

P:\GIS\NIROP_FRIDLEY\FRIDLEY\6966_SITE_ASSESSMENT.APR 02-18-00 ACS LOCATION MAP LAYOUT

P:\GIS\NIROP_FRIDLEY\FS\6966BP05.dwg 08/17/98 HJP

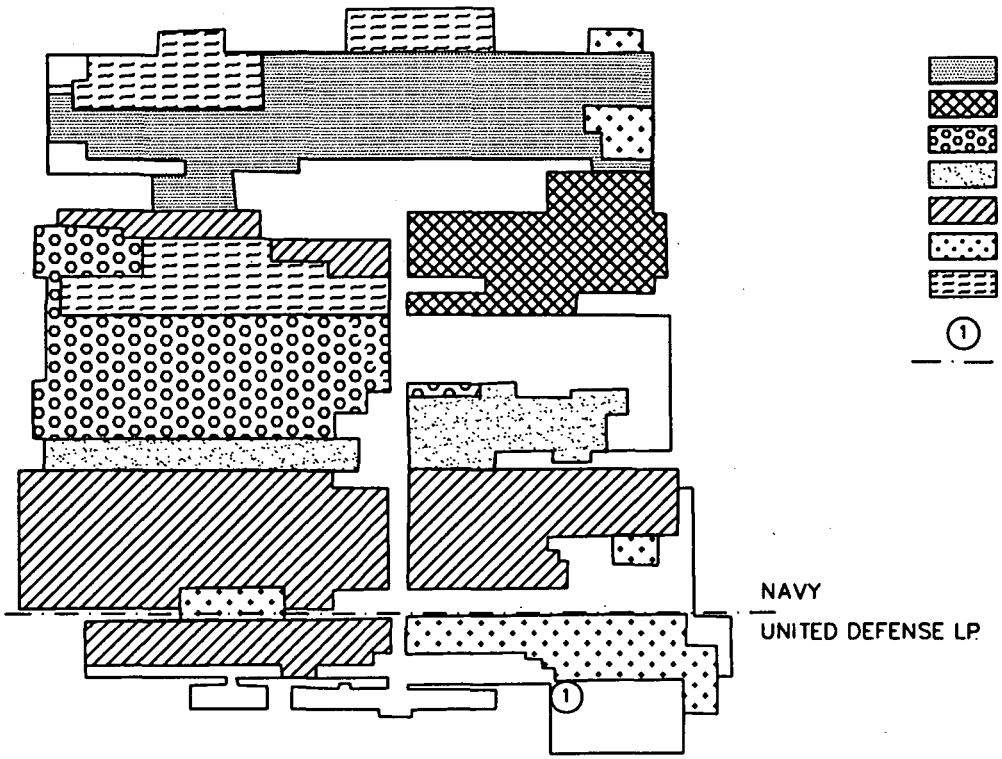


SOURCE: IAS, ENVIRODYNE ENGINEERS, JUNE 1983 AND FS, RMT, INC., JULY 1988.

DRAWN BY HJP 8/17/98	Tetra Tech NUS, Inc.	CONTRACT NO. 6966	OWNER NO. ———
CHECKED BY DATE	PROPERTY BOUNDARIES FOCUSED FEASIBILITY STUDY FOR OPERABLE UNITS 2 AND 3 NAVAL INDUSTRIAL RESERVE ORDNANCE PLANT FRIDLEY, MINNESOTA	APPROVED BY DATE	
COST/SCHED-AREA		APPROVED BY DATE	
SCALE AS NOTED		DRAWING NO. FIGURE 1-2	REV. 0

FORM CADD NO. T1NUS_AV.DWG - REV 0 - 1/22/98

ACAD: 6966KN02.dwg 02/22/00 HJP



LEGEND

- ASSEMBLY & PAINTING
- FOUNDRY
- WELDING
- HEAT TREAT & PLATING
- MACHINE SHOP
- TEST & INSPECTION & QA
- SHIPPING, RECEIVING & STORAGE
- (1) PHOTO LAB
- PROPERTY LINE

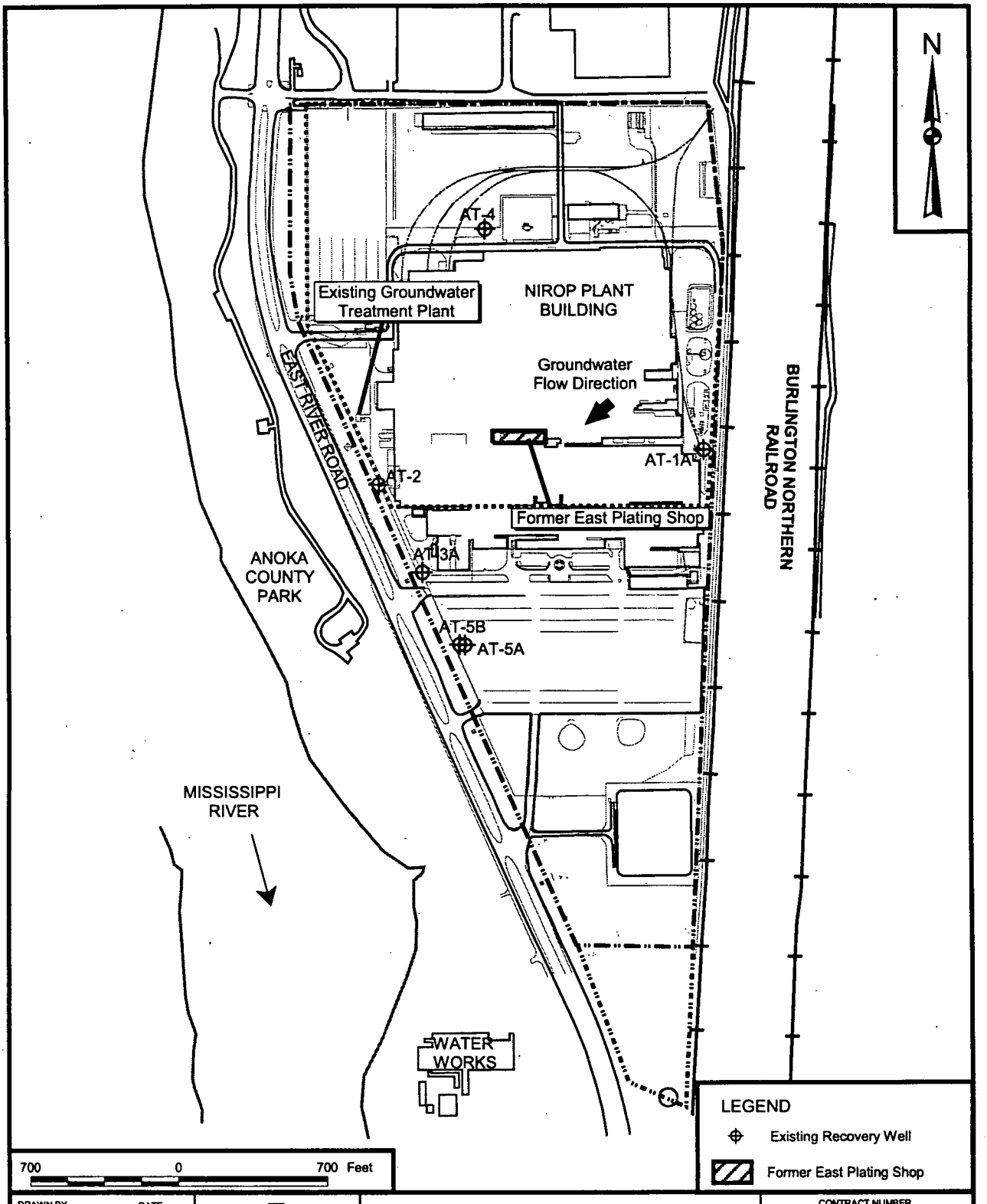
N

NOTE: LOCATIONS OF THE PRODUCTION AREAS HAVE VARIED OVER TIME. THE DATE OF THE PROCESS AREA LAYOUT SHOWN IS NOT KNOWN.

REFERENCE: REMEDIAL INVESTIGATION REPORT, RMT, JUNE 1987

DRAWN BY HJP DATE 2/22/00		FORMER INDUSTRAIL PROCESS AREAS WITHIN THE MAIN INDUSTRIAL PLANT BUILDING FOCUSED FEASIBILITY STUDY FOR OPERABLE UNITS 2 AND 3 NAVAL INDUSTRIAL RESERVE ORDNANCE PLANT FRIDLEY, MINNESOTA	CONTRACT NO. 6966
CHECKED BY DATE			APPROVED BY DATE
COST/SCHED-AREA			APPROVED BY DATE
SCALE NOT TO SCALE			DRAWING NO. FIGURE 1-3 REV. 0

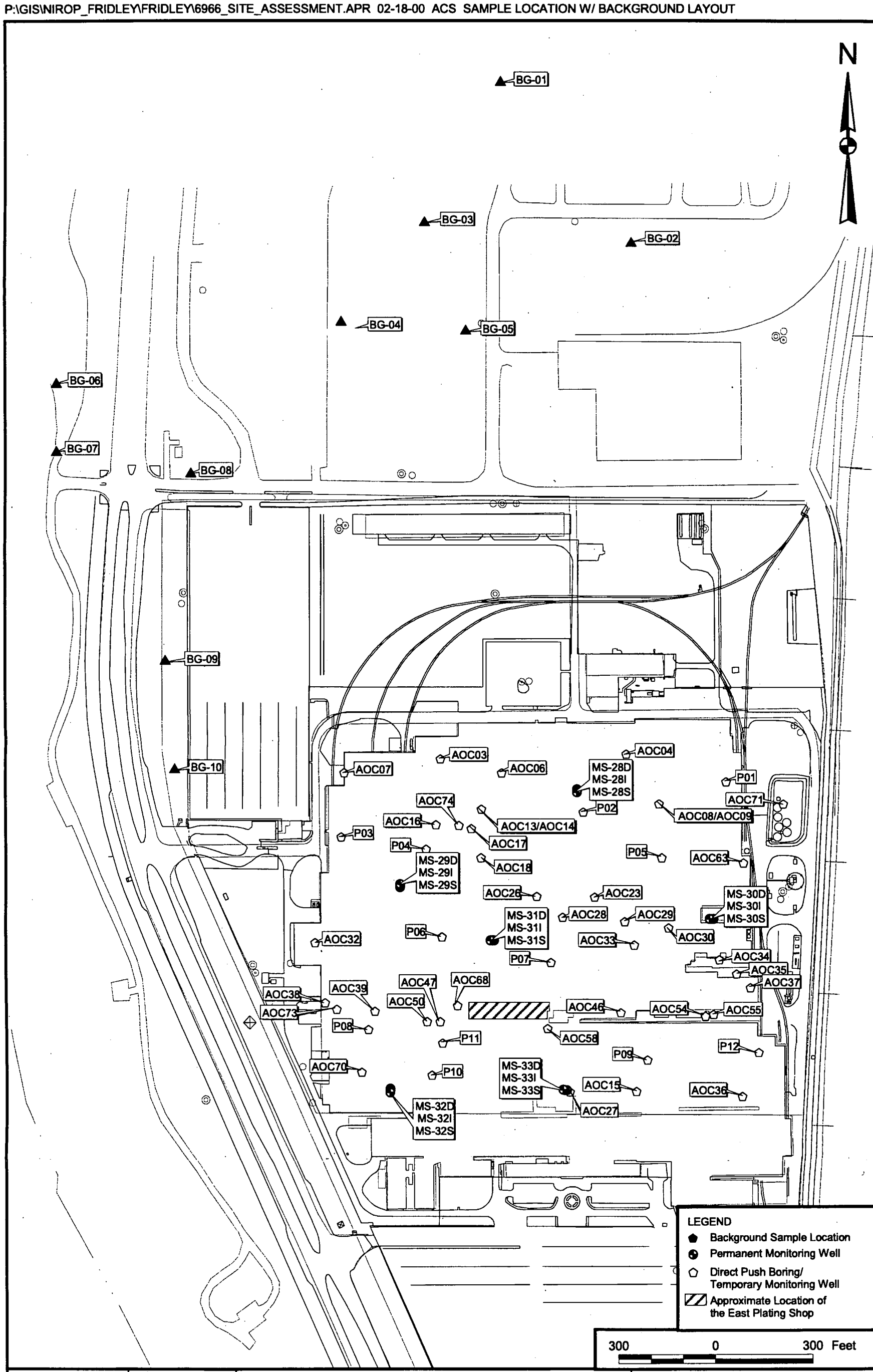
FORM CADD NO. SDIV_AHLDWG - REV 0 - 1/20/98



DRAWN BY T. BECKMAN	DATE 6-12-00	GROUNDWATER REMEDY FOCUSED FEASIBILITY STUDY FOR OPERABLE UNITS 2 AND 3 NAVAL INDUSTRIAL RESERVE ORDNANCE PLANT FRIDLEY, MINNESOTA	CONTRACT NUMBER 6966
CHECKED BY	DATE		APPROVED BY — DATE —
COST/SCHEDULE-AREA			APPROVED BY — DATE —
SCALE AS NOTED			DRAWING NO. FIGURE 1-4 REV 0

P:\GIS\NIROP_FRIDLEY\FS\ALTERNATIVES.APR GROUNDWATER REMEDY LAYOUT TLB 6-12-00

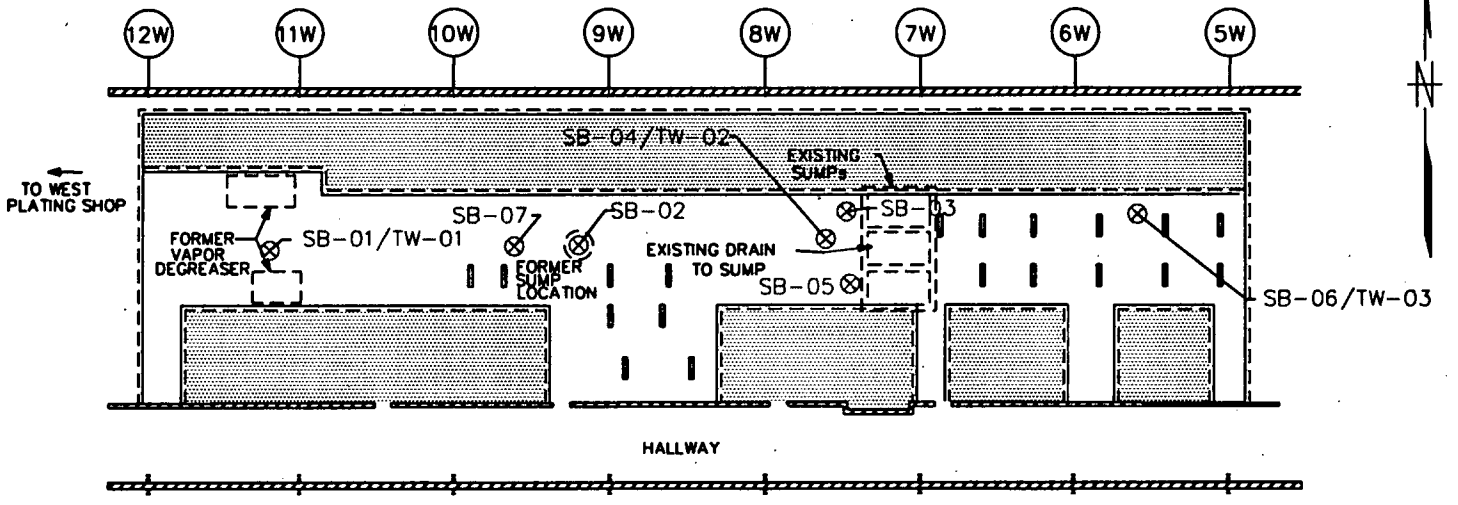
P:\GIS\NIROP_FRIDLEY\FRIDLEY\6966_SITE_ASSESSMENT.APR 02-18-00 ACS SAMPLE LOCATION W/ BACKGROUND LAYOUT



DRAWN BY D. PERRY	DATE 13-AUG-98	OU3 RI SAMPLE LOCATION MAP FOCUSED FEASIBILITY STUDY FOR OPERABLE UNITS 2 AND 3 NAVAL INDUSTRIAL RESERVE ORDNANCE PLANT FRIDLEY, MINNESOTA	CONTRACT NUMBER —
CHECKED BY —	DATE —		APPROVED BY — DATE —
COST/SCHEDULE-AREA			APPROVED BY — DATE —
SCALE AS NOTED			DRAWING NO. FIGURE 1-5 REV 0

ACAD: 6966gm09.dwg 08/17/98 HJP

DRAFT



LEGEND

9W	BUILDING COLUMN
	CONCRETE PIER
	FORMER SUMP LOCATION (PRE-1973)
	FORMER VAPOR DEGREASER LOCATION
SB-01/TW-01	SOIL BORING/ TEMPORARY WELL LOCATION

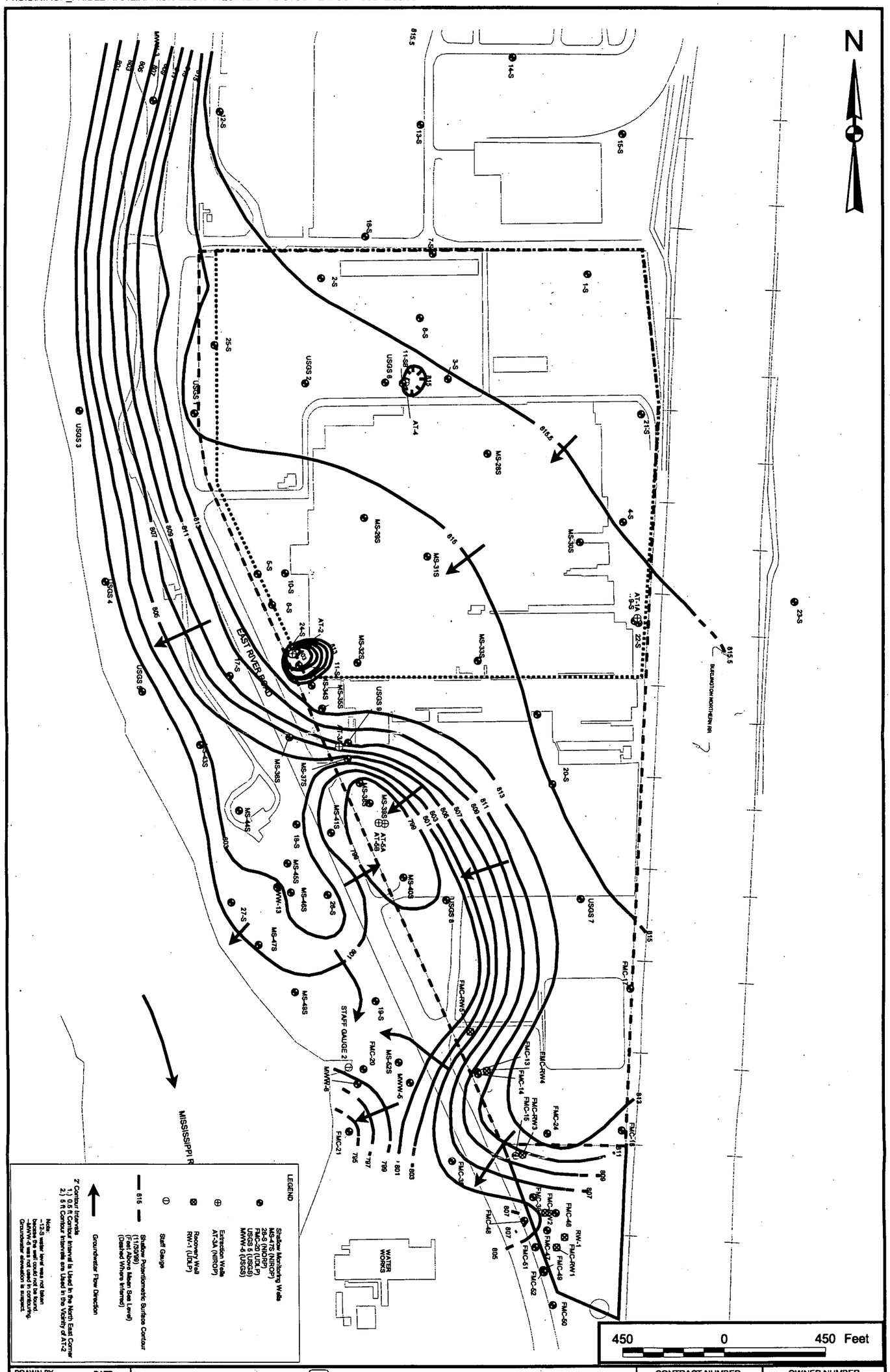
0 30 60
SCALE IN FEET

DRAWN BY HJP DATE 8/17/98	SOIL BORING AND TEMPORARY WELLL LICATIONS EAST PLATING SHOP SOIL AND GROUNDWATER INVESTIGATION FOCUSED FEASIBILITY STUDY FOR OPERABLE UNITS 2 AND 3 NAVAL INDUSTRIAL RESERVE ORDNANCE PLANT FRIDLEY, MINNESOTA	CONTRACT NO. 6966	
CHECKED BY DATE		APPROVED BY DATE	
COST/SCHED-AREA		APPROVED BY DATE	
SCALE AS NOTED		DRAWING NO. FIGURE 1-6	REV. 0

DEPARTMENT OF THE NAVY SOUTHERN DIV FACILITIES ENGINEERING COMD

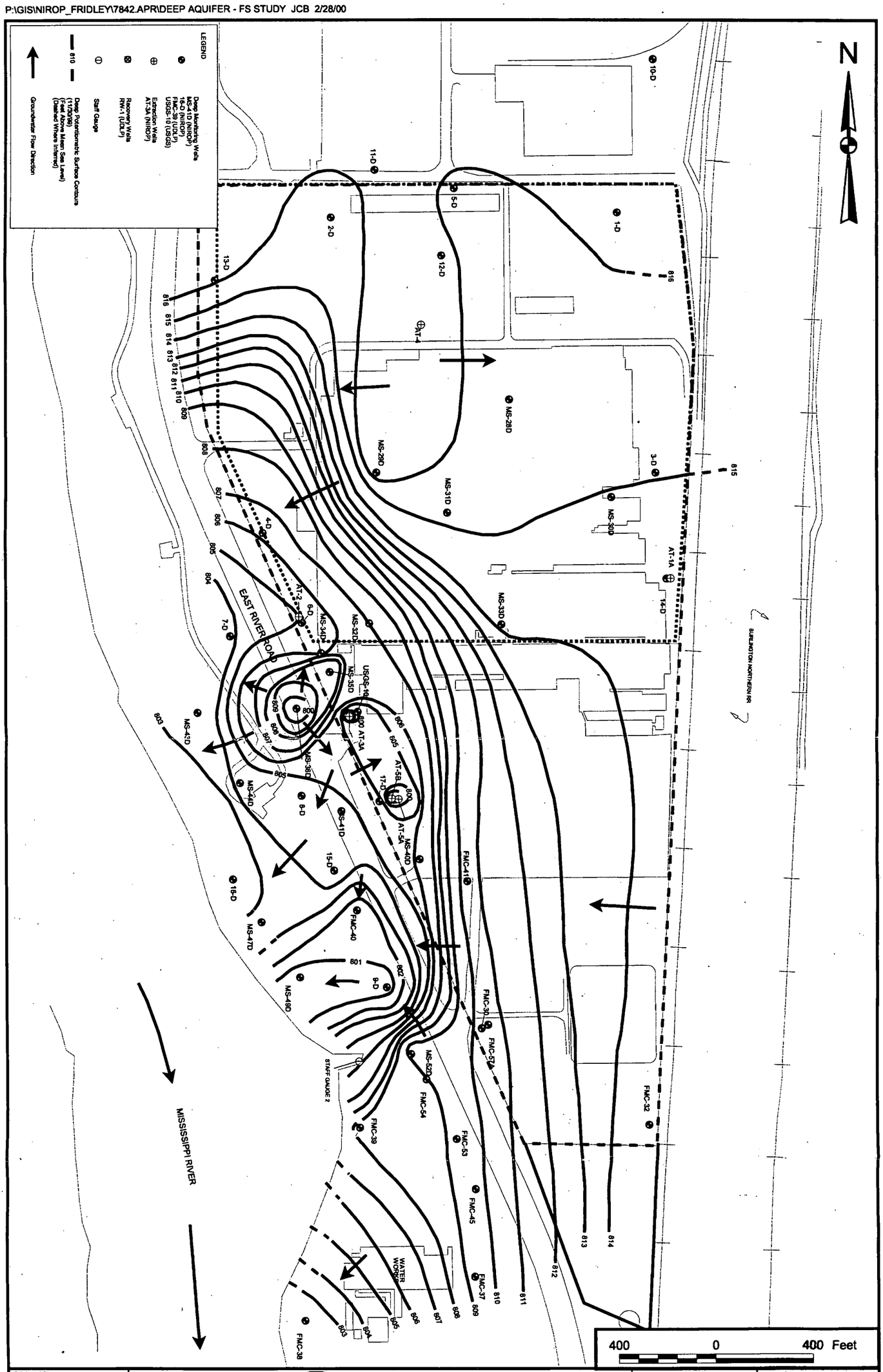
FORM CADD NO. SDIV_AHLDWG - REV 0 - 1/20/98

P:\GIS\NIROP_FRIDLEY\7842.APR\SHALLOW AQUIFIER - FS STUDY LAYOUT JCB 2/28/00



DRAWN BY J. BELLONE	DATE 2/25/00	Tetra Tech NUS, Inc.	CONTRACT NUMBER 6696 / OWNER NUMBER —
CHECKED BY —	DATE —	POTENTIOMETRIC SURFACE CONTOUR MAP SHALLOW AQUIFER FOCUSED FEASIBILITY STUDY FOR OPERABLE UNITS 2 AND 3 NAVAL INDUSTRIAL RESERVE ORDNANCE PLANT FRIDLEY, MINNESOTA	APPROVED BY — / DATE —
COST/SCHEDULE-AREA			APPROVED BY — / DATE —
SCALE AS NOTED			DRAWING NO. FIGURE 1-7 / REV 0

P:\GIS\NIROP_FRIDLEY\7842.APR\DEEP AQUIFER - FS STUDY JCB 2/28/00



DRAWN BY J. BELLONE	DATE 2/25/00	Tetra Tech NUS, Inc.	CONTRACT NUMBER 6696 / OWNER NUMBER —
CHECKED BY	DATE	POTENTIOMETRIC SURFACE CONTOUR MAP DEEP AQUIFER FOCUSED FEASIBILTY STUDY FOR OPERABLE UNITS 2 AND 3 NAVAL INDUSTRIAL RESERVE ORDNANCE PLANT FRIDLEY, MINNESOTA	APPROVED BY — / DATE —
COST/SCHEDULE-AREA			APPROVED BY — / DATE —
SCALE AS NOTED			DRAWING NO. FIGURE 1-8 / REV 0

2.0 REMEDIATION LEVELS, REMEDIAL ACTION OBJECTIVES, AND GENERAL RESPONSE ACTIONS

This section presents remediation levels, remedial action objectives, and general response actions for the Focused FS. Section 2.1 defines the applicable or relevant and appropriate requirements (ARARs) that will be considered when selecting remediation levels and remedies. Section 2.2 evaluates the results of the human health risk assessments for OU2 and OU3 soil, and the effect of plant closure activities on future risks. Section 2.3 presents a discussion of the remediation levels, Section 2.4 identifies the remedial action objectives, and Section 2.5 identifies general response actions to achieve the remedial action objectives.

2.1 APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARS)

The rationale behind the selection of a remedy is highly dependent on the evaluation of ARARs and to-be-considered criteria (TBCs). Section 121 of CERCLA requires that primary consideration be given to remedial alternatives that attain or exceed ARARs. The purpose of this requirement is to make CERCLA response actions compliant with Federal, state, and local environmental requirements.

ARARs consist of the following:

- Any standard, requirement, criterion, or limitation under Federal environmental law.
- Any promulgated standard, requirement, criterion, or limitation under a state environmental or facility-siting law that is more stringent than the associated Federal standard, requirement, criterion, or limitation.

Definitions of ARARs and TBCs criteria are provided below.

Applicable Requirements: Those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under Federal or state law that directly and fully address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site.

Relevant and Appropriate Requirements: Those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under Federal or state law that are not considered "applicable" to a particular CERCLA site but are sufficiently relevant that their use is well suited (appropriate) to the particular site.

TBCs: Non-promulgated, non-enforceable guidelines or criteria that may be useful for developing remedial action alternatives and for determining action levels that are protective of human health and/or the environment. Examples of TBCs include USEPA Drinking Water Health Advisories, Carcinogenic Potency Factors, and Reference Doses.

Section 121(d)(4) of CERCLA allows the waiver of an ARAR if any of the following conditions exist:

1. The remedial action is an interim measure whereby the final remedy will attain the ARAR upon completion.
2. Compliance will result in greater risk to human health and the environment than other options.
3. Compliance is technically impracticable.
4. An alternative remedial action will attain the equivalent of the ARAR.
5. For state requirements, the state has not consistently applied the requirement in similar circumstances.
6. Compliance with the ARAR will not provide a balance between protecting public health, welfare, and the environment at the facility with the availability of funds.

The last condition only applies to Superfund-financed actions.

ARARs fall into three categories: chemical-specific, location-specific, and action-specific. Chemical-specific ARARs govern the extent of site cleanup for the chemicals of concern. They are health- or risk-based numerical values or methodologies that establish concentrations or discharge limits for particular contaminants. Examples include the Safe Drinking Water Act (SDWA) and the Clean Water Act (CWA). Location-specific ARARs are established based on the geographic location of the site. They are rules defining the conduct of activities allowed in a specific location. They may restrict or preclude certain remedial actions or may apply only to certain portions of the site. Examples include Resource Conservation and Recovery Act (RCRA) location requirements and floodplain management requirements. Action-specific ARARs are established based on the type of action being taken at a site. They are action-based controls that affect the implementation of a given remedy.

Tables 2-1, 2-2, and 2-3 present the chemical-specific, location-specific, and action-specific ARARs, respectively, that apply to this Focused FS. Please note that although the Focused FS does not involve treatment technologies, some treatment ARARs were included in the tables. They were included in the event that plant closure activities expose unforeseen contamination and a treatment technology is required.

2.2 EVALUATION OF HUMAN HEALTH RISKS

During the RI process, a human health risk assessment was conducted to determine the carcinogenic and noncarcinogenic risks associated with soil (see Section 1.3.4). The following subsections describe the risk assessments that were conducted for OU2 soil and OU3 soil, respectively, and the effect of on-going plant closure activities. Based on the risk assessment results, the soil at NIROP Fridley does not require active remediation, but may require institutional controls to ensure protection of human health.

A risk assessment was also conducted for OU1 groundwater. However, OU1 groundwater is being addressed separately with the remedy selected in the OU1 ROD and the subsequent ESDs and Minor Changes.

2.2.1 OU2 Soil

Although OU2 soil was previously addressed with a Draft FS (RMT, 1995), the selection of a remedial action plan was postponed until completion of the OU3 RI/FS. It was determined that soil in OU2 and OU3 should be considered as a single unit, since a shared remedy is possible. In the interim, a Supplemental RI was prepared to re-evaluate risks for OU2 soil against the exposure criteria set for OU3 soil (TtNUS, 1999). According to the Supplemental RI, all soil risks were within acceptable limits with the exception of two: a hazard quotient for TCE of 0.64 and a hazard quotient for arsenic of 0.203. Both hazard quotients were generated under the major-infrequent construction worker scenario and exceeded the MPCA acceptable level of 0.2.

However, the Focused FS will not address these OU2 soil risks with active treatment alternatives. TCE was only detected in 11 of 38 soil samples. The maximum detection of 48.1 mg/kg was used in the calculation of the hazard quotient. The second highest detected concentration of TCE was 0.044 mg/kg, which is one thousand times lower than the maximum detection. Using 0.044 mg/kg to generate the hazard quotient results in a value of 0.001, which is also extremely low. As a result, it does not appear as though TCE is a primary concern at the site. The hazard quotient for arsenic, 0.203, only slightly exceeds the acceptable level of 0.2. As a result, it does not appear as though arsenic is a primary concern at the site. Although the Focused FS will not address these soil contaminants as primary concerns, they may be addressed with institutional controls to ensure protection of human health.

2.2.2 OU3 Soil

The human health risk assessment indicated that all risks for OU3 soil were within acceptable limits, with the exception of a cumulative hazard index equivalent to 2.9. The hazard index of 2.9 exceeded the USEPA and MPCA acceptable level of 1.0 and was driven by arsenic, chromium, copper, and mercury.

Individual hazard quotients for arsenic (HQ = 0.3), hexavalent chromium (HQ = 1.35), copper (HQ = 0.23), and mercury (HQ = 0.46) also exceeded the MPCA acceptable level of 0.2. The highest concentrations of the four inorganics exceeded the mean, and each inorganic was detected in a different plant area. However, only chromium in the former East Plating Shop was retained as a COC.

Lead, arsenic, copper, and mercury were not retained as COCs for the following reasons:

- Lead was detected in 111 of 113 surface and subsurface soil samples. The maximum detected lead concentration of 733 mg/kg slightly exceeded the MPCA SRV of 700 mg/kg for industrial exposures. The concentration of lead in all but one of the remaining samples was below the OSWER screening level of 400 mg/kg for residential exposures. Therefore, lead is not considered as a COC since it only slightly exceeded its SRV in one sample and was detected at low concentrations in the remaining samples.

- The HQ of 0.3 for exposure to arsenic in surface and subsurface soil by a major infrequent construction worker slightly exceeded the MPCA acceptable level of 0.2 but was less than the USEPA acceptable level of 1.0. Exposures to arsenic in soil by the industrial worker and minor frequent construction worker were within acceptable levels. Arsenic was only detected in two samples at concentrations above background. Concentrations of arsenic in 111 of 113 would result in HQs of less than 0.2. Therefore, arsenic is not considered a COC since the HQ only slightly exceeded the MPCA acceptable level of 0.2, was less than the USEPA acceptable level of 1.0, and was detected at low concentrations across the site.

- The HQ of 0.23 for exposure to copper in surface and subsurface soil by a major infrequent construction worker slightly exceeded the MPCA acceptable level of 0.2 but was less than the USEPA acceptable level of 1.0. Exposures to copper in soil by the industrial worker and minor frequent construction worker were within acceptable levels. Concentrations of copper in 112 of 113 would result in an HQ of less than 0.2. Therefore, copper is not considered a COC since the HQ only slightly exceeded the MPCA acceptable level of 0.2, was less than the USEPA acceptable level of 1.0, and was detected at low concentrations across the site.

- The HQ of 0.46 for exposure to mercury in surface and subsurface soil by a major infrequent construction worker exceeded the MPCA acceptable level of 0.2 but was less than the USEPA acceptable level of 1.0. Exposures to mercury in soil by the industrial worker and minor frequent construction worker were within acceptable levels. Mercury was only detected in 18 of 113 surface and subsurface soil samples. Therefore, mercury is not considered a COC since the HQ was less

than the USEPA acceptable level of 1.0 and was infrequently detected at low concentrations across the site.

Although chromium was retained as a COC, the Focused FS will not address this chemical with active treatment alternatives. The risk assessment generated a *hexavalent* chromium hazard quotient, in accordance with the MPCA guidelines, that exceeded the acceptable level of 0.2. Because hexavalent chromium analyses were not conducted, this hazard quotient was calculated using a maximum detected *total* chromium concentration. If the maximum detected chromium concentration was evaluated as *trivalent* chromium, the hazard quotient would not exceed the MPCA acceptable level of 0.2. As a result, the hazard index of 2.9 appears to overestimate the risk associated with chromium in soil, and chromium in soil does not require active treatment. To ensure future protection of human health, chromium in soil may ultimately be addressed with institutional controls or a monitoring plan.

2.2.3 Plant Closure Activities

Although the RI results indicate that active treatment of soil is not required, the human health risk assessments were based on current industrial land use scenarios at NIROP Fridley. Plant closure activities, which may involve machinery, equipment, and concrete removal, are conducted on a continual basis at NIROP Fridley. There is a potential for these on-going activities to uncover spatially localized, minor areas of contamination that were not explicitly identified in the risk assessments. The Navy is expected to sell the plant to a private owner, which may accelerate closure-type activities. This Focused FS will evaluate institutional controls as a means for ensuring protection against unforeseen contamination.

2.3 REMEDIATION LEVELS

Remediation levels are selected to establish a regulatory goal for contaminant concentrations. Remediation levels are determined by selecting the most stringent regulatory standard for each COC identified in the risk assessment. Then the maximum concentration of each COC is compared to the remediation level. Those COCs that exceed their standards are retained as chemicals requiring further evaluation in the FS.

For OU2 and OU3 soil, the only chemical retained as a COC is chromium. The most stringent regulatory standard for chromium is the SRV, 100,000 mg/kg. This value becomes the remediation level for chromium in soil. The maximum detected concentration of chromium was 91 mg/kg, which does not exceed the remediation level. As a result, chromium does not require further evaluation in the FS.

Although there are no COCs that require evaluation in the FS, there is still the potential for on-going plant closure activities to uncover spatially localized areas of contamination. The Focused FS is being conducted to address this potential and ensure protection of human health and the environment.

2.4 REMEDIAL ACTION OBJECTIVES

The following remedial action objective (RAO) was developed for the Focused FS:

- Protect human health and the environment against unforeseen soil contamination that may be uncovered during plant closure activities.

2.5 GENERAL RESPONSE ACTIONS

General response actions are broad-based, medium-specific categories of actions that satisfy the remedial action objectives of the FS. For this Focused FS, the general response actions are:

- No Action
- Institutional Controls

The general response actions do not include active treatment technologies because they are not warranted for soil at NIROP Fridley.

TABLE 2-1

CHEMICAL-SPECIFIC ARARs
FOCUSED FEASIBILITY STUDY FOR OPERABLE UNITS 2 AND 3
NAVAL INDUSTRIAL RESERVE ORDNANCE PLANT
FRIDLEY, MINNESOTA

Requirement	Citation	Status	Synopsis
Cancer Slope Factors (CSFs)		To Be Considered	CSFs are guidance values used to evaluate the potential carcinogenic hazard caused by exposure to contaminants. Considered for development of human health protection PRGs for soil and groundwater.
Reference Doses (RFDs)		To Be Considered	RFDs are guidance values used to evaluate the potential noncarcinogenic hazard caused by exposure to contaminants. Considered for development of human health protection PRGs for soil and groundwater.
Minnesota Rules for Lead	Parts 4761.0100 and 4761.0300, Subpart 4	Applicable or Relevant and Appropriate	Surficial soil remediation must achieve a cleanup level for lead of less than 100 parts per million (ppm) for the top 2 cm in bare soil. The rules are 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. The rules are applicable under future land use scenario if lead concentrations exceed 100 ppm in surficial soil.
Minnesota State Reference Values (SRVs)	MPCA Draft Guidelines, Risk Based Guidance for the Soil – Human Health Pathway, Volume 2. Technical Support Document, January 1999	Applicable	Soil contaminant-specific concentrations above which an unacceptable risk to human health is predicted to exist.
Soil Cleanup Numbers, Unsaturated Zone	MPCA Draft Guidelines, Risk Based Guidance for the Soil Leaching Pathway, User's Guide, May 1998	To Be Considered	Contaminant-specific soil leaching values (SLVs) for evaluating the risk to groundwater at sites from the soil-to-groundwater leaching pathway.

TABLE 2-2

LOCATION-SPECIFIC ARARs
FOCUSED FEASIBILITY STUDY FOR OPERABLE UNITS 2 AND 3
NAVAL INDUSTRIAL ORDNANCE RESERVE PLANT
FRIDLEY, MINNESOTA

Requirement	Citation	Status	Synopsis
Historic Sites, Field Archaeology, Minn. Historical Society	Minn. Stat. 138.40	Potential To Be Considered	-- Review of construction or development plans at sites on public lands that have known or potential historic or archaeological significance -- State agencies should cooperate in preserving archaeologically or historically significant sites
Health and Safety, Minn. Dept. of Labor and Industry	Minn. R. 5205	Applicable	-- Standards for health and safety -- Standards for worker training
Minnesota State Building Code	Minn. R. 1300	Applicable	
Amendments to Uniform Building Code	Minn. R. 1305	Applicable	
Electrical Code	Minn. R. 1315	Applicable	

TABLE 2-3

ACTION-SPECIFIC ARARs
FOCUSED FEASIBILITY STUDY FOR OPERABLE UNITS 2 AND 3
NAVAL INDUSTRIAL ORDNANCE RESERVE PLANT
FRIDLEY, MINNESOTA

Requirement	Citation	Status	Synopsis
Air Release Reporting	Minn. Stat. 116.061	Potentially Applicable	Duty to notify and abate unusual or excessive releases to air.
Hazardous Waste	Minn. R. 7045	Potentially Applicable	-- Hazardous Waste Listing -- Generator Standards -- Transporter Standards -- Facility Standards -- Interim-status Standards -- Recycling Standards -- Ground Water Protection to Background, MCLs, ACLs
Off-Site Disposal of Soils Failing TCLP Tests	Minn. R. 7045.0261 Minn. R. 7045.0270	Relevant and Appropriate or Potentially Applicable	-- Manifest documents as per 40 CFR Part 262 and 49 CFR Part 172 -- Pretransport requirements (applicable)
Certification of Environmental Laboratories	Minn. Stat. 144.98	Applicable	Authority to certify laboratories
Plumbing Code	Minn. Stat. 4715	Potentially Applicable	Use of public sewer and water systems; plumbing materials and methods.
Water Well Code	Minn. R. 4725	Applicable	Standards for the construction, maintenance, and sealing of wells, environmental boreholes, and exploratory borings; prohibition of injection wells.

TABLE 2-3

ACTION-SPECIFIC ARARs
FOCUSED FEASIBILITY STUDY FOR OPERABLE UNITS 2 AND 3
NAVAL INDUSTRIAL ORDNANCE RESERVE PLANT
FRIDLEY, MINNESOTA

Requirement	Citation	Status	Synopsis
Construction of Monitoring Wells and Groundwater Monitoring	Minn. R. 4725.2020 Minn. R. 4725.2050 Minn. R. 4725.2150 Minn. R. 4725.2175 Minn. R. 4725.2185 Minn. R. 4725.2250 Minn. R. 4725.2350 Minn. R. 4725.2450 Minn. R. 4725.2550 Minn. R. 4725.2750 Minn. R. 4725.3350 Minn. R. 4725.3450 Minn. R. 4725.3550 Minn. R. 4725.3850 Minn. R. 4725.3875 Minn. R. 4725.6450 Minn. R. 4725.6650 Minn. R. 4725.6755 Minn. R. 4725.6850	Applicable	-- Interconnection of aquifers prohibited -- No disposal of wastes into borehole -- Setback requirements for borehole installations -- Wells within a building -- Distances required from buildings -- Casing requirements -- Steel casings -- Stainless steel casings -- Plastic casings -- Screens -- Interconnections and cross connections -- Flow controls -- Labels -- Sealing a well -- Sealing a well -- Direction to comply -- Construction of monitoring well -- Protection of monitoring well -- At grade monitoring well
Well Abandonment	Minn. R. 4725.0475 Minn. R. 4725.3850, Subps 1-7 Minn. R. 4725.3875	Applicable	
Licensing of Hazardous Waste Transporter	Minn. R. 8870	Potentially Applicable	-- License requirements -- Identification decals -- Training requirements -- Reporting requirements -- Insurance requirements
Discharge to Metropolitan Council Environmental Service's Sanitary Sewer System	Waste Discharge Rules, Sections: 202.00 205.00 212.00 212.01 212.03 212.04 213.00 213.01	Potentially Applicable	-- General information -- Permit conditions -- Monitoring -- Monitoring points -- Samples -- Volumes -- Sampling techniques -- Methods of sampling

TABLE 2-3

ACTION-SPECIFIC ARARs
FOCUSED FEASIBILITY STUDY FOR OPERABLE UNITS 2 AND 3
NAVAL INDUSTRIAL ORDNANCE RESERVE PLANT
FRIDLEY, MINNESOTA

Requirement	Citation	Status	Synopsis
Discharge to Metropolitan Council Environmental Service's Sanitary Sewer System (Continued)	213.02		-- Required methods
	213.03		-- Required methods
	213.04		-- Flow measuring methods
	214.00		-- Records
	215.00		
	218.00		-- Self-monitoring reports
	304.00		-- Approval
	304.01		-- Written applications
	304.03		-- Accordance with provisions
	401.00		-- Pretreatment
	401.02		
	402.00		-- Acceptable discharges
	403.00		-- Solids
	406.00 – 406.22		-- Prohibitions

3.0 SCREENING OF TECHNOLOGIES

Section 3.0 presents the identification and screening of remedial action technologies and process options that may be applicable to groundwater at NIROP Fridley. Section 3.1 describes the general response actions established in Section 2.0. Section 3.2 identifies remedial action technologies and process options for each general response action. Section 3.3 presents the preliminary screening of technologies. Following the preliminary screening, the remaining technologies undergo a detailed screening in Section 3.4. Section 3.5 presents a final set of technologies that will be used to develop remedial action alternatives.

3.1 GENERAL RESPONSE ACTIONS

General response actions are broad-based, medium-specific categories of actions that satisfy the remedial action objectives of the FS. The general response actions applicable to soil at NIROP Fridley include no action and institutional controls. A brief description of each general response action for groundwater is presented below.

3.1.1 No Action

The NCP requires the evaluation of the no action response as part of the FS process. A no action response provides a baseline for comparisons with other remedial alternatives that offer a greater level of response. A no action alternative may be considered appropriate when there are no adverse or unacceptable risks to human health and the environment, or when a response action may cause a greater environmental or health danger than taking no action.

3.1.2 Institutional Controls

Institutional controls are various "institutional" actions that can be implemented as part of a complete remedial action alternative. Institutional controls are designed to minimize the potential for exposure to site contamination. Institutional controls may include deed restrictions that limit residential development, and guarantees of access to the Navy in the event that contamination is discovered in the future. Monitoring programs are also associated with institutional controls to ensure that contaminant levels remain within acceptable limits.

3.2 IDENTIFICATION OF TECHNOLOGIES AND PROCESS OPTIONS

In this step, a set of potentially applicable technologies and process options are identified for each general response action. The term "technology type" refers to general categories of and the term

"process option" refers to specific processes within each generalized technology type. For this Focused FS, the process options are identical to the technology types. Therefore, the technology types/process options will be referred to as technologies henceforth.

The no action general response does not involve technologies. The institutional controls general response action includes the following technologies:

- Deed Restrictions
- Access Guarantee
- Sump and Drywell Investigation

3.3 PRELIMINARY SCREENING OF TECHNOLOGIES

During the preliminary screening, the technologies are evaluated against general contaminant-specific and site-specific applicability. The screening is accomplished by using readily available information from the RI to eliminate technologies that cannot be effectively implemented at the site (USEPA, 1988). All technologies that appear to be applicable to the site contaminants and site conditions are retained for further evaluation.

For this Focused FS, all of the technologies listed in Section 3.2 are applicable to soil at NIROP Fridley. Therefore, all of the technologies are retained for further evaluation.

3.4 TECHNOLOGY DESCRIPTIONS AND DETAILED SCREENING

This section presents a description of each technology listed in Section 3.2 and a detailed screening of the technologies. The objective of the detailed screening is to select the most appropriate technologies in order to simplify the development of remedial action alternatives. The selected technologies provide a basis for developing performance specifications during preliminary design. However, the final technologies that are used to implement the remedial action may not be selected until the remedial design phase. The elimination of a technology at this point does not mean that the technology can never be reconsidered for the site.

The detailed screening is based on three criteria: effectiveness, implementability, and relative cost. These criteria are described below.

- Effectiveness
  - Protection of human health and environment; reduction in toxicity, mobility, or volume; and permanence of solution.

- Ability of the technology to address the estimated areas or volumes of contaminated medium.
- Ability of the technology to meet the remediation goals identified in the remedial action objectives.
- Technical reliability (innovative versus well-proven) with respect to contaminants and site conditions.

- Implementability
  - Overall technical feasibility at the site.
  - Availability of vendors, mobile units, storage and disposal services, etc.
  - Administrative feasibility.
  - Special long-term maintenance and operation requirements.

- Cost (Qualitative)
  - Capital cost.
  - Operation and maintenance (O&M) costs.

3.4.1 No Action

Description: The no action response is required under CERCLA regulations to provide a baseline for comparison to other response actions. The no action response involves taking no remedial actions to address the contaminated media. This includes no active treatment, institutional controls, or monitoring programs.

Effectiveness: The no action response will not meet the remedial action objective for the site. It will provide no protection against unforeseen soil contamination that may be uncovered during plant closure activities.

Implementability: There will be no implementability concerns associated with the no action response since no action is being taken.

Cost: There will be no costs associated with the no action response since no action is being taken.

Decision: The no action response is retained for further evaluation, as required under CERCLA.

3.4.2 Institutional Controls

3.4.2.1 Deed Restrictions

Description: Deed restrictions will prohibit future residential development of the NIROP Fridley facility. In addition to prohibiting residential development, the restrictions will prohibit the installation of wells in the Quaternary aquifer zone and the potable and non-potable use of groundwater from the Quaternary aquifer zone. These restrictions will be implemented in writing via land deeds for the facility. Provisions must also be made to ensure that the deed restrictions are implemented over time.

Effectiveness: Provided they are enforced over time, deed restrictions will effectively meet the remedial action objective and provide protection against unforeseen soil contamination. Under a future residential scenario, construction workers and on-site residents could potentially be exposed to the contamination. However, the deed restrictions will effectively prevent this scenario from occurring. The land use will remain industrial, which is considered to be protective of human health and the environment.

The deed restrictions will also include clauses prohibiting the installation of wells in the Quaternary aquifer zone and the potable and non-potable use of groundwater from the Quaternary aquifer zone. Although the Focused FS addresses soil contamination, these groundwater restrictions were included in the event that contaminants leach from the soil and affect groundwater quality.

The reliability of deed restrictions is highly dependent on their long-term implementation. To ensure that the restrictions are enforced over time, periodic site inspections will be required.

Implementability: Deed restrictions will be easily implemented. Resources are readily available for the preparation of deed modifications. Provisions will be incorporated to ensure the continued implementation of these institutional controls.

Cost: The costs associated with modifying land deeds are low. The costs associated with periodic site inspections are also low.

Decision: Deed restrictions are retained because of their effectiveness at prohibiting future exposure to contaminants.

3.4.2.2 Access Guarantee

Description: The deed will be modified to guarantee the Navy access to the land for environmental investigation, remediation, or other corrective action. This guarantee will become effective once the Navy has transferred ownership of the property.

Effectiveness: The access guarantee will meet the remedial action objective and provide additional protection against unforeseen soil contamination. In the event that additional contamination is discovered, the Navy will be guaranteed the right to conduct the necessary investigation and remediation, thereby reducing the potential for contaminant exposure.

Implementability: The access guarantee will be easily implemented. Resources are readily available for the preparation of deed modifications. Provisions will be incorporated to ensure the continued implementation of this institutional control.

Cost: The costs associated with modifying land deeds are low.

Decision: The access guarantee is retained because of its effectiveness at mitigating future exposure to contaminants.

3.4.2.3 Sump and Drywell Investigation

Description: This technology includes the investigation of key sumps and drywells within the main plant building in areas where specific contamination is present at greater than average concentrations. Drywells are holes in the ground where wastes were discharged. If the sumps and drywells contain visual signs of contamination, removal of that material may be required. In addition, the sump or drywell may be repaired, sealed, or removed.

Effectiveness: The sump and drywell investigation will meet the remedial action objective and provide additional protection against unforeseen soil contamination. The investigation will ensure that sumps and drywells do not constitute a source of contamination at NIROP Fridley. In the event that a sump or drywell appears to be contaminated, the Navy will take appropriate measures to remediate the contamination.

Implementability: The sump and drywell investigation will be easily implemented.

Cost: The costs associated with a sump and drywell investigation are low.

Decision: The investigation is retained to ensure that sumps and drywells are not sources of contamination.

3.5 FINAL SET OF TECHNOLOGIES

All technologies passed the detailed screening and will be retained to form remedial action alternatives in Section 4.0 of the Focused FS. The final set of technologies includes:

- No Action
- Institutional Controls
  - Deed Restrictions
  - Access Guarantee
  - Sump and Drywell Investigation

4.0 ASSEMBLY AND DETAILED ANALYSIS OF ALTERNATIVES

In this section, the final set of technologies and process options are combined to form remedial action alternatives. Two remedial action alternatives were developed for OU2 and OU3 soil:

- Alternative 1 - No Action
- Alternative 2 - Institutional Controls

Sections 4.1 and 4.2 describe these alternatives.

This section presents the detailed analysis of alternatives. The purpose of the detailed analysis is to provide sufficient information to adequately compare the alternatives, select an appropriate remedy, and demonstrate satisfaction of the CERCLA remedy selection requirements in the ROD. The detailed analysis will be conducted in accordance with the Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA (OSWER Directive 9355.3-01, USEPA October 1988) and the NCP (FR Vol. 55, No. 46, March 8, 1990).

The detailed analysis includes two steps: the individual analysis of alternatives against nine criteria, and the comparative analysis. Section 4.2 describes the evaluation criteria, Section 4.3 presents the individual analysis of alternatives, and Section 4.4 presents the comparative analysis of alternatives.

During the FS process, the alternatives may undergo a preliminary screening based on three criteria: effectiveness, implementability, and cost. The objective of this screening is to make comparisons between similar alternatives so that only the most promising ones are carried forward for the detailed analysis (USEPA, 1988). The screening is an optional step in the FS process. It is typically conducted to minimize the number of alternatives involved in the detailed analysis. For this FS, only two alternatives were initially developed, and the detailed analysis will be conducted for each one. As a result, the decision was made to eliminate the preliminary screening of alternatives.

4.1 ASSEMBLY OF ALTERNATIVES

The following remedial action alternatives were developed for OU2 and OU3 soil at NIROP Fridley:

- Alternative 1 - No Action
- Alternative 2 - Institutional Controls

4.1.1 Alternative 1 – No Action

The no action alternative is required under CERCLA regulations to provide a baseline for comparison to other response actions. The no action alternative involves taking no remedial actions to address the contaminated media. This includes no active treatment, institutional controls, or monitoring programs.

Since the soil will remain untreated, the NCP requires the lead agency to review this alternative at least once every 5 years.

4.1.2 Alternative 2 – Institutional Controls

Alternative 2 incorporates deed restrictions, an access guarantee, and a sump and drywell investigation as institutional controls.

The deed restrictions will prohibit future residential development of the NIROP Fridley facility. Residential development would involve concrete removal and other invasive construction activities that could potentially expose spatially localized, minor areas of contamination. In addition, the USEPA has expressed concern about potential vapor infiltration into basements of residential housing units, if constructed. In addition to prohibiting residential development, the restrictions will prohibit the installation of wells in the Quaternary aquifer zone and the potable and non-potable use of groundwater from the Quaternary aquifer zone. Although the Focused FS addresses soil contamination, these groundwater restrictions were included in the event that contaminants leach from the soil and affect groundwater quality. The deed restrictions will be implemented in writing via land deeds for the facility. Periodic site inspections will be conducted to ensure that the deed restrictions are implemented over time.

The access guarantee involves a modification to the deed that will guarantee the Navy access to the land for environmental investigation, remediation, or other corrective action. This guarantee will become effective once the Navy has transferred ownership of the property. In the event that additional contamination is discovered, the Navy will be guaranteed the right to conduct the necessary investigation and remediation, thereby reducing the potential for contaminant exposure.

The sump and drywell investigation will consist of a visual inspection of key sumps and drywells within the main plant building. (Drywells are holes in the ground where wastes were discharged.) The investigation will be focused in areas where specific contamination is present at greater than average concentrations. If the sumps and drywells contain visual signs of contamination, the Navy will conduct the appropriate remediation. This remediation may involve the removal of contaminated material or the repair, sealing, or removal of the sump or drywell.

Since the soil will remain untreated, the NCP requires the lead agency to review this alternative at least once every 5 years.

4.2 EVALUATION CRITERIA

The NCP specifies nine evaluation criteria for the detailed analysis:

- Overall Protection of Human Health and the Environment
- Compliance with ARARs
- Long-Term Effectiveness and Permanence
- Reduction of Mobility, Toxicity, and Volume through Treatment
- Short-Term Effectiveness
- Implementability
- Cost
- State Acceptance (not evaluated at this time)
- Community Acceptance (not evaluated at this time)

The alternatives will be evaluated against seven of these nine criteria. State acceptance and community acceptance will be evaluated in the ROD after the NIROP partnering team and Restoration Advisory Board (RAB) have reviewed the Focused FS and Proposed Remedial Action Plan (PRAP). The NIROP partnering team and RAB include participants from the Navy, the USEPA, the MPCA, and the public.

The nine evaluation criteria are grouped into three categories: threshold criteria, primary balancing criteria, and modifying criteria. The threshold criteria include overall protection of human health and the environment and compliance with ARARs. An alternative must achieve these criteria to be considered for selection. The primary balancing criteria include long-term effectiveness and permanence; reduction of toxicity, mobility, or volume through treatment; short-term effectiveness; implementability; and cost. These criteria are used to differentiate among alternatives during the selection process. The modifying criteria include state and community acceptance, which are not considered in the Focused FS.

The following paragraphs describe the evaluation criteria.

Overall Protection of Human Health and The Environment: Overall protection of human health and the environment is the primary criterion that a remedial action must meet. A remedy is considered protective if it adequately eliminates, reduces, or controls all current and future site risks posed through each exposure pathway at the site. This criterion considers the other evaluation criteria in a global sense, especially long-term effectiveness and permanence, short-term effectiveness, and compliance with

ARARs. To the extent possible, remedial alternatives that use permanent solutions to reduce the mobility, toxicity, and/or volume and alternative treatment technologies are preferred.

Compliance With ARARs: Compliance with ARARs is one of the statutory requirements for remedy selection. Alternatives are developed and refined throughout the FS process to ensure that they will meet all respective ARARs or that there is sound rationale for waiving an ARAR. During the detailed analysis, alternatives will be analyzed based on Federal and state ARARs that are chemical-specific, action-specific, and location-specific. Section 2.0 presents the ARARs and TBCs associated with this Focused FS.

Long-Term Effectiveness and Permanence: This criterion reflects CERCLA's emphasis on implementing remedies that ensure protection of human health and the environment in the distant future, as well as the near future. This criterion focuses on the residual risks present at the site after the remedial action is complete. Factors to be considered include:

- The magnitude of residual risks after the remedial action is complete.
- The degree of threat posed by hazardous wastes remaining at the site.
- The adequacy of controls (e.g., engineering and institutional controls) used to manage the hazardous substances remaining at the site.
- The long-term reliability of the controls.
- The potential impacts on human health and the environment should the remedy fail.

Reduction of Toxicity, Mobility, and Volume through Treatment: This criterion addresses the statutory preference for remedies that employ treatment as a principal element. The criterion ensures an assessment of each alternative's relative ability to reduce toxicity, mobility, or volume. Specifically, the analysis will examine the magnitude, significance, and irreversibility of reductions. Factors to be considered include:

- The treatment or recycling processes the remedies employ and materials they will treat.
- The amount of hazardous materials that will be destroyed, treated, or recycled.
- The degree of expected reduction in toxicity, mobility, and volume of the waste due to treatment or recycling and the specification of which reduction(s) are occurring.
- Degree to which the treatment is irreversible.
- The residuals that will remain following treatment, considering the persistence, toxicity, mobility, and propensity to bioaccumulate of such hazardous substances and their constituents.
- The degree to which treatment reduces the inherent hazards posed by principal threats.

Short-Term Effectiveness: This criterion addresses the short-term impacts associated with implementing the alternative. Implementation may impact neighboring community, workers, or the surrounding environment. Short-term effectiveness also includes potential threats to human health and environment associated with the excavation, treatment, and transportation of hazardous substances, the potential cross-media impacts of the remedy, and the time required to achieve protection of human health and the environment.

Implementability: This criterion assesses the implementability of the alternatives by considering the following factors:

- Degree of difficulty associated with constructing the technology.
- Expected operational reliability of the technology.
- Ability to monitor the effectiveness of the alternative.
- Need to coordinate with and obtain necessary approvals and permits (e.g., NPDES permits) from other state offices and regulatory agencies.
- Ease of undertaking additional remedial actions.
- Availability of necessary equipment and specialists.
- Available capacity and location of needed treatment, storage, and disposal services.

Cost: The cost criterion involves three types of costs:

- Capital costs, including both direct and indirect costs.
- O&M costs.
- Net present worth of capital and O&M costs.

For each alternative, the costs will be estimated within a range of -30 percent to +50 percent (USEPA, 1988). The exact accuracy of the cost estimate depends on the assumptions made and the availability of costing information.

State Acceptance: This criterion, which is an on-going concern throughout the remedial process, reflects the statutory requirement to provide for substantial and meaningful state involvement. State comments will be addressed during the development of the FS, PRAP, and ROD, as appropriate.

Community Acceptance: This criterion addresses the community's comments on the remedial alternatives under consideration, where "community" is broadly defined to include all interested parties. These comments are taken into account throughout the FS process. However, formal public comment will not be received until after the public comment period is held.

4.3 INDIVIDUAL DETAILED ANALYSIS

The following subsections present the individual detailed analysis of alternatives.

4.3.1 Alternative 1 – No Action

4.3.1.1 Overall Protection of Human Health and the Environment

The no action alternative will not provide overall protection of human health and the environment. The no action alternative does not meet the remedial action objective – to protect human health and the environment against unforeseen soil contamination that may be uncovered during plant closure activities.

Under Alternative 1, there will be unlimited potential for residential development at the site, which will involve concrete removal and construction activities. The development activities could potentially uncover spatially localized, minor source areas of contamination. There would be no restrictions against the exposure of construction workers and residents to these contaminated areas. In addition, unforeseen soil contamination could leach into the groundwater and there would be no restrictions against the installation of wells or the potable and non-potable use of the groundwater.

4.3.1.2 Compliance with ARARs

Alternative 1 will not comply with chemical-specific ARARs. The alternative does not involve active treatment to reduce contaminant levels below Federal and state standards in the event that additional soil contamination is uncovered. (An evaluation of active treatment technologies was not warranted for this Focused FS.) Alternative 1 may or may not comply with location-specific ARARs. No action-specific ARARs apply to this alternative.

4.3.1.3 Long-Term Effectiveness and Permanence

Residual risks will remain at the site under the no action alternative. These risks include the potential for future human exposure to contaminated groundwater. Alternative 1 does not provide controls, such as deed restrictions or monitoring, to manage the untreated waste remaining at the site. Based on this information, Alternative 1 will not provide long-term effectiveness and permanence.

The lead agency will be required to review this alternative at least once every 5 years.

4.3.1.4 Reduction of Toxicity, Mobility, or Volume through Treatment

Under the no action alternative, there will be no reduction of toxicity, mobility, or volume though treatment. The alternative will not generate treatment residuals, and it does not meet the statutory preference for treatment as a principal element.

4.3.1.5 Short-Term Effectiveness

There are no actions associated with the implementation of Alternative 1. As a result, the alternative will not pose short-term risks to the community or to workers, and the alternative will not result in environmental impacts. The time until the remedial action objectives are achieved cannot be estimated.

4.3.1.6 Implementability

There are no implementability concerns associated with Alternative 1.

4.3.1.7 Cost

The costs associated with Alternative 1 will be negligible. They will only include the cost of 5 year reviews. The cost of one 5 year review is approximately 16 hours of engineering labor to conduct the site inspection and 16 hours of engineering labor to prepare compliance reports for the regulatory agencies.

4.3.2 Alternative 2 – Institutional Controls

4.3.2.1 Overall Protection of Human Health and the Environment

Alternative 2 will provide overall protection of human health and the environment. Provided they are enforced over time, institutional controls will effectively prevent future exposure to unforeseen contamination.

The deed restrictions will prevent future residential development, installation of wells, and potable and non-potable use of the groundwater. This will prevent exposure to contamination during construction activities and the potable and non-potable use of groundwater potentially contaminated by chemicals leaching from the soil. However, compliance with the restrictions over time is a critical element in the success of this alternative. The access guarantee will provide further protection by guaranteeing the Navy the right to investigate and remediate any soil contamination that occurs on the property in the future. Any investigation or remediation conducted by the Navy will mitigate the potential for exposure to contaminants. Finally, the sump and drywell investigation will ensure that two potentially significant sources of contamination are addressed.

4.3.2.2 Compliance with ARARs

Alternative 2 will not comply with chemical-specific ARARs. The alternative does not involve active treatment to reduce contaminant levels below Federal and state standards in the event that additional soil contamination is uncovered. (An evaluation of active treatment technologies was not warranted for this Focused FS.) Alternative 2 will comply with the location-specific and action-specific ARARs that apply.

4.3.2.3 Long-Term Effectiveness and Permanence

Alternative 2 will reduce the residual risks remaining at the site. These residual risks include the potential for exposure to soil contamination that is uncovered during residential development or that has leached into the groundwater. The deed restrictions will prohibit residential development, the installation of wells, and the potable and non-potable use of the groundwater. The access guarantee will ensure that the Navy can conduct environmental investigations and remediation in the event that soil contamination is uncovered. The sump and drywell investigation will ensure that two potentially significant sources of contamination are addressed. Consequently, Alternative 2 will be an effective and permanent solution. However, the effectiveness and permanence of this alternative is highly dependent on its long-term implementation. The deed restrictions and access guarantee will be adequate and reliable controls for preventing future human exposure provided they are enforced over time.

The lead agency will be required to review this alternative at least once every 5 years.

4.3.2.4 Reduction of Toxicity, Mobility, or Volume through Treatment

Under Alternative 2, there will be no reduction of toxicity, mobility, or volume through treatment. The alternative will not generate treatment residuals, and it does not meet the statutory preference for treatment as a principal element.

4.3.2.5 Short-Term Effectiveness

The actions associated with the implementation of Alternative 2 include written modifications to land deeds and a visual inspection of sumps and drywells. As a result, the alternative will not pose significant short-term risks to the community or to workers, and the alternative will not result in environmental impacts. The time until the remedial action objective is achieved will be two to three months. This is the estimated time frame to complete the preparation of deed modifications and the sump and drywell investigation.

4.3.2.6 Implementability

Alternative 2 will be administratively feasible. Implementation will require the preparation of deed modifications and coordination with the facility's public works/planning department to conduct the sump and drywell investigation.

4.3.2.7 Cost

The costs associated with Alternative 2 are low. The direct capital costs consist of approximately 80 hours of administrative labor to draft the land deed modifications and 40 hours of engineering labor to investigate the sumps and drywells and develop a written report. In addition, the cost of one 5 year review is approximately 16 hours of engineering labor to conduct the site inspection and 16 hours of engineering labor to prepare compliance reports for the regulatory agencies.

4.4 COMPARATIVE DETAILED ANALYSIS

The purpose of the comparative analysis is to evaluate the relative advantages and disadvantages of the remedial action alternatives. The alternatives are compared and contrasted against the nine evaluation criteria.

4.4.1 Overall Protection of Human Health and the Environment

Unlike Alternative 1, Alternative 2 will provide overall protection of human health and the environment and will meet the remedial action objective. Alternative 2 will mitigate the potential for future exposure to unforeseen soil contamination that is uncovered during plant closure activities.

Under Alternative 1, there will be unlimited potential for residential development at the site, including concrete removal and construction activities, and unlimited potential for well installation and potable and non-potable use of the groundwater. Consequently, there will be unlimited potential for future exposure to unforeseen soil contamination. In addition, Alternative 1 ignores the need to identify and address sumps and drywells that may be potential sources of contamination. Alternative 2 provides deed restrictions, an access guarantee, and a sump and drywell investigation to protect against these hazards.

4.4.2 Compliance with ARARs

Alternatives 1 and 2 will not comply with chemical-specific ARARs. The alternatives do not involve active treatment to reduce contaminant levels below Federal and state standards in the event that additional soil contamination is uncovered. (An evaluation of active treatment technologies was not warranted for this Focused FS.) Alternatives 1 and 2 will comply with the location-specific ARARs that apply. In addition,

Alternative 2 will comply with the action-specific ARARs that apply. No action-specific ARARs apply to Alternative 1.

4.4.3 Long-Term Effectiveness and Permanence

Unlike Alternative 1, Alternative 2 will reduce the residual risks remaining at the site. These residual risks include the potential for exposure to soil contamination that is uncovered during residential development or that has leached into the groundwater. The deed restrictions will prohibit residential development, the installation of wells, and the potable and non-potable use of the groundwater. The access guarantee will ensure that the Navy can conduct environmental investigations and remediation in the event that soil contamination is uncovered. The sump and drywell investigation will ensure that two potentially significant sources of contamination are addressed. Consequently, Alternative 2 will be an effective and permanent solution provided the institutional controls are enforced over time. Alternative 1 will not be an effective and permanent solution. Under Alternative 2, the deed restrictions, access guarantee, and sump and drywell investigation will be adequate and reliable controls for preventing future human exposure. Alternative 1 does not provide controls.

The lead agency will be required to review Alternatives 1 and 2 at least once every 5 years.

4.4.4 Reduction of Toxicity, Mobility, or Volume through Treatment

Under both Alternatives 1 and 2, there will be no reduction of toxicity, mobility, or volume through treatment. The alternatives will not generate treatment residuals, and will not meet the statutory preference for treatment as a principal element.

4.4.5 Short-Term Effectiveness

No actions are associated with the implementation of Alternative 1. The actions associated with the implementation of Alternative 2 are minor and include written modifications to land deeds and a visual inspection of sumps and drywells. As a result, Alternative 1 will present no short-term risks to the community and workers and Alternative 2 will present only minor short-term risks. Neither alternative will result in environmental impacts. For Alternative 1, the time until the remedial action objective is achieved cannot be estimated. For Alternative 2, the time until the remedial action objective is achieved will be approximately two to three months. This is the estimated time frame to complete the preparation of deed modifications and the sump and drywell investigation.

4.4.6 Implementability

There are no implementability concerns associated with Alternative 1 because this alternative involves taking no action. Alternative 2 requires some minor actions that will be administratively feasible to implement. Unlike Alternative 1, implementation of Alternative 2 will require the preparation of deed modifications and coordination with the facility's public works/planning department to conduct the sump and drywell investigation.

4.4.7 Cost

The costs associated with Alternative 1 will be negligible. They will only include the cost of 5 year reviews. The costs associated with Alternative 2 are low. In addition to the cost of 5 year reviews, Alternative 2 includes the direct capital costs of the administrative labor required to draft the land deed modifications and the engineering labor required to investigate the sumps and drywells and develop a written report.

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