N91192.AR.000969
NIROP FRIDLEY
5090.3a

FINAL INITIAL ASSESSMENT STUDY FOR NIROP FRIDLEY MN
6/1/83
NAVAL ENERGY AND ENVIRONMENTAL SUPPORT ACTIVITY

June 1983

INITIAL ASSESSMENT STUDY OF NAVAL INDUSTRIAL RESERVE ORDNANCE PLANT MINNEAPOLIS, MINNESOTA

NEESA 13-029

NAVAL ENERGY AND ENVIRONMENTAL SUPPORT ACTIVITY

Port Hueneme, California 93043

RELEASE OF THIS DOCUMENT REQUIRES PRIOR NOTIFICATION
OF THE CHIEF OFFICIAL OF THE STUDIED ACTIVITY

Distribution:
CNO (OP-45)
CHNAVMAT (04H)
COMNAVFACENGCOM (112) (2 copies)
COMNAVSEASYSCOM (0705) (3 copies) (56Y4)
CO NORTHNAVFACENGCOM (114) (2 copies)
CO NAVPRO Minneapolis

Copy to:
CO NAVPRO Minneapolis (INR) (4 copies)

INITIAL ASSESSMENT STUDY

NAVAL INDUSTRIAL RESERVE ORDNANCE PLANT (NIROP)

MINNEAPOLIS, MINNESOTA

UIC: N91192

Prepared by:

Envirodyne Engineers, Inc. (EEI)
12161 Lackland Road
St. Louis, Missouri 63141

Contract No. N62474-82-C-C354

Initial Assessment Study Team Members

Mark Kroenig, Project Manager, Environmental Engineer
Dan Logan, Environmental Engineer
Don Monnot, Hydrogeologist
Stan Muterspaugh, Environmental Scientist

NEESA Contract Coordinator

Jacqueline R. Francis

Prepared for:

NAVY ASSESSMENT AND CONTROL
OF INSTALLATION POLLUTANTS (NACIP) DEPARTMENT
Naval Energy and Environmental Support Activity (NEESA)
Port Hueneme, California 93043

June 1983

EXECUTIVE SUMMARY

This report presents the results of an Initial Assessment Study (IAS) conducted at the Naval Industrial Reserve Ordnance Plant (NIROP), Minneapolis, Minnesota. The purpose of an IAS is to identify and assess sites posing a potential threat to human health or the environment due to contamination from past hazardous materials operations.

NIROP Minneapolis is a government owned-contractor operated facility. The plant is operated by the Northern Ordnance Division of FMC Corporation. Contiguous with the NIROP, including a portion of the main building, is property owned and operated solely by FMC. This IAS deals only with Navy property and does not address FMC property or any waste disposal sites they may have.

The NIROP is situated approximately 2,000 feet from the Mississippi River on a broad flat outwash terrace. The facility is underlain by highly permeable sands which are conducive to the downward migration of contaminants. Thus, the underlying aquifers, which are used for potable purposes, are susceptible to contamination. These aquifers discharge into the Mississippi River, which supplies the potable water for Minneapolis. The water supply intake for Minneapolis is located approximately one mile downstream of the NIROP.

Based on historical data, aerial photographs, field inspections and personnel interviews, a total of four potentially contaminated sites were identified at the NIROP. Each of the sites was evaluated with regard to contamination characteristics, migration pathways and pollutant receptors.

The study concludes that three of the sites warrant further investigation under the Navy Assessment and Control of Installation Pollutants (NACIP) Program, to assess potential long-term impacts. A Confirmation Study, including actual sampling and monitoring of the sites, is recommended to confirm or deny the existence of the suspected contamination and to quantify the extent of any problems which may exist. The three sites recommended for confirmation are listed below in order of priority.

1) Waste Disposal Trenches, Site No. 1
2) Waste Disposal Pits, Site No. 2
3) Area Beneath NIROP Building, Site No. 3

The results of the Confirmation Study will be used to evaluate the necessity of conducting mitigating actions or clean-up operations.

NEPSS

Naval
Environmental
Protection
Support
Service

FOREWORD

The Department of the Navy developed the Navy Assessment and Control of Installation Pollutants (NACIP) Program to identify and control environmental contamination from past use and disposal of hazardous substances at Navy and Marine Corps installations. The NACIP Program is part of the Department of Defense Installation Restoration Program, and is similar to the Environmental Protection Agency's "Superfund" Program authorized by the Comprehensive Environmental Response, Compensation, and Liability Act of 1980.

In the first phase of the NACIP Program, a team of engineers and scientists conducts an Initial Assessment Study (IAS). The IAS team collects and evaluates evidence of contamination that may pose a potential threat to human health or the environment. The IAS includes a review of archival and activity records, interviews with activity personnel, and an on-site survey of the activity. This report documents the findings of an IAS at the Naval Industrial Reserve Ordnance Plant (NIROP), Minneapolis, Minnesota.

Further confirmation studies under the NACIP Program were recommended at three areas at the activity. Northern Division of the Naval Facilities Engineering Command (NORTHDIV) will assist NIROP Minneapolis in implementing those recommendations.

Questions regarding this report should be referred to NEESA 112N at AUTOVON 360-3351, FTS 799-3351, or commercial 805-982-3351. Questions concerning confirmation work or other follow-on efforts should be referred to NORTHDIV 114 at AUTOVON 443-4972, FTS 215-755-4972, or commercial 215-755-4972.

D. L. SPIEGELBERG
Lieutenant Commander, CEC, USN
Environmental Officer

ACKNOWLEDGEMENTS

The Initial Assessment Study Team expresses its thanks for the support, assistance, and cooperation provided by personnel at Northern Division, Naval Facilities Engineering Command; Naval Energy and Environmental Support Activity; NAVPRO; and FMC Corporation. Without their support, the Initial Assessment Study at the Naval Industrial Reserve Ordnance Plant, Minneapolis, Minnesota, could not have been successfully completed. In particular, the team acknowledges the effort provided by the following people:

Jacqueline Francis, NEESA
John McLaughlin, NAVPRO
Earl Wigand, Assistant to Vice President, FMC
Bill Patterson, Director of Manufacturing, FMC
Doug Hildre, Pollution Control/Waste Management, FMC
Dave Smith, Northern Division, NAVFAC

CONTENTS

CONTENTS (Continued)

CONTENTS (Continued)

FIGURES

TABLES

PLATES

CHAPTER 1. INTRODUCTION

1.1 SCOPE. The Department of the Navy has initiated the Navy Assessment and Control of Installation Pollutants (NACIP) Program through OPNAVNOTE 6240 ser 45/733503 of 11 September 1980 and Marine Corps Order 62801 of 30 January 1981. The purpose of the NACIP Program is to identify, assess and control environmental contamination from past hazardous materials disposal operations. The NACIP Program is divided into three phases: the Initial Assessment Study (IAS), the Confirmation Study, and Remedial Actions. The IAS involves collecting and evaluating information concerning past hazardous waste disposal practices. The Confirmation Study involves sampling and analysis to confirm or deny the presence of contamination. The third phase, Remedial Action, involves corrective measures to control and mitigate contamination.

This report represents the IAS for the Naval Industrial Reserve Ordnance Plant (NIROP), Minneapolis, Minnesota. The NIROP is a government owned-contractor operated facility operated by the Northern Ordnance Division of FMC Corporation. Contiguous with the NIROP is property owned and operated solely by FMC. This IAS deals only with Navy property and does not address FMC property or any waste disposal sites they may have.

1.2 SEQUENCE OF EVENTS.

1. NIROP Minneapolis was designated for an IAS by CNO letter 451/391407 of 31 March 1982. Direction was forwarded to the Naval Energy and Environmental Support Activity (NEESA) to accomplish the study by NAVFACENGCOM letter 1121L/LW of 9 April 1982.

2. The Commander of Naval Sea Systems Command and the Commanding Officer of the NIROP were notified of IAS selection by NEESA letter 11100/1:273H serial 1519 of 17 September 1982. This letter forwarded activity support requirements for the IAS to NIROP Minneapolis to outline assessment scope, provide guidelines to personnel and request advance information for review by the IAS team.

3. NIROP personnel were briefed by NEESA's IAS Project Coordinator, Jacqueline Francis, and Don Monnot, of Envirodyne Engineers, Inc. (EEI) on 6 and 7 October 1982.

4. During October and November 1982, a records search at various government agencies was conducted for documents pertinent to the IAS effort. Agencies contacted included:

   a. NEESA Library

   b. NORTHDIV Facilities Planning and Real Estate Department, Environmental Branch, Utilities Division, Applied Biology and Natural Resources Branches

c. Washington National Records Center, Suitland, Maryland

d. National Archives, Washington, DC

e. Naval History Office, Washington Navy Yard, Washington, DC

f. Department of Defense Explosives Safety Board, Alexandria, Virginia

g. U.S. Geological Survey, Reston, Virginia

h. Ordnance Environmental Support Office (OESO), Indian Head, Maryland

i. NAVFAC, Alexandria, Virginia

j. NAVSEA, Alexandria, Virginia

k. Minnesota Geological Survey

5. The on-site phase of the IAS was conducted from 25 through 29 October 1982. The EEI team consisted of four members: two environmental engineers and two environmental scientists. Installation records were reviewed, interviews were conducted with present long-term employees, and ground and aerial tours of the installation were made. Information presented in this report reflects the information available at the time of the on-site survey. Data from on-going investigations in the area, generated after the on-site survey, have not been incorporated into this report. However, these data will be considered in the development of the Confirmation Study.

1.3 SUBSEQUENT NACIP STUDIES. The recommendation for the second phase of the NACIP program, the Confirmation Study, is based on the findings of the IAS. During Confirmation Studies, extensive sampling and monitoring are conducted to confirm or refute the existence of suspected contamination at sites identified during an IAS. If significant contamination exists, the Confirmation Study recommends the types of remedial action to be implemented. A Confirmation Study is conducted only if the IAS concludes that:

1. Sufficient evidence exists to suspect that an installation is contaminated, and

2. The contamination presents a potential danger to:

a. The health of civilians in adjoining communities or personnel within the base fenceline, or

b. The environment within or outside the installation.

If these criteria are not met, no further studies will be conducted under the NACIP program.

If a Confirmation Study is needed, its objective is to determine whether specific toxic or hazardous materials have contaminated the environment at the naval installation. The study includes the identification and quantification of pollutant concentrations, the extent or potential for migration from suspected sites, and possible effects on human health and the environment. The study can consist of field investigations including: aquatic (biological) samples, analysis for chemical contaminants, and preparation of contaminant concentration profiles. Needed contamination abatement actions will subsequently be conducted depending on recommendations and findings contained in the Confirmation Study report.

The Confirmation Study consists of an evaluation of identified sites to determine whether significant concentrations of toxic or hazardous materials are present and migrating by surface or subsurface routes, or whether the potential for migration exists. The study is conducted in two steps: verification and characterization. The verification step may be bypassed at a site if investigations conducted prior to the IAS showed contamination.

The purpose of the verification step is to locate sources of contamination, determine the presence of specific toxic and hazardous materials, and determine generalized site geohydrology. Efforts may include the sampling of existing monitoring wells or installation and sampling of new wells, sediment, soil, or surface water sampling. The result of this phase will be a general evaluation of contamination found, including geohydrological, health, safety, and regulatory aspects, and a recommendation whether or not to proceed with the characterization step.

The characterization step, if required, is designed to determine specifics of groundwater movement, site geohydrology, and the levels and distribution of contamination, both vertical and horizontal, around contaminated sites. Efforts may include the installation of additional monitoring wells, geophysical measurements, and quantitative analyses for selected contaminants. The result of this phase will be a quantitative asessment of contamination sources and a determination of the potential for and extent of contaminant migration.

1.4 WASTE DISPOSAL SITES. All known or suspected hazardous waste disposal sites identified by the IAS team were evaluated using a Confirmation Study Ranking System (CSRS) developed by NEESA for the NACIP program. The system is a two-step procedure for systematically evaluating a site's potential hazard to human health and the environment based on evidence collected during the IAS.

Step One of the system is a flowchart which eliminates innocuous sites from further consideration. Step Two is a ranking model which assigns a numerical score, within a range of 0 to 100, to indicate the potential severity of a site. Scores are a reflection of the characteristics of the wastes disposed of at a site, contaminant migration pathways, and potential contaminant receptors on and off the installation. CSRS scores and engineering judgment are then used to evaluate the need for a Confirmation Study based on the criteria stipulated in Section 1.3. CSRS scores assigned to sites recommended for confirmation studies also assist

Navy personnel to establish priorities for accomplishing the recommended actions.

A detailed description of the Confirmation Study Ranking System is contained in NEESA Report 20.2-042.

1.5 MITIGATING ACTIONS. During the IAS, some areas may be identified that do not warrant a Confirmation Study but do warrant an action of some kind by the installation. For example, a mitigating action could be proposed to clean up a spill area. The operations or areas in question do not warrant Confirmation Studies.

CHAPTER 2. SIGNIFICANT FINDINGS AND CONCLUSIONS

2.1 INTRODUCTION. NIROP Minneapolis is located north of the Minneapolis/St. Paul area in Fridley, Minnesota. The NIROP is owned by the government and operated by the Northern Ordnance Division of FMC Corporation. Advanced naval weapons systems have been produced at the NIROP since the plant was constructed in 1940.

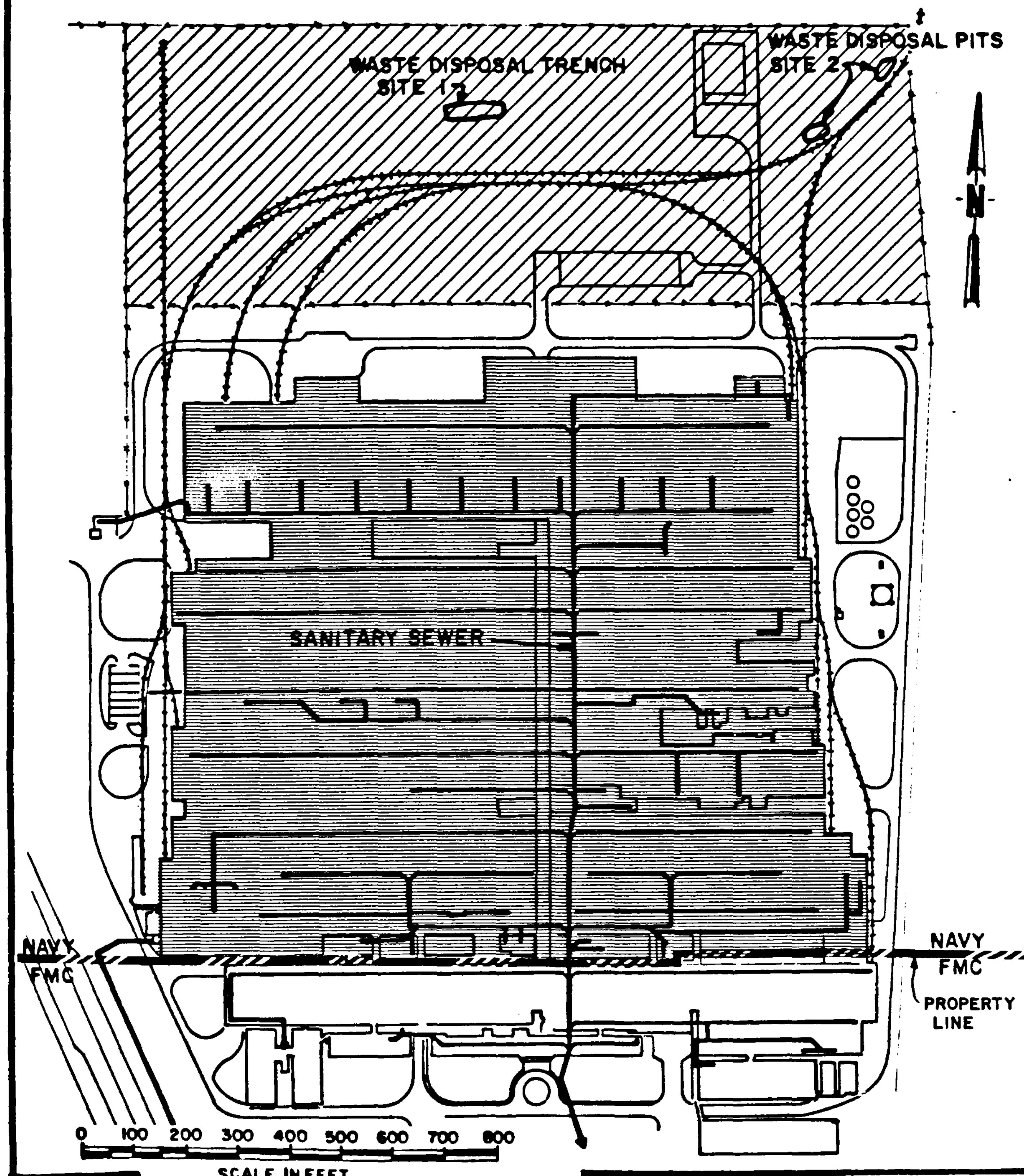
The NIROP is located one-quarter mile east of the Mississippi River on a broad, flat outwash terrace. The site occupies 82.61 acres, most of which are covered with buildings or pavement. The glacial soils occurring at the site consist of stratified coarse sand, medium sand and some gravelly sand. These unconsolidated deposits are up to 150 feet thick. Practically all of the precipitation falling on the ground surface either soaks into the ground or evaporates. There is essentially no runoff due to the flat topography and highly permeable soils. Precipitation flows to the water table very quickly and from there flows rapidly through the upper aquifers to the Mississippi River.

Groundwater flow in the immediate vicinity of the NIROP, however, is more complex. Although the regional groundwater flow under natural conditions is toward the west, four wells in the immediate area historically or presently significantly modify this flow. At times, groundwater has flowed toward the east and south.

Fridley has a peak demand water supply well located just northwest of the plant which taps the Prairie du Chien/Jordan aquifer. This well was sampled in August 1982, and the chemical analysis showed that trichloroethylene (TCE) was present but in amounts too small to quantify (see 4.6.1). Minneapolis has a water supply intake on the Mississippi River located approximately one mile downstream from the NIROP. Analysis has repeatedly shown the presence of TCE in the one part per billion range (see 4.5.1). The NIROP has three production wells in the Prairie du Chien/Jordan aquifer. Two of these wells are government-owned, and the other is FMC-owned. They were used for potable water until 24 April 1981, when they were shut down due to TCE contamination. Sampling on 16 March 1981 and 23 April 1981 indicated TCE contamination at these wells (see 4.6.1). Refer to Appendix C for analytical results.

2.2 WASTE DISPOSAL SITES. Four waste disposal sites were identified at the NIROP during the on-site survey (Figure 2-1). The significant findings and conclusions concerning these sites are outlined below. Detailed discussions of the four disposal sites are in Chapter 8.

2.2.1 Site 1, Waste Disposal Trenches. Two trenches were excavated at this site for waste disposal purposes in 1972. The trenches were located either side-by-side or end-to-end based on conflicting reports. Plate 8-1 verifies the location of one trench. The trenches were used on a one-time basis. Each trench was approximately 10 feet wide, 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



ENVIRODYNE ENGINEERS

SITE 3 AREA BENEATH NIROP BUILDING

SITE 4 CORE BUTT DISPOSAL AREA

FIGURE 2-1
WASTE DISPOSAL SITES
NIROP MINNEAPOLIS

two or three deep and covered with excavated soils. There were also accounts that the drums were pushed from the truck into the trenches.

The material potentially disposed of in drums in these trenches included waste oil, plating sludge, paint sludge, cleaning solvent, and degreasing solvent. Plating sludges may contain cyanide and the following metals: cadmium, chromium, copper, lead, manganese, nickel, silver, tin, and zinc. Both chlorinated and nonclorinated solvents, including trichloroethylene (TCE), methylethylketone (MEK), toluene, naphtha and 1,1,1-trichloroethane may have been in the drums.

At a depth of 8 to 10 feet, the bottoms of the trenches are about 15 feet above the seasonal high water table. If water soluble and low density wastes (such as oils) leak out of drums and into the groundwater, they would migrate in a downgradient direction, generally toward the river. If liquid wastes, which are denser than water and relatively insoluble (such as TCE), leak out of drums, they would migrate downward to the first confining surface (aquitard) and possibly flow down slope (down dip) toward the south. The uppermost aquitard is either the upper surface of the St. Peter Sandstone (bedrock) or one of the shale beds within the bedrock.

2.2.1.1 Conclusion. The drums disposed of in the trenches were believed to contain potentially hazardous wastes. The pathways for migration exist and receptors are in the immediate area. This site could present a hazard to human health or a potential impact to the environment. Therefore, a Confirmation Study is recommended for this site.

2.2.2 Site 2, Waste Disposal Pits. Reportedly, during the late 1960s or early 1970s, two borrow pits were used on a one-time basis for the disposal of drummed wastes. Although the exact location of the pits was not determined, they are reportedly on the northeast portion of the NIROP: one near the railroad gate, the other near the first railroad switch. Each of the pits was approximately 8 feet deep, irregularly shaped and contained about 25 waste filled barrels. In addition to the barrels, the disposal pits contained miscellaneous construction debris, such as metal scraps, lumber and concrete.

The drums contained the same types of wastes as those listed for Site 1 (see 2.2.1). The physical setting of Site 2 is essentially the same as that of Site 1.

2.2.2.1 Conclusion. The drums disposed of in the pits were believed to contain potentially hazardous wastes. The pathways for migration exist, and receptors are in the immediate area. This site may present a hazard to human helath or a potential impact to the environment. Therefore, a Confirmation Study is recommended for this site.

2.2.3 Site 3, Area Beneath the NIROP Building. The sanitary sewer system at the NIROP consists of various sizes of vitrified clay pipe. Installation of the clay pipe dates back to 1940 when the plant was originally constructed. The piping was installed in three-foot sections. Reportedly, the joints were concrete grouted. Given the age of the clay pipe, it is possible that the sanitary line underlying the NIROP was in a deteriorated condition.

Prior to 1973, when the electroplating wastewater treatment facility was installed, wastewater from the extensive electroplating operation was discharged untreated into the sanitary sewer. This wastewater possibly included cyanide and the following metals: cadmium, chromium, copper, lead, manganese, nickel, silver, tin, and zinc. If leakage occurred, these contaminants may have migrated through the sandy material underlying the plant and into the groundwater.

2.2.3.1 Conclusion. The untreated electroplating wastewater may have contained diluted hazardous wastes. If the sewer line was deteriorated, wastes may have leaked from the pipe into the area beneath the building. The pathways for migration exist, and receptors are in the immediate area. This site may present a hazard to human health or a potential impact to the environment. Therefore, a Confirmation Study is recommended for the site.

2.2.4 Site 4, Core Butt Disposal Area. Large quantities of sand are consumed in the casting process at the NIROP (see 5.2.6). Foundry core butts contain mostly sand with minor amounts of metal and resin or oil binders. Most foundry core butt disposal operations occurred off Navy property. However, it was reported that core butts were disposed of in the northern portion of the 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 (see 8.5).

2.2.4.1 Conclusion. Analysis of the foundry core sand indicates that the disposal of core butts does not represent a contamination threat. Therefore, no further action is recommended.

2.3 GENERAL.

2.3.1 TCE and Waste Oil Spraying. As reported by plant personnel, TCE and waste oil were sprayed along the railroad tracks for weed control on a limited number of occasions (probably during the 1960s). Early in the 1970s, this practice was discontinued, and burning became the principal method of weed control. The effect that the limited spraying of waste oil and TCE may have had on the environment is difficult to assess. No physical evidence of environmental contamination, such as oil-stained areas or lack of vegetation, was observed during the on-site survey.

2.3.1.1 Conclusion. There is no physical evidence of hazardous waste at this site. The sampling program recommended at the other disposal sites (discussed in Chapter 3) would reveal any indicators of groundwater contamination. Therefore, no specific action is recommended.

2.4 WATER QUALITY CRITERIA. The water quality criteria for the pollutants most likely to have been disposed of at the disposal sites are contained in Appendix A. Included are the following pollutants: cadmium, chromium, copper, cyanide, lead, nickel, polychlorinated biphenyls (PCBs), silver, toluene, trichloroethylene, and zinc. These pollutants have been designated as toxic under Section 307(a)(1) of the Clean Water Act. The water quality criteria were formulated to protect aquatic life and human health from exposure to pollutants.

CHAPTER 3. RECOMMENDATIONS

3.1 INTRODUCTION. Based on the significant findings and conclusions, three of the four waste disposal sites at NIROP are recommended for further study and remedial action. These include the waste disposal trenches (Site 1), the waste disposal pits (Site 2), and the area beneath the NIROP building (Site 3). Concurrent with the Confirmation Study (the second phase of the NACIP Program) remedial action (the third phase of the program) should be undertaken.

The following recommendations are based on information available at the time of the on-site survey, 25 through 29 October 1982. The well placement recommended in Figure 3-1 is one possible distribution based on this information. The ultimate number of wells and their placement will depend on many factors including the exact location of buried drums, local groundwater flow direction, and additional information from on-going investigations in the area. Local groundwater flow direction could be determined by evaluating data gathered from the first few wells installed.

3.2 CONFIRMATION STUDY AND REMEDIAL ACTION. This section contains the detailed recommendations for the three sites recommended for Confirmation Studies and Remedial Action.

3.2.1 <u>Site 1, Waste Disposal Trenches</u>

Geophysical Surveys to Locate Trenches: Magnetometer and ground penetrating radar and/or metal detector

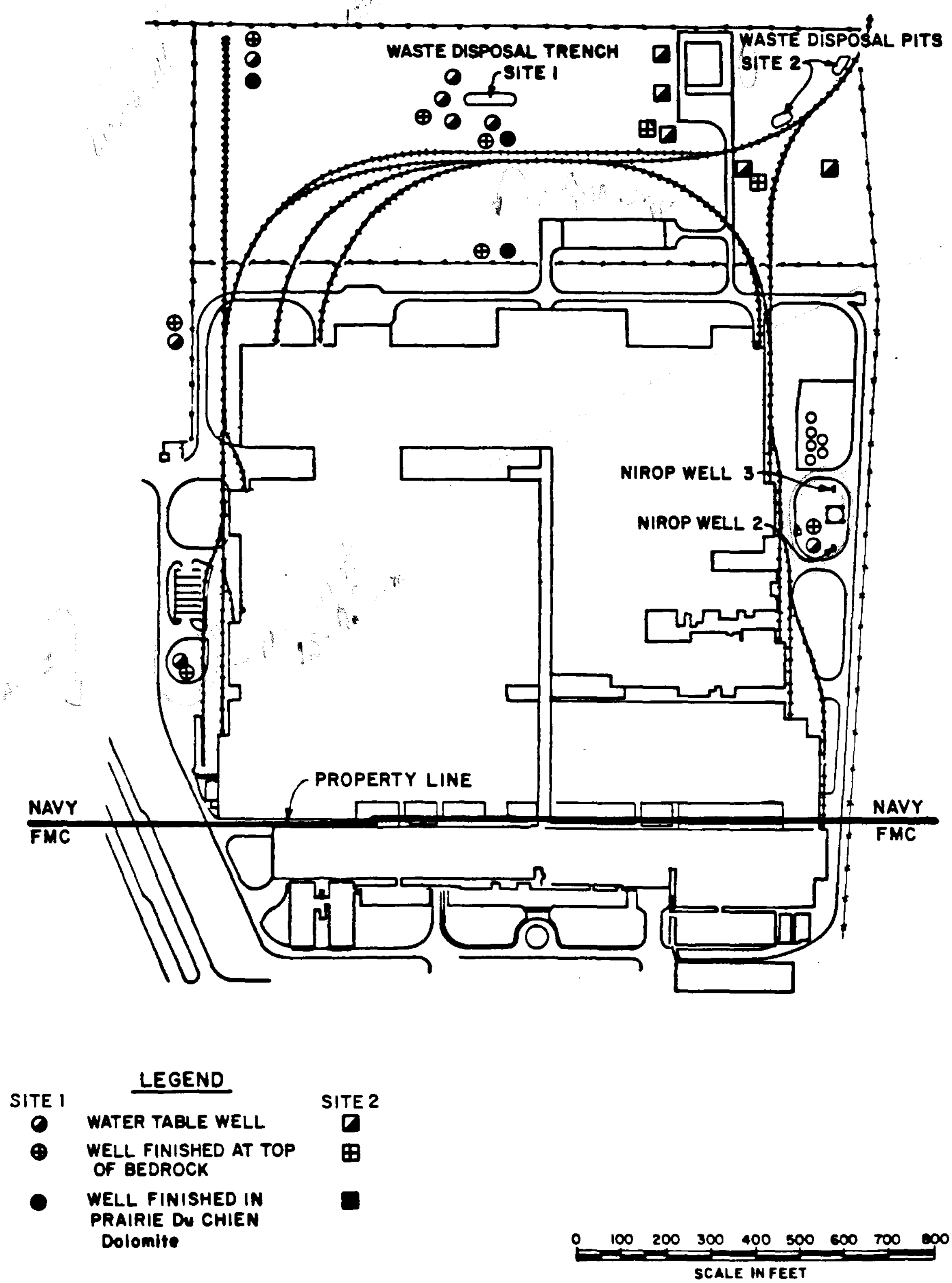
Remedial Action: Excavation and proper disposal of wastes and contaminated soil

Monitoring Wells: Eight water table wells, seven top of bedrock wells, and three Prairie du Chien bedrock wells

Testing Parameters:
- GC/MS Priority Pollutants - Volatile Fraction
- GC/MS Library Search - Volatile Fraction
- GC-EC for Trichloroethylene, PCBs
- TOC (Petroleum Based Hydrocarbons)
- Metals (Cd, Cr, Cu, Pb, Mn, Ni, Ag, Sn, Zn)
- Anions (CN)
- ABS Surfactants
- pH

Testing Frequency: Quarterly for first year after installation

3.2.1.1 Geophysical Surveys. Locating the boundaries of the trenches is essential in implementing the remedial measures and in properly positioning the monitoring wells. The boundaries of the trenches can be located using a combination of geophysical techniques. A magnetometer



ENVIRODYNE ENGINEERS

FIGURE 3-1
RECOMMENDED MONITORING WELL LOCATIONS
NIROP MINNEAPOLIS

survey can be used to locate the approximate boundaries. The magnetometer must be set-up especially for use in this type of work due to possible interferences associated with the equipment stored on the ground surface and the metal scrap that reportedly is present in the surface soils throughout this portion of the plant. A metal detector survey or ground penetrating radar survey can then be used to locate more exactly the boundaries of the trenches. This equipment must also be especially set-up to screen out the expected interferences as mentioned above.

3.2.1.2 Remedial Action. Once the boundaries of the trenches have been determined, it is recommended that the drums be excavated and properly disposed of. During removal of the drums, their condition should be examined to determine if leakage has occurred. Underlying soil should be sampled and contaminated soil removed.

3.2.1.3 Monitoring Wells. It is recommended that 18 monitoring wells be installed (Figure 3-1). In order to detect the presence of water soluble or low density contaminants, the installation of eight water table (quaternary) wells is recommended. Four of these wells should be positioned along the west and south sides of the trenches, two along the western portion of the NIROP building, another at the northern property line between the trenches and Fridley Well 13, and one along the eastern border of the NIROP building.

In order to detect high density contaminants, seven top of bedrock wells are recommended. Two of these should be positioned along the west and south sides of the trenches, three along the western border of NIROP, one along the eastern portion of the NIROP building, and one along the northern portion of the NIROP building.

TCE contamination has been shown in three existing wells tapping the Prairie du Chien/Jordan aquifer (NIROP Wells 2 and 3, and FMC Well 1). To determine if the disposal trenches are contributing to this contamination, it is recommended that an additional three Prairie du Chien/Jordan dolomite wells be installed. The location of these bedrock wells is shown on Figure 3-1. It is also recommended that NIROP Wells 1 and 2 be used for monitoring purposes.

3.2.1.4 Background Wells. Because of the limited area of the NIROP and possible nearby waste disposal pits, it may be difficult to install background wells on Navy property. However, background data must be obtained to determine the quality of groundwater entering Navy property.

3.2.1.5 Well Installation. During installation of the monitoring wells, care should be taken to avoid groundwater contamination. Well installation must be in accordance with the State of Minnesota Department of Health well codes.

3.2.1.6 Testing Parameters. The materials potentially disposed of in the trenches include a variety of organic compounds and heavy metals. The hazardous/toxic organics fall into two categories: volatiles and petroleum based hydrocarbons. The volatiles include both chlorinated (i.e., TCE) and nonchlorinated (i.e., toluene) solvents. Therefore, a non-specific screening method such as total organic halogen (TOH) would not include all of the hazardous/toxic volatiles which may have been placed in the trenches.

The wastes in the trenches also probably include volatiles which are not on the list of priority pollutants but which are relatively toxic and/or hazardous, such as xylene and MEK. Therefore, a combination of gas chromatography/mass spectrometry (GC/MS) library search and priority pollutant scan for volatiles is recommended.

In addition to the above GC/MS method, since TCE contamination has already been documented, it is also recommended that TCE be specifically looked for in all groundwater samples using a gas chromatrography-electron capture (GC-EC) method with a liquid-liquid extraction. This method is titled "Analysis of Trihalomethanes in Drinking Water," published in the Federal Register, Appendix C, Volume 44, Number 231, November 29, 1979. This method will give a much lower detection limit and better quantification than the GC/MS priority pollutant scan.

PCB contamination of waste oil has commonly occurred at many places throughout the country. Some PCB transformers and capacitors still exist at NIROP, and the past disposal method for PCB contaminated oil is unknown. Therefore, it is recommended that all groundwater samples be analyzed for PCBs using a GC-EC method.

Petroleum based hydrocarbons can be adequately characterized in groundwater by analyzing for total organic carbon (TOC). It is also recommended that all of the groundwater samples be analyzed for cyanide because plating wastes were reportedly disposed of on-site.

All groundwater samples should be analyzed for the heavy metals which may have been disposed of in the trenches. These metals include cadmium, chromium, copper, lead, manganese, nickel, silver, tin, and zinc. Due to the fact that the drums were disposed of on a one-time basis and it is not known which of the electroplating tank sludges may have been disposed of in the trenches, all of these metals should be analyzed for. It could be misleading to analyze for three or four metals and assume they would be indicators. It is also recommended that select wells be analyzed for alkyl benzene sulfonate (ABS) surfactants, which were used during parts washing. The pH should also be taken at select wells.

3.2.1.7 Testing Frequency. All of the monitoring wells should be sampled quarterly for the first year and subjected to the analysis outlined above. It is recommended that the full range of analysis be performed for the first year to assure that any seasonal variation is accounted for.

3.2.2 Site 2, Waste Disposal Pits.

Geophysical Surveys to Locate Pits: Magnetometer and ground penetrating radar and/or metal detectors

Remedial Action: Excavation and proper disposal of waste and contaminated soil

Monitoring Wells: Five water table wells, two top of bedrock wells

Testing Parameters:
- GC/MS Priority Pollutants -Volatile Fraction
- GC/MS Library Search - Volatile Fraction
- GC-EC for Trichloroethylene, PCBs
- TOC (Petroleum Based Hydrocarbons)
- Metals (Cd, Cr, Cu, Pb, Mn, Ni, Ag, Sn, Zn)
- Anions (CN)
- ABS Surfactants
- pH

Testing Frequency: Quarterly for first year after installation

3.2.2.1 Geophysical Survey. Locating the boundaries of the two pits is essential in implementing the remedial measures and positioning the monitoring wells. As outlined under Site 1, a combination of geophysical techniques can be used to locate the pits.

3.2.2.2 Remedial Actions. Once the pits have been located, it is recommended that the drums be excavated and properly disposed of. Underlying soil should be sampled and contaminated soil removed.

3.2.2.3 Monitoring Wells. Five water table wells are recommended for placement on the west and south sides of the area encompassing the two pits (Figure 3-1). Two top of bedrock wells are also recommended for placement near the pits. One should be placed to the southwest (down dip/down slope side) of the pits, with the other to the west (downgradient side) of the pits. The wells previously recommended for Site 1 will also help to delineate possible contaminant migration away from the pits. The background wells established for Site 1 can be used for this site as well.

3.2.2.4 Testing Parameters. The wastes disposed of at Site 2 are the same as those disposed of at Site 1. Therefore, the testing parameters recommended for the groundwater samples are the same as those recommended for Site 1. The rationale behind these recommendations is contained in Subparagraph 3.2.1.6.

3.2.2.5 Testing Frequency. All of the monitoring wells should be sampled quarterly for the first year. It is recommended that the full range of analysis be performed for the first year to assure that any seasonal variation is accounted for.

3.2.3 Site 3, Area Beneath the NIROP Building. The groundwater sampling and analysis program recommended for Sites 1 and 2 should be adequate to determine whether the groundwater has been contaminated by exfiltration from the sewer. Therefore, no additional Confirmation Study work is recommended for Site 3.

3.2.4 Summary Table. Table 3-1 summarizes the recommendations and lists the CSRS scores for the three sites recommended for Confirmation Studies.

3.3 CONFIRMATION STUDY NOT REQUIRED.

3.3.1 Core Butt Disposal Area. This site does not warrant further action.

TABLE 3-1

SUMMARY OF RECOMMENDATIONS
NIROP Minneapolis, MN
Study Number 29

Site No.	Name	CSRS* Score	Monitoring Wells	Sample Frequency	Lab Testing Parameters
29-1	Waste Disposal Trench	51	Install New: 8 Water Table Wells 7 Top of Bedrock Wells 3 Prairie du Chien Wells Utilize Existing: NIROP Wells 2 and 3	Sample all wells quarterly for the first year after installation.	GC/MS Priority Pollutants - Volatile Fraction GC/MS Library Search - Volatile Fraction GC-EC for TCE, PCBs, TOC (Hydrocarbons Metals (Cd, Cr, Cu, Pb, Ni, Mn, Ag, Sn, Zn) Anions (CN) pH (selective on wells) ABS Surfactants (selective on wells)
29-2	Waste Disposal Pits	51	Install New: 5 Water Table Wells 2 Top of Bedrock Wells	Same as above	Same as above
29-3	Area Beneath NIROP Building	34	Utilize wells described above.	Same as above	Same as above
29-4	Core Butt Disposal Area	**	None	None	None

Additional Recommendations:

1) Utilize a combination of some of the following geophysical methods to locate and define the boundaries of Sites 1 and 2: Magnetometer, electromagnetics, seismic, resistivity and ground penetrating radar surveys.

2) Excavate and properly dispose of the wastes at NIROP Sites 1 and 2.

*Confirmation Study Ranking System
**Rating Model Not Applied

CHAPTER 4. BACKGROUND

4.1 GENERAL. The NIROP plant is operated by the Northern Ordnance Division of FMC Corporation and is involved with the manufacture of advanced naval weapon systems, including their development, design engineering, and testing. The plant began production in 1941, making it the first plant to mass produce naval guns during World War II. The plant has continued to produce naval guns and has expanded into the production of guided missile launching systems, torpedo tubes, and hydraulic and electric power drive and control systems.

4.1.1 Location. The NIROP is located in the northern portion of the Minneapolis/St. Paul metropolitan area, within the city limits of Fridley, Minnesota. The plant is situated approximately one-quarter mile east of the Mississippi River and less than one mile south of Interstate 694. The plant is bordered on the west by the East River Road and on the east by the Burlington Northern railyard. A general vicinities map is included as Figure 4-1.

The government owned-contractor operated portion of the plant encompasses 82.61 acres. The remainder of the facility is owned and operated by FMC Corporation. Figure 4-2 shows the layout of the plant, delineating those areas owned by the Navy and those areas owned by FMC.

4.2 HISTORY. NIROP Minneapolis dates back to 1940 when Northern Pump Company negotiated with the Navy for the construction of a new manufacturing plant. 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, the move to a new manufacturing plant was needed.

The arrangement made to construct the new plant was unique in that it was partly owned by the government and partly owned by Northern Pump Company. The site chosen for the plant was a corn field just north of the Minneapolis city limits, within the township 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 of 1941, the plant was in full production.

During World War II, the plant was operated in two 12-hour shifts, 365 days a year, producing 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 had received awards annually from 1941 through 1946 from the Navy for meritorious production.

In June of 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 has often been

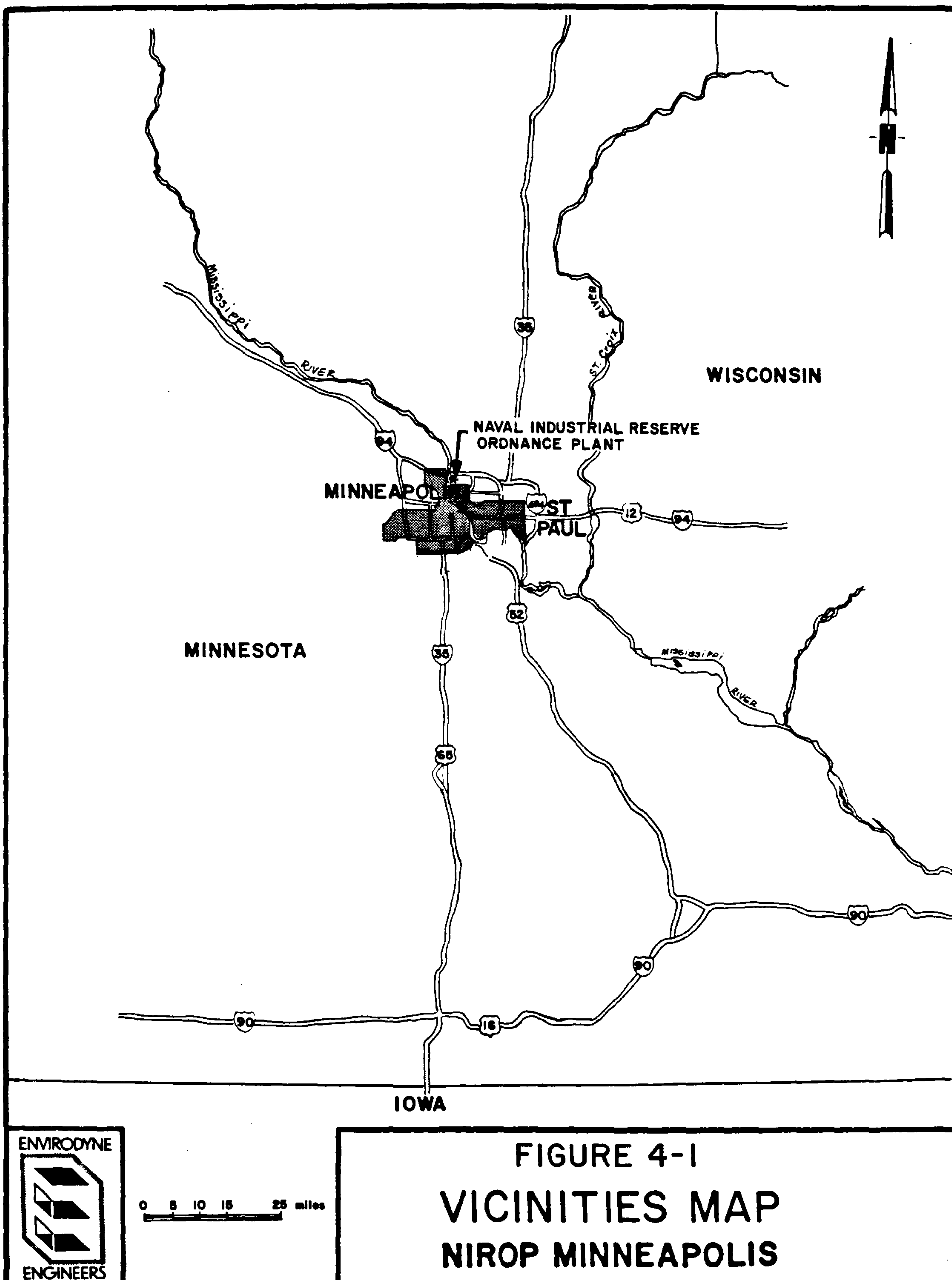
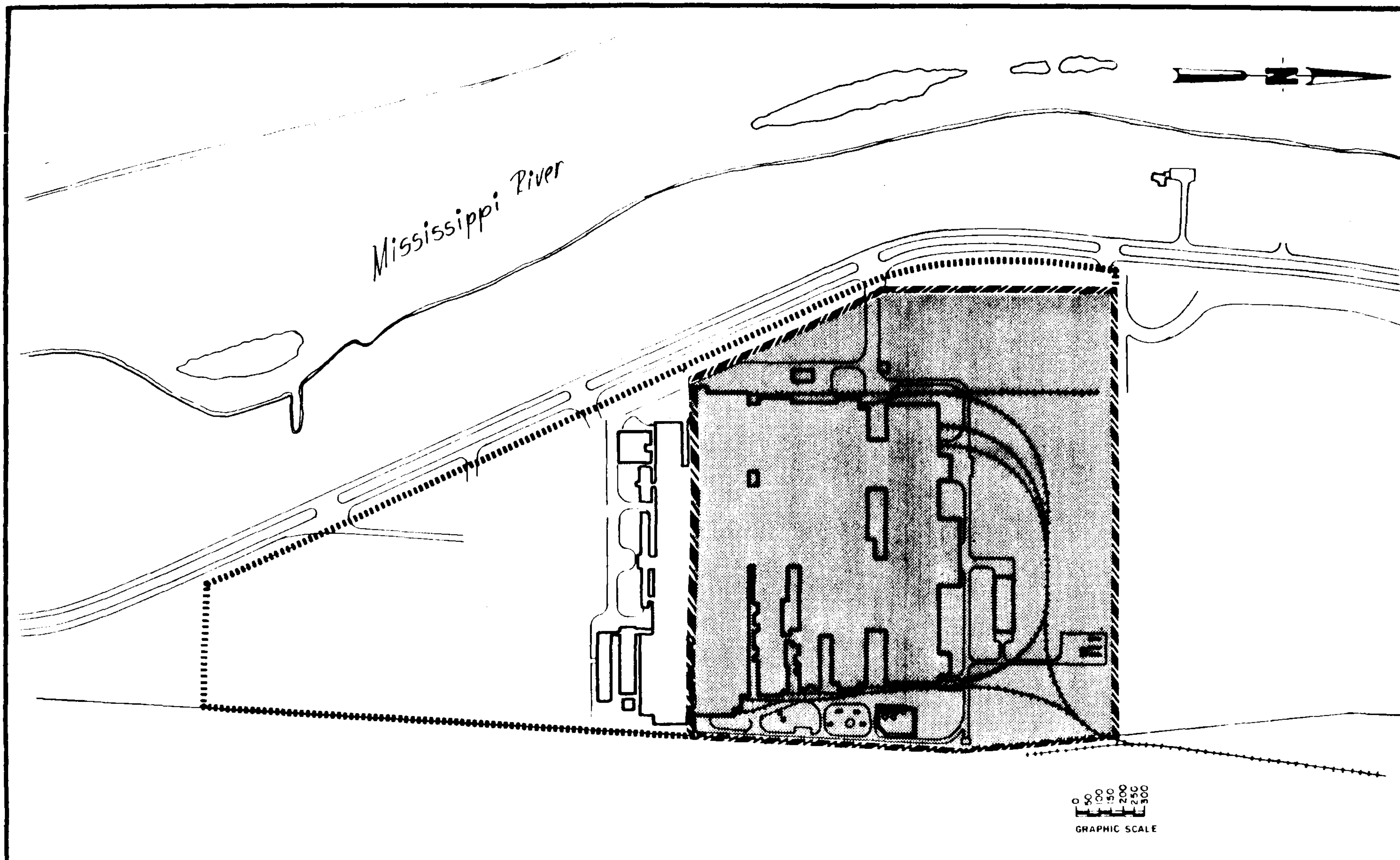


FIGURE 4-1

VICINITIES MAP

NIROP MINNEAPOLIS



ENVIRODYNE ENGINEERS

NAVY PROPERTY
NAVY PROPERTY LINE
FMC PROPERTY LINE
RR TRACKS

FIGURE 4-2

INSTALLATION MAP
NIROP MINNEAPOLIS

referred to as Northern Ordnance, Inc. and later as Northern Ordnance Division (NOD).

Following the end of the war, production of gun mounts dropped substantially, and the work force 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, five-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.

During the 1950s, the Navy had a 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, and Mark 22 - 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 Tartar.

During this same period of time, a series of torpedo launching tubes, the Mark 23, Mark 24, and Mark 25, were produced at the plant.

On January 31, 1964, Northern Ordnance was acquired from Northern Pump Company by FMC Corporation. Northern Ordnance was assigned divisional status within FMC's Ordnance Group. FMC has been the contractor at NIROP since this date.

Since FMC Corporation's takeover of Northern Ordnance, the plant has continued to produce gun mounts and advanced missile launching systems. However, there has been a shift toward smaller, lighter systems. The plant currently produces a five-inch 54 caliber gun mount, the Mark 45, which is the smallest and lightest five-inch gun mount in the world. This gun mount is being used on the Navy's latest cruisers and destroyers. The Mark 75, which is a fast firing, 76 millimeter, 62 caliber gun mount, is also being produced at the plant.

The guided missile launching systems currently being produced at the plant, the Mark 13 and Mark 26, are designed for the Navy's newer, smaller class ships. These products are the main launching systems on the Navy's latest frigates, destroyers, and cruisers.

The NIROP has evolved into one of the prime developers and manufacturers of naval ordnance equipment in the United States. The plant has one of the largest and most diverse machine shops in the world, enabling it to be the major supplier of heavy naval ordnance for the United States Navy.

4.3 PHYSICAL FEATURES.

4.3.1 General. NIROP Minneapolis lies one-quarter mile east of the Mississippi River. The plant is approximately 15 miles north of the confluence of the Mississippi and Minnesota Rivers. The site is small, covering only 82.61 acres, and much of this is taken up by buildings or has been paved over for parking. There are no streams or surface impoundments within the boundaries of the facility.

4.3.2 Climatology. The climate of the Minneapolis-St. Paul area is dominated by its location near the center of North America. The continental climate of the area is characterized by warm summers with ample rainfall, rather long, cold winters and a changeable wind regime over the course of the year. The terrain is generally flat or gently rolling, and is dotted with numerous lakes. These lakes are, for the most part, small and shallow, exerting little or no influence upon the air masses that pass over the area.

Temperature variations are quite extreme from season to season. Summer temperatures range from the upper 70s to the low 80s, while winters are very cold with lows averaging between 3 and 7°F for January and February. The temperature extremes for the area range from -34 to 104°F.

The Minneapolis-St. Paul area lies near the northern edge of the influx of moisture from the Gulf of Mexico. The average annual precipitation is 25.94 inches. Of this annual precipitation, approximately 65 percent (16.9 inches) occurs during the months of May through September. Thunderstorms are the principal source of precipitation during these months. Winter snowfall can be very heavy and averages more than 40 inches per year.

The wind regime varies throughout the year. Northwest winds prevail from November through April; southeast winds are dominant in May, June, August and October; and southern winds dominate in July and September. Wind speeds are fairly constant throughout the year, averaging 10.5 miles per hour.

Table 4-1 summarizes the climatological data for the Minneapolis-St. Paul area.

4.3.3 Topography. The facility is located on a broad, flat outwash terrace of the Mississippi River at an elevation of 835 feet (National Geodetic Vertical Datum). Slopes throughout the site are five percent or less. *

4.3.4 Geology.

4.3.4.1 Quaternary Deposits. The site lies on an alluvial terrace deposit which was formed during the Pleistocene Epoch, when glacial meltwaters caused the nearby Mississippi River to flow at a higher elevation. The terrace deposits consist of a heterogeneous mixture of gravel, sand, silt, and clay. Based on boring logs from six locations situated 1,500 to 2,200 feet south of the NIROP's boundary (see Figure 4-3), the texture varies from a medium to coarse sand with gravel to a sandy clay. The fine grained deposits (sandy clay, clayey sand) were encountered in a few of the borings. The logs of these borings (FMC 11,

TABLE 4-1

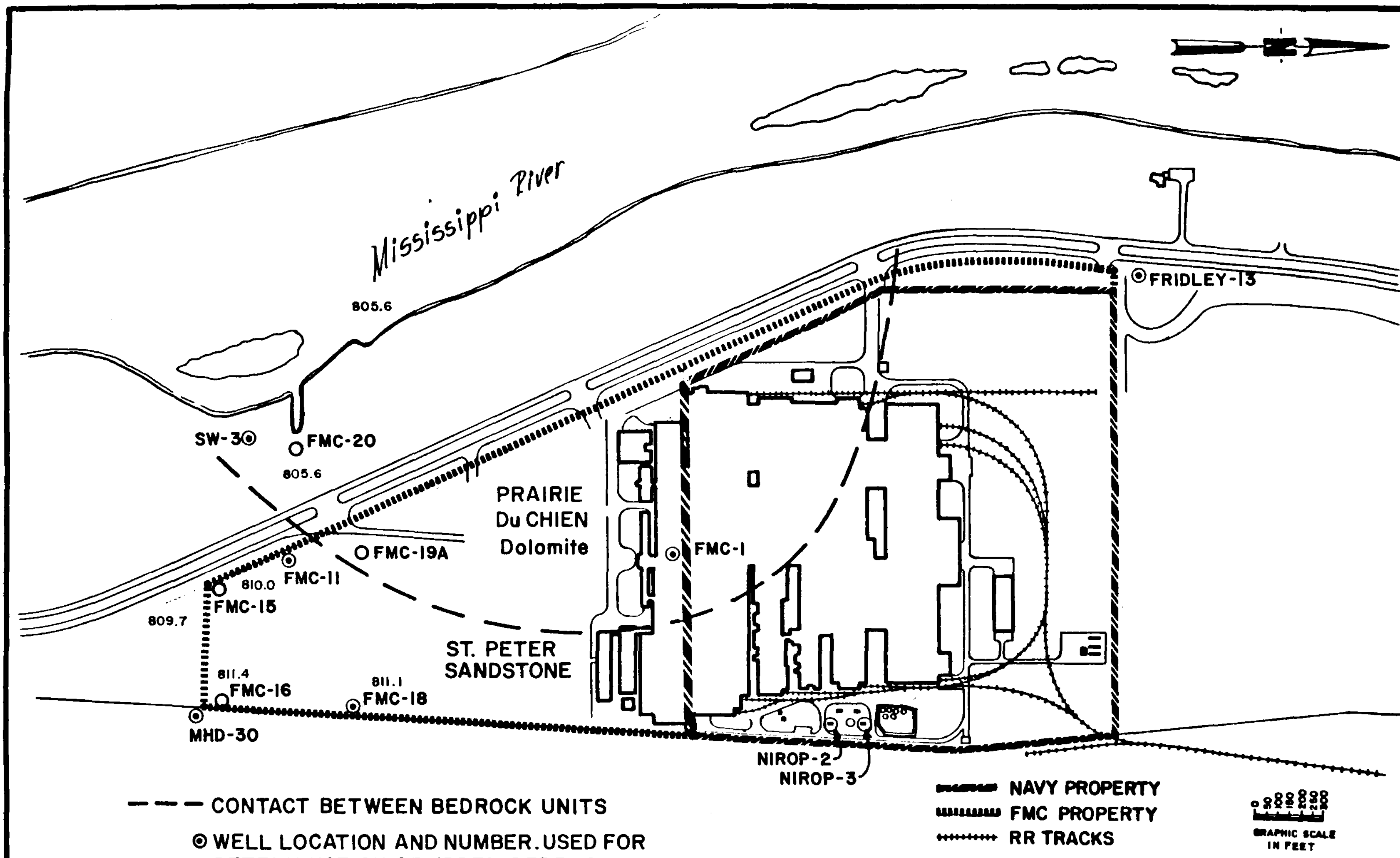
SUMMARY OF CLIMATOLOGICAL DATA

	Normal Temperature (°F)			Extremes (°F)		Precipitation (Inches)				Wind		Mean Number of Days			
Months	Daily Max.	Daily Min.	Monthly	Record Highest	Record Lowest	Normal	Max. Monthly	Min. Monthly	Max. 24 Hour	Mean Speed (MPH)	Prevailing Direction	Precipitation 0.01 inches or more	Thunderstorms	90°F and above	32°F and below
(a)				42	42		42	42	42	42	14	42	42	21	21
Jan	21.2	3.2	12.2	58	-34	0.73	3.63	0.11	1.21	10.4	NW	9	*	0	31
Feb	25.9	7.1	16.5	59	-28	0.84	2.07	0.06	1.10	10.5	NW	7	*	0	28
March	36.9	19.6	28.3	83	-32	1.68	4.75	0.32	1.66	11.2	NW	10	1	0	26
April	55.5	34.7	45.1	95	2	2.04	5.40	0.59	2.23	12.2	NW	10	2	*	12
May	67.9	46.3	57.1	96	18	3.37	8.03	0.61	3.03	11.2	SE	11	5	1	1
June	77.1	56.7	66.9	100	34	3.94	7.99	1.06	2.92	10.5	SE	12	8	3	0
July	82.4	61.4	71.9	104	43	3.69	7.10	0.58	4.12	9.2	S	10	8	7	0
Aug	80.8	59.6	70.2	102	39	3.05	9.31	0.43	7.36	9.1	SE	10	7	4	0
Sept	70.7	49.3	60.0	98	26	2.73	7.53	0.41	3.55	9.8	S	9	4	1	1
Oct	60.7	39.2	50.0	89	15	1.78	5.68	0.01	2.95	10.4	SE	8	2	0	7
Nov	40.6	24.2	32.4	75	-17	1.20	5.15	0.02	2.91	10.9	NW	8	1	0	22
Dec	26.6	10.6	18.6	63	-24	0.89	2.21	T	1.11	10.3	NW	9	*	0	30
Year	53.8	34.3	44.1	104	-34	25.94	9.31	T	7.36	10.5	NW	114	38	15	157

(a) Length of record, years

* less than one half

T Trace



ENVIRODYNE ENGINEERS

FIGURE 4-3

BEDROCK GEOLOGIC MAP NIROP MINNEAPOLIS

* Measurement taken by E. A. Hickok and Associates

15, 16, 18, 19A, and 20) are included in Appendix C. There were fine grained deposits encountered as deep as 105 feet at one location, but these deposits were more typically found at depths of less than 30 feet.

4.3.4.2 Ordovician System. The unconsolidated Quaternary deposits directly overlie Ordovician age bedrock (see Table 4-2). At the NIROP, the upper surface of the bedrock slopes down generally toward the southwest at about 250 feet per mile. The bedrock formation which immediately underlies most of the Navy property is the St. Peter Sandstone.

St. Peter Sandstone - The following description of this formation is modified from Thiel, 1944. St. Peter Sandstone consists of a medium to fine grained, friable, white to yellow sandstone, with beds of siltstone and shale in the lower part of the formation. Texturally and mineralogically the St. Peter Sandstone is remarkably uniform, indicating that its sands were well sorted prior to and during deposition. Most of the quartz grains are from one-eighth to one-half millimeter in diameter, and will pass through a screen with one millimeter openings. The sandstone is poorly cemented and consequently has a high porosity. A number of porosity determinations have been made, showing an average of approximately 28 percent for the upper half of the formation. Because of the small size of its quartz grains, the formation is not highly permeable.

Much of the original thickness of the St. Peter Sandstone was eroded away prior to the deposition of the overlying unconsolidated deposits. Therefore, only the lower portion of the formation is present beneath the site. In the southwestern portion of the NIROP, the St. Peter Sandstone has been completely eroded away, exposing the underlying Prairie du Chien Group (Shakopee Dolomite overlying the Oneota Dolomite) in the subsurface (see Figure 4-3). No bedrock crops out in the immediate vicinity of the site. The following descriptions of the Shakopee and Oneota Dolomites are modified from Thiel, 1944.

Shakopee Dolomite - The Shakopee is much less dolomitic than the Oneota. Its basal beds are sandy and, in many places, the succeeding layers are thin-bedded. Much of the formation is a massive, drab, dolomitic limestone with cavities filled with white calcite. Calcareous oolites may be found throughout the Shakopee, and much of the flint that is common in this formation is also oolitic.

Oneota Dolomite - The Oneota dolomite is thick-bedded, drab to buff, and in places pink, and may be sandy or shaly. The upper part may be cherty and in many localities is porous to cavernous. Many of the cavities and joints are lined with quartz crystals, and huge calcite-lined pockets are common. In the southeastern counties where the dolomite is strongly developed in the bluffs of the Mississippi and its tributaries, there are extensive solution channels, some of which reach the dimensions of caves penetrable for some distance.

TABLE 4-2

GENERALIZED GEOLOGIC COLUMN FOR THE TWIN CITIES AREA

Era	Period	Series	Formation	Member	General Description	Aquifer/Confining Bed
Cenozoic	Quaternary (Pleistocene Epoch)	Eldoran	Recent		Undifferentiated at NIROP. At NIROP, these deposits consist of outwash, sand and gravel, terrace deposits, valley train sand and gravel, and some fine grained (backwater/pond) deposits. Vertical and horizontal distribution is complex.	Quaternary (sand and gravel) Aquifer
			Wisconsin			
			Centralian	Sangamon		
				Illinoian		
			Ottumwan	Yarmouth		
				Kansan		
			Grandian	Aftonian		
				Nebraskan		
Paleozoic	Ordovician	Chazyan	St. Peter Sandstone		Sandstone, white, fine- to medium-grained, well-sorted, quartzose; locally iron-stained and well cemented; rounding and frosting of grains is common; 5-50 feet of siltstone and shale near bottom of formation.	At NIROP, the portion of the St. Peter Sandstone that is present is considered a confining bed.
		Beekmantownian	Prairie du Chien Group:			Principal water supply Aquifer at NIROP (Prairie du Chien/Jordan)
			: Shakopee Dolmite		Dolmite, light-brown to buff, thinly to thickly bedded, cherty; shale partings; commonly sandy and colitic.	
			: Root Valley (New Richmond) Sandstone		Sandstone and sandy dolomite, buff; often missing.	
			: Oneota Dolomite		Dolomite, light-brownish-gray to buff; thinly to thickly bedded, vuggy.	
	Cambrian	St. Croixian	Jordan Sandstone	Van Oser	Sandstone, white to yellowish, fine- to coarse-grained, massive to bedded, cross-bedded in places, quartzose; commonly iron-stained; loosely to well cemented.	
				Norwalk		
			St. Lawrence	Lodi	Dolomitic siltstone and fine-grained dolomitic sandstone; glauconitic, in part.	Regional confining bed
				Nicollet Creek		
			Franconia	Bad Axe	Sandstone, very fine grained; moderately to highly glauconitic; worm-bored in places.	Regional aquifer of lesser importance. (Franconia/Ironton/Galesville)
				Hudson	Interbedded very fine grained stone and shale; mica flakes common.	
				Taylors Falls	Glauconitic fine-grained sandstone and orange to buff silty fine-grained sandstone (often worm-bored).	
				Ironton	Sandstone, white, medium- to fine grained, poorly sorted and silty.	
			Dresbach	Galesville	Sandstone, yellow to white, medium to coarse grained, poorly cemented.	
				Eau Claire	Sandstone, siltstone and shale, gray to reddish-brown, fossiliferous.	Regional confining bed
				Mt. Simon	Sandstone, gray to pink, medium- to coarse-grained; some pebble zones and thin, shaley beds.	Principal water supply aquifer where the Prairie du Chien/Jordan Aquifer is not present (Mt. Simon/Hinckley)
Proterozoic (Precambrian)	Keeweenawan	Lake Superior	Hinckley-Sandstone		Sandstone, buff to red, medium- to coarse-grained, well sorted and cemented.	
			Fond du Lac Beds		Silty feldspathic sandstone and lithic sandstone, fine-grained; probably included red shale.	Aquifer of little importance; not used in Twin Cities Area.

Small quantities of water are found in the upper and more porous portion of the Oneota formation, but great volumes are contained in the larger solution passages, which represent enlarged joints, bedding planes, or other lines of easy circulation. Some underground streams that issue as springs from the dolomite flow at a rate of more than 350 cubic feet per minute. The formation yields little water to wells except from the solution passages. These passages yield freely, but it is always uncertain when or where they will be penetrated by the drill. On the upland prairies east of the Minnesota River and west of the Mississippi, the Oneota is an important source of domestic farm supplies.

Figure 4-4 shows the variation in thickness and the subcrop relationship among the Quaternary deposits, the St. Peter Sandstone, and the Prairie du Chien dolomite in a geologic fence diagram. This fence diagram shows these features from an east looking west perspective. The plane on which the well locations are plotted is the ground surface, since this surface is nearly flat throughout the area shown. The approximate elevation of this plane is 835 feet. The subsurface geology is shown as cross sections drawn from well to well, from an east looking west perspective. This enables the subsurface changes in the geology to be shown in three dimensions.

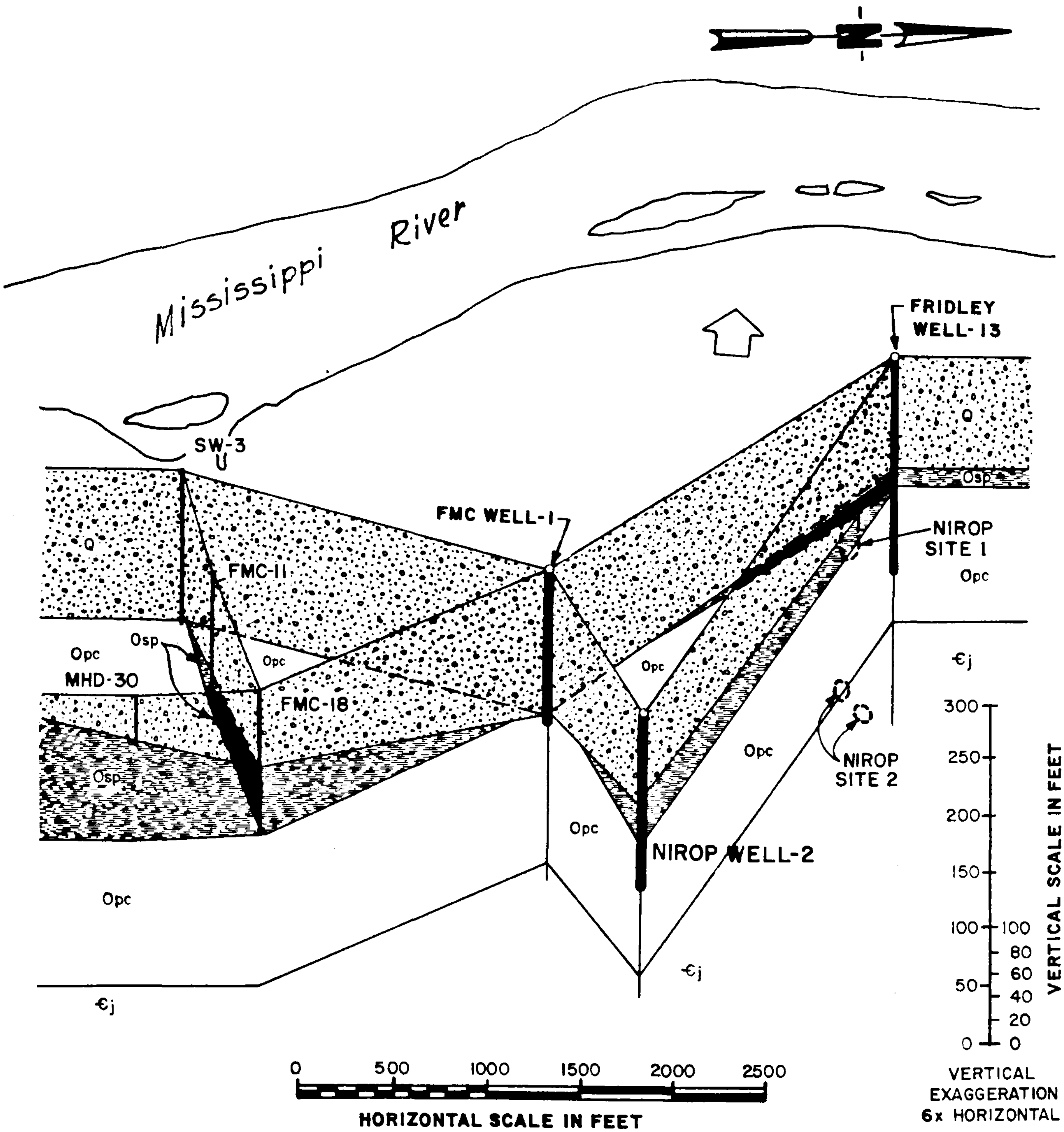
4.3.4.3 Cambrian System. At the plant, the Oneota Dolomite represents the base of the Ordovician system. The Jordan Sandstone (Cambrian Period) underlies the Oneota Dolomite throughout the Twin Cities area. The Jordan Sandstone is underlain, in turn, by the St. Lawrence Formation, the Fanconia Formation, and the Dresbach Formation. The Mt. Simon Sandstone is the lowest member of the Dresbach Formation and represents the base of the Cambrian System in the Twin Cities area. The following description of the Cambrian System is modified from Thiel, 1944.

Jordan Formation - The Jordan Sandstone is a loosely cemented medium to coarse grained white sandstone, which becomes yellow or brown by oxidation along its outcrops and jointing planes. It ranges from 75 to nearly 175 feet in thickness and is exposed in the valleys of the Minnesota River and tributary streams and in the lower part of the bluffs of the Mississippi and its branches from near Hastings southward to the Iowa state line. Elsewhere it is deeply buried beneath younger rock.

The Jordan Sandstone is made up of two members, the Norwalk below and the Van Oser above. The upper Van Oser member is the coarser. It consists of friable gray, white, pink, or brown sand grains, many of which have the faces of the crystals partly or completely restored. The Norwalk member is not present in the Twin Cities area.

St. Lawrence Formation - The St. Lawrence Formation consists of glauconitic, buff, dolomitic limestone. Several conspicuous beds of gray to buff dolomitic siltstone occur near the base of the formation. The St. Lawrence consists of two members, the lower of which is the Nicollet Creek member, the upper, the Lodi shale.

The Lodi shale member of the St. Lawrence Formation occurs between the distinctly dolomitic beds of the Nicollet Creek and the base of the buff to white Jordan Sandstone. This member includes a stratigraphically



ENVIRODYNE ENGINEERS

NOTE:

LEGEND ON SHEET 2

FIGURE 4-4

GEOLOGIC FENCE DIAGRAM

SHEET 1 of 2

LEGEND

Natural direction of groundwater flow

Wells and disposal site locations plotted at ground surface. Approximate ground surface elevation is 835 feet.

Production Well Casing

Open Hole

Monitoring Well or Boring

Q — Quaternary Deposits. Sand and gravel, with widely scattered lenses of silts and clays.

Osp — St. Peter Sandstone. Typically a well sorted, fine grained, friable sandstone, with thin siltstone and shale beds in lower portion of the formation.

Opc — Prairie du Chien Dolomite. Highly fractured, thin bedded to massive dolomite, with some sandy and some cherty horizons.

Єj — Jordan Sandstone. Loosely cemented medium to coarse grained sandstone. The Prairie du Chien Dolomite and Jordan Sandstone act as a single aquifer.

ENVIRODYNE ENGINEERS

LEGEND FOR GEOLOGIC FENCE DIAGRAM

SHEET 2 of 2

important yellowish to ash colored siltstone that is traceable over all the southeastern part of Minnesota. The siltstone contains a remarkable trilobite and graptolite fauna.

The Nicollet Creek member, also known as the Black Earth member, is nearly all sandy buff dolomite, much of which is richly sprinkled with grains of glauconite. Most of the beds range from two to six inches in thickness, but some are much thicker. At its type locality north of Judson, the Nicollet Creek is 35 feet thick. Several conglomerate beds with dolomitic pebbles in a highly glauconitic matrix occur near the base.

Neither member of the St. Lawrence Formation is important as a source of groundwater. The chief value of these members lies in their function as confining strata under the Jordan Sandstone aquifer.

Franconia Formation - The Franconia Formation contains the portion of the St. Croixian series that is highly glauconitic and is referred to as the greensand and green shale horizon. The formation is subdivided into four members which can be distinguished on the basis of the fossils they contain but are difficult to recognize from drill cuttings alone. Furthermore, the lithology of an individual member of the formation may vary greatly in different localities. This variation is found especially in the lower members of the formation, which are pink to green with glauconite in the southeastern counties of the state, but are white to buff in the region of Taylors Falls.

The Bad Axe member is the top part of the Franconia Formation. It is a sandy siltstone with layers of greensand. Natural outcrops of this member show numerous to small burrows and worm trails made by organisms that inhabited the muds before they were lithified. This member is from 40 to 65 feet thick.

The Hudson member of the Franconia formation lies immediately below the Bad Axe member. It is well exposed at Hudson, Wisconsin, from which the town gets its name. It crops out extensively along the valleys of the St. Croix and Mississippi rivers and along the lower courses of their major tributaries, where it consists of gray to buff or pinkish-green sandstones and gray siltstones, all more or less glauconitic. Some layers from two to six inches thick are nearly all glauconite. The Hudson varies in thickness from 30 to 70 feet.

The Taylors Falls member of the Franconia formation lies below the Hudson. It is a medium to fine grained, buff to pink sandstone, from 10 to 100 feet thick. In the southeastern counties it is rarely more than 25 feet thick, whereas in Washington and Chisago counties it attains a thickness of approximately 100 feet.

The Ironton member is the bottom part of the Franconia formation. It is a medium to coarse, buff to brown, poorly sorted sandstone, which varies in thickness from 2 to 25 or more feet. Most of its sands represent a reworking and redeposition of sands derived from the top of the Dresbach formation. In compiling a log of a well from drill cuttings, it is very difficult to establish the contact between the bottom of the Ironton member of the Franconia and the top of the Galesville member of the Dresbach. However, the Ironton is highly fossiliferous, whereas the Galesville contains few shell fragments.

Dresbach Formation - The Dresbach Formation is divided into three members, of which the lowest is the Mt. Simon, the middle is the Eau Claire, and the upper is the Galesville.

The Galesville member is the upper part of the Dresbach Formation. It is a medium to coarse, yellow to white, poorly cemented sandstone from nearly zero to 50 feet in thickness. It crops out at numerous places along the lower portion of the Mississippi River bluffs from Winona southward. The beds in its stratigraphic position along the St. Croix Valley at Taylors Falls are fossiliferous and very glauconitic.

The Eau Claire member is the middle portion of the Dresbach Formation. In general, it is a medium to fine grained gray, greenish-gray to buff sandstone, with beds of greenish-gray and red shales. This portion of the Dresbach Formation is from 25 to 225 feet thick.

The Mt. Simon is a coarse, white to pink and brown sandstone, with some conglomerate or quartz pebble horizons. This member is from 80 to 200 feet thick. It is typically exposed in the hill called Mt. Simon, near Eau Claire, Wisconsin. Along the Mississippi from Winona southward, this sandstone generally rests on the pre-Cambrian granites and related rocks, but northward and westward from Winona (which includes the Twin Cities area), it lies on the Hinckley Sandstone.

4.3.4.4 Lake Superior Series - Upper Keweenawan Sediments Pre-Cambrian. Sedimentary rocks of the Lower Keweenawan are not known to exist in southern Minnesota. The Upper Keweenawan, however, contains several thousand feet of conglomerates, sandstones, and shales that are here correlated with the Lake Superior series. Although these sandstones and shales have occasionally been considered Cambrian in age, their lack of fossils makes classification more or less indeterminate. They definitely lie below the St. Croixian series and their lower beds may be interbedded with Keweenawan lava flows.

Hinckley Sandstone - The Hinckley sandstone is the upper formation of the Lake Superior series. The contact between the Hinckley and Fond du Lac beds does not come to the surface in southern Minnesota; hence it is known only from well cuttings and well drillers' logs. The sandstone is coarse to fine, usually medium grained, yellowish to salmon pink and red, or nearly white. The color is due to varying amounts of iron oxide. A textural analysis of samples from near its type locality shows that its sands are fairly well sorted. The cementation of the sand grains varies from place to place. In the quarries along the Kettle River it is very complete and the cementing material is chiefly silica. In southern Minnesota, the formation varies in thickness from a few feet to more than 200 feet.

The lower beds of the Hinckley sandstone may be colored as deep red as those of the Fod du Lac or red clastic beds. The red color of the Hinckley grades downward into the red clastics without very great or sudden change in character. This gradation is conspicuous at the Federal Prison well near Sandstone. In this well, red sandstone occurs at least 350 feet above the base of the Hinckley sandstone, and for this reason, the Hinckley sandstone has been designated occasionally as the uppermost member of the red clastics. A petrographic study of a series of samples representing all exposed facies of both the red clastics and the Hinckley sandstone shows that the red clastics are uniformly high in feldspar and the Hinckley is uniformly very low. The basal Dresbach (Mt. Simon) that overlies the Hinckley has from two to four times as much feldspar as the Hinckley but far less than the red clastic beds. Furthermore, the assemblage of heavy accessory minerals in the red clastics is very different from that of the Hinckley.

Red Clastics - Fond du Lac Beds - The red clastic beds make up the lower part of the Lake Superior series as it occurs in eastern and southeastern Minnesota. These rocks are now classified as the Fond du Lac beds, from the typical exposure along the St. Louis River at Fond du Lac. Similar red sedimentary rocks are revealed by deep drilling everywhere from the gneisses and quartzites of the southwestern counties eastward toward the valley of the Mississippi River and from the Iowa boundary northward beyond Mora, where they crop out in typical form along the Snake River. They vary greatly in thickness, being many hundreds of feet thick at Minneapolis, Mankato, Stillwater, Faribault, and Rochester, but gradually thinning out eastward toward Winona. In texture, they vary from coarse conglomerate through various textural grades of sandstone to fine red shales.

4.3.4.5 Structural Geology. NIROP Minneapolis lies on the northwestern side of what is known as the Twin Cities Basin. This roughly circular structural basin is easily seen in the map view in Figure 4-5 and in the cross section in Figure 4-6. At the NIROP, the dip of the bedrock is approximately 15 feet per mile to the south-southeast. As shown by the cross section and reported in the literature, there are no faults in the Paleozoic bedrock in the vicinity of NIROP.

4.3.5 Soils. The soils in the area of the NIROP , as well as many of the soils in the Minneapolis-St. Paul area, formed in glacial outwash deposits. The glacial outwash deposits occurring at the site consist of stratified coarse sand, medium sand, and some gravelly sand. These unconsolidated outwash deposits are up to 150 feet thick in the vicinity of the NIROP.

Alluvial deposits occur in areas adjacent to the Mississippi River. These deposits are of recent origin, and the soils formed show little development. The texture of these alluvial deposits varies widely. These deposits are frequently subjected to flooding.

The NIROP is located in the southwesternmost portion of Anoka County in a small strip of land referred to as the "Anoka County Boot." This portion

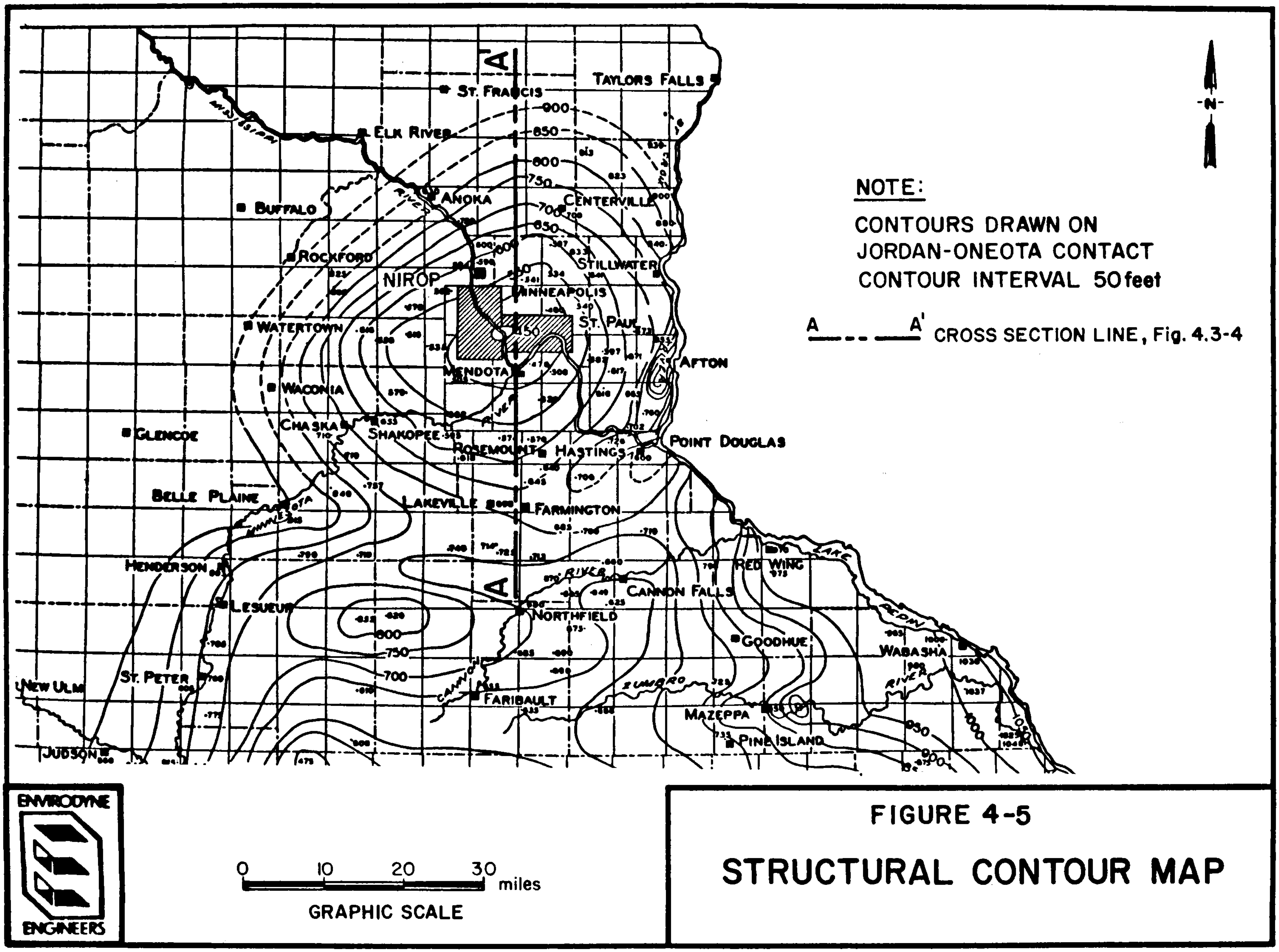
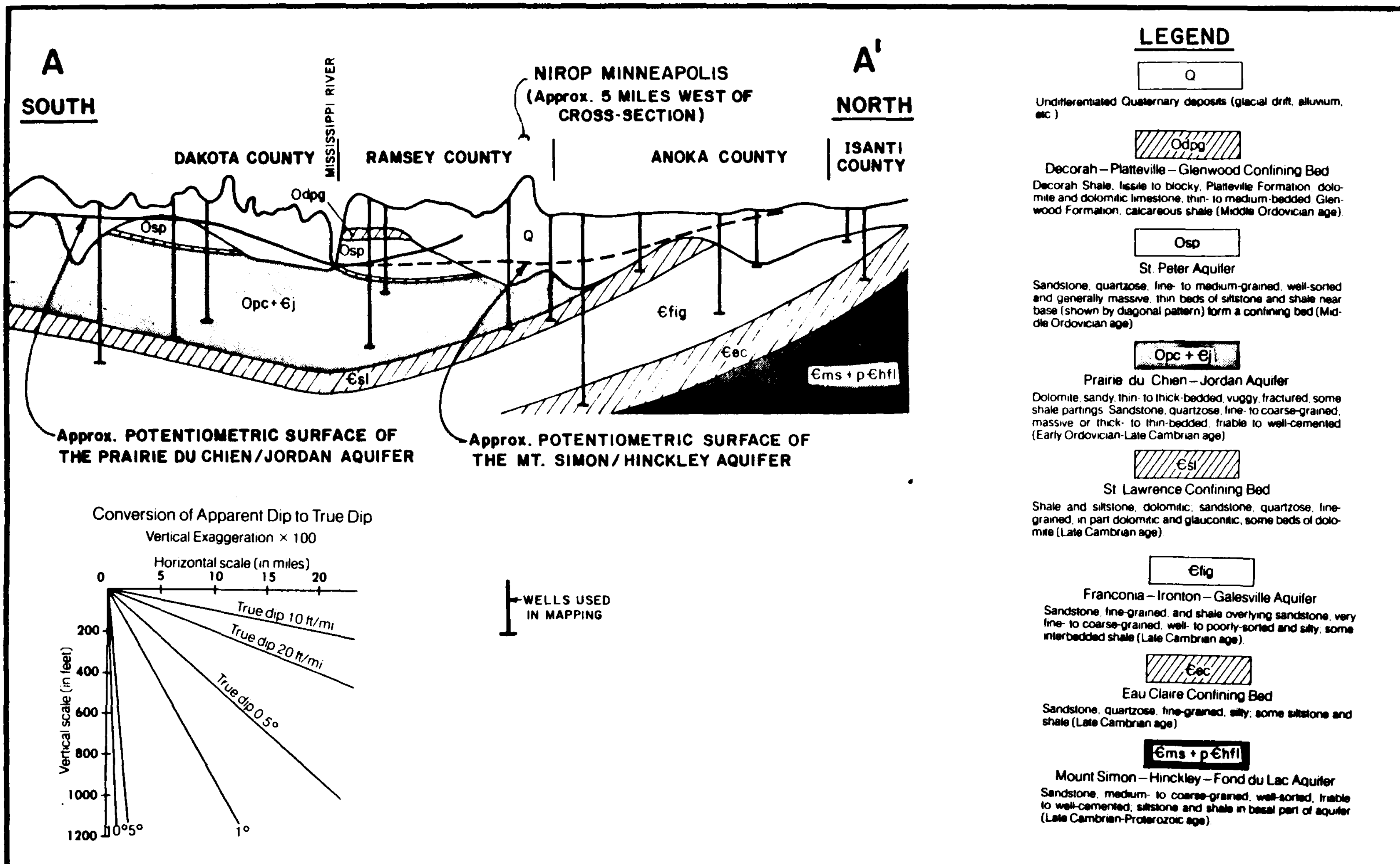


FIGURE 4-5

STRUCTURAL CONTOUR MAP

Source: G. A. Thiel and G. M. Schwartz, 1939



ENVIRODYNE ENGINEERS

FIGURE 4-6

HYDROGEOLOGIC CROSS SECTION THROUGH THE TWIN CITIES AREA

Source: University of Minnesota, 1978

of the county is not included in the present Anoka County Soil Survey. The area was recently surveyed, but this information has not yet been assembled for publication. However, the Soil Conservation Service (SCS) was able to provide information as to the soils present at the NIROP. The SCS indicated that the NIROP was located within the Hubbard-Nymore soil association, which is characterized by nearly level to gently sloping, excessively drained, sandy soils. The majority of the area has Hubbard soils, while small areas close to the Mississippi River are occupied by Becker and Chaska soils. A description of each of these soil types, taken from the Anoka County soil survey, is contained below.

4.3.5.1 Hubbard Series. The Hubbard series consists of nearly level to slightly sloping, excessively drained soils formed in broad outwash sands. These soils are located on broad flats adjacent to drainageways and large depressions in the sandy outwash plains. Hubbard soils have a black and very dark grayish-brown, coarse sandy surface layer about 20 inches thick. The subsoil is dark brown and yellowish-brown coarse sand. The underlying material at a depth of about 44 inches is pale brown, gravelly coarse sand. The permeability of these soils is rapid.

4.3.5.2 Becker Series. The Becker series consists of nearly level, moderately well drained to well drained soils formed in loamy sediments underlain by sand. These soils are found on bottom land along rivers and streams. Permeability of these soils is moderately rapid, and the available water capacity is moderate. This soil is occasionally flooded for short periods. The surface layer is very dark brown, black or dark grayish-brown fine sandy loam about 27 inches thick. The subsoil is dark brown and dark yellowish-brown, friable, very sandy loam about 17 inches thick. The underlying material is mottled yellowish-brown, loose coarse sand. This soil differs from the Hubbard soils in that it has a thick A horizon and a thicker loamy sediment.

4.3.5.3 Chaska Series. The Chaska series consists of deep, poorly and somewhat poorly drained soils formed in loamy alluvium on flood plains. The surface layer is very dark gray silt loam 8 inches thick. The substratum is 30 inches of very dark grayish-brown and very dark gray mottled silt loams with strata of fine sand and very fine sandy loam over stratified and mottled dark grayish-brown and olive fine sandy loam and grayish-brown loamy fine sand. Slopes on these soils range from 0 to 2 percent. These soils are commonly subjected to periods of flooding. The permeability of these soils is moderate to moderately rapid.

4.3.6 Hydrology and Migration Potential.

4.3.6.1 Surface Water. NIROP Minneapolis is situated on an old alluvial terrace 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, which discharge into the Mississippi River, located approximately 800 feet west of the plant boundary.

The soils are very sandy and highly permeable. As such, and because of the flat topography, essentially all of the precipitation falling on these areas either soaks into the ground or is evaporated. There is essentially no runoff from these areas, and no significant watercourses, either perrennial or intermittent, are present on the site.

As mentioned above, the Mississippi River is located very near the site. The river at this point 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 the NIROP), the Mississippi River has had an average discharge of about 7,600 cubic feet per second (cfs). The records also indicate that the seven-day low flow for a two year recurrence interval is about 2,400 cfs.

Approximately two miles north (upstream) from the NIROP, Rice Creek enters the Mississippi River from the east. There are no permanent USGS gaging stations on Rice Creek, although the flow is periodically measured. One springtime (April 1, 1982) estimate of the discharge of the creek near its confluence with the Mississippi River was approximately 150 cfs.

4.3.6.2 Groundwater. At the NIROP, there are four aquifers underlying the site as defined by the Minnesota Geological Survey (Kanivetsky and Walton, 1979). These are (from oldest to youngest) the Mount Simon/Hinckley/Fond du Lac (MSHFL) aquifer, the Franconia/ Ironton/ Galesville (FIG) aquifer, the Prairie du Chien/Jordan aquifer (PCJ), and the Quaternary aquifer. These are all shown on Figure 4-6.

The MSHFL and the FIG are both confined aquifers, and neither is used for water supply purposes in the immediate vicinity of the NIROP. The MSHFL is used fairly extensively to the north of the plant where it is not so deeply buried (see Figure 4-6).

Under the northern and eastern portions of the NIROP, the PCJ is confined by the lower portion of the St. Peter Sandstone. Under the southwestern part of the plant, the St. Peter Sandstone is fully eroded, and the PCJ exists as an unconfined aquifer (Figures 4-3 and 4-7). Where this occurs, the PCJ and the Quaternary deposits act as a single, hydraulically connected unit.

The PCJ aquifer is used for water supply purposes in the immediate vicinity of the NIROP. There are two wells at the plant (NIROP wells 2 and 3) which tap this aquifer. These wells date back to the 1940s and were used to supply potable and industrial water for the NIROP. The average pumping rate for Wells 2 and 3 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 NIROP (FMC Well 1) which taps the PCJ aquifer. This well was also shut down in April 1981 because of TCE contamination. This well was re-opened in August of 1981 and is used for non-contact cooling water. Fridley has a well just beyond the northwest corner of the NIROP (Fridley Well 13) which 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. Logs of these wells are included in Appendix C.

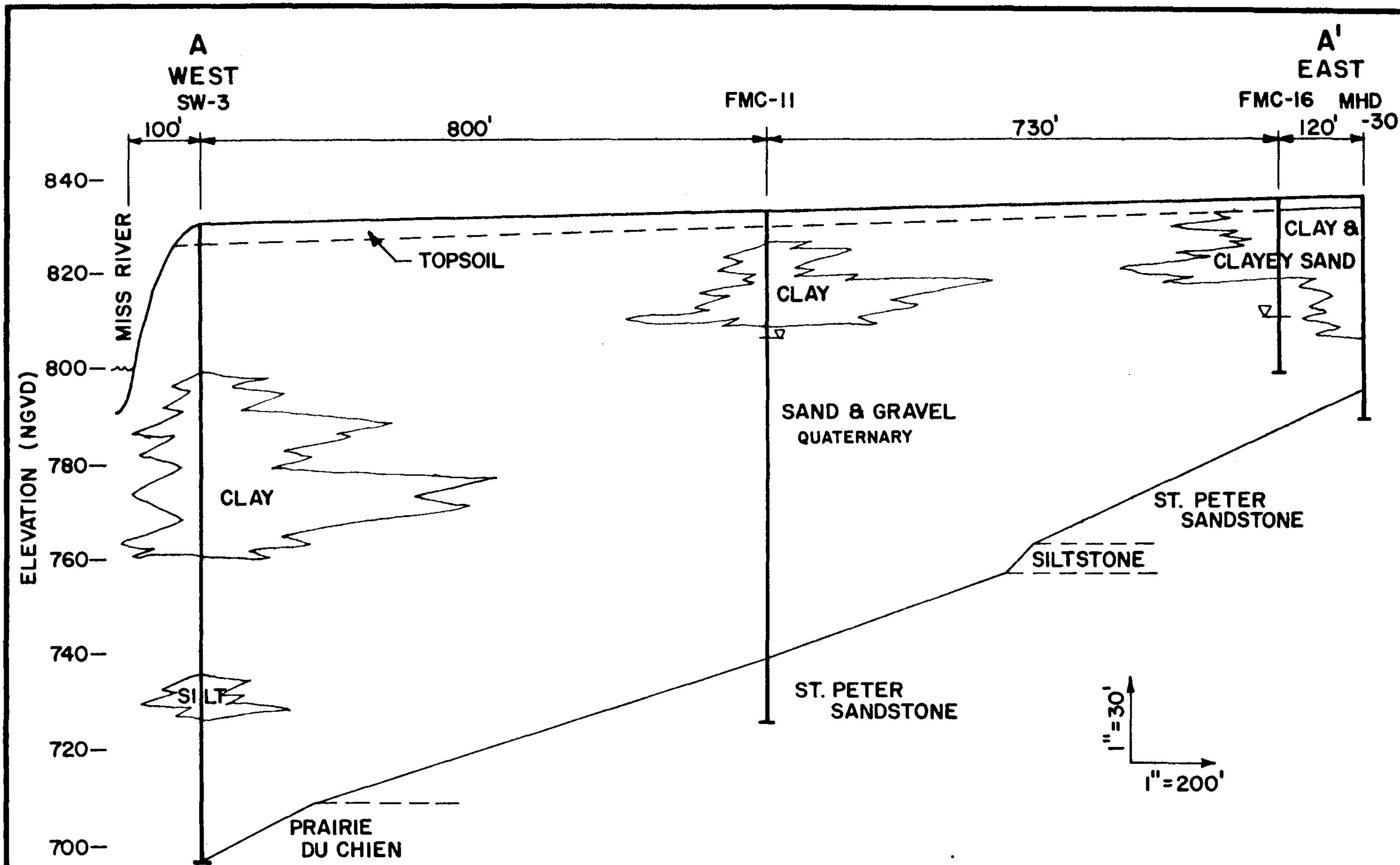


FIGURE 4-7
(EAST-WEST)
GEOLOGICAL CROSS-SECTION
Approx. 2,000ft. south of NIROP

Source: E. A. Hickok and Associates, December 1981

There are several other water supply wells in the general vicinity of the NIROP. The locations of some of these wells are shown on Figure 4-8. Logs of these wells were not obtained, but it is believed that they all tap the PCJ aquifer.

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, and water of good quality and equally high yields is commonly available at less cost in the underlying bedrock units. Wells can typically be completed in a shallow bedrock aquifer without a well screen for less cost than a screened well completed in the Quaternary deposits.

As mapped by Kanivetsky (University of Minnesota, 1979), the Quaternary deposits at the NIROP are capable of a sustained yield to a properly developed well of 100 to 500 gallons per minute (gpm). Wells tapping the PCJ aquifer typically yield 500 to 1,000 gpm (University of Minnesota, 1978). Other hydrogeologic parameters for the bedrock aquifers are shown in Table 4-3.

The depth to the water table at the NIROP is typically about 25 feet and may range from about 22 feet to 34 feet. The effect of pumping at Fridley well 13 on the depth to water at the NIROP is not known, but the radius of pressure influence of this well at the end of a typical pumping season has been estimated at approximately 1,000 feet (Kanivetsky, 1982). Since pumping from this well is not continuous on a year-round basis, the capture area of this well would be somewhat less than the radius of pressure response. How much less is not known and will vary from year to year based on variations in the quantity of water pumped.

Groundwater flow in the Quaternary deposits and the PCJ aquifer is generally toward (and discharges into) the Mississippi River, as shown in Figure 4-8. Flow in the immediate vicinity of FMC's well 1 appears to be radially toward the well, as indicated by the water levels shown on Figure 4-3. Since there are no monitoring wells in the northern portion of the NIROP, the effect of pumping at Fridley well 13 on the local groundwater flow directions in either the Quaternary deposits or PCJ aquifer is unknown. Since the St. Peter Sandstone appears to be present in this vicinity, the effect of this pumping on flow directions in the PCJ aquifer could be different from the effect on flow directions in the Quaternary deposits.

The two NIROP wells (2 and 3), when they were in use (1942 to 1981), may have had a substantial effect on local groundwater flow patterns. As at the Fridley well, the PCJ aquifer at the NIROP wells 2 and 3 is confined by the St. Peter Sandstone. Therefore, the effect on the two aquifers may have been different. Based on the above, it is apparent that the present and historical local groundwater flow patterns are and were much more complex than Figure 4-8 suggests.

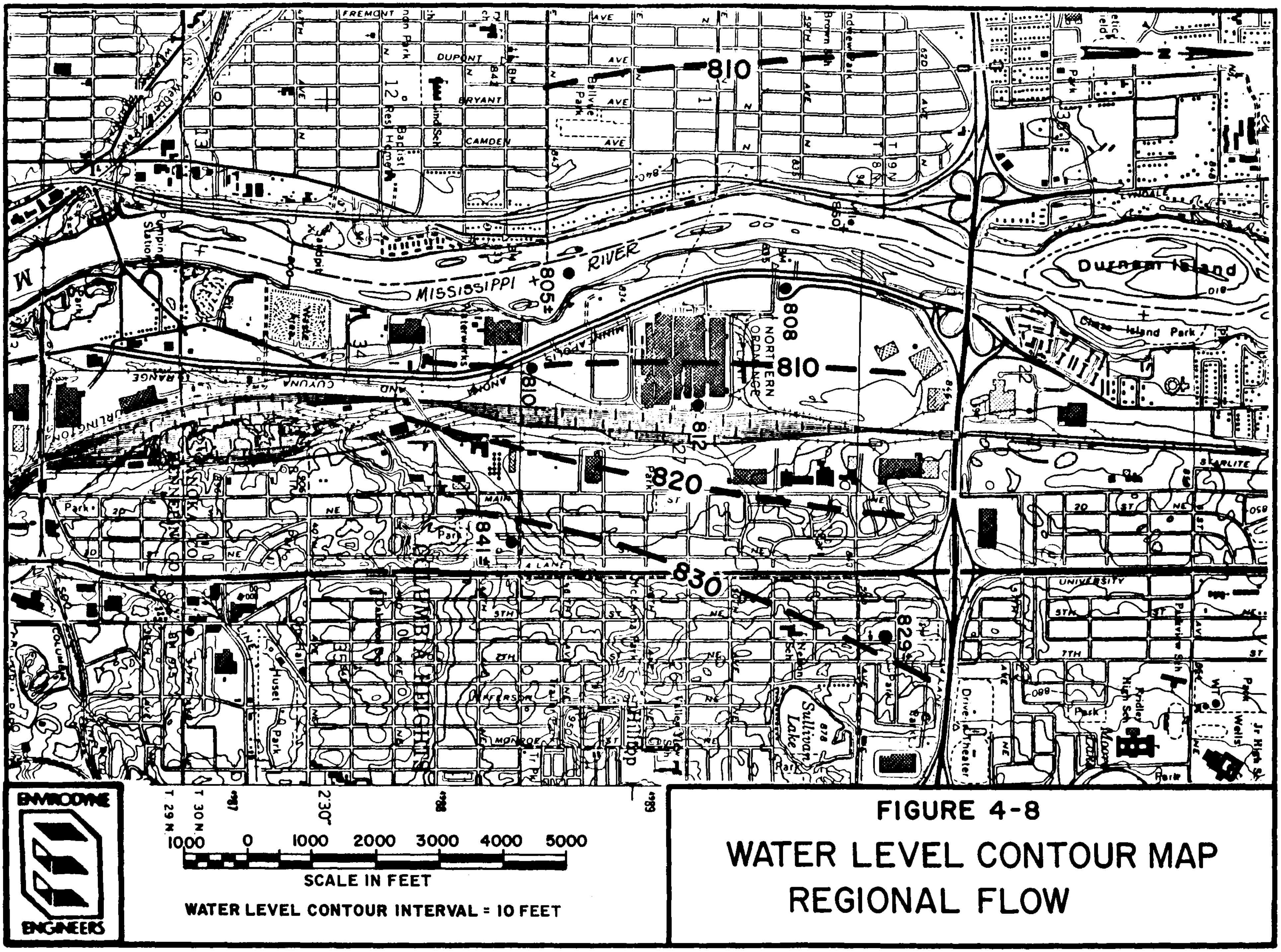


FIGURE 4-8

WATER LEVEL CONTOUR MAP REGIONAL FLOW

Source: E. A. Hickok, April 1981

([illegible] USGS Minneapolis North Quadrangle 7.5 Minute Series)

TABLE 4-3

HYDROGEOLOGIC PARAMETERS OF THE BEDROCK AQUIFER

Aquifer	Specific Capacity (gpm/ft)	Specific Capacity (l/sec/m)	Hydraulic Conductivity (gpd/ft^2)	Hydraulic Conductivity (m/day)	Transmissivity (gpd/ft)	Transmissivity (m^2/day)	Storage Coefficient	Hydraulic Diffusivity (gpd/ft)	Hydraulic Diffusivity (m^2/day)
St. Peter									
Mode	4	0.8	80	3	8,000	100			
Range of values:									
low	1	0.2	25	1	2,500	30	10^{-3}	$2.5x10^{6}$	$3x10^{4}$
high	10	2	250	10	37,000	450	10^{-5}	$3x10^{9}$	$4x10^{7}$
Prairie du Chien-Jordan									
Mode	34	7	350	14	70,000	870			
Range of values:									
low	3	0.7	40	1.5	7,000	90	10^{-3}	$7.6x10^{6}$	$9x10^{4}$
high	118	24	500	20	250,000	3,100	10^{-6}	$2x10^{9}$	$2.5x10^{7}$
Franconia-Ironton-Galesville									
Mode	15	3	200	8	30,000	370			
Range of values:									
low	2	0.4	30	1	4,000	50	10^{-4}	$4x10^{6}$	$5x10^{4}$
high	37	8	250	10	80,000	1,000	10^{-6}	$8x10^{9}$	$1x10^{8}$
Mt. Simon-Hinckley-Fond du Lac									
Mode	15	3	200	8	30,000	370			
Range of values:									
low	1	0.2	15	0.6	2,000	25	10^{-2}	$2x10^{4}$	$2.5x10^{2}$
high	33	7	175	7	70,000	870	10^{-6}	$7x10^{9}$	$9x10^{7}$

Source: University of Minnesota, 1979

4.3.6.3 Migration Potential. As stated in 4.3.6.1, the soils in the non-paved areas of the plant are very permeable. The data in Table 4-3 also show how permeable the Prairie due Chien/Jordan aquifer is. The lower portion of the St. Peter Sandstone contains some siltstone units, but the St. Peter Sandstone does not underlie the NIROP entirely, and where present, thins rapidly toward the west. Contaminants placed on or into the upper soils could leach or flow to the water table very quickly and from there, potentially migrate downward into the upper aquifers.

Under natural conditions, flow in the upper aquifers moves to the west and discharges into the Mississippi River. Using the water table/potentiometric surface slope shown in Figure 4-6 , the mode value of hydraulic conductivity for the Prairie du Chien/Jordan aquifer shown in Table 4-3 , and a porosity value of 0.2, a groundwater flow velocity of approximately 560 feet per year can be calculated as follows:

$$V = ki/n$$

where: V = groundwater flow velocity
k = hydraulic conductivity
i = hydraulic gradient
(slope of the potentiometric surface)
n = porosity of the aquifer (assumed)

This calculation probably underestimates the maximum flow velocity in this aquifer, since the hydraulic conductivity of the aquifer reportedly varies dramatically over very short distances. (This phenomenon is common in fractured limestones, especially where some solutional enlargement of the fractures has occurred.) However, this calculation probably does reflect average flow velocities throughout the aquifer as a whole. Based on the boring logs in Appendix C and the information in Kanivetsky (University of Minnesota, 1979), the flow velocity in the Quaternary deposits is probably comparable to that in the Prairie du Chien/Jordan aquifer.

The flow rate calculated above (560 feet per year) does not reflect the impact of local pumping centers. Three pumping centers have historically existed in the immediate vicinity of the NIROP (NIROP wells 2 and 3 are so close to each other that they probably functioned as a single pumping center). As groundwater moved toward a pumping center, its flow velocity increased. This is simply a function of the hydraulics of radial flow toward a well. In terms of trying to estimate how long it might take (or have taken) a contaminant introduced into the aquifer at a given point to reach an active pumping center, the velocity estimate of 560 feet per year might be considered to be more of a minimum value than a typical value.

For groundwater outside the influence of the pumping centers, flow is toward the Mississippi River, where the groundwater flow velocity of approximately several hundred (500 to 600) feet per year probably applies. At this rate, groundwater would move from the western boundary of the plant and discharge into the river in less than two years.

4.4 BIOLOGICAL FEATURES. NIROP Minneapolis is small, encompassing only 82.61 acres, and much of this is covered by either buildings or pavement. The remaining areas have been extensively altered through grading and filling operations and are being used for open storage purposes. There is very little suitable habitat for flora or fauna at the installation. Therefore, the impact to flora and fauna at this site is minimal.

4.4.1 Threatened Endangered and Rare Species. There are currently four animals which are federally classified as being threatened or endangered in the State of Minnesota (Table 4-4). However, the NIROP is not within the normal range of any of these species. There are no plants within the state which are federally classified as threatened or endangered. The Minnesota Department of Natural Resources is currently preparing its own listing of endangered and threatened plants and animals, but there is presently no official state list. There are no plants or animals listed as rare.

4.5 WATER QUALITY.

4.5.1 Surface Water. The existing water quality of the Mississippi River near the NIROP can be classified as suitable for municipal and domestic supplies. The Mississippi River at this point reflects the headwater quality. The water quality predictably deteriorates downstream toward the Minneapolis-St. Paul area. TCE in the one part per billion range (see Appendix C) has occurred at the Minneapolis water supply intake approximately one mile south of the NIROP (MPCA, 1982).

4.5.2 Groundwater. On a regional basis, the groundwater quality is generally good and is suitable for municipal and domestic supplies. Localized contamination has occurred in some of the upper aquifers, mainly as a result of septic tank or industrial discharges.

In the immediate vicinity of the NIROP, there is a TCE contamination problem in the quaternary and Prairie du Chien/Jordan aquifers. TCE in the quaternary aquifer has been shown to be in the range of 2.0 to 34,522 parts per billion, while TCE in the Prairie du Chien/Jordan aquifer has been shown to be as high as 200 parts per billion (Hickok, Phase II, 1981).

4.6 WATER SUPPLY.

4.6.1 Potable Water. The plant has three bedrock wells completed into the Prairie du Chien/Jordan aquifer. Two of these wells are government owned, and the other is FMC owned (Figure 4-9). These wells date back to the 1940s and were used as a potable water supply for the plant until 24 April 1981. The FMC well was used primarily as a standby well and for water sprinklers in the summer. At this time, the wells were shut down because of TCE contamination. Sampling on 16 March 1981 and 23 April 1981 indicated TCE contamination at these wells ranged from 35 to 200 parts per billion (See Appendix C).

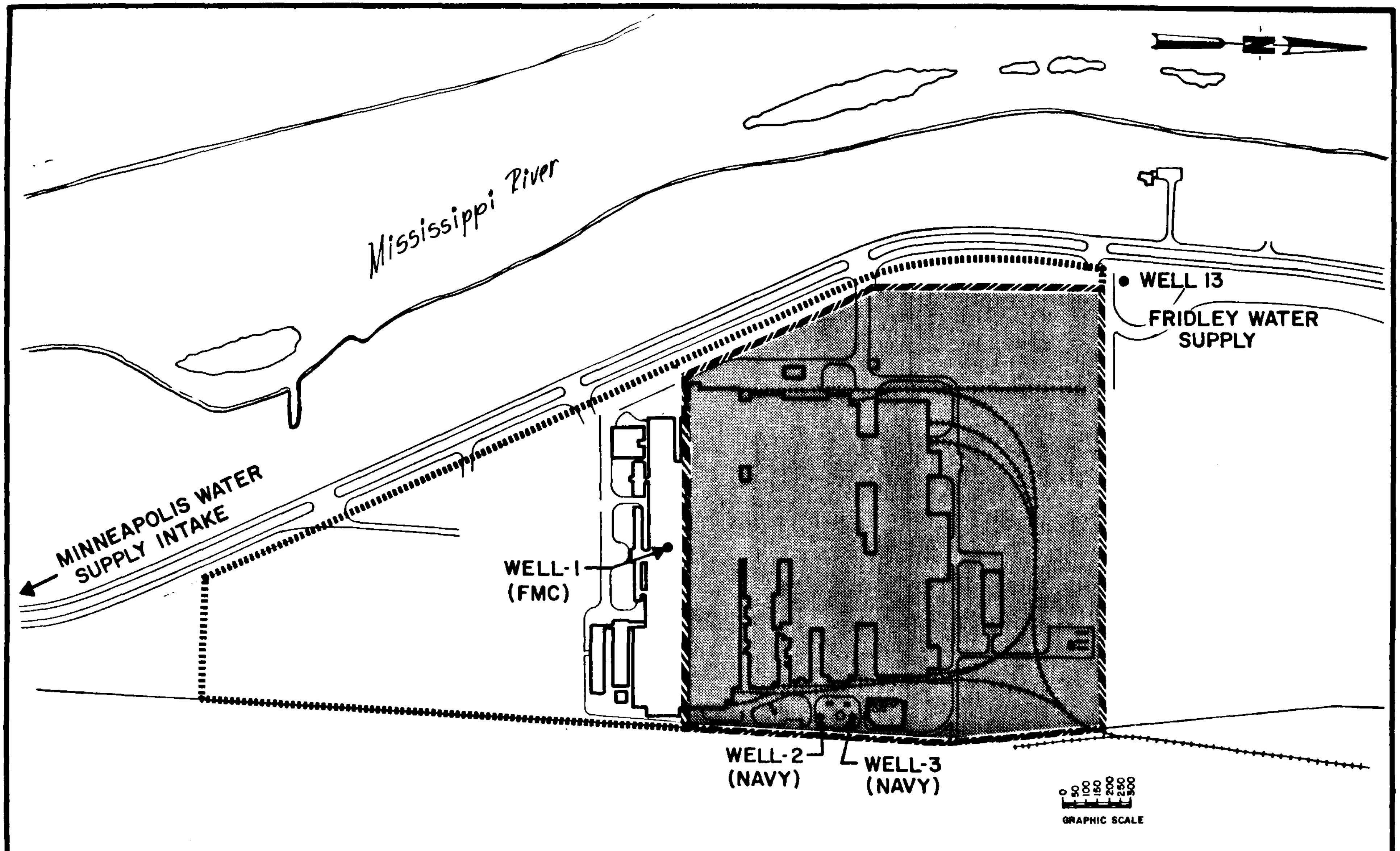
TABLE 4-4

FEDERALLY LISTED THREATENED
AND ENDANGERED SPECIES OF MINNESOTA

LISTED SPECIES

Mammals	Habitat	Distribution
Gray Wolf (T) *Canis lupus*	Northern Forested Areas	Primary Range - Beltrami, Cook, Itasca, Koochiching, Lake, Lake of the Woods, Roseau, St. Louis Counties Peripheral Range - Aitkin, Northeast Becker, Carlton, Cass, Clearwater, North Crow Wing, Hubbard, East Kittson, Mahnomen, East Marshall, East Pennington, Pine Counties
Birds		
* Peregrine Falcon (E) *Falco peregrinus*	Potential Breeding	Chisago, Cook, Dakota, Goodhue, Houston, Lake, Pine, St. Louis, Wabasha, Washington, Winona Counties
Bald Eagle (T) *Haliaeetus leucocephalus*	Breeding	Aitkin, Becker, Beltrami, Carlton, Cass,Chisago, Clearwater, Cook, Crow Wing, Houston, Hubbard, Itasca, Koochiching, Lake, Lake of the Woods, Mahnomen, Mille Lacs, Morrison, Ottertail, Roseau. St. Louis Counties
	Wintering	Chippewa, Dakota, Goodhue, Houston, Lac qui Parle, Sherburne, Wabasha, Washington, Winona Counties
Mussels		
Higgins' Eye Pearly Mussel (E) *Lampsilis higginsi*	Rivers	Lower Mississippi, St. Croix and Minnesota Rivers

* Peregrine Falcon breeding areas are taken from historical records and are to be considered potential breeding areas only. There are no active breeding sites in the State, but spring and fall migrants are seen regularly.



ENVIRODYNE ENGINEERS

NAVY PROPERTY
NAVY PROPERTY LINE
FMC PROPERTY LINE
RR TRACKS

FIGURE 4 -9

WATER SUPPLY

Following closure of the wells, the plant switched to the Minneapolis water supply system for its potable water. The Minneapolis water supply system uses the Mississippi River and has its water supply intake just south of the Plant (Figure 4-9).

Fridley, along with many of the suburban communities, uses groundwater for its potable water supply. Located just north of the Plant (Figure 4-9) is Fridley water supply well No. 13. This well was constructed in 1970, and it is completed into the Prairie du Chien/Jordan aquifer. The well is primarily used during the peak demand summer months. A sample and analysis scan of this well showed no reportable contaminants although a peak too small to quantify was present for TCE (see Appendix D).

4.6.2 Industrial. Prior to shutting down the three wells in April of 1981, the plant relied upon groundwater for almost all of its industrial water needs. City water was used in the foundry, plating and machine shops during periods of high demands. Closure of the wells resulted in a switch to Mississippi River water provided by Minneapolis. In August of 1981, the plant began reusing one of its wells (FMC Well No. 1) for non-contact cooling water.

4.7 ADJACENT LAND USE. The NIROP is located approximately one-quarter mile east of the Mississippi River, within the city limits of Fridley. The plant lies just north of the city limits of Minneapolis. This is an industrial area, with the Burlington Northern switching yard located to the east of the plant, and several metal and manufacturing companies located to the northeast.

Located approximately one mile south of the plant is Minneapolis water supply intake. Minneapolis, as well as several of the suburban communities, uses water from the Mississippi River. The water supply intake has been located at this site since 1925. Just north of the plant is Fridley Well No. 13, which is a source of water for Fridley.

Approximately six miles to the northeast of the NIROP, is the Army's Twin Cities Army Ammunition Plant and other large industrial operations. TCE contamination in the upper aquifers is a problem in this area. TCE has also been detected in Rice Creek, which joins the Mississippi River from the east approximately two miles north of the NIROP. The Rice Creek watershed includes the Twin Cities Army Ammunition Plant.

CHAPTER 5. WASTE GENERATION

5.1 INTRODUCTION. NIROP Minneapolis was constructed in the early 1940s for heavy manufacturing operations. Since no major functional changes have occurred in these operations since plant construction, most of the departments continued to generate wastes similar to those produced initially. Therefore, the information obtained during the on-site survey concerning recent operations was judged to be representative of the past waste generation. It should be noted that, due to the production fluctuations which have occurred since 1941, the quantities of wastes provided in this text are estimated values.

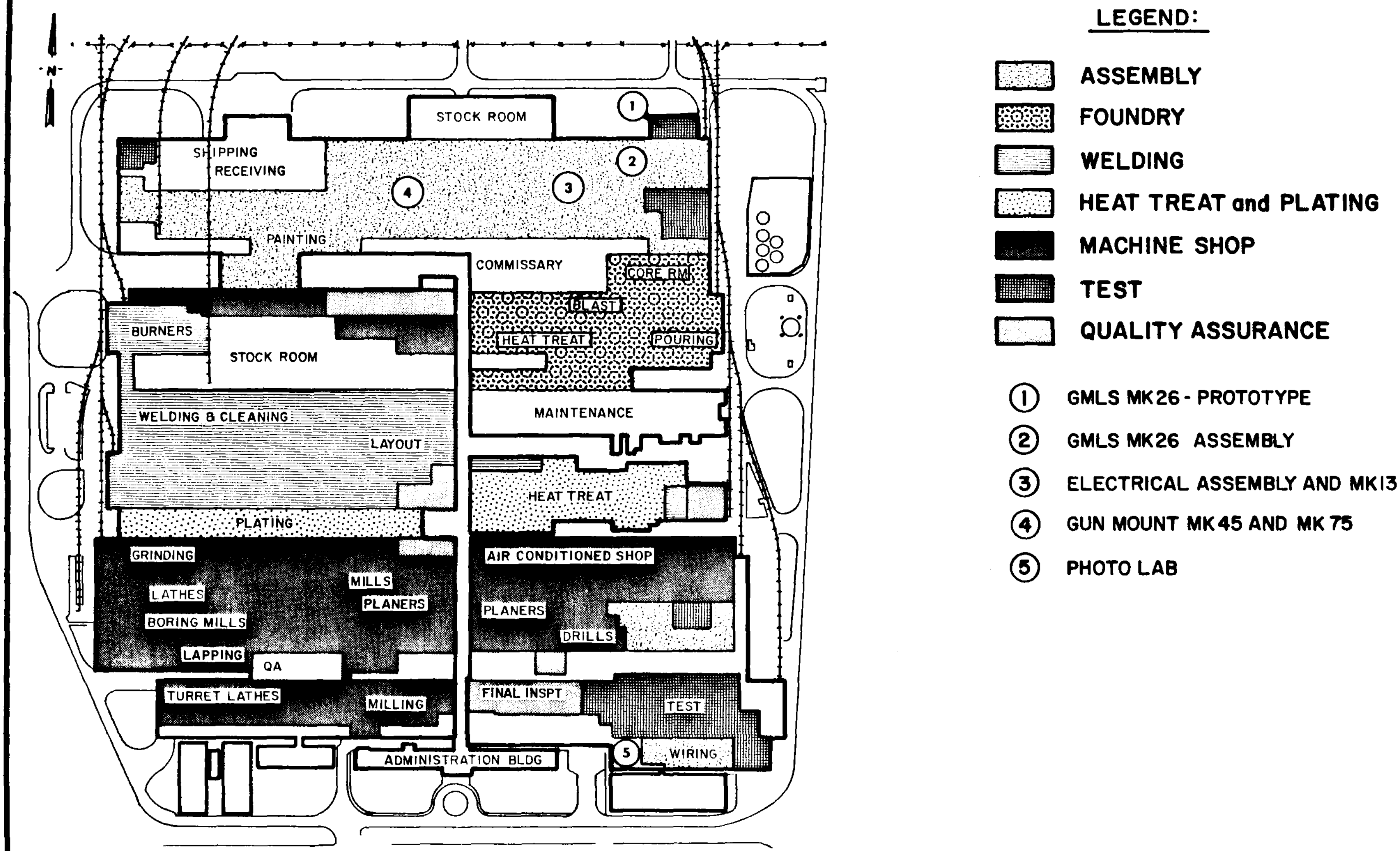
This chapter provides a brief overview of the major operations conducted at the NIROP which generated waste materials. The types and quantities of wastes generated from each of these operations are discussed. Figure 5-1 illustrates the building plan for the NIROP and depicts the locations of the major industrial production areas which generated the bulk of the wastes.

5.2 INDUSTRIAL OPERATIONS. NIROP Minneapolis is an industrial facility linked to ordnance related capabilities for the development, design engineering, production and testing of advanced weapons systems. The facility presently employs approximately 4,100 persons, of which about 2,350 are hourly people involved directly with production operations.

No major functional changes have occurred at the facility since its inception in 1941, but some of the industrial operations have been modernized or relocated. The production lines included guided missile launching systems (GMLS) for several units such as the MK 13, Mod. 4, and MK 26; automatic Naval gun mounts for units such as the five-inch, 54 caliber Gun Mount MK 45, and the fast firing 76 mm, 62 caliber Gun Mount MK 75; heavy duty gear pumps; along with power drives and control systems.

The processing, assembly, and manufacturing operations associated with the facility included metal plating, welding, heat treating, machining, and a non-ferrous and specialty alloy foundry. The testing facilities included an electronics laboratory, metallurgical laboratory, hydraulic test bays, and shock/vibration test equipment. Each of these major industrial production areas is briefly described in the subsequent paragraphs. Information pertaining to the waste types and quantities is also provided.

5.2.1 <u>Machine Shop</u>. The NIROP had a wide variety of specialty machining equipment to produce parts for gun mounts and launching systems. Turret lathes, the "Big Line" of horizontal and vertical boring mills, milling machines and numerically controlled machining centers were all part of the NOD Machine Shop operation. Additionally, the machine shop contained numerous drilling and grinding machines, planers, saws, gear cutting machines and lapping devices. This equipment generated large quantities of metal scrap and shavings which were, for the most part, reclaimed.



ENVIRODYNE ENGINEERS

FIGURE 5-1

INDUSTRIAL PRODUCTION AREAS
NIROP MINNEAPOLIS

Other wastes generated within the machine shop typically included water soluble organic machine coolants, lubricating and cutting oils and oil from the machines' hydraulic systems.

A majority of the spent cooling solutions were discharged to the sanitary sewer. The quantity of discharged coolant ranged from 50,000 to 150,000 gallons per year. A small portion of the coolant was reused. Interviewed NIROP personnel estimated that about 100 barrels of coolant were recycled each year.

Waste lubricating and hydraulic oils were periodically drained from the machines and blended with fuel oil for fueling the boilers. Cutting oil reservoirs were located at 5th, 7th, and 10th Avenues. This oil was periodically pumped from the reservoirs to barrels for disposal off Navy property. Approximately 8 barrels of unburnable oil sludge were disposed of off Navy property annually.

5.2.2 Metal Plating. The original plating shop was expanded and modernized in 1973 to become the east shop, while the west shop was built in 1975. These two shops occupied a major portion of the western side of 11th Avenue. The plating shops were involved with pickling, passivating, anodizing, and the electroplating of numerous metals, including phosphatizing (zinc and manganese), nickel, chromium, zinc, cadmium, copper, silver, and tin.

The solution tanks contained a variety of acids and caustic compounds, such as sodium hydroxide, chromic, nitric, phosphoric, hydrochloric, hydrofluoric and sulfuric acids, manganese, zinc, phosphate, and sodium cyanide. The larger solution tanks ranged in capacity from 1,200 to 2,500 gallons. All cyanide bearing baths and rinse waters were located in the east shop along with the majority of the chromium plating solutions.

After the treatment system (See Section 7.2.2) was installed, the rinse and plating solution tanks drained below the floor of the plating shop into holding tanks for each of the four major categories of liquid waste (acid and caustic, chromium, and cyanide). Contents of the holding tanks were then manually or automatically pumped to the appropriate treatment unit prior to discharge to the sewer system.

Before the treatment system was installed in 1973, all liquid plating wastes were discharged directly to the sewer system or disposed of off Navy property.

The plating operation generated approximately 100,000 gpd of wastewater. This wastewater mixed with other plant waste streams before entering the metropolitan sewer system. An extensive electroplating effluent treatment study was conducted in early 1982. These data were collected from a number of wastewater samples during this program. These data indicated that the plant discharge was generally in compliance with the municipal ordinance.

Quantities of in-process generated sludge were estimated to average around 25 barrels per year. Of this sludge, approximately 5 barrels per year were untreatable. These plating sludges accumulated in the bottom of tanks by repeated use of the plating solutions and were disposed of as the various process tanks were cleaned. Plating tank sludges were disposed of off Navy property in a hazardous waste landfill or treated by the plating department treatment system for the past few years. Prior to 1973, these waste sludges were disposed of both on and off Navy property.

5.2.3 Degreasing and Solvent Cleaning. The cleaning and degreasing of metal parts was essential to the production of high quality finished parts. Three of the six large, open-top vapor degreasing units originally installed in the plating shop were still being used at the time of the survey to clean parts in preparation for various electroplating operations. The solvent TCE was always used in these units because of its effectiveness in cleaning the metal parts. The three remaining TCE vapor degreasing units were located in the Foundry and Paint Shops and Non-Destructive Test Area. Each unit contained approximately 200 gallons of TCE. These units were cleaned about every third month and generated a total of approximately forty 55-gallon drums per year of waste solvent. The waste solvent was sold to a reclaimer for reuse. Some 38 to 45 smaller degreasing tanks containing Stoddard Solvent were scattered throughout the assembly area for manual parts cleaning. Approximately one barrel of waste was disposed of each year from each unit. The majority of this solvent was blended with fuel oil and burned in the boilers. Approximately twelve larger degreasing units (75 gallon capacity) were also located in the assembly area, of which about six contained the solvent 1,1,1-trichloroethane, while the remaining units contained Stoddard Solvent. About one drum per month of this solvent was generated in cleaning the tank. This material was disposed of off Navy property.

5.2.4 Paint Shop. The original paint shop, located in the vicinity of 1st and 2nd Avenues, was in use until the early 1960s. The shop was then moved to the east end of 3rd Avenue. The 3rd Avenue shop reportedly contained a waterfall-type collector for paint overspray. The spray booth contained a large recirculating water tank connected to the water curtain. The continuous buildup of paint sludge was removed from the tank semi-annually. An estimated 2 to 3 barrels of material were removed from the tank during each cleaning operation. Some of this painting sludge was presumably disposed of in the scrap yard, trenches, and pits north of the NIROP building, but the majority of this material was allegedly hauled to a landfill off Navy property.

The painting operation was again moved in the early 1970s to the western side of 23rd Avenue. Three large booths were installed with two-stage dry filter arrestors. Two of the three booths were used for paint spraying, while the third was used for parts washing. Filters were changed every 2 to 3 weeks depending on the work load. Spent filters were compressed into 55-gallon drums for disposal off Navy property. The drums were filled with water to prevent spontaneous combustion of the paint and filter media. One drum was normally required to dispose of all the filters from a single booth.

Parts coming into the paint shop area contained some form of protective coating (oil or wax) which needed to be removed prior to painting. Parts were processed through a three-phased sequence including an alkaline cleaner, phosphatizer (phosphoric acid), and a chromic acid rinse. Spent cleaner and phosphatizing solution were discharged to the sanitary sewer, while the chromic acid rinse water was collected and processed through the plating effluent treatment system (See Section 7.2.2). Wax coated parts were cleaned with naptha (BC-100) or MEK. Parts were then detergent washed and rinsed with water. This rinse water was discharged to the sewer. The majority of the parts were then painted with a zinc chromate primer and finished with light gray enamel.

The cleanup of painting equipment required the use of several solvents including MEK, toluene and naptha. The cleaning operations generated as much as 20 gallons of waste solvent and paint per day, which was disposed of off Navy property as a hazardous waste. This operation was by far the largest generator of liquid wastes disposed of at the facility. Some of the flammable solvent used in hand wiping of parts were burned in the plant boilers.

5.2.5 Assembly. Each gun mount and launching system manufactured at the NIROP contained thousands of mechanical, electrical, and hydraulic parts which were put together in the assembly area. These parts were routinely degreased and cleaned with solvents during various steps in the assembly operation. A number of parts cleaning/degreasing stations (previously referred to in Section 5.2.3), which used either Stoddard Solvent or 1,1,1-trichloroethane, were located throughout the area. Approximately one barrel of waste chlorinated solvent was disposed of off Navy property each month. Flammable solvents, on the other hand, were used in firing the plant boilers. Solvent rags, used to wipe down parts by hand, were collected in closed containers and washed on-site for reuse. Small quantities of parts wash water, containing detergents, were discharged to the sewer.

5.2.6 Foundry. Ferrous, non-ferrous, and specialty alloy parts were produced in the NIROP foundry facilities. The original foundry was expanded and modernized in 1976. The principal foundry operations have not changed significantly over the years. The operation always required the melting of the metal, pouring, molding, casting/cleaning, along with core making, pattern making, casting repair and maintenance.

Basically, the molten metal from the furnaces was transported in a ladle to the pouring area, where it was poured into molds. The poured molds were allowed to cool, and then the solidified castings were removed from the mold, rough cleaned of mold material, and permitted to cool until the cast metal was cold enough to handle. When the castings had cooled enough to be handled, the sprues and cores were removed. Following the knockout, the castings usually required additional cleaning. Depending on the type and size of the casting produced, this operation involved one or more of the following: grinding, abrasive blasting, tumble mills, chipping, sawing, cutting or washing.

Large quantities of sand were consumed in the casting process. Much of this sand was reclaimed through on-site facilities that separated the sand from the chemical binders. The reclaimed sand was used in the foundry for further casting, while the core butts (the non-reclaimable sand) were disposed of off Navy property. Until approximately 1970, core butts were generally disposed of off Navy property, but a limited amount of waste sand was reportedly disposed of on Navy property at the north end of the NIROP. After 1970, this material was disposed of by contract hauler to a landfill certified for this type of waste. An average of approximately 10,000 tons of waste sand was generated and disposed of annually.

5.2.7 Heat Treating. Heat treatment was always an integral part of the NIROP manufacturing operation. It involved the heating and cooling of the metal or alloy parts for the purpose of obtaining certain specified physical properties. These physical properties were attained through changes in the nature, form, size or distribution of the structural constituents. These changes occurred because of the effect of temperature on phase equilibrium and included grain growth, recrystallization, and diffusion of atoms, or were from changes in the composition of the material.

In the heat treatment process, the metal was subjected to a definite time/temperature cycle, which was divided into three parts: heating, holding, and cooling. The cooling operation was conducted by immersion in a fluid (air, water, molten salt, or other media) after an elapsed period of time at the specified holding temperature. A number of standard heat treating processes were employed by the NIROP, including degreasing, hardening, annealing, and tempering. Some of the equipment used to perform these operations included hardening furnaces, gas carburizers, and salt pots.

The heat treating of metal parts generated several types of liquid and solid wastes at the NIROP. Waste quench oils were burned in the activity's boilers. Water based oils were discharged to the sanitary sewer. Low and high temperature non-cyanide bearing quenching salts were also generated in the heat treat area. Each type of bath generated approximately 1,200 pounds of waste material annually. The low and high temperature salts were disposed of off Navy property at a hazardous waste landfill because of their reactive nature. Grit/bead blast wastes were considered non-hazardous and were disposed of with foundry sand off Navy property.

5.2.8 Photo Shop. The photographic laboratory conducted printing and film processing for many years. Rinse waters containing minor amounts of fixer and developer, as well as silver, were discharged to the sewer on a daily basis. The operation discharged approximately 300,000 gallons of rinsewater annually.

5.2.9 Welding Department. Welding operations did not change appreciably since the plant was built. Welders manually cut, formed and welded a variety of metals to make structural parts. The welding operations generated materials, such as rod stubs, flux, and slag, which were collected as floor sweepings. Some of these solid wastes were, from time to time, hauled off Navy property for disposal. Carbide generated by acetylene gas generation was disposed of off Navy property. This was curtailed with the installation of MAPP gas system. When the hydraulic trash compactor was installed in the early 1970s, these wastes were combined with other solid wastes for disposal off Navy property. Metal cutting operations, conducted on the 20-foot by 60-foot "Burning Tables", generated a waste sludge which was collected in the table's holding tank. Typically, several hoppers of sludge were removed from the tank during the cleaning operation. Cleaning was performed on an as needed basis but generally occurred every 2 to 3 months.

5.2.10 Pest Control. Pest and rodent control was handled by subcontract with a state licensed company. Contractor services were used on an as-needed basis for most pests, but mosquito spraying was conducted annually in the spring.

5.2.11 Boiler Plant. The NIROP operated seventeen steam boilers to produce steam required by the plant for heating and process applications. The boilers were originally designed to burn coal. They burned coal from 1941 through 1948. The cinders were disposed of off Navy property. After 1948, the units were fired with #6 fuel oil or natural gas. The principal fuel used during the heating season depended upon which fuel source was the least expensive per BTU. Oil was supplied to the boilers from six 65,000 gallon above ground and four 18,000 gallon underground steel storage tanks. Natural gas was supplied by the Northern Gas Company. Clean waste oil and flammable solvents generated by various production activities were mixed with the fuel oil for burning in the boilers.

The boilers were blown down on a daily basis. The blowdown condensate discharged through a common drain and collected in a holding tank. An automatic lift pump discharged the blowdown to the sewer when the tank was full. Approximately 300,000 gallons per year of wastewater from the boilers were discharged to the sewer.

5.3 ORDNANCE OPERATIONS. Production of naval artillery was always the primary focus of the facility since construction in 1941. No ammunition production or loading operations were conducted at the NIROP.

5.4 RADIOLOGICAL OPERATIONS. The NIROP did not maintain any non-ionizing electromagnetic radiation sources. The on-site sources of ionizing radiation consisted of six X-ray units, ranging in power from 220 KVP to 2.5 MEV, and a Cobalt 60 Gamma-ray unit (100 curies at acquisition). These units were used in quality control/inspection operations. The Cobalt 60 source was used in industrial radiography from 1966 to 1976. A Radionics 60-150-2 camera was used in this operation. The source became depleted to the extent that it was no longer useful. The source was disposed of under government contract N00189-82-M-L661 with Chem-Nuclear Systems of Barnwell, South Carolina. The source was shipped on 15 December 1982 to the Barnwell Waste Management Facility, Barnwell, South Carolina.

CHAPTER 6. MATERIAL HANDLING: STORAGE AND TRANSPORTATION

6.1 INTRODUCTION. The NIROP used a wide variety of raw materials for industrial operations. Tanks and stockrooms used for this purpose were located throughout the facility. This chapter provides a brief review of the main storage areas and the types and quantities of materials which were consumed.

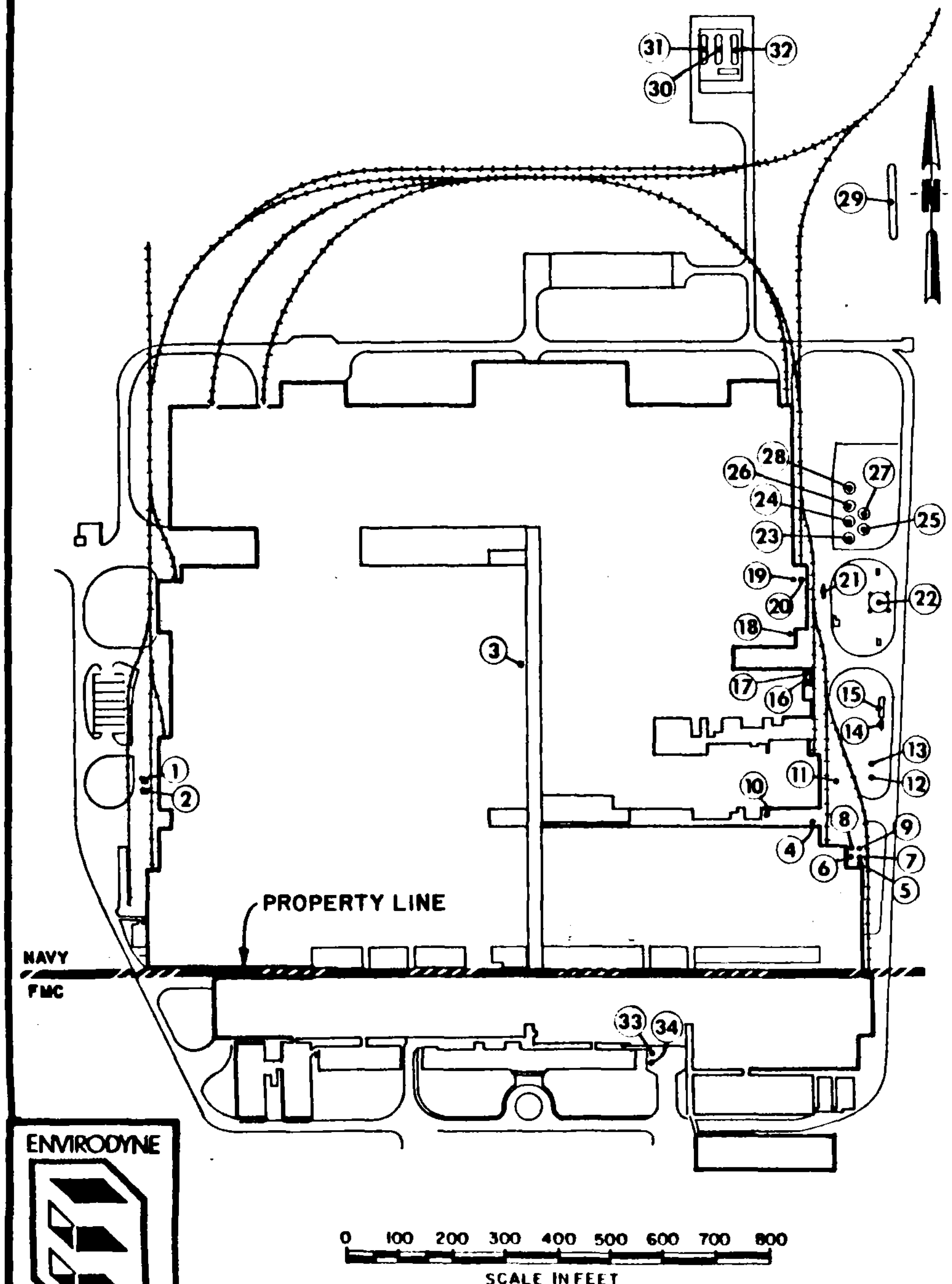
6.2 INDUSTRIAL. Most materials used for the various industrial operations were stored in stockrooms associated with individual departments. Only chemicals and hazardous materials were stored in a central location. These materials were not dispensed from this location but transported directly to the shops through the Maintenance Control Center. Both above ground and underground tanks were located outside for bulk storage of oil and several other materials. A list of vessels used for materials storage at NIROP and their locations is provided in Figure 6-1.

6.2.1 Supply Storage. Storage for raw materials used at the NIROP was handled by each controlling department. Stock rooms were located at several locations within the plant. Hazardous materials were stored at a separate centralized location. The Maintenance Control Center was responsible for the disbursement of all materials.

6.2.2 Chemical and Hazardous Materials Storage. Numerous hazardous materials, including metal conditioners, stripping and cleaning agents, solvents, paints, acids, bases and photographic chemicals were used at the NIROP. All fresh chemicals and machinery oils were kept in the central hazardous materials storage building. Materials were labelled upon receipt and stored in their shipping containers. Items were segregated by type (acids, bases, solvents, etc.) into individually diked rooms. The oil and solvent stockroom contained explosion proof ceilings.

Bulk storage tanks were located outside for TCE and propane. The TCE tank is located on the west side of the facility. Liquid propane was stored in three above ground tanks in a remote area north of the NIROP building. The propane was used in manufacturing areas when natural gas sources were interrupted.

6.2.3 Petroleum, Oil, Lubricants. The principal oil used over the years at NIROP was #6 fuel oil. The oil was stored in six above ground insulated steel tanks (65,000 gallon capacity) located outside in a drainless, diked area adjacent to the Plant Maintenance Department. All tanks were connected by equalizer lines at the top to guard against overflowing.



ENVIRODYNE ENGINEERS

TABLE OF VESSEL LOCATIONS

No.	Location	Capacity	Material	Function*	Type**
1	Above ground	3,000 Gal.	Liquid Oxygen	Storage	Vert. Tank
2	Above ground	8,800 Gal.	Trichloroethylene	Storage	Vert. Tank
3	Below ground	500 Gal.	No. 2 Diesel Fuel	Storage	Horiz. Tank
4	Below ground	12,000 Gal.	No. 2 Diesel Fuel	Storage	Horiz. Tank
5	Below ground	2,000 Gal.	Stoddard Solvent	Storage	Horiz. Tank
6	Below ground	18,000 Gal.	No. 6 Fuel Oil	Process	Horiz. Tank
7	Below ground	18,000 Gal.	No. 6 Fuel Oil	Process	Horiz. Tank
8	Below ground	18,000 Gal.	No. 6 Fuel Oil	Process	Horiz. Tank
9	Below ground	18,000 Gal.	No. 6 Fuel Oil	Process	Horiz. Tank
10	Above ground	6,000 Gal.	Liquid Nitrogen	Storage	Vert. Tank
11	Below ground	1,000 Gal.	Diesel Fuel	Storage	Horiz. Tank
12	Above ground	13,000 Gal.	Liquid Nitrogen	Storage	Vert. Tank
13	Above ground	5,500 Gal.	Methanol	Storage	Horiz. Tank
14	Above ground	1,000 Gal.	Mapp Gas	Storage	Horiz. Tank
15	Above ground	12,000 Gal.	Ammonia	Storage	Horiz. Tank
16	Above ground	20,000 lbs.	Foundry Sand	Storage	Vert. Tank
17	Above ground	20,000 lbs.	Foundry Sand	Storage	Vert. Tank
18	Above ground	20,150 lbs.	Chlorine	Storage	Cylinders
19	Above ground	6,000 Gal.	Pepset	Storage	Vert. Tank
20	Above ground	6,000 Gal.	Pepset	Storage	Vert. Tank
21	Below ground	2,000 Gal.	Gasoline	Storage	Horiz. Tank
22	Above ground	100,000 Gal.	Water	Storage	Vert. Tank
23	Above ground	65,000 Gal.	No. 6 Fuel Oil	Storage	Vert. Tank
24	Above ground	65,000 Gal.	No. 6 Fuel Oil	Storage	Vert. Tank
25	Above ground	65,000 Gal.	No. 6 Fuel Oil	Storage	Vert. Tank
26	Above ground	65,000 Gal.	No. 6 Fuel Oil	Storage	Vert. Tank
27	Above ground	65,000 Gal.	No. 6 Fuel Oil	Storage	Vert. Tank
28	Above ground	65,000 Gal.	No. 6 Fuel Oil	Storage	Vert. Tank
29	Above ground	90,000 Gal.	Propane	Storage	Horiz. Tank
30	Above ground	17,303 Gal.	Propane	Storage	Horiz. Tank
31	Above ground	17,303 Gal.	Propane	Storage	Horiz. Tank
32	Above ground	17,303 Gal.	Propane	Storage	Horiz. Tank
33	Below ground	1,000 Gal.	Gasoline	Storage	Horiz. Tank
34	Below ground	1,000 Gal.	Gasoline	Storage	Horiz. Tank

* Storage, Process, etc.
** Tanks, bins, drums, etc.

FIGURE 6-1

STORAGE VESSELS LOCATIONS NIROP MINNEAPOLIS

Four steel underground tanks (18,000 gallon capacity) were also used to store #6 fuel oil. These tanks were located in an area adjacent to the Boiler Room. The tanks were similarly connected by equalizer lines to prevent overflows. There were no sanitary or storm drain inlets in the vicinity of these tanks. Storm sewers were sealed at the oil unloading stations to prevent leaking or spilled oil from entering the system.

6.2.4 PCB Storage. PCBs were used as dielectric fluid in capacitors for induction furnace and hardening equipment located in the Foundry and Heat Treat Departments and in power capacitors throughout the NIROP. The power transformers located in Substations 1 and 6 were non-PCB containing and in Substations 4 and 5 were PCB containing.

The Maintenance Department usually notified plant engineering when a PCB capacitor was to be removed from service. Plant engineering, in turn, recorded the pertinent information according to applicable regulations and coordinated disposal operations. The out-of-service units were placed in DOT approved 17-H drums containing one foot of sorbent material. The 55-gallon drums were placed into an 800-gallon concrete vault constructed with 4-inch thick walls and a 6-inch bottom. The vault was ultimately filled with a 6-inch layer of sorbent material and sealed with a 4-inch thick concrete cap.

Three sealed concrete PCB storage vaults were located outside in the northeast corner of the facility. These containers were awaiting disposal. No appreciable leaks were reported while the units were in active use. Figure 6-2 depicts the approximate location of these vaults.

Prior to the implementation of this procedure in the late 1970s, the disposal method for PCBs is unknown. Although not reported, it is possible that PCB-containing fluids were mixed with other waste oils and either burned, used for weed control, buried on-site or disposed of off Navy property.

6.2.5 Hazardous Waste Storage. In 1975, an estimated one hundred fifty 55-gallon drums of industrial waste were removed from the NIROP. Prior to disposal, all such waste material was collected and stored at a central waste storage area located outside near the northeastern corner of the NIROP. The area consisted of a 30-foot by 30-foot asphalt and concrete pad graded toward the middle, which drained to a dry well that could be pumped if a spill occurred. Plant personnel indicated that there had never been a spill warranting cleanup operations at the area. This area is depicted in Figure 6-2.

6.2.6 Storage Lots and Scrap Yards. A large storage lot and scrap yard was maintained at the north end of the facility since the plant was built in the early 1940s. A wide variety of scrap metal parts were found in the yard. Items include old gun barrels, cranes, machining jigs, and gun mounts. An unspecified amount of various waste materials was presumably disposed of in this area from time to time since the plant was built. These materials include such items as core butts and floor sweepings from weldment.

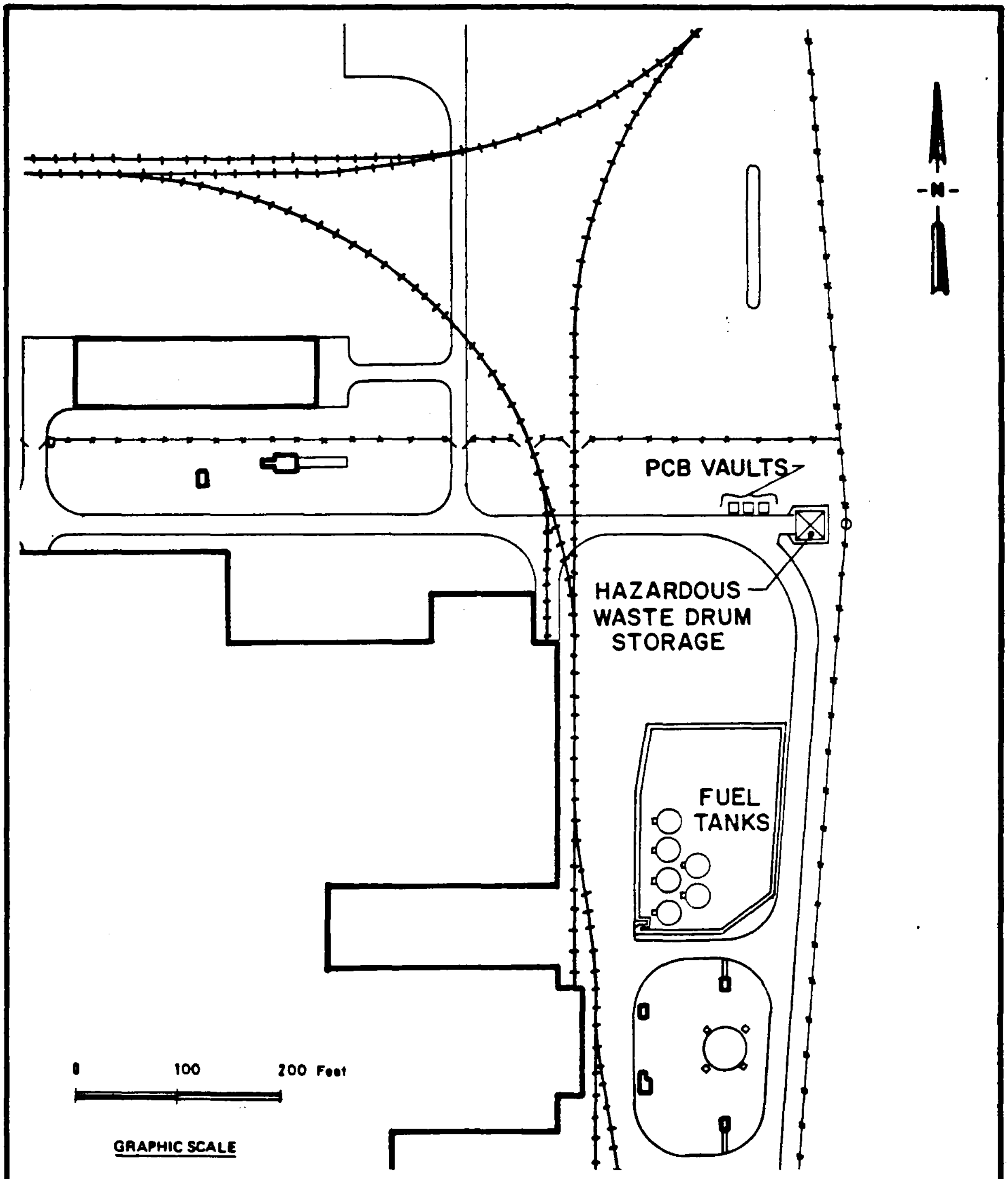


FIGURE 6-2
OUTSIDE WASTE STORAGE AREA
NIROP MINNEAPOLIS

CHAPTER 7. WASTE PROCESSING

7.1 INTRODUCTION. NIROP Minneapolis generated both liquid and solid waste materials which were processed and, in some cases, disposed of on-site. This chapter describes the main processing units employed at the NIROP along with estimated quantities and types of disposed materials.

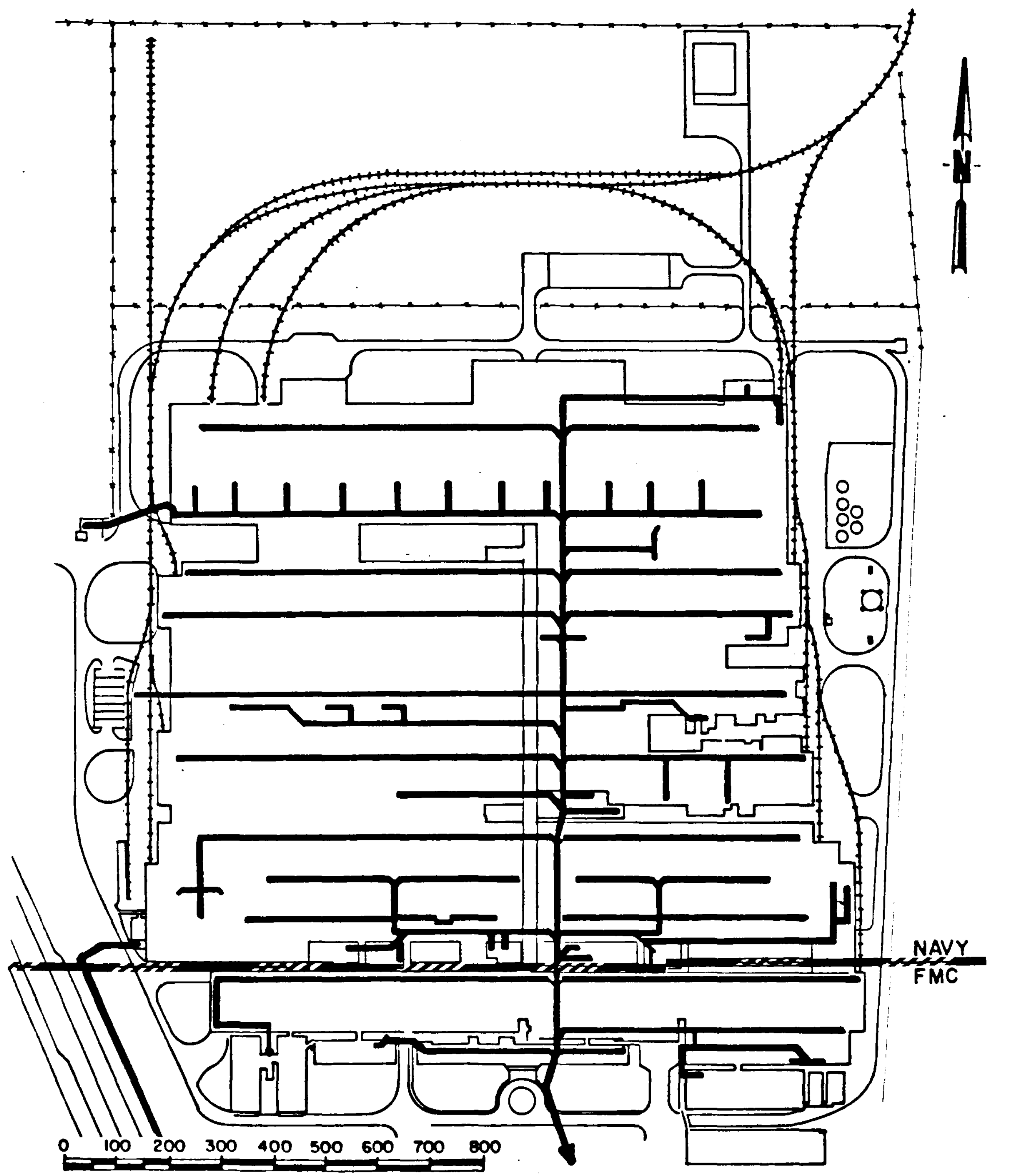
7.2 INDUSTRIAL. General plant wastes, such as paper, scrap wood, and garbage, were handled in the on-site stationary hydraulic compactor which was installed in the early 1970s. The contractor for solid wastes hauled this material to a landfill off Navy property several times per week. An estimated 4,000 tons of this category of wastes was landfilled annually. Between the 1940s and early 1970s, small burnable material was processed in the NIROP incinerator. Incinerator ash was, in turn, hauled to a disposal area off Navy property.

Hazardous wastes were placed in 55-gallon drums for disposal off Navy property by a contractor. On the average, approximately 30 drums per month were disposed of since the early 1970s. Before 1973, industrial wastes such as paint sludge and chlorinated solvents were typically disposed of in landfills off Navy property. Limited disposal of these materials allegedly occurred on Navy property in the early 1970s. These materials were placed in one or two trenches. Additionally, some of these waste materials were disposed of in two smaller pits on a one-time basis.

The NIROP has one on-site industrial wastewater treatment plant for handling chemical wastes from the plating shop. All domestic wastewater, and both treated and untreated industrial wastewater, was discharged to the sanitary sewer system.

7.2.1 Sanitary Sewer System. The sewer system was installed during the original site development. As the facility expanded, so too did the collection system. Figure 7-1 illustrates the configuration of the sewer system network. Various sizes of vitrified clay pipe were used for the gravity flow system. The sewer is four to six feet below the surface on the northern end of the plant and eight to ten feet below the surface on the southern end. The system carried domestic and both treated and untreated industrial wastes and had a single 15-inch connection point to the metropolitan system. Total facility wastewater discharged to the metropolitan sewer system currently ranges from 0.3 to 0.5 MGD. The wastewater discharge would have varied over time, depending on the number of employees, which has ranged from 1,000 to 11,000. There are currently approximately 4,100 employees at the NIROP. The plant effluent was piped to the Pig's Eye Plant for final treatment. This plant was controlled and operated by the Metropolitan Waste Control Commission. Figure 7-2 depicts the types and estimated quantities of wastewater discharged into the plant's sewer system from each of the major industrial operations.

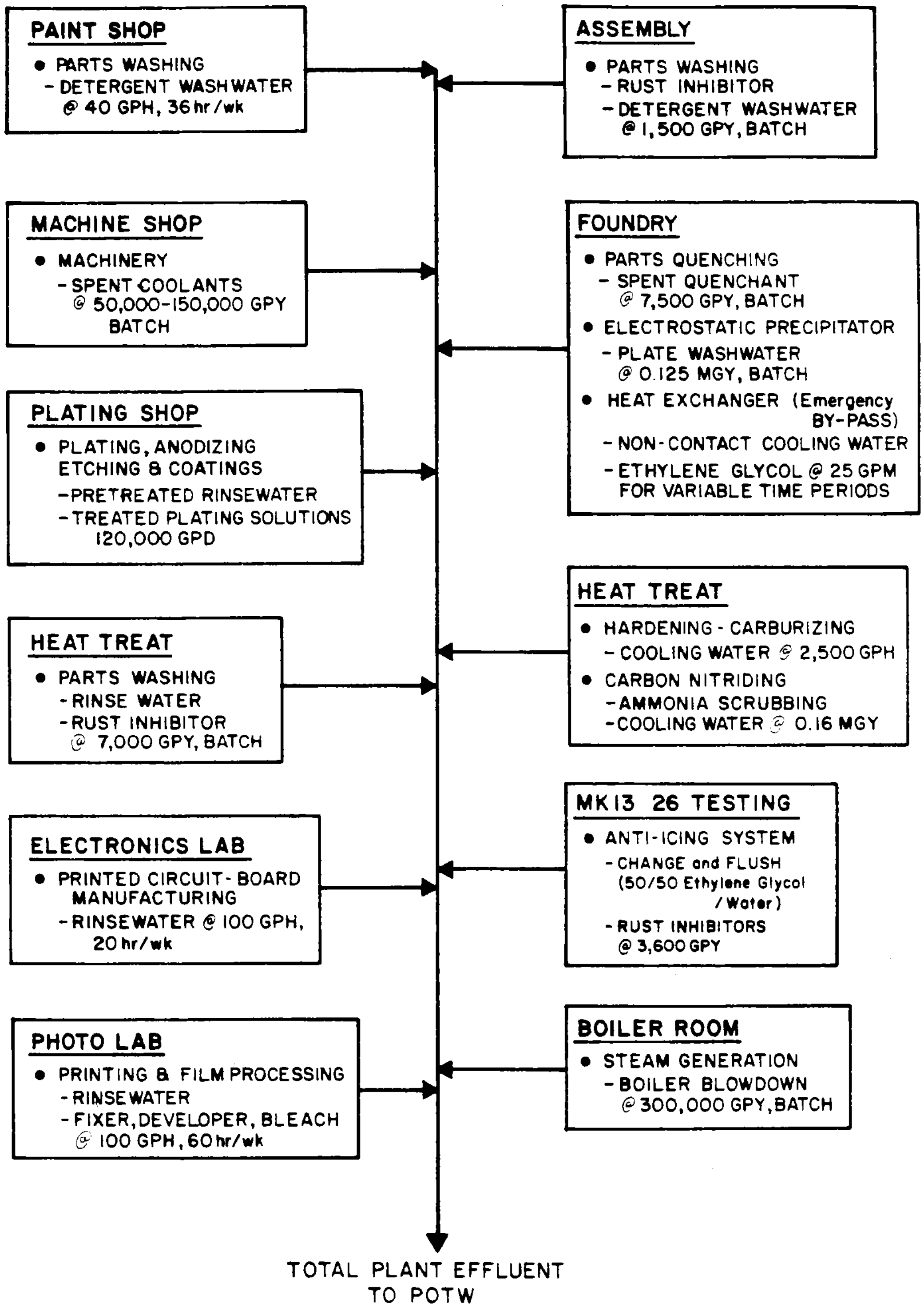
7.2.2 Industrial Wastewater Treatment Plant. The NIROP used an industrial wastewater pretreatment system, constructed in 1973, for



ENVIRODYNE ENGINEERS

FIGURE 7-1

SANITARY SEWER SYSTEM
NIROP MINNEAPOLIS

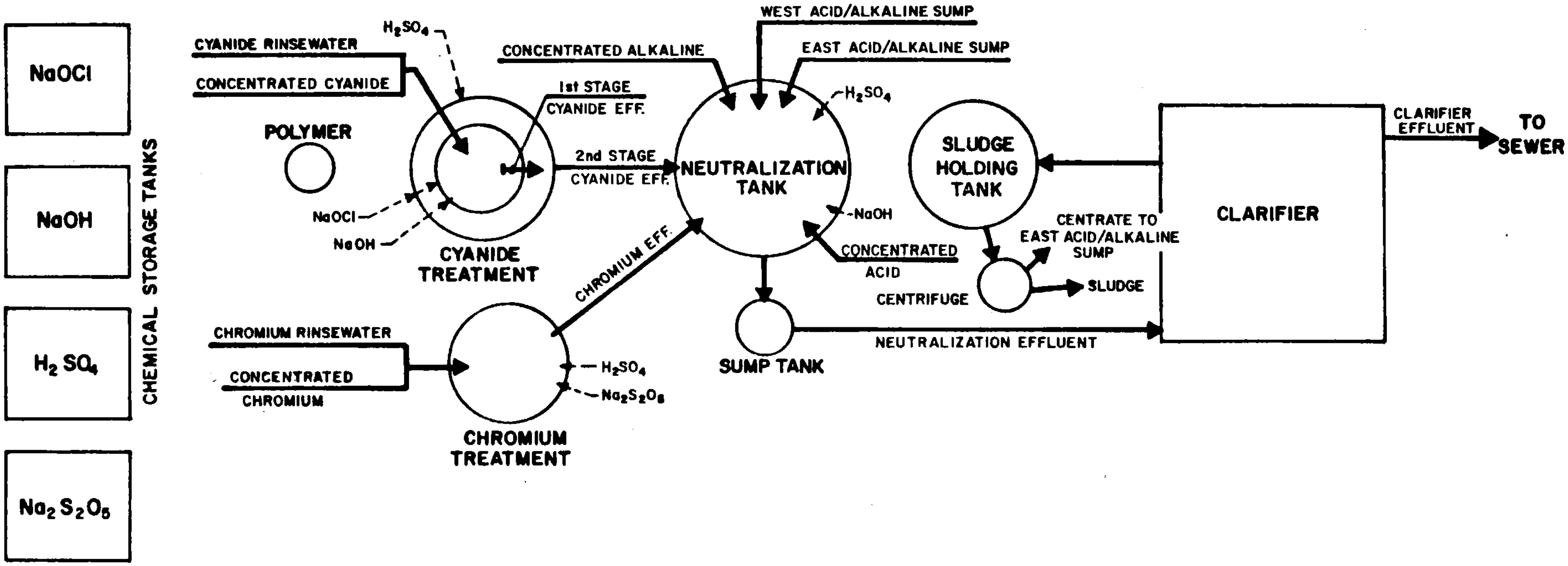


ENVIRODYNE ENGINEERS

FIGURE 7-2
INDUSTRIAL WASTEWATER DISCHARGES
NIROP MINNEAPOLIS

wastewater generated from metal plating operations. Before construction of the treatment plant, plating wastes were discharged directly to the sewer. The treatment facility was located adjacent to the east plating shop, also modernized in 1973. Separate collection, transfer and treatment units were provided for each major waste category.

The continuous treatment system automatically treated approximately 100,000 gallons per day of liquid plating wastes (rinse water and spent plating solutions). The treatment plant employed chemical treatment to destroy cyanide, reduce hexavalent chromium to the trivalent state, neutralize acids and alkalis, and precipitate heavy metals. Sludge, containing the heavy metal ions, was drummed and retained in the fenced NIROP hazardous waste staging area prior to final disposition in an approved landfill. The treatment operation during the 1980s generated approximately 12 to 24 barrels of sludge annually. Clarified wastewater was discharged to the sanitary sewer system. A schematic diagram of the treatment facility is illustrated in Figure 7-3.



ENVIRODYNE ENGINEERS

FIGURE 7-3
ELECTROPLATING PRETREATMENT
NIROP MINNEAPOLIS

CHAPTER 8. DISPOSAL SITES AND POTENTIALLY CONTAMINATED AREAS

8.1 INTRODUCTION. The IAS investigative team identified four potentially contaminated disposal sites at the NIROP. These are sites where waste disposal occurred in the past. Three of these sites, waste disposal trenches (Site 1), waste disposal pits (Site 2), and a foundry core butt disposal area (Site 4), are located in the northern portion of the facility. The final site is the area beneath the NIROP building (Site 3). All four waste disposal sites are shown in Figure 8-1.

A detailed discussion of each of the identified disposal sites is contained in this chapter. Each of the disposal sites is discussed in terms of its history, types of material disposed of at the site, how the site was operated, and its present land use.

8.2 SITE 1, WASTE DISPOSAL TRENCHES. The use of this site for waste disposal purposes occurred circa 1972 when waste-filled drums were disposed of in trenches. Indications are that there were two trenches which were excavated, filled with drums, and covered over with soil. The trenches were used on a one-time basis to dispose of between 50 and 100 drums of wastes which had accumulated.

The location of one of the trenches, as shown in Figure 8-1, was determined using a May 15, 1972 aerial photograph of the area (Plate 8-1, back pocket). The trenches at the site are arranged in one of the following ways. They were either side-by-side, separated by about the width of a truck, or end-to-end. The exact layout of the trenches could not be determined due to conflicting accounts.

The trenches were 8 to 10 feet wide and approximately 8 feet deep. The combined length of the two trenches is believed to be 75 to 100 feet. The drums were placed into the trenches on their sides and stacked two or three deep. A payloader was reportedly used to place the drums into the trenches, although there were also accounts that the drums were simply pushed from the truck into the trenches.

The materials potentially disposed of in these trenches included waste lubricating oils, plating sludge, paint sludge, cleaning solvents and degreasing solvents. Various chlorinated and nonchlorinated industrial solvents were used at the plant, including TCE, toluene, naphtha, 1,1,1-trichloroethane, and MEK. If plating sludges were disposed of in the trenches, they could contain cyanide and the following metals: cadmium, chromium, copper, lead, manganese, nickel, silver, tin, zinc.

In September of 1982, FMC, in attempting to locate the trenches, uncovered a single drum. The drum was accidentally punctured during the excavations, and some of its contents, which reportedly smelled like solvents, spilled out. No further attempt was made to recover the drum or

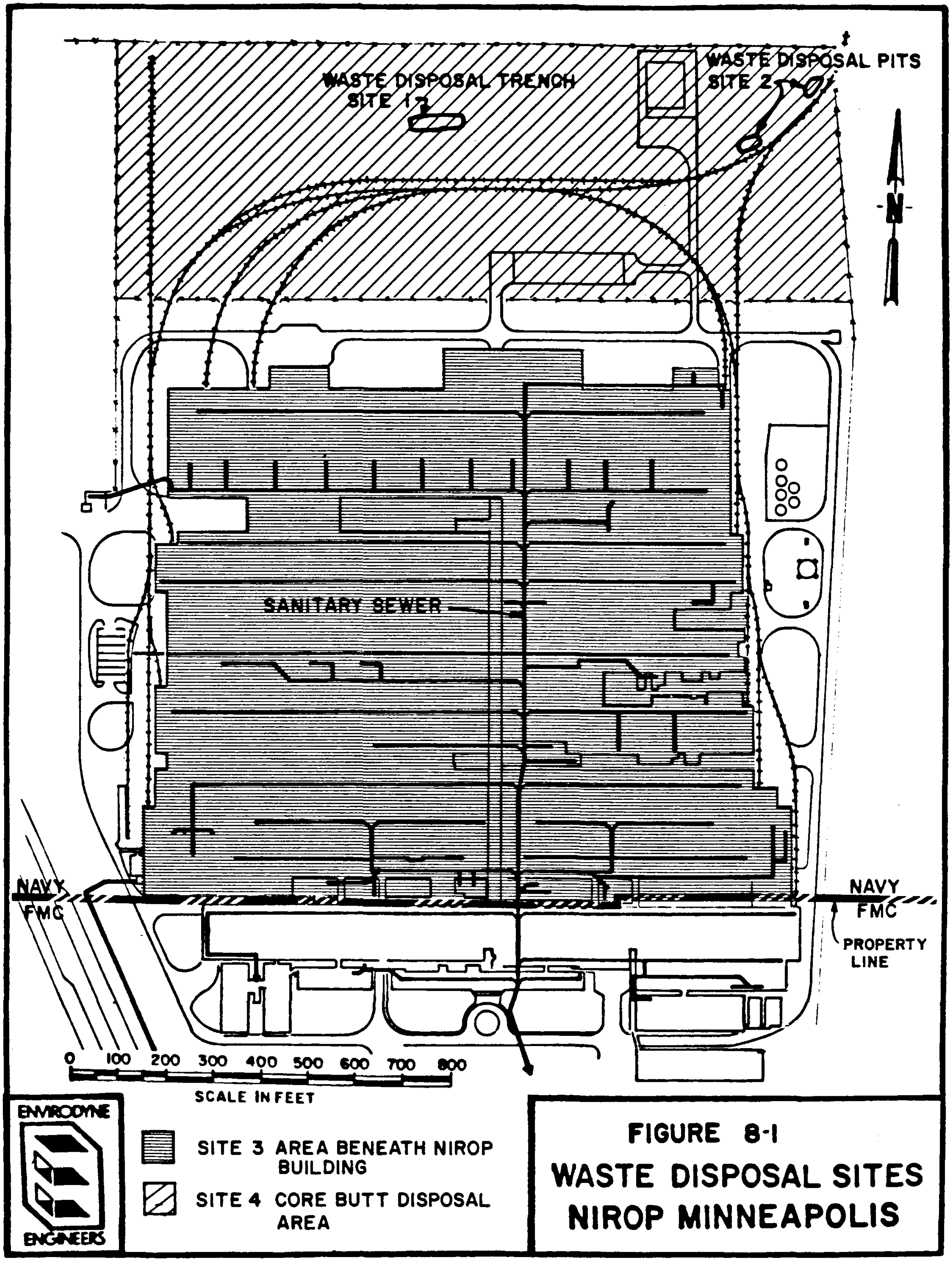


FIGURE 8-1
WASTE DISPOSAL SITES
NIROP MINNEAPOLIS

to analyze its contents. The drum was subsequently covered over with soil. There was also no attempt made to locate additional drums.

Most of the drums in the trenches were reported to have been full at the time of their disposal. It is not known if the drums are in a deteriorated and leaking condition.

The trenches are located in an area which is used for open storage purposes. Stored throughout the area are fixtures, old parts, equipment, and scrap metal.

8.3 SITE 2, WASTE DISPOSAL PITS. During the late 1960s or early 1970s, waste materials were disposed of in two pits at this site. These were originally borrow pits which were used for waste disposal purposes out of convenience. The pits were reportedly used during a period of wet weather which prevented access to the normal disposal site off Navy property. The pits were used on a one-time basis and covered over with soil.

Each of the disposal pits, which are approximately 8 feet deep, is reported to contain around 25 waste-filled drums. The materials potentially disposed of in these drums would include waste lubricating oils, plating sludge, paint sludge, cleaning solvents and degreasing solvents. The solvents could have been both chlorinated and nonchlorinated, including TCE, MEK, toluene, naphtha, and 1,1,1-trichloroethane. The plating sludges could contain cyanide and the following metals: cadmium, chromium, copper, lead, manganese, nickel, silver, tin, and zinc. In addition to the drums, the disposal pits also contain miscellaneous construction debris, such as, metal scrap, lumber, and concrete.

The general area in which the two disposal pits are located is shown in Figure 8-1. The location of the disposal pits is based on the best recollections of plant personnel who were involved with the disposal operations. The suspected location of the northeastern-most pit is believed to be near the railroad gate. The other disposal pit is believed to be located near the first railroad switch.

The present condition of the drums in the disposal pits is unknown. The site is located in an area which is presently used for open storage purposes. Drums, most of which appeared to be empty, are stored on the paved area. Scrap metal parts are also being stored throughout the area. There is also a large mound composed of a mixture of soil and gravel which appears to have been dumped at its present location.

8.4 SITE 3, AREA BENEATH THE NIROP BUILDING. The sanitary sewer system at the NIROP consists of various sizes of vitrified clay pipe, with the main line running down the center of the plant being 15 inches. Installation of the clay pipe dates back to 1940 when the plant was originally constructed. The piping was installed in three-foot sections which reportedly were concrete grouted.

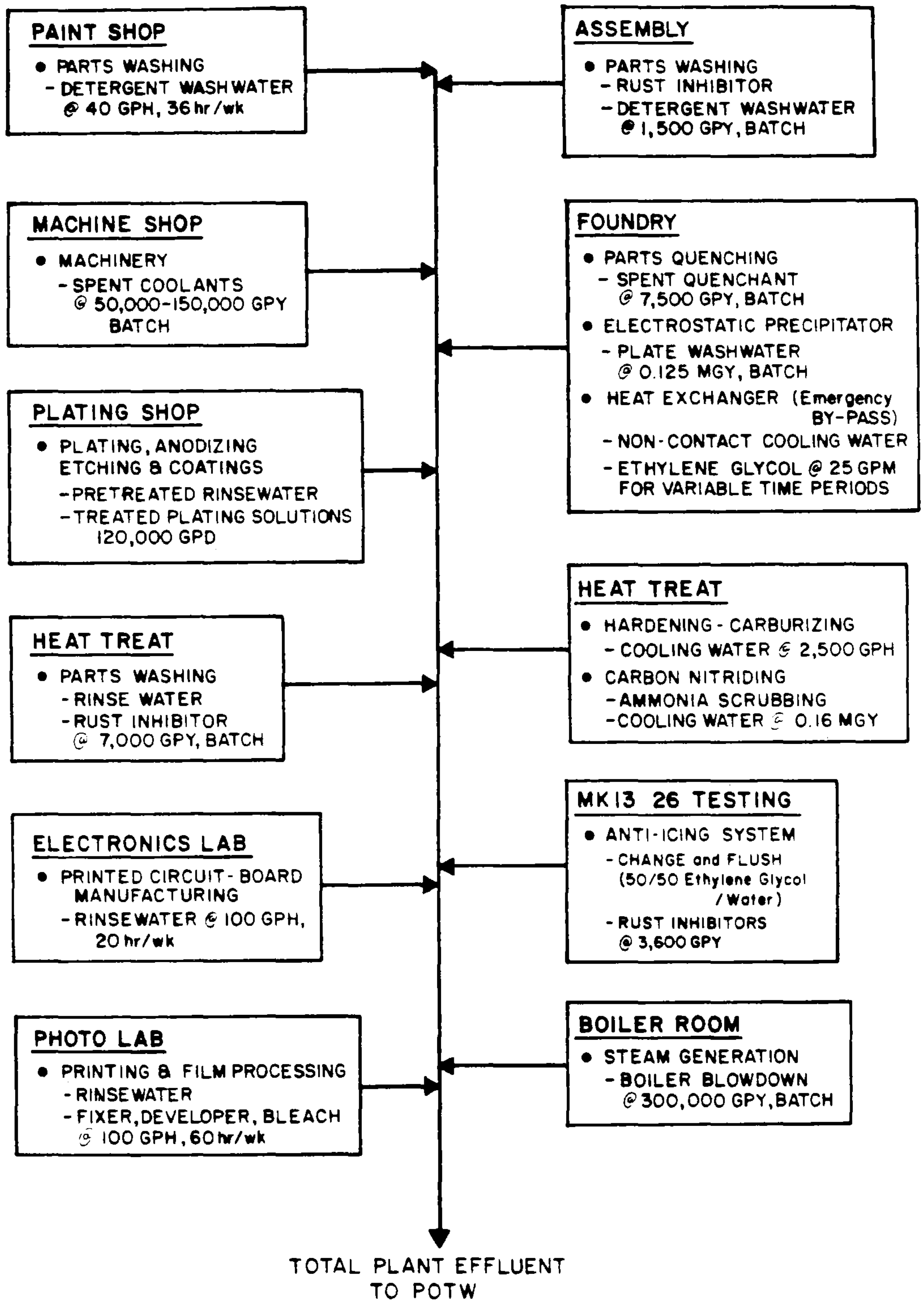
Many of the wastes generated from the various industrial processes occurring throughout the plant were discharged into the sanitary sewer system. These wastes included coolants and plating solutions. Figure 8-2 represents a breakdown (by area) of those wastes which were discharged into the sanitary sewer.

Prior to 1973, when the electroplating wastewater treatment facility was installed, wastewater from the extensive electroplating operations was discharged untreated into the sanitary sewer. This wastewater would have included cyanide and the following metals: cadmium, chromium, copper, lead, manganese, nickel, silver, tin, and zinc.

The condition of the clay pipes underlying the plant is unknown, as no testing has been done. However, a section of the 15-inch sanitary line just south of the plant on FMC property was inspected via a video scan. One part of the pipe was deteriorated and required slip lining. The fractures in the pipe were believed to have been caused by excavation in the area.

8.5 SITE 4, FOUNDRY CORE BUTT DISPOSAL AREA. Most foundry core butt disposal operations occurred off Navy property. However, there were accounts that core butts were disposed of in the northern portion of the NIROP on a very limited basis. This disposal would have occurred prior to the 1970s. The northern portion of the NIROP is used as an open storage area for parts and metal scrap, and the core butts could have been disposed of anywhere throughout this area.

The foundry core butts contain mostly sand with minor amounts of metal and resin or oil binders. The material safety data sheets for the various binders and resins which have been used at the NIROP (Pep Set, Isocure, Rust Lick, Trim Sol, and Piko) were examined. An analysis of the foundry sand, both before and after use, was performed in November 1978. This analysis, the results of which are contained in Appendix E, did not show any hazardous materials.



ENVIRODYNE ENGINEERS

FIGURE 8-2

INDUSTRIAL WASTEWATER DISCHARGES INTO SANITARY SEWER NIROP MINNEAPOLIS

REFERENCES

E. A. Hickok and Associates (Wayzata, Minnesota), December 31, 1981. "Evaluation of Past Disposal Practices, Phase II - Hydrogeological Investigation, FMC Corporation (Minneapolis, Minnesota)."

Kanivetsky, Minnesota Geological Survey, 1982, personal communication.

Minnesota Pollution Control Agency, June 11, 1982 letter from T. W. Kasen (Strike Force Unit - Regulatory Compliance Section, Solid and Hazardous Waste Division) to M. S. Assaad (Naval Facilities Engineering Command Department of the Navy - Minneapolis), Re: FMC Hazardous Waste Site Investigation Chronology.

Thiel, G. A., 1944. "The Geology and Underground Waters of Southern Minnesota," Minnesota Geological Survey Bulletin 31.

University of Minnesota (St. Paul), 1978. "Hydrogeologic Map of Minnesota - Bedrock Hydrogeology," (by Roman Kanivetsky and Matt Walton), prepared for the Minnesota Geological Survey.

University of Minnesota (St. Paul), Minnesota Geological Survey, 1979. "Hydrogeologic Map of Minnesota - Quaternary Hydrogeology" (by Roman Kanivetsky).

U. S. Department of Agricultural Soil Conservation Services, in cooperation with University of Minnesota Agricultural Experiment Station, 1977. "Soil Survey of Anoka County, Minnesota."

BIBLIOGRAPHY

FMC Corporation (Minneapolis, Minnesota), "Contract Manufacturing Capabilities at Northern Ordnance Division".

FMC Corporation-Northern Ordnance Division (Minneapolis), May 1980, "Welcome to FMC/NOD Family Day '80; Northern-Special Products by Special People".

FMC Corporation, Northern Ordnance Division (Naval Industrial Reserve Ordnance Plant) August 8, 1980. "Spill Prevention Control and Countermeasure Plan for Temporary Storage of PCB and PCB-Contaminated Articles".

FMC Corporation, Northern Ordnance Division (Minneapolis), November 14, 1980 letter to USEPA-Region V, RCRA Activities (Chicago, Illinois), Re: FMC/NOD Hazardous Waste Permit Application.

FMC Corporation, Northern Ordnance Division (Naval Industrial Reserve Ordnance Plant), May 7, 1981. "Spill Prevention Control and Countermeasure Plan."

FMC Corporation-Northern Ordnance Division (Minneapolis), March 10, 1982 letter from D. L. Hildre (Plant Engineering) to Commanding Officer-Northern Division, Naval Facilities Engineering Command (Philadelphia, Pennsylvania), Re: Annual Hazardous Waste Report.

FMC Corporation-Northern Ordnance Division (Minneapolis) (Brian Hange), April 7, 1982. "FMC/NOD Hazardous Waste Management Policy."

E. A. Hickok and Associates, December 1977. "Baseline Environmental Inventory - Twin Cities Metropolitan Area," prepared for the Metropolitan Waste Control Commission (201 Facility Study).

E. A. Hickok and Associates (Wayzata, Minnesota), April 10, 1981. "Evaluation of Past Disposal Practices, Phase I - Initial Assessment, FMC Corporation (Minneapolis, Minnesota)."

E. A. Hickok and Associates, April 30, 1982. Memorandum No. 12206-IIIA-1, "Soil Boring Program, FMC Corporation, Minneapolis, Minnesota."

ManTech of New Jersey Corporation, October 30, 1976. "Draft-Environmental/Energy Survey of Government-Owned, Contractor-Operated (GOCO) Facilities - Naval Industrial Reserve Ordnance Plant (NIROP) Operated by FMC Corporation," prepared for Navy Environmental Support Office (NESO).

Minnesota Geological Survey (E. Bradley, Field Geologist), 1949. "Report of the Artesian Water Supply of the Twin City Basin."

Minnesota Geological Survey - The University of Minnesota, 1976. "Geologic Map of Minnesota - Bedrock Geology" (compiled by G. B. Morey).

Minnesota Pollution Control Agency, June 22, 1979 letter from R. Svanda (Chief, Permits Section, Division of Water Quality) to D. Hildre (FMC-Northern Ordnance Division), Re: Reissued NPDES Permit No. MN0000710-Naval Industrial Reserve Ordnance, Fridley, Minnesota.

Minnesota Pollution Control Agency, June 8, 1982 letter from Michael Kanner (Head, Strike Force Unit, Regulatory Compliance Section, Solid and Hazardous Waste Division) to Earl Wigand (FMC-NOD Plant Manager), Re: Review of May 4, 1982 meeting and MPCA intentions if further hydrogeologic studies and effective remedial measures are not undertaken.

North Star Research Institute, Environmental Systems Division (Principal Investigator: R. F. Colingsworth), November 1973. "Final Report: Environmental Impact Assessment Study, Pool 1 of the Northern Section of the Upper Mississippi River," prepared for the St. Paul District of the U. S. Army Corps of Engineers (under Contract No. DACW37-73-C-0059).

S. S. Papadopulos and Associates, Inc. (Rockville, Maryland), September 22, 1981 letter from S. P. Larson to J. Longfield (FMC-Philadelphia), Re: Report on Groundwater Contamination at Minneapolis FMC Facility.

S. S. Papadopulos and Associates, Inc. (Rockville, Maryland), June 1982. "Potential Impacts of the FMC Waste Disposal Site on the Mississippi River - FMC Northern Ordnance Plant, Minneapolis, Minnesota," prepared for FMC Corporation, Philadelphia, Pennsylvania.

Petura, J. C. (Weston Designers/Consultants), May 1980. "TCE in Groundwater - A Problem Assessment," paper presented at Pennsylvania Section of American Water Works Association, 1980 Annual Conference, Buck Hill Falls, Pennsylvania.

The Ranney Company, 1978. "Report to City of Minneapolis Minneapolis, Minnesota, Hydrogeological Investigation for Ground Water Supply System," Westerville, Ohio.

Reeder, H. O., W. W. Wood, G. G. Erlich and R. J. Sun, 1974. "Artificial Recharge Through a Well in Fissured Carbonate Rock, West St. Paul."

SERCO Laboratories, Inc. (Roseville, Minnesota), December 20, 1978 letter from E. E. Finder (Laboratory Administrator) to D. Hildre (FMC/NOD), Re: Report of Laboratory Analyses for Samples Received November 28, 1978.

University of Minnesota (Minneapolis) - Minnesota Geological Survey, Report of Investigations No. 5, 1964. "The Cretaceous System in Minnesota" (by R. E. Sloan).

University of Minnesota (Minneapolis), 1966. "Geologic Map of Minnesota - St. Paul Sheet," prepared for the Minnesota Geological Survey.

University of Minnesota (St. Paul), 1978. "Hydrogeologic Map of Minnesota-Bedrock Hydrogeology" (by Roman Kanivetsky), prepared for the Minnesota Geological Survey.

University of Minnesota (St. Paul), Minnesota Geological Survey, 1979. "Hydrogeologic Map of Minnesota - Quaternary Hydrogeology" (by Roman Kanivetsky).

U. S. Department of the Interior - Geological Survey, Geological Survey Circular 274, 1953. "Water Resources of the Minneapolis St. Paul Area, Minnesota" (by C. H. Prior, R. Schneider and W. H. Durum).

U. S. Department of the Interior - Geological Survey, in co-operation with Division of Waters, Minnesota Conservation Department, Bulletin 23, August 1965. "Chemical Quality of Ground Water in the Minneapolis - St. Paul Area, Minnesota."

U. S. Environmental Protection Agency - Region V, August 12, 1982 letter from V. V. Adamkus (Regional Administrator) to FMC Corporation, Re: FMC-Northern Ordnance Division Hazardous Waste Site, Fridley, Minnesota.

Woldman, M. L. and J. C. Petura (Weston Designers/Consultants), October 1980. "Engineering and Hydrogeological Investigation of TCE-Contaminated Groundwater," paper presented at 53rd Annual Conference of the Water Pollution Control Federation, Las Vegas, Nevada.

APPENDIX A

WATER QUALITY CRITERIA

Cadmium

Freshwater Aquatic Life

For total recoverable cadmium the criterion (in μg/l) to protect freshwater aquatic life as derived using the Guidelines is the numerical value given by $e^{(1.05[\ln(\text{hardness})]-8.53)}$ as a 24-hour average and the concentration (in μg/l) should not exceed the numerical value given by $e^{(1.05[\ln(\text{hardness})]-3.73)}$ at any time. For example, a hardnesses of 50, 100, and 200 mg/l as $CaCO_3$ the criteria are 0.012, 0.025, and 0.051 μg/l, respectively, and the concentration of total recoverable cadmium should not exceed 1.5, 3.0 and 6.3 μg/l, respectively, at any time.

Human Health

The ambient water quality criterion for cadmium is recommended to be identical to the existing drinking water standard which is 10 μg/l. Analysis of the toxic effects data resulted in a calculated level which is protective of human health against the ingestion of contaminated water and contaminated aquatic organisms. The calculated value is comparable to the present standard. For this reason a selective criterion based on exposure solely from consumption of 6.5 grams of aquatic organisms was not derived.

Copper

Freshwater Aquatic Life

For total recoverable copper the criterion to protect freshwater aquatic life as derived using the Guidelines is 5.6 μg/l as a 24-hour average and the concentration (in μg/l) should not exceed the numerical value given by $e(0.94[\ln(\text{hardness})]-1.23)$ at any time. For example, at hardnesses of 50, 100, and 200 mg/l $CaCO_3$ the concentration of total recoverable copper should not exceed 12, 22, and 43 μg/l at any time.

Human Health

Sufficient data is not available for copper to derive a level which would protect against the potential toxicity of this compound. Using available organoleptic data, for controlling undesirable taste and odor quality of ambient water, the estimated level is 1 mg/l. It should be recognized that organoleptic data as a basis for establishing a water quality criteria have limitations and have no demonstrated relationship to potential adverse human health effects.

Chromium

Freshwater Aquatic Life

For total recoverable hexavalent chromium the criterion to protect freshwater aquatic life as derived using the Guidelines is 0.29 μg/l as a 24-hour average and the concentration should not exceed 21 μg/l at any time.

For freshwater aquatic life the concentration (in μg/l) of total recoverable trivalent chromium should not exceed the numerical value given by "$e(1.08[\ln(\text{hardness})]+3.48)$" at any time. For example, at hardnesses of 50, 100 and 200 mg/l as $CaCO_3$ the concentration of total recoverable trivalent chromium should not exceed 2,200, 4,700, and 9,900 μg/l, respectively, at any time. The available data indicate that chronic toxicity to freshwater aquatic life occurs at concentrations as low a 44 μg/l and would occur at lower concentrations among species that are more sensitive than those tested.

Human Health

For the protection of human health from the toxic properties of Chromium III ingested through water and contaminated aquatic organisms, the ambient water criterion is determined to be 170 mg/l.

For the protection of human health from the toxic properties of Chromium III ingested through contaminated aquatic organisms alone, the ambient water criterion is determined to be 3433 mg/l.

The ambient water quality criterion for total Chromium VI is recommended to be identical to the existing drinking water standard which is 50 μg/l. Analysis of the toxic effects data resulted in a calculated level which is protective of human health against the ingestion of contaminated water and contaminated aquatic organisms. The calculated value is comparable to the present standard. For this reason a selective criterion based on exposure solely from consumption of 6.5 grams of aquatic organisms was not derived.

Source: FR45:231 (Nov. 28, 1980)

Cyanide

Freshwater Aquatic Life

For free cyanide (sum of cyanide present as HCN and CN^-, expressed as CN) the criterion to protect freshwater aquatic life as derived using the Guidelines is 3.5 μg/l as a 24-hour average and the concentration should not exceed 52 μg/l at any time.

Human Health

The ambient water quality criterion for cyanide is recommended to be identical to the existing drinking water standard which is 200 μg/l. Analysis of the toxic effects data resulted in a calculated level which is protective of human health against the ingestion of contaminated water and contaminated aquatic organisms. The calculated value is comparable to the present standard. For this reason a selective criterion based on exposure solely from consumption of 6.5 grams of aquatic organisms was not derived.

Polychlorinated Biphenyls

Freshwater Aquatic Life

For polychlorinated biphenyls the criterion to protect freshwater aquatic life as derived using the Guidelines is 0.014 μg/l as a 24-hour average. The available data indicate that acute toxicity to freshwater aquatic life probably will only occur at concentrations above 2.0 μg/l and that the 24-hour average should provide adequate protection against acute toxicity.

Human Health

For the maximum protection of human health from the potential carcinogenic effects due to exposure of PCBs through ingestion of contaminated water and contaminated aquatic organisms, the ambient water concentration should be zero based on the non-threshold assumption for this chemical. However, zero level may not be attainable at the present time. Therefore, the levels which may result in incremental increase of cancer risk over the lifetime are estimated at 10^{-5}, 10^{-6}, and 10^{-7}. The corresponding criteria are .79 ng/l, 0.79 ng/l, and .0079 ng/l, respectively. If the above estimates are made for consumption of aquatic organisms only, excluding consumption of water, the levels are .79 ng/l, .079 ng/l, and .0079 ng/l, respectively. Other concentrations representing different risk levels may be calculated by use of the Guidelines. The risk estimate range is presented for information purposes and does not represent an Agency judgment on an "acceptable" risk level.

Lead

Freshwater Aquatic Life

For total recoverable lead the criterion (in μg/l) to protect freshwater aquatic life as derived using the Guidelines is the numerical value given by $e^{(2.35[\ln(\text{hardness})]-9.48)}$ as a 24-hour average and the concentration (in μg/l) should not exceed the numerical value given by $e^{(1.22[\ln(\text{hardness})]-0.47)}$ at any time. For example, at hardnesses of 50, 100, and 200 mg/l as $CaCO_3$ the criteria are 0.75, 3.8, and 20 μg/l, respectively, as 24-hour averages, and the concentrations should not exceed 74, 170, and 400 μg/l, respectively, at any time.

Human Health

The ambient water quality criterion for lead is recommended to be identical to the existing drinking water standard which is 50 μg/l. Analysis of the toxic effects data resulted in a calculated level which is protective to human health against the ingestion of contaminated water and contaminated aquatic organisms. The calculated value is comparable to the present standard. For this reason a selective criterion based on exposure solely from consumption of 6.5 grams of aquatic organisms was not derived.

Nickel

Freshwater Aquatic Life

For total recoverable nickel the criterion (in μg/l) to protect freshwater aquatic life as derived using the Guidelines is the numerical value given by $e^{(0.76[\ln(\text{hardness})]+1.06)}$ as a 24-hour average and the concentration (in μg/l) should not exceed the numerical value given by $e^{(0.76[\ln(\text{hardness})]+4.02)}$ at any time. For example, at hardnesses of 50, 100, and 200 mg/l as $CaCO_3$ the criteria are 56, 96, and 160 μg/l, respectively, as 24-hour averages, and the concentrations should not exceed 1,100, 1,800, and 3,100 μg/l, respectively, at any time.

Human Health

For the protection of human health from the toxic properties of nickel ingested through water and contaminated aquatic organisms, the ambient water criterion is determined to be 13.4 μg/l.

For the protection of human health from the toxic properties of nickel ingested through contaminated aquatic organisms alone, the ambient water criterion is determined to be 100 μg/l.

Source: FR45:231 (Nov. 28, 1980)

Silver

Freshwater Aquatic Life

For freshwater aquatic life the concentration (in μg/l) of total recoverable silver should not exceed the numerical value given by "$e^{[1.72(\ln(\text{hardness})-6.52)]}$" at any time. For example, at hardnesses of 50, 100, 200 mg/l as $CaCO_3$ the concentration of total recoverable silver should not exceed 1.2, 4.1, and 13 μg/l, respectively, at any time. The available data indicate that chronic toxicity to freshwater aquatic life may occur at concentrations as low as 0.12 μg/l.

Human Health

The ambient water quality criterion for silver is recommended to be identical to the existing drinking water standard which is 50 μg/l. Analysis of the toxic effects data resulted in a calculated level which is protective of human health against the ingestion of contaminated water and contaminated aquatic organisms. The calculated value is comparable to the present standard. For this reason a selective criterion based on exposure solely from consumption of 6.5 grams of aquatic organisms was not derived.

Zinc

Freshwater Aquatic Life

For total recoverable zinc the criterion to protect freshwater aquatic life as derived using the Guidelines is 47 μg/l as a 24-hour average and the concentration (in μg/l) should not exceed the numerical value given by e[illegible] at any time. For example, at hardnesses of 50, 100, and 200 mg/l as $CaCO_3$ the concentration of total recoverable zinc should not exceed 180, 320, and 570 μg/l at any time.

Human Health

Sufficient data is not available for zinc to derive a level which would protect against the potential toxicity of this compound. Using available organoleptic data, for controlling undesirable taste and odor quality of ambient water, the estimated level is 5 mg/l. It should be recognized that organoleptic data as a basis for establishing a water quality criteria have limitations and have not demonstrated relationship to potential adverse human health effects.

Toluene

Freshwater Aquatic Life

The available data for toluene indicate that acute toxicity to freshwater aquatic life occurs at concentrations as low as 17,500 μg/l and would occur at lower concentrations among species that are more sensitive than those tested. No data are available concerning the chronic toxicity of toluene to sensitive freshwater aquatic life.

Human Health

For the protection of human health from the toxic properties of toluene ingested through water and contaminated aquatic organisms, the ambient water criterion is determined to be 14.3 mg/l.

For the protection of human health from the toxic properties of toluene ingested through contaminated aquatic organisms alone, the ambient water criterion is determined to be 424 mg/l.

Trichloroethylene

Freshwater Aquatic Life

The available data for trichloroethylene indicate that acute toxicity to freshwater aquatic life occurs at concentrations as low as 45,000 μg/l and would occur at lower concentrations among species that are more sensitive than those tested. No data are available concerning the chronic toxicity of trichloroethylene to sensitive freshwater aquatic life but adverse behavioral effects occurs to one species at concentrations as low as 21,900 μg/l.

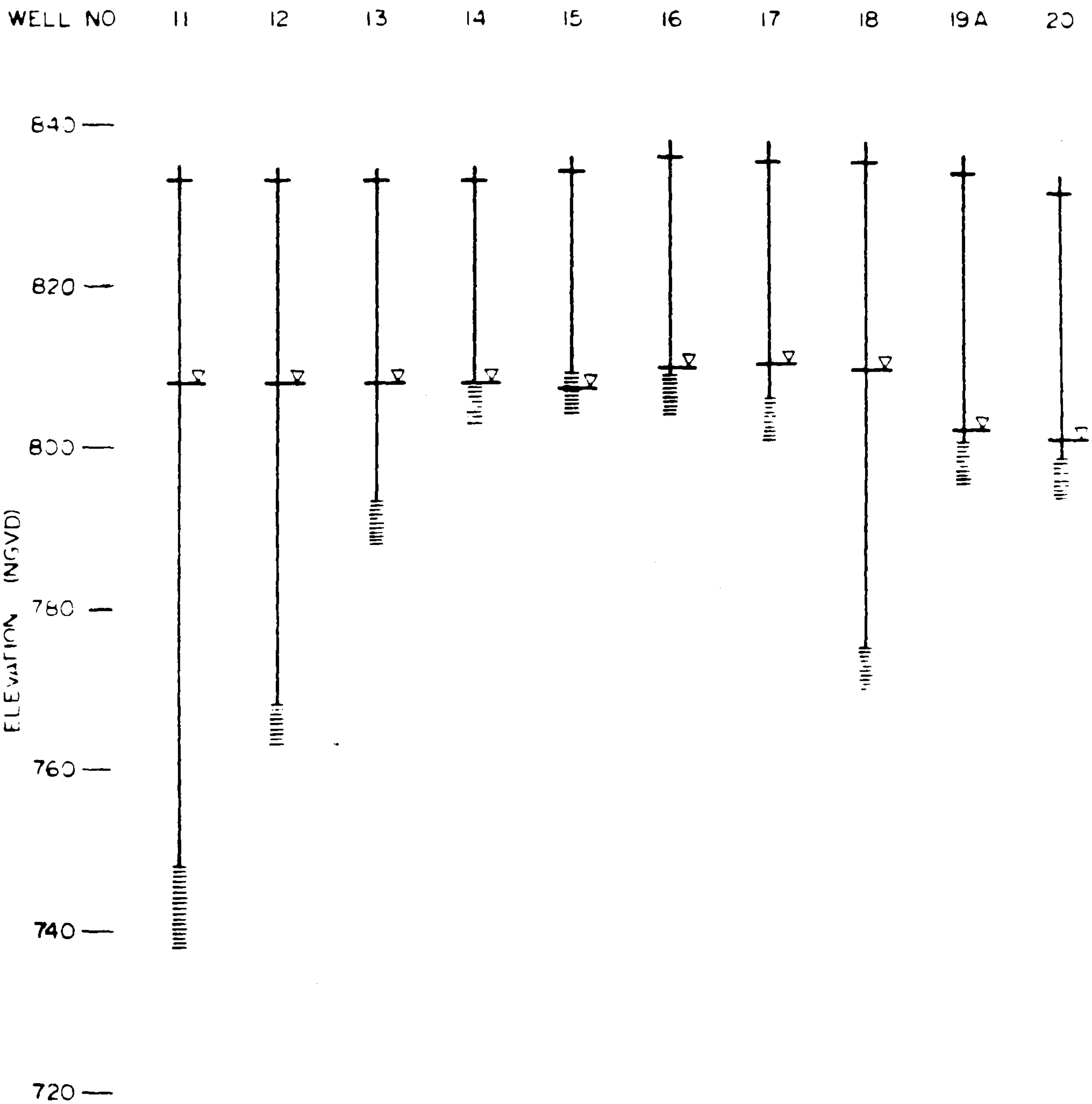
Human Health

For the maximum protection of human health from the potential carcinogenic effects due to exposure of trichloroethylene through ingestion of contaminated water and contaminated aquatic organisms, the ambient water concentration should be zero based on the non-threshold assumption for this chemical. However, zero level may not be attainable at the present time. Therefore, the levels which may result in incremental increase of cancer risk over the lifetime are estimated at 10^{-5}, 10^{-6}, and 10^{-7}. The corresponding criteria are 27 μg/l, 2.7 μg/l, and .27 μg/l, respectively. If the above estimates are made for consumption of aquatic organisms only, excluding consumption of water, the levels are 807 μg/l, 80.7 μg/l, and 8.07 μg/l, respectively. Other concentrations representing different risk levels may be calculated by use of the Guidelines. The risk estimate range is presented for information purposes and does not represent an Agency judgment on an "acceptable" risk level.

Source: FR45:231 (Nov. 28, 1980)

APPENDIX B

WELLS LOGS



WATER LEVEL SHOWN FOR 11/12/81 (▽)

Source: Hickok Phase II, 1981

FMC-11

Drilled June 18, 1981

Depth (ft)	Description
0-2	Sandy LOAM, dark brown
2-6	Clayey SAND, coarse, brown
6-14	Sandy CLAY, light yellowish-brown
14-24	Sandy CLAY, gray-brown
24-32	SAND, coarse, with gravel
32-60	SAND, medium-coarse
60-67	SAND, coarse-medium, with gravel
67-76	SAND, medium
76-86	SAND, medium-fine
86-93	SAND, medium-coarse
93-107	SANDSTONE (St. Peter) buff brown

FMC-12

Drilled June 19, 1981

Depth (ft)	Description
0-2	Sandy LOAM, dark brown
2-13	Sandy CLAY, yellow-brown
13-20	Sandy CLAY, blue-gray
20-23	Sandy CLAY, reddish brown
23-77	SAND, medium-coarse, poorly sorted

Source: Hickok Phase II, 1981

FMC-13

Drilled June 19, 1981

Depth (ft)	Description
0-2	Sandy LOAM, brown
2-6	Clayey SAND, medium-coarse, brown
6-13	Sandy CLAY, brown
13-19	Sandy CLAY, blue-gray
19-24	Sandy CLAY, gray-brown
24-60	SAND, medium-coarse, with gravel, poorly sorted

FMC-14

Drilled June 22, 1981

Depth (ft)	Description
0-2	Sandy LOAM, with gravel
2-14	Sandy CLAY, brown
14-24	Sandy CLAY, blue-gray
24-26	Sandy CLAY, brown with gravel
26-32	SAND, coarse-medium, with gravel

FMC-15

Drilled October 6, 1981

Depth (ft)	Description
0-3	Loamy SAND and sand FILL, with glass fragments
3-12	SAND, brown, poorly sorted, with gravel, occasional stringers of brown sandy clay
12-17	Clayey SAND, brown, poorly sorted
17-22	Sandy CLAY, blue-gray, with gravel in lower portion
22-27	Clayey SAND, blue-gray, with gravel
27-30	GRAVEL and SAND, poorly sorted, minor brown clay
30-37	SAND, medium-coarse

Source: Hickok Phase II, 1981

FMC-16

Drilled October 5, 1981

Depth (ft)	Description
0-2	FILL, topsoil and gravel
2-9	Sandy CLAY, brown
9-17	Sandy CLAY, blue-gray
17-22	SAND, medium, poorly sorted
22-37	SAND, coarse, poorly sorted with fine-medium sand and small gravel

FMC-17

Drilled October 2, 1981

Depth (ft)	Description
0-2	Sandy LOAM, dark brown
2-4	SAND, rusty brown, medium-coarse
4-8	Sandy CLAY, brown
8-30	Sandy CLAY, blue-gray, with small gravel
30-60	SAND, coarse, with gravel lenses
60-62	GRAVEL, 1 inch
62-64	SAND, coarse
64-66	Sandy CLAY, red
66-73	SAND, coarse, with gravel, with siltstone (?)
73-78	Sandy SILTSTONE, pale buff
78-92	SANDSTONE (St. Peter) buff brown to white, iron staining below 87 feet

Source: Hickok Phase II, 1981

FMC-18

Drilled October 2, 1981

Depth (ft)	Description
0-2	Sandy LOAM, dark brown
2-4	SAND, rusty brown, medium-coarse
4-8	Sandy CLAY, brown
8-30	Sandy CLAY, blue-gray, with small gravel
30-60	SAND, coarse, with gravel lenses
60-62	GRAVEL, 1 inch
62-64	SAND, coarse
64-66	Sandy CLAY, red
66-73	Sandy SILTSTONE with gravel
73-78	Sandy SILTSTONE, pale buff
at 78	SANDSTONE (St. Peter) buff brown to white

FMC-19

Drilled October 6, 1981

Depth (ft)	Description
0-2	Loamy SAND, reddish brown
2-32	SAND, medium-coarse, with gravel, poorly sorted

FMC-19A

Drilled November 10, 1981

Depth (ft)	Description
0-2	Loamy, SAND
2-11	SAND, medium-coarse
11-26	SAND, medium
26-37	SAND, medium-fine
37-45	SAND, coarse-medium

Source: Hickok Phase II, 1981

FMC-20

Drilled October 6, 1981

Depth (ft)	Description
0-4	FILL, white and yellow fine sand, rocks (sandstone) blue-green clay, no chemical odor
4-6	SAND, medium-coarse, rusty brown
6-16	SAND, coarse-medium, with some gravel
16-22	Loamy SAND, medium-coarse, with gravel, brown
22-47	SAND, fine to gravel, poorly sorted

Source: Hickok Phase II, 1981

WELL RECORD

KEYS WELL DRILLING COMPANY

WATER PRODUCERS

SAINT PAUL, MINNESOTA

FRIDLEY WELL No. 13

Owner: Fridley, Minnesota — Date Completed: March 19, 1970

Location: East River Road and one mile south of No. 694 — Driller: F. O'Brien & S. Haertl

Well No. 13 — Size 30" x 24" — Total Depth 332' — Type Shakopee-Jordan

DRILLERS LOG

From	To	Formation
0'	102'	Sand and Gravel
102'	115'	Sandrock and Gravel
115'	185'	Shakopee
185'	191'	Shakopee (broken)
191'	236'	Shakopee
236'	330'	Sandrock
330'	332'	

WELL MATERIALS

115' of 30" diameter of Outer Casing

70' of 29" diameter of Open Hole

191' of 24" diameter of Inner Casing

141' of 23" diameter of Open Hole

0' to 185 Mix grout 850 ([illegible] Sacks)

' " diameter Screen

Final RECORD OF TEST PUMPING

Static Water Level 27 ft. from top of pipe

GPM	D.D.	Hours
1022	29'	3
1404	38'-7"	1
1809	53'-3"	1
2013	62'-5"	16
1238	39'-5"	2

Remarks: First Test - SL - 23'

800 GPM - 34' DD - 2 Hrs.

1,000 GPM - 47' DD - 1 Hr.

1,200 GPM - 56' DD - 3 Hrs.

Sand content very high. Blasted and bailed out 419 yards with eleven (11) shots of dynamite (124 lbs.), and air developed the well for 73-1/2 Hrs. Well is now sand free.

PERMANENT PUMP DATA

Mfg. Type Serial No.

Capacity GPM TDH

Motor Make Type

H. P. Volts Ph. RPM

ft. in Col. pipe in. Shaft

ft. in Bowls Stages Type

ft. in suction pipe &

ft. Total Length of Pump

ft. in. drop pipe & No. Cable

ft. in. air line

in. Pitless ft. bury in outlet

REPORT

Tack No.
Well No. 1
Town Minneapolis (Fridley)
Date Started [redacted] 12/8/41 Machine No. 33 State Minn.
Date Completed [redacted] 1/7/42 Owner NORTHERN PUMP COMPANY
Location Court near Compressor room Total Depth of Well 275 feet

DIAMETER OF HOLE	16"	12"			
Top of Pipe above Surface	0	1			
Bottom of Pipe below Surface	20	128'6"			
No. of Ft. of Pipe in the Hole	removed	129'6"			
No. of Ft. of Hole Drilled		149	126		

TEST	1	2	3	4
Depth of the Hole	275			
Depth to Water at Rest	15			
Depth to Water Pumping				
Depth of Pump Pipe				
Gallons per minute				
Will well supply more?				
Was Strainer in Hole?				
Was water clear?				
Was well pumping sand?				
Hours Pumping				

FORMATION	Thickness	Depth
Sand	45	45
Gravel	3	48
Sand	77	125
Clay & sand mixed	2	127
Shakopee limerock	121	248
Jordan sandrock (not thru)	27	275

Sandrock was soft from 255 to 275 ft.

STRAINER

Make		
Type of Metal		
Diameter O. D.		
Diameter I. D.		
Total Length		
Number		
Top of Screen below Surface		
No. of Ft. Exposed		
Bottom of Screen below Surface		
Was Str. swedged		
Did Sand come thru Str.		
Was Str. coarse enough		
Style of Fittings		

All measurements taken from

Customer would not permit digging pit over 5 ft. deep on account of undermining footings of building. When pipe was down about 50 ft sand heaved up in pipe and pit and pit pipe settled and ground caved down around well from under concrete slab. They claimed this was because we did not keep head of water in well, but thereafter we carefully kep t ahead of water and nevertheless sand continued heaving and ground continued settling and following. They kept adding sheeting to top and pit finally got down 35-40 ft. Finally we recommended pulling all sheeting and fill up cave and keep filled and hang 16" from top. Kept sand controlled. Also furnished and installed Fairbanks-Morse Co. turbine, 500 gpm, 50' col, 110 ft. TDH. This well pumps into 40 ft. elevated surge tank and flows by gravity thru compressor coolers.

UNITED STATES
DEPARTMENT OF THE INTERIOR
Geological Survey
Water Resources Branch

1. Location: State Minnesota County Anoka
   Nearest P.O. Col. Hights (sic) Direction from P.O. WNW
   Distance from P.O. 3-1/4 miles; NE 1/4 of SW 1/4, Sec. 27, T. 30N, R. 24W
2. Owner: U. S. Navy Address: Columbia Heights, PO
   Driller: McCarthy Well Co. Address: St. Paul, Minnesota
3. Situation: Is well on upland, in valley, or on hillside? Level Ground
4. Elevation of top of well: 835 ft. above the level of the sea
5. Type of well: Drilled ; kind of drilling rig used Solid tool
6. Depth of well: 288 ft.; year in which well was finished 1942
   Does well enter rock? Yes ; if so, at what depth? 91 ft.; kind of rock Shakopee Limerock
7. Diameter: At top 16 inches; at bottom 16 inches.
8. Principal water bed: Shakopee Limerock and Jordan Sandrock
   Depth to principal water bed 146 ft.; thickness of bed 140 ft.
   If other water supplies were found, give depth to each ______
9. Casings: Kind Steel Pipe ; size 16 ; length 156 ft.;
   between depths of ______ and ______ ft.
   Kind Open hole below; size ____; length ____ ft.; between depths of ____ and ____ ft.
   Kind ______; size ____; length ____ ft.; between depths of ____ and ____ ft.
   Packers (if any): Depth at which packers were used None ; kind ______
   Screen or Strainer: Was well finished with screen? None
   Kind of screen ______; length of screen ______ ft.;
   diameter ______ inches; size of openings ______
10. Head: Does well at present overflow without pumping? No ; did it overflow when new? No ; if flowing give pressure ____ lb. per sq. inch; or height water will rise in a pipe 17 ft. above surface; original pressure or head ______; if not flowing, give water level in well 17 ft. below surface.
11. Pump: Is the well pumped? Yes; kind of pump 50 HP each ;
    size or capacity of pump 600 GPM each ; kind of power Electric
12. Yield: Natural flow at present (if any) ____ gallons per minute; original flow ____ gallons per minute; well has been pumped at ______ gallons per minute continuously for ____ hours; quantity of water ordinarily obtained from well 230,000 gallons per day average for the 2 wells.
13. Use: For what purpose is the water used? All purpose
14. Quality of the water: fresh, moderately hard ; is there an analysis? ______
15. Cost of well, not including pump: $10,000.00 each
    Temperature of water 63°F Name of person filling blank A.C. Born, Plant Eng.

Note: Log was retyped. Original log was not of reproducible quality.

(8)

LOG OF WELL

KIND OF ROCK OR OTHER MATERIAL (Give color and tell whether hard or soft)	DEPTH, IN FEET From—	To—	THICKNESS, IN FEET	REMARKS (Especially information as to water found)
Clay,	0	5	5	
Sand,	5	65	70	
Hard gravel	10		80	
StPetor Sandrock	35		115	
Jordan Limerock, & Sandrock	31		146	
Shakopee Limerock	91		237	
Jordan Sandrock	51		288	

Question #12. Please note that Navy Wells Nos. 2 and 3, have only one motor, hence the total of 230,000 gallon per day, average, includes both wells. Each well is powered by a 50 HP electric motor, capacity 600 GPM.

WELL RECORD[a]

KEYS WELL DRILLING COMPANY
WATER PRODUCERS
SAINT PAUL, MINNESOTA

Owner Fridley, Minnesota   Date Completed March 19, 1970

Location East River Road and 1 mile south of Hwy. 694   Driller F. O'Brien and S. Maartl

Well No. 13   Size 30" x 24"   Total Depth 332'   Type Shakopee-Jordan

DRILLERS LOG

0'	to	102'	Sand and Gravel
102'	to	115'	Sandrock and Gravel
115'	to	185'	Shakopee
185'	to	191'	Shakopee (broken)
191'	to	236'	Shakopee
236'	to	330'	Sandrock
330'	to	332'	
	to		
	to		
	to		
	to		
	to		
	to		
	to		

WELL MATERIALS

115' of 30" diameter of Outer Casing

70' of 29" diameter of Open Hole

191' of 24" diameter of Inner Casing

141' of 23" diameter of Open Hole

0' to 185 Mix grout 858 (sacks)

____' ____" diameter ________ Screen

FINAL RECORD OF TEST PUMPING

Static Water Level 27 ft from top of pipe

1022	GPM	29'	D.D.	3	Hours
1404	GPM	38'-7"	D.D.	1	Hours
1809	GPM	53'-3"	D.D.	1	Hours
2013	GPM	62'-5"	D.D.	16	Hours
1238	GPM	39'-5"	D.D.	2	Hours

Remarks: First Test - WL - 28'
800 GPM - 34' D.D. - 2 Hrs.
1000 GPM - 47' D.D. - 1 Hr.
1200 GPM - 54' D.D. - 3 Hrs.
Sand content very high. Blasted and bailed out 419 yards with eleven (11) shots of dynamite (134 lbs.) and air developed the well for 72-1/2 hours. Well is now sand free.

PERMANENT PUMP DATA

Mfg.______ Type______ Serial No.______

Capacity______ GPM ______ TDH

Motor Make______ Type______

____ H.P. ____ Volts ____ Ph. ____ RPM

____ ft. ____ in Col. pipe ____ in. Shaft

____ ft. ____ in Bowls ____ Stages ____ Type

____ ft. ____ in suction pipe & ______

____ ft. Total Length of Pump

____ ft. ____ in drop pipe & ____ No. Cable

____ ft. ____ in air line

____ in Pitless ____ ft. bury ____

____ in outlet ______

NOTE: (a) Log was retyped. Original log not of reproducible quality.

TRICHLOROETHYLENE ANALYSIS RESULTS*

Sample Date	NIROP Well 2	NIROP Well 3	FMC Well 1	Fridley Well 13	Mpls. Water Intake	Mpls. Finished Water
3/16/81	70	60	200			
4/23/81	55	35	130			
7/22/81					**	
7/29/81					**	
8/14/81					**	
9/8/81					**	
12/31/81				<0.2	1.2	
1/8/82			150			
1/27/82			110		1.3	
2/2/82			230			
2/3/82					1.0	
2/10/82			150		1.2	
2/17/82			130		1.1	
3/3/82			58		0.9	
3/17/82			150		0.8	0.6
4/1/82					<0.2	
4/7/82					<0.2	<0.4
4/16/82			91		<0.2	<0.2
4/19/82					<0.2	
4/21/82					<0.2	0.4
4/23/82					<0.2	
4/28/82			82			
6/16/82					0.9	0.4
6/30/82					0.8	0.2
7/14/82					0.4	1.0
7/28/82					0.6	**
8/11/82				**	0.6	0.2

*All data reported in μg/l (ppb).
**Indicates a peak was present, but the amount was too small to quantify.

APPENDIX C

TCE ANALYSIS

APPENDIX D

ANALYSIS OF FRIDLEY WELL 13

Minnesota Pollution Control Agency

September 16, 1982

Mr. John Flora
Director of Public Works
City of Fridley
Fridley, Minnesota 55432

Dear Mr. Flora:

Enclosed please find the results from the Minnesota Pollution Control Agency (MPCA) sampling of Fridley well 13 on August 11, 1982. Trace quantities of trichloroethylene was detected in the Fridley well sample. I am forwarding this data to the Minnesota Department of Health (MDH) for their review. In addition, I would like to resample Fridley well 13 on September 22, 1982.

Please contact me at 297-3347 to discuss the September 22 sampling date. Thank you.

Sincerely,

Lisa Thorvig

Lisa Thorvig
Soil Scientist
Site Response Unit
Regulatory Compliance Section
Solid and Hazardous Waste Division

LJT/dc

Enclosure

cc: Mr. Earl R. Wigand, FMC Corporation
Ms. Judy Y. Longfield, FMC Corporation
Mr. Robert B. Rice, DCASPRO Northern Ordnance
Mr. Douglas L. Hildre, FMC Corporation
Mr. James F. Hayek, City of Minneapolis
Mr. Gary Englund, MDH

Phone ___________
1935 West County Road B2, Roseville, Minnesota 55113-2785
Regional Offices • Duluth/Brainerd/Detroit Lakes/Marshall/Rochester
Equal Opportunity Employer

VOLATILE HALOGENATED HYDROCARBONS IN WATER (ug/l)

CODE 464

RECEIVED SEP 3 1982

Collected By L. Thorvig

Report To John Aho (MPCA)

MINN. POLLUTION CONTROL AGENCY

	Town/County		Sampling Point	Collection Date and Time
	Fridley	Anoka	Well # 13	8-11-82 9:15 am
(B)	"	"	Field Blank	8-10-82

COMPLETED SEP 1982 ANALYTICAL SERVICES

Date Received 8-11-82	132618 (A)	132619 (B)	Date Analyzed 9-1-82	132618 (A)	132619 (B)
Chloromethane *	——	——	2,3-Dichloro-1-propene	<0.5	<0.5
Dichlorodifluoromethane *	——	——	1,2-Dichloropropane *	<0.5	<0.5
Vinyl Chloride *	——	——	1,1-Dichloro-1-propene	<0.2	<0.2
Bromomethane *	——	——	Trans-1,3-Dichloro-1-propene *	<0.2	<0.2
Chloroethane *	——	——	1,1,2-Trichloroethylene *	**	<0.2
Methylene Chloride *	<1.0	<1.0	1,3-Dichloropropane	<3.0	<3.0
Trichlorofluoromethane *	<0.2	<0.2	Chlorodibromomethane *	<0.5	<0.5
Allylchloride	<0.5	<0.5	1,1,2-Trichloroethane *	<0.2	<0.2
1,1-Dichloroethylene *	<0.5	<0.5	Cis-1,3-Dichloro-1-propene *	<0.2	<0.2
1,1-Dichloroethane *	<0.2	<0.2	1,2-Dibromoethane	<0.5	<0.5
Trans-1,2-Dichloroethylene *	<0.2	<0.2	2-Chloroethylvinyl Ether *	——	——
Cis-1,2-Dichloroethylene	<0.2	<0.2	Bromoform *	<1.0	<1.0
Chloroform *	<0.2	<0.2	1,1,1,2-Tetrachloroethane	<0.2	<0.2
1,2-Dichloroethane *	<0.2	<0.2	1,2,3-Trichloropropane	<2.0	<2.0
Dibromomethane	<0.5	<0.5	1,1,2,2-Tetrachloroethane *	<2.0	<2.0
1,1,1-Trichloroethane *	<0.2	<0.2	1,1,2,2-Tetrachloroethylene *	<2.0	<2.0
Carbon Tetrachloride *	<0.2	<0.2	Pentachloroethane	<2.0	<2.0
Bromodichloromethane *	<0.2	<0.2	Chlorobenzene *	<0.5	<0.5
Dichloroacetonitrile	<0.5	<0.5			
** A peak was present but was to small to quantify					
			Field Blank Sample No. 132619		
			Analysis Confirmed Y/N	No	No

*PRIORITY POLLUTANTS

APPENDIX E

FOUNDRY SAND ANALYSIS

Enclosure (2) to Letter M19958-818.1b dated 9 December 1982.

SERCO

SANITARY ENGINEERING LABORATORIES, INC.
2982 N. Cleveland Ave. Roseville, Mn. 55113 (612) 636-7173

ELY • ROSEVILLE, MN
PERU, ILLINOIS

GERALD ALLEN, P.E.
LAWRENCE BREIMHURST, P.E.

December 20, 1978

FMC Corporation
Northern Ordnance
Columbia Heights P.O.
Minneapolis, MN 55421
Mr. Doug Hildre

CLIENT NO : 2502

Dear Mr. Hildre,

Enclosed please find laboratory report number 2490 for samples received on November 28, 1978. This report, consisting of 3 pages, is considered incomplete unless accompanied by this cover letter.

The laboratory analyses herein reported have been performed by myself or under my direct supervision and in accordance with EPA approved methodologies.

Submitted by,

SERCO LABORATORIES

Earl E. Finder, Chemist
Laboratory Administrator

PROVIDING A SANITARY ENGINEERING RESEARCH AND LABORATORY SERVICE TO INDUSTRY, MUNICIPALITIES AND CONSULTING ENGINEERS

SERCO
ELY • ROSEVILLE, MN
PERU, ILLINOIS

SANITARY ENGINEERING LABORATO .S, INC.
2982 N. Cleveland Ave. Roseville, Mn. 55113 (612) 636-7173

REPORT OF LABORATORY ANALYSIS
(Methodologies EPA approved)

REPORT NO. 2490
12/20/78

CLIENT: FMC Corporation
DATE COLLECTED: 11/27/78 COLLECTED BY: CLIENT
DATE RECEIVED: 11/28/78 PICKED-UP BY: SERCO
SAMPLE DESCRIPTION: SOLID

LAB NO:	7885	7939	7941	7942
SAMPLE SITE:	RAW F.SAND WATER-LEACHED	RAW F.SAND ACID-LEACHED	USED F.SAND WATER-LEACHED	USED F.SAND ACID-LEACHED
ANALYSIS:				
Arsenic, ug/l as As	1	10	<1	5
Barium, mg/l as Ba	<0.25	<0.25	<0.25	<0.25
Boron, mg/l as B	<0.1	<0.1	<0.1	<0.1
Cadmium, mg/l as Cd	<0.01	<0.01	<0.01	<0.01
Total Chromium, mg/l as Cr	<0.05	<0.05	<0.05	<0.05
Copper, mg/l as Cu	<0.05	0.05	<0.05	0.15
Total Iron, mg/l as Fe	0.30	2.1	<0.05	10
Lead, mg/l as Pb	0.4	1.0	<0.1	1.0
Manganese, mg/l as Mn	<0.03	0.12	<0.03	0.18
Nickel, mg/l as Ni	<0.05	<0.05	<0.05	<0.05
Silver, mg/l as Ag	<0.04	0.04	<0.04	0.04
Selenium, mg/l as Se	<0.5	<0.5	<0.5	<0.5

< means "less than"

SERCO
ELY • ROSEVILLE, MN
PERU, ILLINOIS

..ANITARY ENGINEERING LABORATO S, INC.
2982 N. Cleveland Ave. Roseville, Mn. 55113 (612) 636-7173

REPORT OF LABORATORY ANALYSIS
(Methodologies EPA approved)

REPORT NO. 2490
12/20/78

CLIENT: FMC Corporation
DATE COLLECTED: 11/27/78
DATE RECEIVED: 11/28/78
SAMPLE DESCRIPTION: SOLID

COLLECTED BY: CLIENT
PICKED-UP BY: SERCO

LAB NO:	7885	7939	7941	7942
SAMPLE SITE:	RAW F.SAND WATER-LEACHED	RAW F.SAND ACID-LEACHED	USED F.SAND WATER-LEACHED	USED F.SAND ACID-LEACHED
ANALYSIS:				
Zinc, mg/l as Zn	0.02	0.29	0.03	0.28
Chloride, mg/l as Cl	1	68	3	55
Fluoride, mg/l as F	0.1	0.4	0.2	0.4
Nitrates, mg/l as N	<0.1	<0.1	<0.1	<0.1
Kjeldahl Nitrogen, mg/l as N	<0.1	0.4	<0.1	<0.1
Sulfate, mg/l as SO_4	<2	<2	2	<2
Phenol, mg/l	0.92	0.83	1.8	2.2
pH	7.0	4.1	6.5	4.4
COD, Chemical Oxygen Demand, mg/l	20	-	32	-

Approved by: [signature]   < means "less than"

PLATE 8–1