FINAL

Remedial Investigation/ Feasibility Study Work Plan SCA/Hartley and Hartley Landfill Bay County, Michigan

Prepared for:

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September 1994

QUALITY
INTEGRITY
CREATIVITY
RESPONSIVENESS

RUST ENVIRONMENT & INFRASTRUCTURE

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LIST OF ACRONYMS AND ABBREVIATIONS

AEC	Atomic Energy Commission
ALARA	As low as reasonably achievable
ARAR	Applicable or Relevant and Appropriate Requirements
BOD	Biochemical Oxygen Demand
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act (also known as Superfund)
CLP	Contract Laboratory Program
COD	Chemical Oxygen Demand
DPR	Direct Process Residue
DQO	Data Quality Objectives
FS	Feasibility Study
FSP	Field Sampling Plan
HASP	Health and Safety Plan
MDNR	Michigan Department of Natural Resources
MDPH	Michigan Department of Public Health
MERA	Michigan Environmental Response Act (Act 307)
Mg-Th	Magnesium-Thorium
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
O&M	Operations and Management
ORAU	Oak Ridge Associated Universities
OSWER	Office of Solid Waste and Emergency Response
PBB	Polybrominated Biphenyls
POTW	Publicly Owned Treatment Works
PRP	Potentially Responsible Party
PVC	Polyvinyl Chloride
QAPP	Quality Assurance Project Plan
RCRA	Resource Conservation and Recovery Act
RI	Remedial Investigation
ROD	Record of Decision
SARA	Superfund Amendment and Reauthorization Act
SCA	SCA Services, Inc.
SDMP	Site Decommissioning Management Plan
SVSU	Saginaw Valley State University
TAL	Target Analyte List
TAT	Technical Assistance Team
TBC	To-Be-Considered Requirements
TCL	Target Compound List
TDS	Total Dissolved Solids
TOC	Total Organic Carbon
TP	Test Pit
TSD	Treatment, Storage and Disposal
TSDF	Treatment, Storage, and Disposal Facility
U.S. DOI	U.S. Department of the Interior
U.S. EPA	U.S. Environmental Protection Agency
U.S. NRC	U.S. Nuclear Regulatory Commission

1.0 INTRODUCTION

SCA Services, Inc. (SCA) is undertaking studies to determine the nature and extent of contamination and options for cleanup at the SCA/Hartley and Hartley Landfill in Bay County, Michigan. These studies - a Remedial Investigation and a Feasibility Study (RI/FS) - are being implemented by SCA at the SCA/Hartley and Hartley Landfill Site (Site) in accordance with requirements of the State of Michigan, the U.S. Nuclear Regulatory Commission (U.S. NRC) and the National Oil and Hazardous Substances Pollution Contingency Plan (often referred to as the National Contingency Plan or NCP).

This RI/FS Work plan outlines SCA's technical approach to investigate and address the contamination at the Site. It provides the following information:

- Long-Term Objectives for the Site and the Objectives for the RI/FS (Section 1)
- Site Background and Setting (Section 2)
- Initial Site Evaluation (Section 3)
- Work Plan Rationale and Approach (Section 4)
- Remedial Investigation/Feasibility Study Tasks (Section 5)
- Project Management (Section 6)
- References (Section 7)
- Preliminary Screening of Technologies and Process Options (Appendix)

Concurrent with the RI/FS, an interim response activity (leachate collection and treatment system) is being designed to manage the leachate seeps on a short-term basis until the RI/FS is completed and final remedial action is underway.

1.1 LONG-TERM OBJECTIVES

The SCA/Hartley and Hartley Site consists of two closed encapsulated landfills--the East Landfill and the Northwest Landfill. The Site, operated from 1962 to 1978, and accepted municipal, commercial, and industrial wastes for treatment and disposal. The Site also contains a quantity of thorium, a naturally occurring metal which exhibits low levels of radioactivity. SCA entered into a Consent Order for Closure with the State of Michigan in 1980 and an Amendment to the Consent Order for Closure in 1984. These agreements specified closure, monitoring, and maintenance requirements for the Site. The Site does not pose an immediate threat to human health or the environment because the landfills are encapsulated and access to the Site is restricted.

The Site is currently listed on Michigan's Act 307 program and on the U.S. NRC's Site Decommissioning Management Plan (SDMP) program. SCA's ultimate goal is to achieve final closure of the Site. The long-term management of the encapsulated waste and adjacent land must satisfy both the hazardous substance regulations embodied in Act 307 and U.S. NRC's regulations governing radioactive materials. These regulatory requirements will be integrated in a manner consistent with the NCP. The following long-term objectives will be implemented to meet the goal of final closure:

- Conduct an RI/FS to characterize the nature and extent of contamination at the Site and evaluate remedial alternatives

- Submit to the MDNR a Remedial Action Plan for a Type C Cleanup and submit a Decommissioning Plan to U.S. NRC
- Prepare a Remedial Design (RD) for the long-term management of hazardous substances and radioactive materials
- Implement a Remedial Action (RA) as approved by the MDNR and U.S. NRC.

The proposal for final closure will focus on both the encapsulated landfills and the surrounding land.

1.2 OBJECTIVES OF THE RI/FS

The NCP defines the purpose of an RI/FS in 40 CFR 300.430(a)(2):

> "The purpose of the remedial investigation/feasibility study (RI/FS) is to assess site conditions and evaluate alternatives to the extent necessary to select a remedy."

This RI/FS has been formulated to satisfy the purpose defined by the NCP and to meet the requirements of the U.S. NRC and the MDNR.

Potential contaminant sources can be classified as either inside or outside the encapsulated landfills. With respect to the potential contaminant sources inside the encapsulated landfills, the specific objectives of the RI/FS are:

- Verify the integrity of each landfill encapsulation.
- Characterize the landfill leachate quality.
- Estimate the total amount of thorium buried in the landfills.
- Evaluate the extent of mixing of hazardous substances with radioactive material.

With respect to potential contaminant sources outside the encapsulated landfills, the specific objectives of the RI/FS are:

- Identify and delineate potential contamination outside the encapsulated landfills.
- Evaluate potential soil, groundwater, surface water, sediment, and air impacts.
- Evaluate potential exposure pathways for chemical and radiation hazards to humans and sensitive environments.

Specific objectives of the RI/FS common to both potential contamination sources are:

- Evaluate the horizontal and vertical extent of contamination
- Develop preliminary remediation goals.
- Identify and screen technologies and process options.
- Analyze remedial alternatives.

Several sources of data will be utilized to achieve these objectives, including, but not limited to, historical data, monitoring data obtained in accordance with the Closure Order, and field sampling activities.

2.0 SITE BACKGROUND AND SETTING

In this section, the historical relationship of the Site to adjacent properties is described and the physical setting is characterized. A detailed account of the containment actions completed at the two landfills is presented. The technical reports documenting the containment actions provide data for evaluating the integrity of the landfill closures. The historical records are also useful for identifying areas of potential concern which are beyond the closed landfills. The current conditions at the Site are reviewed and the proposed interim response activities are discussed.

2.1 SITE LOCATION AND DESCRIPTION

The SCA/Hartley and Hartley Landfill Site is located at 2370 South Two Mile Road, Kawkawlin Township, Bay County, Michigan, in the east half of Section 25, Township 5 North, Range 4 East (Figure 2-1), and is approximately one mile west of Saginaw Bay (Lake Huron). The Site is situated approximately one-half mile north of Beaver Road on the west side of Two Mile Road. The property covers roughly 160 acres in an area typified by wetlands, adjacent to the Tobico Marsh State Game Area. There are single-family residential homes and some light industrial and commercial properties on South Two Mile Road and Beaver Road. The Bangor Township Landfill, is located immediately east of the site.

Two parcels of land, obtained by Mr. Wayne Hartley in a land trade with the State, are located directly west and south of the site. The State of Michigan owns much of the surrounding land, including a parcel of land bordering the northwest corner of the site which contains an encapsulated landfill. Private property borders the site at the southwest corner.

A chain link fence has been constructed around the Site. A road crosses the landfills to provide access to the encapsulated MDNR landfill.

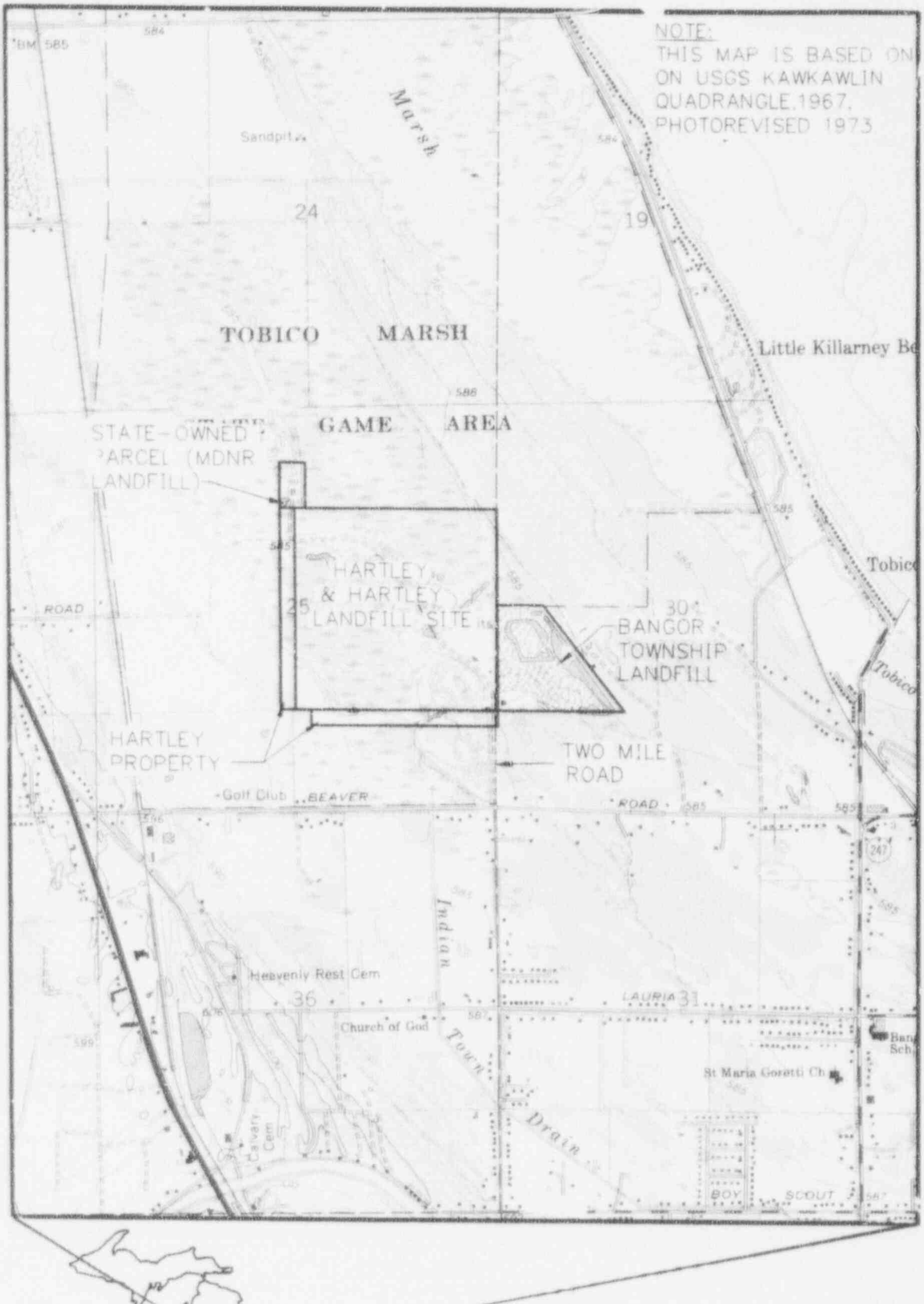
2.2 SITE HISTORY

This section discusses the ownership of the Site and adjacent property and describes the waste treatment and disposal operations at the Site. A brief chronology of the Site is presented in Table 2-1.

2.2.1Ownership of Site and Adjacent Property

Hartley & Hartley, Inc. previously owned the 160-acre parcel of land and a 40-acre parcel, as shown in Figure 2-2 (the acreage is approximate). On March 21, 1973, SCA acquired Hartley and Hartley, Inc., which included the 160-acre site. In 1974, the 40-acre parcel had been exchanged with the State of Michigan for the two unconnected strips of land which totaled about 22 acres (referenced in 2.1 above).

In order to differentiate between the properties, this Work Plan refers to the Hartley and Hartley Landfill owned by SCA as "the Site" or "SCA Property"; to the State of Michigan property as the "State-owned parcel"; and to the land currently owned by Wayne Hartley as the "Hartley Property." Refer to Figure 2-2 for the locations of these properties.



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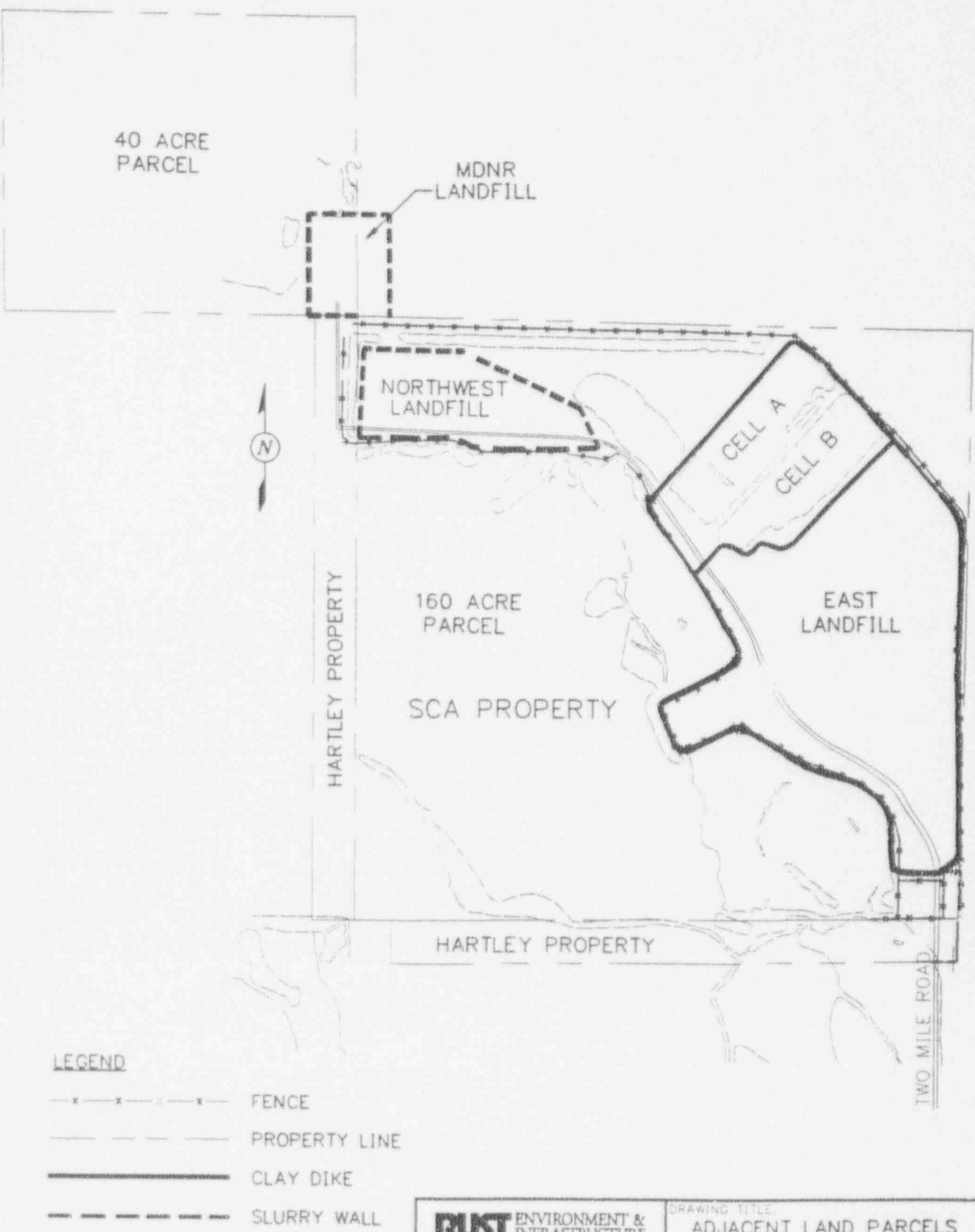
DRAWING TITLE:
SITE LOCATION MAP

HARTLEY & HARTLEY LANDFILL
BAY COUNTY, MICHIGAN

FIGURE 2-1

TABLE 2-1
HARTLEY AND HARTLEY LANDFILL
CHRONOLOGY OF MAJOR MILESTONES

YEAR	MILESTONE
1962	Probable start of landfilling and other waste disposal practices at the Site.
1969	Incinerator begins operating at Site.
1973	SCA buys Hartley and Hartley, Inc.
1978	All operations cease on December 31.
1979	Clay cap and dike completed on East Landfill.
1980	EG&G conducts aerial radiological survey of Bay County area for U.S. NRC. SCA enters into Consent Order for Closure with the State of Michigan; this begins the period of groundwater and surface water monitoring.
1984	ORAU conducts radiological investigations for the U.S. NRC of SCA's property (Northwest Landfill only), the state-owned property, and the northernmost portion of the Hartley-owned property. Clay cap and slurry wall constructed for Northwest Landfill and state-owned property by SCA. SCA enters into Amendment to the Consent Order for Closure of 1980.



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DRAWING TITLE:
ADJACENT LAND PARCELS

HARTLEY & HARTLEY LANDFILL
BAY COUNTY, MICHIGAN

FIGURE 2-2

2.2.2 Waste Treatment and Disposal Operations

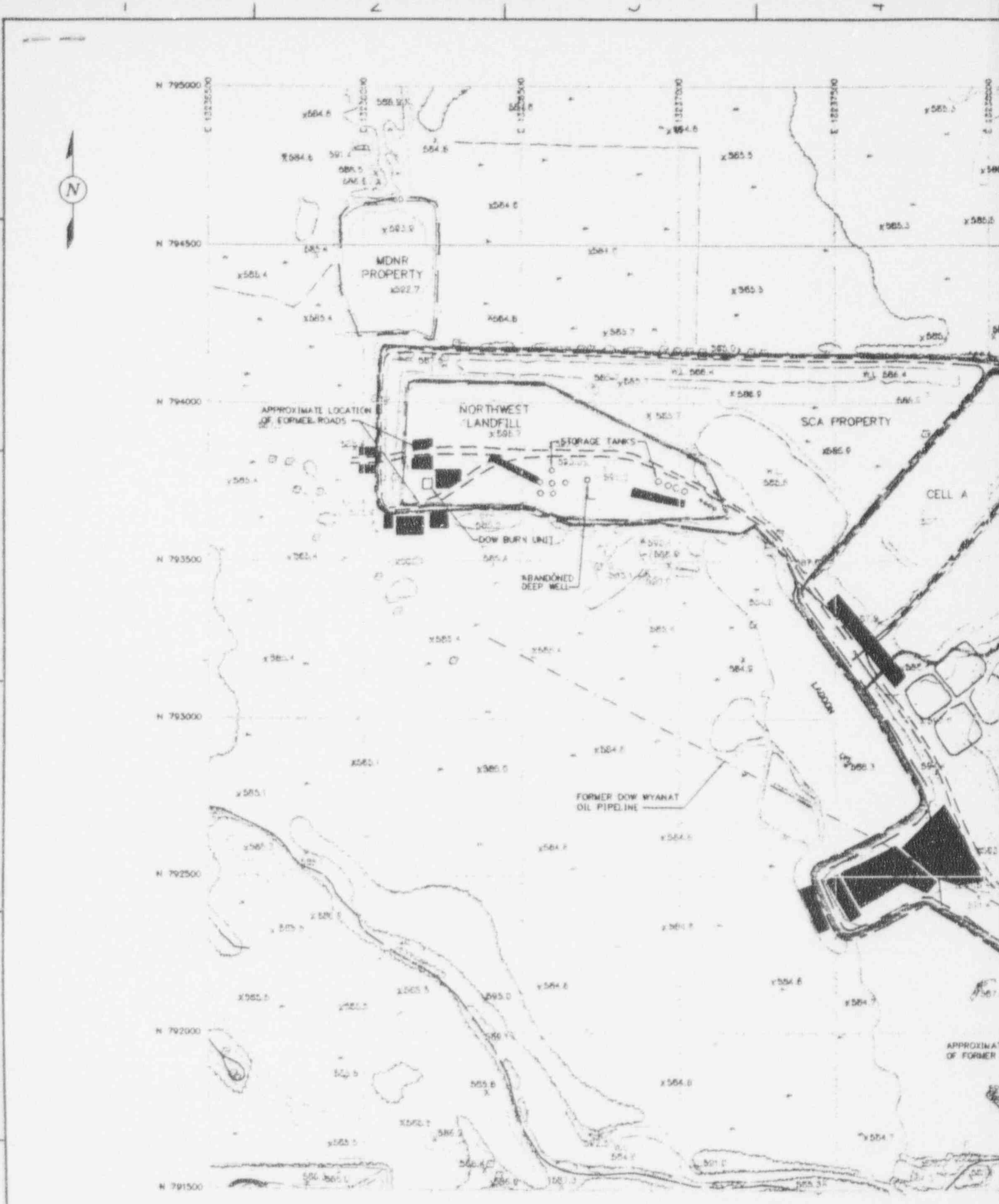
The Site and adjacent properties were undeveloped prior to 1962. Aerial photographs dated 1938 and 1950 show the site to be essentially undisturbed. There were no surface water bodies on the Site at this time. A review of the MDNR correspondence suggests that the waste operations began in 1962.

Typical wastes included foundry sand, drummed liquid chemicals, cutting oils, paint sludges and plating wastes. Prior to 1969, flammable liquid wastes were ponded and ignited. The approximate locations of several disposal pits can be seen in Figure 2-3. In 1969, a liquid waste incinerator was installed. Typically, waste oils and aqueous wastes were blended together and allowed to separate. The oil layer was used as the primary fuel source for the incinerator and the aqueous stream was injected into the burn chamber to moderate the kiln temperature. The resulting ash was landfilled onsite.

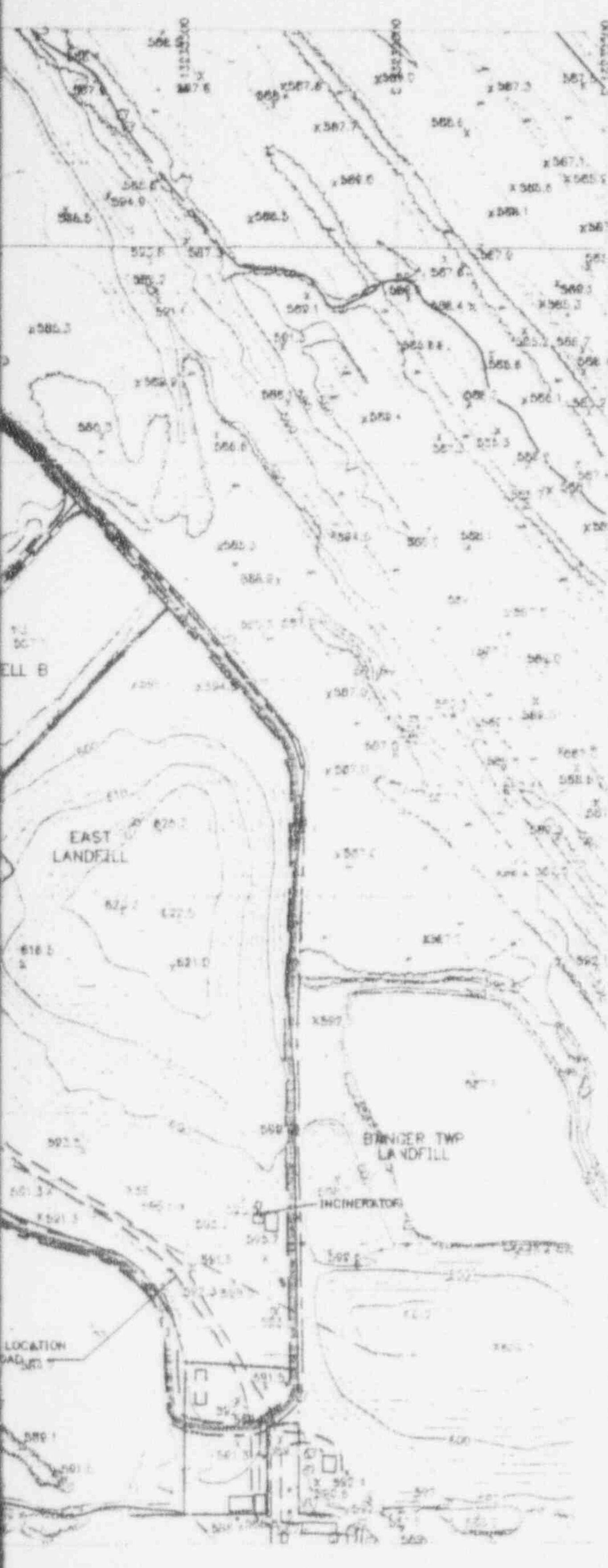
Figure 2-4 shows the development of landfill cells. The cells are numbered in the order of their development. According to records, cells 1 through 4 are unlined and are either constructed on top of the glacial till or extend at most a few feet into the till. Cell 5 was excavated to a depth of approximately ten feet into the till and lined with a synthetic liner.

An abbreviated list of major waste generators (potentially responsible parties or PRPs) and some of the types of wastes contributed are summarized in Appendix A. The generators included on this list are:

- The Ansul Company
- Approved Industrial Removal
- Auburn Diecast Corporation
- The Austin Company
- Baker Perkins, Inc.
- Bergman Scrap Iron & Waste Material Company
- Buckeye Pipe Line
- Center Tool and Machine Company, Inc.
- Chemetron Corp.
- Chemical Leaman Tank Lines, Inc.
- Chemical Recovery Systems, Inc.
- Coastal Tank Lines, Inc.
- Consumers Power Company
- Dow Chemical Company
- Dow Corning Corporation
- E. I. DuPont de Nemours & Company
- Eaton Corporation
- General Motors Corporation
- Grand Trunk Western Railroad Company
- Hannah Marine (Hannah Inland Waterways Corporation)
- Hexcel Specialty Chemicals
- Hitachi Magnetics Corporation
- Hoffman La Roche
- Inmont



NO.	REVISIONS	MADE	CHK	DATE	NO.	REVISIONS	MADE	CHK	DATE	NO.	REVISIONS



LEGEND:

FORMER DISPOSAL AREAS FOR WASTE OIL

BANGOR TWP LANDFILL

SITE LIMITS

0 100' 200' 400' 600'

	NAMES	DATE
DRAWN:	R. KERLIN	06/28/93
DESIGN:	R. VASSILAKIS	06/23/93
CHECKED:	R. OGLE	06/28/93
PM:	R. OGLE	06/28/93
APP'D:		
APP'D:		
APP'D:		

MADE | CHK | DATE

SITE LAYOUT

HARTLEY & HARTLEY LANDFILL

BAY COUNTY MICHIGAN

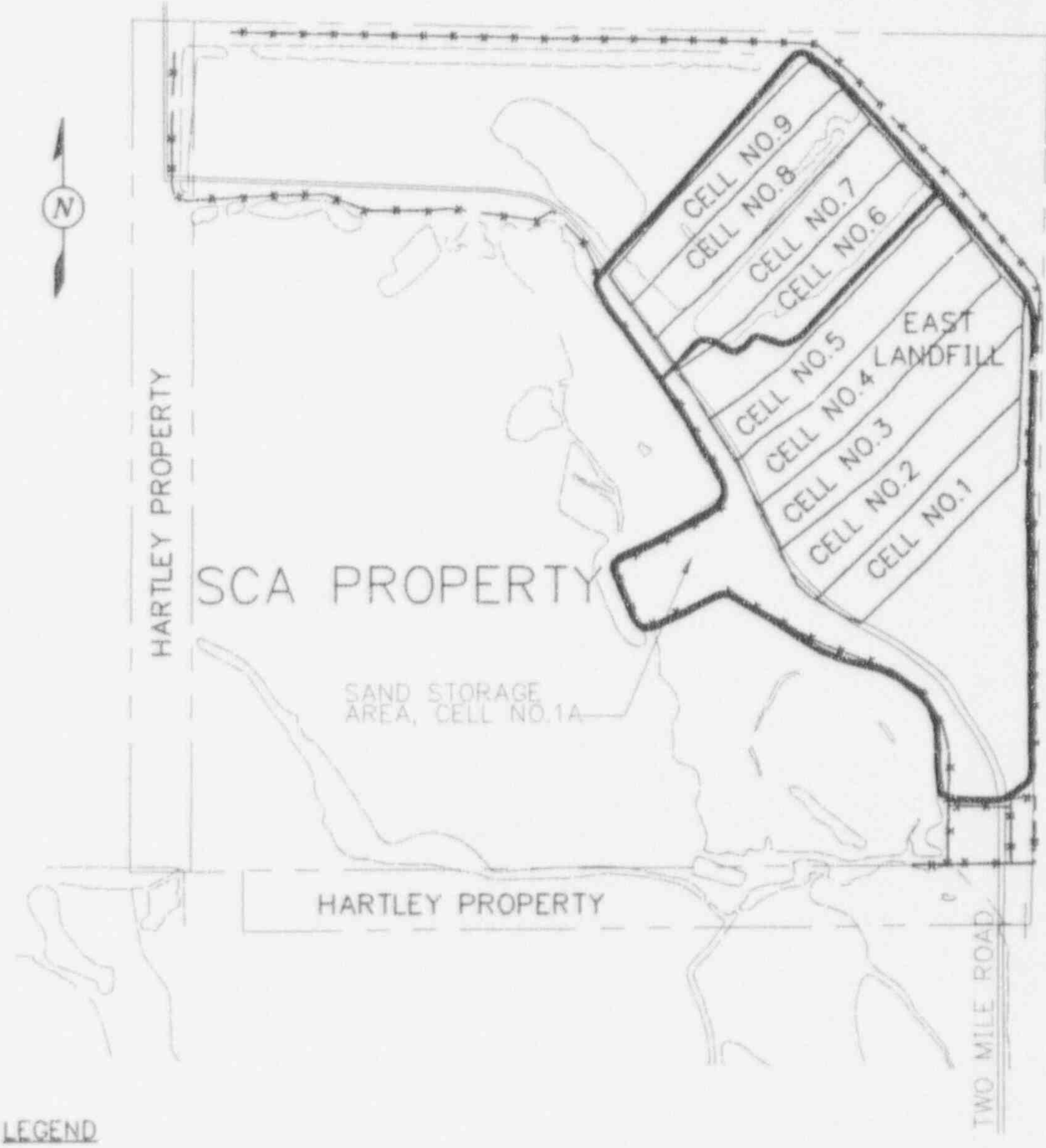
RUST ENVIRONMENT & INFRASTRUCTURE
NAPERVILLE ENVIRONMENTAL DIVISION

PROJECT NUMBER 42578 | DATE

RUST DWG NUMBER FIGURE 2-3 | REVISION

CLIENT DWG NUMBER | SHEET NUMBER

CAD FILE NAME: 2578F2-3
PLOT DATE: 06/23/94/AKW



LEGEND

—x—x—x—x—	FENCE
— — — —	PROPERTY LINE
▬▬▬▬	CLAY DIKE

RUST ENVIRONMENT & INFRASTRUCTURE NAPERVILLE ENVIRONMENTAL DIVISION	DRAWING TITLE: LANDFILL CELL DEVELOPMENT HARTLEY & HARTLEY LANDFILL BAY COUNTY, MICHIGAN
NOT TO SCALE	
DATE: 11/8/93 JOB NO. 42578 CAD FILE NO. 2578F2-6	FIGURE 2-4

- International Terminal, Inc.
- Jameson Corporation
- Jones Chemicals, Inc.
- Justice Trucking Company
- Kerkau Manufacturing Company
- Lakeway Chemicals, Inc.
- Laro Coal & Iron Company
- Lease Management, Inc.
- Lobdell-Emery Manufacturing Company
- Magline, Inc.
- Marathon Oil Company
- Michigan Bell
- Velsicol Chemical Corporation (Michicigan Chemical Corporation)
- Total Petroleum Corporation (Michigan Ohio-Pipeline Corporation)
- Monsanto (G.D. Searle)
- Nelson Chemicals Company
- Newcor, Inc.
- Nordco Drum, Inc.
- Northern Tube Div. - Questor Automotive Div.
- Organic Chemicals, Inc.
- Parke, Davis & Company
- Penn Central Transportation Company
- The Prestolite Company
- Procter & Gamble
- Ray Molder, Inc.
- Story Chemical Corporation
- Total Petroleum, Inc.
- U.S. Chemical Company, Inc.
- The Upjohn Company
- Wellman Dynamics Corporation
- Western Crude Oil, Inc.
- Wickes Corporation
- Wilson Engineering Division - The Allen Group, Inc.
- Basin Oil Company (The Wiser Oil Company)
- Wolverine Gas and Oil Company, Inc.

At the time the Site was in operation, it was standard practice to commingle industrial and municipal wastes. Foundry sand was used as cover material for both landfills. The majority of the foundry sand came from the Dow Chemical/Wellman Dynamics facility which produced magnesium-thorium alloy components. The foundry sand frequently contained slag, metal filings, and metal pieces, as well as general rubbish. Therefore, it is possible that the foundry sand contained some quantity of thorium. The waste treatment and disposal operations continued at the site until January 1979, when the facility was closed. In 1980, SCA and the MDNR entered into a Consent Order for Closure which required closure of the East Landfill and environmental monitoring. In 1984, SCA entered into an Amendment to the Consent Order for Closure in which SCA agreed to encapsulate the Northwest Landfill and the MDNR Landfill and to continue monitoring until the year 2015.

Aerial radiological surveys of two areas were conducted by EG&G for the U.S. NRC in 1980. The surveys were performed at the request of Michigan state agencies. The EG&G report (1981) indicated two locations within the Bay County area which merited further investigation: the MDNR property and the northwest corner of the SCA property. Analyses of samples of slag and metal pieces collected from the site and adjacent areas by U.S. NRC, U.S.EPA, MDNR, and MDPH confirmed the presence of thorium at concentrations above the range of background, which was determined to be less than about 1 picocurie per gram (pCi/g). Subsequent radiological surveys performed by Oak Ridge Associated Universities (ORAU) for the U.S. NRC in 1984 found thorium contamination at the Northwest Landfill, the MDNR Landfill, and on the northernmost portion of the Hartley property (ORAU, 1985a, 1985b, 1985c). The ORAU surveys consisted of surface gamma radiation surveys and sampling of slag, soil, sediment, surface water and groundwater. Thorium contamination was found to be limited to slag, soil, and sediment; there was no evidence of impact to surface water or groundwater.

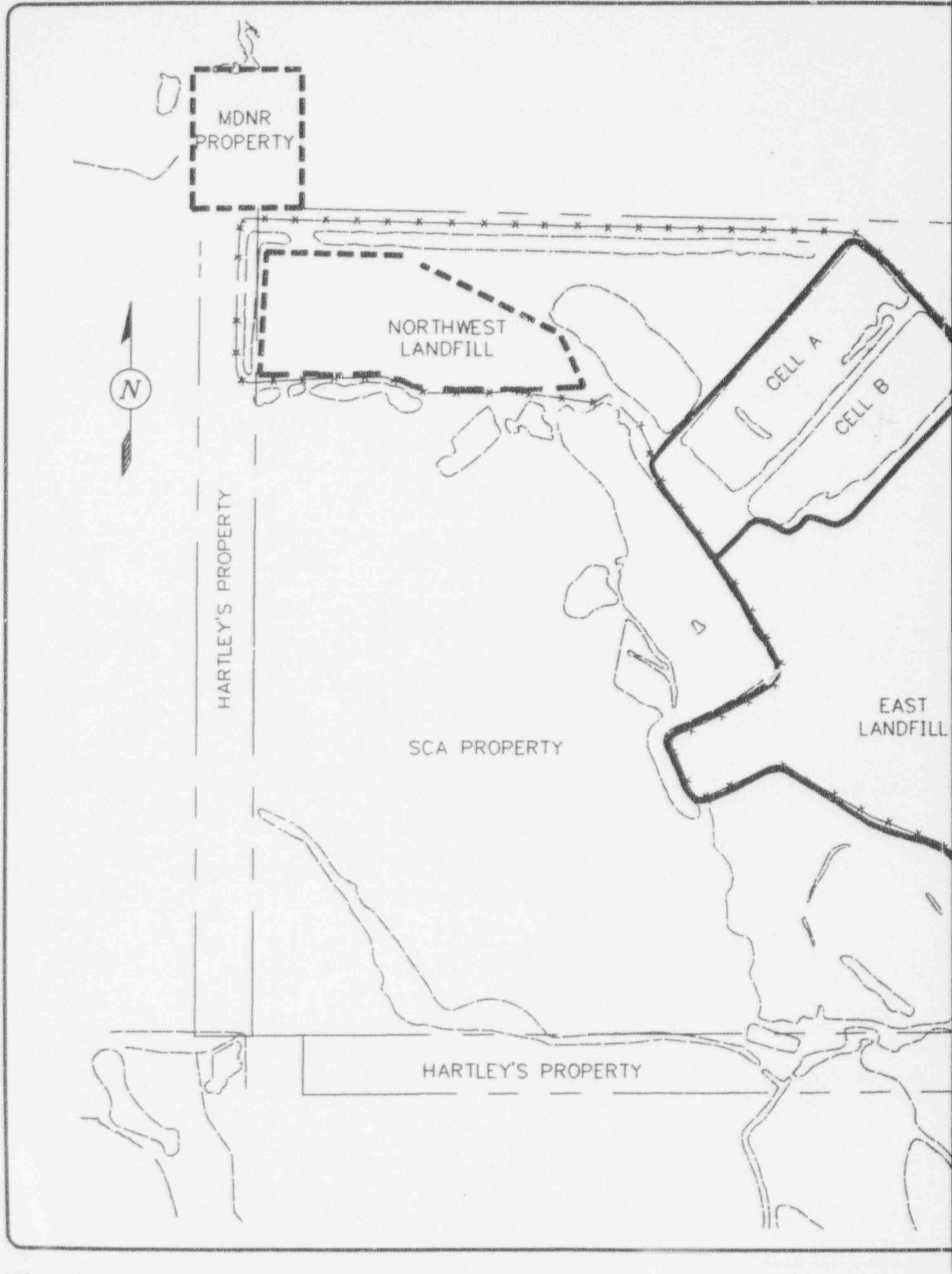
An examination of the EG&G report indicated that the gamma radiation measurements at the East landfill were also above background. In June 1992, RUST collected leachate from three sampling locations in the Northwest Landfill and from four sampling locations in the East Landfill. In December 1992, RUST conducted a surface gamma survey of both landfills. The results of the leachate sampling and surface gamma survey, coupled with the knowledge that foundry sand from Dow Chemical/Wellman Dynamics was used for daily cover, strongly suggest that thorium is buried in the East Landfill as well as the Northwest Landfill. It is also known that two companies whose wastes were accepted by Hartley and Hartley possessed U.S. NRC licenses for radioactive material during the relevant time period, Dow Chemical and Wellman Dynamics.

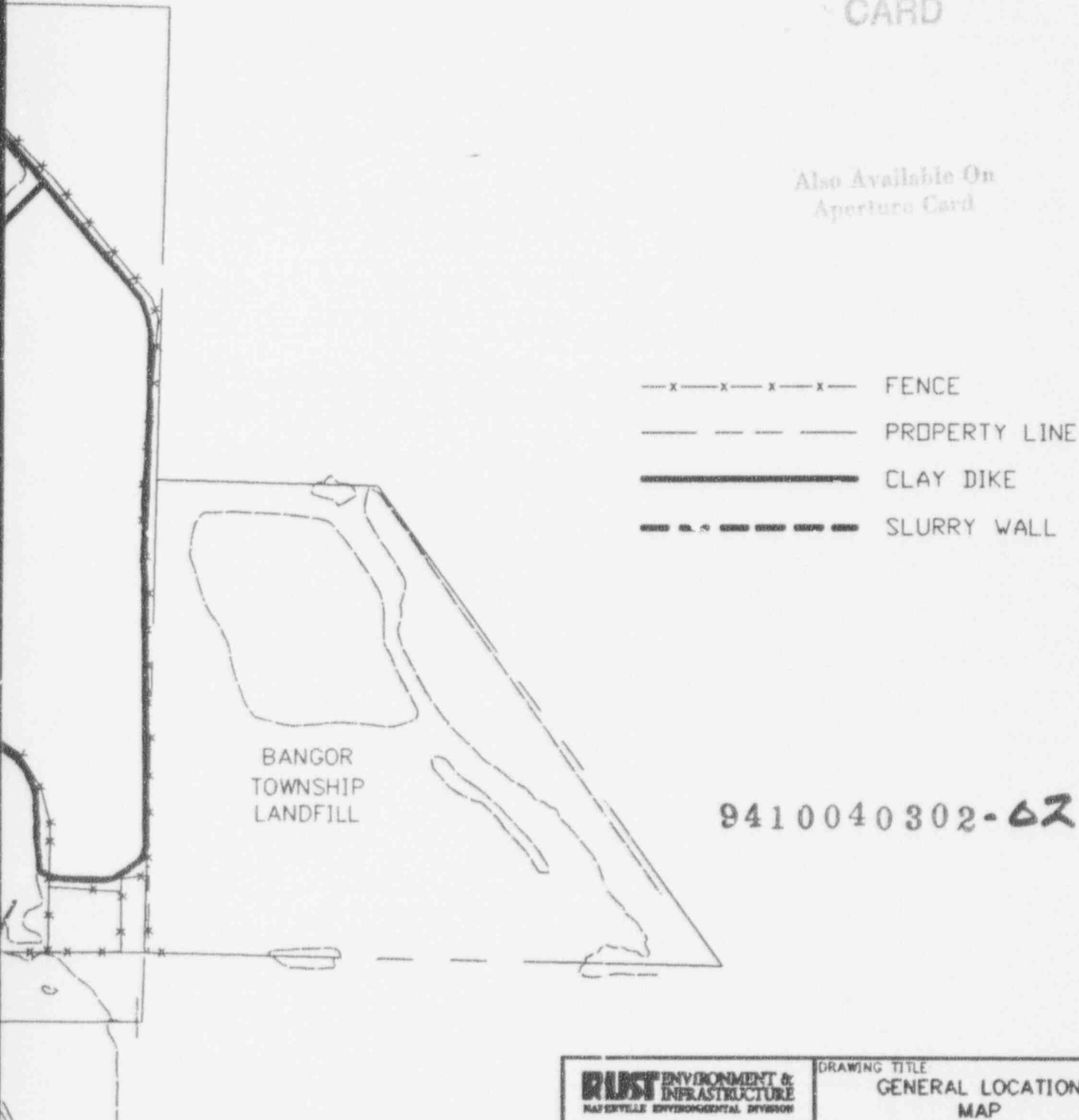
2.2.3 Bangor Township Landfill

The Bangor Township Landfill is located immediately east of the Site as shown in Figure 2-5. The landfill was issued a permit to receive municipal waste in 1967. The waste buried at the facility is situated in two areas. Approximately 15,000 tires were buried along the western boundary. MDNR records indicate that some of the wastes disposed at the landfill include general municipal waste, construction waste, and sewage sludge. Leaking barrels of petroleum-based substances were noted at the site in the Work Plan for Final Closure of Bangor Township Landfill dated August 2, 1989. SCA never owned, operated, or transported any material to the Bangor Township Landfill.

During the 1970s, an extensive construction program was initiated by the Township to meet the requirements of the Solid Waste Management Act 87 enacted by the MDNR in 1975. As part of this program, a clay dike was constructed around the perimeter of the landfill. Operations at the landfill over the following years reportedly resulted in refuse being buried outside the dike limits in the southern area of the site.

Bangor Township Landfill was repeatedly found to be out of compliance with state regulations during its operation. Repeated violations included lack of updated landfill plans, surface water drainage problems, and lack of cover and odor control. This continued up until its closure by MDNR order on January 4, 1986.


MDNR
PROPERTY
NORTHWEST
LANDFILL
CELL A
CELL B
N
HARTLEY'S PROPERTY
EAST
LANDFILL
SCA PROPERTY
HARTLEY'S PROPERTY



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RUST ENVIRONMENT & INFRASTRUCTURE
NAPERVILLE ENVIRONMENTAL DIVISION

DRAWING TITLE
GENERAL LOCATION
MAP
BANGOR TOWNSHIP LANDFILL
BAY COUNTY, MICHIGAN

DATE 11/5/93 JOB NO 42578
CAD FILE NO 2578GLM

FIGURE 2-5

A site investigation was conducted by Terracon Consultants EC, Inc. for MDNR to provide information regarding subsurface geology, groundwater flow direction, and groundwater quality. Eight monitoring wells were installed during October 1986 to depths of 15 feet around the perimeter of the landfill, and were subsequently. sampled on January 9, 1987 (Figure 2-6). The results of the hydrogeologic investigation indicate the presence of contaminants in three monitoring wells located on the southwestern portion of the Bangor Township Landfill site. Groundwater flow in these wells is to the southwest through the near-surface sandy soils.

In 1986, Bangor Township Landfill stopped accepting waste. The landfill's application for a landfill/dump closure grant was selected for funding through the 1988-1989 Clean Michigan Fund. A work plan was prepared to close the Bangor Township Landfill, based on Act 641 requirements.

Final closure construction plans included installing a leachate collection system, cap and cap extension, topsoil, seeding, gas vents, and site grading. Following closure, groundwater monitoring wells were to be sampled quarterly for two years, then semi-annually for 28 years. Quarterly sampling commenced on June 20, 1989. Organic compounds were detected in MW-1 and MW-2. MW-8 was not sampled during this event. Final closure was completed in 1991. A subsequent round (July 1992) of groundwater sampling detected organic compounds in wells MW-1, MW-2, and MW-8. The contaminants that have been detected in the groundwater monitoring program to date are:

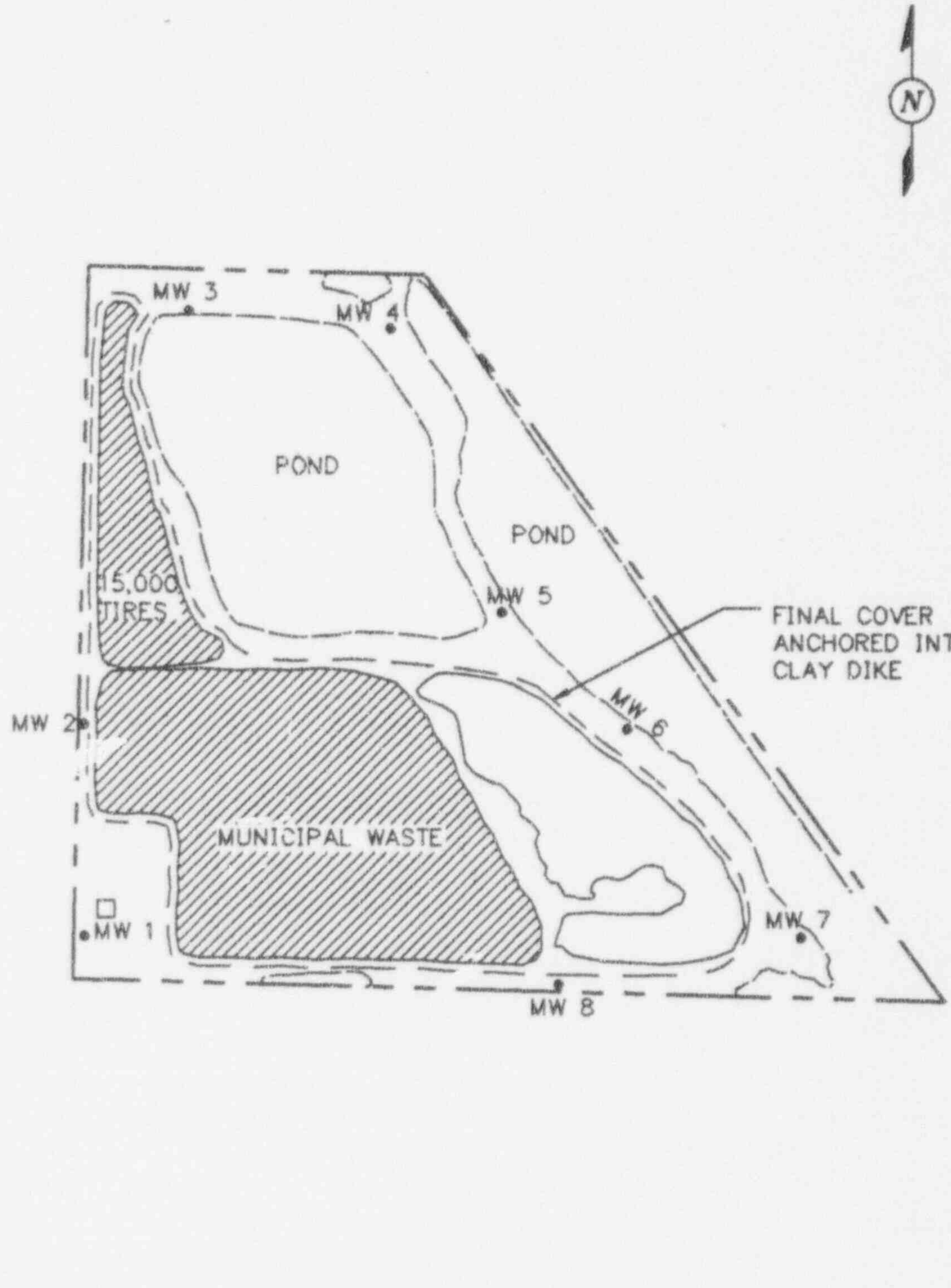
arsenic	chlorides	lead
benzene	chlorobenzene	chloroethane
1,1-dichloroethane	ethylbenzene	toluene
1,2-dichloroethene	1,1,1-trichloroethane	

2.2.4 MDNR Landfill

The MDNR Landfill is an encapsulated area on state-owned property located adjacent to the northwest corner of the Site (see Figure 2-5). Previous investigations and historical records indicate that the landfill contains solvent wastes, drums, drum fragments, and magnesium-thorium slag. The MDNR Landfill is called the "Hartley and Hartley Landfill Site" in a Remedial Investigation Report prepared for the MDNR by E.C. Jordan Co., dated December 1986. Other documents refer to it as the "State-owned portion of the Hartley and Hartley Landfill Site."

2.2.4.1 Summary of the Remedial Investigation of the MDNR Landfill

MDNR contracted E.C. Jordan Company to conduct an RI to determine the nature and extent of contamination outside the MDNR Landfill. The RI was conducted from November 1985 to August 1986. The scope of the RI included:



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NAPERVILLE ENVIRONMENTAL DIVISION

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DATE: 11/8/93 JOB NO: 42578
CAD FILE NO: 2578GLMB

DRAWING TITLE:
GENERAL LAYOUT MAP
BANGOR TOWNSHIP LANDFILL
BAY COUNTY, MICHIGAN

FIGURE 2-6

- one magnetometer survey
- one terrain conductivity survey
- two deep soil borings (advanced to 50 feet below ground surface) and three shallow soil borings (new monitoring wells)
- sixteen soil samples from borings
- six monitoring wells (three existing, three new)
- six groundwater samples from monitoring wells (one round of sampling)
- eighty-one groundwater samples for field screening
- two surface water samples
- two sediment samples

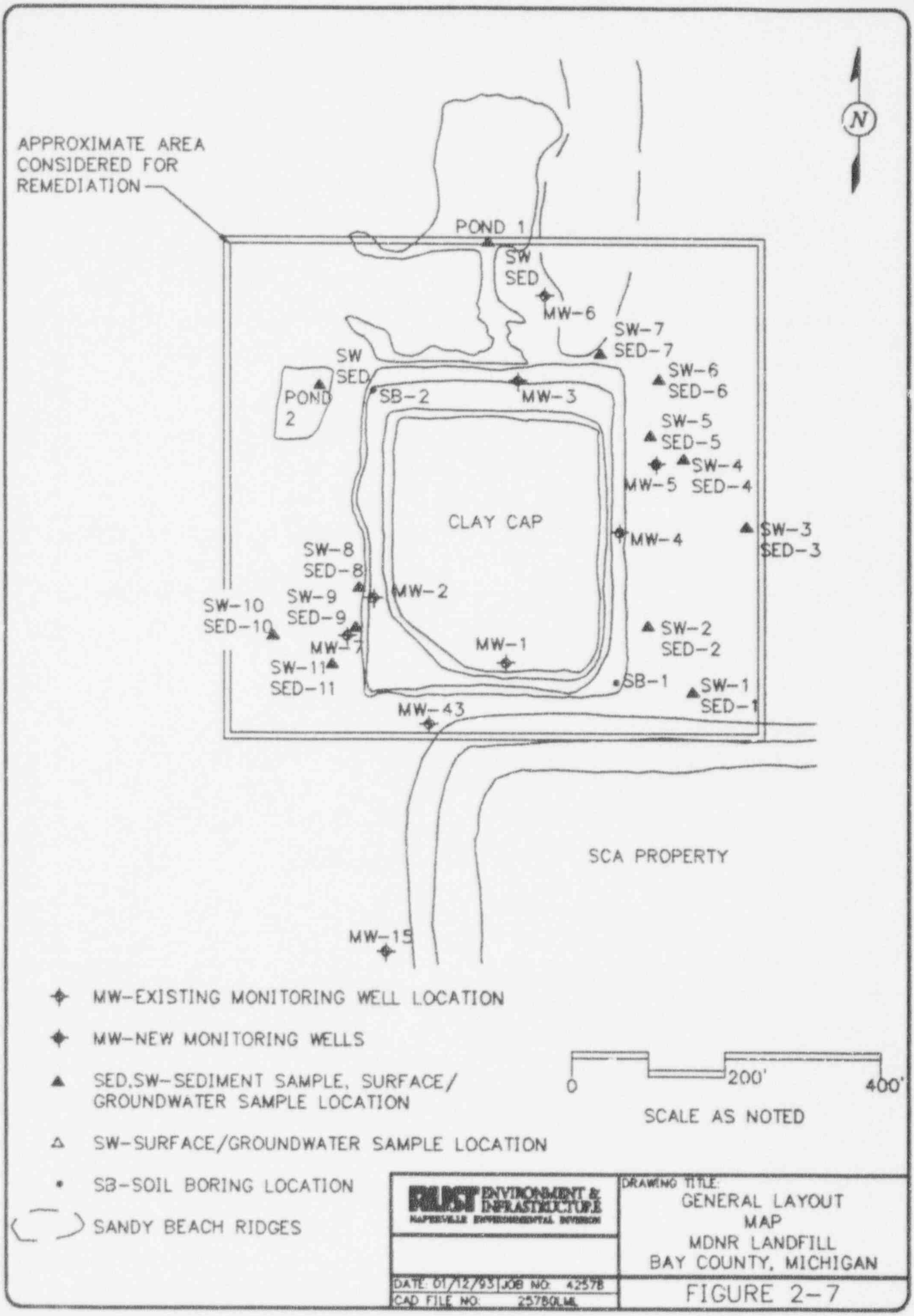
Figure 2-7 shows the sampling locations. The investigation found chromium levels above background in soil and sediment in a limited area east of the capped landfill outside of the containment. Relatively low levels of acetone, xylene, di-n-butyl phthalate and bis (2-ethylhexyl) phthalate were also found in soil and sediment samples (outside of the containment). Some metals were detected in the groundwater and surface water samples, but all were below the Maximum Contaminant Levels (MCLs). Some volatile organics were detected above MCLs but no semivolatile organics were detected in the water samples. The contaminants that have been detected during the RI for the MDNR Landfill are:

chlorides	chromium	lead
acetone	benzene	1,2-dichloroethane
trans-1,2-dichloroethene	ethylbenzene	Methylene chloride
tetrachloroethene	trichloroethene	toluene
vinyl chloride	xylenes	di-n-butylphthalate
naphthalene	bis-(2-ethyl hexyl) phthalate	

A qualitative risk assessment performed by E.C. Jordan concluded that direct contact with contaminated soil was the most significant exposure route and that the potential health risks and environmental risks were insignificant.

The major conclusions of the MDNR's RI are:

- The impermeable glacial till is at least 50 feet thick.
- Local groundwater and surface water are not suitable for potable use; therefore, exposure to contaminated groundwater or surface water is insignificant.
- Inhalation exposure is not significant.
- Direct contact with contaminated soil or sediment is insignificant.
- The area surrounding the MDNR landfill does not present a significant risk to human health or the environment.



APPROXIMATE AREA
CONSIDERED FOR
REMEDIATION
N
POND 1
SW
SED
MW-6
SW-7
SED-7
SW
SED
POND 2
SB-2
MW-3
SW-6
SED-6
SW-5
SED-5
SW-4
SED-4
MW-5
CLAY CAP
MW-4
SW-3
SED-3
SW-8
SED-8
MW-2
SW-9
SED-9
SW-10
SED-10
MW-7
SW-11
SED-11
MW-1
SW-2
SED-2
SB-1
SW-1
SED-1
MW-43
SCA PROPERTY
MW-15
MW-EXISTING MONITORING WELL LOCATION
MW-NEW MONITORING WELLS
SED,SW-SEDIMENT SAMPLE, SURFACE/
GROUNDWATER SAMPLE LOCATION
SW-SURFACE/GROUNDWATER SAMPLE LOCATION
SB-SOIL BORING LOCATION
SANDY BEACH RIDGES
0
200'
400'
SCALE AS NOTED
RUST ENVIRONMENT & INFRASTRUCTURE
NAPERVILLE ENVIRONMENTAL DIVISION
DRAWING TITLE:
GENERAL LAYOUT
MAP
MDNR LANDFILL
BAY COUNTY, MICHIGAN
DATE: 01/12/93
JOB NO: 42578
CAD FILE NO: 25780LML
FIGURE 2-7

2.2.4.2 Summary of the Feasibility Study for the MDNR Landfill

MDNR contracted GZA/Donohue to conduct an FS during 1987. The purpose of the FS was to evaluate remedial measures for contaminant sources identified in the RI. The FS concluded that the encapsulation of the landfill area was effective. Based on a detailed evaluation of the remedial alternatives, the following measures were recommended:

- Repair the existing cap.
- Restrict site access.
- Expand the groundwater monitoring program.

The FS was issued on November 2, 1987.

2.3 CONTAINMENT ACTIONS

While the Site was in operation, several engineering controls were implemented to contain the landfilled wastes. Additional engineering controls were implemented following site closure. This section describes the containment actions implemented at the Site. Both landfills are encapsulated with subsurface vertical barriers and soil covers. The function of a vertical barrier is to isolate the waste material from surface or ground water. The functions of a soil cover are to prevent direct contact with waste materials and to reduce infiltration of precipitation. Because the vertical barriers are less permeable than the soil covers, leachate has accumulated in both landfills.

2.3.1 East Landfill

The East Landfill is completely encapsulated by a subsurface vertical barrier (clay dike) and a soil cover (clay cap). This closure activity was conducted in accordance with MDNR and MDPH requirements prior to the 1980 Consent Order. The integrity of the closure was verified by Dell Engineering and is documented in their 1990 reports.

2.3.1.1 Clay Dike

The original clay dike which encircles the perimeter of the East Landfill was constructed during the period 1971-1979, as summarized in Figure 2-8. At the request of MDNR, SCA conducted a hydrogeologic and geotechnical investigation in 1978 to establish if the clay dike adequately isolated the landfill from surface water and groundwater resources. The study was conducted by Wehran Engineering and was documented in their report Hydrogeologic Investigation and Closure Certification (1979). Test pits were excavated at 500 foot intervals to evaluate the degree to which the clay dike was keyed into the underlying glacial till. In addition, undisturbed samples were obtained at 1,000 foot intervals for hydraulic conductivity testing. Two sections of the clay dike were found to be inadequately keyed-in. These sections were rebuilt and subsequently retested. The Wehran Engineering report concluded that the clay dike is properly keyed into the glacial till, and therefore, isolates the landfill from surface water and groundwater resources.

TP21
TP22
TP4
TP5
TP6
TP20
N
TP44
UD-5
TP16
HARTLEY PROPERTY
SCA PROPERTY
TP88
HARTLEY PROPERTY

ANSTEC
APERTURE
CARD

Also Available On
Aperture Card

LEGEND

FENCE

PROPERTY LINE

TP36 TEST PIT
UD-1 UNDISTURBED SHELBY TUBE SAMPLE

CLAY DIKE RECONSTRUCTED OCTOBER 1978–JULY 1979

CLAY DIKE RECONSTRUCTED JULY-1979

CLAY DIKE CONSTRUCTED IN 1979

CLAY DIKE CONSTRUCTED IN 1977

DATE CLAY DIKE CONSTRUCTED NOT CONFIRMED

RUST ENVIRONMENT & INFRASTRUCTURE NAPERVILLE ENVIRONMENTAL DIVISION	DRAWING TITLE: CLAY DIKE CONSTRUCTION
NOT TO SCALE	HARTLEY & HARTLEY LANDFILL BAY COUNTY, MICHIGAN
DATE: 11/5/93 JOB NO: 42578 CAD FILE NO: 2578F2-8	FIGURE 2-8

9410040302-63

2.3.1.2 Clay Cap

Once the final grades of the East Landfill were reached, a two foot thick clay cap was constructed over the waste to minimize leachate generation. An inspection report by Caden and Thorson dated June 8, 1978 states that, "Cells 1-4 slopes seeded and covered with final clay cover." An inspection report prepared by Art Caden, MDNR, dated January 3, 1979, states that, "Cell No. 5 has been capped but the depth of cover is unknown." Later inspection reports prepared by the MDNR in August 1979 state that 20 to 24 inches of compacted clay had been placed over Cells No. 1 through No. 5.

Edmands Engineering Inc. was hired to verify the depth of the compacted clay cover over the East Landfill by randomly checking the depth of clay at various locations. The results of their survey are documented in two letters to Mr. Dale Dille, District Manager. The first letter, dated August 30, 1979, states that the survey was performed August 29, 1979, under MDNR guidance. The letter also states, "It was found that the final cover has a range of 13 to 108 inches with the average depth being 42+ inches." The letter also says that a portion of the northern part of Cell No. 5 "...lacks the required minimum of 2 feet of final cover." The second letter, dated September 25, 1979, states that additional cover had been placed over the northern half of Cell No. 5. Six pits were excavated to check the depth of the clay cover. Waste was not encountered at a depth less than 24 inches in any of the pits. Information from the 1993 temporary site restoration field work shows that the existing topsoil cover, in areas of leachate seeps, consisted of silty sand.

2.3.2 Northwest Landfill

In accordance with the original November 1980 Consent Order with the MDNR, routine groundwater monitoring was conducted at the Site. In March 1982, the MDNR requested that the frequency of the monitoring in the northwest corner of the Site be increased due to the presence of elevated levels of volatile organics found in the monitoring wells. The additional monitoring verified the presence of volatile organics and a site investigation of the northwest corner was initiated in February 1982. A magnetometer survey was performed over the northwest corner of the Site in February 1983. The survey verified the existence of significant quantities of buried metal drums or drum fragments. In order to remediate the northwest corner of the Site, it was decided that a slurry wall and clay cap would be installed to contain the waste materials.

2.3.2.1 Slurry Wall Construction

Ground/Water Technology, Inc. was contracted to design and construct the slurry wall for the SCA and state-owned properties. The perimeter of the slurry wall was established based on the magnetometer survey prepared by GeoEngineering, Inc. Prior to constructing the slurry wall, 28 borings were drilled along the proposed slurry wall alignment in July 1984. The boring logs were used to determine the depth of the slurry wall. The slurry wall was to penetrate (key) into the existing glacial till a minimum of two feet. The slurry wall was designed to have a three-foot width. In order to achieve an adequate permeability, the slurry wall material consisted of 2.5 to 3 percent bentonite mixed with clay. Laboratory tests determined the hydraulic conductivity of the slurry to be approximately 10^{-8} cm/sec. Construction of the slurry wall began in July 1984 and was completed in August 1984.

The slurry wall construction was documented and certified by Ground/Water Technology, Inc. Three shelby tube samples were collected from the completed slurry wall. Hydraulic conductivity tests were performed on the samples and the results indicated an in-place hydraulic conductivity of less than 10^{-7} cm/sec. The documentation and certification have been compiled into a report titled Closure Certifications, Slurry Wall, Cap and Monitoring Systems, Hartley & Hartley Landfill and State of Michigan DNR Site, Kawkawlin, MI, February 16, 1985. The appendix of the report includes soil boring logs, bentonite certifications, hydraulic conductivity testing results, daily progress reports, and as-built drawings.

2.3.2.2 Clay Cap

A two-foot thick clay cap was constructed over the area enclosed by the slurry wall. Prior to installing the cap, general fill was brought to the Site and graded so that water would drain properly off the cap. The clay cap was also covered with topsoil and seeded. On August 28, 1984, Ground/Water Technology inspected the cap and found it to be in compliance with the specifications. Construction of the cap is also documented in the closure certification report prepared by Ground/Water Technology, Inc.

2.4 CURRENT CONDITIONS AND INTERIM RESPONSE ACTIVITIES

Dell Engineering, Inc. analyzed the performance of the clay dike, slurry wall, and clay caps in September 1988. Subsurface investigations included drilling four soil borings into the clay dike, drilling three soil borings into the slurry wall, and collecting three shelby tube samples from each of the landfill caps. Two Shelby tube samples were also collected from each of the soil borings.

Hydraulic conductivity tests were performed on all of the Shelby tube samples taken from the slurry wall, clay dike, and clay caps and reported in the Site Closure Integrity Investigation, Dell Engineering, Inc., March 1990. The average hydraulic conductivity for each area is presented in Table 2-2. The Dell report concluded that all of the containment structures were meeting or exceeding regulatory requirements.

TABLE 2-2
HYDRAULIC CONDUCTIVITIES
FROM DELL ENGINEERING SEPTEMBER 1978 INVESTIGATION

Area	Average Hydraulic Conductivity (cm/s)
East Landfill	
Clay Dike	2.21×10^{-8}
Clay Cap	6.85×10^{-8}
Northwest Landfill	
Slurry Wall	1.67×10^{-8}
Clay Cap	2.81×10^{-7}

Groundwater monitoring wells and piezometers installed both inside and outside of the encapsulated areas on the Site indicate that leachate has built up inside the capped areas and recent water level measurements show significant head differences in some areas. These head differences have resulted in sporadic leachate outbreaks around the East Landfill. In addition, surface runoff from precipitation caused erosion of the clay cap in some areas of the East Landfill. The accumulation of leachate in both landfills is a further testimonial to the integrity of the landfill closures.

The MDNR has installed a leachate transmission pipeline that runs across the Site in a southeastern direction from the state-owned parcel located immediately north of the Northwest Landfill. A berm, constructed around the pipeline to prevent freezing, has altered the drainage pattern of the Site.

The only structure that remains on site is the former Site office and laboratory building. The area around the landfills is contained within a six-foot high chain link fence topped with three strands of barbed wire. There are locked gates near the entrance to the Site and near the monitoring wells.

Two separate interim response activities will take place at the Site during the RI phase. These activities include (1) temporary site restoration and (2) design and construction of a leachate management system. These activities will be performed to address landfill leachate which has accumulated inside of the landfills. The temporary site restoration activity, which is performed on an as-needed basis, consists of fence repairs, erosion control and repair, and capping of leachate seeps. The leachate management system will extract leachate from both landfills, treat the leachate so that it meets the local wastewater treatment plant's requirements, and discharge the effluent to the sanitary sewer. The objective of the leachate management system is to reduce the leachate elevation to the point that an inward hydraulic gradient is created.

2.5 PHYSICAL SETTING

2.5.1 Physiographic Location

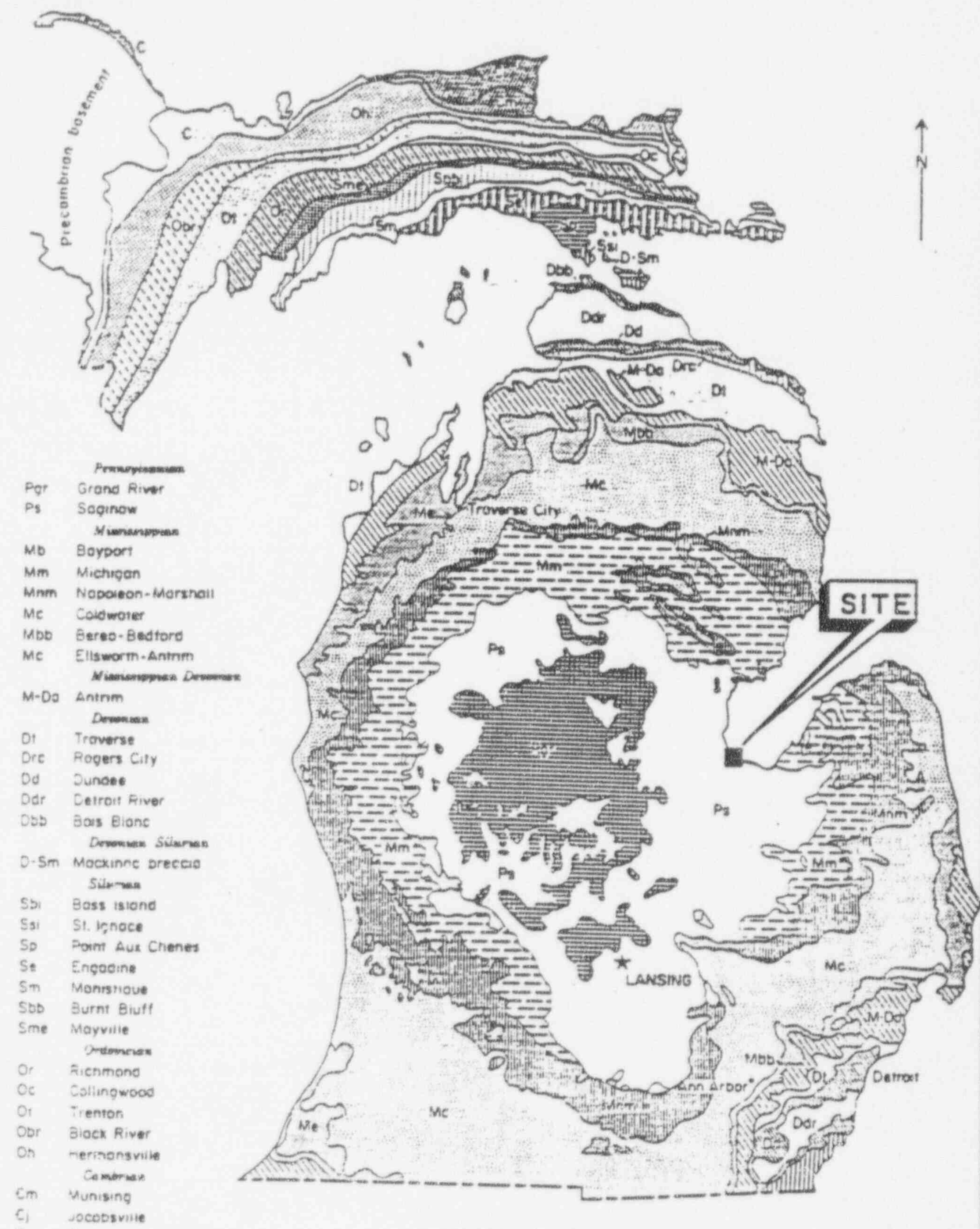
The Site is situated in the low-lying glacial lake area of the Saginaw lowlands, a subdivision of the Central Lowland Physiographic Province (Rheame, 1992). The province is characterized by low-yielding, glacial lake plains of variable thickness that overlie sandstone aquifers of Pennsylvanian and Mississippian age. The regional topography consists of flat and featureless lacustrine sand and clay. Elevations range from about 580 feet above mean sea level (MSL) along Saginaw Bay to just above 700 feet MSL in the areas of Midland and Saginaw counties further inland. Surface drainage in the region is directed toward Saginaw Bay and is dominated by the Saginaw River system which is fed by four major tributaries: the Tittabawassee, Shiawassee, Flint, and Cass rivers. A large percentage of the land is developed. The 100-year flood plain in the area includes all areas with elevations of 586 feet MSL or less.

The Site is at an approximate elevation of 585 feet above MSL. Surface relief over the Site ranges from a few feet over most of the Site to 38 feet in the southeastern portion where landfilling operations have brought final grades up to approximately 622 feet above MSL. A majority of the Site topography has been altered by filling or excavating operations. Surface water drainage at the Site is predominantly to the east-southeast toward the Kawkawlin River located approximately two miles to the southeast. Runoff from the Site is carried to the river via a ditch known as the Indian Town Drain which empties into the Kawkawlin River.

2.5.2 Regional Geology

The regional bedrock geology in the area is characterized by the early Pennsylvanian Saginaw Formation composed of shale, shaley limestone, and sandstone along with interbedded coal deposits and the Mississippian Marshall Sandstone (see Figure 2-9). The depth to bedrock in the region ranges from 50 to 100 feet. The region lies on the northeastern flank of the Michigan Basin. No structural faults are present in the area of the Site that have been active since Holocene time.

The bedrock in the area is overlain by ancient glacial lake and till deposits laid down during the Wisconsinan Glacial Period of the Pleistocene Epoch. The soils surrounding Saginaw Bay are dominated by lake sediments deposited during the Pleistocene through recent times. During the Pleistocene Epoch, thousands of feet of ice covered the Saginaw Bay area. As the ice retreated, melt waters from the ice formed proglacial lakes along the receding ice front. The first lake known to have covered the area was Lake Arkona which had a maximum surface elevation of 710 feet above MSL. Several other lakes formed over the same general region as the ice moved back and forth over the area. The glacial lakes and corresponding ice sheet were responsible for depositing thick sequences of lake sediments and glacial till that currently underlie surface deposits in the area. Lake Nipissing, which attained a surface elevation of 605 feet above MSL, was the last glacial lake to cover the region. As Lake Nipissing receded to become Lake Huron, it left behind a thin veneer of beach deposits laid down over the clayey glacial till. Lake Huron, which is presently at an elevation of 579 feet above MSL, has been responsible for reworking and depositing the very clean, medium-grained quartz sands which now occupy the area. Parallel beach ridges or strandlines have formed along Lake Huron during temporary pauses in the



NOTE: TAKEN FROM DORR, J.H. 1970, p 135.

RUST ENVIRONMENT & INFRASTRUCTURE
NAPERVILLE ENVIRONMENTAL DIVISION

50 MILES

DATE: 10/18/93 JOB NO: 42578

CAD FILE NO: 2578F2-9

DRAWING TITLE:
REGIONAL BEDROCK GEOLOGIC MAP OF MICHIGAN
HARTLEY & HARTLEY LANDFILL
BAY COUNTY, MICHIGAN

FIGURE 2-9

waning of the lake. Since the recession of Lake Huron, peat and organic soils have developed in low lying or poorly drained areas between the former beach ridges. Dunes have formed in areas where the beach sands have been subsequently reworked by wind processes.

2.5.3 Regional Hydrogeology

The groundwater resources in the region are typically characterized by either low yield or poor water quality (Michigan Water Resources Commission, 1968). The surface sandy and/or silty ancient beach deposits and the underlying Pennsylvanian and Mississippian bedrock formations are the two aquifers in the region that yield a majority of the local ground-water resources. Wells screened in the glacial deposits usually yield less than 10 gallons per minute (gpm), while those screened into bedrock can produce from 50 to 500 gpm. Fresh water is not available in many areas surrounding Saginaw Bay because the glacial drift is thin and the underlying bedrock aquifer contains highly mineralized water that is too saline for domestic or public supplies. The water resources for most of the communities in the region are obtained from Lake Huron. Many of the near-shore communities draw water directly from Saginaw Bay. Most cities further inland have connected to the extensive Saginaw-Midland water supply system that draws approximately 200 million gallons per day from the bay.

Groundwater recharge in the region is limited due to the low permeability of the glacial lake bed deposits. Groundwater recharge ranges from two inches per year in the flat, low- lying areas covered by the lacustrine clay and silt near Saginaw Bay to five inches per year in the fine to medium sands of the former glacial lake beaches in western Midland and Saginaw Counties (Michigan Water Resources Commission, 1960).

Groundwater in the uppermost aquifer in the area is generally in direct hydraulic connection with surface water. Groundwater flow in the area is highly dependent upon surface water flow direction, and will vary with changes in the configuration, depth, and stage levels of the surrounding surface water bodies. Surface water bodies located in the area that affect regional groundwater conditions include Saginaw Bay, Tobico Marsh, Saginaw River, and Kawkawlin River.

2.5.4 Site Geology

Data obtained from past field investigation activities (i.e., test pit excavation, soil boring installation, piezometer installation, and monitoring well installation) have been compiled in order to characterize the geology of the Site.

Bedrock in the area consists of limestones, shales, and sandstones of the Pennsylvanian Saginaw Formation. An oil well log from a well drilled on the Site indicates that bedrock occurs at a depth of 122 feet. Most of the soil borings and test pits were completed in glacial till and lacustrine deposits which directly overlie the bedrock below the Site. The combined glacial till and interbedded lacustrine deposits are over 50 feet thick. Boring log descriptions indicate that the till is composed of an unsorted heterogeneous mixture of clay, silt, sand, and gravel with occasional cobbles. The glacial till is commonly described as a clay and silt with medium to fine sand and trace fine gravel, and appears to be rather consistent in composition across the Site. Lacustrine deposits consisting of indistinctly laminated clay with fine to coarse sand and trace gravel are occasionally interbedded within the glacial till layer. The glacial till upon which the waste materials set is a relatively impermeable stratum with hydraulic conductivities typically in the range of 10^{-8} cm/s (Wehren Engineering, 1977).

The surrounding natural surface soils consist primarily of Pipestone and Belleville series soils which are typically poor draining, rapidly permeable soils found on low knolls, drainage ways and depressions on former lake plain deposits (Weesies, 1980). These soils are typically glaciofluvial deposits. In the Unified Soil Classification System, the soil classes present include poorly graded sands (SP), silty sands (SM), inorganic clays of low to medium plasticity (CL), organic silts (OL), and inorganic clays of high plasticity. The surface soils are underlain by glacial till.

The sandy soils at the site range from 0 to 15 feet thick and consist of very clean, well-sorted, quartz sand deposited as ancient beaches and beach ridges during the recession of Saginaw Bay and Lake Huron. Based on grain size, the permeability of the sand is estimated to range from 10^{-2} to 10^{-3} cm/sec. The sand layer covers all portions of the Site, except where it has been removed due to landfilling operations. The Site is surrounded by a series of nearly parallel strandlines, or beach ridges consisting of increased thicknesses of well-sorted beach sand. The largest of the existing ridges exceeds 15 feet while the intervening troughs are typically only 3 to 4 feet thick.

In most physically undisturbed areas of the Site, the sand layer is covered by a thin layer of topsoil. In the areas of the Site that are low-lying and wet, the topsoil is typically black, highly organic and soft. The topsoil attains thicknesses of up to 1.25 feet. Peat is commonly found below the topsoil in low-lying, poorly drained areas. The peat typically consists of very permeable, red-brown, very soft, saturated fibrous material often containing decomposed remains of tree limbs and trunks. The peat ranges from 0 to 3.5 feet thick and commonly occurs as localized "islands" filling natural depressions in the topography. A thin veneer (3 to 6 inches) of topsoil has developed in areas of higher relief above the well-drained beach sands.

As described in Section 2.3, a majority of the Site geology has been altered by excavation and landfilling operations. Several dikes and disposal cells have been constructed throughout the history of the Site, and some of these areas have since been filled or left open to accumulate ponded surface water. The East Landfill area which was permitted for sanitary waste contains approximately 40 feet of fill material. The fill area in the northwest corner of the Site that was used for drum storage and liquid disposal contains an unknown amount of fill material.

2.5.5 Site Hydrogeology

The hydrologic conditions at the Site have been altered by the landfill construction and engineering controls which have been implemented to encapsulate both landfills. The clay and slurry walls have significantly affected the natural flow of groundwater around the Site. Groundwater monitoring wells and piezometers that were installed both inside and outside of the encapsulated areas indicate that leachate has built up inside the capped areas. Recent water level measurements taken both inside and outside of the Northwest Landfill have shown head differences of from 0.45 to 3.35 feet above the surrounding ground water level while head differences between the inside and outside of the East Landfill have shown head differences of up to 9 feet above the surrounding ground water level. Flow direction is radially outward from the landfills. Head differences seen in piezometers located inside of either landfill suggest that leachate is contained within the subsurface barriers and that the potential for release into surrounding groundwater is small.

Figure 2-10 illustrates the surface water bodies at and near the Site today. The surface water on-site generally flows toward the Indian Town Drain which flows to the Kawkawlin River and then to Saginaw Bay of Lake Huron. The landfill areas at the Site are surrounded by shallow cattail marshes and ponds.

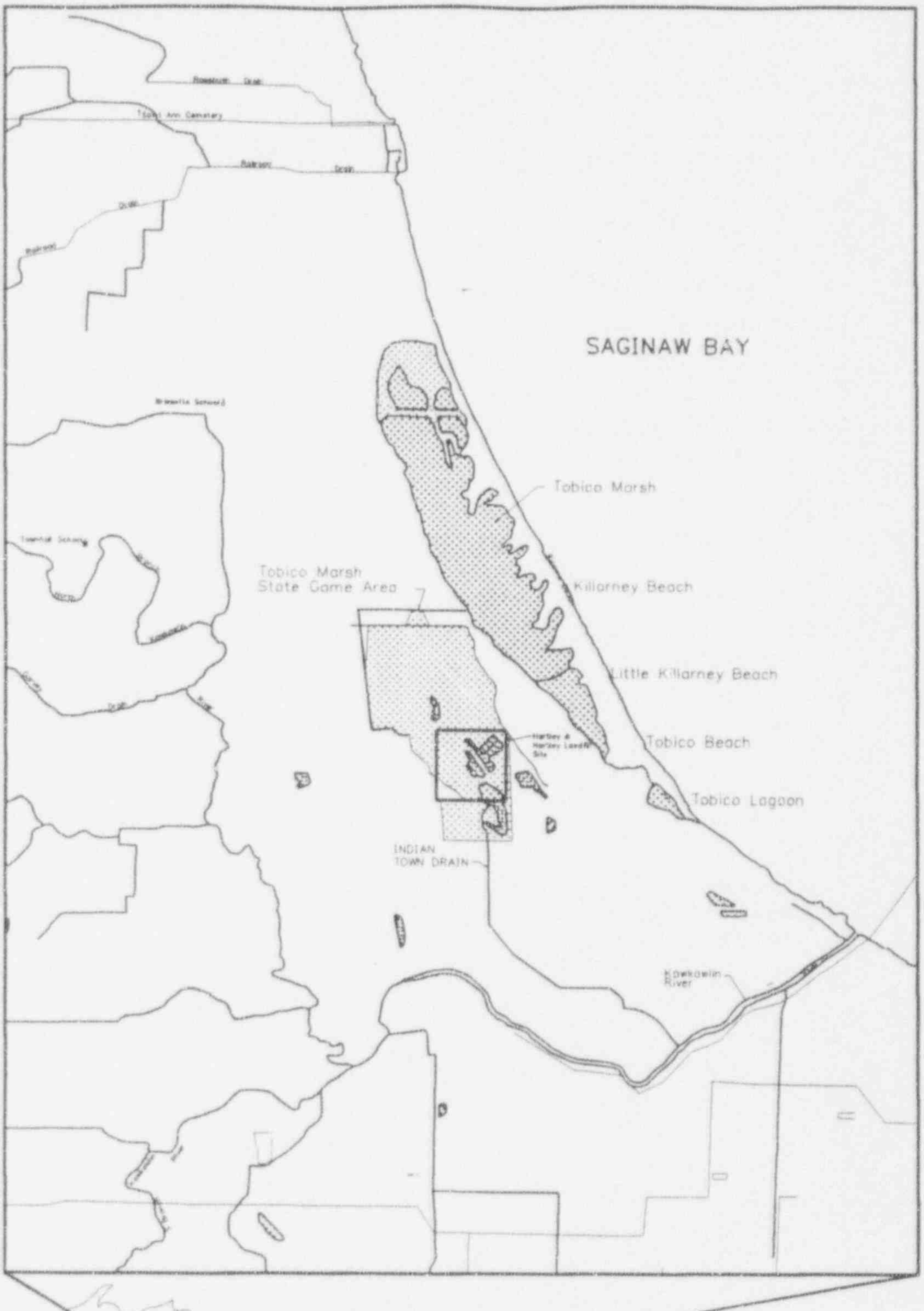
Historical aerial photographs indicate that all of the shallow ponds at the Site were human-made. Many of the ponds were formed when borrow pits were excavated to supply fill material for building roads, dikes, and berms at the Site during waste disposal activities. Several of the ponds were used as temporary storage lagoons for various liquid wastes as part of past waste disposal practices at the Site.

The two rectangular cells adjacent to the East Landfill (called Cells A and B in this report) were constructed to accept waste. The clay cutoff wall installed around the East Landfill encompasses these two cells. When waste disposal activities ceased at the Site, these diked cells became filled with water. The relatively impermeable nature of the cutoff wall has caused water in both cells to rise above the elevation of the surrounding marsh. Overflow water from the cells exits to a marshy area on-site through a culvert installed by the MDNR located at the surface of the cutoff wall on the north side of the cells.

Conceptual cross-sections of the Site have been developed which illustrate the current understanding of the geology and hydrogeology of the area. A plan view is illustrated in Figure 2-11, and the conceptual cross-sections are shown in Figures 2-12 and 2-13.

The Northwest Landfill contains an unknown amount of naturally occurring fill (see Figure 2-12). The layer of sand which generally is found above the clay till throughout this area was not completely excavated before the waste was placed. The slurry wall surrounding the landfill is approximately ten feet deep, and it is keyed into the clay till. The waste is covered by a two-foot thick clay cap. The leachate levels apparently have not yet reached an elevation where seeps could occur. There is a lagoon west of this landfill on Hartley property, between the landfill and the road, which was apparently built on the original clay dike. The water level is close to the ground surface in this area. East of the landfill, some of the sand was removed to create a pond.

BASED ON USGS
KAWKAWLIN QUADRANGLE
REVISED 1984



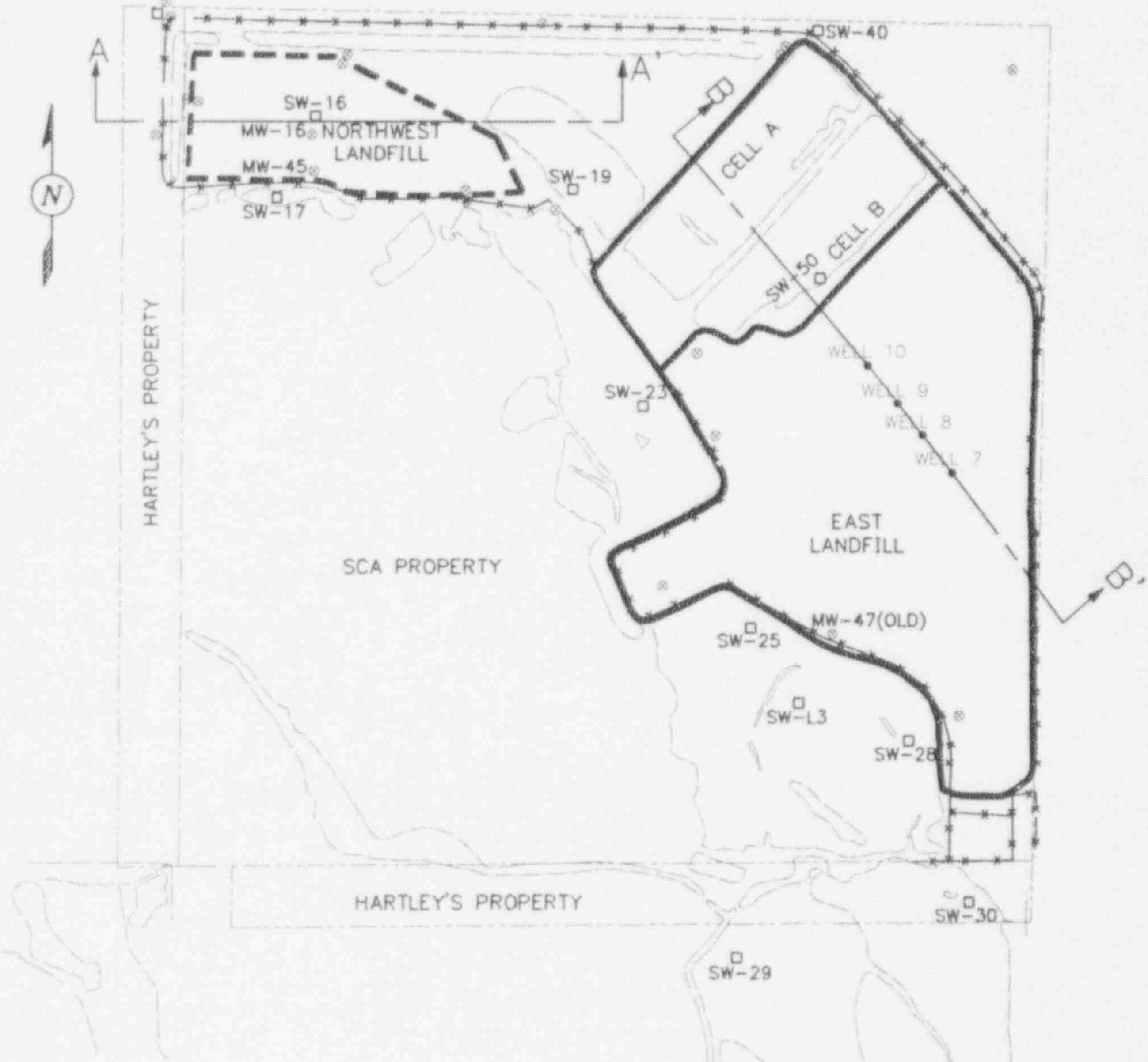
RUST ENVIRONMENT & INFRASTRUCTURE
NAPERVILLE ENVIRONMENTAL DIVISION

NOT TO SCALE

DATE: 11/8/93 | JOB NO: 42578
CAD FILE NO: 2578RM

DRAWING TITLE:
REGIONAL MAP
OF SURFACE WATER
HARTLEY & HARTLEY LANDFILL
BAY COUNTY, MICHIGAN

FIGURE 2-10



FENCE

CLAY DIKE

SLURRY WALL

RUST ENVIRONMENT & INFRASTRUCTURE
NAPERVILLE ENVIRONMENTAL DIVISION

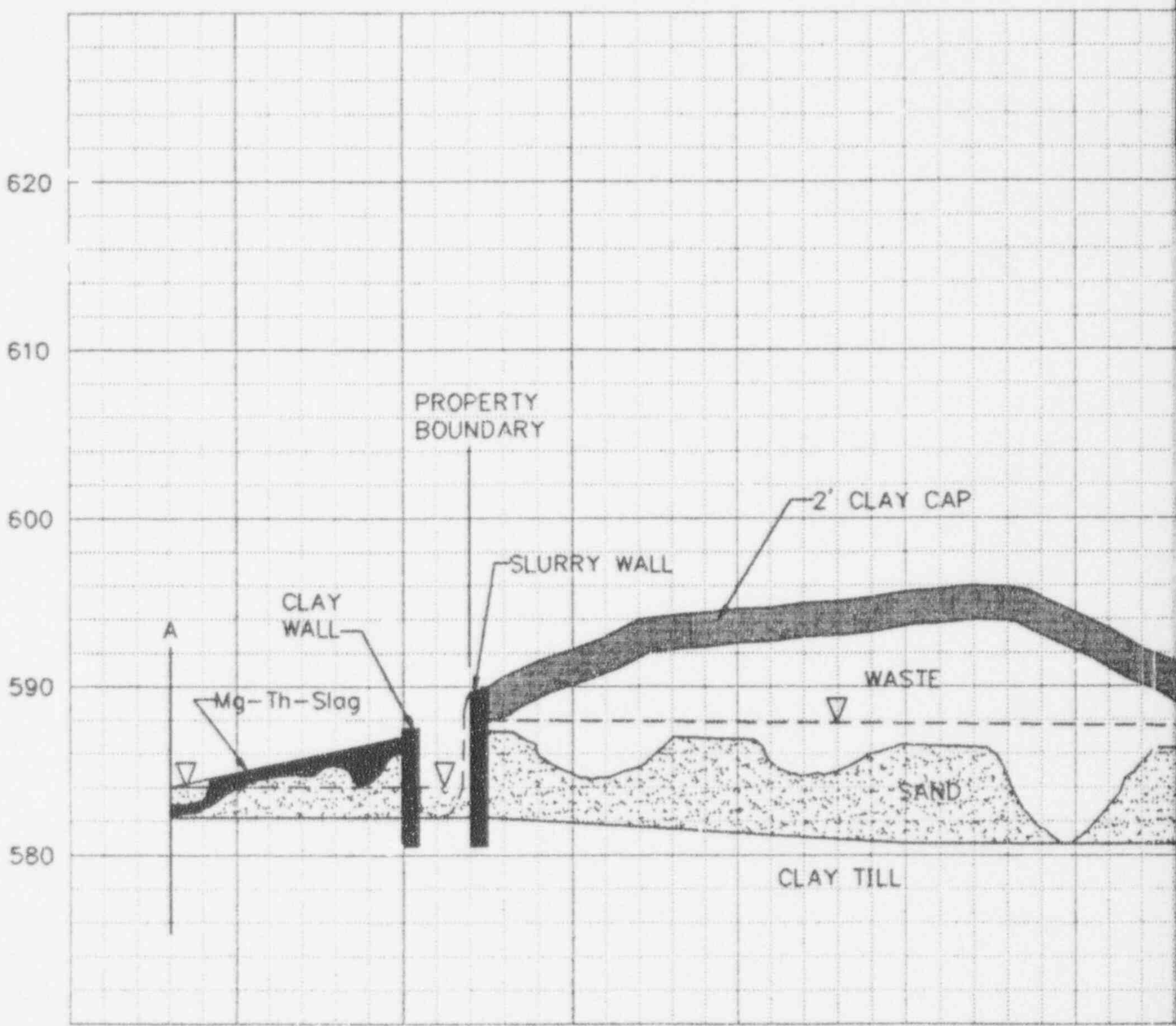
NOT TO SCALE

DATE: 11/8/93 JOB NO. 42578
CAD FILE NO. 2578PCCS

DRAWING TITLE:
PLAN VIEW:
CONCEPTUAL CROSS SECTIONS
HARTLEY & HARTLEY LANDFILL
BAY COUNTY, MICHIGAN

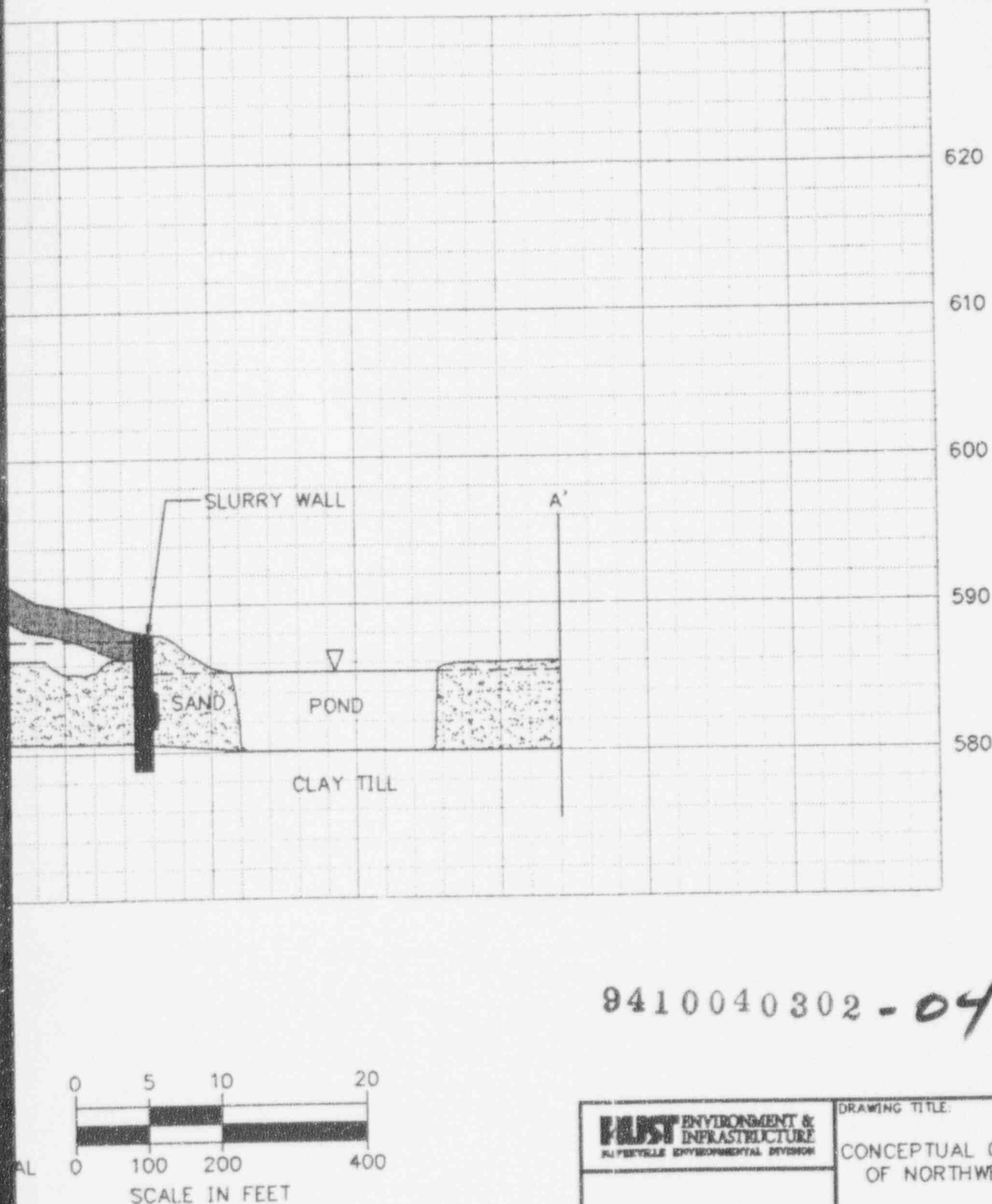
FIGURE 2-11

01/17/94/YSS



VERTICAL

HORIZONT



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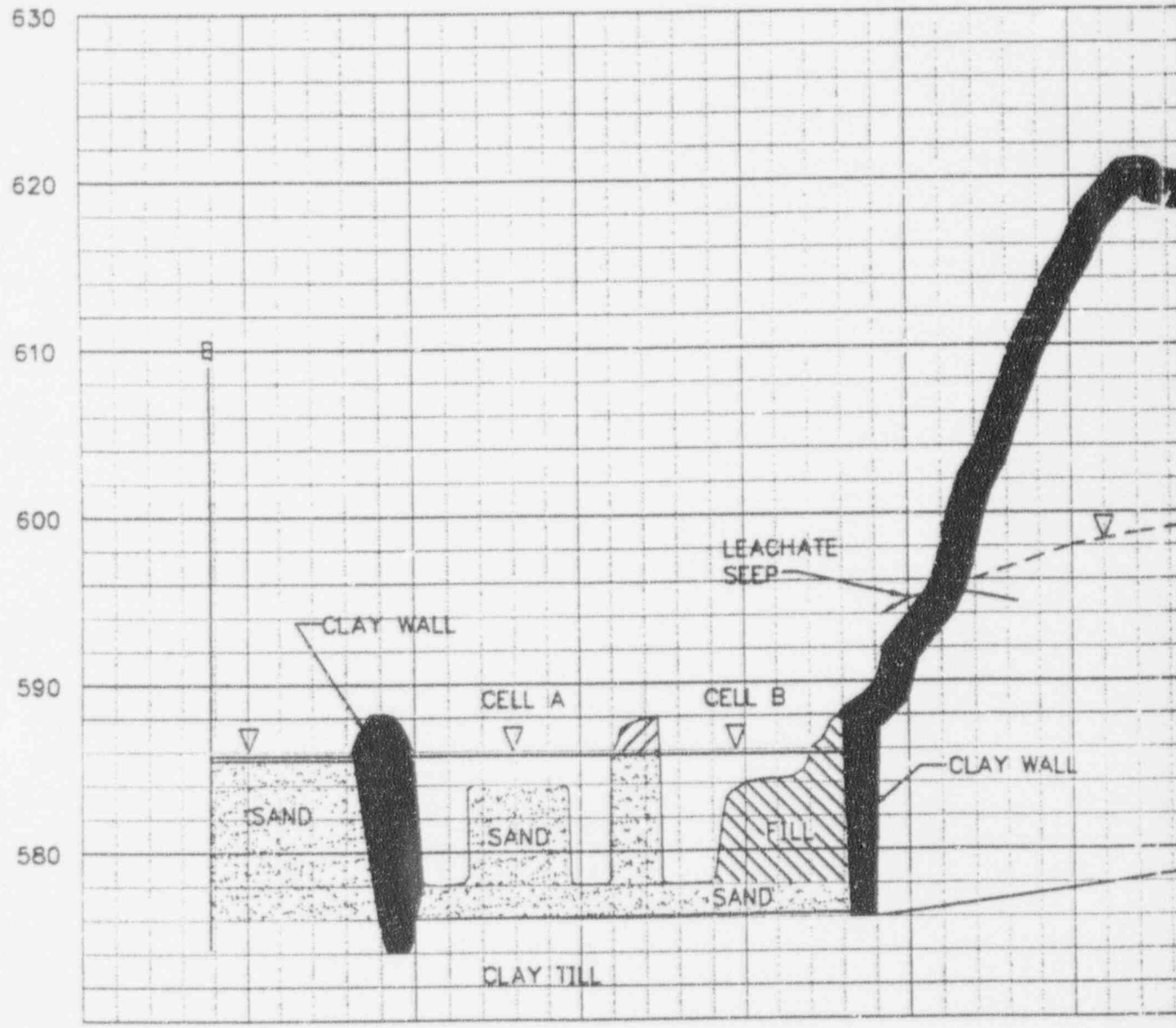
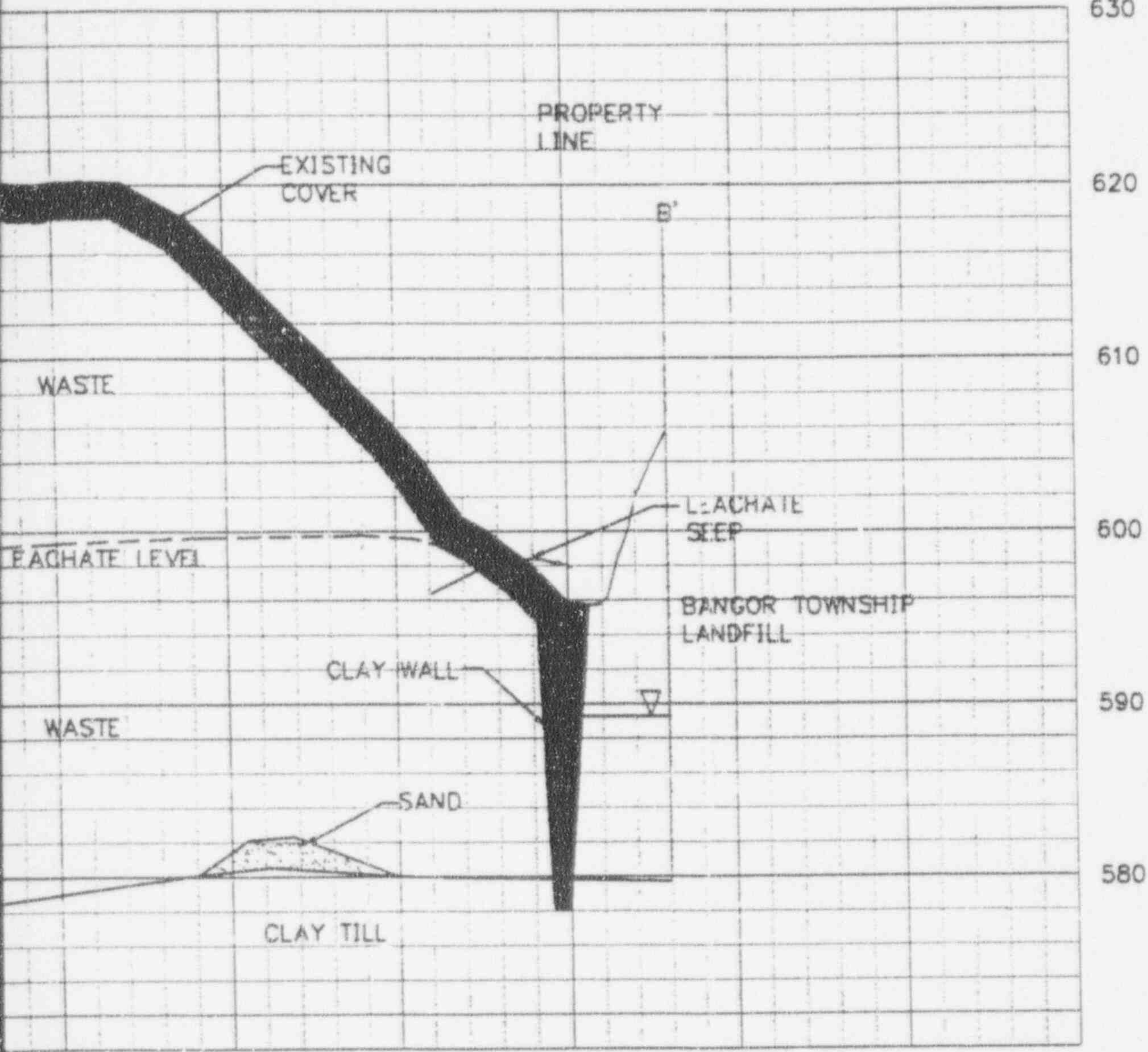
HURST ENVIRONMENT & INFRASTRUCTURE
FAYETTEVILLE ENVIRONMENTAL DIVISION

DATE 10/20/93 JOB NO. 42578	DRAWING TITLE: CONCEPTUAL CROSS-SECTION OF NORTHWEST LANDFILL
CAD FILE NO 2578gst1	FIGURE 2-12



VERTICAL

HORIZONTA



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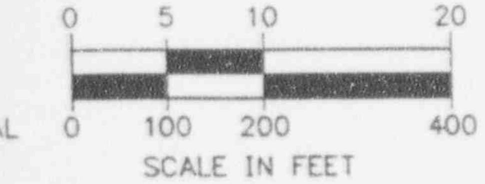


RUST ENVIRONMENT & INFRASTRUCTURE NAPERVILLE ENVIRONMENTAL DIVISION	DRAWING TITLE: CONCEPTUAL CROSS-SECTION OF EAST LANDFILL
DATE 10/19/93 JOB NO: 42578 CAD FILE NO: 2578GST2	FIGURE 2-13

A conceptual cross-section of the East Landfill is shown in Figure 2-13. Based on historical records, the landfill may be up to 40 feet deep. The leachate level is higher than the elevation of the clay wall, and leachate seeps have been observed in several areas. In addition, the existing cover has settled, creating low lying areas on the cap. Leachate may be seeping into Cells A and B, and it is not known if waste was placed in these cells. However, they are surrounded by a clay wall.

2.5.6 Climate

Bay County has a typical mid-continental climate with a large temperature variation between summer and winter. Table 2-3 gives data on temperature and precipitation for the area, as recorded at Bay City for the period 1947 to 1976. Table 2-4 shows probable dates of the first freeze in fall and the last freeze in spring (Weesies, 1980). Table 2-5 provides additional data from the Essexville Station on temperature and precipitation for the period 1961-1990 (Owenby and Ezell, 1992). Essexville is located immediately northeast of Bay City.

In winter the average temperature is 24.9 degrees F, and the average daily minimum temperature is 17.9 degrees F. The lowest temperature on record, which occurred at Bay City on February 5, 1918, is -31 degrees F. In summer the average temperature is 69.8 degrees F, and the average daily maximum temperature is 80.4 degrees F. The highest recorded temperature, which occurred on July 9, 1911, is 110 degrees F.

The average total annual precipitation is 27.87 inches (Bay City, Michigan). Of the total annual precipitation, 16.37 inches, or 59 percent, usually falls in April through September. In 2 years out of 10, the rainfall in April through September is less than 13.7 inches. The heaviest 24-hour rainfall during the period of record was 6.81 inches at Bay City in August 1913. Thunderstorms occur on about 33 days each year, and most occur in June, July, and August.

Average seasonal snowfall is 39.6 inches. The greatest snow depth at any one time during the period of record was 24 inches. On the average, 60 days have at least one inch of snow on the ground, but the number of such days varies greatly from year to year.

The average relative humidity in mid-afternoon is about 61 percent. Humidity is higher at night, and the average at dawn is about 80 percent. The percentage of possible sunshine is 65 in summer and 30 in winter. The prevailing wind is from the southwest. Average windspeed is highest, 12 miles per hour, in March.

2.5.7 Ecology

The Hartley and Hartley site is located immediately west of Tobico Marsh and adjacent to the Tobico Marsh State Game Area (Figure 2-1). The Tobico Marsh State Game Area covers approximately 2,000 acres, with 1,109 of the acres designated as a wildlife refuge. The wildlife refuge is closed to entry except by special authorization. (MDNR, 1979)

Tobico Marsh is a freshwater marsh dominated by wetland habitat and containing several plant associations. In 1976 the U. S. Department of the Interior (U.S. DOI) listed Tobico Marsh on the National Registry of Natural Landmarks. The 1985 edition of this report describes Tobico

TABLE 2-3
TEMPERATURE AND PRECIPITATION

[Recorded in the period 1947-1976 at Bay City, Michigan]
(Modified from Weesies, 1980)

Month	Temperature					Precipitation				
	Average daily maximum	Average daily minimum	Average daily	2 years in 10 will have --		Average	2 years in 10 will have --		Average number of days with 0.10 inch or more	Average snowfall
				Maximum temp. higher than --	Minimum temp. lower than --		Less than --	More than --		
	°F	°F	°F	°F	°F	Inches	Inches	Inches		Inches
January	29.8	25.8	22.8	54	-8	1.59	.7	2.3	4	11.0
February	31.9	16.5	24.2	51	-7	1.29	.5	2.0	4	8.4
March	40.2	24.5	32.4	70	2	2.29	1.2	3.2	5	6.7
April	55.7	36.3	46.0	82	19	2.63	1.6	3.6	6	1.3
May	67.7	46.1	56.9	88	29	2.62	1.8	3.4	7	Trace
June	78.5	57.0	67.7	95	39	3.01	1.7	4.2	6	Trace
July	82.2	61.1	71.7	95	47	2.66	1.4	3.8	6	0
August	80.4	59.6	70.0	96	43	2.80	1.4	4.0	6	0
September	72.3	52.2	62.2	91	33	2.65	1.5	3.6	6	0
October	61.9	42.8	52.3	83	24	2.37	1.0	3.6	5	.2
November	46.1	32.1	39.1	70	9	2.20	1.3	3.0	6	3.6
December	33.9	21.3	27.6	60	-2	1.77	.8	2.6	4	8.5
Year	56.7	38.8	47.7	98	-10	27.87	23.8	31.8	66	39.6

TABLE 2-4
FREEZE DATES IN SPRING AND FALL

[Recorded in the period 1930-1974 at Bay City, Michigan]
(From Weesies, 1980)

	Temperature		
	24°F or lower	28°F or lower	32°F or lower
Last freezing temperature in spring:			
1 year in 10 later than --	April 22	April 30	May 15
2 years in 10 later than --	April 16	April 26	May 11
5 years in 10 later than --	April 6	April 18	May 2
First freezing temperature in fall:			
1 year in 10 earlier than --	October 27	October 13	September 30
2 years in 10 earlier than --	November 1	October 19	October 5
5 years in 10 earlier than --	November 12	October 31	October 16

TABLE 2-5
TEMPERATURE AND PRECIPITATION

[Recorded for the period 1961-1990 at the Essexville Station)
(Modified from Owenby and Ezell, 1992)

MONTH	PRECIPITATION NORMALS (INCHES)		TEMPERATURE NORMALS (°F)			
	Normal	Median	Normal Max	Normal Min	Normal	Median
January	1.51	1.25	27.5	13.5	20.5	19.5
February	1.19	.99	29.4	14.2	21.9	21.5
March	2.28	2.03	39.8	24.5	32.2	32.5
April	2.68	2.68	53.6	36.1	44.8	44.9
May	2.85	2.45	66.2	47.0	56.7	55.9
June	3.11	2.81	76.4	56.5	66.5	66.5
July	2.34	2.18	81.4	61.7	71.6	71.6
August	3.21	2.72	78.4	59.5	69.0	69.1
September	3.89	3.59	70.6	52.3	61.5	61.2
October	2.63	2.73	58.4	41.3	49.9	49.8
November	2.66	2.36	45.7	31.9	38.8	39.0
December	1.95	1.70	32.7	20.2	26.5	26.6
Annual	30.30	29.96	55.0	38.2	46.7	46.5

Marsh as "one of the best freshwater marshes in the north-central United States because of its large size and relatively undisturbed condition and the variety of aquatic plant communities, ranging from open water to marsh vegetation." The report also notes that Tobico Marsh is used by large numbers of migrating waterfowl (U.S. DOI, 1985).

Several ecological surveys of Tobico Marsh and adjacent areas were performed by different researchers between 1982 and 1987. Included in the species identified in these studies are two plants and 11 birds that are on the current federal and state lists of endangered, threatened and special concern species (see Table 2-6). The following two sections summarize the past ecological surveys, arranged in chronological order.

2.5.7.1 Terrestrial Ecology

A Technical Assistance Team (TAT) from the U.S. EPA inspected areas of Tobico Marsh and the Hartley and Hartley Site on May 17 and 18, 1982. The TAT noted that the Tobico Marsh contains several plant associations but is dominated by a wetland habitat consisting mostly of cattails and willows. The TAT listed the tree, shrub, woody vine, herb, and wildlife species in four associations they observed (U.S. EPA, June 2, 1982):

> Floating or Submerged Aquatic Association: Chara-Stonewart, Duckweed
>
> Emergent Aquatics Association: Broad-Leaved Cattail (dominant), Short-Awn Foxtail, Cut Grass, Marsh-Purslane, Narrow-Leaved Cattail, plus five plant species that were present "seldom"; and Mallard
>
> Shrubs-Open Fields Association: Red-Osier Dogwood (dominant), Sandbar Willow (dominant), Quaking Aspen, Horsetail, Goldenrod, plus 20 plant species that were present "occasionally" or "seldom"; Red-Winged Blackbird, Killdeer, Marsh Hawk
>
> Cottonwood-Aspen Association: Cottonwood (dominant), Slippery Elm, Common Strawberry, Goldenrod, plus 12 plant species that were present "seldom"; Marsh Hawk, Common Garter Snake

One plant species identified by the TAT (Black Haw) and one wildlife species (Northern Harrier) are on Michigan's list of Species of Special Concern. While not given legal protection under the Michigan Endangered Species Act, the Special Concern species have declining or remnant populations in the state. Neither species is on the federal endangered species list (MDNR, June 1992 and January 25, 1993; U.S. Fish and Wildlife Service, August 29, 1992).

On April 18, 1983, the Wildlife Division of MDNR District 8 collected waterfowl at the Hartley and Hartley Site. The following bird species were collected: two Blue-Winged Teal, three Scaup, five Mallards plus 17 eggs, one Redhead, two Bufflehead, one Ring-Necked Duck, and two Shovelers. At about the same time, the Wildlife Division collected wildlife at the Site, including raccoons, foxes, and skunks (MDNR, April 19, 1983 and May 4, 1983).

TABLE 2-6
ENDANGERED, THREATENED, AND SPECIAL CONCERN SPECIES

TOBICO MARSH
Bay County, Michigan

SPECIES	FAMILY	RANK		1992 STATUS	
		GLOBAL	STATE	US	MI
PLANTS					
Platanthera leucophaea[3] Prairie fringed orchid	Orchidaceae	G2	S1	LT	E
Viburnum prunifolium[2] Blak Haw	Caprifoliaceae	G5	S3	--	SC
WILDLIFE					
Circus cyaneus[1,2] Northern Harrier	Accipitridae	G5	S3	--	SC
Accipiter cooperi[1] Cooper's Hawk	Accipitridae	G4	S3S4	--	SC
Nycticorax nycticorax[1] Black-crowned Night-Heron	Ardeidae	G5	S2S3	--	SC
Ixobrychus exilis[1] Least Bittern	Ardeidae	G5	S2	--	T
Accipiter gentilis[1] Northern Goshawk	Accipitridae	G4	S3	C2	SC
Gallinula chloropus[1] Common Moorhen	Rallidae	G5	S3	--	SC
Chlidonias niger[1] Black Tern	Laridae	G4	S3	C2	SC
Sterna caspia[1] Caspian Tern	Laridae	G5	S2	--	T
Sterna hirundo[1] Common Tern	Laridae	G5	S2	C2	T
Phalacrocorax auritus[1] Double-crested Cormorant	Phalacrocoracidae	G5	S4	--	SC
Falco columbarius[1] Merlin	Falconidae	G4	S1S2	--	T

Rank Codes (from MDNR Endangered Species lists):

G2	=	Imperiled globally because of rarity (6 to 20 occurrences or few remaining individuals or acres) or because of some factor(s) making it very vulnerable to extinction throughout its range
G4	=	Apparently secure globally, though it may be quite rare in parts of its range, especially at the periphery
G5	=	Demonstrably secure globally, through it may be quite rare in parts of its range, especially at the periphery
S1	=	Critically imperiled in the state because of extreme rarity (5 or fewer occurrences or very few remaining individuals or acres) or because of some factor(s) making it especially vulnerable to extirpation in the state
S2	=	Imperiled in state because of rarity (6 to 20 occurrences or few remaining individuals or acres or becasue of some factor(s) making it especially vulnerable to extirpation in the state
S3	=	Rare or uncommon in state (on the order of 21 to 100 occurrences)
S4	=	Apparently secure in state, with many occurrences

Combinations (e.g., S3S4) = Intermediate ranking

Status Codes (from MDNR Endangered Species lists):

US C2	=	listing as Endangered or Threatened may be appropriate but more information is needed
US LT	=	Officially listed as Threatened
MI E	=	Endangered
MI SC	=	Special Concern. While not afforded legal protection under the Michigan Endangered Species Act, it is of concern because of declining or relict populations in the state. Should it continue to decline, it would be recommended for Threatened or Endangered status. "Special concern" may also designate potentially rare species pending more precise information on their status in the state.
MI T	=	Threatened

Sources for Species in Tobico Marsh:

1 Saginaw Valley State University, 1987-88. Flora and Fauna of Tobico Marsh.

2 U.S. EPA, Region 5, June 2, 1982. Memorandum from Technical Assistance Team re Biological Survey of Hartley and Hartley Company Area.

3 U.S. EPA, Region 5, June 22, 1984. "Potential Hazardous Waste Site Preliminary Assessment" form for State-Owned portion of Hartley and Hartley site.

Facu!ty from the Saginaw Valley State University (SVSU) conducted research at Tobico marsh during the 1980s. These studies identified species of trees, bryophytes (mosses), birds, and mammals.

The SVSU tree survey, completed in October 1987, identified a total of 269 species. The study concluded that the woods around Tobico Marsh are not very diverse in terms of the number of species present. The study found that Red Maple (Acer rubrum), Black Oak (Quercus velutina), and Red Oak (Quercus rubra) were the dominant and most widely distributed species. Since many of the oaks and red maples were small, the study concluded that they would continue to dominate much of the woods for several decades (SVSU, 1987-88).

The bryop e collection project in 1986 and 1987 identified 21 species of mosses (SVSU, 1987-88).

The SVSU bird census was performed from 1985 to 1987 (SVSU, 1987-88). The census identified a total of 127 species, including 67 passerine (songbird) species and 60 non-passerine species. The species were also classified by season, as follows (some species occur in more than one season):

> Permanent residents: 20 species. Examples are Mallard, Cooper's Hawk, Blue Jay, and Northern Cardi.al.
>
> Summer residents: 71 species. Examples are Great Blue Heron, Common Tern, Red-Headed Woodpecker, Yellow Warbler, and Chipping Sparrow.
>
> Migrants: 34 species. Examples are Horned Grebe, Ring-Necked Duck, Winter Wren, and Tennessee Warbler.
>
> Winter visitors: 19 species. Examples are Horned Grebe, Bufflehead, Cedar Waxwing, and Song Sparrow.
>
> Vagrants: 2 species. These were the Mute Swan and Evening Grosbeak.

An SVSU small mammal study conducted from July through September 1987 set live-traps in various wooded areas of Tobico Marsh. The following species were captured: 47 Eastern Chipmunks; 241 White-Footed Mice; 61 Short-Tailed Shrews; and one each Eastern Gray Squirrel, Mink, Eastern Mole, and Least Shrew (SVSU, 1987-88).

The SVSU studies identified three bird species that are on the federal endangered species list and an additional eight bird species that are on Michigan's lists of endangered, threatened, and special concern species. The three species that are on both federal and state lists are Northern Goshawk, Black Tern, and Common Tern (see Table 2-6) (MDNR, June 1992 and January 25, 1993; U.S. Fish and Wildlife Service, august 29, 1992).

In 1984, the U.S. EPA conducted a preliminary hazardous waste assessment of the state-owned parcel. Part 3 of the Preliminary Assessment form notes that a federal endangered species, the

Prairie Fringed Orchid, is on-site and found at the Tobico Marsh game area (U.S. EPA, June 22, 1984). The species is also listed on Michigan's list of "endangered" (MDNR, June 1992).

2.5.7.2 Aquatic Ecology

The U.S. EPA TAT, based on their inspection of the Hartley and Hartley Site and nearby areas of Tobico Marsh in May 1982, concluded that the Hartley and Hartley Site did not appear stressed. The dominant macroinvertebrates identified at all locations the TAT sampled were characteristic of slow-moving or stagnant waters. With the exception of four small ponds near the MDNR Landfill (outside the Hartley and Hartley Site), the TAT found the habitats appeared healthy. The TAT identified nine dominant aquatic macroinvertebrates: Aquatic Sowbugs, Fingernail Clams, Aquatic Snails, Aquatic Fly larvae, Sideswimmers, Dragonflies, Damselflies, Mayflies, and Midge larvae (U.S. EPA, June 2, 1982).

SVSU faculty also conducted aquatic research at Tobico Marsh. As of October 1987, their survey of aquatic invertebrates found approximately 100 species from the following 11 phyla classifications (SVSU, 1987-88):

Protozoa (single-celled animals)
Porifera (sponges)
Coelenterata (hollow-bodies animals)
Platyhelminthes (flatworms)
Rotifera (wheel-bearers)
Gastrotricha (microscopic worm-like animals)
Nematoda (unsegmented roundworms)
Bryozoa (mass animalcules)
Annelida (segmented roundworms)
Mollusca (soft-bodied animals)
Arthropoda (animals with jointed appendages)

2.6 POPULATION DISTRIBUTION AND LAND USE

2.6.1 Demographics

The Hartley and Hartley Site is located in Kawkawlin Township, north of Bay City, Michigan. Between Bay City and Kawkawlin Township is Bangor Township. Of the two townships and Bay City, Kawkawlin has the smallest population at 4,852 compared to 16,028 in Bangor Township, and 38,936 in Bay City. The 1990 census figures show the population to be declining in all three areas: down 4.43 percent from 1980 in Kawkawlin Township, down 8.38 percent in Bangor Township, and down 6.39 percent in Bay City. There are more than 500 housing units, mainly single family homes, within one mile of the Hartley and Hartley Site. (U.S. Census Bureau, Michigan Information Center, 1990).

2.6.2 Land Use

Land use in the northern area of the region is predominantly forestry, with agriculture and industry dominating in the southern portions. The area in the vicinity of the Site consists primarily of rural residential and light industrial or commercial business.

The dominant industry in Bay County is manufacturing. There are about 150 industries in the county which manufacture various items including automobile parts and accessories, cranes and shovels, airplane parts, jet engine components, magnesium products, cement, tubing, prefabricated houses, petroleum products, chemicals, sporting goods, clothing, and food, including cheese, sugar, and potato chips.

2.6.2.1 Scenic and Natural Landmarks

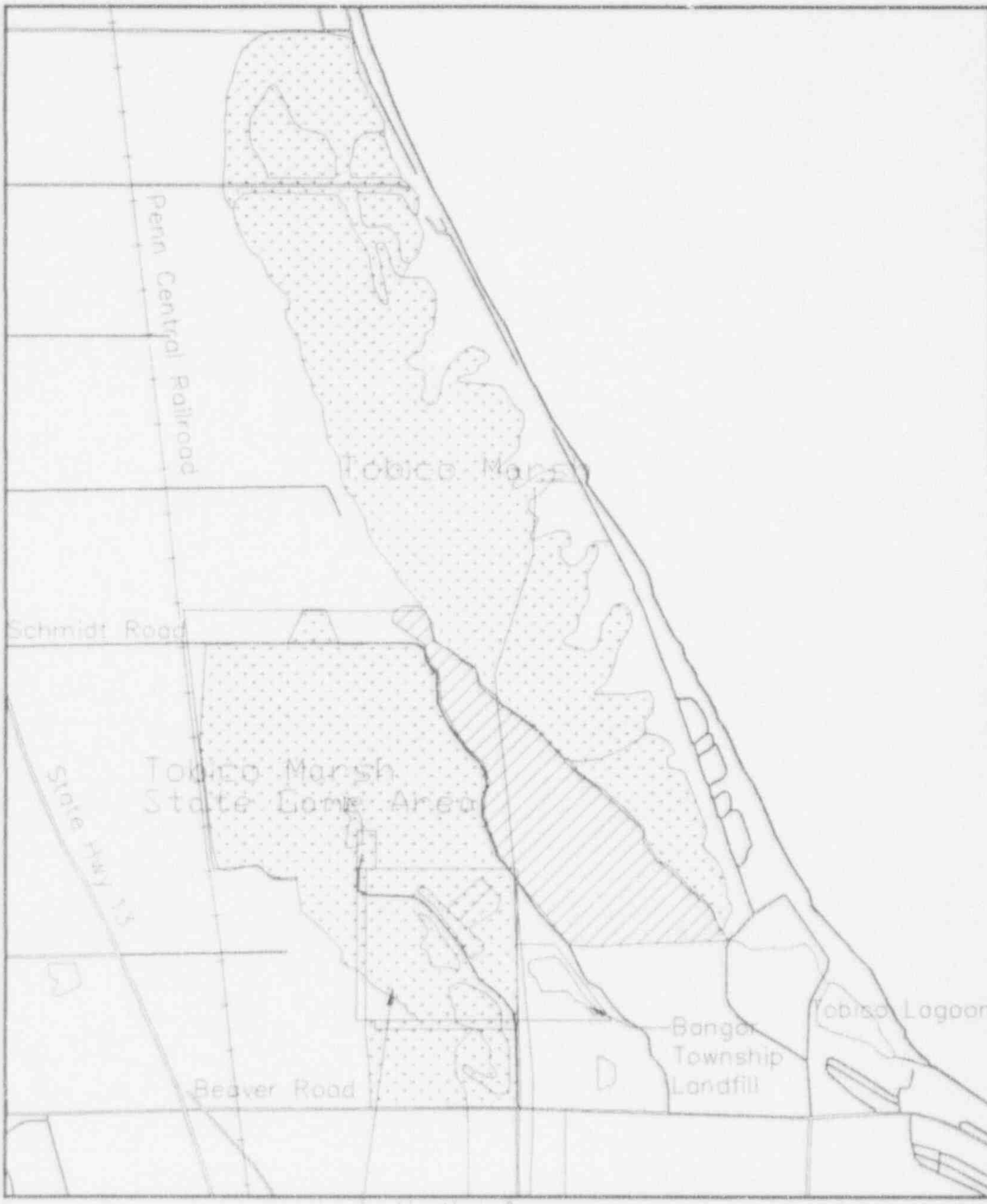
The Hartley and Hartley site is immediately west of Tobico Marsh, which includes a state game area and state park. In 1976 the U.S. DOI designated Tobico Marsh as a Registered Natural Landmark. The National Registry of Natural Landmarks Program was established to encourage preservation of the best remaining examples of the major biotic communities and geologic features, without regard to site ownership or management.

The Tobico Marsh State Game Area, created in 1956, covers approximately 2,000 acres. Within this area, 1,[illegible] acres are designated as a wildlife refuge and are closed to entry except by special authorization. This is one of the largest remaining wildlife refuges along Saginaw Bay. The remainder of the state game area is open to public hunting and, by permit, to trapping of fur-bearing animals. The marsh also includes a five-mile walking path and two 30-foot observation towers. It is within the Mississippi Flyway and is used extensively by large numbers of migrating water fowl.

Bay City State Park is about two miles east and slightly south of the Hartley and Hartley Site. The park includes a swimming beach on Saginaw Bay, a campground, picnic grounds, hiking trails, and a fishing dock on Tobico Lagoon. Within the park near Tobico Lagoon is Jennison Nature Center. The nature center offers interpretative tours of Tobico Marsh. The MDNR operates both the park and the nature center (MDNR, 1979, 1991).

2.6.2.2 Historic and Archaeological Landmarks

The state-owned land at Tobico Marsh northeast of the Hartley and Hartley Site has been documented as having significant archaeological resources. Saginaw Valley State University has conducted archaeological surveys on state lands at Tobico Marsh from 1988 through the present, under permit from the MDNR and with the assistance of the State Archeologist (Payne, 1991, pp. 2-3). The project area for this field work includes approximately 296 acres adjacent to the southwestern edge of the marsh as shown on Figure 2-14. The field work completed through 1991 surveyed approximately 40 acres and documented 26 archaeological sites. Four sites were further investigated through excavation of 18 one-meter-square test units. Cultural features, artifacts, floral remains, and faunal remains were discovered from these excavations (Payne, 1991, p. 56).



NOTE:
THIS MAP IS BASED ON "A PRELIMINARY REPORT OF THE PREHISTORY OF THE TOBICO MARSH AREA: THE 1988 THRU 1991 FIELD SEASONS" BY J.H.PAYNE, 20 DEC, 1991.

KEY:

MARSH

LOCATION OF ARCHEOLOGICAL INVESTIGATION

RUST ENVIRONMENT & INFRASTRUCTURE
NAPERVILLE ENVIRONMENTAL DIVISION

NOT TO SCALE

DATE 11/8/93 | JOB NO. 42578
CAD FILE NO. 2578F215

DRAWING TITLE:
LOCATION OF ARCHEOLOGICAL INVESTIGATION
HARTLEY & HARTLEY LANDFILL
BAY COUNTY, MICHIGAN

FIGURE 2-14

Both prehistoric and historic remains have been found at the marsh. The prehistoric material is associated with the Late Woodland through early historic periods (circa A.D. 500 through the 17th century). Prehistoric artifacts represent a variety of human activities in the area, including hunting, fishing, use of flaked stone tools, evidence of food gathering and processing, smoking of pipes, and use of hearths. The field work has identified three categories of historic sites: a mid-19th century camp used by Native Americans, loggers, or hunters/trappers; a late 19th to mid-20th century sporting camp called the Tobico Hunt Club; and late 19th century to modern domestic refuse from the sporting camp or nearby homes (Payne, 1991, pp. 55-56).

The field work through 1991 inventoried approximately 22 percent of the fossil beach ridges adjacent to Tobico Marsh. Researchers estimate that the remaining portion could be surveyed in approximately 10 weeks. However, the testing of significant sites found in the area would take considerably longer (Payne, 1991, p. 53).

The archaeological resources of the Tobico Marsh area are significant because of the time period they represent, their excellent condition, and the fact that they remain in their natural context. The Late Woodland period is not well understood. Most other Late Woodland sites in the Saginaw Valley were disturbed by human activities long before excavation. The Tobico Marsh area, however, contains a number of Late Woodland sites which are in nearly pristine condition.

The archaeologists studying Tobico Marsh have concluded that any future development or change in the use of this land may have a serious impact on the archaeological resources found there. They recommend preparing a report to nominate the Tobico Marsh state lands to the National Register of Historic Places as an archaeological district.

3.0 INITIAL SITE EVALUATION

This section describes the types and volumes of waste treated or disposed of at the Site and summarizes the recent sampling results for soil, slag, leachate, groundwater and surface water. Potential exposure pathways and receptors are identified next. The preliminary remedial action objectives are organized according to media:

- soil/landfill contents
- groundwater/leachate
- surface water
- sediment
- landfill gas

Finally, a preliminary identification of applicable or relevant and appropriate requirements (ARARs) and to-be-considered requirements (TBCs) is given.

3.1 TYPES AND VOLUMES OF WASTE PRESENT AND RECENT SAMPLING DATA

3.1.1 Types and Volumes of Waste

RUST E&I has estimated that the East Landfill and Northwest Landfill together contain approximately 1,200,000 cubic yards (yd^3) of fill material consisting of municipal, commercial and industrial wastes. The waste volume estimate is based on landfill areas derived from both aerial photographs of the site and technical documents indicating the location of the subsurface barriers. The area of the East Landfill is approximately 32 acres and the area of the Northwest Landfill is eight acres. The waste thickness was assumed to begin 2½ feet below ground surface (below the cap) and extend down to the top of the glacial till. The individual and total waste volumes are estimated to be:

East Landfill	=	1,064,000 yd^3
Northwest Landfill	=	95,000 yd^3
Total	=	1,159,000 yd^3

It is unknown at this time what fractions of this waste volume can be classified as nonhazardous, hazardous (by RCRA characteristic), radioactive, or mixed (both hazardous and radioactive).

Historical information suggests that the East Landfill contains solid industrial wastes including foundry sand, magnesium-thorium slag, paint sludges, plating wastes, wastewater treatment sludges, incinerator ash, and asbestos-containing materials. The East Landfill was also used for the disposal of municipal waste. In addition, liquid industrial wastes were disposed of within the landfills. The liquid wastes were accepted in the form of liquid-filled drums, or bulk liquids that were spread on the ground or placed in pits and ponds for disposal by mass burning. These liquid wastes were stored in drums, aboveground and underground storage tanks, and in open pits and ponds prior to treatment or disposal. A surface gamma survey conducted by RUST in December 1992 indicated that radioactive material is distributed throughout the East Landfill.

3.1.2 Review of Recent Environmental Sampling Data

Numerous samples of material from the Site have been analyzed for radiological and/or chemical parameters during different periods of operation, and since closure of the landfill. Analyses of soil, slag, leachate, groundwater, and surface water are summarized in the following sections. A complete review of the historical data will be presented in a technical memorandum to be issued during the RI.

3.1.2.1 Soil and Slag

From 1983 to 1992, samples of slag, soil, and metal from the northwest corner of the Site, Hartley's property, and MDNR's property were collected and analyzed by various parties. Comparison of these materials to the wastes produced by a former magnesium-thorium processing facility in Bay City (Wellman Dynamics: U.S. NRC Source Material License STB-136) revealed them to be similar. The wastes contain radionuclides from the natural thorium and uranium decay series.

Samples of the magnesium-thorium slag (a grayish substance with a clumpy to powdery texture) indicated the slag is 6 to 20 percent magnesium by weight, with a maximum concentration of thorium-232 (Th-232) of 670 pCi/g. Uranium-238 (U-238) activity of the slag was measured at up to 132 pCi/g, and radium-226 (Ra-226) was 13.8 pCi/g. The highest activity of the metal pieces collected from the three properties was 1.3 percent thorium-232 by weight (approximately 1,430 pCi/g) and 259 pCi/g for uranium-238 (U.S. NRC Region III Report No. 40-17/18-01, 1983; U.S. NRC Lab Analysis Report, 1984; Teledyne Isotopes Lab Report No. 8100-2726). Acceptable levels of radioactivity for these elements, according to U.S. EPA and U.S. NRC guidance documents are:

Natural Thorium	10 pCi/g
Natural Uranium	10 pCi/g
Radium-226	5 pCi/g

An area containing radionuclides up to these levels is considered to be clean enough to be used without restrictions - that is, no access or deed restrictions would be necessary.

The slag apparently was deposited at these properties in bulk and in barrels. A 1980 aerial radiological survey indicates the presence of thorium-232 in the East Landfill, the Northwest Landfill, Hartley's property, and MDNR's property (EG&G, 1980). A radiological survey conducted by RUST in March 1993, during which levels at the ground surface were measured, confirmed the presence of buried radioactive material in the two landfills on the SCA property (RUST, April 1993). The RUST survey also indicated the presence of radioactive material in the area between Cell A and the road, which was subsequently covered with compacted clay to prevent direct contact. With the exception of this small area, gamma radiation exposure levels measured at one meter above the ground at the site were at background levels. Hartley's property exhibits higher-than-background levels because material is present at the ground surface. SCA has fenced this portion of Hartley's property as a public health precaution.

Solid and liquid waste from the Michigan Chemical Company's St. Louis, Michigan facility was hauled to the Site. The facility possessed a U.S. NRC Source Material License (STC-833, later amended to FMB-833) for rare earth oxides (which contained thorium and uranium).

Two soil samples were collected by RUST from leachate-stained areas during a site visit on July 28, 1992. These leachate-stained areas have since been covered with compacted clay to prevent direct contact. The two samples were split and sent to Gulf Coast Labs for chemical analysis for Target Compound List (TCL) volatiles, semi-volatiles, pesticides/ polychlorinated biphenyls (PCBs), and inorganics, and to Core Labs for radiological analysis (gross alpha and beta).

The analytical results of the two leachate-saturated soil samples are summarized in Tables 3-1 through 3-3. As these lists indicate, several unknown ketones, acids, and other volatile and semi-volatile compounds were detected. PCBs and pesticides were analyzed for but not detected; however, the detection limits were elevated because the samples were diluted due to matrix interferences. The gross alpha and beta results were not elevated above background.

3.1.2.2 Leachate

Samples of leachate were collected and analyzed in November of 1988 and June of 1992. Leachate was collected in both landfills from two piezometers (PZ-2 and PZ-4) and five monitoring wells (MW47, MW18A, INS-1, INS-2, and INS-3). The locations of the leachate sampling points are shown in Figure 3-1.

The leachate samples were analyzed for volatiles, semi-volatiles, pesticides, PCBs, radionuclides, and certain conventional parameters. Summaries of the compounds detected in the leachate from each sampling point are shown in Table 3-4.

The concentrations of several parameters were higher in 1992 than in 1988, perhaps because the liquid had been in contact with the waste for a longer period of time. In general, the chemical levels are within the range expected in a municipal/industrial waste landfill.

The leachate samples were analyzed using gamma spectrometry. Although gamma spectrometry is not as accurate for liquids as it is for solids, it is nevertheless a good method for identifying and approximately measuring the concentrations of thorium and uranium daughters.

The following conclusions were reached after an examination of the radionuclide levels:

- High Total Dissolved Solids (TDS) levels caused interference with the gross alpha and beta measurements. The resulting data levels indicate that this type of analysis will not be useful to screen leachate samples. Another method, called liquid beta scintillation, may be used as a screen for the liquid samples with high TDS.

- Most of the gross gamma activity can be attributed to potassium-40 and lead-210, which are naturally occurring nuclides. The presence of lead-210 also means the presence of uranium-238 and/or radium-226.

TABLE 3-1
VOLATILE COMPOUNDS DETECTED IN
LEACHATE-SATURATED SOIL SAMPLES*
(μg/kg)

	Retention Time (in minutes)	Sample 1	Sample 2
acetone		18,000B	870B
2-butanone		13,000	720B
1,1,1-trichloroethane		4J	7U
benzene		9	19
4-methyl-2-pentanone		1,200J	92
2-hexanone		16,000	190
toluene		230	46
ethylbenzene		47	13
styrene		19	7U
xylene		150	68
Tentatively Identified Compounds:			
unknown	11.51	30J	
tetrahydrofuran	13.60, 13.61	300J	40J
unknown	14.81	30J	
unknown	15.02	20J	
unknown ketone	15.90		30J
substituted ketone	19.09		20J
methyl pyridine C6H7N	19.87, 19.86	400J	400J
3-hexanone	18.95	80J	
unknown	19.91	400J	
unknown ketone C7H140	22.43	800J	200J
substituted alkyl benzene C9H12	25.26		8J
substituted ketone	25.49	100J	
substituted ketone C8H160	25.52		20J
unknown ketone	28.39	60J	
unknown	28.40		20J
unknown	28.76		10J

* -Data not yet validated

B -Indicates the compound was found in the blank and the sample.

J -Indicates an estimated value for either a tentatively identified compound or an analyte that meets the identification criteria, but the result is less than the specified detection limit.

U -Indicates an organic compound that was analyzed for but not detected.

TABLE 3-2
SEMI-VOLATILE COMPOUNDS DETECTED IN
LEACHATE-SATURATED SOIL*
($\mu g/kg$)

	Retention Time (in minutes)	Sample 1	Sample 2
phenol		140,000	460U
4-methylphenol		84,000	460U
2,4-dimethylphenol		17,000	460U
diethylphthalate		1,600J	460U
di-n-butylphthalate		11,000U	170JB
bis(2-ethylhexyl)phthalate		5,300JB	670B
Tentatively Identified Compounds:			
pyridine	3.14	50,000J	
unknown	4.57		2,000JB
substituted pyridine & unknown acid	4.79	60,000J	
unknown acid	5.16	100,000J	
unknown	5.24		40,000JB
unknown	6.99		900J
unknown	7.14		1,000JB
alkyl substituted acid	7.83	700,000J	
unknown acid	8.59	500,000J	
hexanoic acid	11.22	2,000,000J	
alkyl substituted acid	12.14	700,000J	
heptanoic acid	12.77	500,000J	
substituted hexanoic acid	13.06	30,000J	
substituted hexanoic acid	13.24	60,000J	
substituted phenol C9H12O	13.87	100,000J	
substituted phenol C9H12O	14.47	30,000J	
unknown acid	14.77	2,000,000J	
nonanoic acid	15.79	100,000J	
unknown	16.52		800J
benzenepropanoic acid	16.81	40,000J	
unknown acid	17.24	40,000J	
unknown (C12H18O)	17.63	10,000J	
unknown	21.10	10,000J	
unknown	21.83		600J
unknown (C10H20)	22.81		600J
unknown	24.34		700J
substituted benzene dicarboxylic acid	24.71		700J
unknown	24.73	10,000J	
hexadecanoic acid	26.06		2,000J
octadecanoic acid	28.31		1,000J
unknown hydrocarbon	30.11		600J
unknown hydrocarbon	34.24		900J
unknown	34.33		700J
unknown hydrocarbon	36.43		900J
unknown	38.81	10,000J	
unknown	38.85		3,000J
unknown	41.69		1,000J
unknown	44.00		600J
unknown	44.30		700J

* - Data not yet validated
B - Indicates the compound was found in the blank and the sample.
J - Indicates an estimated value for either a tentatively identified compound or an analyte that meets the identification criteria, but the result is less than the specified detection limit.
U - Indicates an organic compound that was analyzed for but not detected.

TABLE 3-3
INORGANIC PARAMETERS
MEASURED IN LEACHATE-SATURATED SOIL SAMPLES*

	Sample 1	**Sample 2**
% solids	82.9	92.8
% ash	62.4	72.4
pH	6.4	6.8
Total Silver (mg/kg)	4.7u	4.1u
Total Arsenic (mg/kg)	1.8	1.8
Total Barium (mg/kg)	99.9	59.9
Total Cadmium (mg/kg)	0.78u	0.68u
Total Chromium (mg/kg)	6.3	11.5
Total Mercury (mg/kg)	0.16u	0.12u
Total Lead (mg/kg)	14.3	6.8u
Total Selenium (mg/kg)	0.36	0.26
Gross alpha (pCi/g)	0.9	1.8
Gross beta (pCi/g)	3.4	4.2

* -Data not yet validated.
u -Indicates an inorganic compound that was analyzed for but not detected.
mg/kg - milligrams per kilogram
pCi/g - picocuries per gram

LEGEND

—x—x—x—x—	FENCE
	PROPERTY LINE
———————	CLAY DIKE
— — — — —	SLURRY WALL

RUST ENVIRONMENT & INFRASTRUCTURE NAPERVILLE ENVIRONMENTAL DIVISION	DRAWING TITLE: LEACHATE SAMPLING LOCATIONS HARTLEY & HARLEY LANDFILL BAY COUNTY, MICHIGAN
NOT TO SCALE	
DATE: 11/8/93 JOB NO. 42578 CAD FILE NO. 2578F3-1	FIGURE 3-1

TABLE 3-4
SUMMARY OF COMPOUNDS DETECTED IN LEACHATE*
HIGHEST CONCENTRATIONS DETECTED

	INSO1	INSO2	INSO3	PZ02	PZ04	MW18A	MW47
Volatiles (μg/l)							
Vinyl Chloride	1,600	10,000	<50.0	<10	<10	160	5.0
Chloroethane	40	<10	<10	4-45	<10	91	<10.0
Methylene Chloride	490	<5.0	31	400	300	2,900	<5.0
Acetone	4100	16.0	220.0	380	110	66,000	<10.0
1,1 Dichlorethene	22.0	8.0	<25.0	<5.0	<5.0	<5.0	3.0
1,1 Dichloroethane	76.0	2.0	<25.0	<5.0	<5.0	200	7.0
1,2 Dichloroethene	16,000	11,000	<25.0	<5.0	<5.0	130	13.0
1,2 Dichloroethane	<50	<5.0	<25.0	<5.0	<5.0	41	<5.0
1,1,1 Trichloroethane	<50	<5	18	<5.0	<5.0	<5.0	180
Trichloroethene	1,400	<5	<25	<5.0	<5.0	<5.0	360
Benzene	250	810	540	73	8,800	2,700	860
Tetrachloroethene	<50	<5	<25	<5.0	<5.0	<5.0	92
Toluene	230	590	27	18	8,400	2,000	960
Ethylbenzene	88	170	66	<5.0	1,000	91	470
Xylene	150	180	13	<5.0	1,900	180	840
Acrolein	<5,000	<500	<2,500	<500	<500	230	<500
Trichlorofluoromethane	<10	<10	<10	<10	<10	<10	50
2-Butanone	<10	<10	<10	<10	<10	57,000	<10
Semi-Volatiles (μg/l)							
Phenol	24	<10	<10	<100	<11	1,500	6.0
Isophorone	<20	<10	<10	<100	<11	1,400	<20
2,4 Dimethylphenol	<20	3	<10	<100	2,600	<300	20
2,4 Dichlorophenol	<20	<10	<10	<100	<11	<300	3.0
Naphthalene	17	17	<10	<100	<11	<300	370
Acenaphthene	<20	<10	<10	<100	<11	<300	2.0
Phenanthrene	5	<10	<10	<100	<11	<300	<20.0
bis(2-Ethyl hexyl)phthalate	3	3	3	12.0	3.0	<300	4.0
2 methyl phenol	7	<10	<10	<100	<11	<300	6.0
4 methyl phenol	27	<10	<10	<100	<11	1,700	54.0
Pesticides (μg/l)							
Beta BHC	<480	<0.52	<0.44	<0.24	3.0	<7.2	0.46
4'4 DDT	<0.97	0.1	<0.89	<0.48	<0.11	<1.4	0.46
Metals (μg/l)							
Silver	14			23	15	<30	210
Arsenic	6.6	<2.0	16.0	6.6	3.9-5	<20	10
Beryllium	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Cadmium	<5.0	<5.0	<5.0	27.0	10.0	21.0	<5.0
Chromium	1,200	160	30	<20	78	1,500	71
Copper	<20	81	<20	32	<20	<20	44
Iron	22,600	2,500	10,700	68,200	15,700	33,000	3,100
Mercury	0.48	<0.2	<0.2	<0.2	<0.2	<0.2	0.55
Manganese	710	560	610	1,500	680	6,500	240
Nickel	32	23	<20	340	150	170	<20
Lead	6.9	<50	<50	<50	<50	100	<50
Antimony	<10	<10	<10	<100	<100	100	<100
Selenium	<2.0	<2.0	3.0	<20	<2	12	<2
Thallium	<300	<300	<300	<300	<300	<300	<300
Zinc	56	52	37	<10	68	44	230

042TBLS.3-4\b&hrp\2

TABLE 3-4 (Cont'd.)
SUMMARY OF COMPOUNDS DETECTED IN LEACHATE*
HIGHEST CONCENTRATIONS DETECTED

	INSO1	INSO2	INSO3	PZ02	PZ04	MW18A	MW47
Conventionals (mg/l)							
BOD_5	160	46	60	43	40	6400	51
Chloride	110	58	740	8900	1700	7000	870
Total CN	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
COD	450	300	280	8200	1400	9500	920
NH_3-N	9.60	9.20	7.90	47.10	4.70	470.00	221
O&G	7.00	<6.00	<6.00	<6.00	<6.00	170	<6.00
pH	6.90	7.80	7.10	6.30	7.30	6.40	8.00
Phosphate	1.00	0.40	0.20	3.1	0.21	0.43	2.90
Sulfate	300	178	440	61.1	<1	328	<5
TDS	1600	1700	3300	18000	4500	18000	4200
Total Organic Halogen	13	18	3.2	2.40	3.60	4.20	1.20
TSS	330	25	52	160	320	470	100
Radionuclides(1) (pCi/l)							
Total Gross Alpha	<27.3	<33.2	<46.9	<141	<46.9	<141	
Total Gross Beta	<27.1	<29.9	<39.8	<120	<39.8	343	
Total Gross Gamma(2)	517	560	342	429	966	1150	
Total Sr-90	<2.4	<1.4	<2.4	9.9	2.1	9.2	
Total Th-230	<0.8	<1.2	<1.1	<1.6	<1.8	<2.5	
Total Th-232	<0.3	1.2	<0.5	0.8	<0.8	1.1	
Total Th-228	<0.7	<1.1	<1.0	<1.4	<1.6	2.2	

*Data from two sampling events: 1988 and 1992; data has not been validated.

(1) 1992 data

(2) 12.8 - 1947 KeV

- Traces of strontium-90 and cesium-137 were detected at several sampling points. There is insufficient data at this time to determine whether these levels are within the range of background.

- The levels of thorium could be explained by the presence of the relatively insoluble magnesium-thorium slag. Thorium may be present in several forms. Thorium oxide is relatively insoluble, however thorium chloride or thorium sulfate would be soluble in vater. These compounds could be formed when magnesium-thorium slag comes into contact with an acid. The presence of acids in the landfill is suggested by historical records of the Site operation.

3.1.2.3 Groundwater

Groundwater monitoring is the first of two major components of the environmental monitoring program (surface water monitoring is the second) established by the 1980 Consent Order and the 1984 Amendment to the Consent Order. The frequency of sampling has evolved over time in accordance with the Consent Order and its Amendment:

- quarterly sampling (February, May, August, November): 1981
- semi-annual sampling (May, November): 1982-1989
- annual sampling (May): 1990-2015

As of January 1994, there have been 24 sampling events. The current monitoring locations for groundwater and surface water are shown in Figure 3-2.

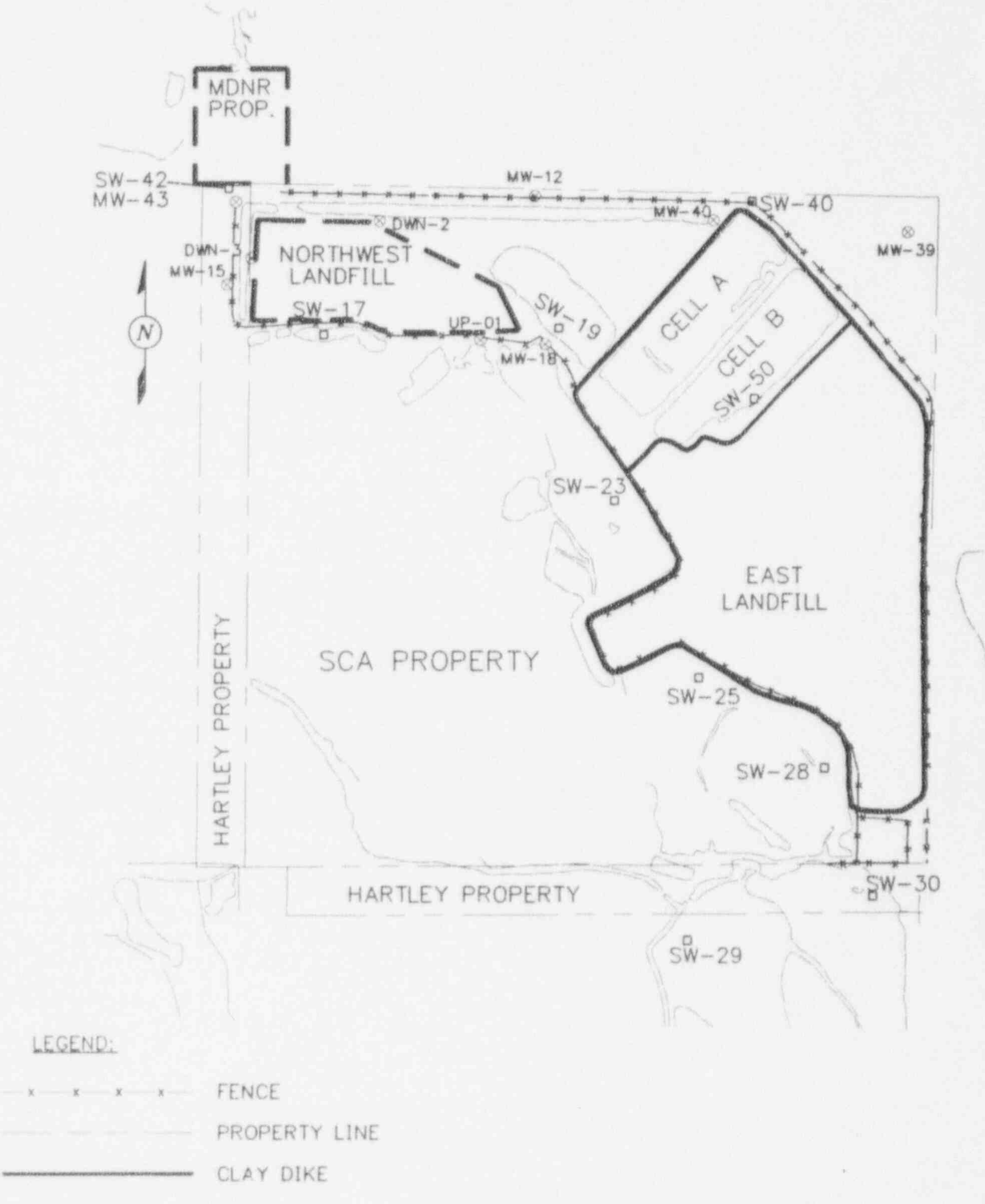
Two sets of monitoring wells have been included in the monitoring program. The first set, specified by the Consent Order, consists of nine groundwater sampling location numbered 12, 15, 16, 18, 39, 40, 43, 45, 47.

The second set, specified by the Amendment to the Consent Order, consists of ten wells:

MW-12	MW-39	MW-47	DWN-3
MW-15	MW-40	UP-1	
MW-18	MW-43	DWN-2	

Table 3-5 is an inventory of these monitoring wells. Note that MW-47 is actually a leachate well.

The list of groundwater analytes has also changed with time as specified by the Consent Order and its Amendment. The analytes required depended on which quarter the samples were taken. For the time period 1981 to 1984, samples taken in February or August required eight analytes:



⊗ MW = MONITORING WELL
▫ SW = SURFACE WATER MONITORING LOCATION

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DRAWING TITLE:
CURRENT GROUNDWATER AND SURFACE WATER MONITORING LOCATIONS
HARTLEY AND HARTLEY LANDFILL
BAY COUNTY, MICHIGAN

FIGURE 3-2

TABLE 3–5
HARTLEY AND HARTLEY LANDFILL
BAY COUNTY, MICHIGAN
EXISTING MONITORING WELL/PIEZOMETER INVENTORY

WELL/ PIEZOMETER	GROUND ELEVATION (MSL)	TOP OF CASING ELEVATION (MSL)	SCREEN LENGTH (FT)	SCREEN INTERVAL (MSL)	WELL/ PIEZOMETER INSIDE DIA. (IN)	MATERIAL OF CONSTRUCTION
INS–01	588.80	590.82	10.0	577.80–587.80	2.0	SS
INS–02	589.50	591.04	10.0	578.50–588.50	2.0	SS
INS–03	588.80	590.46	10.0	577.80–587.80	2.0	SS
UP–01*	586.30	588.38	10.0	575.30–585.30	2.0	SS
DWN–02*	587.20	588.49	10.0	576.20–586.20	2.0	SS
DWN–03*	587.70	589.30	10.0	576.70–586.70	2.0	SS
MW–12*	586.80	591.61	NA	NA	2.0	PVC
MW–12A [Well 3]	585.70	588.69	NA	NA	2.0	PVC
MW–12B	584.60	587.97	NA	NA	2.0	PVC
MW–15*	585.40	589.77	NA	NA	2.0	SS
MW–18*	586.60	591.07	NA	NA	2.0	SS
MW–39*	589.20	591.72	2.0	579.17–581.17	2.0	SS
MW–40*	586.50	589.47	2.0	575.42–577.42	2.0	SS
MW–40A	586.30	589.41	NA	NA	2.0	SS
MW–43*	587.00	588.87	2.0	577.37–579.37	2.0	SS
MW–43A	586.40	589.55	NA	NA	2.0	SS
MW–47	590.90	596.00	NA	NA	2.0	SS
PZ–1 [MW–18A]	588.00	591.20	3.0	576.45–579.45	2.0	SS
PZ–1A [B4][PZ–1]	588.0	590.44	1.0	577.17–578.17	1.5	PVC
PZ–2	591.20	594.78	3.0	573.58–576.58	2.0	SS
PZ–3	589.40	592.39	3.0	573.39–576.39	2.0	SS
PZ–4	591.60	594.86	3.0	577.36–580.36	2.0	SS
PZ–40	583.80	587.78	NA	NA	1.5	PVC
WELL 2	586.40	589.74	3.0	578.74–581.74	2.0	STEEL/SS
WELL 7	619.30	622.52	3.0	586.52–589.52	2.0	STEEL/SS
WELL 8	620.90	624.87	3.0	587.37–590.37	2.0	STEEL/SS
WELL 9	620.50	623.87	3.0	585.87–588.87	2.0	STEEL/SS
WELL 10	610.00	610.00	3.0	590.00–593.00	2.0	STEEL/SS

NOTES:

NA – Not Available
MSL – Mean Sea Level
SS – Stainless Steel
PVC – Polyvinyl Chloride
* – Utilized in Current Monitoring Program
[ ] – Alternate Identification

G:WINVENT.WK3\jwmiscdata

Chemical Oxygen Demand (COD)
Iron, Dissolved
Chloride
Specific Conductance
Total Organic Carbon (TOC)
Sulfate (as SO_4)
pH
Phenols

Samples taken in November required the same eight analytes required for the February/August samples plus eight additional analytes:

Calcium, Dissolved
Sodium, Dissolved
Magnesium, Dissolved
Alkalinity (as $CaCO_3$)
Nitrate (as Nitrogen)
Ammonia (as Nitrogen)
Lead, Dissolved
Total Chromium

For samples taken in May, an organics scan (volatile organic compounds) was required in addition to the 16 analytes required for the November samples.

For the time period 1985 to the present, the Amendment to the Consent Order requires a volatile organics analysis and the following ten analytes:

Chemical Oxygen Demand (COD)
Iron, Dissolved
Chloride
Specific Conductance
Total Organic Carbon (TOC)
pH
Lead, Dissolved
Total Chromium
Magnesium, Dissolved
Phenols

Monitoring for this list of analytes is required until the year 2015.

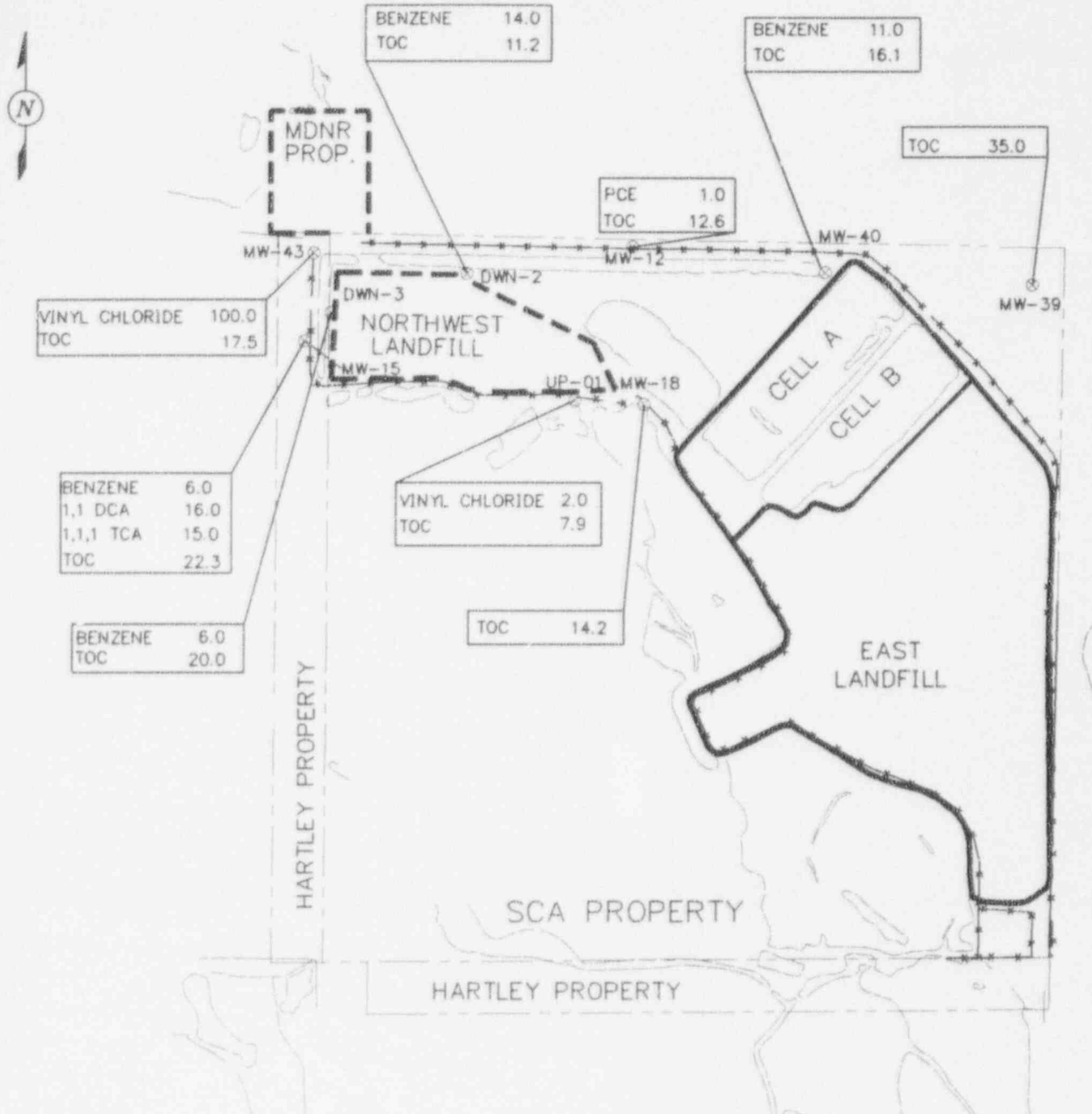
A summary of the 1992 values of the compounds detected are presented in Table 3-6. Figures 3-3 and 3-4 illustrate the levels of organics and inorganics measured at these locations.

TABLE 3-6
SUMMARY OF COMPOUNDS DETECTED IN GROUNDWATER[1]
1992 DATA[2]

		MW12	MW15	MW18	MW39	MW40	MW43	UP01	DWN02	DWN03
Benzene	μg/l	<1.0	6.0	<1.0	<1.0	11.0	<1.0	<1.0	14.0	<1.0
1,1 Dichloroethane	μg/l	<1.0	16.0	<1.0	<1.0	<1.0	1.0	<1.0	<1.0	<1.0
Tetrachloroethylene	μg/l	1.0	<1.0	<1.0)	<1.0	<1.0	<1.0	<1.0	<2.0	2.0
Vinyl Chloride	μg/l	<1.0	<1.0	<1.0	<1.0	<1.0	100	2.0	<1.0	<1.0
Total Phenols	mg/l	<0.005	0.005	0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Chlorides	mg/l	624	408	616	5.1	2237	117	57	479	183
Magnesium	mg/l	79	67.3	61.9	22.26	218	38.4	21.6	51.8	42
TOC	mg/l	12.6	22.3	14.2	35.0	16.1	17.5	7.9	11.2	20.0

(1) The compounds listed were detected above the Michigan Act 307 Type B Acceptable Detection Limits in groundwater that had a health-based Drinking Water Value except for chlorides, magnesium, and TOC. Data has not been validated.

(2) In 1992 WMI's Environmental Monitoring Laboratory (WMI-EML) analyzed the groundwater.



LEGEND

- FENCE
- PROPERTY LINE
- CLAY DIKE
- SLURRY WALL

NOTE:
1. ALL SAMPLES IN ug/l UNLESS OTHERWISE NOTED.

DCA- DICHLOROETHANE
PCE- TETRACHLOROETHENE
TOC- TOTAL ORGANIC CARBON (mg/l)

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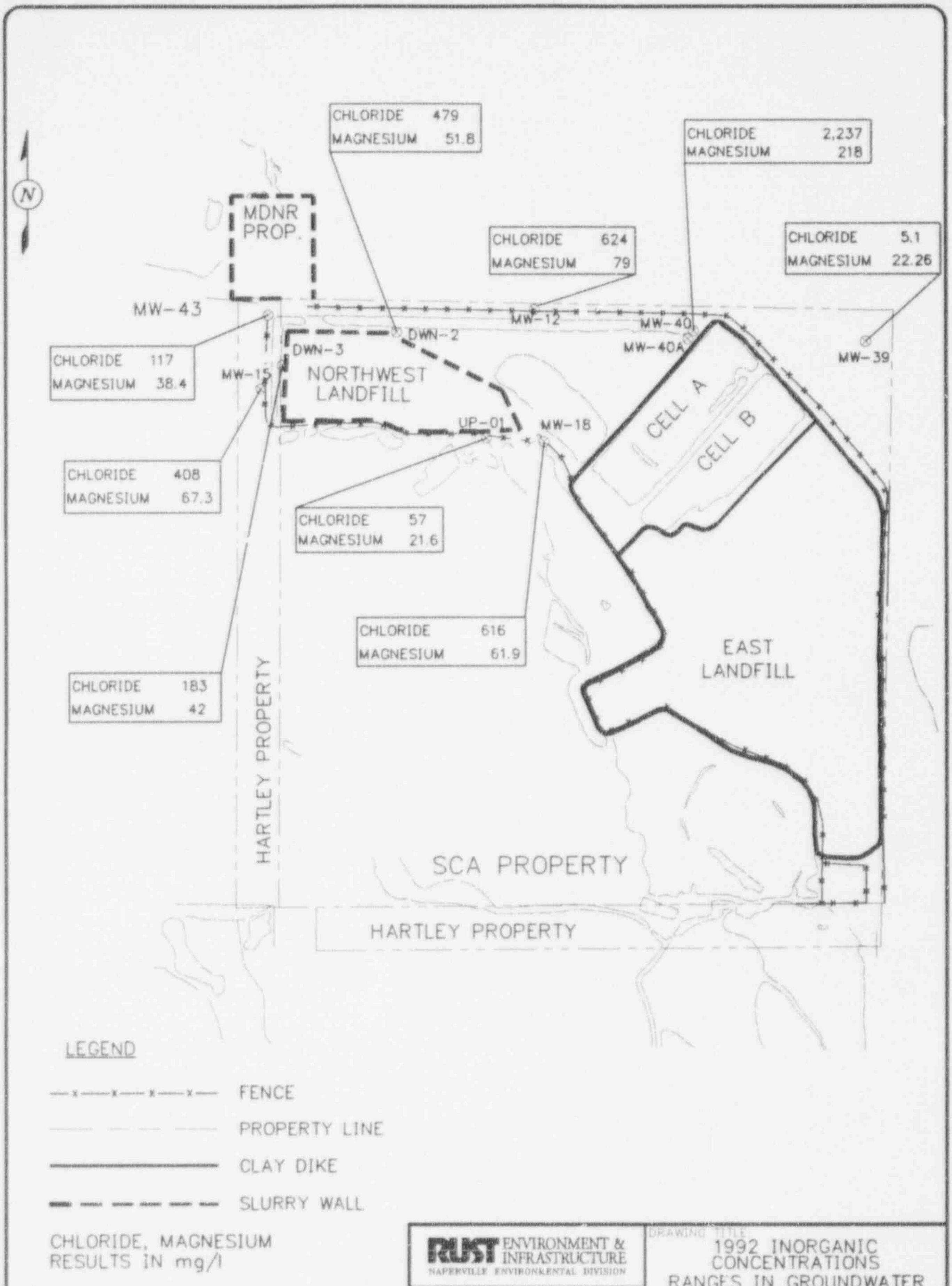
CAD FILE NO. 25780RGW

DRAWING TITLE:
1992 ORGANIC CONCENTRATION RANGES IN GROUNDWATER
HARTLEY AND HARTLEY LANDFILL
BAY COUNTY, MICHIGAN

FIGURE 3-3



1992 INORGANIC CONCENTRATIONS RANGES IN GROUNDWATER
HARTLEY & HARTLEY LANDFILL
BAY COUNTY, MICHIGAN

FIGURE 3-4

3.1.2.4 Surface Water

Surface water monitoring is the second major component of the environmental monitoring program established by the 1980 Consent Order and its 1984 Amendment. The frequency of sampling is the same as for groundwater monitoring. The surface water sampling locations are shown in Figure 3-2.

Two sets of surface water monitoring locations have been included in the monitoring program. The first set, specified by the Consent Order, consists of nine monitoring locations:

SW-12	SW-18	SW-43
SW-15	SW-39	SW-45
SW-16	SW-40	SW-47

The second set, specified by the Amendment to the Consent Order, consists of seven monitoring locations:

SW-17	SW-28	SW-42
SW-23	SW-30	
SW-25	SW-40	

The list of surface water analytes is the same list specified for groundwater samples. A summary of the surface water data is presented in Table 3-7. Figures 3-5 and 3-6 illustrate the levels of organics and inorganics measured at these locations. Historically the detection limits for the surface water measurements have been higher than for the groundwater measurements.

3.2 POTENTIAL EXPOSURE PATHWAYS

The sources and potential pathways of contaminant migration are shown on Figure 3-7, the Potential Exposure Pathway Model. The primary contaminant source is the landfill contents which contains municipal, commercial and industrial wastes, and magnesium-thorium slag. The specific categories of potential contaminants include volatile organic compounds, semi-volatile organic compounds, metals, and radionuclides. A potential secondary contaminant source is contaminated environmental media beyond the encapsulated landfills; the potential contaminants are probably the same as those found in the landfill contents.

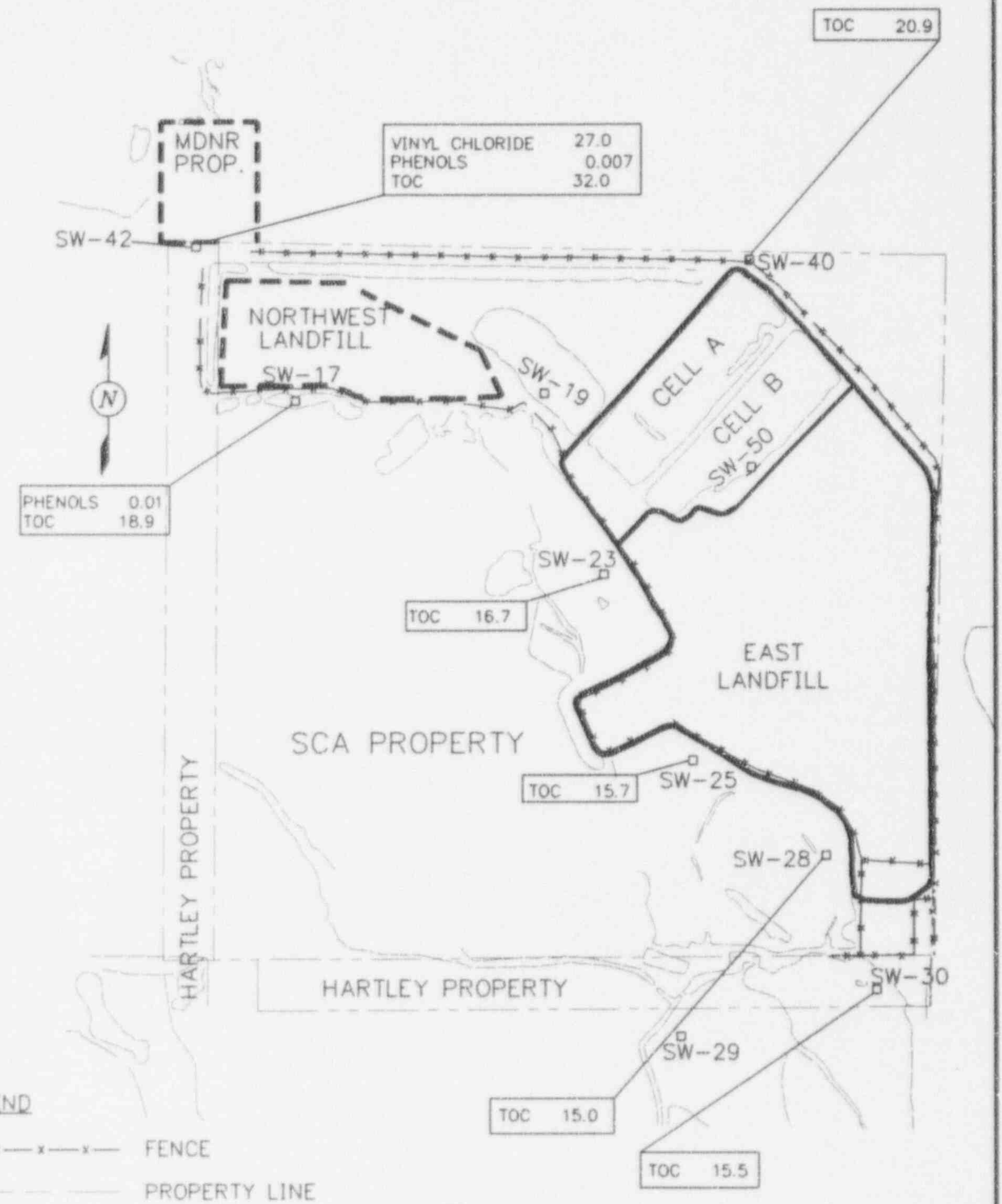
Primary chemical release mechanisms include particulate and volatile emissions, percolation, runoff, and erosion. These release mechanisms result in a secondary contaminant source which includes soil under and surrounding the landfill. Some of these sources also emit gamma radiation; the pathway to be considered is direct exposure to gamma rays.

Secondary release mechanisms include percolation which results in potential contamination of groundwater, sediment, surface water, and wetlands. The secondary release mechanisms of runoff and erosion may contaminate surface water, sediment, and wetlands. Contamination of surface water, sediment, wetlands, and air could also arise from the secondary release mechanism of dust emissions. Radon and landfill gas emissions are another secondary release mechanism. Potential

TABLE 3-7
SUMMARY OF COMPOUNDS DETECTED IN SURFACE WATER(1)
1992 DATA (2)

		SW17	SW23	SW25	SW28	SW30	SW40	SW42
Vinyl Chloride	μg/l	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	27.0
Chlorides	mg/l	81.0	222	266	265	230	384	243
Magnesium	mg/l	15.3	29.9	34.0	34.0	31.0	55.6	50.4
Total Phenols	mg/l	0.01	<0.005	<0.005	<0.005	<0.005	<0.005	0.007
TOC	mg/l	18.9	16.7	15.7	15.0	15.5	20.9	32.0

(1) The compounds listed were detected above laboratory detection limits. Data has not been validated.
(2) In 1992 WMI EML analyzed the surface water.



LEGEND

- FENCE
- PROPERTY LINE
- CLAY DIKE
- SLURRY WALL

TOC- TOTAL ORGANIC CARBON (mg/l)
PHENOLS IN mg/l

NOTE:
1. ALL SAMPLES IN ug/l UNLESS OTHERWISE NOTED.

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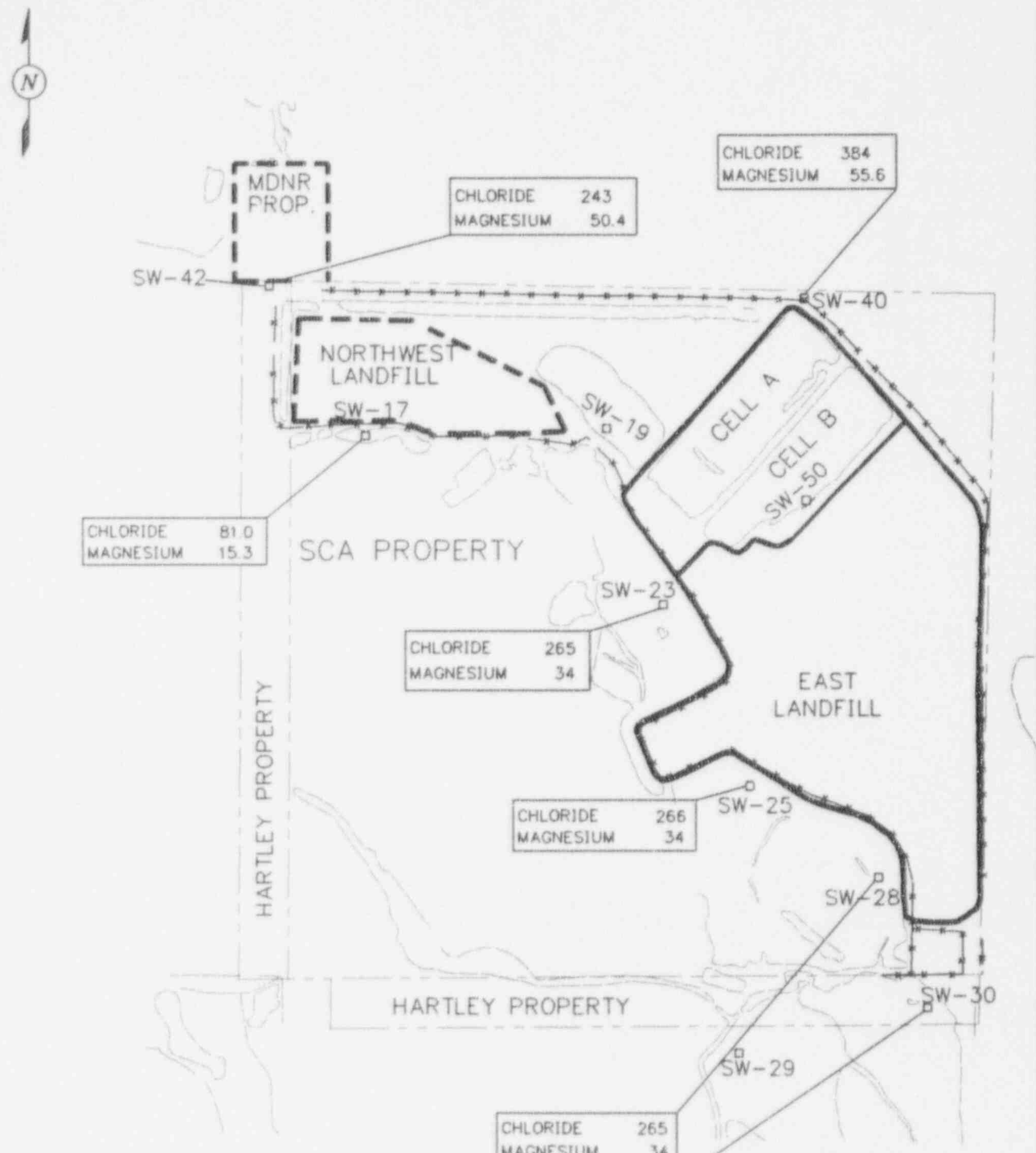
1992 ORGANIC CONCENTRATION RANGES IN SURFACE WATER
HARTLEY AND HARTLEY LANDFILL
BAY COUNTY, MICHIGAN

FIGURE 3-5



LEGEND

—x—x—x—x— FENCE

PROPERTY LINE

CLAY DIKE

SLURRY WALL

CHLORIDE, MAGNESIUM RESULTS IN mg/l

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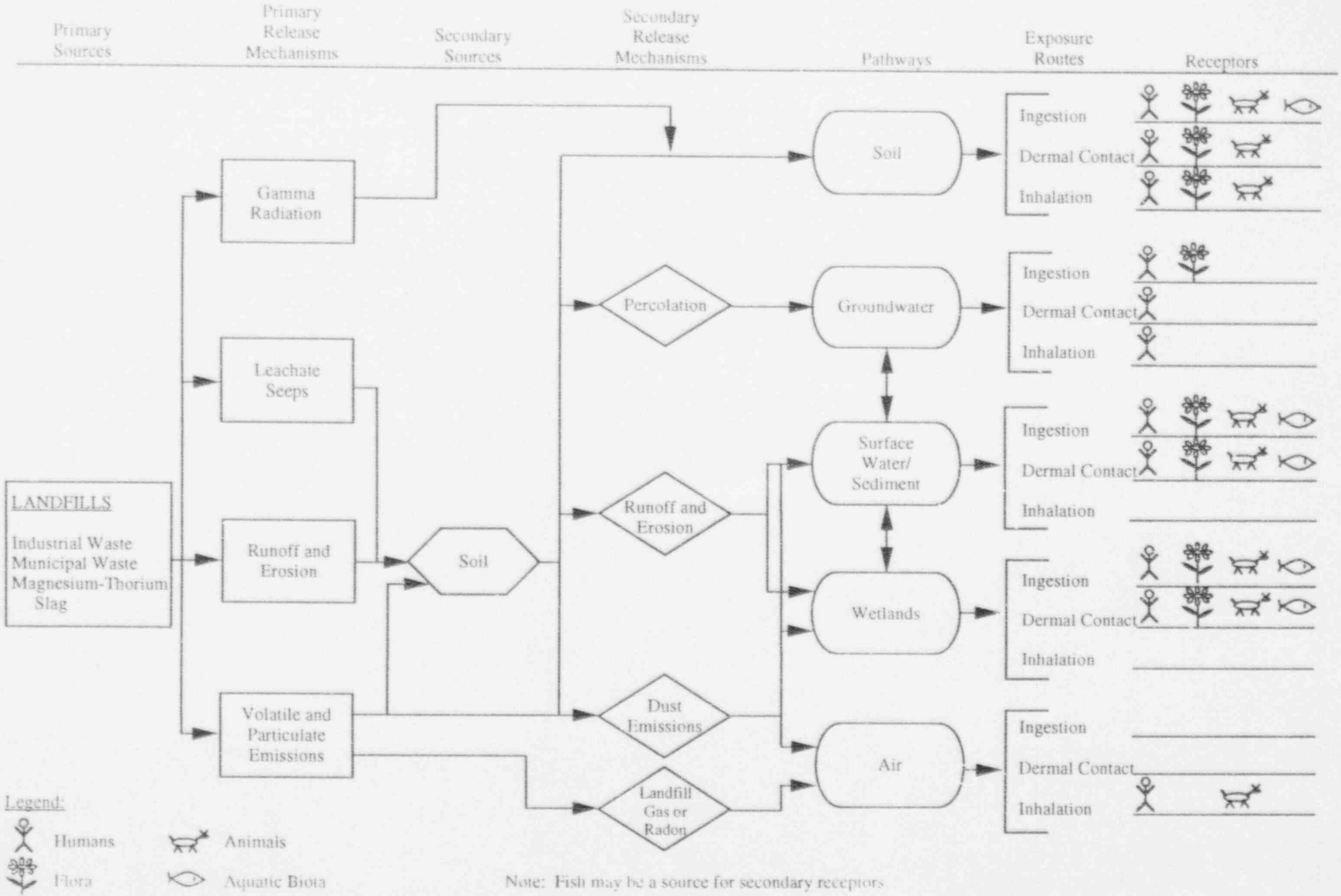
DRAWING TITLE:
1992 INORGANIC CONCENTRAION RANGES IN SURFACE WATER
HARTLEY AND HARTLEY LANDFILL
BAY COUNTY, MICHIGAN

FIGURE 3-6

FIGURE 3-7
POTENTIAL EXPOSURE PATHWAY MODEL
HARTLEY & HARTLEY LANDFILL
BAY COUNTY, MICHIGAN



contaminant transport pathways to receptors include air, groundwater, sediment, surface water, and wetlands.

Primary receptors include humans through external gamma radiation exposure, ingestion, inhalation, and dermal contact. Terrestrial and aquatic species are primary receptors through external gamma radiation exposure, ingestion, inhalation, and dermal contact. Recreational activities such as hunting and fishing could result in human exposure through ingestion.

3.3 PRELIMINARY REMEDIAL ACTION OBJECTIVES

Preliminary remedial action objectives are proposed for each medium (such as soil, groundwater, and leachate) at the Site. The preliminary remedial action objectives, the general response actions, and associated potential remedial technology types and process options are summarized in Tables 3-8 through 3-12. After data have been gathered and evaluated, the remedial action objectives will be refined and further developed or, as appropriate, will be eliminated. The remedial technologies will also be reviewed and developed. Newly recognized remedial technologies and processes may be added to provide a broader base from which to select remedies. The technologies and processes that are determined to be inappropriate for the Site will be eliminated. A preliminary screening of technologies and process options is given in Appendix B.

The media that may be potentially evaluated for remediation at the Site are soil/landfill contents, groundwater, leachate, surface water, sediment, and landfill gas. A summary of the remedial action objectives and general response actions for each medium is presented below. The remedial action objectives and general response actions apply to both the encapsulated waste material and to potential contamination sources outside the landfills.

To protect human health, the remedial action objectives for soil and landfill contents are to prevent ingestion, direct contact with, or inhalation of contaminated material, and to prevent bioaccumulation of toxic compounds that would result in unacceptable risks. Additional objectives are to reduce gamma radiation levels to as low as reasonably achievable (ALARA) and to protect the inadvertent intruder. To protect the environment, remedial action objectives include preventing migration of contaminants that would result in unacceptable risks to human health and the environment. The general response actions include: (1) the no-action alternative, (2) institutional controls, (3) containment, (4) treatment, and (5) removal and disposal (see Table 3-8).

The human health remedial action objective for groundwater is to prevent ingestion of water that is contaminated in excess of acceptable levels (acceptable levels will be determined during the course of the RI/FS). In addition, water quality criteria for surrounding water bodies must be met to protect aquatic species. Remedial action objectives related to environmental protection include restoring the groundwater aquifer surrounding the Site to concentrations below the acceptable risk in a reasonable period of time. The general response actions include: (1) the no-action alternative, (2) institutional controls, (3) containment, (4) extraction, (5) groundwater or leachate treatment, and (6) disposal. Collection and treatment options include external and in-situ treatment (see Table 3-9).

TABLE 3-8
PRELIMINARY REMEDIAL ACTION OBJECTIVES
SOIL/LANDFILL CONTENTS

REMEDIAL ACTION OBJECTIVES	GENERAL RESPONSE ACTIONS	REMEDIAL TECHNOLOGY TYPES	PROCESS OPTIONS
For Human Health: Prevent ingestion/direct contact/inhalation of contaminated soil/landfill contents	No Action: - No action	No Action: - None	No Action Options: - None
Reduce exposure to radiation (ALARA)	Institutional Controls: - Access restrictions - Monitoring and analysis	Institutional Controls: - Access restrictions - Monitoring and analysis	Institutional Control Options: - Deed restrictions: land usage - Fencing - Signs and monuments - Groundwater monitoring
Minimize risk to inadvertent intruder	Containment Actions: - Containment	Containment Technologies: - Capping - Dust control - Surface control - Erosion control - Vertical barriers	Containment Process Options: - Composite capping - Non-composite capping - Grading - Revegetation - Vertical barriers
For Environmental Protection: Prevent migration of contaminants that would result in groundwater contamination in excess of acceptable levels.*	Removal/Treatment Actions: - In-situ treatment - Removal/treatment/disposal - Removal/disposal	Treatment Technologies: - Deep soil mixing - Thermal treatment - Solidification/stabilization - Biological treatment - Size reduction for disposal	Treatment Options: - Incineration/pyrolysis - Fluidized bed combustion - Vitrification - Aerobic/anaerobic degradation - Land treatment - In-situ biological treatment - Dewatering - Infrared thermal treatment - Size reduction
		Removal and Disposal Technologies: - Excavation/disposal	Removal/Disposal Options: - Consolidation on-site - Removal/disposal off-site - Drum removal/disposal - Entombment of sludge from on-site treatment plant

*Acceptable levels (ARARs) will be determined during the course of the RI/FS.

TABLE 3-9
PRELIMINARY REMEDIAL ACTION OBJECTIVES
GROUNDWATER/LEACHATE

REMEDIAL ACTION OBJECTIVES	GENERAL RESPONSE ACTIONS	REMEDIAL TECHNOLOGY TYPES	PROCESS OPTIONS
For Human Health: Prevent ingestion/direct contact of water contaminated in excess of acceptable levels.*	No Action: - No action	No Action: - None	No Action Options: - None
	Institutional Controls: - Access restrictions - Monitoring and analyses	Institutional Controls: - Access restrictions - Monitoring and analysis	Institutional Control Options: - Deed restrictions: groundwater usage - Fencing - Signs and monuments - Groundwater monitoring
	Containment Actions: - Containment	Containment Technologies: - Vertical barriers - Hydraulic barriers	Containment Process Options: - Slurry wall tied into glacial till/grout curtain - Vitrification as barrier wall - Groundwater pumping
For Environmental Protection: Restore groundwater aquifer to acceptable levels.* Prevent migration of leachate to surface water or groundwater.	Removal/Treatment Actions: - Collection/treatment/discharge - On-site groundwater treatment - In-situ groundwater treatment Discharge Actions: - Disposal	Removal Technology Types: - Groundwater/leachate extraction Treatment Technologies: - Physical/chemical treatment - Biological treatment - In-situ treatment - Off-site treatment	Extraction Process Options: - Wells - Subsurface drains Physical/Chemical Treatment Options: - Air stripping/steam stripping - Carbon adsorption/reverse osmosis - Chemical oxidation/reduction - Photo/chemical oxidation - Precipitation - Ion exchange Biological Treatment Options: - Aerobic/anaerobic - Land treatment - In-situ biological treatment - Activated sludge/powdered activated carbon treatment Disposal Options: - Discharge to POTW or RCRA TSDF - Discharge to surface water (after treatment) - Deep-well injection (after treatment) - Temporary storage - Seepage basins/subsurface drains

*Acceptable levels (ARARs) will be determined during the course of the RI/FS.

TABLE 3-10
PRELIMINARY REMEDIAL ACTION OBJECTIVES
SURFACE WATER

REMEDIAL ACTION OBJECTIVES	GENERAL RESPONSE ACTIONS	REMEDIAL TECHNOLOGY TYPES	PROCESS OPTIONS
For Human Health: Prevent ingestion/direct contact/ inhalation/bioconcentration of contaminated surface water in excess of acceptable levels.*	No Action: - No action	No Action: - None	No Action Options: - None
	Institutional Controls: - Access restrictions - Sampling	Institutional Controls: - Access restrictions - Sampling/gauging stations	Institutional Control Options: - Deed restrictions - Fencing - Signs and monuments - Surface water collection and sampling
	Diversion/Collection Actions: - Surface water runoff interception - Surface water treatment/discharge	Surface Water Collection/Control Technologies: - Sediment control barriers - Erosion control - Runon/runoff control	Collection/Control Options: - Dikes and berms - Silt fences - Vegetation - Grading - Pumping/diversion
For Environmental Protection: Restore surface water to acceptable levels.*	Treatment Actions: - On-site treatment - Off-site treatment	Surface Water Treatment Technologies: - Physical/chemical treatment - Biological treatment - Wetlands as treatment	Physical/Chemical/Biological Treatment Options: (See process options for groundwater/leachate, Table 3-8) - Wetlands as treatment
	Discharge Actions: - Disposal	Surface Water Disposal Technologies: - Prior to treatment - After treatment	Disposal Options: (See process options for groundwater/leachate, Table 3-8)

*Acceptable levels (ARARs) will be determined during the course of the RI/FS.

TABLE 3-11
PRELIMINARY REMEDIAL ACTION OBJECTIVES
SEDIMENT

REMEDIAL ACTION OBJECTIVES	GENERAL RESPONSE ACTIONS	REMEDIAL TECHNOLOGY TYPES	PROCESS OPTIONS
For Human Health: Prevent ingestion/direct contact/ bioconcentration of contaminated sediment in excess of acceptable levels.*	No Action: - No action	No Action: - None	No Action Options: - None
	Institutional Controls: - Access restrictions	Institutional Controls: - Access Restrictions	Institutional Control Options: - Deed restrictions: land usage - Fencing - Signs and monuments
		Sediment Removal Technologies: - Excavation	Removal Options: - Sediment excavation
	Sediment Excavation/Treatment Actions: - Removal/disposal - Removal/treatment/disposal	Treatment Technologies: - Thermal treatment - Physical/chemical treatment - Solidification/stabilization - Biological treatment - Wetlands as treatment	Treatment Options: (See also process options for soil/landfill contents, Table 3-7) - Infrared thermal treatment - Circulating fluidized bed - Pyrolysis
For Environmental Protection: Prevent releases of contaminants from sediments that would result in surface water levels in excess of acceptable levels.*			Physical/Chemical Treatment Options: (See process options for soil/landfill contents, Table 3-7) - Wetlands as treatment
		Sediment Disposal Technologies: - Disposal	Sediment Disposal Options: (See process options for soil/landfill contents, Table 3-7)

*Acceptable levels (ARARs) will be determined during the course of the RI/FS.

TABLE 3-12
PRELIMINARY REMEDIAL ACTION OBJECTIVES
LANDFILL GAS

REMEDIAL ACTION OBJECTIVES	GENERAL RESPONSE ACTIONS	REMEDIAL TECHNOLOGY TYPES	PROCESS OPTIONS
For Human Health: Prevent off-site migration of landfill gas Prevent inhalation or explosion	No Action: - No action	No Action: - None - Monitoring	No Action Options: - None - Gas monitoring
	Collection Actions: - Gas collection	Collection Technologies: - Landfill gas collection	Collection Process Options: - Passive vents - Active gas collection system
	Treatment Actions: - Landfill gas treatment	Treatment Technologies: - Landfill gas treatment	Treatment Process Options: - Gas flares - Catalytic oxidation - Carbon adsorption

The human health remedial action objectives for surface water are to prevent ingestion or inhalation of or direct contact with contaminated surface water in excess of acceptable levels and to prevent bioconcentration of contaminants. The environmental remedial action objective is to restore surface water to acceptable levels. The general response actions include: (1) no action, (2) institutional controls, (3) diversion/collection actions, (4) treatment actions, and (5) discharge actions (see Table 3-10).

The human health remedial action objectives for sediment are to prevent ingestion of, direct contact with, or bioconcentration of contaminated sediment in excess of acceptable levels. The environmental remedial action objective is to prevent the release of contaminants from sediments that could result in surface water concentrations in excess of acceptable levels. General response actions include: (1) no action, (2) institutional controls, and (3) excavation/treatment actions (see Table 3-11).

The human health remedial action objective for landfill gas is to prevent off-site migration of the landfill gas. The general response actions include: (1) the no-action alternative, (2) institutional controls, (3) collection, and (4) treatment (see Table 3-12).

The response actions and associated remedial technology types listed in Tables 3-8 through 3-12 are the result of a preliminary screening of potentially applicable technologies. This preliminary screening has been performed to focus the project from the outset on only those technologies that are potentially feasible. Table B-1 in Appendix B summarizes this screening.

3.4 PRELIMINARY IDENTIFICATION OF APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARs) AND TO-BE-CONSIDERED REQUIREMENTS (TBCs)

The Site is currently listed as an Act 307 site (pursuant to the Michigan Environmental Response Act) because of the presence of hazardous substances. The Site is also listed on the Site Decommissioning Management Plan (SDMP) by the U.S. NRC because of the presence of a potentially licensable quantity of thorium. Any investigations, closure actions, or remedial actions taken at the Site must comply with the substantive and administrative requirements of Act 307 and the SDMP. In addition, there are other federal, state, and local laws and regulations which potentially apply to the Site. To ensure that the Site is brought to final closure in a manner which satisfies the MDNR, the U.S. NRC, and other applicable government agencies, an analysis of ARARs and TBCs will be performed.

Requirements which are not applicable may be evaluated according to the following factors to determine whether they are relevant and appropriate:

(1) the purposes of the requirement and of the action,
(2) the medium regulated and the medium at the site,
(3) the substances regulated and the substances found at the site,
(4) the actions regulated and the remedial action contemplated at the site,
(5) any variances, waivers, or exemptions of the requirement and their availability for the circumstances at the site,
(6) the type of place regulated and the type of place affected by the release or action,

(7) the type and size of structure or facility regulated and the type and size of structure/facility at the site, and

(8) the use or potential use of resources in the requirements and the use/potential use of resources at the site.

In addition to ARARs, other advisories, criteria, or guidance to be considered (TBCs) may be identified. One of the tasks of this Work Plan (see Section 5.9.2) is to develop an initial list of potential ARARs and TBCs for the site to promote discussion of the requirements to be met for the Hartley and Hartley Landfill. Appropriate federal, state, and local agencies will be requested to identify their specific requirements.

4.0 WORK PLAN RATIONALE AND APPROACH

The primary objectives of the RI/FS Work Plan are to determine the nature and extent of contamination, and to evaluate remedial alternatives. As required by both the NCP and Michigan Act 307, the remedial alternatives that will be addressed include no action, on-site containment, and off-site disposal. A combination of off-site disposal of discrete pockets of contamination and on-site containment of residual waste may be evaluated, if appropriate. The goal of the RI/FS is to identify and present a comparison of feasible closure plans for the site that are consistent with the NCP and are acceptable to the regulatory agencies.

The specific RI/FS tasks to accomplish these objectives, as discussed in more detail in Section 5.0, include:

Task 1	Project Planning
Task 2	Community Relations
Task 3	Site Investigation
Task 4	Sample Analysis and Data Validation
Task 5	Data Evaluation
Task 6	Risk Assessment
Task 7	Treatability Studies
Task 8	Remedial Investigation (RI) Report
Task 9	Remedial Alternatives Development and Screening
Task 10	Detailed Analysis of Alternatives
Task 11	Feasibility Study (FS) Report
Task 12	Legal Support

The rationale and approach upon which these tasks are based are discussed below.

4.1 DETERMINATION OF THE NATURE AND EXTENT OF CONTAMINATION

The type and volume of chemical and radioactive material at the site will be determined by evaluating data gathered during the field activities (Task 3) and by reviewing historical records of the site. The contents of each landfill will be evaluated and the fill thickness determined. Preliminary data indicate that radioactive material is mixed with chemical contamination throughout both landfills. The intrusive field work will provide information on the extent of mixing.

Existing data indicate that some areas outside of the current landfill boundaries may be contaminated with chemical and/or radioactive material. Sufficient information will be obtained to evaluate remedial alternatives for these suspected localized areas of contamination. Usually, discrete locations containing material of higher toxicity or mobility than in other site areas are called "hot spots." However, this term will not be used in this work plan to avoid confusion since radioactive material is also present on-site and is commonly referred to as "hot."

Leachate levels and quality will be measured in each landfill using existing and proposed monitoring wells and piezometers. These data will provide information for the design of the interim remedial action (the leachate collection and treatment system) as well as information that will be used to attain the primary objectives of the RI/FS Work Plan.

Groundwater, surface water, and sediment samples will be collected and analyzed for chemical and radiological parameters. The data will be used to determine the magnitude and extent of contamination, if any, that exists beyond the encapsulated areas.

Since the East Landfill accepted municipal as well as commercial and industrial waste, landfill gas characteristics will be evaluated in order to determine appropriate remedial actions. Due to the nature of the materials known and suspected to be present, radon data may be obtained in addition to the data usually obtained for municipal landfills. The potential for contaminant transport via an air pathway (i.e., to be released into the air) will be evaluated.

4.2 HUMAN HEALTH AND ENVIRONMENTAL RISK ASSESSMENTS

Evaluations of the chemical and radiologic risks to human health and the environment (Task 6) will be conducted to:

1. Establish the basis for taking early action (i.e., the interim response leachate collection and treatment system), and

2. Compare the short-term and long-term risks of proposed final remedial actions.

The risk evaluations that will be performed during the feasibility study will follow the EPA guidance "Risk Assessment Guidance for Superfund: Volume I - Human Health Evaluation Manual" and will comply with both MDNR and U.S. NRC guidance documents as applicable.

4.3 DATA QUALITY OBJECTIVES (DQOs)

Data Quality Objectives (DQOs) were developed by U.S. EPA based on the premise that different end-users of data necessitate varying levels of analytical data quality. U.S. EPA has defined five levels of analytical data quality: Level (I) field screening; Level (II) on-site analysis; Level (III) engineering analyses; Level (IV) confirmational analyses - CLP Routine Analytical Services (RAS) analysis; and Level (V) non-standard analyses - Special Analytical Services (SAS).

Data collected during the RI/FS will be used to determine the nature and extent of contamination at the site (site and waste characterization), to establish the level of protection needed for investigators or workers at the site (health and safety), to evaluate the potential threat posed by the site to public health and the environment (risk assessment), and to evaluate remedial technologies (alternatives evaluation). Decision types and data needs are identified in the following paragraphs for each medium of interest. Data-use analytical levels are specified as defined in Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA, Interim Final (Office of Solid Waste and Environmental Response (OSWER) Directive 9355.3-01, October 1988).

Data requirements have been identified by evaluating existing data with reference to the Conceptual Site Model (Figure 3-6) and determining what additional data are necessary to accomplish the project objectives. The RI field program will key in on the sampling and analysis of the suspected primary source and the pathways as presented in the Conceptual Site Model. Data needs were also identified according to the response action/remedial technologies that were identified as potentially feasible for this site (see Section 3.3). The Quality Assurance Project Plan for the Hartley and Hartley Site describes the DQO levels for samples to be collected during the field investigation.

4.3.1 Sampling Plan

A summary of the media to be sampled and the parameters to be analyzed is shown in Table 4-1. Leachate and landfill samples will be collected for radiological and chemical analysis (DQO Level IV) to determine waste characteristics and types and to evaluate remedial alternatives.

As shown in Figure 3-6, the primary suspected contaminant sources at the Site are the two landfills. A 100 foot x 100 foot grid has been established on the Site and it is tied into the State plan coordinate system. The grid will be used as a reference to coordinate field activities and to discuss observations of on-site features. It is not a "verification grid," i.e., establishment of the grid does not imply that a sample will be taken within each grid. The sampling plan will be a combination of representative sampling approaches, as described in U.S. EPA's "Removal Program Representative Sampling Guidance," Nov. 91, PB92-963408. Judgmental sampling will be used to investigate suspected areas of contamination outside the landfill boundaries. Judgmental sampling is an attempt to measure "worst-case" conditions, i.e., highest concentrations.

Systematic grid sampling will be used to delineate the extent of contamination and to define concentration gradients. Within the East and Northwest Landfills, systematic random sampling will be used to estimate average concentrations in the landfills.

Field instruments will be used to measure the percent of methane in the borings (DQO Level I). A field portable photoionization detector will be used to provide data on the order of magnitude of volatile organic compounds at each of the borings (DQO Level I).
Surface soil samples will be collected from specific locations on-site and analyzed for radionuclides.

4.3.2 Analysis of Samples

Geotechnical analyses will be done on samples collected from the native clay beneath the landfills (DQO Level III). These geotechnical parameters (wet sieve analysis, hydrometer test, Atterberg limits, cationic exchange capacity, moisture content, and hydraulic conductivity) are needed to identify and classify the soil. The structural properties of the soil will be determined to evaluate the bearing capacity and settlement characteristics of the base of the landfill. The hydraulic conductivity analysis will provide information on the rate of contaminant migration through the native soil.

Groundwater, surface water, sediment, and subsurface soil samples will be collected and analyzed for radiological and chemical parameters (DQO Levels IV and V) to determine the extent of contamination. Background samples of surface water and sediment will also be collected and

TABLE 4-1
SUMMARY OF MEDIA TO BE SAMPLED
AND PARAMETERS TO BE ANALYZED

	Landfill Contents	Leachate	Landfill Gas	Surface Soil	Groundwater	Surface Water	Sediment	Native Clay	Background Sediment	Background Surface Water
TCL Volatiles	X	X			X	X	X	X		
TCL Semivolatiles	X	X			X	X	X	X	X	X
TCL Pesticides/PCBs	X	X			X	X	X	X	X	X
Total TAL Metals/% Solids	X	X			X	X	X	X	X	X
Dissolved TAL Metals/%Solids		X				X				X
PBBs	X	X			X	X	X	X	X	X
Radionuclides	X	X		X	X	X	X	X	X	X
% Solids							X	X	X	
% Ash							X	X	X	
Chemical Oxygen Demand		X				X				X
Biochemical Oxygen Demand		X				X				X
Total Suspended Solids		X			X	X				X
Total Dissolved Solids		X			X	X				X
Ammonia		X				X				X
Nitrate		X				X				X
Nitrite		X				X				X
Total Phosphorus		X				X				X
Sulfates		X				X				X
Chlorides		X			X	X				X
Methane			X							
Geotechnical Parameters								X		

TAL - Target Analyte List
TCL - Target Compound List
PBBs - Polybrominated biphenyls

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analyzed. Analytes will include the Target Analyte List (TAL) metals, and the Target Compound List (TCL) volatiles, semi-volatiles and pesticides/PCBs.

Several additional water quality parameters will be measured (DQO Level III) in the leachate, surface water, and groundwater to assess specific impacts from the fill and to evaluate remedial alternatives. The rationale for the parameters selected is as follows:

Biochemical Oxygen Demand (BOD): Assess the degree of microbially mediated oxygen consumption by contaminants; high levels may affect remedial alternative selection.

Chemical Oxygen Demand (COD): Measure the chemical oxidation in water; poorly degradable contaminants will elevate COD above BOD level and may affect remedial alternative.

Chlorides: Major mobile anion associated with typical landfill leachate.

Sulfates: Anion associated with typical landfill leachate; reduction of sulfate and organic sulfur to H_2S occurs in anaerobic conditions, and oxidation of H_2S to sulfate occurs in aerobic conditions.

Ammonia Nitrogen: Required by POTW.

Total Phosphorus: High levels enhance algae growth and may complicate some treatment alternatives.

Total Dissolved Solids, Total Suspended Solids: Remedial alternatives such as filtration and sorption are dependent on solids loading.

PBBs: Requested by the MDPH since PBB wastes may have been accepted at the Site.

Percent Ash: Allows estimation of total organic carbon on solids.

The analytical data will be used to determine the nature and extent of contamination and to develop the risk assessment (Task 6).

In order to fully evaluate remedial alternatives, the following hydrogeologic data will be collected: aquifer (and landfill) hydraulic conductivity will be measured using slug tests on new and existing wells; water levels will be measured to develop a groundwater elevation contour map; groundwater discharge to surface water bodies will be assessed with staff gauges; and field parameters will be measured to assess groundwater stability after purging (pH, conductivity, and temperature) (DQO Level I).

The following geophysical techniques may be used: downhole gamma logging of the existing wells and piezometers may enable preliminary estimates of the volume of radioactive material to be determined; and an electromagnetic survey of the property may provide information to guide the judgmental sampling effort.

4.4 REMEDIAL INVESTIGATION APPROACH

The field activities (Task 3) for this Site have been organized into three phases. The scope of work for each phase will be proposed in a Field Sampling Plan and submitted to the MDNR and U.S. NRC for review and approval. RUST E&I will submit a technical memorandum following completion of each phase of field work. A final RI report will be submitted upon completion of the last phase.

The Phase I field investigation (an aboveground, surface gamma survey of the landfill areas) was conducted in December 1992. A Field Sampling Plan had been submitted and approved by both the MDNR and the U.S. NRC. Gamma readings were obtained at the ground surface to evaluate the areal extent of radioactive material at both the surface and below the clay cap within both landfills. Gamma readings were also obtained at a height of one meter to determine the potential levels of exposure that could be received during future field work at the site. Radioactive material was noted to be at the ground surface in one small area on-site and was subsequently covered to prevent direct contact.

The Phase II investigation includes both areas inside as well as areas outside the encapsulated landfills. Field investigation methods will include:

- electromagnetic surveys
- surface soil sampling
- soil borings/subsurface soil sampling
- downhole gamma logging
- leachate sampling
- groundwater sampling
- surface water sampling
- sediment sampling
- water body soundings

The scope of the Phase II investigation is presented in the Field Sampling Plan dated November 1993.

The Phase III investigation represents the balance of the field sampling effort. The scope is not defined at this time. It will focus on areas of concern which are discovered or identified during the Phase II investigation and, therefore, will be based on the results of the Phase II studies.

4.5 FEASIBILITY STUDY APPROACH

General response actions and preliminary applicable remedial technologies have been identified for this site based on available historical information. A preliminary screening of process options has been performed (see Section 3.3).

The size of the Site and uncertainties pertaining to the materials disposed of at the Site require a phased and integrated approach to the RI/FS. The scope of the RI is designed to answer data needs in three main areas: the site characterization, the risk assessment, and the alternatives evaluation. By designing the RI to address these areas, we are attempting to focus and streamline the RI/FS so that adequate data are collected and the number of technologies and alternatives to be considered in the FS can be minimized. As the RI data become available, the level of uncertainty in the Conceptual Site Model will be evaluated. Potential additional data needs may be identified, and uncertainties will be evaluated during the FS development and screening phase (Tasks 9 and 10), which will occur concurrently with the RI. Initially, these tasks depend on the development of a preliminary list of ARARs, which will be written as a technical memorandum and updated as necessary. Four other subtasks of this FS phase of work will initially be presented as technical memoranda:

- Identification/screening of potential treatment technologies.
- Development/screening of alternatives based on three of U.S. EPA's nine evaluation criteria for CERCLA sites (effectiveness, implementability, and cost).
- Evaluation of alternatives based on all of U.S. EPA's nine criteria for CERCLA sites (see Section 5.10.2).
- Comparison of alternatives.

After the complete RI data become available, these technical memoranda will be updated and included as part of the FS report.

5.0 REMEDIAL INVESTIGATION/FEASIBILITY STUDY TASKS

This section presents the tasks involved in performing the RI/FS for the Hartley and Hartley Site. A detailed summary of the key assumptions used in estimating project labor and costs of the standard RI/FS Work Plan tasks is included.

5.1 TASK 1 - PROJECT PLANNING

The project planning task includes activities from project initiation through completion of all project plans. The following activities are included:

- Project kickoff meetings involving the project managers from RUST and the regulatory agencies; meetings with the agencies; and project meetings.

- A project scoping meeting involving legal and technical specialists.

- Site visits.

- Attendance at Site Decommissioning Management Plan (SDMP) workshops.

- Collection and evaluation of existing information. It is anticipated that collection and evaluation of data will continue throughout the RI.

- Determination of data needs and level of analytical and sampling certainty required.

- Identification of preliminary remedial action alternatives.

- Preliminary determination of ARARs.

- Interim response activities.

- Preparation of RI/FS draft project plans including the Work Plans, Quality Assurance Project Plans (QAPP), Field Sampling Plans (FSP), and Health and Safety Plan (HASP).

- Preparation of monthly reports.

5.2 TASK 2 - COMMUNITY RELATIONS

The following initial community relations activities are included in this task:

- Community interviews.
- Identification of community relations issues.
- Preparation of a summary of the local newspaper coverage of the site, and a mailing list.
- A meeting with corporate-level public relations managers.
- Attendance at public meetings.

RUST will assist SCA in developing community relations objectives and preparing a community relations plan, as requested. Ongoing community relations activities include attending monthly public meetings; reviewing news releases, fact sheets, or other information; and attending meetings with the public relations team. SCA and RUST will also assist the regulatory agencies in any community relations programs they may be implementing.

5.3 TASK 3 - SITE INVESTIGATION

The field investigations will include the following activities: subcontracting, mobilization and demobilization, subsurface soil sampling, surface soil sampling, borehole drilling, slug testing, groundwater sampling, surface water and sediment sampling, surveying, and quality control review of all activities. These activities are listed in Section 4.4 and described in detail in the Field Sampling Plan.

There will be at least three subcontract types: drilling, surveying, and laboratory analysis. The drilling subcontract will include: drilling, sampling, monitoring well installation; collection and drumming of all drilling cuttings in 55-gallon drums; collection of drilling fluids, development and purge water collected in a 10,000-gallon frac tank; building a fenced-in decontamination (steam cleaning) and drum storage area; and developing monitoring wells with a submersible pump.

The surveying subcontract will include: a field survey to establish vertical and horizontal controls, and a field survey of monitoring wells and staff gauges upon completion of the field work.

The laboratory analysis subcontract parameters will include: analyzing field samples within 35 days for parameters identified in Table 4-1 according to DQOs established in the QAPP.

5.4 TASK 4 - SAMPLE ANALYSIS AND DATA VALIDATION

This task includes analysis of samples collected during the field investigation and validation of data. As indicated in the QAPP and FSP, samples collected during the field investigation will be analyzed using CLP quality procedures, and data validation will be performed by RUST or a subcontractor. Information from this task will be included in RI report appendices.

5.5 TASK 5 - DATA EVALUATION

This task will include analysis of chemical and physical data after the data are verified to be of acceptable accuracy and precision. Data evaluation will be initiated upon receipt of validated field data from the field investigation (Task 3) and after sample analysis and data validation of laboratory parameters are performed (Task 4). Data evaluation activities may include data reduction and tabulation, calculation of aquifer characteristics, statistical analysis, environmental fate and transport modeling, and mapping. The results of this task will be summarized in technical memoranda which will be used in subsequent tasks and incorporated into the RI report.

5.6 TASK 6 - RISK ASSESSMENT

An initial assessment of the potential risks to human health and the environment due to exposure to potential chemical and radiation hazards will be conducted. This initial assessment will be included in the Environmental Report, to be submitted to the U.S. NRC with the license application. A baseline public health risk assessment and an assessment of potential ecological risks will be performed after the data collected during the field investigation have been verified and evaluated. The baseline risk assessment will be presented as a separate document attached to the RI report. The risk assessment methodology will be developed from MDNR, U.S. NRC and U.S. EPA guidance documents.

5.7 TASK 7 - TREATABILITY STUDIES

A treatability study will be performed as part of the interim response to provide the basis for designing the leachate treatment system. The necessity and specific requirements for additional bench-scale and/or pilot treatability studies will be assessed after data from the field investigation are evaluated, and alternatives are developed and screened.

5.8 TASK 8 - RI REPORT

Technical memoranda will be prepared to summarize and evaluate the historical sampling data and the sampling data from each field investigation. A draft RI report will be prepared which summarizes the activities performed, data collected, and conclusions drawn from the remedial investigations. The report will include an updated site description, results of field investigation and laboratory analyses, a discussion of potential routes of contaminant migration, and a baseline risk assessment. Comments received from the regulatory agencies and the public will be addressed in completing the final RI report.

5.9 TASK 9 - REMEDIAL ALTERNATIVES DEVELOPMENT AND SCREENING

5.9.1 Remedial Alternatives Development

A preliminary list of waste management options will be developed in this task. This preliminary list will consist of options which protect human health and the environment by: (1) eliminating or reducing the amount of hazardous substances, (2) preventing exposure to the hazardous substances by engineering and/or institutional controls, or (3) using a combination of the above.

Preliminary remedial action objectives, general response actions, and technology types and process options were identified in Section 3.3. They may apply to the following areas at the Site:

- All or portions of the East Landfill
- The Northwest Landfill
- Cells A and B
- The area between Cell A and the road
- Any discrete areas of contamination which may exist on the Site outside the boundaries of the two landfills.

The evaluation of process options incorporates considerations of three broad criteria: effectiveness, implementability, and cost. Whenever appropriate, innovative technologies will be included in the evaluation of process options.

Evaluation of the effectiveness of specific process options includes the following considerations:

- Potential effectiveness in attaining identified contaminant goals and in handling the estimated areas or volumes.

- Adequate protection of human health and the environment.

- How proven and reliable the process is with respect to the contaminants and conditions at the site.

The implementability of each process option will be evaluated by determining the:

- Availability of the technologies employed by the solution.

- Availability of storage and disposal services.

- Availability of necessary skilled workers to implement the technology.

- Administrative feasibility of implementing the alternative.

An evaluation of cost will play a limited role in this process. Based on engineering judgment, the cost of each process will be described as high, medium, or low relative to other process options. Financial considerations during this evaluation will be used only to screen between process options relative to other process options in the same technology type.

The selected technologies will be assembled into alternatives representing a range of treatment and containment combinations. Assembly of alternatives may include remediation of different volumes and/or areas of the Site and one or more general response actions for each medium. General response actions will be combined to form a range of site-wide alternatives. A description of each alternative will be included in the FS report. These descriptions may include the following information:

- Locations of areas to be excavated or contained.

- Approximate volumes of soil, groundwater, surface water, and/or sediment, and landfill gas to be excavated and/or collected.

- Approximate location of potential water hookups, and connections to local POTW.

- Management options for treatment residuals.

5.9.2 Remedial Alternatives Screening

The following considerations will be defined and developed as they apply to each alternative:

- Extent or volume of contaminated soil, groundwater, surface water, and sediment.
- Size and configuration of on-site extraction and treatment systems or containment structures.
- Time frame in which treatment, containment, or removal goals can be achieved.
- Rates or flows of treatment.
- Spatial requirements for constructing treatment or containment technologies or for staging construction materials or excavated soil or sediment.
- Distances for disposal technologies.
- Required permits for off-site actions and imposed limitations including action-, location-, and chemical-specific ARARs.

The number of alternatives that will undergo a more thorough and extensive analysis during the detailed analysis phase may need to be reduced. The screening evaluation of alternatives provides a final opportunity prior to the detailed analysis to make this determination. If needed, the alternatives will be evaluated on the short- and long-term aspects of their effectiveness, implementability, and cost. This evaluation will be sufficiently detailed to distinguish among alternatives.

A decision will be made, based on the screening evaluation, as to which alternatives should be retained for further analysis. Alternatives selected for further evaluation should preserve a range of treatment and containment technologies initially developed. The alternatives selected for further evaluation are to be agreed upon by the MDNR and the U.S. NRC in a formal consultation. Procedures for evaluating, defining, and screening alternatives will be documented in the FS report, showing the rationale behind the selection process. An array of the alternatives that pass the screening level evaluation will be prepared to elicit the identification of ARARs so that detailed analysis of the individual alternatives may continue in the FS.

5.9.3 Post-Screening Tasks

Post-screening tasks may include additional treatability study testing and site characterization work, as necessary.

5.10 TASK 10 - DETAILED ANALYSIS OF ALTERNATIVES

The detailed analysis of alternatives will provide a presentation of relevant information needed to allow a selection of a site remedy.

5.10.1 Alternative Definition

If necessary, each alternative will be further defined with respect to the volumes or areas of contaminated soil, groundwater, surface water, and sediment to be addressed, the technologies to be used, and any performance requirements associated with those technologies.

5.10.2 Analyze Alternatives Against Nine Evaluation Criteria

The alternatives that remain after the preliminary evaluation will be subjected to detailed analysis. The analysis will take into account the nine evaluation criteria of the NCP: (1) overall protection to human health and the environment, (2) compliance with ARARs, (3) long-term effectiveness and permanence, (4) reduction of toxicity, mobility, or volume, (5) short-term effectiveness, (6) implementability, (7) cost, (8) state acceptance, and (9) community acceptance. The nine evaluation criteria address specific statutory requirements for remedial actions. For purposes of schedule and budget development, it is assumed that up to four alternatives will be subjected to this detailed analysis. These criteria are discussed in greater detail below.

1. Overall Protection of Human Health and the Environment

   A final assessment will be made to check whether each alternative meets the requirement that it protect human health and the environment. The emphasis of this analysis is on long-term effectiveness and permanence, short-term effectiveness, and compliance with ARARs.

2. Compliance with ARARs

   Federal and state responses to the alternatives array submittal will be considered in the detailed analysis of alternatives. Each alternative will be analyzed in view of the contaminant-specific, action-specific, and location-specific requirements identified during ARAR review.

3. Long-Term Effectiveness and Permanence

   Long-term effectiveness addresses the results of the remedial action in terms of residual risk after response objectives have been met. The components of long-term effectiveness will be identified for each alternative as follows:

   - Magnitude of remaining risk from untreated water or treatment residuals.

   - The adequacy and suitability of controls that are used to manage treatment residuals or untreated wastes.

- The long-term reliability of management controls for providing continued protection from residuals.

4. Reduction of Toxicity, Mobility, or Volume through Treatment

   Contaminant reduction will aim to reduce the mobility, toxicity, or volume of the contaminants. The analysis should favor treatment technologies that produce permanent solutions, such as alternative treatment technologies or resource recovery technologies.

5. Short-Term Effectiveness

   Short-term effectiveness includes the effectiveness of the alternatives during the construction and implementation phases until remedial response objectives are met.

   Protective measures will be evaluated for the following areas of concern:

   - Protection of the surrounding community and environment, and of site workers during construction of the alternative.

   - Protection of the community and environment from hazardous substances remaining after implementation of the alternative.

   - Protection of workers during operation and maintenance of the alternative.

6. Implementability

   The technical and administrative feasibility of the alternative will be reviewed along with the availability of the alternative.

   Evaluation of technical feasibility will consider:

   - Constructability of the technology.

   - Relation to additional remedial action.

   - Ability to monitor the effectiveness of the remedy.

   - Maintainability of equipment.

   Evaluation of administrative feasibility will examine the likelihood of favorable community response and the ability of related agencies to obtain approval for Site access and to coordinate activity related to the project. The feasibility of institutional controls will also be examined.

   The review of system availability will indicate whether or not the necessary equipment and specialists are available. If the solution requires long-term operation of a treatment, storage, and disposal (TSD) service, then the review must assure that long-term capacity will be available.

7. Cost

   The financial analysis will consider the costs associated with the following aspects of the project, including:

   - Capital costs associated with development and construction.
   - Operation and maintenance costs.
   - Present-worth analysis.

8. State Acceptance

   This section of the detailed evaluation will be limited to the analysis of formal comments made by the MDNR during previous phases of the RI/FS. Documentation in the FS report will include such details as meetings, opportunities for agency review, and transmittal of comments between the MDNR and SCA.

9. Community Acceptance

   This evaluation will address those features of the alternatives the community supports, has reservations about, or opposes.

5.10.3 Comparative Analysis of Alternatives

The analysis performed for each alternative will be aggregated in order to rank alternatives and support a recommendation. The relative performance of each alternative will be evaluated in relation to each specific evaluation criterion. The advantages and disadvantages of each alternative relative to one another will be identified. The comparative analysis of the alternatives will be presented in a narrative discussion and will include a description of the following:

- Strengths and weaknesses of the alternatives relative to one another with respect to each criterion.
- How reasonable variations of key uncertainties could change the expectations of their relative performance.
- Differences among the alternatives measured either qualitatively or quantitatively.
- Substantive differences among the alternatives.

A discussion of innovative technologies will include a description of their potential advantages in cost or performance and the degree of uncertainty in their expected performance.

This comparative analysis provides each consideration a weight to allow a cost/benefit analysis to be performed. A cost/benefit analysis allows a cost effective alternative to be selected that provides a favorable balance among protection of public health, welfare, and the environment. The cost/benefit analysis contains potential synergistic considerations of a sensitivity analysis. A sensitivity analysis in conjunction with a cost/benefit analysis may be used to screen the alternatives for selection. The variables are analyzed as to their weight (criticalness) in allowing an alternative to be viable.

5.11 TASK 11 - FEASIBILITY STUDY (FS) REPORT

The goal of the feasibility study is to develop a final closure alternative which integrates the regulatory requirements of the MDNR and the U.S. NRC. It is anticipated that in some instances these requirements will conflict with each other. To facilitate the resolution of possible conflicts, RUST will prepare draft technical memoranda on the following subjects:

- Preliminary Screening of Technologies and Process Options
- Analysis of Applicable or Relevant and Appropriate Requirements
- Development and Screening of Alternatives
- Detailed Evaluation of Individual Alternatives
- Comparative Analysis of Alternatives

These memoranda will serve as a basis for identifying and resolving conflicts of regulatory requirements.

5.11.1 Draft FS Report

The draft FS report will summarize data developed during the alternative remedial actions assessment process. The draft FS report will be submitted to the MDNR and other appropriate agencies for comment. The draft FS report will support the MDNR's needs during the public comment period before development of the Remedial Action Plan.

5.11.2 Public Meeting

There will be a period for public comment on the draft FS report. A public meeting may be held during this comment period to receive comments and answer questions on the recommended remedial alternative. RUST may assist SCA and the MDNR in answering questions received during the public hearing and review phase and will respond to comments.

5.11.3 Final FS Report

Following the public comment period, and only if public comments require additional changes to the draft FS report, the final FS report will be submitted for the MDNR's approval.

5.12 TASK 12 - LEGAL SUPPORT

The RUST team may provide technical support to the SCA legal staff in evaluating which wastes were generated from processes at each facility that used the Hartley and Hartley Landfill, and whether or not the wastes generated by each facility correspond to the contaminants of concern at the landfill. RUST may also assist SCA by attending project and agency meetings.

6.0 PROJECT MANAGEMENT

6.1 ORGANIZATION

SCA is the site owner and is overseeing the project. At the direction of the SCA Project Manager, RUST has overall responsibility for all phases of the U.S. NRC License Application, RI, FS, and Interim Response tasks. RUST is also responsible for all field investigation, technical analyses, documentation, and quality assurance activities, as well as for project management and control. The organization structure of the project is illustrated in Figure 6-1.

The RUST Project Manager is responsible for implementing the project, and has the authority to commit the resources necessary to meet project objectives and requirements. The primary function of the RUST Project Manager is to ensure that technical, schedule, and budget objectives are achieved. The RUST Project Manager reports directly to the SCA Project Manager, and is responsible for all technical communications to the regulatory agencies.

The RUST Assistant Project Manager will assist in schedule and budget tracking as well as other project control activities. The RUST Task Managers are directly responsible for the detailed technical, schedule, and budget objectives of each task. The Task managers are also responsible for the procurement and supervision of any subcontractors.

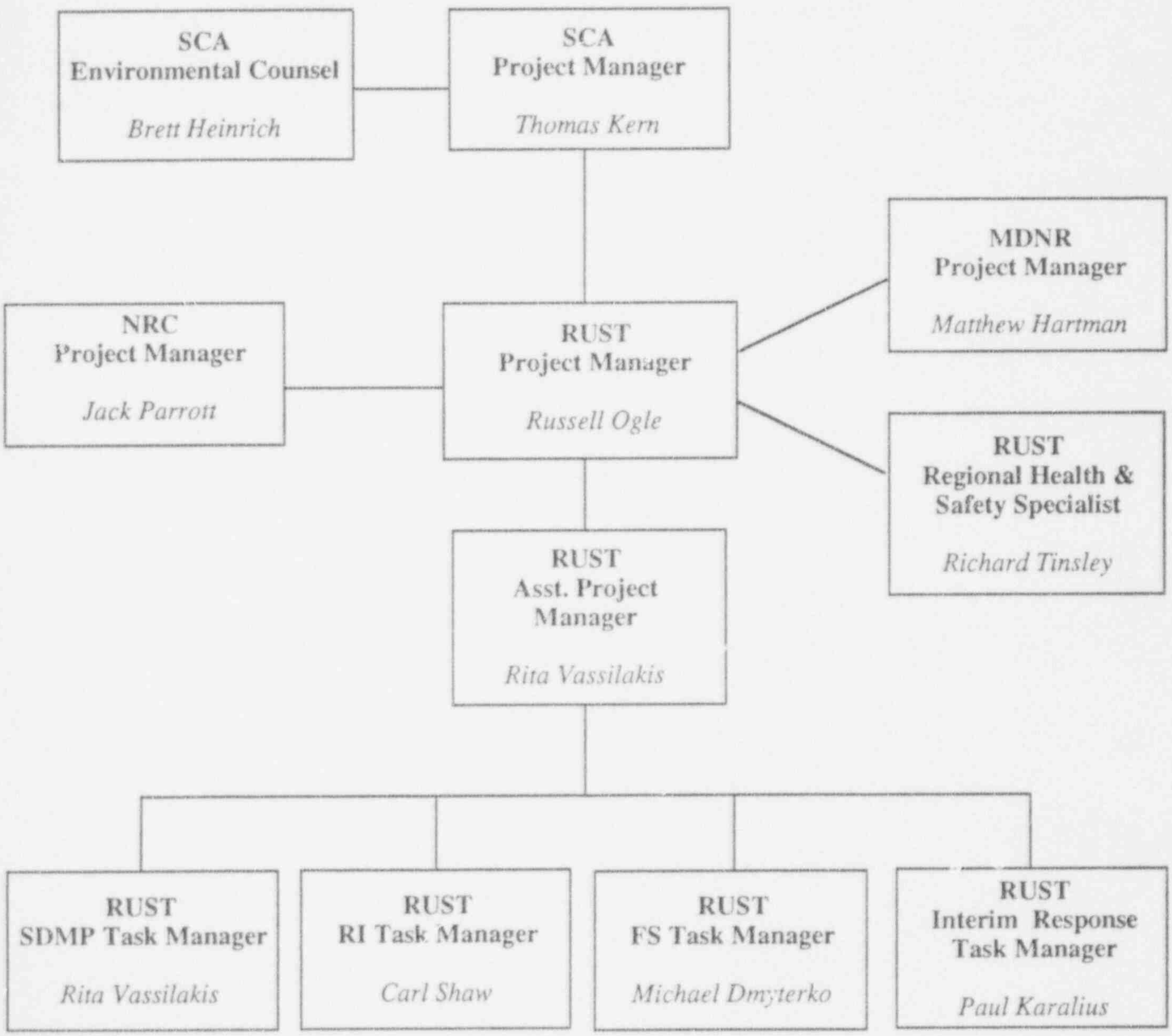
6.2 REPORTING

Given the complexity and significance of this project, RUST will provide formalized status reports to the MDNR and the U.S. NRC, in addition to frequent, informal communications. The formalized status reports will take the form of Quarterly Progress Reports which will be submitted to the MDNR and the U.S. NRC no later than ten business days after the end of the quarter. The Quarterly Progress Report will include a discussion of accomplishments for the quarter, planned activities for the next quarter, any new issues to be resolved, and status on the schedule. Informal communications via telephone, facsimile, or status meetings will occur on at least a monthly basis to supplement the Quarterly Progress Report.

6.3 QUALITY ASSURANCE

Quality control will be maintained by senior technical advisors. They will review all deliverables and will be available to the project team personnel as necessary. Site-specific quality assurance requirements will be in accordance with the Quality Assurance Project Plan.

FIGURE 6-1
PROJECT ORGANIZATION



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APPENDIX A

APPENDIX A

PRELIMINARY LIST OF
POTENTIALLY RESPONSIBLE PARTIES AND
REPRESENTATIVE WASTE STREAMS

ANSUL COMPANY, THE
- Chemical Waste Water

APPROVED INDUSTRIAL REMOVAL
- Acetone and Acetone Waste
- Aqueous Organic Waste
- Car Wax
- Carbon & Oil
- Dirty Solvent
- Graphite & Oil
- Muriatic Dichromate
- Waste Oil
- Waste Paint & Solvents
- Waste; Diesel Fuel
- Water & Oil

AUBURN DIECAST CORPORATION
- 1% Chromic Acid; 99% Water; Non-Flammable
- Acid
- Acid; Chromic Acid - Less than 1%; Oxidant
- Chemical Acid; Chromic Acid - Less than 1%; Oxidant
- Chromic Acid - Less than 1%; cxidant; Corrosive or Irritant
- Chromic acid, 5% Chromic Acid; 95% water; Non-Flammable
- Liquid Waste; Chromic Acid/Water

THE AUSTIN COMPANY
- Sludge
- Waste Plastic

BAKER PERKINS, INC.
- 50% Waste Oil; 30% Paint Sludge & Thinners; 20% Water Chemicals
- Empty Barrels
- Oil
- Paint Looth Washings; 80% H20; 10% Toluene Acetone; 10% Paint Pigment
- Paint Sludge; 85% Water, 15% Paint Sludge & Thinners
- Waste Solvents; 10% Water; 10% Metallic Sludge; 80% acetone, Toluene; Flammable
- Waste; 50% Waste Oil, 30% Paint Sludge & Thinners, 20% Water

BASIN OIL COMPANY (WISER OIL COMPANY)
- No Indicated

BERGMAN SCRAP IRON & WASTE MATERIAL COMPANY
- 90% Hydrocarbon Oil; 10% Water; Flammable
- Waste Drums
- Waste Solvent

APPENDIX A

PRELIMINARY LIST OF
POTENTIALLY RESPONSIBLE PARTIES AND
REPRESENTATIVE WASTE STREAMS
(cont'd)

BUCKEYE PIPE LINE
- Gas & Water
- Gasoline
- Oil & Snow

CENTER TOOL AND MACHINE COMPANY, INC.
- 100% Water; Industrial Waste Water
- Cyanide
- Heat Treat Quenching Waste Water; Cyanide - 2500 ppm
- Waste Liquids
- Waste Water & Oil

CHEMETRON CORP.
- Dirty Oil & Varnish
- Dirty Solvent
- Oil & Solvent

CHEMICAL LEAMAN TANK LINES, INC.
- Caustic Sludge
- LD Lugger; 20% Water; 80% Misc. Organics; Flammable
- Lugger Box
- Oil Waste
- Paper, Wood, etc.
- Scrap Box
- Spent Caustic
- Waste Liquid
- Waste Oil
- Waste Water

CHEMICAL RECOVERY SYSTEMS, INC.
- Liquid Waste
- Paint Sludge
- Sludge
- Waste Chemical
- Waste Materials
- Waste Oil

COASTAL TANK LINES, INC.
- Liquid Waste
- Lugger
- Oil & Water
- Salt Water
- Sludge Box
- Waste Oil

APPENDIX A

PRELIMINARY LIST OF
POTENTIALLY RESPONSIBLE PARTIES AND
REPRESENTATIVE WASTE STREAMS
(cont'd)

CONSUMERS POWER COMPANY

- #2 Fuel Oil
- #6 Fuel Oil Spill - 90-100% Water
- Caustic and Sulfuric Acid (Ferro Lime)
- Oil & Water
- Gas & Water
- Sludge
- Waste Water

DOW CHEMICAL COMPANY

- 1% Benzene; 99% Water
- 10% Benzene; 90% Water Flammable
- 100% Domestic Type Trash; Non-Flammable
- 15% Sulfuric Acid
- 20% Oil; 70% Water; 10% Sludge; Flammable
- 50% Kerosene; 50% Turbine Oil; Flammable
- 580 Tar
- 90% Vinyl Toluene; 10% Organic Tars; Flammable
- Box Sludge
- Methyl Alcohol
- Scrap Barrels
- Soap; Water; Alcohol; Brake Fluid; Insecticides
- Styrene Polymer; Caustic Salts; Rust Scale
- Coke Oil
- Ditch Skimmings

DOW CORNING CORPORATION

- 5% Acetone & Isopropyl Alcohol: 5% Organic Sludge; 94% Water; Flammable; Waste Antifoam
- 10% Chlorinated Solvents; 10% Hydrocarbons; 10% Water; 70% Acetone; 90% Xylene; Toluene; 5% Water; 5% Silicone Polymers
- 100% Gelled Solvent: Flammable; Heavy Gelled Materials with Solvents; Resins
- 20% Calcium Chloride; 20% Magnesium Chloride; 60% Silicon; Flammable; DPR Gels; Solid

E.I. DUPONT DE NEMOURS & COMPANY

- Hexane: Flammable Liquid; Amines & Aeromatic Hydrocarbons; Methylcyclohexyl Pheylurea
- Liquid Waste
- Industrial Waste
- 80% Paint Sludge, 20% Paint Thinner; 45-95% Solvent (Non-Chlorinated) to include thinners; 5-55% Balance Pigment Sludge and Paint Chips; Flammable

APPENDIX A

PRELIMINARY LIST OF
POTENTIALLY RESPONSIBLE PARTIES AND
REPRESENTATIVE WASTE STREAMS
(cont'd)

EATON CORPORATION
- Acid; Chromic Acid Water, Acid Waste
- Chromic Acid
- Coolants used in Manufacturing; Aqueous Waste
- Quench Oil; Waste Chucker Oil

GENERAL MOTORS CORPORATION
- 10% Paint Thinner, 90% Paint Sludge; Flammable; Waste Oil
- 20% Toluene, 80% Paint Sludge; Flammable Compound Lacquer, Paint, Thinning Liquid
- 20-40% Pigments, 10-30% Toluol; 10-30% MEK; 1-5% Mixed Acetates; Liquid; Flammable

GROUND TRUNK WESTERN RAILROAD COMPANY
- Alcohol & Water
- Fuel Oil
- Lube Oil & Fuel Oil
- Oil; 25% Diesel Fuel; 75% Water; Flammable

HEXCEL SPECIALTY CHEMICALS
- B.O.D.; 90% Water, 10% Glycols, Non-Flammable; Formic Acid; N-Methyl Butanol; Tricyclazole; Corrosive or Irritant; Liquid
- Waste Solvents; Flammable, 85% Methanol, 15% Water
- Waste Solvents; Flammable, 80% Methanol, 17% Water, 3% Ammonia
- Spent Solvents; 40% Methanol, 40% Acetone, 20% Water

HITACHI MAGNETICS CORPORATION
- Waste Water & Oil
- Waste Oil Containing Cyanide
- Waste Containing Lime and Cobalt
- Waste Containing Limit, Cobalt, Water & Samarium

HANNAH MARINE (HANNAH INLAND WATERWAYS CORPORATION)
- Fertilizer 90%, 10% Water, Flammable
- Liquid Fertilizer
- Toluene
- Gas & Fuel Oil Mixed
- Waste Benzene

APPENDIX A

PRELIMINARY LIST OF
POTENTIALLY RESPONSIBLE PARTIES AND
REPRESENTATIVE WASTE STREAMS
(cont'd)

HOFFMAN LA ROCHE
- 10.4% Toluene; 62.5% Diacetone Sorbose; 27% H_2O; 1003 ppm Calcium; Liquid; Flammable; Corrosive
- 49% Acetic Acid; 49% Acetic Anhydride; 2% Hexane, Toluene, Pyridine, and Cyclohexane; Corrosive and Flammable
- Chlorinated Solvent Waste; Flammable
- Chlorinated Solvent Waste; Halogenated Organic Solvent; Flammable; Liquid

INMONT
- Dirty Wash Resin Solvent
- Mixed Resins
- Paint Thinners
- Sludge

INTERNATIONAL TERMINAL
- Chloroform
- Fuel Oil & Water
- Methelene
- Mixed Zylenes
- Waste Water

JAMESON CORPORATION
- Sludge
- Sludge Box

JONES CHEMICALS, INC.
- Chem By Prod - Waste - Cyanide; Poisonous
- Cyanide
- Waste Chemical By-Product; Cyanide Poisonous

JUSTICE TRUCKING COMPANY
- Drums
- Liquids
- Waste Sludge

KERKAU MANUFACTURING COMPANY
- Chips
- Metal Shavings
- Scrap Box
- Sludge Box

APPENDIX A

PRELIMINARY LIST OF
POTENTIALLY RESPONSIBLE PARTIES AND
REPRESENTATIVE WASTE STREAMS
(cont'd)

LAKEWAY CHEMICALS, INC.
- Aqueous Waste
- Citrolene
- Cytrolin Waste
- Ethyl Mercaptan
- Waste Acid
- Waste Thimet
- Waste Liquids

LARO COAL & IRON COMPANY
- Waste
- Waste Oil
- Waste Oil Sludge
- 90% Hydraulic Oil; 10% Water; Non-Flammable; Liquid

LEASE MANAGEMENT, INC.
- 100% Crude Oil
- 95% Sand; 1% Crude Oil; 4% Water; Non-Flammable; Oil Spill
- Chloride
- Concrete

LOBDELL-EMERY MANUFACTURING COMPANY
- Scrap Oil & Paint
- Scrap Paint & Thinner
- Oil & Water Sludge
- 98% Oil, Thinners, Paint; 2% Paint Pigment Organics; Flammable

MAGLINE, INC.
- Waste Chromate
- Waste Water Containing Phosphorus; Corrosive or Irritant
- Spent Phenol-Formaldehyde Resin Coated Shell core Foundry

MARATHON OIL COMPANY
- Oil & Water
- Oil Spill
- Water & Sludge

MICHIGAN BELL
- Water & Gas
- Salt Water
- 99% Water; 1% Hydrocarbons

APPENDIX A

PRELIMINARY LIST OF POTENTIALLY RESPONSIBLE PARTIES AND REPRESENTATIVE WASTE STREAMS (cont'd)

VELSICOL CHEMICAL CORPORATION (MICHIGAN CHEMICAL CORP.)
- DBP
- Sulphuric Acid
- Still Residue
- Methanol
- Sodium Bromide
- Sodium Hydroxide

MICHIGAN OHIO PIPELINE CORPORATION
- Crude Oil
- Oil & Snow
- Waste Oil
- Waste; Sludge
- Scrap

MONSANTO (G.D. SEARLE)
- Aqueous Waste
- Liquid Waste
- Nalco Benzine
- Soybean Sludge
- Organic Sludge
- Caustic

NELSON CHEMICALS COMPANY
- Waste
- Paint Thinner
- Thinner & Oil
- Waste Tri-Chlor
- Trichlorethane

NEWCOR, INC.
- Not Indicated

NORDCO DRUM, INC.
- Liquid
- Paint Residue
- Paint Sludge
- Paint Solvent
- Toluene
- Acetone

APPENDIX A

PRELIMINARY LIST OF POTENTIALLY RESPONSIBLE PARTIES AND REPRESENTATIVE WASTE STREAMS (cont'd)

NORTHERN TUBE DIV. - QUESTOR AUTOMOTIVE DIV.
- 100% Waste, Paper, Wood
- Lugger Box
- Sludge Box
- Water & Coolant
- Waste Sludge

ORGANIC CHEMICALS, INC.
- Chloramphenicol
- Drums-of-Sludge
- Liquid Paint Sludge
- Paint Pigment
- Toluene
- Acetone

PARKE, DAVIS & COMPANY
- Ethyl Alcohol
- Organic Sludge
- Still Bottoms
- Methylalcohol
- Methanol

PENN CENTRAL TRANSPORTATION COMPANY
- Oil
- Oil & Sludge
- Pumped Out Waste Pit
- Sludge
- Waste Fuel Oil

PRESTOLITE COMPANY
- 100% Solid Industrial Refuse
- Paint
- Hydrocarbon Oil
- Waste Oil
- Cyanide
- Solid Waste

PROCTOR & GAMBLE
- Detergents
- Dimethyl Alkyl Amine
- Liquid Detergent
- Mineral Oil
- Refrigeration oil
- Solvents
- Skin Care Products

APPENDIX A

PRELIMINARY LIST OF POTENTIALLY RESPONSIBLE PARTIES AND REPRESENTATIVE WASTE STREAMS (cont'd)

RAY MOLDER, INC.
- Diesel Fuel & Water
- Dirty Rinse Water
- Spent Caustic
- Xylene
- Waste Water & Oils

STORY CHEMICAL CORPORATION
- Waste Chemical

TOTAL PETROLEUM, INC.
- Gas
- Gas & Water
- Oil & Water
- Paper & Wood

U.S. CHEMICAL COMPANY
- Barrels
- Paint Sludge
- Toluene
- Acetone
- Paint Thinner
- Paint Pigments

UPJOHN COMPANY, THE
- Solvents
- Acetone
- Methanol
- Toluene
- Chlorotoluene
- Heptane

WELLMAN DYNAMICS CORPORATION
- Salt Water
- Magnesium Slag
- Sludge
- Magnesium Sludge
- Sand Box

WESTERN CRUDE OIL, INC.
- Bottom Sediment
- Crude Oil
- Oil & Water
- Sludge
- Waste Oil

APPENDIX A

PRELIMINARY LIST OF
POTENTIALLY RESPONSIBLE PARTIES AND
REPRESENTATIVE WASTE STREAMS
(cont'd)

WICKES CORPORATION
- Graphite & Dust Water & Sludge
- Liquid Waste; (Sludge)
- Liquid Waste; Sludge
- Dust
- Rubbish & Dirt
- Rubbish & Junk
- #6 Fuel Oil
- Oil Sludge
- 70% Hydrocarbon Oils; 30% Water; Non-Flammable

WILSON ENGINEERING DIVISION - THE ALLEN GROUP, INC.
- Sludge Box
- Waste; Paper, Wood, Etc.
- Waste; Sludge Box

WOLVERINE GAS AND OIL COMPANY, INC.
- Crude
- Heavy Oil
- Oily Straw
- Waste Oil; Bottom Sediment & Water
- Waste; Oil from Dyke

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APPENDIX B

FIGURE B-1
PRELIMINARY SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS: SOIL/LANDFILL CONTENTS
HARTLEY & HARTLEY LANDFILL
BAY COUNTY, MICHIGAN

General Response Action	Remedial Technology	Process Options	Description	Screening Comments
No Action	None	Not Applicable	No action.	Required for consideration by the National Contingency Plan (NCP).
Institutional Controls	Access Restrictions	Deed Restrictions	Deeds for property in the area of influence would include restrictions on land use.	Potentially applicable.
		Fencing	Steel chain link fence around site.	Potentially applicable.
		Signs and Monuments	Warning signs and/or monuments.	Potentially applicable.
	Monitoring	Groundwater Monitoring	Monitoring of wells.	Potentially applicable.
Containment	Horizontal Barriers	Bottom Sealing	Horizontal barrier beneath an existing site formed by injection grouting, jet grouting, or the block displacement method to prevent downward migration of contaminants.	In the developmental stage. Existing natural clay layer beneath site is sufficient to prevent downward migration.
	Capping	Non-RCRA Cap	Cap covering waste material to minimize infiltration of precipitation and to reduce waste contact with the land surface and groundwater.	Potentially applicable.
		RCRA Cap	Cap covering waste material and conforming to RCRA design criteria which minimizes infiltration of precipitation and reduces waste contact with the land surface and groundwater.	Potentially applicable.
		Revegetation	Grade cap to prevent erosion and establish grass growth.	Potentially applicable.
		Grading	reshaping the surface of landfill cover to manage surface water infiltration, runoff, erosion, and leachate generation.	Potentially applicable.
	Vertical Barriers		See groundwater/leachate response actions for description.	Potentially applicable.

FIGURE B-1
PRELIMINARY SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS: SOIL/LANDFILL CONTENTS
HARTLEY & HARTLEY LANDFILL
BAY COUNTY, MICHIGAN

General Response Action	Remedial Technology	Process Options	Description	Screening Comments
Containment (Continued)	Containment	Ground Freezing	Freezing loops placed in the ground to freeze the media surrounding the hazardous waste rendering the medial practically impermeable.	Energy intensive and may be useful only as a temporary containment approach because of utility costs.
		Microencapsulation	Waste covered with inert and impervious coatings or jackets that prevent leaching.	Not applicable due to large volume of material that would have to be contained and high costs associated with implementation of this technology.
	Dust Control	Sprinkling	Sprinkle cap with water and/or foam during construction to control dust.	Potentially applicable.
Treatment	Thermal Treatment	In-Situ Heating	Contaminants are decomposed, vaporized, and distilled by heating soil in-situ with radio frequency waves or electrical energy.	Not commercially available.
		Rotary Kiln Incinerator	Combustion in a horizontally rotating cylinder providing mixing of waste and combustion air.	Potentially applicable. High costs may result from large volume of material that would have to be treated.
		Infrared Thermal Treatment	Infrared radiators pyrolyze the soil as it passes on a wire belt.	Potentially applicable. High costs may result from large volume of material that would have to be treated.
		Circulating Fluidized Bed	A fluidized bed combustor with a higher airflow velocity and higher combustion efficiencies than a conventional fluidized bed.	Potentially applicable. High costs may result from large volume of material that would have to be treated.
		Pyrolysis	Organic material destroyed in the absence of oxygen at a high temperature to break down organic constituents to elemental gas and water.	Potentially applicable. High costs may result from large volume of material that would have to be treated.
		Fluidized Bed Combustion	Air blow through inert granular bed materials until material is suspended and is able to move and mix in a manner similar to a fluid. Heated bed particles come into intimate contact with the waste being burned, allowing completed combustion.	Most appropriate for slurries and sludges. Waste must have minimal heavy metal content.

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BAY COUNTY, MICHIGAN

General Response Action	Remedial Technology	Process Options	Description	Screening Comments
Treatment (Continued)	Thermal Treatment (Continued)	Molten Salt Combustion	Waste/air mixture fed to the bottom of a vessel containing liquid salt. The high rate of heat transfer to the waste causes rapid destruction.	Not commercially available.
		High Temperature Fluid Wall Reactor	Radiant energy provided by electrically treated carbon electrodes heats a porous reactor core. The heated core radiates heat to the waste materials.	Lack of full-scale development.
		Centrifugal Reactor (Plasma Heat)	Heat from a plasma torch is used to decompose organic compounds in a mixed solid and liquid feed.	Lack of full-scale demonstration.
		High Temperature Slagging Incineration	Iron ore, carbon, and limestone are fed to the top of the furnace and iron product and slag are removed in different layers from the bottom. Hazardous wastes used as fuel can be injected above the slag layer.	Not available in the United States for the treatment of hazardous waste.
	Physical-Chemical Treatment	Soil Washing	Extracts contaminants from soils using a washing fluid composed of the appropriate surfactant. Causes a volume reduction of highly contaminated fine material from coarse sands.	Not applicable due to large volume of material that would have to be treated and high costs associated with application of this technology.
		In-Situ Soil Flushing	Contaminants are washed from unexcavated sludges or soils using a groundwater extraction/reinjection system.	Not applicable to due large quantity of solid waste present.
		Solvent Extraction	A process that uses solvent to extract organic compounds from the waste matrix.	Not applicable due to large volume of material that would have to be treated and high costs associated with application of this technology.
		Supercritical Extraction	A process that uses liquified gases near their critical conditions as solvents to remove organic compounds from waste matrices.	Requires media to be pumpable.

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BAY COUNTY, MICHIGAN

General Response Action	Remedial Technology	Process Options	Description	Screening Comments
Treatment (Continued)	Physical/Chemical Treatment (Continued)	Dehalogenation	Alkali metals and other proprietary reagents utilized to displace halogen from halogenated organic compounds contained in wastes.	Not applicable due to large volume of material and high costs associated with application of this technology.
		Hydrolysis (In-Situ)	Degradation of organic compounds by acid- or base-catalyzed reactions performed in-situ.	Not applicable due to large volume of material and high costs associated with application of this technology.
		Electroacoustic Soil Decontamination	In-situ process which uses the application of a direct current electric field and an acoustic field to facilitate the transport of liquids through soils.	Currently in the evaluation stage and is unavailable for commercial application.
		Electrokinetic Removal	Consists of a series of wells used as anodes and cathodes in which a direct current it utilized in conjunction with groundwater pumping to expedite ion migration and removal from saturated soil.	In developmental stage.
		Dewatering	Drying beds utilized to reduce the water content and therefore the volume of contaminated sediment.	Potentially applicable.
		Stabilization by Ion Exchange Resins	Synthetic resin is applied to the soil surface and thoroughly incorporated through the depth of contamination.	Difficult to achieve adequate contact between the contaminants and the resin.
		Low Temperature Thermal Description	A rotary drum equipped with heat transfer surfaces which volatilize organic compounds, condenses them into a liquid phase and leaves clean, dry solids behind. Causes a volume reduction of contaminated material.	Not applicable due to large volumes that would have to be treated and high costs associated with application of this technology.
		In-Situ Steam Extraction	Injects steam or hot air into unexcavated soil to remove VOCs and possibly some semi-volatile organic compounds.	Not applicable due to large volumes present and high costs associated with application of this technology.

FIGURE B-1
PRELIMINARY SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS: SOIL/LANDFILL CONTENTS
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BAY COUNTY, MICHIGAN

General Response Action	Remedial Technology	Process Options	Description	Screening Comments
Treatment (Continued)	Physical/Chemical Treatment (Continued)	In-Situ Adsorption	A variety of organic solute and some inorganic solute are removed from soil in-situ by solute adsorption onto activated carbon with a large surface area.	Desorption may be a long-term problem because of competition for activated carbon by organic compounds.
		In-Situ Vacuum Extraction	Used to remove VOCs from in-place soils by air stripping the soils using production wells, monitoring wells, and high-vacuum pumps.	Not practical for large area of site.
	Solidification/ Stabilization	Cement-Based Solidification	Portland cement and other additives are used to solidify hazardous wastes.	Organic wastes are not chemically bound and matrix is susceptible to breakdown and leaching.
		Pozzolanic-Based Solidification	The reaction of lime with a fine grained siliceous (pozzolanic) material and water produce a concrete-like solid for solidifying hazardous wastes.	Organic wastes are not chemically bound and matrix is susceptible to breakdown and leaching.
		Thermoplastic-Based Solidification	Heat-dried waste mixed within an asphalt bitumen, paraffin, or polyethylene matrix, resulting in a solid matrix.	Extended exposure of the matrix to water may damage the matrix greater increasing the surface area and the rate of waste leaching.
		Organic Polymer-Based Solidification	Wet or dry wastes blended with a prepolymer. A catalyst is then added, and mixing is continued. Mixing is terminated before the polymer is formed. The polymer may require drying before disposal.	Not effective for long-term immobilization of waste in a stabilized matrix. Organic wastes are not chemically bound and the matrix is susceptible to breakdown and leaching.
		Sorbents	This technology involves binding pozzolanic type matrices by physical sorption or chemisorption yielding a stabilized material.	Extended exposure of the matrix to water may damage the matrix greatly increasing the surface area and the rate of waste leaching.
		In-Situ Stabilization	Stabilizing agents fed directly into the contaminated soil through a shaft. At the end of the treatment, a treated block of soil is left.	Extended exposure of the matrix to water may damage the matrix greatly increasing the surface area and the rate of waste leaching.

FIGURE B-1
PRELIMINARY SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS: SOIL/LANDFILL CONTENTS
HARTLEY & HARTLEY LANDFILL
BAY COUNTY, MICHIGAN

General Response Action	Remedial Technology	Process Options	Description	Screening Comments
Treatment (Continued)	Solidification/ Stabilization (Continued)	Vitrification	Hazardous waste treated in a reaction chamber in which high temperature is used to reduce organic compounds to elemental gas and carbon. Inorganic contaminants remain entrained in the glass and siliceous melts.	Potentially applicable.
		In-Situ Vitrification	Electrodes placed into a contaminated soil zone and then electric current passed between the electrodes. The soil becomes a stable/immobile glass or crystalline monolith.	Potentially applicable.
	Biological Treatment	Aerobic	Degradation of organic compounds using micro-organisms in an aerobic environment.	Potentially applicable.
		Anaerobic	Degradation to organic compounds using micro-organisms in an anaerobic environment.	Potentially applicable.
		Land Treatment	Waste is excavated and placed in a containment cell where it is sprinkled with an innoculated fluid promoting bacterial growth. The leachate is separated and treated.	Potentially applicable. Large volume of material would have to be treated. High costs associated with application of this technology.
		In-Situ Biological Treatment	Degradation of organic compounds using micro-organisms in in-situ soils	Potentially applicable. Large volume of material would have to be treated. High costs associated with application of this technology.
		White Rot Fungus	Degradation of organic compounds by white rot fungus.	Has not been adequately demonstrated at full-scale.
Disposal	Land Disposal	Off-Site Secure Landfill	Excavated contaminated soils and sludges disposed of in an off-site RCRA landfill.	Potentially applicable. Large volume present. High costs associated with inplementation of this option.
		On-Site Secure Landfill	Excavated contaminated soils disposed of in an on-site secure landfill.	Potentially applicable.

FIGURE B-1
PRELIMINARY SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS: SOIL/LANDFILL CONTENTS
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BAY COUNTY, MICHIGAN

General Response Action	Remedial Technology	Process Options	Description	Screening Comments
Disposal (Continued)	Land Disposal (Continued)	Entombment	Placement of contaminated media in a concrete vault surrounded by a secondary containment system.	Potentially applicable to specific waste types.

FIGURE B-2
PRELIMINARY SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS: GROUNDWATER/LEACHATE
HARTLEY & HARTLEY LANDFILL
BAY COUNTY, MICHIGAN

General Response Action	Remedial Technology	Process Options	Description	Screening Comments
No Action	None	Not Applicable	No action.	Required for consideration by NCP.
Institutional Controls	Access Restrictions	Deed Restrictions	Deeds for property in the area of influence would included restriction on wells.	Potentially applicable.
		Fencing	Keep unauthorized persons from using existing wells.	Potentially applicable.
	Monitoring	Groundwater Monitoring	Monitoring of wells.	Potentially applicable.
	Alternate Water Supply	City Water Supply	Extension of existing municipal water distribution system to serve residents in area of influence.	Potentially applicable. Data will be collected to ensure that all residents within area of influence use municipal system.
		New Community Well	New uncontaminated wells to serve residents in area of influence.	Not applicable.
		Bottled Water	Delivery of clean bottled water to residents in area of influence.	Not applicable.
Containment	Vertical Barriers	Slurry Wall	Vertical subsurface barriers which are constructed under a slurry, sometimes in combination with extraction wells.	Potentially applicable.
		Grout Curtain	Fixed vertical subsurface barriers formed by injecting a liquid, slurry, or emulsion under pressure into a rock or soil mass.	Potentially applicable.
		Sheet Piling	Vertical barriers formed by piles which are assembled at their edge interlocks and driven into place.	Cannot ensure effective seal in sandy soil.
		Vitrification as Barrier Wall	Vertical subsurface barriers formed by converting soil into a chemically inert, stable glass sand crystalline product.	Has not been demonstrated for use as a groundwater subsurface barrier, but will be evaluated further.
	Hydraulic Barrier	Groundwater Pumping	Mass pumping of contaminated groundwater to contain plume.	Potentially applicable.

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FIGURE B-2
PRELIMINARY SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS: GROUNDWATER/LEACHATE
HARTLEY & HARTLEY LANDFILL
BAY COUNTY, MICHIGAN

General Response Action	Remedial Technology	Process Options	Description	Screening Comments
Collection	Extraction	Extraction Wells	Series of wells to extract contaminated groundwater.	Potentially applicable.
Treatment	Physical/Chemical Treatment	Air Stripping	Mixing large volumes of air with water in a packed column to promote transfer of VOCs to air.	Potentially applicable.
		Reverse Osmosis	Use of high pressure to force water through a membrane leaving contaminants behind.	Potentially applicable.
		Carbon Adsorption	Adsorption of contaminants onto activated carbon by passing water through carbon column.	Potentially applicable.
		Chemical Oxidation	The addition of oxidizing agents to raise the oxidation state of a compound and make it less hazardous or more conducive to subsequent treatment.	Potentially applicable.
		Photo/Chemical Oxidation	Destroys dissolved organic compounds in water by means of chemical oxidation using UV light and hydrogen peroxide and/or ozone.	Potentially applicable.
		Ion Exchange	Contaminated water is passed through a resin bed where ions are exchanged between resin and water.	Potentially applicable.
		Precipitation	Precipitation may be used to remove soluble heavy metals from the aqueous solution by the addition of such precipitant as carbonates, hydroxides, or sulfates.	Potentially applicable.
		Ultrafiltration	A membrane process which discriminates on the basis of molecular size, shape, and flexibility by application of pressure.	Other effective technologies available at lower costs.
		Macro-Resin Adsorption	Adsorption of contaminants onto macro-resins by passing water through resin column.	Not commercially available.

FIGURE B-2
PRELIMINARY SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS: GROUNDWATER/LEACHATE
HARTLEY & HARTLEY LANDFILL
BAY COUNTY, MICHIGAN

General Response Action	Remedial Technology	Process Options	Description	Screening Comments
Treatment (Continued)	Physical/Chemical Treatment (Continued)	Steam Stripping	Contaminated water is added to the top of a try a column or packed tower and steam is injected into the bottom of the column to provide the heat and momentum necessary to carry the volatile organic compounds out of solution.	Potentially applicable.
		Solvent Extraction	The contaminants are transferred from the water to a solvent and concentrated. Then the solvent is removed from the decontaminated water.	Required solvents may be hazardous. Cost prohibitive.
		Chemical Reduction	The addition of reducing agents to lower the oxidation state of a compound to make it less hazardous or more conducive to subsequent treatment.	Potentially applicable.
		Electrodialysis	Concentrations or separates ionic species by passing the water solution through alternately placed cation permeable and anion permeable membranes across which an electrical potential is applied to provide the motive force for ion migration.	Other effective technologies available at less cost.
		Micellar Enhanced Ultrafiltration	Surfactant is added to the groundwater at concentrations greater than its critical miscelle concentration and forms aggregates into which the organic pollutant will dissolve or solubilize. The solution is then passed through an ultrafiltration membrane.	Demonstrated only on a laboratory scale.
		Catalytic Dehydrochlorination	Reaction of polychlorinated hydrocarbons with high pressure hydrogen gas in the presence of a catalyst to remove chlorine and reduce toxicity.	Demonstrated only on a laboratory scale. May be evaluated further.
		Supercritical Extraction	Uses supercritical carbon dioxide to extract hazardous organic components from aqueous streams.	Demonstrated on laboratory and pilot scales only.

FIGURE B-2
PRELIMINARY SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS: GROUNDWATER/LEACHATE
HARTLEY & HARTLEY LANDFILL
BAY COUNTY, MICHIGAN

General Response Action	Remedial Technology	Process Options	Description	Screening Comments
Treatment (Continued)	Physical/Chemical Treatment (Continued)	Blending	Contaminated groundwater is blended with non-contaminated water to achieve discharge standards.	Not applicable.
	Biological Treatment	Aerobic	Degradation of organic compounds using micro-organisms in an aerobic environment.	Potentially applicable.
		Anaerobic	Degradation of organic compounds using micro-organisms in an anaerobic environment.	Potentially applicable.
		Land Treatment	Contaminated water is extracted and sprayed onto land where plant, microbial, and soil interactions stabilize the waste.	Potentially applicable.
		In-Situ Biological Treatment	Injecting micro-organisms to degrade existing compounds.	Potentially applicable.
		White Rot Fungus	Degradation of organic compounds by white rot fungus.	Not yet demonstrated on a full scale.
		Activated Sludge/Powdered Activated Carbon Treatment	Powdered activated carbon is added to activated sludge to treat the contaminants in groundwater via aerobic biodegradation and adsorption.	Potentially applicable.
Effluent Discharge	Disposal	Discharge to POTW (After Treatment)	Connect to existing municipal sewage piping system.	Potentially applicable.
		Discharge to Surface (After Treatment)	Connect to existing overland flow ditch network leading to stream.	Potentially applicable.
		Deep Well Injection	Inject treated water into deep aquifer.	Potentially applicable.
		Discharge to POTW (Prior to Treatment)	Connect to existing municipal sewage piping system.	Not applicable.
		Agricultural/Industrial Use	Use treated or untreated water for agricultural and industrial uses.	Not applicable.

FIGURE B-2
PRELIMINARY SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS: GROUNDWATER/LEACHATE
HARTLEY & HARTLEY LANDFILL
BAY COUNTY, MICHIGAN

General Response Action	Remedial Technology	Process Options	Description	Screening Comments
Effluent Discharge (Continued)	Disposal (Continued)	Seepage Basins	Return treated water to landfill through a basin constructed in sandy material.	Potentially applicable.
		Subsurface Drains	Subsurface drainage system to return treated water to landfill.	Potentially applicable.
		Blending	Contaminated surface water is blended with non-contaminated water to achieve discharge standards.	Not applicable.
		Temporary Storage	Water stored temporarily after treatment.	Potentially applicable.

FIGURE B-3
PRELIMINARY SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS: SURFACE WATER
HARTLEY & HARTLEY LANDFILL
BAY COUNTY, MICHIGAN

General Response Action	Remedial Technology	Process Options	Description	Screening Comments
No Action	None	Not Applicable	No action.	Required for consideration by NCP.
Institutional Controls	Access Restrictions	Deed Restrictions	Deeds for property in the are of influence would include restrictions on wells.	Potentially applicable.
		Fencing	Steel chain link fence around site.	Potentially applicable.
	Sampling	Surface Water Collection and Sampling	Surface water sample collection for laboratory analysis.	Potentially applicable.
Diversion/ Collection	Sediment Control Barriers	Dikes and Berms	Temporary structures used to divert storm runoff, reducing infiltration and leachate production.	Potentially applicable.
		Silt Fences	Geotextile filter fences in ditches to catch sediment in runoff water.	Potentially applicable.
Surface Water Treatment	Physical-Chemical Treatment		See groundwater/leachate response actions for description.	
		Distillation	Vaporization of volatile components out of liquid solution and recovery by condensation.	Cost prohibitive.
		In-Situ Precipitation	In-situ precipitation to remove soluble heavy metals from bodies of surface water by the addition of precipitants.	Precipitate would be difficult to control and would not be applicable if organic compounds are present.
	Biological Treatment		See groundwater/leachate response actions for description.	
Surface Water Discharge	Disposal		See groundwater/leachate response actions for description.	

FIGURE B-4
PRELIMINARY SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS: SEDIMENT
HARTLEY & HARTLEY LANDFILL
BAY COUNTY, MICHIGAN

General Response Action	Remedial Technology	Process Options	Description	Screening Comments
No Action	None	Not Applicable	No action.	Required for consideration by NCP.
Institutional Controls	Access Restrictions	Deed Restrictions	Deeds for property in the are of influence would include restrictions on wells.	Potentially applicable.
		Fencing	Steel chain link fence around site.	Potentially applicable.
Sediment Excavation	Removal	Sediment Excavation	Excavate localized areas of contaminated sediment with a dredge or clamshell.	Potentially applicable.
Sediment Treatment			See soil/landfill contents response actions for description.	
Sediment Disposal	Landfill Disposal		See soil/landfill contents response actions for description.	

FIGURE B-5
PRELIMINARY SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS: LANDFILL GAS
HARTLEY & HARTLEY LANDFILL
BAY COUNTY, MICHIGAN

General Response Action	Remedial Technology	Process Options	Description	Screening Comments
No Action	None	Not Applicable	No action.	Required for consideration by NCP.
	Monitoring	Gas Monitoring	Installation of gas probes.	Potentially applicable.
Collection	Landfill Gas Collection	Passive Vents	Perforated pipe in gravel trenches across top of landfill lead to multiple vents that passively discharge to atmosphere to prevent buildup of gas under cap.	Potentially applicable.
		Passive Flares	Same system as passive vents, however gas is burned upon discharge.	Potentially applicable.
		Active Gas Collection	Perforated piping system connected to a blower creating vacuum pressure to suck out gas.	Potentially applicable.