EPA Region 5 Records Ctr.
200063

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LIST OF APPENDICES

Appendix

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ACRONYMS LIST

ARCS	Alternative Remedial Contracting Strategy
ATSDR	Agency for Toxic Substances And Disease Registry
B	Below the contract reporting limit, but greater than the instrument detection limit
CFS	cubic feet per second
CN	Cyanide
COD	Chemical Oxygen Demand
D	Analyzed at a secondary dilution factor
DCE	Dichloroethene
E	Exceeded the calibration range of the GC/MS
EM	Electromagnetic geophysical survey
EPA	U.S.Environmental Protection Agency
FIT	U.S. EPA Field Investigation Team
GC/MS	Gas Chromatograph/Mass Spectrometer
GP	Poorly Graded Gravels and Gravel Sand Mixtures
HIs	Hazard Indices
HRS	Hazard Ranking Score
IDEM	Indiana Department of Environmental Management
IDNR	Indiana Department of Natural Resources
ISBH	Indiana State Board of Health
Kd	Soil water distribution coefficient
Kf	Complex ion formation constant
Koc	Organic carbon distribution coefficient
Kom	Organic matter distribution coefficient
Kow	Octanol water distribution coefficient
Kh	Henry's Law Constant
Ksp	Solubility Products
LEL	Lower Explosive Limit
J	Estimated Value
Mag	Magnetic geophysical survey
MCLs	Maximum Contaminant Levels
MSL	Mean Sea Level
N	Spike sample recovery not within control limits; this value is usable
ND	Below Detection Limit
NPL	National Priorities List
OVA	Organic Vapor Analyzer
P	Used for pesticides when there is greater than 25% difference between 2 gas chromatograph columns
PAHs	Polynuclear Aromatic Hydrocarbons

PCA	Perchloroethane (tetrachloroethane)
PCB/Pest	Polychlorinated Biphenyls/Pesticides
PID	Photoionization Detector
POTW	Publicly Owned Treatment Works
PRPs	Potential Responsible Parties
PVC	Polyvinyl Chloride
RI	Remedial Investigation
RI/FS	Remedial Investigation/Feasibility Study
SP	Poorly Graded Soils
SM	Silty Sands
SVOCs	Semi-Volatile Organic Compounds
SW	Well Graded Sands
TCA	Trichloroethane
TCE	Tricholorothene
TEM	Technical Evaluation Memoranda
TICs	Tentatively Identified Compounds
TKN	Total Kjedahl Nitrogen
TM	Technical Memoranda
TOC	Total Organic Carbon
TP	Total Phosphorous
TSS	Total Suspended Solids
USCS	Unified Soil Classification System
USGS	U.S. Geological Survey
VOCs	Volatile Organic Compounds
VP	Vapor Pressure

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1.0 INTRODUCTION

1.1 PURPOSE OF REPORT

SEC Donohue (formerly known as Donohue & Associates, Inc., renamed due to the acquisition that occurred in late 1991) is submitting this Remedial Investigation (RI) Report for the Himco Dump Superfund Site to the U.S. Environmental Protection Agency (EPA) in response to Work Assignment No. 17-5L4J under Region V ARCS Contract No. 68-W8-0093.

The scope of work for the Himco Dump Superfund Site (Himco site) Remedial Investigation/Feasibility Study (RI/FS) is described in the Phase I Himco Dump RI/FS Final Work Plan (Donohue, 1990a) and Phase II Himco Dump RI/FS Final Work Plan (Donohue, 1991a). This RI was performed to determine the nature, extent, and sources of contamination at the Himco site and to conduct a human health risk and ecological assessment, and a feasibility study.

The RI was implemented by reviewing available background data and conducting a two-phased field investigation. The primary objective of the first phase (Phase I) of the field investigation was to gather sufficient data to:

- Characterize the nature and extent of contamination in site soils, sediment, surface water, and groundwater.
- Determine the potential for contaminant transport via air, groundwater, and sediment/surface water pathways.
- Conduct a baseline public health evaluation and an ecological endangerment assessment.

The Phase I field investigation included waste characterization, geophysical surveys, excavation of test pits, determination of the presence or absence of wetlands, wetland soil sampling and analysis, soil sampling and analysis, waste mass gas survey, residential basement gas sampling, groundwater sampling and analysis, and determination of the site geologic and hydrogeologic characteristics. The primary purpose of the second phase (Phase II) of the field investigation was to gather additional information regarding groundwater, soil, and surface water and sediment. SEC Donohue carried out the Phase II field investigation by evaluating Phase I data and conducting the field investigation to address data needs relevant to completing a baseline risk assessment and evaluating remedial alternatives. The Phase II field investigation included excavating test pits (primarily along the southern end of the site), sampling and analyzing leachate, soil, surface water and sediment, and groundwater, delineating wetlands and sampling and analyzing wetlands soil, and conducting a private well inventory.

This introductory chapter presents site background and history, a summary of potential on-site sources and pathways of contaminant migration, and the organization of the remaining chapters of the RI report for the Himco site.

1.2 SITE BACKGROUND

1.2.1 Site Location and Description

The Himco site is a closed landfill located at the northwest corner of County Road 10 and the Nappanee Street extension in the Town of Elkhart, in Elkhart County, Indiana (Figure 1-1). The site covers approximately 50 acres and is situated in the Northeast 1/4 of Section 36, Township 38 North, Range 4 East, in Cleveland Township. General site features and land ownership as well as the landfill boundaries are shown in Figure 1-2. The extent of the landfill was determined using a combination of geophysical surveys, test pit excavations, borings, and aerial photographs. The site is bounded on the north by a tree line and northernmost extent of the gravel pit pond; on the west by two excavated ponds; on the south by County Road 10 and private residences; and on the east by the Nappanee Street extension. Land use in the vicinity of the site is agricultural, residential, and light industrial. The Himco site is zoned for industrial use. There is a sand access road into the southeast corner of the site near the intersection of County Road 10 and Nappanee Street extension. Although a locked gate is present across this road, vehicles can easily drive around the gate and enter the site.

The highest elevation on the site is 774.5 feet above mean sea level (MSL). This high point is located on top of the mounded landfill area of the site. The typical ground surface elevation surrounding the mounded landfill area is approximately 762 feet above MSL. The landfill area is covered with a sand layer of varying thickness. Beneath the sand, a layer of white powdery calcium sulfate, also of varying thickness, is present. The western half of the landfill cover is vegetated with grasses. The eastern half of the landfill cover is vegetated with grasses, bushes, and young trees. Numerous piles of concrete and asphalt waste material are present across the eastern half of the landfill.

There are remnants of a gravel pit operation in the northeast corner of the site. An old truck scale and concrete structures as a part of the gravel pit operation are present in this area. The gravel pit itself is filled with water which is approximately 30 feet deep. Two other smaller and shallower ponds, commonly referred to as the L pond and the small pond, exist on the west side of the site.

The area south of the landfill and north of County Road 10 is densely vegetated in places. Numerous small piles of rubble, concrete, asphalt, and metal debris are scattered throughout the area. Calcium sulfate is not present in this area.

Eleven U.S. EPA monitoring wells have been installed as part of this RI and approximately 16 United States Geologic Survey (USGS) monitoring wells exist on or immediately adjacent to the Himco site.

1.2.2 Site History

The following sections describe the history of disposal activities, environmental issues, and state and federal regulatory actions pertaining to the Himco site.

1.2.2.1 History of Disposal Activities

Himco Dump was privately operated by Himco Waste Away Service, Inc. between 1960 and September 1976. The area was initially a marsh and grassland. There was no liner, and no leachate or gas recovery system constructed for the landfill. According to the former operator at the site, refuse was placed at ground surface across the site with the exception of trench filling in the eastern quarter of the site. Five trenches 10 to 15 feet deep (the width of a truck) and 30 feet long were excavated in this area. Paper refuse was dumped in these trenches and burned. The former operator also reported that essentially two-thirds of the waste present in the dump was calcium sulfate from Miles Laboratories. As much as 360 tons/day were dumped over an unspecified duration. In 1976, Miles Laboratories provided the Indiana State Board of Health (ISBH) with a list of industrial pharmaceutical wastes disposed of at the Himco site. The list included calcium sulfate, and sodium and potassium bromide compounds. Other wastes known to be accepted at the landfill included hospital wastes and outdated drugs (U.S. EPA, 1987). A summary of trenching results is provided in Section 3.4.

The landfill had no borrow source; the owners obtained sandy soil for daily cover from the gravel pit to the north, an excavated pond to the west, and essentially anywhere around the perimeter of the site where sand was available. In 1976, the landfill was closed and a final cover was laid down consisting of approximately one foot of sand overlying six inches of calcium sulfate.

1.2.2.2 History of Environmental Issues and State Regulatory Actions

In 1971, the Indiana State Board of Health (ISBH) first identified the Himco site as an open dump. In early 1974, residents nearby the Himco site complained to the ISBH about color, taste, and odor problems with their shallow wells. Analyses of these wells by the ISBH showed high levels of manganese. Mr. Charles Himes (the owner and operator at the time), was advised by ISBH to replace six shallow water wells for residences immediately south of the landfill on County Road 10. The old wells were finished at depths of approximately 22 feet, and the new wells were finished at depths ranging from 152 to 172 feet below ground surface. Well logs indicate that these wells were finished below a clay confining layer.

In 1975, Mr. Himes signed a consent agreement with the ISBH Stream Pollution Control Board to close the dump by September 1976.

1.2.2.3 Previous Studies

In October 1981, the United States Geological Survey (USGS), in cooperation with the Indiana Department of Natural Resources and the Elkhart Water Works completed a three-year study and issued the report entitled "Hydrologic and Chemical Evaluation of the Groundwater Resources of Northwest Elkhart County, Indiana" (USGS 1981).

Data collected in this study included the thickness and areal extent of unconsolidated deposits, their hydraulic conductivity, specific yield, transmissivity, and storage coefficients. The general groundwater flow patterns and stream-aquifer connections were also defined. The USGS determined the horizontal and vertical extent of a leachate plume potentially emanating from the Himco site by using bromide concentrations in the groundwater as an indicator. The bromide concentrations in groundwater have been monitored from 1979 until present.

1.2.2.4 History of Federal Regulatory Actions

In 1984, EPA field investigation team (FIT), prepared a Hazard Ranking System (HRS) scoring package for the Himco site. The team sampled monitoring wells installed by USGS. Laboratory analyses of the samples showed that the groundwater downgradient of the site was impacted by metals and SVOCs and VOCs. The metals detected included aluminum, arsenic, barium, chromium, cobalt, selenium, beryllium, cadmium, copper, zinc, manganese, lead, nickel, and mercury. The VOCs and SVOCs detected included acetone, benzene, phenol, freons, 4-methylphenol, trans 1,2-dichloroethene, 2-butanone, chloroethane, and pyrene. At the time of the site inspections, the team also observed leachate seeps.

In June 1988, the Himco site was proposed for the National Priority List (NPL) and in February 1990 was designated a final NPL site.

In September 1989, the EPA issued a work assignment (EPA, 1989a) to SEC Donohue to initiate a RI/FS. Under EPA's direction, SEC Donohue began the RI field program in October 1990.

As of January 1990, the parcels of land which comprise the landfill are owned by the following individuals or corporations (as shown in Figure 1-2):

1. Miles Laboratories, Inc.
2. CLD Corporation
3. Alonzo Craft, Jr.
4. Indiana and Michigan Electric Company

In early April 1990, EPA reported from community interviews that the residents with private wells south of the landfill were complaining about the taste, odor, and color of their water. Based on these complaints, the U.S. EPA Emergency and Response Branch, which is part of the Superfund program, sampled these wells in late April 1990.

Analysis of the well samples indicated that contamination did not exceed enforceable regulated levels for public drinking water. However, water quality analysis indicated relatively high concentrations of iron, manganese and sodium. The results of these analysis were sent to the Agency for Toxic Substances and Disease Registry (ATSDR) for further evaluation.

In August 1990, ATSDR concluded that concentrations of sodium in residential wells downgradient from the Himco site represented a chronic health threat to the affected residents. ATSDR suggested that high levels of sodium in the water could cause high blood pressure in older residents. ATSDR recommended an alternative source of potable water.

In September 1990, the EPA sent a letter to the PRPs asking them to pay for connecting the homes located south of the landfill along County Road 10 to the municipal water supply.

In October 1990, Himco Waste Away Services, Inc., and Miles Laboratories, Inc., agreed to finance the municipal water connection project. By November 1990, municipal water service was provided to residents indicated in the EPA letter to the PRPs.

1.3 POTENTIAL CONTAMINANT MIGRATION PATHWAYS

The sources and potential pathways of contaminant migration are shown in Figure 1-3, the Conceptual Site Model. The primary suspected contaminant source is the landfill, which contains industrial and municipal wastes.

Primary release mechanisms include particulate and volatile emissions, percolation, and runoff and erosion. These release mechanisms have the potential to result in a secondary contaminant source which includes soil under and surrounding the landfill.

Secondary release mechanisms from soil include percolation, runoff and erosion, and dust emissions. Percolation may result in contamination of groundwater. Runoff and erosion may contaminate surface water, sediment, and wetlands. Dust emissions may contaminate surface water, sediment, wetlands and air. Potential contaminant transport pathways to receptors include air, groundwater, surface water and sediments, and wetlands.

Primary receptors include humans through direct contact, ingestion, inhalation, and dermal contact, and terrestrial and aquatic environmental species through direct contact, ingestion, inhalation, and dermal contact. Crops grown on the landfill cap could serve as a receptor through uptake (ingestion) of contaminated groundwater and surface water. Human and terrestrial receptors could then be exposed through eating the crops and dermal contact.

1.4 RI ACTIVITIES AND ORGANIZATION OF REPORT

Remedial investigation activities associated with the Himco site were conducted to evaluate the elements of the Site Conceptual Model (Figure 1-3). Data collected during the RI were used to determine the nature and extent of contamination at the site and to evaluate the threat posed by the site to public health and the environment. These data will be used to develop and evaluate remedial alternatives for this site.

Sections 2 through 6 of this RI report present details of the study area investigation and discussion of the physical characteristics of the study area, the nature and extent of contamination, contaminant fate and transport, and the baseline risk assessment. The results and conclusions from the RI activities are discussed and integrated in the text of this report, while details on media-specific sampling data, and evaluations are presented in Technical Memoranda (TM) and Technical Evaluation Memoranda (TEM). Section 7 presents conclusions and discussion of uncertainties. Technical Memoranda on field activities are included in Appendix B. Any Technical Evaluation Memoranda on data are included in Appendix C. The analytical chemistry data are contained in Appendix D. The Baseline Risk Assessment Report for Himco is presented under separate cover as Appendix E. The Sample Location Coordinates report is presented in Appendix F.

EPA REGION V ARCS PROGRAM
EPA Contract No. 68-W8-0093
Work Assignment No. 17-5L4J
SEC Donohue Project No. 20026

VOLUME 1

FINAL REMEDIAL INVESTIGATION REPORT

HIMCO DUMP
REMEDIAL INVESTIGATION/FEASIBILITY STUDY
ELKHART, INDIANA

AUGUST 1992

Prepared for:

U.S. Environmental Protection Agency
Emergency and Remedial Response Branch
Region V
77 West Jackson Boulevard
Chicago, Illinois 60604

This document has been prepared for the U.S. Environmental Protection Agency. The material contained herein is not to be disclosed to, discussed with, or made available to any person or persons without the prior expressed approval of a responsible official of the U.S. Environmental Protection Agency.

SEC DONOHUE INC.
in association with

Ebasco Services Inc.
STS Consultants Ltd.
Burlington Environmental, Inc.
Life Systems, Inc.

FINAL REMEDIAL INVESTIGATION REPORT
FOR HIMCO DUMP SUPERFUND SITE
REMEDIAL INVESTIGATION/FEASIBILITY STUDY
ELKHART, INDIANA

AUGUST 1992

Prepared by: M. Geraminegad 8-14-92

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SEC Donohue Inc.

EXECUTIVE SUMMARY

SEC Donohue (formerly known as Donohue & Associates, Inc., renamed due to the acquisition that occurred in late 1991) is submitting this Remedial Investigation (RI) report for the Himco Dump Superfund Site (Himco site). This RI report is submitted to the U.S. Environmental Protection Agency (EPA) in response to Work Assignment No. 17-5L4J under Region V ARCS Contract No. 68-W8-0093.

The Himco site is a closed landfill covering approximately 50 acres. The Himco site is located at County Road 10 and the Nappanee Street Extension in the town of Elkhart, in Elkhart County, Indiana. The Himco site was privately operated by Himco Waste Away Service, Inc., represented by Mr. Charles Himes, and was in operation between 1960 and September 1976. The area was initially a marsh and grassland. There was no liner, no leachate collection, or gas recovery system constructed as part of the landfill. An estimated two-thirds of the waste in the landfill was calcium sulfate from Miles Laboratories. As much as 360 tons/day were dumped over an unknown time period. Other wastes accepted at the landfill included demolition/construction debris, household refuse, and industrial and hospital wastes. In 1976, the landfill was closed and covered. The cover consisted of approximately one foot of sand overlying a calcium sulfate layer.

In 1971, the Indiana State Board of Health (ISBH) first identified the Himco site as an open dump. In early 1974, residents living near the Himco site complained to the ISBH about color, taste, and odor problems with their shallow wells. Analyses of these wells by the state showed high levels of manganese. Mr. Himes was advised by ISBH to replace six shallow water wells for residences immediately south of the landfill on County Road 10 with deep wells. The old wells were finished at depths of approximately 22 feet, and the new wells were finished at depths ranging from 152 to 172 feet below ground surface. Well logs indicate that these wells were finished below a clay confining layer. However, existence of a confining layer was not verified in the RI.

In 1975, Mr. Himes signed a consent agreement with the ISBH Stream Pollution Control Board to close the dump by September of 1976.

In 1984, a U.S. EPA field investigation team (FIT), prepared a Hazard Ranking System (HRS) scoring package for the Himco site. Monitoring wells installed by the U.S. Geological Survey (USGS) were sampled, laboratory analyses of the well samples showed that the groundwater downgradient of the site is contaminated with metals and semi-volatile and volatile organic compounds. The metals detected included aluminum, arsenic, barium, chromium, cobalt, selenium, beryllium, cadmium, copper, zinc, manganese, lead, nickel, and mercury. The volatile and semi-volatile organic compounds detected included acetone, benzene, phenol, freons, 4-methylphenol, trans 1,2-dichloroethene, 2-butanone, chloroethane, and pyrene. At the time of the site inspections, leachate seeps were observed.

In June 1988, the Himco site was proposed for the NPL and in February 1990, was designated a final NPL site.

In July 1989, under the Alternative Remedial Contract Strategy (ARCS) contract, the U.S. EPA issued a work assignment to SEC Donohue to conduct an RI/FS at the Himco site. From October 1990 through February 1991, Donohue conducted a Phase I RI at the site. Activities completed included excavation of test pits, installation of monitoring wells, and collection of soil, landfill gas, surface water, sediment, and groundwater samples for chemical analysis. In September 1991, Donohue conducted a Phase II RI at the site. Activities completed included excavation of test pits, installation of a monitoring well, and collection of soil, surface water, sediment, leachate, and groundwater samples for chemical analysis.

Test pit excavations in the landfill revealed the presence of mixed wastes. In addition, leachate was present in the majority of trenches. Leachate was observed to be gray-black in color with "rainbow sheens," except at one location near the southwest corner of the landfill where the leachate was biphasic and red-brown in color. At this location, the organic phase of the leachate contained approximately 48 percent toluene by weight. This location has been referenced as the hot spot in the landfill. Three general layers consistently observed in the landfill include a silty sand cover up to two feet thick, a calcium sulfate layer which varied from a few inches to nine feet, and an estimated 15 to 20 feet of waste below the calcium sulfate. Wastes under the calcium sulfate include paper, plastic, rubber, wood, glass, metal including an occasional disposal drum, glass, and small amounts of hospital wastes (e.g., syringes, vials). Non-native soil mixed with construction debris was observed in test pits excavated outside the landfill along the south-central and southwest edge of the landfill. No calcium sulfate was found in this area. Contamination by semi-volatile organic compounds (SVOCs) was found to be prominent in surface soil samples collected from this area.

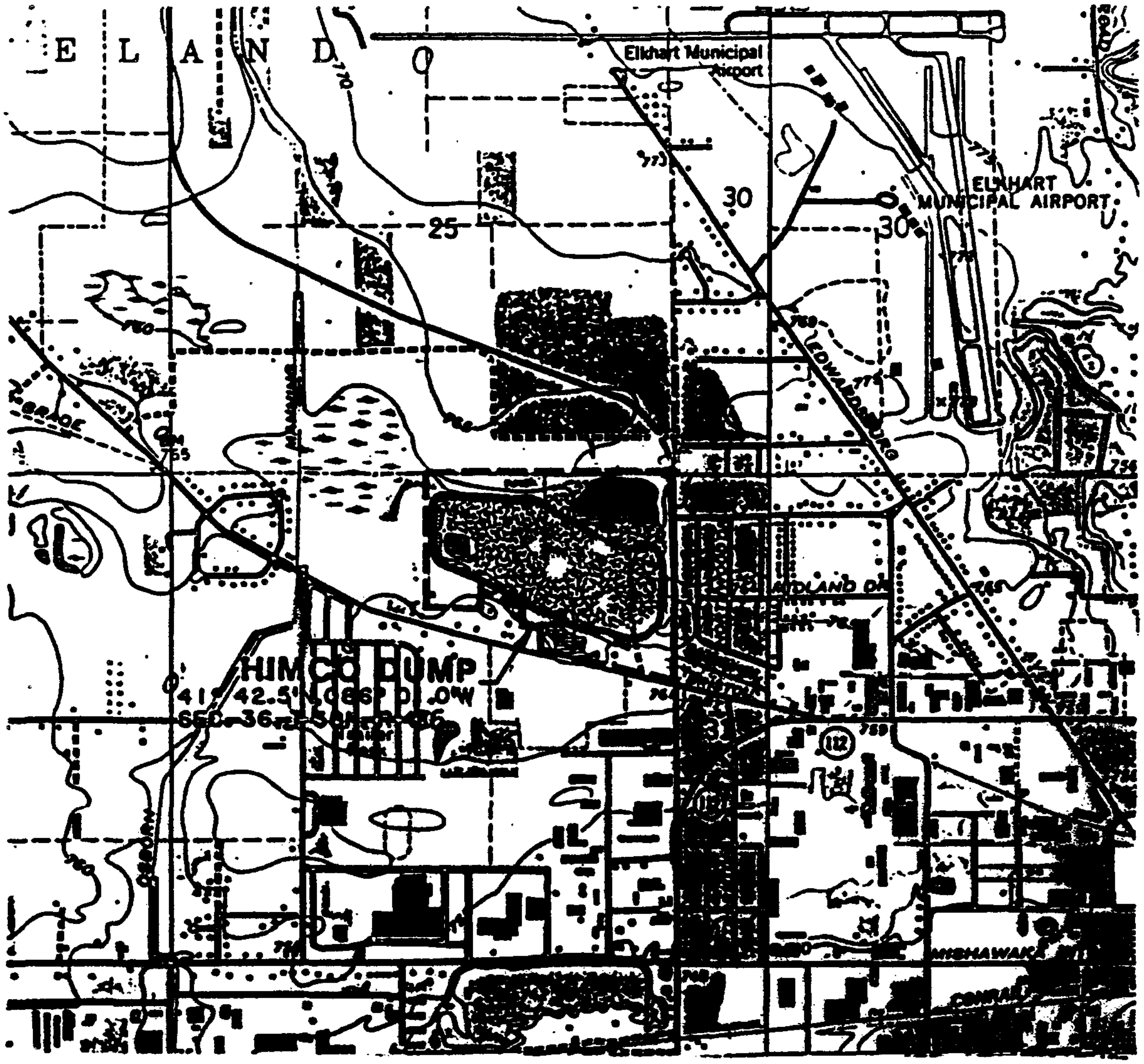
Borehole drilling characterized the stratigraphy beneath the Himco site as sand and gravel outwash deposits comprised of alternating beds, varying in thickness, or poorly to well-graded sands and gravels, and gravel-sand-silt mixtures ranging from approximately 200 to 500 feet below ground surface. Based on information from monitoring wells, groundwater occurs between approximately 5 and 20 feet below the ground surface at the site, at an elevation ranging from 752 to 756 feet (MSL). The elevation of the bottom of the waste mass is estimated to range from 755 to 760 feet (MSL). Groundwater flow is generally to the south-southeast towards the St. Joseph River. The average horizontal flow gradient beneath the site is approximately 0.0016 ft/ft. Vertical gradients were predominately upward and ranged from 0.00021 ft/ft to 0.0013 ft/ft.

Contamination in soil was primarily detected in surface soil samples. Inorganic compounds and volatile organic compounds (VOCs) were detected widespread across the site, but at low concentrations. SVOC soil contamination was found to be most prominent in samples collected in the south-central area characterized by non-native soil and construction debris.

Two rounds of groundwater sampling revealed limited groundwater contamination outside the boundaries of the waste. Concentrations of contaminants detected in leachate were typically orders of magnitude higher than groundwater concentrations. In addition, some VOCs and SVOCs which were detected in the leachate were not detected in the groundwater. Surface water and sediment samples revealed very limited contamination in the three site ponds. Total VOCs detected in waste mass gas samples did not exceed 13 ug/l at any one location.

The majority of the contaminant mass at the Himco site is located below a landfill cover. The greatest potential for contaminant migration is through the groundwater pathway. Contaminant migration through the groundwater pathway is a function of mobility and persistence of specific contaminants as well as groundwater flow characteristics. SVOCs detected at the Himco site exhibit low mobility. Inorganic compounds and VOCs of potential concern detected at the Himco site exhibit high mobility. In addition, the potential for attenuation of these contaminants within the sand and gravel deposits underlying the site is low. However, since groundwater flow velocity is relatively low, contaminants which enter the groundwater may migrate off-site at a very slow rate.

A baseline risk assessment for the Himco site was conducted to analyze the potential adverse health effects resulting from exposures to hazardous substances in site soil and groundwater. The most important exposure pathways were judged to be ingestion of contaminated groundwater, incidental ingestion of contaminated soil, and inhalation of VOCs. For each pathway, risks were calculated for both current populations and hypothetical future populations. Estimated cancer risks for current populations range from 2E-08 to 4E-06. Estimated cancer risks for future populations are highest for residential children at home built on the landfill (2E-01). Approximately 99% of this risk is from groundwater pathways and the major contributors are arsenic, beryllium, PAHs, and vinyl chloride. Non-cancer risk exists for hypothetical future populations assumed to utilize groundwater as drinking water. The calculated HI values ranged from 1E+01 to 1E+03. Chemicals contributing to non-cancer risk include antimony, arsenic, beryllium, cadmium, chromium, vanadium, lead, cyanide, and nitrate/nitrite. Of these risks, background contributions associated with groundwater and soil exposure media are approximately 6. For the hypothetical future agricultural worker, the total HI is 1E+01 with 4E+00 due to inhaled chromium. No HIs for current populations exceed 1E+00.



QUADRANGLE LOCATION

0 1000 2000

SCALE: FT.

SOURCE: USGS 7.5 MIN. QUAD ELKHART, INDIANA, 1961
PHOTOREVISED 1981

Donohue

20026

MARCH, 1992

Engineers • Architects • Scientists

SITE LOCATION MAP

HIMCO DUMP SITE
ELKHART COUNTY, INDIANA

N

FIGURE 1 - 1

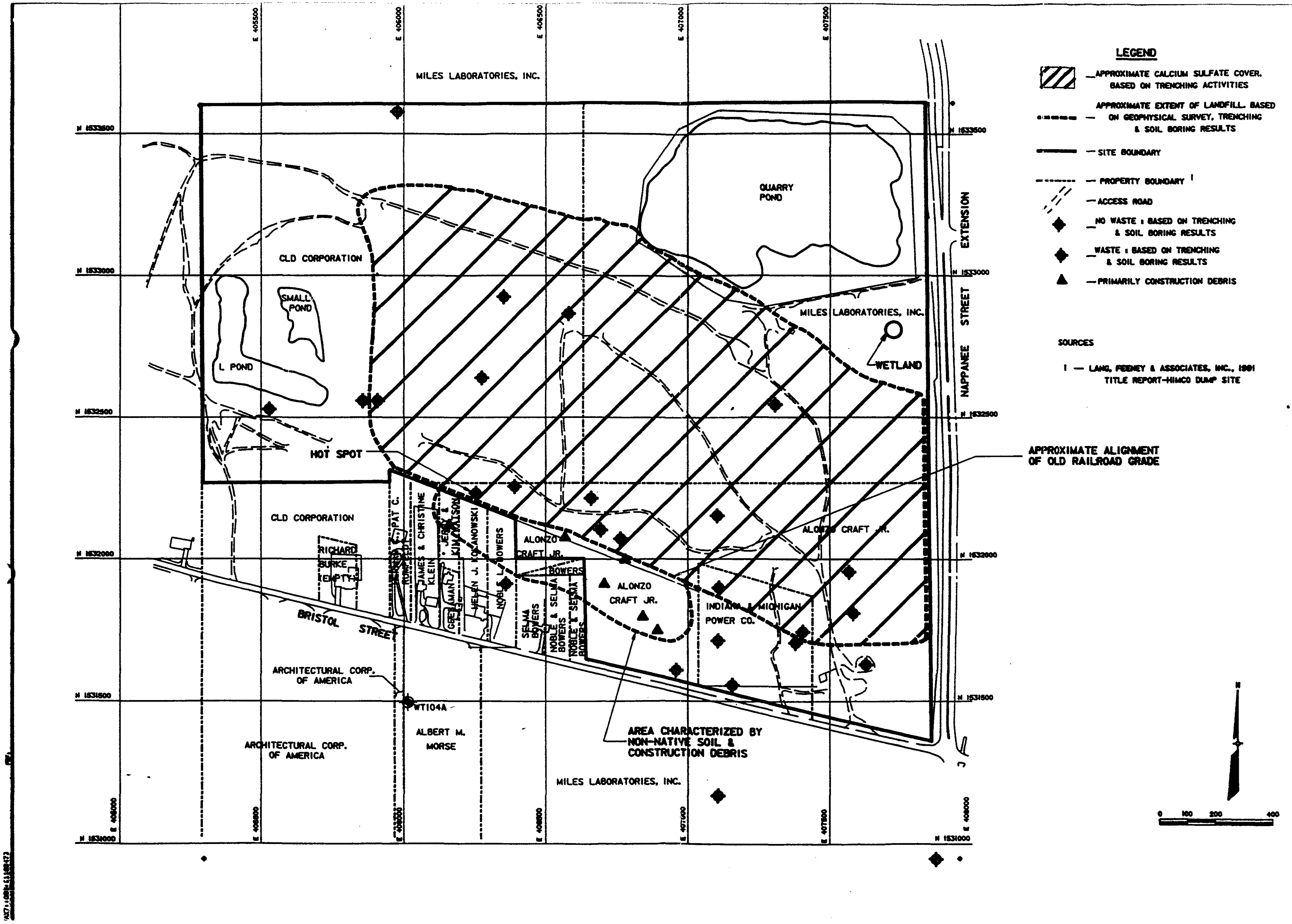


FIGURE 1-2
APPROXIMATE LANDFILL BOUNDARY
HIMCO DUMP SUPERFUND SITE
ELKHART, INDIANA

Donohue ENGINEERS ARCHITECTS SCIENTISTS

Scale	AS SHOWN
Date	NOV. 1991
Designer	SP
Drafter	EZ
Checker	
Approver	

No.	Revisions	By	Date

Sheet No.
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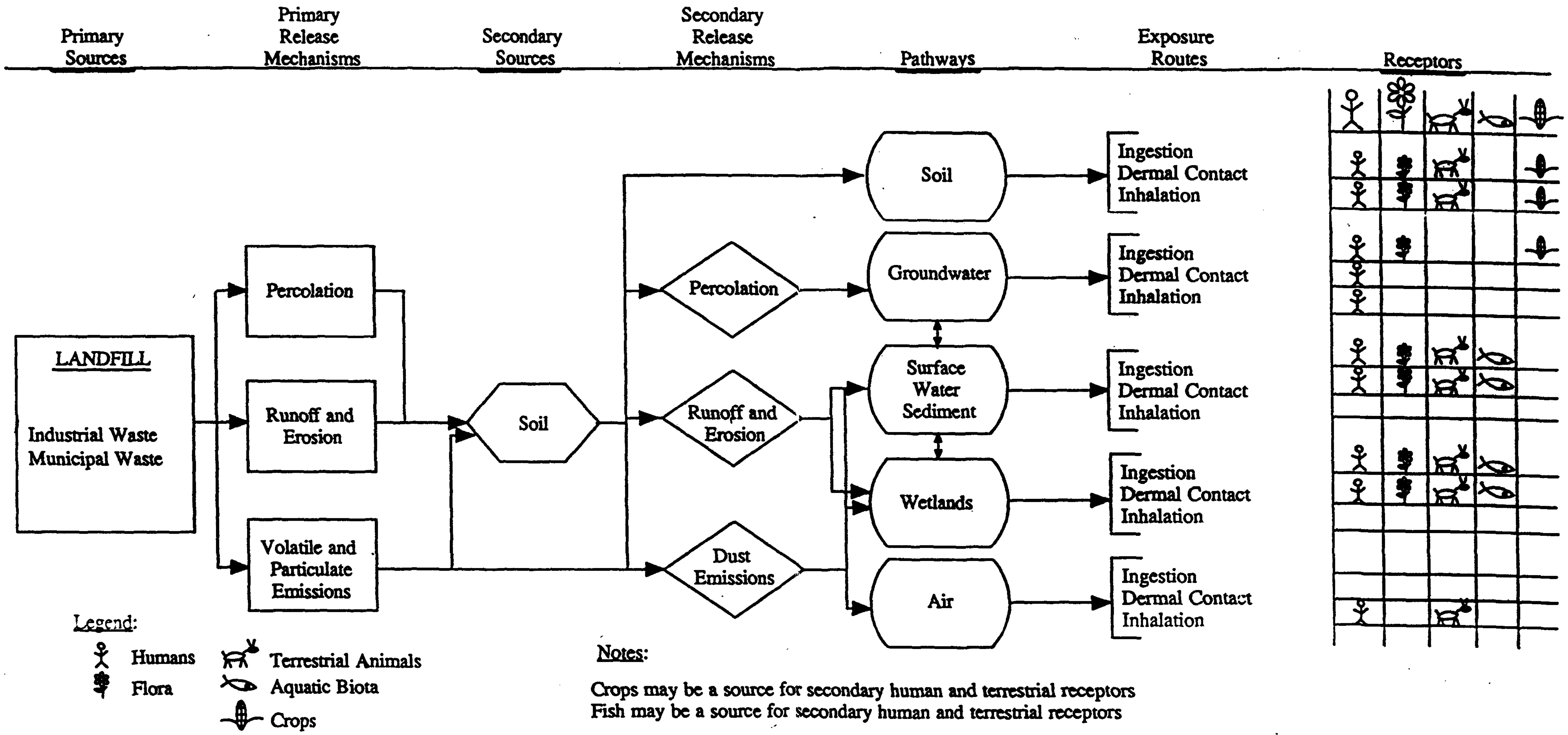
PHASE 2 File No.
Project No. [illegible]
1-2
Drawing No.

FIGURE 1-3
CONCEPTUAL SITE MODEL

Himco Dump
Elkhart, Indiana



Notes:

Crops may be a source for secondary human and terrestrial receptors
Fish may be a source for secondary human and terrestrial receptors

I&P.HIMCO DUMP

2.0 STUDY AREA INVESTIGATION

This section describes field activities and physical and chemical monitoring associated with the remedial investigation (Phase I and II) at the Himco site.

The Phase I remedial investigation (October 1990 through February 1991) for the study area included:

- Site survey
- Geophysical surveys
- Soil sampling
- Trenching
- Monitoring well installation
- Groundwater sampling
- Infield hydraulic conductivity testing
- Landfill waste mass and residential basement gas sampling
- Surface water and sediment sampling
- Determination of presence/absence of wetlands
- Suspected wetland soil sampling
- Staff gauge installation

The Phase II remedial investigation (September and November 1991) for the study area included:

- Additional soil sampling
- Additional trenching
- Leachate sampling
- Installation of one monitoring well
- Additional groundwater sampling
- Infield hydraulic conductivity testing
- Additional surface water and sediment sampling
- Wetlands delineation and sampling
- Well inventory
- Water level measurements

Table 2-1 summarizes the number of samples taken during Phase I and II for each medium sampled.

This section summarizes Phase I and II activities; these activities are discussed in detail in Technical Memoranda (TMs) (Appendix B). Details for the rationale and approach for the sampling locations and sample collection procedures are described in the work plan (Donohue, 1990a and Donohue, 1991a) and the associated project plans (Donohue, 1990b, c, d and 1991b). Exact coordinates for sample locations are provided in Appendix F.

TABLE 2-1

NUMBER OF SAMPLES COLLECTED BY MEDIUM *
HIMCO DUMP SUPERFUND SITE
ELKHART, INDIANA
1992

10/90 7/92

Medium	No. of Phase I Samples	No. of Phase II Samples	Total No. of Samples
Landfill Cover/Miscellaneous Soil	12	11	23
Landfill Cover - Geotechnical	5	5	10
Wetland Soil	16	3	19
Soil Sample from Soil Boring	30	3	33
Soil Sample from Soil Boring - Geotechnical, Total Organic Carbon or % Solids	41	3	44
Surface Water	12	9	21
Sediment	12	9	21
Leachate	0	4	4
Monitoring Wells	36	19	55
Private Wells	8	0	8
Waste Mass Gas	14	0	14

* All samples, except those designated as "geotechnical," were analyzed for chemical characteristics.

2.1 SITE SURVEY AND GRID COORDINATE SYSTEM

The purposes of the site survey were to provide a systematic grid to orient the geophysical investigation, reference all other sample collection activities, and to provide elevation data. The coordinate system was staked with wooden lath at 100-foot centers.

2.2 GEOPHYSICAL SURVEYS

A geophysical survey was conducted using combined electromagnetic (EM) and magnetic (Mag) geophysical surveys during Phase I. The survey was conducted to assess the actual extent of landfilling and to identify and map anomalous zones (i.e., buried drums, plumes, etc.) and to help target subsequent site exploration.

The survey area covered approximately 60 acres. This area included the fill area, the unfilled margins of the dump, and a wetland area along the south central boundary of the landfill. EM and Mag readings were taken at 25-foot intervals. Detailed descriptions of the geophysical equipment and techniques are provided in TM 10 of Appendix B.

2.3 SOIL SAMPLING

Soil sampling activities included surface and subsurface sampling for chemical and geotechnical analysis. Sample locations are shown in Figure 2-1.

The following sections discuss sampling objectives and activities for surface soil and soil borings. When appropriate, Phase I and Phase II sampling activities are discussed separately.

2.3.1 Surface Soil

2.3.1.1 Landfill Cover - Chemical

Sampling of the landfill cover was conducted during Phase I only. A total of 12 landfill cover material samples (GS01 to GS12) were collected to characterize the white powder matrix which composes the majority of the landfill cover material. Table 2-2 summarizes the landfill cover chemical samples taken and associated analyses.

Samples from the landfill cover are surface soil samples. Samples were collected from depths as shallow as three to nine inches and as deep as eight to 16 inches. The depth varied dependent upon the thickness of the overlying sand and topsoil cover. Detailed descriptions of the sampling activities from the landfill cap are provided in TM 7 of Appendix B.

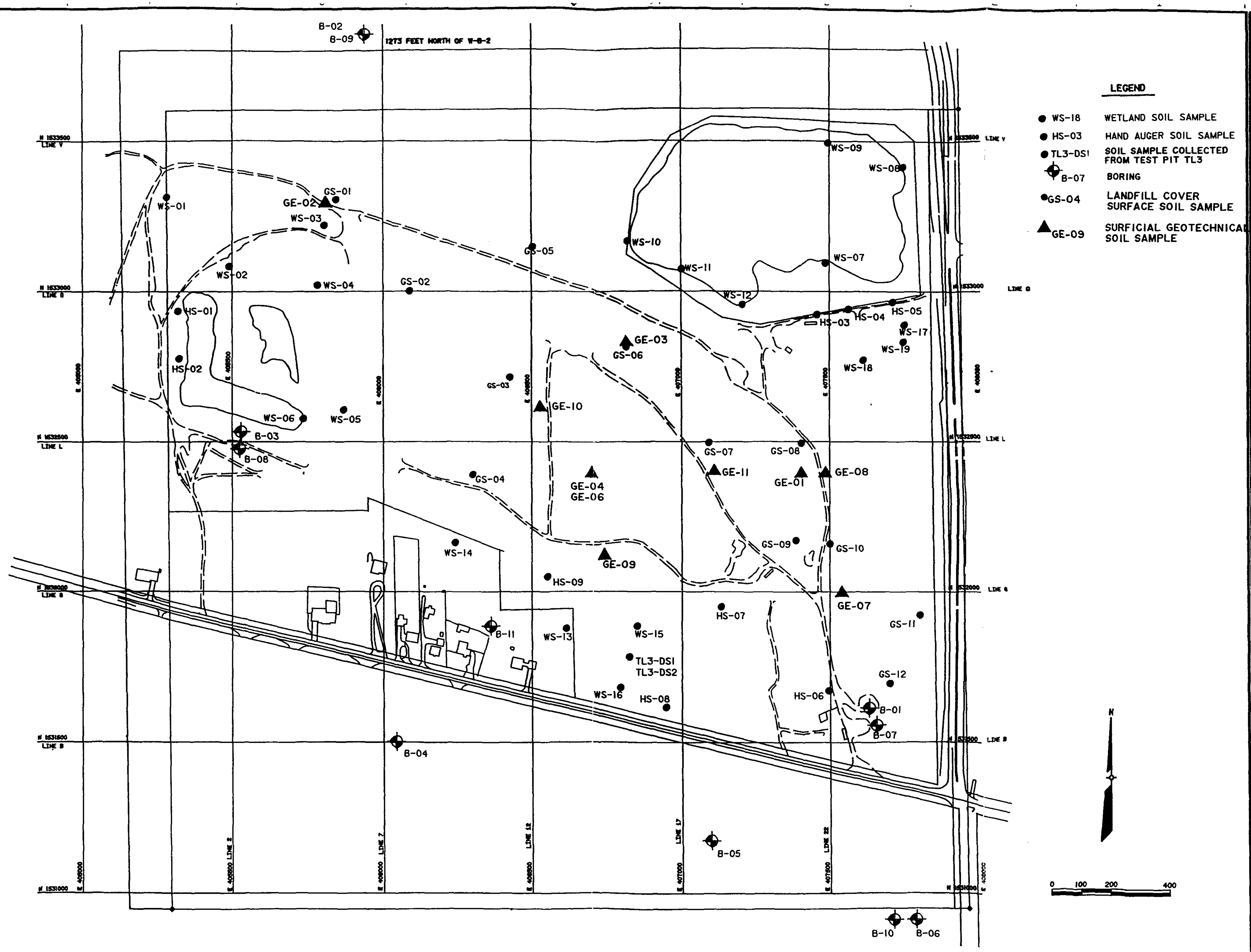


FIGURE 2-1
SOIL SAMPLE LOCATIONS

HIMCO DUMP SUPERFUND SITE
ELKHART, INDIANA

Donohue ENGINEERS ARCHITECTS SCIENTISTS

Scale	AS SHOWN
Date	JAN. 1992
Designer	SP
Drafter	EZ
Checker	
Approver	

No.	Revisions	By	Date

Sheet No.

Off. Loc. File No.

PHASE 2

Drawing No. 2-1

TABLE 2-2

SUMMARY OF LANDFILL COVER - CHEMICALS SAMPLES COLLECTED
HIMCO DUMP SUPERFUND SITE
ELKHART, INDIANA
1992

SAMPLE ID	DATE	ANALYSES
HD-GS01-01	11/8/90	VOC, SVOC, PCB/Pest, METALS/CN
HD-GS02-01	11/8/90	VOC, SVOC, PCB/Pest, METALS/CN
HD-GS03-01	11/9/90	VOC, SVOC, PCB/Pest, METALS/CN
HD-GS04-01	11/9/90	VOC, SVOC, PCB/Pest, METALS/CN
HD-GS05-01	11/10/90	VOC, SVOC, PCB/Pest, METALS/CN
HD-GS06-01	11/10/90	VOC, SVOC, PCB/Pest, METALS/CN
HD-GS07-01	11/11/90	VOC, SVOC, PCB/Pest, METALS/CN
HD-GS08-01	11/11/90	VOC, SVOC, PCB/Pest, METALS/CN
HD-GS09-01	11/11/90	VOC, SVOC, PCB/Pest, METALS/CN
HD-GS10-01	11/12/90	VOC, SVOC, PCB/Pest, METALS/CN
HD-GS11-01	11/12/90	VOC, SVOC, PCB/Pest, METALS/CN
HD-GS12-01	11/12/90	VOC, SVOC, PCB/Pest, METALS/CN

VOC - Volatile Organic Compound
SVOC - Semi-Volatile Organic Compound
PCB - Polychlorinated Biphenyls
Pest - Pesticides
CN - Cyanide

2.3.1.2 Landfill Cover - Geotechnical

A total of 10 geotechnical samples were collected across the existing landfill cover to evaluate the potential for slope failure of the landfill. Table 2-3 summarizes the landfill cover geotechnical samples taken during Phase I and associated analyses. The landfill cap geotechnical samples taken during Phase II and associated analyses are summarized in Table 2-4.

During Phase I, cover soil material was collected at five locations from approximately 0.5 to 1.5 feet. Sample locations (shown in Figure 2-1) were designated as GE-01 through GE-06. In addition, a total of seven 24-inch shelby tubes were driven at the same five locations, except for GE-01. At location GE-01, no sample was recovered because of the dense nature of the calcium sulfate cover. Detailed descriptions of the geotechnical soil sampling activities during Phase I were provided in TM 13. During Phase II, five landfill cover material samples were collected from no more than 18 inches deep. The locations of the samples were selected so that three samples were collected for the sand landfill cover and two samples were collected for the calcium sulfate cover. Sample locations are shown in Figure 2-1 and were designated as GE-07 through GE-11. A detailed description of sampling activities are provided in TM 18 of Appendix B.

2.3.1.3 Soil Sampling in Areas Adjacent to the Landfill

During Phase II, 14 soil samples were collected for chemical analysis from areas adjacent to the landfill. Table 2-5 summarizes these samples and associated analyses. Sample locations are shown in Figure 2-1. A detailed description of sampling activities is provided in TM 22 of Appendix B.

Three soil samples (HS-03 to HS-05) were collected from approximately 0-18 inches along the south side of the quarry pond fence, evenly spaced along a dirt bike trail. These samples were collected to investigate potential contamination which could affect persons using the trail.

Two soil samples (HS-01 and HS-02) were collected west of the "L" shaped pond from approximately 0-18 inches. These samples were collected in order to investigate the potential impact to surface soils from surface water draining from the landfill and ponds during overflow events.

Three soil samples (HS-07 to HS-09) were collected immediately south of the landfill cover from approximately 0-18 inches. These samples were taken to further characterize the nature and extent of contamination (specifically SVOCs) in that area.

TABLE 2-3

SUMMARY OF PHASE I LANDFILL COVER - GEOTECHNICAL SAMPLES COLLECTED
HIMCO DUMP SUPERFUND SITE
ELKHART, INDIANA
1992

SAMPLE ID	DATE	ANALYSES	LOCATION
HD-K21-01	11/8/90	GRAIN SIZE, ATTERBERG LIMITS, TRIAXIAL SHEAR	GE-01
HD-T05-01	11/13/90	GRAIN SIZE, ATTERBERG LIMITS, TRIAXIAL SHEAR, CONSOLIDATION	GE-02
HD-015-01	11/13/90	GRAIN SIZE, ATTERBERG LIMITS, TRIAXIAL SHEAR	GE-03
HD-K14-01	11/13/90	GRAIN SIZE, ATTERBERG LIMITS, TRIAXIAL SHEAR, CONSOLIDATION	GE-04 GE-06
HD-D24-01	11/13/90	GRAIN SIZE, ATTERBERG LIMITS, TRIAXIAL SHEAR	GE-05

Geotechnical test results will be used to evaluate structural stability as well as erosion potential of the landfill cover during the FS and remedial design at this site.

TABLE 2-4

SUMMARY OF PHASE II LANDFILL COVER - GEOTECHNICAL SAMPLES COLLECTED
HIMCO DUMP SUPERFUND SITE
ELKHART, INDIANA
1992

SAMPLE ID	DATE	ANALYSES
HD-GE07-01	9/11/90	TRIAXIAL COMPRESSION
HD-GE08-01	9/11/91	TRIAXIAL COMPRESSION
HD-GE09-01	9/11/91	TRIAXIAL COMPRESSION
HD-GE10-01	9/11/91	TRIAXIAL COMPRESSION
HD-GE11-01	9/11/91	TRIAXIAL COMPRESSION

Geotechnical test results will be used to evaluate structural stability as well as erosion potential of the landfill cover during the FS and remedial design at this site.

TABLE 2-5

SUMMARY OF SOIL SAMPLES COLLECTED IN AREAS ADJACENT TO THE LANDFILL
HIMCO DUMP SUPERFUND SITE
ELKHART, INDIANA
1992

SAMPLE ID	DATE	ANALYSES
HD-HS01-01	9/16/91	VOC, SVOC, PCB/Pest TOTAL METALS/CN, TOC, GRAIN SIZE
HD-HS02-01	9/16/91	VOC, SVOC, PCB/Pest TOTAL METALS/CN, TOC, GRAIN SIZE
HD-HS03-01	9/19/91	VOC, SVOC, PCB/Pest TOTAL METALS/CN, TOC, GRAIN SIZE
HD-HS04-01	9/19/91	VOC, SVOC, PCB/Pest TOTAL METALS/CN, TOC, GRAIN SIZE
HD-HS05-01	9/19/91	VOC, SVOC, PCB/Pest TOTAL METALS/CN, TOC, GRAIN SIZE
HD-HS06-01	9/19/91	VOC, SVOC, PCB/Pest TOTAL METALS/CN, TOC, GRAIN SIZE
HD-HS07-01	9/19/91	VOC, SVOC, PCB/Pest TOTAL METALS/CN, TOC, GRAIN SIZE
HD-HS08-01	9/19/91	VOC, SVOC, PCB/Pest TOTAL METALS/CN, TOC, GRAIN SIZE
HD-HS09-01	9/19/91	VOC SVOC, PCB/Pest TOTAL METALS/CN, TOC, GRAIN SIZE
HD-TL3DS1-01	9/19/91	VOC, SVOC, PCB/Pest TOTAL METALS/CN, TOC, GRAIN SIZE
HD-TL3DS2-01	9/19/91	VOC, SVOC, PCB/Pest TOTAL METALS/CN, TOC, GRAIN SIZE

VOC - Volatile Organic Compound
SVOC - Semi-Volatile Organic Compound
PCB - Polychlorinated Biphenyls
Pest - Pesticides
CN - Cyanide

One sample (HS-06) was taken near the southeast corner of the landfill cover from surface debris associated with an asphalt pile. This sample was taken to investigate contamination associated with leaching from the asphalt debris.

Two surficial soil samples (TL3DS1 and TL3DS2) were collected from trench TL-3 at two feet and six feet during trenching activities. These samples were collected to assess the vertical extent of contamination in that area of the site.

2.3.1.4 Wetland Soils

Nineteen wetland soil samples were collected to investigate possible soil contamination associated with the wetlands. Table 2-6 summarizes of wetland soil samples collected and associated analyses. Sample locations are shown in Figure 2-1.

During Phase I, 16 soil samples (WS01 through WS16) were collected from areas suspected to be wetlands. Six samples were from the area surrounding the two small surface water bodies, four from the area north of County Road 10, and six from the area next to the quarry pit pond. Samples were composited from 0 to 18 inches at each location. Detailed descriptions of sampling activities are provided in TM 15 of Appendix B.

During Phase I, the wetland determination indicated that there was only one wetland south of the quarry pond. Three additional wetland soil samples (WT17 through WT19) were collected at this location. Detailed descriptions of sampling activities are provided in TM 25 of Appendix B.

2.3.2 Soil Borings

Eleven soil borings (B-01 to B-11) were completed at depths ranging from 16 to 175 feet below ground surface. These soil borings were completed to investigate the site stratigraphy and to collect samples for chemical and geotechnical analysis. Descriptions of soil classification, Munsell color, texture, moisture content, and special features were recorded for samples collected during boring activities. The locations of the borings are provided in Figure 2-1, and boring depths and sampling intervals are summarized in Table 2-7.

During Phase I, soil was sampled when six shallow observation wells WT101 through WT106) were installed on or next to the site. Thirty samples were taken for chemical analysis at two-foot intervals from ground surface to a maximum depth of 16 feet. Selected samples were analyzed for TOC and geotechnical analysis. Detailed descriptions of sampling activities are provided in TM 13 of Appendix B.

In addition, four deep (166 to 174.5 feet) borings (B-07 through B-10) were drilled and sampled for geotechnical and total organic carbon (TOC) analysis. Each boring was blind-drilled to 18 feet; split spoon samples were retrieved at 5-foot intervals thereafter. From all four borings, a total of 14 representative samples were collected for geotechnical analysis and 15 random samples were collected for TOC analysis. Detailed descriptions of sampling activities are provided in TM 4 of Appendix B.

During Phase II, soil was sampled when one shallow observation well (WT111A) was installed near the south central portion of the Himco site. Three soil samples were collected for chemical analysis and grain size distribution at five-foot intervals from ground surface to a depth of 12 feet. A detailed description of sampling activities is provided in TM 19 of Appendix B.

2.4 TRENCHING/LEACHATE COLLECTION

Thirty-three test pits were excavated at the Himco site to: 1) determine if metal drums are buried at the site, 2) delineate the extent of the landfill, and 3) collect leachate samples for chemical analysis where leachate was observed. Trench locations are shown in Figure 2-2.

During Phase I, 20 trenches were excavated on the landfill cover. Trench locations were selected based on the distribution of magnetic anomalies indicated by the geophysical survey. Each trench was approximately 25 feet long and was excavated to a maximum depth of approximately 15 feet, unless the water table was reached first. Some trench locations were along the same direction and a direct extension of adjoining trenches. In some cases, this provided a long continuous trench up to 100 feet. No leachate was collected during Phase I field activities. A description of trench excavation procedures and the physical appearance of each trench is provided in TM 10 of Appendix B.

During Phase II, 13 trenches pits were excavated in an area south of the landfill cover. One trench was excavated on the landfill cover. Seven trenches were excavated for the collection of leachate samples and the delineation of construction debris south of the landfill area. Four leachate samples were collected and analyzed for VOCs, SVOCs, polychlorinated biphenyls (PCBs) and pesticides, total metals/cyanide, and water quality. Leachate was collected from trenches TL-1, TL-2, TL-4, and TL-5 and analyzed. Data from the leachate analysis will be used to assess remedial alternatives and to provide data to the Publicly Operated Treatment Works (POTW) for pretreatment assessment. In addition, six trenches were excavated to delineate the thickness and lateral extent of construction debris associated with high SVOC values detected in soil samples taken south of the landfill cover during Phase I.

TABLE 2-6

SUMMARY OF WETLAND SOIL SAMPLES COLLECTED
HIMCO DUMP SUPERFUND SITE
ELKHART, INDIANA
1992

SAMPLE ID	DATE	ANALYSES
HD-WS01-01	10/21/90	VOC, SVOC, PCB/Pest
HD-WS01-02	11/6/90	METALS/CN
HD-WS02-01	10/21/90	VOC, SVOC, PCB/Pest
HD-WS02-02	11/6/90	METALS/CN
HD-WS03-01	10/22/90	VOC, SVOC, PCB/Pest
HD-WS03-02	11/6/90	METALS/CN
HD-WS04-01	10/22/90	VOC, SVOC, PCB/Pest
HD-WS04-02	11/6/90	METALS/CN
HD-WS05-01	10/22/90	VOC, SVOC, PCB/Pest
HD-WS05-02	11/7/90	METALS/CN
HD-WS06-01	10/23/90	VOC, SVOC, PCB/Pest, METALS/CN
HD-WS07-01	10/20/90	VOC, SVOC, PCB/Pest
HD-WS07-02	11/7/90	METALS/CN
HD-WS08-01	10/20/90	VOC, SVOC, PCB/Pest
HD-WS08-02	11/7/90	METALS/CN
HD-WS09-01	10/20/90	VOC, SVOC, PCB/Pest
HD-WS09-02	11/7/90	METALS/CN
HD-WS10-01	10/20/90	VOC, SVOC, PCB/Pest
HD-WS10-02	11/7/90	METALS/CN
HD-WS11-01	10/20/90	VOC, SVOC, PCB/Pest
HD-WS11-02	11/7/90	METALS/CN

TABLE 2-6 (Continued)

SUMMARY OF WETLAND SOIL SAMPLES COLLECTED
HIMCO DUMP SUPERFUND SITE
ELKHART, INDIANA
1992

SAMPLE ID	DATE	ANALYSES
HD-WS12-01	10/20/90	VOC, SVOC, PCB/Pest
HD-WS12-02	11/7/90	METALS/CN
HD-WS13-01	10/23/90	VOC, SVOC, PCB/Pest, METALS/CN
HD-WS14-01	10/23/90	VOC, SVOC, PCB/Pest, METALS/CN
HD-WS15-01	10/23/90	VOC, SVOC, PCB/Pest, METALS/CN
HD-WS16-01	10/23/90	VOC, SVOC, PCB/Pest, METALS/CN
HD-WS17-01	9/10/91	VOC, SVOC, PCB/Pest TOTAL METALS/CN, TOC, GRAIN SIZE
HD-WS18-01	9/10/91	VOC, SVOC, PCB/Pest TOTAL METALS/CN, TOC, GRAIN SIZE
HD-WS19-01	9/10/91	VOC, SVOC, PCB/Pest TOTAL METALS/CN, TOC, GRAIN SIZE

VOC - **Volatile Organic Compound**
SVOC - **Semi-Volatile Organic Compound**
TOC - **Total Organic Carbon**
PCB - **Polychlorinated Biphenyls**
Pest - **Pesticides**
CN - **Cyanide**

TABLE 2-7

SUMMARY OF SOIL BORING SAMPLES COLLECTED
HIMCO DUMP SUPERFUND SITE
ELKHART, INDIANA
1992

SAMPLE ID	DATE	ANALYSES	DEPTH	LOCATION
HD-GT01A-01	11/12/90	VOC, SVOC, PCB/PEST, METALS/CN, TOC	0'-2'	Boring B-01
HD-GT01B-01	11/12/90	VOC, SVOC, PCB/PEST, METALS/CN	2'-4'	Boring B-01
HD-GT01C-01	11/12/90	VOC, SVOC, PCB/PEST, METALS/CN	4'-6'	Boring B-01
HD-GT01D-01	11/12/90	VOC, SVOC, PCB/PEST, METALS/CN	6'-8'	Boring B-01
HD-GT01F-01	11/12/90	VOC, SVOC, PCB/PEST, METALS/CN	10'-12'	Boring B-01
HD-GT01-01	11/12/90	GRAIN SIZE, ATTERBERG LIMITS	14'-16'	Boring B-01
HD-GT02A-01	11/10/90	VOC, SVOC, PCB/PEST, METALS/CN	0'-2'	Boring B-02
HD-GT02B-01	11/10/90	VOC, SVOC, PCB/PEST, METALS/CN, TOC	2'-4'	Boring B-02
HD-GT02C-01	11/10/90	VOC, SVOC, PCB/PEST, METALS/CN	4'-6'	Boring B-02
HD-GT02D-01	11/10/90	VOC, SVOC, PCB/PEST, METALS/CN	6'-8'	Boring B-02
HD-GT02E-01	11/10/90	VOC, SVOC, PCB/PEST, METALS/CN	8'-10'	Boring B-02
HD-GT02-01	11/10/90	GRAIN SIZE, ATTERBERG LIMITS	14'-16'	Boring B-02
HD-GT03A-01	11/11/90	VOC, SVOC, PCB/PEST, METALS/CN	0'-2'	Boring B-03
HD-GT03B-01	11/11/90	VOC, SVOC, PCB/PEST, METALS/CN	2'-4'	Boring B-03
HD-GT03C-01	11/11/90	VOC, SVOC, PCB/PEST, METALS/CN	4'-6'	Boring B-03
HD-GT03D-01	11/11/90	VOC, SVOC, PCB/PEST, METALS/CN	6'-8'	Boring B-03
HD-GT03E-01	11/11/90	TOC	8'-10'	Boring B-03
HD-GT03H-01	11/11/90	VOC, SVOC, PCB/PEST, METALS/CN GRAIN SIZE, ATTERBERG LIMITS	14'-16'	Boring B-03
HD-GT04A-01	11/11/90	VOC, SVOC, PCB/PEST, METALS/CN	0'-2'	Boring B-04
HD-GT04B-01	11/11/90	VOC, SVOC, PCB/PEST, METALS/CN	2'-4'	Boring B-04

TABLE 2-7 (Continued)

SUMMARY OF SOIL BORING SAMPLES COLLECTED
HIMCO DUMP SUPERFUND SITE
ELKHART, INDIANA
1992

SAMPLE ID	DATE	ANALYSES	DEPTH	LOCATION
HD-GT04C-01	11/11/90	VOC, SVOC, PCB/PEST, METALS/CN	4'-6'	Boring B-04
HD-GT04D-01	11/11/90	VOC, SVOC, PCB/PEST, METALS/CN	6'-8'	Boring B-04
HD-GT04E-01	11/11/90	VOC, SVOC, PCB/PEST, METALS/CN	8'-10'	Boring B-04
HD-GT04-01	11/11/90	GRAIN SIZE, ATTERBERG LIMITS	14'-16'	Boring B-04
HD-GT05B-01	11/9/90	VOC, SVOC, PCB/PEST, METALS/CN	2'-4'	Boring B-05
HD-GT05E-01	11/9/90	VOC, SVOC, PCB/PEST, METALS/CN	8'-10'	Boring B-05
HD-GT05F-01	11/9/90	VOC, SVOC, PCB/PEST, METALS/CN	10'-12'	Boring B-05
HD-GT05G-01	11/9/90	VOC, SVOC, PCB/PEST, METALS/CN	12'-14'	Boring B-05
HD-GT05H-01	11/9/90	VOC, SVOC, PCB/PEST, METALS/CN, TOC GRAIN SIZE, ATTERBERG LIMITS	14'-16'	Boring B-05
HD-GT06A-01	11/8/90	VOC, SVOC, PCB/PEST, METALS/CN, TOC	0'-2'	Boring B-06
HD-GT06C-01	11/8/90	VOC, SVOC, PCB/PEST, METALS/CN, TOC	4'-6'	Boring B-06
HD-GT06D-01	11/8/90	GRAIN SIZE, ATTERBERG LIMITS	6'-8'	Boring B-06
HD-GT06E-01	11/8/90	VOC, SVOC, PCB/PEST, METALS/CN, TOC	8'-10'	Boring B-06
HD-GT06G-01	11/8/90	VOC, SVOC, PCB/PEST, METALS/CN, TOC	12'-14'	Boring B-06
HD-GT06H-01	11/8/90	VOC, SVOC, PCB/PEST, METALS/CN, TOC	14'-16'	Boring B-06
HD-GT07-02-01	12/17/90	GRAIN SIZE, ATTERBERG LIMITS	28'-29'	Boring B-07
HD-GT07-04-01	12/17/90	GRAIN SIZE, ATTERBERG LIMITS	58'-60'	Boring B-07
HD-GT07-05-01	12/17/90	GRAIN SIZE, ATTERBERG LIMITS	158'-158.5'	Boring B-07
HD-GT07-06-01	12/17/90	GRAIN SIZE, ATTERBERG LIMITS	163'-164'	Boring B-07
HD-GT07-07-01	12/17/90	GRAIN SIZE, ATTERBERG LIMITS	174'-174.5'	Boring B-07

TABLE 2-7 (Continued)

SUMMARY OF SOIL BORING SAMPLES COLLECTED
HIMCO DUMP SUPERFUND SITE
ELKHART, INDIANA
1992

SAMPLE ID	DATE	ANALYSES	DEPTH	LOCATION
HD-GT08-01-01	12/19/90	GRAIN SIZE, ATTERBERG LIMITS	18'-19'	Boring B-08
HD-GT08-04-01	1/3/91	GRAIN SIZE, ATTERBERG LIMITS	143'-143.5	Boring B-08
HD-GT08-05-01	1/3/91	GRAIN SIZE, ATTERBERG LIMITS	163'-164'	Boring B-08
HD-SB08-01	1/3/91	TOC, % SOLIDS	63'-63.5'	Boring B-08
HD-SB08-02	1/3/91	TOC, % SOLIDS	68'-68.5'	Boring B-08
HD-SB08-03	1/3/91	TOC, % SOLIDS	73'-73.5'	Boring B-08
HD-SB08-04	1/3/91	TOC, % SOLIDS	78'-78.5'	Boring B-08
HD-SB08-05	1/3/91	TOC, % SOLIDS	83'-83.5'	Boring B-08
HD-GT09-01-01	1/5/91	GRAIN SIZE, ATTERBERG LIMITS	53'-53.5'	Boring B-09
HD-GT09-06-01	1/6/91	GRAIN SIZE, ATTERBERG LIMITS	143'-145'	Boring B-09
HD-GT09-07-01	1/6/91	GRAIN SIZE, ATTERBERG LIMITS	163'-163.5'	Boring B-09
HD-SB-09-01	1/5/91	TOC, % SOLIDS	18'-19'	Boring B-09
HD-SB09-02	1/5/91	TOC, % SOLIDS	23'-23.5'	Boring B-09
HD-SB09-03	1/5/91	TOC, % SOLIDS	28'-28.5'	Boring B-09
HD-SB09-04	1/5/91	TOC, % SOLIDS	33'-33.5'	Boring B-09
HD-SB09-05	1/5/91	TOC, % SOLIDS	48'-48.5'	Boring B-09
HD-GT10-01-01	1/8/91	GRAIN SIZE, ATTERBERG LIMITS	38'-39'	Boring B-10
HD-GT10-04-01	1/9/91	GRAIN SIZE, ATTERBERG LIMITS	158'-158.5'	Boring B-10
HD-GT10-05-01	1/9/91	GRAIN SIZE, ATTERBERG LIMITS	173'-174'	Boring B-10
HD-SB10-01	1/8/91	TOC, % SOLIDS	18'-18.5'	Boring B-10

TABLE 2-7 (Continued)

SUMMARY OF SOIL BORING SAMPLES COLLECTED
HIMCO DUMP SUPERFUND SITE
ELKHART, INDIANA
1992

SAMPLE ID	DATE	ANALYSES	DEPTH	LOCATION
HD-SB10-02	1/8/91	TOC, % SOLIDS	23'-23.5'	Boring B-10
HD-SB10-03	1/8/91	TOC, % SOLIDS	28'-28.5'	Boring B-10
HD-SB10-04	1/8/91	TOC, % SOLIDS	48'-50'	Boring B-10
HD-SB10-05	1/8/91	TOC, % SOLIDS	53'-54'	Boring B-10
HD-GT11A-01*	9/10/91	VOC, SVOC, PCB/Pest TOTAL METALS/CN, TOC, GRAIN SIZE	0'-2'	Boring B-11
HD-GT11B-01*	9/10/91	VOC, SVOC, PCB/Pest TOTAL METALS/CN, TOC, GRAIN SIZE	5'-7'	Boring B-11
HD-GT11C-01*	9/10/91	VOC, SVOC, PCB/Pest TOTAL METALS/CN, TOC, GRAIN SIZE	10'-12'	Boring B-11

* Samples collected during Phase II

VOC - Volatile Organic Compound
SVOC - Semi-Volatile Organic Compound
TOC - Total Organic Carbon
PCB - Polychlorinated Biphenyls
Pest - Pesticides
CN - Cyanide

2.8 LANDFILL WASTE MASS AND RESIDENTIAL AIR SCREENING

2.8.1 Landfill Waste Mass Gas Sampling

Waste mass gas sampling was conducted on the landfill cover during Phase I in order to characterize the extent of VOCs in the landfill. A total of 18 gas samples were collected, to include field and laboratory quality control samples, from 12 landfill cover soil sample locations. Samples were collected at depths ranging from 0.75 to 3.0 feet. Waste mass gas sample locations are show in Figure 2-5. The gas samples collected and associated analysis are summarized in Table 2-11. Sample locations were chosen based on the highest field readings of VOCs, methane, or hydrogen sulfide in the 0-18-inch soil sample headspace as measured by an HNu or Lumidor Gasponder IV meter. Detailed descriptions of sampling activities and methods are provided in TM 7 of Appendix B.

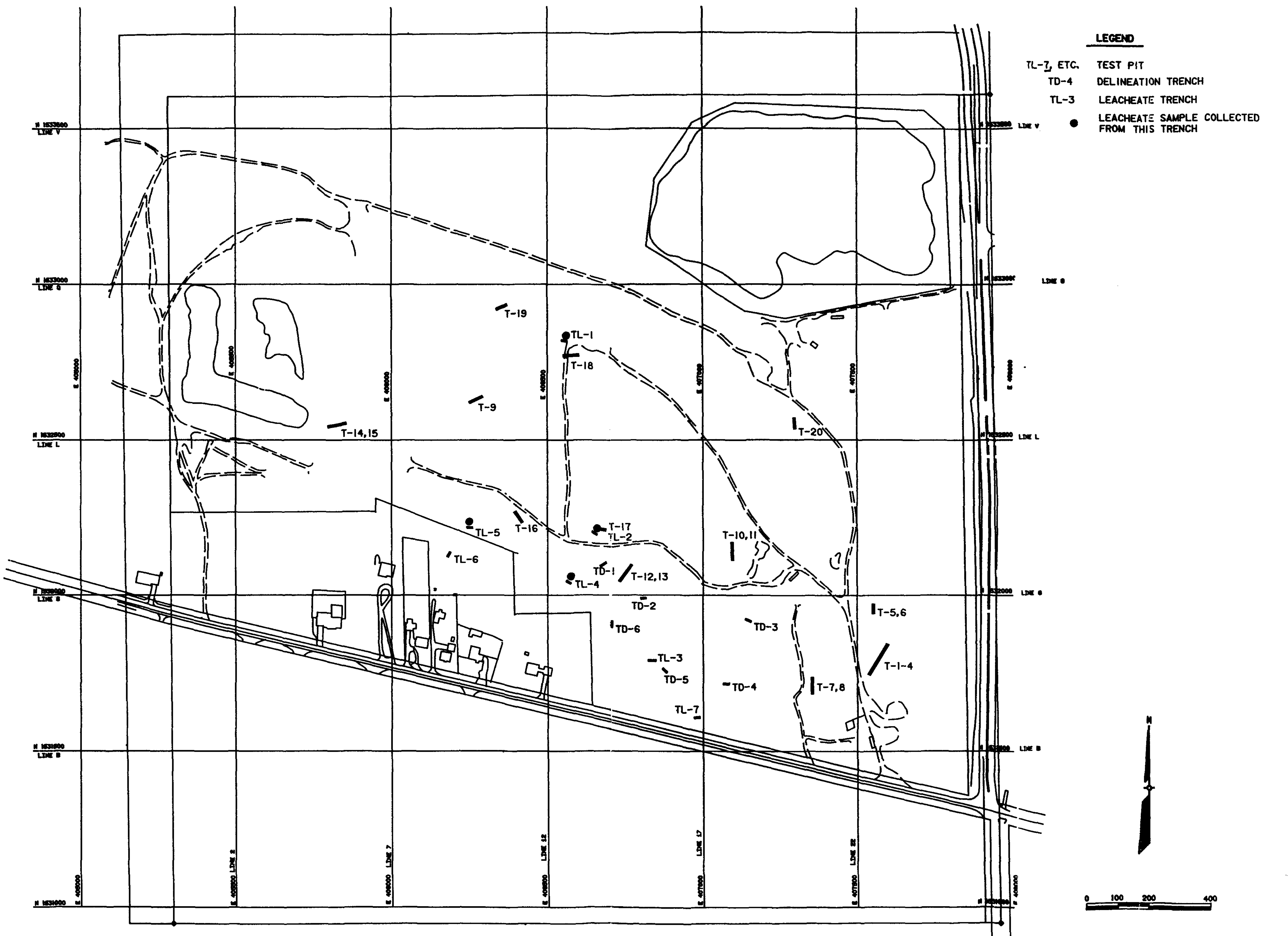
2.8.2 Residential Basement Air Screening

Four residential basements along County Road 10 were screened for the presence of landfill gases during Phase I. The four residencies included the [redacted] (RW-01,02) [redacted] (RW-06), [redacted] (RW-07), and [redacted] (RW-08) homes. Basement gas was screened to evaluate if landfill gas which may be generated at the site had migrated off-site and into these residents basements. This screening was a qualitative check for the presence of methane and hydrogen sulfide. Detailed descriptions of sampling activities are provided in TM 6 of Appendix B.

2.9 SURFACE WATER AND SEDIMENT SAMPLING

A total of 18 surface water and sediment samples were collected from the three ponds located at the Himco site to investigate the degree and extent of surface water and sediment contamination. Surface water samples were collected concurrently with sediment samples. Sampling locations are provided in Figure 2-6. Tables 2-12 and 2-13 summarize Phase I surface water and sediment samples collected and associated analyses, and the surface water and sediment samples collected during Phase II and associated analyses are summarized in Tables 2-14 and 2-15. The following discussion addresses surface water and sediment sampling activities for Phase I and Phase II separately.

During Phase I, 12 surface water and 12 sediment samples were collected at four locations from each of the three ponds. Samples were collected at approximately 2-3 feet offshore at water depths ranging from 0 to 2 feet. Sampling information and field observations were recorded on sediment sampling and surface water sampling forms. This information along with sampling procedures is detailed in TM 9 of Appendix B.



LEGEND

TL-7, ETC.	TEST PIT
TD-4	DELINEATION TRENCH
TL-3	LEACHEATE TRENCH
●	LEACHEATE SAMPLE COLLECTED FROM THIS TRENCH

Scale	AS SHOWN			
Date	JAN. 1992			
Designer	SP			
Drafter	EZ			
Checker				
Approver		No.	Revisions	By	Date

Donohue ENGINEERS ARCHITECTS SCIENTISTS

FIGURE 2-2
TRENCH LOCATIONS
HIMCO DUMP SUPERFUND SITE
ELKHART, INDIANA

Sheet No.

Off. Loc. File No.

PHASE 2

Drawing No. 2-2

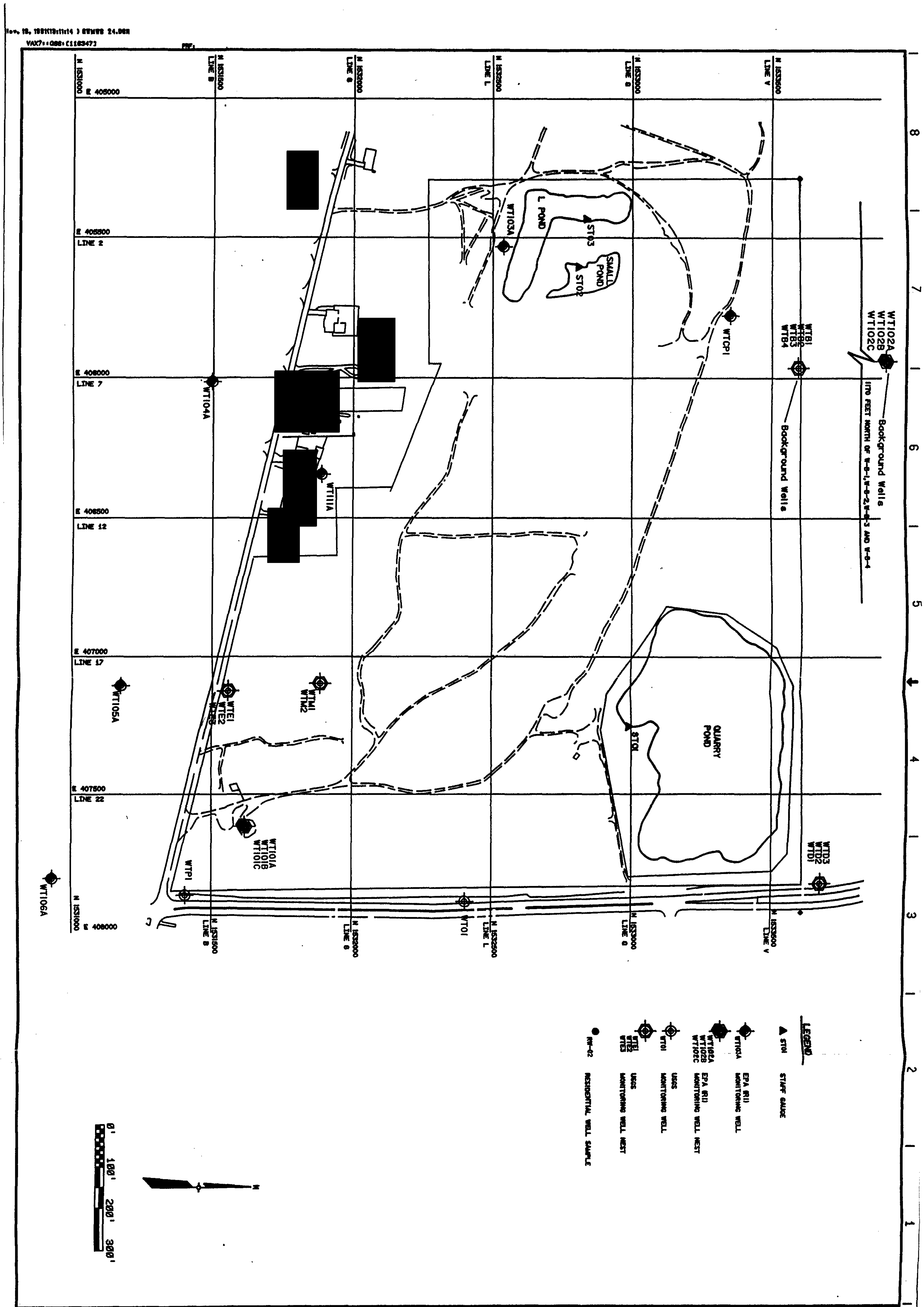
An emergency removal action was conducted following the detection of approximately 50% toluene and other VOC contaminants in a leachate sample during the Phase II field investigation. Himco Waste-Away Services, Inc. contracted with Mittelhauser Corporation to conduct a site assessment on May 7, 1992. It was determined that toluene, xylene, 2-hexaone, 4-methyl-2-pentanone, and ethylbenzene were found in concentrations ranging from 480,000 ppm for toluene to 6,400 ppm for ethylbenzene. The contaminants were buried in leaking drums. Mittelhauser Corporation began the removal action on May 19, 1992; 71 55-gallon drums were removed. Liquid contaminants from the drums and the excavation area were pumped into a 5,500-gallon capacity tanker truck for disposal. The removal action was completed on May 22, 1992. Field testing was conducted following the removal action to ensure material from the leaking drums was removed to below detection limits.

2.5 MONITORING WELL INSTALLATION

Eleven groundwater monitoring wells were installed on or next to the site. These wells were installed to evaluate the aquifer hydraulic characteristics and to determine the nature and extent of groundwater contamination. Groundwater monitoring well locations are shown in Figure 2-3. Those installed during the RI are identified as "EPA well" in the legend. Monitoring well construction details are summarized in Table 2-8.

During Phase I, 10 groundwater monitoring wells were installed to include six shallow and four deep wells. The six shallow wells were installed to intersect the water table. Two of the shallow wells (WT102A and WT101A) were installed next to deep groundwater wells as part of a well nest. Shallow wells were installed to a depth of approximately 16 feet. Because of the shallow water table encountered, modifications were made to the well specifications to ensure that the well screens intersected the water table. Despite these efforts, the water level in WT103A was above the well screen. The four deep wells were finished at the following depths: WTP101B, 98 feet; WTP101C, 165 feet; WTP102B, 65.4 feet; and WTP102C, 159.5 feet. Data collected and observations made during the installation of the monitoring wells were recorded on installation diagrams and are provided in TM 1 and TM 13 of Appendix B.

During Phase II, one shallow well (WT111A) was installed to intersect the water table where a soil boring was completed. Data collection and observations made during the installation of monitoring well WT111A are recorded on installation diagrams and are provided in TM 19 of Appendix B.



[redacted]

[redacted]

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[redacted]

[redacted]

FIGURE 2-3
GROUNDWATER MONITORING WELL LOCATIONS

HIMCO DUMP SUPERFUND SITE
ELKHART, INDIANA

Donohue ENGINEERS ARCHITECTS SCIENTISTS

Scale	AS SHOWN				
Date	NOV. 1991				
Designer	SP				
Drafter	EZ				
Checker					
Approver		No.	Revisions	By	Date

Sheet No.

Off. Loc.

File No.

Drawing No. 2-3

TABLE 2-8

MONITORING WELL INSTALLATION SUMMARY
(PHASE I, PHASE II)
HIMCO DUMP SUPERFUND SITE
ELKHART, INDIANA
1992

						Phase I (February 1 and 2, 1991)		Phase II (November 19, 1991)	
Well Number	Top of Pipe Elevation (ft)	Ground Surface Elevation (ft)	Top of Filter Pack (ft)	Top of Screen (ft)	Bottom of Screen (ft)	Depth to Water (ft)	Water Elevation (ft)	Depth to Water (ft)	Water Elevation (ft)
WT101A	764.33	761.9	757.7	756.5	745.6	9.96	754.37	11.58	752.75
WTP101B	764.23	761.7	670.7	668.7	663.7	9.89	754.34	11.45	752.78
WTP101C	764.11	761.6	605.6	601.6	596.6	9.78	754.33	11.27	752.84
WT102A	769.07	766.6	762.1	761.3	750.6	10.17	758.91	10.92	758.15
WTP102B	768.81	766.3	709.3	705.9	700.9	9.85	758.96	10.62	758.19
WTP102C	769.22	766.7	614.7	612.2	607.2	10.27	758.95	10.27	758.95
WT103A	760.59	758.1	754.1	752.8	742.1	5.28	755.31	6.13	754.46
WT104A	765.57	763.1	758.8	757.5	746.8	11.75	753.82	12.44	753.13
WT105A	762.94	760.4	755.5	754.9	744.4	9.00	753.94	10.42	752.52
WT106A	761.47	759.0	754.0	751.0	740.2	7.87	753.60	9.51	751.96
WT111A	766.50	764.5	756.3	755.2	744.5	--	--	12.96	753.54

-- Measurement not taken.

A/R/HIMCO/AQ4

2.6 GROUNDWATER SAMPLING

A total of 43 groundwater wells were sampled during the field investigation. The wells sampled included 11 EPA stainless steel wells installed during this investigation, 24 USGS poly vinyl chloride (PVC) wells installed in 1977 and 1979, and seven residential wells of unknown construction materials and installation data. Groundwater was sampled to assess the nature and extent of contamination in the aquifer and to investigate groundwater quality. Table 2-9 summaries Phase I groundwater samples collected, well depths, and associated analysis, and Table 2-10 summarizes Phase II samples, well depths, and analysis. Groundwater monitoring well locations are shown in Figures 2-3 and 2-4. The following paragraphs describe groundwater sampling activities during Phase I and Phase II separately.

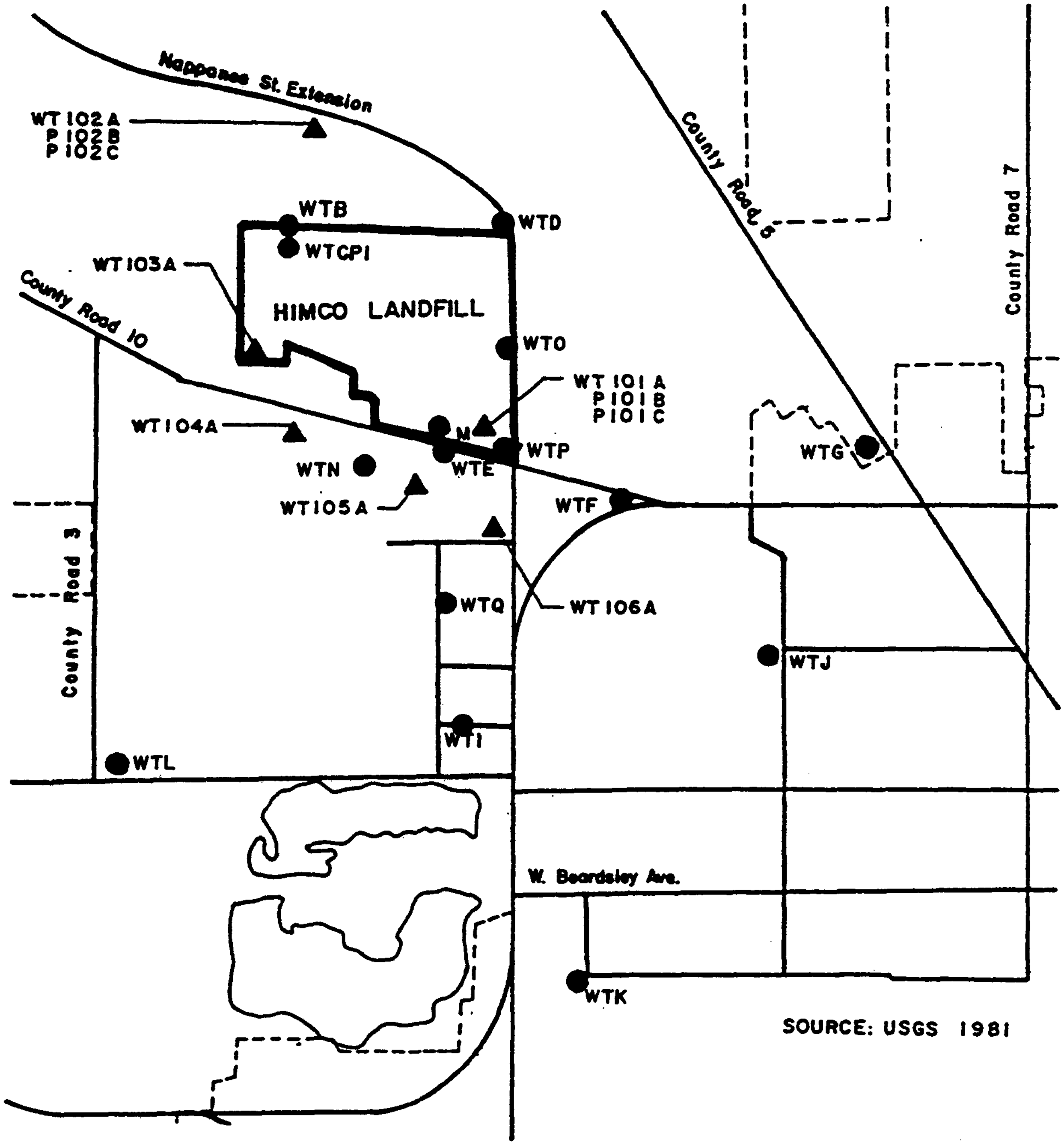
During Phase I, wells sampled for groundwater included: six shallow and four deep EPA wells installed during Phase I, 12 shallow and 11 deep USGS wells, and eight residential (private) wells. Shallow wells were defined as wells with screen bottoms at 50 feet or less below ground surface. Deep wells were defined as wells screened greater than 50 feet below ground surface. Sampling procedures, data collection, and field observations are documented in TM 6 and TM 8 of Appendix B.

During Phase II, a second round of groundwater samples was collected. The wells included 10 EPA wells installed during Phase I, one EPA water table well installed during Phase II, and five shallow and three deep USGS wells. No residential wells were sampled. Sampling procedures, data collection, and field observations are documented in TM 20 of Appendix B.

2.7 INFIELD HYDRAULIC CONDUCTIVITY TESTING

Slug tests were conducted to determine the hydraulic conductivity of the aquifer materials near each well. Both falling and rising head tests were conducted and all appropriate information including test startup and setup parameters, static water levels, well depth, and logging sequences, were recorded.

During Phase I, slug tests were conducted in five USGS wells (WTM1, WTM2, WTF1, WTF2, and WTE3) and eight EPA wells (WTP101B, WTP101C, WT101A, WT102A, WT103A, WT104A, WT105A, and WT106A). These data are provided in TM 11 of Appendix B. During Phase II, a slug test was conducted in EPA well WT111A. These data are provided in TM 26 of Appendix B.



SOURCE: USGS 1981

LEGEND

▲ USEPA MONITOR WELLS

● USGS WELL NEST

USGS WELLS ARE REDESIGNATED IN THE RI REPORT WITH A "WT" ADDED TO EACH WELL LETTER (I.e. WELL "O" IS REDESIGNATED AS "WTO".

NOT TO SCALE

Donohue

20026

MARCH 1992

Engineers • Architects • Scientists

FIGURE 2-4
EXISTING USGS WELL LOCATIONS

HIMCO DUMP SITE
ELKHART, INDIANA

N

TABLE 2-9

SUMMARY OF PHASE I GROUNDWATER SAMPLES COLLECTED
HIMCO DUMP SUPERFUND SITE
ELKHART, INDIANA
1992

Sample ID	Ground Surface Elevation (ft)	Bottom of Well Elevation (ft)	Sampling Date	Analyses
HD-WT101A-01	761.9	745.6	11/28/90	VOC, SVOC, PCB/Pest, TOTAL AND DISSOLVED METALS/CN, WATER QUALITY, BROMIDE
HD-WTP101B-01	761.7	663.7	1/9/91	VOC, SVOC, PCB/Pest, TOTAL AND DISSOLVED METALS/CN, WATER QUALITY, BROMIDE
HD-WTP101C-01	761.6	596.6	1/9/91	VOC, SVOC, PCB/Pest, TOTAL AND DISSOLVED METALS/CN, WATER QUALITY, BROMIDE
HD-WT102A-01	766.6	750.6	11/28/90	VOC, SVOC, PCB/Pest, TOTAL AND DISSOLVED METALS/CN, WATER QUALITY, BROMIDE
HD-WT102A	766.6	750.6	1/7/91	VOC, SVOC, PCB/Pest, TOTAL AND DISSOLVED METALS/CN, WATER QUALITY, BROMIDE
HD-WTP102B-01	766.3	700.9	1/7/91	VOC, SVOC, PCB/Pest, TOTAL AND DISSOLVED METALS/CN, WATER QUALITY, BROMIDE
HD-WTP102C-01	766.7	607.2	1/8/91	VOC, SVOC, PCB/Pest, TOTAL AND DISSOLVED METALS/CN, WATER QUALITY, BROMIDE
HD-WT103A-01	758.1	742.1	11/28/90	VOC, SVOC, PCB/Pest, TOTAL AND DISSOLVED METALS/CN, WATER QUALITY, BROMIDE
HD-WT104A-01	763.1	746.8	11/28/90	VOC, SVOC, PCB/Pest, TOTAL AND DISSOLVED METALS/CN, WATER QUALITY, BROMIDE

TABLE 2-9 (Continued)

SUMMARY OF PHASE I GROUNDWATER SAMPLES COLLECTED
HIMCO DUMP SUPERFUND SITE
ELKHART, INDIANA
1992

Sample ID	Ground Surface Elevation (ft)	Bottom of Well Elevation (ft)	Sampling Date	Analyses
HD-WT105A-01	760.4	744.4	11/29/90	VOC, SVOC, PCB/Pest, TOTAL AND DISSOLVED METALS/CN, WATER QUALITY, BROMIDE
HD-WT105A	760.4	744.4	1/8/91	VOC, SVOC, PCB/Pest, TOTAL AND DISSOLVED METALS/CN, WATER QUALITY, BROMIDE
HD-WT106A-01	759.0	740.2	11/27/90	VOC, SVOC, PCB/Pest, TOTAL AND DISSOLVED METALS/CN, WATER QUALITY, BROMIDE
HD-WT106A	759.0	740.2	1/8/91	VOC, SVOC, PCB/Pest, TOTAL AND DISSOLVED METALS/CN, WATER QUALITY, BROMIDE
HD-WTB1-01	761.2	272.2	12/4/90	VOC, SVOC, PCB/Pest, TOTAL AND DISSOLVED METALS/CN, WATER QUALITY, BROMIDE
HD-WTB2-01	760.72	746.8	12/4/90	VOC, SVOC, PCB/Pest, TOTAL AND DISSOLVED METALS/CN, WATER QUALITY, BROMIDE
HD-WTB3-01	762.2	631.9	12/5/90	VOC, SVOC, PCB/Pest, TOTAL AND DISSOLVED METALS/CN, WATER QUALITY, BROMIDE
HD-WTB4-01	761.2	585.9	12/11/90	VOC, SVOC, PCB/Pest, TOTAL AND DISSOLVED METALS/CN, WATER QUALITY, BROMIDE
HD-WTCP1-01	757.9	737.7	12/3/90	VOC, SVOC, PCB/Pest, TOTAL AND DISSOLVED METALS/CN, WATER QUALITY, BROMIDE

TABLE 2-9 (Continued)

SUMMARY OF PHASE I GROUNDWATER SAMPLES COLLECTED
HIMCO DUMP SUPERFUND SITE
ELKHART, INDIANA
1992

Sample ID	Ground Surface Elevation (ft)	Bottom of Well Elevation (ft)	Sampling Date	Analyses
HD-WTE2-01	761.8	745.3	12/12/90	VOC, SVOC, PCB/Pest, TOTAL AND DISSOLVED METALS/CN, WATER QUALITY, BROMIDE
HD-WTE3-01	763.0	587.4	12/12/90	VOC, SVOC, PCB/Pest, TOTAL AND DISSOLVED METALS/CN, WATER QUALITY, BROMIDE
HD-WTF1-01	*	31.3**	12/13/90	VOC, SVOC, PCB/Pest, TOTAL AND DISSOLVED METALS/CN, WATER QUALITY, BROMIDE
HD-WTF2-01	*	147.8**	12/11/90	VOC, SVOC, PCB/Pest, TOTAL AND DISSOLVED METALS/CN, WATER QUALITY, BROMIDE
HD-WTF3-01	*	180.0**	12/13/90	VOC, SVOC, PCB/Pest, TOTAL AND DISSOLVED METALS/CN, WATER QUALITY, BROMIDE
HD-WTG1-01	759.8	707.8	12/4/90	VOC, SVOC, PCB/Pest, TOTAL AND DISSOLVED METALS/CN, WATER QUALITY, BROMIDE
HD-WTG3-01	760.0	590.1	12/13/90	VOC, SVOC, PCB/Pest, TOTAL AND DISSOLVED METALS/CN, WATER QUALITY, BROMIDE
HD-WTI1-01	752.2	579.3	12/13/90	VOC, SVOC, PCB/Pest, TOTAL AND DISSOLVED METALS/CN, WATER QUALITY, BROMIDE
HD-WTI2-01	751.3	735.6	12/29/90	VOC, SVOC, PCB/Pest, TOTAL AND DISSOLVED METALS/CN, WATER QUALITY, BROMIDE

TABLE 2-9 (Continued)

SUMMARY OF PHASE I GROUNDWATER SAMPLES COLLECTED
HIMCO DUMP SUPERFUND SITE
ELKHART INDIANA
1992

Sample ID	Ground Surface Elevation (ft)	Bottom of Well Elevation (ft)	Sampling Date	Analyses
HD-WTI3-01	751.7	719.6	12/4/90	VOC, SVOC, PCB/Pest, TOTAL AND DISSOLVED METALS/CN, WATER QUALITY, BROMIDE
HD-WTJ1-01	753.6	711.0	12/4/90	VOC, SVOC, PCB/Pest, TOTAL AND DISSOLVED METALS/CN, WATER QUALITY, BROMIDE
HD-WTJ2-01	751.8	734.0	12/3/90	VOC, SVOC, PCB/Pest, TOTAL AND DISSOLVED METALS/CN, WATER QUALITY, BROMIDE
HD-WTJ3-01	753.7	600.3	12/10/90	VOC, SVOC, PCB/Pest, TOTAL AND DISSOLVED METALS/CN, WATER QUALITY, BROMIDE
HD-WTM1-01	767.8	664.6	12/5/90	VOC, SVOC, PCB/Pest, TOTAL AND DISSOLVED METALS/CN, WATER QUALITY, BROMIDE
HD-WTM2-01	767.0	742.2	12/3/90	VOC, SVOC, PCB/Pest, TOTAL AND DISSOLVED METALS/CN, WATER QUALITY, BROMIDE
HD-WTN1-01	760.4	731.2	11/29/90	VOC, SVOC, PCB/Pest, TOTAL AND DISSOLVED METALS/CN, WATER QUALITY, BROMIDE
HD-WTO1-01	760.8	731.0	12/3/90	VOC, SVOC, PCB/Pest, TOTAL AND DISSOLVED METALS/CN, WATER QUALITY, BROMIDE
HD-WTQ1-01	753.3	729.8	11/29/90	VOC, SVOC, PCB/Pest, TOTAL AND DISSOLVED METALS/CN, WATER QUALITY, BROMIDE

TABLE 2-9 (Continued)

SUMMARY OF PHASE I GROUNDWATER SAMPLES COLLECTED
HIMCO DUMP SUPERFUND SITE
ELKHART, INDIANA
1992

Sample ID	Ground Surface Elevation (ft)	Bottom of Well Elevation (ft)	Sampling Date	Analyses
HD-RW01-01	-	(deep)	10/22/90	VOC, SVOC, PCB/Pest, METALS/CN, WATER QUALITY, BROMIDE
HD-RW02-01	-	(shallow)	10/22/90	VOC, SVOC, PCB/Pest, METALS/CN, WATER QUALITY, BROMIDE
HD-RW03-01	-	(deep)	10/23/90	VOC, SVOC, PCB/Pest, METALS/CN, WATER QUALITY, BROMIDE
HD-RW04-01	-	(deep)	10/23/90	VOC, SVOC, PCB/Pest, METALS/CN, WATER QUALITY, BROMIDE
HD-RW05-01	-	(shallow)	10/23/90	VOC, SVOC, PCB/Pest, METALS/CN, WATER QUALITY, BROMIDE
HD-RW06-01	-	(deep)	10/23/90	VOC, SVOC, PCB/Pest, METALS/CN, WATER QUALITY, BROMIDE
HD-RW07-01	-	(deep)	10/24/90	VOC, SVOC, PCB/Pest, METALS/CN, WATER QUALITY, BROMIDE

TABLE 2-9 (Continued)

SUMMARY OF PHASE I GROUNDWATER SAMPLES COLLECTED
HIMCO DUMP SUPERFUND SITE
ELKHART, INDIANA
1992

Sample ID	Ground Surface Elevation (ft)	Bottom of Well Elevation (ft)	Sampling Date	Analyses
HD-RW08-01	-	(deep	10/24/90	VOC, SVOC, PCB/Pest, METALS/CN, WATER QUALITY, BROMIDE

* Elevation not shot
** Actual depth to bottom of well
\- Exact depth not known

VOC - Volatile Organic Compound
SVOC - Semi-Volatile Organic Compound
PCB - Polychlorinated Biphenyls
Pest - Pesticides
CN - Cyanide

TABLE 2-10

SUMMARY OF PHASE II GROUNDWATER SAMPLES COLLECTED
HIMCO DUMP SUPERFUND SITE
ELKHART, INDIANA
1992

Sample ID	Ground Surface Elevation (ft)	Bottom of Well Elevation (ft)	Sampling Date	Analyses
HD-WT101A-02	761.9	745.6	9/23/91	VOC, SVOC, PCB/Pest, TOTAL AND DISSOLVED METALS/CN, WATER QUALITY, BROMIDE
HD-WTP101B-02	761.7	663.7	9/23/91	VOC, SVOC, PCB/Pest, TOTAL AND DISSOLVED METALS/CN, WATER QUALITY, BROMIDE
HD-WTP101C-02	761.6	596.6	9/23/91	VOC, SVOC, PCB/Pest, TOTAL AND DISSOLVED METALS/CN, WATER QUALITY, BROMIDE
HD-WT102A-02	766.6	750.6	9/24/91	VOC, SVOC, PCB/Pest, TOTAL AND DISSOLVED METALS/CN, WATER QUALITY, BROMIDE
HD-WTP102B-02	766.3	700.9	9/24/91	VOC, SVOC, PCB/Pest, TOTAL AND DISSOLVED METALS/CN, WATER QUALITY, BROMIDE
HD-WTP102C-02	766.7	607.2	9/24/91	VOC, SVOC, PCB/Pest, TOTAL AND DISSOLVED METALS/CN, WATER QUALITY, BROMIDE
HD-WT103A-02	758.1	742.1	9/24/91	VOC, SVOC, PCB/Pest, TOTAL AND DISSOLVED METALS/CN, WATER QUALITY, BROMIDE
HD-WT104A-02	763.1	746.8	9/24/91	VOC, SVOC, PCB/Pest, TOTAL AND DISSOLVED METALS/CN, WATER QUALITY, BROMIDE

TABLE 2-10 (Continued)

SUMMARY OF PHASE II GROUNDWATER SAMPLES COLLECTED
HIMCO DUMP SUPERFUND SITE
ELKHART, INDIANA
1992

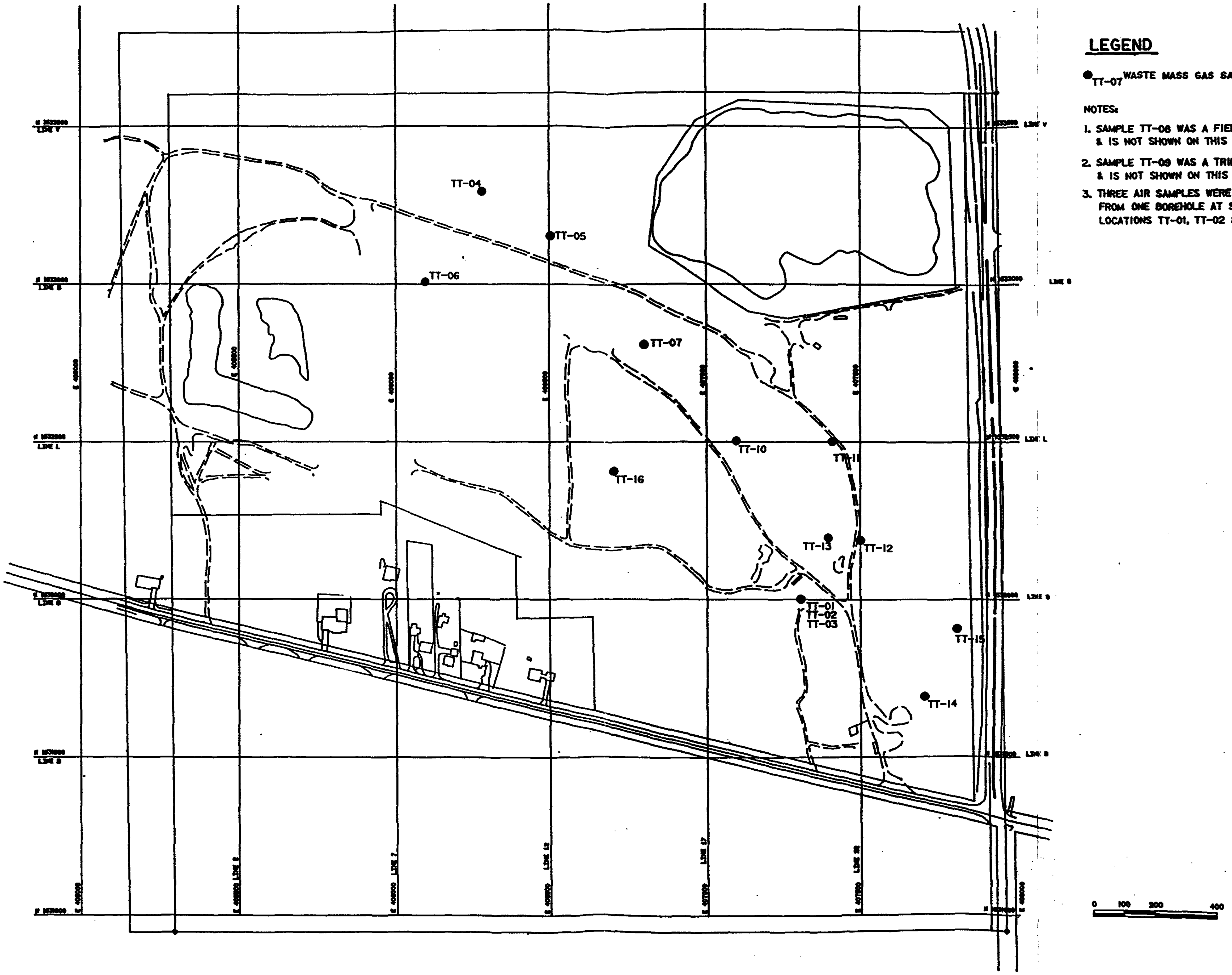
Sample ID	Ground Surface Elevation (ft)	Bottom of Well Elevation (ft)	Sampling Date	Analyses
HD-WT105A-02	760.4	744.4	9/25/91	VOC, SVOC, PCB/Pest, TOTAL AND DISSOLVED METALS/CN, WATER QUALITY, BROMIDE
HD-WT106A-02	759.0	740.2	9/25/91	VOC, SVOC, PCB/Pest, TOTAL AND DISSOLVED METALS/CN, WATER QUALITY, BROMIDE
HD-WT111A-01	764.5	744.5	9/25/91	VOC, SVOC, PCB/Pest, TOTAL AND DISSOLVED METALS/CN, WATER QUALITY, BROMIDE
HD-WTB2-02	760.72	746.8	9/26/91	VOC, SVOC, PCB/Pest, TOTAL AND DISSOLVED METALS/CN, WATER QUALITY, BROMIDE
HD-WTB3-02	762.2	631.9	9/26/91	VOC, SVOC, PCB/Pest, TOTAL AND DISSOLVED METALS/CN, WATER QUALITY, BROMIDE
HD-WTB4-02	761.2	585.9	9/26/91	VOC, SVOC, PCB/Pest, TOTAL AND DISSOLVED METALS/CN, WATER QUALITY, BROMIDE
HD-WTCP1-02	757.9	737.7	9/26/91	VOC, SVOC, PCB/Pest, TOTAL AND DISSOLVED METALS/CN, WATER QUALITY, BROMIDE
HD-WTE2-02	761.8	745.3	9/25/91	VOC, SVOC, PCB/Pest, TOTAL AND DISSOLVED METALS/CN, WATER QUALITY, BROMIDE

TABLE 2-10 (Continued)

SUMMARY OF PHASE II GROUNDWATER SAMPLES COLLECTED
HIMCO DUMP SUPERFUND SITE
ELKHART, INDIANA
1992

Sample ID	Ground Surface Elevation (ft)	Bottom of Well Elevation (ft)	Sampling Date	Analyses
HD-WTM1-02	767.8	664.6	9/26/91	VOC, SVOC, PCB/Pest, TOTAL AND DISSOLVED METALS/CN, WATER QUALITY, BROMIDE
HD-WTM2-02	767.0	742.2	9/25/91	VOC, SVOC, PCB/Pest, TOTAL AND DISSOLVED METALS/CN, WATER QUALITY, BROMIDE
HD-WTP-01	758.7	735.3	9/23/91	VOC, SVOC, PCB/Pest, TOTAL AND DISSOLVED METALS/CN, WATER QUALITY, BROMIDE

VOC - **Volatile Organic Compound**
SVOC - **Semi-Volatile Organic Compound**
PCB - **Polychlorinated Biphenyls**
Pest -**Pesticides**
CN - **Cyanide**



LEGEND

● TT-07 WASTE MASS GAS SAMPLE

NOTES:

1. SAMPLE TT-08 WAS A FIELD BLANK & IS NOT SHOWN ON THIS FIGURE.
2. SAMPLE TT-09 WAS A TRIP BLANK & IS NOT SHOWN ON THIS FIGURE.
3. THREE AIR SAMPLES WERE PULLED FROM ONE BOREHOLE AT SAMPLE LOCATIONS TT-01, TT-02 & TT-03.

FIGURE 2-5
WASTE MASS GAS SAMPLE LOCATIONS

HIMCO DUMP SUPERFUND SITE
ELKHART, INDIANA

Donohue ENGINEERS ARCHITECTS SCIENTISTS

Scale	AS SHOWN
Date	JAN. 1992
Designer	SP
Drafter	EZ
Checker	
Approver	

No.	Revisions	By	Date

Sheet No.
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File No.
Project No. 20028.030
2-5
Drawing No. 0

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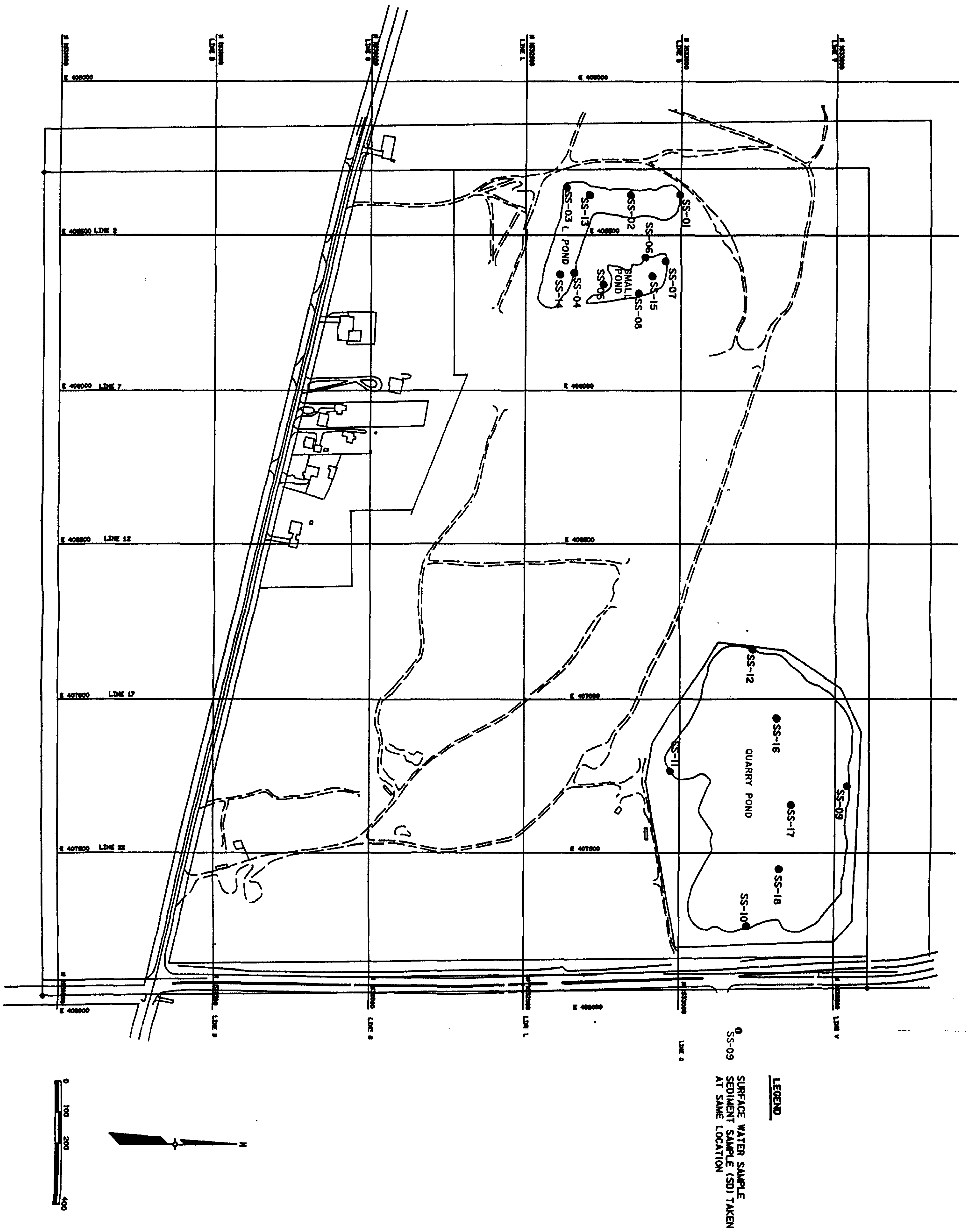

FIGURE 2-6
SURFACE WATER/SEDIMENT SAMPLE LOCATIONS
HIMCO DUMP SUPERFUND SITE
ELKHART, INDIANA

Donohue ENGINEERS ARCHITECTS SCIENTISTS

Scale	AS SHOWN				
Date	JAN. 1992				
Designer	SP				
Drafter	EZ				
Checker					
Approver		No.	Revisions	By	Date

Sheet No.
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File No.
PHASE 2
Drawing No. 2-6

TABLE 2-11

SUMMARY OF WASTE MASS GAS SAMPLES COLLECTED
HIMCO DUMP SUPERFUND SITE
ELKHART, INDIANA
1992

SAMPLE ID	DATE	ANALYSIS
HD-TT01-01	11/7/90	VOC
HD-TT02-01	11/7/90	VOC
HD-TT03-01	11/7/90	VOC
HD-TT04-01	11/13/90	VOC
HD-TT05-01	11/13/90	VOC
HD-TT06-01	11/13/90	VOC
HD-TT07-01	11/13/90	VOC
HD-FBTT08-01	11/13/90	VOC
HD-TBTT09-01	11/13/90	VOC
HD-TT10-01	11/13/90	VOC
HD-TT11-01	11/13/90	VOC
HD-TT12-01	11/13/90	VOC
HD-TT13-01	11/13/90	VOC
HD-TT14-01	11/14/90	VOC
HD-TT15-01	11/14/90	VOC
HD-TT16-01	11/14/90	VOC
HD-TTMS-01	11/14/90	VOC
HD-TTMSD-01	11/14/90	VOC
HD-TTMS-02	11/14/90	VOC
HD-TTMSD-02	11/14/90	VOC

VOC - Volatile Organic Compound

TABLE 2-12

SUMMARY OF PHASE I SURFACE WATER SAMPLES COLLECTED
HIMCO DUMP SUPERFUND SITE
ELKHART, INDIANA
1992

SAMPLE ID	DATE	ANALYSES	LOCATION
HD-SS01-01	10/17/91	VOC, SVOC, PCB/Pest, METAL/CN WATER QUALITY, BROMIDE	L Pond
HD-SS02-01	10/18/90	VOC, SVOC, PCB/Pest, METAL/CN WATER QUALITY, BROMIDE	L Pond
HD-SS03-01	10/18/90	VOC, SVOC, PCB/Pest, METAL/CN WATER QUALITY, BROMIDE	L Pond
HD-SS04-01	10/18/90	VOC, SVOC, PCB/Pest, METAL/CN WATER QUALITY, BROMIDE	L Pond
HD-SS05-01	10/18/90	VOC, SVOC, PCB/Pest, METAL/CN WATER QUALITY, BROMIDE	Small Pond
HD-SS06-01	10/18/90	VOC, SVOC, PCB/Pest, METAL/CN WATER QUALITY, BROMIDE	Small Pond
HD-SS07-01	10/18/90	VOC, SVOC, PCB/Pest, METAL/CN WATER QUALITY, BROMIDE	Small Pond
HD-SS08-01	10/19/90	PCB/Pest, METAL/CN WATER QUALITY, BROMIDE	Small Pond
HD-SS08-02	11/6/90	SVOC	Small Pond
HD-SS09-01	10/19/90	PCB/Pest, METAL/CN WATER QUALITY, BROMIDE	Quarry Pond
HD-SS09-02	11/6/90	SVOC	Quarry Pond
HD-SS10-01	10/19/90	PCB/Pest, METAL/CN WATER QUALITY, BROMIDE	Quarry Pond
HD-SS10-02	11/6/90	SVOC	Quarry Pond
HD-SS11-01	10/19/90	VOC, SVOC, PCB/Pest, METAL/CN WATER QUALITY, BROMIDE	Quarry Pond
HD-SS12-01	10/19/90	VOC, SVOC, PCB/Pest, METAL/CN WATER QUALITY, BROMIDE	Quarry Pond

TABLE 2-13

SUMMARY OF PHASE I SEDIMENT SAMPLES COLLECTED
HIMCO DUMP SUPERFUND SITE
ELKHART, INDIANA
1992

SAMPLE ID	DATE	ANALYSES	LOCATION
HD-SD01-01	10/17/90	VOC, SVOC, PCB/Pest, TOTAL METALS/CN	L Pond
HD-SD02-01	10/17/90	VOC, SVOC, PCB/Pest, TOTAL METALS/CN	L Pond
HD-SD03-01	10/17/90	VOC, SVOC, PCB/Pest, TOTAL METALS/CN	L Pond
HD-SD04-01	10/18/90	VOC, SVOC, PCB/Pest, TOTAL METALS/CN	L Pond
HD-SD05-01	10/18/90	VOC, SVOC, PCB/Pest, TOTAL METALS/CN	Small Pond
HD-SD06-01	10/20/90	VOC, SVOC, PCB/Pest, TOTAL METALS/CN	Small Pond
HD-SD07-01	10/20/90	VOC, SVOC, PCB/Pest, TOTAL METALS/CN	Small Pond
HD-SD08-01	10/20/90	VOC, SVOC, PCB/Pest, TOTAL METALS/CN	Small Pond
HD-SD09-01	10/20/90	VOC, SVOC, PCB/Pest, TOTAL METALS/CN	Quarry Pond
HD-SD10-01	10/20/90	VOC, SVOC, PCB/Pest, TOTAL METALS/CN	Quarry Pond
HD-SD11-01	10/20/90	VOC, SVOC, PCB/Pest, TOTAL METALS/CN	Quarry Pond
HD-SD12-01	10/20/90	VOC, SVOC, PCB/Pest, TOTAL METALS/CN	Quarry Pond

VOC - Volatile Organic Compound
SVOC - Semi-Volatile Organic Compound
PCB - Polychlorinated Biphenyls
Pest - Pesticides
CN - Cyanide

TABLE 2-14

SUMMARY OF PHASE II SURFACE WATER SAMPLES COLLECTED
HIMCO DUMP SUPERFUND SITE
ELKHART, INDIANA
1992

SAMPLE ID	DATE	ANALYSES	LOCATION
HD-SS08-02	9/16/91	VOC	Small Pond
HD-SS09-02	9/19/91	VOC	Quarry Pond
HD-SS10-02	9/19/91	VOC	Quarry Pond
HD-SS13-01	9/16/91	VOC, SVOC, PCB/Pest, TOTAL AND DISSOLVED METALS/CN, WATER QUALITY, BROMIDE	L Pond
HD-SS14-01	9/16/91	VOC, SVOC, PCB/Pest, TOTAL AND DISSOLVED METALS/CN, WATER QUALITY, BROMIDE	L Pond
HD-SS15-01	9/17/91	VOC, SVOC, PCB/Pest, TOTAL AND DISSOLVED METALS/CN, WATER QUALITY, BROMIDE	Small Pond
HD-SS16-01	9/17/91	VOC, SVOC, PCB/Pest, TOTAL AND DISSOLVED METALS/CN, WATER QUALITY, BROMIDE	Quarry Pond
HD-SS17-01	9/17/91	VOC, SVOC, PCB/Pest, TOTAL AND DISSOLVED METALS/CN, WATER QUALITY, BROMIDE	Quarry Pond
HD-SS18-01	9/17/91	VOC, SVOC, PCB/Pest, TOTAL AND DISSOLVED METALS/CN, WATER QUALITY, BROMIDE	Quarry Pond
HD-SS19-01	9/18/91	VOC, SVOC, PCB/Pest, TOTAL AND DISSOLVED METALS/CN, WATER QUALITY, BROMIDE	Background Pond
HD-SS20-01	9/18/91	VOC, SVOC, PCB/Pest, TOTAL AND DISSOLVED METALS/CN, WATER QUALITY, BROMIDE	Background Pond
HD-SS21-01	9/18/91	VOC, SVOC, PCB/Pest, TOTAL AND DISSOLVED METALS/CN, WATER QUALITY, BROMIDE	Background Pond

VOC - Volatile Organic Compound
SVOC - Semi-Volatile Organic Compound
PCB - Polychlorinated Biphenyls
Pest - Pesticides
CN - Cyanide

TABLE 2-15

SUMMARY OF PHASE II SEDIMENT SAMPLES COLLECTED
HIMCO DUMP SUPERFUND SITE
ELKHART, INDIANA
1992

SAMPLE ID	DATE	ANALYSES	LOCATION
HD-SD13-01	9/16/91	VOC, SVOC, PCB/Pest TOTAL METALS/CN/TOC, GRAIN SIZE	L Pond
HD-SD14-01	9/16/91	VOC, SVOC, PCB/Pest TOTAL METALS/CN/TOC, GRAIN SIZE	L Pond
HD-SD15-01	9/17/91	VOC, SVOC, PCB/Pest TOTAL METALS/CN/TOC, GRAIN SIZE	Small Pond
HD-SD16-01	9/17/91	VOC, SVOC, PCB/Pest TOTAL METALS/CN/TOC, GRAIN SIZE	Quarry Pond
HD-SD17-01	9/17/91	VOC, SVOC, PCB/Pest TOTAL METALS/CN/TOC, GRAIN SIZE	Quarry Pond
HD-SD18-01	9/17/91	VOC, SVOC, PCB/Pest TOTAL METALS/CN/TOC, GRAIN SIZE	Quarry Pond
HD-SD19-01	9/18/91	VOC, SVOC, PCB/Pest TOTAL METALS/CN/TOC, GRAIN SIZE	Background Pond
HD-SD20-01	9/18/91	VOC, SVOC, PCB/Pest TOTAL METALS/CN/TOC, GRAIN SIZE	Background Pond
HD-SD21-01	9/18/91	VOC, SVOC, PCB/Pest TOTAL METALS/CN/TOC, GRAIN SIZE	Background Pond

VOC - Volatile Organic Compound
SVOC - Semi-Volatile Organic Compound
PCB - Polychlorinated Biphenyls
Pest - Pesticides
CN - Cyanide
TOC - Total Organic Compound

During Phase II, nine surface water and nine sediment samples were collected from four ponds, three on-site and one off-site background pond. Samples were taken from a rowboat at varying depths and locations in each pond. During Phase I sample shipping, the chain-of-custody was broken on three surface water samples being sent for VOC analysis. As a result, these three samples were collected during Phase II sampling activities. Sampling information and field observations were recorded on sediment sampling and surface water sampling forms. This information and sampling procedures are detailed in TM 23 of Appendix B.

2.10 WETLAND IDENTIFICATION AND DELINEATION

During Phase I, on-site wetlands were assessed and identified. A wetland delineation was conducted during Phase II. The wetland identification and delineation were conducted to determine the extent, type, and quality of the wetland area.

The Phase I wetland identification included five areas that were suspected wetlands. These areas are designated on Figure 1 of TM 14 (Appendix B). Based on prior uses of the site, the Disturbed Area Wetland Determination Method was used. A total of 39 soil and vegetation sampling locations were selected based on visual identification of wetland vegetation. A detailed description of these activities is provided in TM 14 of Appendix B. The wetland delineation conducted during Phase II focused on the one area south of the gravel pit identified as a wetland during the Phase I activities. Because of a smaller area and based on samples taken during Phase I, a total of 13 locations were sampled for hydrology, hydric soils (soils with organic layers or streaks), and wetland vegetation. A detailed description of this event is provided in TM 25 of Appendix B.

2.11 PRIVATE WELL INVENTORY

A private well inventory was conducted in the neighborhood to the east and to the southeast of the Himco site. The inventory consisted of a discussion with the General Manager of the Elkhart Water Department, interviews with five residents who live immediately east of the Himco site, and a telephone conversation with an individual who owns two businesses southeast of the Himco site. The well inventory was conducted to collect information on well depths and water quality.

2.12 INSTALLATION OF STAFF GAUGES

Staff gauges were installed during Phase I. A total of three staff gauges were installed to gather surface water elevation data. These data were used to supplement groundwater elevation measurements from monitoring wells for the development of a water table contour map. One staff gauge was installed at each of three locations to include the "L" shaped pond, the smallest pond (both located west of the site), and the gravel pit pond located at the northeast area of the site. Staff gauge locations are shown in Figure 2-3. Installation procedures and descriptions of the staff gauges are presented in TM 6 of Appendix B.

2.13 WATER LEVEL MEASUREMENTS

Water level measurements were collected during Phase I and Phase II from EPA and USGS wells and three staff gauges. The measurement data were used to determine groundwater flow direction and vertical and horizontal groundwater gradients, as well as a relationship between groundwater and the three surface water bodies at the site. Measurement procedures, field observations, and results are presented in TM 16 and TM 28 of Appendix B.

During Phase I, water levels were measured in 10 EPA wells and 28 USGS wells at the site. Water level measurements were taken to the nearest 0.01 feet. Each well was surveyed with respect to mean sea level (MSL) elevation with an accuracy of 0.01 feet. Staff gauge measurements were not collected during Phase I because all pond surfaces on site were frozen. Measurement procedures, field observations, and results are presented in TM 16 of Appendix B.

During Phase II, water levels were measured in seven EPA wells, 11 USGS wells, and three staff gauging stations on the Himco site. Water level measurements were recorded with accuracy to the nearest 0.01 feet. Each well was surveyed with respect to mean sea level (MSL) elevation with an accuracy of 0.01 feet. Water level and staff gauge measurements were made within a 24-hour period. Measurement procedures, field observations, and results are presented in TM 28 of Appendix B.

3.0 PHYSICAL CHARACTERISTICS OF THE STUDY AREA

The physical setting of the Himco site, including the regional geology, hydrogeology, soils, surface water, physiography, climate, and population and land use are described in the RI/FS Final Work Plan (Donohue, 1991a). This section summarizes information contained in the RI/FS Work Plan and presents results of field investigations to determine the physical characteristics of the landfill and areas around the landfill. The information presented in this section includes descriptions of regional and site-specific geology, hydrogeology, topography, and surface water as well as findings from the site geophysical survey and test pit excavations.

3.1 CLIMATE

Elkhart County has a typical mid-continental climate with a large temperature variation between winter and summer. The average monthly temperatures in Elkhart County range from 23°F in January to 72°F in July. The temperature extremes are from 10°F to 98°F. The mean annual rainfall is 34.5 inches and the mean annual snowfall is approximately 36 inches. Snowfall usually occurs between November and March.

3.2 REGIONAL AND SITE TOPOGRAPHY

The Himco site is located in Elkhart County, Indiana. Elkhart County lies in the Great Lakes section of the Central Lowlands Physiographic Province. The present topography is a result of continental glaciation.

The land surface consists of nearly level and gently sloping eolian and outwash sands in the northern part of the county; level to moderately sloping outwash terraces and plains in the northern and central portions of the county; and nearly level to strongly sloping glacial till plains in the eastern and western portions (Kirchner and McCarter, 1974).

The land surface elevation in Elkhart County ranges from 950 feet in the southeast to 740 feet MSL in the west at the St. Joseph River (USGS, 1981). The Himco site topographic elevations are shown in Figure 3-1.

3.3 GEOPHYSICAL SURVEY RESULTS

The results and interpretation of the combined electromagnetic (EM) and magnetic (Mag) geophysical surveys are discussed in the following paragraphs. Responses from the EM and Mag geophysical surveys were contoured, with the contoured data shown on Figure 3-2. EM survey included quadrature and in-phase readings and the contoured data as shown in Figures 3-3 and 3-4, respectively.

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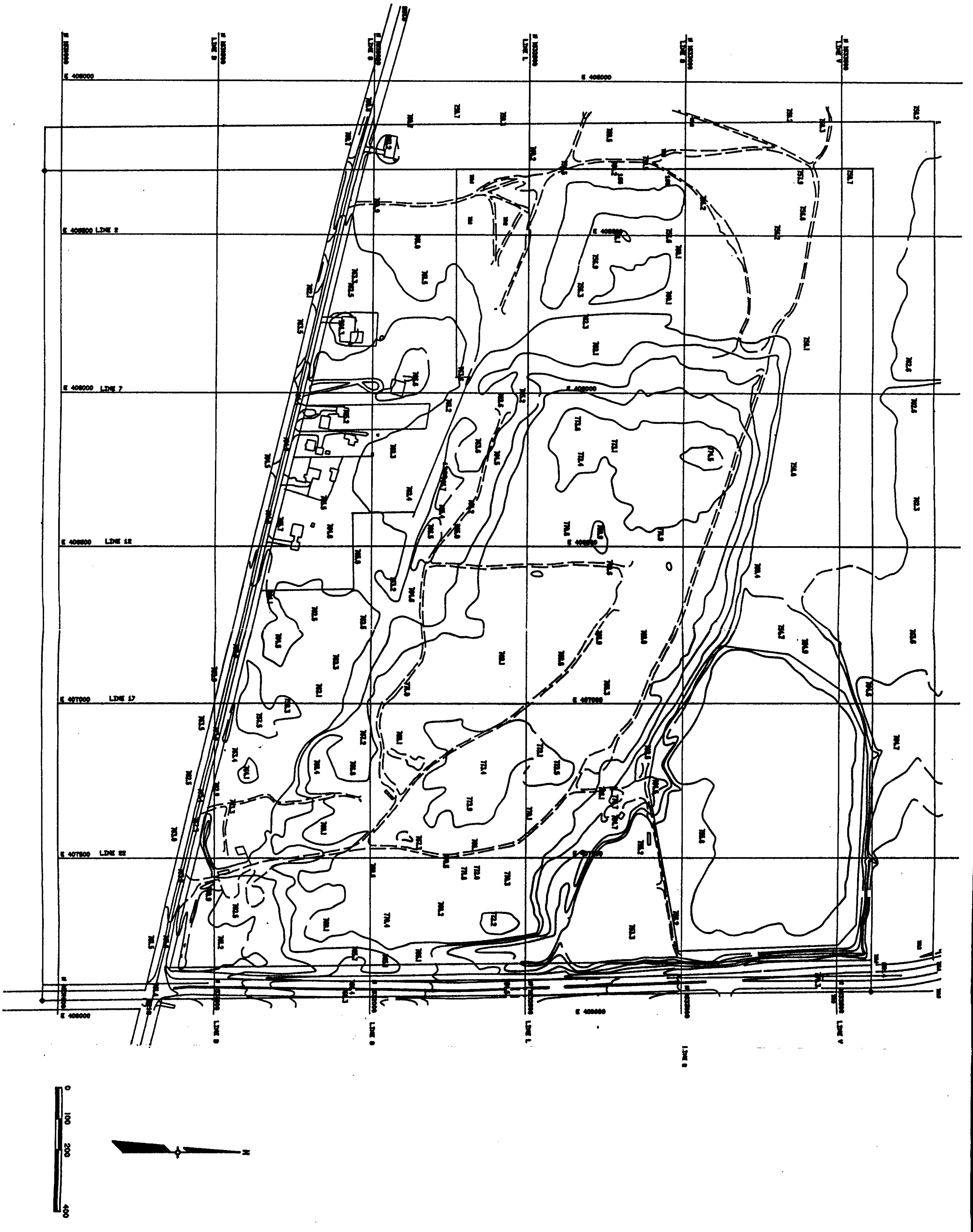

FIGURE 3-1
SITE TOPOGRAPHIC MAP
HIMCO DUMP SUPERFUND SITE
ELKHART, INDIANA

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Project No. PHASE 2

Drawing No. 20026

3-1

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Scale	AS SHOWN				
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Approver		No.	Revisions	By	Date

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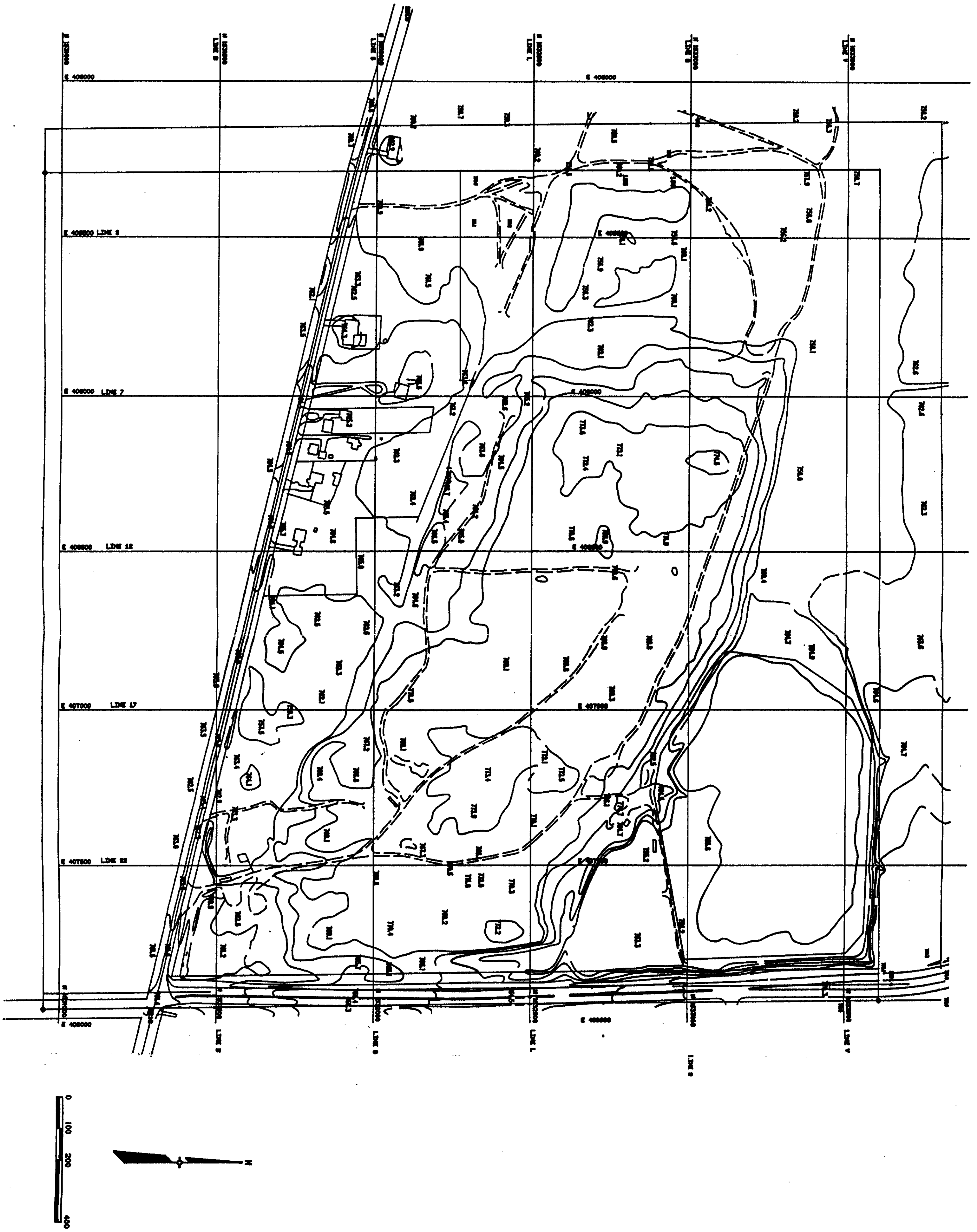

FIGURE 3-1
SITE TOPOGRAPHIC MAP

HIMCO DUMP SUPERFUND SITE
ELKHART, INDIANA

Donohue ENGINEERS ARCHITECTS SCIENTISTS

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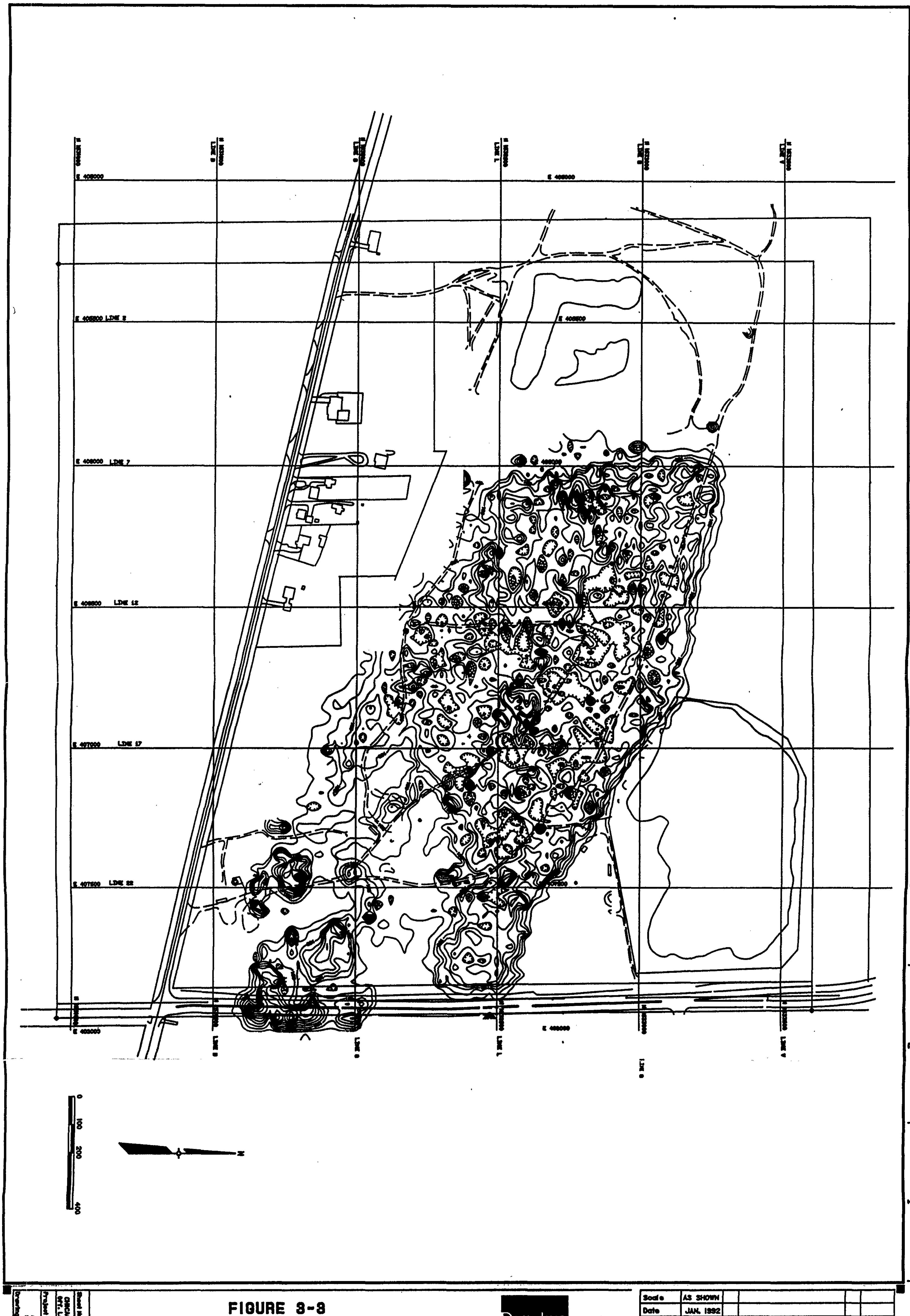

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FIGURE 3-8

QUADRATURE PHASE EM-31 SURVEY

HIMCO DUMP SUPERFUND SITE

ELKHART, INDIANA

Donohue ENGINEERS ARCHITECTS SCIENTISTS

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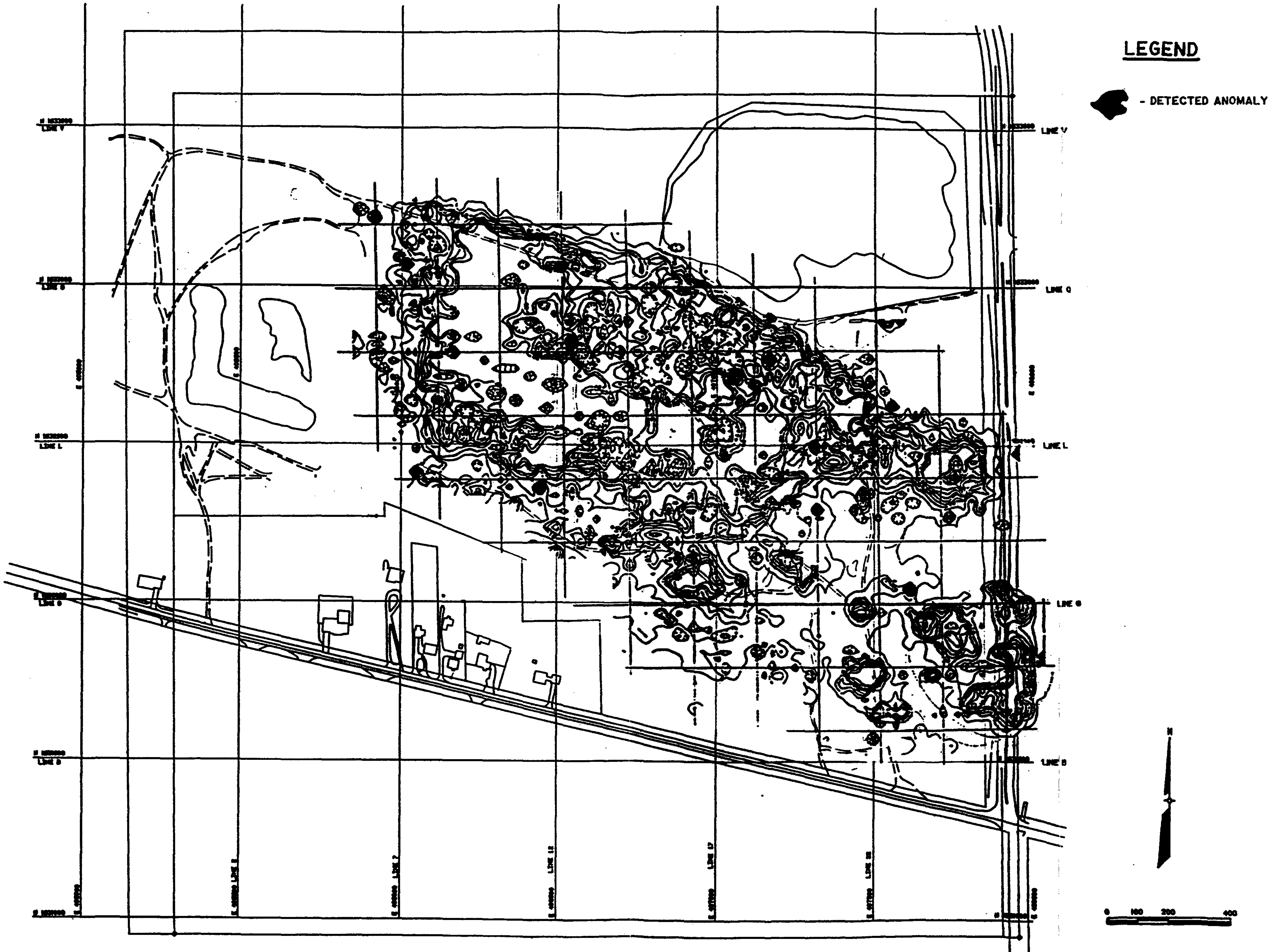

FIGURE 3-4

IN-PHASE EM-31 SURVEY

HIMCO DUMP SUPERFUND SITE
ELKHART, INDIANA

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The quadrature EM data appears to highlight the approximate limits of filling, except along the southern end. Test pit excavations conducted during Phase II revealed buried wastes up to approximately 100 feet south of the filling limits indicated by the quadrature EM data.

The contoured results of the EM and magnetic data show several anomalies on-site. The anomalies result from data readings that are significantly different from natural, or background, readings in the vicinity of the site. The anomalies from the EM and Mag surveys detected metals, but didn't show a large mass of drums. This was confirmed during Phase I and II trenching, which uncovered a variety of municipal and industrial wastes composed of paper, plastic, rubber, wood, and/or glass mixed with varying amounts of metals throughout the site. Some of the most significant anomalies interpreted from the contour maps include the southeast corner, south central, west central, and northeast central areas of the site. Anomalies of significance are indicated on the contour maps as a tight cluster of contour lines. Because the magnetic survey and in-phase EM data were useful in identifying mapping areas containing metals, the areas interpreted to demonstrate significant anomalies were targeted for subsequent test pit excavation. Phase I and II test pit excavations confirmed the presence of areas containing a variety of scrap metal including some drums in the southeast (TI through T8) and west central (TL-1) areas of the site. Drums were also found in the southwest corner of the site (TL-5).

3.4 TRENCHING RESULTS

The following discussion includes a description of the landfill trenching results including types of waste observed, description of the stratigraphy encountered, and air monitoring results. Detailed descriptions of activities and observations made during trenching are provided in TM 10 and TM 24 of Appendix B.

Figure 1-2 shows the landfill boundaries. The extent of the landfill was determined using a combination of geophysical surveys, trench excavations, borings, and aerial photographs. Trenching in the landfill revealed leachate in the majority of trenches and a mixed waste composed of metal deposits, such as wire, metal pipes, and a few drums, near the southeast section of the landfill. In addition, three distinct layers were observed in the majority of trenches. Trench locations are shown in Figure 2-2.

TABLE 3-1

SUMMARY OF LEACHATE WATER AND GROUNDWATER ELEVATIONS AT SELECT TRENCHES
HIMCO DUMP SUPERFUND SITE
ELKHART, INDIANA
1992

Test Pit	Ground Surface Elevation (ft)	Estimate Depth to Leachate Water (ft)	Estimated Leachate Water Elevation (ft)	Water Table Elevation (ft)	Leachate Water Elevation Above Water Table Elevation (ft)
TL-1	769	3.5 and 7	765.5 and 762	755	10.5 and 7
TL-2	765.5	2.5 and 3	763 and 762.5	754	9 and 8.5
TL-5	766	4 and 7	762 and 759	754	8 and 5

The wastes observed in the landfill trenches included: paper; metal and plastic debris; bricks; wire; metal pipes; railroad ties; rubber and fiberglass templates; automobile parts including a bumper, shock absorbers, mufflers and metal wheels; wood; empty plastic garbage bags; unassembled (flattened) Anacin boxes; lids and bottles from Alka Seltzer; aerosol cans of Dristan and Sudden Beauty Hair Spray; five 55-gallon drum lids (one marked aliphatic resin) and one 55-gallon drum which appeared to be used to burn waste items. In addition, gas was observed bubbling up through the water collected in the trenches. In general, municipal waste, such as paper, plastic, wood, and household products, was found in all trenches where waste was present. Metal wastes were frequently found to be mixed with the debris. However, the largest concentrations of metal, such as a 55-gallon drum, drum lids, pipes and sheet metal, were found to be primarily distributed in trenches around the southeast section of the landfill (Trenches 1 through 8). These findings appear to correlate with the geophysical survey interpretation which detected metals within the landfill boundaries and identified a concentrated area of metals and/or high mass materials in the southeast section of the landfill.

Air monitoring was conducted inside the work zone near the excavation and 75 to 250 feet downwind of the work zone. The air was monitored for organic vapor concentration with an Organic Vapor Analyzer (OVA). Hydrogen sulfide concentrations (H_2S), oxygen concentrations (O_2), Lower Explosive Limit (LEL), and carbon monoxide (CO) concentrations were monitored with a Lumidor gas detector, and organic vapors were monitored with a Photo Ionization Detector (PID). In addition, a radiation detector was used during air monitoring. In general, OVA readings in the work zone during trenching ranged from 2 ppm to 1,000 ppm. The highest OVA readings (above 500 ppm) were detected during trenching activities at T-9, T-12, T-13, T-16, and T-20. Outside the work zone, 75 to 250 feet downwind, OVA readings were essentially at background levels. Hydrogen sulfide readings ranged from 14 ppm to 46 ppm during trenching, with the chemical usually detected during the excavation of the calcium sulfate. No other positive or unusual readings were produced on the PID, radiation detectors, or lumidor. A positive OVA reading and a negative PID reading indicates that the OVA reading may be due to methane (CH_4).

Non-native soil mixed with construction debris was observed in test pits located along the south central and southwest edge of the landfill. In general, calcium sulfate and leachate were not found in this area. SVOCs were found to be most prominent in surface soil samples from this area. During trenching activities, this area was observed to be thickly vegetated with grasses, wildflowers, bushes, and small trees. This area was not observed to be marshy at the time of field work. Small piles of construction debris (e.g., concrete and asphalt chunks, bricks) were observed to be present on the ground surface scattered throughout the area. Also, a small household appliance dumping area was observed in an area north of the residences and in between trench locations TL-4 and TL-6. Items observed in this small dumping area were a refrigerator, a stove, and a rider lawn mower. The top soil in this area is typically yellow-brown sand or brown silty sand one to three feet thick. Beneath the top soil, a layer of construction debris commingled with a brown to black sandy material. Specific construction debris items observed included concrete chunks, concrete slabs, bricks, plywood, cinder blocks, cobbles, boards, wire, glass, and small asphalt chunks. The construction debris layer has a thickness of between 1.5 and 5 feet. Native gray to brown sand is present beneath this layer.

In general, it was observed that the trenches excavated near the landfill had a greater probability of filling with leachate water than the trenches excavated further away from the landfill. Large quantities of leachate water were observed filling in trench TL-4. As can be seen from Figure 2-2, this trench was excavated close to the southern end of the landfill. Leachate was not observed in other trenches along the south end of the landfill, such as TL-3, TD-5, and TD-4, even at depths up to 18 feet.

3.5 GEOLOGY

The discussion of geology is divided into two sections. The first section describes the regional geology of Northern Indiana and Elkhart County. The second section describes the site geology in the immediate area of the Himco site.

3.5.1 Regional Geology

The regional geology of northern Indiana and Elkhart County consists of Cenozoic age glacial deposits overlying Paleozoic sedimentary rocks which overlie Precambrian basement rock. Structurally this area is considered part of the Michigan basin. Cenozoic deposits found in the region were deposited during the Wisconsinan glaciation of the Pleistocene Epoch. As the glacial ice receded, the fast-flowing water deposited layers of sand and gravel, and the slower moving and standing water deposited silts and clays. The fast-flowing water deposits are known as valley train outwash deposits. The thickness of these deposits ranges from 85 to 500 feet. The silt and clay layer, where present, has a maximum thickness of 80 feet and an average thickness of 20 feet. The bedrock topography was also modified by continental glaciation. The bedrock topography in Elkhart County varies from approximately 300 feet mean sea level (MSL) to 600 feet MSL. The thickest portion of the outwash deposits occurs by a bedrock valley trending north-south (Figure 3-5).

The Paleozoic units consist of the Coldwater Shale of Mississippian age and the Sunbury and the Ellsworth shales of Devonian and Mississippian age (Figure 3-6). These formations do not crop out in Elkhart County. The Coldwater Formation of Mississippian age is typically a gray to greenish gray, slightly silty shale. In some places, there are lenses of brown dolomite or limestone throughout the section. In Stueben County (Northeastern Indiana), the formation reaches a thickness of greater than 500 feet. A distinctive red shale, 5 to 20 feet thick and sometimes called the Coldwater Red Rock, is at the base of the unit. The Coldwater conformably overlies the Sunbury and Ellsworth Shales (Indiana Department of Natural Resources, Geological Survey, Bulletin 59, 1986).

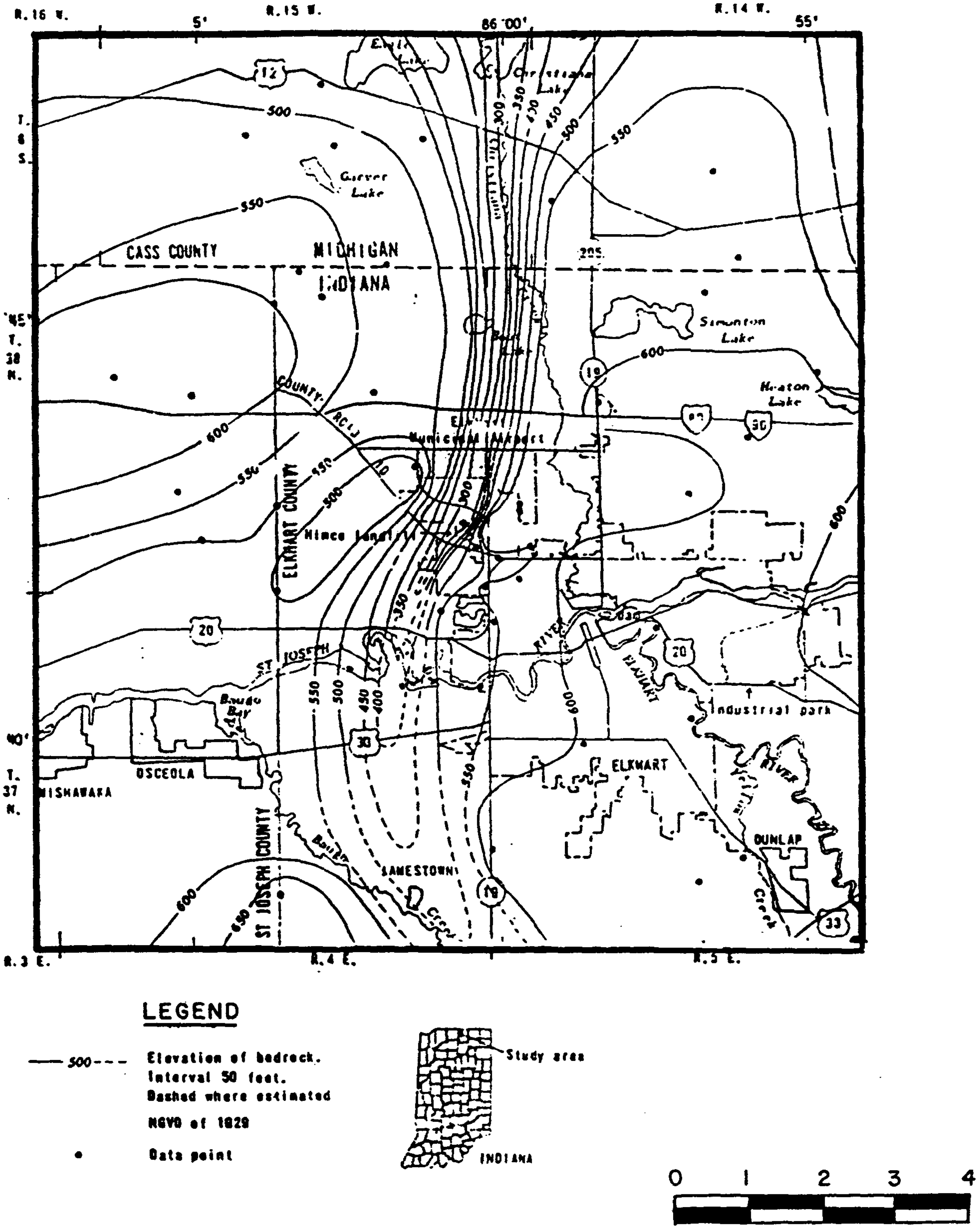
The Sunbury Shale of Mississippian age is a carbonaceous brownish black shale, which lies stratigraphically between the Ellsworth and Coldwater Shales. The Sunbury is slightly greater than ten feet thick in Stueben County, and thins southward and westward. The formation is absent west of LaGrange County. The Ellsworth Shale consists of alternating beds of gray-green shale and brownish-black shale in the lower part, and grayish-green shale bearing light-greenish limestone or dolomite in the upper parts of the formation. The formation consists predominantly of greenish gray shale. The thickness of the Ellsworth ranges from less than 40 feet in northern DeKalb County to more than 200 feet in LaGrange County (IDNR, 1986).

Precambrian basement rock occurs below these thick sequences of Paleozoic sedimentary rock. Based on limited deep borehole information, the rock mass is predominantly granite, including some metasedimentary and basaltic rocks (Gray, Ault, and Keller, 1987).

3.5.2 Site Geology

3.5.2.1 USGS Study (USGS, 1981)

The following discussion of the geology at the Himco site is based on interpretations and regional geological information from a three-year USGS hydrogeological study of Northwest Elkhart County, Indiana. During the study, the USGS advanced 35 borings at depths ranging from 20 to 489 feet below ground surface. The thickness and areal extent of the unconsolidated Pleistocene deposits were determined from lithologic logs and from natural gamma radiation logs of the 35 test borings. Boring logs from the USGS wells are included in the Final Work Plan, Volume 1a (Donohue, 1990a).



SOURCE: USGS, 1981

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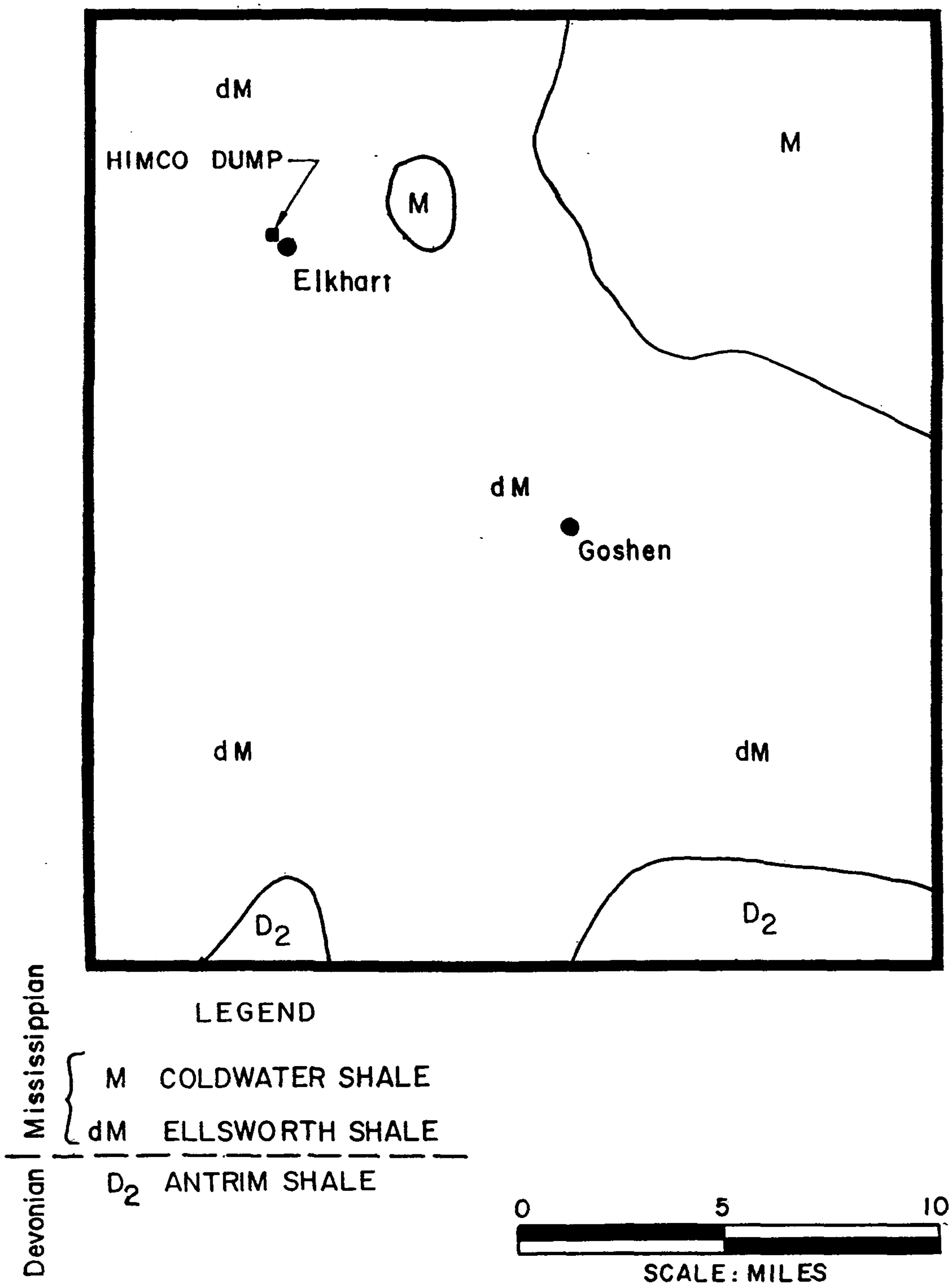
BEDROCK TOPOGRAPHY IN PARTS OF ELKHART AND ST. JOSEPH COUNTIES, INDIANA

N

HIMCO DUMP SITE
ELKHART COUNTY, INDIANA

FIGURE 3-5



SOURCE: GRAY, AULT &
KELLER, 1987

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PALEOZOIC GEOLOGY OF ELKHART, INDIANA

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HIMCO DUMP SITE
ELKHART COUNTY, INDIANA

FIGURE 3-6

The USGS hydrogeological study described a general site area stratigraphy characterized by sand and gravel valley train outwash deposits, interbedded with silt and clay. These deposits range in thickness from 85 to 500 feet, with an average thickness of 175 feet. A regionally extensive silt and clay layer which has the ability to act as a confining layer is present just south of the Himco site. A geologic cross-section through the Himco site and northwest Elkhart County showing the approximate position of the silt and clay layer is presented in Figure 3-7.

Underlying the unconsolidated outwash deposits are the Coldwater and Ellsworth Shale of Mississippian Age. A bedrock valley trending northeast-southwest occurs directly below the Himco site (Figure 3-6). Depth to bedrock in the vicinity of the site ranges from 174 to 489 feet below ground surface. The thickness of the Coldwater and Ellsworth Shale beneath the site is unknown. However, regional stratigraphic information suggests the thickness of the formations to be approximately 200 and 500 feet, respectively (IDNR, Geological Survey, 1986).

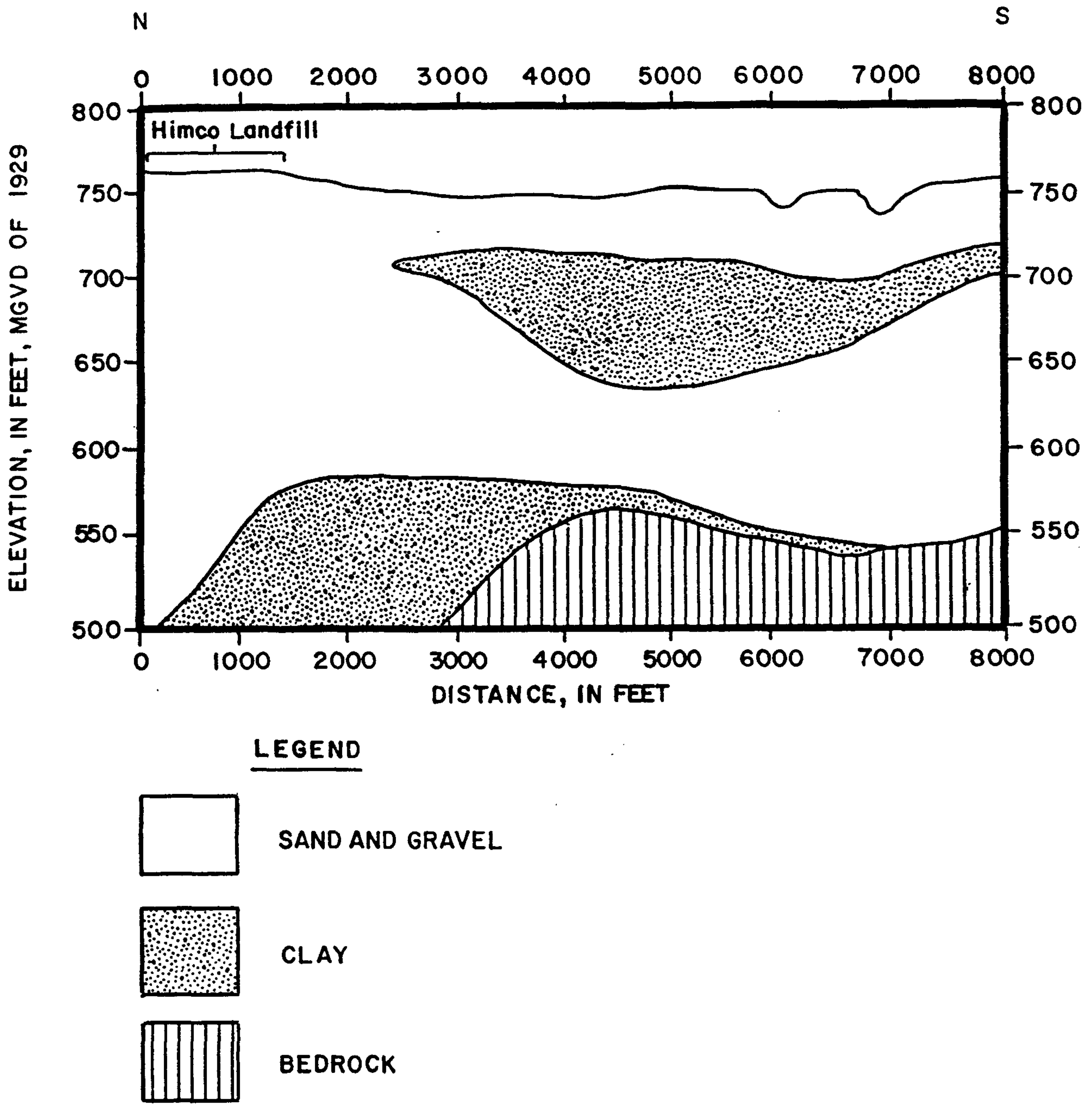
3.5.2.2 RI Study

This discussion is based on lithologic data obtained from eleven borings completed during the Himco site RI. The borings range in depth from 16 to 175 feet below ground surface. Boring logs from the Himco site RI are included in TM 4, TM 13, and TM 19 of Appendix B.

RI boring logs and cross-sections A-A' and B-B' constructed from boring logs (Figures 3-9 and 3-11) (Locations for these cross-sections are presented in Figure 3-8 and 3-10) reveal a site-specific stratigraphy that was similar to that listed in the USGS study. The stratigraphy beneath the site is primarily characterized by sand and gravel glacial outwash deposits from ground surface to bedrock. Depth to bedrock in the site vicinity ranges from 174 to 489 feet below ground surface. The sand and gravel outwash is comprised primarily of alternating beds, varying in thickness, of poorly to well graded sands and gravels, and gravel-sand-silt mixtures. Minor seams of silt and clay were also encountered, primarily in the northwest and southeast corners of the site, but there was no indication of a consistent layer beneath the site which would be considered a confining unit.

3.6 HYDROGEOLOGY

The following discussion addresses regional hydrogeology and site-specific hydrogeology.



SOURCE: USGS, OCTOBER, 1981

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GEOLOGIC CROSS–SECTION THROUGH HIMCO DUMP & NORTHWEST ELKHART COUNTY

HIMCO DUMP SITE
ELKHART COUNTY, INDIANA

FIGURE 3-7

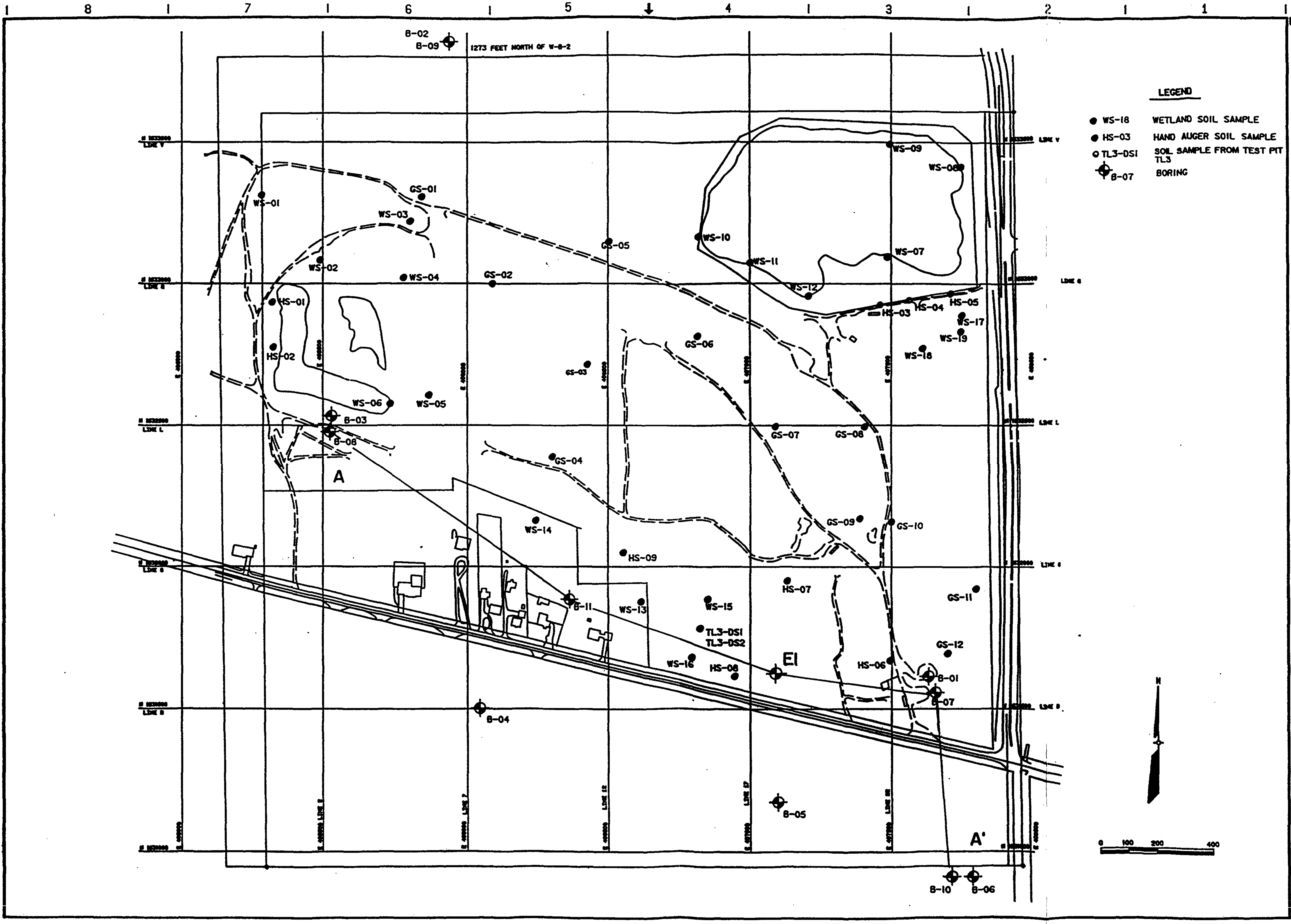

FIGURE 3-8
SOIL SAMPLE LOCATIONS
HIMCO DUMP SUPERFUND SITE
ELKHART, INDIANA

Donohue ENGINEERS ARCHITECTS SCIENTISTS

Scale AS SHOWN
Date JAN. 1992
Designer SP
Drafter EZ
Checker
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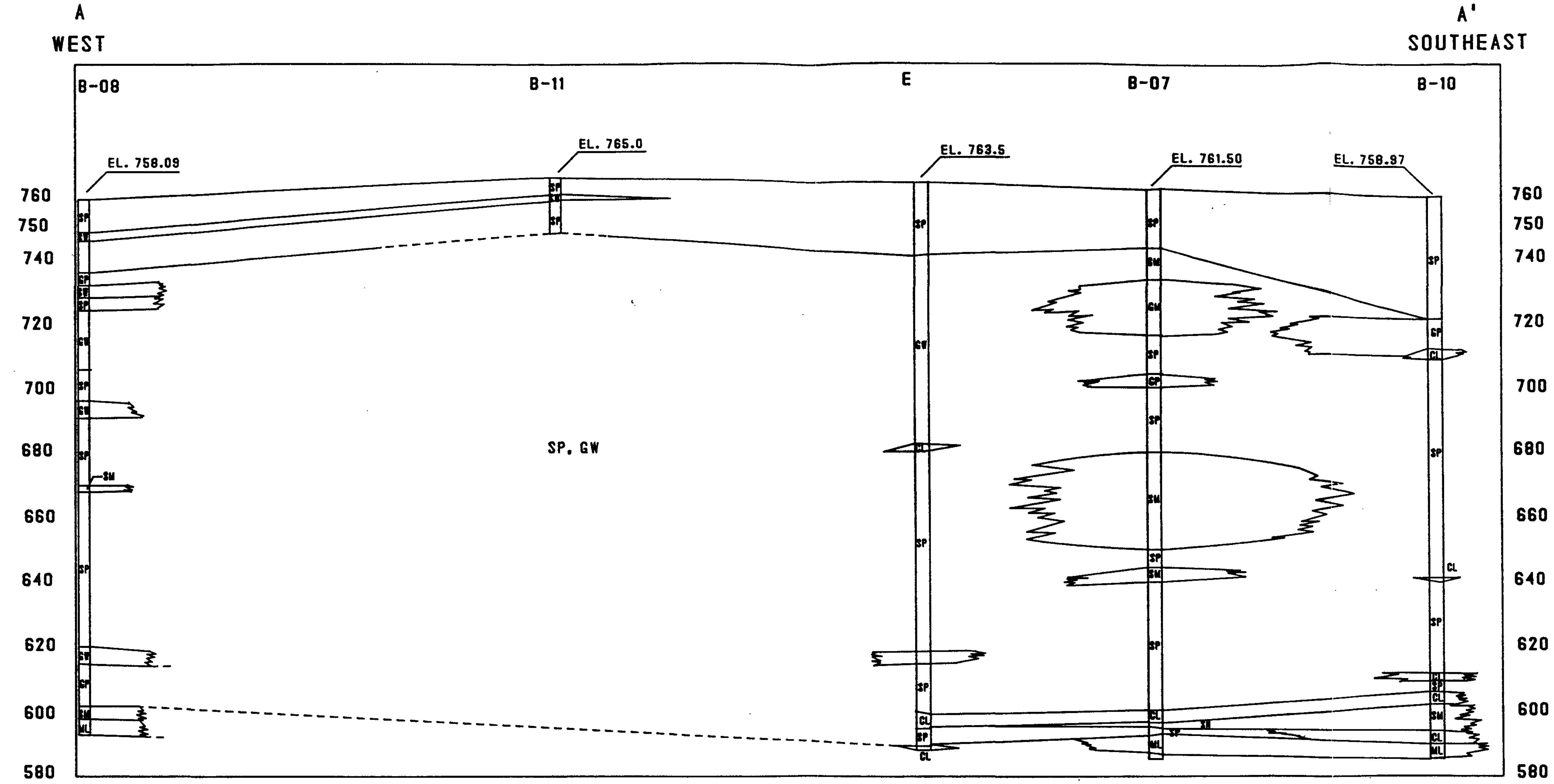
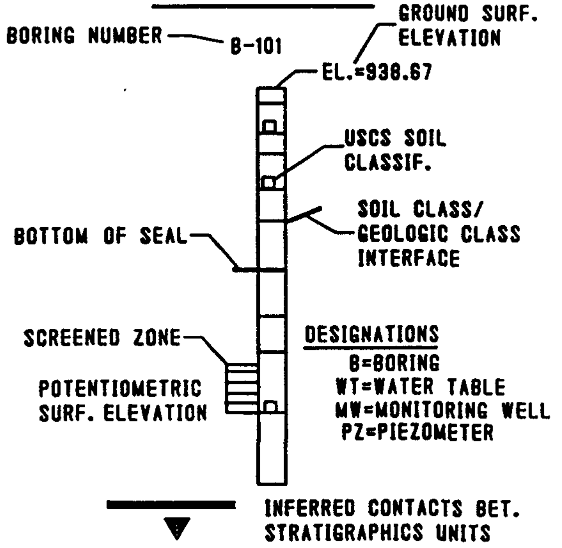


BORING LEGEND



DESIGNATIONS

B=BORING
WT=WATER TABLE
MW=MONITORING WELL
PZ=PIEZOMETER

UNIFIED SOIL CLASSIFICATIONS

GW	WELL GRADED GRAVELS & GRAVEL SAND MIXTURES
GP	POORLY GRADED GRAVELS & GRAVEL SAND MIXTURES
GW-GM	WELL GRADED SILTY GRAVELS, GRAVEL-SAND-SILT MIXTURES
GW-GC	WELL GRADED CLAYEY GRAVELS, GRAVEL-SAND-SILT MIXTURES
GP-GM	POORLY GRADED SILTY GRAVELS, GRAVEL-SAND-SILT MIXTURES
GP-GC	POORLY GRADED CLAYEY GRAVELS, GRAVEL-SAND-SILT MIXTURES
GM	SILTY GRAVELS, GRAVELS-SAND-SILTY MIXTURES
GC	CLAYEY GRAVELS, GRAVELS-SAND-SILTY MIXTURES
GC-GM	SILTY CLAY GRAVELS, GRAVEL-SAND-SILT-CLAY MIXTURES
CL	LEAN CLAY, GRAVELLY-SANDY-LEAN CLAYS
CL-ML	SILTY CLAY, GRAVELLY-SANDY-SILTY CLAYS
ML	SILT, GRAVELLY-SANDY SILT
OL	ORGANIC LEAN SILTY CLAY

SW	WELL GRADED SANDS
SP	POORLY GRADED SANDS
SW-SM	WELL GRADED SILTY SANDS, SAND-SILT-GRAVEL MIXTURES
SW-SC	WELL GRADED CLAYEY SANDS, SAND-SILT-CLAY-GRAVEL MIXTURES
SP-SM	POORLY GRADED SILTY SANDS, SAND-SILT-GRAVEL MIXTURES
SP-SC	POORLY GRADED CLAYEY SANDS, SAND-SILT-CLAY-GRAVEL MIXTURES
SM	SILTY SANDS
SC	CLAYEY SANDS
SC-SM	SILTY, CLAYEY SANDS
CH	FAT CLAY, GRAVELLY-SANDY-FAT CLAYS
MH	PLASTIC SILT, GRAVELLY-SANDY ELASTIC SILT
OH	ORGANIC PLASTIC SILTY CLAY
PI	PEAT, MUCK, OTHER HIGHLY ORGANIC SOILS

NOTE:

1. UNIFIED SOIL CLASSIFICATIONS ARE TAKEN FROM BORING LOGS BASED ON FIELD VISUAL IDENTIFICATION & LAB. TEST DATA. DEPOSITIONAL ENVIRONMENTS ARE INTERPRETED ON THE GEOLOGIC CROSS SECTION.

YAX7::D80:[1163473 FIG_3-9.DGN

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FIGURE 3-9

CROSS SECTION A-A'

HIMCO DUMP SUPERFUND SITE
ELKHART, INDIANA

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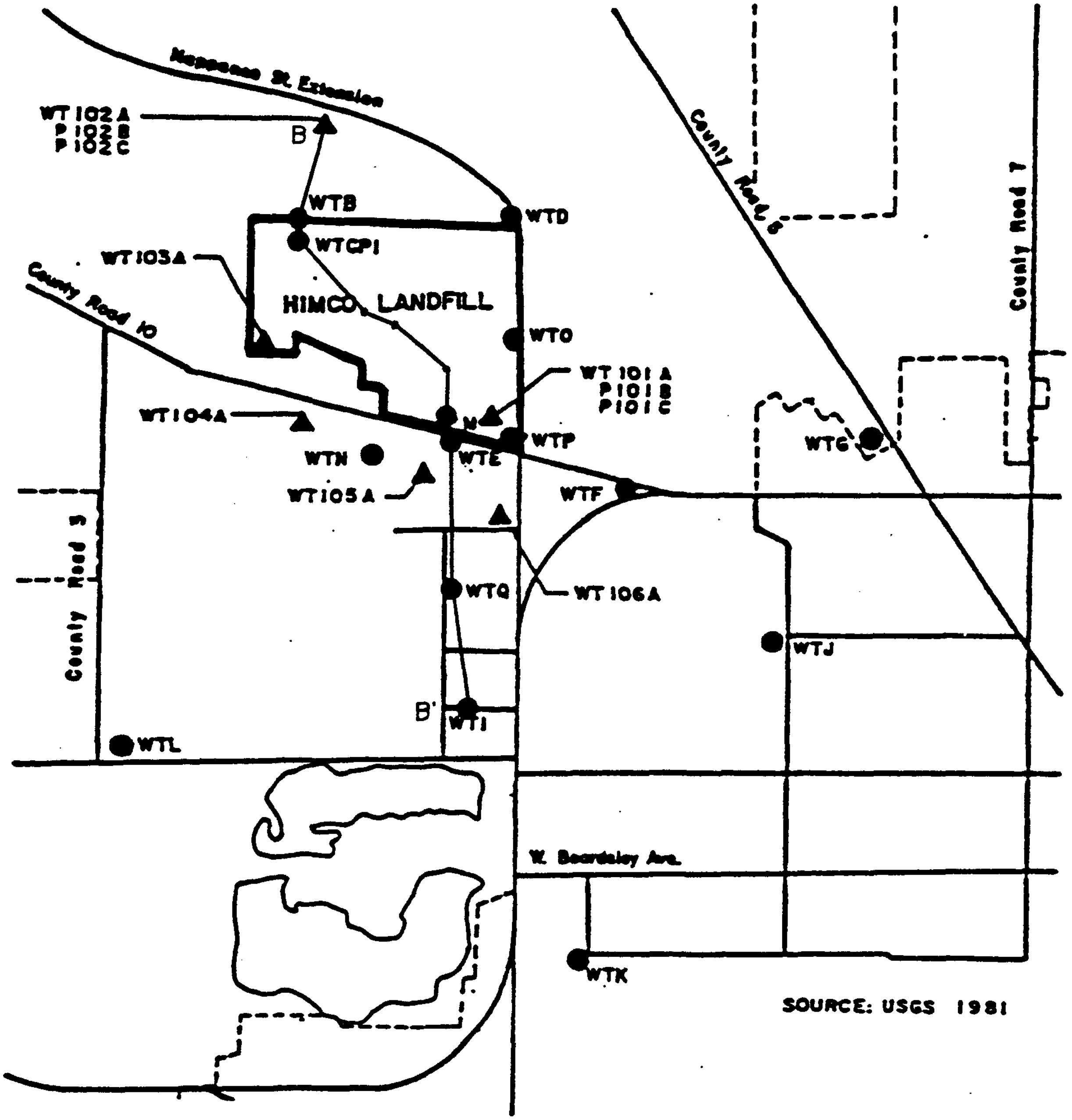

SOURCE: USGS 1981

LEGEND

▲ USEPA MONITOR WELLS

● USGS WELL NEST

USGS WELLS ARE REDESIGNATED IN THE RI REPORT WITH A "WT" ADDED TO EACH WELL LETTER (i.e. WELL "O" IS REDESIGNATED AS "WTO".

NOT TO SCALE

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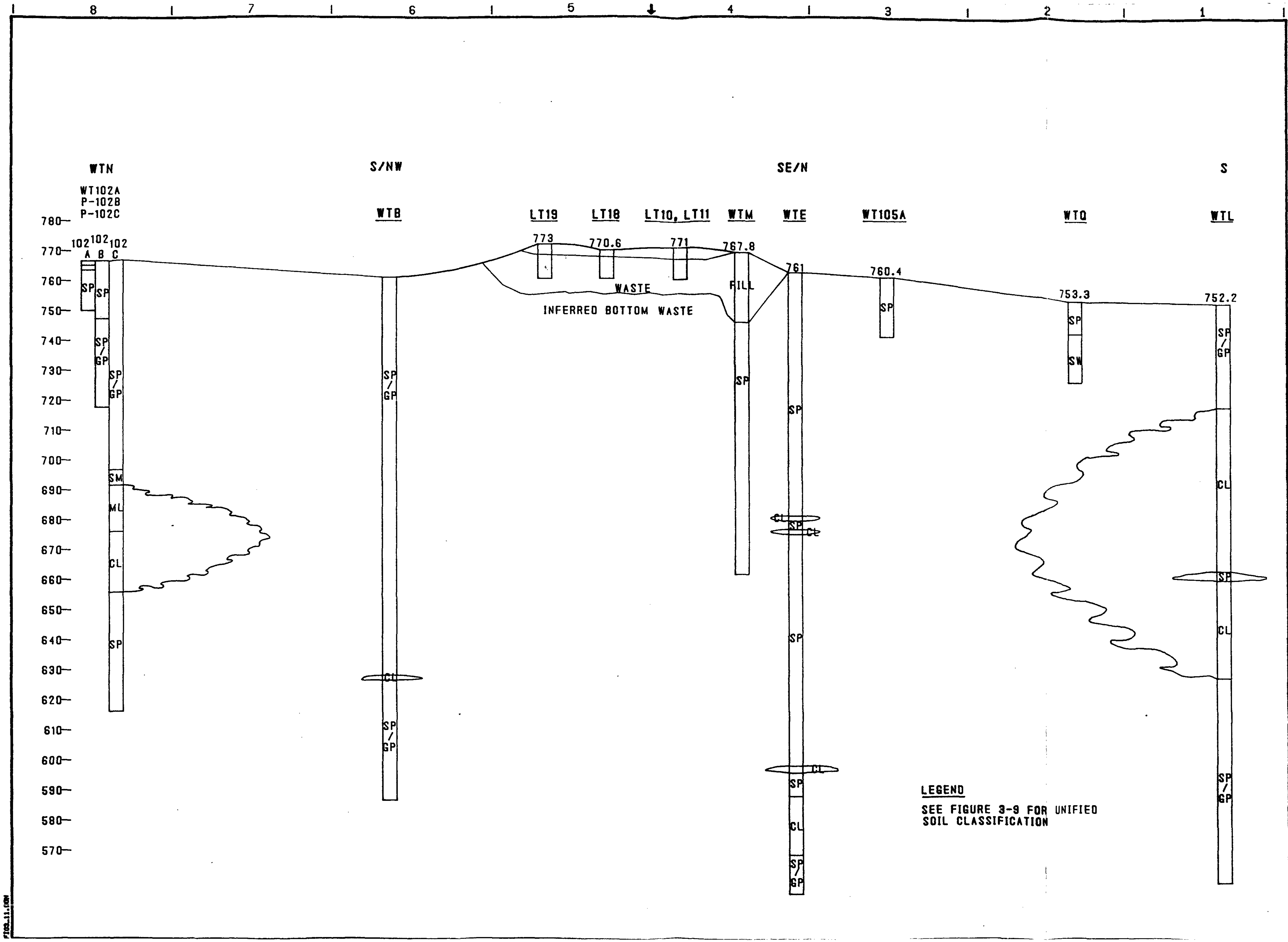
FIGURE 3-10

EXISTING USGS WELL LOCATIONS

HIMCO DUMP SITE

ELKHART, INDIANA

N



LEGEND

SEE FIGURE 3-9 FOR UNIFIED SOIL CLASSIFICATION

FIGURE 3-11
CROSS SECTION B-B'
HIMCO DUMP SUPERFUND SITE
ELKHART, INDIANA

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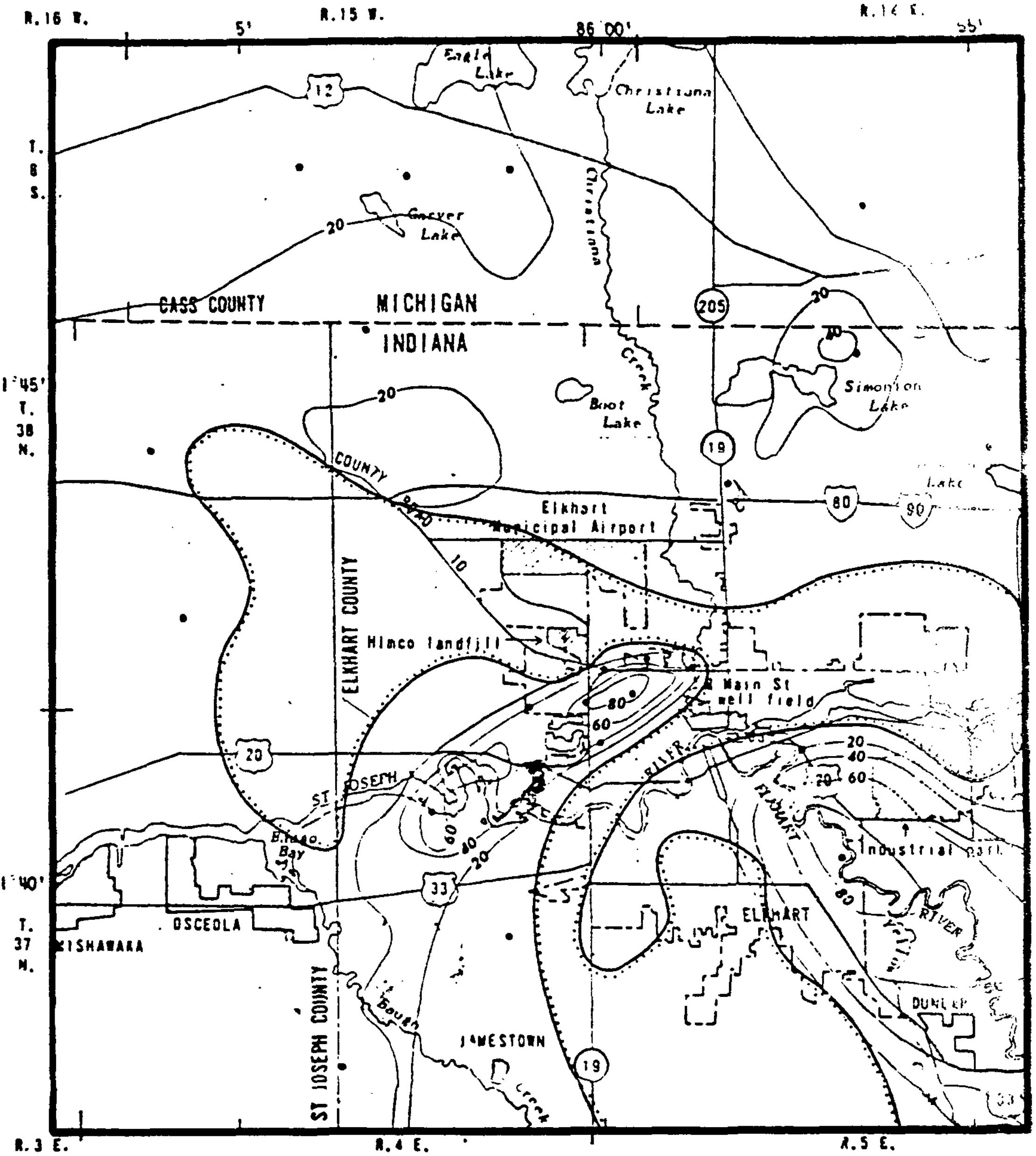
3.6.1 Regional Hydrogeology

The Elkhart County area is underlain by an extensive, thick outwash aquifer composed of sand and gravel. In some parts of the area, there is a silt and clay layer which acts as an aquitard. This confining layer, where present, divides the outwash aquifer into an upper unconfined aquifer and a lower confined aquifer. The extent of the confining layer in the vicinity of the Himco site is shown in Figure 3-12 (USGS, 1981). The Paleozoic rocks (principally shales) below the outwash aquifer generally act as aquicludes and are not used as a source of groundwater. There are no records of any high-capacity wells in these formations near the Himco site (IDNR, 1986).

The saturated thickness of the outwash aquifer ranges from 40 feet in the vicinity of the North Main Street well field to more than 450 feet in the bedrock valley in the vicinity of the site. The average hydraulic conductivities calculated for sand and for sand and gravel deposits were 80 and 400 ft/day, respectively (USGS, 1981). The lateral hydraulic conductivity of the silt and clay aquitard is approximately 0.1 ft/day, based on average hydraulic conductivities of silt and clay (Freeze and Cherry, 1979). The calculated transmissivities for the unconfined aquifer ranged from 4,000 ft^2/day to 175,000 ft^2/day in the bedrock valley near the Himco site. Transmissivities for the confined aquifer ranged from 5,000 ft^2/day to 85,000 ft^2/day (USGS, 1981). Specific yield of 0.16 for the unconfined aquifer and a storage coefficient of 0.00006 for the confined aquifer have been calculated (Marie, 1975). A regional contour map of the groundwater flow in the unconfined aquifer in the vicinity of Himco site is presented in Figure 3-13. Groundwater flow is generally south towards the St. Joseph River (Figure 3-13), which is a regional discharge for this area. This is a flow pattern characteristic of a well-connected stream-aquifer system with a gaining stream. Vertical water level differences between aquifers are generally small in areas away from the St. Joseph River, but upward gradients can be found in areas near the river (USGS, 1981). Water levels in the aquifer fluctuate from 2 to 4 ft/yr. Water levels are highest in late March and April, and lowest in September and October (USGS, 1981). Groundwater pumpage in this aquifer is greatest in the city of Elkhart. The North Main Street well field has 15 production wells supplying approximately 4 to 10 million gallons per day, which constitutes approximately 70 percent of the well field capacity.

The water quality of the outwash aquifer is suitable for most uses and has median concentrations of 440 mg/l total dissolved solids; 286 mg/l hardness (as calcium carbonate); iron, 900 ug/l; nitrate (as nitrogen), 0.01 mg/l; and chloride, 10 mg/l.

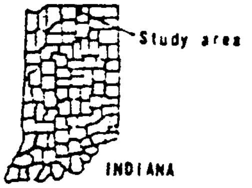


LEGEND

⬚ Confining bed absent

—40— Line of equal thickness Interval 20 feet

• Data point



0 1 2 3 4

SCALE: MILES

SOURCE: USGS, 1981

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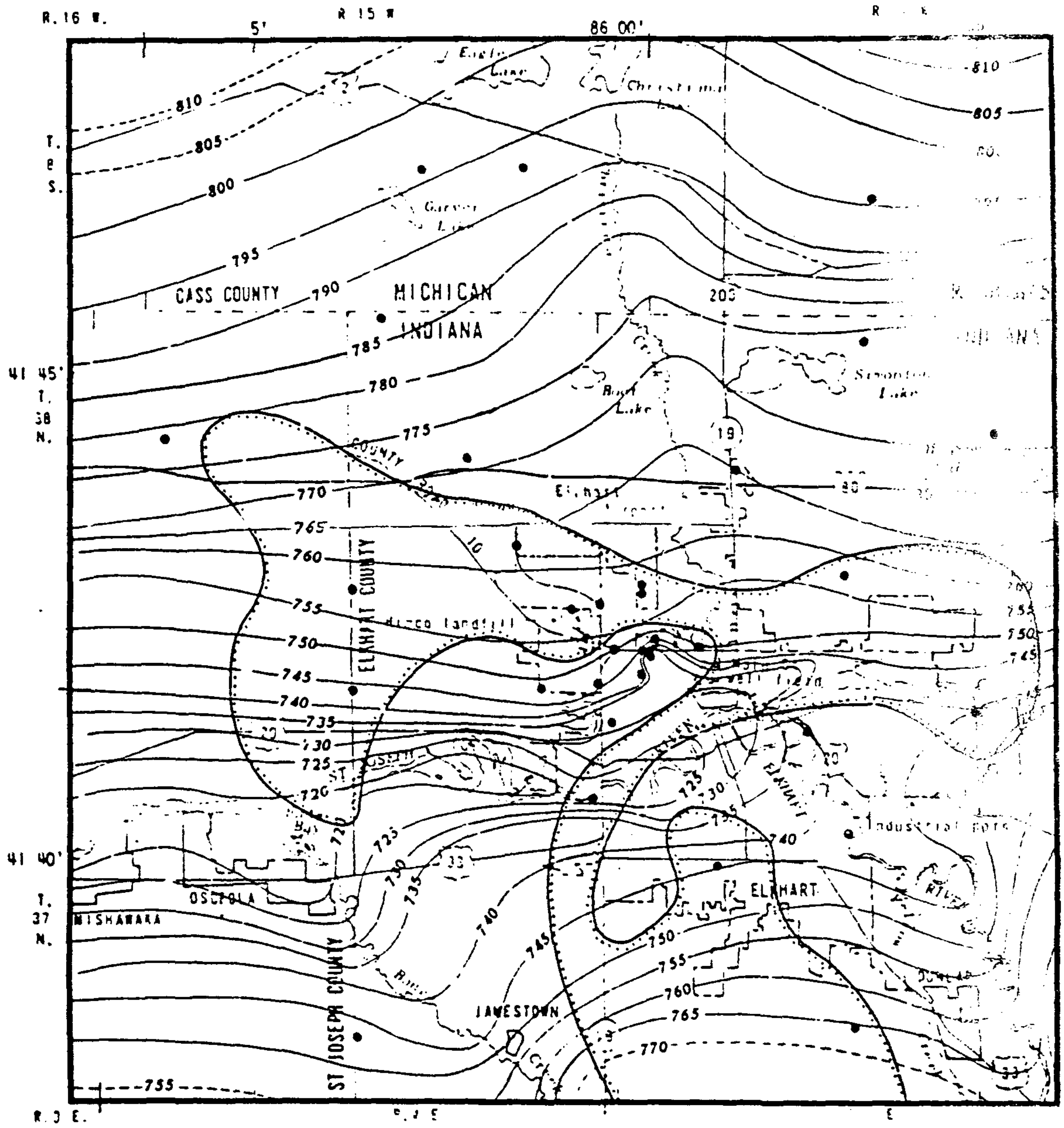
THICKNESS AND EXTENT OF CLAY CONFINING LAYER

HIMCO DUMP SITE
ELKHART COUNTY, INDIANA

N

FIGURE 3-12

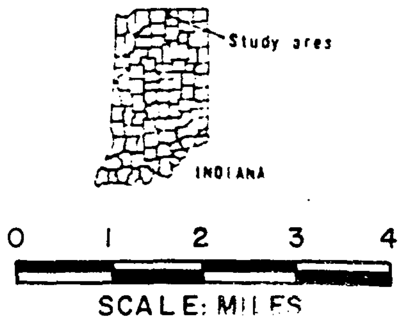


LEGEND

⬚ Confining bed absent

—780--- Line of equal altitude. Interval 5 feet. Dashed where approximate. NGVD of 1929

● Data point



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CONTOUR MAP OF UNCONFINED AQUIFER

HIMCO DUMP SITE
ELKHART COUNTY, INDIANA

N

FIGURE 3-13

3.6.2 Site-Specific Hydrogeology

3.6.2.1 USGS Study (USGS, 1981)

In 1977, the USGS installed a network of groundwater monitoring wells around the Himco site and Northwest Elkhart County. Sixteen well nests (some sites consisting of two or more wells) were constructed within a one-mile radius of the Himco site. The well nests were installed upgradient, downgradient, and sidegradient to the dump site. The USGS locations and designations of the landfill wells are presented in Figure 2-3 of Section 2. Well depths for the study ranged from 14 to 200 feet below ground surface. All wells were screened in sand or sand and gravel.

According to the USGS study, groundwater occurs in the study area at depths ranging from 8 to 17 feet below ground surface. The outwash aquifer is unconfined below the Himco site, and the silt and clay confining layer is absent. Groundwater flow is generally to the St. Joseph River, a groundwater discharge area. The saturated thickness of the aquifer below the site in the vicinity of the bedrock valley is approximately 450 feet. Hydraulic conductivities for the wells were estimated based on particle size analyses of the aquifer material. The average values of hydraulic conductivity calculated for sand, and for sand and gravel, were 80 and 400 feet/day, respectively. No laboratory or in-field hydraulic conductivity tests were performed. In addition, USGS did not place borings in the landfill itself.

3.6.2.2 RI Study

The following discussion of the hydrogeology at the Himco site is based on data obtained from 11 groundwater monitoring wells installed during the RI field program. Information obtained from existing on-site wells was also incorporated. Monitoring well locations are shown on Figure 3-10 and 3-14. The site hydrogeologic analysis and interpretation is summarized below and presented in greater detail in TEM 1.

The RI groundwater flow interpretations at the Himco site include primarily the upper 200 feet (approximately) of the outwash aquifer. This is due to the limited depths of the investigative monitoring wells. Only one well (WTB-1) was screened below the upper 200 feet of the outwash aquifer. In general, groundwater flow found during the RI field program appears to be consistent with regional conditions and USGS investigation results.

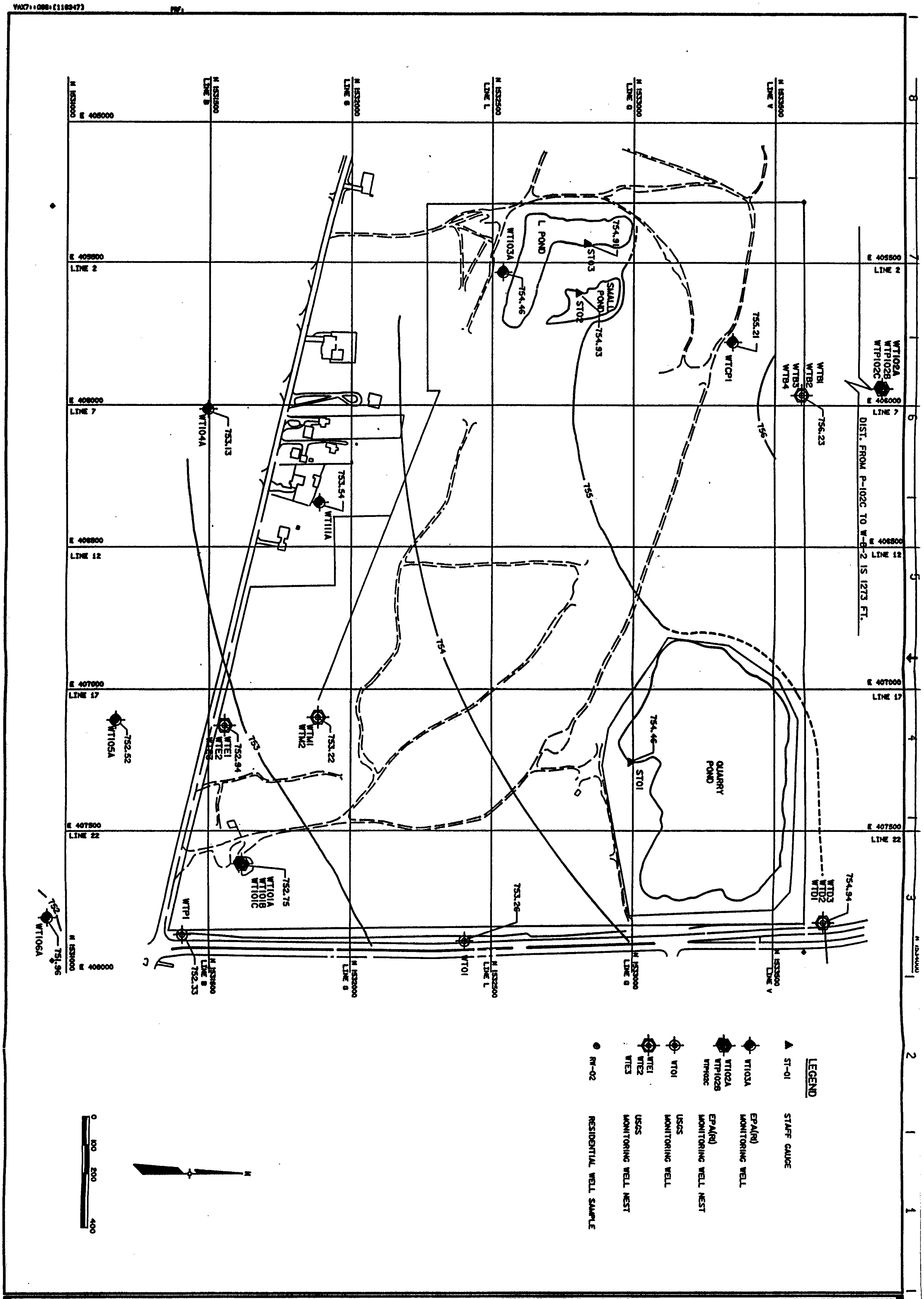

FIGURE 3-14

GROUNDWATER CONTOUR MAP

HIMCO DUMP SUPERFUND SITE
ELKHART, INDIANA

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Groundwater occurs between approximately 5 and 20 feet below the site at an elevation ranging from 752 to 759 feet MSL within the sand and gravel outwash deposits. The elevation of the bottom of the waste mass is estimated to range from 755 to 760 feet (MSL). However, groundwater fluctuations can occur across the site. Static water levels are shown on Figure 3-14 and in Table 2 of TEM 1. Three surface water bodies represent the surface expression of the water table at the site. The groundwater and surface water connection appears to be a flow through pattern, which is typical for the types of geologic deposits found at the Himco site.

Shallow groundwater flow is generally to the south-southeast towards the St. Joseph River, which is a regional groundwater discharge for this area (Figure 3-14). However, groundwater flows in a more southerly direction under the western half of the site. The average horizontal groundwater flow gradient beneath the entire site is approximately 1.6×10^{-3} ft/ft.

Vertical flow gradients were estimated from the two well nests located at the southeast (WT101A, WTP101B, WTP101C) and northwest (WT102A, WTP102B, WTP102C) corners in the site. Well depths are provided in Table 2-8 of Section 2. Vertical flow gradients within the upper 200 feet of the outwash deposits include both upward and downward values. However, vertical gradients are predominately upward. Downward vertical gradients range from 2.6×10^{-4} ft/ft to 3.5×10^{-4} ft/ft. Upward vertical gradients ranged from 2.1×10^{-4} ft/ft to 1.3×10^{-3} ft/ft. In addition, an upward vertical gradient of 7.3×10^{-4} ft/ft was estimated in USGS well nest B between shallow well WTB2 and deep well WTB1 (screen bottom approximately 475 feet below ground surface). This indicates that upward vertical gradients persist towards the bottom of the bedrock valley. Vertical flow gradient values are provided in Table 4 of TEM 1.

Calculated field hydraulic conductivity values are relatively high. Values range from 1.2×10^{-1} cm/s to 7.9×10^{-4} cm/s, with an average value of 2.2×10^{-2} cm/s (Table 3-2). These values fall within hydraulic conductivity values for silty sand, clean sand, and gravel. Shallow wells screened in clean gravel have the highest hydraulic conductivities. Piezometers screened in silty sands have the lowest hydraulic conductivity values. Differences in hydraulic conductivity values indicate the possibility of an heterogeneous condition. Heterogeneous conditions may exist due to the nature of the geologic deposits.

The average linear groundwater flow velocity is estimated to be 3.85×10^{-6} ft/s (0.33 ft/day), or 121 ft/yr. This is based on an average horizontal hydraulic gradient of 1.6×10^{-3} ft/ft, an average hydraulic conductivity of 2.20×10^{-2} cm/s, and a porosity of 0.30. A porosity of 0.30 is a typical value for sand and gravel mixes.

Three specific groundwater characteristics mentioned above which may be important factors in contaminant migration include the low horizontal gradient, low upward vertical gradients, and fluctuations in water table levels. Under these conditions, contaminants are less likely to be carried down to lower portions of the aquifer by advection, which is the primary transport mechanism. Groundwater fluctuations at the Himco site may be important because water table elevations are relatively near the landfill waste. Upward fluctuations may result in a direct contact between groundwater and the waste mass thereby providing a more rapid mechanism by which contaminants from the landfill enter the groundwater system.

3.7 SURFACE SOILS

Soils present on the Himco site include the Tawas Muck and Plainfield Fine Sand, and to a lesser degree the Tyner Loamy Sand, Gilford Sandy Loam, and Oshtemo Loamy Sand (U.S. Department of Agriculture, Soil Conservation Service, 1989). Soil on the landfill cap itself is described in the Test Pit Results of Phase I, Section 3.4.1.

The Tawas Muck is described as dark-colored and mucky in texture, and is present in depressional upland. It is very poorly drained. It has high available water for plant growth and a very high organic matter content.

The Plainfield Fine Sand is described as having two to six percent slopes, dark color, and sandy in texture, and is present on sloping uplands. It is deep and excessively drained with a rapid permeability. It has low available water for plant growth and a very high organic matter content.

The Tyner Loamy Sand (0 to 2 percent slopes) is dark colored and sandy in texture, and is present on sloping uplands. It is deep and somewhat excessively drained with rapid permeability. It has low available water for plan growth and a low organic matter content.

The Gilford Sandy Loam is dark colored and loamy in texture, and is present on depressional uplands. It is deep and very poorly drained. It has moderate available water for plant growth and a high organic matter content.

The Oshtemo Loamy Sand (0 to 2 percent slopes) is a dark colored, sandy soil, and is present on sloping uplands. It is deep and somewhat excessively drained with rapid permeability.

3.8 SURFACE WATER

The Himco site is located in the St. Joseph River basin. The river is approximately two miles south of the site. The St. Joseph River flows from east to west in this area, and all surface drainage flows to the river or its tributaries. Ultimately the St. Joseph River empties into Lake Michigan at St. Joseph, Michigan.

There are three surface water bodies present on the Himco site. There is a gravel pit pond in the northeast corner of the site, and two excavated ponds located in the west corner of the site. One of these ponds is reportedly stocked with fish.

A surface water runoff analysis was conducted to assess historical and future surface water flow off-site from the dump to areas west of the dump. The analysis was conducted by delineating drainage areas, determining surface water flow paths, and routing flows through two on-site ponds. Specific runoff parameters such as drainage area (acres), time of concentration, and runoff curve number were obtained to assist in conducting the analysis. Time of concentration is defined as the time necessary for surface runoff to reach the outlet of the drainage area from the hydrologically most distant point in the drainage area. The lag time is defined as the time from the center of the mass of the rainfall to the peak of the runoff hydrograph. It is approximated as 0.6 times the time of concentration.

The runoff curve number is a rainfall-runoff parameter commonly used in U.S. Soil Conservation hydrologic procedures. The runoff curve number is a function of soil type, land use, and land management practices. The larger the curve number, the greater the percentage of rainfall that would appear as runoff.

Flows and runoff hydrographs for the two ponds were determined for the 2-year, 10-year, and 100-year flood events under present conditions using the Army Corps of Engineers HEC-1 model. A hydrograph is a graph of discharge or runoff versus time, used to determine volume and rate of flow at the outlet, from the drainage area. Subbasin parameters and runoff patterns are outlined in Tables 3-3 and 3-4, respectively.

Analysis of the surface water runoff at the Himco site indicates that surface water runoff has historically or potentially will flow from the dump off-site to the west at the two locations near Subbasins C and D (Figure 3-15). Runoff will flow into Pond D from Subbasin D. Pond D will safely store 10-year flood flows. However, Pond D will overflow during the 100-year flood event.

TABLE 3-2

SUMMARY OF FIELD HYDRAULIC CONDUCTIVITY TESTS
HIMCO DUMP SUPERFUND SITE
ELKHART, INDIANA
1992

Well Number	Hydraulic Conductivity (cm/s)	Bottom of Well Elevation	Soil Class at Well Screened +
M1-RISE	$3.1x10^{-3}$	103.24	SP, GP
M1-FALL	$1.4x10^{-3}$	667.08	SP, GP
F1-RISE	$1.2x10^{-1}$	31.28 **	*
F1-FALL	$4.5x10^{-2}$	31.28 **	*
F2-FALL	$1.2x10^{-3}$	147.83 **	*
F2-RISE	$7.3x10^{-4}$	147.83 **	*
M2-RISE	$3.6x10^{-2}$	744.70	*
E3-RISE	$7.9x10^{-4}$	589.84	SP, GP
E3-FALL	$4.6x10^{-4}$	589.84	SP, GP
P101B-FALL	$3.9x10^{-3}$	633.76	SM
P101C-FALL	$1.1x10^{-3}$	597.58	SP
P102B-RISE	$3.5x10^{-2}$	701.56	SP
P102B-FALL	$3.9x10^{-2}$	701.56	SP
P102C-RISE	$3.5x10^{-3}$	609.26	SP
WT101A-RISE	$2.6x10^{-2}$	745.63	SP
WT101A-FALL	$9.4x10^{-3}$	745.63	SP
WT102A-RISE	$4.1x10^{-3}$	750.89	SP,GP,SM
WT102A-FALL	$6.8x10^{-3}$	750.89	SP,GP,SM
WT103A-RISE	$4.1x10^{-2}$	742.12	SW,GW
WT103A-FALL	$1.8x10^{-2}$	742.12	SW,GW
WT104A-RISE	$3.8x10^{-2}$	746.88	SP,SW,GW
WT104A-FALL	$5.0x10^{-3}$	746.88	SP,SW,GW
WT105A-RISE	$1.9x10^{-2}$	744.38	SP
WT105A-FALL	$1.0x10^{-2}$	744.38	SP
WT106A-RISE	$4.7x10^{-2}$	742.97	SP,GP
WT106A-FALL	$8.4x10^{-2}$	742.97	SP,GP
WT111A-RISE	$7.7x10^{-3}$	745.02	SP,SW
WT111A-FALL	$2.5x10^{-3}$	745.02	SP,SW
AVERAGE	**$2.2x10^{-2}$**		

SP - Poorly Graded Sands
GP - Poorly Graded Gravels and Gravel Sand Mixtures
SM - Silty Sands
SW - Well Graded Sands

* Data not available
** Elevation not shot - value is actual measured well depth
\+ Unified Soil Classification System

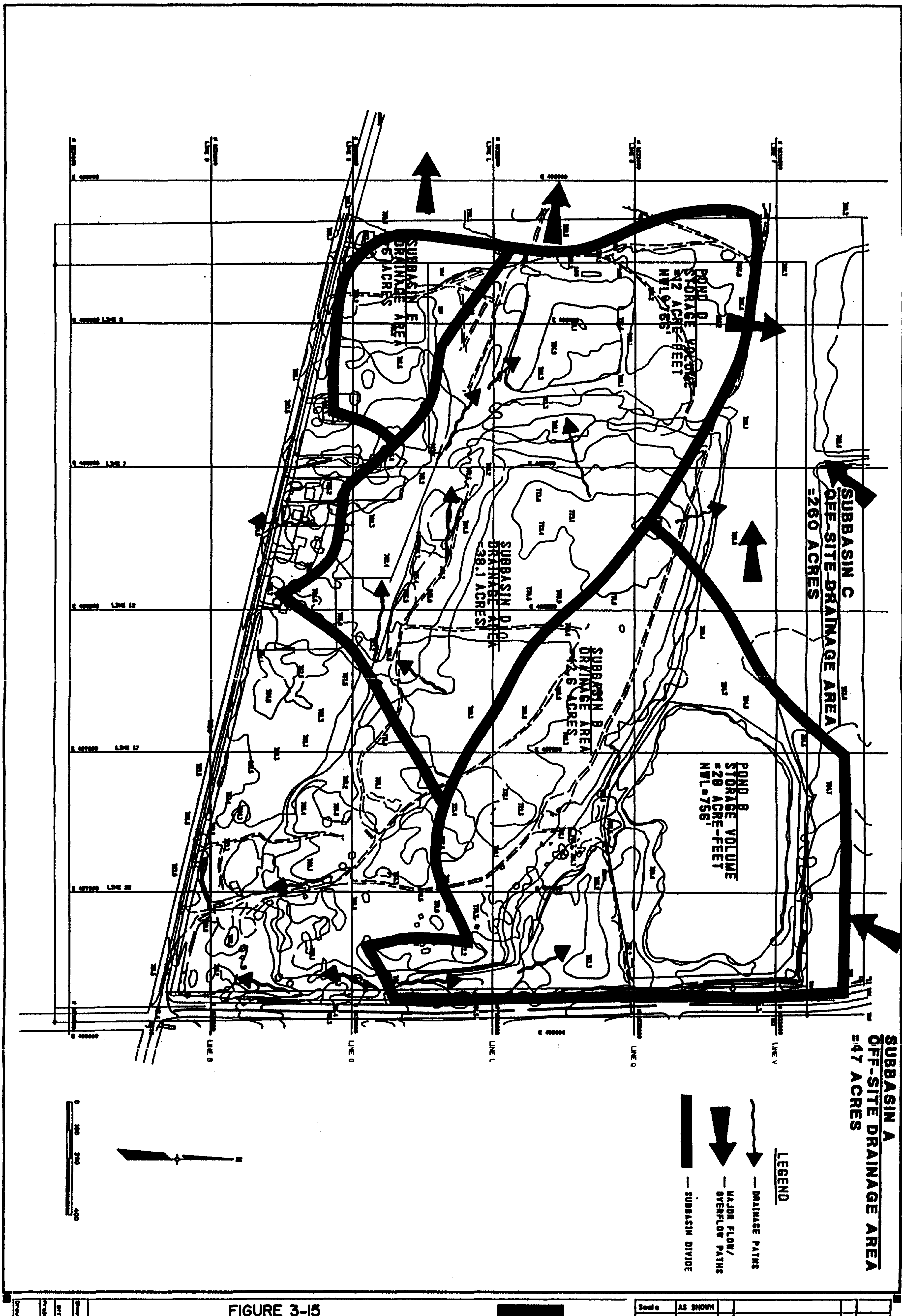

FIGURE 3-15
SURFACE DRAINAGE PATTERNS & SUBBASIN DELINEATION
HIMCO DUMP SUPERFUND SITE
ELKHART, INDIANA

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TABLE 3-3

SUBBASIN PARAMETERS
HIMCO DUMP SUPERFUND SITE
ELKHART, INDIANA
1992

Subbasin No.	Area (acres)	Area (sq. miles)	Time of Concentration (hours)	Lag Time (hours)	Curve Number
A	47	0.07	1.0	0.6	81 (1/2 residential, 1/2 open space)
B	43	0.07	0.5	0.3	90 (25% pond, 25% open space)
C	260	0.41	2.0	1.2	82 (agricultural, open space)
D	38	0.06	0.8	0.5	90 (25% pond, 25% open space)
E	6	0.01	0.25	0.15	86

TABLE 3-4

SUMMARY OF RUNOFF PATTERNS
HIMCO DUMP SUPERFUND SITE
ELKHART, INDIANA
1992

Subbasin No.	Drainage Area (Acres)	10-Year Runoff (cfs)	100-Year Runoff (cfs)	Comments
A	47	16	29	100-year runoff stored in Pond B
B	43	41	64	100-year runoff stored in Pond B
C	260	127	223	Runoff will flow to west near TT-04
D	38	32	52	10-year runoff will be stored in Pond D
				100-year runoff will overflow Pond B and flow west
E	6	5	9	Runoff will flow west, but flow is not in contact with dump

cfs: cubic feet per second

1/2

3.9 WETLANDS

During Phase I, only one area immediately south of the gravel pit, shown in Figure 1-3 and on Figure I of TM 14, was identified as a wetland. None of the other suspect areas were determined to be wetlands. The identified wetland met the hydrophytic vegetation and hydrology criteria, but not the hydric soils criterion. During Phase II, a wetland delineation of boundaries was conducted for the size of the wetland. The wetland is approximately 2,500 square feet, which is less than one-half acre in size.

3.10 POPULATION, LAND USE, AND WATER USE

The population of the city of Elkhart is approximately 40,000. The city has an area of approximately 17 square miles. Within a one mile radius of the Himco site, land use is residential, commercial, industrial, and agricultural. Approximately one-third of the site itself has been used for soybean production. Corn is also grown in the area. The herbicides Alachlor and Atrazine and the pesticide Furadan have been used in the area, according to the Elkhart County Purdue Extension agricultural agent. These compounds degrade within 14 months.

Residences and businesses south of Himco site are connected to the municipal water supply system with the exception of the Stoner residence, south of Highway 10 (Bristol Avenue) which owns a private well. Those residences and businesses to the east and southeast own private water wells.

4.0 NATURE AND EXTENT OF CONTAMINATION

4.1 INTRODUCTION

This chapter presents an assessment of contamination at the Himco site. Each section addresses a specific medium and includes a summary of analytical results emphasizing chemicals of potential concern. A complete report of analytical data by sampling medium and location is included in Appendix C. Appendix C also includes a list of Tentatively Identified Compounds (TICs).

4.2 SOILS

The discussion focuses on the inorganic analytes arsenic and beryllium. These two analytes were listed as contributing to excess cancer risk above 1 in 1 million ($1x10^{-6}$) in the baseline risk assessment. Also discussed are the volatile organic compounds (VOCs) and semi-volatile organic compounds (SVOCs) above detection limits.

On-site contaminant levels were compared to background levels. Background concentrations were established from samples in the 0- to 2-foot interval in borings B-02, B-04, and B-06 which are located approximately 1,000 feet off the site (refer to Figure 4-1). These borings are far away from the site; these borings are at shallow depth and will not be affected by VOC emission from groundwater.

4.2.1 Surface Soil

Forty-two surface soil samples were collected from the landfill cover and areas next to the cover. In addition, two soil samples were collected from Trench TL-3 at two feet and six feet. Sample locations are shown in Figure 4-1.

4.2.1.1 Inorganic Analytes

A summary of the inorganic analyte concentration ranges found in surface soil samples is presented in Table 4-1. Figure 4-1 presents the locations where arsenic and beryllium were detected. Based on this figure, arsenic and beryllium appear to be prominent across the western half of the site, around the quarry pond, south of the quarry pond, and in the southern area of the Himco site characterized by non-native soil mixed with construction debris.

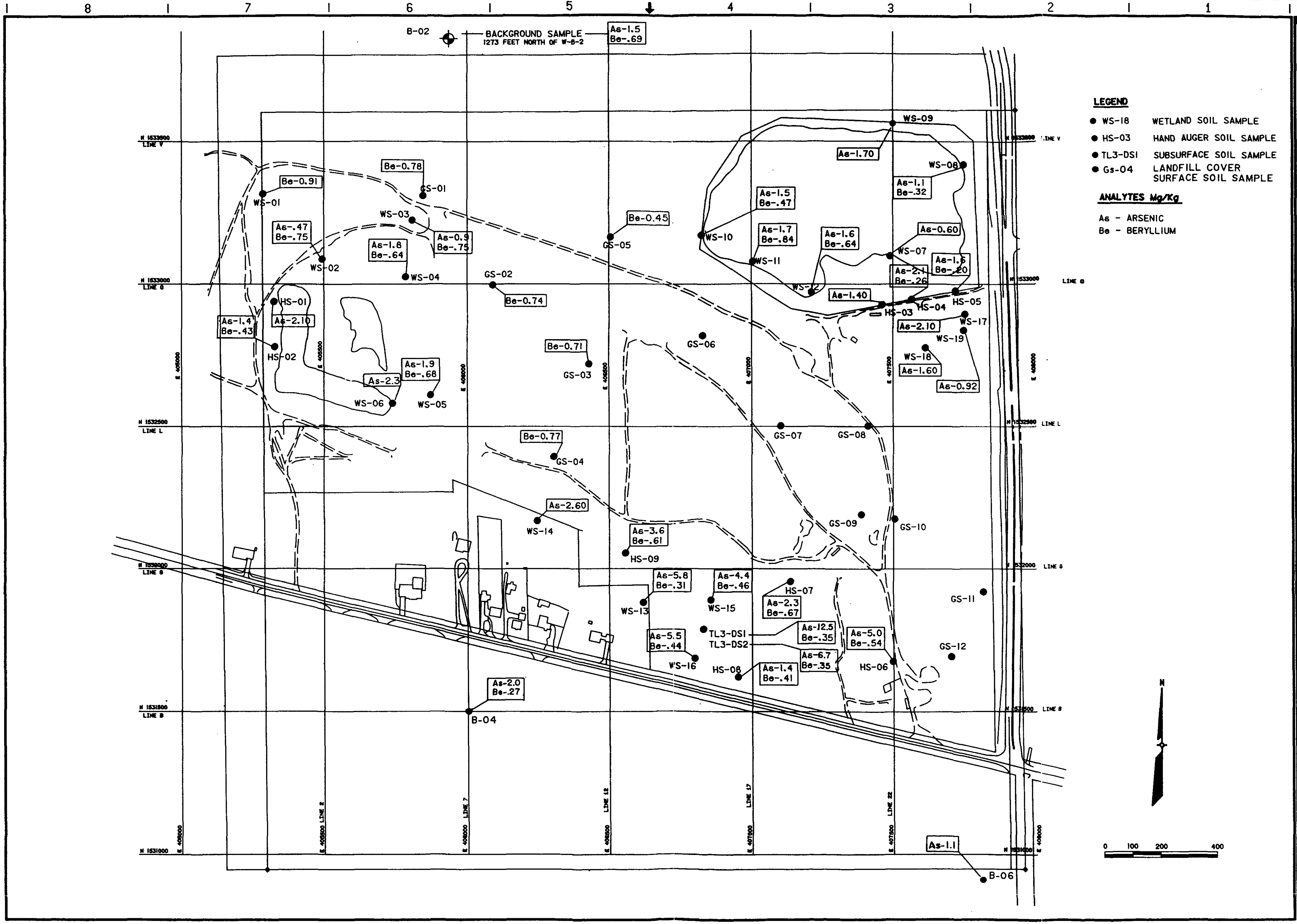

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FIGURE 4-1
ARSENIC & BERYLLIUM DETECTED IN SOIL SAMPLES (Mg/Kg)
HIMCO DUMP SUPERFUND SITE
ELKHART, INDIANA

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TABLE 4-1

SUMMARY OF INORGANIC ANALYTES DETECTED IN SURFACE SOIL
HIMCO DUMP SUPERFUND SITE
ELKHART, INDIANA
1992

Analyte	Background (mg/kg) B-02	B-04	B-06	95% * Lower/Upper Levels (Background)	Range of Concentrations Detected (mg/kg)
Aluminum	5,100(J)	5,720	3,920(J)	3,655/6,172	9.7(B)-6,780(J)
Antimony	ND	ND	ND	4.3/4.3	3.1(BJ)-46.8
Arsenic	1.5(B)	2.0(B)	1.1(BJ)	0.91/2.2	0.47(B)-5.8
Barium	62	61.1	35.5(BJ)	32.2/73.6	1.3(BJ)-101
Beryllium	.69(BJ)	.27(BJ)	ND	ND/0.77	0.20(BJ)-0.91(BJ)
Cadmium	ND	ND	ND	.06/.06	1.1(B)
Calcium	386(B)	498(B)	736(B)	294/786	360(B)-321,000(J)
Chromium	6.5(J)	7.1	4.5	4.2/7.9	1.1(B)-13.2
Cobalt	3.7(B)	3.3(B)	ND	0.49/4.7	1.5(B)-5.3(B)
Copper	4.7(B)	4.3(BJ)	3.8(BJ)	3.7/4.9	1.3(B)-216
Iron	6,370	6,740	4,690(J)	4,429/7,437	9.8(BJ)-10,100
Lead	7.8	7.0	81(J)	ND/90	0.5(BJ)-245(J)
Magnesium	762(B)	976(B)	440(BJ)	355/1,097	14.6(BJ)-14,000
Manganese	402	421	70(J)	2,519/569	1.3(BJ)-561(J)
Mercury	ND	ND	ND	.06/.06	0.13(J)-0.54(J)
Nickel	6.5(B)	7.5(B)	ND	.29/9.8	2.4(B)-12.0
Potassium	252(B)	213(B)	115(B)	96.2/291	86.6(B)-678(B)
Selenium	0.25(BJ)	ND	ND	0.23/0.44	0.27(BJ)-1.4(J)
Silver	ND	ND	ND	0.50/0.50	0.49(B)-2.8(BJ)
Sodium	ND	ND	ND	5.0/5.0	20.8(B)-90.6(B)
Thallium	ND	ND	ND	0.24/0.24	ND
Vanadium	11.8	11.6	10.4(BJ)	10.2/12.3	1.6(BJ)-19.1
Zinc	20.5	22.4	8.4	6.7/27.6	1.7(B)-229
Cyanide	ND	ND	ND	0.60/0.60	1.3-24.3

Qualifiers

ND - Below detection limit
B - Analyte found in the associated blank as well as in the sample
J - Indicates an estimated value
* - Half of the detection limits were used for non-detects

The highest relative concentrations of arsenic (2.6 mg/kg to 12.5 mg/kg) were detected in soil samples near the south end of the landfill. Arsenic concentrations at other locations ranged from 0.47 mg/kg to 1.9 mg/kg. Arsenic was also detected in background samples at concentrations ranging from 1.1 to 2.0 mg/kg. Arsenic was not detected in soil samples on the landfill cover. In summary, because arsenic was found in surface soil at the site up to an order of magnitude higher than the background data, arsenic contamination in surface soil at the site may be attributed to the site contamination.

Beryllium was detected at relatively consistent concentrations ranging from 0.31 ug/kg to 0.91 ug/kg. No single area showed consistently higher concentrations than others. Beryllium was also detected in the background samples at concentrations ranging from 0.27 to 0.69 mg/kg. Based on these data, beryllium may be naturally occurring in surface soils in the area.

A summary of inorganic analytes detected in soil samples collected from TL-3 is presented in Table 4-2. Overall, inorganic analytes from TL-3 at two and six feet below ground surface were similar in concentration to inorganic analytes detected in ground surface samples located within 200 feet of TL-3. In addition, concentrations of inorganic analytes were similar between the two- and six-foot sample depths.

4.2.1.2 Volatile Organic Compounds (VOCs)

The VOC concentration ranges found in surface soil samples are summarized in Table 4-3. The background concentration data are also presented in Table 4-3.

Eleven VOCs were measured above detection limits. These include methylene chloride, acetone, carbon disulfide, 1,1-dichloroethene, 2-butanone, tetrachloroethene, toluene, ethyl benzene, styrene, and xylenes.

Figure 4-2 presents concentrations of the detected VOCs in the surface soil. This figure shows that VOCs were detected widespread across the site, but in all cases were found in the low ug/kg range (less than 140 ug/kg). A comparison of the VOC data with the background data indicates that VOC contamination in the site surface soils may be attributed to the site.

A summary of VOC concentrations found in TL-3 at two and six feet is presented in Table 4-4. The location for TL-3 is presented in Figure 2-2. Seven VOCs were detected above detection limits. Six out seven VOCs detected in TL-3 were detected in ground surface soil samples. Except for methylene chloride, concentrations of VOCs in TL-3 were typically higher than ground surface soil samples. However, VOCs were detected in the

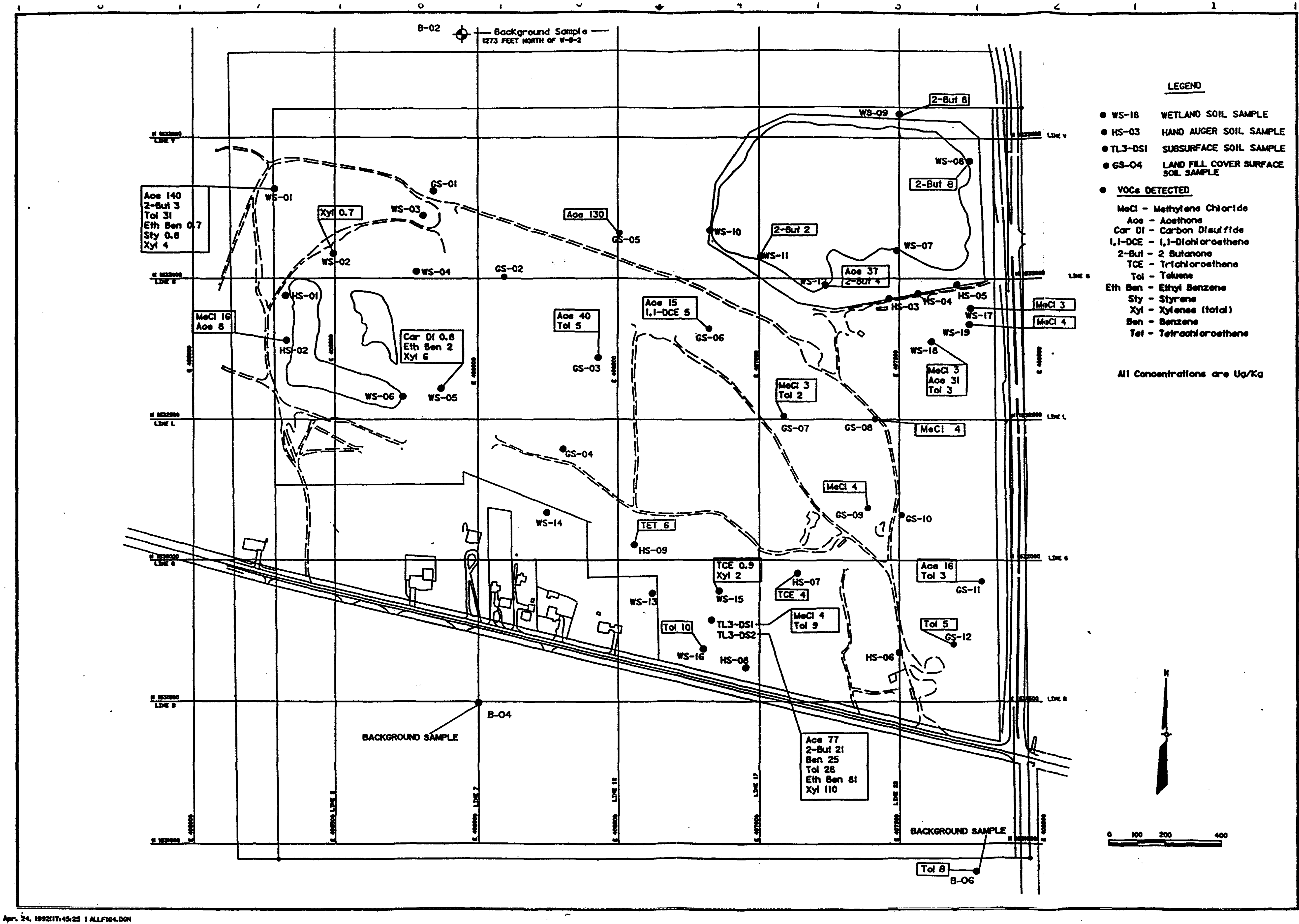

FIGURE 4-2

VOCs DETECTED IN SURFACIAL SOILS (Ug/Kg)

HIMCO DUMP SUPERFUND SITE
ELKHART, INDIANA

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TABLE 4-2

SUMMARY OF INORGANIC ANALYTES
DETECTED IN SOIL SAMPLES FROM TL-3
HIMCO DUMP SUPERFUND SITE
ELKHART, INDIANA
1992

Analyte	Background (mg/kg)			95% * Lower/Upper Levels (Background)	2 feet (mg/kg)	6 feet (mg/kg)
	B-02	B-04	B-06			
Aluminum	5,100(J)	5,720	3,920(J)	3,655/6,172	3,740	3,040
Antimony	ND	ND	ND	4.3/4.3	3.0(BJ)	6.1(BJ)
Arsenic	1.5(B)	2.0(B)	1.1(BJ)	0.91/2.2	12.5	6.7
Barium	62	61.1	35.5(BJ)	32.2/73.6	79.6	44.9(B)
Beryllium	0.69	0.27(BJ)	ND	ND/0.77	0.40(B)	0.35(B)
Cadmium	ND	ND	ND	.06/.06	ND	ND
Calcium	386(B)	498(B)	736(B)	294/786	46,200	23,200
Chromium	6.5(J)	7.1	4.5	4.2/7.9	15.5	5.6
Cobalt	3.7(B)	3.3(B)	ND	0.49/4.7	5.0(B)	3.6(B)
Copper	4.7(B)	4.3(BJ)	3.8(BJ)	3.7/4.9	229	25.3
Iron	6,370	6,740	4,690(J)	4,429/7,437	12,600	13,000
Lead	7.8	7.0	8.1(J)	ND/90	143	67.8
Magnesium	762(B)	976(B)	440(BJ)	355/1,097	4,130	7,450
Manganese	402	421	70(J)	2,579/569	247(J)	171(J)
Mercury	ND	ND	ND	.06/.06	0.39	0.31
Nickel	6.5(B)	7.5(B)	ND	.29/9.8	21.5	6.9(B)
Potassium	252(B)	213(B)	115(B)	96.2/291	193 (B)	327(B)
Selenium	0.25(BJ)	BD	BD	0.23/0.44	0.68(BJ)	0.48(B)
Silver	ND	ND	ND	0.50/0.50	ND	ND
Sodium	ND	ND	ND	5.0/5.0	98.8(B)	71.6(B)
Thallium	ND	ND	ND	0.24/0.24	ND	ND
Vanadium	11.8	11.6	10.4(BJ)	10.2/12.3	13.7	12(B)
Zinc	20.5	22.4	8.4	6.7/27.6	276(J)	94.8(J)
Cyanide	ND	ND	ND	0.60/0.60	11,4(J)	13.7(J)

Qualifiers

ND - Below detection limit
B - Analyte found in the associated blank as well as in the sample
J - Indicates an estimated value
* - Half of the detection limits were used for non-detects

TABLE 4-3

SUMMARY OF VOLATILE ORGANIC COMPOUNDS DETECTED IN SURFACE SOILS
HIMCO DUMP SUPERFUND SITE
ELKHART, INDIANA
1992

Compound	**Background * (ug/kg)**	**Range of Concentrations Detected (ug/kg)**
Methylene Chloride	ND	3(J)-16
Acetone	ND	8(BJ)-140
Carbon Disulfide	ND	0.8(J)
1,1-Dichloroethene	ND	5(J)
2-Butanone	ND	2(J)-8
Tetrachloroethene	ND	6(J)
Trichloroethene	ND	0.9(J)-4(J)
Toluene	8	2(J)-31
Ethyl Benzene	ND	0.7(J)-2(J)
Styrene	ND	0.8(J)
Xylenes (total)	ND	0.7(J)-6
1,2-Dichloroethene (total)	ND	ND
1,1,1-Trichloroethane	ND	ND

Qualifiers

ND - Below detection limit
J - Indicates an estimated value
* - Samples from borings B-02, B-04, and B-06 (0′ to 2′)

TABLE 4-4

SUMMARY OF VOLATILE ORGANIC COMPOUNDS DETECTED IN SOIL SAMPLES FROM TL-3
HIMCO DUMP SUPERFUND SITE
ELKHART, INDIANA
1992

Compound	**2 feet (ug/kg)**	**6 feet (ug/kg)**
Methylene	4(J)	ND
Acetone	ND	77
2-Butanone	ND	21(J)
Benzene	ND	25(J)
Toluene	9(J)	28(J)
Ethyl Benzene	ND	81
Xylenes (Total)	ND	110

Qualifiers

ND - Below detection limit
J - Indicates an estimated value

low ug/kg range (less than 110 ug/kg), similar to ground surface soil samples. In addition, most VOCs and the highest concentrations of VOCs were detected at six feet in TL-3. Benzene was the only VOC not detected at ground surface. Benzene was detected at 25 ug/kg at six feet in TL-3.

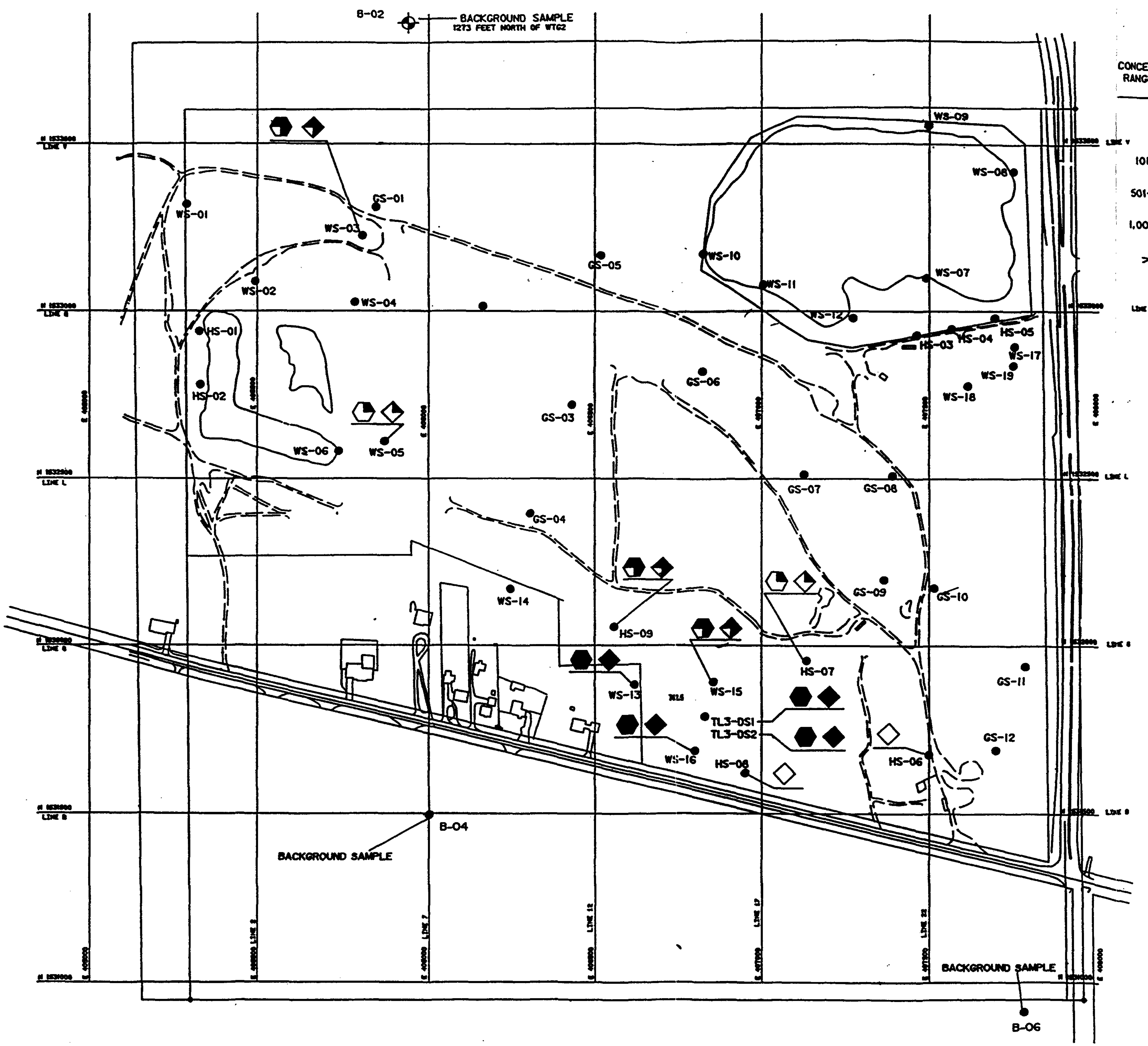
4.2.1.3 Semi-Volatile Organic Compounds (SVOCs)

A summary of the SVOC concentration ranges found in surface soil samples as well as SVOC background data are presented in Table 4-5. Based on this table, 24 SVOCs were detected above detection limits and background concentrations.

Figure 4-3 presents the locations where SVOCs were detected above background concentrations. As shown in this figure, SVOC surface soil contamination was found to be most prominent in samples collected from the south-central edge of the landfill characterized by the non-native soil and construction debris, and at sample location WS-03. Seven of the 18 SVOCs detected above their background concentrations are carcinogenic polyaromatic hydrocarbons (PAHs). The seven carcinogenic PAHs detected are: benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, dibenzo(a,h)anthracene, and indeno(1,2,3-c,d)pyrene. Carcinogenic PAHs were detected above background in five surface soil samples, with the highest level detected in the three samples located near the south central edge of the landfill. The maximum carcinogenic PAH concentration was detected at sample locations WS-16 (14,250 ug/kg). Carcinogenic PAHs were also detected in samples WS-03 and WS-05.

Similarly, seven other SVOCs detected above background are non-carcinogenic PAHs. These seven PAHs are: fluorene, acenaphtene, anthracene, fluoranthene, pyrene, benzo(g,h,i)perylene, and phenanthrene. Non-carcinogenic PAHs were detected above background in the same five surface soil samples as the carcinogenic PAHs. The highest levels of non-carcinogenic PAHs were also detected in the three surface soil samples, where the highest carcinogenic PAHs were detected. The maximum concentration was detected at sample location WS-16 (8,340 ug/kg). Non-carcinogenic PAHs were also detected in samples WS-03 and WS-05.

The remaining 10 SVOCs not shown in Figure 4-3 are: bis(2-ethylhexyl)phthalate, di-n-butylphthalate, 1,4-dichlorobenzene, benzoic acid, naphthalene, 2-methylnaphthalene, dimethylphthalate, dibenzofuran, butylbenzylphthalate, and carbazole.



LEGEND

SEMI-VOLATILE COMPOUNDS

CONCENTRATION RANGE(Ug/Kg)	TOTAL CARCINOGENIC PAHs	TOTAL NON-CARCINOGENIC PAHs
1-100	⬡	◇
101-500	◔	◔
501-1,000	◑	◑
1,001-5,000	◕	◕
>5,000	⬢	◆

CARCINOGENIC PAHs ARE:

benzo(a)anthracene
benzo(a)pyrene
benzo(b)flouranthene
benzo(K)flouranthene
chrysene
di benzo(a,h)anthracene
indeno(1,2,3-c,d)pyrene

NON-CARCINOGENIC PAHs ARE:

flourene
acenaphtene
anthracene
flouranthene
pyrene
benzo(g,h,i)perylene phenanthrene

● WS-18 WETLAND SOIL SAMPLE
● HS-03 HAND AUGER SOIL SAMPLE

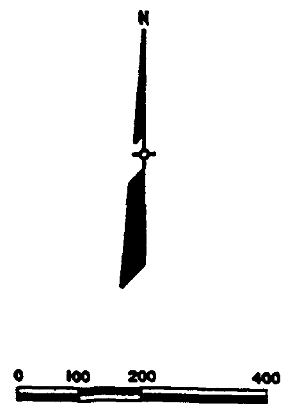


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FIGURE 4-3
SEMI-VOLATILE ORGANIC COMPOUNDS DETECTED IN SURFACIAL SOILS
HIMCO DUMP SUPERFUND SITE
ELKHART, INDIANA

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TABLE 4-5

SUMMARY OF SEMI-VOLATILE COMPOUNDS DETECTED IN SURFACE SOILS
HIMCO DUMP SUPERFUND SITE
ELKHART, INDIANA
1992

Compound	Background * (ug/kg)	Range of Concentrations Detected Above Background (ug/kg)
Naphthalene	ND	18(J)
2-Methylnaphthalene	ND	18(J)
Dimethylphthalate	ND	41(J)
1,4-Dichlorobenzene	80	120(J)-210(J)
Diethylphthalate	80(J)	ND
Benzoic Acid	ND	75(J)
Acenaphthene	ND	59(J)-310(J)
Dibenzofuran	ND	23(J)
Fluorene	ND	43(J)-120(J)
Phenanthrene	ND	42(J)-1,500
Anthracene	ND	82(J)-240(J)
Di-n-butylphthalate	100(J)	92(J)-490(J)
Fluoranthene	ND	17(J)-2,800
Pyrene	ND	34(J)-2,000(J)
Butylbenzylpthalate	ND	300(J)
Benzo(a)anthracene	ND	25(J)-1,300
Chrysene	ND	37(J)-1,600
bis(2-Ethylhexyl)phthalate	93(J)-570(J)	18(J)-7,800(J)
Benzo(b)fluoranthene	ND	67(J)-3,200
Benzo(k)fluoranthene	ND	82(J)-1,700
Benzo(a)pyrene	ND	430(J)-2,200
Indeno(1,2,3-cd)pyrene	ND	230(J)-3,700
Dibenzo(a,h)anthracene	ND	94(J)-550(J)
Benzo(g,h,i)perylene	ND	250(J)-3,500
Carbazole	ND	36(J)
Total Carcinogenic PAHs	ND	138(J)-14,250(J)
Total Non-carcinogenic PAHs	ND	51(J)-8,340(J)

Qualifiers

ND Below detection limit
J - Indicates an estimated value
* - Samples from borings B-02, B-04, and B-06 (0′ to 2′)

Bis(2-ethylhexyl)phthalate was the most frequently detected SVOC being found in 22 surface soil samples above its background concentration of 93 ug/kg. It was detected at a maximum concentration in sample WS-03 (7,800 ug/kg). Di-n-butylphthalate was detected above its background level, which was non-detect, in three surface soil samples. It was detected at a maximum concentration in sample WS-03 (490 ug/kg). 1,4-Dichlorobenzene was detected in the background sample at 80 ug/kg. It was detected above this background level in two surface soil samples and was detected at a maximum in landfill cover sample GS-09 (210 ug/kg). Benzoic acid was detected above its background level, which was non-detect, only in landfill cover sample GS-05 (75 ug/kg). Four SVOCs detected only in surface soil sample HS09 include naphthalene (18 ug/kg), dibenzofuran (23 ug/kg), 2-methylnaphthalene (18 ug/kg), and carbazole (36 ug/kg). These SVOCs were not detected in the background sample.

Two SVOCs detected only in surface soil sample HS06 include butylbenzylphthalate (300 ug/kg) and dimethylphthalate (41 ug/kg). These SVOCs were not detected in the background sample.

In summary, because most SVOCs were detected at levels higher than the background levels, these contaminations may be attributed to the site.

A summary of SVOC concentrations found in soil samples collected from TL-3 is presented in Table 4-6. As shown in this table, 17 SVOCs were detected above detection limits, 16 of which were in ground surface soil samples. Acenaphthylene was the only SVOC detected in TL-3 which was not detected in ground surface soil samples. In addition, SVOCs detected in TL-3 were consistently orders of magnitude higher in concentration than SVOCs detected in ground surface soil samples within 200 feet of TL-3. This holds true for total carcinogenic PAHS and total non-carcinogenic PAHS. Therefore, SVOCs in this area appear to be persistent with depth and at higher concentrations just below ground surface.

4.2.1.4 Pesticides/PCBs

Pesticides were detected in two surface soil samples (WS-15 and HS-09) collected from the construction debris area. 4,4-DDT was detected in sample WS-15 at 64 ug/kg and HS-09 at 12 ug/kg. 4,4-DDE was detected in sample HS-09 at 4.1 ug/kg.

Polychlorinated biphenyls (PCBs) were not detected in any surface soil sample.

TABLE 4-6

SUMMARY OF SEMI-VOLATILE ORGANIC COMPOUNDS
DETECTED IN SOIL SAMPLES
FROM TL-3
HIMCO DUMP SUPERFUND SITE
ELKHART, INDIANA
1992

Compound	**2 feet (ug/kg)**	**6 feet (ug/kg)**
Naphthalene	ND	4,000(J)
Acenaphthylene	5,280(J)	7,700(J)
Acenaphthene	ND	830(J)
Dibenzofuran	1,000(J)	1,700(J)
Fluorene	1,600(J)	630(J)
Phenanthrene	12,000(J)	8,000(J)
Anthracene	4,200(J)	3,800(J)
Fluoranthene	33,000(J)	27,000(J)
Pyrene	15,000(J)	5,900(J)
Benzo(a)anthracene	13,000(J)	13,000(J)
Chrysene	19,000(J)	15,000(J)
Benzo(b)fluoranthene	26,000(J)	22,000(J)
Benzo(k)fluoranthene	13,000(J)	15,000(J)
Benzo(a)pyrene	7,600(J)	2,900(J)
Indeno(1,2,3-cd)pyrene	4,200(J)	1,900(J)
Dibenzo(a,h)anthracene	1,800(J)	2,200(J)
Carbazole	900(J)	480(J)
Carcinogenic PAHs	84,600(J)	72,000(J)
Non-Carcinogenic PAHs	65,800(J)	46,160(J)

Qualifiers

ND Below detection limit
J - Indicates an estimated value

4.2.2 Subsurface Soil

Thirty-three subsurface soil samples were collected for chemical analysis on or next to the Himco site at depths ranging from 0 to 16 feet below ground surface. Sampling activity descriptions are provided in Section 2.3.

4.2.2.1 Inorganic Analytes

In general, inorganic concentrations were relatively low. A summary of arsenic and beryllium concentration ranges at various boring depth intervals is presented in Table 4-7. The background data for inorganic analytes are presented in Table 4-2. Figure 4-4 presents the locations where arsenic and beryllium were detected.

Based on Figure 4-4, arsenic appears to be detected at all boring locations and is vertically persistent. However, concentrations varied between depth intervals and there is no consistent distribution pattern. The highest concentrations of arsenic were detected in B-04 which is considered a background sample at a concentration of 5.6 mg/kg. Beryllium was detected in relatively fewer borings and depths. Beryllium was not detected in B-01 and B-06. Both arsenic and beryllium were detected in off-site borings B-02, B-04, and B-06 in all depth intervals at concentrations ranging from 0.28 ug/l to 5.6 mg/l for arsenic and 0.32 mg/l to 0.69 mg/l for beryllium. Based on these data, arsenic and beryllium may be naturally occurring in subsurface soils in the area.

4.2.2.2 Volatile Organic Compounds (VOCs)

A summary of the VOC concentration ranges found in subsurface soil samples is presented in Table 4-8. The background data for VOCs are presented in Table 4-3.

Six VOCs were detected above detection limits and background levels. These include: methylene chloride, acetone, carbon disulfide, 1,1-dichloroethene, and 1,2-dichloroethane (total).

Figure 4-5 presents total VOC concentrations detected in each sampling interval of each boring drilled during the RI. The highest concentration of VOCs in subsurface soils is at boring B-06.

Total VOCs between 501 and 1,000 ug/kg were detected in samples collected from 4- to 6-foot, 12- to 14-foot, and 14- to 16-foot intervals in boring B-06. Acetone was the major contributor to the total VOC concentrations found in these depth intervals. It was detected at the following concentrations in boring B-06: 4- to 6-foot interval (780 ug/kg), 12- to 14-foot interval (950 ug/kg), and 14- to 16-foot interval (500 ug/kg).

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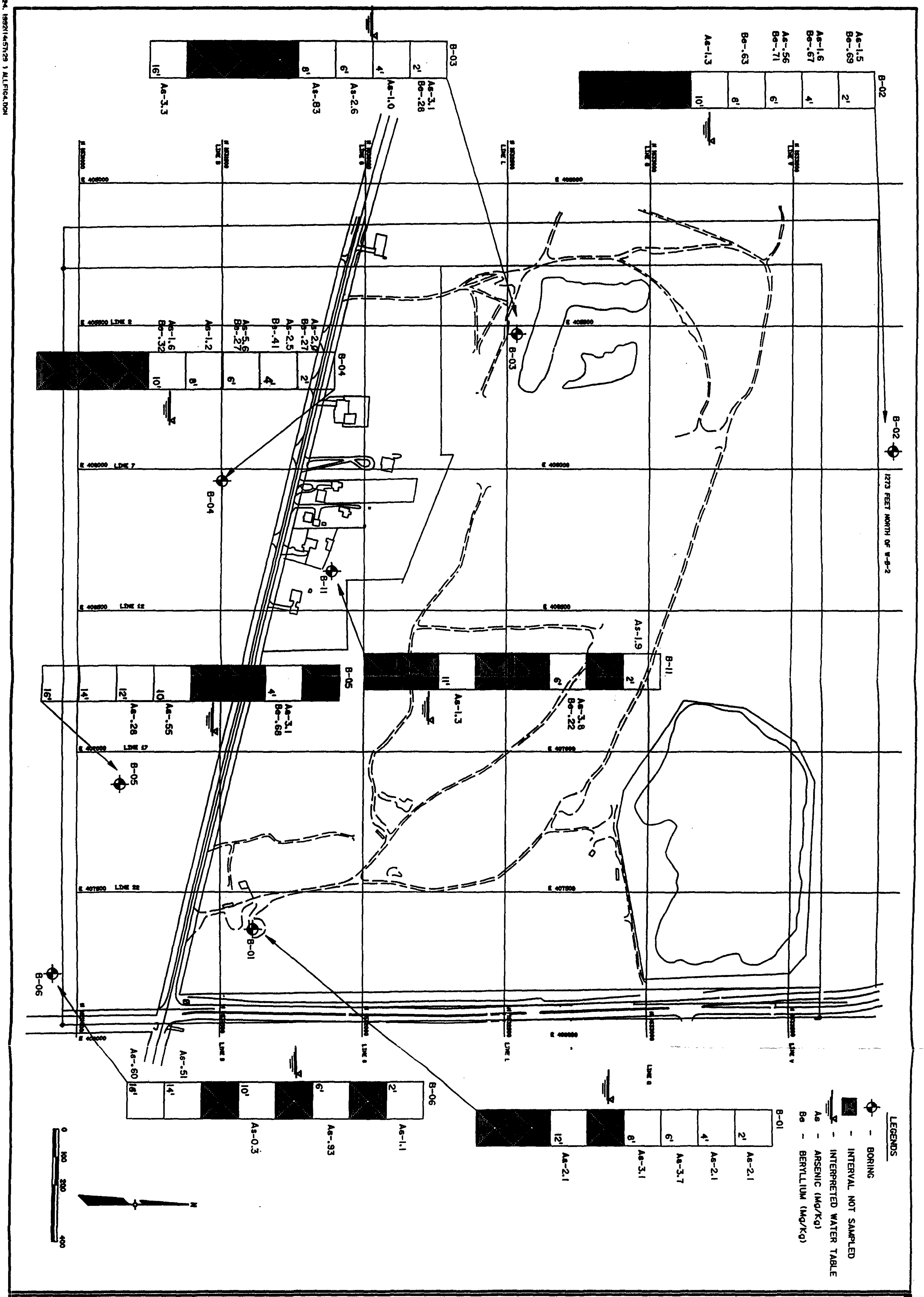

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FIGURE 4-4
ARSENIC & BERYLLIUM CONCENTRATIONS IN SUBSURFACE SOILS
HIMCO DUMP SUPERFUND SITE
ELKHART, INDIANA

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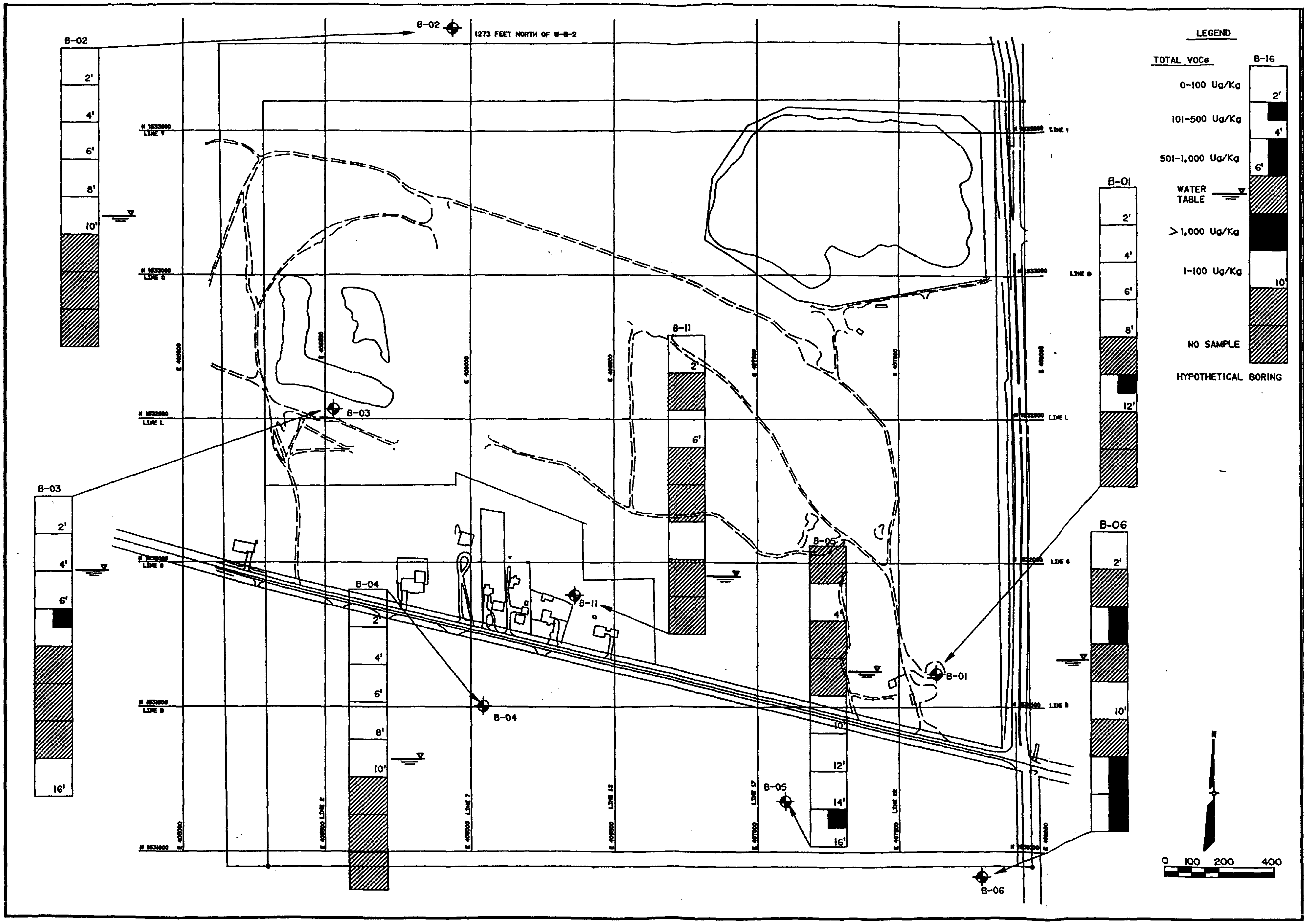

FIGURE 4-5

VOCs DETECTED IN SUBSURFACE SOILS

HIMCO DUMP SUPERFUND SITE
ELKHART, INDIANA

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Project No. 20026
4-5
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TABLE 4-7

SUMMARY OF ARSENIC AND BERYLLIUM DETECTED IN SUBSURFACE SOILS
HIMCO DUMP SUPERFUND SITE
ELKHART, INDIANA
1992

	RANGE OF CONCENTRATIONS DETECTED (MG/KG) AT DEPTH (FT)							
ANALYTE	0-2	2-4	4-6	6-8	8-10	10-12	12-14	14-16
Arsenic	1.1(BJ)-3.1	1.0(B)-3.1	0.56(B)-5.6	0.83(BJ)-3.1	0.30(BJ)-1.6(B)	0.28(BJ)-2.1(B)	0.51(BJ)	0.60(BJ)-3.3(J)
Beryllium	0.27(BJ)-0.69(BJ)	0.41(BJ)-0.68(BJ)	0.27(BJ)-0.71(BJ)	0.63(BJ)	0.32(BJ)	ND	ND	ND

Qualifiers

ND - Not Detected above detection limits
B - The reported value is less than the contract required detection limit, but greater than the instrument detection limit
J - Indicates an estimated value

TABLE 4-8

SUMMARY OF VOLATILE ORGANIC COMPOUNDS DETECTED IN SUBSURFACE SOILS
HIMCO DUMP SUPERFUND SITE
ELKHART, INDIANA
1992

COMPOUND	RANGE OF CONCENTRATIONS DETECTED (UG/KG) AT DEPTH (FT)							
	0-2	2-4	4-6	6-8	8-10	10-12	12-14	14-16
Methylene Chloride	3(J)-4(J)	3(J)	4(J)-55(DJ)	4(J)	4(J)	ND	43(DJ)	ND
Acetone	ND	42(J)	9(J)-780(DJ)	15-120	45(J)-68(J)	110	89(J)-950(DJ)	17-500(EJ)
Carbon Disulfide	ND	4(J)	30(DJ)	ND	ND	ND	ND	ND
1,1 - Dichloroethene	ND	4(J)-5(J)	4(J)	5(J)-12	11-13	ND	ND	ND
1,2 - Dichloroethene (total)	ND	ND	ND	ND	ND	ND	ND	1(J)
1,1,1 - Trichloroethane	2(J)	ND	ND	ND	ND	ND	ND	3(J)
Toluene	2(J)-8	2(J)-4(J)	3(J)-4(J)	4(J)	5(J)-9	5(J)	ND	3(J)-43

Qualifiers

ND - Below detection limit
J - Indicates an estimated value
D - Indicates compounds indentified in an analysis at a secondary dilution factor
E - Compound concentration exceeded the calibration range of the GC/MS

In summary, because no VOCs were detected in the background samples, VOC contamination in the site subsurface soils may be attributed to the site contamination.

4.2.2.3 Semi-Volatile Organic Compounds (SVOCs)

A summary of SVOC concentration ranges found in subsurface soil samples is presented in Table 4-9. The background data for SVOCs are presented in Table 4-5. Bis(2-ethylhexyl)phthalate, di-n-butylphthalate, diethylphthalate, and 1,4-dichlorobenzene were detected at or above the background levels for these compounds. Neither carcinogenic PAHs nor non-carcinogenic PAHs were detected in any of the 35 subsurface soil samples collected.

Figure 4-6 presents the locations where SVOCs were detected. Bis(2-ethylhexyl)phthalate was the most common SVOC detected, occurring in 14 of the 35 subsurface soil samples collected. The maximum concentration detected was in the sample collected from 6 to 8 feet in boring B-01 (6,600 ug/kg). The maximum concentration of bis(2-ethylhexyl)phthalate detected in borings B-04, B-05, and B-06, was in the sample interval collected at or beneath the water table.

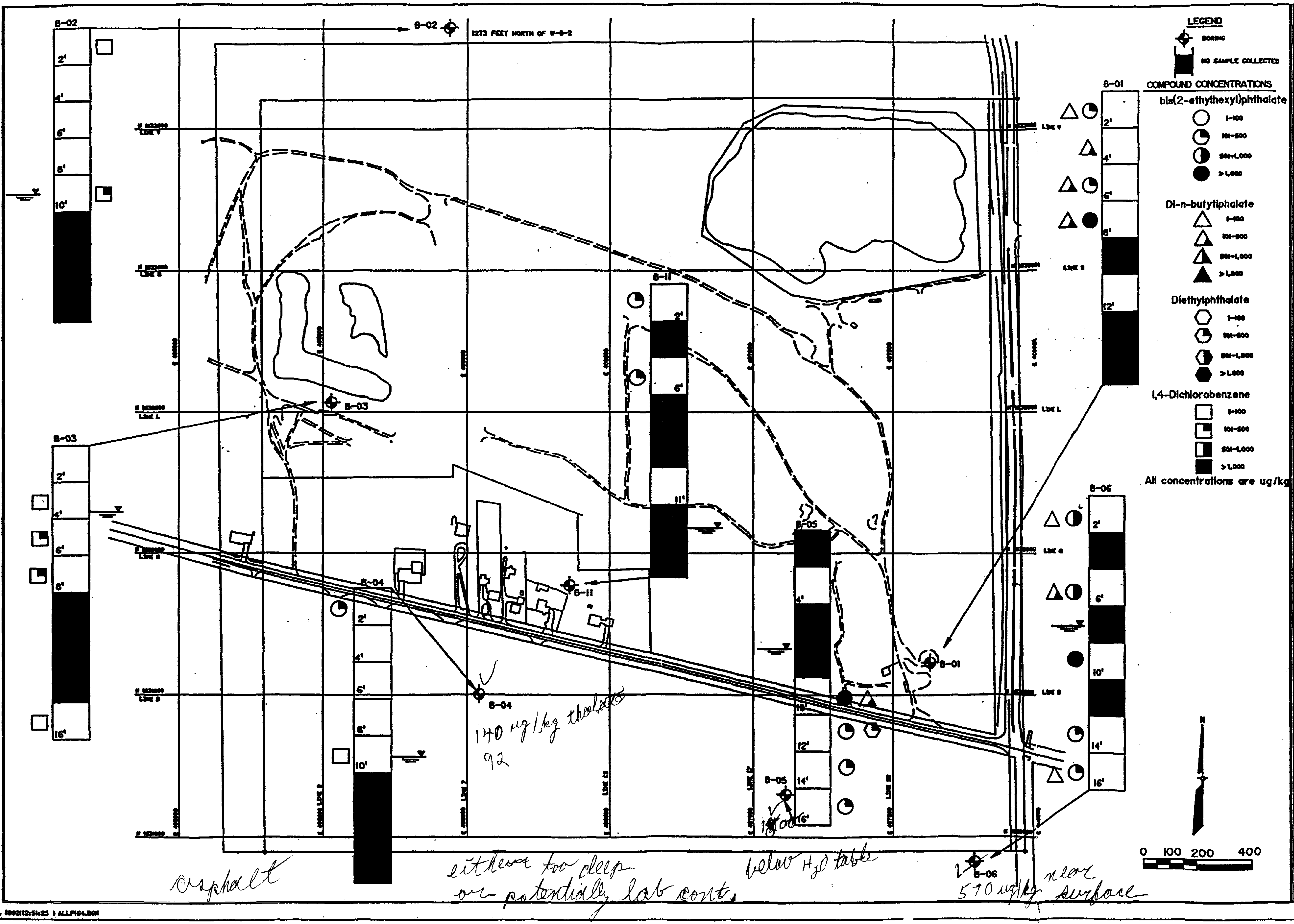
Di-n-butyl phthalate was detected in seven subsurface soil samples. It was detected at a maximum concentration in the sample collected from the 6- to 8-foot interval in boring B-01 (310 ug/kg). Diethylphthalate was detected only in the subsurface soil sample collected from the 10- to 12-foot interval in boring B-05 (140 ug/kg).

4.2.2.4 Pesticides/PCBs

Pesticides or PCBs were not detected in any subsurface soil samples collected during the RI.

4.3 GROUNDWATER

Groundwater was sampled from three well groups: EPA wells, USGS wells, and residential wells. Two rounds of groundwater samples were collected from EPA and USGS wells. EPA wells sampled were installed during the Himco site RI. USGS wells sampled were installed in 1977 and 1979 as part of a hydrogeologic study of Elkhart County (USGS, 1981). Shallow residential wells were installed approximately 20 to 25 years ago. Deep residential wells were installed in the late 1970s. Sampling activities are described in Section 2.7. The following sections discuss contamination found in EPA and USGS wells during both rounds of sampling, followed by a separate section discussing contamination



140 ug/kg thalate
92

1900

asphalt

either too deep
or potentially lab cont.

below H₂O table

570 ug/kg near surface

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FIGURE 4-6
SEMI-VOLATILE COMPOUNDS DETECTED IN SUBSURFACE SOILS

HIMCO DUMP SUPERFUND SITE
ELKHART, INDIANA

Off. Loc. Chicago
File No.
4-6

Apr. 28, 1992(12:54:25) ALLFIG4.DGN

TABLE 4-9

SUMMARY OF SEMI-VOLATILE COMPOUNDS DETECTED IN SUBSURFACE SOILS
HIMCO DUMP SUPERFUND SITE
ELKHART, INDIANA
1992

COMPOUND	RANGE OF CONCENTRATIONS DETECTED (UG/KG) AT DEPTH (FT)							
	0-2	2-4	4-6	6-8	8-10	10-12	12-14	14-16
1,4-Dichlorobenzene	80(J)	81(J)-100(J)	75(J)-120(J)	120(J)	92(J)-110(J)	ND	ND	100(J)
Diethylphthalate	ND	ND	ND	ND	ND	140(J)	ND	ND
Di-n-butylphthalate	86(J)-100(J)	130(J)	130(J)-140(J)	310(J)	310(J)	120(J)	ND	92(J)
bis(2-Ethylhexyl)phthalate	65(J)-570(J)	42(J)-73(J)	38(J)-560(J)	6,600	1,800-4,000	340(J)	130(J)-190(J)	63(J)-320(J)

Qualifiers

ND - Below detection limts
J - Indicates an estimated value

found in residential wells. The discussion of groundwater contamination in EPA and USGS wells is divided into shallow and deep wells. Residential wells are discussed separately because of uncertainties concerning their integrity and problems with developing these wells before sampling.

The discussion on inorganic analytes is focused on arsenic, beryllium, and antimony. These analytes were listed in the baseline risk assessment as contributing to excess cancer risk above 1 in 1 million (1×10^{-6}) or a hazard index greater than one in the groundwater medium. Contaminants which posed unacceptable risk in the landfill groundwater scenario were primarily found in leachate from the landfill, and therefore, are not the focus of discussion in this section.

For both organic and inorganic contaminants, background levels were presented and discussed in relation to on-site contaminant levels. Background levels were determined from wells which were hydraulically upgradient to the site. These wells included shallow wells WTB2 and WT102A and deep wells WTP102B, WTP02C, WTB3, and WTB4. On-site shallow and deep wells were compared to the corresponding shallow and deep background wells.

4.3.1 EPA and USGS Shallow Wells

During the first round of sampling, five EPA and 11 USGS shallow wells hydraulically downgradient or sidegradient from the Himco site were sampled. During round 2, six EPA and four USGS shallow wells were sampled.

4.3.1.1 Inorganic Analytes

A summary of concentration ranges found in shallow EPA and USGS wells is presented in Table 4-10. Figures 4-7 and 4-8 provide the sample location and concentrations of arsenic, beryllium, and antimony found during round 1. Figure 4-9 provides these data for round 2 sampling.

Figures 4-7 and 4-8 show that downgradient wells near the southeast corner of the site have been impacted by arsenic and antimony. Arsenic concentrations did not exceed Maximum Contaminant Levels (MCLs) as established by the Safe Drinking Water Act, except in WTE2. Here, arsenic was detected at 54.5 ug/l, compared to the MCL of 50 ug/l. Well WTE2 showed the highest concentration of arsenic (54.5 ug/l) and beryllium (5.4 ug/l). The highest concentration of antimony (62.5 ug/l) was detected in shallow well WTI. Arsenic and antimony were not found above detection limits in shallow background wells. Beryllium was detected in shallow background well WT102A at 3.1 ug/l during round 1. Therefore, it is possible that the beryllium contamination found in shallow wells in this area is not site-related.

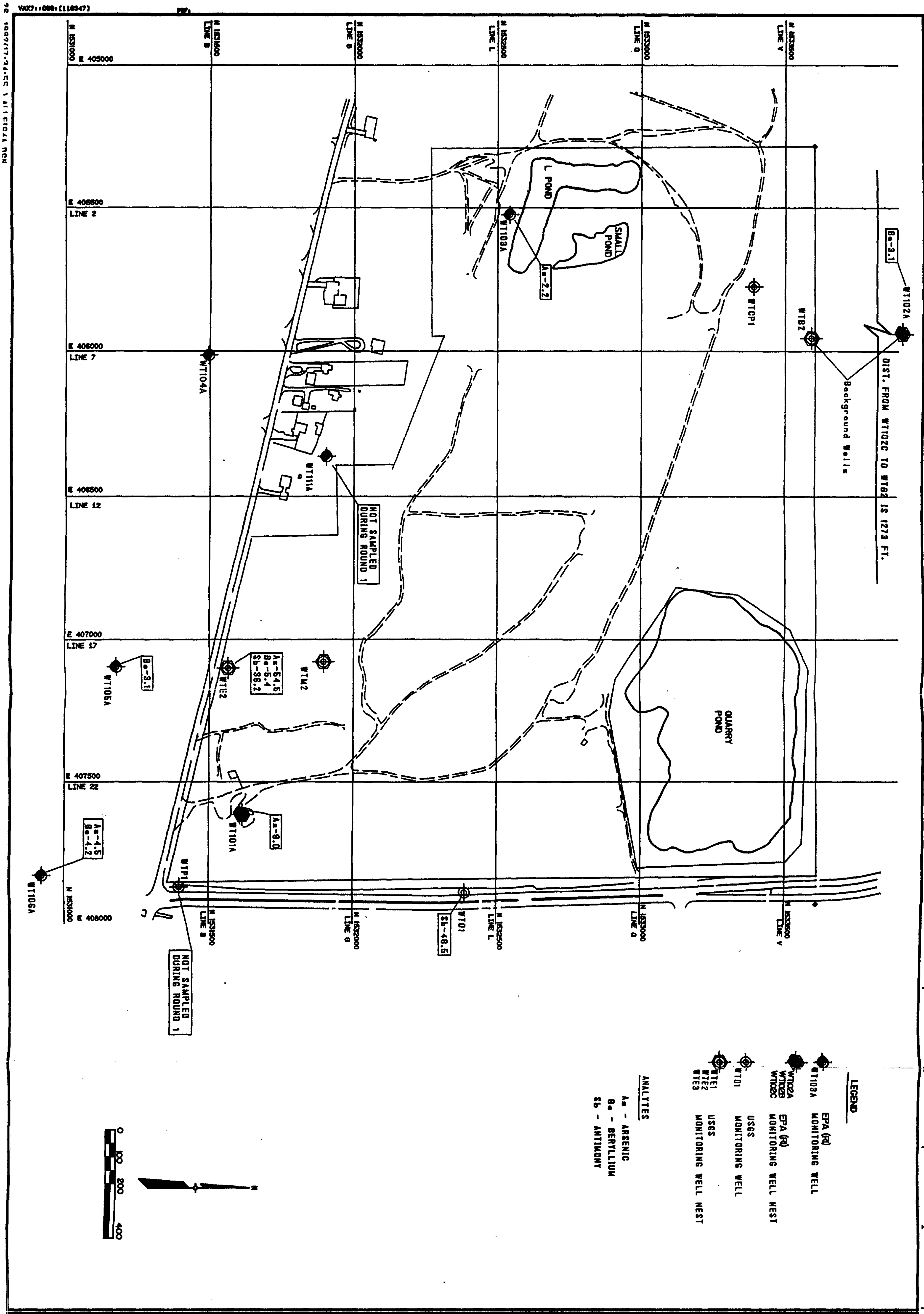

FIGURE 4-7
ARSENIC, BERYLLIUM & ANTIMONY CONCENTRATIONS (ug/L)
DETECTED IN SHALLOW USEPA & USGS WELLS SAMPLED-ROUND 1
HIMCO DUMP SUPERFUND SITE
ELKHART, INDIANA

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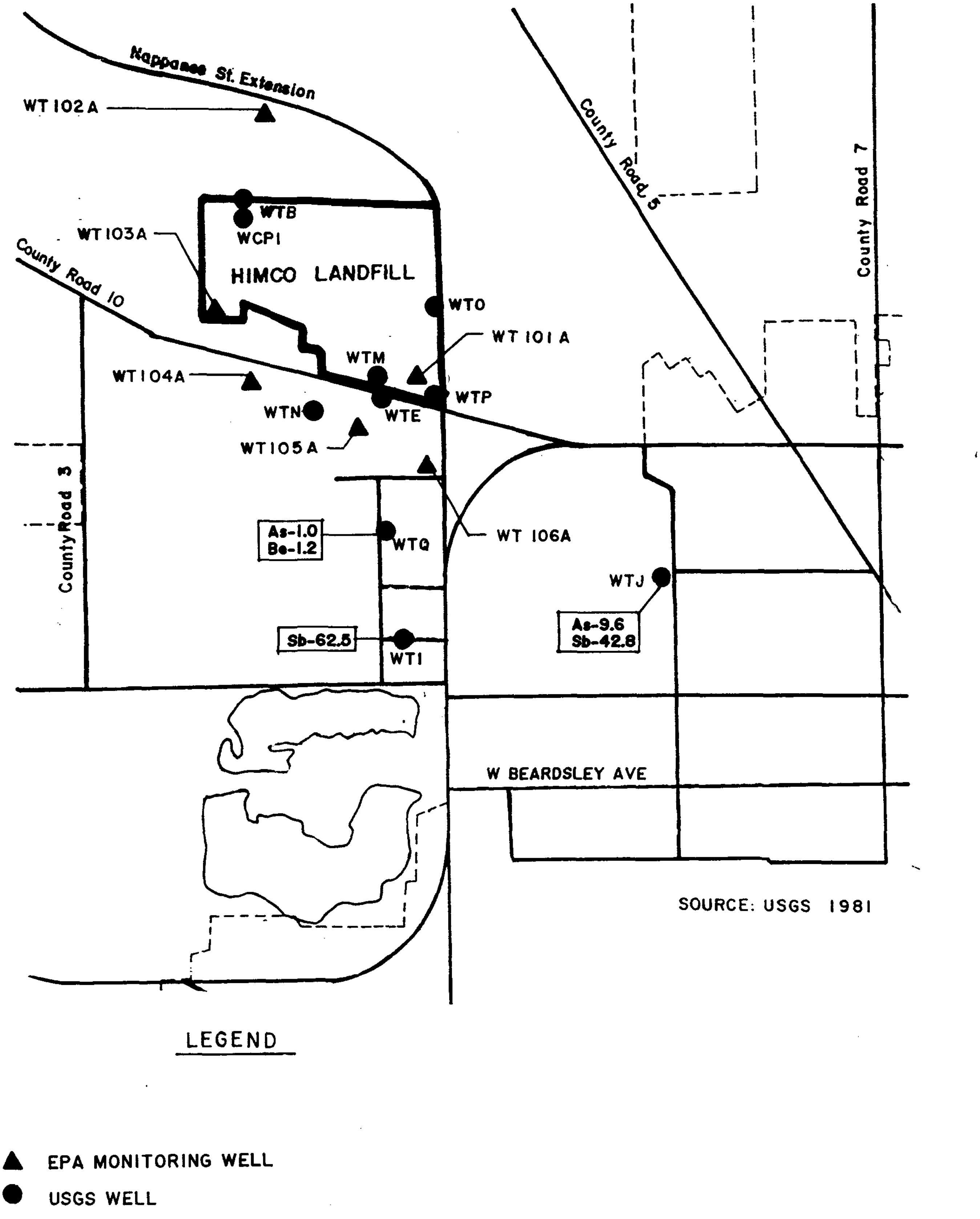
Project No. 20026.030
Drawing No. 4-7



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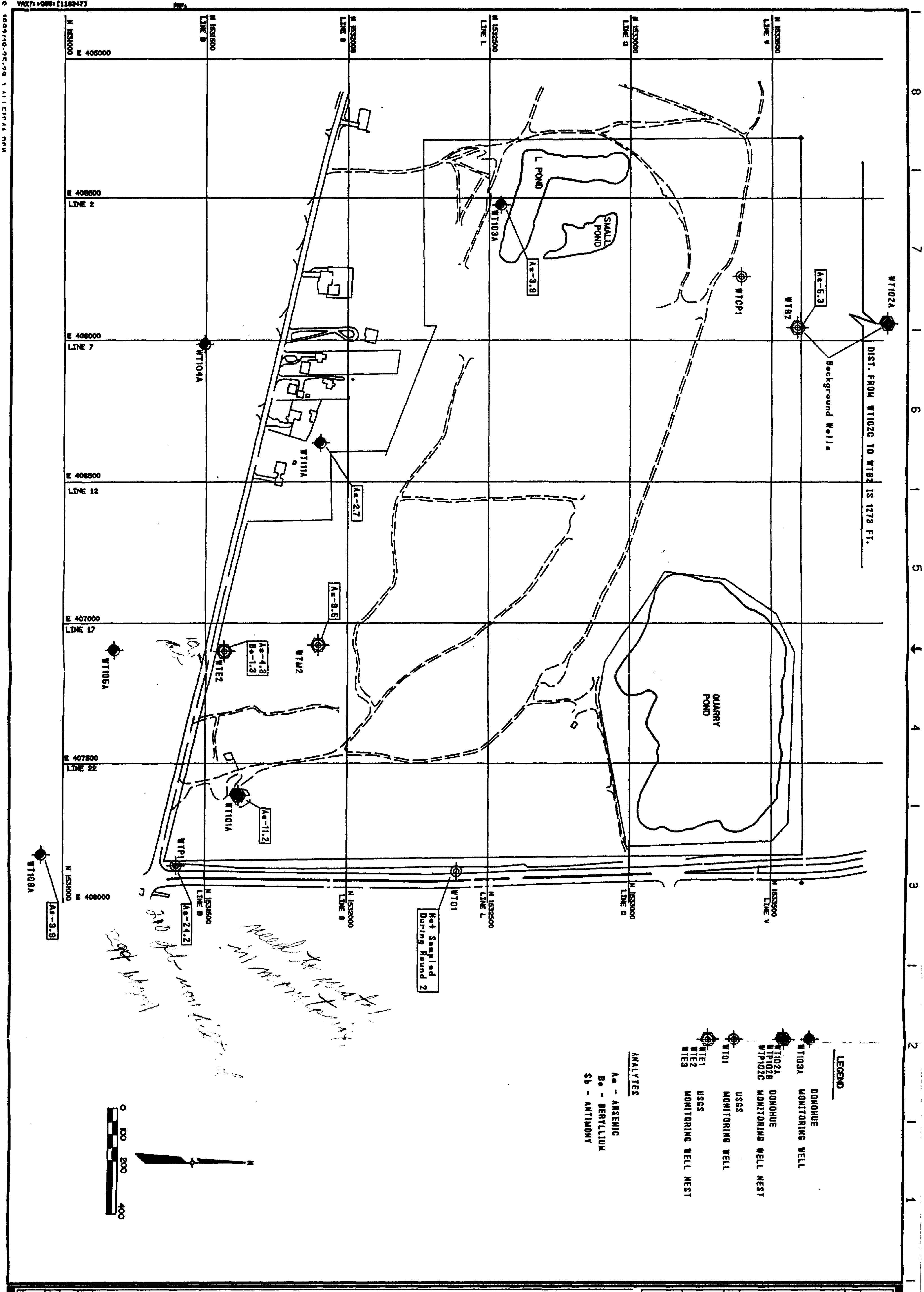
ARSENIC, BERYLLIUM, AND ANTIMONY CONCENTRATIONS(μg/l) DETECTED IN SHALLOW OFF-SITE USGS WELLS-ROUND I

HIMCO DUMP SITE
ELKHART, INDIANA

FIGURE 4-8



need to match [illegible] in monitoring [illegible]

200 ft monitoring [illegible]

200 ft [illegible]

FIGURE 4-9
ARSENIC, BERYLLIUM & ANTIMONY CONCENTRATIONS (ug/L)
DETECTED IN SHALLOW USEPA & USGS WELLS SAMPLED-ROUND 2
HIMCO DUMP SUPERFUND SITE
ELKHART, INDIANA

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Project No. 20026.030
Drawing No. 4-9

TABLE 4-10

SUMMARY OF INORGANIC ANALYTES (TOTAL) DETECTED
IN SHALLOW EPA AND USGS WELLS
HIMCO DUMP SUPERFUND SITE
ELKHART, INDIANA
1992

Analyte	MCL (ug/l)	Background Concentration Range (ug/l)		Range of Concentrations in Downgradient Wells (ug/l)	
		Round 1	Round 2	Round 1	Round 2
Aluminum	-	81.5-695	166(BJ)-6930	23.6(B)-113,000	77.1(BJ)-25,500
Antimony	-	ND	ND (BJ)	31.2(B)-62.5	ND
Arsenic	50	ND	5.3(BJ)	1.0(B)-54.5	2.7(B)-24.2
Barium	1,000	22.5-65.5	56.5(B)-125(B)	6.4(B)-510	8.2(B)-218
Beryllium	-	3.1	ND	1.2(B)-5.4	1.3
Cadmium	10	ND	ND	ND	1.3-3.0(BJ)
Calcium	-	77,700-211,000	138,000-165,000	14,100-217,000	15,300-361,000
Chromium	50	6.5-20.9	2.8-24.6	4.3(BJ)-354	2.2-45.3
Cobalt	-	ND	25.4	5.7(B)-28.6(B)	3.1-11.4
Copper	(SMCL) 1,000	8.7-16.7	31.0	3.7(B)-139	16.6-79.8
Iron	(SMCL) 300	123-1,240	60.8(B)-17200	56.5(BJ)-39,300	29.4-78,500
Lead	15@	2.2*	91.2*	1.1(BJ)-106(J)*	6.8-210*
Magnesium	(SMCL) 50	11,200-25,100	20,300-32,900	2,650(B)-41,700	6,350-78,000
Manganese	-	38.1-99.9	9.2(B)-1,870	3.7(B)-2,070	9.2(B)-3590
Mercury	2	ND	ND	0.20(J)-1.0(J)	ND
Nickel	-	ND	47.5	79.4-111	7.10(B)-36.6(B)
Potassium	-	2,110	1,730(B)-2,120(B)	468(B)-12,900	1,090(B)-13,900
Selenium	10	2.4	ND	2.1(B)-33.0	ND
Silver	50	ND	ND	6.9(B)-18.4(J)	ND
Sodium	-	4,690-48,600	5,490-50,700(J)	1,850(B)-78,800	3,380(BJ)-52,300(J)
Thallium	-	ND	ND	ND	ND
Vanadium	-	ND	26.8(B)	4.5(BJ)-106	3.8(B)-12.5(B)
Zinc	(SMCL) 5,000	13.9-24.1	79	6.1(BJ)-390(J)	17(B)-13,600
Cyanide	-	ND	ND	ND	ND

[illegible] data [illegible]

Qualifiers

ND- Below detection limit
B - The reported value is less than the contract required detection limit, but greater than the instrument detection limit.
J - Indicates an estimated value
* - Filtered sample showed concentrations less than the corresponding MCLs.
@ - Enforceable action level effective July 1992.
\- No data are available.

Overall, inorganic analytes detected in filtered samples from round 1 were similar in concentrations to unfiltered samples, except for USGS well WTE2. The majority of filtered metal concentrations detected in WTE2 were orders of magnitude lower than the unfiltered samples from this well. For example, lead and arsenic were detected in the unfiltered sample at 106 ug/l and 54.5 ug/l, respectively. Lead was detected in the filtered sample at 2.1 ug/l. Arsenic was not detected in the filtered sample. In addition, the total suspended solid concentration detected in WTE2 was 350 mg/l. Therefore, it is suspected that contamination in this well in the unfiltered sample appears to be associated with suspended solids. For other wells with high suspended solids, this is also generally true. For well WTB2, the total suspended solids level was 678 mg/l; the lead level in this well was 57.1 to 101 ug/l. For well WTM2, the total suspended solids level was 264 mg/l; the lead level was 20.0 ug/l. For well WTP1, the total suspended solids level was 572 mg/l; the lead level was 32.1 to 210.0 ug/l. Total lead was also detected in background well below the MCL at 2.2 ug/l. Lead was not detected in the filtered sample from this same well. In general, filtered concentrations did not exceed MCLs.

During round 2, arsenic was detected in downgradient wells near the southeast corner of the site, similar to round 1 (Figure 4-9). Arsenic concentrations were below MCLs. The highest concentration of arsenic was detected in well WTP1 at 24.2 ug/l. Arsenic was also detected in shallow background well WTB2 at 5.3 ug/l. During round 2, beryllium was detected only in well WTE2 at 1.3 ug/l. Antimony was not detected in downgradient wells during round 2.

Overall, Round 2 filtered samples were similar in concentration to unfiltered samples. Lead was detected in the unfiltered samples at a higher concentration of 210 ug/l. However, it is suspected that high lead concentrations were associated with suspended solids, similar to round 1. Total lead was detected above the MCL in seven wells. A background concentration of total lead was also detected at 91.2 ug/l. However, filtered lead concentrations in those same wells were below MCLs or not detected.

4.3.1.2 Volatile Organic Compounds (VOCs)

A summary of round 1 and round 2 concentration ranges detected in shallow EPA and USGS wells is presented in Table 4-11. Table 4-11 also lists concentrations of each compound detected in trip blanks for each round. Eleven VOCs were detected above detection limits from both rounds of sampling. VOCs detected in groundwater from both rounds were consistently in the low ug/l range (less than 20 ug/l). One exception to this was acetone. Acetone ranged from 9-240 ug/l during round 1. However, acetone was also detected in the trip blanks at 53 ug/l during round 1 and in one method blank at 23 ug/l. Therefore, acetone could be considered to be associated with laboratory contamination.

TABLE 4-11

SUMMARY OF VOLATILE ORGANIC COMPOUNDS DETECTED IN SHALLOW EPA AND USGS WELLS
HIMCO DUMP SUPERFUND SITE
ELKHART, INDIANA
1992

Compound	MCL (ug/l)	Range of Concentrations Detected (ug/l) Round 1	Round 2	Trip Blanks (ug/l) Round 1	Round 2
Acetone	-	9(J)-240(E)	ND	53	8
Benzene	5	0.9(J)-3	1(J)-3(J)	.02	ND
Chlorobenzene	-	0.9(J)	ND	2(J)	ND
Chloroethane	-	2(J)	ND	ND	ND
Chloroform	-	1(J)	2(J)-6(J)	2(J)	1
1,1-Dichloroethane	-	3(J)	3(J)	ND	ND
1,2-Dichloroethene (total)	-	5(J)-6(J)	5(J)	ND	ND
2-Hexanone	-	0.7(J)	ND	ND	ND
Methylene Chloride	-	1(BJ)-19(J)	ND	24	ND
1,1,1-Trichloroethane	200	0.8(J)-8	ND	ND	ND
Trichloroethene	5	2(J)-42	ND	ND	ND

Qualifiers

ND - Below detection limits
J - Indicates an estimated value
E - Identifies compounds whose concentrations exceeded the calibration range of the GC/MS instrument for that specific analysis
B - Compound was found in the associated blank as well as in the sample

A/R/HIMCO/AJ2

Figures 4-10 and 4-11 provide the sampling locations and concentrations for VOCs detected in round 1 sampling. It appears that downgradient wells near the southeast corner of the site have been impacted by VOC contaminants similar to the trend found for arsenic, beryllium, and antimony. VOCs were also detected in WTCP1 near the northwest corner of the site. In general, no plume was interpreted. VOCs detected include benzene, chlorobenzene, 1,1-dichloroethane, 1,2-dichloroethene, 2-hexanone, 1,1,1-trichloroethane, and trichloroethene. However, except for trichloroethene at 42 ug/l, VOCs detected were less than 10 ug/l and, for those compounds for which MCLs exist, they were below MCLs. Trichloroethene was detected at 42 ug/l in USGS well J. However, this well is approximately 2,000 feet south and 2,000 feet east of the landfill and is possibly sidegradient to ground flow in the landfill area. Other sources may be responsible for this contamination.

Figure 4-12 shows the sampling locations and concentrations of compounds detected during round 2. Round 2 data confirmed that downgradient wells near the southeast corner of the site have been impacted by VOCs. Chloroform was the only VOC detected in WTCP1 during round 2. All VOCs detected during round 2 were also detected during round 1. Compounds detected in wells during round 1 which were not detected during round 2 include chlorobenzene, chloroethane, 1,1,1-trichloroethane, 2-hexanone, trichloroethene, and methylene chloride.

Based on these data, there is minimal site-related VOC impact to the shallow zone of the aquifer downgradient of the site.

4.3.1.3 Semi-Volatile Organic Compounds (SVOCs)

Table 4-12 summarizes the SVOCs detected during rounds 1 and 2 in downgradient shallow EPA and USGS wells. Four SVOCs were detected in shallow groundwater samples. The most persistent SVOC was bis(2-ethylhexyl)phthalate. This compound was detected in both rounds ranging in concentration from 2 ug/l to 110 ug/l. This compound was also detected in a field blank at 9 ug/l. However, this compound is a common laboratory contaminant. In addition, phthalates in general are a common additive to plastic materials. Plastic material such as tubing and gloves were used during sample collection. Therefore, their presence may be attributable to cross-contamination. Other SVOCs detected were generally infrequent and detected at concentrations less than 20 ug/l.

No SVOCs were detected in shallow background wells. Naphthalene was detected in shallow well B2 at 2 ug/l during round 2. However, naphthalene was not detected in any downgradient well. Based on these data, the impact of site-related SVOCs on the shallow zone of the aquifer downgradient of the site appears to be minimal.

TABLE 4-12

SUMMARY OF SEMI-VOLATILE ORGANIC COMPOUNDS DETECTED IN SHALLOW EPA AND USGS WELLS
HIMCO DUMP SUPERFUND SITE
ELKHART, INDIANA
1992

Compound	Downgradient Well Detected Round 1	Downgradient Well Detected Round 2	Concentration (ug/l) Round 1	Concentration (ug/l) Round 2
Diethylphthalate	WT101A	WT101A	2	20
Butylbenzylphthalate	Q1	-	11	ND
Bis(2-ethylhexyl)phthalate	I2, G1	M2, CP1, E2 WT104A, WP101A, P1, WT103A	8, 6	110, 29, 16, 10, 4, 3, 2
Di-n-octylphthalate	WT104A	-	8	-
Phenol	-	M2	ND	2

ND - Below detection limit
- No data

A/R/HIMCO/AJ2

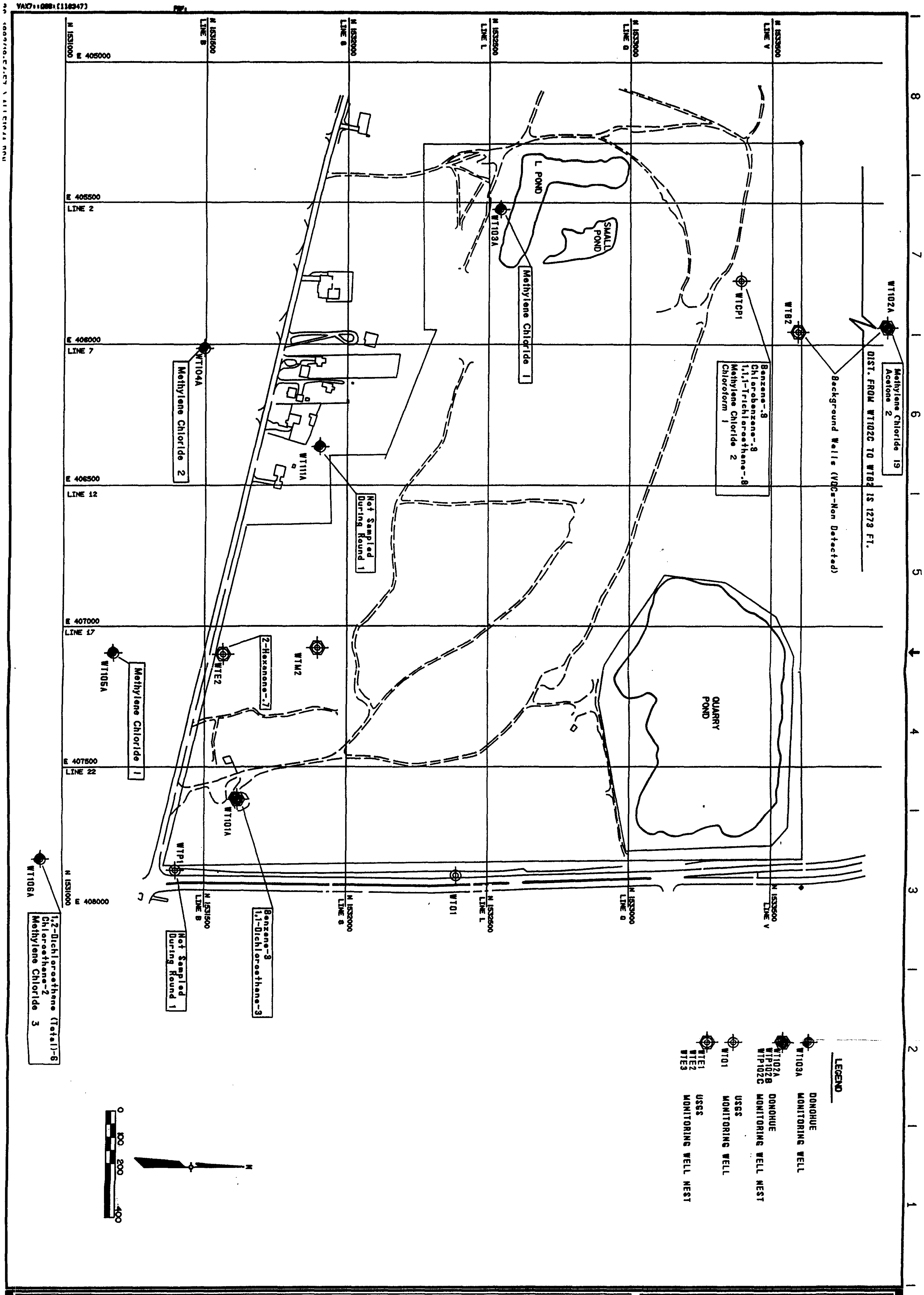

FIGURE 4-10
VOLATILE ORGANIC COMPOUND CONCENTRATIONS (ug/L)
DETECTED IN SHALLOW USEPA & USGS WELLS SAMPLED-ROUND 1
HIMCO DUMP SUPERFUND SITE
ELKHART, INDIANA

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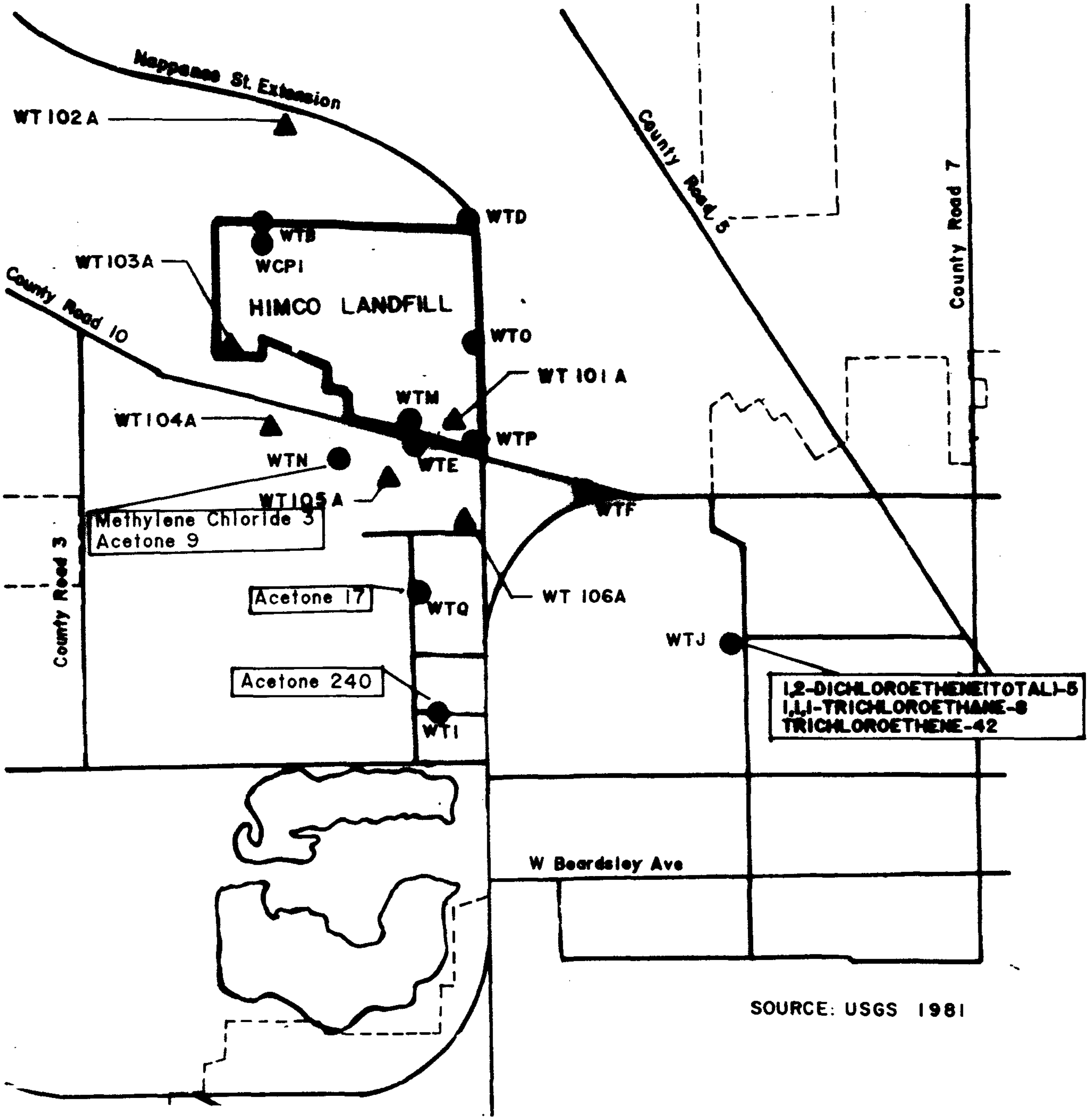

SOURCE: USGS 1981

LEGEND

▲ EPA MONITORING WELL

● USGS WELL

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VOLATILE ORGANIC CONCENTRATIONS(μg/l)
DETECTED IN SHALLOW OFF-SITE USGS
WELLS-ROUND I
HIMCO DUMP SITE
ELKHART, INDIANA

N

FIGURE 4-11

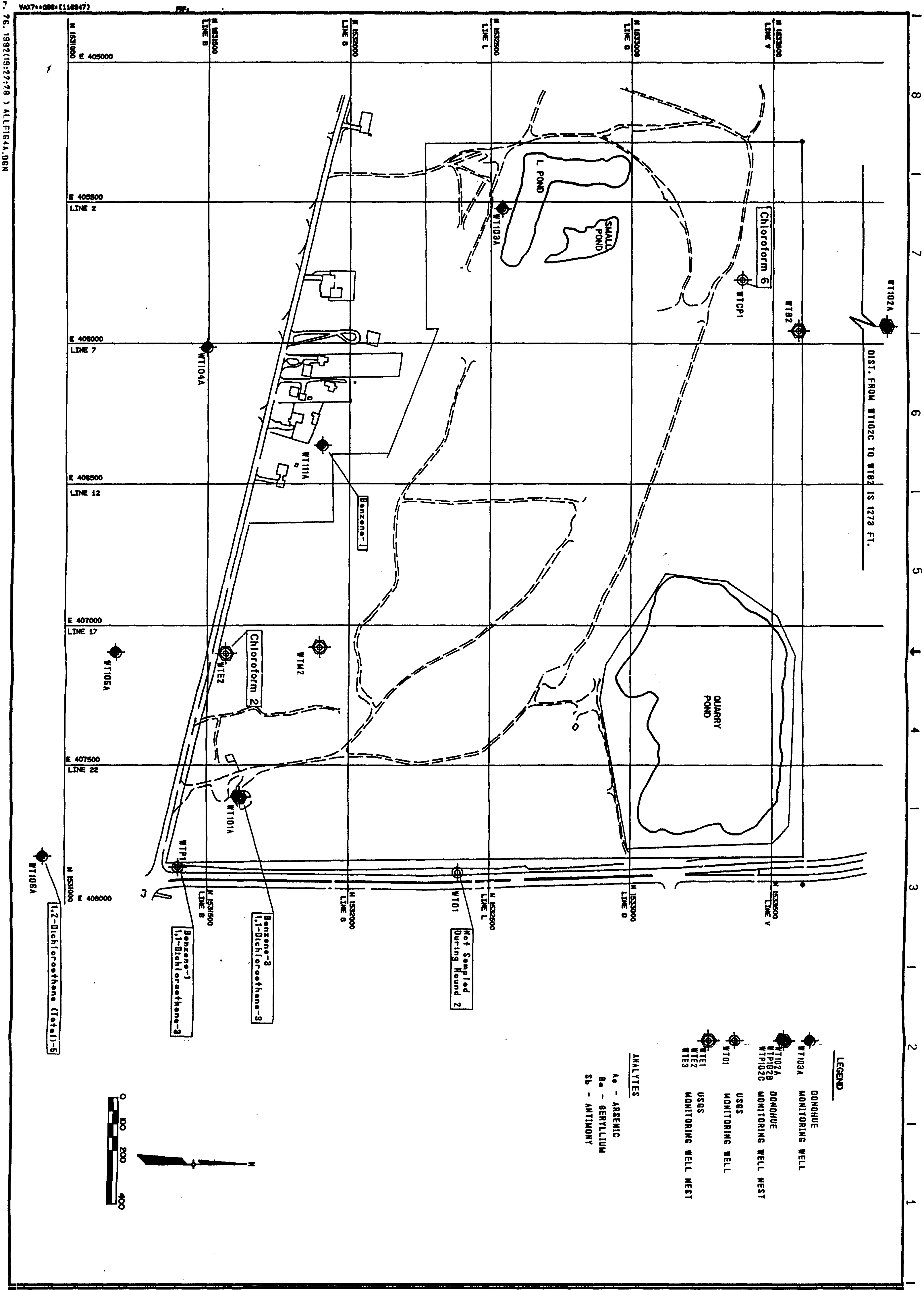

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FIGURE 4-12
VOLATILE ORGANIC COMPOUND CONCENTRATIONS (ug/L)
DETECTED IN SHALLOW USEPA & USGS WELLS SAMPLED-ROUND 2
HIMCO DUMP SUPERFUND SITE
ELKHART, INDIANA

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4.3.1.4 Pesticides/ PCBs

Pesticides and PCBs were not detected during rounds 1 and 2 in any groundwater sample collected from shallow EPA or shallow USGS wells.

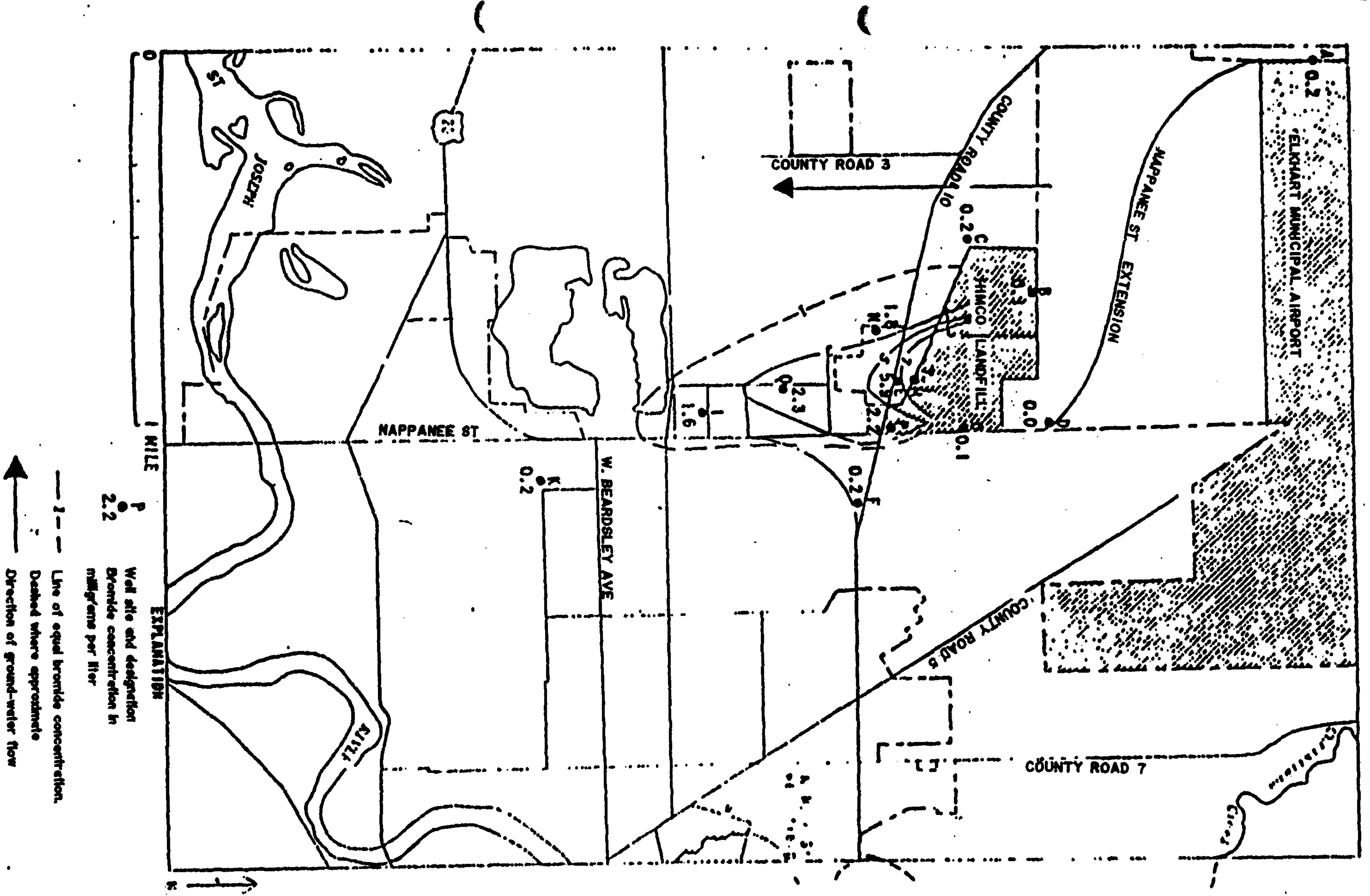
4.3.1.5 Bromide/Water Quality

USGS used bromide concentrations to trace leachate migration from the Himco site (USGS, 1981). These concentrations are shown in Figure 4-13. The study indicated the presence of a plume which originated from the landfill. The study stated that the plume had not spread out much further laterally than the original width of the landfill. The length of the plume was estimated at 5,500 feet.

A bromide plume was confirmed from round 1 RI data. Bromide concentrations detected in shallow wells during round 1 of the RI ranged in concentration from 0.1 mg/l to 3.5 mg/l. Figure 4-14 shows the location of round 1 bromide concentrations. Figure 4-14 shows the extent of the bromide plume to be similar to the USGS study. However, bromide detected during round 1 of the RI study was consistently lower than bromide concentrations detected in wells during the USGS study. Bromide analytical results from round 2 were similar to the round 1 data.

The analytical results of other water quality parameters from round 1 and round 2 sampling did not provide additional information regarding plume definition. However, groundwater chemistry in downgradient wells appears to be impacted by leachate. Downgradient groundwater quality parameter concentration ranges commonly fell between upgradient groundwater and leachate groundwater quality parameter ranges. Groundwater quality appears to change slightly as it passes through the landfill. More detailed information is provided in Section 4.4.

Nitrate/nitrite was listed in the baseline risk assessment as having a hazard index greater than one. Nitrate/nitrite was detected during round 1 in downgradient shallow wells WT105A at 1.76 mg/l and WT106A at 0.14 mg/l. A background concentration of 6.9 mg/l was also detected in WT102A. Nitrate/nitrite was detected during round 2 in immediate upgradient shallow well WTCP1 (6.36 mg/l), and downgradient wells WT105A (2.06 mg/l), WT111A (0.28 mg/l), WT106A (0.16 mg/l) and WTM2 (0.05 mg/l). A background concentration of 5.48 mg/l was also detected in WTB2. Nitrate/nitrite was not detected in leachate samples. Based on these data, the landfill is not suspected as being the source of contamination for the nitrate/nitrite contaminants in the aquifer downgradient of the site.



EXPLANATION

P ● 2.2 Well site and designation. Bromide concentration in milligrams per liter

— 2 — Line of equal bromide concentration. Dashed where approximate

← Direction of ground-water flow

Figure 4-13 --Areal extent of bromide concentrations(mg/l) for shallow landfill wells, September 1979.

FIGURE 4-13
AREAL EXTENT OF BROMIDE CONCENTRATIONS
SEPTEMBER, 1979

HIMCO DUMP SUPERFUND SITE
ELKHART, INDIANA

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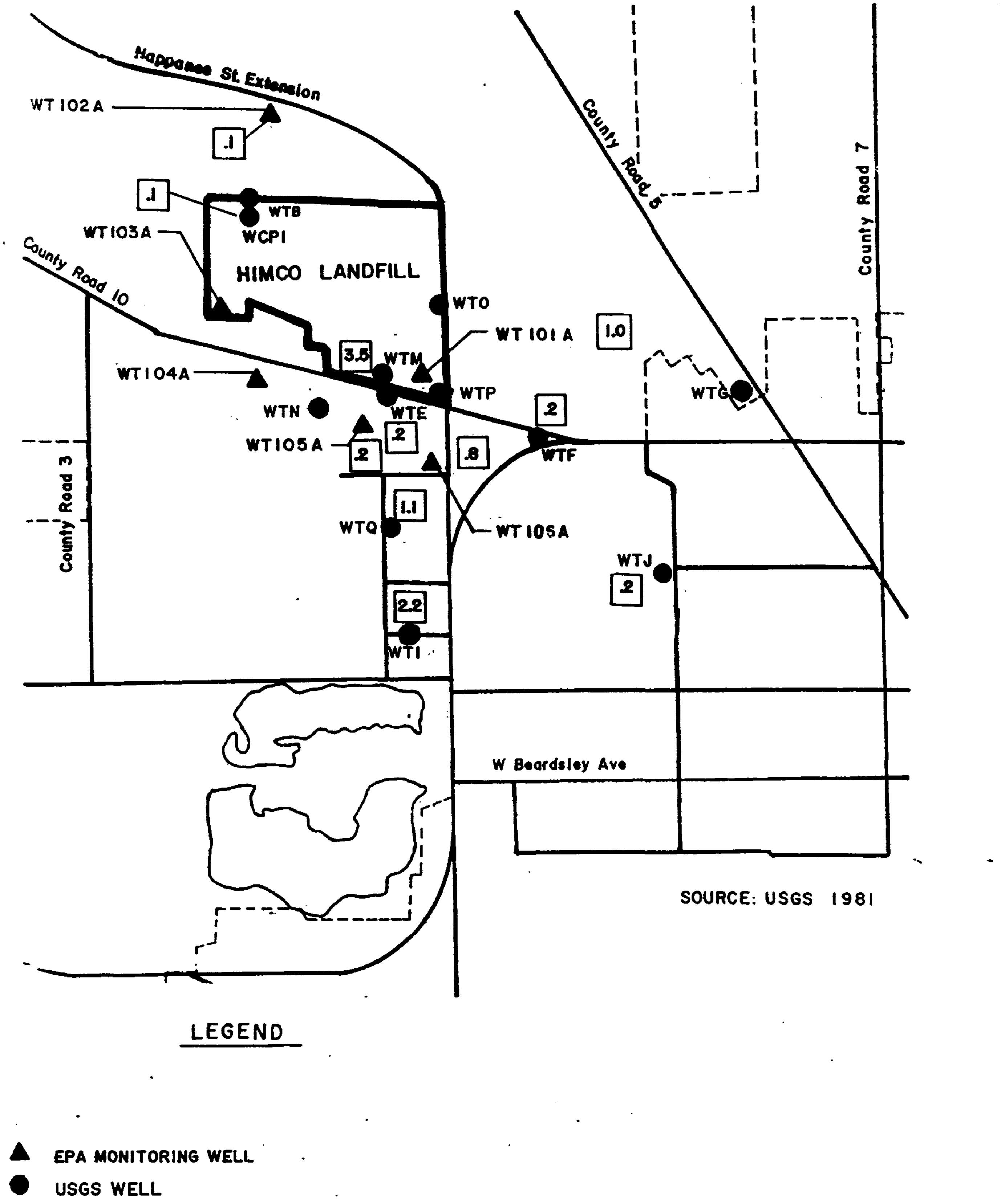

LEGEND

▲ EPA MONITORING WELL

● USGS WELL

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ROUND 1 BROMIDE CONCENTRATIONS (mg/l) IN USEPA AND USGS SHALLOW WELLS

HIMCO DUMP SITE
ELKHART, INDIANA

N

FIGURE 4-14

4.3.2 EPA and USGS Deep Wells

During the first round of sampling, two EPA and six USGS deep wells were sampled. During round 2, two EPA and one USGS deep wells were sampled. The results of these samplings are presented in the following sections.

4.3.2.1 Inorganic Analytes

A summary of round 1 and round 2 concentration ranges found in deep EPA and USGS wells is presented in Table 4-13. Figures 4-15 and 4-16 provide the sample locations and concentrations of arsenic, beryllium, and antimony found during round 1. All deep wells sampled on-site were located near the southeast corner of the site.

The maximum inorganic concentrations were consistently lower in deep wells compared to shallow wells. All samples from deep wells collected during round 1 had detectable concentrations of arsenic, beryllium, and/or antimony. However, the deep well background sample contained arsenic (5.8 ug/l), beryllium (4.5 ug/l), and antimony (36.0-48.7 ug/l), which are in the same range as the downgradient concentrations. Therefore, it is possible that the inorganic contamination found in deep wells in this area is not site-related.

During round 2, only total arsenic was detected in WT101C at 9.10 ug/l and WT101B at 3.9 ug/l. Beryllium and antimony were not detected in downgradient deep wells during round 2.

4.3.2.2 Volatile Organic Compounds (VOCs)

A summary of round 1 and round 2 concentration ranges found in deep EPA and USGS wells is presented in Table 4-14. Table 4-14 also lists concentrations of each compound detected in trip blanks for each round. Based on the trip blank data, acetone, bromodichloroethane, carbon disulfide, chloroform, methylene chloride, and toluene found in round 1 sampling are considered laboratory contaminants. Figures 4-17 and 4-18 provide the locations of compounds detected during round 1.

A small number of VOCs were detected during round 1 at random locations and at low concentrations (below 17 ug/l), except acetone at 270 ug/l. However, acetone is considered a laboratory contaminant. In addition, VOCs detected in deep wells were generally different from VOCs detected in shallow wells. The well which appears to be the most impacted by VOCs (WTG3) is located approximately 3,000 feet sidegradient of the site.

. 27, 1992(12:33:40) ALLFIG4A.DGN

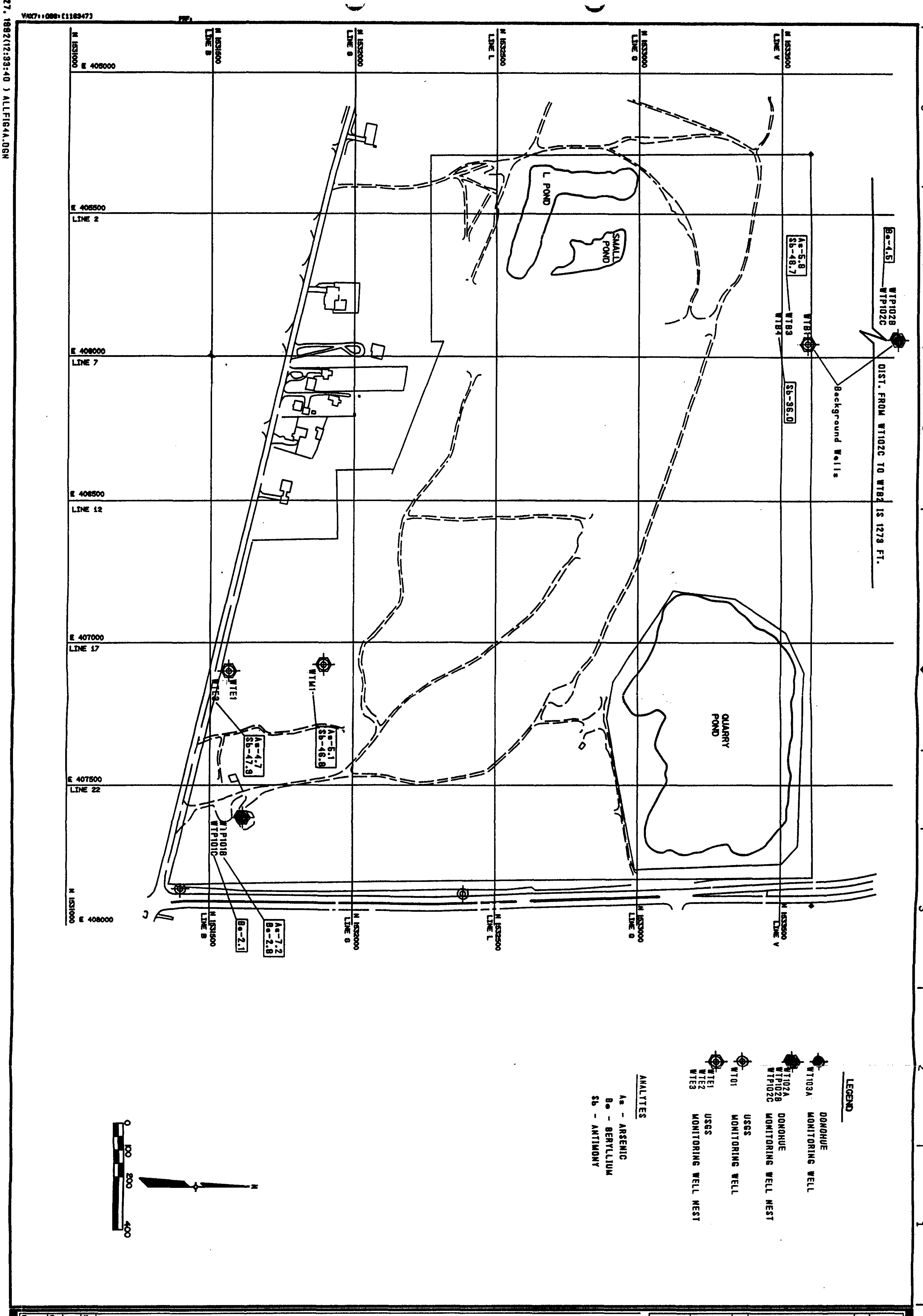


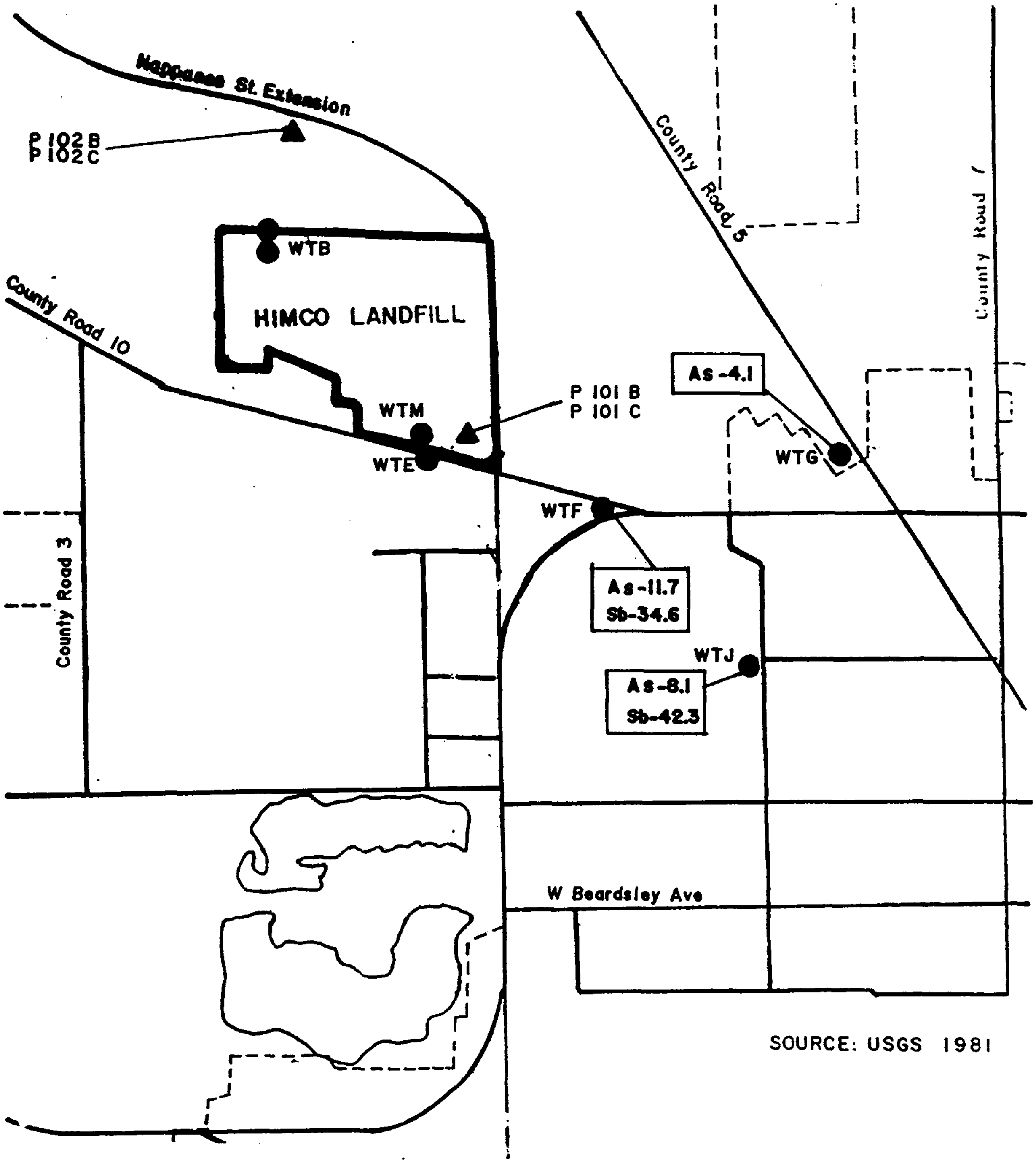
FIGURE 4-15
ARSENIC, BERYLLIUM & ANTIMONY CONCENTRATIONS (ug/L) DETECTED IN DEEP USEPA & USGS WELLS SAMPLED-ROUND 1

HIMCO DUMP SUPERFUND SITE
ELKHART, INDIANA

Drawing No. 4-15
Project No. 20026.030
Chicago Off. Loc.
File No.
Sheet No.

Donohue ENGINEERS ARCHITECTS SCIENTISTS

Scale	AS SHOWN				
Date	NOV. 1991				
Designer	SP				
Drafter	EZ				
Checker					
Approver		No.	Revisions	By	Date



SOURCE: USGS 1981

LEGEND

▲ EPA MONITORING WELL

● USGS WELL NEST

ALL CONCENTRATIONS IN µg/l

NOT TO SCALE

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ARSENIC AND ANTIMONY DETECTED IN DEEP OFF-SITE USGS WELLS-ROUND I

HIMCO DUMP SITE
ELKHART, INDIANA

N

FIGURE 4-16

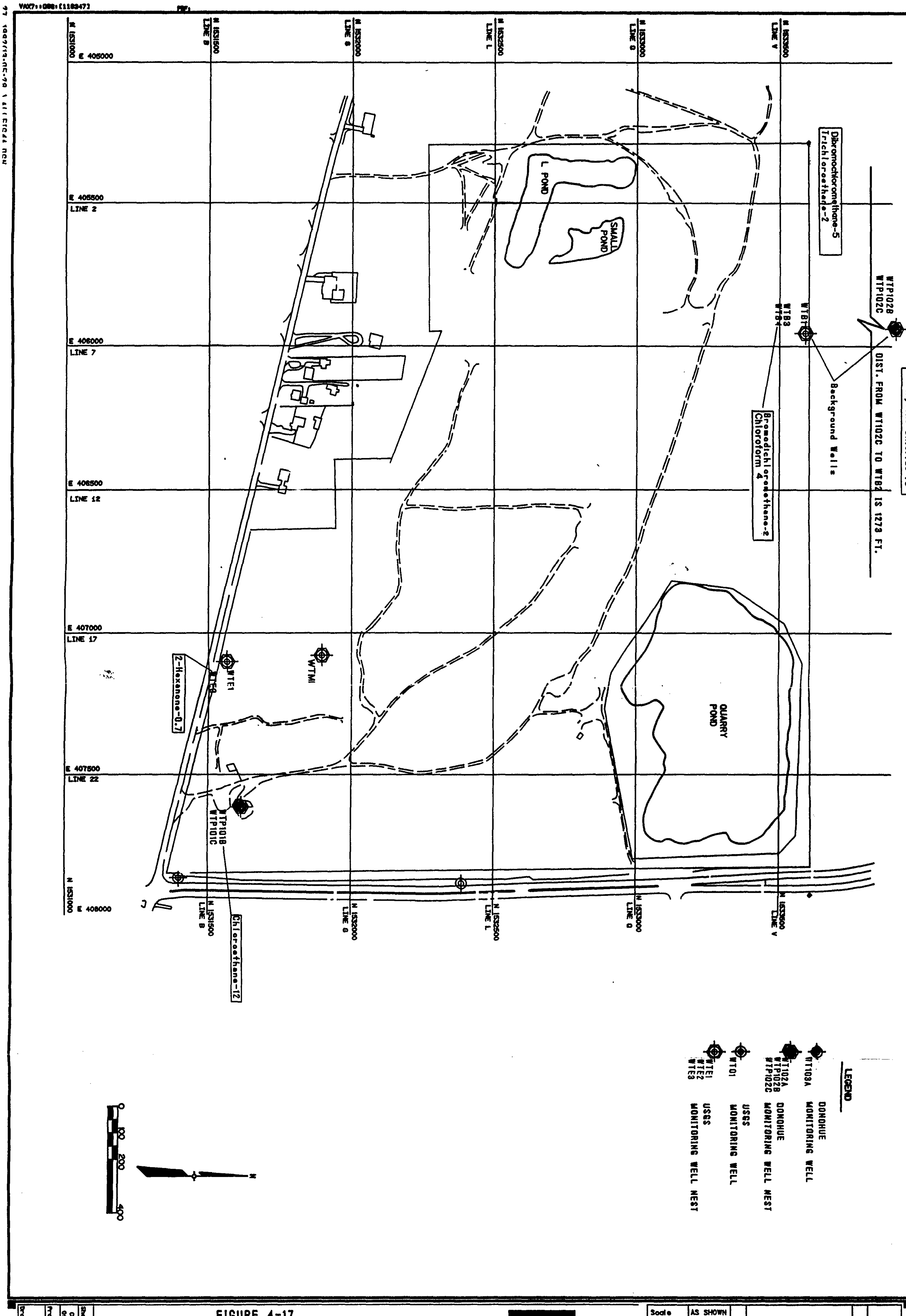

FIGURE 4-17
VOLATILE ORGANIC COMPOUND CONCENTRATIONS (ug/L)
DETECTED IN DEEP USEPA & USGS WELLS SAMPLED-ROUND 1
HIMCO DUMP SUPERFUND SITE
ELKHART, INDIANA

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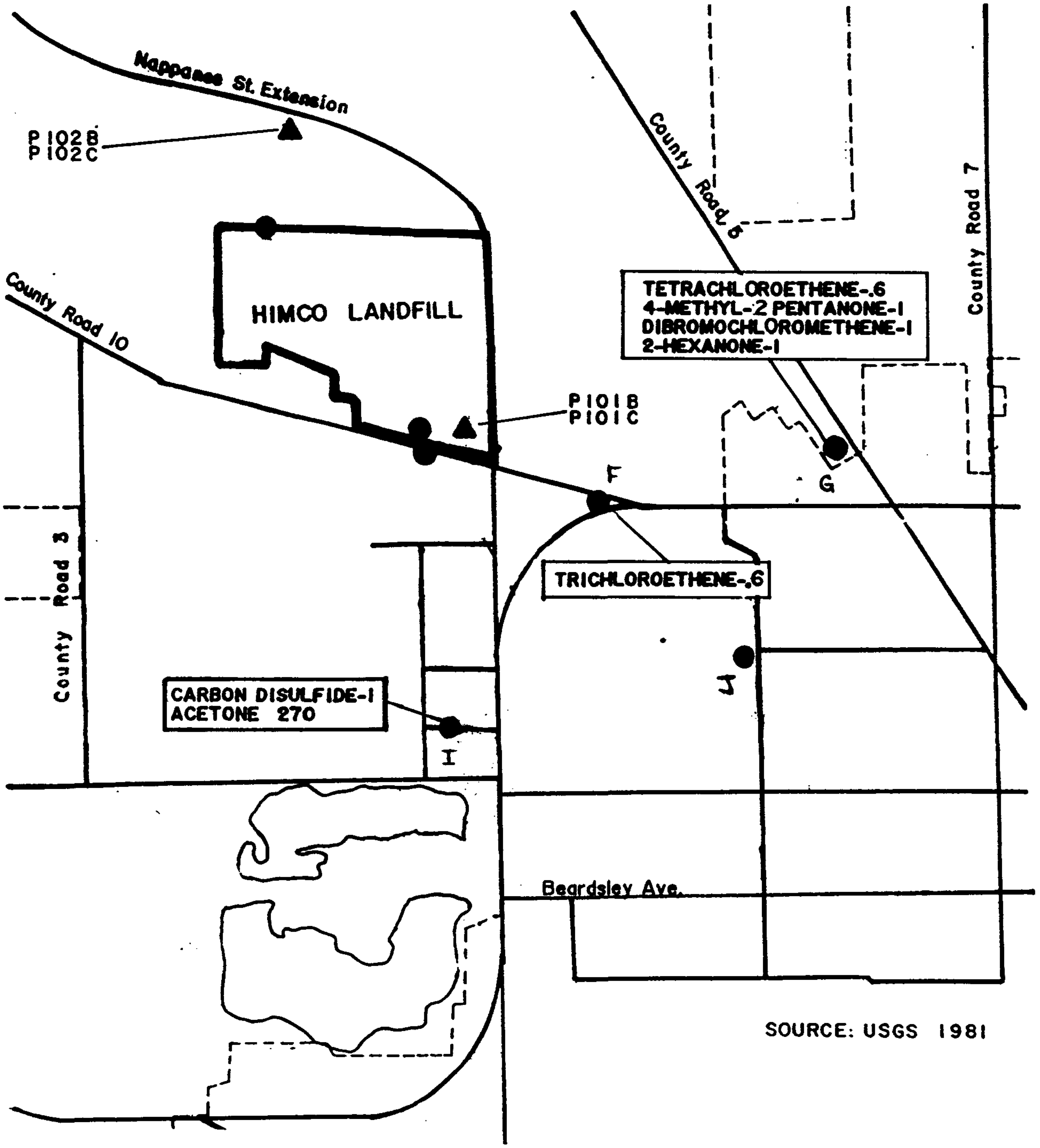
Sheet No.	
Chicago Off. Loc.	File No.
Project No. 20026.030	
Drawing No. 4-17	

		No.	Revisions	By	Date
Scale	AS SHOWN				
Date	NOV. 1991				
Designer	SP				
Drafter	EZ				
Checker					
Approver					



SOURCE: USGS 1981

LEGEND

▲ USEPA MONITOR WELL

● USGS WELL

NOT TO SCALE

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VOLATILE ORGANIC CONCENTRATIONS(µg/l)
DETECTED IN DEEP USGS WELLS-ROUND 1

HIMCO DUMP SITE
ELKHART, INDIANA

N

FIGURE 4-18

TABLE 4-13

SUMMARY OF INORGANIC ANALYTES DETECTED IN
DEEP EPA AND USGS WELLS
HIMCO DUMP SUPERFUND SITE
ELKHART, INDIANA
1992

		Background Concentration Range (ug/l)		Range of Concentrations in Downgradient Wells (ug/l)	
Compound	**MCL (ug/l)**	**Round 1**	**Round 2**	**Round 1**	**Round 2**
Aluminum	-	47.9-1,130	145-171(BJ)	138(B)-6,980	132(BJ)-758(J)
Antimony	-	36.0-48.7	ND	34.6-47.0	ND
Arsenic	50	5.8	4.0	4.7(B)-11.7	3.8-9.1(BJ)
Barium	1,000	40.4-116	35.4(B)-85.1(B)	100(B)-222	63(B)-209
Beryllium	-	4.5	ND	2.1(BJ)-4.5(BJ)	ND
Cadmium	10	ND	ND	ND	ND
Calcium	-	51,700-71,400	50,700-127,000	44,400-145,000	50,700-163,000
Chromium	50	23.8	ND	4.3-23.8	2.8(B)-45.3
Cobalt	-	7.3	ND	5.2(B)-7.3(B)	ND
Copper	(SMCL) 1,000	4.8-32.1	ND	4.9(BJ)-10.7(BJ)	ND
Iron	(SMCL) 300	707-1,680	70.6(B)-594	62.0(BJ)-7,890	89(B)-7,280
Lead	15@	1.2-58	3.5(J)-6.5	1.8(BJ)-11.2(J)	2(BJ)-4(J)
Magnesium	(SMCL) 50	18,500-41,400	16,200-38,000	17,200-50,400	16,200-41,500
Manganese	-	51-445	118-383	18.2(J)-279	75.8-193
Mercury	2	ND	ND	0.20	ND
Nickel	-	ND	ND	21.1(B)	ND
Potassium	-	1,190-1,950	755(BJ)-1,690(B)	758(B)-29,300	902(B)-6,520
Selenium	10	3.1	ND	2.0(B)-3.4(B)	ND
Silver	50	9.8-12.1	ND	7.2(BJ)12.4(J)	ND
Sodium	-	3,180-51,600	4,920(B)-26,900(J)	2,960(B)-91,000	7,230(J)-43,200(J)
Thallium	-	ND	ND	ND	ND
Vanadium	-	7.5-14.1	ND	7.5(B)-14.1(BJ)	3(B)-3.5(B)
Zinc	(SMCL) 5,000	12.1-71.4	8.0(B)	4.9(BJ)-538(J)	60.4-1,240
Cyanide	-	ND	ND	ND	ND

Qualifiers

ND - Below detection limit
B - The reported value is less than the contract required detection limit, but greater than the instrument detection limit.
J - Indicates an estimated value
@ - Enforceable action level effective July 1992
\- No data available.

TABLE 4-14

SUMMARY OF VOLATILE ORGANIC COMPOUNDS DETECTED IN DEEP EPA AND USGS WELLS
HIMCO DUMP SUPERFUND SITE
ELKHART, INDIANA
1992

Compound	MCL (ug/l)	Range of Concentrations Detected (ug/l) Round 1	Round 2	Trip Blanks (ug/l) Round 1	Round 2
Acetone	-	270	ND	53	8
Bromodichloromethane	-	.7(J)-2.0(J)	ND	.5	ND
Carbon disulfide	-	1.0(J)	ND	.013	ND
Chloroethane	-	12	16(J)	ND	ND
Chloroform	-	3.0(J)-4.0(J)	2(J)	2(J)	1
Dibromochloromethane	-	1.0(J)	ND	ND	ND
2-Hexanone	-	0.7(J)-1.0(J)	ND	ND	ND
Methylene Chloride	-	16(J)	ND	24	ND
4-Methyl-2-Pentanone	-	1.0(J)	ND	ND	ND
Toluene	-	0.6(J)	ND	0.47	ND
Tetrachloroethene	-	0.6(J)	ND	ND	ND
Trichloroethene	5	2(J)	ND	ND	ND

Qualifiers

ND - Not detected above detection limit
B - Compound was found in the associated blank as well as in sample
J - Indicates an estimated value

A/R/HIMCO/AJ2

During round 2, only two VOCs were detected in downgradient deep wells. These include chloroethane detected in WT101B at 16 ug/l, and chloroform detected in WTM1 at 2 ug/l. Chloroethane was also detected in this well during round 1. Chloroform was detected in the trip blank at 1 ug/l, which indicates that chloroform from round 2 may be a laboratory contaminant. Two VOCs detected in background deep wells from round 2 include bromodichloromethane (7 ug/l) and dibromochloromethane (2 ug/l). These VOCs were also detected in the background wells during round 1.

Based on the above information, the impacts of site-related VOCs on the deep zone of the aquifer downgradient of the site appear to be very minimal.

4.3.2.3 Semi-Volatile Organic Compounds (SVOCs)

SVOCs detected in deep wells were primarily from samples collected during round 1. The SVOCs detected in deep well samples include dimethylphthalate (7-9 ug/l), diethylphthalate (36-38 ug/l), and bis(2-ethylhexyl)phthalate (3.0 ug/l). These compounds were detected in wells WTG3 and/or WTI1 only. Well WTG3 is located approximately 3,000 feet sidegradient to the site and WTI1 is located approximately 2,000 feet downgradient from the site.

SVOCs detected in round 2 samples include only bis(2-ethylhexyl)phthalate in WTM1 at 3 ug/l and in WTP101C at 3 ug/l. Phthalates are a common additive to plastic materials. Plastic materials such as tubing and gloves were used during sample collection. Therefore, their presence may be attributable to cross-contamination.

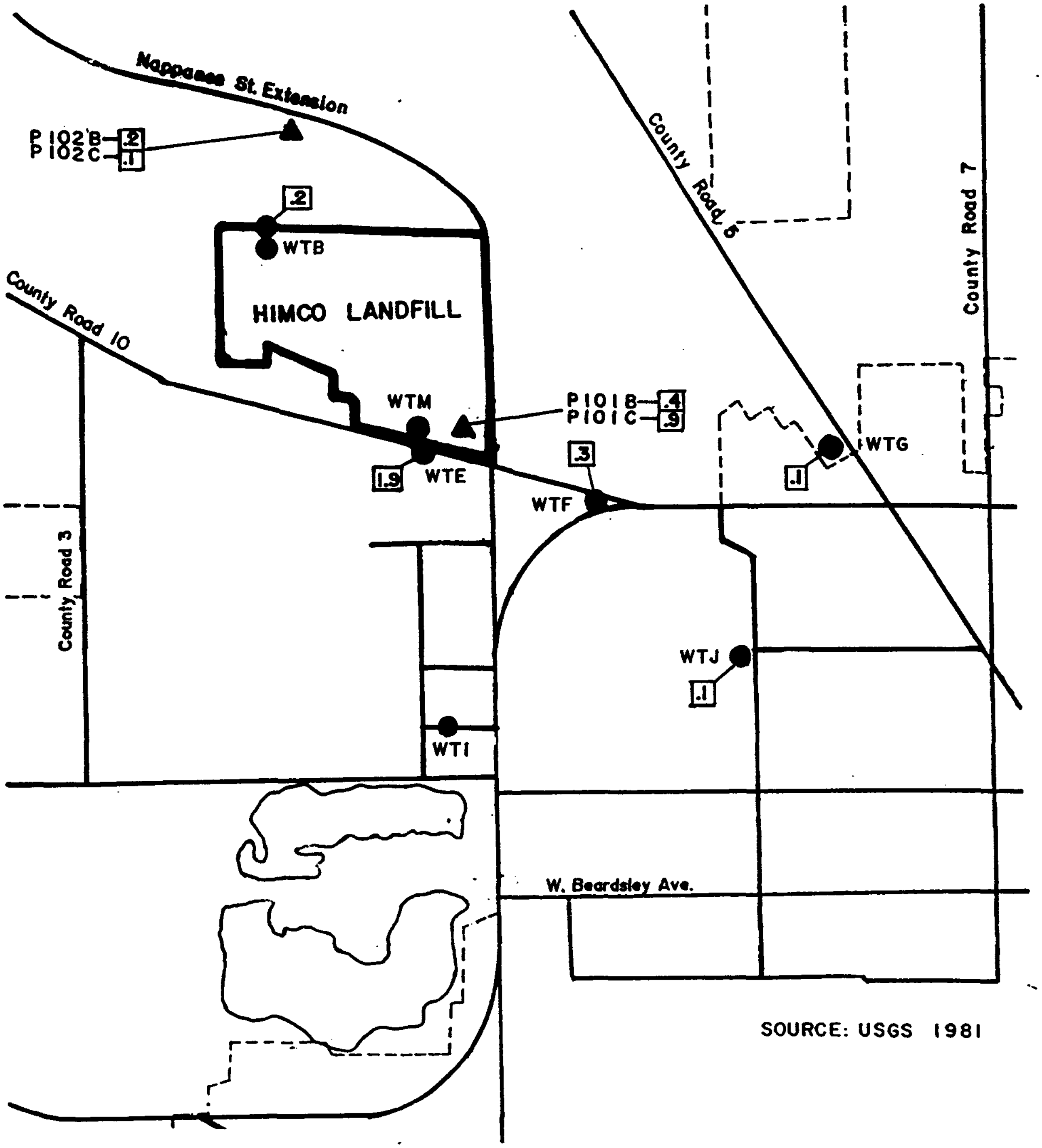
This information does not indicate any site-related SVOC impacts to the deep zone of the aquifer downgradient of the Himco site.

4.3.2.4 Pesticides/PCBs

Pesticides and PCBs were not detected during round 1 and 2 in any groundwater samples collected from shallow EPA or deep USGS wells during the RI.

4.3.2.5 Bromide/Water Quality

As discussed in Section 4.4.1.5 for shallow wells, USGS used bromide to trace the leachate plume migrating from the Himco site (USGS, 1981). Based on the detection of bromide in deep wells on-site and downgradient to the site, the USGS study indicated that the plume was moving downward in the aquifer as it moved downgradient. During the RI field work, bromide was detected in deep wells on or close to the site during round 1. Bromide concentrations in deep wells are provided in Figure 4-19. Bromide was not detected in deep well WTI-3 downgradient from the site. Off-site deep groundwater wells were not sampled during round 2.



SOURCE: USGS 1981

LEGEND

▲ USEPA WELL

● USGS WELL NEST

All Concentrations in mg/l

NOT TO SCALE

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ROUND I BROMIDE CONCENTRATIONS IN USEPA AND USGS DEEP WELLS

HIMCO DUMP SITE
ELKHART, INDIANA

N

FIGURE 4-19

In general, detection of bromide in deep wells supports USGS findings that bromide moves downward as the plume moves downgradient from the site.

The analytical results of other water quality parameters from round 1 sampling did not provide additional information regarding the vertical migration of contamination. However, groundwater chemistry in downgradient wells appears to be impacted by leachate. Downgradient groundwater quality parameter concentration ranges commonly fell between upgradient groundwater and leachate groundwater quality parameter ranges. More detailed information is provided in Section 4.4.

Nitrate/nitrite was listed in the baseline risk assessment as having a hazard index greater than one. Nitrate/nitrite was detected in on-site deep well WTE3 at 0.48 mg/l and in off-site sidegradient deep well WTG3 at 0.15 mg/l.

4.3.3 Residential Wells

Five deep (RW-01, RW-04, RW-06, RW-07, and RW-08) and two shallow (RW-02 and RW-05) residential wells located immediately south of the Himco site and one deep residential well (RW-03) immediately south of County Road 10 were sampled during round 1 of the RI. The location of the residential wells sampled is provided in Figure 2-3 of Section 2.

Although the residential wells were sampled during round 1, the data could not be used for the RI interpretation of groundwater data and for the baseline risk assessment because of poor data quality. The data were considered inadequate because:

- Construction details for the residential wells could not be identified and the wells' integrity could not be verified.
- The wells could not be adequately developed before sampling, resulting in high suspended solid concentration in unfiltered samples.

To verify that the samples from the old residential wells are not representative of the aquifer, a new monitoring well was installed near the residential wells. The sample from the new well had only traces of benzene and arsenic. Therefore, a detailed discussion of residential well data is not warranted, and a summary discussion is presented in the following paragraph.

Data for inorganics and VOCs is provided in Tables 4-15 and 4-16, respectively. The only SVOC detected in residential wells was bis(2-ethylhexyl)phthalate at 21 ug/l to 50 ug/l. In general, the two shallow residential wells had higher concentrations of analytes than the USGS and RI monitoring wells.

4.4 LEACHATE

Leachate was sampled from four trenches during trenching activities. The four trenches included TL-1, TL-2, TL-4, and TL-5. Trench TL-1 was located near the north-central section of the landfill, TL-2 near the south-central section, TL-4 next to the south-central edge of the landfill, and TL-5 near the southwest corner of the site. Exact locations of these trenches are shown in Figure 2-2 of Section 2.

As described in Section 3.4, leachate from TL-5 was a reddish-brown color and separated into two phases. The top phase, referred to as the organic phase, retained its reddish-brown color. The bottom, or aqueous, phase was a cloudy yellow color. The two phases were analyzed separately for VOCs and SVOCs. Pesticides/PCBs, total metals/CN, and water quality were analyzed with the two phases mixed. The other three leachate samples were single-phase samples and were described as gray-black water with some "sheening visible." Analytical results discussed in the following sections are compared to groundwater analytical results when possible.

4.4.1 Inorganic Analytes

A summary of concentration ranges found in leachate samples is presented in Table 4-17. Overall, concentrations of inorganic contaminants detected in leachate were orders of magnitude higher than groundwater concentrations.

Arsenic, beryllium, and antimony were all detected in leachate samples. Concentrations of beryllium and antimony detected in leachate were orders of magnitude higher than in groundwater. However, arsenic was only detected in TL-4 at 19 ug/l, and the highest concentrations of arsenic in downgradient wells was 54.5 ug/l during round 1 and 24.2 ug/l during round 2. These data are inconclusive as to whether leachate was a source of arsenic contamination in groundwater.

Two inorganic analytes detected in groundwater samples and not in leachate samples include selenium and silver. Cyanide was not detected in groundwater, but was detected in leachate sample TL-5 at 48,400 ug/l and in TL-4 at 108 ug/l.

TABLE 4-15

SUMMARY OF INORGANIC ANALYTES DETECTED IN RESIDENTIAL WELLS
HIMCO DUMP SUPERFUND SITE
ELKHART, INDIANA
1992

Analyte	Range of Concentrations Detected (ug/L)
Aluminum	383 - 699
Antimony	4.2(B)
Arsenic	2.4(BJ) - 4.3(BJ)
Barium	5.9(B) - 416
Beryllium	1.0(B)
Cadmium	0.34(BJ) - 117(J)
Calcium	703(B) - 194,000
Chromium	65.8
Cobalt	13.4
Copper	10.4 - 256
Iron	73.4(BJ) - 147,000
Lead	3.5 - 2,380
Magnesium	178(B) - 62,900
Manganese	5.6(B) - 1,570
Mercury	ND
Nickel	76.5
Potassium	473(B) - 19,500
Selenium	ND
Silver	ND
Sodium	5,270 - 438,000
Thallium	1.9(BJ) - 3.5(J)
Vanadium	14.0
Zinc	49.9 - 107,000
Cyanide	ND

Qualifiers

ND -	Not detected above detection limit
B -	The reported value is less than the contract required detection limit, but greater than the instrument detection limit.
J -	Indicates an estimated value

TABLE 4-16

SUMMARY OF VOLATILE ORGANIC COMPOUNDS DETECTED IN RESIDENTIAL WELLS
HIMCO DUMP SUPERFUND SITE
ELKHART, INDIANA
1992

Compound	Range of Concentrations Detected (ug/L)
Acetone	7(J)-22(J)
Benzene	5(J)
Chloroethane	0.6(J)
1,1-Dichloroethane	8(J)
Methylene Chloride	2(J)-73(J)
1,1,1-Trichloroethane	0.9(J)
Toluene	0.6(J)

Qualifiers

J - Indicates an estimated value

TABLE 4-17

SUMMARY OF INORGANIC ANALYTES (TOTAL) DETECTED IN LEACHATE WATER
HIMCO DUMP SUPERFUND SITE
ELKHART, INDIANA
1992

		Concentrations Detected by Trench Number			
	MCL (ug/l)	TL-1	TL-2	TL-4	TL-5
Aluminum	-	78.1(B) mg/l	301 mg/l	8.47(J) mg/l	356(N) mg/l
Antimony	-	ND	10.5 mg/l	.0726(J) mg/l	ND
Arsenic	50	ND	ND	19 ug/l	ND
Barium	1,000	2.1(B) mg/l	3.7(B) mg/l	.53(B) mg/l	4.7(B) mg/l
Beryllium	-	1.6(BNJ*) mg/l	5.7(NJ*) mg/l	ND	1.5(BNJ*) mg/l
Cadmium	10	2,500(B) ug/l	ND	4.4(B) ug/l	ND
Calcium	-	1.66 mg/l	2.14 mg/l	288 mg/l	.55 mg/l
Chromium	50	4,500(BNJ) ug/l	4,500(BNJ) ug/l	32.9 ug/l	10,000(BNJ) ug/l
Cobalt	-	3,300(BJ) ug/l	ND	13.5 ug/l	ND
Copper	(SMCL) 1,000	11,700(BJ) ug/l	8,800(BJ) ug/l	626 ug/l	3,000(BJ) ug/l
Iron	(SMCL) 300	71.2 mg/l	272 mg/l	17.5 mg/l	254 mg/l
Lead	50	ND	28,300(NJ*) ug/l	505(J) ug/l	ND
Magnesium	(SMCL) 50	89.4(J*) mg/l	205(J*) mg/l	60.3 mg/l	108(J*) mg/l
Manganese	-	ND	9.6(B) mg/l	3.15 mg/l	ND
Mercury	2	420(NJ) ug/l	420(NJ) ug/l	1.3(J) ug/l	ND
Nickel	-	ND	ND	55 ug/l	ND
Potassium	-	ND	ND	27.2	ND
Selenium	10	ND	ND	ND	ND
Silver	50	ND	ND	ND	ND
Sodium	-	ND	415 mg/l	83.4 mg/l	ND
Thallium	-	ND	ND	ND	ND
Vanadium	-	3,000(BNJ) ug/l	4,500(BNJ) ug/l	32.1(B) ug/l	ND
Zinc	(SMCL) 5,000	6,700(B) ug/l	18,400 ug/l	713(J) ug/l	10,700(B) ug/l
Cyanide	-	ND	ND	108 ug/l	48,400 ug/l

Qualifiers

ND - Below detection limits
B - The reported value is less than the contract required detection limit, but greater than the instrument detection limit.
J - Indicates an estimated value
N - Spike sample recovery not within control limits. This value is usable.
* - Duplicate analysis not within control limit. The values is usable.

4.4.2 Volatile Organic Compounds (VOCs)

A summary of the VOC concentration ranges detected in leachate samples is presented in Table 4-18. Table 4-18 also summarizes the analysis of the two phases in TL-5 separately. Nineteen VOCs were detected above detection limits.

The highest concentrations of VOCs were detected in leachate from TL-5 and include methylene chloride, acetone, 2-butanone, 4-methyl-2-pentanone, 2-hexanone, toluene, ethylbenzene, and xylenes. Methylene chloride, acetone, and 2-butanone were detected in the aqueous phase only. Ethyl benzene was detected in the organic phase only. The other four VOCs were detected at their highest concentrations in the organic phase and include 4-methyl-2-pentanone (17,000 mg/kg), 2-hexanone (29,000 mg/kg), toluene (480,000 mg/kg), and xylenes (total) (44,000 mg/kg). Because the organic phase of leachate from TL-5 contained approximately 50 percent toluene, location TL-5 was considered a hot spot in the landfill.

Overall, VOC concentrations in leachate were orders of magnitude higher than groundwater VOC concentrations. VOCs in leachate that were not in groundwater samples include vinyl chloride, 2-butanone, ethylbenzene, styrene, and xylenes (total). Three VOCs in groundwater samples that were not in leachate samples include bromodichloromethane, chlorobenzene, and dibromochloromethane. These three compounds were detected below 2.0 ug/l in groundwater samples.

4.4.3 Semi-Volatile Organic Compounds (SVOCs)

SVOC concentration ranges detected in leachate samples are summarized in Table 4-19. Table 4-19 also summarizes the analysis of the two phases in TL-5 separately. Nineteen SVOCs were detected in leachate samples.

The majority of SVOCs were detected in TL-4. The highest SVOC concentrations were detected in TL-5, similar to VOCs. However, only five of the 19 SVOCs were detected in TL-5 and include phenol (560 ug/l), naphthalene (45 mg/kg), and bis(2-ethylhexyl)phthalate (180 mg/kg) in the organic phase only, and benzyl alcohol (11 mg/kg) and benzotic acid (9 mg/kg) in the aqueous phase only.

Phenol was the only SVOC consistently detected in all leachate samples ranging from 7.2 to 6,600 ug/l. Phenol was also detected at 2 ug/l in a groundwater sample from shallow well M2, located near the southeast corner of the site. Three other SVOCs detected in leachate samples and groundwater samples include naphthalene, diethylphthalate, and bis(2-ethylhexyl)phthalate. Three SVOCs detected in groundwater and not in leachate include dimethylphthalate, butylbenzylphthalate, and di-n-octylphthalate. These three compounds were detected at low concentrations, below 12 ug/l).

TABLE 4-18

SUMMARY OF VOLATILE ORGANIC COMPOUNDS DETECTED IN LEACHATE WATER
HIMCO DUMP SUPERFUND SITE
ELKHART, INDIANA
1992

		Concentrations Detected by Trench Number				
					TL-5	
Chemical	**MCL (ug/l)**	**TL-1 (ug/l)**	**TL-2 (ug/l)**	**TL-4 (ug/l)**	**Red Phase (mg/kg) (organic)**	**Yellow Phase (mg/kg) (aqueous)**
Vinyl Chloride	2	47(J)	16	ND	ND	ND
Chloroethane	-	ND	3(BJ)	ND	ND	ND
Methylene Chloride	-	550	18	ND	ND	260(BJ)
Acetone	-	1,300	85	ND	ND	300(BJ)
Carbon Disulfide	-	130	4(J)	ND	ND	ND
1,1-Dichloroethane	-	220	64	5(J)	ND	ND
1,2-Dichloroethene (total)	-	410	66	ND	ND	ND
Chloroform	-	76(J)	ND	ND	ND	ND
2-Butanone	-	420	13	ND	ND	4,100(BJ)
1,1,1-Trichloroethane	200	520	ND	10	ND	ND
Trichloroethene	5	550(J)	11	180	ND	ND
Benzene	5	97(J)	32(J)	ND	ND	ND
4-Methyl 2-pentanone	-	110	9(J)	ND	17,000(J)	410(J)
2-Hexanone	5	ND	ND	ND	29,000(J)	570(J)
Tetrachloroethene	100	48(J)	ND	ND	ND	ND
Toluene	-	1,100	63	ND	480,000(J)	850(J)
Ethyl Benzene	-	640	150	ND	6,400(J)	ND
Styrene	-	ND	3(J)	ND	ND	ND
Xylenes (Total)	-	200	330	ND	44,000(J)	77(J)

Qualifiers

ND - Below detection limit.
B - Analyte found in associated blank as well as in the sample.
J - Indicates an estimated value.

TABLE 4-19

SUMMARY OF SEMI-VOLATILE ORGANIC COMPOUNDS DETECTED IN LEACHATE WATER HIMCO DUMP SUPERFUND SITE ELKHART, INDIANA 1992

Chemical	Concentrations Detected by Trench Number TL-1 (ug/l)	TL-2 (ug/l)	TL-4 (ug/l)	TL-5 Red Phase (mg/kg)	Yellow Phase (mg/kg)
Phenol	6,600	67	7.2	560 ug/l	ND
Benzyl alcohol	NA	NA	NA	ND	11
2-Methylphenol	440(J)	10(J)	ND	ND	ND
4-Methylphenol	4,200(J)	140(J)	ND	ND	ND
2,4-Dimethylphenol	84(J)	10(J)	ND	ND	ND
Benzoic Acid	NA	NA	NA	ND	9(J)
Naphthalene	ND	ND	4(J)	45(J)	ND
Acenaphthylene	ND	ND	1(J)	ND	ND
Diethylphthalate	ND	49(J)	ND	ND	ND
Phenanthrene	ND	ND	2(J)	ND	ND
Fluoranthene	ND	ND	7(J)	ND	ND
Pyrene	ND	ND	8(J)	ND	ND
Chrysene	ND	ND	5(J)	ND	ND
Bis(2-Ethylhexyl)phthalate	ND	22(J)	ND	180(J)	ND
Benzo(b)fluoranthene	ND	ND	6(J)	ND	ND
Benzo(k)fluoranthene	ND	ND	3(J)	ND	ND
Benzo(a)pyrene	ND	ND	5(J)	ND	ND
Indeno(1,2,3-cd)pyrene	ND	ND	2(J)	ND	ND
Benzo(g,h,i)perylene	ND	ND	2(J)	ND	ND
Carcinogenic PAHs	ND	ND	21	ND	ND
Non-carcinogenic PAHs	ND	ND	19	ND	ND

Qualifiers

NA - Not analyzed for
ND - Below detection limit.
J - Indicates an estimated value.

4.4.4 Pesticides/PCBs

No PCBs were detected in leachate samples. However, traces of pesticides were detected in TL-1 and TL-2. Concentration ranges of pesticides detected in leachate samples are summarized in Table 4-20. Pesticides were not detected in groundwater.

4.4.5 Bromide/Water Quality

Table 4-21 summaries the concentration ranges of quality parameters in groundwater samples from upgradient and downgradient wells and leachate samples. Groundwater ranges include both shallow and deep wells.

As indicated in Table 4-21, leachate appears to be impacting groundwater chemistry in downgradient wells. Groundwater quality appears to change slightly as it passes through the landfill. Downgradient groundwater quality concentration ranges commonly fell between upgradient groundwater and leachate concentration ranges. One exception to this was nitrate/nitrite. Nitrate/nitrite was detected in groundwater; it was not detected in leachate. Therefore, it appears that leachate from the landfill may not be the source for nitrate/nitrite in groundwater at the Himco site.

4.5 SURFACE WATER AND SEDIMENT

Eighteen surface water (SS1 through SS18) and 18 sediment samples (SD1 through SD18) were collected from the three ponds located around the Himco site. In addition, three surface water and three sediment samples (SS/SD-19, SS/SD-20, SS/SD-21) were collected from an off-site background pond. The background pond was a private pond with an average depth of nine feet and was located approximately 1.9 miles northwest of the "L" pond. Sampling activities are described in Section 2.9.

4.5.1 Surface Water

The following discussion presents surface water analytical results, focusing on the inorganic analytes arsenic, beryllium, and antimony. These three analytes were discussed in Section 4.3, Groundwater. All VOCs and SVOCs above detection limits are discussed.

TABLE 4-20

SUMMARY OF PESTICIDES/PCBs DETECTED IN LEACHATE WATER
HIMCO DUMP SUPERFUND SITE
ELKHART, INDIANA
1992

Chemical Name	TL-01 (ug/l)	TL-02 (ug/l)
alpha-BHC	.017(DJ)	ND
beta-BHC	.097(DJP)	.068(DJP)
Heptachlor	0.12(DJP)	0.023(DJP)
Aldrin	0.13(DJP)	0.12(DJP)
Dieldrin	ND	0.073(DJP)
Endosulfan II	0.17(DJ)	0.048(DJP)
4,4-DDT	0.29(DJP)	ND
alpha-Chlordane	0.22(DJP)	ND
gamma-Chlordane	0.029(DJP)	0.028(DJP)

Qualifiers

D - This flag identifies all compounds identified in an analysis at a secondary dilution factor and alerts data users that any discrepancies between the sample concentrations reported may be due to dilution of the sample or extract. The value is usable.

J - Indicates an estimated value.

P - This flag is used for a pesticide/aroclor target analyte when there is greater than 25% difference for detected concentrations between two gas chromatograph columns.

TABLE 4-21

SUMMARY OF WATER QUALITY PARAMETERS
IN GROUNDWATER AND LEACHATE
HIMCO DUMP SUPERFUND SITE
ELKHART, INDIANA
1992

	Upgradient Shallow Wells (mg/l)	Downgradient Shallow Wells (mg/l)	Leachate (mg/l)
Alkalinity	110-170	40-564	816-1800
Bromide	0.1	0.1-4.1	.48-3.3
COD	ND	4.4-88	48-29800
Chloride, Cl	5.9-120	<5.0-260	17.6-70.4
Nitrogen, Ammonia (NH_3)	.04-.22	.09-30	15.2-181
Nitrogen, Nitrate + Nitrite ($NO_2 + NO_3$)	5.48-6.9	.05-6.36	ND
Sulfate, SO4	160-430	5.9-284	489-2610
TDS (Total Dissolved Solids)	330-910	404-2790	1550-4330
TKN (total Kjeldahl Nitrogen)	.27-1.2	.12-41	6.08-34.2
TP (Total Phosphorus)	.12-.27	.09-4.72	8.86-9.25
TSS (Total Suspended Solids)	9-678	.53-2010	246-514

ND - Below detection limit

A/R/HIMCO/AJ2

4.5.1.1 Inorganic Analytes

Concentration ranges found in on-site and background surface water samples are summarized in Table 4-22. Overall, inorganic analyte concentrations were not significantly different from background levels. Beryllium and antimony were not detected in any surface water sample. Arsenic was detected at seven locations. These locations are presented in Figure 4-20. Based on this figure, arsenic was detected at relatively consistent concentrations (2.3-5.2 ug/l) and at random locations. Arsenic was also detected in background samples ranging from 2.4 ug/l to 2.8 ug/l. Based on background concentrations, on-site arsenic concentrations may be naturally occurring.

4.5.1.2 Volatile Organic Compounds (VOCs)

A summary of VOC ranges found in surface water samples is presented in Table 4-23, which indicates that six VOCs were detected above detection limits. These include acetone, methylene chloride, carbon disulfide, 4-methyl-2-pentanone, ethyl benzene, and xylenes (total).

Figure 4-21 presents the location and concentration of VOCs present above background concentrations. VOCs were primarily detected in the L-pond and small pond, but in all cases were found in the low ug/l range (less than 120 ug/l). These data suggest that site-related VOC impacts to the surface water in the L-pond and small pond are minimal.

4.5.1.3 Semi-Volatile Organic Compounds (SVOCs)

SVOCs were not detected in any surface water sample during the RI.

4.5.1.4 Pesticides/PCBs

Aroclor-1248 was detected in SD3 at 130 ug/l. Pesticides were not detected in any surface water sample collected during the RI.

4.5.1.5 Bromide/Water Quality

The analytical results of bromide/water quality parameters did not provide additional information regarding potential contamination sources or contaminant nature and extent.

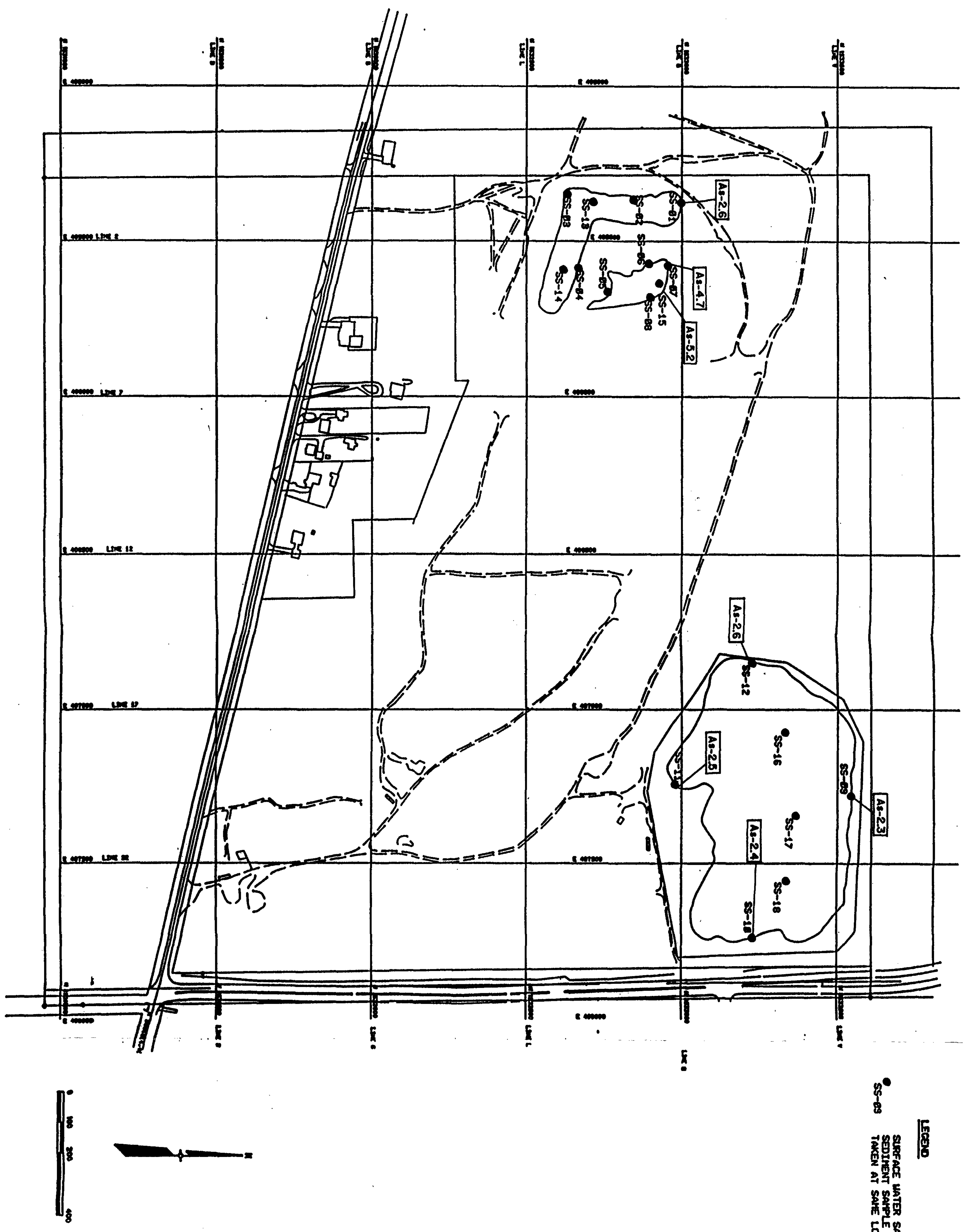

FIGURE 4-20
ARSENIC CONCENTRATIONS(µg/l) DETECTED IN SURFACE WATER SAMPLES
HIMCO DUMP SUPERFUND SITE
ELKHART, INDIANA

Donohue ENGINEERS ARCHITECTS SCIENTISTS

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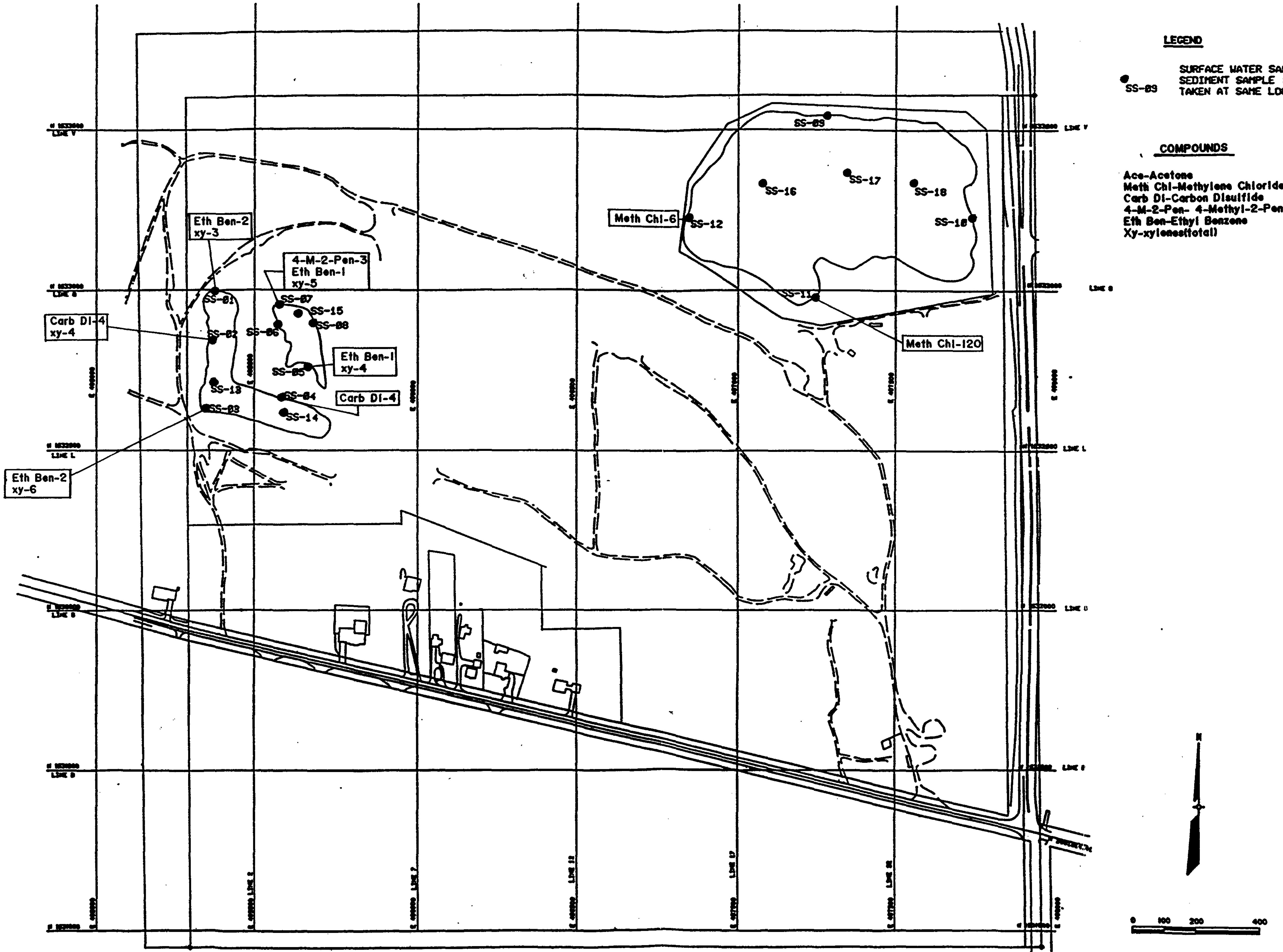

LEGEND

● SS-09	SURFACE WATER SAMPLE SEDIMENT SAMPLE (SD) TAKEN AT SAME LOCATION

COMPOUNDS

Ace-Acetone
Meth Chl-Methylene Chloride
Carb Di-Carbon Disulfide
4-M-2-Pen- 4-Methyl-2-Pentanone
Eth Ben-Ethyl Benzene
Xy-xylenes(total)

FIGURE 4-21
VOC CONCENTRATIONS(µg/l) DETECTED
IN SURFACE WATER SAMPLES
HIMCO DUMP SUPERFUND SITE
ELKHART, INDIANA

Donohue ENGINEERS ARCHITECTS SCIENTISTS

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4.5.2 Sediment

The following discussion presents sediment sample analytical results. Sediment samples were collected from the same location immediately following surface water sample collection.

Inorganic analytes focused on for discussion include arsenic, antimony, and beryllium. Arsenic and beryllium were discussed in Section 4.2, Soils. Antimony was also focused on because it was addressed in Section 4.5.1, Surface Water. All VOCs and SVOCs above detection limits are discussed.

4.5.2.1 Inorganic Analytes

Concentration ranges found in on-site and background sediment samples are summarized in Table 4-24. The majority of inorganic analytes were detected at concentrations similar to background concentrations.

Concentrations of arsenic, beryllium, and antimony by sample location are presented in Figure 4-22. Arsenic was detected in all sediment samples. The highest concentrations of arsenic (21.4 mg/kg-22 mg/kg) were detected in sediment samples collected from three locations (SS-16 through SS-18) in the middle of the quarry pond. However, arsenic was also detected in background samples ranging from 4.2 mg/kg to 20.5 mg/kg. Arsenic concentrations in these sediment samples are similar to background levels. Therefore, arsenic at these levels may be naturally occurring. Arsenic was detected in all other sediment samples at relatively consistent concentrations between 0.90 mg/kg and 6.2 mg/kg.

Beryllium was detected in six sediment samples at relatively consistent concentrations between 0.32 mg/kg and 1.2 mg/kg. Beryllium was also detected in background samples ranging from .45 mg/kg to 1.1 mg/kg. Based on background levels, beryllium in sediment samples at the Himco site may be naturally occurring. Antimony was detected at one location (SS-18) in the quarry pond at 29.2 mg/kg. Antimony was not detected in background samples.

4.5.2.2 Volatile Organic Compounds (VOCs)

VOC ranges found in sediment samples are summarized in Table 4-25. Nine VOCs were detected above detection limits. However, all VOCs were detected in the low ug/kg range (less than 49 ug/kg). In addition, three VOCs which were detected at the highest concentration ranges were also detected in background samples. Based on these data, the impact of site-related VOCs on the sediment at the site is minimal.

TABLE 4-22

SUMMARY OF INORGANIC ANALYTES DETECTED IN SURFACE WATER
HIMCO DUMP SUPERFUND SITE
ELKHART, INDIANA
1992

Analyte	**Background Concentration (ug/L)**	**Range of Concentrations Detected (ug/L)**
Aluminum	23.9(BJ)-863(J)	21.9(BJ)-66(BJ)
Arsenic	2.4(B)-2.8(B)	27.9(B)-5.2(BJ)
Antimony	ND	ND
Barium	3.2(BJ)-18.3(B)	27.9(B)-70.1(B)
Beryllium	ND	ND
Calcium	837(B)-22,700	50,500-79,600
Cadmium	ND	ND
Chromium	ND	9.2(B)-29
Copper	ND	5.6(B)
Cobalt	ND	ND
Iron	18.6(BJ)-184(J)	12.5(BJ)-5,080(J)
Lead	2.1(B)-2.4(B)	2B(J)-3.6(J)
Magnesium	123(B)-16,200	12,700-21,500
Manganese	12(BJ)-52.6(J)	5.8(BJ)-191(J)
Nickel	ND	7.5(B)-10.2(B)
Potassium	762(B)-1,400(B)	1,440(B)-3,600(B)
Selenium	ND	4.9(BJ)
Silver	ND	4.0(B)
Sodium	336(BJ)-18,300	7,480-13,000
Thallium	ND	1.3(BJ)-2.10(BJ)
Vanadium	2.9(BJ)-2.3(BJ)	3.5(B)
Zinc	7.2(BJ)-11.3(BJ)	5.5(BJ)-59.5(J)
Cyanide	ND	ND

Qualifiers

ND - Not detected in any surface water sample above detection limits
B - The reported value is less than the contract required detection limit, but greater than the instrument detection limit
J - Indicates an estimated value

TABLE 4-23

SUMMARY OF VOLATILE ORGANIC COMPOUNDS DETECTED IN SURFACE WATER
HIMCO DUMP SUPERFUND SITE
ELKHART, INDIANA
1992

Analyte	Background Concentration (ug/l)	Range of Concentrations Detected (ug/l)
Acetone	4(J)-5(J)	3(J)-5(J)
Methylene Chloride	ND	6-120
Carbon Disulfide	ND	4(J)
4-Methyl-2-pentanone	ND	3(J)
Ethyl Benzene	ND	1(JB)-2(JB)
Xylenes (total)	ND	0.9(JB)-6

Qualifiers

B - Compound was found in the associated blank as well as in the sample
J - Indicates an estimated value

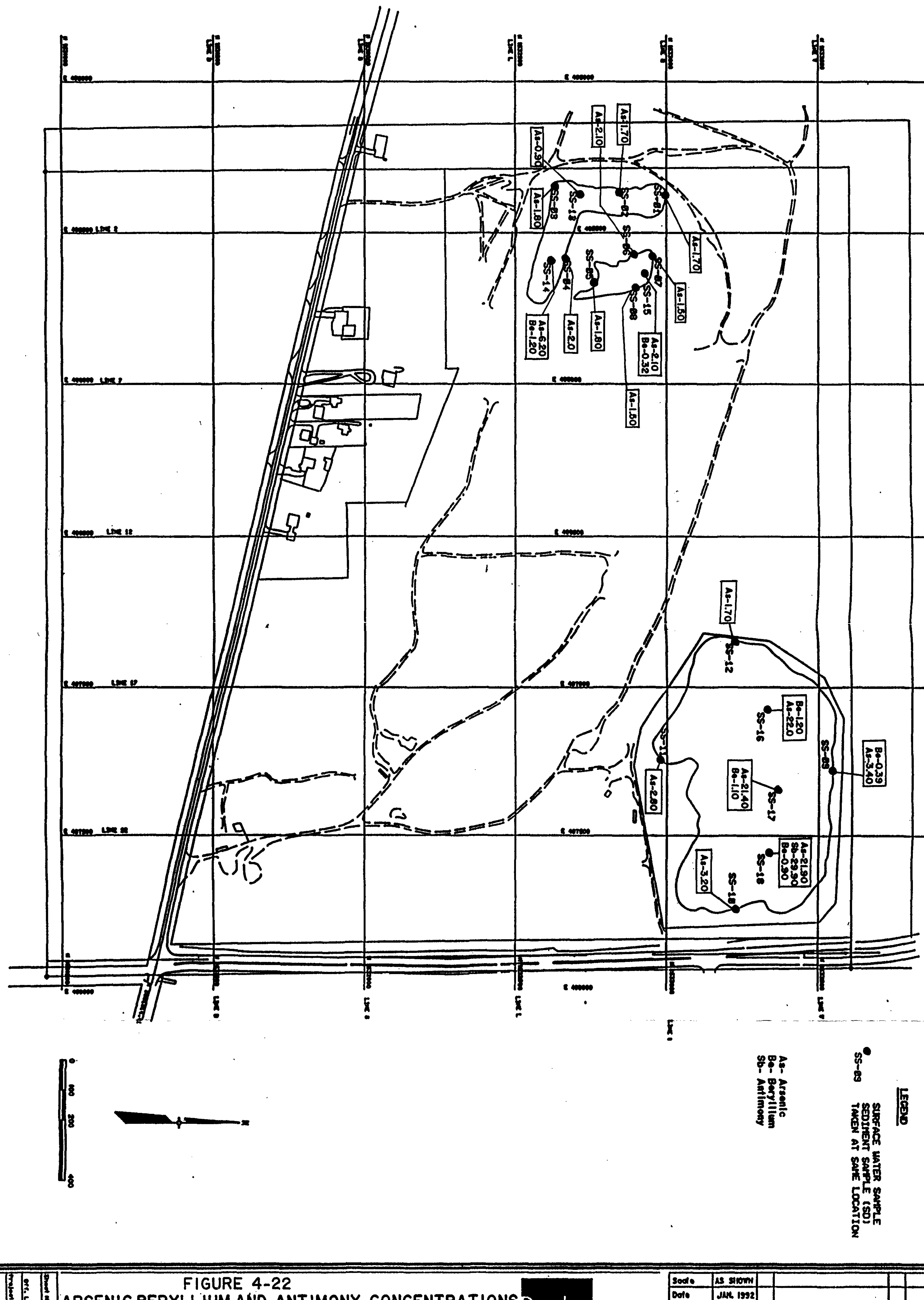

FIGURE 4-22
ARSENIC, BERYLLIUM, AND ANTIMONY CONCENTRATIONS (mg/kg) DETECTED IN SEDIMENT SAMPLES

HIMCO DUMP SUPERFUND SITE
ELKHART, INDIANA

Donohue ENGINEERS ARCHITECTS SCIENTISTS

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TABLE 4-24

SUMMARY OF INORGANIC ANALYTES DETECTED IN SEDIMENT
HIMCO DUMP SUPERFUND SITE
ELKHART, INDIANA
1992

Analyte	Background Concentration (mg/kg)	Range of Concentrations Detected (mg/kg)
Aluminum	4,380-14,900	900-18,100
Antimony	ND	29.9
Arsenic	4.2-20.5	0.90(B)-22
Barium	31.8(B)-119(B)	4.6(B)-131(B)
Beryllium	.45(B)-1.10(B)	0.32(B)-1.2(BJ)
Calcium	21,500(J)-72,800(J)	7,620(J)-124,000(J)
Chromium	6.8-14.9	1.7(B)-21.4
Cobalt	7.3(B)-18.5(B)	2(B)-19.9(B)
Copper	14.2(B)-28.2	1.2(BJ)-44.3
Iron	8,550-25,400	1,400-31,900
Lead	10.2-34.3	1.6(J)-49.5
Magnesium	3,830(J)-9,370(J)	389(BJ)-17,700(J)
Manganese	147-703	12.7(J)-1,240
Nickel	4.9(B)-25.6	1.5(B)-35
Potassium	298(B)-738(B)	82.1(B)-1180(B)
Selenium	ND	0.56(BJ)-7.4(J)
Silver	ND	1.1
Sodium	89.8(BJ)-242(BJ)	17.6(B)-264(BJ)
Thallium	.43(BJ)	10.8(J)
Vanadium	10.10(B)-27.7(B)	2.3(B)-35.1
Zinc	23.0-76.5	5.7(J)-98.4
Cyanide	ND	ND

Qualifiers

ND - Not detected in any surface water sample above detection limits
B - The reported value is less than the contract required detection limit, but greater than the instrument detection limit
J - Indicates an estimated value

TABLE 4-25

SUMMARY OF VOLATILE ORGANIC COMPOUNDS DETECTED IN SEDIMENT
HIMCO DUMP SUPERFUND SITE
ELKHART, INDIANA
1992

Compound	Background Concentration (ug/kg)	Range of Concentrations Detected (ug/kg)
Methylene Chloride	ND	2J
Acetone	18(J)	21J - 49J
Carbon Disulfide	10(J)	11(J)-27(J)
Chloroform	ND	0.7J
2-Butanone	8(J)-28(J)	8(J)-27(J)
1,1,1-Trichloroethane	ND	1J
Trichloroethene	ND	1J
Tetrachloroethene	ND	1J
Xylenes (total)	ND	1J

Qualifiers

J - Indicates an estimated value

4.5.2.3 Semi-Volatile Organic Compounds (SVOCs)

SVOC ranges found in sediment samples are summarized in Table 4-26, which indicates that four SVOCs were detected above detection limits. The concentration of SVOCs by sample location is presented in Figure 4-23. SVOCs were detected at random locations and at consistently low concentrations (less than 220 ug/kg). Therefore, the impact of site-related SVOCs on the sediment at the site is minimal.

4.5.2.4 Pesticides/PCBs

Pesticides or PCBs were not detected in any sediment sample collected during the RI.

4.6 WASTE MASS GAS

Fourteen waste mass gas samples were collected during Phase I RI activities and analyzed for VOCs. Sampling procedures are described in Section 2.4. The waste mass gas samples were analyzed for VOCs.

VOC concentration ranges found in waste mass gas samples are summarized in Table 4-27. Table 4-27 also summarizes the number of waste mass gas sample locations, and the number of samples in which each VOC was detected.

Sixteen VOCs were detected in the 14 waste mass gas samples collected. The VOCs detected were (maximum concentration detected in parentheses): chloromethane (1,100 ng/l), vinyl chloride (8,600 ng/l), methylene chloride (80 ng/l), acetone (26 ng/l), carbon disulfide (300 ng/l), 1,1-dichloroethene (86 ng/l), 1,1-dichloroethane (150 ng/L), 1,2-dichloroethene (total) 1,300 ng/l), 1,1,1-trichloroethane (300 ng/l), trichloroethene (370 ng/l), benzene (140 ng/l), tetrachloroethene (1,400 ng/l), toluene (600 ng/l), ethyl benzene (700 ng/l), styrene (10 ng/l), and xylenes (total) (1,300 ng/l).

Figure 4-24 presents the locations of the waste mass gas samples along with the total VOC concentrations at each sample location. This figure shows that total VOCs were detected in all samples collected. However, the concentration of total VOCs was less than 1 ug/l in 12 of the 14 samples.

Waste mass gas sample TT-05 contained 9,766 ng/l total VOCs. The main contributors to this total VOC concentration were vinyl chloride (4,000 ng/l), total 1,2-dichloroethene (1,300 ng/l), total xylenes (1,300 ng/l), and chloromethane (1,100 ng/l).

SEC DONOHUE
Environment & Infrastructure

August 24, 1992

Ms. Mary Elaine Gustafson (5HSRL-6J)
Remedial Project Manager
U.S. Environmental Protection Agency
Region V
77 West Jackson Boulevard
Chicago, IL 60604

Re: EPA Region V ARCS Contract No. 68-W8-0093
EPA Work Assignment No. 17-5L4J
SEC Donohue Project No. 20026

Himco Dump Superfund Site RI/FS
Figure 4-23 of the Final RI Report

Dear Ms. Gustafson:

Enclosed please find the corrected version of Figure 4-23 of the RI report. The revision on the draft version of this figure was inadvertently not incorporated in the final RI report submitted to EPA on August 17, 1992. SEC Donohue regrets any inconveniences as a result of this error.

Please call me if you have any questions or comments.

Sincerely,

SEC DONOHUE INC.

M. Geraminegad

Mehdi Geraminegad, P.E.
Site Manager

cc: **EPA**
Brigitte Manzke, Contracting Officer (5MC-10J) (cover letter)
Patricia Vogtman, Project Officer (5HSM-5J) (cover letter)

IDEM
Tim Smith

SEC DONOHUE
Tom Dalton (cover letter)
Work Assignment Files
PMO Files (cover letter)

A/O/L/XY7

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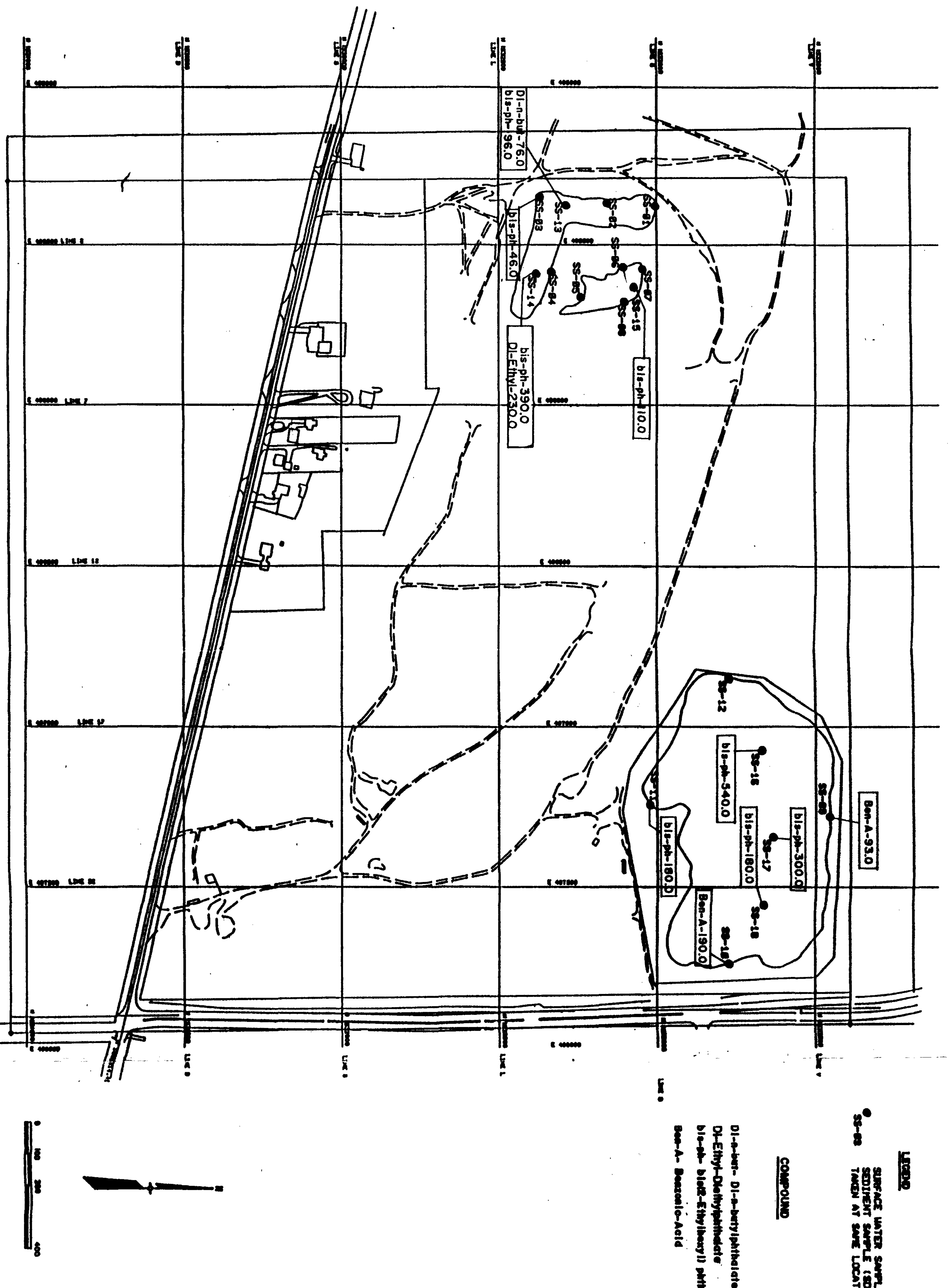

FIGURE 4-23
SEMI-VOC CONCENTRATION (ug/kg)
DETECTED IN SEDIMENT SAMPLES
HIMCO DUMP SUPERFUND SITE
ELKHART, INDIANA

Donohue ENGINEERS ARCHITECTS SCIENTISTS

Scale	AS SHOWN				
Date	JAN. 1992				
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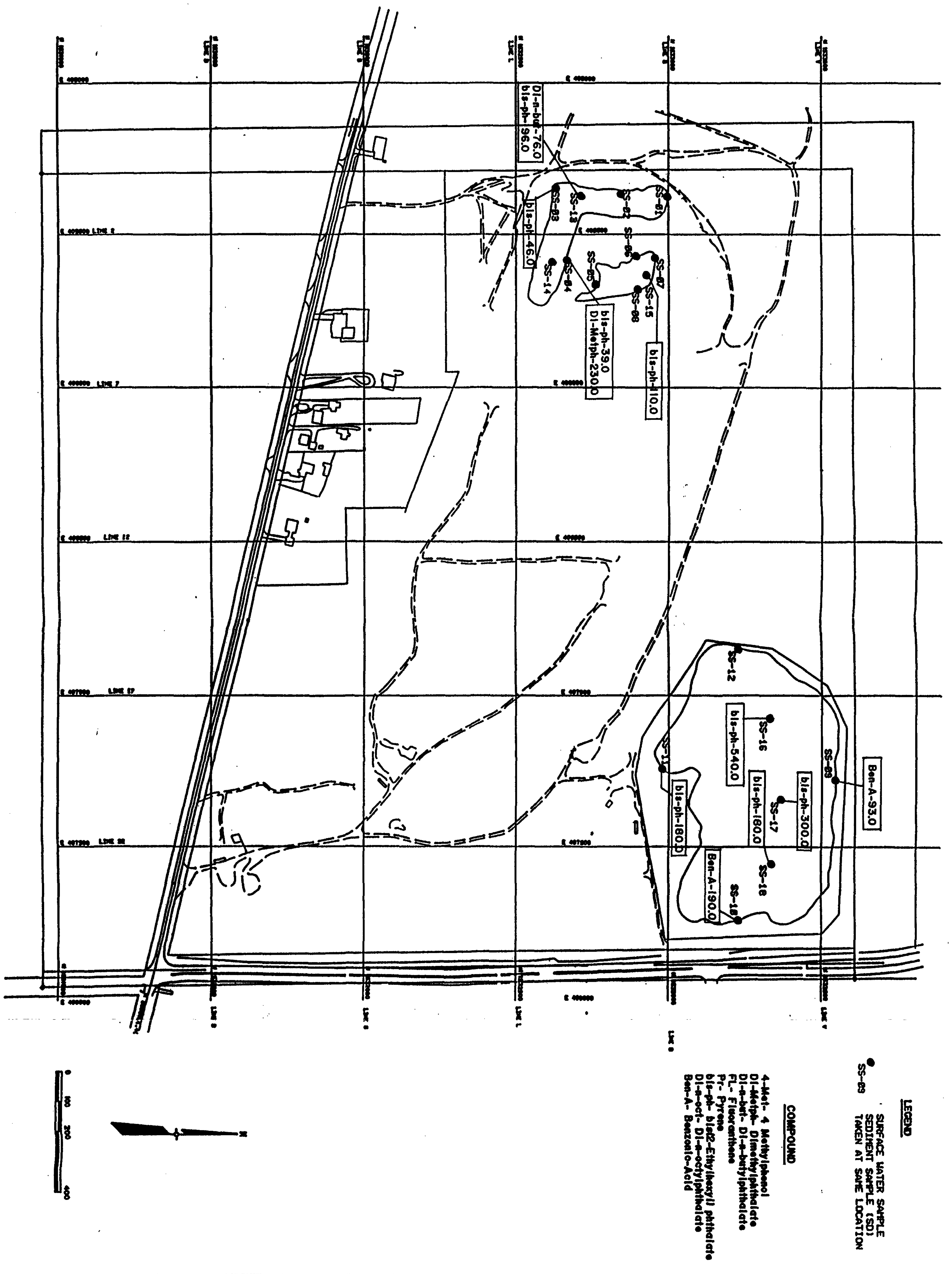

FIGURE 4-23
VOC CONCENTRATION(mg/kg) DETECTED IN SEDIMENT SAMPLES

HIMCO DUMP SUPERFUND SITE
ELKHART, INDIANA

Donohue ENGINEERS ARCHITECTS SCIENTISTS

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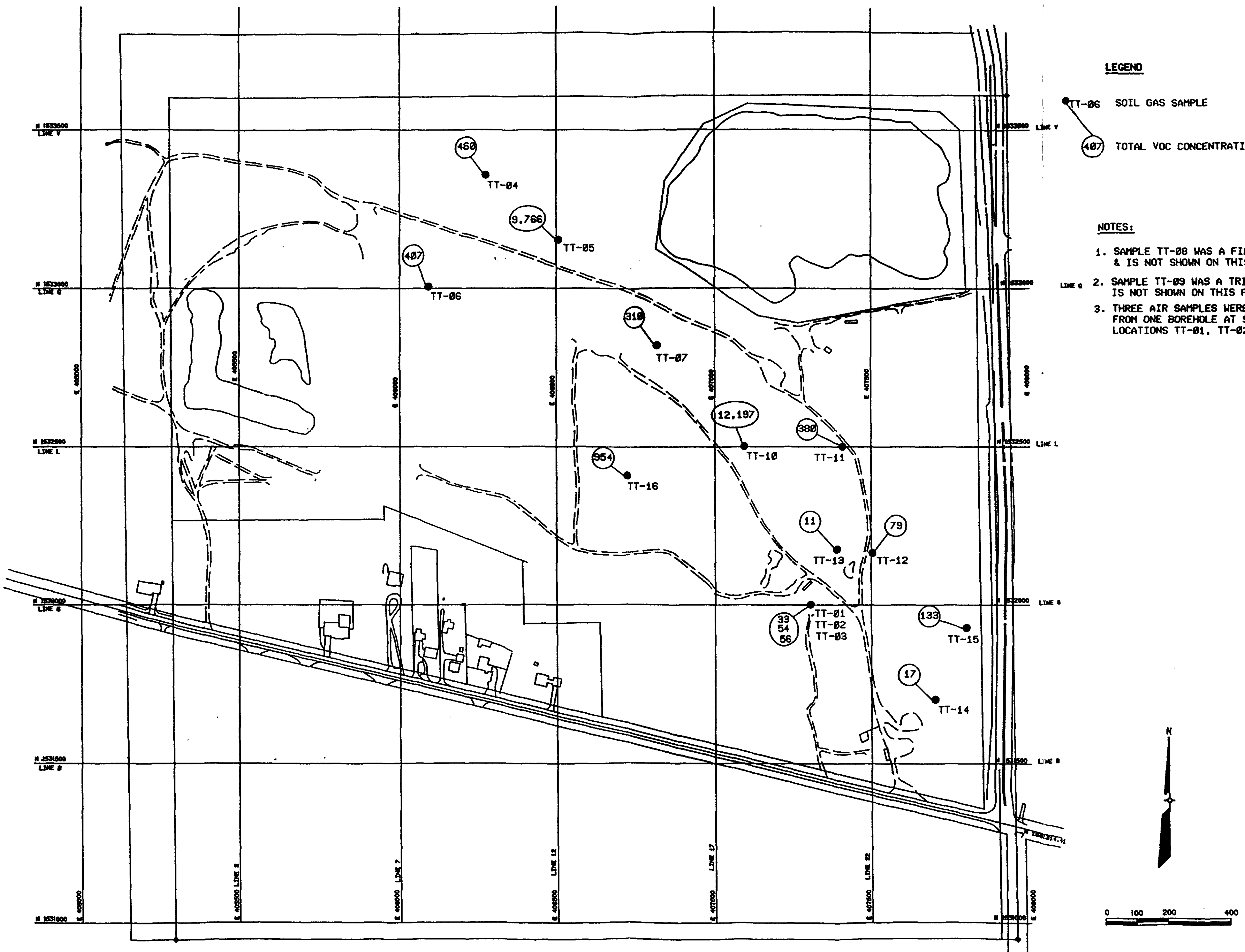

LEGEND

● TT-06 SOIL GAS SAMPLE

(407) TOTAL VOC CONCENTRATION IN ng/L

NOTES:

1. SAMPLE TT-08 WAS A FIELD BLANK & IS NOT SHOWN ON THIS FIGURE.
2. SAMPLE TT-09 WAS A TRIP BLANK & IS NOT SHOWN ON THIS FIGURE.
3. THREE AIR SAMPLES WERE PULLED FROM ONE BOREHOLE AT SAMPLE LOCATIONS TT-01, TT-02 & TT-03.

FIGURE 4-24
TOTAL VOCs DETECTED IN SOIL GAS SAMPLES

HIMCO DUMP SUPERFUND SITE
ELKHART, INDIANA

Donohue ENGINEERS ARCHITECTS SCIENTISTS

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Apr. 24, 1992(19:03:19) ALLFIG4.DGN

TABLE 4-26

SUMMARY OF SEMI-VOLATILE COMPOUNDS DETECTED IN SEDIMENT
HIMCO DUMP SUPERFUND SITE
ELKHART, INDIANA
1992

Compound	Background Concentration (ug/kg)	Range of Concentrations Detected (ug/kg)
Benzoic Acid	ND	93(J) - 190(J)
Diethylphthalate	140(J)	230(J)
Di-n-butylphthalate	ND	76(J)
bis(2-ethylhexyl)phthalate	ND	46(J) - 540(J)

Qualifiers

J - Indicates an estimated value

A/R/HIMCO/AJ2

TABLE 4-27

SUMMARY OF VOLATILE ORGANIC COMPOUNDS DETECTED IN WASTE MASS GAS
HIMCO DUMP SUPERFUND SITE
ELKHART, INDIANA
1992

Compound	Number of Sample Locations	Frequency Detected	Range of Concentrations Detected (ng/L)
Chloromethane	14	6	9-1,100(E)
Vinyl Chloride	14	3	4(J)-8,600(E)
Methylene Chloride	14	12	1(B)-80(B)
Acetone	14	4	5-26
Carbon Disulfide	14	12	2(B)-300(B)
1,1-Dichloroethene	14	2	15-86
1,1-Dichloroethane	14	2	60-150
1,2-Dichloroethene (total)	14	3	2(J)-1,300(E)
1,1,1-Trichloroethane	14	9	2-300
Trichloroethene	14	6	4-370
Benzene	14	13	1(J)-140(B)
Tetrachloroethene	14	4	1(J)-1,400(E)
Toluene	14	13	3(B)-600(BE)
Ethyl Benzene	14	5	2(J)-700(E)
Styrene	14	2	3(B)-10(B)
Xylenes (total)	14	5	2(B)-1,300(BE)

Qualifiers

B - Compound was found in the associated blank as well as in the sample

E - Identifies compounds whose concentrations exceeded the calibration range of the GC/MS instrument for that specific analysis

Waste mass gas sample TT-10 contained 12,197 ng/l total VOCs. The main contributors to this total VOC concentration were vinyl chloride (8,600 ng/l) and tetrachloroethene (1,400 ng/l).

4.7 RESIDENTIAL BASEMENT AIR

During Phase I, basement air was screened at the [redacted] residences to evaluate if gas generated at the landfill had migrated off-site and into these basements. A hydrogen sulfide and methane gas detector was used to screen the basement air. No detection of these compounds were registered during any of the basement air monitoring.

5.0 CONTAMINANT FATE AND TRANSPORT

5.1 INTRODUCTION

The fate of a contaminant in an environmental system (soil, water, air) is controlled by transformation and translocation mechanisms. The contaminant fate is determined by these mechanisms and the contaminant's reaction rates. These reaction rates are dependent on environmental conditions such as temperature, moisture, and light. Contaminants typically reside within the surface soil or subsurface porous materials. Therefore, porous material texture, cation exchange capacity, water and organic matter content, redox condition, and pH often affect those mechanisms that influence contaminant persistence.

The next section addresses potential routes of contaminant migration and the primary mechanisms that influence fate and transport, as well as the chemical and physical characteristics that control the mechanisms. Subsequent sections in this chapter address contaminant persistence and mobility for chemicals of potential concern at the Himco site.

5.2 Potential Routes of Migration

5.2.1 General

The potential routes of contamination migration include percolation/leaching contaminants to groundwater; lateral groundwater flow off-site; erosion and transport of contaminated soils by wind and water to surface water and sediment; volatilization of organic compounds from landfill material; and sorption/desorption of contaminants onto/from soil. The majority of the contaminant mass at the site is located below a landfill cover. The continuity and effectiveness of the cap in containing the contaminants is questionable. Additionally, there is no natural or man-made barrier to isolate the contaminants from contact with groundwater. The following sections describe the potential routes of contamination migration at the Himco site.

5.2.2 Groundwater

The site contaminants enter groundwater via leachate and direct contact between the site groundwater and landfill wastes. Contaminants entering groundwater migrate off-site in the same direction as the site groundwater flow. The rate of transport depends on groundwater velocity as well as solubility, dispersity, and adsorption/desorption characteristics of the contaminants in the aquifer.

5.2.3 Erosion-Transport

Erosion of the landfill cover may result in the transport of contaminants by volatilization, wind, and/or water mechanisms.

5.2.4 Volatilization

VOCs in the landfill may volatilize if landfill wastes are exposed. In addition, volatilization may occur at locations where leachate breakouts occur.

5.2.5 Leachate Breakouts

Leachate may break out along the sides of the landfill. Contaminants at these breakout locations may volatilize, precipitate out of a solution, and sorb onto surface soils, or be transported by surface runoff to one or more of the three site ponds.

5.2.6 Surface Water and Sediments

Surface water runoff from the landfill area flows off-site and to the three site ponds, especially to the small L-shaped ponds located near the west end of the site. Contaminants may migrate by surface water runoff to the ponds and be sorbed onto sediments or remain in solution in the surface water.

5.3 CONTAMINANTS OF CONCERN

The contaminants grouped and listed below have been identified in the baseline risk assessment because either they contribute to an excess cancer risk above 1 in 1 million ($1x10^{-6}$), or a hazard index of greater than one.

Volatile Organic Compounds

- 1,1-Dichloroethene
- Benzene
- 1,1-Dichloroethane
- Bromodichloromethane
- Styrene
- Toluene
- Chloroform
- 1,4-Dichlorobenzene

Semi-Volatile Organic Compounds

- Benzo(a)anthracene
- Benzo(a)pyrene
- Benzo(k)fluoranthene
- Chrysene
- Dibenzo(a,h)anthracene
- Indeno(1,2,3,-cd)pyrene

Inorganic Analytes

- Arsenic
- Beryllium
- Antimony
- Nitrate/nitrite

5.4 PHYSICAL/CHEMICAL CHARACTERISTICS IMPACTING FATE AND TRANSPORT

5.4.1 Organic Compounds

5.4.1.1 Water Solubility

Transport of organic compounds within the hydrologic cycle is affected by the solubility of their solid, liquid, or gas phases in water. Factors that can potentially affect the solubility of organic compounds include temperature, salinity, dissolved organic matter, and pH. Methods to estimate the water solubility of organic compounds are provided by Lyman et al. (1990). The solubility in water of many organic compounds and common organic contaminants is provided by Weast (1981) and EPA (1986). The solubility and mobility classification of some organic solvents are provided by Roy and Griffin (1985). Water solubilities of organic compounds of concern at the Himco site are listed on Table 5-1.

5.4.1.2 Gas Volatilization and Diffusion

Volatilization is the process by which a contaminant changes from the solid or the liquid phase to the gas phase. If the contaminant is located in subsurface porous material, then diffusion is the mechanism by which the organic contaminants transport to the surface.

TABLE 5-1

PROPERTIES OF DETECTED ORGANIC COMPOUNDS
HIMCO DUMP SUPERFUND SITE
ELKHART, INDIANA
1992

	Molecular Weight (grams/mole)	Specific Gravity	Vapor Pressure (mm Hg)	LOG (K_{OW})	LOG (K_{OC})	Henry's Constant at 25°C (atm-m^3/mol)	Vapor Density	Solubility in Water mg/l at 20°C
Volatile Compounds:								
Benzene	78	0.879	76	2.13	1.81	5.43E-03	3.19	1,780
Chloroform			160	1.97	1.64	3.75E-03	4.88	8,220
1,1-dichloroethane	99	1.174	180	1.79	1.48	5.5E-03	4.04	5,500
Bromodichloromethane	163.83	1.98	50	1.88	1.79	2.4E-03	6.70	4,500
1,1-Dichloroethene	97	1.218	591	2.09	1.77	3.84E-1		600
Styrene	104	0.905	5	3.16	ND	2.28E-3	4.26	300
Toluene	92	0.867	22	2.69	2.15	6.6E-03	3.77	515
Semi-Volatile Compounds:								
1,4-Dichlorobenzene		1.2475					-	0.014
Benzo(a)anthracene	228	1.274	1.16E-9	5.61	6.14	4.5E-6	-	0.014
Benzo(a)pyrene	252 (solid)	1.351	5E-09	6.06	6.74	1.8E-05	-	0.0038
Benzo(k)fluoranthene	252 (solid)	-	9.59E-11	6.06	5.74	3.94E-5	-	.0043
Chrysene	228	1.2741	6.3E-9	5.61	5.30	1.05E-6	-	.006
Dibenzo(a,h)anthracene	278	1.282	1E-10	6.80	6.52	7.33E-8	-	.0025
Indeno(1,2,3-cd)pyrene	276	-	1E-10	6.50	6.20	6.95E-8	-	.000534

TABLE 5-2

TYPES OF ORGANIC FUNCTIONAL GROUPS SUSCEPTIBLE TO HYDROLYSIS
(Lyman et al., 1990)

- Alkyl halides
- Amides
- Amines
- Carbamates
- Carboxylic acid esters
- Epoxides
- Nitriles
- Phosphoric acid esters
- Phosphoric acid esters
- Sulfuric acid esters
- Sulfuric acid esters

Source: Lyman, et al. (1990)

Organic chemical properties that can be used to predict the potential for volatilization include vapor pressure and boiling point. The vapor pressure of a chemical is the pressure exerted by its vapor when in equilibrium with its solid or liquid form. The boiling point is defined as the temperature at which the vapor pressure of the chemical equals atmospheric pressure. Therefore, a relatively low boiling point indicates high vapor pressure at a given temperature. High vapor pressures indicate relatively weak intermolecular bonds and greater potential for volatilization.

The chemical structure of an organic compound affects its volatility. Generally, volatility increases with branching of chains and presence of ring structure and double bonds. Volatility decreases with molecular weight. Chemicals with vapor pressures greater than 10^{-2} mm Hg are volatile and occur primarily in the gas phase. Those chemicals with vapor pressures less than 10^{-7} mm Hg do not readily volatilize and occur as liquids or solids (Dragun J., 1988). Weast (1981), provides the vapor pressures of many organic compounds. Vapor pressure values of organic compounds of concern at the Himco site are included on Table 5-1.

Henry's Law is also used to estimate the relative volatility of organic compounds when the contaminant is dissolved in water. In dilute solutions (mole fraction <0.001), the vapor pressure (Vp) of a compound is proportional to its concentration in water as expressed by the equation: $Vp=K_hC$, where K_h is Henry's Law constant and C is the concentration of the contaminant in water. Compounds with K_h values greater or equal to 10^{-3}, between $3x10^{-7}$ to 10^{-3}, and less than $3x10^{-7}$ atm-m^3/mole, have been classified as high, moderate, and low volatility compounds, respectively (Lyman, 1990). Henry's constants have been determined for many compounds or can be approximated (Dragun, 1988). Henry's constants for organic compounds of concern at the Himco site are included on Table 5-1.

The diffusion rate of a gas in a porous media is a function of gas and soil properties. Compound properties, such as vapor pressure and boiling point, can be used to predict gas diffusion rates in the media. Since gas must move through soil pores, properties such as pore function and moisture content also affect gas diffusion. Low soil pore fraction and high moisture content retard the diffusion of a gas through the soil. The forces that cause diffusion are gradients within the soil due to gas concentration, pressure, or temperature differences. A description of models used to predict both diffusion and volatilization are provided by Dragun (1988), Lyman et al. (1990), and Olsen and Davis (1990).

5.4.1.3 Hydrolysis

Hydrolysis refers to a reaction with water in which compound bonds are broken and new bonds with OH^- and H^+ are formed. The typical reaction usually results in the introduction of a hydroxyl group (OH^-) into the chemical compound with the loss of an ion from the chemical (X^-) (Dragun, J., 1988; Olsen and Davis, 1990):

$$RX + H_20 \text{ --> } ROH + H^+ + X^-$$

$$RX + OH^- \text{ --> } ROH + X^-$$

For example, bromopropane is transformed to proply alcohol via a hydrolysis reaction (Olsen and Davis, 1990) as follows:

$$CH_3CH_2CH_2Br + H_2O \quad CH_3CH_2CH_2OH + H^+ + Br.$$

Hydrolysis is often the most important reaction of organic compounds with water in aqueous environments. The rate at which an organic compound is hydrolyzed is generally a function of the concentration of the organic compound, the solution pH, and the temperature. Generally, the hydrolysis rate of organic chemicals in aqueous systems is first order in the concentration of the organic species. Hydrolysis also increases with temperature (Lyman et al., 1990). Types of organic functional groups found that are potentially subject to hydrolysis are given in Table 5-2 (Lyman et al., 1990).

5.4.1.4 Oxidation/Reduction

Oxidation is the removal of electrons from a chemical. Complete oxidation ultimately results in the conversion of organic matter to carbon with the release of CO_2 and water. In aqueous systems, a considerably smaller group of organic compounds are affected by oxidation reactions as compared to those affected by hydrolysis. Oxidation, however, is the dominant loss process for most chemicals in the atmosphere (Mill, 1982). Only a select group of compounds in the aqueous environment are subject to oxidation at rates that are significant. Generally, aromatic amines and phenols can be oxidized by free radicals in aqueous systems (Mill, 1982).

An organic compound is reduced if it gains electrons as a result of a chemical reaction. Reductive dehalogenation is a reaction that results in the loss and gain of a halogen and hydrogen atom, respectively, from an organic compound. Reductive dehalogenation is generally a first-order reaction in aqueous systems, which indicates that the decay rate is directly proportional to the concentration of the organic compound. Degradation of DDT and TCE to DCE, and DCE to vinyl chloride from reductive dehalogenation have been documented (Dragun, 1988). Simple ring compounds (aniline, toluene, and xylene) and halogenated aliphatic compounds may degrade through reduction reactions (Olsen and Davis, 1990). At present, reduction reactions involving organic compounds in soil systems are not well understood (Dragun, 1988).

Oxidation and reduction reactions in groundwater and soil are a function of electrical potentials in the reacting systems. Well-oxidated aerated soils have redox potentials that may range from 800 to 400 millivolts. Highly reduced soils may have potentials that range from -100 to -500 millivolts. For oxidation or reduction of an organic compound to occur, the potential of the system (soil, water) must be greater or less, respectively, than the potential of the organic compound (Dragun, 1988).

5.4.1.5 Dehydrohalogenation (Elimination)

Dehydrohalogenation is an elimination reaction affecting halogenated compounds. It is caused by the removal of a halogen and hydrogen ion from adjacent carbon atoms of a saturated (single carbon bonds) organic compound to form an unsaturated (double carbon bonds) compound (Olsen and Davis, 1990). Generally, reaction rates are first order and dependent on the degree of halogenation. Biotic (bacteria as catalysts) reactions are generally faster than abiotic (no bacteria). Degradation of PCA to TCE and TCA to DCE from dehydrohalogenation have been reported (Olsen and Davis, 1990); Vogel and McCarty, 1987).

5.4.1.6 Photodecomposition

Many organic chemicals degrade due to reactions that are initiated by the adsorption of solar radiation. Photodecomposition of an organic compound can occur with direct adsorption of solar radiation or through energy transfer from other compounds that have adsorbed solar radiation. Photodecomposition reactions depend on latitude, time of year, climate, and temperature. Organic compounds located on the soil surface may be degraded through photodecomposition; however, the affects of photodecomposition on compounds within the soil are not significant (Mill and Mabey, 1985).

5.4.1.7 Adsorption

The amount and rate at which organic compounds adsorb to the soil have significant effects on their transport in the unsaturated and saturated zones. The degree of adsorption also affects other transformation reactions such as volatilization, hydrolysis, and biodegradation. A primary factor that controls organic compound adsorption is the amount of organic matter in the soil matrix. Organic matter typically has high cation exchange capacity and, therefore, increases the potential for adsorption of polar organic compounds. Nonpolar organic compounds are often hydrophobic and, therefore, have low water solubility. These compounds also show an affinity to organic matter through nonionic adsorption mechanisms. Other factors that affect adsorption include temperature, pH of soil and water, surface area of solids, solids-to-solution ratio, and mechanisms that retard or prevent equilibrium (Lyman et al., 1990).

Mathematical models have been developed to predict the adsorption of a compound on a solid matrix in a water solution. The linear, langmuir, and freundlich isotherms are the most common models (Bohn, 1985). Application of the linear adsorption isotherm and solute transport models generally require a description of the specific compound partitioning between the solid and solution phases. This distribution is described by the soil-water distribution coefficient (K_d) which is the ratio of the compound concentrations in the solid and liquid phases. Since K_d values are not readily available for all compounds, other partitioning coefficients have been developed to estimate the partitioning of contaminants between the solid and water phases. Partitioning coefficients that are used to estimate the distribution of a compound between solid and liquid phases include the organic carbon (K_{oc}), organic matter (K_{om}), and octanol water (K_{ow}) distribution coefficients. The K_{oc} and K_{om} measures the ratio of adsorbed compound mass per unit organic carbon and organic matter mass, respectively, in the soil matrix to the solution compound concentration at equilibrium. The K_{ow} measures the distribution of a compound in octanol (immiscible organic solvent) and water solution at equilibrium. Dragun (1988) classified potential chemical mobility based on K_d, K_{ow}, and K_{oc} values (Table 5-3). Lyman et al., 1990; Dragun, 1988; Sawhney and Brown, 1989; Travis and Etnier, 1981; Miller and Weber, 1985; and Olsen and Davis, 1990, describe adsorption models. The EPA, 1986, provides water solubility, vapor pressure, Henry's Law constant, and K_{oc} values for more than 300 organic and inorganic chemical compounds. Log K_{ow} and Log K_{oc} values for organic compounds of concern at the Himco site are included in Table 5-1.

TABLE 5-3

CHEMICAL MOBILITY BASED ON SOIL-WATER PARTITION COEFFICIENTS

(Dragun, 1988)

K_d	K_{ow}	K_{oc}	Mobility
>10	7,200	>2,000	immobile
2-10	60-200	500-2,000	low mobility
0.5-2	20-60	150-500	intermediate mobility
0.1-0.5	5-20	50-150	mobile
<0.1	<5	<50	very mobile

Source: Dragun (1988)

5.4.1.8 Biodegradation

Biodegradation is one of the most important environmental processes that cause the breakdown of organic compounds. It is believed that most chemical reactions in the groundwater zone are slow compared with transformations mediated by microorganisms. Biodegradation can occur in both aerobic and anaerobic environments. The microorganisms predominately responsible for biodegradation in natural systems are heterotrophic (require organic carbon as energy source) and autotrophic (do not require organic carbon) bacteria, fungi, and certain protozoa (Lyman et al., 1990). Biodegradation of an organic compound occurs when the compound is incorporated into the bacterial cell and the organic compound reacts with cell enzymes. The ultimate products of reactions are bacterial cells, carbon dioxide, and water. Factors affecting biodegradation rates include composition and size of soil microbial population, energy source, pH, temperature, moisture, essential elements, organic chemical concentration, microbial toxicants, and degree of organic compound adsorption on soil matrix (Dragun, 1988). The largest microbial population is within the surface soil, but high numbers of bacteria have been identified in shallow unconfined aquifers (Wilson and McNabb, 1983). Some organic contaminants can be transformed by microorganisms attached to solid surface within the aquifer. These bacteria obtain energy and nutrients from the flowing groundwater and form biofilms as their numbers increase (Mackey et al., 1985). Generally, there is a minimum concentration to which a single substrate (organic compound) can be degraded. Further bacterial decomposition requires the addition of a primary substrate to meet bacterial energy requirements (Mackey et al., 1985). Bosma et al. (1987); Alexander and Scow (1989); and Srinivasan and Mercer (1988) provide a description of biodegradation models. Bouwer and McCarty (1984) and Bouwer and Wright (1988) report on laboratory biotransformation studies within biofilm columns.

5.4.2 Inorganic Compounds

5.4.2.1 Water Solubility and Complex Formation

Transport of an inorganic compound within the hydrologic cycle is affected by its solubility. The solubility of inorganics in aqueous systems is controlled by many factors including temperature, pH, oxidation/reduction potential, and solution composition. An inorganic element, such as lead, can exist in more than one form (or species). The amount of each species in water can be evaluated with equilibrium constant expressions which are equations that relate the molar concentrations of reactions and products to one another by means of a temperature dependent numerical quantity called an equilibrium constant. Solubility products (K_{SP}) are constants that describe the equilibrium between a slightly soluble solid and its ions, and are used to calculate solubilities. The formation constant (K_f) describes complex ion formation (Skook et al., 1988). Complex formation generally modifies the inorganic species and may alter solubility and mobility. The number of complexes formed and the degree to which they form depends on the overall chemical composition of the media involved. Many of these inorganic compounds are given by Weast (1973) and EPA (1986).

5.4.2.2 Adsorption

As with organic contaminants, the degree and rate at which inorganic contaminants are adsorbed/desorbed to the soil or subsurface porous medium affects their transport in the unsaturated and saturated zones. Inorganic compound adsorption typically occurs at the solid liquid interface of the porous medium matrix. Inorganic compound adsorption is controlled by chemical and electrostatic forces. Chemical forces at the solid surface cause relatively strong covalent bonding of inorganic ions or complexes at specific sites. Electrostatic forces at the solid surface are caused by differences in potential between the solid surface and polarized compounds and also non-specific physical attractions between the solid surface and adsorbate due to Van Der Walls forces (Anderson and Rubin, 1981). The porous medium factors that affect adsorption or organic contaminants and the models described previously (Organic Adsorption) also apply to inorganic adsorption.

5.4.2.3 Biodegradation

Microbial reactions are not as significant for inorganic compounds as compared to organic compounds. However, microbial processes affect the mobility and form of some inorganics. Microenvironment changes due to microbial activity often control pH and redox potential and, therefore, affect the mobility or toxicity of inorganic elements or compounds. Also, inorganic ions are often immobilized to organic forms to satisfy the needs of microbial growth.

5.5 RESULTS

The following discussion addresses contaminant persistence and mobility for organic and inorganic contaminants of potential concern at the Himco site. Discussions are based on information from Section 5.4.

In general, the greatest potential for contaminant migration is through groundwater or subsurface vapor transport. Therefore, important mechanisms focused on in this section include contaminant solubility, adsorption, and diffusion.

5.5.1 Organic Compounds of Potential Concern

Organic compounds of potential concern are grouped into VOCs and SVOCs. This potential fate and transport are described in the following sections.

5.5.1.1 Volatile Organic Compounds (VOCs)

The potential for VOC mobility is high, and the greatest potential mobility is within the saturated and vadose zones of the sand and gravel deposits at the Himco site. Based on values from Table 5-1, the VOCs of potential concern are ranked as highly volatile, relatively soluble in water, and mobile. Volatility is based on Henry's Law constants (EPA, 1986b) and the ranking system is described in Section 5.4. Solubilities range from 300 mg/l to 5,500 mg/l. The mobilities were estimated based on K_{OC} values (EPA, 1986b) and the use of Dragun's (1988) mobility classification system, as given in Table 5-2.

The potential for attenuation/adsorption of organic contaminants within the sand and gravel deposits at the Himco site is low. Sands and gravels typically have low organic matter content which is not conducive to organic compound adsorption within the soil/water matrix. Minor seams of silt and clay were found below the Himco site, but the sand and gravel deposits are the dominant material below the Himco site from ground surface to bedrock. The potential for organic compound adsorption is greater within the sediment deposits associated with the three site ponds.

The organic compounds at the Himco site may be subject to hydrolysis, degradation through biotic or abiotic processes, oxidation, reductive dehalogenation, or dehydrohalogenation. Degradation of organic compounds may result in the formation of less or more toxic products.

Due to the high mobility of the VOC contaminants at the Himco site, the potential for VOC contaminant migration in groundwater appears to be relatively high. The groundwater sampling indicates little impact to groundwater at present. This may be due to factors such as a limited contaminant mass entering the aquifer because leachate is physically held in the landfill mass by refuse materials, and/or because there is sufficient dilution within the aquifer to rapidly reduce the concentrations. Because the leachate volume cannot be quantified, the relative impact of each of the above factors cannot be determined at this time. The fact that a bromide plume was identified by USGS suggests that leachate moves from the landfill. The fact that current bromide concentrations in the downgradient aquifer are lower now than reported by USGS suggests that there may have been a larger release of leachate in the past.

Due to the high volatility of VOC contaminants at the Himco site, volatilization through subsurface soils, and migration due to diffusion forces is likely. However, the landfill gas analysis shows that the amount of volatiles leaving the landfill by this pathway is small. If landfill wastes are excavated, volatilization to the ambient environment would be enhanced and may become a more dominant fate mechanism at this site.

5.5.1.2 Semi-Volatile Organic Compounds (SVOCs)

The mobility for SVOCs of potential concern at the Himco site is relatively low. The greatest potential for SVOC mobility is within the saturated zone of the sand and gravel deposits at the Himco site. Based on values from Table 5-1, the SVOCs of potential concern are ranked as having low solubilities, are immobile, and have moderate to low volatility. Solubilities range from 0.000534 mg/l to 0.014 mg/l.

The mobilities were estimated based on K_{OC} values (EPA, 1986b) and the use of Dragun's (1988) mobility classification system, as given in Table 5-2. Volatility is based on Henry's Law constant (EPA, 1986b) and vapor pressure values. The ranking system for Henry's Law constants and vapor pressure values is described in Section 5.4.

In general, SVOCs at the Himco site were detected primarily in surface soil samples and relatively high concentrations were detected in an area located near the south-central edge of the landfill. SVOCs were also detected in leachate. SVOCs are expected to remain strongly held in the soils. As expected, only traces of SVOCs were detected in groundwater samples collected during the RI.

In addition, SVOCs at the Himco site may be subject to hydrolysis, degradation through biotic or abiotic processes, and oxidation. Bacteria should be present in the surface soils, and anaerobic conditions probably prevail within the landfill. Degradation of SVOCs may result in the formation of less or more toxic products.

5.5.2 Inorganic Compounds of Potential Concern

Inorganic compounds found at the Himco site characteristically remain in liquid or solid phases. It is anticipated that inorganic compound mobility in the gas phase is insignificant. The solubility of the inorganic compounds arsenic, beryllium, and antimony are dependent in factors that control dissolution, precipitation, and complexation processes. These factors include groundwater solution composition, environmental conditions such as pH and oxidation/reduction potentials, and the inorganic contaminant concentrations. Nitrate/nitrite is not limited by solubility constraints and moves in groundwater with no transformation. Due to the lack of retardation and transformation, nitrate/nitrite is very mobile in groundwater. Nitrate/nitrite would have to transform into NH_3, N_2, or N_2O to become mobile as a gas.

The solubility of arsenate ions (AsO_4^{-3}) in water is dependent on cation solution concentrations. In the presence of metal cations, the solubility of arsenate is less than a few tenths of a milligram of arsenic per liter. The adsorption of arsenate on precipitated ferric hydroxide also limits its solubility in natural systems (USGS, 1982). Beryllium oxide and hydroxide species have very low solubilities. The calculated concentrations of uncomplexed Be^{+2} at a pH of 7.0, based on solubility products, is less than 1 ug/l. At low pH beryllium ions are adsorbed by clay surfaces or other mineral species in water, and at higher pH beryllium ions form complex species with hydroxides (USGS, 1982). Antimony is insoluble in water. However, antimony chlorides and fluorides are soluble with ranges of 384 to 600 grams/100 ccs of water (Weast, 1984). Cyanide tends to form soluble complexes with iron.

Similar mechanisms, as discussed for organic contaminant persistence, apply to these inorganic contaminant trends.

6.0 BASELINE RISK ASSESSMENT

The baseline risk assessment for the Himco site is an analysis of the potential adverse health effects (both current and future) resulting from exposures to hazardous substances in soil and groundwater at the site. By definition, a baseline risk assessment is limited to conditions under the no-action alternative, that is in the absence of remedial actions to control or mitigate releases. The results of this baseline risk assessment will be used to:

- Document both the magnitude and causes of risk at the Himco site.
- Aid in determining if remedial actions may be necessary to mitigate unacceptable health risks.

The methods used in this risk assessment were developed by the U.S. EPA specifically for evaluations of risk at hazardous waste sites (EPA, 1989b). Overall, these methods are intentionally conservative. This means that the estimates of risk calculated in this report are likely to be somewhat higher than the true risk.

The baseline risk assessment report for the Himco site identified 22 inorganic and 65 organic chemicals of potential concern. The most important exposure pathways were judged to be ingestion of contaminated groundwater, incidental ingestion of contaminated soil, and inhalation of VOCs. For each pathway, risks were calculated for both current populations and hypothetical future populations. Current populations are residents south of the site, recreational dirt-bike riders, and recreational visitors (waders, fishers). Future populations include site residents (on the landfill and immediately south of the landfill), plant workers on site, agricultural workers on site, and downwind off-site residents.

Estimated cancer risks for current populations range from 2E-08 (wader) to 2E-07 (downwind adult resident). Estimated cancer risks for future populations are highest for residential children at a home built on the landfill (2E-01). Estimated cancer risks for future adult and children at a home immediately south of the landfill are 5E-3 and 3E-3, respectfully. From these risks, background contributions associated with the groundwater and soil exposure media are approximately 6E-3. Approximately 90% of the cancer risk is from groundwater pathways and the major contributors are arsenic, beryllium, and PAHs.

For hypothetical future populations, HIs are greater than 1E+00 for all populations which are assumed to utilize groundwater as drinking water. The calculated HI values range from 9E+00 (adult resident south of the landfill) to 1E+03 (child resident on the landfill). From the above risks, background contributions associated with groundwater and soil exposure media are approximately 6. Similar to the carcinogenic risks, almost all of these risks are from the groundwater pathways. The contaminants contributing to this risk include ten inorganics (antimony, arsenic, barium, beryllium, cadmium, chromium, mercury, vanadium, cyanide, and nitrate/nitrite) with antimony and nitrate/nitrite accounting for approximatley 90% of the risk. For the hypothetical future agricultural worker, tilling operations on the landfill might result in a HI of 4E+00 (due to inhaled chromium). No HIs for current populations exceed 1E+00. In addition, it appears that lead in groundwater is also a cause for concern at this site.

The baseline risk assessment report is presented in its entirety in Appendix E (Volume 5 of this report).

7.0 SUMMARY AND CONCLUSIONS

7.1 SUMMARY

The RI at the Himco site was conducted to determine the nature, extent, and sources of contamination to support a human health risk assessment, ecological assessment, and to conduct a feasibility study. Media sampled and analyzed during the RI included:

- Surface soil on the landfill cover
- Surface soil in areas next to the landfill
- Subsurface soils next to the landfill
- Waste mass gas under the landfill cover (3 feet deep)
- Groundwater
- Leachate collected from within the landfill
- Surface water and sediment from three surface water bodies (quarry pond, L pond and small pond) at the site

Activities completed during the RI also included characterization of the waste in the landfill, geologic, and hydrogeologic conditions, and an assessment of human and ecological impacts.

7.1.1 Physical Characteristics

7.1.1.1 Landfill Characteristics

Figure 1-2 shows the landfill boundaries. The extent of the landfill was determined using a combination of geophysical surveys, test pit and soil boring observations, and examination of aerial photographs.

Test pit excavations in the landfill revealed the presence of mixed waste. In addition, leachate was present in the majority of trenches. Leachate was observed to be gray-black in color with "rainbow sheens," except at one location near the southwest corner of the landfill where the leachate was biphasic and red-brown in color. At this location, the organic phase of the leachate contained approximately 48 percent toluene by weight. This location has been referenced as the hot spot in the landfill. The hot spot is indicated on Figure 1-2.

Three general layers were consistently observed in the landfill. The top layer can be characterized as a silty sand cover which ranged in thickness from a thin veneer to several feet. Underlying the sand cover, and in some cases at ground surface, calcium sulfate was found which varied in thickness from a few inches to as much as nine feet towards the southeast central and southern areas of the landfill. The areal extent of the calcium sulfate layer is shown in Figure 1-2. Beneath the calcium sulfate layer, an estimated 15- to 20-foot thick waste layer is present. Underneath the calcium sulfate, wastes were found to include paper, plastic, rubber, wood, glass, metal including an occasional drum, glass, and small amounts of hospital wastes (e.g., syringes, vials).

Non-native soil mixed with construction debris was observed in test pits excavated outside the landfill along the south-central and southwest edge of the landfill. This area is shown in Figure 1-2. No calcium sulfate was found in this area. SVOC contamination was found to be most prominent in surface soil samples collected from this area.

7.1.1.2 Geology/Hydrogeology

The stratigraphy beneath the Himco site can be characterized as sand and gravel outwash deposits comprised of alternating beds, varying in thickness, of poorly to well-graded sands and gravels, and gravel-sand-silt mixtures ranging from approximately 200 to 500 feet below ground surface. These outwash deposits constitute the primary groundwater aquifer at the site. Minor seams of silt and clay were also encountered, but there was no indication of a consistent confining layer beneath the site.

Groundwater occurs between approximately 5 and 20 feet below the ground surface at the site, at an elevation ranging from 752 to 756 feet (MSL). The elevation of the bottom of the waste mass is estimated to range from 755 to 760 feet (MSL). Three surface water bodies representing the surface expression of the water table exist at this site. Groundwater flow is generally to the south-southeast towards the St. Joseph River, which is a regional groundwater discharge for this area. The average horizontal flow gradient beneath the site is approximately 0.0016 ft/ft. Vertical gradients were predominately upward and ranged from 0.00021 ft/ft to 0.0013 ft/ft. Calculated field hydraulic conductivities ranged from 0.12 cm/s to 0.00079 cm/s, with an average value of 0.0022 cm/s.

7.1.2 Nature and Extent of Contamination

In general, contamination was primarily found in leachate samples from the landfill and surface soil samples south of the landfill area. SVOC contamination in surface soil samples was especially prominent near the south-central area of the site characterized by non-native soil and construction debris. Limited contamination was revealed from the sampling of subsurface soils, groundwater, surface water and sediment, and waste mass gas. Media-specific descriptions are presented in the following sections.

7.1.2.1 Groundwater

Two rounds of groundwater sampling revealed limited groundwater contamination outside the boundaries of the waste. Trace amounts of VOCs and SVOCs were detected. During RI Phase I sampling, trichloroethene was detected above its MCL of 5 ug/l in two USGS wells WTJ1 and WTJ2, which are located approximately 2,000 feet off-site and sidegradient to the Himco site. However, trichloroethene was not detected in the monitoring wells close to the landfill and potentially upgradient to wells WTJ1, and WTJ2 (i.e., WTP1, WTE1, WTE2, WT101A, WT101B, WTM1, and WTM2). Therefore, the data are inconclusive as to whether the Himco site is the source of the contamination in wells WTJ1 and WTJ2. No pesticides or polychlorinated biphenyls (PCBs) were detected in any groundwater samples.

Three analytes of concern--arsenic, beryllium, and antimony--were also detected in shallow wells near the southeast corner of the site. However, beryllium contamination was not evaluated to be a site-related contaminant because of similar detections in background wells. Arsenic and antimony, which were detected in the shallow wells, were suspected of being site-related contaminants because they were detected in downgradient wells at concentrations significantly higher than the background wells in both round 1 and round 2 samplings. However, arsenic and antimony were detected in deep wells at concentrations comparable to the background wells. Therefore, arsenic and antimony contamination in deep wells is not evaluated to be a site-related contamination.

Arsenic and lead were the only inorganic contaminants detected above their corresponding MCLs. Arsenic was detected above its MCL of 50 ug/l only during round 1 sampling from well WTE2. However, arsenic was not detected in the filtered sample from this same well. In addition, the total suspended solid concentration detected in well WTE2 was 350 mg/l. Therefore, contamination in well WTE2 appears to be associated with suspended solids. Lead was detected above its MCL (15 ug/l, effective December 1992) in eight wells, including well WTE2, between the two rounds of sampling. Lead concentrations ranged from 28.1 ug/l to 210 ug/l. However, filtered lead concentrations from these same wells were non-detect or below MCLs. Inorganic analytes detected in filtered samples from other wells were, in general, similar in concentration to unfiltered samples.

7.1.2.2 Leachate

Leachate was sampled at four test pits and analyzed for VOCs, SVOCs, pesticides/PCBs, metals/cyanide, and water quality. Leachate from test pit TL5 separated into two phases of almost pure product and leachate. Analysis of the pure product phase showed approximately 50% toluene.

Concentrations of VOC and inorganic contaminants detected in leachate were typically orders of magnitude higher than groundwater concentrations. In addition, several VOCs and SVOCs which were detected in the leachate were not detected in the groundwater. The highest concentrations of VOCs and SVOCs were detected in leachate from TL5. Traces of pesticides were detected in leachate samples TL1 and TL2. PCBs were not detected in any of the groundwater samples collected.

7.1.2.3 Soil

Contaminants were detected primarily in surface soils. Two analytes of inorganic concern, arsenic and beryllium, were detected in surface soil samples located across the western half of the site, around the quarry pond, and in the south-central area characterized by non-native soil and construction debris. The highest concentrations of arsenic were detected in soil samples from the south-central area. Although arsenic in surface soil was evaluated to be a site-related contamination, its detection in subsurface soil was evaluated to be a naturally occurring condition because of comparable levels in the background samples. Beryllium was detected at random locations, including the background location, at relatively consistent concentrations. Beryllium detection in surface and subsurface soils was not evaluated to be a site-related contamination because of comparable levels in background samples.

VOCs were detected widespread across the site. In all cases, VOCs were found at low concentrations (less than 140 ug/kg). SVOC soil contamination was found to be most prominent in samples collected in the south-central area characterized by non-native soil and construction debris. VOC and SVOC contamination in surface and subsurface soils is suspected of being site-related. Pesticides were detected in two soil samples collected from this area.

7.1.2.4 Surface Water and Sediment

Surface water and sediment sampled revealed very limited contamination in the three site ponds. Inorganic concentrations were similar to background levels, except for antimony in sediments from the quarry pond which exceeded the background levels. Pesticides and PCBs were not detected. VOCs were detected at low concentrations in both surface water and sediment samples (i.e., less than 6 ug/l in surface water and close to background in sediment). Methylene chloride was detected at concentrations ranging from 6 to 120 ug/l in surface water; however,, this contamination may be a laboratory artifact. SVOCs were detected at low concentrations only in surface water samples.

7.1.2.5 Waste Mass Gas

VOCs were detected in all 14 waste mass gas samples collected from the landfill area. However, the concentration of total VOCs was less than 1 ug/l in 12 of the 14 samples. VOCs at the other two locations totaled 9.8 ug/l and 12.2 ug/l.

7.1.3 Fate and Transport

The majority of the contaminant mass at the Himco site is located below a landfill cover and is evaluated to be occasionally in direct contact with groundwater. Therefore, the greatest potential for contaminant migration is through the groundwater pathway. Contaminant migration through the groundwater pathway is a function of mobility and persistence of the contaminants as well as groundwater flow characteristics. SVOCs detected at the Himco site exhibit low mobility, whereas the detected inorganic and VOC compounds of potential concern exhibit high mobility. In addition, the potential for attenuation within the sand and gravel deposits underlying the site is low. Since groundwater flow velocity is relatively low, contaminants upon entering groundwater may migrate off-site at a very slow rate. However, very little contamination has been detected in groundwater sampled at the Himco site. Therefore, contaminants from the landfill appear to be strongly held to the landfill waste mass and enter groundwater at a very slow rate. This will result in a high dilution rate with groundwater and resulting low concentrations of the contaminants in groundwater.

7.1.4 Risk Assessment

The baseline risk assessment for the Himco site was conducted to analyze the potential adverse health effects resulting from exposures to hazardous substances in soil and groundwater. The calculated risks derived for the site should be considered approximate based on uncertainties inherent to risk assessment procedures, and are likely to overestimate actual risk. Among contaminants detected at the Himco site, 22 inorganic and 65 organic contaminants were selected as chemicals of potential concern.

The most important exposure pathways were judged to be ingestion of contaminated groundwater, incidental ingestion of contaminated soil, and inhalation of VOCs. For each pathway, risks were calculated for both current populations and hypothetical future populations most likely to be exposed.

Carcinogenic Effects

Estimated cancer risks for current populations range from 2E-08 (wader) to 4E-06 (dirt bike rider). Estimated cancer risks for future populations are highest for residential children at a home built on the landfill (7E-01). From these risks, background contributions associated with groundwater and soil exposure media were 6E-4. Approximately 99% of the cancer risk is from groundwater pathways and the major contributors are arsenic, beryllium, PAHs, and vinyl chloride. A majority of the risk is attributable to beryllium, which was not detected in leachate samples, but was evaluated at one-half of its detection limit.

At a hypothetical residence south of the landfill, the estimated excess cancer risks are in the range of one in 1,000 (1E-3) for either shallow or deep groundwater. Virtually all this risk, however, is attributable either to chemicals present in groundwater upgradient of the site and representative of background conditions (arsenic, beryllium) or to chemicals not detected at these locations but conservatively evaluated in the risk assessment at one-half their detection limit. (Refer to Table 5-9 of the Baseline Risk Assessment, Appendix E to the RI report. Therefore, it appears that although the groundwater beneath the landfill is contaminated at a level of health concern, this contamination has not moved to (or at least has not been detected at) downgradient exposure points south of the landfill. In addition to groundwater, the soil ingestion pathway contributes a risk of 6 in 10,000 (6E-4) to a future adult resident living south of the landfill area. This risk is attributable mainly to PAHs detected in this area of the site.

Excess cancer risks for similar groundwater exposures for hypothetical future occupational populations are lower than those of residents, but are still above one in 10,000 (1E-4).

Other future land uses which do not involve groundwater do not appear to present unacceptable carcinogenic risks to hypothetical future populations.

Noncarcinogenic Effects

No HIs calculated for current populations exceed 1 (1E+00). However, for future populations assumed to utilize groundwater as drinking water, HIs range from 10 (1E+1) (adult resident south of the landfill) to 1,000 (1E+3) (child resident on the landfill). Of these risks, backgrouond contributions associated with exposure to soil and groundwater are approximately 6E+0. The chemicals contributing to this risk include antimony, arsenic, beryllium, cadmium, chromium, vanadium, and nitrate/nitrite. Hazard indices calculated for hypothetical future occupational exposures using groundwater also exceed 1 (1E+00).

As was the case for carcinogenic risk, once noncarcinogenic risks attributable to background or non-site related chemicals (i.e., nitrate-nitrite) are accounted for, there does not appear to be a concern for noncarcinogenic health effects due to exposures to groundwater south of the landfill. The groundwater beneath the landfill (as represented by the leachate samples) does, however, present a concern for noncancer health effects.

7.2 CONCLUSIONS

The sampling performed to characterize the Himco site was adequate to determine the following:

- The landfill boundary (refer to Figure 1-2).

- Wastes within the landfill are primarily composed of calcium sulfate, paper, glass, plastic, asphalt, concrete, wood, rubber, and scrap metal such as wire, pipes, and an occasional drum. No drum fields were found. In addition, leachate is a common component of the landfill. Leachate at one location was considered a hot spot because it consisted of 48% toluene.

- The primary aquifer beneath the site consists of alternating beds, varying in thickness, of poorly to well-graded sands and gravels, and gravel-sand silt mixtures with an average hydraulic conductivity of 2.2×10^{-2} cm/s.

- Groundwater occurs between approximately 5 to 20 feet below ground surface, at levels at or above the bottom of the waste mass.
- Groundwater flow is primarily horizontal to the south-southeast.
- Leachate has a potential to contribute inorganic and organic contamination to groundwater.
- Soils in an area along the south end of the landfill characterized as non-native soil and construction debris contain the highest concentrations of SVOCs in soils on site.
- Groundwater, surface water and sediment, and waste mass gas contamination is limited.
- Percolation/leaching and lateral groundwater flow are the primary release mechanisms from the landfill.
- Groundwater serves as the primary pathway for potential contaminant migration.
- Inorganic and VOCs of potential concern detected at the Himco site exhibit high mobility. The potential for attenuation with the sand and gravel deposits underlying the site is low.
- SVOCs of potential concern detected at the Himco site exhibit low mobility.
- The potential for inorganic and VOC contaminant migration to groundwater appears to be relatively high. However, groundwater sampling indicates minimal impact or no impact to groundwater outside of the landfill boundaries. This may be due to factors such as a limited contaminant mass entering the aquifer, and/or dilution within the aquifer.
- Potential carcinogenic lifetime risk to current and future populations is attributable to arsenic, beryllium, and PAHs. Virtually all of this risk is from groundwater pathways.
- Noncarcinogenic risks are attributed primarily to antimony, arsenic, beryllium, cadmium, chromium, vanadium, lead, cyanide, and nitrate/nitrite via groundwater ingestion.

Data Limitations and Recommendations for Future Work

For the remedial investigation at any site, there are data limitations and uncertainties inherent to sampling and analysis procedures used, evaluations performed, and assumptions made. It should be noted that the objective of the RI/FS process is not the removal of all uncertainties, but rather the gathering of information sufficient to support an informed risk management decision to determine which remedy appears most appropriate for a given site.

Perhaps the primary uncertainties related to the Himco site remedial investigation pertain to the depth of waste in the landfill and the rate of leachate infiltration into the groundwater. Additional data limitations and uncertainty are associated with the nature of contaminant release to groundwater and off-site migration through the groundwater pathway. Because such a potential appears to exist, additional monitoring wells south of the landfill are required to better monitor groundwater downgradient of the landfill. Another data limitation and uncertainty associated with the results of groundwater sampling involve background levels. The baseline risk assessment indicates a significant contribution to on-site risk due to background levels. However, there were a limited number of background wells to develop these calculations. For example, only two wells were used for shallow background levels. Therefore, additional background wells are required to monitor the background groundwater.

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