

---

# **Hazardous Waste Ground-Water Task Force**

**Evaluation of  
B. H. S., Inc.  
Wright City, Missouri**

**U.S. Environmental Protection Agency  
Region 5, Library (PL-12J)  
77 West Jackson Boulevard, 12th Floor  
Chicago, IL 60604-3590**



**UNITED STATES ENVIRONMENTAL PROTECTION AGENCY**



## UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

December 11, 1986

### UPDATE OF THE HAZARDOUS WASTE GROUND-WATER TASK FORCE EVALUATION OF THE B.H.S., INC., WRIGHT CITY, MISSOURI, FACILITY

The United States Environmental Protection Agency's Hazardous Waste Ground-Water Task Force (Task Force) conducted an evaluation of the ground-water monitoring program at the B.H.S., Inc. (B.H.S.), hazardous waste disposal facility. The onsite field inspection was conducted during the period February 19 through February 26, 1986. The Task Force was accompanied by Missouri Department of Natural Resources (MDNR) and EPA Region VII personnel. B.H.S. is one of 58 facilities that are being evaluated by the Task Force. The B.H.S. facility is located approximately 50 miles west of St. Louis, Missouri, near the town of Wright City.

The purpose of the Task Force evaluation was to determine the adequacy of the B.H.S. ground-water monitoring system in regard to State and Federal ground-water monitoring requirements. Specifically, the objectives of the evaluation at B.H.S. were to:

- Determine compliance with the State equivalent of 40 CFR Part 265 interim status ground-water monitoring requirements.
- Evaluate the ground-water monitoring program described in the facility's RCRA Part B permit application for compliance with the State equivalent of 40 CFR Part 270.14(c) requirements.
- Determine if hazardous waste constituents have entered the ground-water at the facility.
- Provide information to assist the Regional Administrator in determining if the facility meets EPA requirements for waste management facilities receiving waste from Federal Superfund response actions.

The facility was closed at the time of the inspection and, therefore, little activity has taken place since the field work was completed. The facility has met with MDNR once on July 3, 1986 to discuss closure, ground-water monitoring and Part B issues. EPA Region VII met with the facility on December 8, 1986 to preliminarily identify the deficiencies at the facility, and the alternatives for correcting those deficiencies. EPA and MDNR comments on the Part B application for Area 2 have been formulated and will be sent to the facility in December 1986.

Analytical data from the Task Force sampling effort have qualitatively identified the presence of methylene chloride and 1,2-dichloroethane in the ground water at the facility. A majority of the wells sampled were installed just prior to the investigation and were sampled for the first time with this effort. The presence of these compounds will be confirmed with additional sampling by both the facility, during routine quarterly events, and EPA.

The Task Force investigation identified several deficiencies in the geologic and hydrologic site characterization, and in the ground-water monitoring system. These include lack of identification of the uppermost aquifer, lack of a true upgradient well to characterize the background ground-water quality, failure to define the hydraulic characteristics of Units A and B, failure to determine the nature and extent of the sand lenses present in Unit A, and failure to assess the vertical head distribution within and between Hydrologic Units A and B. EPA, in consultation with MDNR, will initiate an appropriate action that will correct these deficiencies and will ensure full implementation of the Task Force recommendations.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY  
HAZARDOUS WASTE GROUND-WATER TASK FORCE

*EPA-330/2-86-012*

GROUND-WATER MONITORING EVALUATION

B.H.S., INC.  
Wright City, Missouri

December 1986

Alan E. Peckham  
Project Coordinator  
National Enforcement Investigations Center

## CONTENTS

### EXECUTIVE SUMMARY

INTRODUCTION . . . . .	1
SUMMARY OF FINDINGS AND CONCLUSIONS . . . . .	10
GROUND-WATER MONITORING PROGRAM DURING INTERIM STATUS . . . . .	11
Site Hydrogeology . . . . .	12
Ground-Water Sampling and Analysis Plan . . . . .	13
Closure/Post Closure Plans . . . . .	13
GROUND-WATER MONITORING PROGRAM PROPOSED FOR THE RCRA PERMIT . . . . .	13
TASK FORCE SAMPLING AND MONITORING DATA ANALYSIS . . . . .	14
COMPLIANCE WITH CERCLA/SUPERFUND OFFSITE POLICY . . . . .	14

### TECHNICAL REPORT

INSPECTION METHODS . . . . .	15
RECORDS/DOCUMENTS REVIEW AND EVALUATION . . . . .	15
FACILITY INSPECTION . . . . .	15
GROUND-WATER AND LEACHATE SAMPLING AND ANALYSIS . . . . .	16
LABORATORY INSPECTION . . . . .	16
WASTE MANAGEMENT UNITS AND OPERATION . . . . .	17
WASTE MANAGEMENT UNITS . . . . .	17
RCRA-Regulated Landfills . . . . .	19
Nonregulated Landfills . . . . .	20
Surface Impoundments . . . . .	21
FACILITY OPERATION . . . . .	22
Waste Acceptance . . . . .	23
Waste Handling . . . . .	24
Inspection Procedures . . . . .	25
Leachate and Surface Runoff Handling . . . . .	25
SITE HYDROGEOLOGY . . . . .	26
HYDROGEOLOGIC UNITS . . . . .	26
GROUND-WATER FLOW . . . . .	26
Hydrologic Unit A . . . . .	29
Hydrologic Unit B . . . . .	29
Ground-Water Flow Summary . . . . .	30

## CONTENTS (cont.)

GROUND-WATER MONITORING PROGRAM DURING INTERIM STATUS . . . . .	34
REGULATORY REQUIREMENTS . . . . .	34
SWDAOP 721901 . . . . .	35
40 CFR Part 265 Subpart F . . . . .	35
HWFP TSD 122282001 . . . . .	35
10 CSR 25-7.011(10) . . . . .	37
GROUND-WATER SAMPLING AND ANALYSIS PLAN . . . . .	38
December 31, 1981 SAPS . . . . .	38
November 15, 1983 SAPS . . . . .	38
April 16, 1984 SAPS . . . . .	38
February 14, 1986 SAPS . . . . .	39
MONITORING WELLS . . . . .	39
System 1 . . . . .	40
System 2 . . . . .	41
System 3 . . . . .	41
Other Wells . . . . .	42
Interceptor Trenches . . . . .	42
Well Construction . . . . .	42
System 1 . . . . .	43
System 2 . . . . .	46
System 3 . . . . .	47
Other Wells . . . . .	48
Well Locations . . . . .	53
Interceptor Trenches . . . . .	53
SAMPLE COLLECTION AND HANDLING PROCEDURES . . . . .	54
WAIVER OF GROUND-WATER MONITORING REQUIREMENTS DEMONSTRATION . . . . .	54
GROUND-WATER ASSESSMENT PROGRAM AND OUTLINE . . . . .	55
GROUND-WATER MONITORING PROGRAM PROPOSED FOR RCRA PERMIT . . . . .	58
DEFINITION OF WASTE MANAGEMENT AREAS . . . . .	58
POINT OF COMPLIANCE . . . . .	58
DETECTION MONITORING PROGRAM . . . . .	60
COMPLIANCE MONITORING PROGRAM . . . . .	61
CORRECTIVE ACTION PLAN . . . . .	63
TASK FORCE SAMPLE COLLECTION AND HANDLING PROCEDURES . . . . .	64
MONITORING DATA ANALYSIS FOR INDICATIONS OF WASTE RELEASE . . . . .	74
REFERENCES	

## CONTENTS (cont.)

### APPENDICES

A	ANALYTICAL TECHNIQUES AND RESULTS FOR TASK FORCE SAMPLES	
B	CONSTRUCTION DRAWINGS	
C	POTENTIOMETRIC SURFACE MAPS	
D	GROUND-WATER MONITORING SYSTEMS	

### FIGURES

1	Location Map	3
2	Hazardous Waste Management Units and Locations	4
3	Area 1 Disposal Units	6
4	Locations of RCRA-Regulated Units in Area 1	7
5	Typical Well Construction Systems 1 and 2	45
6	Typical Well Construction System 3 and GMW Wells	50
7	Designation of Waste Management Areas	59
8	Location of Task Force Sample Stations with Facility Units Shown	66

### TABLES

1	Status of Waste Disposal Units, Area 1	18
2	Hazardous Waste Landfilled in Trench 21	19
3	Classification of Hydrologic Units	27
4	Additional Sampling and Monitoring Requirements Imposed by MDNR	36
5	Ground-Water Sampling and Monitoring Requirements Imposed by EPA and MDNR	37
6	Summary of Well Information, System 1 Nominal 3-Inch Diameter PVC Pipe with Glued Joints	44
7	Summary of Well Information System 2, Nominal 4-Inch Diameter Schedule 40 PVC Threaded Flush Joint Pipe	47
8	Summary of Well Information System 3 and GMW Wells Nominal 2-Inch Diameter No. 316 Stainless Steel, Treaded, Flush-Jointed Pipe	49
9	Summary of Well Information, Wells P17 Through P22 and P-A Through P-D Nominal 3-Inch Diameter PVC Pipe with Glued Joints	51
10	Summary of Well Information Nominal ½ and 1½-Inch Diameter PVC Pipe with Glued Joints	52
11	Phase I Ground-Water Assessment Plan Parameters	56
12	Wells for Monthly Water Level Measurements	61
13	Parameters for Compliance Monitoring Program	62
14	Sample Collection Data	65
15	Order of Sample Collection Bottle Type and Preservative List	67
16	Chemical Vapor and Radiation Detections at Sample Stations Wellheads	70
17	Purging Data	71

## EXECUTIVE SUMMARY



## INTRODUCTION

Concerns have been raised about whether hazardous waste treatment, storage and disposal facilities (TSDFs) are complying with the ground-water monitoring requirements promulgated under the Resource Conservation and Recovery Act (RCRA).<sup>\*</sup> In question is the ability of existing or proposed ground-water monitoring systems to detect contaminant releases from waste management units. To evaluate these systems and determine the current compliance status, the Administrator of the Environmental Protection Agency (EPA) established a Hazardous Waste Ground-Water Task Force (Task Force) to evaluate compliance at TSDFs and address the cause(s) of noncompliance. The Task Force comprises personnel from the EPA Office of Solid Waste and Emergency Response (OSWER), the National Enforcement Investigations Center (NEIC), Office of Enforcement and Compliance Monitoring (OECM), EPA Regional Offices and State regulatory agencies. The Task Force is conducting in-depth onsite investigations of TSDFs with the following objectives:

- Determine compliance with interim status ground-water monitoring requirements of 40 CFR Part 265 as promulgated under RCRA or the State equivalent (where the State has received RCRA authorization)
- Evaluate the ground-water monitoring program described in the facility's RCRA Part B permit application for compliance with 40 CFR Part 270.14(c) or the state equivalent (where the State has received RCRA authorization)
- Determine if the ground water at the facility contains hazardous waste constituents
- Provide information which can aid in determining whether the TSDF can receive waste from response actions conducted pursuant to the

---

<sup>\*</sup> Regulations promulgated under RCRA address hazardous waste management facility operations, including ground-water monitoring, to ensure that hazardous waste constituents are not released to the environment.

Comprehensive Environmental Response, Compensation and Liability Act (CERCLA, Public Law 91-510)\*

To address these objectives, this Task Force evaluation determined whether:

- The facility has developed and is following an adequate ground-water sampling and analysis plan
- Designated RCRA and/or State-required monitoring wells are properly located and constructed
- Required analyses have been properly conducted on samples from the designated RCRA monitoring wells
- The ground-water quality assessment program outline (or plan, as appropriate) is adequate.

The B.H.S. Incorporated, Wright City, Missouri facility (B.H.S.) onsite inspection was conducted from February 19 through 26, 1986. The inspection was coordinated by personnel from NEIC. In general, the evaluation involved a review of State, Federal and facility records; a facility inspection; and ground-water and landfill leachate sampling and analysis.

The B.H.S. facility is located approximately 50 miles west of St. Louis, Missouri [Figure 1]. The site covers approximately 158 acres. The facility has interim status (EPA ID Number MOD068521228) for a landfill (58.9-acre-feet) and treatment in surface impoundments (123 gallons per day).

Hazardous waste related activities at the site consist of closure of the Area 1 landfill and storage/treatment of landfill leachate by surface impoundments [Figure 2]. A new landfill and tank and drum storage operation is proposed for the site in the February 1986 RCRA Part B application.

---

\* EPA policy, stated in the May 6, 1985 memorandum from Jack McGraw on "Procedures for Planning and Implementing Offsite Response", requires that TSDFs receiving CERCLA wastes be in compliance with applicable RCRA ground-water monitoring requirements.

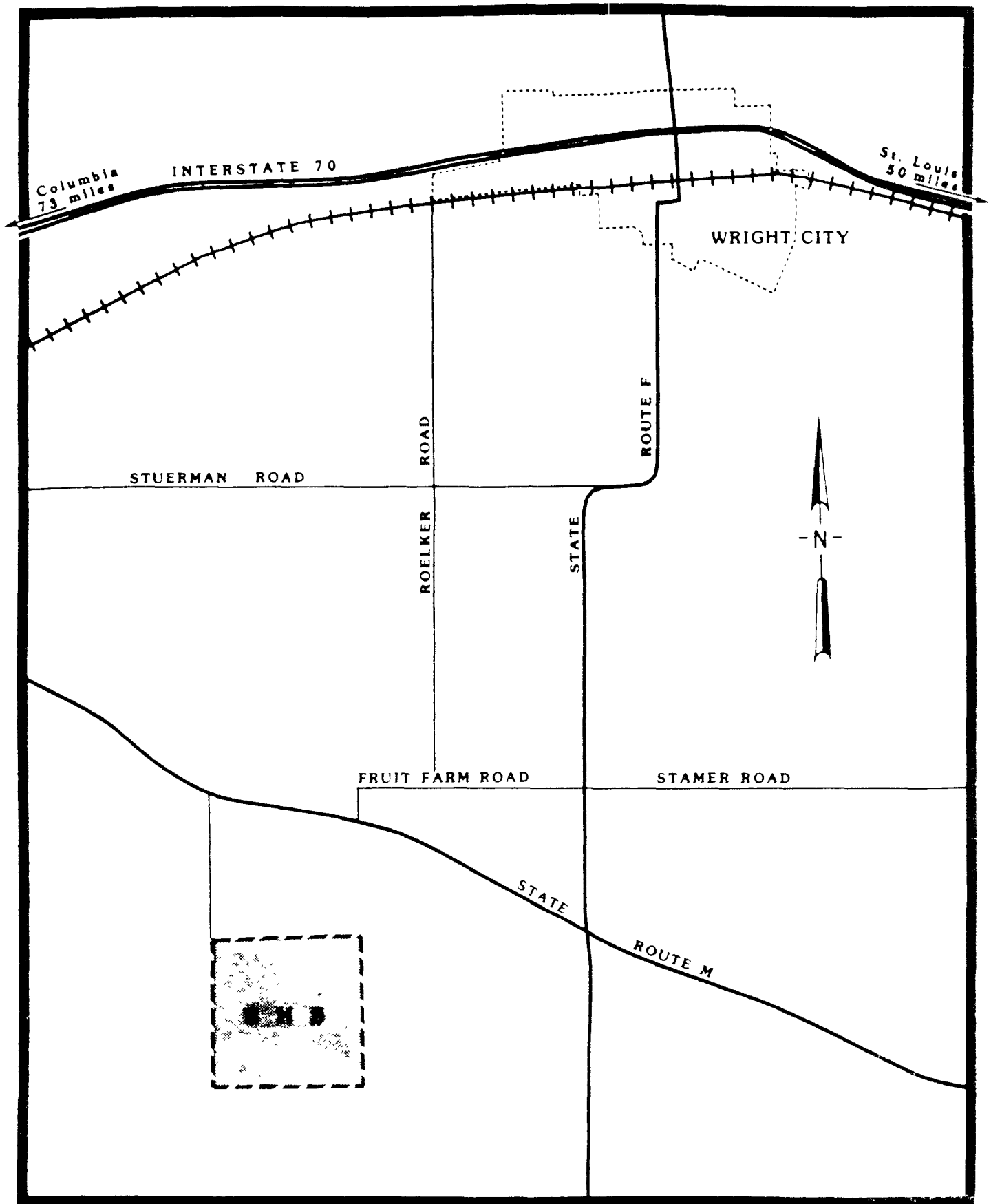


Figure 1. Location Map.  
BHS, Inc., Wright City, Missouri.

Scale: 0 1000 2000 3000 4000 5000 feet

FIGURE 2. HAZARDOUS WASTE MANAGEMENT UNITS AND LOCATIONS

Disposal operations began in 1971 when a sanitary landfill was put into use. Little information is available about its construction, operation or the waste placed in it. This disposal area, designated as the Sanitary Landfill [Figure 2], ceased operation in early 1977.

In June 1977, operations began in Area 1. The disposal area eventually covered approximately 12 acres containing 33 drilled cell\* and trench areas [Figure 3]. Of these, six trenches (1N, 2N, 6N, 11N, 12N, and 21) [Figure 4] and the Progressive Trench Area (PTA-highlighted in Figure 3) were in existence on November 19, 1980 and qualified for interim status. The RCRA regulated portion of Area 1 covers approximately 2 acres.

The proximity of RCRA regulated and pre-RCRA trenches and drilled cells requires that all of Area 1 be treated as a single hazardous waste management unit for ground-water monitoring purposes; however, because of this, ground-water monitoring will be unable to identify releases from a specific trench or drilled cell regardless of when it was placed into or removed from service.

The Missouri Department of Natural Resources (MDNR) has issued two permits to regulate Area 1 operations. The first, a solid waste disposal area operating permit, was issued in May 1977. On December 22, 1982, this was replaced by a hazardous waste permit based on the Missouri Hazardous Waste Management Law and associated regulations. The latter permit will expire December 22, 1987. Missouri was given Phase I authorization to administer the State ground-water monitoring regulations [10 CSR 25-7.011(10)], in lieu of the Federal ones, in November 1983 and received final authorization to administer all of RCRA, except for the 1984 amendments, in December 1985.

A Part B RCRA permit application was submitted August 3, 1983. It consisted mainly of the December 13, 1981 permit application to the MDNR. The application was reviewed by EPA Region VII and the MDNR. EPA issued a

---

\* Drilled cells were reported by E.H.S. to be unlined, 3-foot-diameter auger holes in which drums of waste were stacked and then covered with locally available clayey soil.

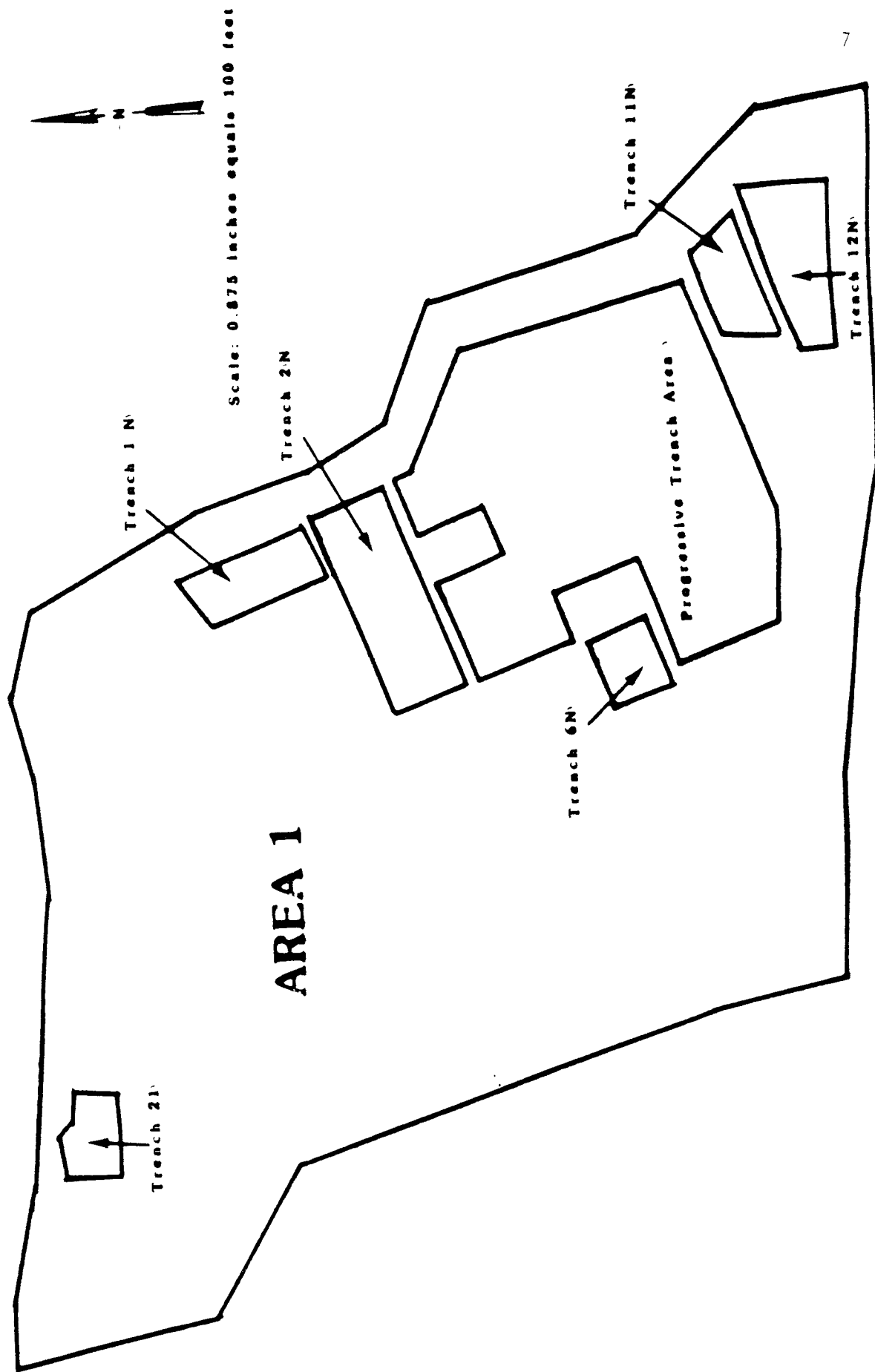


FIGURE 4 LOCATIONS OF RCRA REGULATED UNITS IN AREA 1

comment letter October 3, 1983, in which additional information and correction of deficiencies was requested. In response, B.H.S. submitted an amended Part B application on November 15, 1983. EPA determined that the amended Part B application was also incomplete and contained deficiencies. On March 12, 1984, EPA issued a Letter of Warning to B.H.S. requesting additional information and correction of deficiencies. B.H.S. submitted an amended Part B application to EPA on April 16, 1984. On August 21, 1985, EPA issued an Administrative Order to B.H.S. The order stated B.H.S. had failed to submit a complete application and proposed that B.H.S. pay a penalty of \$7,150. Attached to the order was a letter listing the deficiencies and comments concerning the Part B application. On October 18, 1985, EPA and B.H.S. signed a Consent Agreement in which the Company agreed to pay a \$5,400 penalty and submit a complete application no later than February 14, 1986. The revised Part B was submitted on February 14, 1986 and is currently under review.

The initial Part B and the two revisions covered primarily the expansion of Area 1. The February 1986 submittal was essentially a new Part B. It described a proposed new landfill (Area 2), a leachate treatment system, tanks that would replace the current surface impoundments and a ground-water monitoring system.

B.H.S. was not accepting waste for disposal during the inspection. Area 1 was undergoing closure under interim status and no landfill units were in operation.

The surficial soil at the site is weathered loess, a wind-blown deposit of glacial origin. This is underlain by a weathered/oxidized glacial till and is known as Hydrologic Unit A. Beneath this unit is an unoxidized glacial till and some residual soil known as Hydrologic Unit B. For purposes of RCRA-required ground-water monitoring, the saturated portion of Hydrologic Unit A and the interface between Hydrologic Units A and B are considered by B.H.S. to be the uppermost aquifer.

Beneath the glacial deposits are a series of bedrock formations consisting of shales, limestones and sandstone. The St. Peter Sandstone, ranging in depth between 350 and 500 feet below land surface at the site, is the principal regional water supply aquifer.



## SUMMARY OF FINDINGS AND CONCLUSIONS

The findings and conclusions presented below reflect conditions existing at the facility during the February 1986 investigation. Actions taken by the State, EPA Region VII and B.H.S. subsequent to February are summarized in the accompanying update.

Task Force personnel evaluated the ground-water monitoring program followed at the B.H.S. facility for the period November 1981, when the applicable provisions of the RCRA regulations became effective, through February 1986. This evaluation revealed that the interim status ground-water monitoring program for Area 1, although modified since 1981, still needs further refinements. New wells have been placed around the site as part of an expanded site ground-water monitoring program. The Task Force effort included the first sampling of some of these new wells.

B.H.S. is not in compliance with 10 CSR 25.7.011(10) [40 CFR Part 265.91] or 10 CSR 25.7.011(2)(E)(20) [Part 270.14(c)] because proper well placement cannot be determined with confidence based on currently available hydrogeological site characterization. Apparent ground-water mounding within the site complicates locating an upgradient or background well to provide background ground-water quality data for Area 1. Further, B.H.S. has proposed the entire perimeter of Area 1 as the point of compliance because all areas adjacent to Area 1 are depicted by their consultants as being hydraulically downgradient. More recent (April, May and June 1986) data submitted to MDNR show a different water table configuration than depicted earlier, but some ground-water mounding is still apparent and a large vertically downward hydraulic head differential between the upper and lower glacial till units is still evident. The uncertainty concerning the hydrogeologic interpretation brings into question the ability of the present wells to adequately determine the impact of Area 1 or Area 2 on the ground water. Because of the site conditions, including apparent ground-water mounding and depressions, and apparent differential vertical hydraulic head distribution, the ground-water flow patterns are not sufficiently defined to design an adequate ground-water monitoring system. Upgradient wells may not be truly upgradient

and downgradient wells may not be located or completed in appropriate locations and zones to intercept ground-water contaminant plume(s).

Inadequate interpretation of the hydrogeologic features of the site and deficiencies in the ground-water monitoring system would adversely impact the ability of Area 2 to accept CERCLA wastes, if it is constructed.

The following is a more detailed summary of the inspection findings and conclusions.

#### GROUND-WATER MONITORING PROGRAM DURING INTERIM STATUS

A 19-well system was initially installed in late 1976 to early 1977 to meet State ground-water monitoring requirements. B.H.S. designated six of these wells for Area 1 RCRA ground-water monitoring purposes; however, the 19-well system was considered inadequate to meet ground-water monitoring requirements for the following reasons. Many downgradient wells never produced water or only produced intermittently. The upgradient and downgradient wells were placed in different water-bearing zones, precluding meaningful ground-water quality comparisons.

A second well system, consisting of four wells, was installed in November 1982 to meet Federal and State ground-water monitoring requirements; however, the designated downgradient wells were spaced too far apart to intersect potential contamination plumes from Area 1. In addition, the designated upgradient well was too close to Area 1 and may be influenced by potential releases from the landfill.

Additional wells were installed in 1984 as part of the second system to correct the above problems. A new upgradient well and an additional downgradient well were constructed. The previously designated upgradient well was then redesignated as being downgradient of Area 1.

Due to changes in the well networks, no statistical analysis was done against background data until 1985. At that time, significant statistical

differences were found in a number of the wells for various required parameters. B.H.S. is in the assessment phase which was to begin in May 1986.

The present Area 1 upgradient well is located within the boundary of the proposed landfill (Area 2). If the new Area 2 landfill is issued a RCRA permit and is constructed, this well will be destroyed. Background data will need to be collected for any new upgradient well.

Three interceptor trenches [Figure 2] on the east and south sides of Area 1 may have the capability to intercept shallow plumes of contaminated ground water moving in an easterly or southeasterly direction toward down-gradient monitoring wells. These trenches may be included in the Area 1 ground-water monitoring plan if they are determined to be usable based on their design, construction, ground-water yielding capability and their position in the ground-water flow system.

#### Site Hydrogeology

The hydrogeological investigations of the site, conducted by B.H.S. consultants, have not adequately defined the limits of the uppermost aquifer. The poor quality and confusing interpretations of such information precludes accurately determining ground-water flow direction(s) to design an adequate ground-water monitoring system.

Based on an existing potentiometric map of Hydrologic Unit B, four of the five RCRA-designated downgradient wells may, in fact, be upgradient of Area 1. The presently designated upgradient well and the other downgradient well may be the only downgradient wells monitoring Area 1.

The shallow water-bearing strata are interpreted by B.H.S. consultants to consist of two zones and each is indicated as having ground-water mounds and depressions which make flow generalization across the site difficult. Onsite ponds, which are not regulated by RCRA and which have been drained, have further altered flow patterns. It is also difficult to identify an onsite location for upgradient wells due to the apparent mounds and depressions.

### Ground-Water Sampling and Analysis Plan

Four documents, issued at different times, have been prepared to describe ground-water sampling and analysis activities at the site. The first three documents were inadequate because they only summarized the Federal and State monitoring requirements and did not describe activities needed to comply with the requirements.

The fourth document primarily describes proposed monitoring activities at Area 2 and is also inadequate as a sampling and analysis plan for the site.

### Closure/Post-Closure Plans

Closure and post-closure monitoring plans were submitted in 1985 and were under joint review by EPA and MDNR at the time of the inspection.

### GROUND-WATER MONITORING PROGRAM PROPOSED FOR THE RCRA PERMIT

The February 1986 Part B submittal contains a ground-water monitoring program for the entire site; however, the program does not adequately describe which wells will be sampled to accomplish specific tasks.

The proposed point of compliance for Area 2 is inadequate. It was based on a simulated potentiometric map which used estimated values for hydrogeologic parameters rather than *in-situ* physical measurements of hydraulic conductivity and hydraulic head distribution. Monitoring system and point of compliance evaluations must be based on actual physical measurements rather than estimated values.

Because the hydrogeologic interpretations for the site are not adequate, the proposed monitoring system may not comply with RCRA ground-water monitoring requirements. The proposed program can only be effectively evaluated after a thorough hydrogeologic characterization of the site is completed.

Construction information for some of the wells included in the proposed program is inadequate. Because of this, the usefulness of these wells in meeting permitting program requirements is questionable.

#### TASK FORCE SAMPLING AND MONITORING DATA ANALYSIS

During the inspection, Task Force personnel collected samples from nine ground-water monitoring wells, two leachate collection sumps and two interceptor trench systems. The sampling and analysis were conducted to determine if the ground water contains hazardous waste constituents or other contamination indicators. The monitoring wells were prepared for sampling by B.H.S. and Task Force and contractor personnel. All samples were collected by the Task Force contractor (VERSAR, Inc.) except for leachate samples and samples from Interceptor Trench 3 which were collected by B.H.S. personnel for the Task Force.

The analytical results did not indicate widespread ground-water contamination; however, the majority of the trenches and all of the drilled cells in Area 1 are not lined and do not have leachate collection systems. Thus, the potential for leakage from these disposal units exists. In addition to common naturally occurring cations and anions, selenium was found in wells B-11A and B-15 at 164 µg/L and 280 µg/L, respectively. Organic chemical constituent analyses indicate the presence of 1,2-dichloroethane and acetone in well GM-1. Methylene chloride may also be present in this well. These findings should be further investigated for confirmation and evaluation.

#### COMPLIANCE WITH CERCLA/SUPERFUND OFFSITE POLICY

The EPA offsite policy requires that any TSDF used for land disposal of waste from CERCLA response actions must be in compliance with the applicable technical requirements of RCRA. Interim status facilities must have an adequate ground-water monitoring program to assess whether the facility has had a significant impact on ground-water quality. The B.H.S. facility has not fully complied with the technical ground-water monitoring requirements for waste management facilities.

## TECHNICAL REPORT

## INSPECTION METHODS

The Task Force evaluation of B.H.S. consisted of:

- Review and evaluation of records and documents from EPA Region VII, MDNR and B.H.S.
- A facility inspection conducted February 19 through February 26, 1986
- Sampling and subsequent analysis and data evaluation for selected site ground-water monitoring and leachate collection systems

### RECORDS/DOCUMENTS REVIEW AND EVALUATION

Records and documents from EPA Region VII and the MDNR offices were reviewed before the inspection. B.H.S. records were reviewed to verify information currently in Government files and to supplement Government information where necessary. Selected documents requiring in-depth evaluation were copied and subsequently reviewed. Records review included evaluation of facility operations, construction of waste management units and ground-water monitoring activities.

Specific documents and records included the ground-water sampling and analysis plan, the outline of a ground-water quality assessment program, monitoring well construction data and logs, site geologic reports, site operations plans, facility permits, unit design and operation reports, and operating records showing the general types and quantities of wastes disposed of at the facility and their locations.

### FACILITY INSPECTION

The facility inspection, conducted in February 1986, included identification of waste management units, identification and assessment of waste

management operations and pollution control practices, and verification of the location of ground-water monitoring wells and the leachate collection systems.

Company representatives were interviewed to identify records and documents of interest, answer questions about the documents, and explain (1) facility operations (past and present), (2) site hydrogeology, (3) ground-water monitoring system rationale and (4) the ground-water sampling and analysis plan.

#### GROUND-WATER AND LEACHATE SAMPLING AND ANALYSIS

During the inspection, the Task Force collected samples from B.H.S. ground-water monitoring wells and landfill leachate collection system sumps. Samples were taken from two interceptor trench systems in order to characterize ground-water quality in the zone at the base of the trenches. Most samples were collected by an EPA contractor, Versar, Inc., Springfield, Virginia, and sent to EPA contractor laboratories for analysis. Splits of all samples were offered to B.H.S., but the facility declined. Region VII and MDNR also declined the offer of sample splits. NEIC received and analyzed two split samples. Data from sample analyses were reviewed to further evaluate the B.H.S. ground-water monitoring program and identify possible contaminants in the ground water. Analytical results from the samples collected for the Task Force are presented in Appendix A.

#### LABORATORY INSPECTION

No B.H.S. or contractor laboratory facilities were evaluated. Arrangements with laboratories which had provided analytical services to B.H.S. prior to the Task Force inspection had been discontinued. B.H.S. had not sampled any of the new ground-water monitoring wells prior to the inspection and, while new contract laboratories had been selected, there was no analytical data to evaluate. The onsite laboratory had been dismantled when Area 1 reached capacity in May 1985.



## WASTE MANAGEMENT UNITS AND OPERATION

### WASTE MANAGEMENT UNITS

This section describes the design, construction, operation and management of waste disposal units and waste handling and disposal practices at B.H.S. The discussion presented here provides a framework for assessing waste disposal unit integrity, explains the types and placement of wastes disposed of at B.H.S. and serves as a reference to assist in evaluating the potential for ground-water contamination in the event that leakage occurs.

B.H.S. has operated a number of landfill units and surface impoundments at the facility [Figure 2]. The landfill units can be broken down into two areas: the Sanitary Landfill and Area 1. The Sanitary Landfill, located just south of Area 1, began operation in 1971 and ceased operation in 1977.

Drawings of the facility in the February 1986 revised Part B submittal treat Area 1 and the Sanitary Landfill as one unit designated "Previous Disposal Area".

Area 1, which began operation in 1977 and ceased operation in May 1985, comprises approximately 33 trench and drilled cell areas [Figure 3]. It is currently undergoing closure. A number of the disposal units in Area 1 are not regulated by RCRA [Table 1].

The facility's Part B application proposes that a landfill be built on the western edge of the property [Figure 2]. This application is still under review by the MDNR and EPA Region VII.

Table 1  
STATUS OF WASTE DISPOSAL UNITS  
AREA 1

Facility Designation Number	Opened	Date Last Waste Accepted	RCRA Regulated
1	07/77	09/78	No
2	07/77	09/77	No
3	07/78	06/79	No
4	09/77	07/78	No
5	02/78	10/80	No
6	08/77	08/78	No
7	02/79	03/79	No
8	06/79	06/79	No
9	06/79	07/79	No
10	07/79	08/79	No
11	08/79	09/79	No
12	10/79	11/79	No
13	11/79	01/80	No
14	12/79	12/79	No
15	01/80	04/80	No
16	04/80	07/80	No
17	04/80	06/80	No
18	04/80	06/80	No
19	05/80	05/80	No
20	06/80	09/80	No
21	09/80	12/80	Yes
1N	10/80	03/81	Yes
2N	03/81	12/81	Yes
6N	11/80	03/81	Yes
11N	12/80	06/81	Yes
12N	12/80	06/81	Yes
Drilled cells	03/78	06/80	No
Trench cells			
(0-2 through			
0-4)	11/79	08/80	No
Flammable			
drilled cells	03/78	06/80	No
Alkaline drilled			
cells	04/78	06/80	No
Alkaline trench			
cells			
(B-2 through			
B-6)	11/79	06/80	No
Acid cells	04/78	06/80	No
PTA*	01/82	05/85	Yes

\* Progressive Trench Area

### RCRA-Regulated Landfills

Of the 33 trench and drilled cell units in Area 1, trenches 21, 1N, 2N, 6N, 11N and 12N and the PTA received hazardous waste on or after November 19, 1980 [Figure 4].

Trench 21 was described in the B.H.S. Area 1 closure plans as not in operation after November 1980; however, a review of waste disposal records for the unit revealed that hazardous waste disposal occurred through December 5, 1980 [Table 2]. Therefore, the trench was an active unit and is subject to regulation under RCRA. The PTA and "N" trenches are clearly identified as regulated by RCRA.

Table 2  
HAZARDOUS WASTE LANDFILLED IN TRENCH 21  
ON OR AFTER NOVEMBER 19, 1980

Waste Received	Generator	Waste Description	Quantity*
11/19/80	Litton Systems, Inc.	Wastewater sludge	54 drums
11/24/80	Mobay Chemical	Waste sulfur	34 drums
11/19/80	Monsanto Company	Arsenic gallium trash	24 drums
11/24/80	Mountain View Fabricating	Wastewater sludge	12 drums
11/26/80	Ramsey Corporation	Sludge	14 cubic yards
11/21/80	Rival Manufacturing Co.	Wastewater sludge	8 cubic yards
11/19/80	United Petroleum Service	Zinc sulfate sludge	56 drums
12/05/80	Loxscreen Company	Wastewater sludge	15 cubic yards

\* All drums are 55 gallons

The trenches were dug on demand, dependent upon the types and amounts of waste received at the site. In Appendix B, Figures B-1 through B-6 provide construction details of the RCRA-regulated trenches.

Operation of the PTA began in January 1982 and ceased in May 1985. The section was excavated and five separate cells were consecutively filled as waste was received. A common leachate collection system services the PTA.

Leachate collection and removal systems were installed in the "N" trench system and the PTA. Each of the "N" trenches has a separate system while the PTA has a common system serving all five cells.

Leachate collection and removal systems for the "N" trenches were constructed from a common design. A 4-foot trench was dug below the bottom grade of the disposal trench and 1 foot of sand was laid as a base. A 4-inch polyvinyl chloride (PVC) perforated pipe, enveloped in a filter fabric, was placed on the sand. Sand, to a depth of 2-feet, was backfilled around and over the pipe; 1-foot layers, each of crushed rock and soil, completed the system. The trenches slope to a sand-filled sump dug to a depth of 2 feet below the collection trench. A 6-inch PVC pipe acts as an annulus for a 4-inch PVC collection pipe. Rock and sand were backfilled around the 6-inch pipe to a height above the anticipated waste levels. Figures B-1 through B-6, in Appendix B, contain the construction drawings for each "N" disposal trench and indicate the location of each leachate collection system.

The leachate collection system for the PTA consists of two lateral collection trenches, oriented approximately east-west, which drain to a north-south trench, which has a collection sump. The laterals also have collection sumps, but are used instead as observation sumps [Appendix B, Figures B-7 and B-8].

The laterals are 2 feet deep below the trench bottom grade and 3 feet wide. The trench sides and bottom are lined with a filter fabric which envelopes a layer of crushed stone. The laterals slope approximately 2% toward similarly constructed collection trenches.

#### Nonregulated Landfills

The remainder of the B.H.S. used landfill capacity consists of the sanitary landfill and Area 1 trenches and drilled cells which were filled before November 19, 1980. The latter group consists of trenches 1 through 20, two organic drilled cell areas, a flammable drilled cell area, an alkaline

drilled cell area, trench cells 02 through 04 (04 consists of eight separate trenches), special waste trenches, an alkaline trench, an acid trench and an organics trench.

No construction information is available for the sanitary landfill and only generic types of waste are known to have been disposed of in this unit (e.g., sanitary, industrial and municipal wastes). The landfill has a clay-soil cap and vegetative cover. Portions of the sides have experienced erosion problems as evidenced by runoff gullies exposing fill material. These have been observed by MDNR personnel in the past and were observed during the Task Force site reconnaissance on February 4, 1986.

The trenches in Area 1 were dug with a backhoe to a general depth of 27 feet. The MDNR required B.H.S. to inspect the excavations for pockets of sand and gravel. As they were found, B.H.S. was required to remove as much of the pockets as possible. Usually the trench was widened or deepened to excavate as much of the sand as possible. The trench was then backfilled with local clayey soil to the approximate original dimensions. Waste was then placed in the trench and the unit covered with soil from the site.

The drilled cells were constructed by a 3-foot-diameter auger to an approximate depth of 27 feet. Drums were vertically stacked to a height of seven drums per cell. The remaining volume was backfilled and covered with soil from the site. In each drilled cell area, the number of cells drilled was dependent on the amount of waste to be disposed of.

#### Surface Impoundments

Three surface impoundments (SI-1, SI-2 and SI-4) are currently operational on the site [Figure 2]. These are to be replaced by tanks, as described in the Part B application. A fourth impoundment, SI-3T, has been drained and is not in use. The numbering system of these impoundments has changed through the years, which has caused some confusion in following the history of each unit.

Two of the impoundments were constructed in 1977 and were identified as Lagoons 1 and 2. They were used for the storage of water used for truck washing and water removed from the active trenches at that time. Both were renovated in 1983 with the installation of a clay liner and a leachate collection system. The capacity of these lagoons (50,000 gallons each) was not altered. The units were renumbered. Lagoon 1 became SI-2 and Lagoon 2 became SI-1. Both now store leachate from the PTA and "N" trenches.

Surface impoundment SI-3 was built in 1981 originally as a disposal trench, but was never used. A section was dammed off and acted as an impoundment which held surface runoff from Area 1. In 1983, it was pumped out and spray irrigated, then SI-4 was built over much of the old area. The remainder of the old excavation was backfilled with soil.

In 1983, surface impoundment SI-3T was built to act as a temporary storage unit while SI-3 was being rebuilt. Impoundment SI-3T is not lined nor does it have a leachate collection system. It is still present onsite but is drained and inactive.

SI-4 has a 3-foot compacted clay liner and a leachate collection system. The capacity is approximately 150,000 gallons. B.H.S. considers this as a replacement for SI-3.

The leachate collection system for each surface impoundment was installed beneath the clay liner and consisted of a minimum 1½-foot-deep by 10-foot-wide trench in which a 3-inch layer of sand was placed. The trench was sloped 0.5%. A 4-inch perforated PVC pipe was wrapped in filter fabric and placed on the sand base. The remainder of the trench was backfilled with sand. The perforated PVC pipe was connected to a 4-inch PVC riser used to remove collected leachate [Appendix B, Figures B-8 and B-9].

#### FACILITY OPERATION

Since the site has not received waste since May 1985, no waste acceptance activities could be observed during the inspection. In many cases, a

single load of one type of waste was disposed in a single trench or drilled cell. The following sections discuss past operation practices.

### Waste Acceptance

The MDNR issues approvals for wastes to be accepted at a TSDF. These approvals are based on a review of composition, characteristics and hazards for each waste material. The TSDF (in this case B.H.S.) submitted the requests for review and notified the generator of the approval or denial. Each waste type was assigned a sequence code by the MDNR which they used to track the waste. In this case, each waste received at the B.H.S. site is designated as BHSXXX.

A laboratory for analysis of incoming wastes was in use onsite during the active period of Area 1. Due to the landfill being shutdown, the laboratory has been dismantled and the equipment has been mothballed. If the proposed landfill (Area 2) is opened, the laboratory will be reactivated.

B.H.S. relied heavily on customer waste characterization data for approval submissions to the MDNR. Once a waste was approved by the State for disposal, B.H.S. again relied heavily on the customers to notify them if characteristics of a waste had changed.

Once a waste material had reached the facility, B.H.S. mainly performed a physical, visual and odor examination. More extensive analysis was usually done once a month for a given waste stream. The waste analysis plan was not very detailed and lacked a written basis or schedule when sampling and analysis of incoming waste loads would be done. As an example, the plan states "B.H.S. shall sample a random movement of hazardous wastes. . ." but does not fully identify the procedures to follow in order to determine what is sampled, when and how often. The text refers to monthly sampling of high volume generators but does not identify the sampling frequency of low volume generators.

The waste analysis plan indicates only that the first shipment of each waste stream was tested for free liquids. There was no procedure to ensure later shipments were similar to the first one. If the waste was identified as having greater than 70% moisture content, the waste was tested daily for percent volatiles.

As B.H.S. did not conduct their own analysis of waste as part of the approval process, they relied on the generator not only to submit true and valid data for approval purposes but also to alert B.H.S. to any waste changes. B.H.S.'s waste analysis was not designed to identify changes in waste from the original submittal, but to identify if the waste could be handled at the site. In order to identify changes in waste from the original submission, B.H.S. stated that they would review analyses for large generators (those disposing on a weekly basis), yearly, moderate generators (those disposing on a monthly basis), every 2 years, and other generators when production methods would alter physical characteristics. These time frames were inadequate when based on the minimal analysis B.H.S. performed.

B.H.S. identified the following waste streams which were not to be handled at the facility.

1. Ignitable wastes
2. Reactive wastes
3. Volatile waste having a vapor pressure of greater than 78 millimeters of mercury at 25° C.
4. Bulk liquids and sludges with more than 75% liquid by weight, having free flowing liquid, which were free flowing themselves or contained more than 5% by weight organic liquid

#### Waste Handling

After the waste material was checked at the facility's front gate, the waste was directed to either a storage location or the designated disposal unit. Drilled cells were drilled literally on demand. Trenches took more



time to construct since they had to be excavated and the later ones had to have a leachate collection system installed. In some cases, a single waste was placed in a trench.

#### Inspection Procedures

No formal record of inspections conducted by B.H.S. prior to January 1984 is available. From November 1980 through December 1983, the visitor sign-in log served as the record of inspection results. Few problems were recorded during this period as most activities consisted of pumping water from open trenches to the impoundments.

On January 23, 1984, an inspection log was initiated and maintained along with inspection results. Daily inspections were performed for the following items: surface impoundments, emergency equipment, storage and unloading areas, site fencing, landfill surface-water diversion berms and proper soil cover on disposal areas.

#### Leachate and Surface Runoff Handling

Throughout the operating life of Area 1, surface runoff and water found in open trenches was collected and sprayed on the cover of closed sections of Area 1. In all cases, the liquid was analyzed by B.H.S. and found not to meet hazardous waste characteristic criteria [10 CSR 25.4.010(2) through (5) - 40 CFR Part 261 Subpart C]. Nonetheless, much of this liquid was a hazardous waste since it did come in contact with landfilled hazardous waste.

## SITE HYDROGEOLOGY

### HYDROGEOLOGIC UNITS

The facility is situated in an area characterized by wind-blown soil and glacial deposits which overlie bedrock formations consisting of shales, limestones and sandstones. The wind-blown or loessial deposits comprise the uppermost layer which consists of clayey silt to very silty clay that becomes sandy near the base. This deposit includes the tillable soil in the area and ranges in thickness up to 20 feet.

The loessial soil is underlain by a layer of oxidized glacial till, an interface zone and a layer of unoxidized glacial till. The loess and oxidized till have been designated the "A" hydrologic unit and the unoxidized till and residual soils have been designated the "B" hydrologic unit [Table 3]. These units make up the uppermost water-bearing zone for RCRA ground-water monitoring purposes. The "A" unit consists of sandy clay to sandy, silty clay and the "B" unit consists of silty clay near the top but is primarily a sandy, silty clay.

A series of limestone and shale bedrock formations underlies the site. Underlying the limestones and shales, at a depth of 350 to 500 feet, is the St. Peter Sandstone which serves as a major regional water supply aquifer. Other water-bearing strata occur at greater depths. Table 3 shows the hydrologic units identified at the site and their designation by B.H.S. consultants.

### GROUND-WATER FLOW

Two flow regimes are present for the area, one for the bedrock and one for the overlying glacial deposits. The flow direction in the bedrock formations, including the St. Peter Sandstone, is to the northeast. Flow direction in the overlying glacial deposits is generally believed to be to the south and southwest but localized ground-water mounds and depressions at the site and the difficulty in interpreting subsurface information, makes

it difficult to determine specific ground-water flow directions and rates within portions of the site. Additional information and revised interpretations are needed to clearly define the hydrogeological characteristics of the site including local ground-water flow patterns and potential pathways of pollutant migration.

Table 3  
CLASSIFICATION OF HYDROLOGIC UNITS

Name	Geologic Unit		Hydrologic Unit	
	Lithology	Thickness	Approx. Depth	Designation
Loess	Silt	0-20	0-60	A
Oxidized	Clay	0-60		A
Unoxidized till	Clay	40-190	80-250	B
Residual soil	Clay	0-20		B
Sulfur Springs	Shale	0-20	350-500	C
Snyder Creek	Shale	0-20		C
Callaway	Limestone			C
Kimmswick	Limestone	55-60		C
Decorah	Shale	20		C
Plattin	Limestone	75-95		C
Joachim	Limestone	75		C
St. Peter	Sandstone	110-125	450-600	D
Powell-Cotter	Limestone	325-345	900-1200	E
Jefferson City	Dolomite	130-165		E
Roubidoux	Sandstone/ limestone	150+		F

Hydrogeologic work by Woodward Clyde Consultants (WCC), Kansas City, Missouri, B.H.S.'s consultants, identifies a number of ground-water mounds and depressions at the site. The ground-water flow regime at the site has not been clearly defined and no true upgradient location for Area 1 has been clearly identified. Although recent (April, May and June 1986) water level data submitted to MDNR show a different water table configuration than WCC, the problem of designating an upgradient or background well location for Area 1 has not been resolved. Additional hydrological investigation should reveal whether an acceptable background location or locations can be

identified in an area which is hydrologically separated from, although perhaps not upgradient of, Area 1.

Because of the lack of clear definition of the ground-water gradients at B.H.S., it is not presently clear where and at what interval(s) a truly representative upgradient/background well or wells could be constructed. The three interceptor trenches along the east side and a portion of the south side of Area 1 may be considered for monitoring along this portion of the proposed point of compliance for this area. Consideration should also be given to installing additional interceptor trench systems around the remainder of Area 1 as wells may not provide a feasible means of monitoring ground-water quality in the low permeability terrain which characterizes this site. The uncertainties caused by the difficulty of defining ground-water gradients in this area shed further doubt on the feasibility of clearly establishing acceptable upgradient or background and downgradient locations to monitor this site effectively with wells.

Two ponds on the site, which were not regulated by RCRA since they held stormwater runoff, were drained in October 1985 and were considered by B.H.S. consultants to have contributed to ground-water mounding. With their removal, the associated mound should disappear over time and result in a different ground-water flow pattern. WCC was of the opinion that newly installed wells used to measure ground-water elevations may not have reached hydraulic equilibrium. This further leads to the conclusion that ground-water gradients, as now measured, will change over time. Also, if new interceptor trenches are excavated and if existing interceptor trenches are pumped to maintain lower hydraulic head, these activities will affect ground-water flow patterns.

The following is a discussion of each of the ground-water hydrologic units that make up the uppermost aquifer at the site.

### Hydrologic Unit A

This unit is showing both downward and horizontal hydraulic gradients. Based on calculations by WCC, the downward flow is greater than the horizontal flow. Three ground-water mounds have been tentatively identified and depicted as being: (1) around the present impoundments and stretching to the west and northwest toward the drained ponds, (2) in Area 1 along its eastern border, and (3) an area near the northwest corner of the site [Appendix C, Figure C-1].

### Hydrologic Unit B

This unit contains sand lenses located from place to place. WCC does not feel the lenses are continuous or interconnected. This opinion has not been supported by adequate field testing. Ground-water flow in the unit appears to radiate from the mounds but probably has a net southeasterly to southwesterly direction across the site. Three ground-water mounds and a depression have been tentatively identified. The mounds are shown as being at the approximate location of Unit A's first mentioned mound, at the northwest corner of the site, and along the east boundary of the proposed landfill. The depression appears to be located in the vicinity of Interceptor Trench 3 along Area 1's eastern boundary [Appendix C, Figure C-2].

Much of the water level data for Hydrologic Unit B was obtained from the well series which was installed for permit monitoring purposes. Many of these have not been fully developed according to WCC. These wells may also not show hydraulic stability because of the intermittent purging required for development. A true picture of the ground-water gradients was, therefore, not obtainable at the time of the inspection. Additional hydrologic site characterization is needed to clearly define both vertical and horizontal flow patterns including hydraulic head distribution and permeability characteristics of the site. More recent (April, May and June 1986) water level data submitted to MDNR show a different water table configuration than depicted by WCC in the February 1986 Part B application; however, some ground-water highs within the site are still apparent and a

large vertically downward hydraulic head differential is still evident. These need to be evaluated with respect to their influence on potential pathways for contaminant migration.

#### Ground-Water Flow Summary

Ground-water flow from mounded areas within an aquifer would normally be expected to form radial flow patterns. If this is truly the case at B.H.S., as depicted for Hydrologic Unit A by WCC, an upgradient location is not available within the site; however, a suitable location(s) for determining background ground-water quality may be an acceptable alternative depending on the results of further hydrogeological investigation. Further, the potentiometric surface maps presented by WCC in the February 14, 1986 Part B application show decreasing hydraulic head between Hydrologic Units A and B which provides a strong potential for vertically downward flow [Appendix C, Figures C-1 and C-2]. Therefore, if leakage from old disposal areas occurs, it may be expected to move downward and would not be detectable by wells constructed in Hydrologic Units A and B adjacent to the disposal areas. The potentiometric surface map for Hydrologic Unit A indicates a ground-water mound in approximately the same area as a ground-water depression in the underlying Hydrologic Unit B. If this hydraulic head differential is real, it provides the potential for downward movement of ground water and supports the possibility that contaminants leaking into ground water in this area could move downward to some unknown depth before moving laterally. Thus, they may escape detection in monitoring wells or trenches located adjacent to past waste disposal areas.

The simulated potentiometric surface map "A" Unit [Appendix C, Figure C-3] shows potentiometric contours as much as 20 feet above the ground surface. None of the piezometric surface maps generated by this model, with estimated or assigned values for this site, are acceptable.

B.H.S.'s hydrogeologic investigation reports were prepared by their consultants, D.E. Klockow and Associates (Klockow) and Woodward Clyde Consultants (WCC). Review of reports prepared by these consultants reveals

that a number of deficiencies remain. The Task Force came to the following conclusions and recommendations as a result of the review of these reports.

1. B.H.S. has failed to fully characterize the hydrogeology of the site, particularly with respect to:
  - a. The nature, extent and permeability characteristics of the fracture network in Hydrologic Unit A
  - b. The permeability characteristics of Hydrologic Unit B regarding its integrity as an aquitard
  - c. Evaluation of the broken, jointed and solutioned bedrock in Hydrologic Unit C and its relationship to the overlying strata which may constitute pathways for contaminants to escape the site undetected
  - d. The nature and extent of sand lenses or stringers which have been observed within the glacial till layers which constitute Hydrologic Units A and B
  - e. Assessment of vertical hydraulic head distribution beneath the site to the depth of the first aquiclude, aquifuge or zone where horizontal ground-water flow dominates vertical flow components
2. B.H.S. has failed to define the limits and hydrogeologic characteristics of the uppermost aquifer.
3. B.H.S. has failed to comply with the terms of the EPA August 21, 1985 Compliance Order requiring deficiencies in the site characterization and ground-water monitoring system to be corrected.

The failure to fully characterize the site hydrogeology and define the limits of the uppermost aquifer, as required, will result in the facility

being unable to fully comply with Part B requirements found in 40 CFR Part 270.14(c).

Information addressing the above deficiencies must be provided before an adequate ground-water monitoring system can be designed and evaluated.

It is the consensus of the Task Force that B.H.S. should be required to provide:

1. Adequate characterization of the hydrogeology of the site; including at a minimum:
  - Definition of the nature, extent and permeability characteristics of the fracture network in Hydrologic Unit A utilizing both laboratory and field testing methods.
  - Definition of the permeability characteristics of Hydrologic Unit B regarding its integrity as an aquiclude using both laboratory and field testing methods.
  - Evaluation of the broken, jointed and solutioned bedrock in Hydrologic Unit C and its relationship to the overlying strata with respect to the potential pathways for contaminant migration using cores and *in-situ* field testing methods.
  - Definition of the nature and extent of sand lenses or stringers within the glacial till layers, whether they are interconnected, are isolated pockets or sinuous sand stringers crossing portions of the site or extending offsite.
  - Definition of the vertical hydraulic head distribution beneath the site to the depth of the first aquiclude thoroughly enough to show the three-dimensional characteristics of the ground-water flow system.



2. Provide additional data and interpretive information needed to fully characterize the site hydrogeology in sufficient detail to provide a basis for an integrated ground-water monitoring system.
3. As a result of the site characterization studies, define the limits of the uppermost aquifer.
4. Present a modified ground-water monitoring system.

## GROUND-WATER MONITORING PROGRAM UNDER INTERIM STATUS

Ground-water monitoring at the B.H.S. facility has been conducted under the requirements of Federal and State interim status regulations and two State hazardous/solid waste permits. Prior to November 19, 1981, a State permit defined monitoring requirements and a well system. A number of wells in this system were specified as RCRA ground-water monitoring wells. After November 19, 1981, the Federal and State regulations and a State permit defined monitoring requirements. B.H.S. requested a waiver from RCRA ground-water monitoring requirements but it was denied by EPA Region VII.

The following is an evaluation of the monitoring program between November 1981, when the ground-water monitoring provisions of the RCRA regulations became effective, and February 1986, when the Task Force investigation was conducted.

### REGULATORY REQUIREMENTS

Ground-water monitoring at the facility has been regulated by both Federal and State requirements. Federal requirements (40 CFR Part 265, Subpart F) were in effect from November 1981 through November 1983. The State ground-water monitoring regulations [10 CSR 25-7.011(10)] took effect in lieu of the Federal regulations in November 1983 when the State was granted Phase 1 interim authorization.

Two State permits have also outlined ground-water monitoring at the site. These are Solid Waste Disposal Area Operating Permit (SWDAOP) 721901 issued on May 25, 1977 and Hazardous Waste Facility Permit (HWFP) TSD 122282001 issued on December 22, 1982.

The following discussion reviews the monitoring requirements, according to their source, in chronological order.

SWDAOP 721901

The MDNR issued this permit on May 25, 1977. It required quarterly monitoring for total organic carbon (TOC), pH, heavy metals and conductivity. The following were also to be analyzed initially: lead, chromium, copper, zinc, cadmium, nickel, fluoride, iron and manganese. Monitoring began in August 1977 and two quarters of sampling were completed in that year. The permit required the installation and monitoring of 17 wells and the monitoring of two existing wells (System 1).

On January 1, 1978, the MDNR imposed additional parameter and sampling requirements. These are outlined in Table 4 along with their frequency. Sampling under this permit overlapped with the interim status requirements which follow.

40 CFR Part 265, Subpart F

Monitoring under the Federal requirements began in November 1981. These are outlined in Table 5 along with their frequency. Six wells from System 1 were designated to serve as RCRA monitoring wells. In December 1983, System 1 was replaced for RCRA ground-water monitoring purposes by wells required by the following State permit (HWFP TSD 122282001).

HWFP TSD 122282001

The MDNR issued this permit on December 22, 1982. It referenced sampling and analytical requirements found in 10 CSR 25-7.011(10)(c), the State hazardous waste regulations which were identical to 40 CFR Part 265. It also required the installation of four wells (System 2) and three interceptor trenches as ground-water monitoring points and indicated five surface water sampling points.

Table 4  
ADDITIONAL SAMPLING AND MONITORING  
REQUIREMENTS IMPOSED BY MDNR

Parameter	Frequency
pH	Quarterly <sup>1</sup>
Redox potential	Quarterly
Specific conductivity	Quarterly
TOC	Quarterly
Chemical oxygen demand (COD)	Quarterly
Hardness (total as CaCO <sub>3</sub> )	Quarterly
Chloride	Quarterly
Iron	Quarterly
All of the above	Yearly on July 1
Biochemical oxygen demand (BOD)	Yearly on July 1
Suspended solids	Yearly on July 1
Total dissolved solids	Yearly on July 1
Turbidity	Yearly on July 1
Extractable oil	Yearly on July 1
Fecal coliform bacteria	Yearly on July 1
Alkalinity	Yearly on July 1
Phenols	Yearly on July 1
Nitrate as nitrogen	Yearly on July 1
Sulfates	Yearly on July 1
Fluorides	Yearly on July 1
Cyanides	Yearly on July 1
Heavy metals <sup>2</sup>	Yearly on July 1
Gas chromatograph scan for chlorinated hydrocarbons and pesticides	Yearly on July 1
Arsenic	Quarterly
PCBs (specifically)	Annually

<sup>1</sup> Quarterly is defined as the following periods:

1st quarter: January 1-March 31  
Report due April 1  
2nd quarter: April 1-June 30  
Report due July 1  
3rd quarter: July 1-September 30  
Report due October 1  
4th quarter: October 1-December 31  
Report due January 1

<sup>2</sup> Heavy metals include:

Arsenic	Copper	Selenium
Barium	Lead	Silver
Cadmium	Manganese	Zinc
Hexavalent chromium	Mercury	
Total chromium	Nickel	

The total of each is to be reported.

Table 5  
GROUND-WATER SAMPLING AND MONITORING REQUIREMENTS  
IMPOSED BY EPA AND MDNR

Parameter	Frequency
Chloride	Quarterly for first year, annually thereafter
Iron	Quarterly for first year, annually thereafter
Manganese	Quarterly for first year, annually thereafter
Phenols	Quarterly for first year, annually thereafter
Sodium	Quarterly for first year, annually thereafter
Sulfate	Quarterly for first year, annually thereafter
pH	Quarterly for first year, semiannually thereafter
Specific conductivity	Quarterly for first year, semiannually thereafter
TOC	Quarterly for first year, semiannually thereafter
Total organic halide (TOX)	Quarterly for first year, semiannually thereafter
Arsenic	Quarterly for first year, semiannually thereafter
Barium	Quarterly for first year, semiannually thereafter
Cadmium	Quarterly for first year, semiannually thereafter
Chromium	Quarterly for first year, semiannually thereafter
Fluoride	Quarterly for first year, semiannually thereafter
Lead	Quarterly for first year, semiannually thereafter
Mercury	Quarterly for first year, semiannually thereafter
Nitrate (as nitrogen)	Quarterly for first year, semiannually thereafter
Selenium	Quarterly for first year, semiannually thereafter
Silver	Quarterly for first year, semiannually thereafter
Endrin	Quarterly for first year, semiannually thereafter
Lindane	Quarterly for first year, semiannually thereafter
Methoxychlor	Quarterly for first year, semiannually thereafter
Toxaphene	Quarterly for first year, semiannually thereafter
2,4-D	Quarterly for first year, semiannually thereafter
2,4,5-TP, silvex	Quarterly for first year, semiannually thereafter
Radium	Quarterly for first year, semiannually thereafter
Gross alpha	Quarterly for first year, semiannually thereafter
Gross beta	Quarterly for first year, semiannually thereafter
Coliform bacteria	Quarterly for first year, semiannually thereafter

10 CSR 25-7.011(10)

In November 1983, the State of Missouri was granted Phase 1 interim authorization. At that time, State regulations became enforceable in lieu of Federal ones. The State ground-water monitoring regulations are identical to 40 CFR Part 265. The ground-water monitoring well system consisted of the four wells identified above, which was later modified by the addition of two wells.

## GROUND-WATER SAMPLING AND ANALYSIS PLAN

Three ground-water sampling and analysis plan summaries (SAPS) and one ground-water sampling and analysis plan (SAP) can be identified as being prepared in response to RCRA requirements. These are (1) a SAPS which was part of a December 31, 1981 permit application to the MDNR; (2) a SAPS found in the November 15, 1983 revised Part B; (3) a SAPS found in the April 16, 1984 revised Part B and (4) a SAP contained in the February 14, 1986 Part B.

### December 31, 1981 SAPS

A SAPS was prepared as part of a December 31, 1981 permit application to the MDNR. The SAP could be characterized best as an outline from which a more extensive, detailed plan should have been prepared. Based on this SAPS, it appears B.H.S. personnel monitored according to interpretations site personnel made of Federal and State regulations and State permit requirements.

Those requirements outlined in the State permits were followed closely as all parameters were monitored. On November 20, 1981 monitoring began for Federal requirements, but only indicators of contamination were analyzed.

### November 15, 1983 SAPS

This SAPS was basically a two-page summary of the interim status ground-water monitoring requirements. Monitoring parameters were listed but pH was missing from the indicators of contamination list. No sampling or analytical techniques or methods were described. No procedures were listed for any sampling or monitoring activity. The SAPS referred to new wells (System 2) which were to be sampled to develop background data.

### April 16, 1984 SAPS

This SAPS was also basically a summary of interim status ground-water monitoring requirements. It contained no more information on monitoring

activities at the site than the previous SAPS. Initial background data was included with the revised Part B yet the SAPS still described parameters to be monitored for the first year.

#### February 14, 1986 SAP

The SAP was presented in the February 14, 1986 Part B. It was prepared to meet the requirements of 10 CSR 25.7.011(10)(2) [40 CFR Part 264.98] and does differentiate somewhat between the RCRA requirements for the proposed landfill and some of the post-closure monitoring requirements of Area 1.

The plan, as written, is not clear whether interim status monitoring will be conducted at Area 1. The Part B implies the plan will be used for interim status purposes but does not specifically state this.

#### MONITORING WELLS

B.H.S. has designated two well systems at various times as their RCRA ground-water monitoring system. A well system of 16 piezometer wells (P wells) and a deep downgradient well were installed to comply with SWDAOP 721901. These were monitored along with two existing wells. Six of these wells were designated for the initial RCRA ground-water monitoring system.

The second system (GM wells) initially consisted of four wells with two wells added at a later date. This system replaced the one above for RCRA monitoring purposes.

A third system (B wells) was installed primarily to supplement the GM wells for use in Area 2's RCRA permit monitoring program. Certain of these wells were sampled by the Task Force. They were picked because their locations may intercept contamination plumes which originate in Area 1. Portions of the well system may be used to supplement or replace the GM wells in a post-closure permit issued for Area 1. Certain of the B wells and two GMW wells, described in System 2 below, are to be sampled during ground-water assessment work at the site.

In addition to the well systems placed or designated for RCRA interim status monitoring requirements, other wells had been installed and are listed under the proposed RCRA permit monitoring scheme for Area 2. These wells will be discussed and described in this section under "Other Wells".

This section will include a discussion of the interceptor trenches placed on the east and south sides of Area 1. These trenches are located between Area 1 and the designated downgradient wells GM-3 through GM-5. They, therefore, may have the potential to intercept contaminant plumes which may not reach the monitoring wells. These trenches have become forgotten members of the ground-water monitoring plan for the site and should be included as monitoring points.

The following is a discussion of the wells used for RCRA ground-water monitoring under Federal and State requirements.

#### System 1

The P wells and a companion downgradient well were installed in response to SWDAOP 721901. Sixteen P wells were installed along with one identified in the permit to be located in the southeast corner of Area 1. This well has been identified by B.H.S. consultants as both MW and DMW (hereafter MW).

Two existing water supply wells were also designated by the permit to be part of the system. These were the Zykan Well and the Old/Wash/Truck Wash Well (hereafter the Truck Wash Well).

This first well system [Appendix D, Figure D-1] was sampled to monitor ground water for the State from August 1977 through June 1983.

B.H.S. designated six wells from this system to be their RCRA monitoring system for Area 1. The upgradient ones were the Zykan and Truck Wash Wells which are completed in the deep sandstone aquifer rather than in the shallow aquifer immediately underlying waste disposal units. The downgradient ones were wells P5, P8, P10 and MW. These were sampled for RCRA monitoring purposes from November 1981 through December 1982.



## System 2

The entire first system was deemed inadequate by the MDNR for reasons discussed in the Well Construction section which follows. The four GM wells replaced System 1 in November 1982 (GM-1 through GM-4). These wells were initially installed to meet the requirements of HWFP TSD 122282001.

Well GM-1 was designated as upgradient and wells GM-2 through GM-4 as downgradient. Sampling and monitoring of these wells [Appendix D, Figure D-2] for RCRA began in December 1983 and continued through December 1985.

The GM wells continued to be monitored for RCRA when the MDNR received Phase I authorization. EPA Region VII required two wells be added to the GM series. Well GM-5 was added in May 1984 and GM-1R in July 1984 [Appendix D, Figure D-2]. Well GM-1R was designated as an upgradient well since well GM-1 was considered to be downgradient because it was influenced by the regulated units. Well GM-5 was designated as a downgradient well.

Two additional wells were required to be installed by the MDNR, GMW-1 and GMW-4, in December 1985. They were not part of the RCRA system but were used by the MDNR to evaluate the GM wells. They are used in the ground-water assessment program for the site.

## System 3

The B wells were installed [Appendix D, Figure D-3] to supplement the GM wells for Area 2's RCRA permit ground-water monitoring plan. Certain of these wells were sampled by the Task Force because it was felt they were located in areas that would intercept contaminant plumes coming from Area 1 or possibly provide new background ground-water quality data.

These wells should also be considered among others to supplement or replace the GM wells in Area 1's post-closure permit. Many of these wells would, therefore, act as dual purpose ground-water monitoring points.

### Other Wells

In December 1978, six additional P wells were installed (wells P-17 through P-22) to meet State sampling and monitoring requirements. These wells are located to the east, south and north of Area 1 and were considered to be downgradient [Appendix D, Figure D-4].

During the period July through October 1981, a series of K wells were installed. These were 12 clusters of piezometers placed at various locations throughout the site to monitor water levels to establish hydrogeologic gradients [Appendix D, Figure D-5].

In October 1985, four additional piezometers were installed to monitor hydrogeologic conditions. These are wells P-A, P-B, P-C and P-D and are located to the west of Area 1 [Appendix D, Figure 6].

### Interceptor Trenches

Three trenches were installed to comply with the requirements of State Permit HWFP TSD 122282001. They were designed to intercept flow from Hydrologic Units A and B.

The trenches are pumped once or twice a year and are not on a set monitoring schedule. The sumps for each trench (trenches 1 and 2 share a common sump) were designated by the State permit as monitoring points. Minimal information is available on monitoring results.

### Well Construction

The following is a discussion of the known construction details for each well system installed by B.H.S.

### System 1

This system comprises the P wells, well MW, the Zykan Well and the Truck Wash Well. The P wells and well MW were installed from late 1976 to early 1977. The P wells are all completed 35 feet below surface elevation (BSE) and well MW is 128 feet BSE. Few construction details are available for well MW although a boring log does exist. The well was probably constructed in the same manner and from the same materials as the P wells.

Well MW was initially bored to 174 feet BSE, 6 inches into limestone bedrock. A gravel layer was found at 87 to 97 feet BSE. It subsequently caved in, filling the bottom of the hole. The bottom of well MW's casing sits on top of the gravel. The water quality of samples taken from the well were, in all likelihood, related to the quality of water found in the caved-in section of the boring.

The P wells were constructed by drilling an 8-inch boring and placing a 3-inch PVC pipe within it. All wells were 35 feet deep and have a 25-foot screened interval. Sand was placed as a filter within the boring/well pipe annulus to just above the top screen. A bentonite plug was placed on top of the sand filter and local soil was used to fill in the remaining space to the surface. Table 6 provides a summary of the depth, screened interval and screened hydrogeologic units of the P wells and well MW. Figure 5 provides the typical construction of the P wells and, probably, well MW.

Table 6  
SUMMARY OF WELL INFORMATION,  
SYSTEM 1  
NOMINAL 3-INCH-DIAMETER PVC PIPE  
WITH GLUED JOINTS

Well Number	Surface Elevation (ft. msl)	Screened Zone (ft. msl)	Screened Hydrologic Unit(s)
P-1	804.9	795-770	A
P-2	790.5	780-755	A
P-3	778.3	768-743	A
P-4	770.0	760-735	A, B
P-5	765.9	756-731	A, B
P-6	764.3	754-729	A, B
P-7	759.9	750-725	A, B
P-8	758.4	748-723	A, B
P-9	755.7	746-721	A, B
P-10	761.2	751-726	A, B
P-11	777.1	767-742	A
P-12	586.7	777-752	A
P-13	794.9	785-760	A
P-14	798.5	786-761	A, B
P-15	804.4	794-769	A
P-16	808.4	798-773	A
MW	735.5	Unknown	A, B

Many of the P wells never produced water or produced water intermittently. Later hydrogeologic site investigators concluded fine-grained material may have plugged the screens, causing dry or mud conditions in these wells.

The Zykan Well was constructed in 1970 to act as a water supply for the site. It is approximately 404 feet BSE and draws water from the St. Peter Sandstone formation. The Truck Wash Well also serves as a water supply well for the site. There is no available data of its construction or depth. It supposedly also draws water from the St. Peter Sandstone formation. No other information is known for either well.

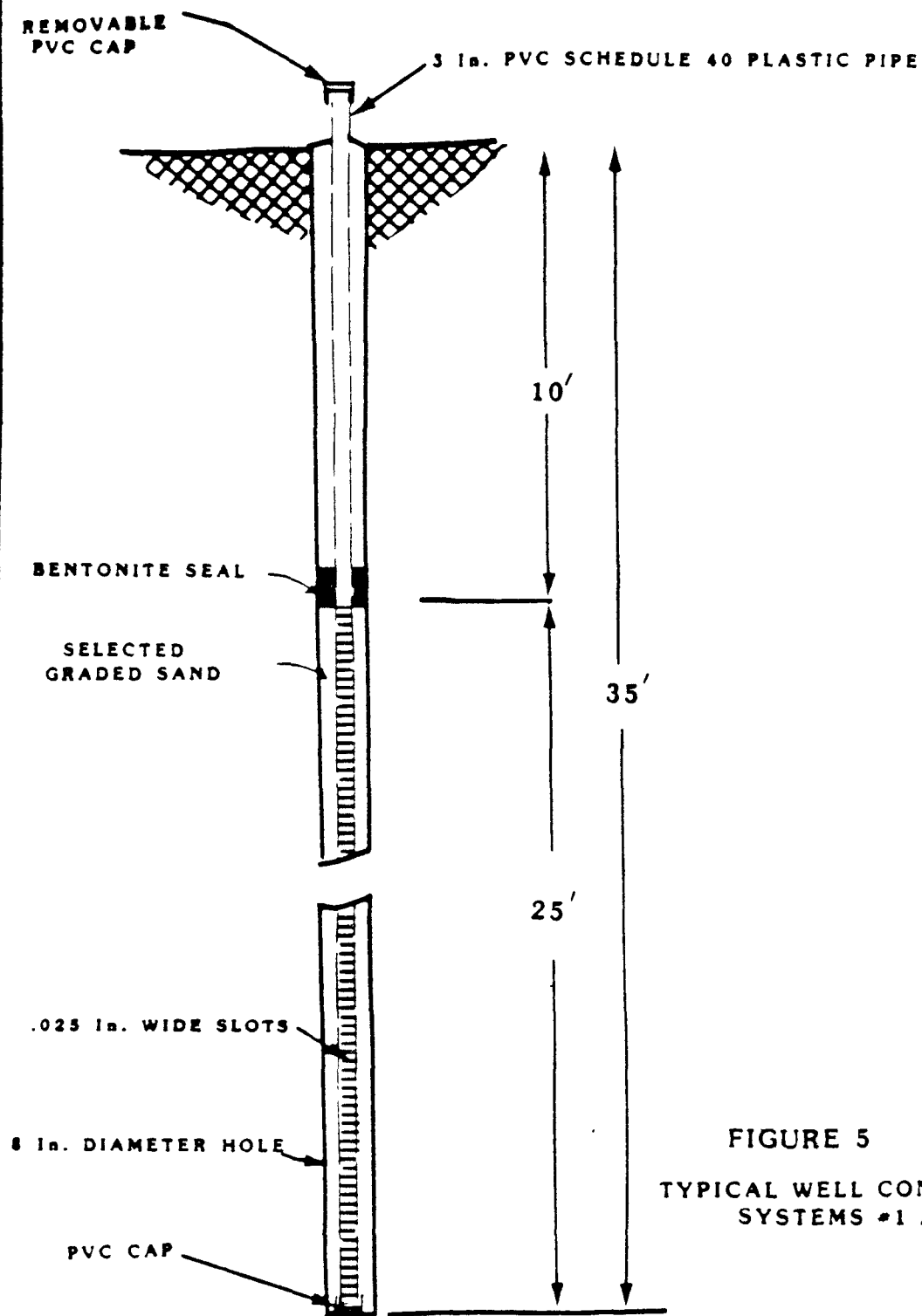


FIGURE 5  
TYPICAL WELL CONSTRUCTION  
SYSTEMS #1 AND #2

(REVISED FROM REITZ & JENS, INC.)

The system P wells were deemed to be inadequate for the following reasons:

1. Fine-grained material was believed to have plugged screens of certain wells. This caused dry or mud conditions within wells, making them unusable for monitoring purposes. It was therefore concluded that certain or all P wells were improperly constructed.
2. The two upgradient wells were not screened in the same water-bearing zone as the downgradient ones. No water quality comparison could be made between the up and downgradient wells because different water-bearing zones were being monitored.

## System 2

This system comprises the GM wells (GM-1 through GM-5 and GM-1R). Wells GM-1 through GM-4 were installed in November 1982 as replacements for the System 1 wells. All were drilled in the same manner as the P wells and well MW, although the System 2 wells have 4-inch PVC casings. Sand was used as a filter pack material in the annulus from the bottom to 8 to 9 feet above the screened interval. The remaining annular space was filled with a cement-bentonite grout to surface elevation.

Wells GM-5 and GM-1R were constructed in May 1984 and July 1984, respectively, in the same manner as the other GM wells. Table 7 provides the depth, screened interval and screened hydrogeologic unit for each well. The typical construction of these wells would follow that of Figure 5 but with a different casing size and depth.

Table 7  
SUMMARY OF WELL INFORMATION  
SYSTEM 2\*  
NOMINAL 4-INCH-DIAMETER  
SCHEDULE 40 PVC  
THREADED FLUSH JOINT PIPE

Well Number	Surface Elevation (ft. msl)	Screened Zone (ft. msl)
GM1	796.3	700.8-670.3
GM2	812.3	665.0-636.5
GM3	772.8	675.8-647.0
GM4	758.0	682.3-653.0
GM5	777.6	686.4-631.4
GM1R	765.3	728.0-705.0

\* All wells are screened in  
Zone B.

The system was deemed by EPA to have an insufficient number of wells in order to constitute effective detection monitoring and compliance monitoring programs. Further wells were needed in order to adequately serve as points of compliance.

### System 3

This system comprises the 27 B wells. Two wells, GMW-1 and GMW-4, were also drilled along with the B wells in order to monitor the performance of wells GM-1 and GM-4, as required by the MDNR. These two wells are not a part of System 3.

All of the above wells were drilled from October through December 1985. They were started with a 6-inch boring in which a 2-inch No. 316 stainless steel casing was placed. The wells are screened in hydrogeologic units A and B. The B wells have 10-foot screens and the GMW wells have 20-foot screens.

Two exceptions are wells B18A and B19 which are constructed of 2-inch PVC pipe with 5-foot screens. These act as piezometers to monitor sand lenses in the oxidized zone (hydrologic unit A).

Sand was packed between the boring and casing from the bottom to 2 feet above the screen. A 2-foot bentonite plug was placed on top of the sand, followed by cement-bentonite grout to the surface. A steel protective casing was placed over the well and a concrete pad poured around the well.

Table 8 provides information on all B and GMW wells. Figure 6 shows the typical construction of the B and GMW wells.

#### Other Wells

Wells P-17 through P-22 and P-A through P-D have 3-inch PVC casings. They were installed soon after the initial P wells. It is unknown how they were constructed, but it is inferred construction procedures followed that of the initial P wells.

Wells P-17, P-18, P-20 and P-22 are 50 feet deep and have 40-foot screens. Wells P-19 and P-21 were drilled 111 feet and 120 feet, respectively, and have 40-foot screens. Sand filled the space between the bore hole and casing just above the screens. It is unknown if a bentonite plug was used to seal off the space above the sand and it is assumed local soil was used to fill the remainder of the annular space.

Little construction information is available for wells P-A through P-D other than their size, depth and screened interval, which is approximately 12 feet.

Table 9 provides the known construction information for the above wells.



Table 8  
SUMMARY OF WELL INFORMATION SYSTEM 3 AND GMW WELLS  
NOMINAL 2-INCH-DIAMETER NO. 316 STAINLESS STEEL, THREADED, FLUSH-JOINTED PIPE

Piezometer* or Monitoring Well Number	Piezometer or Monitoring Well Location	Elevation the ground Surface (ft. msl)	Top of Riser Elevation	Depth (ft.) Elevation of Hole Bottom (msl)	Water Level (ft. msl) January 7, 1986
B-1A	2638N, 995E	808.9	811.48	60.75/748.15	Dry
B-2	2623N, 1260E	791.0	793.22	49.7/744.22	754.1
B-3A	2602N, 1520E	772.8	774.88	38.16/734.64	760.1
B-4	2351N, 1650E	767.0	768.94	38.84/728.16	763.5
B-5	2143N, 1812E	760.8	763.57	28.17/732.63	736.9
B-6A	1900N, 1897E	761.9	763.23	35.7/726.9	747.3
B-7	1889N, 1609E	778.9	782.09	56.7/722.9	762.5
B-8A	1861N, 1428E	790.7	792.27	59.7/731.7	761.0
B-9	2171N, 1053E	799.3	801.64	55.84/743.46	748.0
B-10A	2395N, 959E	804.7	806.24	57.7/747.7	754.6
B-11A	1878N, 1155E	793.1	793.95	57.7/736.1	764.9
B-12A	2380N, 560E	807.4	809.34	116.5/692.9	Dry
B-12B	2392N, 676E	807.6	810.55	65.41/742.39	748.7
B-13	2160N, 625E	800.7	802.75	61.7/739.7	743.9
B-14A	1890N, 625E	792.2	793.2	56.75/735.45	758.3
B-15	1606N, 623E	787.8	791.69	55.7/732.8	756.7
B-16	1320N, 625E	775.6	776.81	54.5/721.1	752.1
B-17A	1046N, 630E	760.4	762.39	79.7/681.4	683.1
B-17C	1031N, 625E	759.4	762.84	47.7/712.4	741.1
B-18	875N, 750E	748.2	750.23	43.82/704.37	732.9
B-18A*	877N, 762E	748.6	749.56	29.83/718.77	733.5
B-19A	876N, 1025E	745.6	746.79	36.83/710.57	733.0
B-19B*	882N, 1030E	746.4	748.62	22.5/723.9	733.2
B-20	1300N, 1425E	769.6	771.46	54.7/715.6	751.2
B-21A	1574N, 1425E	778.0	779.56	49.33/728.67	762.7
B-22A	1035N, 1425E	750.5	752.66	41.7/709.5	735.3
B-23A	889N, 1298E	736.0	738.85	20.58/715.42	734.0
GMW-1	1907N, 1150E	794.3	795.96	124.7/670.3	784.4
GMW-4	1957N, 2095E	761.0	762.61	104.7/657	687.5

\* Piezometers constructed from schedule 40 PVC

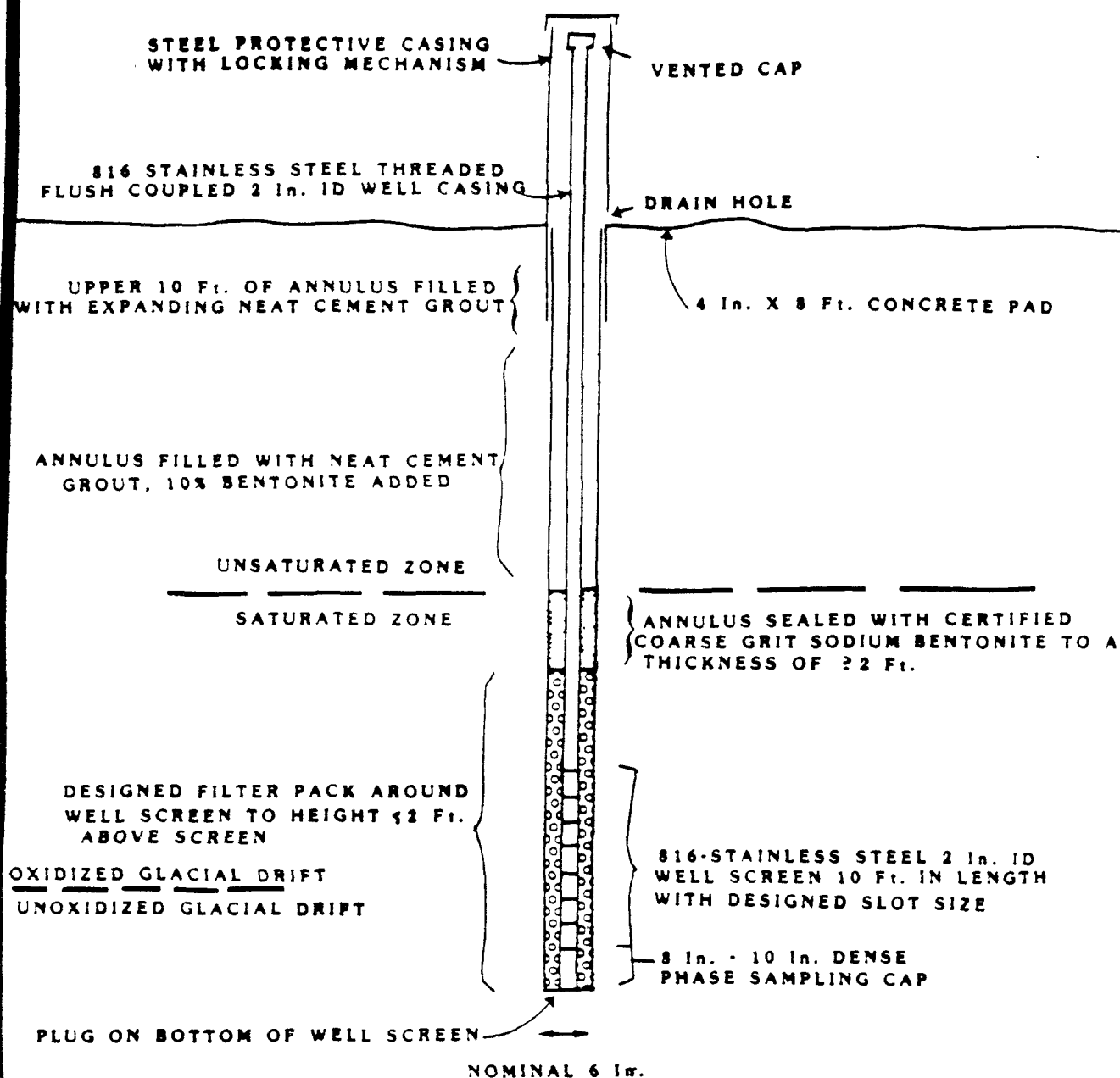


FIGURE 6  
TYPICAL WELL CONSTRUCTION  
SYSTEM #3 AND GMW WELLS

(Revised for Woodward-Clyde Consultants)

Table 9  
SUMMARY OF WELL INFORMATION  
WELLS P17 THROUGH P22 AND P-A THROUGH P-D  
NOMINAL 3-INCH-DIAMETER PVC PIPE  
WITH GLUED JOINTS

Well Number	Surface Elevation (ft. msl)	Screened Zone (ft. msl)	Screened Hydrologic Units
P17	800.2	790-750	A, B
P18	748.5	738-698	B
P19	755.5	765-725	A, B
P20	764.6	755-715	A, B
P21	791.2	781-741	A
P22	779.8	770-730	A, B
PA	793.5*	742-754	A, B
PB	793.5*	714-726	B
PC	796.0*	716-728	B
PD	796.0*	745-757	A, B

\* Approximate

The K series of wells are clusters of  $\frac{1}{2}$ -inch and  $1\frac{1}{2}$ -inch wells. Each cluster was placed to monitor water levels in one or more of the following zones: at the oxidized/unoxidized interface, at a depth of approximately 50 feet below waste disposal and at depths below the 50-foot level to the bedrock. It is unknown which size corresponds to which specific well in a cluster. The holes were bored by 6-inch and  $3\frac{1}{4}$ -inch hollow-stem augers and 4-inch solid core continuous flight augers. Screened intervals ranged from 10 to 20 feet depending upon the depth of the zone to be monitored. Screen size was 0.5 millimeter.

The annular space between the screened interval and the total depth was filled with sand. The remainder of the annular space above the sand was filled with a cement/bentonite grout.

Table 10 provides the available construction details for each cluster.

Table 10

SUMMARY OF WELL INFORMATION  
NOMINAL ½-INCH AND 1½-INCH-DIAMETER  
PVC PIPE WITH GLUED JOINTS

Well Number	Surface Elevation (ft. msl)	Screened Zone (ft. msl)	Screened Hydrologic Unit(s)
K-1-ox*	780.6	721.6-731.6	A, B
K-1-80'*	780.3	725 -705	B
K-1-sa*	781.8	672 -662	B
K-1-br*	781.8	606 -604	B
K-2-ox	796.6	739.6-741.6	A, B
K-2-80'	797.9	741 -721	B
K-2-sa	797.0	677 -667	B
K-2-br	797.0	606.4-604.4	B
K-3-ox	777.4	713 -703	A
K-3-80'	776.5	718 -698	B
K-3-110'*	778.8	688 -658	B
K-3-br	778.8	580 -578	B
K-4-ox	791.7	748 -738	A, B
K-4-80'	791.5	734 -714	B
K-4-120'	792.2	672 -662	B
K-4-br	792.2	672 -662	B
K-4-brr*	791.9	582 -557	B
K-5-ox	773.1	734.6-724.6	A, B
K-5-80'	771.4	715 -695	B
K-5-sa	772.1	677 -667	B
K-5-br	772.1	605 -603	B
K-6-ox	746.3	735.3-727.3	A, B
K-6-si*	745.5	644 -624	B
K-6-br	745.9	573 -568	B
K-7-ox	770.6	737.3-727.3	A, B
K-7-si	769.7	772 -762	B
K-7-br	770.1	581.4-576.4	B
K-8-ox	793.9	745.7-735.7	A, B
K-8-si	791.9	713 -693	B
K-8-br	792.8	605 -600	B
K-9-80'	736.35	678 -658	B
K-9-sa	736.5	625 -615	B
K-9-br	736.5	580 -575	B
K-10-80'	732.9	657 -652	B
K-10-br	732.5	674 -654	B
K-11-ox	759.2	724 -714	A, B
K-11-sa	759.6	701 -691	B
K-11-br	759.2	663 -643	B
K-12-br	768.1	557 -555	B

\* Note:

ox = oxidized unoxidized zone surface

80 = 80 feet in depth

sa = completed in sand layer

si = completed in silty layer

110 = 110 feet in depth

br = bit refusal

brr = bit refusal replacement

### Well Locations

Appendix D, Figures D-1 through D-6, indicates the locations of each well system, the interceptor trenches and the other well networks. The proposed RCRA permit system encompasses nearly all wells installed at the site.

### Interceptor Trenches

Few as-built construction details are available for the trenches. All trenches were to be excavated at least 2 feet below the interface zone between Hydrologic Units A and B. A sand-filled lens was constructed that extended 2 feet into Hydrologic Unit B and the remainder in Hydrologic Unit A. For trench 1, this sand-filled portion was 8 feet in total depth. For trenches 2 and 3, it ranged from 18 to 20 feet in total depth. All lenses were at least 2 feet in width.

On the north side of trench 1 is a sand-filled lens that acts as the collection zone. A clay cutoff wall was constructed to prevent flow beyond the lens. The clay was extended above and beyond the lens to the north and the remainder of the excavation backfilled with previously excavated soil [Appendix B, Figure B-10].

Trenches 2 and 3 had a clay cutoff on top of the sand lens with the remainder of the excavation backfilled with previously excavated soil [Appendix B, Figure B-10].

Observation sumps were placed a short distance from the monitoring sump. It is not clear if the trenches are sloped to either sump. Therefore, it may not be possible to fully evacuate the trenches when they are pumped.

All monitoring sumps were sand-filled, fabric-lined and 20 feet square. They extended at least 4 feet below the interceptor trench. A 6-inch PVC pipe extended into the sump and is used to drain accumulated water. Trenches 1 and 2 share a common sump [Appendix B, Figure B-11].

The observation sump was of a similar construction but only 5 feet to a side [Appendix B, Figure B-11].

#### SAMPLE COLLECTION AND HANDLING PROCEDURES

The Task Force did not observe sample collection and handling by B.H.S. during the inspection because B.H.S. had yet to initiate sampling of the new monitoring well system. B.H.S. did assist in purging some wells in order for the Task Force to take samples. The B.H.S. and Task Force purging procedures are discussed together with the Task Force sampling procedure in the section entitled "Task Force Sample Collection and Handling Procedures".

#### WAIVER OF GROUND-WATER MONITORING REQUIREMENTS DEMONSTRATION

A request for waiver of the interim status ground-water monitoring requirements was submitted to EPA Region VII by B.H.S. in January 1982. During review of the request, it was established that downgradient wells P-5, P-8 and P-10 were not properly constructed (precipitation and surface runoff may penetrate the wells and fine sediment particles entering the screens may have plugged the wells) and the wells may not be screened in the uppermost water-bearing zone. It was also established that the upgradient wells and well MW were not in the same water-bearing zone as the P wells. During the waiver request review period, the GM wells were constructed.

The waiver was denied on September 3, 1983. EPA Region VII required the installation of a new upgradient well (GM-1R) and a new downgradient well (GM-5). These wells became part of the GM well system and were installed in 1984.

A Letter of Warning, dated March 6, 1984, was issued by EPA Region VII requiring the two above wells be installed. In a March 22, 1984 letter, B.H.S. acknowledged they would comply and the wells were installed.

## GROUND-WATER ASSESSMENT PROGRAM AND OUTLINE

Sampling and monitoring under RCRA began with the System 1 wells in November 1981. The program continued through September 1982 to build an initial background data base. The installation of the System 2 wells, in essence, made the data collected from System 1 useless in attempting to determine compliance with ground-water monitoring requirements.

Sampling and monitoring under RCRA began at the System 2 wells in December 1983. Required parameters not analyzed for were radium, gross alpha, gross beta and coliform bacteria. Magnesium was reported instead of manganese and all metals were reported as dissolved. Monthly sampling to establish an initial background data base at these wells was conducted. When well GM-1 was considered by the MDNR and EPA Region VII to not truly represent background, well GM-1R was installed and initial background data base sampling began in September 1984 and continued through May 1985.

In September 1985, the first statistical analysis was done for all downgradient GM wells (GM-1 through GM-5) compared to well GM-1R. The analysis showed the following statistical differences: well GM-1, decrease in pH; well GM-2, increase in TOC; well GM-3, increase in specific conductivity; well GM-4, increase in TOC and TOX; and well GM-5, decrease in pH.

A Ground-water Assessment Plan (GWAP) was submitted to EPA Region VII and MDNR on February 11, 1986. Its intent was to sample and monitor wells B-1 through B-11, GMW-1 and GMW-4 to ascertain ground-water quality effects. The GWAP was reviewed and subsequently amended and approved on April 16, 1986.

The plan calls for three study phases. Phase I is to consist of sampling and analysis of certain B and the two GMW wells for the parameters listed in Table 11. If contamination is found, Phase II will begin. The following parameters will be analyzed to identify a contamination plume: arsenic, barium, cadmium, chromium, lead, mercury and silver. Analysis of vapors in the soil above the ground water will be used as an indicator of contamination in the ground water.

Table 11  
PHASE I GROUND-WATER ASSESSMENT PLAN PARAMETERS

---

Indicator Parameter

pH

Ground-Water Quality Parameters

Total phenols

E.P. Metals

Arsenic

Barium

Cadmium

Chromium

Lead

Mercury

Selenium

Silver

Volatile Organic Priority Pollutants

Acrolein	Chloroform	Methylene chloride
Acrylonitrile	Bromodichloromethane	1,1,2,2-Tetrachloroethane
Benzene	1,1-Dichloroethane	Tetrachloroethene
Bromoform	1,2-Dichloroethane	Toluene
Carbon tetrachloride	1,2-Dichloropropane	Trans-1,2-dichloroethane
Chlorobenzene	cis 1,2-Dichloropropene	1,1,1-Trichloroethane
Dibromochloromethane	Ethylbenzene	1,1,2-Trichloroethane
Chloroethane	Methyl bromide	Trichloroethene
2-Chloroethylvinyl ether	Methyl chloride	Vinyl chloride

Acid Extractables

Naphthalene

Isophorone

Miscellaneous

Maleic acid

---



The plan, as written, reveals that only the previously mentioned parameters will be analyzed in Phase II. This may not be the true intent of the Phase II work. Vapors above the soil are to be monitored and the previously mentioned parameters have extremely low vapor pressures resulting in extremely low vapor concentrations. Only the organic constituents of Table 11 will give off vapors in sufficient quantities so that an attempt can be made to measure them.

An approximate extent of the plume will be defined and additional borings and piezometers will be installed to confirm the shape of the plume. An analytical model will be used to determine the flow rate and direction of the plume movement.

If no contamination is found during Phase I, Phase III will be entered. This portion of the plan is designed to evaluate whether the GM well construction method caused the statistical differences. If this is the case, new wells will be constructed and 4 months of sampling will act as background. The fifth month of sampling will represent the first semiannual analysis and statistical analyses will be initiated. All other sampling will follow a semiannual schedule.

Phase I work of the GWAP was instituted on May 1, 1986.

## GROUND-WATER MONITORING PROGRAM PROPOSED FOR RCRA PERMIT

In its February 1986 Part B application, B.H.S. has proposed a series of programs, parameters and well locations to be included in a RCRA permit for Area 2. The application also briefly describes a program for Area 1. The following is a discussion of these proposals. The RCRA permit will describe these items in greater detail. The sanitary landfill is omitted from any of the monitoring programs.

### DEFINITION OF WASTE MANAGEMENT AREAS

B.H.S. has divided the facility into two Waste Management Areas (WMAs) [Figure 7]. WMA1 includes Area 1 and surface impoundments SI-1, SI-2 and SI-4. WMA2 includes Area 2 and the storage and treatment areas. A Compliance Monitoring Plan for the areas has been proposed by B.H.S. and a proposed Detection Monitoring Plan and Corrective Action Plan were provided in the Part B application. Selected B series wells will serve as compliance points.

The site hydrogeology has been divided into two water-bearing zones (Hydrologic Units A and B) for monitoring purposes. The oxidized glacial till has been designated Hydrologic Unit A. The unoxidized till and below to the first bedrock unit has been designated Hydrologic Unit B. All B-series wells designated as points of compliance are screened in both units.

### POINT OF COMPLIANCE

B.H.S. has designated a network of B wells along the proposed points of compliance for each WMA. Some of these wells are proposed and are identified by "(P)" in the following list. Appendix D, Figure D-7, identifies the location of the wells for each WMA. Wells designated for WMA1 are: B-1A, B-2, B-3A, B-4, B-5, B-6A, B-7, B-8A, B-34(P), B-35(P) and B-36(P). Wells designated for WMA2 are: B-9, B-10A, B-11A, B-12A, B-12B, B-13, B-14A, B-15, B-16A or B, B-17C, B-18, B-19A, B-20, B-21A, B-22A, B-23, B-31(P), B-32(P), B-33(P), B-34(P), B-35(P) and B-36(P).

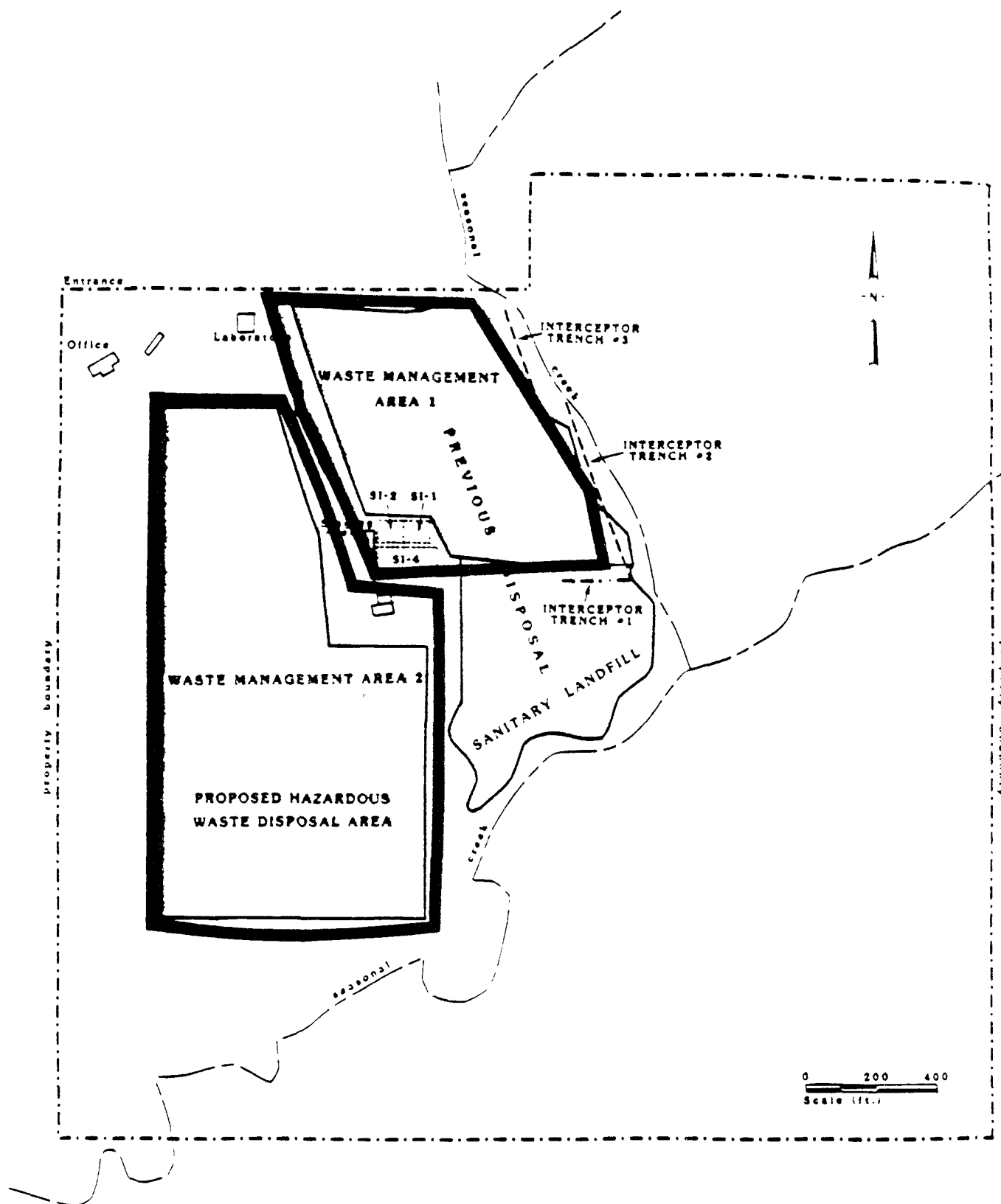


FIGURE 7. DESIGNATION OF WASTE MANAGEMENT AREAS

For WMA2, the point of compliance is the southern boundary of the proposed landfill [Appendix D, Figure D-7]. The sufficiency of the point of compliance proposed for WMA2 cannot be determined until a more thorough hydrogeologic site characterization is provided and a presentation is made to illustrate the effects of design, construction and operating practices on the ground-water flow patterns.

#### DETECTION MONITORING PROGRAM

Both WMAs are to be monitored under the program. Ground-water quality background data will be developed and subsequent monitoring results will be compared to it. Statistical analysis of monitoring data, similar to that done under interim status, will be conducted.

As proposed in the Part B, semiannual monitoring and sampling will be conducted at all B, GM and GMW wells for the following parameters:

- Arsenic
- Lead
- Chromium, total
- 2,4-Dichlorophenoxy acetic acid (2,4,-D)
- Phenol

WMA1 monitoring and sampling points will consist of all previously monitored B wells and wells GM-1 through GM-5, GM-1R, GMW-1 and GMW-4. WMA2 monitoring and sampling points will consist of all previously monitored B wells.

Wells identified in Table 12 are to be monitored monthly for water level. This is being done to determine the impact of Area 2 on ground-water flow directions. To best realize this goal, wells should be selected to represent discrete interconnected intervals and potentiometric maps should be prepared to depict lines of equal change in head over time.

Parameters chosen for analysis should relate to wastes placed in Area 1, wastes anticipated to be placed in Area 2 or constituents known to occur in leachate from Area 1.

Table 12  
WELLS FOR MONTHLY  
WATER LEVEL MEASUREMENTS

B-1A	B-18A	GMW-4	KC-BR
B-2	B-19A	GM-5	K7-0X
B-3A	B-19B	K2-0X	K7-SI
B-4	B-20B	K2-80	K7-BR
B-5	B-21A	K2-SA	K9-SA
B-6A	B-22B	KS-BR	K9-BR
B-7	B-23A	K3-0X	K10-80
B-8A	B-30 (P)	K3-110	K10-BR
B-9	B-31 (P)	K3-BR	K11-0X
B-10A	B-32 (P)	K4-0X	K11-SA
B-11	B-33 (P)	K4-80	K11-BR
B-12A	B-34 (P)	K4-120	K12-BR
B-12B	B-35 (P)	K4-BR	P-18
B-13	B-36 (P)	K4-BRR	P-20
B-14A	GM-1	K5-0X	P-21
B-15	GM-1R	K5-80	P-22
B-16	GMW-1	K5-SA	PA
B-17A	GM-2	K5-BR	PB
B-17C	GM-3	K6-0X	PC
B-18	GM-4	K6-SI	PD
Truck			
Wash			
Well			

#### COMPLIANCE MONITORING PROGRAM

This program will be initiated if the statistical analysis from the detection monitoring program shows significantly elevated levels of monitored parameters. A plan will be prepared that will characterize the contaminated ground water based on 40 CFR 261, Appendix VIII. Table 13 outlines the minimum list of parameters proposed to be monitored. Others will be chosen based on the waste accepted for disposal.

B.H.S. will propose action levels for each hazardous constituent detected, based on background concentrations. All wells that are part of

the detection monitoring program will be monitored at this time. Quarterly monitoring will be performed and a statistical analysis conducted on the generated data.

Table 13  
PARAMETERS FOR COMPLIANCE MONITORING PROGRAM

Parameter	Analytical Methods	Detection Limit for Monitoring
pH	EPA 150.1*	-
Specific conductance	EPA 120.1*	-
Total organic carbon (TOC)	EPA 415.1*	1000 µg/ℓ
Total organic halide (TOX)	EPA 450.1*	10 µg/ℓ
Cyanide, total	EPA 335.2*	1.0 mg/ℓ
Chloride	Method 407B**	1.0 mg/ℓ
Phenol	EPA 625*	
Sulfate	Method 426C**	1.0 mg/ℓ
Dissolved arsenic	EPA 206.2*	50 µg/ℓ
Dissolved barium	EPA 208.1*	1.0 mg/ℓ
Dissolved chromium	EPA 218.2*	50 µg/ℓ
Dissolved cadmium	EPA 213.2*	10 µg/ℓ
Dissolved lead	EPA 239.2*	50 µg/ℓ
Dissolved mercury	EPA 245.1*	2.0 µg/ℓ
Dissolved silver	EPA 272.2*	50 µg/ℓ
Dissolved selenium	EPA 270.2*	10 µg/ℓ
2,4-D	Method 509B**	100 µg/ℓ
2,4,5-TP silvex	Method 509B**	10.0 µg/ℓ
Toxaphene	Method 509A**	5.0 µg/ℓ

\* *Methods for Chemical Analysis of Water and Wastes, EPA 600/4-79-020, March 1979, U.S. Environmental Protection Agency, Washington, D.C.*

\*\* *Standard Methods for the Examination of Water and Waste Water, 15th Edition, 1980, American Public Health Association, Washington, D.C.*

CORRECTIVE ACTION PLAN

This program will be initiated if hazardous constituents measured in the ground water exceed the limits found in Table 1 of 10 CSR 27.7.011(10). B.H.S. has left open the course of action it would take to prevent the contamination and indicates that the problem will be studied and actions developed at that time. The ground-water monitoring system will also be evaluated to determine the adequacy for contamination delineation.

## TASK FORCE SAMPLE COLLECTION AND HANDLING PROCEDURES

Samples were collected from the B.H.S. facility for analysis to determine if the ground water contains hazardous waste constituents or other indicators of contamination. This section describes the sampling procedures followed during the site inspection.

Thirteen stations were sampled comprising nine monitoring wells, two interceptor trench sumps and two leachate collection sumps [Table 14, Figure 8]. The wells were selected to provide areal coverage, both upgradient and downgradient of Area 1. The interceptor trenches receive shallow ground-water discharge. Two leachate samples were also collected to determine leachate chemical characteristics and provide a basis for determining constituents which may leach into and contaminate the ground water.

B.H.S. personnel made all water-level measurements in the wells and interceptor trench sumps and sometimes assisted in the purging of wells and sumps. An EPA contractor did most of the well purging and all but one of the water sample collections. The one exception was interceptor trench 3, where the sump well casing extends 13 feet above the ground. B.H.S. personnel drew the sample while standing on a raised lift of a Caterpillar tractor while EPA contractor personnel stood below and assisted. B.H.S. also drew all samples from the two leachate collection sumps while EPA contractor personnel stood upwind. Task Force personnel observed all purging and sampling procedures throughout the inspection.

A complete set of samples was collected from each sample station to be analyzed by EPA contract laboratories. A complete sample set is shown in Table 15, which lists the sample parameters with respective containers and preservatives in the order in which they were collected. Replicate samples of volatile organic samples and split samples for all other parameters for each sampling station were offered to B.H.S. but were declined. Sample sets from well B-8A and PTA leachate sump were provided to NEIC for quality assurance/quality control purposes.



Table 14  
SAMPLE COLLECTION DATA

Sample Station	Sampling Times				Remarks
		Start		End	
<u>Wells</u>					
GM-1	1549	02/24/86	1129	02/26/86	Sample clear; submersible pump, triplicate
GM-5	1216	02/21/86	1224	02/21/86	Sample clear, submersible pump
GMW-1	1017	02/25/86	0919	02/26/86	Sample slightly turbid, inoperable Well Wizard substituted with Teflon bailer
B-7	0931	02/20/86	1040	02/20/86	Sample clear, Teflon bailer, NEIC split
B-8A	0907	02/25/86	0937	02/26/86	Sample clear, Teflon bailer
B-11A	0900	02/20/86	0954	02/20/86	Sample slightly turbid, Teflon bailer
B-15	0916	02/25/86	0948	02/25/86	Sample slightly turbid, Teflon bailer
B-20	1441	02/20/86	1511	02/20/86	Sample slightly turbid, Teflon bailer
B-23A	1011	02/25/86	1036	02/25/86	Sample clear, Teflon bailer
<u>Interceptor Trenches</u>					
Common sump to interceptor trenches 1 & 2	1236	02/20/86	1247	02/20/86	Sample clear with slight sulfur odor; submersible pump
Interceptor trench 3 sump	1114	02/21/86	1128	02/21/86	Sample clear, submersible pump, collected by B.H.S.
<u>Leachate</u>					
Common sump to progressive trench area	1304	02/24/86	1323	02/24/86	Sample brownish-green, submersible pump, NEIC split, collected by B.H.S.
Trench 2N sump	1331	02/24/86	1340	02/24/86	Sample charcoal-colored, submersible pump, collected by B.H.S.

\* February 22-23, 1986 was a weekend and no sampling took place

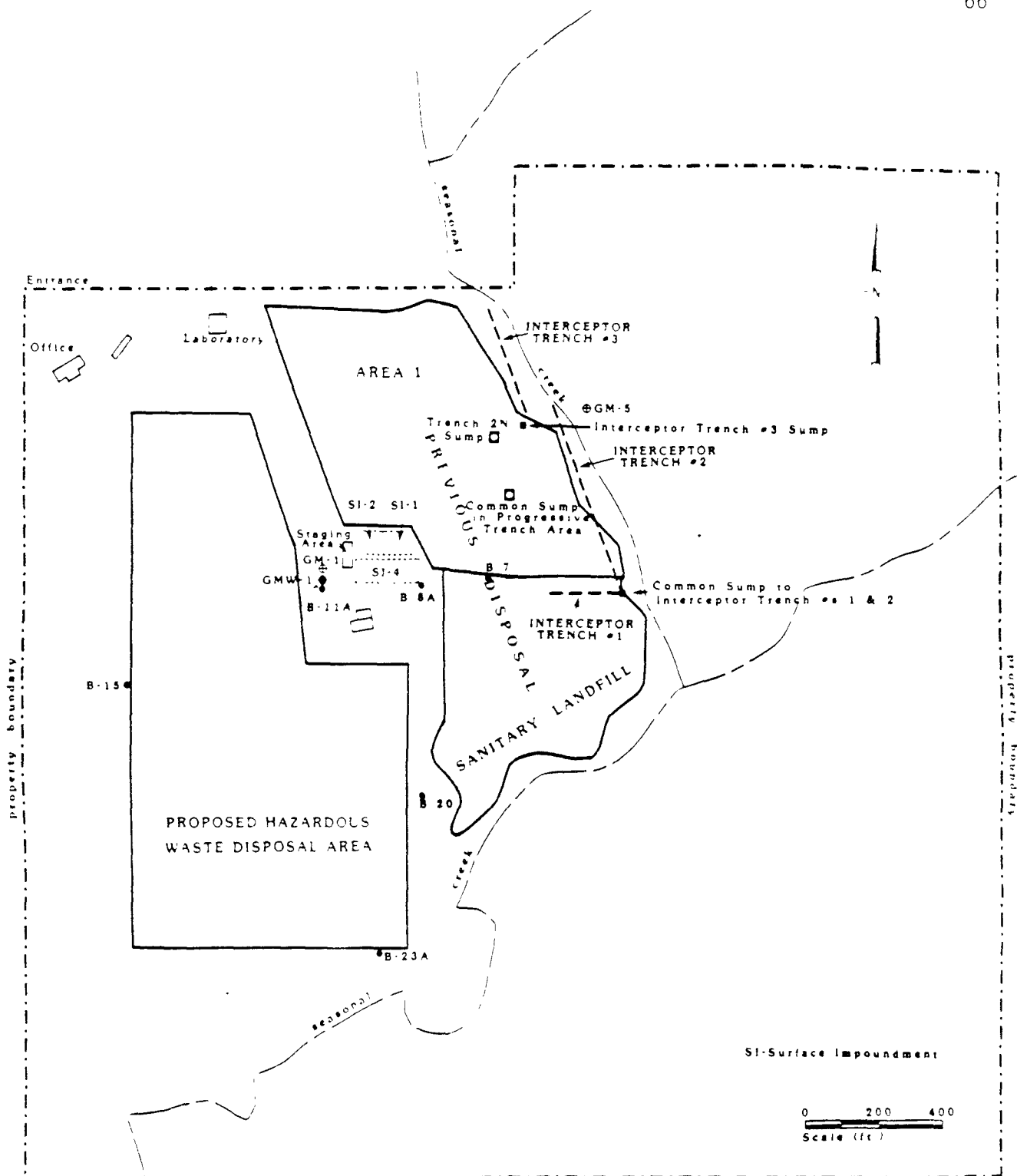


FIGURE 8. LOCATION OF TASK FORCE SAMPLE STATIONS WITH FACILITY UNITS SHOWN

Table 15  
ORDER OF SAMPLE COLLECTION,  
BOTTLE TYPE AND PRESERVATIVE LIST

Parameter	Container	Preservative*
Volatile organic analysis (VOA)		
Purge and trap	2 60-ml VOA vials	
Direct inject	2 60-ml VOA vials	
Purgeable organic carbon (POC)	2 60-ml VOA vials	
Purgeable organic halogens (POX)	2 60-ml VOA vials	
Extractable organics	4 1-qt. amber glass	
Pesticide/herbicide	2 1-qt. amber glass	
Dioxin	2 1-qt. amber glass	
Total metals	1 1-qt. plastic	HNO <sub>3</sub> - pH <2
Dissolved metals	1 1-qt. plastic	HNO <sub>3</sub> - pH <2
Total organic carbon (TOC)	1 4-oz. glass	H <sub>2</sub> SO <sub>4</sub>
Total organic halogens (TOX)	1-qt. amber glass	
Phenols	1-qt. amber glass	CuSO <sub>4</sub> + H <sub>3</sub> PO <sub>4</sub>
Cyanide	1-qt. plastic	NaOH - pH >12
Nitrate/ammonia	1-qt. plastic	H <sub>2</sub> SO <sub>4</sub>
Sulfate/chloride	1-qt. plastic	
Radionuclides (NEIC only)	4 1-qt. amber glass	

\* All samples cooled to 4° C.

All sample containers and preservatives were provided by an EPA contract laboratory. All sampling equipment was provided by the EPA sampling contractor. Ground-water samples were collected from each well using the following protocol:

- B.H.S. personnel or their contractor determined the depth to ground water.
- B.H.S. calculated the height and volume of the water column and amount to be purged.
- The EPA sampling contractor and/or B.H.S. purged the amount calculated (less if the well was purged to dryness).

- The EPA contractor monitored the open wellhead for chemical vapors and radiation (before and after purging).
- The EPA contractor collected a sample aliquot and conducted field measurements for water temperature, pH, specific conductance and turbidity.
- The EPA contractor filled VOA vials and then filled the remaining sample containers in the order shown in Table 15.
- The EPA contractor placed the sample container in ice immediately after collection.

The reference point from which the depth-to-water measurements are made at B.H.S. is at the top of the well casing. B.H.S. personnel and their contractor used a Water Level Indicator (Model 6000 by Slope Indicator Co.) to make their measurements. The Water Level Indicator probe was improperly rinsed with deionized water between use in successive wells. Consequently, the wells were exposed to potential outside or intercontamination. B.H.S. was able to make repeatable water level measurements to within .01 foot.

The volume of the water column in a well can be calculated by first subtracting the depth to water measurement from the total depth of the well (from construction records) to obtain the height of the water column. The volume can then be calculated using the following formula:

$$V = \pi r^2 h$$

where:  $V$  = water column volume  
 $\pi$  = 3.1416  
 $r$  = inside radius of well casing  
 $h$  = height of water column

For the purpose of the Task Force sampling, the amount purged from each well was equivalent to three water column volumes except as noted below. During the inspection, B.H.S. made all calculations which were verified as correct by Task Force personnel.

Dedicated equipment is set up at B.H.S. for the purging and sampling of wells. Of the 11 wells chosen for this investigation, six are equipped with Teflon bailers (B-7, B-8A, B-11A, B-15, B-20, B-23A), one with a Well Wizard<sup>®</sup> pump (GMW-1) and four with submersible pumps (GM-1, GM-5, both interceptor trench sumps). The Well Wizard at GMW-1 was not functioning and, therefore, was replaced by a Teflon bailer on a stainless steel cable provided by the EPA contractor.

Before and after purging, the EPA contractor monitored each open well-head for chemical vapors and radiation. Chemical vapors were measured with one of three instruments: (1) Century Systems Portable Organic Vapor Analyzer Model OVA-128; (2) HNU Model PI-101 Photoionization Analyzer or (3) Photovac, Inc. TIP (Total Ionizable Present). Radiation measurements were made with a Ludlum Measurements, Inc. Model 3. Measurements are shown in Table 16. At stations where measurements exceeded background levels, sampling personnel wore Level C protection. Otherwise, Task Force personnel wore Level D protection during sampling.

From the wells with bailers, water was manually evacuated and discharged into 55-gallon drums at each wellhead. Responsibility for disposal was left to B.H.S. The submersible pumps in wells and interceptor trenches require electrical power sources, which were provided by a B.H.S. electric generator. Electrical connections were made by B.H.S. personnel. Again, responsibility for disposal of the purged water was left to B.H.S. In accordance with B.H.S. standard operating procedures, the water was discharged directly onto the ground. Table 17 lists the purge times and volumes purged from each station.

---

® Well Wizard is a registered trademark; appears hereafter without the ®.

Table 16  
CHEMICAL VAPOR AND RADIATION DETECTIONS  
AT SAMPLE STATION WELLHEADS

Sample Station	Chemical Vapor Level (ppm)/ Meter Used	Radiation Level (mr/hr)
GM-1	Background*/TIP	Background**
GM-5	Background/TIP	Background
GMW-1	Background/TIP	Background
B-7	Background/OVA	Background
B-8A	5/TIP	Background
B-11A	80/TIP	Background
B-15	Background/TIP	Background
B-20	Background/TIP	Background
B-23A	Background/HNU	Background
Common sump to interceptor trenches 1 & 2	Background/TIP	Background
Interceptor trench 3	Background/TIP	Background
Common sump to progressive trench area	20/HNU	Background
Trench 2N sump	20/HNU	Background

\* Chemical vapor background level is 3 ppm.

\*\* Radiation background level is 0.1 mr/hr.

In some cases, the intended (calculated) purge volume could not be evacuated in a single attempt due to dewatering of the well. Purging continued after a time allowing the well to recharge. If the well failed to produce the calculated purge volume after three or four purge attempts, the total volume purged was noted and sampling commenced after recharge. Standard B.H.S. purging procedure for the interceptor trenches is to allow the

Table 17  
PURGING DATA

Sample Station	Purging Times*				Approximate Volume Purged (gallons)	Remarks
	Start	End	Start	End		
GM-1	1628	02/20/86	1019	02/24/86	32	Well dewatered, purged by B.H.S.
GM-5	1204	02/21/86	1212	02/21/86	83	Purged by B.H.S.
GMW-1	1450	02/21/86	1116	02/24/86	9	Well dewatered; purged by B.H.S., EPA Task Force personnel and EPA contractor
B-7	1355	02/19/86	1451	02/19/86	19	Purged by EPA contractor
B-8A	1611	02/21/86	1000	02/24/86	13½	Well dewatered, purged by EPA contractor
B-11A	1320	02/19/86	1626	02/19/86	10	Well dewatered; purged by EPA contractor
B-15	1535	02/20/86	1104	02/24/86	16½	Well dewatered; purged by EPA contractor
B-20	1500	02/19/86	1054	02/20/86	15½	Well dewatered; purged by EPA contractor
B-23A	1503	02/21/86	0944	02/24/86	8½	Well dewatered; purged by EPA contractor
Common sump to interceptor trenches 1 & 2	1205	02/20/86	1235	02/20/86	480	Purged by B.H.S.
Interceptor trench 3	1350	02/20/86	1113	02/21/86	218	Purged by B.H.S.

\* February 22-23, 1986 was a weekend and no purging or sampling took place.

pump to run for 30 minutes before sampling. The Task Force followed this same procedure. The leachate systems were not purged before sampling.

After purging, a sample aliquot was collected for field measurements (water temperature, specific conductance, pH and turbidity) which were made at the EPA contractor's staging area (a garage unit near SI-2). Volatile organic analysis (VOA) vials were the first sample containers filled, followed by the order listed in Table 15. The VOA vials were filled directly from the bailer or an intermediary glass beaker if a submersible pump was used. All other sample containers were sequentially filled directly from the bailer or pump hose.

B.H.S. personnel conducted the sampling at the leachate collection systems (trench 2N and the progressive trench area) and interceptor trench 3, with the assistance of EPA contractor personnel. Difficulty with access to interceptor trench 3 caused a safety problem in sampling from the 13-foot-high outer well casing while standing atop the raised platform of a Caterpillar tractor.

At some stations, as in the case of purging, the ground-water recharge was slow and the well dewatered while sampling. Rather than collecting the entire sample set in a single attempt, all the sample parameters were collected in as many as four attempts over a period of 3 days, as in the case with GM-1. While the collection of a sample set may have been discontinuous, the collection of each parameter was completed in one attempt. Moreover, for the assurance of having enough ground water to obtain a complete sample set, some parameter containers were only partially filled. (VOA vials, however, were always completely filled, as required for proper analysis.) The sample containers of those parameters requiring more than one container (extractable organics, pesticides/herbicides, dioxin and radionuclides) or of each parameter of a split sample contained equal volumes. For example, instead of filling three of the four bottles for extractable organics completely while filling the fourth only partially, all four bottles were filled with an equal, though reduced volume.



After sampling was completed at each well, EPA contractor personnel took the samples to the staging area where a turbidity measurement was taken and the aliquot for dissolved metals analysis was filtered. In addition, samples for analysis for metals, total organic carbon, phenols, cyanide, nitrate and ammonia were preserved as indicated in Table 15. Leachate samples were not preserved.

At the end of each day of sampling, the EPA sampling contractor packaged and shipped the samples to the EPA contract laboratories and the NEIC laboratory, as appropriate. Samples were shipped according to applicable Department of Transportation regulations (40 CFR Parts 171-177). Aqueous samples from monitoring wells and interceptor trench sumps were considered "environmental" and those from leachate collection system sumps were considered "hazardous" for shipping purposes. The EPA sampling contractor also prepared a set of field blanks for each analytical parameter (e.g., VOAs, organics, metals, etc.) each day. Field blanks were used to determine whether contamination was introduced from the sample collection activities or sampling environment.

One set each of trip blanks and equipment blanks was prepared by the EPA sampling contractor during the investigation and shipped to the EPA contract laboratory. Trip blanks were used to determine whether contamination was introduced from the sample containers during transport to and storage at the B.H.S. facility, and equipment blanks were used to determine if contamination was introduced from the bailer used at GMW-1. All blanks were prepared at the staging area using distilled, deionized water of a known high purity.

Additional QA/QC samples submitted by the EPA sampling contractor to the EPA contract laboratories were the performance evaluation (PE) samples and triplicate samples. The PE samples were initially prepared by the EPA Environmental Monitoring and Support Laboratory in Cincinnati and were used to evaluate the accuracy of analyses performed by the contract laboratories. Triplicate samples of each analytical parameter taken at GM-1 were used to evaluate the precision of the analytical methods employed by the contract laboratories.

## MONITORING DATA ANALYSIS FOR INDICATIONS OF WASTE RELEASE

Tabulation, evaluation and interpretation of analytical data for samples collected during the inspection and analyzed by EPA contractor laboratories are discussed in detail in Appendix A. Inorganic chemical constituent analyses of these samples indicate the presence of common, naturally occurring cations and anions. In addition, selenium was found in wells B-11A and B-15 at 164  $\mu\text{g/L}$  and 280  $\mu\text{g/L}$ , respectively. Because of the newness of some of the ground-water monitoring wells in the system being evaluated (B-11A and B-15), it is not appropriate to attempt to undertake a statistical comparison of upgradient and downgradient ground-water quality. This comparison should be made as soon as 1 year of quarterly sampling and analytical results are available from the new system of wells. Evaluation of the organic chemical constituent analyses indicate the presence of 1,2-dichloroethane and acetone in well GM-1. Purgeable organic halide (POX) results indicate that methylene chloride may also be present in this well. The source of these organic constituents in samples should be determined and the first year of quarterly sampling and analysis of the new ground-water monitoring system wells should be completed to confirm whether or not ground water at the facility contains hazardous waste constituents resulting from waste disposal activities.

Trenches 1N, 2N, 6N, 11N, 12N and the PTA have leachate collection systems. All other disposal trenches and drilled cells at Area 1 are unlined and have the potential for leakage.

Due to the incomplete hydrogeologic characterization of the site and the questions regarding ground-water flow direction, the wells may not be properly placed or constructed to intercept leakage.

## REFERENCES

1. D.E. Klockow and Associates, December 31, 1981, *"Engineering Design Manual, Harzardous Waste Management Facility Permit Application Amendments and Revisions"*, prepared for B.H.S., Inc. (included as part of the August 1983 Part B Application)
2. D.E. Klockow and Associates, August 3, 1983, *"Part B RCRA Application"*, prepared for B.H.S., Inc.
3. D.E. Klockow and Associates, April 1984, *"Geotechnical Investigation, Soil Geology and Hydrogeology"*, prepared for B.H.S., Inc.
4. Reitz and Jens, Inc., April 1980, *Bob's Home Service, Inc., Special Waste Disposal Facility"*, Wright City, Missouri, prepared for Bob's Home Service, Inc.
5. Reitz and Jens, Inc., July 1980, *"Bob's Home Service, Inc., Hazardous Waste Disposal Facility"*, prepared for Bob's Home Service, Inc.
6. Woodward-Clyde Consultants, March 15, 1985, *"Evaluation of 1984 Ground-Water Monitoring Data"*, prepared for B.H.S., Inc.
7. Woodward-Clyde Consultants, February 14, 1986, *"Part B RCRA Permit Application"*, prepared for B.H.S., Inc.

## APPENDICES

- A ANALYTICAL TECHNIQUES AND RESULTS FOR TASK FORCE SAMPLES
- B CONSTRUCTION DRAWINGS
- C POTENTIOMETRIC SURFACE MAPS
- D GROUND-WATER MONITORING SYSTEMS

APPENDIX A  
ANALYTICAL TECHNIQUES AND RESULTS FOR TASK FORCE SAMPLES

Appendix A  
ANALYTICAL TECHNIQUES AND RESULTS FOR TASK FORCE SAMPLES  
B.H.S. INC.  
Wright City, Missouri

The following discusses analytical techniques, methods and results for water and leachate samples collected by the Task Force at the B.H.S., Inc. facility, Wright City, Missouri. Water sample analyses and results are discussed in the first section; the second section addresses the leachate analyses and results.

Field measurements on water samples, including specific conductance, pH and turbidity, were made by the EPA sampling contractor at the time of sampling. No field measurements were made for the leachate samples. Laboratory analysis results were obtained from two EPA contractor laboratories (CL) participating in the Contract Laboratory Program (CLP). One CL analyzed the samples for organic compounds while the other analyzed for metals and other parameters.

Standard quality control measures were taken including: (1) the analysis of field and laboratory blanks to allow distinction of possible contamination due to sample handling, (2) the analysis of laboratory spiked samples and performance evaluation samples and comparison of the CL results with NEIC split sample results to estimate accuracy, and (3) the analysis of laboratory duplicates and field triplicates to estimate precision. The performance evaluation (PE) samples were samples of known analyte concentrations prepared by the EPA Environmental Monitoring Systems Laboratory, Cincinnati, Ohio. Split samples from well B-7 and leachate from the Progressive Trench Area (PTA) were also analyzed by NEIC.

Table A-1 provides a summary, by parameter, of the analytical techniques used and the reference methods for the sample analyses. The CLP results are reported in the data tables and the split sample results are discussed where applicable in establishing the reliability of the CLP results.

## WATER SAMPLE ANALYSIS RESULTS

### Specific Organic Analysis Results

Acetone and 1,2-dichloroethane were quantified in samples from well GM-1. This well was sampled as the field triplicate and all three samples were reported to contain between 7.6 µg/L and 8 µg/L 1,2-dichloroethane. The three samples were found to contain acetone at concentrations of 46 µg/L, 46 µg/L and 39 µg/L after laboratory blank contamination correction. An acetone laboratory blank level of 10 µg/L has been subtracted from the above acetone concentrations. Purgeable organic halide (POX) results indicate the presence of about 22 µg/L halogen which is substantially more than that contributed by the 1,2-dichloroethane. Methylene chloride was detected in the samples; however, three field blanks were also found to contain methylene chloride. The methylene chloride concentration cannot be reliably quantified because the field blank concentrations were 1.1 µg/L, 1.2 µg/L and 5 µg/L while the sample concentrations were about 10 µg/L. The POX results indicate, however, that methylene chloride may be present in the ground water at well GM-1 and warrants further investigation.

None of the organic compounds determined were detected above blank levels in the other monitoring well samples, interceptor trench 1 and 2 sump and interceptor trench 3 sump; however, acid extractable compounds should be considered to have not been determined for all samples except those for wells GM-1 and GMW-1. The acid surrogate compound recoveries were below the lower CLP limit even after re-extraction. Table A-2 contains the limits of quantitation for the analyses for the volatile, semivolatile, pesticide, PCB, herbicide and dioxin organic compounds.

Analysis of the PE sample for pesticides, herbicides, dioxins and dibenzofurans was apparently performed very poorly. An investigation has established that shipping and handling of the PE samples for only these specific organic constituents was the major contributing factor. The appropriate PE samples were not analyzed for the particular class of compounds for which the samples were intended. Thus, poor performance on the PE samples is not reflective of the data quality of the other sample analyses.

NEIC did not receive the dioxin and dibenzofuran data. According to the PRC QA/QC data review, no dioxin target compounds were found in any of the samples. Dioxin spike recoveries ranged from 95% to 170%. The Lockheed QA/QC data review stated that there was contamination at a level of approximately 10 ng/L within 10 scans of 2,3,7,8-TCDF in the samples from wells GM-1 and GM-5.

Control measures for the other analyses indicate that sample analysis results are reliable with the exception of the acid extractable compounds results discussed above. Further, NEIC split sample results for the sample from well B-7 agree with the CL results in that neither detected any volatile, semivolatile, pesticide or PCB compounds above blank contaminant levels.

#### Metals Analysis Results

The dissolved and total metals results for the water samples are reported in Tables A-3 and A-4.

Caution must be exercised in associating any significance to trace element concentrations determined by the Inductively Coupled Argon Plasma-Optical Emission Spectroscopy (ICAP-OES) analysis. The CL did not make background corrections for the ICAP-OES analyses. This may result in positive biases for trace elements when large concentrations of aluminum, calcium, iron or magnesium are present in the samples. Further, the CL ICAP-OES analysis for many of the trace elements may be biased low due to the negative drift allowed for the calibration blanks. The negative bias was as much as 307 µg/L for aluminum, 164 µg/L for antimony, 4 µg/L for cadmium, 16 µg/L for chromium, 15 µg/L for cobalt, 34 µg/L for copper, 18 µg/L for nickel, 22 µg/L for silver, 66 µg/L for tin, 13 µg/L for vanadium and 12 µg/L for zinc. The negative blank values arise from letting the intercepts of the calibration curves drift. More frequent calibration was needed. Any detected concentration for these elements could be biased low by the values listed above.



The CL reported 925  $\mu\text{g/L}$  total lead in the sample from well GMW-1 as determined by ICAP-OES. Examination of the raw data found that the CL obtained this value from the analysis of a 1 to 5 dilution of the sample. The diluted sample value was 185  $\mu\text{g/L}$ . The calibration blank values for lead ranged from -96  $\mu\text{g/L}$  to 25  $\mu\text{g/L}$  and calculation of the detection limit from these blank values gives a detection limit of 200  $\mu\text{g/L}$ . Thus the diluted sample value is unreliable, as it is below the detection limit. The CL did analyze the undiluted sample and obtained a value of 603  $\mu\text{g/L}$ . The lead analytical line is severely interfered on by an adjacent aluminum spectral line; however, the CL made no interference correction for the apparent lead due to the aluminum interference. Thus, the lead concentration that should have been reported would be 393  $\mu\text{g/L}$ . The sample was found to contain 131,000  $\mu\text{g/L}$  aluminum which according to the CL would cause an apparent lead concentration of 210  $\mu\text{g/L}$ . Interference corrections of such magnitude, relative to the sample concentration, are not highly accurate and the 393  $\mu\text{g/L}$  value should not be considered accurate. The CL did a screening analysis of this sample using furnace Atomic Absorption Spectroscopy (AAS) but did not quantitate the concentration appropriately. The AAS analysis for lead is not interfered on by aluminum and indicated the concentration to be greater than 200  $\mu\text{g/L}$ .

The dissolved elemental concentrations determined by ICAP-OES for many of the samples are biased high. Mismatching of the calibration standards acid matrix to the dissolved preserved sample acid matrix was the cause of the bias. In comparison of the CL results for the well B-7 samples, the dissolved concentrations for manganese, potassium and sodium are about 50% higher than the total concentrations while calcium and magnesium dissolved concentrations are about 15% higher than the total concentrations. In comparison to NEIC split sample results for well B-7, the CL dissolved concentrations for calcium, magnesium, manganese, potassium and sodium are about 30% higher than NEIC split sample results. Further, the CL total concentrations are from 10% to 20% lower than NEIC total concentrations.

*For barium and zinc the dissolved concentrations are at times about twice the total concentrations. These dissolved barium concentrations are in part higher than the total concentrations because of mismatching of the*

acid matrix. For barium, the digestion used for the total analysis may have caused barium sulfate to precipitate. Zinc contamination due to field sample handling of the dissolved samples has been identified for past Task Force projects and is the suspected cause of much of the bias evident for the dissolved zinc results.

Dissolved and total silver spike recoveries were biased low. The sample analysis results for silver are, however, reported because the spike levels may have exceeded the solubility allowed by the chloride concentration of the spiked samples. The detection limit for silver has been increased based on the average spike recovery. Copper spike recoveries were also quite low indicating that values are unreliable and may be biased low. Aluminum duplicate analyses showed wide variability which probably indicates the presence of suspended solids.

The detection limits for the ICAP-OES analyses were recalculated based on the variability observed for the calibration and field blanks between several analytical runs. The recalculated detection limits increased over those reported by the CL. As part of the detection limit recalculations, the average negative blank value was added to the detection limit calculated from the blank variability. The sample results are reported using the recalculated detection limits.

The CL reported results for arsenic, lead, selenium and thallium did not account for furnace Atomic Absorption Spectroscopy (AAS) matrix effects. These effects were corrected for by use of the known addition recoveries. Further, detection limits were recalculated based on the variability in the calibration curves, on the variability in the signal response and on the known addition recoveries.

The CL reported total lead concentrations of 69 µg/L, 109 µg/L and 110 µg/L for the field triplicate samples for well GM-1. Examination of the raw data indicates that the lead analyses for these samples are in error. The CL analyzed the samples at various dilutions with concentrations of 69 µg/L, 83 µg/L and 110 µg/L being obtained for one of the samples. The

discordance of the dilution values suggests the presence of an interference in the analysis and that the results are unreliable.

Fairly high selenium concentrations were reported by the CL for two of the wells. The samples from wells B-11A and B-15 were reported to contain 164 µg/L and 230 µg/L total selenium, respectively. The dissolved selenium concentrations for these well samples were also high. Because the CL used deuterium arc background correction for the furnace AAS analysis, such concentrations are often considered suspect because of the inability of the correction system to compensate for high nonatomic background due to the presence of high salt concentrations. However, the salt compositions of these two samples are not substantially different than those of some of the other samples where selenium was not detected or detected at much lower concentrations. For example, the sample from well B-20 was found to contain greater concentrations of sulfate and generally greater concentrations of the major cations, yet selenium was not detected in this sample. This suggests that the background correcting capability of the instrument may not have been exceeded. Although NEIC did not receive samples from wells B-11A and B-15, NEIC did find 15 µg/L total selenium in the sample from well B-7 while the CL reported 17 µg/L total selenium. NEIC determined selenium by hydride generation coupled to ICAP-OES. This close agreement between laboratories using different analytical techniques suggests the CL selenium concentrations are reliable. It is possible that the well B-11A and B-15 samples contain unique components that cause interference and confirmational analyses are warranted before placing much significance on the CL selenium results for these two well samples.

High iron concentrations cause a negative bias in deuterium arc background corrected furnace AAS analysis for selenium. Thus, when significant iron was found in a sample, the selenium results may be unreliable. Similarly, high aluminum concentrations cause a positive bias in deuterium arc backgrounded furnace AAS analysis for arsenic. Thus the arsenic results for samples containing high aluminum may be unreliable.

The mercury analysis detection limits ranged from 0.4 µg/L to 1.8 µg/L depending on the volume of the sample analyzed. The detection limit calculated from the variability in the calibration curve and blank values was 0.036 µg which for 100 mL of digested sample would give a detection of 0.36 µg/L instead of the 0.2 µg/L reported by the CL. There are two indications that the laboratory had contamination problems. The initial analysis of one of the dissolved mercury field blanks found a concentration of 2 µg/L while a subsequent analysis of the same blank found less than 0.2 µg/L. For dissolved mercury, the CL reported values of less than 0.2 µg/L for two of three field triplicate samples from well GM-1 and reported 0.7 µg/L for the third sample. The total mercury values for the field triplicate samples were reported as less than 0.2 µg/L.

#### General Analysis Results

The field measurements for conductance, pH and turbidity and the results of other analytical testing for the water samples are reported in Table A-5.

All control measures indicate that the ammonia, cyanide, nitrate and sulfate results should be reliable.

The PE sample result and comparison with the NEIC split sample for well B-7 indicate that the CL chloride values are biased low. The PE sample had a true value of 22.1 mg/L with an acceptance range of 19.6 mg/L to 25 mg/L. The CL reported a value of 15 mg/L for the PE sample. NEIC obtained a chloride value of 14 mg/L for well B-7 while the CL reported 10 mg/L. Other control measure results were acceptable.

Examination of the raw data reveals that the CL analyzed four spiked samples for phenol; however, only two spike recoveries were reported.

Aliquots of the samples from wells B-7 and B-20, the Interceptor Trenches 1 and 2 Sump and a field blank were spiked. Recoveries of 100% were reported for both well B-7 and the field blank spiked samples. Calculation of the recovery for the Trench spiked sample gives a recovery of 52%

and the well B-20 spike recovery was 10%. Further, the CL analyzed the well B-7 spiked sample twice and when the recoveries are calculated from the raw data, recoveries of 50% and 74% are obtained. It is not known how the CL calculated a 100% recovery for the well B-7 spiked sample. Another indication that the phenol results are dubious is that the CL analyzed the sample from well B-11A in duplicate and obtained concentrations of 10 µg/L and 109 µg/L. This set of duplicate data was not, however, reported on the CLP duplicate analysis reporting sheet. Further, the CL reported a value for the PE sample that was unacceptable with a 39% positive bias. These data indicate the phenol results may be unreliable. The detection limit was recalculated based on the variability in the blank over the analysis run and in the calibration curve and a value of 33 µg/L instead of the CL reported limit of 10 µg/L was obtained.

Control measures generally indicate the nonpurgeable organic carbon (NPOC) and the purgeable organic carbon (POC) results should be reliable; however, the laboratory blanks for these parameters were often high and varied widely. NPOC blank values ranged from 0.13 mg/L to 2.12 mg/L. The NPOC detection limit calculated from the variability in the blank values is 2.2 mg/L. Many of the sample NPOC values are close to the detection limit and, thus, should not be considered highly accurate. The POC blanks ranged from about 1.7 mg/L to 4.3 mg/L. These blank values are quite high and would affect the accuracy of the calibration standards prepared with this water. That is, a signal response calibrated as being due to 10 mg/L POC would actually be due to the presence of 14 mg/L POC. Such a calibration would cause a sample concentration to be under estimated. Another possible error is that sample concentrations obtained from dilutions using this water would result in over estimating the sample concentrations. Because of these possible sources of error, the POC results may be unreliable and, thus, are not reported.

All control measures indicate that the purgeable organic halide (POX) results are reliable. A detection limit of 8 µg/L instead of the CL reported limit of 5 µg/L was calculated from the variability in the blank values. POX was detected in all three field triplicate samples from well GM-1. The

reported POX values were 16 µg/L, 23 µg/L and 26 µg/L. As discussed previously, 1,2-dichloroethane and possibly methylene chloride were detected in the samples from GM-1.

Although most control measures indicate that the total organic halide (TOX) results should be reliable, the TOX values may be biased low. The lack of correlation between the POX values and TOX values for the samples from GM-1 suggests the TOX values are biased low. Further, as discussed below in the leachate sample analysis section, TOX values are definitely biased low. Calculation of the detection limit based on the variability in the blank values results in a detection limit of 12 µg/L instead of CL reported limit of 5 µg/L.

#### LEACHATE SAMPLE ANALYSIS RESULTS

##### Specific Organic Analysis Results

Table A-6 reports the organic constituent analysis results for the two leachate samples. Large amounts of volatile and semivolatile organic compounds were detected in both leachate samples.

In consideration of the different dilutions analyzed, thus different detection limits, fairly good agreement was obtained between the split sample analyses performed by NEIC and the reported CL values for the PTA leachate. NEIC analyzed a 1 to 10 dilution for the volatiles while the CL analyzed a 1 to 100 dilution. The concentrations for the detected volatile organic compounds differed very little from NEIC results. The CL reported that 1,1-dichloroethane was present but below the Limit of Quantitation (LOQ). NEIC found 400 µg/L 1,1-dichloroethane with an LOQ of about 60 µg/L. Further, NEIC detected the presence of 1,2-dichloroethane, trichloroethene and tetrachloroethene, although the concentrations were below the LOQs. NEIC also found 500 µg/L xylene, 8,000 µg/L 2-propanol, 3,000 µg/L 2-butanol and the presence of 4-methyl-2-pentanol that were not determined or not detected by the CL.

Similarly, the CL analyzed a more diluted extract for semivolatiles. Benzoic acid and phenol were the major semivolatiles found. The CL D5-phenol surrogate recovery was only 12% and the CL reported the phenol concentration in the sample as 2,000 µg/L. NEIC obtained a 40% recovery for the D5-phenol surrogate recovery and found 8,000 µg/L phenol in the sample. Correction of the CL phenol concentration for the recovery would indicate that the sample actually contained about 17,000 µg/L phenol while correction of the NEIC value would indicate that about 20,000 µg/L phenol was present. NEIC also detected 700 µg/L 2-methylphenol, 220 µg/L 2-nitrophenol, 90 µg/L 4-methylphenol and 30 µg/L 2,4-dimethylphenol. The colorimetric phenol analysis found 41,000 µg/L total phenol which indicates the presence of other phenolic compounds that were not quantified or determined by the gas chromatography-mass spectroscopy analysis.

#### Metals Analysis Results

The total metals results for the leachate samples are reported in Table A-7. Depending on the suspended matter composition, the values reported for certain elements may not represent "total" concentrations. If the suspended matter is siliceous then values for aluminum, calcium, magnesium, potassium and sodium are not "total" because the silicate matrix was not dissolved. The heavy metal results would approximate "total" concentrations because they are usually absorbed and are not incorporated into the silicate matrix.

NEIC split sample ICAP-OES results for the PTA leachate sample analysis agree fairly well with the CL results. For example, the CL reported 6,370,000 µg/L potassium and 2,240,000 µg/L sodium while NEIC found 6,900,000 µg/L potassium and 2,030,000 µg/L sodium. The CL reported 717 µg/L nickel and NEIC found 707 µg/L.

The CL encountered difficulties in analyzing the PTA leachate for arsenic, lead and selenium. Apparently, the high dissolved solids content of the sample caused background correction problems for the furnace AAS analyses. NEIC found 27 µg/L arsenic and less than 7 µg/L selenium for the

PTA split sample. Hydride generation coupled to ICAP-OES was used by NEIC. Less than 7 µg/L lead was found by NEIC using Zeeman Effect background corrected L'vov platform furnace AAS.

The CL raw data for the arsenic analyses are confusing in that it appears that there may have been a mixup between the two leachate samples. For the analysis run, the PTA sample was given a run number of 42 while the other leachate had a run number of 41. The analysis of sample 42 found 15.4 µg/L and the analysis of a 20 µg/L arsenic spike to sample 42 gave a concentration of 76.7 µg/L which is a spike recovery of 307%. A number of different dilutions of sample 42 were analyzed and concentrations ranging from 94 µg/L to 250 µg/L were obtained. Sample 42 was then analyzed by the methods of standard addition and 125 µg/L was found; however, the 125 µg/L value was reported for the Trench 2N leachate and the PTA arsenic was reported as less than 150 µg/L. Analyses of sample 41, which was the Trench 2N leachate, indicate the presence of about 140 µg/L arsenic, although analysis by the methods of standard addition was not performed. Since, the CL results are confusing and interference was apparent, no arsenic data is reported in the data table.

#### General Analysis Results

Table A-8 reports the results of other testing for the leachate samples.

The calculated POX from the specific volatile organic results for the PTA leachate and the measured POX are in good agreement. It is obvious, however, that the TOX is biased substantially low.

The anion data are in general agreement with NEIC split sample results. NEIC did, however, detect 25 µg/L cyanide while the CL reported less than 10 µg/L. Only 3 mg/L ammonia was found by NEIC while the CL reported 30 mg/L.



Table A-1  
Sample Preparation and Analysis Techniques and Methods

Parameter	Preparation Technique	Analysis Technique	Method Reference
Specific Organic Constituents			
Volatiles	Purge and trap Direct injection	Gas Chromatography - Mass Spectroscopy Gas Chromatography - Mass Spectroscopy or Gas Chromatography with Flame Ionization Detection Gas Chromatography - Mass Spectroscopy Gas Chromatography with Electron Capture Detection Gas Chromatography with Electron Capture Detection Gas Chromatography - Mass Spectroscopy	CLP Method (a) CLP Method CLP Method CLP Method CLP Method Method 8150 (b) Method 8280 (b)
Semi-volatiles	Methylene chloride extraction		
Pesticides/PCB	Methylene chloride/hexane extraction		
Herbicides	Diethylether extraction/methylation		
Dioxins and Dibenzofurans	Methylene chloride/hexane extraction		
Elemental Constituents			
Mercury	Wet digestion for dissolved and total	Cold Vapor Atomic Absorption Spectroscopy	CLP Method
As, Pb, Se and Fl	Acid digestion for total	Furnace Atomic Absorption Spectroscopy	CLP Method
Other Elements	Acid digestion for total	Inductively Coupled Plasma Emission Spectroscopy	CLP Method
Field Measurements			
Conductance	None	Electrometric, Wheatstone Bridge	Method 120.1 (c)
pH	None	Potentiometry	Method 150.1 (c)
Turbidity	None	Nephelometric	No reference
Non-specific Organic Parameters			
POX	None	Purgable combust, Microcoulometry	EPA 600/4-84-008
IOX	Carbon absorption	Carbon combust, Microcoulometry	Method 9020 (b)
POC	None	Purgable combust, Non-dispersive Infrared	No reference
NPOC	Acidify and purge	UV Persulfate, Non-dispersive Infrared	Method 415.1 (c)
General Constituents			
Ammonia	Particulates settled	Ion Selective Potentiometry of supernatant	Method 350.3 (c)
Chloride	Particulates settled	Mercuric Precipitation Titration of supernatant	Method 9252 (b)
Nitrate	Particulates settled	Brucine Sulfate Colorimetry of supernatant	Method 9200 (b)
Sulfate	Particulates settled	Barium Sulfate Turbidimetry of supernatant	Method 9038 (b)
Cyanide	Manual distillation	Pyridine Pyrazolone Colorimetry	CLP Method
Phenol	Automated distillation	Ferricyanide 4-Aminoantipyrine Auto-Colorimetry	Method 420.2 (c)

a) Contract Laboratory Program, IFB methods.

b) Test Methods for Evaluating Solid Wastes, SW-846.

c) Methods for Chemical Analysis of Water and Wastes, EPA-600/4-79-020.

Table A-2  
LIMITS OF QUANTITATION FOR ORGANIC COMPOUNDS  
B. H. S., INC.  
Wright City, Missouri

Limit of Quantitation (µg/L)	Limit of Quantitation (µg/L)	Limit of Quantitation (µg/L)
<u>Volatile Compounds (Purge &amp; Trap)</u>		
Bromomethane	10	20
Chloromethane	10	20
Bromodichloromethane	5	100
Dibromochloromethane	5	100
Bromoform	5	100
Chloroform	5	100
Carbon tetrachloride	5	40
Carbon disulfide	5	20
Chloroethane	10	40
1,1-Dichloroethene	5	20
1,2-Dichloroethane	5	20
1,1,1-Trichloroethane	5	20
1,1,2-Trichloroethane	5	20
1,1,2,2-Tetrachloroethane	5	40
1,1-Dichloroethane	5	40
trans-1,2-Dichloroethene	5	40
Trichloroethene	5	20
Tetrachloroethene	5	40
Methylene chloride	10	20
Vinyl chloride	10	20
1,2-Dichloropropane	5	20
cis-1,3-Dichloropropene	5	20
trans-1,3-Dichloropropene	5	20
Benzene	5	20
Chlorobenzene	5	20
Ethylbenzene	5	20
Toluene	5	20
Xylenes	5	20
Acetone	10	20
2-Butanone	10	20
2-Hexanone	10	20
4-Methyl-2-pentanone	10	20
2-Chloroethyl vinyl ether	10	20
Styrene	5	20
Vinyl acetate	10	20
Crotonaldehyde	50	20
1,2-Dibromo-3-chloropropane	20	20
1,1,1,2-Tetrachloroethane	20	20
1,2-Dibromethane	5	20
1,2,3-Trichloropropane	5	20
1,4-Dichloro-2-butene	20	20
Trichlorofluoromethane	5	20
Acrolein	50	20
Acrylonitrile	50	20
<u>Volatile Compounds (DAI)<sup>b</sup></u>		
Acrylonitrile	50	20
1,4-Dioxane	100	20
Allyl alcohol	50	20
Ethyl cyanide	100	20
Isobutyl alcohol	100	20
Methacrylonitrile	25	20
2-Propyn-1-ol	100	20
Acrolein	100	20
Methyl Methacrylate	50	40
<u>Semi-Volatile Compounds</u>		
Aniline	20	20
4-Chloroaniline	20	20
2-Nitroaniline	100	20
3-Nitroaniline	100	20
4-Nitroaniline	100	20
Benzidine	100	20
3,3'-Dichlorobenzidine	40	20
Benzyl alcohol	20	20
Benzyl chloride	40	20
1,2-Dichlorobenzene	20	20
1,3-Dichlorobenzene	20	20
1,4-Dichlorobenzene	20	20
1,2,4-Trichlorobenzene	20	20
1,2,4,5-Tetrachlorobenzene	40	20
1,2,3,4-Tetrachlorobenzene	40	20
Pentachlorobenzene	40	20
Hexachlorobenzene	20	20
Pentachloronitrobenzene	40	20
Nitrobenzene	20	20
2,4-Dinitrotoluene	20	20
2,6-Dinitrotoluene	20	20
N-Nitrosodimethylamine	20	20
N-Nitrosodiphenylamine <sup>a</sup>	20	20
N-Nitrosodipropylamine	20	20
bis(2-Chloroethyl) ether	20	20
4-Chlorophenyl phenyl ether	20	20
4-Bromophenyl phenyl ether	20	20
bis(2-Chloroisopropyl) ether	20	20
bis(2-Chloroethoxy) methane	20	20
Hexachloroethane	20	20
Hexachlorobutadiene	20	20
Hexachlorocyclopentadiene	20	20
bis(2-Ethylhexyl) phthalate	20	20
Butyl benzyl phthalate	20	20
di-n-Butylphthalate	20	20
di-n-Octylphthalate	20	20
Diethylphthalate	20	20
Dimethylphthalate	20	20
Acenaphthene	20	20
Acenaphthylene	20	20
Anthracene	20	20
Benzo(a)anthracene	20	20
Benzo(b)fluoranthene and/or		
Benzo(k)fluoranthene	20	20
Benzo(g,h,i)perylene	20	20
Benzo(a)pyrene	20	20
Chrysene	20	20
Di-benzo(a,h)anthracene	20	20
Di-benzofuran	20	20
Fluoranthene	20	20
Fluorene	20	20
Indeno(1,2,3-c,d)pyrene	20	20
Isophorone	20	20
Naphthalene	20	20
2-Chloronaphthalene	20	20
2-Methylnaphthalene	20	20
Phenanthrene	20	20
Pyrene	20	20
5-Nitro-o-toluidine	40	20
<u>Semi-Volatile Compounds (cont.)</u>		
N-nitrosodiethylamine	20	20
Acetophenone	40	20
N-nitrosodipiperidine	40	20
Safrole	40	20
1,4-Naphthoquinone	40	20
2,3,4,6-Tetrachlorophenol	40	20
2-Naphthylamine	40	20
Pyridine	40	20
Pentachloroethene	40	20
1,3,5-trinitrobenzene	40	20
Ethylmethacrylate	40	20
o-Toluidine hydrochloride	40	20
2,6-Dichlorophenol	40	20
p-Dimethylaminoazobenzene	40	20
1,2,3-Trichlorobenzene	40	20
1,3,5-Trichlorobenzene	40	20
1,2,3,5-Tetrachlorobenzene	40	20
Ethyl-methanesulfonate	40	20
alpha, alpha-		
Dimethylphenethylamine	40	20
Methapyrilene	40	20
7,12-Dimethylbenzanthracene	40	20
Benzal chloride	40	20
Zinophos	40	20
4-Aminobiphenyl	40	20
Tetraethylthiopyro-		
phosphate	40	20
3,3'-Dimethylbenzidine	40	20
Pronamide	40	20
Chlorobenzilate	40	20
o-Phenylenediamine	40	20
m-Phenylenediamine	40	20
p-Phenylenediamine	40	20
Isosafrole	40	20
N-Nitrosopyrrolidine	40	20
Anamite	40	20
Diallate	40	20
Dimethoxybenzidine	40	20
Benzotrichloride	40	20
Nitrosomethylethylamine	160	20
N-Nitroso-di-N-butylamine	40	20
Cyclophosphamide	160	20
Hexachloropropene	40	20
Phenacetin	40	20
Resorcinol	40	20
Dimethoate	40	20
4,4' Methylene-bis		
(2-chloroaniline)	40	20
Paraldehyde	40	20
Methyl methane sulfonate	40	20
N-nitrosomorpholine	40	20
1-Naphthylamine	40	20
1,2-Diphenylhydrazine	40	20
Benzoic acid	100	20
Phenol	20	20
2-Chlorophenol	20	20
2,4-Dichlorophenol	20	20
2,4,5-Trichlorophenol and/or		
2,4,6-Trichlorophenol	100	20

Table A-2 (cont.)

Limit of Quantitation (µg/L)		Limit of Quantitation (µg/L)		Limit of Quantitation (µg/L)	
<u>Semi-volatile Compounds (cont.)</u>		<u>Pesticides/PCBs</u>		<u>Herbicides</u>	
Pentachlorophenol	100	Aldrin	0.05	Dicamba	1
4-Chloro-3-methylphenol	20	alpha-BHC	0.05	Dalapon	2
2-Methylphenol	20	beta-BHC	0.05	MCPP	100
4-Methylphenol	20	gamma-BHC	0.05	MCPA	100
2,4-Dimethylphenol	20	delta-BHC	0.05	Dichloroprop	2
4,6-Dinitro-2-methylphenol	100	Chlordane	0.5	2,4-Dichlorophenoxy	
2-Nitrophenol	20	4,4'-DDD	0.1	acetic acid	4
4-Nitrophenol	100	4,4'-DDE	0.1	2,4,5-T	1
2,4-Dinitrophenol	100	4,4'-DDT	0.1	2,4-DB	4
		Dieldrin	0.1	Dinoseb	1
		Endosulfan I	0.05		
		Endosulfan II	0.1	<u>Dioxins &amp; Dibenzofurans (ng/L)</u>	
		Endosulfan sulfate	0.1	TCDD (Tetra)	1
		Endrin	0.1	PeCDD (Penta)	5
		Endrin aldehyde	0.1	HxCDD (Hexa)	6
		Heptachlor	0.05	HpCDD (Hepta)	4
		Heptachlor epoxide	0.05	OCDD (Octa)	44
		Toxaphene	1	TCDF (Tetra)	1
		Methoxychlor	0.5	PcCDF (Penta)	3
		Endrin ketone	0.1	HxCDF (Hexa)	3
		PCB-1016	0.5	HpCDF (Hepta)	17
		PCB-1221	0.5	OCDF (Octa)	13
		PCB-1232	0.5		
		PCB-1242	0.5		
		PCB-1248	0.5		
		PCB-1254	1		
		PCB-1260	1		
		Kepona	0.1		

a Measured as diphenylamine

b Direct aqueous injection

Table A-3  
Dissolved and Total Metals Analysis Results  
for the Monitoring Well Samples  
B.H.S. Inc., Wright City, MO

Element	Well B-7		Well B-8A		Well B-11A	
	Dissolved Value (a)	Total Value	Dissolved Value	Total Value	Dissolved Value	Total Value
Al	< 530. b	< 530.	< 530.	< 530.	< 530.	1,190.
Sh	< 350.	< 350.	< 350.	< 350.	< 350.	< 350.
As	< 10.	< 10.	< 13.	< 10.	< 10.	< 10.
Ba	22.	< 21.	40.	34.	37.	41.
Be	< 6.	< 6.	< 6.	< 6.	< 6.	< 6.
Cd	< 11.	< 11.	< 11.	< 11.	< 11.	< 11.
Ca	742,000.	629,000.	250,000.	739,000.	792,000.	638,000.
Cr	< 35.	< 35.	< 35.	< 35.	< 35.	< 35.
Cu	< 35.	< 35.	< 35.	< 35.	< 35.	< 35.
Cu	< 80.	< 80.	< 80.	< 80.	< 80.	< 80.
Fe	< 36.	365.	< 36.	316.	< 36.	1,270.
Pb	< 25.	< 6.	< 25.	< 3.	< 25.	< 7.
Mg	182,000.	161,000.	128,000.	273,000.	257,000.	231,000.
Mn	2,270.	1,540.	2,290.	6,240.	2,870.	2,300.
Hg	< .4	< .4	< .4	< .4	< .4	< .4
Ni	< 67.	< 67.	< 67.	< 67.	< 67.	< 67.
K	6,250.	4,200.	7,810.	8,290.	4,450.	3,830.
Se	19.1	17.	< 11.	< 16.	136. c	164. c
Ag	< 36.	< 36.	< 36.	< 36.	< 36.	< 36.
Na	68,900.	47,000.	54,000.	122,000.	122,000.	99,900.
Tl	< 14.	< 16.	< 56.	< 13.	< 18.	< 19.
Sn	< 180.	< 180.	< 180.	< 180.	< 180.	< 180.
V	< 35.	< 35.	< 35.	< 35.	< 35.	< 35.
Zn	30.	< 29.	39.	31.	108.	109.

a) Concentrations are reported in ug/L.

b) Sample concentration is less than the given concentration.

c) See text for the discussion of the reliability of this value.

Table A-3 (continued)  
Dissolved and Total Metals Analysis Results  
for the Monitoring Well Samples  
B.H.S. Inc., Wright City, MO

Element	Well B-15		Well B-20		Well B-23A	
	Dissolved Value (a)	Total Value	Dissolved Value	Total Value	Dissolved Value	Total Value
Al	< 530.	10,700.	< 530.	8,540.	< 530.	< 530.
Sb	< 350.	< 350.	< 350.	< 350.	< 350.	< 350.
As	< 10.	< 10.	< 10.	< 10.	< 10.	< 4.
Ba	141.	161.	40.	59.	122.	115.
Be	< 6.	< 6.	< 6.	< 6.	< 6.	< 6.
Cd	< 11.	< 11.	< 11.	< 11.	< 11.	< 11.
Ca	474,000.	601,000.	596,000.	605,000.	229,000.	259,000.
Cr	< 35.	56.	< 35.	49.	< 35.	< 35.
Co	< 35.	< 35.	< 35.	< 35.	< 35.	< 35.
Cu	< 80.	< 80.	< 80.	< 80.	< 80.	< 80.
Fe	< 36.	11,400.	2,440.	7,620.	< 36.	770.
Pb	< 25.	29.5	< 6.	8.	< 8.	< 5.
Mg	251,000.	269,000.	325,000.	269,000.	58,700.	64,100.
Mn	2,340.	2,880.	6,480.	6,820.	552.	690.
Hg	< .4	< 2.	< 1.	< 2.	< .4	< .4
Ni	< 67.	< 67.	< 67.	< 67.	< 67.	< 67.
K	6,390.	9,080.	10,500.	8,480.	< 3,200.	< 3,200.
Se	165.	280.	< 6.	< 13.	< 8.	< 9.
Ag	< 36.	< 36.	< 36.	< 36.	< 36.	< 36.
Na	91,000.	113,000.	192,000.	134,000.	48,800.	59,800.
Tl	< 11.	< 16.	< 18.	< 15.	< 15.	< 12.
Sn	< 180.	< 180.	< 180.	< 180.	< 180.	< 180.
V	< 35.	< 35.	< 35.	< 35.	< 35.	< 35.
Zn	148.	129.	97.	75.	42.	< 29.

a) Concentrations are reported in ug/L.

b) Sample concentration is less than the given concentration.

Table A-3 (continued)

Dissolved and Total Metals Analysis Results  
for the Monitoring Well Samples  
B.H.S. Inc., Wright City, MO

Element	Well GM-1		Well GM-5		Well GMW-1	
	Dissolved Value (a)	Total Value	Dissolved Value	Total Value	Dissolved Value	Total Value
Al	< 530.	5,030.	< 530.	< 530.	< 530.	131,000.
Sb	< 350.	< 350.	< 350.	< 350.	< 350.	< 350.
As	< 10.	< 10.	< 10.	< 10.	< 10.	28.4
Ba	135.	114.	27.	< 21.	810.	1,260.
Be	< 6.	< 6.	< 6.	< 6.	< 6.	< 6.
Cl	< 11.	< 11.	< 11.	< 11.	< 11.	11.
Ca	56,600.	93,000.	374,000.	364,000.	107,000.	240,000.
Cr	< 35.	< 35.	< 35.	< 35.	< 35.	360.
Co	< 35.	< 35.	< 35.	< 35.	< 35.	90.
Cu	< 80.	124.	< 80.	< 80.	< 80.	391.
Fe	< 36.	5,480.	3,070.	5,430.	49.	230,000.
Pb	< 6.	109.	< 6.	< 5.	< 6.	393. c
Mg	11,600.	15,100.	143,000.	126,000.	35,500.	71,100.
Mn	16.	122.	174.	182.	1,130.	5,270.
Hg	< .4	< 1.	< .4	< 1.	< .4	< 2.
Ni	< 67.	< 67.	< 67.	< 67.	< 67.	306.
K	36,900.	33,700.	< 3,200.	3,400.	8,520.	24,600.
Se	< 7.	< 5.	< 7.	< 14.	< 7.	< 10.
Ag	< 36.	< 36.	< 36.	< 36.	< 36.	< 36.
Na	80,900.	96,800.	88,200.	88,100.	55,600.	53,900.
Tl	< 12.	< 11.	< 15.	< 13.	< 12.	< 10.
Sn	< 180.	< 180.	< 180.	< 180.	< 180.	< 180.
V	< 35.	< 35.	< 35.	< 35.	< 35.	309.
Zn	57.	623.	< 29.	< 29.	286.	1,410.

a) Concentrations are reported in ug/L.

b) Sample concentration is less than the given concentration.

c) See text for the discussion of the reliability of this value.

Table A-4

Dissolved and Total Metals Analysis Results  
for the Interceptor Trench Samples  
B.H.S. Inc., Wright City, MO

Element	Interceptor Trench 1 and 2		Interceptor Trench 3	
	Dissolved Value (a)	Total Value	Dissolved Value	Total Value
Al	< 530.	814.	< 530.	< 530.
Sb	< 350.	< 350.	< 350.	< 350.
As	< 10.	< 10.	< 10.	< 4.
Ba	57.	< 21.	27.	23.
Be	< 6.	< 6.	< 6.	< 6.
Cd	< 11.	< 11.	< 11.	< 11.
Ca	440,000.	419,000.	491,000.	462,000.
Cr	< 35.	< 35.	< 35.	< 35.
Co	< 35.	< 35.	< 35.	< 35.
Cu	< 80.	< 80.	< 80.	< 80.
Fe	140.	1,100.	1,160.	936.
Pb	< 7.	< 5.	< 5.	< 5.
Hg	111,000.	103,000.	133,000.	110,000.
Mn	738.	621.	5,530.	4,780.
Hg	< .4	< .4	< .4	< 2.
Ni	< 67.	< 67.	< 67.	< 67.
K	5,350.	4,880.	5,660.	4,680.
Se	< 8.	< 8.	< 7.	< 13.
Ag	< 36.	< 36.	< 36.	< 36.
Na	35,200.	30,200.	41,800.	32,100.
Fl	< 12.	< 11.	< 13.	< 11.
Sn	< 180.	< 180.	< 180.	< 180.
V	< 35.	< 35.	< 35.	< 35.
Zn	71.	38.	50.	37.

a) Concentrations are reported in ug/L.

b) Sample concentration is less than the given concentration.

Table A-5

Field Measurements and General Analysis Result  
for the Well and Trench Samples  
B.H.S. Inc., Wright City, MO

Parameter	Station	Well B-7	Well B-8A	Well B-11A	Well B-15	Well B-20	Well B-23A
Units	Value	Value	Value	Value	Value	Value	Value
pH							
Conductance	umhos/cm	6.6	6.8	6.7	6.6	7.1	7.7
Turbidity	NTU	2900.	4500.	3500.	3900.	3700.	2000.
		6.	7.	18.	28.	NA	10.
POX	ug/L Cl	< 6.	< 6.	< 6.	< 6.	< 6.	< 6.
TOX (c)	ug/L Cl	29.	21.	27.	< 12.	< 12.	13.
NP0C (c)	mg/L C	3.4	3.5	3.	3.7	4.2	3.1
Ammonia	mg/L N	< .3	< .3	.35	.4	.51	< .3
Chloride	mg/L Cl-	10.	55.	45.	25.	25.	10.
Nitrate	mg/L N	< .3	.4	.94	< .3	< .3	< .3
Sulfate	mg/L SO4=	1860.	2160.	2020.	2240.	2400.	760.
Cyanide	ug/L	< 10.	< 10.	< 10.	< 10.	< 10.	< 10.
Phenol (c)	ug/L	< 33.	172.	< 33.	< 33.	39.	< 33.

a) Parameter was not analyzed.

b) Sample concentration was less than given concentration.

c) See text for the discussion of the reliability of parameter values.



Table A-5 (continued)

Field Measurements and General Analysis Results  
for the Well and Trench Samples  
B.H.S. Inc., Wright City, MO

Parameter	Station:				Well GH-1		Well GH-5		Well GH-1		Trench 1 and 2		Trench 3	
	Units	Value	Value	Value	Value	Value	Value	Value	Value	Value	Value	Value	Value	Value
pH	Units	8.3	7.1	7.8	NA	NA	NA	NA	NA	NA	NA	NA	6.5	6.5
Conductance	umhos/cm	1000.	2700.	1200.	1200.	1200.	1200.	1200.	1200.	1200.	1200.	1200.	2200.	2200.
Turbidity	NTU	35.	85.	24.	24.	24.	24.	24.	24.	24.	24.	24.	1.	1.
POX	ug/L Cl	22.	< 6.	< 6.	< 6.	< 6.	< 6.	< 6.	< 6.	< 6.	< 6.	< 6.	< 6.	< 6.
IOX (c)	ug/L Cl	< 12.	< 12.	13.	13.	13.	13.	13.	13.	13.	13.	13.	16.	16.
NPOC (c)	mg/L C	2.7	1.9	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	4.	4.
Ammonia	mg/L N	.8	1.1	.76	.76	.76	.76	.76	.76	.76	.76	.76	< .3	< .3
Chloride	mg/L Cl-	2.5	10.	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	15.	15.
Nitrate	mg/L N	< .3	< .3	.64	.64	.64	.64	.64	.64	.64	.64	.64	< .3	< .3
Sulfate	mg/L SO4=	372.	1340.	760.	760.	760.	760.	760.	760.	760.	760.	760.	1220.	1220.
Cyanide	ug/L	< 10.	< 10.	< 10.	< 10.	< 10.	< 10.	< 10.	< 10.	< 10.	< 10.	< 10.	< 10.	< 10.
Phenol (c)	ug/L	34.	< 33.	54.	54.	54.	54.	54.	54.	54.	54.	54.	< 33.	< 33.

a) Parameter was not analyzed.

b) Sample concentration was less than given concentration.

c) See text for the discussion of the reliability of parameter values.

Table A-6

Organic Constituent Analysis Results  
for the Leachate Samples  
B.H.S., Inc.; Wright City, Missouri

Compound	Station:	P/A		Trench 2-N
		Value, ug/L		Value, ug/L
1,1-Dichloroethane		300. a		ND b
Methylene Chloride		15000.		ND
Ethylbenzene		100. a		440.
Toluene		1200.		640.
Xylenes		ND		840.
Acetone		2000.		ND
4-Methyl-2-pentanone		1000. a		7600.
Diethylphthalate		ND		40. a
Naphthalene		ND		180.
2-Methylnaphthalene		ND		20. a
Benzoic Acid		3000.		200.
Phenol		2000.		90.
2,4-Dichlorophenol		40. a		ND
2-Methylphenol		ND		10. a
4-Methylphenol		100. a		290.
2,4-Dimethylphenol		ND		20. a
L00 Factors (c)				
Volatiles		100X		50X
Semivolatiles		20X		2X
Pesticides		50X		1X
Herbicides		100X		4X

a) Compound was present but the concentration was below the given L00.

b) Not detected.

c) L00 Factor is the multiplication factor for the Limit of Quantitations (L00s) given in Table A-7 to correct the L00s for the sample analysis dilution.

Table A-7

Total Metals Analysis Results  
for the Leachate Samples  
B.H.S. Inc., Wright City, MO

Element	Trench 2-N	PIA
	Value, ug/L	Value, ug/L
Al	11,300.	< 530.
Sb	< 350. a	< 350.
As	b	b
Ba	454.	40.
Be	< 6.	< 6.
Cd	< 20.	< 20.
Ca	487,000.	64,200.
Cr	53.	< 35.
Co	< 35.	< 35.
Cu	< 80.	< 80.
Fe	257,000.	785.
Pb	21.	b
Mg	383,000.	63,100.
Mn	4,080.	126.
Hg	< 8.	< 8.
Ni	89.	717.
K	14,200.	6,370,000.
Se	< 8.	b
Si	< 36.	< 36.
Na	382,000.	2,240,000.
Tl	< 10.	< 13.
Sn	< 180.	< 180.
V	< 35.	< 35.
Zn	96.	53.

a) Sample concentration is less than the given concentration.

b) Control measures indicate value was not quantified.

Table A-8

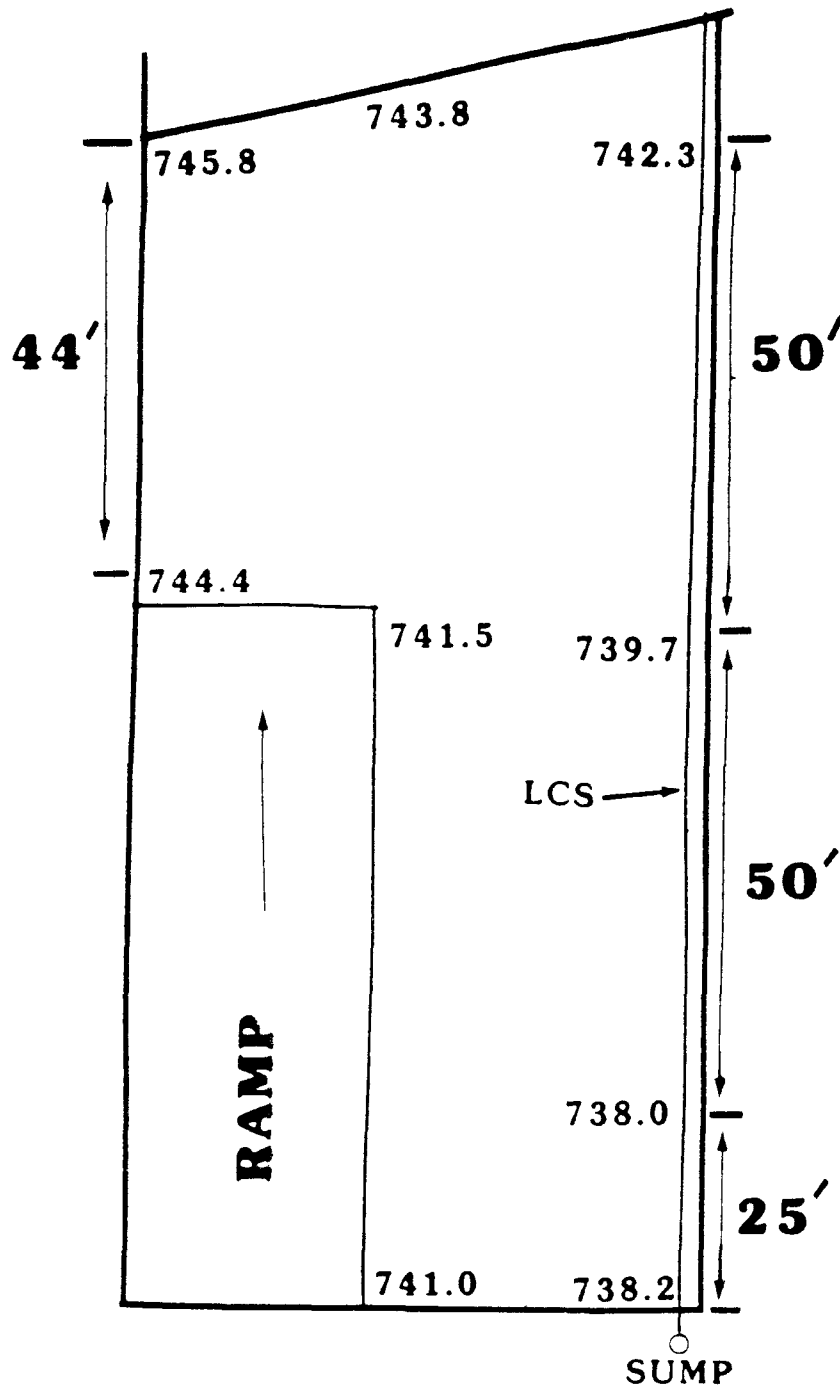
General Constituent Analysis Results  
for the Leachate Samples  
B.H.S. Inc., Wright City, MO

Parameter	Station		Trench 2N		PIA	
	Units		Value		Value	
P0X	ug/l Cl		1030.		19300.	
T0X	ug/l Cl		3700.	a	1550.	a
NP0C	mg/L C		458.		1280.	
Ammonia	mg/L N		4.1		30.	
Chloride	mg/L Cl-		550.		6570.	
Nitrate	mg/L N		< .3	b	< .3	
Sulfate	mg/L SO4=		1180.		2360.	
Cyanide	ug/L		< 10.		< 10.	
Phenol	ug/L		1400.		41600.	
=====	=====		=====		=====	

a) See text for discussion of the reliability of this value.

b) Sample concentration was less than given concentration.

APPENDIX B  
CONSTRUCTION DRAWINGS

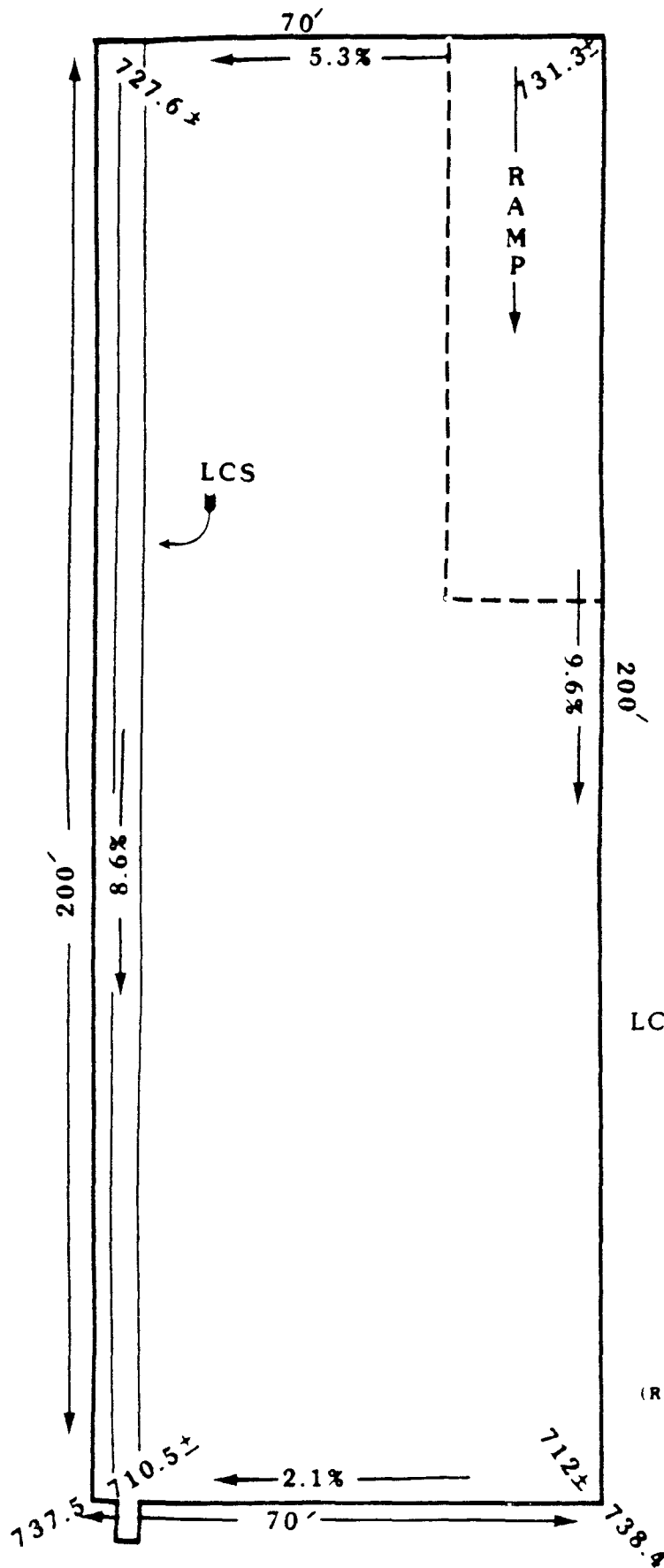


LCS-Leachate Collection System

FIGURE B-1

TRENCH 1-N

(REVISED FROM B.H.S. INC.)

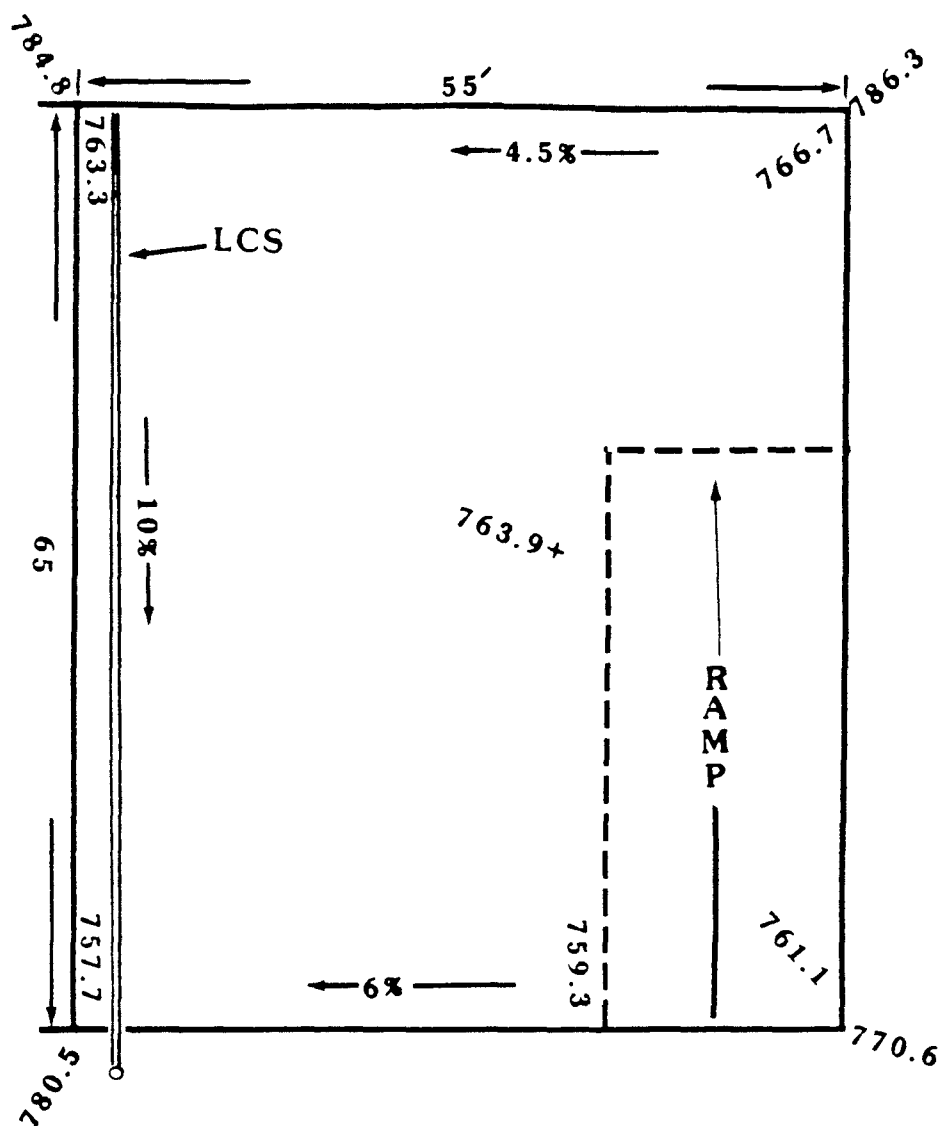


LCS-Leachate Collection System

FIGURE B-2

TRENCH 2-N  
B.H.S., INC.

(REVISED FROM REITZ & JENS, INC.)



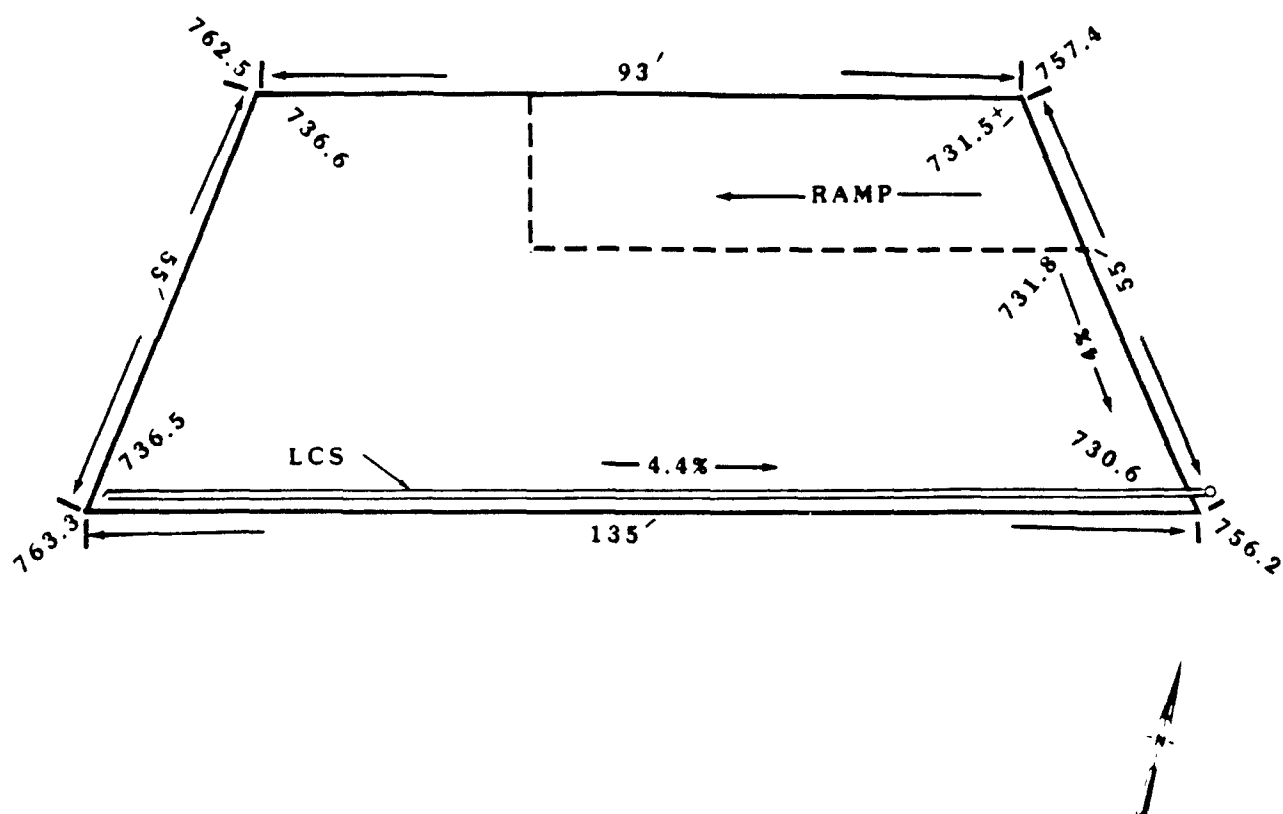
LCS-Leachate Collection System

FIGURE B-3

TRENCH 6-N

(REVISED FROM B.H.S., INC.)



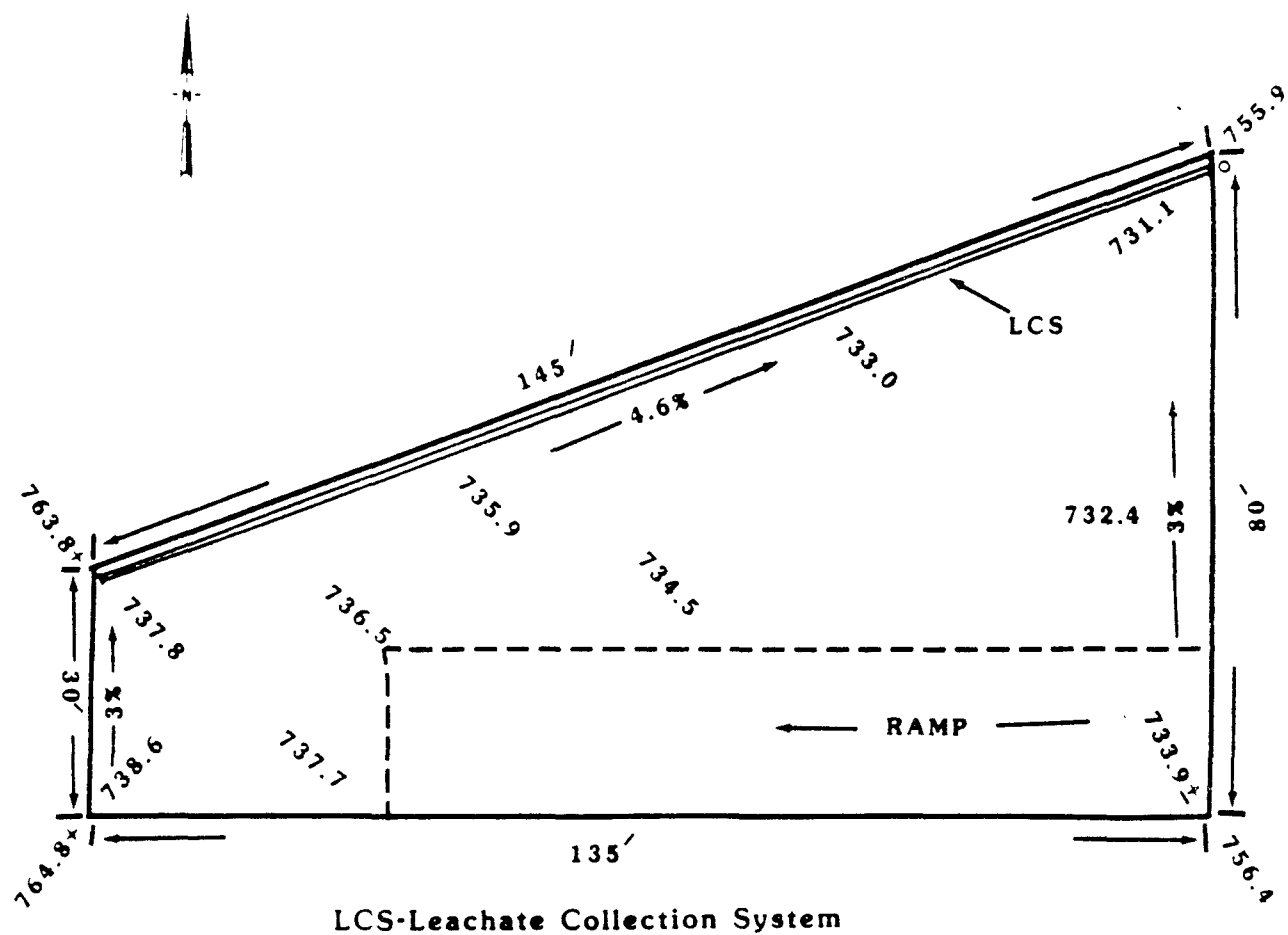


LCS-Leachate Collection System

FIGURE B-4

TRENCH 11-N

(REVISED FROM REITZ & JENS, INC.)



**FIGURE B-5**  
**TRENCH 12-N**

(REVISED FROM REITZ & JENS, INC.)

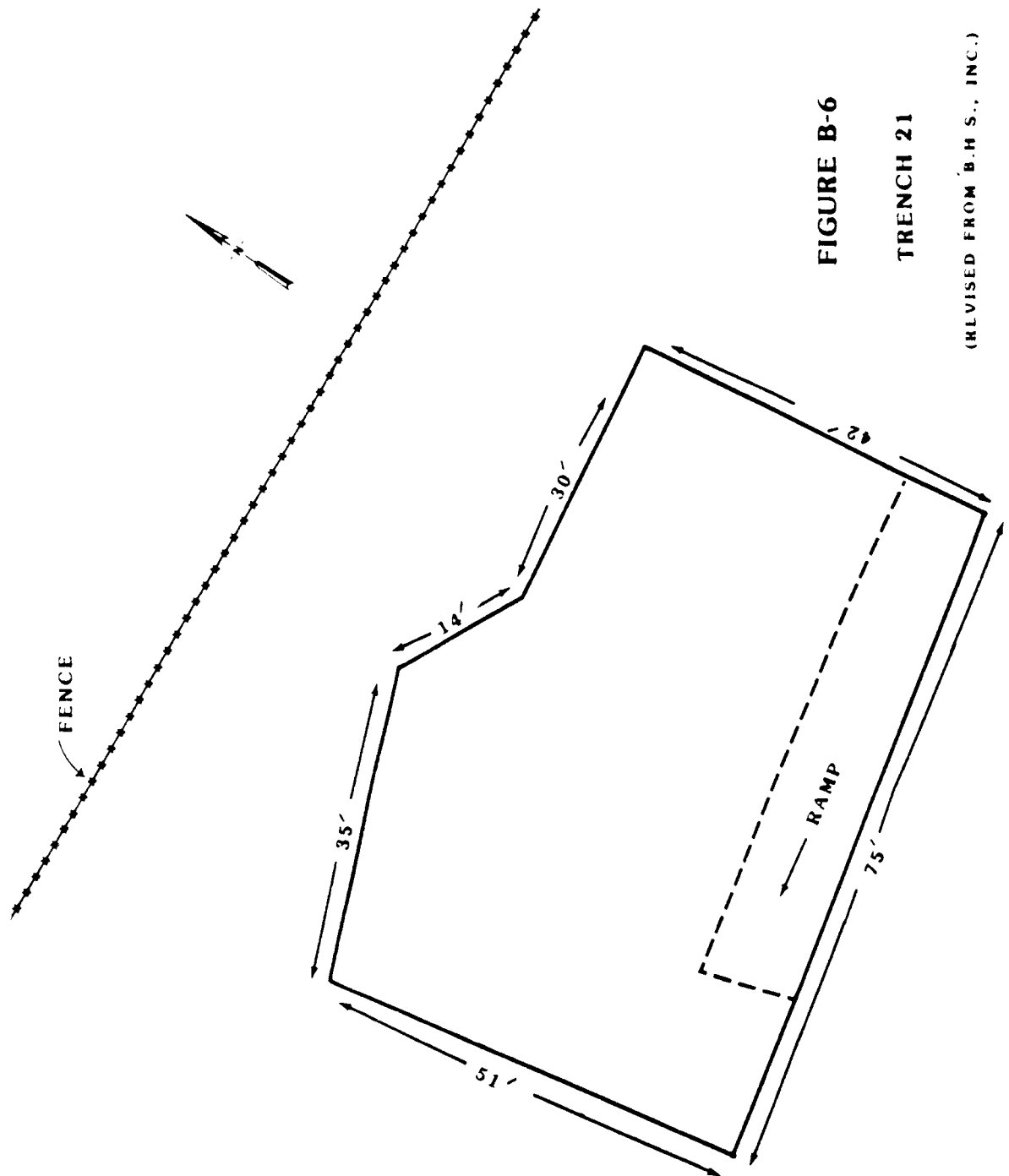


FIGURE B-6

TRENCH 21

(REVISED FROM B.H.S., INC.)

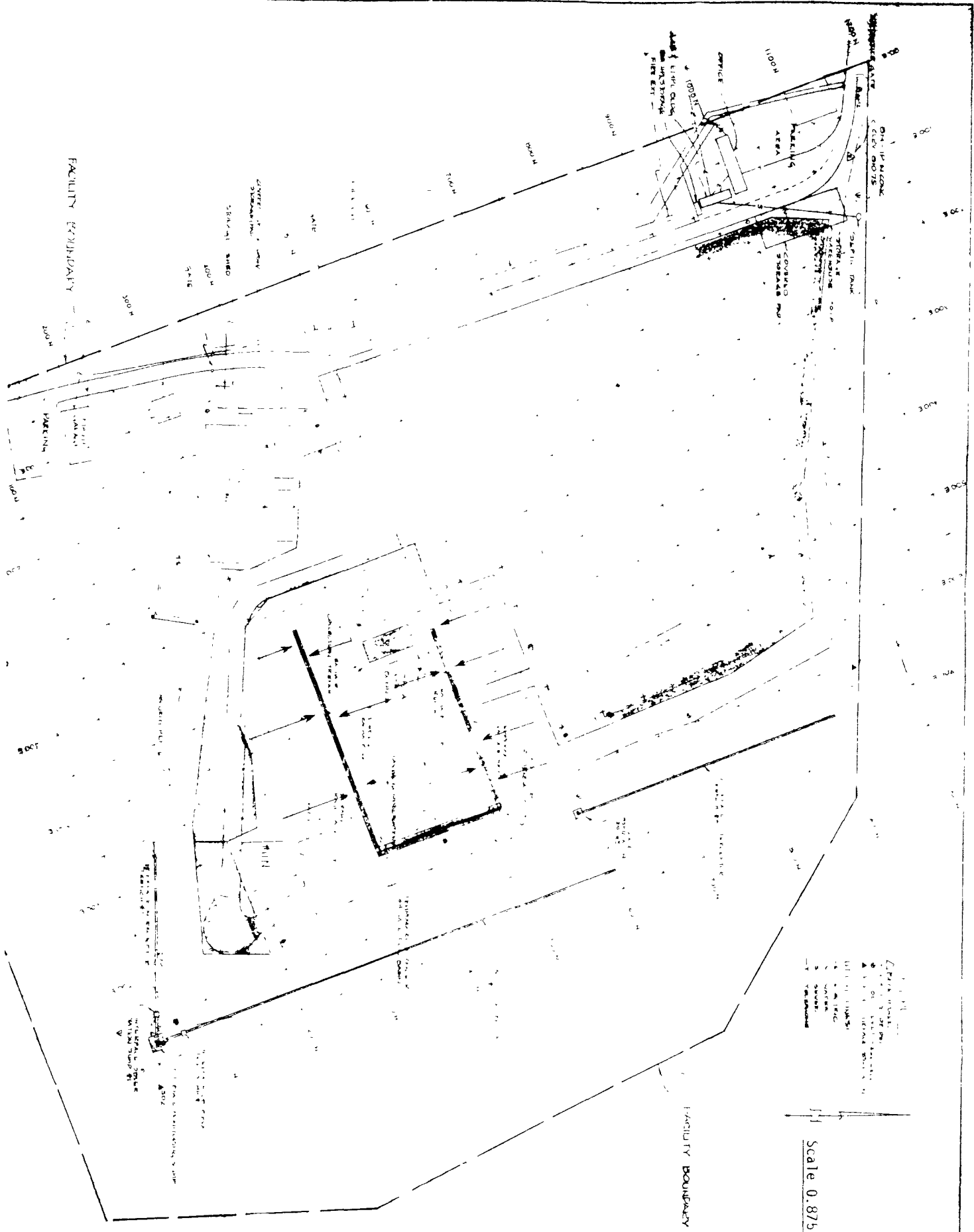
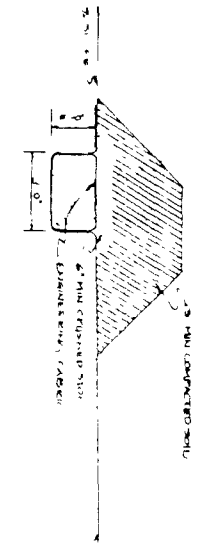
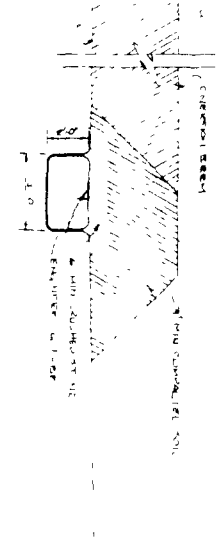


FIGURE B-7

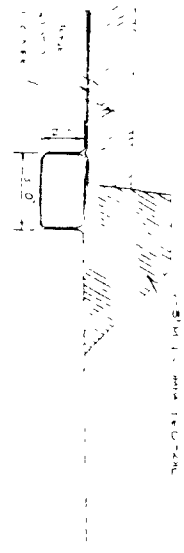
FIGURE B-8



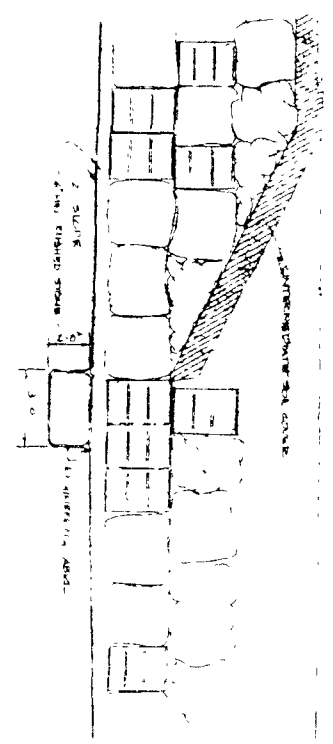
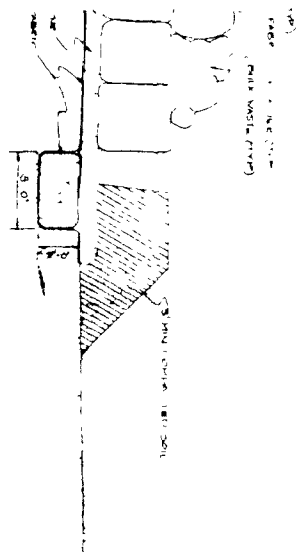
SECTION B-B THROUGH WALL FOUNDATION



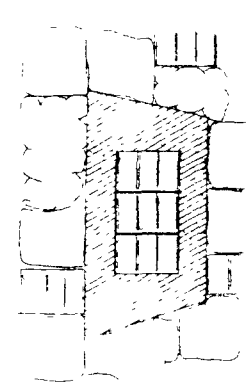
SECTION C-C THROUGH WALL FOUNDATION



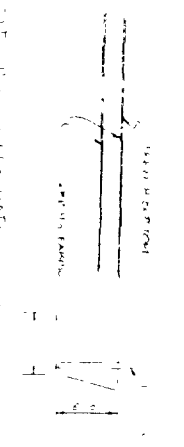
SECTION D-D THROUGH WALL FOUNDATION



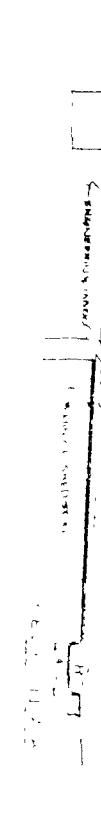
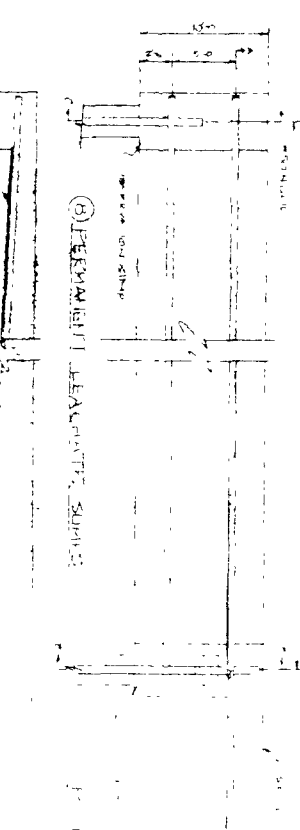
SECTION E-E THROUGH WALL FOUNDATION



SECTION F-F THROUGH WALL FOUNDATION

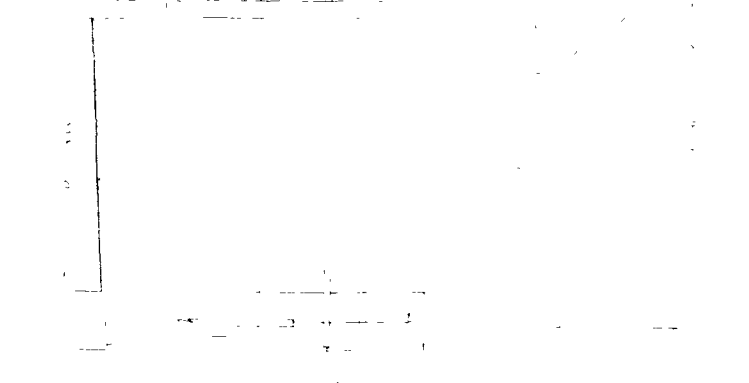


SECTION G-G THROUGH WALL FOUNDATION



1. 12" 12" COMPACTED GRAVEL  
2. 6" 6" CRUSHED STONE  
3. 4" 4" COMPACTED GRAVEL  
4. 12" 12" COMPACTED GRAVEL  
5. 6" 6" CRUSHED STONE  
6. 4" 4" COMPACTED GRAVEL  
7. 12" 12" COMPACTED GRAVEL  
8. 6" 6" CRUSHED STONE  
9. 4" 4" COMPACTED GRAVEL  
10. 12" 12" COMPACTED GRAVEL  
11. 6" 6" CRUSHED STONE  
12. 4" 4" COMPACTED GRAVEL

1. 12" 12" COMPACTED GRAVEL  
2. 6" 6" CRUSHED STONE  
3. 4" 4" COMPACTED GRAVEL  
4. 12" 12" COMPACTED GRAVEL  
5. 6" 6" CRUSHED STONE  
6. 4" 4" COMPACTED GRAVEL  
7. 12" 12" COMPACTED GRAVEL  
8. 6" 6" CRUSHED STONE  
9. 4" 4" COMPACTED GRAVEL  
10. 12" 12" COMPACTED GRAVEL  
11. 6" 6" CRUSHED STONE  
12. 4" 4" COMPACTED GRAVEL



VERTICAL CURVE DATA

SECTION 1000000000



SECTION 1000000000

SECTION 1000000000

SECTION 1000000000

SECTION 1000000000

SECTION 1000000000

SECTION 1000000000

SECTION 1000000000

SECTION 1000000000

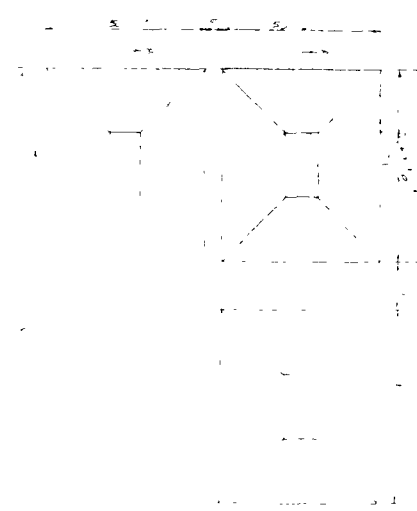
SECTION 1000000000

SECTION 1000000000

SECTION 1000000000

SECTION 1000000000

SECTION 1000000000



SECTION 1000000000

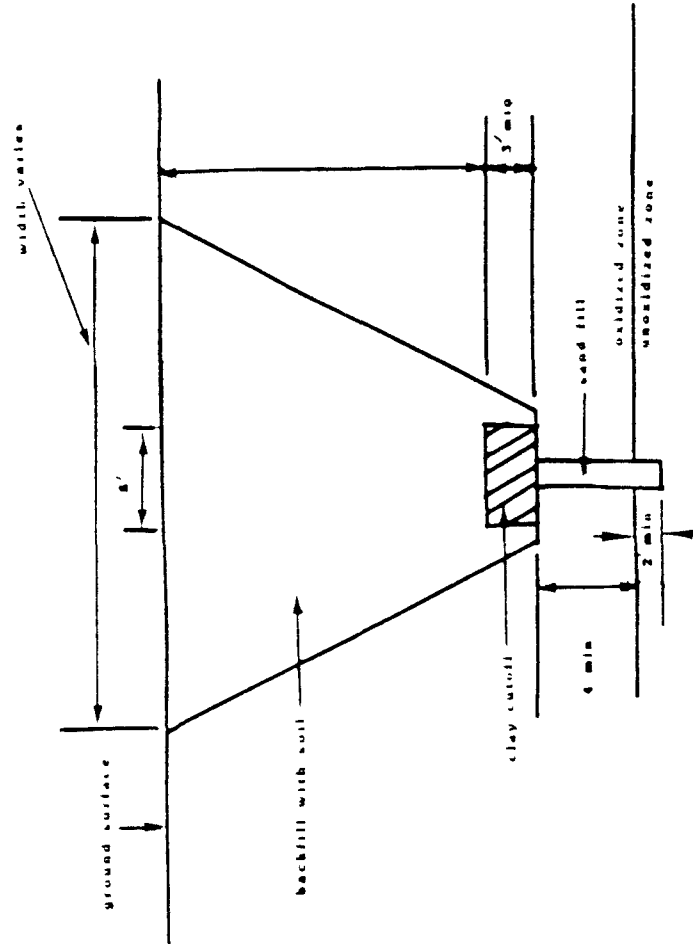
SECTION 1000000000

SECTION 1000000000

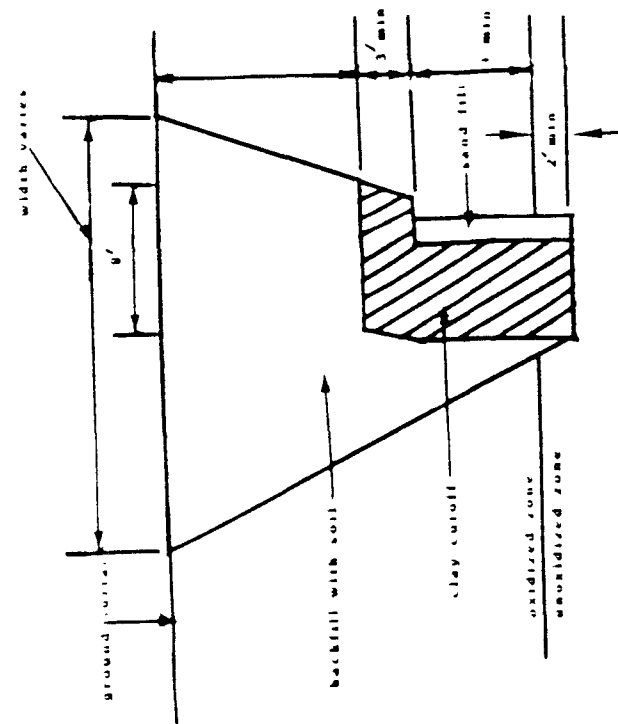
SECTION 1000000000

SECTION 1000000000

FIGURE B-10



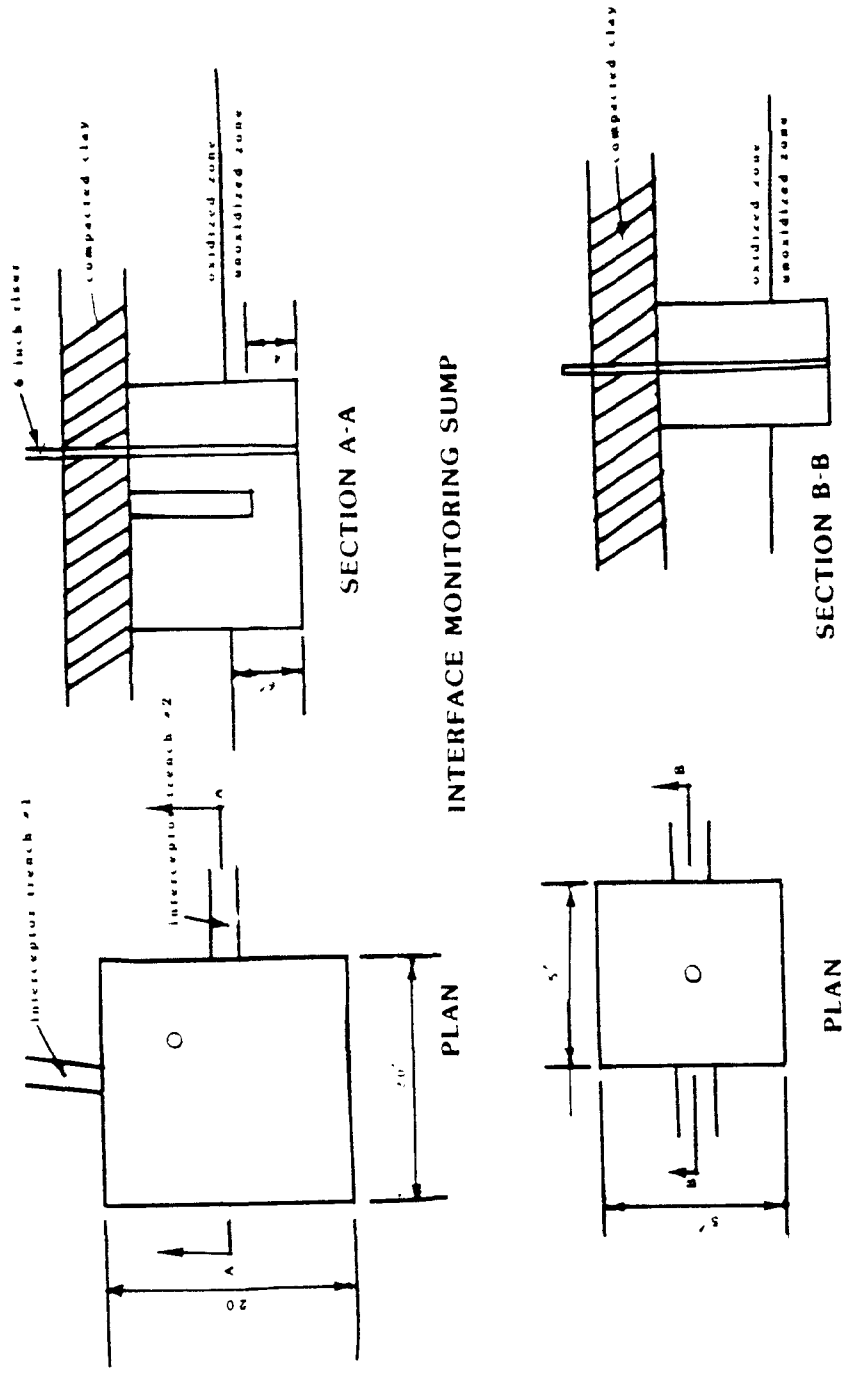
INTERCEPTOR TRENCHES #2 & #3  
TYPICAL CONSTRUCTION



INTERCEPTOR TRENCH #1  
TYPICAL CONSTRUCTION

(FROM D. E. KLOCKOW & ASSOCIATES)

FIGURE B-11



INTERFACE OBSERVATION SUMPS #1 & #2

TYPICAL CONSTRUCTION

(from D. E. Klockow & Associates)



APPENDIX C  
POTENTIOMETRIC SURFACE MAPS

APPENDIX D  
GROUND-WATER MONITORING SYSTEMS

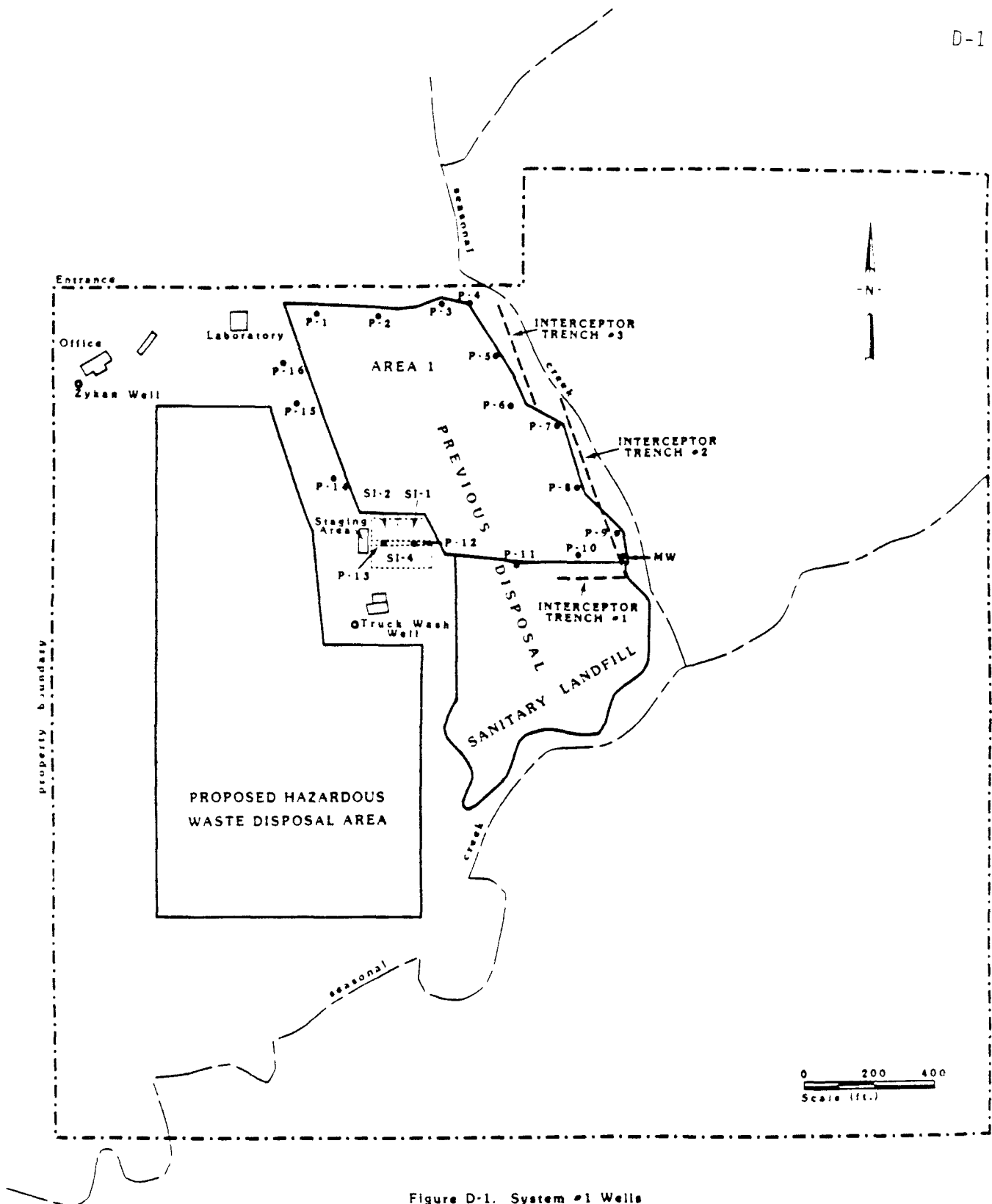


Figure D-1. System #1 Wells

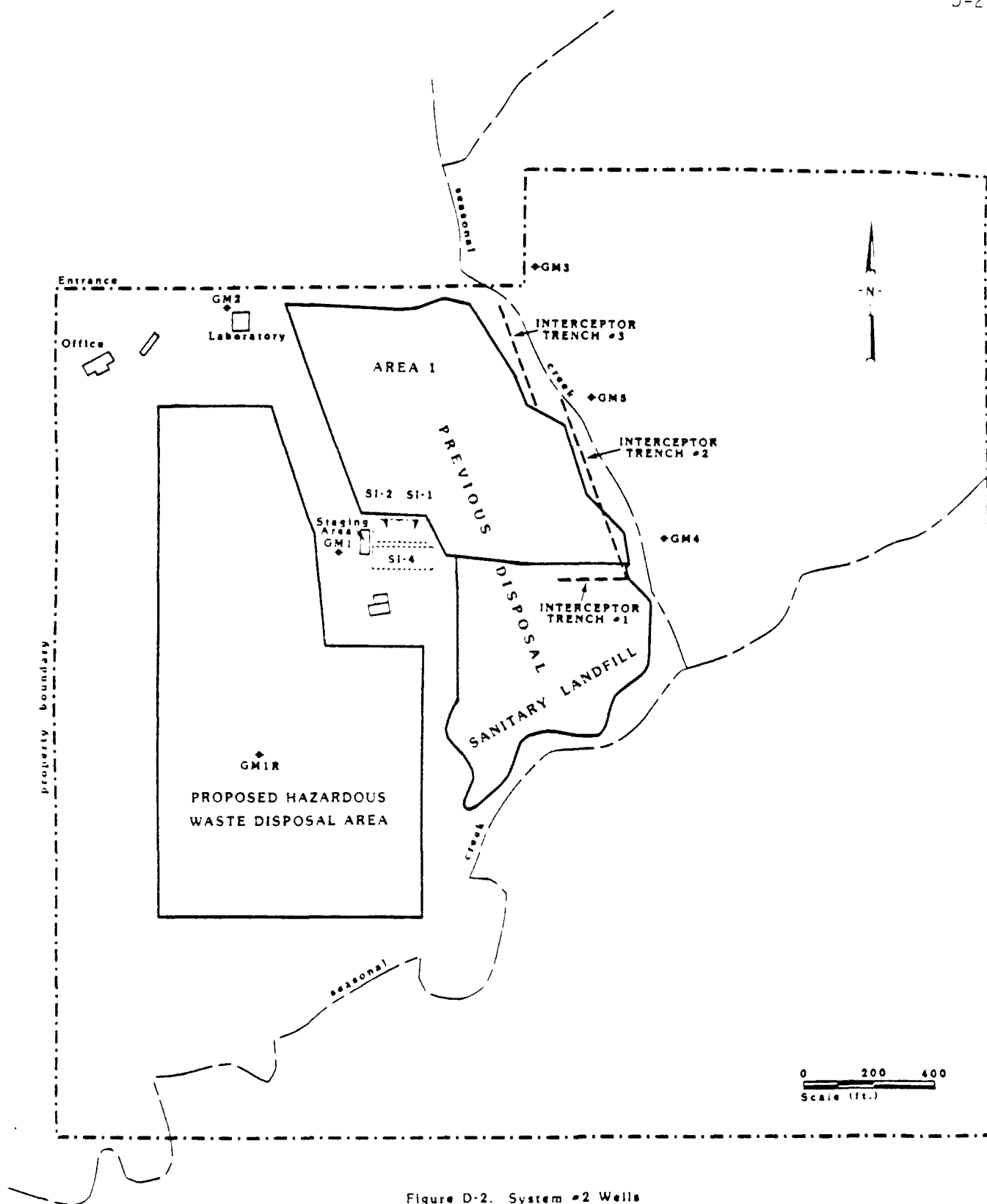


Figure D-2. System #2 Wells

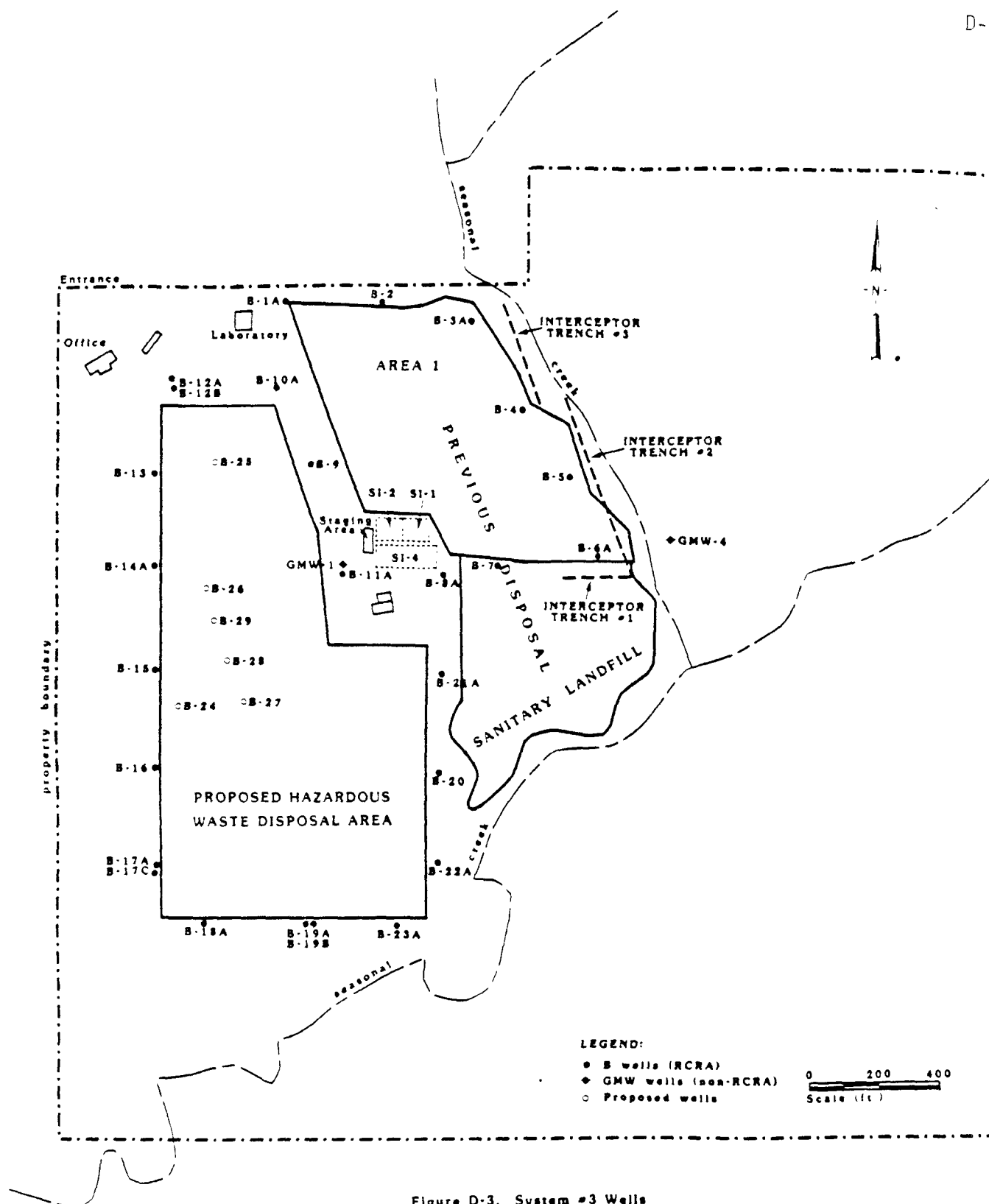


Figure D-3. System #3 Wells

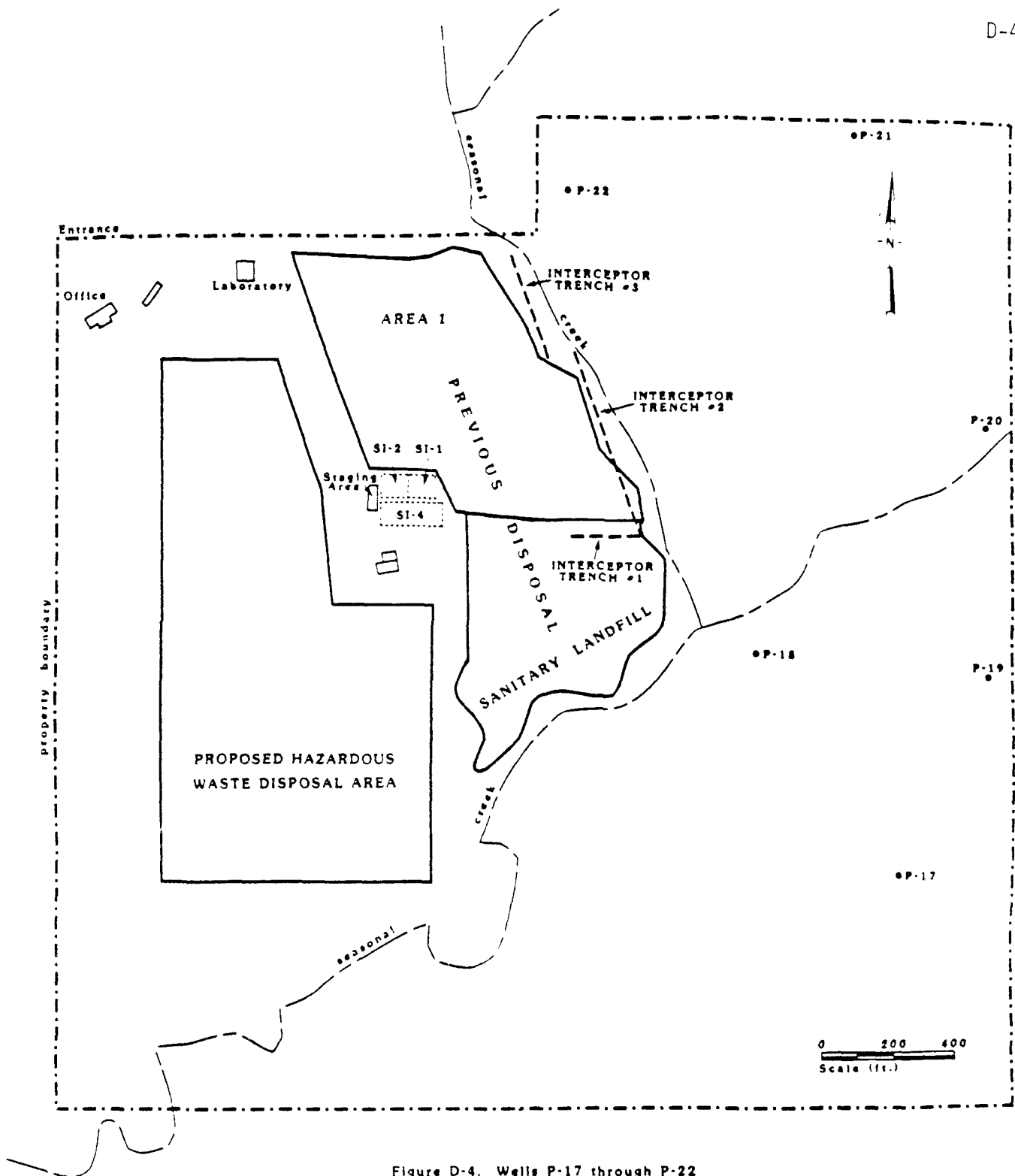


Figure D-4. Wells P-17 through P-22

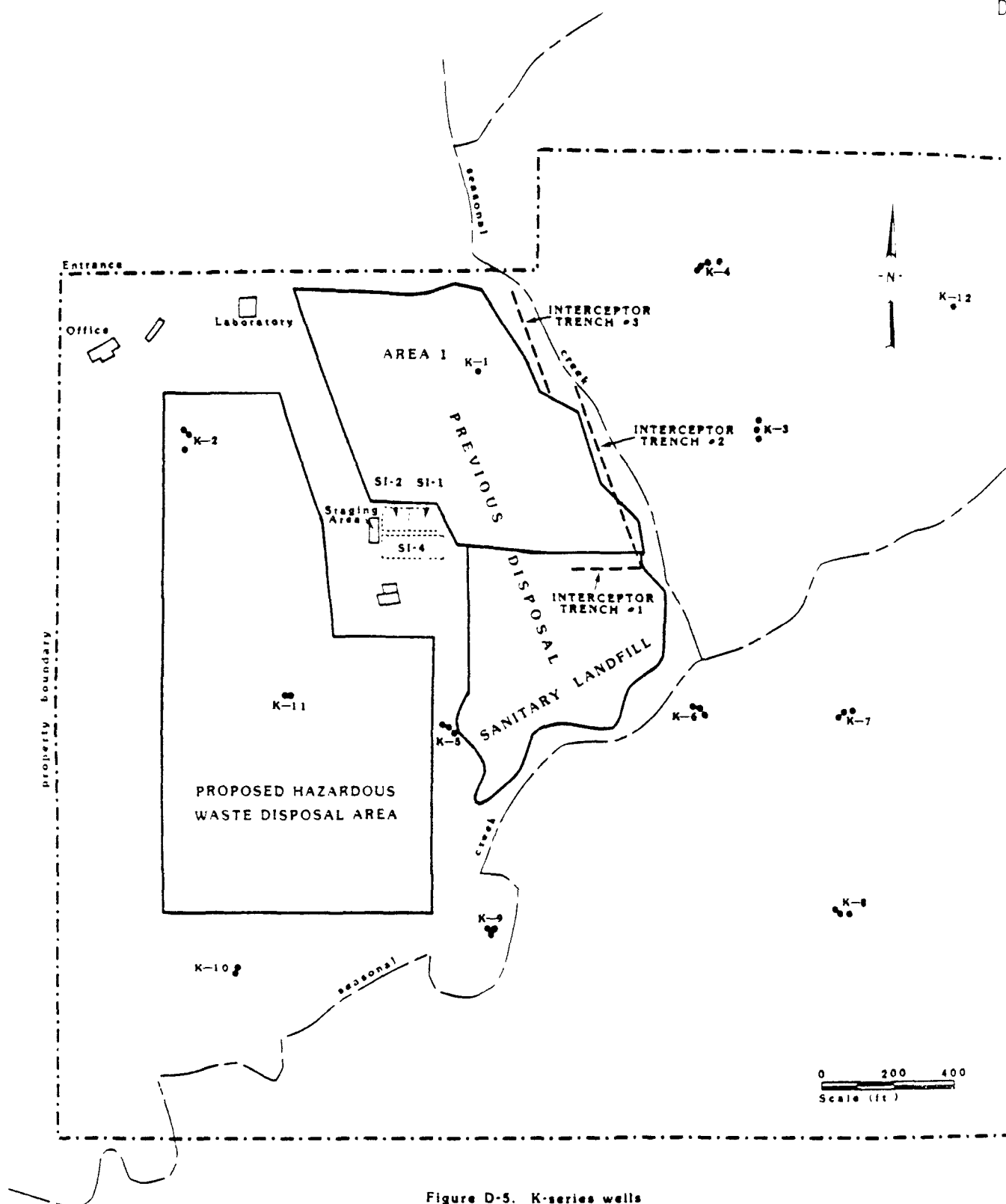


Figure D-5. K-series wells

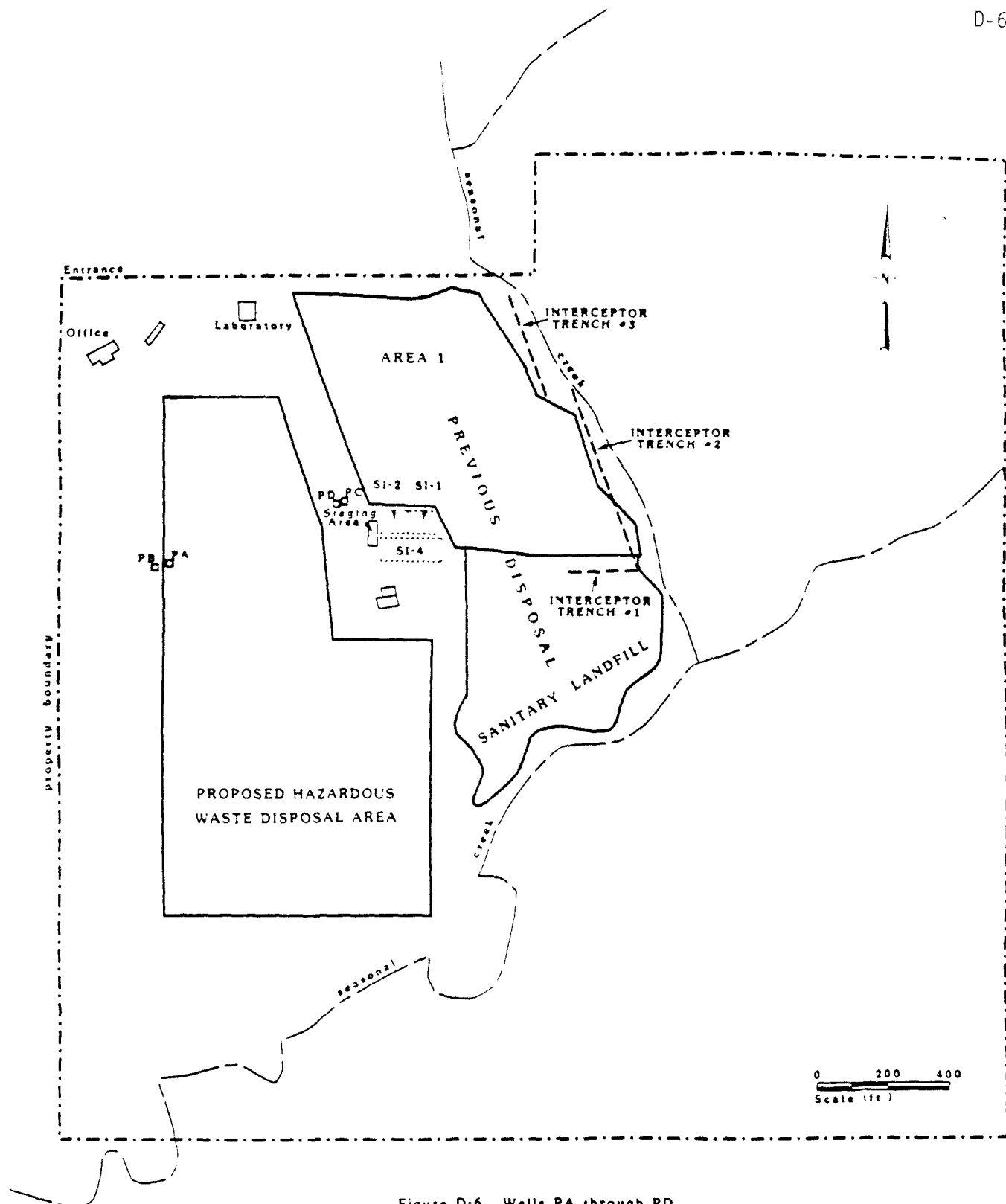


Figure D-6. Wells PA through PD