INTERNATIONAL TECHNOLOGY CORPORATION

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Volume II
Final Report

Goldcamp Disposal Area Feasibility Study

Allied–Signal/ Ironton Coke Site Ironton, Ohio

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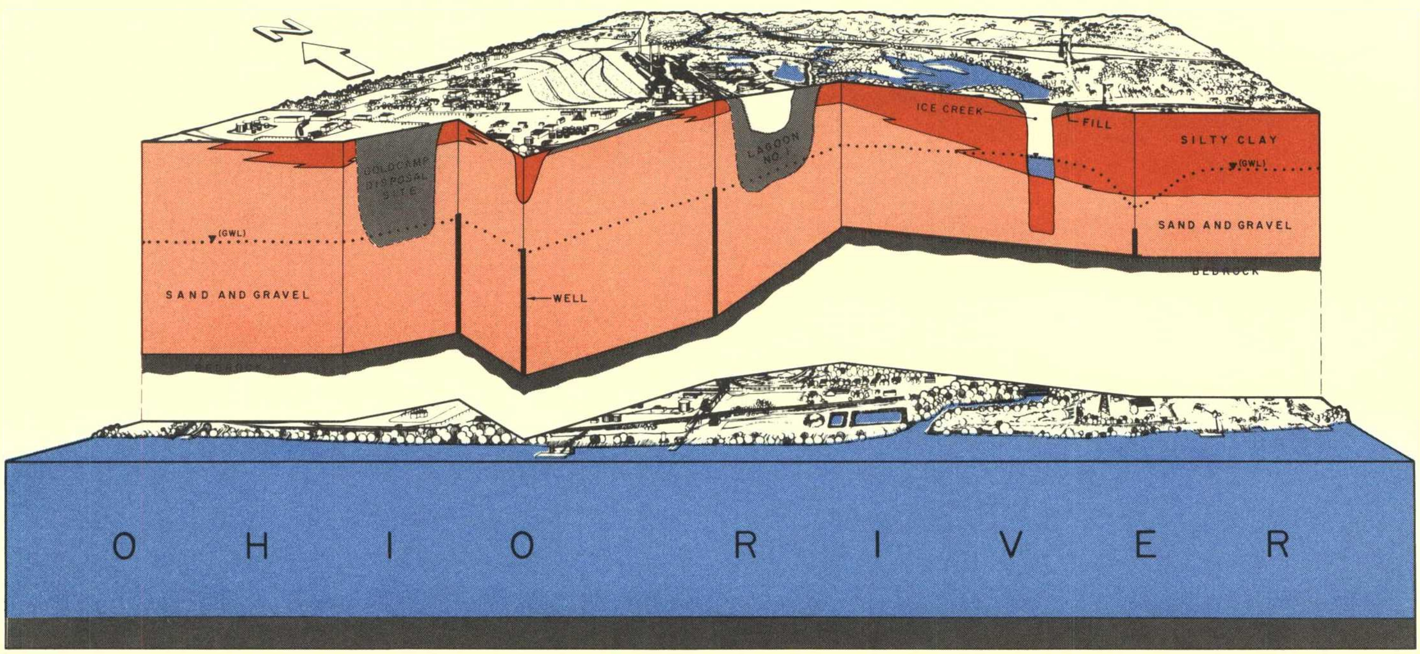

VOLUME II

FINAL
FEASIBILITY STUDY
GOLDCAMP DISPOSAL AREA
ALLIED-SIGNAL/IRONTON COKE SITE
IRONTON, OHIO

PREPARED FOR

ALLIED-SIGNAL, INC.

PREPARED BY

IT CORPORATION

PROJECT NO. 303024
AUGUST 1988

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DECEMBER 1987 AND ADDENDUM
DATED JANUARY 1988

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1.0 Introduction

Phase 2 of the Goldcamp Disposal Area (GDA) Feasibility Study (FS) includes a task for additional field investigations and analyses. The purpose of this task is to develop necessary additional data that are required in formulating design specifications to determine the constructability, applicability, and reliability of each of the eight retained remedial alternative.

A sampling plan has been developed to implement the collection and analyses of necessary data in the field. Sampling locations, sampling techniques, well installation, analytical parameters and methods, and quality control procedures are included in this plan

The information obtained from this investigation will be used to:

- o Determine the horizontal and vertical extent of deposited wastes at the GDA
- o Characterize waste to determine suitability for incineration
- o Evaluate ground water pumping systems
- o Determine slurry wall design parameters.

The details of the proposed sampling are presented in the following sections.

2.0 Deep Soil Boring Program

A total of eight deep borings will be drilled at the Allied-Signal Goldcamp Disposal Area site in Ironton, Ohio. These borings will be used to provide information on material properties and the vertical and lateral extent of contamination. The approximate locations of these borings are shown on Drawing 303024-E3. Based on field conditions and visual inspection of the initial borings; the number, location and depth of the borings may be revised.

Soil Sampling Procedures

The borings will be drilled using hollow stem augers and a casing advancer system. The borings will be advanced to an average depth of 85 feet (down to approximately one foot into bedrock). Continuous soil samples will be collected for the total depth of each boring using a CME continuous tube sampler. An IT geologist will visually characterize each sample and prepare detailed boring logs of the materials encountered. The stratigraphic data collected through the continuous sampling will aid in the determination of the degree of homogeneity and extent of the waste disposed in the GDA.

Soil samples will be collected at 5 foot intervals (representative of the core) from the continuous tube sampler and placed in tightly sealed glass jars which will be individually labeled and identified. Additionally, ground water samples will be collected through the augers in each of the eight bore holes upon encountering the ground water table. Water samples will also be collected at the bedrock interface from the five borings which will not be developed into monitoring wells. Water samples will be collected using a down hole sampling pump or Kemmerer. These samples will be retained in bottles containing appropriate preservatives. Adequate amounts will be collected for chemical analyses. All samples will be placed in coolers and preserved at 4 degrees Celsius in accordance with EPA protocol. Tables 1 and 2 summarize appropriate sampling and preservation requirements. All chain-of-custody documentation and quality assurance samples will accompany the samples from the field to the IT laboratory in Export, Pennsylvania as discussed in Sections 6.0 and 7.0.

After completion of each boring, all down hole equipment will be steam cleaned prior to reuse. Waters generated by this procedure will be handled at the existing on-site treatment plant. Boring cuttings will be collected and disposed of properly. After sample collection, all borings, (except those to be developed into wells) will be grouted to the ground surface with soil-bentonite or a cement-bentonite mixture in accordance with U.S. Environmental Protection Agency (U.S. EPA) and Ohio Environmental Protection Agency (OEPA) requirements.

3.0 Monitoring Well Installation and Development

Three new monitoring wells will be installed at the GDA. The locations of these wells are shown on Drawing 303024-E3. The wells will be installed in previously completed borings and will be constructed with four-inch inside-diameter Schedule 40 polyvinyl chloride (PVC) pipe with threaded flush joint couplings. Slotted well screens with a slot size of 0.010 inch will penetrate the entire saturated thickness of the aquifer.

Wells will be constructed by allowing natural coarse materials to collapse around the well screen. A bentonite seal will then be placed above the sand pack. The remainder of the boring annulus will be filled with cement-bentonite grout to impede infiltration of surface water into the completed well. A protective steel casing with locking cap will be cemented into place over each completed well.

Following completion, each well will be surveyed to determine coordinates and elevations. Monitoring well installation details will be prepared for each well.

Upon completion of the monitoring well installation, the wells will be developed by over pumping and surging. Well development will be conducted by initially pumping from a location just below the static water level in the well. As the suspended sediment in the discharged ground water decreases, the pump will be lowered in approximately five-foot increments and the well pumped and surged until relatively clear ground water is obtained. This procedure is to be conducted over the entire screened interval of each monitoring well so that all water and fines associated with the drilling of the wells are removed and resulting conditions in the well represent in situ aquifer conditions. Additionally, existing monitoring wells, MW-1, MW-2, MW-3, MW-12 and MW-14, will be redeveloped in the same manner before sampling and testing is conducted. All down hole equipment will be thoroughly cleaned following use in each well.

3.1 Ground Water Sampling Procedures

After development of the wells another set of groundwater samples will be collected. Prior to obtaining ground water samples from the monitoring wells, the wells will be purged to evacuate stagnant ground water from the sampling zone. Evacuation of at least three well volumes of water is recommended for a representative sample.

Ground water samples will be collected for both chemical analysis and slurry wall compatibility. Ground water samples will be collected from the three new wells using either a bladder-type pump or a Kemmerer sampler. The bladder pump will be used to collect samples except where a separate organic phase is expected. The Kemmerer sampler will be used to collect the organic phase samples since the Kemmerer is relatively easily cleaned. Sample bottles containing the appropriate chemical preservatives will be filled directly from the sampling device in the field (See Table 2). Sample bottles will be labeled at the time of collection with the appropriate information. Samples will be placed in coolers and preserved at 4 degrees Celsius in accordance with EPA protocol. All chain-of-custody documentation and QA samples will accompany the samples from the field to the IT laboratory in Export, Pennsylvania. Sampling storage, shipment, chain-of-custody and QA procedures are discussed in Sections 5.0, 6.0, and 7.0.

A ground water level measurement will be conducted for all accessible site wells following ground water sampling. Water levels should also be measured in the IIC production wells.

3.2 Single Well Pump Tests

Single well pumps test will be conducted in selected wells from the existing monitoring wells, MW-1, MW-2, MW-3, MW-12 and MW-14 and the three newly installed monitoring wells. The tests will be used to evaluate the hydraulic conductivity of the alluvial aquifer at the site.

4.0 Sample Analysis and Methodology

Selected soil samples collected as part of this additional field investigation will be analyzed for polynuclear aromatic hydrocarbons (PNA's), volatile organic compounds (VOC's), phenol's and creosols.

Based on the results of the analyses, indicative parameters will be selected to define the extent of waste deposits (or contamination) in the GDA disposal area. Analytical methods follow the U.S. EPA approved methods as outlined in U.S. EPA's Test Method for Evaluating Solid Waste, SW-846, September 1986. For those methods not found in SW-846, other U.S. EPA approved methods will be used.

Ground water samples collected from soil borings and the existing monitoring wells (MW-1, MW-2, MW-3, MW-12, and MW-14) will be analyzed for cyanide, phenols, ammonia, chlorides, naphthalene and benzene. Ground water samples collected from the three newly developed monitoring wells will be analyzed for the full scan of volatile priority pollutants, base-neutral extractable priority pollutants, and acid extractable priority pollutants. Additionally, these samples will be tested for metals and cyanide and phenol.

Additionally, moisture content, Atterberg limits, grain size analysis and BTU tests will be conducted on selected soil samples.

All sample analytical and geotechnical testing will be performed by IT's laboratory in Export, Pennsylvania. All samples will be shipped from the site location for receipt by the laboratory on the same day of sampling. All sample handling, shipment, and associated QA/QC procedures will be followed as described in Sections 4.0, 5.0, and 6.0.

5.0 Sample Preservation, Storage, and Shipment

Handling, preservation and shipment procedures for samples collected as part of this study will be in accordance with U.S. EPA guidelines. These procedures ensure that samples collected in the field will arrive in the laboratory in a safe, secure manner without alteration of sample integrity.

Samples shall be adequately marked for identification at the time of collection. Marking shall be on the sample container (bag, jar, bottle, etc.), on a tag or label attached to the sample container, and in a bound field notebook or sample collection log form. Sample identification shall include as a minimum:

- Project name and number
- Unique sample number
- Sampling location (e.g., boring, depth or sampling interval, and field coordinates)
- Sampling date
- Name of sampling personnel
- Preservation or conditioning employed.

6.0 Chain-of-Custody Documentation

Chain-of-custody documentation procedures will be followed for each sample. A chain-of-custody form will be filled out by the sampling person at the time the samples are collected. This form will accompany samples at all times or will be placed in the project file after final sample disposition. All transfers of custody will be documented on this form. Samples are considered to be under a person's custody if:

- The samples are in his possession.
- The samples are within view after being in possession.

- The samples are sealed and placed in a secure Area by the person last having custody.

When a cooler has been filled and is ready to be sealed, a chain-of-custody seal will be filled out and taped onto the cooler in such a way that the cooler cannot be opened without breaking the seal. Similarly, if a cooler containing samples is for any reason out of the immediate custody and observation of the sampler, it will be locked up or sealed whether full or not.

7.0 Quality Assurance/Quality Control (QA/QC)

QA/QC samples will be used for each type of sampling, including field blanks, duplicates, and spiked samples to verify the quality of field and laboratory procedures.

Field blanks will be submitted in the form of organic-free deionized water used to decontaminate the sampling equipment. A field blank will accompany each sample set. The blanks will be appropriately labeled so that they are "blind" to the laboratory and will otherwise be handled the same as the actual samples. This will identify if sample handling procedures are introducing contamination in the samples.

Duplicate samples will be collected by filling two separate containers at the same sampling location to provide a measure of sampling precision. The duplicates, each with a unique sample number, will be sent to the laboratory as "blind" duplicates for analysis.

The use of spiked samples will provide an assessment of analytical accuracy in the laboratory. Spike samples will be prepared by adding a known quantity of an indicator pollutant to the sample container. Field spike samples will be recorded on field collection logs, but will be submitted blind coded to the laboratory. In addition to the above QA/QC samples, replicate analysis of samples will be required of the laboratory to provide a measure of analytical precision. In this procedure, a second aliquot of a sample extract will be analyzed and the results compared to evaluate the variability inherent in the analytical method. The frequency of laboratory replicates will be at least one replicate for every 20 analyses performed.

8.0 Health and Safety

Field activities will be conducted in accordance with health and safety procedures summarized in the Health and Safety Plan for the Goldcamp Disposal Area, December 1987. Procedures will be followed by both IT personnel and IT subcontractors on site.

TABLE 1

SOIL SAMPLING AND PRESERVATION REQUIREMENTS

Parameter	Method	Required Minimum Amount	Bottle Type	Preservative
VOA	8240	40 ml	EPA glass	--
PNA	8270	250 ml	glass	--
Cresol	8270	250 ml	glass	--
Total Phenols	420.1	250 ml	glass	--
Physical (Moisture Content, BTU, Limits, Grain Size/Hydrometer)	--	2-500 ml	plastic jars	--

TABLE 2

WATER SAMPLING AND PRESERVATION REQUIREMENTS

Parameter	Method	Required Minimum Amount	Bottle Type	Preservative
VOA	8240	40 ml	EPA glass	--
BNA	8270	0.5 gallons	glass	--
Total Cyanide	335.2	1 liter	plastic	NaOH/pH<2
Total Phenols	420.1	1 liter	glass	H_2SO_4/pH<2
Benzene	8240	1	VOA vial	--
Naphthalene	8270	0.5 gallons	glass	--
NH_3	350.2	500 ml	plastic	H_2SO_4/pH<2
SO_4	375.4	1 liter	plastic	--
Cl	407C	1 liter	plastic	--
Ag	200.7	500 ml	plastic	HNO_3/pH<2
As	206.1	500 ml	plastic	HNO_3/pH<2
Ba	200.7	500 ml	plastic	HNO_3/pH<2
Cd	200.7	500 ml	plastic	HNO_3/pH<2
Cr	200.7	500 ml	plastic	HNO_3/pH<2
Hg	245.1	500 ml	plastic	HNO_3/pH<2
Pb	200.7	500 ml	plastic	HNO_3/pH<2
Se	270.2	500 ml	plastic	HNO_3/pH<2
Compatibility (Slurry Wall)	--	5 gallon	glass/plastic	--

GOLDCAMP DISPOSAL AREA FEASIBILITY STUDY
SAMPLING PLAN (ADDENDUM)
ALLIED-SIGNAL/IRONTON COKE SITE
IRONTON, OHIO

1.0(A) INTRODUCTION

This document is an addendum to the Goldcamp Disposal Area (GDA) Sampling Plan, dated December 31, 1987. Based on field conditions, several changes to the overall program have been made since initiating the field program. These changes have been mutually agreed upon between Allied-Signal Corporation, the U.S. Environmental Protection Agency and the Ohio Environmental Protection Agency. Changes to the program are described in the following sections. The majority of the program; however, remains unchanged. Reference should be made to the original plan for sampling procedures, decontamination procedures, sample preservation, storage and shipping requirements, chain-of-custody, quality assurance/quality control requirements, and health and safety procedures.

2.0(A) DEEP SOIL BORING PROGRAM

One additional soil boring, B-12, will be drilled at the GDA site. The location of boring B-12 is shown on Drawing No. 303024-E3. Boring and sampling techniques are the same as those described previously in Section 2.1 of the December 31, 1987 Sampling Plan. The boring will be drilled using a hollow stem auger and casing advancer system. The boring will be advanced to the approximate bottom of the waste and continuous samples will be collected for the total depth of the boring using a CME continuous sampler.

Based on previous documentation and photographs, this area is believed to be filled with a material that is characteristically different than materials in the remainder of the site. The continuous samples taken from boring B-12 will be visually characterized by an IT geologist and a detailed boring log of the materials encountered will be prepared.

Soil samples will be collected (as previously) at 5 foot intervals from the continuous tube sampler and placed in appropriate containers. These samples will be analyzed for chemical and physical characteristics. Parameters for chemical analyses will be selected based on preliminary field screening results. Field screening of volatile compounds will be conducted using an HNU Photoionizer.

The original plan outlined the procedure for collection of ground water samples through the augers in each of the borings. Samples were to be collected upon encountering ground water and at the bedrock interface. The collection of these samples (for chemical analysis) was deleted from the field program. Drilling techniques used at the site involved the introduction of water into the boreholes (to prevent sand from entering the auger) as the holes were advanced. Therefore, any samples collected would have been non-representative of actual site conditions. However, the sample of ground water for bentonite compatibility testing will still be taken from MW-19.

3.0(A) MONITORING WELL INSTALLATION AND DEVELOPMENT

Originally, three new monitoring wells (MW-19,MW-20,MW-21) were planned for installation at the GDA. The wells were to be completed through the site wastes at approximately fifty-foot spacings. After beginning the installation of the first well (MW-19), the decision was made to place only one well within the waste. The other two wells were eliminated because advancement through the waste was slow and difficult due to the tarry nature of the waste. Also, based on preliminary pump tests conducted outside of the waste area, only small drawdowns were achieved at a pumping rate of 20 gallons per minute. Therefore, it appears that the placement of the additional wells into the landfill would provide little additional information, since sufficient drawdown would not be achieved in nearby wells.

An additional monitoring well has also been added to the program. This well will be installed off site between the Ironton Iron Corporation (IIC) production wells and the GDA. The purpose of this well is to aid in the evaluation of other potential sources of contamination to the IIC wells.

The well will be drilled using a 6 1/4 inch inside diameter hollow stem auger and casing advancer system. The well will be constructed with a four-inch inside diameter Schedule 40 polyvinyl chloride (PVC) pipe with threaded flushjoint couplings. Slotted well screens with a slot size of 0.010 inch will penetrate the entire saturated thickness of the aquifer. Natural coarse materials will be allowed to collapse around the well screen. A bentonite seal will then be placed above the sand pack. The remainder of the boring will be filled with cement-bentonite grout to impede infiltration of surface water into the completed well. A protective steel casing with locking cap will be cemented into place over the completed well. Proposed installation details are shown in Figure 1.

Well development will be conducted as described previously in Section 3.0 of the original Sampling Plan.

4.0(A) SAMPLE ANALYSIS AND METHODOLOGY

Approxiamtely 4 soil samples (one each from borings B7 through B10) will be selected for a full organic scan using a gas chromatograph/mass spectrometer (GC/MS). This includes analysis for volatile organics, base-neutral extractables, and acid extractables. The selection of these samples will be based on visual inspection.

Additional soil samples from each boring will be selected for analysis of total petroleum hydrocarbons (TPHC) using an infrared spectrophotometer. Selection of samples for the TPHC analysis will also be based on visual inspection and is designed to delineate the zones of contamination and non-contamination. If the contamination appears to extend over a significant depth of the sample, one sample near the top and one sample near the bottom will be selected for analysis. If the selected samples do not appear to provide an adequate representation of the extent of contamination, additional sampes may be analyzed.

5.0(A) METHANE MONITORING

Qualitative methane concentrations will be determined in the field by using color-detector tubes. A grid will be established over the site at 150 feet by 100 feet spacings. Shallow borings, approximately 4-6 inches wide and 1-2 feet deep will be dug at six random locations within the grid intersections. The holes will be covered with aluminum foil and left overnight to allow a sufficient buildup of methane concentration within the hole. Readings of the captured vapors will be taken the next day with the natural gas (methane) color-detector tubes.

Quantitative methane monitoring will not be conducted.

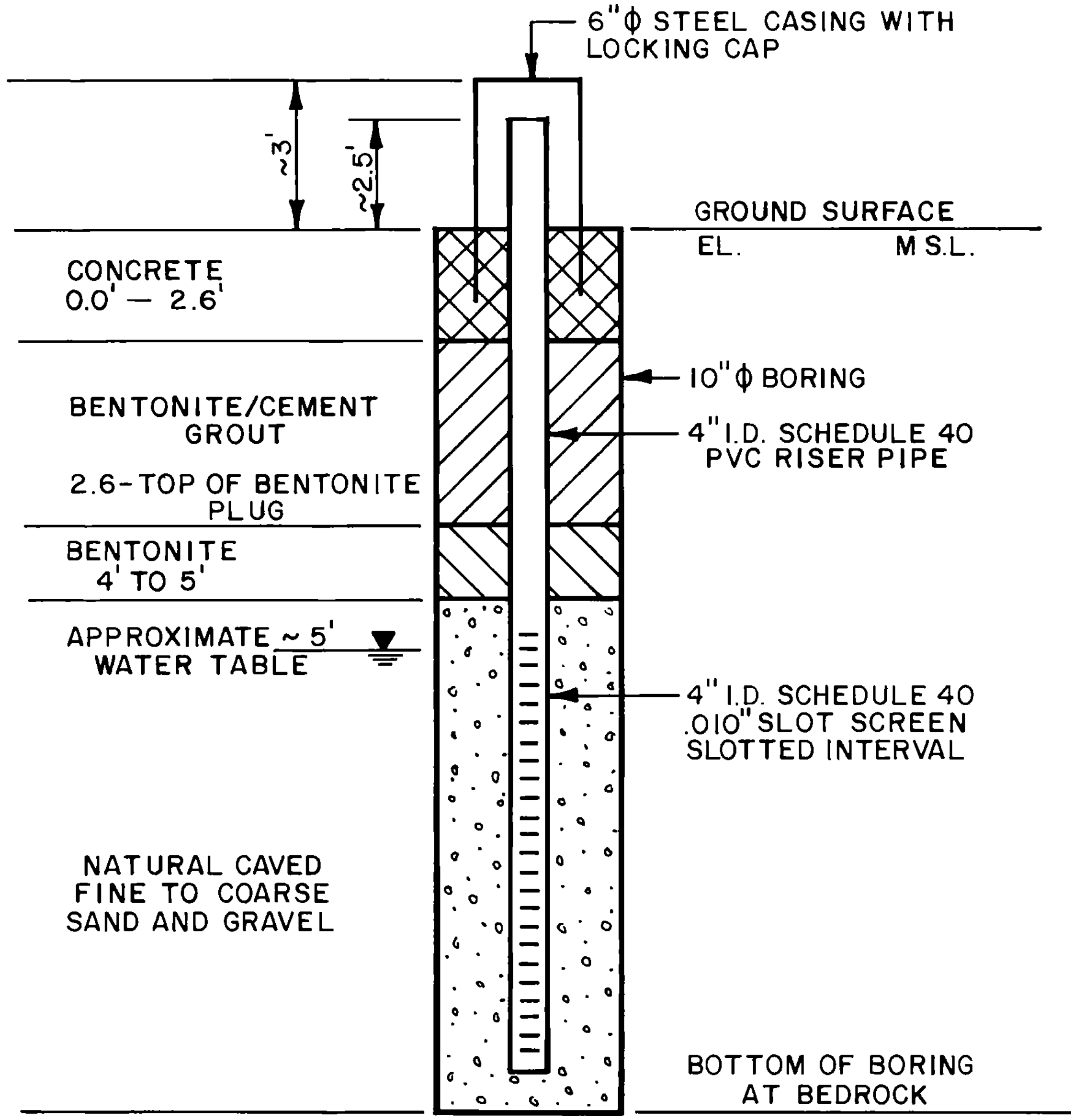

FIGURE 1

(PROPOSED)
INSTALLATION DETAIL
MONITORING WELL MW-20
GOLDCAMP DISPOSAL AREA

PREPARED FOR

ALLIED—SIGNAL INC.
MORRISTOWN, NEW JERSEY

INTERNATIONAL TECHNOLOGY CORPORATION

DRAWING NUMBER	303024-A1
DRAWN BY	MeI 1-22-88
CHECKED BY	RLS 1-25-88
APPROVED BY	SKG 1-25-88

132298

Do Not Scale This Drawing

APPENDIX B

ADDITIONAL FIELD INVESTIGATIONS AND ANALYSES MAY 1988

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ADDITIONAL FIELD INVESTIGATIONS AND ANALYSES GOLDCAMP DISPOSAL AREA ALLIED-SIGNAL/IRONTON COKE SITE MAY 1988

B.1.0 INTRODUCTION

This task was designed to fill data gaps and to develop necessary additional data required for formulating detailed descriptions and conceptual designs of the remedial action alternatives. Specifically, the information obtained from these additional investigations will be used to:

- Confirm the horizontal and vertical extent of wastes deposited at the GDA
- Characterize waste to determine suitability for incineration
- Evaluate ground water pumping systems
- Determine design parameters for various alternatives

A field sampling work plan was submitted on December 31, 1987 outlining the field activities and procedures necessary to achieve the above-mentioned objectives. The original work plan was slightly modified due to unexpected field conditions. These changes are described in an addendum to the original plan, dated January 26, 1988. The work plan and addendum thereto is presented as Appendix A.

The remainder of this technical memorandum summarizes the activities conducted in the field and presents and assesses the results of this investigation.

B.2.0 FIELD INVESTIGATION PROGRAM

The field investigation program included the installation of six deep soil borings and two monitoring wells (Figure B-2-1). Soil samples were collected for analyses from both the borings and the wells. In addition, the new monitoring wells and four other existing GDA wells were developed or redeveloped and sampled and single well pump tests were conducted on selected site wells. A limited soil-gas survey was also conducted at the site to identify the presence of methane gas.

B.2.1 SOIL BORING PROGRAM

Six deep borings were completed at the GDA site in Ironton, Ohio. The purpose of the borings was to obtain information regarding site material properties and to confirm or determine the vertical and lateral extent of soil contamination. The locations of the completed borings are shown in Figure B-2-1.

The borings were drilled using 3-1/4-inch-inside-diameter hollow-stem augers and a casing advancer system. Soil samples were obtained for the total depth of each boring using a CME five-foot continuous sampler. The samples were visually characterized by an IT geologist and detailed boring logs were prepared in the field to include the sample number and type, sample depths, sample recovery, sample descriptions, soil classifications, and other information pertinent to the drilling procedures. The boring logs are presented in Section A. In addition, the monitoring of vapors and gases from the site was conducted using an HNu Photoionizer and an MSA Model 260 Combustible Gas and O_2 Indicator. The levels of gases were monitored both for personnel safety and preliminary indications of the level of contaminants.

Soil composite grab samples were then collected from each five-foot continuous sample and transferred to appropriate containers for chemical and physical analyses. A summary of the sample collection and the analyses performed on each sample is presented in Section B.

Samples were packed in coolers with ice and shipped, along with proper sample identification and chain-of-custody documentation, to the IT Corporation (IT) laboratory in Export, Pennsylvania.

Following completion of each boring, all downhole equipment were steam cleaned prior to reuse. Waters generated from cleaning and drilling procedures were collected temporarily on site in a portable tanker and then transferred to aboveground storage tanks in the Coke Plant area of the site. Allied received permission from the Ohio Environmental Protection Agency (OEPA) concerning modification to their existing Tar Plant National Pollutant Discharge Elimination System (NPDES) permit. The stored water was treated at the existing treatment unit and discharged through Allied's NPDES permitted outfall.

Boring cuttings were collected and stored in 55-gallon drums and stored in a waste bin near the GDA site. The waste was then disposed of through Allied's hazardous waste contractor.

After completion of sampling, all borings were grouted to the ground surface with a cement-bentonite mixture.

B.2.2 HYDROGEOLOGIC PROGRAM

Two Monitoring Wells, MW-19 and MW-20, were installed, developed, and sampled by IT at the GDA site. Other existing GDA-related Monitoring Wells (MW-2, MW-3, MW-12, and MW-14) were redeveloped and sampled. In addition, single-well pump tests were conducted on selected wells.

Locations of these wells are shown in Figure B-2-1.

B.2.2.1 Well Installation Methods

Monitoring Well MW-19 was drilled using 6-1/4-inch-diameter hollow-stem augers and a casing advancer system. Soil samples were collected at two-foot intervals using a split-spoon sampler. Once the bottom of the waste material was encountered, sampling was discontinued and the hole was sealed with a cement plug. This was accomplished by advancing an eight-inch casing into the hole to the bottom of the wastes (44 feet). The cement plug was poured at the bottom depth of the waste and allowed to set. Drilling was then continued using a Spudder rig. The Spudder rig was used to advance a five-inch casing to bedrock. Because of this construction procedure, only two additional soil samples were collected below the bottom of the wastes. Samples were obtained from the material pumped out from the casing. The analytical results of these samples provides only a general idea of the contaminants present at these levels, not an exact representation of the aquifer contaminants at a particular depth.

Monitoring Well MW-20 was initially drilled using 3-1/4-inch-inside-diameter hollow-stem augers in order to obtain continuous soil samples with a CME 5-foot continuous sampler. Soil samples were collected for the entire depth of the boring.

Soil samples from both wells were visually characterized by an IT geologist and detailed boring logs were prepared (Section A).

Soil composite grab samples were then collected from each continuous and split-spoon sampler and transferred to appropriate containers for chemical and physical analyses. The sample collection and analyses performed on each sample are summarized in Section B.

Monitoring Well MW-20 was then redrilled using 6-1/4-inch-inside-diameter hollow-stem augers to allow the boring to be completed as a 4-inch monitoring well. Both Monitoring Wells MW-19 and MW-20 were constructed with 4-inch-inside-diameter Schedule 40 polyvinyl chloride (PVC) pipe with threaded-flush joint couplings. Slotted well screens with a 0.010-inch slot size penetrate the entire saturated thickness of the aquifer. Natural coarse materials were allowed to collapse around the well screen. Other pertinent details such seals, protective steel casings, etc., are presented in Figures B-2-2 and B-2-3. Following completion, each well was surveyed to determine the elevation and location.

B.2.2.2 Well Development

Upon completion of the monitoring well installations, the two new wells MW-19 and MW-20 were developed. In addition, existing Monitoring Wells MW-2, MW-3, MW-12, and MW-14 were redeveloped. All wells were developed prior to pump testing and/or sampling.

Well development was conducted by initially pumping (with a submersible pump) from a location just below the static water level in each well. As the suspended sediment in the discharged ground water decreased, the pump was lowered in approximately ten-foot increments, and the well was pumped and mechanically surged until relatively clear ground water was obtained. This procedure was conducted over the entire screened interval of each well so that all water and fines associated with the drilling of the wells were removed and resulting conditions in the well were representative of in situ aquifer conditions. Well development details are presented in Table B-2-1.

Additionally, existing Monitoring Well MW-1 was scheduled to be redeveloped even though it was believed the casing may have been damaged. However, the pump became stuck in the well during the course of well development and efforts to retrieve it were unsuccessful. The well will be properly closed to prevent any potential cross contamination.

B.2.2.3 Well Pumping Tests

Single well pumping tests were conducted on Monitoring Wells MW-2, MW-3, MW-12, MW-19, and MW-20 to determine the transmissibility of the aquifer material. Each well was pumped at the maximum capacity of the submersible pump. The pumping test was continued until the water in the pumping well had stabilized or for a maximum of 100 minutes. Table B-2-2 gives a summary of the pump test details for each well.

The submersible pump and associated cables and hose used in well development and pump testing were decontaminated after each use. To prevent cross contamination from one monitoring well to the next, the exterior of the equipment was wiped first with methyl alcohol and then with deionized water. To decontaminate the interior of the submersible pump, a dilute methyl alcohol solution, followed by deionized water, was pumped through the equipment. The wastewater, including ground water pumped during well development and pumping tests, in addition to water used for decontamination, was collected and stored on the Coke Plant site in large aboveground temporary storage tanks. Allied did receive approval from the OEPA concerning modification to their existing Tar Plant NPDES permit. The stored water was treated through Allied's existing Tar Plant treatment unit and discharged.

B.2.3 GROUND WATER SAMPLING

Ground water samples were collected from six Monitoring Wells (MW-2, MW-3, MW-12, MW-14, MW-19, and MW-20) at the GDA.

The wells, with the exception of Monitoring Well MW-3, were purged before sampling in order to obtain representative samples. Monitoring Well MW-3 was sampled both before and after well development. Samples were collected from the Monitoring Wells MW-2, MW-3, MW-12, MW-14, MW-19, and MW-20 within one to six days after well development and/or pumping tests were completed. Because floating and sinking contaminants were suspected, the wells were sampled at least 24 hours after pumping to allow these contaminants to resegregate.

Sample suites were collected at three levels (upper, middle, lower) throughout the screened interval of each well using an ISCO bladder pump. The upper suite was collected from within five feet of the water/air interface and the lower suite was collected from within seven feet of the well base. Three levels were chosen because previous sampling indicated the presence of floating and sinking contaminants.

Field duplicate and sample blanks were also obtained. A complete set of duplicate samples was collected from Monitoring Well MW-19 which were labeled as Monitoring Well MW-21 for a laboratory quality assurance check. In addition, to serve as a field blank, deionized water was run through the ISCO pump system, and labeled as Monitoring Well MW-22. The deionized water was representative of all deionized water used in decontamination procedures.

Sample bottles containing appropriate chemical preservatives were filled directly from the sampling device in the field. The samples were packed in coolers with ice and shipped, along with proper sample identification and chain-of-custody documentation, to the IT laboratory in Export, Pennsylvania. Completed sample logs are presented in Section D which provide data on the sample number, sample location, date of sampling, sample depth, and the analyses conducted. Note that not all samples were analyzed for each parameter.

Equipment was decontaminated between use on each well. The pump was disassembled and the parts, including the hoses and safety cable wire wiped with methyl alcohol and rinsed with deionized water. Deionized water was also run through the pump system to decontaminate the inside of the water hose. Site wastewater was collected and stored on the Coke Plant site in large above-ground temporary storage tanks. After receiving approval from OEPA, the stored water was treated through Allied's existing Tar Plant treatment unit and discharged.

B.2.4 METHANE SURVEY

Methane monitoring was conducted at the site to provide a preliminary screening of the existence of combustible gases at the site. Six random locations were established in the field for methane testing. Figure B-2-1 shows the testing locations. Shallow borings (approximately 5 feet deep) were drilled at these locations using 3-1/4-inch-inside-diameter hollow-stem augers. These shallow borings were covered with aluminum foil and secured to allow sufficient buildup of gases overnight. Color-detector tubes were then inserted through the aluminum foil to obtain either a positive or negative indication of the presence of methane gas. Where positive indications were found, Lower Explosive Limit (LEL) readings were also recorded using an MSA Model 260 Combustible Gas and Oxygen Indicator. These readings were then used to calculate the percentage of combustible gases (including methane) present at the site. Since the instrument was calibrated to propane, conversions to methane (using response curves for the MSA 260) were made.

Out of six monitoring locations, methane (or combustible gas) was detected in two test locations. The concentration was estimated to be 2,250 ppm in Location GS-2 and 2,500 ppm in Location GS-4. Higher LEL readings were also detected during the drilling at the GDA. The remedial action design will take into consideration the level of methane gas present at the site.

B.3.0 LABORATORY AND FIELD TESTING RESULTS

This chapter presents the results of laboratory and field testing on soil and ground water samples collected during the January through February 1988 field program conducted at the GDA.

B.3.1 SOIL ANALYSES

Results of the chemical analyses performed on soil samples collected from Borings B-7 through B-12 and during the drilling of Monitoring Wells MW-19 and MW-20 are presented in Tables B-3-1 through B-3-6. Selected samples were analyzed for Hazardous Substance List (HSL) volatile and semivolatile compounds, total metals, total petroleum hydrocarbons (TPHC), oil and grease (O&G), and total organic carbon (TOC).

The detailed analyses (i.e., volatiles, semivolatiles, and total metals) were run on samples representative of the actual waste deposited in the GDA. The intent of gathering this data is to characterize the waste deposits. This characterization will aid in the design of containment and treatment options.

TPHC was selected as an indicator parameter to provide information on the extent of waste and soil contamination. The TPHC results are indicative of trends, not exact constituents or concentrations. The selection of soil samples for analysis of TPHC was based on visual observation. If two consecutive samples appeared to be similar in nature (i.e, clean or contaminated), only one of these samples were analyzed and results were considered representative of both samples. However, when distinctions between clean and contaminated soil were not explicit, both samples were selected for analyses.

Additionally, several samples were analyzed for O&G and TOC. These two tests were run to check the validity of the TPHC results. TPHC analysis measures fluorocarbon-113 extractable petroleum hydrocarbons, i.e., mineral oils. O&G, however, is a measure of biodegradable animal greases and vegetable oils along with the relative nonbiodegradable mineral oils. TOC measures all soluble and insoluble volatile and nonvolatile organic carbon. This method is based on complete combustion of carbon to carbon dioxide with an adjustment for inorganic forms of carbon (i.e., carbonate and bicarbonate).

It is obvious that all three tests measure different types of hydrocarbons. However, animal greases and vegetable oils are not an expected constituent of the GDA wastes; therefore, measurements for TPHC and O&G are comparable. TOC readings, as expected, are much higher than the measures of TPHC and O&G.

Using all three methods, four soil samples were analyzed for comparison purposes. As indicated by these analyses, each of the tests were determined to be indicative of the relative extent and degree of contamination. Therefore, the selected method (TPHC) appears to provide meaningful results.

Additionally, determinations of heat of combustion, water content, and density were made on selected soil samples. The test parameters were selected to provide further information on site characteristics necessary for evaluation of incineration options. Representative samples were selected to provide characteristics of various targeted strata (i.e., waste and aquifer materials). The results are presented in Tables B-3-7 and B-3-8.

B.3.2 GROUND WATER ANALYSES

Results of chemical analyses performed on ground water samples collected from Monitoring Wells MW-2, MW-3, MW-12, MW-14, MW-19, and MW-20 are presented in Tables B-3-9 through B-3-14. Ground water samples were analyzed for site indicator parameters (i.e., ammonia, benzene, cyanide, phenolics, and naphthalene), total metals, radiological parameters, pH, hazardous substance list, and volatile and semivolatile compounds.

B.3.3 SLURRY COMPATIBILITY TESTING

Filter cake tests were performed to test the compatibility of the ground water with commercial bentonite. Federal 90 and Federal 125 bentonites were tested. Ground water collected during the installation of Monitoring Well MW-19 was used for these tests. This sample, collected from within the wastes, represents worst case conditions at the site. Complete chemical analyses (i.e., HSL volatiles and semivolatiles and total metals) were performed on this ground water sample. Results of these analyses are shown in Section D (Tables S-D-1 through S-D-3). Details of the filter cake test method and results are also presented in Section D.

B.4.0 PRELIMINARY ASSESSMENT OF DATA

This chapter summarizes the assessments made of the field and laboratory data presented. These results, along with information gained in the RI, will be expanded and incorporated into the detailed development of site alternatives.

B.4.1 EXTENT OF CONTAMINATION

The analyses of soil samples collected from borings completed in and around the site indicate layers of relatively clean soils versus contaminated soils. A concentration profile of each boring is presented in Figures B-4-1 and B-4-2. The results of the soil boring analyses confirm that the GDA conforms to the grades as shown in a 1955 site drawing (Drawing No. D-9-368-8). The extent of the top and bottom of the disposal area is shown in Figure B-4-3. By referring to the location of each boring and the depths where contamination is indicated, a close correlation can be made of this data versus the expected waste limits. The analysis confirms that Borings B-7, B-8, and B-10 are just within the embankment of the GDA as expected from the predisposal contours. Additionally, analyses confirm that Borings B-9 and B-11 are outside of the disposal area.

Soil boring analytical results also indicate that soils beneath the approximately 40-foot-deep disposal area are slightly contaminated (TPHC < 17 ppm) until approximately 5 to 10 feet above bedrock. This bottom layer of contamination appeared in each new boring installed at the site. This contamination was not detected at Monitoring Well MW-20.

B.4.2 WASTE CHARACTERIZATION FOR INCINERATION

Review of the results of analytical testing performed on the GDA wastes reveals that the wastes are suitable for incineration. Determinations of heat of combustion resulted in three value ranges as follows:

BTUs/lb	Material Description
500 through 800	Aquifer material (slightly contaminated)
3,000 through 5,000	Material containing low percentage of waste
7,000 through 10,000	Material containing high percentage of waste

The highest range of BTUs (7,000 through 10,000) indicates that the site material is, at most, composed of 50 percent contaminants and 50 percent inerts because the expected average BTU value for pure organics common at the site is approximately 18,000 BTUs. This observation will be the basis for design volume, throughput rates, and energy requirements. Additionally, moisture contents ranged between 8 percent and 12 percent. This is an moisture contents ranged between 8 percent and 12 percent. This is an acceptable range for incineration. Also, based on the concentrations of heavy metals present in the wastes, it appears that ashes resulting from this process will not contain a significant amount of hazardous constituents. Accordingly, the ashes may be disposed as nonhazardous waste but this will need verification through the EP toxicity test.

B.4.3 GROUND WATER PUMPING SYSTEMS

Results of the pumping tests (Table B-2-2) were analyzed using the personal computer model TGUESS. Hydraulic conductivity values were obtained ranging from 7.8×10^{-3} through 1.4×10^{-1} centimeters per second (cm/s).

This information was also used to perform preliminary calculations regarding the design of recovery well systems (i.e., number and flow rate) at the site. Model PTI (Walton, 1984, Ground Water Pumping Test Models) was used to simulate a single recovery well to provide information regarding aquifer pumping rates, radius of influence, and drawdown. The THEIS well field model was used to determine well spacings and to investigate the impact of the Ohio River on the recovery well system.

Details of these calculations are presented in a memorandum contained in Section E. This memorandum provides a preliminary basis for the design of a ground water recovery system. Preliminary pumping rates range from 50 gallons per minute (gpm) to 200 gpm. The ground water recovery system design will, however, be further refined using ground water models previously used for the site.

B.4.4 DESIGN PARAMETERS

The field and laboratory tests provided a basis for several design parameters necessary for developing site alternatives. These parameters are discussed in the following paragraphs.

B.4.4.1 Type of Slurry Wall

A preliminary analysis was performed to evaluate the stability of a typical soil-bentonite slurry wall around the GDA. Details of this analysis are provided in Section F. The analysis indicates that a soil-bentonite slurry wall can be located approximately 40 feet from the railroad tracks. This conclusion is based on the assumptions and conditions stated in Section F of this appendix.

B.4.4.2 Type of Bentonite

Based on the results of filter cake testing (designed to test the compatibility of ground water with commercial bentonite), Federal 90 bentonite performed satisfactorily when evaluated for effectiveness as an impermeable barrier. Information from this testing can be used to provide data for selecting the type of bentonite prior to initiation of a long-term testing program. Long-term permeability tests will be used to evaluate the effects of the site ground water on design backfill materials as part of final detailed design.

B.4.4.3 Gas Venting

Methane monitoring field tests indicated the presence of methane at the site. Gas venting will be incorporated into the capping and landfill design options. In addition, safety precautions regarding combustible gases will be taken during any site work involving sources of ignition.

B.4.4.4 Ground Water Quality

In an effort to determine if the overall ground water quality has significantly changed since site monitoring wells were last sampled in September 1984, the 1988 results were compared to the 1984 results (Remedial Investigation, Appendix E, IT Corporation, 1986 contains the 1984 analyses). The same contaminant constituents were detected during both sampling events. Although concentrations varied over time (i.e., average ammonia and chloride concentrations are slightly higher in the 1988 results, while cyanide, benzene, and naphthalene are lower), no significant differences in contaminant concentrations were evidenced. This data will provide the basis for the design of the ground water recovery system.

TABLES

TABLE B-2-1

SUMMARY OF WELL DEVELOPMENT DETAILS
ALLIED IRONTON

	WELL NO.					
	MW-2	MW-3	MW-12	MW-14	MW-19	MW-20
Date of well development	1/15/88	1/14/88	1/25/88	2/1/88	1/30/88	1/29/88
Depth to water level in well before test (feet)[a]	42.63	43.28	43.14	27.97	40.21	40.64
Depth to base of well (feet)	87.30[b]	89.42[b]	84.10[b]	65.45	76.80	76.68
Zone 1:						
Depth to pump intake (feet)[a]	55	45	50	35	50	50
Time pumped (minutes)	6	11	10	36	38	39
Water quality at end	less "turbid" than MW-3	little silty	relatively clear	clearer	reasonable, visible silt	clear, still some silt
Zone 2:						
Depth to pump intake (feet)[a]	65	65	60	45	60	60
Time pumped (minutes)	9	14	10	39	30	40
Water quality at end	"turbid" oily little silty	little silty	clear, oily sheen	some silt	some silt	reasonably clear
Zone 3:						
Depth to pump intake (feet)[a]	75	80	70	60	70	70

See footnotes at end of table.

TABLE B-2-1
(Continued)

	WELL NO. MW-2	MW-3	MW-12	MW-14	MW-19	MW-20
Time pumped (minutes)	27	23	16	29	44	25
Water quality at end	"turbid"	some silt	relatively clear	reasonably clear	clear	little cloudy
MPC truck number	drillers waste water tank	drillers waste water tank	159	162	162	159
Depth of water in truck (feet)	-	-	-[d]	full	4.2	4.75
Volume of water removed (gallons)	~410 (est.)	440[c] 440[c] (est.)	-[d]	~2,500 (est.)	2,075	~2,900 (est.)
Total time pumped (minutes)	42	25/23	36[d]	104	112	104
Q (gallons per minute)	10	18/19	22[d]	24	18.5	~28
Surged during development(?)	yes	yes	yes	yes	yes	yes
Gate value open (turns)	1.3	2.5/2	fully open	fully open	fully open	fully open

[a]All measurements taken from top of PVC casing.

[b]Value taken from well construction diagrams.

[c]Well development occurred over two discrete time intervals.

[d]Calculation of Q for Monitoring Well MW-12 was performed taking into account the water from both the well development and pumping test.

TABLE B-2-2

SUMMARY OF SINGLE WELL PUMPING TEST DETAILS
ALLIED IRONTON

	WELL NO. MW-2	MW-3	MW-12	MW-19	MW-20
Date of pumping test	1/25/88	2/2/88	1/25/88	1/30/88	2/1/88
Depth to water level in well before test (feet)[a]	42.63	43.28	43.14	40.21	40.60
Depth to pump intake (feet)[a]	75	80	70	70	70
Duration of test (minutes)	43	39	17	100	43
Maximum drawdown (feet)	0.53	0.26/0.27	0.76	3.09	0.30
Time to maximum drawdown (minutes)	37	2/16	10	45	36
Hydraulic conductivity from TGUESS (centimeters per second)	5.3×10^{-2}	8.2×10^{-2}[c]	3.6×10^{-2}	7.8×10^{-3}	1.4×10^{-1}
Recovery	instantaneous recovery	instantaneous recovery	recovery of development monitored	Not monitored	Not monitored
Truck number	159	159	159	162	162
Depth of water in truck (feet)	2.3	2.0 (est.)	4.4[d]	4.1	2.3
Volume of water removed (gallons)	892	736	1,149[d]	2,024	1,015
Pumping rate (gallons per minute)	21	19	22[d]	20	24

See footnotes at end of table.

TABLE B-2-2
(Continued)

	WELL NO.				
	MW-2	MW-3	MW-12	MW-19	MW-20
Saturated thickness (feet)[b]	45.2	46.2	41.0	36.6	36.0

[a]All measurements taken from top of PVC casing.

[b]Saturated thickness = depth to bedrock - depth to water level.

[c]Average value.

[d]Calculation of pumping rate for Monitoring Well MW-12 was performed taking into account the water from both the well development and pumping test.

TABLE B-3-1

SOIL ANALYSIS[d]

VOLATILE HAZARDOUS SUBSTANCE LIST COMPOUNDS

PARAMETER	CAS NUMBER[a]	SAMPLE IDENTIFICATION								
		B-7, S-12	B-7, S-17	B-8, S-14	B-9, S-15	B-10, S-14	B-12, S-3	MW-19, S-10/S-11	MW-19, S-20	MW-19, ABOUT 75'
		CONCENTRATION µg/kg[b]								
Acetone[c]	67-64-1	18	<1,900	110	<45	<8,000/<8,000[d]	<47	47	<2,500	39
Benzene	71-43-2	<5.0	1,600	<5.0	25	4,400/6,100	<23	32	13,000	6.8
2-Butanone	78-93-3	<10	<1,900	<10	<45	<8,000/<8,000	<47	<28	3,100	<10
Bromoform	75-25-2	<5.0	<940	<5.0	<23	<4,000/<4,000	<23	<14	<1,300	<5.0
Carbon disulfide	75-15-0	<5.0	<940	<5.0	<23	<4,000/<4,000	<23	<14	2600	7.1
Carbon tetrachloride	56-23-5	<5.0	<940	<5.0	<23	<4,000/<4,000	<23	<14	<1,300	<5.0
Chlorobenzene	108-90-7	<5.0	<940	<5.0	<23	<4,000/<4,000	<23	<14	<1,300	<5.0
Chlorobidbromomethane	124-48-1	<5.0	<940	<5.0	<23	<4,000/<4,000	<23	<14	<1,300	<5.0
Chloroethane	75-00-3	<10	<1,900	<10	<45	<8,000/<8,000	<47	<28	<2,500	<10
2-Chloroethylvinyl ether	110-75-8	<10	<1,900	<10	<45	<8,000/<8,000	<47	<28	<2,500	<10
Chloroform	67-66-3	<5.0	<940	<5.0	<23	<4,000/<4,000	<23	<14	<1,300	<5.0
Cis-1,3-dichloropropene	10061-01-5	<5.0	<940	<5.0	<23	<4,000/<4,000	<23	<14	<1,300	<5.0
Dichlorobromomethane	75-27-4	<5.0	<940	<5.0	<23	<4,000/<4,000	<23	<14	<1,300	<5.0
1,1-Dichloroethane	75-34-3	<5.0	<940	<5.0	<23	<4,000/<4,000	<23	<14	<1,300	<5.0
1,2-Dichloroethane	107-06-2	<5.0	<940	<5.0	<23	<4,000/<4,000	<23	<14	<1,300	5.2
1,1-Dichloroethylene	75-35-4	<5.0	<940	<5.0	<23	<4,000/<4,000	<23	<14	<1,300	<5.0
1,2-Dichloropropane	78-87-5	<5.0	<940	<5.0	<23	<4,000/<4,000	<23	<14	<1,300	<5.0
Ethylbenzene	100-41-4	<5.0	19,000	<5.0	380	8,200/16,000	130	<14	7,200	<5.0
2-Hexanone	591-78-6	<10	<1,900	<10	<45	<8,000/<8,000	<47	<28	<2,500	<10
Methyl bromide	74-83-9	<10	<1,900	<10	<45	<8,000/<8,000	<47	<28	<2,500	<10

See footnotes at end of table.

TABLE B-3-1
(Continued)

PARAMETER	CAS NUMBER[a]	SAMPLE IDENTIFICATION								
		B-7, S-12	B-7, S-17	B-8, S-14	B-9, S-15	B-10, S-14	B-12, S-3	MW-19, S-10/S-11	MW-19, S-20	MW-19, ABOUT 75'
		CONCENTRATION µg/kg[b]								
Methyl chloride	74-87-3	<10	<1,900	<10	<45	<8,000/<8,000	<47	<28	<2,500	<10
Methylene chloride[c]	74-09-2	<5.0	<940	<5.5	<23	<4,000/<4,000	<23	<14	<1,300	14
4-Methyl-2-pentanone	108-10-1	<10	<1,900	<10	<45	<8,000/<8,000	<47	<28	<2,500	<10
Styrene	100-42-5	<5.0	5,800	<5.0	<23	<4,000/<4,000	<23	<14	<1,300	<5.0
1,1,2,2-Tetrachloroethane	79-34-5	<5.0	<940	<5.0	<23	<4,000/<4,000	<23	<14	<1,300	<5.0
Tetrachloroethylene	127-18-4	<5.0	<940	<5.0	<23	<4,000/<4,000	<23	<14	<1,300	<5.0
Toluene	108-88-3	<5.0	16,000	<5.0	26	9,500/9,500	<23	64	18,000	<5.0
trans-1,2-Dichloroethylene	156-60-5	<5.0	<940	<5.0	<23	<4,000/<4,000	<23	<14	1,600	<5.0
trans-1,3-Dichloropropene	10061-02-6	<5.0	<940	<5.0	<23	<4,000/<4,000	<23	<14	<1,300	<5.0
1,1,1-Trichloroethane	71-55-6	<5.0	<940	<5.0	<23	<4,000/<4,000	<23	<14	<1,300	<5.0
1,1,2-Trichloroethane	79-00-5	<5.0	<940	<5.0	<23	<4,000/<4,000	<23	<14	<1,300	<5.0
Trichloroethylene	79-01-6	<5.0	<940	<5.0	<23	<4,000/<4,000	<23	<14	5,600	<5.0
Vinyl acetate	108-05-4	<10	<1,900	<10	<45	<8,000/<8,000	<47	<28	<2,500	<10
Vinyl chloride	75-01-4	<10	<1,900	<10	<45	<8,000/<8,000	<47	<28	<2,500	<10
Total xylenes	95-47-6	<5.0	33,000	8.2	230	16,000/21,000	24	28	20,000	<5.0

[a]The numbers presented in this column are the Chemical Abstracts Service (CAS) numbers used for cataloging the indicated compounds in the Chemical Abstracts Index.

[b]µg/kg = micrograms per kilogram or parts per billion.

[c]The compound is a common laboratory contaminant. Although the method blank has been subtracted, values just above the detection limit should be considered suspect.

[d]The sample was prepared and analyzed in duplicate.

TABLE B-3-2

SOIL ANALYSIS[d]
SEMIVOLATILE HAZARDOUS SUBSTANCE LIST COMPOUNDS

PARAMETER	CAS NUMBER[a]	SAMPLE IDENTIFICATION								
		B-7, S-12	B-7, S-17	B-8, S-14	B-9, S-15	B-10, S-14	B-12, S-3	MW-19, S-10/S-11	MW-19, S-20	MW-19, ABOUT 75'
		CONCENTRATION µg/kg[b]								
Acenaphthene	83-32-9	<390	<81,000	<8,300	130,000	340,000	820,000	56,000	<7,200,000	<660
Acenaphthylene	208-96-8	<390	<81,000	<8,300	<21,000	<230,000	<440,000	<22,000	<7,200,000	<660
Anthracene	120-12-7	<390	110,000	32,000	38,000	<230,000	1,200,000	520,000	8,500,000	<660
Benzo(a)anthracene	56-55-3	<390	85,000	<8,300	40,000	<230,000	<440,000	150,000	<7,200,000	<660
Benzo(a)pyrene	50-32-8	<390	<81,000	<8,300	23,000	<230,000	4,400,000	140,000	<7,200,000	<660
3,4-Benzofluoranthene	205-99-2	<390	<81,000	<8,300	21,000	<230,000	4,500,000	110,000	<7,200,000	<660
Benzo(g,h,i)perylene	191-24-2	<390	<81,000	<8,300	<21,000	<230,000	2,800,000	85,000	<7,200,000	<660
Benzoic acid	65-85-0	<1,900	<400,000	<40,000	<100,000	<1,100,000	<2,100,000	<110,000	<35,000,000	<3,200
Benzo(k)fluoranthene	207-08-9	<390	<81,000	<8,300	23,000	<230,000	3,300,000	<22,000	<7,200,000	<660
Benzyl alcohol	100-51-6	<390	<81,000	<8,300	<21,000	<230,000	<440,0000	<22,000	<7,200,000	<660
Bis(2-chloroethoxy)methane	111-91-1	<390	<81,000	<8,300	<21,000	<230,000	<440,000	<22,000	<7,200,000	<660
Bis(2-chloroethyl)ether	111-44-4	<390	<81,000	<8,300	<21,000	<230,000	<440,000	<22,000	<7,200,000	<660
Bis(2-chloroisopropyl)ether	39638-32-9	<390	<81,000	<8,300	<21,000	<230,000	<440,000	<22,000	<7,200,000	<660
Bis(2-ethylhexyl)phthalate	117-81-7	<390	<81,000	<8,300	<21,000	<230,000	<440,000	<22,000	<7,200,000	<660
4-Bromophenyl phenyl ether	101-55-3	<390	<81,000	<8,300	<21,000	<230,000	<440,000	<22,000	<7,200,000	<660
Butyl benzyl phthalate	85-68-7	<390	<81,000	<8,300	<21,000	<230,000	<440,000	<22,000	<7,200,000	<660

See footnotes at end of table.

TABLE B-3-2
(Continued)

PARAMETER	CAS NUMBER[a]	SAMPLE IDENTIFICATION								
		B-7, S-12	B-7, S-17	B-8, S-14	B-9, S-15	B-10, S-14	B-12, S-3	MW-19, S-10/S-11	MW-19, S-20	MW-19, ABOUT 75'
		CONCENTRATION µg/kg[b]								
4-Chloroaniline	106-47-8	<390	<81,000	<8,300	<21,000	<230,000	<440,000	<22,000	<7,200,000	<660
2-Chloronaphthalene	92-58-7	<390	<81,000	<8,300	<21,000	<230,000	<440,000	<22,000	<7,200,000	<660
2-Chlorophenol	95-57-8	<390	<81,000	<8,300	<21,000	<230,000	<440,000	<22,000	<7,200,000	<660
4-Chlorophenyl phenyl ether	7005-72-3	<390	<81,000	<8,300	<21,000	<230,000	<440,000	<22,000	<7,200,000	<660
Chrysene	218-01-9	<390	<81,000	<8,300	25,000	<230,000	4,200,000	140,000	<7,200,000	<660
Dibenzo(a,h)anthracene	53-70-3	<390	<81,000	<8,300	<21,000	<230,000	<440,000	34,000	<7,200,000	<660
Dibenzofuran	132-64-9	<390	250,000	21,000	80,000	240,000	<440,000	31,000	<7,200,000	<660
1,2-Dichlorobenzene	95-50-1	<390	<81,000	<8,300	<21,000	<230,000	<440,000	<22,000	<7,200,000	<660
1,3-Dichlorobenzene	541-73-1	<390	<81,000	<8,300	<21,000	<230,000	<440,000	<22,000	<7,200,000	<660
1,4-Dichlorobenzene	106-46-7	<390	<81,000	<8,300	<21,000	<230,000	<440,000	<22,000	<7,200,000	<660
3,3'-Dichlorobenzidine	91-94-1	<780	<160,000	<17,000	<42,000	<450,000	<880,000	<44,000	<1,400,000	<1,300
2,4-Dichlorophenol	120-83-2	<390	<81,000	<8,300	<21,000	<230,000	<440,000	<22,000	<7,200,000	<660
Diethyl phthalate	84-66-2	<390	<81,000	<8,300	<21,000	<230,000	<440,000	<22,000	<7,200,000	<660
2,4-Dimethylphenol	105-67-9	<390	<81,000	<8,300	<21,000	<230,000	<440,000	<22,000	<7,200,000	<660
4,6-Dinitro-o-cresol	534-52-1	<1,900	<400,000	<40,000	<100,000	<1,100,000	<2,100,000	<110,000	<35,000,000	<3,200
2,4-Dinitrophenol	51-28-5	<1,900	<400,000	<40,000	<100,000	<1,100,000	<2,100,000	<110,000	<35,000,000	<3,200
Dimethyl phthalate	131-11-3	<390	<81,000	<8,300	<21,000	<230,000	<440,000	<22,000	<7,200,000	<660
Di-n-butyl phthalate	84-74-2	<390	<81,000	<8,300	<21,000	<230,000	<440,000	<22,000	<7,200,000	<660
2,4-Dinitrotoluene	121-14-2	<390	<81,000	<8,300	<21,000	<230,000	<440,000	<22,000	<7,200,000	<660

See footnotes at end of table.

TABLE B-3-2
(Continued)

PARAMETER	CAS NUMBER[a]	B-7, S-12	B-7, S-17	B-8, S-14	B-9, S-15	B-10, S-14	B-12, S-3	MW-19, S-10/S-11	MW-19, S-20	MW-19, ABOUT 75'
		SAMPLE IDENTIFICATION								
		CONCENTRATION µg/kg[b]								
2,6-Dinitrotoluene	606-20-2	<390	<81,000	<8,300	<21,000	<230,000	<440,000	<22,000	<7,200,000	<660
Di-n-octyl phthalate	117-84-0	<390	<81,000	<8,300	<21,000	<230,000	<440,000	<22,000	<7,200,000	<660
Fluoranthene	206-44-0	<390	510,000	36,000	190,000	420,000	8,100,000	290,000	17,000,000	<660
Fluorene	86-73-7	<390	240,000	20,000	82,000	<230,000	<440,000	42,000	7,400,000	<660
Hexachlorobenzene	118-71-1	<390	<81,000	<8,300	<21,000	<230,000	<440,000	<22,000	<7,200,000	<660
Hexachlorobutadiene	87-68-3	<390	<81,000	<8,300	<21,000	<230,000	<440,000	<22,000	<7,200,000	<660
Hexachlorocyclopentadiene	77-47-4	<390	<81,000	<8,300	<21,000	<230,000	<440,000	<22,000	<7,200,000	<660
Hexachloroethane	67-72-1	<390	<81,000	<8,300	<21,000	<230,000	<440,000	<22,000	<7,200,000	<660
Indeno(1,2,3-cd)pyrene	193-39-5	<390	<81,000	<8,300	<21,000	<230,000	2,600,000	82,000	<7,200,000	<660
Isophorone	78-59-1	<390	<81,000	<8,300	<21,000	<230,000	<440,000	<22,000	<7,200,000	<660
2-Methylnaphthalene	91-57-6	<390	390,000	32,000	81,000	300,000	<440,000	39,000	<7,200,000	<660
2-Methylphenol	95-48-7	<390	<81,000	<8,300	<21,000	<230,000	<440,000	<22,000	<7,200,000	<660
4-Methylphenol	106-44-5	<390	<81,000	<8,300	<21,000	<230,000	<440,000	<22,000	<7,200,000	<660
Naphthalene	91-20-3	<390	1,100,000	60,000	410,000	1,600,000	<440,000	570,000	28,000,000	<660
2-Nitroaniline	88-74-4	<1,900	<400,000	<40,000	<100,000	<1,100,000	<2,100,000	<110,000	<35,000,000	<3,200
3-Nitroaniline	99-09-2	<1,900	<400,000	<40,000	<100,000	<1,100,000	<2,100,000	<110,000	<35,000,000	<3,200
4-Nitroaniline	100-01-6	<1,900	<400,000	<40,000	<100,000	<1,100,000	<2,100,000	<110,000	<35,000,000	<3,200
Nitrobenzene	98-95-3	<390	<81,000	<8,300	<21,000	<230,000	<440,000	<22,000	<7,200,000	<660

See footnotes at end of table.

TABLE B-3-2
(Continued)

PARAMETER	CAS NUMBER[a]	SAMPLE IDENTIFICATION B-7, S-12	B-7, S-17	B-8, S-14	B-9, S-15	B-10, S-14	B-12, S-3	MW-19, S-10/S-11	MW-19, S-20[d]	MW-19, ABOUT 75'
		CONCENTRATION µg/kg[b]								
2-Nitrophenol	88-75-5	<390	<81,000	<8,300	<21,000	<230,000	<440,000	<22,000	<7,200,000	<660
4-Nitrophenol	100-02-7	<1,900	<400,000	<40,000	<100,000	<1,100,000	<2,100,000	<110,000	<35,000,000	<3,200
N-Nitrosodi-n-propylamine	621-64-7	<390	<81,000	<8,300	<21,000	<230,000	<440,000	<22,000	<7,200,000	<660
N-Nitrosodiphenylamine (Diphenylamine)[c]	86-30-6	<390	<81,000	<8,300	<21,000	<230,000	<440,000	<22,000	<7,200,000	<660
p-Chloro-m-cresol	59-50-7	<390	<81,000	<8,300	<21,000	<230,000	<440,000	<22,000	<7,200,000	<660
Pentachlorophenol	87-86-5	<1,900	<400,000	<40,000	<100,000	<1,100,000	<2,100,000	<110,000	<35,000,000	<3,200
Phenanthrene	85-01-8	<390	800,000	70,000	320,000	960,000	3,900,000	250,000	27,000,000	<660
Phenol	108-95-2	<390	<81,000	<8,300	<21,000	<230,000	<440,000	<22,000	<7,200,000	<660
Pyrene	129-00-0	<390	400,000	27,000	170,000	540,000	5,500,000	330,000	14,000,000	<660
1,2,4-Trichlorobenzene	120-82-1	<390	<81,000	<8,300	<21,000	<230,000	<440,000	<22,000	<7,200,000	<660
2,4,5-Trichlorophenol	95-95-4	<1,900	<400,000	<40,000	<100,000	<1,100,000	<2,100,000	<110,000	<35,000,000	<3,200
2,4,6-Trichlorophenol	88-06-2	<390	<81,000	<8,300	<21,000	<230,000	<440,000	<22,000	<7,200,000	<660

[a]The numbers presented in this column are the Chemical Abstracts Service (CAS) numbers used for cataloging the indicated compounds in the Chemical Abstracts Index.

[b]µg/kg = micrograms per kilogram or parts per billion.

[c]Detected as compound in parentheses.

[d]Compounds listed as "<" were not detected at or above the indicated detection limits. These compounds may or may not be present and if present concentrations below the detection limit are not known.

TABLE B-3-3

SOIL ANALYSIS
TOTAL METALS

SAMPLE IDENTIFICATION BORING NO.	SAMPLE NO.	PARAMETER	CONCENTRATION (mg/kg)[a]
MW-19	S-10/S-11 Composite	Aluminum	4,200/3,600[b]
		Antimony	<6/<6
		Arsenic	4.0/2.9
		Barium	67/61
		Beryllium	<0.06/<0.6
		Cadmium	<0.6/<0.6
		Calcium	4,800/5,000
		Chromium	9/8
		Cobalt	3/2
		Copper	12/12
		Iron	11,000/10,000
		Lead	25/33
		Magnesium	1,100/1,000
		Manganese	190/200
		Mercury	0.1/0.2
		Nickel	9/9
		Potassium	520/460
		Selenium	<0.6/<0.6
		Silver	<1/<1
		Sodium	320/370
		Thallium	<0.6/<0.6
		Vanadium	120/130
		Zinc	67/70

[a]mg/kg = milligrams per kilogram or parts per million.

[b]The sample was prepared and analyzed in duplicate.

TABLE B-3-4

SOIL ANALYSIS
TOTAL PETROLEUM HYDROCARBONS

SAMPLE IDENTIFICATION		PARAMETER TOTAL PETROLEUM HYDROCARBONS
BORING NO.	SAMPLE NO.	(mg/kg)[a]
B-7	S-2	<17/<17[b]
B-7	S-3	380
B-7	S-5	<17
B-7	S-7	<17
B-7	S-9	<17
B-7	S-11	<16
B-7	S-12	<18
B-7	S-16	27/33
B-7	S-17	250
B-8	S-1/S-2 Composite	240
B-8	S-3	400
B-8	S-6	<17
B-8	S-8	54
B-8	S-10	<17/<17
B-8	S-12	<16
B-8	S-14	130
B-9	S-2	<16
B-9	S-5	<16
B-9	S-7	<17
B-9	S-10	<16/<16
B-9	S-12	<16/<17
B-9	S-14	530
B-9	S-15	120
B-10	S-2	320
B-10	S-4	170
B-10	S-6	250
B-10	S-8	<17
B-10	S-9	<17
B-10	S-12	<17
B-10	S-14	200
B-10	S-20	33
B-11	S-1/S-2 Composite	<17
B-11	S-5/S-6 Composite	<16
B-11	S-8	<17
B-11	S-10	<17
B-11	S-12	<17
B-11	S-16	32/26

See footnotes at end of table.

TABLE B-3-4
(Continued)

SAMPLE IDENTIFICATION		PARAMETER TOTAL PETROLEUM HYDROCARBONS (mg/kg)[a]
BORING NO.	SAMPLE NO.	
B-12	S-2	700
B-12	S-3	200
B-12	S-4	6,700
B-12	S-6	66
B-12	S-7	20
MW-19	S-1/S-2 Composite	620
MW-19	S-4/S-5/S-6 Composite	380
MW-19	S-7/S-8/S-9 Composite	360
MW-19	S-10/S-11 Composite	310
MW-19	S-12/S-13/S-14 Composite	1,800
MW-19	About 58' Composite	36
MW-20	S-2/S-3/S-4 Composite	<17
MW-20	S-15/S-16 Composite	<17/17[b]

[a]mg/kg = milligrams per kilogram or parts per million.

[b]The sample was prepared and analyzed in duplicate.

TABLE B-3-5

SOIL ANALYSIS
OIL AND GREASE

SAMPLE IDENTIFICATION		PARAMETER
BORING NO.	SAMPLE NO.	OIL AND GREASE (mg/kg)[a]
B-7	S-12	22
B-8	S-14	140
B-9	S-15	210/210[b]
MW-19	S-10/S-11 Composite	400

[a]mg/kg = milligrams per kilogram or parts per million.

[b]The sample was prepared and analyzed in duplicate.

TABLE B-3-6

SOIL ANALYSIS
TOTAL ORGANIC CARBON

SAMPLE IDENTIFICATION BORING NO.	SAMPLE NO.	PARAMETER TOTAL ORGANIC CARBON[a] (mg/kg)[b]
B-7	S-12	270
B-8	S-14	530
B-9	S-15	2,350
MW-19	S-10/S-11 Composite	48,000

[a]The results represent the average of at least two values.

[b]mg/kg = milligrams per kilogram or parts per million.

TABLE B-3-7

SOIL ANALYSIS
HEAT OF COMBUSTION

SAMPLE IDENTIFICATION		HEAT OF COMBUSTION[a] (BTU/LB[b])
BORING NO.	SAMPLE NO.	
B-7	S-12	800
B-12	S-3	9,500/9,400[c]
B-12	S-5	4,700
MW-19	S-14	3,100
MW-19	S-20	7,600
MW-19	about 75'	510/550

[a]No correction for the formation of sulfuric acid was applied to the results.

[b]BTU/LB = British Thermal units per pound.

[c]The sample was prepared and analyzed in duplicate.

TABLE B-3-8

GEOTECHNICAL ANALYSES
ONE-POINT PROCTOR[a]

SAMPLE IDENTIFICATION	DEPTH (feet)	WATER CONTENT (%)	WET DENSITY (pcf)	DRY DENSITY (pcf)
MW-19, S-9	6 to 8	11.3	109.8	98.7
MW-19, S-11	20 to 22	28	88.4	69.1
MW-19, S-17	32 to 34	7.9	76.3	70.7

[a]Test was run at natural water content and standard effort.

TABLE B-3-9

GROUND WATER ANALYSIS
INDICATOR PARAMETERS

SAMPLE IDENTIFICATION	PARAMETERS AMMONIA (mg/l)[a]	CYANIDE (mg/l)	PHENOLICS (mg/l)	BENZENE CAS NO. 71-43-2[b] (ug/l)	NAPHTHALENE CAS NO. 91-20-3 (ug/l)
MW-2K	2.0	0.14	0.032	36/48	340
MW-2L	5.2	1.1	0.052/0.049[d]	45	1,600
MW-2M	26.0	0.16	1.0	420	4,300
MW-3K[f]	0.13	<0.02	<0.005/<0.01	<12	<10
MW-3L[f]	0.09	0.09	<0.005	<25	<10
MW-3M[f]	28.0	0.44/0.24/0.26[e]	0.018	120	<10
MW-3K	0.63	<0.02	<0.005	<12	24
MW-3L	4.9	0.03	<0.005	13	28
MW-3M	51.0	0.17	0.023	130	<10
MW-12K	8.5/8.5	<0.02	0.19	400	1,600
MW-12L	11.0	<0.02	0.73	75	2,600
MW-12M	16.0	<0.02	1.8	2,600	5,000
MW-14K	<0.05	<0.02/<0.04	<0.005	<12	33
MW-14L	<0.05	<0.02	0.008	<12	12
MW-14M	0.06	<0.02	0.011	<12	14
MW-19K	22.0	0.02/0.02	3.5	170	600
MW-19L	18.0	<0.02	1.4	390	200
MW-19M	16.0	<0.02	1.4	240	250

See footnotes at end of table.

TABLE B-3-9
(Continued)

SAMPLE IDENTIFICATION	AMMONIA (mg/l)[a]	CYANIDE (mg/l)	PHENOLICS (mg/l)	BENZENE CAS NO. 71-43-2[b] (ug/l)	NAPHTHALENE CAS NO. 91-20-3 (ug/l)
MW-20K	0.43	<0.02	<0.005/<0.01	<12	40
MW-20L	1.2	<0.02	<0.005	<12	24
MW-20M	1.4	0.13	<0.005	<12	25
MW-21K	16.0	0.02	3.9	260	360
MW-21L	14.0	<0.02	1.6	390	220
MW-21M	22.0	<0.02	2.0	290	220
MW-22K[g]	<0.05	<0.02	0.041	43	220

[a]mg/l = milligrams per liter or parts per million.

[b]CAS No. is the Chemical Abstracts Service number used for cataloging the indicated compound in the Chemical Abstracts Index.

[c]ug/l = micrograms per liter or parts per billion.

[d]The sample was analyzed in duplicate.

[e]The sample contained a sediment which made it impossible to obtain a homogeneous aliquot; therefore, the sample was analyzed in triplicate.

[f]Sampled before purging.

[g]Field blank (proceeding decontamination of sample pump, deionized water) shows elevated levels of benzene and naphthalene. This indicates that the stipulated cleaning procedure was adequate to cleanse the constituents like ammonia and phenolics, somewhat adequate for benzene, but inadequate for naphthalene. Subsequent to MW-22, Well MW-3 was sampled and the naphthalene levels in this well show much less than MW-22 (~25 high as compared to 200 high). The purging of Well MW-3 was thus adequate to cleanse the sample. In summary, with the exception of the field blank sample, all other results are representative.

TABLE B-3-10

GROUND WATER ANALYSIS
TOTAL METALS

PARAMETER	UNITS[a]	SAMPLE IDENTIFICATION MW-19KLM[b]
Arsenic	mg/ℓ	0.067
Barium	mg/ℓ	0.26
Cadmium	mg/ℓ	<0.005
Chromium	mg/ℓ	<0.01
Lead	mg/ℓ	<0.05
Mercury	mg/ℓ	<0.0002/<0.0002[c]
Selenium	mg/ℓ	<0.005
Silver	mg/ℓ	<0.01

[a]mg/ℓ = milligrams per liter or parts per million.
[b]KLM = composite sample from Monitoring Well MW-19.
[c]The sample was prepared and analyzed in duplicate.

TABLE B-3-11

GROUND WATER ANALYSIS
RADIOLOGICAL TESTING

SAMPLE IDENTIFICATION	GROSS ALPHA pCi/ℓ[a]	PARAMETER GROSS BETA pCi/ℓ	RADIUM-226 pCi/ℓ	RADIUM-228 pCi/ℓ
MW-19KLM[b]	<3	51 +/-19	2.7 +/-1.1	<2.0
MW-21KLM[c]	4 +/-3	39 +/-15	2.3 +/-0.9	<2.0

[a]pCi/ℓ = pico curie per liter.

[b]KLM = composite ground water sample.

[c]MW-21KLM is a field duplicate of MW-19KLM.

TABLE B-3-12

WATER ANALYSIS SUMMARY pH

SAMPLE IDENTIFICATION	PARAMETER (pH)
MW-2K	7.0
MW-2L	6.9
MW-2M	7.3
MW-3K[b]	6.6/6.6[a]
MW-3L[b]	6.7
MW-3M[b]	7.6
MW-3K	6.8
MW-3L	6.8
MW-3M	7.3
MW-12K	6.7
MW-12L	6.8
MW-12M	6.9
MW-14K	6.9
MW-14L	6.9
MW-14M	6.9
MW-20K	6.8
MW-20L	7.0
MW-20M	7.3/7.3
MW-19K	7.2/7.2
MW-19L	7.0
MW-19M	7.0
MW-21K	7.2
MW-21L	7.3
MW-21M	7.2
MW-22K	6.0

[a]The indicated samples were prepared and analyzed in duplicate.

[b]The sample was collected before purging.

TABLE B-3-13

GROUND WATER ANALYSIS
VOLATILE HAZARDOUS SUBSTANCE LIST COMPOUNDS

PARAMETER	CAS NUMBER[a]	SAMPLE IDENTIFICATION MW-19K	MW-19L	MW-19M	MW-21M
		CONCENTRATION μg/ℓ[b]			
Acetone[c]	67-64-1	<10	85	28	30
Benzene	71-43-2	170	390	240	290
2-Butanone	78-93-3	<10	<25	<25	<25
Bromoform	75-25-2	<5.0	<12	<12	<12
Carbon disulfide	75-15-2	<5.0	<12	<12	<12
Carbon tetrachloride	56-23-5	<5.0	<12	<12	<12
Chlorobenzene	108-90-7	<5.0	<12	<12	<12
Chlorodibromomethane	124-48-1	<5.0	<12	<12	<12
Chloroethane	75-00-3	<10	<25	<25	<25
2-Chloroethylvinyl ether	110-75-8	<10	<25	<25	<25
Chloroform	67-66-3	<5.0	<12	<12	<12
Cis-1,3-dichloropropene	10061-01-5	<5.0	<12	<12	<12
Dichlorobromomethane	75-27-4	<5.0	<12	<12	<12
1,1-Dichloroethane	75-34-3	<5.0	<12	<12	<12
1,2-Dichloroethane	107-06-2	<5.0	<12	<12	<12
1,1-Dichloroethylene	75-35-4	<5.0	<12	<12	<12
1,2-Dichloropropane	78-87-5	<5.0	<12	<12	<12
Ethylbenzene	100-41-4	18	21	<12	<12
2-Hexanone	591-78-6	<10	<25	<25	<25
Methyl bromide	74-83-9	<10	<25	<25	<25
Methyl chloride	74-87-3	<10	<25	<25	<25
Methylene chloride	75-09-2	<5.0	<12	<12	<12
4-Methyl-2-pentanone	108-10-1	<10	<25	<25	<25
Styrene	100-42-5	<5.0	<12	<12	<12
1,1,2,2-Tetrachloroethane	79-34-5	<5.0	<12	<12	<12
Tetrachloroethylene	127-18-4	<5.0	<12	<12	<12
Toluene	108-88-3	29	13	<12	<12
trans-1,2-Dichloroethylene	156-60-5	25	<12	<12	<12
trans-1,3-Dichloropropene	10061-02-6	<5.0	<12	<12	<12
1,1,1-Trichloroethane	71-55-6	<5.0	<12	<12	<12
1,1,2-Trichloroethane	79-00-5	<5.0	<12	<12	<12
Trichloroethylene	79-01-6	76	29	24	29
Vinyl acetate	108-05-4	<10	<25	<25	<25
Vinyl chloride	75-01-4	<10	<25	<25	<25
Total xylenes	95-47-6	38	40	21	27

[a]The numbers presented in this column are the Chemical Abstracts Service (CAS) numbers used for cataloging the indicated compounds in the Chemical Abstracts Index.

[b]μg/ℓ = micrograms per liter or parts per billion.

[c]The compound is a common laboratory contaminant. Although the method blank has been subtracted, values just above the detection limit should be considered suspect.

TABLE B-3-14

GROUND WATER ANALYSIS
BASE NEUTRAL HAZARDOUS SUBSTANCE LIST COMPOUNDS

PARAMETER	CAS NUMBER[a]	MW-19K	MW-19L	MW-19M	MW-21M
		SAMPLE IDENTIFICATION			
		CONCENTRATION µg/ℓ[b]			
Acenaphthene	83-32-9	32	29	16	12
Acenaphthylene	208-96-8	<10	<10	<10	<10
Anthracene	120-12-7	10	<10	<10	<10
Benzo(a)anthracene	56-55-3	<10	<10	<10	<10
Benzo(a)pyrene	50-32-8	<10	<10	<10	<10
3,4-Benzofluoranthene	205-99-2	<10	<10	<10	<10
Benzo(g,h,i)perylene	191-24-2	<10	<10	<10	<10
Benzo(k)fluoranthene	207-08-9	<10	<10	<10	<10
Bis(2-chloroethoxy)methane	111-91-1	<10	<10	<10	<10
Bis(2-chloroethyl)ether	111-44-4	<10	<10	<10	<10
Bis(2-chloroisopropyl)ether	39638-32-9	<10	<10	<10	<10
Bis(2-ethylhexyl)phthalate	117-81-7	<10	<10	<10	<10
4-Bromophenyl phenyl ether	101-55-3	<10	<10	<10	<10
Butyl benzyl phthalate	85-68-7	<10	<10	<10	<10
4-Chloroaniline	106-47-8	<10	<10	<10	<10
2-Chloronaphthalene	91-58-7	<10	<10	<10	<10
4-Chlorophenyl phenyl ether	7005-72-3	<10	<10	<10	<10
Chrysene	218-01-9	<10	<10	<10	<10
Dibenzo(a,h)anthracene	53-70-3	<10	<10	<10	<10
Dibenzofuran	132-64-9	22	13	11	<10
1,2-Dichlorobenzene	95-50-1	<10	<10	<10	<10
1,3-Dichlorobenzene	541-73-1	<10	<10	<10	<10
1,4-Dichlorobenzene	106-46-7	<10	<10	<10	<10
3,3'-Dichlorobenzidine	91-94-1	<20	<20	<20	<10
Diethyl phthalate	84-66-2	<10	<10	<10	<10
Dimethyl phthalate	131-11-3	<10	<10	<10	<10
Di-n-butyl phthalate	84-74-2	<10	<10	<10	<10
2,4-Dinitrotoluene	121-14-2	<10	<10	<10	<10
2,6-Dinitrotoluene	606-20-2	<10	<10	<10	<10
Di-n-octyl phthalate	117-84-0	<10	<10	<10	<10
Fluoranthene	206-44-0	<10	<10	<10	<10
Fluorene	86-73-7	27	15	13	<10

See footnotes at end of table.

TABLE B-3-14
(Continued)

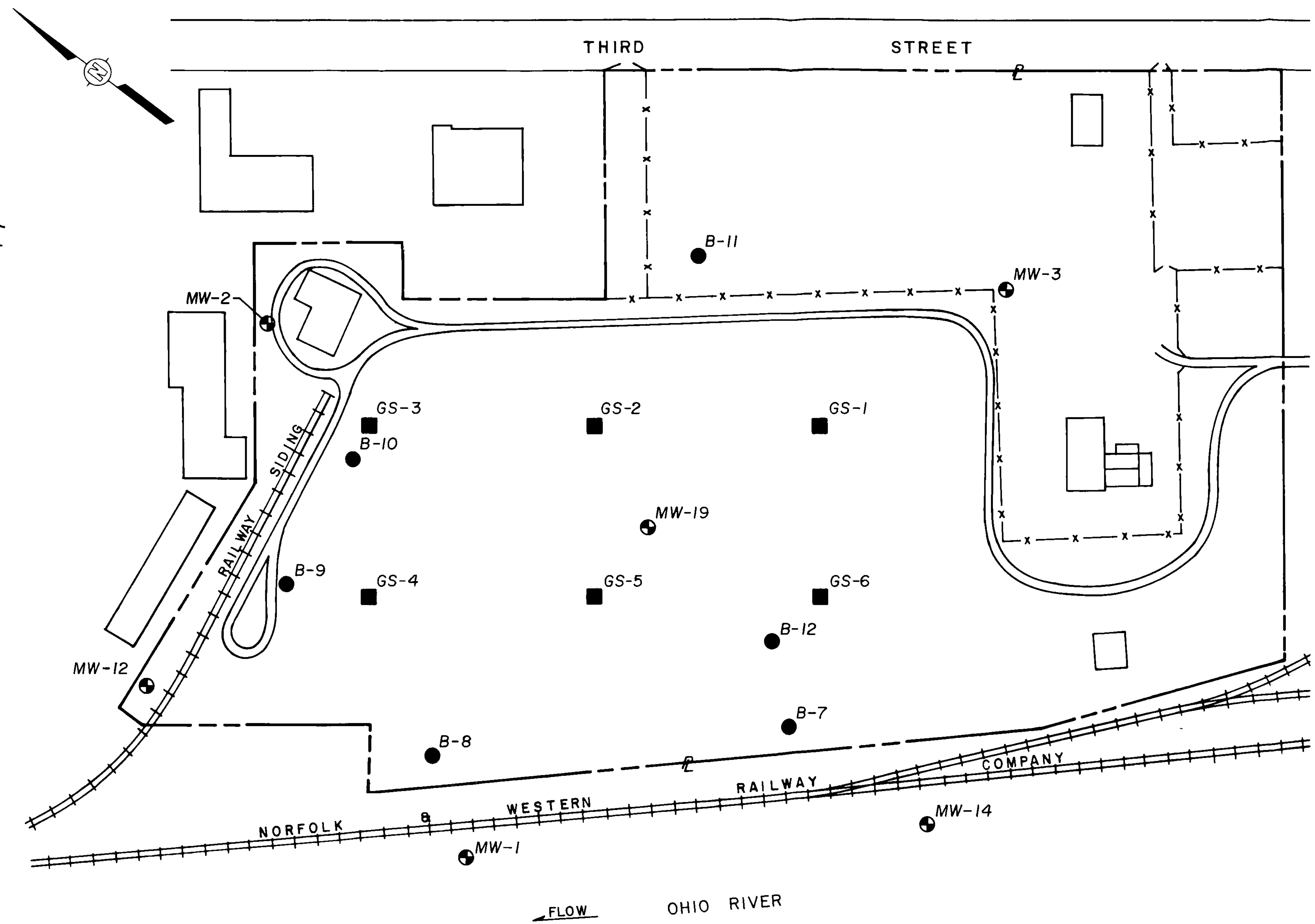
PARAMETER	CAS NUMBER[a]	MW-19K	MW-19L	MW-19M	MW-21M
		SAMPLE IDENTIFICATION			
			CONCENTRATION µg/ℓ[b]		
Hexachlorobenzene	118-71-1	<10	<10	<10	<10
Hexachlorobutadiene	87-68-3	<10	<10	<10	<10
Hexachlorocyclopentadiene	77-47-4	<10	<10	<10	<10
Hexachloroethane	67-72-1	<10	<10	<10	<10
Indeno(1,2,3-cd)pyrene	193-39-3	<10	<10	<10	<10
Isophorone	78-59-1	<10	<10	<10	<10
2-Methylnaphthalene	91-57-6	54	43	28	19
Naphthalene	91-20-3	600	200	250	220
2-Nitroaniline	88-74-4	<50	<50	<50	<50
3-Nitroaniline	99-09-2	<50	<50	<50	<50
4-Nitroaniline	100-01-6	<50	<50	<50	<50
Nitrobenzene	98-95-3	<10	<10	<10	<10
N-Nitrosodi-n-propylamine	621-64-7	<10	<10	<10	20
N-Nitrosodiphenylamine (Diphenylamine)[c]	86-30-60	14	<10	44	<10
Phenanthrene	85-01-8	37	22	18	16
Pyrene	129-00-0	<10	<10	<10	<10
1,2,4-Trichlorobenzene	120-82-1	<10	<10	<10	<10

[a]The numbers presented in this column are the Chemical Abstracts Service (CAS) numbers used for cataloging the indicated compounds in the Chemical Abstracts Index.

[b]µg/ℓ = micrograms per liter or parts per billion.

[c]Detected as compound in parentheses.

FIGURES



NOTE:

MW-20 IS LOCATED NORTHWEST OF MAPPING AREA

LEGEND

B-7 BORING LOCATION

MW-3 MONITORING WELL LOCATION

GS-1 SOIL GAS SURVEY POINT

SCALE

0 100 200 FEET

FIGURE B-2-1
LOCATION OF BORINGS, MONITORING WELLS AND SOIL GAS SURVEY POINTS

PREPARED FOR

ALLIED-SIGNAL INC.
MORRISTOWN, NEW JERSEY

INTERNATIONAL TECHNOLOGY CORPORATION

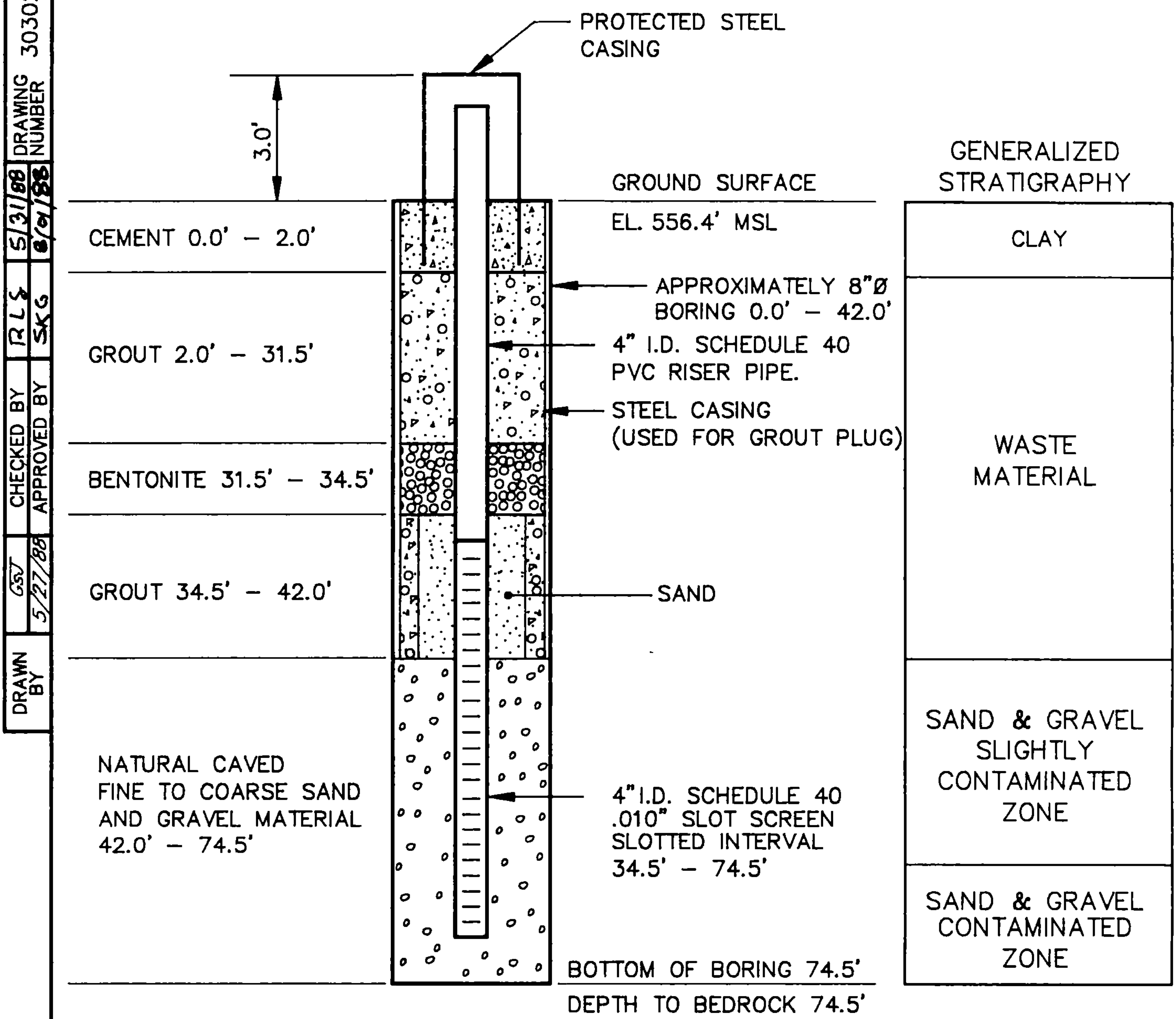
REFERENCE:

ALLIED CORPORATION DRAWINGS, TITLED "LAND ACQUISITION LAYOUT," DWG. NO D-9-368-8, "DATED: 5-11-55, SCALE: 1"=50', AND "GOLDCAMP DISPOSAL SITE", DWG. NO. ICP-2, DATED: 2-13-87, SCALE: 1"=40'.

Do Not Scale This Drawing

DRAWN BY	B. KUMPF	4 APR 88
CHECKED BY	RLG	5/21/88
APPROVED BY	SKG	8/01/88

DRAWING NUMBER 303024-B4



NOTES:

1. ELEVATION OF TOP OF RISER PIPE: APPROX. 558.3 MSL.
2. ELEVATION OF GROUND WATER ON 2/1/88 IS 518.80 MSL.
3. DATUM DEPTH IS GROUND SURFACE.
4. DRAWING "NOT TO SCALE".
5. FOR DETAILED STRATIGRAPHIC DESCRIPTION, SEE BORING LOG MW-19.

FIGURE B-2-2

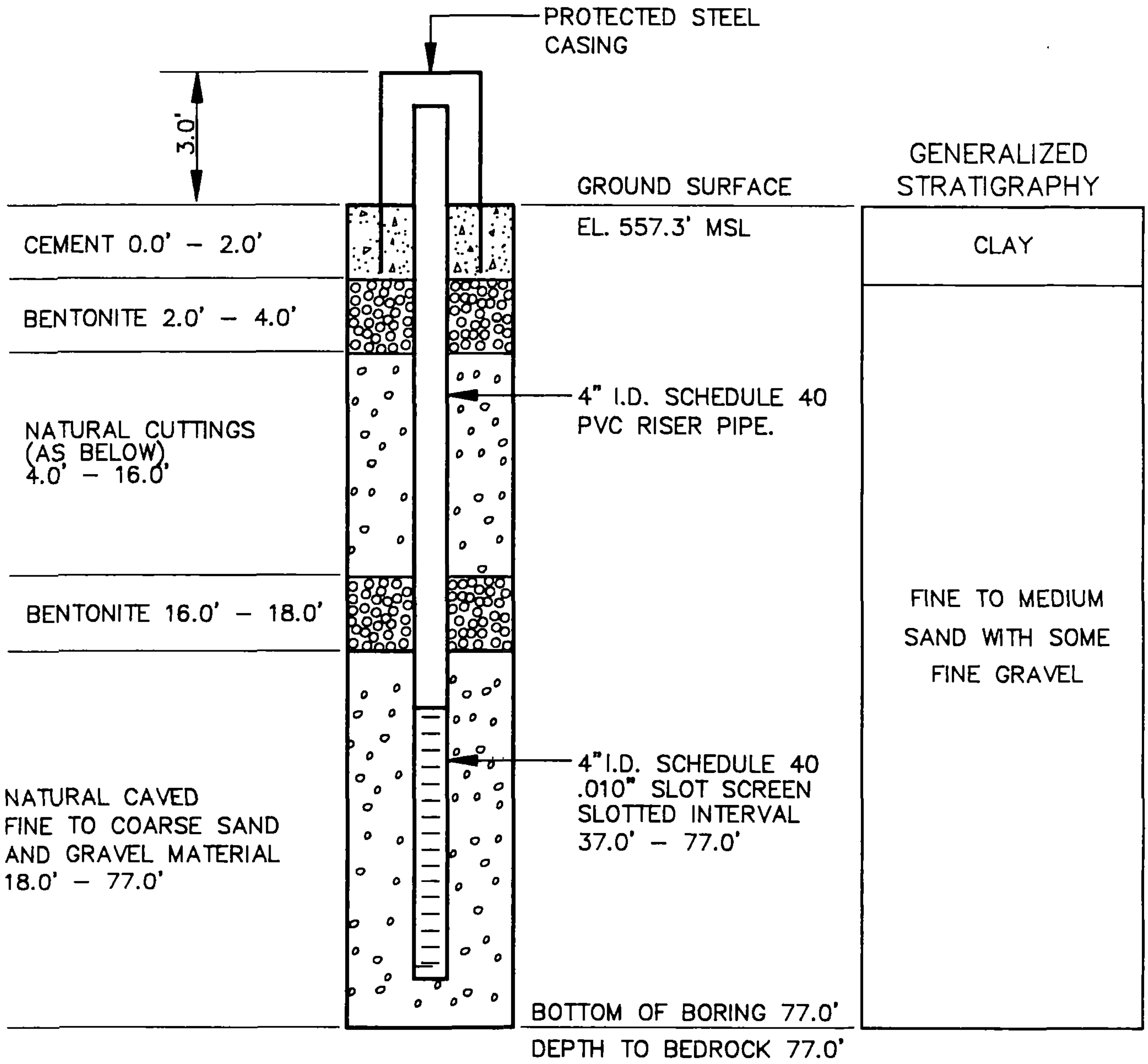
INSTALLATION DETAIL
MONITORING WELL MW-19
IRONTON

PREPARED FOR

ALLIED – SIGNAL INC.
MORRISTOWN, NEW JERSEY

INTERNATIONAL TECHNOLOGY CORPORATION

132298



NOTES:

1. ELEVATION OF TOP OF RISER PIPE: APPROX. 559.3 MSL.
2. ELEVATION OF GROUND WATER ON 2/1/88 IS 518.76 MSL
3. DATUM DEPTH IS GROUND SURFACE.
4. DRAWING NOT TO SCALE.
5. FOR DETAILED STRATIGRAPHIC DESCRIPTION, SEE BORING LOG MW-20.

FIGURE B-2-3

INSTALLATION DETAIL
MONITORING WELL MW-20
IRONTON

PREPARED FOR

ALLIED – SIGNAL INC.
MORRISTOWN, NEW JERSEY

INTERNATIONAL TECHNOLOGY CORPORATION

DRAWING NUMBER 303024-A3
DRAWN BY GSJ 5/27/88
CHECKED BY RLS 5/31/88
APPROVED BY SKG 8/4/88

132298

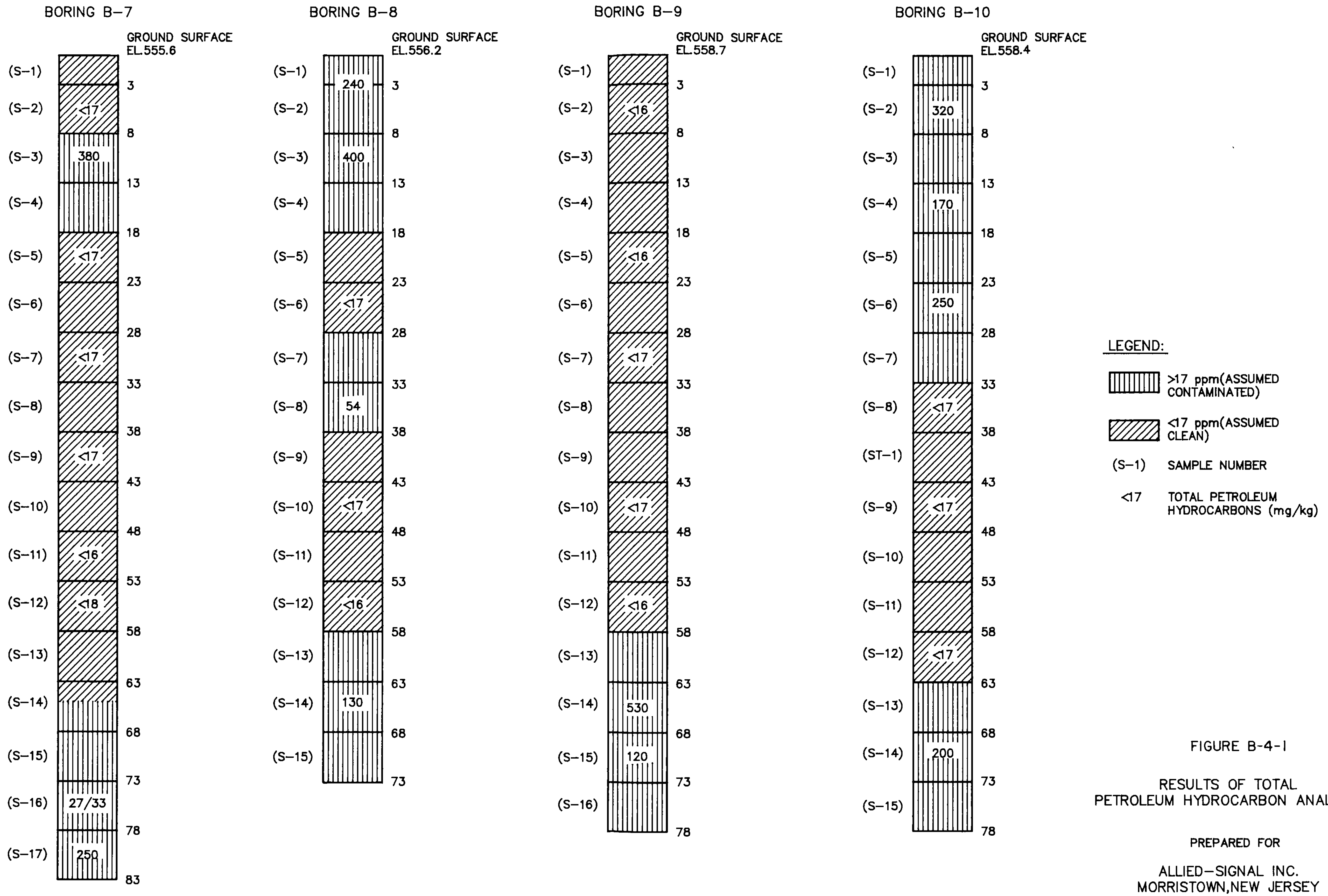


FIGURE B-4-1

RESULTS OF TOTAL
PETROLEUM HYDROCARBON ANALYSIS

PREPARED FOR

ALLIED-SIGNAL INC.
MORRISTOWN, NEW JERSEY

INTERNATIONAL TECHNOLOGY CORPORATION

DRAWING NUMBER 303024-B5
CHECKED BY RLS 5/31/88
APPROVED BY SKG 8/01/88
DRAWN BY GST 4-5-88

132298

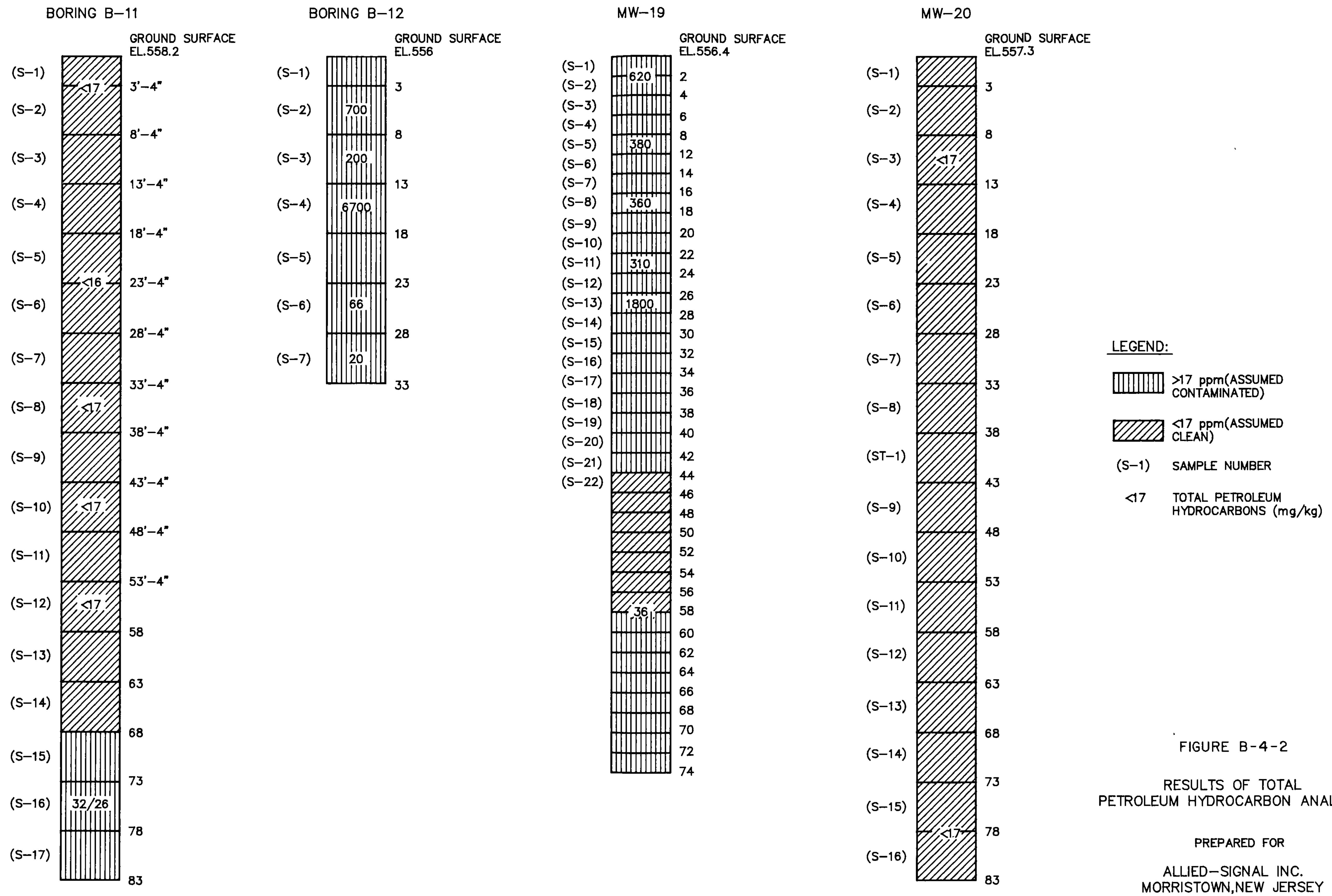


FIGURE B-4-2

RESULTS OF TOTAL PETROLEUM HYDROCARBON ANALYSIS

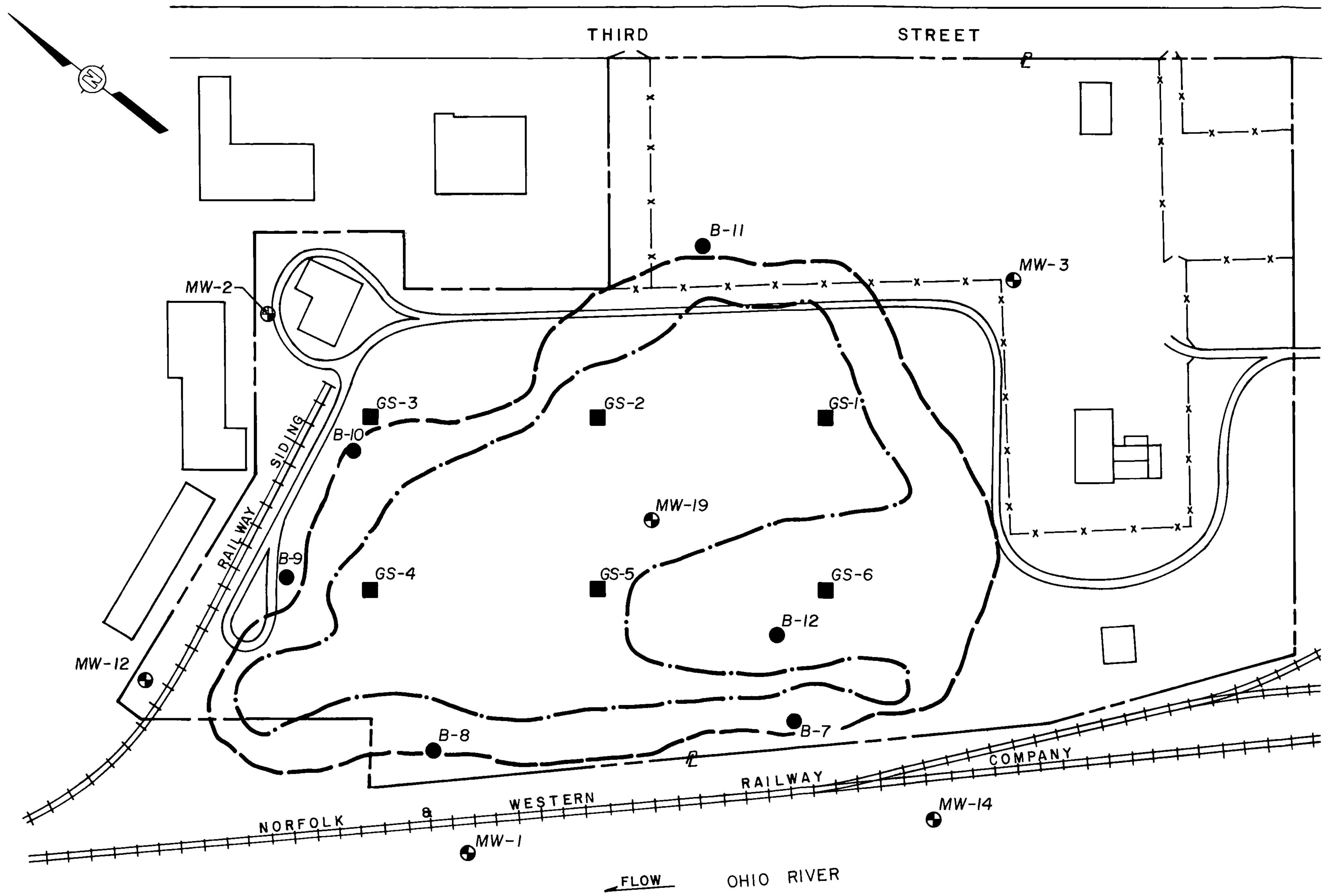
PREPARED FOR

ALLIED-SIGNAL INC.
MORRISTOWN, NEW JERSEY

INTERNATIONAL TECHNOLOGY CORPORATION

DRAWN BY | CHECKED BY | APPROVED BY | DRAWING NUMBER 303024-B6

132298



DRAWN BY: B KUMPF 5 APR 88
CHECKED BY: RLS 5/31/88
APPROVED BY: SKG 8/01/88
DRAWING NUMBER: 303024-B7

NOTE:

MW-20 IS LOCATED NORTHWEST OF MAPPING AREA.

LEGEND:

- B-7 BORING LOCATION
- MW-3 MONITORING WELL LOCATION
- GS-1 SOIL GAS SURVEY POINT
- APPROXIMATE LIMIT OF TOP OF DISPOSAL AREA
- APPROXIMATE LIMIT OF BOTTOM OF DISPOSAL AREA

SCALE

0 100 200 FEET

FIGURE B-4-3

EXTENT OF WASTES

PREPARED FOR

ALLIED-SIGNAL INC.
MORRISTOWN, NEW JERSEY

INTERNATIONAL TECHNOLOGY CORPORATION

REFERENCE:

ALLIED CORPORATION DRAWINGS, TITLED "LAND ACQUISITION LAYOUT", DWG. NO D-9-368-8, "DATED: 5-11-55, SCALE 1"=50', AND "GOLDCAMP DISPOSAL SITE", DWG. NO. ICP-2, DATED: 2-13-87, SCALE: 1"=40'.

SECTION A

SOIL BORING LOGS

GENERAL NOTES AND LEGEND

Symbols to be used for designation of subsurface materials on all boring logs and subsurface sections

- SLAG
- FILL
- CONCRETE
- VOID (INDICATES SIZE OF VOID)
- WATER
- APPROXIMATE EXISTING GROUND
- APPROXIMATE TOP OF ROCK
- GRAVEL
- SAND
- SILT
- CLAY
- ORGANIC MATTER
- ROOTS
- LIMESTONE
- SILTSTONE
- SANDSTONE
- MASSIVE MUDSTONE OR CLAYSTONE
- SHALE
- COAL TAR COAL PITCH
- DOLOMITE
- CONGLOMERATE
- ROCK FRAGMENTS
- RAILROAD TIE

STANDARD PENETRATION RESISTANCE IS THE NUMBER OF BLOWS REQUIRED TO DRIVE A 2 INCH O D SPLIT BARREL SAMPLER 12 INCHES USING A 140 POUND HAMMER FALLING FREELY THROUGH 30 INCHES THE SAMPLER WAS DRIVEN 18 INCHES AND THE NUMBER OF BLOWS RECORDED FOR EACH 6 INCH INTERVAL THE RESISTANCE TO PENETRATION IS INDICATED ON THE DRAWING AS BLOWS PER FOOT

THE BORING LOGS AND RELATED INFORMATION DEPICT SUBSURFACE CONDITIONS ONLY AT THE SPECIFIC LOCATIONS AND DATES INDICATED SOIL CONDITIONS AND WATER LEVELS AT OTHER LOCATIONS MAY DIFFER FROM CONDITIONS OCCURRING AT THESE BORING LOCATIONS ALSO THE PASSAGE OF TIME MAY RESULT IN A CHANGE IN THE CONDITIONS AT THESE BORING LOCATIONS

- 2 O D SPLIT BARREL SAMPLE
- 75/0 5 — PENETRATION REFUSAL RESISTANCE AND FRACTIONAL INCREMENT DRIVEN IN FEET
- 1-8-81 — GROUND WATER LEVEL AND DATE
- U S C S — UNIFIED SOIL CLASSIFICATION SYSTEM (CAPITAL LETTERS INDICATE LAB TEST CLASSIFICATION LOWER CASE LETTERS INDICATE VISUAL FIELD CLASSIFICATION)
- (60) — RQD (ROCK QUALITY DESIGNATION PERCENT) (LENGTH OF NUMBER OF PIECES GREATER THAN 4 INCHES DIVIDED BY THE LENGTH OF THE CORE RUN)
- 90 — INDICATES PERCENT OF CORE RECOVERED (LENGTH OF CORE RECOVERED DIVIDED BY LENGTH OF CORE RUN)

TRACE – INDICATES PRESENCE OF 5 TO 12% OF SUBJECT MATERIAL BY WEIGHT
SOME – INDICATES PRESENCE OF 12 TO 30% OF SUBJECT MATERIAL BY WEIGHT
AND – INDICATES APPROXIMATELY EQUAL PORTIONS OF SUBJECT MATERIAL BY WEIGHT

CONSISTENCY OF COHESIVE SOILS

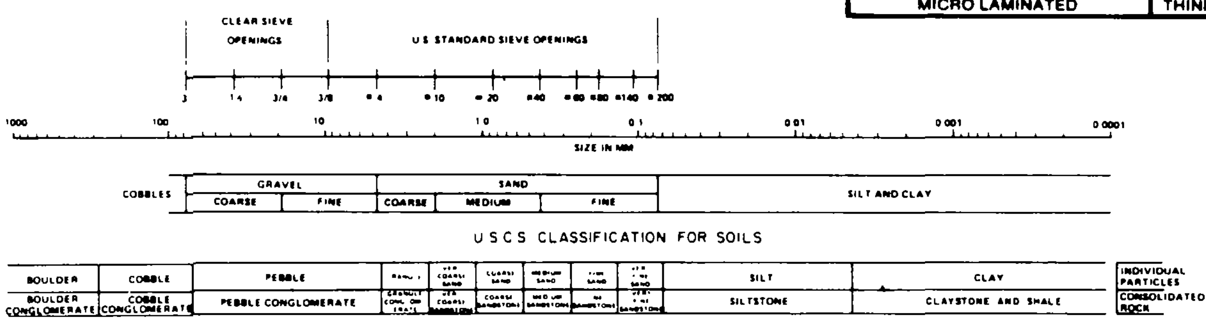
CONSISTENCY	UNCONFINED COMPRESSIVE STRENGTH TONS PER SQUARE FOOT
VERY SOFT	LESS THAN 0 25
SOFT	0 25 TO 0 50
MEDIUM STIFF	0 50 TO 1 0
STIFF	1 0 TO 2 0
VERY STIFF	2 0 TO 4 0
HARD	MORE THAN 4 0

DENSITY OF GRANULAR SOILS

DESIGNATION	BLOWS PER FOOT
VERY LOOSE	0 4
LOOSE	5 10
MEDIUM DENSE	11 30
DENSE	31 50
VERY DENSE	OVER 50

TERMS USED TO DESCRIBE BEDDING THICKNESS

VERY THICK BEDDED OR MASSIVE	THICKER THAN 3 3 ft
THICK BEDDED	1-3 3 ft
MEDIUM BEDDED	4 12 in
THIN BEDDED	1-4 in
VERY THIN BEDDED	2/5-1 in
LAMINATED	1/8-2/5 in
THINLY LAMINATED	1/32-1/8 in
MICRO LAMINATED	THINNER THAN 1/32 in



WENTWORTH SCALE FOR ROCK

TERMS USED TO DESCRIBE THE RELATIVE DEGREES OF ROCK CORE HARDNESS

DESCRIPTIVE TERMS	DEFINING CHARACTERISTICS
VERY SOFT	CRUSHES UNDER PRESSURE OF FINGERS AND/OR THUMB
SOFT	CRUSHES UNDER PRESSURE OF PRESSED HAMMER
MEDIUM HARD	BREAKS EASILY UNDER SINGLE HAMMER BLOW BUT WITH CRUMBLY EDGES
HARD	BREAKS UNDER ONE OR TWO STRONG HAMMER BLOWS BUT WITH RESISTANT SHARP EDGES
VERY HARD	BREAKS UNDER SEVERAL STRONG HAMMER BLOWS BUT WITH VERY RESISTANT SHARP EDGES AND MAY SPALL LEAVING CONCHOIDAL FRACTURES

THE SPACING OF THE DISCONTINUITIES IN THE ROCK MAY BE DESCRIBED BY ONE OF THE FOLLOWING TERMS

DESCRIPTIVE TERMS	SPACING
VERY BROKEN	LESS THAN 1 IN
BROKEN	1 IN TO 3 IN
SLIGHTLY BROKEN	3 IN TO 6 IN
UNBROKEN	6 IN AND GREATER

DATE BEGAN: 1-11-88
DATE FINISHED: 1-12-88
GROUND SURFACE EL.: 555.6'

BORING NO. B-7

N - E -

FIELD ENGINEER: G. HAWK
CHECKED BY: D. ROHAUS

ELEV. (FEET)	DEPTH (FEET)	SAMPLE TYPE	PROFILE	DESCRIPTION	U.S.C.S.	MEASURED CONSISTENCY (TSF)	REMARKS
		S 1		VERY SOFT, DARK BROWN, SILTY CLAY, SOME FINE SAND-MOIST	cl	——	ENCOUNTERED CONCRETE AT 9.0'. MOVED RIG ~10.0'. REDRILLED THE HOLE TO TOP OF BEDROCK.
550.0	5.0	S		STIFF, BROWN, SILTY CLAY, TRACE FINE SAND. MOIST 5.0'	cl		
				VERY SOFT, BROWN, MEDIUM SAND, SOME MEDIUM GRAVEL-MOIST 6.0'	sp	1.5-2.0	
		2		STIFF, BROWN, SILTY CLAY, TRACE TO SOME FINE TO MEDIUM SAND-MOIST 8.0'	cl		
	10.0	S 3		COAL TAR, COAL PITCH, TRACE SULFUR, SOME BLAST FURANCE SLAG AT BOTTOM 12.0'	N/A	N/A	
540.0	15.0	S 4		BLAST FURANCE SLAG, TRACE COAL TAR AND IRON ORE 17.0'	N/A	N/A	
				VERY LOOSE, LIGHT BROWN, FINE TO MEDIUM SAND, TRACE TO SOME FINE TO MEDIUM GRAVEL-MOIST	sp	<0.25	
	20.0	S 5			sp	<0.25	
530.0	25.0	S 6		VERY LOOSE, BROWN, MEDIUM TO COARSE SAND, SOME FINE TO MEDIUM GRAVEL-MOIST	sp	<0.25	
	30.0	S 7		VERY LOOSE, BROWN, COARSE SAND AND FINE TO MEDIUM GRAVEL-WET	sp	<0.25	
520.0	35.0	S 8		VERY LOOSE, BROWN, COARSE SAND AND FINE TO MEDIUM GRAVEL-WET ~38.0'	sp	<0.25	
	40.0	S 9		VERY LOOSE, BROWN, FINE TO MEDIUM GRAVEL AND COARSE SAND-WET	gp	<0.25	
510.0	45.0	S 10		VERY LOOSE, BROWN, FINE TO MEDIUM GRAVEL-WET ~48.0'	gp	<0.25	
	50.0	S		VERY LOOSE, BROWN, FINE TO MEDIUM SAND-WET	sp	<0.25	

PROJECT NO. 303024
PROJECT NAME: ALLIED - IRONTON

DATE BEGAN: 1-11-88 BORING NO. B-7 FIELD ENGINEER: G. HAWK

DATE FINISHED: 1-12-88 CHECKED BY: D. ROHAUS

GROUND SURFACE EL.: 555.6' N – E –

ELEV. (FEET)	DEPTH (FEET)	SAMPLE TYPE	PROFILE	DESCRIPTION	U.S.C.S.	MEASURED CONSISTENCY (TSF)	REMARKS
		11		VERY LOOSE, BROWN, FINE TO MEDIUM SAND-WET	sp	<0.25	
500.0	55.0	S 12		VERY LOOSE, BROWN, FINE TO MEDIUM SAND, TRACE FINE TO MEDIUM GRAVEL-WET	sp	<0.25	
	60.0	S 13		VERY LOOSE, BROWN, MEDIUM SAND, TRACE TO SOME FINE TO MEDIUM GRAVEL-WET	sp	<0.25	
490.0	65.0	S 14		VERY LOOSE, BROWN, MEDIUM SAND, TRACE TO SOME FINE TO MEDIUM GRAVEL-WET	N/A	N/A	HNu = ~1ppm FOR CUTTINGS FROM 63.0'. NO RECOVERY, BUT ASSUME SAME AS ABOVE.
	70.0	S 15		VERY LOOSE, BROWN, FINE TO MEDIUM SAND-WET	sp	<0.25	
480.0	75.0	S 16		VERY LOOSE, BROWN, FINE TO MEDIUM SAND, TRACE MEDIUM TO COARSE GRAVEL-WET	sp	0.25	
474.6	80.0 81.0	S 17		VERY LOOSE, BROWN, FINE TO MEDIUM SAND, TRACE MEDIUM TO COARSE GRAVEL-WET TOP OF BEDROCK ~81.0'	N/A	N/A	
				BOTTOM OF BORING 81.0'			

PROJECT NO. 303024 BORING NO. B-7

PROJECT NAME: ALLIED – IRONTON SHEET 2 OF 2

DATE BEGAN: 1-13-88
DATE FINISHED: 1-14-88
GROUND SURFACE EL.: 556.2'

BORING NO. B-8

N - E -

FIELD ENGINEER: G. HAWK
CHECKED BY: D. ROHAUS

ELEV. (FEET)	DEPTH (FEET)	SAMPLE TYPE	PROFILE	DESCRIPTION	U.S.C.S.	MEASURED CONSISTENCY (TSF)	REMARKS
		S 1		VERY SOFT, BLACK, FINE SILTY CLAY, TRACE TO SOME FINE SAND, TRACE FINE GRAVEL- MOIST	cl	<0.25	HNu = ~300ppm FROM 0.0' TO 3.0'.
550.0	5.0	S 2		STIFF, BROWN, SILTY CLAY, TRACE COAL TAR AND WOOD, TRACE FINE SAND-MOIST	cl	1.5	
	10.0	S 3		STIFF, BROWN, SILTY CLAY, TRACE FINE SAND, TRACE COAL TAR STREAKS-MOIST ~11.8'	cl	1.0-1.5	
				LOOSE, BROWN, SILTY FINE SAND, SOME CLAY-MOIST	sc	1.0	
540.0	15.0	ST-4 N/A		LOOSE, BROWN, SILTY FINE SAND, SOME CLAY-MOIST ~18.0'	N/A	N/A	
	20.0	S 5		MEDIUM STIFF, BROWN AND BLACK SILTY CLAY, TRACE FINE SAND-MOIST ~22.0'	cl	0.75	
				VERY LOOSE, BROWN, FINE TO MEDIUM SAND, TRACE TO SOME FINE GRAVEL-MOIST	sp	<0.25	
530.0	25.0	S 6		VERY LOOSE, MEDIUM SAND AND GRAVEL-MOIST	sp	<0.25	
	30.0	S 7		VERY LOOSE, MEDIUM TO COARSE SAND AND GRAVEL-MOIST	sp	<0.25	
520.0	35.0	S 8		VERY LOOSE, BROWN, COARSE SAND, SJOME FINE TO MEDIUM GRAVEL-WET	sp	<0.25	
	40.0	S 9		VERY LOOSE, BROWN, MEDIUM TO COARSE SAND, SOME FINE GRAVEL-WET	sp	<0.25	
510.0	45.0	S 10		VERY LOOSE, BROWN, MEDIUM TO COARSE SAND, TRACE FINE GRAVEL-WET	sp	<0.25	
	50.0	S		VERY LOOSE, BROWN, MEDIUM TO COARSE SAND, TRACE FINE GRAVEL-WET	sp	<0.25	

DATE BEGAN: 1-13-88
DATE FINISHED: 1-14-88
GROUND SURFACE EL.: 556.2'

BORING NO. B-8

N – E –

FIELD ENGINEER: G. HAWK
CHECKED BY: D. ROHAUS

ELEV. (FEET)	DEPTH (FEET)	SAMPLE TYPE	PROFILE	DESCRIPTION	U.S.C.S.	MEASURED CONSISTENCY (TSF)	REMARKS
		11		VERY LOOSE, BROWN, MEDIUM TO COARSE SAND, TRACE FINE GRAVEL-WET	sp	<0.25	
500.0	55.0	S / 12		VERY LOOSE, BROWN, MEDIUM TO COARSE SAND, TRACE FINE GRAVEL-WET	sp	<0.25	
	60.0	S / 13		VERY LOOSE, GRAY, FINE TO MEDIUM SAND, TRACE FINE GRAVEL-WET	sp	<0.25	
				~62.0' BLACK SHALE, SOME CONTAMINANTS ~62.8'	sp		CONTAMINATED BLACK SHALE AND BONEY COAL HAD A IRIDESCENT OILY SHEEN
490.0	65.0	S / 14		VERY LOOSE, GRAY, FINE TO MEDIUM SAND, TRACE FINE GRAVEL-WET	sp	<0.25	S-14 ALSO CONTAMINATED
	70.0	S / 15		NO RECOVERY	N/A	N/A	
482.2	74.0			TOP OF BEDROCK 74.0'			
				BOTTOM OF BORING 74.0'			

PROJECT NO. 303024
PROJECT NAME: ALLIED – IRONTON

DATE BEGAN: 1-15-88
DATE FINISHED: 1-15-88
GROUND SURFACE EL.: 558.7'

BORING NO. B-9

N - E -

FIELD ENGINEER: G. HAWK
CHECKED BY: D. ROHAUS

ELEV. (FEET)	DEPTH (FEET)	SAMPLE TYPE	DESCRIPTION	U.S.C.S.	MEASURED CONSISTENCY (TSF)	REMARKS
		S-1	HARD, LIGHT BROWN, SILTY CLAY-DRY TO MOIST	cl	>4.0	
	5.0	S-2	STIFF, LIGHT BROWN, SILTY CLAY-MOIST ~6.5	cl	2.0	
			VERY LOOSE, LIGHT BROWN, FINE SAND-MOIST	sp	<0.25	
550.0	10.0	ST-3 N/A	VERY LOOSE, LIGHT BROWN, FINE SAND-MOIST	sp	<0.25	
	15.0	S-4	VERY LOOSE, LIGHT BROWN, FINE TO MEDIUM SAND, TRACE FINE GRAVEL-MOIST	sp	<0.25	
540.0	20.0	S-5	VERY LOOSE, LIGHT BROWN, FINE TO MEDIUM SAND, TRACE TO SOME FINE TO MEDIUM GRAVEL-MOIST	sp	<0.25	
	25.0	S-6	VERY LOOSE, LIGHT BROWN, FINE TO MEDIUM SAND, TRACE TO SOME FINE TO MEDIUM GRAVEL-MOIST	sp	<0.25	
530.0	30.0	S-7	VERY LOOSE, LIGHT BROWN, FINE TO MEDIUM SAND, TRACE TO SOME FINE TO MEDIUM GRAVEL-MOIST	sp	<0.25	
	35.0	ST-2 N/A	VERY LOOSE, LIGHT BROWN, FINE TO MEDIUM SAND, TRACE TO SOME FINE TO MEDIUM GRAVEL-MOIST	sp	<0.25	
520.0	40.0	S-8	NO RECOVERY ~43.0'	N/A	N/A	
	45.0	S-9	VERY LOOSE, GRAY, FINE TO MEDIUM GRAVEL-WET	gp	<0.25	HNu = 0 LEL = 0
510.0	50.0	S	VERY LOOSE, GRAY, FINE TO MEDIUM GRAVEL, SOME COARSE SAND-WET	gp	<0.25	

PROJECT NO. 303024
PROJECT NAME: ALLIED - IRONTON

DATE BEGAN: 1-18-88
DATE FINISHED: 1-19-88
GROUND SURFACE EL.: 558.4'

BORING NO. B-10

N - E -

FIELD ENGINEER: G. HAWK
CHECKED BY: D. ROHAUS

ELEV. (FEET)	DEPTH (FEET)	SAMPLE TYPE	PROFILE	DESCRIPTION	U.S.C.S.	MEASURED CONSISTENCY (TSF)	REMARKS
		S 1		MEDIUM STIFF, LIGHT BROWN, SILTY CLAY, TRACE FINE SAND-MOIST	cl	1.0	HNu = 0ppm LEL = 0%
	5.0	S 2		TOP OF SPOON - MEDIUM STIFF, LIGHT BROWN, SILTY CLAY, TRACE FINE SAND-MOIST ~5.5'	cl		
550.0				BOTTOM OF SPOON - SLAG, COAL, TAR AND COAL PITCH, TRACE SILT AND FINE SAND-MOIST ~8.0'	COAL TAR	<0.25	
	10.0	S 3		MEDIUM, STIFF, DARK BROWN, SILTY CLAY, TRACE FINE SAND-MOIST ~12.5'	cl	<0.75	
					sp	<0.25	
	15.0	S 4		VERY LOOSE, BROWN, FINE SAND, TRACE SILT-MOIST ~15.0'	sp	<0.25	
				STIFF, BROWN, SILTY CLAY-MOIST ~17.0'	cl	1.5	
540.0				VERY LOOSE, BROWN, FINE SAND-MOIST	sp	<0.25	
	20.0	S 5		VERY LOOSE, DARK BROWN, FINE SAND, TRACE FINE GRAVEL-MOIST	sp	<0.25	S-5 WAS OIL STAINED
	25.0	S 6		VERY LOOSE, DARK BROWN, FINE SAND, TRACE FINE GRAVEL-MOIST	sp	<0.25	HNu = 0ppm LEL = 0%
530.0	30.0	S 7		VERY LOOSE, LIGHT BROWN, MEDIUM TO COARSE SAND, TRACE FINE GRAVEL-MOIST	sp	<0.25	S-7 DID NOT APPEAR TO BE OIL STAINED
	35.0	S 8		VERY LOOSE, LIGHT BROWN, MEDIUM TO COARSE SAND, TRACE TO SOME FINE TO MEDIUM GRAVEL-MOIST	sp	<0.25	HNu = 7ppm LEL = 0%
520.0	40.0	ST-1 N/A		VERY LOOSE, LIGHT BROWN, MEDIUM TO COARSE SAND, TRACE TO SOME FINE TO MEDIUM GRAVEL-MOIST	N/A	N/A	
	45.0	S 9		NO RECOVERY	N/A	N/A	
510.0	50.0	S		VERY LOOSE, LIGHT BROWN, MEDIUM TO COARSE SAND, TRACE TO SOME FINE TO MEDIUM SAND, SOME COAL SHALE-MOIST	sp	<0.25	

DATE BEGAN: 1-15-88
DATE FINISHED: 1-15-88
GROUND SURFACE EL.: 558.7'

BORING NO. B-9

N – E –

FIELD ENGINEER: G. HAWK
CHECKED BY: D. ROHAUS

ELEV. (FEET)	DEPTH (FEET)	SAMPLE TYPE	PROFILE	DESCRIPTION	U.S.C.S.	MEASURED CONSISTENCY (TSF)	REMARKS
		10		VERY LOOSE, GRAY, FINE TO MEDIUM GRAVEL, SOME COARSE SAND–WET ~53.0'	gp	<0.25	S–10 HAD SIGNS OF BLACK CONTAMINATION AND A OILY SHEEN ON THE SPOON. HNu = 0ppm LEL = 0% S–11 AND S–12 ALSO HAD MINOR SIGNS OF CONTAMINATION
	55.0	S 11		VERY LOOSE, GRAY, FINE TO MEDIUM SAND, TRACE FINE GRAVEL–WET	sp	<0.25	
500.0	60.0	S 12		VERY LOOSE, GRAY, FINE TO MEDIUM SAND, TRACE FINE GRAVEL–WET	sp	<0.25	
	65.0	S 13		VERY LOOSE, GRAY, FINE TO MEDIUM SAND, TRACE FINE GRAVEL–WET	sp	<0.25	S–13 HAD SIGNS OF CONTAMINENTS
490.0	70.0	S 14		VERY LOOSE, GRAY, FINE TO MEDIUM SAND, TRACE FINE GRAVEL–WET	sp	<0.25	S–14 WAS VERY CONTAMINATED WITH AN OILY TARRY LIQUID, THIS LIQUID FORMED A TAR-LIKE STAIN ON THE LATEX GLOVE.
482.7	75.0 76.0	S 15		VERY LOOSE, GRAY, FINE TO MEDIUM SAND, TRACE FINE GRAVEL–WET TOP OF BEDROCK ~76.0'	sp	<0.25	
				BOTTOM OF BORING 76.0'			

PROJECT NO. 303024
PROJECT NAME: ALLIED – IRONTON

DATE BEGAN: 1-18-88
DATE FINISHED: 1-19-88
GROUND SURFACE EL.: 558.4'

BORING NO. B-10

N - E -

FIELD ENGINEER: G. HAWK
CHECKED BY: D. ROHAUS

ELEV. (FEET)	DEPTH (FEET)	SAMPLE TYPE	PROFILE	DESCRIPTION	U.S.C.S.	MEASURED CONSISTENCY (TSF)	REMARKS
		10		VERY LOOSE, LIGHT BROWN, MEDIUM TO COARSE SAND, TRACE TO SOME FINE TO MEDIUM SAND, SOME COAL SHALE-MOIST	sp	<0.25	
	55.0	S / 11		VERY LOOSE, LIGHT BROWN, MEDIUM TO COARSE SAND, TRACE TO SOME FINE TO MEDIUM SAND-MOIST	sp	<0.25	
500.0	60.0	S / 12		VERY LOOSE, BROWN, MEDIUM SAND, TRACE TO SOME FINE TO MEDIUM GRAVEL-WET	sp	<0.25	
	65.0	S / 13		VERY LOOSE, BROWN, MEDIUM SAND, TRACE TO SOME FINE TO MEDIUM GRAVEL-WET	sp	<0.25	
490.0	70.0	S / 14		VERY LOOSE, BROWN, FINE SAND, TRACE MEDIUM SAND AND FINE GRAVEL-WET	sp	<0.25	
482.4	75.0 / 76.0	S / 15		VERY LOOSE, BROWN, FINE SAND, TRACE MEDIUM SAND AND FINE GRAVEL-WET TOP OF BEDROCK 76.0'	sp	<0.25	
				BOTTOM OF BORING 76.0'			

DATE BEGAN: 1-5-88

DATE FINISHED: 1-6-88

GROUND SURFACE EL.: 558.2'

BORING NO. B-11

N - E -

FIELD ENGINEER: G. HAWK

CHECKED BY: D. ROHAUS

ELEV. (FEET)	DEPTH (FEET)	SAMPLE TYPE	PROFILE	DESCRIPTION	U.S.C.S.	MEASURED CONSISTENCY (TSF)	REMARKS
		S 1		VERY LOOSE, BROWN AND ORANGE, FINE SAND, SOME SILTY CLAY, TRACE FINE GRAVEL-MOIST	sc	0.25	S-1 CONTAINED LARGE PIECES SLAG AT THE TOP OF SPOON
550.0	5.0	S 2		VERY LOOSE, BROWN, FINE SAND, TRACE MEDIUM SAND, TRACE FINE GRAVEL-MOIST	sp	0.25	
	10.0	S 3		VERY LOOSE, BROWN, FINE SAND, TRACE MEDIUM SAND, TRACE FINE GRAVEL-MOIST ~12.0'	sp	0.25	
				STIFF, BROWN, FINE SANDY SILTY CLAY, MOIST TO WET ~14.0'	cl cl	1.5 1.5	
540.0	15.0	S 4		LOOSE, BROWN, MEDIUM TO COARSE SAND, TRACE FINE GRAVEL-MOIST TO WET	sp	0.6 - 0.75	
	20.0	S 5		VERY LOOSE, BROWN, COARSE SAND, SOME MEDIUM SAND, TRACE FINE TO MEDIUM GRAVEL-MOIST TO WET	sp	<0.25	
530.0	25.0	S 6		VERY LOOSE, BROWN, VERY COARSE SAND, SOME MEDIUM TO COARSE GRAVEL-MOIST	sp	<0.25	
	30.0	S 7		VERY LOOSE, BROWN, VERY COARSE SAND, SOME MEDIUM SAND, SOME MEDIUM TO COARSE GRAVEL-MOIST	sp	<0.25	
520.0	35.0	S 8		VERY LOOSE, BROWN, VERY COARSE SAND, SOME MEDIUM SAND, SOME MEDIUM TO COARSE GRAVEL-MOIST	sp	<0.25	
	40.0	S 9		VERY LOOSE, BROWN, MEDIUM TO COARSE GRAVEL, TRACE TO SOME MEDIUM TO COARSE SAND-WET	sp	<0.25	GROUND WATER LEVEL AT 39.0'.
510.0	45.0	S 10		VERY LOOSE, BROWN, MEDIUM SAND, TRACE FINE GRAVEL-WET	sp	<0.25	
	50.0	S		VERY LOOSE, BROWN, FINE TO MEDIUM SAND, TRACE FINE GRAVEL-WET	sp	<0.25	

DATE BEGAN: 1-5-88
DATE FINISHED: 1-6-88
GROUND SURFACE EL.: 558.2'

BORING NO. B-11

N - E -

FIELD ENGINEER: G. HAWK
CHECKED BY: D. ROHAUS

ELEV. (FEET)	DEPTH (FEET)	SAMPLE TYPE	PROFILE	DESCRIPTION	U.S.C.S.	MEASURED CONSISTENCY (TSF)	REMARKS
		11		VERY LOOSE, BROWN, FINE TO MEDIUM SAND, TRACE FINE GRAVEL-WET	sp	<0.25	
	55.0	S		VERY LOOSE, BROWN, FINE TO MEDIUM SAND, TRACE FINE GRAVEL-WET	sp	<0.25	
500.0		12					
	60.0	S		VERY LOOSE, BROWN, FINE SAND-WET	sp	<0.25	
		13					
	65.0	S		VERY LOOSE, BROWN, FINE SAND-WET	sp	<0.25	
490.0		14					
	70.0	S		VERY LOOSE, BROWN, FINE SAND-WET	sp	<0.25	
		15		~73.4'			
	75.0	S		VERY LOOSE, BROWN, FINE TO MEDIUM SAND, TRACE TO SOME MEDIUM TO COARSE GRAVEL-WET	gp	<0.25	
480.0		16					
	80.0	S		VERY LOOSE, BROWN, FINE TO MEDIUM SAND, TRACE TO SOME MEDIUM TO COARSE GRAVEL-WET	gp	<0.25	S-17 - NO VISUAL SIGN OF CONTAMINATION
477.2	81.0	17		TOP OF BEDROCK 81.0'			
				BOTTOM OF BORING 81.0'			

PROJECT NO. 303024
PROJECT NAME: ALLIED - IRONTON

DATE BEGAN: 1-20-88
DATE FINISHED: 1-21-88
GROUND SURFACE EL.: 556.0'

BORING NO. B-12

N - E -

FIELD ENGINEER: G. HAWK
CHECKED BY: D. ROHAUS

ELEV. (FEET)	DEPTH (FEET)	SAMPLE TYPE	PROFILE	DESCRIPTION	U.S.C.S.	MEASURED CONSISTENCY (TSF)	REMARKS
		S 1		VERY SOFT, DARK BROWN, SILTY CLAY-WET 4.0'	cl	<0.25	
550.0	5.0	S 2		HARD, COAL TAR, COAL PITCH, TRACE SULFUR-DRY 6.0' RAILROAD TIE 7.0'	N/A		HNu = 6ppm IN HOLE HNu = 2ppm AT BREATHING ZONE
	10.0	S 3		COAL TAR, COAL PITCH, TRACE WOOD-DRY	N/A		HNu = 50ppm IN HOLE
540.0	15.0	S 4		COAL TAR, COAL PITCH-DRY	N/A		HNu = 13ppm IN HOLE AT 16.0', ENCOUNTERED CONCRETE AND WAS UNABLE TO CONTINUE DRILLING. MOVED RIG 6.0', REDRILLED AND AGAIN HIT CONCRETE AT 16.0'. MOVED RIG FOR THIRD TIME AND HIT BRICKS, CONCRETE, AND SLAG AT 30.0'.
	20.0	S 5		COAL TAR, COAL PITCH-DRY	N/A		BORING WAS ABANDONED BECAUSE UNABLE TO CONTINUE DRILLING.
530.0	25.0	S 6		COAL TAR, COAL PITCH-DRY	N/A		LEL = 100%
526.0	30.0			ON THIRD ATTEMPT, HIT BRICKS, SLAG AND CONCRETE, UNABLE TO CONTINUE DRILLING			METHANE GAS VISIBLY BILLOWING OUT FROM HOLE.
				BORING ABANDONED AFTER THIRD ATTEMPT			

PROJECT NO. 303024
PROJECT NAME: ALLIED - IRONTON

BORING NO. B-12
SHEET 1 OF 1

DATE BEGAN: 1-14-88
DATE FINISHED: 1-29-88
GROUND SURFACE EL.: 556.4'

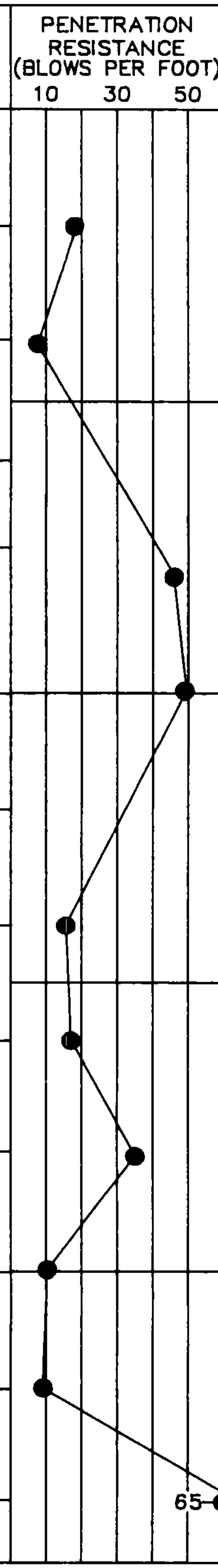
BORING NO. MW-19

N — E —

FIELD ENGINEER: D. M. ROHAUS
CHECKED BY: G. L. HAWK

ELEV. (FEET)	DEPTH (FEET)	SAMPLE TYPE	DESCRIPTION	U.S.C.S.	REMARKS
		S 1	STIFF, DARK BROWN, SILTY CLAY, SOME SAND, SOME HARD SLAG, TRACE COAL TAR-MOIST 2.0'	cl	
	2.5	S 2	STIFF, LIGHT BROWN, SILTY CLAY, SOME SAND, TOP 5" DARK BROWN, STAINED WITH COAL TAR-MOIST 4.0'	cl	
	5.0	ST-3 N/A	STIFF, LIGHT BROWN SILTY CLAY, SOME SAND-MOIST 6.0'	cl	
550.0	7.5	S 4	HARD, LIGHT BROWN, SILTY CLAY, SOME SAND-MOIST ~7.5' BLACK, COAL PITCH, COAL TAR 8.0'	cl	HNu = 43ppm IN HOLE HNu = 3ppm OUTSIDE HOLE LEL = 0%
	10.0	S 5	VERY STIFF, BLACK, COAL PITCH, COAL TAR, LAST 2" COAL WITH CLAY 10.0'	N/A	LEL = 24%
		S 6	VERY STIFF, BLACK, COAL TAR, COAL PITCH, PIECE OF WOOD ON TOP 12.0'	N/A	HNu = 1ppm AT BREATHING LEVEL HNu = 50ppm IN HOLE
	12.5	S 7	STIFF, BLACK, COAL TAR, COAL PITCH, 1/4" CLAY "FLAKES" AT TOP, TRACE SLAG 14.0'	N/A	HNu = 3-5ppm AT GROUND SURFACE
	15.0	S 8	STIFF, BLACK, COAL TAR, COAL PITCH, VERY OILY TOP 2" 16.0'	N/A	HNu = 1ppm AT BREATHING LEVEL HNu = 300ppm IN HOLE
540.0	17.5	S 9	VERY STIFF, BLACK, COAL TAR, COAL PITCH, VERY HARD SLAG AT TOP, NO OILY MATERIAL 18.0'	N/A	
	20.0	S 10	STIFF, BLACK, COAL TAR, COAL PITCH, NO OILY MATERIAL-DRY BOTTOM 12" HAS CONSISTENCY OF CLAY 20.0'	N/A	
		S 11	STIFF, BLACK, COAL TAR, COAL PITCH, VERY OILY 22.0'	N/A	
	22.5	S 12	STIFF, BLACK, COAL TAR, COAL PITCH, SLAG 24.0'	N/A	HNu = 3-4ppm LEL = 2%
	25.0	S	HARD, BLACK, COAL TAR, COAL PITCH, SOME OIL, FIBERS, AND ALUMINUM	N/A	HNu = 3-4ppm LEL = 0%

PENETRATION RESISTANCE (BLOWS PER FOOT)



DATE BEGAN: 1-14-88
DATE FINISHED: 1-29-88
GROUND SURFACE EL.: 556.4'

BORING NO. MW-19

N - E -

FIELD ENGINEER: D. M. ROHAUS
CHECKED BY: G. L. HAWK

ELEV. (FEET)	DEPTH (FEET)	SAMPLE TYPE	PROFILE	DESCRIPTION	U.S.C.S.	PENETRATION RESISTANCE (BLOWS PER FOOT) 10 30 50	REMARKS
		13		26.0'	N/A		
530.0	27.5	S / 14		HARD, BLACK, COAL TAR, COAL PITCH, VERY STICKY, SOME CLAY IN MIDDLE 28.0'	N/A		HNu = 5ppm LEL = 0%
	30.0	S / 15		HARD, BLACK, COAL TAR, COAL PITCH, VERY OILY 30.0'	N/A	114	LEL = 25% IN HOLE LEL = 0% AT GROUND SURFACE
	32.5	S / 16		HARD, BLACK, COAL TAR, COAL PITCH, LESS OILY 32.0'	N/A		LEL = 10%
		S / 17		HARD, BLACK, COAL TAR, COAL PITCH, VERY OILY 34.0'	N/A		HNu = 4ppm LEL = 10%
	35.0	S / 18		HARD, BLACK, COAL TAR, COAL PITCH, NO OIL 36.0'	N/A		LEL = 17%
520.0	37.5	S / 19		HARD, BLACK COAL TAR, COAL PITCH, VERY OILY (DRAINED ~2 CUPS) 38.0'	N/A	64	
	40.0	S / 20		VERY STIFF, BLACK, COAL TAR, COAL PITCH, VERY OILY 40.0'	N/A		HNu = 0ppm LEL = 0%
		S / 21		HARD, BLACK, COAL TAR, COAL PITCH, VERY OILY, R.R. TIE (ALL WOOD) 42.0'	N/A		HNu = 0ppm LEL = 0%
512.4	42.5 / 44.0	S / 22		VERY DENSE, BLACK TO DARK BROWN, MEDIUM TO COARSE SAND-WET 44.0'	sp	70 / 59	

BOTTOM OF SPLIT SPOON SAMPLING
44.0'

CONTINUED TO BOTTOM OF BEDROCK
WITH A SPUDDER RIG

DATE BEGAN: 1-23-88
DATE FINISHED: 1-25-88
GROUND SURFACE EL.: 557.3'

BORING NO. MW-20

N – E –

FIELD ENGINEER: G. HAWK
CHECKED BY: D. ROHAUS

ELEV. (FEET)	DEPTH (FEET)	SAMPLE TYPE	PROFILE	DESCRIPTION	U.S.C.S.	MEASURED CONSISTENCY (TSF)	REMARKS
		S 1		STIFF, BROWN, SILTY CLAY, TRACE SAND-MOIST	cl	N/A	
550.0	5.0	S 2		STIFF, BROWN, SILTY CLAY, TRACE SAND-MOIST ~8.0'	cl	1.4	
	10.0	S 3		VERY LOOSE, BROWN, FINE TO MEDIUM SAND, TRACE FINE GRAVEL-MOIST	sp	<0.25	
540.0	15.0	S 4		VERY LOOSE, BROWN, FINE TO MEDIUM SAND, TRACE FINE GRAVEL-MOIST	sp	<0.25	
	20.0	S 5		VERY LOOSE, BROWN, MEDIUM SAND, TRACE FINE TO MEDIUM GRAVEL-MOIST	sp	<0.25	
530.0	25.0	S 6		VERY LOOSE, BROWN, MEDIUM SAND, TRACE FINE TO MEDIUM GRAVEL-MOIST	sp	<0.25	
	30.0	S 7		VERY LOOSE, BROWN, MEDIUM SAND, TRACE FINE TO MEDIUM GRAVEL-MOIST	sp	<0.25	
520.0	35.0	S 8		VERY LOOSE, BROWN, MEDIUM SAND, TRACE FINE TO MEDIUM GRAVEL-MOIST	sp	<0.25	
	40.0	S 9		VERY LOOSE, BROWN, MEDIUM SAND, TRACE FINE TO MEDIUM GRAVEL-MOIST	sp	<0.25	
510.0	45.0	S 10		VERY LOOSE, BROWN TO LIGHT BROWN, MEDIUM TO COARSE SAND, TRACE FINE GRAVEL-MOIST	sp	<0.25	
	50.0	S		NO RECOVERY	N/A	N/A	METAL RETAINER SPREAD TOO FAR APART.

PROJECT NO. 303024
PROJECT NAME: ALLIED – IRONTON

DATE BEGAN: 1-23-88
DATE FINISHED: 1-25-88
GROUND SURFACE EL: 557.3'

BORING NO. MW-20

N – E –

FIELD ENGINEER: G. HAWK
CHECKED BY: D. ROHAUS

ELEV. (FEET)	DEPTH (FEET)	SAMPLE TYPE	PROFILE	DESCRIPTION	U.S.C.S.	MEASURED CONSISTENCY (TSF)	REMARKS
		11		NO RECOVERY	N/A	N/A	METAL RETAINER SPREAD TOO FAR APART.
500.0	55.0	S 12		VERY LOOSE, BROWN, FINE TO MEDIUM SAND, TRACE FINE GRAVEL-WET	sp	<0.25	
	60.0	S 13		NO RECOVERY	N/A	N/A	
490.0	65.0	S 14		NO RECOVERY	N/A	N/A	
	70.0	S 15		VERY LOOSE, BROWN, FINE TO MEDIUM SAND, TRACE FINE GRAVEL-WET	sp	<0.25	
480.3	75.0 77.0	S 16		VERY LOOSE, BROWN, FINE TO MEDIUM SAND, TRACE FINE GRAVEL-WET TOP OF BEDROCK 77.0'	sp	<0.25	
				BOTTOM OF BORING 77.0'			

SECTION B

SOIL SAMPLE COLLECTION AND ANALYSES LOG

SOIL SAMPLE LOG

SAMPLE IDENTIFICATION		SAMPLE			ANALYSIS	
BORING NO.	SAMPLE NO.	DATE	DEPTH	TYPE	PERFORMED	COMMENTS
B-7	S-1	1/11/88	0'-3'	Soil		
B-7	S-2	1/11/88	3'-8'	Soil	TPHC[a]	
B-7	S-3	1/11/88	8'-13'	Soil	TPHC	
B-7	S-4	1/11/88	13'-18'	Soil		
B-7	S-5	1/11/88	18'-23'	Soil	TPHC	
B-7	S-6	1/11/88	23'-28'	Soil		
B-7	S-7	1/11/88	28'-33'	Soil	TPHC	
B-7	S-8	1/11/88	33'-38'	Soil		
B-7	S-9	1/12/88	38'-43'	Soil	TPHC	
B-7	S-10	1/12/88	43'-48'	Soil		
B-7	S-11	1/12/88	48'-53'	Soil	TPHC	
B-7	S-12	1/12/88	53'-58'	Soil	TPHC, TOC[b], VOA[c], BNAE[d], BTU[e]	
B-7	S-13	1/12/88	58'-63'	Soil		
B-7	S-14	1/12/88	63'-68'	Soil		
B-7	S-15	1/12/88	68'-73'	Soil		
B-7	S-16	1/12/88	73'-78'	Soil	TPHC	
B-7	S-17	1/12/88	78'-83'	Soil	TPHC, VOA, BNAE	

See footnotes at end of table.

SOIL SAMPLE LOG
(Continued)

SAMPLE IDENTIFICATION		SAMPLE DATE	DEPTH	TYPE	ANALYSIS PERFORMED	COMMENTS
BORING NO.	SAMPLE NO.					
B-8	S-1	1/13/88	0'-3'	Soil	TPHC Composite (S-1 & S-2)	
B-8	S-2	1/13/88	3'-8'	Soil		
B-8	S-3	1/13/88	8'-13'	Soil	TPHC	
B-8	ST-4	1/13/88	13'-18'	Soil		
B-8	S-5	1/13/88	18'-23'	Soil		
B-8	S-6	1/13/88	23'-28'	Soil	TPHC	
B-8	S-7	1/13/88	28'-33'	Soil		
B-8	S-8	1/13/88	33'-38'	Soil	TPHC	
B-8	S-9	1/14/88	38'-43'	Soil		
B-8	S-10	1/14/88	43'-48'	Soil	TPHC	
B-8	S-11	1/14/88	48'-53'	Soil		
B-8	S-12	1/14/88	53'-58'	Soil	TPHC	
B-8	S-13	1/14/88	58'-63'	Soil		
B-8	S-14	1/14/88	63'-68'	Soil	TOC, TPHC, VOA, BNAE	
B-8	S-15	1/14/88	68'-73'	Soil		No recovery

See footnotes at end of table.

SOIL SAMPLE LOG
(Continued)

SAMPLE IDENTIFICATION BORING NO.	SAMPLE NO.	SAMPLE DATE	DEPTH	TYPE	ANALYSIS PERFORMED	COMMENTS
B-9	S-1	1/15/88	0'-3'	Soil		
B-9	S-2	1/15/88	3'-8'	Soil	TPHC	
B-9	S-3	1/15/88	8'-13'	Soil		
B-9	S-4	1/15/88	13'-18'	Soil		
B-9	S-5	1/15/88	18'-23'	Soil	TPHC	
B-9	S-6	1/15/88	23'-28'	Soil		
B-9	S-7	1/15/88	28'-33'	Soil	TPHC	
B-9	S-8	1/15/88	38'-43'	Soil		No recovery
B-9	S-9	1/15/88	43'-48'	Soil		
B-9	S-10	1/15/88	48'-53'	Soil	TPHC	
B-9	S-11	1/15/88	53'-58'	Soil		
B-9	S-12	1/15/88	58'-63'	Soil	TPHC	
B-9	S-13	1/15/88	63'-68'	Soil		
B-9	S-14	1/15/88	68'-73'	Soil	TPHC	
B-9	S-15	1/15/88	73'-76'	Soil	TOC, TPHC, VOA, BNAE	

See footnotes at end of table.

SOIL SAMPLE LOG
(Continued)

SAMPLE IDENTIFICATION BORING NO.	SAMPLE NO.	SAMPLE DATE	DEPTH	TYPE	ANALYSIS PERFORMED	COMMENTS
B-10	S-1	1/18/88	0'-3'	Soil		
B-10	S-2	1/18/88	3'-8'	Soil	TPHC	
B-10	S-3	1/18/88	8'-13'	Soil		
B-10	S-4	1/18/88	13'-18'	Soil	TPHC	
B-10	S-5	1/18/88	18'-23'	Soil		
B-10	S-6	1/18/88	23'-28'	Soil	TPHC	
B-10	S-7	1/18/88	28'-33'	Soil		
B-10	S-8	1/18/88	33'-38'	Soil	TPHC	
B-10	S-9	1/18/88	38'-43'	Soil		
B-10	ST-1	1/18/88	38'-43'	Soil		
B-10	S-9	1/18/88	43'-48'	Soil		No recovery
B-10	S-10	1/18/88	48'-53'	Soil		
B-10	S-11	1/19/88	53'-58'	Soil		
B-10	S-12	1/19/88	58'-63'	Soil	TPHC	
B-10	S-13	1/19/88	63'-68'	Soil		
B-10	S-14	1/19/88	68'-73'	Soil	TPHC, VOA, BNAE	
B-10	S-15	1/19/88	73'-78'	Soil		

See footnotes at end of table.

SOIL SAMPLE LOG
(Continued)

SAMPLE IDENTIFICATION						
BORING NO.	SAMPLE NO.	SAMPLE DATE	DEPTH	TYPE	ANALYSIS PERFORMED	COMMENTS
B-11	S-1	1/5/88	0'-3'4"	Soil	TPHC Composite	
B-11	S-2	1/5/88	3'4"-8'4"	Soil	(S-1 & S-2)	
B-11	S-3	1/5/88	8'4"-13'4"	Soil		
B-11	S-4	1/5/88	13'4"-18'4"	Soil		
B-11	S-5	1/5/88	18'4"-23'4"	Soil	TPHC Composite	
B-11	S-6	1/5/88	23'4"-28'4"	Soil	(S-5 & S-6)	
B-11	S-7	1/5/88	28'4"-33'4"	Soil		
B-11	S-8	1/5/88	33'4"-38'4"	Soil	TPHC	
B-11	S-9	1/5/88	38'4"-43'4"	Soil		
B-11	S-10	1/5/88	43'4"-48'4"	Soil	TPHC	
B-11	S-11	1/5/88	0'-3'4"	Soil		
B-11	S-12	1/5/88	0'-3'4"	Soil	TPHC	
B-11	S-13	1/6/88	0'-3'4"	Soil		
B-11	S-14	1/6/88	0'-3'4"	Soil		
B-11	S-15	1/6/88	0'-3'4"	Soil		
B-11	S-16	1/6/88	0'-3'4"	Soil	TPHC	
B-11	S-17	1/6/88	0'-3'4"	Soil		

See footnotes at end of table.

SOIL SAMPLE LOG
(Continued)

SAMPLE IDENTIFICATION		SAMPLE			ANALYSIS	
BORING NO.	SAMPLE NO.	DATE	DEPTH	TYPE	PERFORMED	COMMENTS
B-12	S-1	1/21/88	0'-3'	Soil		
B-12	S-2	1/21/88	3'-8'	Soil	TPHC	
B-12	S-3	1/21/88	8'-13'	Soil	TPHC, BTU VOA, BNAE	
B-12	S-4	1/21/88	13'-18'	Soil	TPHC	
B-12	S-5	1/21/88	18'-23'	Soil	BTU	
B-12	S-6	1/21/88	23'-28'	Soil	TPHC	
B-12	S-7	1/21/88	28'-30'	Soil	TPHC	
MW-19	S-1	1/14/88	0'-2'	Soil	TPHC	
MW-19	S-2	1/14/88	2'-4'	Soil	Composite (S-1 & S-2)	
MW-19	S-3	1/14/88	4'-6'	Soil		
MW-19	S-4	1/14/88	6'-8'	Soil	TPHC	
MW-19	S-5	1/14/88	8'-10'	Soil	Composite	
MW-19	S-6	1/14/88	10'-12'	Soil	(S-4, S-5, & S-6)	
MW-19	S-7	1/14/88	12'-14'	Soil	TPHC	
MW-19	S-8	1/15/88	14'-16'	Soil	Composite	
MW-19	S-9	1/15/88	16'-18'	Soil	(S-7, S-8, & S-9)	

See footnotes at end of table.

SOIL SAMPLE LOG
(Continued)

SAMPLE IDENTIFICATION		SAMPLE DATE	DEPTH	TYPE	ANALYSIS PERFORMED	COMMENTS
BORING NO.	SAMPLE NO.					
MW-19	S-10	1/15/88	18'-20'	Soil	TPHC, TOC	
MW-19	S-11	1/15/88	20'-22'	Soil	Composite (S-10 & S-11) Total Metals, VOA, & BNAE	
MW-19	S-12	1/15/88	22'-24'	Soil	TPHC	
MW-19	S-13	1/15/88	24'-26'	Soil	Composite	
MW-19	S-14	1/15/88	26'-28'	Soil	(S-12, S-13, & S-14) BTU (S-14)	
MW-19	S-15	1/15/88	28'-30'	Soil		
MW-19	S-16	1/15/88	30'-32'			
MW-19	S-17	1/18/88	32'-34'	Soil		
MW-19	S-18	1/18/88	34'-36'	Soil		
MW-19	S-19	1/18/88	36'-38'	Soil		
MW-19	S-20	1/18/88	38'-40'	Soil	BTU, VOA, & BNAE	
MW-19	S-21	1/18/88	40'-42'	Soil		
MW-19	S-22	1/18/88	42'-44'	Soil		
MW-19	Comp. 58'	1/19/88	58'	Soil	TPHC	
MW-19	Comp. 75'	1/19/88	75'	Soil	BNAE, BTU, & VOA	

See footnotes at end of table.

SOIL SAMPLE LOG
(Continued)

SAMPLE IDENTIFICATION BORING NO.	SAMPLE NO.	SAMPLE DATE	DEPTH	TYPE	ANALYSIS PERFORMED	COMMENTS
MW-20	S-1	1/22/88	0'-3'	Soil	BTU	
MW-20	S-2	1/22/88	3'-8'	Soil	TPHC	
MW-20	S-3	1/22/88	8'-13'	Soil	Composite	
MW-20	S-4	1/22/88	13'-18'	Soil	(S-2, S-3 & S-4)	
MW-20	S-5	1/22/88	18'-23'	Soil		
MW-20	S-6	1/22/88	23'-28'	Soil		
MW-20	S-7	1/22/88	28'-33'	Soil		
MW-20	S-8	1/22/88	33'-38'	Soil		
MW-20	S-9	1/22/88	38'-43'	Soil		
MW-20	S-10	1/23/88	43'-48'	Soil		
MW-20	S-11	1/23/88	48'-53'	Soil		No Recovery
MW-20	S-12	1/23/88	53'-58'	Soil		
MW-20	S-13	1/24/88	58'-63'	Soil		No Recovery
MW-20	S-14	1/24/88	63'-68'	Soil		No Recovery
MW-20	S-15	1/24/88	68'-73'	Soil	TPHC	
MW-20	S-16	1/24/88	73'-78'	Soil	Composite (S-15 & S-16)	

[a]TPHC = total petroleum hydrocarbons.

[b]TOC = total organic carbons.

[c]VOA = volatile organic analysis.

[d]BNAE = base-neutral and acid extractables.

[e]BTU = British Thermal Units per pound; the measure of heat of combustion.

SECTION C

GROUND WATER SAMPLE COLLECTION AND ANALYSES LOG

SAMPLE LOG FOR GROUND WATER

SAMPLE NO.	LOCATION	DATE	DEPTH/ELEVATION (ft)[a]	VOLUME	ANALYSIS PERFORMED	COMMENTS
MW2K1	MW-2[b]	1/28/88	44/517.60	1 liter	total cyanide	
MW2K2	MW-2	1/28/88	44/517.60	1 liter	total phenols	
MW2K3	MW-2	1/28/88	44/517.60	VOA vial (40 ml)	benzene	
MW2K4	MW-2	1/28/88	44/517.60	0.5 gallon	naphthalene	
MW2K5	MW-2	1/28/88	44/517.60	500 ml	ammonia	
MW2L1	MW-2	1/31/88	64/497.60	1 liter	total cyanide	
MW2L2	MW-2	1/31/88	64/497.60	1 liter	total phenols	
MW2L3	MW-2	1/31/88	64/497.60	VOA vial (40 ml)	benzene	
MW2L4	MW-2	1/31/88	64/497.60	0.5 gallon	naphthalene	
MW2L5	MW-2	1/31/88	64/497.60	250 ml	ammonia	
MW2M1	MW-2	1/31/88	83/478.60	1 liter	total cyanide	
MW2M2	MW-2	1/31/88	83/478.60	1 liter	total phenols	
MW2M3	MW-2	1/31/88	83/478.60	VOA vial (40 ml)	benzene	
MW2M4	MW-2	1/31/88	83/478.60	0.5 gallon	naphthalene	
MW2M5	MW-2	1/31/88	83/478.60	250 ml	ammonia	
MW3K1A	MW-3	1/26/88	45/517.24	1 liter	total cyanide	sampled without purging, used Kemmerer
MW3K2A	MW-3	1/26/88	45/517.24	1 liter	total phenols	sampled without purging, used Kemmerer
MW3K3A	MW-3	1/26/88	45/517.24	VOA vial (40 ml)	benzene	sampled without purging, used Kemmerer
MW3K4A	MW-3	1/26/88	45/517.24	0.5 gallon	naphthalene	sampled without purging, used Kemmerer
MW3K5A	MW-3	1/26/88	45/517.24	500 ml	ammonia	sampled without purging, used Kemmerer
MW3L1A	MW-3	1/26/88	65/497.24	1 liter	total cyanide	sampled without purging, used Kemmerer
MW3L2A	MW-3	1/26/88	65/497.24	1 liter	total phenols	sampled without purging, used Kemmerer
MW3L3A	MW-3	1/26/88	65/497.24	VOA vial (40 ml)	benzene	sampled without purging, used Kemmerer
MW3L4A	MW-3	1/26/88	65/497.24	0.5 gallon	naphthalene	sampled without purging, used Kemmerer
MW3L5A	MW-3	1/26/88	65/497.24	500 ml	ammonia	sampled without purging, used Kemmerer
MW3M1A	MW-3	1/27/88	86/476.24	1 liter	total cyanide	sampled without purging, used Kemmerer
MW3M2A	MW-3	1/27/88	86/476.24	1 liter	total phenols	sampled without purging, used Kemmerer
MW3M3A	MW-3	1/27/88	86/476.24	VOA vial (40 ml)	benzene	sampled without purging, used Kemmerer
MW3M4A	MW-3	1/27/88	86/476.24	0.5 gallon	naphthalene	sampled without purging, used Kemmerer
MW3M5A	MW-3	1/27/88	86/476.24	500 ml	ammonia	sampled without purging, used Kemmerer

See footnotes at end of table.

SAMPLE LOG FOR GROUND WATER
(Continued)

SAMPLE NO.	LOCATION	DATE	DEPTH/ELEVATION (ft)	VOLUME	ANALYSIS PERFORMED	COMMENTS
MW3K1B	MW-3	2/3/88	45/517.24	1 liter	total cyanide	sampled after pumping and purging
MW3K2B	MW-3	2/3/88	45/517.24	1 liter	total phenols	sampled after pumping and purging
MW3K3B	MW-3	2/3/88	45/517.24	VOA vial (40 ml)	benzene	sampled after pumping and purging
MW3K4B	MW-3	2/3/88	45/517.24	0.5 gallon	naphthalene	sampled after pumping and purging
MW3K5B	MW-3	2/3/88	45/517.24	250 ml	ammonia	sampled after pumping and purging
MW3L1B	MW-3	2/3/88	65/497.24	1 liter	total cyanide	sampled after pumping and purging
MW3L2B	MW-3	2/3/88	65/497.24	1 liter	total phenols	sampled after pumping and purging
MW3L3B	MW-3	2/3/88	65/497.24	VOA vial (40 ml)	benzene	sampled after pumping and purging
MW3L4B	MW-3	2/3/88	65/497.24	0.5 gallon	naphthalene	sampled after pumping and purging
MW3L5B	MW-3	2/3/88	65/497.24	250 ml	ammonia	sampled after pumping and purging
MW3M1B	MW-3	2/3/88	86/476.24	1 liter	total cyanide	sampled after pumping and purging
MW3M2B	MW-3	2/3/88	86/476.24	1 liter	total phenols	sampled after pumping and purging
MW3M3B	MW-3	2/3/88	86/476.24	VOA vial (40 ml)	benzene	sampled after pumping and purging
MW3M4B	MW-3	2/3/88	86/476.24	0.5 gallon	naphthalene	sampled after pumping and purging
MW3M5B	MW-3	2/3/88	86/476.24	250 ml	ammonia	sampled after pumping and purging
MW12K1	MW-12	1/28/88	48/514.17	1 liter	total cyanide	
MW12K2	MW-12	1/28/88	48/514.17	1 liter	total phenols	
MW12K3	MW-12	1/28/88	48/514.17	VOA vial (40 ml)	benzene	
MW12K4	MW-12	1/28/88	48/514.17	0.5 gallon	naphthalene	
MW12K5	MW-12	1/28/88	48/514.17	500 ml	ammonia	
MW12L1	MW-12	1/28/88	65/497.17	1 liter	total cyanide	
MW12L2	MW-12	1/28/88	65/497.17	1 liter	total phenols	
MW12L3	MW-12	1/28/88	65/497.17	VOA vial (40 ml)	benzene	
MW12L4	MW-12	1/28/88	65/497.17	0.5 gallon	naphthalene	
MW12L5	MW-12	1/28/88	65/497.17	500 ml	ammonia	
MW12M1	MW-12	1/28/88	78/484.17	1 liter	total cyanide	
MW12M2	MW-12	1/28/88	78/484.17	1 liter	total phenols	
MW12M3	MW-12	1/28/88	78/484.17	VOA vial (40 ml)	benzene	
MW12M4	MW-12	1/28/88	78/484.17	0.5 gallon	naphthalene	
MW12M5	MW-12	1/28/88	78/484.17	500 ml	ammonia	

See footnotes at end of table.

SAMPLE LOG FOR GROUND WATER
(Continued)

SAMPLE NO.	LOCATION	DATE	DEPTH/ELEVATION (ft)	VOLUME	ANALYSIS PERFORMED	COMMENTS
MW14K1	MW-14	2/3/88	30/517.05	1 liter	total cyanide	
MW14K2	MW-14	2/3/88	30/517.05	1 liter	total phenols	
MW14K3	MW-14	2/3/88	30/517.05	VOA vial (40 ml)	benzene	
MW14K4	MW-14	2/3/88	30/517.05	0.5 gallon	naphthalene	
MW14K5	MW-14	2/3/88	30/517.05	250 ml	ammonia	
MW14L1	MW-14	2/3/88	45/502.05	1 liter	total cyanide	
MW14L2	MW-14	2/3/88	45/502.05	1 liter	total phenols	
MW14L3	MW-14	2/3/88	45/502.05	VOA vial (40 ml)	benzene	
MW14L4	MW-14	2/3/88	45/502.05	0.5 gallon	naphthalene	
MW14L5	MW-14	2/3/88	45/502.05	500 ml	ammonia	
MW14M1	MW-14	2/3/88	63/484.05	1 liter	total cyanide	
MW14M2	MW-14	2/3/88	63/484.05	1 liter	total phenols	
MW14M3	MW-14	2/3/88	63/484.05	VOA vial (40 ml)	benzene	
MW14M4	MW-14	2/3/88	63/484.05	0.5 gallon	naphthalene	
MW14M5	MW-14	2/3/88	63/484.05	500 ml	ammonia	
MW19K1	MW-19	1/31/88	44/515.01	1 liter	total cyanide	
MW19K2	MW-19	1/31/88	44/515.01	1 liter	total phenols	
MW19K3	MW-19	1/31/88	44/515.01	VOA vial (40 ml)	VOA	
MW19K4	MW-19	1/31/88	44/515.01	0.5 gallon	PAH	
MW19K5	MW-19	1/31/88	44/515.01	250 ml	ammonia	
MW19L1	MW-19	1/31/88	60/499.01	1 liter	total cyanide	
MW19L2	MW-19	1/31/88	60/499.01	1 liter	total phenols	
MW19L3	MW-19	1/31/88	60/499.01	VOA vial (40 ml)	VOA	
MW19L4	MW-19	1/31/88	60/499.01	0.5 gallon	PAH	
MW19L5	MW-19	1/31/88	60/499.01	250 ml	ammonia	
MW19M1	MW-19	1/31/88	75/484.01	1 liter	total cyanide	
MW19M2	MW-19	1/31/88	75/484.01	1 liter	total phenols	
MW19M3	MW-19	1/31/88	75/484.01	VOA vial (40 ml)	VOA	
MW19M4	MW-19	1/31/88	75/484.01	0.5 gallon	PAH	
MW19M5	MW-19	1/31/88	75/484.01	250 ml	ammonia	

See footnotes at end of table.

SAMPLE LOG FOR GROUND WATER
(Continued)

SAMPLE NO.	LOCATION	DATE	DEPTH/ELEVATION (ft)	VOLUME	ANALYSIS PERFORMED	COMMENTS
MW19KLM6	MW-19	1/31/88	composite	2 liter	gen. chem. (Cl & SO_4)	field composite
MW19KLM7	MW-19	1/31/88	composite	2 liter	specified metals	field composite, see work plan for metals
MW19KLM8	MW-19	1/31/88	composite	2 liter	radiological, Ra	field composite
MW20K1	MW-20	2/2/88	44/515.40	1 liter	total cyanide	
MW20K2	MW-20	2/2/88	44/515.40	1 liter	total phenols	
MW20K3	MW-20	2/2/88	44/515.40	VOA vial (40 ml)	benzene	
MW20K4	MW-20	2/2/88	44/515.40	0.5 gallon	naphthalene	
MW20K5	MW-20	2/2/88	44/515.40	250 ml	ammonia	
MW20L1	MW-20	2/2/88	60/499.40	1 liter	total cyanide	
MW20L2	MW-20	2/2/88	60/499.40	1 liter	total phenols	
MW20L3	MW-20	2/2/88	60/499.40	VOA vial (40 ml)	benzene	
MW20L4	MW-20	2/2/88	60/499.40	0.5 gallon	naphthalene	
MW20L5	MW-20	2/2/88	60/499.40	250 ml	ammonia	
MW20M1	MW-20	2/2/88	75/484.40	1 liter	total cyanide	
MW20M2	MW-20	2/2/88	75/484.40	1 liter	total phenols	
MW20M3	MW-20	2/2/88	75/484.40	VOA vial (40 ml)	benzene	
MW20M4	MW-20	2/2/88	75/484.40	0.5 gallon	naphthalene	
MW20M5	MW-20	2/2/88	75/484.40	250 ml	ammonia	
MW20KLM6	MW-20	2/2/88	composite	2 liter	none	field composite
MW20KLM7	MW-20	2/2/88	composite	2 liter	none	field composite
MW20KLM8	MW-20	2/2/88	composite	2 liter	none	field composite
MW21K1	MW-19	1/31/88	44/515.01	1 liter	total cyanide	field duplicate of MW-19
MW21K2	MW-19	1/31/88	44/515.01	1 liter	total phenols	field duplicate of MW-19
MW21K3	MW-19	1/31/88	44/515.01	VOA vial (40 ml)	benzene	field duplicate of MW-19
MW21K4	MW-19	1/31/88	44/515.01	0.5 gallon	naphthalene	field duplicate of MW-19
MW21K5	MW-19	1/31/88	44/515.01	250 ml	ammonia	field duplicate of MW-19
MW21L1	MW-19	1/31/88	60/499.01	1 liter	total cyanide	field duplicate of MW-19
MW21L2	MW-19	1/31/88	60/499.01	1 liter	total phenols	field duplicate of MW-19
MW21L3	MW-19	1/31/88	60/499.01	VOA vial (40 ml)	benzene	field duplicate of MW-19
MW21L4	MW-19	1/31/88	60/499.01	0.5 gallon	naphthalene	field duplicate of MW-19
MW21L5	MW-19	1/31/88	60/499.01	250 ml	ammonia	field duplicate of MW-19

See footnotes at end of table.

SAMPLE LOG FOR GROUND WATER
(Continued)

SAMPLE NO.	LOCATION	DATE	DEPTH/ELEVATION (ft)	VOLUME	ANALYSIS PERFORMED	COMMENTS
MW21M1	MW-19	1/31/88	75/484.01	1 liter	total cyanide	field duplicate of MW-19
MW21M2	MW-19	1/31/88	75/484.01	1 liter	total phenols	field duplicate of MW-19
MW21M3	MW-19	1/31/88	75/484.01	VOA vial (40 ml)	benzene	field duplicate of MW-19
MW21M4	MW-19	1/31/88	75/484.01	0.5 gallon	naphthalene	field duplicate of MW-19
MW21M5	MW-19	1/31/88	75/484.01	250 ml	ammonia	field duplicate of MW-19
MW21KLM6	MW-19	1/31/88	composite	2 liter	none	field duplicate of MW-19, field composite
MW21KLM7	MW-19	1/31/88	composite	2 liter	none	field duplicate of MW-19, field composite
MW21KLM8	MW-19	1/31/88	composite	2 liter	radiological, Ra	field duplicate of MW-19, field composite
MW22K1	-	1/31/88	-	1 liter	total cyanide	field blank, deionized water run through ISCO
MW22K2	-	1/31/88	-	1 liter	total phenols	field blank, deionized water run through ISCO
MW22K3	-	1/31/88	-	VOA vial (40 ml)	benzene	field blank, deionized water run through ISCO
MW22K4	-	1/31/88	-	0.5 gallon	naphthalene	field blank, deionized water run through ISCO
MW22K5	-	1/31/88	-	250 ml	ammonia	field blank, deionized water run through ISCO

[a]Depths reported were measured from the highest point of the PVC casing.
[b]MW = Monitoring Well.

SECTION D

FILTER CAKE TESTING

Satish K. Gupta | April 28, 1988

Glenn Schwartz | Project No. 303024

FILTER CAKE TESTING/ALLIED IRONTON

To test the compatibility of the ground water with commercial bentonites, filter cake tests were performed. This test is an indicator of the susceptibility of bentonite attack by the ground water. The bentonites used in this test were Federal 90 and Federal 125. The ground water used in this testing program was obtained from Monitoring Well 19 (MW-19). (See Tables SD1 through SD3 for results.) This water has a high solids content.

Filter cake tests are performed by first mixing a slurry of approximately four percent bentonite by weight with distilled water to obtain a 40-second marsh cone value.(a) After at least 12 hours of hydration, the slurry is placed on a sand bed in a standard API filter press. A schematic of the test apparatus is shown in Figure I1. A 14 pound per square inch (psi) air pressure is applied to the system for two hours which results in the formation of a filter cake. The pressure is relieved and the remaining slurry is poured out and replaced with the permeant (ground water or distilled water). A 14 psi air pressure is then applied to the system and time-flow data are obtained. The filter cake tests (developed by IT) are performed using a single pressure source and flow readings are obtained simultaneously to ensure that each test is conducted under identical conditions.

Bentonites are evaluated by comparing the flow characteristics obtained from the permeation of the filter cakes. The effect of the ground water on various bentonites is evaluated by comparing the ratio of the ground water flow rate to the distilled water flow rate for the bentonites tested. A bentonite's permeability is evaluated by comparing the ground water and/or distilled water flow rates of various bentonites. Approximately ten pore volumes were permeated through the cakes, which is considered sufficient for this indicator test.

The six filter cake test results are presented in Tables SD4 to SD7 and Figures SD2 to SD9. Figures SD2 to SD5 graphically illustrate the ratio of the ground water flow rate to the distilled water flow rate versus the total flow of the ground water divided by the pore volume of the filter cake (pore volumes of fluid exchanged). Figures SD6 to SD9 illustrate the total flow of the distilled water and the ground water versus elapsed time. Photographs of the filter cakes after permeation are also attached.

(a)American Petroleum Institute (API), April 1976, "API Recommended Practice Standard Procedure for testing Drilling Fluids," API RP 13B, Sixth Edition, 33 pp.

Figures SD2 to SD5, the flow rates with ground water range from a factor of approximately 0.5 to 9 higher than the flow rates with distilled water. Based on past experience, bentonites with a ground water to distilled water ratio of less than approximately three have performed satisfactorily in detailed design testing (permeability tests). A total of four tests were performed on of the two bentonites tested. The results can be categorized by flow ratios into two groups; low and consistent (1.0 to 2.0) as shown in Figure SD2 and SD3 and high and inconsistent (0.5 to 8.9) as shown in Figure SD4 and SD5. Based on this flow ratio comparison, the bentonite in the low grouping (Federal 90) is worth further consideration. The other bentonite, Federal 125, is considered undesirable for this site. The next evaluation criteria is the effectiveness of a bentonite as an impermeable barrier. As shown on Figures SD6 to SD9, Federal 90 is again superior. Its ground water flow rate is approximately one-half less than the flow rate of Federal 125 bentonite.Based on these results and a visual observation of the cakes after permeation, Federal 90 bentonite is worth further consideration.

The photographs of the filter cakes record the appearance after permeation. The different colors shown on the filter cake photographs are believed to be caused by the uneven distribution of these solids and are not believed to have influenced the test results. Bentonite cracking during filter cake testing is not uncommon. It is our experience from other testing that cracking of the filter cake is not necessarily indicative of unsatisfactory performance of a soil-bentonite backfill. In addition, this test is an indicator test that provides timely data for selecting a superior bentonite prior to initiation of a long-term testing program. Long-term permeability tests should be used to evaluate the effects of the site ground water on the design backfill materials.

Sodium, calcium, and some heavy metals may affect bentonite. No significant effects were noticed during the filter cake testing using worst case site ground water. To further evaluate the effects of site ground water on the bentonite, additional long-term permeability tests would be conducted on the design mix (i.e., soil-bentonite) to simulate 30 or more years of flow.

GDS:wp

TABLE SD-1

STAGNANT WATER ANALYSIS
SEMIVOLATILE HAZARDOUS SUBSTANCE LIST

PARAMETER	CAS NUMBER[a]	SAMPLE IDENTIFICATION MW-19 0122095[b] Concentration µg/ℓ[c]
Acenaphthene	83-32-9	<5,000
Acenaphthylene	208-96-8	<5,000
Anthracene	120-12-7	18,000
Benzo(a)anthracene	56-55-3	<5,000
Benzo(a)pyrene	50-32-8	<5,000
3,4-Benzofluoranthene	205-99-2	<5,000
Benzo(g,h,i)perylene	191-24-2	<5,000
Benzoic acid	65-85-0	48,000
Benzo(k)fluoranthene	207-08-9	<5,000
Benzyl alcohol	100-51-6	<5,000
Bis(2-chloroethoxy)methane	111-91-1	<5,000
Bis(2-chloroethyl)ether	111-44-4	<5,000
Bis(2-chloroisopropyl)ether	39638-32-9	<5,000
Bis(2-ethylhexyl)phthalate	117-81-7	<5,000
4-Bromophenyl phenyl ether	101-55-3	<5,000
Butyl benzyl phthalate	85-68-7	<5,000
4-Chloroaniline	106-47-8	<5,000
2-Chloronaphthalene	91-58-7	<5,000
2-Chlorophenol	95-57-8	<5,000
4-Chlorophenyl phenyl ether	7005-72-3	<5,000
Chrysene	218-01-9	<5,000
Dibenzo(a,h)anthracene	53-70-3	<5,000
Dibenzofuran	132-64-9	<5,000
1,2-Dichlorobenzene	95-50-1	<5,000
1,3-Dichlorobenzene	541-73-1	<5,000
1,4-Dichlorobenzene	106-46-7	<5,000
3,3'-Dichlorobenzidine	91-94-1	<10,000
2,4-Dichlorophenol	120-83-2	<5,000
Diethyl phthalate	84-66-2	<5,000
2,4-Dimethylphenol	105-67-9	<5,000
4,6-Dinitro-o-cresol	534-52-1	<25,000
2,4-Dinitrophenol	51-28-5	<25,000
Dimethyl phthalate	131-11-3	<5,000
Di-n-butyl phthalate	84-74-2	<5,000
2,4-Dinitrotoluene	121-14-2	<5,000
2,6-Dinitrotoluene	606-20-2	<5,000
Di-n-octyl phthalate	117-84-0	<5,000
Fluoranthene	206-44-0	5,300
Fluorene	86-73-7	6,000

See footnotes at end of table.

TABLE SD-1
(Continued)

PARAMETER	CAS NUMBER[a]	SAMPLE IDENTIFICATION MW-19 0122095[b] Concentration µg/ℓ[c]
Hexachlorobenzene	118-71-1	<5,000
Hexachlorobutadiene	87-68-3	<5,000
Hexachlorocyclopentadiene	77-47-4	<5,000
Hexachloroethane	67-72-1	<5,000
Indeno(1,2,3-cd)pyrene	193-39-5	<5,000
Isophorone	78-59-1	<5,000
2-Methylnaphthalene	91-57-6	<5,000
2-Methylphenol	95-48-7	<5,000
4-Methylphenol	106-44-5	13,000
Naphthalene	91-20-3	12,000
2-Nitroaniline	88-74-4	<25,000
3-Nitroaniline	99-09-2	<25,000
4-Nitroaniline	100-01-6	<25,000
Nitrobenzene	98-95-3	<5,000
2-Nitrophenol	88-75-5	<5,000
4-Nitrophenol	100-02-7	<25,000
N-Nitrosodi-n-propylamine	621-64-7	<5,000
N-Nitrosodiphenylamine (Diphenylamine)[d]	86-30-6	<5,000
p-Chloro-m-cresol	59-50-7	<5,000
Pentachlorophenol	87-86-5	<25,000
Phenanthrene	85-01-8	17,000
Phenol	108-95-2	<5,000
Pyrene	129-00-0	<5,000
1,2,4-Trichlorobenzene	120-82-1	<5,000
2,4,5-Trichlorophenol	95-95-4	<25,000
2,4,6-Trichlorophenol	88-06-2	<5,000

[a]The numbers presented in this column are the Chemical Abstracts Service (CAS) numbers used for cataloging the indicated compounds in the Chemical Abstracts Index.

[b]Ground water sample was collected upon encountering the ground water table during well installation. This sample was used in filter cake testing for slurry compatability.

[c]µg/ℓ = micrograms per liter or parts per billion.

[d]Detected as compound in parentheses.

TABLE SD-2

STAGNANT WATER ANALYSIS
VOLATILE HAZARDOUS SUBSTANCE LIST COMPOUNDS

PARAMETER	CAS NUMBER[a]	SAMPLE IDENTIFICATION MW-19 0122095[b] Concentration µg/ℓ[c]
Acetone	67-64-1	320
Benzene	71-43-2	1200
2-Butanone	78-93-3	130
Bromoform	75-25-2	<25
Carbon disulfide	75-15-0	<25
Carbon tetrachloride	56-23-5	<25
Chlorobenzene	108-90-7	<25
Chlorodibromomethane	124-48-1	<25
Chloroethane	75-00-3	<50
2-Chloroethylvinyl ether	110-75-8	<50
Chloroform	67-66-3	<25
Cis-1,3-dichloropropene	10061-01-5	<25
Dichlorobromomethane	75-27-4	<25
1,1-Dichloroethane	75-34-3	<25
1,2-Dichloroethane	107-06-2	<25
1,1-Dichloroethylene	75-35-4	<25
1,2-Dichloropropane	78-87-5	<25
Ethylbenzene	100-41-4	91

TABLE SD-2
(Continued)

PARAMETER	CAS NUMBER[a]	SAMPLE IDENTIFICATION MW-19 0122095[b] Concentration μg/ℓ[c]
2-Hexanone	591-78-6	<50
Methyl bromide	74-83-9	<50
Methyl chloride	74-87-3	<50
Methylene chloride	75-09-2	<25
4-Methyl-2-pentanone	108-10-1	54
Styrene	100-42-5	110
1,1,2,2-Tetrachloroethane	79-34-5	<25
Tetrachloroethylene	127-18-4	<25
Toluene	108-88-3	620
trans-1,2-Dichloroethylene	156-60-5	120
trans-1,3-Dichloropropene	10061-02-6	<25
1,1,1-Trichloroethane	71-55-6	<25
1,1,2-Trichloroethane	79-00-5	<25
Trichloroethylene	79-01-6	450
Vinyl acetate	108-05-4	<50
Vinyl chloride	75-01-4	37
Total xylenes	95-47-6	450

[a]The numbers presented in this column are the Chemical Abstracts Service (CAS) numbers used for cataloging the indicated compounds in the Chemical Abstracts Index.

[b]Ground water sample was collected upon encountering the ground water table during well installation. This sample was used in filter cake testing for slurry compatability.

[c]μg/ℓ = micrograms per liter or parts per billion.

TABLE SD-3

STAGNANT WATER ANALYSIS
TOTAL METALS
FOR ALLIED IRONTON
PROJECT NO. 303024

PARAMETER	UNITS[a]	SAMPLE IDENTIFICATION MW-19 0122095 and 0121881200[b]
Aluminum	mg/ℓ	260
Antimony	mg/ℓ	0.39
Arsenic	mg/ℓ	0.28
Barium	mg/ℓ	4.4
Beryllium	mg/ℓ	0.024
Cadmium	mg/ℓ	0.029
Calcium	mg/ℓ	1400
Chromium	mg/ℓ	0.39
Cobalt	mg/ℓ	0.24
Copper	mg/ℓ	1.8
Iron	mg/ℓ	810
Lead	mg/ℓ	1.2
Magnesium	mg/ℓ	190
Manganese	mg/ℓ	14
Mercury	mg/ℓ	0.10/0.10[c]
Nickel	mg/ℓ	0.78
Potassium	mg/ℓ	150
Selenium	mg/ℓ	0.034
Silver	mg/ℓ	0.04
Sodium	mg/ℓ	2900
Thallium	mg/ℓ	0.011
Vanadium	mg/ℓ	2.0
Zinc	mg/ℓ	4.6

[a] mg/ℓ = milligrams per liter or parts per million.

[b] Ground water sample was collected upon encountering the ground water table during well installation. This sample was used in filter cake testing for slurry compatability.

[c] The indicated sample was prepared and analyzed in duplicate.

TABLE SD-4

FILTER CAKE TEST

ALLIED IRONTON,303026,TEST1-2,FED 90

Bentonite Type:	FED 90	Concentration:	45.00 gm/l
Cake Formation Tim	2.00 hrs.	Marsh Cone:	40.00 sec.
Cake Thickness:	0.1-0.2 in.	Total Filtrate Loss	
Pore Volume:	9.00 ml.	during cake formation:	36.30 ml.

Comments:MW-19 COMPOSITE WITH FEDERAL 90

ELAPSED TIME (min)	BURRETTE READING H2O (ml)	BURETTE READING LEACHATE (ml)	delta t (min)	delta flow WATER (ml)	delta flow LEACHATE (ml)	PV EXCHANGE (ml)	K (H2O)	K(LEA)	K(LEA)/K(H2O)
0.0	0.0	0.0							
1.0	1.0	1.3	1	1.00	1.30	0.14	1.00	1.30	1.30
2.0	1.5	2.0	1	0.50	0.70	0.22	0.50	0.70	1.40
4.0	1.8	4.0	2	0.25	2.00	0.44	0.13	1.00	8.00
10.0	3.0	9.5	6	1.25	5.50	1.06	0.21	0.92	4.40
20.0	6.0	18.0	10	3.00	8.50	2.00	0.30	0.85	2.83
30.0	10.3	26.0	10	4.30	8.00	2.89	0.43	0.80	1.86
40.0	14.0	35.0	10	3.70	9.00	3.89	0.37	0.90	2.43
50.0	18.0	42.5	10	4.00	7.50	4.72	0.40	0.75	1.88
60.0	22.0	49.5	10	4.00	7.00	5.50	0.40	0.70	1.75
70.0	26.0	57.0	10	4.00	7.50	6.33	0.40	0.75	1.88
80.0	30.0	63.0	10	4.00	6.00	7.00	0.40	0.60	1.50
100.0	38.0	76.0	20	8.00	13.00	8.44	0.40	0.65	1.63
120.0	46.0	89.0	20	8.00	13.00	9.89	0.40	0.65	1.63
140.0	54.0	102.0	20	8.00	13.00	11.33	0.40	0.65	1.63
160.0	62.0	114.0	20	8.00	12.00	12.67	0.40	0.60	1.50
180.0	69.0	126.0	20	7.00	12.00	14.00	0.35	0.60	1.71
200.0	76.0	138.0	20	7.00	12.00	15.33	0.35	0.60	1.71
220.0	82.0	148.0	20	6.00	10.00	16.44	0.30	0.50	1.67
240.0	88.0	158.0	20	6.00	10.00	17.56	0.30	0.50	1.67
260.0	94.0	169.0	20	6.00	11.00	18.78	0.30	0.55	1.83
280.0	100.0	178.0	20	6.00	9.00	19.78	0.30	0.45	1.50
300.0	106.0	188.0	20	6.00	10.00	20.89	0.30	0.50	1.67
320.0	111.0	198.0	20	5.00	10.00	22.00	0.25	0.50	2.00
340.0	116.0	207.0	20	5.00	9.00	23.00	0.25	0.45	1.80
360.0	121.0	216.0	20	5.00	9.00	24.00	0.25	0.45	1.80
380.0	126.0	225.0	20	5.00	9.00	25.00	0.25	0.45	1.80
400.0	131.0	233.0	20	5.00	8.00	25.89	0.25	0.40	1.60
420.0	136.0	241.0	20	5.00	8.00	26.78	0.25	0.40	1.60
440.0	140.0	249.0	20	4.00	8.00	27.67	0.20	0.40	2.00
460.0	144.0	257.0	20	4.00	8.00	28.56	0.20	0.40	2.00
480.0	148.0	265.0	20	4.00	8.00	29.44	0.20	0.40	2.00
500.0	152.0	272.0	20	4.00	7.00	30.22	0.20	0.35	1.75
520.0	156.0	280.0	20	4.00	8.00	31.11	0.20	0.40	2.00
540.0	160.0	288.0	20	4.00	8.00	32.00	0.20	0.40	2.00
580.0	168.0	303.0	40	8.00	15.00	33.67	0.20	0.38	1.88
620.0	176.0	317.0	40	8.00	14.00	35.22	0.20	0.35	1.75
660.0	184.0	331.0	40	8.00	14.00	36.78	0.20	0.35	1.75

TABLE **SD-5**

FILTER CAKE TEST

ALLIED IRONTON,303024,TEST1-5,FED 90

Bentonite Type:	FED 90	Concentration:	45.00 gm/l
Cake Formation Tim	2.00 hrs.	Marsh Cone:	40.00 sec.
Cake Thickness:	0.1-0.2 in.	Total Filtrate Loss	
Pore Volume:	9.00 ml.	during cake formation:	36.30 ml.

Comments.MW-19 COMPOSITE WITH FEDERAL 90

ELAPSED TIME (min)	BURRETTE READING H2O (ml)	BURETTE READING LEACHATE (ml)	delta t (min)	delta flow WATER (ml)	delta flow LEACHATE (ml)	PV EXCHANGE (ml)	K (H2O)	K(LEA)	K(LEA)/K(H2O)
0.0	0.0	0.0							
1.0	1.0	1.5	1	1.00	1.50	0.17	1.00	1.50	1.50
2.0	1.5	1.8	1	0.50	0.25	0.19	0.50	0.25	0.50
4.0	1.8	2.5	2	0.25	0.75	0.28	0.13	0.38	3.00
10.0	3.0	5.3	6	1.25	2.75	0.58	0.21	0.46	2.20
20.0	6.0	11.8	10	3.00	6.50	1.31	0.30	0.65	2.17
30.0	10.3	18.3	10	4.30	6.50	2.03	0.43	0.65	1.51
40.0	14.0	24.0	10	3.70	5.75	2.67	0.37	0.58	1.55
50.0	18.0	30.5	10	4.00	6.50	3.39	0.40	0.65	1.63
60.0	22.0	36.5	10	4.00	6.00	4.06	0.40	0.60	1.50
70.0	26.0	42.5	10	4.00	6.00	4.72	0.40	0.60	1.50
80.0	30.0	48.5	10	4.00	6.00	5.39	0.40	0.60	1.50
100.0	38.0	60.5	20	8.00	12.00	6.72	0.40	0.60	1.50
120.0	46.0	71.5	20	8.00	11.00	7.94	0.40	0.55	1.38
140.0	54.0	82.5	20	8.00	11.00	9.17	0.40	0.55	1.38
160.0	62.0	93.5	20	8.00	11.00	10.39	0.40	0.55	1.38
180.0	69.0	104.5	20	7.00	11.00	11.61	0.35	0.55	1.57
200.0	76.0	114.5	20	7.00	10.00	12.72	0.35	0.50	1.43
220.0	82.0	124.5	20	6.00	10.00	13.83	0.30	0.50	1.67
240.0	88.0	134.5	20	6.00	10.00	14.94	0.30	0.50	1.67
260.0	94.0	143.5	20	6.00	9.00	15.94	0.30	0.45	1.50
280.0	100.0	152.5	20	6.00	9.00	16.94	0.30	0.45	1.50
300.0	106.0	162.5	20	6.00	10.00	18.06	0.30	0.50	1.67
320.0	111.0	172.5	20	5.00	10.00	19.17	0.25	0.50	2.00
340.0	116.0	181.5	20	5.00	9.00	20.17	0.25	0.45	1.80
360.0	121.0	190.5	20	5.00	9.00	21.17	0.25	0.45	1.80
380.0	126.0	199.5	20	5.00	9.00	22.17	0.25	0.45	1.80
400.0	131.0	206.5	20	5.00	7.00	22.94	0.25	0.35	1.40
420.0	136.0	214.5	20	5.00	8.00	23.83	0.25	0.40	1.60
440.0	140.0	222.5	20	4.00	8.00	24.72	0.20	0.40	2.00
460.0	144.0	230.5	20	4.00	8.00	25.61	0.20	0.40	2.00
480.0	148.0	238.5	20	4.00	8.00	26.50	0.20	0.40	2.00
500.0	152.0	245.5	20	4.00	7.00	27.28	0.20	0.35	1.75
520.0	156.0	252.5	20	4.00	7.00	28.06	0.20	0.35	1.75
540.0	160.0	259.5	20	4.00	7.00	28.83	0.20	0.35	1.75
580.0	168.0	272.5	40	8.00	13.00	30.28	0.20	0.33	1.63
[illegible]	176.0	285.5	40	8.00	13.00	31.72	0.20	0.33	1.63
[illegible]	184.0	298.5	40	8.00	13.00	33.17	0.20	0.33	1.63

TABLE SD-6

FILTER CAKE TEST

ALLIED IRONTON,303024,TEST3-4,FED 125

Bentonite Type: FEDERAL 125		Concentration:	37.50 gm/l
Cake Formation Tim	2.00 hrs.	Marsh Cone:	41.00 sec.
Cake Thickness:	0.1-0.2 in.	Total Filtrate Loss	
Pore Volume:	9.00 ml.	during cake formation:	62.30 ml.

Comments:MW-19 COMPOSITE WITH FEDERAL 125

ELAPSED TIME (min)	BURRETTE READING H2O (ml)	BURETTE READING LEACHATE (ml)	delta t (min)	delta flow WATER (ml)	delta flow LEACHATE (ml)	PV EXCHANGE (ml)	K (H2O)	K(LEA)	K(LEA)/K(H2O)
2.0	1.5	2.0	2	1.50	2.00	0.22	0.75	1.00	1.33
4.0	2.5	5.0	2	1.00	3.00	0.56	0.50	1.50	3.00
10.0	3.8	14.0	6	1.25	9.00	1.56	0.21	1.50	7.20
20.0	6.0	25.0	10	2.25	11.00	2.78	0.23	1.10	4.89
30.0	8.0	39.8	10	2.00	14.75	4.42	0.20	1.48	7.38
40.0	10.0	50.0	10	2.00	10.25	5.56	0.20	1.03	5.13
50.0	12.0	63.0	10	2.00	13.00	7.00	0.20	1.30	6.50
60.0	14.0	75.0	10	2.00	12.00	8.33	0.20	1.20	6.00
70.0	16.0	88.0	10	2.00	13.00	9.78	0.20	1.30	6.50
80.0	18.0	100.5	10	2.00	12.50	11.17	0.20	1.25	6.25
100.0	22.0	122.5	20	4.00	22.00	13.61	0.20	1.10	5.50
120.0	27.0	144.5	20	5.00	22.00	16.06	0.25	[illegible]	4.40
140.0	47.0	166.5	20	20.00	22.00	18.50	1.00	1.10	1.10
160.0	66.0	186.5	20	19.00	20.00	20.72	0.95	1.00	1.05
180.0	84.0	206.0	20	18.00	19.50	22.89	0.90	0.98	1.08
[illegible]	102.0	225.5	20	18.00	19.50	25.06	0.90	0.98	1.08
220.0	120.0	244.5	20	18.00	19.00	27.17	0.90	0.95	1.06
240.0	130.0	262.5	20	10.00	18.00	29.17	0.50	0.90	1.80
260.0	141.0	280.5	20	11.00	18.00	31.17	0.55	0.90	1.64
280.0	150.0	296.5	20	9.00	16.00	32.94	0.45	0.80	1.78
300.0	166.0	311.5	20	16.00	15.00	34.61	0.80	0.75	0.94
320.0	[illegible]	317.5	20	12.00	6.00	35.28	0.60	0.30	0.50
340.0	[illegible]	[illegible]	20	5.00	2.00	35.50	0.25	0.10	0.40
360.0	187.0	320.5	20	4.00	1.00	35.61	0.20	0.05	0.25

TABLE SD-7

FILTER CAKE TEST

ALLIED IRONTON,303024,TEST3-6,FED 125

Bentonite Type: FEDERAL 125 Concentration: 37.50 gm/l
Cake Formation Tim 2.00 hrs. Marsh Cone: 41.00 sec.
Cake Thickness: 0.1-0.2 in. Total Filtrate Loss
Pore Volume: 9.00 ml. during cake formation: 62.30 ml.

Comments:MW-19 COMPOSITE WITH FEDERAL 125

ELAPSED TIME (min)	BURRETTE READING H2O (ml)	BURETTE READING LEACHATE (ml)	delta t (min)	delta flow WATER (ml)	delta flow LEACHATE (ml)	PV EXCHANGE (ml)	K (H2O)	K(LEA)	K(LEA)/K(H2O)
0.0	0.0	0.0							
2.0	1.5	1.0	2	1.50	1.00	0.11	0.75	0.50	0.67
4.0	2.5	1.5	2	1.00	0.50	0.17	0.50	0.25	0.50
10.0	3.8	7.0	6	1.25	5.50	0.78	0.21	0.92	4.40
20.0	6.0	11.8	10	2.25	4.75	1.31	0.23	0.48	2.11
30.0	8.0	29.5	10	2.00	17.75	3.28	0.20	1.78	8.87
40.0	10.0	39.5	10	2.00	10.00	4.39	0.20	1.00	5.00
50.0	12.0	49.5	10	2.00	10.00	5.50	0.20	1.00	5.00
60.0	14.0	59.5	10	2.00	10.00	6.61	0.20	1.00	5.00
70.0	16.0	69.0	10	2.00	9.50	7.67	0.20	0.95	4.75
80.0	18.0	78.0	10	2.00	9.00	8.67	0.20	0.90	4.50
100.0	22.0	96.5	20	4.00	18.50	10.72	0.20	0.93	4.63
120.0	27.0	114.5	20	5.00	18.00	12.72	0.25	0.90	3.60
140.0	47.0	132.5	20	20.00	18.00	14.72	1.00	0.90	0.90
160.0	66.0	148.5	20	19.00	16.00	16.50	0.95	0.80	0.84
180.0	84.0	164.5	20	18.00	16.00	18.28	0.90	0.80	0.89
200.0	102.0	180.5	20	18.00	16.00	20.06	0.90	0.80	0.89
220.0	120.0	195.5	20	18.00	15.00	21.72	0.90	0.75	0.83
240.0	130.0	205.5	20	10.00	10.00	22.83	0.50	0.50	1.00
260.0	141.0	220.5	20	11.00	15.00	24.50	0.55	0.75	1.36
280.0	150.0	234.5	20	9.00	14.00	26.06	0.45	0.70	1.56
300.0	166.0	248.5	20	16.00	14.00	27.61	0.80	0.70	0.88
320.0	178.0	261.5	20	12.00	13.00	29.06	0.60	0.65	1.08
340.0	183.0	274.5	20	5.00	13.00	30.50	0.25	0.65	2.60
360.0	187.0	286.5	20	4.00	12.00	31.83	0.20	0.60	3.00
380.0	191.0	298.5	20	4.00	12.00	33.17	0.20	0.60	3.00
400.0	194.0	302.5	20	3.00	4.00	33.61	0.15	0.20	1.33

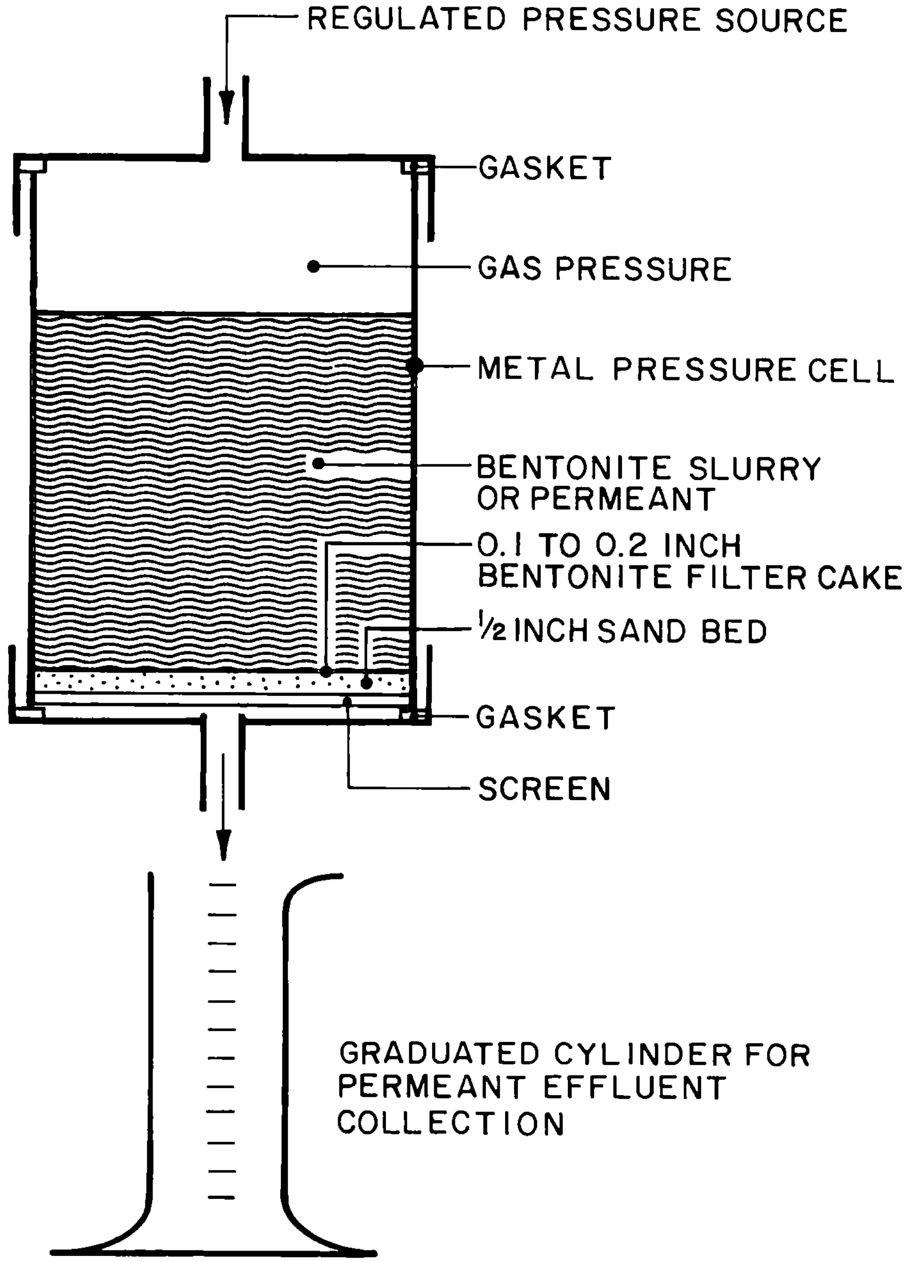


FIGURE SD-1

SCHEMATIC DRAWING OF
FILTER CAKE TEST SYSTEM

PREPARED FOR

ALLIED - SIGNAL INC.
MORRISTOWN, NEW JERSEY

INTERNATIONAL
TECHNOLOGY
CORPORATION

DRAWN BY	CHECKED BY	APPROVED BY	DRAWING NUMBER
M.S.H. 3-3-88	RLS 5/31/88	FKG 08/01/88	303024-A4

132298

Do Not Scale This Drawing

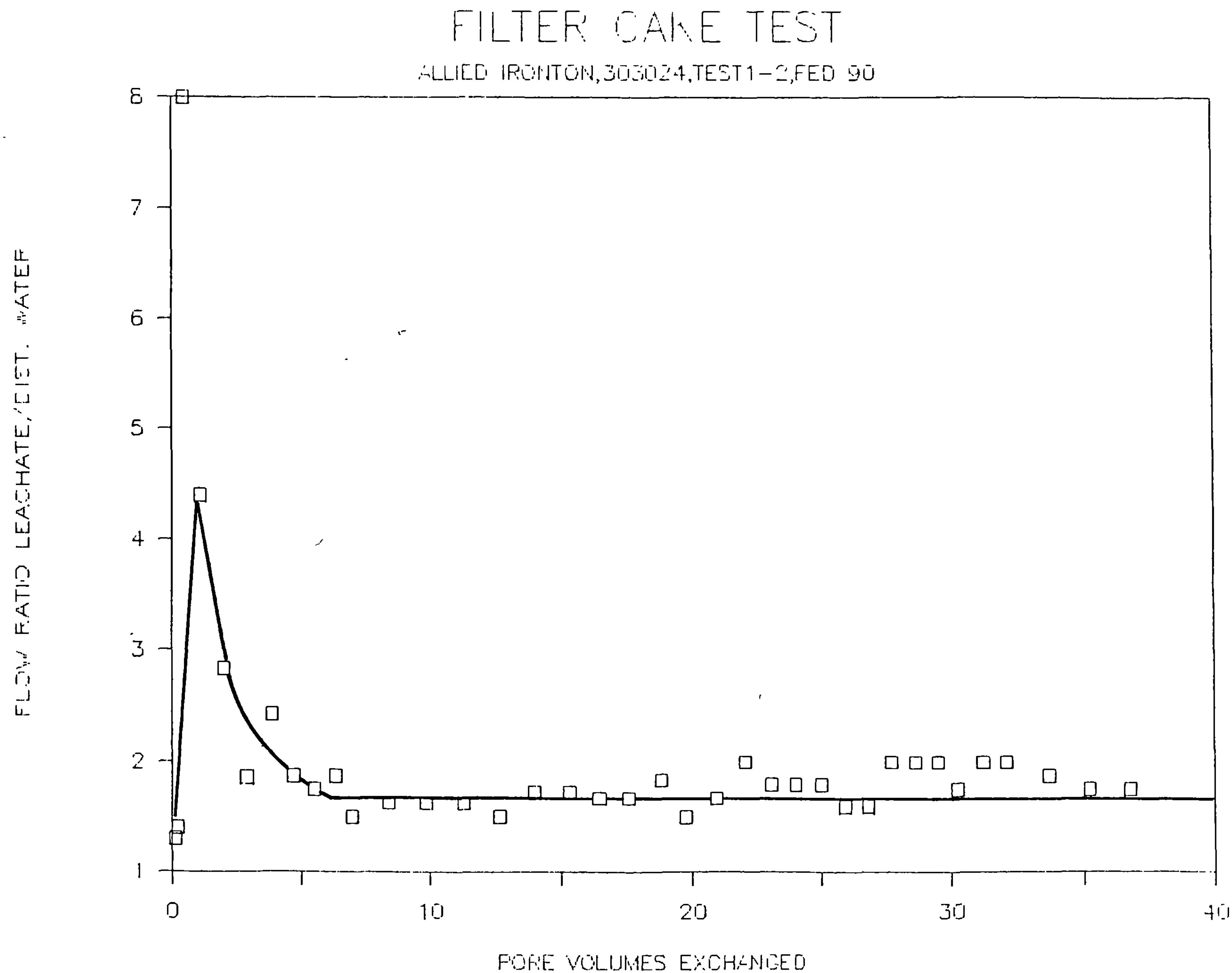

FILTER CAKE TEST
ALLIED IRONTON,303024,TEST1-2,FEB 90
FLOW RATIO LEACHATE/DIST. WATER
PORE VOLUMES EXCHANGED
0
10
20
30
40
1
2
3
4
5
6
7
8

FIGURE SD-2

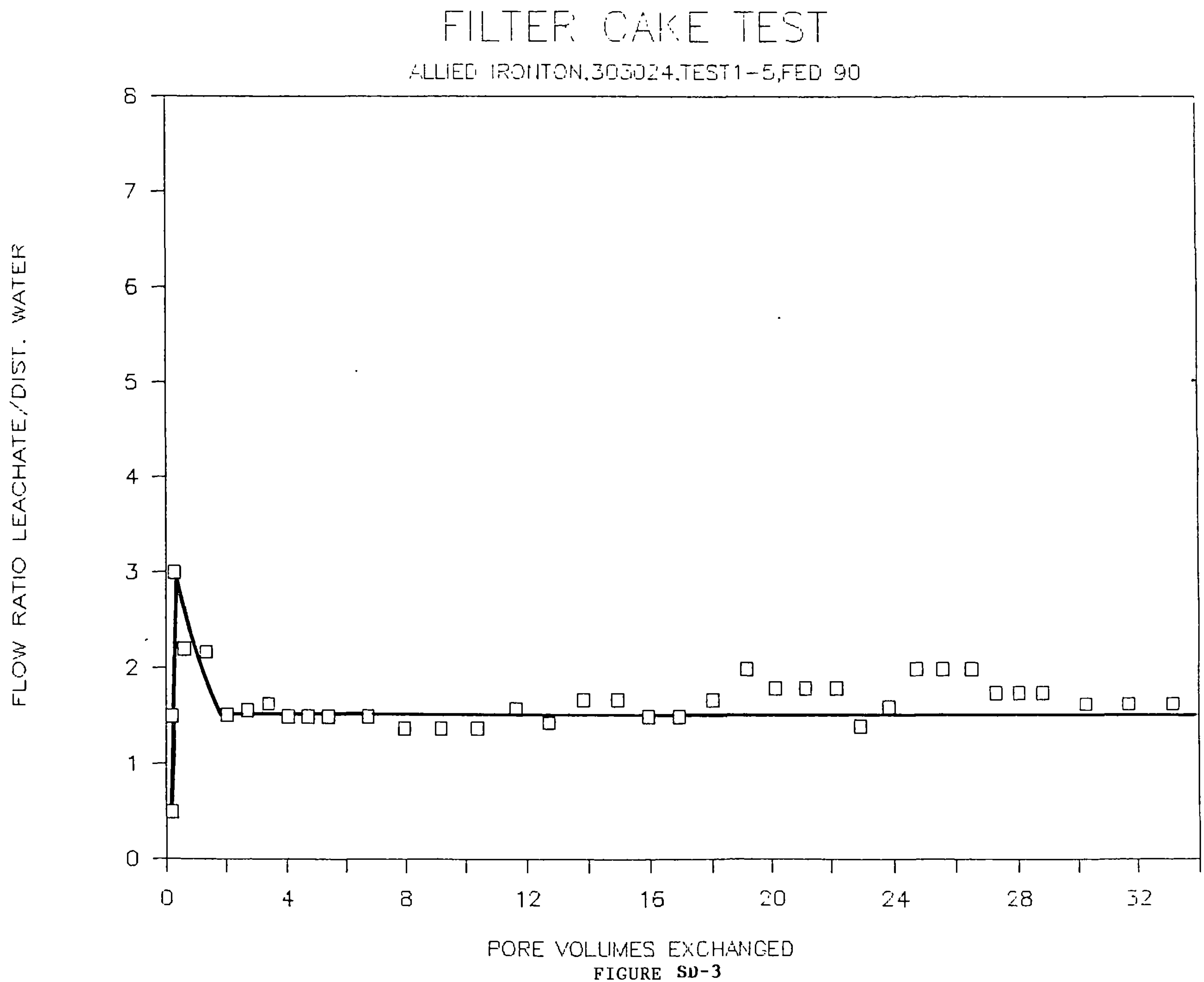
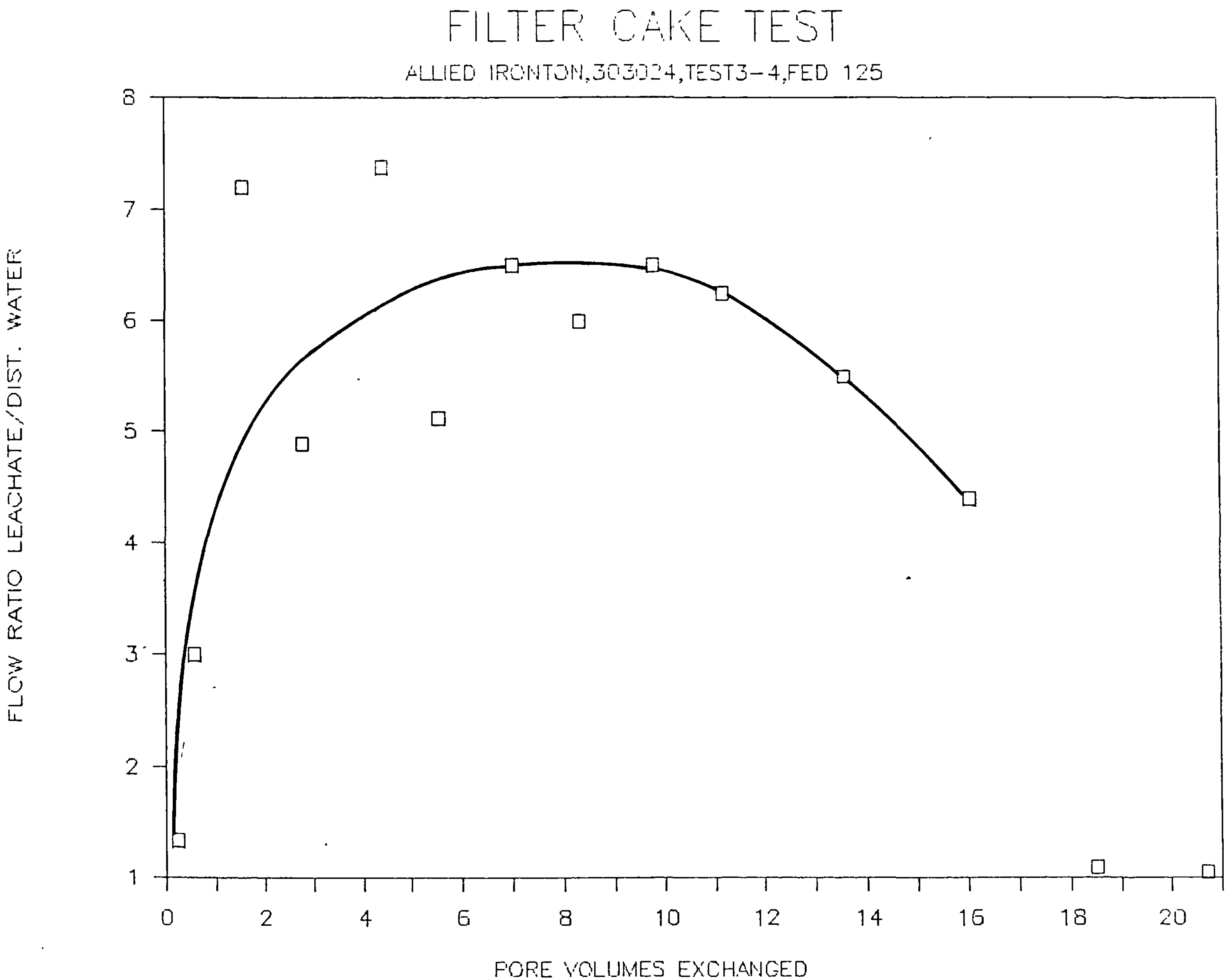

FILTER CAKE TEST
ALLIED IRONTON,303024,TEST1-5,FED 90
FLOW RATIO LEACHATE/DIST. WATER
PORE VOLUMES EXCHANGED
0
1
2
3
4
5
6
7
8
12
16
20
24
28
32

FIGURE SD-3


FILTER CAKE TEST
ALLIED IRONTON,303024,TEST3-4,FED 125
FLOW RATIO LEACHATE/DIST. WATER
8
7
6
5
4
3
2
1
0
2
4
6
8
10
12
14
16
18
20
PORE VOLUMES EXCHANGED
FIGURE SD-4

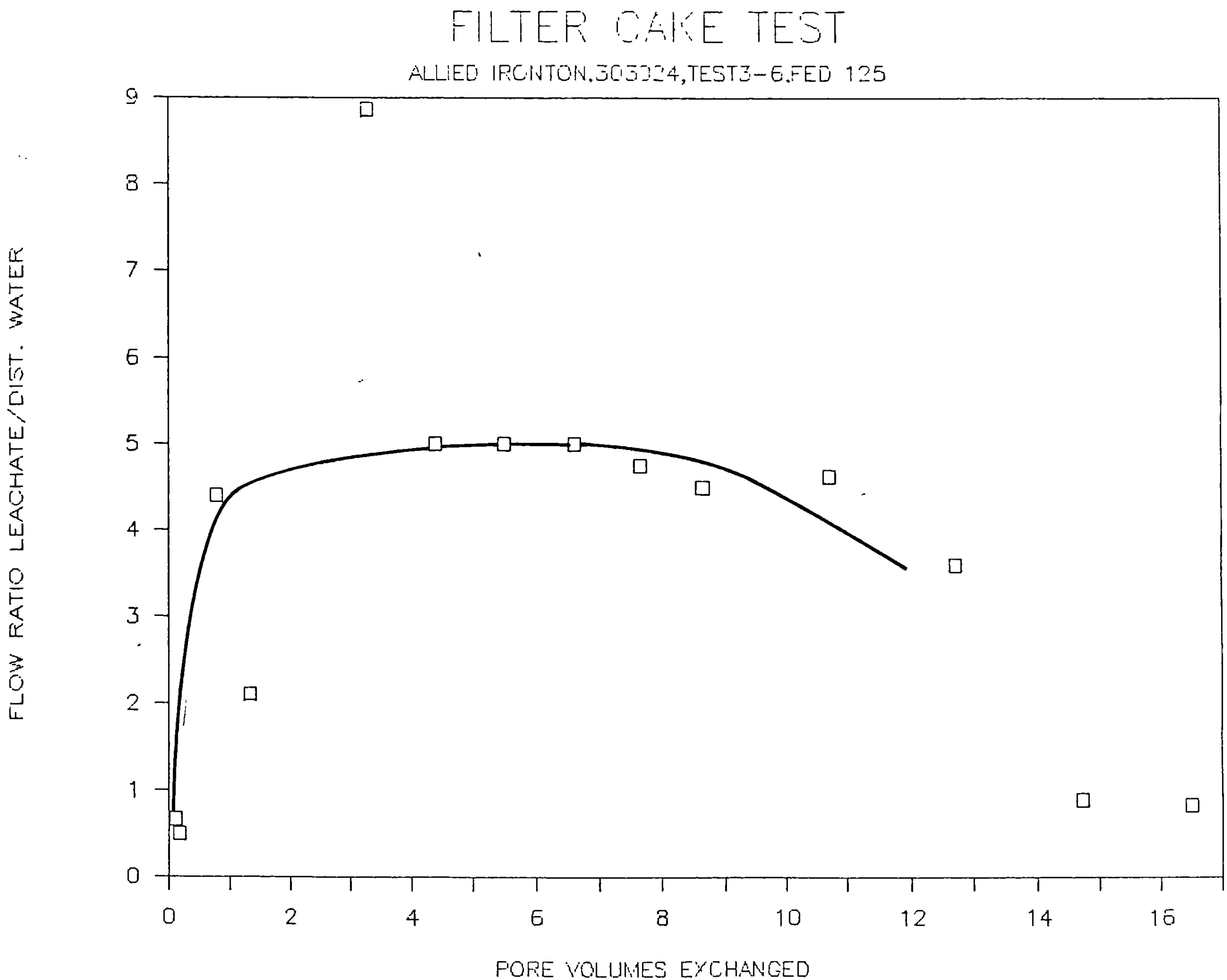

FILTER CAKE TEST
ALLIED IRONTON,303324,TEST3-6,FED 125
FLOW RATIO LEACHATE/DIST. WATER
0
1
2
3
4
5
6
7
8
9
0
2
4
6
8
10
12
14
16
PORE VOLUMES EXCHANGED

FIGURE **SD-5**

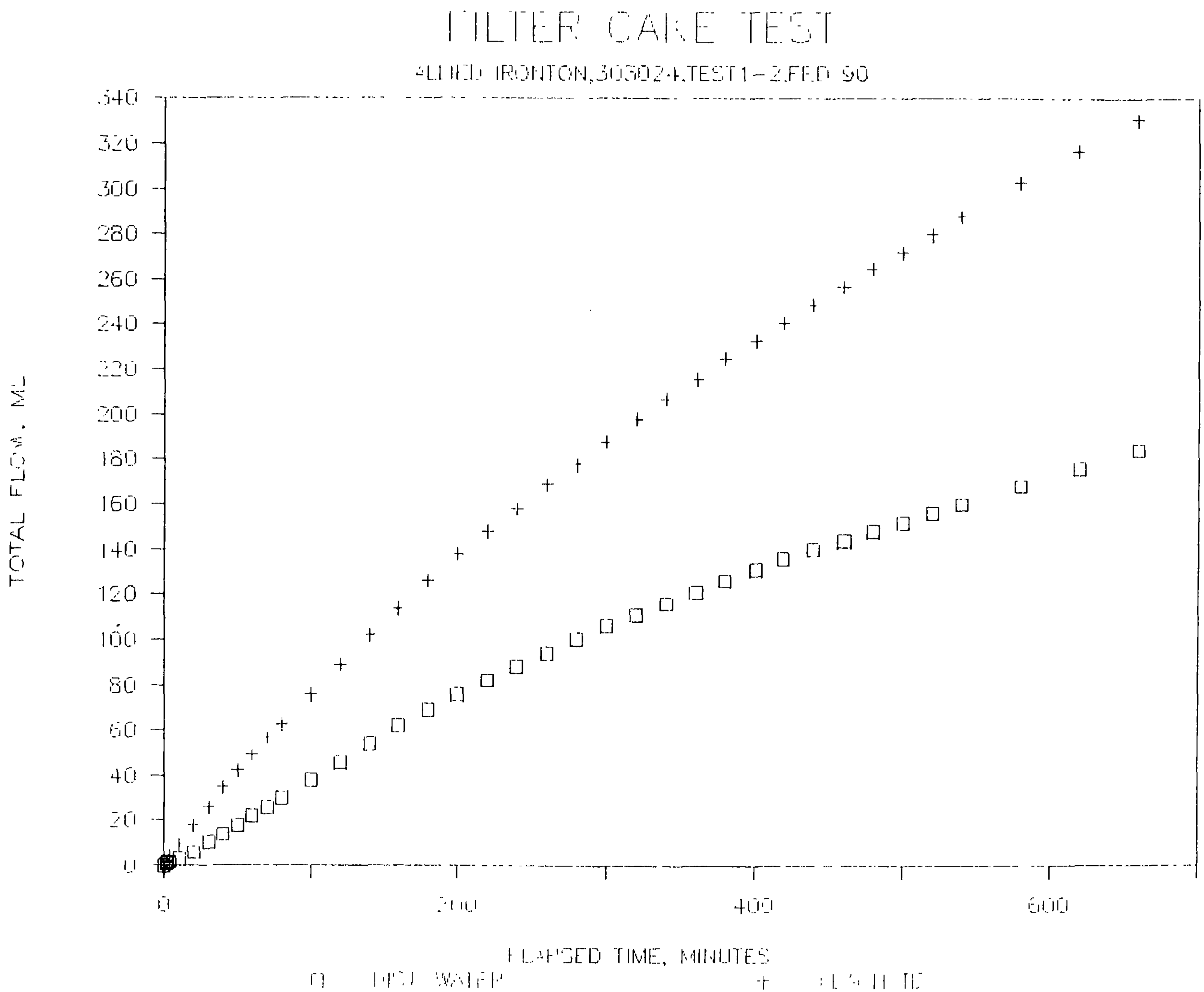

FILTER CAKE TEST
ALLIED IRONTON,303024,TEST1-2,FEB 90
TOTAL FLOW, ML
ELAPSED TIME, MINUTES
0
200
400
600
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
320
340

FIGURE SD-6

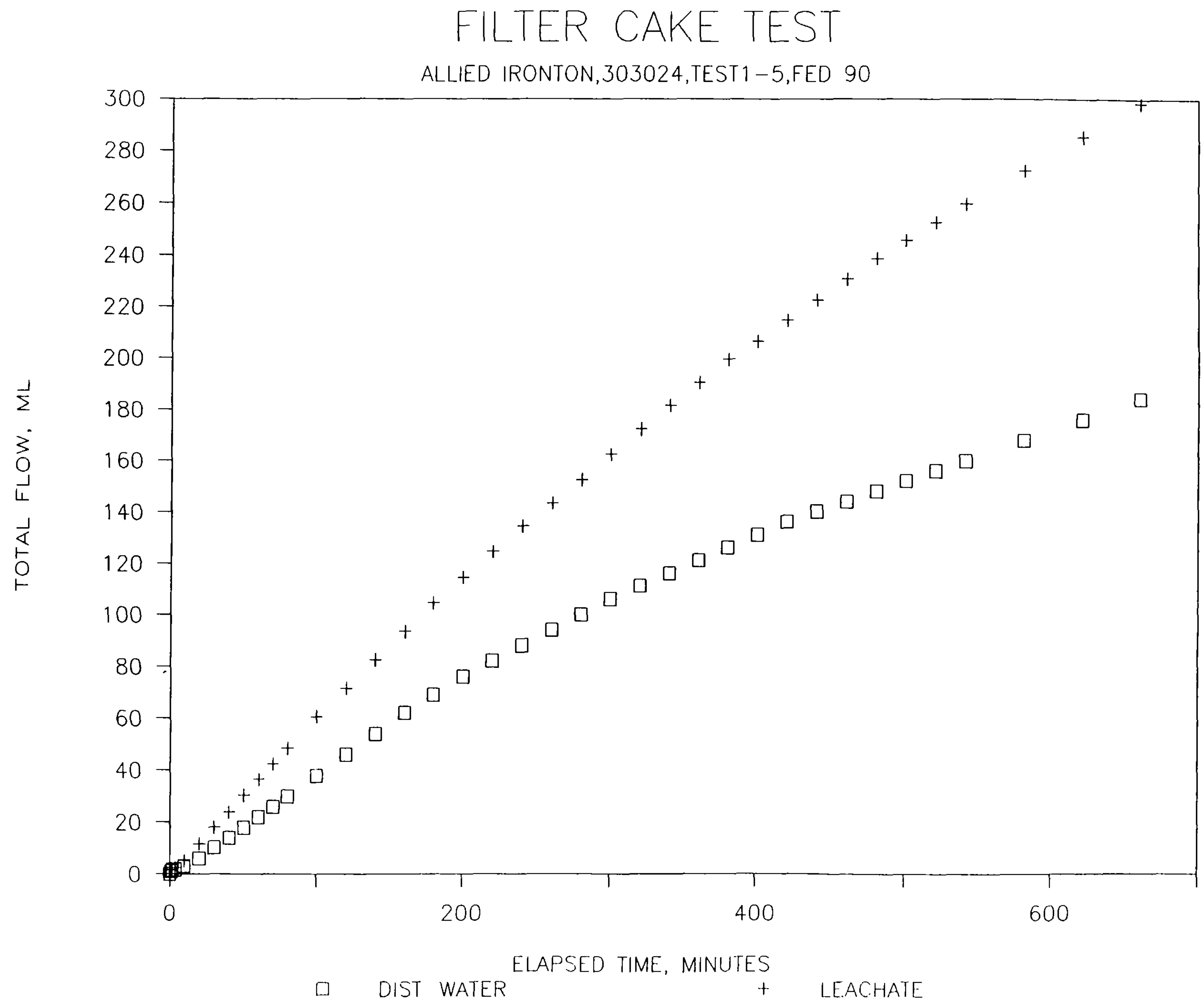

FILTER CAKE TEST
ALLIED IRONTON,303024,TEST1-5,FED 90
TOTAL FLOW, ML
300
280
260
240
220
200
180
160
140
120
100
80
60
40
20
0
0
200
400
600
ELAPSED TIME, MINUTES
DIST WATER
LEACHATE

FIGURE SD-7

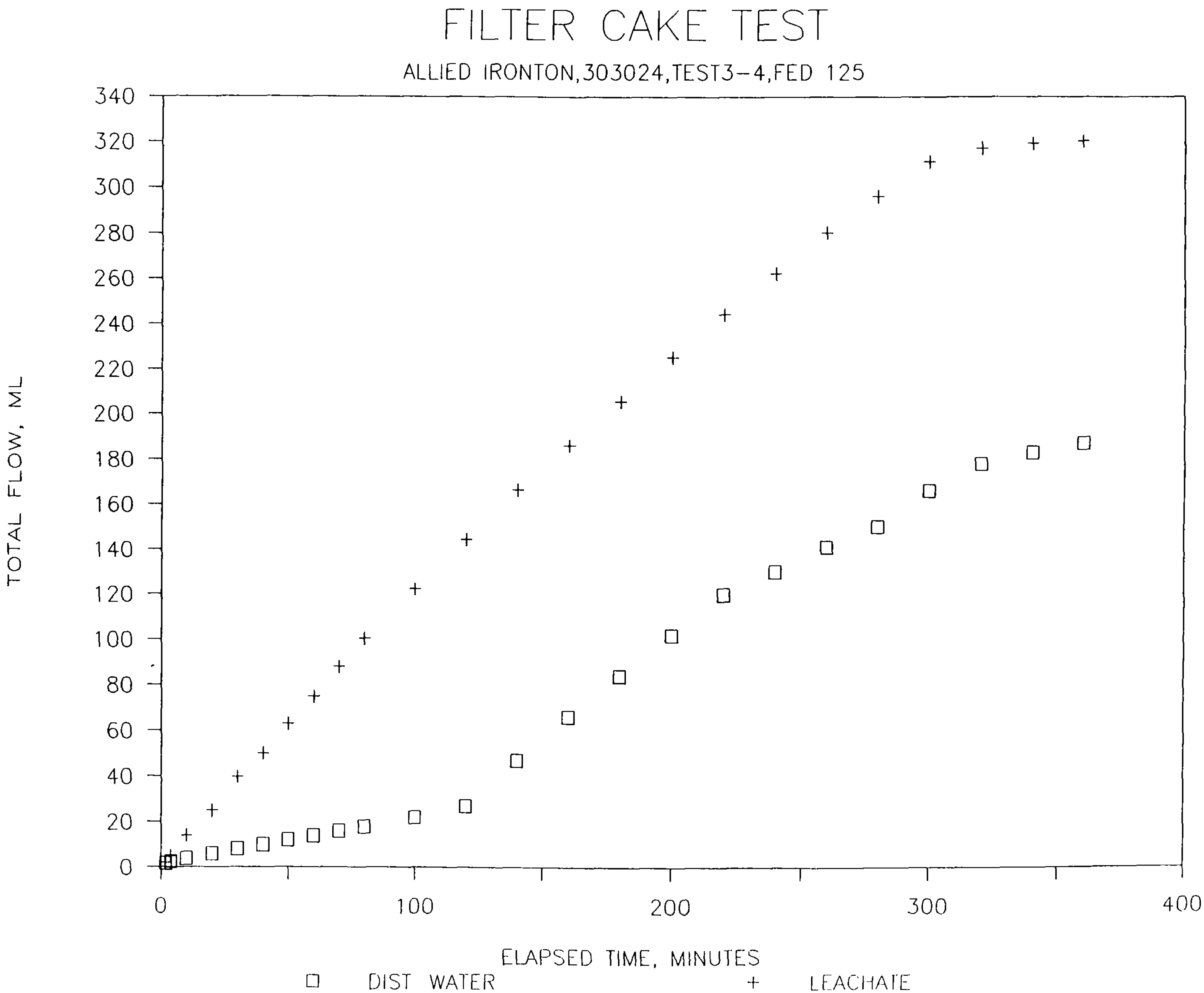

FILTER CAKE TEST
ALLIED IRONTON,303024,TEST3-4,FED 125
TOTAL FLOW, ML
ELAPSED TIME, MINUTES
DIST WATER
LEACHATE

FIGURE SD-8

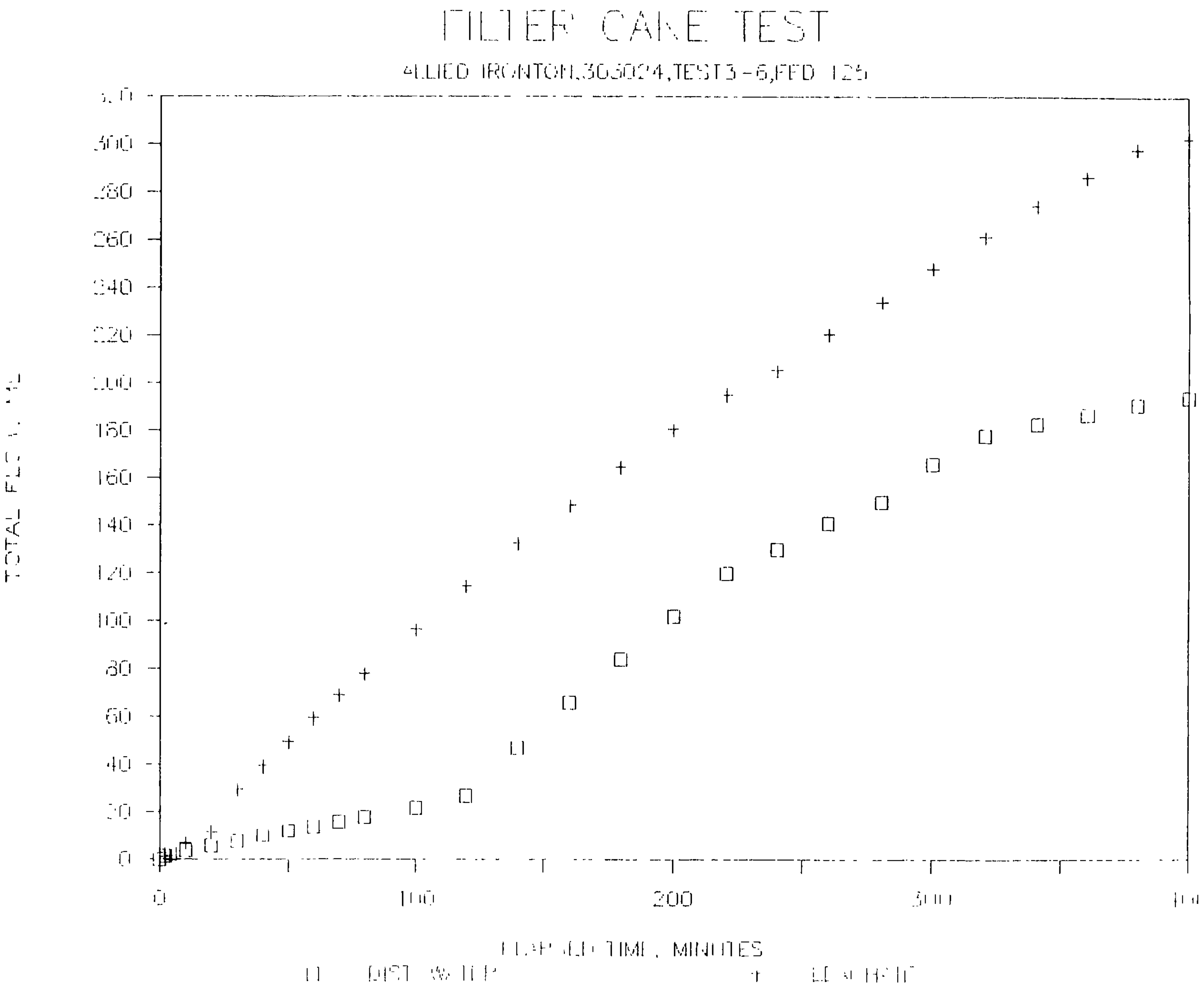


FIGURE SD-9

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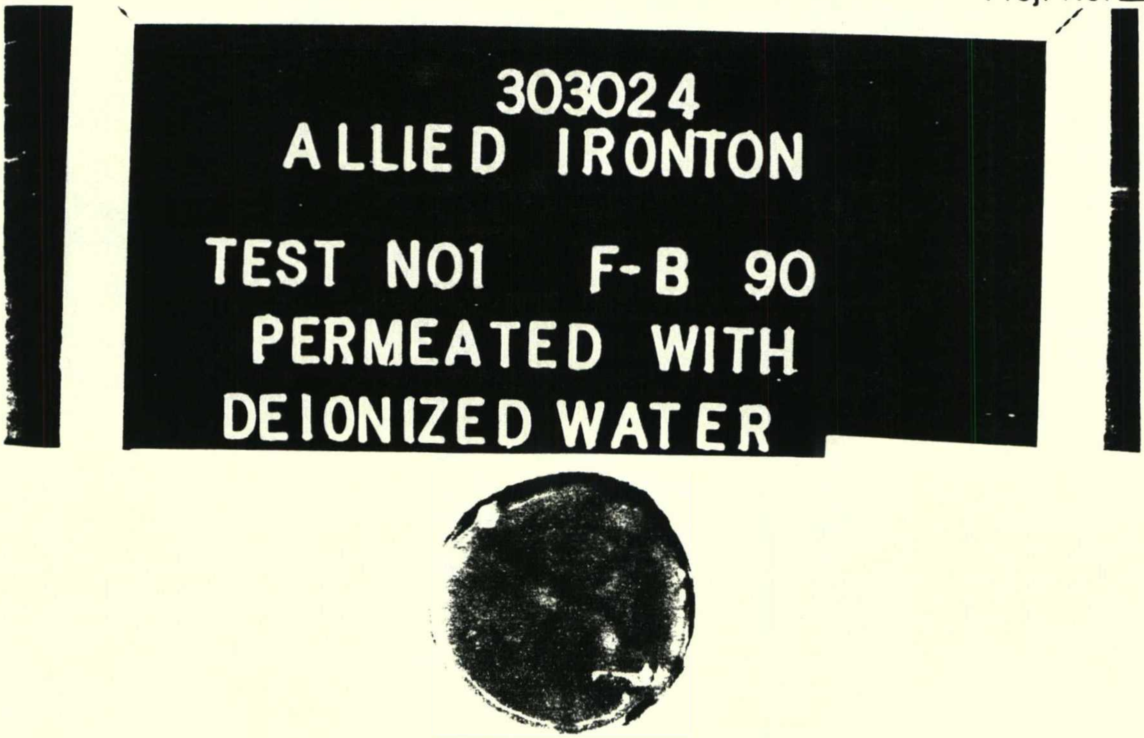
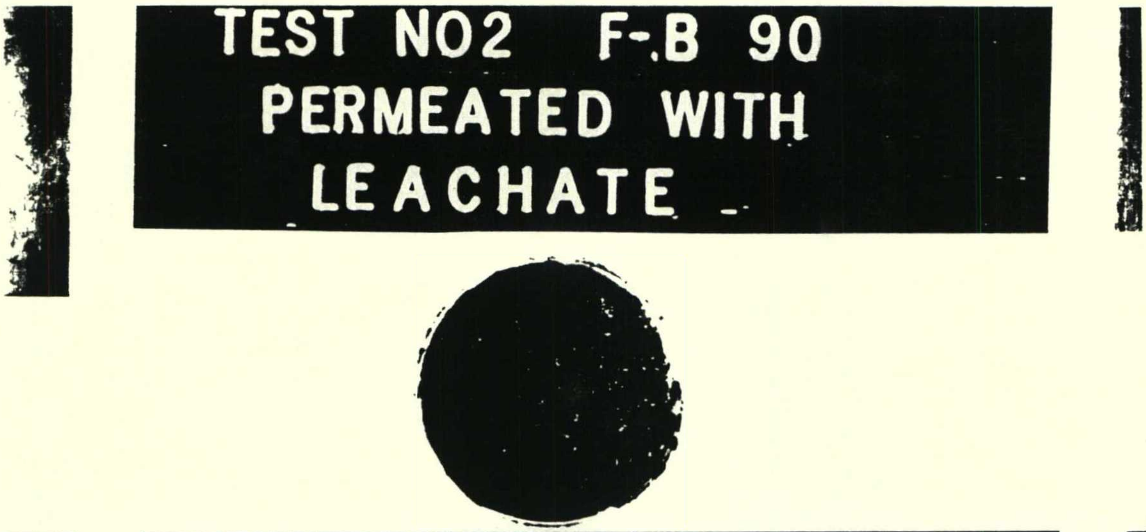
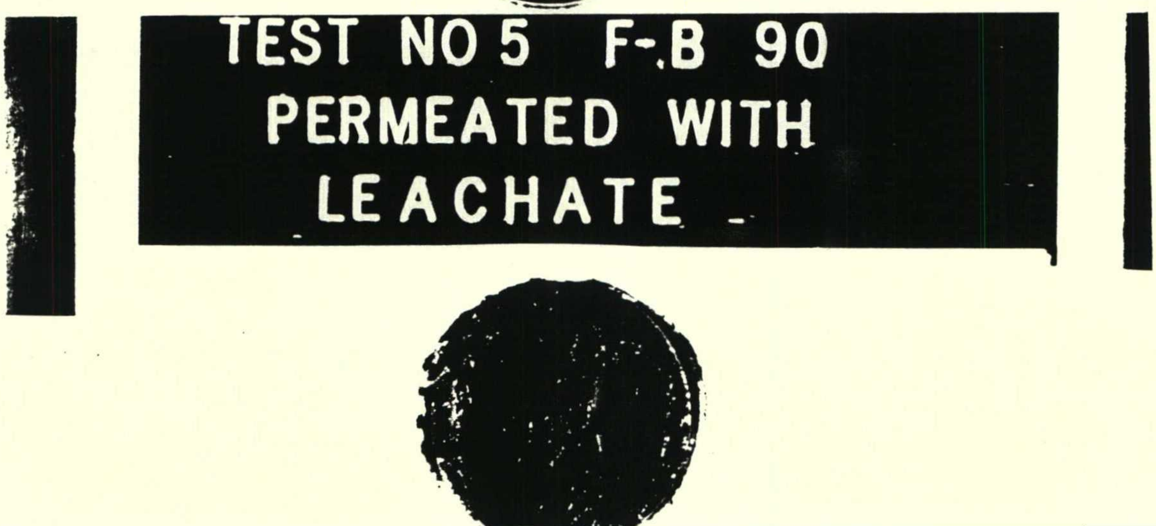
Date 2-5-88 Subject FILTER CAKE TEST Sheet No. 1 of 2

Proj. No. 303024



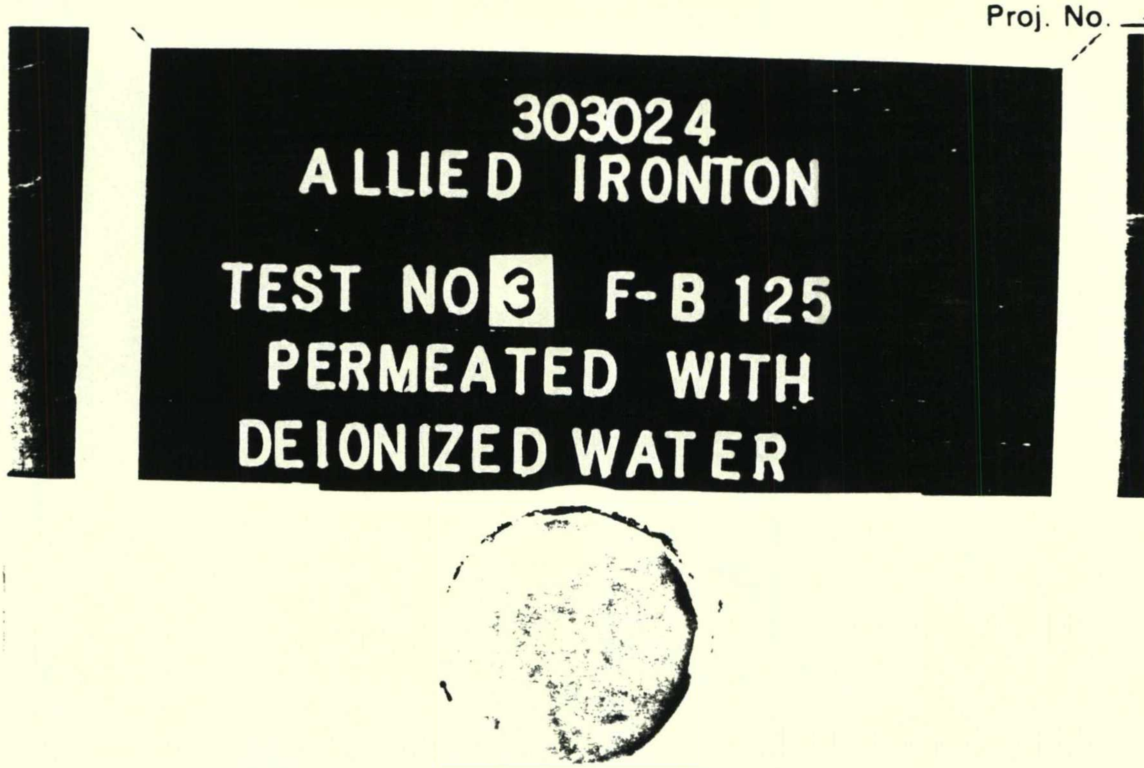


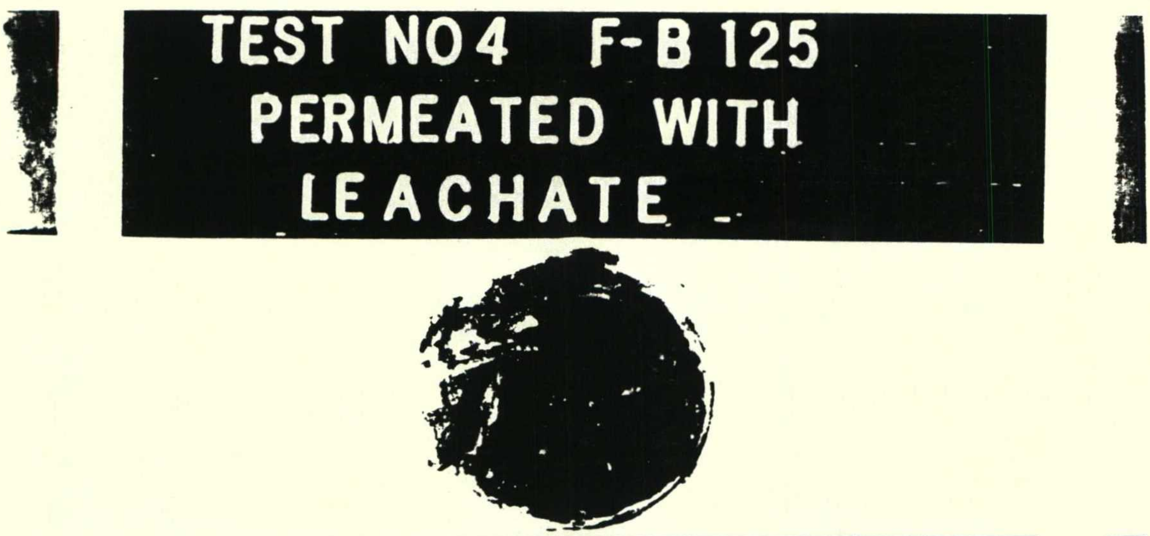


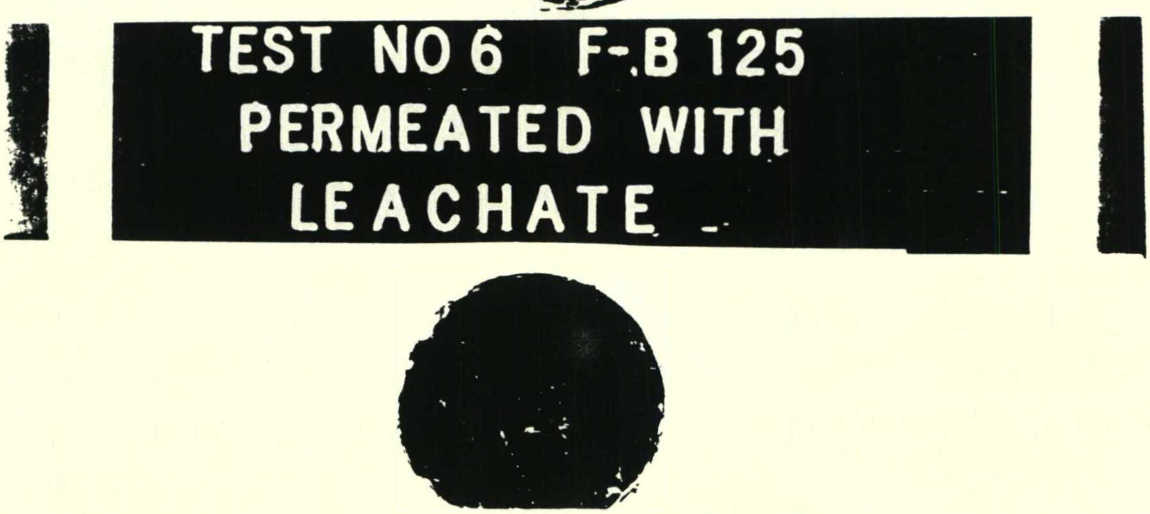
INTERNATIONAL TECHNOLOGY CORPORATION

Date 2-5-88 Subject Filter ... Sheet No. 2 of 2

Proj. No. 30302-4







SECTION E

HYDROGEOLOGIC DETAILS

File April 29, 1988

B. K. Price Project No. 303024

RECOVERY WELLS AT GOLDCAMP AREA, ALLIED IRONTON - PRELIMINARY INVESTIGATION

INTRODUCTION

This memo describes preliminary calculations which have been performed to investigate the potential for recovery wells at the Goldcamp site, Ironton.

The approach consisted of using three programs on a personal computer (PC). The program TGUESS was run using input from single well pumping tests carried out in January and February 1988 to obtain information regarding hydraulic conductivity of the aquifer. Model PT1 was used to simulate a single recovery well. This provided information regarding aquifer pumping rates, radius of influence, and drawdown. The THEIS well field model was used to determine possible recovery well spacings and to investigate the impact of the Ohio River on the recovery well system.

Assuming that a slurry wall was constructed to enclose the Goldcamp area, calculations were performed to determine the required pumping rate of wells within the slurry wall to draw the inside water level down and to capture water passing through the slurry wall into the enclosed area.

RESULTS

1. Analysis of single well pumping tests by the program TGUESS performed at the Goldcamp area in January and February 1988 indicates that local aquifer hydraulic conductivity, K, varies from 10^{-2} to 10^{-1} centimeter per second (cm/s) with an average value of about 6×10^{-2} cm/s.

2. Model PT1 (Walton, 1987, Ground Water Pumping Test Models) was used to investigate potential pumping rates for recovery wells. The following assumptions were made for this model and the THEIS models:

- Horizontal aquifer hydraulic conductivity, $K_h = 10^{-2} - 10^{-1}$ cm/s
- Vertical aquifer hydraulic conductivity, $K_v = \frac{1}{2}\ K_h$
- Aquifer specific yield, S = 0.2
- Aquifer saturated thickness, b = 40 feet
- The local ground water gradient = 0
- Effective radius of recovery wells = 0.25 foot
- The aquifer is homogeneous and isotropic
- No nearby constant head boundaries, i.e., no Ohio River

The following table summarizes the test results at the end of 120 days:

K_h (cm/s)	Q (gpm)	DRAWDOWN AT PUMPING WELL (ft)	DRAWDOWN AT 250 FEET (ft)	HYDRAULIC GRADIENT WITHIN 250 FEET OF PUMPING WELL	APPROXIMATE RADIUS OF INFLUENCE (ft)
10^{-2}	50	13.98	2.19	4.7×10^{-2}	> 2,500
10^{-1}	50	6.26	1.08	2.1×10^{-2}	6,280
10^{-2}	25	1.32	0.37	3.8×10^{-3}	2,500
10^{-1}	25	0.65	0.04	2.4×10^{-3}	> 3,460

This indicates that a pumping rate of 25 gallons per minute (gpm) is unlikely to give much drawdown at the recovery well and, more importantly, does not give a high hydraulic gradient toward the well. To achieve "capture" of contaminants by the recovery wells, a hydraulic gradient toward the recovery wells must be induced which is higher than the regional hydraulic gradient. Here the initial analysis shows that a pumping rate of 50 gpm may be sufficient to achieve this. This was investigated further with the results presented in the next section with regard to multiple recovery wells.

3. The THEIS well field model was employed to investigate the interaction of recovery wells. The following situations were investigated:

$K_h = 10^{-2}$ cm/s and 10^{-1} cm/s
Q = 25 gpm and 50 gpm
Well spacing = 50 feet, 100 feet
t = 1 day, 10 days, 30 days, 120 days

Ranges for drawdowns at the wells and at the midpoint between the wells along with induced hydraulic gradients (for 120 days) are shown in the following table. The first number in the range given refers to $K_h = 10^{-1}$ cm/s and the second number refers to $K_h = 10^{-2}$ cm/s.

	WELL SPACINGS (ft)	Q (gpm)	DRAWDOWN AT CENTER WELL (ft)	DRAWDOWN AT MIDPOINT BETWEEN WELLS (ft)	HYDRAULIC GRADIENT TO RECOVERY WELL
1 DAY					
	50	25	0.8 - 5.3	0.5 - 2.4	N.C.[a]
	50	50	1.5 - 10.7	0.9 - 4.9	N.C.
	100	25	0.7 - 4.6	0.3 - 1.2	N.C.
	100	50	1.3 - 9.2	0.7 - 2.5	N.C.

[a]See footnote at end of table.

	WELL SPACINGS (ft)	Q (gpm)	DRAWDOWN AT CENTER WELL (ft)	DRAWDOWN AT MIDPOINT BETWEEN WELLS (ft)	HYDRAULIC GRADIENT TO RECOVERY WELL
10 DAYS					
	50	25	1.0 - 7.6	0.7 - 4.7	N.C.
	50	50	2.0 - 15.3	1.4 - 9.4	N.C
	100	25	0.9 - 6.7	0.6 - 3.3	N.C.
	100	50	1.8 - 13.4	1.1 - 6.6	N.C.
30 DAYS					
	50	25	1.1 - 8.8	0.8 - 5.8	N.C.
	50	50	2.2 - 17.5	1.6 - 11.6	N.C.
	100	25	1.0 - 7.8	0.7 - 4.4	N.C.
	100	50	2.0 - 15.7	1.3 - 8.8	N.C.
120 DAYS					
	50	25	1.2 - 10.2	1.0 - 7.2	8.0×10^{-3} - 1.2×10^{-1}
	50	50	2.5 - 20.4	1.9 - 14.5	2.4×10^{-2} - 2.4×10^{-1}
	100	25	1.1 - 9.2	0.8 - 5.8	6.0×10^{-3} - 6.8×10^{-2}
	100	50	2.3 - 18.5	1.6 - 11.6	1.4×10^{-2} - 1.4×10^{-1}

[a]N.C. = Not Calculated

At the end of 120 days, a pumping rate of 50 gpm and well spacing of 100 feet will produce a drawdown at the well of 50 percent of the saturated thickness and a drawdown at the midpoint between the recovery wells of approximately 25 percent of the saturated thickness (if $K_h = 10^{-2}$ cm/s). The regional hydraulic gradient toward the Ironton Iron recovery wells has been calculated as approximately 3.1×10^{-3} foot per foot (ft/ft). The maximum hydraulic gradient in the Goldcamp area is toward the river and is 2.0×10^{-2} ft/ft. Normally to achieve capture of contaminants by the recovery well, a pumping rate must be chosen which can achieve an induced hydraulic gradient toward the recovery well which is higher than the maximum regional gradient.

It is proposed that recovery wells be situated down gradient of the contaminant plume as defined in Figure SE-1. The well locations are preliminary and exact locations should be established during the detailed design of the selected remedial action alternative. In this case, it is not necessary to produce an induced hydraulic gradient that is much greater than the regional gradient since the natural flow is towards the recovery wells. Several recovery well scenarios are possible, using single or multiple wells. Two scenarios were investigated using the THEIS model. The first scenario used a line of recovery wells pumping at a moderate rate. The second scenario used a single recovery well pumping at a high rate equal to the combined pumping from the multiple well case.

For the first scenario, it is anticipated that recovery wells would be placed along the line A-A' in Figure SE-1. The data indicates that drawdown at well centers and at midpoints between wells is greater for 50-foot centers than for 100-foot centers. However, the difference is not very great and greater than 10 feet of drawdown at the midpoint wells is probably sufficient drawdown for the purpose of water capture. As stated, the maximum hydraulic gradient in the GDA is 2.0×10^{-2} feet per foot; the hydraulic gradient to the recovery well induced by pumping will likely give a sufficient gradient with 100-foot centers to overcome the regional gradient and ensure contaminant capture. In light of the above, although 50-foot centers give larger numbers for the parameters given, 100-foot centers give values which are expected sufficient to capture the contaminant plume. Accordingly, 100-foot spacing is suggested. Six to ten wells spaced 100 feet apart and pumping at rates of 50 gpm each should be sufficient to effectively capture the contaminant plume. This assumes that the shape of the contaminant plume is adequately simulated by Figure SE-1. The combined pumping rate of all recovery wells would total 300 to 500 gpm. The shape of the capture zone can be described as shown in Figure SE-2. Flow lines within the capture zone are directed towards the pumping well and flow lines outside of the capture zone are not. The distance from the pumping well to the "stagnation point" in the direction of regional flow r, is found from the equation below. A solution is given for the case where Q equals 50 gpm.

$$r = Q \div (2\Pi b\ V_{nat})$$

where

Q = pumping rate of recovery well = 50 gpm = 1.1×10^{-1} ft/s,
b = aquifer thickness = 40 feet, and
V_{nat} = natural velocity of ground water (Darcy velocity) = $\frac{K_h i}{n}$.

where

K_h = horizontal hydraulic conductivity = 6×10^{-2} cm/s = 2.0×10^{-3} ft/s (average value),
i = ground water flow gradient = 2.5×10^{-3} (calculated), and
n = porosity = 0.3 (assumed).

Consequently,

$$r = Qn \div (2\pi b K_h i),$$
$$= 26 \text{ feet.}$$

For the second scenario a single well is envisioned to replace the line of pumping wells in the first scenario. The pumping rate for this well may be as much as 300 to 500 gpm. For this situation, the distance from the pumping well to the stagnation point, in the direction of regional flow, r, was calculated to be between 160 and 260 feet. However, because regional flow will direct contaminants to the recovery well, it is anticipated that the actual Q required at a single recovery well would be much lower (probably lower than 200 gpm).

Modeling studies were conducted in the area in 1986 (IT, 1986, RI, Appendix F). The steady state simulation of ground water contours is shown in Figure SE-3. The modeling exercise used a pumping rate of 250 gpm for Well CG-3. The steady state simulation shows a cone of influence of about 2,000 feet in diameter. Assuming that the aquifer conditions around CG-3 are analogous to the conditions around the proposed recovery well, then the cone of influence under steady state conditions at the proposed recovery well can be expected to be similar in shape and extent for similar pump rates. This analogy suggests that a single recovery well pumping at about 250 gpm may be more than sufficient to clean up the ground water beneath the Goldcamp site, supporting a flow rate of less than 250 gpm.

4. The THEIS model was used to simulate the effect of the Ohio River on the recovery wells. The Ohio River, which acts as a recharge boundary, was simulated by using a series of "image" wells. The image wells were placed the same distance from the boundary as the recovery wells, but on the opposite side of the boundary to simulate a recharge boundary. The pumping rate of the image wells was equal to that of the "real" wells, but water was introduced into the aquifer rather than removed. Cases were simulated with distance from the wells to the boundary of 100, 200, and 300 feet all with pumping rates of 50 gpm. The results are given in the table below for 120 days of pumping:

DISTANCE FROM RECOVERY WELL TO BOUNDARY (ft)	DRAWDOWN IN WELL ASSUMING NO BOUNDARY (ft)	DRAWDOWN IN WELL ASSUMING A BOUNDARY (ft)	PERCENT REDUCTION IN DRAWDOWN
100	3.65	1.87	49
200	3.65	2.30	37
300	3.65	2.56	30

This may indicate that as much as 50 percent of the water from the recovery wells may be derived from the recharge boundary of the Ohio River. The approach assumes that the river fully penetrates the aquifer. This is not the case and the relationship is much more complicated than it would appear from this simplified approach. The contribution of the river water to the total flow from the wells is likely to decrease as pumping rate decreases and distance from the river increases.

The amount of water traveling from the Ohio River to the pumping wells of the Coal Grove area has been determined previously using the IT GEOFLOW model. A range of 19 to 49 percent was determined (IT Internal File No. F-6, 1984). The previous modeling effort used aquifer parameter values which are similar to the values in the Goldcamp area. The Coal Grove area has been assumed to be analogous to the Goldcamp area. If this is the case, then we would expect a similar contribution by the Ohio River to flow at the Goldcamp recovery well(s) for similar flow rates.

5. If a slurry wall was to be constructed so as to completely enclose the Goldcamp area, a pumping well(s) would need to be placed within the slurry wall to remove water flowing through the slurry wall. The following assumptions were made:

- No recharge through the landfill cap
- Slurry wall hydraulic conductivity, $K = 10^{-7}$ cm/s
- Hydraulic gradient across slurry wall, $i = 1$
- Saturated thickness of aquifer, $b = 40$ feet
- Wall dimensions:
  - Side A = 700 feet long; therefore, area = 700 x 40 = 28,000 $feet^2$
  - Side B = 400 feet long; therefore, area = 400 x 40 = 16,000 $feet^2$
  - Side C = 850 feet long; therefore, area = 850 x 40 = 34,000 $feet^2$
  - Side D = 450 feet long; therefore, area = 450 x 40 = 18,000 $feet^2$

The amount of water entering the site through each slurry wall segment was calculated by using:

$$Q = KiA$$

where

A = area of wall,
K = hydraulic conductivity of slurry wall, and
i = hydraulic gradient across slurry wall

as given above.

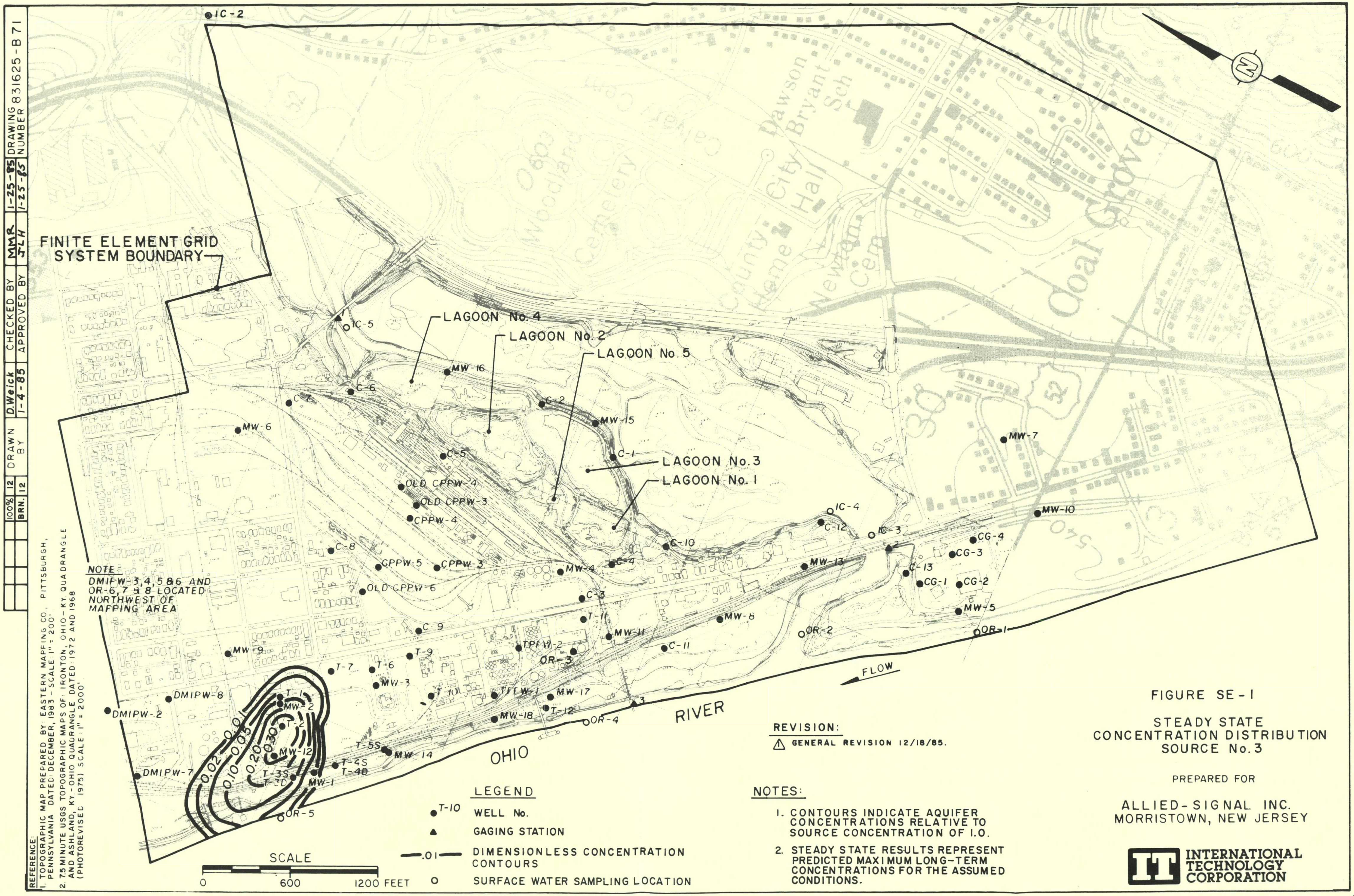
The total was found by adding the amounts of the individual slurry wall segments. A total long term pumping rate of less than 1.0 gpm was determined to maintain the inward hydraulic gradient across the slurry wall. A higher short term pumping rate would be necessary at first to draw the water levels down within the slurry wall to create the desired inward hydraulic gradient across the slurry wall.

Previous modeling of the Goldcamp site in 1986 employed the IT GEOFLOW code. A pumping rate of 0.3 gpm for the area within the slurry wall was determined at that time.

Additional modeling using the GEOFLOW code will be performed to further investigate recovery well scenarios for the Goldcamp area.

BP:amb

cc: S. K. Gupta
G. Gaillot
R. L. Smith
J. A. Broscious
S. H. Djafari
J. I. Tokar


FINITE ELEMENT GRID SYSTEM BOUNDARY
LAGOON No. 4
LAGOON No. 2
LAGOON No. 5
LAGOON No. 3
LAGOON No. 1
IC-2
IC-5
IC-4
IC-3
MW-16
MW-15
MW-6
MW-7
MW-10
MW-13
MW-4
MW-8
MW-11
MW-9
MW-3
MW-17
MW-18
MW-2
MW-12
MW-14
MW-1
MW-5
C-1
C-2
C-3
C-4
C-5
C-6
C-7
C-8
C-9
C-10
C-11
C-12
C-13
CG-1
CG-2
CG-3
CG-4
OLD CPPW-4
OLD CPPW-3
CPPW-4
CPPW-5
CPPW-3
OLD CPPW-6
TPPW-2
TPPW-1
OR-1
OR-2
OR-3
OR-4
OR-5
T-1
T-2
T-3S
T-3D
T-4S
T-4D
T-5S
T-6
T-7
T-9
T-10
T-11
T-12
DMIPW-2
DMIPW-7
DMIPW-8
0.01
0.02
0.05
0.10
0.20
0.30
FLOW
OHIO RIVER
NOTE:
DMIPW-3,4,5 & 6 AND OR-6,7 & 8 LOCATED NORTHWEST OF MAPPING AREA
LEGEND
T-10 WELL No.
GAGING STATION
.01 DIMENSIONLESS CONCENTRATION CONTOURS
SURFACE WATER SAMPLING LOCATION
SCALE
0 600 1200 FEET
REVISION:
1 GENERAL REVISION 12/18/85.
NOTES:
1. CONTOURS INDICATE AQUIFER CONCENTRATIONS RELATIVE TO SOURCE CONCENTRATION OF 1.0.
2. STEADY STATE RESULTS REPRESENT PREDICTED MAXIMUM LONG-TERM CONCENTRATIONS FOR THE ASSUMED CONDITIONS.
FIGURE SE-1
STEADY STATE CONCENTRATION DISTRIBUTION SOURCE No. 3
PREPARED FOR
ALLIED-SIGNAL INC.
MORRISTOWN, NEW JERSEY
INTERNATIONAL TECHNOLOGY CORPORATION
REFERENCE:
1. TOPOGRAPHIC MAP PREPARED BY: EASTERN MAPPING CO. PITTSBURGH, PENNSYLVANIA DATED: DECEMBER, 1983 - SCALE 1" = 200'
2. 7.5 MINUTE USGS TOPOGRAPHIC MAPS OF: IRONTON, OHIO - KY QUADRANGLE AND ASHLAND, KY - OHIO QUADRANGLE DATED 1972 AND 1968 (PHOTOREVISED 1975) SCALE: 1" = 2000'
100% 12
BRN. 12
DRAWN BY D.Weick 1-4-85
CHECKED BY MMR 1-25-85
APPROVED BY JLH 1-25-85
DRAWING NUMBER 831625-B71

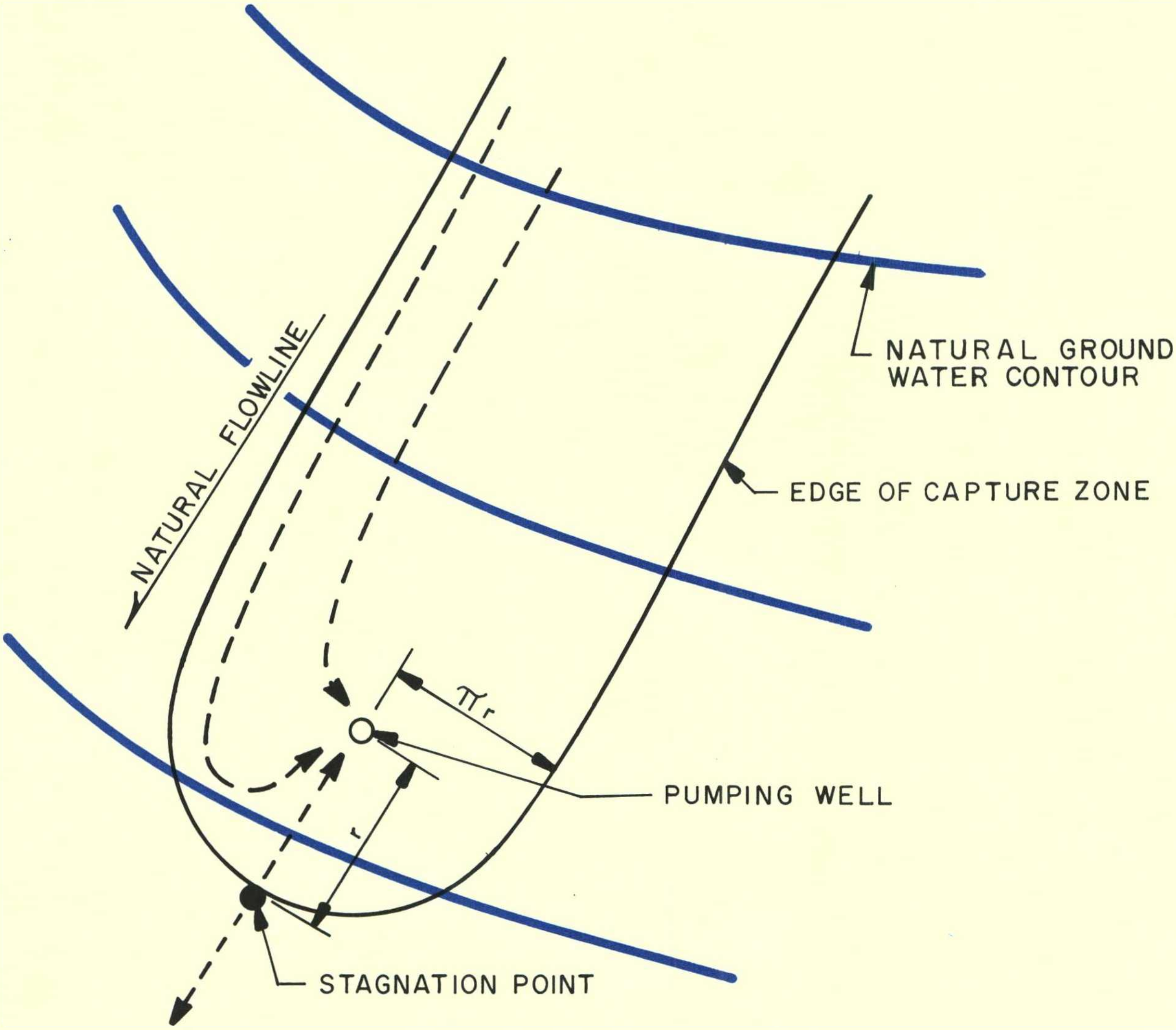


FIGURE SE-2

CONCEPTUAL REPRESENTATION OF CAPTURE ZONE

PREPARED FOR

ALLIED-SIGNAL INC.
MORRISTOWN, NEW JERSEY

INTERNATIONAL TECHNOLOGY CORPORATION

"Do Not Scale This Drawing"

100 of BLUE 01	DRAWN BY	WAD 8/2/88	CHECKED BY RLS 8/2/88	APPROVED BY SKG 8/2/88	DRAWING NUMBER 303024-A32

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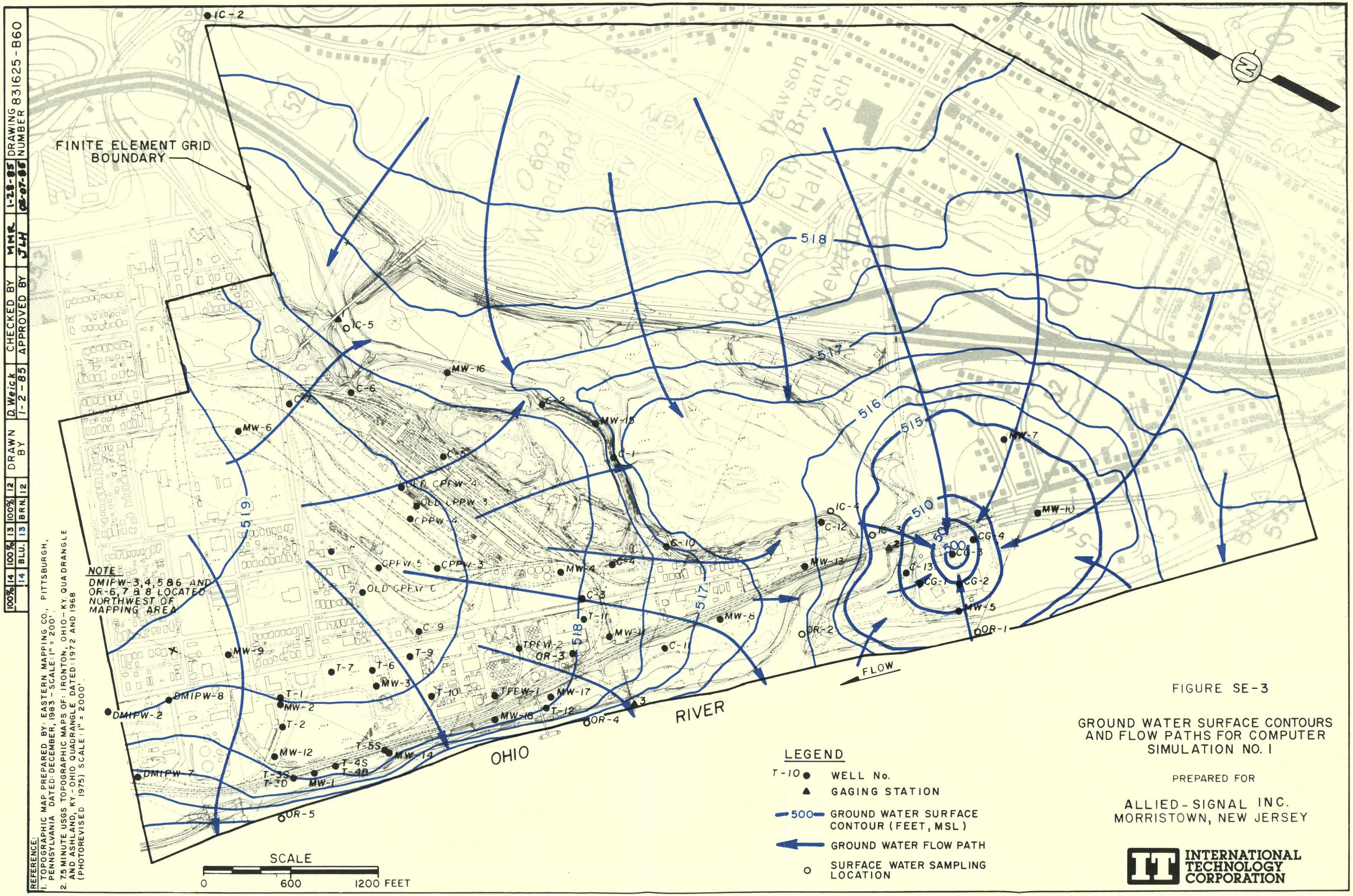


FIGURE SE-3

GROUND WATER SURFACE CONTOURS AND FLOW PATHS FOR COMPUTER SIMULATION NO. 1

PREPARED FOR

ALLIED-SIGNAL INC.
MORRISTOWN, NEW JERSEY

SECTION F

STABILITY ANALYSIS

Satish Gupta - April 28, 1988

Roger Chen Project No. 303024

SLURRY WALL STABILITY STUDY/GOLDCAMP DISPOSAL AREA

Introduction

A preliminary stability analysis was performed for a typical soil-bentonite slurry wall at the Goldcamp Disposal Area (GDA). Three loading conditions, static, earthquake, and dynamic, were analyzed using the force equilibrium method. This analysis was based only on limited data (i.e., Standard Penetration Test results and visual soil classification from three boreholes in the vicinity of the main railway). The preliminary design is based on conservative parameters. Additional subsurface information from borings along the proposed slurry wall alignment will be necessary before a final determination of the wall's stability can be finalized. More costly structural walls and panel type construction were considered and were determined not necessary.

Surface and Subsurface Conditions

The location of the railroad tracks, boreholes, proposed slurry wall and landfill extent is shown in Figure SF1. The GDA is bounded on the southwest and north by the Norfolk and Western Railway.

Results of the subsurface exploration program (see 1986 RI Report) reveal a relatively consistent subsurface condition in this area. Subsurface materials consist of approximately 80 feet of brown to gray poorly graded sand and gravel above bedrock. The N-value (i.e. blow counts per foot of penetration) ranges from approximately 10 to 40, and generally increase with depth. The ground water table is located approximately 40 feet from the ground surface.

Analyses

The parameters used for analyses are as follows:

- Soil profile consists of 80 feet of poorly graded sand and gravel with an N-value of 10 (worst case)
- Dry density of soil = 110 pounds per cubic foot
- Internal friction angle = 30°
- Ground water depth = 40 feet

- Train load = 100 tons, equivalent to a line load of 25 tons per linear foot

- Wall alignment is 40 feet from the tracks

Conclusions and Recommendations

Based on the analysis and parameter discussed herein, it is concluded that a soil-bentonite slurry wall can be constructed as close as 40 feet from the railroad tracks as illustrated in Figure SF1. Recommendations/precautions during the construction period include:

- Reduction of the train's speed

- Monitoring the railway

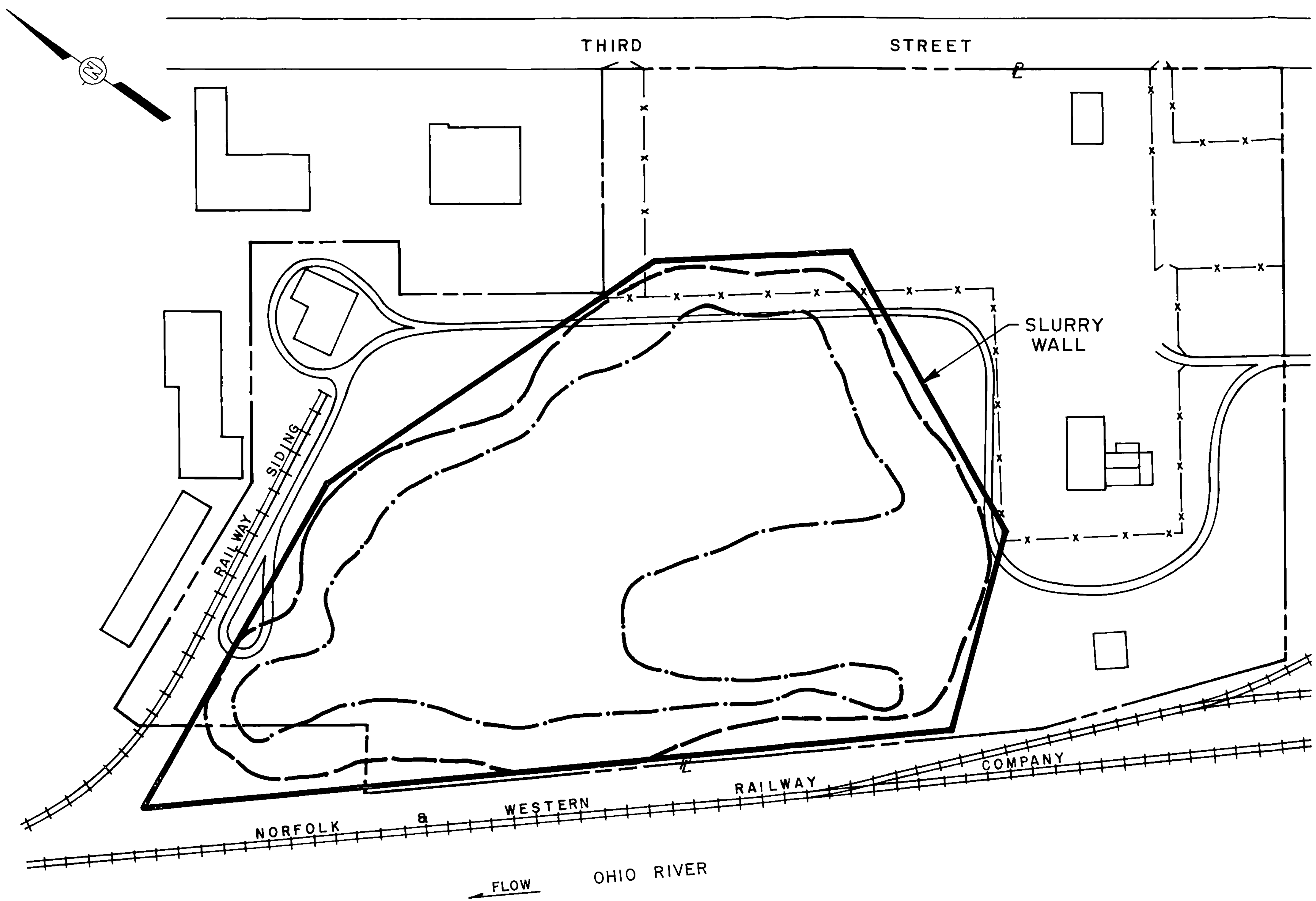
- Minimization of the time and distance of the open trench

- The stability of the trench along the railroad is the primary concern. The best means of reducing the risk along this section of the trench (while using the continuous trench construction method) is to replace the open trench with backfill as quickly as possible. However, the slurry must be desilted prior to backfilling. The time required for this desilting process would allow for the suggested 24-hour elapse time between excavation and the backfill. The elapse time improves the filter cake strength.

RRC:mcc

DRAWING NUMBER 303024-B3

DRAWN BY: B KUMPF, 4 APR 88 | CHECKED BY: RLS, 5/31/88 | APPROVED BY:



LEGEND

APPROXIMATE SLURRY WALL ALIGNMENT

APPROXIMATE LIMIT OF TOP OF DISPOSAL AREA

APPROXIMATE LIMIT OF BOTTOM OF DISPOSAL AREA

SCALE

0 100 200 FEET

FIGURE SF-1

LIMITS OF SLURRY WALL AND WASTE DISPOSAL AREA

PREPARED FOR

ALLIED-SIGNAL INC.
MORRISTOWN, NEW JERSEY

INTERNATIONAL TECHNOLOGY CORPORATION

REFERENCE:

ALLIED CORPORATION DRAWINGS, TITLED "LAND ACQUISITION LAYOUT", DWG. NO D-9-368-8, "DATED: 5-11-55, SCALE: 1" = 50', AND "GOLDCAMP DISPOSAL SITE", DWG. NO. ICP-2, DATED: 2-13-87, SCALE: 1" = 40'.

CALCULATION

Purpose: A SLURRY WALL IS PROPOSED TO BE CONSTRUCTED IN THE SAND LAYER. THE PROPOSED SLURRY WALL EXTENDS DOWN TO BEDROCK AND IS ABOUT 30 TO 40 FEET AWAY FROM AN EXISTING RAILROAD. THE PURPOSES OF THIS STUDY ARE:

(1) TO EVALUATE THE STABILITY OF THE SLURRY WALL UNDER ~~THESE CONDITIONS~~ STATIC AND EARTHQUAKE CONDITIONS, AND
(2) LIQUEFACTION POTENTIAL EVALUATION UNDER TRAIN LOADS, AND
(3) IF THE WALL IS NOT STABLE, WHAT ARE THE ALTERNATIVES.

KNOWN DATA:

(1) EXISTING BORING LOGS FROM
A. RECENT DRILLING OF BORING LOG B-7 TO B-12 & MW-17
B. PREVIOUS REPORT, "VOLUME III, FINAL REPORT – REMEDIAL INVESTIGATION", JULY 1986

(2) LOCATION DRAWING

(3) EXISTING G.W. IS LOCATED ABOUT 41' FROM THE GROUND SURFACE (PROVIDED BY B. PRICE)

ASSUMPTIONS:

(1) SLURRY WALL IS 80' DEEP AND GROUND WATER IS LOCATED AT 40' FROM THE GROUND SURFACE.

(2) AFTER REVIEWING TEST BORINGS B-1, B-2, MW-1, MW-2 MW-12 & MW-14 AS WELL AS THOSE NEWLY DRILLED TEST BORINGS B-7 TO B-12 & MW-19, MW-14 REVEALS THE WORST CONDITION SINCE IT HAS THE LOWEST AVERAGE BLOW COUNTS. THE AVG. BLOW COUNTS IS 10 IN THIS BORING. KNOWING BLOW COUNTS OF 10 AND THE EFFECTIVE OVERBURDEN PRESSURE OF 6 ksf ($\cong 110 \times 40 + (110-62.4) \times 40$), THE RELATIVE DENSITY IS ABOUT 40% (SEE PAGE 1 of 2 OF ATTACH. 1)

INTERNATIONAL TECHNOLOGY CORPORATION

By RRC Date 2/12/88 Subject ALLIED - IRONTON Sheet No. 2 of 7

Chkd. By WAM Date 3/1/88 STABILITY OF A SLURRY WALL Proj No. 303024.03.12

CONSIDERING RELATIVE DENSITY OF 40% AND IN-SITU MATERIAL OF SW OR SP, THIS MATERIAL HAVE THE FOLLOWING PROPERTIES :

$\gamma_D = 110^{pcf}$ (PAGE 2 OF 2 OF ATT. 1)

$\phi = 30^\circ$

(3) EACH TRAIN WEIGHS ABOUT 100^{TONS} AND HAS FOUR AXLES, AND FOR THE SIMPLIFICATION, THE TRAIN WILL BE EQUIVILEN TO APPLYING A LOAD OF $50^{kips/ft}$ (100^{TONS}/4 AXLES = 50^{kips}/AXLE)

REFERENCES:

(1) COULOMB'S THEORY, FROM "GEOTECHNICAL ENGINEERING" BY J.N. CERNICA., 1982

(2) STABILITY OF A SLURRY TRENCH IN COHESIONLESS SOILS. BY N. MORGENSTERN & I. AMIR-TAHMASSEB. GEOTECHNIQE, 15 No. 4 PP 387, 1965

(3) EVALUATION OF LIQUEFACTION POTENTIAL, NAVFAC, DESIGN MANUAL 7.3 APR. 1983

(4) ENGINEERING AND DESIGN, STABILITY OF EARTH AND ROCK-FILL DAMS, ENGINEERING MANUAL, ARMY, CORPS OF ENGINEERS, EM 1110-2-1902, 1, APR. 1970

(5) SIMPLIFIED PROCEDURE FOR EVALUATING SOIL LIQUEFACTION POTENTIAL H.B. SEED & I.M. IDRISS, ASCE, SM&F DIV. VOL. 97, SM9, PP 1249 - 1272.

INTERNATIONAL TECHNOLOGY CORPORATION

By RRC Date 2/16/88 Subject ALLIED- (RONTON) Sheet No 3 of 7

Chkd. By WAM Date 3/1/88 STABILITY OF A SLURRY WALL Proj. No. 303024.03.12

CALCULATIONS:

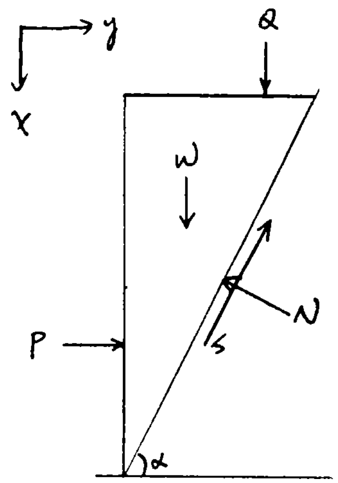
I. STABILITY EVALUATION.

1. THE THEORETICAL FAILURE PLANE IS DETERMINED BY COULOMB'S GRAPHICAL METHOD (Ref. 1, PP ~~338~~-341)

$$\alpha = 63^\circ$$

(See ATTACH. 2 GRAPHIC PAPER FOR DETAIL)

2. USE FORCE EQUILIBRIUM TO FIND THE FACTOR OF SAFETY OF THE SLURRY WALL UNDER STATIC CONDITIONS (Ref. 2)



$\Sigma F_y = 0$

$$P + S\cos\alpha = N\sin\alpha \qquad (1)$$

$\Sigma F_x = 0$

$$W + Q = S\sin\alpha + N\cos\alpha \qquad (2)$$

ALSO,

$$S = N'\tan\phi' = (N-U)\tan\phi' \qquad (3)$$

WHERE U: WATER FORCE

INSERT (3) INTO (1),

$$P + (N-U)\tan\phi'\cos\alpha = N\sin\alpha$$

OR

$$P - U\tan\phi'\cos\alpha = N(\sin\alpha - \tan\phi'\cos\alpha) \qquad (4)$$

INSERT (3) INTO (2)

$$W + Q = (N-U)\tan\phi'\sin\alpha + N\cos\alpha$$

$$W + Q + U\tan\phi'\sin\alpha = N(\cos\alpha + \tan\phi'\sin\alpha) \qquad (5)$$

FROM (4) & (5)

$$\frac{P - U\tan\phi'\cos\alpha}{\sin\alpha - \tan\phi'\cos\alpha} = \frac{W + Q + U\tan\phi'\sin\alpha}{\cos\alpha + \tan\phi'\sin\alpha} \qquad (6)$$

FROM ⑥

$$P = \frac{(W+Q)(\sin\alpha - \tan\phi'\cos\alpha) + U[\tan\phi'\sin\alpha(\sin\alpha - \tan\phi\cos\alpha) + \tan\phi\cos\alpha(\cos\alpha + \tan\phi\sin\alpha)]}{\cos\alpha + \tan\phi\sin\alpha}$$

$$= \frac{(W+Q)(\sin\alpha - \tan\phi'\cos\alpha) + U[\tan\phi(\sin^2\alpha + \cos^2\alpha) - \tan^2\phi\sin\alpha\cos\alpha + \tan^2\phi'\cos\alpha\sin\alpha]}{\cos\alpha + \tan\phi\sin\alpha}$$

i.e.

$$P = \frac{(W+Q)(\sin\alpha - \tan\phi'\cos\alpha) + U\tan\phi'}{\cos\alpha + \tan\phi'\sin\alpha} \qquad ⑦$$

3. STATIC STABILITY OF THE SLURRY WALL UNDER EXISTING CONDITION.

$$W = \tfrac{1}{2}\gamma H^2\cos\alpha = \tfrac{1}{2}(110)(80)^2(\cos 63^\circ) = 159{,}805 \text{ lbs/FT}$$

$$U = \tfrac{1}{2}\gamma_w(mH)^2\operatorname{cosec}\alpha = \tfrac{1}{2}\,62.4(40)^2\operatorname{cosec}(63^\circ) = 56{,}027 \text{ lbs/FT}$$

WHERE $m = \frac{1}{2}$ (HT OF WATER / HT OF WALL)

$Q = 50{,}000$ lb/FT ; $\alpha = 63^\circ$, $\phi = 30^\circ$

INSERT INTO EQU. ⑦

$$\therefore P = \frac{(159{,}805 + 50{,}000)(0.891 - 0.577 \cdot 0.454) + 56{,}027 \cdot 0.577}{0.454 + 0.577 \cdot 0.891}$$

$= 169{,}717$ lbs/FT

$$P_{slurry} = \tfrac{1}{2}\gamma_{slurry}(H)^2 = \tfrac{1}{2}(65.5)(80)^2 = 209{,}600 \text{ lbs/FT}$$

$$\gamma_{slurry} = 1.05 \times 62.4 = 65.5 \text{ pcf}$$

$\therefore$ F.S. $= P_{slurry}/P = 1.24$

$\therefore$ FACTOR OF SAFETY OF THE SLURRY WALL UNDER THE STATIC LOADING CONDITION IS 1.24.

(GO TO NEXT PAGE)

INTERNATIONAL TECHNOLOGY CORPORATION

By RRC Date 2/18/88 Subject ALLIED – IRONTON Sheet No 5 of 7

Chkd By WAM Date 3/1/88 STABILITY OF A SLURRY WALL Proj. No. 303024.03.12

4. STABILITY OF THE SLURRY WALL UNDER EARTHQUAKE (P. 19, 20, 22 & 25 of Ref. 4)

FROM FIG. 6 ON P. 22 OF Ref. 4. (ATT. 3), IN THIS REGION $\psi = 0.05$

$$\therefore F.S = \frac{P_{SLURRY}}{P_{SOIL} + F_{HORI}}$$

WHERE:

$P_{SLURRY} = 209\,600$ lbs/FT

$P_{SOIL} = 169,717$ lbs/FT

$F_{HORI} = \psi \cdot W' = \psi(W+Q)$

$= 0.05(159,805 + 50,000)$

$= 10490$

$$\therefore F.S. = \frac{209600}{169717 + 10490}$$

$= 1.16$

$\therefore$ FACTOR OF SAFETY OF THE SLURRY WALL UNDER EARTHQUAKE IS 1.16.

5. THEREFORE, THIS SLURRY WALL (AT ITS FULL DEPTH) SHOULD BE STABLE UNDER STATIC AND EARTHQUAKE CONDITIONS.

II. LIQUEFACTION EVALUATION (Ref. 2 & 3)

1. MAXIMUM GROUND ACCELERATION (a_{max})

USING PSEUDO FORCE METHOD, (i.e. EVALUATING THE HORIZONTAL FORCE TO LET F.S. = 1, AND USING THIS "PSEUDO HORI. FORCE" TO EVALUATE THE a_{max})

$$F.S. = 1 = \frac{P_{SLURRY}}{P_{SOIL} + (W+Q)\, a_{max}} = \frac{209600}{169717 + (159805 + 50000) \cdot \phi}$$

$\therefore \phi = 0.19 \quad \therefore a_{max} = 0.19\, g$

FROM ATT 4, THIS GROUND ACCELERATION IS GENERATED BY A 6.5 MAGNITUDE OF EARTHQUAKE; Therefore, A MAGNITUDE OF 7's EARTHQUAKE WILL BE USED.

2. ACCORDING TO PROCEDURES IN REF. (3)

(a) R_i

$$R_i = \frac{\tau_{AV}}{\sigma_o'} \cong 0.65 \times \frac{a_{max}}{g} \times \frac{\sigma_o}{\sigma_o'} \times \gamma_d$$

WHERE

σ_o = TOTAL OVERBURDEN PRESSURE $= 80' \times 110^{pcf} = 8800^{psf}$

σ_o' = EFFECTIVE OVERBURDEN PRESSURE $= 40' \times 110 + 40'(110 - 62.4) = 6304^{psf}$

$\gamma_d = 0.54$ (FROM FIG. 4 OF REF. 5)

$$\therefore R_i = 0.65 \times 0.182 \times \frac{8800}{6304} \times 0.54 = 0.089$$

(b) N_1

$$N_1 = C_N \cdot N$$

WHERE $C_N = 0.52$ (FIG. 12 of Ref (3))

$N = 15$

$\therefore N_1 \cong 8$

(c) R_f

FROM FIG 13 OF Ref. (3), $R_f = 0.11$ FOR $M \approx 6$ SITUATION

(d) F.S

$$F.S = R_f / R_i = 0.11/0.089 = 1.2$$

$\therefore$ FACTOR OF SAFETY AGAINST LIQUEFACTION IS 1.2.

3. ACCORDING TO PROCEDURES ON REF (5)

(a) τ_{AV}

$$\tau_{AV} = 0.65 \times \frac{\gamma h}{g} a_{max} \times \gamma_d = 0.65 \times 110 \times 80 \times 0.182 \times 0.54 = 562.2$$

(b) $\frac{\tau_{R10}}{\sigma_0'} \simeq \left(\frac{\sigma_{dc}}{2\sigma_a}\right)_{\ell 50} \frac{D_r}{50} C_r$

FROM FIG. 6 of Ref (5), & $D_{50} = 0.2^{mm}$

$\left(\frac{\sigma_{dc}}{2\sigma_a}\right)_{\ell 50} \triangleq 0.24$

i.e. $\tau_{R10} \triangleq 0.24\, \sigma_0' \frac{D_r}{50} C_r$

(c) THE SAND WILL DEVELOP INITIAL LIQUEFACTION IN 10 CYCLES, IF $\tau_{av} = \tau_{R10}$

i.e. $562.2 = 0.24\, \sigma_0' \frac{D_r}{50} C_r$ (i.e. $\sigma_0' = 6304$ psf)

$\therefore 18.6 = D_r \cdot C_r$

(d) FROM TRIAL & ERROR, AND FIG. 8,

$D_r = 32$ ($\Rightarrow C_r = 0.576 \Rightarrow C_r \times D_r \simeq 18.6$)

$\because D_r = 32 < 48^*$ O.K

* FROM ATTACH 1. p 1/2

4. FROM NUMBERS OF PUBLISHED LITERATURE, LIQUEFACTION WOULD OCCURE IN THE "SATURATED SAND ZONE"; THE GROUNDWATER IN OUR SITE IS ABOUT 40' FROM THE GROUND SURFACE AND THIS WATER SHOULD NOT BE ABLE TO BE PUSHED UP TO NEAR THE GROUND SURFACE UNDER ANY KIND OF LOAD. Therefore, THE DYNAMIC LOAD FROM THE TRAIN SHOULD NOT CAUSE LIQUEFACTION.

$\therefore$ NO LIQUEFACTION WOULD OCCUR UNDER THIS TRAIN LOAD.

IV.

NOT NECESSARY.

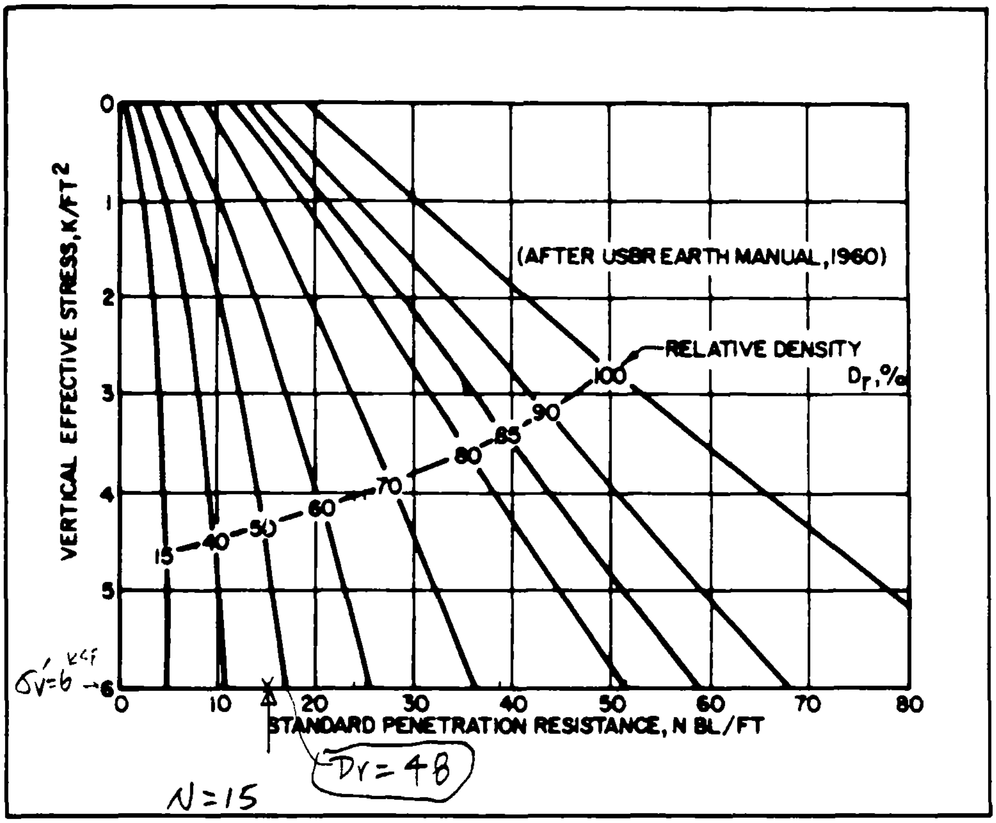
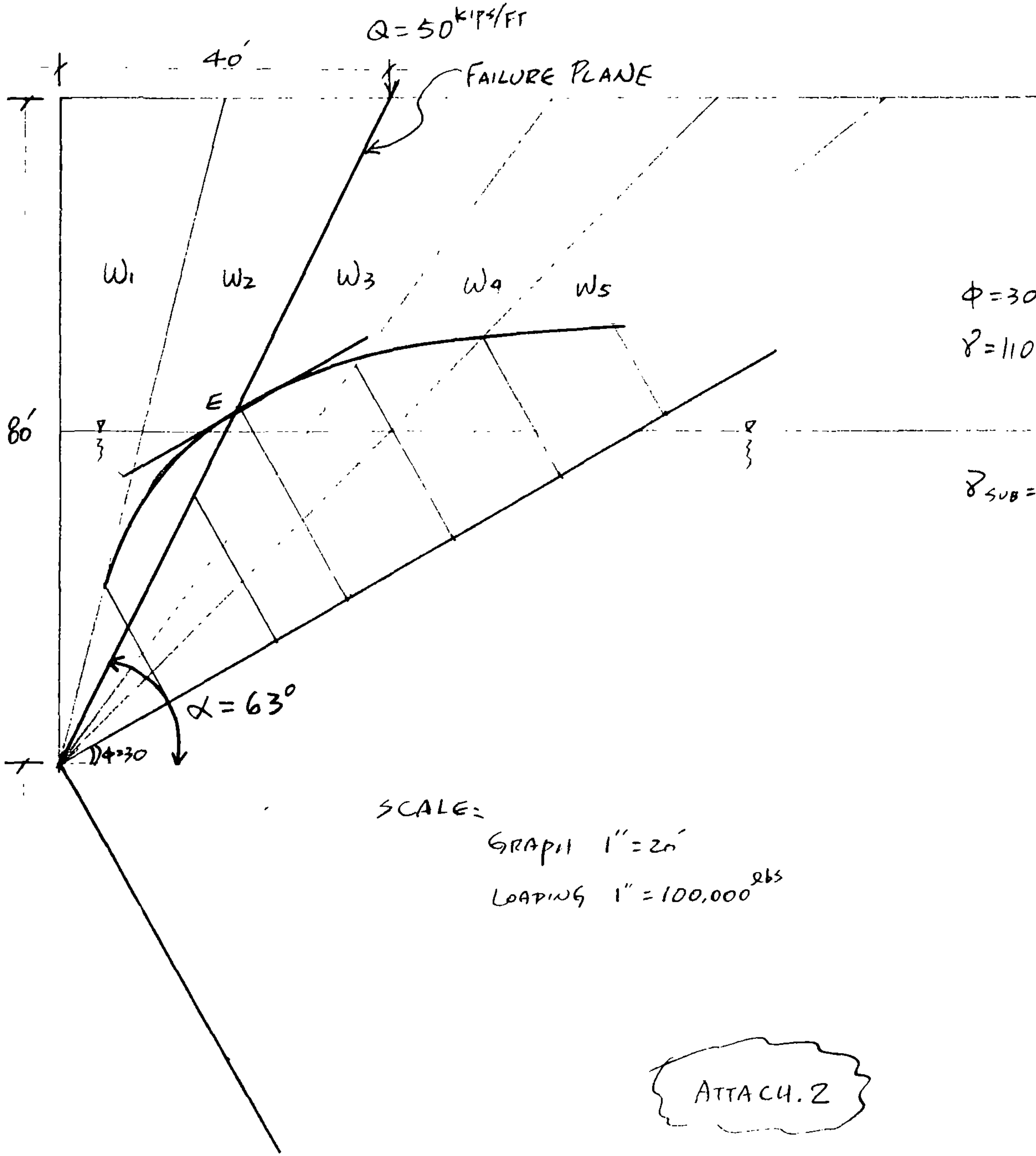


FIGURE 3
Correlations Between Relative Density and Standard Penetration Resistance in Accordance with Gibbs and Holtz

ATTACH 1
1/2



$\phi = 30^{\circ}$

$\gamma = 110^{pcf}$

$\gamma_{sub} = 110 - 62.4 = 47.6^{pcf}$

SECTION	WEIGHT
W_1	$\frac{1}{2}(20+10)\cdot 40' \cdot 110^{pcf} + \frac{1}{2}\, 10' \cdot 40' \cdot 47.6^{pcf}$
	$= 75{,}520^{\,lb/ft}$

$W_2 = W_3 = W_4 = W_5 = 75{,}520^{\,lbs/ft}$

SCALE:

GRAPH 1" = 20'

LOADING 1" = 100,000 lbs

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ATTACH. 2

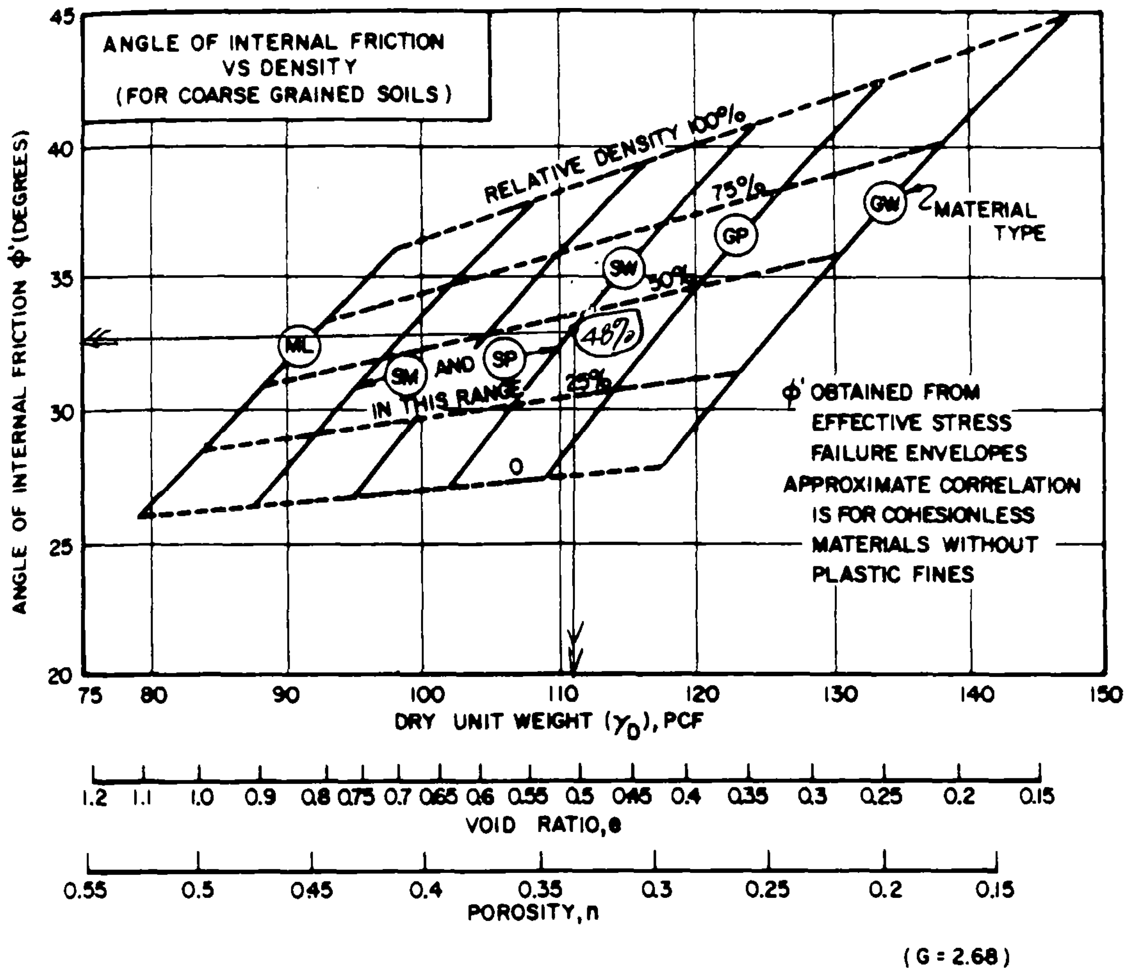


FIGURE 7
Correlations of Strength Characteristics for Granular Soils

USE: $\gamma_D = 110^{pcf}$

$\phi = 32^{\circ}$

ATTACH 1
2/2

ATTA. 3

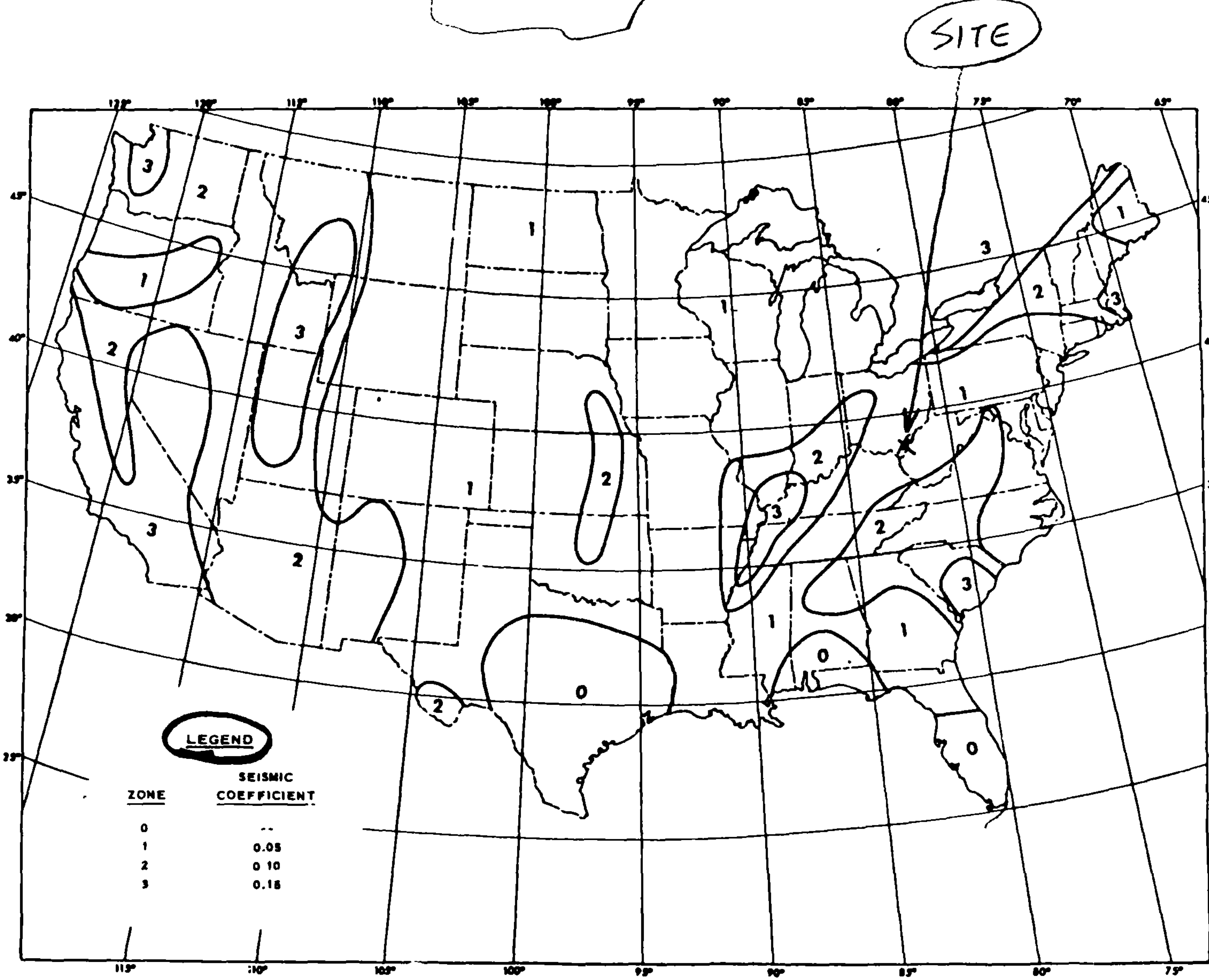
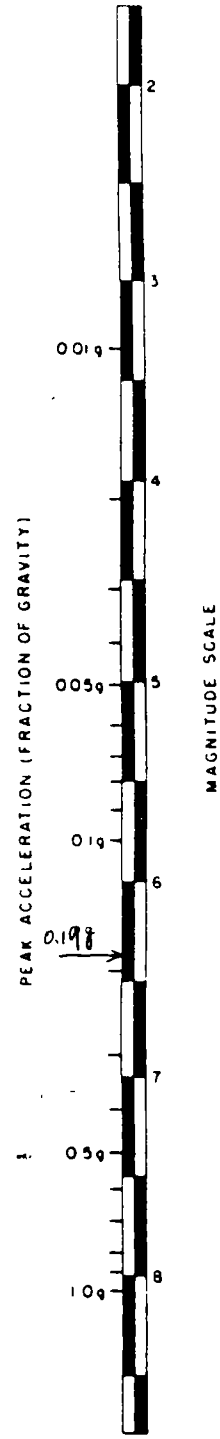


Figure 6. Zones of approximately equal seismic probability and seismic coefficients (Algermissen[8])

[ATTACH 4]

ROSSI-FOREL INTENSITY SCALE (1883)	MODIFIED MERCALLI INTENSITY SCALE [33]
	I Not felt. Marginal and long-period effects of large earthquakes.
I The shock felt by an experienced observer.	II Felt by persons at rest, on upper floors, or favorably placed.
II Recorded by several seismographs; felt by a small number of persons at rest.	III Felt indoors. Hanging objects swing. Vibration like passing of light trucks. Duration estimated. May not be recognized as an earthquake.
III Felt by several persons at rest; strong enough for the direction or duration to be appreciable.	IV Hanging objects swing. Vibration like passing of heavy trucks. Standing motor cars rock. Windows, dishes, doors rattle. Glasses clink. In upper range of IV wooden walls and frame creak.
IV Felt by persons in motion, disturbance of movable objects, doors, windows; cracking of ceilings.	V Felt outdoors; direction estimated. Sleepers wakened. Liquids disturbed. Doors swing. Shutters, pictures move. Pendulum clocks stop, start, change rate.
V Felt generally by everyone, disturbance of furniture, beds, etc.; ringing of some bells.	VI Felt by all. Many frightened and run outdoors. Persons walk unsteadily. Windows, dishes, glassware broken. Books off shelves. Pictures off walls. Furniture moved or overturned. Weak plaster and adobe cracked. Small bells ring.
VI General awakening of those asleep; ringing of bells, oscillation of chandeliers, clocks stop, agitation of trees and shrubs, some startled persons leave dwellings.	VII Difficult to stand. Noticed by drivers of motor cars. Fall of plaster, loose bricks, tiles, etc. Some cracks in masonry. Waves on ponds; water turbid. Small slides, caving of sand or gravel banks. Large bells ring. Concrete irrigation ditches damaged.
VII Overthrow of movable objects, fall of plaster, ringing of bells; panic, without great damage to buildings.	VIII Steering of motor cars affected. Damage to masonry; some partial collapse. Twisting, fall of chimneys, monuments, elevated tanks. Frame houses moved if not bolted down. Branches broken. Changes in springs and wells. Cracks in wet ground and on steep slopes.
VIII Fall of chimneys, cracks in the walls of buildings.	IX General panic. Weak masonry destroyed, good masonry seriously damaged. Frame structures, if not bolted, shifted off foundations. Frames racked. Serious damage to reservoirs. Underground pipes broken. Ground cracked, sand and mud ejected, earthquake fountains, sand craters.
IX Partial or total destruction of some buildings.	X Most masonry and frame structures destroyed with their foundations. Serious damage to embankments. Large landslides. Water thrown on banks of canals, rivers, lakes, etc. Rails bent slightly.
X Great disaster; ruins, disturbance of the strata, fissures in the ground, rockfalls, landslides, etc.	XI Rails bent greatly. Underground pipelines completely out of service.
	XII Damage nearly total. Large rock masses displaced. Lines of sight and level distorted. Objects thrown into the air.



APPROXIMATE RELATIONSHIPS: EARTHQUAKE INTENSITY, ACCELERATION, AND MAGNITUDE [18]

FIGURE A.1

PURPOSE:

D. HSU RECOMMENDS TO EVALUATE THE STABILITY OF SLURRY WALL AT A SHALLOWER DEPTH; ACCORDINGLY, THE CALCULATIONS PERFORMED HERE (USING LOTUS 1-2-3) ARE TO CHECK THE STABILITY AT DIFFERENT WALL DEPTHS.

CALCULATION:

(1) THE THEORETICAL FAILURE PLANE IS DETERMINED BY COULOMB'S GRAPHIC METHOD. FROM ATTACHMENT 5 THE INTERNAL FRICTIONAL ANGLES ARE

SLURRY WALL DEPTH	ϕ
60	61°
50	57°
40	53°
30	47°

(2) FROM ATTACH 6., THE FACTORS OF SAFETY UNDER STATIC & EARTHQUAKE CONDITIONS ARE ALL ABOVE 1 AT DIFFERENT DEPTH.

(3) THE LIQUIFICATION POTENTIAL EVALUATION, ACCORDING TO NAVFAC METHOD (SIMILIAR TO H. SEED'S SIMPLIFIED METHOD, Ref. 5 of ORIGINAL CALC.), $F.S = R_f / R_i$

WHERE

$$R_i \cong 0.65 \times \frac{a_{max}}{g} \times \frac{\sigma_o}{\sigma_o'} \times \gamma_d$$

THE SMALLEST VALUE OF $\frac{\sigma_o}{\sigma_o'}$ IS AT SLURRY WALL DEPTH OF 40' OR SHORTER. IT WILL BE EQUALLED TO 1; AND THE LARGEST VALUE OF σ_o/σ_o' OCCURS IN THE CASE SHOWN ON THE ORIGINAL CALCULATION (i.e H = 80 & H_w = 40), WHICH IS 1.4. THIS INDICATES THAT R_i VALUE WILL BE REDUCED AT SHALLOWER SLURRY WALL DEPTHS. Therefore, THE FACTOR OF SAFETY WILL BE INCREASED AND LIQUIFICATION POTENTIAL IS DECREASED.

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By RRC Date 3/2/88 Subject ALLIED - IRONTON Sheet No 2 of 2

Chkd By WAM Date 3/2/88 ADDENDUM TO STABILITY OF SLURRY WALL Proj No 2-3024-02-12

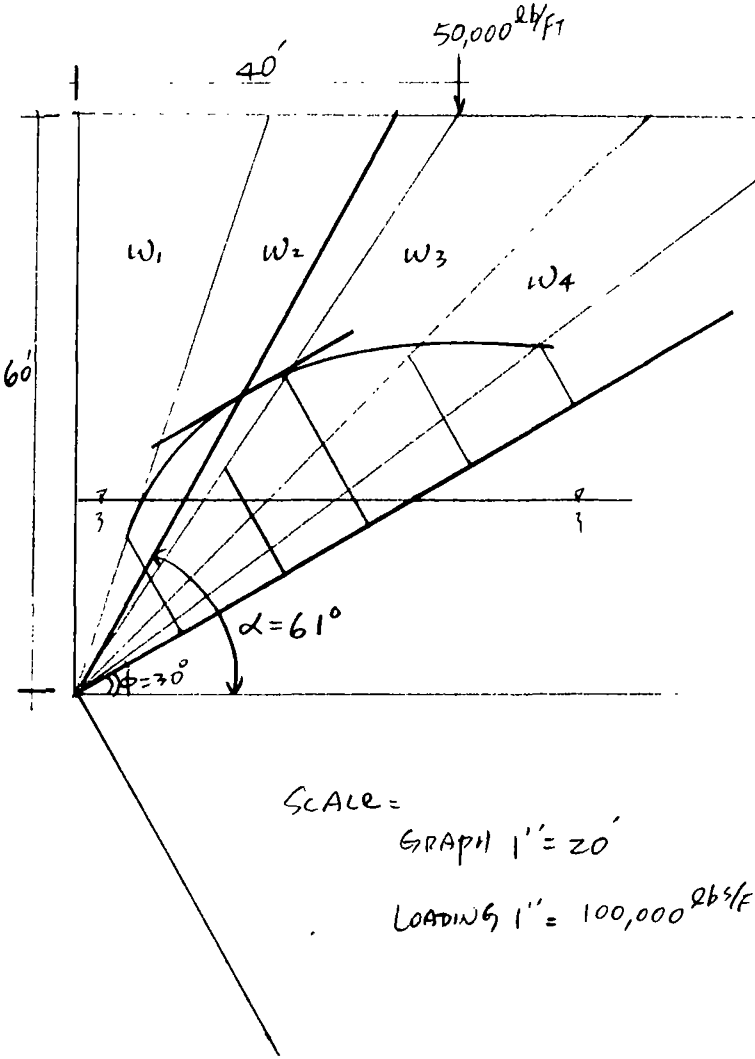
CONCLUSIONS AND RECOMMENDATIONS:

THE SLURRY WALL SHOULD BE STABLE UNDER THIS CONDITION.

HOWEVER, SOME PRECAUTIONS SHOULD BE ADDRESSED:

(1) MINIMIZE THE LENGTH AND TIME OF THE 'OPEN' TRENCH

(2) REDUCE THE TRAIN SPEED IN THIS GENERAL AREA DURING CONSTRUCTION.



$\phi = 30^\circ$

$\gamma = 110^{pcf}$

$\gamma_{SUB} = 110 - 62.4 = 47.6^{pcf}$

SCALE =

GRAPH 1" = 20'

LOADING 1" = 100,000 lbs/FT

SECTION	WEIGHT
W1	$\frac{1}{2}(20' + 6.67') \cdot 40' \cdot 110^{pcf} + \frac{1}{2} 6.67' \cdot 20' \cdot 47.6$ $= 61,849$

$W_2 = W_3 = W_4 = 61,849$

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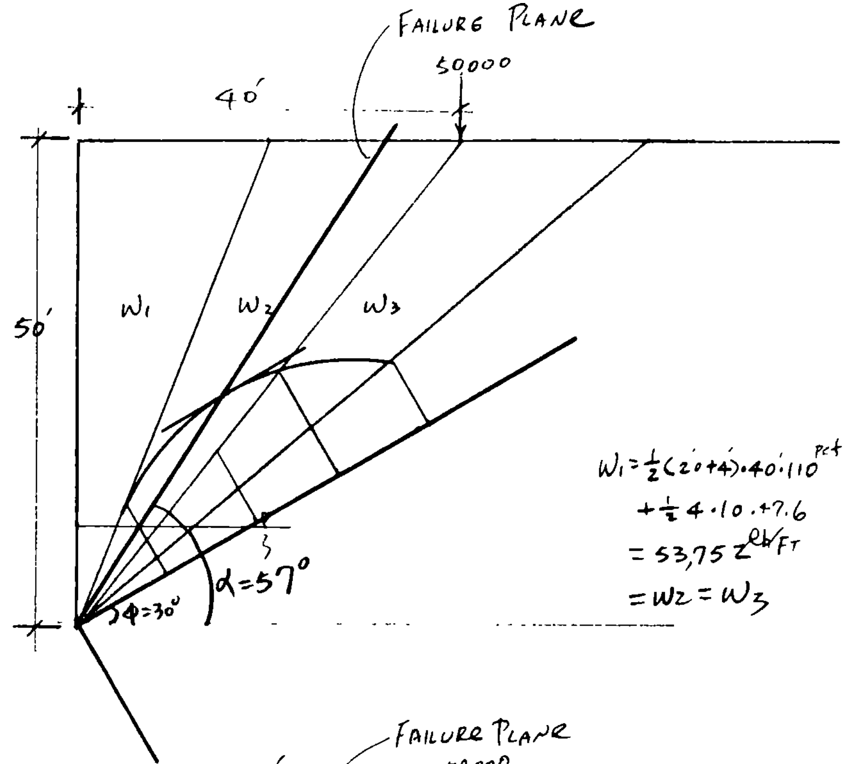
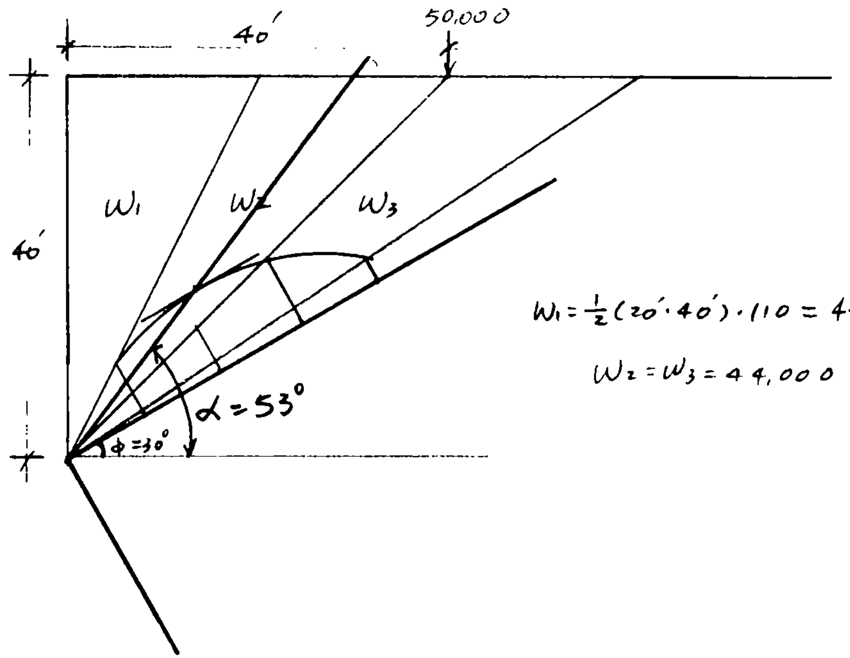
ATTACH 5

1/2

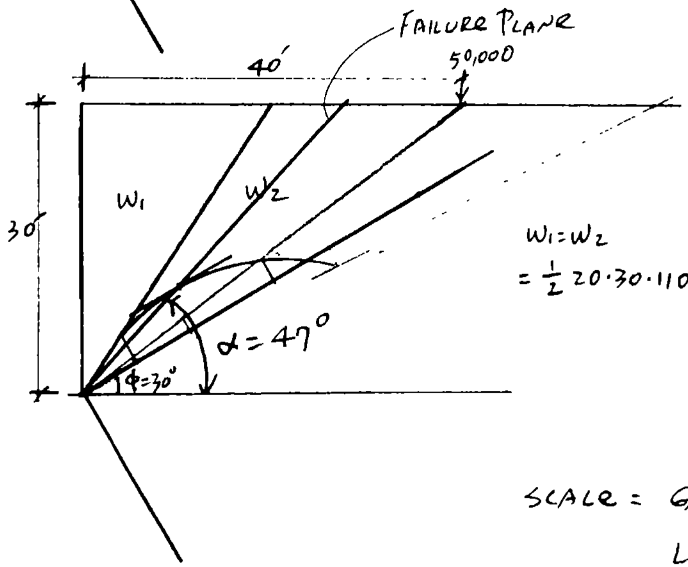


$W_1 = \frac{1}{2}(20'+4)\cdot 40' \cdot 110^{pcf}$
$+ \frac{1}{2} 4 \cdot 10 \cdot +7.6$
$= 53{,}752$ lb/FT
$= W_2 = W_3$



$W_1 = \frac{1}{2}(20' \cdot 40') \cdot 110 = 44{,}000$

$W_2 = W_3 = 44{,}000$



$W_1 = W_2$
$= \frac{1}{2} 20 \cdot 30 \cdot 110' = 33{,}000$

ALLIED-IRONTON
30302 4.03.12
R. Glen

SCALE = GRAPH 1" = 20'
LOADING 1" : 100,000 lb/FT

ATTACH 5

SLURRY WALL STABILITY EVALUATION
PROJECT: ALLIED-IRONTON
PROJ.NO: 303024.03.12

RRC

SLURRY WALL INFO. DEPTH (ft.)	UNIT WT. (pcf)	P slurry (lb/ft)	IN-SITU SOIL & OTHER INFORMATION UNIT WT. (pcf)	PHI DEG.	PHI RAD.	APHA DEG.	APHA RAD.	G.W. FROM G.S. (ft)	LD. TO SLU WALL (ft)	LOADINGS AND/OR FORCES W (lb/ft)	U (lb/ft)	Q (lb/ft)	ACTUAL Q (lb/ft)	P (lb/ft)	FACTOR OF SAFETY STATIC F.S.	EARTHQUAKE PSI	EARTHQUAKE F.S.	YIELDING ACCELE. (g)
80	65.52	209664.0	110	30	0.523598	(1) 63	1.099557	40	40	159804.7	56026.5	50000.0	50000.0	169650.7	1.24	0.05	1.16	0.19
70	65.52	160524.0	110	30	0.523598	(1) 62	1.082104	40	40	126522.6	31802.6	50000.0	0.0	97810.5	1.64	0.05	1.54	0.50
60	65.52	117936.0	110	30	0.523598	(1) 61	1.064650	40	40	95992.3	14269.1	50000.0	0.0	66001.4	1.79	0.05	1.67	0.54
50	65.52	81900.0	110	30	0.523598	(1) 57	0.994837	40	40	74887.9	3720.2	50000.0	0.0	40244.9	2.04	0.05	1.86	0.56
40	65.52	52416.0	110	30	0.523598	(1) 53	0.925024	40	40	52959.7	0.0	50000.0	0.0	22400.1	2.33	0.05	2.09	0.57
30	65.52	29484.0	110	30	0.523598	(1) 47	0.820304	40	40	33758.9	0.0	50000.0	0.0	10321.1	2.86	0.05	2.46	0.57
70	65.52	160524.0	110	30	0.523598	(2) 63	1.099557	40	40	122350.4	31514.9	50000.0	0.0	98243.9	1.63	0.05	1.54	0.51
60	65.52	117936.0	110	30	0.523598	(2) 63	1.099557	40	40	89090.1	14006.6	50000.0	0.0	66725.8	1.77	0.05	1.66	0.57
50	65.52	81900.0	110	30	0.523598	(3) 63	1.099557	40	40	62423.7	3501.7	50000.0	0.0	42626.0	1.92	0.05	1.79	0.63
40	65.52	52416.0	110	30	0.523598	(2) 63	1.099557	40	40	39951.2	0.0	50000.0	0.0	25944.6	2.02	0.05	1.88	0.66
30	65.52	29484.0	110	30	0.523598	(2) 63	1.099557	40	40	22472.5	0.0	50000.0	0.0	14593.8	2.02	0.05	1.88	0.66
80	65.52	209664.0	110	30	0.523598	(3) 60	1.047197	40	40	176000.0	57642.7	50000.0	50000.0	163761.2	1.28	0.05	1.20	0.20
70	65.52	160524.0	110	30	0.523598	(3) 60	1.047197	40	40	134750.0	32424.0	50000.0	50000.0	125385.5	1.28	0.05	1.19	0.19
60	65.52	117936.0	110	30	0.523598	(3) 60	1.047197	40	40	99000.0	14410.7	50000.0	0.0	65477.7	1.80	0.05	1.67	0.53
50	65.52	81900.0	110	30	0.523598	(3) 60	1.047197	40	40	68750.0	3602.7	50000.0	0.0	41772.8	1.96	0.05	1.81	0.58
40	65.52	52416.0	110	30	0.523598	(3) 60	1.047197	40	40	44000.0	0.0	50000.0	0.0	25403.4	2.06	0.05	1.90	0.61
30	65.52	29484.0	110	30	0.523598	(3) 60	1.047197	40	40	24750.0	0.0	50000.0	0.0	14289.4	2.06	0.05	1.90	0.61

(1) FROM COLUMB'S GRAPHIC METHOD

(2) USING Φ WHICH IS OBTAINED FROM COLUMB'S GRAPHIC METHOD UNDER SLURRYWALL = 80'

(3) $\Phi = 45^\circ + \Phi/2 = 60^\circ$

ATTACH 6

APPENDIX C

TECHNICAL MEMORANDUM
ANALYSIS OF OFF-SITE GROUND WATER RECOVERY SYSTEMS
AT GOLDCAMP DISPOSAL AREA

APPENDIX C

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TECHNICAL MEMORANDUM
ANALYSIS OF GROUND WATER FLOW AND MASS TRANSPORT

C.1.0 INTRODUCTION

C.1.1 PURPOSE AND OBJECTIVES

This appendix details the computer modeling carried out by IT Corporation on the Allied-Signal Incorporated (Allied) Goldcamp Disposal Area (GDA) site in 1988. The purpose of the modeling was to develop a representative ground water flow model for the area incorporating the GDA for the purpose of determining optimum ground water recovery schemes for the off-site contamination associated with the GDA. More specifically this included:

- Choosing optimum recovery schemes for the off-site contaminated area of the GDA recovery well(s) with no Ironton Iron wells active
- Investigating the effect of pumping at Ironton Iron Well IIC-7 on the recovery well(s) pumping rate(s)
- Investigating the effect of pumping at Ironton Iron Well IIC-5 (instead of Well IIC-7) on the optimum recovery case.

The choice for the optimum recovery scheme was to be based on the following criteria:

- Maximize containment of potentially contaminated ground water
- Minimize number of recovery wells
- Minimize recovery well flow rate(s), thereby minimizing amount of ground water going to the treatment system.
- Minimize contribution of Ohio River to pumped water at recovery well(s)
- Maintain an inward ground water flow gradient to the GDA.

C.1.2 GEOFLOW MODEL

A hydrogeologic model of the ground water flow regime at the Allied GDA and surrounding area was developed and a two-dimensional, horizontal numerical model of the site ground water system was implemented using the GEOFLOW computer program (IT, 1986a). The GEOFLOW program is a finite element program which numerically solves the governing equations for two-dimensional ground water flow and mass transport. This program is capable of modeling detailed areal variations in hydrogeologic conditions and can also incorporate variations in parameters in the vertical dimension such as variable recharge rates, uneven bedrock surfaces, variable saturated thicknesses, and seepage through low-permeability layers overlying an aquifer. These capabilities make the model a powerful tool even though the aquifer characteristics are known only from a limited data base. (For the purposes of the analyses, the term "aquifer" is used to refer to the water-bearing alluvial sand and gravel deposits in the GDA area.) Validation of the model was performed as described in Section C.2.2.1. All the models were run to steady-state conditions so that comparison could be made between the different remedial alternatives. Because of the high hydraulic conductivity of the aquifer, steady-state conditions would be reached quickly.

The extent of potential contamination was defined by using Figure 4-17 in the RI report (IT, 1986b). The effectiveness of recovery well scenarios in terms of their ability to contain the potential contaminant plume was examined with respect to this figure.

C.1.3 INPUT TO ANALYSIS

The analysis of ground water flow at the site is based upon the results of field investigation programs. Data used in the assessment include geologic information such as boring logs, aquifer test results, and water table measurements. In addition to these raw data, the analysis incorporated the interpretations of site geology based on field data. Finally, additional information such as historical records, reports from previous investigations, and previous modeling was incorporated. Sources of data for specific parameters and analyses are referenced in the corresponding sections of the following text.

C.2.0 FLOW ANALYSES

C.2.1 HORIZONTAL FLOW MODEL

The specific objectives of developing the two-dimensional horizontal flow model was to develop optimum recovery schemes for the off-site contamination at the GDA site under various conditions, both with and without pumping at Ironton Iron Wells. The steps included:

- Develop a finite element grid system optimizing use of field data and incorporating element geometries conducive to accurate numerical results. The model has a finer grid in and around the GDA (area of interest) and a coarser grid outside of this area where detail is less important (and input data less well defined).
- Validate the model by comparing computed versus actual ground water elevations with no wells pumping.
- Perform a series of model runs for different conditions and choose optimum recovery well schemes.

Site-specific input to the model included, boundary conditions (specified water table elevations where appropriate), aquifer recharge and hydraulic conductivity zones, bedrock elevations, initial saturated thicknesses, and locations of pumping wells with corresponding pumping rates. The following discussion includes rationale development of the grid system and for values used in the model.

C.2.1.1 Finite Element Grid System

Grid System Development

The grid system developed for the site consisted of 1272 elements and 1350 nodes representing the area around the GDA, the Ohio River, Ice Creek, the alluvial aquifer north of the GDA, and the Ironton Iron well field.

Figure C-1 shows the site features and GEOFLOW grid system in the area of interest around the GDA. The following factors govern the grid system configuration:

- Grid boundaries coincide with hydrologic features and the limits of the alluvial aquifer to the northwest and northeast, where appropriate

- The northwestern and northeastern grid boundaries are beyond the limits of the radius of influence of the Ironton Iron well field

- The configuration of Ice Creek which is in hydraulic connection with the alluvial aquifer is represented

- Where possible the location of the Ironton Iron Wells and other wells coincide with nodes

- The grid system is finer in the areas of primary interest to reflect the density of data points, variability of aquifer characteristics, and configurations of physical site features; to enable more realistic simulation of potential remedial alternatives; and to increase numerical accuracy of the model

<u>Boundary Conditions</u>

The selection of representative boundary conditions is important as they affect results computed in the interior of the grid. Constant head or no-flow boundaries were assigned according to the following rationale:

- <u>Constant Head Boundary Along Ohio River</u> - The Ohio River is in hydraulic connection with the alluvial aquifer. The constant head represents the approximate normal river stage (516 feet mean sea level) and allows flow across the boundary along this border of the site.

- <u>Constant Head Boundary Along Ice Creek</u> - Ice Creek is in hydraulic connection with the alluvial aquifer. The constant head represents the approximate normal river stage and allows flow across the boundary along this border of the site.

- <u>Variable Specified Head Along Southern Boundary</u> - Various constant water elevations representative of and extrapolated from well measurements and river stage measurements were specified along the southern edge of the grid. These constant heads allow flow across the boundary representing recharge from the aquifer south of the grid boundary.

- <u>No-Flow Boundary Along Northeastern Edge of Grid</u> - The northeastern boundary of the grid is located beyond the radius of influence of the Ironton Iron wells to prevent restriction of flow to the well field.

- <u>No-Flow Boundary Along Northwestern Edge of Grid</u> - The northwestern boundary of the grid is located beyond the radius of influence of the Ironton Iron wells to prevent restriction of flow to the well field.

- <u>Constant Head Boundary Inside Slurry Wall</u> - Constant head values are assigned at the nodes on the inside of the slurry wall elements to simulate expected pumping within the GDA itself.

C.2.1.2 Hydrogeologic Input Parameters

Following development of the grid system with various recharge and hydraulic conductivity zones, values of hydrologic parameters were assigned to each element/node as appropriate. This section describes the values input into the model. Table C.1 gives the final parameters selected for the model to best simulate the existing ground water system given the current data base and present understanding of site hydrogeologic conditions.

Each element within the grid system was assigned to a hydraulic conductivity and recharge zone. Initial aquifer saturated thicknesses and bedrock (bottom of aquifer) elevations were also assigned to the elements on the basis of isopach and bedrock elevation contour maps generated from Phase II field data (IT, 1986b, Figures 4-7 and 4-8) and new field data (1988 boring logs). Each node along the grid boundary was designated as a constant head node (with specified water level elevations) or as part of a no-flow boundary. Constant head values were assigned on the basis of representative measured heads. For runs where the effect of pumping the recovery well(s) in conjunction with pumping at the Ironton Iron wells was being considered, the node corresponding to Ironton Iron Well IIC-7 or Well IIC-5 was specified as a pumping well and assigned a corresponding pumping rate.

Hydraulic Conductivity Zones

Five aquifer material zones, representing different hydraulic conductivities, were assigned within the grid system. The alluvial aquifer is assigned to Zone 1 and the Ohio River bank is assigned to Zone 2. The materials comprising Zone 2 were assigned a hydraulic conductivity lower than that of the alluvial aquifer as discussed below. Zone 3 represents fill and aquifer material within the GDA. For the simulations performed, a slurry wall is assumed to surround the GDA, thus isolating the source of off-site contamination. The slurry wall is incorporated into the model by assigning a low hydraulic conductivity to the elements representing the slurry wall. Two zones are assigned to the slurry wall itself. Zone 4 represents the northwest and northeast sides of the slurry wall and Zone 5 represents the southwest and southeast sides of the slurry wall.

Alluvial Aquifer Hydraulic Conductivity (Zone 1)

Initial estimates of aquifer permeability for modeling applications were based on Phase II field permeability tests, specific capacity data from area pumping wells, and experience with alluvial materials having grain-size distributions similar to those recorded in the field investigations.

- Results from aquifer hydraulic conductivity tests performed during the Phase II investigations indicated that a hydraulic conductivity range of approximately 4×10^{-3} to 4×10^{-2} centimeter per second (cm/s) is representative for the aquifer material.

- Calculations based upon specific capacity data from tests at pumping wells installed at or near the site yield hydraulic conductivity values in the range of approximately 2×10^{-2} to 8×10^{-2} cm/s.

- Phase II field investigations indicated that the aquifer materials may be generally characterized as sands with gravels and silts. Alluvial deposits having grain-size distributions similar to those determined for the Ironton site aquifer generally have hydraulic conductivity in the range of 5×10^{-3} to 1×10^{-1} cm/s (Freeze and Cherry, 1979).

- Single well pumping tests performed in January/February 1988 on wells in and around the GDA indicate that local aquifer hydraulic conductivity varies from 10^{-2} to 10^{-1} cm/s with an average value of about 6×10^{-2} cm/s.

Based on the above estimates, an aquifer hydraulic conductivity of 2×10^{-2} cm/s was assigned to the main aquifer zone in the horizontal model (Zone 1).

Ohio River Bank Hydraulic Conductivity (Zone 2)

The Ohio River bed is directly above the bedrock formation which underlies the site. Materials deposited along the edges of the river have formed a bank zone of variable hydraulic conductivity. Flow from the Ohio River into the aquifer induced by pumping is probably through the riverbank, with the potential for some discharge through the bed into the aquifer via the thin underlying layer of sand and gravel deposits. Under normal stage conditions, it is assumed that ground water flows primarily from the aquifer into the Ohio River. Measured ground water levels indicate that the riverbank is less permeable than the alluvial aquifer in the area adjacent to the tar plant and GDA. A value of 1.6×10^{-3} cm/s was assigned as the hydraulic conductivity of the Ohio River bank zone (Zone 2).

GDA and Slurry Wall Hydraulic Conductivities (Zones 3, 4, 5)

The hydraulic conductivity zone representing the GDA (Zone 3) was assigned a value which is equivalent to the aquifer as a whole. Although it consists of two material types, fill and aquifer material, this approach is considered appropriate because the GDA area is isolated by the slurry wall and is not the principle concern for the model.

Normally a slurry wall would be 3 to 5 feet thick and would have a hydraulic conductivity of approximately 1×10^{-7} cm/s. The slurry wall elements within the model are considerably larger than 3 to 5 feet, they are 60 feet wide in Zone 4 and 50 feet wide in Zone 5. In order to compensate for this "equivalent hydraulic conductivities" were calculated for the two zones from the following formula:

$$K_m = \frac{\Delta X_m}{\Delta X_f} = K_f$$

where

K_m = model hydraulic conductivity
ΔX_m = thickness of slurry wall in model
ΔX_f = expected thickness of slurry wall in reality
K_f = hydraulic conductivity of slurry wall.

Hydraulic conductivities of 2.0×10^{-6} and 1.7×10^{-6} cm/s were assigned to Zone 4 and Zone 5, respectively.

Recharge Zones

Five recharge zones were used to represent recharge to the alluvial aquifer:

- Zone 1 - Zone 1 represents net recharge from precipitation infiltrating through surficial deposits overlying the alluvial aquifer. It includes the entire model area except for a two-element-thick strip along the Ohio River as described below.

- Zone 2 - The Ohio River bank was treated as a separate recharge zone due to steep hydraulic gradients in these areas relative to the flat gradients throughout the majority of the site. This implies the presence of materials of significantly lower hydraulic conductivity in these areas which, in conjunction with steep ground surface slopes and high saturation states, indicates that infiltration in this zone may be negligible compared to Zone 1.

- Zones 3, 4, and 5 - These zones represent the GDA (Zone 3) and the two slurry wall zones (Zones 4 and 5). They are assigned values equivalent to the aquifer as a whole (Zone 1).

Recharge Rate

Previous experience with water balance calculations and hydrogeologic simulation indicates that a range of four to ten inches per year is representative for the Ohio, Kentucky, and West Virginia region. A recharge rate of 8 inches per year was used for Zones 1, 3, 4, and 5. Zero recharge was assumed for the zone representing the Ohio River Bank (Zone 2).

Ohio River and Ice Creek Water Surface Elevations

An elevation of 516 feet MSL was selected for the Ohio River and Ice Creek a the site. The selection process for arriving at this number is described in Section F.2.1.2 of the 1986 RI (IT, 1986b).

Head Values Inside Slurry Wall of GDA

Constant head values were assigned at the nodes at the inside of the slurry wall elements to simulate pumping within the GDA. A value of 506 feet MSL was chosen as low enough to maintain an inward gradient.

C.2.1.3 Well Locations and Pumping Rates

Locations for Ironton Iron wells were assigned to the nearest node as discussed below. Pumping rates for these wells were chosen as equal to the design capacities of the wells. The locations of recovery wells were chosen as discussed below and the pumping rates for these recovery wells were varied as discussed below and in Section C.2.2.2.

Ironton Iron Well Locations and Pumping Rates

Included in the modeling objectives was an investigation of the effect of pumping at Ironton Iron Well IIC-7 on the ground water remediation of the area surrounding the GDA. The well is situated at Node 519 on the finite element grid. The capacity of the pump is 400 gpm and the worst case situation would be realized if the well was pumped at its maximum rate. For this reason the pumping rate chosen to represent Well IIC-7 is 400 gpm.

Ironton Iron Well IIC-5 is situated further from the GDA, for this reason it was investigated as an alternate source of water for Ironton Iron. The well is located at Node 343 on the finite element grid and the capacity of the pump is 300 gpm.

Location of Single Recovery Well

The location for a single recovery well was chosen as Node No. 695 in the model. This location has the following attributes:

- It is between the GDA and Ironton Iron Wells.
- It is to the land side of the railway line.
- It is located approximately 200 feet from the slurry wall. This is expected to be far enough away to not cause excessive drawdown adjacent to the slurry wall.
- It is away from the river to minimize Q_r.
- It is within the probable contaminant plume.

Location of Multiple Recovery Wells

Four recovery wells were included in the multiple recovery well model runs. The first well was located in the same place as for the single recovery well. The three additional wells were placed at approximately equal distance apart along the river side of the GDA (Nodes 797, 872, and 947).

Recovery Well Pumping Rates

Pumping rates for the model runs were varied within a range of 50 to 400 gpm.

C.2.1.4 Assumptions

The following assumptions were made in performing the horizontal flow simulations:

- Ground water flow is along a two-dimensional plane which is nearly horizontal as defined by the bedrock surface (bottom of aquifer). Vertical velocity components are considered negligible with respect to the horizontal components.
- Ground water flow through bedrock underlying the aquifer is negligible relative to the aquifer flow rate.
- Within each hydraulic conductivity zone, the aquifer is homogeneous and isotropic.

- Within each defined recharge zone, the recharge rate is uniform.
- No pumping is currently taking place. However, once a well is turned on, it is pumped at a constant rate for 24 hours per day for the duration of the model.
- The contaminant source area (GDA) is isolated by having a slurry wall around it. Pumping within the slurry wall will occur in order to maintain an inward ground water gradient.

C.2.2 HORIZONTAL FLOW ANALYSES

C.2.2.1 Model Validation

The model was validated as described in this section. A model simulation was performed for the case where there was no slurry wall and no pumping wells. This simulation, showing the existing situation, was performed for the steady-state situation. Figure C-2 shows the computed existing flow vectors across the site. Table C.2 shows a comparison of observed ground water elevation data collected in January/February 1988 with computed values. The negative sign indicates that for all points examined the model generally underestimates water levels slightly, the sum of the differences divided by the number of observations is 0.82 foot and the standard deviation of the differences is 0.41 foot. Away from the river elements, calibration is within one foot (Wells MW-2, and MW-14, MW-19, and MW-20). Closer to the river (in the river elements) calibration is within 1.5 foot (Wells MW-1 and MW-14). The computed ground water surface provides a good representation of observed ground water flow conditions generally observed at the site. Flow is predominantly towards Ice Creek and the Ohio River and steeper hydraulic gradients exist adjacent to the Ohio River. Locally in the area of the GDA, ground water flow is towards the river.

C.2.2.2 Model Optimization Runs

Several model runs were performed. After each run was made, the results were examined with respect to the optimization criteria and the scenario accepted or rejected. Changes were incorporated into subsequent runs based on the results of previous runs.

Optimization Criteria

As stated in Section C.1.1, optimization was based on several criteria. These include:

- Maximizing the containment of the probable contaminant plume
- Minimizing the number of recovery wells
- Minimizing the recovery well flow rates/amount of water to be treated
- Minimizing the contribution of the Ohio River to pumping water at the recovery wells
- Monitoring an inward ground water flow gradient to the GDA

The analysis of the majority of runs with respect to these criteria is straight forward except for the fourth item, the contribution of the Ohio River to the treatment system. This value was calculated as follows.

The sources and magnitudes of river water flow to the Ironton Iron and Recovery wells were determined using a summation of computed flow rates for appropriate nodes within the grid system taken from the model output file. This data was used to accept or reject recovery well scenarios based on the criteria given above. The water at pumping wells is from two sources, the aquifer and the Ohio River as defined in the equation below:

$$Q = Q_r + Q_a$$

where

Q = total amount of flow at well

Q_a = component of flow to wells from aquifer

Q_r = component of flow to wells from river.

The existing condition (Figure C-2) shows all flow vectors for the elements adjacent to the Ohio River pointing towards the Ohio River. For subsequent runs, where the flow vectors point away from the Ohio River, the summation of ground water discharge for these river nodes can be taken as the amount Q_r. Q_r was calculated in gpm and then represented as a percentage of the total flow to the pumping wells. For runs with multiple recovery wells, the value of Q_r was calculated for the group of wells as a whole since the object was to determine how much river water would be going to the wells at the GDA and consequently through the treatment system. Two simulations showed pumping at Ironton Iron Wells IIC-7 and IIC-5 respectively. The value for Q_r calculated from these runs were used to reduce the value obtained in multiple well runs (where IIC-7 or IIC-5 were pumping) to the amount of river water going to the treatment system only.

In these cases:

$$Q_r = Q_{IIC} + Q_{GDA}$$

where

Q_{IIC} = component of flow from river going to Ironton Iron Well

Q_{GDA} = component of flow from the river going to the recovery wells at the GDA.

Model Runs

Table C.3 gives a summary of the model runs. It presents data on the following:

- Recovery well locations and flow rates.
- Q_r in terms of gpm and percentage of total flow both to the pumping wells as a whole and to the recovery wells/treatment system.
- Comments on the run.

A description of each of the simulations, the results of each, and the decisions regarding them are given below.

Single Recovery Well Scenarios with Ironton Iron Wells Inactive

These runs determined the optimum pumping rate for the single recovery well scenario when Ironton Iron wells are inactive.

Run A1 - This run investigated a single recovery well pumping at 400 gpm. The steady state analysis shows that ground water flow will be directed towards the well and that the contaminants are likely to be captured by it. However, drawdown at the well will be excessive and more than 40 percent of the flow to the treatment system will be derived from the Ohio River.

Run A2 - This run consisted of a single recovery well pumping at 250 gpm. This, too, would be effective in containing the spread of contamination, but drawdown at the recovery well will be large and

35 percent of the flow to the treatment system will be derived from the Ohio River.

Run A3 - This run consisted of a single recovery well pumping at a rate of 100 gpm. The analysis shows that this scenario is effective in capturing the contaminant plume, but a lower pumping rate may be applicable.

Run A4 - This run looked at lowering the pumping rate at the recover well further. A pumping rate of 50 gpm was used. The results showed that the pumping rate is a little too low to ensure flushing of the contaminated aquifer adjacent to the river.

Run A5 - This run consisted of a single recovery well pumping at a rate of 75 gpm. The flow vectors associated with the steady state condition are shown in Figure C-3 and they show that ground water from the contaminated portion of the aquifer will be drawn towards the recovery well and the contribution of flow from the Ohio River is low. This is taken as the optimum case for the single recovery well scenario.

Single Recovery Well with Ironton Iron Well IIC-7 Active

These runs determined the optimum pumping rate for a single recovery well if Ironton Iron Well IIC-7 was activated.

Run B1 - This run shows a single recovery well case with Ironton Iron Well IIC-7 activated. The results show that a pumping rate of 50 gpm, which is close to the chosen optimum pumping rate for a single recovery well, is not effective in capturing the contaminant plume. Some flow vectors within the probable plume area do not point towards the recovery well, but towards Well IIC-7.

Run B2 - This run investigated increasing the pumping rate at the single recovery well to 200 gpm with Ironton Iron Well IIC-7 active. The ground water divide between Ironton Iron Well IIC-7 and the recovery well has shifted towards Well IIC-7 with respect to Run B1. This case does ensure that the probable plume will be captured by the recovery well. However, the pumping rate could be lowered slightly and the recovery well still be effective.

Run B3 - This run shows a single recovery well pumping at 150 gpm with Ironton Iron Well IIC-7 active. The flow vector plot is shown on Figure C-4. This case is sufficient to capture the probable plume and is considered as the optimum single recovery well case if Ironton Iron Well IIC-7 was to be activated. The percent of the water going to the treatment system derived from the Ohio River is considerably higher with IIC-7 active than when Well IIC-7 is inactive.

Single Recovery Well with Ironton Well IIC-5 Active

Run C-1 This run investigated the effect of pumping Ironton Iron Well IIC-5 at the capacity of the pump (300 gpm) on the optimum single recovery well scenario. The resulting flow vector plot is shown on Figure C-5, it indicates that with Well IIC-5 pumping, the single recovery well pumping at 75 gpm will still be effective in capturing the probable contaminant plume. Pumping Well IIC-5 by Ironton Iron is preferable to Pumping Well IIC-7 because the former is further from the proposed recovery well and the ground water divide between the two pumping centers is shifted away from the recovery well when compared to runs with Well IIC-7 pumping.

Multiple Recovery Wells with Ironton Iron Wells Inactive

These runs determined the optimum pumping rates for a multiple well recovery scheme when Ironton Iron Well IIC-7 is inactive. One run investigated the effect of activating Ironton Iron Well IIC-7 on the optimum multiple recovery well case.

Run D1 - This run investigated four recovery wells pumping at 250 gpm each. The results showed that the pumping rates are too high and the contribution of the Ohio River water to the ground water treatment system would be high (65 percent).

Run D2 - This run also looked at four recovery wells. One well (at Note 695) was pumping at 250 gpm and the other three wells had a reduced pumping rates of 100 gpm each. The steady state analysis showed that the pumping rates would still be too high and the contribution of the Ohio River water to the ground water treatment system would still be high. It was decided to reduce the pumping rates further.

Run D3 - This simulation shows each of the multiple recovery wells pumping at 50 gpm each. The results as demonstrated by the steady-state case showed that the scenario is effective in capturing the contaminant plume. On further review, it was determined that the wells at Nodes 872 and 947 were redundant in that they are outside the probable plume area. This is considered the optimum case for four recovery wells. However, when compared with the optimum single recovery well case, it is not considered as the best alternative.

Multiple Recovery Wells with Ironton Iron Well IIC-7 Active

Run D4 - The last simulation investigated the optimum multiple recovery well case with Ironton Iron Well IIC-7 active. The analysis showed that if IIC-7 was turned on, the pumping rate at the well at Node 695 would have to be increased to ensure capture of the probable plume by the recovery well system. However, the multiple recovery well scenario was dropped in favor of a single recovery well.

C.2.2.3 Conclusions

Using the specified criteria to determine the optimum recovery well scenario(s), the following conclusions were reached:

- For a single recovery well with Ironton Well IIC-7 inactive, a pumping rate of 75 gpm (Run A5) is considered optimum because it minimizes the number of wells, amount of water pumped and treated, and Q_r while maximizing the contaminant plume capture (Figure C-3) and maintaining an inward ground water flow gradient at the GDA.

- With Ironton Iron IIC-7 active a single recovery well active would need a pumping rate of 150 gpm to remain optimum. (Run B3) (Figure C-4).

- Pumping at the Ironton Iron wells significantly increases the contribution of the Ohio River to flow to the treatment system.

- Pumping by Ironton Iron at Well IIC-5 is preferable to pumping at Well IIC-7 because the former ensures probable contaminant plume capture by the recovery well, while allowing a lower recovery well pumping rate.

- For the multiple recovery well case, 4 wells pumping at 50 gpm each is the optimum case, however, the 2 southernmost wells are redundant. The multiple well scenario does not appear to be the best alternative when compared with the single recovery well case, because (1) more wells will be drilled, (2) more water will be pumped/treated, and (3) Q_r is higher than any single recovery well case with Ironton Iron wells activated.

C.3.0 RECOMMENDATIONS AND DISCUSSION

If Ironton Iron wells remain inactive, then a single recovery well, at the approximate location shown in Figure C-2, pumping at 75 gpm should be sufficient to contain and capture the probable contaminant plume. This scenario was chosen as the optimum case because it maximizes contaminant capture while minimizing the amount of wells, the amount of flow to the treatment system, and the amount of flow from the Ohio River.

If IIC-7 was activated and pumped at the capacity of the pump (400 gpm), then the recovery well pumping rate would have to be increased. The expected pumping rate at the recovery well would be 150 gpm assuming that the two wells were activated simultaneously. Pumping at Ironton Iron wells will significantly increase the amount of flow from the river to the treatment system. However, pumping at the recovery well will change the direction of ground water flow, pulling contaminants towards the recovery well. This will have the effect of making the edge of the contaminant plume retreat and the area of contaminated ground water will be reduced. If, by the time that Ironton Iron Well IIC-7 has been activated, the aquifer between the recovery well and Ironton Iron Well IIC-7 has been "cleaned," then it may not be necessary to increase the pumping rate at the recovery well. Ground water quality monitoring during the remediation process would indicate the retreat of the contaminant plume in the area between the recovery well and Ironton Iron Wells. This would give the required information when deciding on the increased pumping rate at the recovery well.

An alternative would be for Ironton Iron to pump Well IIC-5 up to the capacity of the pump (300 gpm) as a substitute for Well IIC-7. This case is preferable because the zone of influence around the recovery well is increased, when compared with Well IIC-7 pumping, and therefore the capacity of the recovery well to contain the probable contaminant plume is increased.

REFERENCES

Freeze, R.A. and J.A. Cherry, 1979, Groundwater, Prentice-Hall, Inc., Englewood Clifs, New Jersey, pp. 404.

IT Corporation, 1986a, Users Manual, GEOFLOW,, Ground Water Flow and Solute Transport Computer Program, Pittsburgh, Pennsylvania.

IT Corporation, 1986b, Remedial Investigation Allied Chemical/Ironton Coke Site, Ironton, Ohio.

TABLE C-1

SUMMARY OF GEOFLOW MODEL INPUT PARAMETERS FOR GOLDCAMP DISPOSAL AREA IRONTON, OHIO

Aquifer Hydraulic Conductivity (Zone 1 and 3)	2.0×10^{-2} cm/s = 57 ft/day
Ohio River Bank Hydraulic Conductivity (Zone 2)	1.6×10^{-3} cm/s = 4.6 ft/day
Slurry Wall Hydraulic Conductivity (3-foot-thick wall)	1.0×10^{-7} cm/s = 2.8×10^{-4} ft/day
• Zone 4	2.0×10^{-6} cm/s = 5.6×10^{-3} ft/day
• Zone 5	1.7×10^{-6} cm/s = 4.7×10^{-3} ft/day
Aquifer Thickness	28 to 49 feet
Aquifer Recharge (precipitation):	
• Zones 1,3,4,5	8 in/yr
• Zone 2	0 in/yr
Constant Head Boundaries Elevations:	
• Ohio River and Ice Creek	516 feet mean sea level
• Inside slurry wall at GDA	506 feet mean sea level
Area Modeled	~4,100 ft by ~ 8,300 ft
Goldcamp Disposal Area	~380 ft by ~720 ft

Aquifer Boundaries:

- Northeast - Edge of alluvial aquifer (no flow)
- Northwest - About 5,400 feet northwest of GDA (no flow)
- Southwest - Ohio River (constant head, with 100-ft bank zone)
- Southeast - Ice Creek (constant head)

TABLE C-2

COMPARISON OF GROUND WATER LEVELS OBSERVED
IN JANUARY/FEBRUARY 1988 AND GEOFLOW COMPUTED VALUES

WELL NO. (NODE)	OBSERVED GROUND WATER LEVEL (FEET MSL)	COMPUTED GROUND WATER LEVEL (FEET MSL)	DIFFERENCE IN WATER LEVELS OBSERVED-COMPUTED (FEET)
MW-1 (847)	518.98	517.80	-1.18
MW-2 (790)	518.98	518.53	-0.45
MW-3 (990)	519.04	518.09	-0.95
MW-12 (794)	519.03	518.19	-0.84
MW-14 (972)	519.08	517.62	-1.46
MW-19 (893)	518.80	518.08	-0.72
MW-20 (618)	518.76	518.64	-0.12

Sum of differences/number of observations - 0.82 feet.

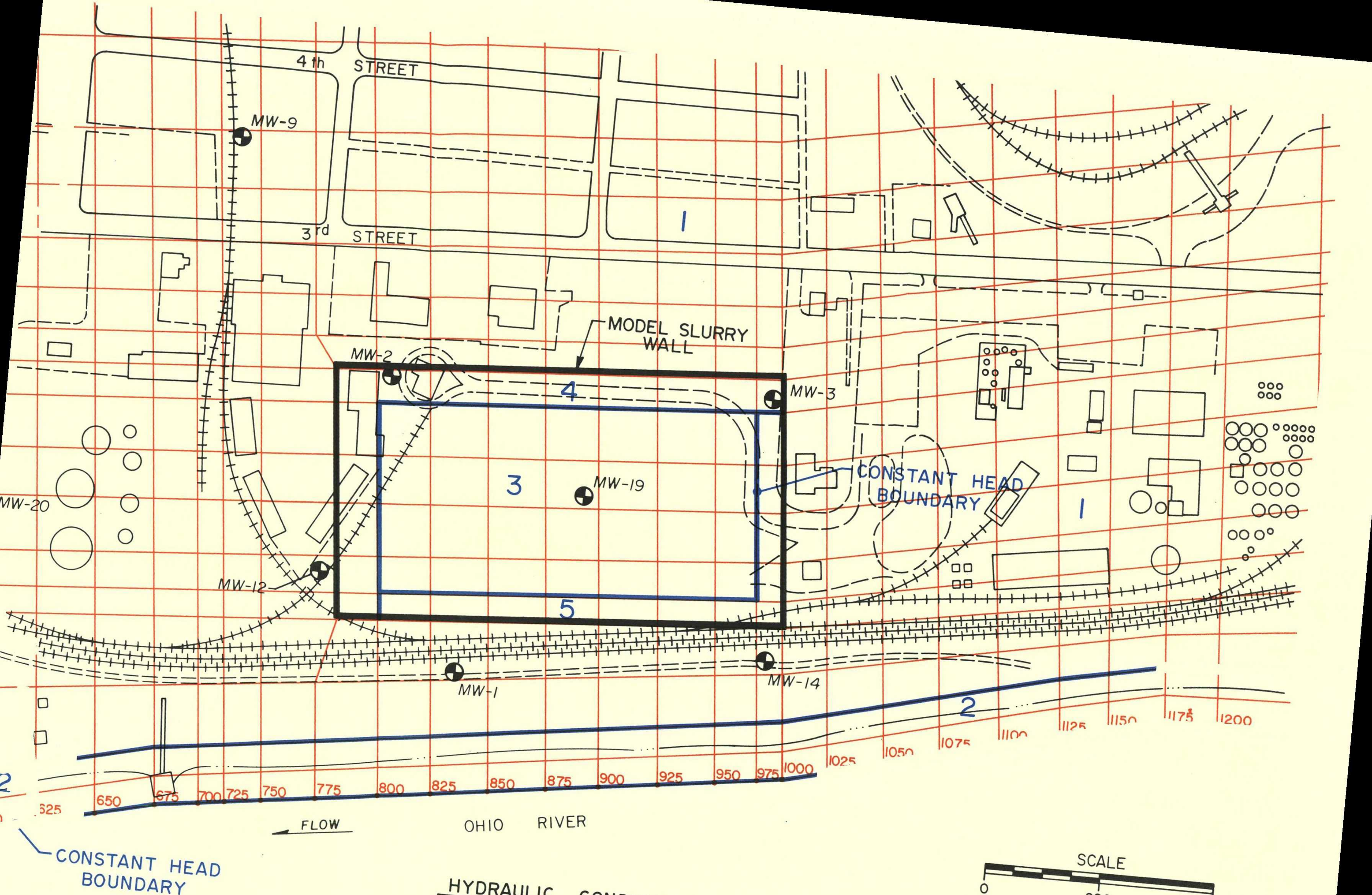
Standard deviation of differences 0.41 feet.

TABLE C.3

SUMMARY OF GEOFLOW MODEL RUNS FOR GOLDCAMP DISPOSAL AREA
IRONTON, OHIO

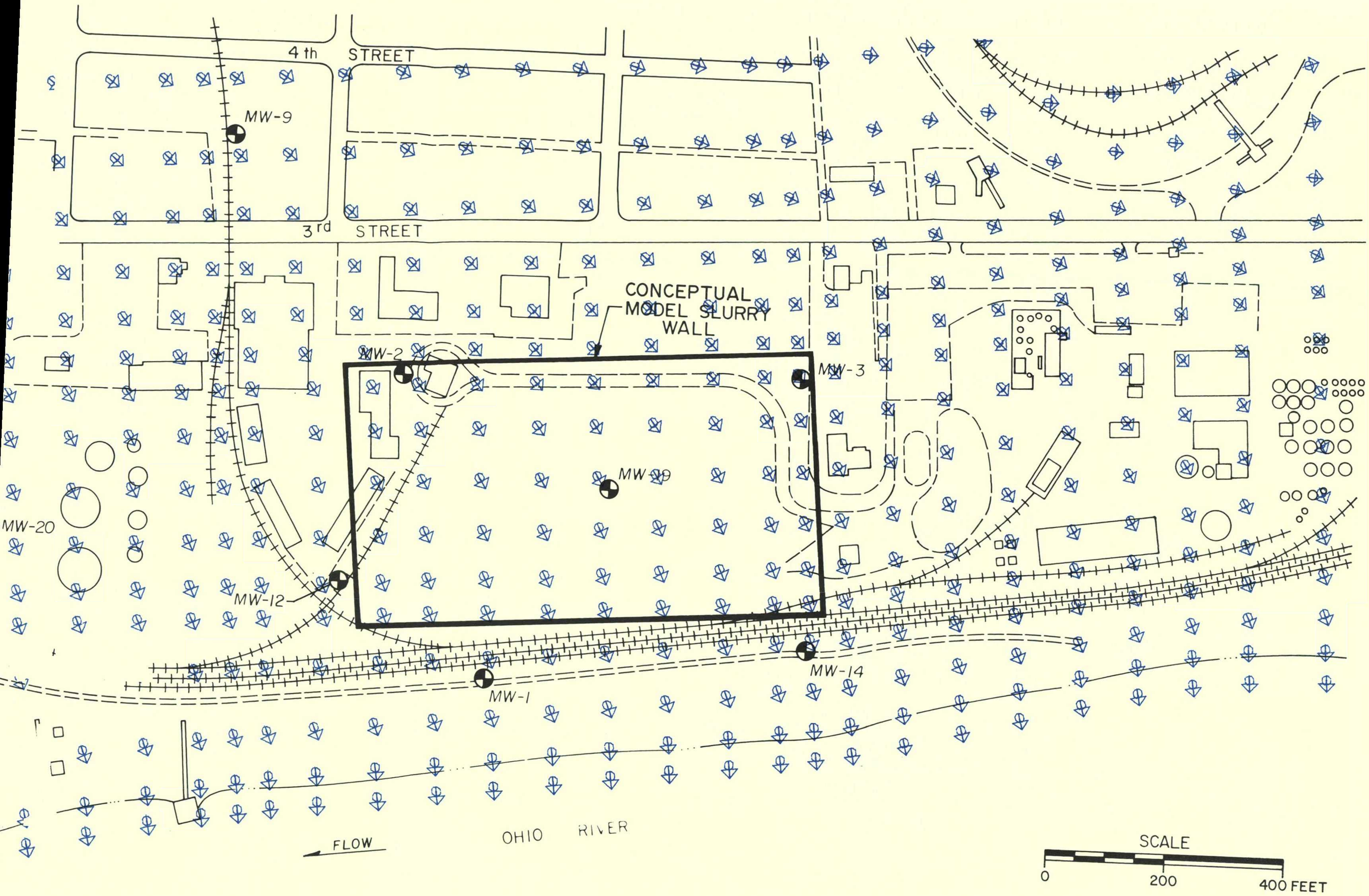
RUN NO.	WELL LOCATIONS(S) (node, gpm)[a]	SLURRY WALL	AMOUNT OF FLOW FROM RIVER TO WELL(S) (gpm [Q_r])[b]	AMOUNT OF FLOW FROM RIVER TO TREATMENT SYSTEM (gpm [Q_a])[b]	AMOUNT OF FLOW FROM RIVER TO WELLS AS PERCENT OF TOTAL FLOW	AMOUNT OF FLOW FROM RIVER TO TREATMENT SYSTEM AS PERCENT OF FLOW TO RECOVERY WELL(S)	COMMENTS
-	-	No	-	-	-	-	Existing conditions. Used to verify model calibration.
-	(519, 400)	Yes	159	-	40	-	Only IIC-7 pumping. Used to calculate Q_r for IIC-7 so that Q_r to the treatment system could be determined in cases with IIC-7 pumping.
-	(343, 300)	Yes	91	-	30	-	Only IIC-5 pumping. Used to calculate Q_r for IIC-5 so that Q_r to the treatment system could be determined in cases with IIC-5 pumping.
A1	(695, 400)	Yes	173	173	43	43	Pumping rate of 400 gpm is too high and Q_r is too high; therefore, scenario is rejected.
A2	(695, 250)	Yes	89	89	35	35	Pumping rate of 250 gpm is too high and Q_r is too high; therefore, scenario is rejected.
A3	(695, 100)	Yes	16	16	16	16	Pumping rate may be slightly high. This scenario is effective in capturing probable plume but pumping rate could be lower; therefore, scenario is rejected.
A4	(695, 050)	Yes	0.3	0.3	1	1	Pumping rate is not quite sufficient to capture probable plume. Q_r is too low to ensure flushing of the contaminated aquifer adjacent to the river; therefore, scenario is rejected.
A5	(695, 075)	Yes	7	7	9	9	A single recovery well pumping at 75 gpm is sufficient to capture the entire contaminant plume. When Well IIC-7 is not pumping, this can be considered the optimum single recovery well case.
B1	(695, 050), (519, 400)	Yes	191	32	43	64	If Well IIC-7 is turned on and pumped at 400 gpm, a recovery well pumping at a rate of 50 gpm is not effective in capturing the probable contaminant plume; therefore, scenario is rejected.
B2	(695, 200), (519, 400)	Yes	289	130	48	65	This scenario is more than sufficient to capture the probable plume. The scenario is rejected because it does not minimize flow rate at the recovery well.
B3	(695, 150), (519, 400)	Yes	256	97	47	65	This scenario is sufficient to capture the probable contaminant plume with Well IIC-7 active and is considered the optimum recovery well case if Well IIC-7 were to be pumped.
C1	(695, 075), (343, 300)	Yes	140	49	37	65	If Well IIC-5 is used by Ironton Iron instead of Well IIC-7, then the optimum recovery well scenario is a single well pumping at 75 gpm.
D1	(695, 250), (797, 250) (872, 250), (947, 250)	Yes	650	650	65	65	Pumping rates are too high and Q_r is too high; therefore, scenario is rejected.
D2	(695, 250), (797, 100) (872, 100), (947, 100)	Yes	313	313	57	57	Pumping rates are too high and Q_r is too high; therefore, scenario is rejected.
D3	(695, 050), (797, 050) (872, 050), (947, 050)	Yes	87	87	44	44	This scenario is effective in capturing probable plume. However, Wells 3 and 4 appear to be redundant; therefore, a "multiple well system" consisting of two wells only may be effective. The scenario is rejected because it does not minimize the number of recovery wells and Q_r is high.
D4	(695, 050), (797, 050) (872, 050), (947, 050) (519, 400)	Yes	304	145	51	72	If Well IIC-7 is turned on and pumped at 400 gpm, pumping four recovery wells at 50 gpm each will not be sufficient to capture the entire contaminant plume. The pumping rate at Well 1 would have to be increased. Wells 3 and 4 appear redundant. The scenario is rejected because it does not minimize the number of recovery wells and Q_r is high.

[a]The node locations refer to well locations as below:



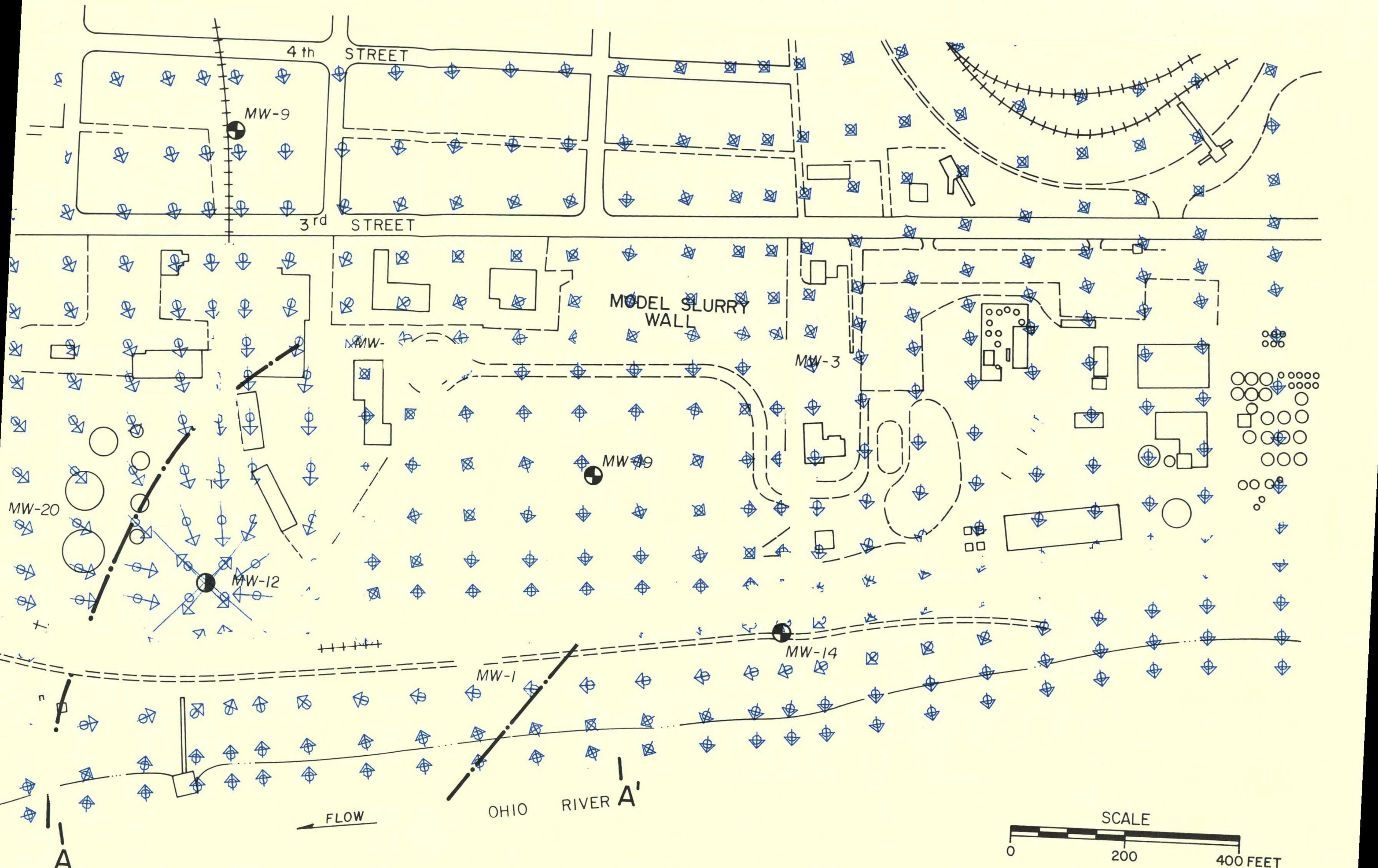
HYDRAULIC CONDUCTIVITY AND RECHARGE ZONES(1)

ZON O DESCRIPTION

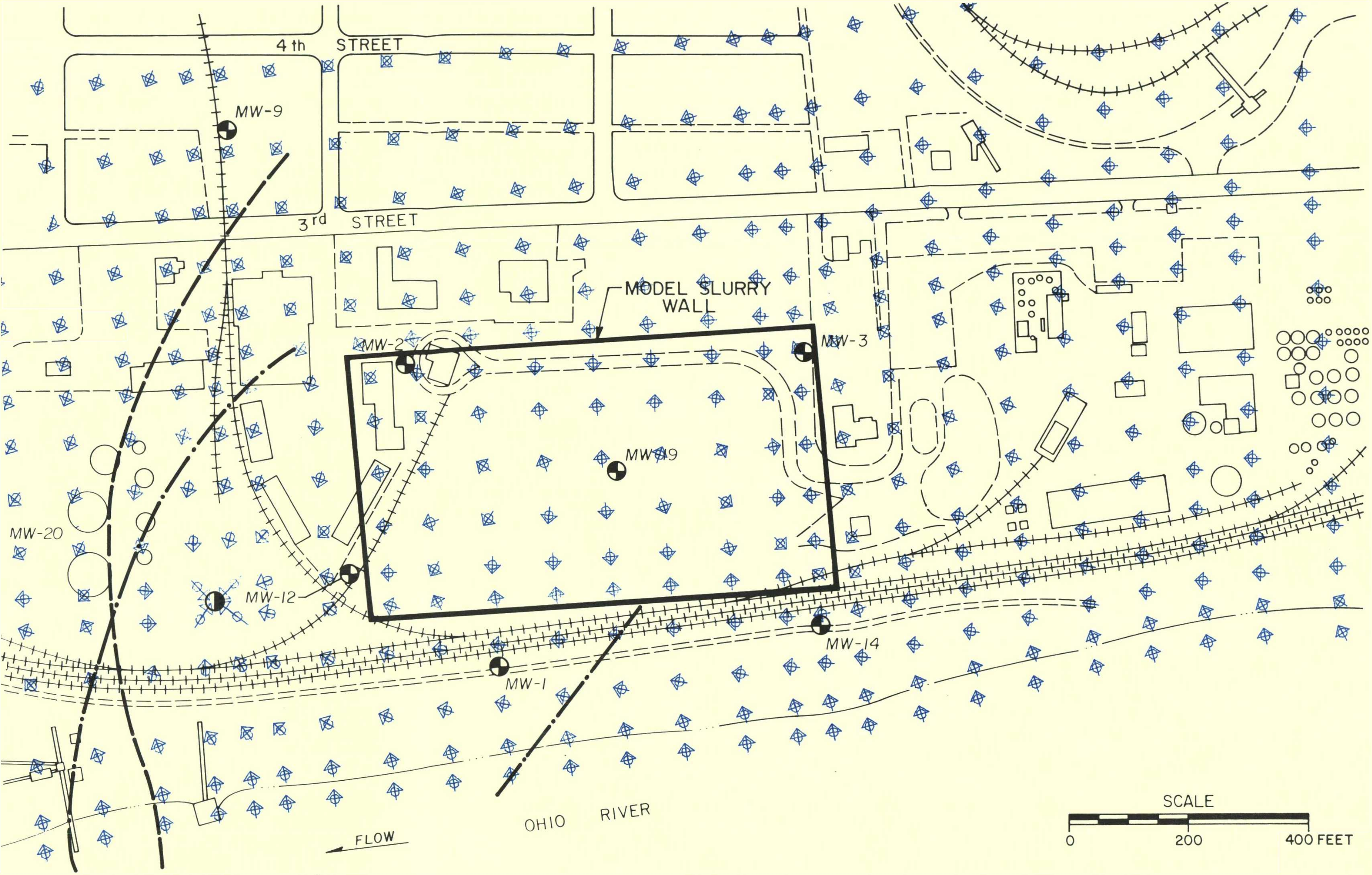


LEGEND:

FIGURE C-2

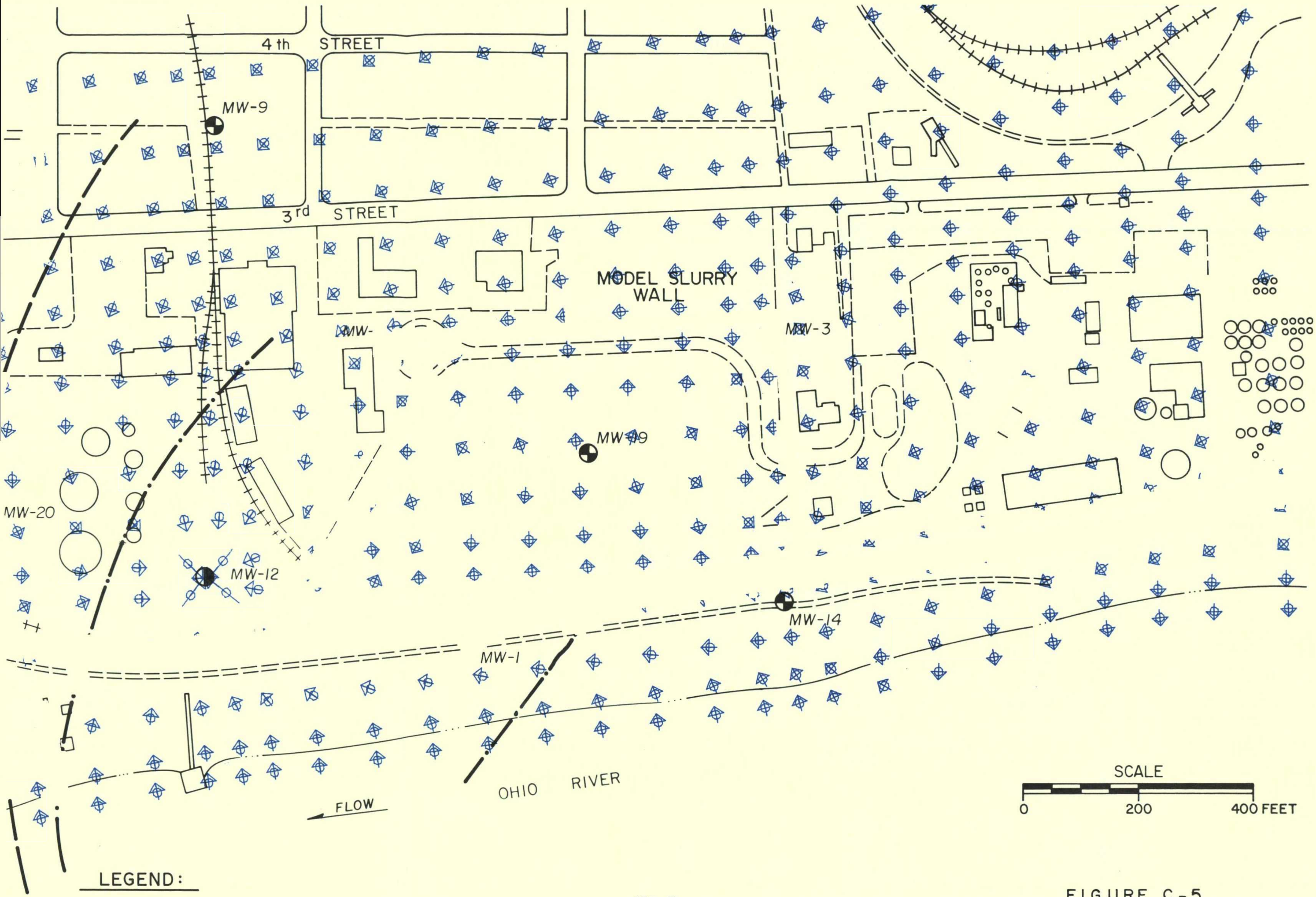

4th STREET
MW-9
3rd STREET
MODEL SLURRY WALL
MW-
MW-3
MW-19
MW-20
MW-12
MW-14
MW-1
OHIO RIVER
A'
A
FLOW
SCALE
0
200
400 FEET

LEGEND:



LEGEND:

FIGURE C-4



LEGEND:

FIGURE C-5

APPENDIX D

COST ESTIMATES

Table D-1
Alternative 2
Cap/Sl.Wall with Inside & Outside Extraction Wells/Treatment System

Capital Cost

Description	Units	Quantity	$/unit	Installed Cost
1-MOBILIZATION				$65,000
2-SLURRY WALL				
Soil/Bentonite	sq. ft.	165600	$8.00	$1,324,800
Health & Safty Measures				$80,000
Sub Total (Slurry Wall)				$1,404,800
3-CAP				
2'Cover soil(6" Top Soil)	cu. yd.	18550	$12.00	$222,600
Geotextile	sq. yd.	27800	$1.50	$41,700
Hydronet	sq. yd.	27800	$3.50	$97,300
60 mil HDPE liner	sq. yd.	27800	$9.00	$250,200
2' of Clay Liner	cu. yd.	18550	$17.00	$315,350
Vent System				
-6" Gravel	cu. yd.	4633	$12.00	$55,600
-Geotextile	sq. yd.	27800	$1.50	$41,700
-Carbon Canisters/Piping				$10,000
Revegetation	sq. yd.	27800	$0.30	$8,340
Sub Total (Cap)				$1,042,790
4-EXTRACTION WELLS				
Inside Wells	unit	2	$30,000	$60,000
Outside Well	unit	1	$40,000	$40,000
Pump connecting pipe	ft.	300	$10.00	$3,000
Transfer Pipe (4" pipe)	ft.	1500	$15.00	$22,500
Sub Total (Extraction Wells)				$125,500
5-IIC PRODUCTION WELL				
Well	unit	1	$50,000	$50,000
Pump (400 gpm)				$12,000
Piping (8" Pipe)	ft.	800	$25.00	$20,000
Sub Total (IIC Production Well)				$82,000
6-PROPOSED MONITORING WELL (GDA)	unit	1	$8,000	$8,000
7-TREATMENT SYSTEM (SEE TABLE D-4)	unit	1	$620,000	$620,000
8-ENGINEERING (15% OF ITEMS 1 TO 7)				$502,214
9-FIELD INVESTIGATION (SLURRY WALL)				$150,000
10-LABORATORY (SLURRY WALL)				$40,000
11-TREATIBILITY STUDY				$40,000
Sub Total (Items 1 to 11)				$4,080,304
12-construction adminstration(5% Items 1 to 11)				$204,015
13-CONTINGENCY (15% Items 1 to 11)				$612,046
Total (Items 1 to 13)				$4,896,364
Total Capital Cost				$4,900,000

Base Annual Operating Costs

Description	Units	Quantity	$/unit	$/yr.
1-MONITORING AND STATISTICAL ANALYSIS				$35,000
2-CAP MAINTENANCE	unit	1	$50,000	$50,000
3-EXTRACTION WELLS (O $ M)	unit	3	$7,000	$21,000
4-TREATMENT SYSTEM (SEE TABLE D-4)	unit	1	$300,000	$300,000
5-FIVE-YEAR REEVALUATION (a)				$40,000
Sub Total (Items 1 to 5)				$446,000
6-CONTINGENCY AT 15%				$66,900
Total (Items 1 to 6)				$512,900
Total Base Annual Operating				$515,000

Table D-1
(Continue)
Alternative 2

Cost Summary

Capital Cost $	Present Worth Annual Operating $ (b)	Present Worth $
4,900,000	8,230,000	13,130,000 (c)

(a) $200,000 at the end of every 5 years, prorated over 5 years using Straight Line Depreciation Method.
(b) Present Worth For Annual Operating Costs From Table D-5
(c) For additional assumptions see Notes 1 and 2 of Appendix F

Table D-2
Alternative 3
GDA Waste Incineration/Sl. Wall with Extraction Wells/Treatment System

Capital Cost

Description	Units	Quantity	$/unit	Installed
1-MOBILIZATION				$60,000
2-RETAINING STRUCTURE				
Reinforced Concerete	sq. ft.	84000	$50.00	$4,200,000
Tie Back	unit	420	$1,785	$749,700
Sub Total (Retaining Structure)				$4,949,700
3-ASH INTERIM STORAGE AREA				
Excavation	cu. yd.	63000	$7.00	$441,000
Dike Compaction	cu. yd.	63000	$3.00	$189,000
60 Mil HDPE Liner	sq. yd.	103333	$9.00	$930,000
Surface Water Collection	ft.	3400	$4.00	$13,600
Sub Total (Ash Interim Storage)				1573600
4-SOIL STAGING AREA	sq. ft.	4000	$20.00	$80,000
5-EXTRACTION WELLS				
Inside Wells	unit	2	$30,000	$60,000
Outside Well	unit	1	$40,000	$40,000
Pump Connecting Pipes	ft.	300	$10.00	$3,000
Transfer Pipes (4"& 1"pipes)	ft.	1500	$15.00	$22,500
Sub Total (Extraction Wells)				$125,500
6-IIC PRODUCTION WELL				
Well	unit	1	$50,000	$50,000
Pump (400 gpm)	unit	1	$12,000	$12,000
Piping (8" Pipe)	ft.	800	$25.00	$20,000
Sub Total (IIC Production Well)				$82,000
7-PROPOSED MONITORING WELL (GDA)		1	$8,000	$8,000
8-TREATMENT SYSTEM (SEE TABLE D-4)		1	$620,000	$620,000
9-ENGINEERING (15% OF ITEM 1 TO 8)				$1,124,820
10-FIELD INVESTIGATION (SLURRY WALL)				$150,000
11-LABORATORY (SLURRY WALL)				$40,000
12-TREATIBILITY STUDY				$40,000
13-MONITORING WELLS (ASH INTERIM STORAGE AREA)	unit	3	$8,000	$24,000
Sub Total (Items 1 to 13)				$8,877,620
14-CONSTRUCTION ADMINSTRATION (5% items 1 to 13)				$443,881
15-Contingency (15% of Items 1 to 13)				$1,331,643
Total (Items 1 to 15)				$10,653,144

Total Capital Cost $10,650,000

Base Annual Operating Costs

				$/yr.
1-MONITORING AND STATISTICAL ANALYSIS				$52,000
2-EXTRACTION WELLS (O & M)	unit	3	$7,000	$21,000
3-TREATMENT SYSTEM (SEE TABLE D-4)	unit	1	$300,000	$300,000
4-FIVE-YEAR REEVALUATION (a)	unit	1	$40,000	$40,000
Sub Total (Items 1 to 4)				$413,000
5-CONTINGENCY AT 15% OF SUB TOTAL				$61,950
TOTAL (Items 1 to 5)				$474,950

Total Base Annual Operating Cost $480,000

Table D-2
(Continue)
Alternative 3

Cost Summary

Capital Cost $	Present Worth Annual Operating $ (b)	Present Worth $
10,650,000	81,580,000	92,230,000 (c)

(a) $200,000 at the end of every 5 years, prorated over 5 years using Straight Line Depreciation Method.
(b) Present Worth For Annual Operating Costs From Table D-6
(c) For additional assumptions see Notes 1 and 2 of Appendix F

Table D-3
Alternative 4
GDA Waste And Subsoils Incineration with Outside Well/Treatment System
and Ash Off-site Disposal

Capital Cost

Description	Units	Quantity	$/unit	Installed
1-MOBILIZATION				$500,000
2-RETAINING STRUCTURE				
Double Wall Excav.	cu. yd.	127407	$15.00	$1,911,111
Double Wall Structure	sq. ft.	172000	$90.00	$15,480,000
Double Wall Backfill. (Include Borrow Soil)	cu. yd.	127407	$25.00	$3,185,185
Sub Total (Retaining Structure)				$20,576,296
3-SOIL STAGING AREA	sq. ft.	4000	$20.00	$80,000
4-EXTRACTION WELL				
Outside Well	unit	1	$40,000	$40,000
Pump Connecting Pipes	ft.	100	$10.00	$1,000
Transfer Pipe (4" pipe)	ft.	900	$15.00	$13,500
Sub Total (Extraction Wells)				$54,500
5-IIC PRODUCTION WELL				
Well		1	$50,000	$50,000
Pump (400 gpm)				$12,000
Piping (8" Pipe)	ft.	800	$25.00	$20,000
Sub Total (IIC Production Well)				$82,000
6-DEWATERING				
Pump (200 gpm)	unit	4	$20,000	$80,000
Misc./Piping				$80,000
Sub Total (Dewatering)				$160,000
7-TREATMENT SYSTEM (SEE TABLE D-4)		1	$620,000	$620,000
8-ENGINEERING (15% ITEMS 1 TO 5)				$3,310,919
9-TREATIBILITY STUDY				$40,000
Sub Total (Items 1 to 9)				$25,423,716
10-CONSTRUCTION ADMINSTRATION (5% Items 1 to 9)				$1,271,186
11-CONTINGENCY (15% Items 1 to 9)				$3,813,557
Total (Items 1 to 11)				$30,508,459
Total Capital Cost				$30,500,000

Base Annual Operating Cost

Description	Units	Quantity	$/unit	$/yr.
1-MONITORING AND STATISTICAL ANALYSIS				$35,000
2-OUTSIDE WELL	unit	1	$10,000	$10,000
3-TREATMENT SYSTEM (SEE TABLE D-4)				$300,000
4-FIVE-YEAR REEVALUATION (a)	unit	1	$40,000	$40,000
Sub Total (Items 1 to 4)				$385,000
5-CONTINGENCY (15% Items 1 to 4)				$57,750
Total (Items 1 to 5)				$442,750
Total Base Annual Operating Cost				$440,000

Table D-3
(Continue)
Alternative 4

Cost Summary

Capital Cost $	Present Worth Annual Operating $ (b)	Present Worth $
30,500,000	187,500,000	218,000,000 (c)

(a) $200,000 at the end of every 5 years, prorated over 5 years using Straight Line Depreciation Method.
(b) Present Worth For Annual Operating Costs From Table D-7
(c) For additional assumptions see Notes 1 and 2 of Appendix F

Table D-4
Ground Water Treatment System with Activated Carbon

Capital Cost

Description	Units	Quantity	$/unit	Uninstalled Cost
1-Equalization Tank (2,000 gal)	vessel	1	$2,000	$2,000
2-Activated Carbon	unit	1	$150,000	$150,000
3-Dual Media Filter	unit	1	$20,000	$20,000
4-Filter Back Wash Tank (10,000 gal)	vessel	1	$10,000	$10,000
5-Pumps				
1,000 gpm (Back Wash)	unit	1	$6,000	$6,000
100 gpm, TDH=120 ft	unit	3	$2,500	$7,500
100 gpm, TDH=150 ft	unit	2	$2,500	$5,000
	Sub Total (Items 1 to 5)			$200,500
6-Installation for Activated Carbon				$50,000
7-Installation at 200% of Equip. Cost (exc. act. Carbon)				$101,000
8-Piping & Electrical at 30% Sub Total 1&Installation Costs				$105,450
9-Instrument and Site Preperation at 10% Sub Total 1				$20,050
10-Building (2600 sq. ft at $55/sq. ft)				$143,000
	Total Capital Cost			$620,000

Annual Operating Costs

				$/yr.
1-Activated Carbon	Pound	168000	$1	$168,000
2-Waste Activated Carbon Disposl	Ton	84	$200	$16,800
3-Labor (8 hr/day, 365 day/yr)	Hour	2920	$25	$73,000
4-Maintenance				$30,000
5-Analytical				$10,000
Sub Total (Items 1 to 5)				$297,800
Total Annual Operating Cost				$300,000

Table D-5
Present Worth
Alternative 2's Annual Operating Costs

YEAR	BASE ANNUAL COST $515000)	COST/YR IIC WATER SUPPLY, $/yr	ANNUAL COST $/yr	INFLATION AT 5%/yr	PRESENT WORTH FACTOR AT i=10%	PRESENT WORTH (a) $/yr
1	0	8100	8100	1.00	1.0000	8100
2	515000	14047	529047	1.05	0.9091	505004
3	515000	22669	537669	1.10	0.8264	489873
4	515000	21639	536639	1.16	0.7513	466728
5	515000	20651	535651	1.22	0.6830	444693
6	515000	19718	534718	1.28	0.6209	422734
7	515000	0	515000	1.34	0.5645	389589
8	515000	0	515000	1.41	0.5132	371894
9	515000	0	515000	1.48	0.4665	354955
10	515000	0	515000	1.55	0.4241	338828
11	515000	0	515000	1.63	0.3855	323289
12	515000	0	515000	1.71	0.3505	308729
13	515000	0	515000	1.80	0.3186	294662
14	515000	0	515000	1.89	0.2897	281330
15	515000	0	515000	1.98	0.2633	268478
16	515000	0	515000	2.08	0.2394	256313
17	515000	0	515000	2.18	0.2176	244622
18	515000	0	515000	2.29	0.1978	233481
19	515000	0	515000	2.41	0.1799	222970
20	515000	0	515000	2.53	0.1635	212776
21	515000	0	515000	2.65	0.1486	203054
22	515000	0	515000	2.79	0.1351	193838
23	515000	0	515000	2.93	0.1228	184999
24	515000	0	515000	3.07	0.1117	176691
25	515000	0	515000	3.23	0.1015	168584
26	515000	0	515000	3.39	0.0923	160969
27	515000	0	515000	3.56	0.0839	153635
28	515000	0	515000	3.73	0.0763	146704
29	515000	0	515000	3.92	0.0693	139907
30	515000	0	515000	4.12	0.0630	133548
31	515000	0	515000	4.32	0.0573	127538
	15450000	106824	15556824			8229615
						PRESENT WORTH FOR OPERATING COSTS

(a) Present Worth = Total Annual Operating Cost * Inflation Factor * Present Worth Factor

Table D-6
Present Worth
Alternative 3's Annual Operating Costs

YEAR	VAPOR SUPPRESSANT sq. ft/yr	COST/YR AT $0.3/sq. ft	GDA GENERAL EXCAVATION cu. yd/yr	COST/YR AT $10/cu. yd	INCINERATION ton/yr	COST/YR AT $200/ton	ASH TRANS.& COMPACT cu. yd/yr	COST/YR AT $8/cu. yd	ASH STORAGE SOIL COVER cu. yd/yr	COST/YR AT $10/cu. yd	BORROW SOIL cu. yd/yr	COST/YR AT $7/cu. yd	REPLACE BOR.SOIL cu. yd/yr	COST/YR AT $3/cu. yd	REVEGETATE sq. ft/yr
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	2009600	602880	60000	600000	70000	14000000	51000	408000	0	0	0	0	0	0	0
3	2509600	752880	60000	600000	70000	14000000	51000	408000	0	0	0	0	0	0	0
4	2509600	752880	60000	600000	70000	14000000	51000	408000	0	0	0	0	0	0	0
5	2509600	752880	60000	600000	70000	14000000	51000	408000	0	0	0	0	0	0	0
6	2509600	752880	60000	600000	70000	14000000	51000	408000	8542	85416	0	0	0	0	51249
7	3364000	1009200	0	0	0	0	0	0	0	0	52500	367500	52500	157500	0
8	3364000	1009200	0	0	0	0	0	0	0	0	15000	105000	15000	45000	27800
9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
26	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
27	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
28	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	18776000	5632800	300000	3000000	350000	70000000	255000	2040000	8542	85416	67500	472500	67500	202500	79049

Table D-6
(Continue)

COST/YR AT $0.3/sq.	TRANSFER ASH TO GDA cu. yd/yr	COST/YR AT $8/cu. yd	ASH EXCAV. cu. yd/yr	COST/YR AT $7/cu. yd	SLURRY WALL sq. ft	COST/YR AT $8.48/sq. ft	LINER DISPOSAL ton/yr	COST/YR AT $200/ton	COST/YR IIC WATER SUPPLY, $/yr	PROGRESSIVE COST $/yr	BASE ANNUAL COST ($480000/yr)	TOTAL ANNUAL COST $/yr	INFLATION AT 5%/yr	PRESENT WORTH FACTOR AT i=10%	PRESENT (a) WORTH $/yr
0	0	0	0	0	0	0	0	0	8100	8100	0	8100	1.00	1.0000	8100
0	0	0	0	0	0	0	0	0	14047	15624927	480000	16104927	1.05	0.9091	15373039
0	0	0	0	0	0	0	0	0	22669	15783549	480000	16263549	1.10	0.8264	14817817
0	0	0	0	0	0	0	0	0	21639	15782519	480000	16262519	1.16	0.7513	14143898
0	0	0	0	0	0	0	0	0	20651	15781531	480000	16261531	1.22	0.6830	13500173
15375	0	0	0	0	0	0	0	0	19718	15881388	480000	16361388	1.28	0.6209	12965471
0	127500	1020000	136042	952291	0	0	0	0	0	3348991	480000	3828991	1.34	0.5645	2896570
8340	127500	1020000	136042	952291	40800	345984	145	29016	0	3469831	480000	3949831	1.41	0.5132	2852267
0	0	0	0	0	40800	345984	0	0	0	345984	480000	825984	1.48	0.4665	569295
0	0	0	0	0	0	0	0	0	0	0	480000	480000	1.55	0.4241	315801
0	0	0	0	0	0	0	0	0	0	0	480000	480000	1.63	0.3855	301411
0	0	0	0	0	0	0	0	0	0	0	480000	480000	1.71	0.3505	287747
0	0	0	0	0	0	0	0	0	0	0	480000	480000	1.80	0.3186	274637
0	0	0	0	0	0	0	0	0	0	0	480000	480000	1.89	0.2897	262211
0	0	0	0	0	0	0	0	0	0	0	480000	480000	1.98	0.2633	250232
0	0	0	0	0	0	0	0	0	0	0	480000	480000	2.08	0.2394	238894
0	0	0	0	0	0	0	0	0	0	0	480000	480000	2.18	0.2176	227997
0	0	0	0	0	0	0	0	0	0	0	480000	480000	2.29	0.1978	217613
0	0	0	0	0	0	0	0	0	0	0	480000	480000	2.41	0.1799	207816
0	0	0	0	0	0	0	0	0	0	0	480000	480000	2.53	0.1635	198315
0	0	0	0	0	0	0	0	0	0	0	480000	480000	2.65	0.1486	189254
0	0	0	0	0	0	0	0	0	0	0	480000	480000	2.79	0.1351	180664
0	0	0	0	0	0	0	0	0	0	0	480000	480000	2.93	0.1228	172427
0	0	0	0	0	0	0	0	0	0	0	480000	480000	3.07	0.1117	164683
0	0	0	0	0	0	0	0	0	0	0	480000	480000	3.23	0.1015	157127
0	0	0	0	0	0	0	0	0	0	0	480000	480000	3.39	0.0923	150029
0	0	0	0	0	0	0	0	0	0	0	480000	480000	3.56	0.0839	143194
0	0	0	0	0	0	0	0	0	0	0	480000	480000	3.73	0.0763	136734
0	0	0	0	0	0	0	0	0	0	0	480000	480000	3.92	0.0693	130399
0	0	0	0	0	0	0	0	0	0	0	480000	480000	4.12	0.0630	124472
0	0	0	0	0	0	0	0	0	0	0	480000	480000	4.32	0.0573	118871
23715	255000	2040000	272083	1904582	81600	691968	145	29016	106824	86026820	14400000	100426820			81577158 PRESENT WORTH FOR OPERATING COSTS

(a) Present Worth = Total Annual operating Cost * Inflation Factor * Present Worth Factor

Table D-7
Present Worth
Alternative 4's Annual Operating Costs

YEAR	VAPOR SUPPRESSANT sq. ft/yr	COST/YR AT $0.3/sq. ft	GDA GENERA EXCAVATION cu. yd/yr	COST/YR AT $10/cu. yd	COST/YR TO DEWATER GDA, $/yr	INCINERATION ton/yr	COST/YR AT $150/ton	BORROW SOIL FOR GDA cu. yd/yr	COST/YR AT $7/cu. yd	PLACING BOR.SOIL cu. yd/yr	COST/YR AT $4/cu. yd	REVEGETATE GDA sq. ft/yr	COST/YR AT $0.3/sq. ft	TRANSFER ASH OFF-SITE cu. yd/yr	COST/YR AT $40/cu. yd	COST/YR IIC WATER SUPPLY, $/yr
1	0	0	0	0	100000	0	0	0	0	0	0	0	0	0	0	8100
2	1440000	432000	57600	576000	200000	77120	11568000	0	0	0	0	0	0	48960	1958400	14847
3	1940000	582000	57600	576000	200000	77120	11568000	0	0	0	0	0	0	48960	1958400	22669
4	1940000	582000	57600	576000	200000	77120	11568000	0	0	0	0	0	0	48960	1958400	21639
5	1940000	582000	57600	576000	200000	77120	11568000	0	0	0	0	0	0	48960	1958400	20651
6	1940000	582000	57600	576000	200000	77120	11568000	0	0	0	0	0	0	48960	1958400	19718
7	1940000	582000	57600	576000	200000	77120	11568000	0	0	0	0	0	0	48960	1958400	0
8	1940000	582000	57600	576000	200000	77120	11568000	0	0	0	0	0	0	48960	1958400	0
9	1940000	582000	57600	576000	200000	77120	11568000	0	0	0	0	0	0	48960	1958400	0
10	1940000	582000	57600	576000	200000	77120	11568000	0	0	0	0	0	0	48960	1958400	0
11	1940000	582000	57600	576000	200000	77120	11568000	0	0	0	0	0	0	48960	1958400	0
12	1940000	582000	57600	576000	200000	77120	11568000	180000	1260000	180000	720000	0	0	48960	1958400	0
13	1940000	582000	57600	576000	200000	77120	11568000	360000	2520000	360000	1440000	0	0	48960	1958400	0
14	970000	291000	28800	288000	200000	38560	5784000	180000	1260000	180000	720000	27800	8340	24480	979200	0
15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
26	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
27	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
28	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	23750000	7125000	720000	7200000	2700000	964000	144600000	720000	5040000	720000	2880000	27800	8340	612000	24480000	106824

Table D-7
(Continue)

PROGRESSIVE COST $/yr	BASE ANNUAL COST ($440000/yr)	SUB TOTAL ANNUAL COST, $/yr (EX. ASH DISPOS.)	INFLATION AT 5%/yr	PRESENT WORTH FACTOR AT i=10%	SUB TOTAL PRESENT WORTH (a) $/yr	ASH FOR OFF-SITE DISPOSAL cu. yd/yr	COST FOR ASH DISPOSAL (b) AT $65/cu. yd	PRESENT WORTH (c) $/yr
108100	0	108100	1.00	1.0000	108100	0	0	108100
14748447	440000	15188447	1.05	0.9091	14498208	48960	3182400	17680608
14907069	440000	15347069	1.10	0.8264	13982807	48960	3182400	17165207
14906039	440000	15346039	1.16	0.7513	13346813	48960	3182400	16529213
14905051	440000	15345051	1.22	0.6830	12739320	48960	3182400	15921720
14904118	440000	15344118	1.28	0.6209	12159342	48960	3182400	15341742
14884400	440000	15324400	1.34	0.5645	11592663	48960	3182400	14775063
14884400	440000	15324400	1.41	0.5132	11066116	48960	3182400	14248516
14884400	440000	15324400	1.48	0.4665	10562082	48960	3182400	13744482
14884400	440000	15324400	1.55	0.4241	10082203	48960	3182400	13264603
14884400	440000	15324400	1.63	0.3855	9622787	48960	3182400	12805187
16144400	440000	16584400	1.71	0.3505	9941916	48960	3182400	13124316
17404400	440000	17844400	1.80	0.3186	10209849	48960	3182400	13392249
8810540	440000	9250540	1.89	0.2897	5053316	24480	1591200	6644516
0	440000	440000	1.98	0.2633	229379	0	0	229379
0	440000	440000	2.08	0.2394	218986	0	0	218986
0	440000	440000	2.18	0.2176	208997	0	0	208997
0	440000	440000	2.29	0.1978	199479	0	0	199479
0	440000	440000	2.41	0.1799	190498	0	0	190498
0	440000	440000	2.53	0.1635	181789	0	0	181789
0	440000	440000	2.65	0.1486	173483	0	0	173483
0	440000	440000	2.79	0.1351	165609	0	0	165609
0	440000	440000	2.93	0.1228	158058	0	0	158058
0	440000	440000	3.07	0.1117	150959	0	0	150959
0	440000	440000	3.23	0.1015	144033	0	0	144033
0	440000	440000	3.39	0.0923	137527	0	0	137527
0	440000	440000	3.56	0.0839	131261	0	0	131261
0	440000	440000	3.73	0.0763	125340	0	0	125340
0	440000	440000	3.92	0.0693	119533	0	0	119533
0	440000	440000	4.12	0.0630	114099	0	0	114099
0	440000	440000	4.32	0.0573	108965	0	0	108965
191260164	13200000	204460164			147723515	612000	39780000	187503515

PRESENT WORTH FOR OPERATING COSTS

(a) Sub Total Present Worth = Sub Total * Inflation Factor * Present Worth factor
(b) Assume 10% discount and 10% inflation for off-site disposal
(c) Total Present Worth = Sub Total present worth + Cost Ash disposal

Table D-8
Cost Summary

Alternative	Capital Cost $	Present Worth Annual Operating $	Present Worth $
1	0	0	0
2	4,900,000	8,230,000	13,130,000
3	10,650,000	81,580,000	92,230,000
4	30,500,000	187,500,000	218,000,000

COST

REFERENCES

PEI Associates, January 1987, Underground Storage Tank Corrective Action Technologies, EPA No. 625/6-87/015.

SAIC, Handbook - Remedial Action at Waste Disposal Sites, EPA No. 625/6-85/006.

Knox, R.C., L.W. Canter, D.J. Keneannon, E.L. Stover, and C.H. Ward, November 1984, State of the Art Aquifer Restoration, Vol. 1, EPA - 600/2-84/182a, National Center for Groundwater Research.

Radian Corporation, January 1983, Draft Methodology Manual - Evaluating Cost Effectiveness of Remedial Actions at Controlled Hazardous Waste Sites.

Environmental Law Institute, September 1983, Draft Compendium of Cost of Remedial Technologies at Hazardous Waste Sites, Washington, D.C.

Rishel, H.L., T.M. Boston, C.J.-Schmidt, 1984, Costs of Remedial Response Actions at Uncontrolled Hazardous Waste Sites, Noyes Publications.

APPENDIX E

GOLDCAMP DISPOSAL AREA
FEASIBLITY STUDY
FEDERAL AND STATE APPLICABLE OR RELEVANT AND
APPROPRIATE REQUIREMENTS
AND
OTHER FACTORS TO BE CONSIDERED

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 5
230 SOUTH DEARBORN ST.
CHICAGO, ILLINOIS 60604

5HR-11

0 6 MAY 1988

Mr. J.P. McBurney
Allied-Signal
P.O. Box 2332 R
Morristown, New Jersey 07960

Re: GDA FS ARARs and TBCs
Allied Chemical/Ironton Coke Superfund Site

Dear Mr. McBurney:

Please find enclosed the Federal and State applicable or relevant and appropriate requirements (ARARs) and other factors to be considered (TBCs) pertinent to the Goldcamp Disposal Area Feasibility Study (GDA FS). Please note that although we have tried to be as complete as possible, the Agencies may need to add to or subtract from this list of ARARs and TBCs. This is necessary because the alternatives and technologies are not yet fully developed. An example of this is ORC 3734.05(C)(6) (g). We may add this as an ARAR depending on the design and location of any proposed incinerator. Other measures, not determined to be ARARs, will be part of the overall site remedy if the Agencies determine that they are necessary to mitigate the public health and environmental problems posed by the site. In addition, the Agencies will include other types of requirements as part of the final cleanup program, such as monitoring, reporting, access, etc.

The ARAR portion of this document is somewhat repetitious because we tried to identify the complete list of ARARs for each alternative. Obviously, many of the alternatives have several ARARs in common. The document is organized by alternative, and each alternative is divided into Source, Receptor, and Migration components. The Federal ARARs are presented first under the headings of "Air," "RCRA," and "Water." The State ARARs are presented next for all media and statutes of concern under the heading of "State." We have not cited to Ohio's hazardous waste regulations because they are not generally more stringent than the federal hazardous waste regulations cited in the document. The Ohio hazardous waste rules equivalent to the federal rules cited in this document will be ARARs, in lieu of the federal rules, should Ohio receive hazardous waste program authorization prior to the ROD being signed. For your convenience, we have cited the pertinent statutes and regulations and included a short summary of the major provisions. The summaries, however, do not define the full scope of responsibilities, those must be obtained from the statutes and regulations and the Agencies. Attached to this document you will find several tables and copies of statutes and regulations which support the ARARs. Throughout the ARAR discussion we have also noted where TBCs may apply. All TBCs are discussed in Attachment D.

Several outstanding issues remain which the Agencies and Allied must address:

1) OAC 3734-1-05(B) may be an ARAR if the Ohio river water quality exceeds the existing ORSANCO criteria. Menzel Associates is already researching this issue through its work on the Endangerment Assessment. Please advise the Agencies of how recent ORSANCO sampling data for the Ohio river compares to the ORSANCO criteria.

2) State air regulations for sulfur dioxide (SO2) may be ARARs for the incineration remedy. Allied must determine whether sulfur dioxide is expected to be a combustion product of the waste and, if so, estimate the quantity of SO2 that will be emitted from the incinerator, sans air pollution controls.

3) The Agencies are still researching whether there are any Federal or State ARARs for the Naturally Occurring Radioactive Materials (NARMS) or accelerated produced radioactive materials that may build-up on the activated carbon. We expect to complete this research in the next couple of weeks and will inform you in writing of our determination.

4) Landfill gas control/monitoring will need to be included as part of any cap/slurry wall remedy. In addition, recently enacted Section 3734.041 to the ORC requires the Director of OEPA to promulgate regulations addressing controls of explosive gases from landfills. If these rules are promulgated and effective before the ROD is signed, these rules may be ARARs.

As you are aware, remedial actions conducted on-site do not require permits. However, the technical requirements (as opposed to the administrative requirements) of any applicable or relevant and appropriate permits must, at a minimum, be satisfied before the remedial action can be approved. Many of the ARARs identified have requirements for obtaining permits. Although the Agencies will not require Allied to obtain permits for on-site remedial actions, we will require Allied to meet the technical requirements of the permit. We may use the pertinent portions of the permit application as the vehicle for documenting that the technical requirements have been met.

We note that a great deal of technical design information for the alternatives and technologies remains to be developed. This information is necessary to identify all ARARs and TBCs, estimate the cost of the alternatives, develop performance standards which the alternatives must meet, and perform the detailed evaluation. We look forward to obtaining these design details during the meeting scheduled for May 18 and 19, 1988.

If you have any questions regarding these ARARs and TBCs, please don't hesitate to call us.

Sincerely,

Therese Gioia
U.S. Environmental Protection Agency
Remedial Project Manager

for Michael Moschell
Ohio Environmental Protection Agency
Project Coordinator

Enclosure

cc: Roger Hannahs, OEPA

LIST OF ALTERNATIVES

- Alternative 1 - No action
- Alternative 2 - Cap/Surface Water Management/Use Restrictions/Security Measures/Municipal Water Supply/Monitor
- Alternative 3 - Slurry Wall/Cap/Inward Gradient/Use Restrictions/Security Measures/Municipal Water Supply/Monitor
- Alternative 10 - Cap/Surface Water Management/Use Restrictions/Security Measures/Collect/Carbon Adsorb/Ion Exchange/Collect/Air Stripping/Activated Carbon
- Alternative 12 - Excavate/Incinerate On-Site/Collect/Carbon Adsorb/Ion Exchange/Collect/Air Stripping/Activated Carbon
- Alternative 14 - Slurry Wall/Cap/Inward Gradient/Surface Water Management/Use Restrictions/Security Measures/Collect/Carbon Adsorb/Ion Exchange/Collect/Air Stripping/Activated Carbon
- Alternative 16 - Excavate/Dispose of in On-site Landfill/Collect Carbon Adsorb/Ion Exchange/Collect Air Stripping/Activated Carbon
- Alternative 17 - Excavate/Dispose of in Off-site Landfill/Collect Carbon Adsorb/Ion Exchange/Collect Air Stripping/Activated Carbon

5/6/88

ARAR AND TBC DOCUMENT

Goldcamp Disposal Area Feasibility Study
Allied Chemical/Ironton Coke Superfund Site

GENERAL STATUTORY AUTHORITIES

Air

All of the remedial action alternatives which have been selected for detailed evaluation under Phase 2 of the project could result in the release of particulate matter, toxic, and/or radioactive gases via the air pathway if implemented. Air ARARs stem from the Clean Air Act, and include substances regulated through the federally approved State Implementation Plan (SIP) and substances regulated under the Federal NESHAPS program (Attachment A) and the New Source Performance Standards. The Air TBCs are discussed in Attachment D.

RCRA

The portions of the Resource Conservation and Recovery Act, as amended, which apply to this project are outlined in the alternative-specific portion of this document. In general the RCRA regulations found in 40 CFR 264 Subparts C, F,G, N, and O apply, as well as 40 CFR 270 (incineration) and to a lesser extent, 40 CFR 262 and 263. Please refer to Attachment B for copies of some of the pertinent regulations. For complete copies, you should refer to the applicable Code of Federal Regulations.

Water

The Clean Water Act and the Safe Drinking Water Act are the general federal statutes to refer to for federal water ARARs. MCLs, MCLGs, and AWQCs, may be ARARs under CERCLA. Please refer to the Attachment C for a list of compounds and their applicable standards. Water TBCs are discussed in Attachment D.

State

The generally pertinent State of Ohio statute is the Ohio Revised Code (ORC). ORC Chapter 3704 establishes Ohio EPA's authority to regulate and control air pollution within the State of Ohio. ORC Chapter 3734 provides statutory authority for the regulation of solid and hazardous waste activities in the State of Ohio. ORC Chapter 6109 establishes Ohio EPA's authority to regulate public water supplies. ORC Chapter 6111 establishes Ohio EPA's authority to set water quality standards and regulate water pollution sources. The pertinent State of Ohio regulations and rules developed on the basis of the ORC can be found in Chapter 3745 of the Ohio Administrative Code.

ALTERNATIVES	ARARs
Alternative 2-Source	Air
° Cap	1) Fugitive dust control from grading-to State Rule 3745-17-08 for requirements
	RCRA
	1) Landfill closure requirements (40 CFR §264.310) ° minimize migration of liquid into landfill ° design for minimum maintenance ° promote drainage-diversion or collection/treatment ° minimize erosion ° accommodate settling ° cover permeability must be designed to be less than or equal to permeability of natural subsoils
	2) Post-closure care (40 CFR §264.310(b)) ° maintain integrity and effectiveness of cap-repair effects of subsidence, settling, erosion, etc. ° Use restrictions to protect human health or environment ° ground water monitoring system in compliance with 40 CFR 264 Subpart F ° prevent run-on/run-off ° protect locational benchmarks
	3) Use Restrictions (40 CFR §264.116 and 264.117 (c)) ° submit survey plat indicating location and dimensions of disposal area and contents of cell. ° plat must contain owners obligation to restrict disturbance of unit ° plat prepared by a professional land surveyor and filed with local zoning authority ° record use of property in facility

ALTERNATIVES	ARARs

Alternative 2-Source

° Cap cont.

RCRA cont.

deed to the property
- limits on post closure use of property

4) Monitor - Ground Water - Substantive requirements of CFR §264.92 - 264.99

- background well(s) at appropriate location/depths
- downgradient wells at point of compliance (boundary of waste unit)
- establish ground water protection standard for constituents of concern; limits are MCL's or health based numbers established by EA.

Water

Not Applicable to Source Control-Cap except for surface water management-See State ARARs

State

1) Water Pollution Control as it applies to Surface Water Management of Run-on/Run-off-Ohio Administrative Code

3745-1-05(A)	Antidegradation policy. Existing instream water uses shall be maintained and protected. No degradation of the present water quality designation is allowable.
3745-1-05(B)	Antidegradation policy. The most stringent statutory and regulatory controls for waste treatment will be required for all new and existing point sources.
3745-1-32	Ohio River criteria.

ALTERNATIVES	ARARs
Alternative 2-Source	State cont.
° Cap cont.	Permits to Install
	3745-31-05(A)(3) Any installation of a new source of pollution must meet Best Available Technology requirements.
	NPDES Permits
	3745-33-04 Criteria for issuing NPDES Permits.
	3745-33-05(A) (6), (8), and (9) General Permit conditions.
	2) Air Pollution-Ohio Administrative Code
	3745-15-07 Air pollution nuisance prohibition. Prohibits the release in to the open air from any source of smoke, ashes, dust, dirt, grime, acids, fumes, gases, vapors, odors or any other substances in such a manner or amount as to endanger the health, safety, or welfare of the public or cause unreasonable injury or damage to property.
	3745-17-08 Restriction of emission of fugitive dust.
Alternative 2-Receptor	Water
° Municipal Water	See State ARARs below.
	State
	Public Water Supply
	OAC 3745-81 through 3745-99 are ARARs, in particular 3745-91.

ALTERNATIVES	ARARs
Alternative 2-Receptor ° Municipal Water	**State cont.** Any changes to public drinking water systems (line extensions, new wells, changes in treatment) must be approved by Ohio EPA prior to construction. A backflow prevention device must be placed on the municipal service line, in compliance with Ohio Administrative Code 3745-95. Public water systems must also comply with OAC 3734-7 regarding operator certification.
Alternative 2-Migration ° Monitor	This technology does not meet State or Federal ARARs-See other Migration Alternatives for a list of ARARs.
Alternative 3-Source Receptor Migration ° Cap/Slurrywall ° Municipal Water ° Monitor	See Alternative 2 for all Alternative 3 ARARs
Alternative 10-Source Receptor ° Cap ° Municipal Water	See Alternative 2 for all Source and Receptor ARARs
Alternative 10-Migration ° Collection/treatment - Air Stripping - Activated Carbon	**Air** 1) Air stripper emissions may not exceed emission standards for this source established in the approved State SIP and any applicable New

ALTERNATIVES	ARARs
Alternative 10-Migration	Air cont.

° Collection/treatment

- Air Stripping
- Activated Carbon

Source Performance Standards (NSPS) or NESHAPs. In addition, volatile organic compounds which may be emitted should be evaluated in the risk assessment (see Air TBCs).

2) Special handling of spent activated carbon is required if radon products which may be present in the water lead to a concentration in the carbon that meets "radioactive" definition of DOT. Breakthrough or release of radon gas shall not create an occupational or public health threat and shall not exceed State radioactive emission standards. Radiation monitoring may be required in the design (and possibly throughout implementation) phase of the remedy.

RCRA

1) Ground water concentrations at the end of cleanup program must be less than or equal to SDWA or RCRA MCL's at the point-of-compliance (waste unit boundary). Alternate Concentration Limits may only be used under the limited conditions outlined in CERCLA Section 121(d)(2)(B)(ii). Ambient Water Quality Criteria may also be ARARs under certain circumstances. A standard for drinking water more stringent than MCL's may be needed in special circumstances. In such cases the Agency will consider the MCLG and other pertinent guidelines. TBCs include Health Advisories and the 10^{-6} risk based levels established by the Endangerment Assessment for compounds without MCLs (see Attachment D).

2) If collection/treatment activities require storage or treatment in tanks, or containers or miscellaneous RCRA units as defined in

ALTERNATIVES	ARARs

Alternative 10-Migration

RCRA cont.

- ° Collection/treatment
  - Air Stripping
  - Activated Carbon

260.10, then the Facility must comply with the substantive elements of 40 CFR 264. Also, if wastes (i.e. spent carbon) are transported off-site, the facility must comply with the generator substantive criteria of 40 CFR 262 and with the disposal requirements of CERCLA Section 121(d)(3), and ensure transporter meets substantive requirements of 40 CFR 263.

3) Disposal of any hazardous residuals must also take into consideration the CERCLA Off-site Policy (see Attachment D).

Water

1) Discharge water from treatment unit must meet or exceed Clean Water Act NPDES permit discharge limits established for the particular discharge, depending on how and where discharge occurs. See State ARARs. TBCs include 10^{-6} risk levels established by EA for compounds without MCLs (see Attachment D).

2) If existing water quality in the Ohio River does not meet ORSANCO standards for the chemicals of concern, no additional discharge of those chemicals to the Ohio River shall be allowed. See State antidigradation standards.

3) Standards, including the State's use designations and chemical limits, for prevention of chronically toxic conditions must be met at the point ground water infiltrates into surface water.

4) MCL's and AWQC, under the Safe Drinking Water Act and Clean Water Act, must be met for groundwater at the completion of cleanup. A standard for drinking water more stringent

ALTERNATIVES	ARARs	
Alternative 10-Migration	Water cont.	
° Collection/treatment	than MCL's may be needed in special circumstances. In such cases, the Agency will consider the MCLG and other pertinent guidelines.	
	State	
	1) Hazardous Waste-Transport OAC 3745-53-11 PUCO Registration	
	2) Water Pollution Control-OAC	
	3745-1-05(A)	Antidegradation policy. Existing instream water uses shall be maintained and protected. No degradation of the present water quality designation is allowable.
	3745-1-05(B)	Antidegradation policy. The most stringent statutory and regulatory controls for waste treatment will be required for all new and existing point sources.
	3745-1-32	Ohio River criteria.
	Permits to Install	
	3745-31-05 (A)(3)	Any installation of a new source of pollution must meet Best Available Technology requirements.
	NPDES Permits	
	3745-33-04	Criterial for issuing NPDES Permits.
	3745-33-05 (A)(6), (8), and (9)	General Permit conditions.

ALTERNATIVES	ARARs	
Alternative 10-Migration	State cont.	
° Collection/Treatment	3) Air Pollution-OAC	
	3745-15-07	Air pollution nuisance prohibition. Prohibits the release in to the open air from any source of smoke, ashes, dust, dirt, grime, acids, fumes, gases, vapors, odors or any other substances in such a manner or amount as to endanger the health, safety, or welfare of the public or cause unreasonable injury or damage to property.
	3745-21-05	Non-degradation policy - ambient air quality standards.
	3745-21-07	Control of emissions of organic materials from stationary sources.
	3745-21-07(B)	All new stationary sources of emissions of photochemically reactive materials shall minimize such emissions by use of the latest available control techniques and operating practices in accordance with best current technology.
	3745-21-07(C)	Alternate means of abatement of emissions can be used if approved by the Director.
	Permits to Install	
	3745-31-05	Any installation of a new source of pollution must meet Best Available Technology requirements.

ALTERNATIVES		ARARs
Alternative 12-Source		**Air**
° Incineration	1)	Fugitive dust control
	2)	State Implementation Plan requirements and applicable NSPS and NESHAPs limitations.
	3)	TBCs include modeling to determine risk/limits of any emissions, volatiles, dioxins, etc.; particulates control - National Ambient Air Quality Standard for particles <10 micrometers (PM_{10})-24-hr PM_{10} standard is 150 micrograms/ cubic meter of air with no more than one exceedance/year, annual PM_{10} standard is 50 ug/m^3 based on annual arithmatic mean; and temperature in secondary chamber maintained at minimum 1800°F/minimum residence time of 1 second.
		RCRA
	1)	Performance standards, including requirements for waste analysis, monitoring, inspections, and closure. See 40 CFR §264.340-264.351.
	2)	Achieve destruction and removal efficiency (DRE) of 99.99% for each principal organic hazardous constituent (POHC).
	3)	Trial burn and trial burn plan per 40 CFR Sections 270.62 and 270.19
	4)	If incineration activities require storage or treatment in tanks, or containers or miscellaneous RCRA units as defined in 260.10, then the facility must comply with the substantive elements of 40 CFR 264. Also, if hazardous wastes (i.e. ash) are transported off-site, the facility must comply with the generator substantive criteria of 40 CFR 262 and with the disposal requirements of CERCLA Section 121(d)(3), and ensure transporter meets substantive requirements of CFR 263.
	5)	Off-site disposal of any hazardous residuals must also take into consideration the CERCLA Off-site Policy (see Attachment D).

ALTERNATIVES	ARARs

Alternative 12-Source

° Incineration

Water

1) Any liquid hazardous waste streams resulting from incinerator will have to be dealt with in accordance with Federal and State Water ARARs outlined in other Alternatives.

State

1) Hazardous Waste-Transport
OAC 3745-53-11 PUCO Registration

2) Air Pollution-OAC

3745-15-07	Air pollution nuisance prohibition. Prohibits the release in to the open air from any source of smoke, ashes, dust, dirt, grime, acids, fumes, gases, vapors, odors or any other substances in such a manner or amount as to endanger the health, safety, or welfare of the public or cause unreasonable injury or damage to property.
3745-17-05	Non-degradation policy - particulate matter standards.
3745-17-07	Control of visible particulate emissions from stationary sources.
3745-17-08	Restriction of emission of fugitive dust.
3745-17-09	Restrictions on particulate emissions and odors from incinerators.
3745-21-05	Non-degradation policy - ambient air quality standards.

ALTERNATIVES	ARARs	
Alternative 12-Source	State cont.	
° Incineration		
	3745-21-07	Control of emissions of organic materials from stationary sources.
	3745-21-07(C)	Alternate means of abatement of emissions can be used if approved by the Director.
	Permits to Install	
	3745-31-05 (A)(3)	Any installation of a new source of pollution must meet Best Available Technology requirements.
Alternative 12-Receptor Migration ° Municipal Water ° Collection/Treatment	See Alternative 2 for all Receptor ARARS and Alternative 10 for all Source ARARs	
Alternative 14-Source ° Cap/Slurrywall	See Alternative 2 for all Alternative 14-Source ARARs	
Alternative 14-Receptor ° Municipal Water	See Alternative 2 for all Alternative 14-Receptor ARARs	
Alternative 14-Migration ° Collection/Treatment	See Alternative 10 for all Alternative 14-Migration ARARs	
Alternative 16-Source	Air	
° On-site Landfill	1) Fugitive Dust Control	

ALTERNATIVES		ARARs
Alternative 16-Source		**RCRA**
° On-site Landfill	1)	On-site landfill must meet requirements of 40 CFR 264 Subpart N, especially Section 264.301 which addresses design and operation standards, including liner/leak detection and leachate collection requirements.
	2)	Use Restrictions (40 CFR §264.116) ° submit survey plat indicating location and dimensions of disposal area and contents of cell. ° plat must contain owners obligation to restrict disturbance of unit ° plat prepared by a professional land surveyor and filed with local zoning authority ° record use of property in facility deed to the property
	3)	If activities require storage or treatment in tanks, or containers or miscellaneous RCRA units as defined in 260.10, then the facility must comply with the substantive elements of 40 CFR 264. Also, if wastes are transported off-site, the facility must comply with the generator substantive criteria of 40 CFR 262 and with the disposal requirements of CERCLA Section 121(d)(3), and ensure transporter meets substantive requirements of 40 CFR 263.
	4)	Off-site disposal of any hazardous wastes must also take into consideration the CERCLA Off-site Policy (see Attachment D).
		Water
		Surface water (including collection, treatment, and discharge) ARARs are covered under Alternative 2-Source ARARs for State and Federal.
		State
	1)	Siting criteria per ORC 3734.05(C)(6)(g):

ALTERNATIVES	ARARs

Alternative 16-Source

° On-site Landfill

State cont.

(f) That the active areas within a new hazardous waste facility where acute hazardous waste as listed in 40 CFR 261.33(e), as amended, or organic waste that is toxic and is listed under 40 CFR 261, as amended, is being stored, treated, or disposed of and where the aggregate of the storage design capacity and the disposal design capacity of all hazardous waste in those areas is greater than two hundred and fifty thousand gallons, are not located or operated within:

(i) Two thousand feet of any residence, school, hospital, jail, or prison;

(ii) Any naturally occurring wetland; or

(iii) Any flood hazard area if the applicant cannot show that the facility will be designed, constructed, operated, and maintained to prevent washout by a one hundred-year flood or that procedures will be in effect to remove the waste before flood waters can reach it.

2) Hazardous Waste-Transport
OAC 3745-53-11 PUCO Registration

3) Solid Waste

Solid waste regulations require plan approval for"...any person proposing to establish a new solid waste disposal facility, or proposing to substantially modify an existing solid waste disposal facility". (OAC 3745-27-06) An important part of the review process concerns siting of solid waste facilities. OAC Section 3745-27-06(I) states:

ALTERNATIVES	ARARs
Alternative 16-Source	State cont.

° On-site Landfill

(I) Except by means of a waiver granted under 3745-27-11, the Director shall not approve plans for a sanitary landfill under any of the following conditions:

(1) The sanitary landfill will be located in a regulatory floodplain outside of a floodway; or

(2) The sanitary landfill will be located in a sand or gravel pit; or

(3) The sanitary landfill will be located in a limestone quarry or a sandstone quarry; or

(4) Those portions of the sanitary landfill where waste materials are to be deposited will be located within 1000' of a water well in existence on the date the plans were received by Ohio EPA; or

(5) Those portions of the sanitary landfill where waste materials are to be deposited will be located within 200' of a stream or lake; or

(6) The seasonal high ground water table and lowest level of waste materials in the sanitary landfill will b separated by less than 5 feet of soil of low permeability; or

(7) The seasonal high ground water table will be less than 5 feet below the existing surface of the site.

4) Permits to Install

3745-31-05 (A)(3) Any installation of a new source of pollution must meet Best Available Technology requirements.

ALTERNATIVES	ARARs	
Alternative 16-Source	State cont.	
° On-site Landfill	5) Air Pollution-OAC	
	3745-15-07	Air pollution nuisance prohibition. Prohibits the release in to the open air from any source of smoke, ashes, dust, dirt, grime, acids, fumes, gases, vapors, odors or any other substances in such a manner or amount as to endanger the health, safety, or welfare of the public or cause unresonable injury or damage to property.
	3745-17-08	Restriction of emission of fugitive dust.
	3745-21-05	Non-degradation policy - ambient air quality standards.
Alternative 16-Receptor ° Municipal Water	See Alternative 2 for all Alternative 16-Receptor ARARs.	
Alternative 16-Migration ° Collection/Treatment	See Alternative 10 for all Alternative 16-Migration ARARs.	
Alternative 17-Source	Air	
° Off-site Landfill	1) Fugitive Dust Control	
	RCRA	
	1) Generation in compliance with 40 CFR Parts 262.	

ALTERNATIVES	ARARs
Alternative 17-Source	RCRA cont.
° Off-site Landfill	2) Decontamination of equipment in accordance with 40 CFR 264.114.
	3) If activites require storage or treatment in tanks, or contains or miscellaneous RCRA units as defined in 260.10, then the facility may have to comply with the substantive elements of 40 CFR 264. Also, for wastes transported off-site, the facility must comply with the generator substantive criteria of 40 CFR 262 and with the disposal requirements of CERCLA Section 121(d) (3), and ensure transporter meets substantive criteria of 40 CFR 263.
	4) Disposal of any hazardous wastes must also take into consideration the CERCLA Off-site Policy (see Attachment D).
	Water
	Any decontamination liquids or other liquid wastes produced from the excavation of wastes for Off-site disposal activities must comply with State ARARs outlined in Alternative 2-Source and as applicable, Alternative 10-Migration, depending on how these liquids are handled and disposed.
	State
	1) Hazardous Waste-Transport OAC 3745-53-11 PUCO Registration
	2) Air Pollution-OAC
	3745-15-07 Air pollution nuisance prohibition. Prohibits the release in to the open air from any source of smoke, ashes,

ALTERNATIVES	ARARs	
Alternative 17-Source	State cont.	
° Off-site Landfill		dust, dirt, grime, acids, fumes, gases, vapors, odors or any other substances in such a manner or amount as to endanger the health, safety, or welfare of the public or cause unreasonable injury or damage to property.
	3745-17-08	Fugitive Dust
Alternative 17-Receptor ° Municipal Water	See Alternative 2 for all Alternative 17-Receptor ARARs	
Alternative 17-Migration ° Collection/Treatment	See Alternative 10 for all Alternative 17-Migration ARARs	

ATTACHMENT A

Promulgated NESHAPS

Radon
Beryllium
Mercury
Vinyl Chloride
Radionuclides
Benzene

ATTACHMENT B

(1) The parameters for which each hazardous waste will be analyzed and the rationale for the selection of these parameters (i.e., how analysis for these parameters will provide sufficient information on the waste's properties to comply with paragraph (a) of this section);

(2) The test methods which will be used to test for these parameters;

(3) The sampling method which will be used to obtain a representative sample of the waste to be analyzed. A representative sample may be obtained using either:

(i) One of the sampling methods described in Appendix I of Part 261 of this chapter; or

(ii) An equivalent sampling method.

[*Comment*. See § 260.21 of this chapter for related discussion.]

(4) The frequency with which the initial analysis of the waste will be reviewed or repeated to ensure that the analysis is accurate and up to date; and

(5) For off-site facilities, the waste analyses that hazardous waste generators have agreed to supply.

(6) Where applicable, the methods which will be used to meet the additional waste analysis requirements for specific waste management methods as specified in §§ 264.17, 264.314, and 264.341.

(c) For off-site facilities, the waste analysis plan required in paragraph (b) of this section must also specify the procedures which will be used to inspect and, if necessary, analyze each movement of hazardous waste received at the facility to ensure that it matches the identity of the waste designated on the accompanying manifest or shipping paper. At a minimum, the plan must describe:

(1) The procedures which will be used to determine the identity of each movement of waste managed at the facility; and

(2) The sampling method which will be used to obtain a representative sample of the waste to be identified, if the identification method includes sampling.

[*Comment*. Part 270 of this chapter requires that the waste analysis plan be submitted with Part B of the permit application.]

(Approved by the Office of Management and Budget under control number 2050-0012)

[45 FR 33221, May 19, 1980, as amended at 46 FR 2848, Jan. 12, 1981; 48 FR 14294, Apr. 1, 1983; 50 FR 4514, Jan. 31, 1985; 50 FR 18374, Apr. 30, 1985]

§ 264.14 Security.

(a) The owner or operator must prevent the unknowing entry, and minimize the possibility for the unauthorized entry, of persons or livestock onto the active portion of his facility, *unless* he can demonstrate to the Regional Administrator that:

(1) Physical contact with the waste, structures, or equipment within the active portion of the facility will not injure unknowing or unauthorized persons or livestock which may enter the active portion of a facility, and

(2) Disturbance of the waste or equipment, by the unknowing or unauthorized entry of persons or livestock onto the active portion of a facility, will not cause a violation of the requirements of this part.

[*Comment*. Part 270 of this chapter requires that an owner or operator who wishes to make the demonstration referred to above must do so with Part B of the permit application.]

(b) Unless the owner or operator has made a successful demonstration under paragraphs (a)(1) and (2) of this section, a facility must have:

(1) A 24-hour surveillance system (e.g., television monitoring or surveillance by guards or facility personnel) which continuously monitors and controls entry onto the active portion of the facility; or

(2)(i) An artificial or natural barrier (e.g., a fence in good repair or a fence combined with a cliff), which completely surrounds the active portion of the facility; and

(ii) A means to control entry, at all times, through the gates or other entrances to the active portion of the facility (e.g., an attendant, television monitors, locked entrance, or controlled roadway access to the facility).

[*Comment*: The requirements of paragraph (b) of this section are satisfied if the facility or plant within which the active portion is located itself has a surveillance system, or a barrier and a means to control entry, which complies with the requirements of paragraph (b)(1) or (2) of this section.]

(c) Unless the owner or operator has made a successful demonstration under paragraphs (a)(1) and (2) of this section, a sign with the legend, "Danger—Unauthorized Personnel Keep Out", must be posted at each entrance to the active portion of a facility, and at other locations, in sufficient numbers to be seen from any approach to this active portion. The legend must be written in English and in any other language predominant in the area surrounding the facility (e.g., facilities in counties bordering the Canadian province of Quebec must post signs in French; facilities in counties bordering Mexico must post signs in Spanish), and must be legible from a distance of at least 25 feet. Existing signs with a legend other than "Danger—Unauthorized Personnel Keep Out" may be used if the legend on the sign indicates that only authorized personnel are allowed to enter the active portion, and that entry onto the active portion can be dangerous.

[*Comment*: See § 264.117(b) for discussion of security requirements at disposal facilities during the post-closure care period.]

(Approved by the Office of Management and Budget under control number 2050-0012)

[45 FR 33221, May 19, 1980, as amended at 46 FR 2848, Jan. 12, 1981; 48 FR 14294, Apr. 1, 1983; 50 FR 4514, Jan. 31, 1985]

§ 264.15 General inspection requirements.

(a) The owner or operator must inspect his facility for malfunctions and deterioration, operator errors, and discharges which may be causing—or may lead to—(1) release of hazardous waste constituents to the environment or (2) a threat to human health. The owner or operator must conduct these inspections often enough to identify problems in time to correct them before they harm human health or the environment.

(b)(1) The owner or operator must develop and follow a written schedule for inspecting monitoring equipment, safety and emergency equipment, security devices, and operating and structural equipment (such as dikes and sump pumps) that are important to preventing, detecting, or responding to environmental or human health hazards.

(2) He must keep this schedule at the facility.

(3) The schedule must identify the types of problems (e.g., malfunctions or deterioration) which are to be looked for during the inspection (e.g., inoperative sump pump, leaking fitting, eroding dike, etc.).

(4) The frequency of inspection may vary for the items on the schedule. However, it should be based on the rate of possible deterioration of the equipment and the probability of an environmental or human health incident if the deterioration or malfunction of any operator error goes undetected between inspections. Areas subject to spills, such as loading and unloading areas, must be inspected daily when in use. At a minimum, the inspection schedule must include the terms and frequencies called for in §§ 264.174, 264.194, 264.226, 264.253, 264.254, 264.303, and 264.347, where applicable.

[*Comment*: Part 270 of this chapter requires the inspection schedule to be submitted with Part B of the permit application. EPA will evaluate the schedule along with the rest of the application to ensure that it adequately protects human health and the environment. As part of this review, EPA may modify or amend the schedule as may be necessary.]

(c) The owner or operator must remedy any deterioration or malfunction of equipment or structures which the inspection reveals on a schedule which ensures that the problem does not lead to an environmental or human health hazard. Where a hazard is imminent or has already occurred, remedial action must be taken immediately.

(d) The owner or operator must record inspections in an inspection log or summary. He must keep these records for at least three years from the date of inspection. At a minimum, these records must include the date and time of the inspection, the name of the inspector, a notation of the observations made, and the date and nature of any repairs or other remedial actions.

ous waste generator from which the facility received a hazardous waste during the year, for imported shipments, the report must give the name and address of the foreign generator;

(d) A description and the quantity of each hazardous waste the facility received during the year. For off site facilities, this information must be listed by EPA identification number of each generator;

(e) The method of treatment, storage, or disposal for each hazardous waste.

(f) [Reserved]

(g) The most recent closure cost estimate under § 264 142, and, for disposal facilities, the most recent post closure cost estimate under § 264 144; and

(h) The certification signed by the owner or operator of the facility or his authorized representative.

(Approved by the Office of Management and Budget under control number 2050-0024)

[46 FR 33221, May 19 1980, as amended at 46 FR 2849, Jan. 12, 1981, 48 FR 3982, Jan. 28, 1983, 50 FR 4514, Jan 31, 1985]

§ 264.76 Unmanifested waste report.

If a facility accepts for treatment, storage, or disposal any hazardous waste from an off-site source without an accompanying manifest, or without an accompanying shipping paper as described in § 263 20(e)(2) of this chapter, and if the waste is not excluded from the manifest requirement by § 261 5 of this chapter, then the owner or operator must prepare and submit a single copy of a report to the Regional Administrator within fifteen days after receiving the waste. The unmanifested waste report must be submitted on EPA form 8700-13B Such report must be designated 'Unmanifested Waste Report' and include the following information:

(a) The EPA identification number, name, and address of the facility;

(b) The date the facility received the waste.

(c) The EPA identification number, name, and address of the generator and the transporter, if available.

(d) A description and the quantity of each unmanifested hazardous waste and facility received;

(e) The method of treatment, storage, or disposal for each hazardous waste,

(f) The certification signed by the owner or operator of the facility or his authorized representative, and

(g) A brief explanation of why the waste was unmanifested, if known.

[*Comment.* Small quantities of hazardous waste are excluded from regulation under this part and do not require a manifest. Where a facility receives unmanifested hazardous wastes, the Agency suggests that the owner or operator obtain from each generator a certification that the waste qualifies for exclusion Otherwise, the Agency suggests that the owner or operator file an unmanifested waste report for the hazardous waste movement]

(Approved by the Office of Management and Budget under control number 2050-0012)

[46 FR 33221, May 19 1980, as amended at 48 FR 3982, Jan 28, 1983; 50 FR 4514, Jan. 31, 1985]

§ 264.77 Additional reports.

In addition to submitting the biennial reports and unmanifested waste reports described in §§ 264 75 and 264.76, the owner or operator must also report to the Regional Administrator:

(a) Releases, fires, and explosions as specified in § 264.56(j);

(b) Facility closures specified in § 264 115, and

(c) As otherwise required by Subparts F and K through N.

[46 FR 2849, Jan 12, 1981, as amended at 47 FR 32350, July 26, 1982; 48 FR 3982, Jan. 28, 1983]

Subpart F—Releases From Solid Waste Management Units

SOURCE: 47 FR 32350, July 26, 1982, unless otherwise noted.

§ 264.90 Applicability.

(a)(1) Except as provided in paragraph (b) of this section, the regulations in this subpart apply to owners or operators of facilities that treat, store or dispose of hazardous waste. The owner or operator must satisfy the requirements identified in paragraph (a)(2) of this section for all wastes (or constituents thereof) contained in solid waste management

units at the facility, regardless of the time at which waste was placed in such units.

(2) All solid waste management units must comply with the requirements in § 264 101 A surface impoundment, waste pile, and land treatment unit or landfill that receives hazardous waste after July 26, 1982 (hereinafter referred to as a "regulated unit") must comply with the requirements of §§ 264 91 through 264.100 in lieu of § 264 101 for purposes of detecting, characterizing and responding to releases to the uppermost aquifer. The finanical responsibility requirements of § 264 101 apply to regulated units

(b) The owner or operator's regulated unit or units are not subject to regulation for releases into the uppermost aquifer under this subpart if:

(1) The owner or operator is exempted under § 264.1; or

(2) He operates a unit which the Regional Administrator finds:

(i) Is an engineered structure,

(ii) Does not receive or contain liquid waste or waste containing free liquids,

(iii) Is designed and operated to exclude liquid, precipitation, and other run on and run-off,

(iv) Has both inner and outer layers of containment enclosing the waste,

(v) Has a leak detection system built into each containment layer,

(vi) The owner or operator will provide continuing operation and maintenance of these leak detection systems during the active life of the unit and the closure and post-closure care periods, and

(vii) To a reasonable degree of certainty, will not allow hazardous constituents to migrate beyond the outer containment layer prior to the end of the the post-closure care period.

(3) The Regional Administrator finds, pursuant to § 264 280(d), that the treatment zone of a land treatment unit that qualifies as a regulated unit does not contain levels of hazardous constituents that are above background levels of those constituents by an amount that is statistically significant, and if an unsaturated zone monitoring program meeting the requirements of § 264 278 has not shown a statistically significant increase in hazardous constituents below the treatment zone during the operating life of the unit. An exemption under this paragraph can only relieve an owner or operator of responsibility to meet the requirements of this subpart during the post-closure care period,

(4) The Regional Administrator finds that there is no potential for migration of liquid from a regulated unit to the uppermost aquifer during the active life of the regulated unit (including the closure period) and the post-closure care period specified under § 264 117. This demonstration must be certified by a qualified geologist or geotechnical engineer In order to provide an adequate margin of safety in the prediction of potential migration of liquid, the owner or operator must base any predictions made under this paragraph on assumptions that maximize the rate of liquid migration.

(5) He designs and operates a pile in compliance with § 264.250(c)

(c) The regulations under this subpart apply during the active life of the regulated unit (including the closure period) After closure of the regulated unit, the regulations in this subpart

(1) Do not apply if all waste, waste residues, contaminated containment system components, and contaminated subsoils are removed or decontaminated at closure;

(2) Apply during the post-closure care period under § 264 117 if the owner or operator is conducting a detection monitoring program under § 264.98; or

(3) Apply during the compliance period under § 264 96 if the owner or operator is conducting a compliance monitoring program under § 264 99 or a corrective action program under § 264.100.

[47 FR 32350, July 26 1982, as amended at 50 FR 28746, July 15, 1985]

§ 264.91 Required programs.

(a) Owners and operators subject to this subpart must conduct a monitoring and response program as follows:

(1) Whenever hazardous constituents under § 264 93 from a regulated unit are detected at the compliance point under § 264.95, the owner o

erator must institute a compliance monitoring program under § 264.99.

(2) Whenever the ground water protection standard under § 264.92 is exceeded, the owner or operator must institute a corrective action program under § 264.100.

(3) Whenever hazardous constituents under § 264.93 from a regulated unit exceed concentration limits under § 264.94 in ground water between the compliance point under § 264.95 and the downgradient facility property boundary, the owner or operator must institute a corrective action program under § 264.100, or

(4) In all other cases, the owner or operator must institute a detection monitoring program under § 264.98.

(b) The Regional Administrator will specify in the facility permit the specific elements of the monitoring and response program. The Regional Administrator may include one or more of the programs identified in paragraph (a) of this section in the facility permit as may be necessary to protect human health and the environment and will specify the circumstances under which each of the programs will be required. In deciding whether to require the owner or operator to be prepared to institute a particular program, the Regional Administrator will consider the potential adverse effects on human health and the environment that might occur before final administrative action on a permit modification application to incorporate such a program could be taken.

§ 264.92 Ground-water protection standard.

The owner or operator must comply with conditions specified in the facility permit that are designed to ensure that hazardous constituents under § 264.93 entering the ground water from a regulated unit do not exceed the concentration limits under § 264.94 in the uppermost aquifer underlying the waste management area beyond the point of compliance under § 264.95 during the compliance period under § 264.96. The Regional Administrator will establish this ground water protection standard in the facility permit when hazardous constituents have entered the ground water from a regulated unit.

§ 264.93 Hazardous constituents.

(a) The Regional Administrator will specify in the facility permit the hazardous constituents to which the ground-water protection standard of § 264.92 applies. Hazardous constituents are constituents identified in Appendix VIII of Part 261 of this chapter that have been detected in ground water in the uppermost aquifer underlying a regulated unit and that are reasonably expected to be in or derived from waste contained in a regulated unit, unless the Regional Administrator has excluded them under paragraph (b) of this section.

(b) The Regional Administrator will exclude an Appendix VIII constituent from the list of hazardous constituents specified in the facility permit if he finds that the constituent is not capable of posing a substantial present or potential hazard to human health or the environment. In deciding whether to grant an exemption, the Regional Administrator will consider the following:

(1) Potential adverse effects on ground-water quality, considering:

(i) The physical and chemical characteristics of the waste in the regulated unit, including its potential for migration;

(ii) The hydrogeological characteristics of the facility and surrounding land;

(iii) The quantity of ground water and the direction of ground-water flow;

(iv) The proximity and withdrawal rates of ground-water users,

(v) The current and future uses of ground water in the area,

(vi) The existing quality of ground water, including other sources of contamination and their cumulative impact on the ground-water quality.

(vii) The potential for health risks caused by human exposure to waste constituents;

(viii) The potential damage to wildlife, crops, vegetation, and physical structures caused by exposure to waste constituents;

(ix) The persistence and permanence of the potential adverse effects, and

(2) Potential adverse effects on hydraulically-connected surface water quality, considering:

(i) The volume and physical and chemical characteristics of the waste in the regulated unit;

(ii) The hydrogeological characteristics of the facility and surrounding land;

(iii) The quantity and quality of ground water, and the direction of ground-water flow;

(iv) The patterns of rainfall in the region;

(v) The proximity of the regulated unit to surface waters;

(vi) The current and future uses of surface waters in the area and any water quality standards established for those surface waters;

(vii) The existing quality of surface water, including other sources of contamination and the cumulative impact on surface-water quality;

(viii) The potential for health risks caused by human exposure to waste constituents;

(ix) The potential damage to wildlife, crops, vegetation, and physical structures caused by exposure to waste constituents; and

(x) The persistence and permanence of the potential adverse effects.

(c) In making any determination under paragraph (b) of this section about the use of ground water in the area around the facility, the Regional Administrator will consider any identification of underground sources of drinking water and exempted aquifers made under § 144.8 of this chapter.

[47 FR 32350, July 26, 1982, as amended at 48 FR 14294, Apr. 1, 1983]

§ 264.94 Concentration limits.

(a) The Regional Administrator will specify in the facility permit concentration limits in the ground water for hazardous constituents established under § 264.93. The concentration of a hazardous constituent:

(1) Must not exceed the background level of that constituent in the ground water at the time that limit is specified in the permit, or

(2) For any of the constituents listed in Table 1, must not exceed the respective value given in that table if background level of the constitue below the value given in Table 1, o

TABLE 1—MAXIMUM CONCENTRATION OF STITUENTS FOR GROUND-WATER PR TION

Constituent	[illegible]
Arsenic	
Barium	
Cadmium	
Chromium	
Lead	
Mercury	
Selenium	
Silver	
Endrin (1,2,3,4,10,10-hexachloro-1,7-epoxy-1,4,4a,5,6,7,8,8a-octahydro-1,4-endo, endo-5,8-dimethano naphthalene)	
Lindane (1,2,3,4,5,6-hexachlorocyclohexane, gamma isomer)	
Methoxychlor (1,1,1-Trichloro-2,2-bis (p-methoxyphenylethane)	
Toxaphene ($C_{10}H_{10}Cl_8$, Technical chlorinated camphene, 67-69 percent chlorine)	
2,4-D (2,4-Dichlorophenoxyacetic acid)	
2,4,5-TP Silvex (2,4,5-Trichlorophenoxypropionic acid)	

[1] Milligrams per liter

(3) Must not exceed an alter limit established by the Regional ministrator under paragraph (b this section.

(b) The Regional Administrator establish an alternate concentr limit for a hazardous constituent finds that the constituent will pose a substantial present or pote hazard to human health or the ronment as long as the alternate centration limit is not exceeded tablishing alternate concentr limits, the Regional Administrat consider the following factors

(1) Potential adverse effect ground-water quality, consideri

(i) The physical and chemical acteristics of the waste in the r ed unit, including its potential gration;

(ii) The hydrogeological chara tics of the facility and surro land;

(iii) The quantity of ground and the directio of ground flow;

(iv) The proximity and with rates of ground-water users,

(v) The current and future uses of ground water in the area.

(vi) The existing quality of ground water, including other sources of contamination and their cumulative impact on the ground water quality.

(vii) The potential for health risks caused by human exposure to waste constituents,

(viii) The potential damage to wildlife, crops, vegetation, and physical structures caused by exposure to waste constituents,

(ix) The persistence and permanence of the potential adverse effects, and

(2) Potential adverse effects on hydraulically connected surface-water quality, considering:

(i) The volume and physical and chemical characteristics of the waste in the regulated unit,

(ii) The hydrogeological characteristics of the facility and surrounding land,

(iii) The quantity and quality of ground water, and the direction of ground water flow,

(iv) The patterns of rainfall in the region,

(v) The proximity of the regulated unit to surface waters,

(vi) The current and future uses of surface waters in the area and any water quality standards established for those surface waters,

(vii) The existing quality of surface water, including other sources of contamination and the cumulative impact on surface water quality;

(viii) The potential for health risks caused by human exposure to waste constituents,

(ix) The potential damage to wildlife, crops, vegetation, and physical structures caused by exposure to waste constituents, and

(x) The persistence and permanence of the potential adverse effects

(c) In making any determination under paragraph (b) of this section about the use of ground water in the area around the facility the Regional Administrator will consider any identification of underground sources of drinking water and exempted aquifers made under § 144.8 of this chapter

[47 FR 32350, July 26, 1982, as amended at 48 FR 14294, Apr. 1, 1983]

§ 264.95 Point of compliance.

(a) The Regional Administrator will specify in the facility permit the point of compliance at which the ground water protection standard of § 264.92 applies and at which monitoring must be conducted. The point of compliance is a vertical surface located at the hydraulically downgradient limit of the waste management area that extends down into the uppermost aquifer underlying the regulated units

(b) The waste management area is the limit projected in the horizontal plane of the area on which waste will be placed during the active life of a regulated unit.

(1) The waste management area includes horizontal space taken up by any liner, dike, or other barrier designed to contain waste in a regulated unit

(2) If the facility contains more than one regulated unit, the waste management area is described by an imaginary line circumscribing the several regulated units.

§ 264.96 Compliance period.

(a) The Regional Administrator will specify in the facility permit the compliance period during which the ground water protection standard of § 264.92 applies. The compliance period is the number of years equal to the active life of the waste management area (including any waste management activity prior to permitting, and the closure period.)

(b) The compliance period begins when the owner or operator initiates a compliance monitoring program meeting the requirements of § 264.99.

(c) If the owner or operator is engaged in a corrective action program at the end of the compliance period specified in paragraph (a) of this section, the compliance period is extended until the owner or operator can demonstrate that the ground water protection standard of § 264.92 has not been exceeded for a period of three consecutive years.

§ 264.97 General ground water monitoring requirements.

The owner or operator must comply with the following requirements for

any ground water monitoring program developed to satisfy § 264.98, § 264.99, or § 264.100.

(a) The ground water monitoring system must consist of a sufficient number of wells, installed at appropriate locations and depths to yield ground water samples from the uppermost aquifer that:

(1) Represent the quality of background water that has not been affected by leakage from a regulated unit; and

(2) Represent the quality of ground water passing the point of compliance.

(b) If a facility contains more than one regulated unit, separate ground-water monitoring systems are not required for each regulated unit provided that provisions for sampling the ground water in the uppermost aquifer will enable detection and measurement at the compliance point of hazardous constituents from the regulated units that have entered the ground water in the uppermost aquifer.

(c) All monitoring wells must be cased in a manner that maintains the integrity of the monitoring-well bore hole. This casing must be screened or perforated and packed with gravel or sand, where necessary, to enable collection of ground water samples. The annular space (i.e., the space between the bore hole and well casing) above the sampling depth must be sealed to prevent contamination of samples and the ground water

(d) The ground water monitoring program must include consistent sampling and analysis procedures that are designed to ensure monitoring results that provide a reliable indication of ground water quality below the waste management area. At a minimum the program must include procedures and techniques for:

(1) Sample collection,

(2) Sample preservation and shipment,

(3) Analytical procedures; and

(4) Chain of custody control

(e) The ground water monitoring program must include sampling and analytical methods that are appropriate for ground water sampling and that accurately measure hazardous constituents in ground water samples.

(f) The ground water monitori[ng] program must include a determinati[on] of the ground water surface elevati[on] each time ground water is sampled

(g) Where appropriate, the groun[d] water monitoring program must esta[b]lish background ground water quali[ty] for each of the hazardous constituen[ts] or monitoring parameters or constit[u]ents specified in the permit

(1) In the detection monitoring pr[o]gram under § 264.98, backgroun[d] ground water quality for a monitori[ng] parameter or constituent must [be] based on data from quarterly sampli[ng] of wells upgradient from the wa[ste] management area for one year

(2) In the compliance monitorin[g] program under § 264.99, backgroun[d] ground water quality for a hazardou[s] constituent must be based on dat[a] from upgradient wells that:

(i) Is available before the permit [is] issued;

(ii) Accounts for measurement error[s] in sampling and analysis, and

(iii) Accounts, to the extent feasibl[e] for seasonal fluctuations in back[ground] ground water quality if su[ch] fluctuations are expected to affect th[e] concentration of the hazardous co[n]stituent

(3) Background quality may [be] based on sampling of wells that a[re] not upgradient from the waste ma[n]agement area where

(i) Hydrogeologic conditions do n[ot] allow the owner or operator to dete[r]mine what wells are upgradient, or

(ii) Sampling at other wells will pr[o]vide an indication of backgrou[nd] ground-water quality that is as repr[e]sentative or more representative th[an] that provided by the upgradient we[lls]

(4) In developing the data base u[sed] to determine a background value [of] each parameter or constituent, [the] owner or operator must take a mi[ni]mum of one sample from each w[ell] and a minimum of four samples f[rom] the entire system used to determ[ine] background ground water qual[ity] each time the system is sampled

(h) The owner or operator must [use] the following statistical procedu[re in] determining whether backgro[und] values or concentration limits h[ave] been exceeded:

(i) If, in a detection monitoring program, the level of a constituent at the compliance point is to be compared to the constituent's background value and that background value has a sample coefficient of variation less than 1.00:

(I) The owner or operator must take at least four portions from a sample at each well at the compliance point and determine whether the difference between the mean of the constituent at each well (using all portions taken) and the background value for the constituent is significant at the 0.05 level using the Cochran's Approximation to the Behrens-Fisher Student's t-test as described in Appendix IV of this part. If the test indicates that the difference is significant, the owner or operator must repeat the same procedure (with at least the same number of portions as used in the first test) with a fresh sample from the monitoring well. If this second round of analyses indicates that the difference is significant, the owner or operator must conclude that a statistically significant change has occurred, or

(II) The owner or operator may use an equivalent statistical procedure for determining whether a statistically significant change has occurred. The Regional Administrator will specify such a procedure in the facility permit if he finds that the alternative procedure reasonably balances the probability of falsely identifying a non-contaminating regulated unit and the probability of failing to identify a contaminating regulated unit in a manner that is comparable to that of the statistical procedure described in paragraph (h)(1)(i)(I) of this section.

(2) In all other situations in a detection monitoring program and in a compliance monitoring program, the owner or operator must use a statistical procedure providing reasonable confidence that the migration of hazardous constituents from a regulated unit into and through the aquifer will be indicated. The Regional Administrator will specify a statistical procedure in the facility permit that he finds:

(i) Is appropriate for the distribution of the data used to establish background values or concentration limits, and

(ii) Provides a reasonable balance between the probability of falsely identifying a non-contaminating regulated unit and the probability of failing to identify a contaminating regulated unit.

(Approved by the Office of Management and Budget under control number 2050-0033)

[47 FR 32350, July 26, 1982, as amended at 50 FR 4514, Jan. 31, 1985]

§ 264.98 Detection monitoring program.

An owner or operator required to establish a detection monitoring program under this subpart must, at a minimum, discharge the following responsibilities:

(a) The owner or operator must monitor for indicator parameters (e.g., specific conductance, total organic carbon, or total organic halogen), waste constituents, or reaction products that provide a reliable indication of the presence of hazardous constituents in ground water. The Regional Administrator will specify the parameters or constituents to be monitored in the facility permit, after considering the following factors:

(1) The types, quantities, and concentrations of constituents in wastes managed at the regulated unit;

(2) The mobility, stability, and persistence of waste constituents or their reaction products in the unsaturated zone beneath the waste management area,

(3) The detectability of indicator parameters, waste constituents, and reaction products in ground water, and

(4) The concentrations or values and coefficients of variation of proposed monitoring parameters or constituents in the ground-water background.

(b) The owner or operator must install a ground-water monitoring system at the compliance point as specified under § 264.95. The ground-water monitoring system must comply with § 264.97(a)(2), (b), and (c).

(c) The owner or operator must establish a background value for each monitoring parameter or constituent specified in the permit pursuant to paragraph (a) of this section. The permit will specify the background values for each parameter or specify the procedures to be used to calculate the background values.

(1) The owner or operator must comply with § 264.97(g) in developing the data base used to determine background values.

(2) The owner or operator must express background values in a form necessary for the determination of statistically significant increases under § 264.97(h).

(3) In taking samples used in the determination of background values, the owner or operator must use a ground-water monitoring system that complies with § 264.97(a)(1), (b), and (c).

(d) The owner or operator must determine ground water quality at each monitoring well at the compliance point at least semi-annually during the active life of a regulated unit (including the closure period) and the post-closure care period. The owner or operator must express the ground-water quality at each monitoring well in a form necessary for the determination of statistically significant increases under § 264.97(h).

(e) The owner or operator must determine the ground-water flow rate and direction in the uppermost aquifer at least annually.

(f) The owner or operator must use procedures and methods for sampling and analysis that meet the requirements of § 264.97 (d) and (e).

(g) The owner or operator must determine whether there is a statistically significant increase over background values for any parameter or constituent specified in the permit pursuant to paragraph (a) of this section each time he determines ground-water quality at the compliance point under paragraph (d) of this section.

(1) In determining whether a statistically significant increase has occurred, the owner or operator must compare the ground-water quality at each monitoring well at the compliance point for each parameter or constituent to the background value for that parameter or constituent, according to the statistical procedure specified in the permit under § 264.97(h).

(2) The owner or operator must determine whether there has been a statistically significant increase at each monitoring well at the compliance point within a reasonable time period after completion of sampling. The Regional Administrator will specify that time period in the facility permit, after considering the complexity of the statistical test and the availability of laboratory facilities to perform the analysis of ground-water samples.

(h) If the owner or operator determines, pursuant to paragraph (g) of this section, that there is a statistically significant increase for parameters or constituents specified pursuant to paragraph (a) of this section at any monitoring well at the compliance point, he must:

(1) Notify the Regional Administrator of this finding in writing within seven days. The notification must indicate what parameters or constituents have shown statistically significant increases;

(2) Immediately sample the ground water in all monitoring wells and determine the concentration of all constituents identified in Appendix VIII of Part 261 of this chapter that are present in ground water.

(3) Establish a background value for each Appendix VIII constituent that has been found at the compliance point under paragraph (h)(2) of this section, as follows:

(i) The owner or operator must comply with § 264.97(g) in developing the data base used to determine background values;

(ii) The owner or operator must express background values in a form necessary for the determination of statistically significant increases under § 264.97(h), and

(iii) In taking samples used in the determination of background values, the owner or operator must use a ground-water monitoring system that complies with § 264.97(a)(1), (b), and (c);

(4) Within 90 days, submit to the Regional Administrator an application for a permit modification to establish a compliance monitoring program meeting the requirements of § 264.99. The application must include the following information:

(i) An identification of the concentration of any Appendix VIII constitu ents found in the ground water at each monitoring well at the compliance point.

(ii) Any proposed changes to the ground-water monitoring system at the facility necessary to meet the requirements of § 264.99;

(iii) Any proposed changes to the monitoring frequency, sampling and analysis procedures or methods, or statistical procedures used at the facility necessary to meet the requirements of § 264.99;

(iv) For each hazardous constituent found at the compliance point, a proposed concentration limit under § 264.94(a)(1) or (2), or a notice of intent to seek a variance under § 264.94(b); and

(5) Within 180 days, submit to the Regional Administrator:

(i) All data necessary to justify any variance sought under § 264.94(b); and

(ii) An engineering feasibility plan for a corrective action program necessary to meet the requirements of § 264.100, unless:

(A) All hazardous constituents identified under paragraph (h)(2) of this section are listed in Table 1 of § 264.94 and their concentrations do not exceed the respective values given in that Table; or

(B) The owner or operator has sought a variance under § 264.94(b) for every hazardous constituent identified under paragraph (h)(2) of this section.

(i) If the owner or operator determines, pursuant to paragraph (g) of this section, that there is a statistically significant increase of parameters or constituents specified pursuant to paragraph (a) of this section at any monitoring well at the compliance point, he may demonstrate that a source other than a regulated unit caused the increase or that the increase resulted from error in sampling, analysis, or evaluation. While the owner or operator may make a demonstration under this paragraph in addition to, or in lieu of, submitting a permit modification application under paragraph (h)(5) of this section, he is not relieved of the requirement to submit a permit modification application within the time specified in paragraph (h)(4) of this section unless the demonstration made under this paragraph successfully shows that a source other than a regulated unit caused the increase or that the increase resulted from error in sampling, analysis, or evaluation. In making a demonstration under this paragraph, the owner or operator must:

(1) Notify the Regional Administrator in writing within seven days of determining a statistically significant increase at the compliance point that he intends to make a demonstration under this paragraph;

(2) Within 90 days, submit a report to the Regional Administrator which demonstrates that a source other than a regulated unit caused the increase, or that the increase resulted from error in sampling, analysis, or evaluation;

(3) Within 90 days, submit to the Regional Administrator an application for a permit modification to make any appropriate changes to the detection monitoring program at the facility; and

(4) Continue to monitor in accordance with the detection monitoring program established under this section.

(j) If the owner or operator determines that the detection monitoring program no longer satisfies the requirements of this section, he must, within 90 days, submit an application for a permit modification to make any appropriate changes to the program.

(k) The owner or operator must assure that monitoring and corrective action measures necessary to achieve compliance with the ground-water protection standard under § 264.92 are taken during the term of the permit.

(Approved by the Office of Management and Budget under control number 2050-0033)

[47 FR 32360, July 26, 1982, as amended at 50 FR 4514, Jan. 31, 1985]

§ 264.99 Compliance monitoring program.

An owner or operator required to establish a compliance monitoring program under this subpart must, at a minimum, discharge the following responsibilities:

(a) The owner or operator must monitor the ground water to determine whether regulated units are in

compliance with the ground-water protection standard under § 264.92. The Regional Administrator will specify the ground water protection standard in the facility permit, including:

(1) A list of the hazardous constituents identified under § 264.93;

(2) Concentration limits under § 264.94 for each of those hazardous constituents;

(3) The compliance point under § 264.95; and

(4) The compliance period under § 264.96.

(b) The owner or operator must install a ground-water monitoring system at the compliance point as specified under § 264.95. The ground-water monitoring system must comply with § 264.97(a)(2), (b), and (c).

(c) Where a concentration limit established under paragraph (a)(2) of this section is based on background ground-water quality, the Regional Administrator will specify the concentration limit in the permit as follows:

(1) If there is a high temporal correlation between upgradient and compliance point concentrations of the hazardous constituents, the owner or operator may establish the concentration limit through sampling at upgradient wells each time ground water is sampled at the compliance point. The Regional Administrator will specify the procedures used for determining the concentration limit in this manner in the permit. In all other cases, the concentration limit will be the mean of the pooled data on the concentration of the hazardous constituent.

(2) If a hazardous constituent is identified on Table 1 under § 264.94 and the difference between the respective concentration limit in Table 1 and the background value of that constituent under § 264.97(g) is not statistically significant, the owner or operator must use the background value of the constituent as the concentration limit. In determining whether this difference is statistically significant, the owner or operator must use a statistical procedure providing reasonable confidence that a real difference will be indicated. The statistical procedure must:

(i) Be appropriate for the distribution of the data used to establish background values; and

(ii) Provide a reasonable balance between the probability of falsely identifying a significant difference and the probability of failing to identify a significant difference.

(3) The owner or operator must:

(i) Comply with § 264.97(g) in developing the data base used to determine background values;

(ii) Express background values in a form necessary for the determination of statistically significant increases under § 264.97(h); and

(iii) Use a ground-water monitoring system that complies with § 264.97(a)(1), (b), and (c).

(d) The owner or operator must determine the concentration of hazardous constituents in ground water at each monitoring well at the compliance point at least quarterly during the compliance period. The owner or operator must express the concentration at each monitoring well in a form necessary for the determination of statistically significant increases under § 264.97(h).

(e) The owner or operator must determine the ground-water flow rate and direction in the uppermost aquifer at least annually.

(f) The owner or operator must analyze samples from all monitoring wells at the compliance point for all constituents contained in Appendix VIII of Part 261 of this chapter at least annually to determine whether additional hazardous constituents are present in the uppermost aquifer. If the owner or operator finds Appendix VIII constituents in the ground water that are not identified in the permit as hazardous constituents, the owner or operator must report the concentrations of these additional constituents to the Regional Administrator within seven days after completion of the analysis.

(g) The owner or operator must use procedures and methods for sampling and analysis that meet the requirements of § 264.97(d) and (e).

(h) The owner or operator must determine whether there is a statistically significant increase over the concentration limits for any hazardous constituents specified in the permit pursu ant to paragraph (a) of this section each time he determines the concentration of hazardous constituents in ground water at the compliance point.

(1) In determining whether a statistically significant increase has occurred, the owner or operator must compare the ground water quality at each monitoring well at the compliance point for each hazardous constituent to the concentration limit for that constituent according to the statistical procedures specified in the permit under § 264.97(h).

(2) The owner or operator must determine whether there has been a statistically significant increase at each monitoring well at the compliance point, within a reasonable time period after completion of sampling. The Regional Administrator will specify that time period in the facility permit, after considering the complexity of the statistical test and the availability of laboratory facilities to perform the analysis of ground water samples.

(i) If the owner or operator determines, pursuant to paragraph (h) of this section, that the ground water protection standard is being exceeded at any monitoring well at the point of compliance, he must:

(1) Notify the Regional Administrator of this finding in writing within seven days. The notification must indicate what concentration limits have been exceeded.

(2) Submit to the Regional Administrator an application for a permit modification to establish a corrective action program meeting the requirements of § 264.100 within 180 days, or within 90 days if an engineering feasibility study has been previously submitted to the Regional Administrator under § 264.98(h)(5). The application must at a minimum include the following information:

(i) A detailed description of corrective actions that will achieve compliance with the ground water protection standard specified in the permit under paragraph (a) of this section; and

(ii) A plan for a ground water monitoring program that will demonstrate the effectiveness of the corrective action. Such a ground water monitoring program may be based on a compliance monitoring program developed to meet the requirements of this section.

(j) If the owner or operator determines, pursuant to paragraph (h) of this section, that the ground water protection standard is being exceeded at any monitoring well at the point of compliance, he may demonstrate that a source other than a regulated unit caused the increase or that the increase resulted from error in sampling, analysis, or evaluation. While the owner or operator may make a demonstration under this paragraph in addition to, or in lieu of, submitting a permit modification application under paragraph (i)(2) of this section, he is not relieved of the requirement to submit a permit modification application within the time specified in paragraph (i)(2) of this section unless the demonstration made under this paragraph successfully shows that a source other than a regulated unit caused the increase or that the increase resulted from error in sampling, analysis, or evaluation. In making a demonstration under this paragraph, the owner or operator must:

(1) Notify the Regional Administrator in writing within seven days that he intends to make a demonstration under this paragraph;

(2) Within 90 days, submit a report to the Regional Administrator which demonstrates that a source other than a regulated unit caused the standard to be exceeded or that the apparent noncompliance with the standards resulted from error in sampling, analysis, or evaluation;

(3) Within 90 days, submit to the Regional Administrator an application for a permit modification to make any appropriate changes to the compliance monitoring program at the facility; and

(4) Continue to monitor in accord with the compliance monitoring program established under this section.

(k) If the owner or operator determines that the compliance monitoring program no longer satisfies the requirements of this section, he must, within 90 days, submit an application for a permit modification to make any appropriate changes to the program.

(l) The owner or operator must assure that monitoring and corrective action measures necessary to achieve compliance with the ground water protection standard under § 264.92 are taken during the term of the permit.

(Approved by the Office of Management and Budget under control number 2050-0033)

[47 FR 32350, July 26, 1982, as amended at 50 FR 4514, Jan. 31, 1985]

§ 264.100 Corrective action program.

An owner or operator required to establish a corrective action program under this subpart must, at a minimum, discharge the following responsibilities:

(a) The owner or operator must take corrective action to ensure that regulated units are in compliance with the ground water protection standard under § 264.92. The Regional Administrator will specify the ground water protection standard in the facility permit, including:

(1) A list of the hazardous constituents identified under § 264.93;

(2) Concentration limits under § 264.94 for each of those hazardous constituents;

(3) The compliance point under § 264.95; and

(4) The compliance period under § 264.96.

(b) The owner or operator must implement a corrective action program that prevents hazardous constituents from exceeding their respective concentration limits at the compliance point by removing the hazardous waste constituents or treating them in place. The permit will specify the specific measures that will be taken.

(c) The owner or operator must begin corrective action within a reasonable time period after the ground-water protection standard is exceeded. The Regional Administrator will specify that time period in the facility permit. If a facility permit includes a corrective action program in addition to a compliance monitoring program, the permit will specify when the corrective action will begin and such a requirement will operate in lieu of § 264.99(i)(2).

(d) In conjunction with a corrective action program, the owner or operator must establish and implement a ground water monitoring program to demonstrate the effectiveness of the corrective action program. Such a monitoring program may be based on the requirements for a compliance monitoring program under § 264.9.. and must be as effective as that program in determining compliance with the ground-water protection standard under § 264.92 and in determining the success of a corrective action program under paragraph (e) of this section, where appropriate.

(e) In addition to the other requirements of this section, the owner or operator must conduct a corrective action program to remove or treat in place any hazardous constituents under § 264.93 that exceed concentration limits under § 264.94 in ground water between the compliance point under § 264.95 and the downgradient facility property boundary. The permit will specify the measures to be taken.

(1) Corrective action measures under this paragraph must be initiated and completed within a reasonable period of time considering the extent of contamination.

(2) Corrective action measures under this paragraph may be terminated once the concentration of hazardous constituents under § 264.93 is reduced to levels below their respective concentration limits under § 264.94.

(f) The owner or operator must continue corrective action measures during the compliance period to the extent necessary to ensure that the ground-water protection standard is not exceeded. If the owner or operator is conducting corrective action at the end of the compliance period, he must continue that corrective action for as long as necessary to achieve compliance with the ground water protection standard. The owner or operator may terminate corrective action measures taken beyond the period equal to the active life of the waste management area (including the closure period) if he can demonstrate, based on data from the ground-water monitoring program under paragraph (d) of this section, that the ground water protection standard of § 264.92 has not been exceeded for a period of three consecutive years.

(g) The owner or operator must report in writing to the Regional Administrator on the effectiveness of the corrective action program. The owner or operator must submit these reports semi-annually.

(h) If the owner or operator determines that the corrective action program no longer satisfies the requirements of this section, he must, within 90 days, submit an application for a permit modification to make any appropriate changes to the program.

(Approved by the Office of Management and Budget under control number 2050-0033)

[47 FR 32350, July 26, 1982, as amended at 50 FR 4514, Jan. 31, 1985]

§ 264.101 Corrective action for solid waste management units.

(a) The owner or operator of a facility seeking a permit for the treatment, storage or disposal of hazardous waste must institute corrective action as necessary to protect human health and the environment for all releases of hazardous waste or constituents from any solid waste management unit at the facility, regardless of the time at which waste was placed in such unit.

(b) Corrective action will be specified in the permit. The permit will contain schedules of compliance for such corrective action (where such corrective action cannot be completed prior to issuance of the permit) and assurances of financial responsibility for completing such corrective action.

[50 FR 28747, July 15, 1985]

§§ 264.102—264.109 [Reserved]

Subpart G—Closure and Post-Closure

SOURCE: 51 FR 16444, May 2, 1986, unless otherwise noted.

EFFECTIVE DATE NOTE: At 51 FR 16444, May 2, 1986, in Part 264, §§ 264.110 through 264.120 (Subpart G) were revised effective October 29, 1986. For the convenience of the user, the superseded text is set forth at the end of this subpart.

§ 264.110 Applicability.

Except as § 264.1 provides otherwise:

(a) Sections 264.111 through 264.115 (which concern closure) apply to the owners and operators of all hazardous waste management facilities; and

(b) Sections 264.116 through 264.120 (which concern post-closure care) apply to the owners and operators of:

(1) All hazardous waste disposal facilities; and

(2) Waste piles and surface impoundments from which the owner or operator intends to remove the wastes at closure to the extent that these sections are made applicable to such facilities in § 264.228 or § 264.258.

§ 264.111 Closure performance standard.

The owner or operator must close the facility in a manner that:

(a) Minimizes the need for further maintenance, and

(b) Controls, minimizes or eliminates, to the extent necessary to protect human health and the environment, post-closure escape of hazardous waste, hazardous constituents, leachate, contaminated run-off, or hazardous waste decomposition products to the ground or surface waters or to the atmosphere; and

(c) Complies with the closure requirements of this subpart including, but not limited to, the requirements of §§ 264.178, 264.197, 264.228, 264.258, 264.280, 264.310 and 264.351.

§ 264.112 Closure plan; amendment of plan.

(a) *Written plan.* (1) The owner or operator of a hazardous waste management facility must have a written closure plan. In addition, certain surface impoundments and waste piles from which the owner or operator intends to remove or decontaminate the hazardous waste at partial or final closure are required by §§ 264.228(c)(1)(i) and 264.258(c)(1)(i) to have contingent closure plans. The plan must be submitted with the permit application, in accordance with § 270.14(b)(13) of this chapter, and approved by the Regional Administrator as part of the permit issuance procedures under Part 124 of this chapter. In accordance with § 270.32 of this chapter, the approved closure plan will become a condition of any RCRA permit.

(2) The Regional Administrator's approval of the plan must ensure that the approved closure plan is consistent with §§ 264.111 through 264.115 and the applicable requirements of §§ 264.90 *et seq.*, 264.178, 264.197, 264.228, 264.258, 264.280, 264.310, and 264.351. Until final closure is completed and certified in accordance with § 264.115, a copy of the approved plan and all approved revisions must be furnished to the Regional Administrator upon request, including request by mail.

(b) *Content of plan.* The plan must identify steps necessary to perform partial and/or final closure of the facility at any point during its active life. The closure plan must include, at least:

(1) A description of how each hazardous waste management unit at the facility will be closed in accordance with § 264.111;

(2) A description of how final closure of the facility will be conducted in accordance with § 264.111. The description must identify the maximum extent of the operations which will be unclosed during the active life of the facility; and

(3) An estimate of the maximum inventory of hazardous wastes ever onsite over the active life of the facility and a detailed description of the methods to be used during partial closures and final closure, including, but not limited to, methods for removing, transporting, treating, storing, or disposing of all hazardous wastes, and identification of the type(s) of the off-site hazardous waste management units to be used, if applicable, and

(4) A detailed description of the steps needed to remove or decontaminate all hazardous waste residues and contaminated containment system components, equipment, structures, and soils during partial and final closure, including, but not limited to, procedures for cleaning equipment and removing contaminated soils, methods for sampling and testing surrounding soils, and criteria for determining the extent of decontamination required to satisfy the closure performance standard; and

(5) A detailed description of other activities necessary during the closure period to ensure that all partial closures and final closure satisfy the closure performance standards, including, but not limited to, ground water monitoring, leachate collection, and run-on and run-off control; and

(6) A schedule for closure of each hazardous waste management unit and for final closure of the facility. The schedule must include, at a minimum, the total time required to close each hazardous waste management unit and the time required for intervening closure activities which will allow tracking of the progress of partial and final closure. (For example, in the case of a landfill unit, estimates of the time required to treat or dispose of all hazardous waste inventory and of the time required to place a final cover must be included.)

(7) For facilities that use trust funds to establish financial assurance under § 264.143 or § 264.145 and that are expected to close prior to the expiration of the permit, an estimate of the expected year of final closure.

(c) *Amendment of plan.* The owner or operator must submit a written request for a permit modification to authorize a change in operating plans, facility design, or the approved closure plan in accordance with the procedures in Parts 124 and 270. The written request must include a copy of the amended closure plan for approval by the Regional Administrator.

(1) The owner or operator may submit a written request to the Regional Administrator for a permit modification to amend the closure plan at any time prior to the notification of partial or final closure of the facility.

(2) The owner or operator must submit a written request for a permit modification to authorize a change in the approved closure plan whenever:

(i) Changes in operating plans or facility design affect the closure plan, or

(ii) There is a change in the expected year of closure, if applicable, or

(iii) In conducting partial or final closure activities, unexpected events require a modification of the approved closure plan.

(3) The owner or operator must submit a written request for a permit modification including a copy of the amended closure plan for approval at least 60 days prior to the proposed

change in facility design or operation, or no later than 60 days after an unexpected event has occurred which has affected the closure plan. If an unexpected event occurs during the partial or final closure period, the owner or operator must request a permit modification no later than 30 days after the unexpected event. An owner or operator of a surface impoundment or waste pile that intends to remove all hazardous waste at closure and is not otherwise required to prepare a contingent closure plan under § 264.228(c)(1)(i) or § 264.258(c)(1)(i), must submit an amended closure plan to the Regional Administrator no later than 60 days from the date that the owner or operator or Regional Administrator determines that the hazardous waste management unit must be closed as a landfill, subject to the requirements of § 264.310, or no later than 30 days from that date if the determination is made during partial or final closure. The Regional Administrator will approve, disapprove, or modify this amended plan in accordance with the procedures in Parts 124 and 270. In accordance with § 270.32 of this chapter, the approved closure plan will become a condition of any RCRA permit issued.

(4) The Regional Administrator may request modifications to the plan under the conditions described in § 264.112(c)(2). The owner or operator must submit the modified plan within 60 days of the Regional Administrator's request, or within 30 days if the change in facility conditions occurs during partial or final closure. Any modifications requested by the Regional Administrator will be approved in accordance with the procedures in Parts 124 and 270.

(d) *Notification of partial closure and final closure.* (1) The owner or operator must notify the Regional Administrator in writing at least 60 days prior to the date on which he expects to begin closure of a surface impoundment, waste pile, land treatment or landfill unit, or final closure of a facility with such a unit. The owner or operator must notify the Regional Administrator in writing at least 45 days prior to the date on which he expects to begin final closure of a facility with only treatment or storage tanks, container storage, or incinerator units to be closed.

(2) The date when he "expects to begin closure" must be either no later than 30 days after the date on which any hazardous waste management unit receives the known final volume of hazardous wastes or, if there is a reasonable possibility that the hazardous waste management unit will receive additional hazardous wastes, no later than one year after the date on which the unit received the most recent volume of hazardous waste. If the owner or operator of a hazardous waste management unit can demonstrate to the Regional Administrator that the hazardous waste management unit or facility has the capacity to receive additional hazardous wastes and he has taken, and will continue to take, all steps to prevent threats to human health and the environment, including compliance with all applicable permit requirements, the Regional Administrator may approve an extension to this one year limit.

(3) If the facility's permit is terminated, or if the facility is otherwise ordered, by judicial decree or final order under section 3008 of RCRA, to cease receiving hazardous wastes or to close, then the requirements of this paragraph do not apply. However, the owner or operator must close the facility in accordance with the deadlines established in § 264.113.

(e) *Removal of wastes and decontamination or dismantling of equipment.* Nothing in this section shall preclude the owner or operator from removing hazardous wastes and decontaminating or dismantling equipment in accordance with the approved partial or final closure plan at any time before or after notification of partial or final closure.

§ 264.113 Closure; time allowed for closure.

(a) Within 90 days after receiving the final volume of hazardous wastes at a hazardous waste management unit or facility, the owner or operator must treat, remove from the unit or facility, or dispose of on-site, all hazardous wastes in accordance with the

approved closure plan. The Regional Administrator may approve a longer period if the owner or operator complies with all applicable requirements for requesting a modification to the permit and demonstrates that:

(1)(i) The activities required to comply with this paragraph will, of necessity, take longer than 90 days to complete; or

(ii)(A) The hazardous waste management unit or facility has the capacity to receive additional hazardous wastes; and

(B) There is a reasonable likelihood that he or another person will recommence operation of the hazardous waste management unit or the facility within one year; and

(C) Closure of the hazardous waste management unit or facility would be incompatible with continued operation of the site; and

(2) He has taken and will continue to take all steps to prevent threats to human health and the environment, including compliance with all applicable permit requirements.

(b) The owner or operator must complete partial and final closure activities in accordance with the approved closure plan and within 180 days after receiving the final volume of hazardous wastes at the hazardous waste management unit or facility. The Regional Administrator may approve an extension to the closure period if the owner or operator complies with all applicable requirements for requesting a modification to the permit and demonstrates that:

(1)(i) The partial or final closure activities will, of necessity, take longer than 180 days to complete; or

(ii)(A) The hazardous waste management unit or facility has the capacity to receive additional hazardous wastes; and

(B) There is reasonable likelihood that he or another person will recommence operation of the hazardous waste management unit or the facility within one year, and

(C) Closure of the hazardous waste management unit or facility would be incompatible with continued operation of the site, and

(2) He has taken and [illegible]
take all [illegible]

human health and the envi[illegible]
from the unclosed but not o[illegible]
hazardous waste management [illegible]
facility, including compliance [illegible]
applicable permit requirements.

(c) The demonstrations refer[illegible] in § 264.113(a) and (b) must be as follows. (1) The demonstrati[illegible] paragraph (a) must be made at 30 days prior to the expiration o[illegible] 90-day period in paragraph (a); an[illegible] the demonstration in paragraph must be made at least 30 days pri[illegible] the expiration of the 180 day perio[illegible] paragraph (b) of this section.

§ 264.114 Disposal or decontamination equipment, structures and soils.

During the partial and final closu[illegible] periods, all contaminated equipmen[illegible] structures and soils must be prope[illegible] disposed of or decontaminated unle[illegible] otherwise specified in §§ 264.22[illegible] 264.258, 264.280, or 264.310. By remo[illegible] ing any hazardous wastes or hazardo[illegible] constituents during partial and fin[illegible] closure, the owner or operator m[illegible] become a generator of hazardo[illegible] waste and must handle that waste [illegible] accordance with all applicable requir[illegible] ments of Part 262 of this chapter.

§ 264.115 Certification of closure.

Within 60 days of completion of cl[illegible] sure of each hazardous waste surfa[illegible] impoundment, waste pile, land trea[illegible] ment, and landfill unit, and within [illegible] days of the completion of final cl[illegible] sure, the owner or operator mu[illegible] submit to the Regional Administrato[illegible] by registered mail, a certification th[illegible] the hazardous waste management un[illegible] or facility, as applicable, has bee[illegible] closed in accordance with the specif[illegible] cations in the approved closure pla[illegible] The certification must be signed [illegible] the owner or operator and by an ind[illegible] pendent registered professional eng[illegible] neer. Documentation supporting t[illegible] independent registered professiona[illegible] engineer's certification must be fu[illegible] nished to the Regional A[illegible] upon request [illegible]

§ 264.116 Survey plat.

No later than the submission of the certification of closure of each hazardous waste disposal unit, the owner or operator must submit to the local zoning authority, or the authority with jurisdiction over local land use, and to the Regional Administrator, a survey plat indicating the location and dimensions of landfills cells or other hazardous waste disposal units with respect to permanently surveyed benchmarks. This plat must be prepared and certified by a professional land surveyor. The plat filed with the local zoning authority, or the authority with jurisdiction over local land use, must contain a note, prominently displayed, which states the owner's or operator's obligation to restrict disturbance of the hazardous waste disposal unit in accordance with the applicable Subpart G regulations.

§ 264.117 Post-closure care and use of property.

(a)(1) Post-closure care for each hazardous waste management unit subject to the requirements of §§ 264.117 through 264.120 must begin after completion of closure of the unit and continue for 30 years after that date and must consist of at least the following:

(i) Monitoring and reporting in accordance with the requirements of Subparts F, K, L, M, and N of this part; and

(ii) Maintenance and monitoring of waste containment systems in accordance with the requirements of Subparts F, K, L, M, and N of this part.

(2) Any time preceding partial closure of a hazardous waste management unit subject to post-closure care requirements or final closure, or any time during the post-closure period for a particular unit, the Regional Administrator may, in accordance with the permit modification procedures in Parts 124 and 270:

(i) Shorten the post-closure care period applicable to the hazardous waste management unit, or facility, if all disposal units have been closed, if he finds that the reduced period is sufficient to protect human health and the environment (e.g., leachate or ground water monitoring results, characteristics of the hazardous wastes, application of advanced technology, or alternative disposal, treatment, or re-use techniques indicate that the hazardous waste management unit or facility is secure), or

(ii) Extend the post-closure care period applicable to the hazardous waste management unit or facility if he finds that the extended period is necessary to protect human health and the environment (e.g., leachate or ground water monitoring results indicate a potential for migration of hazardous wastes at levels which may be harmful to human health and the environment).

(b) The Regional Administrator may require, at partial and final closure, continuation of any of the security requirements of § 264.14 during part or all of the post-closure period when:

(1) Hazardous wastes may remain exposed after completion of partial or final closure, or

(2) Access by the public or domestic livestock may pose a hazard to human health.

(c) Post-closure use of property on or in which hazardous wastes remain after partial or final closure must never be allowed to disturb the integrity of the final cover, liner(s), or any other components of the containment system, or the function of the facility's monitoring systems, unless the Regional Administrator finds that the disturbance:

(1) Is necessary to the proposed use of the property, and will not increase the potential hazard to human health or the environment; or

(2) Is necessary to reduce a threat to human health or the environment.

(d) All post-closure care activities must be in accordance with the provisions of the approved post-closure plan as specified in § 264.118.

§ 264.118 Post-closure plan; amendment of plan.

(a) *Written Plan.* The owner or operator of a hazardous waste disposal unit must have a written post-closure plan. In addition, certain surface impoundments and waste piles from which the owner or operator intends to remove or decontaminate the hazardous wastes at partial or final closure are required by §§ 264.228(c)(1)(ii) and 264.258(c)(1)(ii) to have contingent post-closure plans. Owners or operators of surface impoundments and waste piles not otherwise required to prepare contingent post-closure plans under §§ 264.228(c)(1)(ii) and 264.258(c)(1)(ii) must submit a post-closure plan to the Regional Administrator within 90 days from the date that the owner or operator or Regional administrator determines that the hazardous waste management unit must be closed as a landfill, subject to the requirements of §§ 264.117 through 264.120. The plan must be submitted with the permit application, in accordance with § 270.14(b)(13) of this chapter, and approved by the Regional Administrator as part of the permit issuance procedures under Part 124 of this chapter. In accordance with § 270.32 of this chapter, the approved post-closure plan will become a condition of any RCRA permit issued.

(b) For each hazardous waste management unit subject to the requirements of this section, the post-closure plan must identify the activities that will be carried on after closure of each disposal unit and the frequency of these activities, and include at least:

(1) A description of the planned monitoring activities and frequencies at which they will be performed to comply with Subparts F, K, L, M, and N of this part during the post-closure care period; and

(2) A description of the planned maintenance activities, and frequencies at which they will be performed, to ensure:

(i) The integrity of the cap and final cover or other containment systems in accordance with the requirements of Subparts K, L, M, and N of this part; and

(ii) The function of the monitoring equipment in accordance with the requirements of Subparts F, K, L, M, and N of this part; and

(3) The name, address, and phone number of the person or office to contact about the hazardous waste disposal unit or facility during the post-closure care period.

(c) Until final closure of the facility, a copy of the approved post-closure plan must be furnished to the Region-

al Administrator upon request, includ ing request by mail. After final closu has been certified, the person or offic specified in § 264.118(b)(3) must kee the approved post-closure plan durin the remainder of the post-closur period.

(d) *Amendment of plan.* The own or operator must request a perm modification to authorize a change i the approved post-closure plan in ac cordance with the applicable require ments of Parts 124 and 270. The wri ten request must include a copy of th amended post-closure plan for approv al by the Regional Administrator.

(1) The owner or operator ma submit a written request to the Re gional Administrator for a perm modification to amend the post-cl sure plan at any time during the activ life of the facility or during the pos closure care period.

(2) The owner or operator mu submit a written request for a perm modification to authorize a change i the approved post-closure plan whe ever:

(i) Changes in operating plans or fa cility design affect the approved pos closure plan, or

(ii) There is a change in the expec ed year of final closure, if applicabl or

(iii) Events which occur during th active life of the facility, includin partial and final closures, affect th approved post-closure plan.

(3) The owner or operator mus submit a written request for a perm modification at least 60 days prior t the proposed change in facility desig or operation, or no later than 60 day after an unexpected event has oc curred which has affected the post-clo sure plan. An owner or operator of surface impoundment or waste pil that intends to remove all hazardou waste at closure and is not otherwis required to submit a contingent pos closure plan under §§ 264.228(c)(1)(i and 264.258(c)(1)(ii) must submit post-closure plan to the Regional Ad ministrator no later than 90 days afte the date that the owner or operator o Regional Administrator determine that the hazardous waste managemen unit must be closed as a landfill, sub ject to the requirements of § 264.310

The Regional Administrator will approve, disapprove or modify this plan in accordance with the procedures in Parts 124 and 270. In accordance with § 270.32 of this chapter, the approved post closure plan will become a permit condition.

(4) The Regional Administrator may request modifications to the plan under the conditions described in § 264.118(d)(2). The owner or operator must submit the modified plan no later than 60 days after the Regional Administrator's request, or no later than 90 days if the unit is a surface impoundment or waste pile not previously required to prepare a contingent post closure plan. Any modifications requested by the Regional Administrator will be approved, disapproved, or modified in accordance with the procedures in Parts 124 and 270.

§ 264.119 Post-closure notices.

(a) No later than 60 days after certification of closure of each hazardous waste disposal unit, the owner or operator must submit to the local zoning authority, or the authority with jurisdiction over local land use, and to the Regional Administrator a record of the type, location, and quantity of hazardous wastes disposed of within each cell or other disposal unit of the facility. For hazardous wastes disposed of before January 12, 1981, the owner or operator must identify the type, location, and quantity of the hazardous wastes to the best of his knowledge and in accordance with any records he has kept.

(b) Within 60 days of certification of closure of the first hazardous waste disposal unit and within 60 days of certification of closure of the last hazardous waste disposal unit, the owner or operator must:

(1) Record, in accordance with State law, a notation on the deed to the facility property or on some other instrument which is normally examined during title search that will in perpetuity notify any potential purchaser of the property that:

(i) The land has been used to manage hazardous wastes, and

(ii) Its use is restricted under 40 CFR Subpart G regulations, and

(iii) The survey plat and record of the type, location, and quantity of hazardous wastes disposed of within each cell or other hazardous waste disposal unit of the facility required by §§ 264.116 and 264.119(a) have been filed with the local zoning authority or the authority with jurisdiction over local land use and with the Regional Administrator, and

(2) Submit a certification, signed by the owner or operator, that he has recorded the notation specified in paragraph (b)(1) of this section, including a copy of the document in which the notation has been placed, to the Regional Administrator.

(c) If the owner or operator or any subsequent owner or operator of the land upon which a hazardous waste disposal unit is located wishes to remove hazardous wastes and hazardous waste residues, the liner, if any, or contaminated soils, he must request a modification to the post-closure permit in accordance with the applicable requirements in Parts 124 and 270. The owner or operator must demonstrate that the removal of hazardous wastes will satisfy the criteria of § 264.117(c). By removing hazardous waste, the owner or operator may become a generator of hazardous waste and must manage it in accordance with all applicable requirements of this chapter. If he is granted a permit modification or otherwise granted approval to conduct such removal activities, the owner or operator may request that the Regional Administrator approve either:

(1) The removal of the notation on the deed to the facility property or other instrument normally examined during title search, or

(2) The addition of a notation to the deed or instrument indicating the removal of the hazardous waste.

§ 264.120 Certification of completion of post-closure care.

No later than 60 days after completion of the established post-closure care period for each hazardous waste disposal unit, the owner or operator must submit to the Regional Administrator, by registered mail, a certification that the post-closure care period for the hazardous waste disposal unit was performed in accordance with the specifications in the approved post-closure plan. The certification must be signed by the owner or operator and an independent registered professional engineer. Documentation supporting the independent registered professional engineer's certification must be furnished to the Regional Administrator upon request until he releases the owner or operator from the financial assurance requirements for post-closure care under § 264.145(i).

EFFECTIVE DATE NOTE. At 51 FR 16444, May 2, 1986, in Part 264, §§ 264.110 through 264.120 (Subpart G) were revised, effective October 29, 1986. For the convenience of the user, the superseded text is set forth as follows:

Subpart G—Closure and Post-Closure

SOURCE: 46 FR 2849, Jan. 12, 1981, unless otherwise noted.

§ 264.110 Applicability.

Except as § 264.1 provides otherwise:

(a) Sections 264.111–264.115 (which concern closure) apply to the owners and operators of all hazardous waste management facilities, and

(b) Sections 264.117–264.120 (which concern post closure care) apply to the owners and operators of:

(1) All hazardous waste disposal facilities; and

(2) Piles, and surface impoundments from which the owner or operator intends to remove the wastes at closure, to the extent that these sections are made applicable to such facilities in §§ 264.228 and 264.258.

[46 FR 2849, Jan. 12, 1981, as amended at 47 FR 32356, July 26, 1982]

§ 264.111 Closure performance standard.

The owner or operator must close the facility in a manner that:

(a) Minimizes the need for further maintenance, and

(b) Controls, minimizes or eliminates, to the extent necessary to prevent threats to human health and the environment, post-closure escape of hazardous waste, hazardous waste constituents, leachate, contaminated rainfall or waste decomposition products to the ground or surface waters or to the atmosphere.

§ 264.112 Closure plan; amendment of plan.

(a) The owner or operator of a hazardous waste management facility must have a written closure plan. The plan must be submitted with the permit application in accordance with § 270.14(b)(13) of this chapter, and approved by the Regional Administrator as part of the permit issuance proceeding under Part 124 of this chapter. In accordance with § 122.29 of this chapter, the approved closure plan will become a condition of any RCRA permit. The Regional Administrator's decision must assure that the approved closure plan is consistent with §§ 264.111, 264.113, 264.114, 264.115 and the applicable requirements of §§ 264.178, 264.197, 264.228, 264.258, 264.280, 264.310 and 264.351. A copy of the approved plan and all revisions to the plan must be kept at the facility until closure is completed and certified in accordance with § 264.115. The plan must identify steps necessary to completely or partially close the facility at any point during its intended operating life and to completely close the facility at the end of its intended operating life. The closure plan must include, at least:

(1) A description of how and when the facility will be partially closed, if applicable, and finally closed. The description must identify the maximum extent of the operation which will be unclosed during the life of the facility, and how the requirements of §§ 264.111, 264.113, 264.114, 264.115, and the applicable closure requirements of §§ 264.178, 264.197, 264.228, 264.258, 264.280, 264.310, and 264.351 will be met.

(2) An estimate of the maximum inventory of wastes in storage and in treatment at any time during the life of the facility. (Any change in this estimate is a minor modification under § 270.42),

(3) A description of the steps needed to decontaminate facility equipment during closure, and

(4) An estimate of the expected year of closure and a schedule for final closure. The schedule must include, at a minimum, the total time required to close the facility and the time required for intervening closure activities which will allow tracking of the progress of closure. (For example, in the case of a landfill, estimates of the time required to treat and dispose of all waste inventory and of the time required to place a final cover must be included.)

(b) The owner or operator may amend his closure plan at any time during the active life of the facility. (The active life of the facility is that period during which wastes are periodically received.) The owner or operator must amend the plan whenever changes in operating plans or facility design affect the closure plan, or whenever there is a change in the expected year of closure. When the owner or operator requests a permit modification to authorize a change in operating plans or facility design, he must request a modification of the closure plan at the same time (see § 124.5(a)). If a agement plan for these wastes that is approved by the Regional Administrator pursuant to the standards set out in this paragraph, and in accord with all other applicable requirements of this part. The factors to be considered are:

(1) The volume, physical, and chemical characteristics of the wastes, including their potential to migrate through soil or to volatilize or escape into the atmosphere;

(2) The attenuative properties of underlying and surrounding soils or other materials;

(3) The mobilizing properties of other materials co-disposed with these wastes; and

(4) The effectiveness of additional treatment, design, or monitoring techniques.

(b) The Regional Administrator may determine that additional design, operating, and monitoring requirements are necessary for land treatment facilities managing hazardous wastes FO20, FO21, FO22, FO23, FO26, and FO27 in order to reduce the possibility of migration of these wastes to ground water, surface water, or air so as to protect human health and the environment.

[50 FR 2004, Jan. 14, 1985]

§§ 264.284—264.299 [Reserved]

Subpart N—Landfills

SOURCE: 47 FR 32365, July 26, 1982, unless otherwise noted.

§ 264.300 Applicability.

The regulations in this subpart apply to owners and operators of facilities that dispose of hazardous waste in landfills, except as § 264.1 provides otherwise.

§ 264.301 Design and operating requirements.

(a) Any landfill that is not covered by paragraph (c) of this section or § 265.301(a) of this chapter must have a liner system for all portions of the landfill (except for existing portions of such landfill). The liner system must have:

(1) A liner that is designed, constructed, and installed to prevent any migration of wastes out of the landfill to the adjacent subsurface soil or ground water or surface water at any time during the active life (including the closure period) of the landfill. The liner must be constructed of materials that prevent wastes from passing into the liner during the active life of the facility. The liner must be

(i) Constructed of materials that have appropriate chemical properties and sufficient strength and thickness to prevent failure due to pressure gradients (including static head and external hydrogeologic forces), physical contact with the waste or leachate to which they are exposed, climatic conditions, the stress of installation, and the stress of daily operation,

(ii) Placed upon a foundation or base capable of providing support to the liner and resistance to pressure gradients above and below the liner to prevent failure of the liner due to settlement, compression, or uplift; and

(iii) Installed to cover all surrounding earth likely to be in contact with the waste or leachate, and

(2) A leachate collection and removal system immediately above the liner that is designed, constructed, maintained, and operated to collect and remove leachate from the landfill. The Regional Administrator will specify design and operating conditions in the permit to ensure that the leachate depth over the liner does not exceed 30 cm (one foot). The leachate collection and removal system must be

(i) Constructed of materials that are

(A) Chemically resistant to the waste managed in the landfill and the leachate expected to be generated, and

(B) Of sufficient strength and thickness to prevent collapse under the pressures exerted by overlying wastes, waste cover materials, and by any equipment used at the landfill, and

(ii) Designed and operated to function without clogging through the scheduled closure of the landfill

(b) The owner or operator will be exempted from the requirements of paragraph (a) of this section if the Regional Administrator finds, based on a demonstration by the owner or operator, that alternative design and operating practices, together with location characteristics, will prevent the migra tion of any hazardous constituents (see § 264.93) into the ground water or surface water at any future time. In deciding whether to grant an exemption, the Regional Administrator will consider:

(1) The nature and quantity of the wastes,

(2) The proposed alternate design and operation,

(3) The hydrogeologic setting of the facility, including the attenuative capacity and thickness of the liners and soils present between the landfill and ground water or surface water; and

(4) All other factors which would influence the quality and mobility of the leachate produced and the potential for it to migrate to ground water or surface water.

(c) The owner or operator of each new landfill, each new landfill unit at an existing facility, each replacement of an existing landfill unit, and each lateral expansion of an existing landfill unit, must install two or more liners and a leachate collection system above and between the liners. The liners and leachate collection systems must protect human health and the environment. The requirement for the installation of two or more liners in this paragraph may be satisfied by the installation of a top liner designed, operated and constructed of materials to prevent the migration of any constituent into such liner during the period such facility remains in operation (including any post-closure monitoring period), and a lower liner designed, operated, and constructed to prevent the migration of any constituent through such liner during such period. For the purpose of the preceding sentence, a lower liner shall be deemed to satisfy such requirement if it is constructed of at least a 3-foot thick layer of recompacted clay or other natural material with a permeability of no more than 1×10^{-7} centimeter per second.

(d) Paragraph (c) of this section will not apply if the owner or operator demonstrates to the Regional Administrator, and the Regional Administrator finds for such landfill, that alternative design and operating practices, together with location characteristics, will prevent the migration of any hazardous constituent into the ground water or surface water at least as effectively as such liners and leachate collection systems.

(e) The double liner requirement set forth in paragraph (c) of this section may be waived by the Regional Administrator for any monofill, if:

(1) The monofill contains only hazardous wastes from foundry furnace emission controls or metal casting molding sand, and such wastes do not contain constituents which would render the wastes hazardous for reasons other than the EP toxicity characteristics in § 261.24 of this chapter; and

(2)(i)(A) The monofill has at least one liner for which there is no evidence that such liner is leaking,

(B) The monofill is located more than one-quarter mile from an underground source of drinking water (as that term is defined in § 144.3 of this chapter); and

(C) The monofill is in compliance with generally applicable ground-water monitoring requirements for facilities with permits under RCRA 3005(c), or

(ii) The owner or operator demonstrates that the monofill is located, designed and operated so as to assure that there will be no migration of any hazardous constituent into ground water or surface water at any future time.

(f) The owner or operator must design, construct, operate, and maintain a run-on control system capable of preventing flow onto the active portion of the landfill during peak discharge from at least a 25-year storm.

(g) The owner or operator must design, construct, operate, and maintain a run-off management system to collect and control at least the water volume resulting from a 24-hour, 25-year storm.

(h) Collection and holding facilities (e.g., tanks or basins) associated with run-on and run-off control systems must be emptied or otherwise managed expeditiously after storms to maintain design capacity of the system.

(i) If the landfill contains any particulate matter which may be subject to wind dispersal, the owner or operator must cover or otherwise manage the landfill to control wind dispersal.

(j) The Regional Administrator will specify in the permit all design and operating practices that are necessary to ensure that the requirements of this section are satisfied.

(k) Any permit under RCRA 3005(c) which is issued for a landfill located within the State of Alabama shall require the installation of two or more liners and a leachate collection system above and between such liners, notwithstanding any other provision of RCRA.

(Approved by the Office of Management and Budget under control number 2050-0007)

[47 FR 32365, July 26, 1982, as amended at 50 FR 4514, Jan. 31, 1985, 50 FR 28748, July 15, 1985]

§ 264.302 [Reserved]

§ 264.303 Monitoring and inspection.

(a) During construction or installation, liners (except in the case of existing portions of landfills exempt from § 264.301(a)) and cover systems (e.g., membranes, sheets, or coatings) must be inspected for uniformity, damage, and imperfections (*e.g.*, holes, cracks, thin spots, or foreign materials). Immediately after construction or installation:

(1) Synthetic liners and covers must be inspected to ensure tight seams and joints and the absence of tears, punctures, or blisters; and

(2) Soil-based and admixed liners and covers must be inspected for imperfections including lenses, cracks, channels, root holes, or other structural non-uniformities that may cause an increase in the permeability of the liner or cover.

(b) While a landfill is in operation it must be inspected weekly and after storms to detect evidence of any of the following:

(1) Deterioration, malfunctions, or improper operation of run-on and run-off control systems;

(2) Proper functioning of wind dispersal control systems, where present; and

(3) The presence of leachate in and proper functioning of leachate collection and removal systems, where present.

[47 FR 32365, July 26, 1982, as amended at 50 FR 28748, July 15, 1985]

§§ 264.304—264.308 [Reserved]

§ 264.309 Surveying and recordkeeping.

The owner or operator of a landfill must maintain the following items in the operating record required under § 264.73:

(a) On a map, the exact location and dimensions, including depth, of each cell with respect to permanently surveyed benchmarks; and

(b) The contents of each cell and the approximate location of each hazardous waste type within each cell.

(Approved by the Office of Management and Budget under control number 2050-0007)

[47 FR 32365, July 26, 1982, as amended at 50 FR 4514, Jan. 31, 1985]

§ 264.310 Closure and post-closure care.

(a) At final closure of the landfill or upon closure of any cell, the owner or operator must cover the landfill or cell with a final cover designed and constructed to:

(1) Provide long-term minimization of migration of liquids through the closed landfill;

(2) Function with minimum maintenance;

(3) Promote drainage and minimize erosion or abrasion of the cover;

(4) Accommodate settling and subsidence so that the cover's integrity is maintained; and

(5) Have a permeability less than or equal to the permeability of any bottom liner system or natural subsoils present.

(b) After final closure, the owner or operator must comply with all post-closure requirements contained in §§ 264.117 through 264.120, including maintenance and monitoring throughout the post-closure care period (specified in the permit under § 264.117). The owner or operator must:

(1) Maintain the integrity and effectiveness of the final cover, including making repairs to the cap as necessary to correct the effects of settling, subsidence, erosion, or other events;

(2) Continue to operate the leachate collection and removal system until leachate is no longer detected.

(3) Maintain and monitor the ground-water monitoring system and comply with all other applicable requirements of Subpart F of this part;

(4) Prevent run-on and run-off from eroding or otherwise damaging the final cover; and

(5) Protect and maintain surveyed benchmarks used in complying with § 264.309.

[47 FR 32365, July 26, 1982, as amended at 50 FR 28748, July 15, 1985]

§ 264.311 [Reserved]

§ 264.312 Special requirements for ignitable or reactive waste.

(a) Except as provided in paragraph (b) of this section, and in § 264.316, ignitable or reactive waste must not be placed in a landfill, unless the waste is treated, rendered, or mixed before or immediately after placement in a landfill so that:

(1) The resulting waste, mixture, or dissolution of material no longer meets the definition of ignitable or reactive waste under § 261.21 or § 261.23 of this chapter; and

(2) Section 264.17(b) is complied with.

(b) Ignitable wastes in containers may be landfilled without meeting the requirements of paragraph (a) of this section, provided that the wastes are disposed of in such a way that they are protected from any material or conditions which may cause them to ignite. At a minimum, ignitable wastes must be disposed of in non-leaking containers which are carefully handled and placed so as to avoid heat, sparks, rupture, or any other condition that might cause ignition of the wastes, must be covered daily with soil or other non-combustible material to minimize the potential for ignition of the wastes; and must not be disposed of in cells that contain or will contain other wastes which may generate heat sufficient to cause ignition of the waste.

§ 264.313 Special requirements for incompatible wastes.

Incompatible wastes, or incompatible wastes and materials, (see Appendix V of this part for examples) must not be placed in the same landfill cell, unless § 264.17(b) is complied with.

§ 264.314 Special requirements for bulk and containerized liquids.

(a) Bulk or non-containerized liquid waste or waste containing free liquids may be placed in a landfill prior to May 8, 1985 only if:

(1) The landfill has a liner and leachate collection and removal system that meet the requirements of § 264.301(a); or

(2) Before disposal, the liquid waste or waste containing free liquids is treated or stabilized, chemically or physically (e.g., by mixing with an absorbent solid), so that free liquids are no longer present.

(b) *Effective May 8, 1985*, the placement of bulk or non-containerized liquid hazardous waste or hazardous waste containing free liquids (whether or not absorbents have been added) in any landfill is prohibited.

(c) To demonstrate the absence or presence of free liquids in either a containerized or a bulk waste, the following test must be used: Method 9095 (Paint Filter Liquids Test) as described in "Test Methods for Evaluating Solid Wastes, Physical/Chemical Methods." [EPA Publication No. SW-846].

(d) *Containers holding free liquids* must not be placed in a landfill unless:

(1) All free-standing liquid: (i) has been removed by decanting, or other methods; (ii) has been mixed with absorbent or solidified so that free-standing liquid is no longer observed; or (iii) has been otherwise eliminated; or

(2) The container is very small, such as an ampule; or

(3) The container is designed to hold free liquids for use other than storage, such as a battery or capacitor; or

(4) The container is a lab pack as defined in § 264.316 and is disposed of in accordance with § 264.316.

(e) Effective November 8, 1985, the placement of any liquid which is not a hazardous waste in a landfill is prohib-

Air

Some of the substances which may be released into the air from the site do not yet have promulgated standards. When health effects information for these substances exists, a risk assessment should be conducted to determine if quantities which may be released during remedial action or after site clean-up are harmful to public health or the environment. Table 1 of this attachment lists the health effects information U.S. EPA has compiled for a variety of substances. Other substances currently under review for systemic toxic effects are listed in Table 2 of this attachment. Table 2 is included so that you can be kept informed of Agency reference dose levels under development and which should be available soon, probably before remedial action is begun. Table 3 is a list of additional NESHAPS standards under development which may need to be considered. Appendix 1 to this attachment lists concerns regarding the potential release of naturally occurring radioactive materials to be considered.

If the substances are volatile, emissions are likely to occur from liquid or solid media. Emissions are likely to increase under circumstances which increase the air interface or contribute energy to the system (thermal treatment, volatilization, excavation, etc.). If the substances are not volatile, emissions from solid media are likely to occur during natural erosion or under disturbance scenarios. In the case of incineration, products of combustion should also be evaluated for potential health hazards via the air pathway.

Evaluations of health hazards can be accomplished with modeling estimates of exposure and risk, if emission rates can be estimated. For evaluations of substances which have been determined by U.S. EPA to be carcinogens and for which Agency risk numbers are available, the use of systemic health end points is inappropriate, unless they are more protective than the unit risk factors coupled with a specific risk level. For example, the level of benzene established by the Association of Government and Industrial Hygienists is listed as 24 ppb in the "Recommended Air Quality Guidelines." However, the ambient level of benzene (a U.S. EPA group A carcinogen), associated with a 10^{-6} risk is $4x10^{-2}$ ppb. Further, we recommend reviewing the "Recommended Air Quality Guideline" numbers and using available Agency numbers (see Table 1). Where no specific risk number is available, but the substance has been shown to have carcinogenic potential, caution should be used. Where U.S. EPA has associated safe levels with systemic effects, they should be used instead of time weighted threshold limit values (TLVs). If TLVs are used in some form, safety factors to account for sensitive populations, as well as time adjustments, should be included.

RCRA

The CERCLA Off-site Policy is a hazardous substance TBC and so is included under this heading.

TBCs cont.

Water

Drinking water health advisories are to be considered under circumstances when MCLs, MCLGs, or AWQCs do not exist for compounds of concern. Table 4 of this attachment lists the existing health advisories. In addition, a risk assessment must be conducted to determine if substances without applicable standards present a risk to human health or the environment and to determine the level of clean-up to be achieved if these substances do present an unacceptable risk.

State

No State TBCs have been identified yet.

EXHIBIT C-4

TOXICITY DATA FOR POTENTIAL CARCINOGENIC EFFECTS -- RISK CHARACTERIZATION [1]

Chemical Name	Oral Route: Potency Factor (PF) (mg/kg/d)-1	Oral Route: Source[2]	Oral Route: EPA Weight of Evidence	Inhalation Route: Potency Factor (PF) (mg/kg/d)-1	Inhalation Route: Source[2]	Inhalation Route: EPA Weight of Evidence
2-Acetylaminofluorene			B2			B2
Acrylonitrile	5.40E-1		B1	2.40E-01	CAG	B1
Aflatoxin B1	2.90E+03	CAG	B2			B2
Aldrin	1.7 ~~1.14~~E+01	CAG	B2			B2
Amitrole			B2			B2
Arsenic and Compounds	1.50E+~~01~~0	~~HEA~~ CAG	A	5.00E+01	HEA	A
Asbestos			A			A
Auramine			B2			B2
Azaserine			B2			B2
Aziridine			B2			B2
Benzene	5.20E-02	HEA	A	2.60E-02	HEA	A
Benzidine	2.30E+02	IRIS	A	~~2.30~~E+02 2.11	CAG	A
Benz(a)anthracene			B2			B2
Benz(c)acridine			C			C
Benzo(a)pyrene	reanalysis pending ~~1.15E+01~~	HEA	B2	reanalysis pending ~~6.10E+00~~	HEA	B2
Benzo(b)fluoranthene			B2			B2
Benzo(k)fluoranthene			D			D
Benzotrichloride			B2			B2
Benzyl Chloride			C			C
Beryllium and Compounds	NA		B1	4.86E+00	CAG	B1
Bis(2-chloroethyl)ether	1.10E+00	~~CAG~~ IRIS	B2	1.10E00	IRIS	B2
Bis(chloromethyl)ether			A	9.30E+03	CAG	A
Bis(2-ethylhexyl)phthalate (DEHP)	6.84E-04	CAG	B2			B2
Cacodylic Acid			D			D
Cadmium and Compounds	NA			6.10E+00	~~HEA~~ (IRIS)	B1
Carbon Tetrachloride	1.30E-01	~~HEA~~ IRIS	B2	1.30E-01	(IRIS)	B2
Chlordane	1.30 ~~1.61~~E+00	~~HEA~~ ODW	B2			B2
Chloroform	8.10E-02	HEA	B2			B2
4-Chloro-o-toluidine Hydrochloride			B2			B2
Chromium VI and Compounds	NA			4.10E+01	HEA	A
Chrysene			B2			B2
Cyclophosphamide			B1			B1
DDD			B2			B2
DDE			B2			B2
DDT	3.40E-01	HEA	B2			B2
Chloromethane	1.26E-02	HEA		6.32E-03		
Bromodichloromethane	1.3E-01	HEA		not determined		
Chlorodibromomethane	8.4E-02	HEA		Not determined		

EXHIBIT C-4
(Continued)

TOXICITY DATA FOR POTENTIAL CARCINOGENIC EFFECTS -- RISK CHARACTERIZATION

	Oral Route			Inhalation Route		
Chemical Name	Potency Factor (PF) (mg/kg/d)-1	Source[a]	EPA Weight of Evidence	Potency Factor (PF) (mg/kg/d)-1	Source[a]	EPA Weight of Evidence
Diallate			C			B2
Diaminotoluene (mixed)			B2			B2
1,2,7,8-Dibenzopyrene			B2			B2
Dibenz(a,h)anthracene			B2			B2
1,2-Dibromo-3-chloropropane			B2			B2
Dibutylnitrosamine	5.40E+00	CAG	B2	5.40E+00	(IRIS)	B2
3,3'-Dichlorobenzidine	1.70E+00	CAG	B2			B2
1,2-Dichloroethane (EDC)	9.10E-02	~~HEA~~ IRIS	B2	9.1~~3.50E~~-02	~~HEA~~ IRIS	B2
1,1-Dichloroethylene (vinylidene chloride)	5.80E-01	HEA	C	1.16E+00	HEA	C
Dichloromethane	7.50E-03	~~HEA~~ IRIS	B2	1.43E-02	~~HEA~~ IRIS	B2
Dieldrin	3.00E+01	CAG	B2			B2
Diepoxybutane			B2			B2
Diethanolnitrosamine			B2			B2
Diethyl Arsine			D			D
1,2-Diethylhydrazine			B2			B2
Diethylnitrosamine	~~4.40E+01~~ 150	~~CAG~~ IRIS	B2	150	IRIS	B2
Diethylstilbestrol (DES)			A			A
Dihydrosafrole			B2			B2
3,3'-Dimethoxybenzidine			B2			B2
Dimethyl Sulfate			B2			B2
Dimethylaminoazobenzene			B2			B2
7,12-Dimethylbenz(a)anthracene			B2			B2
3,3'-Dimethylbenzidene			B2			B2
Dimethylcarbamoyl Chloride			B2			B2
1,1-Dimethylhydrazine			B2			B2
1,2-Dimethylhydrazine			B2			B2
Dimethylnitrosamine	~~2.60E+01~~ 51	~~CAG~~ IRIS	B2	51	IRIS	B2
Dinitrotoluene (mixed)			B2			B2
2,4-Dinitrotoluene	6.8 ~~3.10E~~-01	~~CAG~~ HEA	B2			B2
2,6-Dinitrotoluene			C			C
1,4-Dioxane			B2			B2
1,2-Diphenylhydrazine	7.70E-01	~~CAG~~ IRIS	B1	8.00E-01	IRIS	B2
Dipropylnitrosamine			B2			B2
Epichlorohydrin	9.90E-03	CAG	B2	9.90E-03	IRIS	B2
Ethyl-4,4'-dichlorobenzilate			B2			B2
Ethylene Dibromide (EDB)	4.10E+01	CAG	B2			B2
1,1-Dichloroethane	9.1E-2	HEA				

EXHIBIT C-4
(Continued)

TOXICITY DATA FOR POTENTIAL CARCINOGENIC EFFECTS -- RISK CHARACTERIZATION

Chemical Name	Oral Route: Potency Factor (PF) (mg/kg/d)-1	Oral Route: Source[a]	Oral Route: EPA Weight of Evidence	Inhalation Route: Potency Factor (PF) (mg/kg/d)-1	Inhalation Route: Source[a]	Inhalation Route: EPA Weight of Evidence
Ethylene Oxide			B1/B2	3.50E-01	CAG	B1/B2
Ethylenethiourea			B2			B2
Ethyl Methanesulfonate			B2			B2
1-Ethyl-nitrosourea	3.30E+01	CAG	B2			B2
Formaldehyde			B2			B2
Glycidaldehyde			B2			B2
Heptachlor	3.40E+00	CAG	B2			B2
Heptachlor Epoxide	2.60E+00	CAG	B2			B2
Hexachlorobenzene	1.69E+00	HEA	B2			B2
Hexachlorobutadiene	7.75E-02	HEA	C			C
alpha-Hexachlorocyclohexane (HCCH)	~~1.10E-01~~ 6.3	~~CAG~~ / IRIS	B2	6.3	IRIS	B2
beta-HCCH	1.80E+00	CAG	C			C
gamma-HCCH (Lindane)	1.33E+00	HEA	B2/C			B2/C
Hexachloroethane	1.40E-02	~~CAG~~ IRIS	C	1.40E-02	IRIS	C
Hydrazine			B2			B2
Indeno(1,2,3-cd)pyrene			C			C
Iodomethane			C			C
Isosafrole			B2			C
Kepone			B2			B2
Lasiocarpine			B2			B2
Melphalan			B1			B1
Methyl Chloride	1.26E-2	HEA	C	6.32E-3	HEA	C
3-Methylcholanthrene			B2			B2
4,4'-Methylene-bis-2-chloroaniline			B2			B2
Methylnitrosourea	3.00E+02	CAG	B2			B2
Methylnitrosourethane			B2			B2
Methylthiouracil			B2			B2
Methylvinylnitrosamine			B2			B2
N-Methyl-N'-nitro-N-nitrosoguanadine			B2			B2
Mitomycin C			B2			B2
1-Napthylamine			C			C
2-Napthylamine			A			A
Nickel and Compounds	NA		A	1.70 (NiS), 8.4E-1 (refinery dust) ~~1.19E+00~~	HEA	A
N-Nitrosopiperidine			B2			B2
N-Nitrosopyrrolidine	2.10E+00	CAG	B2			B2
5-Nitro-o-toluidine			C			C
N-Nitrodiphenylamine	4.90E-03	IRIS	B2			
N-Nitrosodi-N-propylamine	7.00E+00	IRIS	B2			
N-Nitrosomethylethylamine	2.18E+01	IRIS	B2			
Isophorone	4.1E-3	HEA				

LINDANE 1.33E00 HEA

EXHIBIT C-4
(Continued)

TOXICITY DATA FOR POTENTIAL CARCINOGENIC EFFECTS -- RISK CHARACTERIZATION

	Oral Route			Inhalation Route		
Chemical Name	Potency Factor (PF) (mg/kg/d)-1	Source[2]	EPA Weight of Evidence	Potency Factor (PF) (mg/kg/d)-1	Source[2]	EPA Weight of Evidence
Pentachloronitrobenzene			C			C
Pentachlorophenol			D			D
Phenacetin			B2			B2
Polychlorinated Biphenyls (PCBs)	~~4.34~~ 7.00 E+00	~~HEA~~ CAG	B2			B2
Polynuclear Aromatic Hydrocarbons	~~1.15E+01~~ reanalysis pending	HEA		~~6.11E+00~~ reanalysis pending	HEA	
Propane Sultone			B2			B2
1,2-Propylenimine			B2			B2
Saccharin			C			C
Safrole			B2			B2
Streptozocin			B2			B2
2,3,7,8-TCDD (Dioxin)	1.56E+05	HEA	B2			B2
1,1,1,2-Tetrachloroethane			B2			C
1,1,2,2-Tetrachloroethane	2.00E-01	~~HEA~~ IRIS	C	2.00E-01	IRIS	C
Tetrachloroethylene	5.10E-02	HEA	B2	~~1.70E-03~~ 1.0 to 3.3E-3	HEA	B2
Thioacetamide			B2			B2
Thiourea			B2			B2
o-Toluidine hydrochloride			B2			B2
Toxaphene	1.10E+00	CAG	B2			B2
1,1,2-Trichloroethane	5.73E-02	HEA	C			C
Trichloroethylene	1.10E-02	~~HEA~~ IRIS	B2	4.60E-03	~~HEA~~ IRIS	B2
2,4,6-Trichlorophenol	2.0 ~~1.98~~ E-02	~~HEA~~ IRIS	B2	2.00E-02	IRIS	B2
Tris(2,3-dibromopropyl)phosphate			B2			B2
Trypan Blue			B2			B2
Uracil Mustard			B2			B2
Urethane			B2			B2
Vinyl Chloride	2.30E+00	HEA	A	~~2.30E-02~~ 2.95E-01	~~HEA~~ CAG	A

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[1] The list of chemicals presented in this exhibit is based on EPA's Reportable Quantities Analysis and should not be considered an all-inclusive list of suspected carcinogens. Refer to Exhibit C-3 for toxicity constants for indicator selection for the chemicals listed here.

[2] Sources for Exhibit C-4:

HEA = Health Effects Assessment, prepared by the Environmental Criteria and Assessment Office, U.S. EPA, Cincinnati, Ohio, 1985 (updated in May 1986).

CAG = Evaluation by Carcinogen Assessment Group, U.S. EPA, Washington, D.C., 1985.

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EXHIBIT C-6

TOXICITY DATA FOR NONCARCINOGENIC EFFECTS -- RISK CHARACTERIZATION [1]

Chemical Name	Oral Route: Acceptable Intake: Subchron (AIS) --mg/kg/day--	Oral Route: Acceptable Intake: Chronic (AIC) --mg/kg/day--	Oral Route: Source[2]	Inhalation Route: Acceptable Intake: Subchron (AIS) --mg/kg/day--	Inhalation Route: Acceptable Intake: Chronic (AIC) --mg/kg/day--	Inhalation Route: Source[2]
Acenaphthene @						
Acenaphthylene @						
Acetone	1.00E00	1.00E-01	RfD	3.00E+01	3.00E+00	HEA
Acetonitrile						
2-Acetylaminofluorene @						
Acrylic Acid		8.00E-02	RfD[3J]			
Acrylonitrile @						
Aflatoxin B1 @						
Aldicarb	1.3E-3	~~1.00E-02~~	RfD			
Aldrin @		3.00E-05	RfD			
Allyl Alcohol		5.00E-03	RfD			
Aluminum Phosphide		4.00E-04	RfD			
4-Aminobiphenyl @						
Amitrole @						
Ammonia						
Anthracene @						
Antimony and Compounds		4.00E-04	RfD			
Arsenic and Compounds @						
Asbestos @						
Auramine @						
Azaserine @						
Aziridine @						
Barium and Compounds		5.70E-02	~~HEA~~ IRIS	1.4E-3(T)[4J]	1.40E-04	HEA
Benefin		3.00E-01	RfD			
Benzene @						
Benzidine @						
Benz(a)anthracene @						
Benz(c)acridine @						
Benzo(a)pyrene @						
Benzo(b)fluoranthene @						
Benzo(ghi)perylene @						
Benzo(k)fluoranthene @						
Benzotrichloride @						
Benzyl Chloride @						
Beryllium and Compounds @		5.00E-03	RfD			
1,1-Biphenyl		5.00E-02	RfD			
Bis(2-chloroethyl)ether @						
Bis(2-chloroisopropyl)ether						
Bis(chloromethyl)ether @						
Bis(2-ethylhexyl)phthalate (DEHP) @		2.00E-02	RfD			
Bromomethane	4E-2	1.4.00E-03	RfD	7E-2	7E-3	
Bromoxynil Octanoate		3.00E-02	RfD			
1,3-Butadiene						

Boron	8.6E-2	8.6E-2	HEA	Not determined	
Bromoform	2E-1	2E-2	IRIS	Not determined	

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(Continued)

TOXICITY DATA FOR NONCARCINOGENIC EFFECTS -- RISK CHARACTERIZATION

Chemical Name	Oral Route: Acceptable Intake Subchron (AIS) --mg/kg/day--	Oral Route: Acceptable Intake Chronic (AIC) --mg/kg/day--	Source	Inhalation Route: Acceptable Intake Subchron (AIS) --mg/kg/day--	Inhalation Route: Acceptable Intake Chronic (AIC) --mg/kg/day--	Source
n-Butanol		1.00E-01	RfD			
Butylpthalyl Butylglycolate		1.00E+00	RfD			
Cacodylic Acid @		1.00E-02	RfD			
Cadmium and Compounds @		~~2.~~90E-04	HEA			
Captan		1.30E-02				
Carbaryl		1.00E-01 1.00E-01	RfD			
Carbon Disulfide		1.00E-01	RfD			
Carbon Tetrachloride @		7.00E-04				
Chlordane @		5.00E-05	RfD			
Chlorobenzene	2.70E-01	2.70E-02	HEA	5.70E-02	5.70E-03	HEA
Chlorobenzilate @						
Chlorodibromomethane						
Chloroform @		1.00E-02	RfD			
Chloromethyl Methyl Ether @						
4-Chloro-o-toluidine Hydrochloride@						
Chromium III and Compounds	1.40E+01	1.00E+00	RfD		~~5.10E-03~~	~~HEA~~
Chromium VI and Compounds @	2.50E-02	5.00E-03	HEA			
Chrysene @						
Copper and Compounds	3.70E-02	3.70E-02	HEA		1.00E-02	HEA
Creosote @						
Cresol	reanalysis pending	~~5.00E-02~~	~~RfD~~		1.00E-01	HEA
Crotonaldehyde		1.00E-02	RfD			
Cyanides (n.o.s.) [b]		2.90 ~~2.00~~E-02	RfD			
-- Barium Cyanide		7.00E-02	RfD			
-- Calcium Cyanide		4.00E-02	RfD			
-- Cyanogen		4.00E-02	RfD			
-- Cyanogen Chloride		5.00E-02	RfD			
-- Copper Cyanide		7.00E-02	RfD			
-- Hydrogen Cyanide		2.00E-02	RfD			
-- Nickel Cyanide		2.00E-02	RfD			
-- Potassium Cyanide		5.00E-02	RfD			
-- Potassium Silver Cyanide		2.00E-01	RfD			
-- Silver Cyanide		1.00E-01	RfD			
-- Sodium Cyanide		4.00E-02	~~RfD~~ IRIS			
-- Zinc Cyanide		5.00E-02	RfD			
Cyclophosphamide @						
Dalapon		8.00E-02	RfD			
DDD @						
DDE @						
DDT @		5.00E-04	RfD			
Decabromodiphenyl Ether		1.00E-02	RfD			
Diallate @						
2-Chlorophenol	5.7E-3	5.7E-3	HEA	No [illegible]		

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EXHIBIT C-6
(Continued)

TOXICITY DATA FOR NONCARCINOGENIC EFFECTS -- RISK CHARACTERIZATION

Chemical Name	Oral Route: Acceptable Intake Subchron (AIS) --mg/kg/day--	Oral Route: Acceptable Intake Chronic (AIC) --mg/kg/day--	Source	Inhalation Route: Acceptable Intake Subchron (AIS) --mg/kg/day--	Inhalation Route: Acceptable Intake Chronic (AIC) --mg/kg/day--	Source
?,4-Diaminotoluene @						
,2,7,8-Dibenzopyrene @						
ibenz(a,h)anthracene @						
1,2-Dibromo-3-chloropropane @						
ibutylnitrosamine @						
ibutyl Phthalate		1.00E-01	RfD			
.,2-Dichlorobenzene						
1,3-Dichlorobenzene						
,4-Dichlorobenzene						
,3'-Dichlorobenzidine @						
Dichlorodifluoromethane		2.00E-01	RfD			
1,1-Dichloroethane	1.20E+00	1.20E-01	HEA	1.38E+00	1.38E-01	HEA
,2-Dichloroethane (EDC) @						
,1-Dichloroethylene @		9.00E-03	RfD			
1,2-Dichloroethylene (cis)						
,2-Dichloroethylene (trans)						
ichloromethane @		6.00E-02	RfD			
_,4-Dichlorophenol	3.0E-3	3.00E-03	~~RfD~~ [illegible]			
2,4-Dichlorophenoxyacetic Acid (2,4-D)		1.0E-02	RfD			
-(2,4-Dichlorophenoxy)butyric Acid (2,4-DB)		8.00E-03	RfD			
Dichlorophenylarsine @						
,2-Dichloropropane						
,3-Dichloropropene						
Dieldrin @						
Diepoxybutane @						
iethanolnitrosamine @						
iethyl Arsine @						
1,2-Diethylhydrazine @						
iethylnitrosamine @						
iethyl Phthalate		1.30E+01	RfD			
Diethylstilbestrol (DES) @						
Dihydrosafrole @						
imethoate		2.00E-02	RfD			
,3'-Dimethoxybenzidine @						
Dimethylamine						
Dimethyl Sulfate @						
imethyl Terephthalate		1.00E-01	RfD			
imethylaminoazobenzene @						
7,12-Dimethylbenz(a)anthracene @						
3,3'-Dimethylbenzidine @						
2,6-Dimethylphenol	5.7E-3	5.7E-4	HEA	Not determined		
3,4-Dimethylphenol	1.4E-2	1.4E-3	HEA	Not determined		

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EXHIBIT C-6
(Continued)

TOXICITY DATA FOR NONCARCINOGENIC EFFECTS -- RISK CHARACTERIZATION

Chemical Name	Oral Route: Acceptable Intake: Subchron (AIS) --mg/kg/day--	Oral Route: Acceptable Intake: Chronic (AIC) --mg/kg/day--	Oral Route: Source	Inhalation Route: Acceptable Intake: Subchron (AIS) --mg/kg/day--	Inhalation Route: Acceptable Intake: Chronic (AIC) --mg/kg/day--	Inhalation Route: Source
Dimethylcarbamoyl Chloride @						
1,1-Dimethylhydrazine @						
1,2-Dimethylhydrazine @						
Dimethylnitrosamine @						
1,3-Dinitrobenzene						
4,6-Dinitro-o-cresol						
2,4-Dinitrophenol		2.00E-03	RfD			
2,3-Dinitrotoluene @						
2,4-Dinitrotoluene @						
2,5-Dinitrotoluene @						
2,6-Dinitrotoluene @						
3,4-Dinitrotoluene @						
Dinoseb		1.00E-03	RfD			
1,4-Dioxane @						
N,N-Diphenylamine @		2.50E-02	RfD			
1,2-Diphenylhydrazine @						
Dipropylnitrosamine @						
Disulfoton		4.00E-05	RfD			
Endosulfan	5E-5	5.50E-05	~~RfD~~ IRIS			
Epichlorohydrin @		2.00E-03	RfD			
Ethanol						
Ethyl Acetate		9.00E-01	RfD			
Ethyl Methanesulfonate @						
Ethylbenzene	9.70E-01	1.00E-01	~~RfD~~ IRIS			
Ethyl-4,4'-dichlorobenzilate @						
Ethylene Dibromide (EDB) @						
Ethylene Oxide @						
Ethylenethiourea @						
1-Ethyl-nitrosourea @						
Ethylphthalyl Ethyl Glycolate		3.00E+00	RfD			
Ferric Dextran @						
Fluoranthene @						
Fluorene @						
Fluorides		6.00E-02	RfD			
Fluridone		8.00E-02	RfD			
Formaldehyde						
Formic Acid		2.00E+00	RfD			
Furan		1.00E-03	RfD			
Glycidaldehyde @						
Glycol Ethers (n.o.s.)						
-- Diethylene Glycol, Monoethyl Ether	5.00E+00	2.00E+00	HEA			
	5.0E00	5.0E-1	HEA			
Endrin	4.3E-4	2.8E-4	HEA	not determined		

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EXHIBIT C-6
(Continued)

TOXICITY DATA FOR NONCARCINOGENIC EFFECTS -- RISK CHARACTERIZATION

Chemical Name	Oral Route Acceptable Intake Subchron (AIS) --mg/kg/day--	Oral Route Acceptable Intake Chronic (AIC) --mg/kg/day--	Source	Inhalation Route Acceptable Intake Subchron (AIS) --mg/kg/day--	Inhalation Route Acceptable Intake Chronic (AIC) --mg/kg/day--	Source
-- 2-Ethoxyethanol	4.7E-1(T)	3.60E-01	HEA	6.9E-2(T)	5.00E-02	HEA
-- Ethylene Glycol, Monobutyl Ether	N.D.	2.0E00	IRIS	~~1.60E-01~~ 1.6E-1	~~1.60E-02~~ 1.4E-2	~~HEA~~ HEA
-- 2-Methoxyethanol	1.4E-2	1.4E-3	2.9E-2	~~[illegible]~~(T)	~~[illegible]~~	HEA
-- Propylene Glycol, Monoethyl Ether	6.80E+00	6.80E-01	HEA	4.9E00	4.9E-1	HEA
-- Propylene Glycol, Monomethyl Ether	6.80E+00	6.80E-01	HEA	~~4.90E+00~~	~~4.90E-01~~	HEA
Heptachlor @						
Heptachlor Epoxide @		1.3 ~~.00~~E-05	RfD			
Hexachlorobenzene @						
Hexachlorobutadiene @		2.00E-03	RfD			
Hexachlorocyclopentadiene	7.00E-02	7.00E-03	RfD	2.90E-03	7.6 ~~6.60~~E-05	HEA
alpha-Hexachlorocyclohexane (HCCH)@						
beta-HCCH @						
gamma-HCCH (Lindane) @		3.00E-04	RfD			
delta-HCCH @						
Hexachloroethane @						
Hexachlorophene						
Hydrazine @						
Hydrogen Sulfide		3.00E-03	RfD			
Indeno(1,2,3-cd)pyrene @						
Iodomethane @						
Iron and Compounds					8.60E-03	HEA
Isobutanol		3.00E-01	RfD			
Isoprene						
Isosafrole @						
Isophorone		1.50 ~~2.00~~E-01	RfD			
Isopropalin		1.50 ~~3.00~~E-02	RfD			
Kepone @						
Lasiocarpine @						
Lead and Compounds (Inorganic)		1.40E-03	HEA		~~4.30E-04~~	HEA
Linuron		2.00E-03				
Malathion		2.00E-02	RfD			
Manganese and Compounds	5.30E-01	2.20E-01	HEA	3.00E-04	3.00E-04	HEA
Melphalan @						
Mercury and Compounds (Alkyl)	2.80E-04	3.00E-04	RfD	~~1.00E-04~~	~~1.00E-04~~	HEA
Mercury and Compounds (Inorganic)	~~2.00~~E-03 1.4	~~2.00~~E-03	RfD	~~5.10E-04~~	~~5.10E-03~~	HEA
Mercury Fulminate		3.00E-03	RfD			
Methanol		5.00E-01	RfD			
Methyl Chloride			IRIS	9.1E-1	8.6E-2	
Methyl Ethyl Ketone	5.0E-1	5.00E-02	~~RfD~~	~~2.20E+00~~	~~2.20E-01~~	HEA

LINDANE		3.00E-04	RfD IRIS			
Maleic Hydrazide		5.00E-01	RfD IRIS			
Napthalene	4.1E-1	4.1E-1	HEA	not determined		

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EXHIBIT C-6
(Continued)

TOXICITY DATA FOR NONCARCINOGENIC EFFECTS -- RISK CHARACTERIZATION

Chemical Name	Oral Route: Acceptable Intake Subchron (AIS) --mg/kg/day--	Oral Route: Acceptable Intake Chronic (AIC) --mg/kg/day--	Source	Inhalation Route: Acceptable Intake Subchron (AIS) --mg/kg/day--	Inhalation Route: Acceptable Intake Chronic (AIC) --mg/kg/day--	Source
Methyl Ethyl Ketone Peroxide	reanalysis pending	~~8.00E-03~~	RfD			
Methyl Isobutyl Ketone	5E-1	5.00E-02	~~RfD~~ IRIS	2.3E-1	2.9E-2	HEA
Methyl Methacrylate						
Methyl Parathion	(HEA) 5.7E-3	2.50E-04	~~RfD~~ IRIS			
2-Methyl-4-Chlorophenoxyacetic Acid		1.00E-03	RfD			
2(2-Methyl-4-Chlorophenoxy) propionic Acid		3.00E-03	RfD			
3-Methylcholanthrene @						
4,4'-Methylene-bis-2-chloroaniline@						
Methylnitrosourea @						
Methylthiouracil @						
Methylvinylnitrosamine @						
N-Methyl-N'-nitro-N-nitrosoguanadine@						
Mitomycin C @						
Mustard Gas @						
1-Napthylamine @						
2-Napthylamine @						
Nickel and Compounds @	~~2.00~~ 1.4E-02	1.00E-02	HEA			
Nitric Oxide		1.00E-01	RfD			
Nitrobenzene	5E-3	5.00E-04	~~RfD~~ IRIS	5.7E-3	5.7E-4	HEA
Nitrogen Dioxide		1.00E+00	RfD			
Nitrosomethylurethane @						
N-Nitrosopiperidine @						
N-Nitrosopyrrolidine @						
5-Nitro-o-toluidine @						
Osmium Tetroxide		1.00E-05	RfD			
Pentachlorobenzene		8.00E-04	RfD			
Pentachloronitrobenzene @		8.00E-03	RfD			
Pentachlorophenol	3.0E-2(T)	3.00E-02	~~RfD~~ IRIS			
Phenacetin @						
Phenanthrene @						
Phenobarbital @						
Phenol	(HEA) 4.00E-02	4.00E-02	~~RfD~~ IRIS	~~1.00E-01~~	~~2.00E-02~~	~~HEA~~
Phenylalanine Mustard @						
m-Phenylenediamine		6.00E-03	RfD			
Phenyl Mercuric Acetate		8.00E-05	RfD			
Phosphine		3.00E-04	RfD			
Polychlorinated Biphenyls (PCBs) @						
Propane Sultone @						
Propyleniminе @						
Pyrene @						
Pyridine		2.00E-03	RfD			

Methyl mercury		3.00E-04	~~RfD~~ IRIS
Octabromodiphenyl ether		3.00E-03	~~RfD~~ IRIS
Paraquat		4.50E-03	~~RfD~~ IRIS
pentabromodiphenyl ether		2.00E-03	~~RfD~~ IRIS

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EXHIBIT C-6
(Continued)

TOXICITY DATA FOR NONCARCINOGENIC EFFECTS -- RISK CHARACTERIZATION

	Oral Route			Inhalation Route		
	Acceptable Intake			Acceptable Intake		
Chemical Name	Subchron (AIS) --mg/kg/day--	Chronic (AIC)	Source	Subchron (AIS) --mg/kg/day--	Chronic (AIC)	Source
Saccharin @						
Safrole @						
Selenium and Compounds (n.o.s.)	3.00E-03	3.00E-03	HEA		1.00E-03	HEA
-- Selenious Acid		3.00E-03	~~RfD~~ IRIS			
-- Selenourea		5.00E-03	~~RfD~~ IRIS			
-- Thallium Selenite		5.00E-04	~~RfD~~ IRIS			
Silver and Compounds		3.00E-03	RfD			
Sodium Diethyldithiocarbamate		3.00E-02	RfD			
Streptozocin @						
Strychnine		3.00E-04	RfD			
Styrene		2.00E-01	RfD			
1,2,4,5-Tetrachlorobenzene		3.00E-04	RfD			
2,3,7,8-TCDD (Dioxin) @						
1,1,1,2-Tetrachloroethane @						
1,1,2,2-Tetrachloroethane @						
Tetrachloroethylene @		2.00E-02	RfD			
2,3,4,6-Tetrachlorophenol		1.00E-02	RfD			
2,3,5,6-Tetrachloroterephthalate Acid (DCPA)		5.00E-02	RfD			
Tetraethyl Lead @		1.00E-07	RfD			
Thallium and Compounds (n.o.s.)		4.00E-04	RfD			
-- Thallium Acetate		5.00E-04	RfD			
-- Thallium Carbonate		4.00E-04	RfD			
-- Thallium Chloride		4 ~~5~~.00E-04	RfD			
-- Thallium Nitrate		5.00E-04	RfD			
-- Thallic Oxide		4.00E-04	RfD			
-- Thallium Sulfate		5.00E-04	RfD			
-- Thallium Selenite		5.00E-04	IRIS			
Thioacetamide @						
Thiourea @						
o-Tolidine @						
Toluene	4.30E-01	3.00E-01	~~RfD~~ IRIS	1.50E+00	1.50E+00	HEA
o-Toluidine Hydrochloride @						
Toxaphene @						
Tribromomethane (Bromoform)						
1,2,4-Trichlorobenzene		2.00E-02	RfD			
1,1,1-Trichloroethane	3.1	~~5.40E-02~~ 8.6E-2	~~HEA~~ IRIS	~~1.10E+01~~	~~6.30E+00~~ 3.1	HEA
1,1,2-Trichloroethane @		2.00E-01	~~RfD~~ IRIS			
Trichloroethylene @						
Trichlorofon						
Trichloromonofluoromethane		3.00E-01	RfD			
2,4,5-Trichlorophenol	1.00E+00	1.00E-01	RfD			
2,4,6-Trichlorophenol @						

1,2,4 Tribromobenzene		5.0E-03	HEA			
TIN	6.4E-1	6.4E-1	HEA	Not determined		

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EXHIBIT C-6
(Continued)

TOXICITY DATA FOR NONCARCINOGENIC EFFECTS -- RISK CHARACTERIZATION

Chemical Name	Oral Route: Acceptable Intake: Subchron (AIS) --mg/kg/day--	Oral Route: Acceptable Intake: Chronic (AIC) --mg/kg/day--	Oral Route: Source	Inhalation Route: Acceptable Intake: Subchron (AIS) --mg/kg/day--	Inhalation Route: Acceptable Intake: Chronic (AIC) --mg/kg/day--	Inhalation Route: Source
2,4,5-Trichlorophenoxyacetic Acid		3.00E-02	RfD			
1,2,3-Trichloropropane		6.00E-03	RfD			
1,1,2-Trichloro-1,2,2-Trifluoroethane		3.00E+01	RfD			
Tris(2,3-dibromopropyl)phosphate @						
Trinitrotoluene (TNT)		2.00E-04	RfD			
Trypan Blue @						
Uracil Mustard @						
Uranium and Compounds						
Urethane @						
Vanadium and Compounds (pentoxide)		2.00E-02	RfD			
Vinyl Chloride @						
Warfarin		3.00E-04	RfD			
o-Xylene	4.0 ~~1.00E-01~~	~~1.00E-02~~ 2.0	HEA	4.4E-1 ~~9.6E-1~~(T)	4.4 ~~2.00E-01~~	HEA
m-Xylene	4.0 ~~1.00E-01~~	~~1.00E-02~~ 2.0	HEA	~~1.00E+00~~	~~2.00E-01~~	HEA
p-Xylene	4.0	2.0	HEA	4.4E-1	4.4E-1	
Xylenes (mixed)	4.0 ~~1.00E-01~~	2.00E-02	IRIS ~~HEA~~	~~6.9E-1(T)~~	~~4.00E-01~~	HEA
Zinc and Compounds	2.10E-01	2.10E-01	HEA	~~1.00E-01~~	~~1.00E-02~~	~~HEA~~
-- Zinc Phosphide		3.00E-04	~~RfD~~ IRIS			
Zineb		5.00E-02	~~RfD~~ IRIS			

@ Potential carcinogenic effects also. See Exhibits C-3 and C-4.

[1] Refer to Exhibit C-5 for toxicity data for indicator selection for the chemicals listed here.

[2] Sources for Exhibit C-6:

RfD = Agency-wide reference dose value, developed by an inter-office work group chaired by the Office of Research and Development, U.S. EPA, Washington, D.C., 1986.

HEA = Health Effects Assessment document, prepared by the Environmental Criteria and Assessment Office, U.S. EPA, Cincinnati, Ohio, 1985 (updated in May 1986).

[3] The RfD values listed here are EPA-verified numbers. All RfD values were derived based on oral exposure; however, in the absence of other more specific data, these values may also be useful in assessing risks of inhalation exposure.

[4] T indicates that teratogenic or fetotoxic effects are the basis for the AIS value listed.

[5] N.O.S. = not otherwise specified.

...m metavanadate	1.4E-2	1.4E-3	HEA	
...adium (NOS)	5.7E-3	5.7E-3	HEA	not determined
...yl sulfate	2.3E-2	2.3E-2	HEA	not determined

Table 2

Pollutants for Which Inhalation RfDs will be Developed

	Pollutant Name	CAS #
1.	Acetone	57-64-1
2.	Alkyl mercury	NA*
3.	Barium	7440-39-3
4.	Chlorobenzene	108-90-7
5.	Chromium (trivalent)	15066-33-1
6.	Cresol	1319-77-3
7.	1,1 Dichloroethane	76-34-3
8.	2 Ethoxyethanol	110-80-5
9.	Ethylene glycol monobutyl ether	111-76-2
10.	Hexachlorocyclopentadiene	77-47-4
11.	Iron	15438-31-0
12.	Manganese	7439-96-5
13.	Mercury (inorganic)	7439-97-6
14.	Methoxyethanol	109-86-4
15.	Methyl chloroform	71-55-6
16.	Methyl ethyl ketone	78-93-3
17.	Phenol	108-95-2
18.	Propylene glycol monomethyl ether	107-98-2
19.	Selenium	7782-49-2
20.	Toluene	108-88-3
21.	Xylene, o	95-47-6
22.	Xylene, m	108-38-3
23.	Xylene, mixed	1330-20-7
24.	Xylene, p	106-42-3

* Not applicable

Table 3

Proposed NESHAPS and Planned Development of NESHAPS

FY 1987

Propose 4 NESHAP

Asbestos Revision
Chromium-Comfort Cooling Tower*
Coke By-Product-Final Cool
Coke Chg, TPS, Door Leaks

Promulgate 2 NESHAP

Coke By-Product
Mercury Revision

Develop 10 NESHAP

Chromium-Electroplating
Chromium-Cooling Towers
Municipal Waste Combust (MWC)***
Hazardous Organic NESHAP*
Degreasing
Methylene Chloride
Machinery Mfg. Rebldg.
Drycleaning
Ethylene Oxide-Commercial Sterilization
Industrial Wastewater

Source Assessments (24)****

Gasoline Marketing
Naphthalene
Toluene diisocyanate
Xylene
Methyl isocyanate
Asbestiform fibers
Ethyl chloride
Propylene
Methyl methacrylate
Maleic anhydride
Phthalic anhydride
Phosphorus
Sodium hydroxide
Hydrocyanic acid
Dimethylamine
Methanol
Contaminant asbestos
Selenium and compounds
Mercuric chloride
Hydrogen fluoride
Bromine & inorganic compounds
Acetaldehyde
Acrolein
Phosgene

FY 1988

Propose 6 NESHAP

Chromium-Cooling Towers
Chromium-Electroplating
Drycleaning
Ethylene Oxide-Commercial Sterilization
Hazardous Organic NESHAP*
MWC-New

Promulgate 2 NESHAP

Asbestos Revision
Coke Chg, TPS, Door Leaks

Develop 8 NESHAP

MWC-Existing
Landfills
Industrial Wastewater
Degreasing
Methylene Chloride
Machinery Mfg. Rebldg.
Chromium-Comfort Cooling Tower
Coke By-Product Final Cooler**

Source Assessments (24)****

Gasoline Marketing
Carbon Disulfide
2,4 Toluene Diamine
Hexahydro Azepin
Methyl Chloride
Allyl Chloride
Cumene Hydroperoxide
Camphechlor
Phthalates
Titanium Dioxide
Organophosphate Pesticides
Warfarin
Carbofuran
Pentachlorophenol
Nicotine
Dibromoethane
Legionella
Unspecified (7)

Table 4

Drinking Water Health Advisories

	Health Advisories		
INORGANICS	1-day	10-day	Lifetime w/RSC
Arsenic			0.05(20%)
Barium	0.51	0.51	1.5(83%)
Cadmium	0.43	0.43	0.005(25%)
Chromium	1.4	1.4	0.12(71%)
Cyanide	0.22	0.22	0.154(20%)
Lead	0.02mg/day	0.02mg/day	
Mercury	0.002	0.002	0.0011(20%)
Nickel	1.0	1.0	
ORGANICS			
Benzene	0.235	0.235	
Chlorobenzene	4.3	4.3	0.3(20%)
Carbon Tetrachloride	4.0	0.16	
1,4 Dichlorobenze(para)	10.7	10.7	
1,2-Dichloroethane	0.74	0.74	
1,1-Dichloroethylene	2.0	1.0	0.07(20%)
cis-1,2-Dichloroethylene	4.0	1.0	0.07(20%)
trans-1,2-Dichloroethylene	20	1.43	0.07(20%)
Ethylbenzene	32.0	3.2	
Pentachlorophenol	1.0	0.3	0.22(20%)
Styrene	22.5	2.0	0.14(20%)
1,1,1-Trichloroethane	140	35	0.2(20%)
2,4,5 TP (Silvex)	0.2		0.052(20%)
Vinyl Chloride	2.6	2.6	
Napthalene			(2.8)[a]

[a] calculation based on draft data
RSC - Relative Source Contribution from drinking ingestion
All values in mg/liter unless otherwise noted

Radiation problems can originate with air stripping and soil vapor extraction systems because soils and groundwater can contain substantial concentrations of radioactive radon (radon-222) and thoron (radon-220) gases. Radon and thoron are evacuated along with chemical contaminants during these operations. Also under conditions of long and/or high volume pumping with air stripping systems trace amounts of radon, thoron, and their decay products from the ambient air may also accumulate on the collection media (e.g. charcoal, plastic, etc.). Additional radiation problems may also arise when ion exchange resins used to clean groundwater leads to concentration of naturally occurring radium.

The primary areas of concern are discussed below.

° Buildup of radon, thoron and their decay products on the collection media may lead to personnel exposure problems.

Site measurements at several sites to date have detected the buildup of gamma-ray emitters. The amount of buildup will vary depending on the radon and thoron concentrations in the soil or groundwater, the pumping rate, the pumping time and the characteristics of the packing or collection media. Whole body exposure rates that may lead to personnel doses must be determined and doses kept within relevant requirements. Inhalation and ingestion of alpha and beta emitters and skin doses from beta emitters must be considered for personnel working with the contaminated media. In some cases, personnel protection measures and film badging may be required.

° Buildup of radon and thoron decay products on collection media may subject them to special transport conditions under the Department of Transportation regulations.

The buildup of decay products on the collection media may lead to concentrations that meet the definition of "radioactive" under DOT regulations. Some of these decay products may have to be handled through storage until decay leads to lower concentrations. Other decay products have long half-lives so that they will not decay appreciably in any reasonable amount of time. Those radionuclides, whether short-lived or long-lived that have not decayed sufficiently at the time of shipment, may have to receive special handling according to DOT regulations in Title 49 of the Code of Federal Regulations.

° Buildup of radon decay products on collection media may foreclose their continued or repeated use of the collection media.

Consideration must be made as to whether collection media contaminated with long-lived radionuclides may be reused or recycled back to collection sites. Continued reuse may lead to buildup of long-lived radionuclides that is undesirable.

° Buildup of radon decay products on collection media may require their disposal as radioactive wastes.

Where radionuclides with long half-lives have built up on collection media to quantities that can not be sufficiently reduced by storage for radioactive decay, these materials may have to be treated as a radioactive waste depending upon the residual concentrations and the applicable State requirements.

- Release of adsorbed radionuclides during the regeneration of collection media may lead to emissions that are subject to State and/or Federal standards or regulations.

  The presence of radionuclides on collection media in substantial quantities (shown possible through calculation) may mean these materials might be released during regeneration and may subject the regenerator to State and/or Federal radionuclide emission regulations.

- Breakthrough of radon and thoron through the collection media may violate State radioactive emission standards and/or create occupational or public radiation exposure problems.

  Breakthrough of radon-222 from charcoal collection media has been shown. Stack emission levels have been measured to 78 picocuries per liter (pCi/L). To compare, the most relevant unrestricted area standards, where the workers or the general public need not be considered occupationally exposed, are the Nuclear Regulatory Commission's (NRC) regulatory limit of 3 picocuries per liter (pCi/L) for radon-222 and 10 pCi/L for radon-220. Strictly, the NRC regulations do not directly apply to Naturally Occurring Radioactive Material (NARM), but State regulations which can govern NARM, are usually identical to the NRC's. Thus, if annual average ambient concentrations for radon and thoron that result from these site cleanup operations exceed 3 pCi/L and 10 pCi/L, respectively, they may be in violation of State radiation emission standards.

- Emission of radon and thoron when collection media are not used may be substantially greater than when collection media are in place.

  Radon and thoron exist naturally in the ground at high concentraions. Without collection media, these radioactive materials would be emitted out system stacks and directly into the environment. Emission levels are anticipated to be higher than when collection media are in place. Consequently, there is an even greater likelihood of the State or relevant Federal radiation requirements being violated.

- Use of ion exchange resins in water treatment systems may lead to a buildup of radium on the resins that must be handled in accordance with State radiation control requirements.

  Where groundwater is treated by ion exchange technology subsequent to air stripping, the potential exists for the concentration of soluble and insoluble radium in the backwash and sludge respectively. Radium is controlled by State radiation programs (not the Nuclear Regulatory Commission). Buildup of radium may lead to greater than exempt quantities so that these materials will have to treated in accordance with State radiation rules. Moreover, the disposal of liquid and solid radioactive materials will have to be in accordance with State radiation rules.

Region V Radiation Staff are continuing to investigate these problems through calculations, through site studies and through regulatory investigations. As our understanding of the problems and their ramifications develop we will make this information available.

ATTACHMENT C

Drinking Water ARARs

INORGANICS	MCL	pMCL	MCLG	pMCLG	SMCL
Arsenic	0.05			0.05	
Barium	1.0			1.5	
Cadmium	0.01			0.005	
Chloride					250
Chromium	0.05			0.12	
Copper				1.3	1
Cyanide					
Iron					0.3
Lead	0.05			0.02	
Mercury	0.002			0.003	
Nickel					
Selenium	0.01			0.045	
Silver	0.05				
ORGANICS					
Benzene	0.005		0		
Chlorobenzene				0.6	
Carbon Tetrachloride	0.005		0		
1,4 Dichlorobenze (para)	0.075		0.075		
1,2-Dichloroethane	0.005		0		
1,1-Dichloroethylene	0.007		0.007		

X ( ) lb

75 gpm x

$75 \left(\frac{gal}{MIN}\right) \times 1440 \left(\frac{MIN}{DAY}\right) \times 8.33 \left(\frac{lbs}{gal}\right)$

$\times \frac{X}{1 \times 10^6} =$ (lbs/DAY)

	MCL	pMCL	MCLG	pMCLG	SMCL
cis-1,2-Dichloroethylene				0.07	
trans-1,2-Dichloroethylene				0.07	
Ethylbenzene				0.68	
Pentachlorophenol				0.22	
Styrene				0.14	
1,1,1-Trichloroethane	0.20		0.20		
Trichloroethylene	0.005		0		
2,4,5 TP (Silvex)	0.01			0.052	0.2
Vinyl Chloride	0.002		0		
Total Xylenes				0.44	

Definitions

MCL - Maximum Contaminant Level; enforceable drinking water standard for public (community and noncommunity) water supplies promulgated pursuant to the Safe Drinking Water Act (SDWA)

pMCL - proposed Maximum Contaminant Level

MCLG - Maximum Contaminant Level Goal; nonenforceable goal based solely upon health effects, with an adequate margin of safety

pMCLG - proposed Maximum Contaminant Level Goal

RSC - Relative Source Contribution from drinking water ingestion

All values in mg/l unless otherwise noted.

REMEDIAL ACTION ALTERNATIVES RETAINED FOR DETAILED EVALUATIONS

ALTERNATIVE NO.	PHASE I DESIGNATED NO.	DESCRIPTIONS	REMARKS
1	1	No Action	
2A	2	Cap	
2B	10	Cap with ground water treatment	
3A	3	Cap and slurry wall with ground water treatment (inside slurry wall only)	• Ground water from within slurry wall only • Treatment at the existing tar plant wastewater facility
3B	14	Cap and slurry wall with ground water treatment (inside and outside slurry wall)	• Ground water from both inside and outside slurry wall • New treatment facility

APPENDIX F

FOR CONSIDERATION ISSUES

APPENDIX F

ISSUES FOR CONSIDERATION

In review comments received on July 15, 1988 of the final draft report and at the review meeting, on July 21 and 22, 1988, several comments were made by the U.S. EPA and the OEPA which were relatively new and were not initially of concern. During the meeting, it was agreed to acknowledge these comments within the body of the text. However, these considerations either do not materially impact the alternatives or change the comparisons of the alternatives, and because of the time constraints, it was decided not to revise the figures, schedule, and cost tables. The major items are as follows:

1. In this FS report, it is assumed that the ash produced by incineration is nonhazardous. The method of ash storage, ash disposal, and accordingly the cost would require modification, if the ash is hazardous.

2. The cost and handling of spent carbon with the presence of significant amounts of radioactive constituents is not considered.

3. Preliminary assessment indicates that it is not feasible to pump or treat the NAPS layer identified in this report. No considerations of cost or time is provided for the NAPS investigation. Such considerations will change the implementation schedule and cost for all except the "no action" alternative.