FINAL REPORT

CONTAMINATION EVALUATION

Former Bomarc Missile Site
Raco, Michigan

Contract DACA -87-86-D-0045
Delivery No. 4

Prepared for

U.S. Army Corps of Engineers
St. Louis District
St. Louis, Missouri

and

U.S. Army Corps of Engineers
Huntsville Division
Huntsville, Alabama

200.1e
E05MI002601_01.09_0008

JULY, 1987

ENVIRODYNE ENGINEERS INC.
12161 Lackland Road St. Louis, Missouri 63146,(314)434-6960

ENVIRODYNE
ENGINEERS

12161 Lackland Road,
St. Louis, Missouri 63146
(314) 434-6960

July 31, 1987
3067-40016

U.S. Army Corps of Engineers
St. Louis District
LMSED-PM
210 N. Tucker Boulevard
St. Louis, MO 63101-1986

Re: Contract DACA-87-86-D0045
Delivery Order No. 4
Contamination Evaluation for the
Former Bomarc Missile Site, Raco, Michigan
Final Report

Gentlemen:

Enclosed are eight copies of the subject document. These include copies for distribution to HNDED-PM. The report has been prepared in accordance with Section 4.6 of the Scope of Work, and is submitted in conjunction with the Hazardous Ranking System Form for the site.

As directed in contract documents, the HRS form is based on limited information collected in a one-day field investigation. Inspection of building interiors and debris was not included in Scope of Work.

This submittal incorporates EEI's response to written comments and changes agreed upon during our presentation on July 20, 1987, as summarized in Appendix A.

Very truly yours,

Thomas M. Lachajczyk

Thomas M. Lachajczyk
Program Manager

TML/jam/158
Enclosures

cc: DAEN-ECE-B Washington
MRDED-L Omaha
MRDED-TE Omaha
MROED-E Omaha
MRKED-S Kansas City
NCEED-Detroit

FINAL REPORT

FORMER BOMARC MISSILE BATTERY
HIAWATHA NATIONAL FOREST
RACO, MICHIGAN

Contract No. DACA-87-86-D0045
Delivery Order No. 4

U. S. Army Corps of Engineers
St. Louis District
St. Louis, Missouri 63101-1986

and

U. S. Army Corps of Engineers
Huntsville Division
Huntsville, Alabama 35807-4301

Envirodyne Engineers, Inc.
12161 Lackland Road
St. Louis, Missouri 63146

July 1987

3067-40016

This Final Contamination Evaluation for the Former Bomarc Missile Site, Raco, Michigan, has been prepared to make a preliminary determination of the presence or absence of chemical contamination which may have been caused by DOD related activities. Engineering aspects of this Plan have been reviewed and approved by the undersigned Registered Professional Engineer.

STATE OF MISSOURI
CINDY L.
DAHL
NUMBER
E-21923
REGISTERED PROFESSIONAL ENGINEER

TABLE OF CONTENTS

		Page No.
Letter of Transmittal		i
Title Page		ii
Table of Contents		iii
List of Tables		iv
List of Figures		v
List of Exhibits		v
List of Appendices		vi
List of Symbols and Abbreviations		vii
Chapter No.		
1.0	EXECUTIVE SUMMARY	1-1
1.1	Groudwater	1-1
1.2	Silo Water	1-2
1.3	Soils	1-2
2.0	GENERAL INFORMATION	2-1
2.1	Introduction	2-1
2.2	Project Objectives, Scope and Approach	2-1
2.3	Site Location and Physiography	2-2
2.4	Ownership and Prior Use	2-2
3.0	SITE INVESTIGATION	3-1
3.1	Introduction	3-1
3.2	Monitoring Well Installation	3-5
3.3	Sampling Program	3-9
4.0	ANALYTICAL RESULTS	4-1
4.1	Introduction	4-1
4.2	Groundwater Analysis Results	4-12
4.3	Missile Silo Water Sampling and Analysis Results	4-17
4.4	Soil Sampling and Analysis Results	4-20
5.0	CONCLUSIONS AND RECOMMENDATIONS	5-1
	REFERENCES	R-1
	INVENTORY REPORT AND HAZARDOUS RANKING SYSTEM EVALUATION	

LIST OF TABLES

Table No.		Page No.
3-1	Summary of Aquifer Test Results	3-8
3-2	Summary of Groundwater Elevations	3-9
3-3	Summary of Soil Sampling Field Notes	3-11
3-4	Monitoring Well Development/Collection Data	3-13
3-5	Summary of Silo Sampling	3-15
3-6	Summary of Water Collection, Preservation and Storage Requirements for Each Sample	3-16
3-7	Summary of Soil Collection, Preservation and Storage Requirements for Each Sample	3-17
4-1	Summary of Analytical Methods, Analytes and Minimum Detection Limits in Soil and Water	4-2
4-2	Purgeable Halocarbons and Aromatics Evaluated and Their Detection Limits in Soil and Water	4-3
4-3	Minimum Concentration of Contaminants for Characteristics of EP Toxicity	4-5
4-4	Maximum Concentration of Constituents for Groundwater Protection	4-7
4-5	Final RMCLs and Proposed MCLs Organic Chemicals and State of Michigan Drinking Water Standards	4-8
4-6	Proposed RMCLs and Promulgated MCLs for Inorganic Chemicals and State of Michigan Primary Drinking Water Standards	4-9
4-7	Additional Proposed RMCLs for Volatile Organics	4-10
4-8	Organic Compounds to be Monitored	4-11
4-9	Summary of Analytical Results	4-13
4-10	Summary of Results of Testing of Groundwater at Monitoring Well Sites for Purgeable Halocarbons and Aromatics	4-14
4-11	Comparison of Maximum Groundwater Concentrations for Each Metal with Standards	4-16
4-12	Summary of Results of Testing of Silo Water for Purgeable Halocarbons and Aromatics	4-18
4-13	Comparison of Maximum Silo Water Concentrations for Each Metal with Standards	4-19
4-14	Summary of Results of Testing at Soil Sampling Sites for Purgeable Halocarbons and Aromatics	4-22

LIST OF FIGURES

Figure No.		Page No.
2-1	Raco Missile Battery and Airfield	2-3
3-1	Raco Missile Battery	3-2
3-2	Airfield Fuel Depot	3-3

LIST OF EXHIBITS

Exhibit No.		
3-1	Chain of Custody Form	3-19
3-2	Sample Container Labels	3-20

LIST OF APPENDICES

Appendices

A	Disposition of Comments
B	Right to Entry
C	Results of Soil Analysis
D	Well Construction and Boring Logs
E	Aquifer Testing
F	Results of Land Survey
G	Chain of Custody Forms
H	Results of Analyses
I	External QA Laboratory Analytical Results
J	Michigan State Recommended Limits in Drinking Water Standards
K	Dafter Sanitary Landfill Letter
L	Inventory Report and Hazardous Ranking System Evaluation

LIST OF SYMBOLS AND ABBREVIATIONS

AA	atomic absorption
C	Centigrade
CFR	Code of Federal Regulations
CO_3	carbonate
DERA	Defense Environmental Restoration Account
DI	deionized
DOD	Department of Defense
DNR	Department of Natural Resources
EP	extraction procedure
ft	foot
gal	gallon
gpm	gallons per minute
GC	gas chromatograph
GC/MS	gas chromatograph/mass spectrometer
HCl	hydrochloric acid
Hg	mercury
HNO_3	nitric acid
HRS	Hazardous Ranking System
ICAP	inductively coupled plasma
ID	inside diameter
MCL	Maximum Contaminant Level
ug/g	micrograms per gram (ppm)
ug/l	micrograms per liter (ppb)
mg/l	milligrams per liter (ppm)
ml	milliliters
MRD	Missouri River Division
ng/g	nanograms per gram (ppb)
N	Normal
PCB	polychlorinated biphenyl
ppb	parts per billion
ppm	parts per million
PVC	polyvinyl chloride
QA/QC	Quality Assurance/Quality Control
RMCL	Recommended Maximum Contaminant Level
RCRA	Resource Conservation and Recovery Act
S/A	Sampling/Analysis
SDWA	Safe Drinking Water Act
USDA	United States Department of Agriculture
USEPA	United States Environmental Protection Agency
USFS	United States Forest Service

1.0 EXECUTIVE SUMMARY

A contamination evaluation was performed at the former Bomarc Missile Battery in Raco, Michigan. The site is currently owned by the U. S. Forest Service (USFS) and is part of the Hiawatha National Forest. The contamination evaluation included a records review and visual site inspection; installation of four groundwater monitoring wells; collection of groundwater samples from each well; collection of surface water samples from six missile silos; and collection of near-surface soil samples from nine locations. Samples from each site were analyzed for petroleum hydrocarbons, total metals (including barium, cadmium, chromium, lead, arsenic, silver, selenium and mercury), polychlorinated biphenyls (PCBs), and purgeable halocarbons and aromatics. In addition, water samples were analyzed for dissolved metals.

During the records review and visual site inspection, a site map was developed and locations of former Bomarc site facilities were identified. Several buildings, 14 underground fuel storage tanks, and 28 underground missile silos remain on the property. Currently, the property is not being used by the owner.

During the visual site inspection, evidence of potential soil and water contamination was found at several locations. This evidence included oil-stained soil and gravel surrounding the transformer pad; stained soil in the vicinity of the C-1 and C-2 underground oil storage tanks; a dry wastewater treatment lagoon and adjacent area with sparse vegetation; and 28 missile silos, most of which are partially filled with water and concrete rubble. Two of the silos appeared to contain oil and/or paint wastes. No evidence of surface contamination was noted at underground storage tanks other than C-1 and C-2. A Sampling/Analysis - Quality Assurance/Quality Control (S/A-QA/QC) Plan was developed to evaluate potential contamination at these and other sites on the property.

Based on the visual site inspection, six silos, which exhibited the highest potential for contamination, were selected for sampling and analysis.

During well installation, the depth to groundwater was greater than originally anticipated. Total well depths (including 10-foot screens) ranged from 43.1 to 56.5 feet below ground elevation.

Permeability tests were performed on the four wells. The results ranged from 1.5×10^{-1} to 9.4×10^{-3} cm/sec. These results, combined with water level measurements, verify that wells were positioned such that contaminants could have been transported through the groundwater system to each well location during the period since operations at the missile site ceased.

1.1 GROUNDWATER

All metals concentrations in groundwater samples were found to be below proposed RMCL, MCL, RCRA groundwater protection criteria and State of Michigan groundwater protection criteria. Petroleum hydrocarbons were detected in the sample collected at monitoring well RG-3 at 1.8 mg/l. This may be due to the

position of RG-3 downgradient of the wastewater treatment plant site and underground fuel tanks. Three organic chemicals were also detected in the RG-3 sample: trichloroethylene at 3.0 ug/l, 2-pentene-3,4,5-trimethyl at 3.4 ug/l, and 1-pentene-2,4,4-trimethyl at 20.8 ug/l.

Toluene was detected in the groundwater sample collected at RG-4 at a concentration (1.9 ug/l) slightly higher than the lower detection limit. This could be due to the deuterated toluene that is in the surrogate spike used in Method 8240. Further sampling is recommended.

1.2 SILO WATER

Low levels of barium and lead were detected in most of the silos. Chromium was found just above the detection limit in one silo. The concentrations of the metals found in the silo water samples are below all applicable drinking water standards. Petroleum hydrocarbons were detected in all silos tested, but at a concentration of 5 mg/l or less in each except for RB-4. Silo RB-4 had a concentration of 1,810 mg/l. Silo RB-4 also exhibited signs of organic chemical contamination with benzene and toluene concentrations of 6.0 and 1.2 ug/l, respectively. No contamination was confirmed in silo 2 (RB-10), which visually showed potential contamination. None of the other silos are believed to contain significant contamination.

1.3 SOILS

Arsenic, barium and chromium were detected at low levels and lead was found at 12.4 ng/g in the soil sample from the former wastewater treatment lagoon. The lagoon and adjacent denuded area do not appear to be a source of significant metals contamination. There were comparatively low levels of petroleum hydrocarbons detected at eight soil sampling locations (including near the stained soil of the underground storage tank). A high concentration (8,530 ug/g) of petroleum hydrocarbons was found near the transformer pad. There is no evidence that this soil contamination has affected groundwater concentrations downgradient. Methylene chloride and ethylbenzene were detected in one sample and toluene was detected in three samples. Further sampling is recommended to verify organic chemical values.

PCBs were not detected in samples collected at the transformer pad, or in any other soil or water samples.

There is no evidence that any underground storage tanks are leaking petroleum hydrocarbons into the groundwater system.

Responsibility for the oil spill at the transformer pad is not known. Responsibiilty for potential contamination at monitoring well RG-3 is believed to be due to the DOD's operation of the wastewater treatment plant at the missile site or possible leakage or spillage at underground tanks. Petroleum hydrocarbon and paint contamination in the silos is not believed to be the DOD's because it appears that the sources of these contaminants were placed there after DOD activities ceased.

2.0 GENERAL INFORMATION

2.1 INTRODUCTION

The Department of the Army is responsible for administration of the Defense Environmental Restoration Account (DERA). The objective of the DERA Program is to identify and remedy environmental problems at facilities formerly owned and operated by the DOD.

The U.S. Army Corps of Engineers, Huntsville Division, contracted with Envirodyne Engineers, Inc. (EEI) in March of 1986 (Contract DACA-87-86-D0045) to survey DERA sites in USEPA Regions V, VI, VII and VIII. On April 14, 1986, administration of this contract was transferred from the Huntsville Division to the St. Louis District.

On September 17, 1986, EEI received Delivery Order No. 4 of this contract to perform a contamination evaluation of the former Bomarc Missile Site in Raco, Michigan.

2.2 PROJECT OBJECTIVES, SCOPE AND APPROACH

The objective of the contamination evaluation was to make a preliminary determination of the presence or absence of chemical contamination which may have been caused by DOD related activities. In order to conduct the contamination evaluation, EEI performed a site inspection, developed Safety, Monitoring Well Installation, and S/A-QA/QC Plans, and collected and analyzed soils, silo water and groundwater samples from locations on the former Bomarc site property. The work included collection and chemical analysis of near-surface soil samples from nine locations; physical analysis of two samples from each of the monitoring well borings; collection and chemical analysis of groundwater samples from four groundwater wells and also from an off-site well used as a source of drilling water; and collection and analysis of water samples from six underground missile storage structures. The samples were analyzed for purgeable halocarbons and aromatics, petroleum hydrocarbons, PCBs and total metals (including arsenic, barium, cadmium, chromium, lead, mercury, selenium and silver). In addition, water samples were filtered on-site and analyzed for dissolved metals.

The sampling and analysis program was designed to ensure, to the greatest extent practical, detection of contaminants potentially present on-site. For example, the sampling locations were selected to correspond with locations where evidence of disposal and/or transport of contaminants was most likely to be present. The project was not intended to allow determination of the extent of contamination or the rate of transport from sources. The analytical program was designed to determine the presence or absence of the most probable pollutants, with quantitative measurements of the concentrations of those found. This approach was reflected in the location of sampling points, number of samples collected, and types of QA/QC procedures followed.

Cuttings brought to the surface from auger borings were stored in drums on-site pending results of the analytical program. Based on those results, EEI has disposed of cutting at the Dafter Landfill. (For further information, see Chapter 5 and Appendix K.)

Based on the results of all project tasks, EEI has completed a Hazardous Ranking System (HRS) form. The contents of this form include a summarization and evaluation of existing information on the site, including preliminary general information; real estate search information; previous pollution abatement permits; the status of waste storage areas; hazardous substances; groundwater, surface water and air migration routes; fire and explosion hazards; and ordnance and explosive waste risks and debris.

2.3 SITE LOCATION AND PHYSIOGRAPHY

2.3.1 Site Location

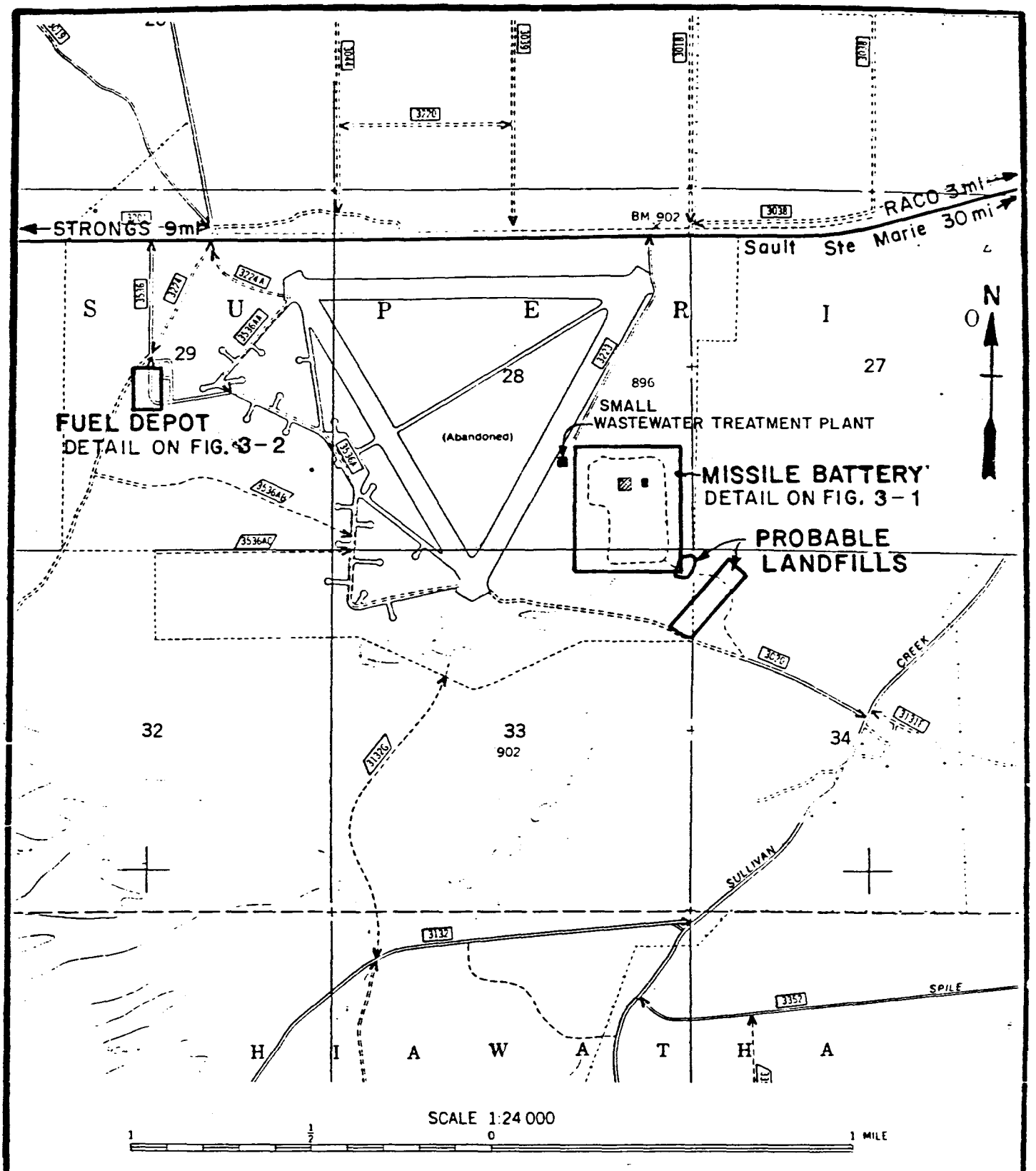
The former Bomarc Missile site is located within the Hiawatha National Forest near Raco, Chippewa County, Michigan, approximately 20 miles southwest of Sault Ste. Marie, Michigan. The property is just south of Michigan State Route 28. The site consists of 152.45 acres and is divided into two parts. The area east of the airstrip consists of the former composite building, former assembly and maintenance building, several smaller stone or concrete buildings, concrete building slabs, an abandoned wastewater treatment plant, 28 in-ground missile silos (each 23 feet x 25 feet x 8 feet deep), and approximately six underground fuel storage tanks. There is also a large (5,000 cubic yards) sawdust pile north of the composite building. West of the airstrip there is an underground fuel depot consisting of approximately eight underground storage tanks. There are also various roads, walkways, fences, standpipes and manholes throughout the property. The former missile site has the approximate Michigan State Plane coordinates of 2,550,000 feet west and 580,000 feet north. The locations of the missile battery and fuel depot are shown in Figure 2-1.

2.3.2 Physiography

The Raco Bomarc missile site and fuel depot parcels each lie on relatively flat ground, with elevations ranging from approximately 900 to 915 feet above sea level at the launch site and about 908 feet at the fuel depot. The physiography of the area includes glacial outwash sand with gravel, cobbles, and boulders [1]. Groundwater was found to be present approximately 33 to 46 feet below the surface. Previous groundwater investigations in the area have reportedly indicated that surface and groundwater flow is toward the south-southeast. This appears to be confirmed by the presence of low-lying areas, swamps, and Prey and Sullivan creeks in that direction [2].

2.4 OWNERSHIP AND PRIOR USE

The former Raco missile site is part of an area that has been intermittently controlled and used by the Department of Defense and its predecessor agencies since 1895. In 1925 the site was part of a 2,671-acre parcel of public domain land given National Forest states by Executive Order 4243. The Executive Order gave jurisdiction to the USFS subject to dominant use for defense purposes when needed by the Department of Defense. The Secretary of Agriculture transferred 240 acres for Raco Airfield use by permit, dated August 27, 1942. The airfield was constructed in 1942-1943. Around 1960, the missile base was constructed adjacent to the airfield. On January 29, 1964, by a



ENVIRODYNE ENGINEERS

FIGURE 2-1

Raco Missile Battery and Airfield

Memorandum of Understanding between the USFS and the Department of the Air Force, the Air Force released the Raco Airfield property, except the 152.54 acres for the missile site. On June 30, 1973, another Memorandum of Understanding released the remaining 152.54 acres back to the USFS together with all improvements.

Since June 30, 1973, the property has remained under USFS jurisdiction. The USFS has entered into several agreements with outside interests that have affected conditions at the site [3]. These are summarized as follows:

1) A special use permit was issued to a local Indian tribe on October 16, 1973, which allowed a sawmill to be operated in the 26,000 square foot Composite Building. The mill was to benefit the local community by providing employment and job training. The operation was discontinued and all related equipment was removed. A large pile of sawdust, wood waste and other debris created by the mill operation still remains adjacent to the building. The USFS did not receive any significant benefit from this operation.

2) In September 1978, the USFS entered into a contract for the sale of six buildings, a water tower and 28 missile silo shelters with a private contractor, which led to the demolition of the above-ground structures for salvage. The USFS has stated that the funds were transferred to the U.S. Treasury and did not directly benefit the USFS. The salvage activities, combined with the unauthorized removal of items by trespassers, left little of value at the site which could be classified as salvageable, with the exception of structural steel and portions of mechanical systems in the two large buildings.

3) In November 1978, a building was sold to Michigan Technological University for $1.00 through the Department of Health, Education and Welfare (HEW) as approved by GSA. The building was removed from the site as a project for educational purposes.

4) On September 4, 1981, the USFS entered into a two-month Special Use Permit with a contractor which allowed the dumping of broken concrete and other construction materials into the open missile silos. The USFS allowed this use to reduce the hazard to public safety created by the open missile silos. A similar Special Use Permit was issued in August 1984 and was in effect until October 1984.

5) On July 11, 1983, the USFS entered into an agreement with Chippewa County, transferring salvage rights for the two large buildings (26,000 square foot composite building and 6,000 square foot assembly and maintenance building) to the county for $1.00 each, conditional on the demolition of the buildings. Demolition of the buildings was never initiated and did not take place under this agreement which terminated on September 30, 1984.

6) Reportedly, the airfield is currently used during the winter months as an automobile tire testing ground [4].

3.0 SITE INVESTIGATION

3.1 INTRODUCTION

Site investigations commenced with a visual site inspection conducted by EEI on October 2, 1986 to identify potential hazardous or toxic pollutant sources. EEI personnel who participated in this survey include Thomas Lachajczyk, Program Manager; Paul Shetley, Project Geologist and Safety and Health Coordinator; and Cindy Dahl, P.E., Principal Engineer. EEI personnel met with Roger Jewell, Larry Burkhart and Joe Carrick of the USFS prior to the site inspection.

As described previously, several above-ground buildings, 28 missile silos and 14 underground oil/fuel storage tanks remain on-site. Their locations are shown in Figures 3-1 and 3-2.

In order to proceed with the contamination evaluation, EEI requested a written right-to-enter the property and approval to drill from the USFS, in accordance with Section 3.4.2 of the Scope of Work. The right-to-enter is presented in Appendix B.

The following sources of potential contamination were identified during the visual site inspection.

3.1.1 Transformer Pad Spill

Surface soil and gravel surrounding the transformer pad located outside the southeast corner of the Composite Building are obviously stained with a black, oil-like substance. There is an odor of oil at the site. Discolored areas include a 14 ft x 20 ft area immediately west of the pad, a 17 ft x 5 ft area between the pad and the Composite Building, and a 10 ft x 20 ft area immediately east of the pad. Of these three areas, the area west of the pad appears most discolored. The area east of the pad is partially covered with gravel and has been partially excavated.

3.1.2 C-1 Surface Soil

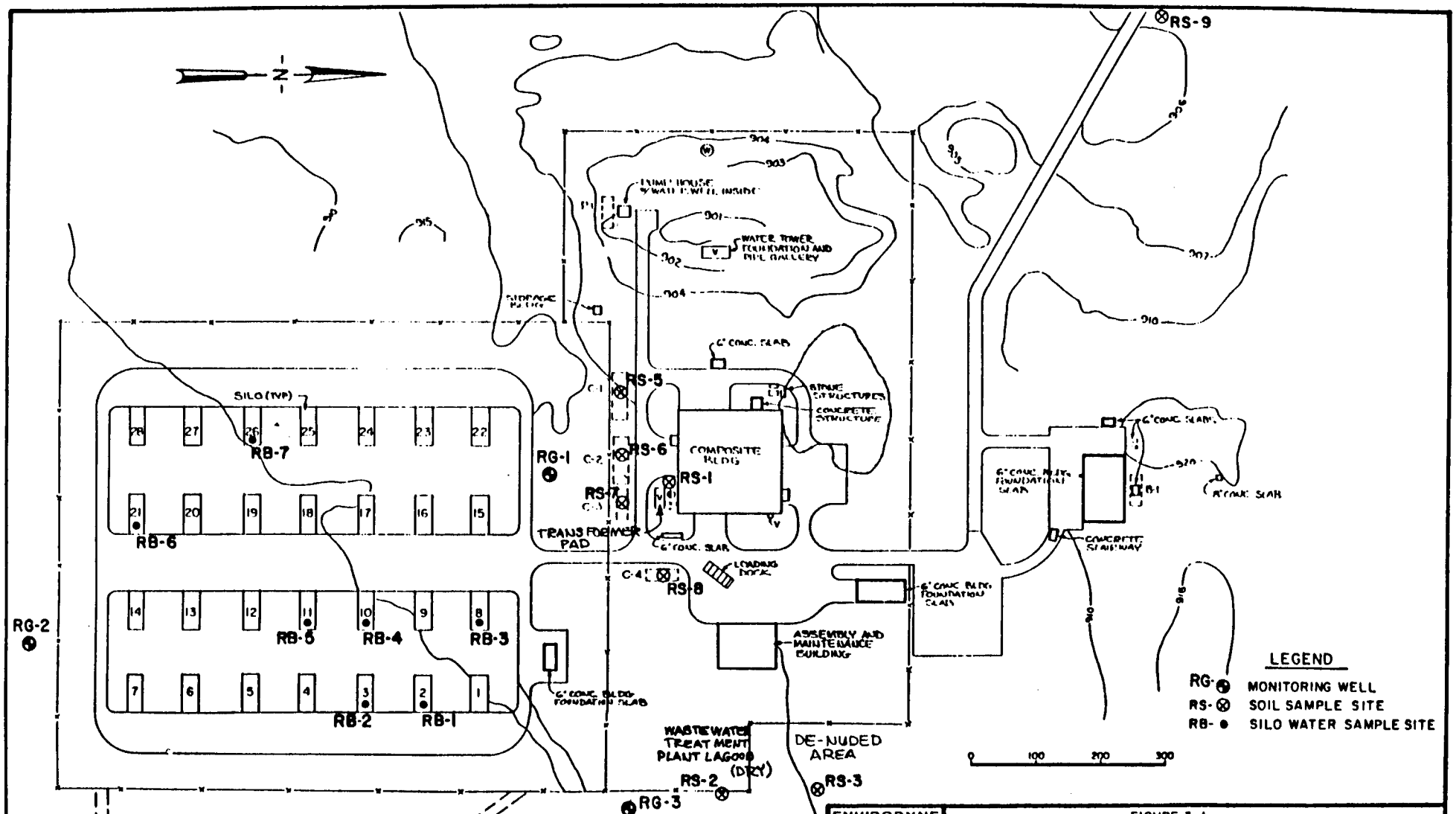
An underground oil storage tank is believed to be located below the C-1 surface soil with liquid present in the tank. The surface is discolored in places with a black, tar-like substance.

3.1.3 C-2 Surface Soil

Another underground storage tank is believed to be located below the C-2 surface soil, with at least a small amount of liquid present. There are black surface stains at this site.

3.1.4 Missile Storage Silos

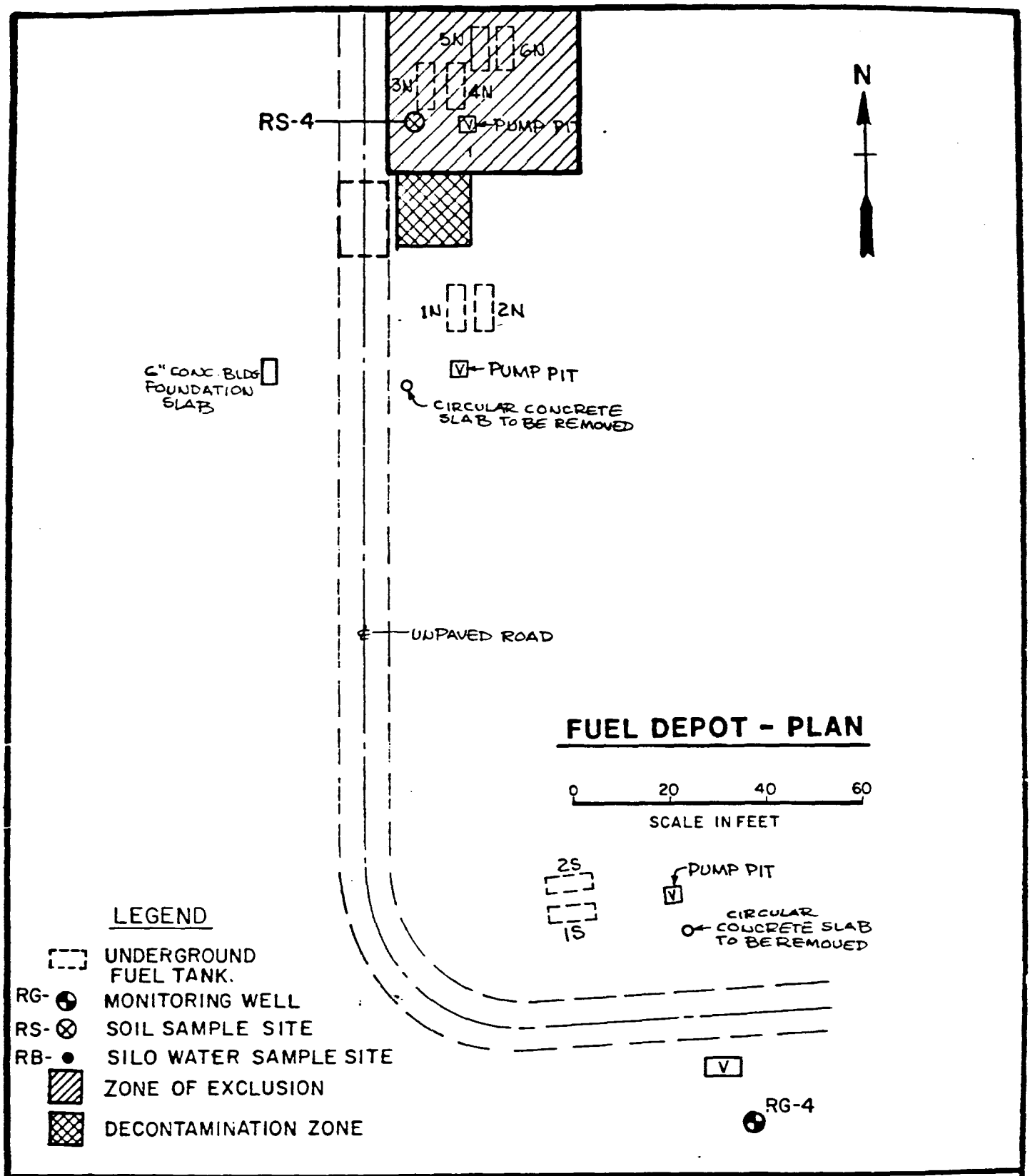
The contents of each of the 28 open silos were inspected. Each silo had dimensions of 23 ft x 25 ft x 8 ft deep. In general, each silo contained



ENVIRODYNE ENGINEERS

FIGURE 3-1

Raco Missile Battery Monitoring Wells, Soil Sampling and Water Sampling Locations



ENVIRODYNE ENGINEERS

FIGURE 3-2

Airfield Fuel Depot

Monitoring Well and Soil Sampling Locations with Safety Zones

concrete rubble and was about half-filled with water. In most of the silos, the water was fairly clear to greenish-brown in color. The color of the liquid in each silo appeared to depend on the amount of leaves in them.

The following exceptions/additions to the general description above were noted:

Silo 2. Observations included concrete rubble, tar (solidified), red sludge-like material on the surface of the water, oil on the surface of the water, water about 4 feet from top of silo.

Silo 3. Beds, rags, mattresses, a hair dryer and other debris were noted.

Silo 9. Water in this silo was about 1 foot from the top.

Silo 10. Two 55-gallon drums were found in the silo above the other debris. This indicates the drums were probably placed in the silo after DOD activities were completed. One drum was labeled "concrete curing compound," the other "white resin." The liquid in this silo was noticeably contaminated with a thick yellow material with an odor of organic solvents or petroleum distillates floating on the surface, especially in one corner of the silo. Some oil sheen was noted on the water's surface.

Silo 11. A 20-gallon (approximate) open top fiber drum labeled "CITGO," an antifreeze container and several small 12 volt batteries were found in this silo. No oil was noted on the surface of the water.

Silo 15. Approximately 50 cans were found in this silo, stacked in groups of 4 or 5, and labeled "Seal Tight Hi-Spec Rubber Asphalt Joint Sealer, Caution Vapor Harmful, 50-Pound Net Weight." Lumber and concrete rubble were also found. No water was present in this silo.

3.1.5 Wastewater Treatment Lagoon

The wastewater treatment plant lagoon (approximately 50 ft x 20 ft) was dry. It apparently received domestic and industrial wastewater from the Composite Building and Assembly and Maintenance Building.

3.1.6 De-nuded Area

A denuded area (approximately 200 ft x 100 ft) is located just north of the wastewater lagoon. This sandy area had sparse vegetation but was not discolored.

3.1.7 Borrow Area/Possible Dump Site

A borrow area and possible dump site is located in the woods, southeast of the missile silos. Joe Carrick of the USFS stated that it is rumored this large (several acres) borrow area was used to dispose of miscellaneous materials during the Air Force's occupation of the site [4]. The site location is shown in Figure 2-1. This site was obviously used as a borrow area, but no direct evidence of dumping was found. This site will be further evaluated by the U.S. Army Corps of Engineers, Detroit District.

3.1.8 Excavated Mound/Possible Dump Site

A large, excavated mound was located in the woods, southeast of the missile silo area and north of the sand road. The mound is not consistent with surrounding topography and is believed to be man-made. A section of the mound was excavated in a horse-shoe shaped configuration. The top of the mound was about 15 to 20 feet higher than the center. There was a pile of concrete rubble in the center and water standing at the entrance. The location of the mound is shown in Figure 2-1.

3.1.9 Three Underground Tanks (C-3, C-4 and Near the Water Pump House)

These three tanks are present below ground level. No stained soil was noted in these areas. Tank C-3 contained liquid. However, it is not known whether the other tanks contained liquid since no open standpipes were found.

3.1.10 Wastewater Treatment Plant

A small plant, consisting of one 6 ft x 5 ft deep concrete pit and two smaller pits, was located just east of the air strip. The location is shown in Figure 2-1.

3.1.11 Underground Fuel Tanks

It appears that nine underground tanks were located west of the airfield. Several standpipes extend above ground and are open to the air. Several of the tanks are at least partially full of liquid.

3.2 MONITORING WELL INSTALLATION

In order to determine if groundwater has been contaminated, EEI supervised the installation of four groundwater monitoring wells and conducted a sampling and analysis program. In conjunction with this activity, EEI prepared a Monitoring Well Installation Plan, which was approved in November 1986. Work was conducted according to this Plan.

3.2.1 Well Locations

Information collected during the on-site inspection and from regional topographic maps indicated the direction of flow is to the south-southeast toward Sullivan Creek. During the site inspection, the depth of an existing well on the property was measured at 42.3 feet below ground level.

Three of the wells were located downgradient of potential pollutant sources in the Bomarc Launch Area (Figure 3-1). The fourth well was located down gradient of fuel tanks at the Fuel Depot (Figure 3-2). Specific rationale corresponding to positioning of each well is described as follows:

MW-1 - This well was located downgradient of underground storage tanks C-1, C-2 and C-3, and used to monitor any contaminants coming from the tanks.

MW-2 - This well was located downgradient of the silo storage area and used to monitor any contamination emanating from the silos.

MW-3 - This well was located downgradient of the wastewater treatment plant lagoon and used to monitor any contaminants leaching from the lagoon and into the groundwater.

MW-4 - This well was located downgradient of the cluster of fuel tanks at the fuel depot, west of the airfield, and used to monitor any contaminants coming from the fuel depot.

3.2.2 Monitoring Well Construction

Monitoring wells were installed in accordance with Section 3.5 of the Scope of Work.

Drilling and installation of the four monitoring wells was performed by STS Consultants of Green Bay, Wisconsin from December 4 through 9, 1986 and supervised by Paul Shetley of EEI.

All borings were completed with a 6-1/2-inch outside diameter, hollow stem auger. Split spoon samples were collected from the boring continuously for the first 10 feet, and at 5-foot intervals or stratum changes to the end of the boring. Each split spoon sample was visually classified and logged. In order to verify the classification, two samples from each boring were submitted for physical analysis (grain size, Atterberg limits and moisture content). The samples were analyzed by STS Consultants and results are presented in Appendix C. Atterberg limit determinations were not practical because the samples were composed of sand. Logs from each of the four borings are presented in Appendix D. All remaining split spoon samples were placed in glass jars and stored at EEI for future reference or physical laboratory verification, if required.

To avoid any contamination during the drilling and well installation procedure, all augers, bits, rods, split spoons and other equipment used were thoroughly steam cleaned prior to drilling at each site. The split spoon samplers were cleaned with an Alconox solution, rinsed with fresh water and rinsed finally with acetone and hexane between each sample. All PVC well casings and stainless steel screens were also steam cleaned prior to installation.

Because of the sandy soil present at all four monitoring well locations, it became necessary to add water to three of the borings to avoid heaving of sand and collapse of the hole. This was done with the concurrence of the Authorized Representative of the Contracting Officer. The volume of water added to each well ranged from none to 100 gallons. EEI's standard operating procedure includes removal of five times the volume added to each well during development. The USFS work station well, located approximately 3 miles northeast of the Launch Area, was the source of water used during construction. The well water was tested for all parameters included in the analytical program and was free from contamination.

At each site, 10 feet of slotted stainless steel well screen was threaded onto the PVC well casing. The screen consists of 2-inch stainless steel casing pre-slotted to 0.010 inch. The entire length of schedule 40 PVC riser was lowered into the boring through the auger center to a depth of 1 foot above the bottom of the boring. The 1 foot open hole and annulus around the well screen to a height of 3 feet above the top of the screen was filled with medium to coarse prewashed filter sand. The augers were successively removed during this process to accomodate the placement of the filter sand.

After the filter sand pack was in place, bentonite pellets were added. To insure a complete seal within the borehole, the pellets were forced out of the bottom of the auger and into the annulus by using a "tamping rod." The pelleted seal had a minimum height of 3 feet above the sand filter. After placement of this seal, the augers were completely removed and the borehole annulus filled with a bentonite cement slurry to the ground surface.

A 5-foot x 6-inch, round steel protector pipe with hinged lid was placed over the PVC riser pipe and allowed to settle for 24 hours. The next day, the cavity created by settling of construction material was filled in and the grout surface was mounded to inhibit puddling of water around the well. Three protective steel guard posts were erected radially around each well. All pipes and posts were painted red for high visibility and protector pipes were locked with a keyed padlock. Keys to each well were given to Mr. Roger Jewell, United States Forest Service, Sault Ste. Marie, Michigan.

3.2.3 Well Development

EEI developed each well after receiving approval of construction logs from the Authorized Representative of the Contracting Officer. The development program was directed by Paul Shetley on January 12 through 15, 1987. Initially each well was bailed for approximately one hour to remove sand and turbid water. Then each well was pumped at a rate of approximately 3.0 gpm using a rod pump. More than 500 gallons of water were removed from each well. At the conclusion of each development period, photos were taken which exhibited the clarity of the well water, and these were submitted to the Authorized Representative of the Contracting Officer for his approval.

3.2.4 Permeability Testing

In-situ permeability testing was conducted by Paul Shetley and Randy Thompson of EEI on January 15, 1987. The results are presented in Appendix E and summarized below.

The depth to water from the top of the PVC casing was measured at each well. A PVC bailer (0.14 feet outside diameter x 3.86 feet long) was then lowered into the well to fill the bailer, and then removed. This generated a slug with a displacement volume of 0.059 cubic feet (0.441 gallon), composed of water from the well and the PVC bailer. The water level was allowed to stabilize until the depth to water measurement was the same as before the bailer had been lowered into the well.

The slug test was then initiated by rapidly lowering the slug back into the well closely followed by the water level indicator (a weighted, bell-type popper attached to a tape measure) to measure the rate at which the water level returned to the pre-slug level.

With the 2-inch (nominal) Schedule 40 pipe, the 0.441-gallon slug would create a calculated 2.68 feet instantaneous rise in the water level in the well. Due to the high permeability of the aquifer, the water level returned to the original level so quickly that only a few measurements were possible. As shown by the data in Appendix E, this was at 0.35 feet or less above the original (static) water level, and then stabilized in less than 30 seconds after the slug was lowered into the well.

To ensure credible results from the limited amount of data the wells yielded during the slug tests, two methods of data reduction were used. The Ferris and Knowles [5] method prescribed by the Scope of Work was compared with the method described by Cooper, et al. [6]. The first method uses a line source approximation of the well function, and is appropriate on wells where residual head is very small compared to initial head. The second method is a curve matching technique, which matches the plotted data to a series of type curves. Considering the characteristics of the Raco wells, both methods are considered valid. The results are nearly the same (Table 3-1). The methods, calculations and graphs used to derive the coefficient of permeability for each well are presented in Appendix E.

TABLE 3-1

SUMMARY OF AQUIFER TEST RESULTS

	k, Coefficient of Permeability	
Well No.	Cooper, et al. (cm/sec)	Ferris and Knowles (cm/sec)
MW-1	3.5×10^{-2}	1.0×10^{-2}
MW-2	1.5×10^{-1}	8.2×10^{-2}
MW-3	1.6×10^{-2}	9.4×10^{-3}
MW-4	7.8×10^{-2}	2.7×10^{-2}

3.2.5 Site Survey

After completion of monitoring well installation, a site survey of the four monitoring wells was performed to establish the horizontal and vertical location of each well, in accordance with Section 3.5.11 of the Scope of Work. This work was conducted by Northwoods Land Surveying, Inc. of Sault Ste. Marie, Michigan in January of 1987. The results of the survey and the location of the permanent monuments placed in the project area are presented in Appendix F.

Based on the results of the monitoring well installations and the site survey, groundwater elevations at each monitoring well were compiled and are summarized in Table 3-2.

TABLE 3-2

SUMMARY OF GROUNDWATER ELEVATIONS

Well	GW Elevation (feet)	Stickup	TOC Elevation (feet)	Dw (feet)	GS Elevation (feet)	1987 Date
MW-1	859.33	2.28	907.08	47.75	904.80	1/15
MW-2	859.91	2.48	905.96	46.05	903.48	1/15
MW-3	858.11	2.52	906.56	48.45	904.04	1/15
MW-4	875.29	2.73	910.04	34.75	907.31	1/15

NOTES: MW = Monitoring Well
TOC = Top of PVC Casing
GS = Ground Surface
DW = Depth from top of PVC Casing to water level
GW = Groundwater

3.3 SAMPLING PROGRAM

The sampling program consisted of:

1) Collection of one set of samples from each groundwater monitoring well, as well as one set of samples from the source of water added to the wells during construction.

2) Collection of soil samples from eight potentially contaminated locations, plus one background site.

3) Collection of water samples from six of the 28 missile silos.

3.3.1 Sample Locations and Collection Methods

3.3.1.1 Soil Samples - Soil sampling locations were designated RS-1 through RS-9 and are shown in Figures 3-1 and 3-2. These locations were proposed and approved in the Monitoring Well Installation Plan. The rationale for selection of the sites is summarized below.

RS-1 - A composite sample was collected from areas immediately west, north and east of the transformer pad. The site was selected based on obvious oil contamination and potential PCB contamination due to a transformer spill.

RS-2 - This sample was collected from a single location near the center of the former wastewater treatment plant lagoon, which is now dry. The site was selected because of the potential for presence of metallic, oil or solvent residues which may have entered the treatment system from operational buildings.

RS-3 - This sample was collected from a single location near the center of the disturbed area immediately north of the wastewater lagoon. The site was selected because of its close proximity to the wastewater treatment system and its possible use as a disposal area. The area is sandy and has very sparse vegetation throughout.

RS-4 - This sample was collected in the western fuel depot area adjacent to the fuel pump pit which served underground fuel storage tanks 3N, 4N, 5N and 6N. The location was chosen because of the potential for spills near the fuel pump and because this pump served the largest number of fuel tanks.

RS-5 - This sample was collected in the area which covered the underground tank designated C-1. The soil in this area is obviously stained with a black, oil-like substance.

RS-6 - This sample site is above the location of underground tank C-2. This soil is also stained.

RS-7 - This sample site corresponds to the location of underground tank C-3. No staining was observed.

RS-8 - This sample site corresponds to the location of underground tank C-4. No staining was observed, but the vegetation covering this area was more sparse and different than surrounding areas.

RS-9 - This sample site was selected to represent background conditions. The rationale for selection is that it would be unlikely that waste disposal would intentially occur near the entrance to the facility.

Soil sampling was performed on December 2, 1986 and January 14, 1987 by Paul Shetley and Randy Thompson of EEI. At each location, soil samples were collected at a depth of approximately 2 feet by using a stainless steel bucket auger. Prior to collection of each sample, the bucket auger was washed with a solution of non-ionic detergent (Alconox) and distilled water and rinsed with distilled water, acetone and finally hexane. The sample was tapped out of the bucket auger into the appropriate containers. When necessary to composite split samples, the soil was mixed in a stainless steel pan before splitting into identical fractions. The mixing pan was washed with Alconox and distilled water and rinsed with distilled water, acetone, and hexane prior to sampling at each site.

At each of the soil sample sites, the following information was recorded in a bound field notebook.

1) Date
2) Time of sampling
3) Sample site designation
4) Description and sketch of locations of samples relative to nearest landmark
5) Description of vegetative cover at site
6) Description of soil encountered, including texture, color, moisture, content, odor, and the presence of any foreign type material or other characteristics

A rinsate sample was collected prior to sampling at site RS-7. A summary of contents of the field notebook are presented in Table 3-3.

TABLE 3-3

SUMMARY OF SOIL SAMPLING FIELD NOTES

Site	Collection Date	Time	Sample Depth (inches)	Location	Soil Description at Sampling Depth	Description of Vegetation
RS-1	01/14/87	1030	24	Composite from 3 sites east, north and west of pad at SE corner of composite building	Tan, fine to medium sand with no staining	Gravel at the surface, a few weeds around the edge
RS-2	12/02/86	1330	22-26	The center of the settling basin, midway between the two discharge pipes	Light brown, medium sand	Some moss and lichens, some grass, some areas void of vegetation
RS-3	12/02/86	1400	22-26	Center of sludge drying bed	Tan, fine to medium sand, very consistent	Very little growth. Only sparse areas of moss and grasses
RS-4	12/02/86	900	22-26	10 ft west of exposed pipes at fuel depot	Tan, medium to coarse sand with occasional staining	Weeds and grasses up to 1 ft. Some shrubs and trees 20' away
RS-5	12/02/86	1030	22-26	3-1/2 feet west of fill spout at C-1 storage tank	Tan, medium sand	Weeds and grasses up to 1 ft high
RS-6	12/02/86	1100	22-26	Approximately 6 ft north of fill spout at C-2 storage tank	Brown, fine sand	Some weeds and grasses in oil stained area. Weeds and grasses up to 2 ft outside oil stained area
RS-7	12/02/86	1130	22-26	3-1/2 ft south of sealed spout at C-3 storage tank	Tan, fine sand	Mainly grasses with some weeds up to 1 ft
RS-8	01/14/87	830	22-26	Composite from two points near the northwest and southwest corner of the C-4 underground storage tank	Medium brown, fine to medium sand	Grasses and weeds
RS-9	12/02/86	1430	22-26	Between site access road and airstrip, 75 ft southwest of the road, near two birch trees	Tan, fine sand	Grass and mosses with a few trees

3.3.1.2 Groundwater Samples - Groundwater sampling locations were designated RG-1 through RG-4 and are shown in Figures 3-1 and 3-2. The rationale for selection of these locations was explained in Section 3.2.1.

The collection of samples from each well took place after the wells were developed. Samples were collected on January 13 through 15, 1987, by Paul Shetley and Randy Thompson of EEI. Immediately prior to sample collection, at least five times the volume of standing water in each well was purged from the well using a rod pump. The amount to be purged from each well (PV) was computed according to the formula:

$$PV\ (gal) = 5\ [D_b(ft) - D_w\ (ft)] \times 0.174\ gal/ft$$

where PV = Minimum purge volume (gallons)
D_b(ft) = Distance from top of PVC casing to bottom of well
D_w(ft) = Distance from top of PVC casing to water level
0.174 gal/ft = Well volume per foot depth of 2-inch schedule 40 well casing

Water quality measurements were taken during each purging and prior to sample collection. Purge volumes and water quality measurements are summarized in Table 3-4.

Samples at RG-1 through RG-4 were collected using a Teflon bailer. Samples from the well at the USFS work station were collected from the truck-mounted steel tank used to haul water from the work station to the site. Bailers, filtration equipment and all other equipment (excluding sample containers) used in collecting the well samples were cleaned and rinsed between collection of samples at each well. A distilled water rinse was used on the filtering apparatus and the monitoring equipment between sites.

3.3.1.3 Missile Storage Structure Water - Silo locations designated RB-1 through RB-7 are shown in Figure 3-1. During the initial site inspection, 27 of the 28 silos were found to contain some water. The locations chosen for sampling were those that exhibited the greatest potential for contamination. The specific rationale for selection of silos for sampling is presented below.

RB-1 - Silo 2 was found to contain concrete rubble, solidified tar, a red coating or sludge near the surface of the water, and an oil sheen on the surface of the water.

RB-2 - Silo 3 was found to have a white powdery material that coated the concrete rubble below the surface of the water.

RB-3 - Silo 8 contained debris and concrete blocks covered with a layer of asphalt. However, there was no visible contamination in the water.

RB-4 - Silo 10 contained the most obvious evidence of contamination, including two 55-gallon drums, the presence of a yellow, sludge-like material with an odor of organic solvents or petroleum distillates floating on the surface, and an oil sheen on portions of the surface of the water.

TABLE 3-4

MONITORING WELL DEVELOPMENT/COLLECTION DATA

Site	1987 Date	D_b (ft)	D_w (ft)	H_t (ft)	PV (gal)	Time	Cumulative Volume Purged (gallon)	Temp °C	Comments	Odor	pH	Cond (umhos/cm)
RG-1	01/13					1000	0	7.5	Very turbid	None	8.4	360
						1130	40	7.5	Somewhat turbid	None	8.8	110
						1300	310	8.0	Clear with some sand	None	7.8	80
						1400	490	7.5	Clear	None	7.6	80
						1430			Collected samples in triplicate			
	01/15	57.8	47.75	10.05	8.74	1545			Measured depth to water			
RG-2	01/13					1000	0	7.0	Turbid	None	7.8	150
						1115	70	6.5	Starting to clear	None	7.4	110
						1245	340	7.0	Clear with some sand	None	7.4	100
		55.9	46.05	9.85	8.57	1405	580	7.0	Clear, very little sand; collected samples	None	7.4	100
RG-3	01/14		48.88			1100	0	7.0	Turbid, very sandy	None	7.0	100
						1200	25	7.0	Clear with some sand	None	7.6	110
						1315	250	7.0	Clear with little sand	None	7.2	110
						1515	610	7.0	Clear, very little sand	None	7.4	120
	01/15	58.7	48.45	10.25	8.92	1615	610		Collected samples	None	7.4	120
RG-4	01/12	45.9	34.88	11.02	9.59	1800	0					
						1805	0	8.0	Very turbid with sand	None	5.5	620
						1900	165	8.0	Clear, but with sand	None	5.6	450
						2100	525	8.0		None	5.4	540
						0855	705	6.5		None	6.6	540
	01/13					0930	705		Collected samples			

NOTES: D_b = Distance from top of PVC casing to bottom of well, feet.
D_w = Distance from top of PVC casing to standing water level, feet.
H_t = Height of water column in well, feet
PV = Required purge volume, gallons before sampling

RB-5 - Silo 11 was chosen for sampling because it contained a 20-gallon, fibrous, open-top drum labeled CITGO, an antifreeze container, and small batteries. The water had a brownish-green to clear color believed to be a result of leaves falling into the water.

RB-6 - Silo 21 was chosen in order to sample a silo from the third row. The appearance of its contents was simlar to others in that row; yellowish brown water, containing leaves.

RB-7 - Silo 26 was chosen in order to sample a silo from the fourth row. Its appearance was similar to Silo 21 and many of the other silos. This sample was deleted on 1/14/87 by the direction of an Authorized Representative of the Contracting Officer.

No other silos were visually found to contain strong evidence of the presence of hazardous or toxic materials.

Samples were collected using a portable peristaltic pump. Teflon tubing was coupled to a stainless steel weight and lowered to the proper depth in the structure to pump out the water. Because of its flexibility, silastic tubing was used through the pump head. Samples for dissolved metals were filtered prior to filling the sample containers.

The pump tubing was rinsed thoroughly with distilled water prior to sample collection. Sampling blanks for all analytical parameters were collected prior to collection of samples from one of the missile storage structures, to ensure that no contamination occurred due to sampling equipment and procedures. Sampling tubing was replaced for each sample set to avoid cross-contamination.

At each of the sample locations, pertinent information was recorded in the field notebook and is summarized in Table 3-5.

During sampling it was found that the water level in Silo 8 (RB-3) had receded and was insufficient to sample. Therefore, Silo 9 was sampled instead and designated RB-3. This was not considered to be a significant deviation from the Monitoring Well Installation Plan, since Silo 8 and 9 were found to be similar during the visual inspection.

Sampling of the silos was performed according to optional Task Numbers 17 through 23. Sites RB-1 through RB-6 were sampled on December 3, 1986. Samples from RB-7 were collected on January 13, 1987. Samples from RB-7 were not analyzed in accordance with verbal instructions received on January 14, 1987 from the Authorized Representative of the Contracting Officer.

3.3.2 Sample Preservation

EEI filtered and preserved samples for dissolved metals analysis in the field. This was done at the collection site immediately after collection. Tables 3-6 and 3-7 describe the preservatives used and associated holding times. Filter apparatus included a Masterflex peristaltic pump coupled to a Geotech 142 mm filter stand with a 0.45 micron filter. Filters were replaced between samples, and the filter stand and all tubing were thoroughly rinsed with distilled water. All samples were placed in insulated containers and iced for holding. Transportation was via United Parcel Service next day delivery service to the laboratories.

TABLE 3-5

SUMMARY OF SILO SAMPLING

Site	Date	Time	Depth to Water From Top of Silo (feet)	Depth of Water Sampled (feet)	Corner of Silo From Which Sample Was Collected	Condition of Water
RB-1	12/03/86	1100	4.0	0 - 1.5	Southwest	Clear with medium yellow tint
RB-2	12/03/86	1030	4.0	0 - 1.5	Southeast	Clear, no color
RB-3	12/03/86	1130	1.0	0 - 1.5	Northeast	Clear, no tint
RB-4	12/03/86	1330	4.5	0 - 1.8	Northeast	Yellowish, slimy, scummy, organic smell with oily (yellow) layer highly visible
RB-5	12/03/86	1300	4.3	0 - 1.5	Northeast	Clear, very slight yellow tint
RB-6	12/03/86	1000	4.0	0 - 1.5	Southwest	Clear with slight yellow tint
RB-7	01/13/87	1200	4.5	0 - 1.5	Southeast	Clear with slight yellow tint

TABLE 3-6

SUMMARY OF WATER COLLECTION, PRESERVATION AND STORAGE REQUIREMENTS FOR EACH SAMPLE

Parameter	FF[a]	Preservative	Maximum Holding Time	Containers	Container Preparation
Purgeable Aromatics/ Purgeable Halocarbons	No	4°C	14 days	Two 40 ml glass vials, with Teflon-lined septum and screw caps	Purchased new (pre-cleaned by Pierce Chemical)
Petroleum Hydrocarbons	No	5 ml HCl, 4°C	28 days	Duplicate 1 liter, wide mouth glass bottles with Teflon-lined lids	Rinse with freon; rinse with DI water; air dry
Total Metals	No	HNO_3, pH <2, 4°C	6 months, except Hg 28 days	32 ounce high density polyethylene bottles with Teflon-lined lids	New; rinse with dilute HNO_3 and then with DI water
Dissolved Metals	Yes	HNO_3, pH <2 after filtration 4°C	6 months	32 ounce high density polyethylene bottles with Teflon-lined lids	New; rinse with dilute HNO_3 and then with DI water
Polychlorinated Biphenyls (PCBs)	No	4°C	7 days before extraction, 40 days after extraction	32 ounce glass bottles with Teflon-lined lids	New; wash with Alconox, rinse with tap water, rinse with DI water, rinse with acetone, rinse with methylene chloride

NOTE: QA bottles will be provided by MRDED-L
[a]FF = Field Filtered

TABLE 3-7

SUMMARY OF SOIL COLLECTION, PRESERVATION AND STORAGE REQUIREMENTS FOR EACH SAMPLE

Parameter	Preser-vative	Holding Time	Containers	Container Preparation
Purgeable Aromatics/ Halocarbons	4°C	14 days	Two 40 ml glass vials, with Teflon-lined septum and screw caps	Purchased new (pre-cleaned by Pierce Chemical)
Petroleum Hydrocarbons	4°C	28 days	250 ml amber wide mouth glass with Teflon-lined lid	Rinse with freon; rinse with DI water; air dry
Total Metals	4°C	6 months, except Hg 28 days	250 ml amber wide mouth glass with Teflon-lined lid	New; rinse with dilute HNO_3 and then with DI water
PCBs	4°C	7 days before and 40 days after extraction	40 mL glass vial with Teflon-lined septum and screw caps	Purchased new (pre-cleaned by Pierce Chemical

NOTES: a40 ml vials will be used to collect shallow soil samples.
QA bottles will be provided by MRDED-L.

3.3.3 Sample Transportation and Custody

An example of a chain of custody transfer form is presented in Exhibit 3-1. Each sample was identified by affixing a pressure sensitive gummed label on the container. The sample collection, source of sample, preservative used, the collector's initials, and analyses required were identified. The form includes documentation concerning offering split samples to the site owner. All records were filled out legibly in ink. Examples of sample identification labels being adapted for use by EEI are illustrated in Exhibit 3-2.

The sample container(s) was then placed in a transportation case along with the chain of custody record form, pertinent field records, and analysis requests as needed. The samples were then iced and the transportation case sealed and labeled.

All packages were shipped daily to the laboratory by United Parcel Service next day delivery and were accompanied by the Chain of Custody Record and other pertinent forms. A copy of these forms was retained by the field crew and transferred to the project files upon completion of the sampling. Completed forms are included in Appendix G.

3.3.5 Samples Shipped to External QA Laboratory

Samples shipped to the external QA laboratory conformed with labeling and packing requirements stated in "Sample Handling Protocol for Low, Medium and High Concentration Samples of Hazardous Waste" (U.S. Army Corps of Engineers, MRDED-L, 3/86) [7]. The procedures are consistent with those specified for low concentration samples.

3.3.6 Laboratory Custody Procedures

When transferring the possession of the samples, the transferee signed and recorded the date and time on the chain of custody record. Custody transfers account for each individual sample, although samples may be transferred as a group. Every person who took custody filled in the appropriate section of the chain of custody record. To prevent undue proliferation of custody records, the number of persons involved in the chain of possession was limited to those with a direct need to handle samples.

ENVIRODYNE ENGINEERS
12161 Lackland Rd.
St. Louis, MO 63146
(314) 434-6960

CUSTODY TRANSFER RECORD/LABORATORY WORK REQUEST

PROJECT NUMBER: _____ DATE WORK IN: _____ REPORT TO: _____ Page__of__

REQUESTED BY: _____ RECEIVED BY: _____ DATE REQUIRED: _____

SPECIAL INSTRUCTIONS: _____

SAMPLE IDENTIFICATION						ANALYSES REQUESTED										
ITEM	LAB NO.	SITE CODE/ SAMPLE DESCRIPTION	DATE COLLECTED	PRESERV.	CONTAINER											COMMENTS
1																
2																
3																
4																
5																
6																
7																
8																
9																
10																
11																
12																
13																
14																
15																
16																

ITEMS TRANSFERRED	RELINQUISHED BY	Date	Time	RECEIVED BY	Date	Time	REASON for TRANSFER

ENVIRODYNE ENGINEERS

EXHIBIT 3-1

Chain of Custody/Laboratory Analysis Form

Project No. _____ Sample Code _____ EEI SOURCE _____ Date and Time _____ Sampler _____	Lab. No. Parameters: Preservative:
Project No. _____ Sample Code _____ EEI SOURCE _____ Date and Time _____ Sampler _____	Lab. No. Parameters: Preservative:
Project No. _____ Sample Code _____ EEI SOURCE _____ Date and Time _____ Sampler _____	Lab. No. Parameters: Preservative:
Project No. _____ Sample Code _____ EEI SOURCE _____ Date and Time _____ Sampler _____	Lab. No. Parameters: Preservative:

ENVIRODYNE ENGINEERS

EXHIBIT 3-2

SAMPLE CONTAINER LABELS

4.0 ANALYTICAL RESULTS

4.1 INTRODUCTION

This chapter contains an identification of the analytical parameters included in the contamination evaluation at the former Bomarc Missile site at Raco; a description of the analytical methods and QA/QC employed and the lower detection limits associated with these methods; criteria for evaluation of the results, a presentation of the results of the sampling and analysis program, and interpretation of results. Analytical results are provided in their entirety in Appendix H.

All samples collected were analyzed for the same parameters, including purgeable halocarbons and aromatics, PCBs, petroleum hydrocarbons, and total metals (mercury, arsenic, selenium, silver, barium, cadmium, chromium and lead). In addition, water samples were analyzed for dissolved metals.

4.1.1 Analytical Methods and Detection Limits

Analytes, analytical methods used, and minimum detection limits for each parameter are summarized in Table 4-1. The specific purgeable halocarbons and aromatics included in the analytical program, and their detection limits in soil and water samples, are identified in Table 4-2.

4.1.2 Quality Assurance/Quality Control

The QA/QC Program was conducted to insure the validity of data generated through the sampling/analytical program. As a part of the QA/QC Program, the U.S. Army's Missouri River Division (MRD) Laboratory served as an external QA laboratory. Results of their analyses are included in Appendix I.

The specific role of various types of QA/QC procedures are briefly described in the following paragraphs.

1) Travel Blanks - These blanks were duplicate, 40 ml vials, filled in the laboratory with organic-free DI water, transported to the site, handled like a sample, and analyzed to ensure contamination was not present due to container preparation or shipping procedures (for purgeable organics and halocarbons only). One set consisting of replicate 40 ml travel blanks was obtained for the project and one vial was analyzed by EEI and one vial was analyzed by MRD laboratory.

2) Sampling Blanks - A complete set of containers was filled with organic-free distilled water. This water was passed through the sampling equipment, filtered where necessary, preserved identically to other samples of this type, and analyzed to demonstrate that sampling equipment was not a source of contamination. In this project, sampling blanks were collected prior to collection of samples at the missile sites.

3) Split Samples - After collection, split samples were divided into two parts and sent to two different laboratories for duplicate analyses. One part was analyzed by EEI while the other part was analyzed by the MRD Lab.

TABLE 4-1

SUMMARY OF ANALYTICAL METHODS, ANALYTES
AND MINIMUM DETECTION LIMITS

		Soil			Water		
Parameter	Analyte	Method	Number[d]	Detection Limit	Method	Number[d]	Detection Limit
Total Metals	Mercury	cold vapor AA[b]	245.5	0.2 ug/g	cold vapor AA	245.1	0.2 ug/l
	Arsenic	furnace AA	3050/7060	0.35 ug/g	furnace AA	206.2	3.5 ug/l
	Selenium	furnace AA	3050/7740	0.32 ug/g	furnace AA	270.2	2.1 ug/l
	Silver	furnace AA	3050/7760	0.2 ug/g	furnace AA	272.2	1.4 ug/l
	Barium	ICAP[c]	3050/6010	5.0 ug/g	ICAP	200.7	5.0 ug/l
	Cadmium	ICAP	3050/6010	1.0 ug/g	ICAP	200.7	1.0 ug/l
	Chromium	ICAP	3050/6010	1.0 ug/g	ICAP	200.7	5.0 ug/l
	Lead	ICAP	3050/6010	5.0 ug/g	ICAP	200.7	5.0 ug/l
Dissolved Metals	Mercury		Not Required		cold vapor AA	245.1	0.2 ug/l
	Arsenic		Not Required		furnace AA	206.2	3.5 ug/l
	Selenium		Not Required		furnace AA	270.2	2.1 ug/l
	Silver		Not Required		furnace AA	272.2	1.4 ug/l
	Barium		Not Required		ICAP	200.7	5.0 ug/l
	Cadmium		Not Required		ICAP	200.7	1.0 ug/l
	Chromium		Not Required		ICAP	200.7	5.0 ug/l
	Lead		Not Required		ICAP	200.7	5.0 ug/l
Petroleum Hydrocarbon			418.1	1.0 ug/g		418.1	0.5 mg/l
Purgeable Hydrocarbons/ Aromatics	Library Search	GC/MS with purge and trap	8240 plus library search	0.4-5.9 ng/g[a]	GC/MS with purge and trap	8240 plus library search	0.4-5.9 ug/l[a]
PCBs	PCBs	GC	8080	22 ug/g	GC	8088	0.22/ug/l

NOTE: [a]Approximate range of values, depending on specific compound, see Table 4-2.
[b]AA=Atomic Absorption
[c]ICAP=Inductively Coupled Plasma
[d]Refers to Analytical Methods

TABLE 4-2

PURGEABLE HALOCARBONS AND AROMATICS EVALUATED AND THEIR DETECTION LIMITS IN SOIL AND WATER

Parameter	Detection Limits Soil (ng/g)	Water (ug/l)
Benzene	0.5	0.5
Bromoform	3.2	3.2
Carbon Tetrachloride	1.5	1.5
Chlorobenzene	0.6	0.6
Chlorodibromomethane	2.0	2.0
Chloroethane	2.4	2.4
2-Chloroethylvinyl Ether	5.9	5.9
Chloroform	0.8	0.8
Dichlorobromomethane	1.1	1.1
1,1-Dichloroethane	0.8	0.8
1,2-Dichloroethane	1.5	1.5
1,1-Dichloroethylene	1.9	1.9
1,2-Dichloropropane	1.5	1.5
1,3-cis-Dichloropropylene	1.5	1.5
1,3-trans-Dichloropropylene	1.5	1.5
Ethylbenzene	0.4	0.4
Methyl Bromide	1.5	1.5
Methyl Chloride	1.6	1.6
Methylene Chloride	1.1	1.1
1,1,2,2-Tetrachloroethane	1.4	1.4
Tetrachloroethylene	1.5	1.5
1,3-Dichlorobenzeneane	3.5	3.5
Trichlorofluoromethane	1.3	1.3
Toluene	1.0	1.0
1,2-trans-Dichloroethylene	1.5	1.5
1,1,1-Trichloroethane	1.2	1.2
1,1,2-Trichloroethane	1.6	1.6
Trichloroethylene	1.3	1.3
Vinyl Chloride	1.2	1.2

4) Field Duplicates - Field duplicates, collected at the same time and location and placed in separate sample containers, were used to assess the precision of the overall sampling and analysis procedures.

5) Laboratory Blanks - Laboratory blanks were analyzed with each group of soil and water samples to determine if laboratory procedures were responsible for introduction of contaminants.

6) Surrogate Analyses - Surrogate analyses involve the introduction into the sample of compounds which behave similarly to the compounds of interest. They were used in purgeable analyses. Surrogates were used to establish control limits for analyses, as well as to estimate the recovery of the target analytes within the sample matrix.

7) Check and Calibration Standards - Check and calibration standards were used for instrument calibration and to establish control limits for analytical parameters.

8) Rinsate Sample - After soil sampling equipment was cleaned and before the sample was collected, distilled water was poured over the sampling equipment into the appropriate sample containers and preserved to determine if sampling equipment was responsible for introduction of contaminants.

9) Background Sample - A sample taken from a nearby site thought to be contaminant-free. The site was selected to be as geographically similar to the actual sample sites as possible.

Samples collected in duplicate at one of the missile silos (RB-7) were not analyzed, at the direction of the Authorized Representative of the Contracting Officer, due to lack of funds in the contract.

4.1.3 Evaluation Criteria for Analytical Results

4.1.3.1 Resource Conservation and Recovery Act Regulations - The Resource Conservation and Recovery Act (RCRA) established criteria by which wastes are classified as hazardous. The eight metals selected for analysis in this program are identical to those metals used in the characterization of EP Toxicity.

The EP Toxicity test involves combination of a solid waste with 16 times its weight of DI water. If the pH of the resulting solution is greater than 5.0, the pH of the solution is lowered to 5.0 by addition of 0.5N acetic acid [8]. A solid waste exhibits the characteristic of EP Toxicity if, using the test methods described in 40 CFR 261, Appendix II, the extract from a representative 100 gram sample contains any of the metals listed in Table 4-3 at a concentration equal to or greater than the respective value given in that table. If the waste contains less than 0.5% filterable solids, the waste after filtering is considered to be the extract.

Although EP Toxicity testing was not performed, it is possible to estimate whether a soil sample could potentially exhibit EP Toxicity characteristics by computing the maximum amount of each metal which might leach from a 100 gram sample, assuming 100% extraction, and then computing the resulting concentration in 1,600 grams DI water.

TABLE 4-3

MINIMUM CONCENTRATION OF CONTAMINANTS
FOR CHARACTERISTIC OF EP TOXICITY

Metal	Minimum Concentration (mg/l)
Arsenic	5.0
Barium	100.0
Cadmium	1.0
Chromium	5.0
Lead	5.0
Mercury	0.2
Selenium	1.0
Silver	5.0

In addition to toxicity, wastes are classified as hazardous if they exhibit characteristics of ignitability, corrosivity and reactivity. These tests were not included in the Program.

4.1.3.2 Groundwater Protection Criteria - Regulations published in 40 CFR 264, Subpart F, apply to owners and operators of hazardous waste treatment storage and disposal facilities. Subpart F establishes groundwater concentration limits for the eight metals included in the analytical program. These limits are presented in Table 4-4 [8]. In addition, hundreds of additional hazardous constituents defined in Appendix VIII of 40 CRF 261 are subject to regulation if detected in groundwater. These hazardous constitutents include some of the purgeable aromatics and halocarbons included in the analytical program. If detected in groundwater due to operation of a hazardous waste storage, treatment or disposal facility, it is the responsibility of the USEPA Regional Administrator to set limits for Appendix VIII compounds [8, 9].

4.1.3.3 Evaluation Criteria Related to the Safe Drinking Act - The Safe Drinking Water Act (SDWA) requires the USEPA to establish primary drinking water regulations. These regulations apply to public water systems. They specify contaminants which, in the judgment of the Administrator of the EPA, may have an adverse effect on the health of persons. They also specify for each contaminant either MCLs or treatment technologies. The regulations are presented in this report as criteria for comparison of analytical results with standards.

In accordance with SDWA, the USEPA has promulgated final RMCLs for organic chemicals and proposed RMCLs for inorganic chemicals. RMCLs are defined as "non-enforceable health goals which are to be set at levels which would result in no known or anticiptaed adverse health effects with an adequate margin of safety." RMCLs have no legal impact on public water system or the public. No system is bound to remove contaminants to this level or take other action regarding contaminants. RMCLs are initial goals used by USEPA in the course of development of MCLs.

MCLs for inorganic chemicals have been promulgated while MCLs for organics have been proposed but not yet promulgated. MCLs are enforceable standards and are to be set as close to the RMCLs (health goals) as is feasible. They are based on treatment technologies, costs, and other feasibility factors such as availability of analytical methods and treatment technology, and costs for achieving various levels of removal.

RMCLs and proposed MCLs for organic chemical parameters included in the Raco Bomarc Missile Site Contamination Evaluation are presented in Table 4-5. Proposed RMCLs and promulgated MCLs for inorganic chemicals evaluated in the project are included in Table 4-6 [9].

In addition to the regulatons noted above, regulations for other volatile organic compounds are in the process of being developed. Proposed RMCLs for additional synthetic organic chemicals are presented in Table 4-7. Also, a proposed regulation to require monitoring additional volatile organic chemicals in drinking water would result in monitoring for contaminants listed in Table 4-8 [10].

TABLE 4-4

MAXIMUM CONCENTRATION OF CONSTITUENTS
FOR GROUNDWATER PROTECTION
(Source: 40 CFR 264, Subpart F)

Constituent	Maximum Concentration (mg/l)
Arsenic	0.05
Barium	1.0
Cadmium	0.01
Chromium	0.05
Lead	0.05
Mercury	0.002
Selenium	0.01
Silver	0.05
Endrin (1,2,3,4,10,10-hexachloro-1,7-epoxy-1,4,4a,5,6,7,8,9a-octahydro-1, 4-endo, endo-5,8-dimethano naphthalene)	0.0002
Lindane (1,2,3,4,5,6-hexachlorocyclohexane, gamma isomer)	0.004
Methoxychlor (1,1,1-trichloro-2,2-bis(p-methoxyphenylethane)	0.1
Toxaphene ($C_{10}H_{10}Cl_6$, Technical chlorinated camphene, 67-69% chlorine)	0.005
2,4-D (2,4-dichlorophenoxyacetic acid)	0.1
2,4,5-TP Silvex (2,4,5-trichlorophenoxypropionic acid)	0.01

TABLE 4-5

FINAL RMCLs AND PROPOSED MCLs FOR ORGANIC CHEMICALS AND STATE OF MICHIGAN DRINKING WATER STANDARDS

Compound	Final RMCL (mg/l)	Proposed MCL (mg/l)	State of Michigan (mg/l)
Benzene	zero	0.005	0.025
Vinyl Chloride	zero	0.001	-
Carbon Tetrachloride	zero	0.005	-
1,2-Dichloroethane	zero	0.005	-
Trichloroethylene	zero	0.005	-
1,1-Dichloroethylene	0.007	0.007	-
1,1,1-Trichloroethane	0.02	0.200	-
p-Dichlorobenzene	0.75	0.750	-
Toluene	-	-	1.0
Ethylbenzene	-	-	3.4
Xylene	-	-	3.6

TABLE 4-6

PROPOSED RMCLs AND PROMULGATED MCLs FOR INORGANIC CHEMICALS AND STATE OF MICHIGAN PRIMARY DRINKING WATER STANDARDS

Parameter	Proposed RMCL (mg/l)	Promulgated MCLs (mg/l)	State of Michigan (mg/l)
Arsenic	0.050	0.050	0.01
Barium	1.5	1.0	1.0
Cadmium	0.005	0.010	0.01
Chromium	0.12	0.05	0.05
Lead	0.020	0.05	0.05
Mercury	0.003	0.002	0.002
Selenium	0.045	0.01	0.01
Silver	-	0.05	0.05

TABLE 4-7

ADDITIONAL PROPOSED RMCLs FOR VOLATILE ORGANICS

Parameter	Proposed RMCL (mg/l)	Parameter	Proposed RMCL (mg/l)
Acrylamide	0	Ethylbenzene	0.68
Alachlor	0	Heptachlor	0
Aldicarb,		Heptachlor Epoxide	0
Aldicarb sulfoxide,		Lindane	0.0002
Aldicarb sulfone	0.009	Methoxychlor	0.34
Carbofuran	0.036	Monochlorobenzene	0.06
Chlordane	0	Pentachlorophenol	0.22
cis-1,2-Dichloroethylene	0.07	Styrene	0.14
DBCP	0	Toluene	2.0
1,2-Dichloropropane	0.006	2,4,5-TP	0.052
o-Dichlorobenzene	0.62	Toxaphene	0
2,4-D	0.07	trans-1,2-Dichloroethylene	0.07
EDB	0	Xylene	0.44
Epichlorohydrin	0		

TABLE 4-8

ORGANIC COMPOUNDS PROPOSED TO BE MONITORED

Chloroform[a]	Chloromethane
Bromodichloromethane[a]	Bromomethane
Chlorodibromomethane[a]	Bromochloromethane
Bromoform[a]	1,2,3-Trichloropropane
trans-1,2-Dichloroethylene	1,2,3-Trichlorobenzene
Chlorobenzene	n-Propylbenzene
m-Dichlorobenzene	1,1,1,2-Tetrachloroethane
Dichloromethane	Chloroethane
cis-1,2-Dichloroethylene	1,1,2-Trichloroethane
o-Dichlorobenzene	Pentachloroethane
1,2,4-Trichlorobenzene	bis-2-Chloroisopropyl ether
Fluorotrichloromethane	2,2-Dichloropropane
Dichlorodifluoromethane	1,2,4-Trimethylbenzene
Dibromomethane	n-Butylbenzene
1,2-Dibromomethane	Napthalene
1,2-Dibromo-3-chloropropane	Hexachlorobutadiene
Toluene	o-Chlorotoluene
p-Xylene	p-Chlorotoluene
o-Xylene	1,3,5-Trimethylbenzene
m-Xylene	p-Isopropyltoluene
1,1-Dichloroethane	1,1-Dichloropropene
1,1,2,2-Tetrachloroethane	iso-Propylbenzene
Ethylbenzene	tert-Butylbenzene
1,3-Dichloropropane	sec-Butylbenzene
Styrene	Bromobenzene

NOTE: [a]Already regulated.

4.1.3.4 Toxic Substances Control Act - The Toxic Substances Control Act establishes limitations related to concentrations of PCBs in soil. Disposal of PCBs is regulated at concentrations exceeding 50 ug/g (ppm) [10]. Concentrations below 50 ppm are not regulated.

4.1.3.5 Comprehensive Environmental Response Compensation and Liability Act - The purpose of the National Oil and Hazardous Substance Pollution Contingency Plan is to effectuate the response powers and responsibilities created by the Comprehensive Environmental Response Compensation and Liability Act (CERCLA) of 1980. The National Oil and Hazardous Substance Pollution Contingency Plan establishes methods and criteria for determining the appropriate extent of response when hazardous substances are released. The states are encouraged to undertake a series of actions in case of a potential release of hazardous substances. These steps include discovery and notification, preliminary assessment, immediate removal, evaluation and determination of appropriate response, planned removal, remedial action, and documentation and cost recovery [11].

CERCLA requires that the relative potential of uncontrolled hazardous substance facilities to cause health and safety problems or ecological or environmental damage be assessed. Assessment is performed using the Hazardous Ranking System (HRS) form which has been completed and submitted together with this contamination evaluation [11]. The HRS form will be used by the Army to evaluate the results of the contamination evaluation.

Under Section 102a of CERCLA, regulations designate those substances which are considered hazardous, establish reportable quantities for these substances, and set forth the notification requirements for releases of these substances. Reportable quantity means that quantity of release which requires notification pursuant to regulations; the total amount of release, not the amount of contaminant in the release. Several hundred substances are considered hazardous substances and are identified in the Code of Federal Regulations [10]. Results of the contamination evaluation will be interpretted with respect to compounds which may have been spilled and may be hazardous substances.

4.1.3.6 State of Michigan Standards - As a primary standard, the State of Michigan Groundwater Quality Rules prohibit degradation of groundwater quality beyond background levels defined by upgradient wells. As a secondary standard, Michigan adopts pertinent USEPA Drinking Water and Groundwater Standards. However, it is not permissible to degrade water quality even if water quality standards will be maintained [12]. Michigan has also defined primary drinking water standards for metals and organics, as noted in Tables 4-5 and 4-6. Michigan's Standards are presented in Appendix J.

4.2 GROUNDWATER ANALYSIS RESULTS

Results of metals, PCB, and petroleum hydrocarbon analysis of samples collected at RG-1 through RG-4 and the USFS Work Station (used as a source of water and added to wells during construction) are presented in Table 4-9. Results of analyses for purgeable halocarbons and aromatics are presented in Table 4-10.

Table 4-9

SUMMARY OF ANALYTICAL RESULTS
FORMER BOMARC MISSILE SITE
RACO, MICHIGAN

	PETROLEUM HYDROCARBONS	METALS																PCB's
		ARSENIC		BARIUM		CADMIUM		CHROMIUM		LEAD		MERCURY		SELENIUM		SILVER		
		T	D	T	D	T	D	T	D	T	D	T	D	T	D	T	D	
SOIL SAMPLING SITES:																		
RS-1 TRANSFORMER PAD	8310	1.48	---	8.4	---	< 1	---	4.3	---	< 5	---	< 0.2	---	< 0.32	---	< 0.2	---	< 22
RS-1 SPLIT	8530	1.15	---	8.7	---	< 1	---	3.1	---	< 5	---	< 0.2	---	< 0.32	---	< 0.2	---	< 22
RS-2	62	1.44	---	7.3	---	< 1	---	4.9	---	12.4	---	< 0.2	---	< 0.32	---	< 0.2	---	< 22
RS-3	36	< 0.35	---	< 5	---	< 1	---	3.1	---	< 5	---	< 0.2	---	< 0.32	---	< 0.2	---	< 22
RS-4	28	0.80	---	5.9	---	< 1	---	2.1	---	< 5	---	< 0.2	---	< 0.32	---	< 0.2	---	< 22
RS-5	40	0.56	---	5.8	---	< 1	---	2.3	---	< 5	---	< 0.2	---	< 0.32	---	< 0.2	---	< 22
RS-6	46	0.47	---	8.1	---	< 1	---	2.8	---	< 5	---	< 0.2	---	< 0.32	---	< 0.2	---	< 22
RS-7	264	0.64	---	6.3	---	< 1	---	2.4	---	< 5	---	< 0.2	---	< 0.32	---	< 0.2	---	< 22
RS-8	63	1.06	---	6.1	---	< 1	---	3.0	---	< 5	---	< 0.2	---	< 0.32	---	< 0.2	---	< 22
RS-9 (BACKGROUND)	24	0.71	---	5.0	---	< 1	---	2.9	---	< 5	---	< 0.2	---	< 0.32	---	< 0.2	---	< 22
WATER SAMPLING SITES:																		
RS-8 RINSATE	0.5	< 0.0035	---	< 0.005	---	< 0.001	---	< 0.005	---	< 0.005	---	< 0.2	---	< 0.0021	---	< 0.0014	---	< 0.22
RB-1	5.0	< 0.0035	< 0.0035	0.008	0.008	< 0.001	< 0.001	< 0.005	< 0.005	0.010	< 0.005	< 0.2	< 0.2	< 0.0021	< 0.0021	< 0.0014	< 0.0014	< 0.22
RB-2	3.7	< 0.0035	< 0.0035	< 0.005	< 0.005	< 0.001	< 0.001	< 0.005	< 0.005	0.011	0.006	< 0.2	< 0.2	< 0.0021	< 0.0021	< 0.0014	< 0.0014	< 0.22
RB-3	4.0	< 0.0035	< 0.0035	0.015	0.013	< 0.001	< 0.001	< 0.005	< 0.005	0.019	0.006	< 0.2	< 0.2	< 0.0021	< 0.0021	< 0.0014	< 0.0014	< 0.22
RB-4	1810	< 0.0035	< 0.0035	< 0.005	< 0.005	< 0.001	< 0.001	< 0.005	< 0.005	0.018	0.009	< 0.2	< 0.2	< 0.0021	< 0.0021	< 0.0014	< 0.0014	< 0.22
RB-5	2.4	< 0.0035	< 0.0035	< 0.005	< 0.005	< 0.001	< 0.001	< 0.005	< 0.005	0.014	0.010	< 0.2	< 0.2	< 0.0021	< 0.0021	< 0.0014	< 0.0014	< 0.22
RB-6	1.7	< 0.0035	< 0.0035	0.006	0.008	< 0.001	< 0.001	< 0.005	< 0.005	0.012	0.014	< 0.2	0.23	< 0.0021	< 0.0021	< 0.0014	< 0.0014	< 0.22
RB-7 SAMPLING BLANK	< 0.5	< 0.0035	< 0.0035	< 0.005	< 0.005	< 0.001	< 0.001	< 0.005	< 0.005	< 0.005	< 0.005	< 0.2	< 0.2	< 0.0021	< 0.0021	< 0.0014	< 0.0014	< 0.22
RG-1	< 0.5	< 0.0035	< 0.0035	0.044	0.019	< 0.001	< 0.001	< 0.005	< 0.005	< 0.005	< 0.005	< 0.2	< 0.2	< 0.0021	< 0.0021	< 0.0014	< 0.0014	< 0.22
RG-1 SPLIT	< 0.5	< 0.0035	< 0.0035	0.062	0.019	< 0.001	< 0.001	0.006	< 0.005	0.009	< 0.005	< 0.2	< 0.2	< 0.0021	< 0.0021	< 0.0014	< 0.0014	< 0.22
RG-2	< 0.5	< 0.0035	< 0.0035	0.029	0.026	< 0.001	< 0.001	< 0.005	< 0.005	< 0.005	< 0.005	< 0.2	< 0.2	< 0.0021	< 0.0021	< 0.0014	< 0.0014	< 0.22
RG-3	1.8	< 0.0035	< 0.0035	0.078	0.071	< 0.001	< 0.001	< 0.005	< 0.005	< 0.005	< 0.005	< 0.2	< 0.2	< 0.0021	< 0.0021	< 0.0014	< 0.0014	< 0.22
RG-4	< 0.5	< 0.0035	< 0.0035	0.019	0.012	< 0.001	< 0.001	< 0.005	< 0.005	< 0.005	< 0.005	< 0.2	< 0.2	< 0.0021	< 0.0021	< 0.0014	< 0.0014	< 0.22
WELL INSTALL. WATER	1.7	< 0.0035	< 0.0035	0.014	0.013	< 0.001	< 0.001	< 0.005	< 0.005	< 0.005	0.008	0.87	< 0.2	< 0.0021	< 0.0021	< 0.0014	< 0.0014	< 0.22

NOTES: T = Total Metals (sample not filtered)
D = Dissolved Metals (sample filtered through 0.45 micron filter)

PCB concentrations are in ng/g for soils and ug/l for waters.
Petroleum Hydrocarbon concentrations are in ug/g for soils and mg/l for waters.
--- = Not Required

All metals concentrations are in ug/g for soils and mg/l for waters except Mercury in water which is in ug/l.

TABLE 4-10. SUMMARY OF RESULTS OF TESTING AT GROUNDWATER MONITORING WELLS FOR PURGEABLE HALOCARBONS AND AROMATICS
(Results in ug/l)

Parameter	Site: Date:[a]	RG-1 1/29	RG-1 Split 1/28	RG-2 1/29	RG-3 1/29	RG-4 1/28	Well Installation Water 12/17/86	Travel Blank 1/29	Lab Blanks 12/17	Lab Blanks 1/28	Lab Blanks 1/28	Lab Blanks 1/29
Benzene		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Bromoform		<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2
Carbon Tetrachloride		<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
Chlorobenzene		<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6
Chlorodibromomethane		<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Chloroethane		<2.4	<2.4	<2.4	<2.4	<2.4	<2.4	<2.4	<2.4	<2.4	<2.4	<2.4
2-Chloroethylvinyl Ether		<5.9	<5.9	<5.9	<5.9	<5.9	<5.9	<5.9	<5.9	<5.9	<5.9	<5.9
Chloroform		<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8
Dichlorobromomethane		<1.1	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1
1,1-Dichloroethane		<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8
1,2-Dichloroethane		<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
1,1-Dichloroethylene		<1.9	<1.9	<1.9	<1.9	<1.9	<1.9	<1.9	<1.9	<1.9	<1.9	<1.9
1,2-Dichloropropane		<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
1,3-cis-Dichloropropylene		<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
1,3-trans-Dichloropropylene		<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
Ethylbenzene		<0.4	<0.4	<0.4	<0.4	1.5	<0.4	<0.4	1.0	1.0	0.8	1.1
Methyl Bromide		<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
Methyl Chloride		<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6
Methylene Chloride		5.5	4.9	3.5	3.8	4.6	22.0	7.0	14.7	17.1	22.3	10.4
1,1,2,2-Tetrachloroethane		<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4
Tetrachloroethylene		<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
Trichlorofluoromethane		<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3
Toluene		<1.0	<1.0	<1.0	<1.0	1.9	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
1,2-trans-Dichloroethylene		<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
1,1,1-Trichloroethane		<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2
1,1,2-Trichloroethane		<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6
Trichloroethylene		<1.3	<1.3	<1.3	3.0	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3
Vinyl Chloride		<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2
Unknown					7.3	5.8		6.6	10.0	7.1	6.6	6
2-pentene,3,4,4-trimethyl-					3.4							
1-pentene,2,4,4-trimethyl-					20.8							

NOTE: [a]12/1986 or 1/1987 Date of Analysis

The levels of metals in groundwater samples and well installation water were near or below detection limits except for barium. The levels of metals found in groundwater did not exceed the proposed RMCL, MCLs (currently in effect) and RCRA groundwater protection criteria as shown in Table 4-11. The total mercury and lead levels in the installation water is above the detection limit but below RCRA groundwater protection criteria.

Petroleum hydrocarbons in monitoring wells RG-1, RG-2 and RG-4 were below detection limits. There is some evidence of petroleum hydrocarbons in the well installation water and monitoring well RG-3. Concentrations ranged from 1.7 mg/l in the well installation water to 1.8 mg/l in RG-3. The low level contamination of the well installation water may be due to an old oil seal on the pump at the Forest Service's Raco Work Center (where the water was obtained). The low level of petroleum hydrocarbon contamination found in the water from RG-3 may have been caused by the addition of 100 gallons of installation water to the borehole during drilling, but this does not seem likely for three reasons:

1) Contamination of RG-3 by the installation water would not account for any dilution that would occur.

2) A large amount of water (510 gallons) was removed from the well during development to protect against contamination from installation water. This purging should have removed all or most of the installation water lost during drilling.

3) Neither of the other two wells that received installation water exhibited signs of petroleum hydrocarbon contamination.

Interpretation of organic chemical data in Table 4-10 requires consideration of results from QA/QC samples such as travel blanks and lab blanks. Methylene chloride and ethylbenzene were found in lab blanks analyzed on December 17, January 28 and 29, and in travel blanks analyzed on January 29, at levels near or greater than the concentrations found in monitoring well samples. Methylene chloride is a commonly used organic laboratory solvent, and its presence in blanks is routinely encountered. Ethylbenzene is also sometimes found in low levels in lab blanks and samples due to its presence in the organic laboratory.

Several unknown compounds were detected in RG-3, RG-4, travel blanks (January 29) and lab blanks (December 17, January 28, 29). These unknowns (ranging from 5.8 to 10.0 ug/l) may have been present in the sample or may have been caused by analytical technical problems such as GC column bleed-down or a similar problem during GC/MS analysis. Unknown compounds are sometimes encountered at concentrations less than 10 ug/l.

Toluene was detected in the sample collected from the RG-4 well at a concentration of 1.9 ug/l, and was also found in the sampling blank and other blanks. This level is slightly above the detection limit. Toluene might be present in RG-4 (near underground fuel tanks) and further testing of the well would confirm whether toluene is present. Toluene is an Appendix VIII compound and is not regulated under SDWA. It might be possible that toluene was present in low levels in the surrogate spike which uses deuterated toluene as part of Method 8240.

TABLE 4-11

COMPARISON OF MAXIMUM GROUNDWATER CONCENTRATIONS FOR EACH METAL WITH STANDARDS[a]

Parameter	Highest Observation	Well	RCRA Groundwater Protection Limits	Proposed RMCL	MCL	Michigan State DWS[b]
Arsenic	<3.5	All	50	50	50	10
Barium	78	RG-3	1,000	1,500	1,000	1,000
Cadmium	<1	All	10	5	10	10
Chromium	6	RG-1 Split	50	120	50	50
Lead	9	RG-2 Split	50	20	50	50
Mercury	0.87	Well Installation Water	2	3	2	2
Selenium	<2.1	All	10	45	10	10
Silver	<1.4	All	50	-	50	50

NOTE: [a]All concentrations in ug/l.
[b]DWS = Drinking Water Standards

Trichloroethylene was detected in the well sample designated RG-3 at a concentration of 3.0 ug/l and was not detected in any other well or lab blanks. This compound is regulated under the SDWA with a RMCL of zero and a proposed MCL of 5 ug/l. Trichloroethylene is a common solvent used for cleaning and degreasing and may have been used during Bomarc missile site operations. Because it was detected only slightly above the detection limit, further sampling is needed to confirm if trichloroethylene is present in well RG- .

Two compounds, 2-pentene-3,4,4-trimethyl and 1-pentene-2,4,4-trimethyl, were also found in RG-3 at concentrations of 3.4 and 20.8 ug/l, respectively. These compounds were not found in any other blank or sample. They are not found in Appendix VIII or regulated under SDWA. Further testing would be necessary to confirm the presence and source of these compounds in groundwater well RG-3.

No other organic compounds were detected in any of the groundwater wells or well installation water. PCBs were not detected in any groundwater sample or blank analyzed. All metals concentrations were well below applicable standards.

4.3 SILO WATER SAMPLING AND ANALYSIS RESULTS

Results of metals, PCB and petroleum hydrocarbon analysis of silo water samples collected at RB-1 through RB-6 are presented in Table 4-9. Results of analyses for purgeable halocarbons and aromatics are presented in Table 4-12.

The highest level of each metal detected in silo water is compared to RMCL, MCLs and RCRA groundwater protection criteria in Table 4-13. None of the eight metals exceeded any present or proposed SDWA. Total lead concentration was close to the proposed RMCL limit in two of the silos (RB-3 and RB-4). Dissolved lead in all silos analyzed was above the detection limit but below any SDWA regulation. These levels show that some lead contamination does exist in the silo water. These levels pose no imminent danger to groundwater supplies and might be caused by lead based paint once used in the upkeep of the missile silos.

Petroleum hydrocarbons were found in low levels in most of the Bomarc missile silos. These low levels (5.0 mg/l or less) in RB-1, RB-2, RB-3, RB-5, and RB-6 might be due to oil on concrete debris or asphalt residues that were placed in the silos after release of the property to the USFS. A high level of petroleum hydrocarbons was found in RB-4. The sample was taken from various depths to create a composite sample. Petroleum hydrocarbons in RB-4 had a concentration of 1,810 mg/l which was most likely caused by the contents of two 55-gallon barrels which were found in the silo. These barrels had leaked and released an oily organic substance into RB-4 (Silo 10). These barrels may have been placed there by the contractor who had received a special use permit from the USFS to dump highway construction debris into the silos, but this is speculative.

Interpretation of purgeable halocarbons and aromatics results in missile silos requires consideration of results of blanks. Methylene chloride and ethylbenzene were present in both lab and travel blanks at or near concentrations found in silo samples. There is no evidence that these compounds are present in any of the silos (Table 4-12).

TABLE 4-12. SUMMARY OF RESULTS OF TESTING AT MISSILE SILO SITES FOR PURGEABLE HALOCARBONS AND AROMATICS
(Results in ug/l)

Parameter	Site: Date:[a]	RB-1 12/15	RB-2 12/15	RB-3 12/15	RB-4 12/17	RB-5 12/17	RB-6 12/17	RB-7 Sampling Blank 1/28	RB-7[b]	Travel Blank 1/29	Lab Blanks 12/15	12/17	1/28	1/28	1/29
Benzene		<0.5	<0.5	<0.5	6.0	<0.5	<0.5	<0.5		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Bromoform		<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2		<3.2	<3.2	<3.2	<3.2	<3.2	<3.2
Carbon Tetrachloride		<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5		<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
Chlorobenzene		<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6		<0.6	<0.6	<0.6	<0.6	<0.6	<0.6
Chlorodibromomethane		<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0		<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Chloroethane		<2.4	<2.4	<2.4	<2.4	<2.4	<2.4	<2.4		<2.4	<2.4	<2.4	<2.4	<2.4	<2.4
2-Chloroethylvinyl Ether		<5.9	<5.9	<5.9	<5.9	<5.9	<5.9	<5.9		<5.9	<5.9	<5.9	<5.9	<5.9	<5.9
Chloroform		<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8		<0.8	<0.8	<0.8	<0.8	<0.8	<0.8
Dichlorobromomethane		<1.1	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1		<1.1	<1.1	<1.1	<1.1	<1.1	<1.1
1,1-Dichloroethane		<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8		<0.8	<0.8	<0.8	<0.8	<0.8	<0.8
1,2-Dichloroethane		<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5		<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
1,1-Dichloroethylene		<1.9	<1.9	<1.9	<1.9	<1.9	<1.9	<1.9		<1.9	<1.9	<1.9	<1.9	<1.9	<1.9
1,2-Dichloropropane		<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5		<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
1,3-cis-Dichloropropylene		<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5		<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
1,3-trans-Dichloropropylene		<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5		<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
Ethylbenzene		1.0	<0.4	<0.4	<0.4	1.1	<0.4	0.8		<0.4	1.2	1.1	1.0	1.0	0.8
Methyl Bromide		<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5		<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
Methyl Chloride		<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6		<1.6	<1.6	<1.6	<1.6	<1.6	<1.6
Methylene Chloride		9.7	16.7	8.2	20.4	29.4	12.1	6.2		7.0	22.7	15.2	17.1	14.7	22.3
1,1,2,2-Tetrachloroethane		<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4		<1.4	<1.4	<1.4	<1.4	<1.4	<1.4
Tetrachloroethylene		<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5		<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
Trichlorofluoromethane		<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	3.2		<1.3	<1.3	<1.3	<1.3	<1.3	<1.3
Toluene		<1.0	<1.0	<1.0	1.2	<1.0	<1.0	9.2		<1.0	1.2	<1.0	<1.0	<1.0	<1.0
1,2-trans-Dichloroethylene		<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5		<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
1,1,1-Trichloroethane		<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2		<1.2	<1.2	<1.2	<1.2	<1.2	<1.2
1,1,2-Trichloroethane		<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6		<1.6	<1.6	<1.6	<1.6	<1.6	<1.6
Vinyl Chloride		<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2		<1.2	<1.2	<1.2	<1.2	<1.2	<1.2
Additional Peaks:															
Unknown Hydrocarbon											8	6			
Unknown								>5.0		6.6			7.1	10.0	

NOTE: [a]12/1986 or 1/1987 Date of Analysis.
[b]RB-7 not analyzed

TABLE 4-13

COMPARISON OF MAXIMUM SILO WATER CONCENTRATIONS
FOR EACH METAL WITH STANDARDS[a]

Parameter	Highest Observation	Well	RCRA Groundwater Protection Limits	Proposed RMCL	MCL	Michigan State DWS[b] (ug/l)
Arsenic	<3.5	All	50	50	50	10
Barium	15	RB-3	1,000	1,500	1,000	1,000
Cadmium	<1	All	10	5	10	10
Chromium	<5	All	50	120	50	50
Lead	19	RB-3	50	20	50	50
Mercury	0.23	RB-6	2	3	2	2
Selenium	<0.21	All	10	45	10	10
Silver	<1.4	All	50	-	50	50

NOTE: [a]All concentrations in ug/l.
[b]DWS = Drinking Water Standards

Benzene and toluene were detected in RB-4 at concentrations of 6.0 ug/l and 1.2 ug/l, respectively. Toluene was also detected in sample and lab blanks, and could possibly have come from the surrogate spike that uses deuterated toluene (some non-deuterated toluene could be present). Detection of these compounds, especially benzene, may be due to an oily substance that has leaked from barrels rather than from DOD operations. Benzene and toluene were not detected in any other silo and are not believed to be present in the other silos. Further sampling and analysis are to be done to confirm these results.

Unknown compounds were detected in sampling blanks, travel blanks, and lab blanks but not in any silo water sample. Trichlorofluoromethane and toluene were detected in the sampling blank. The source of these contaminants are not known but their presence did not affect the interpretation of analytical results.

No other organic compounds were detected in any silo water samples analyzed. PCBs were not detected in any sample or blank analyzed from the Raco Bomarc missile site.

4.4 SOIL SAMPLING AND ANALYSIS RESULTS

Results of metals, PCBs and petroleum hydrocarbon analyses of soil samples are presented in Table 4-9. Results of analyses for purgeable halocarbons and aromatics are presented in Table 4-14.

No cadmium, mercury, selenium, or silver was detected in any soil samples. Arsenic, barium and chromium were detected at low levels in all samples including the soil blank. **Total lead was found at a concentration of 12.4 ug/g only in RS-2 (wastewater treatment lagoon basin), and this is slightly above the detection limit. Concentrations of all metals found are insufficient to result in an EP Toxicity classification. Metals results are not indicative of a problem in any of the soil sampling areas.**

Concentrations of petroleum hydrocarbons (24 to 63 ug/g) in RS-2, RS-3, RS-4, RS-5, RS-6, RS-8 and RS-9 (background) may be due to vehicular traffic before, during or after DOD occupation or decay of vegetation. It is not known whether the presence of petroleum hydrocarbons is due to naturally occurring sources but the background sample (RS-9) equalled 24 ug/g so there might be a naturally occurring compound present which is quantified in Method 418.1. RS-1 (transformer pad) and RS-7 (underground tank C-3) showed concentrations of petroleum hydrocarbons at 8,310 ug/g (8,530 ug/g - RS-1 Duplicate) and 264 ug/g, respectively. The transformer pad area showed visible oil stains around the area where transformers once operated. RS-7 had no visible oil staining around the area sampled that would indicate a possible cause of petroleum hydrocarbon presence. Concentrations in these areas are probably caused by spillage of substances containing petroleum hydrocarbons after decommissioning occurred, due to vandalism or salvage operations.

As with groundwater and silo water samples, several purgeable halocarbons/aromatics were detected in soil samples and lab/travel blanks. These compounds are methylene chloride and ethylbenzene. Methylene chloride appeared in most site samples at levels higher than lab or travel blanks but is not

believed to be present in samples. Methylene chloride in RS-1 was high (130.6 ng/g), but the duplicate RS-1 sample showed a more acceptable level (28.3 ng/g). Methylene chloride and ethylbenzene were present in higher concentrations in both analyses (RS-7 was rerun) when compared to lab blanks. Some organic contamination might be present at the RS-7 site (underground tank C-3) because other organic compounds were found in analyses (Table 4-14). Confirmation through further sampling is recommended.

Toluene was detected in RS-1, RS-1 duplicate, RS-2, RS-8 rinsate, RS-7, RS-7 rerun and the lab blank dated December 17. Some toluene might have come from the surrogate spike which uses deuterated toluene, but higher levels found in RS-1 indicates possible site contamination.

Other halocarbons/aromatics were detected in RS-1, RS-1 duplicate, and RS-7 rerun that were not found in any lab/travel blank or any other sample. These two areas also showed elevated levels of petroleum hydrocarbons that might explain the unknown halocarbon/hydrocarbon and cyclohexane isomers that were found at RS-1 and RS-7. Further sampling is probably needed to determine the amount and the extent of contamination at these two locations.

Analysis of RS-8 Rinsate indicated the presence of trichlorofluoromethane (5.2 ug/g). The source of this contamination in the sample rinsate is not known, but it was not found in any sample.

PCBs were not detected in any soil analyses. The analysis of the soil around transformer pad (RS-1) gave no indication that transformers used on-site contained PCB contaminated oil which might have leaked onto the ground.

TABLE 4-14. SUMMARY OF RESULTS OF TESTING AT SOIL SAMPLING SITES FOR PURGEABLE HALOCARBONS AND AROMATICS
(Results in ng/g)

Parameter	Site: / Date:[a]	RS-1 1/29	RS-1 Dup. 1/29	RS-2 12/15	RS-3 12/15	RS-4 12/19	RS-5 12/12	RS-6 12/12	RS-7 12/12	RS-7 Rerun 12/12	RS-8 1/28	RS-9 Soil BkGd. 12/15	RS-8 Rnst 1/29	Travel Blank 1/29	Lab Blanks 12/12	Lab Blanks 12/15	Lab Blanks 12/19	Lab Blanks 1/28	Lab Blanks 1/28	Lab Blanks 1/29
Benzene		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Bromoform		<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2
Carbon Tetrachloride		<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
Chlorobenzene		<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6
Chlorodibromomethane		<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Chloroethane		<2.4	<2.4	<2.4	<2.4	<2.4	<2.4	<2.4	<2.4	<2.4	<2.4	<2.4	<2.4	<2.4	<2.4	<2.4	<2.4	<2.4	<2.4	<2.4
2-Chloroethylvinyl Ether		<5.9	<5.9	<5.9	<5.9	<5.9	<5.9	<5.9	<5.9	<5.9	<5.9	<5.9	<5.9	<5.9	<5.9	<5.9	<5.9	<5.9	<5.9	<5.9
Chloroform		<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8
Dichlorobromomethane		<1.1	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1
1,1-Dichloroethane		<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8
1,2-Dichloroethane		<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
1,1-Dichloroethylene		<1.9	<1.9	<1.9	<1.9	<1.9	<1.9	<1.9	<1.9	<1.9	<1.9	<1.9	<1.9	<1.9	<1.9	<1.9	<1.9	<1.9	<1.9	<1.9
1,2-Dichloropropane		<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
1,3-cis-Dichloropropylene		<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
1,3-trans-Dichloropropylene		<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
Ethylbenzene		<0.4	1.1	<0.4	1.1	<0.4	<0.4	<0.4	8.4	5.8	0.6	1.0	0.7	<0.4	<0.4	1.2	<0.4	1.0	1.0	0.8
Methyl Bromide		<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
Methyl Chloride		<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6
Methylene Chloride		130.6	28.3	42.8	36.2	36.2	24.7	21.3	50.9	54.5	25.5	19.5	4.0	7.0	15.2	22.7	10.4	14.7	17.1	22.3
1,1,2,2-Tetrachloroethane		<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4
Tetrachloroethylene		<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
Trichlorofluoromethane		<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	5.2	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3
Toluene		9.7	3.6	1.1	<1.0	<1.0	<1.0	<1.0	2.4	2.4	<1.0	<1.0	9.0	<1.0	<1.0	1.2	<1.0	<1.0	<1.0	<1.0
1,2-trans-Dichloroethylene		<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
1,1,1-Trichloroethane		<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2
1,1,2-Trichloroethane		<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6
Trichloroethylene		<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3
Vinyl Chloride		<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2

NOTE: [a]December 1986 or January 1987 date of analysis

(Continued on the following page)

TABLE 4-14. SUMMARY OF RESULTS OF TESTING AT SOIL SAMPLING SITES FOR PURGEABLE HALOCARBONS AND AROMATICS
(Results in ng/g)
(Continued)

Parameter	Site:	RS-1	RS-1 Dup.	RS-2	RS-3	RS-4	RS-5	RS-6	RS-7	RS-7 Rerun	RS-8	RS-9 Soil BkGd.	RS-8 Rnst	Travel Blank	Lab Blanks					
	Date.[a]	1/29	1/29	12/15	12/15	12/19	12/12	12/12	12/12	12/12	1/28	12/15	1/29	1/29	12/12	12/15	12/19	1/28	1/28	1/29
Additional Peaks:																				
Unknown Hydrocarbon						7				37							8			
Unknown Hydrocarbon										66										
Dimethyl Cyclohexane Isomer										18										
Tricyclodecane										38										
Trimethyl Cyclohexane Isomer										135										
Trimethyl Cyclohexane Isomer										23										
Ethyl Methyl Cyclohexane Isomer										95										
Trimethyl Bicycloheptane Isomer										109										
Ethyl Methyl Cyclohexane Isomer										161										
Unknown Hydrocarbon										46										
Unknown Hydrocarbon										443										
Unknown Hydrocarbon										109										
Decahydro Naphthalene										312										
Hexane		5.0																		
Tricyclo(3.3.1.1.3,7)-decane		14.8	58.5																	
Cyclohexane compound		14.2	53.9																	
Phenol compound		116.5																		
Unknown		12.0																		
Substituted decahydro-naphthalene		17.5	91.2																	
Unknown		95.4	24.2																10.0	7.1
Tricyclo(3.3.1.1^{3,7})-decane,-1,3-dimethyl			375.6																	
Alkyl substituted phenol			330.7																	
Hydrocarbon mixture			48.5																	

5.0 CONCLUSIONS AND RECOMMENDATIONS

1) As a result of visual site inspection, several potential sources of environmental contamination were identified at locations within the former Bomarc Missile Site, Raco, Michigan. Most notable are:

   a) An area where oil was spilled onto a transformer pad and nearby soil. This area has a dark oil stain and the odor of oil was evident. It is not known when this spillage occurred.

   b) Two 55-gallon drums were found in Silo 10 (RB-4) and were apparently leaking an oily substance with the odor of organic solvents or petroleum distillates. The two barrels were marked "Concrete Curing Compound" and "White Resin." It appears that disposal of these drums occurred after DOD transferred ownership of the site to the U.S. Forest Service. Detroit District, U.S. Army Corps of Engineers will sample the drums and remove them as part of the Raco Debris Removal Project.

   c) Oil-stained soil was evident near access plates and vents of the underground tanks C-1 (RS-5) and C-2 (RS-6). This could lead to contamination of underlying soils and could have occurred at any time during or after DOD activities.

   d) Sparse vegetation was evident near the wastewater treatment plant. The cause of sparse vegetation is not known.

2) Based on sampling and analysis, it was determined that PCBs are not present in the locations sampled including the composite sample taken near the transformer pad. This area had the highest possibility of PCB contamination.

3) **Based on testing, no metals above applicable standards were found in any silo, monitoring well, or soil sample.**

4) Results of sampling and analysis indicate petroleum hydrocarbons and purgeable halocarbons/aromatics are present in some soil and water samples. The conclusions based on the analytical results are summarized below.

   a) Petroleum hydrocarbons and purgeable organics are present in soil samples RS-1 (transformer pad) (>8000 ug/g) and RS-7 (underground tank C-3) (264 ug/g). A RCRA ignitability test should be performed at RS-1 to determine if the material is classified as hazardous. The depth and extent of contamination should be defined through more sampling and analysis. There is no indication that the underground tanks are presently leaking.

   b) Petroleum hydrocarbons (1810 mg/l) and purgeable halocarbons/aromatics (e.g. benzene, 6 ug/l) were present in Silo 10 (RB-4). Water is not believed to be leaking from the silo. It is believed that the two 55-gallon drums were placed in silo 10 during post-DOD

activities based on their positions in the silo above other construction debris. No contaminants are believed to be present in Silo 2 (RB-1). Silos 2 and 10 will be resampled by the Corps of Engineers, Detroit District.

c) Detroit District is currently soliciting bids for an approved project at the former Raco Bomarc Missile site. The project includes testing and removal of the contaminated soil near the transformer pad, testing and removal of the underground storage tanks, testing and removal of the two 55-gallon drums and testing and disposal of the water in the missile pits in addition to debris removal and site restoration. The contract is scheduled for a September 1987 award. POC concerning this ongoing effort is Mr. Carl Woodruff, CENCE-ED-D.

d) Petroleum hydrocarbons were found in low levels (1.7 to 1.8 mg/l, which is slightly above the detection limit) in the well installation water and monitoring well RG-3. The concentrations exceed Michigan State Drinking Water Standards (0.2 mg/l) (Appendix J). Several other organics were also detected at RG-3, including an unknown (7.3 ug/l), 2-pentene, 3,4,4-trimethyl (3.4 ug/l), and 1-pentene, 2,4,4-trimethyl (20.8 ug/l). EEI recommends resampling to verify these results.

e) Trichloroethylene (a degreaser/solvent) was found in low levels (3.0 ug/l) in monitoring well RG-3. This well was intended to determine if the wastewater treatment plant was leaching any contaminants into the aquifer. Re-sampling would confirm whether this solvent is actually found in the well water. Trichloroethylene may have been used at the Bomarc missile site.

f) Toluene was found in low levels in RG-4 monitoring well, silo sample RB-4, and several soil samples. It was also detected in sampling blanks and some lab blanks. It is not believed to be present in RG-4 and RB-4, but re-sampling would confirm this. Deuterated toluene is used as a surrogate spike and possibly some non-deuterated toluene was present in the spike.

5) Cuttings generated during installation of each well were retained in nine drums and have been stored on-site. No contaminants were found in wells RG-1 and RG-2 and EEI will arrange for emptying these drums into a silo, since the material could be considered clean fill. Wells RG-3 and RG-4 are possibly contaminated with the organic chemicals described above. Tom Polasek of the Hazardous Materials Section of the Michigan DNR was contacted regarding the proper handling of this material. He stated that this material would not be considered a hazardous material under RCRA regulations and could be accepted by any DNR-approved Type II landfill. The Dafter Sanitary Landfill (Route 1, Box 51, Dafter, MI; telephone 906-632-6186), located 15 miles east of Raco, is a Type II landfill and accepted the waste on June 30, 1987 (Appendix K).

6) The DERP Inventory Report and Hazardous Ranking System Evaluation are included in Appendix L.

REFERENCES

[1] Farrand, W. R., "Quaternary Geology of Michigan," State of Michigan Department of Conservation, 1982.

[2] USGS, "Sullivan Creek Quadrangle, Michigan - Chippewa County," 7.5 Minute Series (Topographic), USGS, Reston, VA, 1983.

[3] Environmental Restoration Defense Account, "Site Survey Report, Former DOD Installation, Raco, Michigan," August 1984.

[4] Jewell, Roger, Larry Burkhart and Joe Carrick of USDA, Personal Communications, USFS, Sault Ste. Marie, Michigan, October 2, 1986.

[5] Ferris, J. G. and D. B. Knowles, "The Slug-Injection Test for Estimating the Coefficient of Transmissibility of an Aquifer," USGS Water Supply Paper, No. 1536-1, pp. 299-304, 1963.

[6] Cooper, H. H., et al., "Response of a Finite Diameter Well to an Instantaneous Charge of Water," Water Resources Research, First Quarter, 1967.

[7] U.S. Army Corps of Engineers, "Sample Handling Protocol for Low, Medium and High Concentration Samples of Hazardous Waste," March 1986.

[8] 40 CFR 261 Appendix II.

[9] 40 CFR 264 Subpart F.

[10] 40 CFR 261 Appendix VIII.

[11] Thompson, J.C., "The Safe Drinking Water Act," Public Works, Volume 117, No. 9, p. 123, September 1986.

[12] Demiston, W., Permits Section, Michigan Department of Natural Resources, Personal Communication, November 24, 1986.

APPENDIX A

Disposition of Comments

ENVIRODYNE
ENGINEERS

12161 Lackland Road,
St. Louis, Missouri 63146
(314) 434-6960

July 22, 1987
3067-40027

Mr. John Hallquist
Authorized Representative of the
Contracting Officer
U. S. Army Corps or Engineers
LMSED-PM
210 N. Tucker Boulevard
St. Louis, Missouri 63101

Subject: Minutes of Meeting 7/20/87
Delivery Order No. 4

Dear Mr. Hallquist:

Attached are the minutes of the project presentation meeting held on 7/20/87. Also included are EEI's responses to written comments furnished by Tom Furdek. We expect additional information from you before incorporating these comments into the final report. The minutes of the meeting and disposition of comments will be included as an Appendix to the Final Report. If you are in disagreement with any of the proposed changes to the Final Report, please bring it to our attention.

Very truly yours,

Thomas M. Lachajczyk

Thomas M. Lachajczyk
Associate

TML/jam/200
Enclosure

MINUTES OF THE MEETING

Comment: Further sampling which has been recommended will be performed by The Corps of Engineers and is also being conducted by the Michigan Department of Natural Resources.

Comment: Debris portion of the HRS may not be accurate.

Response: State in the cover letter: "As directed in contract documents, the HRS form is based on limited information collected in a one-day field investigation. Inspection of building interiors and debris was not included in the Scope of Work".

Comment: Please have boring logs typed to improve legibility.

Response: Typed boring logs will be included in an Appendix to the Final Report. Original field logs were hand written.

Comment: State in the report the location of keys to the monitoring wells.

Response: Add to the last paragraph of Section 3.2.2, page 3-7: Keys to each well were given to Mr. Roger Jewell, United States Forest Service, Sault Ste. Marie, Michigan.

Comment: Page 2-1, Section 2.2, first paragraph, line 6: change Nike to Bomarc.

Response: Agree.

Comment: Include a letter describing disposal of cuttings at the Dafter Land Fill.

Response: The letter will be included as an Appendix. Reference to the Appendix and disposal will be shown on page 2-1 and 5-2.

Comment: Insert additional information, to be supplied by the Corps of Engineers, concerning the status of on-going work at the site recommended in the report.

Response: Additional information to be supplied will be included in Chapter 5.

Comment: Section 3.1.6. The possible sludge drying bed's dimensions are inconsistent with use as a drying bed.

Response: No contaminants were found in the soil sample at this area. Change to "De nuded Area".

Comment: P 3-5, first line. "Army" is incorrect.

Response: Change to "Air Force".

Comment: Insert at the end of Section 3.1.7 "This site will be further evaluated by the U. S. Army Corps of Engineers.

Response: Will be changed as stated.

Comment: P 3-6, Section 3.2.2, Paragraph 4, line three, change "after completion of" to "prior to".

Response: To be changed as stated.

Comment: P 3-10, RS-5, first line, correct spelling of "covered".

Response: Agree.

Comment: Table 4-2. Trichlorofluoromethane listed twice, with different detection limits.

Response: Remove one of the references. The correct detection limit is 1.3 ug/l.

Comment: Explain the presence of trichlorofluoromethane in sampling blank and rinsate.

Response: Contamination in the organic laboratory is not believed to be likely since trichlorofluoromethane is not used in that laboratory, which is separated from EEI's other facilities. Therefore, it is more likely that the contamination occurred during sampling, due to an unknown source. This will be stated in the report.

Comment: P 5-1, Section 1b. Remove the last sentence, beginning with the word Responsibility. Replace with: "It appears that disposal of these drums occurred after DOD transferred ownership of the site to the U. S. Forest Service. Detroit District, U. S. Army Corps of Engineers will sample the drums and remove them as part of the Raco Debris Removal Project.

Response: Changed as shown.

Comment: P 5-1, paragraph 1d. Change "in the apparent sludge drying bed" to "near the wastewater treatment plant".

Response: To be changed as shown. Labels on figures should also be changed.

EEI Comment: P 5-1, paragraph 4. Insert "analytical" prior to results in the fourth line of paragraph 4.

Comment: p-5-2, paragraph 4d. Add to the end of paragraph "several other organics were also detected at RG-3, including an unknown (7.3 ug/l), 2-pentene, 3,4,4-trimethyl (3.4 ug/l), and 1-pentene, 2,4,4-trimethyl (20.8 ug/l).

Comment: P-5-2, paragraph 4e. State that surrogate spikes may be the reason toluene was detected at site RG-4.

Response: This will be stated on pages 5-2, 4-23 and 4-20.

Comment: P-4-22. Why are results for RS-7 and RS-7 rerun identical?

Response: The surrogate recovery during analysis of RS-7 was outside control limits, requiring a re-run. A library search was performed for the re-run, not for the original sample analysis. One library search was performed. The results were reported in both columns erroneously, and will be removed from RS-7 results on page 4-22.

Comment: Check the number of underground tanks referred to in the report. It should state 14 tanks.

Response: The number of tanks will be referred to as 14.

Comment: State in the conclusions that silos number 2 and 10 will be resampled.

Response: Change on page 5-1, Section 4b.

Comment: The report is inconsistent in the use of the term DI for deionized versus distilled water which was used? Distilled water may be a source of contamination.

Response: Distilled water was purchased in a store and used in the field. Sampling blanks and rinsates were collected and documented whether the distilled water is a source of potential contamination. EEI will plan to use deionized water in the future. "DI" will be changed to "distilled" where appropriate.

In addition, EEI has received witten comments concerning the Draft Final report and plans to response to these comments as follows:

MRD QA/QC comments:

Comment: P-2 of 4, pg 4. Trichlorofluoromethane listed twice with different detection limits on all tables.

Response: This is an error in the data reporting. Trichlorofluoromethane should be reported only once, with a detection limit of 1.3 ug/l (water) or 1.3 ng/l (soil).

Comment: P-2 of 4, pg 5. Ethylbenzene - not a common lab solvent, but here apparently laboratory contamination.

Response: It is possible that trace quantities of ethylbenzene are present in the surrogate spike. Since ethylbenzene was found more often in lab blanks and sampling blanks than in actual samples it is not believed to be present in the samples. Ethylbenzene is not routinely detected in blanks in EEI's laboratory, so a definite explanation for its presence in lab blanks and sampling blanks in this project is not available.

Comment: P-2 of 4, pg 5. No duplicate for silo water.

Response: Analyses of samples RB-7 and RB-7 replicate were deleted from the project at the direction of the Authorized Representative of the Contracting Officer on January 14, 1987.

Comment: MRD feels that trichlorofluoromethane and toluene being detected in RS-8 rinsate and RB-7 sampling blank (no sampling blank or rinsate for groundwater samples was collected) calls into question the values reported for toluene in field samples. We note that QA/QC results confirm EEI results for RB-7 sampling blank, RS-1, and RS-8 rinsate (see tables 2, 4, 5).

Note: Not all field samples have toluene so field contamination was not systematic.

Note: Highest values for toluene for field samples are RS-1 and RS-7. In addition RS-1 and RS-7 are the field samples with highest values for pet.hc's and "additional peaks" (see AE's comment, p-4-23 pg 2 in 3, 4, 5 in DFR). Pet.hc's and "additional peaks" were not found in controls RS-8 rinsate or RB-7 sampling blank. Therefore toluene in RS-1 and RS-7 may not come from the same source as that in RS-8 rinsate and RB-7 sampling blank.

Conclusion: Cannot tell from this data if toluene found in the field samples is a field contaminant or derives from the sample collected.

Response: EEI is required through Method 8240 to spike all samples with surrogates, including deuterated toluene. Although EEI uses the purest surrogates available, deuterated toluene contains some non-deuterated toluene as a contaminant. This is the most reasonable explanation for detection of toluene in some samples and QA/QC samples.

Conversely, detection of benzene and toluene in the same sample (RB-4) is reasonable since these compounds often are present in the same mixture.

EEI agrees with the comment's conclusion, and this question can be answered only through further sampling.

Comment: p-3 of 4, last pg on page. Why would QA/QC analysis use a method (503 c,d) which cannot be compared with EEI's method (418.1)? We note that MRD agrees EEI used preferred method for these samples.

Response: EEI originally proposed to use Method 503 but switched to 418.1 based on MRD's comments.

Comment: Note: RB-7 - no available comparison with EEI.

Response: See a previous response. EEI was directed to not analyze RB-7.

Comment: MRD again questions Toluene results (see page 2-4, paragraph 5 above).

Response: Toluene is possibly present in the surrogate.

Comment: Failure of reporting all internal QC information by EEI results in problem evaluating metals data by MRD.

Response: Please advise us if additional QC information is required.

Comment: Table 1: RB-7 (silo #26) - No comparison with EEI result possible since EEI did not assay this sample. All QA results except Ba++ and toluene below detection limit.

Response: EEI did not analyze this sample at the direction of the Authorized Representative of the Contracting Officer.

Comment: Table 2: RB-7 sampling blank. Note: QA lab got comparable value for toluene as EEI.

Comment: Table 3: RG-1 (well #1). No comments.

Comment: Table 4: RS-1 (transformer pad). Note: QA lab got a significant value for toluene as did EEI.

Comment: Table 5: RS-9 rinsate. Note: Again toluene found at level similar to EEI!

Response: EEI assumes that the external QA lab also spikes with deuterated toluene (as required by Method 8240), so they may experience similar problems.

Comment: Table 6: Travel blank. Note: Displayed in tables 4-10, 4-12, and 4-14 of DFR. Only purgeable compounds analyzed. QA, EEI results agree.

Response: Analysis of only purgeable compounds for travel blanks is as per EEI's plan. EEI does not normally collect travel blanks for parameters other than purgeables.

Comment: Page 1-2, paragraph 4 in 10. Can one conclude that toluene was really present in soil samples RS-1, RS-2 and RS-7? Apparently nct. (See page 2-4 paragraph 5 of notes on MRD QA/QC results).

Response: See previous discussion of toluene in surrogates. The report will state this possibility. EEI does not believe it can be concluded that toluene is definitely present in any sample.

Comment: p-3-4. P 3-2 is numbered page 3-4.

Response: Will be corrected.

Comment: p-3-5, pg 5 in 1. The word "approximately"; should not statement be quantitative (i.e., the number of tanks either does or does not equal nine)?

Response: The word "approximately" was used because the above ground evidence of underground tanks left some doubt as to the precise number of tanks present. The sentence will be changed to "it appears that nine underground tanks were located west of the airfield".

Comment: p-3-9, see 3.3 SAMPLING PLAN, part 3. "collection from six missile silos" agrees with modification of 3/23/87 but differs from table 1, page 9 of "PLAN" where are 7 numbers. Note: See page 3-14 paragraph 9 below.

Response: See previous explanation concerning deletion of one silo sample.

Comment: p-3-10 pg 7. Can the location of RS-9 be indicated in one of the figures, 2-1, 3-1, or 3-2 as appropriate?

Response: RS-9 is shown in Figure 3-1 (northwest corner of the map).

Comment: p-3-14 pg 9. Samples from RB-7 not analyzed. Note: This sample supposed to be one of the MRD split controls (see table 1, p-9, QA/QC PLAN). Q: Will one of the remaining silo samples be split for MRD analysis? The answer, No (see table 1 of notes on MRD QA/QC results).

Response: This comment has been previously addressed.

Comment: p-4-2. Q: Why does table 4-1 list method 8240 for both soil and water samples while in SOW (p-30) #8020 is listed for soil and #602 for water samples?

Response: EEI proposed to use method 8240 (GC/MS) instead of 602 and 8020. This method allows use of a library search to identify additional unknown compounds.

Comment: p-4-15 pg 2. Apparently pet. hc's detected in RG-3 (just above detection limit) is real.

Response: Several additional organics were found in RG-3.

Comment: p-4-15 pg 7 in 1. RG-4 travel --> RG-4, travel.

Response: A correction will be made.

Comment: p-4-15 pg 7. Should a question concerning the quality of the lab work be raised with regard to the unknowns in travel and lab blanks?

Response: The GC/MS method is semi-quantitative. The concentration of unknowns reported were less than or equal to 10 ug/l (very low). The presence of unknowns in blanks has not affected the interpretation of results of sample analysis.

Comment: p-4-15 pg 8. Toluene detected in RG-4 slightly above detection limit. What to make of if anything? In view of notes on MRD QA/QC results, p-2 of 4 pg 5, the result is questionable?

Response: See previous discussion concerning toluene.

Comment: p-4-15 pg 9. Trichloroethylene in RG-3. What if anything to do about it? Note: See communication of 12 May 1987 from DOD, Wash. D.C.; apparently someone is going ahead with remedial investigation (RI) of this groundwater.

Response: The potential presence of trichloroethylene in the sample from RG-3 should be confirmed through further sampling and analysis. Please note that the concentration (3 ug/l) reported is less than the official minimum detection limit for SW-846.

Comment: p-4-20 pg 1. In RB-4, benzene and toluene were detected. The paragraph concludes that detection of toluene in RB-4 is real. It suggests detection of toluene in sample and lab blanks does not change this conclusion since none of these were analyzed on same day as RB-4. We noted that MRD concludes RB-4's toluene value is questionable (see p-2 of 4 pg 5 of notes on MRD QA/QC results).

Response: This section should be revised to indicate that the detection of toluene (at 1.2 ug/l) should be confirmed through further sampling and analysis.

Comment: p-4-20 pg6 in 1,2,3. Q: Of these values from 24-63 ug/g, can any of them be considered "real" in view of the soil background RS-9 = 24? MRD opinion: Talked to Dr. Solsky (6/15). Concerning RS-2-6,8 values in range 24 to 63; they are not significantly different from RS-9 (background) value of 24 ug/g. Therefore these values should not be described as "low levels".

Response: EEI will revise the report to state that values from 24 to 63 ug/g should not be considered significantly different than background.

Comment: p-4-20 pg 7. RS-7 runs are consistent for ethylbenzene and methylene chloride, therefore apparently RS-7 actually contains ethylbenzene and methylene chloride. Note: But see comment in notes on MRD QA/QC results p-2 of 4 pg 5 concerning ethylbenzene).

Response: EEI does not believe one should conclude that ethylbenzene and methylene chloride are present in RS-7. However since many other organic compounds were detected, the possibility of methylene chloride and ethylbenzene also being present cannot be dismissed. Confirmation through further sampling and analysis is recommended.

Comments: p-4-23 pg 1 in 3,4. Q: With regard to the conclusion that only RS-1 has high enough toluene value to suggest possible site contamination. See the "conclusion" in comments in notes on MRD QA/QC results p-2 of 4 pg 5. Note: No lab blank is dated Dec. 17 in table 4-14. Perhaps Dec. 12 is meant?

Response: Since the results for toluene at RS-1 are higher than at other sites, it raises uncertainty as to whether toluene is actually present or is due to presence in surrogates. Further sampling and analysis may confirm toluene's presence. GC rather than GC/MS should be considered. No samples or blanks were analyzed on Dec. 17.

Comment: p-4-23 pg 2 in 1,2. Q: Why are the values in columns for RS-7 and RS-7 rerun identical (see p-4-22)?

Response: The surrogate recovery for RS-7 was not within limits. The sample was re-run, including library search. No library search was done for RS-7. No results should have been reported. Results for RS-7 library search will be deleted.

Comment: p-5-2 pg 1 in 3,4. I have not found the Michigan Std referred to here?

Response: Michigan DNR standards have been obtained and will be included in an Appendix and referred to in the text.

Comment: p-5-2 pg 3. Q: I do not see toluene in any samples and blanks for Jan. 29. Also the date for RG-4 is 12/29, not 1/29? Therefore why is the date Jan. 29 mentioned?

Response: Some of the dates referred to in table 4-10 are incorrect and will be revised. i.e., RG-2 1/29; RG-3 1/29; RG-4 1/28.

The following comments and responses refer to the HRS form.

Comment: p-2 #25. Therefore answer Q's 100-399 and 500-599.

Response: EEI answered these questions.

Comment: p-7 #101. How many 55-gallon drums? Booklet binder hole obscures number.

Response: Two. This problem will be noted in production of the Final Report.

Comment: p-7 #104. Is this the desired answer?

Response: If not - advise.

Comment: p-7 #105. What is "CY" in the question?

Response: Cubic yards.

Comment: p-7 #108. Is this answer equal to 0 since the drums are in silo "below" the earth's surface?

Response: EEI assumed the silos are not leaking.

Comment: p-8 #112. Note: Idea apparently to "mention" a substance if it is even detected.

Response: EEI believes this is the required approach.

Comment: How decide if a cpd is "hazardous" and therefore includable? i.e., ethylbenzene, methylene chloride, cyclohexane, tricyclo(...)decane, not listed in 40 cfr, 261, app. VIII?

Response: EEI did not list non-specific compounds e.g., "unknown hydrocarbon".

Comment: p-8 #113. Why is not phenol also listed? It is rated "HIGH" in Sax.

Response: Phenol should have been listed.

Comment: p-8 #115. Note: None of the substances in #113 are listed in table 6, thus apparently the reason EEI answered "assumed"?

Response: Correct.

Comment: p-8 #117. Note: Trichloroethylene in RG-3 (groundwater), therefore not mentioned here. Note: Phenol should be in #112, since in RS-1 (a soil sample), therefore should it be mentioned here?

Response: Phenol will be listed.

Comment: p-9 #121. If phenol should be in #122, and since found in RS-1 (a soil sample), should it be listed here?

Response: Phenol will be listed.

Comment: p-27 #294. Storage area - RG-3 (trichloroethylene), RS-1, RS-7, RB-4 (pet. hydrocarbons). Agree. Q: RS-2-6, RS-8 see comment p-4-20 pg 6 in 1,2,3.

Response: The anwser will be modified to RS-1, R-7 RB-4.

Comment: Q: RB-1-3, RB-5-6 talked to Dr. Solsky at MRD (6/15); he indicated from their experience analyzing many of these water samples that these values may be "real". Therefore agree.

Response: None

Comment: Q: RG-3 (pet. hc's) (may be "real"). Its been detected, therefore agree to including it here. That is if the idea is to include anything detected even if may not be detected in a duplicate run by EEI or the QA/QC lab.

Response: None

Comment: Material - add phenol see comment p-8, #113.

Response: Agree.

APPENDIX B

RIGHT OF ENTRY

United States
Department of
Agriculture

Forest
Service

4000 I-75 Business Spur
Sault Ste. Marie, MI 49783

Reply to: 2700

Date: October 2, 1986

Subject: Raco Missile Base

To: Envirodyne Engineers
12161 Lackland Road
St. Louis, MO 63146

You are herein granted permission to enter Forest Service property in and around the former Raco Missile Site for the purpose of determining the existence of environmental hazards to the public. You may insert sample wells to test ground water for the above purpose.

All materials should be removed when project is completed.

ROGER L. JEWELL
District Ranger

APPENDIX C

SOILS - PHYSICAL TESTS

STS Consultants Ltd.

CONSULTING SOIL & FOUNDATION ENGINEERS
1909 Enterprise, Marquette, Michigan 49855 (906) 225-1417
3340 Ranger Road, Lansing, Michigan 48906 (517) 321-4964
540 Lambeau St., Green Bay, Wisconsin 54303 (414) 494-9656

Envirodyne Engineers
12161 Lackland Road
St. Louis, Missouri 63146

Date 12-17-86

STS Job No. 14800

Structure missle silos

Location Raco, Mich

Attention: Tom Lachajczyk

Gentlemen:

We are sending

☒ Herewith

_____ sets of prints of

☐ under separate cover

☐ Soil Boring Location Diagram
☐ Boring Logs
☐ Laboratory Compaction Data
☐ Field Compaction Control Data
☒ Classification Test Data
☐ Consolidation Test Data
☐ Jar Samples
☐ Rock Core Samples
☐ Caisson Reports
☐ Concrete Report #
☐
☐

for the above job.

Remarks

Yours truly,

STS Consultants Ltd.

James A. Sergen

CG 657083 R

STS Consultants Ltd.
540 LAMBEAU ST., GREEN BAY, WIS. 54303

Project No. _____
STS Job No. 14800
Date 12-15-86
Report No. 1

REPORT OF ANALYSIS OF AGGREGATES

Architect Engineer Envirodyne Engineers
Contractor _____
Project Raco Missile Silos
Source _____

REPORT OF TESTS OF MW-1 S-7 9-10.5'

Sieve Size or No.	Weight Retained	% Retained	% Passing	Specifications
3-Inch				
2-Inch				
1 1/2-Inch				
1-Inch				
3/4-Inch				
1/2-Inch				
3/8-Inch				
No. 4	0.0	0.0	100	
No. 8				
No. 10	0.1	---	---	
No. 16	0.8	0.4	99.6	
No. 20				
No. 30				
No. 40	64.5	29.1	70.5	
No. 50				
No. 80				
No. 100	146.7	66.3	4.2	
No. 200	5.6	2.5	1.7	
Pan	3.5	1.7		
Fineness Modulus				

Received at Laboratory _____
Quantity Represented 221.2 grams
Submitted by _____
Sampled From 9-10.5'
Identification MW-1 S-7
Date Sampled 12-5-86
Intended Use _____

Remarks:

Organic matter, colorimetric _____
Coal and Lignite _____
Clay Lumps _____
Chert _____
Soft Particles _____
Percent Absorption _____
Specific Gravity _____
Dry Rodded Wgt. _____
Washed Gradation xx
Percent Passing No. 200 Sieve 1.7 %
Fine to medium sand (SP)
Water Content 3.4%

Checked By: Kenneth D. Kujava

Bob Mottl
Tested By

CG 1642R

STS Consultants Ltd.
540 LAMBEAU ST., GREEN BAY, WIS. 54303

Project No. _____
STS Job No. 14800
Date 12-15-86
Report No. 2

REPORT OF ANALYSIS OF AGGREGATES

Architect Engineer Envirodyne Engineers
Contractor _____
Project Raco Missile Silos
Source _____
REPORT OF TESTS OF MW-1 S-15 48-49.5'

Sieve Size or No.	Weight Retained	% Retained	% Passing	Specifi-cations
3-Inch				
2-Inch				
1 1/2-Inch				
1-Inch				
3/4-Inch				
1/2-Inch				
3/8-Inch				
No. 4				
No. 8				
No. 10				
No. 16	0.0	0.0	100	
No. 20				
No. 30				
No. 40	1.5	0.7	99.3	
No. 50				
No. 80				
No. 100	151.7	72.6	26.7	
No. 200	41.5	19.9	6.8	
Pan	14.3	6.8		
Fineness Modulus				

Received at Laboratory _____
Quantity Represented 209.0 grams
Submitted by _____
Sampled From 48-49.5'
Identification MW-1 S-15
Date Sampled 12-5-86
Intended Use _____

Remarks:

Organic matter, colorimetric _____
Coal and Lignite _____
Clay Lumps _____
Chert _____
Soft Particles _____
Percent Absorption _____
Specific Gravity _____
Dry Rodded Wgt. _____
Washed Gradation xx
Percent Passing No. 200 Sieve 6.8 %
Slightly silty fine sand (SM-SP)
Water Content 21.3%

Checked By: Kenneth D. Kujava

Bob Mottl
Tested By

CG 1642R

STS Consultants Ltd.
540 LAMBEAU ST., GREEN BAY, WIS. 54303

Project No. _____
STS Job No. 14800
Date 12-15-86
Report No. 3

REPORT OF ANALYSIS OF AGGREGATES

Architect Engineer Envirdyne Engineers
Contractor _____
Project Raco Missile Silos
Source _____
REPORT OF TESTS OF MW-2 S-12 33-34.5'

Sieve Size or No.	Weight Retained	% Retained	% Passing	Specifications
3-Inch				
2-Inch				
1 1/2-Inch				
1-Inch				
3/4-Inch				
1/2-Inch				
3/8-Inch				
No. 4				
No. 8				
No. 10				
No. 16	0.0	0.0	100	
No. 20				
No. 30				
No. 40	4.9	2.2	97.8	
No. 50				
No. 80				
No. 100	195.2	87.7	10.1	
No. 200	18.0	8.1	8.0	
Pan	4.5	2.0		
Fineness Modulus				

Received at Laboratory _____
Quantity Represented 222.6 grams
Submitted by _____
Sampled From 33-34.5'
Identification MW-2 S-12
Date Sampled 12-7-86
Intended Use _____

Remarks:

Organic matter, colorimetric _____
Coal and Lignite _____
Clay Lumps _____
Chert _____
Soft Particles _____
Percent Absorption _____
Specific Gravity _____
Dry Rodded Wgt. _____
Washed Gradation xx
Percent Passing No. 200 Sieve 8.0 %
Slightly silty fine sand (SM-SP)
Water Content 3.8%

Checked By: Kenneth D. Kujava

Bob Mottl
Tested By

CG 1642R

STS Consultants Ltd.
540 LAMBEAU ST., GREEN BAY, WIS. 54303

Project No. _____
STS Job No. 14800
Date 12-15-86
Report No. 4

REPORT OF ANALYSIS OF AGGREGATES

Architect Engineer Envirodyne Engineers
Contractor _____

Project Raco Missile Silos
Source _____

REPORT OF TESTS OF MW-2 S-15 48-49.5'

Sieve Size or No.	Weight Retained	% Retained	% Passing	Specifi-cations
3-Inch				
2-Inch				
1 1/2-Inch				
1-Inch				
3/4-Inch				
1/2-Inch				
3/8-Inch				
No. 4	0.0	0.0	100	
No. 8				
No. 10	1.6	0.6	99.4	
No. 16	2.1	0.8	98.6	
No. 20				
No. 30				
No. 40	84.1	30.3	68.3	
No. 50				
No. 80				
No. 100	183.6	66.1	2.2	
No. 200	4.6	1.6	0.6	
Pan	1.6	0.6		
Fineness Modulus				

Received at Laboratory _____
Quantity Represented 277.6 grams
Submitted by _____
Sampled From 48-49.5'
Identification MW-2 S-15
Date Sampled 12-7-86
Intended Use _____

Remarks:

Organic matter, colorimetric _____
Coal and Lignite _____
Clay Lumps _____
Chert _____
Soft Particles _____
Percent Absorption _____
Specific Gravity _____
Dry Rodded Wgt. _____
Washed Gradation xx
Percent Passing No. 200 Sieve 0.6 %
Fine to medium sand (SP)
Water Content 20.0%

Checked By: Kenneth D. Kujava

Bob Mottl
Tested By

CG 1642R

STS Consultants Ltd.
540 LAMBEAU ST., GREEN BAY, WIS. 54303

Project No. _____
STS Job No. 14800
Date 12-15-86
Report No. 5

REPORT OF ANALYSIS OF AGGREGATES

Architect Engineer Envirodyne Engineers
Contractor _____
Project Raco Missile Silos
Source _____
REPORT OF TESTS OF MW-3 S-4 4.5-6.0'

Sieve Size or No.	Weight Retained	% Retained	% Passing	Specifications
3-Inch				
2-Inch				
1 1/2-Inch				
1-Inch				
3/4-Inch				
1/2-Inch				
3/8-Inch				
No. 4	0.0	0.0	100	
No. 8				
No. 10	0.7	0.2	99.8	
No. 16	4.8	1.6	98.2	
No. 20				
No. 30				
No. 40	96.2	31.9	66.3	
No. 50				
No. 80				
No. 100	143.6	47.6	18.7	
No. 200	2.5	0.8	17.9	
Pan	53.8	17.9		
Fineness Modulus				

Received at Laboratory _____
Quantity Represented 301.6 grams
Submitted by _____
Sampled From 4.5-6.0'
Identification MW-3 S-4
Date Sampled 12-8-86
Intended Use _____

Remarks:

Organic matter, colorimetric _____
Coal and Lignite _____
Clay Lumps _____
Chert _____
Soft Particles _____
Percent Absorption _____
Specific Gravity _____
Dry Rodded Wgt. _____
Washed Gradation xx
Percent Passing No. 200 Sieve 17.9 %
Silty fine to medium sand (SM)
Water Content 5.1%

Checked By: Kenneth D. Kujava

Bob Mottl
Tested By

CG 1642R

STS Consultants Ltd.
540 LAMBEAU ST., GREEN BAY, WIS. 54303

Project No. _____
STS Job No. 14800
Date 12-14-86
Report No. 6

REPORT OF ANALYSIS OF AGGREGATES

Architect Engineer Envirodyne Engineers
Contractor _____
Project Raco Missile Silos
Source _____
REPORT OF TESTS OF MW-3 S-15 48-49.5'

Sieve Size or No.	Weight Retained	% Retained	% Passing	Specifications
3-Inch				
2-Inch				
1 1/2-Inch				
1-Inch				
3/4-Inch				
1/2-Inch				
3/8-Inch				
No. 4				
No. 8				
No. 10				
No. 16	0.0	0.0	100	
No. 20				
No. 30				
No. 40	0.5	0.2	99.8	
No. 50				
No. 80				
No. 100	135.1	61.3	38.5	
No. 200	59.5	26.9	11.6	
Pan	25.6	11.6		
Fineness Modulus				

Received at Laboratory _____
Quantity Represented 220.7 grams
Submitted by _____
Sampled From 48-49.5'
Identification MW-3 S-15
Date Sampled 12-8-86
Intended Use _____

Remarks:

Organic matter, colorimetric _____
Coal and Lignite _____
Clay Lumps _____
Chert _____
Soft Particles _____
Percent Absorption _____
Specific Gravity _____
Dry Rodded Wgt. _____
Washed Gradation xx
Percent Passing No. 200 Sieve 11.6 %
Slightly silty fine sand (SM-SP)
Water Content 22.1%

Checked By: Kenneth D. Kujava

Bob Mottl
Tested By

CG 1642R

STS Consultants Ltd.
540 LAMBEAU ST., GREEN BAY, WIS. 54303

Project No. _____
STS Job No. 14800
Date 12-15-86
Report No. 7

REPORT OF ANALYSIS OF AGGREGATES

Architect Engineer Envirodyne Engineers
Contractor _____
Project Raco Missile Silos
Source _____
REPORT OF TESTS OF MW-4 S-10 18-19.5'

Sieve Size or No.	Weight Retained	% Retained	% Passing	Specifi-cations
3-Inch				
2-Inch				
1 1/2-Inch				
1-Inch				
3/4-Inch				
1/2-Inch				
3/8-Inch				
No. 4	0.0	0.0	100	
No. 8				
No. 10	0.7	0.3	99.7	
No. 16	1.6	0.7	99.0	
No. 20				
No. 30				
No. 40	56.5	25.2	73.8	
No. 50				
No. 80				
No. 100	154.3	69.0	4.8	
No. 200	8.3	3.7	1.1	
Pan	2.5	1.1		
Fineness Modulus				

Received at Laboratory _____
Quantity Represented 223.9 grams
Submitted by _____
Sampled From 18-19.5'
Identification MW-4 S-10
Date Sampled 12-4-86
Intended Use _____

Remarks:

Organic matter, colorimetric _____
Coal and Lignite _____
Clay Lumps _____
Chert _____
Soft Particles _____
Percent Absorption _____
Specific Gravity _____
Dry Rodded Wgt. _____
Washed Gradation xx
Percent Passing No. 200 Sieve 1.1 %
Fine to medium sand (SP)
Water Content 6.0%

Checked By: Kenneth D. Kujava

Bob Mottl
Tested By

CG 1642R

STS Consultants Ltd.
540 LAMBEAU ST., GREEN BAY, WIS. 54303

Project No. _____
STS Job No. 14800
Date 12-14-86
Report No. 8

REPORT OF ANALYSIS OF AGGREGATES

Architect Engineer Envirodyne Engineers
Contractor _____
Project Raco Missile Silos
Source _____
REPORT OF TESTS OF MW-4 S-14 38-39'

Sieve Size or No.	Weight Retained	% Retained	% Passing	Specifications
3-Inch				
2-Inch				
1 1/2-Inch				
1-Inch				
3/4-Inch				
1/2-Inch				
3/8-Inch				
No. 4				
No. 8				
No. 10	0.0	0.0	100	
No. 16	0.7	0.3	99.7	
No. 20				
No. 30				
No. 40	104.4	41.5	58.2	
No. 50				
No. 80				
No. 100	141.0	56.1	2.1	
No. 200	3.4	1.3	0.8	
Pan	2.1	0.8		
Fineness Modulus				

Received at Laboratory _____
Quantity Represented 251.6 grams
Submitted by _____
Sampled From 38-39'
Identification MW-4 S-14
Date Sampled 12-4-86
Intended Use _____

Remarks:

Organic matter, colorimetric _____
Coal and Lignite _____
Clay Lumps _____
Chert _____
Soft Particles _____
Percent Absorption _____
Specific Gravity _____
Dry Rodded Wgt. _____
Washed Gradation xx
Percent Passing No. 200 Sieve 0.8 %
Fine to medium sand (SP)
Water Content 20.9%

Checked By: Kenneth D. Kujava

Bob Mottl
Tested By

CG 1642R

APPENDIX D

WELL CONSTRUCTION AND BORING LOGS

ENVIRODYNE ENGINEERS

12161 Lackland Road,
St. Louis, Missouri 63146
(314) 434-6960

December 12, 1986
3067-40006

Mr. John B. Hallquist, P.E.
Contracts Management Group
Engineering Division
US Army Corps of Engineers
St. Louis District
210 North Tucker Boulevard
St. Louis, Missouri 63101

Re: Delivery Order No. 4
Contract Number DACA 87-86-D-0045
Confirmation Study at Former Bomark Missile Battery in Raco, Michigan.
Boring and Well Construction Logs

Dear Mr. Hallquist:

Enclosed are the original copies of field boring logs and Well Construction logs for the four monitoring wells MW-1,2,3 and 4 drilled at the Bomark Missile Battery, Raco, Michigan. The information is supplied in accordance with Section 3.5.10 of the Scope of Work. The information was prepared by Paul Shetley, and checked by Don Monnot, EEI's Senior Geohydrologist.

The well logs do not include the exact reference elevation required in Section 3.5.11 of the Scope of Work. This information will be supplied after the site survey is completed.

Two samples from each boring have been submitted for physical testing including grain size (sieve only), and moisture content.

Auger Boring	Sample Numbers
MW-1	7 & 15
MW-2	12 & 15
MW-3	4 & 15
MW-4	10 & 14

If further information is required or you wish to discuss any aspect of this submittal, please contact me.

Sincerely,

Thomas M. Lachajczyk
Program Manager

PWS/jag
Enclosure

ENVIRODYNE
ENGINEERS

SUMMARY OF DRILLING

Boreholes were drilled using a truck mounted Mobile Drill, model B61 drilling rig. The boreholes were advanced using a 6½ inch O.D. hollow stem auger.

Soil samples were collected using a 2.0 inch x 18 inch split spoon sampler, and driven with a 140 pound hammer.

The borings were drilled to approximately 10 feet below the encountered groundwater level. After drilling was completed a 2 inch ID well consisting of a 10 foot stainless steel screen (0.010 slots) and PVC blank pipe was installed using the methods prescribed in the scope of work. A three inch steel, locking, protective pipe along with a 3 foot square cement pad were also installed at the surface for each well.

The wells were logged using USCS nomenclature and abbreviations. Other abbreviations used were as follows:

Brwn = brown
w/ = with

SUMMARY OF WELL CONSTRUCTION

Monitoring Well Number	Total Depth of Well	Water Level TOC	Protective Case Highth
1	56.5'	46.5'	2.4'
2	53.5'	46.8'	2.5'
3	56.2'	45.8'*	2.6'
4	43.1'	34.6'	2.9'

*Measured while drilling - below ground level.

ENVIRODYNE ENGINEERS

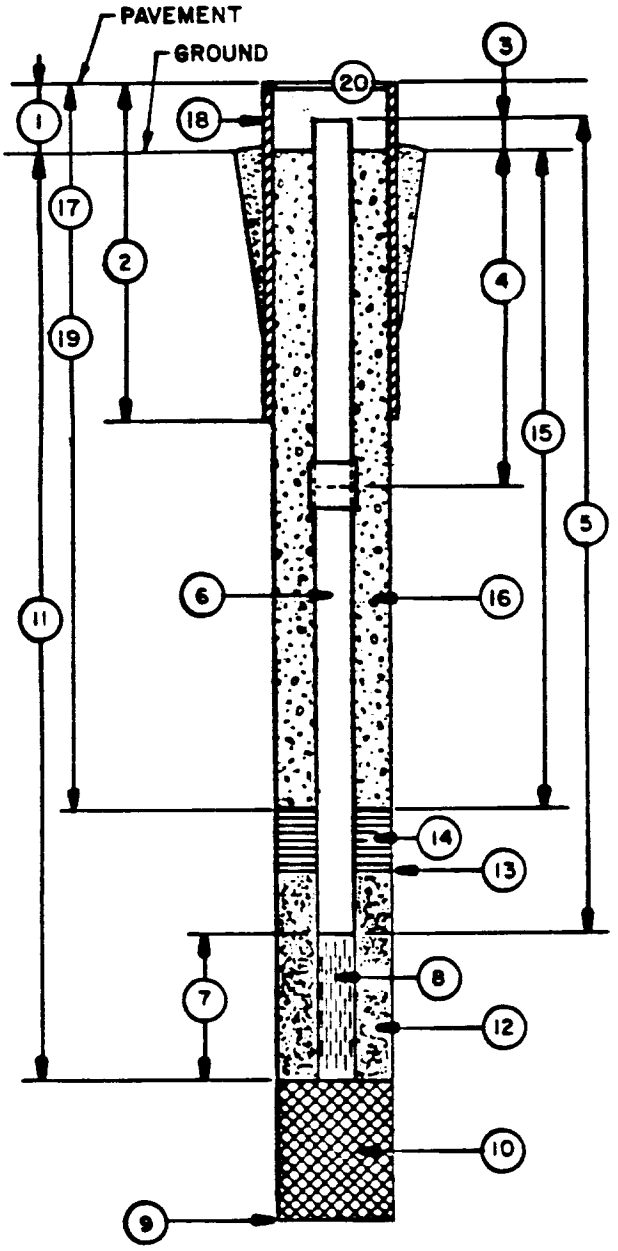
Well Construction Details

Date of Installation 12-6-87 | Job No. 3067 | Boring No. MW-1

Ground Surface Elev. 905 | Time Started 2:00 pm | Time Completed 5:00 pm

Logger Paul Shetley | Drill Firm STS, Inc. | Driller E. Vande Hey

All depth measurements of well detail are from ground surface unless otherwise indicated.



1. Height of Protective Casing Above Ground 2.4'
2. Total Length of Protective Casing 4.2'
3. Height of Standpipe Above Ground 2.3'
4. Depth to First Joint 6.4'
   Joint Interval 10.0 Type Flush thread
5. Total Length of Blank Pipe 48.8'
6. Type of Blank Pipe Sch.40 PVC Diam. 2.0"
7. Length of Screen 10.0'
8. Type of Screen Johnson Wrap Stainless steel 0.010"slo
9. Total Depth of Boring 62.5' Hole Diam. 6.5'
10. Type of Material Formation sand & filter sand
11. Depth to Bottom of Screen 56.5'
12. Type of Screen Filter Course sand
    Quantity Used 120#
13. Depth to Top of Filter 43.0'
14. Type of Seal ¼" Bentonite pellets
    Quantity Used 1¼ x 50# buckets
15. Depth to Top of Seal 41.0'
16. Type of Backfill Grout
17. Depth of Top of Backfill Ground level
18. Type of Protective Casing 3" Black steel pipe
19. Depth of Concrete Grout 41.0'
    Type of Grout Mixture 1/9 - Bentonite/Cement
20. Type of Pipe Cap Threaded PVC

Remarks:

Well had approximately 4' of sand blowin so we overdrilled to set well on top of blowin. Bentonite bridged in augers at approximately 42' BGL so augers were pulled and bentonite pellets were poured into borehole.

ENVIRODYNE ENGINEERS

FIELD BORING LOG

FOR St. Louis Corps of Engineers/DERA - Raco Missile Battery JOB NO. 3067

LOCATION South - Southeast of Composite Building ELEV. 905 BORING NO. MW-1

GROUND WATER			
WHILE DRILLING	48.2	DATE 12-6-86	DRILL CO. STS
BEFORE DEVELOPMENT		TIME START 3:00 pm	DRILLER E. Vande Hey
AFTER DEVELOPMENT		TIME END 5:30 pm	LOGGER P. Shetley

S.S. Dia 1.5
Weight 140#
Drop 30"

SAMPLE NO.	BLOWS ON SAMPLER	DRIVE	RECOVERY	VISUAL FIELD CLASSIFICATION	GRAPHIC LOG	WELL CONSTRUCT	REMARKS
1	7/12	1.5	1.2	0-0.3 Dark brown silty clay (CL)			Augered w/solid auger from 1st 10'. Advanced s. spoon before auger.
				0.3-0.5 Dark brown fine sand (SM)			
1A				0.5-1.5 Tan fine to medium sand (SM)			
				1			
2	4/8	1.5	1.5	2 Same tan (SM) as above w/a few pieces black gravel ¼" diameter scattered throughout.			
3	?	1.5	1.5	3 Same tan (SM) as above with a 1" zone at 4' that had black & white gravel ¼" diam.			
				4			
4	1/5	1.5	1.5	4.5' to 5.5' same tan (SM) as above w/no gravel.			
				5 Tan medium sand (SP) w/25 to 30% black grains.			
5	3/22	1.5	1.5	6 Same medium sand (SP) as above 6.0 to 7.0			
				7 Tan fine sand (SM) w/a few coarse black sand grains scattered throughout.			
6	?	1.5	1.5	8 Tan fine sand, same as above (SM) w/out black sand grains.			
7	8/26	1.5	1.5	9 Tan fine sand (SM) same as above.			
				10			

ENVIRODYNE ENGINEERS

FIELD BORING LOG

FOR St. Louis Corps of Engineers/DERA - Raco Missile Battery JOB NO. 3067

LOCATION South - Southeast of Composite Building ELEV. 905' BORING NO. MW-1

GROUND WATER			
WHILE DRILLING	48.2	DATE 12-6-86	DRILL CO. STS
BEFORE DEVELOPMENT		TIME START 3:00 pm	DRILLER B. Vande Hey
AFTER DEVELOPMENT		TIME END 5:30 pm	LOGGER P. Shetley

S.S. Dia 1.5" Weight 140# Drop 30"

SAMPLE NO.	BLOWS ON SAMPLER	DRIVE	RECOVERY	VISUAL FIELD CLASSIFICATION	GRAPHIC LOG	WELL CONSTRUCT	REMARKS
				10.0			Began drilling w/hollow stem augers at 10.5' Augers: 3¼ ID 6½ OD
				10.5			
				11			
				12			
8	15/38	1.5	1.2	13 Tan fine sand (SM) w/some black sand grains scattered throughout.			
				14			
				15			
				16			
				17			
9	8/30	1.5	1.5	18 Tan fine sand (SM) w/a pinkish tint.			
				19			
				19.5			

ENVIRODYNE ENGINEERS

FIELD BORING LOG

FOR St. Louis Corps of Engineers/DERA - Raco Missle Battery JOB NO. 3067

LOCATION South - Southeast of Composite Builidng ELEV. 905' BORING NO. MW-1

GROUND WATER			
WHILE DRILLING 48.2	DATE 12-6-86	DRILL CO. STS	
BEFORE DEVELOPMENT	TIME START 3:00 pm	DRILLER E. Vande Hey	
AFTER DEVELOPMENT	TIME END 5:30 pm	LOGGER P. Shetley	

S.S. Dia 1.5 Weight 140# Drop 30"

SAMPLE NO.	BLOWS ON SAMPLER	DRIVE	RECOVERY		VISUAL FIELD CLASSIFICATION	GRAPHIC LOG	WELL CONSTRUCT	REMARKS
					19.5			
					20			
					21			
					22			
10	9/33	1.5	1.5		23 Tan fine to medium sand (SP) w/pink sand grains scattered occassionally.			
					24			
					25			
					26			
					27			
11	9/45	1.5	1.5		28 Tan medium sand (SP) w/coarse sand grains scattered throughout. 1" zone of sand w/black grains 1/32" diameter at 28.8'			

ENVIRODYNE ENGINEERS

FIELD BORING LOG

FOR St. Louis Corps of Engineers/DERA - Raco Missle Battery JOB NO. 3067

LOCATION South - Southeast Composite Building ELEV. 905' BORING NO. MW-1

GROUND WATER			
WHILE DRILLING	48.2	DATE 12-6-86	DRILL CO. STS
BEFORE DEVELOPMENT		TIME START 3:00 pm	DRILLER E. Vande Hey
AFTER DEVELOPMENT		TIME END 5:30 pm	LOGGER P. Shetley

S.S. Dia 1.5 Weight 140# Drop 30"

SAMPLE NO.	BLOWS ON SAMPLER	DRIVE	RECOVERY	VISUAL FIELD CLASSIFICATION	GRAPHIC LOG	WELL CONSTRUCT	REMARKS
				29			
				29.5			
				30			
				31			
				32			
12	8/18	1.5	1.5	33			
				Tan fine sand (SM) w/occassional orange sand grains.			
				34			
				35			
				36			
				37			
13	10/24	1.5	1.5	38			
				Tan fine sand (SM)			
				38.5			

ENVIRODYNE ENGINEERS

FIELD BORING LOG

FOR St. Louis Corps of Engineers/DERA - Raco Missle Battery JOB NO. 3067

LOCATION South - Southeast of Composite Building ELEV. 905' BORING NO. MW-1

GROUND WATER			
WHILE DRILLING	48.2	DATE 12-6-87	DRILL CO. STS
BEFORE DEVELOPMENT		TIME START 3:00 pm	DRILLER E. Vande Hey
AFTER DEVELOPMENT		TIME END 5:30 pm	LOGGER P. Shetley

S.S. Dia 1.5 Weight 140# Drop 30"

SAMPLE NO.	BLOWS ON SAMPLER	DRIVE	RECOVERY		VISUAL FIELD CLASSIFICATION	GRAPHIC LOG	WELL CONSTRUCT	REMARKS
					38.5 Tan fine sand (SM) w/occassional orange sand grains.			
					39			
					39.5			
					40			
					41			
					42			
14	15/46	1.5	1.3		43 Tan fine sand (SW) w/traces of ¼" gravel scattered throughout. Sand becoming moist at 43.7'.			Sand moist at 43.7'.
					44			
					45			
					46			
					47			
					48			

ENVIRODYNE ENGINEERS

FIELD BORING LOG

FOR St. Louis Corps of Engineers/DERA - Raco Missle Battery JOB NO. 3067

LOCATION South - Southeast of Composite Building ELEV. 905' BORING NO. MW-1

GROUND WATER			
WHILE DRILLING	48.2	DATE 12-6-86	DRILL CO. STS
BEFORE DEVELOPMENT		TIME START 3:00 pm	DRILLER E. Vande Hey
AFTER DEVELOPMENT		TIME END 5:30 pm	LOGGER P. Shetley

S.S. Dia 1.5 Weight 140# Drop 30"

SAMPLE NO.	BLOWS ON SAMPLER	DRIVE	RECOVERY		VISUAL FIELD CLASSIFICATION	GRAPHIC LOG	WELL CONSTRUCT	REMARKS
15	10/19	1.5	1.5		48.0 Tan very fine to fine sand (SM) orange specks scattered throughout, sand very wet.			
					49			
					50			
					51			
					52			
16	5/34	1.5	1.0		53 Tan fine sand w/black and orange specks throughout.			Sand blowing up into augers approximately 0.5'.
					54			
					55			
					56			
					57			

ENVIRODYNE ENGINEERS

FIELD BORING LOG

FOR St. Louis Corps of Engineers/DERA - Raco Missle Battery JOB NO. 3067

LOCATION South - Southeast of Composite Building ELEV. 905' BORING NO. MW-1

GROUND WATER			
WHILE DRILLING	48.2	DATE 12-6-86	DRILL CO. STS
BEFORE DEVELOPMENT		TIME START 3:00 pm	DRILLER E. Vande Hey
AFTER DEVELOPMENT		TIME END 5:30 pm	LOGGER P. Shetley

S.S. Dia 1.5 Weight 140# Drop 30"

SAMPLE NO.	BLOWS ON SAMPLER	DRIVE	RECOVERY		VISUAL FIELD CLASSIFICATION	GRAPHIC LOG	WELL CONSTRUCT	REMARKS
					57			
17	53	0.5	1.5		58 Tan fine sand (SM) probably blowin from below auger 59.0			Sands blowing into augers approximately 3.7'.
					60 Water level 45.5 measured w/tape through augers at 1:15 pm. 61 62 Overdrilled hole to 66.5 compensate for blowin.			
					TD 62.5'			

ENVIRODYNE ENGINEERS

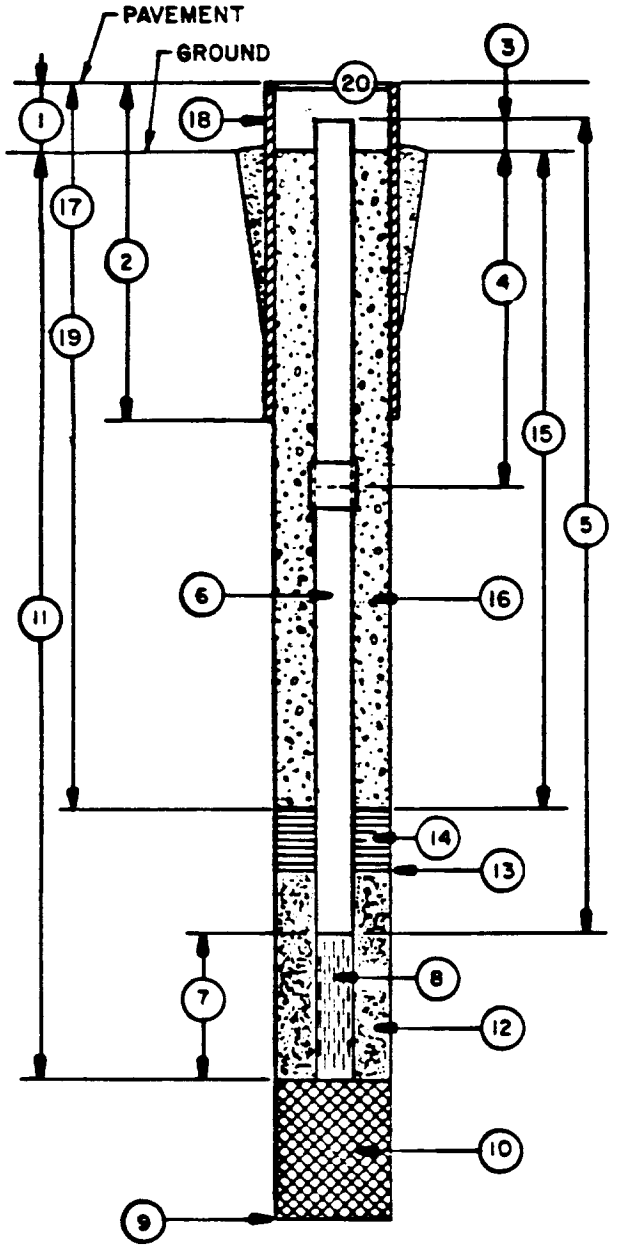
Well Construction Details

Date of Installation 12-7-86 | Job No. 3067 | Boring No. MW-2

Ground Surface Elev. 905 | Time Started 12:00 (noon) | Time Completed 4:00 pm

Logger Paul Shetley | Drill Firm STS, Inc. | Driller E. Vande Hey

All depth measurements of well detail are from ground surface unless otherwise indicated.



1. Height of Protective Casing Above Ground 2.5'
2. Total Length of Protective Casing 4.2'
3. Height of Standpipe Above Ground 2.4'
4. Depth to First Joint 3.4'
   Joint Interval 10.0 Type Flush thread
5. Total Length of Blank Pipe 45.9'
6. Type of Blank Pipe Sch.40 PVC Diam. 2.0"
7. Length of Screen 10.0'
8. Type of Screen Johnson Wrap Stainless steel 0.010 slot
9. Total Depth of Boring 56.5' Hole Diam. 6.5"
10. Type of Material Formation sand & filter sand
11. Depth to Bottom of Screen 53.5'
12. Type of Screen Filter Course sand
    Quantity Used 200#
13. Depth to Top of Filter 41.5'
14. Type of Seal ½" Bentonite pellets
    Quantity Used 3/4 of 50# bucket
15. Depth to Top of Seal 38.7'
16. Type of Backfill Grout
17. Depth of Top of Backfill Ground level
18. Type of Protective Casing 3" Black steel pipe
19. Depth of Concrete Grout 38.7'
    Type of Grout Mixture 1/9 - Bentonite/Cement
20. Type of Pipe Cap Threaded PVC

Remarks:

Added four gallons of water to wash out sand bridge.

ENVIRODYNE ENGINEERS

FIELD BORING LOG

FOR St. Louis Corps of Engineers/DERA - Raco Missile Battery JOB NO. 3067

LOCATION South of Silo Complex ELEV. ≈905' BORING NO. MW-2

GROUND WATER			
WHILE DRILLING	43.3	DATE 12-7-86	DRILL CO. STS
BEFORE DEVELOPMENT		TIME START 9:30 am	DRILLER E. Vande Hey
AFTER DEVELOPMENT		TIME END 11:30 am	LOGGER P. Shetley

S.S. Dia 1.5" Weight 140# Drop 30"

SAMPLE NO.	BLOWS ON SAMPLER	DRIVE	RECOVERY	VISUAL FIELD CLASSIFICATION	GRAPHIC LOG	WELL CONSTRUCT	REMARKS
1	2/7	1.5	1.4	0-0.5 Brown medium sand (SF).			Drilled w/solid auger w/3.5" bit to 10.5'.
				Tan medium sand (SP)			
				1			
2	5/13	1.5	1.2				
				2 Tan fine to medium sand (SM) w/scattered black specks.			
3	2/11	1.5	1.5	3			
				Some fine to medium sand (SM) as above to 3.8'.			
				4 Tan fine sand (SM) w/black specks scattered throughout.			
4	6/15	1.5	1.5				
				5			
4	6/15	1.5	1.5	5.2 to 5.4 moist fine sand w/trace of silt (SM). 5.4 to 5.7 tan fine sand (SM). 5.7 to 6.0 tan fine sand w/pebbl-s (GM) 3/8" diameter.			
5	7/18	1.5	15	6			
				6.0 to 6.9 tan fine to medium sand (SM). Tan fine sand (SM) w/pinkish tint and Fe bands.			
6	7/36	1.5	1.5	7 Same			
				8			
				Sand tan as above but w/gravels (GM) up to 1" diameter.			
7	11/20	1.5	1.5				
				Tan fine sand (SM) to 9.0'.			
				9			
				9.0 to 10.5 tan fine sand (SM) w/ alternating bands of Fe and FeMn.			

ENVIRODYNE ENGINEERS

FIELD BORING LOG

FOR St. Louis Corps of Engineers/DERA - Raco Missile Battery JOB NO. 3067

LOCATION South of Silo Complex ELEV. ≈905 BORING NO. MW-2

GROUND WATER			
WHILE DRILLING	43.3	DATE 12-7-86	DRILL CO. STS
BEFORE DEVELOPMENT		TIME START 9:30 am	DRILLER E. Vande Hey
AFTER DEVELOPMENT		TIME END 11;30 pm	LOGGER P. Shetley

S.S. Dia 1.5 Weight 140# Drop 30"

SAMPLE NO.	BLOWS ON SAMPLER	DRIVE	RECOVERY	VISUAL FIELD CLASSIFICATION	GRAPHIC LOG	WELL CONSTRUCT	REMARKS
				10			Drilled w/solid auger to 10.3'. Began drilling w/ hollow stem augers at 10.3'.
				10.5			
				11			Augers: 3¼ ID 6½ OD
				12			
8	7/28	1.5	1.5	13 Top 0.5 cave-in.			
				13.5 to 14.5 tan fine to medium sand w/approximately 20% coarse sand graining. (SW)			
				14			
				15			
				16			
				17			
9	12/33	1.5	1.4	18 Tan fine sand (SM) w/a 3/8" Fe conc. at 19.3'.			
				19			
				19.5			

ENVIRODYNE ENGINEERS

FIELD BORING LOG

FOR St. Louis Corps of Engineers/DERA - Raco Missile Battery JOB NO. 3067

LOCATION South of Silo Complex ELEV. ≈905' BORING NO. MW-2

GROUND WATER		
WHILE DRILLING 43.3	DATE 12-7-86	DRILL CO. STS
BEFORE DEVELOPMENT	TIME START 9:30 am	DRILLER E. Vande Hey
AFTER DEVELOPMENT	TIME END 11:30 am	LOGGER P. Shetley

S.S. Dia 1.5" Weight 140# Drop 30"

SAMPLE NO.	BLOWS ON SAMPLER	DRIVE	RECOVERY		VISUAL FIELD CLASSIFICATION	GRAPHIC LOG	WELL CONSTRUCT	REMARKS
					29 28.8 to 29.5 medium sand w/scatterd coarse grains (SP) 29.5			
					30			
					31			
					32			
12	13/34	1.5	1.5		33 Tan fine sand (SM), very uniform grain distribution.			
					34			
					35			
					36			
					37			
13	9/23	1.0	1.2		38 Fine to medium sand (SP)			

ENVIRODYNE ENGINEERS

FIELD BORING LOG

FOR St. Louis Corps of Engineers/DERA - Raco Missile Battery JOB NO. 3067

LOCATION South of Silo Complex ELEV. ≈905' BORING NO. MW-2

GROUND WATER			
WHILE DRILLING	43.3	DATE 12-7-86	DRILL CO. STS
BEFORE DEVELOPMENT		TIME START 9:30 am	DRILLER E. Vande Hey
AFTER DEVELOPMENT		TIME END 11:30 am	LOGGER P. Shetley

S.S. Dia 1.5" Weight 140# Drop 30"

SAMPLE NO.	BLOWS ON SAMPLER	DRIVE	RECOVERY		VISUAL FIELD CLASSIFICATION	GRAPHIC LOG	WELL CONSTRUCT	REMARKS
					38.5 Fine to medium sand (SP)			
					39			
					39.5			
					40			
					41			
					42			
14	5/17	1.5	1.4		43 Fine to medium sand (SP) tan. Sand becoming wet at 43.3'.			Sand wet at 43.3'.
					44			
					45			
					46			
					47			
					48			

ENVIRODYNE ENGINEERS

FIELD BORING LOG

FOR St. Louis Corps of Engineers/DERA - Raco Missile Battery JOB NO. 3067

LOCATION South of Silo Complex ELEV. ≈905' BORING NO. MW-2

GROUND WATER			
WHILE DRILLING	43.3	DATE 12-7-86	DRILL CO. STS
BEFORE DEVELOPMENT		TIME START 9:30 am	DRILLER E. Vande Hey
AFTER DEVELOPMENT		TIME END 11:30 am	LOGGER P. Shetley

S.S. Dia 1.5 Weight 140# Drop 30"

SAMPLE NO.	BLOWS ON SAMPLER	DRIVE	RECOVERY		VISUAL FIELD CLASSIFICATION	GRAPHIC LOG	WELL CONSTRUCT	REMARKS
15	7/13	1.5	1.2		48 Brown fine to medium sand (SP) w/scattered coarse grains throughout. 49			Sample very wet.
					50 51 52			
16	28/51	1.0	1.5		53 Fine to medium sand (SP). Sample probably all blown in. 54 Water level 43.9 measured w/tape through augers.			Approximately 3' of sand blow-in in hole.
					55 Over drilled to compensate for blow in. 56 TD 56.5' TD			

ENVIRODYNE ENGINEERS

FIELD BORING LOG

FOR St. Louis Corps of Engineers/DERA - Raco Missile Battery JOB NO. 3067

LOCATION South of Silo Complex ELEV. ≈905 BORING NO. MW-2

GROUND WATER		DATE 12-7-86	DRILL CO. STS
WHILE DRILLING	43.3	TIME START 9:30 am	DRILLER E. Vande Hey
BEFORE DEVELOPMENT		TIME END 11:30 am	LOGGER P. Shetley
AFTER DEVELOPMENT			

S.S. Dia 1.5" Weight 140# Drop 30"

SAMPLE NO.	BLOWS ON SAMPLER	DRIVE	RECOVERY		VISUAL FIELD CLASSIFICATION	GRAPHIC LOG	WELL CONSTRUCT	REMARKS
					20			
					21			
					22			
10	9/31	1.5	1.5		23 Fine to medium sand (SM) w/scattered black grains throughout			
					24			
					25			
					26			
					27			
11	11/33	1.5	1.5		28 28.0 to 28.8 same (SM) as above.			
					29			

ENVIRODYNE ENGINEERS

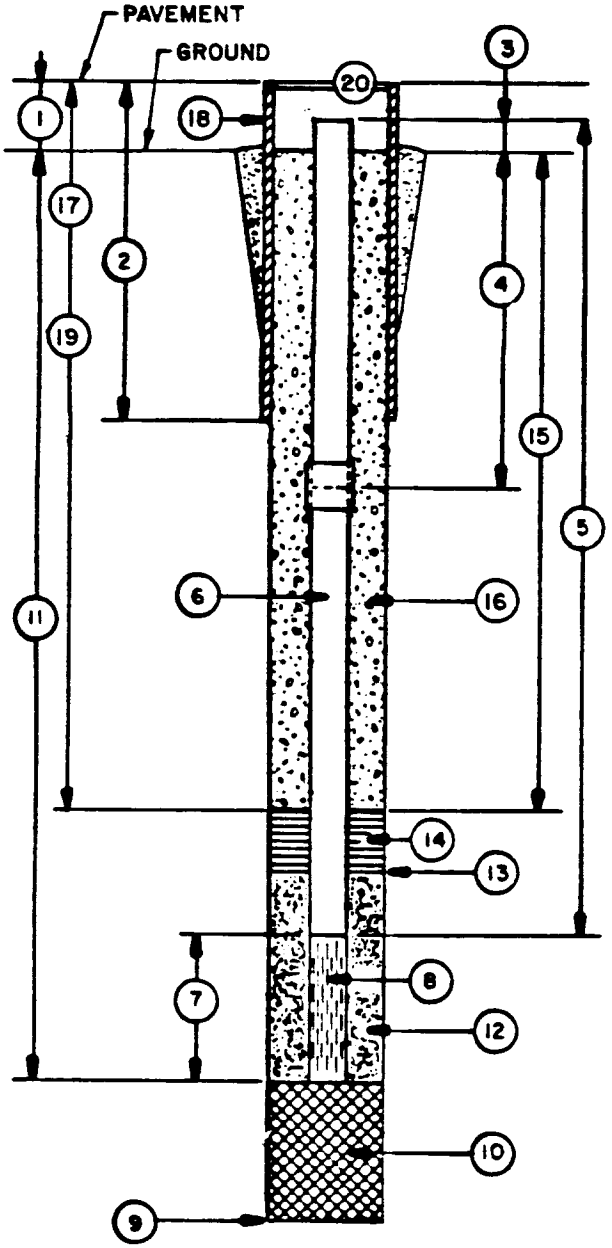
Well Construction Details

Date of Installation 12-9-86 | Job No. 3067 | Boring No. MW-3

Ground Surface Elev. 905 | Time Started 8:00 am | Time Completed 12:30 pm

Logger Paul Shetley | Drill Firm STS, Inc. | Driller E. Vande Hey

All depth measurements of well detail are from ground surface unless otherwise indicated.



1. Height of Protective Casing Above Ground 2.6'
2. Total Length of Protective Casing 4.2'
3. Height of Standpipe Above Ground 2.5'
4. Depth to First Joint 6.2'
   Joint Interval 10.0 Type Flush thread
5. Total Length of Blank Pipe 48.7'
6. Type of Blank Pipe Sch.40 PVC Diam. 2.0"
7. Length of Screen 10.0'
8. Type of Screen Johnson Wrap Stainless steel 0.010"slo
9. Total Depth of Boring 56.5' Hole Diam. 6.5"
10. Type of Material Formation sand
11. Depth to Bottom of Screen 56.2'
12. Type of Screen Filter Course sand
    Quantity Used 100#
13. Depth to Top of Filter 43.0'
14. Type of Seal ¼" Bentonite pellets
    Quantity Used 1½ x 50# buckets
15. Depth to Top of Seal 41.0'
16. Type of Backfill Grout
17. Depth of Top of Backfill Ground level
18. Type of Protective Casing 3" Black steel pipe
19. Depth of Concrete Grout 41.0'
    Type of Grout Mixture 1/9 - Bentonite/Cement
20. Type of Pipe Cap Threaded PVC

Remarks:

Had approximately 4.0' of blowin in augers, tried to wash out sand blowin with water. Pumped water through well screen and pulled up augers to force out blowin, used approximately 100 gallons of water. Able to set well near desired depth of 56.0'.

ENVIRODYNE ENGINEERS

FIELD BORING LOG

FOR St. Louis Corps of Engineers/DERA - Raco Missile Battery JOB NO. 3067

LOCATION South of WWTP/Southeast of Maintenance Bldg. ELEV. ≈905' BORING NO. MW-3

GROUND WATER			
WHILE DRILLING	43.9	DATE 12-8-86	DRILL CO. STS
BEFORE DEVELOPMENT		TIME START 11:00 am	DRILLER E. Vande Hey
AFTER DEVELOPMENT		TIME END 3:00 pm	LOGGER P. Shetley

S.S. Dia 1.5" Weight 140# Drop 30"

SAMPLE NO.	BLOWS ON SAMPLER	DRIVE	RECOVERY	VISUAL FIELD CLASSIFICATION	GRAPHIC LOG	WELL CONSTRUCT	REMARKS
1	13/10	1.5	1.2	0.0 to 0.5 Tan, fine sand w/gravel up to 1.0" in diameter (GP)			Very cold, everything freezing - 5° F.
				0.5 to 1.5 Tan, fine to medium sand (SP)			
				1			Temperature at 7:00 am, approximately 10 F.
2	5/19	1.5	1.5				
				2 Tan fine to medium sand (SP)			Drilled w/solid auger to 10.5'
3	6/14	1.5	1.4	3			
				Tan fine to medium sand (SP) w/ orange grains scattered throughout. A few larger grains (10%), scattered throughout.			
				4			
4	4/12	1.5	1.5				
				5 Tan fine to medium sand (SP) w/coarser black grains scattered througout.			
5	8/24	1.5	1.2	6 Brown silty sand (SM)			
				Tan fine to medium sand (SP) sand scattered black grains, becoming gravelly at 6.8 (GP)			
				7			
6	12/28	1.5	1.2				
				8 Tan fine sand (SM) w/a few black specks and a trace of gravel.			
7	7/24	1.5	1.3	9 Fine to very fine sand (ML) w/2 FeMn bands at approximately 9.0' and 9.1'.			
				10			

ENVIRODYNE ENGINEERS

FIELD BORING LOG

FOR St. Louis Corps of Engineers/DERA - Raco Missile Battery JOB NO. 3067

LOCATION South of WWTP/Southeast Maintenance Bldg. ELEV. ≈905' BORING NO. MW-3

GROUND WATER			
WHILE DRILLING 43.9	DATE 12-8-86	DRILL CO. STS	
BEFORE DEVELOPMENT	TIME START 11:00 am	DRILLER E. Vande Hey	
AFTER DEVELOPMENT	TIME END 3:00 pm	LOGGER P. Shetley	

S.S. Dia 1.5 Weight 140# Drop 30"

SAMPLE NO.	BLOWS ON SAMPLER	DRIVE	RECOVERY		VISUAL FIELD CLASSIFICATION	GRAPHIC LOG	WELL CONSTRUCT	REMARKS
					10			
					10.5			Began drilling w/hollow stem augers at 10.5.
					11			Augers: 3¼ ID 6½ OD
					12			
8	9/35	1.5	1.5		13 Tan fine to very fine (ML) to 14.0'			
					14 1" layer of sandy gravel 1" diameter (SW) tan fine to medium sand (SP)			
					15			
					16			
					17			
9	9/29	1.5	1.5		18 Tan fine to medium sand (SP) 18 to 18.5 Tan fine sand (SM) w/thin band of FeMn at 19.0'.			
					19			
					19.5			

ENVIRODYNE ENGINEERS

FIELD BORING LOG

FOR St. Louis Corps of Engineers/DERA - Raco Missile Battery JOB NO. 3067

LOCATION South of WWTP/Southeast of Maintenance Bldg. ELEV. ≈905 BORING NO. MW-3

GROUND WATER			
WHILE DRILLING	43.9	DATE 12-8-86	DRILL CO. STS
BEFORE DEVELOPMENT		TIME START 11:00 am	DRILLER E. Vande Hey
AFTER DEVELOPMENT		TIME END 3:00 pm	LOGGER P. Shetley

S.S. Dia 1.5" Weight 140# Drop 30"

SAMPLE NO.	BLOWS ON SAMPLER	DRIVE	RECOVERY		VISUAL FIELD CLASSIFICATION	GRAPHIC LOG	WELL CONSTRUCT	REMARKS
					19.5			
					20			
					21			
					22			
10	8/28	1.5	1.5		23			
					1" layer of Fe cemented sand, tan w/Fe stains. Tan fine sand w/occassional Fe conc. approximately ½" diameter.			
					24			
					25			
					26			
					27			
11	15/59	1.5	1.3		28			
					Tan fine to medium sand (SP) w/course sand grains scattered throughout.			
					29			

ENVIRODYNE ENGINEERS

FIELD BORING LOG

FOR St. Louis Corps of Engineers/DERA - Raco Missile Battery JOB NO. 3067

LOCATION South of WWTP/Southeast of Maintenance Bldg. ELEV. ≈905' BORING NO. MW-3

GROUND WATER			
WHILE DRILLING	43.9	DATE 12-8-86	DRILL CO. STS
BEFORE DEVELOPMENT		TIME START 11:00 AM	DRILLER E. Vande Hey
AFTER DEVELOPMENT		TIME END 3:00 PM	LOGGER P. Shetley

S.S. Dia 1.5" Weight 140# Drop 30"

SAMPLE NO.	BLOWS ON SAMPLER	DRIVE	RECOVERY		VISUAL FIELD CLASSIFICATION	GRAPHIC LOG	WELL CONSTRUCT	REMARKS
					29			
					30			
					31			
					32			
12	8/28	1.5	1.5		33 Tan fine sand (SM) to 33.8' becoming fine to medium (SP), 33.8 to 34.5			
					34			
					35			
					36			
					37			
					38			

ENVIRODYNE ENGINEERS

FIELD BORING LOG

FOR St. Louis Corps of Engineers/DERA - Raco Missile Battery JOB NO. 3067

LOCATION South of WWTP/Southeast of Maintenance Bldg. ELEV. ≈905 BORING NO. MW-3

GROUND WATER			
WHILE DRILLING 43.9	DATE 12-8-86	DRILL CO. STS
BEFORE DEVELOPMENT	TIME START 11:00 am	DRILLER E. Vande Hey
AFTER DEVELOPMENT	TIME END 3:00 pm	LOGGER P. Shetley

S.S. Dia 1.5" Weight 140# Drop 30"

SAMPLE NO.	BLOWS ON SAMPLER	DRIVE	RECOVERY		VISUAL FIELD CLASSIFICATION	GRAPHIC LOG	WELL CONSTRUCT	REMARKS
13	8/21	1.5	1.5		38 Tan fine sand (SM) w/a zone of coarse sand (SM) at 38.5 approximately 1" thick. 39			
					40 41 42			
14	12/40	1.5	1.5		43 Tan fine to medium sand (SP) becoming wet at 43.9'. 44			Sand saturated at 43.9'.
					45 46 47			

ENVIRODYNE ENGINEERS

FIELD BORING LOG

FOR St. Louis Corps of Engineers/DERA - Raco Missile Battery JOB NO. 3067

LOCATION South of WWTP/SE of Maintenance Bldg. ELEV. ≈905 BORING NO. MW-3

GROUND WATER		DATE 12-8-86	DRILL CO. STS
WHILE DRILLING	43.9	TIME START 11:00 am	DRILLER E. Vande Hey
BEFORE DEVELOPMENT		TIME END 3:00 pm	LOGGER P. Shetley
AFTER DEVELOPMENT			

S.S. Dia 1.5" Weight 140# Drop 30"

SAMPLE NO.	BLOWS ON SAMPLER	DRIVE	RECOVERY	VISUAL FIELD CLASSIFICATION	GRAPHIC LOG	WELL CONSTRUCT	REMARKS
				47			
15	10/27	1.5	1.3	48			
				Fine to very fine sand (ML) very wet			
				49			
				50			
				51			
				52			
16	26/42	1.0	1.0	53			
				Tan fine to medium sand (SP) most of sample probably blowin.			Approximately 2' of blow-in
				Measured water level at 45.8' at 8:00 am (12-9-86)			
				TD 56.5'			Approximately 4' of blow-in, pumped out blow-in w/ approximately 100 gallons of water.

ENVIRODYNE ENGINEERS

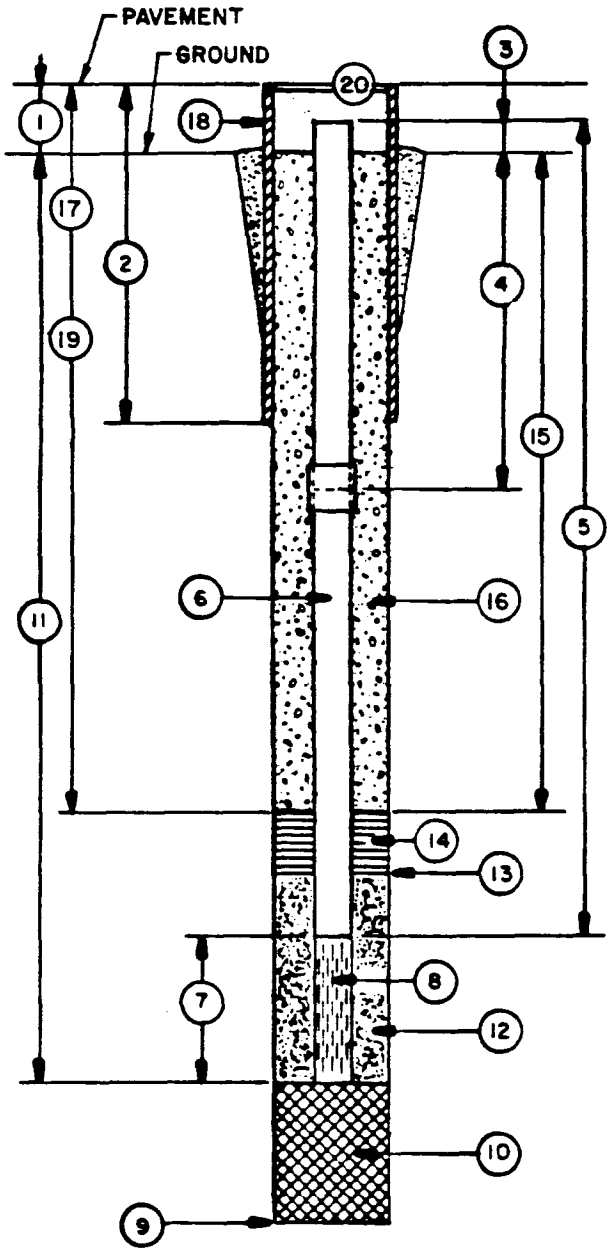
Well Construction Details

Date of Installation 12-6-86 | Job No. 3067 | Boring No. MW-4

Ground Surface Elev. 915 | Time Started 2:45 pm | Time Completed 7:30 pm

Logger Paul Shetley | Drill Firm STS, Inc. | Driller E. Vande Hey

All depth measurements of well detail are from ground surface unless otherwise indicated.



1. Height of Protective Casing Above Ground 2.9
2. Total Length of Protective Casing 4.2'
3. Height of Standpipe Above Ground 2.8
4. Depth to First Joint 3.1
   Joint Interval 10.0 Type Flush thread
5. Total Length of Blank Pipe 35.9
6. Type of Blank Pipe Sch.40 PVC Diam. 2.0"
7. Length of Screen 10.0'
8. Type of Screen Johnson Wrap Stainless steel 0.010"slot
9. Total Depth of Boring 43.1 Hole Diam. 6.5"
10. Type of Material Formation sand
11. Depth to Bottom of Screen 43.1
12. Type of Screen Filter Course sand
    Quantity Used 120#
13. Depth to Top of Filter 31.0'
14. Type of Seal ¼" Bentonite pellets
    Quantity Used 1 x 50# bucket
15. Depth to Top of Seal 29.1'
16. Type of Backfill Grout
17. Depth of Top of Backfill Ground level
18. Type of Protective Casing 3" Black steel pipe
19. Depth of Concrete Grout 29.1'
    Type of Grout Mixture 1/9 - Bentonite/Cement
20. Type of Pipe Cap Threaded PVC

Remarks:

Sand blown in at 43', pumped approximately 20 gallons through rods to the bottom of the hole to remove sand.

ENVIRODYNE ENGINEERS

FIELD BORING LOG

FOR St. Louis Corps of Engineers/DERA - Raco Missile Battery JOB NO. 3067

LOCATION Southeast of Fuel Depot ELEV 915 BORING NO. MW-4

GROUND WATER			
WHILE DRILLING	32.25	DATE 12-4-86	DRILL CO. STS
BEFORE DEVELOPMENT		TIME START 8:30 am	DRILLER E. Vande Hey
AFTER DEVELOPMENT		TIME END 11:15 am	LOGGER P. Shetley

S.S. Dia 1.5 Weight 140# Drop 30"

SAMPLE NO.	BLOWS ON SAMPLER	DRIVE	RECOVERY	VISUAL FIELD CLASSIFICATION	GRAPHIC LOG	WELL CONSTRUCT	REMARKS
1	7/12	1.5	1.5	0-.4 reddish brown fine sand (SM) frozen .4-.7 dark brown to black fine sand (SM) (organic). 0.7 0.9 gray Fine sand (SM). 0.9 1.5' reddish brown			Weather cold and snowing
2				1 fine sand (SM) w/trace of silt.			Drilled w/solid rod to 10.5. Pulled bit and sampled w/SS sample, bit size approx. 3.5".
3	3/15	1.5	1.5	2 Tan fine sand (SM) w/very little silt			
4	6/14	1.5	1.5	3 Same fine (SM) sand as above w/thin bands of Fe conc. at 4.4'			
5	6/13	1.5	1.5	4.5 Same tan fine sand (SM) as above w/Fe conc. to 5.2' and alternating thin 0.01' bands of Fe & Mn from 5.2 to 6.0			
6	4/11	1.5	1.5	6.0 Tan fine to medium sand (SM) w/alternating thin (0.01') bands of Fe & Mn to 7.1. No banding after 7.1, same sand.			
7	6/13	1.5	1.5	7.5 Tan fine sand (SM) w/alternating bands of Fe & Mn.			
8	4/14	1.5	1.5	9.0 Same fine (SM) sand as above. 0.1' diameter gravel at 10.2'.			

ENVIRODYNE ENGINEERS

FIELD BORING LOG

FOR St. Louis Corps of Engineers/DERA - Raco Missile Battery JOB NO. 3067

LOCATION Southeast of Fuel Depot ELEV. 915 BORING NO. MW-4

GROUND WATER			
WHILE DRILLING	32.25	DATE 12-4-86	DRILL CO. STS
BEFORE DEVELOPMENT		TIME START 8:30	DRILLER E. Vande Hey
AFTER DEVELOPMENT		TIME END 11:15	LOGGER P. Shetley

S.S. Dia 1.5 Weight 140# Drop 30"

SAMPLE NO.	BLOWS ON SAMPLER	DRIVE	RECOVERY		VISUAL FIELD CLASSIFICATION	GRAPHIC LOG	WELL CONSTRUCT	REMARKS
					10.5			Began drilling w/hollow stem augers at 9.0' Auger 3¼ ID 6½ OD
					11.0			
					12.0			
9	7/20	1.5	1.5		13.0 Tan fine sand (SM) w/½" band of small gravel ¼" diameter at 13.4'			
					14.0			
					15.0			
					16			
					17			
					18			
10	10/34	1.5	1.5		Tan fine to medium sand (SM), some Fe staining.			
					19			
					19.5			
					20.0			

ENVIRODYNE ENGINEERS

FIELD BORING LOG

FOR St. Louis Corps of Engineers/DERA - Raco Missile Battery JOB NO. 3067

LOCATION Southeast of Fuel Depot ELEV. 915 BORING NO. MW-4

GROUND WATER			
WHILE DRILLING	32.25	DATE 12-4-86	DRILL CO. STS
BEFORE DEVELOPMENT		TIME START 8:30	DRILLER E. Vande Hey
AFTER DEVELOPMENT		TIME END 11:15	LOGGER P. Shetley

S.S. Dia 1.5" Weight 140# Drop 30"

SAMPLE NO.	BLOWS ON SAMPLER	DRIVE	RECOVERY	VISUAL FIELD CLASSIFICATION	GRAPHIC LOG	WELL CONSTRUCT	REMARKS
				20.0			
				21			
				22			
11	9/26	1.5	1.5	23			
				Tan fine to medium sand (SM) w/Fe stains. ¼" band of coarse sand at 24.1'.			
				24			
				24.5			
				25			
				26			
				27			
12	10/31	1.5	1.5	28			
				Fine to medium sand (SM), tan w/Fe stains.			Hammer broke replaced w/extra.
				29.0			
				29.5			

ENVIRODYNE ENGINEERS

FIELD BORING LOG

FOR St. Louis Corps of Engineers/DERA - Raco Missile Battery JOB NO. 3067

LOCATION Southeast of Fuel Depot ELEV. 915 BORING NO. MW-4

GROUND WATER			
WHILE DRILLING	32.25	DATE 12-4-86	DRILL CO. STS
BEFORE DEVELOPMENT		TIME START 8:30	DRILLER E. Vande Hey
AFTER DEVELOPMENT		TIME END 11:15	LOGGER P. Shetley

S.S. Dia 1.5" Weight 140# Drop 30"

SAMPLE NO.	BLOWS ON SAMPLER	DRIVE	RECOVERY	VISUAL FIELD CLASSIFICATION	GRAPHIC LOG	WELL CONSTRUCT	REMARKS
				29.5			
				30.0			
				31.0			
				32.0 Water level 32.25 Measured w/tape.			Inner rod's wet at approximately 31.0'
13	2/12	1.5	1.5	33.0 Light brown fine to coarse sand (SP) w/ some ¼" to ½" gravel scattered throughout. Brown fine sand w/silt (SM) from 34 to 34.5			Sand wet
				34.5			
				35			
				36			
				37			
				38			
				39			

ENVIRODYNE ENGINEERS

FIELD BORING LOG

FOR St. Louis Corps of Engineers/DERA - Raco Missile Battery JOB NO. 3067

LOCATION Southeast of Fuel Depot ELEV. ≈905 BORING NO. MW-4

GROUND WATER			
WHILE DRILLING	32.25	DATE 12-4-86	DRILL CO. STS
BEFORE DEVELOPMENT		TIME START 8:30	DRILLER E. Vande Hey
AFTER DEVELOPMENT		TIME END 11:15	LOGGER P. Shetley

S.S. Dia 1.5" Weight 140# Drop 30"

SAMPLE NO.	BLOWS ON SAMPLER	DRIVE	RECOVERY	VISUAL FIELD CLASSIFICATION	GRAPHIC LOG	WELL CONSTRUCT	REMARKS
14	37/48	1.0	1.0	40 Brown fine to medium sand (SM) w/black & red specks throughout.			Sand wet
				41 Spoon refused at 39'			Sand blowing in through bottom of auger.
				42			
15	4/17	1.5	1.0	43 TD = 43.0 Brown fine to medium sand (SM) w/small reddish specks throughout.			At 43' pumped approximately 20 gallons through drill rods from bottom of hole to remove sand blowin.
				44			
				44.5 After drilling, 1:15 pm, water level 31.8' TD = 43.0 We have 1.1' of sand blown in.			

APPENDIX E

AQUIFER TESTING

SLUG TEST

Field Procedures

At each well, the depth to water from the top of the PVC casing was measured. A PVC bailer (0.14 feet outside diameter x 3.86 feet long) was then lowered into the well to fill the bailer, and then removed. This generated a slug with a displacement volume of 0.059 ft^3 (0.441 gallon), composed of water from the well and the PVC bailer. The water level was allowed to stabilize until the depth to water measurement was the same as before the bailer had been lowered into the well.

The slug test was then initiated by rapidly lowering the slug back into the well closely followed by the water level meter (a weighted, bell-type popper attached to a tape measure) to measure the rate at which the water level returned to the pre-slug level.

With the two-inch (nominal) schedule 80 pipe, the 0.441-gallon slug would create a calculated 2.68 feet instantaneous rise in the water level in the well. Due to the high permeability of the aquifer, the water level returned to the original level so quickly that only a few measurement was possible. As shown by the data, this was at 0.35 feet or less above the original (static) water level, and then stabilized in less than 30 seconds after the slug was lowered into the well.

Data Reduction Procedures

Two methods of data reduction were used in order to see how closely the results compared. The first method used was as described in "Response of a Finite-Diameter Well to an Instantaneous Charge of Water" by Hilton H. Cooper, Jr., John D. Bredehoeft, and Istavros S. Papadopulos, published in Water Resources Research, First Quarter, 1967 (copy enclosed). The second method used was as described in "The Slug-Injection Test for Estimating the Coefficient of Transmissibility of an Aquifer" by John G. Ferris and Doyle B. Knowles, published in the USGS Water Supply Paper, No. 1536-1, 1963, pp. 299-304 (copy enclosed). The first method is a curve matching technique matching the plotted data to a series of type curves. The second method uses a line source approximation of the well function. As Cooper, et al. pointed out, this closely approximates an exact solution when the residual head is very small compared to the initial head. Since this was clearly the case for all four of the wells tested, both methods are considered valid, and as Table 1 shows, the two methods compare very closely.

TABLE 1

SUMMARY OF SLUG TEST RESULTS

	k Coefficient of Permeability	
	Cooper et al (cm/sec)	Ferris & Knowles (cm/sec)
MW-1	3.5×10^{-2}	1.0×10^{-2}
MW-2	1.5×10^{-1}	8.2×10^{-2}
MW-3	1.6×10^{-2}	9.4×10^{-3}
MW-4	7.8×10^{-2}	2.7×10^{-2}

1) Project 3067-40012 DERA

2) Location Former Raco Missile Battery Raco, Michigan

3) Date January 15, 1987

4) Personnel PWS/RJT

5) Well or Boring No. MW-1

6) R=Radius of Well 1 (in.)

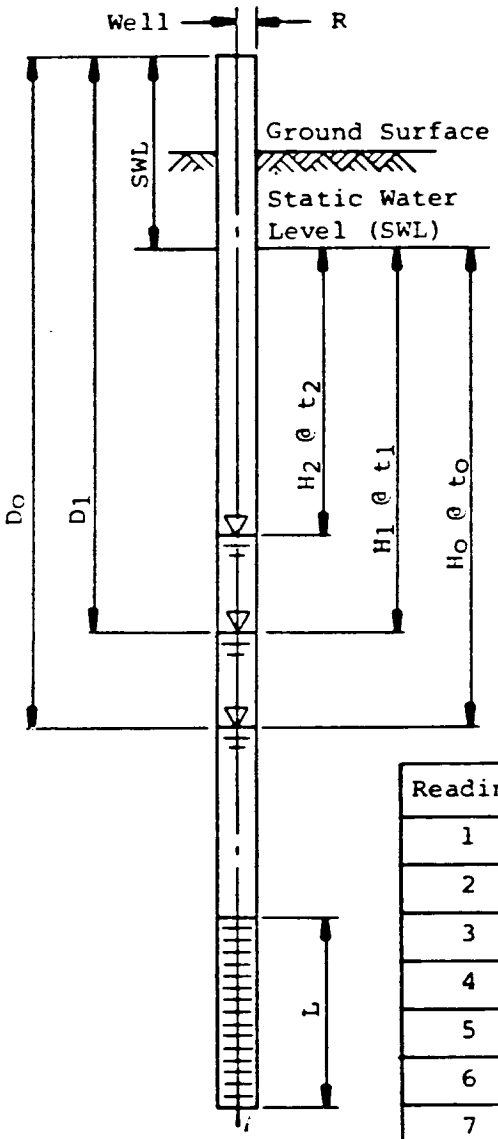
7) L=Length of Screen 10.0 (ft.)
(from well detail sheet)

8) Static Water Level 47.75 (ft.)
(depth to water)

9) Total Well Depth 56.5 (ft.)

10) Slug Volume 0.059 (ft^3)

11) Saturated Screen Length 10.0 (ft.)



Slug Test

Trial #4

Reading*	Time (Start)	Depth to Water (After Baildown) D_t	2** D_t-SWL=Ht	3** Ht/H_o
1	t_o 0.0	D_o 50.43	H_o 2.68	1.00
2	t_1 8 sec	D_1 47.50	H_1 0.25	0.093
3	t_2 12 sec	D_2 47.65	H_2 0.10	0.037
4	t_3 17 sec	D_3 47.70	H_3 0.05	0.019
5	t_4 21 sec	D_4 47.75	H_4 0.00	0.00
6	t_5	D_5	H_5	
7	t_6	D_6	H_6	
8	t_7	D_7	H_7	
9	t_8	D_8	H_8	
10	t_9	D_9	H_9	
11	t_{10}	D_{10}	H_{10}	
12	t_{11}	D_{11}	H_{11}	
13	t_{12}	D_{12}	H_{12}	
14	t_{13}	D_{13}	H_{13}	

*Take readings until well is stabilized, if tight soils - test may be stopped prior to stabilization as necessary.

**Disregard Columns 2 and 3 during baildown test. They are for office calculations.

1) Project 3067-40012 DERA

2) Location Former Raco Missile Battery Raco, Michigan

3) Date January 15, 1987

4) Personnel PWS/RJT

5) Well or Boring No. MW-1

6) R=Radius of Well 1 (in.)

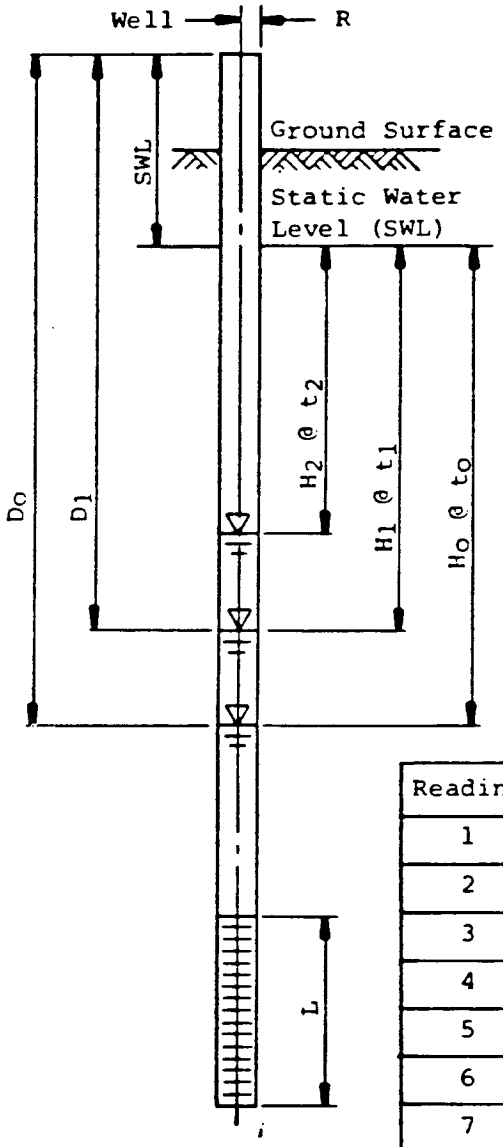
7) L=Length of Screen 10.0 (ft.)
(from well detail sheet)

8) Static Water Level 47.75 (ft.)
(depth to water)

9) Total Well Depth 56.5 (ft.)

10) Slug Volume 0.059 (ft^3)

11) Saturated Screen Length 10.0 (ft.)



Slug Test

Trial #5

Reading*	Time (Start)	Depth to Water (After Baildown) D_t	2** D_t-SWL=Ht	3** Ht/H_o
1	t_o 0.0	D_o 50.43	H_o 2.68	1.00
2	t_1 7 sec	D_1 47.45	H_1 0.30	.112
3	t_2 11 sec	D_2 47.65	H_2 0.10	.037
4	t_3 19 sec	D_3 47.75	H_3 0.00	0.00
5	t_4	D_4	H_4	
6	t_5	D_5	H_5	
7	t_6	D_6	H_6	
8	t_7	D_7	H_7	
9	t_8	D_8	H_8	
10	t_9	D_9	H_9	
11	t_{10}	D_{10}	H_{10}	
12	t_{11}	D_{11}	H_{11}	
13	t_{12}	D_{12}	H_{12}	
14	t_{13}	D_{13}	H_{13}	

*Take readings until well is stabilized, if tight soils - test may be stopped prior to stabilization as necessary.

**Disregard Columns 2 and 3 during baildown test. They are for office calculations.

1) Project 3067-40012 DERA

2) Location Former Raco Missile Battery Raco, Michigan

3) Date January 15, 1987

4) Personnel PWS/RJT

5) Well or Boring No. MW-1

6) R=Radius of Well 1 (in.)

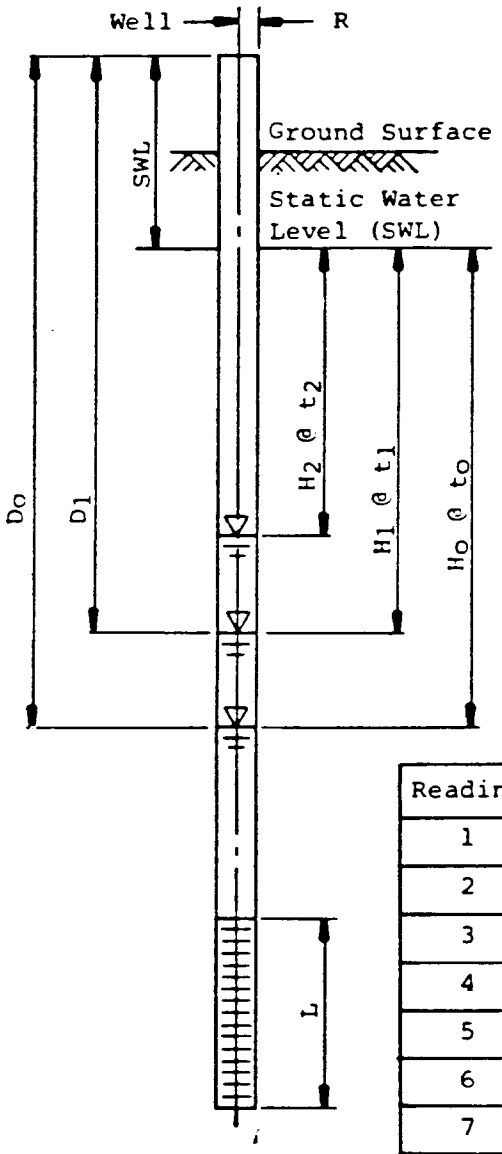
7) L=Length of Screen 10.0 (ft.)
(from well detail sheet)

8) Static Water Level 47.75 (ft.)
(depth to water)

9) Total Well Depth 56.5 (ft.)

10) Slug Volume 0.059 (ft^3)

11) Saturated Screen Length 10.0 (ft.)



Slug Test

Trial #3

Reading*	Time (Start)	Depth to Water (After Baildown) D_t	2** D_t-SWL=Ht	3** Ht/H_o
1	t_o 0.0	D_o 50.43	H_o 2.68	1.00
2	t_1 10 sec.	D_1 47.70	H_1 0.05	0.019
3	t_2 15 sec.	D_2 47.75	H_2 0.00	0.00
4	t_3	D_3	H_3	
5	t_4	D_4	H_4	
6	t_5	D_5	H_5	
7	t_6	D_6	H_6	
8	t_7	D_7	H_7	
9	t_8	D_8	H_8	
10	t_9	D_9	H_9	
11	t_{10}	D_{10}	H_{10}	
12	t_{11}	D_{11}	H_{11}	
13	t_{12}	D_{12}	H_{12}	
14	t_{13}	D_{13}	H_{13}	

*Take readings until well is stabilized, if tight soils - test may be stopped prior to stabilization as necessary.

**Disregard Columns 2 and 3 during baildown test. They are for office calculations.

1) Project 3067-40012 DERA

2) Location Former Raco Missile Battery Raco, Michigan

3) Date January 15, 1987

4) Personnel PWS/RJT

5) Well or Boring No. MW-2

6) R=Radius of Well 1 (in.)

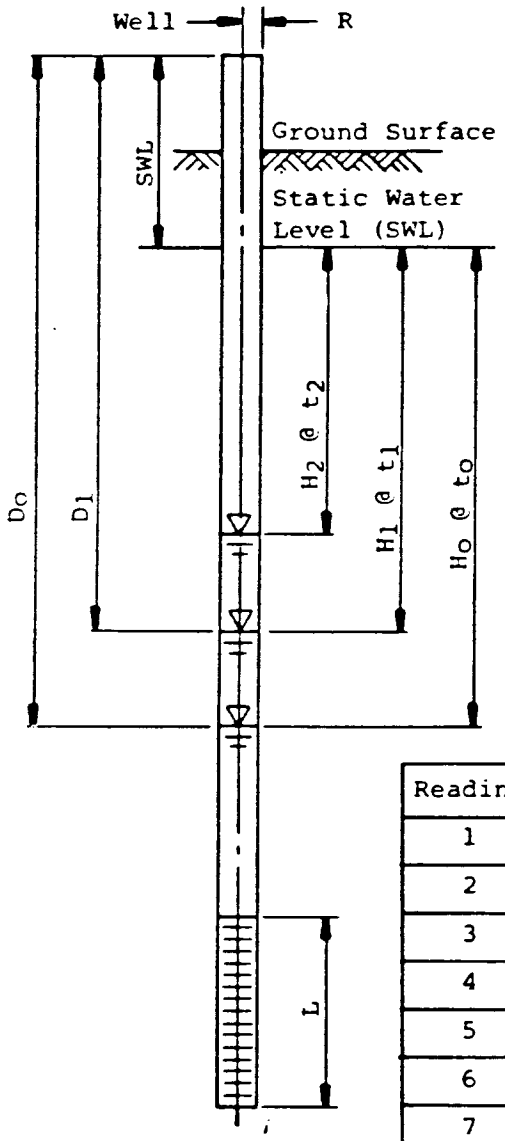
7) L=Length of Screen 10.0 (ft.)
(from well detail sheet)

8) Static Water Level 46.05 (ft.)
(depth to water)

9) Total Well Depth 53.5 (ft.)

10) Slug Volume 0.059 (ft^3)

11) Saturated Screen Length 9.95 (ft.)



Slug Test

Trial #1

Reading*	Time (Start)	Depth to Water (After Baildown) D_t	2** D_t-SWL=Ht	3** Ht/H_o
1	t_o 00 sec	D_o 48.73	H_o 2.68	1.00
2	t_1 4 sec	D_1 46.00	H_1 0.05	.019
3	t_2 7 sec	D_2 46.05	H_2 0.00	0.00
4	t_3	D_3	H_3	
5	t_4	D_4	H_4	
6	t_5	D_5	H_5	
7	t_6	D_6	H_6	
8	t_7	D_7	H_7	
9	t_8	D_8	H_8	
10	t_9	D_9	H_9	
11	t_{10}	D_{10}	H_{10}	
12	t_{11}	D_{11}	H_{11}	
13	t_{12}	D_{12}	H_{12}	
14	t_{13}	D_{13}	H_{13}	

*Take readings until well is stabilized, if tight soils - test may be stopped prior to stabilization as necessary.

**Disregard Columns 2 and 3 during baildown test. They are for office calculations.

1) Project 3067-40012 DERA

2) Location Former Raco Missile Battery Raco, Michigan

3) Date January 15, 1987

4) Personnel PWS/RJT

5) Well or Boring No. MW-2

6) R=Radius of Well 1 (in.)

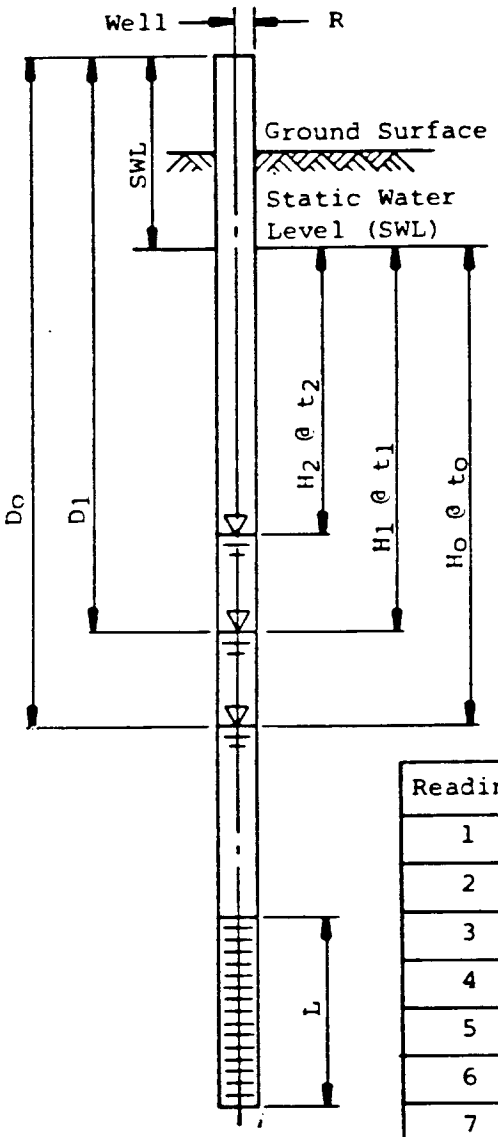
7) L=Length of Screen 10.0 (ft.)
(from well detail sheet)

8) Static Water Level 46.05 (ft.)
(depth to water)

9) Total Well Depth 53.5 (ft.)

10) Slug Volume 0.059 (ft^3)

11) Saturated Screen Length 9.95 (ft.)



Slug Test

Trial #2

Reading*	Time (Start)	Depth to Water (After Baildown) D_t	2** D_t-SWL=Ht	3** Ht/Ho
1	t_o 0.0	D_o 48.73	H_o 2.68	1.00
2	t_1 4 sec	D_1 46.00	H_1 0.05	.019
3	t_2 6 sec	D_2 46.05	H_2 0.00	0.00
4	t_3	D_3	H_3	
5	t_4	D_4	H_4	
6	t_5	D_5	H_5	
7	t_6	D_6	H_6	
8	t_7	D_7	H_7	
9	t_8	D_8	H_8	
10	t_9	D_9	H_9	
11	t_{10}	D_{10}	H_{10}	
12	t_{11}	D_{11}	H_{11}	
13	t_{12}	D_{12}	H_{12}	
14	t_{13}	D_{13}	H_{13}	

*Take readings until well is stabilized, if tight soils - test may be stopped prior to stabilization as necessary.

**Disregard Columns 2 and 3 during baildown test. They are for office calculations.

1) Project 3067-40012 DERA

2) Location Former Raco Missile Battery Raco, Michigan

3) Date January 15, 1987

4) Personnel PWS/RJT

5) Well or Boring No. MW-2

6) R=Radius of Well 1 (in.)

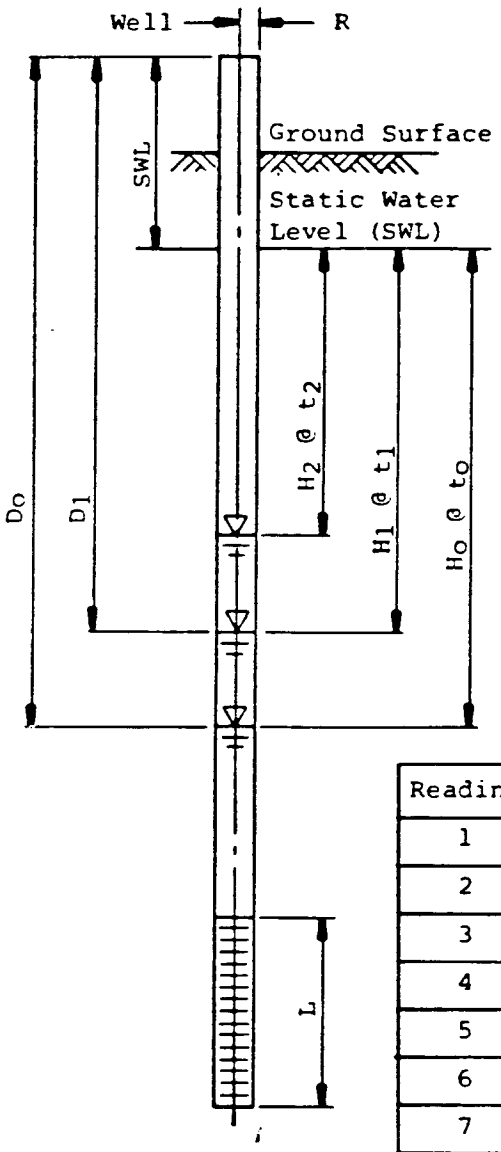
7) L=Length of Screen 10.0 (ft.)
(from well detail sheet)

8) Static Water Level 46.05 (ft.)
(depth to water)

9) Total Well Depth 53.5 (ft.)

10) Slug Volume 0.059 (ft^3)

11) Saturated Screen Length 9.95 (ft.)



Slug Test

Trial #3

Reading*	Time (Start)	Depth to Water (After Baildown) D_t	2** D_t-SWL=Ht	3** Ht/H_o
1	t_o 00	D_o 45.84	H_o 0.21	1.0
2	t_1 3	D_1 46.00	H_1 0.05	.019
3	t_2 5	D_2 46.05	H_2 0.00	0.00
4	t_3	D_3	H_3	
5	t_4	D_4	H_4	
6	t_5	D_5	H_5	
7	t_6	D_6	H_6	
8	t_7	D_7	H_7	
9	t_8	D_8	H_8	
10	t_9	D_9	H_9	
11	t_{10}	D_{10}	H_{10}	
12	t_{11}	D_{11}	H_{11}	
13	t_{12}	D_{12}	H_{12}	
14	t_{13}	D_{13}	H_{13}	

*Take readings until well is stabilized, if tight soils - test may be stopped prior to stabilization as necessary.

**Disregard Columns 2 and 3 during baildown test. They are for office calculations.

1) Project 3067-40012 DERA

2) Location Former Raco Missile Battery Raco, Michigan

3) Date January 15, 1987

4) Personnel PWS/RJT

5) Well or Boring No. MW-3

6) R=Radius of Well 1 (in.)

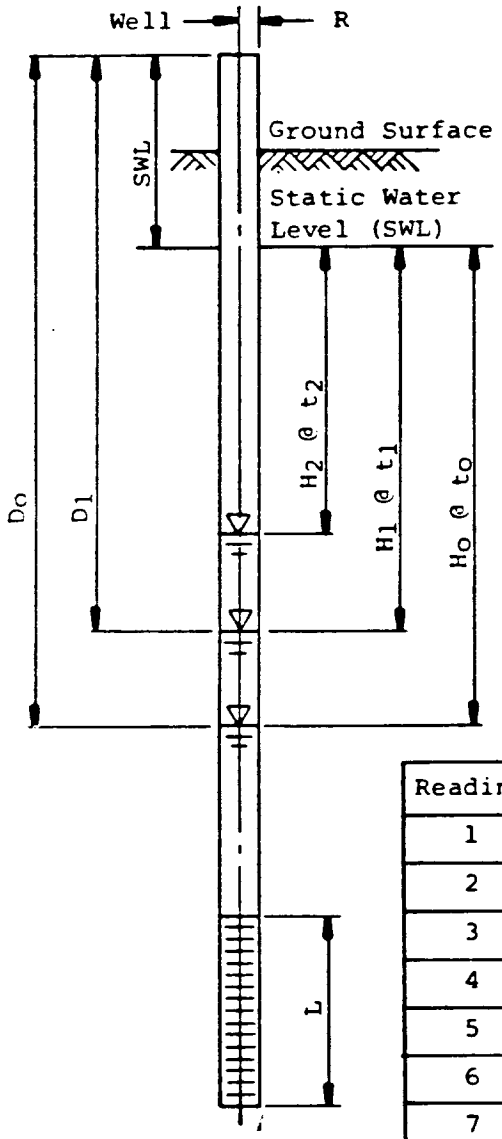
7) L=Length of Screen 10.0 (ft.)
(from well detail sheet)

8) Static Water Level 48.45 (ft.)
(depth to water)

9) Total Well Depth 56.2 (ft.)

10) Slug Volume 0.059 (ft^3)

11) Saturated Screen Length 10.0 (ft.)



Slug Test

Trial #2

Reading*	Time (Start)	Depth to Water (After Baildown) D_t	2** D_t-SWL=Ht	3** Ht/H_o
1	t_o 00	D_o 51.13	H_o 2.68	1.00
2	t_1 5 sec	D_1 48.20	H_1 0.25	.093
3	t_2 8 sec	D_2 48.30	H_2 0.15	.056
4	t_3 12 sec	D_3 48.40	H_3 0.05	.019
5	t_4 16 sec	D_4 48.45	H_4 0.00	0.00
6	t_5	D_5	H_5	
7	t_6	D_6	H_6	
8	t_7	D_7	H_7	
9	t_8	D_8	H_8	
10	t_9	D_9	H_9	
11	t_{10}	D_{10}	H_{10}	
12	t_{11}	D_{11}	H_{11}	
13	t_{12}	D_{12}	H_{12}	
14	t_{13}	D_{13}	H_{13}	

*Take readings until well is stabilized, if tight soils - test may be stopped prior to stabilization as necessary.

**Disregard Columns 2 and 3 during baildown test. They are for office calculations.

1) Project 3067-40012 DERA

2) Location Former Raco Missile Battery Raco, Michigan

3) Date January 15, 1987

4) Personnel PWS/RJT

5) Well or Boring No. MW-3

6) R=Radius of Well 1 (in.)

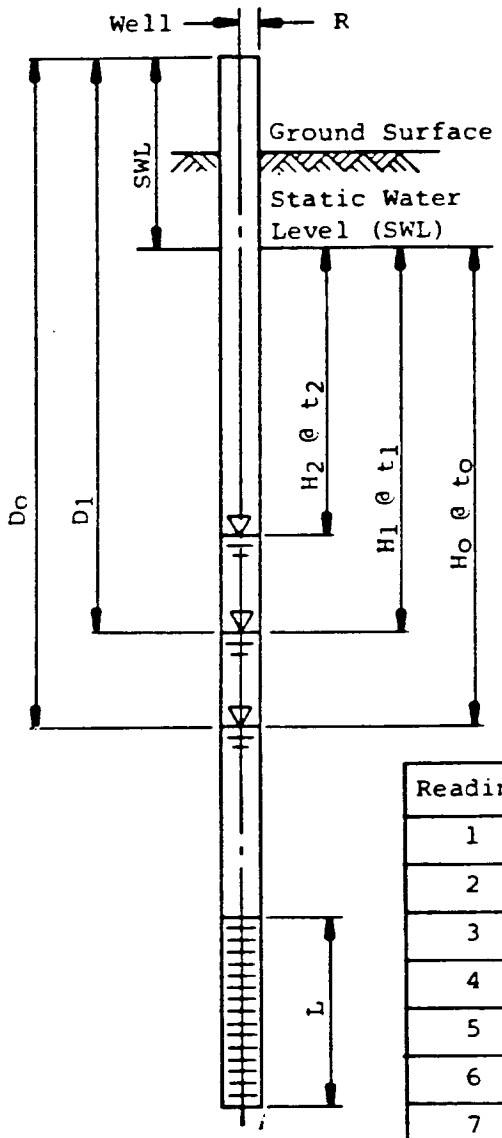
7) L=Length of Screen 10.0 (ft.)
(from well detail sheet)

8) Static Water Level 48.45 (ft.)
(depth to water)

9) Total Well Depth 56.2 (ft.)

10) Slug Volume 0.059 (ft^3)

11) Saturated Screen Length 10.0 (ft.)



Slug Test

Trial #4

Reading*	Time (Start)	Depth to Water (After Baildown) D_t	2** D_t-SWL=Ht	3** Ht/H_o
1	t_o 00	D_o 51.13	H_o 2.68	1.00
2	t_1 5 sec	D_1 48.10	H_1 0.35	.131
3	t_2 9 sec	D_2 48.20	H_2 0.25	.093
4	t_3 12 sec	D_3 48.30	H_3 0.15	.056
5	t_4 15 sec	D_4 48.40	H_4 0.05	.019
6	t_5 21 sec	D_5 48.45	H_5 0.00	0.00
7	t_6	D_6	H_6	
8	t_7	D_7	H_7	
9	t_8	D_8	H_8	
10	t_9	D_9	H_9	
11	t_{10}	D_{10}	H_{10}	
12	t_{11}	D_{11}	H_{11}	
13	t_{12}	D_{12}	H_{12}	
14	t_{13}	D_{13}	H_{13}	

*Take readings until well is stabilized, if tight soils - test may be stopped prior to stabilization as necessary.

**Disregard Columns 2 and 3 during baildown test. They are for office calculations.

1) Project 3067-40012 DERA

2) Location Former Raco Missile Battery Raco, Michigan

3) Date January 15, 1987

4) Personnel PWS/RJT

5) Well or Boring No. MW-3

6) R=Radius of Well 1 (in.)

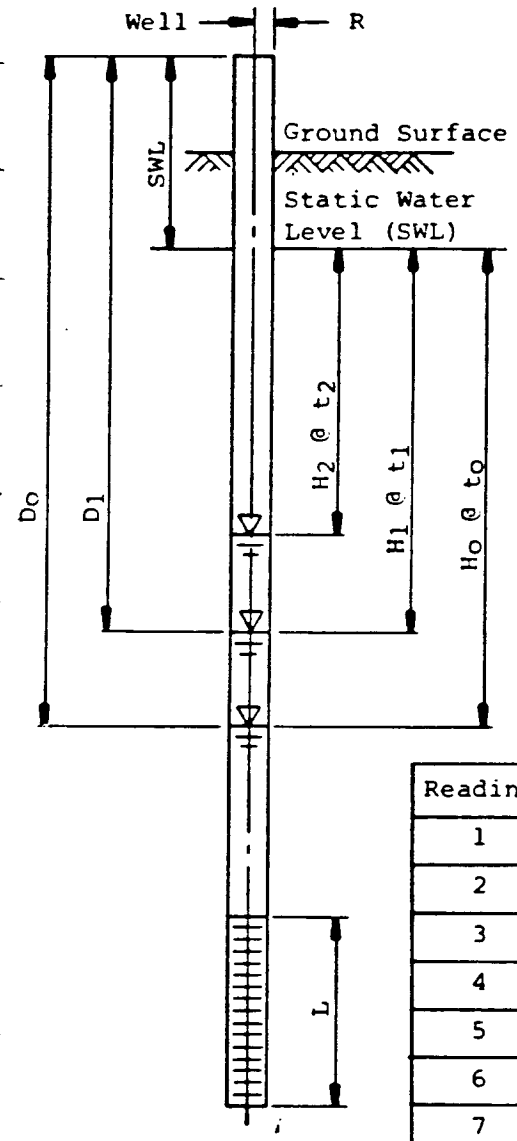
7) L=Length of Screen 10.0 (ft.)
(from well detail sheet)

8) Static Water Level 48.45 (ft.)
(depth to water)

9) Total Well Depth 56.2 (ft.)

10) Slug Volume 0.059 (ft^3)

11) Saturated Screen Length 10.0 (ft.)



Slug Test

Trial #5

Reading*	Time (Start)	Depth to Water (After Baildown) D_t	2** D_t-SWL=Ht	3** Ht/H_o
1	t_o 00	D_o 51.13	H_o 2.68	1.00
2	t_1 5 sec.	D_1 48.10	H_1 0.35	.131
3	t_2 8	D_2 48.20	H_2 0.25	.093
4	t_3 12	D_3 48.30	H_3 0.15	.056
5	t_4 15	D_4 48.40	H_4 0.05	.019
6	t_5 19	D_5 48.45	H_5 0.00	0.00
7	t_6	D_6	H_6	
8	t_7	D_7	H_7	
9	t_8	D_8	H_8	
10	t_9	D_9	H_9	
11	t_{10}	D_{10}	H_{10}	
12	t_{11}	D_{11}	H_{11}	
13	t_{12}	D_{12}	H_{12}	
14	t_{13}	D_{13}	H_{13}	

*Take readings until well is stabilized, if tight soils - test may be stopped prior to stabilization as necessary.

**Disregard Columns 2 and 3 during baildown test. They are for office calculations.

1) Project 3067-40012 DERA

2) Location Former Raco Missile Battery Raco, Michigan

3) Date January 15, 1987

4) Personnel PWS/RJT

5) Well or Boring No. MW-4

6) R=Radius of Well 1 (in.)

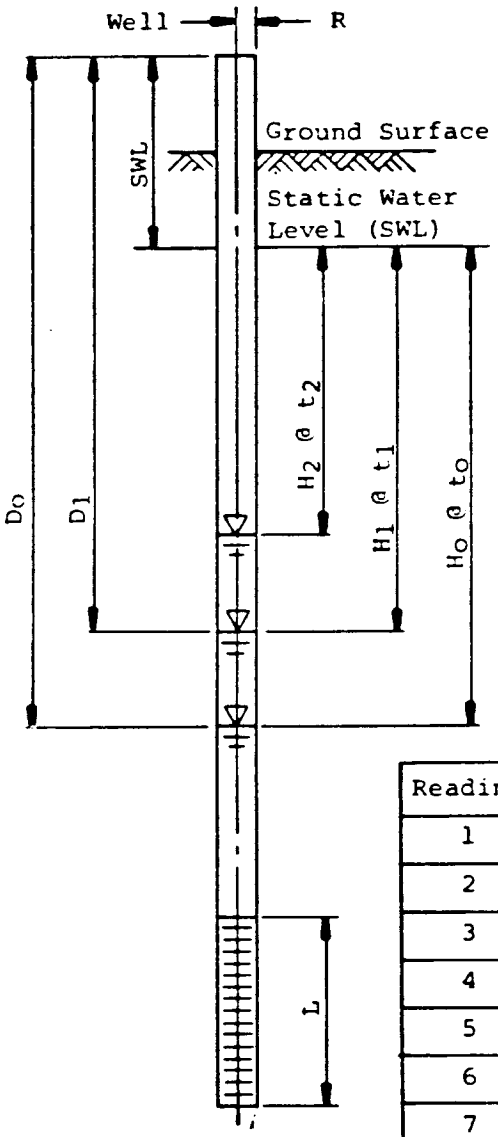
7) L=Length of Screen 10.0 (ft.)
(from well detail sheet)

8) Static Water Level 34.75 (ft.)
(depth to water)

9) Total Well Depth 43.10 (ft.)

10) Slug Volume 0.059 (ft^3)

11) Saturated Screen Length 10.0 (ft.)



Slug Test

Trial #4

Reading*	Time (Start)	Depth to Water (After Baildown) D_t	2** D_t-SWL=Ht	3** Ht/H_o
1	t_o 00	D_o 37.43	H_o 2.68	1.00
2	t_1 6 sec.	D_1 34.65	H_1 0.10	.037
3	t_2 8	D_2 34.70	H_2 0.05	.019
4	t_3 11	D_3 34.75	H_3 0.00	0.00
5	t_4	D_4	H_4	
6	t_5	D_5	H_5	
7	t_6	D_6	H_6	
8	t_7	D_7	H_7	
9	t_8	D_8	H_8	
10	t_9	D_9	H_9	
11	t_{10}	D_{10}	H_{10}	
12	t_{11}	D_{11}	H_{11}	
13	t_{12}	D_{12}	H_{12}	
14	t_{13}	D_{13}	H_{13}	

*Take readings until well is stabilized, if tight soils - test may be stopped prior to stabilization as necessary.

**Disregard Columns 2 and 3 during baildown test. They are for office calculations.

1) Project 3067-40012 DERA

2) Location Former Raco Missile Battery Raco, Michigan

3) Date January 15, 1987

4) Personnel PWS/RJT

5) Well or Boring No. MW-4

6) R=Radius of Well 1 (in.)

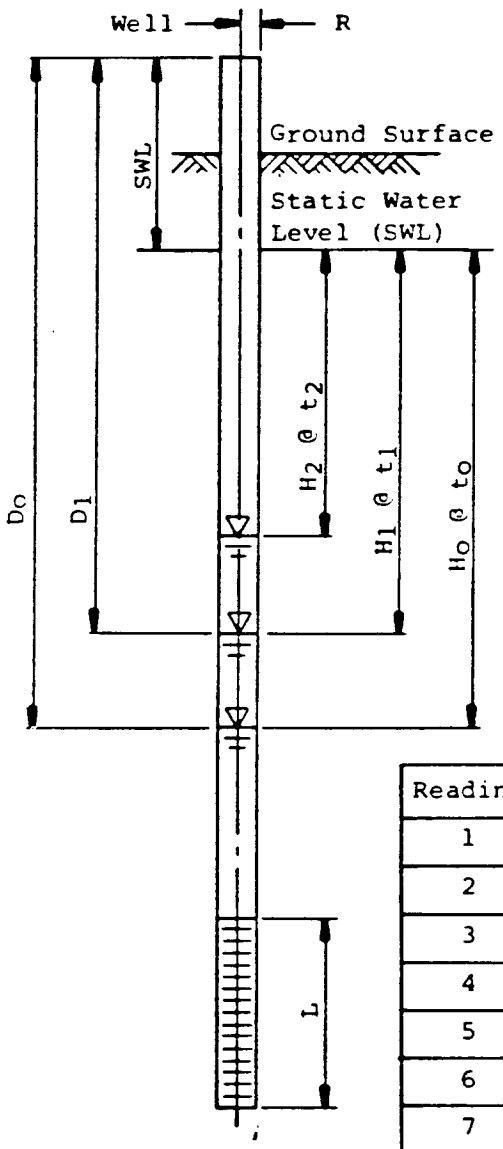
7) L=Length of Screen 10.0 (ft.)
(from well detail sheet)

8) Static Water Level 34.75 (ft.)
(depth to water)

9) Total Well Depth 43.10 (ft.)

10) Slug Volume 0.059 (ft^3)

11) Saturated Screen Length 10.0 (ft.)



Slug Test

Trial #5

Reading*	Time (Start)	Depth to Water (After Baildown) D_t	2** D_t-SWL=Ht	3** Ht/H_o
1	t_o 00	D_o 37.43	H_o 2.68	1.00
2	t_1 5 sec.	D_1 34.60	H_1 0.15	.056
3	t_2 9	D_2 34.70	H_2 0.05	.019
4	t_3 12	D_3 34.75	H_3 0.00	0.00
5	t_4	D_4	H_4	
6	t_5	D_5	H_5	
7	t_6	D_6	H_6	
8	t_7	D_7	H_7	
9	t_8	D_8	H_8	
10	t_9	D_9	H_9	
11	t_{10}	D_{10}	H_{10}	
12	t_{11}	D_{11}	H_{11}	
13	t_{12}	D_{12}	H_{12}	
14	t_{13}	D_{13}	H_{13}	

*Take readings until well is stabilized, if tight soils - test may be stopped prior to stabilization as necessary.

**Disregard Columns 2 and 3 during baildown test. They are for office calculations.

1) Project 3067-40012 DERA

2) Location Former Raco Missile Battery Raco, Michigan

3) Date January 15, 1987

4) Personnel PWS/RJT

5) Well or Boring No. MW-4

6) R=Radius of Well 1 (in.)

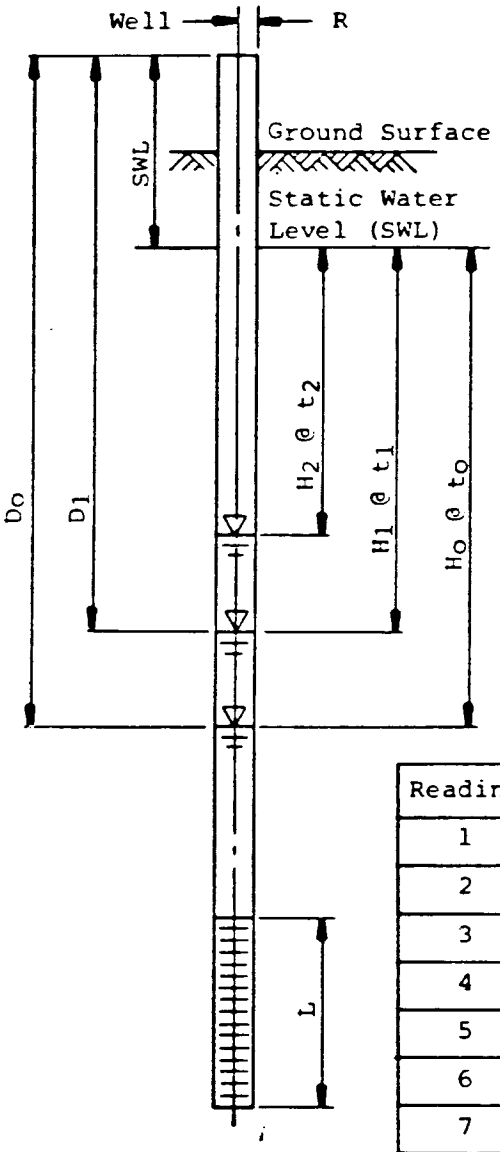
7) L=Length of Screen 10.0 (ft.)
(from well detail sheet)

8) Static Water Level 34.75 (ft.)
(depth to water)

9) Total Well Depth 43.10 (ft.)

10) Slug Volume 0.059 (ft^3)

11) Saturated Screen Length 10.0 (ft.)



Slug Test

Trial #6

Reading*	Time (Start)	Depth to Water (After Baildown) D_t	2** D_t-SWL=Ht	3** Ht/H_o
1	t_o 00	D_o 37.43	H_o 2.68	1.00
2	t_1 4 sec.	D_1 34.65	H_1 0.10	.037
3	t_2 6	D_2 34.70	H_2 0.05	.019
4	t_3 8	D_3 34.75	H_3 0.00	0.00
5	t_4	D_4	H_4	
6	t_5	D_5	H_5	
7	t_6	D_6	H_6	
8	t_7	D_7	H_7	
9	t_8	D_8	H_8	
10	t_9	D_9	H_9	
11	t_{10}	D_{10}	H_{10}	
12	t_{11}	D_{11}	H_{11}	
13	t_{12}	D_{12}	H_{12}	
14	t_{13}	D_{13}	H_{13}	

*Take readings until well is stabilized, if tight soils - test may be stopped prior to stabilization as necessary.

**Disregard Columns 2 and 3 during baildown test. They are for office calculations.

AQUIFER TESTS - CALCULATIONS

Method: Cooper et al. (curve matching)

Formula $T = \frac{r_c^2}{t}$ when $\frac{H}{Ho}$ vs t matches

$$\frac{H}{Ho} \text{ vs } \frac{Tt}{r_c^2} = 1$$

Where T = Transmissivity in cm^2/second

r_c^2 = Radius of the well casing, squared (cm^2)

t = Time in Seconds

$r_c^2 = 6.45\ cm^2$ for all wells installed

Formula $K = \frac{T}{L}$

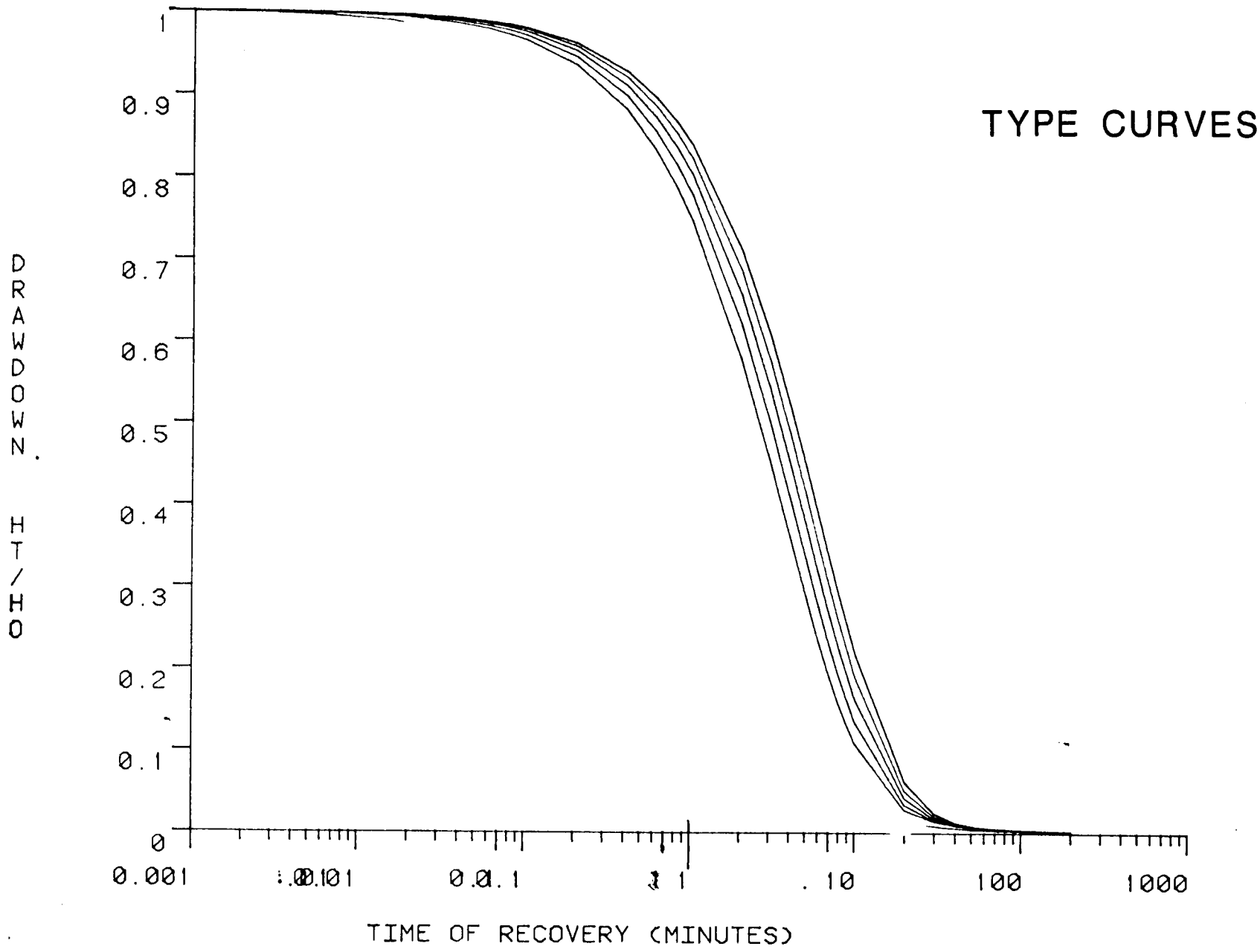
Where K = Coefficient of permeability in cm/second

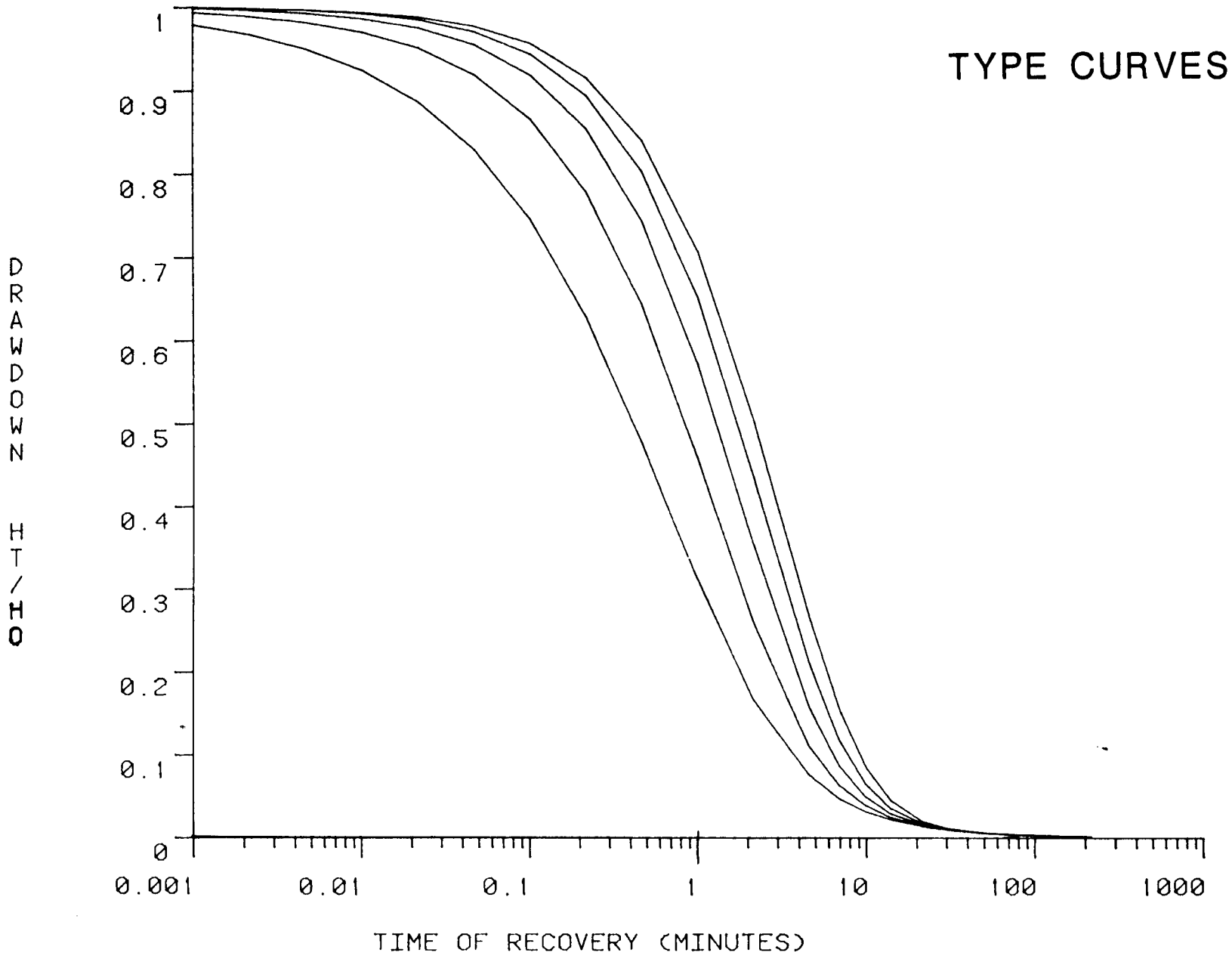
T = Transmissivity in cm/second

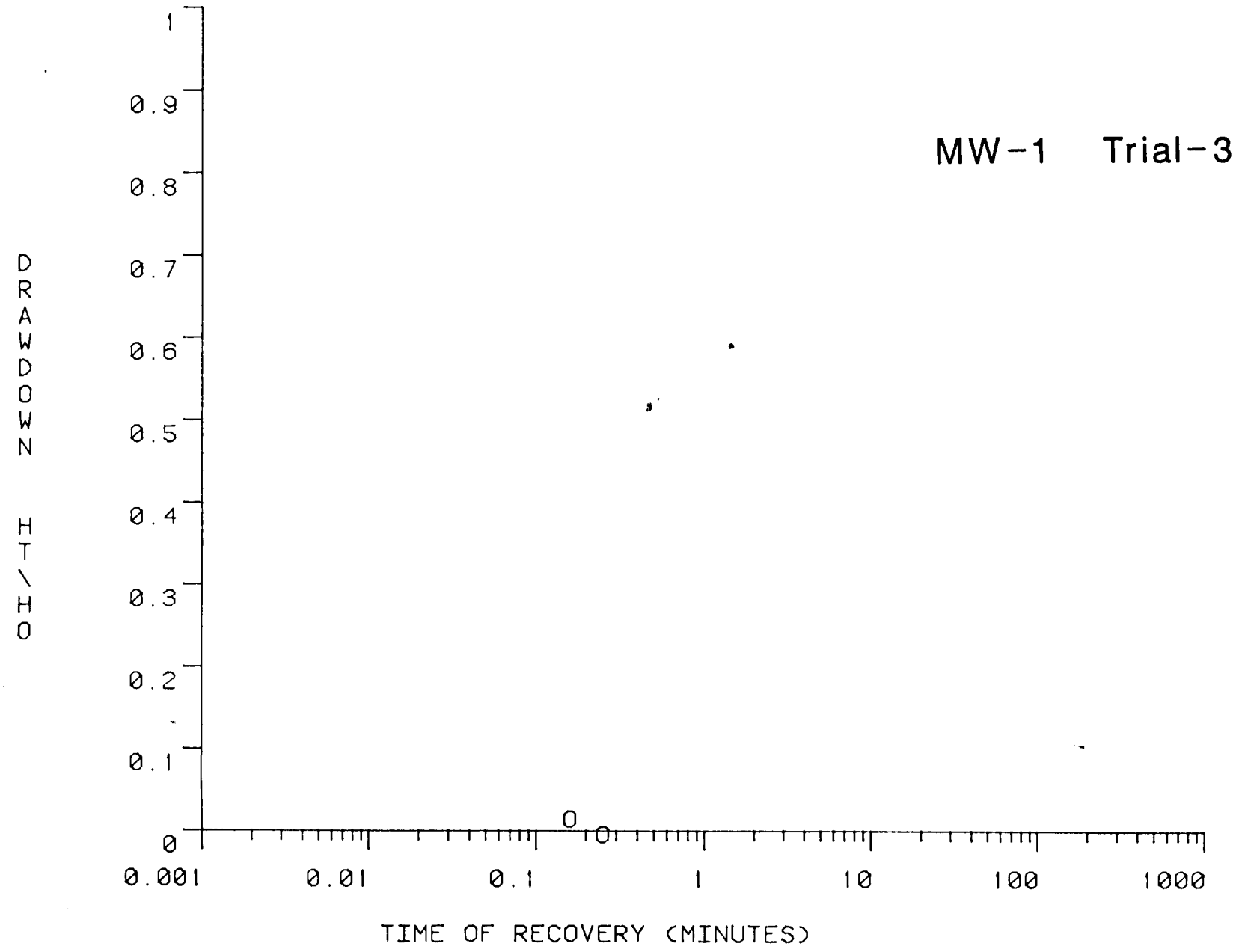
L = Saturated screen length in cm

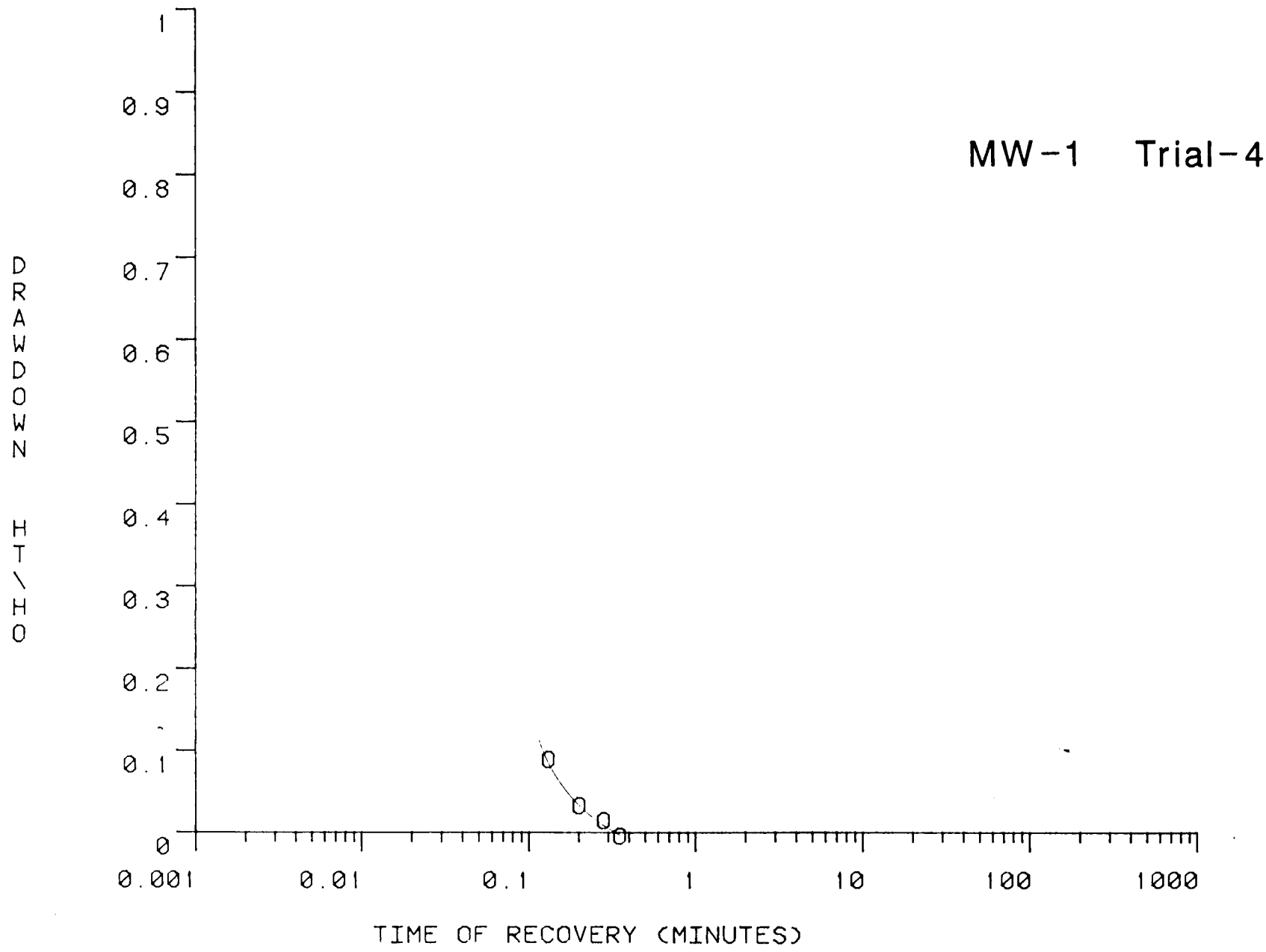
Well No.	Matching Point Log t in minutes	t (sec)	T (cm^2/sec)	L (cm)	K (cm/sec)
MW-1	0.01	0.6	10.75	304.8	3.5×10^{-2}
MW-2	0.0025*	0.15	44.79	303.3	1.5×10^{-2}
MW-3	0.023*	1.38	4.77	304.8	1.6×10^{-2}
MW-4	0.0046*	0.28	23.89	304.8	7.8×10^{-2}

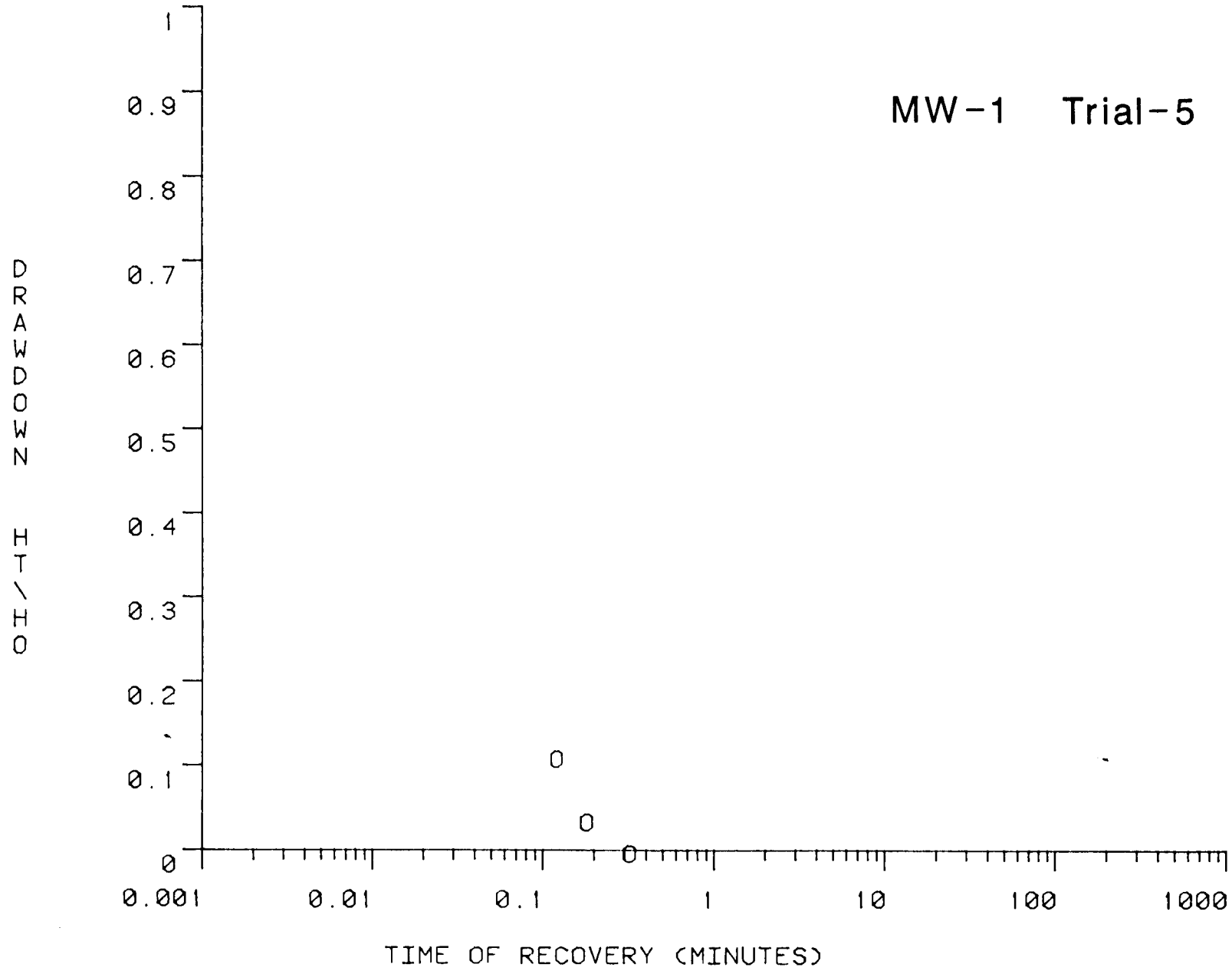
*Mean

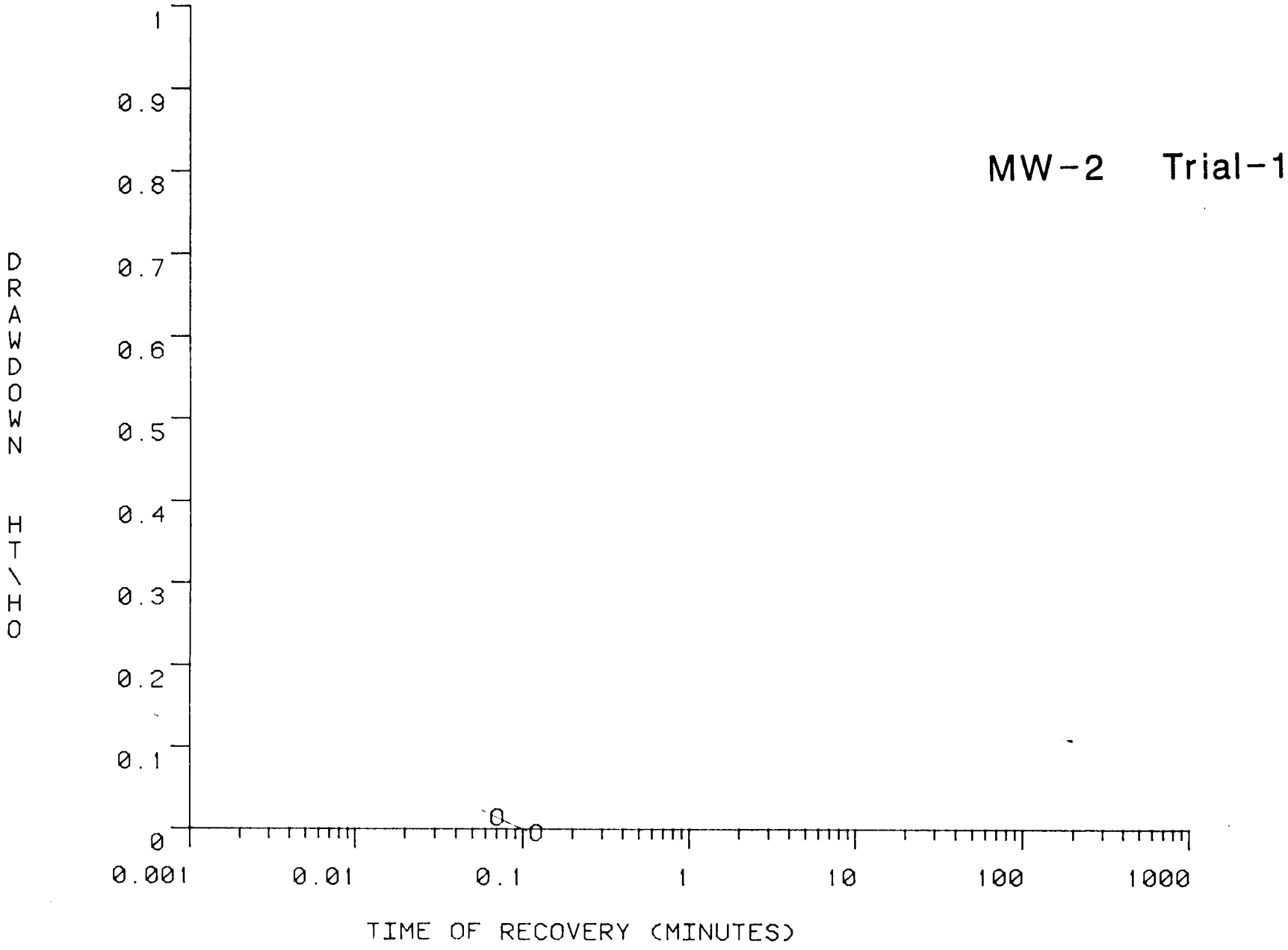

TYPE CURVES
DRAWDOWN, HT/HO
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0.001
0.01
0.1
1
10
100
1000
TIME OF RECOVERY (MINUTES)

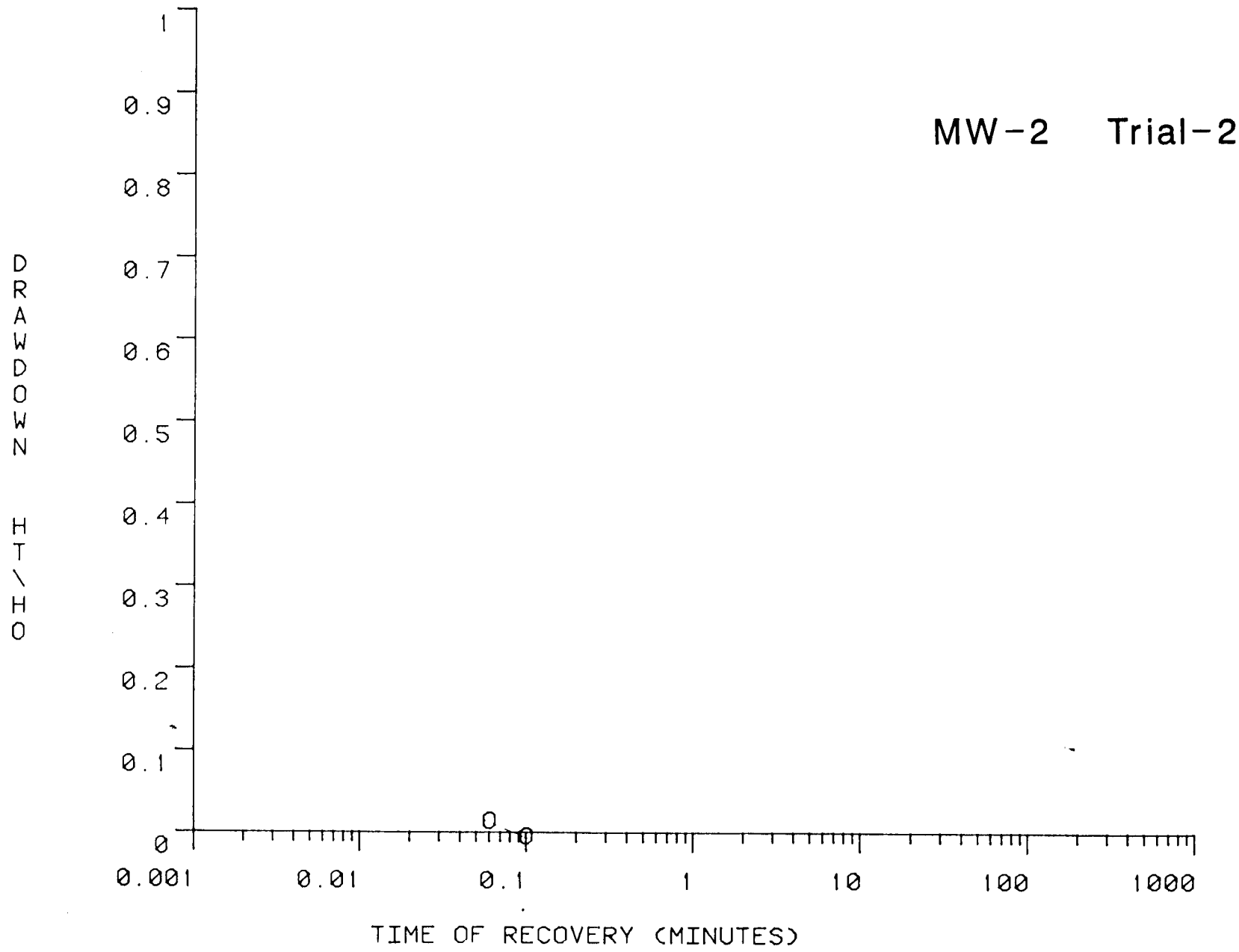

TYPE CURVES
DRAWDOWN HT/HO
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0.001
0.01
0.1
1
10
100
1000
TIME OF RECOVERY (MINUTES)

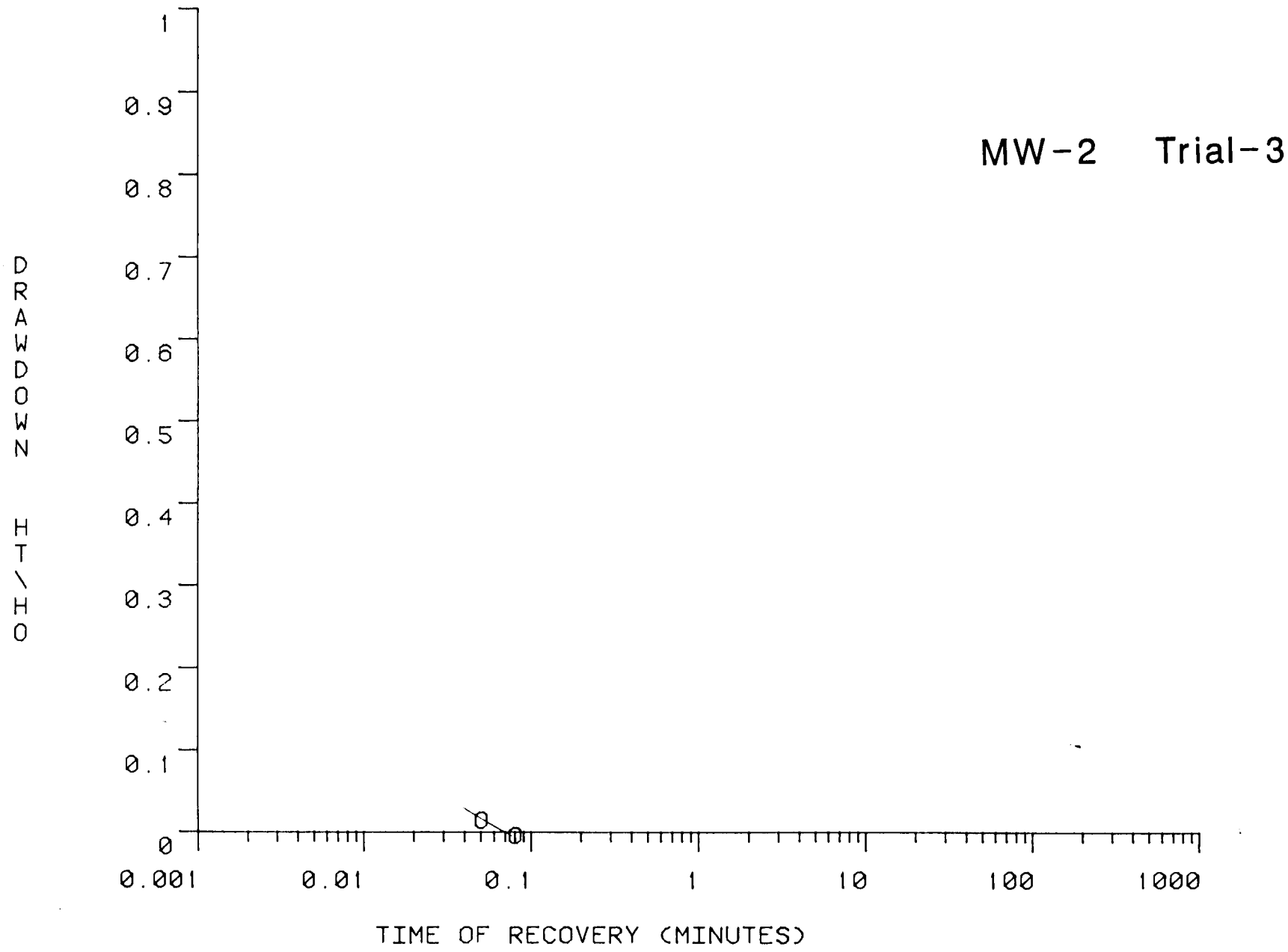

MW-1 Trial-3
DRAWDOWN HT/HO
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0.001
0.01
0.1
1
10
100
1000
TIME OF RECOVERY (MINUTES)

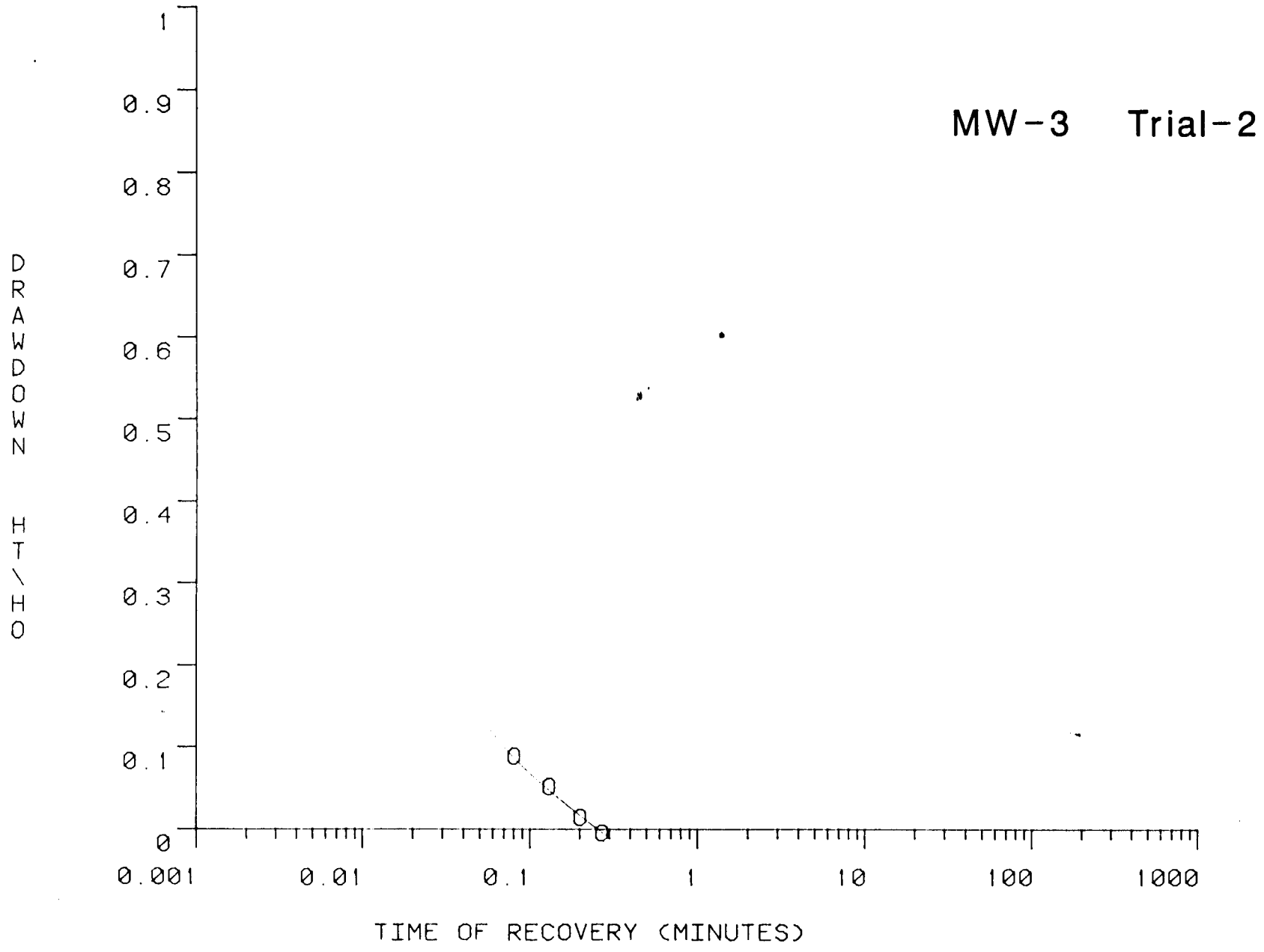

MW-1 Trial-4
DRAWDOWN HT/HO
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0.001
0.01
0.1
1
10
100
1000
TIME OF RECOVERY (MINUTES)

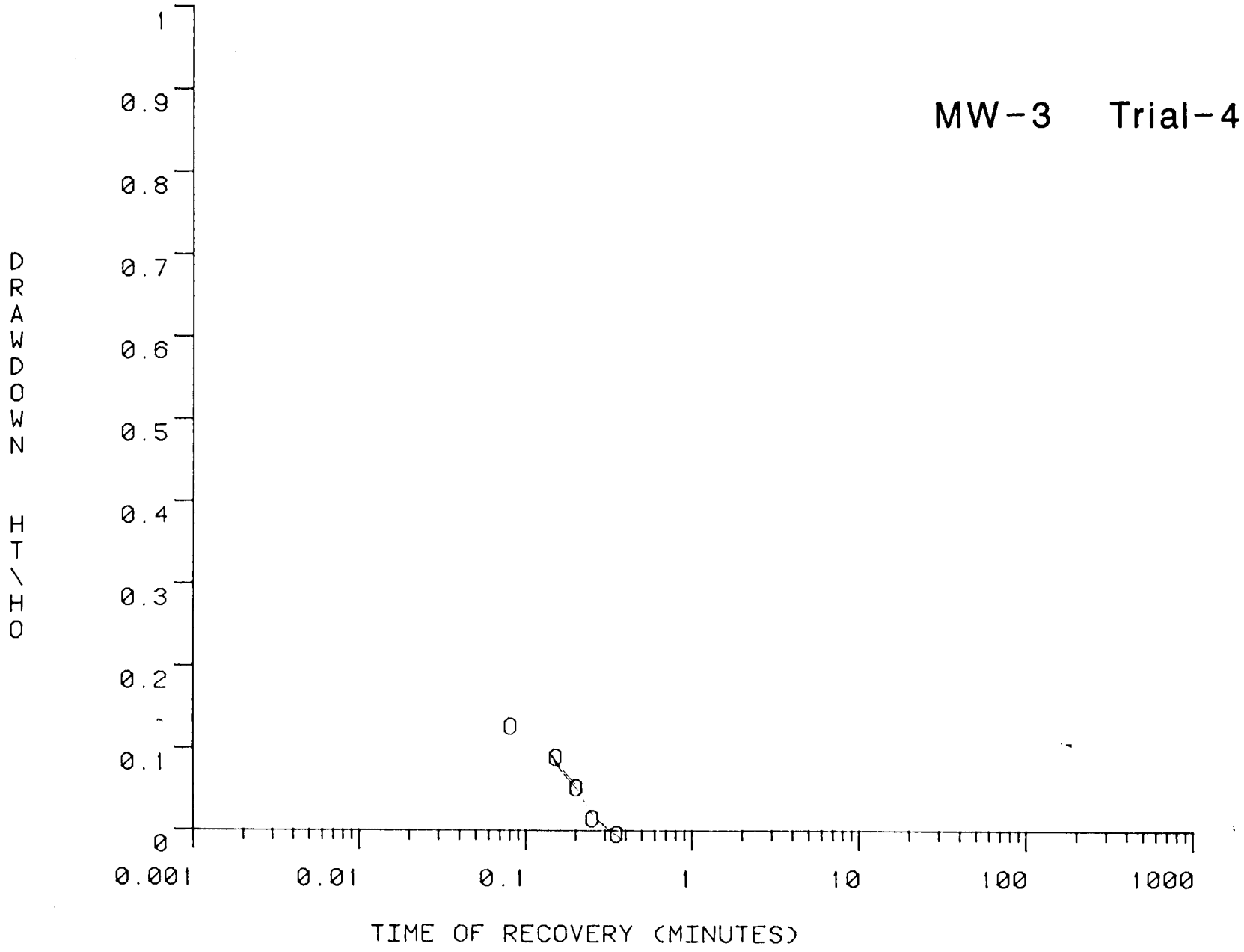

MW-1 Trial-5
DRAWDOWN HT/HO
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0.001
0.01
0.1
1
10
100
1000
TIME OF RECOVERY (MINUTES)

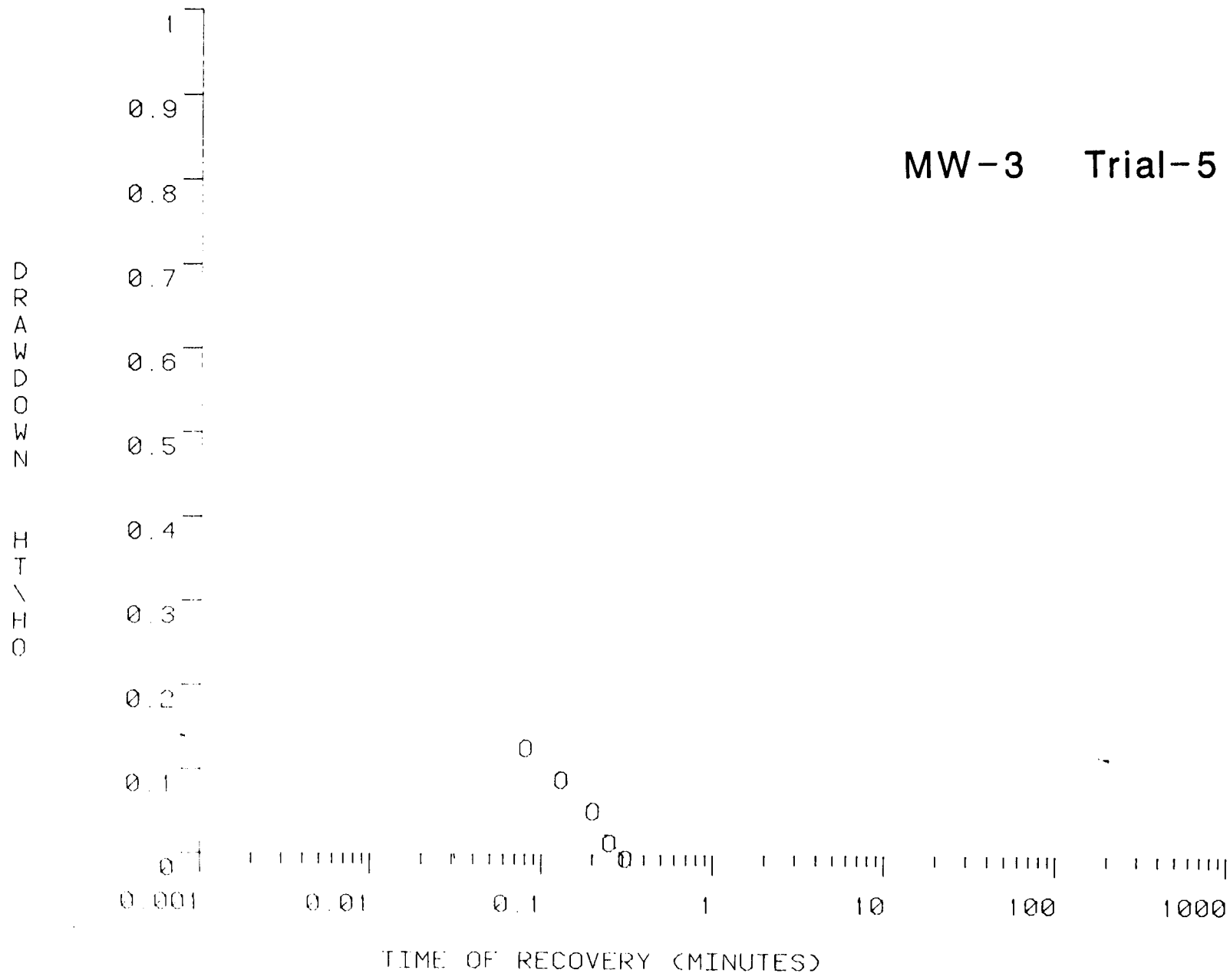

MW-2 Trial-1
DRAWDOWN HT/HO
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0.001
0.01
0.1
1
10
100
1000
TIME OF RECOVERY (MINUTES)

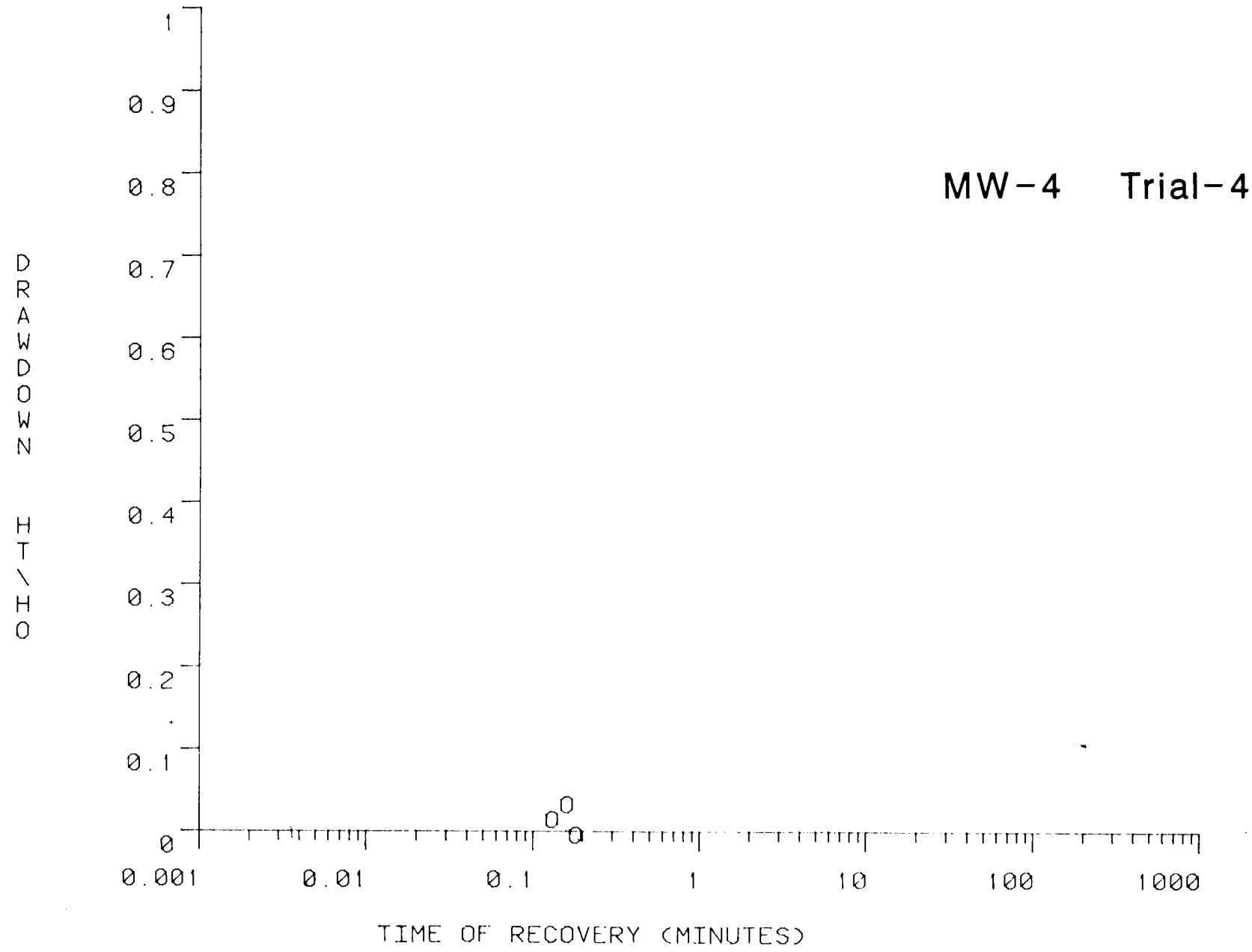

MW-2 Trial-2
DRAWDOWN HT/HO
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0.001
0.01
0.1
1
10
100
1000
TIME OF RECOVERY (MINUTES)

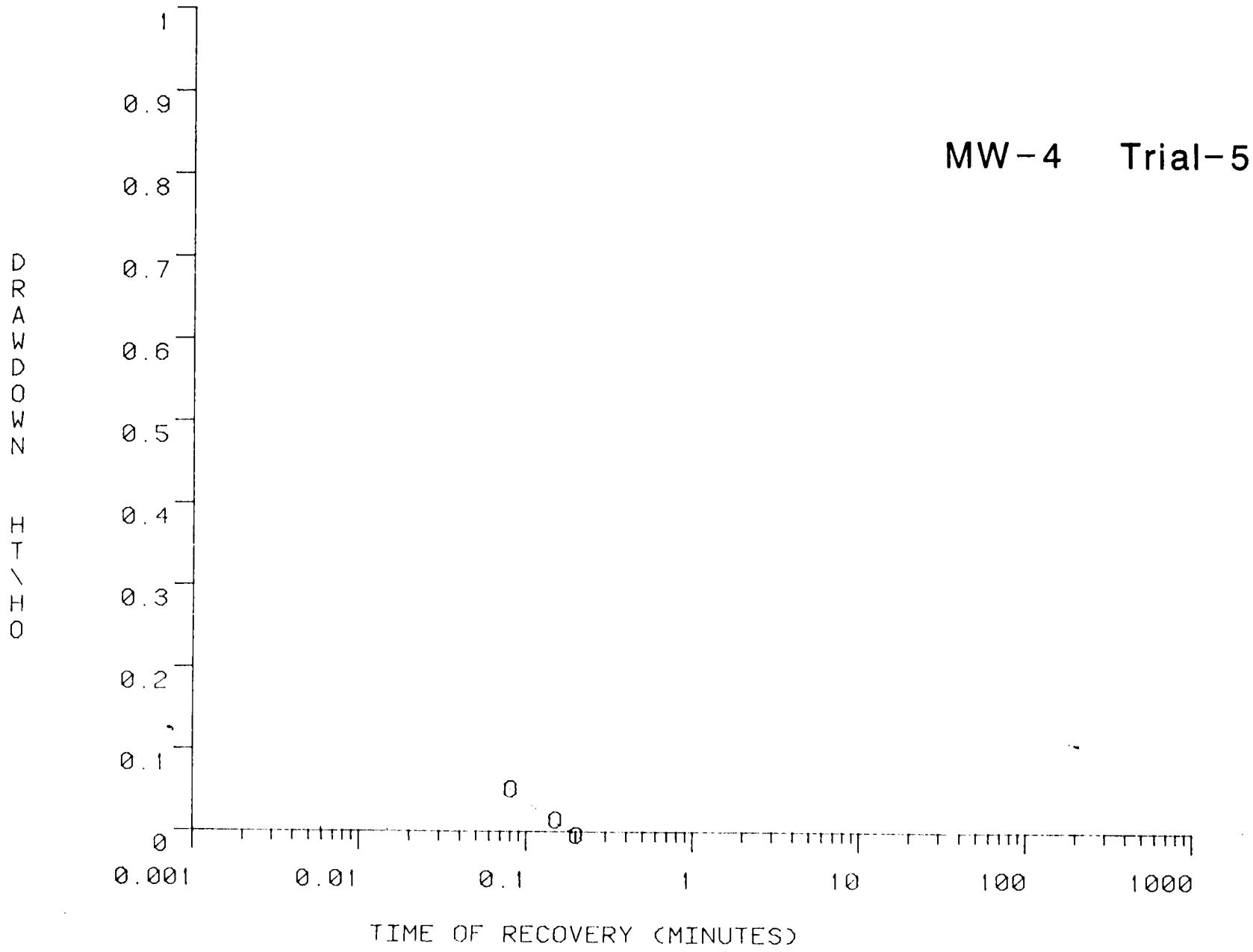

MW-2 Trial-3
DRAWDOWN HT/HO
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0.001
0.01
0.1
1
10
100
1000
TIME OF RECOVERY (MINUTES)

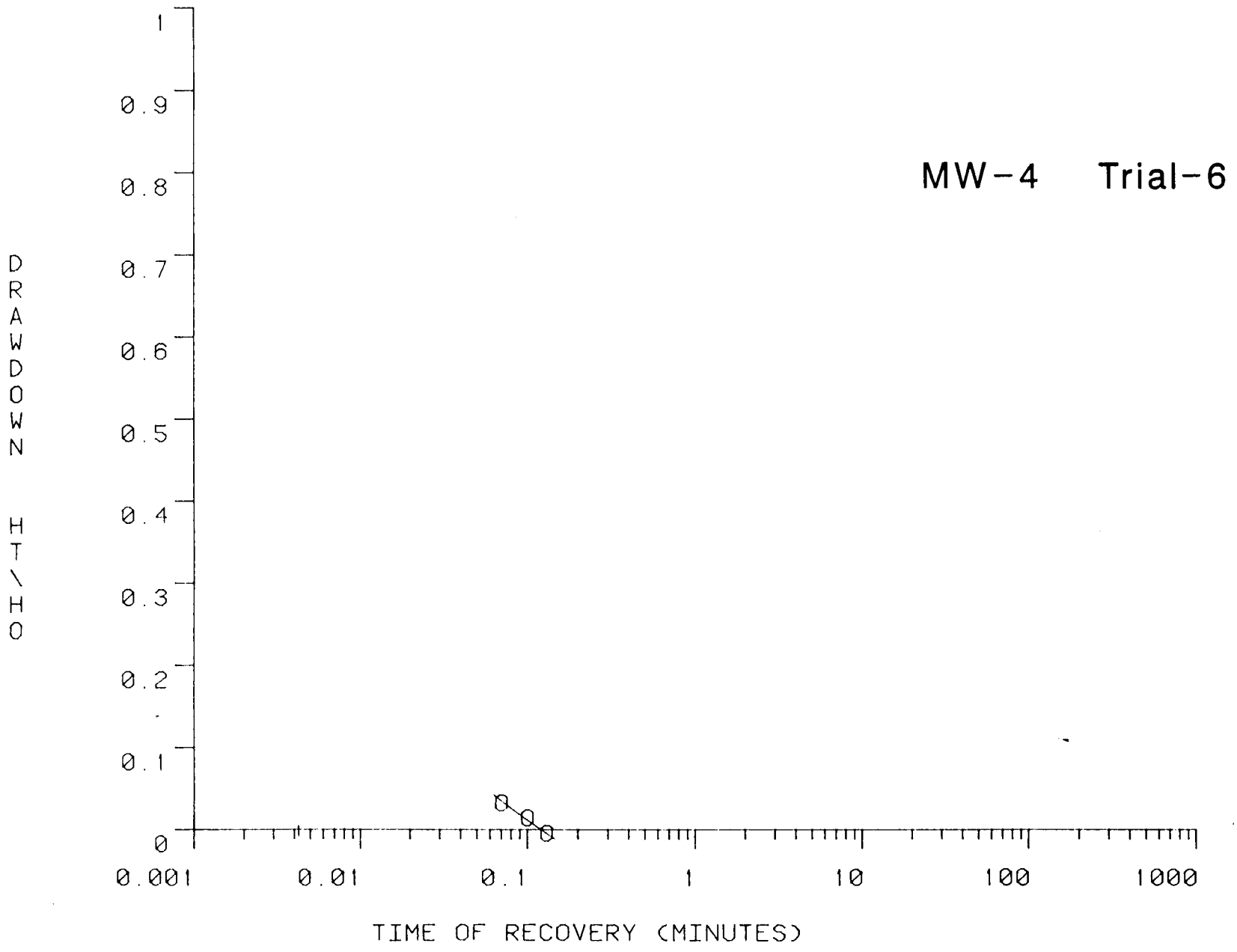

MW-3 Trial-2
DRAWDOWN HT/HO
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0.001
0.01
0.1
1
10
100
1000
TIME OF RECOVERY (MINUTES)


MW-3 Trial-4
DRAWDOWN HT/HO
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0.001
0.01
0.1
1
10
100
1000
TIME OF RECOVERY (MINUTES)


MW-3 Trial-5
DRAWDOWN HT/HO
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0.001
0.01
0.1
1
10
100
1000
TIME OF RECOVERY (MINUTES)


MW-4 Trial-4
DRAWDOWN HT/HO
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0.001
0.01
0.1
1
10
100
1000
TIME OF RECOVERY (MINUTES)


MW-4 Trial-5
DRAWDOWN HT/HO
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0.001
0.01
0.1
1
10
100
1000
TIME OF RECOVERY (MINUTES)


MW-4 Trial-6
DRAWDOWN HT/HO
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0.001
0.01
0.1
1
10
100
1000
TIME OF RECOVERY (MINUTES)

AQUIFER TEST-CALCULATIONS

Method: Ferris and Knowles (Line Source Approximation)

Formula: $T = \frac{114.6q(1/t_m)}{s}$

where
T = transmissivity in gallons per day per foot
q = slug volume in gallons
t_m = time in minutes
s = residual head at time = t_m, in feet

Formula: $k = \frac{T}{L} \times 4.89 \times 10^{-5}$

where
k = coefficient of permeability, in cm/sec
T = transmissivity in gallons per day per foot
L = saturated screen length in feet

MW1

$T = \frac{144.6 \times 0.441\ (4.2)}{0.1} = 2122.6$ gpd/ft

$K = \frac{2122.6}{10.0} \times 4.89 \times 10^{-5} = 1.0 \times 10^{-2}$ cm/sec

MW2

$T = \frac{144.6 \times .441\ (16.5)}{0.05} = 16677.7$ gpd/ft

$K = \frac{16677.7}{9.95} \times 4.89 \times 10^{-5} = 8.2 \times 10^{-2}$ cm/sec

MW3

$T = \frac{144.6 \times .441\ (3.8)}{0.1} = 1920.5$ gpd/ft

$K = \frac{1920.5}{10.0} \times 4.89 \times 10^{-5} = 9.4 \times 10^{-3}$ cm/sec

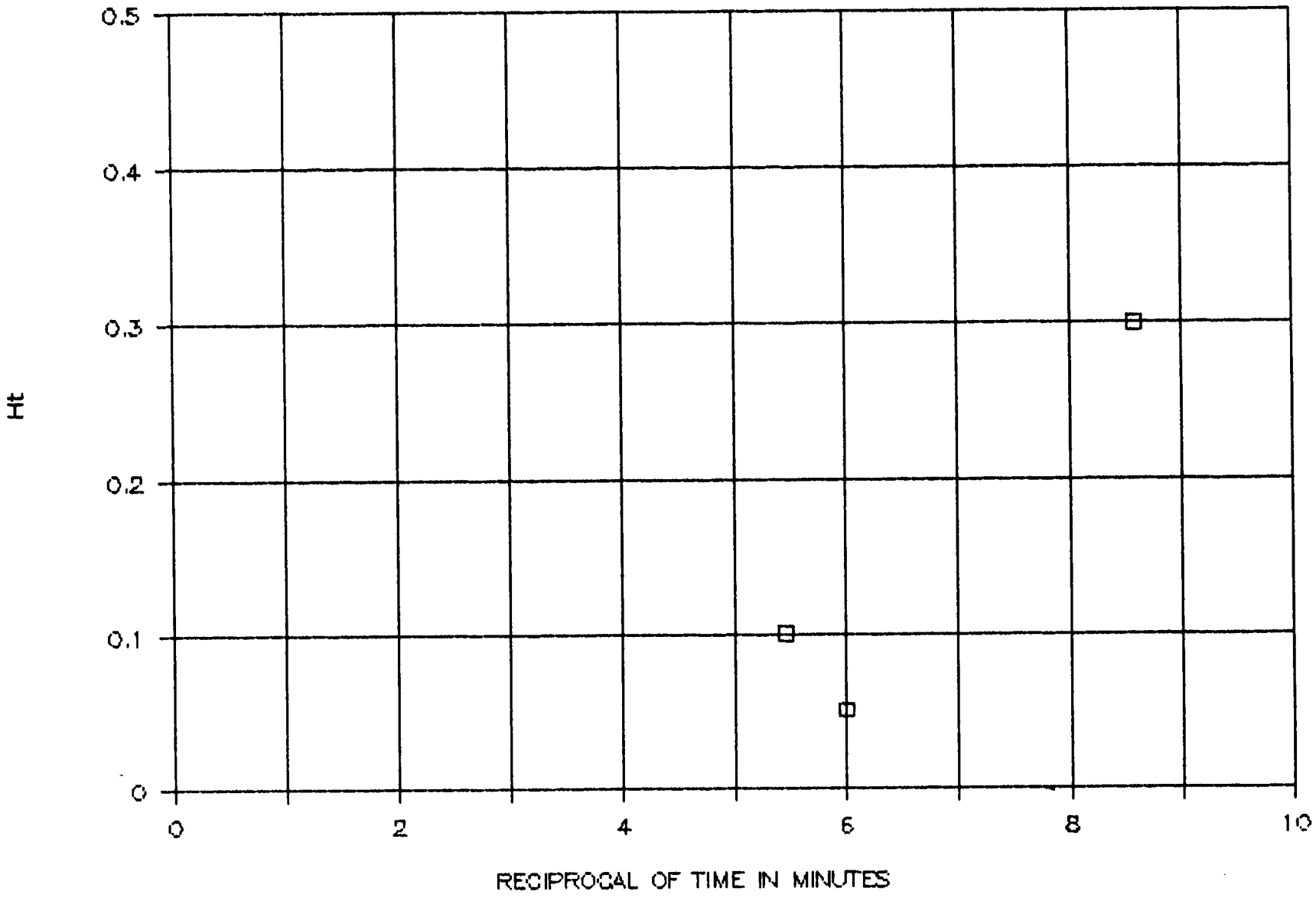
MW4

$T = \frac{114.6 \times .441\ (11)}{0.1} = 5559.3$ gpd/ft

$K = \frac{5559.3}{10} \times 4.89 \times 10^{-5} = 2.7 \times 10^{-2}$ cm/sec

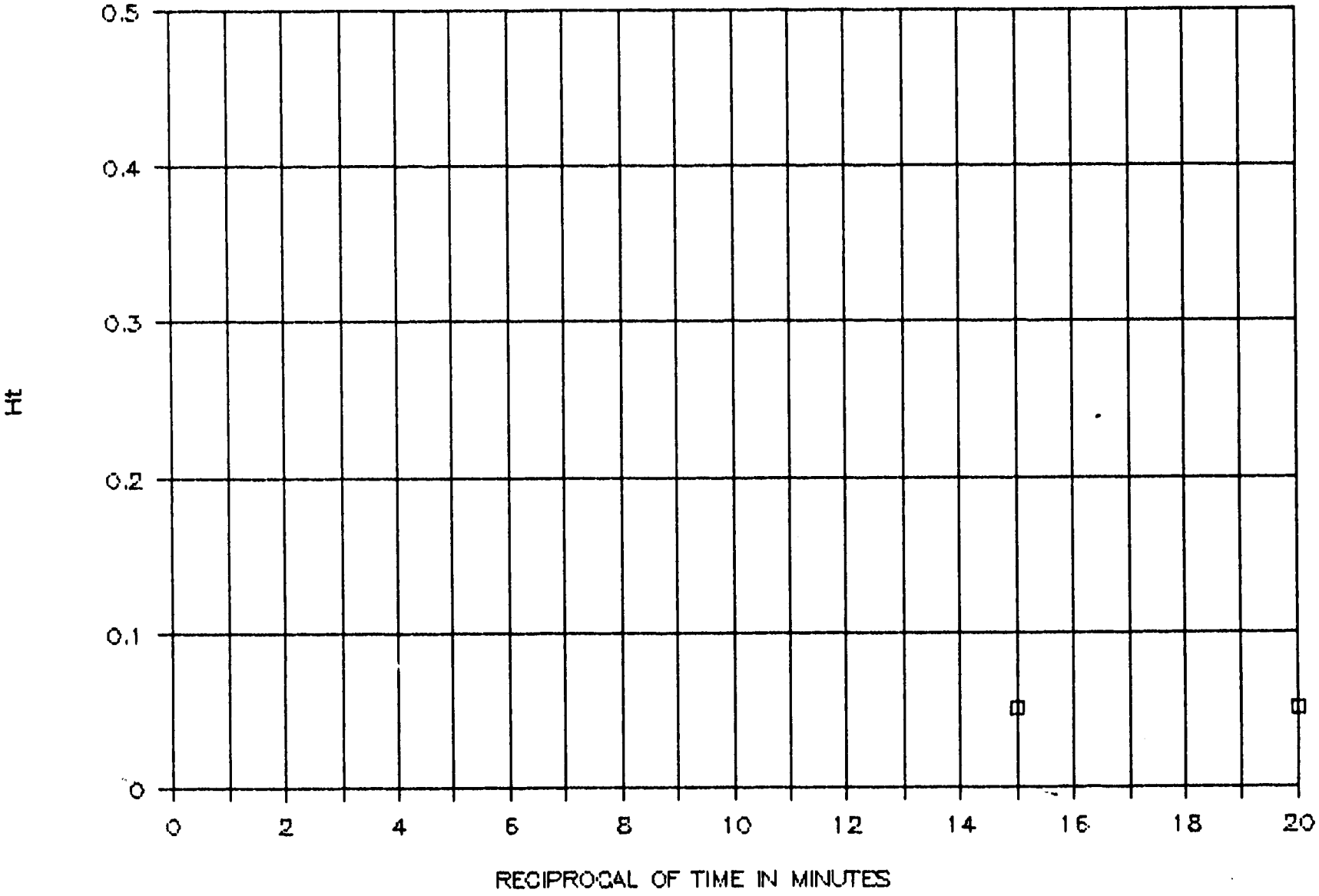
SLUG TEST DATA -- FERRIS & KNOWLES

WELL 1



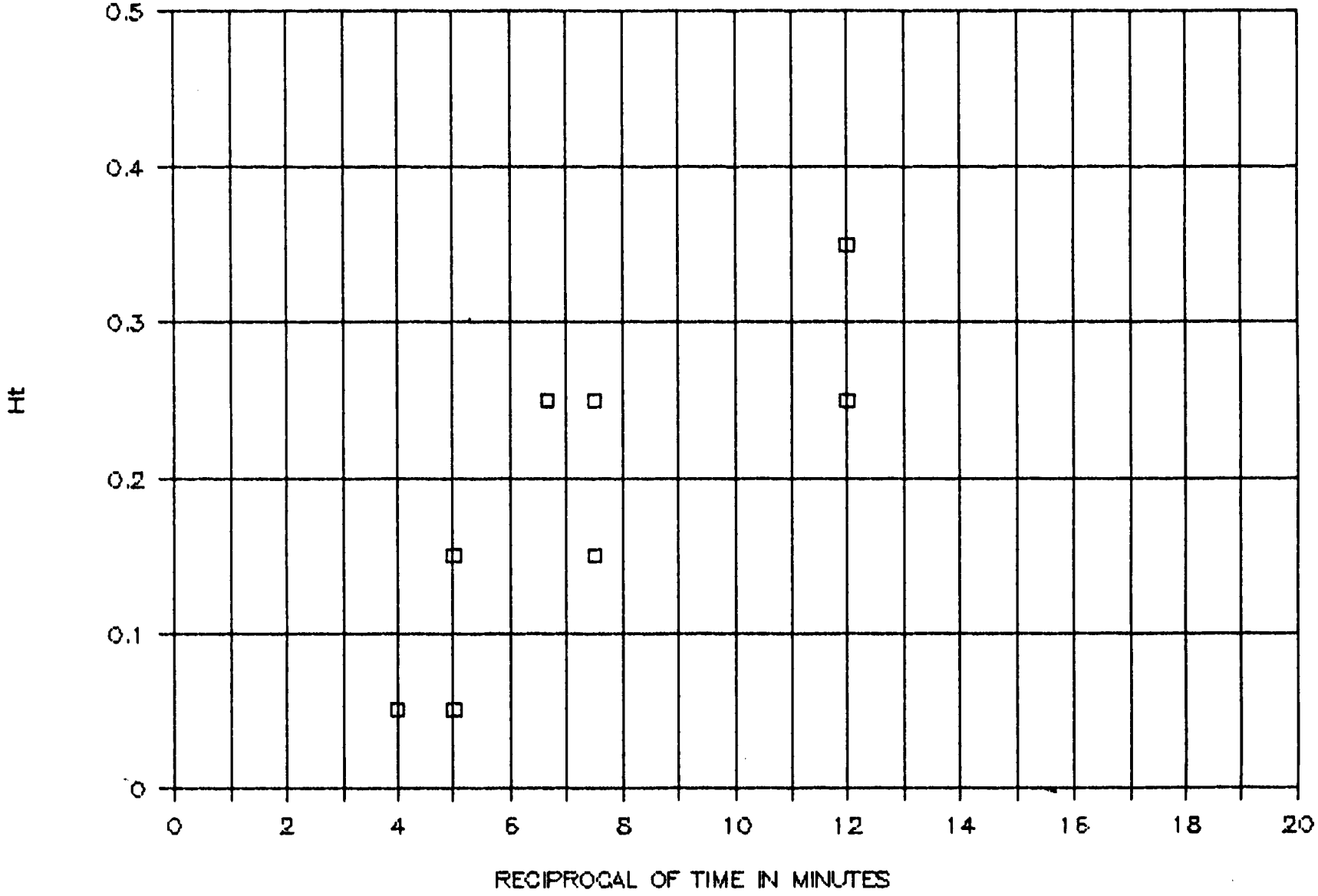
SLUG TEST DATA -- FERRIS & KNOWLES

WELL 2



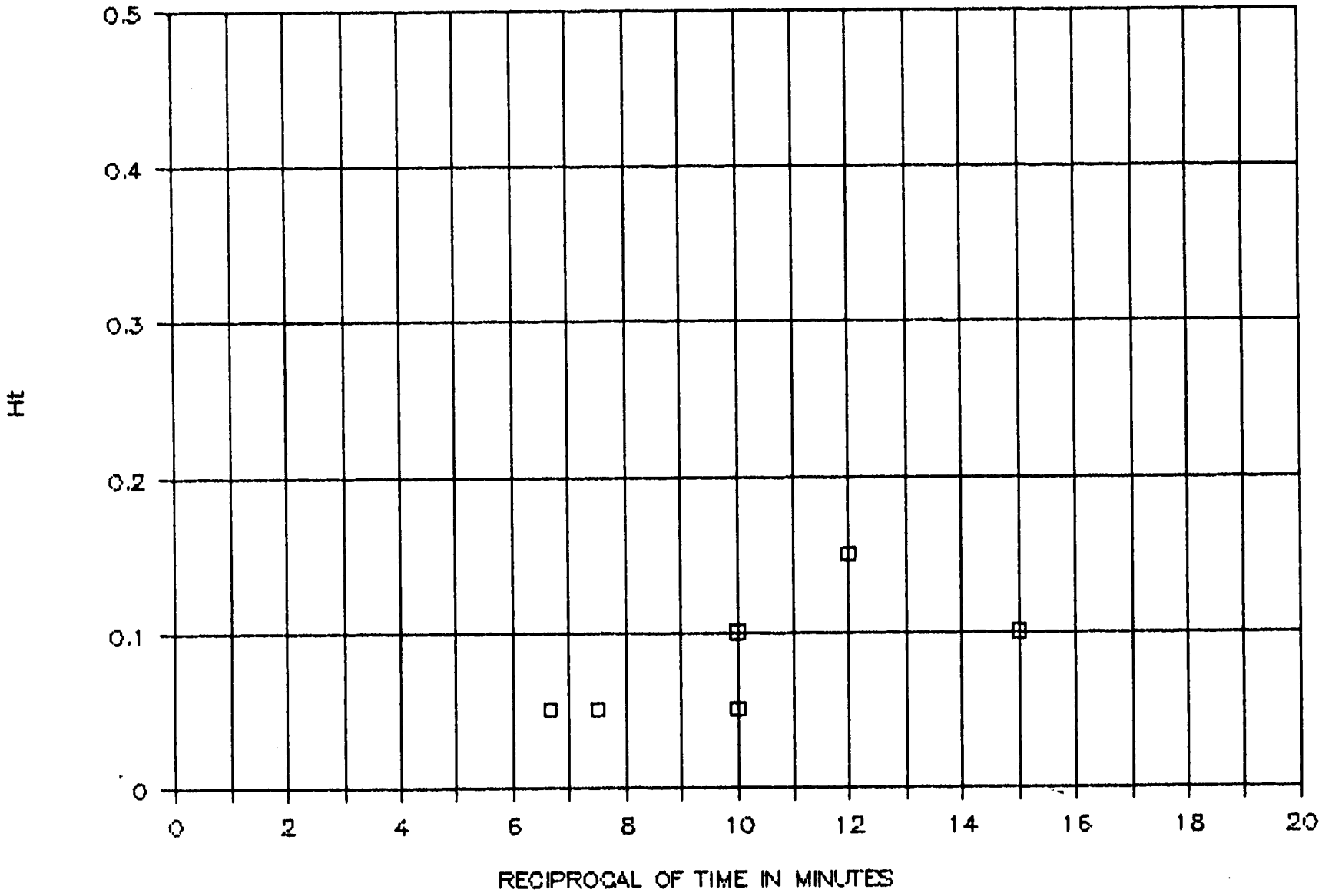
SLUG TEST DATA -- FERRIS & KNOWLES

WELL 3



SLUG TEST DATA -- FERRIS & KNOWLES

WELL 4



where the subscripts identify each bailer cycle in chronological order. Each time t_n represents the interval between the occurrence of the indicated bailer cycle and the time at which s' is observed. The volume of water removed in each bailer cycle can be assumed to be constant. Therefore, equation 13 can be simplified to

$$s' = \frac{q}{4\pi T}\left[\frac{1}{t_1}+\frac{1}{t_2}+\frac{1}{t_3}+\cdots+\frac{1}{t_n}\right] \tag{14}$$

or, in abbreviated notation,

$$s' = \frac{q}{4\pi T}\sum_{i=1}^{n}\frac{1}{t_i} \tag{15}$$

T is in gallons per day per foot if s' is expressed in feet, q in gallons, and t_i in days.

USE AND LIMITATIONS OF THE FORMULAS

The development of equations 7, 12, 13, and 15 involves most of the assumptions inherent in the Theis recovery formula, particularly the stipulation that r be small and t large. As observed by Rorabaugh (written communication, Dec. 8, 1950), the new equations will be most useful when the bailing is hit-or-miss and a reasonable average pumping rate cannot be ascertained. When bailing is at a fairly uniform rate, the cyclic effects might be dissipated before the large-t requirement is satisfied. In this case, the Theis method is preferable because the recovery data are more easily studied graphically. The use of the analytical method described in this paper, particularly when the number of bailer cycles is large, requires much computation for each observed residual drawdown in the recovery period. However, if other methods of analysis are impractical and the artesian aquifer is of low transmissibility, the described analysis affords a means for computing the coefficient of transmissibility by a method that commonly is overlooked.

THE SLUG-INJECTION TEST FOR ESTIMATING THE COEFFICIENT OF TRANSMISSIBILITY OF AN AQUIFER

By John G. Ferris and Doyle B. Knowles

ABSTRACT

If a comparatively small volume, or slug, of water is instantaneously injected into or withdrawn from a well, the well is considered to be an instantaneous vertical line source or line sink. For artesian aquifers, the coefficient of transmissibility of the material in the immediate vicinity of the well can be estimated by an equation developed by Theis (1935) for a vertical instantaneous line sink. The equation can be solved graphically from a straight-line plot of the data. For a slug-injection test, the well should tap the full thickness of the aquifer and be fully developed, and the water-level measurements should be made in rapid succession after the injection or withdrawal of the slug of water into or from the well.

EQUATION FOR DRAWDOWN IN AN INSTANTANEOUS VERTICAL LINE SOURCE OR LINE SINK

In the development of the nonequilibrium formula for drawdowns caused by the pumping of ground water from storage at a constant rate, Theis (1935) presented the equation for drawdown in an instantaneous vertical line source or line sink and obtained, by integration, the equation for a vertical line source or line sink that is continuous at constant strength. Many field tests evidence the applicability of the nonequilibrium formula to the problem of the discharging well that taps an artesian aquifer of infinite extent; however, the importance of the nonequilibrium formula to quantitative ground-water hydrology so over shadowed the initial step of the Theis development that little attention has been accorded the equation for an instantaneous vertical line source or line sink. Although of limited application, the equation provides a useful method for estimating the coefficient of transmissibility in the immediate vicinity of a well, which is a physical approximation of the theoretical vertical line source or line sink.

The slug-injection test for estimating the coefficient of transmissibility involves the instantaneous injection (or withdrawal) of a slug of water into or from a well; hence, the term "slug-injection test" seems appropriate. Use of the slug-injection test should be limited to fully developed wells that are open to the full thickness of an artesian aquifer of small or moderate transmissibility—less than 50,000 gpd per ft. The test probably cannot be used to determine the transmissibility of most water-table aquifers. Because the coefficient of transmissibility determined from this test generally applies only to the material close to the well, indiscriminate use of the results can

lead to erroneous conclusions. Great care must be exercised in conducting the tests, in analyzing the data and, most particularly, in applying the results to the solution of field problems. Nevertheless, the simplicity of the test justifies its use provided the assumptions upon which the formula is based are essentially fulfilled and the limitations of the test are fully recognized.

The equation for residual head in an instantaneous vertical line sink is written

$$s=\frac{qe^{\frac{-r^2S}{4Tt}}}{4\pi Tt} \qquad (1)$$

where

s=the residual head after the injection of a slug of water,
r=the distance from the injection well to an observation well,
t=the time since the slug was injected, and
q=the volume of the slug.

Ordinarily, only a small volume of water can be injected into a well as a slug. For this reason, the reaction to the injected slug usually is not measurable in the aquifer beyond the immediate vicinity of the well. Therefore, the water-level measurements are made only in the injection well; the distance is then the radius, r_w, of the well. For values of r as small as r_w, especially where S is small (as for artesian aquifers), the exponent of e in equation 1 approaches zero as t becomes large and the value of the exponential terms approaches unity. Then, if q is expressed in gallons, T in gallons per day per foot, t in minutes, and s in feet, equation 1 can be written in the form

$$T=\frac{114.6q\,(1/t_m)}{s}, \qquad (2)$$

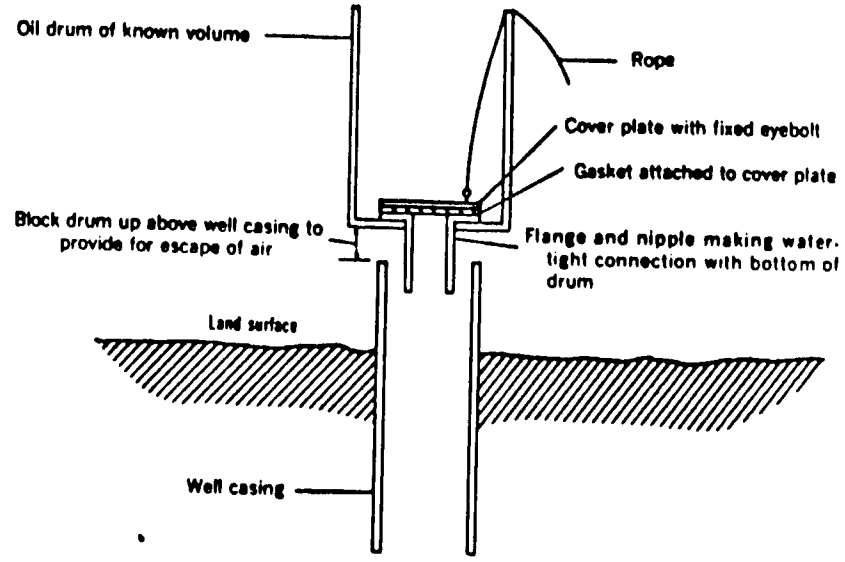
where

t_m=the time in minutes measured from the average of the times marking the beginning and cessation of the injection.

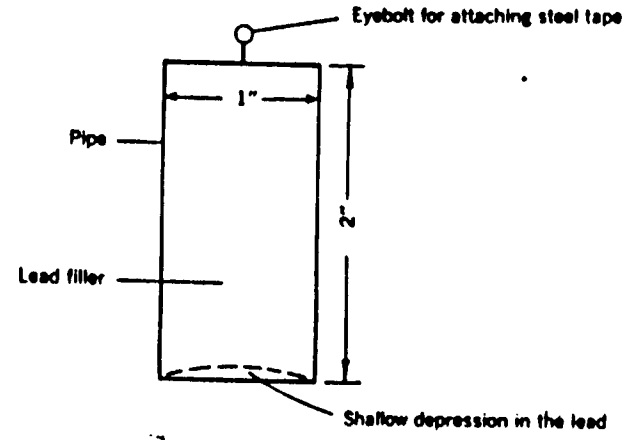
Equations 1 and 2 are equivalent to those derived by Skibitzke in the preceding paper for drawdowns near a vertical line source. The effects of instantaneously injecting a slug of water into a well are identical in the opposite direction to those of instantaneously withdrawing a slug of water of equal volume from the same well; that is, the rate of water-level decline following the injection of a slug equals the rate of water-level recovery following the withdrawal of a slug of equal volume.

EQUIPMENT AND PROCEDURE FOR A SLUG-INJECTION TEST

A convenient apparatus for instantaneously injecting water into a well is shown in figure 89*A*. An oil drum has been adapted for use



A. APPARATUS FOR INJECTING SLUG OF WATER INTO WELL



B. PERCUSSION INSTRUMENT FOR RAPID MEASUREMENT OF WATER LEVELS

FIGURE 89.—Equipment for making a slug-injection test.

as a container to hold the slug of water to be injected. An opening has been made in the bottom of the drum, and a nipple has been attached by using a flange connection. (The nipple could have been welded directly to the container.) A cover plate to which a gasket is attached has been placed over the opening inside the drum. When the rope attached to the cover plate is pulled, the cover plate is raised, thus allowing the slug of water to be introduced into the well almost instantaneously. The drum should be supported by blocks so it can be removed quickly and easily once the injection is completed and also to provide a vent for the escape of air from the well. Water-level measurements must be made rapidly after the slug of water has been introduced into the well. Because the wetted-tape method generally is too slow, a percussion instrument attached to the end of a steel tape or an electric tape should be used. A percussion instrument, such as shown in figure 89*B*, can be constructed easily by filling a short section of steel pipe with lead, carving a shallow, oval depression in the lead at one end of the pipe, and attaching the other end of the pipe to a steel tape. The instrument usually is referred to as a popper because the depression in the lead causes a popping noise upon sharp contact with the water surface in the well. Water-level measurements made with the popper are as accurate as those made by the wetted-tape method.

The residual head at any instant is the difference between the observed water level and the extrapolation of the antecedent water-level trend. In making a slug-injection test, the time at which the injection began and the time that it stopped should be recorded, and the average of these times should be used as the origin of time in analyzing the water-level measurements. The elapsed time during the injection must be small compared to the period of the water-level recession.

A slug-injection test is made as follows:

1. Before injecting the slug of water into the well, define the existing water-level trend by making water-level measurements at frequent intervals.
2. By means of a suitable apparatus, instantaneously (or nearly so) inject a known volume, q, of water into the well.
3. Remove the injection apparatus from the well and resume water-level measurements.
4. Calculate the values of the residual head and $1/t_m$.
5. Plot the corresponding values of s and $1/t_m$ on rectangular coordinate graph paper. The plotted values should define a straight line through the origin.
6. Calculate T from the coordinates of any point on the straight line.

If the observed data from a slug-injection test do not plot on a straight line, the well may be in need of additional development. The slug-injection test cannot be used to estimate transmissibilities that

are much in excess of 50,000 gpd per ft, because the water-level build produced by introducing water into the well disappears so rapidly th the data curve cannot be defined accurately.

A PRACTICAL APPLICATION OF THE SLUG-INJECTION TEST

A slug-injection test to estimate the coefficient of transmissibilit of a water-bearing formation was made on a 6-inch test well at Speed way City, Ind. Measurements of the depth to water prior to an following the instantaneous injection of a 39-gallon slug of water the residual head at the time of each water-level measurement, an the reciprocal of the time since the slug was injected, $1/t_m$, are give in table 7. The residual head, s, was plotted against the reciproca of the time since the slug was injected, $1/t_m$, on rectangular coordinate graph paper, as shown in figure 90. A straight line drawn through points plotted from the observed data passes through the origin. Arbitrary selection of the point on the straight line where $1/t_m=0.5$ and $s=0.165$ foot and substitution of those values in equation 2 gives

$$T=\frac{114.6\times39\times0.5}{0.165}=13{,}500 \text{ gpd per ft.}$$

The well used for the slug-injection test was used later as a water-level observation well during an aquifer test made by pumping from a nearby well. The data from the second test were analyzed by the nonequilibrium formula and gave $T=16{,}000$ gpd per ft.

TABLE 7.—*Data for a slug-injection test at Speedway City, Ind.*

[39-gal slug of water injected into a well 6 in. in diam at time =0 min]

Time (min)	Depth to water below measuring point (ft)	Residual head (ft)	$1/t_m$ (1/min)	Time (min)	Depth to water below measuring point (ft)	Residual head (ft)	$1/t_m$ (1/min)
-20	42.39			3.67	42.31	0.09	0.272
-15	42.40			3.77	42.31	.09	.265
-10	42.40			3.87	42.32	.08	.258
1.20	42.14	0.26	0.800	4.10	42.32	.08	.244
1.30	42.18	.25	.750	4.33	42.32	.08	.231
1.40	42.20	.20	.667	4.52	42.33	.07	.221
1.47	42.23	.17	.521	4.58	42.33	.07	.218
1.50	42.24	.16	.461	4.72	42.33	.07	.212
2.07	42.25	.15	.435	5.17	42.34	.06	.193
2.02	42.26	.14	.422	5.28	42.34	.06	.189
1.07	42.26	.14	.413	5.45	42.34	.06	.183
2.73	42.28	.12	.375	6.10	42.35	.05	.164
2.77	42.28	.12	.368	6.40	42.35	.05	.156
1.42	42.28	.12	.361	6.83	42.35	.05	.146
1.49	42.29	.11	.342	7.17	42.36	.04	.139
1.52	42.29	.11	.333	7.75	42.36	.04	.129
1.55	42.30	.10	.311	8.58	42.36	.04	.117
1.58	42.30	.10	.305	9.37	42.37	.03	.107
1.60	42.30	.10	.300	10.12	42.37	.03	.099
1.67	42.31	.09	.294	11.00	42.37	.03	.091
1.68	42.31	.09	.288	12.5	42.37	.03	.080
	42.31	.09	.282	13.0	42.37	.03	.077

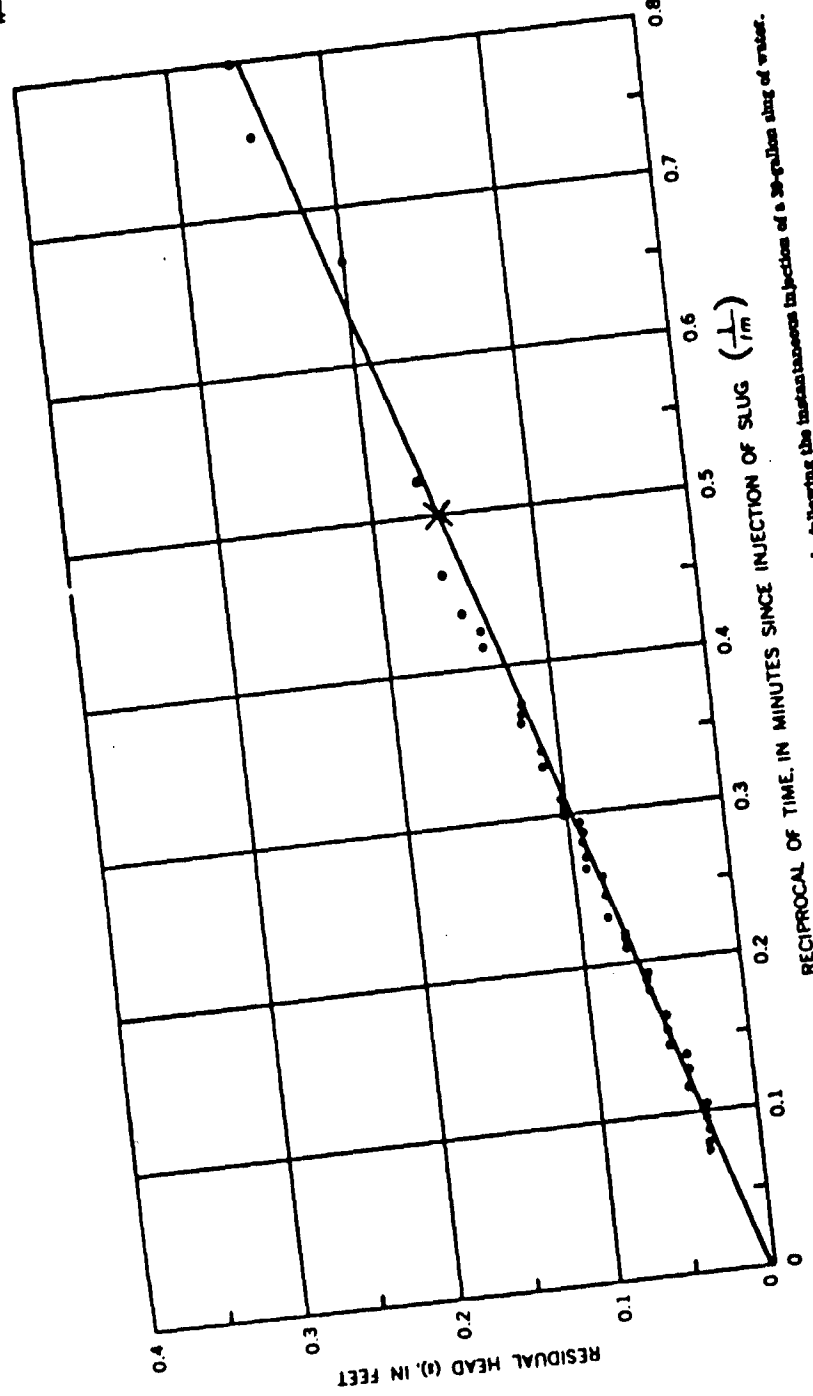


FIGURE 88.—Graph showing decline of residual head in a 6-inch well at Speedway City, Ind., following the instantaneous injection of a 30-gallon slug of water.

CYCLIC WATER-LEVEL FLUCTUATIONS AS A BASIS FOR DETERMINING AQUIFER TRANSMISSIBILITY[1]

By John G. Ferris

ABSTRACT

In an aquifer bounded by a body of tidal water or by a regulated stream, the water level responds to changes in stage of the surface-water body. If the stage fluctuates as a simple harmonic motion, a train of sinusoidal waves is propagated through the ground-water body. Because the amplitude of each transmitted wave decreases as the distance from the boundary increases and the time lag of a given maximum or minimum increases as the distance from the boundary increases, the transmissibility of the aquifer can be found by either the stage-ratio method or the time-lag method. The solution of the formula for each of these methods is facilitated by the use of a straight-line plot. For the stage-ratio method, the logarithm of the ratio of the ground-water stage in an observation well to the surface-water stage is plotted against the distance of the observation well from the boundary. For the time-lag method, the time between a change in surface-water stage and the corresponding maximum or minimum ground-water stage in an observation well is plotted against the distance of the observation well from the boundary. Both methods can be applied to fluctuations that are limited in duration to a single maximum or minimum.

ACKNOWLEDGMENTS

The author is greatly indebted to D. L. Erickson, city engineer and director of parks, public property, and improvements for Lincoln, Nebr., and to members of his staff for their hearty cooperation and effort in making available the data on which this paper is based. The basic data were assembled under the direct supervision of H. A. Waite, district geologist of the U.S. Geological Survey at Lincoln, Nebr.

CYCLIC FLUCTUATIONS OF WATER LEVELS

In coastal areas, many wells near bodies of tidal water exhibit sinusoidal water-level fluctuations in response to periodic changes in the tidewater stage. In many inland places, the regulation of a surface reservoir similarly produces correlative water-level changes in wells that are near either the reservoir or the stream which carries releases from the reservoir. As the surface-water stage rises, the head upon the subaqueous outcrop of the aquifer increases and thereby either increases the rate of flow into the aquifer or reduces the rate of flow from it. The increase in recharge or reduction in discharge results in a general rise of the water level in the aquifer. Conversely, a falling surface-water stage causes a corresponding decline of the water level in the aquifer. When the stage of the surface-water body fluctuates as a simple harmonic motion, a train of sinusoidal waves is propagated inland through the subaqueous outcrop of the aquifer. With increas-

[1] The analysis on which this paper is based [illegible]

Response of a Finite-Diameter Well to an Instantaneous Charge of Water[1]

HILTON H. COOPER, JR., JOHN D. BREDEHOEFT, AND ISTAVROS S. PAPADOPULOS

Water Resources Division, U. S. Geological Survey, Washington, D. C.

Abstract. A solution is presented for the change in water level in a well of finite diameter after a known volume of water is suddenly injected or withdrawn. A set of type curves computed from this solution permits a determination of the transmissibility of the aquifer. (Key words: Aquifer tests; groundwater; hydraulics; permeability)

INTRODUCTION

Ferris and Knowles [1954] introduced a method for determining the transmissibility of an aquifer from observations of the water level in a well after a known volume of water is suddenly injected into the well. (See also *Ferris et al.* [1962]). They reasoned that for practical purposes the well may be approximated by an instantaneous line source in the infinite region, in which the residual head differences due to the injection are described by

$$h = (V/4\pi Tt)e^{-r^2S/4Tt} \qquad (1)$$

where

h = change in head at distance r and time t due to the injection;
r = distance from the line source or center of well;
t = time since instantaneous injection;
V = volume of water injected;
T = transmissibility of aquifer;
S = coefficient of storage of aquifer.

They reasoned further that the head H in the injected well would be described closely by (1) when r is set equal to the effective radius r_e [*Jacob*, 1947, p. 1049] of the screen or open hole. Then, since r_e is small, the exponential approaches unity quickly, so that the equation approaches $H = V/4\pi Tt$, which can be written

$$T = V(1/t)/4\pi H \qquad (2)$$

To the extent that the equation is valid for a well of finite diameter, a determination of the transmissibility can be obtained from the slope of a plot of head H versus the reciprocal of time $(1/t)$.

Since the volume of water injected into the well is $\pi r_e^2 H_0$, where r_e is the radius of the casing in the interval over which the water level fluctuates and H_0 is the initial head increase in the well, equation 1 can be written

$$h/H_0 = (r_e^2/4Tt)e^{-r^2S/4Tt} \qquad (3)$$

and equation 2 can be written

$$H/H_0 = r_e^2/4Tt \qquad (4)$$

Recently *Bredehoeft et al.* [1966] demonstrated by means of an electrical analog model of a well-aquifer system that equation 3 gives a satisfactory approximation of the head in an injected well only after the time t is large enough for the ratio H/H_0 to be very small (see Figure 1). The observed discrepancy appears to arise from the assumption that the injected well can be approximated by a line source.

We present here an exact solution for the head in and around a well of finite diameter after the well is instantaneously charged with a known volume of water.

ANALYSIS

Consider a nonflowing well cased to the top of a homogeneous isotropic artesian aquifer of uniform thickness, and screened (or open) throughout the thickness of the aquifer (Figure 2). Suppose that the well is instantaneously charged with a volume V of water. (We will consider

[1] Publication authorized by the Director, U. S. Geological Survey.

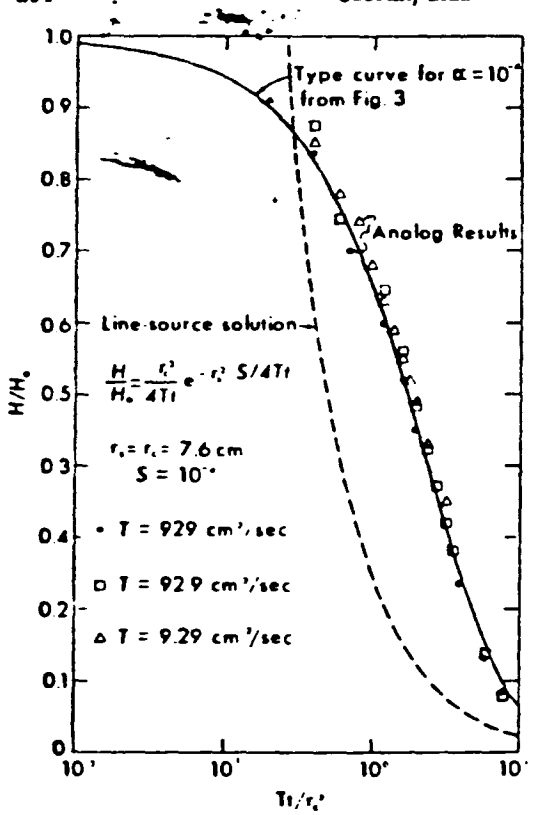


Fig. 1. Comparison of analog results with curve representing line-source solution.

an injection as a positive charge and a withdrawal as a negative one.) The water level in the well instantaneously moves to the height $H_0 = V/\pi r_c^2$ above or below its initial level and immediately begins to return to its initial level according to some function of time $H(t)$. Meanwhile the head in the surrounding aquifer varies according to $h(r, t)$. Our objective is to find a solution for $h(r, t)$ and $H(t)$. The inertia of the column of water in the well will be neglected. (See, in this connection, *Bredehoeft et al.* [1966]). Since the solution to be obtained can be superposed on any initial condition, we can simplify the problem without loss of generality by assuming that the head is initially uniform and constant.

The problem is described mathematically by

$$\partial^2 h/\partial r^2 + 1/r(\partial h/\partial r) = S/T(\partial h/\partial t) \qquad (r > r_c) \qquad (5)$$

$$h(r_c + 0, t) = H(t) \qquad (t > 0) \qquad (5a)$$

$$h(\infty, t) = 0 \qquad (t > 0) \qquad (5b)$$

$$2\pi r_c T[\partial h(r_c + 0, t)]/\partial r = \pi r_c^2(\partial H(t)/\partial t) \qquad (t > 0) \qquad (5c)$$

$$h(r, 0) = 0 \qquad (r > r_c) \qquad (5d)$$

$$H(0) = H_0 = V/\pi r_c^2 \qquad (5e)$$

Equation 5 is the differential equation governing nonsteady radial flow of confined groundwater. (See, for example, *Jacob*, 1950, p. 333.) Boundary condition 5a states that after the first instant the head in the aquifer at the face of the well is equal to that in the well. Boundary condition 5b states that as r approaches infinity the change in head approaches zero. Equation 5c expresses the fact that the rate of flow of water into (or out of) the aquifer is equal to the rate of decrease (or increase) in volume of water within the well. The conditions 5d and 5e state that initially the change in head is zero everywhere outside the well and equal to H_0 inside the well.

By applying the Laplace transform with respect to time the problem is reduced to

$$\partial^2 \bar{h}/\partial r^2 + 1/r\,(\partial \bar{h}/\partial r) = (S/T)\,(p\bar{h}) \qquad (6)$$

$$\bar{h}(\infty, p) = 0 \qquad (6a)$$

$$[\partial \bar{h}(r_c + 0, p)]/\partial r = (r_c^2/2r_cT)[p\bar{h}(r_c + 0, p) - H_0] \qquad (6b)$$

for which the solution is

$$\bar{h}(r, p) = \frac{r_c S H_0 K_0(rq)}{Tq[r_c q K_0(r_c q) + 2\alpha K_0(r_c q)]} \qquad (7)$$

where $q = (pS/T)^{\frac{1}{2}}$, and $\alpha = r_c^2 S/r_c^2$. The solution $h(r, t)$ is the inverse transform, which is available from the analogous problem in heat flow [*Carslaw and Jaeger*, 1959, p. 342]

$$h = \frac{2H_0}{\pi}\int_0^\infty e^{-\beta u^2/\alpha}\{J_0(ur/r_c) \cdot [uY_0(u) - 2\alpha Y_1(u)] - Y_0(ur/r_c) \cdot [uJ_0(u) - 2\alpha J_1(u)]\}\frac{du}{\Delta(u)} \qquad (8)$$

where $\beta = Tt/r_c^2$ and

$$\Delta(u) = [uJ_0(u) - 2\alpha J_1(u)]^2 + [uY_0(u) - 2\alpha Y_1(u)]^2$$

Fig. 2. [illegible]

The head $H(t)$ [illegible] stituting $r =$ [illegible]

$$H = (8H_0/\pi$$

Values of H [illegible] tegrating equa[illegible] computed from [illegible] tions 3 and 4, [illegible] the values fro[illegible] family of five [illegible] mensionless ti[illegible] curve for each [illegible] $\alpha = r_c^2S/r_c^2$. [illegible] curve, are the [illegible] 4.

It is appare[illegible] Figure 3 that [illegible] proposed by [illegible] close approxim[illegible] 8 only for lar[illegible] Tt/r_c^2. The ap[illegible] ble for Tt/r_c^2 [illegible] for H/H_0 less [illegible] at Speedway [illegible] Knowles to [illegible] naged from [illegible]

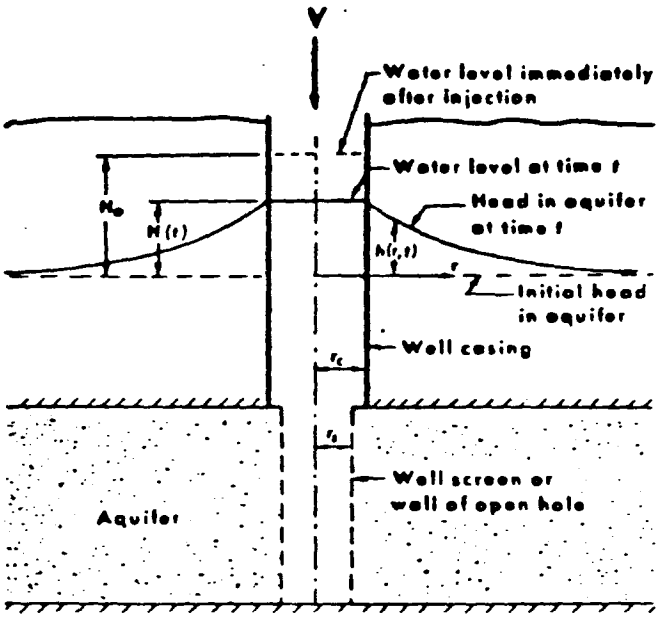


Fig. 2. Idealized representation of a well into which a volume V of water is suddenly injected.

...e head $H(t)$ inside the well, obtained by sub-...uting $r = r_c$ in equation 8, is

$$H = (8H_o\alpha/\pi^2) \int_0^\infty e^{-\beta u^2/\alpha}\, du/(u\,\Delta(u)) \quad (9)$$

Values of H/H_o computed by numerically in-...rating equation 9 are given in Table 1. Values ...puted from the line-source solutions, equa-...s 3 and 4, are given in Table 2. In Figure 3 ... values from Table 1 are represented as a ...ily of five curves of H/H_o versus the di-...nsionless time parameter $\beta = Tt/r_c^2$, one ...ve for each of five values of the parameter ... $= r_c^2S/r_s^2$. Also represented, by a dashed ...ve, are the values computed from equation

It is apparent from Tables 1 and 2 and from ...gure 3 that the line-source solutions 3 and 4 ...posed by *Ferris and Knowles* [1954] give a ...se approximation of the finite-source solution only for large values of the time parameter ...$/r_c^2$. The approximation seems to be accepta-... for Tt/r_c^2 greater than 100 (or, equivalently, ...r H/H_o less than about 0.0025). (In the test ... Speedway City, Indiana, used by Ferris and Knowles to exemplify their method, H/H_o ...nged from 0.01 to 0.001, and the value of transmissibility determined from these data agreed fairly well with one obtained by another method.)

A family of type curves plotted on semilogarithmic paper, as in Figure 3, permits a determination of the transmissibility. The method is similar to the Theis graphical method [*Wenzel*, 1942]. A test on a well near Dawsonville, Georgia, will be used to demonstrate the method. This well is cased to 24 m with 15.2-cm (6-inch) casing and drilled as a 15.2-cm open hole to a depth of 122 m. Figure 4 is a reproduction of a chart showing the hydrograph of the well after the sudden withdrawal of a long weighted float from the well. The weight of the float was 10.16 kilograms, and hence by the principle of Archimedes it had displaced a volume of 0.01016 m³ of water when floating in the well. Its withdrawal was therefore equivalent to a negative charge of $V = 0.01016$ m³. From the relation $H_o = V/\pi r_c^2$ the initial head change is found to be $H_o = 0.560$ m.

The hydrograph in Figure 4 was recorded electrically from a pressure transducer, which was suspended below the water surface in the well. Table 3 lists data from this chart. To determine the aquifer constants the data are

TABLE 1. Values of H/H_0 for a Well of Finite Diameter (computed from equation 9)

		Tt/r_c^2	H/H_0 $\alpha = 10^{-1}$	$\alpha = 10^{-2}$	$\alpha = 10^{-3}$	$\alpha = 10^{-4}$	$\alpha = 10^{-5}$
3	1	1.00×10^{-3}	0.9771	0.9920	0.9969	0.9985	0.9992
4	2	2.15×10^{-3}	0.9658	0.9876	0.9949	0.9974	0.9985
5	3	4.64×10^{-3}	0.9490	0.9807	0.9914	0.9954	0.9970
6	4	1.00×10^{-2}	0.9238	0.9693	0.9853	0.9915	0.9942
7	5	2.15×10^{-2}	0.8860	0.9505	0.9744	0.9841	0.9888
8	6	4.64×10^{-2}	0.8293	0.9187	0.9545	0.9701	0.9781
9	7	1.00×10^{-1}	0.7460	0.8655	0.9183	0.9434	0.9572
10	8	2.15×10^{-1}	0.6289	0.7782	0.8538	0.8935	0.9167
11	9	4.64×10^{-1}	0.4782	0.6436	0.7436	0.8031	0.8410
12	10	1.00×10^{0}	0.3117	0.4598	0.5729	0.6520	0.7060
13	11	2.15×10^{0}	0.1665	0.2597	0.3543	0.4364	0.5038
14	12	4.64×10^{0}	0.07415	0.1086	0.1554	0.2082	0.2620
15	13	7.00×10^{0}	0.04625	0.06204	0.08519	0.1161	0.1521
16	14	1.00×10^{1}	0.03065	0.03780	0.04821	0.06355	0.08378
17	15	1.40×10^{1}	0.02092	0.02414	0.02844	0.03492	0.04426
18	16	2.15×10^{1}	0.01297	0.01414	0.01545	0.01723	0.01999
19	17	3.00×10^{1}	0.009070	0.009615	0.01016	0.01083	0.01169
20	18	4.64×10^{1}	0.005711	0.005919	0.006111	0.006319	0.006554
21	19	7.00×10^{1}	0.003722	0.003809	0.003884	0.003962	0.004046
22	20	1.00×10^{2}	0.002577	0.002618	0.002653	0.002688	0.002725
23	21	2.15×10^{2}	0.001179	0.001187	0.001194	0.001201	0.001208

plotted on semilogarithmic paper of the same scale as that of the type curves in Figure 3, and this plot is superposed on the type curves. With the arithmetic axes coincident, the data plot is translated horizontally to a position where the data best fit the type curves, as

TABLE 2. Values of H/H_0 for Line-source Approximation of a Well

Tt/r_c^2	H/H_0 from equation 3 $\alpha = 10^{-1}$	$\alpha = 10^{-2}$	$\alpha = 10^{-3}$	$\alpha = 10^{-4}$	$\alpha = 10^{-5}$	H/H_0 from eq. 4
1.00×10^{-3}	0.000000	20.52	194.7	243.8	249.4	250.0
2.15×10^{-3}	0.001035	36.35	103.5	115.0	116.2	116.3
4.64×10^{-3}	0.2463	31.44	51.05	53.59	53.85	53.88
1.00×10^{-2}	2.052	19.47	24.38	24.94	24.99	25.00
2.15×10^{-2}	3.635	10.35	11.50	11.62	11.63	11.63
4.64×10^{-2}	3.144	5.105	5.359	5.385	5.388	5.388
1.00×10^{-1}	1.947	2.438	2.494	2.499	2.500	2.500
2.15×10^{-1}	1.035	1.150	1.162	1.163		1.163
4.64×10^{-1}	0.5105	0.5359	0.5385	0.5388		0.5388
1.00×10^{0}	0.2438	0.2494	0.2499	0.2500		0.2500
2.15×10^{0}	0.1150	0.1162	0.1163			0.1163
4.64×10^{0}	0.05359	0.05385	0.05388			0.05388
7.00×10^{0}	0.03558	0.03570	0.03571			0.03571
1.00×10^{1}	0.02494	0.02499	0.02500			0.02500
1.40×10^{1}	0.01783	0.01786				0.01786
2.15×10^{1}	0.01162	0.01163				0.01163
3.00×10^{1}	0.008326	0.008333				0.008333
4.64×10^{1}	0.005385	0.005388				0.005388
7.00×10^{1}	0.003570	0.003571				0.003571
1.00×10^{2}	0.002499	0.002500				0.002500
2.15×10^{2}	0.001163					0.001163

shown in Figure 5
$t = 11$ sec on the
overlie the value T
coordinates. Hence
puted to be

$$T = \frac{1.0r_c^2}{t} = (1$$

In principle the
determined by int
the curves that li
plot in the matche
ample just describ
would be $S = 10^{-}$
so that $\alpha = S$, an
for $\alpha = 10^{-4}$. How
data plot to the ty
shapes of the typ
slightly when α diff
a determination of
tionable reliability.

Fig.

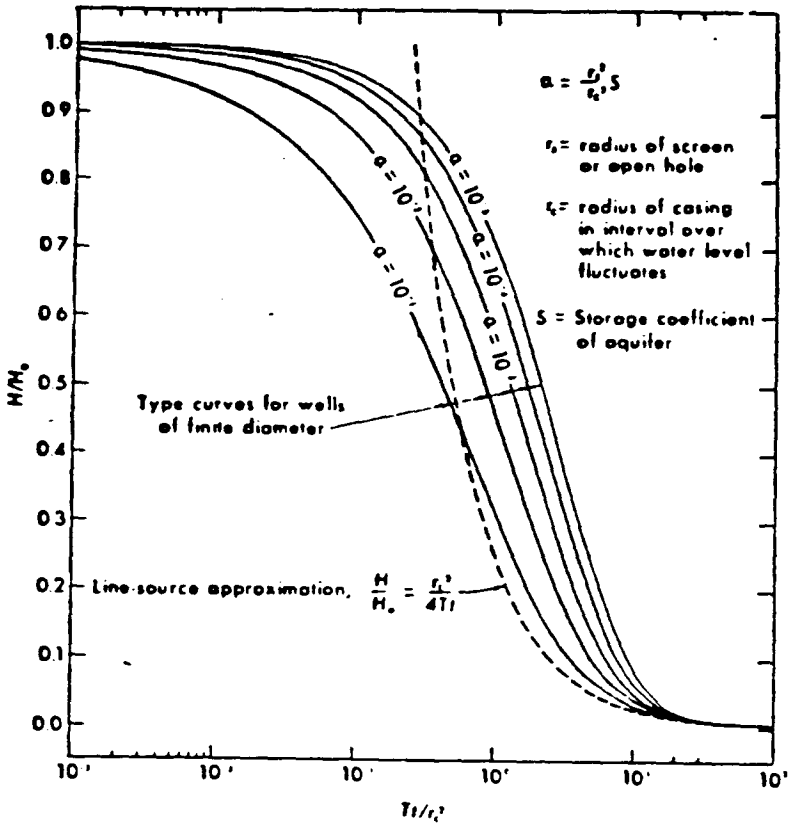


Fig. 3. Type curves for instantaneous charge in well of finite diameter.

shown in Figure 5. In this position the time $t = 11$ sec on the data coordinates is found to overlie the value $Tt/r_s^2 = 1.0$ on the type-curve coordinates. Hence the transmissibility is computed to be

$$T = \frac{1.0 r_s^2}{t} = \frac{(1.0)(7.6)^2}{(11)} = 5.3 \text{ cm}^2/\text{sec}$$

In principle the coefficient of storage can be determined by interpolating from its values for the curves that lie on either side of the data plot in the matched position. Thus, in the example just described, the coefficient of storage would be $S = 10^{-3}$, since for this well $r_c = r_s$, so that $\alpha = S$, and the points fall on the curve for $\alpha = 10^{-3}$. However, because the matching of data plot to the type curves depends upon the shapes of the type curves, which differ only slightly when α differs by an order of magnitude, a determination of S by this method has questionable reliability.

The determination of T is not so sensitive to the choice of the curves to be matched. Whereas the determined value of S will change by an

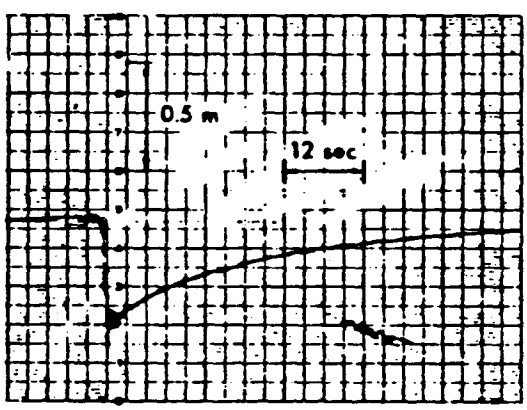


Fig. 4. Hydrograph of well at Dawsonville, Georgia, showing response of water level to the sudden withdrawal of a weighted float.

TABLE 2. Rise of Water Level in Dawsonville Well after Instantaneous Withdrawal of Weighted Float

t (sec)	$1/t$	Head (m)	H (m)	H/H_0
-1		0.896		
0		0.336	0.560	1.000
3	0.333	0.439	0.457	0.816
6	0.167	0.504	0.392	0.700
9	0.111	0.551	0.345	0.616
12	0.0833	0.588	0.308	0.550
15	0.0667	0.616	0.280	0.500
18	0.0556	0.644	0.252	0.450
21	0.0476	0.672	0.224	0.400
24	0.0417	0.691	0.205	0.366
27	0.0370	0.709	0.187	0.334
30	0.0333	0.728	0.168	0.300
33	0.0303	0.747	0.149	0.266
36	0.0278	0.756	0.140	0.250
39	0.0256	0.765	0.131	0.234
42	0.0238	0.784	0.112	0.200
45	0.0222	0.788	0.108	0.193
48	0.0208	0.803	0.093	0.166
51	0.0196	0.807	0.089	0.159
54	0.0185	0.814	0.082	0.146
57	0.0175	0.821	0.075	0.134
60	0.0167	0.825	0.071	0.127
63	0.0159	0.831	0.065	0.116

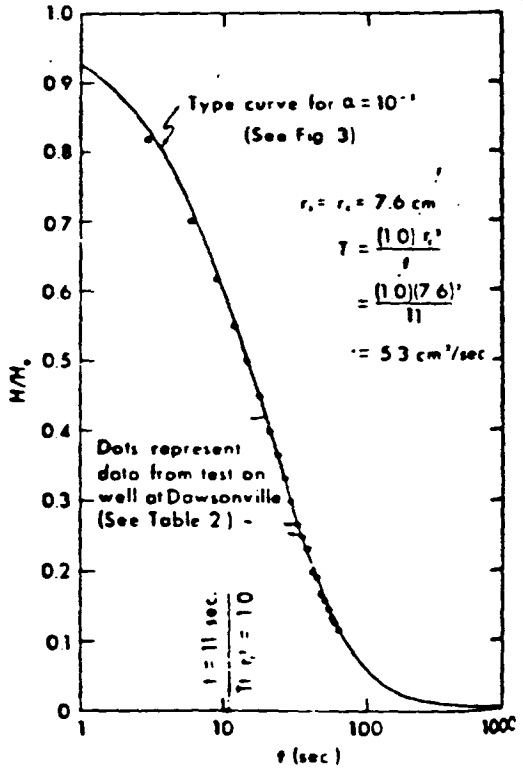


Fig. 5. Plot of data from test at Dawsonville, Georgia, superposed on type curve.

order of magnitude when the data plot is moved from one type curve to another, that of T will change much less. From a knowledge of the geologic conditions and other considerations one can ordinarily estimate S within an order of magnitude and thereby eliminate some of the doubt as to what value of α is to be used for matching the data plot.

Figure 6 shows the data from the test on the Dawsonville well plotted according to the Ferris-Knowles method. The points do not fall along a straight line as postulated in this method but, instead, fall along the trace of the type curve for $\alpha = 10^{-1}$, which has been transferred from Figure 5. Also shown is a straight line through the origin whose slope, when used according to the Ferris-Knowles method, will yield the transmissibility of 5.3 cm²/sec obtained by matching the data to the type curves.

CONCLUSION

The judgment of an experienced hydrologist is needed to decide the significance, if any, of a determination of T by the method of instantaneous charge. As *Ferris et al.* [1962] properly warned

> the duration of a 'slug' test is very short, hence the estimated transmissibility determined from the test will be representative only of the water-bearing material close to the well. Serious errors will be introduced unless the . . . well is fully developed and completely penetrates the aquifer.

Few wells completely penetrate an aquifer, but it is nevertheless possible under some circumstances for a hydrologist to derive useful information from a test on a partially penetrating well. Since the vertical permeabilities of most stratified aquifers are only small fractions of the horizontal permeabilities, the induced flow within the small radius of the cone that develops during the short period of observation is likely to be essentially 2-dimensional. Therefore, the determined value of T would represent approximately the transmissibility of that part

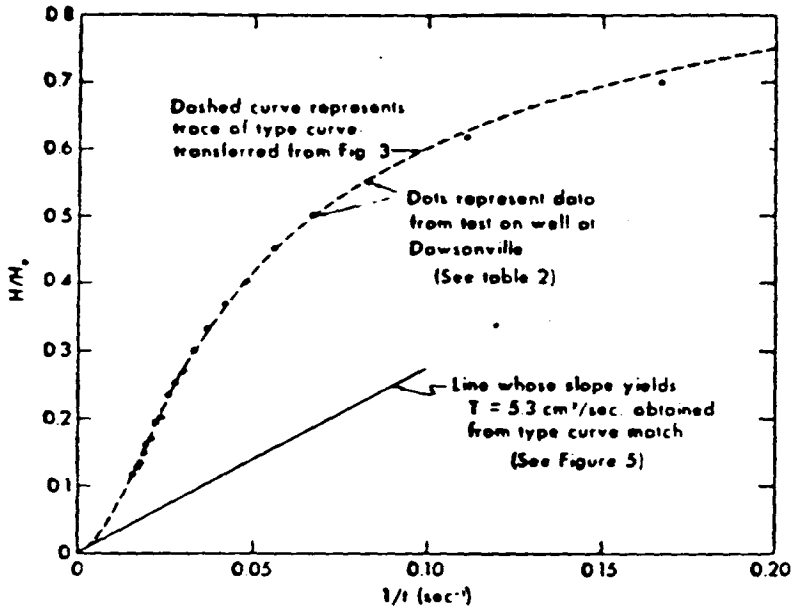


Fig. 6. Data from test on well of Dawsonville, Georgia, plotted according to the Ferris-Knowles method.

the aquifer in which the well is screened or open, provided that the aquifer is reasonably homogeneous and isotropic in planes parallel to the bedding and provided that the effective radius r_e can be estimated closely.

REFERENCES

Bredehoeft, J. D., H. H. Cooper, Jr., and I. S. Papadopulos, Inertial and storage effects in well-aquifer systems: An analog investigation, *Water Resources Res.*, *2*(4), 697–707, 1966.

Carslaw, H. S., and J. C. Jaeger, *Conduction of Heat in Solids*, 510 pp., Oxford University Press, London, 1959.

Ferris, J. G., and D. B. Knowles, The slug test for estimating transmissibility, *U. S. Geol. Surv. Ground Water Note 26*, 1954.

Ferris, J. G., D. B. Knowles, R. H. Brown, and R. W. Stallman, Theory of aquifer tests, *U. S. Geol. Surv. Water-Supply Paper 1536-E*, 1962.

Jacob, C. E., Drawdown test to determine effective radius of artesian well, *Trans. Am. Soc. Civil Engrs.*, *112*, 1047–1064, 1947.

Jacob, C. E., Flow of groundwater, in *Engineering Hydraulics*, edited by H. Rouse, John Wiley & Sons, New York, 1950.

Wenzel, L. K., Methods for determining permeability of water bearing materials, *U. S. Geol. Surv. Water-Supply Paper 887*, 1942.

(Manuscript received May 12, 1966.)

APPENDIX F

SURVEYING RESULTS

NORTHWOODS
LAND SURVEYING, INC.

125 ARLINGTON ST., SUITE 1
[redacted]
SAULT STE. MARIE, MICHIGAN 49783
PHONE 906-632-1500

Thomas M. Lachajczyk
Envirodyne Engineers
12161 Lackland Road
St. Louis, Missouri 63146

February 16, 1987

RE: Raco-Bomarc Missle Site Survey

Dear Mr. Lachajczyk:

Enclosed are (6) copies of the above referenced survey along with the field book as required by the specifications. If you have any questions or need additional data, please feel free to contact our office.

Should you need services such as ours in the future, we have licensed land surveyors on staff with active licenses in the States of Michigan, Colorado, Wisconsin and Florida. Thank you.

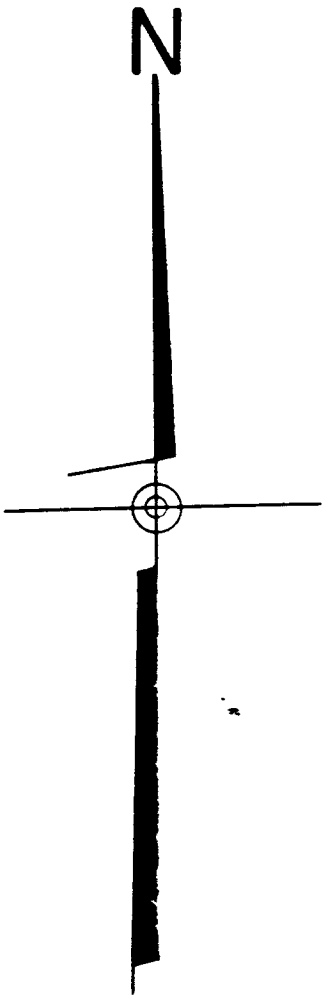
Very truly yours,
NORTHWOODS LAND SURVEYING, INC.

William L. Karr

William L. Karr, L.S.

SURVEY AT RACO MISSILE S

LOCATED IN SECTION 28, 29, & 33, T.46
SUPERIOR TOWNSHIP, CHIPPEWA COUNTY, M



SCALE 1" = 300'

300 150 0 300 600 900

LEGEND

N - NORTHING (Y)
E - EASTING (X)
⊡ - MONITORING WELL
⊙ - CONTROL MONUMENT - 2-1/2" O.D. x 4.0' PIPE W/ 3" STAMPED BRASS CAP
✚ - G.L.O. CORNER POSITION
——— - SECTION LINE

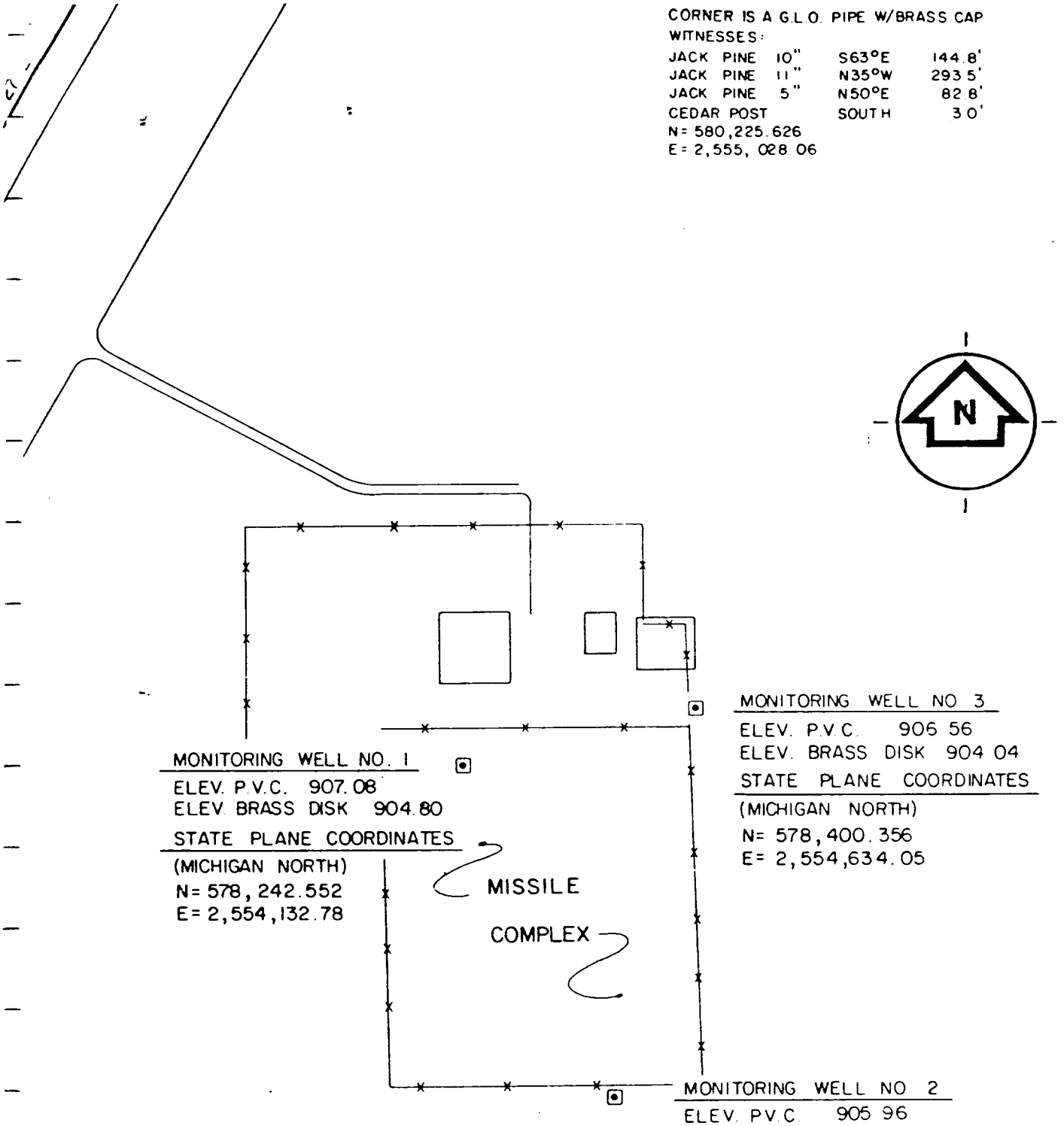
FUEL DEPO

NOTE: ALL ELEVATIONS ARE BASED ON N.G.V. SEA LEVEL DATUM OF 1929.

CORNER IS A G.L.O. PIPE W/BRASS CAP
WITNESSES:

JACK PINE	10"	S63°E	144.8'
JACK PINE	11"	N35°W	293.5'
JACK PINE	5"	N50°E	82.8'
CEDAR POST		SOUTH	3.0'

N= 580,225.626
E= 2,555, 028.06

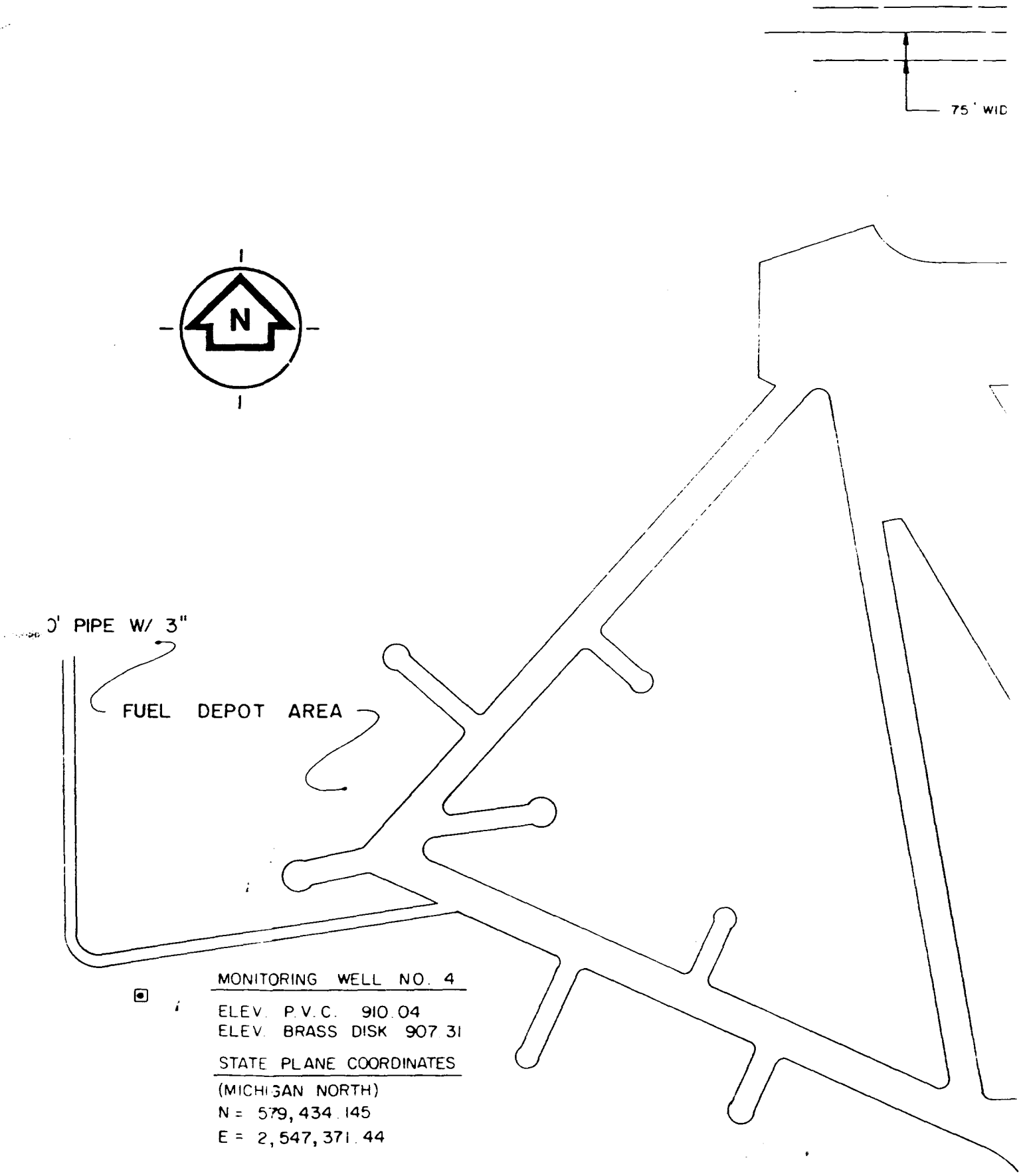


COORDINATES ARE BASED ON
C SYSTEM (LAMBERT PROJECTION)
RIANGULATION STATIONS LOCATED
WATER TOWER N = 578,479.70
E = 2,553,783.93
D FIRE TOWER N = 582,873.247
E = 2,559,944.59

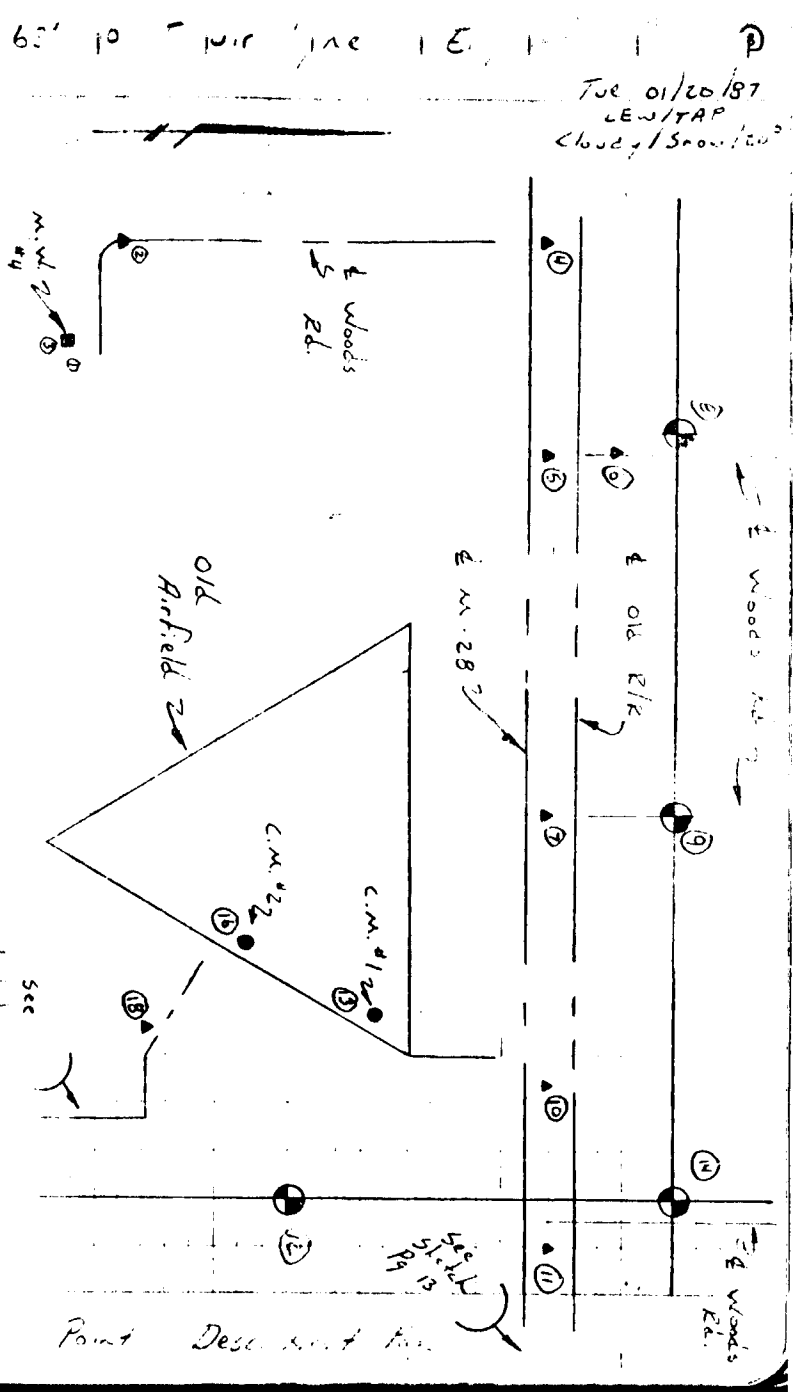
FOR THE PROJECT LOCATION WAS 0.99990357

DRAFTED BY: C.A. PARIS

636-00


75' WID
N
0' PIPE W/ 3"
FUEL DEPOT AREA
MONITORING WELL NO. 4
ELEV. P.V.C. 910.04
ELEV. BRASS DISK 907.31
STATE PLANE COORDINATES
(MICHIGAN NORTH)
N = 579,434.145
E = 2,547,371.44

Horizontal	Vert	
	90-10-00	358.00
555°E	269-49-59	358.02
[Compass]	[illegible]	[illegible]
		(358.008)
00-04-33	90-[illegible]	[illegible]
359-55-[illegible]	269-52-54	[illegible]
359-59-[illegible]	[illegible]	[illegible]
(00-04-36)		(356.794)
238-53-30	89-51-00	2332.81
121-06-28	[illegible]	332.78
359-59-58	359-[illegible]	332.82
[illegible] 238-53-34		047
121-06-23		
359-59-57		
M (238-53-34)		(2332.795)
269-51-53	89-54-54	2741.24
90-08-02	270-05-02	2741.22
359-59-55	359-59-50	835.527
269-51-52		
90-08-12		
359-59-64		
M (269-51-53)		(2741.227)



	Horizontal	Control	
4 E	89-47-16	90-14-05	366.82
5	270-12-45	269-45-52	366.83
6	359-59-63	359-59-[illegible]	1.1909
I	89-47-[illegible]		
	270-12-4[illegible]		
	359-59-5[illegible]		
M>	(89-47-16)		(366.822)
7 E	180-00-56	90-[illegible]	2616.90
	179-59-[illegible]	269-51-[illegible]	2616.89
	359-59-[illegible]	359-59-[illegible]	797.0[illegible]
I	180-00-5[illegible]		
	179-59-19		
	35[illegible]		
M>	(180-00-50)		(2616.387)
8 E	175-59-22	90-[illegible]	304.45
6	184-[illegible]	2[illegible]	304.45
9	359-59-[illegible]	359-59-[illegible]	92.798
I	175-59-18		
	184-00-3[illegible]		
	359-59-5[illegible]		
M>	(175-59-20)		(304.449)

Tue 01/20/87
Wed 01/21/87
LEW/TAP
Sunny/10°

Point Description

Brass tablet for M.W. #4
Tablet 1.3 Southerly of
[illegible] w/ well housing
10 Spike & woods road
[illegible] curve
[illegible] Inch Pine - S40°E - [illegible]
Top of metal well housing
for M.W. #4.
(1/2 inches on)
10 Spike, on & woods
road to South, 8.0' North
of north edge paving M.C.
10 Spike on & woods
[illegible] North 8.0 North
[illegible] north edge paving [illegible]
10 Spike & North [illegible]
wooden frame Stake (3 high)
squared wood Post - East 19.3
10 Spike, on & woods
road to North 8.2' North
of North edge Paving M.C.

	Horizontal	Control	
5 → 7 → 9	89-51-28	90-00-00	645.05
	270-08-35	270-00-03	645.06
	359-59-63	360-00-09	196.615
	89-51-[illegible]		
	270-08-[illegible]		
	359-59-54		
	(89-51-24)		(645.055)
5	179-56-[illegible]	90-03-40	2091.83
	180-03-42	269-56-[illegible]	2091.81
	359-59-62	359-59-74	6375.86
	179-56-23		
	180-03-[illegible]		
	359-59-55		
	(179-56-22)		(2091.819)

Wed 01/21/87

③ Sec. Cor. 20/21 29/28 T46N-R4W. Corner is 1926 GLO monument, 1/2 with stamped brass cap on Westerly side of wood track 4 of 5 U.S.F.S. [illegible] - [illegible] bearing N74E [illegible] Here 1/4 Cor. [illegible] Corner is [illegible] GLO mon. stamped brass cap, 12" Below grade. Corner in North-South woods road, See Pg. 48 for ties. 10" spike, 9.9' North of North edge Paving [illegible] Spike approx 117' East of ℄ drive South into old Airfield.

Horizontal Control

7 / 10 / 11	E	180-06-32	90-06-06	621.72
		179-53-22	269-54-02	621.73
		359-59-54	359-60-08	189.505
	I	180-06-38		
		179-53-18		
		359-59-56		
	M>	(180-06-38)		(621.724)
12	E	255-18-10	90-08-	2087.74
		104-41-45	269-52-14	2087.79
		359-59-55	359-60-26	2087.79
	I	255-18-25		636.361
		104-41-40		
		359-59-65		
	M>	(255-18-18)		(2087.768)
13	E	301-34-14	90-06-12	1850.85
		58-25-46	269-53-40	1850.85
		359-59-60	359-59-52	564.140
	I	301-34-~~34~~ 26		
		58-25-44		
		359-59-70		
	M>	(301-34-18)		(1850.847)

Wed 01/21/87

11 10" Spike, 9.5' North of North edge Paving M-28 Spike approx 51' East of ℄ woods road to North approx 30' East of line to North

12 1/4 Cor Secs 28/27 T46N-R2W Corner is 1926 GLO monument with stamped brass cap. Corner on North South Fence line. All 3 U.S.F.S. BTs there

13 Control Monument #1 - Brass Capped Pipe See Page 46 for ties

Horizontal Control

10, 11, 14	E [82-49-08	~~92-09-06~~	622.60
	277-10-52	90-06-22	622.60
	359-59-60	269-53-38	189.769
	I [82-49-08	359-59-60	
	277-10-52		
	359-59-60		
	⇒ (82-49-08)		(622.599)

10, 13, 15	E [41-15-28		[redacted]
	318-44-25		6820.462
	359-59-53		
	I [41-15-~~42~~ 35		
	318-44-29		
	359-59-64		
	⇒ (41-15-33)		

16	E [178-25-18	90-02-30	1351.855
	181-34-38	269-57-23	1351.855
	359-59-56	359-59-59	412.049
	I [178-25-38		
	181-34-18		
	359-59-56		
	⇒ (178-25-30)		(1351.855)

Wed 01/21/87

(14) Sec Cor 21/22 25/27 T46N R20W 1026 640 monument with stamped brass cap Corner on West side North-South wood road

(15) [illegible] Tower [illegible] antenna [illegible] top center of cabin

(16) Control Monument "[illegible]" Brass [illegible] See Page 451 for ties

(19) 10' Spike, on Southern side of drive into Missle Base. Spike is approx 24' East of ℄ ditch around area.

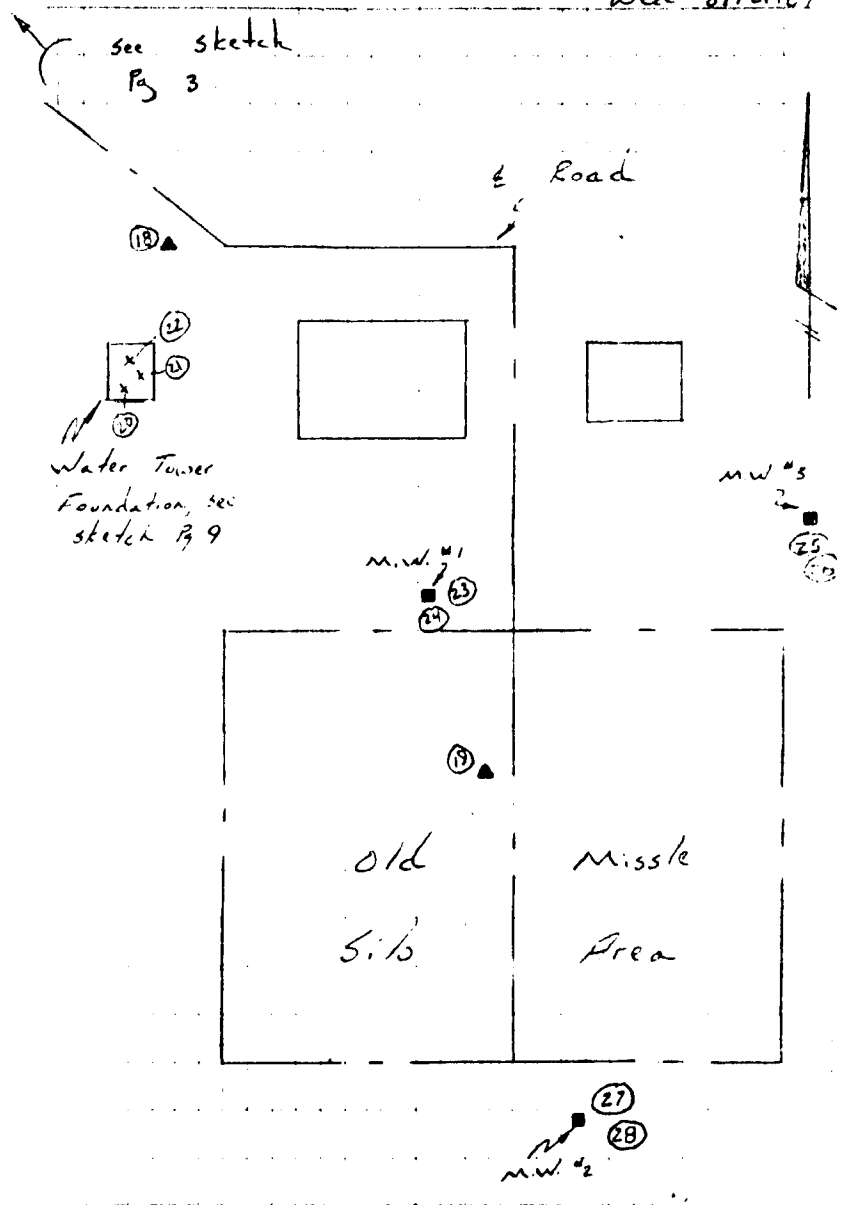
6" Jack Pine - N30°E - 78'

Twin Wh. Birch - North - 93.3 (Southerly tree)

Horizontal / Kor...

(13) (16)	E	36-07-28		[redacted]
		323-52-32		7865.643
(20) 17		359-59-60		
	I	36-07-[illegible]		
		323-5[illegible]		
		[illegible]-59-62		
		⇒ (36-07-26)		
(18)	E	92-40-[illegible]	89-51-52	859.08
		267-13-48	[illegible]	859.07
		359-59-60	359-59-[illegible]	201.542
	I	92-46-08		
		267-13-5[illegible]		
		359-59-6[illegible]		
		⇒ (92-46-10)		(858.046)
(16) (18) (19)	E	208-43-02	90-03-12	1173.90
		151-17-0[illegible]	269-56-4[illegible]	1173.91
		359-60-04	359-59-58	357.809
	I	208-43-04		
		151-16-59		
		359-59-63		
		⇒ (208-43-02)		(1173.904)

Wed 01/21/87



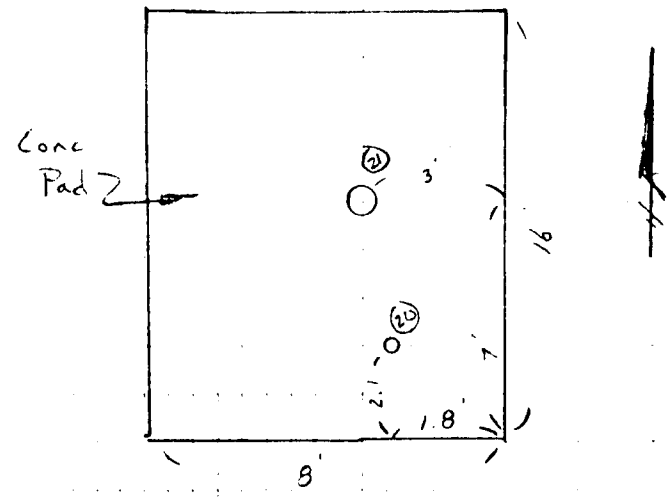
	Horizontal	Control	
18	349-40-0[illegible]	90-21-53	664.17
19	10-20-05	269-38-00	664.16
20	359-60-[illegible]	359-59-53	202.438
I	349-39-53		
	10-[illegible]		
	359-59-[illegible]		
	(349-39-58)		(664.151)
21	349-[illegible]	90-12-45	668.18
	10-[illegible]	269-47-[illegible]	668.19
	359-59-50	359-59-[illegible]	203.664
	349-49-[illegible]		
	[illegible]		
	359-59-20		
	(349-49-37)		(668.180)

Wed 01/21/87

19 10' Spike, in old missle silo area. Spike in crack in conc. Spike on west side N-S road (Center Road), Spike near 3rd silo from North

20 : Approx center 4 3/8" O.D. open pipe from old water tower

21 Approx center 8 1/4" O.D. open Pipe from old water tower



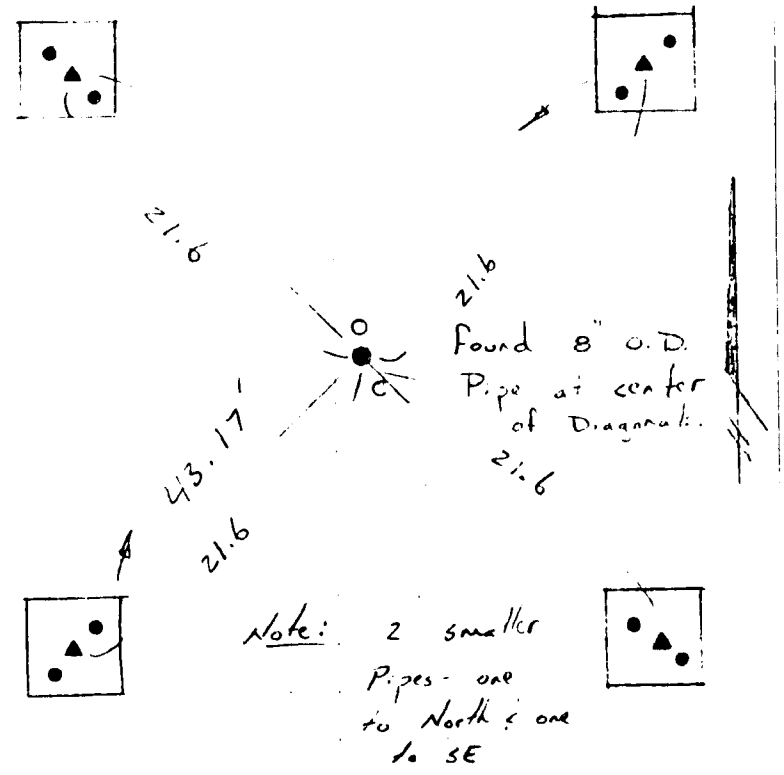
Horizontal Control

18 / 19 / 22 E	350-05-38	90-06-58	673.36
	09-54-23	269-52-54	[illegible]37
	359-59-61	359-58-112	205.244
I	350-05-34		673.37
	09-54-34		
	359-59-69		

MJ

Mon 01/26/87
LEW/TAP
Sunny/0°

Sketch of area of conc footings for water tower



- Each Pad approx 3' x 3'
- ●: 2" Solid iron, split to set up diagonals

Horizontal Control

18	12-35-22	90-42-32	288.09
19	347-24-40	269-17-20	288.10
23	359-59-62	359-59-52	87.812
24 E	12-38-12	90-17-08	287.89
	347-21-48	269-42-48	287.89
	359-59-60	359-59-56	87.749
I	12-38-14		
	347-21-48		
	359-59-62		
M>			
25	74-22-58	90-23-35	596.37
	285-37-05	269-36-36	596.38
	359-59-66	359-59-71	181.777
26 E	74-19-32	90-12-08	596.66
	285-40-28	269-47-42	596.65
	359-59-60	359-59-50	181.858
I	74-19-28		
	285-40-32		
	359-59-60		
M>			

Mon 01/26/87

23 Top of metal well housing for M.W. #1 (lid locked on)

24 Brass tablet for M.W. #1 Tablet is 0.3 East of metal well housing

25 Top of metal well housing for M.W. #3 (lid locked on)

26 Brass tablet for M.W. #3 Tablet is 0.55 North of metal well housing

	Horizontal	control	
18	189-12-14	90-29-04	552.95
19	170-47-52	269-31-06	552.94
27	359-59-66	359-60-10	169.537
28	E 189-16-28	90-16-54	552.60
	170-43-42	269-43-12	552.60
	359-59-70	359-59-66	169.534
	= 189-16-27		
	170-43-42		
	359-59-69		

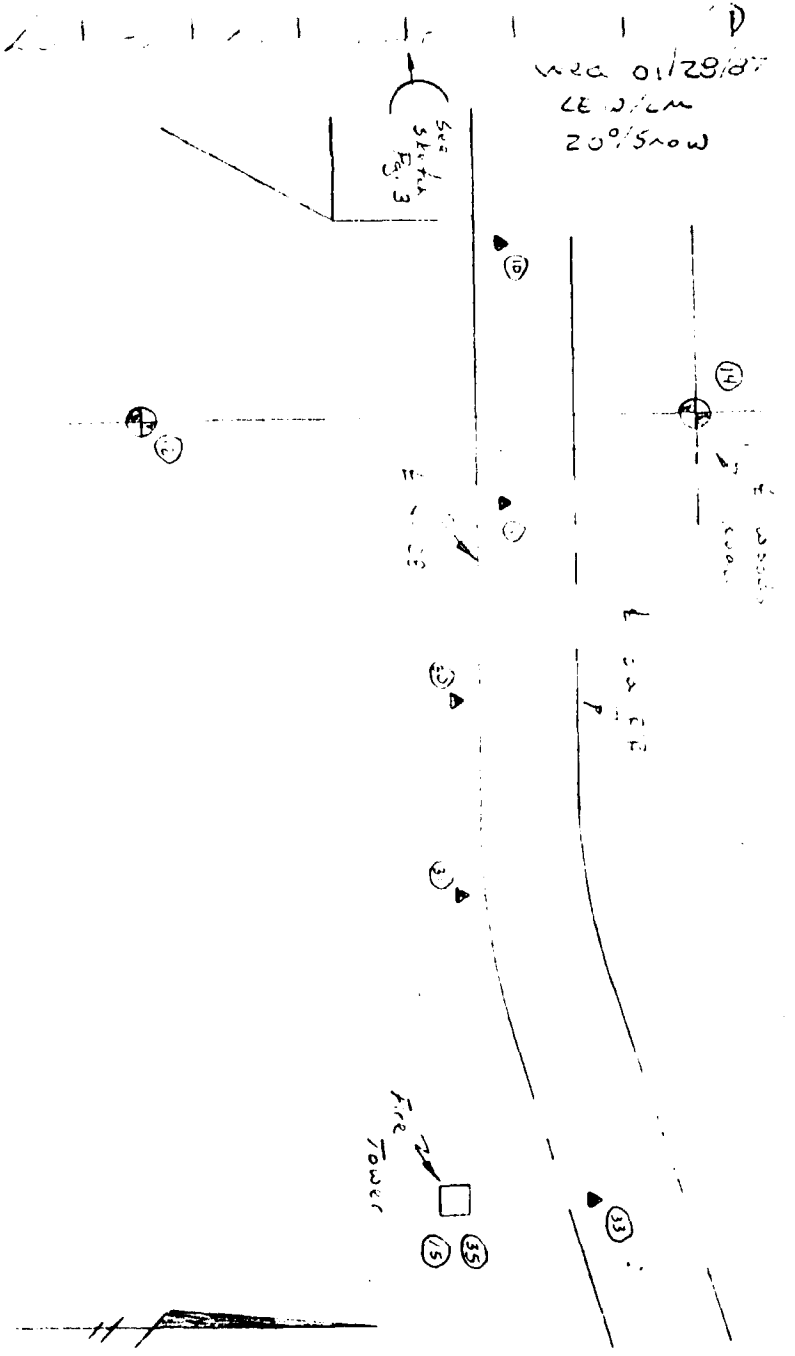
Mon 01/26/87

(27) Top of metal well housing for new #2 (old location only)

(28) Brass tablet for new #2 Tablet is West 0.02' of metal well housing

Horizontal Control

10 – 11 – 30	182-48-25	89-58-35	950.44
	177-11-38	270-01-30	950.44
	359-59-63	[illegible]	[illegible] 094
	182-48-[illegible]		
	177-[illegible]-38		
	359-59-63		
11 – 30 – 31	174-55-[illegible]	90-[illegible]	13[illegible].57
	[illegible]	26[illegible]	[illegible].57
	[illegible]	[illegible]	[illegible]
	174-55-[illegible]		
	185-04-38		
	359-59-66		
30 – 31 – 15 – 32	[illegible]-51-24		
	18[illegible]		
	[illegible]-59-66		
	172-51-24		
	[illegible]-18-45		
	35[illegible]-[illegible]-69		



	Horizontal	Control	
30	167-12-06	90-10-32	2771.18
31	192-47-58	269-49-36	2771.18
32	359-59-64	359-59-69	844.659
	167-12-08		
	192-47-59		
	[illegible]		

4	288-28-52		
31	71-31-1[illegible]		
3	[illegible]-59-64		
	288-28-58		
	71-31-04		
	[illegible]		

		85-40-14	
35	288-9-24	~~85-40-[illegible]~~	280.78
	71-30-42	274-19-42	280.80
	359-59-66	359-59-56	85.588
	288-29-24		
	71-30-42		
	359-59-66		

M>

Log of [illegible] Tower

Wed 01/28/87

30 10" Spike on South side AL-28 along curve. 8.8' South of South [illegible] pavement [illegible] - 199

30 10" Spike, 8.5' South of South edge AL-28 Triangular core hog marker - South - 10.0'

32 10" Spike 8.2' [illegible] of North [illegible] Old [illegible] Tower to South

D 6" Square Concrete Mon. Brass [illegible] missing Placed Pk Nail in Center

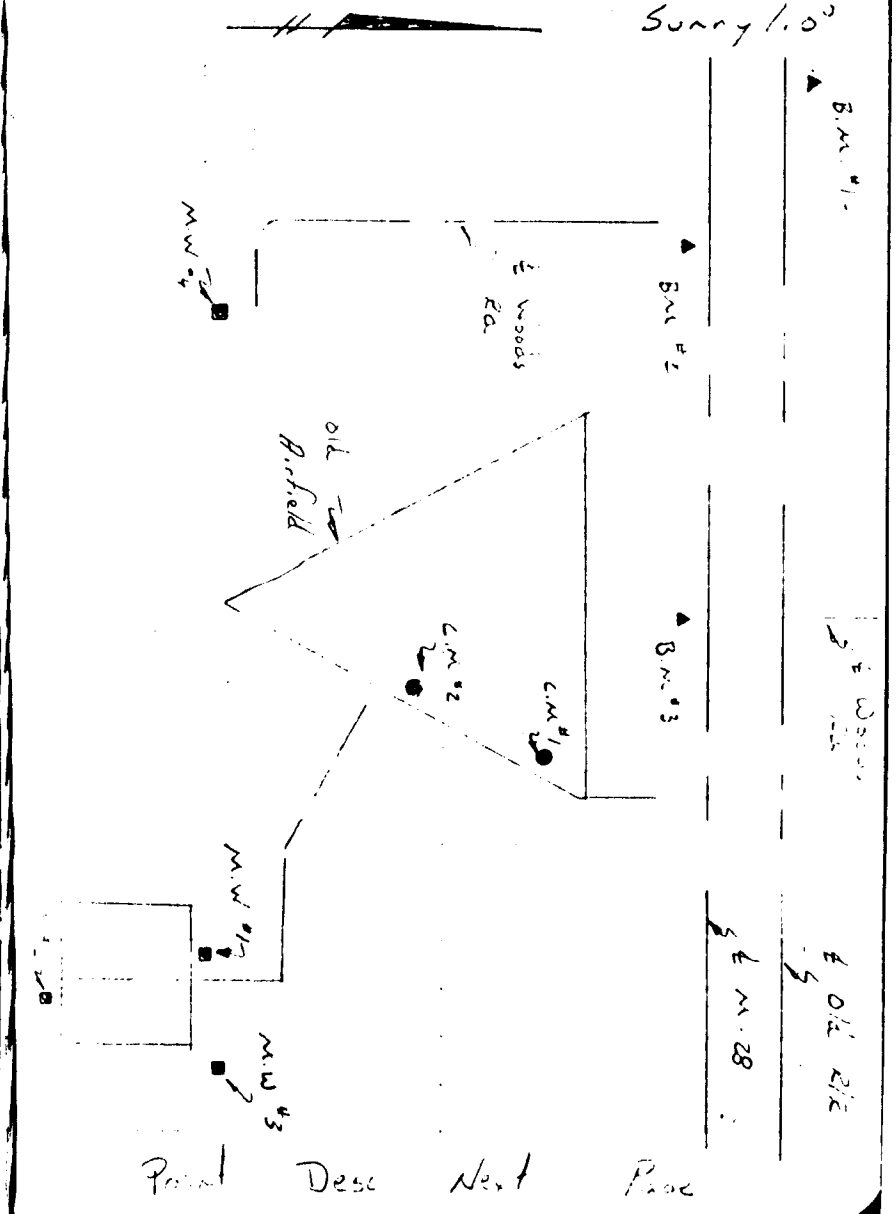
Vertical Loop

STA	BS	HI	FS	Elev	Adj Elev.
E.M.#1	4.44 ~~4.43~~			920.936	
		925.38			
T.P.#1	4.30		5.59	920.79	
		924.1			
T.P.#2	4.19		5.96	918.15	
		922.34			
T.P.#3	4.26		5.77	916.57	
		920.83			
T.P.#4	4.71		5.55	915.28	
		919.99			
B.M.#2			5.58	913.41	913.42

- Return Loop -

B.M.#2	6.41			913.42	
		919.83			
T.P.#4	5.47		4.55	915.28	
		920.75			
T.P.#3	5.76		4.18	916.57	
		922.33			
T.P.#2	5.97		4.17	918.16	
		924.13			

Mon 01/26/87
LEW / TAP
Sunny / 10°



Vertical Control

STA	BS	HI	FS	Elev
		924.13		
T.P. #1	5.64		4.30	919.81
		925.45		
B.M. #1			4.51	920.94
"				
Σ:	51.17		51.18	

Mon 01/26/87

Point Description

B.M. #1: U.S. Coast & Geodetic Bench Mark - T44 - 1934 Conc. Monument with stamped brass cap. 28' North of ℄ RR Grade 6" Red Pine - North - S.S. Elev: 920.936 - Sea Level Datum of 1929

B.M. #2: R.R. Spike in 10" Jack Pine Tree on South side of M 28 45' South of ℄ M 28 91' East of ℄ woods road to South

Elev: 913.42

Vertical Control

STA	BS	HI	FS	Elev	Adj Elev
B.M #c	5.61			913.42	
		919.03			
T.P #5	5.26		7.34	913.69	
		916.95			
T.P #6	4.97		5.47	911.98	
		916.45			
T.P #7	3.01		4.80	911.65	
		914.66			
T.P #8	4.76		6.42	908.24	
		913.00			
M.W #4		Side Shot	2.96	910.04	910.04
S.T #4			5.70	907.30	907.31

- Return Loop -

STA	BS	HI	FS	Elev
S.T #4	5.60			907.31
		912.91		
M.W #4		Side Shot	2.87	910.04
T.P #8	6.51		4.70	908.21
		914.72		

Loop of M.W. #4

True Oil/Gale
LEW/TAP
Cloudy/45°

M.W #4: Top of P.V.C. Pipe (Plug off). 0.09 higher to top of metal well housing
Elev: 910.04

B.T. #4. Brass tablet for M.W #4. Tablet is 1.3' southeasterly of met. well housing
Elev: 907.31

Vertical Control

Loop Rd. #4

Tue 01/2/19

STA	BS	HI	FS	Elev
		914.72		
T.P.#7	4.91		3.10	911.62
		916.53		
T.P.#6	5.72		5.07	911.46
		917.18		
T.P.#5	7.62		5.51	911.67
		919.29		
B.M.#2			5.87	913.42
Σ:	53.97		53.98	

Tue 01/27/87

Vertical Control

STA	BS	HI	FS	Elev	Adj Elev
B.M.#2	6.07			913.42	
		919.49			
T.P.#9	4.44		5.14	914.35	
		918.34			
T.P.#10	4.61		5.16	913.68	
		918.29			
T.P.#11	4.56		5.69	913.60	
		917.16			
T.P.#12	5.74		6.07	911.09	
		914.38			
T.P.13	3.75		5.89	908.99	
		912.74			
T.P.14	4.07		6.13	906.61	
		910.68			
T.P.15	4.87		5.69	904.99	
		909.86			
B.M.#3			4.62	905.24	905.22

Return Loop

B.M.#3	4.25			905.22	
		909.47			

B.M.#3 6' Spike in U.S.F.S. water post (old location has gone post). Post is on South side of road at Woods Creek & Nebraska. Post on approx NES 1/4 line Sec. 28 T46N R6W

Elev. 905.22

Tue 01/27/87

STA	BS	HI	FS	Elev	Adj Elev
		909.47			
T.P #15	5.47		4.50	904.97	
		910.44			
T.P #16	5.98		3.83	906.61	
		912.59			
T.P #13	5.95		3.59	909.00	
		914.95			
T.P #12	5.93		3.85	911.10	
		917.03			
T.P #11	5.59		4.41	912.62	
		918.21			
T.P #10	5.23		4.52	913.69	
		918.92			
T.P #9	5.15		4.57	914.35	
		919.50			
B.M #2			6.06	913.44	913.42
Σ =	79.76		79.72		

Vertical Control

Tue 01/27/9

STA	BS	HI	FS	Elev	Adj Elev
B.M #3	3.47			905.22	
		908.69	4.98		
T.P #16	4.55		4.99	903.71	
		908.26			
T.P #17	4.51		4.90	903.36	
		907.87			
T.P #18	4.09		4.99	902.88	
		906.97			
T.P #19	4.60		5.53	901.44	
		906.04			
T.P #5	4.87		4.75	901.29	
		906.16			
C.M #1			6.26	899.90	899.91

Return Loop

C.M #1	6.24			899.91	
		906.15			
T.P #20	5.17		4.85	901.30	
		906.47			
T.P #19	6.01		5.03	901.44	
		907.45			

C.M. #1: Control Monument #1
Brass Capped Pipe
See P. 46 for Lies
Elev. 899.91

Vertical Control

Tue 01/27/87

STA	BS	HI	FS	Elev
		907.45		
T.P. #18	5.23		4.57	902.88
		908.11		
T.P. #17	5.13		4.76	903.35
		908.48		
T.P. #16	5.28		4.77	903.71
		909.99		
3 ac FS			3.77	905.22
Σ =	59.15		59.16	

Vertical Control

Tue 01/27/87

STA.	BS	HI	FS	Elev.	Adj. Elev.
C.M.#1	6.77			899.91	
		906.68			
T.P.1	5.02		5.13	901.55	
		906.57			
T.P.2	4.97		5.02	901.55	
		906.52			
C.M.#2		side shot	5.75	900.74	900.74
T.P.23	7.39		2.34	904.18	
		911.57			
T.P.24	3.28		6.06	905.51	
		908.79			
T.P.25	7.05		4.80	903.93	
		910.98			
M.W.#1		side shot	3.91	907.07	907.08
B.T.#1		side shot	6.19	904.79	904.80
			4.42		
M.W.#3		side shot	4.41	906.56	906.56
B.T.#3		side shot	6.95	904.03	904.04
T.P.26	5.22		5.22	905.76	
		910.98			

C.M.#2 Control Monument [illegible] Brass [illegible] See Page 45 [illegible]
Elev. = 900.74

M.W.#1 Top of Pvc Pipe (Pipe [illegible]). 0.10 higher than top of metal well housing.
Elev. = 907.08

B.T.#1 Brass Tablet for M.W.#1. Tablet is 0.3 East of metal well housing.
Elev. = 904.80

Vertical Control

STA	BS	HI	FS	Elev	Adj Elev
		910.98			
M.W.#2		Side Shot	5.02	905.96	905.96
B.T.#2			7.50	903.48	903.48
- Return Loop					
B.T.#2	7.55			903.48	
		910.83			
M.W.#2		Side Shot	4.87	905.96	
T.P.26	5.24		5.05	905.78	
		911.02			
M.W.#3		Side Shot	4.45	906.57	
B.T.#2		Side Shot	6.97	904.05	
M.W.#1		Side Shot	3.93	907.09	
B.T.#1		Side Shot	6.21	904.81	
T.P.25	5.20		7.07	903.95	
		909.15			

Top of PVC
Pipe [illegible] 0.05
[illegible]
metal well housing
Elev. 905.96

B.T. [illegible] Brass Tablet for
M.W. #3. Tablet is
[illegible] North of
metal well housing
Elev. 904.04

M.W. [illegible] Top of PVC
Pipe [illegible] 0.05
[illegible]
metal well housing
Elev. 905.96

B.T. [illegible] Brass tablet for
M.W. #2 Tablet is
0.62' West of
metal well housing
Elev. 903.48

Vertical Control

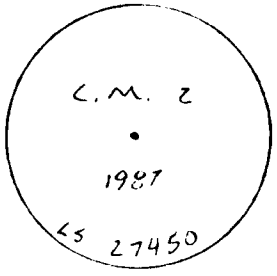
STA	BS	HI	FS	Elev
		909.15		
T.P #24	6.31		3.63	905.52
		911.83		
T.P #3	2.25		7.65	904.18
		906.43		
CMP #2		Side Shot	5.69	900.74
T.P	4.79		4.99	901.44
		906.23		
T.P	4.75		4.80	901.43
		906.18		
CMP #1			6.27	899.[illegible]
Σ =	75.59		75.59	

5

Tie on to [illegible]

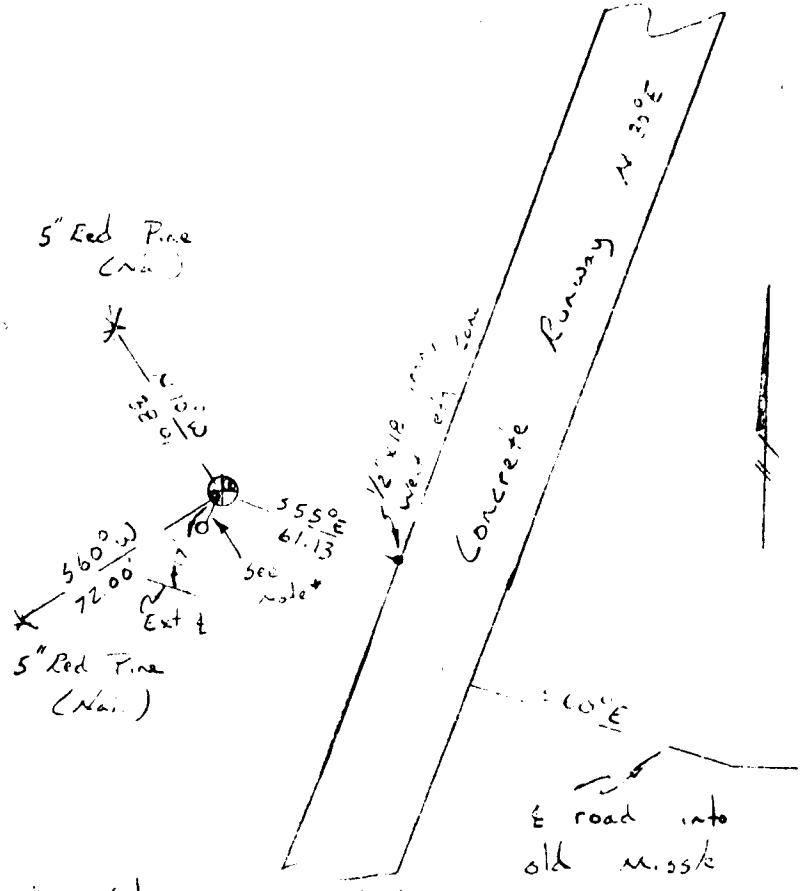
Control Monument "C"

Corner is a 2½" O.D. x 4' Galvanized iron Pipe with a stamped brass cap.



Corner falls ± 17' North of extension ℄ road into old Missle Base

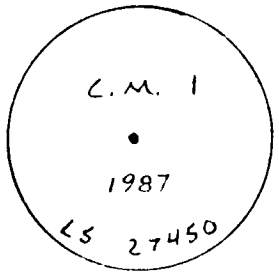
Mon 01/19/87
LEWITAP
Sunny 125°



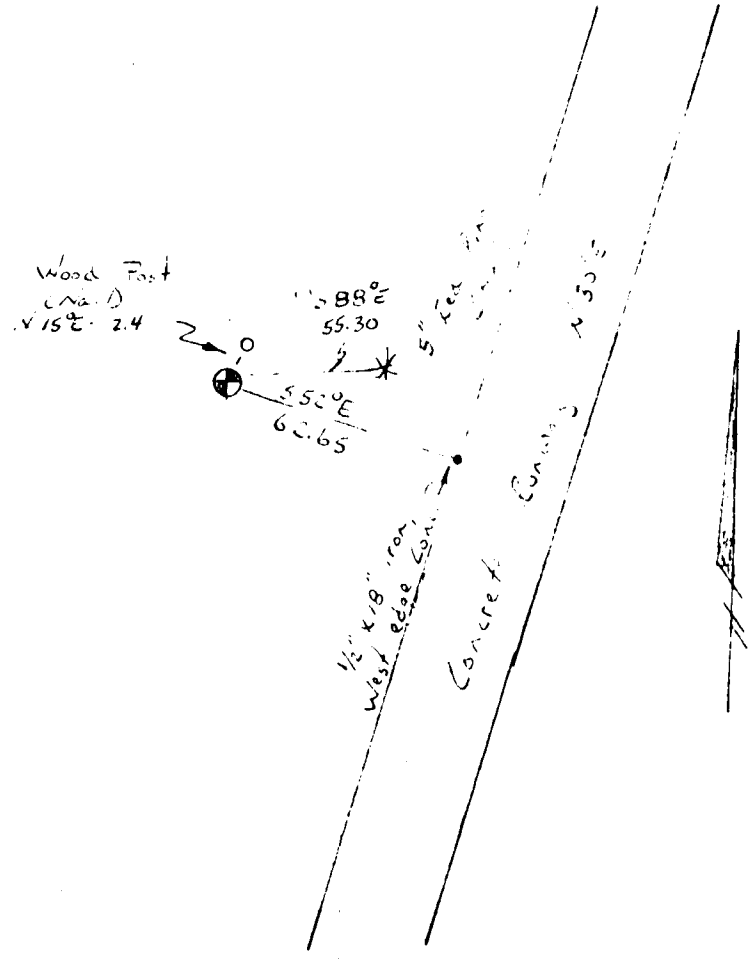
* Note: Set Wood Post (Nail) S 40° W - 1.5'

Control Monument

Corner is a 2½" O.D x 4 Galvanized iron Pipe with a stamped brass cap.



Tue 01/20/0
LEWITAI
Snow / 15°



1/4 Cor. Secs 21/28 T46N R4W

1926 GLO Dependent Resurvey
set an iron post, 3' long
1" dia, 27" in the ground
with marked cross cut
" Jack Pine 6" N53°W 15.0' (Gone)
Jack Pine 5" S20°30W [illegible] (S.B.)

1987: - Found 1926 GLO monument, 12" below surface. Monument facing south. Monument appeared not to be disturbed.

- Found 1 1926 GLO Bearing tree, scribing barely visible

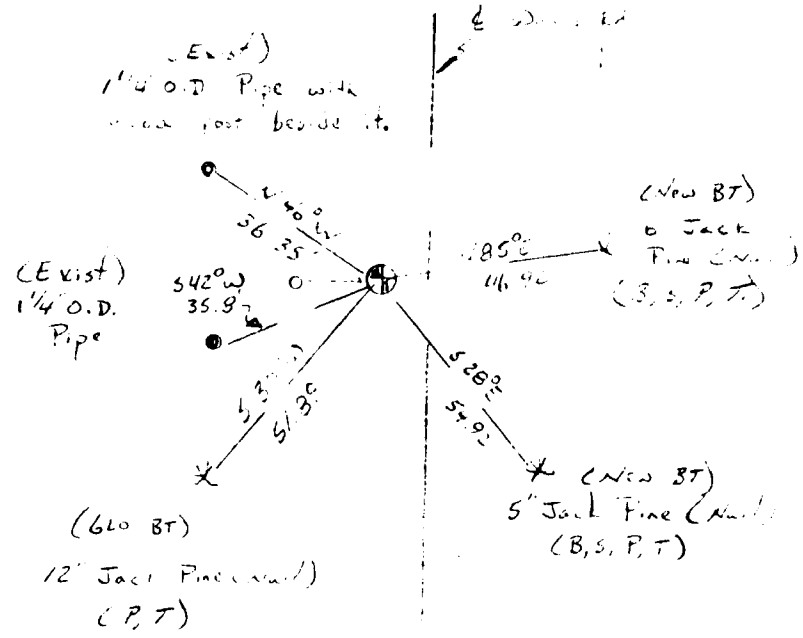
- Placed nail in side of GLO bearing tree

- Found 1¼" O.D. Pipe with wood post beside it in the NW Quad

(4)

Tue 01/20/87
LEW/TAP
Snow/15°

Corner is a [illegible] with a stamped brass cap [illegible] below surface. Corner [illegible] approx 6 [illegible] of ℄ [illegible] wooden [illegible]



Note: Set wood Post (Nail) with monument sign - west - 14.7'

APPENDIX G

CHAIN OF CUSTODY FORMS

ENVIRODYNE ENGINEERS
12161 Lockland Rd.
ST. Louis, MO 63146
(314) 434-6960

CUSTODY TRANSFER RECORD/LABORATORY WORK REQUEST

PROJECT NUMBER: 3067-4002 DATE WORK IN: 1-14-87 REPORT TO: TML Page 1 of 2

REQUESTED BY: STL COE RECEIVED BY: G. YOUNG DATE REQUIRED: 2-14-87

SPECIAL INSTRUCTIONS: METALS = As, Ba, Cr, Cd, Pb, Ag, Mg, Se

SAMPLE IDENTIFICATION						ANALYSES REQUESTED										
ITEM	LAB NO.	SITE CODE/ SAMPLE DESCRIPTION	DATE COLLECTED	PRESERV.	CONTAINER	VOAGLNS	TOTAL METALS	DISSOLVED METALS	PCB							COMMENTS
1		RB-7 SILO 26	1-13-87	COLD	2x40ml	X										
2				HNO3	1xqt pl		X									
3								X								
4				COLD	2x literamb				X							
5		RB-7 DUP SILO 26			2x40ml	X										
6				HNO3	1xqt pl		X									
7								X								
8				COLD	2x literamb				X							
9	87000136	RB-7 SAMPLING BLANK			2x40ml	X										
10				HNO3	1xqt pl		X									
11								X								
12				COLD	2x literamb				X							
13		RG-1 WELL 1			2x40ml	X										
14	87000137			HNO3	1xqt pl		X									
15								X								
16	87000137			COLD	2x literamb				X							

Client decided not to have these sites analyzed.

ITEMS TRANSFERRED	RELINQUISHED BY	Date	Time	RECEIVED BY	Date	Time	REASON for TRANSFER
#12, 16	Will Ewing	1/20/87	930	Keith Hartpence	1-20-87	10:00	PCB
10, 11, 14, 15	Greg Young	1-22-87	1530	R. Jones	1-22-87	3:55	metals
9, 13	Greg Young	1-28-87	1700	B. Beard	1-28-87	4:30	gems
9, 13	B. Beard	2-3-87	0840	Will Ewing	2/3/87	830	STORAGE

DISTRIBUTION: WHITE - Sample Custodian PINK - Project Manager
YELLOW - Records GOLD - Field Copy

ENVIRODYNE ENGINEERS
12161 Lockland Rd.
ST. Louis, MO 63146
(314) 434-6960

CUSTODY TRANSFER RECORD/LABORATORY WORK REQUEST

PROJECT NUMBER: 3067-400-04 DATE WORK IN: 1-14-87 REPORT TO: TML Page 2 of 2

REQUESTED BY: STL COE RECEIVED BY: D. Young DATE REQUIRED: 2-14-87

SPECIAL INSTRUCTIONS: METALS = SEE PAGE 1

SAMPLE IDENTIFICATION						ANALYSES REQUESTED										
ITEM	LAB NO.	SITE CODE/ SAMPLE DESCRIPTION	DATE COLLECTED	PRESERV.	CONTAINER	VOA&CMS	T. METALS	DISSOLVED METALS	PCB							COMMENTS
1	87000138	RG-1 SPLIT WELL 1	1-13-87	COLD	2x40ml	X										
2				HNO3	1xqtpl		X									
3								X								
4				COLD	2xliteramb				X							
5	87000139	RG-4 WELL 4			2x40ml	X										
6				HNO3	1xqtpl		X									
7								X								
8				COLD	2xliteramb				X							
9	87000140	TRAVEL BLANK			2x40ml	X										
10																
11																
12																
13																
14																
15																
16																

ITEMS TRANSFERRED	RELINQUISHED BY	Date	Time	RECEIVED BY	Date	Time	REASON for TRANSFER
#4,8	Will Cin	1/20/87	930	Keith Hartupee	1-20-87	10:00	PCB
2,3,6,7	Greg Young	1-22-87	1530	R. Jones	1-22-87	3:57	Metals
1,5,9	Greg Young	1-28-87	1700	B. Beard GKY			GCMS
1,5,9	B. Beard	2-3-87	0840	Will Cin	2/3/87	830	STORAGE

DISTRIBUTION: WHITE – Sample Custodian PINK – Project Manager
YELLOW – Records GOLD – Field Copy

ENVIRODYNE ENGINEERS
12161 Lackland Rd.
St. Louis, MO 63146
(314) 434-6960

CUSTODY TRANSFER RECORD/LABORATORY WORK REQUEST

PROJECT NUMBER: 3067-40024 DATE WORK IN: 1/13/87 REPORT TO: _____ Page 1 of 1

REQUESTED BY: STL COE RECEIVED BY: _____ DATE REQUIRED: _____

SPECIAL INSTRUCTIONS: (1) PurgeABLE AROMATICS/HALOCARBONS (2) Total METALS (8 Analysis) (3) Dissolved METALS (8 Analysis)

SAMPLE IDENTIFICATION						ANALYSES REQUESTED										
ITEM	LAB NO.	SITE CODE/ SAMPLE DESCRIPTION	DATE COLLECTED	PRESERV.	CONTAINER	PETRO HYDRO CARBON	(1)	(2)	(3)	PCBs						COMMENTS
1		RG-1 WELL #1	1/13/87	HCl	2x QTGl	X										PETROLEUM HydroCARBON
2		RG-1		cold	2x 40mlV		X									
3		RG-1		HNO_3	1 QTPl			X								As, Ba, Cd, Cr, Pb, Ag, Mg, Se
4		RG-1							X							" " " " " " " "
5		RG-1		cold	1l AmB					X						
6		RG-1 split WELL #1		HCl	2x QTGl	X										PETROLEUM HydroCARBONS
7		RG-1		cold	2x 40mlV		X									
8		RG-1		HNO_3	1 QTPl			X								As, Ba, Cd, Cr, Pb, Ag, Mg, Se
9		RG-1							X							" " " " " " " "
10		RG-1		cold	1l AmB					X						
11		RG-4 WELL #4		HCl	2x QTGl	X										PETROLEUM HydroCARBONS
12		RG-4		cold	2x 40mlV		X									
13		RG-4		HNO_3	1 QTPl			X								As, Ba, Cd, Cr, Pb, Ag, Mg, Se
14		RG-4							X							" " " " " " " "
15		RG-4		cold	1l AmB					X						
16		TRAVEL BLANK		cold	2x 40mlV		X									

ITEMS TRANSFERRED	RELINQUISHED BY	Date	Time	RECEIVED BY	Date	Time	REASON for TRANSFER
1-16	JRT	1/13		Greg Young	1-14-87	1300	Analysis

Split samples Refused LARRY Burkhart JRT

DISTRIBUTION: WHITE - Sample Custodian YELLOW - Records PINK - Project Manager GOLD - Field Copy

BARBOYNE ENGINEERS
[illegible] Lemsford Rd
St Louis, MO 63146
(314) 434-6960

CUSTODY TRANSFER RECORD/LABORATORY WORK REQUEST

PROJECT NUMBER: 3067 40024 DATE WORK IN: 1-13-87 REPORT TO: _____ Page 1 of 1

REQUESTED BY: ST COE RECEIVED BY: _____ DATE REQUIRED: _____

SPECIAL INSTRUCTIONS: (1) Purgeable Aromatics/Halocarbons (2) Total Metals (8 Analysis) (3) Dissolved Metals (8 Analysis)

SAMPLE IDENTIFICATION						ANALYSES REQUESTED										
ITEM	LAB NO.	SITE CODE/ SAMPLE DESCRIPTION	DATE COLLECTED	PRESERV.	CONTAINER	PETRO Hydrocarbon	(1)	(2)	(3)	PCBs						COMMENTS
1		RB-7 silo #26	1/13/87	HCl	2x QTGl	X										Petroleum Hydrocarbons
2		RB-7		cold	2x 40ml V		X									
3		RB-7		HNO_3	1 QTPl			X								As, Ba, Cr, Cd, Pb, Ag, Mg, Se
4		RB-7		↓	1 QTPl				X							" " " " " " " "
5		RB-7		cold (2x)	1 l AmB					X						
6		RB-7 Dup silo #26		HCl	2x QTGl	X										Petroleum Hydrocarbons
7		RB-7 Dup		cold	2x 40ml V		X									
8		RB-7 Dup		HNO_3	1 QTPl			X								As, Ba, Cr, Cd, Pb, Ag, Mg, Se
9		RB-7 Dup		↓	↓ ↓				X							" " " " " " " "
10		RB-7 Dup		cold (2x)	1 l AmB					X						
11		RB-7 sampling Blank		HCl	2x QTGl	X										Petroleum Hydrocarbons
12		RB-7 silo #26		cold	2x 40ml V		X									
13		RB-7		HNO_3	1 QTPl			X								As, Ba, Cr, Cd, Pb, Ag, Mg, Se
14		RB-7		↓	↓ ↓				X							" " " " " " " "
15		RB-7		cold (2x)	1 l AmB					X						
16																

ITEMS TRANSFERRED	RELINQUISHED BY	Date	Time	RECEIVED BY	Date	Time	REASON for TRANSFER
1-15	JRT	1/13		Greg Young	1-14-87	1300	Analysis

Samples refused / ARRV Punkhurst [illegible]

DISTRIBUTION: WHITE - Sample Custodian; YELLOW - Records; PINK - Project Manager; GOLD - Field Copy

ENVIRODYNE ENGINEERS
12161 Lockland Rd.
ST. Louis, MO 63146
(314) 434-6960

CUSTODY TRANSFER RECORD/LABORATORY WORK REQUEST

PROJECT NUMBER: 3067-40024 DATE WORK IN: 1-16-87 REPORT TO: TML Page 1 of 1

REQUESTED BY: STL USACOE RECEIVED BY: G YOUNG DATE REQUIRED: 2-13-87

SPECIAL INSTRUCTIONS: METALS = As, Ag, Ba, Cr, Cd, Pb, Mg, Se

SAMPLE IDENTIFICATION						ANALYSES REQUESTED										
ITEM	LAB NO.	SITE CODE/ SAMPLE DESCRIPTION	DATE COLLECTED	PRESERV.	CONTAINER	VOAGCMS	TOTAL METALS	DISSOLVED METALS	PCB							COMMENTS
1	87000190	RG-2 WELL 2	1-15-87	COLD	2x40ml	X										
2				HNO3	1xqt pl		X									
3								X								
4				COLD	2x liter amb				X							
5	87000191	RG-3 WELL 3			2x40ml	X										
6				HNO3	1xqt pl		X									
7								X								
8				COLD	2x liter amb				X							
9																
10																
11																
12																
13																
14																
15																
16																

ITEMS TRANSFERRED	RELINQUISHED BY	Date	Time	RECEIVED BY	Date	Time	REASON for TRANSFER
#4,8	Willi Ewin	1/20/87	930	[illegible]	1-20-87	10:00	PCB
2,3,6,7	Greg Young	1-22-87	1530	R. Jones	1-22-87	3:57	[illegible]
1,5	Greg Young	1-28-87	1700	B. Baird	1-28-87	4:30	[illegible]
1,5	B. Baird	2-3-87	0840	Willi Ewin	2/3/87	830	STORAGE

DISTRIBUTION: WHITE - Sample Custodian PINK - Project Manager
YELLOW - Records GOLD - Field Copy

ENVIRODYNE ENGINEERS
12161 Lockland Rd.
ST. Louis, MO 63146
(314) 434-6960

CUSTODY TRANSFER RECORD/LABORATORY WORK REQUEST

PROJECT NUMBER: 30674 0025 DATE WORK IN: _____ REPORT TO: _____ Page 1 of 1

REQUESTED BY: STL COC RECEIVED BY: _____ DATE REQUIRED: _____

SPECIAL INSTRUCTIONS (1) Purgeable Halocarbons (Aromatics
(2) Total Metals (8 Analyses) (3) Dissolved Metals (8 Analyses)

SAMPLE IDENTIFICATION						ANALYSES REQUESTED										
ITEM	LAB NO.	SITE CODE/ SAMPLE DESCRIPTION	DATE COLLECTED	PRESERV.	CONTAINER	(1)	Petro Hydro	(2)	(3)	PCB						COMMENTS
1		RG-2 WELL # 2	1/15/87 900	Cold	2x 40ml V.	X										
2		RG-2		HCl	2x QTGl		X									PETROLEUM HYDROCARBONS
3		RG-2		HNO_3	QTPl			X								As, Ba, Cr, Cd, Ag, Hg, Pb, Se
4		RG-2							X							" " " " " " " "
5		RG-2		Cold	2x 1l AmB					X						
6		RG-3 WELL # 3	23:	Cold	2x 40ml V	X										
7		RG-3		HCl	2x QTGl		X									PETROLEUM HYDROCARBONS
8		RG-3		HNO_3	QTPl			X								As, Ba, Cr, Cd, Ag, Hg, Pb, Se
9		RG-3							X							" " " " " " " "
10		RG-3		Cold	2x 1l AmB					X						
11																
12																
13																
14																
15																
16																

ITEMS TRANSFERRED	RELINQUISHED BY	Date	Time	RECEIVED BY	Date	Time	REASON for TRANSFER
1-10	JR 1	1/15	1700	Greg Young	1-16-87	1315	Analysis
2,7	Greg Young	1-16-87	1500	AQUA TECH	1-16	1500	G+O Analysis

Split Samples Refused LARRY Burkhart JR 1

DISTRIBUTION: WHITE - Sample Custodian PINK - Project Manager
YELLOW - Records GOLD - Field Copy

DERA-RACO

ENVIRODYNE ENGINEERS
12161 Lackland Rd.
ST. Louis, MO 63146
(314) 434-6960

CUSTODY TRANSFER RECORD/LABORATORY WORK REQUEST

PROJECT NUMBER: 3067 40025 DATE WORK IN: 12-4-86 REPORT TO: MYERS Page 1 of 3

REQUESTED BY: STL CUE RECEIVED BY: G. YOUNG DATE REQUIRED: 2-6-87

SPECIAL INSTRUCTIONS: (1) Purgeable Halocarbons/Aromatics
(2) METALS: Arsenic, Barium, Cadium, Chromium, LEAD, Mercury, Selenium, Silver

ITEM	LAB NO.	SITE CODE/ SAMPLE DESCRIPTION	DATE COLLECTED	PRESERV.	CONTAINER	(1)	PET Hydrocarbons	Total Metals	Dissolved Metals	PCBs						COMMENTS
1	8600404 5	RB-1 Surface Water	12/3/86	Cold	2x40ml Vial	X										
2		RB-1		HCl	2x QT. Glass		X									Petroleum Hydrocarbons
3		RB-1		HNO_3	QT PL			X								Ba, Cr, Cd, As, Ag, Hg, Se, Pb
4		RB-1		↓	↓ ↓				X							" " " " " " " "
5		RB-1		Cold	QT Amber					X						CONSUMED IN PREP
6	8600404 6	RB-2		↓	2x 40ml Vial	X										
7		RB-2		HCl	2x QT Glass		X									Petroleum Hydrocarbons
8		RB-2		HNO_3	QT PL			X								Pb, Ba, Cd, Cr, Pb, Hg, Se, Ag
9		RB-2		↓	↓ ↓				X							" " " " " " " "
10		RB-2		Cold	QT Amber					X						CONSUMED IN PREP
11	8600404 7	RB-3		↓	2x 40ml Vial	X										
12		RB-3		HCl	2x QT Gl		X									Petroleum Hydrocarbons
13		RB-3		HNO_3	QT PL			X								Pb, Ba, Cd, Cr, Pb, Hg, Se, Ag
14		RB-3		↓	↓ ↓				X							" " " " " " " "
15		RB-3		Cold	QT Amb					X						CONSUMED IN PREP
16																

ITEMS TRANSFERRED	RELINQUISHED BY	Date	Time	RECEIVED BY	Date	Time	REASON for TRANSFER
1-15	JPT	12/3	400	Guy Young	12-4-86	800	Analysis
7	Guy Young	12-4-86	1600	TIND. TEST	12-4	1600	Analysis
5,10,15	[illegible]	12/9	1045	K. McGill	12/9	1045	PCB
1,6,11	[illegible]	12/11	1545	J. Hang	12/11	1545	GC/MS Analysis
2,12,7	Willie Eviman	12/17	915	[illegible]	12/17	9:30	[illegible]

Samples splits refused / [illegible] Burkhart

DISTRIBUTION: WHITE – Sample Custodian PINK – Project Manager

DERA-KACO

ENVIRODYNE ENGINEERS
12161 Lackland Rd.
ST. Louis, MO 63146
(314) 434-6960

CUSTODY TRANSFER RECORD/LABORATORY WORK REQUEST

PROJECT NUMBER: 3067-40025 DATE WORK IN: 12-4-86 REPORT TO: Myers Page 2 of 3

REQUESTED BY: STL COE RECEIVED BY: G. Young DATE REQUIRED: 2-6-87

SPECIAL INSTRUCTIONS: (1) Purgeable Halocarbons/Aromatics
(2) METALS: Barium, Cadium, Arsenic, Chromium, Lead, mercury, Selenium, Silver

ITEM	LAB NO.	SITE CODE/ SAMPLE DESCRIPTION	DATE COLLECTED	PRESERV.	CONTAINER	(1) Halocarbons	Petr. Hydr.	(2) Total Solid Metals	As	PCB						COMMENTS
1		RB-4 Surface H_2O	12/3/86	Cold	2x 40ml V.AL	X										
2	8604048	RB-4		HCl	1x QT GL		X									PETROLEum HydroCARBON
3		RB-4		HNO_3	QT PL			X								BA, As, Cr, Cd, Pb, Hg, Se, Ag
4		RB-4		↓	↓ ↓				X							" " " " " " " "
5		RB-4		Cold	QT AMBER					X						CONSUMED IN PROD
6		RB-5		↓	2x 40ml V.AL	X										
7	8604049	RB-5		HCl	1x QT GL		X									PETROLEum HydroCARBON
8		RB-5		HNO_3	QT PL			X								Ba, As, Cr, Cd, Pb, Hg, Se, Ag
9		RB-5		↓	↓ ↓				X							" " " " " " " "
10		RB-5		Cold	QT Amber					X						CONSUMED IN PROD
11		RB-6		↓	2x 40ml V.AL	X										
12	8604050	RB-6		HCl	1x QT GL		X									PETROLEum HydroCARBON
13		RB-6		HNO_3	QT GL			X								Ba, As, Cr, Cd, Pb, Hg, Se, Ag
14		RB-6		↓	↓ ↓				X							" " " " " " " "
15		RB-6		Cold	QT AMBER					X						CONSUMED IN PROD
16																

ITEMS TRANSFERRED	RELINQUISHED BY	Date	Time	RECEIVED BY	Date	Time	REASON for TRANSFER
1-15	JRT	12/3	400	[illegible]	12486	800	Analysis
5,10,15	[illegible]	12/9	1045	[illegible]	12/9	1045	PCB
1,6,11	[illegible]	12/11	1545	[illegible]	12/11	1545	GC/MS Analysis
2,7,12	Willi Eisman	12/17	915	[illegible] GKU	12/17		

Samples splits Refused / Larry Burtchaer

DISTRIBUTION: WHITE – Sample Custodian YELLOW – Records PINK – Project Manager GOLD – Field Copy

DERA-RACO

ENVIRODYNE ENGINEERS
12161 Lockland Rd.
ST. Louis, MO 63146
(314) 434-6960

CUSTODY TRANSFER RECORD/LABORATORY WORK REQUEST

PROJECT NUMBER: 3067 90025 DATE WORK IN: 12-4-86 REPORT TO: TML Page 3 of 3

REQUESTED BY: STL GOE RECEIVED BY: G. YOUNG DATE REQUIRED: 2-6-87

SPECIAL INSTRUCTIONS: ① Purgeable Halocarbons/Aromatics
② Metals: Barium, Cadium, Chromium, Arsenic, Lead, Mercury, Selenium, Silver

SAMPLE IDENTIFICATION / ANALYSES REQUESTED

ITEM	LAB NO.	SITE CODE/ SAMPLE DESCRIPTION	DATE COLLECTED	PRESERV.	CONTAINER	①	Pet Hyd	Total Metals ②	Diss Metals ②	BTEX						COMMENTS
1		WELL Installation WATER	12/3/86 300	Cold	2x40ml V.Ac	X										
2	8600451	↓	↓	HCl	2x QT Gl		X									Petroleum Hydrocarbon
3		↓	↓	HNO_3	QT Pl			X								Ba, Cr, Cd, As, Pb, Hg, Ag, Se
4		↓	↓	↓	↓ ↓				X							" " " " " " " "
5		↓	↓	Cold	QT Amber					X						CONSUMED IN PREP
6																
7																
8																
9																
10																
11																
12																
13																
14																
15																
16																

ITEMS TRANSFERRED	RELINQUISHED BY	Date	Time	RECEIVED BY	Date	Time	REASON for TRANSFER
1-5	JRT	12/3	4:00	Greg Young			
5	[illegible]	12/9	1030	K McGill	12/9	1030	K.B
1	[illegible]	12/11	1945	J Hann	12/11	1945	GC/MS Analysis
2	Walter Eisman	12/17	915	[illegible]	12/17	9:30	G&O

Sample splits Refused LACCY Buckhart

DISTRIBUTION: WHITE – Sample Custodian PINK – Project Manager YELLOW – Records GOLD – Field Copy

ENVIRODYNE ENGINEERS
12161 Lackland Rd.
St. Louis, MO 63146
(314) 434-6960

CUSTODY TRANSFER RECORD/LABORATORY WORK REQUEST

PROJECT NUMBER: 3041-40024 DATE WORK IN: 1/15/87 REPORT TO: TML Page 1 of 1

REQUESTED BY: STL COE RECEIVED BY: [signature] DATE REQUIRED: 2-15-87

SPECIAL INSTRUCTIONS: (1) Purgeable Halocarbons/Aromatics (2) Total Metals (8 Parameters) (3) Petroleum Hydrocarbons

SAMPLE IDENTIFICATION						ANALYSES REQUESTED									
ITEM	LAB NO.	SITE CODE/ SAMPLE DESCRIPTION	DATE COLLECTED	PRESERV.	CONTAINER 2x40ml Vial	(1)	(2)	(3)	PCBs						COMMENTS
1		RS-1 Transformer	1/14/87	Cold	[illegible]	X									
2	87000159	RS-1 (Soil) PAD			250cc AmB		X								As, Ba, Cr, Cd, Mg, Ag, Pb, Se
3		RS-1						X							
4		RS-1			40ml Vial				X						
5		RS-1 Split			2x40ml V	X									
6	87000160	RS-1			250cc AmB		X								As, Ba, Cr, Cd, Mg, Ag, Pb, Se
7		RS-1						X							
8		RS-1			40ml V				X						
9															
10															
11															
12															
13															
14															
15															
16															

ITEMS TRANSFERRED	RELINQUISHED BY	Date	Time	RECEIVED BY	Date	Time	REASON for TRANSFER
1-8	TTC	1/14	1700	[signature]	1/15	1500	ANALYSIS
3,7	Greg Young	1-16-87	1350	AQUA TECH	1-16	1350	Analysis
4,8	Greg Young	1-22-87	1115	D. Nuske	1/22/87	1120	PCB Prep
4,8	Dan Nuske	1/23/87	930	Will [illegible]	1/23/87	930	STORAGE
2,6	Greg Young	1-22-87	1530	R. Jones	1/22/87	3:57	metals

Split samples Refused LARRY Burkhart

DISTRIBUTION: WHITE - Sample Custodian PINK - Project Manager YELLOW - Records GOLD - Field Copy

CUSTODY TRANSFER RECORD/LABORATORY WORK REQUEST

ENGINEERS
11401 Lackland Rd.
St. Louis, MO 63146
(314) 434-6960

PROJECT NUMBER: 3067-40024 DATE WORK IN: 1/15/87 REPORT TO: TML Page 1 of 1

REQUESTED BY: STL-COE RECEIVED BY: [illegible] DATE REQUIRED: 2-15-87

SPECIAL INSTRUCTIONS: (1) Purgeable Halocarbons/Aromatics (2) Petroleum Hydrocarbons (3) Total Metals (8 Parameters)

SAMPLE IDENTIFICATION						ANALYSES REQUESTED									
ITEM	LAB NO.	SITE CODE/ SAMPLE DESCRIPTION	DATE COLLECTED	PRESERV.	CONTAINER	(1)	(2)	(3)	PCB's						COMMENTS
1	87000161	RS-8 RINSATE	1/14/87	Cold	2x40ml V	X									
2		RS-8		HCl	2xQT G1		X								
3		RS-8		HNO_3	QT P1			X							As, Ba, Cr, Cd, Mg, Ag, Pb, Se
4		RS-8		Cold	2x1l AMB				X						
5	87000162	RS-8 C-4 50:1			2x40ml V	X									
6		RS-8			250cc AMB		X								
7		RS-8						X							As, Ba, Cr, Cd, Mg, Ag, Pb, Se
8		RS-8			40ml V				X						
9															
10															
11															
12															
13															
14															
15															
16															

ITEMS TRANSFERRED	RELINQUISHED BY	Date	Time	RECEIVED BY	Date	Time	REASON for TRANSFER
1-8	JRT	1/14	1700	[illegible]	1/15	1500	ANALYSIS
2,6	Greg Young	1-16-87	1350	AQUA TECH	1-16	1350	Analysis
#4	Will Eisen	1/20/87	930	Keith Hartupee	1-20-87	10:00	PCB
8	Greg Young	1-22-87	1115	D. Vuoke GKY	1-22	1120	PCB
3,7	Greg Young	1-22-87	1530	R. Jones	1/22	3:57	metals

Split Samples Refused LARRY Buckhart JRT

DISTRIBUTION: WHITE - Sample Custodian PINK - Project Manager YELLOW - Records GOLD - Field Copy

DERA - RACO

ENVIRODYNE ENGINEERS
12161 Lackland Rd.
St. Louis, MO 63146
(314) 434-6960

CUSTODY TRANSFER RECORD/LABORATORY WORK REQUEST

PROJECT NUMBER: 3067-40025 DATE WORK IN: 12-4-86 REPORT TO: MYERS Page 1 of 2

REQUESTED BY: STL COE RECEIVED BY: G. YOUNG DATE REQUIRED: 2-6-87

SPECIAL INSTRUCTIONS: (1) PurgeABLE HydroCARBONS/AROMATICS
(2) Total METALS: ARSENIC, BARIUM, CADMIUM, Chromium, LEAD, MERCURY, SELENIUM, Silver (2)

SAMPLE IDENTIFICATION						ANALYSES REQUESTED										
ITEM	LAB NO.	SITE CODE/ SAMPLE DESCRIPTION	DATE COLLECTED	PRESERV.	CONTAINER	(1)	PCBs	TOTAL METALS	PET. HYD.							COMMENTS
1	8600 4038	RS-4 Soil 22'-26"	12/2/86 9:00	Cold	2x40ml VIAL	X										
2		RS-4			40ml VIAL		X									
3		RS-4			250ml AMB			X								Ba, Cd, Cr, Ag, Hg, Pb, Se, As
4		RS-4							X							PETROLEUM HYDROCARBON
5	8600 4039	RS-5	1030		2x40ml VIAL	X										
6		RS-5			40ml VIAL		X									
7		RS-5			250ml AMB			X								Ba, Cd, Cr, Ag, Hg, Pb, Se, As
8		RS-5							X							PETROLEUM HYDROCARBON
9	8600 4040	RS-6	1100		2x40ml VIAL	X										
10		RS-6			40ml VIAL		X									
11		RS-6			250ml AMB			X								Ba, Cd, Cr, Ag, As, Hg, Pb, Se
12		RS-6							X							PETROLEUM HYDROCARBON
13	8600 4041	RS-7	1130		2x40ml VIAL	X										
14		RS-7			40ml VIAL		X									
15		RS-7			250ml AMB			X								Ba, Cd, Cr, Ag, As, Hg, Pb, Se
16		RS-7							X							PETROLEUM HYDROCARBON

ITEMS TRANSFERRED	RELINQUISHED BY	Date	Time	RECEIVED BY	Date	Time	REASON for TRANSFER
1-16	JRT	12/2	3:30	Greg Young	12-4-86	1300	Analysis
4, 8, 12, 16	Greg Young	12-4-86	1600	INB. TEST.	12-4	1600	Analysis
2, 6, 10, 14	[illegible]	12/10	820	K. M. Gill	12-10-86	820	PCB's
1, 5, 9, 13	[illegible]	12/11	1545	J. Hann	12/11	1545	GC/MS Analyses
1, 5, 9, 13	J. Hann	12/17	10:20	Willie [illegible]	12/17	1020	STORAGE

Samples splits Refused [illegible]

DISTRIBUTION: WHITE - Sample Custodian PINK - Project Manager

DERA - RACO

WRODYNE ENGINEERS
12161 Lackland Rd.
ST. Louis, MO 63146
(314) 434-6960

CUSTODY TRANSFER RECORD/LABORATORY WORK REQUEST

PROJECT NUMBER: 3067-40025 DATE WORK IN: 12-4-86 REPORT TO: MYERS Page 2 of 2

REQUESTED BY: STL COE RECEIVED BY: G. YOUNG DATE REQUIRED: 2-6-87

SPECIAL INSTRUCTIONS: (1) Purgeable Hydrocarbons/Aromatics
(2) Total Metals: Arsenic, Barium, Cadium, Chromium, Lead, Mercury, Selenium, Silver

SAMPLE IDENTIFICATION							ANALYSES REQUESTED									
ITEM	LAB NO.	SITE CODE/ SAMPLE DESCRIPTION	DATE COLLECTED	PRESERV.	CONTAINER		(1)	PCB's	(2) Total METALS	PETROLEUM Hydro						COMMENTS
1	86004042	RS-2 Soil 22"-26"	12/2/86 130	Cold	2x40ml VIAL		X									
2		RS-2			40ml VIAL			X								
3		RS-2			250ml AMB				X							Ba, Cd, Cr, Pb, As, Ag, Hg, Se
4		RS-2								X						PETROLEUM Hydro CARBON
5	86004043	RS-3	200		2x40ml VIAL		X									
6		RS-3			40ml VIAL			X								
7		RS-3			250ml AMB				X							Ba, Cd, Cr, Pb, As, Ag, Hg, Se
8		RS-3								X						PETROLEUM Hydro CARBON
9	86004044	RS-9	230		2x40ml VIAL		X									
10		RS-9			40ml VIAL			X								
11		RS-9			250ml AMB				X							Ba, Cd, Cr, Pb, As, Ag, Hg, Se
12		RS-9								X						PETROLEUM Hydro CARBON
13																
14																
15																
16																

ITEMS TRANSFERRED	RELINQUISHED BY	Date	Time	RECEIVED BY	Date	Time	REASON for TRANSFER
1-12	JRT	12/2	330	Greg Young	12-4-86	130	Analysis
4, 8, 12	Greg Young	12-4-86	1600	J. WILTEST	12-4	1600	Analysis
2, 6, 10	[illegible]	12/10	820	L McGee	12/10	820	PCB's
1, 5, 9	[illegible]	12/11	1545	J. Hamm	12/11	1545	GC/MS Analyses
1, 5, 9	J. Hamm	12/17	1020	[illegible]	12/17	1020	STORAGE

Sample splits Refused
LARRY Burkhart JRT

DISTRIBUTION: WHITE - Sample Custodian PINK - Project Manager
YELLOW - Records GOLD - Field Copy

APPENDIX H

ANALYTICAL RESULTS

ENVIRODYNE
ENGINEERS

12161 Lackland Road,
St. Louis, Missouri 63146
(314) 434-6960

March 20, 1987
3067-40024

Mr. John B. Hallquist
Authorized Representative of the Contracting Officer
US Army Corps of Engineers
St. Louis District
210 North Tucker Boulevard
St. Louis, Missouri 63101

Re: Delivery Order No. 4
Contract DACA 87-86-D-0045
Results of Laboratory Analyses

Dear Mr. Hallquist:

Enclosed please find results of all laboratory analyses of field samples and QA/QC samples for the Subject Delivery Order.

Very truly yours,

Thomas M. Lachajczyk

Thomas M. Lachajczyk
Program Manager

TML/jag

cc: HNDED-PM
MRDED-L

SUMMARY OF ANALYTICAL RESULTS
FORMER BOMARC MISSILE SITE
ARCO, MICHIGAN

	PETROLEUM HYDROCARBONS	METALS																PCB's
		ARSENIC		BARIUM		CADMIUM		CHROMIUM		LEAD		MERCURY		SELENIUM		SILVER		
		T	D	T	D	T	D	T	D	T	D	T	D	T	D	T	D	
SOIL SAMPLING SITES:																		
RS-1 TRANSFORMER PAD	8310	1.48	———	8.4	———	(1	———	4.3	———	(5	———	(0.2	———	(0.32	———	(0.2	———	(22
RS-1 SPLIT	8530	1.15	———	8.7	———	(1	———	3.1	———	(5	———	(0.2	———	(0.32	———	(0.2	———	(22
RS-2	62	1.44	———	7.3	———	(1	———	4.9	———	12.4	———	(0.2	———	(0.32	———	(0.2	———	(22
RS-3	36	(0.35	———	(5	———	(1	———	3.1	———	(5	———	(0.2	———	(0.32	———	(0.2	———	(22
RS-4	28	0.80	———	5.9	———	(1	———	2.1	———	(5	———	(0.2	———	(0.32	———	(0.2	———	(22
RS-5	40	0.56	———	5.8	———	(1	———	2.3	———	(5	———	(0.2	———	(0.32	———	(0.2	———	(22
RS-6	46	0.47	———	8.1	———	(1	———	2.8	———	(5	———	(0.2	———	(0.32	———	(0.2	———	(22
RS-7	264	0.64	———	6.3	———	(1	———	2.4	———	(5	———	(0.2	———	(0.32	———	(0.2	———	(22
RS-8	63	1.06	———	6.1	———	(1	———	3.0	———	(5	———	(0.2	———	(0.32	———	(0.2	———	(22
RS-9 (BACKGROUND)	24	0.71	———	5.0	———	(1	———	2.9	———	(5	———	(0.2	———	(0.32	———	(0.2	———	(22
WATER SAMPLING SITES:																		
RS-8 RINSATE	0.5	(0.0035	———	(0.005	———	(0.001	———	(0.005	———	(0.005	———	(0.2	———	(0.0021	———	(0.0014	———	(0.22
RS-1	5.0	(0.0035	(0.0035	0.008	0.008	(0.001	(0.001	(0.005	(0.005	0.010	(0.005	(0.2	(0.2	(0.0021	(0.0021	(0.0014	(0.0014	(0.22
RS-2	3.7	(0.0035	(0.0035	(0.005	(0.005	(0.001	(0.001	(0.005	(0.005	0.011	0.006	(0.2	(0.2	(0.0021	(0.0021	(0.0014	(0.0014	(0.22
RS-3	4.0	(0.0035	(0.0035	0.015	0.013	(0.001	(0.001	(0.005	(0.005	0.019	0.006	(0.2	(0.2	(0.0021	(0.0021	(0.0014	(0.0014	(0.22
RS-4	1810	(0.0035	(0.0035	(0.005	(0.005	(0.001	(0.001	(0.005	(0.005	0.018	0.009	(0.2	(0.2	(0.0021	(0.0021	(0.0014	(0.0014	(0.22
RS-5	2.4	(0.0035	(0.0035	(0.005	(0.005	(0.001	(0.001	(0.005	(0.005	0.014	0.010	(0.2	(0.2	(0.0021	(0.0021	(0.0014	(0.0014	(0.22
RS-6	1.7	(0.0035	(0.0035	0.006	0.008	(0.001	(0.001	(0.005	(0.005	0.012	0.014	(0.2	0.23	(0.0021	(0.0021	(0.0014	(0.0014	(0.22
RS-7 SAMPLING BLANK	(0.5	(0.0035	(0.0035	(0.005	(0.005	(0.001	(0.001	(0.005	(0.005	(0.005	(0.005	(0.2	(0.2	(0.0021	(0.0021	(0.0014	(0.0014	(0.22
RS-1	(0.5	(0.0035	(0.0035	0.044	0.019	(0.001	(0.001	(0.005	(0.005	(0.005	(0.005	(0.2	(0.2	(0.0021	(0.0021	(0.0014	(0.0014	(0.22
RS-1 SPLIT	(0.5	(0.0035	(0.0035	0.062	0.019	(0.001	(0.001	0.006	(0.005	0.009	(0.005	(0.2	(0.2	(0.0021	(0.0021	(0.0014	(0.0014	(0.22
RS-2	(0.5	(0.0035	(0.0035	0.029	0.026	(0.001	(0.001	(0.005	(0.005	(0.005	(0.005	(0.2	(0.2	(0.0021	(0.0021	(0.0014	(0.0014	(0.22
RS-3	1.8	(0.0035	(0.0035	0.078	0.071	(0.001	(0.001	(0.005	(0.005	(0.005	(0.005	(0.2	(0.2	(0.0021	(0.0021	(0.0014	(0.0014	(0.22
RS-4	(0.5	(0.0035	(0.0035	0.019	0.012	(0.001	(0.001	(0.005	(0.005	(0.005	(0.005	(0.2	(0.2	(0.0021	(0.0021	(0.0014	(0.0014	(0.22
WELL INSTALL. WATER	1.7	(0.0035	(0.0035	0.014	0.013	(0.001	(0.001	(0.005	(0.005	(0.005	0.008	0.87	(0.2	(0.0021	(0.0021	(0.0014	(0.0014	(0.22

NOTES: T = Total Metals (sample not filtered)
D = Dissolved Metals (sample filtered through 0.45 micron filter)
All metals concentrations are in ug/g for soils and mg/l for waters.
PCB concentrations are in ng/g for soils and ug/l for waters.
Petroleum Hydrocarbon concentrations are in ug/g for soils and mg/l for waters.
——— = Not Required

TABLE 4-~~12~~ 10. SUMMARY OF RESULTS OF TESTING AT GROUNDWATER MONITORING WELLS FOR PURGEABLE HALOCARBONS AND AROMATICS
(Results in ug/l)

Parameter	Site: Date:[a]	RG-1 1/29	RG-1 Split 1/28	RG-2 12/15	RG-3 12/15	RG-4 12/19	Well Installation Water 12/17/86	Travel Blank 1/29	Lab Blanks 12/17	Lab Blanks 1/28	Lab Blanks 1/28	Lab Blanks 1/29
Benzene		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Bromoform		<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2
Carbon Tetrachloride		<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
Chlorobenzene		<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6
Chlorodibromomethane		<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Chloroethane		<2.4	<2.4	<2.4	<2.4	<2.4	<2.4	<2.4	<2.4	<2.4	<2.4	<2.4
2-Chloroethylvinyl Ether		<5.9	<5.9	<5.9	<5.9	<5.9	<5.9	<5.9	<5.9	<5.9	<5.9	<5.9
Chloroform		<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8
Dichlorobromomethane		<1.1	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1
1,1-Dichloroethane		<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8
1,2-Dichloroethane		<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
1,1-Dichloroethylene		<1.9	<1.9	<1.9	<1.9	<1.9	<1.9	<1.9	<1.9	<1.9	<1.9	<1.9
1,2-Dichloropropane		<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
1,3-cis-Dichloropropylene		<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
1,3-trans-Dichloropropylene		<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
Ethylbenzene		<0.4	<0.4	<0.4	<0.4	1.5	<0.4	<0.4	1.0	1.0	0.8	1.1
Methyl Bromide		<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
Methyl Chloride		<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6
Methylene Chloride		5.5	4.9	3.5	3.8	4.6	22.0	7.0	14.7	17.1	22.3	10.4
1,1,2,2-Tetrachloroethane		<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4
Tetrachloroethylene		<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
Trichlorofluoromethane		<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3
Toluene		<1.0	<1.0	<1.0	<1.0	1.9	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
1,2-trans-Dichloroethylene		<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
1,1,1-Trichloroethane		<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2
1,1,2-Trichloroethane		<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6
Trichloroethylene		<1.3	<1.3	<1.3	3.0	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3
Trichlorofluoromethane		<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2
Vinyl Chloride		<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2
Unknown					7.3	5.8		6.6	10.0	7.1	6.6	6
2-pentene,3,4,4-trimethyl-					3.4							
1-pentene,2,4,4-trimethyl-					20.8							

NOTE: [a]12/1986 or 1/1987 Date of Analysis

TABLE 4-11. SUMMARY OF RESULTS OF TESTING OF MISSILE SILO SITES FOR PURGEABLE HALOCARBONS AND AROMATICS
(Results in ug/l)

Parameter	Site: Date:[a]	RB-1 12/15	RB-2 12/15	RB-3 12/15	RB-4 12/17	RB-5 12/17	RB-6 12/17	RB-7 Sampling Blank 1/28	RB-7[b]	Travel Blank 1/29	Lab Blanks 12/15	12/17	1/28	1/28	1/29
Benzene		<0.5	<0.5	<0.5	6.0	<0.5	<0.5	<0.5		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Bromoform		<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2		<3.2	<3.2	<3.2	<3.2	<3.2	<3.2
Carbon Tetrachloride		<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5		<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
Chlorobenzene		<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6		<0.6	<0.6	<0.6	<0.6	<0.6	<0.6
Chlorodibromomethane		<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0		<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Chloroethane		<2.4	<2.4	<2.4	<2.4	<2.4	<2.4	<2.4		<2.4	<2.4	<2.4	<2.4	<2.4	<2.4
2-Chloroethylvinyl Ether		<5.9	<5.9	<5.9	<5.9	<5.9	<5.9	<5.9		<5.9	<5.9	<5.9	<5.9	<5.9	<5.9
Chloroform		<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8		<0.8	<0.8	<0.8	<0.8	<0.8	<0.8
Dichlorobromomethane		<1.1	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1		<1.1	<1.1	<1.1	<1.1	<1.1	<1.1
1,1-Dichloroethane		<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8		<0.8	<0.8	<0.8	<0.8	<0.8	<0.8
1,2-Dichloroethane		<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5		<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
1,1-Dichloroethylene		<1.9	<1.9	<1.9	<1.9	<1.9	<1.9	<1.9		<1.9	<1.9	<1.9	<1.9	<1.9	<1.9
1,2-Dichloropropane		<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5		<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
1,3-cis-Dichloropropylene		<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5		<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
1,3-trans-Dichloropropylene		<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5		<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
Ethylbenzene		1.0	<0.4	<0.4	<0.4	1.1	<0.4	0.8		<0.4	1.2	1.1	1.0	1.0	0.8
Methyl Bromide		<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5		<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
Methyl Chloride		<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6		<1.6	<1.6	<1.6	<1.6	<1.6	<1.6
Methylene Chloride		9.7	16.7	8.2	20.4	29.4	12.1	6.2		7.0	22.7	15.2	17.1	14.7	22.3
1,1,2,2-Tetrachloroethane		<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4		<1.4	<1.4	<1.4	<1.4	<1.4	<1.4
Tetrachloroethylene		<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5		<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
Trichlorofluoromethane		<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	3.2		<1.3	<1.3	<1.3	<1.3	<1.3	<1.3
Toluene		<1.0	<1.0	<1.0	1.2	<1.0	<1.0	9.2		<1.0	1.2	<1.0	<1.0	<1.0	<1.0
1,2-trans-Dichloroethylene		<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5		<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
1,1,1-Trichloroethane		<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2		<1.2	<1.2	<1.2	<1.2	<1.2	<1.2
1,1,2-Trichloroethane		<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6		<1.6	<1.6	<1.6	<1.6	<1.6	<1.6
Trichloroethylene		<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3		<1.3	<1.3	<1.3	<1.3	<1.3	<1.3
Trichlorofluoromethane		<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2		<1.2	<1.2	<1.2	<1.2	<1.2	<1.2
Vinyl Chloride		<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2		<1.2	<1.2	<1.2	<1.2	<1.2	<1.2
Additional Peaks:															
Unknown Hydrocarbon											8	6			
Unknown								>5.0		6.6			7.1	10.0	

NOTE: [a]12/1986 or 1/1987 Date of Analysis.
[b]RB-7 not analyzed

TABLE 4-12. SUMMARY OF RESULTS OF TESTING AT SOIL SAMPLING SITES FOR PURGEABLE HALOCARBONS AND AROMATICS
(Results in ng/g)

Parameter	Site: Date:[a]	RS-1 1/29	RS-1 Dup. 1/29	RS-2 12/15	RS-3 12/15	RS-4 12/19	RS-5 12/12	RS-6 12/12	RS-7 12/12	RS-7 Rerun 12/12	RS-8 1/28	RS-9 Soil BkGd. 12/15	RS-8 Rnst 1/29	Travel Blank 1/29	Lab Blanks 12/12	12/15	12/19	1/28	1/28	1/29
Benzene				<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5		<0.5			<0.5	<0.5	<0.5			
Bromoform				<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2		<3.2			<3.2	<3.2	<3.2			
Carbon Tetrachloride				<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5		<1.5			<1.5	<1.5	<1.5			
Chlorobenzene				<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6		<0.6			<0.6	<0.6	<0.6			
Chlorodibromomethane				<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0		<2.0			<2.0	<2.0	<2.0			
Chloroethane				<2.4	<2.4	<2.4	<2.4	<2.4	<2.4	<2.4		<2.4			<2.4	<2.4	<2.4			
2-Chloroethylvinyl Ether				<5.9	<5.9	<5.9	<5.9	<5.9	<5.9	<5.9		<5.9			<5.9	<5.9	<5.9			
Chloroform				<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8		<0.8			<0.8	<0.8	<0.8			
Dichlorobromomethane				<1.1	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1		<1.1			<1.1	<1.1	<1.1			
1,1-Dichloroethane				<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8		<0.8			<0.8	<0.8	<0.8			
1,2-Dichloroethane				<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5		<1.5			<1.5	<1.5	<1.5			
1,1-Dichloroethylene				<1.9	<1.9	<1.9	<1.9	<1.9	<1.9	<1.9		<1.9			<1.9	<1.9	<1.9			
1,2-Dichloropropane				<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5		<1.5			<1.5	<1.5	<1.5			
1,3-cis-Dichloropropylene				<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5		<1.5			<1.5	<1.5	<1.5			
1,3-trans-Dichloropropylene				<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5		<1.5			<1.5	<1.5	<1.5			
Ethylbenzene				<0.4	1.1	<0.4	<0.4	<0.4	8.4	5.8	0.6	1.0	0.7		<0.4	1.2	<0.4	1.0	1.0	0.8
Methyl Bromide				<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5		<1.5			<1.5	<1.5	<1.5			
Methyl Chloride				<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6		<1.6			<1.6	<1.6	<1.6			
Methylene Chloride		130.6	28.3	42.8	36.2	36.2	24.7	21.3	50.9	54.5	25.5	19.5	4.0	7.0	15.2	22.7	10.4	14.7	17.1	22.3
1,1,2,2-Tetrachloroethane				<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4		<1.4			<1.4	<1.4	<1.4			
Tetrachloroethylene				<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5		<1.5			<1.5	<1.5	<1.5			
Trichlorofluoromethane				<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3		<1.3	5.2		<1.3	<1.3	<1.3			
Toluene		9.7	3.6	1.1	<1.0	<1.0	<1.0	<1.0	2.4	2.4		<1.0	9.0		<1.0	1.2	<1.0			
1,2-trans-Dichloroethylene				<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5		<1.5			<1.5	<1.5	<1.5			
1,1,1-Trichloroethane				<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2		<1.2			<1.2	<1.2	<1.2			
1,1,2-Trichloroethane				<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6		<1.6			<1.6	<1.6	<1.6			
Trichloroethylene				<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3		<1.3			<1.3	<1.3	<1.3			
Trichlorofluoromethane				<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2		<1.2			<1.2	<1.2	<1.2			
Vinyl Chloride				<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2		<1.2			<1.2	<1.2	<1.2			

TABLE 4-12. SUMMARY OF RESULTS OF TESTING AT SOIL SAMPLING SITES FOR PURGEABLE HALOCARBONS AND AROMATICS
(Results in ng/g)
(Continued)

Parameter	Site: Date:[a]	RS-1 1/29	RS-1 Dup. 1/29	RS-2 12/15	RS-3 12/15	RS-4 12/19	RS-5 12/12	RS-6 12/12	RS-7 12/12	RS-7 Rerun 12/12	RS-8 1/28	RS-9 Soil BkGd. 12/15	RS-8 Rnst 1/29	Travel Blank 1/29	Lab Blanks 12/12	12/15	12/19	1/28	1/28	1/29
Additional Peaks:																				
Unknown Hydrocarbon						7			37	37						8				
Unknown Hydrocarbon									66	66										
Dimethyl Cyclohexane Isomer									18	18										
Tricyclodecane									38	38										
Trimethyl Cyclohexane Isomer									135	135										
Trimethyl Cyclohexane Isomer									23	23										
Ethyl Methyl Cyclohexane Isomer									95	95										
Trimethyl Bicycloheptane Isomer									109	109										
Ethyl Methyl Cyclohexane Isomer									161	161										
Unknown Hydrocarbon									46	46										
Unknown Hydrocarbon									443	443										
Unknown Hydrocarbon									109	109										
Decahydro Naphthalene									312	312										
Hexane		5.0																		
Tricyclo(3.3.1.1.3,7)-decane		14.8	58.5																	
Cyclohexane compound		14.2	53.9																	
Phenol compound		116.5																		
Unknown		12.0																		
Substituted decahydro-naphthalene		17.5	91.2																	
Unknown		95.4	24.2																10.0	7.1
Tricyclo(3.3.1.1^{3,7})-decane,-1,3-dimethyl			375.6																	
Alkyl substituted phenol			330.7																	
Hydrocarbon mixture			48.5																	

VOLATILE ORGANICS ANALYSIS
SITE: RS-1 TRANSFORMER PAD
DATE OF ANALYSIS: 1-29-87
ALL RESULTS IN UG/KG

BENZENE	< 0.5
BROMOFORM	< 3.2
CARBON TETRACHLORIDE	< 1.5
CHLOROBENZENE	< 0.6
CHLORODIBROMOMETHANE	< 2.0
CHLOROETHANE	< 2.4
2-CHLOROETHYLVINYL ETHER	< 5.9
CHLOROFORM	< 0.8
DICHLOROBROMOMETHANE	< 1.1
1,1-DICHLOROETHANE	< 0.8
1,2-DICHLOROETHANE	< 1.5
1,1-DICHLOROETHYLENE	< 1.9
1,2-DICHLOROPROPANE	< 1.5
1,3-cis-DICHLOROPROPYLENE	< 1.5
1,3-trans-DICHLOROPROPYLENE	< 1.5
ETHYLBENZENE	< 0.4
METHYL BROMIDE	< 1.5
METHYL CHLORIDE	< 1.6
METHYLENE CHLORIDE	130.6
1,1,2,2-TETRACHLOROETHANE	< 1.4
TETRACHLOROETHYLENE	< 1.5
TRICHLOROFLUOROMETHANE	< 1.3
TOLUENE	9.7
1,2-trans-DICHLOROETHYLENE	< 1.5
1,1,1-TRICHLOROETHANE	< 1.2
1,1,2-TRICHLOROETHANE	< 1.6
TRICHLOROETHYLENE	< 1.3
TRICHLOROFLUOROMETHANE	< 1.2
VINYL CHLORIDE	< 1.2

SURROGATE COMPOUND RECOVERIES:

D4-1,2-DICHLOROETHANE	89%
D8-TOLUENE	114%
4-BROMOFLUOROBENZENE	103%

LIBRARY SEARCH DATA:

HEXANE	5.0
TRICYCLO [3.3.1.13,7]DECANE	14.8
CYCLOHEXANE COMPOUND	14.2
PHENOL COMPOUND	116.5
UNKNOWN	12.0
SUBSTITUTED DECAHYDRONAPHTHALENE	17.5
UNKNOWN	95.4

VOLATILE ORGANICS ANALYSIS
SITE: RS-1 SPLIT
DATE OF ANALYSIS: 1-29-87
ALL RESULTS IN UG/KG

BENZENE	< 0.5
BROMOFORM	< 3.2
CARBON TETRACHLORIDE	< 1.5
CHLOROBENZENE	< 0.6
CHLORODIBROMOMETHANE	< 2.0
CHLOROETHANE	< 2.4
2-CHLOROETHYLVINYL ETHER	< 5.9
CHLOROFORM	< 0.8
DICHLOROBROMOMETHANE	< 1.1
1,1-DICHLOROETHANE	< 0.8
1,2-DICHLOROETHANE	< 1.5
1,1-DICHLOROETHYLENE	< 1.9
1,2-DICHLOROPROPANE	< 1.5
1,3-cis-DICHLOROPROPYLENE	< 1.5
1,3-trans-DICHLOROPROPYLENE	< 1.5
ETHYLBENZENE	< 0.4
METHYL BROMIDE	< 1.5
METHYL CHLORIDE	< 1.6
METHYLENE CHLORIDE	28.3
1,1,2,2-TETRACHLOROETHANE	< 1.4
TETRACHLOROETHYLENE	< 1.5
TRICHLOROFLUOROMETHANE	< 1.3
TOLUENE	3.6
1,2-trans-DICHLOROETHYLENE	< 1.5
1,1,1-TRICHLOROETHANE	< 1.2
1,1,2-TRICHLOROETHANE	< 1.6
TRICHLOROETHYLENE	< 1.3
TRICHLOROFLUOROMETHANE	< 1.2
VINYL CHLORIDE	< 1.2

SURROGATE COMPOUND RECOVERIES:

D4-1,2-DICHLOROETHANE	91%
D8-TOLUENE	116%
4-BROMOFLUOROBENZENE	76%

LIBRARY SEARCH DATA:

UNKNOWN	24.2
TRICYCLO [3.3.1.13,7]DECANE	58.5
CYCLOHEXANE ISOMERS	53.9
ALKYL SUBSTITUTED PHENOL	330.7
HYDROCARBON MIXTURE	48.5
SUBSTITUTED DECAHYDRONAPHTHALENE	91.2
TRICYCLO [3.3.1.13,7]DECANE, - 1,3-DIMETHYL-	375.6

VOLATILE ORGANICS ANALYSIS
SITE: RS-8
DATE OF ANALYSIS: 1-29-87
ALL RESULTS IN UG/KG

BENZENE	< 0.5
BROMOFORM	< 3.2
CARBON TETRACHLORIDE	< 1.5
CHLOROBENZENE	< 0.6
CHLORODIBROMOMETHANE	< 2.0
CHLOROETHANE	< 2.4
2-CHLOROETHYLVINYL ETHER	< 5.9
CHLOROFORM	< 0.8
DICHLOROBROMOMETHANE	< 1.1
1,1-DICHLOROETHANE	< 0.8
1,2-DICHLOROETHANE	< 1.5
1,1-DICHLOROETHYLENE	< 1.9
1,2-DICHLOROPROPANE	< 1.5
1,3-cis-DICHLOROPROPYLENE	< 1.5
1,3-trans-DICHLOROPROPYLENE	< 1.5
ETHYLBENZENE	0.6
METHYL BROMIDE	< 1.5
METHYL CHLORIDE	< 1.6
METHYLENE CHLORIDE	25.5
1,1,2,2-TETRACHLOROETHANE	< 1.4
TETRACHLOROETHYLENE	< 1.5
TRICHLOROFLUOROMETHANE	< 1.3
TOLUENE	< 1.0
1,2-trans-DICHLOROETHYLENE	< 1.5
1,1,1-TRICHLOROETHANE	< 1.2
1,1,2-TRICHLOROETHANE	< 1.6
TRICHLOROETHYLENE	< 1.3
TRICHLOROFLUOROMETHANE	< 1.2
VINYL CHLORIDE	< 1.2

SURROGATE COMPOUND RECOVERIES:

D4-1,2-DICHLOROETHANE	100%
D8-TOLUENE	99%
4-BROMOFLUOROBENZENE	90%

LIBRARY SEARCH DATA:
NO PEAKS TO SEARCH

VOLATILE ORGANICS ANALYSIS
SITE: RS-8 RINSATE
DATE OF ANALYSIS: 1-29-87
ALL RESULTS IN UG/L

BENZENE	< 0.5
BROMOFORM	< 3.2
CARBON TETRACHLORIDE	< 1.5
CHLOROBENZENE	< 0.6
CHLORODIBROMOMETHANE	< 2.0
CHLOROETHANE	< 2.4
2-CHLOROETHYLVINYL ETHER	< 5.9
CHLOROFORM	< 0.8
DICHLOROBROMOMETHANE	< 1.1
1,1-DICHLOROETHANE	< 0.8
1,2-DICHLOROETHANE	< 1.5
1,1-DICHLOROETHYLENE	< 1.9
1,2-DICHLOROPROPANE	< 1.5
1,3-cis-DICHLOROPROPYLENE	< 1.5
1,3-trans-DICHLOROPROPYLENE	< 1.5
ETHYLBENZENE	0.7
METHYL BROMIDE	< 1.5
METHYL CHLORIDE	< 1.6
METHYLENE CHLORIDE	4.0
1,1,2,2-TETRACHLOROETHANE	< 1.4
TETRACHLOROETHYLENE	< 1.5
TRICHLOROFLUOROMETHANE	5.2
TOLUENE	9.0
1,2-trans-DICHLOROETHYLENE	< 1.5
1,1,1-TRICHLOROETHANE	< 1.2
1,1,2-TRICHLOROETHANE	< 1.6
TRICHLOROETHYLENE	< 1.3
TRICHLOROFLUOROMETHANE	< 1.2
VINYL CHLORIDE	< 1.2

SURROGATE COMPOUND RECOVERIES:

D4-1,2-DICHLOROETHANE	98%
D8-TOLUENE	96%
4-BROMOFLUOROBENZENE	91%

LIBRARY SEARCH DATA:
NO PEAKS TO SEARCH

VOLATILE ORGANICS ANALYSIS
SITE: RB-7 SAMPLING BLANK
DATE OF ANALYSIS: 1-28-87
ALL RESULTS IN UG/L

BENZENE	< 0.5
BROMOFORM	< 3.2
CARBON TETRACHLORIDE	< 1.5
CHLOROBENZENE	< 0.6
CHLORODIBROMOMETHANE	< 2.0
CHLOROETHANE	< 2.4
2-CHLOROETHYLVINYL ETHER	< 5.9
CHLOROFORM	< 0.8
DICHLOROBROMOMETHANE	< 1.1
1,1-DICHLOROETHANE	< 0.8
1,2-DICHLOROETHANE	< 1.5
1,1-DICHLOROETHYLENE	< 1.9
1,2-DICHLOROPROPANE	< 1.5
1,3-cis-DICHLOROPROPYLENE	< 1.5
1,3-trans-DICHLOROPROPYLENE	< 1.5
ETHYLBENZENE	0.8
METHYL BROMIDE	< 1.5
METHYL CHLORIDE	< 1.6
METHYLENE CHLORIDE	6.2
1,1,2,2-TETRACHLOROETHANE	< 1.4
TETRACHLOROETHYLENE	< 1.5
TRICHLOROFLUOROMETHANE	3.2
TOLUENE	9.2
1,2-trans-DICHLOROETHYLENE	< 1.5
1,1,1-TRICHLOROETHANE	< 1.2
1,1,2-TRICHLOROETHANE	< 1.6
TRICHLOROETHYLENE	< 1.3
TRICHLOROFLUOROMETHANE	< 1.2
VINYL CHLORIDE	< 1.2

SURROGATE COMPOUND RECOVERIES:

D4-1,2-DICHLOROETHANE	86%
D8-TOLUENE	99%
4-BROMOFLUOROBENZENE	97%

LIBRARY SEARCH DATA:

UNKNOWN	5.0

VOLATILE ORGANICS ANALYSIS
SITE: RG-1 WELL 1
DATE OF ANALYSIS: 1-28-87
ALL RESULTS IN UG/L

BENZENE	< 0.5
BROMOFORM	< 3.2
CARBON TETRACHLORIDE	< 1.5
CHLOROBENZENE	< 0.6
CHLORODIBROMOMETHANE	< 2.0
CHLOROETHANE	< 2.4
2-CHLOROETHYLVINYL ETHER	< 5.9
CHLOROFORM	< 0.8
DICHLOROBROMOMETHANE	< 1.1
1,1-DICHLOROETHANE	< 0.8
1,2-DICHLOROETHANE	< 1.5
1,1-DICHLOROETHYLENE	< 1.9
1,2-DICHLOROPROPANE	< 1.5
1,3-cis-DICHLOROPROPYLENE	< 1.5
1,3-trans-DICHLOROPROPYLENE	< 1.5
ETHYLBENZENE	< 0.4
METHYL BROMIDE	< 1.5
METHYL CHLORIDE	< 1.6
METHYLENE CHLORIDE	5.5
1,1,2,2-TETRACHLOROETHANE	< 1.4
TETRACHLOROETHYLENE	< 1.5
TRICHLOROFLUOROMETHANE	< 1.3
TOLUENE	< 1.0
1,2-trans-DICHLOROETHYLENE	< 1.5
1,1,1-TRICHLOROETHANE	< 1.2
1,1,2-TRICHLOROETHANE	< 1.6
TRICHLOROETHYLENE	< 1.3
TRICHLOROFLUOROMETHANE	< 1.2
VINYL CHLORIDE	< 1.2

SURROGATE COMPOUND RECOVERIES:

D4-1,2-DICHLOROETHANE	92%
D8-TOLUENE	99%
4-BROMOFLUOROBENZENE	98%

LIBRARY SEARCH DATA:
NO PEAKS TO SEARCH

VOLATILE ORGANICS ANALYSIS
SITE: RG-1 SPLIT WELL 1
DATE OF ANALYSIS: 1-28-87
ALL RESULTS IN UG/L

BENZENE	< 0.5
BROMOFORM	< 3.2
CARBON TETRACHLORIDE	< 1.5
CHLOROBENZENE	< 0.6
CHLORODIBROMOMETHANE	< 2.0
CHLOROETHANE	< 2.4
2-CHLOROETHYLVINYL ETHER	< 5.9
CHLOROFORM	< 0.8
DICHLOROBROMOMETHANE	< 1.1
1,1-DICHLOROETHANE	< 0.8
1,2-DICHLOROETHANE	< 1.5
1,1-DICHLOROETHYLENE	< 1.9
1,2-DICHLOROPROPANE	< 1.5
1,3-cis-DICHLOROPROPYLENE	< 1.5
1,3-trans-DICHLOROPROPYLENE	< 1.5
ETHYLBENZENE	< 0.4
METHYL BROMIDE	< 1.5
METHYL CHLORIDE	< 1.6
METHYLENE CHLORIDE	4.9
1,1,2,2-TETRACHLOROETHANE	< 1.4
TETRACHLOROETHYLENE	< 1.5
TRICHLOROFLUOROMETHANE	< 1.3
TOLUENE	< 1.0
1,2-trans-DICHLOROETHYLENE	< 1.5
1,1,1-TRICHLOROETHANE	< 1.2
1,1,2-TRICHLOROETHANE	< 1.6
TRICHLOROETHYLENE	< 1.3
TRICHLOROFLUOROMETHANE	< 1.2
VINYL CHLORIDE	< 1.2

SURROGATE COMPOUND RECOVERIES:

D4-1,2-DICHLOROETHANE	101%
D8-TOLUENE	99%
4-BROMOFLUOROBENZENE	97%

LIBRARY SEARCH DATA:
NO PEAKS TO SEARCH

VOLATILE ORGANICS ANALYSIS
SITE: RG-2 WELL 2
DATE OF ANALYSIS: 1-29-87
ALL RESULTS IN UG/L

BENZENE	< 0.5
BROMOFORM	< 3.2
CARBON TETRACHLORIDE	< 1.5
CHLOROBENZENE	< 0.6
CHLORODIBROMOMETHANE	< 2.0
CHLOROETHANE	< 2.4
2-CHLOROETHYLVINYL ETHER	< 5.9
CHLOROFORM	< 0.8
DICHLOROBROMOMETHANE	< 1.1
1,1-DICHLOROETHANE	< 0.8
1,2-DICHLOROETHANE	< 1.5
1,1-DICHLOROETHYLENE	< 1.9
1,2-DICHLOROPROPANE	< 1.5
1,3-cis-DICHLOROPROPYLENE	< 1.5
1,3-trans-DICHLOROPROPYLENE	< 1.5
ETHYLBENZENE	< 0.4
METHYL BROMIDE	< 1.5
METHYL CHLORIDE	< 1.6
METHYLENE CHLORIDE	3.5
1,1,2,2-TETRACHLOROETHANE	< 1.4
TETRACHLOROETHYLENE	< 1.5
TRICHLOROFLUOROMETHANE	< 1.3
TOLUENE	< 1.0
1,2-trans-DICHLOROETHYLENE	< 1.5
1,1,1-TRICHLOROETHANE	< 1.2
1,1,2-TRICHLOROETHANE	< 1.6
TRICHLOROETHYLENE	< 1.3
TRICHLOROFLUOROMETHANE	< 1.2
VINYL CHLORIDE	< 1.2

SURROGATE COMPOUND RECOVERIES:

D4-1,2-DICHLOROETHANE	98%
D8-TOLUENE	101%
4-BROMOFLUOROBENZENE	100%

LIBRARY SEARCH DATA:
NO PEAKS TO SEARCH

VOLATILE ORGANICS ANALYSIS
SITE: RG-3 WELL 3
DATE OF ANALYSIS: 1-29-87
ALL RESULTS IN UG/L

BENZENE	< 0.5
BROMOFORM	< 3.2
CARBON TETRACHLORIDE	< 1.5
CHLOROBENZENE	< 0.6
CHLORODIBROMOMETHANE	< 2.0
CHLOROETHANE	< 2.4
2-CHLOROETHYLVINYL ETHER	< 5.9
CHLOROFORM	< 0.8
DICHLOROBROMOMETHANE	< 1.1
1,1-DICHLOROETHANE	< 0.8
1,2-DICHLOROETHANE	< 1.5
1,1-DICHLOROETHYLENE	< 1.9
1,2-DICHLOROPROPANE	< 1.5
1,3-cis-DICHLOROPROPYLENE	< 1.5
1,3-trans-DICHLOROPROPYLENE	< 1.5
ETHYLBENZENE	< 0.4
METHYL BROMIDE	< 1.5
METHYL CHLORIDE	< 1.6
METHYLENE CHLORIDE	3.8
1,1,2,2-TETRACHLOROETHANE	< 1.4
TETRACHLOROETHYLENE	< 1.5
TRICHLOROFLUOROMETHANE	< 1.3
TOLUENE	< 1.0
1,2-trans-DICHLOROETHYLENE	< 1.5
1,1,1-TRICHLOROETHANE	< 1.2
1,1,2-TRICHLOROETHANE	< 1.6
TRICHLOROETHYLENE	3.0
TRICHLOROFLUOROMETHANE	< 1.2
VINYL CHLORIDE	< 1.2

SURROGATE COMPOUND RECOVERIES:

D4-1,2-DICHLOROETHANE	89%
D8-TOLUENE	103%
4-BROMOFLUOROBENZENE	101%

LIBRARY SEARCH DATA:

UNKNOWN	7.3
2-PENTENE, 3,4,4-TRIMETHYL-	3.4
1-PENTENE, 2,4,4-TRIMETHYL-	20.8

VOLATILE ORGANICS ANALYSIS
SITE: RG-4 WELL 4
DATE OF ANALYSIS: 1-28-87
ALL RESULTS IN UG/L

BENZENE	< 0.5
BROMOFORM	< 3.2
CARBON TETRACHLORIDE	< 1.5
CHLOROBENZENE	< 0.6
CHLORODIBROMOMETHANE	< 2.0
CHLOROETHANE	< 2.4
2-CHLOROETHYLVINYL ETHER	< 5.9
CHLOROFORM	< 0.8
DICHLOROBROMOMETHANE	< 1.1
1,1-DICHLOROETHANE	< 0.8
1,2-DICHLOROETHANE	< 1.5
1,1-DICHLOROETHYLENE	< 1.9
1,2-DICHLOROPROPANE	< 1.5
1,3-cis-DICHLOROPROPYLENE	< 1.5
1,3-trans-DICHLOROPROPYLENE	< 1.5
ETHYLBENZENE	1.5
METHYL BROMIDE	< 1.5
METHYL CHLORIDE	< 1.6
METHYLENE CHLORIDE	4.6
1,1,2,2-TETRACHLOROETHANE	< 1.4
TETRACHLOROETHYLENE	< 1.5
TRICHLOROFLUOROMETHANE	< 1.3
TOLUENE	1.9
1,2-trans-DICHLOROETHYLENE	< 1.5
1,1,1-TRICHLOROETHANE	< 1.2
1,1,2-TRICHLOROETHANE	< 1.6
TRICHLOROETHYLENE	< 1.3
TRICHLOROFLUOROMETHANE	< 1.2
VINYL CHLORIDE	< 1.2

SURROGATE COMPOUND RECOVERIES:

D4-1,2-DICHLOROETHANE	106%
D8-TOLUENE	88%
4-BROMOFLUOROBENZENE	107%

LIBRARY SEARCH DATA:

UNKNOWN	5.8

VOLATILE ORGANICS ANALYSIS
SITE: TRAVEL BLANK
DATE OF ANALYSIS: 1-29-87
ALL RESULTS IN UG/L

BENZENE	< 0.5
BROMOFORM	< 3.2
CARBON TETRACHLORIDE	< 1.5
CHLOROBENZENE	< 0.6
CHLORODIBROMOMETHANE	< 2.0
CHLOROETHANE	< 2.4
2-CHLOROETHYLVINYL ETHER	< 5.9
CHLOROFORM	< 0.8
DICHLOROBROMOMETHANE	< 1.1
1,1-DICHLOROETHANE	< 0.8
1,2-DICHLOROETHANE	< 1.5
1,1-DICHLOROETHYLENE	< 1.9
1,2-DICHLOROPROPANE	< 1.5
1,3-cis-DICHLOROPROPYLENE	< 1.5
1,3-trans-DICHLOROPROPYLENE	< 1.5
ETHYLBENZENE	< 0.4
METHYL BROMIDE	< 1.5
METHYL CHLORIDE	< 1.6
METHYLENE CHLORIDE	7.0
1,1,2,2-TETRACHLOROETHANE	< 1.4
TETRACHLOROETHYLENE	< 1.5
TRICHLOROFLUOROMETHANE	< 1.3
TOLUENE	< 1.0
1,2-trans-DICHLOROETHYLENE	< 1.5
1,1,1-TRICHLOROETHANE	< 1.2
1,1,2-TRICHLOROETHANE	< 1.6
TRICHLOROETHYLENE	< 1.3
TRICHLOROFLUOROMETHANE	< 1.2
VINYL CHLORIDE	< 1.2

SURROGATE COMPOUND RECOVERIES:

D4-1,2-DICHLOROETHANE	96%
D8-TOLUENE	101%
4-BROMOFLUOROBENZENE	100%

LIBRARY SEARCH DATA:

UNKNOWN	6.6

VOLATILE ORGANICS ANALYSIS
SITE: WATER BLANK
DATE OF ANALYSIS: 1-28-87
ALL RESULTS IN UG/L

BENZENE	< 0.5
BROMOFORM	< 3.2
CARBON TETRACHLORIDE	< 1.5
CHLOROBENZENE	< 0.6
CHLORODIBROMOMETHANE	< 2.0
CHLOROETHANE	< 2.4
2-CHLOROETHYLVINYL ETHER	< 5.9
CHLOROFORM	< 0.8
DICHLOROBROMOMETHANE	< 1.1
1,1-DICHLOROETHANE	< 0.8
1,2-DICHLOROETHANE	< 1.5
1,1-DICHLOROETHYLENE	< 1.9
1,2-DICHLOROPROPANE	< 1.5
1,3-cis-DICHLOROPROPYLENE	< 1.5
1,3-trans-DICHLOROPROPYLENE	< 1.5
ETHYLBENZENE	1.0
METHYL BROMIDE	< 1.5
METHYL CHLORIDE	< 1.6
METHYLENE CHLORIDE	14.7
1,1,2,2-TETRACHLOROETHANE	< 1.4
TETRACHLOROETHYLENE	< 1.5
TRICHLOROFLUOROMETHANE	< 1.3
TOLUENE	< 1.0
1,2-trans-DICHLOROETHYLENE	< 1.5
1,1,1-TRICHLOROETHANE	< 1.2
1,1,2-TRICHLOROETHANE	< 1.6
TRICHLOROETHYLENE	< 1.3
TRICHLOROFLUOROMETHANE	< 1.2
VINYL CHLORIDE	< 1.2

SURROGATE COMPOUND RECOVERIES:

D4-1,2-DICHLOROETHANE	100%
D8-TOLUENE	102%
4-BROMOFLUOROBENZENE	101%

LIBRARY SEARCH DATA:

UNKNOWN	10.0

VOLATILE ORGANICS ANALYSIS
SITE: WATER BLANK
DATE OF ANALYSIS: 1-28-87
ALL RESULTS IN UG/L

BENZENE	< 0.5
BROMOFORM	< 3.2
CARBON TETRACHLORIDE	< 1.5
CHLOROBENZENE	< 0.6
CHLORODIBROMOMETHANE	< 2.0
CHLOROETHANE	< 2.4
2-CHLOROETHYLVINYL ETHER	< 5.9
CHLOROFORM	< 0.8
DICHLOROBROMOMETHANE	< 1.1
1,1-DICHLOROETHANE	< 0.8
1,2-DICHLOROETHANE	< 1.5
1,1-DICHLOROETHYLENE	< 1.9
1,2-DICHLOROPROPANE	< 1.5
1,3-cis-DICHLOROPROPYLENE	< 1.5
1,3-trans-DICHLOROPROPYLENE	< 1.5
ETHYLBENZENE	1.0
METHYL BROMIDE	< 1.5
METHYL CHLORIDE	< 1.6
METHYLENE CHLORIDE	17.1
1,1,2,2-TETRACHLOROETHANE	< 1.4
TETRACHLOROETHYLENE	< 1.5
TRICHLOROFLUOROMETHANE	< 1.3
TOLUENE	< 1.0
1,2-trans-DICHLOROETHYLENE	< 1.5
1,1,1-TRICHLOROETHANE	< 1.2
1,1,2-TRICHLOROETHANE	< 1.6
TRICHLOROETHYLENE	< 1.3
TRICHLOROFLUOROMETHANE	< 1.2
VINYL CHLORIDE	< 1.2

SURROGATE COMPOUND RECOVERIES:

D4-1,2-DICHLOROETHANE	96%
D8-TOLUENE	102%
4-BROMOFLUOROBENZENE	98%

LIBRARY SEARCH DATA:

UNKNOWN	7.1

VOLATILE ORGANICS ANALYSIS
SITE: WATER BLANK
DATE OF ANALYSIS: 1-29-87
ALL RESULTS IN UG/L

BENZENE	< 0.5
BROMOFORM	< 3.2
CARBON TETRACHLORIDE	< 1.5
CHLOROBENZENE	< 0.6
CHLORODIBROMOMETHANE	< 2.0
CHLOROETHANE	< 2.4
2-CHLOROETHYLVINYL ETHER	< 5.9
CHLOROFORM	< 0.8
DICHLOROBROMOMETHANE	< 1.1
1,1-DICHLOROETHANE	< 0.8
1,2-DICHLOROETHANE	< 1.5
1,1-DICHLOROETHYLENE	< 1.9
1,2-DICHLOROPROPANE	< 1.5
1,3-cis-DICHLOROPROPYLENE	< 1.5
1,3-trans-DICHLOROPROPYLENE	< 1.5
ETHYLBENZENE	0.8
METHYL BROMIDE	< 1.5
METHYL CHLORIDE	< 1.6
METHYLENE CHLORIDE	22.3
1,1,2,2-TETRACHLOROETHANE	< 1.4
TETRACHLOROETHYLENE	< 1.5
TRICHLOROFLUOROMETHANE	< 1.3
TOLUENE	< 1.0
1,2-trans-DICHLOROETHYLENE	< 1.5
1,1,1-TRICHLOROETHANE	< 1.2
1,1,2-TRICHLOROETHANE	< 1.6
TRICHLOROETHYLENE	< 1.3
TRICHLOROFLUOROMETHANE	< 1.2
VINYL CHLORIDE	< 1.2

SURROGATE COMPOUND RECOVERIES:

D4-1,2-DICHLOROETHANE	111%
D8-TOLUENE	99%
4-BROMOFLUOROBENZENE	105%

LIBRARY SEARCH DATA:
NO PEAKS TO SEARCH

VOLATILE ORGANICS ANALYSIS
SITE: WATER BLANK
DATE OF ANALYSIS: 12/12/86
ALL RESULTS IN UG/L

BENZENE	< 0.5
BROMOFORM	< 3.2
CARBON TETRACHLORIDE	< 1.5
CHLOROBENZENE	< 0.6
CHLORODIBROMOMETHANE	< 2.0
CHLOROETHANE	< 2.4
2-CHLOROETHYLVINYL ETHER	< 5.9
CHLOROFORM	< 0.8
DICHLOROBROMOMETHANE	< 1.1
1,1-DICHLOROETHANE	< 0.8
1,2-DICHLOROETHANE	< 1.5
1,1-DICHLOROETHYLENE	< 1.9
1,2-DICHLOROPROPANE	< 1.5
1,3-cis-DICHLOROPROPYLENE	< 1.5
1,3-trans-DICHLOROPROPYLENE	< 1.5
ETHYLBENZENE	< 0.4
METHYL BROMIDE	< 1.5
METHYL CHLORIDE	< 1.6
METHYLENE CHLORIDE	15.2
1,1,2,2-TETRACHLOROETHANE	< 1.4
TETRACHLOROETHYLENE	< 1.5
TRICHLOROFLUOROMETHANE	< 1.3
TOLUENE	< 1.0
1,2-trans-DICHLOROETHYLENE	< 1.5
1,1,1-TRICHLOROETHANE	< 1.2
1,1,2-TRICHLOROETHANE	< 1.6
TRICHLOROETHYLENE	< 1.3
TRICHLOROFLUOROMETHANE	< 1.2
VINYL CHLORIDE	< 1.2

SURROGATE COMPOUND RECOVERIES:

D4-1,2-DICHLOROETHANE	95%
D8-TOLUENE	101%
4-BROMOFLUOROBENZENE	102%

LIBRARY SEARCH DATA:
NO PEAKS TO SEARCH

VOLATILE ORGANICS ANALYSIS
SITE: WATER BLANK
DATE OF ANALYSIS: 12/15/86
ALL RESULTS IN UG/L

BENZENE	< 0.5
BROMOFORM	< 3.2
CARBON TETRACHLORIDE	< 1.5
CHLOROBENZENE	< 0.6
CHLORODIBROMOMETHANE	< 2.0
CHLOROETHANE	< 2.4
2-CHLOROETHYLVINYL ETHER	< 5.9
CHLOROFORM	< 0.8
DICHLOROBROMOMETHANE	< 1.1
1,1-DICHLOROETHANE	< 0.8
1,2-DICHLOROETHANE	< 1.5
1,1-DICHLOROETHYLENE	< 1.9
1,2-DICHLOROPROPANE	< 1.5
1,3-cis-DICHLOROPROPYLENE	< 1.5
1,3-trans-DICHLOROPROPYLENE	< 1.5
ETHYLBENZENE	1.2
METHYL BROMIDE	< 1.5
METHYL CHLORIDE	< 1.6
METHYLENE CHLORIDE	22.7
1,1,2,2-TETRACHLOROETHANE	< 1.4
TETRACHLOROETHYLENE	< 1.5
TRICHLOROFLUOROMETHANE	< 1.3
TOLUENE	1.2
1,2-trans-DICHLOROETHYLENE	< 1.5
1,1,1-TRICHLOROETHANE	< 1.2
1,1,2-TRICHLOROETHANE	< 1.6
TRICHLOROETHYLENE	< 1.3
TRICHLOROFLUOROMETHANE	< 1.2
VINYL CHLORIDE	< 1.2

SURROGATE COMPOUND RECOVERIES:

D4-1,2-DICHLOROETHANE	91%
D8-TOLUENE	100%
4-BROMOFLUOROBENZENE	98%

LIBRARY SEARCH DATA:

UNKNOWN HYDROCARBON	8

VOLATILE ORGANICS ANALYSIS
SITE: WATER BLANK
DATE OF ANALYSIS: 12/17/86
ALL RESULTS IN UG/L

BENZENE	< 0.5
BROMOFORM	< 3.2
CARBON TETRACHLORIDE	< 1.5
CHLOROBENZENE	< 0.6
CHLORODIBROMOMETHANE	< 2.0
CHLOROETHANE	< 2.4
2-CHLOROETHYLVINYL ETHER	< 5.9
CHLOROFORM	< 0.8
DICHLOROBROMOMETHANE	< 1.1
1,1-DICHLOROETHANE	< 0.8
1,2-DICHLOROETHANE	< 1.5
1,1-DICHLOROETHYLENE	< 1.9
1,2-DICHLOROPROPANE	< 1.5
1,3-cis-DICHLOROPROPYLENE	< 1.5
1,3-trans-DICHLOROPROPYLENE	< 1.5
ETHYLBENZENE	1.1
METHYL BROMIDE	< 1.5
METHYL CHLORIDE	< 1.6
METHYLENE CHLORIDE	10.4
1,1,2,2-TETRACHLOROETHANE	< 1.4
TETRACHLOROETHYLENE	< 1.5
TRICHLOROFLUOROMETHANE	< 1.3
TOLUENE	< 1.0
1,2-trans-DICHLOROETHYLENE	< 1.5
1,1,1-TRICHLOROETHANE	< 1.2
1,1,2-TRICHLOROETHANE	< 1.6
TRICHLOROETHYLENE	< 1.3
TRICHLOROFLUOROMETHANE	< 1.2
VINYL CHLORIDE	< 1.2

SURROGATE COMPOUND RECOVERIES:

D4-1,2-DICHLOROETHANE	93%
D8-TOLUENE	101%
4-BROMOFLUOROBENZENE	97%

LIBRARY SEARCH DATA:

UNKNOWN	6

VOLATILE ORGANICS ANALYSIS
SITE: WATER BLANK
DATE OF ANALYSIS: 12/19/86
ALL RESULTS IN UG/L

BENZENE	< 0.5
BROMOFORM	< 3.2
CARBON TETRACHLORIDE	< 1.5
CHLOROBENZENE	< 0.6
CHLORODIBROMOMETHANE	< 2.0
CHLOROETHANE	< 2.4
2-CHLOROETHYLVINYL ETHER	< 5.9
CHLOROFORM	< 0.8
DICHLOROBROMOMETHANE	< 1.1
1,1-DICHLOROETHANE	< 0.8
1,2-DICHLOROETHANE	< 1.5
1,1-DICHLOROETHYLENE	< 1.9
1,2-DICHLOROPROPANE	< 1.5
1,3-cis-DICHLOROPROPYLENE	< 1.5
1,3-trans-DICHLOROPROPYLENE	< 1.5
ETHYLBENZENE	< 0.4
METHYL BROMIDE	< 1.5
METHYL CHLORIDE	< 1.6
METHYLENE CHLORIDE	10.4
1,1,2,2-TETRACHLOROETHANE	< 1.4
TETRACHLOROETHYLENE	< 1.5
TRICHLOROFLUOROMETHANE	< 1.3
TOLUENE	< 1.0
1,2-trans-DICHLOROETHYLENE	< 1.5
1,1,1-TRICHLOROETHANE	< 1.2
1,1,2-TRICHLOROETHANE	< 1.6
TRICHLOROETHYLENE	< 1.3
TRICHLOROFLUOROMETHANE	< 1.2
VINYL CHLORIDE	< 1.2

SURROGATE COMPOUND RECOVERIES:

D4-1,2-DICHLOROETHANE	96%
D8-TOLUENE	97%
4-BROMOFLUOROBENZENE	101%

LIBRARY SEARCH DATA:
NO PEAKS TO SEARCH

VOLATILE ORGANICS ANALYSIS
SITE: RB-1
DATE OF ANALYSIS: 12/15/86
ALL RESULTS IN UG/L

BENZENE	< 0.5
BROMOFORM	< 3.2
CARBON TETRACHLORIDE	< 1.5
CHLOROBENZENE	< 0.6
CHLORODIBROMOMETHANE	< 2.0
CHLOROETHANE	< 2.4
2-CHLOROETHYLVINYL ETHER	< 5.9
CHLOROFORM	< 0.8
DICHLOROBROMOMETHANE	< 1.1
1,1-DICHLOROETHANE	< 0.8
1,2-DICHLOROETHANE	< 1.5
1,1-DICHLOROETHYLENE	< 1.9
1,2-DICHLOROPROPANE	< 1.5
1,3-cis-DICHLOROPROPYLENE	< 1.5
1,3-trans-DICHLOROPROPYLENE	< 1.5
ETHYLBENZENE	1.0
METHYL BROMIDE	< 1.5
METHYL CHLORIDE	< 1.6
METHYLENE CHLORIDE	9.7
1,1,2,2-TETRACHLOROETHANE	< 1.4
TETRACHLOROETHYLENE	< 1.5
TRICHLOROFLUOROMETHANE	< 1.3
TOLUENE	< 1.0
1,2-trans-DICHLOROETHYLENE	< 1.5
1,1,1-TRICHLOROETHANE	< 1.2
1,1,2-TRICHLOROETHANE	< 1.6
TRICHLOROETHYLENE	< 1.3
TRICHLOROFLUOROMETHANE	< 1.2
VINYL CHLORIDE	< 1.2

SURROGATE COMPOUND RECOVERIES:

D4-1,2-DICHLOROETHANE	94%
D8-TOLUENE	101%
4-BROMOFLUOROBENZENE	100%

LIBRARY SEARCH DATA:
NO PEAKS TO SEARCH

VOLATILE ORGANICS ANALYSIS
SITE: RB-2
DATE OF ANALYSIS: 12/15/86
ALL RESULTS IN UG/L

BENZENE	< 0.5
BROMOFORM	< 3.2
CARBON TETRACHLORIDE	< 1.5
CHLOROBENZENE	< 0.6
CHLORODIBROMOMETHANE	< 2.0
CHLOROETHANE	< 2.4
2-CHLOROETHYLVINYL ETHER	< 5.9
CHLOROFORM	< 0.8
DICHLOROBROMOMETHANE	< 1.1
1,1-DICHLOROETHANE	< 0.6
1,2-DICHLOROETHANE	< 1.5
1,1-DICHLOROETHYLENE	< 1.9
1,2-DICHLOROPROPANE	< 1.5
1,3-cis-DICHLOROPROPYLENE	< 1.5
1,3-trans-DICHLOROPROPYLENE	< 1.5
ETHYLBENZENE	< 0.4
METHYL BROMIDE	< 1.5
METHYL CHLORIDE	< 1.6
METHYLENE CHLORIDE	16.7
1,1,2,2-TETRACHLOROETHANE	< 1.4
TETRACHLOROETHYLENE	< 1.5
TRICHLOROFLUOROMETHANE	< 1.3
TOLUENE	< 1.0
1,2-trans-DICHLOROETHYLENE	< 1.5
1,1,1-TRICHLOROETHANE	< 1.2
1,1,2-TRICHLOROETHANE	< 1.6
TRICHLOROETHYLENE	< 1.3
TRICHLOROFLUOROMETHANE	< 1.2
VINYL CHLORIDE	< 1.2

SURROGATE COMPOUND RECOVERIES:

D4-1,2-DICHLOROETHANE	94%
D8-TOLUENE	101%
4-BROMOFLUOROBENZENE	100%

LIBRARY SEARCH DATA:
NO PEAKS TO SEARCH

VOLATILE ORGANICS ANALYSIS
SITE: RB-3
DATE OF ANALYSIS: 12/15/86
ALL RESULTS IN UG/L

BENZENE	< 0.5
BROMOFORM	< 3.2
CARBON TETRACHLORIDE	< 1.5
CHLOROBENZENE	< 0.6
CHLORODIBROMOMETHANE	< 2.0
CHLOROETHANE	< 2.4
2-CHLOROETHYLVINYL ETHER	< 5.9
CHLOROFORM	< 0.8
DICHLOROBROMOMETHANE	< 1.1
1,1-DICHLOROETHANE	< 0.8
1,2-DICHLOROETHANE	< 1.5
1,1-DICHLOROETHYLENE	< 1.9
1,2-DICHLOROPROPANE	< 1.5
1,3-cis-DICHLOROPROPYLENE	< 1.5
1,3-trans-DICHLOROPROPYLENE	< 1.5
ETHYLBENZENE	< 0.4
METHYL BROMIDE	< 1.5
METHYL CHLORIDE	< 1.6
METHYLENE CHLORIDE	8.2
1,1,2,2-TETRACHLOROETHANE	< 1.4
TETRACHLOROETHYLENE	< 1.5
TRICHLOROFLUOROMETHANE	< 1.3
TOLUENE	< 1.0
1,2-trans-DICHLOROETHYLENE	< 1.5
1,1,1-TRICHLOROETHANE	< 1.2
1,1,2-TRICHLOROETHANE	< 1.6
TRICHLOROETHYLENE	< 1.3
TRICHLOROFLUOROMETHANE	< 1.2
VINYL CHLORIDE	< 1.2

SURROGATE COMPOUND RECOVERIES:

D4-1,2-DICHLOROETHANE	94%
D8-TOLUENE	100%
4-BROMOFLUOROBENZENE	100%

LIBRARY SEARCH DATA:
NO PEAKS TO SEARCH

VOLATILE ORGANICS ANALYSIS
SITE: RB-4
DATE OF ANALYSIS: 12/17/86
ALL RESULTS IN UG/L

BENZENE	6.0
BROMOFORM	< 3.2
CARBON TETRACHLORIDE	< 1.5
CHLOROBENZENE	< 0.6
CHLORODIBROMOMETHANE	< 2.0
CHLOROETHANE	< 2.4
2-CHLOROETHYLVINYL ETHER	< 5.9
CHLOROFORM	< 0.8
DICHLOROBROMOMETHANE	< 1.1
1,1-DICHLOROETHANE	< 0.8
1,2-DICHLOROETHANE	< 1.5
1,1-DICHLOROETHYLENE	< 1.9
1,2-DICHLOROPROPANE	< 1.5
1,3-cis-DICHLOROPROPYLENE	< 1.5
1,3-trans-DICHLOROPROPYLENE	< 1.5
ETHYLBENZENE	< 0.4
METHYL BROMIDE	< 1.5
METHYL CHLORIDE	< 1.6
METHYLENE CHLORIDE	20.4
1,1,2,2-TETRACHLOROETHANE	< 1.4
TETRACHLOROETHYLENE	< 1.5
TRICHLOROFLUOROMETHANE	< 1.3
TOLUENE	1.2
1,2-trans-DICHLOROETHYLENE	< 1.5
1,1,1-TRICHLOROETHANE	< 1.2
1,1,2-TRICHLOROETHANE	< 1.6
TRICHLOROETHYLENE	< 1.3
TRICHLOROFLUOROMETHANE	< 1.2
VINYL CHLORIDE	< 1.2

SURROGATE COMPOUND RECOVERIES:

D4-1,2-DICHLOROETHANE	92%
D8-TOLUENE	101%
4-BROMOFLUOROBENZENE	102%

LIBRARY SEARCH DATA:
NO PEAKS TO SEARCH

VOLATILE ORGANICS ANALYSIS
SITE: RB-5
DATE OF ANALYSIS: 12/17/86
ALL RESULTS IN UG/L

BENZENE	< 0.5
BROMOFORM	< 3.2
CARBON TETRACHLORIDE	< 1.5
CHLOROBENZENE	< 0.6
CHLORODIBROMOMETHANE	< 2.0
CHLOROETHANE	< 2.4
2-CHLOROETHYLVINYL ETHER	< 5.9
CHLOROFORM	< 0.8
DICHLOROBROMOMETHANE	< 1.1
1,1-DICHLOROETHANE	< 0.8
1,2-DICHLOROETHANE	< 1.5
1,1-DICHLOROETHYLENE	< 1.9
1,2-DICHLOROPROPANE	< 1.5
1,3-cis-DICHLOROPROPYLENE	< 1.5
1,3-trans-DICHLOROPROPYLENE	< 1.5
ETHYLBENZENE	1.1
METHYL BROMIDE	< 1.5
METHYL CHLORIDE	< 1.6
METHYLENE CHLORIDE	29.4
1,1,2,2-TETRACHLOROETHANE	< 1.4
TETRACHLOROETHYLENE	< 1.5
TRICHLOROFLUOROMETHANE	< 1.3
TOLUENE	< 1.0
1,2-trans-DICHLOROETHYLENE	< 1.5
1,1,1-TRICHLOROETHANE	< 1.2
1,1,2-TRICHLOROETHANE	< 1.6
TRICHLOROETHYLENE	< 1.3
TRICHLOROFLUOROMETHANE	< 1.2
VINYL CHLORIDE	< 1.2

SURROGATE COMPOUND RECOVERIES:

D4-1,2-DICHLOROETHANE	94%
D8-TOLUENE	101%
4-BROMOFLUOROBENZENE	97%

LIBRARY SEARCH DATA:
NO PEAKS TO SEARCH

VOLATILE ORGANICS ANALYSIS
SITE: RB-6
DATE OF ANALYSIS: 12/17/86
ALL RESULTS IN UG/L

BENZENE	< 0.5
BROMOFORM	< 3.2
CARBON TETRACHLORIDE	< 1.5
CHLOROBENZENE	< 0.6
CHLORODIBROMOMETHANE	< 2.0
CHLOROETHANE	< 2.4
2-CHLOROETHYLVINYL ETHER	< 5.9
CHLOROFORM	< 0.8
DICHLOROBROMOMETHANE	< 1.1
1,1-DICHLOROETHANE	< 0.8
1,2-DICHLOROETHANE	< 1.5
1,1-DICHLOROETHYLENE	< 1.9
1,2-DICHLOROPROPANE	< 1.5
1,3-cis-DICHLOROPROPYLENE	< 1.5
1,3-trans-DICHLOROPROPYLENE	< 1.5
ETHYLBENZENE	< 0.4
METHYL BROMIDE	< 1.5
METHYL CHLORIDE	< 1.6
METHYLENE CHLORIDE	12.1
1,1,2,2-TETRACHLOROETHANE	< 1.4
TETRACHLOROETHYLENE	< 1.5
TRICHLOROFLUOROMETHANE	< 1.3
TOLUENE	< 1.0
1,2-trans-DICHLOROETHYLENE	< 1.5
1,1,1-TRICHLOROETHANE	< 1.2
1,1,2-TRICHLOROETHANE	< 1.6
TRICHLOROETHYLENE	< 1.3
TRICHLOROFLUOROMETHANE	< 1.2
VINYL CHLORIDE	< 1.2

SURROGATE COMPOUND RECOVERIES:

D4-1,2-DICHLOROETHANE	93%
D8-TOLUENE	102%
4-BROMOFLUOROBENZENE	97%

LIBRARY SEARCH DATA:
NO PEAKS TO SEARCH

VOLATILE ORGANICS ANALYSIS
SITE: RS-2
DATE OF ANALYSIS: 12/15/86
ALL RESULTS IN NG/G

BENZENE	< 0.5
BROMOFORM	< 3.2
CARBON TETRACHLORIDE	< 1.5
CHLOROBENZENE	< 0.6
CHLORODIBROMOMETHANE	< 2.0
CHLOROETHANE	< 2.4
2-CHLOROETHYLVINYL ETHER	< 5.9
CHLOROFORM	< 0.8
DICHLOROBROMOMETHANE	< 1.1
1,1-DICHLOROETHANE	< 0.8
1,2-DICHLOROETHANE	< 1.5
1,1-DICHLOROETHYLENE	< 1.9
1,2-DICHLOROPROPANE	< 1.5
1,3-cis-DICHLOROPROPYLENE	< 1.5
1,3-trans-DICHLOROPROPYLENE	< 1.5
ETHYLBENZENE	< 0.4
METHYL BROMIDE	< 1.5
METHYL CHLORIDE	< 1.6
METHYLENE CHLORIDE	42.8
1,1,2,2-TETRACHLOROETHANE	< 1.4
TETRACHLOROETHYLENE	< 1.5
TRICHLOROFLUOROMETHANE	< 1.3
TOLUENE	1.1
1,2-trans-DICHLOROETHYLENE	< 1.5
1,1,1-TRICHLOROETHANE	< 1.2
1,1,2-TRICHLOROETHANE	< 1.6
TRICHLOROETHYLENE	< 1.3
TRICHLOROFLUOROMETHANE	< 1.2
VINYL CHLORIDE	< 1.2

SURROGATE COMPOUND RECOVERIES:

D4-1,2-DICHLOROETHANE	92%
D8-TOLUENE	108%
4-BROMOFLUOROBENZENE	98%

LIBRARY SEARCH DATA:
NO PEAKS TO SEARCH

VOLATILE ORGANICS ANALYSIS
SITE: RS-3
DATE OF ANALYSIS: 12/15/86
ALL RESULTS IN NG/G

BENZENE	< 0.5
BROMOFORM	< 3.2
CARBON TETRACHLORIDE	< 1.5
CHLOROBENZENE	< 0.6
CHLORODIBROMOMETHANE	< 2.0
CHLOROETHANE	< 2.4
2-CHLOROETHYLVINYL ETHER	< 5.9
CHLOROFORM	< 0.8
DICHLOROBROMOMETHANE	< 1.1
1,1-DICHLOROETHANE	< 0.8
1,2-DICHLOROETHANE	< 1.5
1,1-DICHLOROETHYLENE	< 1.9
1,2-DICHLOROPROPANE	< 1.5
1,3-cis-DICHLOROPROPYLENE	< 1.5
1,3-trans-DICHLOROPROPYLENE	< 1.5
ETHYLBENZENE	1.1
METHYL BROMIDE	< 1.5
METHYL CHLORIDE	< 1.6
METHYLENE CHLORIDE	36.2
1,1,2,2-TETRACHLOROETHANE	< 1.4
TETRACHLOROETHYLENE	< 1.5
TRICHLOROFLUOROMETHANE	< 1.3
TOLUENE	< 1.0
1,2-trans-DICHLOROETHYLENE	< 1.5
1,1,1-TRICHLOROETHANE	< 1.2
1,1,2-TRICHLOROETHANE	< 1.6
TRICHLOROETHYLENE	< 1.3
TRICHLOROFLUOROMETHANE	< 1.2
VINYL CHLORIDE	< 1.2

SURROGATE COMPOUND RECOVERIES:

D4-1,2-DICHLOROETHANE	94%
D8-TOLUENE	101
4-BROMOFLUOROBENZENE	98%

LIBRARY SEARCH DATA:
NO PEAKS TO SEARCH

VOLATILE ORGANICS ANALYSIS
SITE: RS-4
DATE OF ANALYSIS: 12/19/86
ALL RESULTS IN NG/G

BENZENE	< 0.5
BROMOFORM	< 3.2
CARBON TETRACHLORIDE	< 1.5
CHLOROBENZENE	< 0.6
CHLORODIBROMOMETHANE	< 2.0
CHLOROETHANE	< 2.4
2-CHLOROETHYLVINYL ETHER	< 5.9
CHLOROFORM	< 0.8
DICHLOROBROMOMETHANE	< 1.1
1,1-DICHLOROETHANE	< 0.8
1,2-DICHLOROETHANE	< 1.5
1,1-DICHLOROETHYLENE	< 1.9
1,2-DICHLOROPROPANE	< 1.5
1,3-cis-DICHLOROPROPYLENE	< 1.5
1,3-trans-DICHLOROPROPYLENE	< 1.5
ETHYLBENZENE	< 0.4
METHYL BROMIDE	< 1.5
METHYL CHLORIDE	< 1.6
METHYLENE CHLORIDE	36.2
1,1,2,2-TETRACHLOROETHANE	< 1.4
TETRACHLOROETHYLENE	< 1.5
TRICHLOROFLUOROMETHANE	< 1.3
TOLUENE	< 1.0
1,2-trans-DICHLOROETHYLENE	< 1.5
1,1,1-TRICHLOROETHANE	< 1.2
1,1,2-TRICHLOROETHANE	< 1.6
TRICHLOROETHYLENE	< 1.3
TRICHLOROFLUOROMETHANE	< 1.2
VINYL CHLORIDE	< 1.2

SURROGATE COMPOUND RECOVERIES:

D4-1,2-DICHLOROETHANE	99%
D8-TOLUENE	102%
4-BROMOFLUOROBENZENE	98%

LIBRARY SEARCH DATA:

UNKNOWN HYDROCARBON	7

VOLATILE ORGANICS ANALYSIS
SITE: RS-5
DATE OF ANALYSIS: 12/12/86
ALL RESULTS IN NG/G

BENZENE	< 0.5
BROMOFORM	< 3.2
CARBON TETRACHLORIDE	< 1.5
CHLOROBENZENE	< 0.6
CHLORODIBROMOMETHANE	< 2.0
CHLOROETHANE	< 2.4
2-CHLOROETHYLVINYL ETHER	< 5.9
CHLOROFORM	< 0.8
DICHLOROBROMOMETHANE	< 1.1
1,1-DICHLOROETHANE	< 0.8
1,2-DICHLOROETHANE	< 1.5
1,1-DICHLOROETHYLENE	< 1.9
1,2-DICHLOROPROPANE	< 1.5
1,3-cis-DICHLOROPROPYLENE	< 1.5
1,3-trans-DICHLOROPROPYLENE	< 1.5
ETHYLBENZENE	< 0.4
METHYL BROMIDE	< 1.5
METHYL CHLORIDE	< 1.6
METHYLENE CHLORIDE	24.7
1,1,2,2-TETRACHLOROETHANE	< 1.4
TETRACHLOROETHYLENE	< 1.5
TRICHLOROFLUOROMETHANE	< 1.3
TOLUENE	< 1.0
1,2-trans-DICHLOROETHYLENE	< 1.5
1,1,1-TRICHLOROETHANE	< 1.2
1,1,2-TRICHLOROETHANE	< 1.6
TRICHLOROETHYLENE	< 1.3
TRICHLOROFLUOROMETHANE	< 1.2
VINYL CHLORIDE	< 1.2

SURROGATE COMPOUND RECOVERIES:

D4-1,2-DICHLOROETHANE	96%
D8-TOLUENE	103%
4-BROMOFLUOROBENZENE	100%

LIBRARY SEARCH DATA:
NO PEAKS TO SEARCH

VOLATILE ORGANICS ANALYSIS
SITE: RS-6
DATE OF ANALYSIS: 12/12/86
ALL RESULTS IN NG/G

BENZENE	< 0.5
BROMOFORM	< 3.2
CARBON TETRACHLORIDE	< 1.5
CHLOROBENZENE	< 0.6
CHLORODIBROMOMETHANE	< 2.0
CHLOROETHANE	< 2.4
2-CHLOROETHYLVINYL ETHER	< 5.9
CHLOROFORM	< 0.8
DICHLOROBROMOMETHANE	< 1.1
1,1-DICHLOROETHANE	< 0.8
1,2-DICHLOROETHANE	< 1.5
1,1-DICHLOROETHYLENE	< 1.9
1,2-DICHLOROPROPANE	< 1.5
1,3-cis-DICHLOROPROPYLENE	< 1.5
1,3-trans-DICHLOROPROPYLENE	< 1.5
ETHYLBENZENE	< 0.4
METHYL BROMIDE	< 1.5
METHYL CHLORIDE	< 1.6
METHYLENE CHLORIDE	21.3
1,1,2,2-TETRACHLOROETHANE	< 1.4
TETRACHLOROETHYLENE	< 1.5
TRICHLOROFLUOROMETHANE	< 1.3
TOLUENE	< 1.0
1,2-trans-DICHLOROETHYLENE	< 1.5
1,1,1-TRICHLOROETHANE	< 1.2
1,1,2-TRICHLOROETHANE	< 1.6
TRICHLOROETHYLENE	< 1.3
TRICHLOROFLUOROMETHANE	< 1.2
VINYL CHLORIDE	< 1.2

SURROGATE COMPOUND RECOVERIES:

D4-1,2-DICHLOROETHANE	91%
D8-TOLUENE	102%
4-BROMOFLUOROBENZENE	101%

LIBRARY SEARCH DATA:
NO PEAKS TO SEARCH

VOLATILE ORGANICS ANALYSIS
SITE: RS-7
DATE OF ANALYSIS: 12/12/86
ALL RESULTS IN NG/G

BENZENE	< 0.5
BROMOFORM	< 3.2
CARBON TETRACHLORIDE	< 1.5
CHLOROBENZENE	< 0.6
CHLORODIBROMOMETHANE	< 2.0
CHLOROETHANE	< 2.4
2-CHLOROETHYLVINYL ETHER	< 5.9
CHLOROFORM	< 0.8
DICHLOROBROMOMETHANE	< 1.1
1,1-DICHLOROETHANE	< 0.8
1,2-DICHLOROETHANE	< 1.5
1,1-DICHLOROETHYLENE	< 1.9
1,2-DICHLOROPROPANE	< 1.5
1,3-cis-DICHLOROPROPYLENE	< 1.5
1,3-trans-DICHLOROPROPYLENE	< 1.5
ETHYLBENZENE	8.4
METHYL BROMIDE	< 1.5
METHYL CHLORIDE	< 1.6
METHYLENE CHLORIDE	50.9
1,1,2,2-TETRACHLOROETHANE	< 1.4
TETRACHLOROETHYLENE	< 1.5
TRICHLOROFLUOROMETHANE	< 1.3
TOLUENE	2.4
1,2-trans-DICHLOROETHYLENE	< 1.5
1,1,1-TRICHLOROETHANE	< 1.2
1,1,2-TRICHLOROETHANE	< 1.6
TRICHLOROETHYLENE	< 1.3
TRICHLOROFLUOROMETHANE	< 1.2
VINYL CHLORIDE	< 1.2

SURROGATE COMPOUND RECOVERIES:

D4-1,2-DICHLOROETHANE	96%
D8-TOLUENE	114%
4-BROMOFLUOROBENZENE	294%

LIBRARY SEARCH DATA:

UNKNOWN HYDROCARBON	37
UNKNOWN HYDROCARBON	66
DIMETHYL CYCLOHEXANE ISOMER	18
TRICYCLODECANE	38
TRIMETHYL CYCLOHEXANE ISOMER	135
TRIMETHYL CYCLOHEXANE ISOMER	23
ETHYL METHYL CYCLOHEXANE ISOMER	95
TRIMETHYL BICYCLOHEPTANE ISOMER	109
ETHYL METHYL CYCLOHEXANE ISOMER	161
UNKNOWN HYDROCARBON	46
UNKNOWN HYDROCARBON	443
UNKNOWN HYDROCARBON	109
DECAHYDRO NAPHTHALENE	312

VOLATILE ORGANICS ANALYSIS
SITE: RS-7 RERUN
DATE OF ANALYSIS: 12/12/86
ALL RESULTS IN NG/G

BENZENE	< 0.5
BROMOFORM	< 3.2
CARBON TETRACHLORIDE	< 1.5
CHLOROBENZENE	< 0.6
CHLORODIBROMOMETHANE	< 2.0
CHLOROETHANE	< 2.4
2-CHLOROETHYLVINYL ETHER	< 5.9
CHLOROFORM	< 0.8
DICHLOROBROMOMETHANE	< 1.1
1,1-DICHLOROETHANE	< 0.8
1,2-DICHLOROETHANE	< 1.5
1,1-DICHLOROETHYLENE	< 1.9
1,2-DICHLOROPROPANE	< 1.5
1,3-cis-DICHLOROPROPYLENE	< 1.5
1,3-trans-DICHLOROPROPYLENE	< 1.5
ETHYLBENZENE	5.8
METHYL BROMIDE	< 1.5
METHYL CHLORIDE	< 1.6
METHYLENE CHLORIDE	54.5
1,1,2,2-TETRACHLOROETHANE	< 1.4
TETRACHLOROETHYLENE	< 1.5
TRICHLOROFLUOROMETHANE	< 1.3
TOLUENE	2.4
1,2-trans-DICHLOROETHYLENE	< 1.5
1,1,1-TRICHLOROETHANE	< 1.2
1,1,2-TRICHLOROETHANE	< 1.6
TRICHLOROETHYLENE	< 1.3
TRICHLOROFLUOROMETHANE	< 1.2
VINYL CHLORIDE	< 1.2

SURROGATE COMPOUND RECOVERIES:

D4-1,2-DICHLOROETHANE	85%
D8-TOLUENE	88%
4-BROMOFLUOROBENZENE	226%

LIBRARY SEARCH DATA:

UNKNOWN HYDROCARBON	37
UNKNOWN HYDROCARBON	66
DIMETHYL CYCLOHEXANE ISOMER	18
TRICYCLODECANE	38
TRIMETHYL CYCLOHEXANE ISOMER	135
TRIMETHYL CYCLOHEXANE ISOMER	23
ETHYL METHYL CYCLOHEXANE ISOMER	95
TRIMETHYL BICYCLOHEPTANE ISOMER	109
ETHYL METHYL CYCLOHEXANE ISOMER	161
UNKNOWN HYDROCARBON	46
UNKNOWN HYDROCARBON	443
UNKNOWN HYDROCARBON	105
DECAHYDRO NAPHTHALENE	312

VOLATILE ORGANICS ANALYSIS
SITE: RS-9
DATE OF ANALYSIS: 12/15/86
ALL RESULTS IN NG/G

BENZENE	< 0.5
BROMOFORM	< 3.2
CARBON TETRACHLORIDE	< 1.5
CHLOROBENZENE	< 0.6
CHLORODIBROMOMETHANE	< 2.0
CHLOROETHANE	< 2.4
2-CHLOROETHYLVINYL ETHER	< 5.9
CHLOROFORM	< 0.8
DICHLOROBROMOMETHANE	< 1.1
1,1-DICHLOROETHANE	< 0.8
1,2-DICHLOROETHANE	< 1.5
1,1-DICHLOROETHYLENE	< 1.9
1,2-DICHLOROPROPANE	< 1.5
1,3-cis-DICHLOROPROPYLENE	< 1.5
1,3-trans-DICHLOROPROPYLENE	< 1.5
ETHYLBENZENE	1.0
METHYL BROMIDE	< 1.5
METHYL CHLORIDE	< 1.6
METHYLENE CHLORIDE	19.5
1,1,2,2-TETRACHLOROETHANE	< 1.4
TETRACHLOROETHYLENE	< 1.5
TRICHLOROFLUOROMETHANE	< 1.3
TOLUENE	< 1.0
1,2-trans-DICHLOROETHYLENE	< 1.5
1,1,1-TRICHLOROETHANE	< 1.2
1,1,2-TRICHLOROETHANE	< 1.6
TRICHLOROETHYLENE	< 1.3
TRICHLOROFLUOROMETHANE	< 1.2
VINYL CHLORIDE	< 1.2

SURROGATE COMPOUND RECOVERIES:

D4-1,2-DICHLOROETHANE	93%
D8-TOLUENE	101%
4-BROMOFLUOROBENZENE	100%

LIBRARY SEARCH DATA:
NO PEAKS TO SEARCH

VOLATILE ORGANICS ANALYSIS
SITE: WELL INSTALLATION WATER
DATE OF ANALYSIS: 12/17/86
ALL RESULTS IN UG/L

BENZENE	< 0.5
BROMOFORM	< 3.2
CARBON TETRACHLORIDE	< 1.5
CHLOROBENZENE	< 0.6
CHLORODIBROMOMETHANE	< 2.0
CHLOROETHANE	< 2.4
2-CHLOROETHYLVINYL ETHER	< 5.9
CHLOROFORM	< 0.8
DICHLOROBROMOMETHANE	< 1.1
1,1-DICHLOROETHANE	< 0.8
1,2-DICHLOROETHANE	< 1.5
1,1-DICHLOROETHYLENE	< 1.9
1,2-DICHLOROPROPANE	< 1.5
1,3-cis-DICHLOROPROPYLENE	< 1.5
1,3-trans-DICHLOROPROPYLENE	< 1.5
ETHYLBENZENE	< 0.4
METHYL BROMIDE	< 1.5
METHYL CHLORIDE	< 1.6
METHYLENE CHLORIDE	22.0
1,1,2,2-TETRACHLOROETHANE	< 1.4
TETRACHLOROETHYLENE	< 1.5
TRICHLOROFLUOROMETHANE	< 1.3
TOLUENE	< 1.0
1,2-trans-DICHLOROETHYLENE	< 1.5
1,1,1-TRICHLOROETHANE	< 1.2
1,1,2-TRICHLOROETHANE	< 1.6
TRICHLOROETHYLENE	< 1.3
TRICHLOROFLUOROMETHANE	< 1.2
VINYL CHLORIDE	< 1.2

SURROGATE COMPOUND RECOVERIES:

D4-1,2-DICHLOROETHANE	95%
D8-TOLUENE	100%
4-BROMOFLUOROBENZENE	96%

LIBRARY SEARCH DATA:
NO PEAKS TO SEARCH

AQUA TECH
ENVIRONMENTAL CONSULTANTS, INC.
P.O. Box 76, Melmore, Ohio 44845, 419-397-2659 or 397-2222
P.O. Box 436, 181 South Main Street, Marion, Ohio 43302, 614-382-5991

LABORATORY ANALYSIS REPORT

DATE REC'D. 01-21-1987
DATE REP'D. 01-26-1987
P.O. # 3067-40024
LAB NO. 589-87
CLIENT NO. 10030

SAMPLE LOCATION RS-1 SPLIT
SAMPLED BY EE PERSONNEL
DATE SAMPLED ?
TIME SAMPLED ?

--
ENVIRODYNE ENGINEERS
12161 LACKLAND RD
ST. LOUIS MO 63146

COMMENTS:

STORET	ANALYSIS	RESULT	UNITS	DATE OF ANALYSIS
45501	PETROLEUM HYDROCARBONS	8530	MG/KG	01-23-1987

LABORATORY CERTIFICATION # 4053

SIGNED Jeffrey A. Smith

COPY DISTRIBUTION: WHITE - CLIENT YELLOW - FILE

AQUA TECH
ENVIRONMENTAL CONSULTANTS, INC.
P.O. Box 76, Melmore, Ohio 44845, 419-397-2659 or 397-2222
P.O. Box 436, 181 South Main Street, Marion, Ohio 43302, 614-382-5991

LABORATORY ANALYSIS REPORT

DATE REC'D. Ø1-21-1987
DATE REP'D. Ø1-26-1987
P.O. # 3067-4ØØ24
LAB NO. 588-87
CLIENT NO. IØØ3Ø

SAMPLE LOCATION RS-1
SAMPLED BY EE PERSONNEL
DATE SAMPLED ?
TIME SAMPLED ?

--
ENVIRODYNE ENGINEERS
12161 LACKLAND RD
ST. LOUIS MO 63146

COMMENTS:

STORET	ANALYSIS	RESULT	UNITS	DATE OF ANALYSIS
45501	PETROLEUM HYDROCARBONS	8310	MG/KG	Ø1-23-1987

LABORATORY CERTIFICATION # 4053

SIGNED Jeffrey A. Smith

COPY DISTRIBUTION: WHITE - CLIENT YELLOW - FILE

AQUA TECH
ENVIRONMENTAL CONSULTANTS, INC.
P.O. Box 76, Melmore, Ohio 44845, 419-397-2659 or 397-2222
P.O. Box 436, 181 South Main Street, Marion, Ohio 43302, 614-382-5991

LABORATORY ANALYSIS REPORT

DATE REC'D. Ø1-21-1987
DATE REP'D. Ø1-26-1987
P.O. # 3067-4ØØ24
LAB NO. 59Ø-87
CLIENT NO. 1ØØ3Ø

SAMPLE LOCATION RS-8
SAMPLED BY EE PERSONNEL
DATE SAMPLED ?
TIME SAMPLED ?

--
ENVIRODYNE ENGINEERS
12161 LACKLAND RD
ST. LOUIS MO 63146

COMMENTS:

STORET	ANALYSIS	RESULT	UNITS	DATE OF ANALYSIS
45501	PETROLEUM HYDROCARBONS	63	MG/KG	Ø1-23-1987

LABORATORY CERTIFICATION # 4053

SIGNED Jeffrey A. Smith

COPY DISTRIBUTION: WHITE - CLIENT YELLOW - FILE

AQUA TECH
ENVIRONMENTAL CONSULTANTS, INC
P.O. Box 76, Melmore, Ohio 44845 419-397-2659 or 397-2222
P.O. Box 436, 181 South Main Street, Marion, Ohio 43302, 614-382-5991

LABORATORY ANALYSIS REPORT

DATE REC'D. 01-21-1987
DATE REP'D. 01-26-1987 P.O. # 3067-40024

LAB NO. 591-87
CLIENT NO. 10030

SAMPLE LOCATION RS-8 RINSATE
SAMPLED BY EE PERSONNEL

DATE SAMPLED ?
TIME SAMPLED ?

--
ENVIRODYNE ENGINEERS
12161 LACKLAND RD
ST. LOUIS MO 63146

COMMENTS:

STORET	ANALYSIS	RESULT	UNITS	DATE OF ANALYSIS
45501	PETROLEUM HYDROCARBONS	0.5	MG/L	01-23-1987

LABORATORY CERTIFICATION # 4053

SIGNED Jeffrey A. Smith

COPY DISTRIBUTION: WHITE - CLIENT YELLOW - FILE

AQUA TECH
ENVIRONMENTAL CONSULTANTS, INC
P.O. Box 76, Melmore, Ohio 44845, 419-397-2659 or 397-2222
P.O. Box 436, 181 South Main Street, Marion, Ohio 43302, 614-382-5991

LABORATORY ANALYSIS REPORT

DATE REC'D. 01-21-1987
DATE REP'D. 01-26-1987
P.O. # 3067-40024
LAB NO. 592-87
CLIENT NO. 10030

SAMPLE LOCATION RG-1
SAMPLED BY EE PERSONNEL
DATE SAMPLED ?
TIME SAMPLED ?

--
ENVIRODYNE ENGINEERS
12161 LACKLAND RD
ST. LOUIS MO 63146

COMMENTS:

STORET	ANALYSIS	RESULT	UNITS	DATE OF ANALYSIS
45501	PETROLEUM HYDROCARBONS	<0.5	MG/L	01-23-1987

LABORATORY CERTIFICATION # 4053

SIGNED Jeffrey A. Smith

COPY DISTRIBUTION: WHITE - CLIENT YELLOW - FILE

AQUA TECH
ENVIRONMENTAL CONSULTANTS, INC.
P.O. Box 76, Melmore, Ohio 44845, 419-397-2659 or 397-2222
P.O. Box 436, 181 South Main Street, Marion, Ohio 43302, 614-382-5991

LABORATORY ANALYSIS REPORT

DATE REC'D. 01-21-1987
DATE REP'D. 01-26-1987
P.O. # 3067-40024
LAB NO. 593-87
CLIENT NO. 10030

SAMPLE LOCATION RG-1 SPLIT
SAMPLED BY EE PERSONNEL
DATE SAMPLED ?
TIME SAMPLED ?

--
ENVIRODYNE ENGINEERS
12161 LACKLAND RD
ST. LOUIS MO 63146

COMMENTS:

STORET	ANALYSIS	RESULT	UNITS	DATE OF ANALYSIS
45501	PETROLEUM HYDROCARBONS	<0.5	MG/L	01-23-1987

LABORATORY CERTIFICATION # 4053

SIGNED Jeffrey A. Smith

COPY DISTRIBUTION: WHITE - CLIENT YELLOW - FILE

AQUA TECH
ENVIRONMENTAL CONSULTANTS, INC.
P.O Box 76, Melmore, Ohio 44845, 419-397-2659 or 397-2222
P.O Box 436, 181 South Main Street, Marion, Ohio 43302, 614-382-5991

LABORATORY ANALYSIS REPORT

DATE REC'D. 01-21-1987
DATE REP'D. 01-26-1987
P.O. # 3067-40024
LAB NO. 594-87
CLIENT NO. 10030

SAMPLE LOCATION RG-2
SAMPLED BY EE PERSONNEL
DATE SAMPLED ?
TIME SAMPLED ?

--
ENVIRODYNE ENGINEERS
12161 LACKLAND RD
ST. LOUIS MO 63146

COMMENTS:

STORET	ANALYSIS	RESULT	UNITS	DATE OF ANALYSIS
45501	PETROLEUM HYDROCARBONS	<0.5	MG/L	01-23-1987

LABORATORY CERTIFICATION # 4053

SIGNED Jeffrey A. Smith

COPY DISTRIBUTION: WHITE - CLIENT YELLOW - FILE

AQUA TECH
ENVIRONMENTAL CONSULTANTS, INC.
P.O. Box 76, Melmore, Ohio 44845, 419-397-2659 or 397-2222
P.O. Box 436, 181 South Main Street, Marion, Ohio 43302, 614-382-5991

LABORATORY ANALYSIS REPORT

DATE REC'D. Ø1-21-1987
DATE REP'D. Ø1-26-1987
P.O. # 3Ø67-4ØØ24
LAB NO. 595-87
CLIENT NO. IØØ3Ø

SAMPLE LOCATION RG-3
SAMPLED BY EE PERSONNEL
DATE SAMPLED ?
TIME SAMPLED ?

--
ENVIRODYNE ENGINEERS
12161 LACKLAND RD
ST. LOUIS MO 63146

COMMENTS:

STORET	ANALYSIS	RESULT	UNITS	DATE OF ANALYSIS
45Ø1	PETROLEUM HYDROCARBONS	1.8	MG/L	Ø1-23-1987

LABORATORY CERTIFICATION # 4053

SIGNED Jeffrey A. Smith

COPY DISTRIBUTION: WHITE - CLIENT YELLOW - FILE

AQUA TECH
ENVIRONMENTAL CONSULTANTS, INC
P.O Box 76, Melmore, Ohio 44845. 419-397-2659 or 397-2222
P.O Box 436, 181 South Main Street, Marion, Ohio 43302. 614-382-5991

LABORATORY ANALYSIS REPORT

DATE REC'D. Ø1-21-1987
DATE REP'D. Ø1-26-1987
P.O. # 3067-4ØØ24
LAB NO. 596-87
CLIENT NO. IØØ3Ø

SAMPLE LOCATION RG-4
SAMPLED BY EE PERSONNEL
DATE SAMPLED ?
TIME SAMPLED ?

--
ENVIRODYNE ENGINEERS
12161 LACKLAND RD
ST. LOUIS MO 63146

COMMENTS:

STORET	ANALYSIS	RESULT	UNITS	DATE OF ANALYSIS
455Ø1	PETROLEUM HYDROCARBONS	<Ø.5	MG/L	Ø1-23-1987

LABORATORY CERTIFICATION # 4053

SIGNED Jeffrey A. Smith

COPY DISTRIBUTION: WHITE - CLIENT YELLOW - FILE

AQUA TECH
ENVIRONMENTAL CONSULTANTS, INC.
P.O. Box 76, Melmore, Ohio 44845, 419-397-2659 or 397-2222
P.O Box 436, 181 South Main Street, Marion, Ohio 43302, 614-382-5991

LABORATORY ANALYSIS REPORT

DATE REC'D. Ø1-21-1987
DATE REP'D. Ø1-26-1987
P.O. # 3Ø67-4ØØ24
LAB NO. 597-87
CLIENT NO. IØØ3Ø

SAMPLE LOCATION RB-7 BLANK
SAMPLED BY EE PERSONNEL
DATE SAMPLED ?
TIME SAMPLED ?

--
ENVIRODYNE ENGINEERS
12161 LACKLAND RD
ST. LOUIS MO 63146

COMMENTS:

STORET	ANALYSIS	RESULT	UNITS	DATE OF ANALYSIS
45Ø1	PETROLEUM HYDROCARBONS	<Ø.5	MG/L	Ø1-23-1987

LABORATORY CERTIFICATION # 4053

SIGNED Jeffrey A. Smith

COPY DISTRIBUTION: WHITE - CLIENT YELLOW - FILE

LAB NUMBER	PARAMETER	ANAL #1	ANAL #2	AMT.OF SPIKE	SPIKED SAMPLE ANALYSIS	%R	UNITS
588-87	PETROLEUM HYDROCARBONS	8360	8260				MG/KG

INDUSTRIAL TESTING LABORATORIES inc.

Chemists
Engineers
Metallurgists

2350 Seventh Blvd. • St. Louis, Missouri 63104 | 314/771-7111

Report No. 86-12-97 January 7, 1987

Determination of Hydrocarbon content on fifteen (15) samples submitted 12/5/86 marked, "Project No. 3067-40025".

Envirodyne Engineers
12161 Lackland Road
St. Louis, MO. 63146

Attn: Mr. Paul Myers

TEST REPORT

A. Aqueous Samples:

Sample Identification	Hydrocarbons, mg/l
RB-1, 12/3/86	5.0
RB-2, 12/3/86	3.7
RB-3, 12/3/86	4.0
RB-4, 12/3/86	1810
RB-5, 12/3/86	2.4
RB-6, 12/3/86	1.7
Well, 12/3/86	1.7
RB-2, 12/3/86	3.8

INDUSTRIAL
TESTING
LABORATORIES
inc.

B. Soil Samples:

Sample Identification	Hydrocarbons, ppm
RS-2, 12/2/86	62
RS-3, 12/2/86	36
RS-4, 12/2/86	28
RS-5, 12/2/86	40
RS-6, 12/2/86	46
RS-7, 12/2/86	264
RS-9, 12/2/86	24

Respectfully submitted,

INDUSTRIAL TESTING LABORATORIES, INC.

Allan M. Siegel, P.E.
Director

Lab No. 73351
LB22488-90
RW/hj

Inv/ #11256

APPENDIX I

External QA Laboratory Analytical Results

DEPARTMENT OF THE ARMY
ST. LOUIS DISTRICT, CORPS OF ENGINEERS
210 TUCKER BLVD., NORTH
ST. LOUIS, MISSOURI 63101-1986

REPLY TO
ATTENTION OF

June 15,1987

Contracts Management Group
Engineering Division

SUBJECT: Contract No. DACA87-D-0045, Delivery Order No. 4
Former Bomarc Missile Site, Raco, Michigan

Mr. Thomas Lachajczyk
Program Manager
Envirodyne Engineers, Inc.
12161 Lackland Road
St. Louis, Missouri 63146

Dear Mr. Lachajczyk:

In accordance with Operating Procedures for Management of Chemical Data quality, the Contracting Officer shall transmit to the A-E the QA Laboratory's results and appropriate comments. This shall be attached to the A-E's final Engineering Report as an appendix.

Sincerely,

John B. Hallquist III, P.E.
Authorized Representative
of the Contracting Officer

Enclosure

ED-C

MRD LAB NO. 87/56

DEPARTMENT OF THE ARMY
MISSOURI RIVER DIVISION, CORPS OF ENGINEERS
DIVISION LABORATORY
OMAHA, NEBRASKA 68102

12 JUN 1987

Subject: QA/QC Final Report

Project: Former Raco Bomarc Missile Battery
Intended Use: DERA Confirmation Study
Source of Material:

Submitted by: Mike Dace, St. Louis District, CELMS-ED-PM
Date Sampled: _____, Date Received: _____
Method of Test or Specification: See attached tables

References: Project No. E05MI002600

REMARKS

1. Project Objective:

The object is a preliminary determination of the presence or absence of chemical contamination which may have been caused by DOD related activities. The work effort involves the investigation of the contiguous groundwater and soil for possible contamination by solvents, starting fluid mixtures, fuels, hydraulic fluids, paints, and any hazardous substances associated with the operation, maintenance, and deactivation of the site.

2. Brief Site Background:

The former Raco missile site occupies 152.54 acres of land. The site is currently owned by the US Forest Service as part of the Hiawatha National Forest. It is part of an area that has been intermittently controlled and used by DOD and other government agencies since 1895. Areas of interest are a small airfield constructed in approximately 1942-3 and a base for the Bomarc Missiles built in approximately 1960. The airfield property was returned to the Forest Service in 1964, and the missile site was returned in 1973. There has been no DOD use of the area since 1973.

Solsky/gc/3211

3. Initial Project Comments:

Comments were provided to St. Louis District on 24 October 1986, 18 November 1986, and 6 January 1987 on the Scope of Work, Sampling-Analysis QA/QC Plan, and on the Monitoring Well Installation Plan, respectively by the MRD Laboratory. Numerous comments were made on the nature of QA and QC samples, analytical methodology to be used, and background samples. All comments were resolved before work started at the site.

The MRD Laboratory furnished all containers and shipping materials for the collection and shipment of the QA samples. These containers were shipped to the site on 4 December 1986.

4) Contractor Results:

The contractor's lab (Envirodyne Engineers, 12161 Lackland Road, St. Louis, Missouri 64146, (314)434-6960) provided the raw analytical data to the MRD Laboratory on 26 March 1987. The Draft Final report was provided on 13 April 1987.

The contractor's laboratory listed a duplicate compound on all of their data reports. The compound trichlorofluoromethane was listed twice with different detection limits on all tables. This discrepancy should be resolved.

5. Contractor QC Results:

a. Volatile Organics:

All surrogate compound recoveries were within methodology limits. Daily blanks were evaluated. These blanks all indicated the presence of very low levels of ethylbenzene and slightly higher levels of methylene chloride. Methylene chloride is a commonly used laboratory solvent and its presence in these samples is very common. All of the values reported for methylene chloride are most likely the result of laboratory contamination and not the result of site contamination. It is not common to see low levels of ethylbenzene. This is not a common laboratory solvent however, since low levels of this compound are found in virtually all of the samples, it too is more than likely the result of laboratory contamination. Duplicate analyses on single groundwater and soil samples displayed good agreement. No duplicate was analyzed on any silo water sample. All travel blanks were negative except for detected low levels of ethylbenzene and methylene chloride. Rinsate samples also showed low levels of ethylbenzene and methylene chloride for the silo and soil samples. No rinsate was collected for the groundwater samples. These rinsate samples also showed low levels of trichlorofluoromethane and toluene. Since these compounds were not detected in the lab or travel blanks, it must be assumed that field contamination occurred. This data would cast doubt on all values reported for these two compounds. Both were found in several field samples. The QA laboratory also found low levels which would confirm this source of contamination. No volatile compounds were detected in the background soil sample.

b. PCB's:

No PCB's were detected in any sample. No PCB blank values were reported. All duplicate analyses agreed. All rinsates were free of PCB contamination. No background levels of PCB's were reported.

c. Petroleum Hydrocarbons:

All duplicate analyses agreed. No blank values were reported. The single rinsate sample taken showed no detectable petroleum hydrocarbons. Low levels of petroleum hydrocarbons were detected in the background soil sample.

d. Metals:

Low levels of arsenic, barium, and chromium were found in most soil samples, including the background soil sample. Low levels of lead and barium were found in most silo water samples. Low levels of barium were detected in all groundwater samples. All duplicate values agreed. No metals were detected in the soil and silo rinsate samples. No metal QC information was provided in this report for spike analysis. It is therefore not possible to examine any matrix problems which might have been present.

6. QA Results:

All QA samples were contracted out for analysis to the Martin Marietta Energy Systems, Inc. Laboratory in Oak Ridge, Tennessee. Their data report is included.

All samples received were analyzed for the same parameters as performed by the contractor's laboratory. The QA results were received by this office on 8 June 1987.

All duplicate, spike, and blank data fell within acceptable limits. This data are clearly shown on the QA data report.

7. QA Overview:

All samples were delivered to the lab in the appropriate containers properly preserved. No problems were encountered. However, small air bubbles were noted in one of the glass vials received for the sample labelled "RB-7 Sampling Blank."

The analytical methodology used for the petroleum hydrocarbon analyses differed significantly between the two labs. The method specified in the original "Sampling/Analysis - QA/QC Plan" was Standard Methods No. 503 C,D for soil and 503 C,E for water. The method actually used for sample analysis was 418.1. These are different procedures which yield different answers. The QA laboratory analyzed these samples using the methods originally specified. Therefore, a data comparison cannot be performed. The method used by the contractor's laboratory is appropriate, and preferred, for this type of analysis.

8. QA/QC Data Comparison:

Six (6) QA samples were received for this project. The following chart lists the samples' identity and the corresponding enclosed table where the actual data summary and comparison to the contractor's data is given:

Sample	Matrix	Table No.
RB-7 (Silo #26)	Water	1 *
RB-7 (Sampling Blank)	Water	2
RG-1 (Well 1)	Water	3
RS-1 (Transformer Pad)	Soil	4
RS-8 (Rinsate)	Water	5
Travel Blank	Water	6

* Envirodyne did not analyze this sample, therefore no comparison can be made.

Specific data comparison comments can be found at the end of each table.

In general, all data agreed and no significant deviations were noted.

9. Summary:

The QA data agrees with and supports all of the contractor's laboratory data. The change in methodology used for the petroleum hydrocarbon analyses should not alter the conclusions reached in the Contractor's Final Report. The contamination reported for toluene and trichlorofluoromethane should be further examined due to its presence in the sampling blanks. The contractor's laboratory did not report all of its internal Quality Control information which makes a final evaluation of the metals data difficult.

Submitted by:

R. K. SCHLENKER, P.E.
Director, MRD Laboratory

DEPARTMENT OF THE ARMY
Missouri River Division, Corps of Engineers
Division Laboratory
Omaha, Nebraska

TABLE 1

Project: Former Bomarc Missile Battery and Airfield (Raco, MI)
Date Sample Received: RB-7 (Silo #26)
Customer Sample No: 14 January 1987
Material Description: Water

Analysis	QA Lab Result	Contractor Result	Unit
Miscellaneous			
Oil and Grease	<2		mg/L
PCB's	<0.5		ug/L
Total Metals			
Barium	0.013		mg/L
Cadmium	<0.0030		mg/L
Chromium	<0.010		mg/L
Lead	<0.050		mg/L
Silver	<0.0060		mg/L
Arsenic	<0.005		mg/L
Selenium	<0.005		mg/L
Mercury	<0.0002		mg/L
Dissolved Metals			
Barium	0.014		mg/L
Cadmium	<0.0030		mg/L
Chromium	<0.010		mg/L
Lead	<0.050		mg/L
Silver	<0.0060		mg/L
Arsenic	<0.005		mg/L
Selenium	<0.005		mg/L
Mercury	<0.0002		mg/L

DEPARTMENT OF THE ARMY
Missouri River Division, Corps of Engineers
Division Laboratory
Omaha, Nebraska

TABLE 1

Analysis	QA Lab Result	Contractor Result	Unit
Volatile Organics			
Benzene	<5.0		ug/L
Bromoform	<5.0		ug/L
Carbon Tetrachloride	<5.0		ug/L
Chlorobenzene	<5.0		ug/L
Chlorodibromomethane	<5.0		ug/L
Chloroethane	<10.0		ug/L
2-Chloroethylvinyl Ether	<10.0		ug/L
Chloroform	<5.0		ug/L
Dichlorobromomethane	<5.0		ug/L
1,1-Dichloroethane	<5.0		ug/L
1,2-Dichloroethane	<5.0		ug/L
1,1-Dichloroethylene	<5.0		ug/L
1,2-Dichloropropane	<5.0		ug/L
1,3-cis-Dichloropropylene	<5.0		ug/L
1,3-trans-Dichloropropylene	<5.0		ug/L
Ethylbenzene	<5.0		ug/L
Methyl Bromide	<10.0		ug/L
Methyl Chloride	<10.0		ug/L
Methylene Chloride	<5.0		ug/L
1,1,2,2-Tetrachloroethane	<5.0		ug/L
Tetrachloroethylene	<5.0		ug/L
Trichlorofluoromethane	-		ug/L
Toluene	1		ug/L
1,2-trans-Dichloroethylene	<5.0		ug/L
1,1,1-Trichloroethane	<5.0		ug/L
1,1,2-Trichloroethane	<5.0		ug/L
Trichloroethylene	<5.0		ug/L
Vinyl Chloride	<5.0		ug/L

Comments: No contractor data was available for comparison. The contractor failed to run this sample.

DEPARTMENT OF THE ARMY
Missouri River Division, Corps of Engineers
Division Laboratory
Omaha, Nebraska

TABLE 2

Project: Former Bomarc Missile Battery and Airfield (Raco, MI)
Date Sample Received: RB-7 (Sampling Blank)
Customer Sample No: 14 January 1987
Material Description: Water

Analysis	QA Lab Result	Contractor Result	Unit
Miscellaneous			
Oil and Grease	<2	<0.5	mg/L
PCB's	<0.5	<0.22	ug/L
Total Metals			
Barium	<0.0010	<0.005	mg/L
Cadmium	<0.0030	<0.001	mg/L
Chromium	<0.010	<0.005	mg/L
Lead	<0.050	<0.005	mg/L
Silver	<0.0060	<0.0014	mg/L
Arsenic	<0.005	<0.0035	mg/L
Selenium	<0.005	<0.0021	mg/L
Mercury	<0.0002	<0.0002	mg/L
Dissolved Metals			
Barium	<0.0010	<0.005	mg/L
Cadmium	<0.0030	<0.001	mg/L
Chromium	<0.010	<0.005	mg/L
Lead	<0.050	<0.005	mg/L
Silver	<0.0060	<0.0014	mg/L
Arsenic	<0.005	<0.0035	mg/L
Selenium	<0.005	<0.0021	mg/L
Mercury	<0.0002	<0.0002	mg/L

DEPARTMENT OF THE ARMY
Missouri River Division, Corps of Engineers
Division Laboratory
Omaha, Nebraska

TABLE 2

Analysis Volatile Organics	QA Lab Result	Contractor Result	Unit
Benzene	<5.0	<0.5	ug/L
Bromoform	<5.0	<3.2	ug/L
Carbon Tetrachloride	<5.0	<1.5	ug/L
Chlorobenzene	<5.0	<0.6	ug/L
Chlorodibromomethane	<5.0	<2.0	ug/L
Chloroethane	<10.0	<2.4	ug/L
2-Chloroethylvinyl Ether	<10.0	<5.9	ug/L
Chloroform	<5.0	<0.8	ug/L
Dichlorobromomethane	<5.0	<1.1	ug/L
1,1-Dichloroethane	<5.0	<0.8	ug/L
1,2-Dichloroethane	<5.0	<1.5	ug/L
1,1-Dichloroethylene	<5.0	<1.9	ug/L
1,2-Dichloropropane	<5.0	<1.5	ug/L
1,3-cis-Dichloropropylene	<5.0	<1.5	ug/L
1,3-trans-Dichloropropylene	<5.0	<1.5	ug/L
Ethylbenzene	<5.0	0.8	ug/L
Methyl Bromide	<10.0	<1.5	ug/L
Methyl Chloride	<10.0	<1.6	ug/L
Methylene Chloride	4	6.2	ug/L
1,1,2,2-Tetrachloroethane	<5.0	<1.4	ug/L
Tetrachloroethylene	<5.0	<1.5	ug/L
Trichlorofluoromethane	-	3.2	ug/L
Toluene	8	9.2	ug/L
1,2-trans-Dichloroethylene	<5.0	<1.5	ug/L
1,1,1-Trichloroethane	<5.0	<1.2	ug/L
1,1,2-Trichloroethane	<5.0	<1.6	ug/L
Trichloroethylene	<5.0	<1.3	ug/L
Vinyl Chloride	<10.0	<1.2	ug/L

Comments: All data agreed

DEPARTMENT OF THE ARMY
Missouri River Division, Corps of Engineers
Division Laboratory
Omaha, Nebraska

TABLE 3

Project: Former Bomarc Missile Battery and Airfield (Raco, MI)
Date Sample Received: RG-1 (Well #1)
Customer Sample No: 14 January 1987
Material Description: Water

Analysis	QA Lab Result	Contractor Result	Unit
Miscellaneous			
Oil and Grease	<2	<0.5	mg/L
PCB's	<0.5	<0.22	ug/L
Total Metals			
Barium	0.038	0.044	mg/L
Cadmium	<0.0030	<0.001	mg/L
Chromium	<0.010	<0.005	mg/L
Lead	<0.050	<0.005	mg/L
Silver	<0.0060	<0.0014	mg/L
Arsenic	<0.005	<0.0035	mg/L
Selenium	<0.005	<0.0021	mg/L
Mercury	<0.0002	<0.0002	mg/L
Dissolved Metals			
Barium	0.020	0.019	mg/L
Cadmium	<0.0030	<0.001	mg/L
Chromium	<0.010	<0.005	mg/L
Lead	<0.050	<0.005	mg/L
Silver	<0.0060	<0.0014	mg/L
Arsenic	<0.005	<0.0035	mg/L
Selenium	<0.005	<0.0021	mg/L
Mercury	<0.0002	<0.0002	mg/L

DEPARTMENT OF THE ARMY
Missouri River Division, Corps of Engineers
Division Laboratory
Omaha, Nebraska

TABLE 3

Analysis Volatile Organics	QA Lab Result	Contractor Result	Unit
Benzene	<5.0	<0.5	ug/L
Bromoform	<5.0	<3.2	ug/L
Carbon Tetrachloride	<5.0	<1.5	ug/L
Chlorobenzene	<5.0	<0.6	ug/L
Chlorodibromomethane	<5.0	<2.0	ug/L
Chloroethane	<10.0	<2.4	ug/L
2-Chloroethylvinyl Ether	<10.0	<5.9	ug/L
Chloroform	<5.0	<0.8	ug/L
Dichlorobromomethane	<5.0	<1.1	ug/L
1,1-Dichloroethane	<5.0	<0.8	ug/L
1,2-Dichloroethane	<5.0	<1.5	ug/L
1,1-Dichloroethylene	<5.0	<1.9	ug/L
1,2-Dichloropropane	<5.0	<1.5	ug/L
1,3-cis-Dichloropropylene	<5.0	<1.5	ug/L
1,3-trans-Dichloropropylene	<5.0	<1.5	ug/L
Ethylbenzene	<5.0	<0.4	ug/L
Methyl Bromide	<10.0	<1.5	ug/L
Methyl Chloride	<10.0	<1.6	ug/L
Methylene Chloride	<5.0	5.5	ug/L
1,1,2,2-Tetrachloroethane	<5.0	<1.4	ug/L
Tetrachloroethylene	<5.0	<1.5	ug/L
Trichlorofluoromethane	-	<1.3	ug/L
Toluene	<5.0	<1.0	ug/L
1,2-trans-Dichloroethylene	<5.0	<1.5	ug/L
1,1,1-Trichloroethane	<5.0	<1.2	ug/L
1,1,2-Trichloroethane	<5.0	<1.6	ug/L
Trichloroethylene	<5.0	<1.3	ug/L
Vinyl Chloride	<10.0	<1.2	ug/L

Comments: All data agreed

DEPARTMENT OF THE ARMY
Missouri River Division, Corps of Engineers
Division Laboratory
Omaha, Nebraska

TABLE 4

Project: Former Bomarc Missile Battery and Airfield (Raco, MI)
Date Sample Received: RS-1 (Transformer Pad)
Customer Sample No: 15 January 1987
Material Description: Soil

Analysis	QA Lab Result	Contractor Result	Unit
Miscellaneous			
* Oil and Grease	13,000	8,310	mg/kg
PCB's	<0.1	<0.022	ug/g
Total Metals			
Barium	8.6	8.4	ug/g
Cadmium	0.44	<1	ug/g
Chromium	2.3	4.3	ug/g
Lead	<5.0	<5.0	ug/g
Silver	<0.60	<0.20	ug/g
* Arsenic	<0.5	1.48	ug/g
Selenium	<0.5	<0.32	ug/g
Mercury	<1.0	<0.2	ug/g
Volatile Organics			
Benzene	< 25	<0.5	ug/kg
Bromoform	< 25	<3.2	ug/kg
Carbon Tetrachloride	< 25	<1.5	ug/kg
Chlorobenzene	< 25	<0.6	ug/kg
Chlorodibromomethane	< 25	<2.0	ug/kg
Chloroethane	< 50	<2.4	ug/kg
2-Chloroethylvinyl Ether	< 50	<5.9	ug/kg
* Chloroform	54	<0.8	ug/kg
Dichlorobromomethane	< 25	<1.1	ug/kg
1,1-Dichloroethane	< 25	<0.8	ug/kg
1,2-Dichloroethane	< 25	<1.5	ug/kg
1,1-Dichloroethylene	< 25	<1.9	ug/kg
1,2-Dichloropropane	< 25	<1.5	ug/kg
1,3-cis-Dichloropropylene	< 25	<1.5	ug/kg
1,3-trans-Dichloropropylene	< 25	<1.5	ug/kg

DEPARTMENT OF THE ARMY
Missouri River Division, Corps of Engineers
Division Laboratory
Omaha, Nebraska

TABLE 4

Analysis	QA Lab Result	Contractor Result	Unit
Ethylbenzene	< 25	<0.4	ug/kg
Methyl Bromide	< 50	<1.5	ug/kg
Methyl Chloride	< 50	<1.6	ug/kg
* Methylene Chloride	6	130.6	ug/kg
1,1,2,2-Tetrachloroethane	< 25	<1.4	ug/kg
Tetrachloroethylene	< 25	<1.5	ug/kg
Trichlorofluoromethane	-	<1.3	ug/kg
Toluene	4	9.7	ug/kg
1,2-trans-Dichloroethylene	< 25	<1.5	ug/kg
1,1,1-Trichloroethane	< 25	<1.2	ug/kg
1,1,2-Trichloroethane	< 25	<1.6	ug/kg
Trichloroethylene	< 25	<1.3	ug/kg
Vinyl Chloride	< 50	<1.2	ug/kg

Comments: Some of the values disagreed and these compounds are marked with a "*." No serious problem exists with arsenic since the value reported for arsenic is close to the method detection limit. The values listed for methylene chloride and chloroform are typical for laboratories. Both are commonly used solvents and are routinely found at these levels in laboratories. Therefore, it would be expected that if contamination were present, the values would not agree.

The oil and grease values will differ due to the different methods used by each laboratory. The oil and grease method (503 C,D) will yield higher values than the petroleum hydrocarbon method (418.1). Therefore, the QA value would be expected to be higher than the Contractor's value.

DEPARTMENT OF THE ARMY
Missouri River Division, Corps of Engineers
Division Laboratory
Omaha, Nebraska

TABLE 5

Project: Former Bomarc Missile Battery and Airfield (Raco, MI)
Date Sample Received: RS-8 Rinsate
Customer Sample No: 15 January 1987
Material Description: Water

Analysis	QA Lab Result	Contractor Result	Unit
Miscellaneous			
Oil and Grease	<0.5	0.5	mg/L
PCB's	<0.5	<0.22	ug/g
Total Metals			
Barium	<0.0010	<0.005	mg/L
Cadmium	<0.0030	<0.001	mg/L
Chromium	<0.010	<0.005	mg/L
Lead	<0.050	<0.005	mg/L
Silver	<0.0060	<0.0014	mg/L
Arsenic	<0.005	<0.0035	mg/L
Selenium	<0.005	<0.0021	mg/L
Mercury	<0.0002	<0.0002	mg/L
Volatile Organics			
Benzene	<5.0	<0.5	ug/L
Bromoform	<5.0	<3.2	ug/L
Carbon Tetrachloride	<5.0	<1.5	ug/L
Chlorobenzene	<5.0	<0.6	ug/L
Chlorodibromomethane	<5.0	<2.0	ug/L
Chloroethane	<10.0	<2.4	ug/L
2-Chloroethylvinyl Ether	<10.0	<5.9	ug/L
Chloroform	<5.0	<0.8	ug/L
Dichlorobromomethane	<5.0	<1.1	ug/L
1,1-Dichloroethane	<5.0	<0.8	ug/L
1,2-Dichloroethane	<5.0	<1.5	ug/L
1,1-Dichloroethylene	<5.0	<1.9	ug/L
1,2-Dichloropropane	<5.0	<1.5	ug/L
1,3-cis-Dichloropropylene	<5.0	<1.5	ug/L
1,3-trans-Dichloropropylene	<5.0	<1.5	ug/L

DEPARTMENT OF THE ARMY
Missouri River Division, Corps of Engineers
Division Laboratory
Omaha, Nebraska

TABLE 5

Analysis	QA Lab Result	Contractor Result	Unit
Ethylbenzene	<5.0	0.7	ug/L
Methyl Bromide	<10.0	<1.5	ug/L
Methyl Chloride	<10.0	<1.6	ug/L
Methylene Chloride	<5.0	4.0	ug/L
1,1,2,2-Tetrachloroethane	<5.0	<1.4	ug/L
Tetrachloroethylene	<5.0	<1.5	ug/L
Trichlorofluoromethane	-	5.2	ug/L
Toluene	8	9.0	ug/L
1,2-trans-Dichloroethylene	<5.0	<1.5	ug/L
1,1,1-Trichloroethane	<5.0	<1.2	ug/L
1,1,2-Trichloroethane	<5.0	<1.6	ug/L
Trichloroethylene	<5.0	<1.3	ug/L
Vinyl Chloride	<5.0	<1.2	ug/L

Comments: All data agreed

DEPARTMENT OF THE ARMY
Missouri River Division, Corps of Engineers
Division Laboratory
Omaha, Nebraska

TABLE 6

Project: Former Bomarc Missile Battery and Airfield (Raco, MI)
Date Sample Received: Travel Blank
Customer Sample No: 14 January 1987
Material Description: Water

Analysis	QA Lab Result	Contractor Result	Unit
Volatile Organics			
Benzene	<5.0	<0.5	ug/L
Bromoform	<5.0	<3.2	ug/L
Carbon Tetrachloride	<5.0	<1.5	ug/L
Chlorobenzene	<5.0	<0.6	ug/L
Chlorodibromomethane	<5.0	<2.0	ug/L
Chloroethane	<10.0	<2.4	ug/L
2-Chloroethylvinyl Ether	<10.0	<5.9	ug/L
Chloroform	<5.0	<0.8	ug/L
Dichlorobromomethane	<5.0	<1.1	ug/L
1,1-Dichloroethane	<5.0	<0.8	ug/L
1,2-Dichloroethane	<5.0	<1.5	ug/L
1,1-Dichloroethylene	<5.0	<1.9	ug/L
1,2-Dichloropropane	<5.0	<1.5	ug/L
1,3-cis-Dichloropropylene	<5.0	<1.5	ug/L
1,3-trans-Dichloropropylene	<5.0	<1.5	ug/L
Ethylbenzene	<5.0	<0.4	ug/L
Methyl Bromide	<10.0	<1.5	ug/L
Methyl Chloride	<10.0	<1.6	ug/L
Methylene Chloride	7	7.0	ug/L
1,1,2,2-Tetrachloroethane	<5.0	<1.4	ug/L
Tetrachloroethylene	<5.0	<1.5	ug/L
Trichlorofluoromethane	-	<1.3	ug/L
Toluene	<5.0	<1.0	ug/L
1,2-trans-Dichloroethylene	<5.0	<1.5	ug/L
1,1,1-Trichloroethane	<5.0	<1.2	ug/L
1,1,2-Trichloroethane	<5.0	<1.6	ug/L
Trichloroethylene	<5.0	<1.3	ug/L
Vinyl Chloride	<5.0	<1.2	ug/L

Comments: All data agreed

U.S. ARMY CORPS OF ENGINEERS

CHAIN OF CUSTODY RECORD

PROJ. NO. 3067

PROJECT NAME: RACO, MI. / PERA

SAMPLERS: (Signature) John Thompson / Paul Shetley JR

STA. NO.	DATE	TIME	COMP.	GRAB	STATION LOCATION	NO. OF CONTAINERS	Purgeable Halocarbons	Petroleum Hydrocarbons	PCBs	Total METALS (8 PARAMETERS)	Dissolved METALS (8 PARAMETERS)		REMARKS
	1/13	1030		X	RB-7 Sampling Blank	8	2	2	2	1	1		See EEI Custody Transfer
		1230		X	RB-7 (Silo #26)	8	2	2	2	1	1		
		230		X	RG-1 (WELL #1)	8	2	2	2	1	1		
		300			TRAVEL BLANK	2	2						

to Be SENT 1/14/87

SPECIAL NOTE: WE HAD To Remove Two samples to MEET UPS 70 LBS Limit (NEXT DAY AIR)

WE Removed RB-7 Sampling Blank (Total METALS)
RB-7 Sampling Blank (Dissolved METALS)

THESE Samples ARE Being keep cool AND will Be sent 1/14/87 with Remaining samples

Relinquished by: (Signature)	Date / Time	Received by: (Signature)	Relinquished by: (Signature)	Date / Time	Received by: (Signature)
John Thompson	1/13/87 1700	Thomas [illegible] 1-14-87			
Relinquished by: (Signature)	Date / Time	Received by: (Signature)	Relinquished by: (Signature)	Date / Time	Received by: (Signature)
Relinquished by: (Signature)	Date / Time	Received for Laboratory by: (Signature)	Date / Time	Remarks	

Distribution: Original Accompanies Shipment; Copy to Coordinator Field Files

U.S. ARMY CORPS OF ENGINEERS

CHAIN OF CUSTODY RECORD

PROJ. NO. 3067 4025

PROJECT NAME: DERA / RMZO, MI.

SAMPLERS: (Signature) John Thompson / Paul Shettlesser

STA. NO.	DATE	TIME	COMP.	GRAB	STATION LOCATION	NO. OF CONTAINERS	Purgeable Halocarbons	Petroleum Hydrocarbons	Total Metals (8 Parameters)	PCBs			REMARKS
	1/14		X	X	RS-1 Transformer Pad	5	2	1	1	1			see EEI Transfer Sheets
	1/14				RS-8 Rinsate	7	2	2	1	2			↓ ↓ ↓ ↓

Note This shipment also contains the Sampling Blank for total and disolved metal samples from the 1-13-87 shipment

Relinquished by: (Signature)	Date / Time	Received by: (Signature)	Relinquished by: (Signature)	Date / Time	Received by: (Signature)
John Thompson	1/14 1700	Chris Dickey 1/15/87 1130			
Relinquished by: (Signature)	Date / Time	Received by: (Signature)	Relinquished by: (Signature)	Date / Time	Received by: (Signature)
Relinquished by: (Signature)	Date / Time	Received for Laboratory by: (Signature)	Date / Time	Remarks	
					Did not receive enough External Tags from CQR. used EEI manila Tags

Also Ran out of QTGI

Distribution: Original Accompanies Shipment; Copy to Coordinator Field Files

0188

MARTIN MARIETTA

MARTIN MARIETTA ENERGY SYSTEMS, INC.

POST OFFICE BOX P
OAK RIDGE, TENNESSEE 37831

June 2, 1987

Dr. Joseph Solsky
Department of the Army
Corp of Engineers, MRDED-L
420 S. 18th Street
Omaha, Nebraska 68102

Dear Dr. Solsky:

Results for Bomarc Missile DERA Site, Raco, Michigan, Samples

The Analytical Chemistry Department (ACD) received 6 water and soil samples for analysis. The attached table (Table 1) compiles your sample identification and ACD laboratory sample numbers. Please refer to our sample numbers for all future identification.

The following EPA methods were used for the analysis:

EPA-624 for the determination of the Volatile Organic Compound (VOA) in water.
EPA-624 as provided by the EPA-Contract Laboratoy Program (CLP) for Organic Analysis, October 1986 edition for the determination of VOA in the soil sample.
EPA-608 for the determination of PCBs in the water samples.
EPA-8080 for the determination of PCBs in the soil.
EPA-3050 for the preparation of the soil sample prior to the determination of Barium, Cadmium, Chromium, Lead, and Silver by Inductively Coupled Plasma EPA-6010; Arsenic and Selenium by Atomic Absorption Graphite Furnace EPA-7060 and 7740 respectively.
EPA-7471 for the determination of Mercury in the soil.
Standard Method-503C,D for the determination of Petroleum Hydrocarbons in the soil sample.
EPA-6010 for the determination of total or dissolved metals in water by ICP.
EPA-206.2 for the determination of total or dissolved Arsenic in water by AA.
EPA-270.2 for the determination of total or dissolved Selenium in water by AA.
EPA-245.1 for the determination of total or dissolved Mercury in water by CVAA.
EPA-413.1 for the determination of Petroleum Hydrocarbons in water.

Our QA/QC protocol for this group of samples included the analusis of spikes, duplicates, and blanks. Surrogate spikes were added to each individual sample for the VOA and PCB analyses. The percent recoveries for the surrogate spikes are included as part of the sample analysis report. Recoveries are within the limits specified by the CLP document. The analysis report for the operation

blank for the VOA analysis is included as part of the sample analysis report. Duplicate analyses are ACD # 870119-031 and -036 for the VOA analysis and 870119-040 and -043 for the PCB analysis. The duplicate analysis reports are inserted following those of the original sample. All duplicate analyses are in agreement. Matrix spike evaluation for the metals in the soil are included with sample 870204-001 for the soil matrix. For the water matrix, spike evaluation for the Mercury is included with samples 870204-002 and 870210-111, while Arsenic and Selenium spike recoveries are included with sample 870210-114. The associated blanks for the PCB analysis are samples 870121-060 for the water matrix and 870205-002 for the soil. The analysis reports for these blanks are included in a separate section at the end of this data package.

Please feel free to call on us if you have any question or if we can be of any further assistance.

Sincerely,

Ahmed A. Halouma
Project Manager

AAH:pte

Enclosure:
1. Sample Analysis Report

cc: M. S. Miller

TABLE 1

MRD Sample ID	Matrix	Parameter	ACD Sample #	Remarks
RB-7 Sample Blank	Water	VOA	870119-031	1
RB-7 (Silo#26)	Water	VOA	-032	1
RC-1 (Well#1)	Water	VOA	-033	1,2
Travel Blank	Water	VOA	-034	1
RS-8 Rinsate	Water	VOA	-035	1
RB-7-D	Water	VOA	-036	1,3
RS-1 Transformer Pad	Soil	VOA	-037	1
RB-7 Sample Blank	Water	PCB's	-038	1
RB-7 (Silo#26)	Water	PCB's	-039	1
RC-1 (Well#1)	Water	PCB's	-040	1,2
RS-8 Rinsate	Water	PCB's	-041	1
RS-1 Transformer Pad	Soil	PCB'S	-042	1
RC-1 (WELL#1)-D	Water	PCB's	-043	1,3
RS-1	Soil	Total Metals	870204-001	4
RB-7	Water	& Petroleum	-002	4
RG-1	Water	Hydrocarbons	-003	4
RB-7 Blank	Water		-004	4
RS-8 Rinsate	Water		870210-114	4
RB-7-F	Water	Dissolved Metals	870210-111	4,5
RG-1-F	Water	- " -	-112	4,5
RB-7 Blank-F	Water	- " -	-113	4,5

Remarks:

1- Sample received January 16, 1987.
2- Sample identification as shown on chain of custody record, Jan. 15, letter identifies the sample as "RG-1 (Well I).
3- Designated ACD duplicate sample.
4- Sample received January 28, 1987.
5- Analysis done on filtered sample.

U.S. ARMY CORPS OF ENGINEERS

CHAIN OF CUSTODY RECORD

PROJ. NO.

PROJECT NAME: RACO, MI (DERA)

SAMPLERS: (Signature) TRANSFER OF SAMPLES FROM MRD LAB TO OAKRIDGE

STA. NO.	DATE	TIME	COMP.	GRAB	STATION LOCATION	NO. OF CONTAINERS	VOA	PCB						REMARKS
	1-13-87	10:30			RB-7 SAMPLING BLANK	4	2	2						
	"	12:30			RB-7 (Silo #26)	4	2	2						
	"	2:30			RC-1 (WELL #1)	4	2	2						
	"	3:00			TRAVEL BLANK	2	2							
	1-14-87	10:30			RS-1 TRANSFORMER PAD	3	2	1						soil
	"	9:30			RS-8 Rinsate	3	2	1						

Relinquished by: (Signature)	Date / Time	Received by: (Signature)	Relinquished by: (Signature)	Date / Time	Received by: (Signature)
Fremin, [illegible]	1-15-87 3:00 PM	1-16-87 13:00 M.W. Keglung			
Relinquished by: (Signature)	Date / Time	Received by: (Signature)	Relinquished by: (Signature)	Date / Time	Received by: (Signature)
Relinquished by: (Signature)	Date / Time	Received for Laboratory by: (Signature)	Date / Time	Remarks	

Distribution: Original Accompanies Shipment; Copy to Coordinator Field Files

ORGANIC ANALYSIS DATA REPORT

Analis ID: 870205-002
Laboratory Name: Gas/Liquid Chromatography
File ID:
Instrument ID:
Data Release Authorized By: TR Oldham

Customer Sample ID: 2-5-NE-1
Customer Name: SOLSKY
Sample Matrix: SOIL
Requisition Number: 2-5-NE-1
Date Sample Received: 5-FEB-1987

Polychlorinated Biphenyls By GC

Date Extracted/Prepared: 13-MAR-1987
Preparation Procedure Number:
Percent Moisture:
Percent Moisture (decanted):
Associated Blank:

Date Analyzed: 13-MAR-1987
Analysis Procedure Number: EPA-3080
Conc/Dilution Factor: 1.0
Analyst: LC FELLERS

CAS		ug/g	CAS		ug/g
12674-11-2	PCB (Aroclor-1016)	.10			
11104-28-2	PCB (Aroclor-1221)	.10			
11141-16-5	PCB (Aroclor-1232)	.10			
53469-22-9	PCB (Aroclor-1242)	.10			
12672-29-6	PCB (Aroclor-1248)	.10			
11097-69-1	PCB (Aroclor-1254)	.10			
11096-82-5	PCB (Aroclor-1260)	.10			

Data Reporting Qualifiers.

U - Compound was analyzed for but not detected. The number is the attainable detection limit for the sample.
B - Analyte was found in the reagent blank as well as the sample.
J - Indicates an estimated value.
NR - Not Detected.

Surrogate Recovery Data

Surrogate Compound	Amount Spiked	Amount Recovered	Percent Recovered

PCB Extraction Data

Extracted Sample Weight = 0.063
Final Extracted Volume = 10
Extraction method = Soxhlet
Extraction Solvent = Hexane/Acetone
Extraction Cleanup = Sulfuric Acid
Analyst = KE EVANS
Date Completed = 6-FEB-1987

APPENDIX J

Michigan State Recommended Limits In Drinking Water Standards

MICHIGAN DEPARTMENT OF NATURAL RESOURCES

INTEROFFICE COMMUNICATION

October 23, 1985

TO: Laura Southerland, GWQD, Detroit Area District

FROM: Gary Butterfield, SWQD, Toxic Chemical Evaluation Section
Gary Butterfield

In response to your request for information (10/16/85) on petroleum products, I am sending you summaries of toxicity information on several chemicals. Also included is a table of our current recommended limits for Groundwater contamination from these chemicals.

The initial request for information on "petroleum products" covers a wide range of chemicals. For example, crude oil has been estimated to consist of over 300 chemicals. Many of those 300+ chemicals are used to synthesize other chemicals. There could potentially be thousands of chemicals and mixtures classified as "petroleum products".

The handfull of chemicals whose information is enclosed are a few of the better known chemicals. If you would like more information on other chemicals or more detailed information on these few, please feel free to call me at (517) 373-2190.

	Max. Groundwater Concentration (mg/l)
Benzene	0.025
Ethylbenzene	3.4
Toluene	1.0
Phenol	2.1
Xylenes	3.6

RECEIVED
OCT 29 1985
GWQ-DETROIT DIST

Enclosures

Alkyl Benzene Sulfonate (ABS)	-	USPHS 0.5 mg/l maximum permissible
Alkalinity	-	Not a specific-polluting substance but combination of factors
Ammonia (NH_4)	-	USPHS 0.10 mg/l in excess suspect of pollution
**Arsenic	-	USPHS 0.01 mg/l recommended limit 0.05 mg/l mandatory limit EPA (E.L.)
**Barium	-	USPHS 1.0 mg/l mandatory limit EPA (E.L.)
Bicarbonate	-	150 mg/l desirable or permissible (Hibbard)
BOD (see pg. 4)	-	
**Cadmium	-	USPHS 0.01 mg/l mandatory limit EPA (E.L.)
Calcium	-	WHO Permissible 75 mg/l Excessive 200 mg/l
Carbon Chloroform extract	-	USPHS 0.2 mg/l recommended limit
Carbonate	-	20 mg/l (33.3 mg/l as alkalinity) recommended limit (Hibbard)
*Chloride	-	USPHS 250 mg/l recommended maximum limit EPA (R.L.)
Chlorine	-	Very high levels will be objectionable in terms of quality
**Chromium (hexavalent)	-	USPHS 0.05 mg/l mandatory limit EPA (E.L.)
COD	-	Preferred limit less than 50 ppm EPA (P.L.)
*Color	-	USPHS 15 units acceptable limit
Conductivity	-	function of dissolved solids
*Copper	-	USPHS 1.0 mg/l recommended limit EPA (R.L.)
Corrosivity	-	Non-Corrosive (E.P.A.)
Cyanide	-	USPHS 0.01 mg/l recommended limit 0.2 mg/l mandatory limit
Dissolved Solids	-	USPHS 500 mg/l total
Dissolved Oxygen	-	No limits USPHS
Flouride	-	See page 4
*Foaming Agents	-	0.5 mg/l E.P.A. recommended limit EPA (R.L.)

Hardness as $CaCO_3$	- USPHS 300 ppm very hard, 500 ppm unusable for domestic purposes EPA (R.L. 300 ppm)
Herbicides	- Official limits for these have not been established
Hydrocarbons	- 0.2 ppm total
*Hydrogen Sulfide	- 0.05 mg/l E.P.A. recommended limit
*Iron	- USPHS 0.3 mg/l recommended limit EPA (R.L.)
**Lead	- USPHS 0.05 mg/l drinking water limit mandatory limit EPA (E.L.)
Magnesium	- USPHS No recommended limit
Magnesium & Sodium Sulfate	- WHO permissible 500 mg/l Excessive limit 1000 mg/l
*Maganese	- USPHS 0.05 mg/l recommended limit EPA (R.L.)
**Mercury	- EPA 0.002 mg/l mandatory limit EPA (E.L.)
Nickle	- EPA recommended limit 0.1 mg/l
**Nitrate (as N)	- EPA 10.0 mg/l mandatory limit EPA (E.L.)
Nitrate (a NO_3)	- 45 mg/l recommended limit USPHS
Nitrogen-ammonia	- USPHS 0.5 mg/l as NH_4^+ recommended limit
Nitrogen-nitrate	- USPHS 45 mg/l recommended limit
Nitrogen-nitrite	- 2 mg/l generally accepted
Nitrogen-organic	- No limits
*Odor	- USPHS threshold odor number should not exceed 3 EPA (R.L.)
Oxygen, dissolved	- See page 4
PCB's	- No official limit
Pesticides	- Official limits for these have not been established
Phenolic Compounds (as phenols)	
*pH	- 6.5 - 8.5 EPA recommended limit EPA (R.L.)
Phosphate	- USPHS 0.001 mg/l maximum concentration limit
Potassium	- 1000-2000 mg/l extreme limit
**Selenium	- USPHS 0.01 mg/l mandatory limit EPA (E.L.)

Relinquished By: (Signature)	Date / Time	Received By: (Signature)	Date / Time	Phone
MM Lindauer	2/9/87 3:15	HJ Culbert	2/9/87 3:12	
MM Lindauer	2/10/87 1145	E.S. [illegible]	2/10/87 1145	
		JK Lowery	2/10/87 1145	
		W Sullivan		
		E L Hester	2/10/87 312	
		W Sanders	2/10/87 1530	

REMARKS:

RETURN TO (Check One):

☐ ENVIRONMENTAL MANAGEMENT, K-1020, MS 402, 6-2510

☐ SAMPLING MANAGEMENT, K-1004C, MS 440, 4-9609

Relinquished By: (Signature)	Date / Time	Received By: (Signature)	Date / Time	Phone
MM Lindauer	1/19/87 1025	C.R. Knauth	1/19/87 1030	
		AK Poling	1/20/87 12:55	

REMARKS:

RETURN TO: SAMPLING MANAGEMENT, K-1004C, MS 440, 4-9609

U.S. ARMY CORPS OF ENGINEERS

CHAIN OF CUSTODY RECORD

PROJ. NO.

PROJECT NAME: BOMARC MISSILE DERA SITE RACO, MI

SAMPLERS: (Signature) TRANSFER OF SAMPLES FROM MRD LAB TO BALRIDGE

STA. NO.	DATE	TIME	COMP.	GRAB	STATION LOCATION	NO. OF CONTAINERS	Pet. Hydrocarbons + 503 C,D	Total Metals RCRA	Dissolved Metals				REMARKS
	1-13-87	10:30			RB-7 SAMPLING BLANK	3	✓	✓	✓				water
	"	12:30			RB-7 (SILO #26)	3	✓	✓	✓				"
	"	2:30			RG-I (WELL #I)	3	✓	✓	✓				"
	1-14-87	10:30			RS-I TRANSFORMER PAD	2	✓	✓					Soil
	"	930			RS-8 Rinsate	2	✓	✓					water
													Pet. Hydrocarbon. STD. Method + 503 C, D

Relinquished by: (Signature)	Date / Time	Received by: (Signature)	Relinquished by: (Signature)	Date / Time	Received by: (Signature)
Prem N. Arora	1-27-87 2:30 PM	M.M. Lindauer 1/28/87 1:15 P			
Relinquished by: (Signature)	Date / Time	Received by: (Signature)	Relinquished by: (Signature)	Date / Time	Received by: (Signature)
Relinquished by: (Signature)	Date / Time	Received for Laboratory by: (Signature)	Date / Time	Remarks	

Distribution: Original Accompanies Shipment; Copy to Coordinator Field Files

ORGDP CHAIN OF CUSTODY FORM

SAMPLER: (Signature) Raco - Sobsky | Dept. Set 40 | Building/Phone G106B&C | SAMPLE TYPE | REMARKS 210-111,114 (Dissolved metals)

CUSTOMER SAMPLER NUMBER	Sampling Date	Sampling Time	SAMPLE LOCATION	Total No. Of Containers	SAMPLE TYPE	REMARKS
RS-1 (Transformer Pad)					Soil	870204-001
—					—	O&G, metals
RB-7					Water *	(Hg Ag As
RG-1					" *	Se
RB-7 (Blk)					" *	Ba Cd Cr Pb).
RS-8 Rinsate (for soil)					(-114)	* Archive
						* (O&G, grav. metals + Ag)

UCN-15487A (1 12-85) Signatures Required on Back

* Can't put in Computer

ORGDP CHAIN OF CUSTODY FORM 870119-031-043

SAMPLER: (Signature) Raco, MI | Dept. | Building/Phone Army G106 | SAMPLE TYPE | REMARKS

CUSTOMER SAMPLER NUMBER	Sampling Date	Sampling Time	SAMPLE LOCATION	Total No. Of Containers	SAMPLE TYPE	REMARKS	
RB-7						VOAS 038, 039)	PCB 038
RB-7 (Silo 26)						032 036-D	039
RC-1 (Well-1)						033	040, 043
Travel Blk						034	no PCB 041
RS-1 (Soil)						035 037	042
RS-8 Rinsate						035	042

UCN-15487A (1 10-85) Signatures Required on Back

APPENDIX K

Dafter Sanitary Landfill Letter

Purchase Order DACA-87-87-M-1159

SCOPE OF WORK
FOR
DISPOSAL OF FOUR DRUMS OF
LOW LEVEL HAZARDOUS WASTE
AT THE
FORMER BOMARC MISSILE FACILITY
RACO, MICHIGAN

During installation of monitoring wells as part of the contamination evaluation of the former Bomarc Missile Site, Raco, Michigan, under contract DACA-87-86-D-0045, Delivery Order No. 4, Envirodyne Engineers, Inc., generated nine drums of cuttings. Subsequent testing of the groundwater revealed that four of the drums contained cuttings which were contaminated with Trichloroethylene and Toluene. The levels detected in the groundwater were extremely low - (Tricloroethylene - 3.0 ppb and Toluene 1.9 ppb). The remaining five drums contain no contaminants and are the responsibility of Envirodyne Engineers, Inc. The four contaminated drums are the responsibility of the Federal Government. The drums are presently stored onsite in one of the existing buildings.

The Detroit District, U. S. Army Corps of Engineers, is preparing to demolish the building under debris removal of the Defense Environmental Restoration Program. This necessitates removal of the drums.

The Contractor shall arrange for labor, transportation, and disposal of the four contaminated drums in accordance with any applicable regulations under the Resource Conservation Recovery Act (RCRA) and regulations of the Michigan Department of Natural Resources. When completed, the Contractor shall furnish a letter and/or other evidence such as receipts showing proper disposal of the four drums.

Dafter Sanitary Landfill

Old US-2 & 12 Mile Road • Dafter, Michigan 49724
(906) 632-8055

June 30, 1987

Envirodyne Engineers
12161 Lackland Road
St. Louis, Missouri 63146

Attention: Paul Shetley
Environmental Scientist

PER YOUR REQUEST:

The removal of drums from Old Raco Missle Base Battery site near Raco, Michigan, was completed June 30, 1987. The drums were disposed of and handled as Not Controlled, Not Hazardous, Under Act 64.

PURCHASE ORDER #23464

Thank You.
Elaine Reid
Elaine Reid

APPENDIX L

Inventory Report and Hazardous Ranking System Evaluation

75-25-2	BROMOFORM.....	2
591-78-6	4-METHYL-2-PENTANONE.....	<10
108-10-1	2-HEXANONE.....	<10
127-18-4	TETRACHLOROETHENE.....	<5
79-34-5	1,1,2,2-TETRACHLOROETHANE..	3
108-88-3	TOLUENE.....	1
108-90-7	CHLOROBENZENE.....	1
100-41-4	ETHYLBENZENE.....	<5
100-42-5	STYRENE.....	<5
	TOTAL XYLENES.....	<5

SURROGATE STANDARDS	% RECOVERY
1,2-DICHLOROETHANE D4.....	90.4
TOLUENE-D8.....	105.0
4-BROMOFLUOROBENZENE.....	107.4

TIC COMPOUNDS

74953	DIBROMOMETHANE	1
76131	FREON 113	1

ORGANIC ANALYSIS DATA REPORT

AnaLIS ID: 870119-035
Laboratory Name: Organic Mass Spectroscopy
File ID: >03478
Instrument ID: 5995
Data Release Authorized By: DC Canada

Customer Sample ID: RS-8 RINSATE
Customer Name: SOLSKY
Sample Matrix: WATER
Requisition Number:
Date Sample Received: 19-JAN-1987

Volatile Organic Compounds - HSL

Date Extracted/Prepared:
Preparation Procedure Number:
Percent Moisture:
Percent Moisture (decanted):
Associated Blank:

Date Analyzed: 20-JAN-1987
Analysis Procedure Number: EPA-624
Conc/Dilution Factor: 1.0
Analyst: CP KNAUTH

CAS		ug/L	CAS		ug/L
74-87-3	chloromethane	10U	79-00-5	1,1,2-trichloroethane	5U
74-83-9	bromomethane	10U	71-43-2	benzene	5U
75-01-4	vinyl chloride	10U	10061-02-6	trans-1,3-dichloropropene	5U
75-00-3	chloroethane	10U	110-75-8	2-chloroethylvinyl ether	10U
75-09-2	methylene chloride	1 BJ	75-25-2	bromoform	5U
67-64-1	acetone	1000 B	108-10-1	4-methyl-2-pentanone	10U
75-15-0	carbon disulfide	5U	591-78-6	2-hexanone	10U
75-35-4	1,1-dichloroethene	5U	127-18-4	tetrachloroethene	5U
75-34-3	1,1-dichloroethane	5U	79-34-5	1,1,2,2-tetrachloroethane	5U
156-60-5	trans-1,2-dichloroethene	5U	108-88-3	toluene	9 B
67-66-3	chloroform	2 BJ	108-90-7	chlorobenzene	5U
107-06-2	1,2-dichloroethane	5U	100-41-4	ethylbenzene	5U
78-93-3	2-butanone	10U	100-42-5	styrene	5U
71-55-6	1,1,1-trichloroethane	5U		total xylenes	5U
56-23-5	carbon tetrachloride	5U			
108-05-4	vinyl acetate	10U			
75-27-4	bromodichloromethane	5U			
78-87-5	1,2-dichloropropane	5U			
10061-01-5	cis-1,3-dichloropropene	5U			
79-01-6	trichloroethene	5U			
124-48-1	dibromochloromethane	5U			

Data Reporting Qualifiers:

U - Compound was analyzed for but not detected. The number is the attainable detection limit for the sample.
B - Analyte was found in the reagent blank as well as the sample.
J - Indicates an estimated value.
ND - Not Detected.

Surrogate Recovery Data

Surrogate Compound	Amount Spiked	Amount Recovered	Percent Recovered
TOLUENE-D8	50.0	49.3	98.6
BROMOFLUOROBENZENE	50.0	51.3	102.6
1,2-DICHLOROETHANE-D4	50.0	48.4	96.8

ORGANIC ANALYSIS DATA REPORT

AnaLIS ID: 870119-035
Laboratory Name: Organic Mass Spectroscopy
File ID: >03478
Instrument ID: 5995
Data Release Authorized By: DC Canada

Customer Sample ID: RS-8 RINSATE
Customer Name: SOLSKY
Sample Matrix: WATER
Requisition Number:
Date Sample Received: 19-JAN-1987

Tentatively Identified Compounds

Date Extracted/Prepared:
Preparation Procedure Number:
Percent Moisture:
Percent Moisture (decanted):
Associated Blank:

Date Analyzed: 20-JAN-1987
Analysis Procedure Number: EPA-624
Conc/Dilution Factor: 1.0
Analyst: CP KNAUTH

CAS		ug/L	CAS		ug/L
75694	TRICHLOROFLUOROMETHANE	1 J	74953	DIBROMOMETHANE	1 B J
	UNKNOWN	71 J			

Data Reporting Qualifiers:

U - Compound was analyzed for but not detected. The number is the attainable detection limit for the sample.
B - Analyte was found in the reagent blank as well as the sample.
J - Indicates an estimated value.
ND - Not Detected.

***** Comments from the Organic Mass Spectroscopy Laboratory *****

ASSOCIATED VOA REAGENT BLANK DATA LAB. ID NO.

CAS NO.	COMPONENT	UG/L
74-87-3	CHLOROMETHANE.....	<10
74-83-9	BROMOMETHANE.....	<10
75-01-4	VINYL CHLORIDE.....	<10
75-00-3	CHLOROETHANE.....	<10
75-09-2	METHYLENE CHLORIDE.....	1
67-64-1	ACETONE.....	9
75-15-0	CARBON DISULFIDE.....	<5
75-35-4	1,1-DICHLOROETHENE.....	<5
75-34-3	1,1-DICHLOROETHANE.....	<5
156-60-5	TRANS-1,2-DICHLOROETHENE...	<5
67-66-3	CHLOROFORM.....	13
107-06-2	1,2-DICHLOROETHANE.....	<5
78-93-3	2-BUTANONE.....	13
71-55-6	1,1,1-TRICHLOROETHANE.....	<5
56-23-5	CARBON TETRACHLORIDE.....	<5
108-05-4	VINYL ACETATE.....	<10
75-27-4	BROMODICHLOROMETHANE.....	<5
78-87-5	1,2-DICHLOROPROPANE.....	<5
10061-02-6	TRANS-1,3-DICHLOROPROPENE..	<5
79-01-6	TRICHLOROETHENE.....	<5
124-48-1	DIBROMOCHLOROMETHANE.....	<5
79-00-5	1,1,2-TRICHLOROETHANE.....	<5
71-43-2	BENZENE.....	<5

[illegible]	[illegible]	<5
110-75-8	2-CHLOROETHYLVINYLETHER....	<10
75-25-2	BROMOFORM.....	<5
591-78-6	4-METHYL-2-PENTANONE.....	<10
108-10-1	2-HEXANONE.....	<10
127-18-4	TETRACHLOROETHENE.....	<5
79-34-5	1,1,2,2-TETRACHLOROETHANE..	<5
108-88-3	TOLUENE.....	1
108-90-7	CHLOROBENZENE.....	<5
100-41-4	ETHYLBENZENE.....	<5
100-42-5	STYRENE.....	<5
	TOTAL XYLENES.....	1

SURROGATE STANDARDS	% RECOVERY
1,2-DICHLOROETHANE D4.....	97.0
TOLUENE-D8.....	96.0
4-BROMOFLUOROBENZENE.....	107.2

TIC COMPOUNDS

74953	DIBROMOMETHANE	1

ORGANIC ANALYSIS DATA REPORT

AnaLIS ID: 870119-037
Laboratory Name: Organic Mass Spectroscopy
File ID: >03480
Instrument ID: 5995C
Data Release Authorized By: DC Canada

Customer Sample ID: RS-1 TRANS PAD
Customer Name: SOLSKY
Sample Matrix: SOIL
Requisition Number:
Date Sample Received: 19-JAN-1987

Volatile Organic Compounds - HSL

Date Extracted/Prepared:
Preparation Procedure Number:
Percent Moisture: 8
Percent Moisture (decanted):
Associated Blank:

Date Analyzed: 3-MAR-1987
Analysis Procedure Number: EPA-CLP
Conc/Dilution Factor: 5.0
Analyst: CP KNAUTH

CAS		ug/Kg	CAS		ug/Kg
74-87-3	chloromethane	50U	79-00-5	1,1,2-trichloroethane	25U
74-83-9	bromomethane	50U	71-43-2	benzene	25U
75-01-4	vinyl chloride	50U	10061-02-6	trans-1,3-dichloropropene	25U
75-00-3	chloroethane	50U	110-75-8	2-chloroethylvinyl ether	50U
75-09-2	methylene chloride	7 BJ	75-25-2	bromoform	25U
67-64-1	acetone	50U	108-10-1	4-methyl-2-pentanone	50U
75-15-0	carbon disulfide	25U	591-78-6	2-hexanone	50U
75-35-4	1,1-dichloroethene	25U	127-18-4	tetrachloroethene	25U
75-34-3	1,1-dichloroethane	25U	79-34-5	1,1,2,2-tetrachloroethane	25U
156-60-5	trans-1,2-dichloroethene	25U	108-88-3	toluene	5 BJ
67-66-3	chloroform	67 B	108-90-7	chlorobenzene	25U
107-06-2	1,2-dichloroethane	25U	100-41-4	ethylbenzene	25U
78-93-3	2-butanone	50U	100-42-5	styrene	25U
71-55-6	1,1,1-trichloroethane	25U		total xylenes	25U
56-23-5	carbon tetrachloride	25U			
108-05-4	vinyl acetate	50U			
75-27-4	bromodichloromethane	25U			
78-87-5	1,2-dichloropropane	25U			
10061-01-5	cis-1,3-dichloropropene	25U			
79-01-6	trichloroethene	25U			
124-48-1	dibromochloromethane	25U			

Data Reporting Qualifiers:

U - Compound was analyzed for but not detected. The number is the attainable detection limit for the sample.
B - Analyte was found in the reagent blank as well as the sample.
J - Indicates an estimated value.
ND - Not Detected.

Surrogate Recovery Data

Surrogate Compound	Amount Spiked	Amount Recovered	Percent Recovered
TOLUENE-D8	50.0	49.6	99.2
BROMOFLUOROBENZENE	50.0	47.1	94.2
1,2-DICHLOROETHANE-D4	50.0	48.2	96.4

***** Comments from the Organic Mass Spectroscopy Laboratory *****

ASSOCIATED VOA REAGENT BLANK DATA LAB. ID NO.

CAS NO.	COMPONENT	UG/L
74-87-3	CHLOROMETHANE.....	<10
74-83-9	BROMOMETHANE.....	<10
75-01-4	VINYL CHLORIDE.....	<10
75-00-3	CHLOROETHANE.....	<10
75-09-2	METHYLENE CHLORIDE.....	1
67-64-1	ACETONE.....	9
75-15-0	CARBON DISULFIDE.....	<5
75-35-4	1,1-DICHLOROETHENE.....	<5
75-34-3	1,1-DICHLOROETHANE.....	<5
156-60-5	TRANS-1,2-DICHLOROETHENE...	<5
67-66-3	CHLOROFORM.....	13
107-06-2	1,2-DICHLOROETHANE.....	<5
78-93-3	2-BUTANONE.....	13
71-55-6	1,1,1-TRICHLOROETHANE.....	<5
56-23-5	CARBON TETRACHLORIDE.....	<5
108-25-4	VINYL ACETATE.....	<10
75-27-4	BROMODICHLOROMETHANE.....	<5
78-87-5	1,2-DICHLOROPROPANE.....	<5
10061-02-6	TRANS-1,3-DICHLOROPROPENE..	<5
79-01-6	TRICHLOROETHENE.....	<5
124-48-1	DIBROMOCHLOROMETHANE.....	<5
79-00-5	1,1,2-TRICHLOROETHANE.....	<5
71-43-2	BENZENE.....	<5
10061-01-5	CIS-1,3-DICHLOROPROPENE....	<5
110-75-8	2-CHLOROETHYLVINYLETHER....	<10
75-25-2	BROMOFORM.....	<5
591-78-6	4-METHYL-2-PENTANONE.....	<10
108-10-1	2-HEXANONE.....	<10
127-18-4	TETRACHLOROETHENE.....	<5
79-34-5	1,1,2,2-TETRACHLOROETHANE..	<5
108-88-3	TOLUENE.....	1
108-90-7	CHLOROBENZENE.....	<5
100-41-4	ETHYLBENZENE.....	<5
100-42-5	STYRENE.....	<5
	TOTAL XYLENES.....	1

SURROGATE STANDARDS	% RECOVERY
1,2-DICHLOROETHANE D4.....	97.0
TOLUENE-D8.....	96.0
4-BROMOFLUOROBENZENE.....	107.2

TIC COMPOUNDS

74953	DIBROMOMETHANE	1

ORGANIC ANALYSIS DATA REPORT

AnaLIS ID: 870119-038
Laboratory Name: Gas/Liquid Chromatography
File ID:
Instrument ID:
Data Release Authorized By: TR Oldham

Customer Sample ID: RB-7 SAMPLE BLK
Customer Name: SOLSKY
Sample Matrix: WATER
Requisition Number:
Date Sample Received: 19-JAN-1987

Polychlorinated Biphenyls By GC

Date Extracted/Prepared: 2-FEB-1987
Preparation Procedure Number:
Percent Mositure:
Percent Moisture (decanted):
Associated Blank:

Date Analyzed: 2-FEB-1987
Analysis Procedure Number: EPA-608
Conc/Dilution Factor: 1.0
Analyst: RE HOWARD

CAS		ug/L	CAS		ug/L
12674-11-2	PCB (Aroclor-1016)	0.5U			
11104-28-2	PCB (Aroclor-1221)	0.5U			
11141-16-5	PCB (Aroclor-1232)	0.5U			
53469-22-9	PCB (Aroclor-1242)	0.5U			
12672-29-6	PCB (Aroclor-1248)	0.5U			
11097-69-1	PCB (Aroclor-1254)	1U			
11096-82-5	PCB (Aroclor-1260)	1U			

Data Reporting Qualifiers:

U - Compound was analyzed for but not detected. The number is the attainable detection limit for the sample.
B - Analyte was found in the reagent blank as well as the sample.
J - Indicates an estimated value.
ND - Not Detected.

Surrogate Recovery Data

Surrogate Compound	Amount Spiked	Amount Recovered	Percent Recovered
DIBUTYL CHLORENDATE	1.0	0.69	69.0

PCB Extraction Data

Extracted Sample Weight = 1000
Final Extracted Volume = 10
Extraction Method = Separatory Funnel
Extraction Solvent = Methylene Chloride
Associated Blank = 870121-060
Analyst = TM KREIS
Date Completed = 23-JAN-1987

ORGANIC ANALYSIS DATA REPORT

AnaLIS ID: 870119-039
Laboratory Name: Gas/Liquid Chromatography
File ID:
Instrument ID:
Data Release Authorized By: TR Oldham

Customer Sample ID: RB-7 (SILO #26)
Customer Name: SOLSKY
Sample Matrix: WATER
Requisition Number: 0434
Date Sample Received: 19-JAN-1987

Polychlorinated Biphenyls By GC

Date Extracted/Prepared: 2-FEB-1987
Preparation Procedure Number:
Percent Mositure:
Percent Moisture (decanted):
Associated Blank:

Date Analyzed: 2-FEB-1987
Analysis Procedure Number: EPA-608
Conc/Dilution Factor: 1.0
Analyst: RE HOWARD

CAS		ug/L	CAS		ug/L
12674-11-2	PCB (Aroclor-1016)	0.5U			
11104-28-2	PCB (Aroclor-1221)	0.5U			
11141-16-5	PCB (Aroclor-1232)	0.5U			
53469-22-9	PCB (Aroclor-1242)	0.5U			
12672-29-6	PCB (Aroclor-1248)	0.5U			
11097-69-1	PCB (Aroclor-1254)	1U			
11096-82-5	PCB (Aroclor-1260)	1U			

Data Reporting Qualifiers:

U - Compound was analyzed for but not detected. The number is the attainable detection limit for the sample.
B - Analyte was found in the reasent blank as well as the sample.
J - Indicates an estimated value.
ND - Not Detected.

Surrogate Recovery Data

Surrogate Compound	Amount Spiked	Amount Recovered	Percent Recovered
DIBUTYL CHLORENDATE	1.0	0.83	83.0

PCB Extraction Data

Extracted Sample Weight = 1000
Final Extracted Volume = 10
Extraction Method = Separatory Funnel
Extraction Solvent = Methylene Chloride
Associated Blank = 870121-060
Analyst = TM KREIS
Date Completed = 23-JAN-1987

ORGANIC ANALYSIS DATA REPORT

AnaLIS ID: 870119-040
Laboratory Name: Gas/Liquid Chromatography
File ID:
Instrument ID:
Data Release Authorized By: TR Oldham

Customer Sample ID: RC-1 (WELL#1)
Customer Name: SOLSKY
Sample Matrix: WATER
Requisition Number: 0434
Date Sample Received: 19-JAN-1987

Polychlorinated Biphenyls By GC

Date Extracted/Prepared: 2-FEB-1987
Preparation Procedure Number:
Percent Mositure:
Percent Moisture (decanted):
Associated Blank:

Date Analyzed: 2-FEB-1987
Analysis Procedure Number: EPA-608
Conc/Dilution Factor: 1.0
Analyst: RE HOWARD

CAS		ug/L	CAS		ug/L
12674-11-2	PCB (Aroclor-1016)	0.5U			
11104-28-2	PCB (Aroclor-1221)	0.5U			
11141-16-5	PCB (Aroclor-1232)	0.5U			
53469-22-9	PCB (Aroclor-1242)	0.5U			
12672-29-6	PCB (Aroclor-1248)	0.5U			
11097-69-1	PCB (Aroclor-1254)	1U			
11096-82-5	PCB (Aroclor-1260)	1U			

Data Reporting Qualifiers:

U - Compound was analyzed for but not detected. The number is the attainable detection limit for the sample.
B - Analyte was found in the reagent blank as well as the sample.
J - Indicates an estimated value.
ND - Not Detected.

Surrogate Recovery Data

Surrogate Compound	Amount Spiked	Amount Recovered	Percent Recovered
DIBUTYL CHLORENDATE	1.0	0.83	83.0

PCB Extraction Data

Extracted Sample Weight = 1000
Final Extracted Volume = 10
Extraction Method = Separatory Funnel
Extraction Solvent = Methylene Chloride
Associated Blank = 870121-060
Analyst = TM KREIS
Date Completed = 23-JAN-1987

This sample is a duplicate of sample 870119-043

ORGANIC ANALYSIS DATA REPORT

AnaLIS ID: 870119-043
Laboratory Name: Gas/Liquid Chromatography
File ID:
Instrument ID:
Data Release Authorized By: TR Oldham

Customer Sample ID: RC-1 (WELL#1)-D
Customer Name: SOLSKY
Sample Matrix: WATER
Requisition Number: 0434
Date Sample Received: 19-JAN-1987

Polychlorinated Biphenyls By GC

Date Extracted/Prepared: 2-FEB-1987
Preparation Procedure Number:
Percent Mositure:
Percent Moisture (decanted):
Associated Blank:

Date Analyzed: 2-FEB-1987
Analysis Procedure Number: EPA-608
Conc/Dilution Factor: 1.0
Analyst: RE HOWARD

CAS		ug/L	CAS		ug/L
12674-11-2	PCB (Aroclor-1016)	0.5U			
11104-28-2	PCB (Aroclor-1221)	0.5U			
11141-16-5	PCB (Aroclor-1232)	0.5U			
53469-22-9	PCB (Aroclor-1242)	0.5U			
12672-29-6	PCB (Aroclor-1248)	0.5U			
11097-69-1	PCB (Aroclor-1254)	1U			
11096-82-5	PCB (Aroclor-1260)	1U			

Data Reporting Qualifiers:

U - Compound was analyzed for but not detected. The number is the attainable detection limit for the sample.
B - Analyte was found in the reagent blank as well as the sample.
J - Indicates an estimated value.
ND - Not Detected.

Surrogate Recovery Data

Surrogate Compound	Amount Spiked	Amount Recovered	Percent Recovered
DIBUTYL CHLORENDATE	1.0	0.75	75.0

PCB Extraction Data

Extracted Sample Weight = 1000
Final Extracted Volume = 10
Extraction Method = Separatory Funnel
Extraction Solvent = Methylene Chloride
Associated Blank = 870121-060
Analyst = TM KREIS
Date Completed = 29-JAN-1987

This sample is a duplicate of sample 870119-040

ORGANIC ANALYSIS DATA REPORT

AnaLIS ID: 870119-041
Laboratory Name: Gas/Liquid Chromatography
File ID:
Instrument ID:
Data Release Authorized By: TR Oldham

Customer Sample ID: RS-8 RINSATE
Customer Name: SOLSKY
Sample Matrix: WATER
Requisition Number: 0434
Date Sample Received: 19-JAN-1987

Polychlorinated Biphenyls By GC

Date Extracted/Prepared: 2-FEB-1987
Preparation Procedure Number:
Percent Moisture:
Percent Moisture (decanted):
Associated Blank:

Date Analyzed: 2-FEB-1987
Analysis Procedure Number: EPA-608
Conc/Dilution Factor: 1.0
Analyst: RE HOWARD

CAS		ug/L	CAS		ug/L
12674-11-2	PCB (Aroclor-1016)	0.5U			
11104-28-2	PCB (Aroclor-1221)	0.5U			
11141-16-5	PCB (Aroclor-1232)	0.5U			
53469-22-9	PCB (Aroclor-1242)	0.5U			
12672-29-6	PCB (Aroclor-1248)	0.5U			
11097-69-1	PCB (Aroclor-1254)	1U			
11096-82-5	PCB (Aroclor-1260)	1U			

Data Reporting Qualifiers:

U - Compound was analyzed for but not detected. The number is the attainable detection limit for the sample.
B - Analyte was found in the reagent blank as well as the sample.
J - Indicates an estimated value.
ND - Not Detected.

Surrogate Recovery Data

Surrogate Compound	Amount Spiked	Amount Recovered	Percent Recovered
DIBUTYL CHLORENDATE	1.0	0.83	83.0

PCB Extraction Data

Extracted Sample Weight = 1000
Final Extracted Volume = 10
Extraction Method = Separatory Funnel
Extraction Solvent = Methylene Chloride
Associated Blank = 870121-060
Analyst = TM KREIS
Date Completed = 23-JAN-1987

ORGANIC ANALYSIS DATA REPORT

AnaLIS ID: 870119-042
Laboratory Name: Gas/Liquid Chromatography
File ID:
Instrument ID:
Data Release Authorized By: TR Oldham

Customer Sample ID: RS-1 TRANS PAD
Customer Name: SOLSKY
Sample Matrix: WATER
Requisition Number: 0434
Date Sample Received: 19-JAN-1987

Polychlorinated Biphenyls By GC

Date Extracted/Prepared: 13-MAR-1987
Preparation Procedure Number:
Percent Moisture:
Percent Moisture (decanted):
Associated Blank:

Date Analyzed: 13-MAR-1987
Analysis Procedure Number: EPA-8080
Conc/Dilution Factor: 1.0
Analyst: LC FELLERS

CAS		ug/g	CAS		ug/g
12674-11-2	PCB (Aroclor-1016)	0.1U			
11104-28-2	PCB (Aroclor-1221)	0.1U			
11141-16-5	PCB (Aroclor-1232)	0.1U			
53469-22-9	PCB (Aroclor-1242)	0.1U			
12672-29-6	PCB (Aroclor-1248)	0.1U			
11097-69-1	PCB (Aroclor-1254)	0.1U			
11096-82-5	PCB (Aroclor-1260)	0.1U			

Data Reporting Qualifiers:

U - Compound was analyzed for but not detected. The number is the attainable detection limit for the sample.
B - Analyte was found in the reagent blank as well as the sample.
J - Indicates an estimated value.
ND - Not Detected.

Surrogate Recovery Data

Surrogate Compound	Amount Spiked	Amount Recovered	Percent Recovered

PCB Extraction Data

Dry Sample Weight = 9.97
Extracted Sample Weight = 10.790
Final Extracted Volume = 10
Percent Solids = 92.4
Extraction Method = Soxhlet
Extraction Solvent = Hexane/Acetone
Extraction Cleanup = Sulfuric Acid
Associated Blank = 870205-002
Analyst = KO EVANS
Date Completed = 6-FEB-1987

Oak Ridge Gaseous Diffusion Plant
Analytical Chemistry Department
Results of Analyses

Customer Name: SOLSKY
Customer Sample Number: RS-1
Date Sample Received: 4-FEB-1987
Date Sampled:
Material Description: RACO

Lab Sample Number: 870204-001
Date Sample Completed: 10-MAR-1987
Sampled By:
Req. Number:

Activity Number	Preparation Procedure No.	Analysis Procedure No.	Analysis	Result	Units	Analyst	Date Completed
090303	EPA-3050(7.5)	EPA-6010	Barium	8.6	ug/g	EA HESTER	20-FEB-1987
	EPA-3050(7.5)	EPA-6010	Cadmium	0.44	ug/g	EA HESTER	20-FEB-1987
	EPA-3050(7.5)	EPA-6010	Chromium	2.3	ug/g	EA HESTER	20-FEB-1987
	EPA-3050(7.5)	EPA-6010	Lead	<5.0	ug/g	EA HESTER	20-FEB-1987
	EPA-3050(7.5)	EPA-6010	Silver	<0.60	ug/g	EA HESTER	20-FEB-1987
102103	EPA-3050	EPA-7060	Arsenic	<0.5	mg/kg	LG HAMILTON	19-FEB-1987
	EPA-3050	EPA-7740	Selenium	<0.5	mg/kg	LG HAMILTON	19-FEB-1987
103003	EPA-7471	EPA-7471	Mercury	<1.0	ug/g	C. SCHAEFER	11-FEB-1987
184303		SM-503C,D	Oil and Grease	13000	ug/g	HJ CULBERT JR	3-MAR-1987
205107		TP-2051	Archive	K1004A		WD HEDGE	10-MAR-1987

Program Manager: MS Miller
Date Approved: 10-MAR-1987

Spike Recovery Data

Analysis	Amount Spiked	Amount Recovered	Percent Recovered
ARSENIC	2.0	1.9	95.00
MERCURY	0.500	0.496	99.20
SELENIUM	2.0	2.1	105.00

Oak Ridge Gaseous Diffusion Plant
Analytical Chemistry Department
Results of Analyses

Customer Name: SOLSKY
Customer Sample Number: RB-7 Lab Sample Number: 870204-002
Date Sample Received: 4-FEB-1987 Date Sample Completed: 25-MAR-1987
Date Sampled: Sampled By:
Material Description: RACO SET 40 Req. Number:

Activity Number	Preparation Procedure No.	Analysis Procedure No.	Analysis	Result	Units	Analyst	Date Completed
090208	EPA-6010	EPA-6010	Barium	0.013	mg/L	EA HESTER	23-MAR-1987
	EPA-6010	EPA-6010	Cadmium	<0.0030	mg/L	EA HESTER	23-MAR-1987
	EPA-6010	EPA-6010	Chromium	<0.010	mg/L	EA HESTER	23-MAR-1987
	EPA-6010	EPA-6010	Lead	<0.050	mg/L	EA HESTER	23-MAR-1987
	EPA-6010	EPA-6010	Silver	<0.0060	mg/L	EA HESTER	23-MAR-1987
102008	EPA-206.2	EPA-206.2	Arsenic	<0.005	mg/L	LG HAMILTON	20-FEB-1987
	EPA-270.2	EPA-270.2	Selenium	<0.005	mg/L	LG HAMILTON	20-FEB-1987
103008	EPA-245.1	EPA-245.1	Mercury	<0.0002	mg/L	C. SCHAEFER	26-FEB-1987
184308	EPA-413.1	EPA-413.1	oil & grease, gravimetric	<2	mg/L	HJ CULBERT JR	19-FEB-1987

Program Manager: MS Miller
Date Approved: 27-MAR-1987

***** Comments from the Spectrochemistry Laboratory *****

THE ACID BLANK FOR SAMPLES NO.870204-002,004 870204-010,013 870210-111,114
IS AS FOLLOWS :
ARSENIC <0.005 AND SELENIUM <0.005

Spike Recovery Data

Analysis	Amount Spiked	Amount Recovered	Percent Recovered
MERCURY	0.0010	0.0010	100.00

Oak Ridge Gaseous Diffusion Plant
Analytical Chemistry Department
Results of Analyses

Customer Name: SOLSKY
Customer Sample Number: RG-1 Lab Sample Number: 870204-003
Date Sample Received: 4-FEB-1987 Date Sample Completed: 25-MAR-1987
Date Sampled: Sampled By:
Material Description: RACO SET 40 Req. Number:

Activity Number	Preparation Procedure No.	Analysis Procedure No.	Analysis	Result	Units	Analyst	Date Completed
090208	EPA-6010	EPA-6010	Barium	0.038	mg/L	EA HESTER	23-MAR-1987
	EPA-6010	EPA-6010	Cadmium	<0.0030	mg/L	EA HESTER	23-MAR-1987
	EPA-6010	EPA-6010	Chromium	<0.010	mg/L	EA HESTER	23-MAR-1987
	EPA-6010	EPA-6010	Lead	<0.050	mg/L	EA HESTER	23-MAR-1987
	EPA-6010	EPA-6010	Silver	<0.0060	mg/L	EA HESTER	23-MAR-1987
102008	EPA-206.2	EPA-206.2	Arsenic	<0.005	mg/L	LG HAMILTON	20-FEB-1987
	EPA-270.2	EPA-270.2	Selenium	<0.005	mg/L	LG HAMILTON	20-FEB-1987
103008	EPA-245.1	EPA-245.1	Mercury	<0.0002	mg/L	C. SCHAEFER	26-FEB-1987
184308	EPA-413.1	EPA-413.1	oil & grease, gravimetric	<2	mg/L	HJ CULBERT JR	19-FEB-1987

Program Manager: MS Miller
Date Approved: 27-MAR-1987

Oak Ridge Gaseous Diffusion Plant
Analytical Chemistry Department
Results of Analyses

Customer Name: SOLSKY
Customer Sample Number: RB-7 BLANK
Lab Sample Number: 870204-004
Date Sample Received: 4-FEB-1987
Date Sample Completed: 25-MAR-1987
Date Sampled:
Sampled By:
Material Description: RACO SET 40
Req. Number:

Activity Number	Preparation Procedure No.	Analysis Procedure No.	Analysis	Result	Units	Analyst	Date Completed
090208	EPA-6010	EPA-6010	Barium	<0.0010	mg/L	EA HESTER	23-MAR-1987
	EPA-6010	EPA-6010	Cadmium	<0.0030	mg/L	EA HESTER	23-MAR-1987
	EPA-6010	EPA-6010	Chromium	<0.010	mg/L	EA HESTER	23-MAR-1987
	EPA-6010	EPA-6010	Lead	<0.050	mg/L	EA HESTER	23-MAR-1987
	EPA-6010	EPA-6010	Silver	<0.0060	mg/L	EA HESTER	23-MAR-1987
102008	EPA-206.2	EPA-206.2	Arsenic	<0.005	mg/L	LG HAMILTON	20-FEB-1987
	EPA-270.2	EPA-270.2	Selenium	<0.005	mg/L	LG HAMILTON	20-FEB-1987
103008	EPA-245.1	EPA-245.1	Mercury	<0.0002	mg/L	C. SCHAEFER	26-FEB-1987
184308	EPA-413.1	EPA-413.1	oil & grease, gravimetric	<2	mg/L	HJ CULBERT JR	19-FEB-1987

Program Manager: MS Miller
Date Approved: 27-MAR-1987

Oak Ridge Gaseous Diffusion Plant
Analytical Chemistry Department
Results of Analyses

Customer Name: SOLSKY
Customer Sample Number: RB-7-F
Date Sample Received: 10-FEB-1987
Date Sampled:
Material Description: RACO SET 40

Lab Sample Number: 870210-111
Date Sample Completed: 26-MAR-1987
Sampled By:
Req. Number:

Activity Number	Preparation Procedure No.	Analysis Procedure No.	Analysis	Result	Units	Analyst	Date Completed
090208	EPA-6010	EPA-6010	Barium	0.014	mg/L	EA HESTER	23-MAR-1987
	EPA-6010	EPA-6010	Cadmium	<0.0030	mg/L	EA HESTER	23-MAR-1987
	EPA-6010	EPA-6010	Chromium	<0.010	mg/L	EA HESTER	23-MAR-1987
	EPA-6010	EPA-6010	Lead	<0.050	mg/L	EA HESTER	23-MAR-1987
	EPA-6010	EPA-6010	Silver	<0.0060	mg/L	EA HESTER	23-MAR-1987
102008	EPA-206.2	EPA-206.2	Arsenic	<0.005	mg/L	LG HAMILTON	20-FEB-1987
	EPA-270.2	EPA-270.2	Selenium	<0.005	mg/L	LG HAMILTON	20-FEB-1987
103008	EPA-245.1	EPA-245.1	Mercury	<0.0002	mg/L	C. SCHAEFER	26-FEB-1987
205109		TP-205109	Archive	K1004A		WD HEDGE	26-MAR-1987

Program Manager: MS Miller
Date Approved: 27-MAR-1987

Spike Recovery Data

Analysis	Amount Spiked	Amount Recovered	Percent Recovered
MERCURY	0.0010	0.0011	110.00

Silica	-	No limits
**Silver	-	USPHS 0.05 mg/l mandatory limit EPA (E.L.)
Sodium	-	10 mg/l recommended limit (Hibbard)
*Sulfate	-	USPHS recommends 250 mg/l limit EPA (R.L.)
Tannates	-	See color
*Total Dissolved Solids	-	USPHS 500 mg/l (EPA recommended limit) (R.L.)
TOC	-	Preferred limit less than 50 mg/l
Turbidity	-	USPHS should not exceed 5 units
*Zinc	-	USPHS 5 mg/l limit recommended EPA (R.L.)

**Enforceable - Mandatory limits (Primary)
*Recommended limits (Secondary)

Oak Ridge Gaseous Diffusion Plant
Analytical Chemistry Department
Results of Analyses

Customer Name: SOLSKY
Customer Sample Number: RG-1-F
Lab Sample Number: 870210-112
Date Sample Received: 10-FEB-1987
Date Sample Completed: 26-MAR-1987
Date Sampled:
Sampled By:
Material Description: RACO SET 40
Req. Number:

Activity Number	Preparation Procedure No.	Analysis Procedure No.	Analysis	Result	Units	Analyst	Date Completed
090208	EPA-6010	EPA-6010	Barium	0.020	mg/L	EA HESTER	23-MAR-1987
	EPA-6010	EPA-6010	Cadmium	<0.0030	mg/L	EA HESTER	23-MAR-1987
	EPA-6010	EPA-6010	Chromium	<0.010	mg/L	EA HESTER	23-MAR-1987
	EPA-6010	EPA-6010	Lead	<0.050	mg/L	EA HESTER	23-MAR-1987
	EPA-6010	EPA-6010	Silver	<0.0060	mg/L	EA HESTER	23-MAR-1987
102008	EPA-206.2	EPA-206.2	Arsenic	<0.005	mg/L	LG HAMILTON	20-FEB-1987
	EPA-270.2	EPA-270.2	Selenium	<0.005	mg/L	LG HAMILTON	20-FEB-1987
103008	EPA-245.1	EPA-245.1	Mercury	<0.0002	mg/L	C. SCHAEFER	26-FEB-1987
205109		TP-205109	Archive	K1004A		WD HEDGE	26-MAR-1987

Program Manager: MS Miller
Date Approved: 27-MAR-1987

Oak Ridge Gaseous Diffusion Plant
Analytical Chemistry Department
Results of Analyses

Customer Name: SOLSKY
Customer Sample Number: RB-7-BLK-F
Date Sample Received: 10-FEB-1987
Date Sampled:
Material Description: RACD SET 40

Lab Sample Number: 870210-113
Date Sample Completed: 26-MAR-1987
Sampled By:
Req. Number:

Activity Number	Preparation Procedure No.	Analysis Procedure No.	Analysis	Result	Units	Analyst	Date Completed
090208	EPA-6010	EPA-6010	Barium	<0.0010	mg/L	EA HESTER	23-MAR-1987
	EPA-6010	EPA-6010	Cadmium	<0.0030	mg/L	EA HESTER	23-MAR-1987
	EPA-6010	EPA-6010	Chromium	<0.010	mg/L	EA HESTER	23-MAR-1987
	EPA-6010	EPA-6010	Lead	<0.050	mg/L	EA HESTER	23-MAR-1987
	EPA-6010	EPA-6010	Silver	<0.0060	mg/L	EA HESTER	23-MAR-1987
102008	EPA-206.2	EPA-206.2	Arsenic	<0.005	mg/L	LG HAMILTON	20-FEB-1987
	EPA-270.2	EPA-270.2	Selenium	<0.005	mg/L	LG HAMILTON	20-FEB-1987
103008	EPA-245.1	EPA-245.1	Mercury	<0.0002	mg/L	C. SCHAEFER	26-FEB-1987
205109		TP-205109	Archive	K1004A		WD HEDGE	26-MAR-1987

Program Manager: MS Miller
Date Approved: 27-MAR-1987

Oak Ridge Gaseous Diffusion Plant
Analytical Chemistry Department
Results of Analyses

Customer Name: SOLSKY
Customer Sample Number: RS-B-RINSATE
Date Sample Received: 10-FEB-1987
Date Sampled:
Material Description: RACO SET 40

Lab Sample Number: B70210-114
Date Sample Completed: 26-MAR-1987
Sampled By:
Req. Number:

Activity Number	Preparation Procedure No.	Analysis Procedure No.	Analysis	Result	Units	Analyst	Date Completed
090208	EPA-6010	EPA-6010	Barium	<0.0010	mg/L	EA HESTER	23-MAR-1987
	EPA-6010	EPA-6010	Cadmium	<0.0030	mg/L	EA HESTER	23-MAR-1987
	EPA-6010	EPA-6010	Chromium	<0.010	mg/L	EA HESTER	23-MAR-1987
	EPA-6010	EPA-6010	Lead	<0.050	mg/L	EA HESTER	23-MAR-1987
	EPA-6010	EPA-6010	Silver	<0.0060	mg/L	EA HESTER	23-MAR-1987
102008	EPA-206.2	EPA-206.2	Arsenic	<0.005	mg/L	LG HAMILTON	20-FEB-1987
	EPA-270.2	EPA-270.2	Selenium	<0.005	mg/L	LG HAMILTON	20-FEB-1987
103008	EPA-245.1	EPA-245.1	Mercury	<0.0002	mg/L	C. SCHAEFER	26-FEB-1987
184202	EPA-418.1	EPA-418.1	Oil & grease	<0.5	mg/L	JB AKERS	24-FEB-1987
205109		TP-205109	Archive	K1004A		WD HEDGE	26-MAR-1987

Program Manager: MS Miller
Date Approved: 27-MAR-1987

Spike Recovery Data

Analysis	Amount Spiked	Amount Recovered	Percent Recovered
ARSENIC	0.020	0.019	95.00
SELENIUM	0.020	0.021	105.00

ASSOCIATED BLANKS ANALYSIS REPORTS

ORGANIC ANALYSIS DATA REPORT

Analis ID: 870121-060
Laboratory Name: Gas/Liquid Chromatographs
File ID:
Instrument ID:
Data Release Authorized By: TR Oldham

Customer Sample ID:
Customer Name: SOLBX
Sample Matrix: WATER
Requisition Number:
Date Sample Received: 21-JAN-1987

PCB'S/Pesticides - HSL

Date Extracted/Prepared: 2-FEB-1987
Preparation Procedure Number:
Percent Moisture:
Percent Moisture (decanted):
Associated Blank:

Date Analyzed: 2-FEB-1987
Analysis Procedure Number: EPA-608
Conc/Dilution Factor: 1.0
Analyst: RE HOWARD

CAS		ug/L	CAS		ug/L
319-84-6	alpha-BHC	0.05U	11141-16-5	PCB (Aroclor-1232)	0.5U
319-85-7	beta-BHC	0.05U	53469-21-9	PCB (Aroclor-1242)	0.5U
319-86-8	delta-BHC	0.05U	12672-29-6	PCB (Aroclor-1248)	0.5U
58-89-9	gamma-BHC (Lindane)	0.05U	11097-69-1	PCB (Aroclor-1254)	1U
76-44-8	heptachlor	0.05U	11096-82-5	PCB (Aroclor-1260)	1U
309-00-2	aldrin	0.05U			
1024-57-3	heptachlor epoxide	0.05U			
959-98-8	endosulfan I	0.05U			
60-57-1	dieldrin	0.1U			
72-55-9	4,4'-DDE	0.1U			
72-20-8	endrin	0.1U			
33213-65-9	endosulfan II	0.1U			
72-54-8	4,4'-DDD	0.1U			
1031-07-8	endosulfan sulfate	0.1U			
50-29-3	4,4'-DDT	0.1U			
72-43-5	methoxychlor	0.5U			
53494-70-5	endrin ketone	0.1U			
57-74-9	t. chlordane	0.5U			
8001-35-2	toxaphene	1U			
12674-11-2	PCB (Aroclor-1016)	0.5U			
11104-28-2	PCB (Aroclor-1221)	0.5U			

Data Reporting Qualifiers:

U - Compound was analyzed for but not detected. The number is the attainable detection limit for the sample.
B - Analyte was found in the reagent blank as well as the sample.
J - Indicates an estimated value.
NR - Not Detected.

Surrogate Recovery Data

Surrogate Compound	Amount Spiked	Amount Recovered	Percent Recovered
DIBUTYL CHLORENDATE	1.0	0.73	73.0

PCB Extraction Data

Extracted Sample Weight = 1000
Final Extracted Volume = 10

Extraction Method	- Separatory Funnel
Extraction Solvent	- Methylene Chloride
Analyst	- TM KRZIS
Date Completed	- 21-JAN-1987

SAMPLES ANALYSIS REPORTS

ORGANIC ANALYSIS DATA REPORT

AnaLIS ID: 870119-031
Laboratory Name: Organic Mass Spectroscopy
File ID: >03471
Instrument ID: 5995
Data Release Authorized By: DC Canada

Customer Sample ID: RB-7 SAMPLE BLK
Customer Name: SOLSKY
Sample Matrix: WATER
Requisition Number:
Date Sample Received: 19-JAN-1987

Volatile Organic Compounds - HSL

Date Extracted/Prepared:
Preparation Procedure Number:
Percent Moisture:
Percent Moisture (decanted):
Associated Blank:

Date Analyzed: 19-JAN-1987
Analysis Procedure Number: EPA-624
Conc/Dilution Factor: 1.0
Analyst: CP KNAUTH

CAS		ug/L	CAS		ug/L
74-87-3	chloromethane	10U	79-00-5	1,1,2-trichloroethane	5U
74-83-9	bromomethane	10U	71-43-2	benzene	5U
75-01-4	vinyl chloride	10U	10061-02-6	trans-1,3-dichloropropene	5U
75-00-3	chloroethane	10U	110-75-8	2-chloroethylvinyl ether	10U
75-09-2	methylene chloride	5 B	75-25-2	bromoform	5U
67-64-1	acetone	25 B	108-10-1	4-methyl-2-pentanone	10U
75-15-0	carbon disulfide	5U	591-78-6	2-hexanone	10U
75-35-4	1,1-dichloroethene	5U	127-18-4	tetrachloroethene	5U
75-34-3	1,1-dichloroethane	5U	79-34-5	1,1,2,2-tetrachloroethane	5U
156-60-5	trans-1,2-dichloroethene	5U	108-88-3	toluene	9 B
67-66-3	chloroform	2 BJ	108-90-7	chlorobenzene	5U
107-06-2	1,2-dichloroethane	5U	100-41-4	ethylbenzene	5U
78-93-3	2-butanone	10U	100-42-5	styrene	5U
71-55-6	1,1,1-trichloroethane	5U		total xylenes	5U
56-23-5	carbon tetrachloride	5U			
108-05-4	vinyl acetate	10U			
75-27-4	bromodichloromethane	5U			
78-87-5	1,2-dichloropropane	5U			
10061-01-5	cis-1,3-dichloropropene	5U			
79-01-6	trichloroethene	5U			
124-48-1	dibromochloromethane	5U			

Data Reporting Qualifiers:

U - Compound was analyzed for but not detected. The number is the attainable detection limit for the sample.
B - Analyte was found in the reagent blank as well as the sample.
J - Indicates an estimated value.
ND - Not Detected.

Surrogate Recovery Data

Surrogate Compound	Amount Spiked	Amount Recovered	Percent Recovered
TOLUENE-D8	50.0	48.2	96.4
BROMOFLUOROBENZENE	50.0	48.0	96.0
1,2-DICHLOROETHANE-D4	50.0	46.6	93.2

ORGANIC ANALYSIS DATA REPORT

AnaLIS ID: 870119-031
Laboratory Name: Organic Mass Spectroscopy
File ID: >03471
Instrument ID: 5995
Data Release Authorized By: DC Canada

Customer Sample ID: RB-7 SAMPLE BLK
Customer Name: SOLSKY
Sample Matrix: WATER
Requisition Number:
Date Sample Received: 19-JAN-1987

Tentatively Identified Compounds

Date Extracted/Prepared:
Preparation Procedure Number:
Percent Mositure:
Percent Moisture (decanted):
Associated Blank:

Date Analyzed: 19-JAN-1987
Analysis Procedure Number: EPA-624
Conc/Dilution Factor: 1.0
Analyst: CP KNAUTH

CAS		ug/L	CAS		ug/L
75694	TRICHLOROFLUOROMETHANE	1 J	76131	FREON 113	1 B J
74953	DIBROMOMETHANE	1 B J		UNKNOWN	53 J

Data Reporting Qualifiers:

U - Compound was analyzed for but not detected. The number is the attainable detection limit for the sample.
B - Analyte was found in the reagent blank as well as the sample.
J - Indicates an estimated value.
ND - Not Detected.

***** Comments from the Organic Mass Spectroscopy Laboratory *****

ASSOCIATED VOA REAGENT BLANK DATA LAB. ID NO.

CAS NO.	COMPONENT	UG/L
74-87-3	CHLOROMETHANE.....	<10
74-83-9	BROMOMETHANE.....	<10
75-01-4	VINYL CHLORIDE.....	<10
75-00-3	CHLOROETHANE.....	<10
75-09-2	METHYLENE CHLORIDE.....	1
67-64-1	ACETONE.....	8
75-15-0	CARBON DISULFIDE.....	<5
75-35-4	1,1-DICHLOROETHENE.....	<5
75-34-3	1,1-DICHLOROETHANE.....	<5
156-60-5	TRANS-1,2-DICHLOROETHENE...	<5
67-66-3	CHLOROFORM.....	15
107-06-2	1,2-DICHLOROETHANE.....	<5
78-93-3	2-BUTANONE.....	14
71-55-6	1,1,1-TRICHLOROETHANE.....	<5
56-23-5	CARBON TETRACHLORIDE.....	<5
108-25-4	VINYL ACETATE.....	<10
75-27-4	BROMODICHLOROMETHANE.....	1
78-87-5	1,2-DICHLOROPROPANE.....	<5
10061-02-6	TRANS-1,3-DICHLOROPROPENE..	<5
79-01-6	TRICHLOROETHENE.....	<5
124-48-1	DIBROMOCHLOROMETHANE.....	1
79-00-5	1,1,2-TRICHLOROETHANE.....	<5
71-43-2	BENZENE.....	<5

10061-01-5	CIS-1,3-DICHLOROPROPENE....	<5
110-75-8	2-CHLOROETHYLVINYLETHER....	<10
75-25-2	BROMOFORM.....	2
591-78-6	4-METHYL-2-PENTANONE.....	<10
108-10-1	2-HEXANONE.....	<10
127-18-4	TETRACHLOROETHENE.....	<5
79-34-5	1,1,2,2-TETRACHLOROETHANE..	3
108-88-3	TOLUENE.....	1
108-90-7	CHLOROBENZENE.....	1
100-41-4	ETHYLBENZENE.....	<5
100-42-5	STYRENE.....	<5
	TOTAL XYLENES.....	<5

SURROGATE STANDARDS	% RECOVERY
1,2-DICHLOROETHANE D4.....	90.4
TOLUENE-D8.....	105.0
4-BROMOFLUOROBENZENE.....	107.4

TIC COMPOUNDS

74953	DIBROMOMETHANE	1
76131	FREON 113	1

This sample is a duplicate of sample 870119-036

ORGANIC ANALISIS DATA REPORT

AnaLIS ID: 870119-036
Laboratory Name: Organic Mass Spectroscopy
File ID: >03477
Instrument ID: 5995
Data Release Authorized By: DC Canada

Customer Sample ID: RB-7-D
Customer Name: SOLSKY
Sample Matrix: WATER
Requisition Number:
Date Sample Received:

Volatile Organic Compounds - HSL

Date Extracted/Prepared:
Preparation Procedure Number:
Percent Moisture:
Percent Moisture (decanted):
Associated Blank:

Date Analyzed: 20-JAN-1987
Analysis Procedure Number: EPA-624
Conc/Dilution Factor: 1.0
Analyst: CP KNAUTH

CAS		ug/L	CAS		ug/L
74-87-3	chloromethane	10U	79-00-5	1,1,2-trichloroethane	5U
74-83-9	bromomethane	10U	71-43-2	benzene	5U
75-01-4	vinyl chloride	10U	10061-02-6	trans-1,3-dichloropropene	5U
75-00-3	chloroethane	10U	110-75-8	2-chloroethylvinyl ether	10U
75-09-2	methylene chloride	3 BJ	75-25-2	bromoform	5U
67-64-1	acetone	13 B	108-10-1	4-methyl-2-pentanone	10U
75-15-0	carbon disulfide	1 J	591-78-6	2-hexanone	10U
75-35-4	1,1-dichloroethene	5U	127-18-4	tetrachloroethene	5U
75-34-3	1,1-dichloroethane	5U	79-34-5	1,1,2,2-tetrachloroethane	5U
156-60-5	trans-1,2-dichloroethene	5U	108-88-3	toluene	1 BJ
67-66-3	chloroform	2 BJ	108-90-7	chlorobenzene	5U
107-06-2	1,2-dichloroethane	5U	100-41-4	ethylbenzene	5U
78-93-3	2-butanone	6 BJ	100-42-5	styrene	5U
71-55-6	1,1,1-trichloroethane	5U		total xylenes	5U
56-23-5	carbon tetrachloride	5U			
108-05-4	vinyl acetate	10U			
75-27-4	bromodichloromethane	5U			
78-87-5	1,2-dichloropropane	5U			
10061-01-5	cis-1,3-dichloropropene	5U			
79-01-6	trichloroethene	5U			
124-48-1	dibromochloromethane	5U			

Data Reporting Qualifiers:

U - Compound was analyzed for but not detected. The number is the attainable detection limit for the sample.
B - Analyte was found in the reagent blank as well as the sample.
J - Indicates an estimated value.
ND - Not Detected.

Surrogate Recovery Data

Surrogate Compound	Amount Spiked	Amount Recovered	Percent Recovered
TOLUENE-D8	50.0	49.9	99.8
BROMOFLUOROBENZENE	50.0	50.1	100.2
1,2-DICHLOROETHANE-D4	50.0	45.3	90.6

ORGANIC ANALYSIS DATA REPORT

AnaLIS ID: 870119-036
Laboratory Name: Organic Mass Spectroscopy
File ID: >03477
Instrument ID: 5995
Data Release Authorized By: DC Canada

Customer Sample ID: RB-7-D
Customer Name: SOLSKY
Sample Matrix: WATER
Requisition Number:
Date Sample Received:

Tentatively Identified Compounds

Date Extracted/Prepared:
Preparation Procedure Number:
Percent Moisture:
Percent Moisture (decanted):
Associated Blank:

Date Analyzed: 20-JAN-1987
Analysis Procedure Number: EPA-624
Conc/Dilution Factor: 1.0
Analyst: CP KNAUTH

CAS		ug/L	CAS		ug/L
75694	TRICHLOROFLUOROMETHANE	1 J	74953	DIBROMOMETHANE	1 B J

Data Reporting Qualifiers:

U - Compound was analyzed for but not detected. The number is the attainable detection limit for the sample.
B - Analyte was found in the reagent blank as well as the sample.
J - Indicates an estimated value.
ND - Not Detected.

***** Comments from the Organic Mass Spectroscopy Laboratory *****

ASSOCIATED VOA REAGENT BLANK DATA LAB. ID NO.

CAS NO.	COMPONENT	UG/L
74-87-3	CHLOROMETHANE.....	<10
74-83-9	BROMOMETHANE.....	<10
75-01-4	VINYL CHLORIDE.....	<10
75-00-3	CHLOROETHANE.....	<10
75-09-2	METHYLENE CHLORIDE.....	1
67-64-1	ACETONE.....	9
75-15-0	CARBON DISULFIDE.....	<5
75-35-4	1,1-DICHLOROETHENE.....	<5
75-34-3	1,1-DICHLOROETHANE.....	<5
156-60-5	TRANS-1,2-DICHLOROETHENE...	<5
67-66-3	CHLOROFORM.....	13
107-06-2	1,2-DICHLOROETHANE.....	<5
78-93-3	2-BUTANONE.....	13
71-55-6	1,1,1-TRICHLOROETHANE.....	<5
56-23-5	CARBON TETRACHLORIDE.....	<5
108-25-4	VINYL ACETATE.....	<10
75-27-4	BROMODICHLOROMETHANE.....	<5
78-87-5	1,2-DICHLOROPROPANE.....	<5
10061-02-6	TRANS-1,3-DICHLOROPROPENE..	<5
79-01-6	TRICHLOROETHENE.....	<5
124-48-1	DIBROMOCHLOROMETHANE.....	<5
79-00-5	1,1,2-TRICHLOROETHANE.....	<5
71-43-2	BENZENE.....	<5
10061-01-5	CIS-1,3-DICHLOROPROPENE....	<5

110-75-8	2-CHLOROETHYLVINYLETHER....	<10
75-25-2	BROMOFORM.....	<5
591-78-6	4-METHYL-2-PENTANONE.....	<10
108-10-1	2-HEXANONE.....	<10
127-18-4	TETRACHLOROETHENE.....	<5
79-34-5	1,1,2,2-TETRACHLOROETHANE..	<5
108-88-3	TOLUENE.....	1
108-90-7	CHLOROBENZENE.....	<5
100-41-4	ETHYLBENZENE.....	<5
100-42-5	STYRENE.....	<5
	TOTAL XYLENES.....	1

SURROGATE STANDARDS	% RECOVERY
1,2-DICHLOROETHANE D4.....	97.0
TOLUENE-D8.....	96.0
4-BROMOFLUOROBENZENE.....	107.2

TIC COMPOUNDS

74953	DIBROMOMETHANE	1

This sample is a duplicate of sample 870119-031

ORGANIC ANALYSIS DATA REPORT

AnaLIS ID: 870119-032
Laboratory Name: Organic Mass Spectroscopy
File ID: >03472
Instrument ID: 5995
Data Release Authorized By: DC Canada

Customer Sample ID: RB-7 (SILO #26)
Customer Name: SOLSKY
Sample Matrix: WATER
Requisition Number:
Date Sample Received: 19-JAN-1987

Volatile Organic Compounds - HSL

Date Extracted/Prepared:
Preparation Procedure Number:
Percent Moisture:
Percent Moisture (decanted):
Associated Blank:

Date Analyzed: 19-JAN-1987
Analysis Procedure Number: EPA-624
Conc/Dilution Factor: 1.0
Analyst: CP KNAUTH

CAS		ug/L	CAS		ug/L
74-87-3	chloromethane	10U	79-00-5	1,1,2-trichloroethane	5U
74-83-9	bromomethane	10U	71-43-2	benzene	5U
75-01-4	vinyl chloride	10U	10061-02-6	trans-1,3-dichloropropene	5U
75-00-3	chloroethane	10U	110-75-8	2-chloroethylvinyl ether	10U
75-09-2	methylene chloride	5U	75-25-2	bromoform	5U
67-64-1	acetone	35 B	108-10-1	4-methyl-2-pentanone	10U
75-15-0	carbon disulfide	5U	591-78-6	2-hexanone	10U
75-35-4	1,1-dichloroethene	5U	127-18-4	tetrachloroethene	5U
75-34-3	1,1-dichloroethane	5U	79-34-5	1,1,2,2-tetrachloroethane	5U
156-60-5	trans-1,2-dichloroethene	5U	108-88-3	toluene	2 BJ
67-66-3	chloroform	2 BJ	108-90-7	chlorobenzene	5U
107-06-2	1,2-dichloroethane	5U	100-41-4	ethylbenzene	5U
78-93-3	2-butanone	12 B	100-42-5	styrene	5U
71-55-6	1,1,1-trichloroethane	5U		total xylenes	5U
56-23-5	carbon tetrachloride	5U			
108-05-4	vinyl acetate	10U			
75-27-4	bromodichloromethane	5U			
78-87-5	1,2-dichloropropane	5U			
10061-01-5	cis-1,3-dichloropropene	5U			
79-01-6	trichloroethene	5U			
124-48-1	dibromochloromethane	5U			

Data Reporting Qualifiers:

U - Compound was analyzed for but not detected. The number is the attainable detection limit for the sample.
B - Analyte was found in the reagent blank as well as the sample.
J - Indicates an estimated value.
ND - Not Detected.

Surrogate Recovery Data

Surrogate Compound	Amount Spiked	Amount Recovered	Percent Recovered
TOLUENE-D8	50.0	47.7	95.4
BROMOFLUOROBENZENE	50.0	47.8	95.6
1,2-DICHLOROETHANE-D4	50.0	47.6	95.2

AnaLIS ID: 870119-032
Laboratory Name: Organic Mass Spectroscopy
File ID: >03472
Instrument ID: 5995
Data Release Authorized By: DC Canada

Customer Sample ID: RB-7 (SILO #26)
Customer Name: SOLSKY
Sample Matrix: WATER
Requisition Number:
Date Sample Received: 19-JAN-1987

Tentatively Identified Compounds

Date Extracted/Prepared:
Preparation Procedure Number:
Percent Moisture:
Percent Moisture (decanted):
Associated Blank:

Date Analyzed: 19-JAN-1987
Analysis Procedure Number: EPA-624
Conc/Dilution Factor: 1.0
Analyst: CP KNAUTH

CAS		ug/L	CAS		ug/L
75694	TRICHLOROFLUOROMETHANE	1 J	76131	FREON 113	1 B J
74953	DIBROMOMETHANE	1 B J			

Data Reporting Qualifiers:

U - Compound was analyzed for but not detected. The number is the attainable detection limit for the sample.
B - Analyte was found in the reasent blank as well as the sample.
J - Indicates an estimated value.
ND - Not Detected.

***** Comments from the Organic Mass Spectroscopy Laboratory *****

ASSOCIATED VOA REAGENT BLANK DATA LAB. ID NO.

CAS NO.	COMPONENT	UG/L
74-87-3	CHLOROMETHANE.....	<10
74-83-9	BROMOMETHANE.....	<10
75-01-4	VINYL CHLORIDE.....	<10
75-00-3	CHLOROETHANE.....	<10
75-09-2	METHYLENE CHLORIDE.....	1
67-64-1	ACETONE.....	8
75-15-0	CARBON DISULFIDE.....	<5
75-35-4	1,1-DICHLOROETHENE.....	<5
75-34-3	1,1-DICHLOROETHANE.....	<5
156-60-5	TRANS-1,2-DICHLOROETHENE...	<5
67-66-3	CHLOROFORM.....	15
107-06-2	1,2-DICHLOROETHANE.....	<5
78-93-3	2-BUTANONE.....	14
71-55-6	1,1,1-TRICHLOROETHANE.....	<5
56-23-5	CARBON TETRACHLORIDE.....	<5
108-25-4	VINYL ACETATE.....	<10
75-27-4	BROMODICHLOROMETHANE.....	1
78-87-5	1,2-DICHLOROPROPANE.....	<5
10061-02-6	TRANS-1,3-DICHLOROPROPENE..	<5
79-01-6	TRICHLOROETHENE.....	<5
124-48-1	DIBROMOCHLOROMETHANE.....	1
79-00-5	1,1,2-TRICHLOROETHANE.....	<5
71-43-2	BENZENE.....	<5

[illegible]	[illegible]	<5
110-75-8	2-CHLOROETHYLVINYLETHER....	<10
75-25-2	BROMOFORM.....	2
591-78-6	4-METHYL-2-PENTANONE.....	<10
108-10-1	2-HEXANONE.....	<10
127-18-4	TETRACHLOROETHENE.....	<5
79-34-5	1,1,2,2-TETRACHLOROETHANE..	3
108-88-3	TOLUENE.....	1
108-90-7	CHLOROBENZENE.....	1
100-41-4	ETHYLBENZENE.....	<5
100-42-5	STYRENE.....	<5
	TOTAL XYLENES.....	<5

SURROGATE STANDARDS	% RECOVERY
1,2-DICHLOROETHANE D4.....	90.4
TOLUENE-D8.....	105.0
4-BROMOFLUOROBENZENE.....	107.4

TIC COMPOUNDS

74953	DIBROMOMETHANE	1
76131	FREON 113	1

ORGANIC ANALYSIS DATA REPORT

AnaLIS ID: 870119-033
Laboratory Name: Organic Mass Spectroscopy
File ID: >03473
Instrument ID: 5995
Data Release Authorized By: DC Canada

Customer Sample ID: RC-1 (WELL#1)
Customer Name: SOLSKY
Sample Matrix: WATER
Requisition Number:
Date Sample Received: 19-JAN-1987

Volatile Organic Compounds - HSL

Date Extracted/Prepared:
Preparation Procedure Number:
Percent Moisture:
Percent Moisture (decanted):
Associated Blank:

Date Analyzed: 19-JAN-1987
Analysis Procedure Number: EPA-624
Conc/Dilution Factor: 1.0
Analyst: CP KNAUTH

CAS		ug/L	CAS		ug/L
74-87-3	chloromethane	10U	79-00-5	1,1,2-trichloroethane	5U
74-83-9	bromomethane	10U	71-43-2	benzene	5U
75-01-4	vinyl chloride	10U	10061-02-6	trans-1,3-dichloropropene	5U
75-00-3	chloroethane	10U	110-75-8	2-chloroethylvinyl ether	10U
75-09-2	methylene chloride	5U	75-25-2	bromoform	5U
67-64-1	acetone	24 B	108-10-1	4-methyl-2-pentanone	10U
75-15-0	carbon disulfide	5U	591-78-6	2-hexanone	10U
75-35-4	1,1-dichloroethene	5U	127-18-4	tetrachloroethene	5U
75-34-3	1,1-dichloroethane	5U	79-34-5	1,1,2,2-tetrachloroethane	5U
156-60-5	trans-1,2-dichloroethene	5U	108-88-3	toluene	1 BJ
67-66-3	chloroform	2 BJ	108-90-7	chlorobenzene	5U
107-06-2	1,2-dichloroethane	5U	100-41-4	ethylbenzene	5U
78-93-3	2-butanone	10U	100-42-5	styrene	5U
71-55-6	1,1,1-trichloroethane	5U		total xylenes	5U
56-23-5	carbon tetrachloride	5U			
108-05-4	vinyl acetate	10U			
75-27-4	bromodichloromethane	5U			
78-87-5	1,2-dichloropropane	5U			
10061-01-5	cis-1,3-dichloropropene	5U			
79-01-6	trichloroethene	5U			
124-48-1	dibromochloromethane	5U			

Data Reporting Qualifiers:

U - Compound was analyzed for but not detected. The number is the attainable detection limit for the sample.
B - Analyte was found in the reagent blank as well as the sample.
J - Indicates an estimated value.
ND - Not Detected.

Surrogate Recovery Data

Surrogate Compound	Amount Spiked	Amount Recovered	Percent Recovered
TOLUENE-D8	50.0	49.2	98.4
BROMOFLUOROBENZENE	50.0	49.2	98.4
1,2-DICHLOROETHANE-D4	50.0	50.1	100.2

ORGANIC ANALYSIS DATA REPORT

AnaLIS ID: 870119-033
Laboratory Name: Organic Mass Spectroscopy
File ID: >03473
Instrument ID: 5995
Data Release Authorized By: DC Canada

Customer Sample ID: RC-1 (WELL#1)
Customer Name: SOLSKY
Sample Matrix: WATER
Requisition Number:
Date Sample Received: 19-JAN-1987

Tentatively Identified Compounds

Date Extracted/Prepared:
Preparation Procedure Number:
Percent Moisture:
Percent Moisture (decanted):
Associated Blank:

Date Analyzed: 19-JAN-1987
Analysis Procedure Number: EPA-624
Conc/Dilution Factor: 1.0
Analyst: CP KNAUTH

CAS		ug/L	CAS		ug/L
76131	FREON 113	1 B J	74953	DIBROMOMETHANE	1 B J

Data Reporting Qualifiers:

U - Compound was analyzed for but not detected. The number is the attainable detection limit for the sample.
B - Analyte was found in the reagent blank as well as the sample.
J - Indicates an estimated value.
ND - Not Detected.

***** Comments from the Organic Mass Spectroscopy Laboratory *****

ASSOCIATED VOA REAGENT BLANK DATA LAB. ID NO.

CAS NO.	COMPONENT	UG/L
74-87-3	CHLOROMETHANE.....	<10
74-83-9	BROMOMETHANE.....	<10
75-01-4	VINYL CHLORIDE.....	<10
75-00-3	CHLOROETHANE.....	<10
75-09-2	METHYLENE CHLORIDE.....	1
67-64-1	ACETONE.....	8
75-15-0	CARBON DISULFIDE.....	<5
75-35-4	1,1-DICHLOROETHENE.....	<5
75-34-3	1,1-DICHLOROETHANE.....	<5
156-60-5	TRANS-1,2-DICHLOROETHENE...	<5
67-66-3	CHLOROFORM.....	15
107-06-2	1,2-DICHLOROETHANE.....	<5
78-93-3	2-BUTANONE.....	14
71-55-6	1,1,1-TRICHLOROETHANE.....	<5
56-23-5	CARBON TETRACHLORIDE.....	<5
108-25-4	VINYL ACETATE.....	<10
75-27-4	BROMODICHLOROMETHANE.....	1
78-87-5	1,2-DICHLOROPROPANE.....	<5
10061-02-6	TRANS-1,3-DICHLOROPROPENE..	<5
79-01-6	TRICHLOROETHENE.....	<5
124-48-1	DIBROMOCHLOROMETHANE.....	1
79-00-5	1,1,2-TRICHLOROETHANE.....	<5
71-43-2	BENZENE.....	<5
10061-01-5	CIS-1,3-DICHLOROPROPENE....	<5

110-75-8	2-CHLOROETHYLVINYLETHER....	<10
75-25-2	BROMOFORM.....	2
591-78-6	4-METHYL-2-PENTANONE.....	<10
108-10-1	2-HEXANONE.....	<10
127-18-4	TETRACHLOROETHENE.....	<5
79-34-5	1,1,2,2-TETRACHLOROETHANE..	3
108-88-3	TOLUENE.....	1
108-90-7	CHLOROBENZENE.....	1
100-41-4	ETHYLBENZENE.....	<5
100-42-5	STYRENE.....	<5
	TOTAL XYLENES.....	<5

SURROGATE STANDARDS	% RECOVERY
1,2-DICHLOROETHANE D4.....	90.4
TOLUENE-D8.....	105.0
4-BROMOFLUOROBENZENE.....	107.4

TIC COMPOUNDS

74953	DIBROMOMETHANE	1
76131	FREON 113	1

ORGANIC ANALYSIS DATA REPORT

AnaLIS ID: 870119-034
Laboratory Name: Organic Mass Spectroscopy
File ID: >03470
Instrument ID: 5995
Data Release Authorized By: DC Canada

Customer Sample ID: TRAVEL BLK
Customer Name: SOLSKY
Sample Matrix: WATER
Requisition Number:
Date Sample Received: 19-JAN-1987

Volatile Organic Compounds - HSL

Date Extracted/Prepared:
Preparation Procedure Number:
Percent Moisture:
Percent Moisture (decanted):
Associated Blank:

Date Analyzed: 19-JAN-1987
Analysis Procedure Number: EPA-624
Conc/Dilution Factor: 1.0
Analyst: CP KNAUTH

CAS		ug/L	CAS		ug/L
74-87-3	chloromethane	10U	79-00-5	1,1,2-trichloroethane	5U
74-83-9	bromomethane	10U	71-43-2	benzene	5U
75-01-4	vinyl chloride	10U	10061-02-6	trans-1,3-dichloropropene	5U
75-00-3	chloroethane	10U	110-75-8	2-chloroethylvinyl ether	10U
75-09-2	methylene chloride	8 B	75-25-2	bromoform	5U
67-64-1	acetone	31 B	108-10-1	4-methyl-2-pentanone	10U
75-15-0	carbon disulfide	5U	591-78-6	2-hexanone	10U
75-35-4	1,1-dichloroethene	5U	127-18-4	tetrachloroethene	5U
75-34-3	1,1-dichloroethane	5U	79-34-5	1,1,2,2-tetrachloroethane	5U
156-60-5	trans-1,2-dichloroethene	5U	108-88-3	toluene	1 BJ
67-66-3	chloroform	2 BJ	108-90-7	chlorobenzene	5U
107-06-2	1,2-dichloroethane	5U	100-41-4	ethylbenzene	5U
78-93-3	2-butanone	8 BJ	100-42-5	styrene	5U
71-55-6	1,1,1-trichloroethane	5U		total xylenes	5U
56-23-5	carbon tetrachloride	5U			
108-05-4	vinyl acetate	10U			
75-27-4	bromodichloromethane	5U			
78-87-5	1,2-dichloropropane	5U			
10061-01-5	cis-1,3-dichloropropene	5U			
79-01-6	trichloroethene	5U			
124-48-1	dibromochloromethane	5U			

Data Reporting Qualifiers:

U - Compound was analyzed for but not detected. The number is the attainable detection limit for the sample.
B - Analyte was found in the reagent blank as well as the sample.
J - Indicates an estimated value.
ND - Not Detected.

Surrogate Recovery Data

Surrogate Compound	Amount Spiked	Amount Recovered	Percent Recovered
TOLUENE-D8	50.0	49.3	98.6
BROMOFLUOROBENZENE	50.0	49.7	99.4
1,2-DICHLOROETHANE-D4	50.0	46.8	93.6

ORGANIC ANALYSIS DATA REPORT

AnaLIS ID: 870119-034
Laboratory Name: Organic Mass Spectroscopy
File ID: >03470
Instrument ID: 5995
Data Release Authorized By: DC Canada

Customer Sample ID: TRAVEL BLK
Customer Name: SOLSKY
Sample Matrix: WATER
Requisition Number:
Date Sample Received: 19-JAN-1987

Tentatively Identified Compounds

Date Extracted/Prepared:
Preparation Procedure Number:
Percent Mositure:
Percent Moisture (decanted):
Associated Blank:

Date Analyzed: 19-JAN-1987
Analysis Procedure Number: EPA-624
Conc/Dilution Factor: 1.0
Analyst: CP KNAUTH

CAS		ug/L	CAS		ug/L
76131	FREON 113	1 B J	74953	DIBROMOMETHANE	1 B J

Data Reporting Qualifiers:

U - Compound was analyzed for bet not detected. The number is the attainable detection limit for the sample.
B - Analyte was found in the reagent blank as well as the sample.
J - Indicates an estimated value.
ND - Not Detected.

***** Comments from the Organic Mass Spectroscopy Laboratory *****

ASSOCIATED VOA REAGENT BLANK DATA LAB. ID NO.

CAS NO.	COMPONENT	UG/L
74-87-3	CHLOROMETHANE.....	<10
74-83-9	BROMOMETHANE.....	<10
75-01-4	VINYL CHLORIDE.....	<10
75-00-3	CHLOROETHANE.....	<10
75-09-2	METHYLENE CHLORIDE.....	1
67-64-1	ACETONE.....	8
75-15-0	CARBON DISULFIDE.....	<5
75-35-4	1,1-DICHLOROETHENE.....	<5
75-34-3	1,1-DICHLOROETHANE.....	<5
156-60-5	TRANS-1,2-DICHLOROETHENE...	<5
67-66-3	CHLOROFORM.....	15
107-06-2	1,2-DICHLOROETHANE.....	<5
78-93-3	2-BUTANONE.....	14
71-55-6	1,1,1-TRICHLOROETHANE.....	<5
56-23-5	CARBON TETRACHLORIDE.....	<5
108-25-4	VINYL ACETATE.....	<10
75-27-4	BROMODICHLOROMETHANE.....	1
78-87-5	1,2-DICHLOROPROPANE.....	<5
10061-02-6	TRANS-1,3-DICHLOROPROPENE..	<5
79-01-6	TRICHLOROETHENE.....	<5
124-48-1	DIBROMOCHLOROMETHANE.....	1
79-00-5	1,1,2-TRICHLOROETHANE.....	<5
71-43-2	BENZENE.....	<5
10061-01-5	CIS-1,3-DICHLOROPROPENE....	<5

DERP

INVENTORY REPORT AND HAZARDOUS RANKING SYSTEM EVALUATION

Preliminary General Information

1. DERP Code Number. (11) E05MI00Z600

2. Site Name (current). (35) Former Raco Bomarc Missile Battery

3. Site Name when used by DOD. (35) Raco Bomarc Missile Battery

4. Street/Route Number. (25) Michigan State, Route 28

5. City. (16) Raco

6. County. (15) Chippewa

7. State. (2) MI

8. Zip Code. (9) Post Office Closed

9. Congressional District Code Number. (2) 11

10. Latitude: degrees, minutes, seconds. (6) 46° 20' 53"

11. Longitude: degrees, minutes, seconds. (7) 84° 48' 15"

12. Is a large scale, greater than 1 inch equals 200 feet, topograhic map of the site area available to attach to this inventory report? (1) N
Y = YES N = NO

13. Are site maps or sketches on file with the inventory? (1) N
Y = YES N = NO

14. Are there photographs on file with the inventory? (1) Y
Y = YES N = NO

15. Current Owners Name(s). (45) US Department of Agriculture/US Forest Service

16. Owner's Street Address. (25) 4000 I-75 Business Spur

17. Owner's City. (16) Saulte Ste. Marie

18. Owner's State. (2) MI

19. Owner's Zip Code. (9) 49783

20. Number of Years Owned. (2) 14

21. What is the current owner's use of the site? (50) None

REAL ESTATE SEARCH INFORMATION

22. Give chronological list of owners or lessees since termination of DOD ownership or lease; include dates of ownership and brief description of use. (240)

Lease terminated with DOD June 30, 1973, ASDA/US Forest Service has owned it to date.

23. Was property leased out to others by DOD? (Y or N), describe and match owner/lessee with use(s). (51)

Yes - Local Indian Tribe = Sawmill; Local Contractor = Dumping Concrete and other Construction Debris into Silos.

24. Was property leased-out to others by subsequent owners? (Y or N) Describe. (51)

No

25. Type of problem(s) listed in claim documents, check as many as applicable: (3) HD

Hazardous and Toxic = H (if listed complete questions 100 to 399).

Ordnance and Explosive = O (if listed complete questions 400-499).

Debris/Structures = D (if listed complete questions 500 to 599).

26. Has Right of Entry Permit been obtained? (Y or N). (1) Y

27. Are copies of lease agreements or deeds or other instruments conveying title on file? (Y or N). (1) Not Known

28. Does deed(s) or lease agreement(s) contain any disclaimers or restoration requirements? (Y or N). If yes, decribe. (161)

Not Known

29. Date field inspection completed. (6) October 2, 1986

30. Agency performing inspection. (25)

Envirodyne Engineers for St. Louis District COE.

31. Inspection team leader's name. (20) Thomas M. Lachajczyk

32. Title. (25) Program Manager

33. Organization (office symbol). (10)

34. Telephone number(s): Commercial. (10) (314) 434-6960

35. Telephone number(s): FTS. (7)

36. Telephone number(s): AUTOVON. (7)

37. Site Status: A = Active I = Inactive (1) I

38. Years of operation in current status. (2) 14

39. Type(s) of problems found by inspection team. (3) HD

USE:
H = H&T
O = OEW
D = Debris

40. Enter the number of buildings on the site. (3) 4

41. Describe. (80)

Maintenance Building, Composite Building, Well & Pump House, Storage Shed.

42. What is the major land use for a one mile radius around the site? (20) (e.g., agriculture, industry, residential).

National Forest

43. What is the estimated population within a one mile radius around the site? (use 3.8 persons/house). (6) 23

44. Describe the security of the site. (120)

None - All fences and gates have been removed.

45. Describe the best access to the site from the nearest public road. (120)

Three miles West of Raco on M-28, entrance road on south side of M-28 along air field. Missile complex just east of airfields' eastern strip.

LIST CURRENT AND/OR PAST POLLUTION ABATEMENT PERMITS

PERMIT INFORMATION				
TYPE OF PERMIT ISSUED PAST AND/OR PRESENT	PRESENT NO.	DATE ISSUED	EXPIRATION DATE	COMMENTS

46. NPDES. (72) (PERMIT #, DATE ISSUED, EXPIRATION DATE, COMMENTS)

Not known

47. UIC. (72) (SAME AS 46)

Not known

48. AIR. (72) (SAME AS 46)

Not known

49. RCRA. (72) (SAME AS 46)

Not known

---

50. Describe any pertinent environmental protection response actions previously taken at the site. (240)

Wastewater Treatment Plant

51. Describe any environmental protection remediation actions previously taken at the site. (240)

Not known

52. List any court orders, lawsuits, fines or other legal actions that have been taken against any owners/operators of the site since DOD ownership/ lease. (160)

Not known

53. Determination of Responsible Party for restoration: (1) Not known

	DOD	Other	Not yet determined
54.	Contract 1. (13)		
55.	Contract 2. (13)		
56.	Contract 3. (13)		

57. Contract 4. (13) . . . . . .

58. Contract 5. (13) . . . . . .

59-98. (Reserved)

99. Preliminary Information remarks. (80)

The sawdust pile and the construction debris within the silo structures is not DOD responsibility. . . . . .

DESCRIPTION OF WASTE AREAS WITH HRS OF WASTE STORAGE AT THE SITE

CONTAINMENT

100. Types of containment found in the individual waste areas: (4) C

Surface impoundment / / (I) Waste piles, including contaminated surface soils / / (P)

Containers /X/ (C) Landfill, including contaminated subsoils / / (L)

101. Present integrity of containment: (25) (Use TABLES 1, 2 or 3 phrases)

2-55 gallon drums found in one missile storage structure. Leaking with moderately Permeable Liner

102. Evaluation of the integrity of containment versus potential groundwater release, before any remedial actions (see TABLE 1 for evaluation considerations). HRS Value - (Groundwater Containment). (1) 2

103. Evaluation of the integrity of containment versus potential surface water release, before any remedial actions (see TABLE 2 for evaluation considerations). HRS Value - (Surface Water Containment). (1) 2

Note: Containment consists of underground storage tanks and old missile silos. There are no true containment structures.

QUANTITY

104. Total quantity of hazardous waste, as deposited and capable of migrating. (Having a non-zero containment value (TABLE 3). The air pathway quantity is to include only those quantities that can be transported by the air: (10) Two drums and unknown quantity of fuel in underground tanks.

105. Total quantity of waste now present: CY, drums and gallons (use only one common unit). (10) Two drums

106. Quantity with the potential to migrate by groundwater. (10) Two drums

107. HRS Value (groundwater quantity). (1) (TABLE 3) 1

108. Quantity with the potential to migrate by surface water. (10) 0

109. HRS Value (Surface Water Quantity). (1) (TABLE 3) 0

110. Quantity with the potential to migrate by air. (10)

Two drums

111. HRS Value (Air Quantity). (1) (TABLE 3) 1

HAZARDOUS SUBSTANCES

112. Hazardous substances in this area. (360)

Name(s)	Chemical Abstract System (CAS) Number
Petroleum hydrocarbon	None
Toluene	108-88-3
Trichloroethylene	79-01-6
Ethylbenzene	100-41-4
Methylene Chloride	75-09-2
Cyclohexane (also isomers)	110-82-7
Phenol (also alkyl substituted)	108-95-2
Tricyclo (3.3.1.1.3,7) decane	768945
Decahydronapthalene	91178

113. Highest scoring substance for Groundwater Migration Route. (25)

Petroleum hydrocarbons, trichloroethylene, phenol

114.* Toxicity ranking number. (1) 3

115.* Persistence ranking number. (1) (assumed) 1

116.** HRS Matrix Value. (2) 12

117. Highest scoring substance for Surface Water Migration Route. (25)

Petroleum hydrocarbons, phenol

118.* Toxicity (ranking number). (1) 3

119.* Persistence (ranking number). (1) (assumed) 1

120.** HRS Matrix Value. (2) 12

* Use TABLES 4, 5, or 6
**Use TABLE 7

121. Highest scoring substance for Air Migration Route. (25)

Petroleum hydrocarbons, phenol

122.* Toxicity (ranking number). (1) 3

123.** HRS Value. (2) 12

PHYSICAL STATE

124. Physical state of waste as deposited: (1)

	HRS Value		HRS Value
Solid consoidated or stabilized:	0	Powder or fine material:	2
Solid, unconsolidated or unstabilized:	1	Liquid, sludge or gas:	3

HRS value from item 124. 3

125. Description of current physical state of waste. (15)

Two leaking drums/oil stained soil

GROUNDWATER MIGRATION ROUTE

HYDROGEOLOGY

126. Description of strata from surface to the deepest aquifer or condern (names, thickness, type of material). (Refer to TABLE 8) (200)

Fine, medium and coarse sands

127. Direction of regional groundwater flow. (3) SE

128. Are there barriers to horizontal migration of groundwater within 3 miles downgradient of the site (e.g., rivers). These barriers should be identified on a map of the site. (1) Y/N Y

* Use TABLES 4, 5, or 6
**Use TABLE 7

129. Are there discharge and/or recharge areas within 3 miles of the site? (These areas should be identified on a map of the site). (1) Y/N .Y.

COMPARATIVE DOCUMENTATION OF AQUIFERS

(All questions on this page refer to surficial aquifer).

130. Name of aquifer. (25)

Surficial aquifer not named.

131. Designation of aquifer use. (10) Assume residential drinking water.

132. Depth to highest seasonal level. (3) estimated 35'

Circle the HRS value corresponding to the use of groundwater drawn from within 3 miles from the source of contamination:

	VALUE
Unusable	0
Commmercial, irrigation, or not used but usable	1
Drinking water with alternate source available	2
Sole source, drinking water supply	3

133. The HRS Value circled. (1) .3.

134. Location of nearest drinking or irrigation well within 3 miles downgradient of the source of contamination, give direction. (20)

Assume D/I well - SE

135. Depth of the nearest well (ft). (3) Unknown

136. Distance to the well from nearest point of contamination (critical distances that require careful measurement for HRS purposes of 2000', 1 mile, 2 miles and 3 miles). (5) One mile

137. Population served by groundwater drawn from aquifer within 3 miles of contamination. (6) 65

138. Basis of population figure (e.g., census, house count). (10)

House count from map

139. HRS value from Distance/Population Matrix (TABLE 9). (2) 4

140. Acres of cropland/pastureland irrigated by water drawn from the aquifer within 3 miles of contamination. (4) None

COMPARATIVE DOCUMENTATION OF AQUIFERS

(All questions on this page refer to Deeper Aquifer)

141. Name of aquifer. (25)

Blackriver on Trenton

142. Designation of aquifer use. (10) Assume residential/agriculture

143. Distance from ground surface (elevation) to highest seasonal water level. (3) Not known

Circle the HRS value corresponding to the use of groundwater drawn from within 3 miles from the source of contamination:

	VALUE
Unusable	0
Commercial, irrigation, or not used but usable	1
Drinking water with alternate source available	2
Sole source, drinking water supply	3

144. HRS value circled. (1) 3

145. Location of nearest drinking or irrigation well within 3 miles downgradient of the source of contamination, give direction. (20)

Unknown

146. Depth of the nearest well (ft). (3) Unknown

147. Distance to the well from nearest point of contamination (critical distance that require careful measurement for HRS purposes are 2000', 1 mile, 2 miles and 3 miles). (5) N/A

148. Population served by groundwater drawn from aquifer within 3 miles of contamination. (6) Unknown

149. Basis of population figure (e.g., census, house count). (10) N/A

150. HRS value from Distance/Population Matrix (TABLE 9). (2) N/A

151. Acres of cropland/pastureland irrigated by water drawn from the aquifer within 3 miles of contamination. (4) Not known

RELEASE TO AQUIFER OF CONCERN

Select from the comparative documentation of aquifers, the aquifer that yields the highest HRS groundwater score. Document and evaluate this aquifer.

152. Name of aquifer. (25)

Upper aquifer not named

153. Is it the surficial (S) or deeper (D) of the aquifers? (1) S

154. Is there an observed release of contaminants to this aquifer: (1) Y

Y (YES), Value = 45
N (NO), Value = 0

155. HRS Value. (2) 45

156. Are there any analytical findings that document observed release to groundwater above background? (1) Y = YES N = NO Y

157. Date of Analysis. (6) December, 1986 or January, 1987

158. Reference. (60)
Envirodyne Engineers, Inc. contamination analysis

159. Identification of background well(s). (25)

None installed, all wells are downgradient

160. Identification of contaminated well(s). (25)

RG-3, RG-4

161. Contaminants detected. (150)

Toluene, trichloroethylene, 2-pentene, 3,4,4-trimethyl, 1-pentene, 2,4,4-methyl

162. Depth of contamination. (3) 43-56 feet

163. Distance from ground surface to highest seasonal water level in this aquifer. (3) estimated 35'

164. Depth below ground surface of deepest documented waste or of intake of of a contaminated well. (3) 56 feet

165. Depth from deepest point of documented contamination to the aquifer of concern. (3) (Question 163 minus 164) 21

166. HRS Value. (1) 2

DEPTH	VALUE
0 - 20	3
21 - 75	2
76 -150	1
150	0

167. Inches of normal annual total precipitation (Figure 1). (2) + 28

168. Inches of mean annual lake evaporation (Figure 2). (2) - 24

169. Net precipitation, in inches (if seasonal data is used, show month(s) represented). (2) 4

-10 inches = 0 15 inches = 3
-10 to + 5 = 1
+ 5 to +15 = 2

170. HRS Value (Precipitation). (1) 1

171. Permeability of the least permeable layer between documented contamination and the highest seasonal water level of this aquifer of concern (TABLE 10). (6) $<10^{-3} - 10^{-5}$ cm/sec

172. HRS Value (Permeability) (1) 2

GROUNDWATER USE

173. Write the number for the highest-valued actual use of this aquifer within a 3-mile radius as shown on the comparative evaluation. (1) 3

USE	VALUE	USE	VALUE
Unusable	0	Drinking water with with alternate source	2
Commercial or irrigation	1	Without alternate source	3

no readily available alternate source

DISTANCE TO NEAREST WELL

174. Distance to the nearest drinking water or irrigation well in this aquifer (comparative evaluation between surficial and deeper). (3) assume D/I well = 4600 ft.

POPULATION SERVED

175. Total population served by groundwater drawn from the aquifer within 3 miles of contamination (comparative evaluation between surficial and deeper).

Population (3.8 persons/house) (5) + 65

176. Acres irrigated times 1.5 (4) persons/acre + 0

177. Total Population (5) 65

178. Determine the worst case from distance/population Matrix (TABLE 9) and enter HRS value. (2) 8

SURFACE WATER MIGRATION

A topographical map is to be attached showing the migration path that run-off would follow from the areas of waste storage to surface waters and thence to targets within 5 miles downstream. All distances are to be measured along the migration path rather than by a straight line.

Indicate sampling points, the most downstream point (or point along migration path) of documented contamination, all water intakes by use, and sensitive environments and critical habitats that lie contiguous to the migration path. Show names of water bodies.

OBSERVED RELEASE

179. Is there analytical evidence of contamination of surface waters above background? (1) N, Go to Item 185 Y, Go to Item 180 ..N..

180. Date of Evidence: (6) .....

181. Reference: (60)

.....

182. Background sampling points (list well identification): (80)

.....

183. Downstream sampling points (list well identification): (80)

.....

184. Contaminants detected (5 maximum): (100)

.....

185. HRS Value. Direct evidence of release of surface water (evidence must be quantitative) - HRS value = 45; no evidence - HRS value = 0 (2) ..0..

186. Check if drinking water intakes have been contaminated. (1) 0 = NO
1 = YES, Public
2 = YES, Private
3 = BOTH .0.

Questions 187 to 193 MUST BE COMPLETED ONLY IF EVIDENCE OF AN OBSERVED RELEASE TO SURFACE WATER IS LACKING:

ROUTE CHARACTERISTICS

187. Does this facility lie in a topographical depression with no surface water migration route? If YES, assign a surface water migration score of zero. If NO, continue with Item 188. (1) N

SLOPE

188. Slope of the facility. (2) 3%

189. Slope of intervening terrain from nearest point of documented contamination to surface water (Use TABLE 11): (2) 1%

190. HRS Value (Slope Matrix). (1) 1

191. 1 year 24 hour rainfall as indicated for the site on Figure 3 (inches). (2) 1

192. HRS Value (Rainfall). (1) 1

193. Distance along migration path from most downstream point of documented contamination to surface waters. (7) Distances of 2 miles and less are classifiable. Not tested for

*DISTANCE - Assign a value as follows:

Distance	Assigned Value
2 miles	0
1 to 2 miles	1
1000 feet to 1 mile	2
1000 feet	3

194. HRS Value (Distance of Surface Water). (1) N/A

SURFACE WATER USE

195. Surface water use within 3 miles (1 mile maximum in static waters) along the migration path from the most downstream point of documented contamination: (1)

HRS Value

Not currently used for reasons unrelated to contamination from site:	------ 0	Irrigation recreation, etc:	---- 2
Commercial or industrial use:	------ 1	Drinking water:	---- 3

HRS Value (Surface Water Use) (Values may be added if water has more than one use). N/A

DISTANCE TO A SENSITIVE ENVIRONMENT

196. Name of nearest sensitive environment that is within 2 miles. (20) Unamed

197. Type of Sensitive Environment. (3) 1 = Coastal Wetland
2 = Freshwater Wetland
3 = Critical Habitat (S - State or F - Federal) 2

198. Distance to a wetland (5 acre minimum) or a critical habitat of a Federal list endangered species that lies contiguous to the migration path. Measure distance from the nearest point of documented surface contamination along the migration path. (6) 1 3/4 mile

199. HRS Value (Distance to Sensitive Environment). (1) Use TABLE 12 0

DISTANCE TO WATER INTAKE

200. Distance to drinking water or irrigation intake, measured from probable point of entry of migration path to surface water. (6) Not known

POPULATION SERVED

Total Population served by water drawn from surface water within the 3 mile limit:

201. Population (assume 3.8 persons/house). (5) N/A

202. Acres irrigated times 1.5 persons/acre. (4) .....

203. Total HRS population: (5) .....

204. HRS, Value (Dist/Pop Matrix). (2) N/A
(The distance (question 200) and population (question 203) are used in TABLE 9 to determine HRS value.

AIR MIGRATION ROUTE

OBSERVED RELEASE - AIR

205. Is there any reason to suggest that air sampling should be done? (80)

NO X YES ____

Narrative Summary:

Only contamination is stained soils or oily liquids in silos.

206. Is there analytical evidence confirming an observed released air above background? (1) N.

NO ____ Go to Item 212 YES ____ Continue with Item 207

207. Date: (6) .....

208. Reference: (60)

N/A

209. Location of upwind and downwind sampling points: (80)

N/A

210. Method and equipment: (80)

N/A

211. Contaminants detected above background: (150)

N/A

212. Analytical evidence of contaminants. (2) N/A

HRS value - 45 if yes NO evidence - HRS value = 0

REACTIVITY & INCOMPATABILITY

See TABLE 13 and TABLE 14

Most reactive materials onsite are: (List)

213. (25) None, materials detected on site have "0" reactivity rankings on Table 4.

214. (25)

215. (25)

216. (25)

217. (25)

218. (25)

Most incompatible pairs of material onsite are: (List)

219. (25) None

220. (25)

221. (25)

222. (25)

223. (25)

224. (25) . . . . . .

INCOMPATIBILITY	VALUE and TABLE 13
No incompatible materials are present	0
Present but do not pose a hazard	1
Present & may pose a future hazard	2
Present & posing an immediate hazard	3

225. HRS Value (R/I). (1) . . 0

POPULATION EXPOSED

Population exposed to risk of air release, (fill in population information for all distances from the volatilizing source):

Indicate in each box (a, b, c and d) the total population for the given radius.

		Total Population
226.	0 - 1/4 mile (7)	76
227.	0 - 1/2 mile (7)	76
228.	0 - 1 mile (7)	228
229.	0 - 4 miles (8)	1026
230.	Use insert *** to determine HRS value. (2)	12

***Select the highest valuefor this rating factor as follows: Distance to Population from Hazardous Substance

Population	0-4 Mile	0-1 Mile	0-1/2 Mile	0-1/4 Mile
0	0	0	0	0
1-100	9	12	15	18
101-1000	12	15	18	21
1001-3000	15	18	21	24

DISTANCE TO A SENSITIVE ENVIRONMENT

Coastal wetland Freshwater wetland Critical habitat

231. Location and description of wetlands (5 acre minimum): (200)

SE¼, NE¼, Sec34, T46N, R4W

Small areas of standing water within wetlands

Rechange area

Headwaters for Prey Creek

Location of critical habitat of endangered species, including notation of whether the species is on the Federal list.

Bald Eagle and Ospray inhabit the National Forest.

232. Distance from volatile substance to the sensitive environment. (6) — One mile

233. HRS Value - See TABLE 12. (1) — 0

LAND USE within 2 miles - See TABLE 14

		DISTANCE/VALUE
234.	Commercial/industrial area. (5)	None /
235.	Residential area. (5)	None /
236.	National/State park, forest, wildlife reserves. (5)	site within NP / 3
237.	Prime agricultural land. (5)	None /
238.	Agricultural land in production within the past 5 years. (5)	None /

239. Is a historic landmark site within view of the facility or like to be subject to significant impacts from air release? YES/NO (80)
If so, identify, locate and describe expected impacts:

No

240. HRS Value (use TABLE 14, Land Use). (1) — 0

FIRE AND EXPLOSION FROM HAZARDOUS OR TOXIC MATERIALS

FIRE AND EXPLOSION POTENTIAL:

241. Based on field observation and measurement, is there a demonstrated fire and explosion threat at this site? (41) NO YES Describe:

Narrative summary:

Fuel may remain in burried fuel tanks.

242. Has state or local fire marshal certified that site presents a significant hazard of fire or explosion: (41)

Narrative summary:

No

IF ANY QUESTIONS IN ITEMS 241 and 242 HAVE BEEN CHECKED "YES" FOR FIRE AND EXPLOSION POTENTIAL, COMPLETE ITEMS (243 TO 284)

CONTAINMENT

Substances found onsite that are individually ignitable.

243. (25) Suspect fuel in underground tanks.

244. (25)

245. (25)

246. (25)

247. (25)

Substances found onsite that are incompatible.

248. (25) N/A

249. (25)

250. (25)

251. (25)

252. (25)

253. Are any of the substances that are onsite hazardous in combination and are not segregated or isolated so as to prevent the formation of incompatible mixtures: Y OR N (1) N

ISOLATED/SEGREGATED	VALUE
YES	1
NO	3

254. HRS Value (Containment). (1) N/A

WASTE CHARACTERISTICS:

255. Direct evidence of ignitability or explosion potential, as measured: Y = YES N = NO (1) N

256. HRS Value (Direct Evidence). VALUE: YES 3 NO 0 (1) 0

257. Ignitability: List the most ignitable substance onsite and indicate the National Fire Protection Agency (NFPA) level assigned this substance (TABLE 15): (25)

Fuel oil & Jet fuel possibly in tanks.

258. HRS Value (Ignitable). (1) 2

259. Most reactive materials onsite are: See TABLE 16 (25)

N/A

260. HRS Value (Reactive): (1) N/A

261. Most incompatible pairs of material onsite are: See TABLE 13 (40)

N/A

262. HRS Value (Incompatible). (1) N/A

263. Quantity of materials onsite that are flammable or explosive, including hazardous materials that are flammable or explosive alone or in combination: (9) Unknown*

264. HRS (Quantity) - See TABLE 3. (1) *

*NOTE: There are 13 underground storage tanks at the site. The quantity of fuel within the tanks is unknown.

DISTANCE TO TARGETS:

265. Distance to nearest persons like to be at risk to fire or explosion (critical distances that require careful measurement for HRS purposes are 0 feet, 200 feet, 1/2 mile, 1 mile and 2 miles): (6) One mile

266. HRS Value (Population) - See TABLE 15A. (1) 2

267. Distance to the nearest building from the hazardous substance (critical distances that require careful measurement for HRS purposes are 50 feet, 200 feet and 1/2 mile): (6) 200 feet

DISTANCE	VALUE
1/2 mile	0
201'-1/2 mile	1
51'-200'	2
0-50'	3

268. HRS Value (Buildings). (1) 2

269. Distance to nearest wetland from the hazardous substance? (6) One mile

DISTANCE	VALUE
100'	0
100'	3

270. HRS Value (Wetlands). (1) 2

271. Distance to a critical habitat from the hazardous substance (critical distances that require careful management of HRS purposes are 100 feet, 1000 feet and 1/2 mile): (6) >1 mile

DISTANCE	VALUE
>1/2 mile	0
1001 -1/2 mile	1
101-1000'	2
0-100'	3

272. HRS Value (Habitat). (1) 0

273. Is a fire like to spread to this critical habitat, regardless of distance? YES or NO (1) N

TARGETS FOR FIRE AND EXPLOSION:

Land use within 2 miles (note that this item is identical to the air migration pathway, providing the location of the volatilizing substances and the flammable or explosive substance is the same):

(Critical distances requiring measurement for HRS purposes are 1/4 mile, 1/2 mile, 1 mile and 2 miles): See TABLE 14

		DISTANCE/VALUE
274.	Commercial/industrial area. (5)	None /
275.	Residential area. (5)	One mile / 2
276.	National/State park, forest, wildlife reserves. (5)	site within NF / 3
277.	Prime agricultural land. (5)	None /
278.	Agricultural land in production within the past 5 years. (5)	None /

279. Is a historic landmark site within view of the facility or like to be subject to significant impacts from fire or explosion? YES OR NO. Describe (81)

No

TABLE 14 is used to determine the HRS value. The highest value is to be chosen.

280. HRS Value (Land Use). (1) 3

281. Population with 2 mile radius. (If areial photography is used in making the count, assume 3.8 individuals per dwelling). (6) 76

POPULATION	VALUE
0	0
1-100	1
101-1000	2
1001-3000	3
3001-10,000	4
>10,000	5

282. HRS Value (Population). (1) 1

283. Buildings within a 2-mile radius (measures from the hazardous substance). (4) 25

NO OF BUILDINGS	VALUE
0	0
1-26	1
27-60	2
261-790	3
791-2600	4
>2600	5

284. HRS Value (Buildings). (1) . .1

DIRECT CONTACT

285. Is there a confirmed instance in which contact caused injury, illness or death to humans or to domestic or wild animals? (100)

Narrative summary:

An accidental death during salvage operations on Composite building was reported by a USDA employee.

286. HRS Values: YES - 45, NO - 0 (2) . . .45

IF ITEM 285 FOR DIRECT CONTACT IS CHECKED "YES" SKIP TO LINE 292 - IF NO, COMPLETE ITEMS 287 TO 291

Accessibility to where the hazardous material is deposited - evaluate the following aspects: (1)

287. Surveillance system:

	VALUE
YES	0
NO	1

.1.

288. Artificial or natural barriers to entry: (1)

	VALUE
YES	0
NO	1

.1.

289. Control of entry points: (1)

	VALUE
YES	0
NO	1

.1.

Add values from lines 287, 288 and 289 to mark in 291.

290. Have any changes in accessibility been made since the confirmed instance of direct contact? (1) Y/N N/A

291. HRS Value (Access). (1) .3.

292. Indicate if there is Containment of the hazardous materials against direct contact: (6)

CONTAINMENT	VALUE	Y OR N
Surface impound.	15	
Sealed or unsealed containers	15	
Tanks	15	.N.
Landfill with less than 2' cover	15	
Spills	15	.N.
Otherwise	0	

293. HRS Value (Containment) from item 292. (2) 30

294. Toxicity of the most hazardous materials that are not adequately contained against direct contact: Refer to TABLES 4 & 5 (60)

Storage Area #

RG-3, RS-1, RS-7, RB-4 (20)

*Groundwater samples
soils samples
silo samples refer to contamination evaluation

Material

Petroleum hydrocarbons, trichloroethylene (20)

Toxicity

Severe toxicity (20)

295. HRS Value (Toxicity). (1) .3.

296. Population within one mile of hazardous materials: (7) .....23...

POPULATION WITHIN 1 MILE	VALUE
0	0
1-100	1
101-1000	2
1001-3000	3
3001-10,000	4
>10,000	5

Basis for this estimate: House count/map

297. HRS Value (Population): (1) ..1..

Location of critical habitat of endangered species, including notation of whether species is on the federal list:

SE¼, NE¼, T46N, R4W Raptors - fed. protected

298. Circle the appropriate Distance to the critical habitat (critical distance that require measurement for HRS purposes are 1/4 mile, 1/2 mile and 1 mile): (6)

One mile

DISTANCE	VALUE
>1 mile	0
1/2 mile - 1 mile	1
1/4 mile - 1/2 mile	2
<1/4 mile	3

299. Indicate if the critical habitat is on the State S, Federal F, or both B list(s). (1) .F.

300. HRS Value (Distance to critical habitat) from Item 298. (1) ..1..

301-398. Reserved

399. Remarks. (80)

.....

ORDNANCE AND EXPLOSIVE WASTE (OEW)

OEW RISK ASSESSMENT:

The OEW risk assessment is based on records searches, reports of Explosive Ordnance Detachment actions, and field observations and measurements. These data are used to assess the risk involved based upon the hazards identified at the site. The risk assessment is composed of two factors, hazard severity and hazard probability.

Hazard Severity. Hazard severity categories are defined to provide a qualitative measure of the worst credible mishap resulting from personnel error, environmental conditions, or other pertinent factors.

Description	Category	Mishap Definition
CATASTROPHIC	1	Explosion, Death, Life-threatening or other injury causing total permanent disability, or Property damage in excess of $500,000.
CRITICAL	2	Major fire, Severe injury which requires doctor or hospital care for 1 or more persons, or Property damage between $100K and $500K.
MARGINAL	3	Minor fire, Minor injury which would require any medical or Property damage between $700 and $100,000.
NEGLIGIBLE	4	No injuries or Property damage less than $700.

400. The Hazard Category assigned for this site is. (1) N/A

401. This is based primarily upon the following: (160)

No ordnance or explosives on-site described in SOW

Hazard probability. The probability that a hazard has been or will be created due to the presence of unexploded ordnance or explosive materials on a formerly used DOD site.

Description	Level	Probability Definition
FREQUENT	A	Has already occurred more than once or has the potential to occur at least every 1 or 2 years.
PROBABLE	B	Has already occurred once or has the potential to occur more than once in the next 10 to 20 years.
OCCASIONAL	C	Is likely to occur sometime in the next 10 to 20 years.
REMOTE	D	Unlikely but possible due to the nature of past DOD use of the site.
IMPROBABLE	E	So unlikely that it can be assumed that it will not occur.

402. The hazard probability level assigned for this site is. (1) N/A

403. This is based upon the following: (160)

. . . . . .
. . . . . .
. . . . . .
. . . . . .
. . . . . .

Risk Assessment. The risk assessment value for this site is to be found by using the following table. Enter with the results of items 400 & 402.

Probability Level	A	B	C	D	E
Severity Category:					
I	20	20	18	14	10
II	20	18	14	10	6
III	18	14	10	6	2
IV	14	10	6	2	0

404. The risk assessment value for this site is. (3) N/A . . . .

405. Ordnance and Explosive Waste Characteristics. Is there any direct or other evidence that OEW is present or could be present based upon former DOD uses of the site? This evidence can be based upon direct observation of the site survey team, reports received from individuals, government agencies, or news media, review of drawings or archive documents relating to DOD operations at the site, or any other pertinent source.

YES (Complete the rest of this question).

NO (Continue starting with Question 422).

If the answer to this question is YES describe briefly the type of evidence and where that evidence is available for detailed review. (161)

. . . . . .
. . . . . .
. . . . . .
. . . . . .
. . . . . .

(For Questions 406 through 442 underline, check, circle or otherwise indicate each appropriate answer.)

406. High Explosives. (4)

	YES VALUE	NO VALUE	Y OR N
Primary or Initiating Explosives (Lead Styphnate, Lead Azide, Nitroglycerin, Mercury Azide, Mercury Fulminate, etc.)	10	0	. .
Booster or Bursting Explosives (PETN, Compositions A, B, C, Tetryl, TNT, RDX, HMX, HBX, Black Powder, etc.)	5	0	. .
Military Dynamite	5	0	. .
Less Sensitive Explosives (Ammonium Nitrate, Favier Explosives, etc.)	3	0	. .

407. High Explosives Ordnance Ranking System (ORS) Value (Maximum value of 10). (2) . . .

408. Propellants. (5)

	YES VALUE	NO VALUE	Y OR N
Single Base Propellant (M10, M12, etc.)	3	0	. .
Double Base Propellant (M2, M5, M9, M13, etc.)	4	0	. .
Triple Base Propellant (M15, M17, etc.)	4	0	. .
Liquid Propellant	4	0	. .
Large Rocket Motors	5	0	. .

409. Other (describe). (15) . . . . . .

410. Propellants HRS Value from item 408. (1) . .

411. Conventional Ordnance and Ammunition. (11)

	YES VALUE	Y OR N
Small Arms (.22 cal - 20mm)	1	. .
Medium/Large Caliber (over 20mm)	5	. .
Ammunition, Inert	0	. .
Ammunition, Blank or Practice	2	. .
Bombs, Explosive	5	. .
Bombs, Practice, Fuzed	2	. .
Grenades, Mines	5	. .
Grenades, Mines, Practice, Fuzed	2	. .
Detonators, Blasing Caps	5	. .
Rockets, Missiles	5	. .
Demolition Charges	4	. .

412. Other. (15) . . . . . .

413. Conventional Ordnance and Ammunition ORS Value from item 411 (Maximum of 5). (1) . .

414. Pyrotechnics. (4)

	YES VALUE	Y OR N
White Phosphorus	5	. .
Pyrolusite	4	. .
Flares	3	. .
Smoke Rounds and Bombs	3	. .

415. Other Pyrotechnic Devices. (15) . . . . . .

416. Pyrotechnics ORS Value (Maximum of 5). (1) . .

417. Chemical Weapons/Agents. (3)

	YES VALUE	Y OR N
Toxic Chemical Warfare Agents (GB, VX, H, HD, BZ, __, etc.)	40	. .
Vomiting Agents (DA, DM, DC, etc.)	20	. .
Tear Agents (CNS, CNB, BBC, CS, etc.)	10	. .

418. Other Chemical Warfare Agents. (15) . . . . . .

419. Chemical Weapons ORS Value. (2) . . .

420. Total Ordnance and Explosive Waste Characteristics ORS Value (Total = 407 + 410 + 413 + 416 + 419 with a Maximum value of 55). (2) . . .

421. Provide a detailed description on any and all chemical weapons or chemical agents present at the site. (400)

N/A

422. Locations of Contamination. (6)

	VALUE	Y OR N
Within Tanks, Pipes, Vessels or Other confined locations.	5	. .
On the surface or within 3 feet.	5	. .
Inside walls, ceilings, or other parts of Buildings or Structures.	4	. .

423. Other (describe). (22) . . . . . .

424. Locations of Contamination ORS Value (Maximum of 5). (1) . .

425. Area Contaminated. (6) . . . . . .

	VALUE
None	0
Less than 1 acre	1
1 to 5 acres	2
5 to 50 acres	3
50 to 250 acres	4
Over 250 acres	5

426. Area Contaminated ORS Value (Maximum of 5). (1) . .

427. Extent of Contamination ORS Value Sum of items (424 + 426) - (Maximum of 10). (2) . . .

428. Weight of OEW materials on site. (7) . . . . . .

429. Number of rounds (from 428). (7) . . . . . .

Weight of Bulk Explosives in Rounds	No. of Rounds, Containers, etc.	Value
0	0	0
Less than 10	1 to 9	2
10 to 100	10 to 100	4
101 to 500	101 to 500	6
501 to 1000	501 to 1000	8
Over 1000	Over 1000	10

430. Quantity of OEW ORS Value (Maximum of 10). (2) . . .
Two valves may be figured (e.g., 8 lbs TNT gives value of 2 & 200 rounds a value of 6. Then the ORS value would be 8).

431. Provide a detailed description and the types and amounts of ordnance and explosive materials previously removed from the site by EOD forces, currently at the site, or suspected to be at the site. (800)

Unknown

432. Distance to nearest persons or normally inhabited structures likely to be at risk from OEW site. (6) . . . . . .

Distance to Nearest Target	VALUE
Less than 1250 feet	5
1250 feet to 0.5 miles	4
0.6 miles to 1.0 mile	3
1.1 mile to 2.0 miles	2
2.1 miles to 5.0 miles	1
Over 5.0 miles	0

433. Distance to Persons ORS Value (Maximum of 5). (1) . .

434. Distance to nearest utility system (power, water, or gas) or public highway likely to be at risk from OEW site. (6) . . . . . .

Distance to Nearest Target	VALUE
Less than 1250 feet	5
1251 feet to 1 mile	3
11 mile to 2 miles	1
Over 2 miles	0

435. Distances to Public Utilities/Highways ORS Value (Maximum of 5). (1) . .

436. Distances ORS Value (433 + 435) - (Maximum of 10). (2) . . .

437. Numbers and types of Buildings within a 2 mile radius measured from the hazardous area, not the installation boundary. (6) . . . . . .

Numbers of Buildings	VALUE
0	0
1 to 10	1
11 to 50	2
51 to 100	3
101 to 250	4
251 or Over	5

438. Numbers of Buildings ORS Value (Maximum of 5). (1) . .

439. Types of Buildings. (30)

. . . . . .

	VALUE
Educational, Child Care, etc.	5
Residential, Hospitals, Hotels, etc.	5
Commercial, Shopping Centers, etc.	5

Industrial, Warehouse, etc.	4
Agricultural, Forestry, etc.	3
Detention, Correctional	2
Military	1
No Buildings	0

440. Types of Buildings ORS Value (Maximum of 5). (1) . .

441. Numbers and Types of Buildings ORS Value (438 + 440) - Maximum of 10). (2) . . .

442. Accessibility to site refers to the measures taken to limit access by humans or animals to ordnance and explosive wastes. Assign a value using the following guidance: Describe. (40)

. . . . . .

Barrier	Assigned Value
A 24-hour surveillance system (e.g., television monitoring or surveillance by guards or facility personnel) which continuously monitors and controls entry onto the facility;	0
or	
An artificial or natural barrier (e.g., a fence combined with a cliff), which completely surrounds the facility; and a means to control entry, at all times, through the gates or other entrances to the facility (e.g., an attendant, television monitors, locked entrances, or controlled roadway access to the facility).	0
Security guard, but no barrier	1
A barrier, but no separate means to control entry	2
Barriers do not completely surround the facility	3
No barrier or security system	5

443. ORS Value (Maximum of 5). (1) . .

444-498. Reserved

499. Remarks. (80)

. . . . . .
. . . . . .
. . . . . .

DEBRIS

Debris description:

500. Type of Debris. (150)

Concrete rubble within silos, vandalized buildings, very large pile of sawdust.

501. Type of construction for structures. (100)

Concrete block walls, steel beam roof.

502. Quantity. (80)

All of the 28 silo structures contain concrete or highway construction debris.

503. Condition, etc. (15)

Hazardous to walk on.

504. List underground structures or items. (80)

Thirteen underground fuel storage tanks.

505. DOD use of debris items. (80)

DOD not responsible for concrete rubble or sawdust pile.

506. List buildings or other items that owner(s), after DOD disposal, have used for their benefit. Give use. (150)

Composite building used during Saw Mill operations by local Indian Tribe.

DEBRIS (CONTINUED)

507. **List items onsite that were not constructed or used by DOD or DOD contractor. (80)**

Sawdust pile, highway construction debris

508. **List items owner wants to retain. (80)**

None

509. **List items that may have salvage value. (100)**

Not known

510. **Give location of nearest or most economical disposal location. (80)**

Not known

511. **Give special labor, equipment or methods that will be required for project. (100)**

Not known

512. **List any restrictions on methods of demolition or disposal. (80)**

Asbestos present in some buildings (pump house and storage shed).

513. **Describe site grading that will be required for restoration: (include any special requirements or adverse foundation conditions). (40)**

Not known

514. **Give location for borrow material if required. (40)**

Large soil storage area at SE corner of missile storage area.

515. List and give location of underground items that need to be preserved. (60)

Not known

516. Give requirements for seeding and mulching or other erosion measures. (80)

Not known

517. Describe unsightly debris (UD). If no unsightly debris exists, enter NONE for this item, and do not complete items 518 thru 529. (160)

Concrete rubble, sawdust pile

518. Size of Debris Area (UD): (2) alue 2

Debris covers area 5 acres or less in size.	2
Debris covers area 6-25 acres in size.	5
Debris covers area over 25 acres in size.	10

519. Debris Above Ground Level (UD): (2) 2

(Include structures, miscellaneous debris items or piles 3' or more in height. Structures larger than 12,000 SF in area or more than two-story height to count as two structures. Groups of individual items wioll be considered one structure).

Sawdust Pile

Number of Structures or Piles:	Value
0	0
1-2	2
3-6	4
7-15	6
16-30	8
31 or more	10

DEBRIS (CONTINUED)

520. Describe unusual items that require transformation to structure comparison in Item 519. (100)

Very large pile of sawdust

521. Ground level debris (less than 3' high) (UD). Foundations, slabs, small piles, etc: (1)

Area Covered by Debris Items	Value	.3.
No Ground Level Debris	0	
0-20,000 SF	1	
20,000 - 100,000 SF	3	
Over 100,000 SF	5	

522. Briefly describe Item 521 (concrete foundation, rubble etc). (80)

Silos, foundations, roadways

523. Condition of Debris (UD): (2)

	Value	.5.
Building or structures very unsightly, such as partially demolished or collapsed or deteriorated beyond any reasonable renovation.	10	
Structures that are in need of considerable maintenance, very large foundations, piles of building rubble, etc.	5	
Small foundations, small debris piles or buildings in good condition that are not compatible with surrounding area.	2	

524. Give basis for value selected in Item 523. (100)

Buildings still structurally sound, but badly vandalized. Silos partially filled with debris.

DEBRIS (CONTINUED)

525. Location (UD): (2) — Value — . .2.

	Value
Rural	2
Small Town or Community	5
Urban or densely populated residential area	10

526. Effect on Surrounding Area (UD): (1) — Value — .0.

	Value
Contributes highly to general area being slum or very desirable for use.	5
Serves as a deterent to development of general area or has slight bearing on above choice.	2
No effect.	0

527. Briefly describe effect in Item 526. (80)

Area very isolated within National Forest. Very low population density.

528. Public Use or Exposure (UD): (2) — Value — . .1.

	Value
Isolated from public exposure.	0
Located in area with little public exposure.	1
Located in area that receives heavy public use or exposure of seasonal or other varying nature.	6
Located in area that receives heavy year round use.	10

529. Give basis for value seleced in Item 528. (80)

Site in National Forest with unlimited access.

530. Describe Hazardous Debris (HD): (160)

If there is no debris that represents a potential physical or health hazard to persons or is a potential source of damage to surrounding property, enter NONE for this item and 0 for item 540 and do not complete items 531 thru 537.

Debris hazardous to walk on. Demolition of building could me dangerous.

531. Probability of Injury or Health Hazard (HD): (2) — Value . . 2 .

Has occurred frequently or has potential to occur at least annually.	10
Has occurred once and has potential to occur at least once every two years.	8
Has potential to occur every 2-10 years.	6
Has potential to occur every 10-25 years.	4
Unlikely to occur once every 25 years.	2

532. List past occurrences or give basis for value selected in Item 531. (100)

Accidental death during demolition was reported but is not considered likely.

533. Severity of Potential Hazard (HD): (2) (Most probable results from incident involving debris) — Value . . 3 .

Totally disabling or death.	10
Loss of limb, partial sight, hearing, etc.	8
Would require hospitalization or repeated medical treatment.	6
Would require minor medical care.	3
Minor cuts and bruises.	1
No injury.	0

534. Give information on past incidents or describe conditions that would contribute to value selected in Item 533. (100)

Debris would not probably result in serious accidents.

535. Hazard to Property Other Than Owner (HD): (2) (Damage resulting from fire, collapse, etc.) — Value .0.

Potential for damage in excess of $250,000.	10
Potential for damage of $75,000 to $250,000.	5
Potential for damage of less than $75,000.	1
No damage potential.	0

536. List hazard and property that would be exposed to hazard in Item 535. (80)

N/A

537. Probability of Damage Occurring (HD): (1) — Value .1.

In next two years.	5
In 2-10 years.	4
In 10-25 years.	2
Beyond 25 years.	1

538. Has site been coordinated for demolition and/or removal under Section 106 of the National Preservation Act? *X Yes ___ No (1) .Y.

542-598. Reserved.

599. Remarks (80)

*Assumed yes, since some demolition has begun.

DEBRIS WORKSHEET

539. Unsightly Debris Score:

A.

Item No.	Value
518	2
519	2
521	3
523	5
525	2
526	0

TOTAL

B. If value for item 528 is 0, multiply total in A. by 0.5 _____.

If value for items 528 is 1, multiply totasl in A. by 0.9 12.6 .

If value for item 528 is 6 to 10, add value selected to Total in A. _____.

C. Divide B. by 2.10 for Unsightly Debris Score 6.0 (Round to nearest whole number).

540. Hazard Debris Score:

Item No.	Value
531	2
533	3
535	0
537	1

A. Multiply Item 531 value by Item 533 = 6

B. Multiply Item 535 value by Item 537 = 0

TOTAL A + B = 6

Hazardous Debris Score = Total A+B = 6
(Round to nearest whoe number)

DEBRIS WORKSHEET (CONTINUED)

541. Total Score for Ranking.

Total Score = Unsightly Debris Score (Item 538) + Hazardous Debris Score (Item 539) = 12.

TABLE 1

CONTAINMENT VALUE FOR GROUNDWATER ROUTE

(Use technical judgement of best fit)

Assign containment a value of 0 if: (1) all the hazardous substances at the facility are underlain by an essentially nonpermeable surface (natural or artificial) and adequate leachate collection systems and diversion systems are present; or (2) there is no groundwater in the vicinity. The value "0" does not indicate no risk. Rather, it indicates a significantly lower relative risk when compared with more serious sites on a national level. Otherwise, evaluate the containment for each of the different means of storage or disposal at the facility using the following guidance.

A. Surface Impoundment

	Assigned Value
Sound run-on diversion structure, essentially nonpermeable liner (natural or artificial) compatible with the waste, and adequate leachate collection system.	0
Essentially nonpermeable compatible liner with no leachate collection system; or inadequate freeboard.	1
Potentially unsound run-on diversion structure; or moderately permeable compatible liner.	2
Unsound run-on diversion structure; no liner; or incompatible liner.	3

B. Piles

	Assigned Value
Piles uncovered and waste stabilized; or piles covered, waste unstabilized, and essentially nonpermeable liner.	0
Piles uncovered, waste unstabilized, moderately permeable liner, and leachate collection system.	1
Piles uncovered, waste unstabilized, moderately permeable liner, and no leachate collection system.	2
Piles uncovered, waste unstabilized, and no liner.	3

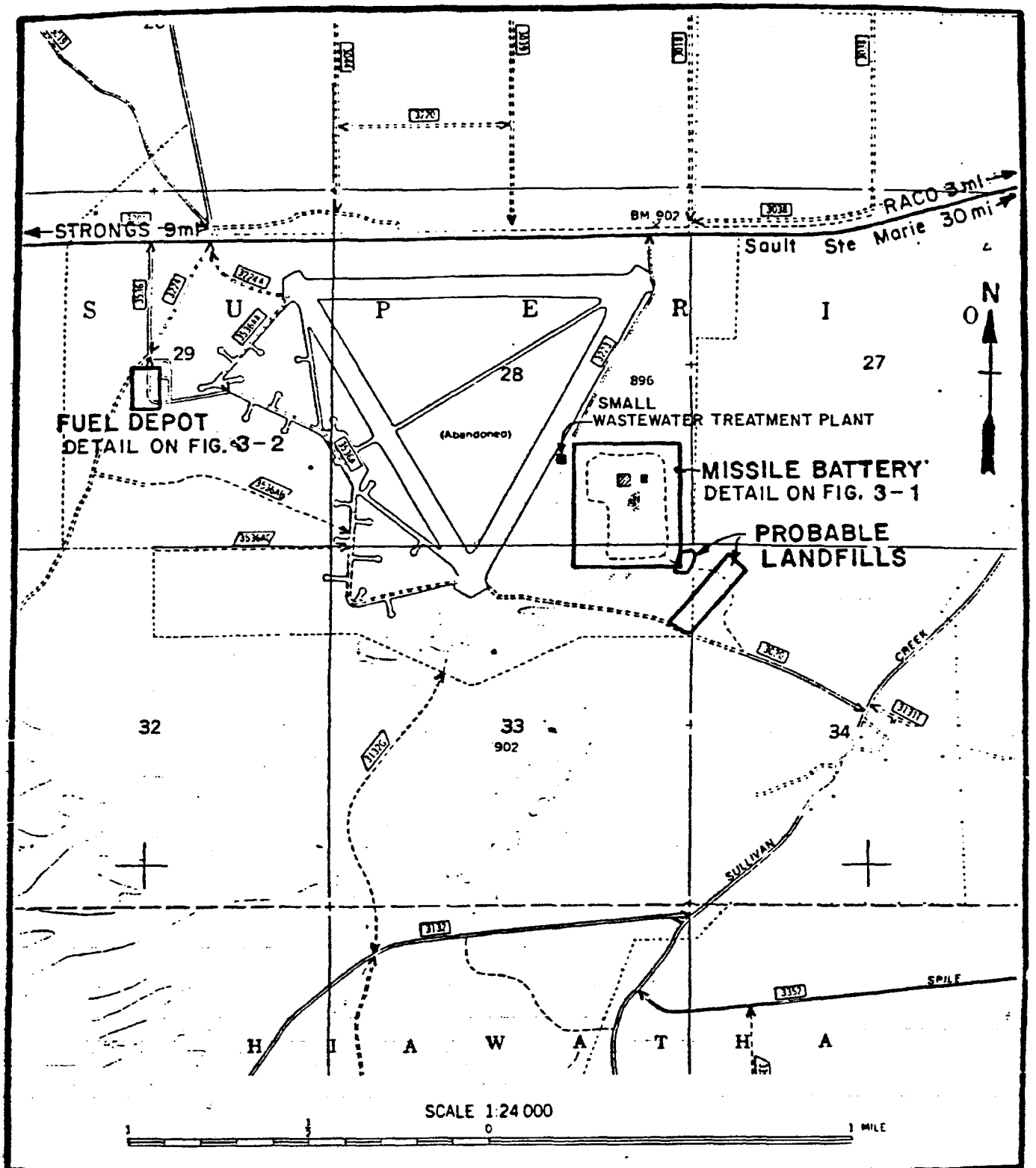
TABLE 1 (CONTINUED)

CONTAINMENT VALUE FOR GROUNDWATER ROUTE

(Use technical judgement of best fit)

C. Containers	Assigned Value
Containers sealed and in sound condition, adequate liner, and adequate leachate collection system.	0
Containers sealed and in sound condition, no liner or moderately permeable liner.	1
Containers leaking, moderately permeable liner.	2
Containers leaking and no liner or incompatible liner.	3

D. Landfill	Assigned Value
Essentially nonpermeable liner, compatible with waste, and adequate leachate collection system.	0
Essentially nonpermeable compatible liner, no leachate collection system, and landfill surface precludes ponding.	1
Moderately permeable, compatible liner, and landfill surface precludes ponding.	2
No liner or incompatible liner; moderately permeable compatible liner; landfill surface encourages ponding; no run-on control.	3



ENVIRODYNE ENGINEERS

FIGURE 2-1

Raco Missile Battery and Airfield

200.1f
E05MI002602_01.04_0010

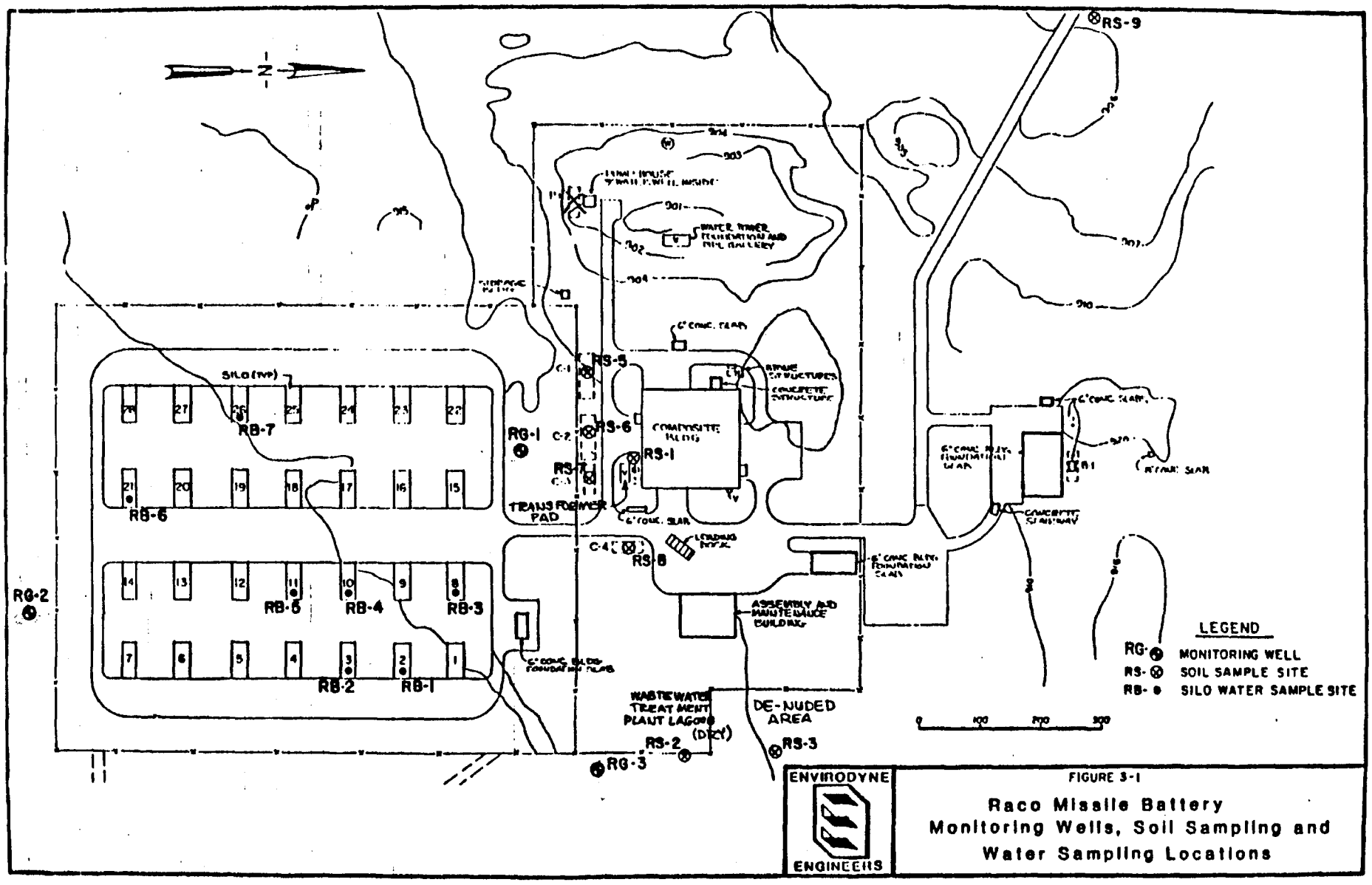
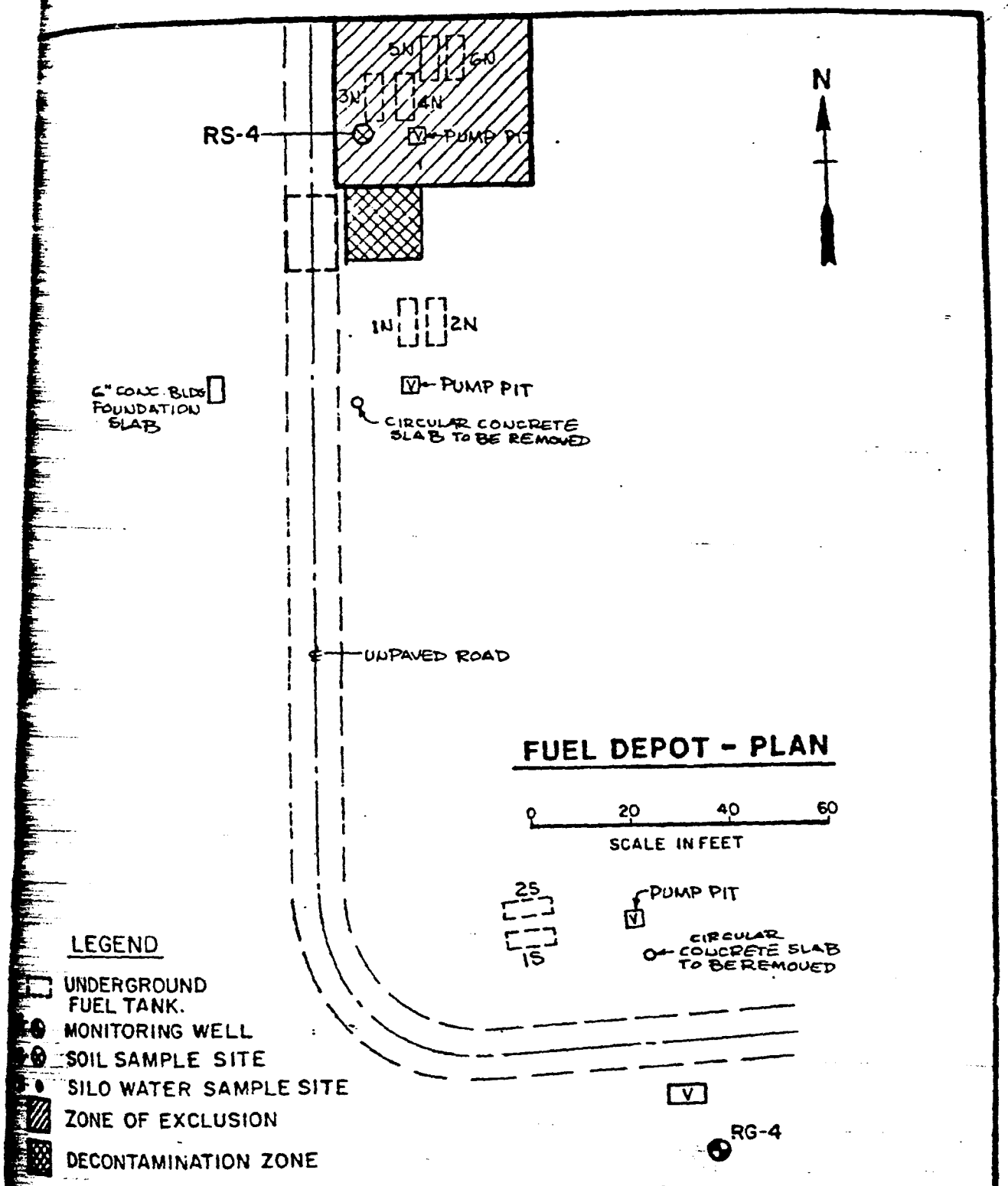


FIGURE 3-1

Raco Missile Battery Monitoring Wells, Soil Sampling and Water Sampling Locations



VIRODYNE ENGINEERS

FIGURE 3-2

Airfield Fuel Depot

Monitoring Well and Soil Sampling Locations with Safety Zones