groundwater resources inc.

5400 ALDRIN CT.
BAKERSFIELD, CALIFORNIA 93313
General Engineering Contractor
Class A/HAZ License No. 520768

SCOTSMAN CORPORATION
6055 Scarlet Ct.
Dublin, California

SITE CHARACTERIZATION REPORT AND REMEDIATION PLAN

December 20, 1989

MAILING ADDRESS: P.O. BOX 9383, BAKERSFIELD, CA 93389 (805) 835-7700
LOS ANGELES (213) 724-3147

SCOTSMAN CORPORATION
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SITE CHARACTERIZATION REPORT AND REMEDIATION PLAN
December 20, 1989

TABLE OF CONTENTS

1.0 INTRODUCTION

Groundwater Resources Inc. (GRI) has been retained by Scotsman Corporation to assess and remediated a groundwater hydrocarbon plume located at the 6055 Scarlet Ct, Dublin, CA facility (Plate 1). A characterization of the plume has been performed and is described. A plan for the remediation of the groundwater is proposed.

2.0 BACKGROUND

The two tanks were removed on October 23, 1987. On December 9, 1988, GRI performed a preliminary site investigation to determine if the soil and groundwater around the former tank locations had been impacted. It was determined that the soil around the tanks had minimal impact, however the groundwater below was reported to have significant levels of hydrocarbons. This report was submitted to the Alameda County Department of Environmental Health. The Department requested that further work be performed to establish aquifer characteristics and further define the extent of the groundwater hydrocarbon plume. In addition, monthly water level readings and bi-monthly water samples were to be collected and reported on a quarterly basis. On May 24, 1989, GRI constructed a series of groundwater monitoring wells to determine the groundwater gradient and to assess the extent of downgradient hydrocarbon migration. The report titled "Site Characterization Report, June 30, 1989" states that the hydrocarbon plume has migrated downgradient of the tank location. It was recommended in the report that a series of boreholes be drilled to the groundwater around the suspected plume so that water samples could be collected and a determination of the extent of the plume could be made. An addendum to the report was sent to Alameda County recommending that one of the downgradient boreholes be completed as a monitoring well so that a qualitative groundwater sample could be collected. Verbal approval of the plan was received on October 3, 1989. This most recent phase of the site characterization was completed on November 30, 1989.

3.0 BORING AND MONITORING WELL COMPLETIONS

One groundwater monitoring well and seven borings were constructed on November 30, 1989. The monitoring well was drilled using an eight inch hollow stem auger while the soil borings were made using six inch solid stem augers. The monitoring well, designated MW-8, was constructed approximately 40 feet downgradient of MW-5 (see Plate 2). The boring for the monitoring well was advanced to a depth of 20 feet and was backfilled with clean filter pack sand to a depth of 15 feet. Four inch PVC casing was installed in the boring. The casing consisted of a ten foot, 0.02" slotted section from 15 feet to 5 feet with blank casing to the surface (see Boring Logs, Plate 3).

Seven borings were made around and downgradient of the tank location so that a groundwater grab sample could be collected. These samples were obtained in order that the dimensions of the groundwater plume might be determined without constructing a series of permanent monitoring wells. The borings were advanced to a depth of 15 feet and a water sample was collected from each. After the water samples were collected, the borings were abandoned by filling the holes with bentonite and compacted cuttings (see Boring Logs, Plate 4-11).

4.0 SAMPLING PROCEDURES

Soil samples were collected from selected borings, however no soil samples were analyzed since it has been determined that a vadose plume does not exist at the site. Those samples collected will be retained incase it is necessary to perform additional tests on the physical properties of the soil beneath the site.

Water samples were collected from each soil boring. The bore holes were allowed to stand open while groundwater flowed in. When the water level had stabilized, a water sample was bailed from each location and collected in a 40 ml VOA bottle with a teflon septa. MW-8 was bailed dry after approximately 15 gallons of water was removed. The well was allowed to stabilize overnight and a water sample was collected the next morning. The water sample was bailed from the well and collected in a 40 ml VOA bottle. All of the water samples were sealed, labeled, chilled at or below 4 degrees Celsius and transported, under a Chain of Custody, to a state certified laboratory for analysis.

5.0 FINDINGS

Water samples analyzed from the borings B-5,6,7,10 and 11 were reported as having no detectable amounts of hydrocarbons present. Borings B-8 and B-9, however, were reported as containing Benzene and TPH concentrations of 890 ppm and 11,000 ppm for B-8 and 12 ppm and 160 ppm for B-9 respectively (Table 1). The groundwater gradient was measured on November 16 and December 1, 1989. No noticeable change in the groundwater gradient or direction has been observed since the last measurements and calculations were made in September (Plate 14).

Table 1

11-16-89	Benzene (ppb)	TPH (ppb)
MW-1	470	2900
MW-2	ND	ND
MW-3	ND	ND
MW-4	ND	ND
MW-5	ND	57
MW-6	ND	2800
MW-7	ND	ND
12-1-89		
B-5	ND	ND
B-6	ND	ND
B-7	ND	ND
B-8	890	11000
B-9	12	160
B-10	ND	ND
B-11	ND	ND
MW-8	ND	ND

6.0 CONCLUSIONS

The results of the analysis for the samples collected from the borings and MW-8 has defined the zero limit of the groundwater plume to the north, south and west of the tank location and can be extrapolated to the east. The isopleth maps on Plates 12 and 13 have been constructed using the groundwater data collected to date (Tables 1 and 2). The water samples collected on November 16, 1989 seem to have anomalously low hydrocarbon concentrations. This data has been omitted from the isopleth maps until confirmation samples are collected in January, 1990 (see Appendix A for Laboratory Results). It can be inferred from the data obtained from boring B-11 that the hydrocarbon plume has not migrated downgradient more than thirty feet from the suspected release point at the tank location. The data obtained from MW-8 qualitatively implies that the hydrocarbon plume has not migrated more than sixty feet downgradient from the suspected release point. The data collected is sufficient to construct the plume zero limit line at the

site and thus defines the entire plume boundary.

7.0 RECOMMENDATIONS

Upon review of the data obtained to date, it is recommended that remediation of the site be initiated. It is anticipated that MW-5 and MW-6 could be utilized in the remediation of the groundwater, however slug tests performed on these wells have shown that water production of less than one half gallon per minute can be expected. These low flow rates would make the use of these wells insufficient by themselves for the effective remediation of the groundwater. It is recommended, therefore, that at least one large diameter recovery well should be constructed in the plume to facilitate a more efficient recovery of the impacted groundwater. The recovery well, designated RW-1, should be located between MW-5 and MW-6 and constructed by advancing a ten inch boring to a depth of thirty feet. A six inch PVC casing should be installed with perforations from five feet to thirty feet (see Plate 12).

Table 2

6-2-89	Benzene (ppb)	TPH (ppb)
MW-1	900	32000
MW-2	15	52
MW-3	4.6	ND
MW-4	ND	ND
MW-5	270	1400
MW-6	6200	76000
MW-7	67	1100
12-1-89		
MW-1	1100	79000
MW-2	ND	ND
MW-3	ND	ND
MW-4	ND	ND
MW-5	18	530
MW-6	3100	6800
MW-7	ND	ND

The water can be removed from the wells using a series of pneumatic pumps. The produced water should then be stored in a 1500 gallon tank before treatment. The prestorage of the water before treatment would allow the water flow to be regulated as it is pumped into the treatment system. This would also allow for batch processing of the water during the pilot phase of the program (see Plate 13 and 14).

The water can be treated using a cavitation-oxidation process to remove the volatile components from the groundwater (see Appendix D). The treated water should be stored in an above ground tank until laboratory analysis confirms that the water is of sufficient quality to be released into the public sewer system. If the levels of hydrocarbons remaining in the treated water exceed the requirements set by the Dublin San Ramon Services District, the water should be passed through water phase granular activated carbon to remove any remaining hydrocarbon constituents before release. After a period of time, when it can be confirmed that the treatment process is completely effective, the water could be allowed to flow directly into the sewer system with periodic sampling of the effluent water as directed by the Dublin San Ramon Services District and the Alameda County Health Agency Department of Environmental Health. All necessary permits for the disposal of the treated water should be obtained from the Dublin San Ramon Services District.

It is difficult to estimate the life of the project until actual pump tests are performed on the primary recovery well and aquifer dynamics can be assessed during the pilot phase of the project. At this time,

it is estimated that 75,000 to 200,000 gallons of water may require treatment to restore the groundwater to acceptable levels. A project life of at least one year is estimated at this time. This estimate may change depending on the recovery rates in the monitoring wells and primary recovery well.

8.0 LIMITATIONS

This report was prepared for the exclusive use of Scotsman Manufacturing Corporation as it relates to the property described. The discussion and conclusions presented in this report are based on:

- The test borings performed at this site.
- The observations of field personnel.
- The results of laboratory tests performed by SMC Laboratory and BC Laboratories, Bakersfield, CA
- Our understanding of the regulations of Alameda County and the California Regional Water Quality Control Board.

Possible variations in the soil or groundwater conditions which may exist beyond the points explored in this investigation might effect the validity of this report unless those variations or conditions come to our attention and are reviewed and assimilated into the conclusions and recommendations of this report. Also, changes in the hydrologic conditions found could occur with time due to variations in rainfall, temperature, regional water usage, or other factors, any of which could effect this report.

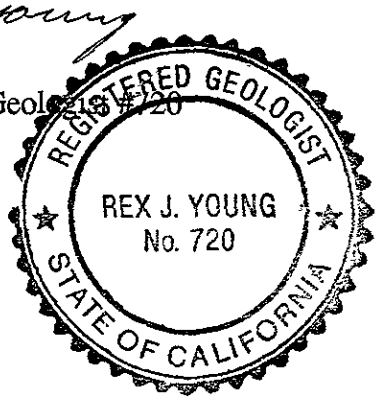
The services performed by GRI have been conducted in a manner consistent with the levels of care and skill ordinarily exercised by professionals currently practicing under similar conditions in California. The absence of contamination on or beneath the property cannot be guaranteed by this report. GRI is not responsible for any contamination or hazardous material found on the property. No other warranty expressed or implied, is made.

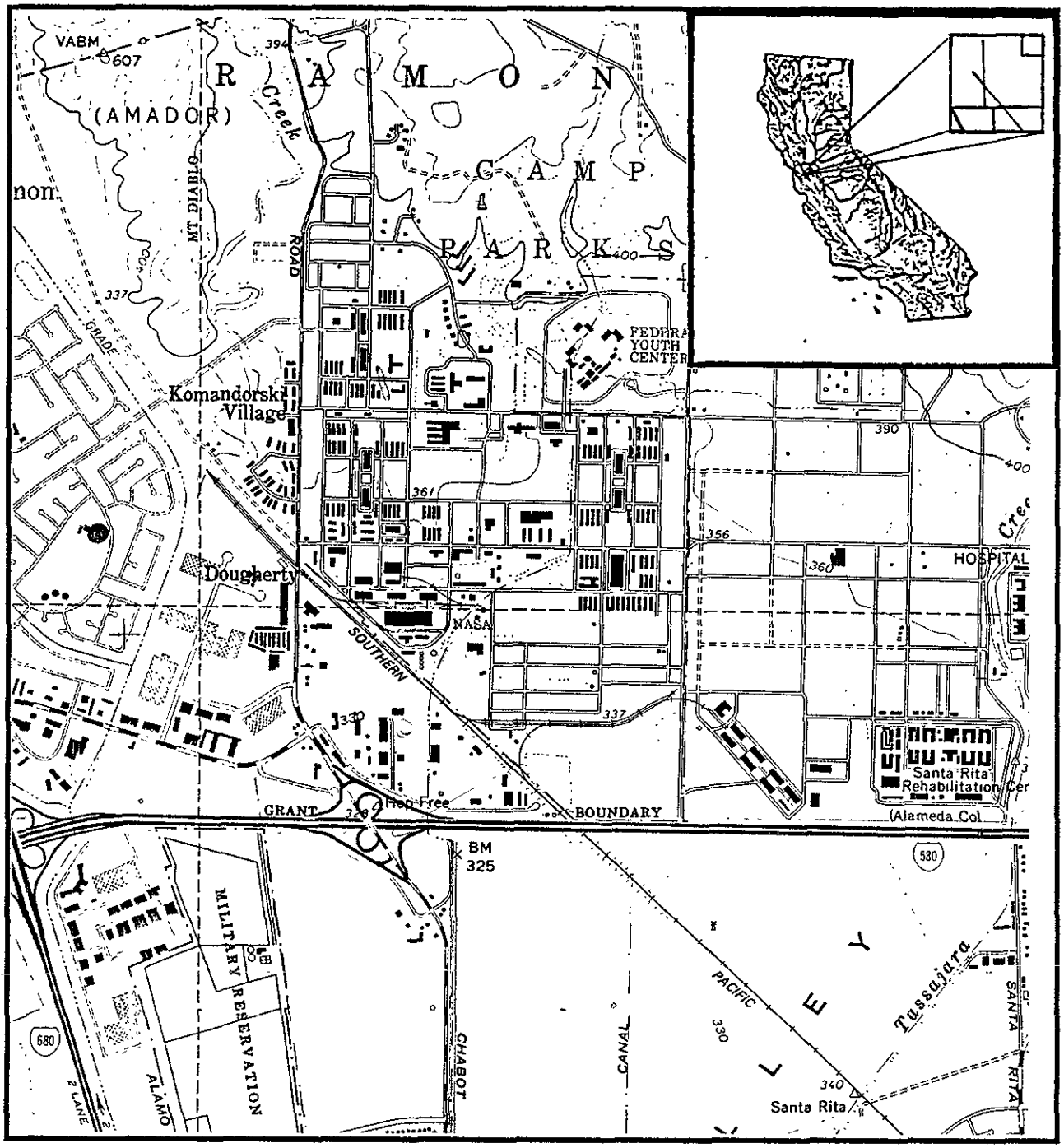
Respectfully submitted,

GROUNDWATER RESOURCES, INC.

Timothy C. Reed
Project Geologist

Rex J. Young
State Registered Geologist #720





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environmental/geotechnical services

Project Number: 55018

SCOTSMAN CORP.

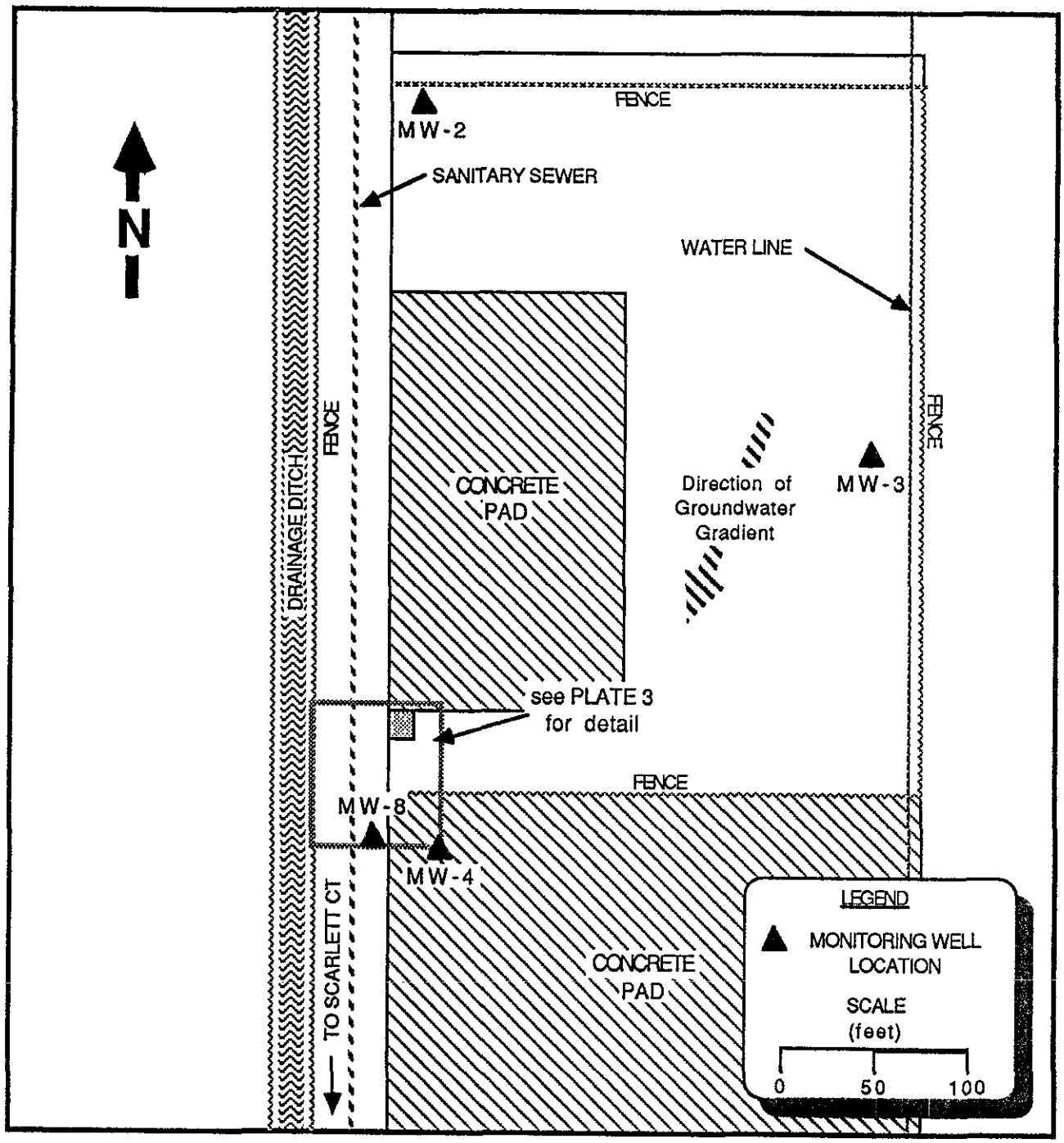
6055 Scarlett Ct.

Dublin, California

LOCATION MAP

PLATE

1



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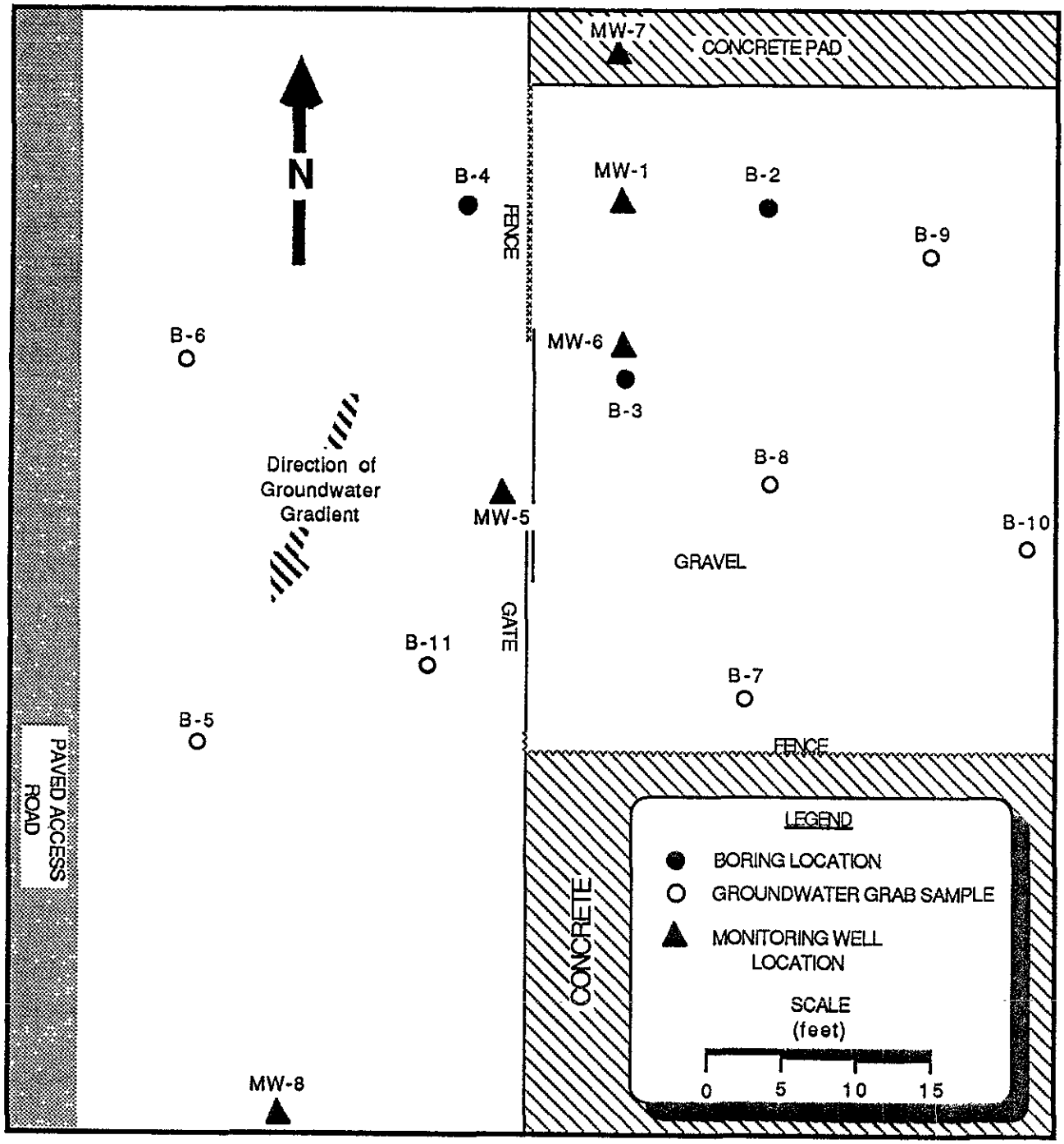
6055 SCARLETT COURT
DUBLIN, CA

PLOT PLAN

PLATE

2



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Project Number: 55018

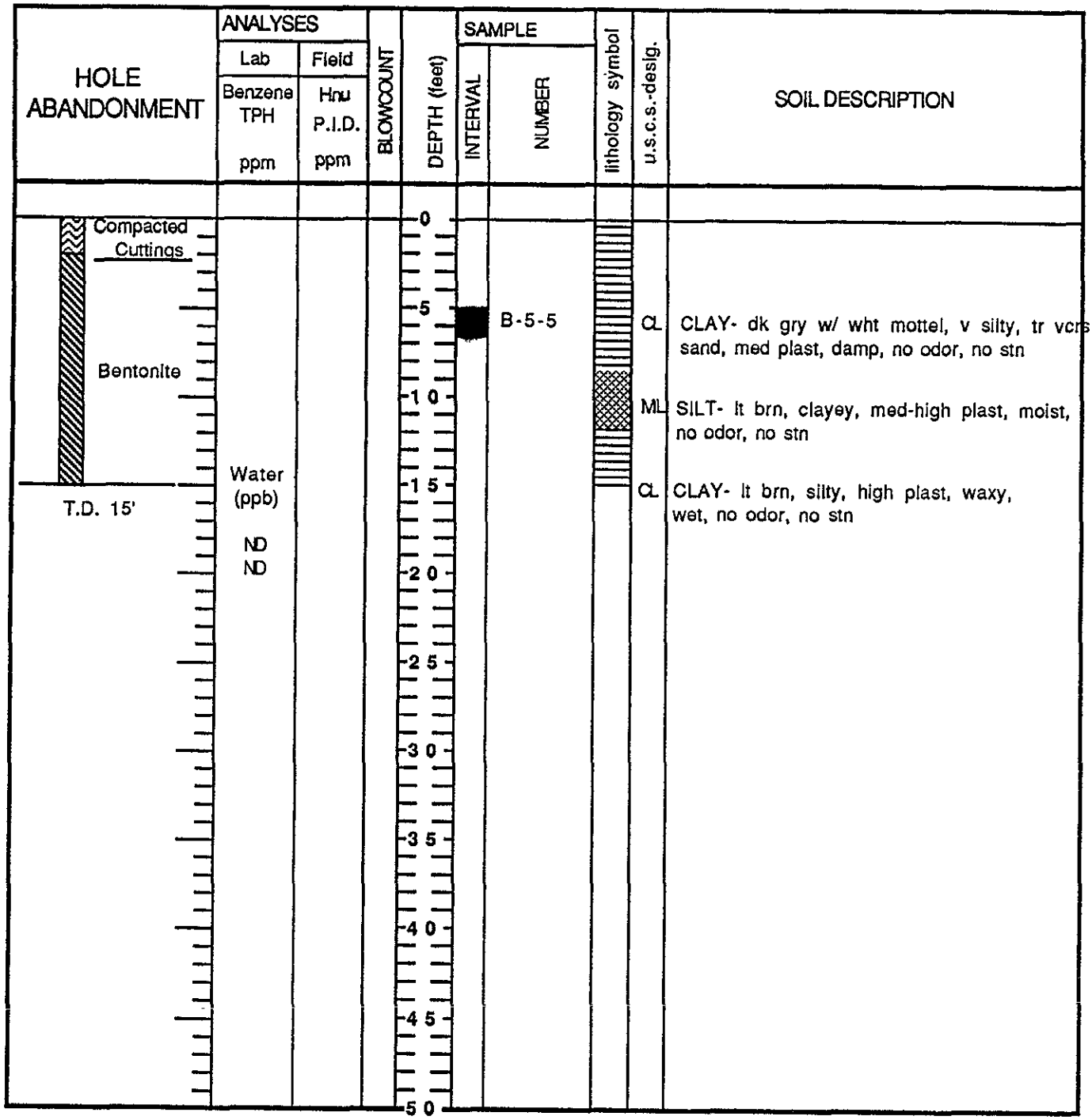
6-27-89

SCOTSMAN CORP.
DUBLIN, CA.

DETAIL OF TANK LOCATION

PLATE

3



SURFACE ELEVATION: 328.2 ft
TOTAL DEPTH: 15 ft
DATE DRILLED: 11-30-89

LOGGED BY: TCR
SUPERVISED BY: RJY
DIAMETER of BORING: 6 inch
WATER ENCOUNTERED AT: 5.5 ft

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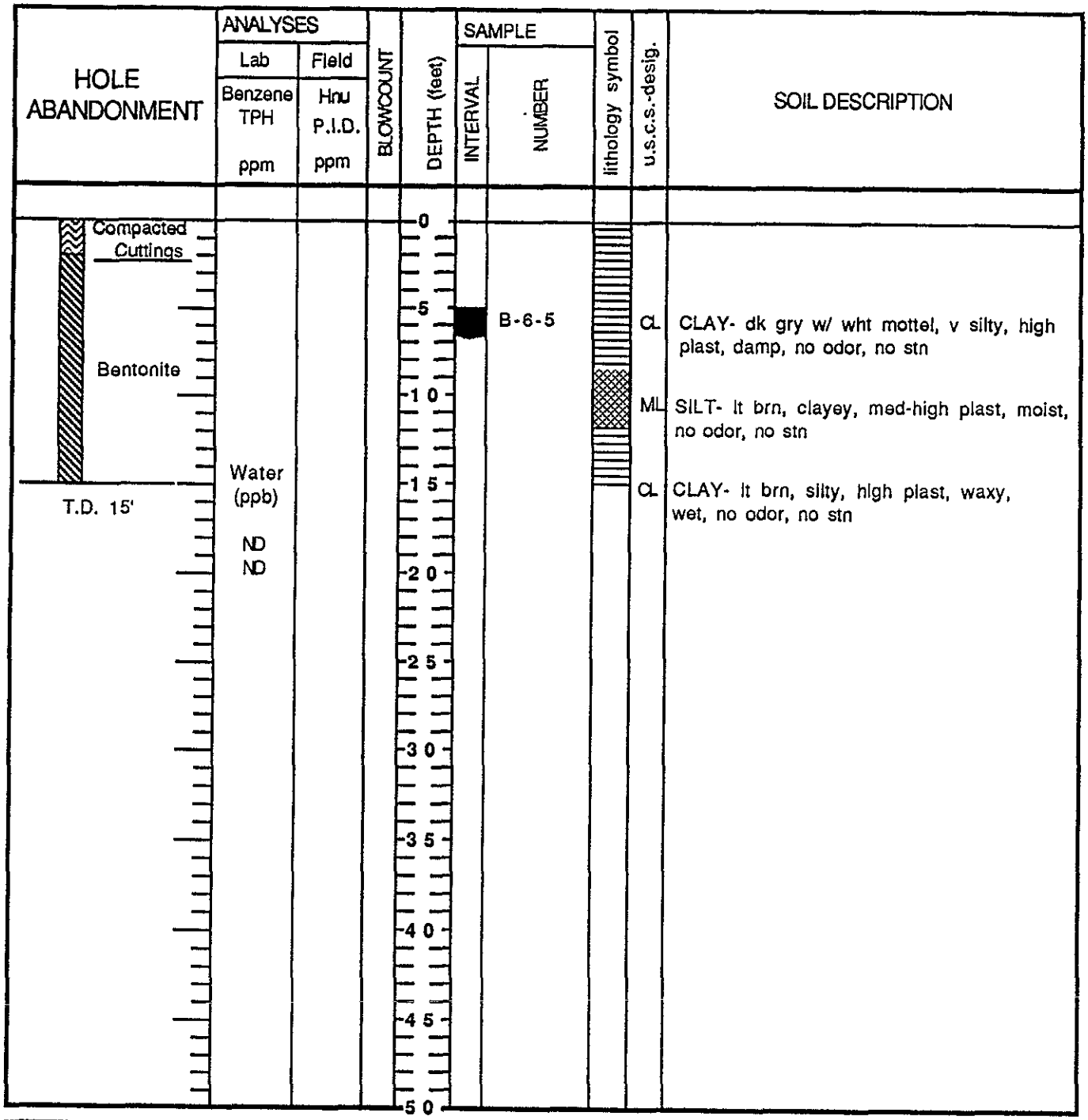
environmental/geotechnical services

PROJECT NUMBER: 55029

LOCATION:

LOG OF BORING B-5

PLATE 4



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TOTAL DEPTH: 15 ft
DATE DRILLED: 11-30-89

LOGGED BY: TCR
SUPERVISED BY: RJY
DIAMETER of BORING: 6 inch
WATER ENCOUNTERED AT: 5.5 ft

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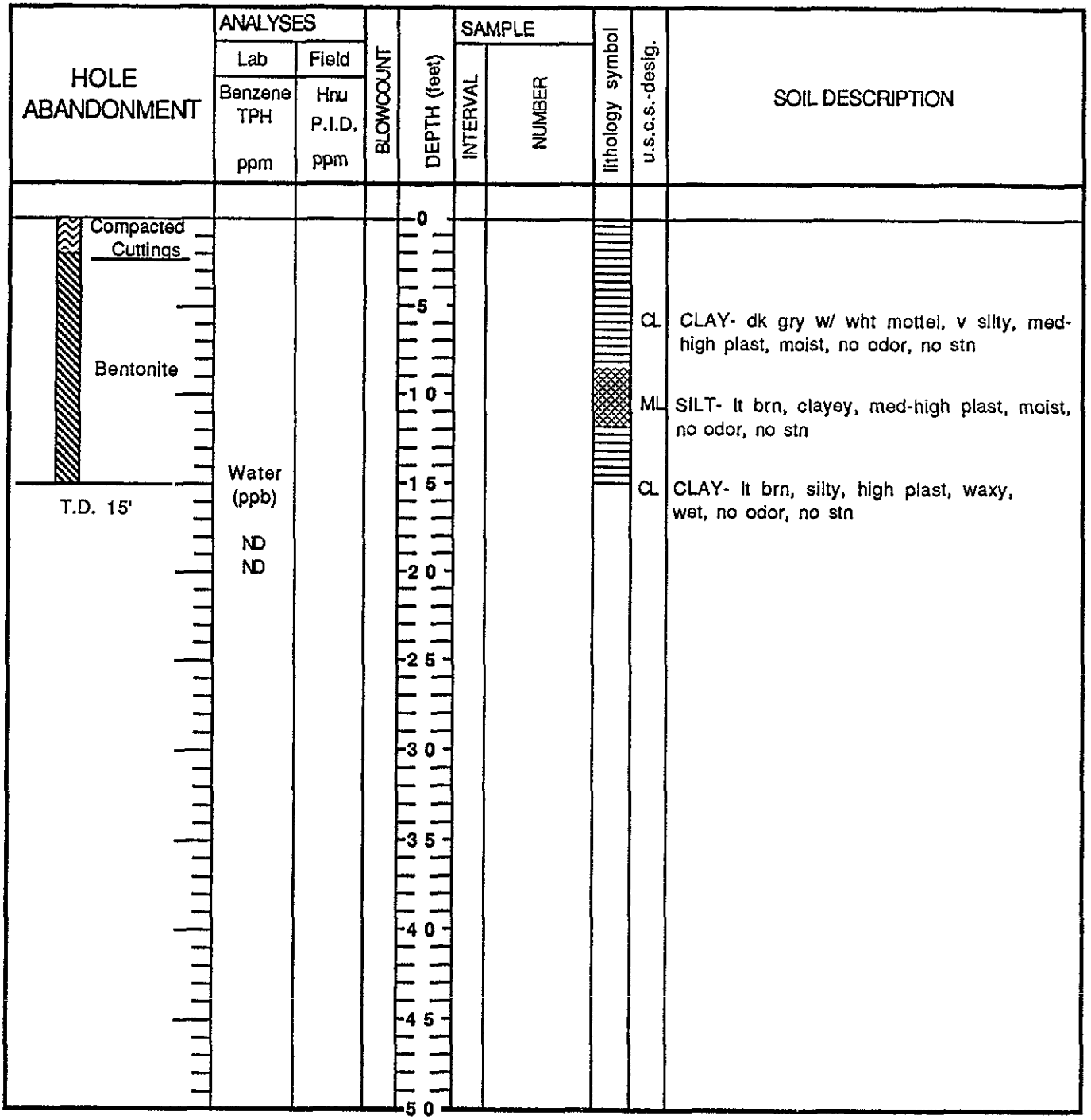
(805)835-7700
environmental/geotechnical services

PROJECT NUMBER: 55029

LOCATION:

LOG OF BORING B-6

PLATE 5



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TOTAL DEPTH: 15 ft
DATE DRILLED: 11-30-89

LOGGED BY: TCR
SUPERVISED BY: RJY
DIAMETER of BORING: 6 inch
WATER ENCOUNTERED AT: 5.5 ft

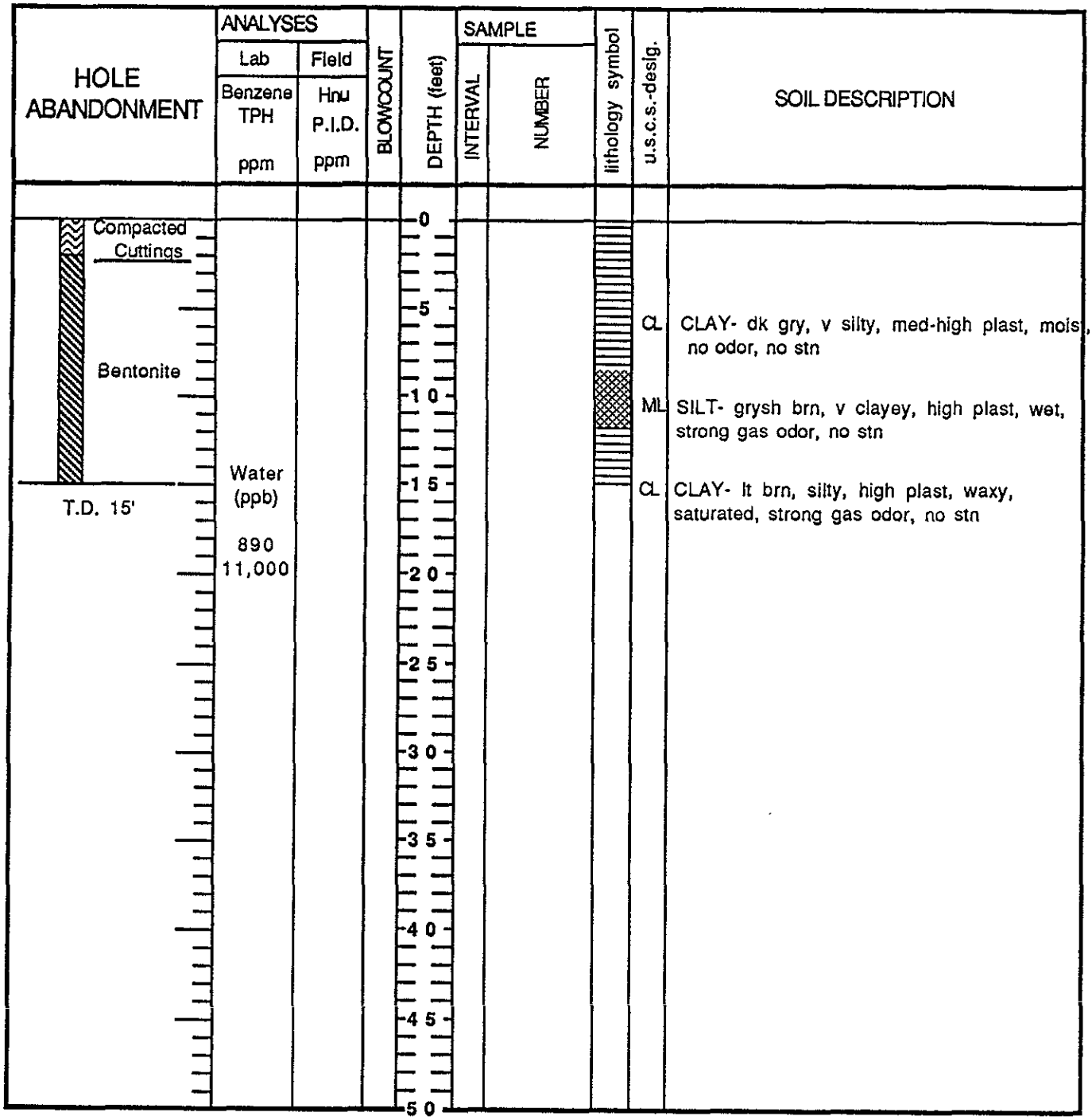
GROUNDWATER RESOURCES, INC.
(805)835-7700
environmental/geotechnical services

PROJECT NUMBER: 55029

LOCATION:

LOG OF BORING B-7

PLATE 6



SURFACE ELEVATION: 328.2 ft
TOTAL DEPTH: 15 ft
DATE DRILLED: 11-30-89

LOGGED BY: TCR
SUPERVISED BY: RJY
DIAMETER of BORING: 6 Inch
WATER ENCOUNTERED AT: 5.5 ft

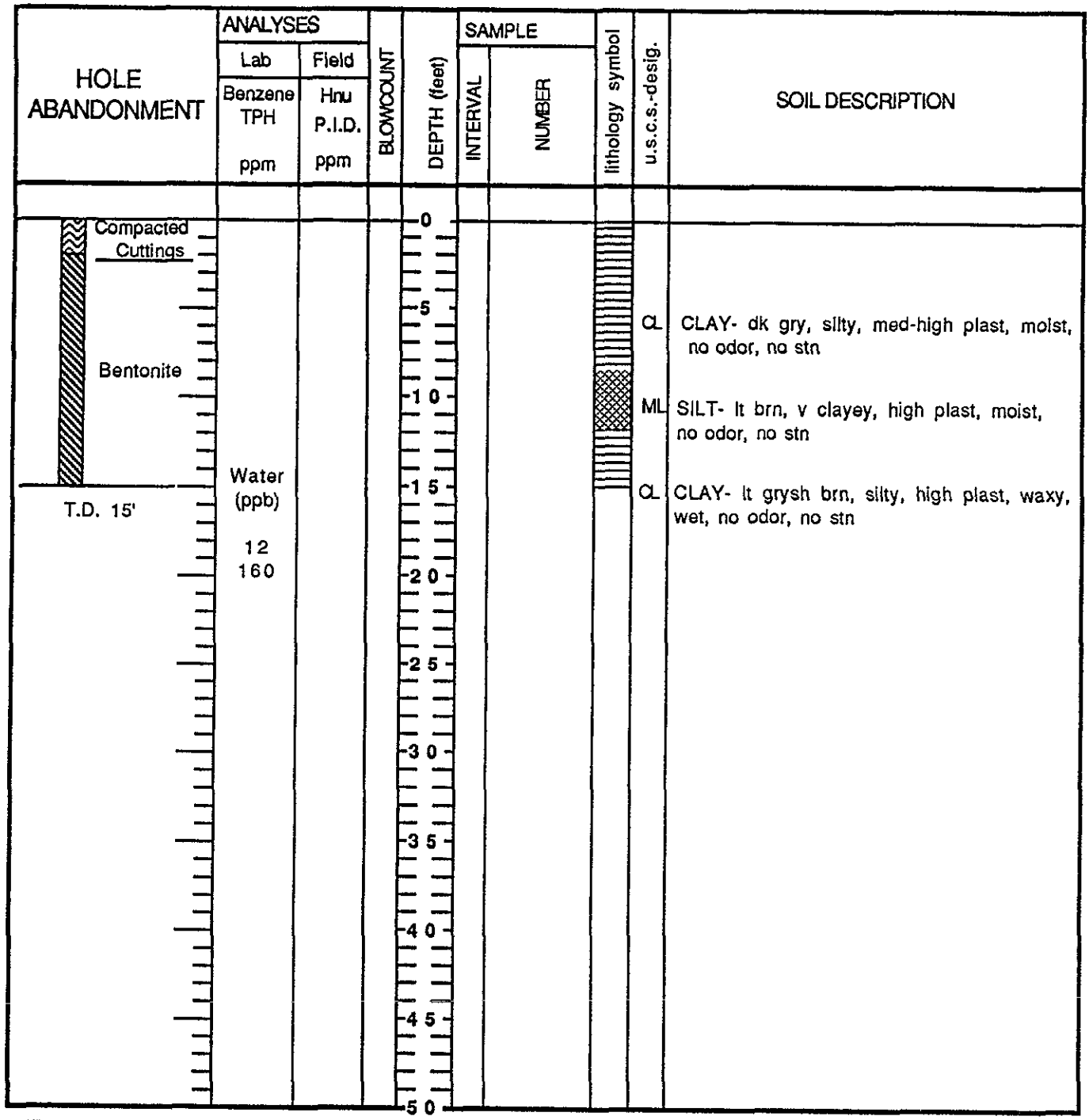
GROUNDWATER RESOURCES, INC.
(805)835-7700
environmental/geotechnical services

PROJECT NUMBER: 55029

LOCATION:

LOG OF BORING B-8

PLATE 7



SURFACE ELEVATION: 328.2 ft
TOTAL DEPTH: 15 ft
DATE DRILLED: 11-30-89

LOGGED BY: TCR
SUPERVISED BY: RJY
DIAMETER of BORING: 6 inch
WATER ENCOUNTERED AT: 5.5 ft

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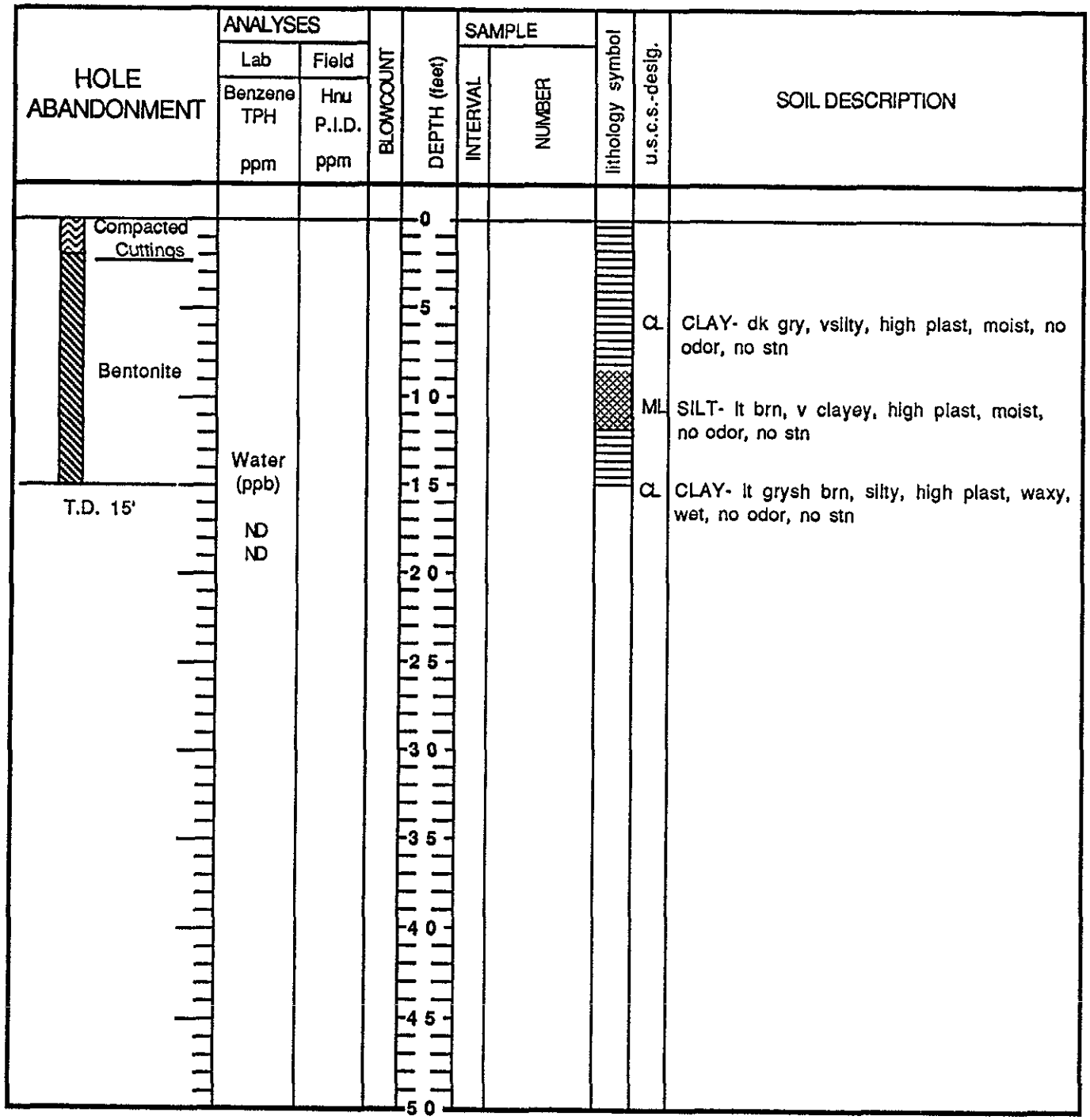
PROJECT NUMBER: 55029

LOCATION:

LOG OF BORING B-9

PLATE 8



SURFACE ELEVATION: 328.2 ft
TOTAL DEPTH: 15 ft
DATE DRILLED: 11-30-89

LOGGED BY: TCR
SUPERVISED BY: RJY
DIAMETER of BORING: 6 inch
WATER ENCOUNTERED AT: 5.5 ft

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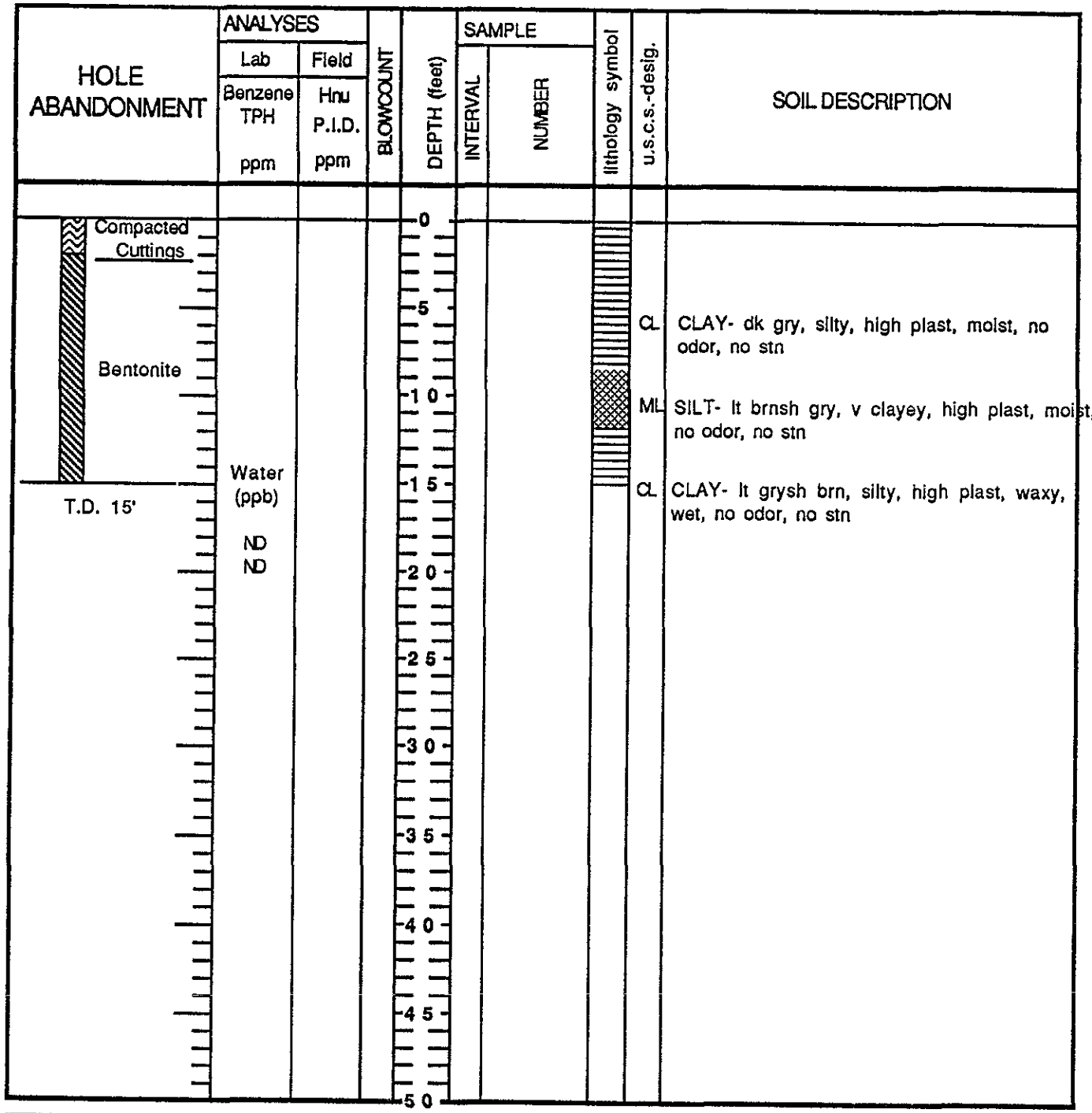
LOCATION:

LOG OF BORING B-10

PLATE
9
page 1 of 1



SURFACE ELEVATION: 328.2 ft
TOTAL DEPTH: 15 ft
DATE DRILLED: 11-30-89

LOGGED BY: TCR
SUPERVISED BY: RJY
DIAMETER of BORING: 6 inch
WATER ENCOUNTERED AT: 5.5 ft

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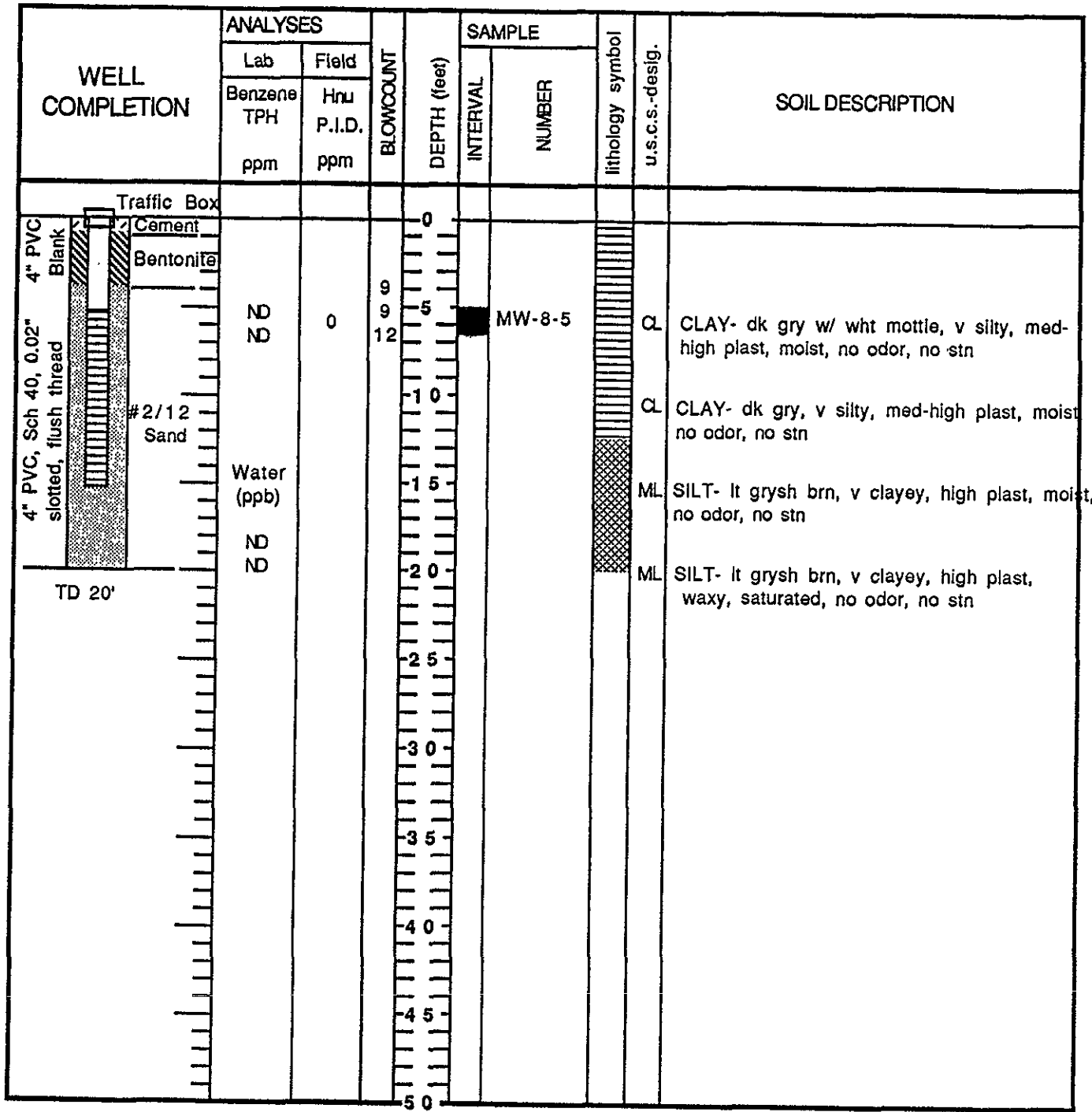
PROJECT NUMBER: 55029

LOCATION:

LOG OF BORING B-11

PLATE 10



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TOTAL DEPTH: 20 ft
DATE DRILLED: 11-30-89

LOGGED BY: TCR
SUPERVISED BY: RJY
DIAMETER of BORING: 8 inch
WATER ENCOUNTERED AT: 5.23 ft

GROUNDWATER RESOURCES, INC.
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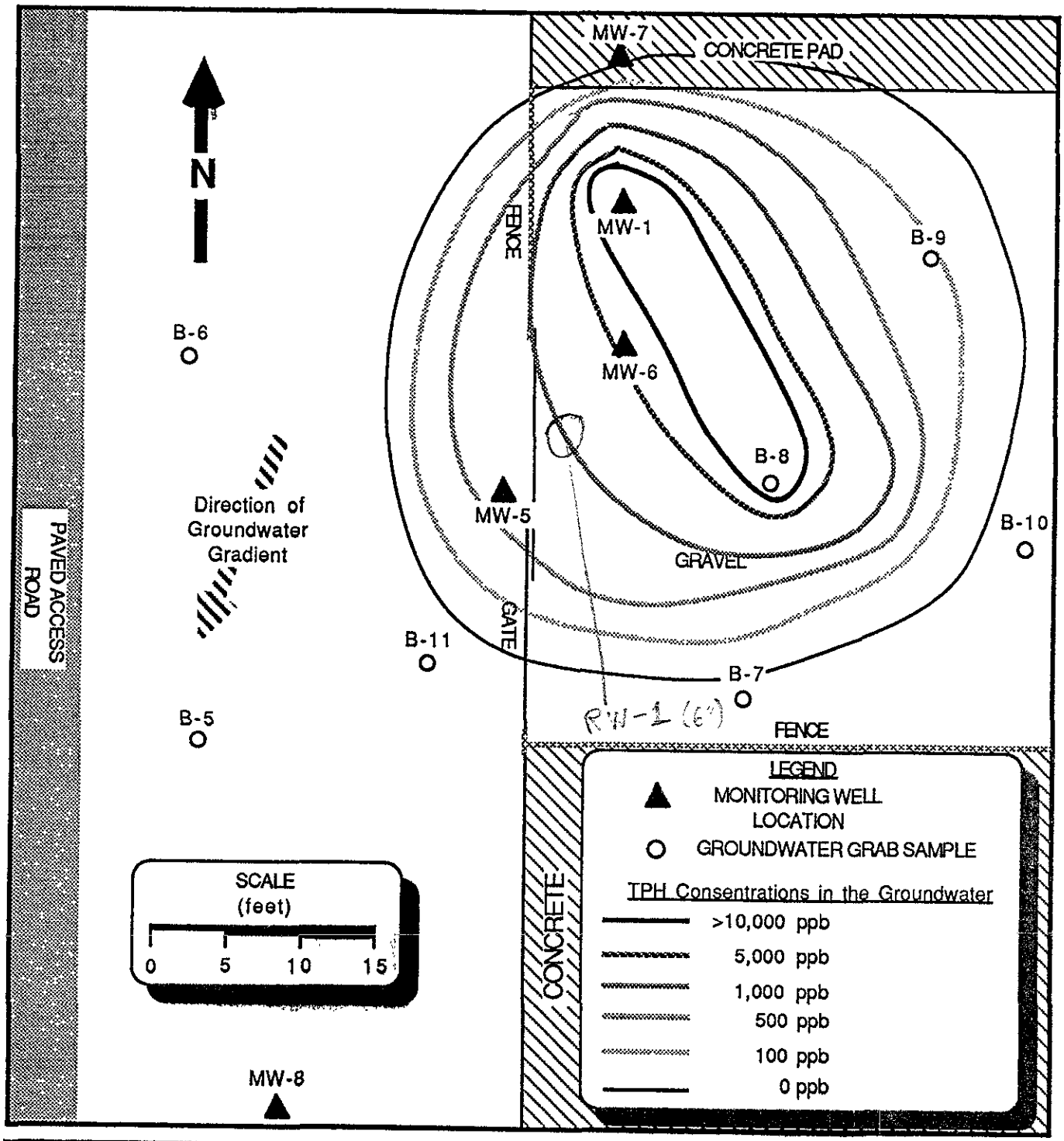
PROJECT NUMBER: 55029

LOCATION:
45' DOWNGRADIENT OF MW-5

LOG OF BORING MW-8

PLATE
11
page 1 of 1



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Project Number: 55018

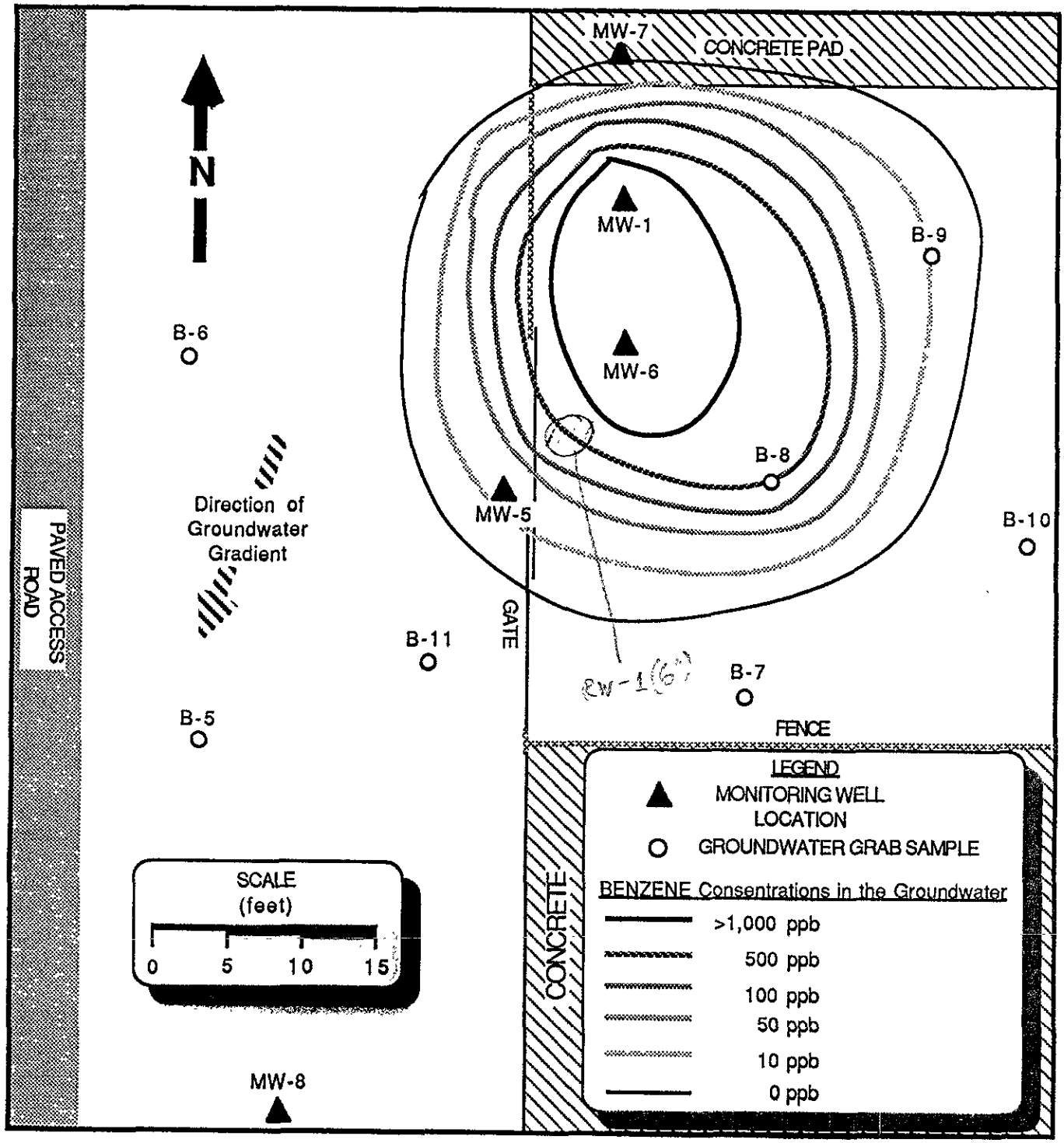
12-20-89

SCOTSMAN CORP.
DUBLIN, CA.

ISOPLETH MAP FOR TPH IN THE GROUNDWATER

PLATE

1 2



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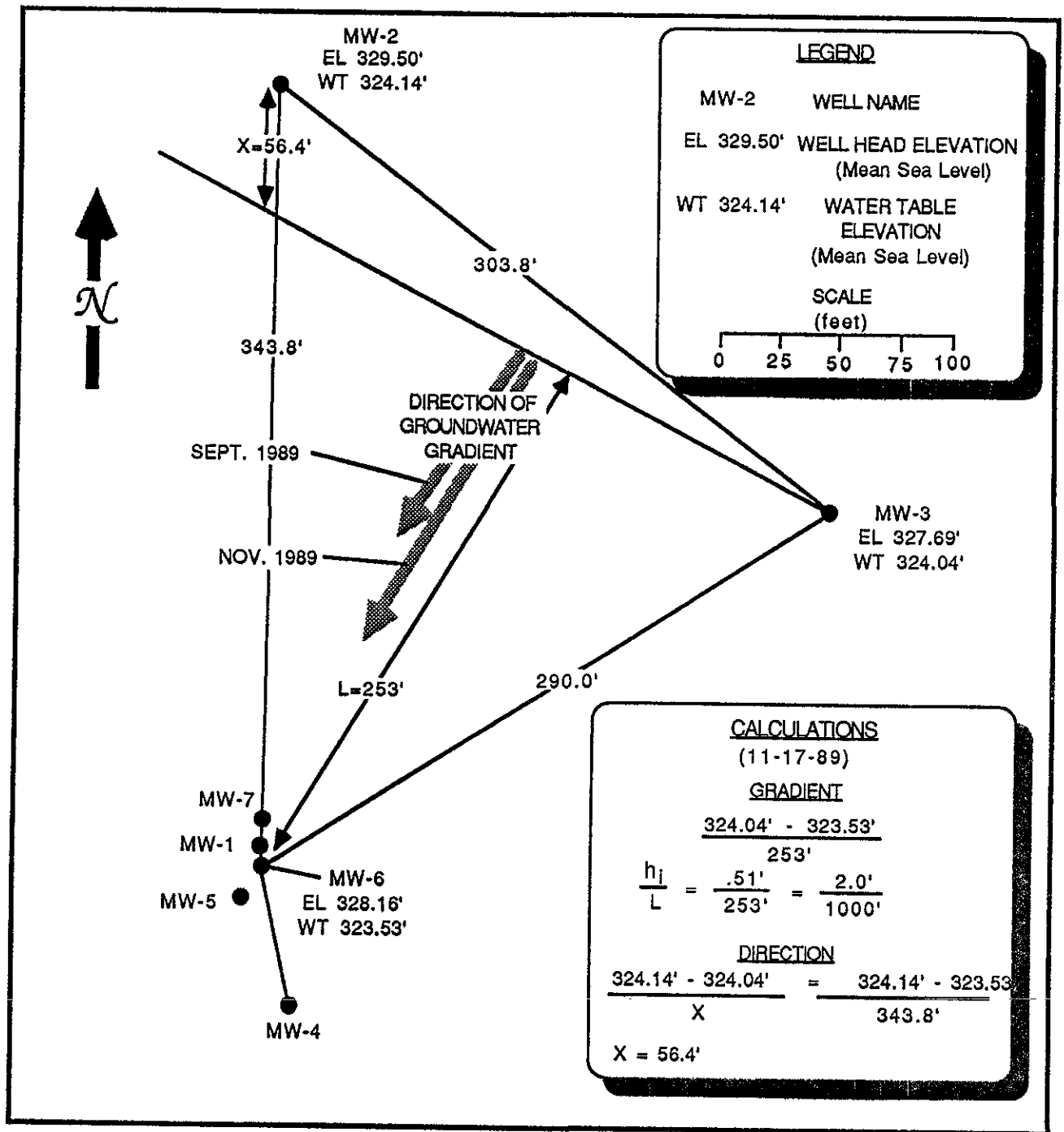
Project Number: 55018

12-20-89

SCOTSMAN CORP.
DUBLIN, CA.

ISOPLETH MAP FOR BENZENE IN THE GROUNDWATER

PLATE 13



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Project Number: 55018

11-17-89

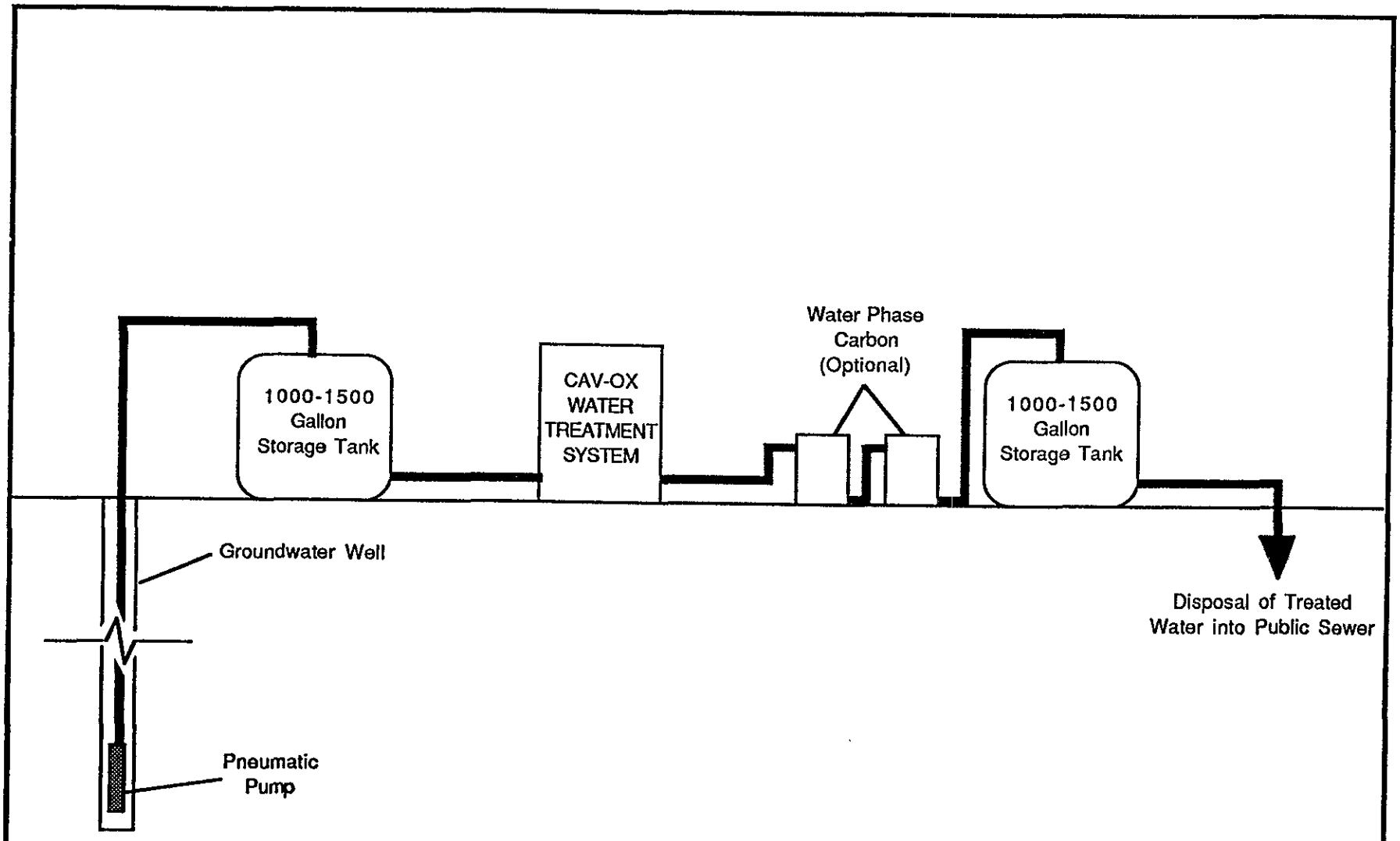
SCOTSMAN CORPORATION

DUBLIN, CALIFORNIA

SHALLOW GROUNDWATER GRADIENT MAP NOVEMBER 17, 1989

PLATE

14



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12-7-89

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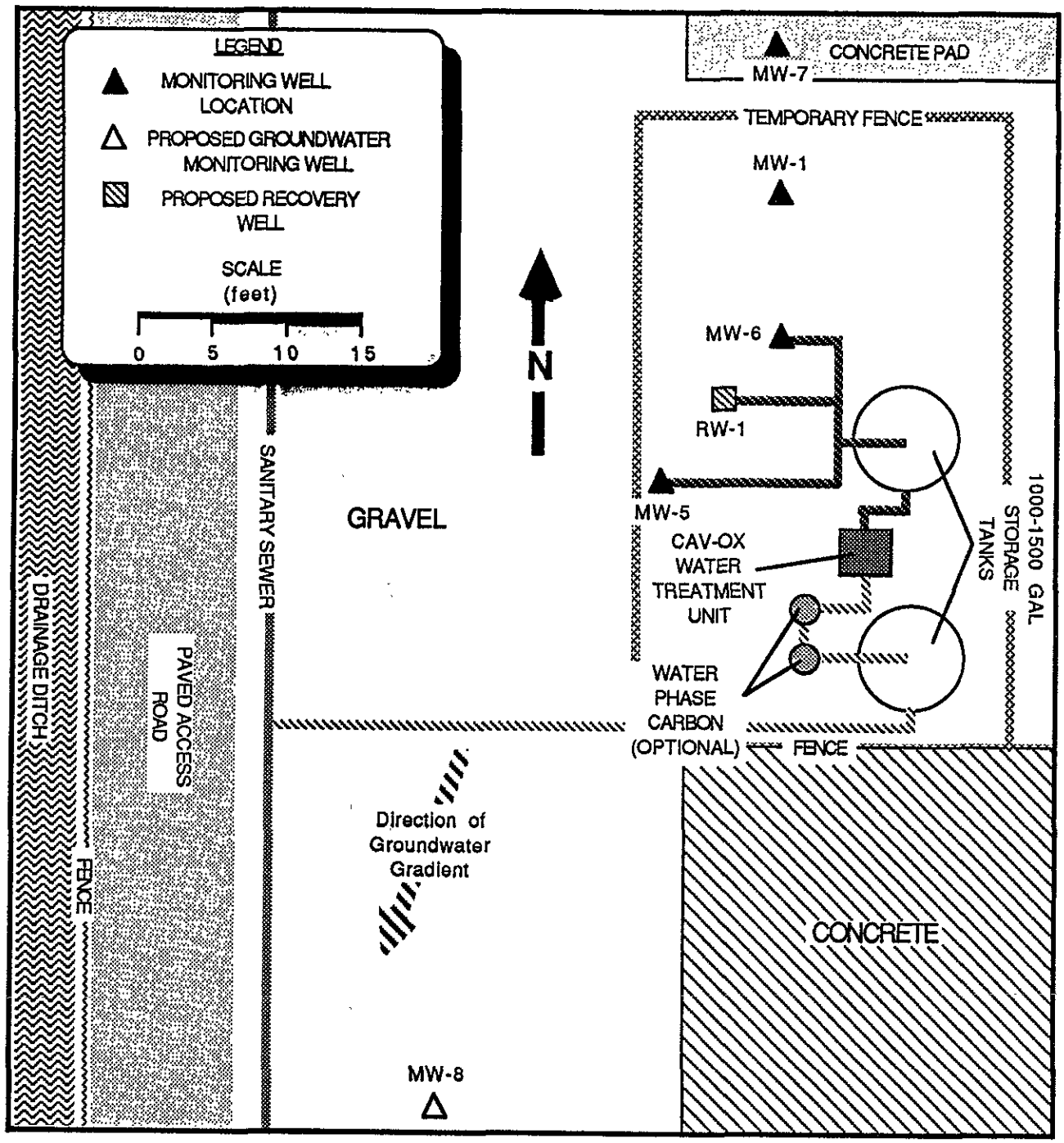
6055 SCARLETT CT.
DUBLIN, CALIFORNIA

GROUNDWATER REMEDIATION EQUIPMENT SCHEMATIC

Plate

15



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12-7-89

SCOTSMAN CORP.
DUBLIN, CA.

GROUNDWATER REMEDIATION PLOT PLAN

PLATE 16

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A T T A C H M E N T A

ENVIRONMENTAL
CHEMICAL ANALYSIS
PETROLEUM

BC LABORATORIES, INC.
J. J. EGLIN, REG. CHEM. ENGR.
4100 PIERCE RD., BAKERSFIELD, CALIFORNIA 93308 PHONE 327-4911

Groundwater Resource Industries

5400 Aldrin Ct
Bakersfield, CA 93313

PURGEABLE ORGANIC ANALYSIS
(Volatiles)

Date of Report: 11/30/89 Lab Sample ID No. 9204-1
Laboratory Name: B C Laboratories Signature Lab Director Dan Farah
Name of Sampler: _____ Sampler Employed By: _____
Date/Time Sample Collected: 11/16/89 Date/Time Sample Received @ Lab: 11/20/89 Were Holding Times Observed? YES
Test Methods: EPA 602 Were all the Constituents listed below quantified? YES

==========

System Name: Project #55018 - Alameda County System #3226 MW-1 11/16/89 @ 15:30 Number: _____
Description of Sampling Point: _____
Name/No. Of Sample Source: _____ Station Number: |-|-|-|4|-|-|-|=|-|-|-|-|-|-|-|
Date & Time of Sample: |-|-|-|-|-|-|-|-|-|-| (Y Y M M D D T T T T) Water Type G/S |-| User ID: |-|-|-| Submitted to SWQIS By: _____

Place an "X" in box to delete all data for this station/date/time |-|

REPORTING UNITS	CONSTITUENT	TT	STORET CODE	ANALYSIS RESULTS	DETECTION LIMIT
	Date Analysis Completed	-		8 9 1 1 2 9 (Y Y M M D D)	- - - - - -
		-			
	Analyzing Agency Code (Lab)	-		- 5 8 0 6 -	- - - - - -
	Intensive Survey Number	-		- - - - - -	- - - - - -
µg/L	Benzene	-	34030	- 4 7 0 . -	- - - 0 . 7 0
µg/L	Chlorobenzene	-	34301	- - N D -	- - - 0 . 7 0
µg/L	1,2-Dichlorobenzene	-	34536	- - N D -	- - - 0 . 7 0
µg/L	1,3-Dichlorobenzene	-	34566	- - N D -	- - - 0 . 7 0
µg/L	1,4-Dichlorobenzene	-	34571	- - N D -	- - - 0 . 7 0
µg/L	Ethyl Benzene	-	34371	- 2 5 0 . -	- - - 0 . 7 0
µg/L	Toluene	-	34010	- 1 4 0 . -	- - - 0 . 7 0
µg/L	Xylenes	-	81551	1 1 0 0 . -	- - - 0 . 7 0

ND - None Detected
California D.O.H.S. Cert. #102

NOTE ANY UNIDENTIFIED PEAKS BELOW
Total Petroleum Hydrocarbons = 2900.0 µg/L
Minimum Reporting Level = 0.70 µg/L

ENVIRONMENTAL
CHEMICAL ANALYSIS
PETROLEUM

BC LABORATORIES, INC.
J. J. EGLIN, REG. CHEM. ENGR.
4100 PIERCE RD., BAKERSFIELD, CALIFORNIA 93308 PHONE 327-4911

Groundwater Resource Industries

5400 Aldrin Ct
Bakersfield, CA 93313

PURGEABLE ORGANIC ANALYSIS
(Volatiles)

Date of Report: 11/30/89 Lab Sample ID No. 9204-2
Laboratory Name: B C Laboratories Signature Lab Director Dan Farah
Name of Sampler: Sampler Employed By:
Date/Time Sample Collected: 11/16/89 Date/Time Sample Received @ Lab: 11/20/89 Were Holding Times Observed? YES
Test Methods: EPA 602 Were all the Constituents listed below quantified? YES

System Name: Project #55018 - Alameda County System #3227 MW-2 11/16/89 @ 14:41 Number:
Description of Sampling Point:
Name/No. Of Sample Source: Station Number: |-|-|-|4|-|-|-|=|-|-|-|-|-|-|-|
Date & Time of Sample: |-|-|-|-|-|-|-|-|-|-|-|-| (Y Y M M D D T T T T)
Water Type G/S |-| User ID: |-|-|-| Submitted to SWQIS By:

Place an "X" in box to delete all data for this station/date/time |-|

REPORTING UNITS	CONSTITUENT	TT	STORET CODE	ANALYSIS RESULTS	DETECTION LIMIT
	Date Analysis Completed	-		89 11 12 09 (Y Y M M D D)	- - - - - -
		-			
	Analyzing Agency Code (Lab)	-		- 5 8 0 6 -	- - - - - -
	Intensive Survey Number	-		- - - - - -	- - - - - -
ug/L	Benzene	-	34030	- - N D - -	- - 0 . 7 0
ug/L	Chlorobenzene	-	34301	- - N D - -	- - 0 . 7 0
ug/L	1,2-Dichlorobenzene	-	34536	- - N D - -	- - 0 . 7 0
ug/L	1,3-Dichlorobenzene	-	34566	- - N D - -	- - 0 . 7 0
ug/L	1,4-Dichlorobenzene	-	34571	- - N D - -	- - 0 . 7 0
ug/L	Ethyl Benzene	-	34371	- - N D - -	- - 0 . 7 0
ug/L	Toluene	-	34010	- - N D - -	- - 0 . 7 0
ug/L	Xylenes	-	81551	- - N D - -	- - 0 . 7 0

ND - None Detected
California D.O.H.S. Cert. #102

NOTE ANY UNIDENTIFIED PEAKS BELOW
Total Petroleum Hydrocarbons = None Detected
Minimum Reporting Level = 0.70 ug/L

ENVIRONMENTAL
CHEMICAL ANALYSIS
PETROLEUM

BC LABORATORIES, INC.

J. J. EGLIN, REG. CHEM. ENGR.

4100 PIERCE RD., BAKERSFIELD, CALIFORNIA 93308 PHONE 327-4911

Groundwater Resource Industries

5400 Aldrin Ct
Bakersfield, CA 93313

PURGEABLE ORGANIC ANALYSIS
(Volatiles)

Date of Report: 11/30/89 Lab Sample ID No. 9204-3
Laboratory Name: B C Laboratories Signature Lab Director Dan Farah
Name of Sampler: _____ Sampler Employed By: _____
Date/Time Sample Collected: 11/16/89 Date/Time Sample Received @ Lab: 11/20/89 Were Holding Times Observed? YES
Test Methods: EPA 602 Were all the Constituents listed below quantified? YES

==========

System Name: Project #55018 - Alameda County System #3228 MW-3 11/16/89 @ 14:54 Number: _____
Description of Sampling Point: _____
Name/No. Of Sample Source: _____ Station Number: |_|_|_|_|4|_|_|_|=|_|_|_|_|_|_|_|
Date & Time of Sample: |_|_|_|_|_|_|_|_|_|_| (Y Y M M D D T T T T) Water Type G/S |_| User ID: |_|_|_| Submitted to SWQIS By: _____

Place an "X" in box to delete all data for this station/date/time |_|

REPORTING UNITS	CONSTITUENT	TT	STORET CODE	ANALYSIS RESULTS	DETECTION LIMIT
	Date Analysis Completed	_		8 9 1 1 2 9 (Y Y M M D D)	
	Analyzing Agency Code (Lab)	_		_ 5 8 0 6 _	
	Intensive Survey Number	_			
µg/L	Benzene	_	34030	_ _ N D _ _ _ _	0.70
µg/L	Chlorobenzene	_	34301	_ _ N D _ _ _ _	0.70
µg/L	1,2-Dichlorobenzene	_	34536	_ _ N D _ _ _ _	0.70
µg/L	1,3-Dichlorobenzene	_	34566	_ _ N D _ _ _ _	0.70
µg/L	1,4-Dichlorobenzene	_	34571	_ _ N D _ _ _ _	0.70
µg/L	Ethyl Benzene	_	34371	_ _ N D _ _ _ _	0.70
µg/L	Toluene	_	34010	_ _ N D _ _ _ _	0.70
µg/L	Xylenes	_	81551	_ _ N D _ _ _ _	0.70

ND - None Detected
California D.O.H.S. Cert. #102

NOTE ANY UNIDENTIFIED PEAKS BELOW
Total Petroleum Hydrocarbons = None Detected
Minimum Reporting Level = 0.70 µg/L

ENVIRONMENTAL
CHEMICAL ANALYSIS
PETROLEUM

BC LABORATORIES, INC.

J. J. EGLIN, REG. CHEM. ENGR.

4100 PIERCE RD., BAKERSFIELD, CALIFORNIA 93308 PHONE 327-4911

Groundwater Resource Industries

5400 Aldrin Ct
Bakersfield, CA 93313

PURGEABLE ORGANIC ANALYSIS
(Volatiles)

Date of Report: 11/30/89 Lab Sample ID No. 9204-4
Laboratory Name: B C Laboratories Signature Lab Director Dan Farah
Name of Sampler: Sampler Employed By:
Date/Time Sample Collected: 11/16/89 Date/Time Sample Received @ Lab: 11/20/89 Were Holding Times Observed? YES
Test Methods: EPA 602 Were all the Constituents listed below quantified? YES

System Name: Project #55018 - Alameda County System #3229 MW-4 11/16/89 @ 16:04 Number:
Description of Sampling Point:
Name/No. Of Sample Source: Station Number: |-|-|-|4|-|-|-|=|-|-|-|-|-|-|-|
Date & Time of Sample: |-|-|-|-|-|-|-|-|-|-|-| (Y Y M M D D T T T T) Water Type G/S |-| User ID: |-|-|-| Submitted to SWQIS By:

Place an "X" in box to delete all data for this station/date/time |-|

REPORTING UNITS	CONSTITUENT	TT	STORET CODE	ANALYSIS RESULTS	DETECTION LIMIT
	Date Analysis Completed	-		89 (Y Y) 11 (M M) 20 (D D)	- - - - - -
		-			
	Analyzing Agency Code (Lab)	-		580 6	- - - - - -
	Intensive Survey Number	-		- - - - - -	- - - - - -
ug/L	Benzene	-	34030	- - ND - - -	- - 0.70
ug/L	Chlorobenzene	-	34301	- - ND - - -	- - 0.70
ug/L	1,2-Dichlorobenzene	-	34536	- - ND - - -	- - 0.70
ug/L	1,3-Dichlorobenzene	-	34566	- - ND - - -	- - 0.70
ug/L	1,4-Dichlorobenzene	-	34571	- - ND - - -	- - 0.70
ug/L	Ethyl Benzene	-	34371	- - ND - - -	- - 0.70
ug/L	Toluene	-	34010	- - ND - - -	- - 0.70
ug/L	Xylenes	-	81551	- - ND - - -	- - 0.70

ND - None Detected
California D.O.H.S. Cert. #102

NOTE ANY UNIDENTIFIED PEAKS BELOW
Total Petroleum Hydrocarbons = None Detected
Minimum Reporting Level = 0.70 ug/L

ENVIRONMENTAL
CHEMICAL ANALYSIS
PETROLEUM

BC LABORATORIES, INC.
J. J. EGLIN, REG. CHEM. ENGR.
4100 PIERCE RD., BAKERSFIELD, CALIFORNIA 93308 PHONE 327-4911

Groundwater Resource Industries

5400 Aldrin Ct
Bakersfield, CA 93313

PURGEABLE ORGANIC ANALYSIS
(Volatiles)

Date of Report: 11/30/89 Lab Sample ID No. 9204-5
Laboratory Name: B C Laboratories Signature Lab Director Dan Farah
Name of Sampler: _____ Sampler Employed By: _____
Date/Time Sample Collected: 11/16/89 Date/Time Sample Received @ Lab: 11/20/89 Were Holding Times Observed? YES
Test Methods: EPA 602 Were all the Constituents listed below quantified? YES

System Name: Project #55018 - Alameda County System #3230 MW-5 11/16/89 @ 15:29 Number: _____
Description of Sampling Point: _____
Name/No. Of Sample Source: _____ Station Number: |-|-|-|4|-|-|-|=|-|-|-|-|-|-|-|
Date & Time of Sample: |-|-|-|-|-|-|-|-|-|-| (Y Y M M D D T T T T) Water Type G/S |-| User ID: |-|-|-| Submitted to SWQIS By: _____

Place an "X" in box to delete all data for this station/date/time |-|

REPORTING UNITS	CONSTITUENT	TT	STORET CODE	ANALYSIS RESULTS	DETECTION LIMIT
	Date Analysis Completed	-		8 9 1 1 2 9 (Y Y M M D D)	- - - - - -
		-			
	Analyzing Agency Code (Lab)	-		- 5 8 0 6 -	- - - - - -
	Intensive Survey Number	-		- - - - - -	- - - - - -
µg/L	Benzene	-	34030	- - N D - -	- - 0 . 7 0
µg/L	Chlorobenzene	-	34301	- - 3 . 2 0	- - 0 . 7 0
µg/L	1,2-Dichlorobenzene	-	34536	- - N D - -	- - 0 . 7 0
µg/L	1,3-Dichlorobenzene	-	34566	- - N D - -	- - 0 . 7 0
µg/L	1,4-Dichlorobenzene	-	34571	- - N D - -	- - 0 . 7 0
µg/L	Ethyl Benzene	-	34371	- 2 9 . 0 0	- - 0 . 7 0
µg/L	Toluene	-	34010	- - 4 . 8 0	- - 0 . 7 0
µg/L	Xylenes	-	81551	- - 4 . 3 0	- - 0 . 7 0

ND - None Detected
California D.O.H.S. Cert. #102

NOTE ANY UNIDENTIFIED PEAKS BELOW
Total Petroleum Hydrocarbons = 57.0 µg/L
Minimum Reporting Level = 0.70 µg/L

ENVIRONMENTAL
CHEMICAL ANALYSIS
PETROLEUM

BC LABORATORIES, INC.
J. J. EGLIN, REG. CHEM. ENGR.
4100 PIERCE RD., BAKERSFIELD, CALIFORNIA 93308 PHONE 327-4911

Groundwater Resource Industries

5400 Aldrin Ct
Bakersfield, CA 93313

PURGEABLE ORGANIC ANALYSIS
(Volatiles)

Date of Report: 11/30/89 Lab Sample ID No. 9204-6
Laboratory Name: B C Laboratories Signature Lab Director Dan Farah
Name of Sampler: Sampler Employed By:
Date/Time Sample Collected: 11/16/89 Date/Time Sample Received @ Lab: 11/20/89 Were Holding Times Observed? YES
Test Methods: EPA 602 Were all the Constituents listed below quantified? YES

System Name: Project #55018 - Alameda County System #3231 MW-6 11/16/89 @ 15:43 Number:
Description of Sampling Point:
Name/No. Of Sample Source: Station Number: |-|-|-|4|-|-|-|=|-|-|-|-|-|-|-|
Date & Time of Sample: |-|-|-|-|-|-|-|-|-|-| (Y Y M M D D T T T T) Water Type G/S |-| User ID: |-|-|-| Submitted to SWQIS By:

Place an "X" in box to delete all data for this station/date/time |-|

REPORTING UNITS	CONSTITUENT	TT	STORET CODE	ANALYSIS RESULTS	DETECTION LIMIT
	Date Analysis Completed	-		8 9 1 1 2 9 (Y Y M M D D)	- - - - - -
		-			
	Analyzing Agency Code (Lab)	-		- 5 8 0 6 -	- - - - - -
	Intensive Survey Number	-		- - - - - -	- - - - - -
ug/L	Benzene	-	34030	- - N D - -	- - 0 . 7 0
ug/L	Chlorobenzene	-	34301	- - 2 . 5 0	- - 0 . 7 0
ug/L	1,2-Dichlorobenzene	-	34536	- - N D - -	- - 0 . 7 0
ug/L	1,3-Dichlorobenzene	-	34566	- - N D - -	- - 0 . 7 0
ug/L	1,4-Dichlorobenzene	-	34571	- - N D - -	- - 0 . 7 0
ug/L	Ethyl Benzene	-	34371	1 7 0 0 . -	- - 0 . 7 0
ug/L	Toluene	-	34010	- 2 8 0 . -	- - 0 . 7 0
ug/L	Xylenes	-	81551	- 4 6 0 . -	- - 0 . 7 0

ND - None Detected
California D.O.H.S. Cert. #102

NOTE ANY UNIDENTIFIED PEAKS BELOW
Total Petroleum Hydrocarbons = 2800. ug/L
Minimum Reporting Level = 0.70 ug/L

ENVIRONMENTAL
CHEMICAL ANALYSIS
PETROLEUM

BC LABORATORIES, INC.
J. J. EGLIN, REG. CHEM. ENGR.
4100 PIERCE RD., BAKERSFIELD, CALIFORNIA 93308 PHONE 327-4911

Groundwater Resource Industries

5400 Aldrin Ct
Bakersfield, CA 93313

PURGEABLE ORGANIC ANALYSIS
(Volatiles)

Date of Report: 11/30/89 Lab Sample ID No. 9204-7
Laboratory Name: B C Laboratories Signature Lab Director Dan Farah
Name of Sampler: Sampler Employed By:
Date/Time Sample Collected: 11/16/89 Date/Time Sample Received @ Lab: 11/20/89 Were Holding Times Observed? YES
Test Methods: EPA 602 Were all the Constituents listed below quantified? YES

==========

System Name: Project #55018 - Alameda County System #3232 MW-7 11/16/89 @ 15:22 Number:
Description of Sampling Point:
Name/No. Of Sample Source: Station Number: |-|-|-|4|-|-|-|=|-|-|-|-|-|-|-|
Date & Time of Sample: |-|-|-|-|-|-|-|-|-|-| (Y Y M M D D T T T T) Water Type G/S |-| User ID: |-|-|-| Submitted to SWQIS By:

Place an "X" in box to delete all data for this station/date/time |-|

REPORTING UNITS	CONSTITUENT	TT	STORET CODE	ANALYSIS RESULTS	DETECTION LIMIT
	Date Analysis Completed	-		89 11 11 26	- - - - - -
		-			
	Analyzing Agency Code (Lab)	-		- 5 8 0 6 -	- - - - - -
	Intensive Survey Number	-		- - - - - -	- - - - - -
ug/L	Benzene	-	34030	- - N D - -	- - 0 . 7 0
ug/L	Chlorobenzene	-	34301	- - N D - -	- - 0 . 7 0
ug/L	1,2-Dichlorobenzene	-	34536	- - N D - -	- - 0 . 7 0
ug/L	1,3-Dichlorobenzene	-	34566	- - N D - -	- - 0 . 7 0
ug/L	1,4-Dichlorobenzene	-	34571	- - N D - -	- - 0 . 7 0
ug/L	Ethyl Benzene	-	34371	- - N D - -	- - 0 . 7 0
ug/L	Toluene	-	34010	- - N D - -	- - 0 . 7 0
ug/L	Xylenes	-	81551	- - N D - -	- - 0 . 7 0

ND - None Detected
California D.O.H.S. Cert. #102

NOTE ANY UNIDENTIFIED PEAKS BELOW
Total Petroleum Hydrocarbons = None Detected
Minimum Reporting Level = 0.70 ug/L

ENVIRONMENTAL
CHEMICAL ANALYSIS
PETROLEUM

BC LABORATORIES, INC.

J. J. EGLIN, REG. CHEM. ENGR.

4100 PIERCE RD., BAKERSFIELD, CALIFORNIA 93308 PHONE 327-4911

Groundwater Resource Industries

5400 Aldrin Ct
Bakersfield, CA 93313

PURGEABLE ORGANIC ANALYSIS
(Volatiles)

Date of Report: 11/30/89 Lab Sample ID No. 9204-8
Laboratory Name: B C Laboratories Signature Lab Director Dan Farah
Name of Sampler: Sampler Employed By:
Date/Time Sample Collected: 11/16/89 Date/Time Sample Received @ Lab: 11/20/89 Were Holding Times Observed? YES
Test Methods: EPA 602 Were all the Constituents listed below quantified? YES

==========

System Name: Project #55018 - Alameda County System #3239 Travel Blank 11/16/89 Number:
Description of Sampling Point:
Name/No. Of Sample Source: Station Number: |-|-|-|4|-|-|-|=|-|-|-|-|-|-|-|
Date & Time of Sample: |-|-|-|-|-|-|-|-|-|-| (Y Y M M D D T T T T) Water Type G/S |-| User ID: |-|-|-| Submitted to SWQIS By:

Place an "X" in box to delete all data for this station/date/time |-|

REPORTING UNITS	CONSTITUENT	TT	STORET CODE	ANALYSIS RESULTS	DETECTION LIMIT
	Date Analysis Completed	-		89 11 06 (Y Y M M D D)	- - - - - -
		-			
	Analyzing Agency Code (Lab)	-		- 5 8 0 6 -	- - - - - -
	Intensive Survey Number	-		- - - - - -	- - - - - -
ug/L	Benzene	-	34030	- - ND - -	- - 0.70
ug/L	Chlorobenzene	-	34301	- - ND - -	- - 0.70
ug/L	1,2-Dichlorobenzene	-	34536	- - ND - -	- - 0.70
ug/L	1,3-Dichlorobenzene	-	34566	- - ND - -	- - 0.70
ug/L	1,4-Dichlorobenzene	-	34571	- - ND - -	- - 0.70
ug/L	Ethyl Benzene	-	34371	- - ND - -	- - 0.70
ug/L	Toluene	-	34010	- - ND - -	- - 0.70
ug/L	Xylenes	-	81551	- - ND - -	- - 0.70

ND - None Detected
California D.O.H.S. Cert. #102

NOTE ANY UNIDENTIFIED PEAKS BELOW
Total Petroleum Hydrocarbons = None Detected
Minimum Reporting Level = 0.70 ug/L

SMC Laboratory

Analytical Chemistry

Client Name:Groundwater Resources, Inc.
Address :5400 Aldrin Court
Bakersfield California 93313

Date samples received :12-01-89
Date analysis completed:12-11-89
Date of report :12-11-89

Laboratory No.3294 through 3302

RESULTS OF ANALYSIS

#3294 ID:B-5	ugm/L	MDL,ugm/L
Benzene	ND	0.5
Toluene	ND	0.5
Ethylbenzene	ND	0.5
p-Xylene	ND	0.5
m-Xylene	ND	0.5
o-Xylene	ND	0.5
Isopropylbenzene	ND	0.5
TPH (Gasoline)	ND	50

#3295 ID:B-6	ugm/L	MDL,ugm/L
Benzene	ND	0.5
Toluene	ND	0.5
Ethylbenzene	ND	0.5
p-Xylene	ND	0.5
m-Xylene	ND	0.5
o-Xylene	ND	0.5
Isopropylbenzene	ND	0.5
TPH (Gasoline)	ND	50

Method of Analysis for BTX/TPH (Gasoline): 5030/8020
Method of Analysis for TPH (Diesel): 3510/8020 (FID)
MDL = Minimum Detection Level
TPH = Total Petroleum Hydrocarbons
ugm/L = micrograms per liter
ND = Not detected

Stan Comer
Stan Comer

3155 Pegasus Drive • Bakersfield, CA 93308 • (805) 393-3597
P.O. Box 80835 • Bakersfield, CA 93380 • FAX (805) 393-3623

Laboratory No.3294 through 3302

RESULTS OF ANALYSIS

#3296 ID:B-7	ugm/L	MDL,ugm/L
Benzene	ND	0.5
Toluene	ND	0.5
Ethylbenzene	ND	0.5
p-Xylene	ND	0.5
m-Xylene	ND	0.5
o-Xylene	ND	0.5
Isopropylbenzene	ND	0.5
TPH (Gasoline)	ND	50

#3297 ID:B-8	ugm/L	MDL,ugm/L
Benzene	890	0.5
Toluene	7.2	0.5
Ethylbenzene	380	0.5
p-Xylene	260	0.5
m-Xylene	ND	0.5
o-Xylene	ND	0.5
Isopropylbenzene	62	0.5
TPH (Gasoline)	11000	50

Method of Analysis for BTX/TPH (Gasoline): 5030/8020
Method of Analysis for TPH (Diesel): 3510/8020 (FID)
MDL = Minimum Detection Level
TPH = Total Petroleum Hydrocarbons
ugm/L = micrograms per liter
ND = Not detected

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Laboratory No.3294 through 3302

RESULTS OF ANALYSIS

#3298 ID:B-9	ugm/L	MDL,ugm/L
Benzene	12	0.5
Toluene	ND	0.5
Ethylbenzene	20	0.5
p-Xylene	ND	0.5
m-Xylene	ND	0.5
o-Xylene	ND	0.5
Isopropylbenzene	3.6	0.5
TPH (Gasoline)	160	50

#3299 ID:B-10	ugm/L	MDL,ugm/L
Benzene	ND	0.5
Toluene	ND	0.5
Ethylbenzene	ND	0.5
p-Xylene	ND	0.5
m-Xylene	ND	0.5
o-Xylene	ND	0.5
Isopropylbenzene	ND	0.5
TPH (Gasoline)	ND	50

Method of Analysis for BTX/TPH (Gasoline): 5030/8020
Method of Analysis for TPH (Diesel): 3510/8020 (FID)
MDL = Minimum Detection Level
TPH = Total Petroleum Hydrocarbons
ugm/L = micrograms per liter
ND = Not detected

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Laboratory No.3294 through 3302

RESULTS OF ANALYSIS

#3300 ID:B-11	ugm/L	MDL,ugm/L
Benzene	ND	0.5
Toluene	ND	0.5
Ethylbenzene	ND	0.5
p-Xylene	ND	0.5
m-Xylene	ND	0.5
o-Xylene	ND	0.5
Isopropylbenzene	ND	0.5
TPH (Gasoline)	ND	50

#3301 ID:MW-8	ugm/L	MDL,ugm/L
Benzene	ND	0.5
Toluene	ND	0.5
Ethylbenzene	ND	0.5
p-Xylene	ND	0.5
m-Xylene	ND	0.5
o-Xylene	ND	0.5
Isopropylbenzene	ND	0.5
TPH (Gasoline)	ND	50

#3302 ID:Travel Blank	ugm/L	MDL,ugm/L
Benzene	ND	0.5
Toluene	ND	0.5
Ethylbenzene	ND	0.5
p-Xylene	ND	0.5
m-Xylene	ND	0.5
o-Xylene	ND	0.5
Isopropylbenzene	ND	0.5
TPH (Gasoline)	ND	50

Method of Analysis for BTX/TPH (Gasoline): 5030/8020
Method of Analysis for TPH (Diesel): 3510/8020 (FID)
MDL = Minimum Detection Level
TPH = Total Petroleum Hydrocarbons
ugm/L = micrograms per liter
ND = Not detected

Stan Comer

Stan Comer

groundwater resources inc.

A T T A C H M E N T B

groundwater resources, inc.

5400 Aldrin Court
Bakersfield, California 93313
Telephone: (805) 835-7700
Tele-Fax: (805) 835-7717

CHAIN OF CUSTODY RECORD

LAB DESTINATION: ~~STL~~ BC

PROJECT NUMBER: 55018

P.O. NUMBER 3351

PROJECT CONTACT: TIM REED

COUNTY: ALAMEDA

SAMPLER(S): (Signature) Tim Read

LAB NUMBER	SAMPLE NUMBER	DATE	TIME	SAMPLE LOCATION	CONDITION ON RECEIPT	ANALYSIS REQUESTED	SAMPLE TYPE	CONTAINER TYPE
3226	MW-1	11-16-89	15:30			BTX&E - TPH (GASOLINE) ~~EPA 8020/8015 MOD~~	WATER	VOA
3227	MW-2	"	14:41					
3228	MW-3	"	14:54					
3229	MW-4	"	16:04					
3230	MW-5	"	15:29					
3231	MW-6	"	15:43					
3232	MW-7	"	15:22					
3239	TRAVEL BLANK							

SPECIAL INSTRUCTIONS: _____

POSSIBLE SAMPLE HAZARDS: _____

1. Relinquished by: Tim Read Date/Time: 11-17-89/5:48 Received by: Karla Henry Date/Time: 11/20/89 9:48 am
1. Relinquished by: Karla Henry Date/Time: 11/20/89 10:55 Received by: Tim Read Date/Time: 11-20-89/10:55
1. Relinquished by: Tim Read Date/Time: 11-20-89/11:18 Received by: Kyle East Date/Time: 11/20/89 11:34
1. Relinquished by: _____ Date/Time: _____ Received by: _____ Date/Time: _____

CCR (Rev. 10/89) WHITE: LABORATORY PINK: JOB FILE YELLOW: SAMPLE LOG

groundwater resources, inc.
5400 Alton Court
Bakersfield, California 93313
Telephone: (805) 835-7700
Tele-Fax: (805) 835-7717

CHAIN OF CUSTODY RECORD

LAB DESTINATION: SMC

PROJECT NUMBER: 55029

P.O. NUMBER 3403

PROJECT CONTACT: TIM RILEY

SAMPLER(S): (Signature) Tim Read

COUNTY: ALAMEDA

LAB NUMBER	SAMPLE NUMBER	DATE	TIME	SAMPLE LOCATION	CONDITION ON RECEIPT	ANALYSIS REQUESTED	SAMPLE TYPE	CONTAINER TYPE
3294	B-5	11-30-89	11:08			BTX&E TPH (GASOLINE)	WATER	VOA
3295	B-6	"	11:13			"	"	"
3296	B-7	"	11:17			"	"	"
3297	B-8	"	11:37			"	"	"
3298	B-9	"	11:28			"	"	"
3299	B-10	"	11:22			"	"	"
3300	B-11	"	11:33			"	"	"
3301	MW-8	12-1-89	8:36			"	"	"
3302	TRAVEL BLANK							

SPECIAL INSTRUCTIONS:

POSSIBLE SAMPLE HAZARDS:

1. Relinquished by: _____ Date/Time: _____ Received by: _____ Date/Time: _____
1. Relinquished by: _____ Date/Time: _____ Received by: _____ Date/Time: _____
1. Relinquished by: _____ Date/Time: _____ Received by: _____ Date/Time: _____
1. Relinquished by: Tim Read Date/Time: 12-1-89/14:15 Received by: Karla Henry Date/Time: 12/1/89 14:15

CCR (Rev. 10/89) WHITE: LABORATORY PINK: JOB FILE YELLOW: SAMPLE LOG

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ATTACHMENT C

groundwater resources inc.

SAMPLING PROTOCOL

groundwater resources inc.

TEST BORING PROCEDURES

I. Soil Sampling Protocol

The following procedures are following during soil sampling operations utilizing the hollow stem auger drilling technique.

A. Hollow Stem Auger

1. Soil borings drilled by the hollow stem auger utilize continuous flight hollow stem augers.

2. Augers, samplers and all downhole equipment are steam cleaned prior to use. In the field steam cleaning is done between borings to minimize the potential for cross-contamination.

3. A G.R.I. geologist observes the work, visually logs the soils, and collects samples at appropriate intervals.

4. The Unified Soils Classification System is utilized to classify soils encountered. Additional geological observations are noted as appropriate.

5. Soil samples destined for laboratory analysis are collected by a modified California Split Spoon. This sampler uses three, six inch long, by two and one-half inch diameter (o.d.) tubes.

Various tubes can be utilized to accommodate the type of analysis necessary:

Brass	-	All organics and general analyses (not to be used for copper or zinc analysis)
Stainless Steel	-	All organics and metals analyses for copper and zinc (not to be used for chrome or nickel analyses)
Plastic	-	All metals analyses (not to be used for organics)

groundwater resources inc.

TEST BORING PROCEDURES
(Cont'd)

6. The tubes are cleaned and prepared in the G.R.I. laboratory. Tubes are scrubbed, inside and outside, with a brush and TSP, rinsed, dryed, and packed in clean containers with seals. Tubes are delivered to the drilling site in these closed containers to preserve the state of cleanliness.

7. After the sample(s) have been removed from the sampler, the sampler is completely disassembled and scrubbed in TSP and tap water. It is then rinsed in clean tapwater and reassembled with three clean tubes.

8. Dirty tubes are field washed in TSP solution, rinsed with water, and reused.

9. The sampler is driven by a 140 pound hammer with a 30 inch free fall. Blow counts are recorded as number of blows per inch of drive.

10. The sampler is driven 18 inches at each sampling interval. The first (or lowest) tube is generally retained as the sample for analysis. The other two tubes are retained for back-up or split samples.

11. A sand catcher is used in the sampler where loose soils are anticipated. This will prevent the soil from falling out of the sampler.

12. After retrieval, the sample is visually logged and immediately sealed with aluminum foil lined caps, labeled, and chilled. Clean ice chests and chemical ice ("blue ice") are used to keep the samples cold until delivered to the chemical laboratory. Teflon seals are also available for field samples.

13. Samples are delivered to the laboratory the same day they are taken, if physically possible. If the samples must be held until the next day, they are kept frozen in a secure freezer at the G.R.I. facility.

14. Sample control is maintained by a Chain of Custody form which accompanies the sample. The form documents the time, date, and responsible person during each step in the transportation process.

groundwater resources inc.

MONITORING WELL SAMPLING PROTOCOL

II. Groundwater Sampling

A. All equipment that is used in a monitoring well for purging, sampling, or depth measurement is decontaminated by steam cleaning or a TSP wash and rinse procedure prior to use and before re-using when more than one sample is collected.

B. Purge Volume Determination

The following procedure is followed to determine the appropriate purging volume prior to well sampling.

1. The depth-to-water is measured by a clean, electric level indicator. Measurement datum is the top of well protector.

2. Depth to the bottom of the well is measured by a clean tape and plumb bob. If possible, this is compared to the well construction log to determine inconsistencies, i.e. damaged casing, sediment in casing, etc.

3. Water volume is calculated by using the total water depth and the inside diameter of the casing.

C. Well Purging and Sampling

1. Prior to sampling, a minimum of three to five well volumes are purged from each well to ensure that water sampled is representative of the groundwater within the formation.

2. Measurements of H, conductivity and temperature are taken at frequent intervals during the purge. Stabilization of these values indicates that representative formation fluids are being removed from the well.

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MONITORING WELL SAMPLING PROTOCOL
(Cont'd)

3. In the event that the well is pumped dry, and alternate procedure will be followed. Once a well is pumped dry, the water that enters the well during recovery is, by definition, representative formation water. The well will, therefore, be pumped dry and allowed to recover to 80% or more of the original water level.

4. Purge water is pumped directly into barrels on site until the proper method of disposal is determined.

5. Samples are pumped or poured from a bailer into sampling bottles prepared by a state certified laboratory contracted for the particular job and placed in refrigerated coolers for transport to the laboratory.

6. Samples are delivered by courier, directly to the lab on the same day of sampling, whenever practical. If next day delivery is necessary, the samples are kept refrigerated at 4 degrees C overnight and delivered to the laboratory the following morning.

7. Samples are accompanied by a Chain of Custody form which documents the time, date and responsible person during each step of the transportation process.

8. The G.R.I. coded sample numbering system allows identification of sample and client to G.R.I., while not revealing the client to anyone else.

groundwater resources inc.

ATTACHMENT D

THE WATER GROUP

ENVIRONMENTAL INSTRUMENTS
2170 Commerce Avenue Unit S
Concord, California 94520
800-648-9355

Profile Of The CAV-OX™ Process

And

The Watergroup, Inc.

Technology Today...Standard Tomorrow

Table of Contents

I. CAV-OX™ PROCESS
Technical Background Information

SUMMARY:

The Cav-Ox Process (COP) involves the synergistic combination of photo-chemistry, induced cavitation, and the production of hydroxyl free radical technologies to permit auto oxidation reactions to be initiated and continue even after the ultra-violet radiation stimulus has been removed. The oxidation follows a free radical mode until it proceeds to completion.

CHEMICAL TECHNOLOGICAL BACKGROUND:

The chemistry involved in the Cav-Ox Process is based on the formation of hydroxyl (OH*) free radicals. The hydroxyl free-radical, one of the simplest diatomic radicals, is a powerful oxidizing agent as well as an excellent chain reaction initiator. The standard oxidation electrode potential for the hydroxyl radical is 2.80 volts: that of ozone is 2.18 volts, while that of chlorine is 1.68 volts. The hydroxyl radical, therefore, more efficiently and rapidly oxidizes organics and microorganisms in water than either ozone or chlorine.

A hydroxyl radical initiates a chain reaction through many paths. One of the predominant routes is the abstraction of a labile hydrogen from an organic molecule. The attack of a glucose molecule by a hydroxyl radical is a typical example of these mechanics.

The chain reaction converting a glucose molecule into the end products of carbon dioxide and water begins when a hydroxyl radical abstracts a hydrogen from a glucose molecule. In the presence of air, the resultant glucose radical readily combines with an oxygen molecule to form a peroxy glucose radical, which in turn abstracts a hydrogen from another glucose molecule. A new glucose radical is generated and a hydrogen peroxide molecule is formed. The latter disassociates easily into an oxy-glucose radical and a hydroxyl radical is regenerated. In the presence of oxygen, the oxy-glucose formation of a smaller organic radical which continues to break down into oxalic acid and eventually to carbon dioxide and water.

In more complex molecules like phenols there are competing reactions between the attack on labile hydrogen and the addition to the double bond. One may expect to find minor amounts of catechol, hydroquinone, quinone, muconic acid, maleic acid and oxalic acid as the intermediates in the photo oxidation of phenol. These reactions are representative of some of the more difficult compounds to oxidize.

CAVITATION TECHNOLOGICAL BACKGROUND:

In combination with the chemistries involved and discussed in the Chemical Technological Background section, induced cavitation is employed in the Cav-Ox Process. A simple definition of cavitation is that point at which the vapor pressure of the liquid media is greater than the surrounding pressure.

Cavitation may be induced in many ways. A proprietary process for inducing cavitation is the subject of several patent applications filed by The Watergroup. Utilizing the synergistic effect of cavitation in combination with ultra-violet radiation beneficial oxidation has been achieved in a variety of water purification applications.

The Watergroup's staff hypothesize the process induces energized radical formation and initiating the oxidation process caused by using the enormous energies in the imploding bubbles, (on a micro scale) of 2000 deg. k temperature and 200,000 atmospheres of pressure. Hydroxyl free radicals are purported to be formed at the inner surface of the bubbles and the surrounding liquid. Organic molecules, microorganisms and other oxidizable materials migrate into the interface between the bubbles and the water and the oxidation process is initiated during the collapse of the bubbles.

Oxidation reactions initiated in this manner, through a hydroxyl free radical reaction, are chain reaction in nature.

In addition to the oxidation effects produced, during the cavitation in liquids, it has been shown to be a significant destructive force in the breakdown of biomass present in wastewater containing microogramisms possessing membranes. The membrane is cellular in nature and is made up primarily of protein material. When cavitation is applied, the outer protective shell along with the cell wall ruptures, resulting in cell disruption and initial oxidation, thus both killing the microorganism and oxidizing the endotoxins (remaining dead organic bodies).

Recent unpublished work performed at Baton Rouge on primary effluent from its central sewage treatment plant indicated a 99.4% reduction in BOD, and 100% reduction in bacteria. Publication of these results are awaiting approval of release from the Baton Rouge Public Works Department.

The parameter of these unpublished results are:

	Sewer Plant Effluent	COP Treated *
BOD'S	157	1
E. Coli Const/100 mb	30,000	0

* COP was operating using 150 ppm of hydrogen peroxide plus 2.0 ppm of catalyst and retention time in the UV reactor of less than 2 minutes.

Additional recent testing has been conducted at a microelectronics plant to demonstrate the reduction of Total Organic Carbon (TOC) in the high purity water used to rinse semiconductor chips. The incoming water to the COP system was measured at 18 megohm purity with approximately 50 ppb (parts per billion) TOC contaminants. The effluent from the process reduced the TOC to less than 0.5 ppb.

The COP equipment used in high purity applications requires no addition of chemicals, atmospheric air, or oxygen. Oxidation is accomplished by COP by a combination of cavitation and ultra-violet oxidation through the free radical mechanism.

In summary the CAV-OX Process is an effective system for reducing contmainants and producing water free of residual toxic chemicals.

II. SUPERIOR PERFORMANCE OF RESULTS USING CAV-OX™ ADVANCED OXIDATION SYSTEMS FOR ELIMINATION OF WATER CONTAMINATION

The attached list shows the Superior performance of CAV-OX™ Advanced Oxidation Systems. The systems incorporate the proprietary CAV-OX™ process developed by The Watergroup, Inc. over the past seven years. This process is based on a synergistic combination of cavitation, ultra-violet radiation and when required, hydrogen peroxide catalyst. As shown on the attached list, this advanced technology enables CAV-OX™ systems to oxidize organic contaminants and microorganisms, as well as some inorganics such as cyanide much more efficiently than previously feasible.

The contaminant reductions shown are typical examples of CAV-OX™ system performance. The reductions were achieved on a flow-through basis with a reaction time of less than two minutes. The outstanding efficiency of Cav-Ox™ systems in oxidizing contaminants results in a very low cost of operation. Exclusive of hydrogen peroxide catalyst, operating costs range from $0.10 to $0.20 per one thousand gallons of water processed. When hydrogen peroxide catalyst is required it generally ranges between a concentration of less than 10 and 150 parts per million, depending on the nature and concentration of the contaminant.

CAV-OX™ ADVANCED OXIDATION SYSTEMS

PERFORMANCE DATA

Name of The Contaminant	Inlet Concentration	Outlet Concentration	Percent Reduction	H2O2 ppm	CAT ppm
INDUSTRIAL WASTEWATER					
Bromoform	10 ppm	ND	100%	50	0
,1-Dichlorethylene	104 ppb	24.2 ppb	76.9%	50	1
,1-Dichlorethane	48.8 ppb	1.8 ppb	96.3%	50	1
)-Chlorophenol	100 ppb	ND	100%	100	0
CN-	7.6 ppm	ND	100%	0	5
Phenol	1400 ppm	150 ppm	89.3%		
DRINKING WATER CONTAMINANTS					
CE	6.7 ppb	ND	100%	10	0
CE	54.5 ppb	ND	100%	10	0
ibromo Chloropentane	0.33 ppb	0.09 ppb	73%	0	0
acteria	39,000 ppm	10 ppm	99.99%	150	2
olor	55 ppm	< 10	> 80%	50	1
. Coliform	5,000,000mpn	< 2 mpn	99.99%	0	0
GROUNDWATER CONTAMINANATS					
asoline	20	ND	100%	0	0
enzene	280 ppm	20 ppm	92.8%	0	0
enzene	280 ppm	ND	100%	50	0
SO-PAR	134	ND	100%	<100	0
HIGH PURITY WATER CONTAMINANTS					
olystryenesulfonic acid	14 ppb **	ND	100%	0	0
OC	50 ppb	ND	100%	0	0

* ppb measured as sulfate

III. MAXIMUM INITIAL CONCENTRATION OF TYPICAL CONTAMINANTS FOR REDUCTION ELIMINATION USING CAV-OX™ PROCESS

Contaminant	ppm	Contaminant	ppm
Acetone	2600	Methyl Acetate	4200
Aniline	2200	Methyl Ethyl Ketone	2600
Benzene	700	Methyl Formate	5900
Butenediol	300	Propionic Acid	4200
Dimethylformamide	2700	Pyridine	2300
Ethanol	280	Tetrahydrofuran	2600
Ethyl Acetate	3500	3-Hexynol	2500
Ethyl Butenol	2200	Toluene	500
Heptane	50	Acetic Acide	5500
Hexane	140	Cyclohexane	1800
Isobutyraldehyde	2600	Ethyl Benzene	100
Isopropanol	2700	Methyl Isobutyl Keytone	2300
Methanol	3800		
Propionic Anydride	3630		

IV. PARTIAL CUSTOMER LIST

* Southern California Edison
* Monarch Mirror Door
* International Technology Corporation
* BFI - Azusa Land Reclamation
* Bio Lab, Inc.
* City of San Bernardino
* Petrolite
* R. Breault (private drinking water well)
* Rohm & Hass
* Advanced Micro Devices
* Motorola
* Gulf Coast Coca Cola Bottling Co.
* Orange County Water District
* American Environmental Management
* Dupont

V. KEY PERSONNEL

Joseph A. Pisani: President and Chief Executive officer is the founder of The Watergroup, Inc. and has more than twenty years of experience developing, manufacturing and marketing water treatment, water pollution and water purification systems. Prior to founding The Watergroup, Mr. Pisani was the Chief Executive Officer of Wynhausen Corporation, a $7,000,000.00 company engaged in Water Treatment Systems.

While with Envirogenics Systems Company, prior to his assignment at Wynhausen Corporation, he was in charge of all reverse osmosis and membrane technology programs, including a plant to convert brackish water to drinking water in the Bahamas.

Mr. Pisani earned his B.S. in Physical Chemistry at St. Francis College and M.S. in Physical Chemistry at Brooklyn College. Mr. Pisani has taken extensive courses in Management at American Management Association.

Charles W. Gossett: Charles W. Gossett is the Vice-President of the company in charge of operations. Mr. Gossett has extensive experience in the manufacture and marketing of water purification systems . He was the Founder and General Manager of Hydrolon Company, located in Compton, California, which was engaged in the manufacture and marketing of water purification systems for industrial, commercial, electronics, and medical applications. From 1984 to

1986, Mr. Gossett was the President of Vanguard Wind Systems, Inc., a company which was the American Agent and marketing arm for a European joint venture manufacturer of power generating systems for utility cogeneration projects. From 1980 to 1983, he was the President of Wecs-Tech Corporation, a company which manufactured wind turbine powered generating systems for utility cogeneration projects. Mr. Gossett attended the University of Oklahoma.

Daniel R. Crooks: Joined the company as Vice-President of Marketing in March 1988. Prior to that, from June 1984 he was the President and Chief Executive Officer of Datatron, Inc., a publicly held, electronic product manufacturing company. From March 1982, he was the President of Waybern Corporation, a distributor of microcomputer products. From April 1976, he was a Division Manager for Anthony Industries with responsibility for the nationwide retail marketing of water oriented products. His educational background includes a B.S. degree from West Point and an M.B.A. from Stanford University.

VI. BENCH TEST RESULTS

Mixed Glycols

Contaminant	Input Concentration	Contact Time	H2O2 Catalyst	Output Concentration	Percent Reduction
Propylene Glycol	1.30%	40 sec.	50 ppm	.52%	60%
Neopentyl Glycol	.89%	40 sec.	50 ppm	.52%	57%

Based on the information you have provided on volume and flow rate, and pending an on-site evaluation of your requirement, it appears that our CAV-OX™ Model IW-35 system would meet your needs. This system has a maximum capacity of 35 gallons per minute and a total power requirement of 14.9 amps. It is skid mounted with outside dimensions of approximately 5' x 4' x 6'.

Cost of operation to meet discharge standards will be under $0.20 per 1,000 gallons.

THE WATERGROUP, INC.
CAV-OX PILOT PROJECT TEST RESULTS
VII. Newmark Reservoir-San Bernardino, California
7/22/88 through 9/1/88

TCE (ppb)			PCE (ppb)			Catalyst (ppm)		Flow
In	Out	Reduction %	In	Out	Reduction %	H2O2	CAT	Rate(gpm)
6.4	<0.5	100%	40.8	1.9	95%	100	3	0.50
2.1	<0.5	100%	54.5	0.5	99%	100	3	1.00
2.8	0.7	75%	63.0	14.0	78%	100	3	4.75
7.9	N.D.	100%	34.7	0.8	98%	50	3	0.75
2.6	0.6	77%	59.7	12.5.	79%	50	3	4.75
5.4	<0.5	100%	43.0	<0.5	99%	25	3	0.50
7.1	N.D.	100%	29.0	<0.5	98%	25	3	0.75
5.6	N.D.	100%	35.6	2.9	92%	25	3	1.00
2.5	1.0	60%	61.9	15.0	76%	25	3	4.75
5.7	N.D.	100%	44.5	<0.5	99%	10	3	0.75

TEST PERFORMED BY GROUNDWATER TECHNOLOGY, INC.

USING CAV-OX^{tm} SYSTEM AT WATERGROUP, INC.

TETRACHLOROETHANE (PCE)

CONCENTRATION, ppb Influent	Effluent	H_2O_2 DOSAGE, ppm	RETENTION TIME, min	% REDUCTIONS
63	2	20	5.4	96.83
64	2	20	5.4	96.87
64	1	50	10.8	98.44
74	1	50	10.8	98.65
64	2	50	5.4	96.83
74	2	50	5.4	97.29
93	<0.5*	20	2.7	99.46 (100)
110	<0.5*	20	2.7	99.55 (100)

*Limit of detection 0.5 ppb

TRICHLOROETHYLENE (TCE)

CONCENTRATION, ppb Influent	Effluent	H_2O_2 DOSAGE, ppm	RETENTION TIME, min	% REDUCTIONS
280	1	20	5.4	99.64
130	2	20	5.4	98.46
150	1	50	5.4	99.33
120	1	50	5.4	99.17
75	2	20	2.7	97.33

Analysis performed at Groundwater Technology, Inc., Torrance Laboratories.

Limited quantity of samplewater (5 gallon only) in each run leads to discrepancy of results.

SONY SUMMARY

CAV-OX SYSTEM PARAMETERS:

-3 lamp reactor.

-6.25 gallon sample (5:1 dilution factor)

-No H2O2

-Flow rate is 1.2 gpm

-Retention time is 2.25 minutes

-Straight through run

Samples 12168811 Before CAV-OX
12168812 After CAV-OX

Sent for analyses to:
McLaren Environmental
Rancho Cordova, CA

RESULTS & COMMENTS:

The Sony sample contained 34 organic compounds and all were successfully reduced except one, 2 butanone. This was probably the result of other long chain compounds breaking down to form smaller chains of 2 butanone, consequently, creation of 2 butanone was detected.

All compounds were significantly reduced by 79-81% with the exceptions of methyl chloride and cyclohexane. These were moderately reduced by 52% and 66%, respectively. Further tests using a catalyst with these compounds will be considered upon request. The compound acetone was substantially reduced by 87%.

30 compounds significantly reduced by 79-81%.
1 compound exceptionally reduced by 87%
2 compounds moderately reduced by 52% and 66%
1 compound generated (2 butanone)

CAV-OX REDUCTION OF ORGANICS

Flow Rate: 1.2 gpm (5:1 dilution of Sony sample)

CHEMICAL	IN (ppb)	OUT (ppb)	REDUCTION (%)
Chloromethane	25,000	5,000	80
Bromomethane	25,000	5,000	80
Vinyl Chloride	25,000	5,000	80
Chloroethane	25,000	5,000	80
Methylene Chloride	25,000	12,000	52
Acetone	160,000	21,000	87
Carbon Disulfide	12,000	2,500	79
1,1 Dichloroethene	12,000	2,500	79
1,1 Dichloroethane	12,000	2,500	79
Cis-trans 1,2 Dichloroethene	12,000	2,500	79
Chloroform	12,000	2,500	79
1,2 Dichloroethane	12,000	2,500	79
2 Butanone	21,000	31,000	Formation
1,1,1 Trichloroethane	12,000	2,500	79
Carbon Tetrachloride	12,000	2,500	79
Bromodichloromethane	12,000	2,500	79
1,2 Dichloropropane	12,000	2,500	79
Trans 1,3 Dichloropropene	12,000	2,500	79
Trichloroethene	12,000	2,500	79
Benzene	12,000	2,500	79
1,1,2 Trichloroethane	12,000	2,500	79

INTER-OFFICE MEMORANDUM

DATE: November 17, 1988

TO: Marty Rigby

FROM: Organic Lab

SUBJECT: RESULTS OF DBCP TEST -FROM THE WATERGROUP

The Watergroup Inc. of Irwindale, California sampled an agriculture well,(Mascart Well), from Redlands, California on November 7, 1988. The raw well water was processed on November 9, 1988 and was received at the OCWD's Organic Lab on November 10, 1988. The samples were microextracted on November 13, 1988 and analyzed for 1,2-Dibromo-3-Chloropropane(DBCP) using EPA Method 504. Samples were run on a Varian 3500 Capillary Gas Chromatograph, equipped with an electron capture detector. The analysis was completed on November 15, 1988 and the results are as follows:

NAME	RESULTS IN ug/l	DUPLICATE	% REJECTION
Laboratory Blank	ND	ND	-
Travel Blank	ND	ND	-
Site Blank	ND	ND	-
0.25 GPM 1109881A	0.09	0.09	72.7
1.00 GPM 1109882A	0.24	0.24	27.3
5.00 GPM 1109883A	0.30	0.30	9.1
Raw Well Water (Mascart Well)	0.33*	0.34	-

If you have any questions please contact the lab

ND - Not detected

Reportable Detection Limit for Method was 0.01 ug/l

* Used in % Rejection Calculation % Rejection = $\frac{\text{FEED} - \text{PRODUCT}}{\text{FEED}} \times 100$

THE WATER GROUP

ENVIRONMENTAL INSTRUMENTS
2170 Commerce Avenue Unit S
Concord, California 94520
800-648-9355

A CROSS-SECTION OF

CAV-OX WATER PURIFICATION RESULTS

WITHOUT CHEMICAL ADDITIONS

Technology Today...Standard Tomorrow

CAV-OX REDUCTION OF ORGANIC CONTAMINANT WITHOUT CATALYSTS & HYDROGEN PEROXIDE

Water samples containing several types of organic compounds of various concentrations have been successfully reduced by The Watergroup, Inc.'s CAV-OX System. Ranges of contaminant reduction are mostly 80 - 100% on a straight through (no recycle) basis without the aid of catalysts or hydrogen peroxide. While some compounds treated only yielded 25 - 50% reduction, these were the most difficult compounds to breakdown. However, the conventional methods currently employed cannot produce results as high as 25% reduction without recycle or extremely long retention times. The retention times for the data compiled range from 0.5 to 10.8 minutes without recycling.

Table 1, Gasoline Removal From Groundwater, shows reductions of hydrocarbons at different retention times. All runs were performed without the aid of catalysts, hydrogen peroxide and run on the IWT-5 System.

The treatment of 31 (if you want to omit butanone, methyl chloride & cyclohexane) organic compounds is outlined in Table 2. These samples were also run on the IWT-5 System also without catalysts and hydrogen peroxide.

BOD Reductions range from 36 -. 46%. The samples were taken from a soft drink bottling plant and treated with the IWT-10

System. The BOD reduction in Table 3 is the only application where some hydrogen peroxide is required due to the nature of the contaminants:

SUMMARY OF TYPICAL DATA

USING CAV-OX FOR BOD REDUCTION

INFLUENT BOD	EFFLUENT BOD	RETENTION TIME
4100	9.8	6.3 min
13000	7300	2.3 min
7800	350	3.5 min
260	0	3.5 min

Estimated cost of operation is: $1.25/1,000 gallons

Coliform analyses show reductions by 5 magnitudes as shown here in TABLE 4:

BEFORE TREATMENT INNOCULATION CON. MPN/100 ml	AFTER TREATMENT MPN/100 ml CONC.
1,300,000	2
8,000,000	<2
2,300,000	<2

TOC Reductions are shown here in **Table 5:**

INFLUENT CON. (ppm)	EFFLUENT CON. FROM CAV-OX (ppm)	% REDUCTION
980	250	74
1,600	260	84

TABLE 1

GASOLINE REMOVAL FROM GROUNDWATER

CAV-OX SYSTEM

RETENTION TIME (min)	INFLUENT* (ppm)	EFFLUENT* (ppm)	REDUCTION* (%)
1.8	13.6	1.1	91.9
1.8	12.0	0.5	96
0.68	17.5	1.5	91.4
5.4	14.4	1.2	91.6
5.4	14.3	0.2	98.6
1.08	12.5	1.3	89.6
10.8	17.0	0.5	97
.054	20.0	3.0	85

* Averaged data points

TABLE 2

CAV-OX REDUCTION OF ORGANICS

Flow Rate: 1.2 gpm (5:1 dilution of Sony sample)

CHEMICAL	IN (ppb)	OUT (ppb)	REDUCTION (%)
Chloromethane	25,000	5,000	80
Bromomethane	25,000	5,000	80
Vinyl Chloride	25,000	5,000	80
Chloroethane	25,000	5,000	80
Methylene Chloride	25,000	12,000	52
Acetone	160,000	21,000	87
Carbon Disulfide	12,000	2,500	79
1,1 Dichloroethene	12,000	2,500	79
1,1 Dichloroethane	12,000	2,500	79
Cis-trans 1,2 Dichloro-ethene	12,000	2,500	79
Chloroform	12,000	2,500	79
1,2 Dichloroethane	12,000	2,500	79
2 Butanone	21,000	31,000	Formation
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Carbon Tetrachloride	12,000	2,500	79
Bromodichloromethane	12,000	2,500	79
1,2 Dichloropropane	12,000	2,500	79
Trans 1,3 Dichloropropene	12,000	2,500	79
Trichloroethene	12,000	2,500	79
Benzene	12,000	2,500	79
1,1,2 Trichloroethane	12,000	2,500	79