**ENVIRONMENTAL
RESTORATION
PROGRAM****Sampling Results, DNAPL
Monitoring Well GW-726,
Oak Ridge Y-12 Plant,
Oak Ridge, Tennessee,
Second and Third Quarter,
FY 1994****DISCLAIMER**

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Energy Systems Environmental Restoration Program

**Sampling Results, DNAPL
Monitoring Well GW-726,
Oak Ridge Y-12 Plant,
Oak Ridge, Tennessee,
Second and Third Quarter,
FY 1994**

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Dear Associates:

Transmittal of Sampling Results, DNAPL Monitoring Well GW-726, Oak Ridge Y-12 Plant, Oak Ridge, Tennessee, Second and Third Quarter FY 1994 (Y/ER-201)

Enclosed you will find a copy of the above document. This report has been developed by the Environmental Restoration Program for your information and use. The purpose of the document is to provide initial groundwater sampling results from multiport wells constructed around the Oak Ridge Y-12 Burial Grounds. These wells were constructed in response to discovery of free phase DNAPL at the Burial Grounds. Results in this report provide contaminate monitoring information and, where appropriate, information for groundwater reference concentrations.

If you have any questions or comments regarding this document please contact RaNaye Dreier at (423) 574-7422.

Sincerely,

J. A. Hodgins
Project Manager

cc w/encl:

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PREFACE

This document, *Sampling Results, DNAPL Monitoring Well GW-726, Second and Third Quarter FY 1994, was performed under Work Breakdown Structure 1.4.12.1.1.02 (Activity Data Sheet 2312, "Bear Creek Valley")*. This document provides the Environmental Restoration Program (ER) with groundwater concentrations for nonradionuclides in the vicinity of the Oak Ridge Y-12 Plant Burial Grounds. This data can be used to determine reference concentrations for intermediate and deep groundwater systems.

CONTENTS

	<u>Page</u>
PREFACE.....	iii
FIGURES.....	vi
TABLES.....	vii
ACKNOWLEDGEMENTS.....	viii
EXECUTIVE SUMMARY	ix
LIST OF ACRONYMS AND ABBREVIATIONS.....	x
1.0 INTRODUCTION	1
1.1 BACKGROUND AND PURPOSE.....	1
1.2 BOREHOLE INFORMATION	3
1.3 MULTIPOINT WELL DESCRIPTION.....	3
1.4 GW-726 SAMPLING ZONES.....	5
2.0 PURGING AND SAMPLING ACTIVITIES	10
2.1 PURGING.....	10
2.2 SAMPLING.....	12
3.0 ANALYTICAL RESULTS	16
3.1 VOLATILE ORGANIC COMPOUNDS	16
3.2 TRACE METALS	18
3.3 MAJOR ELEMENT WATER CHEMISTRY	21
4.0 FUTURE WORK.....	23
REFERENCES.....	24
APPENDIX A. TRIP BLANK VOC ANALYTICAL RESULTS	25
APPENDIX B. LABORATORY BLANK VOC ANALYTICAL RESULTS.....	27
APPENDIX C. VOC ANALYTICAL RESULTS	29
APPENDIX D. TRACE METAL ANALYTICAL RESULTS	36
APPENDIX E. MAJOR ANIONS AND CATIONS AND FIELD PARAMETERS.....	38
APPENDIX F. CHARGE BALANCE CALCULATIONS.....	40

FIGURES

<u>Figure</u>		<u>Page</u>
1	Y-12 Burial Grounds location map.....	2
2	Generalized multiport well design.....	4
3	Multiport sampling zones for GW-726	9
4	GW-726 "J " qualifiers of VOCs known to be present in groundwater	19
5	Plot of strontium vs. calcium concentrations from GW-726.....	20
6	Piper Diagram of GW-726 Water Chemistry.....	22

TABLES

<u>Table</u>		<u>Page</u>
1	GW-726 construction and well design information.....	6
2	Sampling zones for GW-726.....	7
3	GW-726 purge history	11
4	Sampling and analysis plan.....	14
5	GW-726 sampling history.....	15
6	GW-726 "J" Qualifiers of VOC analytical results.....	17

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EXECUTIVE SUMMARY

In January 1990, dense, non aqueous phase liquids (DNAPLs) were discovered at a depth of approximately 274 ft. below ground surface along the southern border of the Y-12 Plant Burial Grounds. Immediately after the discovery, an investigation was conducted to assess the occurrence of DNAPL at the site and to make recommendations for further action. Results of the preliminary DNAPL investigation are presented in detail in Haase and King (1990a), and a work plan for assessment and characterization of the DNAPL is presented in Haase and King (1990b). A major task in the work plan calls for the construction and installation of five multiport wells. This report summarizes purging and sampling activities for one of these multiport wells, GW-726, and presents analytical results for GW-726.

To date, each of the eight sampling zones in GW-726 has been sampled for VOCs, metals and anions. Zones 2 and 6 will be resampled because of charge balance concerns (zone 2) and purging concerns (zone 6). Based on the presence of very low levels of TCE and PCE in the deeper portion of the well, it is recommended that VOC monitoring of GW-726 be continued, and that the modified sample bottles be used. Additional data is required in order to statistically confirm the presence or absence of VOCs through the use of "J" qualifiers. Any additional sampling will be conducted without further purging (except for zones 2 and 6), unless there is corroborative evidence that the water sample is not representative of the formation. There is a concern that excessive or unnecessary purging of units with low storativity, such as those in GW-726, will mobilize and extend the contaminant plume.

Ongoing and future tasks are directed toward collecting data that will provide information about: (1) the presence or absence of DNAPL or dissolved phase DNAPL and (2) the nature of the groundwater system so that the potential mobility of the dissolved phase plume can be evaluated. With this information we will be prepared to address concerns about the current extent of the contamination, the potential for continued spread of the contamination, and the need, if any, for implementing a remediation strategy.

LIST OF ACRONYMS AND ABBREVIATIONS

cps	counts per second
DNAPL	Dense Non Aqueous Phase Liquid
GC/MS	Gas Chromatography / Mass Spectroscopy
ICP	Inductively Coupled Plasma (spectroscopy)
IC	Ion Chromatography
MCL	Maximum Contaminant level
mg/L	milligrams per liter
MP	Multiport
ND	Not Detected
OD	Outer Diameter
psi	pounds per square inch
PCE	Tetrachloroethene
TCE	Trichloroethene
TD	Total Depth
TDS	Total Dissolved Solids
VOC	Volatile Organic Compounds
µg/L	micrograms per liter

1.0 INTRODUCTION

1.1 BACKGROUND AND PURPOSE

In January 1990, dense, non aqueous phase liquids (DNAPLs) were discovered at a depth of approximately 274 ft. below ground surface along the southern border of the Y-12 Plant Burial Grounds. Immediately after the discovery, an investigation was conducted to assess the occurrence of DNAPL at the site and to make recommendations for further action. To date, free-phase DNAPL contamination has been encountered in GW-625 (the discovery well), and is suspected to occur in GW-628 and GW-629 (Fig. 1) (Haase and King, 1990a). In addition, groundwater from GW-117 (Fig. 1) shows levels of volatile organic compounds suggestive of a dissolved contaminant plume. Results of the preliminary DNAPL investigation are presented in detail in Haase and King (1990a), and a work plan for assessment and characterization of the DNAPL is presented in Haase and King (1990b). A major task in the work plan calls for the construction and installation of five multiport wells. These wells (GW-726, GW-727, GW-729, GW-730, GW-730 and GW-790) were constructed and instrumented with multiport components from August, 1991 to April, 1993 (Dreier and Caldanaro, 1994). Subsequently, purging and sampling activities were started in each well. This report summarizes purging and sampling activities for GW-726 and presents analytical results for GW-726.

The purpose of the multiport wells is two-fold and addresses specific recommendations made by an independent consultant and previous work (Keuper 1990; Haase and King 1990b):

- 1) Define the deep and intermediate groundwater flow system within the Bear Creek Burial Ground and contiguous areas. Place special emphasis on defining and characterizing major conductive zones through which most of the groundwater flow may be occurring or through which DNAPL migration may have occurred.
- 2) Track the dissolved plume from outside inward. With an understanding of the groundwater flow system, determine a nondetect envelope within which all DNAPL and dissolved DNAPL contamination exists. As such, the wells are intended to serve as an early warning system for dissolved plume migration.

Fig. 1. Y-12 Burial Grounds location map. Dark circles are wells with known DNAPL accumulation or are wells that intercept secondary groundwater contaminant plumes. Black squares are the five multiport DNAPL investigation wells. Estimated locations of geologic contacts are shown.

If future technological development provides a feasible method to remove DNAPLs, then data from the multiport wells will provide general knowledge of the DNAPL location. Additionally, the information developed will be necessary to evaluate the effectiveness of the remediation technology (Haase and King, 1990b).

1.2 BOREHOLE INFORMATION

The locations of the five multiport wells (GW-726, GW-727, GW-790, GW-729 and GW-730) are shown in Fig. 1. The rationale for well placement is given in Haase and King (1990b) and Dreier and Caldanaro (1994). Well GW-726 is located along strike from the well farthest downdip from the disposal site that intercepts a DNAPL-related secondary contaminant plume (well GW-117). Construction logs for GW-726 are presented in Science Applications International Corporation report, 1993a, and the reader is referred to this report for a detailed construction history of the well. Condensed well construction information is presented in Table 1.

1.3 MULTIPORT WELL DESCRIPTION

The DNAPL investigation multiport wells use components designed by Westbay Instruments Inc. This system isolates zones of interest from each other by a series of packers fitted about a 1.5 in. diameter PVC (MP) casing (Fig. 2) that acts as an inner standpipe. Within specified sampling zones, fluid pressure data and water samples are collected using specialized probes that are lowered down the inner standpipe to the zones of interest. The probes access the zone through a measurement port coupling in the MP casing. Each sampling zone also contain a pumping port, which is used exclusively for purging. Because the packers isolate each sampling zone from the atmosphere, it is not necessary to purge before each sampling event. Purging is only needed to remove fluids that may have been introduced into the zone during drilling and installation operations.

The sampling zones are isolated from each other by one to two additional zones, called QA zones, containing measurement ports, from which only fluid pressure data are collected (Fig. 2). The zones provide added assurance that the sampling zones are isolated from each other. Although, it is possible to obtain water samples from these zones, the zones do not contain pumping ports and it is not possible to purge these intervals. Thus these zones have limited value for characterizing water chemistry.

Figure 2. Generalized multiport well design.

1.4 GW-726 SAMPLING ZONES

The multiport completion design for GW-726 is shown in Table 1. On the basis of core samples, geophysical logs and flowmeter results, 8 sampling zones, 10-to-15 ft. long, were selected from GW-726. The reader is referred to Dreier and Caldanaro (1994) for a more detailed description of the technical rationale and component design for each of the DNAPL investigation wells. Table 8 from Dreier and Caldanaro (1994) specifically lists criteria for choosing sampling zones is repeated here as Table 2 for clarification. The installation history for GW-726 is documented in Westbay Instruments Inc. (1993).

The zones were chosen to sample at least one of the following features, in order of priority. (1) fluids from potential zones of DNAPL migration, (2) fluids from hydraulically conductive fractures or fracture zones, (3) potential changes in fluid chemistry with depth, (4) fluids that show water chemistry signatures associated with a particular rock type, (5) fluids that may show water chemistry correlations between wells, and (6) matrix fluids with long residence times. In general, criteria 3, 4 and 5 can be achieved by having a relatively regular vertical distribution of sampling zones. The spacing between most zones is less than 100 ft, and spacing less than 80 ft is common in potential DNAPL regions.

The stratigraphic positions of the eight sampling zones in GW-726 are shown in Fig. 3. A zone of potential DNAPL migration, shown as a broad shaded portion, (Dreier and Caldanaro, 1994) was identified before the well was instrumented with Westbay components and is based on stratigraphic correlation with GW-625, GW-628, GW-629 and GW-117. This zone is the oolitic-rich limestone interval that defines the base of the middle Nolichucky Shale (Hatcher et.al, 1992) and is sampled by zone 9. In addition, three more zones were installed in the underlying strata in order to investigate the potential for migration of DNAPL into the lower Nolichucky Shale.

Table 1. GW-726 construction and well design information.

BOREHOLE CONSTRUCTION					
Surface Casing (ft bgs)		39.9			
Total Depth (ft bgs)		600.4			
SURVEY COORDINATES					
Grid System		Y-12			
Northing		29200.66			
Easting		42467.12			
ELEVATIONS (ft amsl)					
Ground surface		922.77			
Top of concrete pad		923.37			
Top of steel casing		925.69			
Top of MP casing		925.39			
MULTIPOINT DESIGN					
COMPLETION ZONE		MEASUREMENT PORT			PUMPING PORT
Zone Number	Interval depth bgs (ft)	Port depth bgs (ft)	True Port depth from TOMP (ft)	Elevation (amsl) (ft)	Port depth bgs (ft)
1	591-596	591	593.39	332.00	
2	576-586	581	583.40	341.99	586
3	556-571	561	563.43	361.96	
4	541-551	546	548.44	376.95	551
5	521-536	526	528.47	396.92	
6	501-516	511	513.47	411.92	516
7	476-496	486	488.53	436.86	
8	451-471	461	463.58	461.81	
9	436-446	441	443.60	481.79	446
10	411-431	421	423.61	501.78	
11	386-406	396	398.63	526.76	
12	366-381	376	378.63	546.76	381
13	346-361	356	358.63	566.76	
14	321-341	331	333.64	591.75	
15	301-316	306	308.63	616.76	
16	281-296	291	293.60	631.79	296
17	256-276	266	268.58	656.81	
18	231-251	241	243.55	681.84	
19	210-226	215	218.51	706.88	
20	195-205	200	203.46	721.93	205
21	170-190	180	183.42	741.98	
22	140-165	155	158.37	767.02	
23	125-135	130	133.30	792.09	135
24	100-120	110	113.25	812.14	
25	75-95	85	88.19	837.20	
26	50-70	60	63.14	862.25	
27	0-45	40	43.08	882.31	
NOTE: all depths except for "true depth" are measured along the borehole with no correction for borehole deviation.					
NOTE: samples are only collected from those zones with both measurement and pumping ports.					
* MP = Westbay Multiport Casing, ags = above ground surface.					
* bgs = below ground surface, amsl = above mean sea level.					
* TOMP = Top of MP casing					

Table 2. Sampling zones for GW-726

Multiport zone ^a	Depth (ft.) ^{b,c}	Samp. port depth (ft.) ^{b,c}	Purpose	Logs/Core
23	125-135 (125-135)	130 (130)	Sample fracture at top of uncased portion of borehole.	core: broken shale 127.3-127.6'. logs: fluid resistivity 126-130', flowmeter inflection 130', temperature 130' & 135'. stratigraphy: middle Nolichucky Shale
20	195-205 (195-205)	200 (200)	Sample fracture	core: fracture (no crystals) 201.9'. logs: fluid resistivity 200-204', flowmeter inflection 195', temperatures 195' & 203'. stratigraphy: middle Nolichucky Shale
16	281-296 (280-295)	291 (290)	Sample major fracture at well-scale change in flowmeter and fluid resistivity response. Possibly reflects general fracture density character.	core: fractures with crystals 284', fault 286.1-286.7', fracture 289.9', 291.6'. logs: flowmeter 280-295', fluid resistivity 284-288'. stratigraphy: middle Nolichucky Shale
12	366-381 (370-380)	376 (375)	Vertical distribution. Possible fracture.	core: fracture 366.1'; some crystals on fracture face. logs: temperature 376'. stratigraphy: middle Nolichucky Shale
9	436-446 (435-445)	441 (440)	Sample potential zone of DNAPL migration in oolitic strata at base of middle Nolichucky.	core: -- logs: -- stratigraphy: base of middle Nolichucky Shale
6	501-516 (500-515)	511 (505)	Sample major fracture below suspect DNAPL horizon.	core: fracture 501', 502.7', 509.5'; open, crystals logs: flowmeter 495-510', fluid resistivity 502-505' & 508-512', temperature 505' & 510', SP change at base 510-515'. stratigraphy: lower Nolichucky Shale

Table 2. (cont.)

Multiport zone ^a	Depth (ft.) ^{b,c}	Samp. port depth (ft.) ^{b,c}	Purpose	Logs/Core
4	541-551 (540-550)	546 (545)	Sample possible fracture below suspect DNAPL horizon.	core: fracture 542', crystals. logs: large SP changes, peak at 545', sonic. stratigraphy: lower Nolichucky Shale
2	576-586 (580-590)	582 (585)	Sample well bottom (TD=600').	core: fracture 589.3', small crystals. logs: SP change 585'. stratigraphy: lower Nolichucky Shale

^aMultiport zone number.

^bDepth measured from ground surface, not corrected for borehole deviation

^cParentheses denote planned depth. Other number is correct downhole depth.

Figure 3. Multiport sampling zones for GW-726. The region marked Potential DNAPL was identified by stratigraphic considerations. It does not imply that VOC's will occur at this interval, rather that IF VOC's are identified, we expect to see them in this zone. See text for further discussion.

2.0 PURGING AND SAMPLING ACTIVITIES

2.1 PURGING

Initial purging of the sample zones in GW-726 began in October of 1992, one to two months after hydraulic heads had stabilized from multiport installation, and continued through June of 1994 (Table 3). During purging an appropriate volume of water is extracted from the inner standpipe so that the hydraulic head in the standpipe is lower than the hydraulic head in the sampling zone. This induces water to flow from the formation and annular space through the open purge port into the inner standpipe. Recommended purge volumes were calculated at three times the annular volume of the sampling zone (Table 3). The rate at which this volume is produced is a function of the rock permeability and can vary considerably.

All of the zones, except for the deepest zone (zone 2), produced water in a reasonable amount of time (hours to days). The purge port for zone 6 was closed before 3 volumes had been produced -- 15.6 gallons were produced instead of the recommended 20.2 gallons. Before this zone is sampled again, an additional 4.6 gallons will be purged from the zone so that a consistent volume of water is removed from each sampling zone. In addition, because a purge volume calculation provided by Westbay Instruments proved to over estimate produced water volumes, all of the zones produced less water than originally calculated. The calculation change only impacts purging of zone 2. In this case, 2.2 annular volumes rather than 3 annular volumes were extracted from the zone. Unfortunately, zone 2 shows an extremely low apparent permeability. The purge port was opened for approximately 18 months and produced only 10.1 gallons in that time. This type of low production rate is evident in other DNAPL monitoring wells and purging procedures for the other wells are being changed to accommodate this condition. The changes will be discussed in subsequent reports.

Table 3. GW-726 purge history.

Zone	Packed-off Sampling Zone Height (ft)	Recom. purge volume (gals)*	1st Purge Date Opened	1st Purge Date Closed	Actual purge vol. (gals)	2nd Purge Date Opened	2nd Purge Date Closed	Produced purge vol. (gals)	Total volume (gals)	No. annular vols.	Difference of actual (-) recom. (gals)
2	11	13.9	12/8/92	6/8/93	5.1	8/5/93	6/14/94	5	10.1	2.2	-3.8
4	11	13.9	11/17/92	12/8/92	20.5				20.5	4.4	6.6
6	16	20.2	11/13/92	11/17/92	15.6				15.6	2.3	-4.6
9	11	13.9	11/11/92	11/13/92	15.5				15.5	3.4	1.6
12	16	20.2	11/3/92	11/11/92	42.0				42.0	6.3	21.8
16	16	20.2	10/28/92	11/2/92	20.0				20.0	3.0	-0.1
20	11	13.9	10/26/92	10/28/92	14.4				14.4	3.1	0.5
23	11	13.9	10/22/92	10/26/92	15.2				15.2	3.3	1.4
* PURGE VOLUME CALCULATION: Recommended purge volume = 3 annular volumes 3.7" diameter borehole and 1.81" OD MP casing "= 0.42 gal/ft for one annular volume or 1.26 gal/ft for three annular volumes"											

2.2 SAMPLING

Samples are collected in two evacuated (under vacuum) stainless steel 250 ml sample bottles that are attached in tandem and threaded to a sampling probe. The sample bottles are lowered to the desired zone and water is extracted through the measurement port valve. All equipment is designed specifically for and dedicated to Westbay type multiport wells. Additional information on Westbay-specific sampling procedures is in the Westbay Operation Manuals, which are available from the authors of this report.

The field sampling protocol is given in Table 4. Initially, each zone is sampled for anions, metals, VOCs and field parameters (pH, specific conductance and temperature). The normal suite of anion analysis includes Cl, F, NO₃, and SO₄. Additional sampling events are based on initial analytical results and can be requested at the discretion of the project manager or project technical lead.

Using two sample bottles, a maximum sample volume of 500 ml can be obtained each time bottles are lowered to a port (a sample run) (Table 4). In general, either two or three runs are needed to collect the required sample volume, depending on the desired analysis. The first run is used to collect field parameters and to rinse the sample bottles with formation water. If both inorganic (major and trace elements) and organic constituents are being sampled, the second run is used for the major and trace inorganic water samples and the third run is used for the VOC sample.

The sampling history for GW-726 is given in Table 5. Zone 2 was the only zone in which sampling problems were encountered. Because of the zone's very low permeability (see purging section and Table 3), it was difficult to extract water from the zone. During the 6/22/94 sampling attempt, it was not possible to maintain a seal around the measurement port valve because: (1) the zone could not produce enough water to maintain a sufficient fluid pressure; and (2) there was a large pressure differential between the sample bottles, the MP casing water and the formation water. Thus, this sampling event collected water from the MP casing (Table 5). It is part of the standard sampling procedure to accurately monitor water levels in the MP casing before and after sampling to determine if the water sample came from the MP casing or from the formation. In some cases (T. Early pers. comm.), the low permeability causes the MP casing to expand with lowered formation pressure and then contract as outside pressures return to normal. This would be observed as a drop in water level in the MP casing and a slow rise back to the presampling water

level. During the 6/22/94 sampling event, the MP casing water level dropped with no subsequent water level recovery. Therefore, the sample water was discarded and the zone was resampled at a later date (Table 5) using a modified sampling procedure. The purpose of the modified sampling procedure is to reduce the pressure differential between the sample bottles and the pressure in the MP casing. This is accomplished by pressurizing the sample bottles with inert nitrogen gas up to 50 psi. This pressure is well below the fluid pressure in the MP casing and the formation, yet is sufficient enough to maintain the integrity of the seal around the measurement port valve allowing water to be drawn from the formation. To date, this method has been successful when used in low permeability zones.

Table 4. Sampling and analysis plan.

Sample		Parameter	Container	Volume	Filtered	Preservative	Procedure No.	Analytical Method
Run No.	Bottle No.		Type	(ml)				
1	1	pH	N/A	<250	YES	N/A	EPA-150.1	pH meter
1	1	Specific Conductance	N/A	<250	YES	N/A	EPA-120.1	conductivity meter
1	1	Temperature	N/A	<250	YES	N/A	EPA-170.1	thermometer
1	2	rinsate/discard	N/A		YES	N/A		
2	1	Metals	Plastic	100	YES	HNO3 (<2pH)	EPA-6010	ICP
2	1	Anions (Cl, F, NO3, SO4)	Plastic	100	YES		EPA-300.0	IC
2	2	Nitrite (Nitrate Brucine)	Plastic	40	YES	H2SO4 (<2pH)	EPA-352.1	colormetric
2	2	Alkalinity	Plastic	100	YES		EPA-310.1	titration
3	1	VOC	Amber/Glass	40X2	NO		OLMO1.8	GC/MS
*All samples cooled to 4 degrees celsius unless otherwise noted								

Table 5. GW-726 sampling history.

Zone	Date	Parameters	Comments	Date	Parameters	Date	Parameters
2	6/22/94	-	Sampling failed, sampled MP casing water; no analysis conducted.	10/4/94	VOC Metals, Anions, Alk. Field parameters		
4	6/8/93	VOC		5/12/94	VOC Metals, Anions, Alk. Nitrate, Field parameters	7/19/94	VOC Field parameters
6	6/8/93	VOC		5/12/94	VOC Metals, Anions, Alk. Nitrate, Field parameters	7/19/94	VOC Field parameters
9	6/8/93	VOC		5/12/94	VOC Metals, Anions, Alk. Nitrate, Field parameters	7/19/94	VOC Field parameters
12	6/8/93	VOC		5/12/94	VOC Metals, Anions, Alk. Nitrate, Field parameters	7/19/94	VOC Field parameters
16	6/7/93	VOC		5/12/94	VOC Metals, Anions, Alk. Nitrate, Field parameters	7/21/94	VOC Field parameters
20	6/7/93	VOC		5/12/94	VOC Metals, Anions, Alk. Nitrate, Field parameters	7/21/94	VOC Field parameters
23	6/7/93	VOC		5/12/94	VOC Metals, Anions, Alk. Nitrate, Field parameters	7/21/94	VOC Field parameters

3.0 ANALYTICAL RESULTS

3.1 VOLATILE ORGANIC COMPOUNDS

Samples were collected for VOC analysis on four separate dates (6/7-8/93, 5/12/94, 7/19-21/94 and 10/4/94) (Table 5). Modified sample bottles were used for the 6/93 sampling event. The bottles were modified to prevent degassing of any dissolved gases in the sample, principally for the collection of dissolved CFC's and Helium, but the modification is also appropriate for improved VOC sampling. Trip blanks were collected for the July 1994 sampling event and their results are listed in Appendix A. No VOCs were detected in the trip blanks. Laboratory blank data are available for the June 1993, July 1994 and October 1994 sampling events (Appendix B). The only detectable VOC in the lab blank analysis was methylene chloride, a common laboratory reagent and it was detected in the 6/11/93 sample. A duplicate sample was collected from zone 16 on 6/8/93. The only difference in the results was the detected presence, with a "J" qualifier, of methylene chloride and toluene in one sample but not in the other (Table 6).

VOC results from the sample zones are presented in Appendix C and a list of 18 detectable VOCs is given in Table 6. All detectable values are flagged with a "J" qualifier and represent low but discernible responses from the analytical instrumentation. Results with "J" qualifiers from zones 4, 9, 12 and 16 are less than 1.00 µg/L and results from zone 6 are 2.00 µg/L. Of the 18 detectable VOC concentrations, 4 detects are for methylene chloride, a common laboratory reagent that was also detected in the lab blank at the same concentration reported for the samples, 1 µg/L; 6 detects are for compounds that are rarely (if ever) detected in groundwater and surface water samples from the Bear Creek Regime (benzene, toluene and styrene) (HSW, 1994), although benzene and toluene may be attributable to natural hydrocarbons; and 8 detects are for VOCs of concern that are known to be present in the groundwater in the regime (e.g. PCE, TCE) (HSW, 1994). At least one of these two VOC constituents of concern were observed with "J" qualifiers in zones 4, 6, 9, 12 and 16. In addition zone 6 showed these constituents from 2 out of 3 sampling events and showed the highest values (2.00 µg/L, collected 6/8/93). All results however, are below the MCL of 5 µg/L for both TCE and PCE.

Table 6. GW-726 "J" qualifiers of VOC analytical results.

Lab	Sample No.	Zone No.	Date Sampled	Analysis	Result	Tag	Units	Date Analyzed	Zone Depth (ft.)
	930610-019	4	8-Jun-93	Benzene	0.9	J	µg/L	11-Jun-93	548.4
	930610-019	4	8-Jun-93	Methylene Chloride	1.0	JB	µg/L	11-Jun-93	548.4
	930610-019	4	8-Jun-93	Tetrachloroethene	0.7	J	µg/L	11-Jun-93	548.4
	930610-019	4	8-Jun-93	Toluene	0.7	J	µg/L	11-Jun-93	548.4
	930610-019	4	8-Jun-93	Trichloroethene	1.0	J	µg/L	11-Jun-93	548.4
	930610-016	6	8-Jun-93	Tetrachloroethene	2.0	J	µg/L	11-Jun-93	513.5
	930610-016	6	8-Jun-93	Trichloroethene	2.0	J	µg/L	11-Jun-93	513.5
	930610-015	9	8-Jun-93	Methylene Chloride	1.0	JB	µg/L	11-Jun-93	443.6
	930610-015	9	8-Jun-93	Styrene	1.0	J	µg/L	11-Jun-93	443.6
	930610-015	9	8-Jun-93	Toluene	0.7	J	µg/L	11-Jun-93	443.6
	930610-015	9	8-Jun-93	Trichloroethene	0.4	J	µg/L	11-Jun-93	443.6
	930610-013	12	8-Jun-93	Styrene	1.0	J	µg/L	11-Jun-93	378.6
	930610-013	12	8-Jun-93	Tetrachloroethene	0.7	J	µg/L	11-Jun-93	378.6
	930610-013	12	8-Jun-93	Trichloroethene	0.7	J	µg/L	11-Jun-93	378.6
	930610-011	16	8-Jun-93	Methylene Chloride	1.0	JB	µg/L	11-Jun-93	293.6
	930610-012 16 -duplicate	16	8-Jun-93	Methylene Chloride	1.0	JB	µg/L	11-Jun-93	293.6
	930610-012 16 -duplicate	16	8-Jun-93	Toluene	0.6	J	µg/L	11-Jun-93	293.6
	940721-068	6	19-Jul-94	Trichloroethene	1.0	J	µg/L	22-Jul-94	513.5
J = estimated									
B = analyte found at same concentration in blank as in sample (1.0µg/L)									

Detectable VOCs with "J" qualifiers of TCE and PCE are illustrated graphically in Figure 4. These all occur at the base of the well but do not include zone 2, the zone with extremely low apparent permeability. Based on preconstruction data (Dreier and Caldanaro, 1994), zone 9 was identified as a zone that had a high relative potential for containing DNAPL because it sampled the same stratigraphic interval as the interval with DNAPL in GW-625. Sampling zones with "J" qualifiers of TCE and PCE include zone 9 as well as one overlying and 2 underlying sampling zones. Of note is the fact that the greatest number of "J" qualifiers showed up for the 6/93 sampling event, when the modified sample bottles were used. It is possible that the bottles prevented any VOC's from degassing. The next VOC sampling for GW-726 will again use the modified sample bottles to evaluate this sampling method.

3.2 TRACE METALS

One sample per zone was collected for metal analysis (Table 5). Metal concentrations were determined by ICP spectroscopy and are listed in Appendix D. Samples from zones 2, 4, 6 and 9 were diluted because of high ion concentrations. All of these zones showed specific conductance values greater than 2000 $\mu\text{mho/cm}$. As a result of the dilutions, detection limits are raised and some are raised above the screening limits listed in the GWQAR for Bear Creek Valley (HSW, 1994). This is the case for antimony, cadmium, lead, molybdenum and thorium for zones 2, 4, 6 and 9, and for cobalt for zone 2. Nevertheless, all analytical results for these constituents were below the detection limit, even though concentrations are expected to rise with increase in specific conductance. Specific conductance values are listed in Appendix E.

The upper zones in GW-726 (zones 9, 12, 16, 20 and 23) show boron levels above the 1986 to 1993 screening levels listed in the GWQAR for Bear Creek Valley (HSW, 1994). However the levels are less than or equal to earlier screening levels determined using data from 1986 to 1991. The highest boron level is in zone 20 at 1.1 mg/L. This is above the most recently determined screening level and equal to the earlier screening level.

Strontium is the only other trace metal that shows concentrations above the screening level. The elevated concentrations occur in the deepest two zones (zones 2 and 4) where there is also a corresponding increase in specific conductance. These two zones show specific conductance over 4000 $\mu\text{mho/cm}$. The increase in strontium is apparently related to the increase in TDS as is suggested by the proportional correspondence between calcium and strontium concentrations (Fig. 5).

Figure 4. GW-726 "J" qualifiers of VOCs known to be present in groundwater. ND equals not detected. All values with "J" qualifiers are less than 2 $\mu\text{g/L}$. Sampling activities on 6/8/93 used modified sampling bottles (see text for discussion).

Figure 5. Plot of strontium vs. calcium concentrations from GW-726.

3.3 MAJOR ELEMENT WATER CHEMISTRY

Major element water chemistry and field parameters are given in Appendix E and charge balance information is given in Appendix F. All of the zones except for zone 2 show a charge balance (in percent) less than 10%. Because of the poor charge balance results for zone 2, this zone will be resampled and reanalyzed for major elements. We believe that the poor charge balance is a result of an apparent low chloride result. As expected, the other zones show an increase in both sodium and chloride content with depth. However, zone 2 shows a decrease in chloride content even though sodium concentration increases with respect to zone 4.

Water chemistry types are shown in Fig. 6. Zone 2 is plotted for rough comparison purposes but it should be remembered that results from this zone showed a poor charge balance. In general, there is a systematic change in water type with depth from a shallow Na-HCO₃ type water to a deep Na-Cl type water. The upper four zones (zones 23, 20, 16 and 12 that show a depth range of 100 - 400 ft) are a Na-HCO₃ type water. The middle two zones (zones 9 and 6 that show a depth range of 400 - 525 ft) are a Na-HCO₃-Cl type water and the lowest two zones (zones 2 and 4 that show a depth range of 525 - 600 ft) are a Na-Cl type water. The change in water type with depth also corresponds to an increase in TDS with depth (Fig. 6). Again, TDS values for zone 2 should be considered as minimum values because the chloride results are possibly underestimated.

Figure 6. Piper diagram of GW-726 water chemistry. Zone 2 is plotted for rough comparison purposes but it should be noted that results from this zone showed a poor charge balance (10.96%).

4.0 SUMMARY / FUTURE WORK

Ongoing and future tasks are directed toward collecting data that will provide information about: (1) the presence or absence of DNAPL or dissolved phase DNAPL and (2) the nature of the groundwater system so that the potential mobility of the dissolved phase plume can be evaluated. With this information we will be prepared to address concerns about the current extent of the contamination, the potential for continued spread of the contamination, and the need, if any, for implementing a remediation strategy.

To date, each of the eight sampling zones in GW-726 has been sampled for VOCs, metals and anions. Zones 2 and 6 will be resampled because of charge balance concerns (zone 2) and purging concerns (zone 6). Based on the presence of very low levels of TCE and PCE in the deeper portion of the well, it is recommended that VOC monitoring of GW-726 be continued, and that the modified sample bottles be used. Additional data is required in order to statistically confirm the presence or absence of VOCs through the use of "J" qualifiers. Any additional sampling will be conducted without further purging (except for zones 2 and 6), unless there is corroborative evidence that the water sample is not representative of the formation. There is a concern that excessive or unnecessary purging of units with low storativity, such as those in GW-726, will mobilize and extend the contaminant plume.

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Appendix A

TRIP BLANK VOC ANALYTICAL RESULTS.

Trip Blank VOC Analytical Results.

Sample Number	940513-017	940721-071	940721-066
Trip Date	5/12/94	7/19/94	7/21/94
Date Analyzed	5/16/94	7/22/94	7/22/94
Units	µg/L	µg/L	µg/L
1,1,1-Trichloroethane	< 10.0	< 10.0	< 10.0
1,1,2,2-Tetrachloroethane	< 10.0	< 10.0	< 10.0
1,1,2-Trichloroethane	< 10.0	< 10.0	< 10.0
1,1-Dichloroethane	< 10.0	< 10.0	< 10.0
1,1-Dichloroethene	< 10.0	< 10.0	< 10.0
1,2-Dichloroethane	< 10.0	< 10.0	< 10.0
1,2-Dichloroethene (total)	< 10.0	< 10.0	< 10.0
1,2-Dichloropropane	< 10.0	< 10.0	< 10.0
2-Butanone	< 10.0	< 10.0	< 10.0
2-Hexanone	< 10.0	< 10.0	< 10.0
4-Methyl-2-pentanone	< 10.0	< 10.0	< 10.0
Acetone	< 10.0	< 10.0	< 10.0
Benzene	< 10.0	< 10.0	< 10.0
Bromodichloromethane	< 10.0	< 10.0	< 10.0
Bromoform	< 10.0	< 10.0	< 10.0
Bromomethane	< 10.0	< 10.0	< 10.0
Carbon Disulfide	< 10.0	< 10.0	< 10.0
Carbon Tetrachloride	< 10.0	< 10.0	< 10.0
Chlorobenzene	< 10.0	< 10.0	< 10.0
Chloroethane	< 10.0	< 10.0	< 10.0
Chloroform	< 10.0	< 10.0	< 10.0
Chloromethane	< 10.0	< 10.0	< 10.0
Dibromochloromethane	< 10.0	< 10.0	< 10.0
Ethylbenzene	< 10.0	< 10.0	< 10.0
Methylene Chloride	< 10.0	< 10.0	< 10.0
Styrene	< 10.0	< 10.0	< 10.0
Tetrachloroethene	< 10.0	< 10.0	< 10.0
Toluene	< 10.0	< 10.0	< 10.0
Trichloroethene	< 10.0	< 10.0	< 10.0
Vinyl Acetate	< 10.0	< 10.0	< 10.0
Vinyl Chloride	< 10.0	< 10.0	< 10.0
Xylene (total)	< 10.0	< 10.0	< 10.0
cis-1,3-Dichloropropene	< 10.0	< 10.0	< 10.0
trans-1,3-Dichloropropene	< 10.0	< 10.0	< 10.0

Appendix B

LABORATORY BLANK VOC ANALYTICAL RESULTS.

Laboratory Blank VOC Analytical Results.

Sample Number	930611-001	940516-082	940722-011	941008-008
Date Completed	6/11/93	5/16/94	7/22/94	10/8/94
Units	µg/L	µg/L	µg/L	µg/L
1,1,1-Trichloroethane	< 5.0	< 10.0	< 10.0	< 10.0
1,1,2,2-Tetrachloroethane	< 5.0	< 10.0	< 10.0	< 10.0
1,1,2-Trichloroethane	< 5.0	< 10.0	< 10.0	< 10.0
1,1-Dichloroethane	< 5.0	< 10.0	< 10.0	< 10.0
1,1-Dichloroethene	< 5.0	< 10.0	< 10.0	< 10.0
1,2-Dichloroethane	< 5.0	< 10.0	< 10.0	< 10.0
1,2-Dichloroethene (total)	< 5.0	< 10.0	< 10.0	< 10.0
1,2-Dichloropropane	< 5.0	< 10.0	< 10.0	< 10.0
2-Butanone	< 10.0	< 10.0	< 10.0	< 10.0
2-Hexanone	< 10.0	< 10.0	< 10.0	< 10.0
4-Methyl-2-pentanone	< 10.0	< 10.0	< 10.0	< 10.0
Acetone	< 10.0	< 10.0	< 10.0	< 10.0
Benzene	< 5.0	< 10.0	< 10.0	< 10.0
Bromodichloromethane	< 5.0	< 10.0	< 10.0	< 10.0
Bromoform	< 5.0	< 10.0	< 10.0	< 10.0
Bromomethane	< 10.0	< 10.0	< 10.0	< 10.0
Carbon Disulfide	< 5.0	< 10.0	< 10.0	< 10.0
Carbon Tetrachloride	< 5.0	< 10.0	< 10.0	< 10.0
Chlorobenzene	< 5.0	< 10.0	< 10.0	< 10.0
Chloroethane	< 10.0	< 10.0	< 10.0	< 10.0
Chloroform	< 5.0	< 10.0	< 10.0	< 10.0
Chloromethane	< 10.0	< 10.0	< 10.0	< 10.0
Dibromochloromethane	< 5.0	< 10.0	< 10.0	< 10.0
Ethylbenzene	< 5.0	< 10.0	< 10.0	< 10.0
Methylene Chloride	1.0	< 10.0	< 10.0	< 10.0
Styrene	< 5.0	< 10.0	< 10.0	< 10.0
Tetrachloroethene	< 5.0	< 10.0	< 10.0	< 10.0
Toluene	< 5.0	< 10.0	< 10.0	< 10.0
Trichloroethene	< 5.0	< 10.0	< 10.0	< 10.0
Vinyl Acetate	< 10.0	< 10.0	< 10.0	< 10.0
Vinyl Chloride	< 10.0	< 10.0	< 10.0	< 10.0
Xylene (total)	< 5.0	< 10.0	< 10.0	< 10.0
cis-1,3-Dichloropropene	< 5.0	< 10.0	< 10.0	< 10.0
trans-1,3-Dichloropropene	< 5.0	< 10.0	< 10.0	< 10.0

Appendix C
VOC ANALYTICAL RESULTS.

Well/Zone Number:	GW-726-2	GW-726-4	GW-726-4	GW-726-4
Sample ID Number:		930610-019	940513-014	940721-067
Date Sampled:	10/5/94	6/8/93	5/12/94	7/19/94
Date Analyzed:		6/11/93	5/16/94	7/22/94
Corresponding Trip Blank:			940513-017	940721-071
Corresponding Lab Blank:	941008-008	930611-001	940516-082	940722-011
VOLATILE ORGANICS (µg/L)				
1,1,1-Trichloroethane	< 10.0	< 5.0	< 10.0	< 10.0
1,1,2,2-Tetrachloroethane	< 10.0	< 5.0	< 10.0	< 10.0
1,1,2-Trichloroethane	< 10.0	< 5.0	< 10.0	< 10.0
1,1-Dichloroethane	< 10.0	< 5.0	< 10.0	< 10.0
1,1-Dichloroethene	< 10.0	< 5.0	< 10.0	< 10.0
1,2-Dichloroethane	< 10.0	< 5.0	< 10.0	< 10.0
1,2-Dichloroethene (total)	< 10.0	< 5.0	< 10.0	< 10.0
1,2-Dichloropropane	< 10.0	< 5.0	< 10.0	< 10.0
2-Butanone	< 10.0	< 10.0	< 10.0	< 10.0
2-Hexanone	< 10.0	< 10.0	< 10.0	< 10.0
4-Methyl-2-pentanone	< 10.0	< 10.0	< 10.0	< 10.0
Acetone	< 10.0	< 10.0	< 10.0	< 10.0
Benzene	< 10.0	0.9 J	< 10.0	< 10.0
Bromodichloromethane	< 10.0	< 5.0	< 10.0	< 10.0
Bromoform	< 10.0	< 5.0	< 10.0	< 10.0
Bromomethane	< 10.0	< 10.0	< 10.0	< 10.0
Carbon Disulfide	< 10.0	< 5.0	< 10.0	< 10.0
Carbon Tetrachloride	< 10.0	< 5.0	< 10.0	< 10.0
Chlorobenzene	< 10.0	< 5.0	< 10.0	< 10.0
Chloroethane	< 10.0	< 10.0	< 10.0	< 10.0
Chloroform	< 10.0	< 5.0	< 10.0	< 10.0
Chloromethane	< 10.0	< 10.0	< 10.0	< 10.0
Dibromochloromethane	< 10.0	< 5.0	< 10.0	< 10.0
Ethylbenzene	< 10.0	< 5.0	< 10.0	< 10.0
Methylene Chloride	< 10.0	1.0 JB	< 10.0	< 10.0
Styrene	< 10.0	< 5.0	< 10.0	< 10.0
Tetrachloroethene	< 10.0	0.7 J	< 10.0	< 10.0
Toluene	< 10.0	0.7 J	< 10.0	< 10.0
Trichloroethene	< 10.0	1.0 J	< 10.0	< 10.0
Vinyl Acetate	< 10.0	< 10.0	< 10.0	< 10.0
Vinyl Chloride	< 10.0	< 10.0	< 10.0	< 10.0
Xylene (total)	< 10.0	< 5.0	< 10.0	< 10.0
cis-1,3-Dichloropropene	< 10.0	< 5.0	< 10.0	< 10.0
trans-1,3-Dichloropropene	< 10.0	< 5.0	< 10.0	< 10.0

(Continued...)

Well/Zone Number:	GW-726-6	GW-726-6	GW-726-6
Sample ID Number:	930610-016	940513-015	940721-068
Date Sampled:	6/8/93	5/12/94	7/19/94
Date Analyzed:	6/11/93	5/16/94	7/22/94
Corresponding Trip Blank:		940513-017	940721-071
Corresponding Lab Blank:	930611-001	940516-082	940722-011
VOLATILE ORGANICS (µg/L)			
1,1,1-Trichloroethane	< 5.0	< 10.0	< 10.0
1,1,2,2-Tetrachloroethane	< 5.0	< 10.0	< 10.0
1,1,2-Trichloroethane	< 5.0	< 10.0	< 10.0
1,1-Dichloroethane	< 5.0	< 10.0	< 10.0
1,1-Dichloroethene	< 5.0	< 10.0	< 10.0
1,2-Dichloroethane	< 5.0	< 10.0	< 10.0
1,2-Dichloroethene (total)	< 5.0	< 10.0	< 10.0
1,2-Dichloropropane	< 5.0	< 10.0	< 10.0
2-Butanone	< 10.0	< 10.0	< 10.0
2-Hexanone	< 10.0	< 10.0	< 10.0
4-Methyl-2-pentanone	< 10.0	< 10.0	< 10.0
Acetone	< 10.0	< 10.0	< 10.0
Benzene	< 5.0	< 10.0	< 10.0
Bromodichloromethane	< 5.0	< 10.0	< 10.0
Bromoform	< 5.0	< 10.0	< 10.0
Bromomethane	< 10.0	< 10.0	< 10.0
Carbon Disulfide	< 5.0	< 10.0	< 10.0
Carbon Tetrachloride	< 5.0	< 10.0	< 10.0
Chlorobenzene	< 5.0	< 10.0	< 10.0
Chloroethane	< 10.0	< 10.0	< 10.0
Chloroform	< 5.0	< 10.0	< 10.0
Chloromethane	< 10.0	< 10.0	< 10.0
Dibromochloromethane	< 5.0	< 10.0	< 10.0
Ethylbenzene	< 5.0	< 10.0	< 10.0
Methylene Chloride	< 5.0	< 10.0	< 10.0
Styrene	< 5.0	< 10.0	< 10.0
Tetrachloroethene	2.0 J	< 10.0	< 10.0
Toluene	< 5.0	< 10.0	< 10.0
Trichloroethene	2.0 J	< 10.0	1.0 J
Vinyl Acetate	< 10.0	< 10.0	< 10.0
Vinyl Chloride	< 10.0	< 10.0	< 10.0
Xylene (total)	< 5.0	< 10.0	< 10.0
cis-1,3-Dichloropropene	< 5.0	< 10.0	< 10.0
trans-1,3-Dichloropropene	< 5.0	< 10.0	< 10.0

(Continued...)

Well/Zone Number:	GW-726-9	GW-726-9	GW-726-9
Sample ID Number:	930610-015	940513-016	940721-069
Date Sampled:	6/8/93	5/12/94	7/19/94
Date Analyzed:	6/11/93	5/16/94	7/22/94
Corresponding Trip Blank:		940513-017	940721-071
Corresponding Lab Blank:	930611-001	940516-082	940722-011
VOLATILE ORGANICS (µg/L)			
1,1,1-Trichloroethane	< 5.0	< 10.0	< 10.0
1,1,2,2-Tetrachloroethane	< 5.0	< 10.0	< 10.0
1,1,2-Trichloroethane	< 5.0	< 10.0	< 10.0
1,1-Dichloroethane	< 5.0	< 10.0	< 10.0
1,1-Dichloroethene	< 5.0	< 10.0	< 10.0
1,2-Dichloroethane	< 5.0	< 10.0	< 10.0
1,2-Dichloroethene (total)	< 5.0	< 10.0	< 10.0
1,2-Dichloropropane	< 5.0	< 10.0	< 10.0
2-Butanone	< 10.0	< 10.0	< 10.0
2-Hexanone	< 10.0	< 10.0	< 10.0
4-Methyl-2-pentanone	< 10.0	< 10.0	< 10.0
Acetone	< 10.0	< 10.0	< 10.0
Benzene	< 5.0	< 10.0	< 10.0
Bromodichloromethane	< 5.0	< 10.0	< 10.0
Bromoform	< 5.0	< 10.0	< 10.0
Bromomethane	< 10.0	< 10.0	< 10.0
Carbon Disulfide	< 5.0	< 10.0	< 10.0
Carbon Tetrachloride	< 5.0	< 10.0	< 10.0
Chlorobenzene	< 5.0	< 10.0	< 10.0
Chloroethane	< 10.0	< 10.0	< 10.0
Chloroform	< 5.0	< 10.0	< 10.0
Chloromethane	< 10.0	< 10.0	< 10.0
Dibromochloromethane	< 5.0	< 10.0	< 10.0
Ethylbenzene	< 5.0	< 10.0	< 10.0
Methylene Chloride	1.0 JB	< 10.0	< 10.0
Styrene	1.0 J	< 10.0	< 10.0
Tetrachloroethene	< 5.0	< 10.0	< 10.0
Toluene	0.7 J	< 10.0	< 10.0
Trichloroethene	0.4 J	< 10.0	< 10.0
Vinyl Acetate	< 10.0	< 10.0	< 10.0
Vinyl Chloride	< 10.0	< 10.0	< 10.0
Xylene (total)	< 5.0	< 10.0	< 10.0
cis-1,3-Dichloropropene	< 5.0	< 10.0	< 10.0
trans-1,3-Dichloropropene	< 5.0	< 10.0	< 10.0

(Continued...)

Well/Zone Number:	GW-726-12	GW-726-12
Sample ID Number:	930610-013	940721-070
Date Sampled:	6/8/93	7/19/94
Date Analyzed:	6/11/93	7/22/94
Corresponding Trip Blank:		940721-071
Corresponding Lab Blank:	930611-001	940722-011
VOLATILE ORGANICS (µg/L)		
1,1,1-Trichloroethane	< 5.0	< 10.0
1,1,2,2-Tetrachloroethane	< 5.0	< 10.0
1,1,2-Trichloroethane	< 5.0	< 10.0
1,1-Dichloroethane	< 5.0	< 10.0
1,1-Dichloroethene	< 5.0	< 10.0
1,2-Dichloroethane	< 5.0	< 10.0
1,2-Dichloroethene (total)	< 5.0	< 10.0
1,2-Dichloropropane	< 5.0	< 10.0
2-Butanone	< 10.0	< 10.0
2-Hexanone	< 10.0	< 10.0
4-Methyl-2-pentanone	< 10.0	< 10.0
Acetone	< 10.0	< 10.0
Benzene	< 5.0	< 10.0
Bromodichloromethane	< 5.0	< 10.0
Bromoform	< 5.0	< 10.0
Bromomethane	< 10.0	< 10.0
Carbon Disulfide	< 5.0	< 10.0
Carbon Tetrachloride	< 5.0	< 10.0
Chlorobenzene	< 5.0	< 10.0
Chloroethane	< 10.0	< 10.0
Chloroform	< 5.0	< 10.0
Chloromethane	< 10.0	< 10.0
Dibromochloromethane	< 5.0	< 10.0
Ethylbenzene	< 5.0	< 10.0
Methylene Chloride	< 5.0	< 10.0
Styrene	1.0 J	< 10.0
Tetrachloroethene	0.7 J	< 10.0
Toluene	< 5.0	< 10.0
Trichloroethene	0.7 J	< 10.0
Vinyl Acetate	< 10.0	< 10.0
Vinyl Chloride	< 10.0	< 10.0
Xylene (total)	< 5.0	< 10.0
cis-1,3-Dichloropropene	< 5.0	< 10.0
trans-1,3-Dichloropropene	< 5.0	< 10.0

(Continued...)

Well/Zone Number:	GW-726-16	GW-726-16a	GW-726-16
Sample ID Number:	930610-011	930610-012	940721-063
Date Sampled:	6/8/93	6/8/93	7/21/94
Date Analyzed:	6/11/93	6/11/93	7/22/94
Corresponding Trip Blank:			940721-066
Corresponding Lab Blank:	930611-001	930611-001	940722-011
VOLATILE ORGANICS (µg/L)			
1,1,1-Trichloroethane	< 5.0	< 5.0	< 10.0
1,1,2,2-Tetrachloroethane	< 5.0	< 5.0	< 10.0
1,1,2-Trichloroethane	< 5.0	< 5.0	< 10.0
1,1-Dichloroethane	< 5.0	< 5.0	< 10.0
1,1-Dichloroethene	< 5.0	< 5.0	< 10.0
1,2-Dichloroethane	< 5.0	< 5.0	< 10.0
1,2-Dichloroethene (total)	< 5.0	< 5.0	< 10.0
1,2-Dichloropropane	< 5.0	< 5.0	< 10.0
2-Butanone	< 10.0	< 10.0	< 10.0
2-Hexanone	< 10.0	< 10.0	< 10.0
4-Methyl-2-pentanone	< 10.0	< 10.0	< 10.0
Acetone	< 10.0	< 10.0	< 10.0
Benzene	< 5.0	< 5.0	< 10.0
Bromodichloromethane	< 5.0	< 5.0	< 10.0
Bromoform	< 5.0	< 5.0	< 10.0
Bromomethane	< 10.0	< 10.0	< 10.0
Carbon Disulfide	< 5.0	< 5.0	< 10.0
Carbon Tetrachloride	< 5.0	< 5.0	< 10.0
Chlorobenzene	< 5.0	< 5.0	< 10.0
Chloroethane	< 10.0	< 10.0	< 10.0
Chloroform	< 5.0	< 5.0	< 10.0
Chloromethane	< 10.0	< 10.0	< 10.0
Dibromochloromethane	< 5.0	< 5.0	< 10.0
Ethylbenzene	< 5.0	< 5.0	< 10.0
Methylene Chloride	1.0 JB	1.0 JB	< 10.0
Styrene	< 5.0	< 5.0	< 10.0
Tetrachloroethene	< 5.0	< 5.0	< 10.0
Toluene	< 5.0	0.6 J	< 10.0
Trichloroethene	< 5.0	< 5.0	< 10.0
Vinyl Acetate	< 10.0	< 10.0	< 10.0
Vinyl Chloride	< 10.0	< 10.0	< 10.0
Xylene (total)	< 5.0	< 5.0	< 10.0
cis-1,3-Dichloropropene	< 5.0	< 5.0	< 10.0
trans-1,3-Dichloropropene	< 5.0	< 5.0	< 10.0

(Continued...)

Well/Zone Number:	GW-726-20	GW-726-20	GW-726-23	GW-726-23
Sample ID Number:	930610-010	940721-064	930610-009	940721-065
Date Sampled:	6/8/93	7/21/94	6/8/93	7/21/94
Date Analyzed:	6/11/93	7/22/94	6/11/93	7/22/94
Corresponding Trip Blank:		940721-066		940721-066
Corresponding Lab Blank:	930611-001	940722-011	930611-001	940722-011
VOLATILE ORGANICS (µg/L)				
1,1,1-Trichloroethane	< 5.0	< 10.0	< 5.0	< 10.0
1,1,2,2-Tetrachloroethane	< 5.0	< 10.0	< 5.0	< 10.0
1,1,2-Trichloroethane	< 5.0	< 10.0	< 5.0	< 10.0
1,1-Dichloroethane	< 5.0	< 10.0	< 5.0	< 10.0
1,1-Dichloroethene	< 5.0	< 10.0	< 5.0	< 10.0
1,2-Dichloroethane	< 5.0	< 10.0	< 5.0	< 10.0
1,2-Dichloroethene (total)	< 5.0	< 10.0	< 5.0	< 10.0
1,2-Dichloropropane	< 5.0	< 10.0	< 5.0	< 10.0
2-Butanone	< 10.0	< 10.0	< 10.0	< 10.0
2-Hexanone	< 10.0	< 10.0	< 10.0	< 10.0
4-Methyl-2-pentanone	< 10.0	< 10.0	< 10.0	< 10.0
Acetone	< 10.0	< 10.0	< 10.0	< 10.0
Benzene	< 5.0	< 10.0	< 5.0	< 10.0
Bromodichloromethane	< 5.0	< 10.0	< 5.0	< 10.0
Bromoform	< 5.0	< 10.0	< 5.0	< 10.0
Bromomethane	< 10.0	< 10.0	< 10.0	< 10.0
Carbon Disulfide	< 5.0	< 10.0	< 5.0	< 10.0
Carbon Tetrachloride	< 5.0	< 10.0	< 5.0	< 10.0
Chlorobenzene	< 5.0	< 10.0	< 5.0	< 10.0
Chloroethane	< 10.0	< 10.0	< 10.0	< 10.0
Chloroform	< 5.0	< 10.0	< 5.0	< 10.0
Chloromethane	< 10.0	< 10.0	< 10.0	< 10.0
Dibromochloromethane	< 5.0	< 10.0	< 5.0	< 10.0
Ethylbenzene	< 5.0	< 10.0	< 5.0	< 10.0
Methylene Chloride	< 5.0	< 10.0	< 5.0	< 10.0
Styrene	< 5.0	< 10.0	< 5.0	< 10.0
Tetrachloroethene	< 5.0	< 10.0	< 5.0	< 10.0
Toluene	< 5.0	< 10.0	< 5.0	< 10.0
Trichloroethene	< 5.0	< 10.0	< 5.0	< 10.0
Vinyl Acetate	< 10.0	< 10.0	< 10.0	< 10.0
Vinyl Chloride	< 10.0	< 10.0	< 10.0	< 10.0
Xylene (total)	< 5.0	< 10.0	< 5.0	< 10.0
cis-1,3-Dichloropropene	< 5.0	< 10.0	< 5.0	< 10.0
trans-1,3-Dichloropropene	< 5.0	< 10.0	< 5.0	< 10.0

Appendix D

TRACE METAL ANALYTICAL RESULTS.

Trace Metal Analytical Results.

Well/Zone Number:	GW-726-2	GW-726-4	GW-726-6	GW-726-9	GW-726-12	GW-726-16	GW-726-20	GW-726-23
Date Sampled:	10/5/94	5/12/94	5/12/94	5/12/94	5/12/94	5/12/94	5/12/94	5/12/94
METALS (mg/L)								
Aluminum	< 0.2 d	< 0.1 d	< 0.04 d	< 0.04 d	< 0.02	0.035	< 0.02	0.022
Antimony	< 0.5 d	< 0.25 d	< 0.1 d	< 0.1 d	< 0.05	< 0.05	< 0.05	< 0.05
Arsenic	< 0.5 d	< 0.25 d	< 0.1 d	< 0.1 d	< 0.05	< 0.05	< 0.05	< 0.05
Barium	0.51	0.37	0.14	0.096	0.063	0.053	0.034	0.048
Beryllium	< 0.003 d	< 0.0015 d	< 0.0006 d	< 0.0006 d	< 0.0003	< 0.0003	< 0.0003	< 0.0003
Boron	0.36	0.37	0.43	0.65	0.69	0.98	1.1	0.54
Cadmium	< 0.03 d	< 0.015 d	< 0.006 d	< 0.006 d	< 0.003	< 0.003	< 0.003	< 0.003
Chromium	< 0.1 d	< 0.05 d	< 0.02 d	< 0.02 d	< 0.01	< 0.01	< 0.01	< 0.01
Cobalt	< 0.05 d	< 0.025 d	< 0.01 d	< 0.01 d	< 0.005	< 0.005	< 0.005	< 0.005
Copper	< 0.04 d	< 0.02 d	< 0.008 d	0.0087	< 0.004	< 0.004	< 0.004	0.0064
Iron	0.088	< 0.025 d	0.039	0.013	0.014	0.012	0.011	< 0.005
Lead	< 0.5 d	< 0.25 d	< 0.1 d	< 0.1 d	< 0.05	< 0.05	< 0.05	< 0.05
Manganese	0.028	< 0.005 d	0.0021	0.0021	0.0013	< 0.001	< 0.001	0.0016
Molybdenum	< 0.1 d	< 0.05 d	< 0.02 d	< 0.02 d	< 0.01	< 0.01	< 0.01	< 0.01
Nickel	< 0.1 d	< 0.05 d	< 0.02 d	< 0.02 d	< 0.01	< 0.01	< 0.01	< 0.01
Selenium	< 0.5 d	< 0.25 d	< 0.1 d	< 0.1 d	< 0.05	< 0.05	< 0.05	< 0.05
Silver	< 0.06 d	< 0.03 d	< 0.012 d	< 0.012 d	< 0.006	< 0.006	< 0.006	< 0.006
Strontium	1.2	0.95	0.42	0.31	0.19	0.11	0.075	0.096
Thorium	< 2.0 d	< 1.0 d	< 0.4 d	< 0.4 d	< 0.2	< 0.2	< 0.2	< 0.2
Vanadium	0.05 d	< 0.025 d	< 0.01 d	< 0.01 d	< 0.005	< 0.005	< 0.005	< 0.005
Zinc	< 0.02 d	0.022	0.058	0.0098	0.015	0.0099	0.018	0.021

d = indicates sample diluted for analysis.

Appendix E

MAJOR ANIONS AND CATIONS AND FIELD PARAMETERS.

Major Anions and Cations and Field Parameters.

Well/Zone Number:	GW-726-2	GW-726-4	GW-726-6	GW-726-9	GW-726-12	GW-726-16	GW-726-20	GW-726-23
Date Sampled:	10/5/94	5/12/94	5/12/94	5/12/94	5/12/94	5/12/94	5/12/94	5/12/94
ANIONS (mg/L)								
Alkalinity	482.0	507.0	716.0	773.0	710.0	607.0	430.0	217.0
Alkalinity-HCO ₃ *	587.66	611.96	872.96	942.45	865.64	732.66	524.26	264.57
Alkalinity-CO ₃ *	0.0	3.04	0.0	0.0	0.0	3.64	0.0	0.0
Chloride IC	1282.0	1409.0	568.0	355.0	175.0	39.0	13.0	1.0
Fluoride SIE	3.1	3.0	4.0	4.0	6.0	6.0	3.0	0.4
Nitrate	< 1.0	< 20.0	< 20.0	< 20.0	20.0	20.0	10.0	1.0
Nitrate Brucine		0.14	0.33	< 0.1	0.1	0.38	0.1	0.23
Sulfate	< 1.0	< 20.0	37.0	35.0	40.0	39.0	14.0	6.0
CATIONS (mg/L)								
Calcium	10.0	8.7	4.0	2.9	1.9	1.3	1.1	2.2
Iron	0.088	< 0.025 d	0.039	0.013	0.014	0.012	0.011	< 0.005
Magnesium	2.8	2.6	1.2	0.82	0.5	0.28	0.23	0.47
Potassium	< 6.0 d	5.6	3.1	2.7	2.2	2.1	1.7	1.8
Sodium	1300.0	1200.0	760.0	620.0	450.0	320.0	210.0	100.0
TDS (mg/L)†	3185.65	3244.04	2250.63	1962.88	1561.35	1164.37	777.4	377.67
FIELD PARAMETERS								
pH	7.5	8.5	7.5	8.0	8.3	8.5	8.0	8.0
Temperature (°C)	17.0	18.0	17.5	17.5	17.0	16.5	14.5	14.0
Conductivity (µmho/cm)	4350.0	4500.0	2600.0	2050.0	1600.0	1070.0	700.0	320.0

*values determined by speciating total alkalinity (CaCO₃) based on pH of water sample.

†Sum of major anions and cations (mg/L).

d = indicates sample diluted for analysis.

Appendix F
CHARGE BALANCE CALCULATIONS.

Charge Balance Calculations

Well/Zone Number:	GW-726-2	GW-726-4	GW-726-6	GW-726-9	GW-726-12	GW-726-16	GW-726-20	GW-726-23
Date Sampled:	10/5/94	5/12/94	5/12/94	5/12/94	5/12/94	5/12/94	5/12/94	5/12/94
ANIONS (meq/L)								
Alkalinity-HCO ₃	9.63	10.03	14.31	15.45	14.19	12.01	8.59	4.34
Alkalinity-CO ₃	0.00	0.10	0.00	0.00	0.00	0.12	0.00	0.00
Chloride IC	36.16	39.74	16.02	10.01	4.94	1.10	0.37	0.03
Fluoride SIE	0.16	0.16	0.21	0.21	0.32	0.32	0.16	0.02
Nitrate	0.00	0.00	0.00	0.00	0.32	0.32	0.16	0.02
Nitrate Brucine	0.00	0.00	0.01	0.00	0.00	0.01	0.00	0.00
Sulfate	0.00	0.00	0.77	0.73	0.83	0.81	0.29	0.13
Total Anions	45.95	50.03	31.31	26.40	20.60	14.69	9.57	4.53
CATIONS (meq/L)								
Calcium	0.50	0.43	0.20	0.14	0.09	0.06	0.05	0.11
Iron	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Magnesium	0.23	0.21	0.10	0.07	0.04	0.02	0.02	0.04
Potassium	0.00	0.14	0.08	0.07	0.06	0.05	0.04	0.05
Sodium	56.53	52.18	33.05	26.96	19.57	13.91	9.13	4.35
Total Cations	57.26	52.97	33.43	27.24	19.76	14.06	9.25	4.54
CHARGE BALANCE (%)	10.96	2.86	3.27	1.57	-2.07	-2.19	-1.71	0.14

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