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**Sampling Results, DNAPL Monitoring
Well GW-729, Oak Ridge Y-12 Plant,
Oak Ridge, Tennessee,
Third Quarter FY 1995
through Third Quarter FY 1996**

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FOR THE UNITED STATES
DEPARTMENT OF ENERGY

Energy Systems Environmental Restoration Program

**Sampling Results, DNAPL Monitoring
Well GW-729, Oak Ridge Y-12 Plant,
Oak Ridge, Tennessee,
Third Quarter FY 1995
through Third Quarter FY 1996**

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OAK RIDGE Y-12 PLANT
Oak Ridge, Tennessee 37831
managed by
LOCKHEED MARTIN ENERGY SYSTEMS, INC.
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PREFACE

This document, *Sampling Results, DNAPL Monitoring Well GW-729, Third Quarter FY 1995 through Third Quarter FY 1996*, 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 with groundwater concentrations for nonradionuclides in the vicinity of the Y-12 Burial Grounds. These data can be used to determine reference concentrations for intermediate and deep groundwater systems.

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ABBREVIATIONS

cps	counts per second
DNAPL	dense nonaqueous phase liquid
GC/MS	gas chromatography/mass spectroscopy
ICP	inductively coupled plasma (spectroscopy)
IC	ion chromatography
MCL	maximum contaminant level
MDA	minimum detectable activity
MP	multiport
ND	not detected
OD	outer diameter
PCB	polychlorinated biphenyl
PCE	tetrachloroethene
PVC	polyvinylchloride
TCA	trichloroethane
TCE	trichloroethene
TD	total depth
TDS	total dissolved solids
VOC	volatile organic compounds

EXECUTIVE SUMMARY

In January 1990, dense, nonaqueous phase liquids (DNAPLs) were discovered 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 and presents analytical results for one of these wells, GW-729.

To date, each of the 12 sampling zones in GW-729 has been sampled for volatile organic compounds, metals, and anions. Based on (1) the presence of TCE in the Maynardville portion of the well and (2) the presence of very low levels of benzene within the Nolichucky Shale, it is recommended that VOC monitoring of GW-729 be continued. Additional data are required to statistically confirm the presence or absence of VOCs through the use of "J" qualifiers.

In addition, nitrate monitoring will continue for zone 44. Purging activities will continue for the 10 deepest zones (2, 6, 9, 12, 15, 18, 22, 26, 30, and 34) to be followed by a second round of sampling. A comparison of the two sets of sampling results will be used to determine the need for a third round of purging. Any additional sampling from zones at the top of the well will be conducted without further purging, unless there is corroborative evidence that the water sample does not represent of the formation. There is a concern that excessive or unnecessary purging of units with low storativity, such as those in GW-729, will mobilize and extend contaminant plumes.

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.

1. INTRODUCTION

1.1 BACKGROUND AND PURPOSE

In January 1990, dense, nonaqueous phase liquids (DNAPLs), primarily polychlorinated biphenyls (PCBs), tetrachloroethene (PCE), trichloroethene (TCE), and 1,1,1-trichloroethane (TCA), were discovered approximately 274 ft below ground surface (bgs) 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 (VOCs) 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 (MP) wells. These wells (GW-726, GW-727, GW-729, 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 and presents analytical results for GW-729.

The purpose of the MP wells is twofold 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 DNAPL and dissolved DNAPL contamination exists. As such, the wells are intended to serve as an early warning system for dissolved plume migration.

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-729 is located downdip and grid-east along strike from the discovery of free-phase DNAPL and downdip from localities where secondary groundwater contaminant plumes associated with DNAPL accumulations have been intercepted by other groundwater monitoring wells. Construction logs for GW-729 are presented in a Science Applications International report (SAIC

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. GW-729 is highlighted because it is the subject of this report. Estimated locations of geologic contacts are shown.

1993), which the reader is referred to for a detailed construction history of the well. Condensed well construction information is presented in Table 1.

1.3 MULTI-PORT WELL DESCRIPTION

The DNAPL investigation MP 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 polyvinyl chloride (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 contains 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, they do not contain pumping ports and it is not possible to purge these intervals. Thus these zones have limited value for characterizing water chemistry.

1.4 GW-729 SAMPLING ZONES

The MP completion design for GW-729 is shown in Table 1. On the basis of core samples, geophysical logs and flowmeter results, 12 sampling zones, 10 to 25 ft long, were selected from GW-729. 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 2 specifically lists criteria for choosing sampling zones and is discussed more fully in Dreier and Caldanaro (1994). The installation history for GW-729 is documented in Westbay Instruments Inc. (1993).

The zones were chosen to sample at least one of the following features, listed 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 11 sampling zones in GW-729 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 zones 9 and 12. In addition, two more zones were installed in the underlying strata to investigate the potential for migration of DNAPL into the lower Nolichucky Shale.

Table 1. GW-729 construction and well design information

BOREHOLE CONSTRUCTION					
Surface Casing (ft bgs)		281.5			
Total Depth (ft bgs)		1361			
SURVEY COORDINATES			ELEVATIONS (ft msl)		
Grid System		Y-12	Ground surface		1002.5
Northing		28500.35	Top of concrete pad		NA
Easting		43656.67	Top of steel casing		1004.61
			Top of MP casing		1004.68
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 (msl) (ft)	Port depth bgs (ft)
1	1359-1364	1359	1354.7	-350.2	
2	1344-1354	1349	1344.7	-340.2	1354
3	1323-1339	1323	1318.7	-314.2	
4	1283-1318	1283	1278.7	-274.2	
5	1256-1278	1256	1251.7	-247.2	
6	1241-1251	1246	1241.7	-237.2	1251
7	1216-1236	1216	1211.7	-207.2	
8	1190-1211	1190	1185.7	-181.3	
9	1175-1185	1180	1175.8	-171.3	1185
10	1160-1170	1160	1155.9	-151.4	
11	1142-1155	1142	1137.9	-133.5	
12	1120-1137	1130	1126.0	-121.5	1137
13	1104-1115	1104	1101.1	-96.6	
14	1084-1099	1084	1081.2	-76.7	
15	1067-1079	1074	1071.2	-66.7	1079
16	1047-1062	1047	1044.3	-39.8	
17	1026-1042	1026	1023.3	-18.8	
18	1011-1021	1016	1013.3	-8.9	1021
19	986-1006	986	983.4	21.1	
20	961-981	961	958.5	46.0	
21	931-956	931	928.6	75.9	
22	911-926	921	918.6	85.9	926
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, which are marked in bold.					
NOTE: Only depths and not elevations are provided for the pumping ports because samples are not collected from these ports. Samples are collected from measurement ports.					
* MP = Westbay Multiport Casing, ags = above ground surface.					
* bgs = below ground surface, msl = mean sea level.					
* TOMP = Top of MP casing					

Table 1. cont.

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 (msl) (ft)	Port depth bgs (ft)
23	876-906	876	873.7	130.8	
24	841-871	841	838.8	165.7	
25	814-836	814	811.9	192.6	
26	797-809	802	799.9	204.6	809
27	772-792	772	770.0	234.5	
28	747-767	747	745.0	259.5	
29	725-742	725	723.1	281.4	
30	708-720	710	708.1	296.4	720
31	673-703	673	671.1	333.3	
32	638-668	638	636.2	368.3	
33	613-633	613	611.2	393.3	
34	598-608	603	601.2	403.2	608
35	573-593	573	571.3	433.2	
36	548-568	548	546.3	458.2	
37	518-543	518	516.3	488.1	
38	491-513	491	489.4	515.1	
39	476-486	481	479.4	525.1	486
40	440-471	440	439.4	565.1	
41	405-435	405	404.5	600.0	
42	365-400	365	364.5	640.0	
43	330-360	330	329.6	674.9	
44	315-325	320	319.6	684.9	325
45	0-310	300	299.6	704.9	
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, which are marked in bold.					
NOTE: Only depths and not elevations are provided for the pumping ports because samples are not collected from these ports. Samples are collected from measurement ports.					
* MP = Westbay Multiport Casing, ags = above ground surface.					
* bgs = below ground surface, msl = mean sea level.					
* TOMP = Top of MP casing

Figure 2. Generalized multiport well design.

Table 2. Sampling zones for GW-729

Multiport zone^a	Depth (ft.)^{b, c}	Samp. port depth (ft.)^{b, c}	Purpose	Logs/Core
44	315-325 (312-322)	320 (317)	Sample fracture(s)	core: Many fractures, euhedral (6), granular coating (17), staining (13), unlined (1) and incipient (1) logs: minor sonic log anomaly. stratigraphy: Maynardville Limestone zone 6
39	476-486 (472-482)	481 (477)	Sample fracture	core: Fractures at 473.4' and 478.3 ' logs: minor sonic anomaly stratigraphy: Maynardville Limestone zone 4/3 drilling: lost circulation
34	598-608 (594-604)	603 (599)	Sample fracture	core: Fracture 599.8'. Fracture mineralization shows solution weathering. Small vugs above fracture. logs: No fractures identified. stratigraphy: upper Nolichucky Shale
30	708-720 (704-716)	710 (706)	Sample fracture	core: 3 Fractures, all show euhedral crystals - two have pyrite logs: No fractures identified. stratigraphy: upper Nolichucky Shale
26	797-809 (793-805)	802 (798)	Sample potential conductive zone	core: broken shale, 795.2-795.3' logs: Temperature 793-805'; fluid resistivity 795-808'; minor sonic anomaly stratigraphy: middle Nolichucky Shale
22	911-926 (907-922)	921 (917)	Sample fracture.	core: both small and large euhedral fractures; 909', 917', & 921' logs: No fractures identified. stratigraphy: middle Nolichucky Shale
18	1011-1021 (1007-1017)	1016 (1012)	Sample potential fracture	core: No fractures identified. logs: Fluid resistivity, zone of large SP anomaly stratigraphy: middle Nolichucky Shale

Table 2. (cont.)

15	1067- 1079 (1063-1075)	1074 (1070)	Sample potential conductive zone.	core: Soft clayey shale 1064.2' ; 1069.2-1072.8', broken and soft shale logs: No fractures identified. stratigraphy: middle Nolichucky Shale
12	1120- 1137 (1115-1132)	1130 (1125)	Sample potential zone of DNAPL migration at base of middle Nolichucky Shale.	core: 1125' logs: No fractures identified. stratigraphy: base of middle Nolichucky Shale
9	1175- 1185 (1170-1180)	1180 (1175)	Sample potential zone of DNAPL migration at base of middle Nolichucky Shale.	core: Shale, broken 1175-1175.5' logs: No fractures identified. stratigraphy: base of middle Nolichucky Shale
6	1241- 1251 (1236-1246)	1246 (1241)	Sample fracture.	core: Fracture 1241.2' - Granular to large calcite crystals along fracture plane - possibly opened during drilling logs: geophysical logs not available stratigraphy: lower Nolichucky Shale
2	1344- 1354 (1343-1353)	1349 (1348)	Sample potential conductive zone	core: Fracture zone: 1348-1348.5' Pocked and porous saturated shale zone; partially lined fracture 1348.8' logs: geophysical logs not available 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-729. The region marked Potential DNAPL is not meant to imply that DNAPL occurs in this interval at this location. Rather, this zone correlates to the same stratigraphic interval at shallower depths up dip where DNAPL was visually observed and where dissolved phase plumes were identified.

2. PURGING AND SAMPLING ACTIVITIES

2.1 PURGING

Initial purging of the sample zones in GW-729 began in March 1994, approximately nine months after hydraulic heads had stabilized from MP installation, and continued through April 1996 (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 are 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. In particular, it was found that very low permeability zones could take several months or longer to produce the requisite volumes. Because of this, purging procedures were modified so that sampling activities could fit into a reasonable scheduling framework.

At present, each zone is purged for one month or until the recommended volume of water is produced, whichever occurs first. The zone is then sampled. If the zone does not produce enough water during the first round of purging, purging is continued for another month, to be followed by a second round of sampling. Additional purging requirements will be determined on a case-by-case basis, but in general, the removal of one annular volume for very low permeability zones at the base of the borehole may be considered adequate in the future.

Of twelve sampling zones in GW-729, only two produced the requisite three annular volumes. These zones (zones 39 and 44) are in the upper portion of the well and may indicate that permeability decreases with increasing depth. However, note that purge time for zone 39 was approximately 2 months. It is only the uppermost zone (zone 44) that appears to have the potential to purge rapidly (one day). Of the remaining 10 zones at the base of the well, 2 produced at least 1 annular volume (zones 2 and 26). Zone 9 was open for approximately 1 month and produced over 0.5 annular volume. Therefore, it is anticipated that with another round of month-long purging, this zone will be able to produce at least 1 annular volume. The remaining zones (6, 12, 15, 18, 22, 26, 30, 34) produced between 0.1 and 0.4 annular volume during approximately 1 month of purging.

2.2 SAMPLING

Samples are collected in two (or three) 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 MP wells. The Westbay Operation Manuals, which are available from the authors of this report, contain additional information on Westbay-specific sampling procedures.

Table 4 presents the field sampling protocol. Initially, each zone is sampled for anions, metals, VOCs, gross alpha/beta and field parameters (pH, specific conductance and temperature). The normal suite of anion analysis includes Cl, F, NO₃, and SO₄. If the specific conductance is greater than 2000 μ mho/cm, Br is added to the suite because its concentration may be above detection at

Table 3. GW-729 purge history

Zone	Packed-off Sampling Zone Height (ft)	Recom. purge volume (gals)*	1st Purge Date Opened	1st Purge Date Closed	Produced purge vol. (gals)	Total no. annular vols.	Difference of actual (-) recom. (gals)
2	11	14	12/6/95	4/24/96	8.6	1.9	-5
6	11	14	11/6/95	12/6/95	1.9	0.4	-12.0
9	11	14	9/26/95	11/6/95	3.3	0.7	-13.9
12	16	20	5/3/95	7/26/95	1.6	0.2	-20.2
15	13	16	3/8/95	4/10/95	0.3	0.1	-16.4
18	11	14	1/31/95	3/7/95	0.6	0.1	-13.9
22	16	20	12/28/94	1/18/95	2.3	0.3	-20.2
26	13	16	11/28/94	12/27/94	8.8	1.6	-16.4
30	13	16	10/11/94	11/28/94	2.0	0.4	-16.4
34	11	14	6/1/94	10/11/94	1.80	0.4	-12.1
39	11	14	3/14/95	5/31/94	16.00	3.5	2.1
44	11	14	3/9/94	3/9/94	15.00	3.2	1.1
<p>* 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" Zones shown in bold did not produce the requisite three annular volumes of formation water.</p>							

Table 4. Sampling and analysis plan.

High to Moderate Permeability								
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	N/A	YES	N/A	N/A	N/A
2	1	Metals	Plastic	100	YES	HNO3 (<2pH)	EPA-6010	ICP
2	1	Anions (Br*, Cl, Fl, NO3, SO4)	Plastic	100	YES	NONE	EPA-300.0	IC
2	2	Alkalinity	Plastic	100	YES	NONE	EPA-310.1	titration
3	1	VOC	Amber/Glass	40X2	NO	NONE	OLMO1.8	GC/MS
3	1&2	Gross Alpha and Beta	Plastic	250	BI	HNO3 (<2pH)	Y/P65-7162	Alpha/Beta proptrnl counter

Low Permeability**								
Sample		Parameter	Container	Volume	Filtered	Preservative	EPA	Analytical Method
Run No.	Bottle No.		Type	(ml)			Procedure No.	
1	1	Alkalinity	Plastic	50-100	YES	NONE	done in field OR EPA-310.1	titration
1	1	Anions (Br*, Cl, Fl, NO3, SO4)	Plastic	100	YES	NONE	EPA-300.0	ICP
1	2	pH	N/A	<250	YES	N/A	EPA-150.1	pH meter
1	2	Specific Conductance	N/A	<250	YES	N/A	EPA-120.1	conductivity meter
1	2	Temperature	N/A	<250	YES	N/A	EPA-170.1	thermometer
2	1	Metals	Plastic	100	YES	HNO3 (<2pH)	EPA-6010	ICP
2	2	VOC	Amber/Glass	40X2	NO	NONE	OLMO1.8	GC/MS
3	1&2	Gross Alpha and Beta	Plastic	250	BI	HNO3 (<2pH)	Y/P65-7162	Alpha/Beta proptrnl counter
<p>* Br analysis is requested if specific conductance is greater than 2000 umho/cm</p> <p>**Nitrogen gas used to aid sampling.</p> <p>•All samples cooled to 4 degrees celsius unless otherwise noted</p>								

elevated specific conductance levels. Additional sampling events are based on initial analytical results and are determined at the discretion of the project manager or project technical lead.

As of February 1995, several types of control samples are collected during sampling:

- A trip blank sample is obtained each time a VOC sample is collected.
- A field blank is prepared for 10% of the VOC sampling events.
- A duplicate sample is collected for 10% of all sampling events.
- An equipment rinsate, consisting of the final DI water rinse from the inside of the sample bottle, is collected for 10% of all sampling events. All zones in GW-729 were sampled after February 1995, and zone 44 is part of the 10% population used for duplicates or equipment rinsates.

If two sample bottles are used, 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. Two different protocols are used based on the suspected permeability of the sampling zone. For high to moderate permeability zones, 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. VOCs are collected last to maximize the number of sample bottle rinses with formation water.

A common occurrence with sampling low permeability zones is that the O-ring seal can be compromised around the measurement port. This can be determined by monitoring the water level in the MP casing. A drop in water level is attributed to water from the MP casing that moves past the O-rings, through the sample probe, and into the sample bottles. The resultant sample is a mixture of water from the annular space and from the MP casing. If this happens, the zone is treated as a "low permeability zone," and both the sampling order and collection method is modified (Table 4). Field parameters will be collected from the first-run, second (lower) bottle. This bottle will have the least amount of rinsing with formation waters. Alkalinity and anions will be collected from the first-run, first (upper) bottle. The remainder of the sample will be collected from the second run. As before, VOCs will not be sampled from the first run to ensure that the sample bottle is rinsed with formation water. If an O-ring seal is broken during sampling, water collected from the first run, second bottle will be used to re-rinse the bottle.

In low-permeability zones, the seal around the measurement port may be broken because (1) the zone could not produce enough water to maintain a sufficient fluid pressure or (2) there is a large pressure differential between the sample bottles, the MP casing water, and the formation water. The purpose of the modified sampling collection 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 between 50 and 110 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.

The sampling history for GW-729 is given in Table 5. Zones that show the low permeability characteristics mentioned above include zones 39 and below. Of these 11 zones, 10 did not produce the requisite purge water volumes in 4 weeks of purging (Table 3), which is another indication of low

permeability. In some cases, the field technician used a trial-and-error method to extract water from low permeability zones. Simply not evacuating the sample bottles worked satisfactorily in obtaining sufficient sample volumes for zones 2, 6, 9, 12, 18, 22, 26, 30, 34, and 39. Any potential problem associated with a headspace is minimized because the VOC sample is collected from the lowest bottle, which is the greatest distance from a potential headspace.

3. ANALYTICAL RESULTS

3.1 VOLATILE ORGANIC COMPOUNDS

A sample was collected for VOC analysis for each zone (Table 5). Trip blank data are given in Appendix A, and analysis results show that no VOCs were detected. Laboratory blank data are given in Appendix B; these also show that no VOCS were detected.

VOC results from the sample zones are presented in Appendix C and a list of 26 VOC detects is given in Table 6. Most detectable values are flagged with a "J" qualifier and represent low (1.0 - 10.0 mg/L) but discernible responses from the analytical instrumentation. Of the 26 VOC detects, only 2-butanone from zone 2 corresponds to the lab or trip blank associated with the sample. The remaining detects with "J" qualifiers include three for methylene chloride (a common laboratory reagent) in zones 9, 18 and 22; and benzene (or ethylbenzene) is observed in all but one of the zones below and including zone 34. Based on results from the other DNAPL monitoring wells (Dreier and Caldanaro 1996a, 1996b, 1996c, and 1996d), benzene appears to be a common detect in the low-permeability, deeper portions of the wells. It is possible the pervasive presence of benzene in trace amounts is due to the occurrence of natural hydrocarbons. However, benzene is a VOC of concern because it does occur in more than 5% of wells associated with the Y-12 Burial Grounds (HSW 1994). Other "J" qualifier detects are observed in zone 26 (2-butanone, chloroethane, and styrene). In contrast to most other sampling zones in GW-729, we were able to purge more than one annular volume from this zone, so it bears further monitoring.

Two other VOCs were observed at levels above a "J" qualifier: acetone and TCE. Acetone was observed at the base of the well in zones 2, 6, 9, 18 and 22. The occurrence of acetone at these depths is puzzling because it has not been observed in any of the other MP DNAPL wells (Dreier and Caldanaro 1996a, 1996b, 1996c, and 1996d), however it should be recognized that these zones did not fully purge and the presence of acetone may be a relict of drilling activities.

TCE is observed in the two uppermost zones (zones 39 and 44) at levels that are near the detection limit. Although observed in very low quantities, TCE is a contaminant that has been observed elsewhere in Bear Creek Valley, and we believe that this represents a part of the plume in the Maynardville Limestone that is associated with the S-3 Ponds. Both zones sample potential hydraulically active fractures within the Maynardville Limestone, and the evidence for active flow is more prominent for zone 44, which also showed higher VOC levels.

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 Table 7 and repeated in Appendix D. Two evaluation criteria are also presented in the appendix: (1) Tolerance limits (mg/L) as presented in HSW (1996) for cluster 6, which consists of sodium-chloride-bicarbonate groundwater and (2) available background screening levels listed in the Groundwater Quality Annual Report for Bear Creek Valley (HSW 1994). Both evaluation criteria are listed to preserve consistency with the four previous reports that present sampling results (Dreier and Caldanaro 1996a, 1996b, 1996c, and 1996d). These reports only compare trace metal results with background screening levels because the tolerance levels were published after these reports were distributed. Again, to preserve consistency, the discussion below is directed toward the screening levels presented in HSW 1994. The appendix does show however, where the change from screening level (HSW 1994) to tolerance level (HSW 1996) changed the status of a constituent. These changes occur because (1) the value of the trace metal is below the screening level but above the tolerance level; (2) a screening level was not available, but a tolerance level is available and (3) the tolerance level is below the analysis detection limit.

Detection limits are given as less than (<) values in Appendix D. Samples from zones 30 and below were diluted because of high ionic concentrations. All of these zones showed TDS values greater than 1500 mg/L and dilution rates vary as a function of TDS (listed in Appendix E): Zone 30 (TDS = 1860 mg/L) had the least dilution with a dilution factor of 10, and zone 2 (TDS = 207000 mg/L) had the greatest dilution with a dilution factor of 1000. It appears as though the dilution factors that were used for GW-729 are greater than those used for samples with comparable TDS from other MP wells (Dreier and Caldanaro 1996a, 1996b, 1996c, and 1996d). As a result of the dilutions, detection limits are raised, and some are raised above the background screening levels. This is the case for Al, Sb, Be, Cd, Cr, Co, Cu, Pb, Mo, Ni, Th, and V (see Appendix D). Note also in Appendix D that the undiluted sample detection limits listed for Sb, Pb, and Th are equivalent to the background screening level for that constituent. Nevertheless, all analytical results for constituents with background screening levels below detection limits are below the detection limit, even though concentrations are expected to rise with an increase in TDS.

Boron, iron, manganese, strontium, and zinc are above background screening levels for selected zones. The deepest sampling zone (zone 2) shows boron levels above the background screening levels (HSW 1994). This is in contrast to the other DNAPL MP monitoring wells where elevated boron was observed primarily in shallow portions of the well. In addition, zone 2, which has a TDS of 20700 mg/L, shows most of the other elevated levels about background. Except for zone 15, all the zones below a depth of 700 ft at the base of the borehole show elevated values of zinc that are above the background screening level of 0.079 mg/L.

Elemental strontium also shows concentrations above the background screening level. The elevated concentrations occur in the deepest 8 zones (zones 2, 6, 9, 12, 15, 18, 22 and 26) where there is also a corresponding increase in TDS. These zones show TDS values greater than 6300 mg/L. In addition, zones 30 and 39, with TDS values between 650 and 1900 mg/L also show elevated strontium. This is in contrast to the other MP monitoring wells where strontium only showed elevated values for a TDS greater than 3000 mg/L (Dreier and Caldanaro 1996a, 1996b, 1996c, and 1996d). The increase in strontium is apparently related to an increase in calcium, which can in part be related to an increase in TDS. This is suggested by the proportional correspondence between calcium and strontium concentrations (Fig. 4). Strontium will commonly substitute for calcium in carbonate minerals because they have the same valence state and a similar ionic radius.

Table 5. GW-729 sampling history.

Zone	Date	Parameters	Comments
2	5/1/92	VOC, gross alpha/beta Metals, Anions, Alk. field parameters	Bromide included with Anions Sample bottles were not evacuated (under vacuum) for sampling
6	5/1/92	VOC, gross alpha/beta Metals, Anions, Alk. field parameters	Bromide included with Anions Sample bottles were not evacuated (under vacuum) for sampling Volume retrieved from 3rd run not recorded.
9	4/24-25/96	VOC, gross alpha/beta Metals, Anions, Alk. field parameters	Bromide included with Anions Sample bottles were not evacuated (under vacuum) for sampling VOA and gross alpha collected from second trip, not the third trip sample water appears dirty with milky gray color. Valve appears to be clogged from sediment in sample.
12	4/23-24/96	VOC, gross alpha/beta Metals, Anions, Alk. field parameters	Bromide included with Anions Sample bottles were not evacuated (under vacuum) for sampling
15	5/9/91	VOC Metals, Anions, Alk. field parameters	Bromide included with Anions used nitrogen gas no separate rinsate run Volume retrieved from 3rd run not recorded.
18	6/12/91	VOC, gross alpha/beta Metals, Anions, Alk. field parameters	Bromide included with Anions Volume retrieved from 3rd run not recorded. Sample bottle was not evacuated (under vacuum) for the third run, which sampled for VOC and gross alpha beta.

Table 5. (cont.)

Zone	Date	Parameters	Comments
22	6/13/91	VOC, gross alpha/beta Metals, Anions, Alk. field parameters	Bromide included with Anions Volume retrieved from 3rd run not recorded. Sample bottles were not evacuated (under vacuum) for sampling
26	6/13/91	VOC, gross alpha/beta Metals, Anions, Alk. field parameters	Bromide included with Anions Volume retrieved from 3rd run not recorded. Sample bottles were not evacuated (under vacuum) for sampling
30	6/20/91	VOC, gross alpha/beta Metals, Anions, Alk. field parameters	Sample bottles were not evacuated (under vacuum) for sampling used 2 runs with three sample bottles attached in tandem.
34	6/20/91	VOC, gross alpha/beta Metals, Anions, Alk. field parameters	Sample bottles were not evacuated (under vacuum) for sampling used 2 runs with three sample bottles attached in tandem.
39	6/20/91	VOC, gross alpha/beta Metals, Anions, Alk. field parameters	Sample bottles were not evacuated (under vacuum) for sampling used 2 runs with three sample bottles attached in tandem.
44	6/7/91	VOC, gross alpha/beta Metals, Anions, Alk. field parameters	

Table 6. GW-729 VOC detects, including "J" qualifiers

Lab	Sample No.	Zone No.	Date Sampled	Analysis	Result	Tag	Units	Date Analyzed	Zone Depth (ft.)
	960503-047	2	2-May-96	2-Butanone	25.0	B	ug/L	7-May-96	1349
	960503-047	2	2-May-96	Acetone	22.0		ug/L	7-May-96	1349
	960503-046	6	2-May-96	Acetone	25.0		ug/L	7-May-96	1246
	960503-046	6	2-May-96	Benzene	2.0	J	ug/L	7-May-96	1246
	960425-084	9	25-Apr-96	Acetone	39.0		ug/L	29-Apr-96	1180
	960425-084	9	25-Apr-96	Benzene	2.0	J	ug/L	29-Apr-96	1180
	960425-084	9	25-Apr-96	Methylene Chloride	2.0	J	ug/L	29-Apr-96	1180
	950512-020	15	10-May-95	Benzene	3.0	J	ug/L	12-May-95	1074
	950614-111	18	13-Jun-95	Acetone	37.0		ug/L	19-Jun-95	1016
	950614-111	18	13-Jun-95	Benzene	2.0	J	ug/L	19-Jun-95	1016
	950614-111	18	13-Jun-95	Methylene Chloride	4.0	J	ug/L	19-Jun-95	1016
	950614-112	22	14-Jun-95	Acetone	17.0		ug/L	19-Jun-95	921
	950614-112	22	14-Jun-95	Benzene	2.0	J	ug/L	19-Jun-95	921
	950614-112	22	14-Jun-95	Methylene Chloride	4.0	J	ug/L	19-Jun-95	921
	950614-113	26	14-Jun-95	2-Butanone	8.0	J	ug/L	19-Jun-95	802
	950614-113	26	14-Jun-95	Benzene	1.0	J	ug/L	19-Jun-95	802
	950614-113	26	14-Jun-95	Chloroethane	3.0	J	ug/L	19-Jun-95	802
	950614-113	26	14-Jun-95	Ethylbenzene	1.0	J	ug/L	19-Jun-95	802
	950614-113	26	14-Jun-95	Styrene	2.0	J	ug/L	19-Jun-95	802
	941027-008	30	21-Jun-95	Ethylbenzene	1.0	J	ug/L	22-Jun-95	710
	950622-057	34	21-Jun-95	Benzene	5.0	J	ug/L	22-Jun-95	603
	950622-057	34	21-Jun-95	Chloroform	2.0	J	ug/L	22-Jun-95	603
	950622-058	39	21-Jun-95	Chloroform	1.0	J	ug/L	22-Jun-95	481
	950622-058	39	21-Jun-95	Trichloroethene	2.0	J	ug/L	22-Jun-95	481
	950608-128	44	8-Jun-95	Trichloroethene	13.0		ug/L	8-Jun-95	320
	950608-126	44D	8-Jun-95	Trichloroethene	9.0	J	ug/L	8-Jun-95	320
J = estimated									
B = analyte found at same concentration in blank as in sample									

Table 7. GW-729 trace metal analytical results

Well/Zone Number:			GW-729-2	GW-729-6	GW-729-9	GW-729-12	GW-729-15
Date Sampled:			5/2/96	5/2/96	4/24-25/96	4/23-24/96	5/10/95
METALS (mg/L)	Cluster 6 tolerance levels*	Screening levels*					
Aluminum	2.4	7.9	< 20.0 d	0.93	0.45	< 0.2 d	0.42
Antimony	<0.05	0.05	< 50.0 d	< 0.5 d	< 0.5 d	< 0.5 d	< 1.0 d
Arsenic	0.078	NA	< 50.0 d	< 0.5 d	< 0.5 d	< 0.5 d	< 1.0 d
Barium	0.34	NA	1200.0	21.0	14.0	3.7	6.8
Beryllium	0.00045	0.0019	< 0.3 d	< 0.003 d	< 0.003 d	< 0.003 d	< 0.006 d
Boron	3.1	0.57	6.0	0.35	0.21	0.35	0.38
Cadmium	0.0025	0.005	< 3.0 d	< 0.03 d	< 0.03 d	< 0.03 d	< 0.06 d
Chromium	0.043	NA	< <u>10.0</u> d	< <u>0.1</u> d	< <u>0.1</u> d	< <u>0.1</u> d	< <u>0.2</u> d
Cobalt	0.019	0.025	< 5.0 d	< 0.05 d	< 0.05 d	< 0.05 d	< 0.1 d
Copper	0.012	0.3	< 4.0 d	<u>0.073</u>	< <u>0.04</u> d	< <u>0.04</u> d	< <u>0.08</u> d
Iron	11	13.0	140.0	6.3	0.52	0.33	2.2
Lead	0.0096	0.05	< 50.0 d	< 0.5 d	< 0.5 d	< 0.5 d	< 1.0 d
Lithium	NA	NA	10.0	1.4	1.1	1.2	1.6
Manganese	1.7	2.7	21.0	0.9	0.49	0.09	0.24
Molybdenum	NA	0.01	< 10.0 d	< 0.1 d	< 0.1 d	< 0.1 d	< 0.2 d
Nickel	0.06	0.33	< 10.0 d	< <u>0.1</u> d	< <u>0.1</u> d	< <u>0.1</u> d	< <u>0.3</u>
Selenium	<0.05	NA	< <u>50.0</u> d	< <u>0.5</u> d	< <u>0.5</u> d	< <u>0.5</u> d	< <u>1.0</u> d
Silver	<0.006	NA	< <u>6.0</u> d	< <u>0.06</u> d	< <u>0.06</u> d	< <u>0.06</u> d	< <u>0.12</u> d
Strontium	0.92	0.83	4100.0	120.0	40.0	22.0	41.0
Thorium	<0.2	0.2	< 200.0 d	< 2.0 d	< 2.0 d	< 2.0 d	< 4.0 d
Vanadium	0.0044	0.058	< 5.0 d	< <u>0.05</u> d	< <u>0.05</u> d	< <u>0.05</u> d	< <u>0.1</u> d
Zinc	0.041	0.079	5.7	2.2	0.17	0.083	< 0.04 d
Dilution factor			1000	10	10	10	20

* Cluster 6 tolerance levels from HSW et.al., 1996. Screening levels obtained from HSW Environmental Consultants, 1994.

Levels listed are for ORR Aquitards.

** italicized values show a detection limit that is above the recommended screening level.

*** bold face values show levels that are above the detection limit and the screening level.

**** underlined values show a status change in caused by the switch from screening levels to tolerance levels. See text for discussion.

Table 7. (cont.)

Well/Zone Number:			GW-729-18	GW-729-22	GW-729-26	GW-729-30	GW-729-34
Date Sampled:			6/13/95	6/14/95	6/14/95	6/21/95	6/21/95
METALS (mg/L)	Cluster 6 tolerance levels*	Screening levels*					
Aluminum	2.4	7.9	0.51	0.34	< 0.4 d	< 0.2 d	0.022
Antimony	<0.05	0.05	< 0.5 d	< 0.5 d	< 1.0 d	< 0.5 d	< 0.05
Arsenic	0.078	NA	< 0.5 d	< 0.5 d	< 1.0 d	< 0.5 d	< 0.05
Barium	0.34	NA	2.8	4.2	4.0	0.1	0.027
Beryllium	0.00045	0.0019	< 0.003 d	< 0.003 d	< 0.006 d	< 0.003 d	< 0.0003
Boron	3.1	0.57	0.34	0.43	0.73	0.48	0.31
Cadmium	0.0025	0.005	< 0.03 d	< 0.03 d	< 0.06 d	< 0.03 d	< 0.003
Chromium	0.043	NA	<u>0.19</u>	<u>0.17</u>	<u>0.35</u>	<u>0.16</u>	< 0.01
Cobalt	0.019	0.025	< 0.05 d	< 0.05 d	< 0.1 d	< 0.05 d	< 0.005
Copper	0.012	0.3	< <u>0.04</u> d	< <u>0.04</u> d	< <u>0.08</u> d	< <u>0.04</u> d	< 0.004
Iron	11	13.0	1.9	1.5	2.4	0.81	0.034
Lead	0.0096	0.05	< 0.5 d	< 0.5 d	< 1.0 d	< 0.5 d	< <u>0.05</u>
Lithium	NA	NA	1.1	1.6	2.2	0.4	0.063
Manganese	1.7	2.7	0.2	0.12	0.11	0.027	0.0016
Molybdenum	NA	0.01	< 0.1 d	< 0.1 d	< 0.2 d	< 0.1 d	< 0.01
Nickel	0.06	0.33	<u>0.22</u>	<u>0.17</u>	<u>0.33</u>	<u>0.16</u>	< 0.01
Selenium	<0.05	NA	< <u>0.5</u> d	< <u>0.5</u> d	< <u>1.0</u> d	< <u>0.5</u> d	< 0.05
Silver	<0.006	NA	< <u>0.06</u> d	< <u>0.06</u> d	< <u>0.12</u> d	< <u>0.06</u> d	< 0.006
Strontium	0.92	0.83	19.0	25.0	25.0	0.99	0.21
Thorium	<0.2	0.2	< 2.0 d	< 2.0 d	< 4.0 d	< 2.0 d	< 0.2
Vanadium	0.0044	0.058	< <u>0.05</u> d	< <u>0.05</u> d	< <u>0.1</u> d	< <u>0.05</u> d	< <u>0.005</u>
Zinc	0.041	0.079	0.15	0.091	0.12	0.46	0.25
Dilution factor			10	10	20	10	1

* Cluster 6 tolerance levels from HSW et.al., 1996. Screening levels obtained from HSW Environmental Consultants, 1994.

Levels listed are for ORR Aquitards.

** italicized values show a detection limit that is above the recommended screening level.

*** bold face values show levels that are above the detection limit and the screening level.

**** underlined values show a status change in caused by the switch from screening levels to tolerance levels. See text for discussion.

Table 7. (cont.)

Well/Zone Number:			GW-729-39	GW-729-44	GW-729-44D
Date Sampled:			6/21/95	6/8/95	6/8/95
METALS (mg/L)	Cluster 6 tolerance levels*	Screening levels*			
Aluminum	2.4	7.9	0.054	0.049	0.042
Antimony	<0.05	0.05	< 0.05	< 0.05	< 0.05
Arsenic	0.078	NA	< 0.05	< 0.05	< 0.05
Barium	0.34	NA	0.58	0.15	0.19
Beryllium	0.00045	0.0019	< 0.0003	< 0.0003	< 0.0003
Boron	3.1	0.57	0.086	0.029	0.049
Cadmium	0.0025	0.005	< 0.003	< 0.003	< 0.003
Chromium	0.043	NA	< 0.01	< 0.01	< 0.01
Cobalt	0.019	0.025	< 0.005	< 0.005	< 0.005
Copper	0.012	0.3	< 0.004	< 0.004	< 0.004
Iron	11	13.0	0.037	0.012	0.0074
Lead	0.0096	0.05	< <u>0.05</u>	< <u>0.05</u>	< <u>0.05</u>
Lithium	NA	NA	0.054	0.0099	0.012
Manganese	1.7	2.7	0.035	0.16	0.15
Molybdenum	NA	0.01	< 0.01	< 0.01	< 0.01
Nickel	0.06	0.33	< 0.01	< 0.01	< 0.01
Selenium	<0.05	NA	< 0.05	< 0.05	< 0.05
Silver	<0.006	NA	< 0.006	< 0.006	< 0.006
Strontium	0.92	0.83	1.9	0.49	0.55
Thorium	<0.2	0.2	< 0.2	< 0.2	< 0.2
Vanadium	0.0044	0.058	< <u>0.005</u>	< <u>0.005</u>	< <u>0.005</u>
Zinc	0.041	0.079	0.024	0.031	0.19
Dilution factor			1	1	1

* Cluster 6 tolerance levels from HSW et.al., 1996. Screening levels obtained from HSW Environmental Consultants, 1994.

Levels listed are for ORR Aquitards.

** italicized values show a detection limit that is above the recommended screening level.

*** bold face values show levels that are above the detection limit and the screening level.

**** underlined values show a status change in caused by the switch from screening levels to tolerance levels. See text for discussion.

Figure 4. Plot of strontium vs. calcium concentrations from GW-729. The Sr/Ca ratio average is 0.11 and ranges from 0.008 to 0.158.

3.3 RADIONUCLIDES

In May 1995, a decision was made by Y-12 ER staff to include gross alpha/beta analysis in the standard suite of samples, and this parameter was immediately added to the sampling program for radionuclide screening purposes. Zone 15 had already been sampled at this time. Therefore, gross alpha/beta data is available for each sampling zone except for zone 15 (Appendix E). All gross alpha and gross beta values are below the listed MDA for that sample, however the MDA's vary considerably. During the period that this well was sampled, modifications were made at the laboratory regarding reporting MDA values (HSW 1995). Therefore we give greater credence to MDA values for the bottom four zones, which were sampled in calendar year 1996.

3.4 MAJOR ELEMENT WATER CHEMISTRY

Major element water chemistry and field parameters are given in Appendix F, and charge balance information is given in Appendix G. Of immediate note is the presence of low concentrations of nitrate in zone 44. This is the same zone that showed detectable levels of TCE. This zone does not show a stratigraphic correlation with the DNAPL discovery in GW-625 and presumably represents a western edge of the S-3 Plume within the Maynardville Limestone.

Water chemistry types are shown in Fig. 5. There is an abrupt change in water type with depth from a relatively shallow mixed cation- HCO_3 type water to a deep Na-Cl type water. The uppermost zone (zone 44 at a depth of 320 ft) is a mixed cation- HCO_3 type water. In contrast to the other MP monitoring wells, the change in water type does not correspond to a large increase in TDS (Fig. 5). In the other wells, Na-Cl type water was associated with a minimum TDS value of 2000 mg/L (GW-730), however this well shows Na-Cl type water with a TDS value less than 1000 mg/L. There may be some correlation between the presence of fractures and TDS values, but this requires further evaluation of the MP data from all five wells.

4. 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 twelve sampling zones in GW-729 has been sampled for VOCs, metals and anions. Based on (1) the presence of TCE in the Maynardville portion of the well and (2) the presence of very low levels of benzene within the Nolichucky Shale, it is recommended that VOC monitoring of GW-729 be continued. Additional data are required to statistically confirm the presence or absence of VOCs through the use of "J" qualifiers. In addition, nitrate monitoring will continue for zone 44. Purging activities will continue for the deepest 10 zones (2, 6, 9, 12, 15, 18, 22, 26, 30 and 34) to be followed by a second round of sampling. A comparison of the two sets of sampling results will be used

Figure 5. Piper diagram of GW-729 water chemistry. It should be noted that zones 2 and 15 were plotted for comparison purposes only. Zones 2 and 15 both had charge balances greater than $\pm 10\%$.

to determine the need for a third round of purging. Any additional sampling from zones at the top of the well will be conducted without further purging, 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-729, will mobilize and extend contaminant plumes.

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Appendix A:

TRIP BLANK VOC ANALYTICAL RESULTS

GW-729 Trip Blank VOC Analytical Results.

Sample Number:	950512-021	950608-129	950614-114	950622-059
Trip Date:	5/10/95	6/8/95	6/14/95	6/21/95
Date Analyzed:	5/12/95	6/12/95	6/20/95	6/22/95
Units:	ug/L	ug/L	ug/L	ug/L
1,1,1-Trichloroethane	< 10.0	< 10.0	< 10.0	< 10.0
1,1,2,2-Tetrachloroethane	< 10.0	< 10.0	< 10.0	< 10.0
1,1,2-Trichloroethane	< 10.0	< 10.0	< 10.0	< 10.0
1,1-Dichloroethane	< 10.0	< 10.0	< 10.0	< 10.0
1,1-Dichloroethene	< 10.0	< 10.0	< 10.0	< 10.0
1,2-Dichloroethane	< 10.0	< 10.0	< 10.0	< 10.0
1,2-Dichloroethene (total)	< 10.0	< 10.0	< 10.0	< 10.0
1,2-Dichloropropane	< 10.0	< 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	< 10.0	< 10.0	< 10.0	< 10.0
Bromodichloromethane	< 10.0	< 10.0	< 10.0	< 10.0
Bromoform	< 10.0	< 10.0	< 10.0	< 10.0
Bromomethane	< 10.0	< 10.0	< 10.0	< 10.0
Carbon Disulfide	< 10.0	< 10.0	< 10.0	< 10.0
Carbon Tetrachloride	< 10.0	< 10.0	< 10.0	< 10.0
Chlorobenzene	< 10.0	< 10.0	< 10.0	< 10.0
Chloroethane	< 10.0	< 10.0	< 10.0	< 10.0
Chloroform	< 10.0	< 10.0	< 10.0	< 10.0
Chloromethane	< 10.0	< 10.0	< 10.0	< 10.0
Dibromochloromethane	< 10.0	< 10.0	< 10.0	< 10.0
Ethylbenzene	< 10.0	< 10.0	< 10.0	< 10.0
Methylene Chloride	< 10.0	< 10.0	< 10.0	< 10.0
Styrene	< 10.0	< 10.0	< 10.0	< 10.0
Tetrachloroethene	< 10.0	< 10.0	< 10.0	< 10.0
Toluene	< 10.0	< 10.0	< 10.0	< 10.0
Trichloroethene	< 10.0	< 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)	< 10.0	< 10.0	< 10.0	< 10.0
cis-1,3-Dichloropropene	< 10.0	< 10.0	< 10.0	< 10.0
trans-1,3-Dichloropropene	< 10.0	< 10.0	< 10.0	< 10.0

GW-729 Trip Blank VOC Analytical Results.

Sample Number:	960425-085	960503-048
Trip Date:	4/23/96	5/2/96
Date Analyzed:	4/29/96	5/7/96
Units:	ug/L	ug/L
1,1,1-Trichloroethane	< 10	< 10
1,1,2,2-Tetrachloroethane	< 10	< 10
1,1,2-Trichloroethane	< 10	< 10
1,1-Dichloroethane	< 10	< 10
1,1-Dichloroethene	< 10	< 10
1,2-Dichloroethane	< 10	< 10
1,2-Dichloroethene (total)	< 10	< 10
1,2-Dichloropropane	< 10	< 10
2-Butanone	< 10	< 10
2-Hexanone	< 10	< 10
4-Methyl-2-pentanone	< 10	< 10
Acetone	< 10	< 10
Benzene	< 10	< 10
Bromodichloromethane	< 10	< 10
Bromoform	< 10	< 10
Bromomethane	< 10	< 10
Carbon Disulfide	< 10	< 10
Carbon Tetrachloride	< 10	< 10
Chlorobenzene	< 10	< 10
Chloroethane	< 10	< 10
Chloroform	< 10	< 10
Chloromethane	< 10	< 10
Dibromochloromethane	< 10	< 10
Ethylbenzene	< 10	< 10
Methylene Chloride	< 10	< 10
Styrene	< 10	< 10
Tetrachloroethene	< 10	< 10
Toluene	< 10	< 10
Trichloroethene	< 10	< 10
Vinyl Acetate	< 10	< 10
Vinyl Chloride	< 10	< 10
Xylene (total)	< 10	< 10
cis-1,3-Dichloropropene	< 10	< 10
trans-1,3-Dichloropropene	< 10	< 10

Appendix B :

LABORATORY BLANK VOC ANALYTICAL RESULTS

GW-729 Laboratory Blank VOC Analytical Results.

Sample Number:	950512-028	950612-008	950619-001	950620-005*	950622-022	960429-001	960507-012
Date Completed:	5/18/95	6/12/95	6/19/95	6/20/95	6/22/95	4/29/96	5/7/96
Units:	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
1,1,1-Trichloroethane	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10	< 10
1,1,2,2-Tetrachloroethane	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10	< 10
1,1,2-Trichloroethane	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10	< 10
1,1-Dichloroethane	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10	< 10
1,1-Dichloroethene	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10	< 10
1,2-Dichloroethane	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10	< 10
1,2-Dichloroethene (total)	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10	< 10
1,2-Dichloropropane	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10	< 10
2-Butanone	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	10	10 J
2-Hexanone	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10	< 10
4-Methyl-2-pentanone	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10	< 10
Acetone	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10	< 10
Benzene	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10	< 10
Bromodichloromethane	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10	< 10
Bromoform	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10	< 10
Bromomethane	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10	< 10
Carbon Disulfide	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10	< 10
Carbon Tetrachloride	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10	< 10
Chlorobenzene	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10	< 10
Chloroethane	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10	< 10
Chloroform	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10	< 10
Chloromethane	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10	< 10
Dibromochloromethane	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10	< 10
Ethylbenzene	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10	< 10
Methylene Chloride	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10	< 10
Styrene	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10	< 10
Tetrachloroethene	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10	< 10
Toluene	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10	< 10
Trichloroethene	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10	< 10
Vinyl Acetate	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10	< 10
Vinyl Chloride	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10	< 10
Xylene (total)	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10	< 10
cis-1,3-Dichloropropene	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10	< 10
trans-1,3-Dichloropropene	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10	< 10

*Lab Blank for Trip Blank sample 950614-114

Appendix C:
VOC ANALYTICAL RESULTS

GW-729 VOC Analytical Results

Well/Zone Number:	GW-729-2	GW-729-6	GW-729-9	GW-729-12
Sample Number:	960503-047	960503-046	960425-084	960425-083
Date Sampled:	5/2/96	5/2/96	4/25/96	4/24/96
Date Analyzed:	5/7/96	5/7/96	4/29/96	4/29/96
Corresponding Trip Blank:	960503-048	960503-048	960425-085	960425-085
Corresponding Lab Blank:	960507-012	960507-012	960429-001	960429-001
VOLATILE ORGANICS (µg/L)				
1,1,1-Trichloroethane	< 10.0	< 10.0	< 10.0	< 10.0
1,1,2,2-Tetrachloroethane	< 10.0	< 10.0	< 10.0	< 10.0
1,1,2-Trichloroethane	< 10.0	< 10.0	< 10.0	< 10.0
1,1-Dichloroethane	< 10.0	< 10.0	< 10.0	< 10.0
1,1-Dichloroethene	< 10.0	< 10.0	< 10.0	< 10.0
1,2-Dichloroethane	< 10.0	< 10.0	< 10.0	< 10.0
1,2-Dichloroethene (total)	< 10.0	< 10.0	< 10.0	< 10.0
1,2-Dichloropropane	< 10.0	< 10.0	< 10.0	< 10.0
2-Butanone	25.0 B	< 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	22.0	25.0	39.0	< 10.0
Benzene	< 10.0	2.0 J	2.0 J	3.0 J
Bromodichloromethane	< 10.0	< 10.0	< 10.0	< 10.0
Bromoform	< 10.0	< 10.0	< 10.0	< 10.0
Bromomethane	< 10.0	< 10.0	< 10.0	< 10.0
Carbon Disulfide	< 10.0	< 10.0	< 10.0	< 10.0
Carbon Tetrachloride	< 10.0	< 10.0	< 10.0	< 10.0
Chlorobenzene	< 10.0	< 10.0	< 10.0	< 10.0
Chloroethane	< 10.0	< 10.0	< 10.0	< 10.0
Chloroform	< 10.0	< 10.0	< 10.0	< 10.0
Chloromethane	< 10.0	< 10.0	< 10.0	< 10.0
Dibromochloromethane	< 10.0	< 10.0	< 10.0	< 10.0
Ethylbenzene	< 10.0	< 10.0	< 10.0	< 10.0
Methylene Chloride	< 10.0	< 10.0	2.0 J	< 10.0
Styrene	< 10.0	< 10.0	< 10.0	< 10.0
Tetrachloroethene	< 10.0	< 10.0	< 10.0	< 10.0
Toluene	< 10.0	< 10.0	< 10.0	< 10.0
Trichloroethene	< 10.0	< 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)	< 10.0	< 10.0	< 10.0	< 10.0
cis-1,3-Dichloropropene	< 10.0	< 10.0	< 10.0	< 10.0
trans-1,3-Dichloropropene	< 10.0	< 10.0	< 10.0	< 10.0

(Continued...)

GW-729 VOC Analytical Results

Well/Zone Number:	GW-729-15	GW-729-18	GW-729-22	GW-729-26
Sample Number:	950512-020	950614-111	950614-112	950614-113
Date Sampled:	5/10/95	6/13/95	6/14/95	6/14/95
Date Analyzed:	5/12/95	6/19/95	6/19/95	6/19/95
Corresponding Trip Blank:	950512-021	950614-114	950614-114	950614-114
Corresponding Lab Blank:	950512-028	950619-001	950619-001	950619-001
VOLATILE ORGANICS (µg/L)				
1,1,1-Trichloroethane	< 10.0	< 10.0	< 10.0	< 10.0
1,1,2,2-Tetrachloroethane	< 10.0	< 10.0	< 10.0	< 10.0
1,1,2-Trichloroethane	< 10.0	< 10.0	< 10.0	< 10.0
1,1-Dichloroethane	< 10.0	< 10.0	< 10.0	< 10.0
1,1-Dichloroethene	< 10.0	< 10.0	< 10.0	< 10.0
1,2-Dichloroethane	< 10.0	< 10.0	< 10.0	< 10.0
1,2-Dichloroethene (total)	< 10.0	< 10.0	< 10.0	< 10.0
1,2-Dichloropropane	< 10.0	< 10.0	< 10.0	< 10.0
2-Butanone	< 10.0	< 10.0	< 10.0	8.0 J
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	37.0	17.0	< 10.0
Benzene	3.0 J	2.0 J	2.0 J	1.0 J
Bromodichloromethane	< 10.0	< 10.0	< 10.0	< 10.0
Bromoform	< 10.0	< 10.0	< 10.0	< 10.0
Bromomethane	< 10.0	< 10.0	< 10.0	< 10.0
Carbon Disulfide	< 10.0	< 10.0	< 10.0	< 10.0
Carbon Tetrachloride	< 10.0	< 10.0	< 10.0	< 10.0
Chlorobenzene	< 10.0	< 10.0	< 10.0	< 10.0
Chloroethane	< 10.0	< 10.0	< 10.0	3.0 J
Chloroform	< 10.0	< 10.0	< 10.0	< 10.0
Chloromethane	< 10.0	< 10.0	< 10.0	< 10.0
Dibromochloromethane	< 10.0	< 10.0	< 10.0	< 10.0
Ethylbenzene	< 10.0	< 10.0	< 10.0	1.0 J
Methylene Chloride	< 10.0	4.0 J	4.0 J	< 10.0
Styrene	< 10.0	< 10.0	< 10.0	2.0 J
Tetrachloroethene	< 10.0	< 10.0	< 10.0	< 10.0
Toluene	< 10.0	< 10.0	< 10.0	< 10.0
Trichloroethene	< 10.0	< 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)	< 10.0	< 10.0	< 10.0	< 10.0
cis-1,3-Dichloropropene	< 10.0	< 10.0	< 10.0	< 10.0
trans-1,3-Dichloropropene	< 10.0	< 10.0	< 10.0	< 10.0

(Continued...)

GW-729 VOC Analytical Results

Well/Zone Number:	GW-729-30	GW-729-34	GW-729-39	GW-729-44
Sample Number:	950622-056	950622-057	950622-058	950608-128
Date Sampled:	6/21/95	6/21/95	6/21/95	6/8/95
Date Analyzed:	6/22/95	6/22/95	6/22/95	6/12/95
Corresponding Trip Blank:	950622-059	950622-059	950622-059	950608-129
Corresponding Lab Blank:	950622-022	950622-022	950622-022	950612-008
VOLATILE ORGANICS (µg/L)				
1,1,1-Trichloroethane	< 10.0	< 10.0	< 10.0	< 10.0
1,1,2,2-Tetrachloroethane	< 10.0	< 10.0	< 10.0	< 10.0
1,1,2-Trichloroethane	< 10.0	< 10.0	< 10.0	< 10.0
1,1-Dichloroethane	< 10.0	< 10.0	< 10.0	< 10.0
1,1-Dichloroethene	< 10.0	< 10.0	< 10.0	< 10.0
1,2-Dichloroethane	< 10.0	< 10.0	< 10.0	< 10.0
1,2-Dichloroethene (total)	< 10.0	< 10.0	< 10.0	< 10.0
1,2-Dichloropropane	< 10.0	< 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	< 10.0	5.0 J	< 10.0	< 10.0
Bromodichloromethane	< 10.0	< 10.0	< 10.0	< 10.0
Bromoform	< 10.0	< 10.0	< 10.0	< 10.0
Bromomethane	< 10.0	< 10.0	< 10.0	< 10.0
Carbon Disulfide	< 10.0	< 10.0	< 10.0	< 10.0
Carbon Tetrachloride	< 10.0	< 10.0	< 10.0	< 10.0
Chlorobenzene	< 10.0	< 10.0	< 10.0	< 10.0
Chloroethane	< 10.0	< 10.0	< 10.0	< 10.0
Chloroform	< 10.0	2.0 J	1.0 J	< 10.0
Chloromethane	< 10.0	< 10.0	< 10.0	< 10.0
Dibromochloromethane	< 10.0	< 10.0	< 10.0	< 10.0
Ethylbenzene	1.0 J	< 10.0	< 10.0	< 10.0
Methylene Chloride	< 10.0	< 10.0	< 10.0	< 10.0
Styrene	< 10.0	< 10.0	< 10.0	< 10.0
Tetrachloroethene	< 10.0	< 10.0	< 10.0	< 10.0
Toluene	< 10.0	< 10.0	< 10.0	< 10.0
Trichloroethene	< 10.0	< 10.0	2.0 J	13.0
Vinyl Acetate	< 10.0	< 10.0	< 10.0	< 10.0
Vinyl Chloride	< 10.0	< 10.0	< 10.0	< 10.0
Xylene (total)	< 10.0	< 10.0	< 10.0	< 10.0
cis-1,3-Dichloropropene	< 10.0	< 10.0	< 10.0	< 10.0
trans-1,3-Dichloropropene	< 10.0	< 10.0	< 10.0	< 10.0

(Continued...)

GW-729 VOC Analytical Results

Well/Zone Number:	GW-729-44D	GW-729-44FB	GW-729-44ER
Sample Number:	950608-126	950608-127	950608-125
Date Sampled:	6/8/95	6/8/95	6/8/95
Date Analyzed:	6/12/95	6/12/95	6/12/95
Corresponding Trip Blank:	950608-129	950608-129	950608-129
Corresponding Lab Blank:	950612-008	950612-008	950612-008
VOLATILE ORGANICS (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	9.0 J	< 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 D:
TRACE METAL ANALYTICAL RESULTS

GW-729 Trace Metal Analytical Results

Well/Zone Number:			GW-729-2	GW-729-6	GW-729-9	GW-729-12	GW-729-15
Date Sampled:			5/2/96	5/2/96	4/24-25/96	4/23-24/96	5/10/95
METALS (mg/L)	Cluster 6 tolerance levels*	Screening levels*					
Aluminum	2.4	7.9	< 20.0 d	0.93	0.45	< 0.2 d	0.42
Antimony	<0.05	0.05	< 50.0 d	< 0.5 d	< 0.5 d	< 0.5 d	< 1.0 d
Arsenic	0.078	NA	< 50.0 d	< 0.5 d	< 0.5 d	< 0.5 d	< 1.0 d
Barium	0.34	NA	1200.0	21.0	14.0	3.7	6.8
Beryllium	0.00045	0.0019	< 0.3 d	< 0.003 d	< 0.003 d	< 0.003 d	< 0.006 d
Boron	3.1	0.57	6.0	0.35	0.21	0.35	0.38
Cadmium	0.0025	0.005	< 3.0 d	< 0.03 d	< 0.03 d	< 0.03 d	< 0.06 d
Chromium	0.043	NA	< 10.0 d	< 0.1 d	< 0.1 d	< 0.1 d	< 0.2 d
Cobalt	0.019	0.025	< 5.0 d	< 0.05 d	< 0.05 d	< 0.05 d	< 0.1 d
Copper	0.012	0.3	< 4.0 d	<u>0.073</u>	< 0.04 d	< 0.04 d	< 0.08 d
Iron	11	13.0	140.0	6.3	0.52	0.33	2.2
Lead	0.0096	0.05	< 50.0 d	< 0.5 d	< 0.5 d	< 0.5 d	< 1.0 d
Lithium	NA	NA	10.0	1.4	1.1	1.2	1.6
Manganese	1.7	2.7	21.0	0.9	0.49	0.09	0.24
Molybdenum	NA	0.01	< 10.0 d	< 0.1 d	< 0.1 d	< 0.1 d	< 0.2 d
Nickel	0.06	0.33	< 10.0 d	< 0.1 d	< 0.1 d	< 0.1 d	< 0.3 d
Selenium	<0.05	NA	< 50.0 d	< 0.5 d	< 0.5 d	< 0.5 d	< 1.0 d
Silver	<0.006	NA	< 6.0 d	< 0.06 d	< 0.06 d	< 0.06 d	< 0.12 d
Strontium	0.92	0.83	4100.0	120.0	40.0	22.0	41.0
Thorium	<0.2	0.2	< 200.0 d	< 2.0 d	< 2.0 d	< 2.0 d	< 4.0 d
Vanadium	0.0044	0.058	< 5.0 d	< 0.05 d	< 0.05 d	< 0.05 d	< 0.1 d
Zinc	0.041	0.079	5.7	2.2	0.17	0.083	< 0.04 d
Dilution factor			1000	10	10	10	20

* Cluster 6 tolerance levels from HSW et.al., 1996. Screening levels obtained from HSW Environmental Consultants, 1994.

Levels listed are for ORR Aquitards.

** italicized values show a detection limit that is above the recommended screening level.

*** bold face values show levels that are above the detection limit and the screening level.

**** underlined values show a status change in caused by the switch from screening levels to tolerance levels. See text for discussion.

GW-729 Trace Metal Analytical Results

Well/Zone Number:			GW-729-18	GW-729-22	GW-729-26	GW-729-30	GW-729-34
Date Sampled:			6/13/95	6/14/95	6/14/95	6/21/95	6/21/95
METALS (mg/L)	Cluster 6 tolerance levels*	Screening levels*					
Aluminum	2.4	7.9	0.51	0.34	< 0.4 d	< 0.2 d	0.022
Antimony	<0.05	0.05	< 0.5 d	< 0.5 d	< 1.0 d	< 0.5 d	< 0.05
Arsenic	0.078	NA	< 0.5 d	< 0.5 d	< 1.0 d	< 0.5 d	< 0.05
Barium	0.34	NA	2.8	4.2	4.0	0.1	0.027
Beryllium	0.00045	0.0019	< 0.003 d	< 0.003 d	< 0.006 d	< 0.003 d	< 0.0003
Boron	3.1	0.57	0.34	0.43	0.73	0.48	0.31
Cadmium	0.0025	0.005	< 0.03 d	< 0.03 d	< 0.06 d	< 0.03 d	< 0.003
Chromium	0.043	NA	<u>0.19</u>	<u>0.17</u>	<u>0.35</u>	<u>0.16</u>	< 0.01
Cobalt	0.019	0.025	< 0.05 d	< 0.05 d	< 0.1 d	< 0.05 d	< 0.005
Copper	0.012	0.3	< <u>0.04</u> d	< <u>0.04</u> d	< <u>0.08</u> d	< <u>0.04</u> d	< 0.004
Iron	11	13.0	1.9	1.5	2.4	0.81	0.034
Lead	0.0096	0.05	< 0.5 d	< 0.5 d	< 1.0 d	< 0.5 d	< <u>0.05</u>
Lithium	NA	NA	1.1	1.6	2.2	0.4	0.063
Manganese	1.7	2.7	0.2	0.12	0.11	0.027	0.0016
Molybdenum	NA	0.01	< 0.1 d	< 0.1 d	< 0.2 d	< 0.1 d	< 0.01
Nickel	0.06	0.33	<u>0.22</u>	<u>0.17</u>	<u>0.33</u>	<u>0.16</u>	< 0.01
Selenium	<0.05	NA	< <u>0.5</u> d	< <u>0.5</u> d	< <u>1.0</u> d	< <u>0.5</u> d	< 0.05
Silver	<0.006	NA	< <u>0.06</u> d	< <u>0.06</u> d	< <u>0.12</u> d	< <u>0.06</u> d	< 0.006
Strontium	0.92	0.83	19.0	25.0	25.0	0.99	0.21
Thorium	<0.2	0.2	< 2.0 d	< 2.0 d	< 4.0 d	< 2.0 d	< 0.2
Vanadium	0.0044	0.058	< <u>0.05</u> d	< <u>0.05</u> d	< <u>0.1</u> d	< <u>0.05</u> d	< <u>0.005</u>
Zinc	0.041	0.079	0.15	0.091	0.12	0.46	0.25
Dilution factor			10	10	20	10	1

* Cluster 6 tolerance levels from HSW et.al., 1996. Screening levels obtained from HSW Environmental Consultants, 1994.

Levels listed are for ORR Aquitards.

** italicized values show a detection limit that is above the recommended screening level.

*** bold face values show levels that are above the detection limit and the screening level.

**** underlined values show a status change in caused by the switch from screening levels to tolerance levels. See text for discussion.

GW-729 Trace Metal Analytical Results

Well/Zone Number:			GW-729-39	GW-729-44	GW-729-44D	GW-729-44FB	GW-729-44ER
Date Sampled:			6/21/95	6/8/95	6/8/95	6/8/95	6/8/95
METALS (mg/L)	Cluster 6 tolerance levels*	Screening levels*					
Aluminum	2.4	7.9	0.054	0.049	0.042	0.026	0.022
Antimony	<0.05	0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Arsenic	0.078	NA	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Barium	0.34	NA	0.58	0.15	0.19	< 0.001	< 0.001
Beryllium	0.00045	0.0019	< 0.0003	< 0.0003	< 0.0003	< 0.0003	< 0.0003
Boron	3.1	0.57	0.086	0.029	0.049	0.0086	0.023
Cadmium	0.0025	0.005	< 0.003	< 0.003	< 0.003	< 0.003	< 0.003
Chromium	0.043	NA	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Cobalt	0.019	0.025	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Copper	0.012	0.3	< 0.004	< 0.004	< 0.004	0.004	< 0.004
Iron	11	13.0	0.037	0.012	0.0074	0.045	< 0.005
Lead	0.0096	0.05	< <u>0.05</u>	< <u>0.05</u>	< <u>0.05</u>	< <u>0.05</u>	< <u>0.05</u>
Lithium	NA	NA	0.054	0.0099	0.012	< 0.004	< 0.004
Manganese	1.7	2.7	0.035	0.16	0.15	< 0.001	< 0.001
Molybdenum	NA	0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Nickel	0.06	0.33	< 0.01	< 0.01	< 0.01	0.01	< 0.01
Selenium	<0.05	NA	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Silver	<0.006	NA	< 0.006	< 0.006	< 0.006	< 0.006	< 0.006
Strontium	0.92	0.83	1.9	0.49	0.55	< 0.0004	< 0.0004
Thorium	<0.2	0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
Vanadium	0.0044	0.058	< <u>0.005</u>	< <u>0.005</u>	< <u>0.005</u>	< <u>0.005</u>	< <u>0.005</u>
Zinc	0.041	0.079	0.024	0.031	0.19	0.014	0.007
Dilution factor			1	1	1	1	1

* Cluster 6 tolerance levels from HSW et.al., 1996. Screening levels obtained from HSW Environmental Consultants, 1994.

Levels listed are for ORR Aquitards.

** italicized values show a detection limit that is above the recommended screening level.

*** bold face values show levels that are above the detection limit and the screening level.

**** underlined values show a status change in caused by the switch from screening levels to tolerance levels. See text for discussion.

Appendix E:

GROSS ALPHA/BETA ANALYTICAL RESULTS

GW-729 Gross Alpha/Beta Analytical Results*

Well/Zone Number:	GW-729-2	GW-729-6	GW-729-9	GW-729-12	GW-729-18	GW-729-22	GW-729-26
Sample Number:	960503-047	960503-046	960425-084	960425-083	950614-111	950614-112	950614-113
Date Sampled:	5/2/96	5/2/96	4/25/96	4/24/96	6/13/95	6/14/95	6/14/95
Date Analyzed:	5/31/96	5/31/96	5/15/96	5/15/96	7/10/95	7/10/95	7/10/95
Units:	(pCi/L)	(pCi/L)	(pCi/L)	(pCi/L)	(pCi/L)	(pCi/L)	(pCi/L)
Alpha Activity	2630.0	-110.0	-15.3	45.6	-1.3	-2.7	0.0
error	5000.0	23.0	5.9	96.0	3.9	3.9	5.0
MDA	7950.0	799.0	184.0	165.0	8.0	8.5	9.5
Beta Activity	-3470.0	-105.0	-68.6	-35.9	4.5	3.2	5.1
error	51.0	5.1	1.1	1.1	7.0	7.1	7.3
MDA	8380.0	838.0	171.0	168.0	11.6	11.8	12.0

Well/Zone Number:	GW-729-30	GW-729-34	GW-729-39	GW-729-44	GW-729-44D	GW-729-44FB	GW-729-44ER
Sample Number:	950622-056	950622-057	950622-058	950608-128	950608-126	950608-127	950608-125
Date Sampled:	6/21/95	6/21/95	6/21/95	6/8/95	6/8/95	6/8/95	6/8/95
Date Analyzed:	7/21/95	7/21/95	7/21/95	7/10/95	7/10/95	7/10/95	7/10/95
Units:	(pCi/L)	(pCi/L)	(pCi/L)	(pCi/L)	(pCi/L)	(pCi/L)	(pCi/L)
Alpha Activity	0.0	0.6	1.3	-1.3	1.9	-1.5	-0.3
error	6.2	4.6	5.1	3.0	3.5	2.5	2.8
MDA	12.6	9.0	9.6	6.2	6.0	5.5	5.5
Beta Activity	6.3	5.4	5.3	-2.3	-0.2	0.2	-4.3
error	9.0	9.1	9.0	6.8	7.1	7.5	7.3
MDA	14.9	15.2	15.0	11.8	12.1	12.8	12.8

* See text for discussion of MDA values

Appendix F:

MAJOR ANIONS AND CATIONS AND FIELD PARAMETERS

Major Anions and Cations and Field Parameters.

Well/Zone Number:	GW-729-2	GW-729-6	GW-729-9	GW-729-12	GW-729-15	GW-729-18	GW-729-22
Date Sampled:	5/2/96	5/2/96	4/25/96	4/24/96	5/10/95	6/13/95	6/14/95
ANIONS (mg/L)*							
Alkalinity (K-25 Lab)	10.9	113.0	137.0	113.0	115.0	205.0	110.0
Alkalinity-HCO ₃ *	13.3	137.8	167.0	137.8	140.2	249.9	134.1
Alkalinity-CO ₃ *	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Bromide	1960.0	141.0	< 100.0	d < 100.0	d < 100.0	d 49.0	58.0
Chloride IC	<u>114000.0</u>	10600.0	6170.0	5230.0	6500.0	4300.0	5400.0
Fluoride SIE	0.11	0.54	0.68	0.93	0.94	1.3	0.8
Nitrate	< <u>100.0</u>	d < <u>100.0</u>	d < <u>100.0</u>	d < 1.0	< <u>100.0</u>	d < 1.0	< 1.0
Sulfate	< 1.0	2.97	4.96	< 1.0	< 100.0	d 12.0	2.0
CATIONS (mg/L)*							
Calcium	<u>26000.0</u>	<u>870.0</u>	<u>340.0</u>	<u>190.0</u>	<u>290.0</u>	<u>150.0</u>	<u>180.0</u>
Iron	<u>140.0</u>	6.3	0.52	0.33	2.2	1.9	1.5
Magnesium	<u>5400.0</u>	<u>220.0</u>	<u>94.0</u>	<u>52.0</u>	<u>82.0</u>	<u>41.0</u>	<u>54.0</u>
Potassium	<u>810.0</u>	39.0	30.0	21.0	31.0	17.0	22.0
Sodium	<u>59000.0</u>	<u>6300.0</u>	4100.0	3200.0	<u>5300.0</u>	3200.0	3800.0
TDS (mg/L)†	207323.4	18317.6	10907.2	8832.0	12346.3	8022.1	9652.4
FIELD PARAMETERS							
pH	6.5	7.0	6.8	6.8	7.5	7.0	6.8
Temperature (°C)	19.0	14.0	14.0	14.0	15.0	14.0	13.0
Conductivity (µmho/cm)	> 50000.0	26000.0	12000.0	12000.0	16800.0	10000.0	11500.0

*values determined by speciating total alkalinity (CaCO₃) from K-25 labs, based on pH of water sample.

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

d = indicates sample diluted for analysis.

na = not analyzed

** underlined values are above tolerance levels (HSW, 1996).

Major Anions and Cations and Field Parameters.

Well/Zone Number:	GW-729-26	GW-729-30	GW-729-34	GW-729-39	GW-729-44	GW-729-44D	GW-729-44FB	GW-729-44ER
Date Sampled:	6/14/95	6/21/95	6/21/95	6/21/95	6/8/95	6/8/95	6/8/95	6/8/95
ANIONS (mg/L)*								
Alkalinity (K-25 Lab)	105.0	124.0	114.0	106.0	240.0	240.0	2.0	3.0
Alkalinity-HCO ₃ *	128.0	151.2	139.0	129.2	292.6	292.6	2.4	3.7
Alkalinity-CO ₃ *	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Bromide	72.0							
Chloride IC	6700.0	960.0	130.0	290.0	12.0	18.0	< 1.0	< 1.0
Fluoride SIE	0.7	0.88	0.84	0.85	0.3	0.3	< 0.1	< 0.1
Nitrate	< 1.0	< 1.0	< 1.0	< 1.0	3.7	3.5	< 1.0	< 1.0
Sulfate	1.8	5.5	18.0	1.2	10.0	9.1	< 1.0	< 1.0
CATIONS (mg/L)*								
Calcium	<u>180.0</u>	9.2	4.3	<u>45.0</u>	<u>62.0</u>	<u>61.0</u>	0.043	0.025
Iron	2.4	0.81	0.034	0.037	0.012	0.007	0.045	< 0.005
Magnesium	<u>55.0</u>	3.2	1.6	<u>21.0</u>	<u>24.0</u>	<u>24.0</u>	0.006	< 0.003
Potassium	26.0	< 6.0 d	2.3	4.8	1.2	1.3	< 0.6	< 0.6
Sodium	4500.0	730.0	160.0	170.0	7.5	11.0	0.16	0.082
TDS (mg/L)†	11665.9	1860.8	456.1	662.1	413.3	421.4	2.7	3.8
FIELD PARAMETERS								
pH	7.0	7.0	7.5	7.0	7.0	-	-	-
Temperture (°C)	15.0	20.0	18.0	19.0	18.0	-	-	-
Conductivity (µmho/cm)	15000.0	1300.0	650.0	900.0	500.0	-	-	-

*values determined by speciating total alkalinity (CaCO₃) from K-25 labs, based on pH of water sample.

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

d = indicates sample diluted for analysis.

na = not analyzed

** underlined values are above tolerance levels (HSW, 1996).

Appendix G:

CHARGE BALANCE CALCULATIONS

Charge Balance Calculations

Well/Zone Number:	GW-729-2	GW-729-6	GW-729-9	GW-729-12	GW-729-15
Date Sampled:	5/2/96	5/2/96	4/25/96	4/24/96	5/10/95
ANIONS (meq/L)					
Alkalinity-HCO ₃	0.2	2.3	2.7	2.3	2.3
Alkalinity-CO ₃	0.0	0.0	0.0	0.0	0.0
Bromide	24.5	1.8	0.0	0.0	0.0
Chloride IC	3215.2	299.0	174.0	147.5	183.3
Fluoride SIE	0.0	0.0	0.0	0.0	0.0
Nitrate	0.0	0.0	0.0	0.0	0.0
Sulfate IC	0.0	0.1	0.1	0.0	0.0
Total Anions	3239.9	303.1	176.9	149.8	185.7
CATIONS (meq/L)					
Calcium	1297.4	43.4	17.0	9.5	14.5
Iron	7.5	0.3	0.0	0.0	0.1
Magnesium	444.1	18.1	7.7	4.3	6.7
Potassium	20.7	1.0	0.8	0.5	0.8
Sodium	2565.6	273.9	178.3	139.1	230.5
Total Cations	4335.3	336.8	203.8	153.5	252.6
CHARGE BALANCE (%)	14	5	7	1	15

Charge Balance Calculations

Well/Zone Number:	GW-729-18	GW-729-22	GW-729-26	GW-729-30	GW-729-34	GW-729-39
Date Sampled:	6/13/95	6/14/95	6/14/95	6/21/95	6/21/95	6/21/95
ANIONS (meq/L)						
Alkalinity-HCO ₃	4.1	2.2	2.1	2.5	2.3	2.1
Alkalinity-CO ₃	0.0	0.0	0.0	0.0	0.0	0.0
Bromide	0.6	0.7	0.9	0.0	0.0	0.0
Chloride IC	121.3	152.3	189.0	27.1	3.7	8.2
Fluoride SIE	0.1	0.0	0.0	0.0	0.0	0.0
Nitrate	0.0	0.0	0.0	0.0	0.0	0.0
Sulfate IC	0.3	0.0	0.0	0.1	0.4	0.0
Total Anions	126.3	155.3	192.0	29.7	6.4	10.4
CATIONS (meq/L)						
Calcium	7.5	9.0	9.0	0.5	0.2	2.2
Iron	0.1	0.1	0.1	0.0	0.0	0.0
Magnesium	3.4	4.4	4.5	0.3	0.1	1.7
Potassium	0.4	0.6	0.7	0.0	0.1	0.1
Sodium	139.1	165.2	195.7	31.7	7.0	7.4
Total Cations	150.5	179.3	210.0	32.5	7.4	11.5
CHARGE BALANCE (%)	9	7	4	4	7	5

Charge Balance Calculations

Well/Zone Number:	GW-729-44	GW-729-44D	GW-729-44FB	GW-729-44ER
Date Sampled:	6/8/95	6/8/95	6/8/95	6/8/95
ANIONS (meq/L)				
Alkalinity-HCO ₃	4.8	4.8	0.0	0.1
Alkalinity-CO ₃	0.0	0.0	0.0	0.0
Bromide	0.0	0.0	0.0	0.0
Chloride IC	0.3	0.5	0.0	0.0
Fluoride SIE	0.0	0.0	0.0	0.0
Nitrate	0.1	0.1	0.0	0.0
Sulfate IC	0.2	0.2	0.0	0.0
Total Anions	5.4	5.6	0.0	0.1
CATIONS (meq/L)				
Calcium	3.1	3.0	0.0	0.0
Iron	0.0	0.0	0.0	0.0
Magnesium	2.0	2.0	0.0	0.0
Potassium	0.0	0.0	0.0	0.0
Sodium	0.3	0.5	0.0	0.0
Total Cations	5.4	5.5	0.0	0.0
CHARGE BALANCE (%)	0	0	0	-85

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