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APPENDIXES

**SAMPLING AND ANALYSIS
METHODS FOR GEOTHERMAL
FLUIDS AND GASES**

**D. W. Shannon
Project Manager**

**Prepared for the U.S. Department of Energy
under Contract EY-76-C-06-1830**

**Pacific Northwest Laboratory
Operated for the U.S. Department of Energy
by**

Battelle
Memorial Institute

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Appendix 1
Field Test - 1978

Appendix 1 will be a report of the evaluation of sampling techniques conducted at the Republic Geothermal, Inc., East Mesa, CA, site during March and April 1978. This report is currently in preparation and will be mailed out separately.

Appendix 2

GRR-1 and GRR-2 Analytical Round Robin Data

Data Processing for GRR-1 and GRR-2 Samples

For the two round robin samples analyzed, the following list of components proposed by PNL and amended by the participants was chosen to characterize a liquid brine sample:

1) pH	21) Iron
2) Conductivity	22) Lead
3) Alkalinity	23) Lithium
4) Hardness	24) Magnesium
5) Suspended solids	25) Manganese
6) Turbidity	26) Mercury
7) Aluminum	27) Phosphate
8) Ammonia	28) Potassium
9) Antimony	29) Rubidium
10) Arsenic	30) Silica (SiO_2)
11) Bicarbonate, carbonate	31) Silver
12) Barium	32) Sodium
13) Boron	33) Strontium
14) Bromide	34) Sulfate
15) Calcium	35) Sulfide
16) Cesium	36) Zinc
17) Chloride	37) Total dissolved solids
18) Copper	38) H_2S (entrained)
19) Fluoride	39) CO_2 (entrained)
20) Iodide	40) Radioactive isotopes

Table 1 summarizes the data obtained for the first round robin sample collected at Mesa 6-2 wellhead, East Mesa Test Site, Imperial Valley, CA on July 7, 1977. Test results are listed by method used for cross reference to the analytic methods section. Table 2 contains a summary of results obtained for radioactive isotopes present in the Mesa 6-2 brine sample. As in Table 1 test results are listed by method used for cross reference purposes.

Table 3 summarizes the data obtained for the second round robin sample collected from the Woolsey #1 first stage flash unit, San Diego Gas and Electric Niland Test Facility, Niland, CA on August 11, 1977. Table 4 contains a summary of results obtained for radioactive isotopes present in the Woolsey #1 brine sample.

In Tables 1 and 3, values for the control samples prepared by PNL are presented in bold face type for reference purposes. These control samples, described in the analysis section; were sent out with the brine samples.

Lists of the participants of the two round robins are given in Tables 5 and 6. Lab numbers were assigned to the participants in order to exclude the identity of the participating laboratories.

Symbols and abbreviations used in the data tables are explained in Table 7.

Miscellaneous Analyses

In the course of conducting the analyses of GRR-1 and GRR-2 samples for the purpose of methods comparison, some of the participating laboratories generated additional data not in the original proposal. It was felt that this information should be presented for completeness.

An analysis of the total dissolved solids residue from GRR-1 by emission spectrometry was made by one of the participants and the results are presented in Table 8. The elemental composition of the residue is nearly the same as the brine composition from Mesa 6-2 as would be expected.

Analysis of the precipitate from the raw unacidified GRR-2 sample for radioisotopes was performed by one of the participants. These results are presented in Table 9.

Inductively coupled plasma-atomic emission spectrometry was used by several of the participating laboratories to analyze the brine. Additional brine components obtained using this procedure are presented

in Table 10 for the GRR-1 sample and in Table 11 for the GRR-2 sample. Spark source mass spectrometry generated some additional values for the GRR-1 and GRR-2 samples. These values are presented in Tables 12 and 13. Additional values for both GRR-1 and GRR-2 samples were generated by those participants using neutron activation analysis. These values are presented in Tables 14 and 15.

One of the participants examined organic components in the two geothermal samples by gas chromatography/mass spec. The results of these analyses are presented in Table 16.

Analyses for nitrate and nitrite in the brine samples were performed by two of the participating laboratories. These results using two different methods of analysis are presented in Table 17.

Statistical Evaluation of GRR-1 and GRR-2 Data

Tables 18 and 19 are summaries of values derived from the raw data presented in Tables 1 and 3 for GRR-1 and GRR-2. The values presented in Tables 18 and 19 are a) mean values for each of the parameters given in Tables 1 and 3, based on the total number of determinations, b) ranges for each of the parameters based on the total number of determinations, and c) mean values and ranges for individual methods of analysis within each parameter determination. Also included in these tables is the total number of reported values for each parameter and the PNL control sample value.

Under each parameter the various methods of analysis are presented. Individual methods with means and ranges are given if three or more independent (3 different laboratories) values were reported for the method. All those methods with less than three values are listed as "others."

Ranges presented in Tables 18 and 19 were calculated by determining the difference between the mean and the highest and lowest reported values in Tables 1 and 3. The reported range corresponds to the larger of the two calculated differences.

TABLE 1. GRR-1 RESULTS (EAST MESA 6-2 WELLHEAD SAMPLE)

PARAMETER	METHOD	PNL PREPARED CONTROL SAMPLE	LAB 17	LAB 19	LAB 21	LAB 23	LAB 25	LAB 27	LAB 29	LAB 31	LAB 33	LAB 35	LAB 37	LAB 39	LAB 41	LAB 43	LAB 45	LAB 47	LAB 49	LAB 51
pH	pH METER		6.24	6.41	6.4	6.15	5.95	6.30 (RU) 6.30 (FU)	6.34 (LAB) 5.66 (FIELD)	---	---	6.28	6.28 (LAB) 5.75 (FIELD)	6.5	7.32	6.25	6.5 6.7	6.4	---	---
CONDUCTIVITY (μ mhos /cm)	CONDUCTIVITY METER		6310	---	6124	---	6750	6730	6910	---	---	7300	7000	7000	8000	6900	8000	510	---	---
ALKALINITY (mg/l CaCO_3)	ACID TITRATION		501	503	507	474.6	595	---	---	---	---	545	490	493	---	---	550	500	---	---
HARDNESS (mg/l CaCO_3)	EDTA TITRATION	---	39.0 36.6	40.5 38.5	38.6 35.6	---	50.5 48.6	---	35.8	---	---	32 32	---	38	30 32	---	19.5, 16.8 19.5, 16.8	34 35	---	---
"	CALCULATION	41.6	---	---	---	---	---	41.2 (RA) 34.1 (FA) 40.8	---	---	---	---	36.7 41.6	---	---	---	---	---	---	---
SUSPENDED SOLIDS (mg/l)	GRAVIMETRIC		4.3	1.3	16	---	ND <5	10	---	---	---	12	3	9	0.29	32	---	2.9	---	---
TURBIDITY (NTU)	NEPHELOMETER		0.33	0.62	---	---	---	---	---	---	---	0.1	---	---	1.6	---	---	---	---	---
"	VISUAL MATCHING		---	---	---	---	1	---	---	---	---	---	---	---	---	---	---	---	---	---
"																				
(FORMAZIN TURBIDITY U.)	HACH METER		---	---	18	---	---	0.0	---	---	---	---	1	---	---	---	---	0.22	---	---
ALUMINUM (mg/l)	AA	0.80	---	0.24 1.00	---	---	---	---	---	---	---	0.11 1.00	<0.7 1.0	---	---	---	0 1.70	---	---	---
"	MIBK AND 8-HYDROXY- QUINOLINE EXTRACT, AND AA	"	---	---	---	---	0.16 0.94	---	---	---	---	---	---	---	---	---	---	---	---	---
"	FLAME EMISSION	"	---	---	---	---	---	0.2 (RA) 0.2 (FA)	1.0	---	---	---	---	---	---	---	---	---	---	---

TABLE 1. GRR-1 RESULTS (CONTINUED)

PARAMETER	METHOD	PNL PREPARED CONTROL SAMPLE	LAB 17	LAB 19	LAB 21	LAB 23	LAB 25	LAB 27	LAB 29	LAB 31	LAB 33	LAB 35	LAB 37	LAB 39	LAB 41	LAB 43	LAB 45	LAB 47	LAB 49	LAB 51
ALUMINUM (mg / L)	AA GRAPHITE FURNACE	0.80	0.22 0.81	---	0.13 0.52	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
"	ARGON PLASMA EMISSION	"	---	---	0.16 0.96	---	---	---	---	0.3 1.3	---	---	---	---	---	---	---	---	---	0.073 0.59
"	EMISSION SPEC.	"	---	---	0.57 2.0	---	---	---	---	---	---	---	---	---	< 0.3 0.87	---	---	---	---	---
"	NEUTRON ACTIVATION	"	---	---	---	---	---	---	---	---	< 5 (FA) 2.0 < 1 (RU) < 1 (FU)	---	---	---	---	---	---	---	---	---
"	SPARK SOURCE MASS SPEC.	"	---	---	---	---	---	---	---	---	0.2 (FA) 0.6 0.4 (RU) 0.5 (FU)	---	---	0.06	---	---	---	---	---	---
"	X-RAY FLUORESCENCE (LIQUID)	"	---	---	---	---	---	---	---	---	37 (FA) 43 15 (FU) 19 (RU)	---	---	---	---	---	---	---	---	---
AMMONIA (mg / L)	DIRECT NESSLERIZATION	14.0 AS NH ₄	---	10.47 AS N 12.46 AS N	---	---	---	18 (RA) 18 (FA) 15	11.5 AS N	---	---	---	---	---	---	17.9	---	---	---	---
"	ION SPECIFIC ELECTRODE	"	---	---	13.6 9.9	---	---	---	---	---	---	17 12	14.0 10.8	5.9 7.8	14.2 11.7	---	---	---	---	---
"	DISTILLATION, COLLECTION IN H ₂ SO ₄ AND TIT. WITH NaOH	"	---	---	---	---	33 20.6	---	---	---	---	---	---	---	---	---	---	---	---	---
"	DISTILLATION AND NESSLERIZATION	"	---	---	14.6 10.9	---	14.8 12.5	---	---	---	---	16.0 13.7	---	---	---	---	---	---	---	---
"	AUTO ANALYZER	"	---	---	---	---	---	---	---	---	16.9 (FU) 16.6 (RU) 16.8 (FA) 14.1	---	---	---	---	---	---	---	---	---
"	ION EXCHANGE CHROMATOGRAPHY	"	---	---	---	---	---	---	---	---	---	---	---	---	17.3 (RU) 17.0 (FU) 16.1 (FA) 13.0	---	---	---	---	---
"	ACIDIMETRIC	"	15.7 AS N 12.8 AS N	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---

TABLE 1. GRR-1 RESULTS (CONTINUED)

PARAMETER	METHOD	PH. PREPARED CONTROL SAMPLE	LAB 17	LAB 19	LAB 21	LAB 23	LAB 25	LAB 27	LAB 29	LAB 31	LAB 33	LAB 35	LAB 37	LAB 39	LAB 41	LAB 43	LAB 45	LAB 47	LAB 49	LAB 51
ANTIMONY (mg/l)	AA	1.0	---	---	---	---	ND < 0.25 0.98	---	---	---	---	0.1 1.0	0.6 0.95	---	---	---	---	---	---	---
"	HYDRIDE EVOL. ANE AA	"	---	---	0.8 1.0	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
"	EMISSION SPEC.	"	---	---	ND ND	---	---	---	---	---	---	---	---	---	0.34 0.98	---	---	---	---	---
"	AA GRAPHITE FURN.	"	<0.05 0.28	---	---	---	0.04 1.07	---	---	---	---	---	---	---	---	---	---	---	---	---
"	X-RAY FLUORESCENCE (LIQUID)	"	---	---	---	---	---	<10 (RA) <10 <10 (FA)	---	---	---	---	---	---	---	---	---	---	---	---
"	ARGON PLASMA EMISSION	"	---	---	---	---	---	---	---	0.32 1.2	---	---	---	---	---	---	---	---	---	0.01 0.71
"	NEUTRON ACTIVATION	"	---	---	---	0.06 0.9	---	---	---	---	0.1 (FA) 0.16 (FU) 0.88 0.045 (RU)	---	---	---	---	---	---	---	0.00145 (FA) 0.0475 (RU) 0.00352 (FU) 0.916	---
"	SPARK SOURCE MASS SPEC.	"	---	---	---	---	---	---	---	---	0.02 (FA) 0.15 ≤0.02 (RU) ≤0.02 (FU)	---	---	<0.001	---	---	---	---	---	---
ARSENIC (mg/l)	AA GRAPHITE FURN.	0.30	0.29 0.23	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
"	HYDRIDE EVOL. (SILVER DITHIO- CARBAMATE) AND SPECTROPHOTO.	"	---	---	---	---	0.51 0.25	0.41 (RA) 0.38 (FA) 0.2E	---	---	---	---	---	---	---	---	---	---	---	---
"	ARGON PLASMA EMISSION	"	---	---	ND ND	---	---	---	---	0.6 0.5	---	---	---	---	---	---	---	---	---	0.33 0.25
"	EMISSION SPEC.	"	---	---	ND ND	---	---	---	---	---	---	---	---	---	0.38 0.32	---	---	---	---	---
"	NEUTRON ACTIVATION	"	---	---	---	---	---	---	---	---	0.28 (FA) 0.32 (FU) 0.23 0.53 (RU)	---	---	---	---	---	---	---	---	---
"	SPARK SOURCE MASS SPEC.	"	---	---	---	---	---	---	---	---	0.3 (FA) 0.2 0.5 (RU) 0.5 (FU)	---	---	0.5	---	---	---	---	---	---

TABLE 1. GRR-1 RESULTS (CONTINUED)

PARAMETER	METHOD	FNL PREPARED CONTROL SAMPLE	LAB 17	LAB 19	LAB 21	LAB 23	LAB 25	LAB 27	LAB 29	LAB 31	LAB 33	LAB 35	LAB 37	LAB 39	LAB 41	LAB 43	LAB 45	LAB 47	LAB 49	LAB 51
ARSENIC (mg / L)	ARS INE GEN AND AA	0.30	---	---	0.44 0.28	---	---	---	---	---	---	0.40 0.09	---	---	---	---	---	---	---	---
BICARBONATE (mg / L)	ACID TITRATION		---	613.9	537	474.6	595	612	580 (FIELD) 889 (LAB)	---	---	670	586	---	---	604	660	500	---	---
"	CALCULATION		501	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
CARBONATE (mg / L)	ACID TITRATION		---	0	0	0	ND < 2	0	0	---	---	ND	0	---	---	0	0	0	---	---
"	CALCULATION		0	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
BARIUM (mg / L)	AA	0.30	---	0.21 0.30	---	---	---	---	---	---	---	0.30 0.32	0.24 0.35	0.3 0.3	---	---	---	---	---	---
"	AA GRAPHITE FURNACE	"	0.3 0.4	---	---	---	0.35 0.50	---	---	---	---	---	---	---	---	---	---	---	---	---
"	ARGON PLASMA EMISSION	"	---	---	0.53 0.36	---	---	---	---	0.24 0.25	---	---	---	---	---	---	---	---	---	0.27 0.29
"	EMISSION SPEC.	"	---	---	ND ND	---	---	---	---	---	---	---	---	---	0.25 0.36	---	---	---	---	---
"	FLAME EMISSION	"	---	---	0.29 0.22	---	---	0.3 (RA) 0.3 (FA) 0.30	---	---	---	---	---	---	---	---	---	---	---	---
"	NEUTRON ACTIVATION	"	---	---	---	---	---	---	---	---	≤1 (FA) ≤2 ≤2 (FU) ≤1 (RU)	---	---	---	---	---	---	---	---	---
"	SPARK SOURCE MASS SPEC.	"	---	---	---	---	---	---	---	---	0.2 (FA) 0.28 0.2 (RU) 0.26 (FU)	---	---	0.8	---	---	---	---	---	---
"	ABSORPTOMETRIC	"	---	---	---	---	---	---	---	---	---	---	0.57 0.29	---	---	---	---	---	---	---

TABLE 1. GRR-1 RESULTS (CONTINUED)

[illegible]

TABLE 1. GRR-1 RESULTS (CONTINUED)

PARAMETER	METHOD	PNL PREPARED CONTROL SAMPLE	LAB 17	LAB 19	LAB 21	LAB 23	LAB 25	LAB 27	LAB 29	LAB 31	LAB 33	LAB 35	LAB 37	LAB 39	LAB 41	LAB 43	LAB 45	LAB 47	LAB 49	LAB 51
BROMIDE (mg/l)	ION EXCHANGE CHROMATOGRAPHY	5.0	---	---	---	---	---	---	---	---	---	---	---	---	1.6 (RU) 1.6 (FU)	---	---	---	---	---
"	SPARK SOURCE MASS SPEC.	"	---	---	---	---	---	---	---	---	---	---	---	0.1	---	---	---	---	---	---
"	PHENOL RED COLORIMETRIC	"	---	---	---	< 0.1	METHOD NOT APPLICABLE DUE TO INTERFERENCES				---	---	---	---	---	---	---	---	---	---
CALCIUM (mg/l)	AA	13.0	5.0 12.0	13.1 12.0	3 10.1	---	14.2 13.2	---	14.0	---	---	8.1 12.0	13.0 12.5	12.8 13.9	---	14.2 13.4	18.3 17.3	14 14	---	---
"	NEUTRON ACTIVATION	"	---	---	---	8.7 13	---	---	---	---	< 60 (FA) ≤ 60 < 25 (RU) < 25 (FU)	---	---	---	---	---	---	---	---	---
"	SPARK SOURCE MASS SPEC.	"	---	---	---	---	---	---	---	---	14 (FA) 13 14 (RU) 16 (FU)	---	---	MAJOR COMPONENT		---	---	---	---	---
"	ARGON PLASMA EMISSION	"	---	---	15 12.7	---	---	---	---	13.9 12.9	---	---	---	---	---	---	---	---	---	15 13
"	EMISSION SPEC.	"	---	---	18 8.3	---	---	---	---	---	---	---	---	13.0 11.5	---	---	---	---	---	---
"	FLAME EMISSION	"	---	---	---	---	---	16 (RA) 16 13 (FA)	---	---	---	---	---	---	---	---	---	---	---	---
"	EDTA TITRATION	"	---	---	---	---	---	---	17 (FIELD)	---	---	---	---	---	---	---	---	---	---	---
CESIUM (mg/l)	AA	0.42	---	0.37 0.39	---	---	---	---	---	---	---	0.31 0.55	0.25 0.38	---	---	---	---	0.21 0.19	---	---
"	FLAME EMISSION	"	---	---	0.21 0.32	---	0.20 0.42	0.2 (RA) 0.2 (FA) 0.40	0.27	---	---	---	---	---	0.31 0.53	---	---	---	---	---
"	NEUTRON ACTIVATION	"	---	---	---	0.27 0.45	---	---	---	---	0.24 (FA) 0.22 (FU) 0.43 0.27 (RU)	---	---	---	---	---	---	---	0.275 (FA) 0.290 (RU) 0.261 (FU) 0.473	---
"	SPARK SOURCE MASS SPEC.	"	---	---	---	---	---	---	---	---	0.5 (FA) 0.6 1.0 (RU) 0.75 (FU)	---	---	0.2	---	---	---	---	---	---
"	EMISSION SPEC.	"	---	---	ND ND	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
"	AA GRAPHITE FURNACE	"	0.4 0.5	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---

TABLE 1. GRR-1 RESULTS (CONTINUED)

[illegible]

TABLE 1. GRR-1 RESULTS (CONTINUED)

PARAMETER	METHOD	PNL PREPARED CONTROL SAMPLE	LAB 17	LAB 19	LAB 21	LAB 23	LAB 25	LAB 27	LAB 29	LAB 31	LAB 33	LAB 35	LAB 37	LAB 39	LAB 41	LAB 43	LAB 45	LAB 47	LAB 49	LAB 51
COPPER (mg/l)	AA GRAPHITE FURN.	0.38	---	---	0.013 0.034	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
"	EMISSION SPEC.	■	---	---	0.016 0.075	---	---	---	---	---	---	---	---	---	<0.04 0.12	---	---	---	---	---
"	X-RAY FLUORESCENCE (LIQUID)	■	---	---	---	---	---	---	---	---	ND (FA) ND ND (FU) 0.9 (RU)	---	---	---	---	---	---	---	---	---
FLUORIDE (mg/l)	SPECIFIC ION ELECTRODE	1.2	3.85 0.6	---	3.75 0.61	---	---	3.4 0.7	4.2	---	---	3 0.5	2.9 0.6	2.7 0.5	3.69 0.69	---	---	3.5	---	---
"	ALIZARIN VISUAL AND DISTILLATION	"	---	---	---	---	2.7	---	---	---	---	---	---	---	---	---	---	---	---	---
"	AMADAC F AND DISTILLATION	"	---	---	---	---	1.64	---	---	---	---	---	---	---	---	---	---	---	---	---
"	SPARK SOURCE MASS SPEC.	"	---	---	---	---	---	---	---	---	---	---	---	2.4	---	---	---	---	---	---
"	ION EXCHANGE CHROMATOGRAPHY	"	---	---	---	---	---	---	---	---	---	---	---	---	5.6 (RU) 5.5 (FU)	---	---	---	---	---
"	SPADNS SPECTROPHOTO- METRIC	"	---	---	---	---	---	---	---	---	---	4.3 1.4	---	---	---	---	---	---	---	---
IODIDE (mg/l)	HYPOCHLORITE OXIDATION AND TITRATION	5.3	---	---	---	---	0.71	---	---	---	---	---	1.32 6.30	---	---	---	---	---	---	---
"	X-RAY FLUORESCENCE (LIQUID)	"	---	---	---	---	---	ND<10	---	---	---	---	---	---	---	---	---	---	---	---
"	NEUTRON ACTIVATION	"	---	---	---	---	---	---	---	---	≤2 (FA) 4.7 0.43 (RU) 0.27 (FU)	---	---	---	---	---	---	---	---	---
"	LEUCO CRYSTAL VIOLET COLORIMETRIC	"	---	---	---	---	ND<0.6 ND	---	---	---	---	---	---	---	---	---	---	---	---	---

TABLE 1. GRR- RESULTS (CONTINUED)

PARAMETER	METHOD	PNL PREPARED CONTROL SAMPLE	LAB 17	LAB 19	LAB 21	LAB 23	LAB 25	LAB 27	LAB 29	LAB 31	LAB 33	LAB 35	LAB 37	LAB 39	LAB 41	LAB 43	LAB 45	LAB 47	LAB 49	LAB 51
IODIDE (mg / l)	SPARK SOURCE MASS SPEC.	5.0	---	---	---	---	---	---	---	---	---	---	---	< 0.001	---	---	---	---	---	---
"	ION SPECIFIC ELECTRODE	"	0.5 4.9	---	0.2 2.0	---	---	---	---	---	---	0.4 4.8	---	---	---	---	---	---	---	---
"	ARSENIOUS- CERIC COLORIMETRIC	"	---	---	0.48 2.25	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
"	API PHOTOMETRIC	"	---	---	---	---	---	---	---	---	---	< 0.5	3.5	---	---	---	---	---	---	---
"	COLORIMETRIC (ARSENIOUS - CERIC-FERRIC THIOCYANATE)	"	---	---	---	0.4	---	---	---	---	---	---	---	---	---	---	---	---	---	---
IRON (mg / l)	AA	0.70	0.4 0.6	0.25 0.74	0.23 0.76	---	---	0.4 (RA) 0.3 (FA)	0.6 0.365	---	---	0.26 0.74	0.3 0.7	0.2 0.7	---	0.41 0.76	0.75 1.0	---	---	---
"	AMM. PYRROLIDINE DITHIO. - MIBK EXT. AND AA	"	---	---	---	---	0.81 1.08	---	---	---	---	---	---	---	---	---	---	---	---	---
"	SPARK SOURCE MASS SPEC.	"	---	---	---	---	---	---	---	---	0.4 (FA) 0.5 (RU) 0.9 (FU)	0.75	---	0.7	---	---	---	---	---	---
"	ARGON PLASMA EMISSION	"	---	---	0.30 0.73	---	---	---	---	0.26 0.74	---	---	---	---	---	---	---	---	---	0.24 0.69
"	EMISSION SPEC.	"	---	---	0.32 0.57	---	---	---	---	---	---	---	---	---	< 0.5 0.61	---	---	---	---	---
"	X-RAY FLUORESCENCE (LIQUID)	"	---	---	---	---	---	---	---	---	2 (FU) 6 (RU) ND (FA) ND	---	---	---	---	---	---	---	---	---
"	NEUTRON ACTIVATION	"	---	---	---	< 0.08 0.08	---	---	---	---	< 5 (FA) < 5 (FU) ≤ 5 < 5 (RU)	---	---	---	---	---	---	---	0.327 (FA) 0.592 (RU) 0.362 (FU) 1.078	---
LEAD (mg / l)	AA	0.30	---	0.06 0.43	0.07 0.32	---	---	0.05 (FA) < 0.05 (FA)	0.32 0.07	---	---	< 0.05 0.32	---	< 0.3 0.4	< 0.5 0.5	---	0.03 0.17	---	---	---
"	AA GRAPHITE FURNACE	"	0.1 0.2	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
"	SPARK SOURCE MASS SPEC.	"	---	---	---	---	---	---	---	---	< 0.06 (FA) 0.06 (RU) 0.03 (FU)	0.1	---	≤ 0.007	---	---	---	---	---	---

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TABLE 1. GRR-1 RESULTS (CONTINUED)

PARAMETER	METHOD	PNL PREPARED CONTROL SAMPLE	LAB 17	LAB 19	LAB 21	LAB 23	LAB 25	LAB 27	LAB 29	LAB 31	LAB 33	LAB 35	LAB 37	LAB 39	LAB 41	LAB 43	LAB 45	LAB 47	LAB 49	LAB 51
LEAD (mg/l)	AMM. PYRROLIDINE DITHIO. -MIBK EXT. AND AA	0.30	---	---	---	---	ND<0.008 0.30	---	---	---	---	---	---	---	---	---	---	---	---	---
"	EMISSION SPEC.	■	---	---	ND 0.48	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
"	ARGON PLASMA EMISSION	■	---	---	0.3 0.6	---	---	---	---	0.17 0.5	---	---	---	---	---	---	---	---	---	0.04 0.29
LITHIUM (mg/l)	AA	4.0	4.2 3.9	4.17 3.75	4.3 3.8	---	---	---	---	---	---	4.4 4.0	4.25 4.65	---	---	4.6 4.3	6.00 4.60	5 6.1	---	---
"	FLAME EMISSION	■	---	---	---	---	4.18 3.84	4.1(RA) 4.0(FA)	43.5 3.6	---	---	---	---	---	4.6 4.2	---	---	---	---	---
"	SPARK SOURCE MASS SPEC.	■	---	---	---	---	---	---	---	---	3.6(FA) 5(RU) 5(FU)	3.6	---	5	---	---	---	---	---	---
"	EMISSION SPEC.	■	---	---	2.3 2.4	---	---	---	---	---	---	---	---	---	---	---	---	---	---	4.1 3.8
"	ION EXCHANGE CHROMATOGRAPHY	■	---	---	---	---	---	---	---	---	---	---	---	---	4.5(RU) 4.6(FU) 4.2(FA)	3.8	---	---	---	---
MAGNESIUM (mg/l)	AA	0.20	0.22 0.25	0.250 0.205	0.28 0.16	---	0.38 0.31	0.3(RA) 0.4(FA) 0.21	0.4	---	---	0.35 0.23	0.31 0.22	0.32 0.21	---	---	0.22 0.17	0.32 0.20	---	---
"	NEUTRON ACTIVATION	■	---	---	---	---	---	---	---	---	<100(FA)≤100 <30(RU) <20(FU)	---	---	---	---	---	---	---	---	---
"	SPARK SOURCE MASS SPEC.	■	---	---	---	---	---	---	---	---	0.38(FA) 0.38(RU) 0.38(FU)	0.25	---	MAJOR COMPONENT	---	---	---	---	---	---
"	ARGON PLASMA EMISSION	■	---	---	0.28 0.19	---	---	---	---	0.33 0.200	---	---	---	---	---	---	---	---	---	0.31 0.20

TABLE 1. GRR-1 RESULTS (CONTINUED)

PARAMETER	METHOD	PNL PREPARED CONTROL SAMPLE	LAB 17	LAB 19	LAB 21	LAB 23	LAB 25	LAB 27	LAB 29	LAB 31	LAB 33	LAB 35	LAB 37	LAB 39	LAB 41	LAB 43	LAB 45	LAB 47	LAB 49	LAB 51
MAGNESIUM (mg/l)	EMISSION SPEC.	0.20	---	---	0.14 0.033	---	---	---	---	---	---	---	---	---	C.23 C.15	---	---	---	---	---
"	EDTA TITRATION	"	---	---	---	---	---	---	1 (FIELD)	---	---	---	---	---	---	---	---	---	---	---
MANGANESE (mg/l)	AA	0.06	0.012 0.03	0.006 0.075	0.035 0.065	---	---	0.03 (RA) 0.02 (FA) 0.07	C.02	---	---	0.01 0.06	0.02 0.06	< 0.03 0.06	---	---	---	---	---	---
"	AMM.PYRROLID NE DITHIO - MIBK EXT.AND AA	"	---	---	---	---	0.005 0.052	---	---	---	---	---	---	---	---	---	---	---	---	---
"	NEUTRON ACTIVATION	"	---	---	---	---	---	---	---	---	< 1 (FA) ≤ 1 < 1 (RU) < 1 (FU)	---	---	---	---	---	---	---	---	---
"	SPARK SOURCE MASS SPEC.	"	---	---	---	---	---	---	---	---	0.005 (FA) 0.07 0.03 (RU) 0.008 (FU)	---	---	0.04	---	---	---	---	---	---
"	ARGON PLASMA EMISSION	"	---	---	0.017 0.06	---	---	---	---	---	---	---	---	---	---	---	---	---	---	0.010 0.056
"	EMISSION SPEC.	"	---	---	0.021 0.19	---	---	---	---	---	---	---	---	---	< 0.03 0.06	---	---	---	---	---
"	X-RAY FLUORESCENCE (LIQUID)	"	---	---	---	---	---	---	---	---	ND (FU) ND ND (FU) 5 (RU)	---	---	---	---	---	---	---	---	---
MERCURY (mg/l)	COLD VAPOR (FLAMELESS) AA	0.01	0.001 0.005	---	0.0004 0.0005	---	ND < 0.002	---	---	---	0.00015 (FU) 0.00179 (RU) 0.00008 (FA) 0.010 ND (FA) ND ND (FU) 0.3 (RU)	0.0006 0.009	---	---	< 0.1 0.1	---	---	---	0.00280 (FA) 0.00172 (RU) 0.000264 (FU) 0.00930	---
"	X-RAY FLUORESCENCE (LIQUID)	"	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
"	NEUTRON ACTIVATION	"	---	---	---	< 0.01 0.01	---	---	---	---	---	---	---	---	---	---	---	---	---	---

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TABLE 1. GRR-1 RESULTS (CONTINUED)

PARAMETER	METHOD	PNL PREPARED CONTROL SAMPLE	LAB 17	LAB 19	LAB 21	LAB 23	LAB 25	LAB 27	LAB 29	LAB 31	LAB 33	LAB 35	LAB 37	LAB 39	LAB 41	LAB 43	LAB 45	LAB 47	LAB 49	LAB 51
PHOSPHATE (mg/l)	SnCl ₂ COLORIMETRIC	0.25	---	---	0.43 0.26	---	---	0.08 0.04	---	---	---	0.96 0.09	---	---	0.42 0.49	---	---	---	---	---
"	ASCORBIC ACID COLORIMETRIC (INC. AUTO ANALYZER)	"	0.1 0.3	---	---	<0.50	ND<0.05 0.32	---	---	---	0.052 (FU) 0.058 (RU) 0.048 (FA)0.36	---	0.099 ≤ 0.1	---	---	---	0.20 (RU) 1.12 (FU) 0.12 0.24 (FA)	0.16 AS P 0.16 AS P	---	---
"	SPARK SOURCE MASS SPEC.	"	---	---	---	---	---	---	---	---	---	---	---	MAJOR COMPONENT (AS P)	---	---	---	---	---	---
"	ARGON PLASMA EMISSION	"	---	---	7.0 5.8	---	---	---	---	---	---	---	---	---	---	---	---	---	---	0.15 0.34
"	SnCl ₂ COLORIMETRIC (BENZ. -ISOBUTANOL EXTRACT)	"	---	---	0.36	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
"	SnCl ₂ COLORIMETRIC WITH PERSULFATE DIGESTION	"	---	---	---	---	<0.05 0.36	---	---	---	---	---	---	---	---	---	---	---	---	---
"	X-RAY FLUORESCENCE (LIQUID)	"	---	---	---	---	---	---	---	---	ND (FA) 2 ND (FU) 3 (RU) AS P	---	---	---	---	---	---	---	---	---
"	MOLYBDOPHOS- PHORIC ACID METHOD	"	---	---	---	---	---	---	---	---	---	1.6 0.55	---	---	---	---	---	---	---	---
POTASSIUM (mg/l)	AA	180	---	121 164	166 235	---	---	---	---	---	---	123 180	138 188	117 160	---	130 191	130 135	140 180	---	---
"	FLAME EMISSION	"	175 180	---	---	---	140 195	123 (RA) 124 (FA) 174	150	---	---	---	---	---	124 178	---	---	---	---	---
"	SPARK SOURCE MASS SPEC.	"	---	---	---	---	---	---	---	---	165 (FA) 180 200 (RU) 165 (FU)	---	---	MAJOR COMPONENT	---	---	---	---	---	---
"	ARGON PLASMA EMISSION	"	---	---	200 122	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
"	EMISSION SPEC.	"	---	---	110 170	---	---	---	---	---	---	---	---	---	---	---	---	---	---	119 165
"	X-RAY FLUORESCENCE (LIQUID)	"	---	---	---	---	---	---	---	---	172 (FA) 222 135 (FU) 239 (RU)	---	---	---	---	---	---	---	---	---
"	ION EXCHANGE CHROMATOGRAPHY	"	---	---	---	---	---	---	---	---	---	---	---	---	130 (RU) 130 (FA) 127 (FA) 182	---	---	---	---	---

TABLE 1. GRR-1 RESULTS (CONTINUED)

PARAMETER	METHOD	PNL PREPARED CONTROL SAMPLE	LAB 17	LAB 19	LAB 21	LAB 23	LAB 25	LAB 27	LAB 29	LAB 31	LAB 33	LAB 35	LAB 37	LAB 39	LAB 41	LAB 43	LAB 45	LAB 47	LAB 49	LAB 51
POTASSIUM (mg/L)	NEUTRON ACTIVATION	180	---	---	---	< 60 ≤ 60	---	---	---	---	< 20 (FA) ≤ 40 (FU) ≤ 900 ≤ 40 (RU)	---	---	---	---	---	---	---	---	---
"	SPECIFIC ION ELECTRODE	"	---	---	---	---	---	---	120 (FIELD)	---	---	---	---	---	---	---	---	---	---	---
RUBIDIUM (mg/L)	AA	5.0	---	0.41 4.66	0.4 4.2	---	---	---	---	---	---	0.65 5.5	0.6 4.7	---	---	---	---	0.4 5.6	---	---
"	FLAME EMISSION	"	---	---	---	---	0.72 6.06	1.5 (RA) 1.5 (FA) 5.2	0.62	---	---	---	---	---	0.59 5.4	---	---	---	---	---
"	NEUTRON ACTIVATION	"	---	---	---	< 0.02 4.8	---	---	---	---	0.1 (FA) 0.1 (FU) 6.8 0.1 (RU)	---	---	---	---	---	---	---	0.614 (FA) 0.949 (RU) 0.583 (FU) 8.313	---
"	SPARK SOURCE MASS SPEC.	"	---	---	---	---	---	---	---	---	2.5 (FA) 2.4 3.5 (RU) 3.5 (FU)	---	---	1	---	---	---	---	---	---
"	EMISSION SPEC.	"	---	---	ND ND	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
"	AA GRAPHITE FURNACE	"	0.38 5.0	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
SILICA (mg/L)	AA	250	---	388 ± 0.5 169 264	395 266	---	165 228	35 (FA) ND < 1 35 (FA) 35.8 (256.8)	---	---	---	210 206	---	---	---	265 276	---	---	---	---
"	HETEROPOLY - BLUE COLORIMETRIC	"	---	---	---	---	203 206	---	237	---	---	---	---	---	---	---	---	230 250	---	---
"	MOLYBDEOSILICATE COLORIMETRIC	"	---	2.5, 0.1 220, 210	---	219 219	---	---	---	---	---	230 226	200 (FIELD) 290 (LAB) 300	---	---	---	---	---	---	---
"	FLAME EMISSION	"	---	---	---	---	---	---	---	---	---	---	---	---	267 ± 2 226 220	---	535 300	---	---	---
"	ARGON PLASMA EMISSION	"	---	---	---	103.7 0.43	---	---	---	---	---	---	---	---	---	---	---	---	---	260 ≤ 1 (UNDIR. FA CONTROL)
"	SPARK SOURCE MASS SPEC.	"	---	---	---	---	---	---	---	---	---	---	---	MAJOR COMPONENT AS IS	---	---	---	---	---	---
"	EMISSION SPEC.	"	---	---	---	28 2.6	---	---	---	---	---	---	---	---	---	---	---	---	---	---

TABLE 1. GRR-1 RESULTS (CONTINUED)

PARAMETER	METHOD	PNL PREPARED CONTROL SAMPLE	LAB 17	LAB 19	LAB 21	LAB 23	LAB 25	LAB 27	LAB 29	LAB 31	LAB 33	LAB 35	LAB 37	LAB 39	LAB 41	LAB 43	LAB 45	LAB 47	LAB 49	LAB 51
SILVER (mg/l)	AA	0.07	---	0.02 0.02	---	---	---	ND<0.02 (RA) ND<0.02 (FA) ND<0.02	<0.02	---	---	0.012 0.018	0.08 0.08	<0.01 <0.01	---	---	0 0.06	---	---	---
"	AA GRAPHITE FURN.	"	0.08 0.01	---	0.004 0.006	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
"	EMISSION SPEC.	"	---	---	0.016 0.0065	---	---	---	---	---	---	---	---	---	<0.01 <0.01	---	---	---	---	---
"	AMM. PYRROLIDINE DITHIO. -MIBK EXT. AND AA	"	---	---	---	---	ND <0.005 0.122	---	---	---	---	---	---	---	---	---	---	---	---	---
"	NEUTRON ACTIVATION	"	---	---	---	0.024 0.052	---	---	---	---	<0.05 (FA) <0.1 (FU) ≤1.0 <0.05 (RU)	---	---	---	---	---	---	---	<0.0027 (FA) <0.0023 (RU) 0.00028 (FU) 0.0152	---
"	SPARK SOURCE MASS SPEC.	"	---	---	---	---	---	---	---	---	---	---	---	0.07	---	---	---	---	---	---
"	ARGON PLASMA EMISSION	"	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	0.007 0.007
SODIUM (mg/l)	AA	1500	---	1380 1390	1601 1930	---	---	---	---	---	---	1430 1520	1400 1440	970 1200	---	1360 1460	---	1700 1600	---	---
"	FLAME EMISSION	"	1400 1400	---	---	---	1400 1450	1450 (RA) 1410 (FA) 1520	1550	---	---	---	---	---	1400 1480	---	2000 1550	---	---	---
"	NEUTRON ACTIVATION	"	---	---	---	1462 1498	---	---	---	---	1400 (FA) 1450 (FU) 1513 1400 (RU)	---	---	---	---	---	---	---	---	---
"	SPARK SOURCE MASS SPEC.	"	---	---	---	---	---	---	---	---	1470 (FA) 1470 (RU) 1500 1470 (FU)	---	---	>4	---	---	---	---	---	---
"	ARGON PLASMA EMISSION	"	---	---	1450 1540	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---

TABLE 1. GRR-1 RESULTS (CONTINUED)

[illegible]

TABLE 1. GRR-1 RESULTS (CONTINUED)

PARAMETER	METHOD	PNL PREPARED CONTROL SAMPLE	LAB 17	LAB 19	LAB 21	LAB 23	LAB 25	LAB 27	LAB 29	LAB 31	LAB 33	LAB 35	LAB 37	LAB 39	LAB 41	LAB 43	LAB 45	LAB 47	LAB 49	LAB 51
SULFATE (mg/l)	FLAME EMISSION (BaSO ₄ PPT., EMISS. ON Ba)	150	---	---	---	---	---	---	---	---	---	---	---	---	113 173	---	---	---	---	---
"	ION EXCHANGE CHROMATOGRAPHY	"	---	---	---	---	---	---	---	---	---	---	---	---	159(RU) 159(FU)	---	---	---	---	---
SULFIDE (mg/l)	IODOMETRIC TITRATION		0.4	1.43	---	---	---	0.6	1.6	---	---	0.26	---	---	---	---	174	---	---	---
"	METHYLENE BLUE COLORIMETRIC		---	---	<0.01	---	---	---	0.15 (FIELD)	---	---	---	0.32 (FIELD)	0.05	---	---	---	---	---	---
"	NEUTRON ACTIVATION		---	---	---	---	---	---	---	---	<5000(FA) ≤5000 ≤1000(RU) ≤1000(FU)	---	---	---	---	---	---	---	---	---
"	SPECIFIC ION ELECTRODE		---	---	0.5	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
"	SPARK SOURCE MASS SPEC.		---	---	---	---	---	---	---	---	---	---	---	MAJOR COMPONENT	---	---	---	---	---	---
"	X-RAY FLUORESCENCE (LIQUID)		---	---	---	---	---	---	---	---	67(FA) 74 42(FU) 36(RU)	---	---	---	---	---	---	---	---	---
ZINC (mg/l)	AA	0.60	0.21 0.65	0.026 0.584	0.15 0.73	---	---	0.07(RA) 0.07(FA) 0.73	0.01	---	---	0.02 0.61	0.05 0.62	<0.01 0.55	<0.1 0.5	---	0 0.48	---	---	---
"	AMM. PYRROLIDINE DITHIO. -MIBK EXT. AND AA	"	---	---	---	---	0.014 0.61	---	---	---	---	---	---	---	---	---	---	---	---	---
"	EMISSION SPEC.	"	---	---	ND ND	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
"	SPARK SOURCE MASS SPEC.	"	---	---	---	---	---	---	---	---	0.005(FA) 0.1 0.01(RU) 0.01(FU)	---	---	0.03	---	---	---	---	---	---

TABLE 1. GRR-1 RESULTS (CONTINUED)

PARAMETER	METHOD	PNL PREPARED CONTROL SAMPLE	LAB 17	LAB 19	LAB 21	LAB 23	LAB 25	LAB 27	LAB 29	LAB 31	LAB 33	LAB 35	LAB 37	LAB 39	LAB 41	LAB 43	LAB 45	LAB 47	LAB 49	LAB 51
ZINC (mg/l)	ARGON PLASMA EMISSION	0.60	---	---	0.06 0.74	---	---	---	---	< 0.02 0.66	---	---	---	---	---	---	---	---	---	0.06 0.58
"	AA GRAPHITE FURNACE	"	0.61 0.65	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
"	NEUTRON ACTIVATION	"	---	---	---	0.06 0.6	---	---	---	---	0.42(FA) ≤0.3(FU) ≤400 0.32(RU)	---	---	---	---	---	---	---	0.00248(FA) 0.00344(RU) 0.00152(FU) 0.731	---
TOTAL DISSOLVED SOLIDS (mg/l)	GRAVIMETRIC		4032	4282	4363	4333	4220	3883	4238	---	---	4510	4217	---	4220	4224	4320 4120	4200	---	---
H ₂ S (ENTRAINED) (mg/l)	IODOMETRIC TITRATION	5.5	1.5 5.3	1.08 5.27	0.85 6.2	---	1.2 5.8	5.2 5.11	1.4	---	---	3.1 5.2	1.80 5.5	---	---	3.6 6.8	0 0	---	---	---
"	METHYLENE BLUE COLORIMETRIC	"	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	1.3, 10 0.095 0.40 (LAUTH'S VIOLET)	---	---
CO ₂ (ENTRAINED) (mg/l)	ACID TITRATION	2000	---	---	5163 1956	---	---	---	---	---	---	---	4770 (LAB) 1344 (FIELD) 1980	---	5320 1940	---	2489 2489	---	---	---
"	PRECISE EVOLUTION	"	---	---	---	---	---	5400 2090	---	---	---	5780 2060	---	---	---	---	---	---	---	---
"	TOTAL CARBON ANALYZER	"	---	---	---	---	---	---	---	---	---	---	---	---	5440 2000	---	---	---	---	---
"	STRONTIUM GRAVIMETRIC	"	---	---	---	---	3748 1968	---	6700	---	---	---	---	---	---	---	---	---	---	---
"	CALCULATION	"	4514 2449	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---

TABLE 2. RADIOACTIVE ISOTOPES GRR-1 (EAST MESA 6-2 WELLHEAD BRINE)

PARAMETER	METHOD	LAB 25	LAB 33	LAB 35	LAB 47	LAB 51
ACTINIUM-228 (pCi /l)	γ -SPECTROMETRY	---	---	---	---	8.81 (@ 785.4 keV) 5.96 (@ 911.1 keV) 6.34 (@ 969.0 keV)
BISMUTH-214 (pCi /l)	γ -SPECTROMETRY	---	---	---	---	17.6 (@ 609.4 keV) 21.1 (@ 1120.4 keV) 31.7 (@ 1408.0 keV) 33.1 (@ 1764.7 keV)
LEAD-210 (pCi /l)	BETA COUNTING OF Bi-210 DAUGHTER	0.0	---	---	---	---
LEAD-212 (pCi /l)	γ -SPECTROMETRY	---	---	---	---	9.52 (@ 238.6 keV)
LEAD-214 (pCi /l)	γ -SPECTROMETRY	---	---	---	---	17.5 (@ 295.2 keV) 20.3 (@ 352.0 keV)
MANGANESE-54 (pCi /l)	γ -SPECTROMETRY	---	---	---	---	0.651 (@ 834.0 keV)
POTASSIUM-40 (pCi /l)	γ -SPECTROMETRY	---	200	---	---	166 (@ 1460.0 keV)
RADIUM-223 (pCi /l)	PRECIPITATION AND ALPHA SPECTROMETRY	---	Ra 1.8 Th < 0.9 (COMBINED ACTIVITIES OF Ra AND Th)	---	---	---
RADIUM-226 (pCi /l)	RADON EMANATION	0.0	---	---	2.4	---
"	PRECIPITATION AND ALPHA SPECTROMETRY	---	Ra 1.8 Th < 0.9 (COMBINED ACTIVITIES OF Ra AND Th)	1.5	---	---
"	γ -SPECTROMETRY	---	> 13.5	---	---	42.4 (@ 186.1 keV)
RADIUM-234 (pCi /l)	PRECIPITATION AND ALPHA SPECTROMETRY	---	Ra 1.8 Th < 0.9 (COMBINED ACTIVITIES OF Ra AND Th)	---	---	---
THALLIUM-208 (pCi /l)	γ -SPECTROMETRY	---	---	---	---	9.75 (@ 583.1 keV)
THORIUM-228 (pCi /l)	ALPHA SPECTROMETRY	0.0	Ra 1.8 Th < 0.9 (COMBINED ACTIVITIES OF Ra AND Th)	---	---	---
THORIUM-230 (pCi /l)	ALPHA SPECTROMETRY	0.0	"	---	---	---
THORIUM-232 (pCi /l)	ALPHA SPECTROMETRY	0.0	"	---	---	---
THORIUM-234 (pCi /l)	γ -SPECTROMETRY	---	---	---	---	20 (@ 63.0 keV) 17.5 (@ 93.0 keV)
THORIUM (X RAY) (pCi /l)	γ -SPECTROMETRY	---	---	---	---	197 (@ 76.7 keV) 78.2 (@ 84.5 keV)
URANIUM-234 (pCi /l)	ALPHA SPECTROMETRY	4.2	---	---	---	---
URANIUM-238 (pCi /l)	ALPHA SPECTROMETRY	2.7	---	---	---	---

TABLE 3 GRR-2 RESULTS (WOOLSEY #1 FIRST STAGE FLASH SAMPLE)

PARAMETER	METHOD	PNL PREPARED CONTROL SAMPLE	LAB 17	LAB 19	LAB 21	LAB 23	LAB 25	LAB 27	LAB 29	LAB 31	LAB 33	LAB 34	LAB 35	LAB 37	LAB 39	LAB 41	LAB 45	LAB 47	LAB 49	LAB 51	LAB 53
pH	pH METER		3.60	3.32	3.0	2.83	4.3	4.0	4.30	---	---	5.04	3.85	6.2 AT 45°C (FIELD) 3.90 (LAE)	4.3	2.95	2.77	---	---	---	---
CONDUCTIVITY (µmhos/cm)	CONDUCTIVITY METER		84,000	---	193,300	---	344,000	202,500	406,000	---	---	---	140,000	158,000	---	---	---	---	---	---	---
ALKALINITY (mg/l CaCO ₃)	ACID TITRATION		0	0	0	0	ND<2	---	0	---	---	---	N.D.	0	0	---	0	---	---	---	---
HARDNESS (mg/l CaCO ₃)	EDTA TITRATION		56,000	57,900	51,200	---	61,504	---	---	---	---	---	60,600	60,700	62,000	---	---	---	---	---	---
"	CALCULATION		34,000	31,600	33,300	---	34,800	---	---	---	---	---	32,400	32,400	---	---	---	---	---	---	---
"			---	---	---	---	---	60,300 18,300	---	---	---	---	---	---	---	---	---	---	---	---	---
SUSPENDED SOLIDS (mg/l)	GRAVIMETRIC		1287 256	34.6	2080	---	---	---	---	---	---	---	1054	---	2400	---	---	---	---	---	---
TURBIDITY (NTU)	NEPHELOMETER		285	24	---	---	---	---	---	---	---	---	32	---	---	---	---	---	---	---	---
" (JTU)	VISUAL MATCHING		---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
" (FORMAZIN TURBIDITY U.)	FACH METER		---	---	---	---	---	305	---	---	---	---	---	---	---	---	---	---	---	---	---
ALUMINUM (mg/l)	AA	0.98	---	4.0 3.0	---	---	ND<0.1 ND=0.1	---	---	---	---	---	0.18 1.25	1.0 1.3	---	---	ND ND	---	---	---	---
"	MIBK & 8-HYDROXY- QUINOLINE EXTRACT, AND AA	"	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---

TABLE 3 (CONTINUED)

PARAMETER	METHOD	PNL PREPARED CONTROL SAMPLE	LAB 17	LAB 19	LAB 21	LAB 23	LAB 25	LAB 27	LAB 29	LAB 31	LAB 33	LAB 34	LAB 35	LAB 37	LAB 39	LAB 41	LAB 45	LAB 47	LAB 49	LAB 51	LAB 53
ALUMINUM (mg /l)	AA GRAPHITE FURNACE	0.98	0.01 0.03	---	0.81 0.28	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
"	ARGON PLASMA EMISSION	"	---	---	1.25 2.02	---	---	---	---	6 5	---	---	---	---	---	---	---	---	---	0.41 1.22	---
"	EMISSION SPEC.	"	---	---	7.0 4.9	---	---	---	---	---	---	---	---	---	---	3 3	---	---	---	---	---
"	NEUTRON ACTIVATION	"	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
"	SPARK SOURCE MASS SPEC.	"	---	---	---	---	---	---	---	---	3 (RA) 5 (RU) 3	---	---	---	0.3	---	---	---	---	---	---
"	X-RAY FLUOR- ESCECE (LIQUID)	"	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
"	FLAME EMISSION	"	---	---	---	---	---	0.08 1.3	---	---	---	---	---	---	---	---	---	---	---	---	---
AMMONIA (mg /l)	DIRECT NESSLERIZATION	448	---	453 AS N 441 AS N	---	---	---	341 448	---	---	---	---	---	---	---	---	---	---	---	---	---
"	ION SPECIFIC ELECTRODE	"	---	---	329 464	---	---	---	---	---	---	---	370 135	341 361	139	332 436	---	---	---	---	---
"	DISTILLATION, COLLECTION IN H ₂ SO ₄ AND TIT. WITH NaOH	"	---	---	---	---	319 414	---	---	---	---	---	---	---	---	---	---	---	---	---	---
"	DISTILLATION AND NESSLERIZATION	"	---	---	380 493	---	331 400	---	---	---	---	---	420 430	---	---	---	---	---	---	---	---
"	AUTO ANALYZER	"	---	---	---	---	---	---	---	382 (RU) 350 (RA) 444	---	---	---	---	---	---	---	---	---	---	---
"	ION EXCHANGE CHROMATOGRAPHY	"	---	---	---	---	---	---	---	---	---	---	---	---	---	371 (RU) 346 (RA) 480	---	---	---	---	---
"	DISTILLATION AND ACIDIMETRIC	"	265 AS N 128 AS N	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---

TABLE 3 (CONTINUED)

PARAMETER	METHOD	PML PREPARED CONTROL SAMPLE	LAB 17	LAB 19	LAB 21	LAB 23	LAB 25	LAB 27	LAB 29	LAB 31	LAB 33	LAB 34	LAB 35	LAB 37	LAB 39	LAB 41	LAB 45	LAB 47	LAB 49	LAB 51	LAB 53
ANTIMONY (mg/l)	AA	4.3	---	---	---	---	---	---	---	---	---	---	3.9 3.5	5.6 5.6	---	---	---	---	---	---	---
"	HYDRIDE EVOL. AND AA	"	---	---	0.14 1.29	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
"	EMISSION SPEC.	"	---	---	ND ND	---	---	---	---	---	---	---	---	---	---	0.75 2.5	---	---	---	---	---
"	AA GRAPHITE FURNACE	"	1.09 0.11	---	---	---	0.10 4.1	---	---	---	---	---	---	---	---	---	---	---	---	---	---
"	X-RAY FLUORESCENCE (LIQUID)	"	---	---	---	---	---	ND < 10 ND < 10	---	---	---	---	---	---	---	---	---	---	---	---	---
"	ARGON PLASMA EMISSION	"	---	---	---	---	---	---	---	13 14	---	---	---	---	---	---	---	---	---	0.74 4.6	---
"	NEUTRON ACTIVATION	"	---	---	---	0.48	---	---	---	---	0.8(RA) 0.35(RU) 4.5	---	---	---	---	---	---	---	---	---	---
"	SPARK SOURCE MASS SPEC.	"	---	---	---	---	---	---	---	---	1(RA) 1 3(RU)	---	---	---	≤ 0.5	---	---	---	---	---	---
ARSENIC (mg/l)	AA GRAPHITE FURNACE	0.095 0.02	1.036 0.02	---	---	---	---	---	---	---	---	---	---	10.4 0.8	---	---	---	0.18	---	---	---
"	HYDRIDE EVOL. (SILVER DITHIOCAR- BAMATE) AND SPECTROPHOTO.	"	---	---	---	---	6.4 ND < 0.02	10 0.3	---	---	---	---	---	---	---	---	---	---	---	---	---
"	ARGON PLASMA EMISSION	"	---	---	5.9 ND	---	---	---	---	22 9	---	---	---	---	---	---	---	---	---	11 0.23	---
"	EMISSION SPEC.	"	---	---	ND ND	---	---	---	---	---	---	---	---	---	---	3.5 ≤ 0.1	---	---	---	---	---
"	NEUTRON ACTIVATION	"	---	---	---	28	---	---	---	---	0.5(RA) 4.6(RU) ≤ 2	---	---	---	---	---	---	---	---	---	---
"	SPARK SOURCE MASS SPEC.	"	---	---	---	---	---	---	---	---	1(RA) 1 3(RU)	---	---	---	17	---	---	---	---	---	---

TABLE 3 (CONTINUED)

PARAMETER	METHOD	PNL PREPARED CONTROL SAMPLE	LAB 17	LAB 19	LAB 21	LAB 23	LAB 25	LAB 27	LAB 29	LAB 31	LAB 33	LAB 34	LAB 35	LAB 37	LAB 39	LAB 41	LAB 45	LAB 47	LAB 49	LAB 51	LAB 53
ARSENIC (mg /l)	ARSINE GEN. AND AA	0.098	---	---	10.5 0.10	---	---	---	---	---	---	---	2.60 0.033	---	---	---	---	---	---	---	---
BICARBONATE (mg /l)	ACID TITRATION		---	---	0	0	ND<2	0	0	---	---	5	ND	0	0	---	ND	---	---	---	---
"	CALCULATION		0	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
CARBONATE (mg /l)	ACID TITRATION		---	---	0	0	ND<2	0	0	---	---	ND	ND	0	0	---	ND	---	---	---	---
"	CALCULATION		0	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
BARIUM (mg /l)	AA	90.0	---	130 103	---	---	83 88	---	---	---	---	115 73	140 90	---	97	---	200 59	---	---	---	---
"	AA GRAPHITE FURNACE	"	29.8 40.3	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
"	ARGON PLASMA EMISSION	"	---	---	35.7 53.8	---	---	---	---	90 80	---	---	---	---	---	---	---	---	---	116 83.6	---
"	EMISSION SPEC.	"	---	---	ND NE	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
"	FLAME EMISSION	"	---	---	275 200	---	---	157 92	---	---	---	---	---	---	---	---	---	---	---	---	---
"	NEUTRON ACTIVATION	"	---	---	---	---	---	---	---	---	72 (RA) 33 (RU) ≤50	---	---	---	---	---	---	---	---	---	---
"	SPARK SOURCE MASS SPEC.	"	---	---	---	---	---	---	---	---	150 (RA) 155 (RU) 95	---	---	---	87	---	---	---	---	---	---
"	ABSORPTOMETRIC	"	---	---	---	---	---	---	---	---	---	---	---	176 84	---	---	---	---	---	---	---

TABLE 3 (CONTINUED)

[illegible]

TABLE 3 (CONTINUED)

PARAMETER	METHOD	PNL PREPARED CONTROL SAMPLE	LAB 17	LAB 19	LAB 21	LAB 23	LAB 25	LAB 27	LAB 29	LAB 31	LAB 33	LAB 34	LAB 35	LAB 37	LAB 39	LAB 41	LAB 45	LAB 47	LAB 49	LAB 51	LAB 53
BROMIDE (mg/l)	ION EXCHANGE CHROMATOGRAPHY	1.64	---	---	---	---	---	---	---	---	---	---	---	---	---	94.5	---	---	---	---	---
"	SPARK SOURCE MASS SPEC.	"	---	---	---	---	---	---	---	---	---	---	---	---	56	---	---	---	---	---	---
CALCIUM (mg/l)	AA	12,830	25,000 13,000	23,000 12,100	21,000 10,500	---	---	---	20,000 10,000	---	---	22,250 11,600	24,900 11,800	24,700 13,700	---	---	34,500 17,000	24,000 14,000	---	---	---
"	NEUTRON ACTIVATION	"	---	---	---	13,300	---	---	---	---	18,700(RA) 14,300(RU) 16,800	---	---	---	---	---	---	---	---	---	---
"	SPARK SOURCE MASS SPEC.	"	---	---	---	---	---	---	---	---	25,000(RA) 24,000(RU) 13,000	---	---	---	MAJOR COMPONENT	---	---	---	---	---	---
"	ARGON PLASMA EMISSION	"	---	---	18,500 10,800	---	---	---	---	229,000 12,200	---	---	---	---	---	---	---	---	---	24,600 14,000	---
"	EMISSION SPEC.	"	---	---	19,000 9800	---	---	---	---	---	---	---	---	---	---	32,500 14,200	---	---	---	---	---
"	FLAME EMISSION	"	---	---	---	---	---	22,900 11,900	---	---	---	---	---	---	---	---	---	---	---	---	---
"	EDTA TITRATION	"	---	---	---	---	23,000 12,400	---	22,900 12,100	---	---	---	---	---	---	---	---	---	---	---	---
CESIUM (mg/l)	AA	159.6	---	152 250	---	---	---	---	---	---	---	---	13.5 165	36 158	---	---	10.6 200	13 140	---	---	---
"	FLAME EMISSION	"	---	---	58 104	---	11.3 14.6	10 160	12 ND	---	---	---	---	---	---	14 163	---	---	---	---	---
"	NEUTRON ACTIVATION	"	---	---	---	11.24 138	---	---	---	---	10(RA) 6.2(RU) 155	---	---	---	---	---	---	---	---	---	---
"	SPARK SOURCE MASS SPEC.	"	---	---	---	---	---	---	---	---	2(RA) 2(RU) 15	---	---	---	5	---	---	---	---	---	---
"	EMISSION SPEC.	"	---	---	ND ND	---	---	---	---	---	---	---	---	---	---	---	---	---	---	190 220	---
"	AA GRAPHITE FURNACE	"	5.0 204	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---

TABLE 3 (CONTINUED)

PARAMETER	METHOD	PNL PREPARED CONTROL SAMPLE	LAB 17	LAB 19	LAB 21	LAB 23	LAB 25	LAB 27	LAB 29	LAB 31	LAB 33	LAB 34	LAB 35	LAB 37	LAB 39	LAB 41	LAB 45	LAB 47	LAB 49	LAB 51	LAB 53
			LAB 17	LAB 19	LAB 21	LAB 23	LAB 25	LAB 27	LAB 29	LAB 31	LAB 33	LAB 34	LAB 35	LAB 37	LAB 39	LAB 41	LAB 45	LAB 47	LAB 49	LAB 51	LAB 53
CHLORIDE (mg/l)	Ag NO ₃ TITR.		--	151,200	130,500	125,300	122,700	--	127,000	--	--	AVERAGE	--	--	--	--	130,600	--	--	--	--
"	Hg (NO ₃) ₂ TITR.		132,000	--	--	--	122,100	--	--	--	--	130,000	--	150,000	--	--	--	140,000	--	--	--
"	X-RAY FLUORESCENCE (LIQUID)		--	--	--	--	--	133,000	--	--	--	--	--	--	--	--	--	--	--	--	--
"	NEUTRON ACTIVATION		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
"	GRAVIMETRIC		--	--	--	--	--	--	--	--	--	--	128,900	--	--	--	--	--	--	--	--
"	ION SPECIFIC ELECTRODE		--	--	--	--	--	--	--	--	--	--	140,000	--	--	--	--	--	--	--	--
"	SPARK SOURCE MASS SPEC.		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
"	ION EXCHANGE CHROMATOGRAPHY		--	--	--	--	--	--	--	--	--	--	--	--	--	132,000	--	--	--	--	--
COPPER (mg/l)	AA	1.88	0.9 1.4	1.50 2.13	--	--	1.22 2.10	<2 3	1 2	--	--	1.5 1.7	1.25 2.10	1.2 2.3	1.08	--	1.9 2.6	--	--	--	--
"	AMM. PYRROLIDINE DITHIO. MIBK EXT. AND AA	"	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
"	NEUTRON ACTIVATION	"	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
"	SPARK SOURCE MASS SPEC.	"	--	--	--	--	--	--	--	--	0.5 (RA) 0.5 (RU)	--	--	--	0.9	--	--	--	--	--	--
"	ARGON PLASMA EMISSION	"	--	--	0.74 1.85	--	--	--	--	2 2.2	--	--	--	--	--	--	--	--	--	1.14 2.21	--

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TABLE 3 (CONTINUED)

PARAMETER	METHOD	PNL PREPARED CONTROL SAMPLE	LAB 17	LAB 19	LAB 21	LAB 23	LAB 25	LAB 27	LAB 29	LAB 31	LAB 33	LAB 34	LAB 35	LAB 37	LAB 39	LAB 41	LAB 45	LAB 47	LAB 49	LAB 51	LAB 53
COPPER (mg/l)	AA. GRAPHITE FURNACE	1.88	---	---	0.88 1.74	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
"	EMISSION SPEC.	"	---	---	0.42 0.62	---	---	---	---	---	---	---	---	---	---	1 3	---	---	---	---	---
"	X-RAY FLUORESCENCE (LIQUID)	"	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
FLUORIDE (mg/l)	SPECIFIC ION ELECTRODE	12.3	3.9 11.2	---	43 101	---	---	1.5	1.2 0.1	---	---	---	1.2 3.5	9.77	---	1.18 5.88	1.1	---	---	---	---
"	ALIZARIN VISUAL AND DISTILLATION	"	---	---	---	---	14.7 8.0	---	---	---	---	---	---	---	---	---	---	---	---	---	---
"	AMADAC F AND DISTILLATION	"	---	---	---	---	1.3 3.9	---	---	---	---	---	---	---	---	---	---	---	---	---	---
"	SPARK SOURCE MASS SPEC.	"	---	---	---	---	---	---	---	---	---	---	---	---	~25	---	---	---	---	---	---
"	ION EXCHANGE CHROMATOGRAPHY	"	---	---	---	---	---	---	---	---	---	---	---	---	---	13.8	---	---	---	---	---
"	SPADNS SPECTROPHOTOMETRIC	"	---	---	---	---	---	---	---	---	---	---	1.6 4.5	---	---	---	---	---	---	---	---
IODIDE (mg/l)	LEUCO CRYSTAL VIOLET COLORIMETRIC	327	---	---	---	---	1.94	---	---	---	---	---	---	---	---	---	---	---	---	---	---
"	HYPOCHLORITE OXIDATION AND TITRATION	"	---	---	---	---	5.8 11.4	---	---	---	---	---	---	8.7 4.2	---	---	---	---	---	---	---
"	X-RAY FLUORESCENCE (LIQUID)	"	---	---	---	---	---	ND<10	---	---	---	---	---	---	---	---	---	---	---	---	---
"	NEUTRON ACTIVATION	"	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---

TABLE 3 (CONTINUED)

PARAMETER	METHOD	PNL PREPARED CONTROL SAMPLE																				
			LAB 17	LAB 19	LAB 21	LAB 23	LAB 25	LAB 27	LAB 29	LAB 31	LAB 33	LAB 34	LAB 35	LAB 37	LAB 39	LAB 41	LAB 45	LAB 47	LAB 49	LAB 51	LAB 53	
IODIDE (mg /l)	SPARK SOURCE MASS SPEC.	3.27	---	---	---	---	---	---	---	---	---	---	---	0.4	---	---	---	---	---	---		
"	ION SPECIFIC ELECTRODE	"	25.2 2.6	---	12.0 6.0	---	---	---	---	---	---	9.0 0.5	---	---	---	0.11	---	---	---	---		
"	ARSENIOUS-CERIC COLORIMETRIC	"	---	---	14.2 6.5	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---		
"	API PHOTOMETRIC	"	---	---	---	---	---	---	---	---	---	10 0.7	---	---	---	---	---	---	---	---		
"	ARSENIOUS-CERIC- FERRIC THIOCYANATE COLORIMETRIC	"	---	---	---	0.44	---	---	---	---	---	---	---	---	---	---	---	---	---	---		
IRON (mg /l)	AA	104	220 89	216 112	312 135	---	251 111	---	210 110	---	---	255 95	292 108	255 104	262	---	257 113	---	---	---		
	AMM. PYRROLIDINE DITHIO-MIBK EXT. AND AA	"	---	---	---	---	374 126	---	---	---	---	---	---	---	---	---	---	---	---	---		
	SPARK SOURCE MASS SPEC.	"	---	---	---	---	---	---	---	310(RA), 290(RU) 140	---	---	---	78	---	---	---	---	---	---		
	ARGON PLASMA EMISSION	"	---	---	206 91.4	---	---	---	260 106	---	---	---	---	---	---	---	---	---	---	319 158		
	EMISSION SPEC.	"	---	---	500 92	---	---	---	---	---	---	---	---	---	---	238 130	---	---	---	---		
	X-RAY FLUORESCENCE (LIQUID)	"	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---		
	NEUTRON ACTIVATION	"	---	---	---	202	---	---	---	242(RA), 159(RU) 106	---	---	---	---	---	---	---	---	---	---		
	FLAME EMISSION	"	---	---	---	---	---	290 114	---	---	---	---	---	---	---	---	---	---	---	---		
	PHENANTHROLINE COLORIMETRIC	"	---	262 111	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---		
LEAD (mg /l)	AA	22.7	---	51.6 22.6	48.0 8.0	---	52 25	55 35	143 110	---	---	44 22	46 22	47 23	---	47 22	53 24	---	---	---		
	AA GRAPHITE FURNACE	"	18 4	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---		
	SPARK SOURCE MASS SPEC.	"	---	---	---	---	---	---	---	---	25 (RA), 20 (RU) 10	---	---	---	6	---	---	---	---	---		

TABLE 3 (CONTINUED)

PARAMETER	METHOD	PNL PREPARED CONTROL SAMPLE	LAB 17	LAB 19	LAB 21	LAB 23	LAB 25	LAB 27	LAB 29	LAB 31	LAB 33	LAB 34	LAB 35	LAB 37	LAB 39	LAB 41	LAB 45	LAB 47	LAB 49	LAB 51	LAB 53
LEAD (mg/l)	AMM. PYRROLIDINE DITHIO. -MIBK EXT. AND AA	22.7	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
"	EMISSION SPEC.	"	---	---	91 13	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
"	ARGON PLASMA EMISSION	"	---	---	21.6 15.6	---	---	---	---	47 25	---	---	---	---	---	---	---	---	---	47.9 24.0	---
LITHIUM (mg/l)	AA	98.2	170 95	154 93	135 106	---	---	---	146 92	---	---	---	164 94	161 95	---	---	133 93	190 100	---	---	---
"	FLAME EMISSION	"	---	---	---	---	200 95	150 83	162 90	---	---	144 80	---	---	---	161 96	---	---	---	---	---
"	SPARK SOURCE MASS SPEC.	"	---	---	---	---	---	---	---	470(RA) 490(RU)	180	---	---	>91	---	---	---	---	---	---	---
"	EMISSION SPEC.	"	---	---	41 23	---	---	---	---	---	---	---	---	---	---	---	---	---	---	180 120	---
"	ION EXCHANGE CHROMATOGRAPHY	"	---	---	---	---	---	---	---	---	---	---	---	---	---	167(RU) 167(RA) 93.7	---	---	---	---	---
MAGNESIUM (mg/l)	AA	114.7	143 108	147 112	135 145	---	160, 120 148, 123	144 110	134 100	---	---	113 100	142 110	145 110	---	---	155 115	150 110	---	---	---
"	NEUTRON ACTIVATION	"	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
"	SPARK SOURCE MASS SPEC.	"	---	---	---	---	---	---	---	---	130(RA) 150(RU)	110	---	---	MAJOR COMPONENT	---	---	---	---	---	---
"	ARGON PLASMA EMISSION	"	---	---	57.5 67.0	---	---	---	---	120 110	---	---	---	---	---	---	---	---	---	199 199	---

TABLE 3 (CONTINUED)

PARAMETER	METHOD	PNL PREPARED CONTROL SAMPLE	LAB 17	LAB 19	LAB 21	LAB 23	LAB 25	LAB 27	LAB 29	LAB 31	LAB 33	LAB 34	LAB 35	LAB 37	LAB 39	LAB 41	LAB 45	LAB 47	LAB 49	LAB 51	LAB 53
MAGNESIUM (mg/l)	EMISSION SPEC.	114.7	---	---	60 55	---	---	---	---	---	---	---	---	---	---	160 120	---	---	---	---	---
"	EDTA TITRATION	"	---	---	---	---	---	---	161 115	---	---	---	---	---	---	---	---	---	---	---	---
MANGANESE (mg/l)	AA	336	660 312	646 354	690 350	---	710 342	640 330	665 333	---	---	585 275	720 330	660 305	---	---	643 322	---	---	---	---
"	ANM, PYRROLIDINE DITHIO. -MIBK EXC. AND AA	"	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
"	NEUTRON ACTIVATION	"	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
"	SPARK SOURCE MASS SPEC.	"	---	---	---	---	---	---	---	859(RA) 703(RU)	450	---	---	---	MAJOR COMPONENT	---	---	---	---	---	---
"	ARGON PLASMA EMISSION	"	---	---	550 309	---	---	---	---	---	---	---	---	---	---	---	---	---	---	953 536	---
"	EMISSION SPEC.	"	---	---	650 310	---	---	---	---	---	---	---	---	---	---	670 330	---	---	---	---	---
"	X-RAY FLUORESCENCE (LIQUID)	"	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
MERCURY (mg/l)	COLD VAPOR (FLAMELESS) AA	1.06	0.0005 0.86	---	0.0003 15	---	0.038 1.04	---	---	---	0.00009 (RU) 0.00018 (RA) 1.06	---	0.002 1.3	---	---	0.002 1.1	---	---	---	---	---
"	X-RAY FLUORESCENCE (LIQUID)	"	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
"	NEUTRON ACTIVATION	"	---	---	---	<0.01T	---	---	---	---	≤0.1 (RA) ≤0.07 (RU)	0.6	---	---	---	---	---	---	---	---	---
"	EMISSION SPEC.	"	---	---	ND ND	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---

TABLE 3 (CONTINUED)

PARAMETER	METHOD	PNL PREPARED CONTROL SAMPLE	LAB 17	LAB 19	LAB 21	LAB 23	LAB 25	LAB 27	LAB 29	LAB 31	LAB 33	LAB 34	LAB 35	LAB 37	LAB 39	LAB 41	LAB 45	LAB 47	LAB 49	LAB 51	LAB 53
PHOSPHATE (mg/l)	SnCl ₂ COLORIMETRIC	0.46	---	---	---	---	ND<0.05 0.34	ND<0.2	---	---	---	---	0.04 0.28	---	---	6.97 1.16	---	---	---	---	---
"	ASCORBIC ACID COLORIMETRIC (INC. AUTO ANALYZER)	"	2.5 0.2	---	---	>12.5	---	---	---	---	0.128 (RU) 4.23 (RA) 0.715	---	---	ND 0.46	---	---	0.25	---	---	---	---
"	SPARK SOURCE MASS SPEC.	"	---	---	---	---	---	---	---	---	---	---	---	---	Q.2 AS P	---	---	---	---	---	---
"	ARGON PLASMA EMISSION	"	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
"	SnCl ₂ COLORIMETRIC (BENZ. -ISOBUTANOL EXTRACT)	"	---	---	0.53 1.1	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
"	SnCl ₂ COLORIMETRIC WITH PERSULFATE DIGESTION	"	---	---	---	---	ND<0.02 0.43	---	---	---	---	---	---	---	---	---	---	---	---	---	---
"	X-RAY FLUORESCENCE (LIQUID)	"	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
"	MOLYBDOPHOSPHORIC ACID METHOD	"	---	---	---	---	---	---	---	---	---	---	0.42 0.12	---	---	---	---	---	---	---	---
POTASSIUM (mg/l)	AA	6910	---	10,500 6900	10,000 6750	---	---	---	6850 3000	---	---	10,270 6650	12,300 6920	10,200 6700	---	---	---	11,000 7200	---	---	---
"	FLAME EMISSION	"	11,300 6200	---	---	---	8000 5000	10,000 6620	10,800 6450	---	50,000 (RA) 50,000 (RU) 25,000	---	---	---	---	10,400 7000	10,300 5150	---	---	---	---
"	SPARK SOURCE MASS SPEC.	"	---	---	---	---	---	---	---	---	---	---	---	---	MAJOR COMPONENT	---	---	---	---	---	---
"	ARGON PLASMA EMISSION	"	---	---	8500 6400	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
"	EMISSION SPEC.	"	---	---	4200 4200	---	---	---	---	---	---	---	---	---	---	---	---	---	---	9100 6600	---
"	X-RAY FLUORESCENCE (LIQUID)	"	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
"	ION EXCHANGE CHROMATOGRAPHY	"	---	---	---	---	---	---	---	---	---	---	---	---	---	11,300 (RU) 11,200 (RA) 7150	---	---	---	---	---

TABLE 3 (CONTINUED)

PARAMETER	METHOD	PNL PREPARED CONTROL SAMPLE	LAB 17	LAB 19	LAB 21	LAB 23	LAB 25	LAB 27	LAB 29	LAB 31	LAB 33	LAB 34	LAB 35	LAB 37	LAB 39	LAB 41	LAB 45	LAB 47	LAB 49	LAB 51	LAB 53
POTASSIUM (mg/l)	NEUTRON ACTIVATION	6910	---	---	---	---	---	---	---	---	9025 (RU) 7500	---	---	---	---	---	---	---	---	---	---
RUTHENIUM (mg/l)	AA	39.3	---	58 33	50 30	---	---	---	---	---	---	---	67 39	---	---	---	112.5 41	76 48	---	---	---
"	FLAME EMISSION	"	---	---	---	---	76 50	62 36	73 ND	---	---	---	---	71 45	---	67 41	---	---	---	---	---
"	NEUTRON ACTIVATION	"	---	---	---	60	---	---	---	---	65 (RA) 47 (RU) 44	---	---	---	---	---	---	---	---	---	---
"	SPARK SOURCE MASS SPEC.	"	---	---	---	---	---	---	---	---	80 (RA) 90 (RU) 40	---	---	---	56	---	---	---	---	---	---
"	EMISSION SPEC.	"	---	---	ND ND	---	---	---	---	---	---	---	---	---	---	---	---	---	---	57 40	---
"	AA GRAPHITE FURNACE	"	4.0 3.0	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
SILICA (mg/l)	AA	44.9 (10:1 DM.) 0 IN RA CONTROL	---	475 43.2	438 49.2	---	375 583	405, 42.8 405, 8.6 (RA CONTROL)	---	---	297 36.2	370 37.5	400 41	405 27.8	---	---	---	---	---	---	---
"	HETEROPOLY- BLUE COLORIMETRIC	"	---	---	---	---	279 401	---	264 30	---	---	---	---	---	---	---	---	---	---	---	---
"	MOLYBDOSILICATE COLORIMETRIC	"	355 31	---	268 37.9	---	---	---	---	---	---	355 36.8	400 38	320 (FIELD) 500, 45 (LAB)	---	---	---	---	---	---	---
"	FLAME EMISSION	"	---	---	---	---	---	---	---	---	---	---	---	---	---	---	428 25.7	---	---	---	---
"	ARGON PLASMA EMISSION	"	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
"	SPARK SOURCE MASS SPEC.	"	---	---	---	---	---	---	---	---	321 (RA) 251 (RU) 42.8	---	---	---	28 AS Si	---	---	---	---	---	407 ND (RA CONTROL)
"	EMISSION SPEC.	"	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---

TABLE 3 (CONTINUED)

PARAMETER	METHOD	PNL PREPARED CONTROL SAMPLE	LAB 17	LAB 19	LAB 21	LAB 23	LAB 25	LAB 27	LAB 29	LAB 31	LAB 33	LAB 34	LAB 35	LAB 37	LAB 39	LAB 41	LAB 45	LAB 47	LAB 49	LAB 51	LAB 53
SILICA (mg/l)	GRAVIMETRIC	44.9 (10:1 DIL) 0 IN RA CONTROL	---	---	---	---	---	---	---	---	---	---	---	---	---	---	166 17	---	---	---	---
SILVER (mg/l)	AA	3.13	---	2.5 0.53	---	---	---	<0.8 1.6	0.8 0.75	---	---	---	0.03 0.10	0.15 0.10	---	---	0.70 0.52	---	---	---	---
"	AA GRAPHITE FURNACE	"	0.014 0.06	---	0.25 0.20	---	0.07 0.13	---	---	---	---	---	---	---	---	---	---	---	---	---	---
"	EMISSION SPEC.	"	---	---	ND ND	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
"	AMM. PYRROLIDINE DITHIO.-MIBK EXT. AND AA	"	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
"	NEUTRON ACTIVATION	"	---	---	---	<0.01	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
"	SPARK SOURCE MASS SPEC.	"	---	---	---	---	---	---	---	---	---	---	---	<0.001	---	---	---	---	---	---	---
"	ARGON PLASMA EMISSION	"	---	---	0.12 0.17	---	---	---	---	---	---	---	---	---	---	---	---	---	---	0.65 0.82	---
SODIUM (mg/l)	AA	17,700	---	45,600 17,500	37,000 15,500	---	---	---	48,500 19,000	---	---	43,240 16,300	46,700 17,600	57,000 18,000	---	---	48,125 18,000	56,000 13,000	---	---	---
"	FLAME EMISSION	"	48,300 18,600	---	---	---	50,500 19,200	48,500 16,500	49,000 18,200	---	---	---	---	---	3000	---	48,600 17,200	---	---	---	---
"	NEUTRON ACTIVATION	"	---	---	---	44,400	---	---	---	---	48,900(RA) 40,000(RU) 16,500	---	---	---	---	---	---	---	---	---	---
"	SPARK SOURCE MASS SPEC.	"	---	---	---	---	---	---	---	---	45,000(RA) 45,000(RU) 18,000	---	---	---	MAJOR COMPONENT	---	---	---	---	---	---
"	ARGON PLASMA EMISSION	"	---	---	38,200 17,400	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---

TABLE 3 (CONTINUED)

PARAMETER	METHOD	PNL PREPARED CONTROL SAMPLE	LAB 17	LAB 19	LAB 21	LAB 23	LAB 25	LAB 27	LAB 29	LAB 31	LAB 33	LAB 34	LAB 35	LAB 37	LAB 39	LAB 41	LAB 45	LAB 47	LAB 49	LAB 51	LAB 53
			LAB 17	LAB 19	LAB 21	LAB 23	LAB 25	LAB 27	LAB 29	LAB 31	LAB 33	LAB 34	LAB 35	LAB 37	LAB 39	LAB 41	LAB 45	LAB 47	LAB 49	LAB 51	LAB 53
SODIUM (mg/l)	EMISSION SPEC.	17,700	---	---	45,000 20,000	---	---	---	---	---	---	---	---	---	---	---	---	---	---	25,000 9000	---
"	ION EXCHANGE CHROMATOGRAPHY	"	---	---	---	---	---	---	---	---	---	---	---	---	---	48,900(RU) 48,700(RA) 17,700	---	---	---	---	---
STRONTIUM (mg/l)	AA	147	---	---	520 215	---	---	---	---	---	---	---	---	400 160	---	355 150	403 180	390 160	---	---	---
"	FLAME EMISSION	"	---	---	---	---	430 84	410 150	420 140	---	---	365 125	490 190	---	---	---	---	---	---	---	---
"	SPARK SOURCE MASS SPEC.	"	---	---	---	---	---	---	---	---	530(RA) 460(RU)	230	---	---	MAJOR COMPONENT	---	---	---	---	---	---
"	ARGON PLASMA EMISSION	"	---	---	300 145	---	---	---	---	---	145(RA) 180(RU)	109	---	---	---	---	---	---	---	416 172	---
"	EMISSION SPEC.	"	---	---	130 43	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
"	X-RAY FLUORESCENCE (LIQUID)	"	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
"	NEUTRON ACTIVATION	"	---	---	---	311	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
"	AA GRAPHITE FURNACE	"	109.4 71.4	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
SULFATE (mg/l)	GRAVIMETRIC WITH IGNITION	0	---	---	---	---	153	---	---	---	---	80 ND <5	---	---	---	---	---	---	---	---	---
"	TURBIDIMETRIC	"	---	---	20(RU) 70(RA) 10	37.2	---	---	21.5 1	---	---	---	---	18 7	---	---	39.9	24 41	---	---	---
"	AA (BaSO ₄ ppt., AA ON Ba)	"	---	---	---	---	---	---	---	---	---	---	---	---	<10	---	---	---	---	---	---
"	GRAVIMETRIC WITH DRYING	"	171(TOTAL) 117(SOL) 0	---	---	---	---	---	---	---	---	---	41 8	---	---	---	---	---	---	---	---

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TABLE 3 (CONTINUED)

PARAMETER	METHOD	PNL PREPARED CONTROL SAMPLE	LAB 17	LAB 19	LAB 21	LAB 23	LAB 25	LAB 27	LAB 29	LAB 31	LAB 33	LAB 34	LAB 35	LAB 37	LAB 39	LAB 41	LAB 45	LAB 47	LAB 49	LAB 51	LAB 53
SULFATE (mg/l)	FLAME EMISSION (BaSO ₄ ppt. EMISS. ON Ba)	0	---	---	---	---	---	---	---	---	---	---	---	---	---	116 87	---	---	---	---	---
"	ION EXCHANGE CHROMATOGRAPHY	"	---	---	---	---	---	---	---	---	---	---	---	---	---	33.4	---	---	---	---	---
SULFIDE (mg/l)	IODOMETRIC TITRATION	0	0	2.48	---	---	ND<0.2	---	0 ND	---	---	---	---	---	---	---	---	---	---	---	---
"	METHYLENE BLUE COLORIMETRIC	"	---	---	2	---	---	---	---	---	---	---	---	YELLOW FLUID (FIELD)	---	---	---	---	---	---	---
"	NEUTRON ACTIVATION	"	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
"	SPECIFIC ION ELECTRODE	"	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
"	SPARK SOURCE MASS SPEC.	"	---	---	---	---	---	---	---	---	---	---	---	---	33	---	---	---	---	---	---
"	X-RAY FLUORESCENCE (LIQUID)	"	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
"	POTASSIUM ANTIMONY TARTRATE QUALITATIVE TEST	"	---	---	---	---	---	---	---	---	---	---	<0.5	---	---	---	---	---	---	---	---
ZINC (mg/l)	AA	90	205 43	270 102	293 124	---	---	230 71	240 33	---	---	98 65	246 132	270 120	---	215 100	232 86	---	---	---	---
"	AMM. PYRROLIDINE DITHIO. -MIBK EXT. AND AA	"	---	---	---	---	213 107	---	---	---	---	---	---	---	---	---	---	---	---	---	---
"	EMISSION SPEC.	"	---	---	ND ND	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
"	SPARK SOURCE MASS SPEC.	"	---	---	---	---	---	---	---	250(RA) 500(RU) 150	---	---	---	---	28	---	---	---	---	---	---

TABLE 3 (CONTINUED)

PARAMETER	METHOD	PNL PREPARED CONTROL SAMPLE	LAB 17	LAB 19	LAB 21	LAB 23	LAB 25	LAB 27	LAB 29	LAB 31	LAB 33	LAB 34	LAB 35	LAB 37	LAB 39	LAB 41	LAB 45	LAB 47	LAB 49	LAB 51	LAB 53
ZINC (mg/l)	ARGON PLASMA EMISSION	90	---	---	81.5 46.3	---	---	---	---	230 78	---	---	---	---	---	---	---	---	---	290 118	---
"	AA GRAPHITE FURNACE	"	205 43	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
"	NEUTRON ACTIVATION	"	---	---	---	221	---	---	---	---	212 (RA) 131 (RU)	80	---	---	---	---	---	---	---	---	---
TOTAL DISSOLVED SOLIDS (mg/l)	GRAVIMETRIC		223,300	216,200	265,000	---	226,000	240,700	245,000	---	---	213,700	258,380	247,800	---	---	236,200	---	---	---	---
H ₂ S (ENTRAINED) (mg/l)	IODOMETRIC TITRATION	2	3.2	---	ND 3.68	---	0.64 3.6	ND<1 1.36	0 2.6	---	---	2.1 4.1	---	ND 2.2	---	---	ND ND	---	---	---	---
"	METHYLENE BLUE COLORIMETRIC	"	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	1, 1.6 0.05, 0.12 (LAUTH'S VIOLET)	---	---	---
CO ₂ (ENTRAINED) (mg/l)	ACID TITRATION	595	---	---	1352 2618	---	---	---	---	---	---	176 1289	---	MURKY (FIELD) SOLN 250, 690 (LAB)	---	0 0.7	330.6 1322	---	---	---	---
"	PRECISE EVOLUTION	"	---	---	---	---	---	40 630	---	---	---	---	870 1320	---	---	---	---	---	---	---	---
"	TOTAL CARBON ANALYZER	"	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
"	STRONTIUM GRAVIMETRIC	"	---	---	---	---	---	---	1.1 4.7	---	---	---	---	---	---	---	---	---	---	---	---
"	CALCULATION	"	1576 4465	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---

TABLE 4 RADIOACTIVE ISOTOPES-GRR-2 (WOOLSEY #1 FIRST STAGE BRINE)

PARAMETER	METHOD	LAB 23	LAB 25	LAB 33	LAB 35	LAB 47	LAB 51
ACTINIUM-228 (pCi / l)	γ-SPECTROMETRY	---	---	---	---	---	81.8 (@ 129.1 keV) 98.4 (@ 209.5 keV) 97.8 (@ 270.2 keV) 115 (@ 327.9 keV) 105 (@ 338.5 keV) 99.4 (@ 409.5 keV) 79.9 (@ 463.0 keV) 68.9 (@ 794.9 keV) 96.8 (@ 911.1 keV) 65.8 (@ 969.0 keV) 45.6 (@ 1588.1 keV)
BISMUTH-212 (pCi / l)	γ-SPECTROMETRY	---	---	---	---	---	39.8 (@ 727.2 keV)
BISMUTH-214 (pCi / l)	γ-SPECTROMETRY	---	---	---	---	---	42.8 (@ 609.4 keV) 48.2 (@ 1120.4 keV) 7.5 (@ 1377.8 keV) 62.0 (@ 1764.7 keV)
LEAD-210 (pCi / l)	BETA COUNTING OF Bi-210 DAUGHTER	---	580	811	---	---	---
LEAD-212 (pCi / l)	γ-SPECTROMETRY	---	---	---	---	---	17.7 (@ 238.6 keV)
LEAD-214 (pCi / l)	γ-SPECTROMETRY	---	---	---	---	---	35.5 (@ 295.2 keV) 42.1 (@ 352.0 keV)
POTASSIUM-40 (pCi / l)	γ-SPECTROMETRY	---	---	8100	---	---	2490 (@ 1460.0 keV)
RADIUM-226 (pCi / l)	RADON EMANATION	---	---	---	---	---	---
RADIUM-226 (pCi / l)	PRECIPITATION AND ALPHA COUNTING	---	---	333	425	---	---
RADIUM-226 (pCi / l)	γ-SPECTROMETRY	---	---	---	---	---	152 (@ 186.1 keV)
THALLIUM-208 (pCi / l)	γ-SPECTROMETRY	---	---	---	---	---	16.4 (@ 583.1 keV)
THORIUM-228 (pCi / l)	ALPHA SPECTROMETRY	---	---	19.4	---	---	---
THORIUM-232 (pCi / l)	γ-SPECTROMETRY	---	---	~81	---	---	---
THORIUM-234 (pCi / l)	γ-SPECTROMETRY	---	---	---	---	---	64.7 (@ 93.0 keV)
THORIUM (X-RAY) (pCi / l)	γ-SPECTROMETRY	---	---	---	---	---	249 (@ 76.7 keV)
URANIUM-234 (pCi / l)	ALPHA SPECTROMETRY	---	---	0.45	---	---	---
URANIUM-235 (pCi / l)	ALPHA SPECTROMETRY	---	---	0.05	---	---	---
URANIUM-238 (pCi / l)	ALPHA SPECTROMETRY	T TRACE (~0.003)	---	0.41	---	---	---

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Table 7

Symbols and Abbreviations used in Data Tables

ND	None detected
<	Less than
>	Greater than
FA	Filtered and acidified
FU	Filtered and unacidified
RU	Raw and unacidified
RA	Raw and acidified
≤	Less than or equal to
≥	Greater than or equal to
pCi/l	Picocuries per liter
Mg/l	Milligrams per liter (ppm)
μmhos/cm	Micromhos per centimeter
NTU	Nephelometric Turbidity Units
JTU	Jackson Turbidity Units
FTU	Formazin Turbidity Units
μg/l	Micrograms per liter (ppb)

Table 8
Arc Emission Analysis - Total Dissolved Solids
Residue From Sample FU (GRR-1)
(Lab 21)

Parameter	Concentration Calculated as mg/l In Original Solution
Na	1439
K	122
Li	3.4
Si	153 (=327 as SiO ₂)
Mg	0.74
B	17
Fe	0.41
Mn	0.09
Al	0.12
Cu	<0.004
Sr	2.5
Cr	0.14
Ca	15.7
Other	Nil

Table 9

Radioactive Isotopes - GRR-2
(Precipitate From Raw Unacidified Woolsey #1 First Stage Brine)

Parameter	Method	Lab 51	Parameter	Method	Lab 51
Actinium-228 (pCi/g)	γ -spectrometry	103 (@ 99.6 keV)	Actinium-228 (pCi/g)	γ -spectrometry	106 (@ 969.0 keV)
		118 (@ 129.1 keV)			48.0 (@ 1588.1 keV)
		110 (@ 209.5 keV)			128 (@ 1631.0 keV)
		128 (@ 270.2 keV)			
		116 (@ 327.9 keV)	Antimony-124 (pCi/g)	γ -spectrometry	1.13 (@ 1691.0 keV)
		146 (@ 338.5 keV)	Bismuth-212 (pCi/g)	γ -spectrometry	24.0 (@ 727.2 keV)
		148 (@ 409.5 keV)	Bismuth-214 (pCi/g)	γ -spectrometry	142 (@ 609.4 keV)
		121 (@ 463.0 keV)			76.9 (@ 665.6 keV)
		137 (@ 794.9 keV)			93.4 (@ 768.4 keV)
		34.0 (@ 835.7 keV)			94.5 (@ 934.1 keV)
		150 (@ 911.1 keV)			140 (@ 1120.4 keV)
		91.9 (@ 964.0 keV)			144 (@ 1238.2 keV)

Table 9 (Cont.)

Radioactive Isotopes - GRR-2
(Precipitate From Raw Unacidified Woolsey #1 First Stage Brine)

Parameter	Method	Lab 51	Parameter	Method	Lab 51
Bismuth-214 (pCi/g)	γ -spectrometry	99.7 (@ 1509.5 keV) 153 (@ 1729.9 keV) 178 (@ 1764.7 keV)	Thorium-234 (pCi/g)	γ -spectrometry	149 (@ 93.0 keV)
			Thorium (X-ray) (pCi/g)	γ -spectrometry	160 (@ 105.6 keV)
Lead-212 (pCi/g)	γ -spectrometry	16.6 (@ 238.6 keV)			
Lead-214 (pCi/g)	γ -spectrometry	138 (@ 241.9 keV) 158 (@ 295.2 keV) 152 (@ 352.0 keV)			
Potassium-40 (pCi/g)	γ -spectrometry	174 (@ 1460.0 keV)			
Radium-226 (pCi/g)	γ -spectrometry	184 (@ 186.1 keV)			
Thallium-208 (pCi/g)	γ -spectrometry	10.8 (@ 583.1 keV)			

Table 10
Additional Analyses - GRR-1 by Argon Plasma Emission

<u>Parameter</u>	<u>Lab 21</u>	<u>Lab 31</u>	<u>Lab 51</u>
Beryllium (mg/l)	<0.001	0.0009	0.0006
Cadmium (mg/l)	-----	<0.02	0.008
Cobalt (mg/l)	0.31	0.4	0.02
Chromium (mg/l)	0.040	0.017	0.004, 0.006, 0.006
Molybdenum (mg/l)	-----	0.3	<0.025
Nickel (mg/l)	-----	0.04	<0.01, 0.02
Selenium (mg/l)	-----	0.28	<0.03
Titanium (mg/l)	0.011	-----	<0.002
Thallium (mg/l)	-----	-----	<0.15
Vanadium (mg/l)	0.028	0.04	<0.003
Yttrium (mg/l)	-----	-----	<0.002
Zirconium (mg/l)	0.037	-----	-----

Table 11
Additional Analyses - GRR-2 by Argon Plasma Emission

<u>Parameter</u>	<u>Lab 31</u>	<u>Lab 51</u>
Beryllium (mg/l)	<0.005	<0.02
Cadmium (mg/l)	1.3	1.22
Chromium (mg/l)	0.8	<0.02, <0.05
Cobalt (mg/l)	13	<0.3
Molybdenum (mg/l)	87	<0.5
Nickel (mg/l)	2	<0.2
Selenium (mg/l)	15.4	<0.2
Titanium (mg/l)	-----	<0.05
Vanadium (mg/l)	0.9	<0.03

Table 12

Additional Analyses - GRR-1 by Spark Source Mass Spectrometry

<u>Parameter</u>	<u>Lab</u> <u>33</u>	<u>Lab</u> <u>39</u>
Beryllium (mg/l)	-----	≤0.001
Bismuth (mg/l)	0.05 (FA) 0.08 (RU) <0.04 (FU)	<0.001
Cadmium (mg/l)	-----	<0.001
Cerium (mg/l)	-----	0.003
Chromium (mg/l)	0.007 (FA) 0.001 (RU) 0.001 (FU)	0.05
Cobalt (mg/l)	<0.006 (FA) <0.01 (RU) <0.01 (FU)	≤0.003
Dysprosium (mg/l)	-----	<0.001
Erbium (mg/l)	-----	<0.001
Europium (mg/l)	-----	<0.001
Gadolinium (mg/l)	-----	<0.001
Gallium (mg/l)	-----	0.001
Germanium (mg/l)	-----	0.04
Gold (mg/l)	0.3 (FA) 0.03 (RU) 0.03 (FU)	<0.001
Hafnium (mg/l)	-----	<0.001

Table 12 (cont.)

<u>Parameter</u>	<u>Lab</u> <u>33</u>	<u>Lab</u> <u>39</u>
Holmium (mg/l)	-----	<0.001
Iridium (mg/l)	-----	<0.001
Lanthanum (mg/l)	-----	0.004
Lutetium (mg/l)	-----	<0.001
Molybdenum (mg/l)	-----	0.02
Neodymium (mg/l)	-----	<0.001
Nickel (mg/l)	0.1 (FA) 0.15 (RU) 0.1 (FU)	0.02
Niobium (mg/l)	-----	≤0.004
Osmium (mg/l)	-----	<0.001
Palladium (mg/l)	-----	<0.001
Platinum (mg/l)	-----	<0.001
Praseodymium (mg/l)	-----	≤0.002
Rhenium (mg/l)	-----	<0.001
Rhodium (mg/l)	-----	<0.001
Ruthenium (mg/l)	-----	<0.001
Samarium (mg/l)	-----	<0.001

Table 12 (cont.)

<u>Parameter</u>	<u>Lab</u> <u>33</u>	<u>Lab</u> <u>39</u>
Scandium (mg/l)	-----	0.002
Selenium (mg/l)	-----	<0.03
Tantalum (mg/l)	-----	<0.001
Tellurium (mg/l)	-----	<0.001
Terbium (mg/l)	-----	<0.001
Thallium (mg/l)	-----	<0.001
Thorium (mg/l)	-----	<0.001
Thulium (mg/l)	-----	<0.001
Tin (mg/l)	-----	≤0.004
Titanium (mg/l)	-----	1
Tungsten (mg/l)	<0.01 (FA) <0.01 (RU) <0.012 (FU)	≤0.008
Uranium (mg/l)	-----	<0.001
Vanadium (mg/l)	0.008 (FA) 0.02 (RU) <0.01 (FU)	0.04
Ytterbium (mg/l)	-----	<0.001
Yttrium (mg/l)	-----	<0.001
Zirconium (mg/l)	-----	0.003

Table 13

Additional Analyses - GRR-2 by Spark Source Mass Spectrometry

<u>Parameter</u>	<u>Lab 33</u>	<u>Lab 39</u>
Beryllium (mg/l)	<0.1 (RA) <0.1 (RU)	0.004
Bismuth (mg/l)	---	<0.001
Cadmium (mg/l)	<1 (RA) <3 (RU)	<0.001
Cerium (mg/l)	---	<0.001
Chromium (mg/l)	1 (RA) 1 (RU)	0.09
Cobalt (mg/l)	<0.5 (RA) <0.5 (RU)	≤0.02
Dysprosium (mg/l)	---	<0.001
Erbium (mg/l)	---	<0.001
Europium (mg/l)	---	<0.001
Gadolinium (mg/l)	---	<0.001
Gallium (mg/l)	---	≤0.04
Germanium (mg/l)	---	<0.001
Gold (mg/l)	---	<0.001
Hafnium (mg/l)	---	<0.001
Holmium (mg/l)	---	<0.001

Table 13 (cont.)

<u>Parameter</u>	<u>Lab 33</u>	<u>Lab 39</u>
Iridium (mg/l)	---	<0.001
Lanthanum (mg/l)	---	≤0.7
Lutetium (mg/l)	---	<0.001
Molybdenum (mg/l)	<1 (RA) <1 (RU)	2
Neodymium (mg/l)	---	<0.001
Nickel (mg/l)	3 (RA) 5 (RU)	---
Niobium (mg/l)	≤1.0 (RA) ≤1.0 (RU)	<0.001
Osmium (mg/l)	---	<0.001
Palladium (mg/l)	---	<0.001
Platinum (mg/l)	---	<0.001
Praseodymium (mg/l)	---	<0.001
Rhenium (mg/l)	---	<0.001
Rhodium (mg/l)	---	<0.001
Ruthenium (mg/l)	---	<0.001
Samarium (mg/l)	---	<0.001
Scandium (mg/l)	---	≤0.02

Table 13 (cont.)

<u>Parameter</u>	<u>Lab 33</u>	<u>Lab 39</u>
Selenium (mg/l)	---	0.5
Tantalum (mg/l)	---	<0.001
Tellurium (mg/l)	<0.3 (RA) <0.3 (RU)	<0.001
Terbium (mg/l)	---	<0.001
Thallium (mg/l)	---	≤0.2
Thorium (mg/l)	---	<0.001
Thulium (mg/l)	---	0.2
Tin (mg/l)	---	<0.001
Titanium (mg/l)	0.9 (RA) 1.5 (RU)	0.2
Tungsten (mg/l)	---	<0.001
Uranium (mg/l)	---	<0.001
Vanadium (mg/l)	0.3 (RA) 0.9 (RU)	0.5
Ytterbium (mg/l)	---	<0.001
Yttrium (mg/l)	---	≤0.02
Zirconium (mg/l)	<1 (RA) <1 (RU)	0.09

Table 14

Additional Analyses - GRR-1 by Neutron Activation

Parameter	Lab 23	Lab 33	Lab 49
Cadmium (mg/l)	<0.06	≤20 (FA) ≤2 (FU) ≤2 (RU)	---
Cerium (mg/l)	---	≤0.05 (FA) ≤0.05 (FU) ≤0.05 (RU)	---
Chromium (mg/l)	<0.05	≤0.6 (FA) ≤0.7 (FU) ≤0.7 (RU)	0.00274 (FA) 0.00203 (RU) 0.00135 (FU)
Cobalt (mg/l)	Trace <0.05	≤0.05 (FA) ≤0.05 (FU) ≤0.05 (RU)	0.000151 (FA) 0.000235 (RU) 0.000143 (RU)
Dysprosium (mg/l)	---	≤1 (FA) ≤1 (RU) ≤1 (FU)	---
Europium (mg/l)	---	≤0.001 (FA) ≤0.005 (FU) ≤0.005 (RU)	---
Gadolinium (mg/l)	---	≤5 (FA) ≤1 (RU) ≤1 (FU)	---
Gallium (mg/l)	---	≤5 (FA) ≤5 (FU) ≤5 (RU)	---
Germanium (mg/l)	---	≤700 (FA) ≤800 (FU) ≤800 (RU)	---
Gold (mg/l)	<0.005	0.0014 (FA) ≤0.020 (FU) ≤0.002 (RU)	---
Hafnium (mg/l)	---	≤0.005 (FA) ≤0.005 (FU) ≤0.005 (RU)	---

Table 14 (cont.)

<u>Parameter</u>	<u>Lab 23</u>	<u>Lab 33</u>	<u>Lab 49</u>
Indium (mg/l)	---	≤0.06 (FA) ≤0.01 (RU) ≤0.05 (FU)	---
Iridium (mg/l)	---	≤0.001 (FA) ≤0.001 (FU) ≤0.001 (RU)	---
Lanthanum (mg/l)	---	≤1 (FA) ≤1 (FU) ≤1 (RU)	---
Molybdenum (mg/l)	---	≤5 (FA) ≤1 (FU) ≤1 (RU)	---
Neodymium (mg/l)	---	≤0.2 (FA) ≤0.2 (RU) ≤0.5 (FU)	---
Nickel (mg/l)	---	≤3000 (FA) ≤500 (RU) ≤500 (FU)	---
Samarium (mg/l)	---	≤0.03 (FA) ≤0.2 (FU) ≤0.1 (RU)	---
Scandium (mg/l)	---	≤0.0005 (FA) ≤0.0005 (FU) ≤0.0005 (RU)	<0.000001 (FA) <0.000001 (RU) <0.000001 (FU)
Selenium (mg/l)	---	≤0.05 (FA) ≤0.05 (FU) ≤0.05 (RU)	<0.0003 (FA) <0.0004 (RU) <0.00077 (FU)
Tantalum (mg/l)	---	≤0.005 (FA) ≤0.005 (FU) ≤0.005 (RU)	---
Tellurium (mg/l)	---	≤0.1 (FA) ≤0.5 (FU) ≤0.1 (RU)	---
Terbium (mg/l)	---	≤0.01 (FA) ≤0.01 (FU) ≤0.01 (RU)	---

Table 14 (cont.)

<u>Parameter</u>	<u>Lab 23</u>	<u>Lab 33</u>	<u>Lab 49</u>
Thorium (mg/l)	---	≤0.05 (FA) ≤0.05 (FU) ≤0.05 (RU)	---
Titanium (mg/l)	---	≤25 (FA) ≤10 (RU) ≤10 (FU)	---
Tungsten (mg/l)	Trace <0.02	≤1 (FA) ≤1 (FU) ≤1 (RU)	---
Uranium (mg/l)	---	≤0.01 (FA) ≤0.01 (FU) ≤0.01 (RU)	0.0014 (FA) 0.0017 (RU) 0.0014 (FU)
Vanadium (mg/l)	<0.01	≤0.2 (FA) ≤0.1 (RU) ≤0.1 (FU)	---
Ytterbium (mg/l)	---	≤0.05 (FA) ≤0.05 (FU) ≤0.05 (RU)	---
Zirconium (mg/l)	---	≤2 (FA) ≤3 (FU) ≤2 (RU)	---

Table 15

Additional Analyses - GRR-2 by Neutron Activation

<u>Parameter</u>	<u>Lab 23</u>	<u>Lab 33</u>	<u>Lab 49</u>
Cadmium (mg/l)	<0.06	≤15 (RA) ≤20 (RU)	
Cerium (mg/l)	---	≤1 (RA) ≤1 (RU)	
Chromium (mg/l)	<0.05	≤0.5 (RA) ≤0.7 (RU)	
Cobalt (mg/l)	Trace <0.05	≤0.05 (RA) ≤0.05 (RU)	
Dysprosium (mg/l)	---	---	
Europium (mg/l)	---	≤0.050 (RA) ≤0.007 (RU)	
Gadolinium (mg/l)	---	---	
Gallium (mg/l)	---	≤200 (RA) ≤70 (RU)	
Gold (mg/l)	<0.005	≤0.008 (RA) ≤0.007 (RU)	
Hafnium (mg/l)	---	≤0.050 (RA) ≤0.050 (RU)	
Indium (mg/l)	---	---	
Iridium (mg/l)	---	≤0.005 (RA) ≤0.001 (RU)	
Lanthanum (mg/l)	---	≤1 (RA) ≤20 (RU)	
Molybdenum (mg/l)	---	≤3 (RA) ≤5 (RU)	
Neodymium (mg/l)	---	≤10 (RA)	

Table 15 (cont.)

<u>Parameter</u>	<u>Lab 23</u>	<u>Lab 33</u>	<u>Lab 49</u>
Nickel (mg/l)	---	---	
Samarium (mg/l)	---	---	
Scandium (mg/l)	---	≤ 0.005 (RA) ≤ 0.005 (RU)	
Selenium (mg/l)	---	≤ 0.3 (RA) ≤ 0.1 (RU)	
Tantalum (mg/l)	---	≤ 0.050 (RA) ≤ 0.010 (RU)	
Tellurium (mg/l)	---	≤ 15 (RA) ≤ 10 (RU)	
Terbium (mg/l)	---	≤ 0.05 (RA) ≤ 0.1 (RU)	
Thorium (mg/l)	---	≤ 0.05 (RA) ≤ 0.1 (RU)	
Titanium (mg/l)	---	---	
Tungsten (mg/l)	Trace <0.02	≤ 5 (RA) ≤ 20 (RU)	
Uranium (mg/l)	---	≤ 0.01 (RA) ≤ 0.016 (RU)	
Vanadium (mg/l)	<0.01	---	
Ytterbium (mg/l)	---	≤ 0.05 (RA) ≤ 0.05 (RU)	
Zirconium (mg/l)	---	≤ 25 (RA) ≤ 10 (RU)	

Table 16
Organic Analyses of Brines (GRR-1 and GRR-2)
(Lab 39)

<u>Parameter</u>	<u>GRR-1</u>	<u>GRR-2</u>
Bis (2-ethylhexyl) phthalate (μ g/l)	13.9	2.3
Methylene chloride (μ g/l)	32.4	84
Chloroform (μ g/l)	13.9	2
Benzene (μ g/l)	500	<1
Toluene (μ g/l)	16.8	<1

Table 17
Nitrate and Nitrite Analyses

<u>GRR-1</u>			
<u>Parameter</u>	<u>Method</u>	<u>Lab 33</u>	<u>Lab 41</u>
Nitrate (mg/l)	Auto Analyzer	0.026 (FA) 0.235 (RU) 0.102 (FU)	-----
" "	Ion exchange chromatography	-----	3.3 (RU) 0.3 (FU)
Nitrite (mg/l)	Auto Analyzer	0.020 (FA) 0.046 (RU) 0.020 (FU)	
<u>GRR-2</u>			
Nitrate (mg/l)	Auto Analyzer	0.004 (RU)	-----
" "	Ion exchange chromatography	-----	3.8 (RU)
Nitrite (mg/l)	Auto Analyzer	0.125 (RU) 0.388 (RA)	-----

Table 18.

Mean Value and Ranges for GRR-1 Data
(All Values in mg/l Unless Otherwise Specified)

Parameter	PNL Control Sample	Total		Results by Method					
		No. of Data	GRR-1 Value	Mean	Range	Mean	Range	Mean	Range
pH (no units)		18	6.32	±1.00					
Conductivity (μmhos/cm)		12	6465	±6414					
Alkalinity		10	516	±41					
Hardness (Brine)		14	35	±18					
Hardness (Control)	41.6	11	34	±17					
Suspended Solids		11	9	±23					
Turbidity (JTU, NTU, etc.)		9	2.5	±2.5	Nephelometer		Hach Meter		Others
					0.7	±0.9	4.8	±13.2	1
					AA		Plasma Emission		Others
Aluminum (Brine)		24	3.4	±34	0.3	±0.4	0.18	±0.12	4.8 ±32
Aluminum (Control)	0.80	16	3.7	±39	1.2	±0.5	1.0	±0.4	5.7 ±37
Ammonia (Brine)		21	16.5	±16.5	Direct Nessler		Ion Electrode		Distill & Ness.
					16.1	±3.4	13.7	±3.8	15.1 ±0.9
					AA		Neutron Act.		Others
Ammonia (Control)	14.0 asNH ₄	14	13.0	±7.6			10.4	±2.6	12.4 ±1.5
Antimony (Brine)		23	1.0	±9.0	0.3	±0.3	0.06	±0.06	1.6 ±8.4
Antimony (Control)	1.0	15	1.4	±8.6	0.95	±0.5	0.9	±0.1	1.7 ±8.3
Arsenic (Brine)		18	0.39	±0.51	Plasma Emiss.		Others		
					0.31	±0.31	0.42	±0.48	
					Acid Titrat.		Others		
Arsenic (Control)	0.30	12	0.22	±0.22	0.25	±0.25	0.21	±0.21	
Bicarbonate		13	599	±290	607	±282	501		

Table 18. (cont'd)
Mean Value and Ranges for GRR-1 Data
(All Values in mg/l Unless Otherwise Specified).

		Total		Results by Method												
Parameter	PNL Control Sample	No. of Data	GRR-1 Value		Mean	Range	Mean	Range	Mean	Range						
Carbonate	0.30	12	0.16	±0.16	Acid Titrat.		Others									
					0.18	±0.18	0									
					AA		Plasma Emmis.		Others							
					Barium (Brine)	22	0.45	±1.5	0.26	±0.05	0.35	±0.18	0.52	±1.5		
					Barium (Control)	16	0.41	±1.6	0.32	±0.05	0.30	±0.06	0.48	±1.5		
					Curcumin Color.		Carmine Cclor.		Plasma Emiss.		Others					
					Boron (Brine)	20	8.0	±7.4	7.5	±1.5	8.7	±5.3	7.7	±0.3	7.8	±7.2
					Boron (Control)	2	7.4	±5.6	6.8	±0.2	6.4	±0.1	6.4	±0.2	9.3	±3.7
					Hypochl. Oxid.		Others									
					Bromide (Brine)	9	2.6	±12.9	2.9	±1.1	2.6	±13.4				
					Bromide (Control)	9	10.5	±39.5	3.4		11.4	±38.6				
					AA		Plasma Emiss.		Others							
Calcium (Brine)	26	15.9	±44.1	11.8	±8.8	14.6	±0.7	20.0	±40							
Calcium (Control)	13.0	19	15.3	±44.7	13.0	±4.3	12.9	±0.2	20.4	±40						
AA		Flame Emiss.		Neutron Act.		Others										
Cesium (Brine)	23	0.31	±0.69	0.28	±0.09	0.23	±0.08	0.26	±0.04	0.48	±0.52					
Cesium (Control)	0.42	14	0.40	±0.40	0.38	±0.19	0.42	±0.11	0.45	±0.02	0.37	±0.37				
AgNO ₃ Tit.		Hg(NO ₃) ₂ Tit.		Others												
Chloride		23	1684	±1650	1940	±120	1530	±1496	1512	±952						
AA		Plasma Emiss.		Others												
Copper (Brine)		26	1.2	±18.8	0.02	±0.02	0.04	±0.03	2.2	±17.8						
Copper (Control)	0.08	17	1.3	±18.7	0.08	±0.03	0.13	±0.03	2.9	±17.1						

Table 18. (cont'd)

Mean Value and Ranges for GRR-1 Data
(All Values in mg/l Unless Otherwise Specified)

		Total		Results by Method								
Parameter	PNL Control Sample	No. of Data	GRR-1 Value		Mean	Range	Mean	Range	Mean	Range		
F-65	Fluoride (Brine)	15	3.6	±2.0	Ion Electrode		Others					
					3.4	±0.8	2.4	±3.2				
	Fluoride (Control)	8	0.7	±0.7	Ion Electrode		Others					
					0.6	±0.1	1.4					
	Iodide (Brine)	14	1.3	±8.7	Ion Electrode		Others					
					0.4	±0.2	1.5	±8.5				
	Iodide (Control)	8	3.6	±2.7	Ion Electrode		Others					
					3.9	±1.9	3.4	±3.4				
	Iron (Brine)	31	1.1	±3.9	AA		Plasma Emiss.		Neutron Act.	Others		
					0.35	±0.40	0.27	±0.03				
	Iron (Control)	19	0.9	±4.1	AA		Plasma Emiss.					
					0.73	±0.27	0.72	±0.03				
	Lead (Brine)	19	0.10	±0.40	AA		Plasma Emiss.					
					0.13	±0.37	0.17	±0.13				
	Lead (Control)	14	0.35	±0.25	AA		Plasma Emiss.					
					0.40	±0.23	0.46	±0.17				
	Lithium (Brine)	22	6.2	±37.3	AA		Plasma Emiss.					
					4.6	±1.4	12.1	±31.4				
	Lithium (Control)	15	4.0	±2.1	AA		Plasma Emiss.					
					4.4	±1.7	3.9	±0.3				
	Magnesium (Brine)	24	6.5	±93.5	AA		Flame Emiss.					
					0.31	±0.09	0.31	±0.03				
	Magnesium (Control)	17	6.1	±93.9	AA		Flame Emiss.					
					0.22	±0.09	0.20	±0.01				
	Manganese (Brine)	24	0.28	±4.7	AA		Others					
					0.02	±0.02	0.43	±0.57				
	Manganese (Control)	15	0.13	±0.87	AA		Others					
					0.06	±0.02	0.19	±0.81				

Table 18. (cont'd)

Mean Value and Ranges for GRR-1 Data
(All Values in mg/l Unless Otherwise Specified)

Parameter	PNL Control Sample	Total			Results by Method							
		No. of Data	GRR-1 Value	Mean	Range	Mean	Range	Mean	Range	Mean	Range	
						Cold Vap. AA	Others					
Mercury (Brine)		15	0.028	±0.072		0.010	±0.090	0.078	±0.078			
Mercury (Control)	0.01	8	0.018	±0.082		0.022	±0.078	0.005	±0.005			
						SnCl ₂ Color.	Ascorb. A. Color.	Others				
Phosphate (Brine)		23	1.0	±8.2		0.46	±0.50	0.27	±0.85	2.3	±6.9	
Phosphate (Control)	0.25	15	1.0	±5.1		0.22	±0.27	0.28	±0.18	2.6	±3.5	
						AA	Flame Emiss.	Others				
Potassium (Brine)		31	160	±240		133	±33	139	±36	181	±219	
Potassium (Control)	180	20	238	±692		179	±56	182	±13	250	±650	
						AA	Flame Emiss.	Neut. Act.	Others			
Rubidium (Brine)		23	0.90	±2.6		0.49	±0.16	0.59	±0.13	0.62	±0.60	1.8 ±1.8
Rubidium (Control)	5.0	14	4.9	±3.4		4.9	±0.7	5.6	±0.5	6.6	±1.8	2.5 ±2.5
						AA	Heteropoly-Blue	Molyb. Color.	Others			
Silica (Brine)		25	259	±276		252	±87	223	±20	229	±29	320 ±215
Silica (Control)	250	21	164	±164		187	±187	228	±22	191	±191	88 ±87
						AA	Neut. Act.	Others				
Silver (Brine)		22	0.03	±0.07		0.02	±0.06	0.032	±0.068	0.03	±0.05	
Silver (Control)	0.07	15	0.10	±0.90		0.03	±0.05	0.356	±0.644	0.03	±0.09	
						AA	Flame Emiss.	Others				
Sodium (Brine)		29	1388	±612		1406	±436	1516	±484	1320	±220	
Sodium (Control)	1500	19	1498	±298		1506	±424	1480	±80	1503	±103	

Table 18. (cont'd)

Mean Value and Ranges for GRR-1 Data
(All Values in mg/l unless Otherwise Specified)

Parameter	PNL Control Sample	No. of Data	Total		Results by Method					
			Mean	Range	Mean	Range	Mean	Range	Mean	Range
Strontium (Brine)	1.6	29	2.2	±7.8	AA		Flame Emiss.		Neut. Act.	Others
					2.1	±0.1	1.9	±0.6	3.1	±6.9
					1.6	±0.1	1.6	±0.1	4.6	±5.4
					Turbidimetric		Others			
					155	±45	149	±36		
					152	±26	161	±13		
					Iodomet. Tit.		Methyl. Blue		Others	
					30	±144	0.13	±0.19	1021	±3979
					AA		Plasma Emiss.		Neut. Act.	Others
					0.07	±0.14	0.05	±0.03	0.16	±0.26
Zinc (Brine)	0.60	19	22	±379	0.61	±0.13	0.66	±0.08	134	±266
Total Dissolved Solids	5.5	12	1.8	±3.4	2.0	±3.2	0.70	±0.60		
					5.0	±5.0	5.2	±4.8		
					Acid Tit.		Others			
					3817	±2473	5264	±1516		
					2101	±388	2095	±354		
H ₂ S-entrained (Brine)	2000	9	2103	±386						
H ₂ S-entrained (Control)	2000	9	2103	±386						
CO ₂ -entrained (Brine)	2000	9	2103	±386						
CO ₂ -entrained (Control)	2000	9	2103	±386						

Table 19.

Mean Value and Ranges for GRR-2 Data
(All Values in mg/l Unless Otherwise Specified)

Parameter	PNL Control Sample	No. of Data	Total		Results by Method					
			Mean	Range	Mean	Range	Mean	Range	Mean	Range
pH (no units)		14	3.88	±2.32						
Conductivity (μmhos/cm)		7	200,257	±205,743						
Alkalinity		10	0.2	±1.8						
					EDTA Tit.		Others			
Hardness (Brine)		8	60,025	±4025	59,986	±3986	60,300			
Hardness (Control)		7	30,971	±3829	33,083	±1717	18,300			
Suspended Solids		5	1371	±1336						
					Nephelometer		Others			
Turbidity (JTU, NTU, etc.)		4	156	±154	106	±179	305			
					AA		Plasma Emiss.		Others	
Aluminum (Brine)		16	2.0	±5.0	1.1	±2.9	2.5	±3.5	2.4	±4.6
Aluminum (Control)	0.98	14	1.9	±3.1	1.1	±1.9	2.7	±2.3	2.1	±2.8
					Ion Electrode		Distill and Ness.		Others	
Ammonia (Brine)		16	351	±212	302	±163	377	±46	373	±177
Ammonia (Control)	448	13	400	±265	349	±214	441	±52	413	±258
Antimony (Brine)		16	0.16	±13						
Antimony (Control)	4.3	11	4.6	±9.4						
					AA (Graph. Furn.)		Plasma Emiss.		Others	
Arsenic (Brine)		18	8.7	±19	3.5	±6.9	13	±9	8.9	±19.1
Arsenic (Control)	0.098	13	1.0	±8.0	0.4	±0.4	4.6	±4.6	0.4	±1.6
					Acid Tit.		Others			
Bicarbonate		11	0.6	±4.4	0.7	±4.3	0			

Table 19. (cont'd)

Mean Value and Ranges for GRR-2 Data
(All Values in mg/l Unless Otherwise Specified)

Parameter	PNL Control Sample	No. of Data	Total		Results by Method					
			Mean	Range	Mean	Range	Mean	Range	Mean	Range
Carbonate		11	0.2	±1.8	Acid Tit.		Others			
					0.2	±1.8	0			
Barium (Brine)		20	109	±166	AA		Plasma Emiss.		Others	
					128	±72	81	±45	107	±168
Barium (Control)	90	16	79	±121	83	±24	72	±18	79	±121
Boron (Brine)		16	433	±1367	Curcumin Color.		Carmin Color.		Plasma Emiss.	Others
					626	±674	289	±24	301	±42
Boron (Control)	205	13	222	±628	136	±133	144	±144	220	±68
Bromide (Brine)		13	224	±861						
Bromide (Control)	1.64	5	273	±587						
Calcium (Brine)		22	32,139	±196,861	AA		Plasma Emiss.		Others	
					24,372	±10,128	90,700	±138,300	21,560	±10,940
Calcium (Control)	12,830	19	12,679	±4321	12,633	±4367	12,333	±1667	12,886	±3914
Cesium (Brine)		19	22	±168	AA		Flame Emiss.		Others	
					18	±18	21	±37	26	±164
Cesium (Control)	159.6	16	130	±130	183	±67	88	±88	122	±122
Chloride		16	122,206	±17,794	AgNO ₃ Tit.		Hg(NO ₃) ₂ Tit.		Others	
					127,883	±5183	131,025	±8975	133,475	±6525
Copper (Brine)		19	1.1	±0.9	AA		Plasma Emiss.		Others	
					1.4	±0.6	1.3	±0.7	0.7	±0.3
Copper (Control)	1.88	16	2.0	±1.5	2.1	±0.7	2.1	±0.2	1.5	±1.5

F-70

		Total		Results by Method							
Parameter	PNL Control Sample	No. of Data	GRR-2 Value	Mean	Range	Mean	Range	Mean	Range		
F-70	Fluoride (Brine)	13	9.2	±34	Ion Electrode		Others				
					7.9	±35	11	±14			
	Fluoride (Control)	12.3	8	17	±84						
						24	±77	5.5	±2.5		
	Iodide (Brine)	3.27	12	8.1	±17	Ion Electrode		Others			
						12	±13	6.4	±7.8		
	Iodide (Control)	7	4.6	±6.8							
					3.0	±3.0	5.7	±5.7			
	Iron (Brine)	104	23	282	±318	AA		Plasma Emiss.		Others	
									265	±47	262
	Iron (Control)		19	117	±63						
						116	±64	118	±40	116	±24
	Lead (Brine)	22.7	18	48	±97	AA		Plasma Emiss.		Others	
									59	±86	39
	Lead (Control)		16	26	±84						
						32	±78	22	±6	11	±8
Lithium (Brine)	58.2	20	182	±288	AA		Flame Emiss.		Others		
								164	±31	163	±37
Lithium (Control)		17	96	±84							
					96	±10	89	±9	104	±81	
Magnesium (Brine)	114.7	20	145	±88	AA		Plasma Emiss.		Others		
								147	±38	126	±73
Magnesium (Control)		19	113	±86							
					114	±31	125	±74	100	±45	
Manganese (Brine)	336	16	687	±266	AA		Others				
								662	±77	729	±224
Manganese (Control)		15	346	±190							
					325	±50	387	±149			

Table 19. (cont'd)

Mean Value and Ranges for GRR-2 Data
(All Values in mg/l Unless Otherwise Specified)

		Total		Results by Method					
Parameter	PNL Control Sample	No. of Data	GRR-2 Value Mean Range	Mean	Range	Mean	Range	Mean	Range
Mercury (Brine)	1.06	11	0.020	±0.08	Cold Vap: AA		Others		
		8	0.93	±0.93	0.006	±0.032	0.045	±0.055	
Mercury (Control)					1.14	±0.36	0.30	±0.30	
Phosphate (Brine)	0.46	14	2.0	±10.5	SnCl ₂ Color.		Ascorb. A. Color.		Others
		9	0.53	±0.63	1.8	±5.2	3.3	±9.2	0.39 ±0.39
Phosphate (Control)					0.59	±0.57	0.46	±0.26	0.55 ±0.55
Potassium (Brine)	6910	21	13,583	±36,417	AA		Flame Emiss.		Others
		19	7231	±17,769	10,160	±3310	20,100	±29,900	8887 ±4687
Potassium (Control)					6303	±3303	8774	±16,226	6370 ±2170
Rubidium (Brine)	39.3	19	62	±62	AA		Flame Emiss.		Others
		15	33	±33	73	±40	70	±8	51 ±47
Rubidium (Control)					39	±9	34	±34	25 ±25
Silica (Brine)	44.9	23	345	±285	AA		Molyb. Color.		Others
		17	92	±491	398	±101	366	±134	308 ±248
Silica (Control)					108	±475	38	±7	86 ±315
Silver (Brine)	0.13	14	0.44	±2.1	AA		AA(Graph. Furn.)		Others
		12	0.42	±1.2	0.83	±1.7	0.11	±0.14	0.16 ±0.49
Silver (Control)					0.60	±1.0	0.13	±0.07	0.33 ±0.49
Sodium (Brine)	17,700	24	44,169	±41,169	AA		Flame Emiss.		Others
		19	17,010	±8010	47,771	±10,771	41,317	±38,317	42,910 ±17,910
Sodium (Control)					16,863	±3863	17,940	±1260	16,433 ±7433

Table 19. (cont'd)

Mean Value and Ranges for GRR-2 Data
(All Values in mg/l Unless Otherwise Specified)

Parameter	PNL Control Sample	No. of Data	Total		Results by Method					
			Mean	Range	Mean	Range	Mean	Range	Mean	Range
					AA		Flame Emiss.		Plasma Emiss.	Others
Strontium (Brine)		19	358	±249	420	±100	423	±57	261	±155
Strontium (Control)	147	16	145	±102	173	±42	139	±55	142	±33
					Turbidimetric		Others			
Sulfate (Brine)		15	64	±107	34	±42	90	±81		
Sulfate (Control)	0	8	5	±72	4.8	±5.2	25	±62		
Sulfide (Brine)		7	5.5	±28						
Sulfide (Control)	0	1	0							
					AA		Plasma Emiss.		Others	
Zinc (Brine)		22	198	±302	230	±132	201	±120	196	±304
Zinc (Control)	90	13	84	±84	88	±55	81	±37	78	±72
Total Dissolved Solids		10	235,228	±29,772						
					Iodomet. Tit.		Others			
H ₂ S-entrained (Brine)		9	0.5	±1.6	0.5	±1.6	0.5	±0.5		
H ₂ S-entrained (Control)	2	12	1.8	±2.3	2.0	±2.1	0.9	±0.8		
					Acid Tit.		Others			
CO ₂ -entrained (Brine)		9	511	±1055	422	±930	622	±954		
CO ₂ -entrained (Control)	595	9	1371	±3094	1184	±1434	1605	±2860		

Control Chart Presentation of GRR-1 and GRR-2 Data

Presentation of the data generated during the two analyses round robins in control chart form allows for relative comparisons of methods for analyzing the various parameters. A statistical analysis of the data was performed by Mark A. Floyd, Ames Laboratory, Energy and Mineral Resources Research Institute, U.S. Department of Energy, Iowa State University, Ames, Iowa, 50011. The control charts are presented in Tables 20 and 21. In each table presentations of the reported values for both the control samples and the brine samples are included.

The features of the control charts are as follows:

1. The center line on the plot represents the average ($\bar{X}$ or $\bar{X}$ BAR) of the N values omitting outliers. (i.e., the average and standard deviation for each data set were calculated with the exclusion of values exceeding 3s [3 standard deviations] from the mean.)
2. The lines on either side of the average represent ± 3 standard deviations from the average and the outside lines represent values corresponding to or exceeding ± 5 standard deviations from the average.
3. The $\pm 3s$ values are shown above the graph as the "lower" and "upper" numerical values.
4. Just above the column headings on the left the standard deviation is expressed in mg/l and as a percentage of the average.
5. The 3s criterion for rejection of data does not work well for some of the data; therefore, some data were rejected by other criteria. For example, the XRF data for aluminum in the brine sample were excluded because they surely are significantly different than the data from the other methods.

ABBREVIATION CODE FOR ANALYTICAL METHODS

AA	Atomic absorption
AA EXT	Atomic absorption, extraction method
AA GF	Atomic absorption, graphite furnace
AA H EV	Atomic absorption, hydride evolution
AA A GEN	Atomic absorption, arsine generation
AB ABSORPT }	Absorptometric
ACID TIT	Acid titration
AG TIT	AgNO ₃ titration
AMA DIST	Amadac F and distillation
API PHOT	API photometric
AS COLOR	Arsenious ceric colorimetric
ASC COLOR	Ascorbic acid colorimetric
AUTO ANA	Auto analyzer
CALCULAT	Calculation
CAR C	Carmine colorimetric
COLOR	Colorimetric
CUR C	Curcumin colorimetric
CV AA	Cold vapor (flameless) Atomic absorption
DIR NES	Direct nesslerization
DIST NES	Distillation and nesslerization
DIST TIT	Distillation, collection in H ₂ SO ₄ and titration with NaOH
EDTA TIT	EDTA titration
ES	Emission spectroscopy
FE	Flame emission
GRAVI	Gravimetric

HACH MET	Hach meter
HBC HB COLOR }	Heteropoly-blue colorimetric
HG TIT	Hg(NO ₃) ₂ titration
ICP-AES	Inductively coupled plasma-atomic emission spectroscopy
IODO TIT	Iodometric titration
ION EXC	Ion exchange
ION SP	Ion specific electrode
MB COLOR } MC	Methylene blue colorimetric
METER	Conductivity meter
MPA MET	Molybdophosphate acid method
MS COLOR	Molybdosilicate colorimetric
NA	Neutron activation
NEPHEL	Nephelometer
OXI-TIT	Hypochlorite oxidation and titration
PH METER	pH meter
PRE EVO	Precise evolution
SN CO DI	SnCl ₂ colorimetric with digestion
SN COLOR	SnCl ₂ colorimetric
SR GRAVI	Strontium gravimetric
SPECTR	SPADNS spectrophotometric
SSMS	Spark source mass spectrometry
TOT C ANA	Total carbon analyzer
TURBID	Turbidimetric
VIS DIST	Alizarin visual and distillation
VIS MAT	Visual matching
XRF	X-Ray Fluorescence

Table 20

PH

XBAR AND 3 SIGMA LIMITS BASED ON POINTS

1- 18 OMITTING OUTLIERS

$$\%RSD = \quad \epsilon \cdot$$

XBAR= 6.313

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Table 20 (Continued)

GRR-1 RESULTS

CONDUCTIVITY(MICRO MHOS/CM) UNKNOWN

CHART OF INDIVIDUALS

XBAR AND 3 SIGMA LIMITS BASED ON POINTS 1- 12 OMITTING OUTLIERS

N= 11 S= 583.2

LOWER= 5257.1

UPPER= 8756.4

%RSD= 8.

XBAR= 7006.7

PT	METHOD	RESULT							
1	METER	6310.			*				
2	METER	6174.			*				
3	METER	6750.				*			
4	METER	6730.				*			
5	METER	6910.				*			
6	METER	7300.					*		
7	METER	7000.					*		
8	METER	7000.					*		
9	METER	8000.						*	
10	METER	6900.				*			
11	METER	8000.						*	
12	METER	510.	*						

Table 20 (Continued)

GRR-1 RESULTS
ALKALINITY(MG/L CaCO_3) UNKNOWN

CHART OF INDIVIDUALS

XBAR AND 3 SIGMA LIMITS BASED ON POINTS 1- 10 OMITTING OUTLIERS

N= 10 S= 36.3 LOWER= 407.0 UPPER= 624.8
%RSD= 7. XBAR= 515.9

PT	METHOD	RESULT							
1	ACID TIT	501.				*			
2	ACID TIT	503.				*			
3	ACID TIT	507.				*			
4	ACID TIT	475.			*				
5	ACID TIT	595.						*	
6	ACID TIT	545.						*	
7	ACID TIT	490.			*				
8	ACID TIT	493.			*				
9	ACID TIT	550.						*	
10	ACID TIT	500.				*			

Table 20 (Continued)

GRR-1 RESULTS
HARDNESS CONTROL 41.6 (MG/L CaCO₃)

CHART OF INDIVIDUALS

XBAR AND 3 SIGMA LIMITS BASED ON POINTS 1- 11 OMITTING OUTLIERS

N= 11 S= 9.259

LOWER= 6.623

UPPER= 62.177

%RSD= 27.

XBAR= 34.400

PT	METHOD	RESULT	-----			
1	EDTA TIT	38.60				
2	EDTA TIT	38.50				
3	EDTA TIT	35.60				
4	EDTA TIT	48.00				
5	EDTA TIT	32.00				
6	EDTA TIT	32.00				
7	EDTA TIT	19.50				
8	EDTA TIT	16.80				
9	EDTA TIT	35.00				
10	CALCULAT	40.80				
11	CALCULAT	41.60				

GRR-1 RESULTS
HARDNESS(MG/L CAC03) UNKNOWN

XBAR AND 3 SIGMA LIMITS BASED ON POINTS 1- 14 OMITTING OUTLIERS

PT	METHOD	RESULT					
1	EDTA TIT	39.00				*	
2	EDTA TIT	40.50				*	
3	EDTA TIT	38.60				*	
4	EDTA TIT	50.50					*
5	EDTA TIT	35.80				*	
6	EDTA TIT	32.00			*		
7	EDTA TIT	38.00				*	
8	EDTA TIT	30.00			*		
9	EDTA TIT	19.50			*		
10	EDTA TIT	16.80			*		
11	EDTA TIT	34.00				*	
12	CALCULAT	41.20	RA				*
13	CALCULAT	34.10	FA			*	
14	CALCULAT	36.70				*	

Table 20 (Continued)

GRR-1 RESULTS
SUSPENDED SOLIDS(MG/L) UNKNOWN

CHART OF INDIVIDUALS

XBAR AND 3 SIGMA LIMITS BASED ON POINTS 1- 10 OMITTING OUTLIERS

N= 10 S= 9.474 LOWER= -20.812 UPPER= 36.030
%RSD= 125. XBAR= 7.609

PT	METHOD	RESULT	-----			
1	GRAVI	4.00			*	
2	GRAVI	1.30			*	
3	GRAVI	1.60			*	
4	GRAVI	10.00			*	
5	GRAVI	12.00			*	
6	GRAVI	3.00			*	
7	GRAVI	9.00			*	
8	GRAVI	0.29			*	
9	GRAVI	32.00			*	
10	GRAVI	2.90			*	

Table 20 (Continued)

GRR-1 RESULTS
TURBIDITY UNKNOWN

CHART OF INDIVIDUALS

XBAR AND 3 SIGMA LIMITS BASED ON POINTS 1- 8 OMITTING OUTLIERS

N= 8 S= 6.138 LOWER= -15.555 UPPER= 21.273
 %RSD= 215. XBAR= 2.859

PT	METHOD	RESULT	-----			
1	NEPHEL	0.33			*	
2	NEPHEL	0.62			*	
3	NEPHEL	0.10			*	
4	NEPHEL	1.60			*	
5	VIS MAT	1.00			*	
6	HACH MET	18.00				*
7	HACH MET	1.00			*	
8	HACH MET	0.22			*	

Table 20 (Continued)

GRR-1 RESULTS
ALUMINUM CONTROL 0.60 MG/L

CHART OF INDIVIDUALS

XBAR AND 3 SIGMA LIMITS BASED ON POINTS 1- 16 OMITTING OUTLIERS

N= 15 S= 0.469 LOWER= -0.322 UPPER= 2.494
%RSD= 43. XBAR= 1.086

PT	METHOD	RESULT	
1	AA	1.00	*
2	AA	1.00	*
3	AA	1.00	*
4	AA	1.70	*
5	AA EXT	0.54	*
6	FE	1.00	*
7	AA GF	0.81	*
8	AA GF	0.52	*
9	ICP-AES	0.96	*
10	ICP-AES	1.30	*
11	ICP-AES	0.59	*
12	ES	2.00	*
13	ES	0.87	*
14	NA	2.00	*
15	SSMS	0.60	*
16	XRF	43.00	*

Table 20 (Continued)

GRR-1 RESULTS
ALUMINUM UNKNOWN (MG/L)

CHART OF INDIVIDUALS

XBAR AND 3 SIGMA LIMITS BASED ON POINTS 1- 17 OMITTING OUTLIERS

N= 16 S= 5.790 LOWER= -15.082 UPPER= 19.660
%RSD= 253. XBAR= 2.289

PT	METHOD	RESULT							
1	AA	0.24			*				
2	AA	0.11			*				
3	AA	0.0			*				
4	AA EXT	0.16			*				
5	FE	0.20 RA			*				
6	FE	0.20 FA			*				
7	AA GF	0.22			*				
8	AAGF	0.13			*				
9	ICP-AES	0.16			*				
10	ICP-AES	0.30			*				
11	ICP-AES	0.07			*				
12	ES	0.57			*				
13	SSMS	0.20 FA			*				
14	SSMS	0.06			*				
15	XRF	37.00 FA							*
16	XRF	15.00 FU					*		
17	XRF	19.00 RU					*		

Table 20 (Continued)

GRR-1 RESULTS

AMMONIA (AS NH₄) CONTROL 14.0 MG/L

CHART OF INDIVIDUALS

XBAR AND 3 SIGMA LIMITS BASED ON POINTS 1- 12 OMITTING OUTLIERS

N= 12 S= 3.176

LOWER= 3.138

UPPER= 22.195

%RSD= 25.

XBAR= 12.667

PT	METHOD	RESULT	-----			
1	ICN SP	9.90			*	
2	ICN SP	12.00			*	
3	ICN SP	10.80			*	
4	ICN SP	7.80			*	
5	ICN SP	11.70			*	
6	DIST-TIT	20.60			*	
7	DIST-NES	10.90			*	
8	DIST-NES	12.50			*	
9	DIST-NES	13.70			*	
10	AUTO ANA	14.10			*	
11	ICN EXC	13.00			*	
12	DIR-NES	15.00			*	

GRF-1 RESULTS

CHART OF INDIVIDUALS

```

N=      17      S=      2.09      LOWER=      9.53      UPPER=      22.08
      %RSD=      13.      XBAR=      15.81

```

10.47 as N excluded
11.5 as N excluded
15.7 as N excluded

Table 20 (Continued)

GRR-1 RESULTS
ANTIMONY CONTROL 1.00 MG/L

CHART OF INDIVIDUALS

XBAR AND 3 SIGMA LIMITS BASED ON POINTS 1- 13 OMITTING OUTLIERS

N= 13 S= 0.301 LOWER= -0.061 UPPER= 1.746
%RSD= 36. XBAR= 0.842

PT	METHOD	RESULT							
1	AA	0.91				*			
2	AA	1.00				*			
3	AA	0.95				*			
4	AA H EV	1.00				*			
5	ES	0.98				*			
6	AA GF	0.28			*				
7	AA GF	1.07				*			
8	ICP-AES	1.20				*			
9	ICP-AES	0.71			*				
10	NA	0.90				*			
11	NA	0.88				*			
12	NA	0.92				*			
13	SSMS	0.15			*				

GRR-1 RESULTS

CHART OF INDIVIDUALS

```

N=      15  S=      0.239      LOWER=    -0.539      UPPER=      0.895
      %RSD=    134.      XBAR=      0.178

```

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Table 20 (Continued)

GRR-1 RESULTS
ARSENIC CONTROL 0.30 MG/L

CHART OF INDIVIDUALS

XBAR AND 3 SIGMA LIMITS BASED ON POINTS 1- 8 OMITTING OUTLIERS

N= 8 S= 0.095 LOWER= -0.002 UPPER= 0.567
%RSD= 34. XBAR= 0.282

PT	METHOD	RESULT	-----			
1	AA GF	0.23			*	
2	AA H EV	0.25			*	
3	AA H EV	0.28			*	
4	ICP-AES	0.50				*
5	ICP-AES	0.25			*	
6	ES	0.32			*	
7	NA	0.23			*	
8	SSMS	0.20			*	

GRR-1 RESULTS

CHART OF INDIVIDUALS

N= 13 S= 0.117 LOWER= 0.065 UPPER= 0.770
XRS= 28. XBAR= 0.418

F-90

Table 20 (Continued)

GRR-1 RESULTS
BICARBONATE (MG/L) UNKNOWN

CHART OF INDIVIDUALS

XBAR AND 3 SIGMA LIMITS BASED ON POINTS 1- 13 OMITTING OUTLIERS

N= 13 S= 106.91 LOWER= 278.68 UPPER= 920.16
%RSD= 18.0 XBAR= 599.42

PT	METHOD	RESULT	-----			
1	ACID TIT	613.9				
2	ACID TIT	507.0				
3	ACID TIT	474.6				
4	ACID TIT	595.0				
5	ACID TIT	612.0				
6	ACID TIT	580.0 Field				
7	ACID TIT	889.0 Lab				
8	ACID TIT	670.0				
9	ACID TIT	586.0				
10	ACID TIT	604.0				
11	ACID TIT	660.0				
12	ACID TIT	500.0				
13	CALCULAT	501.0				

Table 20 (Ccntirued)

GRA-1 RESULTS

BARIUM CONTROL 0.30 MG/L

CHART OF INDIVIDUALS

XBAR AND 3 SIGMA LIMITS BASED ON POINTS

1- 14 OMITTING OUTLIERS

N= 14 S= 0.069

LOWER= 0.115

UPPER= 0.531

%RSD= 21.

XBAR= 0.323

PT	METHOD	RESULT							
1	AA	0.30				*			
2	AA	0.32					*		
3	AA	0.35						*	
4	AA	0.30				*			
5	AA GF	0.40						*	
6	AA GF	0.50							*
7	ICP-AES	0.36						*	
8	ICP-AES	0.25			*				
9	ICP-AES	0.29				*			
10	ES	0.36						*	
11	FE	0.22			*				
12	FE	0.30				*			
13	SSMS	0.28				*			
14	AB	0.29				*			

Table 20 (Continued)

GRR-17 RESULTS

BARIUM UNKNOWN (MG/L)

CHART OF INDIVIDUALS

XBAR AND 3 SIGMA LIMITS BASED ON POINTS

1- 17 OMITTING OUTLIERS

N= 17 S= 0.103

LOWER= -0.007

UPPER= 0.609

%RSD= 34.

XBAR= 0.301

PT	METHOD	RESULT					
1	AA	0.21			*		
2	AA	0.30				*	
3	AA	0.24			*		
4	AA	0.30				*	
5	AA GF	0.30				*	
6	AA GF	0.35				*	
7	ICP-AES	0.53					*
8	ICP-AES	0.24			*		
9	ICP-AES	0.27				*	
10	ES	0.25			*		
11	FE	0.29				*	
12	FE	0.30	RA			*	
13	FE	0.30	FA			*	
14	SSMS	0.20	FA		*		
15	SSMS	0.20	RU		*		
16	SSMS	0.26	FU		*		
17	AB	0.57					*

Table 20 (Continued)

GRR-1 RESULTS
BORON CONTROL 7.00 MG/L

CHART OF INDIVIDUALS

XBAR AND 3 SIGMA LIMITS BASED ON POINTS 1- 11 OMITTING OUTLIERS

N= 11 S= 1.953 LOWER= 1.440 UPPER= 13.159
%RSD= 27. XBAR= 7.300

PT	METHOD	RESULT	-----			
1	CUR C	7.00			*	
2	CUR C	6.67			*	
3	CUR C	6.59			*	
4	FE	7.00			*	
5	CAR C	6.40			*	
6	CAR C	6.30			*	
7	SSMS	8.00			*	
8	ICP-AES	6.60			*	
9	ICP-AES	6.54			*	
10	ICP-AES	6.20			*	
11	ES	13.00				*

Table 20 (Continued)

GRR-1 RESULTS
BORON UNKNOWN (MG/L)

CHART OF INDIVIDUALS

XBAR AND 3 SIGMA LIMITS BASED ON POINTS 1- 19 OMITTING OUTLIERS

N= 17 S= 0.988 LOWER= 5.037 UPPER= 10.963
%RSD= 12. XBAR= 8.000

PT	METHOD	RESULT	
1	CUR C	8.12	*
2	CUR C	6.00	*
3	CUR C	7.89	*
4	CUR C	7.89	*
5	FE	8.00	*
6	CAR C	14.00	*
7	CAR C	7.00	*
8	CAR C	7.50	*
9	CAR C	7.00	*
10	CAR C	9.50	*
11	CAR C	6.50	*
12	SSMS	9.00	FA
13	SSMS	9.00	RU
14	SSMS	9.40	FU
15	SSMS	0.60	*
16	ICP-AES	8.00	*
17	ICP-AES	7.40	*
18	ICP-AES	7.70	*
19	ES	9.30	*

Table 20 (Continued)

GRR-1 RESULTS
BROMIDE CONTROL 5.0 MG/L

CHART OF INDIVIDUALS

XBAR AND 3 SIGMA LIMITS BASED ON POINTS 1- 9 OMITTING OUTLIERS

N= 9 S= 15.590 LOWER= -36.227 UPPER= 57.316
%RSD= 148. XBAR= 10.544

PT	METHOD	RESULT	-----			
1	API PHOT	7.00			*	
2	ICN SP	17.80			*	
3	ICN SP	50.00				*
4	COLOR	3.60			*	
5	OXI-TIT	3.40			*	
6	XRF	5.00			*	
7	XRF	1.50			*	
8	NA	5.00			*	
9	NA	1.60			*	

Table 20 (Continued)

GRR-1 RESULTS
BROMIDE UNKNOWN MG/L

CHART OF INDIVIDUALS

XBAR AND 3 SIGMA LIMITS BASED ON POINTS 1- 14 OMITTING OUTLIERS

N= 13 S= 2.058 LOWER= -3.584 UPPER= 8.767
%RSD= 79. XBAR= 2.592

PT	METHOD	RESULT							
1	API PHCT	2.00				*			
2	ICN SP	4.50					*		
3	ICN SP	16.00							*
4	COLOR	8.50						*	
5	OXI-TIT	2.16				*			
6	CXI-TIT	2.40				*			
7	OXI-TIT	4.00					*		
8	XRF	2.00				*			
9	NA	1.33				*			
10	NA	1.10	FA			*			
11	NA	1.20	FU			*			
12	NA	1.30	RU			*			
13	ICN EXC	1.60	RU			*			
14	ICN EXC	1.60	FU			*			

Table 20 (Continued)

GRR-1 RESULTS

CALCIUM CONTROL 13.0 MG/L

CHART OF INDIVIDUALS

XBAR AND 3 SIGMA LIMITS BASED ON POINTS 1- 18 OMITTING OUTLIERS

$$N=18 \quad S=1.878$$

LOWER= 7.222

UPPER= 18.489

%RSD= 15.

XBAR= 12.856

PT	METHOD	RESULT
1	AA	12.00
2	AA	12.00
3	AA	10.10
4	AA	13.20
5	AA	12.00
6	AA	12.50
7	AA	13.90
8	AA	13.40
9	AA	17.30
10	AA	14.00
11	SSMS	13.00
12	NA	13.00
13	ICP-AES	12.70
14	ICP-AES	12.90
15	ICP-AES	13.00
16	ES	8.90
17	ES	11.50
18	FE	16.00

GRR-1 RESULTS
CALCIUM UNKNOWN (MG/L)

XBAR AND 3 SIGMA LIMITS EASED ON POINTS 1- 21 OMITTING OUTLIERS

N=	21	S=	3.830	LOWER=	1.525	UPPER=	24.503
		%RSD=	29.			XBAR=	13.014

PT	METHOD	RESULT
1	AA	5.00
2	AA	13.10
3	AA	3.00
4	AA	14.20
5	AA	14.00
6	AA	8.10
7	AA	13.00
8	AA	12.80
9	AA	14.20
10	AA	18.30
11	AA	14.00
12	NA	8.70
13	SSMS	14.00 FA
14	SSMS	14.00 RU
15	SSMS	16.00 FU
16	ICP-AES	15.00
17	ICP-AES	13.50
18	ICP-AES	15.00
19	ES	18.00
20	ES	13.00
21	FE	16.00 RA

Table 20 (Continued)

GRR-1 RESULTS
CESIUM CONTROL 0.42 MG/L

CHART OF INDIVIDUALS

XBAR AND 3 SIGMA LIMITS BASED ON POINTS 1- 13 OMITTING OUTLIERS

N= 13 S= 0.106 LOWER= 0.115 UPPER= 0.751
%RSD= 24. XBAR= 0.433

PT	METHOD	RESULT
1	AA	0.39
2	AA	0.55
3	AA	0.38
4	AA	0.19
5	FE	0.32
6	FE	0.42
7	FE	0.40
8	FE	0.53
9	NA	0.45
10	NA	0.43
11	NA	0.47
12	SSMS	0.60
13	AA GF	0.50

GRR-1 RESULTS
CESIUM UNKNOWN (MG/L)

XBAR AND 3 SIGMA LIMITS BASED ON POINTS 1- 22 OMITTING OUTLIERS

PT	METHOD	RESULT
1	AA	0.37
2	AA	0.31
3	AA	0.25
4	AA	0.21
5	FE	0.21
6	FE	0.20
7	FE	0.20 RA
8	FE	0.20 FA
9	FE	0.27
10	FE	0.31
11	NA	0.27
12	NA	0.24 FA
13	NA	0.22 FU
14	NA	0.27 RU
15	NA	0.28 FA
16	NA	0.29 RU
17	NA	0.26 FU
18	SSMS	0.50 FA
19	SSMS	1.00 RU
20	SSMS	0.75 FU
21	SSMS	0.20
22	AA GF	0.40

Table 20 (Continued)

GRR-1 RESULTS
CHLORIDE (MG/L) UNKNOWN

CHART OF INDIVIDUALS

XBAR AND 3 SIGMA LIMITS BASED ON POINTS 1- 23 OMITTING OUTLIERS

N= 23 S= 560.1 LOWER= 3.3 UPPER= 3363.9
%RSD= 33. XBAR= 1583.6

PT	METHOD	RESULT							
1	AG TIT	1937.					*		
2	AG TIT	1917.					*		
3	AG TIT	1820.					*		
4	AG TIT	1957.					*		
5	* Field	1950.					*		
6	AG TIT	1880. Lab					*		
7	AG TIT	1955.					*		
8	AG TIT	2009.					*		
9	AG TIT	2038.					*		
10	HG TIT	1932.					*		
11	HG TIT	1909.					*		
12	HG TIT	1773.					*		
13	HG TIT	34.		*					
14	HG TIT	2000.					*		
15	XRF	1957.					*		
16	XRF	560. FU		*					
17	XRF	599. RU		*					
18	NA	1010. RU			*				
19	NA	1566. FU				*			
20	GRAVI	1970.					*		
21	ICN SP	2000.					*		
22	ICN EXC	1970. RU					*		
23	ICN EXC	1980. FU					*		

* Quantab

GRR-1 RESULTS
COPPER CONTROL 0.08 MG/L

XBAR AND 3 SIGMA LIMITS EASED ON POINTS 1- 14 OMITTING OUTLIERS

XBAR= 0.090

PT	METHOD	RESULT
1	AA	0.05
2	AA	0.09
3	AA	0.09
4	AA	0.09
5	AA	0.08
6	AA	0.07
7	AA EXT	0.09
8	SSMS	0.09
9	ICP-AES	0.14
10	ICP-AES	0.14
11	ICP-AES	0.10
12	AA GF	0.03
13	ES	0.08
14	ES	0.12

GRR-1 RESULTS
COPPER UNKNOWN (MG/L)

XBAR AND 3 SIGMA LIMITS BASED ON POINTS 1- 15 OMITTING OUTLIERS

PT	METHOD	RESULT
1	AA	0.0
2	AA	0.02
3	AA	0.02
4	AA	0.01
5	AA	0.0
6	SSMS	0.10 FA
7	SSMS	0.10 RU
8	SSMS	0.07 FU
9	SSMS	0.05
10	ICP-AES	0.08
11	ICP-AES	0.04
12	ICP-AES	0.01
13	AA GF	0.01
14	ES	0.02
15	XRF	0.90 RU

Table 20 (Continued)

GRR-1 RESULTS
FLUORIDE CONTROL 1.2 MG/L

CHART OF INDIVIDUALS

XBAR AND 3 SIGMA LIMITS BASED ON POINTS 1- 8 OMITTING OUTLIERS

N= 8 S= 0.383 LOWER= -0.537 UPPER= 1.762
%RSD= 63. XBAR= 0.612

PT	METHOD	RESULT	-----			
1	ICN SP	0.60			*	
2	ICN SP	0.61			*	
3	ICN SP	0.6		*		
4	ICN SP	0.50			*	
5	ICN SP	0.60			*	
6	ICN SP	0.50			*	
7	ICN SP	0.69			*	
8	SPECTRO	1.40			*	

GRR-1 RESULTS
FLUORIDE UNKNOWN (MG/L)

XBAR AND 3 SIGMA LIMITS BASED ON POINTS 1- 14 OMITTING OUTLIERS

UPPER= 6.836

XBAR= 3.624

PT	METHOD	RESULT
1	ICN SP	3.85
2	ION SP	3.75
3	ICN SP	3.40
4	ICN SP	4.20
5	ICN SP	3.00
6	ICN SP	2.90
7	ICN SP	2.70
8	ICN SP	3.69
9	ICN SP	3.50
10	VIS-DIST	2.70
11	AMA-DIST	1.64
12	ICN EXC	5.60 RU
13	ICN EXC	5.50 FU
14	SPECTRO	4.30

Table 20 (Continued)

GRR-1 RESULTS
 IODIDE CONTROL 5.0 MG/L

CHART OF INDIVIDUALS

XBAR AND 3 SIGMA LIMITS BASED ON POINTS 1- 7 OMITTING OUTLIERS

N= 7 S= 1.555 LOWER= -0.602 UPPER= 8.730
 %RSD= 38. XBAR= 4.064

PT	METHOD	RESULT	-----			
1	OXI TIT	6.30				
2	NA	4.70				
3	ICN SP	4.90				
4	ICN SP	2.00				
5	ICN SP	4.80				
6	AS COLOR	2.25				
7	API PHOT	3.50				

Table 20 (Continued)

GRR-1 RESULTS
 IODIDE UNKNOWN (MG/L)

CHART OF INDIVIDUALS

XBAR AND 3 SIGMA LIMITS BASED ON POINTS 1- 8 OMITTING OUTLIERS

N= 8 S= 0.354 LOWER= -0.537 UPPER= 1.589
 %RSD= 67. XBAR= 0.526

PT	METHOD	RESULT							
1	OXI TIT	0.71					*		
2	OXI TIT	1.32						*	
3	NA	0.43	RU			*			
4	NA	0.27	FU			*			
5	IGN SP	0.20				*			
6	IGN SP	0.40				*			
7	AS COLCR	0.48				*			
8	AS COLCR	0.40				*			

GRF-1 RESULTS
IRON CONTROL 0.70 MG/L

XBAR AND 3 SIGMA LIMITS BASED ON POINTS 1- 17 OMITTING OUTLIERS

UPPER= 1.222

XBAR= 0.756

PT	METHOD	RESULT
1	AA	0.60
2	AA	0.74
3	AA	0.76
4	AA	0.60
5	AA	0.74
6	AA	0.70
7	AA	0.70
8	AA	0.76
9	AA	1.00
10	AA EXT	1.08
11	SSMS	0.75
12	ICP-AES	0.73
13	ICP-AES	0.74
14	ICP-AES	0.69
15	ES	0.57
16	ES	0.61
17	NA	1.08

Table 20 (Continued)

GRR-1 RESULTS
IRON UNKNOWN (MG/L)

CHART OF INDIVIDUALS

XBAR AND 3 SIGMA LIMITS BASED ON POINTS 1- 24 OMITTING OUTLIERS

N= 22 S= 0.194 LOWER= -0.177 UPPER= 0.984
%RSD= 48. XBAR= 0.404

PT	METHOD	RESULT	
1	AA	0.40	*
2	AA	0.25	*
3	AA	0.23	*
4	AA	0.40	RA *
5	AA	0.30	FA *
6	AA	0.37	*
7	AA	0.26	*
8	AA	0.30	*
9	AA	0.20	*
10	AA	0.41	*
11	AA	0.75	*
12	AA EXT	0.81	*
13	SSMS	0.40	FA *
14	SSMS	0.50	RU *
15	SSMS	0.90	FU *
16	ICP-AES	0.30	*
17	ICP-AES	0.26	*
18	ICP-AES	0.24	*
19	ES	0.32	*
20	XRF	2.00	FU *
21	XRF	6.00	RU *
22	NA	0.33	FA *
23	NA	0.59	RU *
24	NA	0.36	FU *

Table 20 (Continued)

GRR-1 RESULTS
LEAD CONTROL 0.30 MG/L

CHART OF INDIVIDUALS

XBAR AND 3 SIGMA LIMITS BASED ON POINTS 1- 14 OMITTING OUTLIERS

N= 14 S= 0.141

LOWER= -0.072

UPPER= 0.776

%RSD= 40.

XBAR= 0.352

PT	METHOD	RESULT				
1	AA	0.43			*	
2	AA	0.32			*	
3	AA	0.32			*	
4	AA	0.32			*	
5	AA	0.40			*	
6	AA	0.50				*
7	AA	0.17		*		
8	AA GF	0.20		*		
9	SSMS	0.10	*			
10	AA EXT	0.30		*		
11	ES	0.48			*	
12	ICP-AES	0.60				*
13	ICP-AES	0.50			*	
14	ICP-AES	0.29		*		

Table 20 (Continued)

GRR-1 RESULTS
LEAD UNKNOWN (MG/L)

CHART OF INDIVIDUALS

XBAR AND 3 SIGMA LIMITS BASED ON POINTS 1- 11 OMITTING OUTLIERS

N= 11 S= 0.080 LOWER= -0.152 UPPER= 0.330
%RSD= 90. XBAR= 0.089

PT	METHOD	RESULT							
1	AA	0.06			*				
2	AA	0.07			*				
3	AA	0.05 RA			*				
4	AA	0.07			*				
5	AA	0.03			*				
6	AA GF	0.10				*			
7	SSMS	0.06 RU			*				
8	SSMS	0.03 FU			*				
9	ICP-AES	0.30					*		
10	ICP-AES	0.17				*			
11	ICP-AES	0.04			*				

Table 20 (Continued)

GRR-1 RESULTS
LITHIUM CONTROL 4.00 MG/L

CHART OF INDIVIDUALS

XBAR AND 3 SIGMA LIMITS BASED ON POINTS 1- 15 OMITTING OUTLIERS

N= 15 S= 0.775 LOWER= 1.697 UPPER= 6.348
%RSD= 19. XBAR= 4.023

PT	METHOD	RESULT				
1	AA	3.50			*	
2	AA	3.75			*	
3	AA	3.80			*	
4	AA	4.00			*	
5	AA	4.65				*
6	AA	4.30			*	
7	AA	4.60			*	
8	AA	6.10				*
9	FE	3.84			*	
10	FE	3.60		*		
11	FE	4.20			*	
12	SSMS	3.60		*		
13	ES	2.40	*			
14	ES	3.80		*		
15	IGN EXC	3.80		*		

GRR-1 RESULTS
LITHIUM UNKNOWN (MG/L)

XBAR AND 3 SIGMA LIMITS BASED ON POINTS 1- 21 OMITTING OUTLIERS

UPPER= 6.478

XBAR= 4.336

PT	METHOD	RESULT
1	AA	4.20
2	AA	4.17
3	AA	-4.30
4	AA	4.40
5	AA	4.25
6	AA	4.60
7	AA	6.00
8	AA	5.00
9	FE	4.18
10	FE	4.10 RA
11	FE	4.00 FA
12	FE	4.60
13	SSMS	3.60 FA
14	SSMS	5.00 RU
15	SSMS	5.00 FU
16	SSMS	5.00
17	ES	2.30 *
18	ES	4.10
19	IGN EXC	4.50 RU
20	IGN EXC	4.60 FU
21	IGN EXC	4.20 FA

Table 20 (Continued)

GRR-1 RESULTS
MAGNESIUM CONTROL 0.20 MG/L

CHART OF INDIVIDUALS

XBAR AND 3 SIGMA LIMITS BASED ON POINTS 1- 16 OMITTING OUTLIERS

N= 16 S= 0.057 LOWER= 0.028 UPPER= 0.372
%RSD= 29. XBAR= 0.200

PT	METHOD	RESULT	-----			
1	AA	0.25				
2	AA	0.21				
3	AA	0.16				
4	AA	0.31				
5	AA	0.21				
6	AA	0.23				
7	AA	0.22				
8	AA	0.21				
9	AA	0.17				
10	AA	0.20				
11	SSMS	0.25				
12	ICP-AES	0.19				
13	ICP-AES	0.20				
14	ICP-AES	0.20				
15	ES	0.04				
16	ES	0.15				

Table 20 (Continued)

GRR-1 RESULTS
MAGNESIUM UNKNOWN (MG/L)

CHART OF INDIVIDUALS

XBAR AND 3 SIGMA LIMITS BASED ON POINTS 1- 20 OMITTING OUTLIERS

N= 20 S= 0.071 LOWER= 0.097 UPPER= 0.521
%RSD= 23. XBAR= 0.309

PT	METHOD	RESULT	
1	AA	0.22	*
2	AA	0.25	*
3	AA	0.28	*
4	AA	0.38	*
5	AA	0.30	*
6	AA	0.40	*
7	AA	0.40	*
8	AA	0.35	*
9	AA	0.31	*
10	AA	0.32	*
11	AA	0.22	*
12	AA	0.32	*
13	SSMS	0.38 FA	*
14	SSMS	0.38 RU	*
15	SSMS	0.38 FU	*
16	ICP-AES	0.28	*
17	ICP-AES	0.33	*
18	ICP-AES	0.31	*
19	ES	0.14	*
20	ES	0.23	*

Table 20 (Continued)

GRR-1 RESULTS
MANGANESE CONTROL 0.06 MG/L

CHART OF INDIVIDUALS

XBAR AND 3 SIGMA LIMITS BASED ON POINTS 1- 13 OMITTING OUTLIERS

N= 12 S= 0.008 LOWER= 0.040 UPPER= 0.087
%RSD= 12. XBAR= 0.063

PT	METHOD	RESULT				
1	AA	0.06		*		
2	AA	0.08			*	
3	AA	0.07			*	
4	AA	0.07			*	
5	AA	0.06		*		
6	AA	0.06		*		
7	AA	0.06		*		
8	AA EXT	0.05	*			
9	SSMS	0.07			*	
10	ICP-AES	0.06		*		
11	ICP-AES	0.06		*		
12	ES	0.19				*
13	ES	0.06		*		

Table 20 (Continued)

GRR-1 RESULTS
MANGANESE UNKNOWN (MG/L)

CHART OF INDIVIDUALS

XBAR AND 3 SIGMA LIMITS BASED ON POINTS 1- 16 OMITTING OUTLIERS

N= 15 S= 0.010 LOWER= -0.012 UPPER= 0.050
%RSD= 53. XBAR= 0.019

PT	METHOD	RESULT							
1	AA	0.01			*				
2	AA	0.02				*			
3	AA	0.04					*		
4	AA	0.03 RA					*		
5	AA	0.02 FA				*			
6	AA	0.02				*			
7	AA	0.01			*				
8	AA	0.02				*			
9	AA EXT	0.01			*				
10	SSMS	0.01 FA			*				
11	SSMS	0.08 RU							*
12	SSMS	0.01 FU			*				
13	SSMS	0.04					*		
14	ICP-AES	0.02				*			
15	ICP-AES	0.01			*				
16	ES	0.02				*			

Table 20 (Continued)

GRR-1 RESULTS
MERCURY CONTROL 0.01 MG/L

CHART OF INDIVIDUALS

XBAR AND 3 SIGMA LIMITS BASED ON POINTS 1- 4 OMITTING OUTLIERS

N= 4 S= 0.00440 LOWER=-0.00699 UPPER= 0.01939
%RSD= 71. XBAR= 0.00620

PT	METHOD	RESULT	-----			
1	CV AA	0.00500				
2	CV AA	0.00050				
3	CV AA	0.01000				
4	CV AA	0.00930				

Table 20 (Continued)

GRR-1 RESULTS
MERCURY UNKNOWN (MG/L)

CHART OF INDIVIDUALS

XBAR AND 3 SIGMA LIMITS BASED ON POINTS 1- 10 OMITTING OUTLIERS

N= 10 S= 0.09456 LOWER=-0.25281 UPPER= 0.31457
%RSD= 306. XBAR= 0.03086

PT	METHOD	RESULT					
1	CV AA	0.00100			*		
2	CV AA	0.00040			*		
3	CV AA	0.00015 FU			*		
4	CV AA	0.00179 RU			*		
5	CV AA	0.00008 FA			*		
6	CV AA	0.00060			*		
7	CV AA	0.00280 FA			*		
8	CV AA	0.00172 RU			*		
9	CV AA	0.00026 FU			*		
10	XRF	0.30000 RU				*	

Table 20 (Continued)

GRR-1 RESULTS

PHOSPHATE CONTROL 0.25 MG/L

CHART OF INDIVIDUALS

XBAR AND 3 SIGMA LIMITS BASED ON POINTS 1- 13 OMITTING OUTLIERS

N= 11 S= 0.159 LOWER= -0.184 UPPER= 0.771
 %RSD= 54. XBAR= 0.294

PT	METHOD	RESULT										
1	SN COLOR	0.26				*						
2	SN COLOR	0.04			*							
3	SN COLOR	0.09			*							
4	SN COLOR	0.49						*				
5	ASC COLO	0.30					*					
6	ASC COLO	0.32					*					
7	ASC COLO	0.36					*					
8	ASC COLO	0.12			*							
9	ICP-AES	5.80									*	
10	ICP-AES	0.34					*					
11	SN CO CI	0.36					*					
12	XRF	2.00									*	
13	MPA MET	0.55						*				

GRR-1 RESULTS
PHOSPHATE UNKNOWN (MG/L)

XBAR AND 3 SIGMA LIMITS BASED ON POINTS 1- 15 OMITTING OUTLIERS

XBAR= 0.394

PT	METHOD	RESULT				
1	SN COLGR	0.43			*	
2	SN COLGR	0.03			*	
3	SN COLGR	0.96				*
4	SN COLGR	0.42			*	
5	ASC COLO	0.10			*	
6	ASC COLO	0.05	FU		*	
7	ASC COLO	0.06	RU		*	
8	ASC COLO	0.05	FA		*	
9	ASC COLO	0.10			*	
10	ASC COLO	0.20	RU		*	
11	ASC COLO	1.12	FU			*
12	ASC COLO	0.24	FA		*	
13	ICP-AES	7.00				
14	ICP-AES	0.15			*	
15	MPA MET	1.60				*

GRR-1 RESULTS
POTASSIUM CONTROL 180 MG/L

XBAR AND 3 SIGMA LIMITS BASED ON POINTS 1- 18 OMITTING OUTLIERS

PT	METHOD	RESULT
1	AA	164.
2	AA	235.
3	AA	180.
4	AA	188.
5	AA	160.
6	AA	191.
7	AA	135.
8	AA	180.
9	FE	180.
10	FE	195.
11	FE	174.
12	FE	178.
13	SSMS	180.
14	ICP-AES	122.
15	ES	170.
16	ES	165.
17	XRF	222.
18	ICN EXC	182.

Table 20 (Continued)

GRR-1 RESULTS
POTASSIUM UNKNOWN (MG/L)

CHART OF INDIVIDUALS

XBAR AND 3 SIGMA LIMITS BASED ON POINTS 1- 27 OMITTING OUTLIERS

N= 26 S= 25.1 LOWER= 65.9 UPPER= 216.7
%RSD= 18. XBAR= 141.3

PT	METHOD	RESULT	
1	AA	120.	*
2	AA	166.	*
3	AA	123.	*
4	AA	138.	*
5	AA	117.	*
6	AA	130.	*
7	AA	130.	*
8	AA	140.	*
9	FE	175.	*
10	FE	140.	*
11	FE	123. RA	*
12	FE	124. FA	*
13	FE	150.	*
14	FE	124.	*
15	SSMS	165. FA	*
16	SSMS	200. RU	*
17	SSMS	165. FU	*
18	ICP-AES	200.	*
19	ES	110.	*
20	ES	119.	*
21	XRF	172. FA	*
22	XRF	135. FU	*
23	XRF	239. RU	*
24	ICN EXC	130. RU	*
25	ICN EXC	130. RA	*
26	ICN EXC	127. FA	*
27	S ICN EL	120. Field	*

GRR-1 RESULTS
RUBIDIUM CONTROL 5.0 MG/L

XBAR AND 3 SIGMA LIMITS BASED ON POINTS 1- 13 OMITTING OUTLIERS

PT	METHOD	RESULT
1	AA	4.66
2	AA	4.20
3	AA	5.50
4	AA	4.70
5	AA	5.60
6	FE	6.06
7	FE	5.20
8	FE	5.40
9	NA	4.80
10	NA	6.80
11	NA	8.31
12	SSMS	2.40
13	AA GF	5.00

Table 20 (Continued)

GRR-1 RESULTS
RUBIDIUM UNKNOWN (MC/L)

CHART OF INDIVIDUALS

XBAR AND 3 SIGMA LIMITS BASED ON POINTS 1- 20 OMITTING OUTLIERS

N= 20 S= 0.971 LOWER= -1.933 UPPER= 3.894
%RSD= 99. XBAR= 0.580

PT	METHOD	RESULT							
1	AA	0.41			*				
2	AA	0.40			*				
3	AA	0.65			*				
4	AA	0.60			*				
5	AA	0.40			*				
6	FE	0.72			*				
7	FE	0.50 RA			*				
8	FE	0.50 FA			*				
9	FE	0.62			*				
10	FE	0.59			*				
11	NA	0.70 FA			*				
12	NA	0.70 FU			*				
13	NA	0.80 RU			*				
14	NA	0.61 FA			*				
15	NA	0.95 RU			*				
16	NA	0.58 FU			*				
17	SSMS	2.50 FA				*			
18	SSMS	3.50 RU					*		
19	SSMS	3.50 FU					*		
20	AA GF	0.38			*				

Table 20 (Continued)

GRR-1 RESULTS
SILICA CONTROL 250 MG/L

CHART OF INDIVIDUALS

XBAR AND 3 SIGMA LIMITS BASED ON POINTS 1- 16 OMITTING OUTLIERS

N= 16 S= 88.58

LOWER= -51.36

UPPER= 480.13

%RSD= 41.

XBAR= 214.38

PT.	METHOD	RESULT					
1	AA	264.0				*	
2	AA	265.0				*	
3	AA	228.0				*	
4	AA	257.0				*	
5	AA	206.0				*	
6	AA	276.0				*	
7	HB COLOR	206.0				*	
8	HB COLOR	250.0				*	
9	MS COLOR	210.0				*	
10	MS COLOR	219.0				*	
11	MS COLOR	226.0				*	
12	MS COLOR	300.0				*	*
13	FE	220.0				*	
14	FE	300.0				*	*
15	ICP-AES	0.5		*			
16	ES	2.6		*			

Table 20 (Continued)

GRR-1 RESULTS
SILICA UNKNOWN (MG/L)

CHART OF INDIVIDUALS

XBAR AND 3 SIGMA LIMITS BASED ON POINTS 1- 25 OMITTING OUTLIERS

N= 23 S= 55.224 LOWER= 81.480 UPPER= 412.824
%RSD= 22. XBAR= 247.152

PT	METHOD	RESULT	
1	AA	338.00	*
2	AA	199.00	*
3	AA	295.00	*
4	AA	165.00	*
5	AA	255.00	RA
6	AA	255.00	FA
7	AA	256.80	*
8	AA	210.00	*
9	AA	266.00	*
10	AA	276.00	*
11	HB COLOR	203.00	*
12	HB COLOR	237.00	*
13	HB COLOR	230.00	*
14	MS COLOR	215.00	*
15	MS COLOR	220.00	*
16	MS COLOR	219.00	*
17	MS COLOR	230.00	*
18	MS COLOR	200.00	Field
19	MS COLOR	290.00	Lab
20	FE	267.00	*
21	FE	226.00	*
22	FE	535.00	*
23	ICP-AES	203.70	*
24	ICP-AES	260.00	*
25	ES	428.00	*

Table 20 (Continued)

GRR-1 RESULTS
SILVER CONTROL 0.07 MG/L

CHART OF INDIVIDUALS

XBAR AND 3 SIGMA LIMITS BASED ON POINTS 1- 11 OMITTING OUTLIERS

N= 11 S= 0.036 LOWER= -0.072 UPPER= 0.146
%RSD= 98. XBAR= 0.037

PT	METHOD	RESULT					
1	AA	0.02			*		
2	AA	0.02			*		
3	AA	0.08				*	
4	AA	0.06				*	
5	AA GF	0.01			*		
6	AA GF	0.01			*		
7	ES	0.01			*		
8	AA EXT	0.12				*	
9	NA	0.05				*	
10	NA	0.02			*		
11	ICP-AES	0.01			*		

Table 20 (Continued)

GRR-1 RESULTS
SILVER UNKNOWN (MG/L)

CHART OF INDIVIDUALS

XBAR AND 3 SIGMA LIMITS BASED ON POINTS 1- 10 OMITTING OUTLIERS

N= 10 S= 0.032 LOWER= -0.063 UPPER= 0.127
%RSD= 99. XBAR= 0.032

PT	METHOD	RESULT				
1	AA	0.02		*		
2	AA	0.01		*		
3	AA	0.08			*	
4	AA	0.0		*		
5	AA GF	0.08			*	
6	AA GF	0.01		*		
7	ES	0.02		*		
8	NA	0.02		*		
9	SSMS	0.07			*	
10	ICP-AES	0.01		*		

Table 20 (Continued)

GRR-1 RESULTS
SODIUM CONTROL 1500 MG/L

CHART OF INDIVIDUALS

XBAR AND 3 SIGMA LIMITS BASED ON POINTS 1- 19 OMITTING OUTLIERS

N= 17 S= 59.8 LOWER= 1310.5 UPPER= 1669.6
%RSD= 4.0 XBAR= 1490.1

PT	METHOD	RESULT							
1	AA	1390.			*				
2	AA	1930.							*
3	AA	1520.				*			
4	AA	1440.			*				
5	AA	1200.	*						
6	AA	1460.			*				
7	AA	1600.					*		
8	FE	1400.		*					
9	FE	1450.			*				
10	FE	1520.				*			
11	FE	1480.			*				
12	FE	1550.					*		
13	NA	1490.				*			
14	NA	1513.				*			
15	SSMS	1500.				*			
16	ICP-AES	1540.					*		
17	ES	1400.		*					
18	ES	1560.					*		
19	ICN EXC	1510.				*			

Table 20 (Continued)

GRR-1 RESULTS
SODIUM UNKNOWN (MG/L)

CHART OF INDIVIDUALS

XBAR AND 3 SIGMA LIMITS BASED ON POINTS 1- 28 OMITTING OUTLIERS

N= 24 S= 60.7 LOWER= 1254.7 UPPER= 1618.9
%RSD= 4. XBAR= 1436.8

PT	METHOD	RESULT	
1	AA	1380.	*
2	AA	1601.	*
3	AA	1430.	*
4	AA	1400.	*
5	AA	970.	*
6	AA	1360.	*
7	AA	1700.	*
8	FE	1400.	*
9	FE	1400.	*
10	FE	1450. RA	*
11	FE	1410. FA	*
12	FE	1550.	*
13	FE	1400.	*
14	FE	2000.	*
15	NA	1462.	*
16	NA	1400. FA	*
17	NA	1450. FU	*
18	NA	1400. RU	*
19	SSMS	1470. FA	*
20	SSMS	1470. RU	*
21	SSMS	1470. FU	*
22	ICP-AES	1450.	*
23	ES	1300.	*
24	ES	1460.	*
25	IGN EXC	1480. RU	*
26	IGN EXC	1470. FU	*
27	IGN EXC	1420. FA	*
28	S ICN EL	1100.Field*	

Table 20 (Continued)

GRR-1 RESULTS
STRONTIUM CONTROL 1.60 MG/L

CHART OF INDIVIDUALS

XBAR AND 3 SIGMA LIMITS BASED ON POINTS 1- 16 OMITTING OUTLIERS

N= 15 S= 0.164 LOWER= 1.009 UPPER= 1.995
%RSD= 11. XBAR= 1.502

PT	METHOD	RESULT							
1	AA	1.49				*			
2	AA	1.50				*			
3	AA	1.56					*		
4	AA	1.60					*		
5	AA	1.60					*		
6	AA	1.60					*		
7	FE	1.73						*	
8	FE	1.50				*			
9	FE	1.70						*	
10	SSMS	1.20		*					
11	ICP-AES	1.49				*			
12	ICP-AES	1.10		*					
13	ES	1.50				*			
14	NA	2.40							*
15	NA	1.46				*			
16	AA GF	1.50				*			

Table 20 (Continued)

GRR-1 RESULTS
STRONTIUM UNKNOWN (MG/L)

CHART OF INDIVIDUALS

XBAR AND 3 SIGMA LIMITS BASED ON POINTS 1- 24 OMITTING OUTLIERS

N= 24 S= 0.678 LOWER= -0.241 UPPER= 3.826
%RSD= 38. XBAR= 1.792

PT	METHOD	RESULT	
1	AA	2.15	*
2	AA	2.10	*
3	AA	2.10	*
4	AA	2.10	*
5	AA	2.00	*
6	AA	2.20	*
7	FE	2.50	*
8	FE	2.10	RA *
9	FE	0.80	*
10	FE	2.14	*
11	SSMS	1.60	FA *
12	SSMS	1.50	RU *
13	SSMS	1.50	FU *
14	ICP-AES	2.02	*
15	ICP-AES	1.50	*
16	ES	3.40	*
17	XRF	0.10	FU *
18	XRF	0.40	RU *
19	NA	1.80	FA *
20	NA	2.30	*
21	NA	1.50	FA *
22	NA	1.41	RU *
23	NA	1.50	FU *
24	AA GF	1.50	*

Table 20 (Continued)

GRR-1 RESULTS
SULFATE CONTROL 150 MG/L

CHART OF INDIVIDUALS

XBAR AND 3 SIGMA LIMITS BASED ON POINTS 1- 6 OMITTING OUTLIERS

N= 6 S= 17.317 LOWER= 104.717 UPPER= 208.617
%RSD= 11. XBAR= 156.667

PT	METHOD	RESULT	-----			
1	TURBIMET	178.00				
2	TURBIMET	133.00				
3	TURBIMET	146.00				
4	AA	148.00				
5	GRAVI	162.00				
6	FE	173.00				

GRR-1 RESULTS
SULFATE UNKNOWN (MG/L)

XBAR AND 3 SIGMA LIMITS BASED ON POINTS 1- 13 OMITTING OUTLIERS

UPPER= 279.764

XBAR= 144.231

PT	METHOD	RESULT							
1	GRAVI	133.00				*			
2	GRAVI	154.00					*		
3	GRAVI	158.00						*	
4	TURBIMET	180.00							*
5	TURBIMET	11.00		*					
6	TURBIMET	194.00							*
7	TURBIMET	132.00				*			
8	TURBIMET	162.00						*	
9	TURBIMET	150.00					*		
10	AA	170.00						*	
11	FE	113.00				*			
12	ICN EXC	159.00	RU					*	
13	ICN EXC	159.00	FU					*	

Table 20 (Continued)

GRR-1 RESULTS
SULFIDE UNKNOWN (MG/L)

CHART OF INDIVIDUALS

XBAR AND 3 SIGMA LIMITS BASED ON POINTS

1- 13 OMITTING OUTLIERS

N= 13 S= 49.783

LOWER=-124.402

UPPER= 174.296

%RSD= 200.

XBAR= 24.947

PT	METHOD	RESULT					
1	ICDC TIT	0.40			*		
2	ICDC TIT	1.43			*		
3	ICDC TIT	0.60			*		
4	ICDC TIT	1.60			*		
5	ICDC TIT	0.26			*		
6	ICDC TIT	174.00				*	
7	MB COLCR	0.15			*		
8	MB COLCR	0.32			*		
9	MB COLCR	0.05			*		
10	ICN SP	0.50			*		
11	XRF	67.00	FA			*	
12	XRF	42.00	FU			*	
13	XRF	36.00	RU			*	

GRR-1 RESULTS
ZINC CONTROL 0.60 MG/L

XBAR AND 3 SIGMA LIMITS BASED ON PCINTS 1- 17 OMITTING OUTLIERS

UPPER= 0.860

XBAR= 0.626

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Table 20 (Continued)

GRR-1 RESULTS
ZINC UNKNOWN (MG/L)

CHART OF INDIVIDUALS

XBAR AND 3 SIGMA LIMITS BASED ON POINTS

1- 23 OMITTING OUTLIERS

N= 21 S= 0.06373

LOWER=-0.13990

UPPER= 0.24251

%RSD= 124.

XBAR= 0.05131

PT	METHOD	RESULT							
1	AA	0.21000						*	
2	AA	0.03000			*				
3	AA	0.15000					*		
4	AA	0.07000	RA				*		
5	AA	0.07000	FA				*		
6	AA	0.01000			*				
7	AA	0.02000			*				
8	AA	0.05000					*		
9	AA	0.0			*				
10	AA EXT	0.01000	FA		*				
11	SSMS	0.01000	RU		*				
12	SSMS	0.01000	FU		*				
13	SSMS	0.01000			*				
14	SSMS	0.03000			*				
15	ICP-AES	0.06000					*		
16	ICP-AES	0.06000					*		
17	AA GF	0.21000						*	
18	NA	0.06000					*		
19	NA	0.42000	FA						*
20	NA	0.32000	RU					*	
21	NA	0.00248	FA		*				
22	NA	0.00344	RU		*				
23	NA	0.00152	FU		*				

Table 20 (Continued)

GRR-1 RESULTS
TOTAL DISSOLVED SOLIDS(MG/L) UNKNOWN

CHART OF INDIVIDUALS

XBAR AND 3 SIGMA LIMITS BASED ON POINTS 1- 14 OMITTING OUTLIERS

N= 14 S= 144.8 LOWER= 3794.9 UPPER= 4563.5
%RSD= 3. XBAR= 4229.2

PT	METHOD	RESULT							
1	GRAVI	4082.			*				
2	GRAVI	4282.					*		
3	GRAVI	4360.						*	
4	GRAVI	4333.					*		
5	GRAVI	4220.					*		
6	GRAVI	3883.			*				
7	GRAVI	4238.					*		
8	GRAVI	4510.						*	
9	GRAVI	4217.					*		
10	GRAVI	4220.					*		
11	GRAVI	4224.					*		
12	GRAVI	4320.]						*	
13	GRAVI	4120.]			*				
14	GRAVI	4200.					*		

Table 20 (Continued)

GRR-1 RESULTS
H2S(ENTRAINED) CONTROL 5.5 MG/L

CHART OF INDIVIDUALS

XBAR AND 3 SIGMA LIMITS BASED ON POINTS 1- 10 OMITTING OUTLIERS

N=	10	S=	2.335	LOWER=	-1.478	UPPER=	12.532
		%RSD=	42.		XBAR=	5.527	
PT	METHOD	RESULT					
1	ICDO TIT	5.00			*		
2	ICDO TIT	5.27			*		
3	ICDO TIT	6.20			*		
4	ICDO TIT	5.60			*		
5	ICDO TIT	5.10			*		
6	ICDO TIT	5.20			*		
7	ICDO TIT	5.50			*		
8	ICDO TIT	6.80			*		
9	MB CGLCR	10.00			*		
10	LAUTH'S VIOLET	0.40		*			

GRR-1 RESULTS
H2S (ENTRAINED) UNKNOWN (MG/L)

XBAR AND 3 SIGMA LIMITS, BASED ON POINTS 1- 11 OMITTING OUTLIERS

PT	METHOD	RESULT
1	IODO TIT	1.90
2	IODO TIT	1.08
3	IODO TIT	0.85
4	IODO TIT	1.20
5	IODO TIT	5.20
6	IODO TIT	1.40
7	IODO TIT	3.10
8	IODO TIT	1.80
9	IODO TIT	3.60
10	MB COLOR	1.30
11	LAUTH'S VIOLET	0.10

Table 20 (Continued)

GRR-1 RESULTS
CO₂(ENTRAINED) CONTROL 2000 MG/L

CHART OF INDIVIDUALS

XBAR AND 3 SIGMA LIMITS BASED ON POINTS 1- 9 OMITTING OUTLIERS

N= 9 S= 213.0 LOWER= 1459.0 UPPER= 2737.0
%RSD= 10. XBAR= 2098.0

PT	METHOD	RESULT							
1	ACID TIT	1996.			*				
2	ACID TIT	1980.			*				
3	ACID TIT	1940.			*				
4	ACID TIT	2489.					*		
5	PRE EVO	2000.			*				
6	PRE EVO	2060.			*				
7	TCT C AN	2000.			*				
8	SR GRAVI	1968.			*				
9	CALCULAT	2449.					*		

Table 20 (Continued)

GRR-1 RESULTS
CO2(ENTRAINED) UNKNOWN (MG/L)

CHART OF INDIVIDUALS

XBAR AND 3 SIGMA LIMITS BASED ON POINTS 1- 11 OMITTING OUTLIERS

N= 11 S=1542.714 LOWER= -22.234 UPPER=9234.047
%RSD= 33. XBAR=4605.906

PT	METHOD	RESULT								
1	ACID TIT	5160.00					*			
2	ACID TIT	4770.00	Lab				*			
3	ACID TIT	1344.00	Field	*						
4	ACID TIT	5320.00					*			
5	ACID TIT	2489.00			*					
6	PRE EVO	5400.00					*			
7	PRE EVO	5780.00					*			
8	TOT C AN	5440.00					*			
9	SR GRAVI	3748.00			*					
10	SR GRAVI	6700.00						*		
11	CALCULAT	4514.00					*			

Table 21

GRR-2 RESULTS

PH UNKN CWN

CHART OF INDIVIDUALS

XBAR AND 3 SIGMA LIMITS BASED ON POINTS 1- 13 OMITTING OUTLIERS

N= 13 S= 0.699 LOWER= 1.609 UPPER= 5.800
 %RSD= 19. XBAR= 3.705

PT	METHOD	RESULT				
1	PH METER	3.60				
2	PH METER	3.32				
3	PH METER	3.00				
4	PH METER	2.83				
5	PH METER	4.30				
6	PH METER	4.00				
7	PH METER	4.30				
8	PH METER	5.04				
9	PH METER	3.85				
10	PH METER	3.90				
11	PH METER	4.30				
12	PH METER	2.95				
13	PH METER	2.77				

Table 21 (Continued)

GRR-2 RESULTS
CONDUCTIVITY (MICRO MHOS/CM) UNKNOWN

CHART OF INDIVIDUALS

XBAR AND 3 SIGMA LIMITS BASED ON POINTS 1- 7 OMITTING OUTLIERS

N= 7 S=115260.4

LOWER=*****

UPPER=564038.5

%RSD= 53.

XBAR=218257.1

PT	METHOD	RESULT	-----			
1	METER	84000.		*		
2	METER	193300.		*		
3	METER	344000.			*	
4	METER	202500.		*		
5	METER	406000.			*	
6	METER	140000.		*		
7	METER	158000.		*		

Table 21 (Continued)

GRR-2 RESULTS
HARDNESS(MG/L CaCO3) UNKNOWN

CHART OF INDIVIDUALS

XBAR AND 3 SIGMA LIMITS BASED ON POINTS 1- 8 OMITTING OUTLIERS

N= 8 S= 2036.6 LOWER= 53915.1 UPPER= 65134.9
%RSD= 3.0 XBAR= 60025.0

PT	METHOD	RESULT	-----			
1	EDTA TIT	56000.				
2	EDTA TIT	57900.				
3	EDTA TIT	61200.				
4	EDTA TIT	61500.				
5	EDTA TIT	60600.				
6	EDTA TIT	60700.				
7	EDTA TIT	62000.				
8	CALCULAT	60300.				

Table 21 (Continued)

GRR-2 RESULTS
SUSPENDED SOLIDS (MG/L) UNKNOWN

CHART CF INDIVIDUALS

XBAR AND 3 SIGMA LIMITS BASED ON POINTS 1- 5 OMITTING OUTLIERS

N= 5 S= 929.4 LOWER= -1417.0 UPPER= 4159.3
XRSD= 68. XBAR= 1371.1

PT	METHOD	RESULT	-----			
1	GRAVI	1287.				
2	GRAVI	35.				
3	GRAVI	2080.				
4	GRAVI	1054.				
5	GRAVI	2400.				

Table 21 (Continued)

GRR-2 RESULTS
TURBIDITY UNKNOWN

CHART OF INDIVIDUALS

YEAR AND 3 SIGMA LIMITS BASED ON POINTS 1- 4 OMITTING OUTLIERS

N= 4 S= 161.050 LOWER=-327.049 UPPER= 639.249
%RSD= 103. XBAR= 156.100

PT	METHOD	RESULT	-----			
1	NEPHEL	285.00				
2	NEPHEL	2.40				
3	NEPHEL	32.00				
4	HACH MET	305.00				

Table 21 (Continued)

GRR-2 RESULTS
ALUMINUM CONTROL 0.98 MG/L

CHART OF INDIVIDUALS

XBAR AND 3 SIGMA LIMITS BASED ON POINTS 1- 12 OMITTING OUTLIERS

N= 12 S= 1.623 LOWER= -2.676 UPPER= 7.059
%RSD= 74. XBAR= 2.192

PT	METHOD	RESULT				
1	AA	3.00			*	
2	AA	1.25		*		
3	AA	1.30		*		
4	AA GF	0.03	*			
5	AA GF	0.28	*			
6	ICP-AES	2.02		*		
7	ICP-AES	5.00			*	
8	ICP-AES	1.22		*		
9	ES	4.50			*	
10	ES	3.00			*	
11	SSMS	3.00			*	
12	FE	1.30		*		

Table 21 (Continued)

GRR-2 RESULTS
ALUMINUM UNKNOWN (MG/L)

CHART OF INDIVIDUALS

XBAR AND 3 SIGMA LIMITS BASED ON POINTS 1- 13 OMITTING OUTLIERS

N= 13 S= 2.414 LOWER= -4.801 UPPER= 9.684
%RSD= 99. XBAR= 2.442

PT	METHOD	RESULT	
1	AA	4.00	*
2	AA	0.18	*
3	AA	1.00	*
4	AA GF	0.01	*
5	AA GF	0.81	*
6	ICP-AES	1.25	*
7	ICP-AES	6.00	*
8	ICP-AES	0.41	*
9	ES	7.00	*
10	ES	3.00	*
11	SSMS	3.00 RA	*
12	SSMS	5.00 RU	*
13	FE	0.08	*

Table 21 (Continued)

GRR-2 RESULTS
AMMONIA CONTROL 448 MG/L

CHART OF INDIVIDUALS

XBAR AND 3 SIGMA LIMITS BASED ON POINTS 1- 11 OMITTING OUTLIERS

N= 11 S= 98.245 LOWER= 114.911 UPPER= 704.280
%RSD= 24. XBAR= 409.545

PT	METHOD	RESULT					
1	DIR NES	448.00				*	
2	ICN SP	464.00				*	
3	ICN SP	135.00		*			
4	ICN SP	361.00				*	
5	ICN SP	436.00				*	
6	DIST-TIT	414.00				*	
7	DIST-NES	493.00				*	
8	DIST-NES	400.00				*	
9	DIST-NES	430.00				*	
10	AUTO ANA	444.00				*	
11	ICN EXC	480.00				*	

Table 21 (Continued)

GRR-2 RESULTS
AMMONIA UNKNOWN (MG/L)

CHART OF INDIVIDUALS

XBAR AND 3 SIGMA LIMITS BASED ON POINTS 1- 14 OMITTING OUTLIERS

N= 13 S= 28.335 LOWER= 269.765 UPPER= 439.773
%RSD= 8.0 XBAR= 354.769

PT	METHOD	RESULT	
1	DIR NES	341.00	*
2	ICN SP	329.00	*
3	ICN SP	370.00	*
4	ICN SP	341.00	*
5	ICN SP	139.00	*
6	ICN SP	332.00	*
7	DIST-TIT	319.00	*
8	DIST-NES	380.00	*
9	DIST-NES	331.00	*
10	DIST-NES	420.00	*
11	AUTO ANA	382.00 RU	*
12	AUTO ANA	350.00 RA	*
13	ICN EXC	371.00 RU	*
14	ICN EXC	346.00 RA	*

Table 21 (Continued)

GRR-2 RESULTS
ANTIMONY CONTROL 4.3 MG/L

CHART OF INDIVIDUALS

XBAR AND 3 SIGMA LIMITS BASED ON POINTS 1- 10 OMITTING OUTLIERS

N= 10 S= 3.902 LOWER= -7.585 UPPER= 15.825
%RSD= 95. XBAR= 4.120

PT	METHOD	RESULT	-----			
1	AA	3.50				
2	AA	5.60				
3	AA H EV	1.29				
4	ES	2.50				
5	AA GF	0.11				
6	AA GF	4.10				
7	ICP-AES	14.00				
8	ICP-AES	4.60				
9	NA	4.50				
10	SSMS	1.00				

Table 21 (Continued)

GRR-2 RESULTS
ANTIMONY UNKNOWN (MG/L)

CHART OF INDIVIDUALS

XBAR AND 3 SIGMA LIMITS BASED ON POINTS 1- 13 OMITTING OUTLIERS

N= 13 S= 3.637 LOWER= -8.606 UPPER= 13.214
%RSD= 158. XBAR= 2.304

PT	METHOD	RESULT	
1	AA	3.90	*
2	AA	5.60	*
3	AA H EV	0.14	*
4	ES	0.75	*
5	AA GF	0.09	*
6	AA GF	0.10	*
7	ICP-AES	13.00	*
8	ICP-AES	0.74	*
9	NA	0.48	*
10	NA	0.80 RA	*
11	NA	0.35 RU	*
12	SSMS	1.00	*
13	SSMS	3.00	*

Table 21 (Continued)

GRR-2 RESULTS
ARSENIC CONTROL 0.098 MG/L

CHART OF INDIVIDUALS

XBAR AND 3 SIGMA LIMITS BASED ON POINTS 1- 8 OMITTING OUTLIERS

N= 8 S= 3.078 LOWER= -7.799 UPPER= 10.669
%RSD= 214. XBAR= 1.435

PT	METHOD	RESULT					
1	AA GF	0.02			*		
2	AA GF	0.80			*		
3	H EV SP	0.30			*		
4	ICP-AES	9.00				*	
5	ICP-AES	0.23			*		
6	SSMS	1.00			*		
7	AA H EV	0.10			*		
8	AA H EV	0.03			*		

Table 21 (Continued)

GRR-2 RESULTS
ARSENIC UNKNOWN (MG/L)

CHART OF INDIVIDUALS

XBAR AND 3 SIGMA LIMITS BASED ON POINTS 1- 16 OMITTING OUTLIERS

N= 16 S= 5.789 LOWER= -9.328 UPPER= 25.406
%RSD= 72. XBAR= 8.039

PT	METHOD	RESULT	
1	AA GF	0.04	*
2	AA GF	10.40	*
3	AA GF	0.18	*
4	H EV SP	6.40	*
5	H EV SP	10.00	*
6	ICP-AES	5.50	*
7	ICP-AES	22.00	*
8	ICP-AES	11.00	*
9	ES	3.50	*
10	NA	10.50 RA	*
11	NA	4.60 RU	*
12	SSMS	7.00 RA	*
13	SSMS	7.00 RU	*
14	SSMS	17.00	*
15	AA H EV	10.50	*
16	AA H EV	2.60	*

Table 21 (Continued)

GRR-2 RESULTS
BICARBONATE UNKNOWN (MG/L)

CHART OF INDIVIDUALS

XBAR AND 3 SIGMA LIMITS BASED ON POINTS 1- 8 OMITTING OUTLIERS

N= 8 S= 1.768 LOWER= -4.678 UPPER= 5.928
%RSD= 283. XBAR= 0.625

PT	METHOD	RESULT				
1	ACID TIT	0.0			*	
2	ACID TIT	0.0			*	
3	ACID TIT	0.0			*	
4	ACID TIT	0.0			*	
5	ACID TIT	5.00				*
6	ACID TIT	0.0			*	
7	ACID TIT	0.0			*	
8	CALCULAT	0.0			*	

Table 21 (Continued)

GRR-2 RESULTS
 BARIUM CONTROL 90.0 MG/L

CHART OF INDIVIDUALS

XBAR AND 3 SIGMA LIMITS BASED ON POINTS 1- 14 OMITTING OUTLIERS

N= 13 S= 18.07 LOWER= 23.47 UPPER= 131.87
 %RSD= 23. XBAR= 77.67

PT	METHOD	RESULT							
1	AA	103.0						*	
2	AA	88.0					*		
3	AA	73.0			*				
4	AA	90.0					*		
5	AA	59.0			*				
6	AA GF	40.3		*					
7	ICP-AES	53.8		*					
8	ICP-AES	80.0				*			
9	ICP-AES	83.6				*			
10	ES	68.0			*				
11	FE	200.0							*
12	FE	92.0					*		
13	SSMS	95.0					*		
14	ABSORPT	84.0				*			

Table 21 (Continued)

GRR-2 RESULTS
 BARIUM UNKNOWN (MG/L)

CHART OF INDIVIDUALS

XBAR AND 3 SIGMA LIMITS BASED ON POINTS 1- 18 OMITTING OUTLIERS

N= 18 S= 62.58 LOWER= -68.77 UPPER= 306.72
 %RSD= 53. XBAR= 118.97

PT	METHOD	RESULT	
1	AA	130.0	*
2	AA	83.0	*
3	AA	115.0	*
4	AA	140.0	*
5	AA	97.0	*
6	AA	200.0	*
7	AA GF	29.8	*
8	ICP-AES	35.7	*
9	ICP-AES	90.0	*
10	ICP-AES	116.0	*
11	FE	275.0	*
12	FE	157.0	*
13	NA	72.0	RA *
14	NA	33.0	RU *
15	SSMS	150.0	RA *
16	SSMS	155.0	RU *
17	SSMS	87.0	*
18	ABSORPT	176.0	*

GRR-2 RESULTS
BUCON CONTROL 205 MG/L

XBAR AND 3 SIGMA LIMITS BASED ON POINTS 1- 12 OMITTING OUTLIERS

N= 11 S= 68.4 LOWER= -20.6 UPPER= 389.7
%RSD= 37. XBAR= 184.5

PT	METHOD	RESULT
1	CUR CCL	230.
2	CUR CCL	175.
3	CUR CCL	3.
4	CAR CCL	210.
5	CAR CCL	180.
6	CAR CEL	184.
7	SSMS	200.
8	ICP-AES	288.
9	ICP-AES	190.
10	ICP-AES	182.
11	ES	850.
12	ES	188.

Table 21 (Continued)

GRR-2 RESULTS
BORON UNKNOWN (MG/L)

CHART OF INDIVIDUALS

XBAR AND 3 SIGMA LIMITS BASED ON PCINTS 1- 15 OMITTING OUTLIERS

N= 15 S= 453.0 LOWER= -898.6 UPPER= 1819.3
%RSD= 98. XBAR= 460.3

PT	METHOD	RESULT					
1	CUR CCL	30E.			*		
2	CUR CCL	1300.				*	
3	CUR CCL	270.			*		
4	FE	291.			*		
5	CAR CCL	285.			*		
6	CAR CCL	300.			*		
7	CAR CCL	265.			*		
8	CAR CCL	306.			*		
9	SSMS	320. RA			*		
10	SSMS	300. RU			*		
11	ICP-AES	343.			*		
12	ICP-AES	300.			*		
13	ICP-AES	255.			*		
14	ES	1800.				*	
15	ES	258.			*		

Table 21 (Continued)

GRR-2 RESULTS
BROMIDE CONTROL 1.64 MG/L

CHART OF INDIVIDUALS

XBAR AND 3 SIGMA LIMITS BASED ON POINTS 1- 5 OMITTING OUTLIERS

N= 5 S= 353.04 LOWER= -785.95 UPPER= 1332.27
%RSD= 129. XBAR= 273.16

PT	METHOD	RESULT							
1	ICN SP	205.0				*			
2	ICN SP	300.0				*			
3	IP COLOR	860.0						*	
4	NA	0.8				*			
5	OXI-TIT	0.0				*			

Table 21 (Continued)

GRR-2 RESULTS
BROMIDE UNKNOWN (MG/L)

CHART OF INDIVIDUALS

XBAR AND 3 SIGMA LIMITS BASED ON POINTS 1- 10 OMITTING OUTLIERS

N= 10 S= 381.98 LOWER= -881.81 UPPER= 1410.09
%RSD= 145. XBAR= 264.14

PT	METHOD	RESULT							
1	API PHCT	60.0			*				
2	ICN SP	350.0			*				
3	ICN SP	830.0				*			
4	IP CGLCR	1085.0					*		
5	OXI TIT	60.8 RA			*				
6	OXI TIT	19.8 RU			*				
7	XRF	46.0			*				
8	NA	74.8			*				
9	NA	46.0 RA			*				
10	NA	69.0 RU			*				

Table 21 (Continued)

GRR-2 RESULTS
CALCIUM CONTROL 12830 MG/L

CHART OF INDIVIDUALS

XBAR AND 3 SIGMA LIMITS BASED ON POINTS 1- 19 OMITTING OUTLIERS

N= 19 S= 1571.6 LOWER= 6764.1 UPPER= 18593.8
%RSD= 16. XBAR= 12678.9

PT	METHOD	RESULT	
1	AA	13000.	*
2	AA	12100.	*
3	AA	10500.	*
4	AA	10000.	*
5	AA	11600.	*
6	AA	11800.	*
7	AA	13700.	*
8	AA	17000.	*
9	AA	14000.	*
10	NA	16800.	*
11	SSMS	13000.	*
12	ICP-AES	10800.	*
13	ICP-AES	12200.	*
14	ICP-AES	14000.	*
15	ES	9800.	*
16	ES	14200.	*
17	FE	11900.	*
18	EDTA TIT	12400.	*
19	EDTA TIT	12100.	*

Table 21 (Continued)

GRR-2 RESULTS
CALCIUM UNKNOWN (MG/L)

CHART OF INDIVIDUALS

XBAR AND 3 SIGMA LIMITS BASED ON POINTS 1- 21 OMITTING OUTLIERS

N= 21 S= 4891.3 LOWER= 8090.4 UPPER= 37438.2
 %RSD= 21. XBAR= 22764.3

PT	METHOD	RESULT	
1	AA	25000.	*
2	AA	23000.	*
3	AA	21000.	*
4	AA	20000.	*
5	AA	22250.	*
6	AA	24900.	*
7	AA	24700.	*
8	AA	34500.	*
9	AA	24000.	*
10	NA	13300.	*
11	NA	18700. RA	*
12	NA	14300. RU	*
13	SSMS	25000. RA	*
14	SSMS	24000. RU	*
15	ICP-AES	18500.	*
16	ICP-AES	24600.	*
17	ES	19000.	*
18	ES	32500.	*
19	FE	22900.	*
20	EDTA TIT	23000.	*
21	EDTA TIT	22900.	*

ICP-AES 229,000 value not included in this chart.

Table 21 (Continued).

GRR-2 RESULTS
CESIUM CONTROL 159.6 MG/L

CHART OF INDIVIDUALS

XBAR AND 3 SIGMA LIMITS BASED ON POINTS 1- 14 OMITTING OUTLIERS

N= 14 S= 67.83 LOWER= -54.43 UPPER= 352.52
%RSD= 46. XBAR= 149.04

PT.	METHOD	RESULT	
1	AA	250.0	*
2	AA	165.0	*
3	AA	158.0	*
4	AA	200.0	*
5	AA	140.0	*
6	FE	104.0	*
7	FE	14.6	*
8	FE	160.0	*
9	FE	163.0	*
10	NA	138.0	*
11	NA	155.0	*
12	SSMS	15.0	*
13	ES	220.0	*
14	AA GF	204.0	*

Table 21 (Continued)

GRR-2 RESULTS
CESIUM UNKNOWN (MG/L)

CHART OF INDIVIDUALS

XBAR AND 3 SIGMA LIMITS BASED ON POINTS 1- 18 OMITTING OUTLIERS

N= 15 S= 4.30 LOWER= -3.50 UPPER= 22.31
 %RSD= 46. XBAR= 9.40

PT	METHOD	RESULT							
1	AA	15.2						*	
2	AA	13.5						*	
3	AA	36.0							*
4	AA	10.6					*		
5	AA	13.0						*	
6	FE	58.0							*
7	FE	11.3					*		
8	FE	10.0					*		
9	FE	12.0						*	
10	FE	14.0						*	
11	NA	11.2					*		
12	NA	10.0	PA				*		
13	NA	6.2	RU			*			
14	SSMS	2.0	PA		*				
15	SSMS	2.0	RU		*				
16	SSMS	5.0			*				
17	ES	190.0							*
18	AA GF	5.0			*				

Table 21 (Continued)

GRR-2 RESULTS
CHLORIDE UNKNOWN (MG/L)

CHART OF INDIVIDUALS

XBAR AND 3 SIGMA LIMITS BASED ON POINTS 1- 15 OMITTING OUTLIERS

N= 15 S= 5107.3

LOWER=115031.5

UPPER=145675.1

%RSD= 4.

XBAR=130353.3

PT	METHOD	RESULT	
1	AG TIT	131200.	*
2	AG TIT	130500.	*
3	AG TIT	125300.	*
4	AG TIT	122700.	*
5	AG TIT	127000.	*
6	AG TIT	130600.	*
7	HG TIT	132000.	*
8	HG TIT	122100.	*
9	HG TIT	130000.*	*
10	HG TIT	130000.	*
11	HG TIT	140000.	*
12	XRF	133000.	*
13	GRAVI	128900.	*
14	ICN SP	140000.	*
15	ICN EXC	132000.	*

* Average of AgNO_3 and $\text{Hg}(\text{NO}_3)_2$ titr. values.

Table 21 (Continued)

GRR-2 RESULTS
COPPER CONTROL 1.88 MG/L

CHART OF INDIVIDUALS

XBAR AND 3 SIGMA LIMITS BASED ON POINTS 1- 16 OMITTING OUTLIERS

N= 16 S= 0.695 LOWER= -0.120 UPPER= 4.051
%RSD= 35. XBAR= 1.966

PT	METHOD	RESULT							
1	AA	1.40			*				
2	AA	2.13				*			
3	AA	2.10				*			
4	AA	3.00					*		
5	AA	2.00				*			
6	AA	1.70			*				
7	AA	2.10				*			
8	AA	2.30					*		
9	AA	2.60					*		
10	SSMS	0.50	*						
11	ICP-AES	1.85			*				
12	ICP-AES	2.20				*			
13	ICP-AES	2.21				*			
14	AA GF	1.74			*				
15	ES	0.62	*						
16	ES	3.00					*		

Table 21 (Continued)
GRR-2 RESULTS
COPPER UNKNOWN (MG/L)

CHART OF INDIVIDUALS

XBAR AND 3 SIGMA LIMITS BASED ON POINTS 1- 18 OMITTING OUTLIERS

N= 18 S= 0.439 LOWER= -0.230 UPPER= 2.406
%RSD= 40. XBAR= 1.088

Table 21 (Continued)

GRR-2 RESULTS
FLUORIDE CONTROL 12.3 MG/L

CHART OF INDIVIDUALS

XBAR AND 3 SIGMA LIMITS BASED ON POINTS 1- 8 OMITTING OUTLIERS

N= 8 S= 33.955 LOWER= -84.724 UPPER= 119.244
%RSD= 157. XBAR= 17.260

PT	METHOD	RESULT	-----			
1	ICN SP	11.20			*	
2	ICN SP	101.00				
3	ICN SP	0.10			*	
4	ICN SP	3.50			*	
5	ICN SP	5.88			*	
6	VIS DIST	8.00			*	
7	AMA DIST	3.90			*	
8	SPECTRO	4.50			*	

Table 21 (Continued)

GRR-2 RESULTS
FLUORIDE UNKNOWN (MG/L)

CHART OF INDIVIDUALS

XBAR AND 3 SIGMA LIMITS BASED ON POINTS 1- 12 OMITTING OUTLIERS

N= 12 S= 12.203 LOWER= -28.753 UPPER= 44.462
 %RSD= 155. XBAR= 7.854

PT	METHOD	RESULT							
1	ICN SP	3.90				*			
2	ICN SP	43.00						*	
3	ICN SP	1.50				*			
4	ICN SP	1.20				*			
5	ICN SP	1.20				*			
6	ICN SP	9.77						*	
7	ICN SP	1.18				*			
8	ION SP	1.10				*			
9	VIS DIST	14.70						*	
10	AMA DIST	1.30				*			
11	ICN EXC	13.80						*	
12	SPECTRO	1.60				*			

25 as F value excluded.

Table 21 (Continued)

GRR-2 RESULTS
 IODIDE CONTROL 3.27 MG/L

CHART OF INDIVIDUALS

XBAR AND 3 SIGMA LIMITS BASED ON POINTS 1- 7 OMITTING OUTLIERS

N= 7 S= 3.829 LOWER= -6.930 UPPER= 16.045
 %RSD= 34. XBAR= 4.557

PT	METHOD	RESULT					
1	OXI TIT	11.40				*	
2	OXI TIT	4.20				*	
3	ICN SP	2.60				*	
4	ICN SP	6.00				*	
5	ICN SP	0.50				*	
6	AS COLOR	6.50				*	
7	API PHCT	0.70				*	

Table 21 (Continued)

GRR-2 RESULTS
ICDIDE UNKNOWN (MG/L)

CHART OF INDIVIDUALS

XBAR AND 3 SIGMA LIMITS BASED ON POINTS 1- 10 OMITTING OUTLIERS

N= 10 S= 7.537 LOWER= -13.872 UPPER= 31.350
%RSD= 36. XBAR= 8.739

PT	METHOD	RESULT							
1	LC COLCR	1.94			*				
2	OXI TIT	5.60			*				
3	OXI TIT	8.70			*				
4	ICN SP	25.20					*		
5	ICN SP	12.00					*		
6	ICN SP	9.00			*				
7	ICN SP	0.11		*					
8	AS COLCR	14.20					*		
9	API PHET	10.00			*				
10	AS COLCR	0.44		*					

0.4 as I excluded.

GRR-2 RESULTS
IRON CONTROL 104 MG/L

XBAR AND 3 SIGMA LIMITS BASED ON POINTS 1- 19 OMITTING OUTLIERS

PT	METHOD	RESULT
1	AA	89.
2	AA	112.
3	AA	135.
4	AA	111.
5	AA	180.
6	AA	95.
7	AA	108.
8	AA	104.
9	AA	113.
10	AA EXT	126.
11	SSMS	140.
12	ICP-AES	91.
13	ICP-AES	106.
14	ICP-AES	158.
15	ES	92.
16	ES	130.
17	NA	106.
18	FE	114.
19	COLOR.	111.

Table 21 (Continued)

GRR-2 RESULTS
IRON UNKNOWN (MG/L)

CHART OF INDIVIDUALS

XBAR AND 3 SIGMA LIMITS BASED ON POINTS 1- 24 OMITTING OUTLIERS

N= 22 S= 45.6 LOWER= 127.0 UPPER= 400.4
%RSD= 17. XBAR= 263.7

GRR-2 RESULTS
LEAD CONTROL 22.7 MG/L

XBAR AND 3 SIGMA LIMITS BASED ON PGINTS 1- 16 OMITTING OUTLIERS

PT	METHOD	RESULT
1	AA	22.60
2	AA	18.00
3	AA	25.00
4	AA	35.00
5	AA	110.00
6	AA	22.00
7	AA	22.00
8	AA	23.00
9	AA	22.00
10	AA	24.00
11	AA GF	4.00
12	SSMS	10.00
13	ES	19.00
14	ICP-AES	15.60
15	ICP-AES	25.00
16	ICP-AES	24.00

Table 21 (Continued)

GRR-2 RESULTS
LEAD UNKNOWN (MG/L)

CHART OF INDIVIDUALS

XBAR AND 3 SIGMA LIMITS BASED ON POINTS 1- 18 OMITTING OUTLIERS

N= 18 S= 19.005 LOWER= -14.619 UPPER= 99.408
XRSD= 45. XBAR= 42.394

PT	METHOD	RESULT	
1	AA	50.60	*
2	AA	48.00	*
3	AA	52.00	*
4	AA	55.00	*
5	AA	45.00	*
6	AA	44.00	*
7	AA	46.00	*
8	AA	47.00	*
9	AA	47.00	*
10	AA	53.00	*
11	AA GF	18.00	*
12	SSMS	25.00	RA *
13	SSMS	20.00	RU *
14	SSMS	6.00	*
15	ES	91.00	*
16	ICP-AES	20.60	*
17	ICP-AES	47.00	*
18	ICP-AES	47.90	*

Table 21 (Continued)

GRR-2 RESULTS
LITHIUM CONTROL 98.2 MG/L

CHART OF INDIVIDUALS

XBAR AND 3 SIGMA LIMITS BASED ON POINTS 1- 17 OMITTING OUTLIERS

N= 17 S= 29.1 LOWER= 8.4 UPPER= 183.2
%RSD= 30. XBAR= 95.8

PT	METHOD	RESULT							
1	AA	95.				*			
2	AA	93.				*			
3	AA	106.					*		
4	AA	92.				*			
5	AA	94.				*			
6	AA	95.				*			
7	AA	93.				*			
8	AA	100.					*		
9	FE	95.				*			
10	FE	83.				*			
11	FE	90.				*			
12	FE	80.				*			
13	FE	96.				*			
14	SSMS	180.					*		
15	ES	23.			*				
16	ES	120.					*		
17	ICN EXC	94.				*			

Table 21 (Continued)

GRR-2 RESULTS
LITHIUM UNKNOWN (MG/L)

CHART OF INDIVIDUALS

XBAR AND 3 SIGMA LIMITS BASED ON POINTS 1- 19 OMITTING OUTLIERS

N= 16 S= 18.7 LOWER= 109.3 UPPER= 221.2
%RSD= 11. XBAR= 165.3

PT	METHOD	RESULT	
1	AA	170.	*
2	AA	154.	*
3	AA	195.	*
4	AA	146.	*
5	AA	154.	*
6	AA	161.	*
7	AA	133.	*
8	AA	190.	*
9	FE	200.	*
10	FE	150.	*
11	FE	162.	*
12	FE	144.	*
13	FE	161.	*
14	SSMS	470. RA	*
15	SSMS	400. RU	*
16	ES	41. *	
17	ES	180.	*
18	IGN EXC	167. RU	*
19	IGN EXC	167. RA	*

Table 21 (Continued)

GRR-2 RESULTS
MAGNESIUM CONTROL 114.7 MG/L

CHART OF INDIVIDUALS

XBAR AND 3 SIGMA LIMITS BASED ON POINTS 1- 19 OMITTING OUTLIERS

N= 18 S= 19.8 LOWER= 48.5 UPPER= 167.1
%RSD= 18. XBAR= 107.8

PT	METHOD	RESULT					
1	AA	108.			*		
2	AA	112.			*		
3	AA	145.				*	
4	AA	120.			*		
5	AA	123.			*		
6	AA	110.			*		
7	AA	100.		*			
8	AA	100.		*			
9	AA	110.			*		
10	AA	110.			*		
11	AA	115.			*		
12	AA	110.			*		
13	SSMS	110.			*		
14	ICP-AES	67.		*			
15	ICP-AES	110.			*		
16	ICP-AES	199.				*	
17	ES	55.		*			
18	ES	120.			*		
19	EDTA TIT	115.			*		

Table 21 (Continued)

GRR-2 RESULTS
MAGNESIUM UNKNOWN (MG/L)

CHART OF INDIVIDUALS

XBAR AND 3 SIGMA LIMITS BASED ON POINTS 1- 20 OMITTING OUTLIERS

N= 19 S= 20.0 LOWER= 89.9 UPPER= 209.7
%RSD= 13. XBAR= 149.8

PT	METHOD	RESULT	
1	AA	143.	*
2	AA	147.	*
3	AA	185.	*
4	AA	160.	*
5	AA	148.	*
6	AA	144.	*
7	AA	134.	*
8	AA	113.	*
9	AA	142.	*
10	AA	145.	*
11	AA	155.	*
12	AA	150.	*
13	SSMS	130. RA	*
14	SSMS	150. RU	*
15	ICP-AES	58.	*
16	ICP-AES	120.	*
17	ICP-AES	199.	*
18	ES	160.	*
19	ES	160.	*
20	EDTA TIT	161.	*

知 照 各 商 號 均 有 關 涉 茲 將 各 商 號 所 領 執 照 分 列 如 左 以 便 查 核 其 有 未 領 執 照 而 在 本 埠 經 營 者 亦 應 於 本 月 內 向 本 局 領 取 執 照 以 便 查 核 其 有 未 領 執 照 而 在 本 埠 經 營 者 亦 應 於 本 月 內 向 本 局 領 取 執 照 以 便 查 核

Table 21 (Continued)

GRR-2 RESULTS
MANGANESE CONTROL 336 MG/L

CHART OF INDIVIDUALS

XBAR AND 3 SIGMA LIMITS BASED ON POINTS 1- 15 OMITTING OUTLIERS

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N=      15  S=      65.0      LOWER=      151.0      UPPER=      540.7
      %RSD=      19.          XBAR=      345.9

```

PT	METHOD	RESULT
1	AA	312.
2	AA	354.
3	AA	350.
4	AA	342.
5	AA	330.
6	AA	333.
7	AA	275.
8	AA	330.
9	AA	305.
10	AA	322.
11	SSMS	450.
12	ICP-AES	309.
13	ICP-AES	536.
14	ES	310.
15	ES	330.

Table 21 (Continued)

GRR-2 RESULTS
MANGANESE UNKNOWN (MG/L)

CHART OF INDIVIDUALS

XBAR AND 3 SIGMA LIMITS BASED ON POINTS 1- 16 OMITTING OUTLIERS

N= 16 S= 95.8 LOWER= 399.5 UPPER= 974.5
 %RSD= 14. XBAR= 687.0

PT	METHOD	RESULT	
1	AA	660.	*
2	AA	646.	*
3	AA	690.	*
4	AA	710.	*
5	AA	640.	*
6	AA	665.	*
7	AA	585.	*
8	AA	720.	*
9	AA	660.	*
10	AA	643.	*
11	SSMS	850. RA	*
12	SSMS	700. RU	*
13	ICP-AES	550.	*
14	ICP-AES	953.	*
15	ES	650.	*
16	ES	670.	*

GRR-2 RESULTS
MERCURY CONTROL 1.06 MG/L

XBAR AND 3 SIGMA LIMITS BASED ON POINTS 1- 7 OMITTING OUTLIERS

UPPER= 1.93569

XBAR= 1.06571

PT	METHOD	RESULT
1	CV AA	0.86000
2	CV AA	1.50000
3	CV AA	1.04000
4	CV AA	1.06000
5	CV AA	1.30000
6	CV AA	1.10000
7	NA	0.60000

Table 21 (Continued)

GRR-2 RESULTS
MERCURY UNKNOWN (MG/L)

CHART OF INDIVIDUALS

XBAR AND 3 SIGMA LIMITS BASED ON POINTS 1- 7 OMITTING OUTLIERS

N= 7 S= 0.01407

LOWER=-0.03605

UPPER= 0.04836

%RSD= 229.

XBAR= 0.00615

PT	METHOD	RESULT							
1	CV AA	0.00050			*				
2	CV AA	0.00030			*				
3	CV AA	0.03800				*			
4	CV AA	0.00009	RU		*				
5	CV AA	0.00018	RA		*				
6	CV AA	0.00200			*				
7	CV AA	0.00200			*				

Table 21 (Continued)

GRR-2 RESULTS
PHOSPHATE CONTROL 0.46 MG/L

CHART OF INDIVIDUALS

XBAR AND 3 SIGMA LIMITS BASED ON POINTS 1- 9 OMITTING OUTLIERS

N= 9 S= 0.379 LOWER= -0.602 UPPER= 1.671
%RSD= 71. XBAR= 0.534

PT	METHOD	RESULT						
1	SN COLCR	0.34			*			
2	SN COLCR	0.28			*			
3	SN COLCR	1.16				*		
4	ASC COLO	0.20		*				
5	ASC COLO	0.72			*			
6	ASC COLO	0.46		*				
7	SN COLOR	1.10				*		
8	SN CO CI	0.43		*				
9	MPA MET	0.12	*					

Table 21 (Continued)

GRR-2 RESULTS
PHOSPHATE UNKNOWN (MG/L)

CHART OF INDIVIDUALS

XBAR AND 3 SIGMA LIMITS BASED ON POINTS 1- 8 OMITTING OUTLIERS

N= 8 S= 2.532 LOWER= -5.712 UPPER= 9.479
%RSD= 134. XBAR= 1.884

PT	METHOD	RESULT					
1	SN COLCR	0.04			*		
2	SN COLOR	6.57				*	
3	ASC COLO	2.50				*	
4	ASC COLO	0.13 RU			*		
5	ASC COLO	4.23 RA				*	
6	ASC COLO	0.25			*		
7	SN COLCR	0.53			*		
8	MPA MET	0.42			*		

0.2 as P excluded.

Table 21 (Continued)

GRR-2 RESULTS
POTASSIUM CONTROL 6910 MG/L

CHART OF INDIVIDUALS

XBAR AND 3 SIGMA LIMITS BASED ON POINTS 1- 19 OMITTING OUTLIERS

N= 18 S= 1167.8 LOWER= 2740.6 UPPER= 9747.2
%RSD= 19. XBAR= 6243.9

PT	METHOD	RESULT							
1	AA	6900.							
2	AA	6750.							
3	AA	3000.							
4	AA	6650.							
5	AA	6920.							
6	AA	6700.							
7	AA	7200.							
8	FE	6200.							
9	FE	5000.							
10	FE	6620.							
11	FE	6450.							
12	FE	25000.							
13	FE	7000.							
14	FE	5150.							
15	ICP-AES	6400.							
16	ES	4200.							
17	ES	6600.							
18	ICN EXC	7150.							
19	NA	7500.							

Table 21 (Continued)

GRR-2 RESULTS
 POTASSIUM UNKNOWN (MG/L)

CHART OF INDIVIDUALS

XBAR AND 3 SIGMA LIMITS BASED ON POINTS 1- 21 OMITTING OUTLIERS

N= 21 S= 12235.9 LOWER=-23124.5 UPPER= 50290.7
 %RSD= 90. XBAR= 13583.1

PT	METHOD	RESULT							
1	AA	10500.			*				
2	AA	10000.			*				
3	AA	6850.			*				
4	AA	10270.			*				
5	AA	12300.			*				
6	AA	10200.			*				
7	AA	11000.			*				
8	FE	11300.			*				
9	FE	8000.			*				
10	FE	10000.			*				
11	FE	10800.			*				
12	FE	50000. RA						*	
13	FE	50000. RU						*	
14	FE	10400.			*				
15	FE	10300.			*				
16	ICP-AES	8500.			*				
17	ES	4200.			*				
18	ES	9100.			*				
19	IGN EXC	11300. RU			*				
20	IGN EXC	11200. RA			*				
21	NA	9025. RU			*				

Table 21 (Continued)

GRR-2. RESULTS
RUBIDIUM CONTROL 39.3 MG/L

CHART OF INDIVIDUALS

XBAR AND 3 SIGMA LIMITS BASED ON POINTS 1- 13 OMITTING OUTLIERS

N= 13 S= 11.7 LOWER= 2.9 UPPER= 73.2
%RSD= 31. XBAR= 38.1

PT	METHOD	RESULT
1	AA	38.
2	AA	30.
3	AA	39.
4	AA	41.
5	AA	48.
6	FE	50.
7	FE	36.
8	FE	45.
9	FE	41.
10	NA	44.
11	SSMS	40.
12	ES	40.
13	AA GF	3.

Table 21 (Continued)

GRR-2 RESULTS
RUBIDIUM UNKNOWN (MG/L)

CHART OF INDIVIDUALS

XBAR AND 3 SIGMA LIMITS BASED ON POINTS 1- 18 OMITTING OUTLIERS

N= 18 S= 21.6 LOWER= 0.2 UPPER= 130.0
 %RSD= 33. XBAR= 65.1

PT	METHOD	RESULT	
1	AA	58.	*
2	AA	50.	*
3	AA	67.	*
4	AA	113.	*
5	AA	76.	*
6	FE	76.	*
7	FE	62.	*
8	FE	73.	*
9	FE	71.	*
10	FE	67.	*
11	NA	60.	*
12	NA	65. RA	*
13	NA	47. RU	*
14	SSMS	80. RA	*
15	SSMS	90. RU	*
16	SSMS	56.	*
17	ES	57.	*
18	AA CF	4.	*

GRR-2 RESULTS
SILICA CONTROL 44.9 MG/L

XBAR AND 3 SIGMA LIMITS BASED ON POINTS 1- 18 OMITTING OUTLIERS

PT	METHOD	RESULT
1	AA	43.2
2	AA	49.2
3	AA	583.0
4	AA	42.8
5	AA	36.2
6	AA	37.5
7	AA	41.0
8	AA	27.8
9	HB COLOR	401.0
10	HB COLOR	30.0
11	MS COLOR	31.0
12	MS COLOR	37.9
13	MS COLOR	36.8
14	MS COLOR	38.0
15	MS COLOR	45.0
16	FE	25.7
17	SSMS	42.8
18	GRAVI	17.0

Table 21 (Continued)

GRR-2 RESULTS
SILICA UNKNOWN (MG/L)

CHART OF INDIVIDUALS

XBAR AND 3 SIGMA LIMITS BASED ON POINTS 1- 22 OMITTING OUTLIERS

N= 22 S= 82.0 LOWER= 111.9 UPPER= 603.7
%RSD= 23. XBAR= 357.8

PT	METHOD	RESULT							
1	AA	475.						*	
2	AA	438.						*	
3	AA	375.					*		
4	AA	407.]					*		
5	AA	405.]					*		
6	AA	297.			*				
7	AA	370.					*		
8	AA	400.					*		
9	AA	407.					*		
10	HB COLOR	279.			*				
11	HB COLOR	244.		*					
12	MS COLOR	355.					*		
13	MS COLOR	268.		*					
14	MS COLOR	355.					*		
15	MS COLOR	400.					*		
16	MS COLOR	320. Field			*				
17	MS COLOR	500. Lab						*	
18	FE	428.						*	
19	ICP-AES	407.					*		
20	SSMS	321. RA			*				
21	SSMS	251. RU		*					
22	GRAVI	166.		*					

Table 21 (Continued)

GR-2 RESULTS
SILVER CONTROL 0.13 MG/L

CHART OF INDIVIDUALS

XBAR AND 3 SIGMA LIMITS BASED ON POINTS 1- 11 OMITTING OUTLIERS

N= 11 S= 0.469 LOWER= -0.955 UPPER= 1.860
%RSD= 104. XBAR= 0.453

PT	METHOD	RESULT	-----			
1	AA	0.53			*	
2	AA	1.60				*
3	AA	0.75			*	
4	AA	0.10		*		
5	AA	0.10		*		
6	AA	0.52			*	
7	AA GF	0.06		*		
8	AA GF	0.20		*		
9	AA GF	0.13		*		
10	ICP-AES	0.17		*		
11	ICP-AES	0.82			*	

Table 21 (Continued)

GRR-2 RESULTS
SILVER UNKNOWN (MG/L)

CHART OF INDIVIDUALS

XBAR AND 3 SIGMA LIMITS BASED ON POINTS 1- 10 OMITTING OUTLIERS

N= 10 S= 0.753 LOWER= -1.729 UPPER= 2.789
 %RSD= 142. XBAR= 0.530

PT	METHOD	RESULT							
1	AA	2.50							
2	AA	0.80							
3	AA	0.03							
4	AA	0.16							
5	AA	0.70							
6	AA GF	0.02							
7	AA GF	0.25							
8	AA GF	0.07							
9	ICP-AES	0.12							
10	ICP-AES	0.65							

Table 21 (Continued)

GRR-2 RESULTS
SODIUM CONTROL 17700 MG/L

CHART OF INDIVIDUALS

XBAR AND 3 SIGMA LIMITS BASED ON POINTS 1- 19 OMITTING OUTLIERS

N= 18 S= 1565.1 LOWER= 12760.1 UPPER= 22151.0
%RSD= 9. XBAR= 17455.5

PT	METHOD	RESULT	
1	AA	17500.	*
2	AA	15500.	*
3	AA	19000.	*
4	AA	16300.	*
5	AA	17600.	*
6	AA	18000.	*
7	AA	18000.	*
8	AA	13000.	*
9	FE	18600.	*
10	FE	19200.	*
11	FE	16500.	*
12	FE	18200.	*
13	FE	17200.	*
14	NA	16500.	*
15	SSMS	18000.	*
16	ICP-AES	17400.	*
17	ES	20000.	*
18	ES	9000.	*
19	ICN EXC	17700.	*

Table 21 (Continued)

GRR-2 RESULTS
SODIUM UNKNOWN (MG/L)

CHART OF INDIVIDUALS

XBAR AND 3 SIGMA LIMITS BASED ON POINTS 1- 24 OMITTING OUTLIERS

N= 21 S= 4470.1

LOWER= 33873.9

UPPER= 60694.2

%RSD= 9.

XBAR= 47284.0

PT	METHOD	RESULT	
1	AA	45600.	*
2	AA	37000.	*
3	AA	48500.	*
4	AA	43240.	*
5	AA	46700.	*
6	AA	57000.	*
7	AA	48125.	*
8	AA	56000.	*
9	FE	48300.	*
10	FE	50500.	*
11	FE	48500.	*
12	FE	49000.	*
13	FE	3000.	*
14	FE	48600.	*
15	NA	44400.	*
16	NA	48900. RA	*
17	NA	40000. RU	*
18	SSMS	45000. RA	*
19	SSMS	45000. RU	*
20	ICP-AES	17400.	*
21	ES	45000.	*
22	ES	25000.	*
23	ICN EXC	48900. RU	*
24	ICN EXC	48700. RA	*

Table 21 (Continued)

GRR-2 RESULTS
STRONTIUM CONTROL 147 MG/L

CHART OF INDIVIDUALS

XBAR AND 3 SIGMA LIMITS BASED ON POINTS 1- 16 OMITTING OUTLIERS

N= 16 S= 50.2 LOWER= -5.5 UPPER= 296.0
 %RSD= 35. XBAR= 145.3

PT	METHOD	RESULT
1	AA	215.
2	AA	160.
3	AA	150.
4	AA	180.
5	AA	160.
6	FE	84.
7	FE	150.
8	FE	140.
9	FE	125.
10	FE	190.
11	ICP-AES	145.
12	ICP-AES	109.
13	ICP-AES	172.
14	SSMS	230.
15	ES	43.
16	AA GF	71.

Table 21 (Continued)

GRR-2 RESULTS
STRONTIUM UNKNOWN (MG/L)

CHART OF INDIVIDUALS

XBAR AND 3 SIGMA LIMITS BASED ON POINTS 1- 19 OMITTING OUTLIERS

N= 19 S= 134.1 LOWER= -46.6 UPPER= 757.9
%RSD= 38. XBAR= 355.7

PT	METHOD	RESULT	
1	AA	520.	*
2	AA	430.	*
3	AA	355.	*
4	AA	403.	*
5	AA	390.	*
6	FE	430.	*
7	FE	410.	*
8	FE	420.	*
9	FE	365.	*
10	FE	490.	*
11	ICP-AES	301.	*
12	ICP-AES	145. RA	*
13	ICP-AES	180. RU	*
14	ICP-AES	416.	*
15	SSMS	530. RA	*
16	SSMS	460. RU	*
17	ES	130.	*
18	NA	311.	*
19	AA GF	71.	*

Table 21 (Continued)

GRR-2 RESULTS
SULFATE CONTROL 0.0 MG/L

CHART OF INDIVIDUALS

XBAR AND 3 SIGMA LIMITS BASED ON POINTS 1- 7 OMITTING OUTLIERS

N= 7 S= 31.431 LOWER= -78.007 UPPER= 110.579
%RSD= 193. XBAR= 16.286

PT	METHOD	RESULT	-----			
1	TURBIMET	10.00			*	
2	TURBIMET	1.00			*	
3	TURBIMET	7.00			*	
4	TURBIMET	1.00			*	
5	GRAVI	0.0			*	
6	GRAVI	8.00			*	
7	FE	87.00				

Table 21 (Continued)

GRR-2 RESULTS
SULFATE UNKNOWN (MG/L)

CHART OF INDIVIDUALS

XBAR AND 3 SIGMA LIMITS BASED ON POINTS 1- 12 OMITTING OUTLIERS

N= 12 S= 53.571

LOWER= -94.230

UPPER= 227.196

%RSD= 81.

XBAR= 66.483

PT	METHOD	RESULT	-----			
1	GRAVI	153.00				
2	GRAVI	80.00				
3	GRAVI	171.00				
4	GRAVI	41.00				
5	TURBIMET	24.00				
6	TURBIMET	76.00				
7	TURBIMET	21.50				
8	TURBIMET	18.00				
9	TURBIMET	39.90				
10	TURBIMET	24.00				
11	FE	116.00				
12	ION EXC	33.40				

117 (SOL) excluded.

Table 21 (Continued)

GRR-2 RESULTS
SULFIDE UNKNOWN (MG/L)

CHART OF INDIVIDUALS

XBAR AND 3 SIGMA LIMITS BASED ON POINTS 1- 5 OMITTING OUTLIERS

N= 5 S= 14.302 LOWER= -35.410 UPPER= 50.402
%RSD= 191. XBAR= 7.496

PT	METHOD	RESULT				
1	IODO TIT	0.0			*	
2	IODO TIT	2.48			*	
3	IODO TIT	0.0			*	
4	MB COLOR	2.00			*	
5	SSMS	33.00				

Table 21 (Continued)

GRR-2 RESULTS
ZINC CONTROL 90 MG/L

CHART OF INDIVIDUALS

XBAR AND 3 SIGMA LIMITS BASED ON POINTS 1- 17 OMITTING OUTLIERS

N= 17 S= 34.8 LOWER= -15.8 UPPER= 193.3
%RSD= 39. XBAR= 88.7

PT	METHOD	RESULT	
1	AA	43.	*
2	AA	102.	*
3	AA	124.	*
4	AA	71.	*
5	AA	33.	*
6	AA	65.	*
7	AA	132.	*
8	AA	120.	*
9	AA	100.	*
10	AA	85.	*
11	AA EXT	107.	*
12	SSMS	150.	*
13	ICP-AES	46.	*
14	ICP-AES	78.	*
15	ICP-AES	118.	*
16	AA CF	43.	*
17	NA	90.	*

GRR-2 RESULTS
ZINC UNKNOWN (MG/L)

XBAR AND 3 SIGMA LIMITS EASED ON POINTS 1- 21 OMITTING OUTLIERS

PT	METHOD	RESULT							
1	AA	205.				*			
2	AA	270.					*		
3	AA	258.						*	
4	AA	230.				*			
5	AA	240.					*		
6	AA	98.			*				
7	AA	246.					*		
8	AA	270.						*	
9	AA	215.				*			
10	AA	232.					*		
11	AA EXT	213.				*			
12	SSMS	250. RA					*		
13	SSMS	500. RU							*
14	SSMS	28.			*				
15	ICP-AES	82.			*				
16	ICP-AES	230.				*			
17	ICP-AES	290.						*	
18	AA GF	205.				*			
19	NA	221.					*		
20	NA	212. RA				*			
21	NA	131. RU			*				

Table 21 (Continued)
 GRR-2 RESULTS
 TOTAL DISSOLVED SOLIDS UNKNOWN (MG/L)

CHART OF INDIVIDUALS

XBAR AND 3 SIGMA LIMITS BASED ON POINTS 1- 10 OMITTING OUTLIERS

N= 10 S= 18076.7

LOWER=180997.9

UPPER=289458.0

%RSD= 8.

XBAR=235228.0

PT	METHOD	RESULT				
1	GRAVI	223300.		*		
2	GRAVI	216200.	*			
3	GRAVI	265000.			*	
4	GRAVI	226000.		*		
5	GRAVI	220700.		*		
6	GRAVI	245000.			*	
7	GRAVI	213700.	*			
8	GRAVI	258380.			*	
9	GRAVI	247800.			*	
10	GRAVI	236200.		*		

Table 21 (Continued)

GRR-2 RESULTS
H2S(ENTRAINED) CONTROL 2.0 MG/L

CHART OF INDIVIDUALS

XBAR AND 3 SIGMA LIMITS BASED ON POINTS 1- 10 OMITTING OUTLIERS

N= 10 S= 1.238 LOWER= -1.545 UPPER= 5.881
%RSD= 57. XBAR= 2.163

PT	METHOD	RESULT				
1	ICDC TIT	3.20				
2	IODC TIT	2.20				
3	IODC TIT	0.68				
4	IODC TIT	3.60				
5	IODC TIT	1.06				
6	IODC TIT	2.60				
7	ICDC TIT	4.10				
8	ICDC TIT	0.44				
9	IODC TIT	2.20				
10	MB COLCR	1.60				

Table 21 (Continued)

GRR-2 RESULTS
H2S(ENTRAINED) UNKNOWN (MG/L)

CHART OF INDIVIDUALS

XBAR AND 3 SIGMA LIMITS BASED ON POINTS 1- 4 OMITTING OUTLIERS

N= 4 S= 0.880 LOWER= -1.705 UPPER= 3.575
%RSD= 94. XBAR= 0.935

PT	METHOD	RESULT	-----					
1	IODO TIT	0.64			*			
2	IODO TIT	0.0			*			
3	IODO TIT	2.10					*	
4	MB COLOR	1.00			*			

Table 21 (Continued)

GRR-2 RESULTS
CO2(ENTRAINED) CENTROL 595 MG/L

CHART OF INDIVIDUALS

XBAR AND 3 SIGMA LIMITS BASED ON POINTS 1- 9 OMITTING OUTLIERS

N= 9 S= 1409.7 LOWER= -2857.9 UPPER= 5600.0
%RSD= 103. XBAR= 1371.0

PT	METHOD	RESULT							
1	ACID TIT	2618.				*			
2	ACID TIT	1289.				*			
3	ACID TIT	690.				*			
4	ACID TIT	1.				*			
5	ACID TIT	1322.				*			
6	PRE EVO	630.				*			
7	PRE EVO	1320.				*			
8	SR GRAVI	5.				*			
9	CALCULAT	4465.						*	

Table 21 (Continued)

GRR-2 RESULTS
CO2(ENTRAINED) UNKNOWN (MG/L)

CHART OF INDIVIDUALS

XBAR AND 3 SIGMA LIMITS BASED ON POINTS

1- 9 OMITTING OUTLIERS

N= 9 S= 604.8

LOWER= -1303.8

UPPER= 2325.0

%RSD= 118.

XBAR= 510.6

PT	METHOD	RESULT						
1	ACID TIT	1352.						
2	ACID TIT	176.						
3	ACID TIT	250.						
4	ACID TIT	0.						
5	ACID TIT	331.						
6	PRE EVU	40.						
7	PRE EVC	870.						
8	SR GRAVI	1.						
9	CALCULAT	1576.						

Appendix 3

Comments from Round Robin Participants

This appendix contains notes taken during the three working sessions of the round robin participants. The first session held at the Battelle Seattle Research Center on May 24-25, 1977 was the organizational session prior to the GRR-1 and GRR-2 field tests. The other sets of notes are from the two geothermal round robin discussion sessions held in San Francisco, CA on August 2-3 and September 13-14, 1977.

The purpose of including these notes is to give the user of this manual some idea of the potential problem areas as reported by the participants involved in geothermal sampling and analysis.

Notes from Geothermal Sampling and Analysis Workshop
BSRC, May 24 & 25, 1977

9:00 am session, 5/24/77

I. Introduction: Gene Woodruff

Gene made introductory comments concerning the workshop. Each participant present introduced himself, his company, and his interest in geothermal sampling and analysis. Don Shannon completed the introductions with a brief presentation of why the workshop was necessary and what goals it should accomplish.

II. Discussion of Comment Issue: Gene Woodruff

A. Gene briefly introduced and reviewed the Comment Issue (BNWL-2094).

He presented the following points concerning the manual:

1. The underlying need and philosophy which generated the manual.
2. Concentration range table of constituents and properties in geothermal brines: Gene indicated that there may be no clear correlation of concentration ranges among constituents when comparing different brines.
3. Matrix of chemical analyses vs tasks.
4. Analytical tools presently available.
5. The form of the present manual is not binding to the final version.

B. Comments concerning the Comment Issue: The comments and suggestions fell into four broad categories:

1. The different goals of environmental, engineering, legal and quality assurance may affect the document format as well as individual sampling and analysis procedures.
2. The sampling procedures must match the analytical procedures in terms of precision, quality of data, and stabilization of constituents to be analyzed. It was suggested that separate sampling and analysis documents be written and contained under the same cover in looseleaf form; sampling and analysis procedures would be cross-matched with each other. A strong

caveat should be inserted indicating that sampling influences the subsequent analysis.

3. Possible or probable interferences arising from injections of chemicals into the brine and the high ionic strength of the brines should be included.
4. General comments: increase number of literature references and designate known standard methods as such.

III. Discussion of BNW methods and sampling flow diagram:

Jim Watson. The discussion yielded these specific comments:

- A. Trace constituents which cause scale or are concentrated in scale must be analyzed accurately and precisely.
- B. The presence of the gas separation caused some concern that the pH would be affected. It was felt that in situ pH measurement at temperature and pressure was preferable to drawing a sample for pH measurement.
- C. The sample point for incoming brine on the corrosion field test apparatus should be ahead of the gas separator to obtain a more representative well sample.
- D. There were differences of opinion over the relative merits and needs of acidifying filtered and/or unfiltered samples for acid stabilized samples.
- E. The pH of acid stabilized samples should be 1 to 2. Questions concerning the relative merits of HCl and HNO₃ stabilization were discussed:
 1. Does HNO₃ change the redox potential and/or oxidation states of species present in solution?
 2. Do HCl and HNO₃ oxidize ammonia to nitrosyl chloride?
- F. Other acid stabilization comments were:
 1. HNO₃ stabilization does not allow as much container wall adsorption as HCl stabilization.
 2. Some metal chlorides are volatile.
 3. HNO₃ is purer than HCl.
 4. HNO₃ exhibits more antibacteriological action against NH₃ consuming bacteria.
 5. The consensus was that AgCl precipitation was not a concern.
 6. The natural high chloride content of most geothermal samples may act as a natural preservative.

- G. Virgin grade high density plastic (e.g., Nalgene) containers washed in HNO_3 was presented as a better alternative to pyrex. Bottle caps often contain heavy metal contamination. Sampling in glass vs sampling in plastic was a suggested area for round robin testing.
- H. Species consuming bacteria may be a possible problem: SO_4^{2-} consuming bacteria may survive hot brine temperatures as well as be introduced from sampling apparatus.
- I. Reservoir fluctuations three to four weeks after well-flow startup may cause variations in the analysis of CO_2 and H_2S .
- J. Cd, Zn, and Pb stabilizations of H_2S were discussed: CdS and PbS are more insoluble than ZnS, but ZnS precipitation kinetics are faster. Yellow CdS precipitation is more easily seen than ZnS, but CdS must be stabilized to photodecomposition with "Stractan."
- K. Silica stabilization was discussed: Union Oil uses a 10:1 dilution, acidification to a pH of 1.5 and addition of ammonium heptamolybdate concurrently to maintain the monomeric SiO_2 form. Analysis is by AA.
- L. Ion selective electrodes: it was generally felt that high ionic strengths affected most electrodes including the ammonia electrode. The sulfide electrode was not liked except as an endpoint indicator.
- IV. Jim Watson presented the AA vs ICP-AES analysis of several geothermal brines. Several questions were asked regarding the utility of spark source mass spectrometry and stable isotope analyses.
- V. Presentation of questionnaire: Gene Woodruff. A questionnaire asking information regarding desire to participate in round robin testing, analytical capabilities and funding needs was given to the participants to be completed and returned the morning session of 5/25/77 or through the mail.
- VI. Adjournment for lunch.

1:15 pm session, 5/24/77

- I. Inductively Coupled Plasma - Atomic Emission Spectroscopy Presentation by Royce Winge of Ames Laboratories.
 - A. A ratio of wavelength intensities can indicate spectral line interferences due to the matrix.

- B. Stray light increases background signals. Some corrections are:
 - 1. Holographically ruled gratings
 - 2. Interference filter at entrance slit
 - 3. Baffles in secondary optics
 - C. A possible chemical interference was suggested: Na ionization suppresses the Be signal; Be is determined using an ionization line.
 - D. The best analytical lines used in the instrument will vary with the matrix.
 - E. A minimum of 30 Å spacing is required between analytical lines due to the physical size of exit slits and photomultiplier tubes.
 - F. Phosphorus by ICP-AES has good detection limits, but the Zn line only 2 Å away usually has higher priority.
- II. Sampling and analysis capabilities of TRW: Presentation by Warren Hamersma of TRW.
- A. TRW is not directly involved in geothermal sampling and analysis, but is funded by ERDA and EPA to develop sampling and analysis methods for energy and environmental R&D.
 - B. TRW has had experience in developing sampling methods for oil shale, coal gasification, incineration systems, gases, liquids, solids, slurries and pressurized systems; the sampling methods for each system are tailored to the analytical needs.
 - C. Sampling methods are written on three levels:
 - 1. General survey methods which are cheap, quick and generate low quality data for general survey purposes.
 - 2. Site specific survey techniques which yield better quality data than level 1.
 - 3. Techniques which yield engineering or legal compliance data: these are detailed sophisticated sampling techniques.
 Hamersma indicated that there is often controversy over the simplest level 1 sampling methods.
 - D. Examples of TRW manuals:
 - 1. Coal gasification manual which includes detailed equipment specifications and methods for sampling particulates.

2. General sampling manuals.
3. Inorganic sampling: "Technical Manual for Inorganic Sampling and Analysis" (by TRW) EPA-600/2-77-024. This manual is available from Dr. R. M. Statnick, Research Triangle, NC.
4. Organic sampling.
5. Aerosol and particulate SO_2 sampling.
- E. All methods are field tested and user information is gathered.
- F. Information gathered from sampling and analysis usage in the field is circulated among different groups to ensure accuracy and completeness of data.

III. Silica redissolution: Presentation by Chuck Grigsby of IASL: At a pH greater than 12, colloidal and/or precipitated SiO_2 will redissolve. The pH may be raised without adding sodium ion by the addition of organic amines of $\text{pK}_b > 10^{-3}$ such as triethylamine, piperidine or pyrrolidine. An example was presented of a redissolution using 0.5 N NaOH to redissolve a SiO_2 sample resulting in a 2000 mg/liter SiO_2 solution.

IV. Sampling: Gene Woodruff

- A. The BNW flowchart of sampling methods at East Mesa was presented for comment. The point was made that different sampling requirements are necessary for a 2 $\emptyset$ system as opposed to the 1 $\emptyset$ system in use at East Mesa. The sampling of flashed systems is particularly important in the case of carbonate scaling brines. An alternative CO_2 sampling method is to flash brine and collect non-condensable gases.
- B. Possible wells to sample for round robin tests:
 1. East Mesa 6-1 or 6-2 (CA).
 2. Heber (CA).
 3. Raft River (ID).
- C. Flashed System Sampling: Robert Wheatley of Union Oil
Mr. Wheatley presented the scheme for flashed system sampling shown in figure 1. Otto Vetter added the information shown in figure 2. It was also pointed out that stable gaseous hydrated forms of NaCl and SiO_2 may be present in gas phase streams.

FIGURE 1A: UNION OIL METHOD OF SAMPLING 2" FLOW SYSTEMS

FIGURE 1B: CROSS SECTIONAL VIEW OF PIPE WITH TWO TYPES OF SAMPLING POSSIBILITIES FOR 2" SYSTEMS

FIGURE 2: DUE TO THE FLOW OF BOTH GASEOUS AND AEROSOL CONSTITUENTS IN THE NON-CONDENSABLE GASES, THE ORIENTATION OF THE SAMPLING HORN WILL AFFECT THE COLLECTION OF SAMPLE. POSITION 2 WILL COLLECT GAS AND SOMEWHAT FEWER PARTICULATES THAN POSITION 1, BUT WILL COLLECT MORE PARTICULATES THAN POSITION 3

D. Taking a large common sample vs taking individual samples for distribution and analysis.

1. Individual liquid brine samples should be taken for each lab; splitting up one large collected sample introduces non-uniformity in the distribution of particulates and precipitated species in the individual sub-samples.

For the round robin, we will use carboys and stir them while splitting. Sampling individually in a sequential manner would introduce a brine variation with time and we feel the carboy source for the total sample is the best compromise.

2. Gases collected for round robin testing in a large gas bag may be subdivided into smaller sample bags through a gas manifold, then shipped to individual laboratories for analysis.

E. One general comment made was that different sampling methods may be required for different flow rates.

V. Problems of Gas Analysis

A. GC vs mass spec

1. Different labs have different systems, some have GC, but not mass spec capabilities and vice versa.
2. Mass spec yields more data with less interpretation than GC.
3. GC needs several columns for a complete gas analysis.

B. H₂S stabilization and/or analysis

1. The "equilizer" is an electrolytic cell which oxidizes the H₂S in solution; the amount of electricity required for the oxidation of H₂S is proportional to the H₂S concentration. Cost of the commercial device is ~ \$2500.
2. H₂S stabilizing solutions and analysis
 - a. Stabilize as CdS or ZnS and titrate iodometrically.
 - b. Collect under NH₄OH and titrate with Ag⁺ using the Ag/AgS electrode for endpoint detection.
3. It was generally agreed that H₂S could not be done reliably by GC.

- VI. Anion Analysis was discussed briefly:
- A. Intermediate pressure (~ 400 psi) anion exchange chromatography with conductivity detection was mentioned as one high speed method of multi-constituent anion analysis. Commercial instrumentation costs $\sim \$15K$.
 - B. SO_4^{2-} needs a reliable method with low detection limits; $BaSO_4$ solubility increases with increasing NaCl concentration.
- VII. Record keeping was obvious to all present to be a vital portion of geothermal sampling and analysis. Data logging should include:
- A. T, P, and flow rates at well head and sample points.
 - B. Well history.
 - C. Sampling method: Condensing coil used? What is coil made of? Sample taken by quenching flashed brine under known weight of H_2O ?
 - D. Exhaustive documentation of the techniques used to analyze sample in laboratory.
 - E. Quality assurance program.
- VIII. The round robin test program methodology should include the following items:
- A. Documentation of sampling and analyses.
 - B. A quality assurance program.
 - C. Documented standards sent with samples.
 - D. A statistical method of data reduction and analysis of variance.
- IX. The round robin test program scope should include:
- A. Initial sampling of 2-3 wells simultaneously done by BNW.
 - B. Allow each lab to follow its own analytical procedures.
 - C. Analyze a documented synthetic brine concurrently with actual brines.

5/25/77, 9:00 am session

- I. Discussion of Contract Issuance: Gene Woodruff
- A. Battelle will attempt to work up a bid package with the BNW contract people for ERDA funding dispersal.
 - B. Exact amount of funding to each lab dependent upon:
 - 1. Number of participating labs.
 - 2. Final scope of work.

- C. Scope of work covered by contract will (hopefully) include one complete round robin test on two brines by September 7, 1977.
- D. Potential participants will have until approximately June 24, 1977, to make final decision to participate in round robin test or not.
- E. A detailed scope of work is needed for participating labs.

II. General Work Requirements

A. Battelle Northwest will be required to:

- 1. Collect samples: RU, FU, FA, S^{2-} (under $Zn(OAc)_2$), CO_2 (under NaOH) and SiO_2 (10:1 field dilution), where R = raw (unfiltered) brine, F = filtered (through 0.45 μm filter), U = unacidified, A = acidified (with HCl).
- 2. Include synthetic controls for FA, S^{2-} , CO_2 , SiO_2 .

B. Participating labs will need to:

- 1. Submit a schedule for completing the analyses.
- 2. Attend 1-2 meetings.
- 3. Write reports.

III. Discussion followed concerning contract negotiations; major points were:

- A. Contracting may need to be redone at the beginning of FY 78.
- B. FY 77 and FY 78 contracts might be negotiated simultaneously.
- C. FY 77 contract may need only small changes to produce a FY 78 contract.
- D. It would be cheaper to do as much sampling and analysis simultaneously under the FY 77 contract if time and logistics permit, rather than send a second series of samples out at the beginning of FY 78.
- E. The second series of samples could not be sent out with the first set due to logistics, but the contract negotiations for FY 78 could certainly begin.

III. Scheduling

A. Time table:

June	July	August	September	FY 78 October
negotiate contract 1st week: financial requirement estimates from labs by phone	analyze 1st set BNW collects and distributes first samples with controls	analyze 2nd set 1st week: meet to discuss 1st test results; distribute set 2 samples	write report Mid-Sept: meet to discuss 2nd test results	Issue report

B. Remain flexible

1. Include travel funding in contract estimates.
2. Include more than one method for a given determination where possible.

IV. Other possible participants

A. USGS

B. Bureau of Mines

V. Adjournment

Geothermal Round Robin Discussion Session I

August 2-3, 1977

San Francisco

Participants in the Geothermal Round Robin met to discuss sampling methods and analytical results and procedures. Several laboratories had not yet completed analysis of the GRR-1 brine at that time, mainly due to late arrival of sample bottles. For the second sampling, non-local participants will receive shipment via UPS-Blue Label or Greyhound to minimize this delay.

While Battelle is currently employing standard, approved analytical methods, it was agreed that both approved routine methods and currently unapproved methods should be tried for later comparison. Participants should include, along with their numerical results, a detailed description of the sample handling, analytical procedure, and quality control methods. Information on the unsuitability or difficulty of particular methods for geothermal brines should also be noted. These items will be incorporated into the interim manual to be written during the last half of September.

Sampling for GRR-2

The wellsite for the second round robin will contain a more complicated brine of a much higher salt content than the previous brine. Sampling is to be from Magmamax #1 (roughly 20% solids). Hence, sampling is likely to be more difficult and more care will have to be taken to provide a raw sample that is homogeneous, due to the likelihood of precipitation in the brine. The possibility of using a chelate or other complexing agent to keep solids in solution was discarded, as such an agent might cause unknown difficulties and errors in the analyses, for which there was insufficient time to investigate. A raw acidified solution, similar to the previous filtered-acidified sample was selected as appropriate for trace element analysis. Sufficient acid in the collecting carboy will be present to prevent precipitation of silica and sulfides. In addition, a raw unacidified sample will be obtained by collecting each sample

bottle individually and titrating for chloride ion between samples to determine the constancy of the brine chemistry throughout the raw sampling. In addition to anion analysis from this sample, the possibility exists for alternative sample treatment, such as filtration of the raw brine and sequential analysis of both aqueous and solid portions.

Samples for entrained CO_2 and H_2S , and for SiO_2 (diluted) will be similar to those provided in GRR-1.

The following schedule is set for the remaining round robin activities of this year:

August 10-11	Collect brine for GRR-2
	Written results from GRR-1 should be received by BNW at this time
August 15	Begin analysis of GRR-2 brine
September 10	Written results in for GRR-2
September 13-15	GRR-2 conference
End of September	Interim manual written at BNW
Early October	Issue report of Round Robin results

Notes on GRR-2 samples

August 12, 1977

- 1) The brine was taken from Woolsey well #1, (approx. 16% solids), similar in complexity to that of Magmamax #1.
- 2) Chloride titration results:

Five samples were taken for titration throughout the raw-unfiltered sampling process. They were titrated against 3 M AgNO_3 , using a chromate indicating solution. The chloride content of these titration results were all within 0.6% of the average value. They were high, (2.6%), however, relative to the chloride content determined just previous to sampling. This difference is believed to be caused by error in determination of the endpoint due to slow endpoint reaction at such high chloride concentrations.
- 3) One liter of raw acid control was again provided for this round robin, and was mailed separately from the other samples. Some additional control solution is available if needed.
- 4) The brine was collected on August 11 (Thursday) and mailed via UPS (El Centro, CA) the following morning. All boxes should be received by the 19th.

Meeting Notes from the Third Geothermal Round Robin Workshop Session:
San Francisco, September 13 and 14, 1977.

Tuesday, 9/13/77, 9:00 am session

- I. Introductory Remarks: Gene Woodruff
- II. GRR-1 Results: Jim Watson
 - A. A histogram of GRR-1 results was presented and some scatter of results were noted on key constituents:
 - 1. Ca and K suffered from poor interlaboratory precision: Atomic absorption and emission seemed to be the methods of choice.
 - 2. SO_4 also suffered from poor precision; a variety of analytical methods was used.
 - B. The H_2S results seemed to be in good agreement; the iodine titration was the method of choice.
 - C. Entrained CO_2 results were badly scattered; a variety of methods were used.
 - D. There were two reports on naturally occurring radioactive isotopes.
 - E. A summary of the methods used on each parameter was presented.
 - F. It was noted that some in-house comparison of results was done.
- III. GRR-2 Sampling: Gene Woodruff
 - A. The original well chosen for GRR-2, Magmamax #1 was dead; attempts to restart the well with ditchwater were in progress, but not successful in time for sampling.
 - B. The alternate sampling point was ^{the first stage flash unit of} the Niland test loop ~~at~~ fed by Woolsey #1 well.
 - C. Notes on sampling:
 - 1. Temperature of samples when drawn was about 81°C .
 - 2. Precipitation in a test sample was visible 20 minutes after drawing sample.
 - 3. Raw, unacidified samples were drawn individually with a silver nitrate (Mohr) titration of chloride performed every third sample as a check on brine uniformity; no significant variation in chloride noted.

4. The commercial test kits for silica (Hach) and dissolved O_2 (Chemetrics) faired poorly on this brine; results (such as they were) were: SiO_2 -320 mg/l and O_2 -40 ppb.

IV. Individual Laboratory Reports

A. John Baldwin: Allied Chemical Corporation.

John used a less common technique for anions and certain cations: ion exchange chromatography.

1. A commercial ion exchange chromatograph costs about \$12K on up, and is usually equipped with a spectrophotometric or conductivity detector; the conductivity detector can suffer from eluant background conductivity.
2. John produced a schematic of the system:

3. Cations (Li^+ , Na^+ , K^+ , and NH_4^+) were separated on a surface sulfonated styrene divinylbenzene resin using HCl as the eluant

(AgNO_3 eluant may be used for better cation separation).

The suppressor column is a strong base (OH^-) exchanger column and functions to remove the HCl eluant background so that it does not register on the conductivity bridge detector; the species of interest are in essentially deionized water when they reach the conductivity detector. Rb and Cs could not be determined due to interfering peaks.

4. Anions (F^- , Cl^- , Br^- , NO_3^- , SO_4^{2-}) were separated on an anion exchange resin adsorbed onto a support. Typically OH^- is used as the eluant; alternatively phenate ion, CO_3^{2-} and HCO_3^- may be used. PO_4^{3-} and I^- in the brines could not be determined because the dilutions required to drop the Cl^- concentration to acceptable levels also dropped PO_4^{3-} and I^- concentrations below the detection limits of the chromatograph.
5. Several unidentified peaks were noted on the chromatograph; these seem to be constituents in the brines rather than column artifacts or channeling effects.
6. For the anions and cations investigated, ion chromatography seems readily applicable to geothermal brines.

B. Dave Hemphill: EPA-Las Vegas

1. Dave used an Applied Research Laboratory inductively coupled plasma-atomic emission spectrophotometer for cation analysis; he was interested in possible interferences associated with this method.
2. Direct aspiration of brines caused nebulizer clogging, even when ARL's nebulizer backflushing mechanism was employed.
3. Dave suggested that a background acid blank be included in future round robin tests.

C. Ken Chen: University of Southern California

1. Ken attempted to have his group completely analyze the geothermal brines as quickly as possible; analysis time was approximately 200 man-hours.

2. Some problems were noted when analyzing Cs and Ba by graphite furnace atomic absorption. Ken indicated he attempted to use background correction when possible.

D. Larry Kraft: TRW

1. Larry stored his brine samples at 4°C until he could open them in the TRW clean room.
2. Standard methods were used where possible.
3. Various atomic absorption atomization procedures were used including hydride generation, graphite furnace and cold vapor evolution (Hg); these were supplemented with background correction and standard additions where possible.
4. A distillation of ammonia was made before analysis.
5. Boron was extracted from the aqueous matrix and analyzed with curcumin.

E. Mary McKown: Gulf South Research Institute.

Mary was ill, hence Gene Woodruff presented the handouts of her data.

F. Rich Walters: U.S. Bureau of Mines

Analysis of metal constituents in the GRR-2 brine by AA showed the major constituents to be within naturally occurring concentration ranges. The minor constituents in GRR-2 had higher than expected concentrations in relationship to the major constituents.

V. Manual Format: Jim Watson

A. The manual page forms were handed out with the following information requested:

1. Include simplified general outline of the method used on a given parameter.
2. Method references.
3. Interferences and problems noted in analysis.

B. The spaces designated "Precision" and "Accuracy" sparked some debate on these topics. It was generally agreed that better controls were needed to establish better accuracy and bias data.

VI. Adjournment for lunch.

Tuesday, 9/13/77, 1:00 pm session

VII. Continuation of Individual Presentations

A. Steve Wade: GHT Laboratories

1. Atomic absorption was used for metal determinations:

- a. Al was determined after extraction with 8-hydroxyquinoline.
- b. Ba, Sb, and Mn by graphite furnace suffered from salt interferences.
- c. An in-house comparison of three AA determinations for Fe yielded the following results:

direct AA	212 mg/l Fe
standard additions AA	251 mg/l Fe
extraction	354 mg/l Fe

Similar results obtained for Mn.

- d. Na was determined both by AA and AE.

2. Observations were made on following anions:

- a. Br^- was determined indirectly by the hypochlorite-iodine titration method and also by the phenol red method; the phenol red procedure suffered from severe matrix interferences.
- b. PO_4^{3-} was determined by ascorbic acid and stannous chloride methods.
- c. F^- was determined after distillation using alizarin and Amadac F procedures. There was a significant difference between the results of the two methods.
- d. SO_4^{2-} was determined after attempting to precipitate silica out of solution on a hotplate.

3. Observations of general brine properties:

- a. pH, conductivity and alkalinity need to be determined in the field.
- b. Turbidity changed with time.

B. Jerry Riehl: Physical Dynamics

1. Jerry used mainly neutron activation analysis (NAA): Samples were irradiated in the University of Washington nuclear

reactor and counted at four times after irradiation:

- a. Immediately (using a rabbit).
 - b. Short term count (2.5 hours after activation).
 - c. Intermediate count (2 weeks after activation).
 - d. Long term count (4 weeks after activation).
2. Some results from GRR-1 and GRR-2:
- a. Na: High sodium content in the samples caused problems due to the high background signal it produced before it decayed to acceptable levels.

<u>Sample</u>	<u>mg/l Na by NAA</u>
GRR-1 control FA	1498 mg/l
GRR-1 sample FA	1462
GRR-2 control RA	1.62×10^4
GRR-2 sample RA (multichannel)	4.4×10^4
GRR-2 sample RA (single channel)	3.9×10^4

- b. Bromide was easily analyzed by NAA with a 3 - 5% RSD:

GRR-1 sample FA	5.41 mg/l Br
GRR-2 sample RA	76.43 mg/l Br

- c. Arsenic was detected at 0.06 mg/l in GRR-1, and a substantial amount was detected in GRR-2 brine.
- d. Several trace elements were detected, but not quantifiable in GRR-2 brine:

U	Trace
Co	<0.05 mg/l
W	<0.02 mg/l
Zn	<0.06 mg/l

C. Art Soinski: LFE

1. Alkaline and alkaline earth metals were determined by flame atomic absorption. Results from direct comparison of sample

to standards were confirmed using standard additions. Extractions were attempted on trace metals.

2. Phosphate was attempted by ascorbic acid; a brown precipitate formed during digestion.
3. Silica was attempted by siliconmolybdate and heteropoly blue methods; sulfide interfered during digestion.
4. Bromide was attempted by the phenol red method and did not work.

D. Carson Nealy: Atomics International. Carson's main comment was that the analysis of Na "needs work".

E. Ron Lukasiewicz: Union Oil Research

1. Ron used a flame emission spectrometer incorporating a Jarrell-Ash 0.5 m monochromator and a vibrating quartz window for background correction. Some metals in both GRR-1 and GRR-2 were analyzed using flame atomic emission, others by flame atomic absorption:

<u>FAE</u>	<u>FAA</u>
Al	Cu
Ba	Pb
Ca	Mg
Cs	Mn
Fe	Ag
Li	Zn
K	Si
Rb	
Na	
Sr	
B (249.7 nm atomic line)	

2. Flameless atomic absorption may be alright for relatively dilute samples, but may not work as well on more complex geothermal brines.

3. Liquid - liquid extractions for trace metals suffered from emulsions.
 4. Ron was planning on using HPLC to separate the heavy metal transition elements using a chelex resin column.
- F. Wayne Subcasky: Chevron Oil Field Research: Standard analytical methods were used for the most part to analyze the metal cations and common anions.
- G. Mike Thompson: U.S. Geological Survey
1. The GRR-1 samples and controls were introduced into the analytical laboratory as routine samples and analyzed as such. The GRR-2 samples and controls were analyzed separately from routine samples.
 2. Some observations were made on flame atomization techniques:
 - a. Potassium by FAA and FAE gave quite different results.
 - b. Lithium (in contrast to potassium) gave very similar results when analyzed by FAA and FAE.
 - c. Lead did not give the same results when analyzed neat (undiluted) and diluted.
 3. Sulfate analysis by BaCl_2 - thorin titration was attempted after running sample through cation exchange resin mainly to remove calcium. An alternative clean-up technique would be to run sample through an ammonium exchanger on an aluminum support.
 4. Silica was analyzed by the molybdate method.
- H. Otto Vetter: Vetter Associates
1. Otto asked two questions regarding atomic spectrophotometric techniques in an effort to ensure we were all speaking the same language:
 - a. What is meant by "standard additions"?
 - b. What is meant by "percent recovery"?
 2. Discussion resulted which yielded the following:

Standard additions may be used to help determine analyte concentrations when chemical interferences other than ionization retard or accelerate the rate of formation of

analyte atoms in the sample as compared to the standards. Consequently, standard additions may be of little value when analyzing the alkaline and alkaline earth metals, but may help the analysis of transition metals. Ultimately, standard additions may be more confusing than helpful.

3. If matrix effects are such a hindrance and the reliability of standard additions is questionable, are chemical separations the answer?

a. This question sparked discussion in which the following fundamental questions arose:

1. If a particular specie or parameter is difficult to analyze, is there really reason to quantify the problem specie?
2. How accurate and precise an answer is really required when coupled with costs of analysis and sampling accuracy and precision?

b. Ron Lukasiewicz of Union suggested their approach when it was necessary to analyze difficult species: Dilute the sample until the behavior of the analyte signal is consistent with standards; if this fails, then separate the analyte from the matrix and reanalyze.

4. Charge balance (of at least major species in sample) should be included in analysis of brines.

I. Bill Lyon: Oak Ridge National Laboratory

1. Comments on Neutron Activation Analysis:

- a. Results and observations on Na and Br agree with Jerry Riehl's observations.
- b. Will attempt to rid sample of Na by exchange on an arsenic oxide column.
- c. NAA is an excellent analytical tool for these brines if the answers aren't required for 3 - 4 weeks.

2. Spark Source Mass Spectrometry determination of cations compared favorably with NAA results.
 3. X-ray Fluorescence did not work very well on liquid samples; will attempt to dry samples before next analysis.
- J. Carson Nealy asked time for a brief rebuttal to some of Otto's ideas:
1. It may not always be necessary to have absolutely accurate and precise data when analyzing a brine; the data should not be "prejudged" at this point concerning their usefulness solely on accuracy and precision; even relative values are useful.
 2. Cautions should be attached to accuracy and precision information in methods manual; the accuracy/precision data is limited by the sampling methods used to generate the samples and subsequent analyses.
- K. Jim Douglas: Battelle Northwest
1. Samples for GRR-1 were analyzed by conventional flame atomic absorption and standard analytical wet techniques.
 2. The question was raised whether or not silver is lost from solution due to photochemical degradation and subsequent plating onto container walls; there seemed to be no consensus that this is a problem.
 3. The question was also asked if Ba and SO_4 in solution could be stabilized by field dilution (similar to SiO_2); apparently the K_{sp} of BaSO_4 is small enough that dilution will not necessarily stabilize the sample.
- L. Royce Winge: Ames Laboratory: Royce's discourse covered some of the practice and problems when the brine samples were analyzed by inductively coupled argon plasma emission spectroscopy:
1. Ultrasonic nebulization of undiluted GRR-1 brine worked well, but GRR-2 brine samples required a 10:1 dilution before using the ultrasonic nebulizer.

2. Background interference was no problem on GRR-1, but GRR-2 suffered from some high background. Background correction and analysis was effected as follows:
 - a. Scan through wavelength regions (by moving entrance slit in light path) of analytical lines for 1) blank, 2) sample, and 3) spiked samples.
 - b. Use computer program to subtract out background, match peak baselines of sample and spiked samples, and compute concentrations of species of interest.

VIII. Adjourn until Wednesday, 9/14/77, 8:30 am session.

Wednesday, 9/14/77, 8:30 am session

IX. Manual Format

- A. Organization will probably be alphabetical by parameter.
- B. Some discussion centered upon how best to represent the "cost of an analysis":
 1. Specify an approximate dollar amount for each element.
 2. Specify the approximate man-hours and operator proficiency required for an analysis. (This was favored over the estimated dollar amount.)
- C. Proposed manual outline:
 - I. Introduction
 - A. Objectives
 - B. Sampling-Analysis Relationship
 - C. Limitations
 - II. Matrix of Geothermal Analytical Tasks
 - III. Sampling in Geothermal Operations
 - A. Matrix of Sample Points
 - B. Problems
 - C. Methods
 - D. Sample Treatment
 - IV. Analytical Methods
 - A. Introduction - Round Robin Based
 - B. Parameter Lists
 - V. Survey of Constituents (GRR Results?)

- D. Much discussion followed concerning whether or not future trends and theoretical ideas should be included in the manual. It was generally agreed that unproven concepts should not be included with existing techniques. A separate section labeled "problems and theoretical solutions" might be included which would contain conceptual-stage sampling and analysis methods.
- X. Proposed Work Scope for FY 78:
 - A. Two or three phase sampling, including gas sampling. Liquid sampling is not necessarily deemphasized.
 - B. Sampling ideology:
 - 1. Analytical methods (especially for gases) may be tested by a single sampling method.
 - 2. More than one sampling method is needed to check various sampling techniques.
 - 3. Sampling and analytical program should be entitled "method evaluation" rather than "method development" to protect proprietary interests.
 - 4. Sampling apparatus must be portable.
 - 5. Two phase sampling requires an efficient separator.
 - C. Who can participate?
 - 1. Chevron and Union need to check with their gas sampling and analysis groups.
 - 2. Possible ^{new} participants may be:
 - a. Republic
 - b. Geothermal kinetics
 - c. Magma
 - d. ^{Phillips}
 - D. Where might we sample?
 - 1. ~~USGS~~
 - 2. Roosevelt
 - 3. Geysers
 - 4. Cerro Prieto (Mexico) appears to be a good neutral meeting ground and the wells are flowing.

E. It was pointed out that the well supplier where samples will be taken must be involved in the early stages of the program so that arrangements may be made to evaluate such nonportable equipment as moveable stream probes.

F. Work outline:

1. Interested groups meet together to plan details of task.
2. Plan to do single and two phase flow surface sampling.
3. May want to sample a single source several different ways and at several sampling points.

XI. Adjournment.

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