DOE/NV/10872--T267

ANALYTICAL LABORATORY and MOBILE SAMPLING PLATFORM

FINAL REPORT

April 30, 1996

DOE Cooperative Agreement
No. DE-FC 08-90NV10872

Klaus Stetzenbach
Amy Smiecinski

Harry Reid Center For Environmental Studies
University of Nevada - Las Vegas

This is the final report for the Analytical Laboratory and Mobile Sampling Platform project. This report contains only major findings and conclusions resulting from this project. Detailed reports of all activities performed for this project were provided to the Project Office every quarter since the beginning of the project.

This report contains water chemistry data for samples collected in the Nevada section of Death Valley National Park (Triangle Area Springs), Nevada Test Site springs, Pahranagat Valley springs, Nevada Test Site wells, Spring Mountain springs and Crater Flat and Amargosa Valley wells.

Groundwater samples were collected and analyzed using the following quality assurance plans and standard operating procedures (SOPs). Work was recorded in scientific notebooks. Reported data has been verified and validated using HRC procedures.

Sample Verification Project Groundwater Monitoring Task QA Project Plan, GWMONQA.pln, Rev. 0, 3/1/93.

Sample Verification Project QA Project Plan, samverqa.pln, Rev. 0, 8/5/92.

Sampling Protocol Inorganics, Sampino1.sop, Rev. 1, 5/17/95.

Sampling Protocol Inorganics, Sampinor.sop, Rev. 0, 11/5/93.

Analytical Balance Use, BALANCE2.SOP, Rev. 1, 4/8/95.

Analytical Balance Use, BALANCE.SOP, Rev. 0, 9/8/94.

Flame Atomic Absorption Spectrometry, FlameAA2.sop, Rev. 2, 5/17/95.

Flame Atomic Absorption Spectrometry, FlameAA.sop, Rev. 1, 10/13/93.

Flame Atomic Absorption Spectrometry, FlameAA.sop, Rev. 0, 3/1/93.

Mercury Cold Vapor Technique with Gold Amalgam Preconcentration, Mercury2.sop, Rev. 2, 5/17/95.

Mercury Cold Vapor Technique with Gold Amalgam Preconcentration, Mercury.sop, Rev. 1, 10/13/93.

Mercury Cold Vapor Technique with Gold Amalgam Preconcentration, Mercury.sop, Rev. 0, 3/1/93.

Graphite Furnace Atomic Absorption Spectrometry, GRAFAAS2.sop, Rev. 2, 5/17/95.

Graphite Furnace Atomic Absorption Spectrometry, GRAFAAS.sop, Rev. 1, 10/13/93.

Graphite Furnace Atomic Absorption Spectrometry, GRAFAAS.sop, Rev. 0, 3/1/93.

Ion Chromatography System, IonChrom.sop, Rev. 1, 2/10/94.

Ion Chromatography System, IonChrom.sop, Rev. 0, 3/1/93.

Ultro-Pure Reverse Osmosis water system, Rosmosis.sop, Rev. 0, 4/8/93.

Nanopure water system, Nanopure.sop, Rev. 0, 4/9/93.

Inductively Coupled Plasma-Atomic Emission Spectrometry, ICP-AES.sop, Rev. 0, 3/1/93.

Inductively Coupled Plasma - Mass Spectrometry, ICP-MS.sop, Rev. 1, 12/20/93.

Inductively Coupled Plasma - Mass Spectrometry, ICP-MS.sop, Rev. 0, 3/1/93.

pH Meters, pHMeter.sop, Rev. 1, 9/18/95.

pH Meters, pHMeter.sop, Rev. 0, 3/1/93.

Scientific Notebooks, Notebok2.sop, Rev. 2, 4/21/95.

Scientific Notebooks, Notebook.sop, Rev. 1, 3/31/93.

Lanthanide Concentration Procedure, LACONC.SOP, Rev. 0, 12/27/93.

Europium Concentration Procedure, EUCONC.SOP, Rev. 0, 12/27/93.

HRC has participated in the U.S. Geological Survey inorganic round-robin water sample laboratory performance programs twice per year since the Fall of 1992. The round-robin water samples that HRC chooses to be evaluated against consist of trace metals, major cations, nutrients, precipation, and occasionally mercury. Laboratories are scored against one another, the scores for all of the samples for each lab are combined into an overall weighted laboratory ratings for entire sample set. A perfect score is 4. HRC's OWRs are as follows:

Fall 92: 2.7
Spring 93: 2.9
Fall 93: 3.1
Spring 94: 3.1
Spring 94 (one-time only volatile organics program): 2.9
Fall 94: 3.2
Spring 95: 2.9
Fall 95: 3.3

HRC has participated in the U.S. Environmental Protection Agency's Water Pollution (WP) laboratory performance programs twice per year since the Fall of 1992. Participation in this program has consisted of measurements HRC normally performs in the field, such as pH, conductivity, alkalinity, etc., nutrients, anions, and major cations. WP samples were analyzed and reported using the SOPs listed previously. HRC's performance scores (in terms of percent correct measurements) are as follows:

Fall 92, WP029: 94%
Spring 93, WP030: 93%
Fall 93, WP031: 92%

Spring 94, WP032: 96%
Fall 94, WP033: 96%
Spring 95, WP034: 100%
Fall 95, WP035: scores not received (5/96)

In order to be certified by the State of Nevada as a laboratory that is qualified to analyze water samples under the Safe Drinking Water Act, HRC has participated in the U.S. Environmental Protection Agency's Water Supply (WS) laboratory performance program, twice per year since the Fall of 1992. WS samples were analyzed and reported using the SOPs listed previously in addition to the following:

Analysis of SDWA Samples, SDWA.sop, Rev. 0, 5/17/95.

Volatile Organic Compounds in SDWA Samples, VOC1.SOP, Rev. 0, 5/17/95.

Participation in this program has consisted of measurement of water samples containing trace metals, major cations, nutrients, anions, trihalomethanes (THMs) and volatile organic compounds (VOCs). HRC's performance scores are as follows:

Fall 92, WS031:	Trace metals - 68%
	Nutrients - 100%
	THMs - 20%
	VOCs - 42%
Spring 93, WS032:	Trace metals - 94%
	Nutrients - 100%
	THMs - 0%
	VOCs - 67%
Fall 93, WS033:	Trace metals - 80%
	Nutrients - 75%
	THMs - 75%
	VOCs - 65%
Spring 94, WS034:	Trace metals - 87%
	Nutrients - 100%
	THMs - 100%
	VOCs - 93%
Fall 94, WS035:	Trace metals - 88%
	Nutrients - 100%
	THMs - 100%
	VOCs - 92%
Spring 95, WS036:	Trace metals - 94%
	Nutrients - 100%
	THMs - 100%
	VOCs - 65%

Internal assessments performed at HRC include scientific notebook reviews, data verifications, and instrument systems audits. No assessments were performed by the U.S.DOE, however the YM QA branch of the U.S.GS audited HRC. That audit was completed with U.S.GS recommendation for HRC to be placed on the QSL. The State of Nevada audited HRC for certification under its SDWA analytical laboratories program in May 1995. The findings of that audit are unknown since HRC has not received the audit report.

Springs and Wells sampled for the Sample Verification Study

NV SECTION OF DEATH VALLEY NATIONAL PARK
(Triangle Area Springs)
Upper Briar/Pipe
Lower Briar
Woodcamp

NEVADA TEST SITE SPRINGS
Topopah
Cane
Tippipah

PAHRANAGAT VALLEY, NV
Hiko
Crystal
Ash
Rogers
Muddy

NEVADA TEST SITE WELLS
Army MV-1
J-12
J-13

SPRING MOUNTAINS, NV
Ash Spring
Cold Creek
Deer Creek
Grapevine Spring
Willow Creek
Willow Spring

CRATER FLAT AND AMARGOSA VALLEY, NV
(Environmental Field Activity Plan Springs and Wells)
Windmill Well-Coffer Ranch
Ranch Spring-Coffer Ranch
CF-1a-Coffer Well
formerly Gexa 3
or USNG
Cinderlite
Lathrop Wells
NDOT Rest Stop
Saga Exploratory Well
(VH-2), (CF-2a)
Jackass Aero Park
formerly Rigler Airport

NEVADA SECTION OF DEATH VALLEY NATIONAL PARK
(Triangle Area Springs)

TRIANGLE AREA - Field Measurements

SITE	Collection Date	pH	Temperature Celsius	Conductivity (uS/cm)	Alkalinity ppm	TDS (mg/L)	Altitude (ft)	Latitude	Longitude
Briar Spring Bottom	3/93	7.29	13.9	346	106	173	6105	36 56.45	117 04.57
	7/93	7.89	20.6	256		130	6091	36 56.46	117 04.57
Briar Spring Pipe	3/93	7.37	16	263	86	131			
	7/93	6.72		237		123	6474	36 56.43	117 04.53
	4/94	6.72	14.2	225	75.6	119	6391	36 56.42	117 04.05
		6.71	13.9	231	76.8	113			
					78.8	120			
Woodcamp Spring	3/93	7.19	19.4	357	84	178	5170	36 58.15	116 59.66
	3/93	7.26	19	333	82	166	4738	36 58.11	116 59.66
	7/93	6.01	20	320		167	4775	36 58.15	116 59.66
	4/94	6.04	19.6	316	100.4	163			
	4/94	6.06	19.5	318	94	163			
	4/94	6.06	19.4	319	94.4	163			

Triangle Area - Briar Spring Bottom

		Sample #1 March 1993 Mean S.D.	Sample #2 July 1993 Mean S.D.	Sample #3 April 1994 Mean S.D. No sample collected.	Detection Limit
ANIONS					
Alkalinity	PPM	106	NM		10
Bromide	PPM	0.088	0.070		0.03
		0.008	0.004		
Chloride	PPM	14.0	10.9		0.08
		0.1	0.4		
Fluoride	PPM	0.232	0.16		0.03
		0.007	0.02		
Nitrate	PPM	2.35	0.070		0.02
		0.03	0.001		
Sulfate	PPM	17.79	11.50		0.03
		0.05	0.06		
MAJOR METALS					
Ca	PPM	27.6	21.6		0.06
		0.5	0.3		
Mg	PPM	4.6	3.42		0.3
		0.2	0.06		
K	PPM	10.6	10.9		0.05
		0.2	0.3		
Na	PPM	33.6	36.5		1.5
		0.7	0.5		
TRACE METALS					
Li 7	PPB	36	NM		0.009
		6			
Al 27	PPB	NM	NM		0.02
Ti 47	PPB	1.68	1.16		0.009
		0.05	0.08		
V 51	PPB	3.0	2.64		0.003
		0.1	0.02		
Cr 52	PPB	0.52	1.30		0.02
		0.01	0.07		

ND=Not detected NM=Not measured A=Anomalous value H=Holding exceeded R=Exceeded calibration range

Triangle Area - Briar Spring Bottom (page 2)

		Sample #1 March 1993 Mean S.D.	Sample #2 July 1993 Mean S.D.	Sample #3 April 1994 Mean S.D. No sample collected.	Detection Limit
Mn 55	PPB	1.00 0.06	3.36 0.03		0.005
Ni 60	PPB	0.53 0.06	0.24 0.01		0.01
Cu 63	PPB	NM	NM		0.07
Zn 66	PPB	NM	NM		0.01
Ge 73	PPB	0.15 0.03	0.02 0.01		0.0009
As 75	PPB	7 1	NM		0.009
Se 82	PPB	0.96 0.03	ND		0.10
Rb 85	PPB	16.0 0.9	NM		0.001
Sr 88	PPB	35 5	NM		0.40
Mo 95	PPB	1.15 0.05	0.67 0.01		0.025
Sn 117	PPB	0.16 0.02	ND		0.004
Sb 121	PPB	0.141 0.009	0.221 0.004		0.005
Cs 133	PPB	0.021 0.001	0.025 0.001		0.0005
Ba 137	PPB	6 1	NM		0.002
W 182	PPB	0.27 0.02	0.146 0.006		0.018
Tl 205	PPB	0.15 0.01	0.012 0.001		0.002
U 238	PPB	2.7 0.2	1.5 0.1		0.0002

ND=Not detected NM=Not measured A=Anomalous value H=Holding exceeded R=Exceeded calibration range

Triangle Area - Briar Spring Bottom (page 3)

		Sample #1 March 1993 Mean S.D.	Sample #2 July 1993 Mean S.D.	Sample #3 April 1994 Mean S.D. No sample collected.	Detection Limit
Be 9	PPT	ND	ND		20
Co 59	PPT	54 6	22 1		1
Ga 71	PPT	6 1	22 1		0.8
Zr 90	PPT	219 13	36 3		0.6
Nb 93	PPT	9 1	ND		4
Ru 99	PPT	3.4 0.7	ND		1.5
Rh 103	PPT	6.9 0.7	ND		2
Ag 107	PPT	75 8	ND		3
Cd 114	PPT	40 10	11 2		5
In 115	PPT	ND	ND		0.4
Te 125	PPT	267 33	12 5		9
Hf 178	PPT	9 2	ND		3
Ta 181	PPT	1.2 0.5	2.1 0.5		0.03
Re 185	PPT	3.7 0.6	2.1 0.3		0.12
Ir 193	PPT	ND	ND		0.6

ND=Not detected NM=Not measured A=Anomalous value H=Holding exceeded R=Exceeded calibration range

Triangle Area - Briar Spring Bottom (page 4)

		Sample #1 March 1993 Mean S.D.	Sample #2 July 1993 Mean S.D.	Sample #3 April 1994 Mean S.D.	Detection Limit
				No sample collected.	
Pt 195	PPT	3.9 1.0	ND		0.3
Au 197	PPT	10 4	ND		3
Pb 208	PPT	1170 50	42 3		8
Bi 209	PPT	3.3 0.8	ND		2

ND=Not detected NM=Not measured A=Anomalous value H=Holding exceeded R=Exceeded calibration range

Triangle Area - Briar Spring Bottom (page 5)

		Sample #1 March 1993 Mean S.D.	Sample #1 March 1993 Mean S.D.	Sample #2 July 1993 Mean S.D.	Sample #3 April 1994 Mean S.D. No sample collected.	Detection Limit		
		D	I	E		D	I	E
Y 89	PPT	192 1	35 6	52 3		1	0.2	0.2
La 139	PPT	93 1	104 4	66 4		1	0.08	0.08
Ce 140	PPT	87 1	110 4	42 4		0.8	0.06	0.06
Pr 141	PPT		22.0 0.5	6.3 0.3		0.6	0.01	0.01
Nd 146	PPT		93 2	26 1		5	0.08	0.08
Sm 147	PPT		22.3 0.7	6.2 0.5		1	0.1	0.1
Eu 153	PPT		NM	NM		0.6	0.06	0.06
Gd 157	PPT		27.9 0.3	6.9 0.2		3	0.1	0.1
Tb 159	PPT		4.1 0.2	0.93 0.08		0.7	0.01	0.01
Dy 163	PPT		26.2 0.7	5.8 0.2		4	0.05	0.05
Ho 165	PPT		6.4 0.2	1.43 0.03		0.8	0.01	0.01
Er 166	PPT		21.5 0.4	4.7 0.1		2	0.05	0.05
Tm 169	PPT		3.5 0.1	0.67 0.04		0.5	0.01	0.01
Yb 172	PPT		23 1	4.7 0.1		2	0.1	0.1
Lu 175	PPT		4.02 0.08	0.86 0.06		0.8	0.01	0.01
Th 232	PPT		4.6 0.2	0.3 0.1		0.8	0.05	0.05

D = Direct analysis; I = Preconcentration by ion exchange; E = Preconcentration by extraction

ND=Not detected NM=Not measured A=Anomalous value H=Holding exceeded R=Exceeded calibration range

Triangle Area - Briar Spring Pipe

		Sample #1 March 1993 Mean S.D.	Sample #2 July 1993 Mean S.D.	Sample #3 April 1994 Mean S.D.	Detection Limit
ANIONS					
Alkalinity	PPM	86	NM	77	10
Bromide	PPM	0.059 0.008	0.100 0.007	0.084 0.003	0.03
Chloride	PPM	9.17 0.05	9.9 0.1	9.87 0.06	0.08
Fluoride	PPM	0.193 0.006	0.13 0.01	0.134 0.001	0.03
Nitrate	PPM	3.406 0.004	0.37 0.01	4.41 0.01	0.02
Sulfate	PPM	13.11 0.03	11.4 0.2	11.98 0.01	0.03
MAJOR METALS					
Ca	PPM	20.58 0.02	15.4 0.3	15.85 0.02	0.06
Mg	PPM	3.2 0.1	2.2 0.1	2.4 0.1	0.3
K	PPM	7.51 0.02	6.7 0.2	7.13 0.02	0.05
Na	PPM	28.0 0.4	31.3 0.5	25.3 0.5	1.5
TRACE METALS					
Li 7	PPB	30.400 0.003	NM	8.9 0.2	0.009
Al 27	PPB	NM	NM	13.7 0.5	0.02
Ti 47	PPB	1.67 0.05	0.94 0.09	ND	0.009
V 51	PPB	2.0 0.1	1.234 0.008	0.91 0.02	0.003
Cr 52	PPB	0.4 0.3	0.80 0.01	0.79 0.04	0.02

ND=Not detected NM=Not measured A=Anomalous value H=Holding exceeded R=Exceeded calibration range

Triangle Area - Briar Spring Pipe (page 2)

		Sample #1 March 1993 Mean S.D.	Sample #2 July 1993 Mean S.D.	Sample #3 April 1994 Mean S.D.	Detection Limit
Mn 55	PPB	0.125 0.009	0.047 0.002	ND	0.005
Ni 60	PPB	0.51 0.06	0.25 0.01	0.15 0.02	0.01
Cu 63	PPB	NM	NM	0.75 0.03	0.07
Zn 66	PPB	NM	NM	NM	0.01
Ge 73	PPB	0.1610 0.0003	0.0285 0.0003	ND	0.0009
As 75	PPB	5.850 0.003	NM	1.086 0.007	0.009
Se 82	PPB	0.58 0.03	ND	0.19 0.02	0.10
Rb 85	PPB	15 2	ND	11.2 0.2	0.001
Sr 88	PPB	1530 (A) 20	NM	0.19 0.02	0.40
Mo 95	PPB	1.1 0.5	0.70 0.02	ND	0.025
Sn 118	PPB	0.12 0.05	ND	ND	0.004
Sb 121	PPB	0.108 0.008	0.157 0.004	ND	0.005
Cs 133	PPB	0.0396 0.0002	0.0498 0.0002	ND	0.0005
Ba 137	PPB	2.990 0.001	ND	0.293 0.008	0.002
W 182	PPB	0.22 0.02	0.101 0.002	ND	0.018
Tl 205	PPB	0.114 0.001	0.145 0.001	ND	0.002
U 238	PPB	5.52 0.01	1.99 0.01	2.10 0.02	0.0002

ND=Not detected NM=Not measured A=Anomalous value H=Holding exceeded R=Exceeded calibration range

Triangle Area - Briar Spring Pipe (page 3)

		Sample #1 March 1993 Mean S.D.	Sample #2 July 1993 Mean S.D.	Sample #3 April 1994 Mean S.D.	Detection Limit
Be 9	PPT	ND	ND	ND	20
Co 59	PPT	41.3 0.3	15 1	ND	1
Ga 71	PPT	4.7 0.3	ND	ND	0.8
Zr 90	PPT	360(A) 7	31 3	ND	0.6
Nb 93	PPT	15.3 0.7	ND	ND	4
Ru 99	PPT	3.1 0.5	ND	ND	1.5
Rh 103	PPT	5.8 0.7	ND	ND	2
Ag 107	PPT	27 1	ND	ND	3
Cd 114	PPT	9 2	15 2	ND	5
In 115	PPT	ND	ND	ND	0.4
Te 125	PPT	242 9	ND	ND	9
Hf 178	PPT	6 1	ND	ND	3
Ta 181	PPT	1.2 0.4	1.8 0.3	ND	0.03
Re 185	PPT	4.8 0.4	1.7 0.3	21 5	0.12
Ir 193	PPT	ND	ND	ND	0.6

ND=Not detected NM=Not measured A=Anomalous value H=Holding exceeded R=Exceeded calibration range

Triangle Area - Briar Spring Pipe (page 4)

		Sample #1 March 1993 Mean S.D.	Sample #2 July 1993 Mean S.D.	Sample #3 April 1994 Mean S.D.	Detection Limit
Pt 194	PPT	2.5 0.4	1.7 0.4	ND	0.3
Au 197	PPT	7 1	ND	ND	3
Pb 208	PPT	147 8	90 3	ND	8
Bi 209	PPT	ND	ND	ND	2

ND=Not detected NM=Not measured A=Anomalous value H=Holding exceeded R=Exceeded calibration range

Triangle Area - Briar Spring Pipe (page 5)

		Sample #1 March 1993 Mean S.D.	Sample #1 March 1993 Mean S.D.	Sample #2 July 1993 Mean S.D.	Sample #3 April 1994 Mean S.D.	Detection Limit		
		D	I	I		D	I	E
Y 89	PPT	1100(A) 10	18.2 0.3	160 5	90 2	1	0.2	0.2
La 139	PPT	355(A) 5	4.7 0.3	100 10	17 2	1	0.08	0.08
Ce 140	PPT	103 2	108 2	29 2	22 1	0.8	0.06	0.06
Pr 141	PPT		88 1	11.0 0.3	6.81 0.09	0.6	0.01	0.01
Nd 141	PPT		403.0(A) 0.3	51.1 0.5	29.8 0.4	5	0.08	0.08
Sm 147	PPT		97.5 0.3	13.0 0.5	6.51 0.07	1	0.1	0.1
Eu 153	PPT		NM	NM	1.350 0.007	0.6	0.06	0.06
Gd 158	PPT		122.0 0.2	14.9 0.4	9.37 0.04	3	0.1	0.1
Tb 159	PPT		18.60 0.05	2.34 0.08	1.30 0.02	0.7	0.01	0.01
Dy 163	PPT		122.73 0.17	15.7 0.6	8.2 0.2	4	0.05	0.05
Ho 165	PPT		30.10 0.04	4.06 0.09	2.08 0.05	0.8	0.01	0.01
Er 166	PPT		99.40 0.09	13.7 0.4	7.3 0.1	2	0.05	0.05
Tm 169	PPT		15.40 0.03	2.12 0.02	1.09 0.03	0.5	0.01	0.01
Yb 172	PPT		98.1 0.2	14.2 0.5	7.5 0.3	2	0.1	0.1
Lu 175	PPT		17.20 0.02	2.53 0.08	1.31 0.02	0.8	0.01	0.01
Th 232	PPT		11.50 0.06	5.68 0.09	1.5 0.2	0.8	0.05	0.05

D = Direct analysis; I = Preconcentration by ion exchange; E = Preconcentration by extraction

ND=Not detected NM=Not measured A=Anomalous value H=Holding exceeded R=Exceeded calibration range

Triangle Area - Woodcamp Spring

		Sample #1 March 1993 Mean S.D.	Sample #2 July 1993 Mean S.D.	Sample #3 April 1994 Mean S.D.	Detection Limit
ANIONS					
Alkalinit	PPM	83	NM	96	10
		1		4	
Bromide	PPM	0.11	0.26	0.104	0.03
		0.02	0.01	0.006	
Chloride	PPM	23.4	27.5	25.2	0.08
		0.4	0.3	0.1	
Fluoride	PPM	0.300	0.26	0.226	0.03
		0.005	0.04	0.004	
Nitrate	PPM	12.4	1.66	13.25	0.02
		0.1	0.04	0.09	
Sulfate	PPM	23.87	23.0	21.18	0.03
		0.02	0.4	0.04	
MAJOR METALS					
Ca	PPM	25.0	23.47	23.41	0.06
		0.2	0.02	0.08	
Mg	PPM	3.2	2.9	1.9	0.3
		0.3	0.1	0.1	
K	PPM	14.38	15	14.8	0.05
		0.06	1	0.2	
Na	PPM	38.0	37.8	38	1.5
		0.6	0.8	1	
TRACE METALS					
Li 7	PPB	46	NM	20	0.009
		3		1	
Al 27	PPB	NM	NM	0.86	0.02
				0.02	
Ti 47	PPB	1.65	1.23	0.40	0.009
		0.04	0.07	0.05	
V 51	PPB	4.2	3.90	3.72	0.003
		0.1	0.05	0.04	
Cr 52	PPB	0.44	1.06	1.01	0.02
		0.01	0.07	0.03	

ND=Not detected NM=Not measured A=Anomalous value H=Holding exceeded R=Exceeded calibration range

Triangle Area - Woodcamp Spring (page 2)

		Sample #1 March 1993 Mean S.D.	Sample #2 July 1993 Mean S.D.	Sample #3 April 1994 Mean S.D.	Detection Limit
Mn 55	PPB	0.220 0.008	0.087 0.005	0.101 0.002	0.005
Ni 60	PPB	0.34 0.04	0.213 0.007	0.46 0.01	0.01
Cu 63	PPB	NM	NM	0.99 0.03	0.07
Zn 66	PPB	NM	NM	NM	0.01
Ge 73	PPB	0.22 0.02	0.102 0.017	0.084 0.005	0.0009
As 75	PPB	9.210 0.003	NM	5.06 0.08	0.009
Se 77	PPB	1.0 0.4	1.4 0.1	0.86 0.07	0.10
Rb 85	PPB	23 1	NM	25.0 0.2	0.001
Sr 88	PPB	24.7 0.4	NM	21 1	0.40
Mo 95	PPB	3.2 0.4	1.3 0.4	1.09 0.05	0.025
Sn 117	PPB	0.14 0.01	ND	0.02 0.01	0.004
Sb 121	PPB	0.106 0.008	0.33 0.01	0.061 0.008	0.005
Cs 133	PPB	0.066 0.004	0.080 0.002	0.176 0.001	0.0005
Ba 135	PPB	4.3 0.9	NM	1.81 0.03	0.002
W 182	PPB	0.306 0.010	0.217 0.007	0.158 0.009	0.018
Tl 205	PPB	0.26 0.03	0.007 0.001	0.112 0.002	0.002
U 238	PPB	1.27 0.02	1.27 0.02	1.49 0.05	0.0002

ND=Not detected NM=Not measured A=Anomalous value H=Holding exceeded R=Exceeded calibration range

Triangle Area - Woodcamp Spring (page 3)

		Sample #1 March 1993 Mean S.D.	Sample #2 July 1993 Mean S.D.	Sample #3 April 1994 Mean S.D.	Detection Limit
Be 9	PPT	103 42	ND	102 9	20
Co 59	PPT	22 3	17 1	84 1	1
Ga 71	PPT	2.8 0.8	16.8 0.3	50.9 0.9	0.8
Zr 90	PPT	33 4	ND	ND	0.6
Nb 93	PPT	ND	ND	ND	4
Ru 99	PPT	6 2	ND	ND	1.5
Rh 103	PPT	9.5 0.7	ND	ND	2
Ag 107	PPT	28 3	ND	156 2	3
Cd 114	PPT	15 5	29 3	42.1 0.8	5
In 115	PPT	ND	ND	78.0 0.2	0.4
Te 125	PPT	380 30	15 7	ND	9
Hf 178	PPT	6 2	ND	ND	3
Ta 181	PPT	0.9 0.2	2.0 0.3	ND	0.03
Re 185	PPT	3.4 0.5	2.2 0.5	9 1	0.12
Ir 193	PPT	ND	ND	ND	0.6

ND=Not detected NM=Not measured A=Anomalous value H=Holding exceeded R=Exceeded calibration range

Triangle Area - Woodcamp Spring (page 4)

		Sample #1 March 1993 Mean S.D.	Sample #2 July 1993 Mean S.D.	Sample #3 April 1994 Mean S.D.	Detection Limit
Pt 194	PPT	ND	3 1	ND	0.3
Au 197	PPT	17 7	ND	ND	3
Pb 208	PPT	239 6	75 3	88 1	8
Bi 209	PPT	3.5 0.6	ND	120(A) 2	2

ND=Not detected NM=Not measured A=Anomalous value H=Holding exceeded R=Exceeded calibration range

Triangle Area - Woodcamp Spring (page 5)

		Sample #1 March 1993 Mean S.D.	Sample #1 March 1993 Mean S.D.	Sample #2 July 1993 Mean S.D.	Sample #3 April 1994 Mean S.D.	Sample #3 April 1994 Mean S.D.	Sample #3 March 1994 Mean S.D.	Detection Limit		
		D	I	I	D	I	E	D	I	E
Y 89	PPT	8.6	9.3	5.1	4.93	5.20	6.88	1	0.2	0.2
		0.4	0.6	0.2	0.43	0.09	0.07			
La 139	PPT	2.3	4.3	31	1.6	1.7	0.53	1	0.08	0.08
		0.2	0.3	2	0.3	0.1	0.02			
Ce 140	PPT	3.9	12.1	7.35	5.7	1.29	0.53	0.8	0.06	0.06
		0.4	0.7	0.47	0.1	0.08	0.09			
Pr 141	PPT		0.52	0.56	ND	0.23	0.14	0.6	0.01	0.01
			0.01	0.03		0.01	0.01			
Nd 146	PPT		2.6	2.30	ND	0.82	0.68	5	0.08	0.08
			0.4	0.07		0.09	0.06			
Sm 147	PPT		ND	5.6	ND	0.16	0.21	1	0.1	0.1
				0.1	ND	0.03	0.02			
Eu 153	PPT		NM	NM	ND		ND	0.6	0.06	0.06
Gd 157	PPT		ND	0.51	ND	0.40	0.24	3	0.1	0.1
				0.03		0.01	0.02			
Tb 159	PPT		ND	0.124	ND	0.04	0.09	0.7	0.01	0.01
				0.003		0.01	0.01			
Dy 163	PPT		ND	0.56	ND	0.35	0.40	4	0.05	0.05
				0.03		0.01	0.03			
Ho 165	PPT		ND	0.29	ND	0.09	0.11	0.8	0.01	0.01
				0.02		0.01	0.01			
Er 166	PPT		1.0	0.72	ND	0.36	0.41	2	0.05	0.05
			0.1	0.04		0.01	0.02			
Tm 169	PPT		ND	0.79	ND	0.06	0.07	0.5	0.01	0.01
				0.02		0.01	0.01			
Yb 172	PPT		ND	1.8	ND	0.43	0.53	2	0.1	0.1
				0.1		0.08	0.05			
Lu 175	PPT		0.25	1.97	ND	0.08	0.09	0.8	0.01	0.01
			0.03	0.07		0.01	0.01			
Th 232	PPT		0.09	0.11	ND	ND	ND	0.8	0.05	0.05
			0.02	0.04						

D = Direct analysis; I = Preconcentration by ion exchange; E = Preconcentration by extraction

ND=Not detected NM=Not measured A=Anomalous value H=Holding exceeded R=Exceeded calibration range

NEVADA TEST SITE SPRINGS

NEVADA TEST SITE SPRINGS - Field Measurements

SITE	Collection Date	pH	Temperature Celsius	Conductivity (uS/cm)	Alkalinity (mg/L)	TDS (mg/L)	Altitude (ft)	Latitude	Longitude
Topopah Spring	12/94	6.99	16.9	145	48.2	72.3		36 56.27	116 16.18
Cane Spring	12/94	7.19	10.9	437	149	218		36 47.64	116 05.96
Tippipah Spring	12/94	7.07	6.6	223	79.0	111			

NTS Springs - Cane Spring

		Sample # 1 December 94 Mean S.D.	Detection Limit
ANIONS			
Alkalinity	PPM	149 4	10
Bromide	PPM	0.153 0.006	0.01
Chloride	PPM	20.0 0.8	0.002
Fluoride	PPM	0.52 0.01	0.006
Nitrate	PPM	15.4 0.2	0.01
Sulfate	PPM	27.1 0.7	0.02
MAJOR METALS			
Ca	PPM	36.1 0.3	0.62
Mg	PPM	9.45 0.05	0.15
K	PPM	5.9 0.1	0.037
Na	PPM	42.1 0.1	1.1
TRACE METALS			
Li 7	PPB	27.4 0.7	0.021
Al 27	PPB	0.90 0.07	0.0055
Ti 47	PPB	1.27 0.04	0.018
V 51	PPB	9.5 0.1	0.0039
Cr 52	PPB	0.802 0.002	0.0094

NTS Springs - Cane Spring (Page 2)

		Sample # 1 December 94 Mean S.D.	Detection Limit
Mn 55	PPB	1.12 0.02	0.0077
Ni 60	PPB	0.106 0.002	0.012
Cu 63	PPB	0.320 0.004	0.013
Zn 66	PPB	9.9 0.3	0.021
Ge 73	PPB	0.20 0.02	0.022
As 75	PPB	7.2 0.2	0.0097
Se 77	PPB	2.2 0.1	0.137
Rb 85	PPB	9.7 0.2	0.0022
Sr 86	PPB	108 2	0.018
Mo 95	PPB	4.23 0.03	0.009
Sn 117	PPB	ND	0.013
Sb 121	PPB	0.069 0.001	0.0015
Cs 133	PPB	0.080 0.001	0.0044
Ba 135	PPB	18.6 0.1	0.019
W 182	PPB	0.28 0.01	0.0042
Tl 205	PPB	18.6 0.1	0.0036
U 238	PPB	1.73 0.04	0.0035

NTS Springs - Cane Spring (Page 3)

		Sample # 1 December 94 Mean S.D.	Detection Limit
Be 9	PPT	ND	25
Co 59	PPT	42 2	8.1
Ga 71	PPT	ND	9.3
Zr 90	PPT	ND	7.7
Nb 93	PPT	13 6	1.5
Ru 99	PPT	2.4 0.8	0.8
Rh 103	PPT	ND	3.9
Ag 107	PPT	ND	10
Cd 114	PPT	ND	8.1
In 115	PPT	ND	0.7
Te 125	PPT	ND	14
Hf 177	PPT	ND	2.4
Ta 181	PPT	ND	2.1
Re 187	PPT	21 2	2.2
Ir 193	PPT	3.2 0.7	2

NTS Springs - Cane Spring (Page 4)

		Sample # 1 December 94 Mean S.D.	Detection Limit
Pt 195	PPT	ND	1.6
Au 197	PPT	28 10	6
Pb 208	PPT	15 2	8.3
Bi 209	PPT	ND	5.7

NTS Springs - Cane Spring (Page 5)

		Sample # 1 December 94 Mean S.D.			Detection Limit		
		D	I	E	D	I	E
Y 89	PPT	97.3 2.3			1.2		
La 139	PPT	19.6 0.9			1.4		
Ce 140	PPT	22.1 0.2			1.9		
Pr 141	PPT		2.23 0.05			0.1	
Nd 143	PPT		11.3 0.3			0.18	
Sm 147	PPT		2.8 0.2			0.19	
Eu 153	PPT			4.45 0.06			0.08
Gd 158	PPT		4.1 0.1			0.29	
Tb 159	PPT		0.62 0.06			0.07	
Dy 163	PPT		4.8 0.2			0.28	
Ho 165	PPT		1.16 0.05			0.06	
Er 166	PPT		3.82 0.08			0.16	
Tm 169	PPT		0.57 0.04			0.05	
Yb 173	PPT		4.0 0.2			0.33	
Lu 175	PPT		0.70 0.05			0.08	
Th 232	PPT		0.27 0.06			0.13	

D = Direct analysis; I = Preconcentration by ion exchange; E = Preconcentration by extraction
R = Exceeds calibration range; H = Exceeds holding time; A = Anomalous value;
ND = Not detected.

NTS Springs - Tippipah Spring

		Sample # 1 December 94 Mean S.D.	Detection Limit
ANIONS			
Alkalinity	PPM	79.0 0.8	10
Bromide	PPM	0.067 0.002	0.01
Chloride	PPM	7.48 0.08	0.002
Fluoride	PPM	0.152 0.009	0.006
Nitrate	PPM	5.90 0.08	0.01
Sulfate	PPM	15.50 0.04	0.02
Phosphate	PPM	0.35 0.01	0.02
MAJOR METALS			
Ca	PPM	5.5 0.2	0.62
Mg	PPM	0.35 0.01	0.15
K	PPM	2.66 0.08	0.037
Na	PPM	42.5 0.2	1.1
TRACE METALS			
Li 7	PPB	11.77 0.07	0.021
Al 27	PPB	348 2	0.0055
Ti 47	PPB	4.1 0.2	0.018
V 51	PPB	1.40 0.01	0.0039
Cr 52	PPB	0.087 0.004	0.0094

NTS Springs - Tippipah Spring (Page 2)

		Sample # 1 December 94 Mean S.D.	Detection Limit
Mn 55	PPB	1.39 0.04	0.0077
Ni 60	PPB	0.087 0.004	0.012
Cu 63	PPB	0.65 0.01	0.013
Zn 66	PPB	1.15 0.03	0.021
Ge 73	PPB	0.041 0.006	0.022
As 75	PPB	2.04 0.03	0.0097
Se 77	PPB	0.56 0.05	0.137
Rb 85	PPB	7.07 0.02	0.0022
Sr 86	PPB	6.24 0.09	0.018
Mo 95	PPB	0.70 0.02	0.009
Sn 117	PPB	ND	0.013
Sb 121	PPB	1.94 0.06	0.0015
Cs 133	PPB	0.139 0.002	0.0044
Ba 135	PPB	0.34 0.02	0.019
W 182	PPB	0.012 0.007	0.0042
Tl 205	PPB	0.0429 0.0006	0.0036
U 238	PPB	0.52 0.02	0.0035

NTS Springs - Tippipah Spring (Page 3)

		Sample # 1 December 94 Mean S.D.	Detection Limit
Be 9	PPT	70 10	25
Co 59	PPT	28 2	8.1
Ga 71	PPT	76 2	9.3
Zr 90	PPT	294 15	7.7
Nb 93	PPT	41 3	1.5
Ru 99	PPT	ND	0.8
Rh 103	PPT	ND	3.9
Ag 107	PPT	ND	10
Cd 114	PPT	ND	8.1
In 115	PPT	0.8 0.2	0.7
Te 125	PPT	ND	14
Hf 177	PPT	13 2	2.4
Ta 181	PPT	16 1	2.1
Re 187	PPT	11 1	2.2
Ir 193	PPT	ND	2

NTS Springs - Tippipah Spring (Page 4)

		Sample # 1 December 94 Mean S.D.	Detection Limit
Pt 195	PPT	ND	1.6
Au 197	PPT	7.7 0.8	6
Pb 208	PPT	101 1	8.3
Bi 209	PPT	ND	5.7

NTS Springs - Tippipah Spring (Page 5)

		Sample # 1 December 94 Mean S.D.			Detection Limit		
		D	I	E	D	I	E
Y 89	PPT	146 7			1.2		
La 139	PPT	321 19			1.4		
Ce 140	PPT	722 36			1.9		
Pr 141	PPT	68 5			1		
Nd 143	PPT	236 23			2.4		
Sm 147	PPT	69 5			1.9		
Eu 153	PPT	3.7 0.5			1.7		
Gd 158	PPT	42 1			1.4		
Tb 159	PPT	6.3 0.6			1.4		
Dy 163	PPT	29 2			2.4		
Ho 165	PPT	5.5 0.8			0.9		
Er 166	PPT	15.1 0.6			1.5		
Tm 169	PPT	1.9 0.2			1.1		
Yb 173	PPT	14.5 1.5			1.1		
Lu 175	PPT	1.93 0.07			1.4		
Th 232	PPT	63 2			0.9		

D = Direct analysis; I = Preconcentration by ion exchange; E = Preconcentration by extraction
R = Exceeds calibration range; H = Exceeds holding time; A = Anomalous value;
ND = Not detected.

NTS Springs - Topopah Spring

		Sample # 1 December 94 Mean S.D.	Detection Limit
ANIONS			
Alkalinity	PPM	48.2 0.3	10
Bromide	PPM	ND	0.01
Chloride	PPM	3.23 0.03	0.002
Fluoride	PPM	0.086 0.003	0.006
Nitrate	PPM	2.480 0.006	0.01
Sulfate	PPM	8.79 0.03	0.02
Phosphate	PPM	0.42 0.01	0.02
MAJOR METALS			
Ca	PPM	8.9 0.1	0.62
Mg	PPM	1.8 0.1	0.15
K	PPM	5.62 0.03	0.037
Na	PPM	13.9 0.3	1.1
TRACE METALS			
Li 7	PPB	4.55 0.06	0.021
Al 27	PPB	101 2	0.0055
Ti 47	PPB	1.94 0.02	0.018
V 51	PPB	1.34 0.04	0.0039
Cr 52	PPB	0.086 0.006	0.0094

NTS Springs - Topopah Spring (Page 2)

Element	Units	Sample # 1 December 94 Mean S.D.	Detection Limit
Mn 55	PPB	5.2 0.1	0.0077
Ni 60	PPB	0.20 0.01	0.012
Cu 63	PPB	0.54 0.01	0.013
Zn 66	PPB	7.32 0.08	0.021
Ge 73	PPB	0.034 0.005	0.022
As 75	PPB	1.64 0.04	0.0097
Se 77	PPB	0.17 0.06	0.137
Rb 85	PPB	10.0 0.2	0.0022
Sr 86	PPB	7.2 0.3	0.018
Mo 95	PPB	0.387 0.004	0.009
Sn 117	PPB	ND	0.013
Sb 121	PPB	0.269 0.007	0.0015
Cs 133	PPB	0.70 0.01	0.0044
Ba 135	PPB	0.258 0.007	0.019
W 182	PPB	0.024 0.001	0.0042
Tl 205	PPB	0.053 0.005	0.0036
U 238	PPB	0.076 0.001	0.0035

NTS Springs - Topopah Spring (Page 3)

		Sample # 1 December 94 Mean S.D.	Detection Limit
Be 9	PPT	66 12	25
Co 59	PPT	46 3	8.1
Ga 71	PPT	93 4	9.3
Zr 90	PPT	261 7	7.7
Nb 93	PPT	28 3	1.5
Ru 99	PPT	0.9 0.3	0.8
Rh 103	PPT	0.5 0.2	3.9
Ag 107	PPT	12 2	10
Cd 114	PPT	22 3	8.1
In 115	PPT	0.9 0.3	0.7
Te 125	PPT	ND	14
Hf 177	PPT	10 2	2.4
Ta 181	PPT	20 2	2.1
Re 187	PPT	16.7 0.6	2.2
Ir 193	PPT	2.4 0.3	2

NTS Springs - Topopah Spring (Page 4)

		Sample # 1 December 94 Mean S.D.	Detection Limit
Pt 195	PPT	3.8 0.8	1.6
Au 197	PPT	8 3	6
Pb 208	PPT	183 3	8.3
Bi 209	PPT	3.2 0.6	5.7

NTS Springs - Topopah Spring (Page 5)

		Sample # 1 December 94 Mean S.D.			Detection Limit		
		D	I	E	D	I	E
Y 89	PPT	205 8			1.2		
La 139	PPT	136 4			1.4		
Ce 140	PPT	450 15			1.9		
Pr 141	PPT	32.6 0.1			1		
Nd 143	PPT	125 5			2.4		
Sm 147	PPT	25 3			1.9		
Eu 153	PPT	2.3 0.2			1.7		
Gd 158	PPT	31 2			1.4		
Tb 159	PPT	5.1 0.1			1.4		
Dy 163	PPT	30 2			2.4		
Ho 165	PPT	6.6 0.3			0.9		
Er 166	PPT	19 2			1.5		
Tm 169	PPT	3.2 0.1			1.1		
Yb 173	PPT	21 2			1.1		
Lu 175	PPT	3.6 0.3			1.4		
Th 232	PPT	14.3 0.8			0.9		

D = Direct analysis; I = Preconcentration by ion exchange; E = Preconcentration by extraction
R = Exceeds calibration range; H = Exceeds holding time; A = Anomalous value;
ND = Not detected.

PAHRANAGAT VALLEY, NV

PAHRANAGAT - Field Measurements

SITE	Collection Date	pH	Temperature Celsius	Conductivity (uS/cm)	Alkalinity (mg/L)	TDS (mg/L)	Altitude (ft)	Latitude	Longitude
Hiko Spring	8/92	7.53	30.4	470	232	238	3940	37.35.91	115.12.93
	9/93	6.43	26.6	595	220	297	3951	37 35.91	115 12.93
Crystal Spring	8/92	7.56	28.7	470	202	232	3993	37.31.90	115.14.03
	9/93	7.13	27.9	563	200	283		37 31.97	115 13.93
	3/95	7.45	27.1	484	204	240			
Ash Spring	8/92	7.43	34.5	450	248	262	3594	37.27.80	115.11.54
	9/93	6.86	36.1	560	280	273		37 27.81	115 11.54
	3/95	7.23	35	483	195	240		37 27.97	115 11.42
Rogers Spring	12/93	6.34	29	3830	115	1844			
	7/95	7.0	31.8	3490	141				
Big Muddy Spring	12/93	6.64	31.3	998	198	471			
	7/95	7.1	30.8	968	215				

Pahranagat - Ash Spring

		Sample #2 Sept. 1993 Mean S.D.	Detection Limit
ANIONS			
Alkalinity	PPM	248	10
Bromide	PPM	0.118 0.006	0.02
Chloride	PPM	9.1 0.1	0.02
Fluoride	PPM	0.844 0.006	0.01
Nitrate	PPM	1.06(H) 0.01	0.01
Sulfate	PPM	32.93 0.01	0.02
MAJOR METALS			
Ca	PPM	46.40 0.30	0.08
Mg	PPM	13.5 0.1	0.14
K	PPM	8.1 0.7	0.07
Na	PPM	32.7 0.5	1.4
TRACE METALS			
Li 7	PPB	40.6 0.6	0.04
Al 27	PPB	ND	0.04
Ti 47	PPB	0.5 0.1	0.02
V 51	PPB	1.54 0.03	0.003
Cr 52	PPB	0.16 0.06	0.02

ND=Not detected; NM=Not measured; A=Anomalous value; H=Holding time exceeded; R=Exceeds calibration

Pahranagat - Ash Spring (page 2)

		Sample #2 Sept. 1993 Mean S.D.	Detection Limit
Mn 55	PPB	ND	0.01
Ni 60	PPB	0.16 0.06	0.03
Cu 63	PPB	NM	
Zn 66	PPB	13 2	0.03
Ge 73	PPB	0.46 0.07	0.007
As 75	PPB	34.6 0.5	0.007
Se 77	PPB	0.66 0.07	0.03
Rb 85	PPB	20.3 0.2	0.003
Sr 86	PPB	425 3	0.01
Mo 95	PPB	4.5 0.1	0.007
Sn 117	PPB	ND	0.006
Sb 121	PPB	1.30 0.02	0.002
Cs 133	PPB	8.86 0.12	0.0005
Ba 135	PPB	146 2	0.02
W 182	PPB	1.76 0.03	0.001
Tl 205	PPB	0.276 0.005	0.008
U 238	PPB	3.01 0.03	0.005

ND=Not detected; NM=Not measured; A=Anomalous value; H=Holding time exceeded; R=Exceeds calibration

Pahranagat - Ash Spring (page 3)

		Sample #2 Sept. 1993 Mean S.D.	Detection Limit
Be 9	PPT	ND	10
Co 59	PPT	13 2	0.4
Ga 71	PPT	20 1	4
Zr 90	PPT	ND	10
Nb 93	PPT	ND	3
Ru 99	PPT	ND	5
Rh 103	PPT	8 2	2
Ag 107	PPT	ND	23
Cd 114	PPT	ND	6
In 115	PPT	1.7 0.3	0.7
Te 125	PPT	ND	10
Hf 177	PPT	ND	5
Ta 181	PPT	2.6 0.5	2
Re 187	PPT	10 2	3
Ir 193	PPT	ND	4

ND=Not detected; NM=Not measured; A=Anomalous value; H=Holding time exceeded; R=Exceeds calibration

Pahranagat - Ash Spring (page 4)

		Sample #2 Sept. 1993 Mean S.D.	Detection Limit
Pt 195	PPT	ND	10
Au 197	PPT	ND	10
Pb 208	PPT	ND	5
Bi 209	PPT	2.6 0.9	1

ND=Not detected; NM=Not measured; A=Anomalous value; H=Holding time exceeded; R=Exceeds calibration

Pahranagat - Ash Spring (page 5)

		Sample #2 Sept. 1993 Mean S.D.	Detection Limit
Y 89	PPT	7.2 0.5	0.5
La 139	PPT	ND	2
Ce 140	PPT	7.8 0.6	0.8
Pr 141	PPT	ND	1.0
Nd 143	PPT	ND	2.0
Sm 147	PPT	ND	2.0
Eu 153	PPT	26 2	0.8
Gd 158	PPT	ND	2.0
Tb 159	PPT	8 1	1.0
Dy 163	PPT	ND	5.0
Ho 165	PPT	ND	3.0
Er 166	PPT	ND	1.0
Tm 169	PPT	ND	1.0
Yb 173	PPT	ND	2
Lu 175	PPT	ND	0.9
Th 232	PPT	ND	7.0

ND=Not detected; NM=Not measured; A=Anomalous value; H=Holding time exceeded; R=Exceeds calibration

Pahranagat - Ash Spring

		Sample #4 March 1995 Mean S.D.	Detection Limit
ANIONS			
Alkalinity	PPM	195 7	10
Bromide	PPM	0.11 0.01	0.01
Chloride	PPM	8.41 0.02	0.002
Fluoride	PPM	0.700 0.008	0.006
Nitrate	PPM	1.040 0.006	0.01
Sulfate	PPM	32.5 0.1	0.02
MAJOR METALS			
Ca	PPM	48 1	0.49
Mg	PPM	16.5 0.9	0.14
K	PPM	6.0 0.4	0.04
Na	PPM	29.7 0.7	1.1
TRACE METALS			
Li 7	PPB	42 1	0.02
Al 27	PPB	NM	0.05
Ti 47	PPB	0.383 0.006	0.07
V 51	PPB	1.58 0.01	0.01
Cr 52	PPB	0.31 0.02	0.04

ND=Not detected; NM=Not measured; A=Anomalous value; H=Holding time exceeded; R=Exceeds calibration

Pahranagat - Ash Spring (page 2)

		Sample #4 March 1995 Mean S.D.	Detection Limit
Mn 55	PPB	ND	0.01
Ni 60	PPB	0.71 0.01	0.03
Cu 63	PPB	0.57 0.02	0.05
Zn 66	PPB	0.412 0.005	0.06
Ge 73	PPB	0.43 0.01	0.02
As 75	PPB	33 1	0.04
Se 77	PPB	0.63 0.05	0.41
Rb 85	PPB	15.6 0.2	0.01
Sr 86	PPB	492 1	0.03
Mo 95	PPB	4.42 0.08	0.009
Sn 117	PPB	ND	0.011
Sb 121	PPB	1.35 0.01	0.009
Cs 133	PPB	4.79 0.08	0.012
Ba 135	PPB	159 3	0.03
W 182	PPB	1.80 0.03	0.004
Tl 205	PPB	0.26 0.01	0.018
U 238	PPB	2.58 0.05	0.007

ND=Not detected; NM=Not measured; A=Anomalous value; H=Holding time exceeded; R=Exceeds calibration

Pahranagat - Ash Spring (page 3)

		Sample #4 March 1995 Mean S.D.	Detection Limit
Be 9	PPT	ND	11.2
Co 59	PPT	42 2	8.6
Ga 71	PPT	ND	16.7
Zr 90	PPT	ND	7.6
Nb 93	PPT	ND	3.3
Ru 99	PPT	ND	5.9
Rh 103	PPT	15 1	4.9
Ag 107	PPT	ND	16.1
Cd 114	PPT	ND	18.4
In 115	PPT	ND	7.4
Te 125	PPT	ND	25.3
Hf 177	PPT	7 1	5.7
Ta 181	PPT	ND	17.6
Re 187	PPT	13 1	4.6
Ir 193	PPT	ND	8

ND=Not detected; NM=Not measured; A=Anomalous value; H=Holding time exceeded; R=Exceeds calibration

Pahranagat - Ash Spring (page 4)

		Sample #4 March 1995 Mean S.D.	Detection Limit
Pt 195	PPT	ND	19.2
Au 197	PPT	ND	9.4
Pb 208	PPT	ND	12.2
Bi 209	PPT	ND	8.7

ND=Not detected; NM=Not measured; A=Anomalous value; H=Holding time exceeded; R=Exceeds calibration

Pahranagat - Ash Spring (page 5)

		Sample #4 March 1995 Mean S.D.			Detection Limit		
		D	I	E	D	I	E
Y 89	PPT	6.7 1.1	4.76 0.05		0.66	0.03	
La 139	PPT	7.2 0.3	2.2 0.2		1.3	0.05	
Ce 140	PPT	ND	ND		0.78	0.03	
Pr 141	PPT		ND		1.1	0.1	
Nd 143	PPT		0.46 0.14		1.5	0.18	
Sm 147	PPT		1.3 0.3		1.8	0.19	
Eu 153	PPT			29.2 0.6	0.8		0.08
Gd 158	PPT		ND		2.2	0.29	
Tb 159	PPT		ND		1.2	0.07	
Dy 163	PPT		ND		0.5	0.28	
Ho 165	PPT		ND		0.3	0.06	
Er 166	PPT		ND		1.4	0.16	
Tm 169	PPT		ND		1.1	0.05	
Yb 173	PPT		ND		2	0.33	
Lu 175	PPT		ND		0.9	0.08	
Th 232	PPT		0.19 0.03		7.4	0.13	

D = Direct analysis; I = Preconcentration by ion exchange; E = Preconcentration by extraction
R = Exceeds calibration range; H = Exceeds holding time; A = Anomalous value; ND = Not detected

ND=Not detected; NM=Not measured; A=Anomalous value; H=Holding time exceeded; R=Exceeds calibration

Pahranagat - Crystal Spring

		Sample #2 Sept. 1993 Mean S.D.	Detection Limit
ANIONS			
Alkalinity	PPM	200	10
Bromide	PPM	0.120 0.003	0.02
Chloride	PPM	9.6 0.1	0.02
Fluoride	PPM	0.480 0.004	0.01
Nitrate	PPM	1.32(H) 0.02	0.01
Sulfate	PPM	33.51 0.06	0.02
MAJOR METALS			
Ca	PPM	43.0 0.2	0.08
Mg	PPM	20.2 0.1	0.14
K	PPM	4.98 0.02	0.07
Na	PPM	28 1	1.4
TRACE METALS			
Li 7	PPB	22.7 0.2	0.04
Al 27	PPB	ND	0.04
Ti 47	PPB	0.5 0.1	0.02
V 51	PPB	0.964 0.005	0.003
Cr 52	PPB	0.12 0.06	0.02

ND=Not detected; NM=Not measured; A=Anomalous value; H=Holding time exceeded; R=Exceeds calibration

Pahranagat - Crystal Spring (page 2)

		Sample #2 Sept. 1993 Mean S.D.	Detection Limit
Mn 55	PPB	ND	0.01
Ni 60	PPB	0.16 0.06	0.03
Cu 63	PPB	NM	
Zn 66	PPB	45 2	0.03
Ge 73	PPB	0.13 0.03	0.007
As 75	PPB	12.9 0.1	0.007
Se 77	PPB	0.8 0.1	0.03
Rb 85	PPB	10.1 0.1	0.003
Sr 86	PPB	224 3	0.01
Mo 95	PPB	5.8 0.3	0.007
Sn 117	PPB	ND	0.006
Sb 121	PPB	0.63 0.01	0.002
Cs 133	PPB	2.40 0.03	0.0005
Ba 135	PPB	77.1 0.7	0.02
W 182	PPB	0.61 0.01	0.001
Tl 205	PPB	0.297 0.007	0.008
U 238	PPB	4.46 0.06	0.005

ND=Not detected; NM=Not measured; A=Anomalous value; H=Holding time exceeded; R=Exceeds calibration

Pahranagat - Crystal Spring (page 3)

		Sample #2 Sept. 1993 Mean S.D.	Detection Limit
Be 9	PPT	ND	10
Co 59	PPT	11 1	0.4
Ga 71	PPT	ND	4
Zr 90	PPT	10 2	10
Nb 93	PPT	ND	3
Ru 99	PPT	ND	5
Rh 103	PPT	ND	2
Ag 107	PPT	ND	23
Cd 114	PPT	ND	6
In 115	PPT	ND	0.7
Te 125	PPT	ND	10
Hf 177	PPT	ND	5
Ta 181	PPT	ND	2
Re 187	PPT	17 2	3
Ir 193	PPT	ND	4

ND=Not detected; NM=Not measured; A=Anomalous value; H=Holding time exceeded; R=Exceeds calibration

Pahranagat - Crystal Spring (page 4)

		Sample #2 Sept. 1993 Mean S.D.	Detection Limit
Pt 195	PPT	ND	10
Au 197	PPT	ND	10
Pb 208	PPT	ND	5
Bi 209	PPT	ND	1

ND=Not detected; NM=Not measured; A=Anomalous value; H=Holding time exceeded; R=Exceeds calibration

Pahranagat - Crystal Spring (page 5)

		Sample #2 Sept. 1993 Mean S.D.	Detection Limit
Y 89	PPT	3.0 0.2	0.5
La 139	PPT	47 3	2
Ce 140	PPT	13 1	0.8
Pr 141	PPT	ND	1.0
Nd 143	PPT	ND	2.0
Sm 147	PPT	ND	2.0
Eu 153	PPT	17 1	0.8
Gd 158	PPT	ND	2.0
Tb 159	PPT	5 1	1.0
Dy 163	PPT	ND	5.0
Ho 165	PPT	ND	3.0
Er 166	PPT	ND	1.0
Tm 169	PPT	ND	1.0
Yb 173	PPT	ND	2
Lu 175	PPT	ND	0.9
Th 232	PPT	ND	7.0

ND=Not detected; NM=Not measured; A=Anomalous value; H=Holding time exceeded; R=Exceeds calibration

Pahranagat - Crystal Spring

	Sample #4 March 1995 Mean S.D.	Detection Limit
ANIONS		
Alkalinity PPM	204 0	10
Bromide PPM	0.112 0.005	0.01
Chloride PPM	8.9 0.1	0.002
Fluoride PPM	0.335 0.007	0.006
Nitrate PPM	1.24 0.01	0.01
Sulfate PPM	33.1 0.1	0.02
MAJOR METALS		
Ca PPM	46 1	0.49
Mg PPM	22.8 0.3	0.14
K PPM	4.1 0.3	0.04
Na PPM	24.2 0.5	1.1
TRACE METALS		
Li 7 PPB	19.8 0.5	0.02
Al 27 PPB	NM	0.05
Ti 47 PPB	0.32 0.04	0.07
V 51 PPB	0.99 0.02	0.01
Cr 52 PPB	0.53 0.02	0.04

ND=Not detected; NM=Not measured; A=Anomalous value; H=Holding time exceeded; R=Exceeds calibration

Pahranagat - Crystal Spring (page 2)

		Sample #4 March 1995 Mean S.D.	Detection Limit
Mn 55	PPB	ND	0.01
Ni 60	PPB	0.68 0.03	0.03
Cu 63	PPB	0.45 0.01	0.05
Zn 66	PPB	0.30 0.03	0.06
Ge 73	PPB	0.14 0.01	0.02
As 75	PPB	12.3 0.4	0.04
Se 77	PPB	0.8 0.1	0.41
Rb 85	PPB	7.7 0.2	0.01
Sr 86	PPB	260 5	0.03
Mo 95	PPB	5.3 0.1	0.009
Sn 117	PPB	ND	0.011
Sb 121	PPB	0.71 0.02	0.009
Cs 133	PPB	1.36 0.03	0.012
Ba 135	PPB	87 1	0.03
W 182	PPB	0.60 0.02	0.004
Tl 205	PPB	0.27 0.02	0.018
U 238	PPB	3.9 0.1	0.007

ND=Not detected; NM=Not measured; A=Anomalous value; H=Holding time exceeded; R=Exceeds calibration

Pahranagat - Crystal Spring (page 3)

		Sample #4 March 1995 Mean S.D.	Detection Limit
Be 9	PPT	ND	11.2
Co 59	PPT	38 3	8.6
Ga 71	PPT	ND	16.7
Zr 90	PPT	ND	7.6
Nb 93	PPT	ND	3.3
Ru 99	PPT	ND	5.9
Rh 103	PPT	7.1 0.3	4.9
Ag 107	PPT	ND	16.1
Cd 114	PPT	ND	18.4
In 115	PPT	ND	7.4
Te 125	PPT	ND	25.3
Hf 177	PPT	ND	5.7
Ta 181	PPT	ND	17.6
Re 187	PPT	20 1	4.6
Ir 193	PPT	ND	8

ND=Not detected; NM=Not measured; A=Anomalous value; H=Holding time exceeded; R=Exceeds calibration

Pahranagat - Crystal Spring (page 4)

		Sample #4 March 1995 Mean S.D.	Detection Limit
Pt 195	PPT	ND	19.2
Au 197	PPT	ND	9.4
Pb 208	PPT	ND	12.2
Bi 209	PPT	ND	8.7

ND=Not detected; NM=Not measured; A=Anomalous value; H=Holding time exceeded; R=Exceeds calibration

Pahranagat - Crystal Spring (page 5)

		Sample #4 March 1995 Mean S.D.			Detection Limit		
		D	I	E	D	I	E
Y 89	PPT	2.4 0.3	1.90 0.08		0.66	0.03	
La 139	PPT	2.0 0.3	1.09 0.13		1.3	0.05	
Ce 140	PPT	1.3 0.3	0.44 0.05		0.78	0.03	
Pr 141	PPT		ND		1.1	0.1	
Nd 143	PPT		0.48 0.13		1.5	0.18	
Sm 147	PPT		2.5 0.2		1.8	0.19	
Eu 153	PPT			14.8 0.4	0.8		0.08
Gd 158	PPT		ND		2.2	0.29	
Tb 159	PPT		ND		1.2	0.07	
Dy 163	PPT		ND		0.5	0.28	
Ho 165	PPT		ND		0.3	0.06	
Er 166	PPT		ND		1.4	0.16	
Tm 169	PPT		ND		1.1	0.05	
Yb 173	PPT		ND		2	0.33	
Lu 175	PPT		ND		0.9	0.08	
Th 232	PPT		0.19 0.05		7.4	0.13	

D = Direct analysis; I = Preconcentration by ion exchange; E = Preconcentration by extraction
R = Exceeds calibration range; H = Exceeds holding time; A = Anomalous value; ND = Not detecte

ND=Not detected; NM=Not measured; A=Anomalous value; H=Holding time exceeded; R=Exceeds calibration

Pahranagat - Hiko Spring

		Sample #2 Sept. 1993 Mean S.D.	Detection Limit
ANIONS			
Alkalinity	PPM	220	10
Bromide	PPM	0.122 0.002	0.02
Chloride	PPM	9.99 0.02	0.02
Fluoride	PPM	0.636 0.007	0.01
Nitrate	PPM	56.2(H)* 0.3	0.01
Sulfate	PPM	35.47 0.03	0.02

* Unusually high value for first sample of the day; may result from incomplete rinse of collecti equipment following nitric acid cleaning procedure.

MAJOR METALS			
Ca	PPM	45.4 0.4	0.08
Mg	PPM	20.9 0.1	0.14
K	PPM	6.73 0.01	0.07
Na	PPM	29 1	1.4
TRACE METALS			
Li 7	PPB	32.6 0.4	0.04
Al 27	PPB	3.7 1.2	0.04
Ti 47	PPB	0.8 0.1	0.02
V 51	PPB	2.0 0.1	0.003
Cr 52	PPB	ND	0.02

ND=Not detected; NM=Not measured; A=Anomalous value; H=Holding time exceeded; R=Exceeds calibration

Pahranagat - Hiko Spring (page 2)

		Sample #2 Sept. 1993 Mean S.D.	Detection Limit
Mn 55	PPB	ND	0.01
Ni 60	PPB	0.14 0.06	0.03
Cu 63	PPB	NM	
Zn 66	PPB	46 2	0.03
Ge 73	PPB	0.21 0.02	0.007
As 75	PPB	15.1 0.3	0.007
Se 77	PPB	0.78 0.09	0.03
Rb 85	PPB	13.8 0.4	0.003
Sr 86	PPB	308 2	0.01
Mo 95	PPB	6.02 0.11	0.007
Sn 117	PPB	ND	0.006
Sb 121	PPB	0.770 0.004	0.002
Cs 133	PPB	2.8 0.1	0.0005
Ba 135	PPB	107 1	0.02
W 182	PPB	0.82 0.02	0.001
Tl 205	PPB	0.41 0.02	0.008
U 238	PPB	5.2 0.1	0.005

ND=Not detected; NM=Not measured; A=Anomalous value; H=Holding time exceeded; R=Exceeds calibration

Pahranagat - Hiko Spring (page 3)

		Sample #2 Sept. 1993 Mean S.D.	Detection Limit
Be 9	PPT	ND	10
Co 59	PPT	14.0 1.4	0.4
Ga 71	PPT	ND	4
Zr 90	PPT	13 2	10
Nb 93	PPT	ND	3
Ru 99	PPT	ND	5
Rh 103	PPT	10 2	2
Ag 107	PPT	ND	23
Cd 114	PPT	ND	6
In 115	PPT	4 1	0.7
Te 125	PPT	ND	10
Hf 177	PPT	ND	5
Ta 181	PPT	ND	2
Re 187	PPT	17 1	3
Ir 193	PPT	ND	4

ND=Not detected; NM=Not measured; A=Anomalous value; H=Holding time exceeded; R=Exceeds calibration

Pahranagat - Hiko Spring (page 4)

		Sample #2 Sept. 1993 Mean S.D.	Detection Limit
Pt 195	PPT	ND	10
Au 197	PPT	ND	10
Pb 208	PPT	ND	5
Bi 209	PPT	4.7 0.5	1

ND=Not detected; NM=Not measured; A=Anomalous value; H=Holding time exceeded; R=Exceeds calibration

Pahranagat - Hiko Spring (page 5)

		Sample #2 Sept. 1993 Mean S.D.	Detection Limit	E
Y 89	PPT	1.8 0.4	0.5	
La 139	PPT	ND	2	
Ce 140	PPT	ND	0.8	
Pr 141	PPT	ND	1.0	
Nd 143	PPT	ND	2.0	
Sm 147	PPT	ND	2.0	
Eu 153	PPT	14 1	0.8	
Gd 158	PPT	ND	2.0	
Tb 159	PPT	ND	1.0	
Dy 163	PPT	ND	5.0	
Ho 165	PPT	ND	3.0	
Er 166	PPT	ND	1.0	
Tm 169	PPT	ND	1.0	
Yb 173	PPT	ND	2	
Lu 175	PPT	ND	0.9	
Th 232	PPT	ND	7.0	

ND=Not detected; NM=Not measured; A=Anomalous value; H=Holding time exceeded; R=Exceeds calibration

Pahranagat - Rogers Spring #1

		Sample #1 Dec 1993 Mean S.D.	Sample #1 Duplicate Mean S.D.	Detection Limit
ANIONS				
Alkalinity	PPM	116	114	10
Bromide	PPM	0.42	0.41	0.02
		0.03	0.03	
Chloride	PPM	326	326	0.02
		1	3	
Fluoride	PPM	0.95	0.831	0.01
		0.04	0.005	
Nitrate	PPM	1.51	1.47	0.01
		0.02	0.02	
Sulfate	PPM	1759	1607	0.02
		11	7	
MAJOR METALS				
Ca	PPM	500	NM	0.03
		2		
Mg	PPM	141	142	0.2
		1	1	
K	PPM	20.8	20.6	0.04
		0.1	0.1	
Na	PPM	296	301	0.6
		4	3	
TRACE METALS				
Li 7	PPB	566	554	0.04
		21	19	
Al 27	PPB	0.62	0.35	0.04
		0.01	0.04	
Ti 47	PPB	1.04	1.53	0.02
		0.08	0.64	
V 51	PPB	1.41	1.76	0.003
		0.02	0.03	
Cr 52	PPB	0.55	0.91	0.02
		0.02	0.04	

ND=Not detected; NM=Not measured; A=Anomalous value; H=Holding time exceeded; R=Exceeds calibration

Pahranagat - Rogers Spring #1 (page 2)

		Sample #1 Dec 1993 Mean S.D.	Sample #1 Duplicate Mean S.D.	Detection Limit
Mn 55	PPB	0.077 0.001	0.033 0.003	0.01
Ni 60	PPB	6.7 0.9	8.6 0.9	0.03
Cu 63	PPB	6.4 0.3	7.9 0.3	0.01
Zn 66	PPB	7.5 0.3	8 1	0.03
Ge 73	PPB	0.5 0.1	0.6 0.2	0.007
As 75	PPB	43.1 0.7	39.7 0.4	0.007
Se 77	PPB	4.7 0.2	3 1	0.03
Rb 85	PPB	57 1	57 2	0.003
Sr 86	PPB	4687 109	4362 39	0.01
Mo 95	PPB	16 1	17 6	0.007
Sn 117	PPB	0.21 0.01	0.17 0.03	0.006
Sb 121	PPB	0.14 0.02	0.17 0.05	0.002
Cs 133	PPB	5.9 0.1	6.0 0.2	0.0005
Ba 135	PPB	14.0 0.5	14.2 0.3	0.02
W 182	PPB	0.025 0.004	0.06 0.02	0.001
Tl 205	PPB	0.49 0.01	0.55 0.03	0.008
U 238	PPB	3.7 0.1	3.6 0.2	0.005

ND=Not detected; NM=Not measured; A=Anomalous value; H=Holding time exceeded; R=Exceeds calibration

Pahranagat - Rogers Spring #1 (page 3)

		Sample #1 Dec 1993 Mean S.D.	Sample #1 Duplicate Mean S.D.	Detection Limit
Be 9	PPT	ND	ND	10
Co 59	PPT	925 46	3089 194	0.4
Ga 71	PPT	114.2 0.4	72.4 0.5	4
Zr 90	PPT	ND	ND	10
Nb 93	PPT	ND	ND	3
Ru 99	PPT	ND	ND	5
Rh 103	PPT	108 7	ND	2
Ag 107	PPT	53 2	26 2	23
Cd 114	PPT	50 2	58 7	6
In 115	PPT	151.5 0.3	ND	0.7
Te 125	PPT	24 7	89 42	10
Hf 177	PPT	ND	30 9	5
Ta 181	PPT	ND	26 2	2
Re 187	PPT	43 5	76 22	3
Ir 193	PPT	ND	ND	4

ND=Not detected; NM=Not measured; A=Anomalous value; H=Holding time exceeded; R=Exceeds calibration

Pahranagat - Rogers Spring #1 (page 4)

		Sample #1 Dec 1993 Mean S.D.	Sample #1 Duplicate Mean S.D.	Detection Limit
Pt 195	PPT	ND	ND	10
Au 197	PPT	ND	ND	10
Pb 208	PPT	ND	ND	5
Bi 209	PPT	189 6	150 18	1

ND=Not detected; NM=Not measured; A=Anomalous value; H=Holding time exceeded; R=Exceeds calibration

Pahranagat - Rogers Spring #1 (page 5)

		Sample #1 Dec 1993 Mean S.D.	Sample #1 Duplicate Mean S.D.	Detection Limit
Y 89	PPT	15.0 0.8	9.3 0.5	0.5
La 139	PPT	5.7 0.4	3.4 0.3	0.2
Ce 140	PPT	2.4 0.5	1.7 0.2	0.8
Pr 141	PPT	2.58 0.02	0.16 0.01	0.02
Nd 143	PPT	7.41 0.08	0.6 0.1	0.03
Sm 147	PPT	2.6 0.1	5.3 0.1	0.04
Eu 153	PPT	0.026 0.003	0.031 0.003	0.02
Gd 158	PPT	1.5 0.1	0.25 0.01	0.04
Tb 159	PPT	0.062 0.004	ND	0.02
Dy 163	PPT	0.15 0.02	0.17 0.03	0.01
Ho 165	PPT	0.029 0.004	0.04 0.01	0.01
Er 166	PPT	0.159 0.006	0.15 0.02	0.03
Tm 169	PPT	ND	ND	0.02
Yb 173	PPT	0.08 0.02	0.10 0.02	0.04
Lu 175	PPT	ND	ND	0.02
Th 232	PPT	0.16 0.04	0.4 0.1	0.2

ND=Not detected; NM=Not measured; A=Anomalous value; H=Holding time exceeded; R=Exceeds calibration

Pahranagat - Rogers Spring #2

		Sample #2 July 1995 Mean S.D.	Detection Limit
ANIONS			
Alkalinity	PPM	141	10
Bromide	PPM	0.172 0.003	0.01
Chloride	PPM	328 5	0.002
Fluoride	PPM	2.35 0.08	0.006
Nitrate	PPM	1.45 0.01	0.01
Sulfate	PPM	1608 3	0.02
MAJOR METALS			
Ca	PPM	430 1	0.3
Mg	PPM	146.5 0.1	0.1
K	PPM	20.46 0.02	0.1
Na	PPM	301 4	0.7
TRACE METALS			
Li 7	PPB	642 21	0.019
Al 27	PPB	0.318 0.006	0.018
Ti 47	PPB	1.10 0.06	0.054
V 51	PPB	1.35 0.03	0.0104
Cr 52	PPB	0.075 0.006	0.021

ND=Not detected; NM=Not measured; A=Anomalous value; H=Holding time exceeded; R=Exceeds calibration

Pahranagat - Rogers Spring #2 (page 2)

		Sample #2 July 1995 Mean S.D.	Detection Limit
Mn 55	PPB	0.061 0.003	0.007
Ni 60	PPB	4.8 0.3	0.018
Cu 63	PPB	4.3 0.1	0.022
Zn 66	PPB	4.4 0.1	0.025
Ge 73	PPB	0.34 0.03	0.029
As 75	PPB	48 1	0.019
Se 77	PPB	8 1	0.195
Rb 85	PPB	52 1	0.008
Sr 86	PPB	4622 35	0.029
Mo 95	PPB	11.6 0.4	0.012
Sn 117	PPB	ND	0.028
Sb 121	PPB	0.015 0.003	0.0039
Cs 133	PPB	5.1 0.3	0.0059
Ba 135	PPB	15.2 0.2	0.018
W 182	PPB	44 5	0.0092
Tl 205	PPB	0.69 0.03	0.0095
U 238	PPB	4.0 0.3	0.012

ND=Not detected; NM=Not measured; A=Anomalous value; H=Holding time exceeded; R=Exceeds calibration

Pahranagat - Rogers Spring #2 (page 3)

		Sample #2 July 1995 Mean S.D.	Detection Limit
Be 9	PPT	ND	29
Co 59	PPT	220 7	6.9
Ga 71	PPT	ND	10
Zr 90	PPT	9.5 0.4	7.8
Nb 93	PPT	23 5	4.9
Ru 99	PPT	ND	5.4
Rh 103	PPT	40 4	3
Ag 107	PPT	ND	19
Cd 114	PPT	31 2	8.9
In 115	PPT	154 5	4.2
Te 125	PPT	0.10 0.03	25
Hf 177	PPT	ND	15
Ta 181	PPT	335 90	7.3
Re 187	PPT	48 5	4.3
Ir 193	PPT	ND	5.7

ND=Not detected; NM=Not measured; A=Anomalous value; H=Holding time exceeded; R=Exceeds calibration

Pahranagat - Rogers Spring #2 (page 4)

		Sample #2 July 1995 Mean S.D.	Detection Limit
Pt 195	PPT	ND	13
Au 197	PPT	37 7	10
Pb 208	PPT	ND	11
Bi 209	PPT	802 26	4.9

ND=Not detected; NM=Not measured; A=Anomalous value; H=Holding time exceeded; R=Exceeds calibration

Pahranagat - Rogers Spring #2 (page 5)

		Sample #2 July 1995 Mean S.D.			Detection Limit		
		D	I	E	D	I	E
Y 89	PPT	10 1	4.57 0.04		1.2	0.05	
La 139	PPT	ND	3.16 0.04		1.2	0.05	
Ce 140	PPT	ND	1.18 0.05		1.3	0.06	
Pr 141	PPT		0.14 0.03			0.09	
Nd 143	PPT		0.51 0.17			0.18	
Sm 147	PPT		0.38 0.03			0.17	
Eu 153	PPT			NM		0.09	
Gd 158	PPT		ND			0.11	
Tb 159	PPT		ND			0.1	
Dy 163	PPT		ND			0.09	
Ho 165	PPT		ND			0.06	
Er 166	PPT		ND			0.09	
Tm 169	PPT		ND			0.06	
Yb 173	PPT		ND			0.2	
Lu 175	PPT		ND			0.07	
Th 232	PPT		ND			0.09	

D = Direct analysis; I = Preconcentration by ion exchange; E = Preconcentration by extraction
R = Exceeds calibration range; H = Exceeds holding time; A = Anomalous value; ND = Not detected

ND=Not detected; NM=Not measured; A=Anomalous value; H=Holding time exceeded; R=Exceeds calibration

Pahranagat - Big Muddy Spring #1

		Sample #1 Dec 1993 Mean S.D.	Detection Limit
ANIONS			
Alkalinity	PPM	198	10
Bromide	PPM	0.255 0.013	0.02
Chloride	PPM	63 1	0.02
Fluoride	PPM	2.056 0.077	0.01
Nitrate	PPM	1.81 0.01	0.01
Sulfate	PPM	174.0 0.3	0.02
MAJOR METALS			
Ca	PPM	65.1 0.2	0.03
Mg	PPM	26.8 0.6	0.2
K	PPM	10.40 0.02	0.04
Na	PPM	103 2	0.6
TRACE METALS			
Li 7	PPB	132 5	0.04
Al 27	PPB	0.35 0.01	0.04
Ti 47	PPB	2.7 0.1	0.02
V 51	PPB	2.8 0.1	0.003
Cr 52	PPB	2.4 0.1	0.02

ND=Not detected; NM=Not measured; A=Anomalous value; H=Holding time exceeded; R=Exceeds calibration

Pahranagat - Big Muddy Spring #1 (page 2)

		Sample #1 Dec 1993 Mean S.D.	Detection Limit
Mn 55	PPB	ND	0.01
Ni 60	PPB	5.22 0.29	0.03
Cu 63	PPB	4.32 0.10	0.01
Zn 66	PPB	1.92 0.03	0.03
Ge 73	PPB	0.93 0.06	0.007
As 75	PPB	20.2 0.3	0.007
Se 77	PPB	7.9 0.2	0.03
Rb 85	PPB	30.2 0.2	0.003
Sr 86	PPB	1268 15	0.01
Mo 95	PPB	7.3 0.3	0.007
Sn 117	PPB	0.10 0.01	0.006
Sb 121	PPB	0.54 0.04	0.002
Cs 133	PPB	5.0 0.1	0.0005
Ba 135	PPB	45 2	0.02
W 182	PPB	1.17 0.04	0.001
Tl 205	PPB	0.33 0.01	0.008
U 238	PPB	4.09 0.09	0.005

ND=Not detected; NM=Not measured; A=Anomalous value; H=Holding time exceeded; R=Exceeds calibration

Pahranagat - Big Muddy Spring #1 (page 3)

		Sample #1 Dec 1993 Mean S.D.	Detection Limit
Be 9	PPT	ND	10
Co 59	PPT	559 15	0.4
Ga 71	PPT	ND	4
Zr 90	PPT	ND	10
Nb 93	PPT	ND	3
Ru 99	PPT	ND	5
Rh 103	PPT	125 8	2
Ag 107	PPT	ND	23
Cd 114	PPT	20 2	6
In 115	PPT	13.7 0.5	0.7
Te 125	PPT	ND	10
Hf 177	PPT	ND	5
Ta 181	PPT	ND	2
Re 187	PPT	15 1	3
Ir 193	PPT	ND	4

ND=Not detected; NM=Not measured; A=Anomalous value; H=Holding time exceeded; R=Exceeds calibration

Pahranagat - Big Muddy Spring #1 (page 4)

		Sample #1 Dec 1993 Mean S.D.	Detection Limit
Pt 195	PPT	ND	10
Au 197	PPT	ND	10
Pb 208	PPT	7.4 0.4	5
Bi 209	PPT	9 1	1

ND=Not detected; NM=Not measured; A=Anomalous value; H=Holding time exceeded; R=Exceeds calibration

Pahranagat - Big Muddy Spring #1 (page 5)

		Sample #1 Dec 1993 Mean S.D.	Detection Limit
Y 89	PPT	5.4 0.3	0.5
La 139	PPT	5.3 0.4	0.2
Ce 140	PPT	1.20 0.09	0.8
Pr 141	PPT	0.15 0.02	0.02
Nd 143	PPT	0.56 0.07	0.03
Sm 147	PPT	1.7 0.1	0.04
Eu 153	PPT	0.05 0.01	0.02
Gd 158	PPT	0.14 0.02	0.04
Tb 159	PPT	0.09 0.01	0.02
Dy 163	PPT	0.14 0.02	0.01
Ho 165	PPT	0.03 0.01	0.01
Er 166	PPT	0.10 0.02	0.03
Tm 169	PPT	ND	0.02
Yb 173	PPT	0.08 0.02	0.04
Lu 175	PPT	ND	0.02
Th 232	PPT	ND	0.2

ND=Not detected; NM=Not measured; A=Anomalous value; H=Holding time exceeded; R=Exceeds calibration

Pahranagat - Big Muddy Spring #2

		Sample #2 July 1995 Mean S.D.	Detection Limit
ANIONS			
Alkalinity	PPM	215	10
Bromide	PPM	0.219 0.002	0.01
Chloride	PPM	63.7 0.3	0.002
Fluoride	PPM	1.74 0.02	0.006
Nitrate	PPM	1.91 0.01	0.01
Sulfate	PPM	162.2 0.1	0.02
MAJOR METALS			
Ca	PPM	61.2 0.2	0.3
Mg	PPM	27.88 0.08	0.1
K	PPM	9.43 0.02	0.1
Na	PPM	101.3 0.3	0.7
TRACE METALS			
Li 7	PPB	154 6	0.019
Al 27	PPB	0.71 0.06	0.018
Ti 47	PPB	0.99 0.07	0.054
V 51	PPB	2.73 0.07	0.0104
Cr 52	PPB	0.59 0.02	0.021

ND=Not detected; NM=Not measured; A=Anomalous value; H=Holding time exceeded; R=Exceeds calibration

Pahranagat - Big Muddy Spring #2 (page 2)

		Sample #2 July 1995 Mean S.D.	Detection Limit
Mn 55	PPB	0.031 0.003	0.007
Ni 60	PPB	0.80 0.03	0.018
Cu 63	PPB	1.65 0.09	0.022
Zn 66	PPB	1.52 0.01	0.025
Ge 73	PPB	0.71 0.02	0.029
As 75	PPB	15.6 0.6	0.019
Se 77	PPB	2.0 0.2	0.195
Rb 85	PPB	28 1	0.008
Sr 86	PPB	1036 19	0.029
Mo 95	PPB	6.2 0.1	0.012
Sn 117	PPB	ND	0.028
Sb 121	PPB	0.464 0.006	0.0039
Cs 133	PPB	4.7 0.1	0.0059
Ba 135	PPB	43 1	0.018
W 182	PPB	1.30 0.02	0.0092
Tl 205	PPB	0.30 0.02	0.0095
U 238	PPB	4.1 0.2	0.012

ND=Not detected; NM=Not measured; A=Anomalous value; H=Holding time exceeded; R=Exceeds calibration

Pahranagat - Big Muddy Spring #2 (page 3)

		Sample #2 July 1995 Mean S.D.	Detection Limit
Be 9	PPT	ND	29
Co 59	PPT	26 1	6.9
Ga 71	PPT	ND	10
Zr 90	PPT	49 2	7.8
Nb 93	PPT	6.9 0.6	4.9
Ru 99	PPT	ND	5.4
Rh 103	PPT	10.7 0.3	3
Ag 107	PPT	ND	19
Cd 114	PPT	14 1	8.9
In 115	PPT	9.5 0.3	4.2
Te 125	PPT	ND	25
Hf 177	PPT	ND	15
Ta 181	PPT	59 4	7.3
Re 187	PPT	19 1	4.3
Ir 193	PPT	ND	5.7

ND=Not detected; NM=Not measured; A=Anomalous value; H=Holding time exceeded; R=Exceeds calibration

Pahranagat - Big Muddy Spring #2 (page 4)

		Sample #2 July 1995 Mean S.D.	Detection Limit
Pt 195	PPT	ND	13
Au 197	PPT	12.6 2.3	10
Pb 208	PPT	ND	11
Bi 209	PPT	ND	4.9

ND=Not detected; NM=Not measured; A=Anomalous value; H=Holding time exceeded; R=Exceeds calibration

Pahranagat - Big Muddy Spring #2 (page 5)

		Sample #2 July 1995 Mean S.D.			Detection Limit		
		D	I	E	D	I	E
Y 89	PPT	4.2 0.6	5.98 0.06		1.2	0.05	
La 139	PPT	7.4 0.5	4.70 0.11		1.2	0.05	
Ce 140	PPT	ND	1.15 0.14		1.3	0.06	
Pr 141	PPT		0.35 0.02			0.09	
Nd 143	PPT		1.18 0.12			0.18	
Sm 147	PPT		1.74 0.37			0.17	
Eu 153	PPT			NM		0.09	
Gd 158	PPT		0.13 0.02			0.11	
Tb 159	PPT		ND			0.1	
Dy 163	PPT		0.14 0.04			0.09	
Ho 165	PPT		ND			0.06	
Er 166	PPT		ND			0.09	
Tm 169	PPT		ND			0.06	
Yb 173	PPT		ND			0.2	
Lu 175	PPT		ND			0.07	
Th 232	PPT		ND			0.09	

D = Direct analysis; I = Preconcentration by ion exchange; E = Preconcentration by extraction
R = Exceeds calibration range; H = Exceeds holding time; A = Anomalous value; ND = Not d

ND=Not detected; NM=Not measured; A=Anomalous value; H=Holding time exceeded; R=Exceeds calibration

NEVADA TEST SITE WELLS

NTS Wells - Field Measurements

SITE	Collection Date	pH	Temperature Celsius	Conductivity (uS/cm)	Alkalinity (mg/L)	TDS (mg/L)	Altitude (ft)	Latitude	Longitude
Well J-13	5/92	7.47	30.1	290		142	3318	36 48.32	116 23.75
	3/93	7.36	30.8	285	61.0	137			
	3/94	6.54	28.7	289	92.8	143			
	6/95	7.41	30.8	297	94.0	150			
Well J-12	6/95	6.67	26.8	304	86.4		3130	36 45.90	116 23.40
Army Well #3 (MV-1)	6/94	7.48	30.9	575	188	326	3154	36 35.63	116 02.23
ER-30 700-ft. depth	01/31/95	9.16	23.5	308	105	154	4647	37 03.00	116 19.19
ER-30 500-ft. depth	02/01/95	9.21	23.5	350	99	175	4647	37 03.00	116 19.19

J-13

Comparison of sample preservation with 1% and 2% HNO3

Sample #2

March, 1993

		Mean S.D.				Detection Limit
ANIONS						
Alkalinity	PPM	61 4				10
Bromide	PPM	0.85 0.02				0.03
Chloride	PPM	7.5 0.1				0.08
Fluoride	PPM	2.12 0.10				0.03
Nitrate	PPM	8.84 0.09				0.02
Sulfate	PPM	18.07 0.07				0.03
MAJOR METALS						
Ca	PPM	12.3 0				0.06
Mg	PPM	1.56 0				0.3
K	PPM	4.58 0.06				0.05
Na	PPM	44.9 0.5				1.5

TRACE METALS		Undilute 10 ml/lt	20ml/lt	Diluted 10ml/lt	20ml/lt	
Li 7	PPB	41.6 0.6	36 1	70 1	62 8	0.04
Al 27	PPB	NM	NM	NM	NM	0.04
Ti 47	PPB	1.35 0.06	1.29 0.05	14 2	11 3	0.02
V 51	PPB	11.4 0.4	10.4 0.3	13 1	14 0	0.003
Cr 52	PPB	2.25 0.03	1.8 0.1	37 2	34 2	0.02

ND=Not detected; NM=Not measured; A=Anomalous value; H=Holding time exceeded; R=Calibration range exceeded.

J-13 (Page 2)

Comparison of sample preservation with 1% and 2% HNO3

Sample #2

March, 1993

Mean

S.D.

		Undilute 10 ml/lt	20ml/lt	Diluted 10ml/lt	20ml/lt	Detection Limit
Mn 55	PPB	3.5	2.8	21	18.8	0.01
		0.1	0.1	1	0.7	
Ni 60	PPB	0.36	0.34	10.5	10	0.03
		0.02	0.02	0.5	1	
Cu 63	PPB	NM	NM	NM	NM	0.01
Zn 66	PPB	NM	NM	NM	NM	0.03
Ge 73	PPB	0.40	0.39	6.7	6.0	0.007
		0.01	0.05	0.6	0.7	
As 75	PPB	17.3	15.3	17	16	0.007
		0.7	0.3	2	2	
Se 77	PPB	1.6	3.3	52	55	0.03
		0.2	0.1	8	6	
Rb 85	PPB	12.7	11.2	12.0	11.9	0.003
		0.7	0.4	0.7	0.9	
Sr 86	PPB	55	48	49	47	0.01
		2	1	5	2	
Mo 95	PPB	8.2	8.0	26	14	0.007
		0.4	0.2	5	2	
Sn 117	PPB	0.23	0.19	15	12	0.006
		0.02	0.02	2	1	
Sb 121	PPB	0.52	0.44	0.6	0.5	0.002
		0.01	0.01	0.1	0.1	
Cs 133	PPB	1.94	1.75	1.7	1.6	0.0005
		0.09	0.05	0.2	0.1	
Ba 135	PPB	1.6	1.42	3	2.9	0.02
		0.2	0.06	1	0.4	
W 182	PPB	1.18	1.23	5.5	4.2	0.001
		0.07	0.03	0.4	0.3	
Tl 205	PPB	0.059	0.065	2.7	2.4	0.008
		0.009	0.006	0.3	0.3	
U 238	PPB	0.62	0.57	0.8	0.8	0.005
		0.01	0.02	0.1	0.1	

ND=Not detected; NM=Not measured; A=Anomalous value; H=Holding time exceeded; R=Calibration range exceeded.

J-13 (Page 3)

Comparison of sample preservation with 1% and 2% HNO3

Sample #2

March, 1993

Mean

S.D.

		Undilute 10 ml/lt	20ml/lt	Diluted 10ml/lt	20ml/lt	Detection Limit
Be 9	PPT	136	156	12391	9480	10
		69	79	5974	2777	
Co 59	PPT	20	21	970	909	0.4
		4	3	255	219	
Ga 71	PPT	11	9	241	328	4
		3	4	140	96	
Zr 90	PPT	43	32	274	323	10
		16	5	56	66	
Nb 93	PPT	7	4	72	90	3
		1	1	29	26	
Ru 99	PPT	4	4	407	291	5
		1	1	137	45	
Rh 103	PPT	2	2	94	94	2
		0	0	32	46	
Ag 107	PPT	3	3	239	195	23
		1	1	101	100	
Cd 114	PPT	13	13	433	523	6
		5	5	328	238	
In 115	PPT	0	1	40	40	0.7
		1	1	32	28	
Te 125	PPT	87	107	6342	5840	10
		17	24	1141	1773	
Hf 177	PPT	35	12	219	252	5
		14	4	98	122	
Ta 181	PPT	6	3.5	93	91	2
		1	0.3	20	26	
Re 187	PPT	2.3	2.4	57	58	3
		0.5	0.5	46	26	
Ir 193	PPT	0.9	0.9	42	71	4
		0.2	0.3	21	17	

ND=Not detected; NM=Not measured; A=Anomalous value; H=Holding time exceeded; R=Calibration range exceeded.

J-13 (Page 4)

Comparison of sample preservation with 1% and 2% HNO3

Sample #2

March, 1993

Mean

S.D.

		Undilute 10 ml/lt	20ml/lt	Diluted 10ml/lt	20ml/lt	Detection Limit
Pt 195	PPT	5	7	286	160	10
		2	1	173	85	
Au 197	PPT	33	19	322	1109	10
		4	3	87	152	
Pb 208	PPT	287	271	1145	1126	5
		14	6	235	305	
Bi 209	PPT	3	2	259	172	1
		2	1	204	106	

ND=Not detected; NM=Not measured; A=Anomalous value; H=Holding time exceeded; R=Calibration range exceeded.

J-13 (Page 5)

Comparison of sample preservation with 1% and 2% HNO3

		Sample #2 March, 1993 Mean S.D. Undilute 10 ml/lt	20ml/lt	Sample #2 March, 1993 Mean S.D. Dilute	Detection Limit
Y 89	PPT	1.2	1.5	Not performed	0.5
		0.4	0.3	for these elements	
La 139	PPT	2.3	6.4		0.2
		0.2	0.2		
Ce 140	PPT	2.7	1.3		0.8
		0.5	0.2		
Pr 141	PPT	0.3	0.2		0.02
		0.1	0.1		
Nd 143	PPT	2.5	1.6		0.03
		0.4	0.9		
Sm 147	PPT	16	7		0.04
		1	2		
Eu 153	PPT	0.3	0.2		0.02
		0.3	0.1		
Gd 158	PPT	0.4	0.7		0.04
		0.2	0.5		
Tb 159	PPT	0.07	0.09		0.02
		0.07	0.07		
Dy 163	PPT	0.7	0.5		0.01
		0.3	0.4		
Ho 165	PPT	0.13	0.12		0.01
		0.10	0.05		
Er 166	PPT	0.3	0.3		0.03
		0.1	0.3		
Tm 169	PPT	0.10	0.11		0.02
		0.06	0.03		
Yb 173	PPT	0.6	0.4		0.04
		0.5	0.1		
Lu 175	PPT	0.07	0.06		0.02
		0.03	0.06		
Th 232	PPT	0.7	0.42		0.2
		0.4	0.08		

ND=Not detected; NM=Not measured; A=Anomalous value; H=Holding time exceeded; R=Calibration range exceeded.

J-13

		Sample #3 March, 1994 Mean S.D.	Detection Limit
ANIONS			
Alkalinity	PPM	93 3	10
Bromide	PPM	0.1 0.2	0.05
Chloride	PPM	6.52 0.09	0.08
Fluoride	PPM	2.05 0.01	0.033
Nitrate	PPM	8.90 0.03	0.004
Sulfate	PPM	18.09 0.03	0.032
Phosphat	PPM	0.12 0.03	0.1
MAJOR METALS			
Ca	PPM	12.81 0.03	0.032
Mg	PPM	1.69 0.03	0.13
K	PPM	4.6 0.6	0.04
Na	PPM	43.8 0.5	0.59
TRACE METALS			
Li 7	PPB	39.2 0.6	0.037
Al 27	PPB	0.75 0.03	0.043
Ti 47	PPB	0.74 0.04	0.02
V 51	PPB	9.4 0.2	0.0025
Cr 52	PPB	1.41 0.05	0.022

ND=Not detected; NM=Not measured; A=Anomalous value; H=Holding time exceeded; R=Calibration range exceeded.

J-13 (Page 2)

		Sample #3 March, 1994 Mean S.D.	Detection Limit
Mn 55	PPB	2.96 0.05	0.0098
Ni 60	PPB	0.46 0.02	0.029
Cu 63	PPB	1.52 0.04	0.012
Zn 66	PPB	0.61 0.01	0.03
Ge 73	PPB	0.350 0.003	0.0069
As 75	PPB	12.2 0.1	0.0072
Se 77	PPB	0.7 0.1	0.031
Rb 85	PPB	9.9 0.1	0.0029
Sr 86	PPB	39.2 0.7	0.011
Mo 95	PPB	7.87 0.03	0.0072
Sn 117	PPB	0.012 0.004	0.006
Sb 121	PPB	0.509 0.002	0.002
Cs 133	PPB	1.61 0.03	0.0005
Ba 135	PPB	1.19 0.02	0.024
W 182	PPB	1.02 0.03	0.001
Tl 205	PPB	0.074 0.003	0.0082
U 238	PPB	0.51 0.01	0.0052

ND=Not detected; NM=Not measured; A=Anomalous value; H=Holding time exceeded; R=Calibration range exceeded.

J-13 (Page 3)

		Sample #3 March, 1994 Mean S.D.	Detection Limit
Be 9	PPT	ND	10
Co 59	PPT	ND	0.4
Ga 71	PPT	ND	3.7
Zr 90	PPT	28 4	10
Nb 93	PPT	30 4	3
Ru 99	PPT	ND	4.5
Rh 103	PPT	20 2	4.9
Ag 107	PPT	ND	23
Cd 114	PPT	ND	5.9
In 115	PPT	4 1	0.7
Te 125	PPT	ND	8.2
Hf 177	PPT	ND	5
Ta 181	PPT	17 3	1.5
Re 187	PPT	11.4 0.9	2.6
Ir 193	PPT	7 1	4.2

ND=Not detected; NM=Not measured; A=Anomalous value; H=Holding time exceeded; R=Calibration range exceeded.

J-13 (Page 4)

		Sample #3 March, 1994 Mean S.D.	Detection Limit
Pt 195	PPT	ND	10
Au 197	PPT	ND	10
Pb 208	PPT	289 8	5.4
Bi 209	PPT	ND	1.4

ND=Not detected; NM=Not measured; A=Anomalous value; H=Holding time exceeded; R=Calibration range exceeded.

J-13 (Page 5)

		Sample #3 March, 1994 Mean S.D. D	I	E	Detection Limit D	I	E
Y 89	PPT	0.8 0.2			0.5		
La 139	PPT	2.21 0.17			0.24		
Ce 140	PPT	1.4 0.3			0.8		
Pr 141	PPT		0.135 0.008			0.02	
Nd 143	PPT		0.5 0.2			0.03	
Sm 147	PPT		7.34 0.05			0.04	
Eu 153	PPT			ND			0.02
Gd 158	PPT		ND			0.04	
Tb 159	PPT		ND			0.02	
Dy 163	PPT		0.171 0.005			0.01	
Ho 165	PPT		0.03 0.01			0.01	
Er 166	PPT		0.068 0.007			0.03	
Tm 169	PPT		ND			0.02	
Yb 173	PPT		ND			0.04	
Lu 175	PPT		ND			0.02	
Th 232	PPT		ND			0.2	

D = Direct analysis; I = Preconcentration by ion exchange; E = Preconcentration by extr

ND=Not detected; NM=Not measured; A=Anomalous value; H=Holding time exceeded; R=Calibration range exceeded.

J-12

		Sample #1 March, 1994 Mean S.D.	Detection Limit
ANIONS			
Alkalinity	PPM	86 1	10
Bromide	PPM	0.080 0.007	0.05
Chloride	PPM	6.9 0.2	0.08
Fluoride	PPM	1.67 0.03	0.033
Nitrate	PPM	8.471 0.009	0.004
Sulfate	PPM	22.32 0.002	0.032
Phosphat	PPM	0.089 0.001	0.1
MAJOR METALS			
Ca	PPM	14.8 0.2	0.032
Mg	PPM	2.09 0.03	0.13
K	PPM	4.78 0.03	0.04
Na	PPM	41.8 0.4	0.59
TRACE METALS			
Li 7	PPB	39 1	0.037
Al 27	PPB	0.43 0.01	0.043
Ti 47	PPB	0.86 0.02	0.02
V 51	PPB	5.39 0.05	0.0025
Cr 52	PPB	1.00 0.01	0.022

ND=Not detected; NM=Not measured; A=Anomalous value; H=Holding time exceeded; R=Calibration range exceeded.

J-12 (Page2)

		Sample #1 March, 1994 Mean S.D.	Detection Limit
Mn 55	PPB	0.104 0.001	0.0098
Ni 60	PPB	0.32 0.01	0.029
Cu 63	PPB	1.133 0.002	0.012
Zn 66	PPB	0.668 0.008	0.03
Ge 73	PPB	0.36 0.02	0.0069
As 75	PPB	10.2 0.3	0.0072
Se 77	PPB	0.69 0.07	0.031
Rb 85	PPB	13.7 0.2	0.0029
Sr 86	PPB	44.5 0.6	0.011
Mo 95	PPB	7.4 0.1	0.0072
Sn 117	PPB	ND	0.006
Sb 121	PPB	0.219 0.004	0.002
Cs 133	PPB	0.82 0.02	0.0005
Ba 135	PPB	1.81 0.03	0.024
W 182	PPB	0.49 0.01	0.001
Tl 205	PPB	ND	0.0082
U 238	PPB	0.58 0.02	0.0052

ND=Not detected; NM=Not measured; A=Anomalous value; H=Holding time exceeded; R=Calibration range exceeded.

J-12 (Page 3)

		Sample #1 March, 1994 Mean S.D.	Detection Limit
Be 9	PPT	ND	10
Co 59	PPT	ND	0.4
Ga 71	PPT	ND	3.7
Zr 90	PPT	17 3	10
Nb 93	PPT	ND	3
Ru 99	PPT	ND	4.5
Rh 103	PPT	15.1 0.5	4.9
Ag 107	PPT	ND	23
Cd 114	PPT	ND	5.9
In 115	PPT	ND	0.7
Te 125	PPT	ND	8.2
Hf 177	PPT	ND	5
Ta 181	PPT	ND	1.5
Re 187	PPT	2.6 0.2	2.6
Ir 193	PPT	ND	4.2

ND=Not detected; NM=Not measured; A=Anomalous value; H=Holding time exceeded; R=Calibration range exceeded.

J-12 (Page 4)

		Sample #1 March, 1994 Mean S.D.	Detection Limit
Pt 195	PPT	ND	10
Au 197	PPT	ND	10
Pb 208	PPT	100 5	5.4
Bi 209	PPT	ND	1.4

ND=Not detected; NM=Not measured; A=Anomalous value; H=Holding time exceeded; R=Calibration range exceeded.

J-12 (Page 5)

		Sample #1 March, 1994 Mean S.D.			Detection Limit		
		D	I	E	D	I	E
Y 89	PPT	1.98 0.07			0.5		
La 139	PPT	2.87 0.15			0.24		
Ce 140	PPT	2.41 0.58			0.8		
Pr 141	PPT		0.15 0.01			0.02	
Nd 143	PPT		0.06 0.07			0.03	
Sm 147	PPT		6.77 0.04			0.04	
Eu 153	PPT			ND			0.02
Gd 158	PPT		0.20 0.04			0.04	
Tb 159	PPT		ND			0.02	
Dy 163	PPT		0.23 0.03			0.01	
Ho 165	PPT		0.047 0.007			0.01	
Er 166	PPT		0.108 0.009			0.03	
Tm 169	PPT		ND			0.02	
Yb 173	PPT		ND			0.04	
Lu 175	PPT		ND			0.02	
Th 232	PPT		0.37 0.09			0.2	

D = Direct analysis; I = Preconcentration by ion exchange; E = Preconcentration by extrac

ND=Not detected; NM=Not measured; A=Anomalous value; H=Holding time exceeded; R=Calibration range exceeded.

J 13 #4 -Filtered

			Sample #4 June, 95 Mean S.D.	Detection Limit
ANIONS				
Alkalinity	PPM		94 3	10
Bromide	PPM		0.09 0.003	0.01
Chloride	PPM		6.9 0.2	0.002
Fluoride	PPM		2.11 0.007	0.006
Nitrate	PPM		9.21 0.02	0.01
Sulfate	PPM		17.80 0.07	0.02
Phosphate	PPM		0.083 0.008	0.02
MAJOR METALS				
Ca	PPM		13.6 0.20	0.62
Mg	PPM		2.00 0.01	0.02
K	PPM		4.43 0.04	0.062
Na	PPM		43.2 1.4	1.8
TRACE METALS				
Li 7	PPB		37.1 1.0	0.0185
Al 27	PPB		NM	0.051
Ti 47	PPB		0.64 0.08	0.0652
V 51	PPB	R	9.0 0.3	0.0123
Cr 52	PPB		0.81 0.04	0.04

ND=Not detected; NM=Not measured; A=Anomalous value; H=Holding time exceeded; R=Calibration range exceeded.

J 13 #4 Filtered (Page 2)

			Sample #4 June, 95 Mean S.D.	Detection Limit
Mn 55	PPB		3.66 0.06	0.0145
Ni 60	PPB		0.72 0.05	0.0257
Cu 63	PPB		0.77 0.02	0.0473
Zn 66	PPB		0.57 0.02	0.0559
Ge 73	PPB		0.32 0.02	0.0227
As 75	PPB		11.9 0.2	0.0363
Se 77	PPB		0.9 0.1	0.413
Rb 85	PPB	R	9.6 0.2	0.0115
Sr 86	PPB		38.8 0.5	0.0313
Mo 95	PPB		7.0 0.1	0.0091
Sn 117	PPB		ND	0.0113
Sb 121	PPB		0.300 0.005	0.0087
Cs 133	PPB		1.44 0.04	0.0117
Ba 135	PPB		1.11 0.05	0.03
W 182	PPB		0.94 0.03	0.0041
Tl 205	PPB		0.02 0.01	0.0176
U 238	PPB		0.45 0.01	0.0071

ND=Not detected; NM=Not measured; A=Anomalous value; H=Holding time exceeded; R=Calibration range exceeded.

J 13 #4 Filtered (Page 3)

		Sample #4 June, 95 Mean S.D.	Detection Limit
Be 9	PPT	ND	11.2
Co 59	PPT	18.5 1.9	8.6
Ga 71	PPT	ND	16.7
Zr 90	PPT	ND	7.6
Nb 93	PPT	5.92 0.17	3.3
Ru 99	PPT	ND	5.9
Rh 103	PPT	ND	4.9
Ag 107	PPT	ND	16.1
Cd 114	PPT	ND	18.4
In 115	PPT	ND	7.4
Te 125	PPT	ND	25.3
Hf 177	PPT	ND	5.7
Ta 181	PPT	ND	17.6
Re 187	PPT	7.5 0.9	4.6
Ir 193	PPT	ND	8

ND=Not detected; NM=Not measured; A=Anomalous value; H=Holding time exceeded; R=Calibration range exceeded.

J 13 #4 Filtered (Page 4)

		Sample #4 June, 95 Mean S.D.	Detection Limit
Pt 195	PPT	ND	19.2
Au 197	PPT	ND	9.4
Pb 208	PPT	118 5	12.2
Bi 209	PPT	ND	8.7

ND=Not detected; NM=Not measured; A=Anomalous value; H=Holding time exceeded; R=Calibration range exceeded.

J 13 #4 Filtered (Page 5)

		Sample #4 June, 95 Mean S.D.			Detection Limit		
		D	I	E	D	I	E
Y 89	PPT	2.8 0.3	5.71 0.17		0.66	0.03	
La 139	PPT	ND	5.39 0.30		1.3	0.05	
Ce 140	PPT	1.7 1.1	4.26 0.05		0.78	0.03	
Pr 141	PPT		0.8 0.1			0.1	
Nd 143	PPT		2.7 0.5			0.18	
Sm 147	PPT		7.0 0.2			0.19	
Eu 153	PPT			0.47 0.06			0.08
Gd 158	PPT		0.66 0.15			0.29	
Tb 159	PPT		0.12 0.05			0.07	
Dy 163	PPT		0.58 0.23			0.28	
Ho 165	PPT		0.10 0.03			0.06	
Er 166	PPT		0.32 0.06			0.16	
Tm 169	PPT		ND			0.05	
Yb 173	PPT		ND			0.33	
Lu 175	PPT		ND			0.08	
Th 232	PPT		0.97 0.05			7.1	

D = Direct analysis; I = Preconcentration by ion exchange; E = Preconcentration by extractio

ND=Not detected; NM=Not measured; A=Anomalous value; H=Holding time exceeded; R=Calibration range exceeded.

J 13 #4 -Unfiltered

			Sample #4 June, 95 Mean S.D.	Detection Limit
ANIONS				
Alkalinity	PPM		NM	10
Bromide	PPM		0.046 0.003	0.01
Chloride	PPM		6.67 0.11	0.002
Fluoride	PPM		2.14 0.033	0.006
Nitrate	PPM		9.31 0.118	0.01
Sulfate	PPM		17.9 0.075	0.02
Phosphate	PPM		0.071 0.006	0.02
MAJOR METALS				
Ca	PPM		13.2 0.1	0.62
Mg	PPM		2.01 0.02	0.02
K	PPM		4.40 0.05	0.062
Na	PPM		43.4 0.6	1.8
TRACE METALS				
Li 7	PPB		37 1	0.0185
Al 27	PPB			0.051
Ti 47	PPB		ND	0.0652
V 51	PPB	R	8.68 0.02	0.0123
Cr 52	PPB		0.63 0.01	0.04

ND=Not detected; NM=Not measured; A=Anomalous value; H=Holding time exceeded; R=Calibration range exceeded.

J 13 #4 -Unfiltered (Page 2)

			Sample #4 June, 95 Mean S.D.	Detection Limit
Mn 55	PPB		3.85 0.09	0.0145
Ni 60	PPB		0.60 0.03	0.0257
Cu 63	PPB		3.54 0.06	0.0473
Zn 66	PPB		3.1 0.1	0.0559
Ge 73	PPB		0.315 0.005	0.0227
As 75	PPB		12.5 0.3	0.0363
Se 77	PPB		0.66 0.04	0.413
Rb 85	PPB	R	9.4 0.1	0.0115
Sr 86	PPB		39.6 0.3	0.0313
Mo 95	PPB		ND	0.0091
Sn 117	PPB		0.015 0.003	0.0113
Sb 121	PPB		0.245 0.003	0.0087
Cs 133	PPB		1.42 0.03	0.0117
Ba 135	PPB		1.13 0.01	0.03
W 182	PPB		0.94 0.01	0.0041
Tl 205	PPB		0.02 0.01	0.0176
U 238	PPB		0.468 0.005	0.0071

ND=Not detected; NM=Not measured; A=Anomalous value; H=Holding time exceeded; R=Calibration range exceeded.

J 13 #4 -Unfiltered (Page 3)

		Sample #4 June, 95 Mean S.D.	Detection Limit
Be 9	PPT	61 11	11.2
Co 59	PPT	17 2	8.6
Ga 71	PPT	ND	16.7
Zr 90	PPT	302 3	7.6
Nb 93	PPT	22 2	3.3
Ru 99	PPT	ND	5.9
Rh 103	PPT	ND	4.9
Ag 107	PPT	ND	16.1
Cd 114	PPT	ND	18.4
In 115	PPT	ND	7.4
Te 125	PPT	ND	25.3
Hf 177	PPT	9 3	5.7
Ta 181	PPT	ND	17.6
Re 187	PPT	5.8 0.7	4.6
Ir 193	PPT	ND	8

ND=Not detected; NM=Not measured; A=Anomalous value; H=Holding time exceeded; R=Calibration range exceeded.

J 13 #4 -Unfiltered (Page 4)

		Sample #4 June, 95 Mean S.D.	Detection Limit
Pt 195	PPT	ND	19.2
Au 197	PPT	ND	9.4
Pb 208	PPT	283 6	12.2
Bi 209	PPT	ND	8.7

ND=Not detected; NM=Not measured; A=Anomalous value; H=Holding time exceeded; R=Calibration range exceeded.

J 13 #4 -Unfiltered (Page 5)

		Sample #4 June, 95 Mean S.D.			Detection Limit		
		D	I	E	D	I	E
Y 89	PPT	5.1 0.2	4.72 0.12		0.66	0.03	
La 139	PPT	1.9 0.1	2.47 0.05		1.3	0.05	
Ce 140	PPT	3.3 0.6	2.55 0.12		0.78	0.03	
Pr 141	PPT		0.26 0.02			0.1	
Nd 143	PPT		1.1 0.2			0.18	
Sm 147	PPT		0.3 0.1			0.19	
Eu 153	PPT			0.60 0.06			0.08
Gd 158	PPT		ND			0.29	
Tb 159	PPT		ND			0.07	
Dy 163	PPT		0.6 0.2			0.28	
Ho 165	PPT		0.09 0.02			0.06	
Er 166	PPT		0.4 0.1			0.16	
Tm 169	PPT		0.09 0.02			0.05	
Yb 173	PPT		0.5 0.1			0.33	
Lu 175	PPT		ND			0.08	
Th 232	PPT		0.34 0.07			7.1	

D = Direct analysis; I = Preconcentration by ion exchange; E = Preconcentration by extracti

ND=Not detected; NM=Not measured; A=Anomalous value; H=Holding time exceeded; R=Calibration range exceeded.

EFAP - MV - 1, Army Well

		Sample #3 June, 1994 Mean S.D.	Detection Limit
ANIONS			
Alkalinity	PPM	188 6	10
Bromide	PPM	0.157 0.008	0.05
Chloride	PPM	17.875 0.006	0.08
Fluoride	PPM	0.922 0.008	0.033
Nitrate	PPM	1.448 0.003	0.004
Sulfate	PPM	52.5 0.3	0.032
Phosphate	PPM	ND	0.1
MAJOR METALS			
Ca	PPM	47.0 0.3	0.08
Mg	PPM	21.6 0.2	0.096
K	PPM	5.41 0.04	0.044
Na	PPM	42 2	1.13
TRACE METALS			
Li 7	PPB	44 1	0.04
Al 27	PPB	0.70 0.03	0.04
Ti 47	PPB	0.53 0.03	0.02
V 51	PPB	1.57 0.02	0.003
Cr 52	PPB	3.38 0.06	0.02

ND=Not detected; NM=Not measured; A=Anomalous value; H=Holding time exceeded; and R=Calibration range exceeded.

EFAP - MV - 1 (Page 2)

		Sample #3 June, 1994 Mean S.D.	Detection Limit
Mn 55	PPB	0.165 0.004	0.010
Ni 60	PPB	0.98 0.02	0.03
Cu 63	PPB	1.97 0.05	0.012
Zn 66	PPB	2.01 0.09	0.03
Ge 73	PPB	0.30 0.03	0.007
As 75	PPB	9.6 0.2	0.0072
Se 77	PPB	1.31 0.07	0.031
Rb 85	PPB	8.8 0.1	0.003
Sr 86	PPB	741 19	0.011
Mo 95	PPB	5.6 0.3	0.007
Sn 117	PPB	0.043 0.007	0.006
Sb 121	PPB	0.191 0.008	0.002
Cs 133	PPB	1.79 0.03	0.0005
Ba 135	PPB	80 2	0.02
W 182	PPB	0.17 0.01	0.001
Tl 205	PPB	0.096 0.004	0.008
U 238	PPB	2.34 0.06	0.005

ND=Not detected; NM=Not measured; A=Anomalous value; H=Holding time exceeded; and R=Calibration range exceeded.

EFAP - MV - 1 (Page 3)

		Sample #3 June, 1994 Mean S.D.	Detection Limit
Be 9	PPT	209 25	10
Co 59	PPT	29 1	0.4
Ga 71	PPT	10 4	3.7
Zr 90	PPT	17 3	10
Nb 93	PPT	19 3	3
Ru 99	PPT	8 2	4.5
Rh 103	PPT	ND	2
Ag 107	PPT	ND	23
Cd 114	PPT	ND	5.9
In 115	PPT	6 1	0.7
Te 125	PPT	53 13	8.2
Hf 177	PPT	ND	5
Ta 181	PPT	28 3	1.5
Re 187	PPT	24 4	2.6
Ir 193	PPT	29 2	4.2

ND=Not detected; NM=Not measured; A=Anomalous value; H=Holding time exceeded; and R=Calibration range exceeded.

EFAP - MV - 1 (Page 4)

		Sample #3 June, 1994 Mean S.D.	Detection Limit
Pt 195	PPT	25 2	10
Au 197	PPT	ND	10
Pb 208	PPT	897 9	5.4
Bi 209	PPT	ND	1.4

ND=Not detected; NM=Not measured; A=Anomalous value; H=Holding time exceeded; and R=Calibration range exceeded.

EFAP - MV - 1 (Page 5)

		Sample #3 June, 1994 Mean S.D.			Detection Limit		
		D	I	E	D	I	E
Y 89	PPT	3.3 0.2			0.5		
La 139	PPT	1.2 0.1			0.24		
Ce 140	PPT	ND			0.8		
Pr 141	PPT		0.31 0.01			0.02	
Nd 143	PPT		1.31 0.09			0.03	
Sm 147	PPT		4.7 0.2			0.04	
Eu 153	PPT			0.08 0.02			0.02
Gd 158	PPT		0.28 0.03			0.04	
Tb 159	PPT		0.051 0.007			0.02	
Dy 163	PPT		0.24 0.03			0.01	
Ho 165	PPT		0.065 0.006			0.01	
Er 166	PPT		ND			0.03	
Tm 169	PPT		0.031 0.002			0.02	
Yb 173	PPT		0.14 0.02			0.04	
Lu 175	PPT		0.029 0.002			0.02	
Th 232	PPT		0.4 0.1			0.2	

D = Direct analysis; I = Preconcentration by ion exchange; E = Preconcentration by extraction

ND=Not detected; NM=Not measured; A=Anomalous value; H=Holding time exceeded; and R=Calibration range exceeded.

NTS Well ER-30 - 500-ft. Depth

		Sample #1 Feb., 1995 Mean S.D.	Detection Limit
ANIONS			
Alkalinity	PPM	99 3	10
Bromide	PPM	0.20 0.01	0.01
Chloride	PPM	5.67 0.01	0.002
Fluoride	PPM	1.53 0.02	0.006
Nitrate	PPM	21.6 0.05	0.01
Sulfate	PPM	13.2 0.3	0.02
MAJOR METALS			
Ca	PPM	4.0 0.2	0.26
Mg	PPM	0.062 0.005	0.008
K	PPM	1.87 0.05	0.05
Na	PPM	66 2	1
TRACE METALS			
Li 7	PPB	56 1	0.0319
Al 27	PPB	19.0 0.2	0.051
Ti 49	PPB	0.26 0.01	0.021
V 51	PPB	8.3 0.2	0.0305
Cr 52	PPB	2.2 0.1	0.2984

ND = Not detected; NM = Not measured; A = Anomalous value; H = Holding time exceeded; and R = Calibration curve exceeded.

NTS Well ER-30 - 500-ft. Depth (page 2)

		Sample #1 Feb., 1995 Mean S.D.	Detection Limit
Mn 55	PPB	18.2 0.2	0.0109
Ni 60	PPB	0.42 0.07	0.0342
Cu 65	PPB	0.38 0.01	0.0195
Zn 66	PPB	0.11 0.02	0.0468
Ge 73	PPB	0.16 0.06	0.007
As 75	PPB	11.6 0.3	0.0291
Se 77	PPB	0.6 0.1	0.194
Rb 85	PPB	4.6 0.1	0.0057
Sr 86	PPB	12.4 0.1	0.0103
Mo 97	PPB	4.3 0.1	0.037
Sn 117	PPB	ND	0.015
Sb 123	PPB	0.295 0.004	0.004
Cs 133	PPB	0.522 0.004	0.0056
Ba 135	PPB	1.05 0.01	0.011
W 184	PPB	0.91 0.02	0.005
Tl 205	PPB	0.023 0.002	0.0067
U 238	PPB	2.09 0.03	0.0072

ND = Not detected; NM = Not measured; A = Anomalous value; H = Holding time exceeded; and R = Calibration curve exceeded.

NTS Well ER-30 - 500-ft. Depth (page 3)

		Sample #1 Feb., 1995 Mean S.D.	Detection Limit
Be 9	PPT	ND	54.6
Co 59	PPT	ND	16.6
Ga 71	PPT	175 5	6.5
Zr 90	PPT	ND	19
Nb 93	PPT	ND	5.7
Ru 99	PPT	ND	8.5
Rh 103	PPT	ND	6
Ag 107	PPT	ND	13.3
Cd 114	PPT	ND	10.2
In 115	PPT	ND	6.3
Te 125	PPT	ND	58.2
Hf 177	PPT	ND	21.8
Ta 181	PPT	ND	15.4
Re 187	PPT	9.7 0.9	2.7
Ir 193	PPT	ND	5.2

ND = Not detected; NM = Not measured; A = Anomalous value; H = Holding time exceeded; and R = Calibration curve exceeded.

NTS Well ER-30 - 500-ft. Depth (page 4)

		Sample #1 Feb., 1995 Mean S.D.	Detection Limit
Pt 195	PPT	ND	3.8
Au 197	PPT	ND	14.8
Pb 208	PPT	118 2	5.2
Bi 209	PPT	ND	7.9

ND = Not detected; NM = Not measured; A = Anomalous value; H = Holding time exceeded; and R = Calibration curve exceeded.

NTS Well ER-30 - 500-ft. Depth (page 5)

		Sample #1 Feb., 1995 Mean S.D.			Detection Limit		
		D	I	E	D	I	E
Y 89	PPT	4.6 0.5			1.6		
La 139	PPT	2.9 0.2			2.4		
Ce 140	PPT	5.5 0.5			1.5		
Pr 141	PPT		ND			1.2	
Nd 146	PPT		ND			4.6	
Sm 147	PPT		ND			5.1	
Eu 153	PPT			ND			2.2
Gd 158	PPT		ND			3.0	
Tb 159	PPT		ND			1.8	
Dy 163	PPT		ND			1.9	
Ho 165	PPT		ND			1.9	
Er 166	PPT		ND			2.6	
Tm 169	PPT		ND			1.1	
Yb 174	PPT		ND			2.3	
Lu 175	PPT		ND			1.4	
Th 232	PPT		ND			2.6	

ND = Not detected; NM = Not measured; A = Anomalous value; H = Holding time exceeded; and R = Calibration curve exceeded.

NTS Well ER-30 - 700-ft. Depth

		Sample #1 Jan., 1995 Mean S.D.	Detection Limit
ANIONS			
Alkalinity	PPM	105 7	10
Bromide	PPM	0.120 0.004	0.01
Chloride	PPM	5.7 0.2	0.002
Fluoride	PPM	1.27 0.03	0.006
Nitrate	PPM	26.50 0.02	0.01
Sulfate	PPM	12.0 0.3	0.02
MAJOR METALS			
Ca	PPM	2.26 0.09	0.26
Mg	PPM	0.082 0.003	0.008
K	PPM	1.01 0.02	0.05
Na	PPM	67 1	1
TRACE METALS			
Li 7	PPB	63 1	0.0319
Al 27	PPB	4.71 0.06	0.051
Ti 49	PPB	0.16 0.01	0.021
V 51	PPB	4.9 0.1	0.0305
Cr 52	PPB	2.4 0.1	0.2984

ND = Not detected; NM = Not measured; A = Anomalous value; H = Holding time exceeded; and R = Calibration curve exceeded.

NTS Well ER-30 - 700-ft. Depth (page 2)

		Sample #1 Jan., 1995 Mean S.D.	Detection Limit
Mn 55	PPB	17.0 0.4	0.0109
Ni 60	PPB	0.67 0.01	0.0342
Cu 65	PPB	0.34 0.01	0.0195
Zn 66	PPB	0.19 0.01	0.0468
Ge 73	PPB	0.187 0.07	0.007
As 75	PPB	7.8 0.2	0.0291
Se 77	PPB	0.6 0.1	0.194
Rb 85	PPB	3.7 0.1	0.0057
Sr 86	PPB	6.72 0.04	0.0103
Mo 97	PPB	2.97 0.05	0.037
Sn 117	PPB	ND	0.015
Sb 123	PPB	0.34 0.01	0.004
Cs 133	PPB	1.54 0.04	0.0056
Ba 135	PPB	1.18 0.02	0.011
W 184	PPB	0.664 0.003	0.005
Tl 205	PPB	0.024 0.002	0.0067
U 238	PPB	1.80 0.03	0.0072

ND = Not detected; NM = Not measured; A = Anomalous value; H = Holding time exceeded; and R = Calibration curve exceeded.

NTS Well ER-30 - 700-ft. Depth (page 3)

		Sample #1 Jan., 1995 Mean S.D.	Detection Limit
Be 9	PPT	ND	54.6
Co 59	PPT	57 5	16.6
Ga 71	PPT	168 5	6.5
Zr 90	PPT	ND	19
Nb 93	PPT	ND	5.7
Ru 99	PPT	ND	8.5
Rh 103	PPT	ND	6
Ag 107	PPT	ND	13.3
Cd 114	PPT	ND	10.2
In 115	PPT	ND	6.3
Te 125	PPT	ND	58.2
Hf 177	PPT	ND	21.8
Ta 181	PPT	ND	15.4
Re 187	PPT	11 1	2.7
Ir 193	PPT	ND	5.2

ND = Not detected; NM = Not measured; A = Anomalous value; H = Holding time exceeded; and R = Calibration curve exceeded.

NTS Well ER-30 - 700-ft. Depth (page 4)

		Sample #1 Jan., 1995 Mean S.D.	Detection Limit
Pt 195	PPT	ND	3.8
Au 197	PPT	ND	14.8
Pb 208	PPT	166 5	5.2
Bi 209	PPT	ND	7.9

ND = Not detected; NM = Not measured; A = Anomalous value; H = Holding time exceeded; and R = Calibration curve exceeded.

NTS Well ER-30 - 700-ft. Depth (page 5)

		Sample #1 Jan., 1995 Mean S.D.			Detection Limit		
		D	I	E	D	I	E
Y 89	PPT	2.4 0.5			1.6		
La 139	PPT	4.4 0.8			2.4		
Ce 140	PPT	4.6 0.5			1.5		
Pr 141	PPT		ND			1.2	
Nd 146	PPT		ND			4.6	
Sm 147	PPT		ND			5.1	
Eu 153	PPT			ND			2.2
Gd 158	PPT		ND			3.0	
Tb 159	PPT		ND			1.8	
Dy 163	PPT		ND			1.9	
Ho 165	PPT		ND			1.9	
Er 166	PPT		ND			2.6	
Tm 169	PPT		ND			1.1	
Yb 174	PPT		ND			2.3	
Lu 175	PPT		ND			1.4	
Th 232	PPT		ND			2.6	

ND = Not detected; NM = Not measured; A = Anomalous value; H = Holding time exceeded; and R = Calibration curve exceeded.

SPRING MOUNTAINS, NV

Spring Mountains - Field Measurements

SITE	Collection Date	pH	Temperature Celsius	Conductivity (uS/cm)	Alkalinity (mg/L)	TDS (mg/L)	Altitude (ft)	Latitude	Longitude
Cold Creek Spring	3/95	7.6	10.8	522	215	265	6220	36 24.30	115 44.89
Willow Spring	3/95	7.9	17.5	189.7	68.0	94.0	4590	36 09.67	115 29.83
Grapevine Spring	4/95	7.7	22.9	644	195	315	4400		
Deer Creek Spring #2	6/95	8.5	7.42	326	160	161	8680	36 18.33	115 37.67
Willow Creek Spring	6/95	8.0	11.9	558	210	285	5990	36 25.00	115 45.83

Spring Mountains Springs - Cold Creek

		Sample #1 March 95 Mean S.D.		Detection Limit
ANIONS				
Alkalinity	PPM	215 21		10
Bromide	PPM	ND		0.01
Chloride	PPM	1.86 0.03	Field blank contaminated (4.64ppm)	0.002
Fluoride	PPM	0.120 0.004		0.006
Nitrate	PPM	1.490 0.002		0.01
Sulfate	PPM	7.74 0.03	Field blank contaminated (3.48ppm)	0.02
MAJOR METALS				
Ca	PPM	79 1		0.4
Mg	PPM	15.0 0.1		0.1
K	PPM	0.47 0.03		0.05
Na	PPM	2.0 0.1	Field blank contaminated (6.2ppm)	0.04
TRACE METALS				
Li 7	PPB	1.31 0.04		0.02
Al 27	PPB	NM		0.05
Ti 47	PPB	0.21 0.01		0.07
V 51	PPB	0.69 0.03		0.01
Cr 52	PPB	0.61 0.06		0.04

NM = Not measured; ND = See page 4; A = Anomalous value; R = Exceeds calibration range.

Spring Mountains Springs - Cold Creek (Page 2)

		Sample #1 March 95 Mean S.D.	Detection Limit
Mn 55	PPB	ND	0.01
Ni 60	PPB	1.32 0.06	0.03
Cu 63	PPB	0.28 0.02	0.05
Zn 66	PPB	1.4 0.1	0.06
Ge 73	PPB	ND	0.02
As 75	PPB	0.41 0.02	0.04
Se 77	PPB	1.1 0.3	0.41
Rb 85	PPB	0.29 0.02	0.01
Sr 86	PPB	253 2	0.03
Mo 95	PPB	0.88 0.06	0.009
Sn 117	PPB	ND	0.011
Sb 121	PPB	0.035 0.002	0.009
Cs 133	PPB	ND	0.012
Ba 135	PPB	21.1 0.4	0.03
W 182	PPB	0.008 0.001	0.004
Tl 205	PPB	0.04 0.02	0.018
U 238	PPB	1.8 0.1	0.007

NM = Not measured; ND = See page 4; A = Anomalous value; R = Exceeds calibration range.

Spring Mountains Springs - Cold Creek (Page 3)

		Sample #1 March 95 Mean S.D.	Detection Limit
Be 9	PPT	ND	11.2
Co 59	PPT	60 1	8.6
Ga 71	PPT	ND	16.7
Zr 90	PPT	25 3	7.6
Nb 93	PPT	ND	3.3
Ru 99	PPT	ND	5.9
Rh 103	PPT	7.3 0.7	4.9
Ag 107	PPT	ND	16.1
Cd 114	PPT	ND	18.4
In 115	PPT	ND	7.4
Te 125	PPT	ND	25.3
Hf 177	PPT	ND	5.7
Ta 181	PPT	ND	17.6
Re 187	PPT	11 1	4.6
Ir 193	PPT	ND	8

NM = Not measured; ND = See page 4; A = Anomalous value; R = Exceeds calibration range.

Spring Mountains Springs - Cold Creek (Page 4)

		Sample #1 March 95 Mean S.D.	Detection Limit
Pt 195	PPT	ND	19.2
Au 197	PPT	ND	9.4
Pb 208	PPT	ND	12.2
Bi 209	PPT	ND	8.7

ND = Not detected: when the measurement is < or = zero; when the measurement is less than the detection limit; when the %RSD is > 50; or when subtracting the standard deviation from the value forces it below the detection limit.

NM = Not measured; ND = See page 4; A = Anomalous value; R = Exceeds calibration range.

Spring Mountains Springs - Cold Creek (Page 5)

		Sample #1 March 95 Mean S.D.		Detection Limit	
		D	I	D	I
Y 89	PPT	14.8 0.4	9.9 0.1	0.66	0.03
La 139	PPT	4.7 0.3	2.9 0.2	1.3	0.05
Ce 140	PPT	1.0 0.2	0.8 0.2	0.78	0.03
Pr 141	PPT		0.41 0.02		0.1
Nd 143	PPT		2.4 0.4		0.18
Sm 147	PPT		0.53 0.15		0.19
Eu 153	PPT		4.16 0.06		0.08
Gd 158	PPT		0.67 0.15		0.29
Tb 159	PPT		0.10 0.02		0.07
Dy 163	PPT		0.69 0.17		0.28
Ho 165	PPT		0.20 0.05		0.06
Er 166	PPT		0.50 0.13		0.16
Tm 169	PPT		ND		0.05
Yb 173	PPT		0.59 0.12		0.33
Lu 175	PPT		0.09 0.01		0.08
Th 232	PPT		0.25 0.06		0.13

D = Direct analysis; I = Preconcentration by ion exchange;

NM = Not measured; ND = See page 4; A = Anomalous value; R = Exceeds calibration range.

Spring Mountains Springs - Deer Creek #2

		Sample #1 June 95 Mean S.D.		Detection Limit
ANIONS				
Alkalinity	PPM	160 6		10
Bromide	PPM	ND		0.01
Chloride	PPM	0.83 0.05		0.002
Fluoride	PPM	0.084 0.003	Field blank contaminated (0.057ppm)	0.006
Nitrate	PPM	0.133 0.002		0.01
Sulfate	PPM	2.46 0.01		0.02
MAJOR METALS				
Ca	PPM	52 1		0.4
Mg	PPM	11.4 0.1		0.1
K	PPM	0.28 0.02		0.06
Na	PPM	0.78 0.04		0.7
TRACE METALS				
Li 7	PPB	0.50 0.03		0.02
Al 27	PPB	NM		0.05
Ti 47	PPB	0.21 0.05		0.07
V 51	PPB	0.24 0.01		0.01
Cr 52	PPB	0.42 0.06		0.04

NM = Not measured; ND = See page 4; A = Anomalous value; R = Exceeds calibration range.

Spring Mountains Springs - Deer Creek #2 (Page 2)

		Sample #1 June95 Mean S.D.	Detection Limit
Mn 55	PPB	ND	0.01
Ni 60	PPB	0.85 0.03	0.03
Cu 63	PPB	0.29 0.02	0.05
Zn 66	PPB	0.456 0.008	0.06
Ge 73	PPB	ND	0.02
As 75	PPB	0.18 0.02	0.04
Se 77	PPB	ND	0.41
Rb 85	PPB	0.143 0.006	0.01
Sr 86	PPB	47 1	0.03
Mo 95	PPB	0.41 0.03	0.009
Sn 117	PPB	ND	0.011
Sb 121	PPB	0.046 0.002	0.009
Cs 133	PPB	ND	0.012
Ba 135	PPB	6.3 0.1	0.03
W 182	PPB	0.007 0.001	0.004
Tl 205	PPB	ND	0.018
U 238	PPB	0.55 0.02	0.007

NM = Not measured; ND = See page 4; A = Anomalous value; R = Exceeds calibration range.

Spring Mountains Springs - Deer Creek #2 (Page 3)

		Sample #1 June 95 Mean S.D.	Detection Limit
Be 9	PPT	ND	11.2
Co 59	PPT	54 3	8.6
Ga 71	PPT	ND	16.7
Zr 90	PPT	26.4 1.5	7.6
Nb 93	PPT	ND	3.3
Ru 99	PPT	ND	5.9
Rh 103	PPT	ND	4.9
Ag 107	PPT	ND	16.1
Cd 114	PPT	ND	18.4
In 115	PPT	ND	7.4
Te 125	PPT	ND	25.3
Hf 177	PPT	ND	5.7
Ta 181	PPT	ND	17.6
Re 187	PPT	8 1	4.6
Ir 193	PPT	ND	8

NM = Not measured; ND = See page 4; A = Anomalous value; R = Exceeds calibration range.

Spring Mountains Springs - Deer Creek #2 (Page 4)

		Sample #1 June 95 Mean S.D.	Detection Limit
Pt 195	PPT	ND	19.2
Au 197	PPT	ND	9.4
Pb 208	PPT	ND	12.2
Bi 209	PPT	ND	8.7

ND = Not detected: when the measurement is < or = zero; when the measurement is less than the detection limit; when the %RSD is > 50; or when subtracting the standard deviation from the value forces it below the detection limit.

NM = Not measured; ND = See page 4; A = Anomalous value; R = Exceeds calibration range.

Spring Mountains Springs - Deer Creek #2 (Page 5)

		Sample #1 June 95 Mean S.D.		Detection Limit	
		D	I	D	I
Y 89	PPT	24 3	15.7 0.5	0.66	0.03
La 139	PPT	7.4 0.5	4.6 0.4	1.3	0.05
Ce 140	PPT	ND	0.37 0.09	0.78	0.03
Pr 141	PPT		ND		0.1
Nd 143	PPT		3.9 0.4		0.18
Sm 147	PPT		1.0 0.2		0.19
Eu 153	PPT		3.3 0.1		0.08
Gd 158	PPT		1.2 0.1		0.29
Tb 159	PPT		0.14 0.01		0.07
Dy 163	PPT		1.1 0.1		0.28
Ho 165	PPT		0.25 0.05		0.06
Er 166	PPT		0.88 0.16		0.16
Tm 169	PPT		0.12 0.03		0.05
Yb 173	PPT		0.59 0.17		0.33
Lu 175	PPT		0.11 0.02		0.08
Th 232	PPT		0.20 0.04		0.13

D = Direct analysis; I = Preconcentration by ion exchange;

NM = Not measured; ND = See page 4; A = Anomalous value; R = Exceeds calibration range.

Spring Mountains Springs - Grapevine

		Sample #1 April 95 Mean S.D.		Detection Limit
ANIONS				
Alkalinity	PPM	195 1		10
Bromide	PPM	0.140 0.003		0.01
Chloride	PPM	14.7 0.2		0.002
Fluoride	PPM	0.097 0.001		0.006
Nitrate	PPM	1.10 0.01		0.01
Sulfate	PPM	112.4 0.5	Field blank contaminated (2.83ppm)	0.02
MAJOR METALS				
Ca	PPM	57.2 0.6		0.4
Mg	PPM	38.4 0.2		0.1
K	PPM	1.81 0.03		0.05
Na	PPM	24.2 0.4		2
TRACE METALS				
Li 7	PPB	11.2 0.1		0.02
Al 27	PPB	NM		0.05
Ti 47	PPB	0.21 0.02		0.07
V 51	PPB	0.214 0.005		0.01
Cr 52	PPB	0.20 0.02		0.04

NM = Not measured; ND = See page 4; A = Anomalous value; R = Exceeds calibration range.

Spring Mountains Springs - Grapevine (Page 2)

		Sample #1 April 95 Mean S.D.	Detection Limit
Mn 55	PPB	ND	0.01
Ni 60	PPB	0.71 0.03	0.03
Cu 63	PPB	0.415 0.005	0.05
Zn 66	PPB	1.36 0.01	0.06
Ge 73	PPB	0.04 0.01	0.02
As 75	PPB	0.45 0.02	0.04
Se 77	PPB	0.84 0.05	0.41
Rb 85	PPB	1.05 0.02	0.01
Sr 86	PPB	727 6	0.03
Mo 95	PPB	0.70 0.02	0.009
Sn 117	PPB	0.012 0.003	0.011
Sb 121	PPB	ND	0.009
Cs 133	PPB	0.116 0.002	0.012
Ba 135	PPB	75 1	0.03
W 182	PPB	0.013 0.002	0.004
Tl 205	PPB	0.03 0.01	0.018
U 238	PPB	1.83 0.02	0.007

NM = Not measured; ND = See page 4; A = Anomalous value; R = Exceeds calibration range.

Spring Mountains Springs - Grapevine (Page 3)

		Sample #1 April 95 Mean S.D.	Detection Limit
Be 9	PPT	ND	11.2
Co 59	PPT	40 1	8.6
Ga 71	PPT	ND	16.7
Zr 90	PPT	ND	7.6
Nb 93	PPT	6 1	3.3
Ru 99	PPT	ND	5.9
Rh 103	PPT	19 1	4.9
Ag 107	PPT	ND	16.1
Cd 114	PPT	ND	18.4
In 115	PPT	ND	7.4
Te 125	PPT	ND	25.3
Hf 177	PPT	ND	5.7
Ta 181	PPT	ND	17.6
Re 187	PPT	6 1	4.6
Ir 193	PPT	ND	8

NM = Not measured; ND = See page 4; A = Anomalous value; R = Exceeds calibration range.

Spring Mountains Springs - Grapevine (Page 4)

		Sample #1 April 95 Mean S.D.	Detection Limit
Pt 195	PPT	ND	19.2
Au 197	PPT	18 5	9.4
Pb 208	PPT	ND	12.2
Bi 209	PPT	ND	8.7

ND = Not detected: when the measurement is < or = zero; when the measurement is less than the detection limit; when the %RSD is > 50; or when subtracting the standard deviation from the value forces it below the detection limit.

NM = Not measured; ND = See page 4; A = Anomalous value; R = Exceeds calibration range.

Spring Mountains Springs - Grapevine (Page 5)

		Sample #1 April 95 Mean S.D.		Detection Limit	
		D	I	D	I
Y 89	PPT	23 1	14.9 0.3	0.66	0.03
La 139	PPT	2.9 0.4	1.4 0.1	1.3	0.05
Ce 140	PPT	1.4 0.2	3.9 0.2	0.78	0.03
Pr 141	PPT		0.20 0.07		0.1
Nd 143	PPT		1.4 0.1		0.18
Sm 147	PPT		0.5 0.1		0.19
Eu 153	PPT		12.1 0.2		0.08
Gd 158	PPT		0.9 0.2		0.29
Tb 159	PPT		0.12 0.04		0.07
Dy 163	PPT		0.85 0.07		0.28
Ho 165	PPT		0.25 0.02		0.06
Er 166	PPT		0.8 0.1		0.16
Tm 169	PPT		0.10 0.01		0.05
Yb 173	PPT		0.70 0.05		0.33
Lu 175	PPT		ND		0.08
Th 232	PPT		0.26 0.05		0.13

D = Direct analysis; I = Preconcentration by ion exchange;

NM = Not measured; ND = See page 4; A = Anomalous value; R = Exceeds calibration range.

Spring Mountains Springs - Willow Creek

		Sample #1 June 95 Mean S.D.		Detection Limit
ANIONS				
Alkalinity	PPM	210 4		10
Bromide	PPM	ND		0.01
Chloride	PPM	1.87 0.04		0.002
Fluoride	PPM	0.147 0.002	Field blank contaminated (.057ppm)	0.006
Nitrate	PPM	1.51 0.01		0.01
Sulfate	PPM	6.78 0.04		0.02
MAJOR METALS				
Ca	PPM	72 1		0.4
Mg	PPM	12.8 0.2		0.1
K	PPM	0.46 0.03		0.06
Na	PPM	1.81 0.02		0.7
TRACE METALS				
Li 7	PPB	1.3 0.2		0.02
Al 27	PPB	NM		0.05
Ti 47	PPB	0.31 0.03		0.07
V 51	PPB	0.72 0.02		0.01
Cr 52	PPB	0.49 0.01		0.04

NM = Not measured; ND = See page 4; A = Anomalous value; R = Exceeds calibration range.

Spring Mountains Springs - Willow Creek (Page 2)

		Sample #1 June 95 Mean S.D.	Detection Limit
Mn 55	PPB	ND	0.01
Ni 60	PPB	1.26 0.12	0.03
Cu 63	PPB	0.26 0.01	0.05
Zn 66	PPB	1.2 0.2	0.06
Ge 73	PPB	ND	0.02
As 75	PPB	0.37 0.01	0.04
Se 77	PPB	0.76 0.07	0.41
Rb 85	PPB	0.293 0.005	0.01
Sr 86	PPB	320 4	0.03
Mo 95	PPB	0.74 0.05	0.009
Sn 117	PPB	ND	0.011
Sb 121	PPB	0.074 0.003	0.009
Cs 133	PPB	ND	0.012
Ba 135	PPB	21.8 0.4	0.03
W 182	PPB	0.010 0.001	0.004
Tl 205	PPB	ND	0.018
U 238	PPB	1.6 0.1	0.007

NM = Not measured; ND = See page 4; A = Anomalous value; R = Exceeds calibration range.

Spring Mountains Springs - Willow Creek (Page 3)

		Sample #1 June 95 Mean S.D.	Detection Limit
Be 9	PPT	ND	11.2
Co 59	PPT	58 10	8.6
Ga 71	PPT	ND	16.7
Zr 90	PPT	27 2	7.6
Nb 93	PPT	ND	3.3
Ru 99	PPT	ND	5.9
Rh 103	PPT	11.0 0.3	4.9
Ag 107	PPT	ND	16.1
Cd 114	PPT	ND	18.4
In 115	PPT	ND	7.4
Te 125	PPT	ND	25.3
Hf 177	PPT	7 1	5.7
Ta 181	PPT	ND	17.6
Re 187	PPT	15 1	4.6
Ir 193	PPT	ND	8

NM = Not measured; ND = See page 4; A = Anomalous value; R = Exceeds calibration range.

Spring Mountains Springs - Willow Creek (Page 4)

		Sample #1 Sample #1 June 95 Mean S.D.	Detection Limit
Pt 195	PPT	ND	19.2
Au 197	PPT	ND	9.4
Pb 208	PPT	ND	12.2
Bi 209	PPT	ND	8.7

ND = Not detected: when the measurement is < or = zero; when the measurement is less than the detection limit; when the %RSD is > 50; or when subtracting the standard deviation from the value forces it below the detection limit.

NM = Not measured; ND = See page 4; A = Anomalous value; R = Exceeds calibration range.

Spring Mountains Springs - Willow Creek (Page 5)

		Sample #1 June 95 Mean S.D.		Detection Limit	
		D	I	D	I
Y 89	PPT	27.5 0.1	24.4 0.3	0.66	0.03
La 139	PPT	9.5 0.3	7.6 0.2	1.3	0.05
Ce 140	PPT	1.4 0.2	0.7 0.1	0.78	0.03
Pr 141	PPT		1.4 0.2		0.1
Nd 143	PPT		5.1 0.2		0.18
Sm 147	PPT		4.3 0.7		0.19
Eu 153	PPT		11.1 0.4		0.08
Gd 158	PPT		1.9 0.2		0.29
Tb 159	PPT		0.28 0.07		0.07
Dy 163	PPT		1.74 0.17		0.28
Ho 165	PPT		0.34 0.03		0.06
Er 166	PPT		1.45 0.05		0.16
Tm 169	PPT		0.17 0.04		0.05
Yb 173	PPT		1.25 0.40		0.33
Lu 175	PPT		0.15 0.01		0.08
Th 232	PPT		0.31 0.03		0.13

D = Direct analysis; I = Preconcentration by ion exchange;

NM = Not measured; ND = See page 4; A = Anomalous value; R = Exceeds calibration range.

Spring Mountains Springs - Willow Spring (at Red Rock)

		Sample #1 March 95 Mean S.D.		Detection Limit
ANIONS				
Alkalinity	PPM	68 2		10
Bromide	PPM	0.03 0.01		0.01
Chloride	PPM	3.86 0.01	Field blank contaminated (4.64ppm)	0.002
Fluoride	PPM	0.10 0.01		0.006
Nitrate	PPM	0.70 0.01		0.01
Sulfate	PPM	17.67 0.06	Field blank contaminated (3.48ppm)	0.02
MAJOR METALS				
Ca	PPM	24.1 0.7		0.4
Mg	PPM	6.8 0.1		0.1
K	PPM	1.16 0.07		0.05
Na	PPM	4.0 0.1	Field blank contaminated (6.2ppm)	0.04
TRACE METALS				
Li 7	PPB	1.33 0.04		0.02
Al 27	PPB	NM		0.05
Ti 47	PPB	0.30 0.04		0.07
V 51	PPB	0.371 0.003		0.01
Cr 52	PPB	0.25 0.08		0.04

NM = Not measured; ND = See page 4; A = Anomalous value; R = Exceeds calibration range.

Spring Mountains Springs - Willow Spring (at Red Rock) (Page 2)

		Sample #1 March 95 Mean S.D.	Detection Limit
Mn 55	PPB	0.030 0.006	0.01
Ni 60	PPB	0.50 0.02	0.03
Cu 63	PPB	0.37 0.02	0.05
Zn 66	PPB	0.144 0.004	0.06
Ge 73	PPB	ND	0.02
As 75	PPB	0.27 0.02	0.04
Se 77	PPB	ND	0.41
Rb 85	PPB	1.72 0.03	0.01
Sr 86	PPB	87 1	0.03
Mo 95	PPB	0.27 0.01	0.009
Sn 117	PPB	0.016 0.003	0.011
Sb 121	PPB	0.026 0.004	0.009
Cs 133	PPB	0.040 0.001	0.012
Ba 135	PPB	67 1	0.03
W 182	PPB	ND	0.004
Tl 205	PPB	ND	0.018
U 238	PPB	0.141 0.003	0.007

NM = Not measured; ND = See page 4; A = Anomalous value; R = Exceeds calibration range.

Spring Mountains Springs - Willow Spring (at Red Rock) (Page 3)

		Sample #1 March 95 Mean S.D.	Detection Limit
Be 9	PPT	ND	11.2
Co 59	PPT	43 2	8.6
Ga 71	PPT	ND	16.7
Zr 90	PPT	0.037 0.002	7.6
Nb 93	PPT	ND	3.3
Ru 99	PPT	ND	5.9
Rh 103	PPT	ND	4.9
Ag 107	PPT	17 4	16.1
Cd 114	PPT	ND	18.4
In 115	PPT	ND	7.4
Te 125	PPT	ND	25.3
Hf 177	PPT	ND	5.7
Ta 181	PPT	ND	17.6
Re 187	PPT	7 1	4.6
Ir 193	PPT	ND	8

NM = Not measured; ND = See page 4; A = Anomalous value; R = Exceeds calibration range.

Spring Mountains Springs - Willow Spring (at Red Rock) (Page 4)

		Sample #1 March 95 Mean S.D.	Detection Limit
Pt 195	PPT	ND	19.2
Au 197	PPT	ND	9.4
Pb 208	PPT	ND	12.2
Bi 209	PPT	ND	8.7

ND = Not detected: when the measurement is < or = zero; when the measurement is less than the detection limit; when the %RSD is > 50; or when subtracting the standard deviation from the value forces it below the detection limit.

NM = Not measured; ND = See page 4; A = Anomalous value; R = Exceeds calibration range.

Spring Mountains Springs - Willow Spring (at Red Rock) (Page 5)

		Sample #1 March 95 Mean S.D. D	Sample #1 March 95 Mean S.D. I	Detection Limit D	Detection Limit I
Y 89	PPT	103 11	61.8 0.5	0.66	0.03
La 139	PPT	60 5	36.6 0.3	1.3	0.05
Ce 140	PPT	26 2	13.1 0.3	0.78	0.03
Pr 141	PPT	16 1	9.7 0.3		0.1
Nd 143	PPT		47 1		0.18
Sm 147	PPT		11.5 0.3		0.19
Eu 153	PPT		16.3 0.4		0.08
Gd 158	PPT		13.7 0.2		0.29
Tb 159	PPT		1.8 0.1		0.07
Dy 163	PPT		9.9 0.6		0.28
Ho 165	PPT		2.0 0.1		0.06
Er 166	PPT		5.5 0.3		0.16
Tm 169	PPT		0.7 0.1		0.05
Yb 173	PPT		4.3 0.5		0.33
Lu 175	PPT		0.71 0.05		0.08
Th 232	PPT		1.4 0.3		0.13

D = Direct analysis; I = Preconcentration by ion exchange;

NM = Not measured; ND = See page 4; A = Anomalous value; R = Exceeds calibration range.

CRATER FLAT AND AMARGOSA VALLEY, NV

CRATER FLAT AND AMARGOSA VALLEY, NV - Field Measurements

(Environmental Field Activity Plan)

SITE	Collection Date	pH	Temperature Celsius	Conductivity (uS/cm)	Alkalinity (mg/L)	TDS (mg/L)	Altitude (ft)	Latitude	Longitude
Windmill Well	9/94	7.59	23.4	149	144	226	4455	37 00.25	116 33.42
Ranch Spring	9/94	7.13	18.1	293	231	445		35 07.53	116 36.70
CF-1a Coffer Well, formerly Gexa or USNG	6/94	7.56	27.3	1373	214	365	4081	36 54.75	116 38.65
Cinderlite	5/94	7.98	32.9	148	152	222	2800	36 41.80	116 30.20
Lathrop Wells NDOT Rest Stop	5/94	7.48	26.9	552	128	274	2657	36 38.58	116 23.67
Saga Exp. Well (VH-2),(CF-2a), Sterling Mine	6/94	7.13	32.7	929	290	465		36 48.35	116 34.62
Jackass Aero Park formerly Rigler Airport	6/92	8.73	30.1	332		166	2488	36 38.40	116 24.59
	5/94	9.05	30.0	324	100	170			

Cind R-lite well

		Sample #1 May, 1994 Mean S.D.	Detection Limit
ANIONS			
Alkalinity	PPM	152 4	10
Bromide	PPM	ND	0.05
Chloride	PPM	8.73 0.05	0.08
Fluoride	PPM	2.324 0.001	0.033
Nitrate	PPM	4.64 0.01	0.004
Sulfate	PPM	43.1 0.1	0.032
Phosphate	PPM	ND	0.1
MAJOR METALS			
Ca	PPM	13.3 0.0	0.08
Mg	PPM	6.7 0.3	0.096
K	PPM	3.9 0.2	0.044
Na	PPM	73 2	1.13
TRACE METALS			
Li 7	PPB	64.9 0.7	0.04
Al 27	PPB	1.08 0.04	0.04
Ti 47	PPB	0.93 0.03	0.02
V 51	PPB	4.79 0.06	0.003
Cr 52	PPB	1.4 0.2	0.02

ND=Not detected; NM=Not measured; A=Anomalous value; H=Holding time exceeded; and R=Calibration range exceeded.

Cind R-lite well (Page 2)

		Sample #1 May, 1994 Mean S.D.	Detection Limit
Mn 55	PPB	0.187 0.008	0.010
Ni 60	PPB	0.11 0.02	0.03
Cu 63	PPB	1.47 0.04	0.012
Zn 66	PPB	69 1	0.03
Ge 73	PPB	0.82 0.06	0.007
As 75	PPB	19.7 0.4	0.0072
Se 77	PPB	1.05 0.08	0.031
Rb 85	PPB	12.7 0.6	0.003
Sr 86	PPB	105 5	0.011
Mo 95	PPB	5.5 0.1	0.007
Sn 117	PPB	0.034 0.005	0.006
Sb 121	PPB	0.41 0.02	0.002
Cs 133	PPB	1.52 0.04	0.0005
Ba 135	PPB	1.34 0.04	0.02
W 182	PPB	1.9 0.1	0.001
Tl 205	PPB	0.030 0.001	0.008
U 238	PPB	2.54 0.07	0.005

ND=Not detected; NM=Not measured; A=Anomalous value; H=Holding time exceeded; and R=Calibration range exceeded.

Cind R-lite well (Page 3)

		Sample #1 May, 1994 Mean S.D.	Detection Limit
Be 9	PPT	204 60	10
Co 59	PPT	27 2	0.4
Ga 71	PPT	48 2	3.7
Zr 90	PPT	14 4	10
Nb 93	PPT	20 4	3
Ru 99	PPT	ND	4.5
Rh 103	PPT	15.1 2	2
Ag 107	PPT	ND	23
Cd 114	PPT	12 4	5.9
In 115	PPT	20 2	0.7
Te 125	PPT	ND	8.2
Hf 177	PPT	ND	5
Ta 181	PPT	25 3	1.5
Re 187	PPT	16.143 0.004	2.6
Ir 193	PPT	8 2	4.2

ND=Not detected; NM=Not measured; A=Anomalous value; H=Holding time exceeded; and R=Calibration range exceeded.

Cind R-lite well (Page 4)

		Sample #1 May, 1994 Mean S.D.	Detection Limit
Pt 195	PPT	ND	10
Au 197	PPT	ND	10
Pb 208	PPT	697 9	5.4
Bi 209	PPT	ND	1.4

ND=Not detected; NM=Not measured; A=Anomalous value; H=Holding time exceeded; and R=Calibration range exceeded.

Cind R-lite well (Page 5)

		Sample #1 May, 1994 Mean S.D.			Detection Limit		
		D	I	E	D	I	E
Y 89	PPT	6.4 0.2			0.5		
La 139	PPT	0.78 0.08			0.24		
Ce 140	PPT	ND			0.8		
Pr 141	PPT		0.63 0.01			0.02	
Nd 143	PPT		1.77 0.09			0.03	
Sm 147	PPT		0.141 0.013			0.04	
Eu 153	PPT			0.082 0.009			0.02
Gd 158	PPT		0.24 0.01			0.04	
Tb 159	PPT		0.039 0.006			0.02	
Dy 163	PPT		0.29 0.01			0.01	
Ho 165	PPT		0.084 0.004			0.01	
Er 166	PPT		0.290 0.009			0.03	
Tm 169	PPT		0.035 0.002			0.02	
Yb 173	PPT		0.22 0.02			0.04	
Lu 175	PPT		0.031 0.004			0.02	
Th 232	PPT		0.5 0.1			0.2	

D = Direct analysis; I = Preconcentration by ion exchange; E = Preconcentration by extraction

ND=Not detected; NM=Not measured; A=Anomalous value; H=Holding time exceeded; and R=Calibration range exceeded.

AD-2, Jackass Aero Park well

		Sample #2 May, 1994 Mean S.D.	Detection Limit
ANIONS			
Alkalinity	PPM	100 3	10
Bromide	PPM	ND	0.05
Chloride	PPM	6.222 0.001	0.08
Fluoride	PPM	1.723 0.001	0.033
Nitrate	PPM	6.03 0.01	0.004
Sulfate	PPM	42.6 0.1	0.032
Phosphate	PPM	ND	0.1
MAJOR METALS			
Ca	PPM	5.8 0.0	0.08
Mg	PPM	0.185 0.002	0.096
K	PPM	1.45 0.04	0.044
Na	PPM	68 3	1.13
TRACE METALS			
Li 7	PPB	73 2	0.04
Al 27	PPB	2.22 0.07	0.04
Ti 47	PPB	0.72 0.04	0.02
V 51	PPB	10.15 0.09	0.003
Cr 52	PPB	5.6 0.2	0.02

ND=Not detected; NM=Not measured; A=Anomalous value; H=Holding time exceeded; and R=Calibration range exceeded.

AD-2, Jackass Aero Park well (Page 2)

		Sample #2 May, 1994 Mean S.D.	Detection Limit
Mn 55	PPB	0.360 0.007	0.010
Ni 60	PPB	ND	0.03
Cu 63	PPB	1.31 0.07	0.012
Zn 66	PPB	10.6 0.6	0.03
Ge 73	PPB	0.92 0.02	0.007
As 75	PPB	23.2 0.2	0.0072
Se 77	PPB	2.1 0.1	0.031
Rb 85	PPB	5.73 0.08	0.003
Sr 86	PPB	24.1 0.5	0.011
Mo 95	PPB	1.99 0.02	0.007
Sn 117	PPB	0.027 0.002	0.006
Sb 121	PPB	0.295 0.006	0.002
Cs 133	PPB	1.35 0.05	0.0005
Ba 135	PPB	1.74 0.04	0.02
W 182	PPB	1.82 0.02	0.001
Tl 205	PPB	0.031 0.003	0.008
U 238	PPB	0.60 0.02	0.005

ND=Not detected; NM=Not measured; A=Anomalous value; H=Holding time exceeded; and R=Calibration range exceeded.

AD-2, Jackass Aero Park well (Page 3)

		Sample #2 May, 1994 Mean S.D.	Detection Limit
Be 9	PPT	151 33	10
Co 59	PPT	23 3	0.4
Ga 71	PPT	39 2	3.7
Zr 90	PPT	62 4	10
Nb 93	PPT	13 2	3
Ru 99	PPT	ND	4.5
Rh 103	PPT	20.3 1.1	2
Ag 107	PPT	ND	23
Cd 114	PPT	ND	5.9
In 115	PPT	14 3	0.7
Te 125	PPT	19 4	8.2
Hf 177	PPT	ND	5
Ta 181	PPT	12 3	1.5
Re 187	PPT	25 2	2.6
Ir 193	PPT	12 2	4.2

ND=Not detected; NM=Not measured; A=Anomalous value; H=Holding time exceeded; and R=Calibration range exceeded.

AD-2, Jackass Aero Park well (Page 4)

		Sample #2 May, 1994 Mean S.D.	Detection Limit
Pt 195	PPT	ND	10
Au 197	PPT	ND	10
Pb 208	PPT	69 4	5.4
Bi 209	PPT	ND	1.4

ND=Not detected; NM=Not measured; A=Anomalous value; H=Holding time exceeded; and R=Calibration range exceeded.

AD-2, Jackass Aero Park well (Page 5)

		Sample #2 May, 1994 Mean S.D.			Detection Limit		
		D	I	E	D	I	E
Y 89	PPT	1.52 0.07			0.5		
La 139	PPT	1.7 0.2			0.24		
Ce 140	PPT	ND			0.8		
Pr 141	PPT		0.20 0.03			0.02	
Nd 143	PPT		0.758 0.007			0.03	
Sm 147	PPT		0.17 0.03			0.04	
Eu 153	PPT			0.057 0.003			0.02
Gd 158	PPT		0.16 0.03			0.04	
Tb 159	PPT		ND			0.02	
Dy 163	PPT		0.14 0.02			0.01	
Ho 165	PPT		0.032 0.003			0.01	
Er 166	PPT		0.10 0.02			0.03	
Tm 169	PPT		ND			0.02	
Yb 173	PPT		0.07 0.02			0.04	
Lu 175	PPT		0.015 0.005			0.02	
Th 232	PPT		0.7 0.2			0.2	

D = Direct analysis; I = Preconcentration by ion exchange; E = Preconcentration by extraction

ND=Not detected; NM=Not measured; A=Anomalous value; H=Holding time exceeded; and R=Calibration range exceeded.

EFAP - AD-2a, Lathrop Wells NDOT well

		Sample #2 May, 1994 Mean S.D.	Detection Limit
ANIONS			
Alkalinity	PPM	128 6	10
Bromide	PPM	0.098 0.004	0.05
Chloride	PPM	11.893 0.006	0.08
Fluoride	PPM	1.636 0.001	0.033
Nitrate	PPM	8.72 0.02	0.004
Sulfate	PPM	106.2 0.1	0.032
Phosphate	PPM	ND	0.1
MAJOR METALS			
Ca	PPM	17.4 0.4	0.08
Mg	PPM	0.911 0.005	0.096
K	PPM	3.59 0.03	0.044
Na	PPM	103 2	1.13
TRACE METALS			
Li 7	PPB	80 3	0.04
Al 27	PPB	0.62 0.03	0.04
Ti 47	PPB	0.72 0.06	0.02
V 51	PPB	9.83 0.02	0.003
Cr 52	PPB	7.7 0.1	0.02

ND=Not detected; NM=Not measured; A=Anomalous value; H=Holding time exceeded; and R=Calibration range exceeded.

EFAP - AD-2a, Lathrop Wells NDOT well (Page 2)

		Sample #2 May, 1994 Mean S.D.	Detection Limit
Mn 55	PPB	0.216 0.008	0.010
Ni 60	PPB	0.11 0.03	0.03
Cu 63	PPB	1.97 0.06	0.012
Zn 66	PPB	62.4 0.6	0.03
Ge 73	PPB	1.08 0.03	0.007
As 75	PPB	22.2 0.3	0.0072
Se 77	PPB	2.5 0.2	0.031
Rb 85	PPB	11.0 0.2	0.003
Sr 86	PPB	101 2	0.011
Mo 95	PPB	6.6 0.2	0.007
Sn 117	PPB	0.033 0.006	0.006
Sb 121	PPB	0.50 0.02	0.002
Cs 133	PPB	1.41 0.01	0.0005
Ba 135	PPB	8.8 0.2	0.02
W 182	PPB	1.32 0.05	0.001
Tl 205	PPB	0.049 0.002	0.008
U 238	PPB	2.34 0.08	0.005

ND=Not detected; NM=Not measured; A=Anomalous value; H=Holding time exceeded; and R=Calibration range exceeded.

EFAP - AD-2a, Lathrop Wells NDOT well (Page 3)

		Sample #2 May, 1994 Mean S.D.	Detection Limit
Be 9	PPT	120.18 0.04	10
Co 59	PPT	12 3	0.4
Ga 71	PPT	ND	3.7
Zr 90	PPT	ND	10
Nb 93	PPT	ND	3
Ru 99	PPT	ND	4.5
Rh 103	PPT	ND	2
Ag 107	PPT	ND	23
Cd 114	PPT	9 2	5.9
In 115	PPT	ND	0.7
Te 125	PPT	ND	8.2
Hf 177	PPT	18 3	5
Ta 181	PPT	25 4	1.5
Re 187	PPT	31 2	2.6
Ir 193	PPT	14 2	4.2

ND=Not detected; NM=Not measured; A=Anomalous value; H=Holding time exceeded; and R=Calibration range exceeded.

EFAP - AD-2a,Lathrop Wells NDOT well (Page 4)

		Sample #2 May, 1994 Mean S.D.	Detection Limit
Pt 195	PPT	ND	10
Au 197	PPT	ND	10
Pb 208	PPT	165 9	5.4
Bi 209	PPT	ND	1.4

ND=Not detected; NM=Not measured; A=Anomalous value; H=Holding time exceeded; and R=Calibration range exceeded.

EFAP - AD-2a,Lathrop Wells NDOT well (Page 5)

		Sample #2 May, 1994 Mean S.D.			Detection Limit		
		D	I	E	D	I	E
Y 89	PPT	4.7 0.1			0.5		
La 139	PPT	2.2 0.1			0.24		
Ce 140	PPT	ND			0.8		
Pr 141	PPT		0.34 0.01			0.02	
Nd 143	PPT		1.26 0.07			0.03	
Sm 147	PPT		0.28 0.01			0.04	
Eu 153	PPT			0.10 0.03			0.02
Gd 158	PPT		0.30 0.01			0.04	
Tb 159	PPT		0.046 0.006			0.02	
Dy 163	PPT		0.32 0.02			0.01	
Ho 165	PPT		0.10 0.01			0.01	
Er 166	PPT		0.33 0.03			0.03	
Tm 169	PPT		0.042 0.005			0.02	
Yb 173	PPT		0.265 0.008			0.04	
Lu 175	PPT		0.04 0.01			0.02	
Th 232	PPT		1.0 0.2			0.2	

D = Direct analysis; I = Preconcentration by ion exchange; E = Preconcentration by extraction

ND=Not detected; NM=Not measured; A=Anomalous value; H=Holding time exceeded; and R=Calibration range exceeded.

EFAP - CF-1a

		Sample #1 June, 1994 Mean S.D.	Detection Limit
ANIONS			
Alkalinity	PPM	214 6	10
Bromide	PPM	0.6 0.1	0.05
Chloride	PPM	152 1	0.08
Fluoride	PPM	ND	0.033
Nitrate	PPM	0.097 0.001	0.004
Sulfate	PPM	415 1	0.032
Phosphate	PPM	ND	0.1
MAJOR METALS			
Ca	PPM	114.4 0.4	0.08
Mg	PPM	84.8 0.9	0.096
K	PPM	3.55 0.05	0.044
Na	PPM	73.7 0.8	1.13
TRACE METALS			
Li 7	PPB	72 1	0.04
Al 27	PPB	0.33 0.04	0.04
Ti 47	PPB	0.73 0.01	0.02
V 51	PPB	0.069 0.006	0.003
Cr 52	PPB	2.3 0.1	0.02

ND=Not detected; NM=Not measured; A=Anomalous value; H=Holding time exceeded; and R=Calibration range exceeded.

EFAP - CF-1a (Page 2)

			Sample #1 June, 1994 Mean S.D.	Detection Limit
Mn 55	PPB		47.3 0.5	0.010
Ni 60	PPB		1.38 0.07	0.03
Cu 63	PPB		1.50 0.08	0.012
Zn 66	PPB		629 2	0.03
Ge 73	PPB		0.23 0.01	0.007
As 75	PPB		3.01 0.09	0.0072
Se 77	PPB		0.61 0.06	0.031
Rb 85	PPB		5.0 0.2	0.003
Sr 86	PPB	R	4210 20	0.011
Mo 95	PPB		3.6 0.2	0.007
Sn 117	PPB		0.041 0.007	0.006
Sb 121	PPB		0.022 0.002	0.002
Cs 133	PPB		1.6 0.1	0.0005
Ba 135	PPB		40 1	0.02
W 182	PPB		0.005 0.002	0.001
Tl 205	PPB		0.051 0.001	0.008
U 238	PPB		0.023 0.003	0.005

ND=Not detected; NM=Not measured; A=Anomalous value; H=Holding time exceeded; and R=Calibration range exceeded.

EFAP - CF-1a (Page 3)

		Sample #1 June, 1994 Mean S.D.	Detection Limit
Be 9	PPT	187 61	10
Co 59	PPT	75 4	0.4
Ga 71	PPT	13 3	3.7
Zr 90	PPT	ND	10
Nb 93	PPT	10 3	3
Ru 99	PPT	ND	4.5
Rh 103	PPT	ND	2
Ag 107	PPT	ND	23
Cd 114	PPT	ND	5.9
In 115	PPT	7 2	0.7
Te 125	PPT	ND	8.2
Hf 177	PPT	ND	5
Ta 181	PPT	ND	1.5
Re 187	PPT	ND	2.6
Ir 193	PPT	ND	4.2

ND=Not detected; NM=Not measured; A=Anomalous value; H=Holding time exceeded; and R=Calibration range exceeded.

EFAP - CF-1a (Page 4)

		Sample #1 June, 1994 Mean S.D.	Detection Limit
Pt 195	PPT	ND	10
Au 197	PPT	ND	10
Pb 208	PPT	20 5	5.4
Bi 209	PPT	26 5	1.4

ND=Not detected; NM=Not measured; A=Anomalous value; H=Holding time exceeded; and R=Calibration range exceeded.

EFAP - CF-1a (Page 5)

		Sample #1 June, 1994 Mean S.D.			Detection Limit		
		D	I	E	D	I	E
Y 89	PPT	10 1			0.5		
La 139	PPT	0.6 0.1			0.24		
Ce 140	PPT	ND			0.8		
Pr 141	PPT		0.189 0.003			0.02	
Nd 143	PPT		0.69 0.03			0.03	
Sm 147	PPT		0.43 0.03			0.04	
Eu 153	PPT			0.050 0.003			0.02
Gd 158	PPT		0.121 0.009			0.04	
Tb 159	PPT		ND			0.02	
Dy 163	PPT		0.09 0.02			0.01	
Ho 165	PPT		0.033 0.006			0.01	
Er 166	PPT		0.11 0.03			0.03	
Tm 169	PPT		ND			0.02	
Yb 173	PPT		0.12 0.02			0.04	
Lu 175	PPT		ND			0.02	
Th 232	PPT		0.5 0.2			0.2	

D = Direct analysis; I = Preconcentration by ion exchange; E = Preconcentration by extraction

ND=Not detected; NM=Not measured; A=Anomalous value; H=Holding time exceeded; and R=Calibration range exceeded.

VH-2, Saga Exploration Well

		Sample #1 June, 1994 Mean S.D.	Detection Limit
ANIONS			
Alkalinity	PPM	290 8	10
Bromide	PPM	0.111 0.002	0.05
Chloride	PPM	13.114 0.009	0.08
Fluoride	PPM	0.913 0.001	0.033
Nitrate	PPM	1.691 0.002	0.004
Sulfate	PPM	143.6 0.5	0.032
Phosphate	PPM	ND	0.1
MAJOR METALS			
Ca	PPM	93.0 0.3	0.08
Mg	PPM	34.7 0.3	0.096
K	PPM	3.9 0.1	0.044
Na	PPM	74.4 0.8	1.13
TRACE METALS			
Li 7	PPB	92.4 0.1	0.04
Al 27	PPB	0.43 0.06	0.04
Ti 47	PPB	0.543 0.009	0.02
V 51	PPB	1.51 0.03	0.003
Cr 52	PPB	3.2 0.2	0.02

ND=Not detected; NM=Not measured; A=Anomalous value; H=Holding time exceeded; and R=Calibration range exceeded.

VH-2, Saga Exploration Well (Page 2)

		Sample #1 June, 1994 Mean S.D.	Detection Limit
Mn 55	PPB	0.82 0.02	0.010
Ni 60	PPB	0.56 0.05	0.03
Cu 63	PPB	1.85 0.08	0.012
Zn 66	PPB	4.2 0.2	0.03
Ge 73	PPB	0.548 0.009	0.007
As 75	PPB	8.72 0.08	0.0072
Se 77	PPB	1.56 0.08	0.031
Rb 85	PPB	26.7 0.4	0.003
Sr 86	PPB	610 10	0.011
Mo 95	PPB	5.32 0.08	0.007
Sn 117	PPB	0.039 0.004	0.006
Sb 121	PPB	0.278 0.004	0.002
Cs 133	PPB	3.3 0.1	0.0005
Ba 135	PPB	51 1	0.02
W 182	PPB	0.118 0.004	0.001
Tl 205	PPB	0.385 0.009	0.008

ND=Not detected; NM=Not measured; A=Anomalous value; H=Holding time exceeded; and R=Calibration range exceeded.

VH-2, Saga Exploration Well (Page 3)

		Sample #1 June, 1994 Mean S.D.	Detection Limit
U 238	PPB	6.1 0.2	0.005
Be 9	PPT	140 40	10
Co 59	PPT	19 5	0.4
Ga 71	PPT	ND	3.7
Zr 90	PPT	17 2	10
Nb 93	PPT	9 3	3
Ru 99	PPT	ND	4.5
Rh 103	PPT	22.8 1.3	1
Ag 107	PPT	ND	23
Cd 114	PPT	30 8	5.9
In 115	PPT	4 3	0.7
Te 125	PPT	15 2	8.2
Hf 177	PPT	ND	5
Ta 181	PPT	5 3	1.5
Re 187	PPT	25 2	2.6
Ir 193	PPT	ND	4.2

ND=Not detected; NM=Not measured; A=Anomalous value; H=Holding time exceeded; and R=Calibration range exceeded.

VH-2, Saga Exploration Well (Page 4)

		Sample #1 June, 1994 Mean S.D.	Detection Limit
Pt 195	PPT	ND	10
Au 197	PPT	26.34 0.06	10
Pb 208	PPT	103 11	5.4
Bi 209	PPT	ND	1.4

ND=Not detected; NM=Not measured; A=Anomalous value; H=Holding time exceeded; and R=Calibration range exceeded.

VH-2, Saga Exploration Well (Page 5)

		Sample #1 June, 1994 Mean S.D.			Detection Limit		
		D	I	E	D	I	E
Y 89	PPT	21.7 0.7			0.5		
La 139	PPT	5.9 0.3			0.24		
Ce 140	PPT	14 2			0.8		
Pr 141	PPT		1.73 0.03			0.02	
Nd 143	PPT		6.00 0.05			0.03	
Sm 147	PPT		1.94 0.04			0.04	
Eu 153	PPT			0.20 0.03			0.02
Gd 158	PPT		1.39 0.03			0.04	
Tb 159	PPT		0.220 0.004			0.02	
Dy 163	PPT		1.54 0.06			0.01	
Ho 165	PPT		0.40 0.02			0.01	
Er 166	PPT		1.39 0.06			0.03	
Tm 169	PPT		0.21 0.02			0.02	
Yb 173	PPT		1.36 0.03			0.04	
Lu 175	PPT		0.22 0.01			0.02	
Th 232	PPT		0.7 0.1			0.2	

D = Direct analysis; I = Preconcentration by ion exchange; E = Preconcentration by extraction

ND=Not detected; NM=Not measured; A=Anomalous value; H=Holding time exceeded; and R=Calibration range exceeded.

Coffer Ranch - Ranch Spring

		Sample #1 Sept., 1994 Mean S.D.	Detection Limit
ANIONS			
Alkalinity	PPM	231 1	10
Bromide	PPM	0.31 0.01	0.01
Chloride	PPM	65.8 0.8	0.002
Fluoride	PPM	3.32 0.03	0.006
Nitrate	PPM	0.93 0.03	0.01
Sulfate	PPM	110.0 0.3	0.02
MAJOR METALS			
Ca	PPM	21.8 0.9	0.05
Mg	PPM	1.52 0.03	0.009
K	PPM	9.5 0.1	0.08
Na	PPM	176 2	1.7
TRACE METALS			
Li 7	PPB	166 4	0.01
Ti 47	PPB	1.09 0.03	0.02
V 51	PPB	2.67 0.03	0.02
Cr 52	PPB	0.80 0.01	0.01

ND=Not detected; NM=Not measured; A=Anomalous value; H=Holding time exceeded; and R=Calibration range exceeded.

Coffer Ranch - Ranch Spring (Page 2)

		Sample #1 Sept., 1994 Mean S.D.	Detection Limit
Mn 55	PPB	0.341 0.007	0.02
Ni 60	PPB	0.10 0.02	0.01
Cu 63	PPB	0.76 0.08	0.02
Zn 66	PPB	7.07 0.08	0.01
Ge 73	PPB	1.55 0.05	0.01
As 75	PPB	6.4 0.2	0.01
Se 77	PPB	0.57 0.07	0.03
Rb 85	PPB	18.1 0.7	0.02
Sr 86	PPB	163 4	0.03
Mo 95	PPB	12.2 0.6	0.003
Sn 117	PPB	0.023 0.007	0.01
Sb 121	PPB	0.192 0.007	0.02
Cs 133	PPB	0.062 0.001	0.02
Ba 135	PPB	9.8 0.1	0.02
W 182	PPB	0.80 0.01	0.004
Tl 205	PPB	0.074 0.004	0.03
U 238	PPB	15.4 0.2	0.02

ND=Not detected; NM=Not measured; A=Anomalous value; H=Holding time exceeded; and R=Calibration range exceeded.

Coffer Ranch - Ranch Spring (Page 3)

		Sample #1 Sept., 1994 Mean S.D.	Detection Limit
Be 9	PPT	ND	26
Co 59	PPT	30 4	13
Ga 71	PPT	ND	22
Zr 90	PPT	28 2	1
Nb 93	PPT	ND	8
Ru 99	PPT	3.3 0.5	0.8
Rh 103	PPT	ND	2
Ag 107	PPT	ND	10
Cd 114	PPT	ND	25
In 115	PPT	ND	25
Te 125	PPT	ND	8
Hf 177	PPT	ND	2
Ta 181	PPT	ND	10
Re 187	PPT	7.0 0.3	3
Ir 193	PPT	ND	2

ND=Not detected; NM=Not measured; A=Anomalous value; H=Holding time exceeded; and R=Calibration range exceeded.

Coffer Ranch - Ranch Spring (Page 4)

		Sample #1 Sept., 1994 Mean S.D.	Detection Limit
Pt 195	PPT	ND	2
Au 197	PPT	43 5	26
Pb 208	PPT	ND	20
Bi 209	PPT	ND	23

ND=Not detected; NM=Not measured; A=Anomalous value; H=Holding time exceeded; and R=Calibration range exceeded.

Coffer Ranch - Ranch Spring (Page 5)

		Sample #1 Sept., 1994 Mean S.D.			Detection Limit		
		D	I	E	D	I	E
Y 89	PPT	5.5 0.5			1		
La 139	PPT	1.6 0.3			1.0		
Ce 140	PPT	10 1			0.6		
Pr 141	PPT		ND			1	
Nd 143	PPT		ND			4	
Sm 147	PPT		ND			2	
Eu 153	PPT			ND			2
Gd 158	PPT		ND			2	
Tb 159	PPT		ND			1	
Dy 163	PPT		ND			3	
Ho 165	PPT		ND			2	
Er 166	PPT		ND			3	
Tm 169	PPT		ND			1	
Yb 173	PPT		ND			4	
Lu 175	PPT		ND			2	
Th 232	PPT		ND			1	

D = Direct analysis; I = Preconcentration by ion exchange; E = Preconcentration by extraction

ND=Not detected; NM=Not measured; A=Anomalous value; H=Holding time exceeded; and R=Calibration range exceeded.

Coffer Ranch - Windmill Well

		Sample #1 Sept., 1994 Mean S.D.	Detection Limit
ANIONS			
Alkalinity	PPM	144 11	10
Bromide	PPM	0.070 0.003	0.01
Chloride	PPM	7.6 0.2	0.002
Fluoride	PPM	3.73 0.06	0.006
Nitrate	PPM	1.59 0.02	0.01
Sulfate	PPM	30.4 0.1	0.02
MAJOR METALS			
Ca	PPM	18.3 0.2	0.05
Mg	PPM	0.19 0.01	0.009
K	PPM	0.91 0.01	0.08
Na	PPM	73 2	1.7
TRACE METALS			
Li 7	PPB	111 3	0.01
Ti 47	PPB	0.63 0.04	0.02
V 51	PPB	0.99 0.03	0.02
Cr 52	PPB	0.26 0.01	0.01

ND=Not detected; NM=Not measured; A=Anomalous value; H=Holding time exceeded; and R=Calibration range exceeded.

Coffer Ranch - Windmill Well (Page 2)

		Sample #1 Sept., 1994 Mean S.D.	Detection Limit
Mn 55	PPB	11.8 0.3	0.02
Ni 60	PPB	0.575 0.004	0.01
Cu 63	PPB	2.8 0.2	0.02
Zn 66	PPB	41.3 0.6	0.01
Ge 73	PPB	0.78 0.01	0.01
As 75	PPB	7.82 0.09	0.01
Se 77	PPB	0.38 0.09	0.03
Rb 85	PPB	4.7 0.1	0.02
Sr 86	PPB	183 8	0.03
Mo 95	PPB	11.2 0.2	0.003
Sn 117	PPB	0.03 0.01	0.01
Sb 121	PPB	0.23 0.02	0.02
Cs 133	PPB	3.99 0.08	0.02
Ba 135	PPB	1.82 0.04	0.02
W 182	PPB	1.53 0.06	0.004
Tl 205	PPB	0.05 0.01	0.03
U 238	PPB	5.1 0.2	0.02

ND=Not detected; NM=Not measured; A=Anomalous value; H=Holding time exceeded; and R=Calibration range exceeded.

Coffer Ranch - Windmill Well (Page 3)

		Sample #1 Sept., 1994 Mean S.D.	Detection Limit
Be 9	PPT	ND	26
Co 59	PPT	130 4	13
Ga 71	PPT	ND	22
Zr 90	PPT	17 2	1
Nb 93	PPT	ND	8
Ru 99	PPT	2.2 0.5	0.8
Rh 103	PPT	2.0 0.4	2
Ag 107	PPT	9 3	10
Cd 114	PPT	47 8	25
In 115	PPT	ND	25
Te 125	PPT	ND	8
Hf 177	PPT	ND	2
Ta 181	PPT	16 3	10
Re 187	PPT	7 1	3
Ir 193	PPT	ND	2

ND=Not detected; NM=Not measured; A=Anomalous value; H=Holding time exceeded; and R=Calibration range exceeded.

Coffer Ranch - Windmill Well (Page 4)

		Sample #1 Sept., 1994 Mean S.D.	Detection Limit
Pt 195	PPT	ND	2
Au 197	PPT	ND	26
Pb 208	PPT	418 6	20
Bi 209	PPT	ND	23

ND=Not detected; NM=Not measured; A=Anomalous value; H=Holding time exceeded; and R=Calibration range exceeded.

Coffer Ranch - Windmill Well (Page 5)

		Sample #1 Sept., 1994 Mean S.D.			Detection Limit		
		D	I	E	D	I	E
Y 89	PPT	2.3 0.4			1		
La 139	PPT	ND			1.0		
Ce 140	PPT	0.8 0.2			0.6		
Pr 141	PPT		ND			1	
Nd 143	PPT		ND			4	
Sm 147	PPT		ND			2	
Eu 153	PPT			ND			2
Gd 158	PPT		ND			2	
Tb 159	PPT		ND			1	
Dy 163	PPT		ND			3	
Ho 165	PPT		ND			2	
Er 166	PPT		ND			3	
Tm 169	PPT		ND			1	
Yb 173	PPT		ND			4	
Lu 175	PPT		ND			2	
Th 232	PPT		ND			1	

D = Direct analysis; I = Preconcentration by ion exchange; E = Preconcentration by extraction

ND=Not detected; NM=Not measured; A=Anomalous value; H=Holding time exceeded; and R=Calibration range exceeded.

STANDARD OPERATING PROCEDURES AND QA PLAN CURRENTLY IN USE

UNIVERSITY OF NEVADA, LAS VEGAS

HARRY REID CENTER FOR ENVIRONMENTAL STUDIES

QUALITY ASSURANCE PROJECT PLAN

Sample Verification Project
Groundwater Monitoring Task

Klaus J. Stetzenbach
Principal Investigator

Harry Reid Center for Environmental Studies
University of Nevada, Las Vegas
4505 S. Maryland Parkway
Box 454009
Las Vegas, NV 89154-4009

SIGNATURES OF APPROVAL

Klaus J. Stetzenbach — 24 Mar 93
Principal Investigator — Date

Amy J. Smiecinski — 3-24-93
Quality Assurance Staff — Date

CONTENTS

Distribution of document revisions:

Principal Investigator, HRC
QA Staff, HRC

INTRODUCTION

This document is in a developmental stage. Requirements of two separate programs must be met for the analytical methods and instruments available to the laboratory. It is anticipated that this QA plan will not be finalized soon. Finalization requires the review by the sponsors as well as trial use of the plan.

The purpose of this document is to specify how HRC's Quality Assurance (QA) Program applies quality controls (QC) to the analysis of water samples to meet the QA objectives of this task. This document is designed to meet the QA requirements of the State of Nevada Drinking Water Program, those of the United States Geological Survey Water Resources Division (hereafter referred to as the USGS) (Open-file Report 91-222), and the United States Department of Energy Yucca Mountain Project (hereafter referred to as DOE).

Quality assurance objectives for this task are 1) to meet the State of Nevada and USGS Drinking Water analytical and quality control (QC) requirements, 2) to meet these requirements with less than 10% reanalysis of samples per year, 3) to provide a sample report to the sponsor within 6 weeks of sample receipt, and 4) to attain acceptable scores in the State of Nevada and USGS performance sample programs with less than 10% reanalysis of samples per batch.

ORGANIZATION AND RESPONSIBILITIES

ORGANIZATION AND AUTHORITY

Principal Investigator:	Klaus J. Stetzenbach Harry Reid Center for Environmental Studies (HRC) UNLV - 4505 S. Maryland Pkwy Las Vegas, NV 89154-4009 (702) 895-3742 Fax: (702) 895-3094
Investigators/Analysts:	Megumi Amano Gary Coates Tonya Dombrowski Kathy Lao Caixia Guo HRC (702) 895-4123 (same fax)
Quality Assurance:	Amy Cross-Smiecinski HRC (702) 895-0840 (same fax)
Safety:	Steve Ward HRC (702) 895-1083 (same fax)

TASK RESPONSIBILITIES

Principal Investigator:	Document Control Scientific notebook review Procedural modifications authorization Task coordination Programmatic QA/QC Data validation Report preparation Training
Investigators/Analysts:	Sample control Sample preparation and analysis Preparation and analytical QC Scientific notebook and log maintenance Data generation, reduction, and verification Preventive maintenance scheduling and performance

Quality Assurance Officer:	
	QA liaison between HRC and USGS, State of Nevada, and DOE
	Preparation of QA Plan
	Internal assessments
	Reviews
Safety Officer:	Laboratory safety assessments
	Safety document preparation

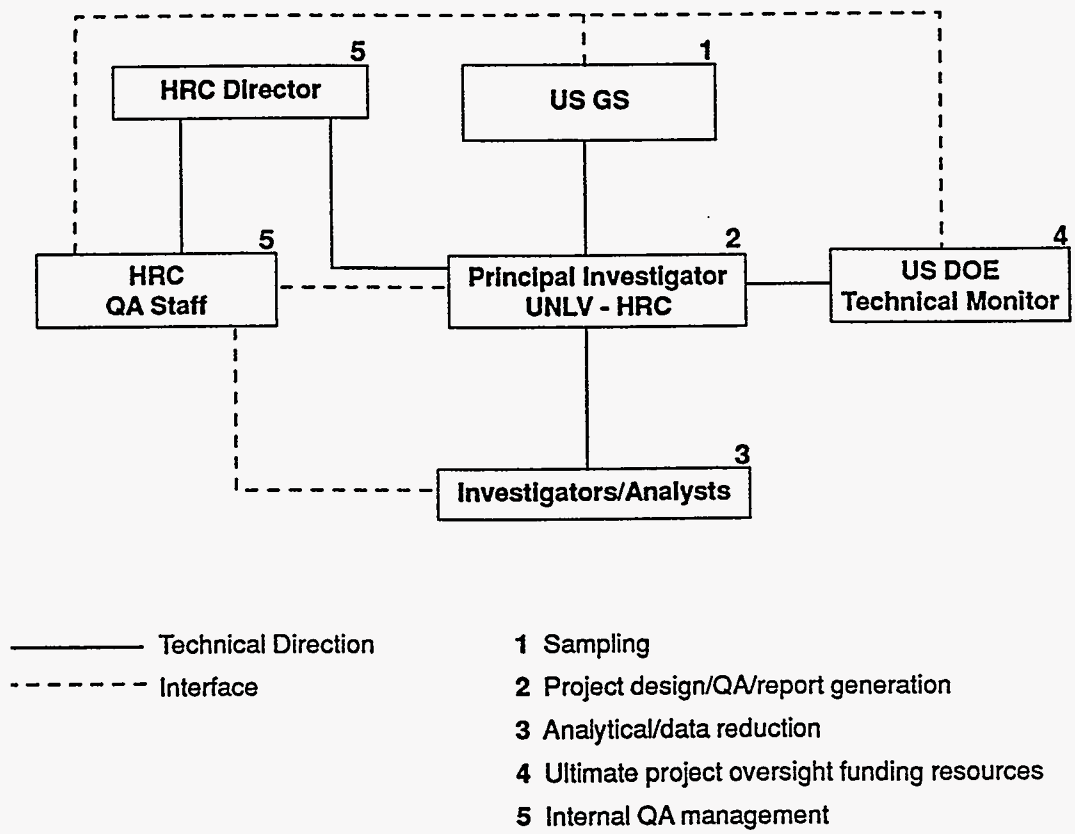

Figure 1. Sample Verification Project organization and responsibilities.

FACILITIES AND INSTRUMENTATION

FACILITIES DESCRIPTION

All analytical chemistry work will be performed at the UNLV - HRC chemistry laboratory. The laboratory is kept clean and free from atmospheric contaminants. A safety program is in place that is designed to meet requirements of the university's Environmental Health and Safety Program.

The HRC analytical laboratory contains more than 6,500 square feet containing a bio-containment lab, a wet chemistry lab, and four instrumentation labs. Major analytical instruments include gas chromatographs with electrolytic conductivity, photoionization, electron capture, and flame ionization detectors. HRC has a gas chromatograph/mass spectrometer (GC/MS) for analysis and identification of most of the compounds on the U.S. EPA priority pollutant list.

For the analysis of non-volatile organic compounds, HRC has high performance liquid chromatographs (HPLC) with UV absorption and fluorescence detectors and a HPLC/MS with both thermospray and particle beam interfaces.

For inorganic analysis, the HRC has an atomic absorption spectrophotometer capable of both flame and electrothermal atomization and an inductively coupled plasma (ICP)/MS that can detect most elements at the part per trillion level. An ion chromatograph is also available for routine drinking water parameters.

All instruments are equipped with autosamplers for maximum sample throughput. Major instruments are research grade enabling analysts to attain maximum analytical capability, sensitivity, and flexibility to perform non-routine procedures and method development.

INSTRUMENTATION

Scientific notebooks containing all information on repair, maintenance, and daily analyses and operating conditions are maintained and available for each instrument. Entries are made in scientific notebooks using the HRC standard operating procedure (SOP).

Inorganic analysis

- Varian atomic absorption spectrometer, Model AA-20 serial No.9061386
  Varian graphite furnace, Model VGA-76 serial No. 2021208
  Varian cold vapor analyzer, Model GTA-96 serial No. 9061247
  Varian Hg concentrator, Model MCA-90 serial No. 2021499
- Perkin-Elmer inductively coupled plasma mass spectrometer, Model Elan 5000 serial No. 114920888
- Dionex ion chromatograph, Model LCM-3 serial No. 912602
  Dionex Advanced Computer Interface AI-450
  Dionex Autoregen (Anion) System p/n 039564

Dionex Conductivity Detector, Model CDM-II serial No. 912111
Dionex Eluant Degas Module, serial No. 912337
Dionex Ionpac AS4A Analytical column, Serial No. 22579
Dionex Guard Column HPLC AS4A, serial No. 15478
Dionex Anion Micromembrane Suppressor, Model AMMS-II serial No. 2863
Dionex Autosampler, Model ASM-3 serial No. 911723
Dionex A1-450 Data Chromatography Software Version 3.1

Volatile Organic analysis

- Tekmar purge & trap, Model 2000 serial #92009020
- Varian gas chromatograph, Model 3400 serial #14328
- Varian mass spectrometer, Model Saturn II serial #0245

Pesticide analysis

- _____ gas chromatograph, Model___ serial #_____
- _____ ______ detector, Model ___ serial #_____

LABORATORY PROCEDURES

Analysts use the manufacturer instructions in combination with the "analytical methods" to operate instrumentation as described in the associated SOP. These procedures are written using the guidelines provided by the HRC QA Staff.

General laboratory SOPs and/or log sheets exist for the scientific notebooks use, water purification system use and maintenance, refrigerator temperatures records, and balance calibration.

SCIENTIFIC NOTEBOOKS

Scientific notebooks are used to record details of the task as described in the HRC Scientific Notebook SOP *with the following amplification: If a large blank space remains on a notebook page that the scientist does not intend to use prior to the next record, line-through the space and initial and date it. If the scientist likes to leave a blank page for non quality-affecting jottings, and notes, he/she must title the page appropriately.* ***Be aware that anything on such a page will be considered to be exactly as the page is titled and is potentially invalid***

Scientific Notebook contents are organized to meet the needs of the scientist, PI, and the task provided that a paper trail among all of the notebooks, instruments, reagent sources, chemists, and data exist for the project. The PI reviews scientific notebooks quarterly and the QAO reviews them semiannually.

TRAINING

At the time of installation of instruments, analysts receive training from the manufacturer. Analysts who begin working on an instrument after the manufacturer-provided training are required to read the manuals and SOPs associated with the instruments that they will use, and are given the opportunity to question the PI and other personnel about any aspects of their work area. All analysts must satisfactorily analyze a proficiency sample. A bachelor's degree scientist having been trained as described must satisfactorily analyze a proficiency sample prior to analyzing field samples.

SAFETY

HRC has a safety program which meets the requirements of the University of Nevada, Las Vegas and Clark County Community College Hazardous Materials Management Program. This program and HRC's associated SOPs covers all activities involving the purchase, on-campus transportation, storage, and disposal of hazardous materials;. and the response to a hazardous material emergency.

PREVENTIVE MAINTENANCE

SERVICE

Service contracts exist on instruments and equipment for which funding is available to support the cost.

DOCUMENTATION

As stated in the previous section, scientific notebooks are maintained for each analytical system. Information on repair, maintenance, and daily operation of each instrument shall be recorded by the analyst or service rep performing the activity. Records of purchased service are filed in the Grants and Contracts office of HRC.

PROCEDURES

Maintenance procedures suggested by the manufacturer for each piece of instrumentation, and equipment will be performed by HRC personnel or qualified service representatives.

SCHEDULES

Analysts may establish schedules of preventive maintenance or purchase a service contract that provides preventive maintenance. Schedules are based on each instrument manual. Balances are calibrated annually by an independent authorized service.

SAMPLING PROCEDURES

Sampling procedures used to collect, preserve, handle, and transport field samples are described in the Groundwater Sampling SOP. The SOP shall specify methods of sampling compatible with the analytical parameters that will result in accurate, precise, and complete measurements.

HANDLING AND STORAGE

Samples will be preserved, transported, and stored with due care to assure analytical integrity. SOPs shall specify that the samples be maintained at 4°C and be analyzed within the holding times required by the analytical methods.

CUSTODY

The sample control system, including tracking of samples and corresponding analyses, is described in the Sample Control SOP. Sample identification is accomplished using an identifier system specified by the sampling team. The identifier follows the sample from the field to the final report. At receipt, the sample is logged into a Sample Control database.

It is not anticipated that strict NEIC-type chain-of-custody procedures will be necessary for this task. However in the event that such procedures are required, HRC's Chain-of-custody SOP will be updated to reflect current practices and implemented to meet the needs of the project.

TRAINING

Sampling personnel will be trained to the SOPs. Participation in sampling will be determined by the PI based on performance in the field

CALIBRATION PROCEDURES AND FREQUENCY

STANDARDS

Standards are traceable to the National Institute of Standards and Technology (NIST) or certified as such by the manufacturer. Standards preparation and analytical results will be recorded in a scientific notebook. Standards purity will be verified by the manufacturer as documented on a certificate of analysis or by the analyst using the sample method to ensure concentration and component response (USGS, 1987). Impurity requires corrective action. Newly prepared standards are compared to previously prepared standards. Response/unit value of the new standard must be within 5% of the old standard or corrective action must be taken. Records of standards preparation, especially source and lot are maintained by the analyst.

CALIBRATIONS

Calibration procedures and frequencies specified for each analytical method will be followed. Instruments will be calibrated daily during analyses, as specified in each SOP, using NIST-traceable standards at three or more levels (USGS, 1989) in the concentration range of the samples. Instrument SOPs include the procedure for determining acceptability of the calibration. After calibration during or after sample analysis, one or more standard solutions in the concentration range of the samples will be analyzed with each sample set, and results compared to the calibration curve before sample results can be reported to verify that the calibration curve is stable. Calibration check results will be recorded on control charts for each method. Any deviation from acceptance limits will require corrective action before samples can be analyzed.

Samples must be analyzed on an instrument that is in control (stable and optimized). Any doubts in the mind of the scientist about the condition or ability of the instrument must be resolved prior to analysis of samples. Calibrations are verified using a reference material or standard prepared by another laboratory. Calibration data are maintained by the analyst.

Minimum calibration requirements are listed for each instrumental system below.

ATOMIC ABSORPTION SPECTROMETER

Three or more-point calibration is performed daily during sample analysis using NIST-traceable standards. For every 20 samples, a reagent blank, a calibration check standard, and an externally-prepared QC standard will be analyzed.

INDUCTIVELY COUPLED PLASMA MASS SPECTROMETER

Three or more-point calibration is performed daily during sample analysis using NIST-traceable standards. For every 20 samples, a reagent blank, a calibration check standard, and an externally-prepared QC standard will be analyzed.

GAS CHROMATOGRAPH/MASS SPECTROMETER

The instrument is BFB-tuned daily prior to five-point daily calibration using NIST-traceable standards. For every 20 samples, a reagent blank, a calibration check standard, and an externally-prepared QC standard will be analyzed.

ION CHROMATOGRAPHY

Three or more-point calibration is performed daily during sample analysis using NIST-traceable standards. For every 20 samples, a reagent blank, a calibration check standard, and an externally-prepared QC standard will be analyzed.

ANALYTICAL PROCEDURES

Approved U.S. EPA, USGS, or equivalent methods will be used to analyze water samples to drinking water and wastewater guidelines for the analytes listed in Table 1.

Table 1. Groundwater Monitoring Task Analytes and Methods of Analysis.

Minerals[*]	**Trace Constituents**
Calcium[1,6]	Silver[1]
Chloride[3]	Aluminum[7]
Fluoride[3]	Arsenic[1]
Potassium[1,6]	Barium[4,6]
Magnesium[1,6]	Cobalt[4]
Sodium[1,6]	Cadmium[1]
Sulfate[3]	Chromium[1]
Chloride[3]	Copper[1]
Fluoride[3]	Iron[1,6]
Sulfate[3]	Beryllium[1]
	Lithium[4]
	Molybdenum[4]
	Manganese[1]
	Antimony[4]
	Nickel[1]
	Lead[1]
	Selenium[1]
Nutrients	Zinc[1]
Ammonia[3]	Strontium[4]
Nitrate[3]	Vanadium[4]
Kjeldahl nitrogen[3]	Mercury[2,6]
Phosphorous[3]	**Pesticides-future plans**
orthophosphate[3]	**Organic Semivolatiles-future plans**

1 AAS primary analysis (U.S. EPA, 1983), Method 200.8 confirmation (U.S. EPA, 1991a)
2 Cold vapor method only(U.S. EPA, 1983)
3 Ion chromatography method 300.0 (U.S. EPA, 1991b)
4 Method 200.8 primary analysis (U.S. EPA, 1991a), AAS confirmation (U.S. EPA, 1983). This analytical scheme will be used more often as the ICP/MS procedures are developed because of the advantage of multi-element determinations.
5 Method 524.2 (U.S. EPA, 1988)
6 No confirmation analysis is performed.
* Minerals are usually analyzed by flame rather than furnace. Sometimes salts are analyzed by atomic emission.

Table 1 continued.

Volatile Organics[5]	
Benzene	2,2-Dichloropropane
Bromobenzene	1,1-Dichloropropene
Bromochloromethane	cis-1,3-Dichloropropene
Bromodichloromethane	trans-1,3-Dichloropropene
Bromoform	Ethylbenzene
Bromomethane	Hexachlorobutadiene
n-Butylbenzene	Isopropylbenzene
sec-Butylbenzene	4-Isopropyltoluene
tert-Butylbenzene	Methylene chloride
Carbon tetrachloride	Naphthalene
Chlorobenzene	n-Propylbenzene
Chloroethane	Styrene
Chloroform	1,1,1,2-Tetrachloroethane
Chloromethane	1,1,2,2-Tetrachloroethane
2-Chlorotoluene	Tetrachloroethene
4-Chlorotoluene	Toluene
Dibromochloromethane	1,2,3-Trachlorobenzene
1,2-Dibromo-3-chloropropane	1,2,4-Trichlorobenzene
1,2-Dibromoethane	1,1,1-Trichloroethane
Dibromomethane	1,1,2-Trichloroethane
1,2-Dichlorobenzene	Trichloroethene
1,3-Dichlorobenzene	Trichlorofluoromethane
1,4-Dichlorobenzene	1,2,3-Trichloropropane
Dichlorodifluoromethane	1,2,4-Trimethylbenzene
1,1-Dichloroethane	1,2,5-Trimethylbenzene
1,2-Dichloroethane	Vinyl chloride
1,1-Dichloroethene	*o*-Xylene
cis-1,2-Dichloroethene	*m*-Xylene
trans-1,2-Dichloroethene	*p*-Xylene
1,2-Dichloropropane	
1,3-Dichloropropane	

1 AAS primary analysis (U.S. EPA, 1983), Method 200.8 confirmation (U.S. EPA, 1991a)

2 Cold vapor method only(U.S. EPA, 1983)

3 Ion chromatography method 300.0 (U.S. EPA, 1991b)

4 Method 200.8 primary analysis (U.S. EPA, 1991a), AAS confirmation (U.S. EPA, 1983). This analytical scheme will be used more often as the ICP/MS procedures are developed because of the advantage of multi-element determinations.

5 Method 524.2 (U.S. EPA, 1988)

6 No confirmation analysis is performed.

• Minerals are usually analyzed by flame rather than furnace. Sometimes salts are analyzed by atomic emission.

QUALITY CONTROL CHECKS

Analytical quality requirements for the USGS Water Resources Division and State of Nevada certification are to be met unless otherwise specified.

ANALYST PROFICIENCY

Prior to sample analysis, the analysts will demonstrate the ability to produce data of acceptable accuracy and precision using the method by successfully analyzing replicate aliquots of performance materials. Performance samples will be analyzed semiannually (NV, USGS, 1987). To be considered successful, results obtained will fall within two standard deviations (USGS, 1987) of the expected values for each constituent measured.

CONTROL CHARTS

Control charts contain instrument calibration check data and defined acceptance limits for each method and serve to give the analysts a real-time QC check on system stability. AAS and GC/MS analysts record daily calibration checks on these charts. For the ICP/MS the analyst records the analytical results of a check solution available from Perkin-Elmer daily for the following parameters which are indicators of instrument stability: CeO/Ce, BaO, Ba^{++}, oxides, Mg, Pb, Rh, and background. Control charts will be prepared using the guidance provided in *Quality Assurance of Chemical Measurements*, by John Keenan Taylor, pp. 129-146. Lewis Publishers, 1987, Chelsea, MI. Control charts will be checked periodically by the QA Officer for data entry and usefulness to the analyst.

DUPLICATE ANALYSES

Five percent of the samples will be analyzed in duplicate.

SPIKED SAMPLES

Ten percent of the samples will be spiked prior to analysis (NV). One portion of each organic sample that does not have appropriate surrogate spikes will be spiked with a mixture of the compounds of interest and analyzed. If the recovery for any constituent does not fall within control limits for method performance, the results reported for that constituent in all samples processed as part of the same set must be qualified as "suspect". Suspect data must remain at less than 5% of the data (USGS, 1987).

BLANK DETERMINATIONS

The laboratory will demonstrate, through analysis of an aliquot of reagents processed as a sample, that all labware and reagents are free of contamination. Such a method or reagent blank must be analyzed at the detection limit at least daily during sample set analysis and whenever there is a change in one or more of the reagents. Reagents and glassware cannot be used unless analyses show they are free of contamination.

Field blanks will be analyzed for each transport container. In addition, a holding blank will be analyzed to document that volatile samples are not contaminated during storage.

QC SAMPLES

Check samples (QC standards prepared by another lab) will be analyzed with each group of 20 samples (NV). QC performance samples will be prepared and analyzed upon receipt from the USGS and State of NV.

REFERENCE MATERIALS

Reference materials will be analyzed with each batch of samples. Source, type, and preparation shall be recorded in an appropriate scientific notebook.

SURROGATES

Surrogates specified for the analytical method will be used for GC/MS analysis.

CORRECTIVE ACTION

PERFORMANCE SAMPLES

The PI will discuss corrective action with the analysts and come to a mutual agreement on the corrective action required. The corrective action and results shall be documented by the PI in a memo to the QAO.

INTERNAL QC CHECKS

Exceeding Calibration

If samples exceed the range of daily calibration corrective action is performed and recorded in the appropriate scientific notebook. Calibration QC, such as linearity requirements must be met before samples may be analyzed. The PI is to be consulted for resolution of ineffective corrective action.

QC Samples

Specific corrective action, when predictable, is to be indicated for each QC sample type in the individual SOPs. QC samples include duplicates, check standards, spikes, and other types described in the individual SOPs. Corrective actions shall be recorded in the scientific notebooks by the investigator/analysts. The PI is consulted for resolution of ineffective corrective action.

Internal Assessments

The need for corrective actions as a result of internal assessments is documented by the assessor, usually the QA staff. The PI sees that the appropriate corrective actions are instituted and documented. The assessor checks that the corrective action is exercised, effective, and documented. he PI is consulted for resolution of ineffective corrective action.

Reference Materials

The analyst will record unacceptable results as such and take the corrective action that he/she feels is appropriate prior to reanalysis of reference materials. If results are still not acceptable, the PI is consulted for resolution of ineffective corrective action prior to sample analysis. Corrective actions are recorded in the scientific notebooks by the investigator/analysts.

AUDIT FINDINGS

The need for corrective actions as a result of internal or external audits is documented by the auditors. The PI sees that the appropriate corrective actions are instituted and documented.

The auditor checks that the corrective action is exercised, effective, and documented. The PI is consulted for resolution of ineffective corrective action.

QA OBJECTIVES

Non-attainment of QA objectives may require corrective action in the form of resampling and/or reanalysis, or data qualification with the use of flags to indicate the treatment or usability of outliers. Non-attainment of QA objectives requires corrective action as directed by the PI generally with agreement from the sponsor. Such corrective action and the results shall be documented by the PI in a memo to the QAO.

SPECIFIC ROUTINE PROCEDURES USED TO ASSESS PRECISION AND ACCURACY

PRECISION

Precision will be determined as described in individual SOPs or using the standard deviation of replicate analytical results:

(U.S. EPA, 1989a)

If calculated from duplicate measurements:

$$RPD = \frac{(C_1 - C_2) \times 100}{(C_1 + C_2)/2} \;;$$

RPD = relative percent difference,
C_1 = larger of the two observed values, and
C_2 = smaller of the two observed values.

If calculated from three or more replicates, use relative standard deviation (RSD) rather than RPD:

$$RSD = (s/\bar{y}) \times 100 \;;$$

RSD = relative standard deviation,
s = standard deviation, and
$\bar{y}$ = mean of replicate analyses.

When s is defined as follows:

$$s = \sqrt{\sum_{i=1}^{n} \frac{(y_i - \bar{y})^2}{n-1}}$$

s = standard deviation,
y_i = measured value of the i-th replicate,
$\bar{y}$ = mean of replicate measurements, and
n = number of replicates.

ACCURACY

Accuracy will be determined as described in individual SOPs or by analysis of spiked samples. Accuracy may also be determined by analysis of reference materials performance samples submitted concurrently with field samples.

(U.S. EPA, 1989a)

For measurements where matrix spikes are used:

$$\%R = 100 \ x \ \left[\frac{S-U}{C_{sa}}\right] \ ;$$

%R = percent recovery,
S = measured concentration in spiked aliquot,
U = measured concentration in unspiked aliquot, and
C_{sa} = actual concentration of spike added.

For situations where a standard reference material (SRM) is used instead of, or in addition to, matrix spikes:

$$\%R = 100 \ x \left[\frac{C_m}{C_{srm}}\right] \ ;$$

%R = percent recovery,
C_m = measured concentration of SRM, and
C_{srm} = actual concentration of SRM.

DETECTION LIMITS

Detection limits will be determined when they are required by the sponsor to be reported or when "less than" values are reported. Determination of detection limits may be determined a number of ways depending on what type of information is most useful for the task. Specific methods of determining detection limits must be discussed in the SOPs or recorded in the scientific notebooks. A discussion of detection limit determinations follows(APHA, 1992):

Determining Detection Limits Instrument Detection Limit (IDL):

The IDL is the *constituent concentration that produces a signal greater than three standard deviations of the mean noise level* or that can be determined by *injecting a standard to produce a signal that is five times the signal-to-noise ratio.*

Lower Limit of Detection (LLD):

The LLD is the amount of constituent that produces a signal sufficiently large that 99% of the trials with that amount will produce a detectable signal. Determine the LLD by *multiple injections of a standard at near zero concentration (no greater than five times the IDL)*. [Determine the standard deviation by the usual method. To reduce the probability of a Type I error (false detection) 5%, multiply *s* by 1.645 from a cumulative normal probability table. Also, to reduce the probability of a Type II error (false nondetection) to 5%, double this amount to 3.290. *As an example, if 20 determinations of low-level standard yielded a standard deviation of 6μg/L, the LLD is 3.29 x 6 = 20 μg/L* (ASTM, 1983).]

Method Detection Limit (MDL):

To determine this parameter, an experienced analyst operating a well-calibrated instrument *adds a constituent to reagent water, or to the matrix of interest at the estimated MDL* (Glaser et al, 1981). *Analyze seven portions of this solution and calculate the standard deviation (s).* From a table of the one-sided *t* distribution select the value of *t* for 7 - 1 = 6 degrees of freedom and at the 99% level; this value is 3.14. *The product 3.14 times s is the desired MDL.*

Limit of Quantitation (LOQ):

Although the LOQ is useful within a laboratory, the practical quantitation limit (PQL) has been proposed as the lowest level achievable among laboratories within specified limits during routine laboratory operations (U.S.EPA, 1985).

DATA REDUCTION, VALIDATION, AND REPORTING

DATA COLLECTION

Analytical data will be collected from instruments via hardcopy printouts. Other pertinent data such as that concerning sampling sites, sample appearances, etc. will be recorded in scientific notebooks with reference to the sample IDs. Scientific notebook usage will conform with the HRC Laboratory Notebook SOP.

REDUCTION

Data reduction that is not accomplished by the instruments' computers will be accomplished with PCs or by hand. Any data reduction pages that are generated will be kept with the raw data in the project files.

VERIFICATION

Data for each class of analyte will be verified by the analyst to determine that each data set is complete, accurately quantified, recorded, legible, and transcribed; and if the data appear to be reasonable and consistent, based on prior knowledge of the samples and sample site. See Figure 2. Any discrepancy discovered during verifications should be corrected and recorded as such.

VALIDATION

75 - 100% of verified sample and 100% of QC data for each sample set will be reviewed by the PI or other qualified non-analyst designee (Figure 2) to evaluate the data's adequacy for its intended purpose. For this task the intended purpose is the set of QA objectives previously described in addition to understandability and data set completeness.

REPORTING

Report formats shall be consistent with the needs of the sponsor.

RECORDS STORAGE, RETRIEVAL, AND DISPOSAL

It is necessary that scientific records pertaining to this task be stored so that a paper trail allows each sample set and/or site to be studied as a unit. In addition, the data and reports from this task are used and referenced in other tasks. It is therefore important that the scientists be able to access them. Upon HRC's laboratory expansion in Spring of 1993, a system will be instituted for records storage, retrieval, and disposal. Until that time there is not space to provide a central location for such a resource.

The records system that will be initiated will include provisions for fire protection, electronic media storage, duplication for research purposes, authorized external release, and subtask traceability. Procedures will include a procedure for time-based authorized disposal.

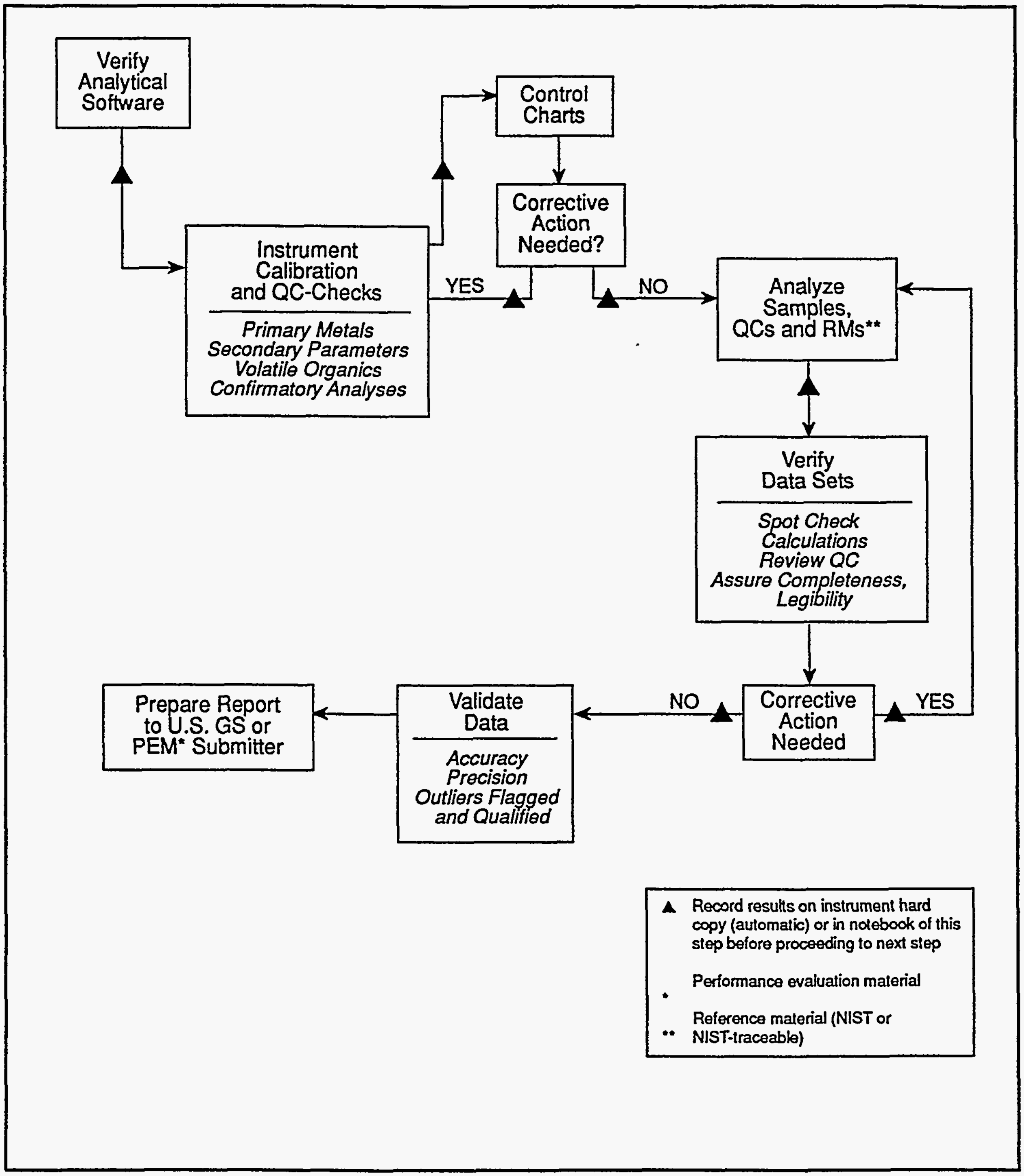

Figure 2. Data handling flow chart.

REFERENCES

1. **U.S. GS. 1989.** Techniques of Water-Resources Investigations of the United States Geological Survey. Methods for Determination of Inorganic Substances in Water and Fluvial Sediments, Book 5 Chapter A1. 1989 545 p. Available from: U.S. Geological Survey, Federal Center, Box 25425, Denver, CO 80225.

2. **U.S. GS. 1987.** Techniques of Water-Resources Investigations of the United States Geological Survey. Methods for Determination of Organic Substances in Water and Fluvial Sediments, Book 5 Chapter A3. 1987 80 p. Available from: U.S. Geological Survey, Federal Center, Box 25425, Denver, CO 80225.

3. **U.S. EPA. 1988.** Methods for the Determination of Organic Compounds in Drinking Water, EPA-600/4-88/039. December, 1988. Environmental Monitoring Systems Laboratory, Office of Research and Development, U.S. Environmental Protection Agency, Cincinnati, OH 45268. Available as PB89-220461 from: National Technical Information Service, Springfield, VA 22161.

4. **U.S. EPA. 1991a.** Method 200.8 Determination of Trace Elements in Waters and Wastes by Inductively Coupled Plasma - Mass Spectrometry, Revision 4.4, April 1991. Environmental Monitoring Systems Laboratory, Office of Research and Development, U.S. Environmental Protection Agency, Cincinnati, OH 45268.

5. **U.S. EPA. 1991b. Test Method** The Determination of Inorganic Anions in Water by Ion Chromatography - Method 300.0, Revised 1991. Environmental Monitoring Systems Laboratory, Research and Development, U.S. Environmental Protection Agency, Cincinnati, OH 45268.

6. **U.S. EPA. 1983.** Methods for Chemical Analysis of Water and Wastes, EPA 600/4-79-020, revised 1983. Environmental Monitoring Systems Laboratory, Office of Research and Development, U.S. Environmental Protection Agency, Cincinnati, OH 45268.

7. **U.S. EPA. 1979.** Handbook for Analytical Quality Control in Water and Wastewater Laboratories, EPA 600/4-79-020 March 1979. Environmental Monitoring Systems Laboratory, Office of Research and Development, U.S. Environmental Protection Agency, Cincinnati, OH 45268.

8. **APHA/ AWWA/ WEF. 1992.** Standard Methods for the Examination of Water and Wastewater. 18th Edition. American Public Health Association, American Water Works Association, and Water Environment Federation. Arnold E. Greenberg, Lenore S. Clesceri, and Andrew D. Eaton, editors. Washington, DC: APHA; 1992.

9. **ASTM. 1983.** Standard Practice for Intralaboratory Quality Control Procedures and a Discussion on Reporting Low-Level Data, Designation D4210-83, American Soc. Testing & Materials, Philadelphia, PA.

10. **Glaser, J.A., D.L. Foerst, J.D. McKee, S.A. Quave & W.L. Budde. 1981.** Trace analyses for wastewater, *Environ. Sci. Technol.* 15:1426.

11. **U.S. EPA. 1985.** National Primary Drinking Water Standards: Synthetic Organics, Inorganics, and Bacteriologicals. 40 CFR Part 141: *Federal Register* 50: No. 219. November 13, 1985.

12. **NV.** Certification requirements supplied to HRC in a December, 1991 letter from the Chemistry Certification Officer, Nevada State Health Lab.

13. **Taylor, John K. 1987.** *Quality Assurance of Chemical Measurements*, pp. 129-146. Lewis Publishers, Chelsea, MI.

Harry Reid Center for Environmental Studies (HRC)
Standard Operating Procedure (SOP)
for
SAMPLING PROTOCOL INORGANICS

Purpose: To collect a representative water sample which is free from contamination.

1. Approvals

Principal Investigator	5/18/95 Approval Date
Reviewer	5/18/95 *Approval Date*
Quality Assurance Staff	5-17-95 Approval Date

2. Sample containers.
   - 2.1 Samples to be analyzed for inorganic constituents will be collected in acid cleaned polyethylene bottles.
   - 2.2 Samples for trace element/cation analysis will be collected in *four* 1-L bottles at each site.
   - 2.3 Samples for *cation and* anion analys*es* will *each* be collected in *a* 125-mL bottle.
   - 2.4 An additional 125-mL sample will be collected for field measurements (Total dissolved solids, conductivity, temperature, pH, and alkalinity).
   - 2.5 Sample containers will be handled at all times with clean polyethylene gloves to prevent contamination of the containers.

3. Sample container preparation.
   - 3.1 New 1-L polyethylene bottles.
     - 3.1.1 Wash with tap water and detergent.
     - 3.1.2 Rinse thoroughly with tap water.
     - 3.1.3 Rinse three times with Nanopure water.
     - 3.1.4 Soak in 10-20% reagent-grade nitric acid for one week.
     - 3.1.5 Rinse three times with Nanopure water.
     - 3.1.6 Soak in 10-20% trace-metal grade nitric acid for one week.
     - 3.1.7 Rinse twice with Nanopure water, then rinse a final time with distilled Nanopure water.
     - 3.1.8 Air dry bottles, seal, bag in sealable plastic bags.
   - 3.2 Used 1-L polyethylene bottles.
     - 3.2.1 Dispose of old sample.

*Revisions are italicized.

3.2.2 Rinse three times with Nanopure water.
3.2.3 Continue to prepare as in sections 3.1.4 to 3.1.8 above.

3.3 All other new polyethylene bottles.
3.3.1 Prepare as in sections 3.1.1 to 3.1.5.
3.3.2 Then dry as in 3.1.8 above.

3.4 All other used polyethylene bottles.
3.4.1 Prepare as in 3.2.1 and 3.2.2 above.
3.4.2 Soak in 10-20% reagent-grade nitric acid for at least three days.
3.4.3 Rinse three times with Nanopure water.
3.4.4 Air dry bottles, seal, bag in sealable plastic bags.

4. Record Keeping.

4.1 All records regarding sample collection will be kept in the Field Sampling Log Book or on the HRC Field Sampling Data Form and are entered into the sample tracking database.

4.2 Information to be recorded will include, but not be limited to:
4.2.1 Date and time of sample collection.
4.2.2 Location name.
4.2.3 The sample number.
4.2.4 Sample type and purpose.
4.2.5 Samplers initials.
4.2.6 When possible: location and altitude as read by Global Positioning System (GPS), including the GPS error.
4.2.7 Any problems or observations are recorded on the sampling form.

4.3 Measurements to be taken and recorded in the field.
4.3.1 Total dissolved solids (TDS).
4.3.2 Conductivity.
4.3.3 Temperature.
4.3.4 pH.
4.3.5 Alkalinity. *(If necessary, alkalinity samples can be tightly sealed, stored, on ice, and returned to the lab for analysis the same day as the sample is collected.)*

5. Sample Collection.

5.1 Information regarding the sample collection will be recorded in the HRC Field Sampling Data Form.

5.2 Always wear polyethylene gloves when handling bottles or sample collection tubing. While wearing gloves, don't touch anything but clean bottles or tubing. If you touch anything other than these items, put on clean gloves.

5.3 Samples will be collected directly into the sample bottle from the source using a peristaltic pump system.
5.3.1 Teflon tubing will be used except in the pump head, where Tygon tubing will be used.

*Revisions are italicized.

5.3.2 The teflon tubing will be cleaned in the same manner as the bottles.

5.3.3 The tygon tubing will be cleaned in a manner similar to the teflon tubing, except new and used tubing will be soaked for only 30 minutes to prevent damage to the tubing.

5.3.4 A 0.45 micron in-line filter will be used to filter all samples.

5.3.5 The sample tube inlet and outlet will be covered with plastic during transport of the system and when the system is not in use to prevent contamination.

5.3.6 If the tubing openings become dirty (touched the dirt or mud, etc.), rinse well with dilute acid, then with Nanopure water before using.

5.3.7 If the sample site can not be reached with the pump system, the sample will be collected directly into a clean *10-liter collapsible container.* The sample will then be filtered through the pump system described above as soon as possible after collection.

5.4 The sample should be collected as close to the source of a spring as possible, or nearest the center of a well or pool. The end of the sample collection tubing should be approximately 1 ft below the surface, when possible, to prevent surface contamination.

5.5 To prevent contamination, sample containers will be open for the shortest time possible to allow sample collection.

5.6 Do not touch the inside of bottles, caps or tubes. Hold the bottle cap with the inside facing down to prevent contamination of the inside of the cap.

5.7 Do not place the sample collection tube inside of the bottle. Allow the sample water to flow into the bottle from above.

5.8 Approximately one liter of sample will be pumped through the system prior to actual sample collection.

5.9 Sample bottles will be rinsed three times with a small amount of filtered sample. After rinsing, fill the bottle with the filtered sample and seal tightly.

5.10 If the wind is blowing while collecting the sample, try to block the wind to prevent dust from blowing into the bottle.

5.11 Filters will be changed daily, or as needed due to clogging.

6. Sample preservation.

6.1 At the time of collection, all samples for trace element/cation analysis will be acidified to < pH 2 with nitric acid (10 ml of concentrated nitric acid to 1 L of sample *and 1.25 mL concentrated nitric acid to 125-mL sample*). The amount of acid added will be recorded on the HRC Field Sampling Data Form.

6.2 Samples collected for anion analysis will not be acidified. These samples will be placed in sealable plastic bags and stored on ice in an insulated container.

6.3 After acidification, sample containers will be closed tightly, placed back in the sealable plastic bags, then placed on ice in an insulated container.

6.4 Samples will be returned to the lab as soon as possible, but no later than the following day.

6.5 Samples will be stored in the lab in a cold storage room at 4 °C.

*Revisions are italicized.

7. Quality Control.
   - 7.1 A lab blank consisting of unfiltered, distilled Nanopure water will be collected for each sample type. These samples will remain in the lab, stored at 4 °C.
   - 7.1 Nanopure water from the lab will be brought to the field, filtered, and subsequently treated as a sample.
     - 7.1.1 One blank for trace element (*four* 1-L)*, and blank for cation analysis (125 mL)* and one blank for anion analysis (125-ml) per day, per sampling team, will be prepared.
     - 7.1.2 If the blank is being collected for trace element/cation analysis, it should be acidified as in 7.1 above.
     - 7.1.3 All further treatment, storage, and analysis will be the same as that for all samples collected at the same time.

*Revisions are italicized.

Harry Reid Center for Environmental Studies (HRC)
Standard Operating Procedure (SOP)

ANALYTICAL BALANCE USE

1. Approvals:

Klaus J. Stetzenbach — 3 APR 95
HRC Project Manager — Date

Amy J Smiecinski — 4-3-95
HRC QA Staff — Date

2. Reagents and equipment
   Analytical balance
   Camel hair brush or lint-free tissue wipes
   Standard weights

3. Procedure
   3.1 Visually check the level bubble to assure the balance is sitting level. If the bubble is not resting within the circle, adjust the thumb wheels at the base of the balance until the bubble is centered.
   3.2 Using a camel hair brush or lint-free wipe, gently brush away dust and particles on the weighing pan and surrounding area.
   3.3 Close the doors and zero the balance using the tare bar or knob as indicated by the manufacturer.
   3.4 Using forceps check standard weights in the range of the item to be weighed. If the result is unacceptable inspect the weights for corrosion. Corroded weights must be discarded and replaced. If the balance measures weights inaccurately, and the weights are not corroded, take the corrective action that seems most logical in your professional judgment. If the balance still operates inaccurately, label it "out-of-order" or isolate it and seek service.
   3.5 Record weights, item measured, user ID, date, and any corrective actions performed in the balance log book that accompanies the balance.
   3.6 **When finished weighing, please gently brush away dust and particles on the weighing pan and surrounding area.**
   3.7 The balances are to be calibrated annually by a NIST-certified service. The balance weight set is to be calibrated annually using a NIST-traceable weight set that is controlled for this purpose. Annual calibrations are recorded in the log assigned to the balance and weight set.

4. Resulting QA Records
   balance logs
   balance calibration and weight set certificates

Harry Reid Center for Environmental Studies (HRC)
Standard Operating Procedure (SOP)

ANALYTICAL BALANCE USE

1. Approvals:

Klaus J. Stetzenbach — 3 APR 95

HRC Project Manager — Date

Amy J. Smiecinski — 4-3-95

HRC QA Staff — Date

2. Reagents and equipment
Analytical balance
Camel hair brush or lint-free tissue wipes
Standard weights

3. Procedure
   - 3.1 Visually check the level bubble to assure the balance is sitting level. If the bubble is not resting within the circle, adjust the thumb wheels at the base of the balance until the bubble is centered.
   - 3.2 Using a camel hair brush or lint-free wipe, gently brush away dust and particles on the weighing pan and surrounding area.
   - 3.3 Close the doors and zero the balance using the tare bar or knob as indicated by the manufacturer.
   - 3.4 Using forceps check standard weights in the range of the item to be weighed. If the result is unacceptable inspect the weights for corrosion. Corroded weights must be discarded and replaced. If the balance measures weights inaccurately, and the weights are not corroded, take the corrective action that seems most logical in your professional judgment. If the balance still operates inaccurately, label it "out-of-order" or isolate it and seek service.
   - 3.5 Record weights, item measured, user ID, date, and any corrective actions performed in the balance log book that accompanies the balance.
   - 3.6 **When finished weighing, please gently brush away dust and particles on the weighing pan and surrounding area.**
   - 3.7 The balances are to be calibrated annually by a NIST-certified service. The balance weight set is to be calibrated annually using a NIST-traceable weight set that is controlled for this purpose. Annual calibrations are recorded in the log assigned to the balance and weight set.

4. Resulting QA Records
balance logs
balance calibration and weight set certificates

Harry Reid Center for Environmental Studies (HRC)
Standard Operating Procedure (SOP)
for
FLAME ATOMIC ABSORPTION SPECTROMETRY

1. Approvals

Klaus J. Stetzenbach — Principal Investigator — 5/17/95 — Approval Date

[signature] — *Reviewer* — 5/17/95 — *Approval Date*

Amy J. Smiecinski — Quality Assurance Staff — 5-17-95 — Approval Date

2. Instrumentation.
   2.1 Varian Atomic Absorption Spectrometer. Model AA-20. Serial # 9061386.

3. Sample Storage and Handling
   Sample containers are stored in plastic ziploc bags at 4°C and are handled at all times with gloved hands.

4. Analytical Methods.
   4.1 Atomic absorption direct aspiration method, EPA Atomic Absorption Method in *Methods for Chemical Analysis of Water and Wastes*, EPA-600/4-79-020, 1983.
   4.2 Supplemental EPA methods, element specific.
   4.3 The Varian publication *Flame Atomic Absorption Spectrometry Analytical Methods* (publication #85-100009-00, 1989) will provide additional guidance, especially when developing a method for an element not previously analyzed.

5. Instrument start-up and operation will be conducted as per the manufacturer's specifications (SpectrAA-10/20 Operation Manual, Varian publication #85-100625-00, 1986).

6. Instrument Log Book.
   6.1 An instrument log book will be kept following the HRC Scientific Notebook SOP.
   6.2 Parameters to be included in the log book are:
      6.2.1 Analyst ID.
      6.2.2 Project name and/or sample ID.
      6.2.3 Date.
      6.2.4 Element to be analyzed.
      6.2.5 Wavelength.

*Revisions are italicized.

6.2.6 Photomultiplier Volts.
6.2.7 Lamp ID number, *when available.*
6.2.8 The number and type of samples run.
6.2.9 Calibration response.
6.2.10 Problems and corrective action taken.

7. Calibration.
7.1 Calibration, following EPA Atomic Absorption Method in *Methods for Chemical Analysis of Water and Wastes*, EPA-600/4-79-020, 1983, will be completed each day that samples are analyzed.
7.2 Standards will be prepared from the appropriate reference standards. The method of preparation and source of the standards, including lot numbers, will be recorded in the analyst's notebook.
7.3 At least 4 standards and a blank will be prepared for the calibration curve.
7.4 The calibration slope and correlation coefficient will be recorded in the instrument log book.
7.4.1 Correlation coefficients must have an r value of 0.995 or greater ($r^2 = 0.990$) to be acceptable. Preferably, the r value will be 0.998 or greater ($r^2 = 0.996$). If r is less than 0.995, corrective action will be taken as specified in 4.1 above.
7.4.2 Only the linear portion of the calibration curve will be used for sample analysis.

8. Quality Assurance.
8.1 Quality assurance will be conducted as in EPA Atomic Absorption Method in *Methods for Chemical Analysis of Water and Wastes*, EPA-600/4-79-020, 1983.
8.2 An unknown performance sample, either an EPA performance sample or a USGS Standard Reference Water Sample, will be analyzed annually. The results must be within the control limit established by the agency from which the sample was obtained. If the results are not in the acceptable range, corrective action should be taken, and a follow-up performance sample should be analyzed.
8.3 A QC standard from another laboratory will be analyzed immediately following the instrument calibration. The determined value must be within 10% of the certified value. If the deviation is greater than 10%, corrective action will be taken as specified in the EPA method listed in 4.1.
8.4 Triplicate measurements will be taken for each sample.
8.4.1 The average value and the standard deviation will be reported.
8.4.2 The relative standard deviation (RSD), the standard deviation divided by the average value and expressed as a percent, should be below 10%, preferably below 5%. If the standard deviation is greater than 10%, the samples will be re-run to obtain a standard deviation within the acceptable range.
8.5 For every 20 samples, the calibration blank, a mid-range standard, and a QC standard will be run as samples. These values must be within 10% of the value determined during the initial calibration. If the deviation is greater than 10%, corrective action will be taken as specified in the EPA method listed in 4.1.
8.6 One replicate preparation and analysis will be completed for each 20 samples.
8.7 A reagent blank and method blank will be run with each analysis.

8.8 Detection limits will be determined for each group of samples analyzed by multiplying by three the standard deviation of the method blank analyzed with the samples. These values will be reported with the analytical results for the corresponding samples.

8.9 To determine if matrix effects are present in a sample, a laboratory fortified sample must be run for all new samples. The percent recovery of a fortified sample must be within 20% of the expected concentration. If the percent recovery is not within the required limits, the method of standard additions must be applied (section 4.1 above). For samples previously analyzed and shown to be free of matrix effects, fortified samples will be run at a frequency of 10% or one for each sample set, whichever is greater.

9. Record keeping.

9.1 An analyst's notebook will be kept as specified in the *current* HRC Scientific Notebook SOP. All information relating to sample identification, preparation, and analysis will be kept in the analyst's notebook. Data to be recorded in the notebook includes, but is not limited to: *the name and revision number of this SOP,* method number, element to be analyzed, wavelength, QC standard value, weights and concentrations used in preparing standards and samples, type and source of reagents used, and any corrective action taken.

9.2 Any data originating from instrument or computer printouts will be kept in the *data management AA files, sorted by element.*

10. Calculations and data manipulations.

10.1 The concentration values provided directly by the Varian SpectrAA 10/20 will not be the reported values used. The software program which this instrument uses calculates a curve fit for the calibration standards, not a linear regression. This could result in the use of non-linear portions of the calibration curve. Instead, the following method of calculating the concentration for the absorbance readings will be used:

10.1.2 Prepare the calibration curve by plotting the absorbance against the concentration.

10.1.3 Using the Quattro Pro mathematics calculations, calculate the least squares linear regression for the calibration standards.

10.1.4 If the r value meets the specifications in 7.4.1, use the slope of this line to convert the sample absorbance values to concentration using the following equation: absorbance/slope = concentration. Take corrective action as specified in 7.4.1, if the r value is not in the acceptable range.

10.1.5 Apply any sample dilution factors to the concentration obtained in 10.1.4.

10.1.6 Print out the calculations and *submit to the QA staff for verification.*

Harry Reid Center for Environmental Studies (HRC)
Standard Operating Procedures
for

MERCURY COLD VAPOR TECHNIQUE WITH GOLD AMALGAM PRECONCENTRATION

1. Approvals

Klaus J. Stetzenbach	5/17/95
Principal Investigator	Approval Date
[signature]	5/17/95
Reviewer	*Approval Date*
Amy J. Smiecinski	5-17-95
Quality Assurance Staff	Approval Date

2. Instrumentation.
   2.1 Varian Atomic Absorption Spectrometer.
   Model AA-20. Serial # 9061386.
   deleted 2.2, concentrator accessory and all references to it in the text
   2.2 Varian Cold Vapor Analyzer.
   Model VGA-76. Serial #2021208.

3. Samples are stored in plastic ziploc bags at 4°C and are handled at all times with gloved hands.

4. This analytical technique combines several methods.
   4.1 The sample preparation, including oxidation with potassium permanganate and potassium persulfate, heating of the sample, and the addition of sodium chloride-hydroxylamine sulfate to reduce the excess permanganate, is completed as outlined in the EPA method 245.1 (Mercury Manual Cold Vapor Technique). The reagents needed for this step are prepared as specified in EPA method 245.1.
   4.2 The addition of stannous chloride, and introduction of the mercury vapor into the light path of the AA is accomplished with the VGA-76 accessories. The reagents needed in this step are prepared as specified in the Varian publication *Operation Manual, MCA-90 Mercury Concentration Accessory* (Varian publication #85-100973-00, 1991).
   4.3 Supplemental publications which may provide additional information include:
      4.3.1 Atomic absorption direct aspiration method, EPA Atomic Absorption Method in *Methods for Chemical Analysis of Water and Wastes*, EPA 600/4-79-020, 1983.
      4.3.2 *Flame Atomic Absorption Spectrometry Analytical Methods* (Varian publication #85-100009-00, 1989).

*Revisions are italicized.

4.3.3 VGA-76 Vapor Generation Accessory, Operation Manual (Varian publication #85-100577-00, 1989).

5. Instrument start-up and operation will be conducted as per the manufacturer's specifications (SpectrAA-10/20 Operation Manual, Varian publication #85-100625-00, 1986; Varian publications listed in 4.2, 4.3.2, and 4.3.3 above).

6. Instrument Log Book.

6.1 An instrument log book will be kept following the HRC Scientific Notebook SOP.

6.2 Parameters to be included in the log book are:

6.2.1 Analyst ID.
6.2.2 Project name and/or sample ID.
6.2.3 Date.
6.2.4 Photomultiplier Volts.
6.2.5 Lamp ID number, *if available*.
6.2.6 Sample uptake rate.
6.2.7 Reagent uptake rate.
6.2.*8* The number and type of samples run.
6.2.*9* Calibration response.
6.2.*10* Problems and corrective action taken.

7. Calibration.

7.1 Calibration, following EPA Atomic Absorption Method in *Methods for Chemical Analysis of Water and Wastes*, EPA-600/4-79-020, 1983, will be completed each day that samples are analyzed.

7.2 Standards will be prepared from the appropriate reference standard. The method of preparation and source, including lot number, of the standard will be recorded in the analyst's notebook.

7.3 At least 4 standards and a blank will be prepared for the calibration curve.

7.4 The calibration slope and correlation coefficient will be recorded in the instrument log book.

7.4.1 Correlation coefficients must have an r value of 0.995 or greater (r^2 = 0.990) to be acceptable. Preferably, the r value will be 0.998 or greater (r^2 = 0.996). If r is less than 0.995, corrective will be taken as specified in 3.3.1.

7.4.2 Only the linear portion of the calibration curve will be used for sample analysis.

8. Quality Assurance.

8.1 Quality assurance will be conducted as in EPA Atomic Absorption Method in *Methods for Chemical Analysis of Water and Wastes*, EPA-600/4-79-020, 1983.

8.2 An unknown performance sample, either an EPA performance sample or a USGS Standard Reference Water Sample, will be analyzed annually. The results must be within the control limit established by the agency from which the sample was obtained. If the

*Revisions are italicized.

results are not in the acceptable range, corrective action should be taken, and a follow-up performance sample should be analyzed.

8.3 A QC standard from another laboratory will be analyzed immediately following the instrument calibration. The determined value must be within 10% of the certified value. If the deviation is greater than 10%, corrective action will be taken as specified in the EPA method listed in 4.3.1.

8.4 Triplicate measurements will be taken for each sample.

8.4.1 The average value and the standard deviation will be reported.

8.4.2 The relative standard deviation (RSD), the standard deviation divided by the average value and expressed as a percent, should be below 10%, preferably below 5%. If the standard deviation is greater than 10%, the samples will be re-run to obtain a standard deviation within the acceptable range.

8.5 For every 20 samples, the calibration blank, a mid-range standard, and a QC standard will be run as samples. These values must be within 10% of the value determined during the initial calibration. If the deviation is greater than 10%, corrective action will be taken as specified in the EPA method listed in 4.3.1.

8.6 One replicate preparation and analysis will be completed for each 20 samples.

8.7 A reagent blank and method blank will be run with each analysis.

8.8 Detection limits will be determined for each group of samples analyzed by multiplying by three the standard deviation of the method blank analyzed with the samples. These values will be reported with the analytical results for the corresponding samples.

8.9 To determine if matrix effects are present in a sample, a laboratory fortified sample must be run for all new samples. The percent recovery of a fortified sample must be within 10% of the expected concentration. If the percent recovery is not within the required limits, the method of standard additions must be applied (section 4.3.1 above). For samples previously analyzed and shown to be free of matrix effects, fortified samples will be run at a frequency of 10% or one for each sample set, whichever is greater.

9. Record keeping.

9.1 An analysts notebook will be kept as specified in the *current* HRC Scientific Notebook SOP. All information relating to sample identification, preparation and analysis will be kept in the analysts notebook. Data to be recorded in the notebook includes, but is not limited to: *the name and revision number of this SOP,* method number, QC standard value, and weights and concentrations used in preparing standards and samples, type and source of reagents used, and any corrective action taken.

9.2 Any data originating from instrument or computer printouts will be kept in the *data management AA mercury file.*

10. Calculations and data manipulations.

10.1 The concentration values provided directly by the Varian SpectrAA 10/20 will not be the reported values used. The software program which this instrument uses calculates a curve fit for the calibration standards, not a linear regression. This could result in the

*Revisions are italicized.

use of non-linear portions of the calibration curve. Instead, the following method of calculating the concentration for the absorbance readings will be used:

10.1.2 Prepare the calibration curve by plotting the absorbance against the concentration.

10.1.3 Using the Quattro Pro mathematics calculations, calculate the least squares linear regression for the calibration standards.

10.1.4 If the r value meets the specifications in 7.4.1, use the slope of this line to convert the sample absorbance values to concentration using the following equation: absorbance/slope = concentration. Take corrective action as specified in 7.4.1, if the r value is not in the acceptable range.

10.1.5 Apply any sample dilution factors to the concentration obtained in 10.1.4.

10.1.6 Print out the calculations and *submit to the QA staff for verification.*

*Revisions are italicized.

Harry Reid Center for Environmental Studies (HRC)
Standard Operating Procedure (SOP)
for
GRAPHITE FURNACE ATOMIC ABSORPTION SPECTROMETRY

1. Approvals

Principal Investigator	5/17/95 Approval Date
Reviewer	5/17/95 *Approval Date*
Quality Assurance Staff	5-17-95 Approval Date

2. Instrumentation.
   2.1 Varian Atomic Absorption Spectrometer. Model AA-20. Serial # 9061386.
   2.2 Varian Graphite Tube Atomizer. Serial #GTA-96-9061247.

3. Samples are stored in ziploc bags at 4^{0}C and are handled at all times with gloved hands.

4. Analytical Methods.
   4.1 EPA Atomic Absorption Method in *Methods for Chemical Analysis of Water and Wastes*, EPA-600/4-79-020, 1983.
   4.2 *EPA method 200.9, Determination of Trace Elements by Stabilized Temperature Graphite Furnace Atomic Absorption.*
   4.3 Supplemental EPA methods, element specific.
   4.4 The Varian publication *Analytical Methods for Graphite Tube Atomizers* (publication #85-100848-00, 1988) will provide additional guidance, especially when developing a method for an element not previously analyzed.

5. Instrument start-up and operation will be conducted as per the manufacturer's specifications (*SpectrAA-10/20 Operation Manual*, Varian publication #85-100625-00, 1986).

6. Instrument Log Book.
   6.1 An instrument log book will be kept following the HRC Scientific Notebook SOP.
   6.2 Parameters to be included in the log book are:
      6.2.1 Analyst ID.

*Revisions are italicized.

6.2.2 Project name and/or sample ID.
6.2.3 Date of analysis.
6.2.4 Element to be analyzed.
6.2.5 Wavelength.
6.2.6 Photomultiplier Volts.
6.2.7 Lamp ID number, *when available.*
6.2.8 Furnace Program.
6.2.9 The number and type of samples run.
6.2.10 Calibration response.
6.2.11 Problems and corrective action taken.

7. Calibration.

7.1 Calibration, following the EPA method listed in 4.1 above, will be completed each day that samples are analyzed.

7.2 Standards will be prepared from the appropriate reference standards. The method of preparation and source, including lot numbers, of the standards will be recorded in the analyst's notebook.

7.3 At least 4 standards and a blank will be prepared for the calibration curve.

7.4 The calibration slope and correlation coefficient will be recorded in the instrument log book.

7.4.1 Correlation coefficients must have an r value of 0.995 or greater ($r^2 = 0.990$) to be acceptable. Preferably, the r value will be 0.998 or greater ($r^2 = 0.996$). If r is less than 0.995, corrective will be taken as specified in the EPA methods listed in 4.1 and 4.2.

7.4.2 Only the linear portion of the calibration curve will be used for sample analysis.

8. Quality Assurance.

8.1 Quality assurance will be conducted as in the EPA method listed in 4.1 above.

8.2 The method detection limits will be determined every six months or sooner, as specified in the EPA method listed in section 4.1.

8.3 An unknown performance sample, either an EPA performance sample or a USGS Standard Reference Water Sample, will be analyzed annually. The results must be within the control limit established by the agency from which the sample was obtained. If the results are not in the acceptable range, corrective action should be taken, and a follow-up performance sample should be analyzed.

8.4 A QC standard from another laboratory will be analyzed immediately following the instrument calibration. The determined value must be within 10% of the certified value. If the deviation is greater than 10%, corrective action will be taken as specified in the EPA methods listed in 4.1 and 4.2.

8.5 Triplicate measurements will be taken for each sample.

8.5.1 The average value and the standard deviation will be reported.

8.5.2 The relative standard deviation (RSD), the standard deviation divided by the average value and expressed as a percent, should be below 10%, preferably

*Revisions are italicized.

below 5%. If the standard deviation is greater than 10%, the samples will be re-run to obtain a standard deviation within the acceptable range.

8.6 For every 20 samples, the calibration blank, a mid-range standard, and a QC standard will be run as samples. These values must be within 10% of the value determined during the initial calibration. If the deviation is greater than 10%, corrective action will be taken as specified in the EPA methods listed in 4.1 and 4.2.

8.7 One replicate preparation and analysis will be completed for each 20 samples.

8.8 A reagent blank and method blank will be run with each analysis.

8.9 Detection limits will be determined for each group of samples analyzed by multiplying by three the standard deviation of the method blank analyzed with the samples. These values will be reported with the analytical results for the corresponding samples.

8.10 To determine if matrix effects are present in a sample, a laboratory fortified sample must be run for all new samples. The percent recovery of a fortified sample must be within 20% of the expected concentration. If the percent recovery is not within the required limits, the method of standard additions must be applied (see 4.1 and 4.2). For samples previously analyzed and shown to be free of matrix effects, fortified samples will be run at a frequency of 10% or one for each sample set, whichever is greater.

9. Record keeping.

9.1 An analysts notebook will be kept as specified in the *current* HRC Scientific Notebook SOP. All information relating to sample identification, preparation and analysis will be kept in the analysts notebook. Data to be recorded in the notebook includes, but is not limited to: *the name and revision number of this SOP,* method number, element to be analyzed, wavelength, furnace program, QC standard value, weights and concentrations used in preparing standards and samples, type and source of reagents used, and any corrective action taken.

9.2 Any data originating from instrument or computer printouts will be kept in the *data management AA files, sorted by element.*

10. Calculations and data manipulations.

10.1 The concentration values provided directly by the Varian SpectrAA 10/20 will not be the reported values used. The software program which this instrument uses calculates a curve fit for the calibration standards, not a linear regression. This could result in the use of non-linear portions of the calibration curve. Instead, the following method of calculating the concentration for the absorbance readings will be used:

10.1.2 Prepare the calibration curve by plotting the absorbance against the concentration.

10.1.3 Using the Quattro Pro mathematics calculations, calculate the least squares linear regression for the calibration standards.

10.1.4 If the r value meets the specifications in 7.4.1, use the slope of this line to convert the sample absorbance values to concentration using the following equation: absorbance/slope = concentration. Take corrective action as specified in 7.4.1, if the r value is not in the acceptable range.

*Revisions are italicized.

10.1.5 Apply any sample dilution factors to the concentration obtained in 10.1.4.

10.1.6 Print out the calculations and *submit to the QA staff for verification.*

*Revisions are italicized.

Harry Reid Center for Environmental Studies (HRC)
Standard Operating Procedure (SOP)
for
Ion Chromatography System

1. Approvals:

Klaus J. Stetzenbach — Principal Investigator

Amy J. Smiecinski — Quality Assurance Staff

10 Feb 94 — Approval Date

2-10-94 — Approval Date

2. Instrumentation:
   - 2.1 Dionex Ion Chromatograph System consisting of:
     - Advanced Gradient Pump, Model# AGP-1
     - Eluant Degas Module, Model# EDM-2
     - Liquid Chromatography Module, Model# LCM-3
     - Conductivity Detector, Model# CDM-2
     - Advanced Computer Interface, Model# ACI-1
     - Automated Sampler, Model# ASM-3
     - Dionex AI-450 Chromatography Automation Software, Version 3.1 (or equivalent)
     - Anion AS4A-Ionpac Chromatography Column
     - Anion AG4A Guard Column
     - Micromembrane Suppressor, Model# AMMS-II

3. Analytical Method:
   - 3.1 Test Method, *The Determination of Inorganic Anions in Water by Ion Chromatography-Method 300.0*, Revised August 1991.

4. Sample Collection and Preparation:

4.1 All samples will be logged in to the sampling notebook upon collection, and any applicable environmental factors and on site measurements will be noted, along with site location, time, and date of sample collection.

4.2 Samples will be filtered through a 0.45um filter, and stored in low-density polyethylene (LDPE) sample jars. A minimum of 50 ml of water will be collected at each site for anion analysis.

4.3 Field blanks will be collected on each sampling day. These consist of DI water that is run through the pumping apparatus and will be used to correct for any field contamination.

4.4 Lab blanks consisting of DI water taken at the same time as field blanks will be taken into the field on each sampling day. These will be compared to the field blank to determine contamination due solely to field sampling.

4.5 Samples will be transported from the sampling site to the laboratory in ice chests. Blue ice will be used as the primary coolant in these chests.

4.6 Samples will be stored at the laboratory in a cold room (currently located in room 165), at approximately 4°C until analysis.

4.7 Analyses will be performed within 48 hours of collection for phosphate and nitrite determinations. Analysis of all other must be performed within 28 days of collection.

5. Instrument Start-up:

5.1 Instrument start-up will be performed according to the instructions listed in the manufacturer's operation manuals. These manuals are available for each separate module of the system, and each instrument operator will have read through all applicable manuals for the current system before starting any part of the system, to avoid problems with those modules functioning as a group, or controlled by the computer interface. The appropriate manuals and sections are listed below:

Advanced Gradient Pump, Model# AGP-1, Sections 1.4 - 3.4
Eluant Degas Module, Model# EDM-2, Complete instructions
Liquid Chromatography Module, Model# LCM-3, Sections 3 and 4
Conductivity Detector, Model# CDM-2, Sections 2, 4, and 5
Advanced Computer Interface, Model# ACI-1, Sections 2 and 3.4 of Autoregen Manual, and section 4 of the EX Series Pump manual
Automated Sampler, Model# ASM-3, Sections 2, 4, and 5
Dionex AI-450 Chromatography Automation Software, Version 3.1 (or equivalent), User's Guide
Anion AS4A-Ionpac Chromatography Column, Sections 3 - 6
Anion AG4A Guard Column
Micromembrane Suppressor, Model# AMMS-II, sections 1, 2, and 3
Anion Autoregen Cartridge Accessory, section 2.0

NOTE: All sections of the manuals listed above pertaining to installation, operation, service/maintenance, and troubleshooting will be read and understood to the fullest possible degree by all analysts using the instrument.

6. Instrument Log Book:
   6.1 An instrument logbook entitled, Ion Chromatography, will be kept to record all pertinent information including (but not limited to): analyst ID, date, conductivity, type of analyses run, calibration concentration ranges, instrument maintenance, and standard preparation.
   6.2 This logbook will be kept in accordance with standard laboratory notebook/logbook guidelines and procedures laid out in the HRC Notebook SOP.

7. Calibration:
   7.1 Calibration standards preparation, curve range evaluation and etc. will be performed according to EPA Method 300.0 with the following exceptions:
      7.1.1 A 50 ul loop will be used for sample introduction, instead of the 0.1 to 1.0 ml loop recommended by the method.
      7.1.2 A four or more-point calibration, including the reagent blank as the zero-point, is performed prior to each sample analysis.
      7.1.3 Because environmental samples will be analyzed, accurate prediction of analyte concentrations is difficult to do. All samples which fall above the calibration range will be diluted and re-run, or will be re-run under a higher concentration calibration curve.
      7.1.4 Each chromatogram peak will be viewed and if necessary, manually integrated .
      7.1.5 A separate calibration curve for each anion of interest will be prepared by plotting peak area against concentration values.
      7.1.6 Each calibration curve will be verified using a NIST-traceable quality control sample.
      7.1.7 Correlation coefficients for calibration curves will be equal to or greater than 0.95, or new calibration standards will be prepared and re-run until this value is met or exceeded.

8. Quality Control:
   8.1 The following QC guidelines set forth in EPA Method 300.0 (Section 10) will be used:
      8.1.1 A reagent blank, consisting of reagent water that was used to prepare standards and dilute samples, will be analyzed prior to the calibration standards. Corrective action such as blank subtraction or reanalysis will take place if reagent interferences are not under control, as defined on the QC checklist.

8.1.2 Field blank subtraction will be performed for any sample for which the field blank contamination is greater than or equal to 1% of the sample. Contamination due to field conditions is equal to the field blank minus the lab blank. Field blank subtraction should not be performed on samples that are diluted.

8.1.3 A quality control sample prepared by an independent source (currently Dionex) will be analyzed immediately following instrument calibration. This standard will be NIST traceable, and will be compared to standards made up in-house to verify the accuracy of the in-house standard solutions. The true values, measured values and the %difference will be recorded on the QC check list. If the % difference is greater than 10% corrective action will take place.

8.1.4 Triplicate measurements will be taken for each sample. The average values, standard deviations and percent relative standard deviations (%RSD) will be reported. If a %RSD is above 10%, the samples will be re-run to obtain a standard deviation within the limits.

8.1.5 A mid range calibration check standard will be analyzed for every 20 samples. The percent difference, between the mid range concentration and that measured for the check standard, will be calculated and documented on the QC check list. The %difference must be less than 10% or corrective action will take place.

8.1.6 Control charts will be prepared using the quality control sample. The upper and lower control limits will be the actual concentration $\pm$ 10%. If the measured concentration falls out of the limits, the standards will be rerun or new standards prepared.

8.1.7 A minimum of 10% of all samples will be run in duplicate. The duplicates must agree within 10%.

8.1.8 Method detection limits will be performed (as in 13.1 of 300.0) each 6 months or whenever there is a significant change in the system that would effect response, such as a column change.

8.1.9 Instrument detection limits will be determined and reported for each set of samples.

8.1.10 The Laboratory Fortified Matrix procedure (LFM, described in 3.8 of 300.0) is intended to detect matrix effects and interferences (see also 4.1 of 300.0). LFM will be performed for each U.S.EPA performance sample analyzed for certification. LFM will also be performed for each initial field site/matrix and biannually if no interference or matrix effect is observed or sooner if a significant change in the site/matrix chemistry is observed.

If an interference or matrix effect is inherent in the site/matrix then the LFM procedure will be used on all field samples from that site/matrix.

9. Record Keeping:

9.1 An instrument logbook entitled, Ion Chromatography, will be kept to record all pertinent information including (but not limited to): analyst ID, analyses run, calibration concentration ranges, instrument maintenance, and standard preparation.

9.2 A QC check list will be prepared with every analysis. These check lists will be placed in a notebook entitled, Ion Chromatograph, Quality Control Check List.

9.3 Hard copies of all analyses will be stored in the analysts' files referenced by site name, and sample date until data are transferred to the HRC Chemistry Division Data Management System.

10. Retention Time Analysis:

10.1 Chromatographic analysis will be accomplished using the Dionex AI-450 Chromatography Automation Software, Version 3.1 (or equivalent).

10.2 Retention time windows will be calculated using guidelines set out in EPA Method 300.0 (Section 11.4), and the experience of the analyst.

11. Calculations and Data Manipulations:

11.1 All mean values, and %RSD values calculated for the anion analyses will be performed using the Dionex AI-450 Chromatography Automation Software, Version 3.1 or a standard spreadsheet program such as Lotus 1-2-3 or QuattroPro.

11.2 All other calculations and data manipulations will be performed using the Dionex AI-450 Chromatography Automation Software, Version 3.1 (or equivalent).

Harry Reid Center for Environmental Studies (HRC)
Standard Operating Procedure (SOP)
for
ULTRO-PURE REVERSE OSMOSIS WATER SYSTEM

1. Approvals

[signature]
HRC Director

[signature]
Quality Assurance Staff

4-14-93
Approval Date

4-14-93
Approval Date

2. Purpose

The Ultro-pure Reverse Osmosis water purification system was installed 07/18/89 by the University of Nevada-Las Vegas operations and maintenance work crew. The Reverse Osmosis membrane was installed, and some initial rewiring (see Water System Log Book for details), cleaning, and fine tuning done by the Analytical Chemistry Laboratory personnel. The actual start-up was on 12/15/89. The Ultro-pure system product water is piped to an additional purification system (Nano-pure) to provide HPLC grade water. This system has a separate SOP that should be followed.

3. Specifications

Manufactured by:	Barnstead/Thermolyne Corporation 2555 Kerper Blvd., Dubuque, IA 52001 (800) 446-6060, (319) 556-8843
Model No.:	D2710
Serial No.:	8907003
Membrane:	Standard Cellulose-Acetate Membrane (# D2730)

4. Description

System originally set at 35% recovery with an estimated 700 ppm TDS (688 ppm TDS actual). At these settings, the product water should contain about 63 ppm TDS, have a 91% rejection rate, and contain between 0.3 and 1.0 ppm residual chlorine. These parameters may need to be altered with fluctuations in incoming water and analytical needs. The reverse osmosis membrane pressure gauge was set at 200 psig by adjusting the reject and recycle valves in the reverse osmosis unit. (Page 19 of the Ultro-pure System Booklet.)

The reverse osmosis storage system is wired so that when the water level reaches the uppermost float contact in the tank, this will turn the power OFF to the reverse osmosis outlet, shutting the reverse osmosis unit down. When the water level drops below the second or middle float contact in the tank, this will turn the power ON to the reverse osmosis unit, starting the flow of product water to refill the tank. The lowermost float contact in the tank is a safety switch; when the water level drops below this mark, the power to the pump outlet is turned OFF. This prevents the pump from running when there is no water in the tank and burning itself out.

The pump is equipped with a pressure switch which activates the pump when pressure in the lines falls below a certain point (i.e., when the distilled water faucets in Lab 163 are turned on and allowed to run) and turns the pump off when the lines are re-pressurized.

5. Procedure

The reverse osmosis unit should be left ON at all times, and so should the pump. The reverse osmosis unit and pump outlets are wired through breaker switches numbers 2 and 4, in breaker box #2, located in the hallway between Lab 166 and Room 161. The circuit diagrams for the relay box wiring are located behind the log sheets in the Water System Log Book.

The Reverse Osmosis unit should not be shut down for more than four days at a time, or bacteria and other impurities may grow on the membrane.

To prohibit the growth of these impurities, the reverse osmosis unit should be activated at least twice each week (Monday and Thursday). To accomplish this, the faucets in Lab 163 should be turned on and allowed to run until the level of the water in the storage tank drops below the middle or second float contact and the power is turned ON to the reverse osmosis unit. The reverse osmosis unit should continue to operate until the water level in the storage tank reaches the uppermost float contact, and power to the reverse osmosis outlet is turned OFF. If normal lab use activates the reverse osmosis unit at least once every four days, it will not be necessary to let the water run as described above.

If it is necessary to shut the reverse osmosis unit down for more than four days, the membrane must be cleaned prior to shutdown, and some mild preservative added. The directions for cleaning the reverse osmosis membrane can be found on pages 28-29 of the Ultro-pure System booklet. A ½ to 1% sodium bisulfite solution (about one liter) is added to the prefilter housing as a preservative, and then the reverse osmosis unit is switched on for about 30 seconds, and then shut off. This should be repeated 3 or 4 times to saturate the membrane with the solution. More detailed instructions are found on page 31 of the Ultro-pure System booklet. It is extremely important that the preservative solution be rinsed from the membrane before it is put back into use. (See page 31 of the Ultro-pure System booklet.)

The log sheets give places for ± Usage, which refers to approximate volume of water used; Cl^- ppm, which refers to the chlorine content of the product water; pH, which refers to the pH of the product water; and Comments. The Comments section should be used to record % recovery, water or air temperature if it is unusually hot or cold, or any other item which seems out of the ordinary, or of special note. These comments may be useful to other lab personnel, or to the service technicians if the reverse osmosis unit were to require service.

Weekly checks should be made of product water pH and chlorine content using the appropriate papers or test kits located in Lab 163 (in the cabinet on the east wall marked TEST KITS), and the values noted in the appropriate spaces in the Ultro-pure Water Unit Log Sheet.

An estimate of water usage should also be kept in the Ultro-pure Water Unit Log Sheet. This can be done by a simple calculation using the approximate flow of 8.33 L/min (500 L/hr) from one faucet turned on "full blast." To estimate actual usage, take the fraction of "full blast" flow multiplied by the amount of time the water was flowing (e.g., if the faucet was turned on half-way for 30 minutes, the calculation would be: ½(8.33 L/min) (30 min) = 125 L total).

The Reverse Osmosis membrane should be cleaned every three months or sooner if the rejection flow-rate values decrease 5% from initial values or the product flow-rate decreases by 10% from the initial values. The instructions for cleaning the reverse osmosis membrane can be found on pages 28-29 of the Ultro-pure System booklet. Note: product and reject flows differ by approximately 3% for each degree Celsius above or below the listed flow rate at 25°C or 77°F. This means that a change from cold winter temperatures to warm summer temperatures or vice versa may require some adjustment of the reject or recycle valves. (See page 33 of the Ultro-pure System booklet.) Membrane cleanings or changes should be noted in the Operating Record Log Sheet behind the initial log sheets. If the membrane is cleaned and maintained properly , it can be expected to last from three to five years, depending on water conditions, before replacement is necessary.

Harry Reid Center for Environmental Studies (HRC)
Standard Operating Procedure (SOP)
for
NANOPURE WATER SYSTEM

1. Approvals

HRC Director | Quality Assurance Staff

4-14-93 Approval Date | 4-14-93 Approval Date

2. Introduction

The NANOpure water purification system was installed by the University of Nevada-Las Vegas operations and maintenance work crew. It was designed to take RO water and purify it further to produce TYPE 1 18.3 megaohm water. Regardless of the design, the best that has been produced is 18.2 megaohm water.

3. Specifications

Manufactured by:	Barnstead/Thermolyne Corporation 2555 Kerper Blvd., Dubuque, IA 52001 (800) 446-6060, (319) 556-8843
Model No.:	D4741
Serial Number:	55000463
Cartridge Filters:	#1: MACROpure #D0836 #2: High Capacity #D0803 #3: Ultrapure SG #D5054 #4: ORGANICfree #D5021 Remote Final: 0.2 micron #D3751

4. Description

There are three membrane switches that allow the user to control most of the functions of the NANOpure water system. The MODE switch can be used to display water temperature in degrees centigrade, water resistivity in megaohm-centimeter, and the water system setpoint. The setpoint warns the user when water purity drops below a set resistance. It is currently set at 18.0 megaohm-centimeter but can be changed using the CONTROL switch. Water temperature and resistance displays cannot be changed. When NANOpure displays an "Err" message, this indicates a problem in the resistivity monitoring system. One can refer to the troubleshooting guide at the back of the owner's manual for causes and solutions. The third membrane switch is the ON/STANDBY/OFF switch.

5. Procedure

The water system should only be turned "OFF" when service or maintenance is to be performed. The system should be turned "ON" when in use. If the system is not in use, it should be in the "STANDBY" mode. This will optimize filter life because in this mode the water will recirculate through the entire system for 10 minutes out of every hour of non-use. When the system is in the "standby" mode, "SbY" will show on the display.

6. Maintenance

Maintenance on the NANOpure water system has three schedules. It is recommended that the remote final filter be replaced every 45 days, when there is an unacceptable amount of bacteria entering into the water, or when the water flow rate is less than one liter per minute. Instructions for this filter replacement can be found on page 17 of the owner's manual. It is also recommended that the Ultrapure filter (#D5054) be sanitized every month or when pyrogen passage occurs. Instructions for this maintenance procedure can be found on page 19 of the owner's manual. When a cartridge is replaced, if residual deposits are found on the inside of the canister, then the entire system needs to be cleaned and sanitized. The instructions are on page 20 of the owner's manual. If the system has been on "standby" for more than one day, then the system should be turned on and the water allowed to recirculate until 18.1 or 18.2 megaohm-centimeter water is achieved. When the desired resistance is reached, then the remote dispenser should be opened and 4-6 liters of water should be allowed to drain if it is not to be used. Always log how long it takes the water system to achieve desired resistance!. Log this number in the "comment" space on the log sheet.

7. Recordkeeping

The log sheet has columns for DATE, ±USAGE, Cl^- ppm, pH, Resistance, and Comments. When the NANOpure system is used, its use should be recorded in the log book. The date should e recorded in the DATE space, approximate amount of water used in the ±Usage space, achieved resistance in the Resistance space, and the time it took to achieve that resistance in the Comment space. Every week the pH and chlorine content of the product water should be checked using the appropriate kits. (See SOP of the Ultrapure RO water system.) These figures should then be entered into the pH and Cl^- ppm spaces.

ULTROPURE WATER UNIT LOG SHEET ACL/ERC/UNLV

DATE	±Usage	pH	Cl ppm	Comments		DATE	±Usage	pH	Cl ppm	Comments	

Harry Reid Center for Environmental Studies (HRC)
Standard Operating Procedure (SOP)
for

INDUCTIVELY COUPLED PLASMA-ATOMIC EMISSION SPECTROMETRY

1. Approvals

Klaus J. Stetzenbach
Principal Investigator

Amy J. Smiecinski
Quality Assurance Staff

2 Mar 93
Approval Date

3-2-93
Approval Date

2. Instrumentation.
   2.1 Perkin-Elmer Plasma 40 Emission Spectrometer. Serial #130262.

3. Analytical Methods.
   3.1 EPA method 200.7, *Determination of Metals and Trace Elements in Water and Wastes by Inductively Coupled Plasma-Atomic Emission Spectrometry.*
   3.2 The Perkin-Elmer manual, *Instructions, Plasma 40 Emission Spectrometer* (Perkin-Elmer, 1987), will provide additional guidance, especially when developing a method for an element not previously analyzed.

4. Instrument start-up, optimization and operation will be conducted as per the manufacturers specifications (*Instructions, Plasma 40 Emission Spectrometer*, Perkin-Elmer, 1987).

5. Instrument Log Book.
   5.1 An instrument log book will be kept following the HRC Scientific Notebook SOP.
   5.2 Parameters to be included in the log book are:
      5.2.1 Analyst.
      5.2.2 Date.
      5.2.3 Project name and/or sample ID.
      5.2.4 The number of samples run.
      5.2.5 Argon pressure to instrument.
      5.2.6 Nebulizer argon flow rate.
      5.2.7 Elements to be analyzed.
      5.2.8 Wavelengths.
      5.2.9 Photomultiplier Volts.
      5.2.10 Background correction location.

5.2.11 Calibration response.
5.2.12 Any problems and corrective action.

6. Calibration.

6.1 Calibration following the EPA method listed in 3.1 will be completed each day that samples are analyzed. However, the manufacturers instructions (3.2) will be followed when optimizing the instrument.

6.2 Wavelength calibration will be completed, following the method in 3.2, each day that samples are analyzed.

6.3 Interelement spectral interference checks will be conducted following the method in 3.2.

6.3.1 An initial determination of correction factors to be applied will be completed.

6.3.2 Periodic checks of the correction factors will be completed as specified in the method listed in 3.2.

6.4 Calibration standards will be prepared from the appropriate reference standards. The method of preparation and source, including lot numbers, of the standards will be recorded in the analyst's notebook.

6.5 At least 4 standards and a blank will be prepared for the calibration curve.

6.6 The calibration slope and correlation coefficient will be recorded in the instrument log book.

6.6.1 Correlation coefficients must have an r value of 0.995 or greater (r^2 = 0.990) to be acceptable. Preferably, the r value will be 0.998 or greater (r^2 = 0.996). If r is less than 0.995, corrective will be taken as specified in the EPA method listed in 3.1.

6.6.2 Only the linear portion of the calibration curve will be used for sample analysis.

7. Quality Assurance.

7.1 Quality assurance will be conducted as in the EPA method listed in section 3.1 above.

7.2 The method detection limits will be determined every six months or sooner, as specified in the EPA method listed in section 3.1.

7.3 An unknown performance sample, either an EPA performance sample or a USGS Standard Reference Water Sample, will be analyzed annually. The results must be within the control limit established by the agency from which the sample was obtained. If the results are not in the acceptable range, corrective action should be taken, and a follow-up performance sample should be analyzed.

7.4 A QC standard from another laboratory will be analyzed immediately following the instrument calibration. The determined value must be within 10% of the certified value. If the deviation is greater than 10%, corrective action will be taken as specified in the EPA method listed in 3.1. The response of this QC standard will be plotted on a control chart to track instrument stability.

7.5 All samples will be analyzed in triplicate.

7.5.1 The average value and the standard deviation will be reported.

7.5.2 The relative standard deviation (RSD), the standard deviation divided by the average value and expressed as a percent, should be below 10%, preferably below 5%. If the standard deviation is greater than 10%, the samples will be re-run to obtain a standard deviation within the acceptable range.

7.6 For every 20 samples, the calibration blank, a mid-range standard, and a QC standard will be run as samples. These values must be within 10% of the value determined during the initial calibration. If the deviation is greater than 10%, corrective action will be taken as specified in the EPA method listed in 3.1.

7.7 One replicate preparation and analysis will be completed for each 20 samples.

7.8 A reagent blank and method blank will be run with each analysis.

7.9 Detection limits will be determined for each group of samples analyzed by multiplying by three the standard deviation of the method blank analyzed with the samples. These values will be reported with the analytical results for the corresponding samples.

7.10 A laboratory fortified blank will be run daily. The percent recovery of a laboratory fortified blank must be within the limits as specified in the EPA method listed in 3.1. If the percent recovery is not within the acceptable limits, corrective action, as specified in the EPA method listed in 3.1, will be taken.

7.11 To determine if matrix effects are present in a sample, a laboratory fortified sample must be run for all new samples. The percent recovery of a fortified sample must be within 10% of the expected concentration. If the percent recovery is not within the required limits, the method of standard additions must be applied (see EPA method in 3.1 above). For samples previously analyzed and shown to be free of matrix effects, fortified samples will be run at a frequency of 10% or one for each sample set, whichever is greater.

8. Record keeping.

8.1 An analyst's notebook will be kept as specified in the HRC Scientific Notebook SOP. All information relating to sample identification, preparation and analysis will be kept in the analyst's notebook. Data to be recorded in the notebook includes, but it not limited to: method number, elements to be analyzed, wavelengths, photomultiplier volts, calibration response, QC standard value and the percent deviation from the true value, weights and concentrations used in preparing standards and samples, type and source of reagents used, and any corrective action taken.

8.2 Any data originating from instrument or computer printouts will be kept in the analyst's file, named by project and/or sample set, and the location will be referenced in the analyst's notebook.

9. Calculations and data manipulations.

9.1 The concentration values provided directly by the Perkin-Elmer Plasma 40 will be the reported values. The software program which this instrument uses calculates the sample concentration based on a linear regression of the calibration standards.

9.2 Apply any sample dilution factors to the concentration obtained in 9.1.

9.3 Print out the calculations and file with the original instrument readings in the appropriate file. Reference the location of the files in the analyst's notebook.

Harry Reid Center for Environmental Studies (HRC)
Standard Operating Procedure (SOP)
for

INDUCTIVELY COUPLED PLASMA - MASS SPECTROMETRY

1. Approvals

Klaus J. Stetzenbach
Principal Investigator

Quality Assurance Staff

10 Jan 94
Approval Date

12-28-93
Approval Date

2. Instrumentation.
   - 2.1 Perkin-Elmer inductively coupled plasma mass spectrometer, Model Elan 5000. Serial #114920888.
   - 2.2 Instrument Software: SCO XENIX 386 Operating System. Release 2.3.2 and Elan software.

3. Samples are stored in plastic ziploc bags at 4°C and are handled at all times with gloved hands.

4. Analytical Methods.
   - 4.1 EPA method 200.8, *Determination of Trace Elements in Waters and Wastes by Inductively Coupled Plasma-Mass Spectrometry*
   - 4.2 The Perkin-Elmer manuals, *Users Manual, Elan 5000 Inductively Coupled Plasma-Mass Spectrometry (#0993-8429) and Reference Manual, Elan 5000 Inductively Coupled Plasma-Mass Spectrometry (#0993-8467)*, will provide additional guidance.

5. Instrument start-up and operation will be conducted as per the manufacturer's specifications (see manuals listed in 4.2 above).
   - 5.1 The tuning solution will be obtained directly from Perkin-Elmer. This solution contains 10ppb of each of the following elements: Mg, Cu, Cd, Pb, Sc, Rh, Tl, Ce, Tb, Ba, Ge.
   - 5.2 Intensity and oxide checks will be conducted with the tuning solution (4.1) per the instrument manufacturer's instructions (4.2).
   - 5.3 To demonstrate instrument stability, at least 70 replicates of the tuning solution should result in relative standard deviations (RSD's) of less than 10%. If the RSD's are greater than 10%, corrective action should be taken as specified in the manuals listed in 4.2.

*Revisions are indicated by vertical lines in the right margin.

5.4 The oxide ratios will not exceed the following: CeO/Ce less than 3%, BaO/Ba less than 2%, and Ba++/Ba less than 3%. If these values are exceeded, take corrective action as specified in the manuals listed in 4.2.

6. Instrument Log Book.

6.1 An instrument log book or file will be kept following the HRC Scientific Notebook SOP.

6.2 Parameters to be included in the log book are:

6.2.1 Analyst ID.
6.2.2 Project and/or sample ID.
6.2.3 Date.
6.2.4 Elements to be analyzed. A parameter file will be generated and saved.
6.2.5 The number and type of samples run.
6.2.6 Nebulizer flow rate.
6.2.7 Sensitivity for Mg, Pb and Rh.
6.2.8 Oxide ratios for CeO/Ce, BaO/Ba and Ba++/Ba.
6.2.9 Problems and corrective actions.

7. Calibration and Standardization.

7.1 Calibration, following the EPA method listed in 4.1 above, will be completed each day that samples are analyzed.

7.2 Standards will be prepared from the appropriate reference standards. The method of preparation and source, including lot numbers, of the standards will be recorded in the analyst's notebook. Standards may vary from those specified in the EPA method so that additional elements may be analyzed.

7.3 At least 4 standards and a blank will be prepared for the calibration curve.

7.4 The calibration slope and correlation coefficient will be recorded in the instrument log book or file.

7.4.1 Correlation coefficients must have an r value of 0.995 or greater ($r^2 = 0.990$) to be acceptable. Preferably, the r value will be 0.998 or greater ($r^2 = 0.996$). If r is less than 0.995, corrective will be taken as specified in the methods referenced in 4.1 and 4.2 above.

7.5 Internal standardization will be used unless standard addition procedures are used when appropriate to correct for instrumental drift and physical interferences. If employed in the analysis, internal standard(s) will be prepared based on the nature and analyte concentrations of the samples. They will be spiked into all blanks, standards, and sample solutions at identical levels. The level of the spikes is important for achieving a range of intensity rather than a specific concentration. For this reason the expiration dates of the primary internal standards are not monitored.

8. Quality Assurance.

8.1 Quality assurance will be conducted as in the EPA method in 4.1 above.

8.2 The method detection limits will be determined to insure that the analysis is carried out as specified in the EPA method listed in section 4.1.

8.3 An unknown performance sample, either an EPA performance sample or a USGS Standard Reference Water Sample, will be analyzed annually. The results must be within the control limit established by the agency from which the sample was obtained. If the results are not in the acceptable range, corrective action should be taken, and a follow-up performance sample should be analyzed.

8.4 An NIST QC reference material or one from another laboratory will be analyzed immediately following the instrument calibration. The determined value must be within 10% of the certified value. If the sample is in the ppb range. Samples with concentrations in the ppt range should be within $\pm$20% of the certified value. If the deviation is greater than 10%, corrective action will be taken as specified in the EPA method listed in 4.1 above.

8.5 Five replicate measurements of all samples will be made.

8.5.1 The average value and the standard deviation will be reported.

8.5.2 The relative standard deviation (RSD), the standard deviation divided by the average value and expressed as a percent, should be below 10%, preferably below 5% for ppb concentrations and 20% for ppt concentrations. If the standard deviation is greater than 10% for ppb or 20% for ppt, the samples will be re-run to obtain a standard deviation within the acceptable range.

8.6 For every 10 to 20 samples, the calibration blank, a mid-range standard, and a QC standard will be run as samples. These values must be within 10% of the value determined during the initial calibration. If the deviation is greater than 10%, corrective action will be taken as specified in the EPA method listed in 4.1.

8.7 A reagent blank and method blank will be run with each analysis.

8.8 Instrument detection limits will be determined whenever a significant change in the instrumental response is observed using a blank solution and a approximately 1 ppb solution.The detection limit will be calculated using the following formula from the Perkin Elmer manual:

$$DL\ (ppt) = \frac{3 \times SD_{blank}\ (counts\ sec^{-1})}{I_{1ppb}\ (counts\ sec^{-1})} \cdot 10^3\ ppt$$

where

DL = detection limit of the analyte (in ppt)
SD_{blank} = Standard deviation of blank (counts sec^{-1})
I_{1ppb} = Intensity of the analyte in 1-ppb solution in counts sec^{-1}

These values will be reported with the analytical results for the corresponding samples.

8.9 If matrix effects are suspected by observing the internal standard response as required in 8.10, to be present in a sample, the method of standard additions will be used.

8.10 The absolute response of the internal standard should not deviate more than 60-125% of the original response in the calibration blank. If deviations greater than this are observed, corrective action as specified in the EPA method listed in 4.1 will be taken.

9. Record keeping.

9.1 An analyst's notebook, files, and other records will be kept as specified in the HRC Scientific Notebook SOP. All information relating to sample identification, preparation and analysis will be kept in the analyst's notebook or records. Data to be recorded in the notebook includes, but it not limited to: method number, elements to be analyzed, calibration response, QC standard value and the percent deviation from the true value, weights and concentrations used in preparing standards and samples, type and source of reagents used, and any corrective action taken.

9.2 Any data originating from instrument or computer printouts will be kept in the analyst's file, named by project and/or sample set, and the location will be referenced in the analyst's notebook.

10. Calculations and data manipulations.

10.1 The concentration values provided directly by the Perkin-Elmer Elan 5000 will be the reported values used. The software program which this instrument uses applies element correction equations to the data.

10.2 Apply any dilution factors to the concentrations obtained in 10.1.

10.3 Copies of the final calculations are stored in the analyst's files and referenced in the analyst's notebook. Computer files which are a necessary part of the ICP-MS system are also referenced in the notebook. The files for a particular analysis will be kept on 3½-inch disks (UNIX and DOS) and will be retrieved as necessary.

Harry Reid Center for Environmental Studies (HRC)
Standard Operating Procedure (SOP)
for
pH Meters

1. Approvals:

N/A	N/A
Author-Unknown	Approval Date
Klaus J. Stetzenbach	11 Sep 95
Project Manager	Approval Date
[signature]	9/11/95
Other Reviewer	Draft Review Date
Amy J. Smiecinski	9/11/95
Quality Assurance Staff	Approval Date

2. References: "Methods of Chemical Analysis of Water and Wastes." U.S.EPA, EMSL, Cincinnati, OH 45268, March 1983, EPA-600/4-79-020.

3. Method: pH, Method 150.1

4. Reagents and Equipment
pH meters (portable and bench-top models) such as the Orion Expandable ionAnalyzer, Model# EA 940, Serial# 2074
Operating manuals for individual pH meters
Buffers used for calibration and linearity check
Deionized water
Thermometer or sensor temperature compensation

The following procedures are general procedures only, and should be used as a basic guideline in conjunction with the information contained in the specific instrument manuals.

5. Operating Conditions:

5.1 Samples should be analyzed as soon as possible, preferably in the field at the time of collection. High-purity waters and waters not at equilibrium with the atmosphere are subject to changes when exposed to the atmosphere, therefore the sample containers should be filled completely and kept sealed prior to analysis.

5.2 The determination of pH is not affected by the color, turbidity, or concentration of organic or colloidal material in the water sample. This reading may therefore be taken directly in the natural environment without a significant effect on the accuracy of the reading obtained.

5.3 pH measurement is appreciably affected by temperature changes. The calibration buffers must therefore be within the same temperature ranges as the samples being measured. A difference of more than 5°C between samples and buffers may cause some error and should be corrected for as outlined in the respective manual of the pH meter being used.

5.4 A new glass electrode, or one that has been dry for an extended period of time may require additional soaking in the buffer solution or distilled water before a stable reading is obtainable. Consideration should be taken of this fact before using the pH meter. The tip of the glass electrode should be immersed in distilled or de-ionized water when not in use.

5.5 A reference electrode should be checked before each use to establish that the correct level of reference solution is present in the electrode. The operators manual of the electrode should be consulted to determine proper solutions and solution levels for the specific electrodes being used.

6. Instrument Start-up and Operation:

6.1 Standard buffer solutions of at least two of the following three pH values 4.00, 7.00, 10.00, should be prepared. Ready-made solutions may be used if they are reasonably new and free of contamination. Any questionable solutions will be properly disposed of, and fresh solutions purchased or prepared before pH meter(s) will be calibrated. Solutions should be replaced at least monthly.

6.2 The calibration buffers should cover the range of the pH of the samples to be measured. If samples are found that fall outside this range, a new calibration using buffers which bracket the pH of the samples should be prepared, and the measurements repeated.

6.3 Calibration:

6.3.1 pH calibration using at least two buffer solutions will be done a minimum of once daily.

6.3.2 Meter should be turned on and initialized according to the manufacturer's instructions.

6.3.3 The manufacturer's instructions for calibration will be followed for each specific instrument and electrode. After an adequate warm up period, the electrode will be rinsed thoroughly with distilled or de-ionized water prior to calibration to assure a clean electrode surface. The instrument will then be calibrated with buffer solutions at approximately the same temperatures as the samples, and pH values bracketing the expected pH values of the samples.

6.4 Quality Control

6.4.1 Prior to measuring the pH of samples and after calibration a quality control (QC) check should be made to see that the pH meter is measuring accurately. Measure a buffer that is at a level between the two calibration buffers. If the meter does not read within .05 pH units of the true value, take corrective action suggested by the operating manual or that seems the most effective for the situation. The millivolt reading for the electrode should be checked occasionally to assure its stable condition. See the manual.

6.5 Operation:

6.5.1 pH measurements will be made using sufficient solution to immerse the electrode to the recommended level (specific manufacturer's instructions will be followed). pH measurements will be made with a minimum of aeration or agitation.

6.5.2 Measure the sample repeatedly until three consecutive replicates agree within 0.1 pH units.

7. Instrument Log Book:

7.1 All pH values for calibration and QC check buffers, buffer/sample temperature values, and pH values measured for samples as well as any corrective actions will be recorded in the appropriate record for the study, such as field sampling forms and scientific notebooks. The date and identification or initials of the chemist and pH meter used are also recorded. Some studies may have specific requirements for recordkeeping such as buffer preparation and lot numbers, SOP revision and date,and other requirements that the chemist must be aware of and record for that study.

8. Calculations and Data Manipulations:

8.1 All pH values will be read directly from the meter. This value will be recorded on the sampling form or in the appropriate scientific notebook.

8.2 All other calculations required for temperature differences will be performed according to the manufacturer's specifications as listed in the respective instrument manual.

Harry Reid Center for Environmental Studies (HRC)
Standard Operating Procedure (SOP)

SCIENTIFIC NOTEBOOKS

1.0 Approvals

D. Baepler
HRC Director
Approval date: 4-21-95

Amy J. Smiecinski
Reviewer, signature indicates resolution
Approval date: 4-21-95

2.0 Distribution

Revisions of this document are distributed by HRC Quality Assurance (QA) Staff to each Principal Investigator (PI) having a project in the laboratory *and to each individual on the controlled document list for this SOP.*

3.0 Control

Certain laboratory projects are required to use document control for this SOP. For these personnel the QA staff provides "controlled" stamped copies of this SOP and any revisions or modifications of the document.

4.0 Purpose

This SOP describes procedures for the use and maintenance of HRC scientific notebooks and establishes guidelines for recording and preserving data. This serves:

- To record and preserve research, development, experimental, test, and evaluation data.
- To provide a convenient reference for scientists to use in the performance of current and future work.
- To provide a complete and permanent record to assure the continuity of effort in the event of transfer, termination, illness, etc. of an employee.
- To preserve for legal purposes all data describing the work performed.

5.0 Scope

This SOP addresses the use of scientific notebooks in laboratory studies. *Some sponsor QA requirements may supercede parts of this SOP. Project personnel need to be aware of specific project*

*Revisions to this document are indicated in italices.

requirements.

6.0 Responsibilities

Group supervisors *and/or PIs* are responsible for seeing that individuals in their work groups: 1) use proper recordkeeping procedures; and 2) record data in a timely manner. Evidence of notebook reviews by supervisors *should* be documented in each scientific notebook *periodically*. A laboratory notebook assessment plate is attached to aid in the review process.

The QA *staff* is responsible for *seeing* that associated SOPs are updated on a regular basis. The QA *staff* assesses the scientific notebooks *periodically* using the attached *checklist*. Assessment results with suggested corrective action are reported to the associated *notebook user*. Unresolved defects are reported to the *supervisor or PI.*

7.0 Acceptable Recordkeeping Practices

Laboratory personnel will use laboratory notebooks to record pertinent information in a timely fashion on research, development, test and evaluation activities, and production tasks. In addition, information from conferences, laboratories, and agencies pertinent to the project shall be included in the scientific notebooks.

Laboratory notebooks will be maintained in accordance with the procedures described below. This policy is not intended to restrict the use of additional records provided the laboratory notebook references the additional records.

Please keep in mind also that procedures can be referenced by document or page number rather than rewritten in the notebook each time they are performed.

Pages must not be removed from any notebook.

Ink (preferably *blue or* black) only is to be used in notebooks.

White-out is not to be used in the scientific notebooks.

No notation is to be completely obliterated. A single line-through, with initials and date of the change are acceptable.

Notations are to be legible and understandable.

Loose papers and forms may be permanently affixed to a page of the scientific notebook provided the margin of the attachment is initialled and dated across the insert edge and notebook page.

If there is a continuation of work from other notebooks or to other notebooks, reference these

*Revisions to this document are indicated in italices.

numbers in each notebook (i.e., "continued in..." and "continued from..." *or Vol.1, etc.*).

Record data and observations in a timely manner; carry the scientific notebook with you as you perform the work (unless this is hazardous) and record steps, data, etc., as it occurs. This will often help a scientist catch his own error.

If a large blank space remains on a notebook page that the scientist does not intend to use prior to the next record, line-through the space and initial and date it.

Sign and date the bottom of each completed page and the conclusion of each separate entry.

The name of the scientific notebook, other identifiers, *is* to be written on the cover.

Omitted data or appended data is to be recorded on the first available page with the date of addition and reference to the appropriate notebook page. Reference to the appended data should be noted and dated at the page it applies to as well.

All hardbound scientific notebooks will be *reviewed for technical completeness* by a supervisor or the *PI* and *for proper recordkeeping practices using the attached checklist* by the QA *staff periodically and when the notebook is complete*. Written comments concerning the maintenance of the notebook are to be made in the notebook. The employee is to take immediate corrective actions on deficiencies noted during an inspection or audit. (Note: Any changes that are made to previous records should be initialled and dated to reflect the date that the corrective action is being taken. Omitted data should be added on the first available page *and cross-referenced at thepage of omission and the page of addition as for "omitted data" discussed previously.*)

8.0 Disposition

Laboratory notebooks are to be kept for a period of at least three years after completion of the last project covered by the notebook, or when it is no longer needed for reference purposes, or superseded by the client's policy, whichever is later. Notebooks will not be disposed of unless approved by the HRC director after written direction from the client.

9.0 General Guidance

The following descriptions serve as suggestions for types of information that should be included for each record category. Organization of the records within scientific notebooks is decided by the scientists and PI based on the needs of the project. For example, for some research projects more than one of the categories described may be found in a notebook.

Instrument Records

Analysts are responsible to see that a scientific notebook is assigned and used according to this

*Revisions to this document are indicated in italices.

SOP for the analytical instrument being used. Instrument records should contain the types of information listed here as appropriate to the analytical system.

Instrument maintenance records include service records and repairs performed by HRC personnel and service representatives. It is important from a preventive maintenance standpoint that symptoms be recorded with the resulting repair for future troubleshooting.

Injection or "run" records contain documentation of every analysis, burn, calibration, standardization, etc, that is performed on the associated instrument. Information should be complete enough to allow duplication of the analysis, within the limits of the process, and show traceability from the original sample or standard to the raw and hardcopy data printout. Examples of pertinent information include injection volumes, column parameters, project name, repeat analyses due to rejected data, instrument conditions, sample control numbers (such as case numbers), analyst name or initials, instrument conditions, *methods or SOPs,* computer programs used to process data, etc.

Tape notebooks serve as a reference tool to indicate which tape project analytical data is stored on and when.

Extraction Records

Information that is documented for extractions includes a step-by-step description or reference to the processing of each sample or aliquot that is extracted. This may be accomplished with the use of a checksheet that is attached to the scientific notebook using the procedure described in Section 3. Critical information includes lot numbers of any standards or spikes that are used, sample control numbers, extraction chemist name or initials, project name, observations, reagent lots, etc.

Digestion Records

Digestion records include the same type of information listed for Extraction records.

Standards Preparation

All information concerning the preparation, dilution, transfer, etc., of standards and spikes is to be recorded in the standards preparation records. It is required that these solutions be traceable to their original source and to any resulting data. Therefore lot numbers and any other identifications must be included in the associated scientific notebook entries.

It is highly recommended that all standard and spike preparation and dilution calculations be doublechecked by a coworker as a quality control measure to insure accuracy of the preparation and prevent human error. Therefore, calculations should be presented in an equation format that will facilitate the review.

Sample Control

*Revisions to this document are indicated in italices.

Sample receipt records contain basic information that is critical to the project: the date and time of sample arrival, the sample conditions, the assigned storage area, the sample and analysis types, any associated identification names and numbers, chain-of-custody seals, shipping papers, and the sample numbers, etc.

Project Records

These scientific notebooks are highly project-specific for formatting and contents. However, certain basic information may be pertinent to any project:

Project names, project coordinators, client technical monitors, and other identifiers.

Associated document titles (work plans, task directives, literature, SOPs, standard procedures, etc.) used.

Detailed observations, variations from the original experimental design, problems, external influences on the project, thought processes and scientific notebook trees, and concerns of the chemist.

Statistical analyses, conclusions, and results.

Data from other scientific notebooks or references to other scientific notebooks, the contents of which may contribute to the project.

Balance Accuracy and Precision

Balance Accuracy and Precision scientific notebooks or log sheets are generally maintained for the entire HRC lab rather than for each project. However, special needs of the project or client may require otherwise.

This scientific notebook or log is maintained as stated in the associated SOP for this equipment. The record includes the dates of the checks, the identity of the weight set used, the initials of the personnel making the check, observations of malfunctions, and documentation of corrective actions and service as well as scheduled manufacturer calibrations.

Laboratory Water System

The scientific notebook or log contains the dates of the checks, the initials of the personnel making the check, pressure and conductivity readings, observations of malfunctions, and documentation of corrective actions and service.

Refrigerator Temperature

*Revisions to this document are indicated in italices.

The scientific notebook or log contains the dates of the checks, the initials of the personnel making the check, thermometer readings, observations of malfunctions, and documentation of corrective actions and service.

Fume Hood Flows

The scientific notebook or log contains the dates of the checks, the initials of the personnel making the check, flow readings, observations of malfunctions, and documentation of corrective actions and service.

Software Verification

This scientific notebook contains the software/version being tested, who tested it on what date, and a notation of any problems or special code used in the verification/validation. Finally, a signature shows that the software was successfully tested and approved for use.

*Revisions to this document are indicated in italices.

HRC Lab Scientific Notebook Assessment Plate

Notebook Title:
User:

		Yes	No	Comment
1.	Is a *hardbound*, with pre-printed consecutively-numbered pages scientific notebook in use?			
2.	Using this notebook, is it possible to trace from it to the other pieces of the project that it represents?			
3.	If this notebook contains standards preparation, is it possible to trace from the raw data it represents to the original standard material, using this notebook?			
4.	Is the front of the lab notebook labeled with the notebook name?			
5.	If there is a continuation of work from or to another notebook, is this indicated in each scientific notebook?			
6.	Are the scientific notebook pages intact?			
7.	Is the notebook understandable?			
8.	Is the notebook legible?			
9.	Is the notebook up to date?			
10.	Are entries made in ink?			
11.	Does the notebook contain "white out"?			
12.	Are corrections made using a single line-through, with initials and date?			

*Revisions to this document are indicated in italices.

13. Are attachments or inserts permanently secured and signed across the margin and onto the scientific notebook page?

14. Is recorded information signed and dated by the notebook user at each entry (when > 1 day's entries are recorded on a page) and at the bottom of each complete page?

15. Are blank entry areas covered with a line-through, initialled, and dated?

16. Has the supervisor or director reviewed the notebook *recently*?

Numbered comments regarding checkpoints above:

Reviewer's signature: ______________________________ Date: ________________________

*Revisions to this document are indicated in italices.

Harry Reid Center for Environmental Studies
Standard Operating Procedure
for
LANTHANIDE CONCENTRATION PROCEDURE

1. Approvals:

Klaus J. Stetzenbach
Principal Investigator

Amy J. Smiecinski
Quality Assurance Staff

11 Jan 94
Approval Date

1-11-94
Approval Date

Objective of Method:

The Lanthanides are present in spring water at less than one part per trillion (ppt). This concentration is at or below the detection limit of the ICP-MS. The Lanthanides are concentrated on a cation exchange column. The concentrated Lanthanides are then eluted with a small volume of 8 Molar nitric acid. This column ion exchange procedure can concentrate the Lanthanides fifty to one hundred times, depending on the sample volume passed through the column and the final volume of the sample after extraction. The column does not retain most other ions, which normally clog the skimmers of the ICP-MS.

Preparation of The Ion Exchange Column:

Reagents:

* Ultrapure Nitric acid concentrated purchased from Seastar Industries; Seattle,WA
* Deionized and distilled water
* AG* 50W-X8 Cation exchange resin; purchased from Bio-Rad laboratories; Richmond,CA
* 8 Molar Nitric acid; prepared from equal volumes of Seastar nitric acid and distilled deionized water
* 1% Nitric acid solution prepared from ultrapure acid and deionized distilled water.

Equipment:

* Top loading balance capable of weighing one thousand grams to one tenth of a

gram
* One liter polyethylene bottles and caps
* Hot plate heater, large
* Vacuum pump
* Poly-Prep columns; purchased from Bio-Rad laboratories,Richland, WA: catalogue # 731-1550
* Teflon wool; purchased from Alltech Associates, Deerfield, IL
* Teflon beakers, 50 ml

Procedure:

1. Clean the cation exchange resin by soaking in 8 Molar nitric acid overnight.
2. Decant the fines and floating ion enchange beads, after swirling the slurry.
3. Pack each poly-prep column with 5 ml of cleaned cation exchange resin slurry. Placing the columns in a vacuum filter device will aid the packing procedure.
4. Plug each column with teflon wool to hold the packing securely in place.
5. Clean and condition each column by first passing 100 ml of 8 Molar nitric acid then 20 ml of 1% nitric acid solution through the column.

Method For Concentrating The Lanthanides:

1. Weigh 500g of sample into a tared 1 liter polyethylene bottle.
2. Pass the sample through a packed ion exchange column. The flow rate should be about 1 ml/minute for optimum mass transfer of ions.
3. Elute the column with 50 ml of 8 Molar nitric acid and collect the eluent in a 50 ml teflon beaker.
4. Take the eluent to less than one ml on a hot plate under a hood. A setting of 2 on the hot plate is optimum.
5. Bring the concentrate to 10 or 20 ml using 1% nitric acid.
6. Analyze the sample for the lanthanides using the ICP-MS procedure.

Calculation of The Dilution Factor (DF):

$$DF = \frac{\text{Weight of the original water sample}}{\text{Weight of the final volume to be analyzed}}$$

Harry Reid Center for Environmental Studies
Standard Operating Procedure (SOP)
for
EUROPIUM CONCENTRATION PROCEDURE

1. Approvals:

Klaus J. Stetzenbach
Principal Investigator

Amy J. Smiecinski
Quality Assurance Staff

11 Jan 94
Approval Date

1-11-94
Approval Date

Objective of Method:

Europium is present in spring water at less than one part per trillion (ppt). This concentration is at or below the detection limit of the ICP-MS. In addition to the low concentration, the presence of barium, which forms barium oxide in the plasma, is measured at the same masses as europium. This interference cannot be corrected by the use of correction factors. This method eliminates both problems. Europium is concentrated on the column while barium is not retained by the column. The concentrated europium is then eluted with a small volume of 8 Molar nitric acid. This column extraction procedure can concentrate the europium fifty to one hundred times depending on the sample volume passed through the column and the final volume of the sample after extraction.

Preparation of The extraction Column:

Reagents:

* Bis(2-ethylhexyl) hydrogen phosphate (1) purchased from Pfaltz and Bauer
* 2-ethylhexyl dihydrogen phosphate (2) Waterbury, CT
* Ultrapure Nitric acid concentrated purchased from Seastar Industries; Seattle,WA
* Heptane reagent grade
* Deionized and distilled water
* Bio-Beads SM-2 Adsorbent; purchased from Bio-Rad laboratories; Richmond,CA
* 8 Molar Nitric acid; prepared from equal volumes of Seastar nitric acid and distilled deionized water

* 1% Nitric acid solution prepared from ultrapure acid and deionized distilled water.

Equipment:

* Top loading balance capable of weighing one thousand grams to one tenth of a gram
* One liter polyethylene bottles and caps
* Teflon bottles, 125 ml
* Polyethylene beakers, 50 ml
* Polyethylene stirring rods
* Hot plate heater, large
* Vacuum pump
* Poly-Prep columns; purchased from Bio-Rad laboratories,Richland, WA: catalogue # 731-1550
* Teflon wool; purchased from Alltech Associates, Deerfield, IL
* Teflon beakers, 50 ml

Procedure:

1. Weigh approximately 6.5 g of (1) from the reagent list and 3.5g of (2) into a tared Teflon bottle.
2. Add heptane till the final weight is 100 g approximately.
3. Cap the bottle and shake till solution is homogeneous
4. Weigh 5g of Bio-Beads into a polyethylene beaker then add 15g of the heptane solution and mix with a polyethylene stir rod till the beads are thoroughly coated
5. Place the beaker on a hot plate in a hood. The hot plate setting should be low or 1. Stir every fifteen minutes to distribute the reagent uniformly.
6. When the beads are dry, no solvent odor, add 20 to 40 ml of 8 Molar nitric acid to hydrate the beads.
7. Pack the slurried contents of the beaker equally into two poly-prep column. Placing the columns in a vacuum filter device will aid the packing procedure.
8. Plug each column with teflon wool to hold the packing securely in place.
9. Clean and condition each column by first passing 100 ml of 8 Molar nitric acid then 20 ml of 1% nitric acid solution through the column.

Method for Concentrating Europium:

1. Weigh 500 g of sample into a tared 1 liter polyethylene bottle.

2. Pass the sample through a packed poly-prep column.
3. Elute the column with 50 ml of 8 Molar nitric acid and collect the eluent in a 50 ml Teflon beaker.
4. Take the eluent to one ml on a hot plate under a hood. A setting of 2 on the hot plate is optimum.
5. Bring the concentrate to 10 or 20 ml using 1% nitric acid.
6. Analyze the sample for europium using the ICP-MS procedure.

Calculation of The Dilution Factor (DF):

$$DF = \frac{\text{Weight of the original water sample}}{\text{Weight of the final volume to be analyzed}}$$

Harry Reid Center for Environmental Studies (HRC)
Standard Operating Procedure (SOP)
for
ANALYSIS OF SDWA SAMPLES

1. Approvals

Klaus J Stetzenbach	5/18/95
Principal Investigator	Approval Date
Kat Cao	5/18/95
Reviewer	Approval Date
Amy J Smiecinski	5-17-95
Quality Assurance Staff	Approval Date

2. Instrumentation.
See individual SOPs.

3. Samples falling under the Safe Drinking Water Act (SDWA), including certification program performance samples (WS), will be analyzed using the applicable instrumental SOPs and those methods required for SDWA samples by the State of Nevada Administrative Code. See the Appendix for current methods.

APPENDIX

State of Nevada SDWA Analytical Methods

HRC (NV 00049) Analytical Methods
USEPA WS034 Samples

Ag	200.8	5
Al	200.8	5
As	206.2	1
Ba	200.8	5
Be	200.8	5
Cd	213.2	1
Cr	218.2	1
Cu	220.2	1
Mn	200.8	5
Mo	200.8	5
Ni	200.8	5
Pb	200.8	5
Sb	200.8	5
Se	270.2	1
Tl	200.8	5
Zn		
nitrate	300	4
nitrite	300	4
fluoride	340.2	1
chloride	300	4
sulfate	300	4
orthophosphate	300	4
pH	150.1	1
alkalinity	D-1067-82C	3
VOCs	524.2	6
THMs	524.2	6

1 "Methods of Chemical Analysis of Water and Wastes." U.S. EPA, EMSL, Cincinnati, OH 45268, March, 1983 EPA-600/4-79-020.

2 Corning Checkmate Electrode Sensors

3 Annual Book of ASTM Standards, Vol 11.01 and 11.02 for Water, American Society for Testing and Materials, 1916 Race St,, Philadelphia, PA 19103.

4 "The Determination of Inorganic Anions in Water by Ion Chromatography", Method 300.0, August 1991, U.S.EPA, EMSL, Cincinnati, OH 45268.

5 "Methods for the Determination of Metals in Environmental Samples", U.S. EPA, EMSL, Cincinnati, OH 45268, June 1991, EPA-600/4-91-010.

6 "Methods for the Determination of Organic Compounds in Drinking Water", U.S. EPA, EMSL, Cincinnati, OH 45268, December, 1988 (Rev. July, 1991), EPA 600/4-88-039.

Harry Reid Center for Environmental Studies (HRC)
Standard Operating Procedure (SOP)
for

VOLATILE ORGANIC COMPOUNDS IN SDWA SAMPLES

1. Approvals

Klaus J. Stetzenbach — 5/17/95
Principal Investigator — Approval Date

Gary Coates — 5-17-95
Reviewer — Approval Date

Amy J. Smiecinski — 5-17-95
Quality Assurance Staff — Approval Date

2. Reference
"Methods for the Determination of Organic Compounds in Drinking Water," EPA 600/4-88-039, December 1988 (Rev. 4.0, August, 1992), EPA Environmental Monitoring Systems Laboratory, Cincinnati, Ohio 45268.

3. Method
524.2 Measurement of Purgeable Organic Compounds in Water by Capillary Column Gas Chromatography/Mass Spectrometry. Within the method text, any phrases containing the word, "must" are considered to be a requirement of the method and therefore must be performed by the HRC analyst.

4. Reagents and Equipment
HRC instrumentation meets the following requirements of method 524.2.

Varian Gas Chromatograph, Model 3400. Serial #14328.

The GC is temperature programmable. The column can be cooled to 10C. A split/splitless injection port is available for injections of 4-bromofluorobenzene (BFB).

Varian Mass Spectrometer, Model Saturn II. Serial #245.

The MS is capable of electron ionization at a nominal electron energy of 70 eV. The MS can scan from 35 to 260 amu with a complete scan cycle time of ≤ 2 sec. The MS must produce a mass spectrum that meets the criteria in Table 3 of the method when ≤ 25 ng of BFB is introduced into the GC.

Tekmar Purge and Trap, Model LSC 2000. Serial #92009020.

The PAT is equipped with a trap that is at least 25 cm long x .105 ID . A needle sparger may be used if gas is introduced ≤ 5 mm from the base of the water

*Completely new document.

column. The glass purging device contains < 15 ml of dead space above the sample. The desorber is capable of rapidly heating the trap to 180C before or at the beginning of the desorption flow.

Equipment
- Analytical balance
- Gas-tight syringes in sizes from 25 mL on down to 10μL
- 2-mL and 40-mL glass vials

Standards
- See Method, Sect. 7.3 - 7.4, & 7.8.

Reagents
- Calibration gas
- Bromofluorobenzene
- Methanol (HPLC-grade)
- $\geq$ 18-ohm Nanopure laboratory water
- Other materials, see Method, Sect. 7.1 - 7.2.

QC Materials
- Fortification Solutions and Blanks; see Method, Sect. 7.5 - 7.7.
- EPA-traceable reference materials from an alternate external source

6. Procedure

Sample collection, dechlorination, and preservation; see Method, Sect. 8.
Calibration and standardization; see Method, Sect. 10.
Quality control; see Method, Sect. 9.
Sample analysis; see Method, Sect. 11.
Data reduction; see Method, Sect. 12.

Method 524.2 Example Run Schedules

<u>Daily</u>
- Condition PAT trap
- Mass calibration gas
- Tune GC-MS with 25ng BFB
- Analyze lab reagent blank - contaminants must be < MDLs
- Proceed with day's plans

<u>Calibration Day</u>
- Perform "daily" routine
- Analyze mid-range standard
  - examine chromatography
  - 99-100% of compounds recognized by data system
- Calibration standards analyzed (+ surrogate and internal standard)
  - calculate RF for each analyte & surrogate using fluorobenzene
  - calculate the mean RFs, sd, and RSD < 20%

<u>Analysis Day</u>
- Perform "daily routine"
- Continuing calibration check at the beginning of each eight hours of analysis

*Completely new document.

areas of surrogate and internal standard must drift < 50%
Analyze lab reagent blank and a lab fortified blank
Analyze samples

Quarterly
Analyze replicate lab fortified blanks and a quality control sample

7. QC Requirements - See Method, Sect. 9 - 9.11.
MDL Studies - These studies are performed, as described in the Method, Sect. 9.3, at HRC twice per year preferably in June prior to WS studies and late November or early December.

Data verification - software calculations are spot-checked by the analyst to assure that the software is performing properly.

8. Analytical Variations
Variations, that are not described in this SOP, must be justified with data or other qualifier, such as the inavailability of an item or reagent due to funding constraints or the recommendation of equivalency of the instrument or item manufacturer. Any variations from the analytical method must be recorded in the scientific notebook.

9. Recordkeeping - scientific notebooks are to be completed in accordance with the HRC Scientific Notebook SOP.

Information to be recorded for each sample set include, as appropriate:
regarding each sample set
analyst,
date,
computer file names,
name and version of data acquisition software,
HRC sample tracking number,
study title and sample set,
SOP or analytical method and deviations,
reference to scientific notebook volume and page number,
reference material and standards lot numbers,
GC program,
instrument detection limits,
statistical values such as means, standard deviations, relative standard deviations, correlation coefficients, % recoveries, blank values subtracted, and any qualifiers or flags.

Data Reporting - Data packages for each sample set are to include:
Chromatogram for samples, standards, and QC
Quantitation lists for each

*Completely new document.

Spectral matches for positive hits other than surrogates and internal standards for samples
Data Summary - reduced data in reportable units by analyte and sample

10. Problems with the Method
Any deviations from the method are recorded in the scientific notebook.

11. Method applicability
Safe Drinking Water Act performance and certification samples

*Completely new document.

Data analysis books entitled, Chemical Analysis of Water from Ash Meadows Springs and Chemical Analysis of Water from Death Valley Springs can be issued upon request. Please call 895-1357 and ask for Sally Hamilton.