Monitoring Report for
CSMRI Site
First Quarter 2009

Prepared for:

Colorado School of Mines
Golden, Colorado

Prepared by:

The S.M. Stoller Corporation
Broomfield, Colorado

June 2009

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

1. Introduction

This report presents the first quarter (January, February, March) 2009 results for groundwater monitoring and surface water monitoring conducted at the Colorado School of Mines Research Institute (CSMRI) site in Golden, Colorado. The monitoring was conducted by the S.M. Stoller Corporation (Stoller).

2. Sampling and Analysis

Stoller obtained quarterly samples of groundwater and surface water on March 16, 17, and 18, 2009 from eight groundwater monitoring wells and two surface water sample locations. Groundwater quality samples were obtained on March 16 (CSMRI-9 and CSMRI-10), March 17 (CSMRI-1, CSMRI-4, and CSMRI-5), and March 18 (CSMRI-1B, CSMRI-2, and CSMRI-8). Several monitor wells require purging on one day and sample collection on subsequent visits over the following days. Monitor well CSMRI-1B was visited three times over the course of three days to provide sufficient volume of water for sampling. Monitor well CSMRI-7B was dry at the time of sample collection.

No groundwater samples were collected from replacement monitor wells CSMRI-11B and CSMRI-6C during this quarterly sampling event. These two wells were installed on December 1, and 2, 2008 respectively, and at the time of sampling the wells were dry. The precursors to these wells (11 and 6B, respectively) were abandoned in July 2008 due to construction activities associated with the Colorado School of Mines (CSM) soccer field. Monitor well CSMRI-6C is located approximately 27.2 feet to the south of the location of former well 6B, and monitor well CSMRI-11B is located approximately 51.5 feet to the northeast of the location of former well 11.

Surface water samples were collected on March 16, 2009, from SW-1 and SW-2. All aqueous samples were placed in iced coolers and couriered to Paragon Analytics Laboratory, Inc. of Fort Collins, Colorado or to TestAmerica, Inc. of Arvada, Colorado for analysis.

Figure 1 presents the monitor well and surface water sample locations. The figure also presents the groundwater potentiometric surface elevations based on depth to groundwater relative to the surveyed top-of-casing for the time periods of March 16 through March 18, 2009. The elevations of the groundwater potentiometric surface at the time of sampling are posted adjacent to each monitor well location. Historically the figure indicates a northeasterly component of flow for groundwater located on the bench terrace above the Clear Creek flood plain.

2.1 Groundwater Sampling

Water quality samples were collected following the procedures outlined in Appendix A, Groundwater Sampling Procedures. All monitor wells have depth-to-water measured to the nearest 1/100th of a foot (0.01) prior to sample purging. Graphs of water table elevation are presented as Figure 2 for monitor wells CSMRI-1, CSMRI-1B, CSMRI-4, CSMRI-5, CSMRI-6B (abandoned July 2008), CSMRI-7B (dry after December 2007), CSMRI-8, CSMRI-9, CSMRI-10, and CSMRI-11 (abandoned July 2008). Figure 2 monitor wells are all located within the CSMRI site proper and illustrates historical trends in changes to the potentiometric surface throughout the site.

The Figure 3 hydrograph of monitor well CSMRI-2, located near the southeast corner of the freshman parking lot on West Campus Drive and the Welch Ditch, is located upgradient of the CSMRI site and historically is used to provide background groundwater quality conditions. The hydrograph initially reflected the use of and leakage from the hearby irrigation ditch during the summer months in 2005 and 2006 by a seasonal rise in the potentiometric surface. Through late 2006 and 2007, the water level has remained elevated and only recently has shown a seasonal pattern of rising and falling.

Sample collection field forms that record the water quality parameters of the monitor well groundwater as it is purged and the volume removed are provided in Appendix B, Sample Collection Forms. After parameter stabilization, the water samples are filtered through a 0.45 micron (μ) filter, collected in laboratory-provided containers, and preserved in the field as appropriate for the analyte and analytical method. Some monitor wells require multiple trips in order to collect sufficient sample volume due to slow recharge.

After conferring with the Colorado Department of Public Health and Environment (CDPHE), CSM was allowed to remove select analytes from the March, September, and December quarterly sampling events. Specific analytes removed from the parameter analytical list included metals (arsenic, barium, cadmium, chromium, lead, mercury, selenium, silver, and vanadium) and radioisotopes (thorium 228, 230, and 232). These parameters will be sampled only once per year during the June (second quarter) sampling event. Analytes that have been added to the sampling program for all sampling events include anions (bicarbonate, carbonate, chloride, nitrate, nitrite, and sulfate); cations (calcium, magnesium, potassium, and sodium); plus ferrous/ferric iron (flood plain wells).

2.2 Surface Water Sampling

Surface water samples from Clear Creek were collected on March 16, 2009 from two locations: one upstream of the site (SW-1) and one downstream of the site (SW-2) as shown on Figure 1. The surface water samples were collected following the procedures outlined in Appendix C, Surface Water Sampling Procedures. Surface water samples are filtered through a 0.45μ filter, collected in laboratory-provided containers, and preserved in the field as appropriate for the analyte and analytical method.

As with the groundwater samples described above, sampling for select metals from the surface water sampling program has been reduced to once per year (June), and the anions, cations, and iron speciation has been added.

Discharge data of stream flow of Clear Creek, as measured by the United States Geological Survey, Golden, Colorado Clear Creek gauging station (#06719505 USGS Surface Water Online Database) during the first quarter from January 1, 2009 through March 31, 2009 are presented as Figure 4. Tabular representation of the data indicates provisional values of stream flow of 43, 44, and 46 cubic feet per second (cfs) during the sample dates of March 16, March 17, and March 18, respectively.

2.3 Analyses

All samples collected were analyzed using a Comprehensive Environmental Response, Compensation and Liability Act (CERCLA)-certified analytical laboratory. The results received from the laboratory were evaluated based on the following parameters:

- Data completeness
- Holding times and preservation
- Instrument initial calibrations
- Instrument performance checks
- Preparation blanks
- Duplicate sample results
- Laboratory control samples results
- Compound quantization and reporting limits (full validation only)\

As a quality control/quality assurance (QA/QC) check, an equipment blank sample was collected in the field by pouring distilled water through a sample bailer and submitting the filtered aqueous sample for the identical analytical parameters as the groundwater and surface water samples. The results of the equipment blank analyses did not identify any interferences or anomalies in the laboratory data.

Results of the QA/QC check indicate the SW-1 sample was analyzed for Ra-228 on detector A3, which failed the daily performance check and there is a potential low bias of 7.2 percent for the reported result of 0.73 ± 0.54 pCi/l. Even though this sample had been prepped in duplicate and the duplicate was counted on a passing detector with both detectors yielding a non-detect result, the reported result for sample SW-1 is qualified as Rejected [R].

Data validation results are presented in Appendix D.

2.3.1 Groundwater Quality Analyses

Summaries of groundwater results for radioisotopes, metals, and inorganic anion and cations are presented in Table 2-1, Table 2-2, and Table 2-3, respectively. Groundwater parameters are reported as picoCuries per liter (pCi/l) for radioisotopes, micrograms per liter (µg/l) for uranium, and milligrams per liter (mg/l) for metals.

Paragon Analytics Laboratory, Inc. of Ft. Collins, Colorado and TestAmerica Laboratories, Inc. of Arvada, Colorado conducted laboratory analyses of the aqueous samples. Analytical parameters submitted to Paragon included radium isotopes (Ra-226 and Ra-228), uranium (U), calcium (Ca), potassium (K), magnesium (Mg), sodium (Na), phosphorus (P), chloride (Cl), sulfate (SO_4), carbonate as calcium carbonate (CO_3), bicarbonate as calcium carbonate (HCO_3), dissolved organic carbon (DOC), and total phosphorous.

Analytical parameters submitted to TestAmerica include nitrate (NO_3), nitrite (NO_2), and ferrous (Fe^2) and ferric (Fe^3) iron. TestAmerica was selected to conduct the short holding time analyses because of their proximity to the CSMRI site.

Groundwater samples were measured onsite for purged volume, temperature, pH, specific conductance, dissolved oxygen (DO), oxygen reduction potential (ORP), and turbidity as nephlometer turbidity units (NTU) during the purging and sampling process. Onsite measurement parameters are presented on the sample collection forms in Appendix B.

Since the first quarter of monitoring in February 2005, the concentration of total uranium in mg/l had been analyzed using Paragon method 714R9. In this method, the concentration of uranium is calculated based on the activity of the uranium isotopes U-234, U-235, and U-238. Effective with the first quarter 2007 sampling event, the concentration of uranium is now analyzed using mass spectrometry method EPA 6020, which analyzes for total isotopic uranium and not for the activity of the individual isotopes.

Analytical data from Paragon and from TestAmerica as an electronic data deliverable (EDD) are presented in Appendix E on a compact disk as a series of Excel spreadsheets. Appendix F presents copies of the chain-of-custody for the CSMRI samples.

2.3.2 Surface Water Analyses

A summary of Clear Creek surface water results for radioisotopes, metals, and anions and cations are presented in Table 2-4, Table 2-5, and Table 2-6, respectively. Surface water parameters are reported as pCi/l for radioisotopes, µg/l for uranium, and mg/l for metals. Surface water samples were measured onsite for temperature, pH, specific conductance, DO, ORP, and NTU as the sampling was conducted. Onsite measurement parameters are presented on the sample collection forms in Appendix B.

2.4 Health and Safety Program

Stoller developed a program to protect the health and safety of field personnel for implementation of the environmental monitoring at the CSMRI site. This program has been developed in accordance with requirements of 29 CFR 1910.120.

3. Results

Groundwater analytical results from samples collected from the CSMRI site during the first quarter 2009 for radioisotopes, metals, and anions and cations are summarized on Table 2-1, Table 2-2, and Table 2-3, respectively. Surface water analytical results from samples collected from the CSMRI site during the first quarter 2009 for radioisotopes, metals, and anions and cations are summarized on Table 2-4, Table 2-5, and Table 2-6, respectively. Table 2-7 presents historical data collected by previous consultants for select contaminants of potential concern in groundwater at the site. The historical uranium data presented in Table 2-7 are presented in pCi/l as "activity" yet recent (2005 through 2008) analytical data are presented in µg/l as "mass concentration." The December 7, 2000 Federal Register discusses the final uranium maximum contaminant level (MCL) and presents a conversion factor of a geometric average mass:activity ratio of 0.9 pCi/g for values near the National Primary Drinking Water Standards MCL, based on data from the National Inorganics and Radionuclides Survey.

Tables G-1 and G-2 in Appendix G present the quarterly historical groundwater radioisotopic and metals sample results, respectively, collected by Stoller since February 2005. Tables G-3 and G-4 in Appendix G present the quarterly historical Clear Creek surface water radioisotopic and metals sample results, respectively, collected by Stoller since February 2005.

3.1 Groundwater Conditions

Groundwater monitor wells are located in areas likely to detect impacts, if any, to groundwater emanating from the site as well as locations that represent background water quality. Monitor Wells CSMRI-4 and CSMRI-5 are located downgradient from the site in the Clear Creek flood plain. Well CSMRI-1 is located along Clear Creek upstream from the site, and well CSMRI-2 is located offsite on the southeast corner of the freshman parking lot on West Campus Drive.
In February 2007, seven new groundwater monitor wells were installed to assess the effectiveness of the source excavation and stockpile creation that were conducted during the summer of 2006. Monitor well CSMRI-8 is located along Clear Creek within the flood plain area; and monitor wells CSMRI-1B, CSMRI-6B, CSMRI-7B, CSMRI-9, CSMRI-10, and CSMRI-11 are located on the upland areas and essentially encircle the CSMRI site.

In July 2008, two monitor wells (CSMRI-6B and CSMRI-11) were abandoned due to construction activities at the CSMRI site. These two wells were replaced in December 2008 with CSMRI-6C and CSMRI-11B, respectively.

3.2 Groundwater Quality

Groundwater samples were collected from eight monitor wells and tested for the presence of metals and radioisotopes as identified in Section 2.3.1. Groundwater samples were not collected from monitor wells CSMRI-6C, CSMRI-7B, and CSMRI-11B due to no water in the wells at the time of sampling.

The sum of the detected activities of Ra-226 (2.37 ± 0.81 pCi/l) and Ra-228 (2.68 ± 0.96 pCi/l) at monitor well CSMRI-2 exceeded the MCL standards of 5 pCi/l. In all other wells the detected activities of Ra-226 and Ra-228 were below the MCL standards as shown on Table 2-1. Figure 5 presents the historical activity results of CSMRI-2 for the summing of the Ra-226 and Ra-228. The graph indicates that since 2005 the activity results have been below the MCL until the most recent sampling event.

Uranium was detected in monitor wells CSMRI-4 at 80 µg/l, CSMRI-8 at 980 µg/l, and CSMRI-9 at 34 µg /l at concentrations exceeding the MCL of 30 µg /l. Uranium was also detected in the remaining six groundwater monitor wells but at concentrations below the MCL.

The detected concentration of uranium in CSMRI-9 at 34 µg/l is higher than the initial February 2007 sampling at this location indicated a concentration of 7.9 µg/l. The concentration of uranium then spiked to 35 µg/l but until the March 2009 sampling event has fluctuated slightly above 20 µg/l in the past five quarterly sampling events. This monitor well is located at the top of the bench terrace that rises above the flood plain.

In the flood plain area, uranium was detected in monitor wells CSMRI-4 at 80 µg/l, CSMRI-5 at 11 µg/l, and CSMRI-8 at 980 µg/l. Uranium in monitor well CSMRI-4 has historically had elevated concentrations of uranium, but the values had been declining since 1991 until the last several quarterly sampling events as shown on Figure 6. Historically, the concentration of uranium in this monitor well has spiked; once in 1999 and then again in 2003. The spike in the concentration of uranium in 2003 was attributed to precipitation effects at the CSMRI site and removal of the site asphalt and concrete as discussed in Section 4.2.2 of the New Horizons RI-FS (New Horizons 2004). Soil remediation activities in the flood plain area in December 2006 may have affected the recent rise in the concentration of uranium in this monitor well.

Figure 7 presents the potentiometric surface elevation of the groundwater in CSMRI-4 (left Y axis) and the concentration of uranium (right Y axis) from 2005 through the first quarter 2009. The figure indicates the concentration of uranium had previously been fluctuating seasonally slightly above to slightly below the MCL of 30 µg/l for seven quarterly sampling events in 2005 and 2006. Since 2007 the concentration of uranium in this well has increased after the 2006 surface soil remediation activities. An ice chest from the fourth quarter 2007 (December) sampling event was lost by the courier service resulting in a gap in the analytical data for CSMRI-4.

The concentration of uranium detected in CSMRI-8 decreased to 980 µg/l from the previous quarterly value of 1,900 µg/l. Monitor well CSMRI-8 was installed in February 2007. Figure 8 presents the potentiometric surface elevation of the groundwater at this well (left Y axis) and the concentration of uranium (right Y axis) from 2007 through the first quarter 2009. quarterly monitoring will be continued to document seasonal variability and trends in the concentration of uranium at this location.

The groundwater at the CSMRI site will be monitored on a quarterly basis and the exceedances of uranium in monitoring wells CSMRI-4, CSMRI-8, and CSMRI-9 will continue to be evaluated as more data are made available. The relationship between the seasonal stream flow of Clear Creek and the exceedances of uranium for the monitor wells located on the flood plain will be assessed.

3.2.1 Ionic Balance Evaluation

Groundwater and surface water samples were collected and tested for major anions and cations, dissolved organic carbon, and at select locations (CSMRI-1, CSMRI-4, CSMRI-5, and CSMRI-8) ferric and ferrous iron. Analytical results for these parameters are presented in Table 2-3 for groundwater and Table 2-6 for surface water. Ionic balance calculations between the anions and cations for all samples indicate good results for most samples (less than 5 percent difference). Summary sheets from the AqQA® geochemical software for each of the water samples are presented in Appendix H. Dominant water types identified at the CSMRI site include Ca-Cl (CSMRI-1); Ca-HCO_3 (CSMRI-2, CSMRI-5, CSMRI-9, and CSMRI-10); and Ca-SO_4 (CSMRI-4, CSMRI-8, SW-1, and SW-2).

A Piper quadrilateral diagram is included in Appendix H and presents the overall chemical properties and water types for each water sample.

3.2.2 Comparison of Upgradient and Downgradient Groundwater Quality

Monitor wells CSMRI-4, CSMRI-5, and CSMRI-8 are downgradient from the site and are located on the Clear Creek flood plain. Monitor wells CSMRI-7B, CSMRI-9, and CSMRI-10 are located downgradient of the CSMRI site at the top of a topographical slope above the flood plain. Monitor well CSMRI-11B is located at the eastern edge of the site, and monitor wells CSMRI-1B and CSMRI-6C are located upgradient to the site.

Metals concentrations that are above detection limits vary widely regarding upgradient versus downgradient wells. The analytical data indicate the influence of Clear Creek to CSMRI-1 where Ca was detected in SW-1, SW-2, and CSMRI-1 at concentrations of 35 mg/l, 37 mg/l, and 46 mg/l, respectively. The analytical results indicate the presence of Ca at a concentration of 250 mg/l in monitor well CSMRI-8, over twice the concentration of most of the other monitor wells. The same observation for elevated concentrations of K, Na, Mg, and sulfate in monitor well CSMRI-8 applies when compared to other monitor well analytical data.

Uranium was detected in monitor wells CSMRI-9 at a concentration of 34 µg /l, CSMRI-4 at a concentration of 80 µg/l, and in CSMRI-8 at a concentration of 980 µg/l, which exceed the MCL of 30 µg/l. As shown on Figure 7, until the last several rounds of sampling, there appeared to be a seasonal correlation between fluctuations of the water table elevation and the concentration of uranium in monitor well CSMRI-4. The recent rise in the concentration of uranium in CSMRI-4 will continue to be monitored to assess the variability of uranium in this monitor well and the interaction with the seasonal fluctuations of Clear Creek.

Quarterly monitoring will be continued at monitor well CSMRI-8 to document the seasonal variability and trends of the presence of uranium at this location.

3.2.3 Comparison with Previous Groundwater Quality Analyses

Table 2-7 presents groundwater analytical results from past sampling events dating back to 1991 for radioisotopes of concern. The data indicate a slight decreasing trend in contaminant concentrations over time, indicating improving groundwater quality.

As additional data are collected and trends become more defined, graphs of concentration versus time will be produced and presented. This analytical data will be incorporated to show long-term trends and correlation between the detected concentration of uranium in groundwater, the fluctuating water table, and seasonal variability if present.

3.2.4 Comparison with Colorado Groundwater Standards

The statewide activity standard of 5 pCi/l for the sum of Ra-226 and Ra-228 in drinking water was exceeded in monitoring well CSMRI-2. No exceedances of the MCL for tested metals were identified in any of the groundwater and surface water samples.

The MCL for uranium in drinking water was exceeded in monitor wells CSMRI-9 at a concentration of 34 µg /l, CSMRI-4 at a concentration of 80 µg/l, and in CSMRI-8 at a concentration of 980 µg/l, which exceed the MCL of 30 µg/l. In January 2008, CDPHE Water Quality Control Commission adopted the surface water quality standard of 30 µg/l as the groundwater quality standard in an effort to keep both uranium standards consistent.

The spikes in the concentration of uranium in CSMRI-4 shown in Figure 7 may be attributed to the increased precipitation during the months of December 2006 through February 2007 and surface soil remediation activities in the flood plain. This monitor well exhibited the same trend in 2003 during a prolonged high precipitation time period and when the asphalt cover and buildings associated with CSMRI had been removed.

The concentration of uranium at 980 µg/l at monitoring well CSMRI-8 may be due to the following factors:

- The well contains residual uranium from the former pond area on the flood plain.
- Uranium was disturbed and introduced into the monitor well during installation.
- The well contains residual uranium from the former Building 101 area at the top of the slope above the flood plain.
- Uranium is naturally occurring in the Fox Hills bedrock formation.
- The well is located in a zone where strong mixing between Clear Creek water and groundwater occurs, and the oxidizing conditions associated with creek water causes uranium to dissolve more readily.

Monitoring well CSMRI-8 will continue to be sampled on a quarterly basis along with the other site wells, and the reason for the elevated level of uranium will be evaluated.

3.3 Surface Water Quality

Surface water samples are collected from two locations at the site. Location SW-1 is located upstream from the site and the second location, SW-2, is downstream from the site. The metals detected above their respective detection limits include: Ca, K, Mg, and Na. The upstream and downstream surface-water concentrations of all metals and radionuclides detected at the CSMRI site from stations SW-1 and SW-2 are similar. No established MCLs were exceeded.

4. Activities for First Quarter 2009

The artificial turf soccer field that overlies the former CSMRI site and the artificial turf football practice field to the south are in-place and construction is nearing completion. Both fields overlie drain beds with perimeter drains that collect any direct precipitation onto the fields and discharge the water to the flood plain area. The affect of the drains in reducing the contribution of precipitation to the groundwater at the former CSMRI site will be monitored.

5. References

Colorado Department of Public Health and Environment, Water Quality Control Commission, Regulation No. 41, *The Basic Standards for Ground Water*. Amended: January 14, 2008, Effective: May 31, 2008.

New Horizons Environmental Consultants, Inc. Remedial Investigation/Feasibility Study and Proposed Plan, Colorado School of Mines Research Institute Site, Golden, CO, January 21, 2004.

Stoller, Final Site Characterization Work Plan, May 2006.

USGS Surface Water website: http://nwis.waterdata.usgs.gov

Table 2-1
Summary of Radioisotopes in Groundwater

		Ra-226 (pCi/l)		Ra-228 (pCi/l)		Total U (µg/l)
Sample Station	Sample Date	Result	Uncertainty	Result	Uncertainty	Result
CSMRI-1	3/17/09	0.09	0.19	0.96	0.52	2
CSMRI-1B	3/18/09	0.2	0.19	1.15	0.59	8.1
CSMRI-2	3/18/09	2.37	0.81	2.68	0.96	0.77
CSMRI-4	3/17/09	0.54	0.31	0.56	0.6	80
CSMRI-5	3/17/09	0.29	0.28	1.24	0.6	11
CSMRI-6C	DRY	NT	NT	NT	NT	NT
CSMRI-7B	DRY	NT	NT	NT	NT	NT
CSMRI-8	3/18/09	0.31	0.26	0.69	0.47	980
CSMRI-9	3/16/09	0.17	0.18	0.45	0.47	34
CSMRI-10	3/16/09	.15	0.19	1.01	0.54	16
CSMRI-11B	DRY	NT	NT	NT	NT	NT
MCL*		Total Ra = 5				30

*Maximum Contaminant Level – National Primary Drinking Water Regulations
**5 CCR 1002-41 Reg 41 – Colorado Groundwater Standards
NT – Not Tested

Table 2-2
Summary of Metals in Groundwater

Sample Station	Sample Date	Ag	As	Ba	Ca	Cd	Cr	Hg	K	Mg	Na	Pb	V
CSMRI-1	3/17/09	NT	NT	NT	46	NT	NT	NT	3	14	27	NT	NT
CSMRI-1B	3/18/09	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
CSMRI-2	3/18/09	NT	NT	NT	76	NT	NT	NT	6.4	34	19	NT	NT
CSMRI-4	3/17/09	NT	NT	NT	100	NT	NT	NT	9.3	45	63	NT	NT
CSMRI-5	3/17/09	NT	NT	NT	110	NT	NT	NT	4.4	40	44	NT	NT
CSMRI-6C	DRY	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
CSMRI-7B	DRY	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
CSMRI-8	3/18/09	NT	NT	NT	250	NT	NT	NT	13	74	97	NT	NT
CSMRI-9	3/16/09	NT	NT	NT	100	NT	NT	NT	4.7	49	45	NT	NT
CSMRI-10	3/16/09	NT	NT	NT	110	NT	NT	NT	4.5	43	43	NT	NT
CSMRI-11B	DRY	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
Detection Limits		0.01	0.01	1	1	0.005	0.01	0.0002 (B)	1	1	1	0.003	0.01
MCL*		NE	0.010	NE	NE	0.005	0.1	0.002 (B)	NE	NE	NE	0.015	NE

*Maximum Contaminant Level – National Primary Drinking Water Regulations
**5 CCR 1002-41 Reg 41 – Colorado Groundwater Standards
NE - Not Established
NT – Not Tested – Scheduled for June only (2nd Quarter)

Table 2-3
Summary of Anions and Cations in Groundwater

Sample Station	Sample Date	Bicarbonate as $CaCO_3$ (mg/l)	Carbonate as $CaCO_3$ (mg/l)	Total Alkalinity as $CaCO_3$ (mg/l)	Chloride (mg/l)	Dissolved Organic Carbon	Ferric Iron (mg/l)	Ferrous Iron (mg/l)	Total Iron (ug/l)	Nitrate (mg/l)	Nitrite (mg/l)	Dissolved Phosphorous (mg/l)	Sulfate (mg/l)
CSMRI-1	3/17/09	67	10	67	76	1	ND	ND	ND	0.78	ND	ND	81
CSMRI-1B	3/18/09	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
CSMRI-2	3/18/09	310	20	310	13	1	NT	NT	NT	ND	ND	ND	62
CSMRI-4	3/17/09	260	20	260	120	3.7	ND	ND	ND	2.1	ND	0.083	190
CSMRI-5	3/17/09	230	20	230	120	2.1	ND	ND	ND	6.5	ND	ND	130
CSMRI-6C	DRY	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
CSMRI-7B	DRY	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
CSMRI-8	3/18/09	350	20	350	180	3.6	ND	ND	ND	ND	ND	ND	530
CSMRI-9	3/16/09	240	20	240	130	1.7	NT	NT	NT	7.5	ND	ND	110
CSMRI-10	]3/16/09	250	20	250	110	1.8	NT	NT	NT	9.9	ND	ND	120
CSMRI-11B	DRY	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
Reporting Limits		5 or 20	5 or 20	5 or 20	1, 2 or 4	1	0.20	0.20	100	0.50	0.50	0.05	1, 10 or 20

ND – Non Detect
NT – Not Tested

Table 2-4
Summary of Radioisotopes in Surface Water

Sample Station	Sample Date	Ra-226 (pCi/l)		Ra-228 (pCi/l)		Total U (µg/l)
		Result	Uncertainty	Result	Uncertainty	Result
SW-1	3/16/09	0.14	0.16	0.73	0.54	1.9
SW-2	3/16/09	0.2	0.22	0.29	0.47	1.9
MCL*		Total Ra = 5				30

*Maximum Contaminant Level – National Primary Drinking Water Regulations
**5 CCR 1002-31 Reg 31 – Colorado Surface Water Standards
NE – Not Established

Table 2-5
Summary of Metals in Surface Water
(All results in milligrams per liter)

Sample Station	Sample Date	Ag	As	Ba	Ca	Cd	Cr	Hg	K	Mg	Na	Pb	V
SW-1	3/16/09	NT	NT	NT	35	NT	NT	NT	3.1	8.9	17	NT	NT
SW-2	3/16/09	NT	NT	NT	37	NT	NT	NT	3.5	9.7	19	NT	NT
Detection Limits		0.01	0.01	0.1	1	0.005	0.01	0.0002	1	0.01	1	0.003	0.01
MCLs*		0.01	0.010	2	NE	0.005	0.1	0.002	NE	NE	NE	0.015	NE

*Maximum Contaminant Level – National Primary Drinking Water Regulations
ND – Non Detect
NE – Not Established
NT – Not Tested - Scheduled for June only (2nd Quarter)

Table 2-6
Summary of Anions and Cations in Surface Water

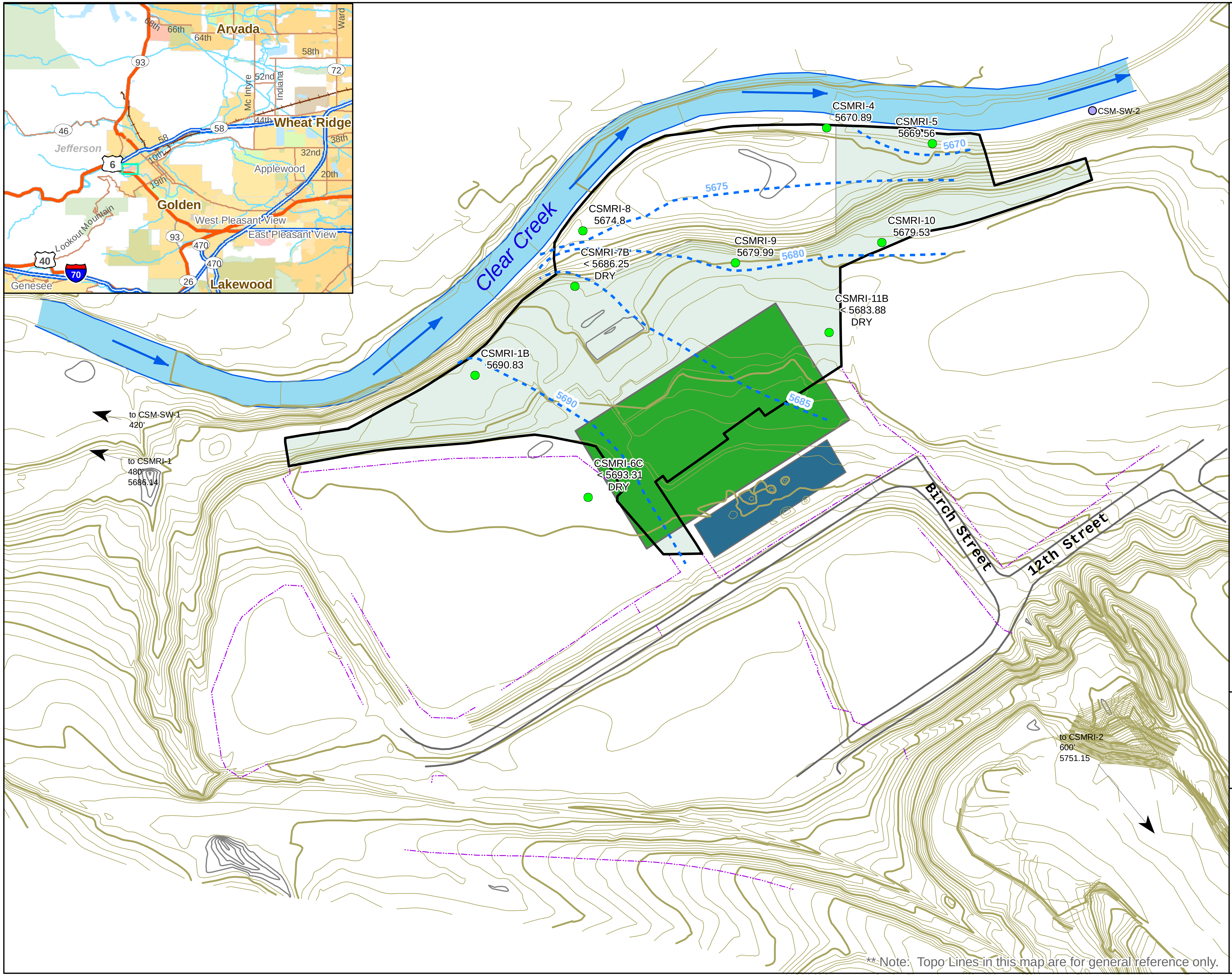
Sample Station	Sample Date	Bicarbonate as $CaCO_3$ (mg/l)	Carbonate as $CaCO_3$ (mg/l)	Total Alkalinity as $CaCO_3$ (mg/l)	Chloride (mg/l)	Dissolved Organic Carbon (mg/l)	Ferric Iron (mg/l)	Ferrous Iron (mg/l)	Total Iron (mg/l)	Nitrate (mg/l)	Nitrite (mg/l)	Total Phosphorous (mg/l)	Sulfate (mg/l)
SW-1	3/16/09	47	5	50	30	1.3	NT	NT	NT	ND	ND	ND	83
SW-2	3/16/09	53	5	53	34	1.5	NT	NT	NT	ND	ND	ND	86
Reporting Limits		5	5	5	0.4	1				0.50	0.50	0.05	1

ND = Not Detected at or above the Reporting Limits
NT = Not Tested

Table 2-7
CSMRI Historical Groundwater Data (Previous Consultants)
(All results in picoCuries per liter)

Well ID (d)	Analyte	1/1991 (a)	6/1991 (a)	3/1999 (b)	6/1999 (b)	10/1999 (b)	2/2003 (c)	4/2003 (c)	7/2003 (c)	10/2003 (c)
CSMRI-1	Ra-226			0.1	0.3	0.2	<0.55	<0.45	ND (<0.38)	ND (<0.31)
	U Total			2.09	2.59	1.44	2.4	2.9	0.87	1.4
	Th-230			0.4	0.2	0.2	<0.19	0.21	ND (<0.13)	<0.15
CSMRI-2	Ra-226		1.9	1.9	1.4	1.4	1.4	2.8	2.1	1.7
	U Total	11	5.7	0.55	1.46	0.71	1.5	1.3	1.9	1.3
	Th-230		0	0.1	0.1	0.9	<0.17	0.43	0.20	0.31
CSMRI–3	Ra-226		0.6	1.5	1.2	1.6	<0.75	<0.81	ND (<0.49)	<0.98
	U Total	17	10.4	8.41	12.4	10	12	12	9	10
	Th-230		0	0.3	0.3	1.1	<0.12	ND (<0.15)	ND (<0.17)	ND (<0.14)
CSMRI-4	Ra-226		1	<0.4	0.6	0.4	<0.85	<0.42	<0.32	ND (<0.64)
	U Total	86	57.3	23.4	58.6	33.7	16	34.2	53	19
	Th-230		0	0.7	0.3	0.4	<0.099	ND (<0.15)	ND (<0.17)	ND (<0.12)
CSMRI-5	Ra-226		0.6	2.4	3.3	2.7	ND (<0.49)	1.1	2.6	1.59
	U Total	14	16.8	3.6	3.6	4	2.8	2.3	2.7	3.3
	Th-230		0	0.2	0.2	1.4	0.062	ND (<0.14)	ND (<0.19)	ND (<0.13)

Notes: ND = Not Detected
a - Samples collected by Grant and Associates and analyzed by Barringer Labs
b - Samples collected by URS Greiner Woodward Clyde and analyzed by CORE Labs
c - Samples collected by New Horizons Environmental Consultants and analyzed by Paragon Analytics; Total U activity (pCi/l) calculated from concentration (µg/l) reported by Paragon.
d - Well Identification numbers changed from the 1991 data to the 1999 data. Data presented account for this change



Explanation

- ● Monitor Well
- ● Surface Water Sample Location
- - - - Potentiometric Surface Contours (5 Ft.)
- ▬ CSMRI Site
- ‐·‐· Fences
- ▬ Roads
- — Topography (Depressions)
- — Topography (10 Ft Intervals)
- — Topography (2 Ft Intervals)
- 🟩 Soccer Field
- 🟦 Stands
- ▨ Site Area

Note:
< number means that value = Elevation of the Bottom of the Well Screen

N
W E
S

Scale: 1" = 150'

0 95 190 380 Feet

Figure 1

Groundwater Potentiometric Elevation Map - March 2009

CSMRI
Quarterly Report

Stoller

J:\projects\CSMRI\QuarterlyReport_FIG1_Potentiometric.mxd Printed @ 06/23/2009 by WES

Figure 2
CSMRI
All Monitor Wells Hydrograph

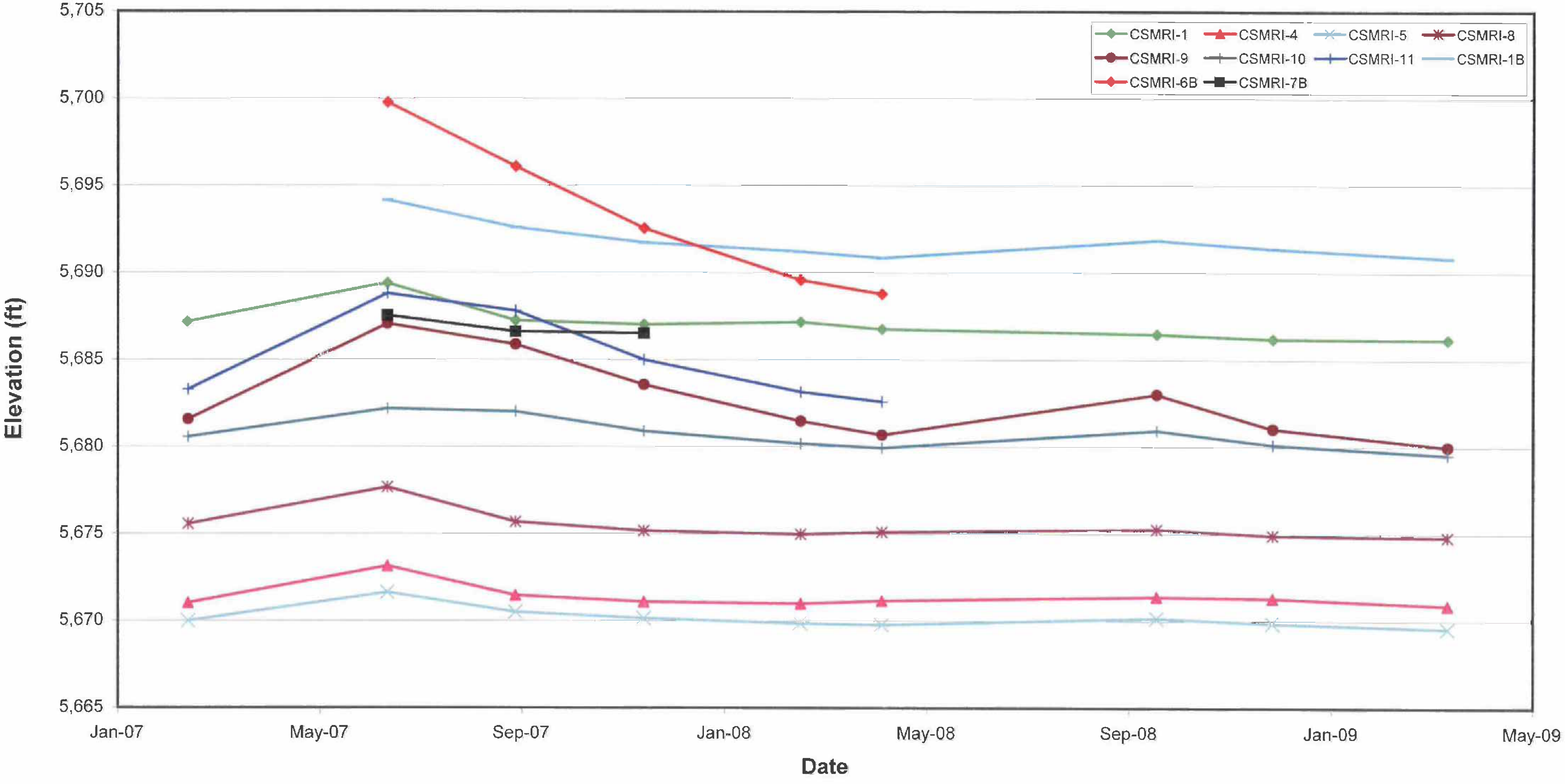


Figure 3
CSRMI-2
Hydrograph

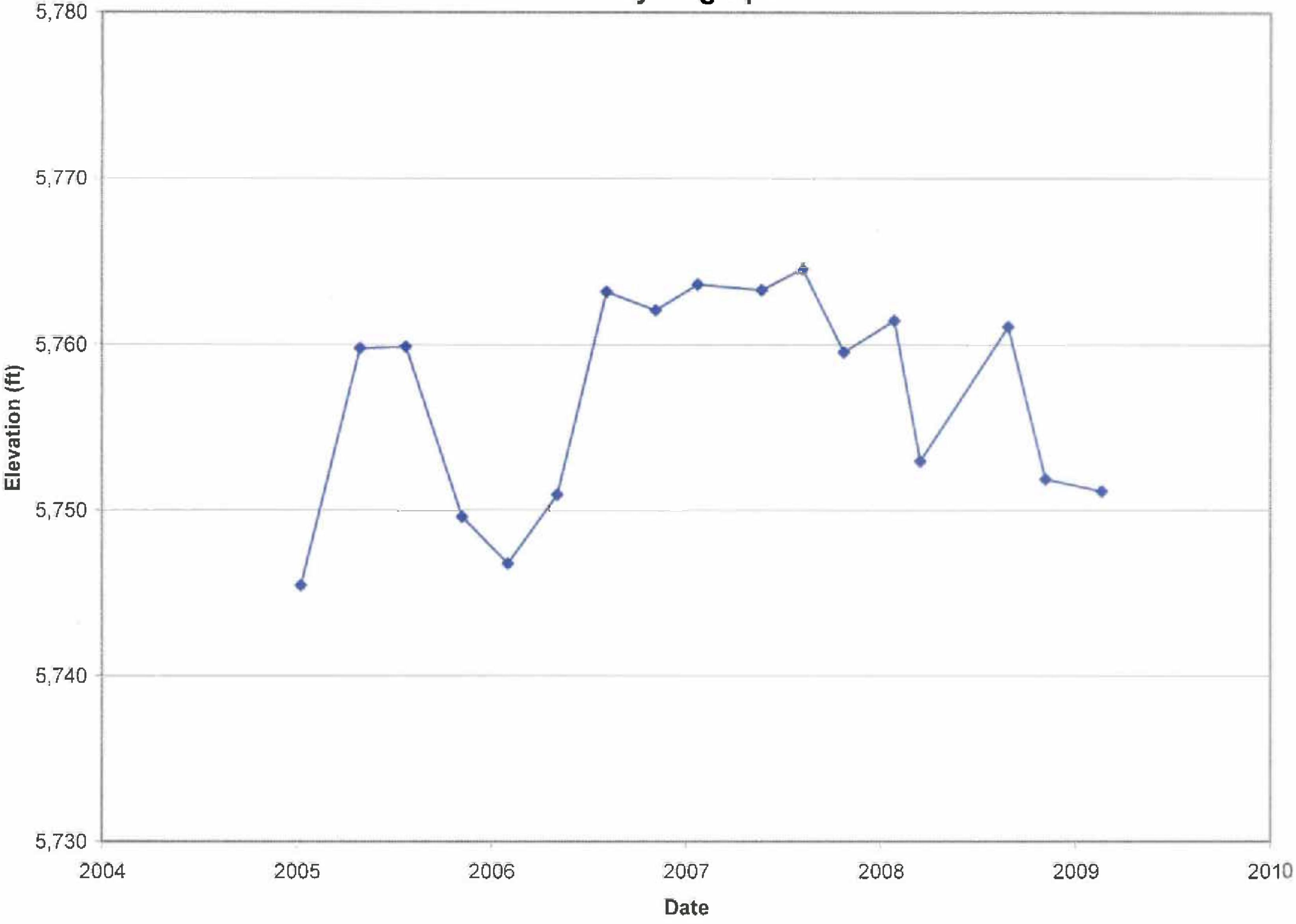


Figure 4
Clear Creek Gauging Graph
January – March 2009

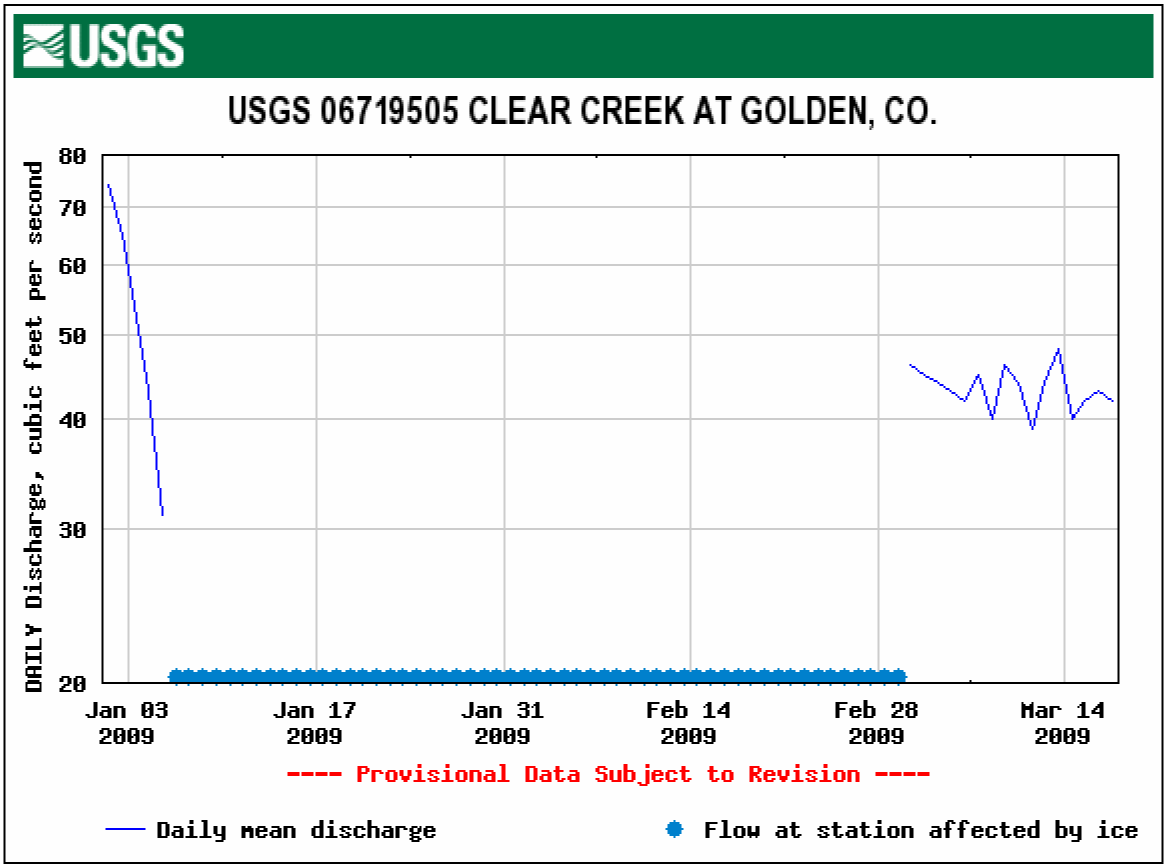
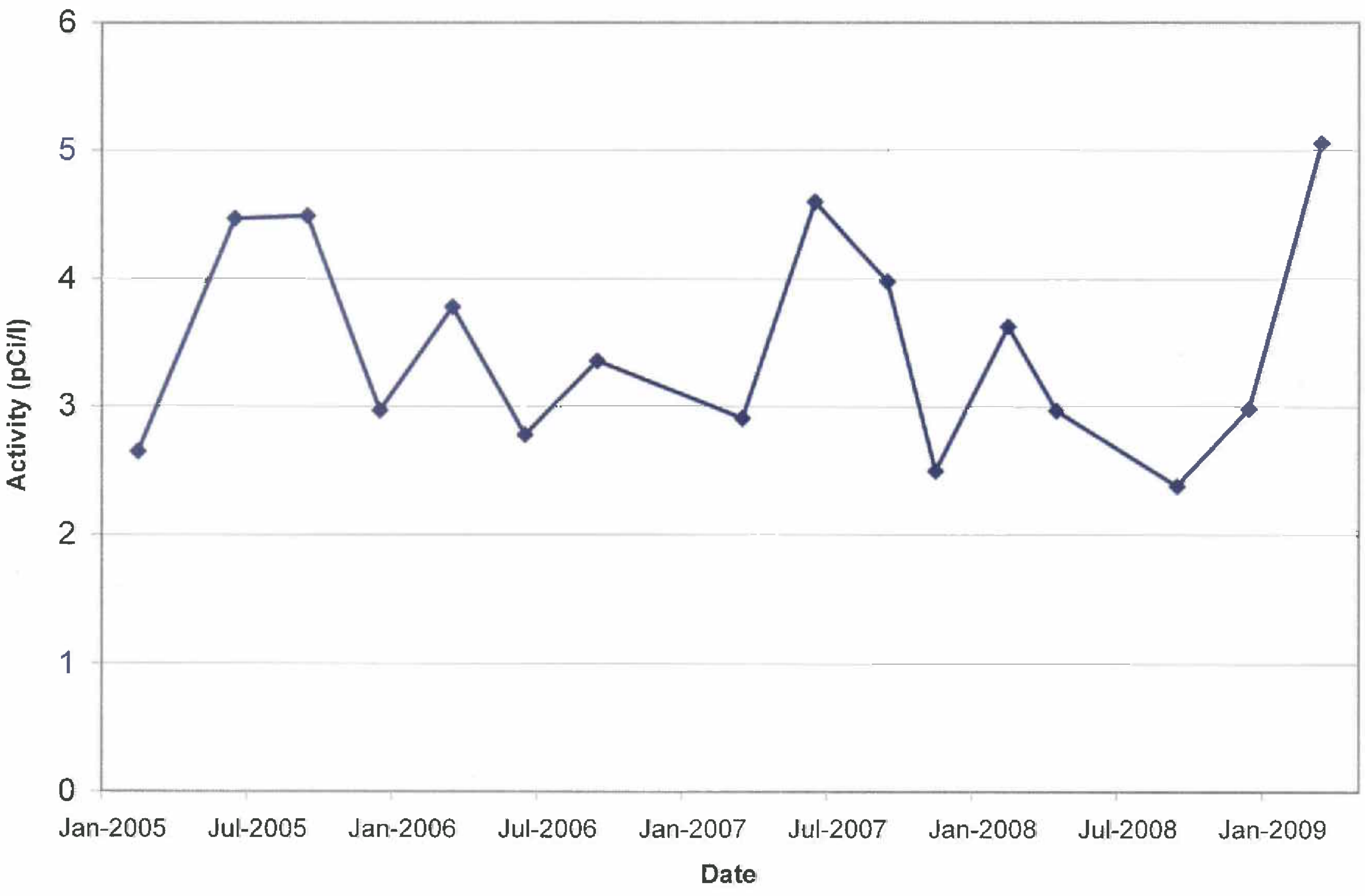


Figure 5
CSMRI-2
Sum of Ra-226 and Ra-228



Only activity results are presented.
Total propagated uncertainty (TPU +/-) activity results are not presented.

Figure 6
CSMRI-4
Historical Total Uranium Concentration (1990 - 2009)

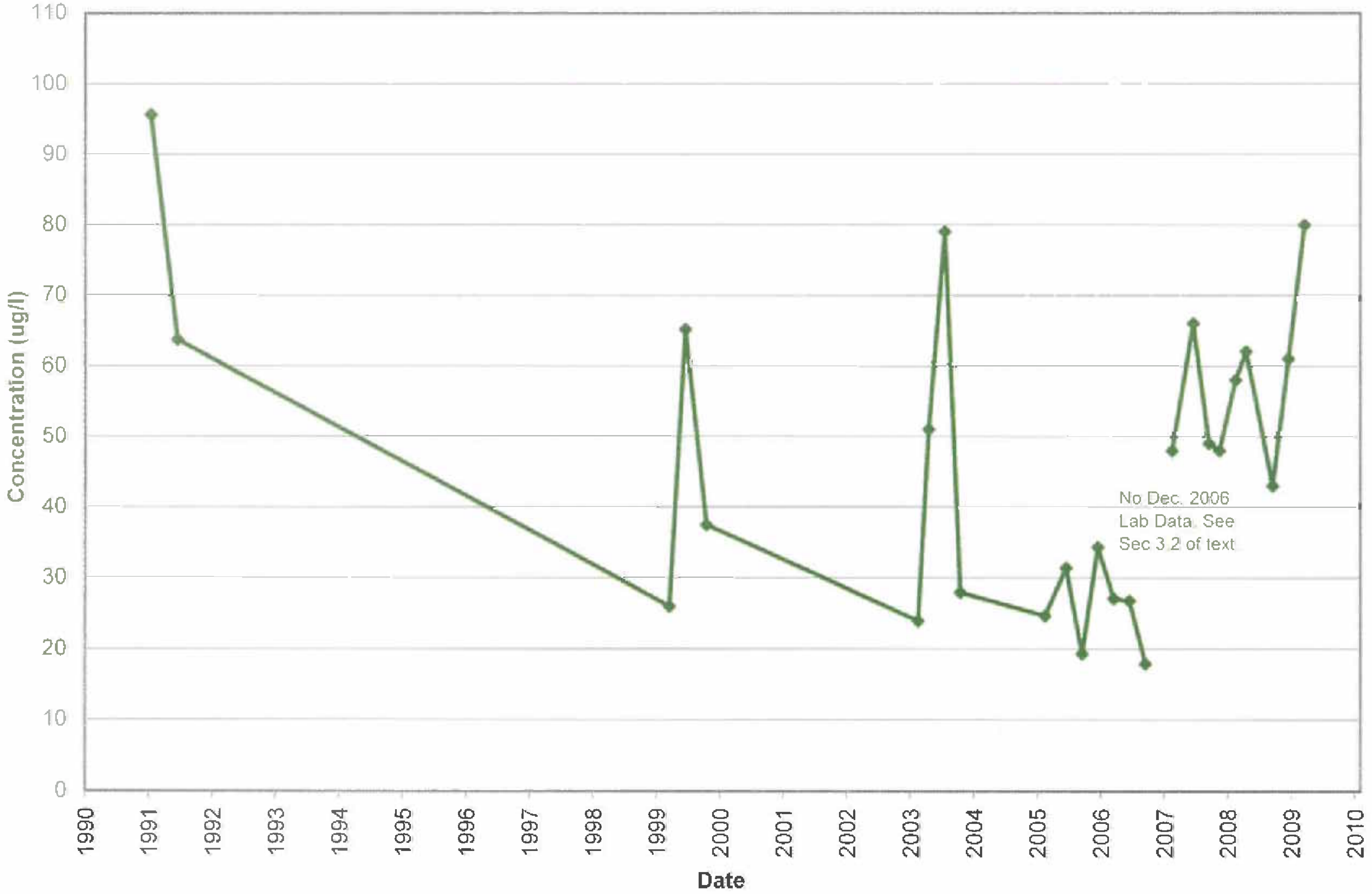


Figure 7
CSMRI-4
Total Uranium Concentration and Potentiometric Elevation

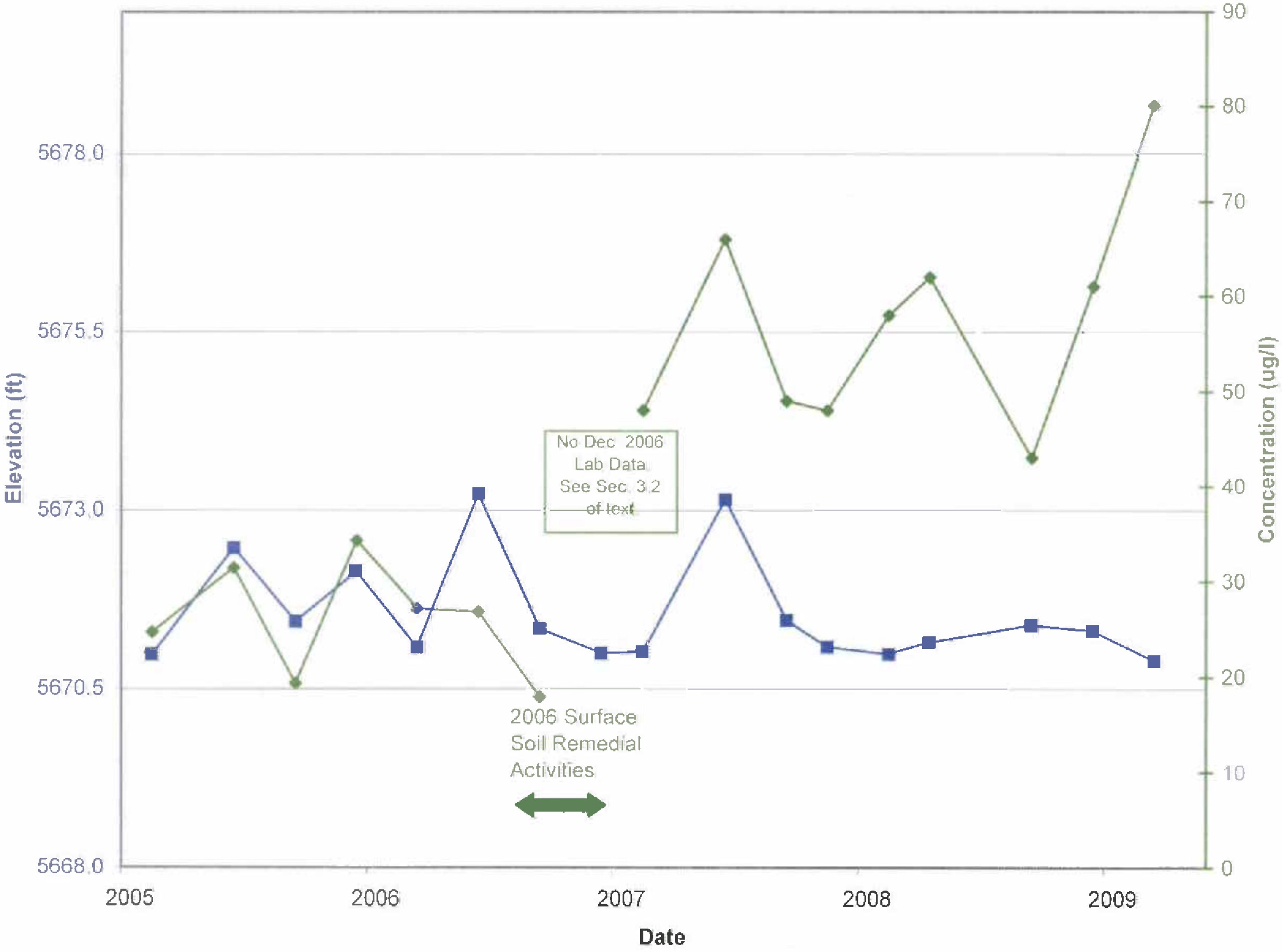
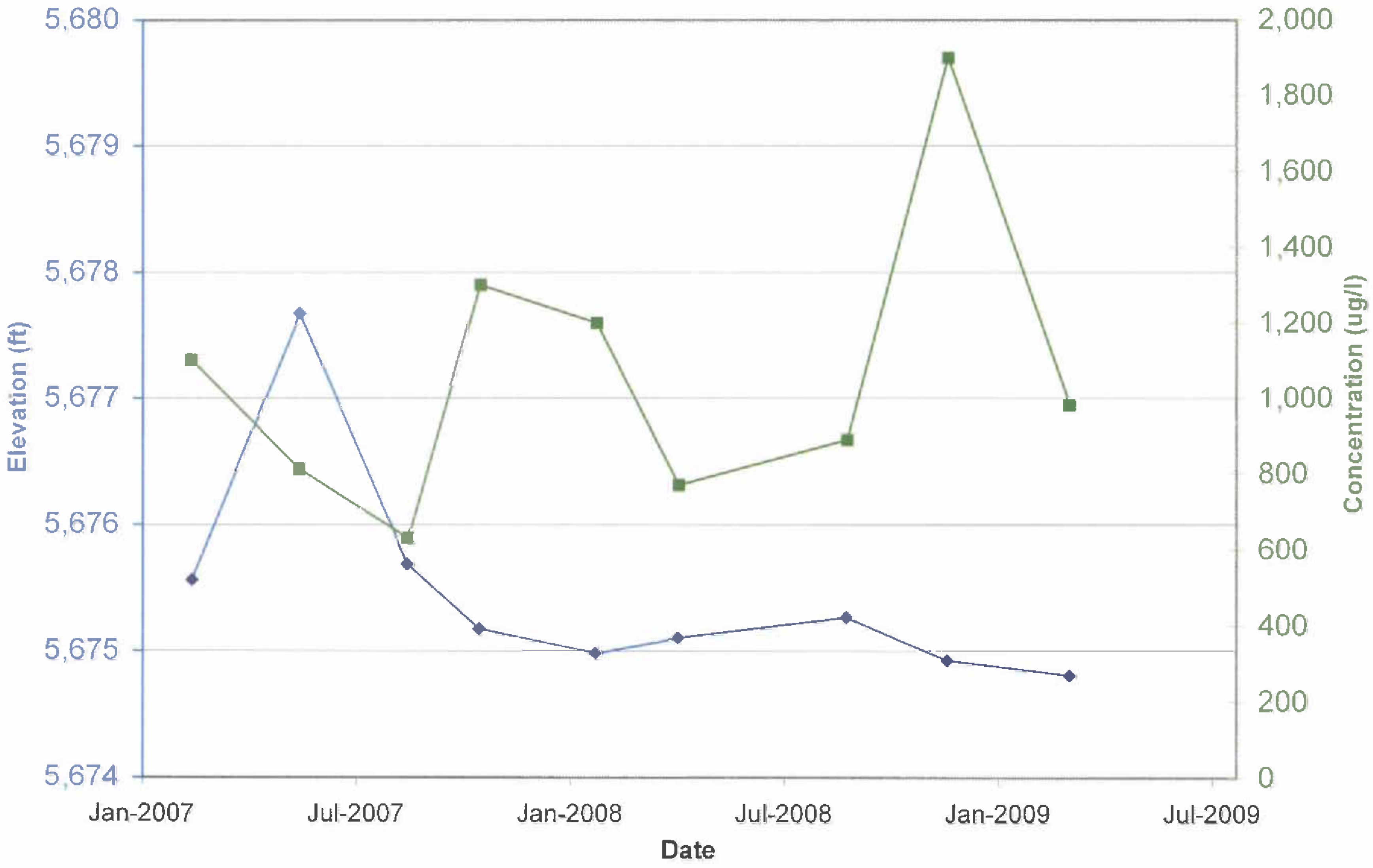


Figure 8
CSMRI-8
Total Uranium Concentration and Potentiometric Elevation



Appendix A
Groundwater Sampling Procedures

Groundwater Sampling

1.0 Purpose

This procedure describes actions to be used to sample groundwater from monitoring wells and piezometers. Monitoring wells are generally sampled on a semiannual, quarterly, or monthly basis, or by special request in support for specific projects. All wells are to be sampled using this procedure unless superseded by specific site, facility, or client procedures.

This procedure describes equipment decontamination and transport, site preparation, detection and sampling of immiscible layers, water level measurements, well purging, sample collection, field and analytical parameters, quality assurance/quality control (QA/QC) requirements, and documentation that shall be used for field data collection.

2.0 Scope

This document describes acceptable methods for the sampling of wells and piezometers.

3.0 Responsibilities and Qualifications

Personnel performing groundwater sampling procedures are required to have completed the initial 40-hour OSHA classroom training that meets the Department of Labor requirements at 29 CFR 1910.120(e)(3)(i), and must maintain a current training status by completing the appropriate annual 8-hour OSHA refresher courses. Personnel must also have read the appropriate project, site, or facility Health and Safety Plan(s). Prior to engaging in groundwater sampling activities, personnel must have a complete understanding of the procedures described within this procedure and, if necessary, will be given specific training regarding these procedures by other personnel experienced in the methods described within this procedure.

4.0 Groundwater Sampling Procedures

4.1 Introduction

Many monitoring wells are constructed of either 2-inch stainless steel, or 2- or 4-inch flush threaded PVC casing. Some piezometers are completed as monitoring wells, and they are usually constructed of ¾-inch inside diameter, flush threaded PVC casing. Some wells have been constructed to incorporate a sump below the well screen. Because these vary in length, the well construction diagrams should be consulted to determine the sump lengths for specific wells. Most piezometers are constructed with a flush threaded cap at the bottom of the well screen. However, the well construction diagrams should also be consulted for information about specific piezometers.

Procedures for groundwater sampling are designed to obtain a sample that is representative of the formation water beneath the site in question. Since an analysis of the quality of formation water is desired, standing water within the well must be purged before sampling. Also, a measure of the static water elevations is important to determine the effect of seasonal horizontal and vertical flow gradient changes during site characterization activities.

Groundwater sampling procedures can be initiated after sampling personnel take the required water level measurements and purge the well in accordance with this procedure. Methods for accomplishing each of these activities are included in this procedure in the following sequence:

- Collection of immiscible layers samples, if present
- Well purging
- Groundwater sampling using a bailer

- Groundwater sampling using a peristaltic pump
- Groundwater sampling with a bladder pump

4.2 General Equipment Requirements

Down-hole sampling equipment shall be constructed of inert material such as polytetrafluoroethylene (Teflon®) or stainless steel. This equipment shall be assessed on an individual basis prior to use in the field.

The following is a primary list of well sampling and associated equipment:

- Bailers – Teflon®, stainless steel, or other appropriate inert materials
- Teflon® coated stainless steel cable with reels
- Peristaltic pumps and tubing
- Water level measuring devices – sufficiently accurate to measure water levels to the nearest 0.01 foot
- Graduated purge water containers
- Plastic sheeting
- Distilled or deionized water
- Decontamination equipment and supplies
- Organic vapor detector (OVD)
- Gloves (nitrile)
- Calculator and watch
- Sample containers precleaned to EPA specifications
- pH paper
- Custody tape
- Coolers with sufficient blue ice to cool samples to 4°C
- Preservatives (trace metals grade)
- Disposable in-line 0.45-micron membrane filters
- Logbooks and field forms
- Black waterproof pens
- Portable laboratory equipment for measuring field parameters for pH, temperature, specific conductance, and turbidity
- Total alkalinity reagent
- Beakers and graduated cylinders

Additional equipment may be required to meet project or client health and safety standards, to perform specialized sampling, or to meet personnel and equipment decontamination requirements.

4.3 Equipment Decontamination and Transport

Equipment associated with the tasks involved in groundwater sampling shall be decontaminated upon arrival at the sampling location. All sampling equipment shall be decontaminated between sample locations. Decontamination frequency shall be increased appropriately as field conditions dictate.

Transportation of all equipment shall be performed in a manner that eliminates any possibility of cross-contamination. Calibration solutions, fuel, decontamination solutions and wastewater, and all other sources of contamination shall be segregated from sampling equipment during transport. Purge water being transported to holding areas shall be kept in closed containers.

If the decontamination of downhole equipment is not performed at the well, used downhole equipment shall be wrapped in plastic sheeting and/or segregated from clean equipment to eliminate the possibility of cross contamination. The equipment shall then be decontaminated as soon as possible.

4.3.1 Routine Field Decontamination

Decontamination of delicate equipment and the routine decontamination of sampling equipment prior to use at each well shall consist of the following steps:

- Vigorously scrub the equipment with a brush and solution of phosphate-free laboratory grade detergent (e.g., Liquinox) and distilled water.
- Rinse the equipment thoroughly with approved distilled water.
- If the decontaminated equipment is not immediately packaged to eliminate any adhesion of airborne impurities, perform an additional final rinse, or decontamination and rinse, immediately prior to actual sampling operations.

4.3.2 Routine Decontamination of Sampling Pumps

The external surfaces of all non-dedicated pumping equipment shall be decontaminated as described in Subsection 4.3.1. Internal surfaces shall be decontaminated according to the following procedures, except under special situations where the pump(s) must be disassembled and the internal parts cleaned separately (see Subsection 4.3.3). For routine decontamination, the following procedures shall be followed.

- Pump several pump volumes of a solution of a phosphate-free laboratory grade detergent (e.g., Liquinox) and water through the equipment.
- Displace the soap solution immediately by pumping approved distilled water, equivalent to three or more volumes of the pump storage capacity, through the equipment.
- If any detergent solution remains in the pump, continue pumping distilled water through the system until the detergent is no longer visibly present. Sudsing is the common indicator used to determine incomplete rinsing.

4.3.3 Unusual Decontamination Requirements

When equipment becomes grossly contaminated, such as from the collection of immiscible layer samples (see Subsection 4.5), routine decontamination of sampling equipment is not considered sufficient and thus is not allowed. This situation and other unusual equipment decontamination problems shall be reported to the field site supervisor. Under certain circumstances, a pump can be disassembled and the parts cleaned separately using approved solvents (i.e., hexane, alcohol, etc.). If specific instructions are required, the field site supervisor shall consult with a management representative for proper decontamination procedures.

4.3.4 Disposition of Decontamination Water

All water generated during the decontamination of equipment used for the sampling of wells shall be containerized in either a satellite container or in the purge water container in the groundwater sampling vehicle. It will then be disposed of according to the procedure designated in Subsection 4.6.3 of this procedure.

4.4 Site Preparation

Sheet plastic may be used to protect clean equipment from contacting contaminated surfaces. Plastic bags and sheeting, along with the segregation of clean and dirty equipment, can be used to reduce the chances of cross contamination. If a mechanical bailer retrieval system is used, the amount of plastic appropriate for protection of sampling equipment may be lessened. The sampling crew members are responsible for determining the amount of plastic sheeting required.

Disposable nitrile gloves, or gloves made of other approved materials, shall be used at all times when handling sampling equipment. Gloves shall be changed between each site and as often as necessary to ensure the integrity of clean sampling equipment.

4.5 Collection of Immiscible Layer Samples

When specified in the project sampling plan, or when the well to be sampled contains immiscible layers, immiscible phases must be collected before purging activities begin. The method of choice for collecting light non-aqueous phase liquids (LNAPLS) is a bottom valve bailer or peristaltic pump. Dense non-aqueous phase liquids (DNAPL) or "sinkers" shall be collected with a bottom double check valve bailer or peristaltic pump.

In all cases, the bailer shall be carefully lowered into the well so that agitation of the immiscible layer is minimal. Any bailer used to collect immiscible layers shall be dedicated to the well that is sampled. Peristaltic pumps shall be equipped entirely with silicon, or other chemical compatible tubing, when sampling immiscible layers. The project manager shall be responsible for determining the type materials to be used for specific projects. Dedicated equipment used for collecting immiscible layers shall be decontaminated prior to and after use as described in Subsection 4.3 of this procedure, if removed from the well.

Immiscible layer sampling shall be performed as follows.

- Remove dedicated bailers from the well and decontaminate as specified in Subsection 4.3 of this procedure. Decontaminate dedicated pump tubing, if used, prior to use.
- For LNAPLs, carefully lower the bailer intake or sampling port to the midpoint of the immiscible layer and allow it to fill while it is held at this level. The bailer must be lowered into the immiscible layer slowly so that minimal agitation of the immiscible layer occurs. Peristaltic pump intakes must also be lowered to the midpoint of the immiscible layer.
- If a DNAPL layer is being sampled, use either the double check valve bailer or peristaltic pump. Lower the bailer into the well until bottom is encountered. Lower peristaltic pump intakes also to the well bottom. Care must be taken not to immerse the pump intake into accumulated sediments.
- Do not allow the bailer or line to touch the ground at any time or allow the ground to come in contact with other physical objects that might introduce contaminants into the well.
- Decontaminate all equipment immediately after sampling is completed. Suspend dedicated bailers in the well from the well cap above the high water level. Discard silicon tubing used with peristaltic pumps.

4.6 Well Purging

Purging stagnant water from a well is required so that the collected sample is representative of the formation groundwater. The device used (bailer or pump) depends upon aquifer properties, individual well construction, and data quality objectives. Wells that contain immiscible layers will not be purged unless specified in the site-specific work plan. Any well scheduled for purging and sampling that subsequently is found to contain immiscible layers must be reported to the site supervisor or project manager. The project manager shall be notified immediately prior to continued activities.

Before obtaining water level elevations or initiating purge activities, obtain the following information in reference to the well to be sampled, and enter the applicable information on the sample collection log.

- Location code (well number)
- Previous purge volume (information only)
- Depth to top of screen (bailed wells only)
- Well sample number
- Report Identification Number (RIN)
- Sample event number

Record the location code (well number), date, sampling team members, visitors, well condition, and any other pertinent information on the sample collection log. Enter the well number, time well is opened, and other information regarding the field activities on the Field Activity Daily Log.

The field instruments shall be standardized (to check calibration) and the results recorded on the sample collection form.

Measure the depth to the top of the water column and the total depth of the well in order to determine the height of the water column in the well. Calculate the well casing volume using the well casing inner diameter and the height of the water column in the well. The formula for calculating the volume in gallons of water in the well casing is as follows:

$(\pi r^2 h)\ 7.481$ = gallons; where

$\pi = 3.142$

r = inside radius of the well pipe in feet

h = linear feet of water in well

7.481 = gallons per cubic foot of water

1 gallon = 3785 ml

Calculations of the volume of water in typical well casings may be done as follows:

a. 2" diameter well:

0.16 gal./ft x (linear ft of water) = gallons of water

b. 4" diameter well:

0.65 gal./ft x (linear ft of water) = gallons of water

c. 3/4" diameter well:

87 ml./ft x (linear ft of water) = milliliters of water

4.6.1 Purging Duration

Purging shall be considered complete if any of the following conditions are met.

1. Purging is complete if at least three casing volumes of water are removed from the well, and the last three consecutive pH, specific conductance, and temperature measurements do not deviate by more than the following: 1) pH = ±0.1 pH units; 2) Specific Conductance = ±10% and; 3) temperature ±0.5°C. A turbidity measurement will be taken for every other purge sample for wells that are purged using a bailer. For wells that are equipped with a dedicated bladder pump, the turbidity will be measured each time the parameters are taken. The purge rate should be such that the turbidity is maintained at 5 NTU units or less (if possible). If the readings are not stabilized after three volumes, continue purging until stabilization or until five volumes have been removed. Field parameter measurements shall be collected after every half-casing volume (approximate) is removed from the well. When casing volumes are less than 1-liter, parameter measurements will be collected after each whole casing volume is removed. If readings do not stabilize after five well volumes have been recovered, obtain additional guidance from the project manager concerning the proper course of action.
2. A well is considered dewatered when only a few milliliters of water (or none) can be recovered each time the bailer is lowered into the well. When this occurs, a 10-minute recharge rate will be calculated (linearly). If, at the end of the 10-minute period, the well has not recovered sufficiently to continue the purge in thirty minutes, the purge is considered completed. If, at the end of the 10-minute period, there is sufficient water to collect the VOA samples, the samples may be collected at that time. If the well has not recovered sufficient water during the 10 minutes, and depending upon the well history, the samplers may elect to return to the well the same day (preferably within two hours), check the water level, and collect the VOA samples (first), and other samples as feasible. If the sample team cannot return the same day, the well will be checked in 24 hours to determine if sample collection is feasible. If an extended period of time is required to collect samples, the procedures in Subsection 4.8.1 shall be followed. The well will not require an additional purge before sampling.

Wells that dewater (have a slow recharge rate as specified in 2 above) will not be restricted by parameter stabilization requirements. Sampling of these wells will follow the protocol established in Subsection 4.8.

4.6.2 Purging Methods

Wells will be purged by either bailing or pumping. When purging a well, the rate of water withdrawal during purging should not exceed the rate of withdrawal at which the well was developed (if known). All purge times (initiation and completion) and the rate of purging will be recorded on the field log sheets.

4.6.2.1 Bailing

Generalized procedures for purging a well with a bailer are as follows.

- Prepare the sampling site as discussed in Subsection 4.4. Use properly decontaminated equipment to determine the static water level of the well. Measure the total depth of the well. Use this information to determine the volume of water in the well casing.

- Decontaminate all dedicated bailers prior to initiating purging as described in Subsection 4.3 of this procedure.
- Use a mechanical reel equipped with Teflon® coated stainless steel cable attached to a bailer for bailing and sampling operations. Lower the bailer slowly into the well until water is encountered. Minimize agitation of the well water. Avoid lowering the bailer to the bottom of the well so sediments accumulated in the bottom do not become suspended. For wells that dewater, do not allow the bailer to strike the well bottom with force. Raise and lower the bailer carefully to limit surge energy and ensure that cable does not come in contact with any potentially contaminated surfaces. Do not allow the cable to drag along the well casing or against other objects that will cause fraying. Monitor the amount of water purged.

Wells with significant levels of contamination may have dedicated bailers installed. Dedicated bailer systems shall consist of a Teflon® bailer with check valve or double check valve for DNAPLS and a 5-foot leader of Teflon® coated stainless steel cable. Bailer sampling attachments and the stainless steel reel cable will not be dedicated to individual wells.

Dedicated bailers will be decontaminated at the conclusion of sampling activities and suspended from the well cap above the high water table. If the well interval above the high water table is not adequate to allow for storage in the casing, the dedicated bailers will be stored in labeled and sealed plastic bags at the equipment trailer.

4.6.2.2 Pumping

Pump designs that meet the following criteria are allowed for purging.

- The pump is constructed of a material that does not introduce a source of contamination to the well.
- The pump drive system does not introduce a source of contamination into the well.
- All downhole parts to the pump can be easily decontaminated.
- A return check system that does not allow pumped water to return to the well is integral in the pump design.
- The pump is easily used and does not require excessive amounts of time to install, use, remove, and decontaminate.

The pumps currently in use to purge groundwater include peristaltic pumps and dedicated submersible bladder pumps. A procedure for the use of each style of pump is specific to its applications. User manuals, which accompany each pump, shall be referenced for operating procedures.

Basic operating procedures common to all pumps are as follows.

- Prepare the sampling site as described in Subsection 4.4 regardless of the type of pump being used.
- Use properly decontaminated equipment to determine the static water level and the total depth of the well. This information is utilized to determine the volume of water in the well casing.

- For wells with dedicated pumps, calculate the minimum purge volume using the pump storage volume and the volume of the discharge tubing. A total depth of a 2-inch well cannot be taken without the removal of the pump.
- Position a dedicated pump near the bottom of the well or according to the information on the well construction form. Monitor the discharge rates and the amount of water purged during purging. The pumping rate for purging can be higher than the pumping rate for sampling, however, the water level in the well should be monitored during purging to avoid excessive water level drawdown.
- Ensure that any tubing that enters the well casing is composed of inert material. Disposable silicon tubing will be used in the drive mechanism of peristaltic pumps and discarded after each well is purged. The air supply for all air-driven pumps (dedicated bladder pumps) will be free of oil (i.e., no hydrocarbon containing substances will be added to the compressor).

4.6.3 Disposition of Purge Water

All water removed from a well during sampling operations shall be collected either in a satellite container or the purge water collection container in the groundwater sampling vehicle. The water from these containers will then be transferred to another approved collection container on the sampling or project site. When the collection container is filled, or is near capacity, it will be transported for disposition or treatment in accordance with approved project plans.

4.7 Measurement of Field Parameters

The following field parameters will be measured during groundwater purging operations unless otherwise specified by the project manager or the approved project work plans.

Parameter	Relative Precision	Minimum Calibration
pH	0.01 pH units	Daily
Conductivity	10 μS/cm	Daily
Temperature	0.1 °C	Weekly
Total Alkalinity (unfiltered)	1 mg/l	None
Turbidity (photometric)	2 FTU (or NTU)	Specified purge samples (bailed wells) Daily (dedicated bladder pump wells)

The measuring equipment shall be stored and handled in a manner that will maintain the integrity of the equipment. Appropriate field manuals will accompany each instrument in the field. Each instrument will also be given an identification number. All logbook and field form references to individual instruments will refer to this number for ease of identification.

Field parameters will be measured at the following intervals.

- Conductivity, pH, temperature, and turbidity shall be measured from the first water removed from the well when initiating well purging procedures. For bailed wells, the initial bail of water will be carefully removed from the well and the water transferred to a sample beaker by decanting the bailer through a bottom control valve. For wells purged with a peristaltic pump, similarly collect the first water removed in a sample beaker and then measure parameters. For wells with dedicated pumps, measure the parameters of the first recovered water that is collected in the continuous sampler.

- During purging operations, conductivity, pH, and temperature shall be measured for every half-casing volume (one half of the initial casing volume as calculated on the sample collection log form) of water removed from the well (because of the accuracy of the graduated containers for the purge water, the purge volume will be estimated as close as feasible). For wells that have half volumes less than the volume of a sample bailer (approximately 1 liter), only measure parameters after each full casing volume of water is removed from the well. Turbidity will be measured on every other sample recovered for parameters for bailed wells, or wells purged with a peristaltic pump. All parameters, including turbidity, will be measured at predetermined intervals while purging wells with dedicated pumps.
- During purging, if a well is dewatered prior to the measurement of the final required set of parameters, then conductivity, pH, temperature, and turbidity shall be measured immediately before the start of sample collection. These parameters may be delayed until sampling is completed if, at the discretion of the sampling crew, the well recharge has provided insufficient water volume to collect all the samples and also measure parameters. If there is insufficient water for samples and field parameters, the parameters will not be measured.
- Total alkalinity measurements shall be collected only once upon completion of purging. For wells that do not dewater and sample collection proceeds to completion immediately after purging, alkalinity will be measured after the completion of all other final purge field parameters. Wells that dewater and require repeated visits for the collection of samples will have alkalinity measured subsequent to the collection of the sample for inorganic water chemistry. Alkalinity will not be measured if sufficient water is not available.
- For micro purged wells, a purge is considered completed when the parameters have stabilized.
- Whenever a method used to remove well water is changed, a set of field parameters shall be recorded from water removed with the new method.

4.8 Groundwater Sampling

Techniques used to withdraw groundwater samples from a well shall be based on consideration of the parameters of interest. The order of collection, collection techniques, choice of sample containers, preservatives, and equipment are all critical to ensuring that samples are not altered or contaminated. The preferred methods for collection of groundwater samples are either bailing and/or the use of bladder pumps.

Sites shall be prepared prior to sampling as described in Subsection 4.4. All necessary and appropriate information will be recorded on the sample collection log and on the Field Activity Daily Log.

4.8.1 Sample Collection

The following discussion involves collection of groundwater samples using bailers and peristaltic or bladder pumps. Regardless of the collection method, care shall be taken not to alter the chemical nature of the sample during the collection activity by agitating the sample or allowing prolonged contact with the atmosphere. To minimize the potential for altering the sample and to maximize the available water, the following sample collection sequence is preferred.

- Radiation Screening
- VOC
- Nitrate/Nitrite, as N
- Dissolved Metals – TAL, with Cs, Li, Sr, Sn, Mo, Si
- $^{239/240}$ Plutonium, ^{241} Americium
- $^{233/234}$U, ^{235}U, ^{238}U
- Gross alpha and beta
- $^{89/}$Strontium
- ^{137}Cesium
- $^{226.228}$Radium
- Tritium
- Total Metals – TAL, with Cs, Li, Sr, Sn, Mo, Si
- TDS, CL, F, SO^4, CO3, HCO^3
- TSS
- BNA
- Pesticides/PCB
- Cyanide
- Orthophosphate

VOC samples shall be collected first and as soon as possible after the well has been purged. If a well is purged using a peristaltic pump, then all other samples shall be collected prior to removing the pump from the well. The VOC sample will then be collected using a bailer.

For wells that dewater, if a sufficient volume of water for VOC sample collection has still not accumulated within 48 hours after the completion of purging, VOCs will not be collected for that well. Other samples may be collected using a maximum of five attempts to recover sufficient sample water for analysis. This procedure is discussed in the following paragraph.

The containers used for sample collection from poor producing wells may differ from those used for high yield wells in some instances due to constraints on obtaining enough sample to fill sample containers. In some instances smaller containers may be utilized, or analyte samples normally collected in separate containers may be combined into a single container. Well histories can be used to identify which wells may require a modified sample suite and an extended sampling period. These wells will initially be sampled for a period of 48 hours after the completion of purging, with the exception of VOC sample collection, which is discussed in the previous paragraphs. The completion of purging will be considered 0 hour. At the end of 48 hours, any partial sample will be measured. The accumulated sample will be compared to the minimum volume requirement identified in Table 1 and the allowed sample holding time. If the minimum volume requirement for the target analyte has not been achieved, then sampling may continue as determined from the well recharge history. All analyte samples that have only minimum sample volumes collected, and all uncollected samples will be documented on the sample collection log.

Table 1

Sample Containers and Preservatives for Groundwater Samples

Parameter	Minimum Container[1]	Preservative	Holding Time
Radiation Screen	120 ml poly	None	NA
VOC - CLP	3 – 40 ml amber glass	Cool to 4° C	4 Days
BNA	1 L amber glass	Cool to 4° C	7 Days
Pesticides/PCB	1 L amber glass	Cool to 4° C	7 Days
TSS	125 ml poly	Cool to 4° C	7 Days
TDS, Cl, F, SO_4, CO_3, HCO_3	1 L poly	Cool to 4° C	7 Days
Dissolved Metals - CLP, with Cs, Li, Sr, Sn, Mo, Si	1 L poly	*Filtered, HNO_3 to pH <2, Cool to 4° C	6 Months
TOC	125 ml poly	H_2SO_4 < pH2, Cool to 4° C	28 Days
COD	125 ml poly	H_2SO_4 < pH2, Cool to 4° C	28 Days
Total Metals - CLP with Cs, Li, Sr, Sn, Mo, Si	1 L poly	Unfiltered, HNO_3 to pH <2, Cool to 4° C	6 Months
Orthophosphate	250 ml poly	Filtered, Cool to 4° C	2 Days
Nitrate / Nitrite as N	250 ml poly	H_2SO_4 to pH <2, Cool to 4° C	28 Days
Cyanide	1 L poly	NaOH to pH >12, Cool to 4° C	14 Days
Gross Alpha / Beta	550 ml poly	HNO_3 to pH <2	6 Months
$^{233/234}U$, ^{235}U, ^{238}U	100 ml poly	Filtered, HNO_3 to pH <2	6 Months
$^{239/240}Pu$	1 L poly	HNO_3 to pH <2	6 Months
^{241}Am	1 L poly	HNO_3 to pH <2	6 Months
$^{89/90}Sr$	700 ml poly	Filtered, HNO_3 to pH <2	6 Months
$^{226/228}Ra$	750 ml poly	Filtered, HNO_3 to pH <2	6 Months
^{137}Cs	2.5 L poly	Filtered, HNO_3 to pH <2	6 Months

[1] The volume listed is the minimum amount required for analysis. Actual sample volumes may be slightly higher and some parameters may be combined in a single container.

* Some samples may not require filtering if taken from a well with a dedicated pump and turbidity of 5 NTU or less.

The order of sample collection may be changed at the discretion of the sampling team. Changes in the order shall be based on the predicted volume of water that will be recovered and the priority stated in the controlling document. The sampling team shall document their sample selections on the sample collection log.

Sample containers shall be stored away from sunlight and cooled to 4°C prior to filling. Immediately after collection, samples requiring cooling shall be cooled to 4°C. A chilled cooler shall be used as the storage container. Whenever a sample bottle that requires chilling is not being physically handled, it will be placed in the cooler to prevent heating or freezing, exposure to sunlight, and possible breakage.

VOC samples shall be collected using a bailer equipped with a bottom-decanting control valve or directly from the pump discharge line on wells equipped with bladder pumps. The procedures for collecting VOC samples are discussed in Subsections 4.8.1.1 and 4.8.1.2 of this procedure.

VOC vials shall never be filled and stored below capacity because of insufficient quantities of water in the well. Except for the VOC vials, adequate air space should be left in the sample bottles to allow for expansion.

Samples shall be placed in the appropriate containers and packed with ice in coolers as soon as practical. VOC samples will be stored in the cooler in an inverted position immediately after collection. When sampling is complete, the well cap shall be replaced and locked.

Sampling tools, instruments, and equipment shall be protected from sources of contamination before use and decontaminated after use as specified in Subsection 4.3. *Liquids from decontamination operations will be handled in accordance with the procedures in Subsection 4.6.3 of this procedure.* Sample containers shall also be protected from sources of contamination. Sampling personnel shall wear chemical-resistant gloves (e.g., nitrile) when handling samples, and the gloves will be disposed of between well sites.

4.8.1.1 Groundwater Sampling Using a Bailer

This subsection describes the use of a bailer for collecting groundwater samples that may be used to obtain physical, chemical, or radiological data.

A bailer attached to a Teflon® coated stainless steel cable is carefully lowered into the well. After filling within the well, the bailer is withdrawn by rewinding the bailer line, and the bailer contents are drained into the appropriate containers. Certain recommendations and/or constraints should be observed when using bailers for sampling groundwater monitoring wells, as follows.

- Use only bottom-filling Teflon® bailers or bailers made of other inert materials.
- Ensure that bailers are attached to a Teflon® coated stainless steel line that is pre-wound on a reel.
- Do not use bailers constructed with adhesive joints.
- Lower the bailer slowly to the interval from which the sample is to be collected.

VOC samples shall be collected using a bailer equipped with a bottom-decanting control valve. The first water through the valve assembly will be discarded into the purge water container. Vials will be filled by dispensing water through the control valve along the inside edge of the slightly tilted sample vial. Care shall be taken to eliminate aeration of the sample water. The vials will be filled beyond capacity so the resulting meniscus will produce an airtight seal when capped. The capped vial will be checked for trapped air by lightly tapping the vial in an inverted position. If air becomes trapped in the vial, the sample water shall be discarded, and the vial refilled. If two consecutive attempts to fill a VOC vial result in trapped air bubbles, the vial shall be discarded.

The remainder of the sampling water shall be collected in a stainless steel container from which the remaining sample bottles will be filled. Samples requiring filtration shall be filtered and then containerized.

4.8.1.2 Groundwater Sampling Using a Peristaltic Pump

Use of peristaltic pumps shall generally be limited to collecting sample aliquots for radionuclides, metals, and other species that are not subject to volatilization and degassing. Peristaltic pumps shall never be used to collect VOCs or other volatile species in routine wells, although such samples may be collected for special screening applications. All downhole tubing shall be Teflon® except in areas of special concern (e.g., where immiscible layers exist) where special tubing, such as stainless steel or Viton®, may be required. If so, the project manager will make this determination. Only the portion of tubing that is inserted into the mechanical drive shall be made of silicon. This drive portion of the tubing shall be discarded after each use.

4.8.1.3 Groundwater Sampling Using a Downhole Bladder Pump

Some wells are equipped with dedicated downhole bladder pumps for purging and sampling. These are wells that will normally produce an adequate amount of water during a single visit to complete the required sampling suite. The equipment required to purge and sample a well consists of a pump control unit, a portable air compressor, a continuous sampler for measuring the field parameters, and the necessary sample containers, graduated cylinders, and container(s) to collect the purge and excess water. The following precautions should be observed during the sampling operation.

- Locate the compressor used to power the pump downwind from the well to eliminate the contamination of equipment and samples with exhaust.
- If the flow-through cell will not maintain a full sample chamber (tends to drain back), then clean the check valve on the pump if it is fouled, or replace the pump.
- Calculate the minimum purge volume using the procedure in Section 4.6. Note that a purge is considered completed only when the groundwater parameters have stabilized.
- Upon completion of purging, initiate sampling with the collection of the VOC sample(s). The pump should operate with minimum interruptions while the full sample suite is collected. Allowing the pump to stop for an extended period of time will cause the water trapped in the discharge lines to equilibrate to ambient temperatures, which is not acceptable. During sampling, the pump can be slowed to any rate that allows efficient sampling while also maintaining stable field parameters.
- Measure groundwater parameters periodically during sample collection and record them on the sample collection log to document conditions during sampling.
- Because micropurging is the method used for sampling, adjust the flow rate to limit the drawdown in the well. Also adjust the rate such that the turbidity is below 5 NTU for sampling. If this criterion is met, the samples need not be filtered.
- Operate the pump, pump control unit, and the flow-through cell according to the manufacturer's recommendations.

4.8.1.4 Groundwater Sampling Using a Push Type Sampler

This portion of this procedure describes the use of a Geoprobe® Screen Point 15 Groundwater Sampler, or similar type equipment, for collecting groundwater samples at predetermined depths. These samples may be used to obtain physical, chemical, or radiological analyses.

A Geoprobe® Screen Point 15 Groundwater Sampler, or equivalent tool, is driven to a predetermined depth by a push type-sampling rig. The Screen Point 15 Groundwater Sampler is equipped with a 41-inch retractable screen and expendable drive point. It can then be partially or fully withdrawn (up to 41 inches) to expose a portion or the entire deployed well screen. After groundwater enters the exposed screen, a sample is collected using either the procedures in Subsection 4.8.1.1, Groundwater Sampling Using a Bailer, or in Section 4.8.1.2, Groundwater Sampling Using a Peristaltic Pump. Note that these samples are collected only for screening purposes because the sampling tool hole has not been completed as a well.

The method for obtaining QC samples using the push type-sampling tool is provided in Subsection 4.8.4.1 for groundwater sampling. Duplicate groundwater samples shall be collected only if there is enough water to collect two full suites of analytes without dewatering the annulus. If insufficient water is available for the collection of a planned QC sample, it shall be explained and documented in the field log book, and the project manager informed. If insufficient water is available for two full suites of analytes, it may be come necessary to prioritize the analyte list. The prioritization sequence should be described in the project-specific work plan.

4.8.2 Sample Filtering and Preservation

Samples for dissolved metals, Gross Alpha/Beta, $^{233/234}$Uranium, ^{235}Uranium, ^{238}Uranium, $^{89/90}$Strontium, ^{137}Cesium, ^{226}Radium, ^{228}Radium, and orthophosphate shall be filtered in the field at the well location during the sampling event through a disposable 0.45-micrometer membrane filter. If a peristaltic or bladder pump is used, a disposable filter may be attached directly to the sample delivery line so that the sample is filtered directly into the sample container as it exits the delivery line. Discharge pressure shall be gauged so it does not exceed 50 psi. Alternatively, sample water may be collected in a stainless steel container and filtered with a peristaltic pump. Before sample collection, 100 to 200 milliliters of sample water shall be passed through the filter in order to rinse the filter and filtration apparatus of possible contaminating substances.

Preservatives shall be added to the sample bottles prior to the introduction of the filtered sample water. The preservative shall be added in aliquots appropriate to the size of the bottle.

After sample collection has been completed, the pH of preserved samples shall be checked as follows.

- Pour a small amount of sample from the sample bottle directly onto approved pH paper. Use care so that the threaded neck of the bottle does not contact the pH paper. Do not, under any circumstances, insert the pH paper into the sample bottle.
- Check the pH paper against the supplied color chart. If the appropriate pH has not been achieved, add additional preservative to the sample in 5 ml aliquots and repeat the pH test after each addition.

4.8.3 QA/QC Samples

The frequency and types of field QA/QC samples collected during groundwater sampling are described in project-specific work plans or quality assurance plan documents. These documents detail the applicable criteria for collecting QA/QC samples.

4.8.3.1 Duplicates

Duplicate samples shall be collected only from wells that produce enough water to collect two full suites of analytes without dewatering. Wells that produce sufficient water shall be incorporated into the sampling program such that the required duplicate frequency can be maintained.

Wells scheduled for duplicate sample collection shall be sampled as described in Subsection 4.8 of this procedure, and in relevant sections of project-specific work plans and/or quality assurance documents. Field duplicates are collected following the same sampling procedures used to obtain the real samples. With the exception of VOCs, the typical procedure for a location is to collect the real and duplicate of each sample at the same time, in two equal portions, with each portion going to the laboratory in separate containers. This is accomplished by alternately filling two sample bottles one half at a time to minimize heterogeneity. Note that real and duplicate VOC samples shall be collected independently to reduce the possibility of volatilization of the sample.

When a well with a dedicated pump is being used for sample collection, all samples shall be collected in the normal order, with duplicate VOC samples being collected first. The remaining samples will be sampled as described above.

If a well is being used for matrix spike (MS) and matrix spike duplicate (MSD) samples, the duplicate shall be collected after collection of the MS and MSD.

All duplicate samples shall be given a sample number different from the original sample and the information recorded on the sample collection log and/or the field QC sample collection log.

4.8.3.2 Matrix Spike and Matrix Spike Duplicate

MS and MSD samples shall be collected only from wells that produce enough water to collect the required suites of analytes without dewatering. MS and MSD samples are not collected on a routine basis, but will be collected if so designated in a site-specific sampling plans, or if requested by the project manager.

MS and MSD samples shall be collected as follows.

- Purge the well as described in Subsection 4.6 of this procedure..
- After completion of purging, collect VOC samples. Collect the real sample followed by the MS and MSD. Collect these samples in immediate succession.
- Collect the remaining samples not requiring filtering. For each sample parameter, collect the original sample, MS, and MSD concurrently. Fill the original sample bottle one-third full followed by the MS and MSD sample bottles, which are also filled one-third full. Rotate each bottle in the sequence, filling in one-third full until all three bottles are full. For analytes not requiring an MSD, collect only the original sample and the MS.
- After the real sample, MS, and MSD (where appropriate) are collected for one parameter, repeat the process for the next parameter.
- Similarly, collect samples requiring filtering. When a bailer is used, fill a stainless steel bucket with sample water. As samples are collected and the reservoir of water in the bucket is depleted, add more water with discretion. When a pump is used, attach the filter directly to the discharge line. Fill

sample bottles as described above, partially filling the original sample, MS, and MSD in rotating sequence until each parameter bottle is full.

- Radiochemistry samples may have more than one bottle for each parameter group. In this case, include all required bottles in the rotating sequence.
- Field parameter measurements are not be required for MS and MSD samples.
- Retain the original sample number for MS and MSD samples. However, add a suffix of MS or MSD to the sample number to correspond with each QA/QC sample. Record all information on the field QC groundwater sample collection log.

4.8.3.3 Replicates and Splits

Replicate and split samples shall be collected in the same manner as described for the MS and MSD. Seek instruction from the project manager for replicates and splits exceeding three samples. Record all information will be recorded on the groundwater sample collection logs.

4.8.3.4 Field Equipment Rinses

Wells scheduled for equipment rinsate samples shall be sampled as described in Subsection 4.8 of this procedure, and field equipment rinses shall be collected as described in this Subsection and in relevant portions of project-specific QC documents and work plans. Field equipment rinses shall be collected in a manner designed to reflect sampling techniques. All equipment used during sampling will be fully decontaminated as described in Subsection 4.3, then rinsed with distilled or deionized water. The rinse water will then be collected in bottles identical to those used for the original sample, and assigned a separate sample number. Analytes requiring filtration will be filtered using a new filter and tubing as required for the real sample. All information will be recorded on groundwater sample collection logs.

4.8.3.4.1 Bailed Wells

After completion of sampling, all equipment shall be decontaminated. Prior to leaving the well location, the equipment rinse will then be collected as follows.

- Fill the bailer with distilled or deionized water by pouring the water into the top opening.
- Decant the rinse water to the VOC vials through the bottom valve just as was done during sample collection.
- For the remaining unfiltered samples, fill the bailer with distilled or deionized water each time additional rinsate is needed. Transfer the rinsate to sample bottles or to a stainless steel bucket and then to sample containers in the same manner used during collection.
- Collect filtered samples in an identical manner as the real samples. Fill the bailer with distilled or deionized water. Then transfer the rinse water to a stainless steel bucket. Filter the rinse water in the bucket through a new disposable filter.

- Preserve rinse samples in the same manner as the real samples.

4.8.3.4.2 Pumped Wells

Rinsate samples are not routinely collected from wells that are equipped with dedicated bladder pumps because the samples from these wells are collected directly from the pump discharge line. However, wells sampled using peristaltic pumps for sampling may be selected for rinsate sampling, with equipment used in sample collection (down hole tubing, filter tubing and the stainless steel bucket used for sample water collection, etc.) being decontaminated prior to rinsate sampling. The tubing at the pump head will be replaced, and a new filter used for filtered analytes. To collect the samples, distilled or deionized water will be poured into the decontaminated stainless steel bucket and pumped, using the decontaminated tubing, into the sample containers. The equipment used to collect the real VOC samples will also be decontaminated, rinsed, and used to collect the VOC rinse samples. All samples will be preserved at the same pH levels as the real samples.

4.8.3.5 Distilled Water Blanks

Distilled water sample blanks are not submitted on a routine basis, but will be made up if so designated in a site-specific sampling plan. Samples of the distilled or deionized water used for the final decontamination of equipment will be transferred directly to sample bottles to determine any baseline contamination the water may have introduced into the samples. Five-gallon bottles of the distilled or deionized water will be opened in a controlled area, such as the bottle storage room, and then poured directly into the appropriate sample bottle. A Teflon®, glass, or stainless steel funnel may be used to help control flows into small mouth bottles. Blank samples will be preserved to the appropriate pH required for each analyte. All information will be recorded on groundwater sample collection logs.

4.9 Sample Handling and Control

Pre-cleaned sample containers will be obtained from a contract analytical sample container source. Preserving solution will be added to the bottles by a laboratory, the sample manager or qualified sampling personnel. The bottles will be labeled to indicate the preservative added.

The sampling containers, preservation requirements, and holding times for the various types of analyses are shown in Table 1. Groundwater samples will be properly labeled so that they can be easily identified. The sample numbering system will be assigned by project-specific sampling plan documents. A sample identification (ID) number will be assigned to each sample suite. The sample ID number will contain the following information as part of a nine to twelve character, alpha-numeric code:

Character(s)	Description	Code
1 and 2	Project ID	GW
3 through 7	Sample Number	00001 to 99999
8 and 9	Subcontractor ID	Alpha (e.g. TE = Tierra Environmental Consultants)
10, 11, and 12	QA/QC	MS for matrix spike, MSD for matrix spike duplicate

In addition to a sample number, each well sampled will be assigned a current Record Identification Number (RIN), an event number (specific to the RIN), and bottle numbers that are specific to the RIN and event number.

5.0 Records

All field activities shall be recorded on a Field Activity Daily Log or Groundwater Sample Collection Log. Additional logs may be required to record QC samples and for recording well status. Refer to specific project, site, or facility work plans for further information. Summary information of the day's activities or other pertinent information should always be recorded on the field forms. Under some circumstances, the project manager may assign a bound field logbook to the field personnel that will remain in their custody during all sampling activities. The cover of each logbook shall contain the following information at a minimum:

- Name of the organization to which the book is assigned
- Book number
- Project name
- Start and end dates

Logbook pages shall be sequentially numbered and marked with the book number before any data are recorded. All data and information pertinent to field sampling shall be recorded in the logbook or on the field forms that identify all required data entries. Enough detail must be included in the documentation to reconstruct the sampling event. Field form entries shall include the following minimum information:

- Date and time
- Names of field personnel
- Names of all visitors
- Location of field activities
- Description of sampling sites including weather conditions
- All field observations and comments
- Field parameters
- Sample identification information
- References to all prepared field activity forms and chain-of-custody records

Field logbooks, when required on specific projects, shall normally be kept only by the field sampling team leaders and the site supervisor and shall typically be used only to summarize field activities and to document project information not required by the procedure field forms.

Permanent ink shall be used for all entries in the logbooks and on the field forms. Mistakes shall be crossed out with a single line, initialed, and dated. Unused pages or partial pages shall be voided by drawing a line through the blank sections and initialing and dating the mark. Any deviation from this procedure shall require documentation in the site supervisor's logbook.

The field activity daily log narrative should create a chronological record of the sampling team's activities, including the time and location of each activity. Descriptions of problems encountered, personnel contacted, deviations from the procedure, and visitors on site shall also be included. The weather conditions, date, signature of the person responsible for entries, and the number of field activity daily log sheets used to record media team activities for a given day shall also be included.

The Groundwater Levels Measurement/Calculations Form and the Chain of Custody Record (see *Containing, Preserving, Handling, and Shipping Soil and Water Samples*) shall also be completed for each site. All blank fields on the forms must be completed or voided.

6.0 References

Environmental Protection Agency, 1982, Test Methods for Evaluating Solid Waste, SW-846, Volume II. Field Methods, 2nd edition.

Environmental Protection Agency, 1986a, Engineering Support Branch Standard Operating Procedures and Quality Assurance Manual, EPA Region IV Environmental Service Division.

Environmental Protection Agency, September 1986b, RCRA Ground Water Monitoring Technical Enforcement Guidance Document, OSWER-9950.1.

Environmental Protection Agency, 1987a, A Compendium of Superfund Field Operations Methods, EPA/540/P-87/001. 1987.

Environmental Protection Agency, 1987b, Data Quality Objectives for Remedial Activities, Development Process, EPA/540/G-87/003.

Environmental Protection Agency, December 1988, User's Guide to the Contract Laboratory Program.

APPENDIX A

STANDARD GROUNDWATER FORMS

Appendix B
Sample Collection Forms

SM Stoller Corp.

105 Technology Dr., Suite 190
Broomfield, CO 80021
(303) 546-4300

Project Name: Colorado School of Mines	Sample Location: CSMRI-1
Project Number: 4107-510	Date: 3/17/09
Sample Type: [✓ GW] SW EB Duplicate Other:	Sampler: V Malczyk

Purge Volume Calculations		
Measured TD =	24.93 (+.28)	(ft)
Total Depth =	25.21	(ft)
Depth to Water =	8.28	(ft)
Initial Water Column =	16.93	(ft)
Initial Water Volume =	2.70	(gal)
3 X Water Volume	8.10	(gal)

Sample Collection

Analysis	Container	Preservative	Date	Time	
Ra-226 Ra-228 Diss. U	1 gal cube	HNO_3	3/17/09	1445	
NO_2 / NO_3	1L Plastic	—	3/17/09	1445	TA
Cations Ca, Mg, K, Na	500mL Plastic	HNO_3	3/17/09	1445	
Anions	500mL Plastic	—	3/17/09	1445	

Lab: Paragon-Fort Collins, Test America - Arvada

Purge Volumes and Field Water Quality Measurements

Time	Volume (gal)	Temperature ([✓ °C]/°F)	pH (SU)	Conductivity (uS/cm)	DO (mg/L)	ORP (mV)	Turbidity (NTU)	Appearance
1419	1.35	8.55	8.79	408	12.28	149	222	brown
1422	2.70	7.25	8.28	429	10.29	162	315	↓
1424	4.05	6.95	7.84	445	9.10	175	317	
1426	5.40	7.32	7.66	504	8.03	177	375	
1428	[illegible].75	6.81	7.68	427	8.98	174	425	
1431	[illegible]10	7.09	7.55	473	7.96	177	449	↓

Volume purged: 8.1 gal

	Analysis	Container	Preservative	Date	Time
Comments:	Diss. Phosphorus	250mL Plastic	H_2SO_4	3/17/09	1445
	TOC	125mL Amber	H_2SO_4	3/17/09	1445
TA	Ferric Fe	500mL Plastic	HNO_3	3/17/09	1445
TA	Ferrous Fe	1L Plastic	—	3/17/09	1445

SM Stoller Corp.

105 Technology Dr., Suite 190
Broomfield, CO 80021
(303) 546-4300

Project Name: Colorado School of Mines	Sample Location: CSMRI-1B
Project Number: 4107-510	Date: 3/16/09, 3/17/09, 3/18/09
Sample Type: [✓ GW] SW EB Duplicate Other:	Sampler: V Malczyk

Purge Volume Calculations

Measured TD =	23.40 (+.28)	(ft)
Total Depth =	23.68	(ft)
Depth to Water =	21.31	(ft)
Initial Water Column =	2.37	(ft)
Initial Water Volume =	0.38	(gal)
3 X Water Volume	1.14	(gal)

Sample Collection

Analysis	Container	Preservative	Date	Time
Ra-226 Ra-228 Diss. U	1 gal cube	HNO_3	3/18/09	1230
~~NO_2/NO_3~~	~~1L Plastic~~	~~—~~	~~3/ /09~~	TA vrm
~~Cations Ca, Mg, K, Na~~	~~500mL Plastic~~	~~HNO_3~~	~~3/ /09~~	vrm
~~Anions~~	~~500mL Plastic~~	~~—~~	~~3/ /09~~	vrm

Lab: Paragon - Fort Collins, Test America - Arvada

Purge Volumes and Field Water Quality Measurements

Time	Volume (gal)	Temperature [✓ °C] ~~°F~~ vrm	pH (SU)	Conductivity (uS/cm)	DO (mg/L)	ORP (mV)	Turbidity (NTU)	Appearance
1039	0.38	~~52.8~~ vrm	7.51	~~1264~~ 930 vrm	6.36	-27	681	brown
	0.76	11.78						
	1.14							
								vrm

Volume purged: 0.55 gal

Comments:

Analysis	Container	Preservative	Date	Time
~~Diss. Phosphorus~~	~~250mL Plastic~~	~~H_2SO_4~~	~~3/ /09~~	vrm
~~TOC~~	~~125mL Amber~~	~~H_2SO_4~~	~~3/ /09~~	vrm
~~TA Ferric Fe~~	~~500mL Plastic~~	~~HNO_3~~	~~3/ /09~~	vrm
~~TA Ferrous Fe~~	~~1L Plastic~~	~~—~~	~~3/ /09~~	vrm

There was insufficient water to collect all of the samples

·930, 11.78

SM Stoller Corp.

105 Technology Dr., Suite 190
Broomfield, CO 80021
(303) 546-4300

Project Name: Colorado School of Mines	Sample Location: CSMRI-2
Project Number: 4107-510	Date: 3/16/09, 3/18/09
Sample Type: [✓ GW] SW EB Duplicate Other:	Sampler: V Malczyk

Purge Volume Calculations		
Measured TD =	95.10 (+.28)	(ft)
Total Depth =	95.38	(ft)
Depth to Water =	68.40	(ft)
Initial Water Column =	26.98	(ft)
Initial Water Volume =	4.32	(gal)
3 X Water Volume	12.96	(gal)

Sample Collection

Analysis	Container	Preservative	Date	Time	
Ra-226 Ra-228 Diss. U	1 gal cube	HNO_3	3/18/09	1300	
NO_2/ NO_3	1L Plastic	—	3/18/09	1300	TA
Cations Ca, Mg, K, Na	500mL Plastic	HNO_3	3/18/09	1300	
Anions	500mL Plastic	—	3/18/09	1300	

Lab: Paragon-Fort Collins, Test America - Arvada

Purge Volumes and Field Water Quality Measurements

Time	Volume (gal)	Temperature ([✓ °C] ~~°F~~) vem	pH (SU)	Conductivity (uS/cm)	DO (mg/L)	ORP (mV)	Turbidity (NTU)	Appearance
1342	2.16	14.87	7.82	412	2.16	122	238	brown
1351	4.32	14.00	7.91	374	2.21	120	1000+	↓
1357	6.48	~~15.18~~ 13.89	~~7.77~~ 7.77	399	7.53	~~135~~ 134	1000+	
1406	8.64	13.84	7.78	403	2.51	131	1000+	
	10.80							
	12.96							

vem

Volume purged: 8.64 gal

Comments:

Analysis	Container	Preservative	Date	Time
Diss. Phosphorus	250mL Plastic	H_2SO_4	3/18/09	1300
TOC	125mL Amber	H_2SO_4	3/18/09	1300
~~TA Ferric Fe~~	~~500mL Plastic~~	~~HNO_3~~	~~3/ /09~~ vem	
~~TA Ferrous Fe~~	~~1L Plastic~~	~~—~~	~~3/ /09~~ vem	

Well went dry at 8.64 gallons

SM Stoller Corp.

105 Technology Dr., Suite 190
Broomfield, CO 80021
(303) 546-4300

Project Name: Colorado School of Mines	Sample Location: CSMRI - 4
Project Number: 4107-510	Date: 3/17/09
Sample Type: [✓ GW] SW EB Duplicate Other:	Sampler: V Malczyk

Purge Volume Calculations		
Measured TD =	17.29 (+.28)	(ft)
Total Depth =	17.57	(ft)
Depth to Water =	7.36	(ft)
Initial Water Column =	10.21	(ft)
Initial Water Volume =	1.64	(gal)
3 X Water Volume	4.92	(gal)

Sample Collection

Analysis	Container	Preservative	Date	Time	
Ra-226 Ra-228 Diss. U	1 gal cube	HNO_3	3/17/09	1115	
NO_2 / NO_3	1L Plastic	—	3/17/09	1115	TA
Cations Ca, Mg, K, Na	500mL Plastic	HNO_3	3/17/09	1115	
Anions	500mL Plastic	—	3/17/09	1115	

Lab: Paragon - Fort Collins, Test America - Arvada

Purge Volumes and Field Water Quality Measurements

Time	Volume (gal)	Temperature (°C, °F)	pH (SU)	Conductivity (uS/cm)	DO (mg/L)	ORP (mV)	Turbidity (NTU)	Appearance
1103	1.64	7.54	7.66	1380	6.00	156	222	brown
1106	3.28	7.52	7.57	892	3.65	158	101	↓
1110	4.92	7.53	7.08	889	3.29	160	105	↓
								NA

Volume purged: 5 gallons

	Analysis	Container	Preservative	Date	Time
Comments:	Diss. Phosphorus	250mL Plastic	H_2SO_4	3/17/09	1115
	TOC	125mL Amber	H_2SO_4	3/17/09	1115
TA	Ferric Fe	500mL Plastic	HNO_3	3/17/09	1115
TA	Ferrous Fe	1L Plastic	—	3/17/09	1115

SM Stoller Corp.

105 Technology Dr., Suite 190
Broomfield, CO 80021
(303) 546-4300

Project Name: Colorado School of Mines	Sample Location: CSMRI-5
Project Number: 4107-510	Date: 3/17/09
Sample Type: [✓ GW] SW EB Duplicate Other:	Sampler: N Malczyk

Purge Volume Calculations

Measured TD =	10.98 ~~16.97~~ (+.28)	(ft)
Total Depth =	11.26 ~~17.25~~	(ft)
Depth to Water =	7.05	(ft)
Initial Water Column =	4.21	(ft)
Initial Water Volume =	0.68	(gal)
3 X Water Volume	2.04	(gal)

Sample Collection

Analysis	Container	Preservative	Date	Time	
Ra-226 Ra-228 Diss. U	1 gal cube	HNO_3	3/17/09	1215	
NO_2 / NO_3	1L Plastic	—	3/17/09	1215	TA
Cations Ca, Mg, K, Na	500mL Plastic	HNO_3	3/17/09	1215	
Anions	500mL Plastic	—	3/17/09	1215	

Lab: Paragon - Fort Collins, Test America - Arvada

Purge Volumes and Field Water Quality Measurements

Time	Volume (gal)	Temperature (°C, ~~°F~~) NCM	pH (SU)	Conductivity (uS/cm)	DO (mg/L)	ORP (mV)	Turbidity (NTU)	Appearance
1200	0.68	8.76	7.85	872	9.58	168	740	brown
1202	1.36	7.76	7.74	835	7.73	169	959	↓
1205	2.04	7.68	7.41	1170	6.59	150	650	↓
								NCM

Volume purged: 2.04 gallons

Comments:

	Analysis	Container	Preservative	Date	Time
	Diss. Phosphorus	250mL Plastic	H_2SO_4	3/17/09	1215
	TOC	125mL Amber	H_2SO_4	3/17/09	1215
TA	Ferric Fe	500mL Plastic	HNO_3	3/17/09	1215
TA	Ferrous Fe	1L Plastic	—	3/17/09	1215

SM Stoller Corp.

105 Technology Dr., Suite 190
Broomfield, CO 80021
(303) 546-4300

Project Name: Colorado School of Mines	Sample Location: CSMRI-6C
Project Number: 4107-510	Date: 3/16/09
Sample Type: [✓ GW] SW EB Duplicate Other:	Sampler: N Malczyk

Purge Volume Calculations		
Measured TD =	29.94 (+.28)	(ft)
Total Depth =	30.22	(ft)
Depth to Water =	DRY	(ft)
Initial Water Column =		(ft)
Initial Water Volume =		(gal)
3 X Water Volume	NZM	(gal)

Sample Collection

Analysis	Container	Preservative	Date	Time
Ra-226 Ra-228 Diss. U	1 gal cube	HNO_3	3/—/09	—
NO_2/ NO_3	1L Plastic	—	3/—/09	—
Cations Ca, Mg, K, Na	500mL Plastic	HNO_3	3/—/09	—
Anions	500mL Plastic	—	3/—/09	—

TA

Lab: Paragon-Fort Collins, Test America - Arvada

Purge Volumes and Field Water Quality Measurements

Time	Volume (gal)	Temperature (°C, [✓ °F])	pH (SU)	Conductivity (uS/cm)	DO (mg/L)	ORP (mV)	Turbidity (NTU)	Appearance
								NZM

Volume purged: N/A

	Analysis	Container	Preservative	Date	Time
Comments:	Diss. Phosphorus	250mL Plastic	H_2SO_4	3/—/09	—
	TOC	125mL Amber	H_2SO_4	3/—/09	—
TA	Ferric Fe	500mL Plastic	HNO_3	3/—/09	—
TA	Ferrous Fe	1L Plastic	—	3/—/09	—

SM Stoller Corp.

105 Technology Dr., Suite 190
Broomfield, CO 80021
(303) 546-4300

Project Name: Colorado School of Mines	Sample Location: CSMRI-7B
Project Number: 4107-510	Date: 3/16/09
Sample Type: [✓ GW] SW EB Duplicate Other:	Sampler: N Malczyk

Purge Volume Calculations			Sample Collection				
			Analysis	Container	Preservative	Date	Time
Measured TD =	16.82 (+.28)	(ft)	Ra-226 Ra-228 Diss. U	1 gal cube	HNO_3	3/—/09	—
Total Depth =	17.10	(ft)					
Depth to Water =	DRY	(ft)	NO_2/ NO_3	1L Plastic	—	3/—/09	—
Initial Water Column =	—	(ft)	Cations Ca, Mg, K, Na	500mL Plastic	HNO_3	3/—/09	—
Initial Water Volume =	—	(gal)	Anions	500mL Plastic	—	3/—/09	—
3 X Water Volume		(gal)	Lab: Paragon-Fort Collins, Test America - Arvada				

TA

Purge Volumes and Field Water Quality Measurements

Time	Volume (gal)	Temperature (°C, [✓ °F])	pH (SU)	Conductivity (uS/cm)	DO (mg/L)	ORP (mV)	Turbidity (NTU)	Appearance
								NM

Volume purged: N/A

	Analysis	Container	Preservative	Date	Time
Comments:	Diss. Phosphorus	250mL Plastic	H_2SO_4	3/—/09	—
	TOC	125mL Amber	H_2SO_4	3/—/09	—
TA	Ferric Fe	500mL Plastic	HNO_3	3/—/09	—
TA	Ferrous Fe	1L Plastic	—	3/—/09	—

SM Stoller Corp.

105 Technology Dr., Suite 190
Broomfield, CO 80021
(303) 546-4300

Project Name: Colorado School of Mines	Sample Location: CSMRI-8
Project Number: 4107-510	Date: 3/17/09, 3/18/09
Sample Type: [✓ GW] SW EB Duplicate Other:	Sampler: N Malczyk

Purge Volume Calculations		
Measured TD =	17.06 (+.28)	(ft)
Total Depth =	17.34	(ft)
Depth to Water =	8.80	(ft)
Initial Water Column =	8.54	(ft)
Initial Water Volume =	1.36	(gal)
3 X Water Volume	4.08	(gal)

Sample Collection

Analysis	Container	Preservative	Date	Time	
Ra-226 Ra-228 Diss. U	1 gal cube	HNO_3	3/18/09	1200	
NO_2 / NO_3	1L Plastic	—	3/18/09	1200	TA
Cations Ca, Mg, K, Na	500mL Plastic	HNO_3	3/18/09	1200	
Anions	500mL Plastic	—	3/18/09	1200	

Lab: Paragon - Fort Collins, Test America - Arvada

Purge Volumes and Field Water Quality Measurements

Time	Volume (gal)	Temperature [✓ °C] ~~°F~~	pH (SU)	Conductivity (uS/cm)	DO (mg/L)	ORP (mV)	Turbidity (NTU)	Appearance
1028	1.36	7.69	6.99	2036	6.55	204	1000+	brown
1030	2.72	7.76	7.42	2320	6.71	194	1000+	↓
	4.08							

Volume purged: 3.0 gal

Comments:	Analysis	Container	Preservative	Date	Time
	Diss. Phosphorus	250mL Plastic	H_2SO_4	3/18/09	1200
	TOC	125mL Amber	H_2SO_4	3/18/09	1200
TA	Ferric Fe	500mL Plastic	HNO_3	3/18/09	1200
TA	Ferrous Fe	1L Plastic	—	3/18/09	1200

SM Stoller Corp.

105 Technology Dr., Suite 190
Broomfield, CO 80021
(303) 546-4300

Project Name: Colorado School of Mines	Sample Location: CSMRI-~~10~~ 9 ncm
Project Number: 4107-510	Date: 3/16/09
Sample Type: [✓ GW] SW EB Duplicate Other:	Sampler: N Malczyk

Purge Volume Calculations

Measured TD =	33.01 (+.28)	(ft)
Total Depth =	33.29	(ft)
Depth to Water =	27.72	(ft)
Initial Water Column =	5.57	(ft)
Initial Water Volume =	0.90	(gal)
3 X Water Volume	2.70	(gal)

Sample Collection

Analysis	Container	Preservative	Date	Time	
Ra-226 Ra-228 Diss. U	1 gal cube	HNO_3	3/16/09	1540	
NO_2/NO_3	1L Plastic	—	3/16/09	1540	TA
Cations Ca, Mg, K, Na	500mL Plastic	HNO_3	3/16/09	1540	
Anions	500mL Plastic	—	3/16/09	1540	

Lab: Paragon-Fort Collins, Test America - Arvada

Purge Volumes and Field Water Quality Measurements

Time	Volume (gal)	Temperature (°C) ~~(°F)~~ ncm	pH (SU)	Conductivity (uS/cm)	DO (mg/L)	ORP (mV)	Turbidity (NTU)	Appearance
1104	0.90	12.72	7.79	750	4.23	73	582	brown
1109	1.80	13.15	7.54	732	4.13	84	1000 +	↓
1114	2.70	13.27	7.50	725	4.33	97	1000+	↓

Volume purged: 2.70 gal

Comments:

	Analysis	Container	Preservative	Date	Time
	Diss. Phosphorus	250mL Plastic	H_2SO_4	3/16/09	1540
	TOC.	125mL Amber	H_2SO_4	3/16/09	1540
~~TA~~	~~Ferric Fe~~	~~500mL Plastic~~	~~HNO_3~~	~~3/ /09~~	ncm
~~TA~~	~~Ferrous Fe~~	~~1L Plastic~~	~~—~~	~~3/ /09~~	ncm

SM Stoller Corp.

105 Technology Dr., Suite 190
Broomfield, CO 80021
(303) 546-4300

Project Name: Colorado School of Mines	Sample Location: CSMRI-10
Project Number: 4107-510	Date: 3/16/09
Sample Type: [✓ GW] SW EB Duplicate Other:	Sampler: V Malczyk

Purge Volume Calculations		
Measured TD =	27.26 (+.28)	(ft)
Total Depth =	27.54	(ft)
Depth to Water =	2477	(ft)
Initial Water Column =	2.77	(ft)
Initial Water Volume =	.44	(gal)
3 X Water Volume	1.32	(gal)

Sample Collection

Analysis	Container	Preservative	Date	Time	
Ra-226 Ra-228 Diss. U	1 gal cube	HNO_3	3/16/09	1600	
NO_2 / NO_3	1L Plastic	—	3/16/09	1600	TA
Cations Ca, Mg, K, Na	500mL Plastic	HNO_3	3/16/09	1600	
Anions	500mL Plastic	—	3/16/09	1600	

Lab: Paragon-Fort Collins, Test America - Arvada

Purge Volumes and Field Water Quality Measurements

Time	Volume (gal)	Temperature [✓ °C] ~~°F~~ vem	pH (SU)	Conductivity (uS/cm)	DO (mg/L)	ORP (mV)	Turbidity (NTU)	Appearance
1136	0.44	12.22	7.77	680	6.22	106	1000+	brown
1138	0.88	11.89	7.70	697	6.36	112	1000+	↓
1141	1.32	11.89	7.64	692	5.79	104	1000+	
								vem

Volume purged: 1.32 gal

Comments:

	Analysis	Container	Preservative	Date	Time
	Diss. Phosphorus	250mL Plastic	H_2SO_4	3/16/09	1600
	TOC	125mL Amber	H_2SO_4	3/16/09	1600
~~TA~~	~~Ferric Fe~~	~~500mL Plastic~~	~~HNO_3~~	~~3/ /09~~	vem
~~TA~~	~~Ferrous Fe~~	~~1L Plastic~~	~~—~~	~~3/ /09~~	vem

SM Stoller Corp.

105 Technology Dr., Suite 190
Broomfield, CO 80021
(303) 546-4300

Project Name: Colorado School of Mines

Sample Location: CSMEI-11B

Project Number: 4107-510

Date: 3/16/09

Sample Type: [✓ GW] SW EB Duplicate Other:

Sampler: N Malczyk

Purge Volume Calculations

Measured TD =	28.55 (+.28)	(ft)
Total Depth =	28.83	(ft)
Depth to Water =	DRY	(ft)
Initial Water Column =	—	(ft)
Initial Water Volume =	—	(gal)
3 X Water Volume		(gal)

Sample Collection

Analysis	Container	Preservative	Date	Time	
Ra-226 Ra-228 Diss. U	1 gal cube	HNO_3	3/–/09	—	
NO_2 / NO_3	1 L Plastic	—	3/–/09	—	TA
Cations Ca, Mg, K, Na	500mL Plastic	HNO_3	3/–/09	—	
Anions	500mL Plastic	—	3/–/09	—	

Lab: Paragon - Fort Collins, Test America - Arvada

Purge Volumes and Field Water Quality Measurements

Time	Volume (gal)	Temperature (°C, [✓ °F])	pH (SU)	Conductivity (uS/cm)	DO (mg/L)	ORP (mV)	Turbidity (NTU)	Appearance
								N/A

Volume purged: N/A

Comments:

	Analysis	Container	Preservative	Date	Time
	Diss. Phosphorus	250mL Plastic	H_2SO_4	3/–/09	—
	TOC	125mL Amber	H_2SO_4	3/–/09	—
TA	Ferric Fe	500mL Plastic	HNO_3	3/–/09	—
TA	Ferrous Fe	1L Plastic	—	3/–/09	—

SM Stoller Corp.

105 Technology Dr., Suite 190
Broomfield, CO 80021
(303) 546-4300

Project Name: Colorado School of Mines	Sample Location: SW-1
Project Number: 4107-510	Date: 3/16/09
Sample Type: GW [✓ SW] EB Duplicate Other:	Sampler: N Malczyk

Purge Volume Calculations		
Measured TD =	(+.28)	(ft)
Total Depth =		(ft)
Depth to Water =		(ft)
Initial Water Column =	nm	(ft)
Initial Water Volume =		(gal)
3 X Water Volume		(gal)

Sample Collection				
Analysis	Container	Preservative	Date	Time
Ra-226 Ra-228 Diss. U	1 gal cube	HNO_3	3/16/09	1515
NO_2 / NO_3	1L Plastic	—	3/16/09	1515
Cations Ca, Mg, K, Na	500mL Plastic	HNO_3	3/16/09	1515
Anions	500mL Plastic	—	3/16/09	1515
Lab: Paragon - Fort Collins, Test America - Arvada				

TA

Purge Volumes and Field Water Quality Measurements

Time	Volume (gal)	Temperature [✓ C] ~~F~~ nm	pH (SU)	Conductivity (uS/cm)	DO (mg/L)	ORP (mV)	Turbidity (NTU)	Appearance
1446	n/a	7.94	9.41	252	9.68	~~111~~ nm 115	86.2	cloudy
								nm

Volume purged: n/A

	Analysis	Container	Preservative	Date	Time
Comments:	Diss. Phosphorus	250mL Plastic	H_2SO_4	3/16/09	1515
	TOC	125mL Amber	H_2SO_4	3/16/09	1515
~~TA~~	~~Ferric Fe~~	~~500mL Plastic~~	~~HNO_3~~	~~3/ /09~~ nm	
~~TA~~	~~Ferrous Fe~~	~~1L Plastic~~	~~—~~	~~3/ /09~~ nm	

SM Stoller Corp.

105 Technology Dr., Suite 190
Broomfield, CO 80021
(303) 546-4300

Project Name: Colorado School of Mines	Sample Location: SW-2
Project Number: 4107-510	Date: 3/16/09
Sample Type: GW [✓ SW] EB Duplicate Other:	Sampler: N Malczyk

Purge Volume Calculations		
Measured TD =	(+.28)	(ft)
Total Depth =		(ft)
Depth to Water =		(ft)
Initial Water Column =	nm	(ft)
Initial Water Volume =		(gal)
3 X Water Volume		(gal)

Sample Collection

Analysis	Container	Preservative	Date	Time
Ra-226 Ra-228 Diss. U	1 gal cube	HNO_3	3/16/09	1215
NO_2 / NO_3	1L Plastic	—	3/16/09	1215
Cations Ca, Mg, K, Na	500mL Plastic	HNO_3	3/16/09	1215
Anions	500mL Plastic	—	3/16/09	1215

TA

Lab: Paragon - Fort Collins, Test America - Arvada

Purge Volumes and Field Water Quality Measurements

Time	Volume (gal)	Temperature (°C/°F) nm	pH (SU)	Conductivity (uS/cm)	DO (mg/L)	ORP (mV)	Turbidity (NTU)	Appearance
1200	n/A	6.69	8.66	288	10.37	93	55.4	cloudy brown
								nm

Volume purged: n/A

Comments:

	Analysis	Container	Preservative	Date	Time
	Diss. Phosphorus	250mL Plastic	H_2SO_4	3/16/09	1215
	TOC	125mL Amber	H_2SO_4	3/16/09	1215
~~TA~~	~~Ferric Fe~~	~~500mL Plastic~~	~~HNO_3~~	~~3/ /09~~	nm
~~TA~~	~~Ferrous Fe~~	~~1L Plastic~~	~~—~~	~~3/ /09~~	nm

SM Stoller Corp.

105 Technology Dr., Suite 190
Broomfield, CO 80021
(303) 546-4300

Project Name: Colorado School of Mines	Sample Location: Equipment Blank
Project Number: 4107-510	Date: 3/16/09
Sample Type: GW SW [✓ EB] Duplicate Other:	Sampler: N Malczyk

Purge Volume Calculations

Measured TD =		(ft)
	(+.28)	
Total Depth =		(ft)
Depth to Water =		(ft)
Initial Water Column =	vcm	(ft)
Initial Water Volume =		(gal)
3 X Water Volume		(gal)

Sample Collection

Analysis	Container	Preservative	Date	Time	
Ra-226 Ra-228 Diss. U	1 gal cube	HNO_3	3/16/09	1030	
NO_2 / NO_3	1 L Plastic	—	3/16/09	1030	TA
Cations Ca, Mg, K, Na	500mL Plastic	HNO_3	3/16/09	1030	
Anions	500mL Plastic	—	3/16/09	1030	

Lab: Paragon - Fort Collins, Test America - Arvada

Purge Volumes and Field Water Quality Measurements

Time	Volume (gal)	Temperature (°C, [✓ F])	pH (SU)	Conductivity (uS/cm)	DO (mg/L)	ORP (mV)	Turbidity (NTU)	Appearance
								vcm

Volume purged: N/A

Comments:

	Analysis	Container	Preservative	Date	Time
	Diss. Phosphorus	250mL Plastic	H_2SO_4	3/16/09	1030
	TOC	125mL Amber	H_2SO_4	3/16/09	1030
~~TA~~	~~Ferric Fe~~	~~500mL Plastic~~	~~HNO_3~~	~~3/ /09~~	vcm
~~TA~~	~~Ferrous Fe~~	~~1L Plastic~~	—	~~3/ /09~~	vcm

Appendix C
Surface Water Sampling Procedures

Surface Water Sampling

1.0 Scope and Objective

1.1 Scope

This procedure provides instructions and establishes requirements for the collection and documentation of surface water samples by Stoller personnel. This procedure applies to the collection of surface water samples from streams, rivers, ponds, lakes, seeps, impoundments, and other surface sources.

1.2 Objective

The objective of this procedure is to establish a uniform method for the collection of surface water samples that provides representative samples in a safe and responsible manner.

2.0 Definitions

Composite Sample – A sample that is comprised of roughly equal amounts of water collected from a set of sample locations known as a sample group.

Grab Sample – A single sample collected at one sampling point over a short period of time. Grab sample results are representative of the sample location at the time of sample collection. Also called a catch sample.

Peristaltic Pump – A self-priming, low volume pump consisting of a rotor and ball bearing rollers. Tubing placed around the rotors is squeezed by the rotors as they revolve. The squeezing produces a wavelike contractual movement which causes water to be drawn through the tubing. The peristaltic pump is limited to sampling at depths of less than 25 feet.

3.0 Responsibilities and Qualifications

3.1 Project Manager

The Project Manager is responsible for ensuring that surface water samples are properly and safely collected. This will be accomplished through staff training and by maintaining quality control (QC). At a minimum, project management shall:

3.1.1 Verify that personnel have reviewed, and are familiar with, site-specific work plans which address surface water sampling, this procedure, and any associated procedures.

3.1.2 Ensure that hazards are identified and analyzed with respect to collecting surface water samples, and develop and implement controls to minimize hazards.

3.1.3 Provide personnel with training in the operation of surface water sampling equipment and the requirements of this procedure.

3.1.4 Periodically review field generated documentation associated with surface water sampling to ensure compliance with project requirements and implement corrective action if necessary.

3.1.5 Receive feedback from field sampling personnel in order to continually improve surface water sampling process.

3.2 Site Supervisor

The Site Supervisor is responsible for directing and overseeing all field activities, including sampling, to ensure that site-specific plan requirements are met in a safe and efficient manner within the established safety envelope.

3.3 Field Sampling Personnel

Field sampling personnel are responsible for the proper sample collection and documentation of the sampling event in accordance with this procedure. At a minimum, field sampling personnel have the responsibility to:

3.3.1 Familiarize themselves with site-specific work plans, surface water sampling procedures, potential hazards, and health and safety plan.

3.3.2 Implement the controls to minimize hazards.

3.3.3 Be familiar with sampling equipment and its proper use.

3.3.4 Properly complete field documentation.

3.3.5 Provide feedback to project manager in order to improve sampling process.

4.0 Equipment/Materials and Calibration

4.1 Equipment/Materials

A number of devices are available for the collection of surface water samples. These devices are constructed of a number of materials including, but not limited to: stainless steel, glass, Teflon®, Tygon®. The sampling and analytical requirements, as well as site characteristics, must be taken into account when determining the proper surface water sampling equipment to use. The site-specific work plans should identify the specific equipment to be used, and methods for safely using equipment.

4.2 Calibration

Equipment shall be calibrated in accordance with manufacturer's recommendations and calibration documentation shall be maintained in project files.

5.0 Method

5.1 Field Preparation

Field preparation requires the organization of sample containers, sample labels, and documentation in an orderly, systematic manner to promote consistency and traceability of all data.

5.1.1 General sampling areas will be predetermined to ensure coverage of the various impact scenarios and should be described in project-specific work plans. The location of each sampling point shall be surveyed or mapped and staked as described in Section 5.1.6 prior to sampling.

5.1.2 In flowing water, surface water sampling shall be conducted from downstream locations first, then proceed to upstream locations to avoid potential cross contamination from disturbing the substrate.

5.1.3 Prior to sampling and between sampling locations, sampling equipment shall be decontaminated.

5.1.4 Appropriate personal protective equipment shall be used, as specified in the project-specific health and safety plan.

5.1.5 All pertinent information (date, site name, identification number, and location) shall be recorded on a Field Activity Daily Log (FADL) and a Sample Collection Log, as appropriate. Field conditions, unusual circumstances, and weather conditions shall be noted.

5.1.6 Due to the nature of sampling an aqueous environment, additional steps are required to verify and mark sample locations. Depending on the project needs, it may be useful to use a Global Positioning System (GPS) to verify and mark the sample locations. Refer to *Field Mapping with a Global Positioning System* for details. The following steps shall be followed by the sampler in addition to the field preparation requirements described in Section 5.1.1.

5.1.6.1 Place a marker (stake) on the shore approximately perpendicular to the sampling location and mark the sample number on the stake.

5.1.6.2 If the sample location is accessible by foot, use a measuring tape to measure the distance between the marked point and the sample location station. Record the compass bearing from the sample location to the shore marker.

5.1.6.3 If the sample location is accessible only by boat, use a rangefinder to estimate the distance to the shore marker to obtain the most accurate measurement. Record the compass bearing from the sample location to the shore marker. It is recommended that the boat's position on the water be stabilized to prevent drifting.

5.1.6.4 Determine and record the distance and direction of each shore marker from a reference point shown on the topographic map and mark all points on a map or use a GPS, if available.

5.1.7 Quality Control samples, including field and source blanks, shall be collected in accordance with the project-specific work plan.

5.2 Surface Water Sample Collection Using a Transfer Container

The device most commonly used to collect grab surface water samples is a transfer container (beaker, flask, etc.) made of inert material such as glass, stainless steel or Teflon®. When sampling with a transfer container, the procedure is as follows:

5.2.1 Survey and clearly map sampling points as described in Section 5.1.6 prior to sampling. The sample should be collected as close to the mapped location as possible. If the collection point must be moved, the new location must be approved and documented.

5.2.2 Dip the transfer container into the surface water. Always use a clean, properly decontaminated transfer container at each sample location.

5.2.3 Filter the sample if required.

5.2.4 Fill the sample bottle, allowing the sample stream to flow gently down the inside of the bottle with minimal turbulence.

5.2.5 Cap the bottle and handle the sample according to the procedures outlined in Project *Sample Shipping*.

5.2.6 Label the sample and document the sampling event.

5.3 Surface Water Sample Collection Using a Peristaltic Pump

A device used to collect composite surface water samples is a peristaltic pump. Samples to be analyzed for volatile organic analysis cannot be composited. When sampling with a peristaltic pump, the procedure is as follows:

5.3.1 Survey and clearly map sampling points as described in Section 5.1.6 prior to sampling. The sample should be collected as close to the mapped location as possible. If a collection point must be moved, the new location must be approved and documented.

5.3.2 Attach the appropriate tubing to the peristaltic pump. Always use new tubing at each sample location. Do not try to decontaminate and reuse tubing.

5.3.3 If filtering is required, attach the filtering device to the discharge end of the tubing.

5.3.4 Lower the intake end of the tubing into the water and begin pumping. If the pump is computerized, program the pump to collect the sample at the desired intervals and flow rate. If the pump is not programmable, record the discharge rate (compute discharge rate by dividing an amount of water collected by the time it took to collect it). Collect the sample at the desired interval.

5.3.5 Fill the sample bottle, allowing the sample stream to flow gently down the inside of the bottle with minimal turbulence. The programmable pump will perform this automatically.

5.3.6 Cap the bottle and handle the sample according to the procedures outlined in Project *Sample and Shipping*.

5.3.7 Label the sample and document the sampling event.

6.0 Required Inspection/Acceptance Criteria

None.

7.0 Records

The following records generated as a result of implementation of this procedure shall be maintained in a safe manner and submitted to project central files for storage and disposition.

Field Activity Daily Log

Sample Collection Log

Chain of Custody

8.0 References

8.1 Others

U.S. Environmental Protection Agency. 1987. *EPA Compendium of Superfund Field Operations Methods*, EPA 540/P-87/001a, OSWER 9355.0-14. Washington, DC.

U.S. Environmental Protection Agency. 1988. *EPA Guidance for Conducting Remedial Investigation and Feasibility Studies under CERCLA*, Interim Final OSWER Directive 9355.3-01. Washington, DC.

American Public Health Association, American Water Works Association, Water Pollution Control Federation. 1985. *Standard Methods for the Examination of Water and Wastewater*, 16th Edition, American Public Health Association, Washington, DC.

Appendix D
Data Validation Reports

DATA VALIDATION REPORT

To:	Steve Brinkman/Robert Hill
From:	John Garrett
Date:	May 28, 2009
Project/Site:	Colorado School of Mines
Project No.:	4060
SDG No.:	0903149 Radium-226

This report presents the radiological data validation for the data obtained during the field activities for the above referenced work assignment. The purpose of this review is to provide a technical evaluation of the radiological results that were obtained by Paragon Procedure PA SOP 783R8 for Radium-226 by Radon Emanation Counting for SDG 0903149 from Paragon Analytics, Inc. (Fort Collins, CO). This report consists of eleven water samples for the Colorado School of Mines/4060 project collected on March 16, 2009, March 17, 2009, and March 18, 2009 and submitted to Paragon Analytics, Inc on March 19, 2009. The samples were analyzed for Radium-226 by Radon Emanation Counting on May 8, 2009. All analyses were conducted by Paragon Analytics, Inc. The field sample numbers and corresponding laboratory numbers are presented below:

Client Sample Number	Laboratory Sample Number	Matrix	Collection Date
EQUIPMENT BLANK	0903149-1	Water	March 16, 2009
SW-2	0903149-2	Water	March 16, 2009
SW--1	0903149-3	Water	March 16, 2009
CSMRI-9	0903149-4	Water	March 16, 2009
CSMRI-10	0903149-5	Water	March 16, 2009
CSMRI-4	0903149-6	Water	March 17, 2009
CSMRI-5	0903149-7	Water	March 17, 2009
CSMRI-1	0903149-8	Water	March 17, 2009
CSMRI-8	0903149-9	Water	March 18, 2009
CSMRI-2	0903149-10	Water	March 18, 2009
CSMRI-1B	0903149-11	Water	March 18, 2009

Data validation was conducted in accordance with the Analytical Services Statement of Work for the following modules: Gas Proportional Counting Module RC04-v2, October 1, 2002, and U.S. DOE Quality Systems for Analytical Services Revision 2.3 (QSAS).

The radiological data were evaluated based on the following parameters:

- Data Completeness
- Holding Times and Preservation
- Instrument Initial Calibrations
- Instrument Performance Checks
- Preparation Blanks
- Duplicate Sample Results
- Laboratory Control Samples (LCS) Results
- Laboratory Control Samples Duplicate (LCSD) Results
- Compound Quantitation and Reporting Limits (full validation only)

Data Completeness

The data package was complete as per Paragon Procedure PA SOP 783R8 for Radium-226 by Radon Emanation counting.

Holding Times and Preservation

Analytical holding times were evaluated and all criteria were met. However, holding time requirements are not applicable to radiochemistry analyses unless the isotopes of interest have short half-lives.

Calibrations

The instruments were calibrated at the required frequency.

Initial Calibration

All instruments were calibrated properly using NIST traceable SRM.

Instrument Performance Checks

All isotopes were within criteria.

Preparation Blanks

All isotopes that were analyzed had activities that were below their respective MDCs in their QC batch preparation blanks.

Duplicate Sample Analysis

All isotopic activities for Radium-226 duplicate and original analysis were within the limits of the statistical test for equivalency. No action was required.

Matrix Spike/Matrix Spike Duplicates

Matrix spike/matrix spike duplicates were not performed for the samples in this SDG, nor were any required.

Laboratory Control Samples

All recoveries were within 75-125% limits. No calculation errors or transcription errors were found.

Analyte Quantitation and Reporting Limits

Analyte quantitation was evaluated for all samples. No calculation or transcription errors were found. The results and reporting limits were correctly reported.

Overall Comments

Radium-226 was detected above the RDL in sample CSMRI-2 at 2.37 pCi/L and is considered detected.

DATA QUALIFIER DEFINITIONS

For the purpose of Data Validation, the following code letters and associated definitions are provided for use by the data validator to summarize the data quality.

R - Reported value is "rejected." Resampling or reanalysis may be necessary to verify the presence or absence of the compound.

J - The associated numerical value is an estimated quantity because the Quality Control criteria were not met.

U J - The reported quantitation limit is estimated because Quality Control criteria were not met. Element or compound was not detected.

U - The material was analyzed for, but was not detected above the level of the associated value. The associated value is either the sample quantitation limit or the sample detection limit.

NR - Result was not used from a particular sample analysis. This typically occurs when more than one result for an element is reported due to dilutions and reanalyses.

DATA VALIDATION REPORT

To:	Steve Brinkman/Robert Hill
From:	John Garrett
Date:	May 28, 2009
Project/Site:	Colorado School of Mines
Project No.:	4060
SDG No.:	0903149 Radium-228

This report presents the radiological data validation for the data obtained during the field activities for the above referenced work assignment. The purpose of this review is to provide a technical evaluation of the radiological results that were obtained by Paragon PA SOP 724R10 for Radium-228 by gas proportional counting for SDG 0903149 from Paragon Analytics, Inc. (Fort Collins, CO). This report consists of eleven water samples for the Colorado School of Mines/4060 project collected on March 16, 2009, March 17, 2009, and March 18, 2009 and submitted to Paragon Analytics, Inc on March 19, 2009. The samples were analyzed for Radium-228 by Radon gas proportional counting on April 24 8, 2009. All analyses were conducted by Paragon Analytics, Inc. The field sample numbers and corresponding laboratory numbers are presented below:

Client Sample Number	Laboratory Sample Number	Matrix	Collection Date
EQUIPMENT BLANK	0903149-1	Water	March 16, 2009
SW-2	0903149-2	Water	March 16, 2009
SW-1	0903149-3	Water	March 16, 2009
CSMRI-9	0903149-4	Water	March 16, 2009
CSMRI-10	0903149-5	Water	March 16, 2009
CSMRI-4	0903149-6	Water	March 17, 2009
CSMRI-5	0903149-7	Water	March 17, 2009
CSMRI-1	0903149-8	Water	March 17, 2009
CSMRI-8	0903149-9	Water	March 18, 2009
CSMRI-2	0903149-10	Water	March 18, 2009
CSMRI-1B	0903149-11	Water	March 18, 2009

Data validation was conducted in accordance with the Analytical Services Statement of Work for the following modules: Gas Proportional Counting Module RC04-v2, October 1, 2002, and U.S. DOE Quality Systems for Analytical Services Revision 2.3 (QSAS).

The radiological data were evaluated based on the following parameters:

- Data Completeness
- Holding Times and Preservation
- Instrument Initial Calibrations
- Instrument Performance Checks
- Preparation Blanks
- Duplicate Sample Results
- Laboratory Control Samples (LCS) Results
- Laboratory Control Samples Duplicate (LCSD) Results
- Compound Quantitation and Reporting Limits (full validation only)

Data Completeness

The data package was complete as per Paragon Procedure PA SOP 724R10 for Radium-228 by gas proportional counting for SDG 0903149.

Holding Times and Preservation

Analytical holding times were evaluated and all criteria were met. However, holding time requirements are not applicable to radiochemistry analyses unless the isotopes of interest have short half-lives.

Calibrations

The instruments were calibrated at the required frequency.

Initial Calibration

All instruments were calibrated properly using NIST traceable SRM.

Instrument Performance Checks

Detector A3 on detector A failed low on the day that sample SW1 laboratory ID 0903149-3 was counted 04/24/2009. The reported sample activity was 0.73 pCi/l ± 0.54 with the MDC 1 pCi/l. The laboratory additionally reports that a daily check on this detector was not performed the following day on 04/25/2009. There is a potential low bias of the reported result of 7.2% which exceeds the 3σ control limit. The reported result for sample SW-1 is qualified as **[R]** Rejected.

All other performance checks were within criteria.

Preparation Blanks

All isotopes that were analyzed had activities that were below their respective MDCs in their QC batch preparation blanks.

Duplicate Sample Analysis

All isotopic activities for Radium-228 duplicate and original analysis were within the limits of the statistical test for equivalency. No action was required.

Matrix Spike/Matrix Spike Duplicates

Matrix spike/matrix spike duplicates were not performed for the samples in this SDG, nor were any required.

Laboratory Control Samples

All recoveries were within 75-125% limits. No calculation errors or transcription errors were found.

Analyte Quantitation and Reporting Limits

Analyte quantitation was evaluated for all samples. No calculation or transcription errors were found. The results and reporting limits were correctly reported.

Overall Comments

Due to failed daily performance check for the detector A3 used to analyze sample SW-1 there is a potential low bias of 7.2% for the reported result of 0.73 ± 0.54, The reported result for sample SW-1 is qualified as **[R]** Rejected.
Radium-228 was detected above the RDL in samples CSMRI-10 at 1.01 pCi/L, CSMRI-5 at 1.24, CSMRI-2 at 2.68 pCi/L, CSMRI-1B at 1.15 pCi/L and are considered detected.

DATA QUALIFIER DEFINITIONS

For the purpose of Data Validation, the following code letters and associated definitions are provided for use by the data validator to summarize the data quality.

R - Reported value is "rejected." Resampling or reanalysis may be necessary to verify the presence or absence of the compound.

J - The associated numerical value is an estimated quantity because the Quality Control criteria were not met.

U J - The reported quantitation limit is estimated because Quality Control criteria were not met. Element or compound was not detected.

U - The material was analyzed for, but was not detected above the level of the associated value. The associated value is either the sample quantitation limit or the sample detection limit.

NR - Result was not used from a particular sample analysis. This typically occurs when more than one result for an element is reported due to dilutions and reanalyses.

DATA VALIDATION REPORT

To:	Steve Brinkman/Robert Hill
From:	John Garrett
Date:	June 13, 2009
Project/Site:	Colorado School of Mines
Project No.:	4060
SDG No.:	0903149

This report presents the inorganic anions data validation for the data obtained for ten CSMRI water sample collected on March 16, 2009, March 17, 2009, and March 18, 2009 and submitted to Paragon Analytics, Inc on March 19, 2009 for the above referenced work assignment. The purpose of this review is to provide a technical evaluation of the inorganic anions results that were obtained by preparation method MCAWW, May 1994, and EMSL Rev 2.1 Alkalinity, Bicarbonate, and Carbonate by Method 310.1, Total Phosphorus by Method 365.2, Bromide, Chloride, and Sulfate by Method 300.0 from Paragon Analytics, Inc. (Fort Collins, CO). The water samples were analyzed for Bicarbonate, Carbonate, Total Alkalinity on March 27, 2009, Sulfate on March 24, 2009, and Chloride on March 26, 2009, Total Phosphorus on March 25, 2009. All analyses were conducted by Paragon Analytics, Inc. The field sample numbers and corresponding laboratory numbers are presented below:

Client Sample Number	Laboratory Sample Number	Matrix	Collection Date
EQUIPMENT BLANK	0903149-1	Water	March 16, 2009
SW-2	0903149-2	Water	March 16, 2009
SW-1	0903149-3	Water	March 16, 2009
CSMRI-9	0903149-4	Water	March 16, 2009
CSMRI-10	0903149-5	Water	March 16, 2009
CSMRI-4	0903149-6	Water	March 17, 2009
CSMRI-5	0903149-7	Water	March 17, 2009
CSMRI-1	0903149-8	Water	March 17, 2009
CSMRI-8	0903149-9	Water	March 18, 2009
CSMRI-2	0903149-10	Water	March 18, 2009
CSMRI-1	0903149-11	Water	March 18, 2009

Data validation was conducted in accordance with the USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review.

The Inorganics data were evaluated based on the following parameters:

* Data Completeness
* Holding Times and Preservation
* Initial and Continuing Calibration Verification
* Contract Required Detection Limit (CRDL)
* Preparation/ Initial (ICB)/ and Continuing (CCB) Calibration Blanks
* Interference Check Sample (ICSA) Results
* Matrix Spike Results
* Duplicate Sample Results
* Laboratory Control Samples (LCS) Results
* Serial Dilution Sample Results
* Compound Quantitation and Reporting Limits (full validation only)

*** All criteria were met for this parameter**

Data Completeness

The data package was complete. No results were qualified as a result of the missing data.

Holding Times and Preservation

Analytical holding times were evaluated and all criteria were met.

The water samples were all found to be field filtered and had a pH less than 2.

Initial and Continuing Calibration Verification

Initial and Continuing Calibration Verification standards were analyzed at the required frequency and all were within the required 90-110%. No action was necessary.

Contract Required Detection Limit (CRDL)

All CRDL %Rs CRI %Rs were within 80-120% limits. No action was necessary.

Preparation and Initial/ Continuing Calibration Blanks

Preparation and Initial/ Continuing Calibration Blanks are evaluated to assess the level of contamination in the preparation and analytical processes.

Preparation and Initial/ Continuing Calibration Blanks were prepared and analyzed at the required frequencies.

All of the blanks that were analyzed had concentrations that were below their respective Reporting Limits (RLs).

However, if blank results were above the Instrument Detection Limits (IDLs) and below the RLs, it caused the associated sample results to be qualified for contamination as estimated and non-detected **[UJ 107]**. If blank results were below the negate IDL and above the negate RL, it caused the associated sample results to be qualified for negative contamination as estimated **[J 107]**. No sample results were qualified due to blank contamination.

Matrix Spike/Matrix Spike Duplicate Results

All MS/MSD percent recoveries were within 75-125% limits. No action was necessary.

Duplicate Sample Analysis

All original sample/duplicate sample and MS/MSD differences were less than 20% RPD or less than the RDL for results less than (5)(RDL). No actions were necessary.

Laboratory Control Samples

The laboratory analyzed laboratory control samples for all analytes. All recoveries were within 80-120% limits. No action was necessary.

Serial Dilution Results

All %Ds were less than 10% for all analytes.

Analyte Quantitation and Reporting Limits

Analyte quantitation was evaluated for all samples. No calculation or transcription errors were found. The results and reporting limits were correctly reported.

Overall Comments

Matrix Spike recoveries were not evaluated for Chloride. The Chloride concentration was above the analytical range and therefore quantitation of MS/MSD recoveries were not possible as the spike added was small relative to the unspiked sample concentration. The LCS, ICV, and CCV QC results indicate that the procedure was in control and no action was necessary.

All data were acceptable without qualification as received by the laboratory.

DATA QUALIFIER DEFINITIONS

For the purpose of Data Validation, the following code letters and associated definitions are provided for use by the data validator to summarize the data quality.

R - Reported value is "rejected." Resampling or reanalysis may be necessary to verify the presence or absence of the compound.

J - The associated numerical value is an estimated quantity because the Quality Control criteria were not met.

U J - The reported quantitation limit is estimated because Quality Control criteria were not met. Element or compound was not detected.

U - The material was analyzed for, but was not detected above the level of the associated value. The associated value is either the sample quantitation limit or the sample detection limit.

NR - Result was not used from a particular sample analysis. This typically occurs when more than one result for an element is reported due to dilutions and reanalyses.

DATA VALIDATION REPORT

To:	Steve Brinkman/Robert Hill
From:	John Garrett
Date:	June 15, 2009
Project/Site:	Colorado School of Mines
Project No.:	4060
SDG No.:	00903149

This report presents the Dissolved Organic Carbon data validation for the data obtained for ten CSMRI water sample collected on March 16, 2009, March 17, 2009, and March 18, 2009 and submitted to Paragon Analytics, Inc on March 19, 2009 for the above referenced work assignment. The purpose of this review is to provide a technical evaluation of Dissolved Organic Carbon results that were obtained by MCAWW, May 1994, Dissolved Organic Carbon by Method 415.1 from Paragon Analytics, Inc. (Fort Collins, CO). The water samples were analyzed March 24, 2009. All analyses were conducted by Paragon Analytics, Inc. The field sample numbers and corresponding laboratory numbers are presented below:

Client Sample Number	Laboratory Sample Number	Matrix	Collection Date
EQUIPMENT BLANK	0903149-1	Water	March 16, 2009
SW-2	0903149-2	Water	March 16, 2009
SW-1	0903149-3	Water	March 16, 2009
CSMRI-9	0903149-4	Water	March 16, 2009
CSMRI-10	0903149-5	Water	March 16, 2009
CSMRI-4	0903149-6	Water	March 17, 2009
CSMRI-5	0903149-7	Water	March 17, 2009
CSMRI-1	0903149-8	Water	March 17, 2009
CSMRI-8	0903149-9	Water	March 18, 2009
CSMRI-2	0903149-10	Water	March 18, 2009

Data validation was conducted in accordance with the USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review.

The organics data were evaluated based on the following parameters:

- * Data Completeness
- * Holding Times and Preservation
- * Initial and Continuing Calibration Verification
- * Contract Required Detection Limit (CRDL)
- * Preparation/ Initial (ICB)/ and Continuing (CCB) Calibration Blanks
- * Interference Check Sample (ICSA) Results
- * Matrix Spike Results
- * Duplicate Sample Results
- * Laboratory Control Samples (LCS) Results
- * Serial Dilution Sample Results
- * Compound Quantitation and Reporting Limits (full validation only)

* **All criteria were met for this parameter**

Data Completeness

The data package was complete. No results were qualified as a result of the missing data.

Holding Times and Preservation

Analytical holding times were evaluated and all criteria were met.

The water samples were all found to be field filtered and had a pH less than 2.

Initial and Continuing Calibration Verification

Initial and Continuing Calibration Verification standards were analyzed at the required frequency and all were within the required 90-110%. No action was necessary.

Contract Required Detection Limit (CRDL)

All CRDL %Rs CRI %Rs were within 80-120% limits. No action was necessary.

Preparation and Initial/ Continuing Calibration Blanks

Preparation and Initial/ Continuing Calibration Blanks are evaluated to assess the level of contamination in the preparation and analytical processes.

Preparation and Initial/ Continuing Calibration Blanks were prepared and analyzed at the required frequencies.

All of the blanks that were analyzed had concentrations that were below their respective Reporting Limits (RLs).

However, if blank results were above the Instrument Detection Limits (IDLs) and below the RLs, it caused the associated sample results to be qualified for contamination as estimated and non-detected **[UJ 107]**. If blank results were below the negate IDL and above the negate RL, it caused the associated sample results to be qualified for negative contamination as estimated **[J 107]**. No sample results were qualified due to blank contamination.

Matrix Spike/Matrix Spike Duplicate Results

All MS/MSD percent recoveries were within 75-125% limits. No action was necessary.

Duplicate Sample Analysis

All original sample/duplicate sample and MS/MSD differences were less than 20% RPD or less than the RDL for results less than (5)(RDL). No actions were necessary.

Laboratory Control Samples

The laboratory analyzed laboratory control samples for all analytes. All recoveries were within 80-120% limits. No action was necessary.

Serial Dilution Results

All %Ds were less than 10% for all analytes.

Analyte Quantitation and Reporting Limits

Analyte quantitation was evaluated for all samples. No calculation or transcription errors were found. The results and reporting limits were correctly reported.

Overall Comments

All data were acceptable without qualification as received by the laboratory.

DATA QUALIFIER DEFINITIONS

For the purpose of Data Validation, the following code letters and associated definitions are provided for use by the data validator to summarize the data quality.

R - Reported value is "rejected." Resampling or reanalysis may be necessary to verify the presence or absence of the compound.

J - The associated numerical value is an estimated quantity because the Quality Control criteria were not met.

U J - The reported quantitation limit is estimated because Quality Control criteria were not met. Element or compound was not detected.

U - The material was analyzed for, but was not detected above the level of the associated value. The associated value is either the sample quantitation limit or the sample detection limit.

NR - Result was not used from a particular sample analysis. This typically occurs when more than one result for an element is reported due to dilutions and reanalyses.

DATA VALIDATION REPORT

To: Steve Brinkman/Robert Hill
From: John Garrett
Date: May 28, 2009
Project/Site: Colorado School of Mines
Project No.: 4060
SDG No.: 0903149

This report presents the inorganic metals data validation for the data obtained for eleven CSMRI water sample collected on March 16, 2009, March 17, 2009, and March 18, 2009 and submitted to Paragon Analytics, Inc on March 19, 2009 for the above referenced work assignment. The purpose of this review is to provide a technical evaluation of the inorganic metals results that were obtained by SW-846, 3rd edition, Method 6010B and Paragon Procedure PA SOP 834R7 for trace metals by Inductively Coupled Plasma (ICP) atomic emission spectrometry analysis, Method 6020B and Paragon Procedure PA SOP 827R6 for dissolved metals by Inductively Coupled Plasma mass spectrometry (ICP-MS) (Uranium only) analysis for SDG 0903149 from Paragon Analytics, Inc. (Fort Collins, CO). The water samples were analyzed for dissolved ICP trace metals on March 31, 2009 and dissolved ICP-MS uranium on April 9, 2009. All analyses were conducted by Paragon Analytics, Inc. The field sample numbers and corresponding laboratory numbers are presented below:

Client Sample Number	Laboratory Sample Number	Matrix	Collection Date
EQUIPMENT BLANK	0812064-1	Water	March 16, 2009
SW-2	0812064-2	Water	March 16, 2009
SW-1	0812064-3	Water	March 16, 2009
CSMRI-9	0812064-4	Water	March 16, 2009
CSMRI-10	0812064-5	Water	March 16, 2009
CSMRI-4	0812064-6	Water	March 17, 2009
CSMRI-5	0812064-7	Water	March 17, 2009
CSMRI-1	0812064-8	Water	March 17, 2009
CSMRI-8	0812064-9	Water	March 18, 2009
CSMRI-2	0812064-10	Water	March 18, 2009
CSMRI-1B	0812064-11	Water	March 18, 2009

Data validation was conducted in accordance with the USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review.

The metals data were evaluated based on the following parameters:

- * Data Completeness
- * Holding Times and Preservation
- * Initial and Continuing Calibration Verification
- * Contract Required Detection Limit (CRDL)
- Preparation/ Initial (ICB)/ and Continuing (CCB) Calibration Blanks
- * Interference Check Sample (ICSA) Results
- * Matrix Spike Results
- * Duplicate Sample Results
- * Laboratory Control Samples (LCS) Results
- Serial Dilution Sample Results
- * Compound Quantitation and Reporting Limits (full validation only)

*** All criteria were met for this parameter**

Data Completeness

The data package was complete except for the missing CRDL (2B) and IDL (10) QC Summary Forms. No results were qualified as a result of the missing data.

Holding Times and Preservation

Analytical holding times were evaluated and all criteria were met.

The water samples were field filtered and had a pH less than 2.

Initial and Continuing Calibration Verification

Initial and Continuing Calibration Verification standards were analyzed at the required frequency and all were within the required 90-110% limits for ICP trace. No action was necessary.

Contract Required Detection Limit (CRDL)

No CRDL or CRI standard recovery summary forms (EPA Form 2b) were included in the data package. The reviewer obtained the %Rs from the instrument raw data. All CRDL %Rs for ICP and CRI %Rs for mercury were within 80-120% limits. No action was necessary.

Preparation and Initial/ Continuing Calibration Blanks

Preparation and Initial/ Continuing Calibration Blanks are evaluated to assess the level of contamination in the preparation and analytical processes.

Preparation and Initial/ Continuing Calibration Blanks were prepared and analyzed at the required frequencies.

All of the blanks that were analyzed had concentrations that were below their respective Reporting Limits (RLs).

However, if blank results were above the Instrument Detection Limits (IDLs) and below the RLs, it caused the associated sample results to be qualified for contamination as estimated and non-detected **[UJ 107]**. If blank results were below the negate IDL and above the negate RL, it caused the associated sample results to be qualified for negative contamination as estimated **[J 107]**. No sample results were qualified due to blank contamination.

Interference Check Sample (ICSA) Results

Interference Check Samples were prepared and analyzed at the required frequencies.

No aqueous concentrations of aluminum, calcium, iron, or magnesium exceeded the ICSA values in any of the samples. No action was necessary.

Matrix Spike/Matrix Spike Duplicate Results

All ICP and Mercury MS/MSD percent recoveries were within 75-125% limits. No action was necessary.

Duplicate Sample Analysis

All ICP and Mercury original sample/duplicate sample and MS/MSD differences were less than 20% RPD or less than the RDL for results less than (5)(RDL). No actions were necessary.

Laboratory Control Samples

The laboratory analyzed laboratory control samples for all metals and mercury. All recoveries were within 80-120% limits. No action was necessary.

Serial Dilution Results

All %Ds were less than 10% for all ICP and ICP-MS metals.

Analyte Quantitation and Reporting Limits

Analyte quantitation was evaluated for all samples. No calculation or transcription errors were found. The results and reporting limits were correctly reported.

Overall Comments

No CRDL or CRI standard recovery summary forms (EPA Form 2b) were included in the data package. The reviewer obtained the results from the raw data. No action was necessary.
All data were acceptable without qualification as received by the laboratory.

DATA QUALIFIER DEFINITIONS

For the purpose of Data Validation, the following code letters and associated definitions are provided for use by the data validator to summarize the data quality.

R - Reported value is "rejected." Resampling or reanalysis may be necessary to verify the presence or absence of the compound.

J - The associated numerical value is an estimated quantity because the Quality Control criteria were not met.

U J - The reported quantitation limit is estimated because Quality Control criteria were not met. Element or compound was not detected.

U - The material was analyzed for, but was not detected above the level of the associated value. The associated value is either the sample quantitation limit or the sample detection limit.

NR - Result was not used from a particular sample analysis. This typically occurs when more than one result for an element is reported due to dilutions and reanalyses.

Appendix E
Results of Analyses CD

Appendix F
Chains of Custody

Chain of Custody Record

4124 (0907)

Temperature on Receipt ____

Drinking Water? Yes ☐ No ☐

TestAmerica

THE LEADER IN ENVIRONMENTAL TESTING

Client: Stoller

Address: 105 Technology Dr #190

City: Broomfield State: CO Zip Code: 80021

Project Name and Location (State): CO School of Mines

Contract/Purchase Order/Quote No.:

Project Manager: Robert Hill

Telephone Number (Area Code)/Fax Number: (303) 546-4440

Site Contact:

Lab Contact: Lisa Anharzak

Carrier/Waybill Number:

Date: 3/16/09

Lab Number:

Chain of Custody Number: 405650

Page 1 of 1

Sample I.D. No. and Description (Containers for each sample may be combined on one line)	Date	Time	Matrix					Containers & Preservatives							Analysis (Attach list if more space is needed)												Special Instructions/ Conditions of Receipt
			Air	Aqueous	Sed.	Soil		Unpres.	H2SO4	HNO3	HCl	NaOH	ZnAc/ NaOH		NO2 + NO3	Ferrous Fe	Ferric Fe										
Equipment Blank	3/16/09	1130		X				X							X												
SW-2		1215		X				X							X												
SW-1		1515		X				X							X												
CSMRI-9		1540		X				X							X												
CSMRI-10		1100		X				X							X												

Possible Hazard Identification

☒ Non-Hazard ☐ Flammable ☐ Skin Irritant ☐ Poison B ☐ Unknown

Sample Disposal

☐ Return To Client ☒ Disposal By Lab ☐ Archive For ____ Months (A fee may be assessed if samples are retained longer than 1 month)

Turn Around Time Required

☐ 24 Hours ☐ 48 Hours ☐ 7 Days ☐ 14 Days ☐ 21 Days ☒ Other 10 days

QC Requirements (Specify)

1. Relinquished By: Date 3/16/09 Time 1135
1. Received By: Date Time

2. Relinquished By: Date Time
2. Received By: Date Time

3. Relinquished By: Date Time
3. Received By: Date Time

Comments

DISTRIBUTION: WHITE - Returned to Client with Report; CANARY - Stays with the Sample; PINK - Field Copy

Chain of Custody Record

4124 (0907)

Temperature on Receipt ____

Drinking Water? Yes ☐ No ☐

TestAmerica

THE LEADER IN ENVIRONMENTAL TESTING

Client: Stoller

Project Manager: Robert Hill

Date: 3/17/09

Chain of Custody Number: 405648

Address: 105 Technology Dr #190

Telephone Number (Area Code)/Fax Number: (303) 546-4410

Lab Number:

Page 1 of 1

City: Broomfield

State: CO

Zip Code: 80021

Site Contact:

Lab Contact: Lisa Artencook

Project Name and Location (State): CO School of Mines

Carrier/Waybill Number:

Contract/Purchase Order/Quote No.:

Analysis (Attach list if more space is needed)

Special Instructions/ Conditions of Receipt

Sample I.D. No. and Description (Containers for each sample may be combined on one line)	Date	Time	Matrix: Air	Aqueous	Sed.	Soil		Containers & Preservatives: Unpres.	H2SO4	HNO3	HCl	NaOH	ZnAc/NaOH		NO2/NO3	Ferric Fe	Ferrous Fe	Special Instructions/ Conditions of Receipt
CSMRI-4	3/17/09	1115		X				X							X			
	↓			X						X						X		
↓		↓		X				X									X	
CSMRI-5		[illegible]		X				X							X			
				X						X						X		
↓		↓		X				X									X	
CSMRI-1		[illegible]		X				X							X			
				X						X						X		
↓	↓	↓		X				X									X	

Possible Hazard Identification

☒ Non-Hazard ☐ Flammable ☐ Skin Irritant ☐ Poison B ☐ Unknown

Sample Disposal

☐ Return To Client ☑ Disposal By Lab ☐ Archive For ____ Months (A fee may be assessed if samples are retained longer than 1 month)

Turn Around Time Required

☐ 24 Hours ☐ 48 Hours ☐ 7 Days ☐ 14 Days ☐ 21 Days ☒ Other <10 days

QC Requirements (Specify)

1. Relinquished By — Date 3/17/09 — Time 1615
1. Received By — Date — Time
2. Relinquished By — Date — Time
2. Received By — Date — Time
3. Relinquished By — Date — Time
3. Received By — Date — Time

Comments

DISTRIBUTION: WHITE - Returned to Client with Report; CANARY - Stays with the Sample; PINK - Field Copy

Chain
Custody Record

4124 (0907)

Temperature on Receipt ______

Drinking Water? Yes ☐ No ☐

TestAmerica
THE LEADER IN ENVIRONMENTAL TESTING

Client: Stoller

Address: 105 Technology Dr #190

City: Broomfield State: CO Zip Code: 80021

Project Name and Location (State): CO School of Mines

Contract/Purchase Order/Quote No.:

Project Manager: Robert Hill

Telephone Number (Area Code)/Fax Number: (303) 546-4440

Site Contact:

Lab Contact: Lisa Antonczak

Carrier/Waybill Number:

Date: 3/18/09

Lab Number:

Chain of Custody Number: 405649

Page 1 of 1

Sample I.D. No. and Description (Containers for each sample may be combined on one line)	Date	Time	Matrix				Containers & Preservatives						Analysis (Attach list if more space is needed)		
			Air	Aqueous	Sed.	Soil	Unpres.	H2SO4	HNO3	HCl	NaOH	ZnAc/NaOH	NO2+NO3	Ferric Fe	Ferrous Fe
CSMRT-R	3/18/09	1200		X			X						X		
↓	↓	↓		X					X					X	
↓	↓	↓		X			X								X
CSMRT-2	↓	1300		X			X						X		

Special Instructions/ Conditions of Receipt

Possible Hazard Identification
☒ Non-Hazard ☐ Flammable ☐ Skin Irritant ☐ Poison B ☐ Unknown

Sample Disposal
☐ Return To Client ☒ Disposal By Lab ☐ Archive For ______ Months (A fee may be assessed if samples are retained longer than 1 month)

Turn Around Time Required
☐ 24 Hours ☐ 48 Hours ☐ 7 Days ☐ 14 Days ☐ 21 Days ☒ Other <10 days

QC Requirements (Specify)

1. Relinquished By: Date: 3/18/09 Time: 1335

1. Received By: Date: 3/18/09 Time: 1335

2. Relinquished By: Date: Time:

2. Received By: Date: Time:

3. Relinquished By: Date: Time:

3. Received By: Date: Time:

Comments

DISTRIBUTION: WHITE - Returned to Client with Report; CANARY - Stays with the Sample; PINK - Field Copy

P on Analytics
A Division of DataChem Laboratories, Inc.

225 Commerce Drive Fort Collins, CO 805
800-443-1511 or (970) 490-1511 (970) 490-1522 Fax

Accession Number (LAB ID) ______

Chain-of-Custody

Date 3/19/09 Page 1 of 6 **Originator: Retain pink copy!**

Project Name/No.: CO School of Mines **Sampler(s):** N Malczyk Turnaround (circle one) [✓ **Standard**] or **Rush (Due** ______) Dispose: **Date** ______ or **Return to Client**

Report To: Robert Hill
Phone: (303) 546-4440
Fax: (303) 443-1408
E-mail: rhill@stoller.com
Company: SM Stoller
Address: 105 Technology Dr #190
Broomfield, CO 80021

Circle method (right); provide additional information as needed (comments).

Sample ID	Date	Time *	Lab ID	Matrix	Preservative (indicate type... HCl, etc.)	No. of Containers	**VOCs** SW8260B	**BTEX (only)** SW8021B	**SVOCs** SW8270C	**OC Pesticides** SW8081A	**PCBs** SW8082	**Herbicides** SW8151A	**Explosives** SW8330	**TCLP Organics** SW1311 SW8260B 8270C 8081A 8151A	**TCLP Metals** SW1311 Hg SW6010B 7470	**Total Metals** by ICP Hg SW6010B 7470 7471 E200.7	**Dissolved Metals** by ICP Hg SW6010B 7470 E200.7	**Total Metals** by ICP/MS SW6020A E200.8	**Dissolved Metals** by ICP/MS SW6020A E200.8	**Hexavalent Chromium** SW7196A Alkaline Digest? Y / N	**Inorganic Anions** SW9056 E300.0 (specify in comments)	**Solids:** Total E160.3 TDS E160.1 TSS E160.2	**pH** SW9040B SW9045C	**TPH** SW8015B GRO DRO (circle one or both)	**Gross Alpha / Beta** SW9310 E900.0	**Actinides** by Paragon SOP Pu / U / Am / Th / Cm / ___	**Tritium** E906.0	**Total Alpha-Emitting Radium** SW9315 E903.0	**Radium 226** E903.1	**Radium 228** SW9320 E904.0	**Strontium 90** (Total RadioSr) D5811-00	**Gamma Isotopes** E901.1	**Radon 222** SM7510Rn	Dissolved Uranium	Cations	Dissolved phosphorus SCC 2
Equipment Blank	3/4/09	1020		W	HNO3	1																							X	X				X		
					HNO3	1																													X	
					—	1															X															
					H2SO4	1																														X
					H2SO4	1																														
SW-2		1215			HNO3	1																							X	X				X		
					HNO3	1																													X	
					—	1															X															
					H2SO4	1																														X
					H2SO4	1																														

* **Time Zone:** EST CST [✓ MST] PST **Matrix Key:** O = oil, S = soil, NS = non-soil solid, W = water, L = liquid, E = extract, F = filter

Comments:

All samples were filtered
Anions - HCO3, CO3, Alkalinity, Cl, SO4
Cations - Ca, Mg, K, Na

Relinquished By: (1)
Signature
Printed Name Nick Malczyk
Date 3/19/09 Time 0915
Company Stoller

Relinquished By: (2)
Signature ______
Printed Name ______
Date ______ Time ______
Company ______

Received By: (1)
Signature Lara J Orban
Printed Name Lara J Orban
Date 3/19/09 Time 0915
Company ALS Paragon

Received By: (2)
Signature ______
Printed Name ______
Date ______ Time ______
Company ______

Form 202r6.xls (6/16/06)

P.. on Analytics
A Division of DataChem Laboratories, Inc.

225 Commerce Drive Fort Collins, CO 805.
800-443-1511 or (970) 490-1511 (970) 490-1522 Fax

Accession Number (LAB ID) ____________

Chain-of-Custody Date 3/19/09 Page 2 of 6

Originator. Retain pink copy!

Project Name/No.: CO School of Mines **Sampler(s):** N Malczyk Turnaround (circle one) [✓ **Standard**] or **Rush (Due** ____________) Dispose: **Date** ________ or **Return to Client**

Report To:
Phone:
Fax: see page 1
E-mail:
Company:
Address:

Circle method (right); provide additional information as needed (comments).

Sample ID	Date	Time *	Lab ID	Matrix	Preservative (indicate type… HCl, etc.)	No. of Containers	VOCs SW8260B	BTEX (only) SW8021B	SVOCs SW8270C	OC Pesticides SW8081A	PCBs SW8082	Herbicides SW8151A	Explosives SW8330	TCLP Organics SW1311 SW8260B 8270C 8081A 8151A	TCLP Metals SW1311 Hg SW6010B 7470	Total Metals by ICP Hg SW6010B 7470 7471 E200.7	Dissolved Metals by ICP Hg SW6010B 7470 E200.7	Total Metals by ICP/MS SW6020A E200.8	Dissolved Metals by ICP/MS SW6020A E200.8	Hexavalent Chromium SW7196A Alkaline Digest? Y / N	Inorganic Anions SW9056 E300.0 (specify in comments)	Solids: Total E160.3 TDS E160.1 TSS E160.2	pH SW9040B SW9045C	TPH SW8015B GRO DRO (circle one or both)	Gross Alpha / Beta SW9310 E900.0	Actinides by Paragon SOP Pu / U / Am / Th / Cm / ___	Tritium E906.0	Total Alpha-Emitting Radium SW9315 E903.0	Radium 226 E903.1	Radium 228 SW9320 E904.0	Strontium 90 (Total RadioSr) D5811-00	Gamma Isotopes E901.1	Radon 222 SM7510Rn	Dissolved Uranium	Cations	Dissolved Phosphorus 365.2
SW-1	3/16/09	1515	[redacted]	W	HNO_3	1																							X	X				X		
			[redacted]		HNO_3	1																													X	
			[redacted]		–	1														X																
			[redacted]		H_2SO_4	1																														X
			[redacted]		H_2SO_4	1																														
CSMRI-9		1540	[redacted]		HNO_3	1																							X	X				X		
			[redacted]		HNO_3	1																													X	
			[redacted]		–	1														X																
			[redacted]		H_2SO_4	1																														X
			[redacted]		H_2SO_4	1																														

* **Time Zone:** EST CST [✓ MST] PST **Matrix Key:** O = oil, S = soil, NS = non-soil solid, W = water, L = liquid, E = extract, F = filter

Comments:

see page 1

Relinquished By: (1)
Signature
Printed Name Nick Malczyk
Date 3/19/09 Time 0915
Company Stoller

Relinquished By: (2)
Signature ____________
Printed Name ____________
Date ________ Time ________
Company ____________

Received By: (1)
Signature Lara Olsen
Printed Name Lara Olsen
Date 3/19/09 Time 0915
Company ALS Paragon

Received By: (2)
Signature ____________
Printed Name ____________
Date ________ Time ________
Company ____________

P ,on Analytics
A Division of DataChem Laboratories, Inc.

225 Commerce Drive Fort Collins, CO 805
800-443-1511 or (970) 490-1511 (970) 490-1522 Fax

Accession Number (LAB ID) ____________

Chain-of-Custody Date 3/16/09 Page 3 of 6 **Originator: Retain pink copy!**

Project Name/No.: CC School Fields **Sampler(s):** N Mleczyk Turnaround (circle one) [✓ **Standard**] or **Rush (Due** ____________) Dispose: **Date** ________ or **Return to Client**

Report To:
Phone:
Fax:
E-mail:
Company: see page 1
Address:

Circle method (right); provide additional information as needed (comments).

Sample ID	Date	Time *	Lab ID	Matrix	Preservative (indicate type... HCl, etc.)	No. of Containers	VOCs SW8260B	BTEX (only) SW8021B	SVOCs SW8270C	OC Pesticides SW8081A	PCBs SW8082	Herbicides SW8151A	Explosives SW8330	TCLP Organics SW1311 SW8260B 8270C 8081A 8151A	TCLP Metals SW1311 Hg SW6010B 7470	Total Metals by ICP Hg SW6010B 7470 7471 E200.7	Dissolved Metals by ICP Hg SW6010B 7470 E200.7	Total Metals by ICP/MS SW6020A E200.8	Dissolved Metals by ICP/MS SW6020A E200.8	Hexavalent Chromium SW7196A Alkaline Digest? Y / N	Inorganic Anions SW9056 E300.0 (specify in comments)	Solids: Total E160.3 TDS E160.1 TSS E160.2	pH SW9040B SW9045C	TPH SW8015B GRO DRO (circle one or both)	Gross Alpha / Beta SW9310 E900.0	Actinides by Paragon SOP Pu / U / Am / Th / Cm / ___	Tritium E906.0	Total Alpha-Emitting Radium SW9315 E903.0	Radium 226 E903.1	Radium 228 SW9320 E904.0	Strontium 90 (Total RadioSr) D5811-00	Gamma Isotopes E901.1	Radon 222 SM7510Rn	Dissolved Uranium	Cations	Dissolved Phosphorus 365.2
CSMW7-10	3/16/09	1100		W	HNO3	1																							X	X				X		
↓	↓	↓		↓	HNO3	1																													X	
					–	1															X															
					H2SO4	1																														X
					H2SO4	1																														
CSMW7-11	3/16/09	[illegible]			HNO3	1																							X	X				X		
↓	↓	↓			HNO3	1																													X	
					–	1															X															
					H2SO4	1																														X
				↓	H2SO4	1																														

* **Time Zone:** EST CST [✓ MST] PST **Matrix Key:** O = oil, S = soil, NS = non-soil solid, W = water, L = liquid, E = extract, F = filter

Comments:

see page 1

Relinquished By: (1)
Signature
Printed Name Nick Mleczyk
Date 3/16/09 Time [illegible]
Company Stoller

Relinquished By: (2)
Signature ____________
Printed Name ____________
Date ________ Time ________
Company ____________

Received By: (1)
Signature
Printed Name Lori J. Orten
Date 3/17/09 Time 0915
Company ALS Para

Received By: (2)
Signature ____________
Printed Name ____________
Date ________ Time ________
Company ____________

Form 202r6.xls (6/16/06)

P on Analytics
A Division of DataChem Laboratories, Inc.

225 Commerce Drive Fort Collins, CO 805
800-443-1511 or (970) 490-1511 (970) 490-1522 Fax

Accession Number (LAB ID)

Chain-of-Custody Date 3/19/09 Page 4 of 6 **Originator: Retain pink copy!**

Project Name/No.: CO School of Mines **Sampler(s):** M Maleryk Turnaround (circle one) [✓ Standard] or **Rush (Due** ____________) Dispose: **Date** __________ or **Return to Client**

Report To:
Phone:
Fax:
E-mail:
Company: see page 1
Address:

Circle method (right); provide additional information as needed (comments).

Sample ID	**Date**	**Time ***	**Lab ID**	**Matrix**	**Preservative** (indicate type... HCl, etc.)	**No. of Containers**	**VOCs** SW8260B	**BTEX (only)** SW8021B	**SVOCs** SW8270C	**OC Pesticides** SW8081A	**PCBs** SW8082	**Herbicides** SW8151A	**Explosives** SW8330	**TCLP Organics** SW1311 SW8260B 8270C 8081A 8151A	**TCLP Metals** SW1311 Hg SW6010B 7470	**Total Metals** by ICP Hg SW6010B 7470 7471 E200.7	**Dissolved Metals** by ICP Hg SW6010B 7470 E200.7	**Total Metals** by ICP/MS SW6020A E200.8	**Dissolved Metals** by ICP/MS SW6020A E200.8	**Hexavalent Chromium** SW7196A **Alkaline Digest?** Y / N	**Inorganic Anions** SW9056 E300.0 (specify in comments)	**Solids:** Total E160.3 TDS E160.1 TSS E160.2	**pH** SW9040B SW9045C	**TPH** SW8015B GRO DRO (circle one or both)	**Gross Alpha / Beta** SW9310 E900.0	**Actinides** by Paragon SOP Pu / U / Am / Th / Cm / ___	**Tritium** E906.0	**Total Alpha-Emitting Radium** SW9315 E903.0	**Radium 226** E903.1	**Radium 228** SW9320 E904.0	**Strontium 90** (Total RadioSr) D5811-00	**Gamma Isotopes** E901.1	**Radon 222** SM7510Rn	Dissolved Uranium	Cations	Dissolved Phosphorus 365.2
CSMRI 5	3/16/09	1215		W	HNO3	1																							X	X				X		
↓	↓	↓		↓	HNO3	1																													X	
↓	↓	↓		↓	—	1															X															
↓	↓	↓		↓	H2SO4	1																														X
↓	↓	↓		↓	H2SO4	1																														
CSMRI-1	↓	1415		↓	HNO3	1																							X	X				X		
↓	↓	↓		↓	HNO3	1																													X	
↓	↓	↓		↓	—	1															X															
↓	↓	↓		↓	H2SO4	1																														X
↓	↓	↓		↓	H2SO4	1																														

* **Time Zone:** EST CST [✓ MST] PST **Matrix Key:** O = oil, S = soil, NS = non-soil solid, W = water, L = liquid, E = extract, F = filter

Comments:

see page 1

Form 202r6.xls (6/16/06)

Relinquished By: (1)
Signature
Printed Name Mike Maleryk
Date 3/18/09 Time 0915
Company Stoller

Received By: (1)
Signature
Printed Name Lara Jordan
Date 3/19/09 Time 0815
Company ALS Paragon

Relinquished By: (2)
Signature ____________
Printed Name ____________
Date ________ Time ________
Company ____________

Received By: (2)
Signature ____________
Printed Name ____________
Date ________ Time ________
Company ____________

P on Analytics
A Division of DataChem Laboratories, Inc.

225 Commerce Drive Fort Collins, CO 805
800-443-1511 or (970) 490-1511 (970) 490-1522 Fax

Accession Number (LAB ID) ____________

Chain-of-Custody

Date 3/19/09 Page 5 of 6 **Originato.** **Retain pink copy!**

Project Name/No.: CO School of Mines **Sampler(s):** nick Malczyk Turnaround (circle one) [✓ **Standard**] or **Rush (Due** ________) **Dispose: Date** ________ or **Return to Client**

Report To:
Phone:
Fax:
E-mail:
Company: see page 1
Address:

Circle method (right); provide additional information as needed (comments).

Sample ID	Date	Time *	Lab ID	Matrix	Preservative (indicate type... HCl, etc.)	No. of Containers	VOCs SW8260B	BTEX (only) SW8021B	SVOCs SW8270C	OC Pesticides SW8081A	PCBs SW8082	Herbicides SW8151A	Explosives SW8330	TCLP Organics SW1311 SW8260B 8270C 8081A 8151A	TCLP Metals SW1311 Hg SW6010B 7470	Total Metals by ICP Hg SW6010B 7470 7471 E200.7	Dissolved Metals by ICP Hg SW6010B 7470 E200.7	Total Metals by ICP/MS SW6020A E200.8	Dissolved Metals by ICP/MS SW6020A E200.8	Hexavalent Chromium SW7196A Alkaline Digest? Y / N	Inorganic Anions SW9056 E300.0 (specify in comments)	Solids: Total E160.3 TDS E160.1 TSS E160.2	pH SW9040B SW9045C	TPH SW8015B GRO DRO (circle one or both)	Gross Alpha / Beta SW9310 E900.0	Actinides by Paragon SOP Pu / U / Am / Th / Cm / ___	Tritium E906.0	Total Alpha-Emitting Radium SW9315 E903.0	Radium 226 E903.1	Radium 228 SW9320 E904.0	Strontium 90 (Total RadioSr) D5811-00	Gamma Isotopes E901.1	Radon 222 SM7510Rn	Dissolved Uranium	Cations	Dissolved Phosphorus 365.2
CSMRT-1	3/18/09	1100		W	HNO3	1																							X	X			~~X~~	X		
					HNO3	1																													X	
					-	1															X															
					H2SO4	1																														X
↓		↓			H2SO4	1																														
CSMRT-2		1100			HNO3	1																							X	X				X		
					HNO3	1																													X	
					-	1															X															
					H2SO4	1																														X
↓	↓	↓		↓	H2SO4	1																														

* **Time Zone:** EST CST [✓ MST] PST **Matrix Key:** O = oil, S = soil, NS = non-soil solid, W = water, L = liquid, E = extract, F = filter

Comments:

see page 1

Relinquished By: (1)
Signature
Printed Name nick Malczyk
Date 3/19/09 Time [illegible]
Company Stoller

Received By: (1)
Signature Tara [illegible]
Printed Name [illegible]
Date 3/19/09 Time 0915
Company ALS Paragon

Relinquished By: (2)
Signature ____________
Printed Name ____________
Date ________ Time ________
Company ____________

Received By: (2)
Signature ____________
Printed Name ____________
Date ________ Time ________
Company ____________

F gon Analytics
A Division of DataChem Laboratories, Inc.

225 Commerce Drive Fort Collins, CO 80
800-443-1511 or (970) 490-1511 (970) 490-1522 Fax

Accession Number (LAB ID)

Chain-of-Custody

Date 3/19/09 Page 6 of 6

Origina **Retain pink copy!**

Project Name/No.: CO School of Mines **Sampler(s):** N Malczyk Turnaround (circle one) [✓ Standard] or **Rush (Due** ______) Dispose: **Date** ______ or **Return to Client**

Report To:
Phone:
Fax:
E-mail:
Company: see page 1
Address:

Circle method (right); provide additional information as needed (comments).

Sample ID	Date	Time *	Lab ID	Matrix	Preservative (indicate type... HCl, etc.)	No. of Containers	VOCs SW8260B	BTEX (only) SW8021B	SVOCs SW8270C	OC Pesticides SW8081A	PCBs SW8082	Herbicides SW8151A	Explosives SW8330	TCLP Organics SW1311 SW8260B 8270C 8081A 8151A	TCLP Metals SW1311 Hg SW6010B 7470	Total Metals by ICP Hg SW6010B 7470 7471 E200.7	Dissolved Metals by ICP Hg SW6010B 7470 E200.7	Total Metals by ICP/MS SW6020A E200.8	Dissolved Metals by ICP/MS SW6020A E200.8	Hexavalent Chromium SW7196A Alkaline Digest? Y / N	Inorganic Anions SW9056 E300.0 (specify in comments)	Solids: Total E160.3 TDS E160.1 TSS E160.2	pH SW9040B SW9045C	TPH SW8015B GRO DRO (circle one or both)	Gross Alpha / Beta SW9310 E900.0	Actinides by Paragon SOP Pu / U / Am / Th / Cm / ___	Tritium E906.0	Total Alpha-Emitting Radium SW9315 E903.0	Radium 226 E903.1	Radium 228 SW9320 E904.0	Strontium 90 (Total RadioSr) D5811-00	Gamma Isotopes E901.1	Radon 222 SM7510Rn	Dissolved Uranium	Cations	Dissolved Phosphorus 365.2
CS-MRJ-1B	3/17/09	1230		W	HNO3	1																							X	X				X		

* **Time Zone:** EST CST [✓ MST] PST **Matrix Key:** O = oil, S = soil, NS = non-soil solid, W = water, L = liquid, E = extract, F = filter

Comments:

see page 1

Relinquished By: (1)
Signature
Printed Name Nick Malczyk
Date 3/19/09 Time 0915
Company Stoller

Relinquished By: (2)
Signature ______
Printed Name ______
Date ______ Time ______
Company ______

Received By: (1)
Signature Lara J Orban
Printed Name Lara J Orban
Date 3/19/09 Time 0915
Company ALS Paragon

Received By: (2)
Signature ______
Printed Name ______
Date ______ Time ______
Company ______

Form 202r6.xls (6/16/06)

Table G-1
Historical Summary of Radioisotopes in Groundwater (Stoller)

Sample Station	Sample Date	Ra-226 (pCi/l)	Ra-228 (pCi/l)	Th-228 (pCi/l)	Th-230 (pCi/l)	Th-232 (pCi/l)	U-234 (pCi/l)	U-235 (pCi/l)	U-238 (pCi/l)	Total U (µg/l)
CSMRI-1	2/25/05	-0.11	0.81	0.007	0.07	0.01	0.77	0.043	0.53	1.61
	6/14/05	0.16	0.44	0.018	-0.021	0.012	0.43	0.011	0.217	0.64
	9/7/05	0.1	0.63	0.068	0.167	0.114	0.85	0.053	0.43	1.3
	12/20/05	-0.19	0.59	-0.045	0.32	0.014	0.94	0.073	0.46	1.41
	3/15/06	-0.15	0.58	0.025	0.032	-0.004	1.76	0.11	0.92	2.8
	6/14/06	0.42	0.05	0.15	-0.06	0.062	0.18	0.18	0.08	0.31
	9/13/06	0.25	0.34	0.11	-0.079	0.027	0.45	0.051	0.25	0.77
	3/1/07	0.32	0.78	0.052	-0.031	0.012	NT	NT	NT	1.2
	6/27/07	0.51	0.91	0.17	0.064	-0.005	NT	NT	NT	0.88
	9/11/07	-0.3	0.53	-0.031	0.019	0.001	NT	NT	NT	0.72
	11/27/07	-0.2	0.72	0.71	0.101	0.02	NT	NT	NT	1.2
	2/27/08	0.2	0.85	0.035	0.032	0.011	NT	NT	NT	1.5
	4/18/08	-0.02	0.66	-0.03	-0.004	0.01	NT	NT	NT	1.9
	9/25/08	0.26	0.88	NT	NT	NT	NT	NT	NT	0.96
	12/3/08	0.32	1.39	NT	NT	NT	NT	NT	NT	1.5
CSMRI-1B	3/8/07	0.13	1.19	-0.03	-0.09	0.02	NT	NT	NT	2.7
	6/26/07	0.09	0.3	0.001	0.002	0.012	NT	NT	NT	5
	9/11/07	-0.13	0.65	0.019	0.012	0.001	NT	NT	NT	6.3
	11/27/07	0.11	1.16	0.004	0.06	0.016	NT	NT	NT	6.9
	2/28/08	0.32	0.61	0.01	0.058	0.033	NT	NT	NT	6.5
	4/18/08	0.03	0.72	-0.004	-0.046	0	NT	NT	NT	6
	9/24/08	0.05	0.3	NT	NT	NT	NT	NT	NT	4
	12/5/08	0.02	0.88	NT	NT	NT	NT	NT	NT	4.6
CSMRI-2	2/25/05	0.8	1.85	0.07	-0.02	0.01	0.6	0.05	0.16	0.53
	6/14/05	1.47	3.0	0.14	0.003	0.026	0.68	0.025	0.299	0.89
	9/7/05	1.78	2.71	0.162	0.108	0.049	0.65	0.050	0.31	0.94
	12/20/05	1.35	1.62	0.108	0.285	0.024	0.83	0.002	0.35	1.06
	3/15/06	1.25	2.53	0.03	0.204	0.012	0.83	0.066	0.45	1.36
	6/14/06	0.99	1.79	0.25	0.22	0.049	0.69	0.04	0.25	0.76
	9/13/06	1.01	2.35	0.088	-0.039	-0.008	0.46	0.014	0.28	0.85
	3/8/07	0.76	2.15	0.022	-0.01	0.011	NT	NT	NT	0.72
	6/28/07	1.4	3.2	-0.075	-0.01	-0.007	NT	NT	NT	2
	9/11/07	0.78	3.2	0.016	0.101	0.014	NT	NT	NT	0.98
	11/27/07	0.45	2.05	0.037	0.035	0.006	NT	NT	NT	1
	2/28/08	1.37	2.26	0.043	0.085	0.044	NT	NT	NT	0.68
	4/17/08	1.08	1.89	0.041	-0.021	0.008	NT	NT	NT	0.89
	9/24/08	0.97	1.41	NT	NT	NT	NT	NT	NT	0.69
	12/5/08	1.1	1.88	NT	NT	NT	NT	NT	NT	0.83
CSMRI-4	2/25/05	-0.03	0.16	0.019	-0.009	0.013	9.7	0.53	8.2	24.7
	6/14/05	0.26	0.34	0.013	0.014	0.005	11.4	0.49	10.6	31.4
	9/7/05	0.17	0.78	-0.013	0.164	0.086	6.4	0.33	6.4	19.3

Table G-1
Historical Summary of Radioisotopes in Groundwater (Stoller)

Sample Station	Sample Date	Ra-226 (pCi/l)	Ra-228 (pCi/l)	Th-228 (pCi/l)	Th-230 (pCi/l)	Th-232 (pCi/l)	U-234 (pCi/l)	U-235 (pCi/l)	U-238 (pCi/l)	Total U (µg/l)
	12/20/05	0.13	0.1	0.033	0.311	0.012	11.5	0.61	11.4	34.3
	3/15/06	0	0.38	0.004	0.174	0.007	9	0.43	9	27.1
	6/15/06	0.41	0.39	0.11	0.17	0.061	9.2	0.4	8.9	26.8
	9/13/06	-0.05	0.79	0.056	-0.015	0.007	6.5	0.35	6	17.9
	3/8/07	0.09	0.37	-0.034	-0.037	0.013	NT	NT	NT	48
	6/27/07	0.07	0.87	0.011	0.035	0.004	NT	NT	NT	66
	9/11/07	0.99	1.12	0.024	0.112	0.021	NT	NT	NT	49
	11/26/07	0.33	0.73	0.029	0.149	0.016	NT	NT	NT	48
	2/27/08	0.24	0.78	0.011	0.038	0.014	NT	NT	NT	58
	4/17/08	0.11	0.71	0.017	-0.019	0.002	NT	NT	NT	62
	9/25/08	0.32	0.8	NT	NT	NT	NT	NT	NT	43
	12/5/08	0.09	0.97	NT	NT	NT	NT	NT	NT	61
CSMRI-5	2/25/05	1.06	0.53	0.009	0.007	0.034	1.22	0.056	0.93	2.8
	6/14/05	2.51	0.44	-0.018	0.039	0.011	1.51	0.086	1.2	3.57
	9/7/05	2.50	0.76	0.06	1.25	0.051	1.85	0.051	1.47	4.4
	12/20/05	1.97	0.52	0.032	0.126	0.01	1.45	0.066	1.21	3.63
	3/15/06	0.57	0.45	0.038	0.144	0.019	1.81	0.058	1.38	4.1
	6/15/06	2.13	0.87	0.145	0.08	0.043	1.03	0.13	0.92	2.8
	9/13/06	2.29	0.56	0.053	-0.053	0.005	3.18	0.17	2.32	7
	3/8/07	1.78	0.39	-0.012	-0.061	0	NT	NT	NT	5.8
	6/27/07	2.22	0.86	0.008	-0.023	0.013	NT	NT	NT	10
	9/11/07	1.91	1.2	0.091	0.003	0.006	NT	NT	NT	11
	11/26/07	1.52	0.49	0.004	-0.008	0.01	NT	NT	NT	6.6
	2/27/08	1.05	0.17	-0.011	0.02	0.051	NT	NT	NT	6.6
	4/17/08	1.37	0.64	0.068	0.029	0.017	NT	NT	NT	6.7
	9/25/08	2.87	0.47	NT	NT	NT	NT	NT	NT	10
	12/4/08	0.78	0.68	NT	NT	NT	NT	NT	NT	10
CSMRI-6B	2/27/07	NT	NT	NT	NT	NT	NT	NT	NT	NT
	6/26/07	0.46	0.63	-0.009	-0.006	0.024	NT	NT	NT	17
	9/10/07	0.15	0.91	0.046	0.025	0.023	NT	NT	NT	11
	11/27/07	-0.02	0.77	-0.002	0.069	0.004	NT	NT	NT	8.2
	2/28/08	0.26	1	-0.009	0.022	0.022	NT	NT	NT	4.7
	4/18/08	0.36	0.88	-0.005	-0.022	0.021	NT	NT	NT	5
CSMRI-6C	7/11/08 (DRY)	NT	NT	NT	NT	NT	NT	NT	NT	NT
CSMRI-7B	2/27/07	NT	NT	NT	NT	NT	NT	NT	NT	NT
	6/26/07	0.65	0.22	0.036	0.054	0.027	NT	NT	NT	68
	9/10/07	NT	NT	NT	NT	NT	NT	NT	NT	NT
		NT	NT	NT	NT	NT	NT	NT	NT	NT
		NT	NT	NT	NT	NT	NT	NT	NT	NT
	9/24/08	DRY	DRY	NT	NT	NT	NT	NT	NT	NT
	DRY	NT	NT	NT	NT	NT	NT	NT	NT	NT

Table G-1
Historical Summary of Radioisotopes in Groundwater (Stoller)

Sample Station	Sample Date	Ra-226 (pCi/l)	Ra-228 (pCi/l)	Th-228 (pCi/l)	Th-230 (pCi/l)	Th-232 (pCi/l)	U-234 (pCi/l)	U-235 (pCi/l)	U-238 (pCi/l)	Total U (µg/l)
CSMRI-8	3/8/07	0.7	1.06	0.072	-0.031	0.016	NT	NT	NT	1,100
	6/27/07	0.8	0.4	0.039	0.046	0.008	NT	NT	NT	810
	9/10/07	1.31	0.9	0.031	0.05	0.009	NT	NT	NT	630
	11/27/07	1.27	1.2	-0.02	0.074	-0.003	NT	NT	NT	1,300
	2/27/08	1.19	1.38	0.089	0.1	0.043	NT	NT	NT	1,200
	4/17/08	0.39	0.71	-0.015	-0.053	0.009	NT	NT	NT	770
	9/25/08	1.5	1.02	NT	NT	NT	NT	NT	NT	890
	12/5/08	1.55	1.44	NT	NT	NT	NT	NT	NT	1,900
CSMRI-9	2/27/07	0.12	0.53	-0.017	0.04	0.027	NT	NT	NT	7.9
	6/26/07	0.22	0.37	0.018	0.004	-0.015	NT	NT	NT	32
	9/10/07	0.5	1.01	0.04	-0.043	0.012	NT	NT	NT	35
	11/26/07	0.25	0.27	0.023	0.003	0.003	NT	NT	NT	28
	2/27/08	0.11	0.24	0.047	0.037	0.041	NT	NT	NT	24
	4/15/08	0.27	0.65	-0.004	0.015	0.022	NT	NT	NT	22
	9/24/08	0.11	0.48	NT	NT	NT	NT	NT	NT	28
	12/5/08	0.13	0.65	NT	NT	NT	NT	NT	NT	26
CSMRI-10	3/1/07	0.19	0.63	0.014	-0.004	0.018	NT	NT	NT	7.8
	6/26/07	0.26	0.43	-0.008	0.03	-0.005	NT	NT	NT	8.8
	9/10/07	-0.04	0.48	0.103	0.05	0.005	NT	NT	NT	9.9
	11/26/07	-0.05	0.57	0.068	0.141	0.031	NT	NT	NT	10
	2/26/08	0.12	0.44	0.094	0.011	0.019	NT	NT	NT	9.2
	4/15/08	0.03	0.56	-0.006	-0.05	0.005	NT	NT	NT	8.7
	9/24/08	0.21	0.48	NT	NT	NT	NT	NT	NT	11
	12/4/08	0.11	0.92	NT	NT	NT	NT	NT	NT	19
CSMRI-11	3/1/07	0.16	0.46	0.051	0.085	0.007	NT	NT	NT	4.8
	6/26/07	0.37	0.43	0.084	0	0.008	NT	NT	NT	8.4
	9/10/07	-0.26	0.52	0.012	0.006	0.016	NT	NT	NT	10
	11/26/07	0.16	0.87	0.089	0.099	-0.012	NT	NT	NT	11
	2/26/08	0.28	-0.03	0.044	0.044	0.074	NT	NT	NT	8.7
	4/15/08	0.35	0.75	-0.032	0.004	0.016	NT	NT	NT	7.6
	Not sampled	NT	NT	NT	NT	NT	NT	NT	NT	NT
CSMRI-11B	DRY	NT	NT	NT	NT	NT	NT	NT	NT	NT
MCL*		Total Ra = 5		NE	Th 230 + Th 232 = 60**		NE	NE	NE	30

*Maximum Contaminant Level – National Primary Drinking Water Regulations
**5 CCR 1002-41 Reg 41 – Colorado Groundwater Standards
pCi/l - picocuries per liter
NE – Not Established
NT – not tested
µg/l – micrograms per liter

Table G-2
Historical Summary of Metals in Groundwater (Stoller)
(All results in milligrams per liter)

Sample Station	Sample Date	Ag	As	Ba	Ca	Cd	Cr	Hg	K	Mg	Mo	Na	Pb	Se	V	Zn
CSMRI-1	2/25/05	ND	ND	ND	28	ND	ND	ND	2.8	9.4	ND	29	ND	ND	ND	0.032
	6/14/05	ND	ND	ND	17	ND	ND	ND	2.3	5.1	ND	16	ND	ND	ND	0.032
	9/7/05	ND	ND	0.055 (B)	21	ND	ND	ND	2.9	6.3	0.0021 (B)	25	ND	0.0041 (B)	ND	.034
	12/20/05	ND	ND	0.067 (B)	32	ND	ND	0.000034 (B)	2.9	10	ND	26	ND	ND	ND	0.052
	3/15/06	ND	ND	0.064 (B)	33	ND	ND	0.00002 (B)	2.6	10	0.0013 (B)	24	ND	ND	ND	0.049
	6/14/06	ND	ND	0.031 (B)	10	ND	ND	ND	1.9	3	0.0051 (B)	9.2	ND	0.0035 (B)	ND	0.015 (B)
	9/13/06	ND	ND	0.061 (B)	20	ND	0.041 (B)	ND	2.7	6	0.0038 (B)	14	ND	ND	ND	0.03
	3/1/07	ND	ND	0.081 (B)	39	0.00045 (B)	0.00063 (B)	0.000017 (B)	3	12	0.0059 (B)	26	ND	0.0066	ND	0.048
	6/27/07	ND	ND	0.063 (B)	23	ND	ND	0.0000073 (B)	2.4	9	ND	21	ND	ND	ND	0.017 (B)
	9/11/07	ND	ND	0.065 (B)	23	ND	0.00061 (B)	0.000011 (B)	2.5	7.2	0.002 (B)	14	ND	ND	ND	0.038
	11/27/07	ND	ND	0.075 (B)	31	ND	ND	0.000029 (B)	2.5	9.7	0.0014 (B)	18	ND	ND	ND	0.049
	2/27/08	ND	ND	0.08 (B)	36	ND	ND	ND	2.5	12	0.0013 (B)	22	ND	ND	ND	0.048
	4/18/08	ND	ND	0.081 (B)	36	ND	ND	ND	2.7	11	0.0015 (B)	22	ND	ND	ND	0.057
	9/25/08	NT	NT	NT	30	NT	NT	NT	3	9	NT	18	NT	NT	NT	NT
	12/3/08	NT	NT	NT	39	NT	NT	NT	3.5	12	NT	25	NT	NT	NT	NT
CSMRI-1B	3/1/07	ND	ND	0.098 (B)	130	ND	0.00014 (B)	0.000017 (B)	52	47	0.17	91	ND	0.0058	0.0009 (B)	ND
	6/26/07	ND	ND	0.071 (B)	83	ND	ND	0.0000072 (B)	10	38	0.029	35	ND	ND	ND	ND
	9/11/07	ND	ND	0.1	93	ND	ND	0.0000094 (B)	8.4	43	0.031	36	ND	ND	ND	0.0012 (B)
	11/27/07	ND	ND	0.11	100	ND	ND	0.000029 (B)	9.4	46	0.024	42	ND	ND	0.00073 (B)	0.0039 (B)
	2/28/08	ND	ND	0.11	97	ND	0.0015 (B)	ND	9.3	45	0.029	41	ND	0.0039 (B)	ND	0.0033 (B)
	4/18/08	ND	ND	0.11	93	ND	ND	ND	9.1	43	0.027	39	ND	ND	0.00065 (B)	ND
	9/24/08	NT	NT	NT	92	NT		NT	7.3	39	NT	38	NT	NT	NT	NT
	12/5/08	NT	NT	NT	95	NT	NT	NT	7.6	39	NT	40	NT	NT	NT	NT
CSMRI-2	2/25/05	ND	ND	0.11	72	ND	ND	ND	7.1	32	ND	19	ND	ND	ND	0.02
	6/14/05	ND	ND	0.1	76	ND	ND	ND	6.3	32	ND	18	ND	ND	ND	ND
	9/7/05	ND	ND	0.11	81	ND	ND	ND	7.1	35	ND	19	ND	ND	ND	0.011 (B)
	12/20/05	ND	ND	0.098 (B)	76	ND	ND	0.000031 (B)	6.7	33	ND	18	ND	ND	ND	0.0043 (B)
	3/15/06	ND	ND	0.09 (B)	74	ND	ND	0.000023 (B)	6.1	31	ND	17	ND	ND	ND	0.0059 (B)
	6/14/06	ND	ND	0.093 (B)	70	ND	ND	ND	6.3	31	0.0048 (B)	17	ND	0.0031 (B)	ND	0.0092 (B)
	9/13/06	ND	ND	0.11	81	ND	ND	ND	6.7	35	0.0014 (B)	19	ND	ND	ND	0.0092 (B)
	3/8/07	ND	0.0058 (B)	0.12	88	ND	ND	ND	8.3	39	ND	21	ND	0.03	ND	0.0011 (B)
	6/28/07	ND	ND	0.11	97	ND	ND	0.0000056 (B)	7.9	49	ND	26	ND	ND	0.002 (B)	0.0041 (B)
	9/11/07	ND	ND	0.1	91	ND	ND	0.000016 (B)	7.2	43	ND	23	ND	ND	0.00086 (B)	0.0082 (B)
	11/27/07	ND	ND	0.093 (B)	83	ND	ND	0.000023 (B)	7	38	ND	22	ND	ND	0.001 (B)	0.0075 (B)
	2/28/08	ND	ND	0.094 (B)	81	ND	0.0018 (B)	ND	6.6	38	ND	21	ND	ND	0.0017 (B)	0.0073 (B)
	4/17/08	ND	ND	0.092 (B)	78	ND	ND	ND	6.6	36	ND	20	ND	ND	0.0014 (B)	0.0055 (B)
	9/24/08	NT	NT	NT	74	NT	NT	NT	6.4	34	NT	19	NT	NT	NT	NT
	12/5/08	NT	NT	NT	75	NT	NT	NT	6.6	33	NT	20	NT	NT	NT	NT
CSMRI-4	2/25/05	ND	ND	ND	72	ND	ND	ND	5.1	31	0.017	29	ND	ND	ND	0.12
	6/14/05	ND	ND	ND	86	ND	ND	ND	6.6	34	0.038	34	ND	0.0063	ND	0.068
	9/7/05	ND	0.0035 (B)	0.055 (B)	82	ND	ND	ND	7.6	33	0.035	31	ND	0.0049 (B)	ND	0.097

Table G-2
Historical Summary of Metals in Groundwater (Stoller)
(All results in milligrams per liter)

Sample Station	Sample Date	Ag	As	Ba	Ca	Cd	Cr	Hg	K	Mg	Mo	Na	Pb	Se	V	Zn
	12/20/05	ND	ND	0.056 (B)	100	ND	ND	0.000045 (B)	6.8	43	0.024	34	ND	ND	ND	0.18
	3/15/06	ND	ND	0.042 (B)	81	ND	ND	0.000034 (B)	5	35	0.021	29	ND	ND	0.00056 (B)	0.21
	6/15/06	ND	0.0031 (B)	0.055 (B)	89	0.00085 (B)	ND	0.0000049 (B)	8.3	37	0.03	31	ND	ND	0.0011 (B)	0.11
	9/13/06	ND	ND	0.043 (B)	66	ND	ND	0.000016 (B)	8.3	27	0.038	30	ND	ND	ND	0.082
	3/8/07	ND	0.0057 (B)	0.072 (B)	120	0.00023 (B)	ND	0.000018 (B)	11	49	0.015	47	ND	0.019	ND	0.088
	6/27/07	ND	ND	0.067 (B)	110	ND	ND	0.000022 (B)	11	46	0.04	47	ND	ND	0.00073 (B)	0.14
	9/11/07	ND	0.0045 (B)	0.089 (B)	120	0.0011 (B)	0.0014 (B)	0.000037 (B)	12	49	0.05	41	ND	ND	0.0012 (B)	0.17
	11/26/07	ND	ND	0.081 (B)	110	0.00049 (B)	ND	0.000035 (B)	10	50	0.024	43	ND	ND	0.0011 (B)	0.1
	2/27/08	ND	ND	0.073 (B)	130	ND	ND	0.000016 (B)	8.2	58	0.015	45	ND	0.0034 (B)	ND	0.069
	4/17/08	ND	0.0063 (B)	0.089 (B)	150	0.00047 (B)	ND	0.000016 (B)	10	66	0.014	53	ND	ND	0.00078 (B)	0.087
	9/25/08	NT	NT	NT	130	NT	NT	NT	13	55	NT	50	NT	NT	NT	NT
	12/5/08	NT	NT	NT	130	NT	NT	NT	11	54	NT	48	NT	NT	NT	NT
CSMRI-5	2/25/05	ND	ND	ND	54	ND	ND	ND	3.4	22	ND	27	ND	ND	ND	0.067
	6/14/05	ND	ND	ND	63	ND	ND	ND	3.3	23	ND	28	ND	ND	ND	0.047
	9/7/05	ND	ND	0.085 (B)	85	ND	ND	ND	4.2	31	0.0042 (B)	35	ND	0.0037 (B)	0.0018 (B)	0.089
	12/20/05	ND	ND	0.072 (B)	79	0.00071 (B)	ND	0.000048 (B)	4.1	30	0.002 (B)	31	ND	ND	0.0012 (B)	0.17
	3/15/06	ND	ND	0.058 (B)	70	0.00037 (B)	ND	0.000029 (B)	3.5	26	0.0031 (B)	29	ND	0.0035 (B)	0.00067 (B)	0.11
	6/15/06	ND	ND	0.052 (B)	51	ND	ND	0.000012 (B)	3.6	19	0.0028 (B)	26	ND	ND	ND	0.055
	9/13/06	ND	ND	0.087 (B)	110	ND	0.0022 (B)	ND	4.5	41	0.0027 (B)	50	ND	ND	0.001 (B)	0.11
	3/8/07	ND	0.0037 (B)	0.063 (B)	80	ND	ND	ND	4.5	31	0.0019 (B)	34	ND	0.015	ND	0.083
	6/27/07	ND	ND	0.066 (B)	98	ND	ND	0.0000091 (B)	4.5	40	0.006 (B)	40	ND	ND	0.0017 (B)	0.025
	9/11/07	ND	ND	0.13	110	ND	0.00082 (B)	0.000023 (B)	4.9	44	0.0042 (B)	47	ND	ND	0.0015 (B)	0.054
	11/26/07	ND	ND	0.087 (B)	110	ND	0.00089 (B)	0.000032 (B)	4.5	42	ND	47	ND	ND	0.0012 (B)	0.12
	2/27/08	ND	ND	0.073 (B)	100	ND	ND	ND	4.3	40	ND	42	ND	ND	ND	0.094
	4/17/08	ND	ND	0.078 (B)	100	ND	ND	0.000018 (B)	4.6	40	0.0011 (B)	41	ND	ND	0.0011 (B)	0.093
	9/25/08	NT	NT	NT	160	NT	NT	NT	5.5	61	NT	59	NT	NT	NT	NT
	12/4/08	NT	NT	NT	110	NT	NT	NT	4.8	40	NT	47	NT	NT	NT	NT
CSMRI-6B	2/27/08	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
	6/26/07	ND	ND	0.12	100	ND	ND	0.0000059 (B)	5.9	56	0.004 (B)	41	ND	ND	ND	ND
	9/10/07	ND	0.0046 (B)	0.15	110	ND	0.00088 (B)	0.000013 (B)	4.8	48	0.0022 (B)	46	ND	ND	0.00081 (B)	0.0051 (B)
	11/27/07	ND	0.0048 (B)	0.17	110	ND	ND	0.000025 (B)	6	49	0.0028 (B)	57	ND	0.0051	0.00066 (B)	ND
	2/28/08	ND	ND	0.17	100	ND	ND	ND	5.8	43	0.004 (B)	49	ND	ND	ND	0.0048
	4/18/08	ND	ND	0.17	96	ND	ND	ND	6.1	40	0.0059 (B)	45	ND	ND	0.0013 (B)	0.0099 (B)
CSMRI-6C	DRY	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
CSMRI-7B	2/27/07	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
	6/26/07	ND	ND	0.056 (B)	70	ND	ND	0.000006 (B)	5.5	37	0.024	53	ND	ND	0.00061 (B)	0.0041 (B)
	9/10/07	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
	DRY--	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
	2/27/08	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
	DRY	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
	DRY	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT

Table G-2
Historical Summary of Metals in Groundwater (Stoller)
(All results in milligrams per liter)

Sample Station	Sample Date	Ag	As	Ba	Ca	Cd	Cr	Hg	K	Mg	Mo	Na	Pb	Se	V	Zn
	DRY	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
CSMRI-8	3/807	ND	0.0053 (B)	0.068 (B)	230	ND	ND	ND	23	72	0.094	74	ND	0.034	ND	0.0024 (B)
	6/27/07	ND	ND	0.053 (B)	190	ND	ND	0.0000099 (B)	19	55	0.043	52	ND	ND	ND	0.069
	9/10/07	ND	0.0069 (B)	0.076 (B)	160	ND	0.00074 (B)	0.000027 (B)	15	49	0.034	54	0.0018 (B)	ND	ND	0.025
	11/27/07	ND	ND	0.091 (B)	230	ND	ND	0.000024 (B)	15	67	0.026	70	ND	0.0046 (B)	0.001 (B)	0.011 (B)
	2/27/08	ND	0.036 (B)	0.07 (B)	270	ND	ND	ND	15	82	0.019	100	ND	ND	ND	0.038
	4/17/08	ND	ND	0.046 (B)	210	ND	0.0011 (B)	ND	13	63	0.016	73	ND	ND	ND	0.032
	9/25/08	NT	NT	NT	230	NT	NT	NT	17	68	NT	70	NT	NT	NT	NT
	12/5/08	NT	NT	NT	400	NT	NT	NT	18	95	NT	84	NT	NT	NT	NT
CSMRI-9	2/27/07	ND	ND	0.08 (B)	69	ND	0.0011 (B)	0.000024 (B)	12	31	0.045	33	ND	0.011	0.001 (B)	ND
	6/26/07	ND	ND	0.049 (B)	160	ND	ND	0.000002 (B)	8.5	77	0.0028	150	ND	0.0049 (B)	0.00096 (B)	0.0096 (B)
	9/10/07	ND	0.004 (B)	0.059 (B)	100	ND	0.0009 (B)	0.000016 (B)	6	51	0.0037 (B)	49	ND	ND	0.00071 (B)	0.0097 (B)
	11/26/07	ND	ND	0.078 (B)	110	0.00051 (B)	0.0011 (B)	0.000031 (B)	5.9	56	0.0023 (B)	52	ND	0.0054	0.0012 (B)	0.015 (B)
	2/27/08	ND	ND	0.079 (B)	110	ND	ND	ND	5.4	56	ND	49	ND	0.0033 (B)	ND	0.011
	4/15/08	ND	ND	0.077 (B)	100	ND	ND	0.000013 (B)	5	52	0.0017 (B)	46	ND	ND	0.00077 (B)	0.0079 (B)
	9/24/08	NT	NT	NT	110	NT	NT	NT	5.8	54	NT	50	NT	NT	NT	NT
	12/5/08	NT	NT	NT	100	NT	NT	NT	5.3	48	NT	46	NT	NT	NT	NT
CSMRI-10	3/1/07	0.00051 (B)	ND	0.064 (B)	79	ND	0.0013 (B)	0.000024 (B)	7.3	33	0.01	36	ND	0.01	0.0011 (B)	ND
	6/26/07	ND	ND	0.079 (B)	100	ND	ND	0.0000063 (B)	4.7	44	ND	37	ND	0.0044 (B)	0.00055 (B)	ND
	9/10/07	ND	0.0039 (B)	0.071 (B)	89	ND	0.0012 (B)	0.00002 (B)	4.2	38	0.0014 (B)	36	ND	ND	0.00099 (B)	0.0042 (B)
	11/26/07	ND	ND	0.085 (B)	110	ND	ND	0.000026 (B)	4.7	43	ND	41	ND	ND	ND	ND
	2/26/08	ND	ND	0.09 (B)	110	ND	ND	ND	4.6	46	ND	41	ND	ND	ND	0.0052
	4/15/08	ND	ND	0.088 (B)	100	ND	0.0044 (B)	ND	4.5	44	ND	40	ND	ND	0.00059 (B)	0.0018 (B)
	9/24/08	NT	NT	NT	100	NT	NT	NT	4.6	42	NT	41	NT	NT	NT	NT
	12/4/08	NT	NT	NT	100	NT	NT	NT	4.8	41	NT	43	NT	NT	NT	NT
CSMRI-11	2/27/07	ND	ND	0.073 (B)	75	ND	0.00013 (B)	0.000023 (B)	9.7	29	0.033	33	ND	0.013	0.00073 (B)	0.0023 (B)
	6/26/07	ND	ND	0.096 (B)	110	ND	0.0012 (B)	0.0000071 (B)	5.4	44	0.0014 (B)	39	ND	0.0064	0.00059 (B)	ND
	9/10/07	ND	0.004 (B)	0.071 (B)	96	ND	0.00083 (B)	0.000016 (B)	4.5	39	0.0016 (B)	44	ND	ND	0.00078(B)	0.0033 (B)
	11/26/07	ND	ND	0.11	110	ND	ND	0.000028 (B)	4.9	44	0.0012 (B)	40	ND	ND	0.0013 (B)	ND
	2/26/08	ND	ND	0.11	110	ND	ND	ND	4.6	42	ND	44	ND	ND	ND	0.0048
	4/15/08	ND	ND	0.12	100	ND	ND	ND	4.7	41	ND	44	ND	ND	ND	ND
CSMRI-11B	DRY	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
Detection Limits		0.01	0.01	0.1	1	0.005	0.01	0.0002	1	1	0.01	1	0.003	0.005	0.01	0.02
MCL*		NE	0.01	2	NE	0.005	0.1	0.002	NE	NE	NE	NE	0.015	0.05	NE	NE

*Maximum Contaminant Level – National Primary Drinking Water Regulations

ND – non detect

NE – not established

NT – not tested

(B) – Detected above Instrument Detection Level but below Reported Detection Level

Table G-3
Historical Summary of Radioisotopes in Surface Water (Stoller)

Sample Station	Sample Date	Ra-226 (pCi/l)	Ra-228 (pCi/l)	Th-228 (pCi/l)	Th-230 (pCi/l)	Th-232 (pCi/l)	U-234 (pCi/l)	U-235 (pCi/l)	U-238 (pCi/l)	Total U (µg/l)
SW-1	2/25/05	0	0.58	0.018	-0.026	-0.001	0.89	0.083	0.65	1.97
	6/14/05	0.14	0.05	0.05	-0.025	0.016	0.246	0.021	0.251	0.75
	9/7/05	0.18	0.42	0.041	0.25	0.102	0.35	0.031	0.35	1.04
	12/20/05	-0.31	0.47	0.028	0.197	-0.005	0.64	0.041	0.7	2.11
	3/15/06	-0.16	0.35	0.059	0.125	0.005	0.6	0.029	0.53	1.59
	6/14/06	0.13	0.45	0.16	0.53	0.062	0.11	0.08	0.19	0.61
	9/13/06	-0.03	0.25	-0.019	-0.035	0.01	0.37	-0.005	0.34	1
	3/1/07	-0.1	0.25	-0.038	0.15	0.026	NT	NT	NT	1.7
	6/27/07	0.13	0.77	0.006	0.016	0.014	NT	NT	NT	0.6
	9/11/07	0.15	0.74	0.063	0.088	0.012	NT	NT	NT	0.94
	11/27/07	0.2	0.24	0.026	0.049	0.025	NT	NT	NT	1.8
	2/27/08	0.1	0.48	0.014	0.002	0.024	NT	NT	NT	2
	4/18/08	0.06	-0.07	-0.023	-0.026	0.012	NT	NT	NT	1.9
	9/25/08	0.18	-0.01	NT	NT	NT	NT	NT	NT	1.1
	12/3/08	-0.06	0.34	NT	NT	NT	NT	NT	NT	1.6
SW-2	2/25/05	0.45	0.06	0.011	-0.016	0.033	0.8	0.066	0.42	1.29
	6/14/05	0.04	0.29	0.071	-0.028	0.007	0.259	0.032	0.23	0.69
	9/7/05	-0.08	0.24	-0.013	0.107	0.051	0.54	0.014	0.54	1.62
	12/20/05	0.09	0.07	-0.003	0.126	0	0.71	0.067	0.49	1.5
	3/15/06	-0.04	-0.15	0.009	0.184	0.01	0.79	0.004	0.51	1.52
	6/14/06	0.03	0.04	0.172	0.24	0.1	0.39	0	0.48	1.44
	9/13/06	0.11	0.35	0.009	-0.03	0.01	0.43	-0.006	0.3	0.89
	3/8/07	0.12	0.73	0.047	-0.055	0	NT	NT	NT	1.7
	6/28/07	0.02	0.78	0.028	0.014	0	NT	NT	NT	0.57
	9/11/07	0.1	0.27	0.066	0.068	0.002	NT	NT	NT	0.97
	11/26/07	0.11	0.36	0.007	0	0.012	NT	NT	NT	1.7
	2/26/08	0.1	0	-0.01	0.113	0.011	NT	NT	NT	2
	4/18/08	0.13	0.58	0.015	0.24	0.024	NT	NT	NT	1.8
	9/24/08	-0.16	-0.02	NT	NT	NT	NT	NT	NT	0.99
	12/3/08	0.1	0.46	NT	NT	NT	NT	NT	NT	1.5
MCL*		Total Ra = 5		NE	Th 230 + Th 232 = 60**		NE	NE	NE	30

*Maximum Contaminant Level – National Primary Drinking Water Regulations
**5 CCR 1002-31 Reg 31 – Colorado Surface Water Standards
pCi/l - picoCuries per liter
µg/l – micrograms per liter

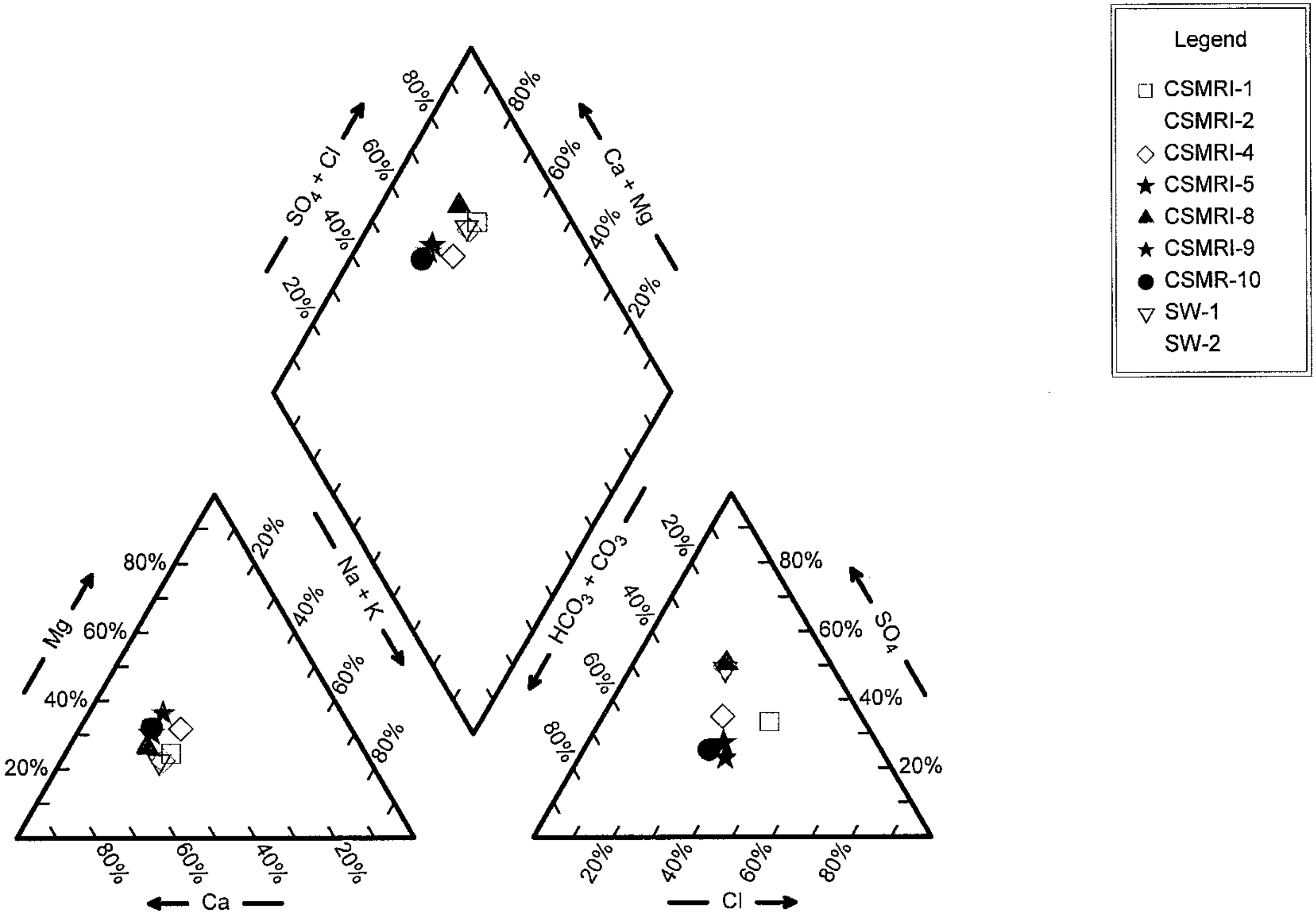
Table G-4
Historical Summary of Metals in Surface Water (Stoller)
(All results in milligrams per liter)

Sample Station	Sample Date	Ag	As	Ba	Ca	Cd	Cr	Hg	K	Mg	Mo	Na	Pb	Se	V	Zn
SW-1	2/25/05	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.2
	6/14/05	ND	ND	ND	11	ND	ND	ND	1.1	2.8	ND	5.2	ND	ND	ND	0.09
	9/7/05	ND	0.0037 (B)	0.029 (B)	20	ND	ND	ND	2.2	4.4	0.0044 (B)	8.5	ND	0.0045 (B)	ND	0.063
	12/20/05	ND	ND	0.042 (B)	35	0.00057 (B)	ND	0.000034 (B)	3.7	7.6	0.004 (B)	19	ND	ND	ND	0.22
	3/15/06	ND	ND	0.04 (B)	37	0.00084 (B)	0.00047 (B)	0.000024 (B)	3.7	8.5	0.0048 (B)	23	ND	ND	0.00067 (B)	0.19
	6/14/06	0.0012 (B)	0.0032 (B)	0.011 (B)	8.2	ND	ND	ND	1	1.9	0.0042 (B)	3.1	ND	ND	ND	0.029
	9/13/06	ND	ND	0.03 (B)	21	ND	ND	ND	2.1	4.4	0.0049 (B)	8.6	ND	ND	ND	0.053
	3/1/07	ND	ND	0.049 (B)	44	0.0011 (B)	0.00092 (B)	0.000023 (B)	4.3	11	0.0046 (B)	26	ND	ND	ND	0.22
	6/27/07	ND	ND	0.018 (B)	10	ND	ND	0.0000068 (B)	0.93 (B)	2.5	0.0017 (B)	3.2	ND	ND	ND	0.067
	9/11/07	ND	ND	0.032 (B)	21	ND	ND	0.000019	1.7	5	0.0029 (B)	7.4	ND	ND	ND	0.078
	11/27/07	ND	ND	0.042 (B)	33	0.00076 (B)	ND	0.00027 (B)	2.8	8.2	0.0032 (B)	15	ND	ND	ND	0.18
	2/27/08	ND	ND	0.042 (B)	36	ND	ND	ND	3.3	9.6	0.0022 (B)	19	ND	ND	ND	0.15
	4/18/08	ND	ND	0.044 (B)	35	0.00044 (B)	ND	ND	3.4	9	0.0034 (B)	23	ND	ND	ND	0.13
	9/25/08	NT	NT	NT	23	NT	NT	NT	1.9	5.1	NT	9	NT	NT	NT	NT
	12/3/08	NT	NT	NT	32	NT	NT	NT	3	7.1	NT	15	NT	NT	NT	NT
SW-2	2/25/05	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.17
	6/14/05	ND	ND	ND	11	ND	ND	ND	1.1	2.8	ND	4.8	ND	ND	ND	0.085
	9/7/05	ND	ND	0.028 (B)	20	ND	ND	ND	2.1	4.4	0.0037 (B)	8.7	ND	0.0037 (B)	ND	0.051
	12/20/05	ND	ND	0.042 (B)	35	0.00043 (B)	ND	0.000034 (B)	3.8	8	0.0038 (B)	19	ND	ND	ND	0.21
	3/15/06	ND	ND	0.042 (B)	39	0.00053 (B)	0.00055 (B)	0.000022 (B)	3.8	8.9	0.0046 (B)	25	ND	ND	0.00053 (B)	0.2
	6/14/06	ND	0.0022 (B)	0.011 (B)	8.4	ND	ND	ND	1	1.9	0.0045 (B)	3	ND	ND	ND	0.031
	9/13/06	ND	ND	0.03 (B)	21	ND	ND	ND	2.1	4.4	0.0048 (B)	8.5	ND	ND	ND	0.04
	3/8/07	ND	0.0053 (B)	0.049 (B)	39	0.00064 (B)	ND	ND	4.2	9.8	0.0014 (B)	22	ND	ND	ND	0.17
	6/28/07	ND	ND	0.019 (B)	10	ND	ND	0.0000056 (B)	0.93 (B)	2.6	ND	3.3	ND	ND	ND	0.075
	9/11/07	ND	ND	0.033 (B)	21	ND	ND	0.00001	1.7	5.1	0.0035 (B)	7.5	ND	ND	ND	0.084
	11/26/07	ND	ND	0.044 (B)	35	0.0005 (B)	ND	0.00027 (B)	2.9	8.6	0.0027 (B)	15	ND	ND	ND	0.19
	2/26/08	ND	ND	0.051	35	0.0005 (B)	ND	ND	3.1	9.2	0.0023 (B)	21	ND	ND	ND	0.15
	4/18/08	ND	ND	0.045 (B)	35	0.0005 (B)	ND	ND	3.4	9.1	0.0031 (B)	23	ND	ND	ND	0.14
	9/24/08	NT	NT	NT	23	NT	NT	NT	1.9	5.1	NT	9	NT	NT	NT	NT
	12/3/08	NT	NT	NT	31	NT	NT	NT	3	7.5	NT	15	NT	NT	NT	NT
Detection Limits		0.01	0.01	0.1	1	0.005	0.01	0.0002	1	1	0.01	1	0.003	0.005	0.01	0.02
MCL*		0.01	0.01	2	NE	0.005	0.1	0.002	NE	NE	NE	NE	0.015	0.05	NE	NE

*Maximum Contaminant Level National Primary Drinking Water Regulations
ND – Non Detect
NE – Not Established
(B) – Detected above Instrument Detection Level but below Reported Detection Level

Appendix H
Anion and Cation Balances and Piper Diagram

Piper Diagram CSMRI 2009 Quarter 1



CSMRI-1

Water Type	Ca-Cl		
Dissolved Solids	326.17 mg/kg	325.28 mg/L	Calculated
Density	0.99728 g/cm^3		Calculated
Conductivity	473 µmho/cm		Measured
Hardness (as $CaCO_3$)			
Total	172.99 mg/kg	172.51 mg/L	Calculated
Carbonate	126.93	126.58	
Non-Carbonate	46.057	45.932	

CSMRI-1

Primary Tests		
Anion-Cation Balance		
Anions	5.05	
Cations	4.7	
% Difference	3.573	Not within ± 2%
Measured TDS = Calculated TDS		
Measured	N/A	
Calculated	326.168	
Ratio	N/A	
Measured EC = Calculated EC		
Measured	473.000	
Calculated	513.096	
Ratio	0.922	OK
Secondary Tests		
Measured EC and Ion Sums:		
Anions	1.067008	Within preferred range (0.9-1.1)
Cations	0.993392	Within preferred range (0.9-1.1)
Calculated TDS to EC ratio	0.690	OK
Measured TDS to EC ratio		
Measured TDS unavailable		
Organic Mass Balance		
DOC ≥ Sum of Organics		
Dissolved Organic Carbon	1.000 mg/L	
Sum of Organics	0.000 mg/L	OK

CSMRI-2

Water Type	Ca-HCO_3		
Dissolved Solids	542.79 mg/kg	541.4 mg/L	Calculated
Density	0.99744 g/cm^3		Calculated
Conductivity	43 µmho/cm		Measured
Hardness (as $CaCO_3$)			
Total	330.63 mg/kg	329.78 mg/L	Calculated
Carbonate	330.63	329.78	
Non-Carbonate	0.0	0.0	

CSMRI-2

Primary Tests		
Anion-Cation Balance		
Anions	6.92	
Cations	7.58	
% Difference	4.541	Not within ± 2%
Measured TDS = Calculated TDS		
Measured	N/A	
Calculated	542.789	
Ratio	N/A	
Measured EC = Calculated EC		
Measured	43.000	
Calculated	638.817	
Ratio	0.067	Not within range 0.9 to 1.1
Secondary Tests		
Measured EC and Ion Sums:		
Anions	16.097630	Not within preferred range (0.9-1.1)
Cations	17.629173	Not within preferred range (0.9-1.1)
Calculated TDS to EC ratio	12.623	Not within preferred range (0.55-0.7)
Measured TDS to EC ratio		
Measured TDS unavailable		
Organic Mass Balance		
DOC ≥ Sum of Organics		
Dissolved Organic Carbon	1.000 mg/L	
Sum of Organics	0.000 mg/L	OK

CSMRI-4

Water Type	Ca-SO_4		
Dissolved Solids	811.81 mg/kg	809.9 mg/L	Calculated
Density	0.99764 g/cm^3		Calculated
Conductivity	889 µmho/cm		Measured
Hardness (as $CaCO_3$)			
Total	436.04 mg/kg	435.01 mg/L	Calculated
Carbonate	436.04	435.01	
Non-Carbonate	0.0	0.0	

CSMRI-4

<u>**Primary Tests**</u>		
Anion-Cation Balance		
Anions	11.3	
Cations	11.7	
% Difference	1.645	OK
Measured TDS = Calculated TDS		
Measured	N/A	
Calculated	811.813	
Ratio	N/A	
Measured EC = Calculated EC		
Measured	889.000	
Calculated	1073.200	
Ratio	0.828	Not within range 0.9 to 1.1
<u>**Secondary Tests**</u>		
Measured EC and Ion Sums:		
Anions	1.270385	Not within preferred range (0.9-1.1)
Cations	1.312881	Not within preferred range (0.9-1.1)
Calculated TDS to EC ratio	0.913	Not within preferred range (0.55-0.7)
Measured TDS to EC ratio		
Measured TDS unavailable		
<u>**Organic Mass Balance**</u>		
DOC ≥ Sum of Organics		
Dissolved Organic Carbon	3.700 mg/L	
Sum of Organics	0.000 mg/L	OK

CSMRI-5

Water Type	Ca-HCO_3		
Dissolved Solids	707.12 mg/kg	705.4 mg/L	Calculated
Density	0.99756 g/cm^3		Calculated
Conductivity	1170 µmho/cm		Measured
Hardness (as $CaCO_3$)			
Total	440.46 mg/kg	439.39 mg/L	Calculated
Carbonate	411.64	410.64	
Non-Carbonate	28.823	28.752	

CSMRI-5

<u>Primary Tests</u>		
Anion-Cation Balance		
Anions	10	
Cations	10.8	
% Difference	3.869	OK
Measured TDS = Calculated TDS		
Measured	N/A	
Calculated	707.122	
Ratio	N/A	
Measured EC = Calculated EC		
Measured	1170.000	
Calculated	974.467	
Ratio	1.201	Not within range 0.9 to 1.1
<u>Secondary Tests</u>		
Measured EC and Ion Sums:		
Anions	0.854885	Not within preferred range (0.9-1.1)
Cations	0.923698	Within preferred range (0.9-1.1)
Calculated TDS to EC ratio	0.604	OK
Measured TDS to EC ratio		
Measured TDS unavailable		
<u>Organic Mass Balance</u>		
DOC ≥ Sum of Organics		
Dissolved Organic Carbon	2.100 mg/L	
Sum of Organics	0.000 mg/L	OK

CSMRI-8

Water Type	Ca-SO_4		
Dissolved Solids	1517.8 mg/kg	1515 mg/L	Calculated
Density	0.99818 g/cm^3		Calculated
Conductivity	2320 µmho/cm		Measured
Hardness (as $CaCO_3$)			
Total	930.68 mg/kg	928.98 mg/L	Calculated
Carbonate	608.59	607.48	
Non-Carbonate	322.09	321.5	

CSMRI-8

<u>**Primary Tests**</u>		
Anion-Cation Balance		
Anions	21.8	
Cations	23.1	
% Difference	2.984	OK
Measured TDS = Calculated TDS		
Measured	N/A	
Calculated	1517.769	
Ratio	N/A	
Measured EC = Calculated EC		
Measured	2320.000	
Calculated	1969.830	
Ratio	1.178	Not within range 0.9 to 1.1
<u>**Secondary Tests**</u>		
Measured EC and Ion Sums:		
Anions	0.938672	Within preferred range (0.9-1.1)
Cations	0.996412	Within preferred range (0.9-1.1)
Calculated TDS to EC ratio	0.654	OK
Measured TDS to EC ratio		
Measured TDS unavailable		
<u>**Organic Mass Balance**</u>		
DOC ≥ Sum of Organics		
Dissolved Organic Carbon	3.600 mg/L	
Sum of Organics	0.000 mg/L	OK

CSMRI-9

Water Type	Ca-HCO_3		
Dissolved Solids	708.42 mg/kg	706.7 mg/L	Calculated
Density	0.99757 g/cm^3		Calculated
Conductivity	725 μmho/cm		Measured
Hardness (as $CaCO_3$)			
Total	452.58 mg/kg	451.48 mg/L	Calculated
Carbonate	428.08	427.04	
Non-Carbonate	24.501	24.441	

CSMRI-9

Primary Tests		
Anion-Cation Balance		
Anions	10.1	
Cations	11.1	
% Difference	4.743	OK
Measured TDS = Calculated TDS		
Measured	N/A	
Calculated	708.425	
Ratio	N/A	
Measured EC = Calculated EC		
Measured	725.000	
Calculated	982.477	
Ratio	0.738	Not within range 0.9 to 1.1
Secondary Tests		
Measured EC and Ion Sums:		
Anions	1.392368	Not within preferred range (0.9-1.1)
Cations	1.531034	Not within preferred range (0.9-1.1)
Calculated TDS to EC ratio	0.977	Not within preferred range (0.55-0.7)
Measured TDS to EC ratio		
Measured TDS unavailable		
Organic Mass Balance		
DOC ≥ Sum of Organics		
Dissolved Organic Carbon	1.700 mg/L	
Sum of Organics	0.000 mg/L	OK

CSMR-10

Water Type	Ca-HCO_3		
Dissolved Solids	712.63 mg/kg	710.9 mg/L	Calculated
Density	0.99757 g/cm^3		Calculated
Conductivity	692 µmho/cm		Measured
Hardness (as $CaCO_3$)			
Total	452.84 mg/kg	451.74 mg/L	Calculated
Carbonate	444.53	443.44	
Non-Carbonate	8.3197	8.2995	

CSMR-10

Primary Tests		
Anion-Cation Balance		
Anions	10	
Cations	11	
% Difference	4.780	OK
Measured TDS = Calculated TDS		
Measured	N/A	
Calculated	712.633	
Ratio	N/A	
Measured EC = Calculated EC		
Measured	692.000	
Calculated	971.137	
Ratio	0.713	Not within range 0.9 to 1.1
Secondary Tests		
Measured EC and Ion Sums:		
Anions	1.446299	Not within preferred range (0.9-1.1)
Cations	1.591500	Not within preferred range (0.9-1.1)
Calculated TDS to EC ratio	1.030	Not within preferred range (0.55-0.7)
Measured TDS to EC ratio		
Measured TDS unavailable		
Organic Mass Balance		
DOC ≥ Sum of Organics		
Dissolved Organic Carbon	1.800 mg/L	
Sum of Organics	0.000 mg/L	OK

SW-1

Water Type	Ca-SO_4		
Dissolved Solids	230.64 mg/kg	230 mg/L	Calculated
Density	0.9972 g/cm^3		Calculated
Conductivity	252 µmho/cm		Measured
Hardness (as $CaCO_3$)			
Total	124.39 mg/kg	124.05 mg/L	Calculated
Carbonate	85.675	85.436	
Non-Carbonate	38.718	38.609	

SW-1

Primary Tests		
Anion-Cation Balance		
Anions	3.58	
Cations	3.3	
% Difference	4.104	Not within ± 2%
Measured TDS = Calculated TDS		
Measured	N/A	
Calculated	230.645	
Ratio	N/A	
Measured EC = Calculated EC		
Measured	252.000	
Calculated	377.625	
Ratio	0.667	Not within range 0.9 to 1.1
Secondary Tests		
Measured EC and Ion Sums:		
Anions	1.420621	Not within preferred range (0.9-1.1)
Cations	1.308611	Not within preferred range (0.9-1.1)
Calculated TDS to EC ratio	0.915	Not within preferred range (0.55-0.7)
Measured TDS to EC ratio		
Measured TDS unavailable		
Organic Mass Balance		
DOC ≥ Sum of Organics		
Dissolved Organic Carbon	1.300 mg/L	
Sum of Organics	0.000 mg/L	OK

SW-2

Water Type	Ca-SO_4		
Dissolved Solids	244.88 mg/kg	244.2 mg/L	Calculated
Density	0.99722 g/cm^3		Calculated
Conductivity	288 µmho/cm		Measured
Hardness (as $CaCO_3$)			
Total	132.7 mg/kg	132.33 mg/L	Calculated
Carbonate	95.544	95.278	
Non-Carbonate	37.159	37.056	

SW-2

Primary Tests		
Anion-Cation Balance		
Anions	3.63	
Cations	3.56	
% Difference	0.985	OK
Measured TDS = Calculated TDS		
Measured	N/A	
Calculated	244.882	
Ratio	N/A	
Measured EC = Calculated EC		
Measured	288.000	
Calculated	386.043	
Ratio	0.746	Not within range 0.9 to 1.1
Secondary Tests		
Measured EC and Ion Sums:		
Anions	1.260897	Not within preferred range (0.9-1.1)
Cations	1.236307	Not within preferred range (0.9-1.1)
Calculated TDS to EC ratio	0.850	Not within preferred range (0.55-0.7)
Measured TDS to EC ratio		
Measured TDS unavailable		
Organic Mass Balance		
DOC ≥ Sum of Organics		
Dissolved Organic Carbon	1.500 mg/L	
Sum of Organics	0.000 mg/L	OK