

**CSMRI
CHARACTERIZATION SUMMARY**

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Prepared by:

New Horizons Environmental Consultants, Inc.
6585 S. Wright Street
Littleton, CO 80127

CSMRI CHARACTERIZATION SUMMARY

The CSMRI Site is located on the west side of the City of Golden, in Jefferson County, Colorado (Site). The Site is directly south of Clear Creek approximately 1/2 mile east of the intersection of U.S. Highway 6 and State Highway 58.

From 1912 to 1985, a wide variety of mining related research was conducted at the Site. Research activities included developing and improving processes for recovering natural resources from ore, including copper, nickel, silver, lead, uranium, and others. During the period of operation private companies and the federal government sponsored or conducted research at the Site. Buildings and research facilities were constructed and operated, resulting in residual effects to many of the buildings and surrounding soils. Radiological impacts to the Site were the result of work conducted on ores; there is no historical evidence that any other radiological work was performed at the Site.

Between the months of November 2002 and March 2003 a number of methods were used to characterize the Site. The objective of the characterization was to obtain enough data to evaluate soils and groundwater and to evaluate a variety of management options. The Site characterization methods included the following:

- A gamma survey of the area (3,282 survey points),
- Collection of 265 surface soil samples along with four background sample, two blanks, and 16 duplicate samples,
- Examination of 36 test pits including gamma surveys and collection of 56 samples along with seven duplicate samples; and
- Examination of 28 borings including gamma surveys and collection of 68 samples along with one duplicate sample (sample sizes were limited, preventing collection of additional duplicates).
- Collection of ground-water samples from seven monitoring wells.

SURFACE GAMMA SURVEY

After the removal of the concrete and asphalt to allow direct access to the soil, a surface gamma survey was performed on the majority of the Site. The survey consisted of dividing the Site into a grid of about 3.3-meter x 3.3-meter (10-foot x 10-foot) squares and recording a 10-second gamma reading inside each grid square. Two Ludlum Model 44-10 gamma detectors in combination with Ludlum Model 2350-1 data loggers were used to perform the survey. Each survey coordinate was recorded using a Trimble Pathfinder Pro XRS Global Positioning System (GPS) unit. Additional readings were collected in areas that exhibited elevated gamma readings to better define the extent of the anomaly. If the resulting data indicated areas of incomplete coverage, additional points were surveyed to achieve the desired survey density.

SURFACE SOIL SAMPLES

Samples were collected from surface soils at 165 locations on the Site in accordance with the approved Sampling and Analysis Plan (SAP), the Characterization Survey Work Plan (CSWP), and using the guidance provided in Multi-Agency Radiation Survey and Site Investigation

Manual (MARSSIM) (Figure 1). The Site was divided into 12 sections with up to 10 samples collected from each section. A GPS unit was used to delineate the section boundaries. Once the boundaries were established, sample locations were selected by randomly placing markers in the area. GPS coordinates were recorded for each sampling location, with location post-processing completed the following day. Because of the irregular shape of the Site, two sections on the Site's eastern side were smaller in area, requiring fewer samples. Additional samples were collected in areas where the gamma survey indicated elevated gamma readings.

Figure 1 shows the locations and relative concentrations of the combined radium (Ra-226 & Ra-228), thorium (Th-228, Th-230, & Th-232) and uranium (U-234 & U238) on the Site. The combined thorium concentration is shown at the actual sample location with the radium and uranium concentrations shown offset. Relative concentrations are not shown if the sample contained less than the combined isotope background concentration.

The samples were sent to Paragon Analytical, Inc. (PAI) in Fort Collins, CO for analysis. The soil samples were analyzed for 11 metals, isotopic thorium and uranium (alpha spectroscopy), and 40 common isotopes (gamma spectroscopy) in accordance with the approved CSWP and SAP.

Table 1 provides a statistical summary of the analyses. Laboratory flagged qualitative data (metal or isotope detected but at less than the reporting limit) was included in the summary statistics. Metals/isotopes reported as undetected were included as half the laboratory detection limit to limit a downward bias of the statistics.

Because this data, like most environmental data, has a lognormal distribution rather than a normal distribution, mean concentrations are often dominated by a limited number of elevated concentrations. The lognormal mean is more representative of the actual data. Figure 2 shows a histogram of the sample distribution for the lead concentrations. Instead of the bell shaped curve that is the basis of standard statistics, the one-sided, lognormal curve is evident. Both the normal mean concentration and the lognormal mean concentrations are provided for comparison. Standard statistics produce a mean value of 482 milligrams per kilogram (mg/kg) for lead (lognormal mean is 154 mg/kg) when in actuality 79-percent of the samples are less than 400 mg/kg.

Table 2 is a summary of the background samples. Background values represent metal and radioisotope concentrations that naturally occur in the soil in the vicinity of the CSMRI Site. To properly address material that has been introduced to the Site, background values must be used to screen the samples. Removing native material is not a typical remediation goal. An example of the effect of background concentrations is provided in Figures 3 and 4. Figure 3 shows the distribution of samples using the actual concentrations of the combined radium (Ra-226 & Ra-228). If a five picocurie per kilogram standard is applied to the combined radium concentrations, 65-percent of the samples are above the standard. However, if the samples are corrected for background (Figure 4), 26-percent of the samples are above the standard.

Figure 2 Lead Concentration Histogram

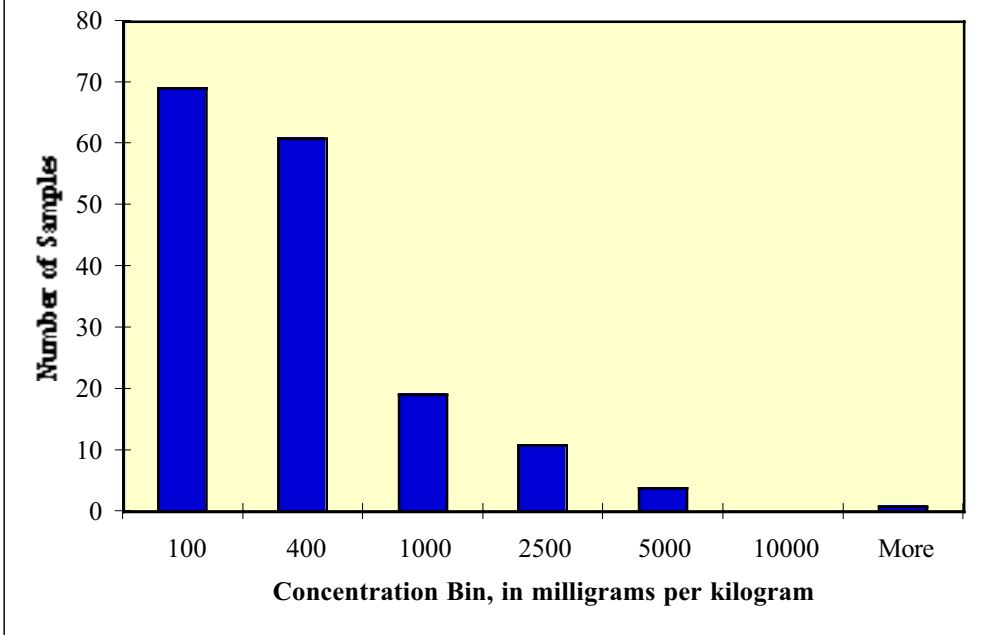
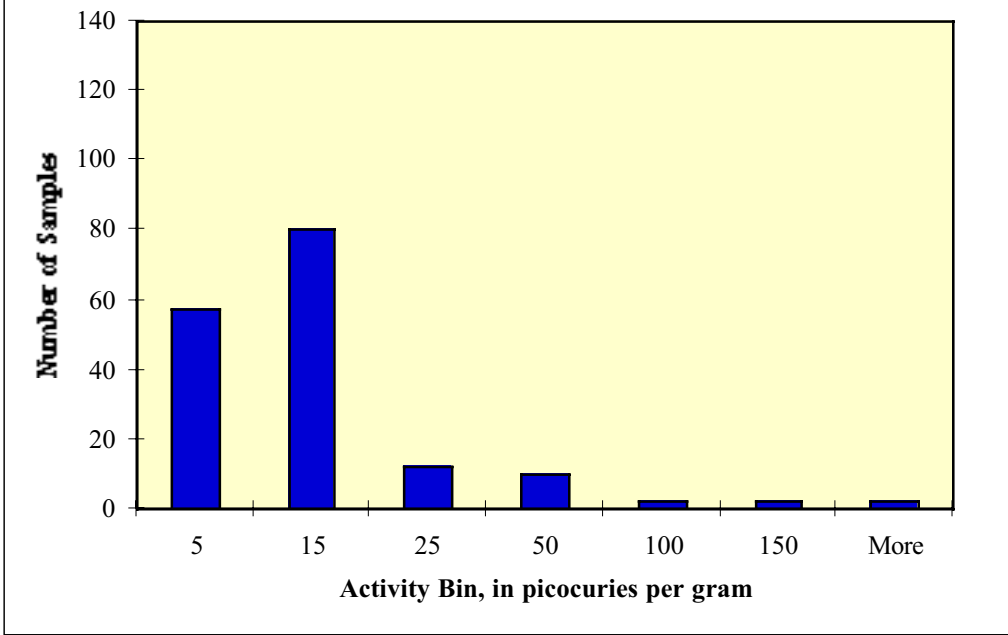
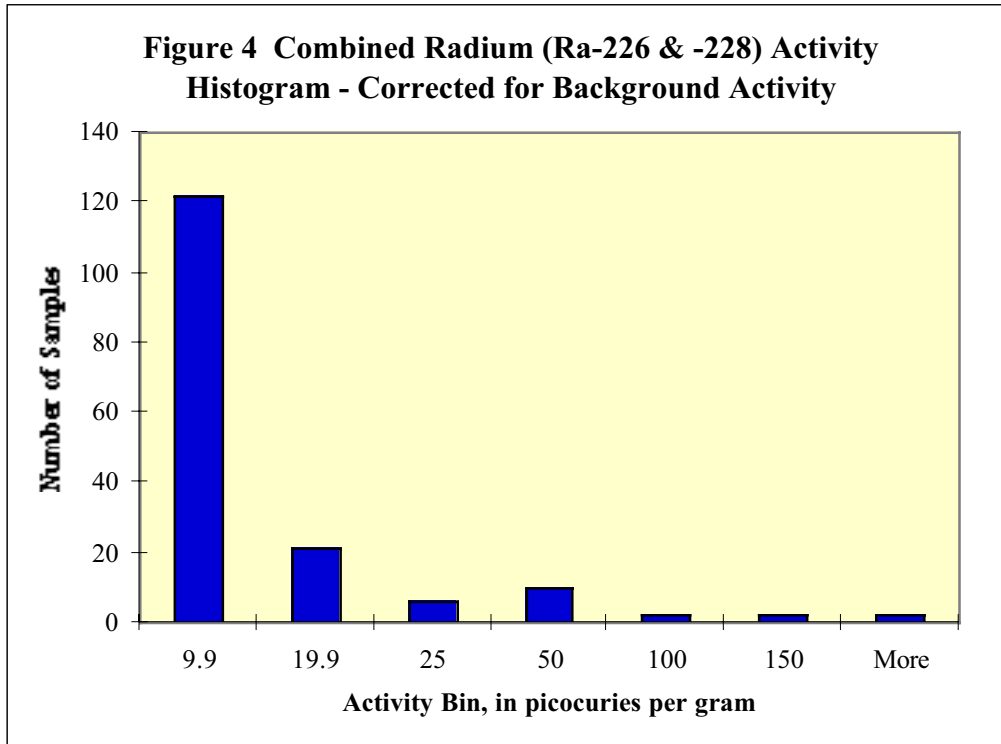


Figure 3 Combined Radium (Ra-226 & Ra-228) Activity Histogram





SUBSURFACE SOIL INVESTIGATION

Thirty-six trenches/test pits (dug with a backhoe) and 28 borings (advanced with a drill rig) were used to investigate the subsurface soils at the Site. The test pit subsurface investigation primarily focused on those areas where drains or pipelines had penetrated building flooring and other visually suspect areas identified following the concrete and asphalt removal. The borings were primarily focused in those areas with elevated surface gamma readings.

Test pit samples were collected from 56 locations in the 36 test pits along with 7 duplicate samples. Sample collection focused on soil layers exhibiting elevated gamma readings but additional samples were collected to characterize general soil types.

Borings samples were collected from 68 locations in the 28 borings. Sample collection focused on soil layers that exhibited elevated gamma readings but additional samples were collected to characterize general soil types.

The samples were sent to Paragon Analytical, Inc. (PAI) in Fort Collins, CO for analysis. The soil samples were analyzed for 11 metals, isotopic thorium and uranium (alpha spectroscopy), and 40 common isotopes (gamma spectroscopy) in accordance with the approved Characterization Survey Work Plan and Sampling and Analysis Plan.

Tables 3 and 4 provide summary statistics of the analyses. Laboratory flagged qualitative data (metal or isotope detected but at less than the reporting limit) was included in the summary statistics. Metals/isotopes reported as undetected were included as half the laboratory detection limit to limit a downward bias of the statistics.

GROUND-WATER SAMPLING

Five existing wells and the two new monitoring wells were sampled as part of the investigation to determine current ground-water conditions in and near the Site. The existing wells included three wells located along Clear Creek (CSMRI-01, -04, and -05), one background well located south of the clay pits (CSMRI-02), and one well located downgradient of the clay pits (CSMRI-03). One newly installed well is located along the north-south border of the Site and the Colorado School of Mines baseball field (CSMRI-06) and a second is located just to the north of the former Building 101N (CSMRI-07).

Ground-water samples were forwarded to Paragon Analytical, Inc. for analysis. The samples were analyzed for specific metals, volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), specific radioisotopes (radium, thorium, and uranium), and major anions and cations. Field parameters (dissolved oxygen, pH, specific conductance, and temperature) were measured when the samples were collected (Table 5). A summary of the sample results (three quarterly sampling rounds) is provided in Tables 6 through 10.

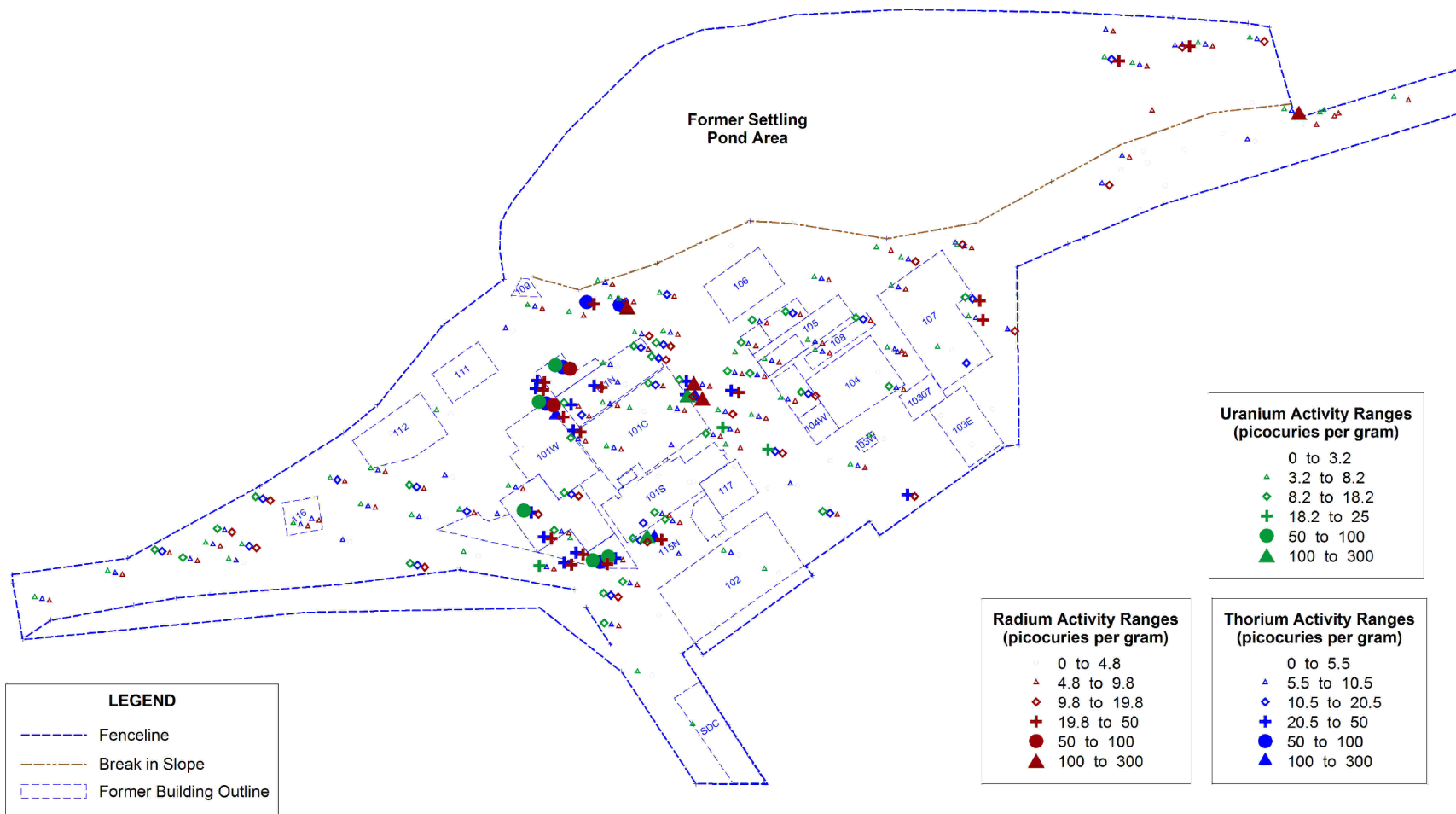
SUBSURFACE HYDROCARBON INVESTIGATION

During the installation of the groundwater monitoring well site initially chosen for the background well (CSMRI 06), an unidentified hydrocarbon was detected. The hydrocarbon was measurable at about six feet and continued to about 14 feet. Soil samples were collected at 6, 10, and 14 feet and sent to Evergreen Analytical, Inc. in Wheat Ridge, Colorado for VOC analysis.

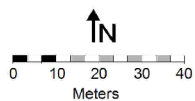
The analytical results indicated the presence of low concentrations of trichloroethene and acetone (see Table 11), so a backhoe was used to continue the investigation of the area. The visual investigation of the site showed a darkened layer of clay with a strong odor of hydrocarbons. The upper horizon of the material appeared at a depth of about five feet but dipped somewhat as the excavation continued to the north. The material was visible to about 10 feet, the depth of the excavation. A PID meter reported minimal VOC concentrations in the vicinity of the excavation, but elevated concentrations were detected in the headspace of a sample. Two additional samples were collected during the excavation for analysis. These samples also were sent to Evergreen Analytical and analyzed for both VOCs and SVOCs. A summary of the analyses is provided in Tables 11 and 12.

Figures

Figure 1
CSMRI Surface Soil Samples
Combined* Radium, Thorium, and Uranium Activity



Notes: Thorium sample symbol at actual sample location. Radium and uranium samples are offset.
 * Combined radium (Ra-226 & Ra-228); thorium (Th-228, 230, & 232); uranium (U-234 & U-238)



New Horizons Environmental Consultants, Inc.
 6585 South Wright Street
 Littleton, CO 80127-4806

Project: CSMRI Site Investigation

Date: July 7, 2003

Project Number: 2112

Figure 1 CSMRI Surface Soil Samples
 Combined Radium, Thorium, and Uranium Activities

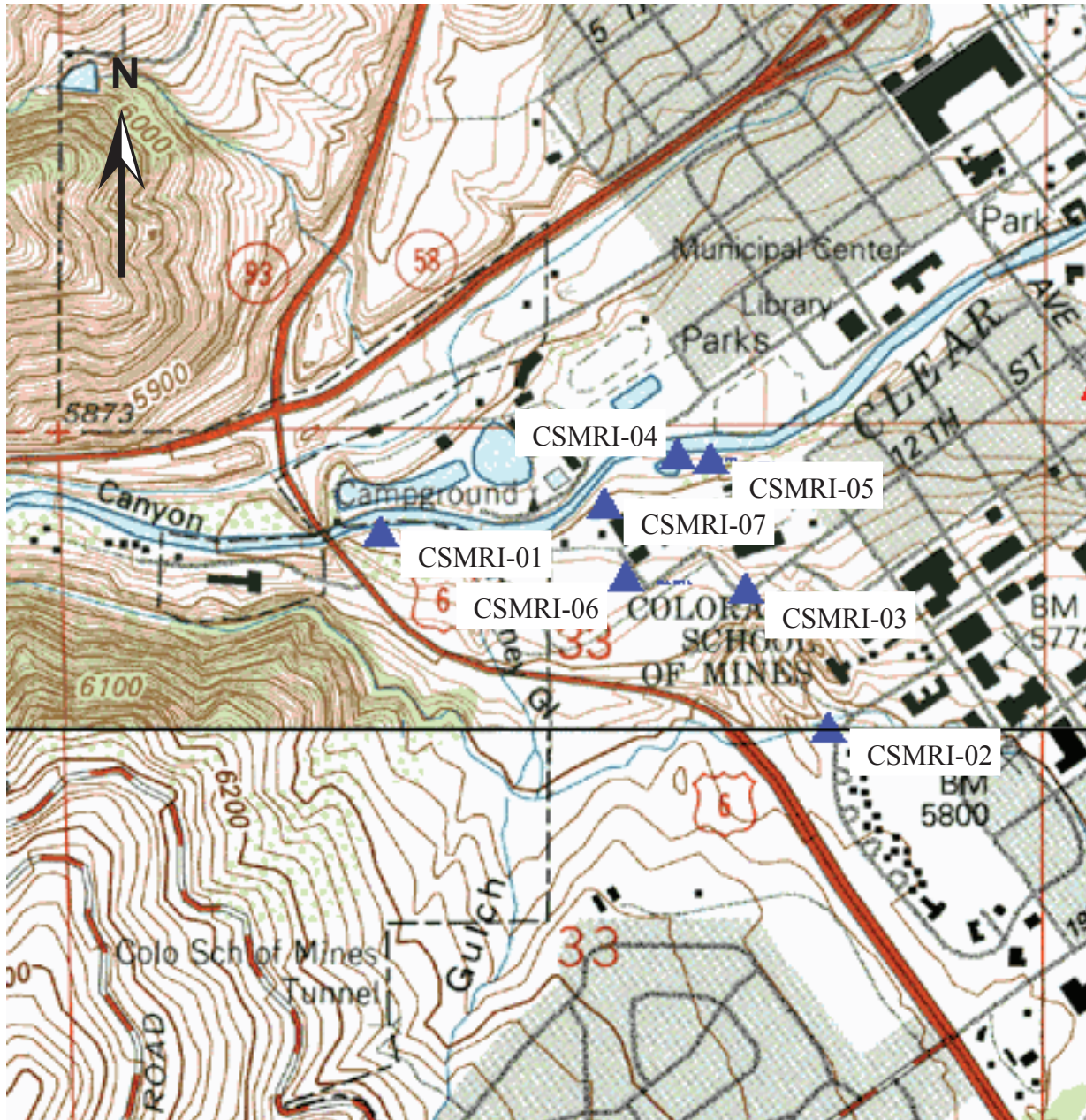


Figure 5. CSMRI Ground-Water Monitoring Well Locations

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New Horizons Environmental Consultants, Inc.
 6585 South Wright Street
 Littleton, CO 80127-4806

Tables

Table 1 CSMRI Surface Samples Summary Statistics

Metal	Mean	Median	Mode	Standard Deviation	Minimum	Maximum	Lognormal Mean
Arsenic	30.9	17	13	41.2	1.8	330	18.0
Barium	325	180	170	403	48	2900	229
Cadmium	3.28	0.93	0.02	6.97	ND	51	0.676
Chromium	17.3	15	14	9.56	6	79	15.8
Lead	462	140	140	1270	6.4	14000	154
Mercury	5.92	0.87	0.57	32.2	0.015	400	0.966
Molybdenum	37.6	14	1.8	92.1	0.89	980	13.8
Selenium	1.84	1.2	1.1	1.75	ND	11	1.34
Silver	2.69	0.85	ND	6.11	ND	58	0.682
Vanadium	46.3	37	29	37.2	15	350	39.5
Zinc	673	260	110	1120	49	7100	317

Note: All metals units in milligrams per kilogram

Isotope	Mean	Median	Mode	Standard Deviation	Minimum	Maximum	Lognormal Mean
Thorium-228	2.78	1.9	1.5	8.02	0.94	109	2.05
Thorium-230	9.13	3.1	1.9	23.8	0.75	270	4.02
Thorium-232	2.58	1.7	1.4	8.1	0.76	110	1.86
Uranium-234	6.23	2.4	1.2	11	ND	85	3.15
Uranium-235	0.344	0.120	0.1100	0.62	ND	4.9	0.164
Uranium-238	6.23	2.3	1.1	11.1	0.63	88	3.07

Note: All isotope units in picocuries per gram

Isotope	Mean	Median	Mode	Standard Deviation	Minimum	Maximum	Lognormal Mean
Bi-212	2.20	2.0	1.7	1.09	ND	8.0	1.98
Bi-214	7.67	3.4	1.3	15.3	0.66	110	3.75
Cd-109	8.86	6.7	7.4	9.01	ND	82	6.91
Co-56	0.764	0.39	0.27	1.57	ND	15	0.415
K-40	20.6	20	20	3.98	7.3	36	20.2
Pb-212	2.17	1.9	1.4	0.979	0.76	6.8	2.00
Pb-214	8.75	3.8	1.6	18.6	0.78	150	4.20
Ra-226	10.7	4.7	1.8	22.4	0.93	170	5.15
Ra-228	1.97	1.8	1.3	0.930	0.68	7.3	1.82
Th-234	5.28	3.3	3.8	6.20	ND	42	3.64
Tl-208	0.625	0.55	0.55	0.293	0.209	2.2	0.574

Note: All isotope units in picocuries per gram

Table 2 CSMRI Background Surface Soil Samples Statistics

Metal / Isotope	Mean	Lognormal Mean	Background Upper Limit¹
Arsenic	6.59	6.01	13.5
Barium	174	147	337
Cadmium	0.311	0.059	1.28
Chromium	11.7	11.5	15.9
Lead	31.4	24.1	81.3
Mercury	0.168	0.100	0.575
Molybdenum	2.65	2.25	5.43
Selenium	0.747	0.692	1.40
Silver	0.0383	0.0256	0.0809
Vanadium	28.6	27.1	46.1
Zinc	114	99.3	226
Thorium-228	1.68	1.61	2.56
Thorium-230	1.24	1.22	1.71
Thorium-232	1.55	1.50	2.32
Uranium-234	1.30	1.22	2.28
Uranium-235	0.0581	0.0557	0.0917
Uranium-238	1.02	0.991	1.51
Bi-212	1.79	1.74	2.64
Bi-214	1.19	1.14	1.88
Cd-109	4.32	4.18	6.52
Co-56	0.201	0.190	0.340
K-40	21.4	21.1	26.9
Pb-212	1.77	1.72	2.59
Pb-214	1.38	1.32	2.20
Ra-226	1.66	1.59	2.60
Ra-228	1.56	1.52	2.28
Th-234	2.21	2.07	3.90
Tl-208	0.504	0.490	0.722

Note: All metals units in milligrams per kilogram, all isotope units in picocuries per gram.

¹ Background upper limit represents the 90-percent confidence level of a lognormal distribution of the background samples.

Table 3 CSMRI Test Pits Summary Statistics

Metal	Mean	Median	Mode	Standard Deviation	Minimum	Maximum	Lognormal Mean
Arsenic	21.9	8.4	11	36.9	0.98	180	9.26
Barium	211	140	120	216	16	1300	156
Cadmium	1.51	0.05	0.05	3.55	ND	17	0.226
Chromium	15.8	14	12	16.5	ND	130	12.7
Lead	502	72.5	16	1680	7.2	12000	83.8
Mercury	5.78	0.3	1.1	29.5	0.004	220	0.32
Molybdenum	43.6	5.3	1.2	115	1	610	7.6
Selenium	3.16	1.2	1.4	4.91	ND	24	1.58
Silver	3.52	0.16	0.02	16.3	ND	120	0.182
Vanadium	38.8	30.5	29	27.4	0.071	130	29.3
Zinc	511	160	75	820	13	3300	191

Note: All metals units in milligrams per gram

Isotope	Mean	Median	Mode	Standard Deviation	Minimum	Maximum	Lognormal Mean
Thorium-228	2.46	2	1.4	1.62	0.27	8.3	2.02
Thorium-230	10.8	1.6	1.6	23.7	0.46	102	2.95
Thorium-232	2.32	1.8	1.8	1.55	0.14	7.9	1.89
Uranium-234	8.08	1.6	1.4	16.7	0.28	66	2.52
Uranium-235	0.423	0.089	0.0580	0.88	0.024	3.7	0.135
Uranium-238	8.06	1.55	1.3	16.5	0.27	71	2.55

Note: All isotope units in picocuries per gram

Isotope	Mean	Median	Mode	Standard Deviation	Minimum	Maximum	Lognormal Mean
Bi-212	2.76	2.4	1.5	1.88	ND	9.7	2.18
Bi-214	15.70	1.75	1.1	59.5	0.39	430	2.94
Cd-109	14.10	6.4	4.3	33.80	ND	240	6.93
Co-56	0.324	0.275	0.35	0.25	ND	1.6	0.271
K-40	20.9	22	25	5.95	4.5	41	19.9
Pb-212	2.69	2.3	2.5	1.740	0.17	10	2.19
Pb-214	18.10	1.95	1.3	71.4	0.37	520	3.31
Ra-226	21.8	2.4	1.6	84.1	0.49	610	4.03
Ra-228	2.50	2.1	1.7	1.670	ND	9.4	1.99
Th-234	7.60	2.9	2.9	12.60	ND	59	3.77
Tl-208	0.788	0.655	1.3	0.514	ND	2.9	0.629

Note: All isotope units in picocuries per gram

Table 4 CSMRI Borings Summary Statistics

Metal	Mean	Median	Mode	Standard Deviation	Minimum	Maximum	Lognormal Mean
Arsenic	20.5	5.55	1.9	41.1	0.96	180	7.06
Barium	151	120	120	136	43	920	122
Cadmium	2.14	0.025	0.025	7.26	ND	52	0.084
Chromium	14	14	12	3.71	5.9	25	13.5
Lead	182	21	18	431	5	2400	39.5
Mercury	0.568	0.0465	0.014	1.6	0.0058	11	0.078
Molybdenum	10.2	1.6	1.3	25	0.49	160	2.80
Selenium	0.93	0.745	0.2	0.911	ND	4.8	0.639
Silver	1.12	0.02	0.02	2.91	ND	18	0.079
Vanadium	44	28.5	34	118	10	1000	29.6
Zinc	560	85	100	1674	26	13000	155

Note: All metals units in milligrams per kilogram

Isotope	Mean	Median	Mode	Standard Deviation	Minimum	Maximum	Lognormal Mean
Thorium-228	2.29	2.1	1.4	1.01	0.93	6.7	2.10
Thorium-230	7.7	1.45	1.1	27	0.76	210	2.17
Thorium-232	2.19	1.95	1.5	1.08	0.88	7.5	1.99
Uranium-234	8.62	1.4	1.1	20.1	0.59	110	2.40
Uranium-235	0.52	0.094	0.0560	1.15	ND	5.8	0.139
Uranium-238	8.7	1.3	1.1	20.3	0.64	110	2.42

Note: All isotope units in picocuries per gram

Isotope	Mean	Median	Mode	Standard Deviation	Minimum	Maximum	Lognormal Mean
Bi-212	2.30	2.0	1.4	1.22	0.72	8.7	2.07
Bi-214	8.17	1.1	1.6	30.1	0.54	210	1.78
Cd-109	6.07	4.35	2.8	6.77	1	45	4.73
Co-56	0.956	0.15	0.08	3.80	ND	26	0.192
K-40	20.4	19	19	3.68	14	36	20.1
Pb-212	2.21	2	1.2	1.160	1.1	8.3	1.99
Pb-214	9.23	1.25	1.1	34.8	0.58	250	2.01
Ra-226	11.2	1.5	1.3	42.0	0.71	300	2.47
Ra-228	2.04	1.8	1	1.060	0.99	7.2	1.83
Th-234	6.32	2.55	1.4	11.50	ND	62	3.25
Tl-208	0.655	0.565	1	0.347	0.31	2.5	0.591

Note: All isotope units in picocuries per gram

Table 5 CSMRI Ground-Water Field Parameters

	Well	CSMRI-01	CSMRI-02	CSMRI-03	CSMRI-04	CSMRI-05	CSMRI-06	CSMRI-07
First Round (Feb 2003)	Dissolved Oxygen (milligrams per liter)	7.8	4.3	0.40	1.5	2.0	7.6	6.9
	pH	7.75	7.52	6.86	6.44	7.01	7.38	7.75
	Specific Conductance (microsiemens per centimeter)	464	552	2460	655	574	408	876
	Temperature (°C)	5.1	11.5	13.4	6.1	8.3	12.3	9.6
Second Round (Apr 2003)	Dissolved Oxygen (milligrams per liter)	3.4	1.6	0.16	0.90	1.3	6.2	5.4
	pH	7.11	7.27	6.84	6.92	6.95	7.20	7.35
	Specific Conductance (microsiemens per centimeter)	725	601	2530	949	580	391	958
	Temperature (°C)	5.6	12.7	13.4	7.6	9.2	12.1	10.5
Third Round (Jul 2003)	Dissolved Oxygen (milligrams per liter)	1.5	1.0	0.23	0.00	0.55	9.5	5.5
	pH	7.34	7.29	6.64	6.87	7.02	7.21	7.12
	Specific Conductance (microsiemens per centimeter)	431	588	2350	968	639	545	1021
	Temperature (°C)	11.2	15.2	14.0	14.6	14.1	12.2	13.8

Table 6 CSMRI Ground-Water Detected Volatile Organic Compounds, in micrograms per liter

Note: No semivolatile compounds were detected

	Compound	CSMRI-01	CSMRI-02	CSMRI-03	CSMRI-04	CSMRI-05	CSMRI-06	CSMRI-07
First Round (Feb 2003)	Acetone	ND (<10)	ND (<10)	ND (<10)	ND (<10)	ND (<10)	ND (<10)	4 J
	Bromodichloromethane	ND (<1)	ND (<1)	ND (<1)	ND (<1)	0.49 J	ND (<1)	ND (<1)
	Chloroform	ND (<1)	ND (<1)	ND (<1)	0.35 J	1.5	ND (<1)	ND (<1)
	cis-1,2-Dichloroethene	ND (<1)	ND (<1)	ND (<1)	1.0	1.0	ND (<1)	ND (<1)
	Tetrachloroethene	ND (<1)	ND (<1)	ND (<1)	1.1	ND (<1)	ND (<1)	ND (<1)
	Trichloroethene	ND (<1)	ND (<1)	ND (<1)	4.1	0.51 J	ND (<1)	ND (<1)
Second Round (Apr 2003)	Acetone	ND (<10)	ND (<10)	ND (<10)	ND (<10)	ND (<10)	ND (<10)	ND (<10)
	Bromodichloromethane	ND (<1)	ND (<1)	ND (<1)	ND (<1)	0.45 J	ND (<1)	ND (<1)
	Chloroform	ND (<1)	ND (<1)	ND (<1)	0.80 J	1.4	ND (<1)	ND (<1)
	cis-1,2-Dichloroethene	ND (<1)	ND (<1)	ND (<1)	1.5	ND (<1)	ND (<1)	ND (<1)
	Tetrachloroethene	ND (<1)	ND (<1)	ND (<1)	0.79 J	ND (<1)	ND (<1)	ND (<1)
	Trichloroethene	ND (<1)	ND (<1)	ND (<1)	4.2	0.58 J	ND (<1)	ND (<1)
Third Round (Jul 2003)	Acetone	1.6 J,B	2.8 J,B	1.5 J,B	5.8 J,B	2.5 J,B	3.1 J,B	1.6 J,B
	Bromodichloromethane	ND (<0.18)	ND (<0.18)	ND (<0.18)	ND (<0.18)	ND (<0.18)	ND (<0.18)	ND (<0.18)
	Chloroform	ND (<0.18)	ND (<0.18)	ND (<0.18)	1.3	0.55 J	ND (<0.18)	ND (<0.18)
	Chloromethane	0.21 J	ND (<0.21)	ND (<0.21)	0.26 J	ND (<0.21)	0.25 J	0.37 J
	cis-1,2-Dichloroethene	ND (<0.24)	ND (<0.24)	ND (<0.24)	1.3	ND (<0.24)	ND (<0.24)	ND (<0.24)
	Tetrachloroethene	ND (<0.18)	ND (<0.18)	ND (<0.18)	1.9	ND (<0.18)	ND (<0.18)	ND (<0.18)
	Trichloroethene	ND (<0.14)	ND (<0.14)	ND (<0.14)	3.3	0.44 J	ND (<0.14)	ND (<0.14)

Notes: ND, not detected; J, compound identified but at less than minimum detection limit, qualitative value

Table 7 CSMRI Ground-Water Trace Metals, in micrograms per liter

	Metal	CSMRI-01	CSMRI-02	CSMRI-03	CSMRI-04	CSMRI-05	CSMRI-06	CSMRI-07
First Round (Feb 2003)	Arsenic	ND (<10)	ND (<10)	2.2 B	3.2 B	ND (<10)	1.7 B	ND (<10)
	Barium	81 B	100	35 B	74 B	46 B	120	83 B
	Cadmium	ND (<5.0)	ND (<5.0)	ND (<5.0)	0.21 B	ND (<5.0)	ND (<5.0)	ND (<5.0)
	Chromium	0.63 B	5.6 B	5.5 B	2.6 B	ND (<10)	8.7 B	2.7 B
	Lead	ND (<3.0)	ND (<3.0)	1.3 B	5.4	ND (<3.0)	3.9	ND (<3.0)
	Mercury	0.015 B	0.021 B	0.024 B	0.37	0.20 B	0.012 B	0.019 B
	Molybdenum	4.5 B	ND (<10)	4.6 B	28	ND (<10)	2.8 B	ND (<10)
	Selenium	ND (<5.0)	ND (<5.0)	3.4 B	3.3 B	ND (<5.0)	ND (<5.0)	ND (<5.0)
	Silver	ND (<10)	ND (<10)	ND (<10)	ND (<10)	ND (<10)	ND (<10)	ND (<10)
	Vanadium	1.3 B	4.7 B	2.0 B	4.3 B	ND (<10)	5.8 B	1.4 B
	Zinc	63	6.8 B	9.4 B	210	77	25	13 B
Second Round (Apr 2003)	Arsenic	ND (<10)	6.1 B	ND (<10)	1.7 B	ND (<10)	ND (<10)	ND (<10)
	Barium	110	240	47 B	57 B	47 B	15 B	92 B
	Cadmium	0.42 B	0.23 B	ND (<5.0)	0.20 B	0.25 B	ND (<5.0)	ND (<5.0)
	Chromium	1.6 B	190	4.3 B	1.4 B	0.74 B	0.56 B	3.0 B
	Lead	ND (<3.0)	24	ND (<3.0)	ND (<3.0)	ND (<3.0)	ND (<3.0)	ND (<3.0)
	Mercury	ND (<0.20)	0.072 B	ND (<0.20)	0.039 B	ND (<0.20)	ND (<0.20)	ND (<0.20)
	Molybdenum	ND (<10)	18	7.0 B	34	4.1 B	39	3.3 B
	Selenium	ND (<5.0)	ND (<5.0)	ND (<5.0)	2.3 B	2.3 B	ND (<5.0)	2.0 B
	Silver	ND (<10)	ND (<10)	ND (<10)	ND (<10)	ND (<10)	ND (<10)	ND (<10)
	Vanadium	1.4 B	36	4.2 B	1.0 B	1.1 B	ND (<10)	ND (<10)
	Zinc	61	68	11 B	140	88	8.1 B	11 B
Third Round (Jul 2003)	Arsenic	ND (<1.6)	ND (<1.6)	3.6 B	4.1 B	3.8 B	ND (<1.6)	4.6 B
	Barium	82 B	85 B	25 B	53 B	66 B	75 B	62 B
	Cadmium	ND (<0.13)	ND (<0.13)	ND (<0.13)	ND (<0.13)	ND (<0.13)	ND (<0.13)	ND (<0.13)
	Chromium	ND (<0.54)	ND (<0.54)	ND (<0.54)	ND (<0.54)	ND (<0.54)	ND (<0.54)	ND (<0.54)
	Lead	ND (<0.91)	ND (<0.91)	ND (<0.91)	ND (<0.91)	ND (<0.91)	ND (<0.91)	ND (<0.91)
	Mercury	ND (<0.0024)	ND (<0.0024)	ND (<0.0024)	0.010 B	ND (<0.0024)	ND (<0.0024)	ND (<0.0024)
	Molybdenum	ND (<2.7)	ND (<2.7)	6.5 B	140	13	ND (<2.7)	6.5
	Selenium	ND (<1.3)	3.2 B	4.5 B	3.5 B	6.7	1.3 B	4.9 B
	Silver	ND (<0.69)	1.1 B	0.73 B	1.4 B	ND (<0.69)	ND (<0.69)	2.0 B
	Vanadium	1.2 B	0.89 B	ND (<0.43)	1.1 B	ND (<0.43)	0.67 B	2.2 B
	Zinc	36	12 B	9.1 B	230	48	ND (<4.9)	23

Notes: ND, not detected; B, compound identified but at less than practical reporting limit, qualitative value

Table 8 CSMRI Ground-Water Anions/Cations, in milligrams per liter

	Anion / Cation	CSMRI-01	CSMRI-02	CSMRI-03	CSMRI-04	CSMRI-05	CSMRI-06	CSMRI-07
First Round (Feb 2003)	Chloride	39	4.9	99	33	29	18	46
	Nitrate, as N	0.79	ND (<0.20)	6.6	0.23	0.53	0.39	0.41
	Nitrite, as N	ND (<0.10)	ND (<0.10)	ND (<0.20)	ND (<0.10)	ND (<0.10)	ND (<0.10)	ND (<0.10)
	Sulfate	90	40	980	100	84	61	90
	Calcium	34	59	310	64	53	38	86
	Magnesium	12	27	160	27	22	15	35
	Potassium	3.4	6.7	12	4.5	3.1	4.7	6.9
	Sodium	33	17	110	26	26	19	42
Second Round (Apr 2003)	Bicarbonate as CaCO3	80	260	580	210	150	100	290
	Carbonate as CaCO3	ND (<10)	ND (<20)	ND (<20)	ND (<10)	ND (<10)	ND (<10)	ND (<20)
	Chloride	120	3.7	88	48	31	17	40
	Fluoride	0.43	1.3	0.56	0.53	0.35	0.28	0.57
	Nitrate, as N	0.84	ND (<0.20)	3.6	0.63	0.47	0.23	0.74
	Nitrite, as N	ND (<0.10)	ND (<0.10)	ND (<0.20)	ND (<0.10)	ND (<0.10)	ND (<0.10)	ND (<0.10)
	Sulfate	99	36	940	230	90	62	170
	Calcium	54	67 (66 ¹)	310	95	54	3.6 (37 ¹)	100
	Magnesium	19	29 (28 ¹)	160	39	22	1.5 (16 ¹)	43
	Potassium	4.6	7.6 (6.4 ¹)	14	5.4	3.3	2.3 (7.2 ¹)	8.1
	Sodium	51	17 (17 ¹)	100	40	27	230 (20 ¹)	40
Second Round (Apr 2003)	Bicarbonate as CaCO3	62	270	590	320	140	110	210
	Carbonate as CaCO3	ND (<10)	ND (<10)	ND (<10)	ND (<10)	ND (<10)	ND (<10)	ND (<10)
	Chloride	73	3.8	76	33	42	63	35
	Fluoride	0.58	1.3	0.52	0.74	0.46	0.22	0.56
	Nitrate, as N	0.44	ND (<0.20)	ND (<1.0)	ND (<0.20)	ND (<0.20)	1.4	1.7
	Nitrite, as N	ND (<0.10)	ND (<0.10)	ND (<0.50)	ND (<0.10)	ND (<0.10)	ND (<0.10)	ND (<0.10)
	Sulfate	41	34	820	160	120	62	140
	Calcium	31	64	310	100	67	55	84
	Magnesium	12	29	160	41	22	20	38
	Potassium	3	6	14	8.1	3.9	3.3	6.2
	Sodium	31	17	97	43	28	22	39

Notes: All data units in milligrams per liter; ND, not detected.

¹ Results of sample cation analyses rerun (7-9-03) after excessive differences were determined in anion/cation balance calculations.

Table 9 CSMRI Ground-Water Radioisotopes, in picocuries per liter

Isotope	CSMRI-01		CSMRI-02		CSMRI-03		CSMRI-04		CSMRI-05		CSMRI-06		CSMRI-07		
	Activity	TPU	Activity	TPU	Activity	TPU	Activity	TPU	Activity	TPU	Activity	TPU	Activity	TPU	
First Round (Feb 2003)	Radium-226	0.55 LT	±0.29	1.4	±0.44	0.75 LT	±0.25	0.85 LT	±0.36	ND (<0.49)	±0.33	0.61 LT	±0.24	0.63 LT	±0.28
	Thorium-228	ND (<0.21)	±0.13	±0.11	0.45	±0.13	0.3	±0.11	ND (<0.12)	±0.055	0.43	ND (<0.17)	±0.13	ND (<0.17)	±0.10
	Thorium-230	0.19 LT	±0.066	0.17 LT	±0.072	0.12 LT	±0.059	0.099 LT	±0.045	0.062 LT	±0.044	0.16 LT	±0.054	0.080 LT	±0.048
	Thorium-232	0.077 LT	±0.047	0.16 LT	±0.072	0.14 LT	±0.064	0.065 LT	±0.038	ND (<0.049)	±0.031	0.17 LT	±0.055	0.052 LT	±0.038
	Uranium-234	2.0	±0.39	1.1	±0.095	9.9	±1.4	9.1	±1.3	2.3	±0.43	1.8	±0.34	4.5	±0.69
	Uranium-235	ND (<0.14)	±0.082	0.15 LT	±0.035	0.31	±0.13	0.58	±0.18	ND (<0.036)	±0.11	0.16 LT	±0.088	0.29	±0.12
	Uranium-238	1.2	±0.27	0.57	±0.076	6.0	±0.88	7.9	±1.1	1.4	±0.31	1.4	±0.29	4.1	±0.63
Second Round (Apr 2003)	Radium-226	0.45 LT	±0.23	2.8	±0.82	0.81 LT	±0.33	0.42 LT	±0.26	1.1	±0.41	2.0	±0.64	0.49 LT	±0.22
	Radium-228	ND (<0.89)	±0.54	2.6	±0.69	2.0	±0.71	ND (<1.1)	±0.72	ND (<1.1)	±0.67	2.3	±0.68	1.3	±0.66
	Thorium-228	0.23	±0.13	1.1	±0.26	0.22	±0.098	0.18 LT	±0.08	ND (<0.11)	±0.050	0.99	±0.21	ND (<0.14)	±0.082
	Thorium-230	0.21	±0.10	0.43	±0.15	ND (<0.15)	±0.078	ND (<0.15)	±0.084	ND (<0.14)	±0.084	0.15 LT	±0.090	ND (<0.16)	±0.097
	Thorium-232	0.092 LT	±0.060	0.41	±0.13	0.059 LT	±0.041	ND (<0.061)	±0.032	ND (<0.054)	±0.029	0.59	±0.15	ND (<0.095)	±0.059
	Uranium-234	2.0	±0.38	0.97	±0.24	10	±1.5	18	±2.6	1.4	±0.30	0.93	±0.23	7.4	±1.1
	Uranium-235	ND (<0.093)	±0.062	ND (<0.099)	±0.061	0.24	±0.11	0.67	±0.19	ND (<0.072)	±0.059	ND (<0.085)	±0.058	0.28	±0.12
Uranium-238	1.4	±0.30	0.64	±0.18	5.9	±0.94	17	±2.4	1.1	±0.26	0.84	±0.21	6.0	±0.94	
Third Round (Jul 2003)	Radium-226	ND (<0.38)	±0.19	2.07	±0.64	ND (<0.49)	±0.32	0.32 LT	±0.21	2.63	±0.77	0.33 LT	±0.21	0.36 LT	±0.24
	Radium-228	ND (<0.63)	±0.32	2.86	±0.95	1.98	±0.70	0.76 LT	±0.36	0.95 LT	±0.42	ND (<0.60)	±0.31	ND (<0.58)	±0.34
	Thorium-228	ND (<0.19)	±0.094	0.72	±0.19	0.22	±0.10	0.44	±0.15	ND (<0.11)	±0.050	0.40	±0.13	ND (<0.20)	±0.10
	Thorium-230	ND (<0.13)	±0.062	0.20	±0.11	ND (<0.17)	±0.083	ND (<0.17)	±0.076	ND (<0.19)	±0.063	ND (<0.16)	±0.077	ND (<0.15)	±0.057
	Thorium-232	ND (<0.055)	±0.021	0.25	±0.097	0.15 LT	±0.068	0.075 LT	±0.057	ND (<0.032)	±0.038	0.15 LT	±0.072	ND (<0.062)	±0.038
	Uranium-234	0.80	±0.17	1.51	±0.28	7.4	±1.0	28	±3.7	1.6	±0.29	1.1	±0.23	15	±2.0
	Uranium-235	0.050 LT	±0.039	ND (<0.025)	±0.030	0.27	±0.098	1.3	±0.27	ND (<0.059)	±0.039	0.080 LT	±0.053	0.61	±0.16
Uranium-238	0.42	±0.11	0.99	±0.21	4.8	±0.71	27	±3.6	1.4	±0.26	0.72	±0.17	14	±1.9	

Notes: TPU, total propagated uncertainty; ND, not detected; LT, less than requested minimum detection limit, greater than sample specific minimum detection limit.

Table 10 CSMRI Ground-Water Total Uranium, in micrograms per liter

Isotope	CSMRI-01		CSMRI-02		CSMRI-03		CSMRI-04		CSMRI-05		CSMRI-06		CSMRI-07	
	Concentration	TPU	Concentration	TPU	Concentration	TPU	Concentration	TPU	Concentration	TPU	Concentration	TPU	Concentration	TPU
Total Uranium, Feb 2003	3.6	±0.84	1.8	±0.24	18	±2.7	24	±3.4	4.2	±0.97	4.2	±0.90	12	±1.9
Total Uranium, Apr 2003	4.3	±0.90	1.9	±0.54	18	±2.8	51	±7.2	3.4	±0.77	2.5	±0.63	18	±2.8
Total Uranium, Jul 2003	1.3	±0.34	2.9	±0.62	14	±2.1	79	±11	4.1	±0.77	2.2	±0.51	42	±5.7

Notes: TPU, total propagated uncertainty

**Table 11 CSMRI Hydrocarbons Investigation Soil
Detected Volatile Organic Compounds, in micrograms per kilogram**

Compound	CB-18-6	CB-18-10	CB-18-14	CS-4.5	CS-5
Acetone	100 J	ND (<120)	40 J	190	120
Trichloroethene	30 J	ND (<29)	7 J	ND (<31)	ND (<31)

Notes: ND, not detected; J, compound identified but at less than minimum detection limit, qualitative value

**Table 12 CSMRI Hydrocarbons Investigation Soil
Detected Semi-Volatile Organic Compounds, in micrograms per kilogram**

Compound	CS-4.5	CS-5
2-Methylnaphthalene	ND (<2000)	4000

Notes: ND, not detected