

CHAPTER 3

Radionuclides and Inorganics in Selected Water Sources

INTRODUCTION

During 2007, water samples were collected for CEMRC environmental monitoring studies from five drinking water sources in the region of the WIPP. The drinking water wells in the vicinity of the WIPP site provide water primarily for livestock, industrial usage by oil and gas production operations, and monitoring studies conducted by various groups. The sources included the community water supplies of Carlsbad, Loving, Otis, and Hobbs, and the water supply for the WIPP site (Double Eagle). An additional source in the past, a private well, has been dry for the last several years.

Aquifers in the region surrounding the WIPP include Dewey Lake, Culebra-Magenta, Ogalalla, Dockum, Pecos River alluvium and Capitan Reef. The main Carlsbad water supply is the Sheep Draw well field whose primary source is the Capitan Reef aquifer. The Hobbs and WIPP-Double Eagle water supplies are drawn from the Ogalalla aquifer, while the Loving/Malaga and Otis supply wells draw from deposits that are hydraulically linked to the flow of the Pecos River. The source for the private well sampling site is a well seven miles southwest of the WIPP; this water is drawn from the Culebra aquifer when it is not dry.

CEMRC began collecting drinking water samples in 1997, and summaries of methods, data and results from previous sampling were reported in previous CEMRC reports (available at <http://www.cemrc.org>). Present results as well as the results of previous analyses of drinking water were consistent for each

source across sampling periods, with few organic contaminants detected and inorganic substances mostly below levels specified under the Safe Drinking Water Act.

Analyses reported herein are for 2007 for drinking water samples, analyzed for both inorganics and radionuclides.

METHODS

The alpha-emitting radionuclides ^{238}Pu and $^{239,240}\text{Pu}$ were analyzed in these drinking water samples. Discussions with stakeholders will determine if further analyses of other radioanalytes will be performed on these samples.

All drinking water samples were collected according to CEMRC protocols for the collection, handling and preservation of drinking water as follows: (1) 4 L for radiological analyses, (2) 1 L for elemental analyses, (3) 1 L for anion tests and (4) 500 mL for Hg analysis. None of the samples were filtered before analysis, but a portion of the 4 L sample was transferred to a 3 L Marinelli beaker for possible future gamma spectroscopy analyses.

CEMRC performed non-radiological analyses of drinking water samples using ICP-MS and IC, shown in Table 3-1. Radiochemistry was then applied to each sample for actinide separation and purification using multiple precipitation, co-precipitation and ion-exchange and/or extraction chromatography. Once the actinides were separated elementally, they were co-precipitated with LaF_3 and deposited onto filters, which were then counted on an alpha spectroscopy system.

Aliquots were blank-corrected after application of dilution factors. In cases where blank corrections lowered solution concentrations below MDC values, concentrations greater than zero are reported; negative concentrations are reported as less than MDC.

RESULTS AND DISCUSSION

Radiological Drinking Water

No radionuclides were measured above MDC in 2007. The federal and state action level for gross alpha emitters, which includes isotopes of Pu and U, is 15 pCi/L (0.56 Bq/L). This is over 10,000 times the levels measured by CEMRC in any drinking water sample over the last nine years.

Since 1998, Pu has not been measured above the MDC in any samples. Figures 3.1 and 3.2 show the historic values for $^{239,240}\text{Pu}$ and ^{238}Pu at all sites. All are below the MDC.

Non-Radiological Results Drinking Water

Measurements of inorganic analytes by CEMRC from the five drinking water sources showed little variation between years for each source. Differences of a factor of two or three between one set of successive years is common, as it is for all natural waters.

The 2007 measurements exhibit a high level of consistency with past results that provides a useful characterization of each source (Table 3-1).

As per the grant requirements and the fact that CEMRC does not use EPA compliance procedures, these results are not appropriate for use in assessing regulatory compliance. However, CEMRC results for drinking water collected during 2007 agreed well with, and were generally below, measurements for the same elements published in 2006 by the City of Carlsbad Municipal Water System (*2006 Annual Consumer Report on the Quality of Your Drinking Water* (www.cityofcarlsbadnm.com/documents/CCR2006.pdf)).

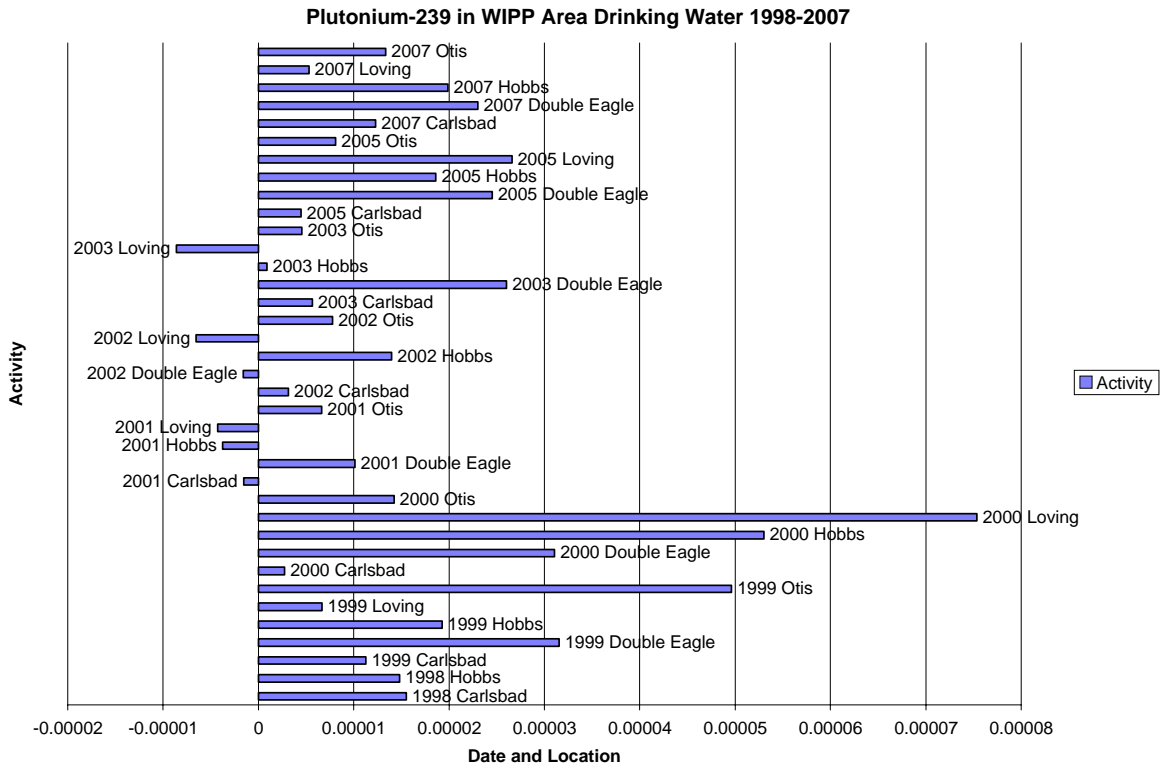


Figure 3.1: ^{239,240}Pu in Bq/L in regional drinking water from 1998 to 2007, all are about 10,000 times below the EPA Action level of 0.56 Bq/L. The EPA Action level is for all alpha-emitters, including U plus Pu.

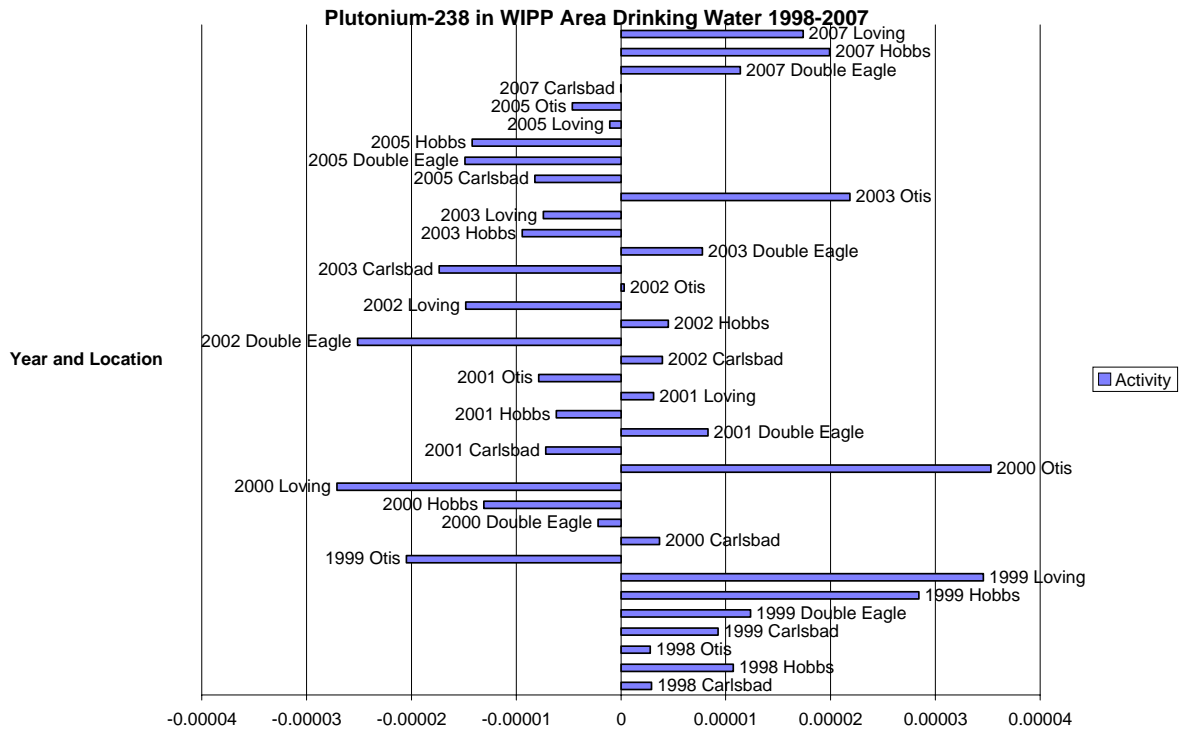


Figure 3.2: ²³⁸Pu in Bq/L in regional drinking water from 1998 to 2007, all are about 10,000 times below the EPA Action level of 0.56 Bq/L. The EPA Action level is for all alpha-emitters, including U plus Pu.

Table 3-1: Measured Concentration of Selected Inorganic Analytes in Drinking Water from 1998 to 2007 at Five Locations

Carlsbad													
	1998-2005					2005				2007			
EL ¹	N ²	N _{DET} ²	Min ³	Max ³	MDC ⁴ (ug/L)	Blank Conc. (ug/L)	Avg Conc. w/Blank Subt ⁵ (ug/L)	Avg Conc. w/o Blank Subt ⁵ (ug/L)	MDC ⁴ (ug/L)	Blank Conc. (ug/L)	Avg Conc. w/Blank Subt ⁵ (ug/L)	Avg Conc. w/o Blank Subt ⁵ (ug/L)	
Ag	8	2	1.23E-02	1.75E-02	2.30E-02	1.11E-01	<MDC	<MDC	N/A	N/A	N/A	N/A	
Al	10	4	2.34E+00	3.17E+01	1.49E+01	-2.80E+01	<MDC	<MDC	2.34E+01	1.92E+02	<MDC	<MDC	
As	10	7	3.45E-01	1.10E+00	2.01E+00	3.19E+01	<MDC	<MDC	7.12E-01	3.15E+00	1.10E+00	1.10E+00	
B	1	1	3.07E+01	3.07E+01	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
Ba	10	10	6.64E+01	7.62E+01	1.24E-01	-5.63E+00	7.62E+01	7.62E+01	1.99E-01	-1.36E+00	7.15E+01	7.15E+01	
Be	8	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
Ca	9	9	6.32E+04	8.06E+04	N/A	N/A	N/A	N/A	1.80E+03	1.43E+04	6.32E+04	7.76E+04	
Cd	8	0	N/A	N/A	6.73E-02	1.91E+00	<MDC	<MDC	N/A	N/A	N/A	N/A	
Ce	8	0	N/A	N/A	N/A	N/A	N/A	N/A	3.20E-02	-7.02E-01	<MDC	<MDC	
Co	9	7	8.80E-02	3.41E-01	7.21E-01	8.25E-01	<MDC	<MDC	6.40E-02	-1.82E-01	1.38E-01	1.38E-01	
Cr	10	8	1.24E+00	7.15E+00	7.82E+00	9.24E+01	<MDC	<MDC	2.87E-01	1.11E+00	1.24E+00	1.24E+00	
Cu	10	9	1.23E+00	1.67E+01	8.98E-02	3.68E+01	1.67E+01	1.67E+01	1.17E+00	4.23E+01	6.55E+00	6.55E+00	
Dy	9	0	N/A	N/A	2.79E-02	-1.77E-01	<MDC	<MDC	5.80E-02	1.49E-01	<MDC	<MDC	
Er	9	0	N/A	N/A	1.21E-02	-5.61E-02	<MDC	<MDC	3.70E-02	1.33E-01	<MDC	<MDC	
Eu	9	6	1.35E-02	2.43E-02	1.64E-02	-1.04E-01	<MDC	<MDC	9.30E-02	-7.61E-02	<MDC	<MDC	
Fe	9	3	2.14E+01	3.85E+01	2.94E+02	3.66E+03	<MDC	<MDC	N/A	N/A	N/A	N/A	
Ga	2	2	3.24E+00	3.25E+00	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
Gd	7	0	N/A	N/A	N/A	N/A	N/A	N/A	5.30E-02	6.00E-02	<MDC	<MDC	
Hg	7	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
K	9	8	1.04E+03	3.56E+03	N/A	N/A	N/A	N/A	2.33E+01	2.26E+03	<MDC	1.08E+03	
La	9	5	1.41E-02	4.48E-02	1.36E-02	1.00E-01	<MDC	<MDC	1.25E-01	2.07E-02	<MDC	<MDC	
Li	7	7	6.09E+00	7.87E+00	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
Mg	9	9	3.14E+04	3.47E+04	5.97E+00	-8.94E+01	3.47E+04	3.47E+04	3.43E+02	-2.56E+02	3.40E+04	3.40E+04	
Mn	10	8	5.50E-02	9.40E-01	1.60E+00	1.97E+01	<MDC	<MDC	1.64E-01	3.22E+00	<MDC	<MDC	
Mo	9	8	7.03E-01	1.26E+00	1.35E+00	-3.05E+01	<MDC	<MDC	N/A	N/A	N/A	N/A	
Na	9	9	8.47E+03	9.94E+04	N/A	N/A	N/A	N/A	8.01E+02	2.91E+02	8.47E+03	8.47E+03	
Nd	9	0	N/A	N/A	1.65E-02	3.60E-01	<MDC	<MDC	8.80E-02	1.76E-01	<MDC	<MDC	
Ni	9	8	1.01E+00	2.89E+00	1.74E+00	1.14E+01	<MDC	<MDC	1.14E+00	6.04E-01	2.06E+00	2.06E+00	
P	1	0	N/A	N/A	2.27E+01	-2.59E+02	<MDC	<MDC	N/A	N/A	N/A	N/A	
Pb	8	8	1.63E-01	8.53E+00	3.16E-02	-7.17E+00	8.53E+00	1.36E+00	N/A	N/A	N/A	N/A	
Pr	9	0	N/A	N/A	1.29E-02	-1.81E-01	<MDC	<MDC	3.80E-02	6.63E-02	<MDC	<MDC	
Rh	2	1	1.10E-02	1.10E-02	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
Sb	9	4	3.00E-02	1.99E-01	1.02E-01	1.96E-01	<MDC	<MDC	N/A	N/A	N/A	N/A	
Sc	6	6	1.72E+00	3.11E+00	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
Se	8	3	9.25E-02	1.75E+00	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
Si	4	4	5.31E+03	1.68E+04	7.32E+01	-1.01E+04	1.68E+04	6.77E+03	N/A	N/A	N/A	N/A	
Sm	9	7	2.34E-02	3.64E-02	1.62E-02	-2.01E-01	<MDC	<MDC	5.30E-02	1.70E-02	<MDC	<MDC	
Sn	5	1	5.97E-02	5.97E-02	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
Sr	10	10	3.23E+02	4.59E+02	2.51E-01	-1.19E-01	3.48E+02	3.48E+02	9.30E-01	9.59E-02	3.28E+02	3.28E+02	
Th	8	1	1.98E-02	1.98E-02	1.49E-02	6.30E-03	<MDC	<MDC	N/A	N/A	N/A	N/A	
Ti	4	3	3.64E-01	4.22E+00	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
Tl	8	8	9.97E-02	1.54E-01	1.07E-02	2.05E-02	9.97E-02	9.97E-02	N/A	N/A	N/A	N/A	
U	9	9	8.21E-01	1.04E+00	7.76E-03	-9.50E-04	8.60E-01	8.60E-01	6.10E-02	1.09E-02	1.04E+00	1.04E+00	
V	10	10	3.82E+00	5.90E+00	2.75E+00	-2.71E+00	4.53E+00	4.53E+00	1.07E-01	4.84E+00	4.09E+00	4.09E+00	
Zn	10	9	2.36E+00	1.52E+01	7.92E-01	-3.37E+01	3.32E+00	3.32E+00	1.78E+00	1.02E+02	<MDC	6.25E+00	

¹El = Element analyzed;

²N = Total number of samples analyzed; N_{det} = number of samples with detectable (above MDC) values;

³Min = the lowest value measured above MDC; Max = the highest value measured;

⁴MDC = Minimum detectable concentration;

⁵Average sample values with and without subtraction of the blank value; when blank subtraction is performed, it is only done when the blank value falls outside of the range (-MDC < blank < +MDC)

⁶N/A = Not Applicable

Table 3-1: Measured Concentration of Selected Inorganic Analytes in Drinking Water from 1998 to 2007 at Five Locations (Continued)

Double Eagle													
	1998-2005					2005				2007			
EL ¹	N ²	N _{DET} ²	Min ³	Max ³	MDC ⁴ (ug/L)	Blank Conc. (ug/L)	Avg Conc. w/Blank Subt ⁵ (ug/L)	Avg Conc. w/o Blank Subt ⁵ (ug/L)	MDC ⁴ (ug/L)	Blank Conc. (ug/L)	Avg Conc. w/Blank Subt ⁵ (ug/L)	Avg Conc. w/o Blank Subt ⁵ (ug/L)	
Ag	8	1	3.62E-03	3.62E-03	2.30E-02	1.11E-01	<MDC	<MDC	N/A	N/A	N/A	N/A	
Al	10	5	2.57E+00	7.22E+01	1.49E+01	-2.80E+01	<MDC	<MDC	2.34E+01	1.92E+02	<MDC	<MDC	
As	10	10	4.26E+00	7.80E+00	2.01E+00	3.19E+01	7.80E+00	7.80E+00	7.12E-01	3.15E+00	7.14E+00	7.14E+00	
B	1	1	7.00E+01	7.00E+01	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
Ba	9	9	7.93E+01	1.26E+02	1.24E-01	-5.63E+00	7.93E+01	7.93E+01	1.99E-01	-1.36E+00	8.54E+01	8.54E+01	
Be	7	1	3.63E-02	3.63E-02	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
Ca	9	9	5.18E+03	5.83E+04	N/A	N/A	N/A	N/A	1.80E+03	1.43E+04	4.24E+04	5.67E+04	
Cd	8	3	1.87E-02	1.85E-01	6.73E-02	1.91E+00	<MDC	<MDC	N/A	N/A	N/A	N/A	
Ce	8	2	3.18E-03	3.63E-03	N/A	N/A	N/A	N/A	3.20E-02	-7.02E-01	<MDC	<MDC	
Co	10	6	8.45E-02	1.12E+00	7.21E-01	8.25E-01	<MDC	<MDC	6.40E-02	-1.82E-01	8.45E-02	8.45E-02	
Cr	10	10	1.22E+00	3.25E+01	7.82E+00	9.24E+01	3.25E+01	3.25E+01	2.87E-01	1.11E+00	2.10E+00	2.10E+00	
Cu	10	10	8.09E-01	5.69E+00	8.98E-02	3.68E+01	3.26E+00	3.26E+00	1.17E+00	4.23E+01	3.56E+00	3.56E+00	
Dy	10	0	N/A	N/A	2.79E-02	-1.77E-01	<MDC	<MDC	5.80E-02	1.49E-01	<MDC	<MDC	
Er	10	0	N/A	N/A	1.21E-02	-5.61E-02	<MDC	<MDC	3.70E-02	1.33E-01	<MDC	<MDC	
Eu	10	6	1.68E-02	2.86E-02	1.64E-02	-1.04E-01	<MDC	<MDC	9.30E-02	-7.61E-02	<MDC	<MDC	
Fe	8	5	7.93E+01	9.32E+02	2.94E+02	3.66E+03	9.32E+02	9.32E+02	N/A	N/A	N/A	N/A	
Ga	1	1	4.46E+00	4.46E+00	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
Gd	8	0	N/A	N/A	N/A	N/A	N/A	N/A	5.30E-02	6.00E-02	<MDC	<MDC	
Hg	6	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
K	9	9	7.79E+02	2.94E+04	N/A	N/A	N/A	N/A	2.33E+01	2.26E+03	7.79E+02	3.04E+03	
La	10	5	1.19E-02	6.26E-02	1.36E-02	1.00E-01	<MDC	<MDC	1.25E-01	2.07E-02	<MDC	<MDC	
Li	7	7	1.29E+01	1.90E+01	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
Mg	9	9	1.09E+03	1.25E+04	5.97E+00	-8.94E+01	1.01E+04	1.01E+04	3.43E+02	-2.56E+02	1.25E+04	1.25E+04	
Mn	10	10	1.91E-01	6.04E+00	1.60E+00	1.97E+01	5.89E+00	5.89E+00	1.64E-01	3.22E+00	1.91E-01	1.91E-01	
Mo	8	8	1.48E+00	6.70E+00	1.35E+00	-3.05E+01	6.70E+00	6.70E+00	N/A	N/A	N/A	N/A	
Na	9	9	3.84E+03	4.04E+04	N/A	N/A	N/A	N/A	8.01E+02	2.91E+02	4.02E+04	4.02E+04	
Nd	10	1	5.37E-01	5.37E-03	1.65E-02	3.60E-01	<MDC	<MDC	8.80E-02	1.76E-01	<MDC	<MDC	
Ni	10	10	8.00E-01	4.03E+00	1.74E+00	1.14E+01	4.03E+00	4.03E+00	1.14E+00	6.04E-01	1.24E+00	1.24E+00	
P	1	0	N/A	N/A	2.27E+01	-2.59E+02	<MDC	<MDC	N/A	N/A	N/A	N/A	
Pb	8	8	2.56E-01	7.70E+00	3.16E-02	-7.17E+00	7.70E+00	5.28E-01	N/A	N/A	N/A	N/A	
Pr	10	1	9.05E-04	9.05E-04	1.29E-02	-1.81E-01	<MDC	<MDC	3.80E-02	6.63E-02	<MDC	<MDC	
Rh	1	1	1.56E-02	1.56E-02	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
Sb	8	5	2.41E-02	1.39E-01	1.02E-01	1.96E-01	<MDC	<MDC	N/A	N/A	N/A	N/A	
Sc	6	6	4.61E+00	9.08E+01	2.68E-01	-8.94E+01	9.08E+01	1.40E+00	N/A	N/A	N/A	N/A	
Se	7	4	2.28E+00	3.53E+00	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
Si	3	3	1.53E+04	2.64E+04	7.32E+01	-1.01E+04	2.64E+04	1.64E+04	N/A	N/A	N/A	N/A	
Sm	10	6	2.69E-02	4.26E-02	1.62E-02	-2.01E-01	<MDC	<MDC	5.30E-02	1.70E-02	<MDC	<MDC	
Sn	4	2	9.41E-02	3.36E-01	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
Sr	10	10	5.06E+01	5.63E+02	2.51E-01	-1.19E-01	5.28E+02	5.28E+02	9.30E-01	9.59E-02	5.52E+02	5.52E+02	
Th	8	3	4.32E-03	1.36E-02	1.49E-02	6.30E-03	<MDC	<MDC	N/A	N/A	N/A	N/A	
Ti	4	3	2.62E+00	2.87E+00	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
Tl	7	2	2.73E-02	4.84E-02	1.07E-02	2.05E-02	<MDC	<MDC	N/A	N/A	N/A	N/A	
U	10	10	1.34E+00	2.34E+00	7.76E-03	-9.50E-04	1.99E+00	1.99E+00	6.10E-02	1.09E-02	2.34E+00	2.34E+00	
V	10	10	2.46E+01	3.26E+01	2.75E+00	-2.71E+00	3.01E+01	3.01E+01	1.07E-01	4.84E+00	2.46E+01	2.46E+01	
Zn	10	8	1.80E+00	1.25E+01	7.92E-01	-3.37E+01	2.72E+00	2.72E+00	1.78E+00	1.02E+02	<MDC	4.99E+00	

¹El = Element analyzed;

²N = Total number of samples analyzed; N_{det} = number of samples with detectable (above MDC) values;

³Min = the lowest value measured above MDC; Max = the highest value measured;

⁴MDC = Minimum detectable concentration;

⁵Average sample values with and without subtraction of the blank value; when blank subtraction is performed, it is only done when the blank value falls outside of the range (-MDC < blank < +MDC)

⁶N/A = Not Applicable

Table 3-1: Measured Concentration of Selected Inorganic Analytes in Drinking Water from 1998 to 2007 at Five Locations (Continued)

Hobbs													
EL ¹	1998-2005					2005				2007			
	N ²	N _{DET} ²	Min ³	Max ³	MDC ⁴ (ug/L)	Blank Conc. (ug/L)	Avg Conc. w/Blank Subt ⁵ (ug/L)	Avg Conc. w/o Blank Subt ⁵ (ug/L)	MDC ⁴ (ug/L)	Blank Conc. (ug/L)	Avg Conc. w/Blank Subt ⁵ (ug/L)	Avg Conc. w/o Blank Subt ⁵ (ug/L)	
Aq	7	2	3.86E-03	1.04E-01	2.30E-02	1.11E-01	<MDC	<MDC	N/A	N/A	N/A	N/A	
Al	8	5	3.03E+00	1.14E+02	1.49E+01	-2.80E+01	<MDC	<MDC	2.34E+01	1.92E+02	<MDC	<MDC	
As	8	8	4.51E+00	7.37E+00	2.01E+00	3.19E+01	6.78E+00	6.78E+00	7.12E-01	3.15E+00	6.70E+00	6.70E+00	
B	1	1	1.41E+02	1.41E+02	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
Ba	8	8	5.65E+01	6.52E+01	1.24E-01	-5.63E+00	6.06E+01	6.06E+01	1.99E-01	-1.36E+00	6.52E+01	6.52E+01	
Be	6	1	5.39E-02	5.39E-02	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
Ca	7	7	8.09E+03	9.06E+04	N/A	N/A	N/A	N/A	1.80E+03	1.43E+04	8.63E+04	1.01E+05	
Cd	7	1	1.57E-01	1.57E-01	6.73E-02	1.91E+00	<MDC	<MDC	N/A	N/A	N/A	N/A	
Ce	7	4	5.10E-03	2.23E-02	N/A	N/A	N/A	N/A	3.20E-02	-7.02E-01	<MDC	<MDC	
Co	8	6	9.78E-02	3.61E-01	7.21E-01	8.25E-01	<MDC	<MDC	6.40E-02	-1.82E-01	1.88E-01	1.88E-01	
Cr	8	8	7.33E-01	1.13E+01	7.82E+00	9.24E+01	1.13E+01	1.13E+01	2.87E-01	1.11E+00	8.45E-01	8.45E-01	
Cu	8	8	1.06E+00	6.93E+00	8.98E-02	3.68E+01	6.93E+00	6.93E+00	1.17E+00	4.23E+01	4.86E+00	4.86E+00	
Dy	8	1	4.18E-03	4.18E-03	2.79E-02	-1.77E-01	<MDC	<MDC	5.80E-02	1.49E-01	<MDC	<MDC	
Er	8	0	N/A	N/A	1.21E-02	-5.61E-02	<MDC	<MDC	3.70E-02	1.33E-01	<MDC	<MDC	
Eu	8	5	1.31E-02	1.97E-02	1.64E-02	-1.04E-01	<MDC	<MDC	9.30E-02	-7.61E-02	<MDC	<MDC	
Fe	6	4	3.64E+01	4.44E+02	2.94E+02	3.66E+03	4.44E+02	4.44E+02	N/A	N/A	N/A	N/A	
Ga	1	1	2.56E+00	2.56E+00	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
Gd	7	0	N/A	N/A	N/A	N/A	N/A	N/A	5.30E-02	6.00E-02	<MDC	<MDC	
Hg	5	2	1.06E-02	1.42E-02	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
K	7	7	4.12E+02	2.53E+04	N/A	N/A	N/A	N/A	2.33E+01	2.26E+03	4.12E+02	2.68E+03	
La	8	4	1.51E-02	5.01E-02	1.36E-02	1.00E-01	<MDC	<MDC	1.25E-01	2.07E-02	<MDC	<MDC	
Li	6	6	2.65E+01	3.18E+01	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
Mg	7	7	2.11E+03	2.51E+04	5.97E+00	-8.94E+01	2.08E+04	2.08E+04	3.43E+02	-2.56E+02	2.51E+04	2.51E+04	
Mn	8	8	3.79E-01	2.67E+00	1.60E+00	1.97E+01	2.67E+00	2.67E+00	1.64E-01	3.22E+00	1.78E+00	1.78E+00	
Mo	7	7	2.60E+00	3.31E+00	1.35E+00	-3.05E+01	3.31E+00	3.31E+00	N/A	N/A	N/A	N/A	
Na	7	7	4.97E+03	5.46E+04	N/A	N/A	N/A	N/A	8.01E+02	2.91E+02	5.46E+04	5.46E+04	
Nd	8	3	3.01E-03	1.28E-02	1.65E-02	3.60E-01	<MDC	<MDC	8.80E-02	1.76E-01	<MDC	<MDC	
Ni	8	8	1.08E+00	2.77E+00	1.74E+00	1.14E+01	2.01E+00	2.01E+00	1.14E+00	6.04E-01	2.46E+00	2.46E+00	
P	1	0	N/A	N/A	2.27E+01	-2.59E+02	<MDC	<MDC	N/A	N/A	N/A	N/A	
Pb	7	7	9.44E-02	7.72E+00	3.16E-02	-7.17E+00	7.72E+00	5.50E-01	N/A	N/A	N/A	N/A	
Pr	8	1	1.57E-03	1.57E-03	1.29E-02	-1.81E-01	<MDC	<MDC	3.80E-02	6.63E-02	<MDC	<MDC	
Rh	1	1	2.52E-02	2.52E-02	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
Sb	6	5	3.88E-02	7.02E-02	1.02E-01	1.96E-01	<MDC	<MDC	N/A	N/A	N/A	N/A	
Sc	5	5	7.17E+00	9.25E+01	2.68E-01	-8.94E+01	9.25E+01	3.06E+00	N/A	N/A	N/A	N/A	
Se	5	3	3.50E+00	6.23E+00	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
Si	3	3	2.54E+04	3.59E+04	7.32E+01	-1.01E+04	3.59E+04	2.58E+04	N/A	N/A	N/A	N/A	
Sm	8	6	1.93E-02	3.27E-02	1.62E-02	-2.01E-01	<MDC	<MDC	5.30E-02	1.70E-02	<MDC	<MDC	
Sn	3	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
Sr	8	8	7.89E+01	1.06E+03	2.51E-01	-1.19E-01	9.92E+02	9.92E+02	9.30E-01	9.59E-02	1.06E+03	1.06E+03	
Th	7	2	4.54E-03	4.56E-03	1.49E-02	6.30E-03	<MDC	<MDC	N/A	N/A	N/A	N/A	
Ti	3	3	3.14E+00	7.47E+00	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
Tl	5	2	2.24E-02	2.31E-02	1.07E-02	2.05E-02	<MDC	<MDC	N/A	N/A	N/A	N/A	
U	8	8	2.90E+00	3.77E+00	7.76E-03	-9.50E-04	3.43E+00	3.43E+00	6.10E-02	1.09E-02	3.77E+00	3.77E+00	
V	8	8	3.23E+01	3.71E+01	2.75E+00	-2.71E+00	3.30E+01	3.30E+01	1.07E-01	4.84E+00	3.23E+01	3.23E+01	
Zn	8	7	1.47E+00	4.37E+00	7.92E-01	-3.37E+01	2.31E+00	2.31E+00	1.78E+00	1.02E+02	<MDC	3.60E+00	

¹El = Element analyzed;

²N = Total number of samples analyzed; N_{det} = number of samples with detectable (above MDC) values;

³Min = the lowest value measured above MDC; Max = the highest value measured;

⁴MDC = Minimum detectable concentration;

⁵Average sample values with and without subtraction of the blank value; when blank subtraction is performed, it is only done when the blank value falls outside of the range (-MDC < blank < +MDC)

⁶N/A = Not Applicable

Table 3-1: Measured Concentration of Selected Inorganic Analytes in Drinking Water from 1998 to 2007 at Five Locations (Continued)

Loving													
EL ¹	N ²	1998-2005			2005				2007				
		N _{DET} ²	Min ³	Max ³	MDC ⁴ (ug/L)	Blank Conc. (ug/L)	Avg Conc. w/Blank Subt ⁵ (ug/L)	Avg Conc. w/o Blank Subt ⁵ (ug/L)	MDC ⁴ (ug/L)	Blank Conc. (ug/L)	Avg Conc. w/Blank Subt ⁵ (ug/L)	Avg Conc. w/o Blank Subt ⁵ (ug/L)	
Ag	9	3	2.55E-03	1.30E-01	2.30E-02	1.11E-01	<MDC	<MDC	N/A	N/A	N/A	N/A	
Al	9	3	3.76E+00	5.19E+01	1.49E+01	-2.80E+01	<MDC	<MDC	2.34E+01	1.92E+02	4.42E+01	4.42E+01	
As	9	7	1.20E+00	2.16E+00	2.01E+00	3.19E+01	2.16E+00	2.16E+00	7.12E-01	3.15E+00	1.70E+00	1.70E+00	
B	1	1	7.55E+01	7.55E+01	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
Ba	9	9	2.86E+01	3.37E+01	1.24E-01	-5.63E+00	3.06E+01	3.06E+01	1.99E-01	-1.36E+00	3.37E+01	3.37E+01	
Be	6	1	9.35E-02	9.35E-02	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
Ca	7	7	9.14E+03	1.04E+05	N/A	N/A	N/A	N/A	1.80E+03	1.43E+04	7.54E+04	8.98E+04	
Cd	8	0	N/A	N/A	6.73E-02	1.91E+00	<MDC	<MDC	N/A	N/A	N/A	N/A	
Ce	7	1	9.74E-04	9.74E-04	N/A	N/A	N/A	N/A	3.20E-02	-7.02E-01	<MDC	<MDC	
Co	9	6	1.02E-01	4.04E-01	7.21E-01	8.25E-01	<MDC	<MDC	6.40E-02	-1.82E-01	1.33E-01	1.33E-01	
Cr	9	7	1.21E+00	7.44E+00	7.82E+00	9.24E+01	<MDC	<MDC	2.87E-01	1.11E+00	4.24E+00	4.24E+00	
Cu	9	8	1.71E+00	5.59E+00	8.98E-02	3.68E+01	1.71E+00	1.71E+00	1.17E+00	4.23E+01	<MDC	<MDC	
Dy	9	0	N/A	N/A	2.79E-02	-1.77E-01	<MDC	<MDC	5.80E-02	1.49E-01	<MDC	<MDC	
Er	9	0	N/A	N/A	1.21E-02	-5.61E-02	<MDC	<MDC	3.70E-02	1.33E-01	<MDC	<MDC	
Eu	9	5	7.00E-03	1.01E-02	1.64E-02	-1.04E-01	<MDC	<MDC	9.30E-02	-7.61E-02	<MDC	<MDC	
Fe	8	3	1.56E+01	2.24E+02	2.94E+02	3.66E+03	<MDC	<MDC	N/A	N/A	N/A	N/A	
Ga	1	1	1.26E+00	1.26E+00	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
Gd	7	2	2.15E-03	2.26E-03	N/A	N/A	N/A	N/A	5.30E-02	6.00E-02	<MDC	<MDC	
Hg	4	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
K	7	6	1.85E+03	1.98E+04	N/A	N/A	N/A	N/A	2.33E+01	2.26E+03	<MDC	2.04E+03	
La	9	4	7.27E-03	2.22E-02	1.36E-02	1.00E-01	<MDC	<MDC	1.25E-01	2.07E-02	<MDC	<MDC	
Li	6	6	1.66E+01	1.96E+01	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
Mg	8	8	4.04E+03	4.02E+04	5.97E+00	-8.94E+01	3.53E+04	3.53E+04	3.43E+02	-2.56E+02	3.99E+04	3.99E+04	
Mn	9	7	1.43E-02	1.77E+00	1.60E+00	1.97E+01	1.77E+00	1.77E+00	1.64E-01	3.22E+00	5.48E-01	5.48E-01	
Mo	8	6	1.41E+00	1.81E+00	1.35E+00	-3.05E+01	<MDC	<MDC	N/A	N/A	N/A	N/A	
Na	7	7	2.33E+03	2.73E+04	N/A	N/A	N/A	N/A	8.01E+02	2.91E+02	2.73E+04	2.73E+04	
Nd	9	1	3.37E-03	3.37E-03	1.65E-02	3.60E-01	<MDC	<MDC	8.80E-02	1.76E-01	<MDC	<MDC	
Ni	9	7	1.19E+00	3.43E+00	1.74E+00	1.14E+01	<MDC	<MDC	1.14E+00	6.04E-01	2.15E+00	2.15E+00	
P	2	0	N/A	N/A	2.27E+01	-2.59E+02	<MDC	<MDC	N/A	N/A	N/A	N/A	
Pb	8	8	6.33E-01	7.34E+00	3.16E-02	-7.17E+00	7.34E+00	1.71E-01	N/A	N/A	N/A	N/A	
Pr	8	0	N/A	N/A	1.29E-02	-1.81E-01	<MDC	<MDC	3.80E-02	6.63E-02	<MDC	<MDC	
Rh	1	1	3.07E-02	3.07E-02	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
Sb	7	4	3.51E-02	1.84E-01	1.02E-01	1.96E-01	<MDC	<MDC	N/A	N/A	N/A	N/A	
Sc	6	6	3.22E+00	8.97E+01	2.68E-01	-8.94E+01	8.96E+01	<MDC	N/A	N/A	N/A	N/A	
Se	5	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
Si	4	4	8.54E+03	2.01E+04	7.32E+01	-1.01E+04	1.99E+04	9.85E+03	N/A	N/A	N/A	N/A	
Sm	9	3	8.43E-03	1.30E-02	1.62E-02	-2.01E-01	<MDC	<MDC	5.30E-02	1.70E-02	<MDC	<MDC	
Sn	4	1	4.45E-01	4.45E-01	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
Sr	9	9	7.60E+01	9.37E+02	2.51E-01	-1.19E-01	8.07E+02	8.07E+02	9.30E-01	9.59E-02	7.67E+02	7.67E+02	
Th	8	2	5.69E-03	9.63E-03	1.49E-02	6.30E-03	<MDC	<MDC	N/A	N/A	N/A	N/A	
Ti	3	3	2.68E+00	1.04E+01	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
Tl	7	1	4.32E-02	4.32E-02	1.07E-02	2.05E-02	<MDC	<MDC	N/A	N/A	N/A	N/A	
U	9	9	1.98E+00	2.26E+00	7.76E-03	-9.50E-04	2.10E+00	2.10E+00	6.10E-02	1.09E-02	2.13E+00	2.13E+00	
V	9	9	1.19E+01	1.44E+01	2.75E+00	-2.71E+00	1.21E+01	1.21E+01	1.07E-01	4.84E+00	1.22E+01	1.22E+01	
Zn	9	8	4.13E+00	2.09E+01	7.92E-01	-3.37E+01	2.01E+01	2.01E+01	1.78E+00	1.02E+02	<MDC	1.21E+01	

¹El = Element analyzed;

²N = Total number of samples analyzed; N_{det} = number of samples with detectable (above MDC) values;

³Min = the lowest value measured above MDC; Max = the highest value measured;

⁴MDC = Minimum detectable concentration;

⁵Average sample values with and without subtraction of the blank value; when blank subtraction is performed, it is only done when the blank value falls outside of the range (-MDC < blank < +MDC)

⁶N/A = Not Applicable

Table 3-1: Measured Concentration of Selected Inorganic Analytes in Drinking Water from 1998 to 2007 at Five Locations (Continued)

Otis													
	1998-2005					2005				2007			
EL ¹	N ²	N _{DET} ²	Min ³	Max ³	MDC ⁴ (ug/L)	Blank Conc. (ug/L)	Avg Conc. w/Blank Subt ⁵ (ug/L)	Avg Conc. w/o Blank Subt ⁵ (ug/L)	MDC ⁴ (ug/L)	Blank Conc. (ug/L)	Avg Conc. w/Blank Subt ⁵ (ug/L)	Avg Conc. w/o Blank Subt ⁵ (ug/L)	
Aq	7	1	2.63E-02	2.63E-02	2.30E-02	1.11E-01	<MDC	<MDC	N/A	N/A	N/A	N/A	
Al	8	1	5.74E+00	5.74E+00	1.49E+01	-2.80E+01	<MDC	<MDC	2.34E+01	1.92E+02	<MDC	<MDC	
As	9	5	6.53E-01	2.34E+00	2.01E+00	3.19E+01	<MDC	<MDC	7.12E-01	3.15E+00	2.34E+00	2.34E+00	
B	2	2	1.46E+02	1.52E+02	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
Ba	9	9	1.35E+01	1.75E+01	1.24E-01	-5.63E+00	1.44E+01	1.44E+01	1.99E-01	-1.36E+00	1.60E+01	1.60E+01	
Be	6	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
Ca	8	8	2.14E+05	3.83E+05	N/A	N/A	N/A	N/A	1.80E+04	1.43E+04	2.67E+05	2.82E+05	
Cd	7	0	N/A	N/A	6.73E-02	1.91E+00	<MDC	<MDC	N/A	N/A	N/A	N/A	
Ce	6	0	N/A	N/A	N/A	N/A	N/A	N/A	3.20E-02	-7.02E-01	<MDC	<MDC	
Co	8	7	1.19E-01	9.51E-01	7.21E-01	8.25E-01	<MDC	<MDC	6.40E-02	-1.82E-01	4.14E-01	4.14E-01	
Cr	9	8	8.76E-01	6.67E+00	7.82E+00	9.24E+01	<MDC	<MDC	2.87E-01	1.11E+00	8.76E-01	8.76E-01	
Cu	9	8	2.43E+00	6.02E+00	8.98E-02	3.68E+01	2.43E+00	2.43E+00	1.17E+00	4.23E+01	3.00E+00	3.00E+00	
Dy	8	1	3.39E-03	3.39E-03	2.79E-02	-1.77E-01	<MDC	<MDC	5.80E-02	1.49E-01	<MDC	<MDC	
Er	8	0	N/A	N/A	1.21E-02	-5.61E-02	<MDC	<MDC	3.70E-02	1.33E-01	<MDC	<MDC	
Eu	8	3	3.42E-03	9.48E-03	1.64E-02	-1.04E-01	<MDC	<MDC	9.30E-02	-7.61E-02	<MDC	<MDC	
Fe	8	8	2.87E+00	8.53E+02	2.94E+02	3.66E+03	4.60E+02	4.60E+02	N/A	N/A	N/A	N/A	
Ga	1	1	6.54E-01	6.54E-01	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
Gd	6	0	N/A	N/A	N/A	N/A	N/A	N/A	5.30E-02	6.00E-02	<MDC	<MDC	
Hg	6	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
K	8	8	6.81E+02	4.01E+03	N/A	N/A	N/A	N/A	2.33E+01	2.26E+03	6.81E+02	2.94E+03	
La	8	2	3.97E-03	6.30E-03	1.36E-02	1.00E-01	<MDC	<MDC	1.25E-01	2.07E-02	<MDC	<MDC	
Li	6	6	4.11E+01	4.85E+01	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
Mg	8	8	5.16E+04	1.08E+05	5.97E+00	-8.94E+01	5.16E+04	5.16E+04	3.43E+02	-2.56E+02	7.77E+04	7.77E+04	
Mn	8	6	1.78E-01	2.32E+00	1.60E+00	1.97E+01	<MDC	<MDC	1.64E-01	3.22E+00	<MDC	<MDC	
Mo	7	7	2.39E+00	3.13E+00	1.35E+00	-3.05E+01	3.13E+00	3.13E+00	N/A	N/A	N/A	N/A	
Na	8	8	7.83E+04	1.62E+05	N/A	N/A	N/A	N/A	8.01E+02	2.91E+02	1.02E+05	1.02E+05	
Nd	8	3	4.80E-03	3.97E-02	1.65E-02	3.60E-01	<MDC	<MDC	8.80E-02	1.76E-01	<MDC	<MDC	
Ni	8	8	2.45E+00	1.06E+01	1.74E+00	1.14E+01	2.62E+00	2.62E+00	1.14E+00	6.04E-01	5.91E+00	5.91E+00	
P	1	1	4.54E+01	4.54E+01	2.27E+01	-2.59E+02	4.54E+01	4.54E+01	N/A	N/A	N/A	N/A	
Pb	7	7	1.08E-01	7.20E+00	3.16E-02	-7.17E+00	7.20E+00	<MDC	N/A	N/A	N/A	N/A	
Pr	8	0	N/A	N/A	1.29E-02	-1.81E-01	<MDC	<MDC	3.80E-02	6.63E-02	<MDC	<MDC	
Rh	1	1	1.29E-01	1.29E-01	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
Sb	7	5	3.50E-02	4.10E-01	1.02E-01	1.96E-01	<MDC	<MDC	N/A	N/A	N/A	N/A	
Sc	6	6	3.53E+00	8.95E+01	2.68E-01	-8.94E+01	8.95E+01	<MDC	N/A	N/A	N/A	N/A	
Se	7	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
Si	4	4	9.77E+03	1.99E+04	7.32E+01	-1.01E+04	1.99E+04	9.83E+03	N/A	N/A	N/A	N/A	
Sm	8	1	3.56E-03	3.56E-03	1.62E-02	-2.01E-01	<MDC	<MDC	5.30E-02	1.70E-02	<MDC	<MDC	
Sn	4	1	9.71E-02	9.71E-02	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
Sr	9	9	2.38E+03	3.61E+03	2.51E-01	-1.19E-01	2.41E+03	2.41E+03	9.30E+00	9.59E-02	2.81E+03	2.81E+03	
Th	7	2	3.44E-03	2.67E-02	1.49E-02	6.30E-03	<MDC	<MDC	N/A	N/A	N/A	N/A	
Ti	4	4	5.68E+00	3.79E+01	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
Tl	6	0	N/A	N/A	1.07E-02	2.05E-02	<MDC	<MDC	N/A	N/A	N/A	N/A	
U	8	8	3.73E+00	5.34E+00	7.76E-03	-9.50E-04	3.73E+00	3.73E+00	6.10E-02	1.09E-02	4.42E+00	4.42E+00	
V	9	9	1.05E+01	1.29E+01	2.75E+00	-2.71E+00	1.05E+01	1.05E+01	1.07E-01	4.84E+00	1.08E+01	1.08E+01	
Zn	9	8	1.54E+00	1.64E+01	7.92E-01	-3.37E+01	1.54E+00	1.54E+00	1.78E+00	1.02E+02	<MDC	3.21E+00	

¹El = Element analyzed;

²N = Total number of samples analyzed; N_{det} = number of samples with detectable (above MDC) values;

³Min = the lowest value measured above MDC; Max = the highest value measured;

⁴MDC = Minimum detectable concentration;

⁵Average sample values with and without subtraction of the blank value; when blank subtraction is performed, it is only done when the blank value falls outside of the range (-MDC < blank < +MDC)

⁶N/A = Not Applicable