



October 31, 2011

Mr. Chad Pulsifer
918 S. Los Charros Court
Pueblo West, CO 81007-6405

RE: Complaint 200204502
Water Well Analysis
Well Permit 250313
SWSW 35 32S, 68W Las Animas County, Colorado

Dear Chad:

In response to your concerns regarding possible impacts to water quality from coal bed methane (CBM) operations in the area near your home, the Colorado Oil and Gas Conservation Commission (COGCC) conducted field visits to your property on March 19, 2009 and on April 14, 2009. Water samples were collected for general organic and inorganic water quality testing as well as for analysis of dissolved methane on March 19, 2009. A water sample for analysis of gas composition and isotopic ratio determination was collected on April 14, 2009. A summary of the results of the chemical analyses is presented below. The analytical results are also compared to published water quality standards and to results of prior and subsequent testing of water produced from your domestic well.

FIELD TESTING

The COGCC utilized the services of Whetstone Associates to collect samples from your well in response to this complaint. Christa Whitmore of Whetstone Associates collected samples from your well on March 5, 2009. The samples collected on March 5, 2009 were shipped to the laboratory via UPS but the samples were never received at the lab nor were the samples returned to the COGCC nor were the samples returned to Whetstone Associates.

On behalf of the COGCC, Christa Whitmore of Whetstone Associates visited your property on March 19, 2009. The pump was started at 10:40. The samples were collected at 11:05 after the temperature, pH and conductivity measurements of the water were stable for 15 minutes. The samples for general chemical analyses were shipped to ALS Paragon in Fort Collins, CO and received by them on March 20, 2009.

I visited your property on April 14, 2009. We screened for the presence of combustible gases inside your home and none were detected in the home. We went to your domestic well and removed the small doghouse covering the casing. I detected 50-65% by volume methane venting from your well casing. After the arrival of two Norwest Applied Hydrology staff, you started the pump and water flowing from a tap near your home. After the pH, temperature and conductivity had been stable for 10 minutes I collected a sample from a small plastic hose attached to the outside tap. This sample was shipped to Isotech Laboratories in Champaign, IL and received on April 15, 2009.

COMPARISON OF INORGANIC ANALYTICAL RESULTS TO CDPHE INORGANIC STANDARDS

The Water Quality Control Commission (WQCC) of the Colorado Department of Public Health and Environment (CDPHE) has established “Domestic Use-Quality” human health standards and drinking water standards. Analytical data for the samples from your water well was compared to these standards. This information is summarized in Table 1 which is located in Attachment 1 and discussed in narrative form below. Please keep in mind that these “Domestic Use-Quality Standards” were established for **municipal public** drinking water supplies and often people use and consume ground water from private wells that exceed these standards. Table 2 (Attachment 2) also includes results from testing conducted in 2006 and 2008 on water from your well and from COGCC sampling and analyses in March, 2009 as well as data from sampling conducted on behalf of Pioneer Natural Resources by Norwest Applied Hydrology staff in April, 2009. The analytical data provided by ALS Paragon was hand delivered to you on April 14, 2009.

- **Antimony (Sb):** The CDPHE human health standard for antimony is 0.006mg/l. Antimony is a contaminate metal.

Antimony was detected in the sample collected from your water well at a concentration of 0.00068mg/l which is below the CDPHE human health standard.

- **Arsenic (As):** The CDPHE human health standard for arsenic is 0.05 mg/l. Arsenic is a highly poisonous metal.

Arsenic was not detected in the sample collected from your water well.

- **Barium (Ba):** The CDPHE human health standard for barium is 2.0 mg/l. Barium is a contaminate metal.

Barium was detected in the sample collected from your water well at a concentration of 0.3mg/l which is below the CDPHE human health standard.

- **Beryllium (Be):** The CDPHE human health standard for beryllium is 0.004mg/l. Beryllium is a contaminate metal.

Beryllium was not detected in the sample collected from your water well.

- **Cadmium (Cd):** The CDPHE human health standard for cadmium is 0.005 mg/l. Cadmium is a contaminate metal.

Cadmium was not detected in the sample collected from your water well.

- **Chromium (Cr):** The CDPHE human health standard for chromium is 0.1 mg/l. Chromium is a contaminate metal.

Chromium was not detected in the sample collected from your water well.

- **Lead (Pb):** The CDPHE human health standard for lead is 0.05 mg/l. Prolonged exposure to this metal can result in serious health effects.

Lead was not detected in the sample collected from your water well.

- **Nickel (Ni):** The CDPHE human health standard for nickel is 0.1mg/l. Nickel is a contaminate metal.

Nickel was not detected in the sample collected from your water well.

- **Selenium (Se)**: The CDPHE human health standard for selenium is 0.05 mg/l. Selenium is a contaminate metal.

Selenium was not detected in the sample collected from your water well.

- **Silver (Ag)**: The CDPHE human health standard for silver is 0.05 mg/l. Excess amounts of silver may cause a permanent gray discoloration of the skin.

Silver was not detected in the sample collected from your water well.

- **Thallium (Tl)**: The CDPHE human health standard for thallium is 0.002 mg/l. Thallium is a contaminate metal.

Thallium was not detected in the sample collected from your water well.

- **Uranium (U)**: The CDPHE human health standard for thallium is 0.03 mg/l. Uranium can be present due to erosion of natural deposits of this element.

Uranium was not detected in the sample collected from your water well.

- **Fluoride (F)**: The CDPHE human health standard for fluoride is 4.0 mg/l. Where fluoride concentrations are in the range of 0.7 mg/l to 1.2 mg/l health benefits such as reduced dental decay have been observed. Consumption of fluoride at concentrations of greater than 2.0 mg/l can result in mottling of teeth. Consumption of fluoride at concentrations greater than 4.0 mg/l can increase the risk of skeletal fluorosis or other adverse health effects. Fluoride occurs naturally in the ground water in many areas in Colorado at concentrations that exceed the drinking water standard.

Fluoride was detected in the sample collected from your water well at a concentration of 0.5mg/l which is below the CDPHE human health standard.

- **Nitrate (NO₃)**: The CDPHE human health standard for nitrate is 10.0 mg/l. Nitrate can cause cyanosis in infants; a household water supply should not contain nitrate concentration in excess of 10 mg/l.

Nitrate was not detected in the sample collected from your water well.

- **Nitrite (NO₂)**: The CDPHE human health standard for nitrite is 1.0 mg/l. Nitrite concentrations exceeding 1.0 mg/l should not be used for feeding infants.

Nitrite was not detected in the sample collected from your water well.

- **Copper (Cu)**: The CDPHE secondary drinking water standard for copper is 1 mg/l.

Copper was detected in the sample collected from your water well at a concentration of 0.018mg/l which is below the CDPHE human health standard.

- **Chloride (Cl)**: The CDPHE secondary drinking water standard for chloride is 250mg/l. Chloride concentrations in excess of 250 mg/l usually produce a noticeable taste in drinking water.

Chloride was detected in the sample collected from your water well at a concentration of 5.5mg/l which is below the CDPHE drinking water standard.

- **Iron (Fe):** The CDPHE secondary drinking water standard for iron is 0.3mg/l. Small amounts of iron are common in ground water. Iron produces a brownish-red color in laundered clothing, can leave reddish stains on fixtures, and impart a metallic taste to beverages and food made with it. After a period of time iron deposits can build up in pressure tanks, water heaters, and pipelines, reducing the effective flow rate and efficiency of the water supply.

Iron was not detected in the sample collected from your water well.

- **Manganese (Mn):** The CDPHE secondary drinking water standard for manganese is 0.05mg/l. Manganese produces a brownish color in laundered clothing, may stain fixtures and affect the taste of coffee or tea.

Manganese was not detected in the sample collected from your water well.

- **Sulfate (SO₄):** The CDPHE sulfate secondary standard for human drinking water is 250mg/l. Although CDPHE does not have an agricultural standard for sulfate, other agencies recommend a concentration below 1,500 mg/l for livestock watering. Waters containing high concentrations of sulfate, typically caused by the leaching of natural deposits of magnesium sulfate (Epsom salts) or sodium sulfate (Glauber's salt), may be undesirable because of their laxative effects.

Sulfate was detected in the sample collected from your water well at a concentration of 49mg/l which is below the CDPHE drinking water standard.

- **pH:** pH is the measure of the hydrogen ion concentration in water. The pH of water in its natural state is generally from 5.5 to 9.0. The CDPHE standard for domestic and agricultural water is a range of 6.5 to 8.5. Seven (7) represents neutrality, while values less than 7 indicate increasing acidity and values greater than 7 indicate increasing alkalinity.

pH was measured in the water sample from your well with a value of 8.15 which is within the CDPHE drinking water and agricultural standards.

- **Total Dissolved Solids (TDS):** CDPHE's TDS standard for human drinking water is 500 milligrams per liter (mg/l). Although CDPHE does not have an agricultural standard for TDS, other agencies recommend concentrations below 1500 mg/l for irrigation, and below 5,000 mg/l for most livestock watering. TDS occurs naturally in the ground water in many areas of Colorado at concentrations that exceed the drinking water standard.

TDS was measured in the water sample collected from your well at a concentration of 250mg/l which is below the drinking water standard.

- **Zinc (Zn):** CDPHE's Zn standard for human drinking water is 5 milligrams per liter (mg/l) and the agricultural standard is 2mg/l.

Zinc was not detected in the water sample collected from your well.

The following parameters were also measured as part of the laboratory analysis although there are no CDPHE standards.

- **Sodium (Na):** People on salt restricted diets should be aware of the sodium concentration in the water they drink. A concentration of less than 20 mg/l is recommended by some for people on salt restricted diets or for people suffering from hypertension or heart disease. Sodium occurs naturally in the ground water in

many areas of Colorado at concentrations that exceed this health advisory level.

Sodium was detected in the water sample from your well at a concentration of 48mg/l which is above the recommended level.

- **Boron (B):**

Boron was not detected in the sample collected from your water well.

- **Calcium (Ca):**

The calcium concentration in the sample collected from your well was 39mg/l.

- **Magnesium (Mg):**

The magnesium concentration detected in the sample collected from your well was 6.5mg/l.

- **Potassium (K):**

The potassium concentration detected in the sample collected from your well was 1.8mg/l.

- **Molybdenum (Mo):**

The concentration of molybdenum detected in the sample collected from your water well was 0.0014mg/l.

- **Bicarbonate (HCO₃):**

Bicarbonate alkalinity was measured in the sample collected from your well at a concentration of 180mg/l.

- **Bromide (Br):**

Bromide was not detected in the sample collected from your water well.

METHANE GAS ANALYSIS

Methane was detected in the sample collected from your well in March 2009 at a concentration of 12mg/l. One each of the four sampling events shown in Table 2, the concentration of methane in the water produced from the well and entering your house from your well is above the threshold level of 1.1mg/l that could allow methane to accumulate in confined unventilated spaces and potentially be explosive.

VOLATILE ORGANIC COMPOUND ANALYSIS

A target list of sixty-nine volatile organic compounds (VOC) was utilized during analysis of water from your well. None of the 69 target compounds (chloroform) was detected in water samples from your well. Three volatile tentatively identified compounds (TICs) were detected in the water sample from your well collected in March, 2009. None of the TICs were detected in the laboratory method blank prepared and analyzed with the sample from your domestic well. This indicates the lab did not contaminate the sample from your well with the TIC's. All three of the TICs are possibly hydrocarbons.

SEMI-VOLATILE ORGANIC COMPOUND ANALYSIS

A target list of seventy-two semi-volatile organic compounds (SVOC) was utilized during analysis of water from your well. None of the 72 target compounds were detected in water samples from your well. One semi-volatile tentatively identified compound was detected in the water samples from your well. The analyst tentatively identified the TIC as an oxygenated hydrocarbon. The one semi-volatile TIC may be an artifact of the analytical process as the same TIC was present in the method blank prepared and analyzed with the sample from your well.

CONCLUSIONS

The inorganic chemistry of water from your well is not similar to coal bed methane (CBM) produced water and does not appear to have been impacted by CBM operations in the vicinity of your home. CBM produced water is typically much higher in sodium content than your well water is. CBM produced water typically has much greater levels of total dissolved solids than water from your well. The major ion chemistry of water in your well (sodium, potassium, magnesium, calcium, chloride, sulfate, bicarbonate) has remained relatively constant over that time. The limits of laboratory precision and accuracy typical of analyses for these ions are in the range of $\pm 10\%$.

Table 2 shows a comparison of results from a sample collected from your well in 2006 by a private consultant engaged by Petrogulf to the results from September, 2008 and to results from March and April, 2009. The overall inorganic chemistry of the water from your well has not changed during the three years for which data is available. The water is predominantly of a sodium-bicarbonate with lesser calcium-sulfate character. TDS is a good indicator of overall inorganic water quality and it has remained stable over the last three years as seen in Table 2.

Antimony, barium and copper have been detected in water from your well during one or more tests, including the 2006 sampling and analysis. The concentrations of these elements have always been below the concentrations present in the groundwater standards of the Colorado Water Quality Control Commission. All of these elements may leach from rocks in contact with water in the aquifer your well taps. Copper may leach from pipes installed as part of your plumbing.

Methane concentrations measured in your well water are at levels that could pose an explosion hazard when that water is brought into your home or other confined space. I recommend that you install methane detectors in your home if you do not already have such devices. Installation of a vented cistern is also recommended to lessen the potential for explosion or fire caused by the methane in your water.

The Stiff diagram graphs below illustrate the major ion composition of the water in your well during four sampling events since 2006. Stiff diagrams are a means of visualizing the major ion chemistry of water. The plots below show that the water from your well is dominantly sodium-bicarbonate with lesser calcium-sulfate character water. The plots also illustrate that the major ion chemistry of water produced from your domestic well has not changed appreciably since first sample in 2006. Produced waters from coal bed methane (CBM) wells typically have several times higher concentrations of total dissolved solids than your well water contains. The major ion chemistry of two nearby Raton Formation coal bed methane wells. I conclude that your water well is completed in the Raton Formation from examination of geologic maps and well logs. The major ion chemistry of your well water is considerably different in character than the two nearby Raton Formation CBM wells. The water quality data for the 2009 sampling and analysis does not show any impacts from nearby CBM drilling and production activities.

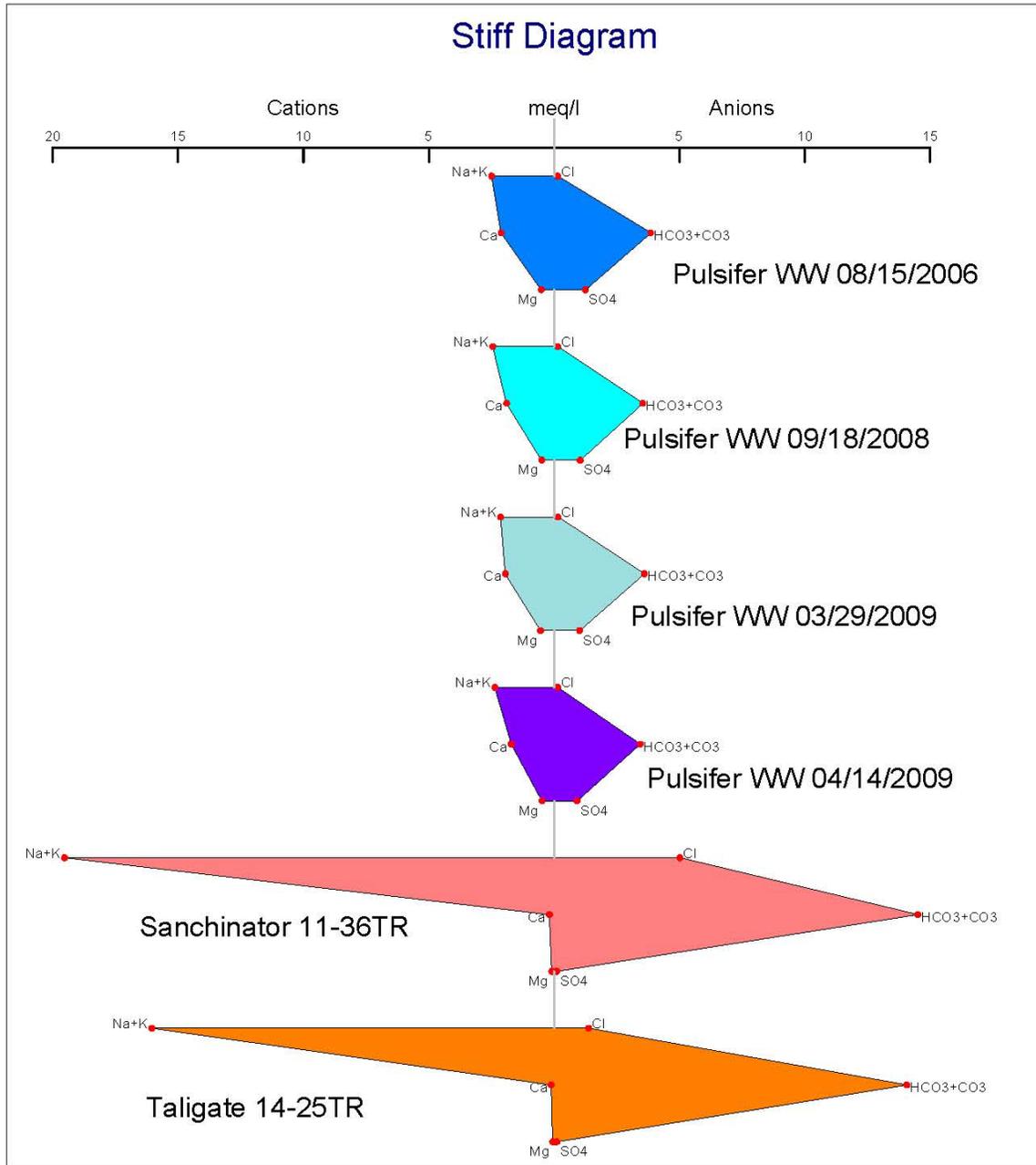


Figure 1. Stiff Diagrams - Pulsifer Water Well and nearby CBM Wells

Chad Pulsifer
Complaint 200204502
October 31, 2011

If you have any questions or would like to discuss these matters further, please contact me at 719-846-3091 or by email at peter.gintautas@state.co.us .

Sincerely,
Colorado Oil and Gas Conservation Commission

Peter Gintautas
Environmental Protection Specialist

Attachments: Attachment 1 - Table 1 - Analytical Summary
Attachment 2 - Table 2 – Comparison of 2006-2009 Results

cc: David Neslin, COGCC Director w/o attachments
Debbie Baldwin, COGCC Environmental Protection Manager w/o attachments
Steve Linblom, COGCC Environmental Protection Supervisor w/o attachments

**TABLE 1
ANALYTICAL SUMMARY
Complaint 200204502
Pulsifer Water Well**

Parameter	Water Sample		CDPHE Standards		
	Sample Date				
	19-Mar-09				
	Result	Unit	Domestic	Agriculture	Units
Antimony	0.00068	mg/l	0.006	NS	mg/l
Arsenic	ND	mg/l	0.01	0.1	mg/l
Barium	0.3	mg/l	2.0	NS	mg/l
Beryllium	ND	mg/l	0.004	0.1	mg/l
Boron	ND	mg/l	NS	0.75	mg/l
Cadmium	ND	mg/l	0.005	0.01	mg/l
Calcium	39	mg/l	NS	NS	
Chromium	ND	mg/l	0.1	0.1	mg/l
Cobalt	ND	mg/l	NS	0.05	mg/l
Copper	0.018	mg/l	1	0.2	mg/l
Iron	ND	mg/l	0.3	5	mg/l
Lead	ND	mg/l	0.05	0.1	mg/l
Lithium	0.01	mg/l	NS	NS	
Magnesium	6.5	mg/l	NS	NS	
Manganese	ND	mg/l	0.05	0.2	mg/l
Molybdenum	ND	mg/l	0.035	NS	mg/l
Nickel	ND	mg/l	0.1	0.2	mg/l
Potassium	1.8	mg/l	NS	NS	
Selenium	ND	mg/l	0.05	0.02	mg/l
Silver	ND	mg/l	0.05	NS	mg/l
Sodium	48	mg/l	NS	NS	
Strontium	1.2	mg/l	NS	NS	
Thallium	ND	mg/l	0.002	NS	mg/l
Uranium	ND	mg/l	0.03	NS	mg/l
Zinc	ND	mg/l	5	2	mg/l
Chloride	5.5	mg/l	250	NS	mg/l
Nitrite	ND	mg/l	1.0	10	mg/l
Nitrate	ND	mg/l	10.0	100	mg/l
Total Nitrite/Nitrate	ND	mg/l	10.0	100	mg/l
Fluoride	0.5	mg/l	4.0	NS	mg/l
Total Dissolved Solids	250	mg/l	400	*1500	mg/l
pH	8.15	No units	6.5 - 8.5	6.5 - 8.5	No units
Sulfate	49	mg/l	250	NS	mg/l
Bromide	ND	mg/l	NS	NS	
Total Alkalinity	180	mg/l	NS	NS	
Bicarbonate	180	mg/l	NS	NS	
Carbonate	ND	mg/l	NS	NS	
Conductivity	402	umhos/cm	NS	NS	
methane	12	mg/l	NS	NS	
Total Organic Carbon	ND	mg/l	NS	NS	

Notes

CDPHE	Colorado Department of Public Health and the Environment.
Domestic	Water Quality Control Commission 5 CCR 1002-41, Regulation No. 41 - The Basic Standards For Groundwater.
Agriculture	* Standards for agriculture compiled from CDPHE and other sources.
mg/l	milligrams per liter (ppm or parts per million).
umhos/cm	micromhos per centimeter
NA	Not analyzed.
ND	Not detected.
NS	No Standard.
**	Health Advisory.
	Human health standard.
	Secondary standard.

TABLE 2
Comparison of Results 2006 to 2009
Complaint 200204502
Pulsifer Water Well

Parameter	Water Sample					CDPHE Standards		
	Sample Date	Sample Date	Sample Date	Sample Date	Unit	Domestic	Agriculture	Units
	15-Aug-06	18-Sep-08	19-Mar-09	04/14/2009 (10:40)				
	Result	Result	Result	Result				
Antimony	ND(<0.0004)	ND(<0.0004)	0.00068	na	mg/l	0.006	NS	mg/l
Arsenic	ND	ND	ND	na	mg/l	0.01	0.1	mg/l
Barium	0.345	0.315	0.3	0.285	mg/l	2.0	NS	mg/l
Beryllium	ND	ND	ND	ND	mg/l	0.004	0.1	mg/l
Boron	ND	ND	ND	ND	mg/l	NS	0.75	mg/l
Cadmium	ND	ND	ND	na	mg/l	0.005	0.01	mg/l
Calcium	42.3	38	39	34.2	mg/l	NS	NS	
Chromium	ND	ND	ND	ND	mg/l	0.1	0.1	mg/l
Cobalt	na	na	ND	na	mg/l	NS	0.05	mg/l
Copper	ND(<0.01)	0.03	0.018	0.0162	mg/l	1	0.2	mg/l
Iron	ND	ND	ND	ND	mg/l	0.3	5	mg/l
Lead	0.0003	0.0004	ND(<0.0005)	na	mg/l	0.05	0.1	mg/l
Lithium	na	na	0.01	na	mg/l	NS	NS	
Magnesium	6.2	6	6.5	5.86	mg/l	NS	NS	
Manganese	0.094	ND(<0.005)	ND(<0.01)	ND(<0.01)	mg/l	0.05	0.2	mg/l
Molybdenum	ND	ND	ND	ND	mg/l	0.035	NS	mg/l
Nickel	ND	ND	ND	ND	mg/l	0.1	0.2	mg/l
Potassium	1.5	1.1	1.8	1.34	mg/l	NS	NS	
Selenium	ND	0.0001	ND(<0.001)	na	mg/l	0.05	0.02	mg/l
Silver	na	na	ND	ND	mg/l	0.05	NS	mg/l
Sodium	56.5	55.6	48	53.6	mg/l	NS	NS	
Strontium	na	na	1.2	1.08	mg/l	NS	NS	
Thallium	na	na	ND	ND	mg/l	0.002	NS	mg/l
Uranium	ND	ND	ND	na	mg/l	0.03	NS	mg/l
Zinc	ND(<0.01)	0.02	ND(<0.01)	ND(<0.02)	mg/l	5	2	mg/l
Chloride	5	5	5.5	4.9	mg/l	250	NS	mg/l
Nitrite	ND	ND	ND	ND	mg/l	1.0	10	mg/l
Nitrate	ND	ND	ND	ND	mg/l	10.0	100	mg/l
Total Nitrite/Nitrate	ND	ND	ND	ND	mg/l	10.0	100	mg/l
Fluoride	na	na	0.5	0.51	mg/l	4.0	NS	mg/l
Total Dissolved Solids	270	260	250	243	mg/l	400	*1500	mg/l
pH	8.5	8.3	8.15	8.0	No units	6.5 - 8.5	6.5 - 8.5	No units
Sulfate	60	50	49	44.1	mg/l	250	NS	mg/l
Bromide	na	na	ND	ND	mg/l	NS	NS	
Total Alkalinity	193	177	180	172	mg/l	NS	NS	
Bicarbonate	183	175	180	172	mg/l	NS	NS	
Carbonate	10	2	ND(<20)	ND(<5)	mg/l	NS	NS	
Conductivity	483	444	402	433	umhos/cm	NS	NS	
methane	7.8	2.11	12	15	mg/l	NS	NS	
Total Organic Carbon	na	na	ND	na	mg/l	NS	NS	

Notes

- CDPHE** Colorado Department of Public Health and the Environment.
Domestic Water Quality Control Commission 5 CCR 1002-41, Regulation No. 41 - The Basic Standards For Groundwater.
Agriculture * Standards for agriculture complied from CDPHE and other sources.
mg/l milligrams per liter (ppm or parts per million).
umhos/cm micromhos per centimeter
na Not analyzed.
ND Not detected.
NS No Standard.
****** Health Advisory.
Human health standard.
Secondary standard.