STATE OF COLORADO
OIL & GAS
CONSERVATION COMMISSION

September 25, 2008

Certified Mail Return Receipt Requested # 7007 1490 0001 8186 1009

Mrs. Angela Robinson
PO Box 194
Weston, CO 81091

RE: Complaint 200191862
Baseline Water Well Analysis
Well Permit 216298
SWSW 29 32S, 67W Las Animas County, Colorado

Dear Mrs. Robinson:

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 a field visit to your property on July 9, 2008. Water samples were collected for general organic and inorganic water quality testing as well as for analysis of dissolved methane and BART kit tests. A summary of the results of the chemical and bacterial analyses is presented below. The analytical results are also compared to published water quality standards and to results of prior testing of water from your well.

FIELD TESTING

I visited your property on July 9, 2008 and you and I went to your cistern. You started your pump at 8:05 and I obtained samples from the pipe entering the cistern at 9:07. I went to your domestic water well so that I could determine if methane was venting from your water well. I determined that there was no methane venting from the casing of your water well after the sampling. The samples for general chemical analyses were shipped to Paragon Analytics in Fort Collins, CO and received by them on July 10, 2008.

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. The analytical reports from Paragon Analytics are included as Attachment 2.

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

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

- **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 0.13mg/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 detected in the sample collected from your water well at a concentration of 0.00023mg/l which is below the CDPHE human health standard.

- **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 0.85mg/l which is below the CDPHE human health standard.

- **Nitrate (NO_3):** 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 (NO_2):** 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 not detected in the sample collected from your water well.

- **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 32mg/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 detected in the sample collected from your water well at a concentration of 0.011mg/l which is below the CDPHE drinking water standard.

- **Sulfate (SO_4):** 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 66mg/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 8.34 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 360mg/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 100mg/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 15mg/l.

- **Magnesium (Mg):**

  The magnesium concentration in the sample collected from your well was 1.4mg/l.

- **Potassium (K):**

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

- **Molybdenum (Mo):**

  The molybdenum concentration in the sample collected from your water well was 0.0029mg/l.

- **Bicarbonate (HCO_3):**

  Bicarbonate alkalinity was measured in the sample collected from your well at a concentration of 190mg/l.

- **Bromide (Br):**

  The bromide concentration in the sample collected from your water well was 0.23mg/l.

METHANE GAS ANALYSIS

Methane was detected in the sample collected from your well at a concentration of 1.6mg/l. The concentration of methane in the water produced from the well is above the threshold level of 1.1mg/l that could allow methane to accumulate in confined unventilated spaces and potentially be explosive. The water from your domestic well is piped directly into a cistern inside your home.

BACTERIAL ANALYSIS

The COGCC collected samples to analyze for the presence of iron, slime and sulfur bacteria in your water well. Samples from your water well were tested for the presence of iron-related (IRB), sulfate reducing (SRB) and slime forming (SLYM) bacteria using Biological Activity Reaction Test (BART) kits. In addition to detecting the presence of bacteria the BART Kits allow for an estimation of the size of the population and/or the rate at which they can metabolize and/or grow through an observable change or reaction. This reaction rate is referred to as the "aggressivity" of the bacterial population. The aggressivity levels of the bacteria are described as **Not Detected, Background, Moderately Aggressive, Very Aggressive, or Extremely Aggressive Levels**. The results of the tests are provided below and documented in Photographs 1 and 2. The progress of the bacterial growth on the day the cultures were started is seen in Photograph 1. Photograph 2 shows the progress of the bacterial tests six days after the cultures were started. Photograph 3 shows the progress of the bacterial test 12 days after the cultures were started.

- **Iron-Related Bacteria (IRB):** Although not harmful, iron-related bacteria can become a nuisance by plugging the well pump, causing red staining on plumbing fixtures and laundered clothing, building up red, slimy accumulations on any surface the water touches, and causing what appears to be a sheen on standing water. Signs that may indicate an iron bacteria problem include "yellowish, red or orange colored water, rusty deposits in toilet tanks and strange smells resembling fuel oil, cucumbers or sewage. Sometimes the odor will only be apparent in the morning or after other extended periods of non-use" (CDPHE, Laboratory Services Division).

Moderately Aggressive levels of IRB bacteria were detected in the water sample collected at this well. The orange cloudy layer, at the bottom of the IRB tube (red cap) and the foam at the top in Photograph 2 developed after six days. This relatively rapid development of foam and orange color indicates Moderately Aggressive levels of IRB population present in the water from your well.

Photograph 1. BART Kits July 9, 2008

- **Sulfate Reducing Bacteria (SRB)**: Sulfate reducing bacteria are serious nuisance organisms in water since they can cause severe taste and odor problems. These bacteria reduce sulfate that occurs naturally in the water and generate hydrogen sulfide (H_2S) gas as they grow. In turn, the hydrogen sulfide (H_2S) gas is a nuisance because it smells like rotten eggs, initiates corrosion on metal surfaces and reacts with dissolved metals such as iron to generate black sulfide deposits.

  The test indicated that SRB were detected at Background levels in your well water as shown by the black liquids in the black capped vial in Photograph 3. The culture turns black if SRB are present and this culture turned black after nine days.

- **Slime Forming Bacteria (SLYM)**: Although not usually harmful, Slime Forming Bacteria (SFB) can become a nuisance by plugging well pumps and causing slimy accumulations on plumbing fixtures and standing water. Slimes are often gelatinous in nature and may range in color from white, to red, or black. As slime bacteria mats grow they create an environment in which complex associations of other strains of bacteria can develop.

  SLYM bacteria were detected at Moderately to Very Aggressive levels in the water sample collected from this well as indicated by the cloudy yellow liquid seen in the green capped vial in Photograph 2.

Photograph 2. BART Kits July 15, 2008

Iron related, sulfate reducing and slime bacteria were present in your well. Since three types of bacteria were detected in the water distribution system or the well you should consider treating the well and distribution system with disinfecting solutions in the near future. Once bacterial colonies are established they are difficult to eliminate; therefore, you may need to establish a schedule for periodic disinfection of your well system to help control the bacteria present in it. The chlorination process is more easily accomplished if you have a frost-proof hydrant near the well head that you can use to remove the chlorinated water from the well. One technique that water well professionals use is to re-circulate the chlorine solution down the sides of the well shortly after adding the chlorine. This helps to kill bacteria on the sides of the well and on the pipes in the well.

Pamphlets published by the CDPHE that provide more information concerning the treatment of iron and sulfur bacteria and shock chlorination treatment of bacteria are included as Attachment 3. You may also want to contact a licensed water well contractor for additional information or for help in disinfecting your well and distribution system. Additional information and assistance can be provided through the State of Colorado Health Department. Contact information for the agency is provided below.

Colorado Department of Public Health and Environment

Colorado Drinking Water Program
4300 Cherry Creek Drive South
Denver, CO 80246-1530
Phone: 303-692-3500
Fax: 303-782-0390

Photograph 3. BART Kits July 21, 2008

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 that your well water is. CBM produced water typically has much greater levels of total dissolved solids than water from your well. Table 2 below compares analytical results from your well to data from two coal bed methane (CBM) wells located in the vicinity of your home. The Lynch 43-30 is located about 900 feet to the northwest of your domestic well. The Dude Canyon 22-32 is located approxiamterly 3300 feet to the southeast of your domestic well. The water from your well is predominantly of a calcium-sodium-sulfate-bicarbonate character. Waters produced from CBM wells in the Raton Basin are generally of a sodium-bicarbonate character.

Table 2. Comparison of Major Ion Chemistry

Analyte	**units**	**Robinson Water Well**	**Lynch 43-30 CBM Well**	**Dude Canyon 22-32 CBM Well**
TDS	mg/l	360	1340	1100
Cl	mg/l	32	192	116
HCO_3	mg/l	190	863	839
SO_4	mg/l	66	<5	<5

NA = not analyzed

Table 1 shows a comparison of results from the sample collected from your well in 2008 to groundwater standards established by the Water Quality Control Commission. None of the parameters exceed the groundwater standards. You should compare the results from 2008 sampling to any previous analyses that were performed. Shock chlorination of the well and cistern can help to reduce the activity of bacterial colonies. The water quality data for the 2008 sampling and analysis does not show any impacts from nearby CBM drilling and production activities.

As noted previously the concentration of methane detected in your domestic well water may pose a risk of buildup of methane in an enclosed space to levels that could be hazardous. Installing a vent at your well head may lessen this risk. Installing a vent from your indoor cistern to the outside would also serve to lessen the risk of methane building up to explosive levels. Detectors or alarms for methane and other combustible gasses are commercially available. You may want to consider installing an alarm in your basement where your cistern is located. Installing an outdoor vented cistern can also lessen the risk of methane buildup inside your home.

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 - Paragon Analytics Reports
Attachment 3 - CDPHE water well pamphlets

cc: David Neslin, Acting COGCC Director w/o attachments
Debbie Baldwin, COGCC Environmental Protection Manager w/o attachments
Margaret Ash, COGCC Environmental Protection Supervisor w/o attachments

TABLE 1
ANALYTICAL SUMMARY
Complaint 200191862
Robinson Water Well

Parameter	Sample Date		CDPHE Standards		
	09-Jul-08				
	Result	Unit	Domestic	Agriculture	Units
Antimony	ND	mg/l	0.006	NS	mg/l
Boron	ND	mg/l	NS	0.75	mg/l
Copper	ND	mg/l	1	0.2	mg/l
Arsenic	ND	mg/l	0.01	0.1	mg/l
Barium	0.13	mg/l	2.0	NS	mg/l
Berylium	ND	mg/l	0.004	0.1	mg/l
Cadmium	ND	mg/l	0.005	0.01	mg/l
Calcium	15	mg/l	NS	NS	
Chromium	ND	mg/l	0.1	0.1	mg/l
Iron	ND	mg/l	0.3	5	mg/l
Lead	ND	mg/l	0.05	0.1	mg/l
Lithium	ND	mg/l	NS	NS	
Magnesium	1.4	mg/l	NS	NS	
Manganese	0.011	mg/l	0.05	0.2	mg/l
Molybdenum	0.0029	mg/l	0.035	NS	mg/l
Nickel	ND	mg/l	0.1	0.2	mg/l
Potassium	ND	mg/l	NS	NS	
Selenium	ND	mg/l	0.05	0.02	mg/l
Silver	ND	mg/l	0.05	NS	mg/l
Sodium	100	mg/l	NS	NS	
Strontium	0.33	mg/l	NS	NS	
Thallium	ND	mg/l	0.002	NS	mg/l
Uranium	0.00023	mg/l	0.03	NS	mg/l
Zinc	ND	mg/l	5	2	mg/l
Chloride	32	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	0.85	mg/l	4.0	NS	mg/l
Total Dissolved Solids	360	mg/l	400	*1500	mg/l
pH	8.34	No units	6.5 - 8.5	6.5 - 8.5	No units
Sulfate	66	mg/l	250	NS	mg/l
Bromide	0.23	mg/l	NS	NS	
Total Alkalinity	190	mg/l	NS	NS	
Bicarbonate	190	mg/l	NS	NS	
Carbonate	ND	mg/l	NS	NS	
Conductivity	583	umhos/cm	NS	NS	
methane	1.6	mg/l	NS	NS	
Total Organic Carbon	1.8	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 of sources.
mg/l	milligrams per liter (ppm or parts per million).
µmhos/cm	micromhos per centimeter
NA	Not analyzed.
ND	Not detected.
NS	No Standard.
****	Health Advisory.
	Human health standard.
	Secondardy standard.