



September 3, 2009

Certified Mail Return Receipt Requested # 7008 3230 0003 3235 3639

Mr. and Mrs. Dave and Lisa York
12570 Stonewall Parallel Road
Weston, CO 81091-9572

RE: Complaint 200212599
Baseline Water Well Analysis
Well Permit 241287
SESW 16 33S, 68W Las Animas County, Colorado

Dear Mr. and Mrs. York:

In response to your request for a continued baseline water quality testing of your water well, the Colorado Oil and Gas Conservation Commission (COGCC) conducted a field visit to your property on June 22, 2009. Samples were collected on June 22, 2009 for general water quality parameters including dissolved methane analysis. A sample was also collected for analysis of gas composition and isotope ratios. The samples for analysis of inorganic parameters and dissolved methane analysis were received by Accutest Laboratories in Wheat Ridge, Colorado on June 23, 2009. The sample for isotopic and gas composition analysis was received by Isotech Laboratories in Champaign, Illinois on June 23, 2009. The sample you provided to me of cloudy water produced from your well was delivered to Accutest Laboratories on August 3, 2009. This letter summarizes the results of the chemical analyses and compares the laboratory data to published water quality standards.

FIELD TESTING

I visited your property on June 22, 2009. You assisted me during sample collection. We pumped water from an outdoor spigot located near your well for 22 minutes at a rate of approximately 15 gallons per minute. I then collected samples for analysis of general inorganic water quality parameters, dissolved methane. I did observe effervescent bubbles in the water as it was pumped and also could smell hydrogen sulfide while we pumped the well. The water was relatively clear with some gray-white particulates present. You provided me with a water sample collected from your well on March 24, 2009. A filtered and an unfiltered aliquot of that cloudy water sample was analyzed for metals content to aid in determining what type of particles were causing the cloudiness.

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 laboratory data reports from Accutest Laboratories are included as Attachment 2. The

laboratory data reports from Isotech Laboratories are included as Attachment 3.

- **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 0.01 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 0.0977mg/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 detected in the sample collected from your water well at a concentration of 0.0006mg/l which is below the CDPHE human health standard.
- **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 1.7mg/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 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 7.1mg/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 0.00642mg/l which is below the CDPHE drinking water standard.

- **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 2.9mg/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 8.82 which is outside the CDPHE drinking water and agricultural standard.

- **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 450mg/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 sample collected from your water 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 151mg/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 1.16mg/l.

- **Magnesium (Mg):**

Magnesium was not detected in the sample collected from your well.

- **Potassium (K):**

The potassium concentration in the sample collected from your well was 0.634mg/l.

- **Molybdenum (Mo):**

Molybdenum was not detected in the water sample from your well.

- **Bicarbonate (HCO₃):**

Bicarbonate alkalinity was measured in the sample collected from your well at a concentration of 311mg/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 at a concentration of 5.1mg/l. The concentration of methane in the water produced from the well and entering your cistern is above the threshold level of 1.1mg/l that could allow methane to accumulate in confined unventilated spaces and potentially be explosive. You have a vented cistern which acts as to passively remove methane from your well water before it enters your home. Installation of combustible gas detector(s) in your home is recommended.

VOLATILE ORGANIC COMPOUND ANALYSIS

A target list of thirty-nine volatile organic compounds (VOC) was utilized during analysis of water from your well. Two of the target list compounds were present above the method detection limit in samples from your well. Benzene was detected at 2.9µg/l and toluene was detected at 3.8µg/l in the water samples collected from your domestic well. The reported concentrations of both aromatic organic compounds are below the groundwater standards established by the Colorado Water Quality Control Commission.

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, 2 and 3. The progress of the bacterial growth the same day the cultures were started is seen in Photograph 1. Photograph 2 shows the progress of the bacterial tests three days after the cultures were started. Photograph 3 shows the progress of the tests eight 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).

Very 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 three days. The rapid development of foam and orange color indicates Very Aggressive levels of IRB population present in the water from your well.



Photograph 1. BART Kits June 22, 2009

- **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 (H₂S) gas as they grow. In turn, the hydrogen sulfide (H₂S) 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.

SRB were detected at background levels in your well water as shown by the slow development of black particulates at the bottom of the black capped vial in Photograph 3. The culture turns black if SRB

are present and this culture remained clear with black precipitates at the bottom on the eighth day of culture growth.

- **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 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 Photograph2 after three days.

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.



Photograph 2. BART Kits June 25, 2009

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 4. 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 1, 2009

CONCLUSIONS

As noted in the narrative discussion and summarized in Table 1, the overall quality of water produced from your well is good. The concentration of total dissolved solids in water is one means of evaluating general water quality. The measured concentration of TDS in your well water is relatively low for water produced from coals.

Methane concentrations measured in your water are at levels that could pose an explosion hazard if water is brought directly into your home or other confined space. Coals present in and around your well are likely sources of the methane in your water well. A graph of isotopic composition of methane from nearby CBM wells (in or near the North Fork Ranch subdivision) is included as Attachment 5. Examination of geologic maps shows that your water well is likely to be completed in the Raton Formation. Nearby Raton Formation CBM wells produce methane with similar isotopic composition to the methane found in your well. The isotopic composition indicates the methane may be from a thermally immature coal.

Table 1 illustrates that one parameter tested (pH) is over the CDPHE groundwater standards. The pH of produced water from nearby CBM wells is similar to the pH of water from your well. The water from your well is dominantly of sodium-bicarbonate character. CBM produced water in the Raton Basin is also characteristically of a sodium-bicarbonate nature (with lesser chloride). The water well construction report for your well does not identify that coal seams were encountered in

drilling your well, but you indicated that coals were present in the well. The general inorganic chemistry of the water produced from your domestic well is consistent with water produced from coal bed methane wells. The relatively high concentration of dissolved methane in water produced from your domestic well is likely to be caused by localized reduction of pressure in coals. The use of your well can reduce pressure in the coals and induce desorption of methane from coals. Low concentrations of volatile aromatic compounds have been detected in water produced from CBM wells in the Raton Basin. The concentrations of benzene and toluene present in water produced from your well are lower than the groundwater or drinking water standards. Both compounds can be present in samples from contamination during sampling, transport and analysis. Both benzene and toluene are present in gasoline. I would recommend that you contact me so a sample can be collected and analyzed to confirm or rule out the presence of these two volatile aromatic organic compounds.

There were low concentrations of suspended particulates in the water from your well when we sampled the well. The sample you collected in March, 2009 appeared to have more suspended material than the water pumped while I was present at your home. The lab determined that the amount of suspended particles present in the March 2009 sample was not high enough to filter the particles out of the water and analyze directly. A modified approach was used in which they performed a total metals digestion on the water with the particles present for comparison to analysis of metals dissolved in the water. The differences should reflect the composition of the particles if they are inorganic.

The results of the metals analysis of the suspension are included in Attachment 2. The concentrations of calcium, magnesium, potassium and silicon in the unfiltered water are 2 to 10 times higher than in the filtered water sample. These elements are present in clay minerals. The particles did not settle out of the water even when left standing for days. Clay minerals are typically very fine grained and would appear as a suspension in your water. Some bacteria are also small enough to remain suspended in water for long periods of time, but they tend to coagulate into larger aggregations of bacteria, which then settle out of suspension. The metals analysis of the suspended sediments tends to indicate the particles are aquifer material such as clays or perhaps iron oxides. Typically these elements are all present in clay mineral particles. There are also low levels of iron and manganese which can come from aquifer minerals but are more likely from iron oxide particles. The iron oxide particles may be a by-product of bacterial colonies present in your well.

Your well casing has several zones with perforated casing and sediment may be entering the well bore throughout most of the well as no sand packing or screens were placed in the hole by the driller. Use of your pump can disturb fine grained particles that naturally occur in the rocks your well is drilled through. I do not know of any CBM activity conducted near your home that would have resulted in re-suspension of fine grained particles present in your well.

Dave and Lisa York
Complaint 200212599
September 3, 2009

At present there is no data that would indicate the water quality in your domestic well has been impacted by nearby CBM drilling and operations. 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 – Accutest Laboratories Data Reports
Attachment 3 – Isotech Laboratories Data Report
Attachment 4 – CDPHE Bacteria and Disinfection Pamphlets
Attachment 5 – Isotopic Composition of Methane in the York Water Well

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

**TABLE 1
ANALYTICAL SUMMARY
Complaint 200212599
Dave York Water Well**

Parameter	Water Sample		CDPHE Standards		
	Sample Date				
	22-Jun-09				
	Result	Unit	Domestic	Agriculture	Unit
Antimony	ND	mg/l	0.006	NS	mg/l
Arsenic	ND	mg/l	0.01	0.1	mg/l
Barium	0.0977	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	0.000642	mg/l	0.005	0.01	mg/l
Calcium	1.16	mg/l	NS	NS	
Chromium	ND	mg/l	0.1	0.1	mg/l
Cobalt	ND	mg/l	NS	0.05	mg/l
Copper	ND	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	0.0046	mg/l	NS	NS	
Magnesium	ND	mg/l	NS	NS	
Manganese	0.00642	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	0.634	mg/l	NS	NS	
Selenium	ND	mg/l	0.05	0.02	mg/l
Silver	ND	mg/l	0.05	NS	mg/l
Sodium	151	mg/l	NS	NS	
Strontium	0.0454	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	7.1	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	1.7	mg/l	4.0	NS	mg/l
Total Dissolved Solids	450	mg/l	400	*1500	mg/l
pH	8.82	No units	6.5 - 8.5	6.5 - 8.5	No units
Sulfate	2.9	mg/l	250	NS	mg/l
Bromide	ND	mg/l	NS	NS	
Total Alkalinity	329	mg/l	NS	NS	
Bicarbonate	311	mg/l	NS	NS	
Carbonate	18.1	mg/l	NS	NS	
Conductivity	593	umhos/cm	NS	NS	
methane	5.1	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.

Lab #: 165002 Job #: 11591
 Sample Name/Number: York WW
 Company: Colorado Oil & Gas Conservation
 Date Sampled: 6/22/2009
 Container: Dissolved Gas Bottle
 Field/Site Name: Complaint 200212594
 Location: Las Animas CO
 Formation/Depth:
 Sampling Point:
 Date Received: 6/23/2009 Date Reported: 7/17/2009

Component	Chemical mol. %	Delta 13C per mil	Delta D per mil	Delta 18O per mil
Carbon Monoxide -----	nd			
Hydrogen Sulfide -----	nd			
Helium -----	nd			
Hydrogen -----	nd			
Argon -----	0.913			
Oxygen -----	5.71			
Nitrogen -----	61.78			
Carbon Dioxide -----	0.11			
Methane -----	31.15	-57.61	-234.7	
Ethane -----	0.228			
Ethylene -----	nd			
Propane -----	0.0831			
Iso-butane -----	0.0148			
N-butane -----	0.0128			
Iso-pentane -----	0.0033			
N-pentane -----	nd			
Hexanes + -----	nd			
Water -----			-77.9	-10.35
Dissolved Inorganic Carbon -		-17.86		

Total BTU/cu.ft. dry @ 60deg F & 14.7psia, calculated: 323

Specific gravity, calculated: 0.852

Remarks: Analysis is of gas extracted from water by headspace equilibration. Analysis has been corrected for helium added to create headspace. Helium dilution factor = 0.44

nd = not detected. na = not analyzed. Isotopic composition of carbon is relative to VPDB. Isotopic composition of hydrogen and oxygen are relative to VSMOW. Calculations for BTU and specific gravity per D3588. Chemical compositions are normalized to 100%. Mol. % is approximately equal to vol. %. ASTM Chemical analysis based on standards accurate to within 2%

Isotopic Composition of Methane from York Water Well

