



DEPARTMENT OF NATURAL RESOURCES
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September 29, 2009

Dr. Gerald Calvin
PO Box 429
Fort Lupton, Colorado 80621

RE: Water Quality Analytical Results for Your Water Well (Permit #160720)
Section 8 – Township 2 North – Range 66 West
Weld County, Colorado; Complaint No. 200218900

Dear Dr. Calvin:

On September 9, 2009, Terracon Inc, under direction of the Colorado Oil and Gas Conservation Commission (COGCC), sampled your water well and submitted these samples for laboratory analysis. The purpose of this water sampling was to determine if natural gas drilling and production activities in your area might have impacted your well water. The water sample was submitted to Test America Laboratories, Inc. in Arvada, Colorado (TA), for analysis of inorganic chemical constituents, organic compounds associated with petroleum hydrocarbons, methane gas, and pH. A copy of the TA laboratory analytical report is enclosed. Additionally a sample of gas from your water well was collected for compositional and stable isotope analysis of methane and deuterium and submitted to Isotech Laboratories, Inc. (Isotech), in Champaign, Illinois. A copy of the Isotech report is also enclosed.

As you are aware, in August 2008 the COGCC sampled your water well and this letter will compare the sample results from the 2008 sampling with the recent 2009 sample results.

The Water Quality Control Commission (WQCC) of the Colorado Department of Public Health and Environment (CDPHE) has established drinking water standards for the protection of human health. The analytical results from the water samples from your well have been compared to applicable ground water and/or drinking water standards and are summarized below. Please keep in mind that these water standards were established for public drinking water supplies. Often people use and consume ground water from private wells that can exceed these standards.

COMPARISON OF INORGANIC ANALYTICAL RESULTS TO STANDARDS

- **Total Dissolved Solids (TDS):** CDPHE has established a TDS standard for human drinking water of 500 milligrams per liter (mg/l). The standard is called the secondary maximum contaminant level (SMCL) and is based on the aesthetic quality of the water (such as taste and odor) and is intended as a guideline for public water supply systems and is not an enforceable standard. Although CDPHE does not have an agricultural standard for TDS, other agencies recommend concentrations below 2,000 mg/l for irrigation, and below 5,000 mg/l for most

livestock watering. TDS concentrations are related to the presence of naturally occurring elements and chemical compounds such as chloride, sodium, potassium, calcium, magnesium, and sulfate.

TDS was detected in the water sample from your well at concentrations of 700 mg/l, which is greater than the CDPHE SMCL, below the recommended maximum concentration for irrigation, and below the recommended maximum concentration for most livestock watering. The sample results for the 2008 sample was 732 mg/l.

- Sodium (Na): Although CDPHE does not have a standard for sodium, people on salt restricted diets should be aware of the Na concentration in the water they drink. A concentration of drinking water with a concentration of sodium 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 at concentrations that exceed the recommended level.

Sodium was detected in the water sample from your well at a concentration of 290 mg/l, which is greater than the recommended level for people of salt restricted diets. The sample result for the 2008 sampling was 332 mg/l.

- Fluoride (F): CDPHE has established a fluoride (F) standard for human drinking water 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 was detected in the water sample from your water well at a concentration of 2.4 mg/l, which is below the CDPHE water standard. The sample result for the 2008 sampling was 2.8 mg/l.

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

Chloride was detected in the water sample from your well at a concentration of 79 mg/l, which is less than the CDPHE SMCL. The sample result for the 2008 sampling was 85.3 mg/l.

- **Sulfate (SO₄):** The CDPHE sulfate standard for drinking water is 250 mg/l (SMCL). 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 occurs naturally in the ground water in many areas in Colorado at concentrations that exceed the drinking water standard.

Sulfate was not detected in the water sample from your well for this sampling or for the 2008 sampling.

- **Total Nitrate (NO₃) + Nitrite (NO₂) as Nitrogen (N):** The CDPHE total nitrate (NO₃) + nitrite (NO₂) as nitrogen (N) for standard for human drinking water is 10 mg/l. Nitrate and nitrite are common contaminants in ground water from agricultural sources, such as fertilizer and animal, including human, wastes. They are known to cause infant cyanosis or "blue baby disease" in humans and, at concentrations greater than 100 mg/l as nitrogen (N), may be dangerous to livestock. High concentrations of nitrate and nitrite in ground water are known to occur in agricultural areas in Colorado.

Total nitrate/nitrite, as N was not detected in the water sample from your well for this sampling or for the 2008 sampling.

- **Iron (Fe):** The CDPHE standard for human drinking water for iron is 0.3 mg/l (SMCL). Small amounts of iron are common in ground water. Iron may produce 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 detected in the water sample from your well at a concentration of 0.11 mg/l, which is less than the CDPHE SMCL water standard. The concentration for the 2008 sample was 0.146 mg/l.

- **Selenium (Se):** The CDPHE selenium standard for human drinking water is 0.05 mg/l and the agricultural standard is 0.02 mg/l. Excessive selenium (Se) (concentrations greater than 0.05 mg/l) can cause loss of hair and/or fingernails as well as adverse effects on the central nervous system. Selenium (Se) occurs naturally in the ground water in many areas of Colorado at concentrations that exceed the drinking water standard.

Selenium was not detected in recent water well sample from your well. Selenium was detected in the 2008 sample from your water well at a concentration of 0.00738 mg/l, which is below the CDPHE drinking water standard.

- Calcium (Ca), Potassium (K), Magnesium (Mg), Bicarbonate (HCO₃) and Carbonate (CO₃) were also tested for in your water. There are no standards from CDPHE for these parameters. In addition, the COGCC also collected samples for metals and the Table 1 (attached) presents the analytical laboratory results. Please note that Primary standard (P) is

the CDPHE Human Health Standard and the Secondary standard (S) is the CDPHE secondary maximum contaminant level (SMCL).

**Table 1
 CALVIN WATER WELL**

METAL/INORGANIC	August 6, 2008 Sample Concentration (in Milligrams per liter [mg/l])	September 2, 2009 Sample Concentration (in Milligrams per liter [mg/l])	CDPHE Water Quality Standard (P – Primary S-Secondary) (in Milligrams per liter [mg/l])
Calcium (Ca)	2.61	2.40	NS
Barium (Ba)	NA	0.067	2 (P)
Bromide (Br)	0.85	0.78	NS
Potassium (K)	1.87	ND	NS
Manganese (Mn)	0.00552	ND	0.05 (S)
Magnesium (Mg)	0.562	0.570	NS
pH	8.58 pH units	8.6 pH units	NS

NS – no standard
 ND – not detected in the sample
 NA – not analyzed

ORGANIC COMPOUNDS ASSOCIATED WITH PETROLEUM HYDROCARBONS
 (please see enclosed TA METHOD E 602/SW 8021B, BTEX DATA REPORT)

- Benzene: CDPHE's basic ground water standard for benzene is 5 micrograms per liter ($\mu\text{g/l}$). **Benzene was not detected in the sample from your water well in this or for the 2008 sample.**
- Toluene: CDPHE's basic ground water standard for toluene is 1,000 $\mu\text{g/l}$. **Toluene was not detected in the sample from your water well in this or for the 2008 sample.**
- Ethylbenzene: CDPHE's basic ground water standard for ethylbenzene is 680 $\mu\text{g/l}$. **Ethylbenzene was not detected in the sample from your water well in this or for the 2008 sample.**
- Total Xylenes (sum of m,p, and o-xylene): CDPHE's basic ground water standard for total xylenes is 10,000 $\mu\text{g/l}$. **Total xylenes were not detected in the sample from your water well in this or for the 2008 sample.**

METHANE GAS CONCENTRATION

- **Methane was detected in the sample from your water well at a concentration of 16 mg/l. The methane sample results for the 2008 sample from your water well was 7.5 mg/l.**

Methane gas alone is physiologically inert and non-toxic to humans. Normal breath exhalation contains 1 to 99 ppm of methane (parts per million [ppm] is the same units as mg/l). The presence of methane in drinking water does not present a known health hazard to humans or other animals via ingestion; however, methane in domestic water supplies can be associated with undesirable and potentially serious side effects. Methane gas dissolved in water “exsolves” when exposed to the atmosphere and dissipates rapidly because it is lighter than air. This is often responsible for the “fizzing” observed in water wells that may contain methane gas. If the methane occurs at a high enough concentration and if it is allowed to accumulate in a confined space, such as a well pit, crawl space, closet, etc., an explosion hazard can be established. In addition, if methane concentrations in well water are high, then pockets of free gas form within the water and cause the well pump to cavitate and no longer bring water to the surface.

Methane gas is common in water wells in Colorado. It occurs naturally and the source of the methane is commonly from one or more of the sources listed below.

1. Methane is commonly found as a gas in coal or black shale seams in the subsurface.
2. Methane is commonly found as a byproduct of the decay of organic matter and the presence of bacteria in water wells can provide the conditions favorable for the production of methane either from the activity or decay of bacteria.

As the result of extensive testing for methane gas in water wells throughout Colorado, concentrations of methane gas below 1 mg/l are considered harmless, with concern for possible hazards from the methane increasing at concentration levels in well water at 7 mg/l and higher. You should be aware that the methane gas in your water well is at a high enough concentration that precautions should be taken to adequately vent your water system to avoid potential gas accumulations.

GAS COMPOSITION

The gas produced from the oil/gas wells around your home is “thermogenic” methane. Thermogenic methane gas is formed by the thermal breakdown of organic material in rocks resulting from high temperatures created by deep burial. With the methane are other higher carbon number compounds (“heaver”) such as propane (C3), iso-butane (iC4), normal butane (nC4), iso-pentane (iC5), normal pentane (nC5), and hexane (C6). Biogenic methane gas occurs in most near-surface environments and is a principal product of the decomposition of buried organic material. In Weld County many of the coal zones in the Laramie/Fox Hills aquifer contain biogenic methane gas.

Laboratory results of the gas sample collected from your water well show that methane (57.14 percent) and ethane (0.0938percent) were detected along with nitrogen (38.97 percent),

argon/oxygen (3.28 percent), and carbon dioxide (0.52 percent). The nitrogen, argon/oxygen, and carbon dioxide are components of air and the presence of methane (C1) with ethane (C2) is typical of the naturally occurring biogenic gas in the Laramie/Fox Hills aquifer. No “heaver” carbon compounds that would indicate a thermogenic gas impact are present.

Isotopic Analysis of Methane

- The deuterium/hydrogen isotope ratio for the methane in the water sample from your water well is -262.5 parts per mil (‰).
- The carbon-13/carbon-12 isotope ratio for the methane in the water sample from your water well is -71.16 ‰.

Isotopic Cross-Plot

I have included a cross-plot of the stable methane isotopes for your water well sample to help discuss the sample results for your well. On the cross-plot you will notice the area near the top right corner as defined a “Thermogenic Gas”. This is the area of the cross-plot that the natural gas produced by the gas wells in the Denver Basin and where the production gas sample plot. Your well plots in the area to the left defined as “Sub-surface Microbial Gas (CO₂ Reduction)” which is methane gas of a biogenic origin.

BACTERIA OCCURENCE

Samples of your well water were collected for the determination of the presence of bacteria using the Biological Activity Reaction Test (**BART**[™]) for the following; Iron Related Bacteria (IRB), Sulfate Reducing Bacteria (SRB), and Slime Forming Bacteria (SFB). In addition, an estimation of the size of the population and/or the rate at which they can metabolize and/or grow to generate an observable change or reaction was made. This reaction rate is referred to as the “aggressivity” of the bacterial population. The aggressivity levels of the bacteria are described as **Not Detected**, **Non Aggressive (Background)**, **Moderately Aggressive**, **Very Aggressive**, or **Extremely Aggressive** Levels. Your well water showed the presence of the IRB, SRB, and SFB types. Please see attached figure.

Iron Related Bacteria: Although not usually harmful, iron related bacteria (IRB) 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 may appear to be a oily sheen on standing water. In rare cases, IRB may cause sickness.

- **Very Aggressive IRB bacteria were detected in the water sample from your well.**

Sulfate Reducing Bacteria: Sulfate reducing bacteria (SRB) 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, it initiates corrosion on metal surfaces, and it reacts with dissolved metals such as iron to generate black sulfide

deposits.

- **Non Aggressive, SRB bacteria were detected in the water sample from your well.**

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

- **Non Aggressive SFB bacteria were detected in the water sample from your well.**

CONCLUSION

Because your water exceeded the CDPHE drinking water (SMCL) standard for total dissolved solids and the health advisory for sodium (Na), and because you or your livestock and/or pets drink your water, you may wish to discuss the possible health effects of continued consumption with your physician and/or veterinarian. There are no indications of any oil & gas related impacts to your water well.

The positive bacteria result from your well indicates that treating your water well for bacteria may help to improve your water quality. I earlier sent to your attention a well treatment procedure for bacteria.

If you have any questions or would like to discuss these matters further, please contact me at the COGCC in Denver via e-mail (robert.chesson@state.co.us) or by phone at 303-894-2100, extension 5112.

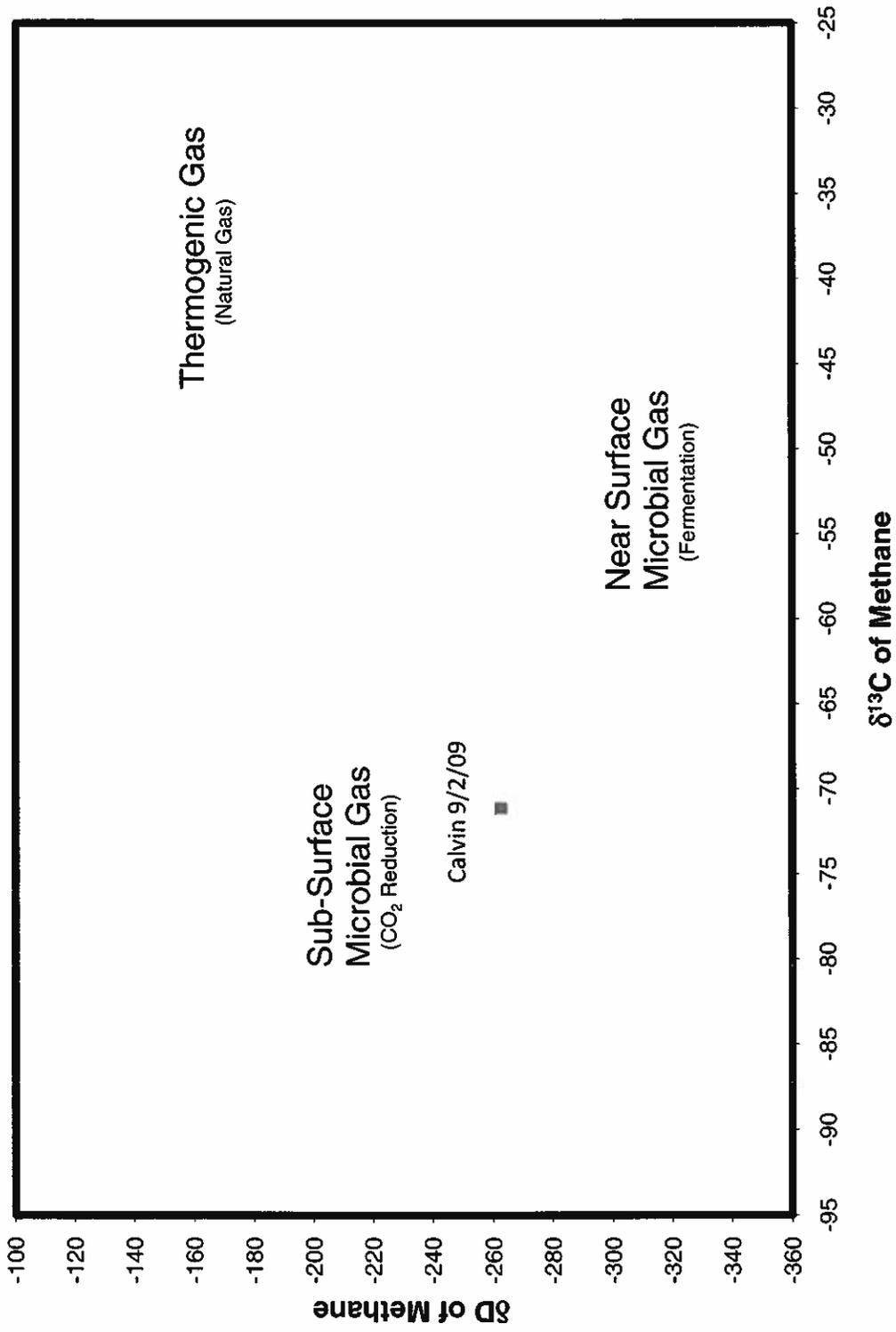
Respectfully,



Robert H. Chesson, C.P.G., P.G.
Environmental Protection Specialist

Enclosure

Typical Compositional Ranges of Methanes - Calvin Water Well



**Calvin Water Well
BART™ TEST RESULTS
Sampled: 9/2/2009**

Calvin
Day 8
9-09-09
8:45am



Iron-Related Bacteria
Very Aggressive
(Population count of
9,000 cfu/ml)

Sulfate Reducing Bacteria
Non Aggressive
(Population count of
100 cfu/ml)

Slime Forming Bacteria
Non Aggressive
(Population count of
100 cfu/ml)



Residential Water Well Field Data Form

Project Name: COGCC - Environmental Support
Project Number: 25087038

Permit No: Not applicable
Owner: Gerald Calvin

Well Owner Survey

Is there a holding tank for the well? Yes _____ No x
Do you have a water softener/treatment system? Yes _____ No x
Do you have an in-line filter? Yes _____ No x
Sampling point upstream of pressure tank and treatment system? Yes x No _____

Address: 13595 Weld County Road 22
Fort Lupton, CO
Location: Platteville Quad., Section 8
Date: 9/2/2009
Weather: Sunny, 75 degrees F

Location of well: South of red barn, north of County Road 22
Type of pump (jet, submersible, suction): submersible
Casing material and diameter: 6-inch steel
Depth to Static Water Table (fluctuations): Unknown
Description of area around well: Relatively flat residential/agricultural grassland
Location and description of sample point: Relatively flat residential/agricultural grass and dirt driveway
Pump start time: 12:24 PM

Time	Volume Purged (gal.)	PH (SI Units)	Spec Cond (ms/cm)	DO (mg/L)	Turbidity (NTU)	Temperature (°C)	Clarity	Other *
12:24 PM					none		clear	none
12:43 PM	10	8.52	1.088	0.46	none	20.92	clear	none
12:47 PM	12	8.51	1.108	0.40	none	21.23	clear	none
12:49 PM	14	8.50	1.111	0.42	none	21.27	clear	none

* odors (if any); effervescence (if any); produced sediment (if any); evidence of bacterial fouling (bioslimes or biofilms).
Field Sample ID : Calvin Collection Time: 12:55 PM Number of Containers: 10

Analyte	# of Containers	Container Size	Type	Analytical Method	Preservative
Dissolved Methane	3	40 ml	vial	RSK175	4°C
BTEX	3	40 ml	vial	8021	HCl 4°C
Total Metals	1	500 ml	HDPE	6020	4°C
Anions, Spec. Cond., TDS, pH	1	250 ml	HDPE	various	HNO ₃ , 4°C
Isotopic Analysis	1	1 L	Plastic	NG-2	biocide
CO ₃ , HCO ₃	1	500 ml	HDPE	2320B	4°C
Duplicate Sample Collected?	Yes: _____	No: _____		X	

Sampler: Chris Roy

Duplicate ID: _____

GPS Coordinates

Latitude: N 40° 8' 43.9" Longitude: W 104° 47' 56.6"

Comments: Well is 680 feet deep. Nearest oil/gas operations are to the north and south, approximately 500 feet to the north and south of the well



Photo #1 View of purging process while recording parameters



Photo #2 View of the purged water



Photo #3 View of the sampling hydrant in relation to the location of the residence



Photo #4 View of the well