

November 11, 2016

VIA EMAIL

Martin Christianson
M&C Farms
22915 County Road 23
Fort Morgan, CO 80701

Subject: Water Quality Results (DWR Permit #276799A; COGCC Facility ID #755063)
NENE Section 15, Township 4 North, Range 57 West, Morgan County
Upper Pierre Water Quality Study (COGCC Project No. 2141)

Dear Mr. Christianson,

On behalf of the Colorado Oil and Gas Conservation Commission (COGCC), Pinyon Environmental, Inc. (Pinyon) visited your property on September 20, 2016 and collected water samples from your water well for general water quality, gas composition and stable isotope analysis. COGCC has received the laboratory results from ALS Environmental (ALS) and Dolan Integration Group (DIG). This letter provides a summary of the laboratory results and a comparison to Human Health and Secondary Drinking Water Standards. The complete ALS and DIG laboratory reports are attached to this letter. Thank you for participating in this study.

DISCUSSION OF ANALYTICAL RESULTS

The Water Quality Control Commission (WQCC) of the Colorado Department of Public Health and Environment (CDPHE) established "Domestic Use - Quality" Human Health and Secondary Drinking Water Standards in Regulation 41 "The Basic Standards for Groundwater" (5CCR 1002-41). The COGCC is an implementing agency of the groundwater standards for impacts associated with oil and gas exploration and production activities. COGCC compared the analytical data for the sample from your water well to the CDPHE Human Health and Secondary Drinking Water Standards in the table provided as Attachment 1. The complete laboratory analytical reports are provided as Attachments 2 and 3.

DISSOLVED INORGANIC PARAMETERS

Total Dissolved Solids (TDS): The CDPHE has not established a groundwater standard for TDS for "Domestic Use - Quality". The Environmental Protection Agency (EPA) has established the secondary maximum contaminant level (SMCL), which is based on the aesthetic quality of the water (such as taste and odor) and is not an enforceable standard. It is intended as a guideline for public water supply systems. The total dissolved solids concentration of most groundwater in Colorado exceeds the SCML due to the interaction of the groundwater with



naturally occurring minerals in the aquifers. Total dissolved solids concentrations are related to the presence of naturally occurring elements and chemical compounds such as chloride, sodium, potassium, calcium, magnesium, and sulfate. Although the CDPHE does not have an agricultural standard for TDS, other agencies or extension offices recommend concentrations below 1,500 mg/l for irrigation and below 5,000 mg/l for most livestock watering.

The total dissolved solids concentration detected in the sample collected from your water well was 2,100 milligrams per liter (mg/l), which is greater than the SMCL of 500 mg/l.

The total dissolved solids concentration in the sample collected from your water well is composed primarily of sodium and sulfate. There is no primary or secondary drinking water standard for sodium, although an excess of sodium can make the water unsuitable for irrigation.

Sulfate was detected in the groundwater sample at a concentration of 1,200 mg/l. The CDPHE domestic supply drinking water standard for sulfate is 250 mg/l. This drinking water standard is an aesthetic standard that is based on the EPA's SCML and is set to protect the aesthetic quality of drinking water such as taste, odor and color. Waters containing high concentrations of sulfate, typically caused by the leaching of natural deposits of magnesium sulfate (Epsom salt) or sodium sulfate (Glauber's salt), may be undesirable because of their laxative effects.

VOLATILE ORGANIC COMPOUNDS

COGCC requested ALS Environmental to analyze the water sample from your water well for a list of sixty-nine (69) volatile organic compounds (VOCs). Volatile organic compounds include organic pollutants commonly related to human activity, including oil and gas exploration. No VOCs were detected in the water sample collected from your water well.

DISSOLVED GAS CONCENTRATION

The gases methane, ethane and propane were not detected in the water sample collected from your water well.

BACTERIA OCCURRENCE

The COGCC also collected samples of your water for Biological Activity Reaction Tests (BART™) to determine the presence of bacteria, as described below.

- **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 that the water touches, and causing what appears to be a sheen on standing water. Signs that may indicate an IRB 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. IRB were detected in the water sample collected from your water well.

- **Sulfate-Reducing Bacteria (SRB):** Sulfate-reducing bacteria are serious nuisance organisms in water, as they can cause severe taste and odor problems. These bacteria reduce sulfate that occurs naturally in water and generate hydrogen sulfide (H₂S) gas as they grow. The 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 in the water sample collected from your water well.**
- **Slime-Forming Bacteria (SLYM):** Although not usually harmful, slime-forming bacteria can become a nuisance by plugging well pumps and causing slimy accumulations on plumbing fixtures and standing water. These bacteria are often gelatinous in nature and may range in color from white to red to black. As SLYM mats grow, they create an environment in which complex associations of other bacterial strains can develop. **SLYM were detected in the water sample collected from your water well.**

CONCLUSIONS

The general water quality results indicate that the water produced from your water well is a sodium-sulfate type of water with a TDS of 2,100 mg/l. The sodium and sulfate present in the water makes the water of poor quality for irrigation or drinking water without additional treatment.

Nuisance bacteria are present in the water sample. While harmless to humans or livestock, these bacteria can eventually foul the well screen and/or the well pump reducing the yield from the water well. Routine maintenance such as that described in the attached booklet "How well do you know your water well" can reduce the bacteria populations to prevent fouling of the well and its components.

Please feel free to contact me by phone, 970-461-2970, or email, rick.allison@state.co.us, if you have any questions regarding the results of your water well sampling.

Sincerely,

Richard Allison, P.G.
Environmental Protection Specialist, Northeastern Colorado

Attachments:

- Summary Table
- Field Data Sheet and Photographs
- ALS Laboratory Reports
- DIG Laboratory Report
- Water Well Booklet

c: File, COGCC Facility #755063