

November 7, 2013

Ms. Melba Farley  
PO Box 363  
Platteville, CO 80651

RE: Stable Isotope Analysis  
Farley Water Wells – DWR Permits No. 247419 and No. 231884  
COGCC Sample IDs 752812 and 752813 (Project Facility ID 434043)

Dear Ms. Farley:

On September 5, 2013 the Colorado Oil and Gas Conservation Commission (COGCC) collected a water sample from three water wells located on your properties. The purpose of the sampling was to determine whether methane was present in the water produced from your water wells. COGCC also analyzed the samples for general organic and inorganic constituents. COGCC reported the analytical results to you in letters dated October 14, 2013.

The water in the two deeper of the three water wells on your properties contains methane at concentrations high enough to warrant further investigation. Therefore, COGCC submitted the samples to Isotech Laboratories in Champaign, Illinois for gas composition and stable isotope analysis to determine if the methane present in the well water is biogenic or thermogenic in origin. This information is used to determine whether oil and gas drilling and production activity may have impacted the water wells.

### GAS COMPOSITION

The gas produced from the oil and 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 thermogenic methane gas are other higher carbon number compounds (“heavier”) gases 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, in which your water well is completed, contain biogenic methane gas.

*WATER WELL PERMIT NO. 231884*

Laboratory results of the gas sample collected from your water well with permit number 231884 show it contains nitrogen (46.83 percent), methane (47.63 percent), oxygen (3.79 percent), argon (0.879 percent), carbon dioxide (0.82 percent), and trace amounts of ethane and propane. The nitrogen, oxygen, argon, and carbon dioxide are components of air. The presence of methane (C1) in the absence of the "heavier" carbon compounds (propane, butanes, pentanes, etc.) indicates the methane is likely biogenic in origin.

*WATER WELL PERMIT NO. 247419*

Laboratory results of the gas sample collected from your water well with permit number 247419 show it contains nitrogen (48.73 percent), methane (46.75 percent), oxygen (2.86 percent), argon (0.940 percent), carbon dioxide (0.65 percent), and trace amounts of ethane and propane. The nitrogen, oxygen, argon, and carbon dioxide are components of air. The presence of methane (C1) in the absence of the "heavier" carbon compounds (propane, butanes, pentanes, etc.) indicates the methane is likely biogenic in origin.

**STABLE ISOTOPE ANALYSIS OF METHANE***WATER WELL PERMIT NO. 231884*

- The deuterium/hydrogen isotope ratio for the methane in the water sample from your water well is -243.2 parts per mil (‰).
- The carbon-13/carbon-12 isotope ratio for the methane in the water sample from your water well is -69.19 ‰.

*WATER WELL PERMIT NO. 247419*

- The deuterium/hydrogen isotope ratio for the methane in the water sample from your water well is -253.0 parts per mil (‰).
- The carbon-13/carbon-12 isotope ratio for the methane in the water sample from your water well is -68.61 ‰.

***STABLE ISOTOPE CROSS-PLOT***

I have included a cross-plot of the stable isotopes for methane in your water well samples to help discuss the sample results for your water well. On the cross-plot you will notice the yellow-shaded area near the top right corner as defined a "Thermogenic Gas". This is the area of the cross-plot where the natural gas produced by the gas wells in the Denver Basin plots. There are is also a blue-shaded area in the middle left area of the cross-plot defined as "Sub-Surface Microbial Gas (CO<sub>2</sub> Reduction)". This is the area of the cross-plot where the biogenic



## CONCLUSION

Enclosures    Attachment 1 – Stable Isotope Cross-Plot  
Attachment 2 – Isotech Laboratories Report  
Attachment 3 – Water Well Information