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Division of Environmental Health Services

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November 19, 2009

Mr. Jack Dahl
Director, Bureau of Oil & Gas Regulation
NYS Department of Environmental Conservation
Division of Mineral Resources
625 Broadway
Albany, NY 12233-6500

Dear Mr. Dahl:

Thank you for responding to my letter dated June 1, 2009 regarding a water well complaint at the Ferrugia home in the Town of Kiantone, Chautauqua County. I appreciate the time you and your staff spent reviewing the information I sent, obtaining additional information, and preparing the response.

With over 6,000 gas and oil wells having been drilled in Chautauqua County, I understand and appreciate the positive impact that the oil and gas industry has had on Chautauqua County's economy and on the region's energy production. I further believe that drilling and development of gas and oil wells in Chautauqua County has resulted in relatively few environmental impacts that we know of. However, there is no denying that impacts have occurred in our county and elsewhere and, due to the rural nature of our county, there may be groundwater quality impacts that we are unaware of.

The increase in gas well drilling activity over the past few years has resulted in an increase in complaints to this Department from property owners who state their water wells were impacted by gas well development. The Ferrugia case happens to be one where the gas drilling company tested nearby water wells before and after drilling gas wells in that area. The data showed a water quality impact following gas well drilling. I understand you have limited resources to spend on these issues. However the information provided herein warrants that a more thorough review of this case be conducted by your Department, especially in light of the anticipated increase in drilling activity we will see in Western New York associated with Marcellus shale.

In summary, your response indicates that the following issues may explain the Ferrugia's well contamination:

- 1) Hydraulic fracturing of the Ferrugia water well by Caster Drilling led to an increase in permeability of the shale aquifer, which likely created a pathway for contaminants to migrate from greater distances to the well.
- 2) The Ferrugia septic system is a likely source of their well contamination.
- 3) Neighboring water wells exhibit chloride and sodium concentrations similar to those currently found in Ferrugia's.
- 4) Concentrations of chlorides and sodium in the Ferrugia well are improving (decreasing) and do not indicate contamination from production brine.

I provide the following discussion on each one of the above issues for your consideration in helping to identify the source of contamination to the Ferrugia water well and to correct the problem:

1) Hydraulic Fracturing of Ferrugia Water Well

The Ferrugia water well was hydraulically fractured when it was drilled in 2001. According to Mr. Gordon Caster owner of Caster Well Drilling, this hydrofracing consisted of installing a packer just above the 30' deep water producing vein and applying ~180 psi to the bore hole for between ~1 to 1.5 minutes until break then immediately releasing the pressure. According to Mr. Caster they have no way of knowing how far fracturing a well in this manner may extend beyond the wellbore, as it is completely dependant on the presence of existing fractures in the rock intersected by the well during drilling, and the type and integrity of rock. They do have evidence that in one case hydrofracing extended 125 ft.

This is similar to hydrofracing a vertical Medina gas well, except pressure is typically ~4000 psi until break and they hold pressure for a longer duration. Also gas well hydrofracing usually creates new fractures and expands old ones, extending several hundred feet from the well bore, according to professionals in the oil and gas well industry.

I agree that hydrofracing the water well increased the zone of contribution to the well, which increased the risk for potential contaminants located further from the well to impact well water quality. However, the only potential contaminant source present within ~300 ft when the water well was fractured was the septic system until 2005 when a gas well was drilled. Hydrofracing the gas well also extended its zone of contribution and could have created contaminant pathways to the water well under unusual conditions.

2) Ferrugia Onsite Sewage Treatment System

The soils in the vicinity of the Ferrugia house are Fremont Silt Loam. These soils are poorly drained and exhibit slow permeability in the substratum. Because of the slow percolation rate at this site, a sand filter was installed for sewage treatment. These systems consist of a layer of washed stone with a dosing system, over 2 ft of sand, over more washed stone that contains an under drain to collect the treated wastewater and direct it to a shallow absorption trench. This trench is designed to "weep" treated effluent onto the ground surface because the soil is too impervious to absorb it. The thickness of overburden (in this case glacial till) above bedrock is 7 ft at the Ferrugia water well. Overburden thickness in the area of their sand filter is at least that thick and likely thicker since overburden usually thickens from hilltop to valley.

The Ferrugia well is more than 273 ft away from and up-gradient of the absorption trench. As you pointed out in your letter, the water well is approximately 15 ft higher in elevation than the 'leach field.' While regional bedrock dip is southeast, locally the top of bedrock surface follows topography; therefore top of rock at this site dips northwest, as pointed out by Dr. Michael P. Wilson from SUNY Fredonia in his 9/30/09 letter.

The bacteriological analysis from the sample collected on 8/1/05 showed a Total Coliform count of 3 bacteria colonies per 100 ml of water. If the septic system were the source of these bacteria, the levels would have been several orders of magnitude greater, and the sample collected on 4/16/07 would have also contained Coliform bacteria. It did not.

The concentration of chlorides in Ferrugia water well increased from 3.8 mg/l before gas well drilling to 223 and 122 mg/l after gas well drilling. Note that they have no water treatment such as a softener that could contribute chloride or sodium to their drinking water or wastewater. Research by the NYSDOH on the transport of contaminants from 17 various types of leach fields to ground water indicates that chloride concentrations do not change or increase only slightly down-gradient of leach fields. The maximum chloride increase between shallow up-gradient (uncontaminated groundwater) and shallow down-gradient (contaminated groundwater) was between 11 mg/l and 48 mg/l. Other systems studied showed no change between up-gradient and down-gradient chloride levels. Research by Ptacek (1998) showed that septic tank effluent from a typical single family home contains approximately 57.0 mg/l of chlorides.

The concentration of barium in the Ferrugia water well increased from 0.181 mg/l before gas well drilling to 1.12 and 1.34 mg/l after. Barium is not associated with household wastewater or septic system effluent. It is however associated with gas field brines as pointed out by Mr. Paul Heisig from the USGS in his 8/17/09 letter.

It is highly unlikely that the septic system is contaminating the Ferrugia water well because:

- a) The low permeability of the soil at the site and the fact that treated effluent is discharged very close to or at the ground surface inhibits transport of contaminants to groundwater,
- b) Top of bedrock, the most permeable conduit between the leach field and the water well dips away from the well towards the leach field,
- c) The concentration of chlorides contributed to groundwater by the leach field is negligible compared to the concentration detected in the drinking water,
- d) Drinking water quality problems were noticed five years after the septic system was installed. If the source of contamination was from the septic system, the impact would have occurred sooner under these fractured-rock groundwater flow conditions.
- e) The increase in barium in the drinking water indicates some other source of contamination besides household wastewater.

3) Adjacent Landowner Water Well Tests

Well testing from Nordlund, Legere and Pelham on 8/1/05 showed that their drinking water exceeds NYSDOH public water supply standards for chlorides, sodium, and/or TDS. Based on Attachment 4 of your letter, the Piper diagram shows that the Legere well exhibits a chemical fingerprint of brine contaminated groundwater.

Additional information is needed to speculate as to the potential source of the neighbor's well contamination including: details on water well depths, a well log and water test results collected from these wells in 2007.

4) Concentrations of contaminants in the Ferrugia well are improving (decreasing) and do not indicate contamination from production brine.

As pointed out by Mr. Paul Heisig in his letter to you, concentrations of barium exhibit a "6 fold increase" and suggest that the fourth water sample collected on 4/23/09 is in error as shown by the misbalance of the major ions. Other factors may also be at play that causes variability in water chemistry including seasonal variations in groundwater recharge and changes in contaminant plume geometry, as pointed out in Dr. Wilson's letter to you.

Unfortunately, I did not receive the 'fourth test' results from the Ferrugias until after sending my 6/1/09 letter to Mr. Chris Miller, therefore these were not included in my analysis. However, as shown in the piper diagram you prepared in your response (Attachment 4) the change in water quality did not create an appreciable difference in where the sample plots on the diagram. Additionally, the fourth sample contains a charge imbalance and may be erroneous as noted above.

Conclusion

While I did not speculate as to the source of contamination in my 6/1/09 letter to Chris Miller, I did indicate that the change in water quality was likely related to nearby gas well drilling and development activity. The timing between drilling the well and the Ferrugias noticing a problem (~24 months) is reasonable for groundwater to travel ~300 feet through fractured shale. Research and investigations conducted by Stearns and Wheler, LLC at the Chautauqua County Landfill indicated that reclaimed mud pits used for disposal of drilling mud, brine and cuttings during gas well drilling were responsible for contaminating groundwater at that site. The aquifer geometry and geology at the Ferrugia site is such that a mud pit excavated ~300 ft up-gradient of the Ferrugia water well would have been deep enough to be very close to the top of fractured rock. Disposal of mud and cuttings in this pit is a likely source of the Ferrugia water well contamination. Other sources also exist that may be related to oil and gas well drilling and development.

A visual inspection of the gas well heads, brine tanks and related equipment conducted by Region 8 Minerals staff can only identify a limited number of problems, such as a surface spill of brine. A more invasive investigation is needed to identify the source of contamination when water quality data clearly shows a problem occurred coincident to gas or oil well drilling. Dr. Wilson suggested several investigative methods that should be used to fully evaluate the problem. In the Ferrugia case, where the mud pits are the likely source of contamination, terrain conductivity should be used to identify the location of the pit. Then at least two sets of nested monitoring wells should be drilled taking into account the location of the mud pits, followed by water quality monitoring. If the investigation confirms the source of contamination is a mud pit (as found in the Stearns and Wheler study), then it should be removed and the water quality monitoring continued.

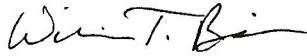
The Chautauqua County Health Department requests that DEC Minerals undertake the following:

- Hire an independent third party such as the USGS to plan and conduct a study to evaluate potential impacts of mud pits to local groundwater quality. This should be funded by NYSDEC and/or the oil and gas industry. (The Ferrugia case makes an excellent starting point for such a study.)
- Collect quarterly samples from the Ferrugia home for one year and analyze for the same constituents sampled for in April 2009.

Mr. Jack Dahl
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Thank you for your assistance with this matter.

Sincerely,



William T. Boria, BS Geophysics, MS Geology
Water Resource Specialist

Pc: Mr. Chris Miller, NYSDEC
Mr. Mark Klotz, P.E. NYSDEC
Gregory J. Edwards, County Executive
David Rowley, P.E., NYSDOH
Paul Heisig, USGS
Dr. Michael Wilson, SUNY Fredonia
Mr. and Mrs. David Ferrugia

Encl: Letter from Dr. Michael Wilson
Letter from Paul Heisig

References

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Wilson, M. September 30, 2009 Letter to Mr. David Wilson, Mr. William Boria and Mr. Jack Dahl.