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United States Department of the Interior

BUREAU OF LAND MANAGEMENT
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In Reply Refer To:
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MAR 0 1 2012

James B. Martin
Regional Administrator
U.S. Environmental Protection Agency, Region 8
1595 Wynkoop Street (OC)
Denver, CO 80202-1129

Dear Mr. Martin:

Reference is made to "Draft Research Report: Investigation of Ground Water Contamination Near Pavillion, Wyoming." Environmental Protection Agency (EPA) Office of Environmental Information (OEI) Docket [FRL–9506–7; Docket ID No. EPA–HQ–ORD–2011–0895]

We appreciate the opportunity to provide comments concerning the draft document of EPA's findings for the investigation of the Pavillion Field, Wyoming. It is recognized that this is a critical study that requires a high level understanding of the complexities of the hydrogeologic environment and complete data collection and analysis commensurate with the desired goals of the study. This is in addition to review and analysis of the best engineering practices employed over the life of the oil and gas operations in the area. These comments were summarized and presented informally to the EPA Region 8 in a teleconference on January 11, 2012.

We have categorized our comments into the following six categories: Hydrogeologic Environment; Groundwater Sampling; Shallow Gas; Hydraulic Fracturing; Fluid Contamination; Adequacy of Study Approach and its Conclusions; and Editorial Quality. We have also included proposed remedies, where indicated, to address our comments relating to each specific category.

1. Hydrogeologic Environment

There are many unknowns with regard to the geology and hydrogeology of the area of investigation. The Wind River Formation has been described historically in the technical literature as a complexly-bedded series of largely fluvial and over-bank deposits consisting of variegated clay-stones, sandstones, and conglomerates with discontinuous thin beds of coal and carbonaceous shales. The complexity of this formation is well-known and easily observed in well logs as well as in outcrop. The degree to which this formation demonstrates heterogeneity and anisotropy at a useful scale is important to the investigation and is not well understood presently. Structural control, i.e., faulting and fracture systems, of the area are known even less.

These factors have a bearing on aquifer properties such as hydraulic conductivity, potentiometric flow directions, water quality/water chemistry and how the aquifer may yield water to wells and may change over time. A comprehensive, defensible, understanding of these properties and their spatial and temporal variability is required to develop an idea of the origin, nature and extent of the contamination.

In addition, the degree to which small scale structures such as faults and fractures influences groundwater flow is largely unknown. Also unknown is the degree that surface/subsurface hydrology/geohydrology flow and quality conditions have changed over the life history of oil and gas operations, agricultural development and population growth in the Pavilion area.

The source of groundwater in these water-bearing zones may be infiltration of precipitation, infiltration of irrigation water or other surface water, or leakage from other aquifers. There has been little to no work expended on characterizing these inputs.

Further, there is presently no good data nor assessment of the role or potential role of legacy wells and associated production operations, i.e., oil, gas, center pivot irrigation, and domestic wells, that may have played or are currently playing in this field.

Proposed Remedy:

Additional research should be carried out to fully characterize the geohydrology environment. Data presented thus far seems to be at a scale and resolution insufficient to answer the questions this investigation raises. The discussion of preferential pathways and "enhanced gas migration" may be premature and perhaps be deemphasized until a clear understanding of such phenomenon is developed. The monitor wells MW-01 and MW-02 are sited close and down-gradient to Five-Mile Creek and any possible impact to groundwater flow regime (and resultant water quality measured at monitor wells) should be understood.

2. Groundwater Sampling

The groundwater samples obtained at the purpose-built monitor wells MW-01 and MW-02 are important to telling the story that has been presented thus far, however, two rounds of sampling obtained at these two locations are not statistically valid to arrive at any reliable conclusion given potential reservoir complexities. The degree to which the hydrogeologic environment varies spatially and temporally further complicates this reliability.

Bias in the samples obtained from these wells may exist. Possible causes include transfer of shallow contamination into deeper zones through the drilling process, or contamination of samples through the introduction of contamination during the drilling and well installation process (e.g., bentonite muds, additives such as soda ash, pipe-dope, and make-up water). In addition, the development of these monitor wells appears to be deficient for sampling purposes and groundwater samples from the wells should not be fully trusted until development activities indicate that the wells are yielding formation water untainted by any effects introduced by the

drilling, well completion, and sampling process. The amount of water removed from the wells during development appears small in comparison to the amount of fluids likely introduced into the formation during drilling and completion. Consequently, there is a chance that groundwater samples from these monitor wells are not representative of true water quality in the aquifer.

The appearance and disappearance of detected analytes[1] between these two rounds of sampling as well as the anonymous high pH values in groundwater samples should be taken as indicators that additional data are warranted.

The presence of Diesel Range Organics (DRO)[2] and Gasoline Range Organics (GRO)[2] analyses in the groundwater samples from the monitoring wells MW-01 and MW-02 is problematic. Finding such constituents should be unexpected for a formation that naturally yields hydrocarbons. What is the mechanism by which these constituents arrived at these deeper wells?

Proposed Remedy:

Given the potential implications of the water quality investigation, it is recommended that additional monitor wells be installed, with at least one well located up-gradient from the gas field and any inputs from irrigation, and one well located cross-gradient from regional groundwater flow. Several other monitor wells should be dispersed throughout the area of investigation at various depths. Vertical contaminant profiling by sampling groundwater from packed-off water-bearing zones should be employed during drilling to maximize the amount of data obtained from each well installation.

A minimum of four quarters of groundwater samples should be obtained from each well to fully gauge the seasonal variability. Additional work and data are needed to confirm and delineate the 3-dimensional extent of EPA's "plume" concept. Is the contamination moving up, down, horizontally? By what drive mechanisms… diffusion, advection, infiltration, injection pressure response, etc.? If a plume of groundwater contamination is present, is there a specific source, and where in the plume's potential field are the monitor wells located?

To ensure clean samples, it is recommended that monitor wells should be drilled with reverse-circulation using filtered air and no bentonite muds or hydrocarbon-based additives or pipe-dope. Cuttings should be sampled regularly and analyzed for contamination in a laboratory. The wells should be developed according to the approved sampling and analysis plan, ensuring that water quality parameters are stable before sampling and that the wells demonstrate good hydraulic connection to the formation (pump testing, slug testing), and that true formation water is obtained. Only through careful drilling, installation and development can reliable samples of groundwater be obtained.

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[1] Analytes: An analyte, or component (in clinical chemistry), is a substance or chemical constituent that is of interest in an analytical procedure.

[2] See USGS Toxic Substances Hydrology Program Definitions.

3. Shallow Gas

According to the EPA, "Historically, methane had been reported in the area at shallow depths, but there was little evidence that this observation was widespread." We surmise that EPA's statement was based on the lack of gas spikes on electric logs of drilled production wells in the area. The lack of gas spikes on electric logs is not necessarily evidence that gas does not naturally exist in the shallow subsurface, and therefore any gas detected is a result of "enhanced migration." Gas will be present where conditions favor its presence. Similarly, an aquifer will yield water to wells where hydrogeologic conditions indicate. Again, there is a lack of understanding of the spatial and temporal variability of the geologic environment and what role, if any, that thin discontinuous coal beds and carbonaceous shales may be playing. What is clear is that this is a relatively shallow gas field (1,500 ft +/-), and observations have shown that large amounts of gas have been found in the shallow subsurface at certain locations.[3]

These observations are anticipated and should not be prematurely used as a line of evidence that supports EPA's suggestion that gas has migrated to the shallow subsurface due to hydraulic fracturing or improper well completion until more data is collected and analyzed.
In addition, there is a question of the nature and extent of shallow gas in relation to the observed "blow-out" at a domestic well drilled earlier at the Meeks' place. This well blew out at about 700 feet. The fact that the gas flowed for a prolonged length of time suggests a significant in-place source rather than gas that just migrated into position from an improperly completed well somewhere in the vicinity, or along some preferential pathway created by hydraulic fracturing.

Proposed Remedy:

Due to the demonstrated anisotropy and heterogeneity of the geologic environment, it should be recognized that anecdotal observations of the presence or absence of methane at the well scale is not an indicator of the larger picture. Additional testing of the shallow environment should be carried out if this is an important line of evidence in arriving at a conclusion. In addition, the bradenhead testing should be completed at all possible well locations and correlated with observation of shallow gas and/or with data obtained from groundwater samples.

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[3] Given the mixed surface and mineral estate ownership, potential differences in drilling and completion standards use overtime, it is not surprising that complexity reigns in sorting out the history of oil and gas operations and their geotechnical context of potential impacts in the area. Oil and gas exploration wells were drilled in the 1950s. Commercial natural gas extraction in the field commenced in 1960 with gas production well installation activity intensifying in the late 1990s through 2006. The field currently consists of approximately 169 vertical production wells. Ninety-seven production wells are designated as "Tribal Pavillion" and are regulated by the Bureau (BLM) with the remaining wells designated as "Pavillion Fee" and are regulated by Wyoming Oil and Gas Conservation Commission (WOGCC).

4. Hydraulic Fracturing Fluid Contamination

The suggestion that hydraulic fracturing is the explanation for the presence of certain analytes detected in groundwater samples is premature and is largely based on the supposition that such compounds are known to have been used in some fracturing fluid formulations, based on Material Safety Data Sheets and other industry data that has been only recently released. It is important to note that the history of this field dates as far back as the 1960s, and it is unknown what fracturing fluid formulations were specifically used in this gas field at that time, and whatever formulations were used are not necessarily the same as modern formulations, which the EPA seems to indicate as the standard for chemical makeup of such fluids.

The presence of DRO, GRO, and Methyl Tertiary Butyl Ether (MTBE)[2] in water samples from monitoring wells was used as evidence to support fracturing fluid migration since such fuels have been known to be used as slickening agents in some fracturing fluid formulations. It is important to note that due to the large timeframe this gas field has been in existence, if such fuels were used, there is a good chance that such use coincided with the period of time (pre-1979) where tetraethyl lead was used instead of MTBE. Furthermore, the use of MTBE has been steadily decreasing since the 2000's in favor of ethanol.

Proposed Remedy:

Since a large number of gas wells were constructed before 1979, groundwater samples should be analyzed for the presence of lead in order to provide more reliable evidence of whether or not fracturing fluids are responsible for the contamination. Because some fracturing fluid formulations employ CO_2-based foams, it would be expected that carbonic acids would form in the groundwater and subsequently lowering the pH. Since a great deal of effort has been expended on explaining that unbuffered KOH (another fracturing fluid constituent) as the mechanism for the observed high pH, similar effort should be expended on the role of an acid-forming mechanism such as CO_2–based foams to help fully understand the observed geochemistry of the groundwater.

5. Adequacy of Study Approach and its Conclusions

It is our understanding that this investigation was originally intended as a "presence/absence" effort, and designed and funded as such. The objectives and scope of the study appear to have grown into a source, fate and transport investigation, while the methods and scope of data collection have not. We recommend a larger and much more comprehensive study that is equal to the challenge of the larger question of contamination and potential role of hydraulic fracturing use involvement.

In regard to the hydraulic fracturing use question in general, we have little reason to believe at this time that the constituents found in the samples thus far were not already present in the groundwater sampled. Question is, how did they get there? Can we conclusively say that had some oil and gas wells in the Pavillion area not been fracked, would we be seeing this level and

quality of contamination? Or, can this reasoning be extended to the preposition that had the Pavillion area never had a gas well drilled, there would be no contamination? Or, if the pits were just managed better, previous permitted oil and gas wells properly plugged and abandoned, industry best practices followed, domestic water wells and center pivot irrigation wells properly permitted, would there be no contamination? What was the background water quality in the naturally-occurring, shallow aquifer, hydrocarbon accumulations, at this locality? There are a lot of questions and concluding that the oil field use of hydraulic fracturing as the cause at this time may be premature.

6. Editorial Quality.
We recommend that a glossary be included with a list of acronyms and abbreviations.

Proposed Remedy:

See Government Printing Office (GPO) and EPA guidance on Federal Government publications and scientific writing style.

In Summary:
In summary, the study and draft report appears to be a good, initial, technical effort, however, in its present form it needs additional data and analysis equal to the scope and scale of the problems it attempts to address. We recommend a larger and much more robust study effort and investment prior to drawing any conclusions, particularly in the case about the role of hydraulic fracturing use in development of the oil and gas resource. As a land managing agency, it is very important to understand the situation so we may take proactive, appropriate, action to protect the safety of the residents in the Pavillion area.

Thank you for the opportunity to participate on the technical committee alongside EPA in this complex, technically challenging and high visibility investigation. We also appreciate the technical discussions that have taken place between EPA and BLM. We welcome the opportunity to discuss these comments in greater detail with EPA. It is appreciated that the Pavillion Field can help regulatory agencies better understand more fully the nature and impact of downhole oil and gas operations.

If you have any questions, please call Larry Claypool, Deputy State Director, Minerals and Lands, at 307-775-6146.

Sincerely,

Donald A. Simpson

Donald A. Simpson
State Director