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James Bearzi, Bureau Chief
Hazardous Waste Bureau
New Mexico Environment Department
2905 Rodeo Park Drive East, Building 1
Santa Fe, NM 87505-6303

Subject: Response to the New Mexico Environment Department's Approval with Modification of Completion Report for Regional Aquifer Well R-39

Dear Mr. Bearzi:

This letter provides the Los Alamos National Laboratory's (the Laboratory's) response to the New Mexico Environment Department's (NMED's) letter of Approval with Modification of the Completion Report for Regional Aquifer Well R-39, submitted on October 30, 2009. NMED's comment on Section 2.2.1 of the R-39 completion report requires a response to address an apparent discrepancy regarding the use of foam during drilling at R-39. The apparent discrepancy stems from video-log observations of foam on the regional groundwater table and the reason the foam is present.

Our investigation confirmed no additional AQF-2 foaming agent was added to the municipal water used as the drilling fluid after November 6, 2009, at 707 ft bgs (117 ft above the regional water table), as stated in the completion report for R-39 (section 2.2.1, p. 3).

The following is a reconstruction of sequence of events and information using field notes, the well completion report, and the downhole video.

- The borehole video of R-39 taken on November 13, 2008, shows approximately 1 to 3 ft of foam floating on the regional groundwater surface in the R-39 borehole. The estimated depth is based on the difference between the top of the foam at 823.9 ft below ground surface(bgs) visible in the borehole video and the estimated base of the foam identified at 825 ft bgs in the borehole video. The static water level in the completed well was 826.7 ft bgs at the onset of aquifer testing (section F-1.1 of Appendix F of the completion report). This static water level is consistent with water-level depths measured following overnight periods of resting during well development (Table 3.1-1 of the completion report).

- The borehole video shows foam adhering to the open borehole wall in the unsaturated interval between 706 ft bgs and the top of the foam at 824 ft bgs. The foam on the borehole wall first appears in the borehole video abruptly below a depth of 706 ft bgs. The zone between 707 ft and 718 ft bgs is characterized by a rough borehole wall in an interval of fractured lava. The Laboratory believes a small volume of residual drilling fluid (municipal water plus AQF-2) was forced into this fractured lava by introduced air that aids circulation during drilling. After drilling was completed, return flow of residual drilling fluid drained into the borehole from the fractures, flowed down the borehole wall, and accumulated as foamy water on top of the standing water surface of the regional aquifer. It should be noted that below 718 ft bgs, the video shows foam adhering to smooth borehole walls through a thick sequence of unfractured lava. No drilling fluid would have been lost in this tight interval; for the same reason, no return flow of drilling fluid with foam would have reentered the borehole in this zone.

- The seepage appears to have been short-lived, as this zone was no longer actively seeping when the video log was taken on November 13, 2008.

The Laboratory estimates that the concentration of foam in the borehole screening sample collected on November 12, 2008, was about 2% of the concentration in the original mix of drilling fluid. This estimate is calculated from the total organic carbon (TOC) value of 30 mg/L measured for screening sample RC45-09-1035 compared with an estimated initial TOC of 1400 mg/L for the drilling fluid added to the borehole on November 6, 2008. The initial concentration is based on the dilution of 4 gal. AQF-2 with about 35% TOC with 1000 gal. municipal water. The same result is obtained if the initial composition of the drilling foam is based on the cumulative volumes of additives (i.e., 74 gal. AQF-2 with 35% TOC diluted with 17,900 gal. municipal water, yielding an average TOC of 1450 mg/L in the drilling fluid).

The most significant observation is that residual foam in the groundwater was completely removed during well development. Analytical data for characterization samples collected after well development confirm the absence of residual foam in the regional groundwater at R-39. The four characterization samples collected in 2009 pass all the indicator tests used to evaluate residual effects of drilling in accordance with the protocol set forth in the NMED-approved Well Screen Analysis Report, Revision 2.

- Indicators selected to detect residual organic drilling products in groundwater samples are TOC, acetone, total Kjeldahl nitrogen, and ammonia. The highest TOC value measured among the characterization samples was 0.72 mg/L on March 12, 2009. This concentration is well within the range of natural background variation. For comparison, the 95th percentile concentration of TOC is 1.08 mg/L in background groundwater from the regional aquifer (Table 4.2-3 of the 2007 Groundwater Background Investigation Report). For the other three indicators of residual organic products, concentrations were below detection limits for all four characterization samples.

- Among the indicators used to detect residual inorganic components of drilling products, chloride, sodium, and sulfate are particularly relevant because they are present in the AQF-2 product. Measured concentrations for these indicators are stable within the range of local

background levels, presented the 2007 Groundwater Background Investigation Report, in all of the characterization samples:

- ❖ Sodium concentrations average 10.7 ± 0.5 mg/L in the characterization samples, compared to the upper tolerance limit (UTL) of 12.2 mg/L. For comparison, sodium concentrations were 39 mg/L in the borehole screening samples collected before well completion and development.

- ❖ Chloride concentrations average 2.2 ± 0.1 mg/L in the characterization samples, compared to the UTL value of 7.8 mg/L. Chloride concentrations were 6.6 mg/L in the borehole screening samples.

- ❖ Sulfate concentrations average 2.9 ± 0.1 mg/L in the characterization samples, compared to the UTL value of 40 mg/L. Sulfate concentrations were 6 mg/L in the first borehole screening sample, and 18 mg/L in the second sample.

- Among the suite of indicators routinely used to assess redox conditions, the analytical data for the characterization samples are well within the ranges indicative of an oxidizing environment.

  - ❖ The redox tests include five trace metals. Under oxidizing conditions in the regional aquifer, dissolved concentrations of iron and manganese are low or not detected, while dissolved concentrations of chromium, uranium, and vanadium are present above specified threshold values. The four characterization samples pass these tests with the following results: iron < 30 µg/L (compared with an upper threshold of 103 µg/L); manganese < 7 µg/L (compared with an upper threshold of 14 µg/L); chromium > 3 µg/L (compared with a lower threshold of 0.9 µg/L); uranium > 0.3 µg/L (compared with a lower threshold of 0.16 µg/L); and vanadium > 4.6 µg/L (compared with a lower threshold of 3.8 µg/L).

  - ❖ Inorganic anions used to assess redox conditions include nitrate, perchlorate, and sulfate, which are detected in the local regional aquifer under oxidizing conditions. Each characterization sample passes these tests. Average anion concentrations for these four samples are nitrate + nitrite (as nitrogen) = 0.6 ± 0.2 mg/L (compared with a lower test threshold of 0.15 mg/L); perchlorate = 0.33 ± 0.03 µg/L (compared with a lower test threshold of 0.22 µg/L); and sulfate = 2.9 ± 0.1 mg/L (compared with a lower test threshold of 1.7 mg/L).

In summary, postdevelopment groundwater samples show stable concentrations for geochemical indicators, well within the range of local background concentrations. This finding indicates no residual foam is present within the regional aquifer at R-39 and the well is fully capable of providing reliable and representative water-quality data.

If you have any questions, please contact Danny Katzman at (505) 667-6333 (katzman@lanl.gov) or Hai Shen at (505) 665-5046 (hshen@doeal.gov).

Sincerely,

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