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Date: 3/31/06

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Re: UNC Church Rock Site
Gallup, New Mexico
Mill Well Testing Results

INTRODUCTION

This technical memorandum (Tech Memo) presents the results of laboratory testing to evaluate the proposed use of groundwater withdrawn from the former mill domestic supply well (Mill Well), to stabilize and/or improve the recovery of tailings-impacted groundwater from Zone 3, at the United Nuclear Corporation (UNC) Church Rock Site (site) located in Gallup, New Mexico. This Tech Memo provides supplemental information to that presented previously, as part of a comprehensive program outlined in a document entitled: *In Situ Alkalinity Stabilization Pilot Study (Pilot Test)*, prepared by Blasland, Bouck & Lee, Inc. (BBL) and submitted to the United States Environmental Protection Agency (USEPA) on October, 12, 2005. BBL also prepared a January 26, 2006 Tech Memo that described results of bench-scale testing (bench tests) to evaluate the proposed injection of alkalinity-rich groundwater from a non-impacted part of the Southwest Alluvium into Zone 3.

Laboratory testing described in this document was performed in response to discussion with representatives from UNC, BBL, USEPA, the Nuclear Regulatory Commission (NRC) and the New Mexico Environment Department (NMED), concerning the results of bench tests documented in the January 26, 2006 Tech Memo. Concerns were expressed that the groundwater from the Southwest Alluvium, proposed for injection as part of the pilot study, did not meet applicable groundwater criteria for sulfate (SO₄), total dissolved solids (TDS), and manganese (Mn). Consequently, NMED requested that alternative water sources be identified and evaluated for injection into Zone 3 for use as a “fixiviant” for targeted constituents of concern (COCs).

NMED identified groundwater withdrawn from geologic formations below Zone 3 via the onsite Mill Well as a potential alternative source of groundwater to serve as a “fixiviant”. Review of existing groundwater quality data for Mill Water samples indicated that this alternative source would satisfy NMED’s concerns regarding the presence of SO₄, TDS, and Mn in the proposed fixiviant. Geochemical modeling using PHREEQCI, however, suggested that the Mill Water did not contain sufficient alkalinity to neutralize seepage-impacted groundwater within areas of greatest impact, such as near monitoring well 613. One of the objectives of the laboratory testing, therefore, was to evaluate approaches to increase the alkalinity of the Mill Water, in order to provide sufficient neutralization capability for Zone 3 seepage impacts areas.

The remainder of this Tech Memo provides a description of the analyses and results of the latest laboratory testing. In summary, the results presented below indicate that the Mill Water, with appropriate alkalinity enhancement, should serve as a suitable fixiviant for seepage-impacted groundwater during the pilot study.

LABORATORY TESTING AND RESULTS

Table 1 identifies the testing procedures and the three samples analyzed as part of the Mill Well water evaluation. The first sample, Mill Well 1, involved laboratory analysis of a sample, collected from the Mill Well on February 28, 2006, for a range of major ions, metals, and radionuclides, including COCs for the site.

The other two samples evaluated included: i) Mill Well 2, a Mill Well water sample dosed with sodium bicarbonate (NaHCO_3); and ii) Mill Well 3, a mixture of 9 parts Mill Well 2, and 1 part groundwater from well 517, which is located within an area of seepage impacts where the proposed field portion of the pilot test will be performed. These samples were analyzed for major ion/element chemistry only, because results from the earlier bench tests indicated that injection of the alkaline-rich fixiviant would achieve the treatment objectives for Zone 3 COCs.

Table 2 presents the laboratory analytical results for the three samples submitted for analysis. Also presented are analytical data for well 517.

Saturation indices, calculated using PHREEQCI, are presented for calcite (CaCO_3), magnesite (MgCO_3), and gypsum ($\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$). Indices for these minerals are provided because in situations where they are oversaturated (i.e. indices > 0), the possibility/likelihood exists that the minerals may precipitate, which may influence well performance (fouling), and constituent migration.

The last two columns in Table 2 describe calculations applicable to the Mill Well 3 sample, which contained a mixture of alkalinity-enhanced Mill Well water, and seepage-impacted groundwater from well 517. These two columns provide information about whether aqueous constituents contained in the mixed solutions may have precipitated or adsorbed/desorbed during the laboratory testing.

The column labeled "Calculated ..." corresponds to the mathematical product calculated by multiplying the analytical results for well 517(1 part) by 9 times the analytical results for Mill Well 2 (9 parts). Comparing the values in this column with the laboratory results for the Mill Well 3 (MW#3) sample, provides an assessment of potential precipitation/sorption reactions occurring during the testing. This is provided in the final column, labeled "Difference Calculated vs. MW#3". Negative values in the final column correspond to percent loss of constituent in the laboratory sample for Mill Well 3, compared to the theoretical mixing calculation presented in the adjacent column. Negative values may be indicative of loss of constituents via precipitation during the experiments, as well as analytical uncertainty. Positive values may reflect analytical uncertainty and/or leaching/desorbing of materials during the test.

Analytical results for the Mill Well 1 sample presented in Table 2 indicate that concentrations of SO_4 , TDS, Mn or the Zone 3 COCs should not be an issue regarding its use as a fixiviant. Results for the Mill Well 2 sample indicate that the added alkalinity will increase TDS, but not as high as the applicable groundwater criteria of 4,800 mg/L.

Results for the Mill Well 3 sample indicate that the alkalinity-enhanced Mill Well water can neutralize seepage-impacted groundwater represented by well 517. The observed pH of 8.6 is in agreement with the calculated mixture (using PHREEQCI) pH value of 8.5. PHREEQCI calculations indicate that if calcite were to precipitate for the Mill Well 3 sample, the resulting equilibrium pH would be approximately 7.8. Data presented in the last two columns in Table 2 suggest that magnesite and/or calcite may have precipitated to some extent during the experiments.

Additional PHREEQCI calculations provide insight regarding the extent to which alkalinity enhancement of the Mill Well water is needed to achieve sufficient neutralizing capacity. Results indicate that the Mill Well water without alkalinity enhancement would be sufficient to neutralize seepage-impacted groundwater from well 517. Calculations assuming a 9/1 (fixiviant/well 517) mixing ratio result in an equilibrium pH of ~7.95 in the absence of alkalinity enhancement. For 9/1 mixtures of fixiviant/well 613, an equilibrium pH of ~4.45 is predicted without alkalinity enhancement, and an equilibrium pH of ~6.6 using alkalinity-enhanced Mill Well water equivalent to the Mill Well 2 sample. Although Mill Well water without added-alkalinity should neutralize seepage-impacted groundwater near well 517, it appears prudent to conduct the field pilot test with alkalinity-enhanced Mill Well water. This will assist in evaluating potential well-fouling issues, and also provide greater confidence that the proposed fixiviant will successfully neutralize/stabilize groundwater where seepage impacts are greatest during full-scale operations.

In conclusion, considering the results from laboratory testing described herein, in combination with bench tests described in the January 2006 Tech Memo, using alkalinity-enhanced Mill Well water should serve as an effective fixiviant. BBL recommends that the field-portion of the Pilot Test be implemented as soon as possible to expedite improvement in groundwater quality within the area of seepage impacts at the site.

PMS/jlc
Attachments

TABLE 1

MILL WELL SAMPLES–LABORATORY PROCEDURES

**UNC CHURCH ROCK SITE
IN-SITU ALKALINITY STABILIZATION PILOT STUDY**

Sample No.	Sample Procedure	Sample Analyses
Mill Well 1	No additions or mixing Analyze upon receipt at the lab	Full list of analytes listed on Table 2
Mill Well 2	<ol style="list-style-type: none"> 1) Add NaHCO₃ to the Mill Well water at the ratio of 2g/L of water 2) Manually agitate mixture a minimum of three times during a 24 hour period 3) After 24 hours, filter with a 0.45 um filter, split the volume (half for analysis as sample Mill Well 2 and half to be used as sample Mill Well 3[see below]) 	Alkalinity as CaCO ₃ Chloride Nitrate as N, dissolved Nitrate/Nitrite as N, dissolved Nitrite as N, dissolved Nitrogen, ammonia pH (lab) TDS Sulfate Calcium, dissolved Magnesium, dissolved Sodium, dissolved Potassium, dissolved
Mill Well 3	<ol style="list-style-type: none"> 1) Use split of mixture described above in Mill Well 2 2) Add water from Well 517 at a ratio of 9:1 (9 parts Mill Well mixture to 1 part Well 517 water) 3) Manually agitate mixture a minimum of three times during a 24 hour period 4) After 24 hours, filter with a 0.45 um filter, analyze as sample Mill Well 3 for the parameters listed to the right 	Alkalinity as CaCO ₃ Chloride Nitrate as N, dissolved Nitrate/Nitrite as N, dissolved Nitrite as N, dissolved Nitrogen, ammonia pH (lab) TDS Sulfate Calcium, dissolved Magnesium, dissolved Sodium, dissolved Potassium, dissolved

TABLE 2

MILL WATER SAMPLE RESULTS
UNC CHURCH ROCK SITE
IN-SITU ALKALINITY STABILIZATION PILOT STUDY

	GW Standard	517	Mill Well #1	Mill Well #2	Mill Well #3	Calculated 0.1*517 and 0.9*MW#2	Difference Calculated vs MW#3
ANALYTE							
Aluminum, dissolved	5	4.0	U				
Arsenic, dissolved	0.01		U				
Beryllium, dissolved	0.004		U				
Cadmium, dissolved	0.005	0.0068	0.0001B				
Calcium, dissolved		475	16.1	15.7	59.4	61.6	-4%
Cobalt, dissolved	0.05	0.82	U				
Lead, dissolved	0.05	0.0010	0.034				
Magnesium, dissolved		508	4.2	4.1	44.6	54.5	-18%
Manganese, dissolved	2.6	9.10	0.04				
Molybdenum, dissolved	1		U				
Nickel, dissolved	0.2	0.71	0.07B				
Potassium, dissolved		10	3.6	3.6	4.1	4.24	-3%
Selenium, dissolved	0.05		0.002				
Sodium, dissolved		156	716	1250	1140	1141	0%
Uranium, dissolved	0.03	0.0400	0.0081				
Vanadium, dissolved			U				
Gross Alpha	15	65	16 +/- 11				
Gross Beta		65	16 +/- 11				
Radium 226	5	9.2	1.7 +/- 0.6				
Radium 228, total		8.6	0.69 +/- 0.73				
Thorium 228		0.72	0.05 +/- 0.08				
Thorium 230	15	-0.3	-0.14 +/- 0.12				
Thorium 232		-0.03	0.02 +/- 0.14				
Bicarbonate as CaCO ₃			196	1310	1140		
Carbonate as CaCO ₃			13	136	118		
Chloride		40	154	161	150	149	1%
Hydroxide as CaCO ₃			U				
Nitrate as N, dissolved*	190	0.05	0.02	0.03	0.02		
Nitrate/Nitrite as N, dissolve			0.02	0.03	0.02		
Nitrite as N, dissolved			U				
Nitrogen, ammonia		8.00	0.65	0.6	1.35	1.34	1%
pH		4.0	8.6	8.7	8.6	8.5	
pH measured at oC		21	22	22	22	22	
Residue, Filterable (TDS) @180	4800	5360	2180	3470	3530	3659	-4%
Sulfate	2125	3560	1180	1200	1390	1436	-3%
Total Alkalinity			209	1440	1260	1296	-3%
Calcite Saturation Index		-7.67	0.37	1.12	1.56	1.51	
Magnesite Saturation Index		-7.98	-0.53	0.29	1.17	1.18	
Gypsum Saturation Index		-0.03	-1.61	-1.84	-1.19	-1.16	