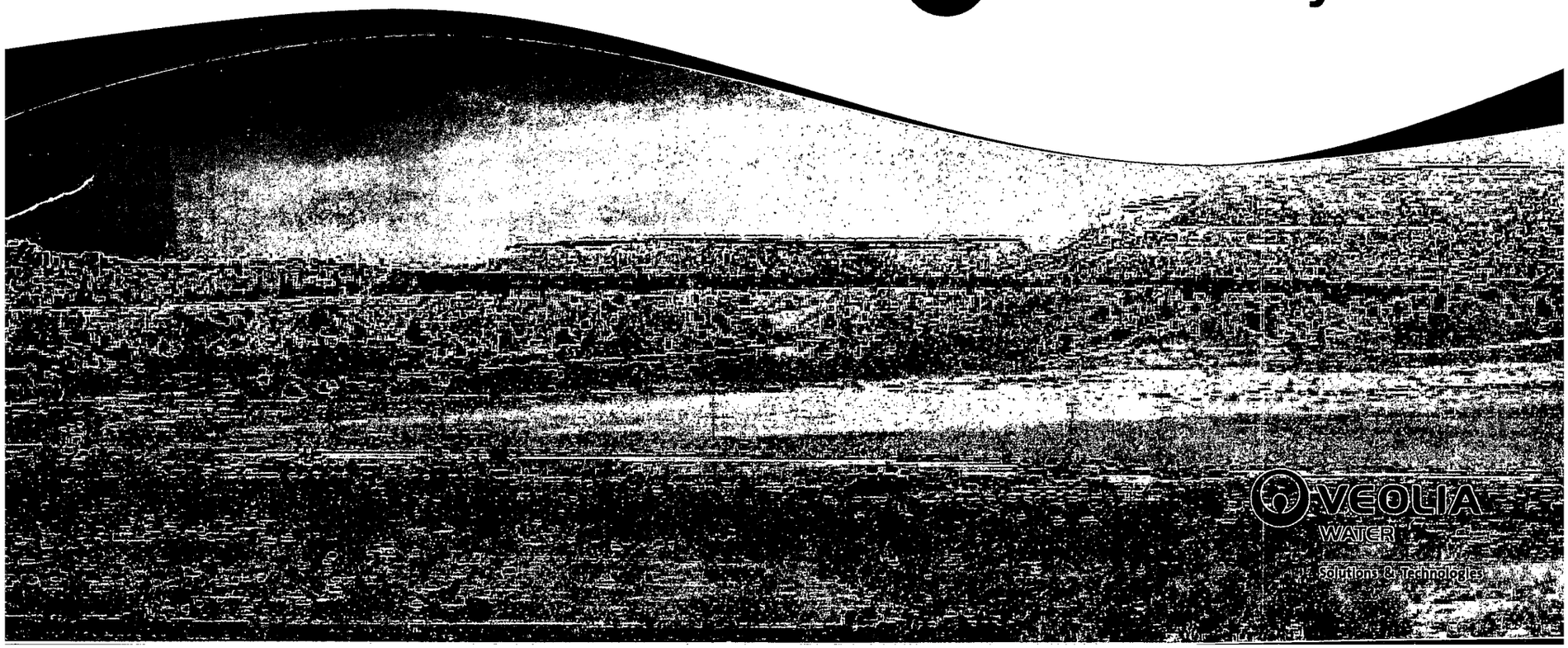
United Nuclear Corporation
Gallup, New Mexico

Annual Review Report - 2007
Groundwater Corrective Action
Church Rock Site, Church Rock, New Mexico

January 2008

N.A. Water Systems



N.A. Water Systems

January 29, 2008

Mr. Keith I. McConnell, Deputy Director
Decommissioning and Uranium Recovery Licensing Directorate
Division of Waste Management and Environmental Protection
Office of Federal and State Materials and Environmental Management Programs
U.S. Nuclear Regulatory Commission
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Mr. Mark D. Purcell
Remedial Project Manager
Superfund Division
U.S. Environmental Protection Agency, Region 6
1445 Ross Avenue, Suite 1200
Dallas, TX 75202-2733

Re: Executive Summary
2007 Groundwater Corrective Action Annual Review Report
Materials License No. SUA-1475
United Nuclear Corporation's Church Rock Tailings Site, Gallup, New Mexico

Dear Messrs. McConnell and Purcell:

On behalf of United Nuclear Corporation (UNC), N.A. Water Systems has prepared this annual performance review of the groundwater corrective action at UNC's Church Rock Mill and Tailings Site near Gallup, New Mexico, pursuant to License Condition 30C. This report is for the 2007 operating year and represents the period from October 2006 through October 2007. This cover letter serves as an Executive Summary of the report.

This report focuses on both active remediation and the groundwater performance of the natural systems without active remediation. As indicated in the U.S. Environmental Protection Agency's (EPA's) *First Five-Year Review Report* (EPA, 1998) and by the approvals to decommission or temporarily shut off the three corrective action systems, the agencies recognized that those corrective action pumping systems had reached the limit of their effectiveness. EPA (1988b) recommended that Technical Impracticability (TI) Waivers, Alternate Concentration Limits (ACLs), and Monitored Natural Attenuation (MNA) be used to complete the corrective action program. Presentations and reports prepared to document the geochemical processes in the Southwest Alluvium (Earth

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Tech, 2000d and 2002c; N.A. Water Systems, 2004, 2005a, and 2005b) and the Zone 1 hydrostratigraphic unit (Earth Tech, 2000c; N.A. Water Systems, 2005b) showed that the natural geochemical mechanisms are at least as effective as the active remediation systems in controlling the migration of constituents of concern. This annual report describes how these natural processes are performing. This report updates active remediation efforts in Zone 3, including pumping of hydrofractured extraction wells and the results of the in-situ alkalinity stabilization pilot study. 18 years of active remediation of Zone 3 by the extraction of impacted groundwater and constituent mass resumed with the Phase I hydrofracture study in 2005 and continued through 2007.

Corrective Action Systems

The corrective action systems for tailings seepage remediation were installed and began operating during the summer and fall of 1989. These systems have been decommissioned or, in the case of the Southwest Alluvium, temporarily shut off, and performance monitoring is ongoing. The Zone 1 system was decommissioned in July 1999 in accordance with the letter from the NRC dated July 30, 1999 (NRC, 1999a).

The Zone 3 system was shut down in June 2000 for maintenance and repairs. Prior to the Zone 3 system being brought back on-line, the agencies agreed that the existing system should be decommissioned (NRC, December 29, 2000 License Amendment). This decision included a provision for UNC to submit a modified corrective action plan, an application for ACLs, or an alternative to the specific requirements of 10 CFR Part 40, Appendix A, if the License standards are not achievable. During 2006 UNC completed an extended pilot investigation to evaluate the suitability of hydrofracturing to enhance the extraction potential within the impacted area of this hydrostratigraphic unit (MACTEC, 2006). The hydrofracture study demonstrated that the new pumping configuration has achieved nearly complete capture of the northward-advancing impacted water, while causing a notable improvement in the water quality within the northern tracking wells. For these reasons, pumping in this part of Zone 3 continued during 2007. A new extraction well (RW A) was installed and started pumping on September 24, 2007. Hydrofractured extraction-well pumping (plus converted pumping Well PB 2) has removed more than 6.7 million gallons from 2005 through 2007. The pumped water was conveyed to an evaporation pond overlying part of the South Cell. In October 2006, UNC began an in-situ alkalinity stabilization pilot study in an area of relatively highly impacted groundwater in Zone 3. The objective of the study was to evaluate the potential to enhance remediation through the use of alkalinity injection wells combined with controlled-rate extraction wells. This pilot study was completed

during 2007 (ARCADIS BBL, 2007) and the results are summarized in Section 3 of this report.

The Southwest Alluvium system was temporarily shut off in January 2001 to allow implementation of the Natural Attenuation (NA) test, which was discussed and approved during the November 14 and 15, 2000, meeting in Santa Fe, New Mexico, and documented in the November 15, 2000, letter from the EPA. As requested by the EPA (2004a; and during meetings in Santa Fe on February 26, 2004, and at Church Rock on May 5, 2005), UNC continues to acquire groundwater quality data from wells in the Southwest Alluvium to monitor the effectiveness of natural attenuation and compare its performance to that of previous remedial efforts.

This annual evaluation of the Site corrective action has resulted in the following conclusions and recommendations.

Conclusions

- *There are no exceedances of hazardous constituents outside the UNC property within seepage-impacted groundwater – this is the case for all three hydrostratigraphic units.*
- *UNC is in full compliance with the NRC groundwater protection standards in the Southwest Alluvium.*
- Hydraulic containment is not a necessary feature of the corrective action program in the Southwest Alluvium because of the geochemical attenuation that occurs naturally.
- Evaluation and prediction of constituent concentrations in the Southwest Alluvium is predicated on understanding the geochemical evolution of both the background water quality and later changes associated with passage of the seepage-impact front. Hazardous constituents derived from seepage impact are effectively attenuated to acceptable concentrations within the Site boundary.
- Sulfate, total dissolved solids (TDS), and manganese are non-hazardous constituents that exceed standards outside the Site boundary in both seepage-impacted and background wells. Sulfate (the primary component of TDS) tends to temporarily fall below the standard in the migrating reaction zone associated with the front and northwestern flank of the migrating seepage-impacted groundwater in the Southwest Alluvium. Ahead of this migrating front, background concentrations for sulfate and TDS tend to exceed the standards but this water quality is unrelated to seepage impact and application of the Site standards is inappropriate. Behind this

migrating front, impacted groundwater quality offsite will tend to have sulfate and TDS levels approximately equal to, or lower than, those in the background water. Ahead of the current seepage-impact front, downgradient background well SBL 1 has shown very high sulfate and TDS and minor exceedances of manganese, cobalt, and nickel that are not due to seepage impact.

- Concentrations of uranium in the Southwest Alluvium are an indicator that natural attenuation is at least as effective a remedy as pumping. The uranium concentrations and concentration-time trends have either stabilized (e.g., Wells GW 1, GW 2, and GW 3) or shown decreasing trends (e.g., Well 802) since the pumps were turned off. The range of uranium concentrations in the background water has been empirically shown to be the same as the range within impacted water (GE, 2006). Uranium and bicarbonate concentrations are covariant within all the wells, i.e., when the concentration of the bicarbonate parameter changes uranium changes with it. This observation has held for both the 11 years of active pumping and the 6 years of post-pumping monitoring. This means that uranium concentrations in the Southwest Alluvium are not directly related to the migration of uranium in tailings fluids. In fact, tailings solutions are far more depleted in uranium than are natural background solutions. This is an important consideration for the Site-Wide Supplemental Feasibility Study (SWSFS, in preparation by UNC) because it means the following: (1) uranium in tailings-impacted water is not degrading the water quality, and (2) there is no further improvement in alluvial water quality that can be made with respect to uranium concentrations.

- *Both the Southwest Alluvium and Zone 1 natural systems are at least as effective as the former active remediation systems in attenuating the seepage-impacted water.* Acidic seepage is being neutralized, resulting in attenuation of metals and radionuclides. Natural geochemical conditions related to gypsum equilibrium and bicarbonate availability will control sulfate and manganese concentrations in both hydrostratigraphic units, regardless of whether or not the extraction wells are operated.

- Starting in approximately January 2006, the new pumping-well configuration in Zone 3 (initiated in 2005 during the hydrofracture program) has caused the following three beneficial effects: (1) interception of northward-advancing impacted water (i.e., partial or possibly complete hydrodynamic control); (2) marked groundwater quality improvement (of water evading capture) and recession of the northern seepage-impact front to the south; and (3) dewatering. The pumping well array has been supplemented by the addition of a new extraction well in September 2007. The groundwater quality improvement is expected to be temporary. Pumping rates have

begun to decline and this is expected to continue because this has been the case for all other pumping wells in the past. .

- Based on the monthly bicarbonate concentration data in the northern Zone 3 tracking wells through October 2007, the location of the full seepage-impact front has remained unchanged during the last year and is near Well PB 2. The reconfigured pumping appears to have contained, or nearly contained, the overall area affected by seepage impacts.
- The in-situ alkalinity stabilization pilot study was terminated in 2007 because of unexpectedly low injection and extraction well flow rates. This was interpreted to have been caused by clogging of pores by clay created from the interaction of acidic tailings seepage with feldspar minerals. Based on these results, the use of alkalinity rich solutions to remediate the Zone 3 impacted groundwater in-situ is not feasible.
- Outside the UNC property boundary in Zone 1, the post-pumping groundwater quality continues to improve overall (Tables 16 and 17). The exceedances of sulfate and TDS in Wells EPA 5 and EPA 7 reflect geochemical equilibrium of the groundwater with gypsum; these constituents are non-hazardous.
- In Zone 1, the continuing improvement in offsite water quality, combined with the stability of onsite concentrations, leads to the conclusion that the Zone 1 groundwater corrective action program has achieved success. However, closure will depend on meeting the groundwater protection standards, which will require that ACLs be established for point-of-compliance Wells 604 (aluminum, manganese, and nickel) and 614 (total trihalomethanes (TTHMs; this group of compounds includes chloroform) and chloride).

Recommendations

Southwest Alluvium

Predicted performance of the Southwest Alluvium natural attenuation system is summarized on Table 6. The continuing assessment of natural attenuation in this annual report is the basis for the following recommendations for the Southwest Alluvium corrective action system:

1. Decommission the pumping wells. Attenuation via natural geochemical processes has been shown to be at least as effective as pumping. Implement a No Further Action remedial alternative.

2. Continue to perform monitoring on an annual basis because the seepage-impacted water quality is largely stable, the offsite impacted water quality is not hazardous, and a yearly frequency is sufficient for tracking the migration of the seepage-impact front (estimated to be moving southwestward toward Well SBL 1 at an average rate of 34 ft per year).
3. EPA should consider adopting the recently revised NRC standards (NRC, 2006b) for chloroform (revised to a TTHMs site-wide standard of 80 ug/L) and combined radium (revised to 5.2 pCi/L standard for the Southwest Alluvium). EPA should also consider (a) revising their current ROD uranium standard of 5 mg/L and adopting the NRC site-wide standard of 0.3 mg/L (based on the review of dissolved uranium occurrences in the Southwest Alluvium presented by UNC (GE, 2006)), and (b) adopting the NRC (1996) standard for nitrate (throughout all three Site hydrostratigraphic units). Sulfate, TDS and manganese should be waived as constituents of concern based on NRC's (1996) background water quality analysis report and multiple reports by UNC (all of which are summarized in the SWSFS Part I; N.A. Water Systems, 2007b).
4. The Southwest Alluvium is in full compliance with the NRC groundwater protection standards. The EPA must consider granting a TI Waiver for sulfate and TDS; there are no known groundwater analyses anywhere in the Southwest Alluvium, seepage-impacted or not, that meet the New Mexico Standards for sulfate and TDS. In lieu of eliminating sulfate and TDS concentrations as applicable or relevant and appropriate requirements (ARARs), a TI Waiver for sulfate and TDS could best be applied in a non-traditional sense in that there would not be a classic TI zone. Instead, UNC proposes that the projected 200-year seepage front (as extrapolated during 2004) be used, which we understand to be compatible with NRC guidance. Background water quality has shown modest exceedances of manganese, cobalt, and nickel; it is appropriate that the EPA consider revising the Record of Decision to recognize the historic background water quality for these constituents in the Southwest Alluvium.
5. As first put forth by the NRC (1996), and further developed in several geochemistry (Earth Tech, 2000d and 2002c) and annual reports (Earth Tech, 2002d; N.A. Water Systems, 2004, 2005b), there is quite simply no method to achieve the standards for sulfate, TDS and manganese -- short of dewatering the alluvium. The last drop of water left in the alluvium would exceed the standards for these parameters. *UNC once again requests approval of a TI Waiver for sulfate and TDS in the year 2204 extrapolated, downgradient impact zone shown in Figure 59.* The ongoing development of a SWSFS will formally evaluate and prioritize the most appropriate remedial course of action.

Zone 3

Continue Zone 3 remediation using the natural system to stabilize the seepage impacts, in conjunction with the current pumping system that (1) provides capture of most if not all of the downgradient migration of seepage-impacted water, (2) maintains the marked improvement in groundwater quality that occurred during 2006 within the water near the northern seepage-impact front, and (3) dewaters and removes constituent mass.

Declining yields from the current extraction-well array indicate that such hydraulic control is temporary. This has always been the case for pumping in Zone 3. Zone 3 saturated thicknesses are quite low, and any future pumping to reduce the pressure head will obtain only limited short-term results. Because the bedrock slope drives groundwater flow to the north, there is an irreducible elevation head that cannot be decreased by pumping. Counteracting this force is clogging of the bedrock pore spaces by the seepage-induced chemical alteration of feldspar to clay. This clogging reduces the bedrock permeability, which retards the migration of the seepage. Eventually, there will be a balance developed between the irreducible elevation head and the trapping of the seepage-impacted groundwater due to the diminished bedrock permeability. Although the timing and location of such a balance cannot be predicted, such a development is likely. UNC recommends that consideration be given to other regulatory tools to manage the inherent physical limitations to the Zone 3 bedrock-groundwater system. As with Zone 1 and the Southwest Alluvium, the tools might include: ACLs, TI Waivers, monitored natural attenuation, and institutional controls.

EPA should consider revision of the ROD background concentrations for the following metals in Zone 3: arsenic, molybdenum, nickel, cobalt and manganese. Uranium should also be addressed unless EPA adopts the NRC standard for uranium.

Sulfate, TDS and manganese should be waived as constituents of concern based on NRC's (1966) background water quality analysis report.
1966

Zone 1

Predicted performance of the Zone 1 natural attenuation system is summarized on Table 17. Implement the following recommendations toward closure of the Zone 1 corrective action system:

1. EPA should consider adopting the current NRC Site-wide groundwater protection standard of 80 ug/L for TTHMs. This value is the current MCL.

2. EPA should consider adopting the current NRC standard of 9.4 pCi/L for combined radium in Zone 1. This value is based on background water quality statistical analysis.

3. The Zone 1 seepage-impacted area has attained as-low-as-reasonably-achievable (ALARA) goals. To complete the corrective action program for Zone 1 UNC should submit ACL applications for TTHMs (Well 614), aluminum (Well 604), manganese (Well 604), nickel (Well 604), and chloride (Well 614). With the vast amount of spatial and temporal monitoring data in Zone 1, it is a straightforward exercise to empirically demonstrate that chloroform (the only detected TTHM compound) attenuates to below the proposed standard everywhere off of UNC property. The other cited constituents are (a) associated with wells inside the UNC property that have monitoring histories indicating longstanding ALARA concentrations, and (b) non-hazardous constituents in the context of the federal Safe Drinking Water Act.

4. As first put forth by the NRC (1996), and further developed in several geochemistry (Earth Tech, 2000c) and annual reports (Earth Tech, 2000e; N.A. Water Systems, 2004, 2005b), there is no method to achieve the standards for sulfate and TDS, and Zone 1 has already been dewatered to the extent that is feasible (all pumping wells were decommissioned in 1999 because their yields were less than the decommissioning limit). It is not appropriate to tie remediation progress to sulfate or TDS concentrations. Even the last drop of water left in Sections 1 and 2 of Zone 1 would exceed the standards for these parameters. Remedial alternatives to be presented in the pending SWSFS should be closely coordinated with the necessary TI Waiver(s), ACL applications, and other potentially appropriate changes in Site remediation standards.

5. In lieu of no. 4, approve a TI Waiver for sulfate and TDS in the TI zone shown on Figure 59.

Please contact Mr. Roy Blickwedel (General Electric Corporation) at (610) 992-7935 if you have any questions or need additional information.

Sincerely,

Mark Jancin, P.G.
Project Manager

MDJ: 56007343

Enclosures (2 copies for each addressee)

cc with enclosure: Paul Michalak, Nuclear Regulatory Commission
David Mayerson, New Mexico Environment Department
Diana Malone, Navajo Nation Superfund
Larry Bush, United Nuclear Corporation
Roy Blickwedel, General Electric Corporation