

Excerpt from Dr. Richard Abitz's Written
Testimony to NRC (Jan. 8, 1999)

Water quality in the non-ore zones of the Westwater Canyon Member at Church Rock (Sections 8 and 17) and Crownpoint is very good to excellent with respect to all primary and secondary drinking water standards (Table 1), whereas groundwater within the ore zones at Church Rock exceeds the radium-226 and uranium standards. Also, restoration values for the Teton Pilot in situ test, which was conducted 2 miles west of Church Rock, are shown for comparison. Only a very small volume of rock was disturbed at the Teton site, yet the restoration was unsuccessful for selenium, radium, and uranium. This important point is revisited in Question 9. With regard to the radium and uranium standards in Table 1, the EPA drinking water standard for radium-226 plus radium-228 is 5 pCi/L, while the EPA promulgated 1995 UMTRA groundwater standard for uranium-234 plus uranium-238 is 30 pCi/L (which is normally equivalent to 0.044 mg/L total uranium). 40 C.F.R. Part 192, Subpart A, Table 1; 60 Fed.Reg. 2854-2867 (January 11, 1995). In 1991, EPA proposed a drinking water standard for uranium of 0.020 mg/L, 56 Fed.Reg. 33126 (July 18, 1991), and this proposed standard is adopted as the drinking water standard for the aquifer below the Fernald Superfund Site. As can be seen in Table 1, monitored water quality parameters have concentrations well below primary and secondary drinking water standards for all constituents, except radium-226 and uranium values in the Church Rock ore zone. The elevated levels of radium and uranium at the Church Rock site are very likely to be related to previous upgradient underground mining activities at this site, as elevated levels for radium and uranium are not observed in the Crownpoint ore zone. The drinking water quality of groundwater in the Westwater Canyon Member at Church Rock and Crownpoint is discussed in more detail below.

TABLE 1

Parameter	MCL ^a (mg/L)	Church Rock (mg/L)		Crownpoint (mg/L)		Teton Pilot (mg/L)
Primary Standards		non-ore zone	ore zone	non-ore zone	ore zone	restoration values
Arsenic	0.05	0.001	0.002	0.001	0.001	0.032
Barium	2	0.08	0.06	0.04	0.06	0.07
Cadmium	0.005	0.0001	0.0002	0.0001	0.0001	<0.01
Chromium	0.1	0.01	0.01	0.01	0.01	<0.05
Fluoride	4	0.39	0.30	0.24	0.33	0.30
Mercury	0.002	0.0001	0.0001	0.0001	0.0001	<0.001
Nitrate (as N)	10	0.01	0.02	0.02	0.04 ^j	1.34
Selenium	0.05	0.001	0.001	0.001	0.001	0.72
²²⁶ Radium	5 ^b (pCi/L)	0.3 (pCi/L)	8.6 ^d (pCi/L)	0.5 (pCi/L)	0.7 ^k (pCi/L)	8.5 (pCi/L)
Uranium	0.044 ^c	0.002 ^e	0.303 ^f	0.001	0.006	2.7
Secondary Standards						
Chloride	250	6.1	6.0 ^g	3.5	3.2 ^l	6.0
Iron	0.3	0.03	0.04	0.04	0.05	0.67
Manganese	0.05	0.01	0.01	0.01	0.01	<0.05
Silver	0.1	0.01	0.01	0.01	0.01	not reported
Sulfate	250	24	37 ^h	35	37	37
TDS	500	364	364 ⁱ	314	326	426

^a Maximum Contaminant Level

^b MCL is for $^{226}\text{Ra} + ^{228}\text{Ra}$.

^c EPA promulgated UMTRA standard for uranium is 30 pCi/L, which is equivalent to 0.044 mg/L when assuming a natural distribution of uranium isotopes.

^d Outlier¹ values of 24 and 26 removed.

^e Outlier value of 0.494 removed.

^f Outlier values of 6.28, 6.66, 10.0, and 10.4 removed.

^g Outlier values of 10 and 12 removed.

^h Outlier value of 71 removed.

ⁱ Outlier values of 435 and 451 removed.

^j Outlier value of 0.26 removed.

^k Outlier value of 1.8 removed.

^l Outlier value of 15 removed.

Church Rock Water Quality

In the Section 8 ore zone at the Church Rock site, HRI reported quarterly water quality data from December 1987 through March 1989 for wells CR-3, CR-4 (plugged after July 1988), CR-5, CR-6, CR-7, and CR-8. Church Rock Project Revised Environmental Report, March 1993. The analytical data indicate that drinking water quality in the Westwater Canyon Member at Church Rock is very good (Table 1), with the exception of radium-226 and uranium values in areas of mineralization. The average uranium and radium-226 values in groundwater samples from six wells in Sections 8 and 17 of the Church Rock site are summarized in Table 2. Note that only a small fraction of the Westwater Canyon Member contains uranium mineralization, yet all of the wells except CR-7 were placed in mineralized sand channels of the Westwater Canyon Member.

¹ Outliers are single nonrepeating values for a well that lie outside 95 percent of the population (i.e., outside the range of \pm two standard deviations).

TABLE 2

	CR-3	CR-4	CR-5	CR-6	CR-7	CR-8
Uranium (mg/L)	0.060 ^a	0.035	0.013 ^b	0.474	0.002 ^c	6.63
Radium-226 (pCi/L)	15.2	3.9	5.3 ^b	5.9	0.3	13.1

^a Outlier value of 0.104 removed.

^b Outlier value of 0.068 removed.

^c Outlier value of 0.494 removed.

Well CR-7 is separated from the mineralized sand channels in this area by a clay bed, and the well is completed in the lowest sand of the Westwater Canyon Member. Therefore, wells CR-3, CR-4, CR-5, CR-6, and CR-8 reflect variability in the uranium and radium-226 values in ore zones, while CR-7 reflects uranium and radium-226 water quality in non-ore zones. These combination of wells were used to calculate the non-ore and ore zone compositions shown in Table 1. As only a small fraction of the Westwater Canyon Member contains uranium mineralization, the largest volume of groundwater in this area is of the very good quality exhibited by uranium and radium-226 water analyses for well CR-7. The differences between uranium and radium-226 values in groundwater from non-ore zones and the ore zone are clear (Tables 1 and 2). Accordingly, HRI should establish baseline water quality in the Church Rock area for non-ore and ore zones as indicated in Table 1. It is important to note that some of the wells within the mineralized zones (CR-4 and CR-5) also meet the EPA promulgated UMTRA groundwater standard of 30 pCi/L for uranium-234 plus uranium-238 (which is the equivalent of 0.044 mg/L total uranium) and 5 pCi/L for radium-226 plus radium-228, when individual wells within the ore zone are treated as separate populations (Table 2), rather than combining all ore zone wells into one population (Table 1). That is, undisturbed groundwater in the mineralized zones is not necessarily unfit for human consumption. The elevated levels of uranium and radium-226 in groundwater from well CR-8 in Section 17 likely reflect previous underground mining operations carried out at the Church Rock mine in Section 17, which is directly south of and hydrologically upgradient from CR-8.

Crownpoint Water Quality

Groundwater quality in the Westwater Canyon Member was summarized in HRI's Crownpoint Project In Situ Mining Technical Report (June 1992). Major-ion chemistry of the water is similar to the Church Rock site (Table 1), that is the groundwater is dominantly a sodium/bicarbonate water of very good quality for human consumption. Most of the sampled wells at Crownpoint contain groundwater that meets all EPA primary and secondary drinking water standards. One well, CP-2, samples groundwater that does not meet the drinking water standards for total dissolved solids (TDS), chloride, and radium (Table 3), and this may be attributed to improper completion and development of the well, or the use of the well for unknown testing purposes.

TABLE 3

	CP-1	CP-2	CP-3	CP-4	CP-5	CP-6	CP-7	CP-8
TDS	380	2888	581	371	300	314	337	322
Chloride	15	1325	42	6.0	2.5	3.5	3.0	3.5
Uranium (mg/L)	0.006	0.014	0.004	0.001	0.012	0.001	0.001	0.004
Radium-226 (pCi/L)	0.9	391	1.8	0.8	1.0	0.5	0.4	0.8

Groundwater quality for CP-2 is poor, and the major-ion chemistry is uncharacteristic of the Westwater Canyon Member. Elevated levels of calcium (120 mg/L), magnesium (12 mg/L), potassium (847 mg/L), sulfate (70 mg/L), chloride (1325 mg/L), and radium-226 (391 pCi/L) distinguish this groundwater composition from indigenous water of the Westwater Canyon Member (calcium < 5 mg/L, magnesium < 2 mg/L, potassium < 10 mg/L, and Table 1). In my professional opinion, this indicates some anthropogenic source for the solute or slotting of the casing in a zone of poor water quality below or above the Westwater Canyon Member. HRI completion records do not indicate slotted casing outside of the Westwater Canyon Member, which suggests that solute was introduced into this well for some test purpose, or that drilling brine and mud were not successfully removed during development of the well. If the well was not successfully developed, remnants of solute from a chloride brine and elevated radium-226 activity, possibly from a barium-enriched mud used during drilling, would remain and contaminate groundwater samples removed from the well. The composition is not indigenous of the Westwater Canyon Member, and HRI should have omitted samples from well CP-2 when baseline water quality was established.

A second well, CP-3, does not meet the drinking water standard for TDS (Table 3). Relative to indigenous groundwater in the Westwater Canyon Member (potassium < 10 mg/L and Table 1), well CP-3 contains elevated levels of potassium (42 mg/L), sulfate (140 mg/L), and chloride (42 mg/L), causing the TDS of this water to exceed EPA drinking water standards. CP-3 is proximal to CP-2, and the elevated chloride and potassium values indicate that the poor CP-2 groundwater chemistry is affecting CP-3 groundwater quality. This is likely to be the result of dissolved constituents at CP-2 being pulled into the field of CP-3 during the HRI pump test at CP-5 (see HRI's Crownpoint Project In Situ Mining Technical Report, June 12, 1992). Elevated levels of sulfate in CP-3, relative to CP-2, may indicate introduction of a sulfate-rich water, possibly from the overlying Dakota Formation. HRI also failed to omit groundwater samples from well CP-3 when they established baseline conditions in the Westwater Canyon Member.

Well completion records for CP-1 through CP-8 show all wells to be slotted over multiple intervals in the Westwater Canyon Member, rather than at a specific ore-zone horizon. This may account for the lower uranium and radium-226 values relative to wells at Church Rock (Table 1). All groundwater samples from the ore and non-ore zones at Crownpoint meet EPA drinking water standards (Table 1), and are well below the EPA promulgated UMTRA standards of 30 pCi/L for uranium-234 plus uranium-238 (normally 0.044 mg/L total uranium) and 5 pCi/L for radium-226 plus radium-228. Based on HRI's Crownpoint Project In Situ Mining Technical Report (June 12, 1992), ore-zone baseline in the Westwater Canyon Member near Crownpoint should be determined from wells CP-1, CP-4, CP-5, CP-7, and CP-8, and non-ore zone groundwater is represented by CP-6. These wells were grouped as described above to produce the Crownpoint non-ore and ore zone summary in Table 1. It was also noted above that HRI's use of CP-2 and CP-3 to establish baseline water quality is inappropriate, due to the presence of nonindigenous fluids in these wells. Therefore, these analyses have been omitted from the statistical averages presented in Table 1.

