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Mail Stop: K497
Telephone: (505) 667-0313

Mr. Hank L. Daneman
P.O. Box 31056
Santa Fe, NM 87594

SUBJECT: GROUNDWATER STRONTIUM-90 MONITORING AT LOS ALAMOS

Dear Mr. Daneman:

I am responding to issues raised in your December 20, 2000 email to Dr. John Browne, Laboratory Director, replying to my December 11, 2000 letter to you on strontium-90 monitoring in the regional aquifer at Los Alamos National Laboratory. I am also responding to your January 27, 2001 letter to Dr. Brown, as you raise some of the same issues in that letter. I am a hydrologist and a member of the Laboratory's Water Quality and Hydrology Group. I am responsible for groundwater monitoring conducted under the Laboratory's Environmental Surveillance Program.

Before responding specifically to your correspondence, I want to reiterate comments from my earlier letter that the Laboratory is committed to maintaining and improving our groundwater monitoring capability and to increasing our understanding of possible impacts of the Laboratory on groundwater quality. We take all indications of groundwater impacts very seriously and want to take all reasonable actions to prevent and/or minimize such impacts.

Contamination of the Los Alamos regional aquifer by strontium-90 would be of significant concern to our community. Staffs from the Laboratory, the Department of Energy, Los Alamos County, and the New Mexico Environment Department work together to assure that the best possible methods are used to monitor groundwater quality at Los Alamos. While strontium-90 contamination is present at the Laboratory in the shallow alluvial groundwater of Los Alamos Canyon and Mortandad Canyon, our monitoring data do not provide evidence that this contamination has affected the underlying regional aquifer. These water bodies are separated in depth by hundreds of feet of unsaturated rock. The Laboratory acknowledges that there is a complex hydrologic connection between the alluvial groundwater and the regional aquifer, and has undertaken an extensive groundwater characterization program to examine whether Laboratory activities present risks to the regional aquifer and determine if remedial actions are required.

It appears that strontium-90 has occasionally been detected in individual samples taken from regional aquifer water supply or test wells beneath areas of past and present liquid effluent discharges. But since these measurements are not repeatable, these apparent detections are far more likely due to analytical outliers (that is, false positives) than to the presence of strontium-90 in groundwater.

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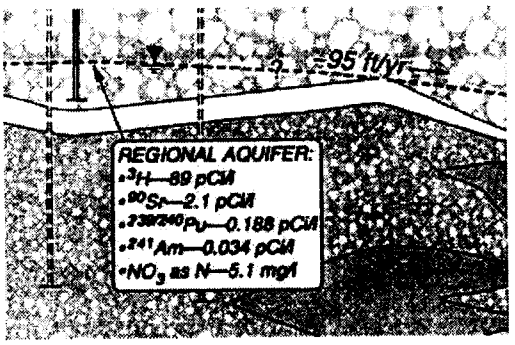
Important factors regarding strontium-90 monitoring are using detection limits substantially below the EPA drinking water maximum contaminant level (MCL) and drawing conclusions based on a large body of data rather than from an individual sample. By observing data trends over time and location, we eliminate false positives potentially associated with any errors arising from chemical analysis or sampling. At values near the detection limit, it is technically difficult to determine whether or not an analyte has been detected in an individual sample. Therefore, it is important to establish an analytical detection limit at a value substantially below any regulatory or health-related limits and to base conclusions of whether or not an analyte is present on a large number of samples collected over a period of time.

As noted above, past monitoring for strontium-90 in the regional aquifer has resulted in apparent positive results for some samples. However, long-term sampling results, including repeat samples at the same locations, split sample results analyzed by different laboratories, and analysis using the most sensitive detection limits available have not verified these apparent positive results. So that we can continue to monitor for strontium-90 in the regional aquifer at detection limits well below the MCL, we have adopted more costly analytical techniques. Beginning in 2000, for water supply wells and other regional aquifer samples, Los Alamos has been utilizing independent external analytical laboratories, which provide detection limits for strontium-90 of 0.2 pCi/L to 0.5 pCi/L, or 2.5% to 6.25% of the 8 pCi/L EPA drinking water MCL.

Below, I have addressed specific questions and comments from your correspondence. Your comments are shown in italics and quotation marks, followed by my response.

"EVIDENCE: Attached is Figure 4-23 of December 6, 1996 taken from the draft Hydrogeological Workplan showing "Schematic cross section showing conceptual model and proposed regional aquifer wells for Mortandad Canyon". This drawing was distributed at an early meeting of the group which became the Water Quality Task Force. Dr. Rogers affirms it is available in the final version of the Hydrogeological Workplan. A section is reproduced below:



This figure identified the concentration of 2.1 pCi/L of Strontium 90 in the regional aquifer (as well as other COC's such as Plutonium). This value happens to coincide with the 1999 measurement in PM-1. Table 5-22 of this Workplan shows a value of 2.7 pCi/L on 8/13/96 for the "New Community Well". (The one sigma uncertainty is given as 0.6.) In view of the DCG limit of 8, it is admitted that this level is hazardous. Other charts, such as Figure 3-20 of November 1995, show much higher concentrations (perhaps 60 pCi/L) in alluvial groundwater under Los Alamos Canyon from 1990 to 1992."

The individual measurements of 2.1 and 2.7 pCi/L strontium-90 at the referenced locations are below the analytical detection limits. Also, while it is a moot point given the absence of any reliable detection, it is incorrect to characterize values below a level of 8 pCi/L as "hazardous." Rather, the EPA derived 8 pCi/L is a regulatory threshold (MCL) for drinking water. As such, the MCL is based upon conservative assumptions and water is presumed to be safe below this level, even if it is the sole source of drinking water. Additionally, as discussed in more detail below, there is current scientific discussion within the EPA over whether the value should be raised to 42 pCi/L to be consistent with the protective basis of other drinking water standards.

The figure above is Figure 4-31 in LANL's final Hydrogeologic Workplan, dated May 22, 1998. The figure appears to indicate that strontium-90 is present in the regional aquifer beneath Mortandad Canyon at a level of 2.1 pCi/L. The value of 2.1±0.7 pCi/L for Test Well 8 comes from Table 7-1 in the report "Environmental Surveillance at Los Alamos during 1994". The method detection limit for this analysis was given as 1 pCi/L in the report. However, the strontium-90 detection limit for many years preceding and following 1994 was 3 pCi/L. The Chemistry Division group that provided that information has been unable to verify the 1 pCi/L value for 1994, so I believe that the correct detection limit was 3 pCi/L. The value of 2.7±0.6 pCi/L for the New Community Well in 1996 is also from an analysis with a method detection limit of 3 pCi/L, putting the measurement below the detection limit.

Your email draws a connection between these strontium-90 observations in Test Well 8 and New Community Well and the apparent 1999 detection of strontium-90 in PM-1 by the NMED DOE Oversight Bureau. As I addressed in my December 11, 2000 letter to you, many other measurements from that well have not substantiated the apparent PM-1 detection. Therefore, a conclusion that strontium-90 is present throughout the regional aquifer at a level of 2 to 3 pCi/L is not supported when the facts regarding the monitoring data are considered.

A value of 8 pCi/L is not the DOE Derived Concentration Guide (DCG), but instead is the drinking water standard as governed by EPA regulations contained in 40 CFR 141. The DOE standard for strontium-90 in a DOE-administered drinking water system (which does not apply to Los Alamos) is 40 pCi/L. In both cases, but using different assumptions, these standards are derived from calculating the level that would result in a 4 millirem annual dose if the water were the sole source of drinking water for an entire year. The EPA has proposed (1991, 2000a) a revised value of 42 pCi/L as a MCL for strontium-90 activity that would make it consistent with the DOE DCG. This proposal for a higher strontium-90 standard resulted from new data on the health effects of radiation, and a better understanding of the risks posed to human health by radionuclides. However, at this time, the EPA (2000b) has maintained the 8 pCi/L MCL pending further review.

"There seems little doubt that the only way this man-made chemical gets into the regional aquifer is via drainage from LANL release sites."

Once again, when all of the data are reviewed, instead of looking only at isolated sample results, our monitoring data do not provide evidence that strontium-90 contamination has affected the regional aquifer. In order to further clarify this conclusion, I would like to briefly discuss the chemistry of strontium-90 as it pertains to transport in the environment. Transport of strontium-90 in groundwater is controlled by adsorption: a large portion of the strontium-90 adheres to the surface of soil or sediment particles, while a much smaller portion is present in solution in any water that is present. Because of this strong adsorption, strontium-90 tends to move slowly through the environment. A portion of the strontium-90 that adsorbs to sediments and soils continually desorbs, resulting in the persistent presence of strontium-90 in surrounding surface and groundwater. For these reasons, much of the legacy strontium-90 released by the Laboratory is still present in surface sediments and adjacent shallow groundwater near the discharge locations. Further, strontium-90 is undergoing radioactive decay to non-radioactive elements with a half-life of about 29 years, thereby gradually disappearing from the environment.

If strontium-90 were present in deeper groundwater, it would be regularly detected because a steady supply is maintained as strontium-90 desorbs from soils to adjacent water. As you note, there are occasions when it appears that strontium-90 has been detected in individual samples taken from regional aquifer water supply or test wells beneath areas of past and present liquid effluent discharges, but it is important to note that these "detections" are only occasional. Since the measurements are not repeatable, these apparent detections are more likely due to analytical outliers (that is, to false positives or errors arising from chemical analysis and sampling) than to the presence of strontium-90 in groundwater.

"In 1991, Stoker suggested "Recharge to the regional aquifer maybe occurring through the canyon bottom". In 1994, Stoker wrote, "Low-level Tritium analysis of samples from a test well in the Mortandad Canyon to the regional aquifer clearly shows the presence of recent recharge."

The movement of small amounts of tritium into the regional aquifer does not provide evidence of similar strontium-90 movement because of differences in their chemical behavior and in their environmental transport. Tritium moves without adsorption, while strontium-90 transport is strongly slowed by adsorption. The presence of very low levels of tritium in deeper groundwater is not an indication that strontium-90 will also be present.

"ANALYSES: The rejection of the full year of 1999 measurements of Strontium 90 (as stated by Dr. Rogers) is an indication that people were not paying attention to the quality of the data being reported for that year. I understand that duplicate samples were shared between outside labs to insure reliable data. It is not clear whether these duplicates showed the same values or not. We are told that additional samples taken a month after the "hit" failed to show reportable traces of Strontium 90. It seems inappropriate to wait one month for check samples as conditions can change. It is also not clear why LANL's own chemical laboratory can not provide duplicate analyses, especially in light of IG report #0461 of 2/22/2000 on "Groundwater Monitoring" criticising the DOE for spending far too much money on outside analyses."

The topic of 1999 data and subsequent sampling results was addressed in my December 11, 2000 letter to you. To reiterate, the Laboratory moved quickly and judiciously when questions arose regarding the strontium-90 analyses.

"Further, Dr. Rogers relies on the rejection criteria of 3 sigma discussed in the above-mentioned letter. This is a mistake. An uncertainty of one sigma is sufficient for chemical analysis where we are trying to distinguish between 2 and 3 pCi/L and not, for example, 2.11 vs. 2.12. I cannot understand rejecting all of 1999 measurements if only for failure to meet 3 sigma uncertainty limits."

Your statement inappropriately mixes the concepts of analytical detection and data validation. The criterion of three sigma is used to determine if an individual result is a statistically valid detection. This is a well-accepted scientific practice and consistent with recommendations in published literature (for example, Keith, 1991). Alternately, data validation is based upon a systematic review of other analytical and monitoring factors such as results of sample blanks and standards, equipment and sampling parameters, and overall method statistical analyses. It is inaccurate to say that the 1999 strontium-90 measurements were rejected because they failed to meet 3 sigma uncertainty limits. The data were rejected because, due to a manufacturer's change in the analytical processing materials, the analytical laboratory procedures produced unreliable results. This was addressed in my December 11, 2000 letter to you.

Please contact me at 667-0313 if I can provide further information or if you have additional questions.

Sincerely,

David B. Rogers, Ph.D.
Hydrologist
Water Quality and Hydrology Group

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References:

EPA 1991: Environmental Protection Agency, "40 CFR Parts 141 and 142; National Primary Drinking Water Regulations; Radionuclides; Proposed Rule," Federal Register, v. 56, no. 138, p. 33050-33127, July 18, 1991.

EPA 2000a: Environmental Protection Agency, "40 CFR Parts 141 and 142; National Primary Drinking Water Regulations; Radionuclides; Notice of Data Availability; Proposed Rule," Federal Register, v. 65, no. 78, p. 21576-21628, April 21, 2000.

EPA 2000b: Environmental Protection Agency, "40 CFR Parts 9, 141, and 142; National Primary Drinking Water Regulations; Radionuclides; Radionuclides; Final Rule," Federal Register, v. 65, no. 236, p. 76708-76753, December 7, 2000.

Keith 1991: Keith, L.H., Environmental Sampling and Analysis: A Practical Guide, Lewis Publishers, Boca Raton, 143 pp., 1991.

Cy: John C. Browne, DLDOPS, MS A100
Richard J. Burick, DLDOPS, MS A100
Joseph Vozella, DOE/LAAO, MS A316
Mat Johansen, DOE/LAAO, MS A316
Dennis J. Erickson, ESH-DO, MS K491
Al Sattelberger, C-DO, MS J515
Jonathan Thompson, CER, A112
Ray Madden, IG-44/DOE, Washington, DC
John Parker, NMED/DOE/OB, Santa Fe, NM
Steve Yanicak, NMED, MS J993
WQ&H File, MS K497
IM-5, MS A150