

September 12, 1994

R. S. Ziegler, Project Manager  
Atlantic Richfield Company  
Bluewater Mill  
P.O. Box 638  
Grants, NM 87020

SUBJECT: RELEASE OF PROPRIETARY MATERIAL

Dear Mr. Ziegler:

This letter is to confirm that your letter of August 2, 1994 did not contain any proprietary information as specified in Title 10 Code of Federal Regulations Section 2.790. On August 25, 1994, Mr. Ken Hooks, the NRC Project Manager for Atlantic Richfield Company's (ARCO) Bluewater Uranium Mill Site, telephoned Mr. Natver Patel and Mr. Kenneth Baker and verified that neither ARCO or Mr. Baker were claiming that the August 2, 1994, letter or its enclosures contained proprietary information. In addition, Mr. Hooks stated that the letter and enclosures would be placed in the NRC's Public Document Room ten (10) days from the date of this letter.

If you have any questions regarding this letter please contact Ken Hooks on (301) 415-7777.

Sincerely,

Joseph J. Holonich, Chief  
High-Level Waste and Uranium  
Recovery Projects Branch  
Division of Waste Management  
Office of Nuclear Material Safety  
and Safeguards

Docket No. 40-8902  
License No. SUA-1470

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46-2902

August 2, 1994

Joseph Holonich, Branch Chief  
 Uranium Recovery Branch  
 Division of Low-Level Waste Management  
 and Decommissioning, NMSS (5 E2)  
 11555 Rockville Pike  
 Rockville, Maryland 20850

Re. **Request for Extension of Reclamation Milestones**  
**Bluewater Uranium Mill Site, Source Material License #SUA-1470**

Dear Mr. Holonich:

Atlantic Richfield Company (ARCO) is reclaiming the Bluewater Uranium Mill Site (Site) under a Reclamation Plan (Plan) approved by the U. S. Nuclear Regulatory Commission (NRC) in 1990 and pursuant to a Source Material License #SUA-1470 (License). The reclamation work is being done to meet reclamation milestones for placement of the radon barrier contained in the License, as amended to conform with the Memorandum of Understanding (MOU) between the Environmental Protection Agency (EPA) and the NRC regarding the National Emission Standard for Hazardous Air Pollutants (NESHAPs) for radon (56 Fed. Reg. 55432, (Oct. 25, 1991)). See also 57 Fed. Reg. 20715 (May 14, 1992). These milestones are as follows:

1. August 31, 1992 - Windblown tailings retrieval and placement on the Main Tailings Pile (MTP).
2. August 31, 1992 - Placement of the interim cover to decrease the potential for tailings dispersal and erosion.
3. December 31, 1993 - Projected completion of groundwater Corrective Action Program (CAP).
4. December 28, 1994 - Placement of the final radon barrier.
5. October 23, 1995 - Placement of erosion protection.

As indicated in the completion reports submitted to your office by ARCO, ARCO has successfully met the deadlines for the first three milestones: windblown tailings retrieval; placement of the interim cover; and completion of the groundwater CAP. ARCO has also

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Atlantic Richfield Company

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expended considerable effort and made reasonable and substantial progress towards placement of final radon barriers on the tailings piles at the Site, completing about 75% of that work and currently limiting radon flux emissions to an average of 6.4 pCi/m<sup>2</sup>-s, which represents only 32% of the 20 pCi/m<sup>2</sup>-s radon flux emission standard. However, due to several circumstances beyond ARCO's control, as described below, ARCO is respectfully requesting an extension of the milestones for placement of the final radon barrier and erosion protection materials.

**Summary of Work To Date:**

Following is a brief review of work completed to date.

ARCO completed decommissioning of the Bluewater Mill in December 1990 under an NRC-approved Decommissioning Plan. The Bluewater Mill Decommissioning Report was submitted to the NRC in March 1991.

The Reclamation Plan was approved by the NRC in August 1990. ARCO started the Phase I Reclamation of the mill tailings in January 1991. The 1991 reclamation activities included reconfiguration of embankment slopes on the MTP. Approximately 1,016,000 cubic yards of fill material and radon barrier material were used to reconfigure the MTP slopes. Evaporation pond residue from four of the seven evaporation ponds was excavated and placed on the MTP as a part of the loading for consolidation of tailings slimes on the MTP. A total of about 1,256,000 cubic yards of the residue was excavated compared to 840,000 cubic yards estimated in the Reclamation Plan. The excavation was conducted 24 hours per day for four months in order to maintain the reclamation schedule. In 1992, reclamation work continued with the drying, compacting, and grading of the evaporation pond residue on the MTP. Approximately 50,000 cubic yards of dry clean soils were used to dry the residue and to assist in meeting the reclamation schedule.

In March 1992, cleanup of windblown tailings contaminated soils began. The windblown tailings contaminated soils were excavated and placed on top of the compacted evaporation pond residue on the MTP to complete loading of the slimes for consolidation. A total of 623,000 cubic yards of windblown tailings contaminated soils from about 400 acres was excavated, compared to a volume of 400,000 cubic yards estimated in the Reclamation Plan. The windblown tailings cleanup was completed by July 31, 1992 and the Windblown Contamination Cleanup Report was submitted to the NRC in October 1992.

The evaporation pond residue and off-pile windblown tailings contaminated soil that was

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placed on the MTP averaged 15 feet in thickness over 155 acres compared to the initial estimate of 10 feet thick over 141 acres. This acts as both a loading layer as well as an interim cover, since the material has low Ra-226 concentration levels. This layer provides significantly greater radiological protection of human health and the environment than the initial Reclamation Plan requirements.

ARCO then completed implementation of the revised groundwater CAP and subsequently submitted an application for the groundwater Alternate Concentration Limits (ACL) in June 1990. The ACL application contained wick drains as a supplemental groundwater CAP for the Site. In early 1993, ARCO installed about 27,000 wick drains on the slimes area of the MTP in accordance with the supplemental groundwater CAP. The wick drains expedited consolidation of the slimes, culminating in NRC's concurrence that 90 percent consolidation had been achieved. The Settlement Analysis Report and the Groundwater CAP Review Report were submitted to the NRC in October 1993 and December 1993, respectively.

ARCO started Phase II reclamation activities in November 1992. During Phase II, placement of the permanent radon barrier on the Carbonate Tailings Pile (CTP) was completed. Grading and placement of the final radon barrier on 102 acres of the MTP was completed. Phase II work also included placement of 12 inches of engineered fill and eight inches of top soil on the 70-acre stockpile area, excavation of 290,000 cubic yards of tailings contaminated soils from the rock outcrop areas, and excavation of 35,000 cubic yards of residue and contaminated soils from two evaporation ponds and placement of this excavated material on the MTP.

In summary, ARCO has moved about 5.7 million cubic yards of material to date, including placement of about 1.3 million cubic yards of radon barrier material on the MTP and CTP, which constitutes about 75% placement of the final radon barrier.

The final phase of reclamation work, Phase III, will begin in August 1994 and will be conducted to conform to the Reclamation Plan as revised recently by the NRC. The new proposed milestones for placement of radon barrier and erosion protection on the tailings piles will be met. The Phase III reclamation activities will include: (1) excavation of the residue from the remaining evaporation pond and placement of that material on the Acid Tailings Pile (ATP); (2) excavation of material from an abandoned natural gas pipeline right-of-way and other miscellaneous areas and placement of these materials on the ATP; (3) grading and placing final radon barrier on the ATP; (4) grading the MTP surface and completing the placement of the final radon barrier on the MTP; and (5) placing erosion protection on all radon barriers.

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Originally, ARCO planned to start the Phase III work in March 1994 in order to meet the December 28, 1994 final radon barrier placement deadline. This would have required ARCO to issue Invitations To Bid (ITB) by January 1994 and to award a contract by February 1994. ARCO did issue the ITB on January 28, 1994. However, the NRC technical staff raised several issues on February 15, 1994, prior to ARCO's receipt of the Phase III bids regarding the Reclamation Plan, and it became obvious that the resolution of the issues would result in modifications to the Reclamation Plan and could significantly alter the scope of work set forth in the ITB. Therefore, on March 11, 1994, ARCO withdrew the ITB pending resolution and NRC approval of the issues prior to proceeding with further reclamation work.

**Factors Beyond ARCO's Control:**

Several major issues arose during the planning stages of the Phase III reclamation. These issues are briefly described below.

Radon cover design for the MTP: In the Reclamation Plan, the radon cover thickness on the slimes tailings area and part of the mixed tailings area on top of the MTP was designed based on the average 10-foot thick loading layer consisting of embankment slope material, evaporation pond residue, and windblown tailings contaminated soil. The loading layer material is of a much lower radionuclide activity than the slimes and mixed tailings area. As discussed above, an excessive quantity of these loading layer materials, substantially greater than anticipated, was encountered which resulted in an increase in the loading layer thickness from the 10-foot estimated in the original Reclamation Plan to 15 feet. This changed the source term significantly requiring a redesign of the radon barrier. Consistent with fulfilling Condition 36A of the Amendment No. 21 of the License, ARCO reassessed the source term and redesigned the final radon cover for the MTP accordingly. This design was submitted to the NRC on December 13, 1993 prior to issuing the ITB. In the interest of expediting the approval, ARCO staff initiated informal contacts with the NRC regarding the approval of the final radon barrier design. On February 16, 1994 ARCO was advised that this technical review would be performed by NRC Headquarters staff. Telephone discussions were initiated at that time and technical modifications made to address NRC's concerns. These submittals culminated in approval of the radon cover design in the form of Amendment No. 22 to the License issued on May 27, 1994. As approved, NRC's construction specification of radon barrier may limit radon barrier work from November through February due to extended periods of below freezing temperatures.

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Erosion Protection: The Reclamation Plan includes the use of a soil-rock matrix design for erosion protection on the top surfaces of the MTP and the CTP. For placement of the soil rock matrix, ARCO had proposed mixing the soil and rock prior to placement. Premixing was considered the most feasible method of placement using the gradation sizes approved in the Reclamation Plan. In February 1994, NRC headquarters expressed concerns about this placement method and questioned the long-term stability of the soil-rock matrix. As a result of the NRC's concerns, ARCO reevaluated the erosion protection requirements for the impoundment surfaces and submitted a revised rock erosion protection design to the NRC in April 1994. On July 20, 1994, the NRC approved the revised design.

Modification of Surfaces: In December 1993, ARCO requested from the NRC an amendment to the Reclamation Plan for adjustments to the top surface design of the CTP and the northeast slope and south bench of the MTP. The CTP surface was reshaped to reduce potential runoff and more effectively control erosion. As part of the Reclamation Plan design for the MTP, the northeast embankment was modified so as not to impact an adjacent natural gas pipeline right-of-way. Since then, however, El Paso Natural Gas Company, which owns and operates the natural gas pipeline, has relocated its pipeline some distance north of the MTP embankment, and has abandoned its former right-of-way near the northeast MTP embankment. Consequently, modification of the embankment off the right-of-way is no longer required, and the MTP surface configuration was changed accordingly and was included in the December 1993 amendment request. It is ARCO's understanding that during the transition from the Denver Uranium Recovery Field Office (URFO) to the NRC headquarters in Washington, D.C., this particular amendment request was misplaced for some time, which delayed NRC's review of it. ARCO received approval of the northeast slope portion of this amendment request on July 20, 1994.

Windblown Cleanup in Rock Outcrop Areas: During cleanup of the windblown tailings contaminated area, it was discovered that it was not practical to excavate a portion of the area where bedrock was near the surface. In January 1994, ARCO submitted a request to the NRC for an exemption from the cleanup criteria for those areas within the windblown tailings contaminated area. The request addressed the efforts expended by ARCO to clean up these areas to the maximum extent practical, the radiological dose and risk assessment of the residual windblown tailings, and the cost-benefit analysis to determine the ALARA evaluation. It was necessary for ARCO to determine whether the exemption request would be granted or additional attempts would be required prior to issuing the Phase III ITB. For example, if additional excavation would be required, the excavated materials would have to be placed on the MTP prior to placement of the final radon barrier. On May 31, 1994, the NRC issued a license amendment approving the exemption for these rock outcrop areas.

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Slime Tailings Consolidation on the MTP: Pursuant to the Reclamation Plan, at least 90 percent of tailings consolidation must be complete prior to placing final radon barrier on the MTP. Consolidation eliminates the potential of differential settlement of the slime tailings after placement of the final radon barrier and maintains long-term effectiveness of the barrier. As noted previously, ARCO has placed an average of 15 feet of loading material over 155 acres of slimes and the mixed tailings area for consolidation. In addition, ARCO utilized an effective technology, wick drains, to dewater the slime tailings in accordance with the groundwater CAP for the Site. Approximately 27,000 wick drains were installed to dewater the slimes and mixed tailings areas to expedite consolidation. A Settlement Analysis Report and supplementary information were submitted to the NRC on October 27, 1993 and December 1, 1993, respectively, in which ARCO verified the 90 percent consolidation based on the measurement of settlement monuments as approved in the Reclamation Plan. On February 11, 1994, the NRC concurred with the data and conclusion that 90 percent consolidation was complete.

Upon NRC's concurrence of the 90 percent consolidation, the wick drains were deactivated for preparation of placing the final radon barrier on the MTP by pushing the wicks down into the pre-drilled wick holes, compacting the holes, and plugging the holes with soil cement. While overall 90 percent consolidation in 155 acres has occurred, about 20 acres continue to exhibit unanticipated dewatering with the presence of fluid on the surface of the MTP.

If the final radon barrier is placed on the 20-acre area presently affected by the slimes dewatering at this time, there is a potential for significant differential settlement in the slime tailings area, which in turn, could impact the long-term effectiveness of the radon barrier. ARCO believes that the final radon barrier cannot be placed on this area of the MTP until it is dewatered sufficiently to eliminate the potential for localized differential settlement. Currently, ARCO is evaluating these isolated wet areas and developing a plan to address this matter. The results of this evaluation are not known at this time.

The resolution of these issues and the associated regulatory review and approval consumed five months of the ten-month construction schedule for the Phase III reclamation work. This left only five months for bidding and contracting the work, and completing the work to meet the December 28, 1994 milestone for placement of the final radon barrier. After receiving NRC approval of the modifications described above, ARCO immediately incorporated them into the ITB and bidders were advised to prepare their proposal(s) to meet the five-month schedule. When received, however, all proposals were based on working unreasonable overtime based on ten hours per day, six days per week, with a second shift for maintenance

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and repair. Such a schedule left no margin to make up for time lost due to inclement weather or any other factors beyond ARCO's control. Additionally, such a schedule could present potential worker health and safety concerns, and imposed unreasonable and grossly excessive costs to complete the work. Such a schedule also makes quality control difficult.

**ARCO's Request for Extension of Milestones:**

For the reasons set forth above, ARCO is requesting an extension of the December 28, 1994 milestone for placement of the final radon barrier and the October 23, 1995 milestone for placement of erosion protection. Extension of these milestones to December 31, 1997 is necessary to adequately, cost effectively, and safely complete the Site reclamation pursuant to ARCO's Reclamation Plan and License. While ARCO intends to complete the work as soon as practical, the completion date is dependent upon the dewatering of the isolated wet areas of the slimes tailings. The date of adequate dewatering is unknown at this time.

ARCO's request to extend these milestones is authorized pursuant to the NESHAPs Subpart T Settlement Agreement between the American Mining Congress (AMC), EPA, NRC licensees and others, EPA's final rule pertaining to the NESHAPs radon standard (See 58 Fed. Reg. 60341 (Nov. 15, 1993)), and the NRC's final rule regarding the same. (See 59 Fed. Reg. 28220 (June 1, 1994)).

As set forth in the agreement and these regulations, a licensee is permitted to request an extension of time to comply with the 20 pCi/m<sup>2</sup>-s flux standard based on either of two criteria. First, a licensee may demonstrate, through appropriate monitoring, compliance with the flux standard and continue to demonstrate compliance annually during the extension period. 58 Fed. Reg. at 60347, 60356; 40 C.F.R. § 192.32(a)(3)(ii); 59 Fed. Reg. at 28231; and 10 C.F.R. Part 40, Appendix A, Criterion 6A(2). Alternatively, if a licensee is not in compliance with the flux standard, the licensee may seek an extension based on cost and must show that (1) it is making good faith efforts to emplace the final radon barrier; (2) the extended time period is consistent with the definition of "available technology;" and (3) the radon releases during the extended period will not result in a significant incremental risk to the public health. 58 Fed. Reg. at 60356; 40 C.F.R. § 192.32(a)(3)(ii); 59 Fed. Reg. at 28231; and 10 C.F.R. Part 40, Appendix A, Criterion 6A(2).

ARCO is seeking its extension of the final radon barrier milestone based upon the first criterion because, as noted above, ARCO is presently in compliance with the radon flux standard. ARCO is also addressing the second criterion for an extension. However, in order to extend the final radon barrier milestone, the License Conditions No. 38.C.

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requires ARCO to demonstrate that compliance with the final radon barrier milestone is not technologically feasible. In order to extend the erosion protection milestone, the License condition No. 38.D. requires ARCO to address any added risk to the public health and safety and the environment. ARCO believes that each of these criterion for extending the milestones is met fully based on the facts set forth herein, and as summarized below.

As discussed earlier, final radon cover has already been placed entirely on the CTP. The MTP contains final radon barrier on the sands area and interim cover on the remaining portion of the MTP. The Acid Tailings Pile (ATP) also contains interim cover consisting of low activity material. Radon flux emissions from all three piles were measured within the last 12 months using the EPA Method 115. The results show that all three piles presently comply with the 20 pCi/m<sup>2</sup>-s standard (See Attachment A). In fact, the area-weighted average for all three piles at the Site is only 6.4 pCi/m<sup>2</sup>-s, which is only 32% of the flux standard.

ARCO has expended all reasonable and practical efforts and resources to emplace the final radon cover by the December 28, 1994 milestone deadline as explained above. Yet despite ARCO's good faith efforts to do so, compliance with that deadline has become technologically infeasible due to factors beyond ARCO's control. This circumstance also impacts ARCO's ability to place erosion protection on the tailings piles by October 23, 1995. The need for NRC headquarters' review, modification and approval of the existing radon barrier and erosion protection designs in the Reclamation Plan, time delays associated with regulatory approvals of these modifications, bidding, contracting and scheduling problems resulting from these delays, and grossly excessive costs and worker health and safety considerations including unreasonable overtime associated with meeting the December 1994 milestone, and unanticipated indeterminate delays due to the physical characteristics of the slime tailings and Site with respect to the slime tailings and rock outcrops are all factors that warrant the extension of the final radon barrier and erosion protection milestones.

ARCO's proposed extension of milestones is consistent with the programmatic goal for compliance with the NESHAPs standard for all licensees by December 31, 1997, ARCO already complies with the flux standard on all three tailings piles at the Site; in fact, ARCO has proceeded in good faith as expeditiously as practicable considering technological feasibility, but is nevertheless unable to emplace the final radon barrier and erosion protection on the tailings piles by the milestone dates set forth in the License. Additionally, not only does ARCO presently comply with the 20 pCi/m<sup>2</sup>-s standard, the current radon emissions from the Site are far below that standard. This shows that the extension of the final radon barrier and erosion protection placement will not result in any incremental risk

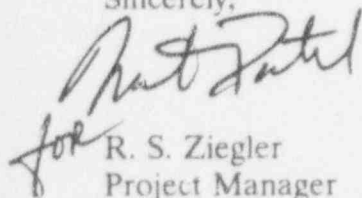
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to human health and the environment. Furthermore ARCO is committed to place the erosion protection on the piles as soon as practical once all the radon barrier has been placed. Therefore, ARCO respectfully requests that the NRC approve an extension of the December 1994 milestone for placement of the final radon barrier and the October 1995 milestone for placement of erosion protection to December 31, 1997.

I would be pleased to respond to any questions or requests for additional information which you may have regarding this extension. Please feel free to call me at (505) 876-2211.

Sincerely,

  
for R. S. Ziegler  
Project Manager

pc: S.M. Purdy/DAT-1618  
N. Patel/Grants  
C. E. Sanchez  
J. Gilchrist/AMC

Attachment A  
to  
Request For Reclamation Milestones Extension  
Bluewater Uranium Mill Site  
Material License #SUA-1470

Atlantic Richfield Company  
Grants, New Mexico

August 1994

Radon Flux Measurement  
Bluewater Uranium Mill Site

### Radon Flux Measurements

Radon flux measurements were made at the ARCO Bluewater Mill Site on two separate occasions. The flux on the portion of the main tailings area, referred to as the Main Tailings Pile in Figure A-1, was characterized in September 1993. The data was included as part of the final radon barrier design ( "Final Radon Barrier Design, ARCO Bluewater Mill Main Tailings Pile, December 1993) which was submitted to the Nuclear Regulatory Commission.

On July 13-14, 1994, flux measurements were made on the acid tailings portion of the main tailings area. The acid tailings portion (26 acres), referred to in Figure A-1 as the Acid Tailings Pile, was originally a portion of the larger main tailings area but was later isolated by the construction of a dike on top of the tailings to restrict the flow of tailings to that area.

The final radon barrier has been placed on the Carbonate Tailings Pile (see Figure A-2). One hundred flux measurements were made on the pile on July 13-14, 1994 to confirm that the completed pile meets the flux standard of 20 pCi/m<sup>2</sup>s.

All measurements were made by Environmental Restoration Group, Inc. using a canister design and associated procedures that are in full compliance with the EPA Method 115 (40 CFR Part 61). A copy of the procedures are attached to the end of this appendix.

A summary of the data is provided in Table A-1 which shows that the area-weighted-average flux from the tailings piles is 6.4 pCi/m<sup>2</sup>s. The individual measurements are presented in Tables A-2 to Table A-6.

Table A-1

## ARCO Bluewater Mill Site Average Radon Flux

Tailings Pile	Area (acres)	Number of Measurements	Average Flux (pCi/sq. m s)
Carbonate Tailings	55	100	1.3
Main Tailings			
Sand Tailings	170	33	1.3
Mixed Tailings	68	30	14.4
Slimes Tailings	80	30	9.7
Acid Tailings	26	20	8.5

Area-Weighted-Average Flux

6.4

Table A-2

**ARCO Bluewater Mill Main Tailings Pile  
Sands Area**

Location I. D. No.		Depth of Sample (ft) Below Radon Barrier				Exit Flux (pCi/m <sup>2</sup> s)	Avg Moisture	Avg Ra-226	Cover Thickness(ft)	Avg Cover Moisture
		0'-2'	2'-4'	4'-6'	6'-8'					
1021	Ra-226 (pCi/g)	34.4	18.2	114.1	124.4	5.84		72.8	2.7	10.4
	Percent Moisture	13.2	6.6	16.7	10.6		11.8			
1027	Ra-226 (pCi/g)	126.5	121.4	111.0	138.9	1.00		124.5	1.7	12.5
	Percent Moisture	10.2	8.4	7.3	14.4		10.1			
1023	Ra-226 (pCi/g)	27.9	128.7	64.8	104.2	1.30		81.4	2.4	11.1
	Percent Moisture	9.1	5.0	12.4	11.4		9.5			
1011	Ra-226 (pCi/g)	71.8	110.2	116.1	117.4	0.21		103.9	2.2	10.4
	Percent Moisture	7.5	14.1	12.3	12.6		11.6			
1003	Ra-226 (pCi/g)	8.6	98.2	69.0	89.3	0.12		66.3	2.2	11.2
	Percent Moisture	9.1	8.3	11.2	10.3		9.7			
1004	Ra-226 (pCi/g)	17.2	26.9	127.1	73.2	0.47		61.1	2.5	10.4
	Percent Moisture	7.8	8.3	9.6	4.0		7.4			
1001	Ra-226 (pCi/g)	7.2	22.0	17.2	21.8	-0.40		17.1	2.3	13.2
	Percent Moisture	15.5	15.5	12.3	13.5		14.2			
1010	Ra-226 (pCi/g)	48.1	129.8	104.4	139.8	0.10		105.5	1.9	11.8
	Percent Moisture	12.5	15.9	9.2	13.1		12.7			
1012	Ra-226 (pCi/g)	111.8	61.7	124.7	138.1	0.13		109.1	1.7	11.6
	Percent. Moisture	9.2	6.5	7.0	7.5		7.6			
1030	Ra-226 (pCi/g)	83.4	110.8	149.1	255.8	0.25		149.8	1.5	12.2
	Percent Moisture	9.4	10.0	20.0	28.2		16.9			

Table A-2

**ARCO Bluewater Mill Main Tailings Pile  
Sands Area**

Location I. D. No.		Depth of Sample (ft) Below Radon Barrier				Exit Flu. (pCi/m <sup>2</sup> s)	Avg Moisture	Avg Ra-226	Cover Thickness(ft)	Avg Cover Moisture
		0'-2'	2'-4'	4'-6'	6'-8'					
1025	Ra-226 (pCi/g)	95.7	156.4	193.2	164.1	11.36		152.4	0.9	11
	Percent Moisture	9.9	12.3	27.6	13.0		15.7			
1031	Ra-226 (pCi/g)	2.6	7.8	82.9	106.8	1.51		50.0	0.3	15
	Percent Moisture	16.6	9.4	14.4	7.6		12.0			
1026	Ra-226 (pCi/g)	96.8	95.7	186.0	152.4	0.33		132.7	1.5	11.5
	Percent Moisture	9.2	20.8	25.5	23.1		19.7			
1006	Ra-226 (pCi/g)	1.6	6.3	99.5	161.4	0.20		67.2	1.9	11.8
	Percent Moisture	12.8	11.4	10.0	14.3		12.1			
1002	Ra-226 (pCi/g)	12.3	6.2	114.4	149.2	0.73		70.5	2	12.9
	Percent Moisture	8.8	7.7	6.0	12.1		8.7			
1033	Ra-226 (pCi/g)	23.4	21.6	5.8	119.6	0.24		42.6	0.6	13.6
	Percent Moisture	12.8	15.5	3.2	7.4		9.7			
1024	Ra-226 (pCi/g)	85.7	122.7	142.3	176.8	0.19		131.9	1.9	13
	Percent Moisture	8.9	11.0	15.2	17.3		13.1			
1007	Ra-226 (pCi/g)	56.3	85.4	161.7	112.4	0.05		104.0	1.4	10.9
	Percent Moisture	6.0	5.6	9.7	7.6		7.2			
1013	Ra-226 (pCi/g)	29.0	27.9	240.7	110.0	0.22		101.9	1.1	12.9
	Percent Moisture	16.8	23.7	12.4	7.9		15.2			
1032	Ra-226 (pCi/g)	41.5	146.2	104.7	129.2	0.39		105.4	0.9	16.9
	Percent Moisture	17.9	12.2	12.9	13.6		14.2			

Table A-2

**ARCO Bluewater Mill Main Tailings Pile  
Sands Area**

Location I. D. No.		Depth of Sample (ft) Below Radon Barrier				Exit Flux (pCi/m <sup>2</sup> s)	Avg Moisture	Avg Ra-226	Cover Thickness(ft)	Avg Cover Moisture
		0'-2'	2'-4'	4'-6'	6'-8'					
1008	Ra-226 (pCi/g)	54.8	79.9	100.9	100.0	0.24		83.9	1.5	12.7
	Percent Moisture	7.1	8.6	9.0	10.5		8.8			
1014	Ra-226 (pCi/g)	26.5	132.9	175.2	154.0	9.74		122.2	1.7	11
	Percent Moisture	14.0	10.6	15.6	17.2		14.4			
1005	Ra-226 (pCi/g)	4.2	28.6	10.6	68.8	0.53		28.1	2.1	6.6
	Percent Moisture	6.7	10.3	11.0	11.0		9.8			
1015	Ra-226 (pCi/g)	90.2	76.1	128.1	145.7	0.49		110.0	1.7	14.6
	Percent Moisture	8.4	7.9	7.4	14.8		9.6			
1022	Ra-226 (pCi/g)	61.5	107.8	138.5	111.3	3.55		104.8	2.4	13
	Percent Moisture	11.0	11.1	12.9	7.1		10.5			
1029	Ra-226 (pCi/g)	76.0	85.5	96.1	155.4	0.30		103.3	1.4	15.6
	Percent Moisture	11.2	6.5	9.7	22.0		12.4			
1016	Ra-226 (pCi/g)	115.3	199.5	104.8	82.2	0.29		125.5	1.8	11.6
	Percent Moisture	10.3	10.1	12.2	12.4		11.3			
1009	Ra-226 (pCi/g)	57.2	42.3	123.2	164.9	0.06		96.9	1.1	11.3
	Percent Moisture	8.6	7.5	11.3	9.8		9.3			
1020	Ra-226 (pCi/g)	68.5	49.7	112.5	177.0	0.36		101.9	1.1	12.3
	Percent Moisture	13.1	13.5	11.8	15.5		13.5			
1028	Ra-226 (pCi/g)	126.4	92.1	126.5	191.9	1.18		134.2	1.2	10.5
	Percent Moisture	10.0	11.6	9.5	24.5		13.9			

Table A-2

**ARCO Bluewater Mill Main Tailings Pile  
Sands Area**

Location I. D. No.	Depth of Sample (ft) Below Radon Barrier				Exit Flux (pCi/m <sup>2</sup> s)	Avg Moisture	Avg Ra-226	Cover Thickness(ft)	Avg Cover Moisture
	0'-2'	2'-4'	4'-6'	6'-8'					
1018		31.4	36.4	187.5	199.4	0.08	113.7	2.5	12.6
	Percent Moisture	11.0	11.8	18.3	18.8		15.0		
1017	Ra-226 (pCi/g)	63.1	119.4	115.5	124.5	0.84	105.6	2.1	11.8
	Percent Moisture	7.9	12.6	16.3	12.4		12.3		
1019	Ra-226 (pCi/g)	83.3	38.5	110.6	92.2	0.11	81.2	1.3	9.9
	Percent Moisture	8.6	9.0	10.8	10.6		9.8		
Average Cover Thickness								1.68	
Average Ra-226		55.76	78.57	116.93	131.88		95.79		
Average Flux						1.27			
Average Moisture		10.64	10.89	12.45	13.22		11.80		11.05

Table A-3

**ARCO Bluewater Mill Main Tailings Pile  
Mixed Area**

Location I. D. No.		Depth of Sample (ft)				Exit Flux (pCi/m <sup>2</sup> s)	Avg Moisture	Avg Ra-226
		0'-2'	2'-4'	4'-6'	6'-8'			
1046	Ra-226 (pCi/g)	47.1	20.7	51.3	255.1	13.7	93.6	
	Percent Moisture	11.2	20.4	14.3	44.2	22.5		
1049	Ra-226 (pCi/g)	63.7	82.4	73.4	129.9	52.5	87.4	
	Percent Moisture	10.8	12.3	27.9	25.7	19.2		
1051	Ra-226 (pCi/g)	18.3	13.3	32.7	17.1	1.1	20.4	
	Percent Moisture	17.3	10.1	11.5	18.4	14.3		
1053	Ra-226 (pCi/g)	18.9	8.9	6.7	86.0	4.3	30.6	
	Percent Moisture	13.5	16.5	18.8	11.7	15.1		
1052	Ra-226 (pCi/g)	2.9	7.6	13.3	6.4	5.3	7.6	
	Percent Moisture	9.3	16.0	22.4	17.7	16.4		
1050	Ra-226 (pCi/g)	6.7	16.4	26.7	28.7	6.0	19.6	
	Percent Moisture	13.3	19.1	34.0	13.3	19.9		
1048	Ra-226 (pCi/g)	-0.4	9.2	7.8	21.9	9.5	9.6	
	Percent Moisture	11.5	14.0	19.0	19.4	16.0		
1047	Ra-226 (pCi/g)	18.6	0.9	21.9	31.1	12.2	18.1	
	Percent Moisture	7.6	7.0	17.9	16.1	12.2		
1044	Ra-226 (pCi/g)	15.8	9.6	14.2	15.4	11.6	13.8	
	Percent Moisture	9.6	14.4	20.3	22.4	16.7		
1043	Ra-226 (pCi/g)	12.3	3.5	13.1	15.9	7.4	11.2	
	Percent Moisture	8.6	14.1	15.6	20.0	14.6		

Table A-3

**ARCO Bluewater Mill Main Tailings Pile  
Mixed Area**

Location I. D. No.		Depth of Sample (ft)				Exit Flux (pCi/m <sup>2</sup> s)	Avg Moisture	Avg Ra-226
		0'-2'	2'-4'	4'-6'	6'-8'			
1040	Ra-226 (pCi/g)	20.4	7.9	10.1	7.1	0.9		11.4
	Percent Moisture	15.0	22.7	19.7	12.3		17.4	
1039	Ra-226 (pCi/g)	15.3	14.1	28.5	18.1	1.3		19.0
	Percent Moisture	11.1	10.9	16.9	21.5		15.1	
1036	Ra-226 (pCi/g)	15.5	11.8	11.4	14.0	1.0		13.2
	Percent Moisture	10.9	9.6	9.0	18.2		11.9	
1035	Ra-226 (pCi/g)	3.6	3.0	4.3	58.1	0.7		17.3
	Percent Moisture	19.2	15.9	7.4	16.0		14.6	
1034	Ra-226 (pCi/g)	14.4	11.3	9.3	105.6	2.8		35.2
	Percent Moisture	13.1	15.0	10.1	5.8		11.3	
1054	Ra-226 (pCi/g)	10.9	72.8	149.4	288.8	6.8		130.5
	Percent Moisture	26.3	17.7	29.5	38.8		30.6	
1045	Ra-226 (pCi/g)	6.2	8.9	13.2	200.5	4.5		57.2
	Percent Moisture	8.1	11.1	11.3	44.3		18.7	
1042	Ra-226 (pCi/g)	10.5	17.9	150.0	274.5	16.5		113.2
	Percent Moisture	12.3	13.3	22.5	25.5		18.4	
1041	Ra-226 (pCi/g)	6.0	18.5	4.2	87.1	5.4		29.0
	Percent Moisture	15.5	15.5	14.8	13.7		14.9	
1038	Ra-226 (pCi/g)	5.9	1.6	12.7	31.1	6.1		12.8
	Percent Moisture	9.5	6.6	14.0	22.9		13.3	

Table A-3

**ARCO Bluewater Mill Main Tailings Pile  
Mixed Area**

Location I. D. No.		Depth of Sample (ft)				Exit Flux (pCi/m <sup>2</sup> s)	Avg Moisture	Avg Ra-226
		0'-2'	2'-4'	4'-6'	6'-8'			
1037	Ra-226 (pCi/g)	14.4	3.3	9.7	19.4	4.7		11.7
	Percent Moisture	16.6	11.8	16.2	15.9		15.1	
1055	Ra-226 (pCi/g)	22.7	86.1	203.0	258.7	6.4		142.6
	Percent Moisture	14.3	26.4	54.7	49.1		36.1	
1056	Ra-226 (pCi/g)	5.9	103.9	103.5	212.0	5.8		106.3
	Percent Moisture	10.7	16.7	16.8	19.6		16.0	
1058	Ra-226 (pCi/g)	87.7	139.6	142.4	179.1	40.0		137.2
	Percent Moisture	12.7	16.3	18.1	25.2		18.1	
1057	Ra-226 (pCi/g)	123.3	130.2	141.3	125.3	16.3		130.0
	Percent Moisture	14.9	13.1	17.9	17.0		15.7	
1059	Ra-226 (pCi/g)	176.8	97.4	143.1	307.3	42.4		181.2
	Percent Moisture	22.7	15.3	15.4	31.3		21.2	
1060	Ra-226 (pCi/g)	168.1	127.7	104.8	319.0	37.5		179.9
	Percent Moisture	26.5	20.7	17.0	27.7		23.0	
1062	Ra-226 (pCi/g)	86.0	179.5	137.9	327.1	31.4		182.6
	Percent Moisture	5.5	25.0	14.0	20.8		16.3	
1063	Ra-226 (pCi/g)	90.7	116.6	177.3	400.6	47.8		196.3
	Percent Moisture	10.6	12.5	29.5	43.5		24.0	
1061	Ra-226 (pCi/g)	73.9	198.2	98.3	202.3	30.4		143.2
	Percent Moisture	7.6	18.4	11.2	24.5		15.4	
Average Ra-226		38.7	50.8	63.9	134.8			72.0
Average Moisture		13.2	15.3	18.9	23.8		17.8	
Average Flux						14.4		

Table A-4

**ARCO Bluewater Mill Main Tailings Pile  
Slimes Area**

Location I. D. No.		Depth of Sample (ft)				Exit Flux (pCi/m <sup>2</sup> s)	Avg Moisture	Avg Ra-226
		0'-2'	2'-4'	4'-6'	6'-8'			
1064	Ra-226 (pCi/g)	14.2	19.1	15.7	3.8	1.3		13.2
	Percent Moisture	14.4	10.4	16.6	16.1		14.4	
1093	Ra-226 (pCi/g)	5.1	7.1	17.3	4.4	9.0		8.5
	Percent Moisture	19.0	17.7	24.7	19.0		20.1	
1092	Ra-226 (pCi/g)	14.6	4.9	10.4	16.4	7.5		11.6
	Percent Moisture	13.0	13.8	20.2	22.4		17.4	
1091	Ra-226 (pCi/g)	14.4	7.7	10.3	15.6	3.5		12.0
	Percent Moisture	13.6	11.8	21.2	21.8		17.1	
1039	Ra-226 (pCi/g)	22.5	13.3	6.9	8.4	13.3		12.8
	Percent Moisture	12.2	8.4	12.8	18.6		13.0	
1090	Ra-226 (pCi/g)	4.2	10.2	13.7	18.7	10.5		11.7
	Percent Moisture	11.8	11.0	17.9	24.7		16.4	
1088	Ra-226 (pCi/g)	12.4	10.3	3.3	11.0	8.2		9.3
	Percent Moisture	16.4	17.4	23.2	27.9		21.2	
1087	Ra-226 (pCi/g)	10.2	4.2	4.0	12.7	4.7		7.8
	Percent Moisture	10.5	12.3	20.4	25.0		17.1	
1086	Ra-226 (pCi/g)	3.4	1.9	3.6	7.6	1.5		4.1
	Percent Moisture	7.9	11.9	12.2	20.5		13.1	

Table A-4

**ARCO Bluewater Mill Main Tailings Pile  
Slimes Area**

Location I. D. No.		Depth of Sample (ft)				Exit Flux (pCi/m <sup>2</sup> s)	Avg Moisture	Avg Ra-226
		0'-2'	2'-4'	4'-6'	6'-8'			
1085	Ra-226 (pCi/g)	7.8	5.1	9.5	3.2	3.9		6.4
	Percent Moisture	15.6	17.6	19.8	26.4		19.9	
1084	Ra-226 (pCi/g)	5.8	6.9	6.4	7.0	1.8		6.5
	Percent Moisture	16.5	12.7	14.5	17.4		15.3	
1083	Ra-226 (pCi/g)	69.3	25.4	7.4	25.8	31.6		32.0
	Percent Moisture	19.5	15.1	23.1	35.5		23.3	
1082	Ra-226 (pCi/g)	54.1	5.8	2.3	13.6	18.2		19.0
	Percent Moisture	20.9	26.0	26.1	30.3		25.8	
1081	Ra-226 (pCi/g)	25.1	19.7	10.1	8.2	9.3		15.8
	Percent Moisture	11.7	16.3	21.4	22.9		18.1	
1080	Ra-226 (pCi/g)	20.5	28.5	11.5	8.9	11.2		17.4
	Percent Moisture	11.4	8.6	15.7	25.5		15.3	
1077	Ra-226 (pCi/g)	17.6	9.3	2.9	18.8	6.3		12.2
	Percent Moisture	21.4	10.5	23.0	24.7		19.9	
1076	Ra-226 (pCi/g)	7.5	11.6	14.0	4.2	7.5		9.3
	Percent Moisture	14.5	19.8	20.2	21.2		18.9	
1075	Ra-226 (pCi/g)	26.1	33.8	5.8	6.7	59.6		18.1
	Percent Moisture	17.2	17.7	18.5	19.1		18.1	
1074	Ra-226 (pCi/g)	3.1	9.4	4.5	6.2	2.0		5.8
	Percent Moisture	12.7	24.4	17.8	24.9		20.0	

Table A-4

**ARCO Bluewater Mill Main Tailings Pile  
Slimes Area**

Location I. D. No.		Depth of Sample (ft)				Exit Flux (pCi/m2s)	Avg Moisture	Avg Ra-226
		0'-2'	2'-4'	4'-6'	6'-8'			
1073	Ra-226 (pCi/g)	10.0	11.5	15.5	6.8	3.7		11.0
	Percent Moisture	18.6	15.5	22.1	23.6		20.0	
1072	Ra-226 (pCi/g)	4.1	3.0	4.4	12.7	4.5		6.1
	Percent Moisture	11.9	9.1	20.5	26.4		17.0	
1079	Ra-226 (pCi/g)	3.1	10.7	16.2	6.4	1.2		9.1
	Percent Moisture	6.9	11.1	21.4	11.1		12.6	
1078	Ra-226 (pCi/g)	5.5	11.2	8.2	5.5	27.9		7.6
	Percent Moisture	11.1	13.5	15.3	18.1		14.5	
1071	Ra-226 (pCi/g)	14.9	11.4	9.4	0.9	10.6		9.2
	Percent Moisture	9.9	5.2	28.6	10.1		13.5	
1070	Ra-226 (pCi/g)	19.6	79.9	5.1	1.4	5.3		26.5
	Percent Moisture	17.8	15.6	17.7	20.5		17.9	
1069	Ra-226 (pCi/g)	2.8	9.8	16.4	11.6	12.0		10.2
	Percent Moisture	13.4	17.8	18.5	24.4		18.5	
1068	Ra-226 (pCi/g)	37.5	21.5	9.9	4.6	5.8		18.4
	Percent Moisture	15.9	23.0	24.8	27.2		22.7	
1067	Ra-226 (pCi/g)	13.8	5.2	8.9	2.1	3.0		7.5
	Percent Moisture	30.2	14.2	16.3	10.8		17.9	
1066	Ra-226 (pCi/g)	23.8	7.1	12.5	26.5	5.8		17.5
	Percent Moisture	8.6	7.0	15.3	13.6		11.1	
1065	Ra-226 (pCi/g)	9.0	6.0	10.5	12.8	2.1		9.6
	Percent Moisture	12.3	10.3	16.7	26.1		16.4	
Average Ra-226		16.1	13.7	9.2	9.8			12.2
Average Moisture		14.6	14.2	19.6	21.9		17.5	
Average Flux						9.7		

Table A-5

## ARCO Bluewater Mill Acid Tailings Pile

Location I.D.	Coordinates		Canister Number	Radon Flux (pCi/sq.m sec)
	Northing	Easting		
126	35077	22131	27	3.05
127	34777	21786	63	10.01
128	34777	22086	78	15.40
129	34777	22386	64	3.81
130	34777	22686	46	3.98
131	34477	21886	107	11.28
132	34477	21636	58	9.12
133	34177	21507	62	7.13
134	34177	21207	6	6.91
135	33877	21154	57	5.51
136	33577	20986	80	16.50
137	34100	21240	18	5.79
138	34380	21720	20	7.72
139	34680	21920	49	2.89
140	34940	22280	43	1.82
215	34947	21955	202	6.19
216	34650	22220	105	5.07
217	34663	21640	42	26.28
218	34363	21430	19	9.32
219	34050	21020	203	12.63
Average =				8.52

Table A-6

## ARCO Bluewater Mill Carbonate Tailings Pile

Location I.D.	Coordinates		Canister Number	Radon Flux (pCi/sq.m sec)
	Northing	Easting		
101	30475	22154	12	0.97
102	30332	21854	82	2.39
103	30217	22154	262	0.49
104	30288	22754	254	0.55
105	30332	23054	37	0.28
106	30332	23354	8	0.63
107	30332	23654	96	0.82
108	30032	23654	77	0.75
109	30032	23354	67	0.77
110	30032	23054	65	0.38
111	30032	22754	100	0.55
112	30032	22454	26	0.38
113	29732	22154	71	0.36
114	29732	22454	7	1.22
115	29732	22754	70	0.18
116	29732	23054	93	0.35
117	29732	23354	17	0.29
118	29732	23654	23	4.67
119	29432	23054	109	0.15
120	29432	22754	258	0.45

Table A-6

## ARCO Bluewater Mill Carbonate Tailings Pile

Location I.D.	Coordinates		Canister Number	Radon Flux (pCi/sq.m sec)
	Northing	Easting		
121	29432	22454	98	0.40
122	29432	22154	250	0.86
123	29132	22154	30	0.70
124	29132	22454	11	0.46
125	29132	23227	84	0.14
141	29606	22036	261	0.75
143	30182	23353	252	0.66
144	29077	22754	255	3.02
145	30482	23800	256	1.13
146	30182	23804	104	5.56
147	29882	23804	94	5.27
148	29732	23804	9	0.70
149	29612	23654	74	0.92
150	30182	23654	13	0.76
151	30420	22004	103	0.78
152	30482	23504	39	0.74
153	30332	23504	38	0.37
154	30182	23504	5	0.64
155	30032	23504	33	0.36
156	29882	23504	68	0.44

Table A-6

## ARCO Bluewater Mill Carbonate Tailings Pile

Location I.D.	Coordinates		Canister Number	Radon Flux (pCi/sq.m sec)
	Northing	Easting		
157	29732	23501	76	1.37
158	29882	23354	2	0.53
159	29612	23354	106	1.61
160	29432	23284	44	0.41
161	29060	23364	47	0.35
162	29040	23204	24	0.24
163	29282	23204	10	0.02
164	29582	23204	79	0.48
165	29732	23204	51	0.46
166	29882	23204	95	0.00
167	30032	23204	72	0.71
168	30182	23204	75	0.24
169	30332	23204	251	0.53
170	29881	23054	50	0.12
171	30182	23054	97	0.42
172	29582	23054	4	0.37
173	29172	23054	48	2.90
174	29230	22904	53	1.82
175	29432	22904	22	0.53
176	29582	22904	260	0.15

Table A-6

## ARCO Bluewater Mill Carbonate Tailings Pile

Location I.D.	Coordinates		Canister Number	Radon Flux (pCi/sq.m sec)
	Northing	Easting		
177	29732	22904	36	0.38
178	29882	22904	55	0.47
179	30032	22904	88	0.41
180	30182	22904	108	2.12
181	30302	22604	257	0.99
182	30182	22604	253	0.58
183	30032	22604	66	0.40
184	29882	22604	91	0.39
185	29732	22604	61	1.91
186	29582	22604	99	3.98
187	29582	22754	259	0.22
188	29432	22604	85	4.07
189	29282	22604	14	10.55
190	29284	23054	21	0.55
191	30183	22755	31	3.49
192	30555	23654	3	0.76
193	30500	23354	15	0.81
194	30289	22904	25	0.25
195	30182	22454	52	5.01
196	29882	22755	89	9.01

Table A-6

## ARCO Bluewater Mill Carbonate Tailings Pile

Location I.D.	Coordinates		Canister Number	Radon Flux (pCi/sq.m sec)
	Northing	Easting		
197	29882	22455	60	2.23
198	29594	22153	110	0.67
199	29132	22304	69	0.31
200	29282	22754	200	1.26
201	29132	22604	81	0.37
202	29282	22454	83	0.53
203	29022	22304	41	0.45
204	29282	22304	29	0.56
205	29432	22304	90	0.51
206	29582	22304	201	0.76
207	29732	22304	1	0.73
208	29882	22304	102	0.50
209	30182	22304	54	1.94
210	30380	22304	263	8.85
211	30353	22215	56	2.19
212	30160	22004	59	0.93
213	29581	22453	101	0.74
214	29281	22154	87	0.44
220	30280	22004	35	0.54
313	30475	21845	73	2.52
Average =				1.28