SHEPHERD MILLER
INCORPORATED

January 17, 1997 SMI #06-429

40-4492

Mr. Mark Moxley
Wyoming DEQ
Land Quality Division
250 Lincoln Street
Lander, WY 82520-2848

Re: Tailings Reclamation Plan for Tailings Pond #2, ANC Gas Hills Site
Revisions to Final Report

Dear Mark:

Enclosed are further revisions to the Final Reclamation Plan for American Nuclear Corporation's (ANC's) Tailings Pond #2. The revisions primarily address comments received from NRC staff subsequent to the April 9, 1996 final draft and the June 10, 1996 revisions. The further revisions are included as page inserts which can be substituted for the previous pages.

Included are a revised table of contents and page inserts from Chapters 1, 2, 4, 5 and 6. An entirely revised Chapter 7 and two new attachments to Appendix B also included. The changes in Chapter 1 correct an error in relating site history, present changes to the reclamation plan overview, and revise the construction schedule. The Chapter 2 revision removes reference to the site license. An additional section is included in Chapter 4 addressing the radon flux measurements. Chapter 5 revisions reflect the modified protection of the toe of the north side slope of Pond #2, an additional riprap apron along the western margin of the top of Pond #2, modifications to the Southwest Diversion Channel and the ANC spoil pile, and a new seed mix. Revisions in Chapter 6 address modified compaction specifications in the radon barrier and riprap sizing and durability testing specifications. A new Chapter 7 is included that reflects the decision to present in this document a preliminary contaminated soils cleanup plan with the understanding that a detailed decommissioning plan will be prepared and submitted at a later date prior to additional field work in this matter. The new attachments to Appendix B present the results of a test plot for evaluating the effectiveness of tilling the soil to achieve cleanup criteria and an SOP for radon flux measurements.

Drawings available in Central Files

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Revised Drawings 6, 8, 9, 10 and 16 present modifications to the windblown cleanup areas, the toe of the north side slope of Pond #2, the Southwest Diversion Channel and the ANC spoil pile, and present the additional riprap apron.

The footer shows today's date which will distinguish between pages with changes from those without. Please call me if you have any questions.

Best regards,

SHEPHERD MILLER, INC.

Kent Bruxvoort

Kent Bruxvoort, P.E.
Project Engineer

cc: Ken Hooks, NRC
Rick Chancellor, DEQ
Jim Voeller, AVI
Bill Salisbury

enclosures

40-4492 AMERICAN NUCLEAR CORP.

REVISIONS TO THE FINAL RECLAMATION PLAN FOR AMERICAN NUCLEAR CORPORATION'S TAILINGS POND #2

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TABLE OF CONTENTS

miscellaneous site closure work. Final design for Pond #1 reclamation will be submitted to the NRC prior to reclamation construction for Pond #1, which is expected to be performed in 1999.

Preliminary design for Phases II (Pond #2) and III (Pond #1) was submitted to the NRC in a document dated November 13, 1995. Comments on the radiologic, geotechnical and erosional control elements of the plan were provided to LQD by the NRC and have been incorporated in this document.

1.2 History

The ANC mill operated from 1960 through 1982. Some preliminary closure activities have been conducted in anticipation of final site closure: the Willow Springs Draw diversion was constructed and windblown contamination was relocated to Pond #2 in 1983; the mill was decommissioned and buried at the south end of Pond #2 in 1989; tailings in Pond #2 were reshaped and an interim cover placed in 1990; and an interim cover was placed on Pond #1 in 1988. Finalization of the site reclamation plan will incorporate the efforts already completed.

ANC obtained U.S. Nuclear Regulatory Commission (NRC) approval of its original tailings closure-reclamation plan in 1984. However, NRC requested that ANC reevaluate the 1984 closure plan design based on its closure Staff Technical Position (STP) which was issued in August 1990. ANC complied and submitted a revised plan in March 1992. NRC responded with technical review comments on March 11, 1994 which described perceived ANC closure plan deficiencies.

ANC became insolvent and forfeited its reclamation performance bond in October 1994. The bond was administered by the Wyoming Department of Environmental Quality, Land Quality Division (LQD). LQD subsequently assumed responsibility for redesigning and implementing the closure plan for the ANC tailings site. The redesign and closure work will be paid for using the forfeited reclamation performance bond which amounts to approximately $3,200,000 and potential DOE Title X reimbursements. No State funds are available for the project.

is superior to the previously approved 1984 plan and which meets all current NRC design standards.

As noted previously, frequent and constructive contact with NRC has occurred throughout the performance of field sampling activities, the preparation of the 1995 Phase I construction plans, the preliminary design process, and the preparation of this document.

1.3 Comparison of the 1984 Plan and Current Final Reclamation Plan

LQD examined varying configurations of slopes, erosion protection and diversion channel design. Insofar as possible, design features from the approved 1984 ANC closure plan were used in the conceptual design. However, in consideration of NRC comments on the proposed 1992 plan, current STP criteria, LQD concerns and project economic constraints, certain modifications were incorporated to effect an improved design that will both demonstrate long-term stability of surface features and control the release of radioactive constituents to regulated levels. Several options were evaluated during the preliminary design process. Detailed alternative descriptions are provided in Chapter 3 of the preliminary design report. The following narrative summarizes the revised reclamation plan features which are presented in greater detail in the following sections of this document. The revised plan incorporates NRC comments on the preliminary design, and compares the plan to both the 1984 plan and to current NRC standards.

Embankment Slopes: The 1984 plan specified 10:1 (horizontal:vertical) side slopes for both Ponds #1 and #2. Additionally, the 1984 plan was approved with no rock protection specified for the side slopes; erosional stability was to be provided through vegetated 10:1 side slope surfaces. This revised plan improves upon the 1984 plan by placing rock erosion protection along the side slopes. The final reclamation plan for Pond #2 calls for 3-inch D_{50} rock placed on 8:1 slopes, with a 12:1 slope located at the toe of the northern side slope. The preliminary reclamation plan for Pond #1 calls for 3-inch D_{50} rock placed on 5:1 slopes. This rock protection was sized based on an event equal to one-half of the plan. The Pond #1 East diversion channel will also convey the full PMF, and the half-PMF with significant freeboard.

Inclusion of these three diversion channels in the revised plan as designed is an improvement over the 1984 plan.

The final reclamation design is shown in plan view on Figure 1.3 and is described in detail in the following chapters of this report. Drawing 5 presents an overview of the Phase II grading plan. Drawings 7 and 8 also present the grading plan, focusing on Pond #2 and the ANC Spoil Pile, respectively.

1.4 Reclamation Plan Summary

The following text summarizes the specific features of the final reclamation of Pond #2 and preliminary reclamation of Pond #1.

Side Slopes. The embankment of Pond #2 will be regraded to a slope of 8:1. The north embankment of Pond #2, which is composed entirely of fill, will consist of a slight cut near the top of the embankment to reduce the existing 9:1 slope. The slope of the bottom of the north embankment will be flattened to 8:1, and 12:1 at the toe, from the pre-reclamation 5:1 slope through the placement of clean borrow. Layers of mine spoil and clean borrow, with clean borrow placed on top, will be imported to cover the east embankment of Pond #2, which is composed of tailings. The embankment of Pond #1 will be reduced from its existing 3:1 slope to a reclaimed slope of 5:1 by importing clean fill. Geotechnical stability of the side slopes of both ponds is detailed in Chapter 3.

Rock will be placed along the regraded side slopes for long-term erosion protection, designed to be stable at one-half of the PMF. The rock layer for both ponds will be six inches thick and will be composed of 3-inch D_{50} rock. The rock will have a relatively narrow gradation specification and will meet NRC durability criteria. Both on-site and off-site rock sources will around the pond and into the Willow Springs Draw diversion. The Southwest diversion will route flow which would otherwise flow onto Pond #1 around and to the west of Pond #1. The Pond #1 East diversion will capture flow which would otherwise run on to the Pond #1 surface from the area to the east of Pond #1. Final design of the Campsite Draw diversion and preliminary design of the Southwest and Pond #1 East diversions is included in this document. All diversions are designed to convey the full PMF, and the half-PMF with significant freeboard.

A swale will be formed in the borrow area between the two tailings ponds to convey drainage away from the toe of Pond #2.

Chapter 5 details the diversion channel design and Figure 1.3 shows the locations of the diversions.

Contaminated Soils Cleanup. Areas surrounding the tailings ponds contaminated with soils containing elevated levels of radium-226 will be cleaned to meet the NRC criteria of 5 pCi/g radium-226 more than background in the upper 15 cm of soil and 15 pCi/g radium-226 more than background in 15 cm layers below the upper 15 cm.

To achieve the standard LQD may elect to till to depths of 12 to 18 inches (30 to 45 cm) areas with lightly contaminated soils, as detailed in Chapter 7. Tilling would be performed under the ALARA (as low as reasonable achievable) concept, given the limited budget available to LQD for site reclamation. Where achievement of the criteria cannot be met through tilling, contaminated soils will be excavated, hauled to the tailings ponds and covered with the reclamation cap. Drawing 6 depicts contaminated soils levels and those areas excavated under the Phase II construction effort. A test plot was established in 1996 to assess the effectiveness of tilling, or plowing, relatively lightly contaminated soils. Chapter 7 presents the test plot results, which indicate that tilling or plowing areas with scintillometer readings of 60 to 75 μR/hr, or above will not be successful in achieving the radium-226 standard.

Construction Timing. LQD will rely on the amount and timing of cash reimbursements through the DOE Title X program to help fund the reclamation. Because DOE's policy is to reimburse only after reclamation has been performed and to do so over three years, there will not be a sufficient cash balance to fund the entire effort at one time. Therefore, LQD will conduct a reclamation program which is phased in at least three construction efforts, beginning in 1995 and ending in approximately 2000. In addition to cash flow timing, expected continued settlement of Pond #1 tailings suggests placement of the Pond #1 radon barrier at a later time and thus Pond #1 reclamation follows Pond #2 reclamation (Pond #1 settlement is detailed in Chapter 3). Table 1.1 presents LQD's expected reclamation construction schedule.

Table 1.1 Proposed ANC Reclamation Construction Schedule

Phase	Year	Reclamation Measures
I	1995/96	Bullrush Heap Leach materials relocation (complete)
II	1996/97	Windblown cleanup around Pond #2 Pond #2 embankment regrading Pond #2 side slope rock Pond #2 radon barrier Pond #2 cover rock Campsite Draw diversion General site work
III-A	1997/98	Windblown cleanup and Pond #1 preload Contaminated soils cleanup verification
III	2000	Pond #1 embankment regrading Pond #1 side slope rock Pond #1 radon barrier Pond #1 cover rock Southwest diversion Pond #1 East diversion General site work
IV	2001	Miscellaneous site work, if needed

analyzed in the laboratory for radium content. Correlations were then determined for radium content and gamma reading. The site radiological survey summary is provided in Appendix B.

ANC previously determined that the background radium content of surrounding area surface soils is 4.27 pCi/g. This is documented in a July 14, 1988 letter to NRC's Uranium Recovery Field Office. A cleanup standard of 5 pCi/g above background in the first 15 cm is established by regulation; therefore the cleanup standard for the site is 9.27 pCi/g radium-226 in the first 15 cm of soil (19.27 pCi/g in the next 15 cm of soil). The correlation between gamma reading and radium-226 concentration determined from the 1995 radiological survey, corresponding to the 5-cm measurement height, indicates that a reading of 45 microR/hr corresponds to the 9.27 pCi/g cleanup standard.

Cleanup of contaminated soils in the vicinity of Pond #2 will occur as part of the Phase II reclamation effort prior to placing the final radon barrier on Pond #2. Cleanup of contaminated soils in the vicinity of Pond #1, and any other soils as necessary, will occur in Phase III-A. The cleanup verification survey will also occur in Phase III-A. The methodology for soil sampling and radiological analysis during the cleanup and verification survey is presented in preliminary form in Chapter 7 of this document. Appendix B provides additional detail to supplement the description of the contaminated soils cleanup effort.

2.5.3 Geomorphic Investigation

A geomorphic investigation was conducted in the site vicinity in September 1995 to evaluate potential long-term impacts to reclamation design elements. The geomorphic investigation report is included in Appendix C. The report presents an evaluation of the reclamation plan considering long-term stability, potential sediment impacts, and potential head-cutting impacts. The geomorphic analysis concluded that the stability provided by the reclamation measures will not be diminished by geomorphic processes.

4.3 Radon Flux Measurements

Radon flux from the covered tailings ponds will be measured in the field prior to placement of the riprap erosion protection layer. The flux measurements will be used to determine if the standard of 20 pCi/m^2-sec is achieved or whether additional cover material is necessary. At least 100 regularly spaced measurements for each region, or tailings pond, will be made using Large Area Activated Charcoal Collectors (LAACCs), as detailed in the Standard Operating Procedure, with weather-related restrictions, is provided as Attachment B.3.

Table 5.2 Erosion Protection Cover Design Input

Location	Slope ID	Slope (%)	Hydraulic Length (ft)	Lag Time (hr)	Curve Number
Pond #1	Top Surface	0.25	1300	0.176	76
	Embankment	20.0	326	0.013	76
Pond #2	Top, Central	5.0	200	0.015	76
	Top, Northern	1.9	630	0.051	76
	Embankment	12.5	597	0.024	76

5.2 Diversion Channels

Three diversion channels and a drainage swale will be constructed as integral parts of the site closure configuration. Designs for the diversion channels were based on one-half of the PMF with significant freeboard. Phase II reclamation at the site includes the design and construction of the Campsite Draw diversion, construction of the swale between and below Ponds #1 and #2 and partial construction of the Southwest diversion. Designs for the Southwest and the Pond #1 East diversions are preliminary at this time and will be finalized at a later date. Construction of the Pond #1 East diversion and completion of the Southwest diversion will occur in Phase III.

The diversions minimize run-on to and provide drainage from the ponds and adjacent areas. The swale provides controlled drainage from the site. The locations of the diversion channels and swale were selected from several alternatives and represent an optimal balance for providing adequate drainage and minimizing cost. Riprap protection was sized using the 1991 U.S. Army Corps of Engineers' Riprap Sizing Methodology, which is detailed in Appendix I.

Locations of the preliminary and final design diversion channels and the swale are presented on Figure 5.3. Table 5.3 presents channel hydrologic and hydraulic design parameters, which are further described in Appendix I.

Table 5.3 **Diversion Channel Hydrologic and Hydraulic Design Parameters**

Channel	Half-PMF Flow (cfs)	Velocity (ft/s)	Design Slope (ft/ft)	Bottom Width (ft)	Side Slopes (H:V)	Design Depth (ft)
Campsite Draw	1,896	10.49	0.0143	30	5:1	8.0
Southwest*	1,061	5.81	0.005	30	5:1	6.0
Pond #1 East*	163	5.47	0.0067	12	3:1	4.0

* Preliminary design

Diversion of Campsite Draw runoff away from Pond #2 is necessary because undiverted discharge from the design event would flow onto the reclaimed surface and potentially erode the cover. The channel design includes riprap protection that was conservatively sized and also takes into account the erosive forces along the outside of bends. Details of channel design are discussed further in Appendix I. The Campsite Draw diversion will also carry flows from the southern slopes of Pond #2 and the basins southwest of Pond #2. Figure 5.4 is a typical cross section and Drawing 12 presents a plan view and profile for the Campsite Draw diversion. Drawings 13 through 15 present Campsite Draw diversion cross sections.

The Southwest and Pond #1 East diversion channels will divert runoff from the basins to the east, south, and southwest of Pond #1 into the natural drainages northwest and northeast of the pond. Diversion of the flows will help minimize potential infiltration and minimize the potential for erosive flows over the reclaimed cover. Drawing 16 presents a preliminary profile and cross sections for the Southwest diversion.

As part of Phase II of the reclamation plan the surface of the ANC Spoil Pile, where the Southwest diversion is located, will be regraded to minimize the potential for sediment to adversely impact the channel. The slopes will be regraded to 5:1 and a 25 to 50 feet wide, flat buffer will be constructed to minimize sediment deposition in the channel. A bench will be placed midway down the 5:1 slope and will be sloped back toward the pile to intercept runoff and direct it along the bench rather than down the pile's face. This preliminary configuration is depicted in cross section on Drawing 16. The Wyoming AML program has agreed to move portions of the ANC Spoil Pile that will not be used in the radon barrier for Ponds #1 and #2.

Movement of mine spoil from the ANC Spoil Pile to Pond #2 during Phase II construction will result in the construction of a portion of the Southwest diversion. Completion of the Southwest diversion through the natural ridge to the southwest of Pond #1 will occur in Phase III. However, a temporary connection between the Southwest diversion and an existing temporary ditch adjacent to Pond #1 will be constructed in Phase II to provide drainage.

The Southwest diversion will collect potential run-on to Pond #1 as well as runoff from the pond surface. The channel bottom will have a lower elevation than the reclaimed surface and drainage will be directed from the pond surface toward the channel, and will be unlined. The channel was designed to be very wide in order to minimize flow velocities.

The swale between Ponds #1 and #2 will carry the runoff from the area between the ponds and from portions of the Pond #2 surface. Because the swale will be located a minimum of 300 feet from a tailings embankment and the erosive forces in the swale are directed away from the reclaimed ponds the swale will not be lined with riprap.

Outlet erosion protection will not be necessary at the confluence of the Campsite Draw diversion and the Willow Springs Draw diversion as the transition between the channels will be smooth and with very little change in slope, which will minimize scouring and head cutting.

Drainage channel design was performed using normal depth assumptions. The velocity for a particular section of channel is dependent on channel roughness and geometry. Channel slopes were selected in order to balance the need to minimize slope to minimize scour and the need to provide sufficient slope to flush sediments.

5.3 Surface Erosion Protection

Pond #2 will be reclaimed by adding a nearly uniform thickness of 6 feet of cover soil, which will approximate current slopes. This surface will be covered with gravel-sized riprap (detailed in Appendix H) for erosional stability. The Pond #1 surface, which will slope toward the Southwest diversion channel at an approximate 0.25 percent slopes, will also have gravel-sized riprap protection. The sloped areas of the Pond #2 and Pond #1 top surfaces were analyzed using Shields' incipient motion relationship (NRC, 1990), also discussed in Appendix H. Both top surfaces will have 1¼-inch median diameter riprap placed in a minimum 3-inch thick layer. Riprap that will be placed on the top surfaces will be uniformly graded, which will minimize segregation during placement, thereby ensuring adequate coverage by the required rock size.

Required surface riprap size for Pond #2 was evaluated at two locations (see Figure 5.5). The first is located in the approximate center of the pond where the slope is steepest, at 5 percent. However, the discharge is less in the center than at the northern portion of the top surface where the flow length is greater. The second location is near the northern portion of the top surface where the discharge is greatest, but where the slope is only about 2 percent.

The embankment slopes will be regraded to 5:1 for Pond #1 and 8:1 for Pond #2 and will be covered with riprap. Erosion protection was designed for the embankment surfaces of Ponds #1 and #2 using the Stephenson Method, which is discussed in more detail in Appendix H. The erosion protection sizing calculation for the Pond #2 north embankment was conservatively performed assuming that all of the discharge from the upgradient contributing area would flow down the faces of the embankments. The Pond #1 embankment protection was sized using only the embankment discharge since flows from the top surface will be directed toward the Southwest diversion channel. Both pond embankments will be protected with 3-inch median diameter riprap placed in a 6-inch thick layer. Table 5.4 summarizes the results of the rock sizing.

Table 5.4 Riprap Sizing Summary

Area	Slope (%)	Design Unit Discharge (cfs/ft)	Minimum Riprap D_{50} (in.)	Design Riprap D_{50} (in.)
Pond #1 Embankment*	20.0	0.29	2.0	3
Pond #1 Top Surface	0.25	0.36	0.14	1¼
Pond #2 Embankment	12.5	0.80	2.5	3
Pond #2 Top, Central Portion	5.0	0.35	1.1	1¼
Pond #2 Top, Northern Portion	1.9	0.68	0.9	1¼

* Preliminary Design

The swale between Ponds #1 and #2 starts near the western margin of the top of Pond #2. As shown in Drawing 9, an apron of 3-inch riprap, 300 feet long and 30 feet wide, will be placed adjacent to the 1¼-inch surface riprap and as extension of the 3-inch side slope riprap.

The north toe of Pond #2 will be protected by the 3-inch riprap placed over the 12:1 toe slope (Drawing 9). The north toe is also over 600 feet horizontally from the limit of tailings. The east toe of Pond #2 is at least 150 feet horizontally from the limit of tailings. Tailings along the eastern margin are also protected from potential erosion starting at the toe by the access road (see Drawing 23) which was constructed primarily out of gravel and cobbles. If oversize material from the Class 3 riprap is available, it will be placed at the toe in lieu of Class 3 riprap, as directed by the field engineer.

The southern margin of Pond #2 does not have a toe; slopes are continuous and gentle. Tailings at the southern margin therefore will be adequately protected by the surface riprap.

Both pond configurations also include a riprap apron on the top surface margins in which the embankment riprap is continued for approximately ten feet beyond the crest of the embankment to provide a transition between the 3-inch median diameter embankment riprap and the 1 ¼-inch median diameter top surface riprap. The configuration of the transition apron is presented on Figure 5.6 and on Drawing 10.

A small area on the extreme southern portion of the reclaimed Pond #1 surface will be approximately eight feet higher than the remainder of the reclaimed surface. Both portions will be nearly flat; however a sloped transition area between the two portions will require riprap protection. This transition area will slope at 10:1 and will consist of a rock layer of 3-inch median diameter riprap placed on the slope in a 6-inch thick layer.

Required riprap gradations for all rock are presented in Section 6.

Temporary (on the order of tens of years) erosion control will be provided until vegetation is fully established through erosion control ditches, berms and straw bale check dams as shown in plan view on Drawings 8 and 12, with details depicted in Drawing 11.

SHRUBS	GRASSES	INVADERS
Low sage Rabbit sage Fringed sage Bushy birds beak Phlox	Columbia needlegrass Prairie junegrass Bluebunch wheatgrass Dryland sage Western wheatgrass Indian ricegrass Crested wheatgrass Smooth brome	Thistle Knapweed

Random sampling of soil profiles on undisturbed plant communities on slopes which are similar to the proposed final grade, revealed that there is typically a soil layer which is restrictive to plant root penetration at 6 to 8 inches in depth. The greatest mass of plant roots occurs at 0 to 5 inches with a lesser abundance of roots occurring from 5 to 9 inches. A few roots of larger plants, such as sagebrush, were observed to penetrate the restrictive layer and proceed to depths of 48 inches into loosely cemented sandstone parent material.

Reclamation plans call for a 6-inch thick topsoil layer over areas with uncontaminated soils and a 12-inch thick topsoil layer on the mine spoil borrow area. The clean borrow area between Ponds #1 and #2 will be covered with 6 inches of topsoil and revegetated at the close of Phase II. Clean borrow for Phase III will derive primarily from the natural ridge southwest of Pond #1, through which the Southwest diversion will be constructed. Revegetation of the mine spoil borrow area will inhibit sediment transport into the Southwest diversion channel.

Based upon these observations and reclamation plans, it is reasonable to expect revegetation success of the ANC site and also help achieve compliance with NRC requirements for long-term stability.

Presently, the barren mine spoil pile is a contributor of sediment, atmospheric dust and is a visual detraction. Native plant cover would ameliorate these problems and would color blend this reclaimed area into the natural landscape.

The following species and quantities (PLS = pure live seed) are recommended for reseeding of the top surfaces of the tailings impoundments and the borrow areas:

Species (common name)	**PLS** (lbs/acre)
Cicer milkvetch	0.5
Sheep fescue, Covar variety	3
Indian ricegrass	3
Bluebunch wheatgrass	3
Western wheatgrass	4
Streambank wheatgrass	4
Thickspike wheatgrass	4
Rubber rabbitbush	0.5
	22.0 lbs/acre

the density or moisture specification will be reworked as necessary to achieve the minimum requirements as set forth in these specifications.

6.2.1 Compaction and Moisture Criteria

The Standard Proctor Test (ASTM D 698) will be used by the field engineer to determine the maximum density for soil compaction. The Standard Proctor Test will be performed at a rate of one (1) test per every fifteen (15) field density tests, depending upon the variability of materials as determined by the engineer.

Soil fill is divided into five categories depending on placement location and fill source. Compaction specifications are listed below for each fill category.

1. **Embankment fill.** Embankment fill will derive from the clean borrow area shown in Drawing 5. It will be placed at a density of greater than 92 percent of the maximum dry density due to its sand content.

2. **Lower portion of radon barrier.** Fill for the lower three feet of the Pond #2 radon barrier will derive from the ANC spoil pile shown in Drawing 5. It will be placed at 90 percent of the maximum dry density.

3. **Upper portion of radon barrier.** Fill for the upper three feet of the Pond #2 radon barrier will derive from the clean borrow area shown in Drawing 5. It will be placed at 92 percent of the maximum dry density for the lower 2.5 feet of the layer (note: the radon cover was modeled at an assumed density that was 80 percent of the measured dry density for the clean borrow). Fill for the upper six inches of the layer will be placed at 90 percent of the maximum dry density.

6.2.2 Testing Criteria

To satisfy the moisture-density control criteria for fill material placed, the following field testing frequencies will be performed by the engineer:

1. A minimum of one density test for each 5,000 cubic yards of embankment material placed,
2. A minimum of two density tests for each day when embankment material in excess of 2,500 cubic yards is placed, and
3. A minimum of one test per lift and a minimum of one test per full shift of compaction operations.

6.3 Riprap Sizing and Durability Testing

6.3.1 Riprap Durability Testing

The suitability of rock for use as riprap will be determined prior to construction of riprap structures. Required rock durability test results will be submitted to the engineer three weeks prior to the scheduled construction. Rock durability ratings will be based on results of the tests as listed in Table 6.1.

Table 6.1 Riprap Durability Testing

Test	Test Method
Specific Gravity	ASTM C127
Absorption	ASTM C127
Sodium Sulfate Soundness	ASTM C88
L.A. Abrasion	ASTM C535

The results of the above testing will be used to determine a rock durability rating in accordance with Table D1 of the NRC's Staff Technical Position (NRC, 1990) on the design of erosion protection covers. Table D1 is included as an attachment to Appendix H. Rock having a durability rating less than 65 as described in Table D1 will not be used.

On-site rock (Dry Coyote Conglomerate cobble) will be used to the maximum practical extent. The durability of this rock, tabularized in Appendix H, is shown to meet NRC durability standards with a rating of 92.

Rock durability testing will be performed by the contractor at the following frequencies:

1. A minimum of three rock durability tests for each source of rock, consisting of the four testing procedures identified above, will be provided by the contractor.
2. For any type of rock where the placement volume is greater than 30,000 cubic yards, a minimum of one rock durability test will be performed for each additional 10,000 cubic yards of rock placed.

Samples of rock for durability testing will be obtained from the contractor's stockpiles, by the contractor, at an area approved by the field engineer. Documentation of the results of the tests will be collected, organized and stored at the offices of AVI, p.c. in Cheyenne, Wyoming.

6.3.2 Riprap Gradation Testing

The gradation for each class of riprap shown in the drawings will be as listed in Table 6.2.

Table 6.2 Riprap Gradations

Riprap Class	Intermediate Orthogonal Dimension (inches)	Percent Passing Not to Exceed
Class 1 ¼	3	100
D_{50} =	1 ¼	50
	1	20
	¾	15*
Class 3	6	100
D_{50} =	3	50
	2	20
	1 ½	15*
Class 8	12	100
D_{50} =	8	50
	4	20
	2	15*

* Not to exceed 15 percent. Material below 15 percent by weight will consist of spalls and rock fragments to provide a stable compact mass.

Riprap was designed assuming round rock in order to be conservative. However, for stability purposes angular rock, achieved through fracturing, is specified. No more than twenty percent of any gradation of riprap is allowed to be non-fractured.

The contractor will provide to the engineer certified laboratory results of gradation testing for each source of rock to be used. The samples will be obtained from the contractor's stockpiles at locations approved by the engineer. Rock gradation testing will be performed by the contractor in the following frequencies:

1. A minimum of three rock gradation test for each source of rock will be conducted by the contractor.

2. For any type of rock where the placement volume is greater than 30,000 cubic yards, a minimum of one rock gradation test will be performed for each additional 10,000 cubic yards of rock placed.

Documentation of the results of the tests will be collected, organized and stored at the offices of AVI, p.c. in Cheyenne, Wyoming.

Control of grading will be by visual inspection. The sample will be used as a reference for judging the gradation of riprap supplied. Any difference of opinion between the field engineer and contractor will be resolved by dumping and checking the gradation of two random truck loads of riprap material.

Riprap will be placed by methods that will produce a compact uniform mass of riprap having a reasonably uniform surface. Riprap will be placed to its full thickness in one operation and in a manner to avoid displacing the underlying material. Placing of riprap materials by methods likely to cause segregation or damage to the surface will not be permitted. Hand placing or rearranging of individual stones or particles by mechanical equipment may be required to the extent necessary to secure the results required in the specifications. The Class 1¼ riprap will be at least three inches thick, the Class 3 riprap will be at least six inches thick and the Class 8 riprap will be at least 12 inches thick.

It is the intent of the specifications to produce a dense, compact riprap protection of uniform thickness. No tolerance for less than the specified thickness is provided. Thickness will be verified through survey of 100-foot grid points. A survey of blue top stake elevations will be performed prior to rock placement at 100-foot intervals along the project cross sections that will be established every 100 feet along the baseline (Drawing 9). Survey of rock elevations following placement at the same grid points will also be performed. Thicknesses will be recorded and areas of insufficient thickness will be subject to additional rock placement until the standard is achieved.

7.0 CONTAMINATED SOILS CLEANUP PLAN

This section of the reclamation plan presents a preliminary cleanup plan for contaminated soils at the ANC site. Soils cleanup and verification will occur in Phase III-A. A detailed decommissioning plan will be prepared and submitted at a later date, prior to the Phase III-A effort. The following description addresses in a general sense the topics that will be presented in greater detail with the final decommissioning plan.

The NRC's regulation pertaining to cleanup of contaminated soils, 10 CFR 40, Appendix A, Criterion 6 requires that site soils be cleaned up so that concentrations of radium, averaged over areas of 100 square meters, which as a result of byproduct material do not exceed background by more than 5 picocuries per gram (pCi/g) averaged over the first 15 centimeters (cm) below the surface, and 15 pCi/g averaged over 15 cm thick layers more than 15 cm below the surface.

This regulation requires NRC licensees to decontaminate site soils to within the 5 and 15 pCi/g radium above background limits. Four major steps are involved in this process: (1) background determination, (2) investigative survey, (3) contamination excavation and removal and (4) verification survey.

While, achievement of the standard is the goal, the means is not specified in the regulation. LQD may elect to till to depths of 12 to 18 inches (30 to 45 cm) areas with lightly contaminated soils, as detailed below. Tilling would be performed under the ALARA (as low as reasonable achievable) concept, given the limited budget available to LQD for site reclamation. Excavation of soils to a depth of 6 inches would cost approximately $2,000 per acre. Alternatively, tilling the soil would likely cost from $100 to $200 per acre, an approximate order of magnitude difference. Tilling as an alternative for cleanup is discussed further in Section 7.3.3.

The mill was buried at the southern end of Pond #2 in 1989. With the exception of the Bullrush Heap Leach, which was relocated to Pond #1 in 1995, all processing facilities, ore storage, and yellowcake storage were located, and subsequently buried, in the area adjacent to Pond #2. These buried facilities are all within the area delineated by the "limit of tailings" line displayed on figures and drawings (e.g., Figure 3 and Drawing 4). This entire area will be capped with the reclamation cover, which will include the radon barrier and erosion protection cover. There is no reason to expect that deep contamination due to releases from such storage or processing facilities exists in any of the soils to be cleaned under this program.

7.1 ANC Site Background Determination

In a NRC letter to ANC dated June 9, 1988, the NRC requested that ANC submit a sampling program for determining background concentrations of Ra-226 in soil. In response, ANC submitted data collected in 1983 which described background gamma exposure rates and Ra-226 concentrations in soil. These data indicated an average background gamma exposure rate of 30 micro R/hr (μR/hr) at 1 meter (unshielded) and average background Ra-226 concentrations in soil of 4.27 pCi/g at a depth of 0-15 cm and 4.07 pCi/g at a depth of 15-30 cm.

The background concentration for natural uranium was determined to be 15.8 μg/g, which equates in units of activity to 5.2 pCi/g of U-238, for near surface depth of 0-15 cm. At depths of 15-30 cm the average natural uranium concentration was determined to be 6.27 μg/g or 2.07 pCi/g U-238.

These background values were reviewed and accepted by the NRC and documented in a letter dated October 31, 1988. LQD, in performing the soils cleanup at the ANC site, will use these values as the background standard; no other background determination for the site will be performed by LQD.

Similar studies have been performed for several Wyoming Department of Environmental Quality (DEQ) Abandoned Mine Land (AML) projects in the Gas Hills region of Fremont County. For these projects background radiological assessments have been performed which evaluated background gamma exposure and radium-226 concentrations in soil. Surveys conducted in the West and Central Gas Hills areas, which include the ANC site, indicate radium-226 concentrations from 0-15 cm in depth ranging from 2.9 to 6.0 pCi/g with surface gamma readings of 24 to 32 μR/hr. One background location was sampled to a depth of 90 cm with chemical analyses indicating radium-226 soil concentration at 75-90 cm of 3.0 pCi/g. The ANC background values therefore appear to be consistent with those reported for the west and central Gas Hills Area. Additionally, Umetco's Gas Hills site has been studied to assess background. According to data presented by Umetco at the March 1996 NRC/National Mining Association Joint Workshop, site soil background corresponds to 28.4 μR/hr with a radium-226 activity of 9.9 pCi/g.

7.2 Investigative Survey

An investigative survey was performed in June 1995 to assess the extent of windblown contamination to be cleaned up at the ANC site. This survey included the use of microR meters and soil sampling with radiochemical analyses of the soils sampled for Ra-226 and natural uranium. The results of this survey are presented in Attachment B.1 in Appendix B of this document and are plotted geographically on Drawing 32. The investigative survey determined that background plus 5 pCi/g correlated with a gamma reading of 45 μR/hr with the instrument held within a few centimeters of the surface.

Drawing 6 depicts areas from which windblown material was excavated in 1996 Phase II efforts. The areas were staked in the field on the basis of scintillometer readings collected in 1996. Additional investigative surveys will be conducted prior to Phase III-A cleanup efforts to delineate the extent of additional windblown contamination. This information will be used to assess volumes and radium-226 activities so that an accurate final reclamation plan for Pond #1 can be prepared. Additionally, the correlation between gamma reading in μR/hr and radium-226 concentration in pCi/g will be confirmed. This correlation will allow cleanup and verification to occur in a timely and cost-effective manner. The investigative survey and correlation will be included in the final decommissioning plan to be submitted at a later date.

Also shown on Figure 6 are four lines proceding eastward from Pond #2 that were surveyed for gamma using a scintillometer. The lines were walked to determine the extent of windblown contamination east of the pond. The gamma readings along the four lines, proceeding from near Pond #2 eastward, are presented in Table 7.1.

7.3 Cleanup Procedure and Surveys

The following information is preliminary and will be revised and amplified with the final decommissioning plan to be submitted at a later date.

7.3.1 Training

All personnel participating in the cleanup process will be trained in the handling of radioactive material and in practicing good housekeeping when working around radioactive materials. Training will include such topics as:

- potential hazards of exposure to uranium and its decay products,
- how uranium and its decay products enter the body (inhalation, ingestion, skin penetration),
- why exposures should be kept as low as reasonably achievable (ALARA), and

Table 7.1 Results of Gamma Measurements, Extent of Windblown Tailings

Line 1		Line 2		Line 3		Line 4	
37	43	25	35	24	33	23	31
45	41	26	33	23	34	25	31
40	40	28	34	32	34	27	31
48	40	29	32	41	33	36	31
35	41	28	33	42	33	39	31
39	37	27	34	50	32	40	32
33	40	28	34	60	32	41	32
32	39	33	34	34	31	41	31
43	36	28	33	39	32	38	35
44	35	28	32	39	32	38	38
49	33	30	32	42	32	38	45
45	34	31	31	43	32	39	46
43	33	35	31	55	32	39	39
41	32	42	31	50	31	38	35
30	33	43	30	43	31	36	33
30	34	38	29	42	32	36	30
30	30	42	28	38	31	35	28
31	30	40	28	37	31	35	28
35	29	40	27	37	30	33	27
37	27	40	28	37	29	33	28
39	27	40	28	39	28	34	30
41	28	40	27	36	27	32	28
37	28	37	28	36	26	33	29
29	28	38	27	36	25	32	29
29	27	38	27	37	26	32	31
35	27	37	27	36		32	29
37		36	27	37		34	27
37		34	27	34		32	26
40		36	28	34		30	
42		35	27	34		30	

Note: Gamma was measured every 30 feet along these transects, beginning just east of the Willow Springs Draw diversion channel and progressing eastward. The transect locations are depicted in Drawing 6.

- the importance of observing the principles of personal hygiene with regard to reducing potential exposure, and the importance of the compliance of all site personnel with health and safety requirements to ensure that all exposures are ALARA.

Records of this training will be maintained for inspection at the offices of AVI, p.c. at 2035 Westland Rd., Cheyenne, WY.

7.3.2 Radiation Safety Program

Attachment B.2 in Appendix B outlines the radiation safety program which will be used during contaminated soils cleanup of the Gas Hills Uranium Mill site. Documentation of all monitoring for radiation safety will be maintained for inspection at the offices of AVI, p.c.

7.3.3 Cleanup Program

Cleanup of the ANC Gas Hills Uranium Mill site will be conducted in a phased approach, as described in Section 1 of this document. Phase II will be conducted in 1996 and will include cleanup of contaminated soils surrounding Pond #2. Phase III-A will include cleanup of contaminated soils surrounding Pond #1 and additional soils in the vicinity of Pond #2, with corresponding verification survey for the entire site to be conducted in Phase III-A.

The 1995 investigative survey collected radiochemical data which allow comparison of activity with soil depth. At several locations, both near-surface and deeper samples were collected and analyzed radiochemically for either radium-226 or natural uranium. At some locations the near-surface samples were collected from 0 to 3 inches in depth and the deeper samples were collected from 3 to six inches in depth. At other locations, the near surface samples constituted 0 to 6 inches in depth and the deeper samples constituted 6 to 12 inches in depth. In all instances, radium-226 and natural uranium concentrations were higher in the near surface samples. The average ratio for the near surface to deeper sample concentrations was 3.8. In other words, the deeper soils average an activity which is nearly 4 times less than the near surface soils.

All areas previously identified as having been affected by windblown contamination (refer to Drawing 6) exceeding the established criteria (9.27 pCi/g Ra-226, corresponding to a 45 μR/hr gamma reading, in the top 15 cm) will be cleaned up by one of two methods: tilling or excavation. If the tilling program is found to be effective, based on additional test plot results, it will be employed selectively where the methodology can be applied with reasonable expectation of success. All other areas will be cleaned up by excavating the windblown material with disposal on Pond #1.

Tilling. The results of the investigative survey indicate that for much of the areas contaminated by windblown materials, the contamination is relatively thin and confined to the upper 6 inches (15 cm) of soil. Tilling the soil in these areas through approximately the upper 18 inches (45 cm) of material is therefore presumed to result, through mixing, in meeting the cleanup criteria. The effectiveness of tilling was preliminarily assessed by establishing a test plot program in 1996 prior to application of the tilling method on a large scale.

The test plot was delineated in an area previously determined to exhibit gamma readings averaging approximately 45 to 75 μR/hr. The overall size of the test plot was 150 feet by 150 feet (50 m x 50 m) as shown in Figure 7.1. The plot was surveyed and tied to the project grid so that it could be relocated accurately after the tilling treatment.

The 150 foot by 150 foot test plot was divided into 25 subplots, or grids, each measuring 30 feet by 30 feet (10 m x 10 m) as shown in Figure 7.1. Each grid was assigned a number. Sample points were located at the corners and centers of each grid, for a total of 61 sample points in the test plot, as shown in Figure 7.1.

The tilling treatment in the test plot included ripping and disking as described in the Phase II specifications, and plowing. Ripping was done to a minimum depth of 18 inches and disking to a minimum depth of 8 inches. Each operation was performed in two directions, the second pass perpendicular to the first. Thus, the plot was ripped in two directions and disked in two directions, for a total of four passes of the equipment. A plow was then used in the test plot after ripping and disking because the plow turned the soil over and resulted in better mixing. A perimeter of approximately 25 feet was tilled beyond the test plot edges to ensure that the entire plot was treated effectively.

The test plot was sampled by gamma measurement and soil collection for laboratory analysis both before and after tilling. Gamma measurement was performed with a properly calibrated scintillometer at 1 cm and 1 m above the ground surface and at 6 inches below ground level. Soil samples for laboratory analysis of Ra-226 were collected from the 0 to 6 inches (0 to 15 cm) and 6 to 12 inches (15 to 30 cm) depth intervals. Both gamma measurements and soil samples were collected at all 61 sample points and grid results consisted of the averages of the five individual data points (four corners and center). Scintillometers were evaluated with a check source daily to ensure that the instruments remained in calibration.

All of the soil samples sent to the laboratory were analyzed for Ra-226 using a single channel analyzer cross-correlated to the Bi-214 peak. Approximately ten percent of the soil samples (or about 12) were chemically analyzed for Ra-226. This resulted in sufficient data to determine a statistically significant correlation between the gamma readings and Ra-226 lab analysis. The laboratory used was independent and authorized, with adequate QA/QC procedures and with QA/QC documents available for inspection. The laboratory was required to demonstrate that their QA program includes the use of traceable standards and duplicates. These conditions hold for analysis during both the test plot program and the verification survey.

The field gamma measurements coupled with laboratory testing provide control and documentation that the criteria are indeed being attained and that the gamma reading of 45 μR/hr is a valid breakpoint for defining contaminated conditions. Adjustments to the windblown cleanup program will be made as necessary based on the results of additional characterization efforts in Phase III-A.

Test plot results are presented in Attachment B.4 and are summarized in Table 7.2. The values in Table 7.2 are averages of values obtained at the four corners and center of each grid. The data indicate that the gamma readings in the test plot ranged from 40 to 98 μR/hr for the 61 sample points (54 to 80 μR/hr for the 25 grids), with a grid average of 68 μR/hr. Prior to the tilling/plowing treatment the mean radium-226 concentration for the 25 grids was 25.5 pCi/g in the first 6 inches (15 cm) of the soil column. All 25 grids failed the 9.27 pCi/g standard before treatment. After tilling and plowing only 4 grids passed the standard, with a mean radium-226 concentration of 12.07 pCi/g for the 25 grids in the upper 6 inches of the soil.

At a depth of 6 to 12 inches (15 to 30 cm), all 25 of the grids met the 19.27 pCi/g standard prior to the treatment, with a grid average of 5.05 pCi/g (close to established background). All 25 of the grids also met the standard after tilling and plowing, with a grid average of 11.74 pCi/g. Therefore, mixing of the windblown material into the lower portion of the soil column did not result in radium-226 concentrations too high to meet the 6 to 12 inches (15 to 30 cm) standard.

Excavation. Scrapers were used to remove contaminated soils during Phase II and the removed material was placed along the eastern margin of Pond #2 (Drawing 6). It is estimated that approximately 20,000 to 40,000 cubic yards of material were relocated in Phase II. The reclamation cover of 3 feet of mine spoil material and 3 feet of clean borrow will be placed over the relocated material. Soils excavated in cleanup conducted during Phase III-A will be relocated to Pond #1. A more detailed description of the cleanup to be conducted in Phase III-A will be provided at a later date.

Table 7.2 Test Plot Results Summary

Grid #	0 to 6 inches (0-15 cm)			6 to 12 inches (15-30 cm)	
	Gamma (μR/hr)	Ra-226 Before tilling (pCi/g)	Ra-226 After tilling (pCi/g)	Ra-226 Before tilling (pCi/g)	Ra-226 After tilling (pCi/g)
1	54	9.7	8.7	3.4	9.7
2	64	23.1	10.4	4.0	13.3
3	79	39.0	15.8	5.4	11.4
4	80	37.7	12.8	4.9	10.7
5	71	30.6	13.7	4.3	10.0
6	62	21.6	11.2	4.3	14.0
7	63	22.6	10.0	4.1	15.9
8	70	27.0	13.4	4.9	16.1
9	72	28.6	14.1	10.8	12.1
10	63	17.4	15.1	4.2	11.0
11	61	21.1	10.5	4.2	10.1
12	66	25.6	10.4	5.2	12.7
13	74	32.8	12.8	5.3	16.2
14	76	35.1	18.0	5.0	18.9
15	68	24.3	17.4	4.7	12.6
16	71	28.1	8.6	4.6	7.4
17	66	25.1	11.5	5.7	7.2
18	72	26.3	12.9	4.6	8.8
19	69	24.0	11.2	5.5	13.6
20	71	27.6	12.9	5.6	12.6
21	62	21.0	9.2	4.8	6.8
22	63	18.2	11.6	4.3	10.3
23	60	13.1	10.4	4.7	9.1
24	63	19.5	8.3	5.4	10.3
25	71	38.1	11.1	6.4	13.0
Mean	68	25.5	12.1	5.1	11.7

7.3.4 Cleanup QA Plan

The cleanup procedures will be monitored and controlled on the ground by using scintillometers to measure gamma to determine the effectiveness of cleanup while cleanup is in process. Gamma readings will be taken at frequent intervals while walking behind the equipment using properly calibrated scintillometers. The same scintillometers used in the correlation survey will be used in field QA to ensure instrument consistency. The field QA technician will be trained in radiation safety, gamma measurement techniques, and program objectives. The scintillometers will be evaluated with a check source daily. Soil sampling will not be used in cleanup QA due to the long turn-around times in laboratory measurement.

Visual verification will be used as a supplement to gamma measurements. Field observations indicate that there is an easily noticeable demarcation between the windblown material and the underlying native soils. The demarcation consists of an obvious change in color from the lighter overlying windblown material to the darker native soils, coupled with a layer of vegetation organics. In the area where this was examined, north of the substation approximately 1,000 feet northeast of Pond #2 (see Drawing 6), the windblown material was about 6 inches deep.

7.4 Verification Survey

The verification survey as defined in the final decommissioning plan will be conducted after the completion of contaminated soils cleanup in Phase III-A. All windblown cleanup areas will be subjected to verification sampling to verify that the cleanup meets the established standards. A 150 foot by 150 foot (50 m by 50 m) sampling grid will be established on all cleanup areas. This grid will be surveyed and tied in to the project grid prior to cleanup operations so that sampling points can be accurately located after cleanup. The 150 foot by 150 foot grid will be further divided into 25 30 foot by 30 foot (10 m by 10 m) subgrids. Each 30 foot by 30 foot grid will be assigned a number in consecutive order. It is expected that approximately 3,500 to 4,000 30 foot by 30 foot grids will be established. Sample points will be located entirely within each grid.

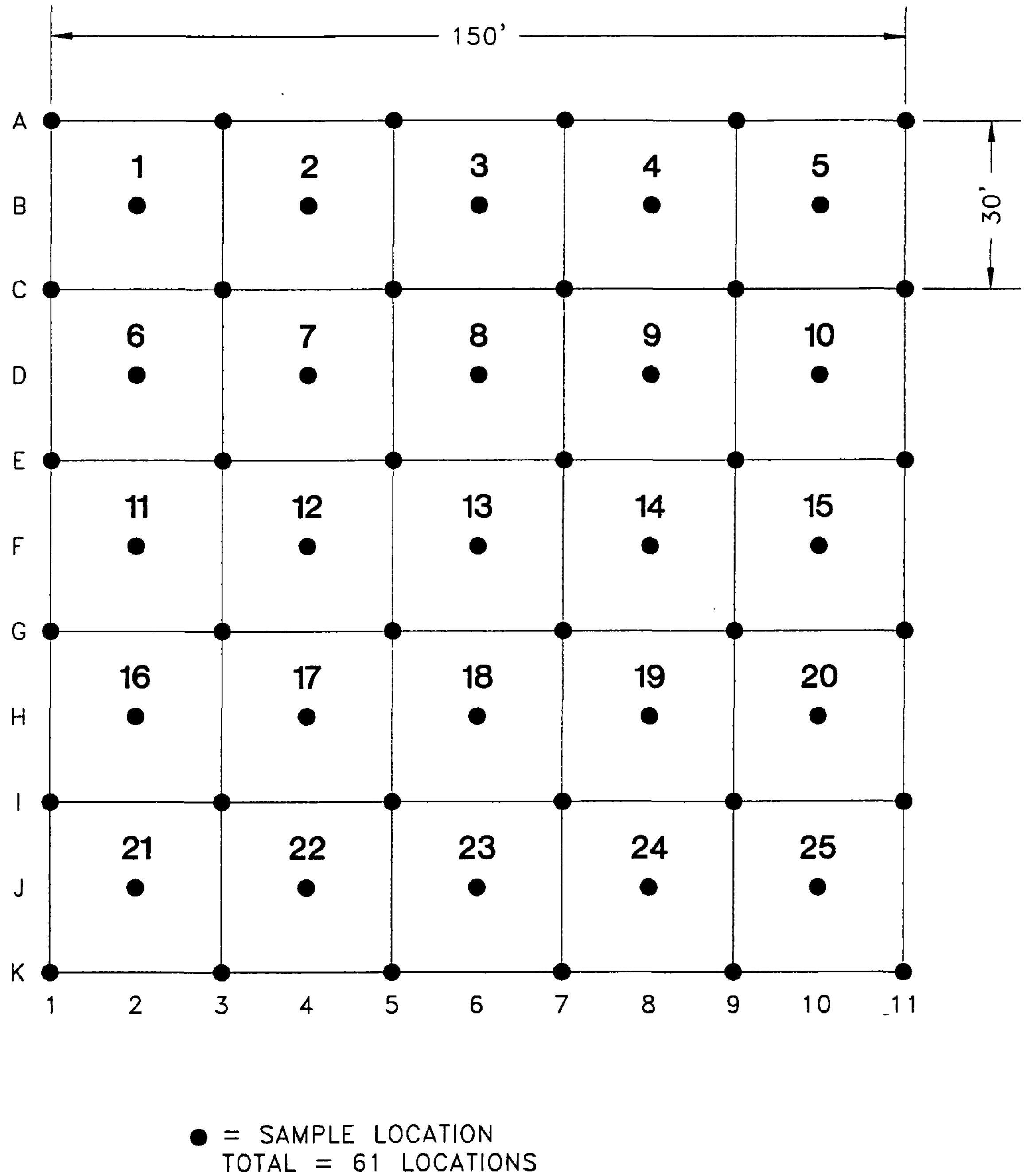
Gamma readings will be collected using properly calibrated scintillometers. The same instruments used in the correlation survey and in QA during cleanup will be used during verification for instrument consistency. Scintillometers will be evaluated daily with a check source. Soil samples for laboratory analysis will be collected in 30 feet by 30 feet (10m by 10m) grids in accordance with the detailed verification plan to be submitted later. Each sample will be a composite of individual samples within the grid. Composite samples will be collected at two depth intervals: 0 to 6 inches (0 to 15 cm) and 6 to 12 inches (15 to 30 cm). Additionally, 10 percent of the grids for which soil samples are collected will be selected for analysis of similarly composited soil samples at depths up to 24 inches (60 cm). The details regarding the gamma measurement approach, number of grids to be checked with soil samples, the number of soil samples in each grid composite, and the method for selecting the 10 percent of the grids for analysis of soils to depths of 24 inches will be submitted with the final decommissioning plan.

All soil samples sent to the lab will be analyzed for Ra-226 using a single channel analyzer cross-correlated to the Bi-214 peak. Ten percent of the soil samples (approximately 30) will be chemically analyzed for Ra-226.

Any grids which do not meet the established cleanup criteria will be remediated as necessary, including tillage as an option, and then the verification plan repeated. This process will be repeated until each grid is verified as cleaned. As stated above, an obvious visual demarcation exists between windblown material and underlying native ground and contamination is not expected to extend to depths beyond about 6 to 12 inches. Additionally, natural background is variable. To avoid cleaning up what in reality is natural background, a performance-based criterion will be established: if 12 inches of material are removed, or a line of obvious demarcation between windblown material and native soil is reached, and gamma measurements indicate that the grid still exceeds the cleanup criteria, excavation will be halted.

7.5 Documentation

Field gamma measurements and results of soil analyses will be recorded on data sheets and on topographical maps of the area being cleaned up. Permanent site survey markers will be established prior to commencing cleanup to provide reference survey locations which can be used during all phases of the cleanup. All documentation, including laboratory sheets, field sheets, and maps will be made available for NRC reveiw.



SHEPHERD MILLER INCORPORATED

FIGURE 7.1
CONTAMINATED SOILS CLEANUP
TEST PLOT AND VERIFICATION GRID

Date:	JUNE 1996
Project:	04-428
File:	GRIDVER

TABLE OF CONTENTS

ATTACHMENTS

ATTACHMENT B.3

RADON FLUX MEASUREMENT
STANDARD OPERATING PROCEDURE

ENERGY LABORATORIES, INC. - CASPER, WYOMING

STANDARD OPERATING PROCEDURES

LARGE AREA ACTIVATED CHARCOAL COLLECTORS (LAACC)

Approved By:

Originator	8/16/96 *Date*
Technical Reviewer (if applicable)	8/16/96 *Date*
ELI Quality Assurance Officer	8-16-96 *Date*
R. A. Harling *ELI Laboratory Manager*	8-16-96 *Date*

Distribution of Official Copies:

ELI Laboratory Manager
All ELI Staff

1.0 MEASURING RADON FLUX USING LARGE AREA ACTIVATED CHARCOAL COLLECTORS (LAACC)

The method used to measure radon flux involves absorption of radon on activated charcoal in a large area collector. The collector is placed onto the surface of the material to be measured and is allowed to collect radon for a time period of 24 hours. The radon collected on the charcoal is then measured by gamma spectroscopy.

Per 40 Code of Federal Regulations (CFR), *Part 61, Environmental Protection Agency, National Emission Standards for Hazardous Air Pollutants; Radionuclides; Final Rule and Notice of Reconsideration*, December 15, 1989, it is imperative that the temperature and moisture conditions are met for the measurement activity. Notification to the appropriate agencies should be made accordingly.

The collector consists of a PVC end cap with handle, screened spacer pads, charcoal distribution grid, screened retainer pad, and a steel retaining rod. Approximately 180 grams of activated charcoal is spread in the distribution grid. The retainer pad is placed over the charcoal and held in place by the retaining rod.

The collector is loaded with the charcoal by removing the retaining rod and pad, and placing the preweighed charcoal into the collector. The charcoal is then transported to the field in a sealed prenumbered can. The LAACC and charcoal canister numbers are recorded. The loading process should be done in an enclosed area so adverse wind conditions do not disturb the charcoal (blow it away). To allow for a quick transfer of charcoal into the LAACCs prior to deployment, LAACC units should be loaded by two or more personnel. Another team of two or more personnel should begin deployment immediately upon the charcoal transfer of a group of 10 to 20 LAACCs. Minimize the time a loaded LAACC is allowed to sit in ambient atmosphere. Care must be taken to minimize confusion and order of LAACCs and charcoal cans. An organized method of transfer and a large working area assist in minimizing any errors in LAACC/canister mismatching. A large vehicle could provide for the necessary enclosed area (such as a Suburban or equivalent).

The prenumbered collectors are deployed by carefully positioning the end cap on a flat surface of the material to be measured with soils or tailings used to seal the edge, at the predetermined location. It is imperative that a complete seal is obtained between the collector and the material to be measured. A shovel or a hand trowel may be used to scoop the material around the edge of the collector, being careful not to scoop material into the vent hole. The location identification, LAACC number, and the set time should be recorded.

After approximately 24 hours (minor time overruns are acceptable) of exposure, the collectors are picked up and the time retrieved is recorded. If any other conditions are observed (such as a broken seal, wind blown conditions, etc.), they should also be recorded. The transfer of the charcoal should begin immediately upon retrieval. The LAACCs are transported to the enclosed work area where a team of two or more personnel are responsible for transferring the charcoal carefully back into the appropriate prenumbered cans. The time between retrieval and transferring the exposed charcoal should be held to a minimum, however, site and field conditions contribute to the timeliness of the transfer.

The activated charcoal is removed from the collector by removing the retaining rod and pad from the collector and dumping the charcoal into a large funnel which leads into the prenumbered steel alloy can. The can's lid is placed and a wrap of electrical tape is applied to the can seam to eliminate any leakage or introduction of air into the can. The tape also assists in creating a closed (sealed) system to allow for the radon collected to equilibrate for four (4) hours before counting to allow the ingrowth of the radon daughters.

The sealed cans are transported to the laboratory where they are counted and recorded. The following information pertains to the calculation that will be made to ascertain the radon flux for each specific LAACC location.

2.0 U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA) REQUIREMENTS FOR FIELD MEASUREMENT OF RADON FLUX

Radon-222 Emissions from Uranium Mill Tailings Piles - Per 40 CFR, *Part 61, Environmental Protection Agency, National Emission Standards for Hazardous Air Pollutants; Radionuclides; Final Rule and Notice of Reconsideration*, December 15, 1989, the following has been reprinted:

Method 115 - Monitoring for Radon-222 (^{222}Rn) Emissions

This Appendix describes the monitoring methods which must be used in determining the ^{222}Rn emissions from underground uranium mines, uranium mill tailings piles, phosphogypsum stacks, and other piles of waste material emitting radon.

2.1 Measurement and Calculation of Radon Flux from Uranium Mill Tailings Piles

2.1.1 Frequency of flux measurement

A single set of radon flux measurements may be made, or if the owner or operator chooses, more frequent measurements may be made over a one year period. These measurements may involve quarterly, monthly, or weekly intervals. All radon measurements shall be made as described in paragraphs 2.1.2 through 2.1.6 except that for measurements made over a one year period, the requirement of paragraph 2.1.4(c) shall not apply. The mean radon flux from the pile shall be the arithmetic mean of the mean radon flux for each measurement period. The weather conditions, moisture content of the tailings and area of the pile covered by water existing at the time of the measurement shall be chosen so as to provide measurements representative of the long term radon flux from the pile and shall be subject to EPA review and approval.

2.1.2 Distribution of flux measurements

The distribution and number of radon flux measurements required on a pile will depend on the clearly defined areas of the pile (called regions) that can have significantly different radon fluxes due to surface conditions. The mean radon flux shall be determined for each individual region of the pile. Regions that shall be considered for operating mill tailings piles are:

- water covered areas,
- water saturated areas (beaches),
- dry top surface areas, and
- sides, except where earthen material is used in dam construction.

For mill tailings after disposal the pile shall be considered to consist of only one region.

2.1.3 Number of radon flux measurements

Radon flux measurements shall be made within each region of the pile, except for those areas covered with water. Measurements shall be made at regularly spaced locations across the surface of the region, realizing that surface roughness will prohibit measurements in some areas of a region. The minimum number of flux measurements considered necessary to determine a representative mean radon flux value for each type of region on an operating pile is:

- water saturated area - no measurements required as radon flux is assumed to be zero,
- water saturated beaches - 100 radon flux measurements,
- loose and dry top surface - 100 radon flux measurements, and
- sides - 100 radon flux measurements, except where earthen materials is used in dam construction.

For mill tailings pile after disposal which consists of only one regional minimum of 100 measurements are required.

2.1.4 Restrictions to radon flux

Measurements - the following restrictions are placed on making radon flux measurements:

- measurements shall not be initiated within 24 hours of a rainfall;
- if a rainfall occurs during the 24 hour measurements period, the measurement is invalid if the seal around the lip of the collector is surrounded by water; and
- measurements shall not be performed if the ambient temperature is below 35°F or if the ground is frozen.

2.1.5 Areas of pile regions

The approximate area of each region of the pile shall be determined in units of square meters.

2.1.6 Radon Flux Measurements

Measuring radon flux involves the absorption of radon on activated charcoal in a large-area collector. The radon collector is placed on the surface of the pile area to be measured and allowed to collect for a period of 24 hours. The radon collected on the charcoal is measured by gamma-ray spectroscopy. The detailed measurement procedure provided in Appendix A of EPA 520/5-85-0029(1) shall be used to measure the radon flux on uranium mill tailings, except the surface of the tailings shall not be penetrated by the lip of the radon collector as directed in the procedure, rather the collector shall be carefully positioned on a flat surface with soil or tailings used to seal the edge.

2.1.7 Calculations

The mean radon flux for reach region on the pile and for the total pile shall be calculated and reported as follows:

a. The individual radon flux calculations shall be made as provided in Appendix A EPA 86 (1). The mean radon flux for each region of the pile shall be calculated by summing all individual flux measurements for the region and dividing by the total number of flux measurements for the region.

b. The mean radon flux for the total uranium mill tailings pile shall be calculated as follows:

$$J_s = \frac{J_1A_1 + \ldots J_2A_2 \ldots J_iA_i}{A_t}$$

Where:

J_S	=	mean flux for the total pile (pCi/m^2-s)
J_1	=	mean flux measured in region i (pCi/m^2-s)
A_1	=	area of region i (m^2)
A_t	=	total area of pile (m^2)

2.1.8 Reporting

The results of the individual flux measurements, the approximate locations on the pile, and the mean radon flux foe each region and the mean radon flux for the total stack shall be included in the emission test report. Any conditions or unusual event that occurred during the measurements that could significantly affect the results should be reported.

3.0 SAMPLING AND LABORATORY PROCEDURES FOR ATTAINING RADON FLUX MEASUREMENTS

Quality Assurance Procedures for Measuring ^{222}Rn Flux - Per 40 CFR, Part 61, *Environmental Protection Agency, National Emission Standards for Hazardous Air Pollutants; Radionuclides; Final Rule and Notice of Reconsideration*, December 15, 1989, the following has been reprinted:

Method 115 - Monitoring for ^{222}Rn Emissions

This Appendix describes the monitoring methods which must be used in determining the ^{222}Rn emissions from underground uranium mines, uranium mill tailings piles, phosphogypsum stacks, and other piles of waste material emitting radon.

a. *Sampling Procedures*

Records of field activities and laboratory measurements shall be maintained. The following information shall be recorded for each charcoal canister measurement:

- site,
- name of pile,
- sample location,
- sample ID number,
- date and time on,
- date and time off, and
- observations of meteorological conditions and comments.

Records shall include all applicable information associated with determining the sample measurement, calculations, observations, and comments.

b. *Sample Custody*

Custodial control of all charcoal samples exposed in the field shall be maintained in accordance with EPA chain of custody field procedures. A control record shall document all custody changes that occur between the field and laboratory personnel.

c. *Calibration Procedures and Frequency*

The radioactivity of two standard charcoal sources, each containing a carefully determined quantity of Radium-226 (^{226}Ra) uniformly distributed through 180 grams of activated charcoal, shall be measured. An efficiency factor is computed by dividing the average measured radioactivity of the two standard charcoal sources, minus the background, in cpm by the known radioactivity of the sources in dpm. The same two standard charcoal sources shall be at the beginning and at the end of each day's counting as a check of the radioactivity counting equipment. A background count using unexposed charcoal should be made at the beginning and at the end of each counting day to check for inadvertent contamination of the detector or other changes affecting the background. The unexposed charcoal comprising the blank is changed with each new batch of charcoal used.

d. *Internal Quality Control Checks and Frequency*

The charcoal from every tenth exposed canister shall be recounted. Five percent of the samples analyzed shall be either blanks (charcoal having no radioactivity added) or samples spiked with known quantities of ^{226}Ra.

e. ***Data Precision, Accuracy, and Completeness***

The precision, accuracy, and completeness of measurements and analyses shall be within the following limits for samples measuring greater than 1.0 pCi/m^2-s.

- Precision: 10%
- Accuracy: 10%
- Completeness: At least 85% of the measurements must yield usable results

Energy Laboratories, Inc. (ELI) has two multi-channel gamma spectrometers available at its Casper facility.

ELI is an EPA certified and listed laboratory. Certification has been maintained in the areas for determination of radiochemical, inorganics, and organics in drinking waters. ELI has been actively participating in EPA's Radon Proficiency Program since its inception for determination of radon concentrations in homes and structures. ELI has two staff members presently accepted by the U. S. Nuclear Regulatory Commission (NRC) as Radiation Safety Officers and have performed radiation surveys for uranium operations since 1980. These surveys include alpha, beta, and gamma emitting radionuclides in air, soil/surface, and water for determination of employee occupational exposure awhile working at mine sites.

Copies of ELI's Quality Assurance and certifications are available upon request.

The professional personnel will be available for consultation prior to and during the sampling duration. The following areas should be addressed before sampling:

- timing of collection (24 hours sampling or annual),
- regions within the tailings impoundment (quantity and area),
- personnel responsible for placement of collectors,
- EPA notification of intent to proceed with collection,
- current topographical map of tailings impoundments to be sampled,
- sample point locations to be marked prior to collector placement, and
- location of any background samples such as up wind of the impoundment (undisturbed areas) as a point of comparison.

ELI will provide the company with a report that will include a minimum of the following:

- number and laboratory ID of collectors placed;
- date and time of collectors placed, retrieved, and charcoal counted;
- map of location of collectors (provided by company);
- radon flux calculations for each detector, region, and total tailings impoundment;
- spectrum print out for each detector, if requested; and
- quality assurance data will be provided upon request. This data will consists of duplicates, blanks, standards, and geometry verification.

ATTACHMENT B.4

TEST PLOT DATA

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LABORATORY ANALYSIS REPORT - AVI, Inc.

Report Date: June 16, 1996 (revised 11-30-96)
Project: American Nuclear Corpration's Gas Hills Facility
Matrix: Soils - Before Disking

		Depth - 0-6"						Depth - 6-12"	
Laboratory Number	AVI Grid ID	Field Gamma Reading @ 1m uR/hr	Field Gamma Reading @ 1cm uR/hr	Ra226 By Gamma pCi/gm	Ra226 By Chemical pCi/gm	Laboratory Number	AVI Grid ID	Field Gamma Reading @ 1cm uR/hr	Ra226 By Gamma pCi/gm
96- 35939	Control	-	27	11.3 ± 1.2	-	-	-	-	-
96- 35940	Control #2	-	28	5.9 ± 0.7	-	-	-	-	-
96- 35941	Control #3	-	27	5.9 ± 0.7	-	-	-	-	-
96- 35942	Back #4	-	30	6.8 ± 0.8	-	-	-	-	-
96- 35943	Back #5	-	30	5.7 ± 0.6	-	-	-	-	-
96- 35944	Back #6	-	32	6.9 ± 0.8	-	-	-	-	-
96- 29907	A-1	65	46	7.2 ± 0.9	5.4 ± 0.3	29908	A-1	38	4.9 ± 0.7
96- 29907	Duplicate	-	-	7.0 ± 0.8	-	-	-	-	-
96- 29909	A-3	63	55	6.4 ± 0.8	-	29910	A-3	40	2.5 ± 0.4
96- 29911	A-5	81	88	67.6 ± 3.1	-	29912	A-5	65	8.4 ± 1.0
96- 29913	A-7	80	91	54.3 ± 2.7	51.4 ± 0.8	29914	A-7	65	4.7 ± 0.7
96- 29915	A-9	80	98	61.0 ± 3.1	61.4 ± 0.9	29916	A-9	82	5.9 ± 0.8
96- 29917	A-11	60	51	8.6 ± 0.9	-	29918	A-11	39	4.3 ± 0.6
96- 29917	Duplicate	-	-	8.7 ± 0.9	-	-	-	-	-
96- 29919	B-2	60	49	5.8 ± 0.7	-	29920	B-2	38	2.1 ± 0.4
96- 29921	B-4	70	60	14.4 ± 1.3	-	29922	B-4	45	2.9 ± 0.5
96- 29923	B-6	77	75	31.4 ± 2.2	33.6 ± 0.7	29924	B-6	60	5.8 ± 0.7
96- 29925	B-8	80	75	31.8 ± 2.0	-	29926	B-8	59	6.2 ± 0.8
96- 29927	B-10	73	78	50.6 ± 2.6	-	29928	B-10	50	3.5 ± 0.5
96- 29927	Duplicate	-	-	53.9 ± 2.7	-	-	-	-	-
96- 29929	C-1	65	65	16.5 ± 1.4	-	29930	C-1	42	4.0 ± 0.6
96- 29931	C-3	58	55	12.5 ± 1.2	-	29932	C-3	39	3.3 ± 0.5
96- 29933	C-5	70	63	14.7 ± 1.4	-	29934	C-5	50	3.3 ± 0.5
96- 29935	C-7	73	78	27.0 ± 1.8	-	29936	C-7	52	5.0 ± 0.7
96- 29937	C-9	73	59	14.3 ± 1.3	-	29938	C-9	41	3.3 ± 0.5
96- 29937	Duplicate	-	-	11.5 ± 1.1	-	-	-	-	-
96- 29939	C-11	68	68	18.5 ± 1.4	-	29940	C-11	45	4.9 ± 0.7
96- 29941	D-4	62	62	30.9 ± 1.9	-	29942	D-4	50	3.8 ± 0.6
96- 29943	D-6	75	58	14.6 ± 1.3	-	29944	D-6	45	4.6 ± 0.6
96- 29945	D-8	70	72	27.1 ± 1.8	-	29946	D-8	52	34.8 ± 2.1
96- 29947	D-10	71	60	5.3 ± 0.7	-	29948	D-10	48	3.4 ± 0.5
96- 29947	Duplicate	-	-	5.1 ± 0.7	-	-	-	-	-
96- 29949	E-1	67	65	32.5 ± 2.0	25.6 ± 0.6	29950	E-1	50	5.0 ± 0.7
96- 29951	E-3	62	55	10.1 ± 1.0	7.2 ± 0.3	29952	E-3	42	3.6 ± 0.5
96- 29953	E-5	72	80	44.7 ± 2.3	-	29954	E-5	60	6.6 ± 0.8
96- 29955	E-7	70	70	34.2 ± 2.1	29.1 ± 0.6	29956	E-7	50	4.8 ± 0.7
96- 29957	E-9	80	80	40.6 ± 2.2	-	29958	E-9	65	6.3 ± 0.8
96- 29957	Duplicate	-	-	39.4 ± 2.2	-	-	-	-	-
96- 29959	E-11	70	50	8.1 ± 0.9	-	29960	E-11	42	3.0 ± 0.5
96- 29961	F-2	61	50	11.3 ± 1.1	6.4 ± 0.3	29962	F-2	48	3.7 ± 0.6
96- 29963	F-4	68	55	8.3 ± 0.9	-	29964	F-4	42	3.9 ± 0.6
96- 29965	F-6	72	65	13.4 ± 1.2	-	29966	F-6	49	3.2 ± 0.5
96- 29967	F-8	70	73	42.8 ± .3	-	29968	F-8	59	4.7 ± 0.6
96- 29967	Duplicate	-	-	43.3 ± 2.3	-	-	-	-	-
96- 29969	F-10	70	65	7.8 ± 0.9	-	29970	F-10	50	4.8 ± 0.6
96- 29971	G-1	63	71	27.2 ± 1.8	-	29972	G-1	50	4.9 ± 0.7
96- 29973	G-3	62	65	24.5 ± 1.7	-	29974	G-3	42	4.0 ± 0.6
96- 29975	G-5	70	73	40.6 ± 2.3	-	29976	G-5	60	7.7 ± 0.9
96- 29977	G-7	71	80	31.1 ± 2.0	23.9 ± 0.6	29978	G-7	60	4.2 ± 0.6
96- 29977	Duplicate	-	-	30.7 ± 1.9	-	-	-	-	-

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LABORATORY ANALYSIS REPORT - AVI, Inc.

Report Date: June 16, 1996 (revised 11-30-96)
Project: American Nuclear Corpration's Gas Hills Facility
Matrix: Soils - Before Disking

		Depth - 0-6"						Depth - 6-12"	
Laboratory Number	AVI Grid ID	Field Gamma Reading @ 1m uR/hr	Field Gamma Reading @ 1cm uR/hr	Ra226 By Gamma pCi/gm	Ra226 By Chemical pCi/gm	Laboratory Number	AVI Grid ID	Field Gamma Reading @ 1cm uR/hr	Ra226 By Gamma pCi/gm
96- 29979	G-9	70	75	26.8 ± 1.8	-	29980	G-9	55	5.2 ± 0.8
96- 29981	G-11	68	69	38.3 ± 2.1	-	29982	G-11	50	4.4 ± 0.6
96- 29983	H-2	65	81	51.4 ± 2.6	-	29984	H-2	60	5.1 ± 0.7
96- 29985	H-4	70	60	25.5 ± 1.8	24.6 ± 0.6	29986	H-4	50	8.2 ± 0.9
96- 29987	H-6	70	78	34.2 ± 2.0	-	29988	H-6	50	3.7 ± 0.5
96- 29987	Duplicate	-	-	37.3 ± 2.1	-	-	-	-	-
96- 29989	H-8	66	60	21.6 ± 1.6	-	29990	H-8	50	5.8 ± 0.7
96- 29991	H-10	68	71	23.4 ± 1.7	-	29992	H-10	48	5.3 ± 5.3
96- 29993	I-1	60	62	7.8 ± 0.9	-	29994	I-1	40	4.2 ± 0.6
96- 29995	I-3	68	75	29.8 ± 1.9	-	29996	I-3	52	4.7 ±0.6
96- 29997	I-5	68	59	5.3 ± 0.7	-	29998	I-5	45	4.1 ± 0.6
96- 29997	Duplicate	-	-	6.3 ± 0.8	-	-	-	-	-
96- 29999	I-7	55	69	20.4 ± 1.5	-	30000	I-7	50	3.9 ± 0.5
96- 30001	I-9	69	60	19.9 ± 1.5	-	30002	I-9	50	8.7 ± 1.0
96- 30003	I-11	72	79	29.5 ± 1.8	-	30004	I-11	55	4.4 ± 0.6
96- 30005	J-2	60	65	19.6 ± 1.5	-	30006	J-2	42	3.7 ± 0.5
96- 30007	J-4	68	85	41.6 ± 2.2	32.3 ± 0.7	30008	J-4	88	4.7 ± 0.7
96- 30007	Duplicate	-	-	39.1 ± 2.2	-	-	-	-	-
96- 30009	J-6	65	62	17.9 ± 1.4	-	30010	J-6	48	6.3 ± 0.8
96- 30011	J-8	69	61	12.7 ± 1.2	-	30012	J-8	50	3.9 ± 0.6
96- 30013	J-10	71	79	49.2 ± 2.5	-	30014	J-10	58	8.0 ± 0.9
96- 30015	K-1	59	69	42.4 ± 2.2	-	30016	K-1	50	8.1 ± 0.9
96- 30017	K-3	52	40	5.5 ± 0.7	2.9 ± 0.2	30018	K-3	30	3.4 ± 0.5
96- 30017	Duplicate	-	-	6.0 ± 0.8	-	-	-	-	-
96- 30019	K-5	69	55	8.9 ± 1.0	-	30020	K-5	40	4.4 ± 0.6
96- 30021	K-7	65	55	12.8 ± 1.2	-	30022	K-7	39	5.0 ± 0.7
96- 30023	K-9	70	68	31.8 ± 1.9	-	30024	K-9	50	5.9 ± 0.8
96- 30025	K-11	68	70	60.2 ± 2.7	-	30026	K-11	42	5.1 ± 0.7
96- 30027	D-2	68	70	36.3 ± 2.0	-	30028	D-2	52	5.4 ± 0.7
96- 30027	Duplicate	-	-	34.3 ± 2.0	-	-	-	-	-

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LABORATORY ANALYSIS REPORT - AVI, Inc.

Report Date: August 28, 1996 (revised 11-30-96)
Project: American Nuclear Corporation's Gas Hills Facility
Matrix: Soils - After Disking

		Depth - 0-6"							Depth - 6-12"		
Laboratory Number	AVI Grid ID	Field Gamma Reading @ 1m uR/hr	Field Gamma Reading @ 1cm uR/hr	Ra226 By Gamma pCi/gm	Ra226 By Chemical pCi/gm	% Moisture %	Laboratory Number	AVI Grid ID	Field Gamma Reading @ 1m uR/hr	Ra226 By Gamma pCi/gm	% Moisture %
96- 42018	A-1	42	43	10.4 ± 1.1	6.2 ± 0.3	4.5	42019	A-1	-	7.5 ± 0.9	5.5
96- 42018	Duplicate	-	-	11.5 ± 1.2	-	-	-	-	-	-	-
96- 42020	A-3	38	34	6.3 0.8	-	6.5	42021	A-3	-	8.2 ± 1.0	7.3
96- 42022	A-5	46	50	14.0 ± 1.3	-	3.6	42023	A-5	-	6.2 ± 0.8	5.7
96- 42024	A-7	43	47	14.1 ± 1.4	-	4.7	42025	A-7	-	4.2 ± 0.6	3.8
96- 42026	A-9	43	44	17.9 ± 1.6	-	3.7	42027	A-9	-	16.1 ± 1.5	4.7
96- 42028	A-11	42	38	12.1 ± 1.2	10.5 ± 0.4	5.2	42029	A-11	-	8.8 ± 1.0	4.8
96- 42028	Duplicate	-	-	14.4 1.4	-	-	-	-	-	-	-
96- 42030	B-2	36	34	7.5 ± 0.9	-	5.0	42031	B-2	-	4.4 ± 0.7	5.8
96- 42032	B-4	42	40	7.3 ± 0.9	-	3.8	42033	B-4	-	18.8 ± 1.6	6.1
96- 42034	B-6	48	52	21.3 ± 1.8	-	3.9	42035	B-6	-	17.7 ± 1.6	4.9
96- 42036	B-8	47	61	12.3 ± 1.3	-	3.4	42037	B-8	-	20.2 ± 1.7	4.6
96- 42038	B-10	44	49	20.3 ± 1.7	18.2 ± 0.6	3.3	42039	B-10	-	4.2 ± 0.6	3.0
96- 42038	Duplicate	-	-	22.3 ± 1.7	-	-	-	-	-	-	-
96- 42040	C-1	38	40	8.8 ± 1.0	-	4.6	42041	C-1	-	15.7 ± 1.5	4.8
96- 42042	C-3	34	34	10.4 ± 1.1	-	4.7	42043	C-3	-	12.5 ± 1.3	3.8
96- 42044	C-5	46	45	14.1 ± 1.4	-	4.0	42045	C-5	-	21.0 ± 1.7	6.4
96- 42046	C-7	45	40	15.5 ± 1.4	-	3.0	42047	C-7	-	7.8 ± 1.0	5.1
96- 42048	C-9	40	51	4.4 ± 0.6	12.9 ± 0.5	1.9	42049	C-9	-	5.2 ± 0.7	3.9
96- 42048	Duplicate	-	-	9.2 ± 1.0	-	-	-	-	-	-	-
96- 42050	C-11	44	43	13.8 ± 1.4	-	3.8	42051	C-11	-	15.7 ± 1.4	4.1
96- 42052	D-2	38	36	8.6 ± 1.0	-	7.0	42053	D-2	-	8.9 ± 1.1	9.3
96- 42054	D-4	42	50	12.7 ± 1.3	-	2.4	42055	D-4	-	6.9 ± 0.9	4.9
96- 42056	D-6	43	48	9.7 ± 1.1	-	2.4	42057	D-6	-	6.4 ± 0.8	4.2
96- 42058	D-8	43	43	10.0 ± 1.1	7.3 ± 0.4	2.3	42059	D-8	-	16.8 ± 1.5	5.7
96- 42058	Duplicate	-	-	9.5 ± 1.1	-	-	-	-	-	-	-
96- 42060	D-10	46	44	13.6 ± 1.3	-	4.2	42061	D-10	-	16.5 ± 1.5	4.3
96- 42062	E-1	40	35	15.5 ± 1.4	-	3.9	42063	E-1	-	15.6 ± 1.5	4.8
96- 42064	E-3	45	51	12.5 ± 1.3	-	4.1	42065	E-3	-	17.3 ± 1.5	4.2
96- 42066	E-5	46	44	9.3 ± 1.1	-	5.1	42067	E-5	-	21.8 ± 1.8	4.3
96- 42068	E-7	46	48	18.2 ± 1.6	12.6 ± 0.5	2.4	42069	E-7	-	23.3 ± 1.8	5.9
96- 42068	Duplicate	-	-	19.1 ± 1.6	-	-	-	-	-	-	-
96- 42070	E-9	48	61	22.5 ± 1.8	-	3.7	42071	E-9	-	7.3 ± 0.9	7.2
96- 42072	E-11	48	56	21.3 ± 1.8	-	2.0	42073	E-11	-	10.4 ± 1.1	3.4
96- 42074	F-2	37	33	6.0 ± 0.8	-	3.4	42075	F-2	-	4.0 ± 0.6	6.0
96- 42076	F-4	39	37	13.6 ± 1.4	-	5.2	42077	F-4	-	10.4 ± 1.1	5.5
96- 42078	F-6	46	42	9.3 ± 1.1	6.8 ± 0.3	4.1	42079	F-6	-	8.0 ± 1.0	8.1
96- 42078	Duplicate	-	-	7.2 ± 0.9	-	-	-	-	-	-	-
96- 42080	F-8	43	42	17.3 ± 1.5	-	2.7	42081	F-8	-	31.7 ± 2.2	2.5
96- 42082	F-10	43	45	16.0 ± 1.5	-	2.2	42083	F-10	-	20.5 ± 1.7	3.3
96- 42084	G-1	40	43	10.6 ± 1.2	-	5.5	42085	G-1	-	9.3 ± 1.1	4.4
96- 42086	G-3	36	40	7.7 ± 0.9	-	5.4	42087	G-3	-	4.4 ± 0.7	5.9
96- 42088	G-5	42	47	9.0 ± 1.1	6.8 ± 0.3	2.6	42089	G-5	-	9.6 ± 1.1	5.0
96- 42088	Duplicate	-	-	9.3 ± 1.1	-	-	-	-	-	-	-
96- 42090	G-7	47	49	18.1 ± 1.6	-	2.6	42091	G-7	-	18.5 ± 1.6	3.7
96- 42092	G-9	45	46	14.0 ± 1.3	-	1.1	42093	G-9	-	13.7 ± 1.4	5.6
96- 42094	G-11	45	46	13.1 ± 1.3	-	3.8	42095	G-11	-	11.2 1.2	4.0
96- 42096	H-2	36	34	7.6 ± 0.9	-	3.5	42097	H-2	-	7.3 ± 0.9	5.0
96- 42098	H-4	40	39	9.5 ± 1.1	5.5 ± 0.3	5.3	42099	H-4	-	6.8 ± 0.9	8.6
96- 42098	Duplicate	-	-	8.0 ± 1.0	-	-	-	-	-	-	-

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		Depth - 0-6"							Depth - 6-12"		
Laboratory Number	AVI Grid ID	Field Gamma Reading @ 1m uR/hr	Field Gamma Reading @ 1cm uR/hr	Ra226 By Gamma pCi/gm	Ra226 By Chemical pCi/gm	% Moisture %	Laboratory Number	AVI Grid ID	Field Gamma Reading @ 1m uR/hr	Ra226 By Gamma pCi/gm	% Moisture %
96- 42100	H-6	43	47	8.3 ± 1.0	-	4.0	42101	H-6	-	5.5 ± 0.8	3.7
96- 42102	H-8	43	41	9.9 ± 1.1	-	4.5	42103	H-8	-	12.4 ± 1.2	3.4
96- 42104	H-10	42	39	10.6 ± 1.1	-	2.0	42105	H-10	-	6.1 ± 0.8	2.9
96- 42108	I-1	38	40	9.1 ± 1.1	5.1 ± 0.3	5.1	42109	I-1	-	6.4 ± 0.9	11.1
96- 42108	Duplicate	-	-	9.0 ± 1.0	-	-	-	-	-	-	-
96- 42110	I-3	41	42	8.0 ± 1.0	-	5.4	42111	I-3	-	9.4 ± 1.1	4.7
96- 42112	I-5	40	40	23.1 1 1.8	-	3.9	42113	I-5	-	5.5 ± 0.8	3.6
96- 42114	I-7	41	42	5.8 ± 0.8	-	4.0	42115	I-7	-	5.0 ± 0.7	6.6
96- 42116	I-9	42	50	8.2 ± 1.0	-	2.3	42117	I-9	-	18.6 ± 1.6	2.8
96- 42106	I-11	41	42	13.5 ± 1.3	-	8.4	42107	I-11	-	13.4 ± 1.3	3.3
96- 42118	J-2	38	40	8.5 ± 1.0	5.1 ± 0.3	2.8	42119	J-2	-	6.0 ± 0.8	5.3
96- 42118	Duplicate	-	-	7.5 ± 0.9	-	-	-	-	-	-	-
96- 42120	J-4	42	38	11.0 ± 1.2	-	3.6	42121	J-4	-	18.1 ± 1.6	4.0
96- 42122	J-6	44	48	7.5 ± 0.9	-	3.6	42123	J-6	-	9.0 ± 1.1	5.9
96- 42124	J-8	41	39	8.7 ± 1.0	-	3.8	42125	J-8	-	6.0 ± 0.8	6.6
96- 42126	J-10	43	42	14.1 ± 1.4	-	6.4	42127	J-10	-	19.9 ± 1.7	4.4
96- 42128	K-1	40	38	12.1 ± 1.2	10.3 ± 0.4	3.8	42129	K-1	-	6.7 ± 0.9	4.4
96- 42128	Duplicate	-	-	12.3 ± 1.3	-	-	-	-	-	-	-
96- 42130	K-3	39	36	8.2 ± 1.0	-	3.3	42131	K-3	-	5.3 ± 0.7	5.1
96- 42132	K-5	43	46	7.5 ± 0.9	-	3.6	42133	K-5	-	13.0 ± 1.3	4.4
96- 42134	K-7	42	38	8.1 ± 1.0	-	2.1	42135	K-7	-	13.1 ± 1.3	3.6
96- 42136	K-9	48	49	10.9 ± 1.2	-	3.5	42137	K-9	-	8.8 ± 1.1	6.4
96- 42138	K-11	45	43	8.9 ± 1.0	6.4 ± 0.3	2.2	42139	K-11	-	4.2 ± 0.6	0.6
96- 42138	Duplicate	-	-	9.5 ± 1.1	-	-	-	-	-	-	-

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LABORATORY ANALYSIS REPORT - AVI, Inc.

Report Date: September 27, 1996
Project: American Nuclear Corporation's Gas Hills Facility
Matrix: Soils

		Depth - 0-6"			Depth - 6-12"
Laboratory Number	AVI Grid ID	Ra226 By Gamma pCi/gm	Laboratory Number	AVI Grid ID	Ra226 By Gamma pCi/gm
96- 46951	F-1	10.6 ± 1.1	46952	F-1	15.6 ± 1.4
96- 46953	H-1	4.1 ± 0.6	46954	H-1	17.7 ± 0.7

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SHEPHERD MILLER INCORPORATED

CLIENT WDEQ JOB NO. 05-429 PAGE 1 OF 1

PROJECT ANC RECLAMATION DATE 11/95 DATE CHECKED

DETAIL TEST PLOT COMPUTED BY KJB CHECKED BY

0-6" Ra-226

GRID #	BEFORE	AFTER
1	9.68	8.67
2	23.12	10.40
3	39.00	15.78
4	37.68	12.82
5	30.60	13.71
6	21.58	11.16
7	22.58	10.00
8	27.04	13.35
9	23.64	14.11
10	17.36	15.14
11	21.12	10.48
12	25.64	10.41
13	32.80	12.78
14	35.10	18.02
15	24.32	17.39
16	28.14	8.60
17	25.14	11.46
18	26.32	12.35
19	23.96	11.20
20	27.58	12.87
21	21.02	9.16
22	18.22	11.55
23	13.06	10.40
24	19.52	8.34
25	38.12	11.09
MEAN	25.49	12.07

6-12" Ra-226

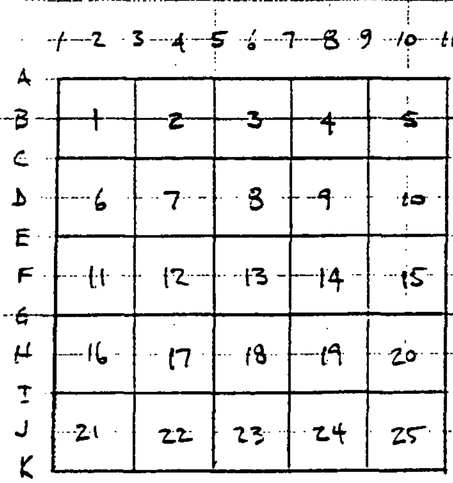
GRID #	BEFORE	AFTER
1	3.36	9.66
2	3.96	13.34
3	5.44	11.36
4	4.90	10.69
5	4.26	10.00
6	4.26	14.00
7	4.12	15.89
8	4.86	16.05
9	10.84	12.08
10	4.18	11.04
11	4.24	10.14
12	5.16	12.69
13	5.30	16.22
14	5.04	18.83
15	4.74	12.61
16	4.58	7.38
17	5.74	7.15
18	4.64	8.82
19	5.48	13.63
20	5.60	12.59
21	4.82	6.76
22	4.26	10.25
23	4.66	9.11
24	5.40	10.29
25	6.42	12.97
MEAN	5.05	11.74

0-6":

BEFORE
PASSING: 0
FAILING: 25

AFTER
PASSING: 4
FAILING: 21

STANDARD = 9.27 pCi/g



6-12":

BEFORE
PASSING: 25
FAILING: 0

AFTER
PASSING: 25
FAILING: 0

STANDARD = 19.27 pCi/g

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Energy Laboratories, Inc. is currently reviewing all of its Standard Operating Procedures. At this time this procedure is in technical writing for content and format. It will then be reviewed by the quality assurance department. Upon completion, a final SOP will be issued. You will receive an updated version during the first quarter of 1997.

This procedure is accurate and follows all of EPA's guidelines for Method 115, Large Area Activated Charcoal Canisters.

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