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UMTRA-DOE/AL -140
RAP Modification No. 2 -Rev. 1
Cooperative Agreement No.
DE-FC04-82AL19487

United States Department of Energy

Rec'd w/ltr dtd 12/24/85

Attachment 1

Modification to the

Remedial Action Plan for Stabilization of the Inactive Uranium Mill Tailings Site at Canonsburg, Pennsylvania

December 1985

Uranium Mill Tailings Remedial Action Project UMTRAP

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Uranium Mill Tailings Remedial Action Project Office
Albuquerque Operations Office
Department of Energy
Albuquerque, New Mexico 87108

Attachment 1

Modification to the

Remedial Action Plan for Stabilization of the Inactive Uranium Mill Tailings Site at Canonsburg, Pennsylvania

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Enclosures:

1. Nuclear Regulatory Commission (NRC) Comments of 10 June 1985 on Modifications Proposed for the Canonsburg Site

2. Responses to NRC Comments of 10 June 1985 on Modifications Proposed for the Canonsburg site

3. "Effect of Organic Material on Compressibility of Encapsulated Tailings" (5 pp.), (Reference "RAC, 1985a" for Change No. 2)

4. "Shear Strength Tests on Soils with Organics" (3 pp.), (Reference "RAC, 1985b" for Change No. 2)

5. "Possible Effects of Organics on Clay Liners" (3 pp.), (Reference "RAC, 1985c" for Change No. 2)

6. Calculation No. 02-200-16, "Potential Groundwater and Chartiers Creek Cc .tamination, Leachate from Pile and from Lens in Area B", (12 pp.), (Supporting information for Changes No. 2 and 4)

7. "Lens of Contaminated Material in Area B - Potential Effects on Slope Stability" (1 p.), (Supporting information for Change No. 3)

8. Calculation No. 02-200-07, "Radon Flux in Area B O/S of Cell and Average Flux for Entire Site" (43 pp.), (Supporting information for Change No. 3)

9. Memo from Tony Orlando, Pa. Bureau of Solid Waste Management to Jim Yusko, Pa. Radiation Protection, dated 17 July 1985

MODIFICATION NO. 2 TO THE
CANONSBURG REMEDIAL ACTION PLAN

CHANGE NO. 2

A. Description:

Allow disposal of contaminated organic material in the encapsulation cell. The average organic content of the encapsulated material will not exceed 5 percent by volume, and organic material will be distributed in a manner that avoids development of conditions that could lead to excessive differential settlements.

B. Resulting Changes to the RAP:

Pages F.2-25 and F.2-26, Section F.2.7, Part III - Add a Subsection F, "It was determined that inclusion of the onsite, highly contaminated organic material in the encapsulated material will cause a negligible increase in compressibility as long as the organic material is evenly distributed." (RAC, 1985a)

Pages F.2-34 through F.2-36, Section F.2.8, Part II-F - Replace by:

"F. Calculation of post-encapsulation concentrations of contaminants in Chartiers Creek for the encapsulated and non-encapsulated areas:

Assumptions:

- The sources of contaminated leachate will be the encapsulated pile and the lens of contaminated tailings left in Area B.
- The primary contaminants in the leachate from the pile will be uranium as the key indicator, and chromium.
- It is conservatively assumed that organics present in the pile will cause complete mobility of the contaminants.
- The primary contaminant in the lens of contaminated tailings in Area B is uranium.
- The effects of the contaminant leachate will be instantaneous.
- The most conservative approach will be taken. Therefore, the effect of dispersion, molecular diffusion, and hydrogeochemical retardation will be ignored.
- The flow in Chartiers Creek will be the average yearly flow.
- Leachate generation from the pile will be steady state.

Leachate Generation

To determine whether more detailed calculations would be required conservative estimates of infiltration were developed. Area B is not covered by a clay layer. For a conservative estimate of infiltration 100% of the average yearly precipitation is assumed for this area. For the encapsulated area a conservative infiltration rate equal to 4 times the design infiltration rate is used.

Average precipitaiton: Figure F.2.9.1, 38.1 inches.

Percolation into existing soil through encapsulated area: Figure F.2.9.1, 1.2 inches/year.

Area B: 1.64 acres

Encapsulated Area: 6.5 acres

Weighted Infiltration: $\frac{1.64\ (38.1) + (6.5).4(1.2)}{1.64 + 6.5}$ = 11.5 inches/year.

Rate of Leachate Production: (6.5 acres + 1.64 acres) 43,560 feet/acre (11.5 in/year) 1 ft/12 in. = 1.1×10^{-2} cfs.

Ground-Water Discharge into Chartiers Creek:

Flow per unit length of creek channel:

$$q = k \frac{(h_1^2 - h_2^2)}{2L}$$

Where, q is the flow per unit width,
k is the hydraulic conductivity,
h_1 and h_2 are the heads on the unconfined aquifer, and
L is the distance between measurements

$$q = 18.7 \frac{(10^2 - 6^2)}{2\ (260)}$$

$$= 2.3\ ft^3/day\ per\ foot$$

Discharge into Chartiers Creek is along a 1400 ft. stretch between Well No. GP1 and Well No. 22A.

Flow into Chartiers Creek:
(2.3 ft^3/day per foot) 1400 ft. = 3.7×10^{-2} $ft.^3$/sec

Contaminant Concentrations:

Conservative estimates for uranium and chromium concentration are estimated from Markos, et. al.

	Concentration in Leachate	Background Concentrations	
		Ground-water	Creek
Uranium:	43,333 pCi/l	.167 pCi/l	.133pCi/l
Chromium:	1.4 ppm	. 02 ppm	0.01 ppm

The average yearly flow in Chartiers Creek is 90 cfs. The concentrations are calculated from:

$$C_{gwf} = \frac{C_{gwi}\ Q_{gw} + C_l\ Q_l}{Q_{gw} + Q_l}, \text{ and}$$

$$C_{crf} = \frac{C_{cri}\ Q_{cr} + C_{gwf}\ (Q_{gw} + Q_l)}{Q_{cr} + Q_{gw} + Q_l},$$

where:

C_{gwf} = final concentration in groundwater,

C_{gwi} = initial concentration in groundwater,

Q_{gw} = rate of flow of groundwater,

C_l = concentration in leachate,

Q_l = rate of flow of leachate,

C_{crf} = final concentration in creek,

C_{cri} = initial concentration in creek, and

Q_{cr} = rate of flow in creek.

The predicted concentrations of the contaminants in Chartiers Creek are:

Uranium: 5.42 pCi/l or 0.016 mg/l
Chromium: 0.0102 ppm"

Page F.2-37, Section F.2.8, Part III-F and III-G - Replace by:

"F. The maximum concentration of uranium resulting from encapsulated and non-encapsulated material is predicted to be 0.016 mg/l east of the site in Chartiers Creek. The allowable EPA limits are 4.0 mg/l maximum and 2.0 mg/l 30-day average."

"G. The maximum concentration of chromium resulting from encapsulated material is predicted to be 0.0102 ppm east of the site in Chartiers Creek. The allowable EPA limit is 0.05 ppm."

Page F.2-52, Section F.2.10, Part III - Add a Subsection D, "It was determined by laboratory tests that inclusion of the onsite, highly contaminated organic material in the encapsulated tailings will not cause the shear strength of the tailings to be less than that used in design". (RAC, 1985b)

Page F.2-68, Section F.2.14, Part III.B.1 - Add an additional item, "The potential effects of decay products from the organic materials to be placed in the cell on the permeability of the clay liner were determined to be negligible". (RAC, 1985c)

Pages F-16 to F-17, Section F.3.2.1 - Replace last 2 sentences with: "Highly contaminated organic materials shall be placed in the cell. Low level contaminated organic materials, except railraod ties will be reduced in size to the extent necessary and buried on the site outside the encapsultion area. Organic material will comprise 5 percent or less of the material placed on the site, and will be distributed evenly in a uniform manner, to avoid development of conditions which could lead to excessive differential settlements."

Page F.4-17, Section F.4.4.3.2, Part 3.c Item 7 - Revise to read: "Highly contaminated organic materials shall be placed in the cell. The average organic content of the encapsulated material must not exceed 5 percent by volume. Organic material must be distributed evenly in a uniform manner, to avoid development of conditions which could lead to excessive differential settlements. Grind or chip low level contaminated organic materials, excepting railroad ties, and mix uniformly with Type G material in a ratio that produces not more than 5 percent by volume of organic material. Place in lower third of excavations only".

Page F.2-72 - Insert the following references in alphabetical order:

RAC (Remedial Action Contractor), 1985a. "Effect of Organic Material on Compressibility of Encapsulated Tailings", unpublished report prepared by Morrison-Knudsen Engineers, Inc., San Francisco, California, for the U.S. Department of Energy, UMTRA Project Office, Albuquerque Operations Office, Albuquerque, New Mexico.

RAC (Remedial Action Contractor), 1985b. "Shear Strength Tests on Soils with Organics", unpublished report prepared by Morrison-Knudsen Engineers, Inc., San Francisco, California, for the U.S. Department of Energy, UMTRA Projct Office, Albuquerque Operations Office, Albuquerque, New Mexico.

RAC (Remedial Action Contractor), 1985c. "Possible Effects of Organics on Clay Liner", unpublished telephone conversation records prepared by Morrison-Knudsen Engineers, Inc., San Francisco, California, for the U.S. Department of Energy, UMTRA Project Office, Albuquerque Operations Office, Albuquerque, New Mexico.

C. Overall Impact to the Design and Completed Remedial Action:

The change allows the remedial action to proceed and avoids conditions that could lead to placement of highly contaminated material outside the cell.

D. Compliance of Revised Design with EPA Standards:

The design revision complies with EPA standards for longevity and water quality protection.

E. Reason for the Proposed Change:

It is impractical to separate organics from the highly contaminated oprganic material, and it is less desireable to place highly contaminated organic materials outside the encapsulation cell than within the cell.

CHANGE NO. 3

A. Description:

The bulk of the deeply buried, contaminated material in Area B will remain in-place. This material, averaging about 650 pCi/g, lies on the side of the buried riprap wall away from the creek.

B. Resulting Changes to the RAP:

Page 19, Section 5.3.1 Para. 4 - Revise to read: "One exception to the above strategy is that no excavation will be required to retrieve the bulk of the deeply buried material in Area B which is covered with several feet of low-level contaminated soil. This material, averaging about 650 pCi/g, lies in a thin layer (average 4 feet thick) throughout a large portion (about 1.6 acres) of Area B. Limits of the material to be left in place and of the additional excavation and backfill required are shown in Figures 5.3 and 5.4. Analyses show that it is neither practical nor necessary to excavate this material for encapsulation." | Rev. 1

Page 22 - Insert Figures 5.3 and 5.4 immediately following this page.

Page F.2-9 through F.2-11, Section F.2.2.III - Add a Subsection E, "Average Radon Flux. The parameters used to calculate the average flux for the site were the radon diffusion coefficient and other properties determined for the material being used for the radon barrier (from North Strabane Township Borrow Area) and the projected radium contents for the various portions of the site."

Page F.2-12, Section F.2.2.IV.B - Revise last four sentences to read: "Taking no credit for the rock cover or topsoil, the final post remedial action flux from the encapsulation cell is calculated to be 10.0 $pCi/m^2/sec$. The average flux from the deeply buried material left in Area B will be approximately 30 $pCi/m^2/sec$. The remainder of the site will have a minimum of 2 feet of borrow material for cover. This will result in a flux of 9.2 $pCi/m^2/sec$. from the remainder of the site. The combined average site flux is calculated to be 10.6 $pCi/m^2/sec$." | Rev. 1 | Rev. 1

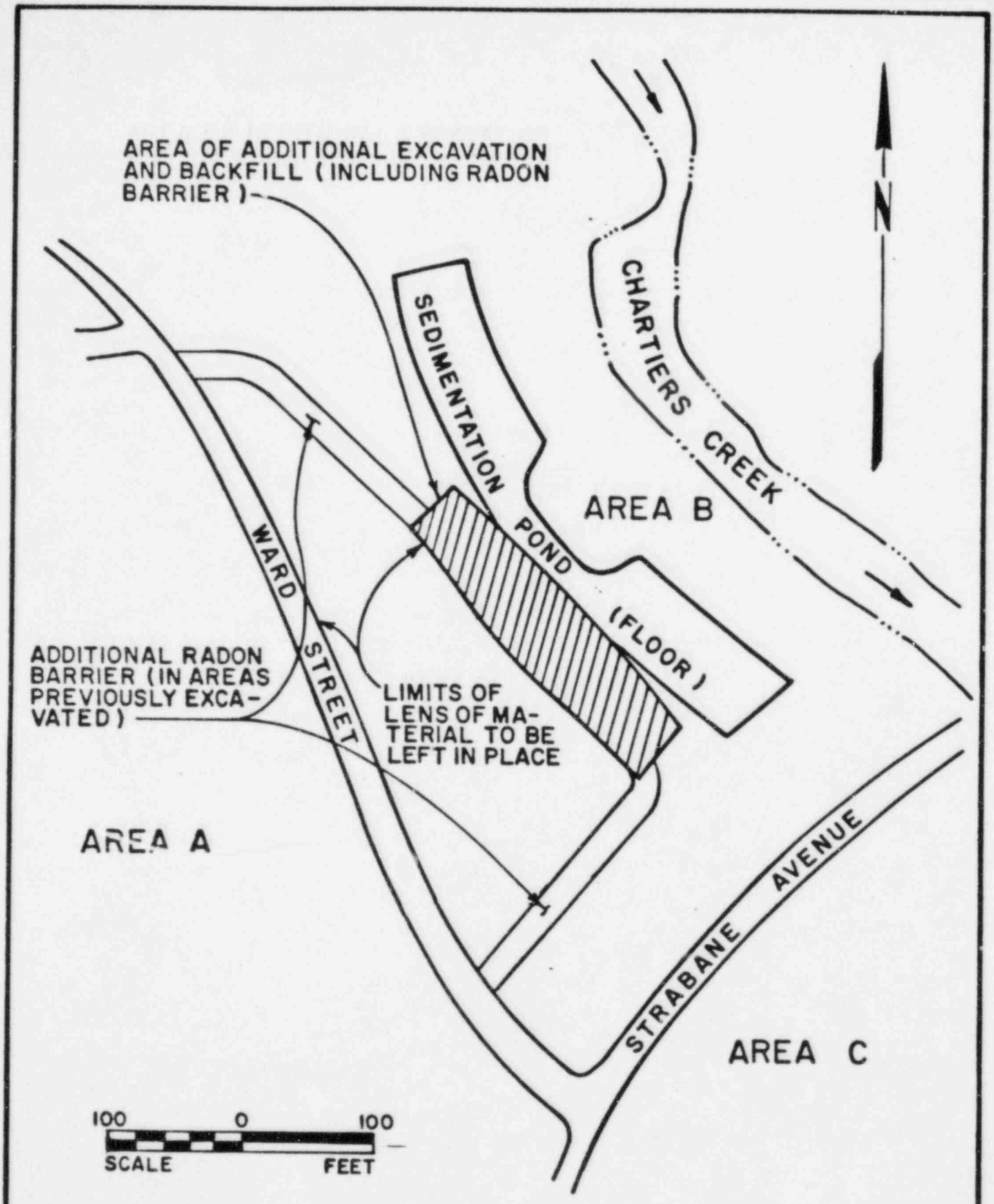
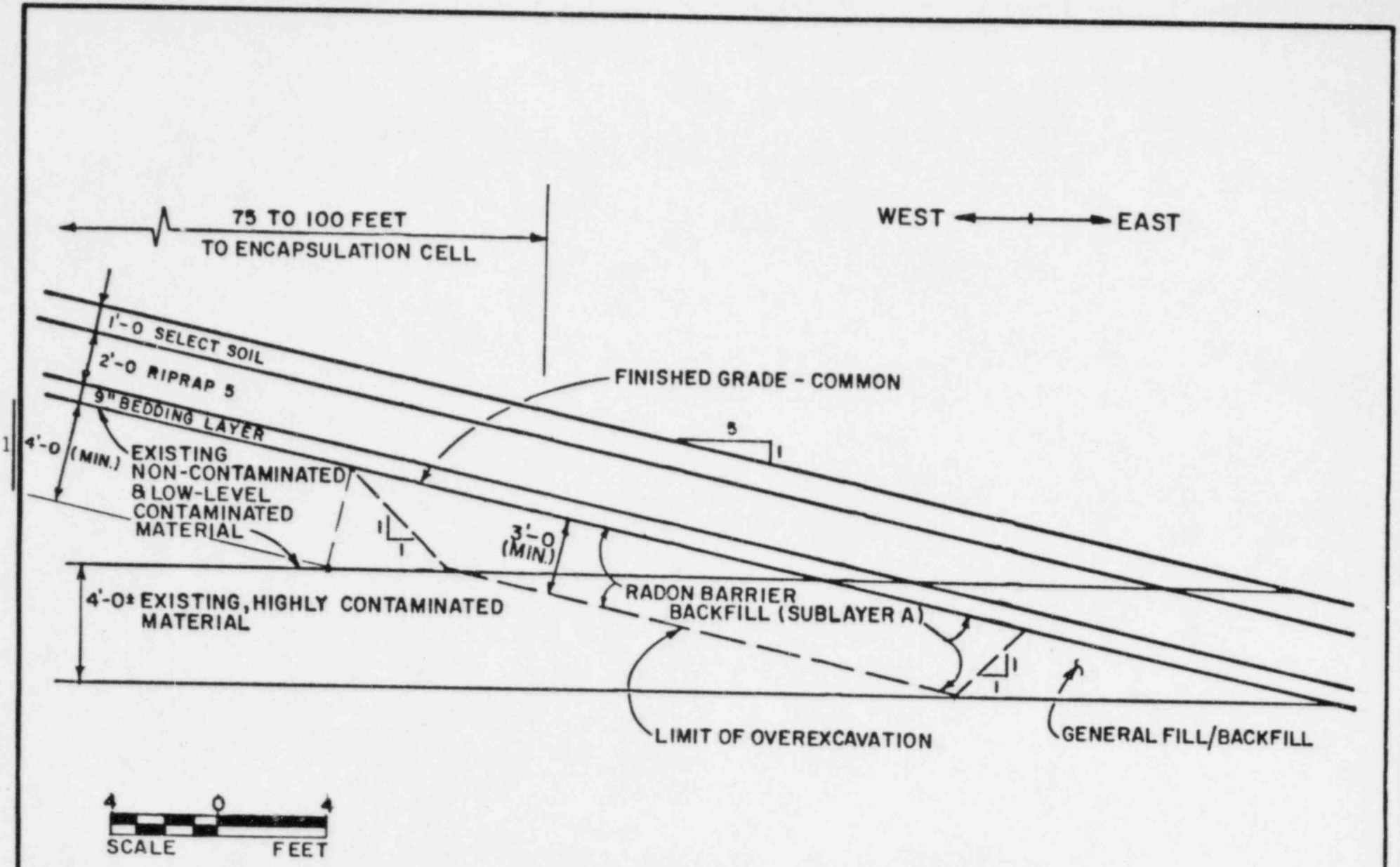


FIGURE 5.3

PLAN VIEW OF LENS OF HIGHLY CONTAMINATED MATERIAL TO BE LEFT IN AREA B



Rev. 1

FIGURE 5.4

TYPICAL CROSS-SECTION FOR DISPOSITION OF LENS OF HIGHLY CONTAMINATED MATERIAL TO BE LEFT IN AREA B

C. Overall Impact to Design and Completed Remedial Action:

Additional construction requirements are necessary to ensure compliance with EPA standards. These additional requirements include minor overexcavation of highly contaminated materials and backfill with radon barrier materials.

D. Compliance of Revised Design with EPA Standards:

The design revision complies with EPA standards for radon control, longevity, and water quality protection.

E. Reason for the Proposed Change:

It is neither practical nor necessary to remove the contaminated material to be left in place in Area B.

CHANGE NO. 4

A. Description:

Contaminated materials saturated with chromium wastes will be disposed of in the encapsulation cell.

B. Resulting Changes to the RAP:

Page F.2-27, Section F.2.8, Part I - Revise sections I-D and I-F to read as follows:

"D. Calculation of present rates and concentrations of contaminant migration, including chromium and using total uranium as the key indicator."

"F. Calculation of post-remedial action rates and concentrations of contaminant migration, including chromium and using total uranium as the key indicator."

Pages F.2-34 through F.2-36, Section F.2.8, Part III - See changes to these pages under No. 2, Modification 1 above.

Page F.2-37, Section F.2.8, Parts III-F and III-G - See changes to this page under No. 2, Modification 1 above.

C. Overall Impact to the Design and Completed Remedial Action:

This change allows the remedial action to proceed and avoids conditions that could lead to placement of mixed radioactively and chromium-contaminated waste outside the cell.

D. Compliance of Revised Design with EPA Standards:

The design revision complies with EPA standards for longevity and water quality protection.

E. Reason for the Proposed Change:

It is impractical to separate the chromium waste from the radioactive waste.

CHANGE NO. 5

A. Description:

Area C will be decontaminated to a level meeting the requirements of the EPA Standards for cleanup of open lands, and will not be included as a part of the fenced disposal site. The buried riprap wall within Area B will be relocated about 100 feet southwest of the original location, and shortened by approximately 300 feet. Also, it will no longer be necessary to fence Area C, and the fence along the northeast border of Area B will be relocated to match the new location of the buried riprap wall. An increase in the size of the encapsulation cell will be necessary to accommodate the additional 9,000 c.y. of excavation.

B. Resulting Changes to the RAP:

Page 16, Section 4.6, Paragraph 3: - Revise last sentence to read: "Relocation of the contaminated material away from Chartiers Creek and provision of additional riprap protection will inhibit river channel migration and protect against the erosion of small amounts of radioactive material to be left in Area B."

Page 20, Section 5.4, Paragraph 6: - Revise first two sentences to read: "A fence will enclose the site west of Strabane Avenue; Area C, east of Strabane Avenue, will be decontaminated, and DOE and the Commonwealth will agree on alternate disposition of Area C. "No Trespassing" signs will be attached to the fence."

Page 21, Figure 5.1: - Delete fence in Area C (lower right-hand corner of this figure).

Page B-23, Section B.9, Paragraph 2: - Revise third item to read "On-site water contamination is expected to be well below the calculated maximum of 13 pCi/l, and off-site transport of Ra-226 is expected to be negligible. The migration of uranium off the site should be limited to levels below 3 pCi/l."

Page D-3, Section D.2, Paragraph 1: - Revise last sentence to read: "This applies primarily to the residential areas which will not be covered and to Area C."

Page F-11, Section F.2.5: - Revise second sentence of second paragraph to read: "Uncontaminated rubble may be mixed with uncontaminated excess material and placed in Area C.

Replace fourth sentence of third paragraph with: "A chain link fence with warning signs will enclose the site."

Page F-12, Figure F.2.3: - Delete fence in Area C (lower right-hand corner of this figure).

Page F-16, Section F.3.1.4: - Revise first sentence of second paragraph on this page to read: "Removal of the waste materials below the ground-water level in Area C will greatly reduce the existing source for water-soluble constituents."

Page F-41, Figure F.5.4: - Revise to show southeastern end of riprap wall to stop northwest of Strabane Avenue, with a short segment of wall extending parallel to Strabane Avenue to the southwest.

Page F.3-4, Figure F.3.1.2: - Delete fence in Area C (lower right-hand corner of this figure).

Page F.3-14, Section F.3.3.2.3.b: - Revise first sentence to read: "The areas over which the site cover will be placed includes as a minimum, the encapsulation cell, the remainder of Areas A and B, and Georges Pottery."

References to Encapsulation Cell Volume and Area: - Required revisions will be included in the Completion Report for the site. Rev. 1

C. Overall Impact to the Design and Completed Remedial Action:

This change will reduce the area of the fenced disposal site, the length of the buried riprap wall, and the length of fencing required, with a slight increase in the volume of the encapsulation cell. The resulting cost savings will balance the costs of increased excavation and fill. The change will not cause a significant impact on schedule. Rev. 1

D. Compliance of Revised Design with EPA Standards:

The design revision complies with EPA standards for clean-up of land.

E. Reason for the Proposed Change:

Rubble and other demolition debris were disposed of in Area A. Thus Area C is no longer needed as a debris disposal area as originally planned. The change will reduce the area of the fenced disposal site at no net increase in cost.

References

RAC, 1985a - Enclosure 3 to CAN RAP MOD. No. 2

RAC, 1985b - Enclosure 4 to CAN RAP MOD. No. 2

RAC, 1985c - Enclosure 5 to CAN RAP MOD. No. 2

Enclosures

ENCLOSURE 1 (2 pages) 4005-CAN-L-09-00602-00

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

JUN 10 1985

Department Of Energy
Albuquerque Operations Office
ATTN: Mr. John G. Themelis, Project Manager
Uranium Mill Tailings Project Office
P.O. Box 5400
Albuquerque, New Mexico 87115

RECEIVED - IECO
JUN 19 1985
UMTRA - S. F.

Dear Mr. Themelis:

Enclosed is a memorandum dated May 21, 1985, which summarizes the status of our review of various modifications which have been proposed for the Canonsburg site. The conclusions in this memorandum were discussed with your Mr. Ball and by our Mr. Nixon.

We are also enclosing two memoranda which contain detailed comments on the proposed changes. We believe review of these memoranda will clarify the need for additional documentation and justification for the changes.

In direct response to your undated letter concerning our review of the changes, the status of each major change is as follows:

1. Changing Organic Material Disposition Requirements Onsite.

   a. We have concluded that incorporation of small quantities of organic material will not significantly affect the hydraulic properties of the clay-silt liner beneath the encapsulation cell.

   b. Based on our own analysis, we have concluded that incorporation of small quantities of organic material in the encapsulation cell will not adversely affect surface water quality in Chartiers Creek. However, we recommend that DOE provide further justification for this issue and appropriate revisions to the RAP.

2. Disposition of Lens of Contaminated Material in Area B.

   a. Based on our own analysis, we have concluded that stabilizing the contaminated soil lens in Area B in place will not adversely affect surface water quality in Chartiers Creek. However, we recommend that DOE provide further justification for this issue and appropriate revisions to the RAP.

   b. The slope stability analysis of the encapsulation cell should be revised to address the effects of the lens of contaminated material in Area B. This analysis should be submitted to NRC.

   c. The RAP should be revised to reflect the modifications and to document that radon control will be acceptable.

3. Complete decontamination of Area C including deletion of a portion of buried rip rap wall and increasing the site of the encapsulation cell.

   a. All questions regarding this item have been resolved.

4. Inclusion of Chromium Waste Within the Encapsulation Cell.

   a. Based on our own analysis, we have concluded that incorporation of the chromium contaminated waste in the encapsulation cell will not adversely affect surface water quality in Chartiers Creek. However, we recommend that DOE provide further justification for this issue and appropriate revisions to the RAP.

   b. DOE should provide NRC, in writing, documentation of the resolution of RCRA applicability to dispose of chromic acid contaminated tailings and for any other hazardous waste materials.

5. Deletion of Bentonite Material From the Encapsulation Cells Radon Cover.

   a. This proposal was withdrawn by DOE.

If you have any further questions concerning the status of NRC's review of the proposed Canonsburg modifications, please contact Mr. W. A. Nixon (FTS 427-4510).

W. T. Crow, Acting Chief
Uranium Fuel Licensing Branch
Division of Fuel Cycle and
Material Safety, NMSS

Enclosures:
1. Higginbotham to Crow,
   Memo dtd May 21, 1985
2. Knapp to Higginbotham,
   Memo dtd May 15, 1985
3. Greeves to Higginbotham,
   Memo dtd April 25, 1985

cc w/encls.: Mr. David Ball
Operations Group Leader
Uranium Mill Tailings
Project Office

Enclosures: 4005-CAN-N-09-00603-00
4005-CAN-R-09-00604-00

Responses to NRC Comments of 10 June 1985, on Modifications Proposed for the Canonsburg Site

This report presents responses to NRC Comments No. 1 b, 2 b, 2 c, 4 a, and 4 b given in their letter of 10 June 1985 to John Themalis of the Department of Energy UMTRA Project Office.

Comment 1b. Changing Organic Material Disposition Requirements Onsite. The NRC recommends that the DOE provide further justification for the change proposed and appropriate revisions to the RAP.

The enclosed calculations (Enclosure 6) are submitted as further justification that inclusion of up to 5% by volume of vegetation in the encapsulated tailings will not cause surface water degredation beyond appropriate water quality criteria. A synopsis of the calculations is as follows:

The calculation assumes the organics will cause complete mobility of contaminants, and the effects of the contaminant leachate will be instantaneous and steady state. Hence, the calculation does not account for potential attenuation or changes in concentration of contaminants before they reach Chartiers Creek. The most conservative approach is taken; i.e., the effects of dispersion, molecular diffusion, and hydrogeochemical retardation are ignored.

Leachate generation from the pile was assumed using conservative infiltration rates of 4.8 inches/year, for the 6.5-acre cell (4 times the design infiltration rate), and 38 inches/year for the 1.6-acre tailings lens in Area B, (100% infiltration). The net effect is a conservative estimate of the rate of leachate discharge. The quality of the leachate was estimated using studies prepared by Markas, et. al. (UMTRA-DOE/ALO-226; May 1981). The highest reported value for concentrations in water extracts from core samples was used for a conservative estimate of leachate quality.

The calculation then assumed that the leachate was discharged into Chartiers Creek along a 1400-feet stretch from near well GP-1 to well 22A. The quantity of ground-water flow per foot was based on water level measurements found in the Final Environmental Impact Statement. The flow in Chartiers Creek is also from the Final Environmental Impact Statement, and is the mean average yearly flow.

Background concentrations of contaminants in the ground water and Chartiers Creek were assumed from Markas, et. al. (UMTRA-DOE/ALO-226; May 1981).

The final concentrations of the contaminants in the ground water and Chartiers Creek are based on a common weighted average, mass conservation formula.

The calculations lead to the same conclusion as that reached by the NRC; i.e., that the inclusion of up to 5% by volume of vegetation in the encapsulated tailings will not cause surface water degredation beyond appropriate water quality criteria.

Revisions to the RAP related to the organic material disposition requirements onsite should be:

a. Section F.2.7, Part III (Pages F.2-25 and F.2-26) should be modified by adding a Subsection F, "It was determined that inclusion of the onsite, highly contaminated organic material in the encapsulated material will cause a negligible increase in compressibility as long as the organic material is evenly distributed." (RAC, 1985a, "Effect of Organic Material on Compressibility of Encapsulated Tailings"), (Enclosure 3).

b. Section F.2.6, Part II-F (Pages F.2-34 through F.2-36) should be replaced by:

"F. Calculation of post-encapsulation concentrations of contaminants in Chartiers Creek for the encapsulated and non-encapsulated areas:

Assumptions:

- The sources of contaminated leachate will be: the encapsulated pile and the lens of contaminated tailings left in Area B.
- The primary contaminants in the leachate from the pile will be uranium as the key indicator, and chromium.
- It is conservatively assumed that organics present in the pile will cause complete mobility of the contaminants.
- The primary contaminant in the lens of contaminated tailings in Area B is uranium.
- The effects of the contaminant leachate will be instantaneous.
- The most conservative approach will be taken. Therefore, the effect of dispersion, molecular diffusion, and hydrogeochemical retardation will be ignored.
- The flow in Chartiers Creek will be the average yearly flow.
- Leachate generation from the pile will be steady state.

Leachate Generation

To determine whether more detailed calculations would be required conservative estimates of infiltration were developed. Area B is not covered by a clay layer. For a conservative estimate of infiltration 100% of the average yearly precipitation is assumed for this area. For the encapsulated area a conservative infiltration rate equal to 4 times the design infiltration rate is used.

Average precipitation: Figure F.2.9.1, 38.1 inches.

Percolation into existing soil through encapsulated area: Figure F.2.9.1, 1.2 inches/year.

Area B: 1.64 acres

Encapsulated Area: 6.5 acres

Weighted Infiltration: $\frac{1.64\ (38.1) + (6.5).4(1.2)}{1.64 + 6.5}$ = 11.5 inches/year.

Rate of Leachate Production: (6.5 acres + 1.64 acres) 43,560 feet/acre (11.5 in/year) 1 ft/12 in. = 1.1×10^{-2} cfs.

Ground-Water Discharge Into Chartiers Creek:

Flow per unit length of creek channel:

$$q = k \frac{(h_1^2 - {}^2_2h)}{2L}$$

Where, q is the flow per unit width,
k is the hydraulic conductivity,
h_1 and h_2 are the heads on the unconfined aquifer, and
L is the distance between measurements

$$q = 18.7 \frac{(10^2 - 6^2)}{2\ (260)}$$

$$= 2.3\ ft^3/day\ per\ foot$$

Discharge into Chartiers Creek is along a 1400 ft. stretch between Well No. GP1 and Well No. 22A.

Flow into creek:
(2.3 ft^3/day per foot) 1400 ft. = 3.7×10^{-2} $ft.^3$/sec

Contaminant Concentrations:

Conservative estimates for uranium and chromium concentration are estimated from Markos, et. al.

	Concentration in Leachate	Background Concentrations	
		Ground-water	Creek
Uranium:	43,333 pCi/l	.167 pCi/l	.133pCi/l
Chromium:	1.4 ppm	. 02 ppm	0.01 ppm

The average yearly flow in Chartiers Creek is 90 cfs. The concentrations are calculated from:

$$C_{gwf} = \frac{C_{gwi}\ Q_{gw} + C_l\ Q_l}{Q_{gw} + Q_l}, \text{ and}$$

$$C_{crf} = \frac{C_{cri}\ Q_{cr} + C_{gwf}\ (Q_{gw} + Q_l)}{Q_{cr} + Q_{gw} + Q_l},$$

where:

C_{gwf} = final concentration in groundwater,

C_{gwi} = initial concentration in groundwater,

Q_{gw} = rate of flow of groundwater,

C_l = concentration in leachate,

Q_l = rate of flow of leachate,

C_{crf} = final concentration in creek,

C_{cri} = initial concentration in creek, and

Q_{cr} = rate of flow in creek.

The predicted concentrations of the contaminants in Chartiers Creek are:

Uranium: 5.42 pCi/l or 0.016 mg/l
Chromium: 0.0102 ppm

c. Section F.2.8, Part III-F and III-G (Pages F.2-37) should be replaced by:

- The maximum concentration of uranium resulting from encapsulated and non-encapsulated material is predicted to be 0.16 mg/l east of the site in Chartiers Creek. The allowable EPA limits are 4.0 mg/l maximum and 2.0 mg/l 30-day average.

- The maximum concentration of chromium resulting from encapsulated material is predicted to be 0.0102 ppm east of the site in Chartiers Creek. The allowable EPA limit is 0.05 ppm.

d. Section F.2.10, Part III (Page F.2-52) should be modified by adding a Subsection D, "It was determined by laboratory tests that inclusion of the onsite, highly contaminated organic material in the encapsulated tailings will not cause the shear strength of the tailings to be less than that assumed in design". (RAC, 1985b, "Shear Strength Tests on Soils with Organics"), (Enclosure 4).

e. Section F.2.14, Part III.B.1 (Pages F.2-68) should be modified by adding an additional item, "The potential effects of decay products from the organic materials to be placed in the cell on the permeability of the clay liner were determined to be negligible". (RAC, 1985c, "Possible Effects of Organics on Clay Liner"), (Enclosure 5).

f. Section F.3.2.1, (Pages F-16 to F-17) last 2 sentences should be replaced with: "Highly contaminated organic mterials shall be placed in the cell. Low level contaminated organic materials, except railraod ties will be reduced in size to the extent necessary and buried on the site outside the encapsultion area. Organic material will comprise 5 percent or less of the material placed on the site, and will be distributed evenly in a uniform manner, to avoid development of conditions which could lead to excessive differential settlements.

g. Section F.4.4.3.2, Part 3. c (Page F.4-17), Item 7, should be revised to read: "Highly contaminated organic materials shall be placed in the cell. The average organic content of the encapsuated material must not exceed 5 percent by volume. Organic material must be distributed evenly in a uniform manner, to avoid development of conditions which could lead to excessive differential settlements. Grind or chip low level contaminated organic materials, excepting railroad ties, and mix uniformly with Type G material in a ratio that produces not more than 5 percent by volume of organic material. Place in lower third of excavations only".

Comment 2b. Disposition of the Lens of Contaminated Material in Area B - Stability Analysis. The NRC has requested a revised slope stability analysis for the encapsulation cell, addressing the effects of the lens. As disucssed with Steve Smykowski of the NRC on 26 April 1985 the strength of the material in the lens is equal to or greater than the strength assumed in the original stability analysis for the cell. Information regarding the strength of this material is provided in the enclosed brief report, "Potential Effects on Slope Stability," (Enclosure 7). Based on this report it is concluded that additional calculations are not needed to show the lens will not adversely affect the stability of the encapsualtion cell.

Comment 2c. RAP and Radon Control. THE NRC requests submission of revisions to the RAP reflecting the proposed disposition of the lens of contaminated material in Area B and documenting that radon control will be acceptable.

Revisions to the RAP should be:

a. Section 5.3.1 (Page 19) Para. 4, should be revised to read: "One exception to the above strategy is that no excavation will be required to retrieve the bulk of the deeply buried material in Area B which is covered with several feet of low-level contaminated soil. This material, averaging about 650 pCi/g, lies in a thin layer (about 4 feet thick) throughout a large portion (about 1.6 acres) of Area B. Limits of the material to be left in place and of the additional excavation and backfill required are shown in Figures 5.3 and 5.4 (enclosed with Change No. 3). Analyses show that it is neither practical nor necessary to excavate this material for encapsulation.

b. Section F.2.2.III (Page F.2-9 through F.2-11), add a Subsection E, "Average Radon Flux. The parameters used to calculate the average flux for the site were the radon diffusion coefficient and other properties determined for the material being used for the radon barrier (from North Strabane Township Borrow Area) and the projected radium contents for the various portions of the site."

c. Section F.2.2.IV.B (Page F.2-12), revise last four sentences to read: "Taking no credit for the rock cover or topsoil, the final post remedial action flux from the encapsulation cell is calculated to be 9.3 $pCi/m^2/sec$. The average flux from the deeply buried material left in Area B will be approximately 30 $pCi/m^2/sec$. The remainder of the site will have a minimum of 2 feet of borrow material for cover. This will result in a flux of 8.6 $pCi/m^2/sec$. from the remainder of the site. The combined average site flux is calculated to be 10.6 $pCi/m^2/sec$."

Documentation that radon control will be acceptable is presented in enclosed Calculation No. 02-200-07, (Enclosure 8). A copy of this calculation was sent to Steve Smykowski of NRC on June 20, 1985.

Comment 4a. Inclusion of Chromium Waste Within the Encapsulation Cell. The NRC recommends that the DOE provide further justification for this proposed change and appropriate revisions to the RAP. The enclosed calculations serve to demonstrate that inclusion of the chromium wastes, as proposed, will not cause surface water degredation beyond appropriate water quality criteria. The same conclusion was reached by the NRC.

Revisions to the RAP related to this issue should be:

a. Section F.2.8, Part II-F: See Item b under Comment 1b above.

b. Section F.2.8, Part III-F and III-G: See Item c under Comment 1b above.

Comment 4b. Resolution of RCRA Applicability to Disposal of Chromium Waste. DOE should provide NRC, in writing, documentation of the resolution of RCRA applicability to dispose of chromic acid contaminated tailings and for any other hazardous waste materials.

Response

The enclosed memo from Tony Orlando to Jim Yusko (Enclosure 9) indicates that DOE has coordinated with the Commonwealth of Pennsylvania regarding the disposal of chromium residue into the encapsulation cell. Pennsylvania is an EPA agreement state.

DOE will advise NRC of the ultimate resolution (between DOE and EPA) of the general issue concerning the RCRA applicability for disposal of hazardous waste as soon as this resolution is accomplished.

Enclosure 3 (5pp.)

Effect of Organic Material on Compressibility of Encapsulated Tailings

1. Organic Content in Soil by Weight:

The estimated organic content of the encapsulated tailings (by weight) is 1.36%. This value was determined as follows:

- Estimated organic content in soil by volume, V_o = 2.5%. (Ref. 1)
- Compacted field dry density of soil including the weight of organic matter present, γ_d^s = 78.2 pcf. (Ref. 2)
- The organic content is in the form of leaves, grass and roots, and is treated as wood with water content of 12%. The dry density of wood at water content of 12% and specific gravity of 0.60 (Ref. 3, Table 3-7, p. 3-14), γ_d^o = 41.9 pcf.
- Therefore, the weight of organic material per cubic foot of soil, $W_o = V_o \cdot \gamma_d^o = (0.025)\ (41.9) = 1.05$ pcf.
- Thus, the organic content in soil, w_o (percent by weight) = $W_o / (\gamma_d^s - W_o) = 1.05/77.15 = 1.36\%$.

2. Theoretical Settlement Resulting from Organic Material Decay

As the organic material decays the solid material is converted into humus resulting in a reduction in volume due to the loss of some organic matter through leaching and other processes. Using engineering judgement it is assumed that the unit volume decreases by 1/3. On this basis 2.5% by volume of organic material will reduce to 1.67% due to the decay process and the total volume of the organic fill will be reduced by 0.83%.

The 0.83% reduction in organic material volume due to the decay process could theoretically cause a maximum settlement of 0.0083 X 18 = 0.15 ft. or 1.8 inches in the thickest portion of the encapsulated tailings (18 ft.).

3. Some Other Factors to be Considered for a Realistic Evaluation of Settlement of the Encapsulated Tailings

The actual settlement due to decay of the organic material will be significantly less than that computed in Section 2 due to the following reasons:

a) Due to the arching effect, the small percentage of organic material (1.36% by weight) embedded in the soil mass in the form of discreet particles of roots and leaves will induce very little settlement.

b) The decay process inside the compacted soil mass with depleted to no oxygen supply conditions will be extremely slow, possibly taking hundreds to several thousands of years (Refs. 4 and 5).

c) In many specifications the amount of vegetable matter permissible in foundation and the embankment soils ranges from 3 to 8%, with some beneficial (Ref. 4 and 5) to minor adverse effects.

4. Conclusion

From consideration of the factors discussed above, and also by referring to Figures 1 and 2 established from published data on organic soils after Natarajan and Rao (Ref. 6), it is concluded that the pontential settlement resulting from the decay of 1.36% (by weight) of organic matter in the encapsulated cell at Canonsburg will be of the order of 0.3%. From figure 2, for 1.36% organic matter (by weight), and 200-year design life, the settlement works out to 0.3% of the fill height; i.e., about 0.6 inch for the thickest section. In other words, instead of 9 inches settlement due to the compression of the fill, the total settlement will be about 9.6 inches. This is considered a negligible increase in compressibility.

NGB/GRT
22 October 1984

References:

1. "Disposition of Organic Materials", Doc. No. 4005-CAN-R-01-00047-01.

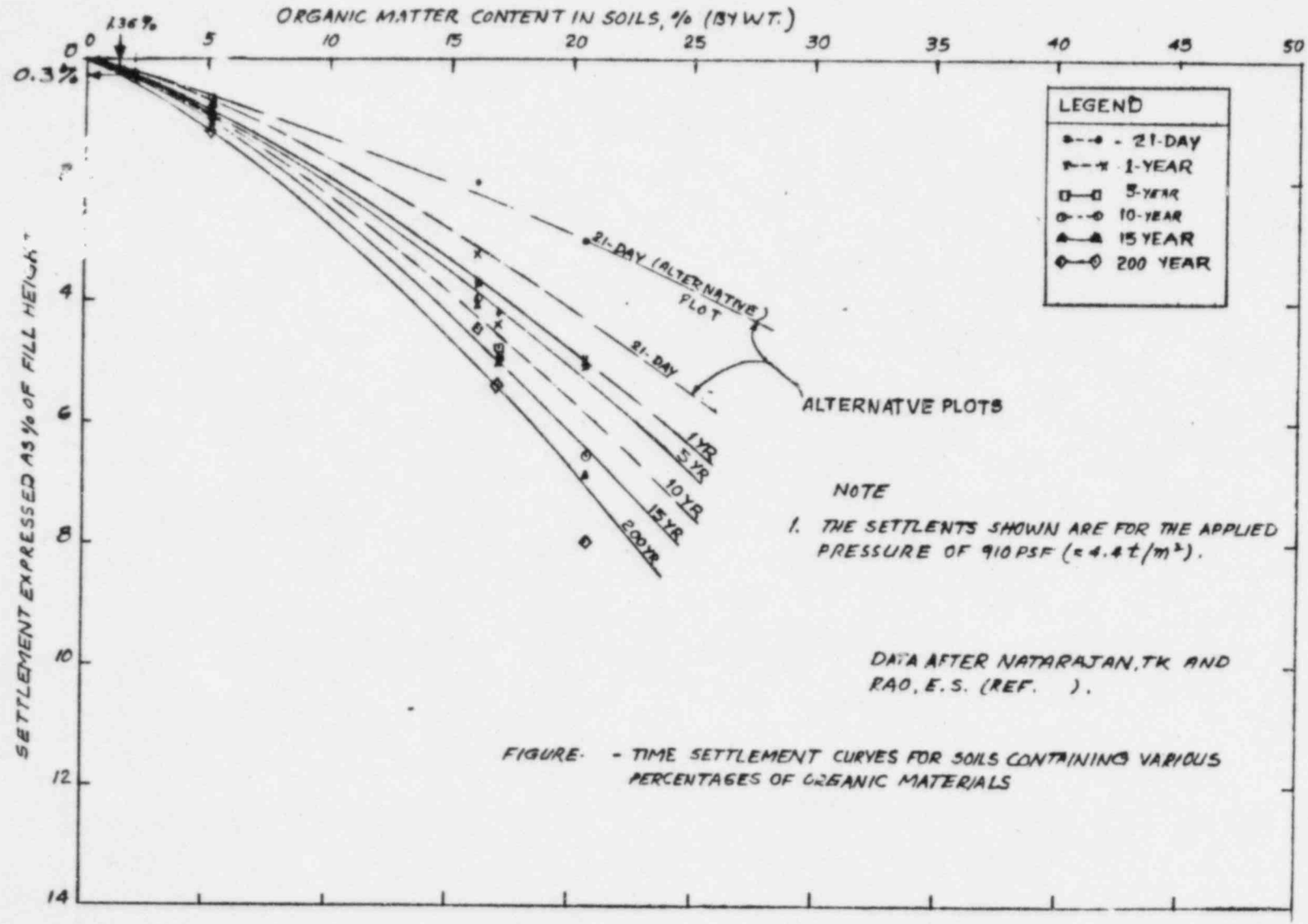
2. IOC of 26 September 1984, Mitch Steele of M-K to Don Summers of M-K, Doc. No. 4005-CAN-I-02-00181-01. (Included as Part 1 of Attachment 2.)

3. Wood Handbook, USDA, Forest Products Laboratory, Forest Service, Agriculture Handbook No. 72.

4. Trans Am. Soc. Civil Engrs., Vol. 48, 1002, p. 267.

5. "Engineering for Dams, Vol. III, Earth, Rock-fill, Steel and Timber Dams", Creager, W. P., Justin, J. D., and Hinds, J. (1961), p. 751.

6. Natarajan, T. K. and Rao, E. S. (1972), "Design of Embankments on Rubbish Soils", Proc. of the Third Southeast Asian Conference on Soil Engineering", Hong Kong, November 1972, pp. 147 to 154.



NOTE

1. THE SETTLENTS SHOWN ARE FOR THE APPLIED PRESSURE OF 910 PSF (≈ 4.4 t/m²).

DATA AFTER NATARAJAN, TK AND RAO, E.S. (REF.).

FIGURE - TIME SETTLEMENT CURVES FOR SOILS CONTAINING VARIOUS PERCENTAGES OF ORGANIC MATERIALS

CONSULTING ENGINEERS
INTERNATIONAL ENGINEERING COMPANY, INC.
180 HOWARD STREET, SAN FRANCISCO, CALIFORNIA 94105

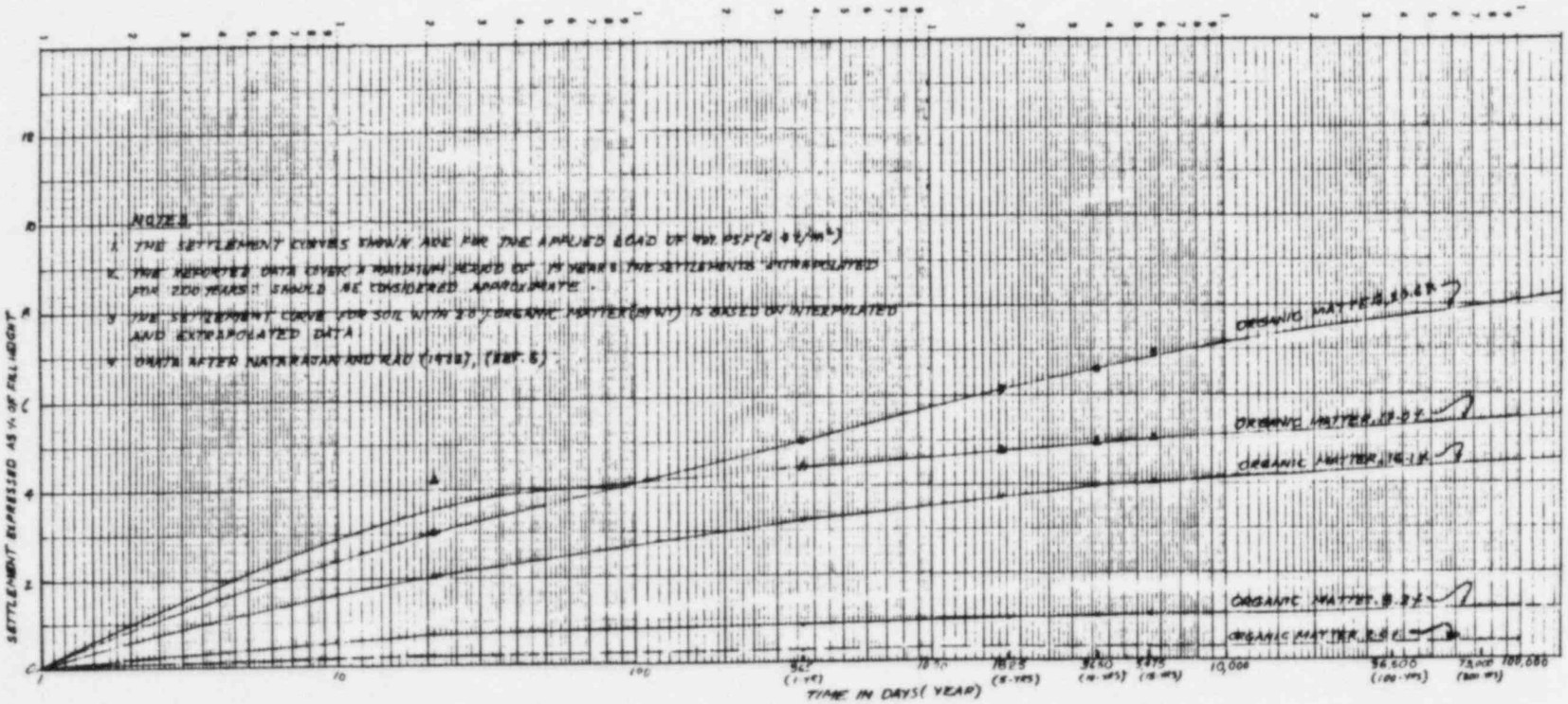
DESIGNED | DRAWN | CHECKED | APPROVED | RECOMMENDED | DATE

UMTRAP-CANONSBURG SITE

SETTLEMENT-VS ORGANIC CONTENT IN SOILS

FIGURE-1

ECO NO. | SHEET OF | REV



NO.	DATE	REVISIONS	BY	CHK	APPD	DESIGNED NGP	DRAWN NGS	CHECKED	RECOMMENDED	
						DATE 10-4-84		APPROVED		

CONSULTING ENGINEERS
INTERNATIONAL ENGINEERING COMPANY, INC.
180 HOWARD STREET, SAN FRANCISCO, CALIFORNIA 94105

UMTRAP - CANONSBURG SITE

TIME-SETTLEMENT CURVES FOR ORGANIC SOILS

FIGURE-2

SHEET OF | REV

W.O. NO.

Enclosure 4 (3pp.)

Shear Strength Tests on Soils With Organics

Part 1: "IOC of 26 September 1984, Mitch Steele of M-K, Canonsburg, to Don Summers of M-K, Albuquerque", Doc. No. 4005-CAN-I-02-00181-01.

Part 2: "Pittsburgh Testing Laboratory Report No. 7 for Purchase Order No. 3050-511-9050", Doc. No. 4005-CAN-R-09-00255-00.

MORRISON-KNUDSEN COMPANY, INC.

RECEIVED
NOV 1 1984
UMTRA - S. F.

INTER-OFFICE CORRESPONDENCE

DATE: September 26, 1984

TO: Don Summers

FROM: Mitch Steele

LOCATION: Albuquerque, NM

LOCATION: Canonsburg, PA

SUBJECT: Testing of Soils With and Without Organics

As you requested on 9-19-84, a special lift of soil containing some organics was constructed in the Technology Inc. area. The lift was mostly topsoil with grass included. The lift was first compacted with a tow-behind sheepsfoot roller, but the compaction test if taken at that time would not have been in the required soil. The lift was then compacted with approximately six passes of a RayGo Rascal 400-A Vibratory Compactor.

Two inplace density tests, ASTM D 1556, were performed on the lift. A large amount of organics, grass, was included in one test and the other test was relatively free of the grass. Both tests did extend down into the previous lift approximately 2 inches in order to obtain a large enough test sample to eliminate the errors, that will occur in small test samples. The following is the data obtained from the tests:

	With Organics	Without Organics
Hole Size	0.0493	0.0432
Wet Density	90.85	103.42
Dry Density	78.2	84.1
% Moisture	16.1	23.0

On 9-20-84, Shelby tube samples containing organics were extracted from this lift and transported to Pittsburgh Testing Lab for direct shear testing. PTL was requested to send you the test results upon completion of the test.

MS/db

Pittsburgh Testing Laboratory

001
PTL-PITTSBURGH
850 POPLAR STREET
PITTSBURGH, PENNSYLVANIA 15220
412/922-4000

Client's P.O.#3050-511-9050

4005-CAN-R-09-00255-00

REPORT

No.7

ORDER NO. PG-24366

DATE Nov. 1, 1984

RECEIVED
NOV 1984
UMTRA - S.E.

REPORT TO: Morrison-Knudsen Company, Inc.
P.O. Box 9136
Albuquerque, New Mexico 87119

ATTENTION OF: Mr. Don Summers

SUBJECT: Laboratory Test - Canonsburg Site

DIRECT SHEAR TEST RESULTS

Client's Sample Identification	Cohesion (tsf)	Friction Ø (°)
Topsoil	0.30	29.5

Note: 3 Shelby Tubes Used

PITTSBURGH TESTING LABORATORY

Charles Urishko, Manager
Geotechnical Engineering Department

CU:ms
cc: Mr. G. R. Thiers, Earth Sciences

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INTERNATIONAL ENGINEERING COMPANY, INC.
A MORRISON-KNUDSEN COMPANY

Enclosure 5 (3pp.)

UMTRA PROJECT
TELEPHONE CONVERSATION RECORD

DATE 3/21/85 TIME 11:20 ☑ AM ☐ PM DOC. NO. 4005-CAN-T-01-00421-00

☑ TO ☐ FROM Dave Daniel RECORDED BY GRT

AFFILIATION Univ. of Texas PHONE NO. (512) 471-4730

LOCATION Austin

SUBJECT Possible Effect of Organics on Clay Liners at Canonsburg

1. Dave doubts that the rate of infiltration expected (1"/yr.) & the % organics expected in the tailings (< 5%) could produce a leachate which would significantly increase the permeability of a clay liner compacted to be as tight as 5×10^{-6} cm/sec.

2. The concentration of organics in the leachate would have to exceed 50% to even begin to have an effect. Dave said it was inconceivable that the concentration in the leachate would be this high.

(OVER) →

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SITE DE ✓
PROJ SECTY
CHRON ✓

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QUALITY MNGR

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A MORRISON-KNUDSEN COMPANY

UMTRA PROJECT
TELEPHONE CONVERSATION RECORD

DATE 3/21/85 TIME 11 30 ☑ AM ☐ PM DOC. NO. 4005-CAN-T-01-00422-00

☑ TO ☐ FROM K. W. Brown RECORDED BY GRT

AFFILIATION Texas A & M PHONE NO. (409) 845-5251

LOCATION Bryant, Texas

SUBJECT Possible Effect of Organics on Clay Liner

1. Brown doesn't think the effect of leachate at 1"/yr. through the tailings having ~ 5% grass roots on permeability of a clay liner compacted to ≤ 5x10⁻⁶ cm/sec is "anything to worry about".

2. He says anerobic decay could give acetone or ~~ethyl~~ ethylene glycol, but at concentrations << 50% the lowest concentration at which any effect would show up.

(OVER) →

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FORM 42-111

INTERNATIONAL ENGINEERING COMPANY, INC.
A MORRISON-KNUDSEN COMPANY

UMTRA PROJECT
TELEPHONE CONVERSATION RECORD

DATE 3/28/85 TIME 1 55 ☐ AM ☑ PM DOC. NO. 4005-CAN-T-01-00443 00

☑ TO ☐ FROM K.W. Brown RECORDED BY GRT

AFFILIATION Texas A & M PHONE NO. (409) 845-5251

LOCATION Bryant, Texas

SUBJECT Tests w/ Acetone & Ethylene Glycol on Clay Liners

Brown said data showing that low concentration of acetone & ethylene glycol have no effect on clay liners are in "Permeability of Compacted Soils to Solvent Mixtures and Petroleum Products", by K.W. Brown, J.C. Thomas & J.W. Green, published in Proceedings of Symposium on Land Disposal of Hazardous Wastes, Ft. Mitchell, Kentucky, April 3-5, 1984, EPA Document No. EPA-600/9-84-007, pages 124-137.

(OVER) →

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Enclosure 6 (12pp.)

4005.CAN.C.01.00645.C

Calculation Cover Sheet

Contract No. 4005 Discipline ESCI Calc. No. 02-200-16 No. of Sheets 11

Project
WATERN / CHIN

Feature
Potential Groundwater and Chartiers Creek Contamination

Item
Leachate From Pile and From Lens in Area B

Sources of Data

See p. 2

Sources of Formulae & References

See p. 2

Preliminary Calc. ☐ Final Calc. ☒ Supersedes Calc. No. _____

Rev. No.	Revision	Calculation By	Date	Checked By	Date	Approved By	Date
		D Calvarese	6/27/85	J T Kam	7/9/85	E.R. Thiers	7/10/85

Reviewed by [signature] 7/10/85

IECO Form 42-110

INTERNATIONAL ENGINEERING COMPANY, INC.

Project UMTRA / CAN
Feature Ground water Contamination
Item Chartiers Creek Evaluation

Contract No. 4005
Designed GKJ
Checked JTK

Sheet 1
File No.
Date 1/24/95
Date 7/5/95

Summary:

The maximum conservative Uranium contaminant level in Chartiers Creek is:

0.016
5.43 pCi/l 0.016 mg/l see page 9

The maximum allowable limit for effluent limitations of Uranium is:

(40 CFR 440.32 and .33)

	Maximum Daily	30-day average
Uranium	4.0 mg/l	2.0 mg/l

The predicted value does not exceed allowable limits

The maximum conservative contaminant level for Chromium in Chartiers Creek is:

.0102 ppm

From Ref. 4 the allowable EPA limit is

.05 ppm

The predicted value does not exceed allowable limits

References:

1) Remedial Action Plan for Stabilization of the Inactive Uranium Mill Tailings Site at Canonsburg, Pennsylvania, October 1983, Department of Energy, Albuquerque, New Mexico 87108

2) Final Environmental Impact Statement, Remedial Actions at the Former Vitro Rare Metals Plant Site, Vol. I & II, July 1983, Department of Energy, Albuquerque, New Mexico 87108

3) Fetter C.W., Applied Hydrogeology, 1980, Bell & Howell Company.

4) Geochemical Investigation of UMTRAP Designated Site at Canonsburg, Pa. May 1981, Department of Energy, Albuquerque, New Mexico 87108

Purpose:

The purpose of this calculation is to evaluate the effects of the contaminated soil ions in Area B, to be stabilized in place, on surface water quality hydraulically downgradient from the encapsulated tailings.

Assumptions:

1) The effects of the contaminate leachate will be instantaneous.

2) The most conservative approach will be taken. Therefore, the effect of dispersion, molecular diffusion, and hydrogeochemical retardation will be ignored.

3) The flow in Chartiers Creek will be based on average yearly.

4) Leachate generation from the pile is steady state.

Leachate generation from the pile: (see page 4a)

Steady state conditions

Infiltration rate (Ref. 1): 1.2 in/year

for a conservative estimate of infiltration, the estimated rate of infiltration is increased by a factor of 4.

Conservative estimate $4 \cdot 1.2 \text{ in/yr} = 4.8 \text{ in/year}$

Area of the contaminated soil lens (Cov. calculation # 02-200-07):

1.64 acres

Area of encapsulation (Cov. calculation # 02-200-10)

6.5 acres

Rate of leachate production:

Total Area · Infiltration = Leachate Production

$$(6.5 \text{ acres} + 1.64 \text{ acres}) \, 43560 \frac{\text{ft}^2}{\text{acre}} \cdot \left(\frac{\text{ft}}{12 \text{ in}}\right) \left(11.5 \frac{\text{in}}{\text{year}}\right)$$

1.1×10^{-2} cfs

The infiltration rate is not constant over the entire site. Area B is not covered by a clay layer and for a conservative estimate of infiltration, 100% average yearly precipitation is assumed for Area B

Average yearly precipitation = 38.1 inches (Ref. 1)

$$\frac{1.64(38.1) + 6.5(4.8)}{1.64 + 6.5} = 11.5 \text{ inches/year}$$

Note: A factor is not applied to the 100% of the precipitation which infiltrates because the weighted average infiltration rate (11.5 in/yr) >> what NRC has used.

ITK
7/9/05

INTERNATIONAL ENGINEERING COMPANY, INC.

Project: [illegible]TRH/CAIN
Feature: Ground-Water Contamination
Item: Chartiers Creek Evaluation

Contract No. 4005
Designed EAT
Checked FTK

Sheet 5
File No.
Date [illegible]/85
Date 7/5/85

Ground Water discharge into Chartiers Creek:

Flow per unit length of Creek Channel:

$$q = K\frac{(h_1^2 - h_2^2)}{2L}$$ Reference 3

where q is the flow per unit width,
K is the hydraulic conductivity,
h_1 & h_2 are the heads of the unconfined aquifer.

From Reference 1
K = 18.7 ft/day

From Reference 2
h_1 = 961 - 951 = 10
h_2 = 956 - 950 = 6
L = 260'

} conservative approach using shallow aquifer thickness.

$$q = 18.7\frac{(10^2 - 6^2)}{2(260)}$$

= 2.3 ft^3/day per unit width

= 2.66×10^{-5} $\frac{ft^3}{sec}$ per unit width

Ground Water discharge into Chartiers Creek: (continued)

Discharge into Chartiers Creek as baseflow along a 1400' stretch between well # GP1 and # 22A

Flow into creek:

$(2.66 \times 10^{-5} \frac{ft^3}{sec \cdot unit\ width})$ 1400' width = $3.7 \times 10^{-2} \frac{ft^3}{sec}$

$\frac{10' + 21'}{2} = 15.5'$

$\frac{6' + 17'}{2} = 11.5'$

} using average saturated thickness

$L = \frac{260 + 280}{2} = 270'$

$$q = 18.7 \frac{(15.5^2 - 11.5^2)}{2(270)}$$

$= 3.74\ ft^3/day$ per unit width

$= 4.33 \times 10^{-5}\ ft^3/sec$ per unit width

$(4.33 \times 10^{-5} ft^3/sec \cdot unit\ width)$ 1400' width = $6.06 \times 10^{-2}\ ft^3/sec$

From Reference 4 the greatest concentration of uranium for water extracts from core samples is 43333 pCi/L

The mean flow for Chartiers Creek (Ref. 2) is

.90 cfs

Surface Water Contaminant Concentration: (continued)

Background levels in Chartiers Creek:

From Reference 4;

Uranium .0004 ppm = .133 pCi/l

Background levels in ground-water

From Reference 4;

Uranium .0005 ppm = .167 pCi/l

Predicted levels in ground-water: (using shallow aquifer thickness)

$$C_{mixed} = \frac{(.167 \cdot 3.7\times10^{-2}) + (43333 \cdot 1.1\times10^{-2})}{(3.7\times10^{-2} + 1.1\times10^{-2})}$$

$$= 9930.6 \text{ pCi/l}$$

Predicted levels in Chartiers Creek:

$$C_{pred.\,creek} = \frac{(.133 \cdot 90) + (9930.6 \cdot 4.8\times10^{-3})}{90 + 4.8\times10^{-3}}$$

$$= 5.43 \text{ pCi/L} \quad 0.016 \text{ mg/l}$$

or

Predicted levels in ground water: (using average saturated thickness)

$$C_{predicted} = \frac{(.167 \cdot 6.06\times10^{-2}) + (\frac{43333}{1.1\times10^{-2}} \cdot \frac{4.\times10^{-3}}{1.1\times10^{-2}})}{(6.06\times10^{-2} + 4.\times10^{-3})}$$

see page 4i 4a for changes

$$= 6657.4 \text{ pCi/l}$$

Predicted levels in Chautiers Creek:

$$C_{predicted} = \frac{(.133 \cdot 90) + (\frac{665}{7.2} \cdot \frac{7.16\times10^{-2}}{7.16\times10^{-2}})}{90 + 7.16\times10^{-2}}$$

$$= 5.40 \text{ pCi/l} \text{ or } 0.016 \text{ mg/l}$$

There is insignificant difference in the concentration of the leachate due to gravity of ground water flow

Predicted levels in Chatfield Creek:

For a conservative check on the possible concentration in Chatfield Creek, it will be assumed that the leachate reaches the creek from interflow (no ground water mixing).

$$\frac{(.133 \cdot 90) + (43333 \cdot 1.1 \cdot 10^{-3})}{90 + 1.1 \cdot 10^{-3}}$$

$$= 5.43 \text{ pCi/l} \text{ or } 0.016 \text{ mg/l}$$

The highest estimated Chromium concentration for the tailings pile is (Ref. 4) : 1.4 ppm

The background levels for the surface water is (Ref. 4): < 0.01 ppm.

The background levels for ground water is (Ref. 4) : .02 ppm

Predicted levels in ground-water: (using average estimated thickness)

$$C_{predicted} = \frac{(.02 \cdot 6.06 \cdot 10^{-2}) + (1.4 \cdot 1.1 \cdot 10^{-3})}{6.06 \cdot 10^{-2} + 1.1 \cdot 10^{-3}}$$

$$= .232 \text{ ppm}$$

This exceeds the allowable limits of .05 ppm (Ref. 3) in drinking water.

Predicted levels in Chartiers Creek.

$$C_{predicted} = \frac{(.01 \cdot 90) + (.232 \cdot 7.16 \cdot 10^{-2})}{90 + 7.16 \cdot 10^{-2}}$$

$$= .0102 \text{ ppm}$$

Enclosure 7 (1p.)

Lens of Contaminated Material In Area B - Potential Effects on Slope Stability

The potential effects of the lens of contaminated material in Area B on radon emission and ground water were discussed in Document No. 4005-CAN-R-01-00446-00. The possibility that this lens could have an adverse effect on the stability of the adjacent slope of the encapsulation cell is discussed below.

Visual classification and standard penetration test results indicate that the material in the 4-foot thick layer in question is medium stiff silty clay and sandy clay, and loose to medium dense fine silty sand. The material is located above the ground water table. Blow counts in the lens range from 6 to 8, averaging approximately 7 blows/foot. The corresponding shear strength parameters are c = 875 pounds per square foot for the cohesive portions, and phi = 29 degrees for the cohesionless material. The latter parameter results in an average shear strength of 1,466 pounds per square foot for the sandy material along the portion of the critical circle passing through the lens. The shear strength parameters for both types of material are greater than 750 pounds per square foot, which is the shear strength assumed for the stability analyses. Therefore it is concluded that the lens will not adversely affect the stability of the encapsulation cell.

Calculation Cover Sheet

Calc. No. 02-200-07

Contract No. 4005-100 Discipline ESCUP No. of Sheets 1R 24

↳ plus 12 pp. of attachments.

Project

UMTRA - CAN

Feature

RADON FLUX IN AREA B O/S OF CELL AND AVERAGE FLUX FOR ENTIRE SITE

Item

Sources of Data

1. Morrison Knudsen Company, Inc. IOC "Contaminated Material - Area B", from Larry Fanner to J. Oldham, 3-6-85. (IOC + attachments = 12 pages = 7 attached to this calc.)
2. IECO Calc. No. 01-709-01, BUFFELL CONCEPTUAL DESIGN (based on Canonsburg data with additional summary of input parameters

Sources of Formulae & References

1. U.S. DOE "Remedial Action Plan For Stabilization of the Inactive Uranium mill Tailings Site at Canonsburg, Pennsylvania", U.S. DOE Rpt # UMTRA-DOE/AL-160, OCT 1983
2. V. C. Rogers et al "Radon Attenuation Handbook for Uranium Mill Tailings Cover Design", Rogers & Associates Engineering Corporation / Pacific Northwest Laboratory, U. S. Nuclear Regulatory Commission Rpt # NUREG/CR-3533, April 1984
3. Baker, K.R., Mohr, D.E., and Hillman, R.L., February 1984, "Radiological Aspects Canonsburg, Pennsylvania UMTRA Site", Sixth Symposium on Uranium Mill Tailings Management, Fort Collins, Colorado, 13 February 1984, pp. 463-472

Preliminary Calc. ☐ Final Calc. ☒ Supersedes Calc. No. ——

Rev. No.	Revision	Calculation By	Date	Checked By	Date	Approved By	Date
2	Radon Calc. For Average Flux for Entire Site (pp 24)	G. R. Thiers	5/30/85	F.B. Eures	6-6-85	[signature]	6/11/85
1	Check Alt. to Correct Typing and additional data (pp 1R-4)	G.R. Thiers	4/24/85	F.B. Eures	4-29-85	[signature]	5/2/85
0	——	E.C. Tom	3/20/85	F.B. Eures	4-1-85	H.R. Thiers	4/1/85

IECO Form 42-1-0

PURPOSE

A 4 to 5 foot-thick layer of contaminated material with an average radium concentration of 400 pCi/g was identified during Phase II construction. A portion of this layer is located outside of the cell area between the buried riprap wall and the limit of cell foundation. Since the present design does not include a site cover in this area, it is the purpose of this calculation to determine: 1) the average surface radon flux using the present design, 2) the required site cover or compacted backfill thickness to limit a radon flux of 20 pCi/m²/sec. This calculation was performed at the request of Jim Oldham to G.R. Thiers on 3-27-85.

PART I - EXISTING Ra-226 CONTENT IN 4-FT THICK LAYER

INPUT PARAMETERS -

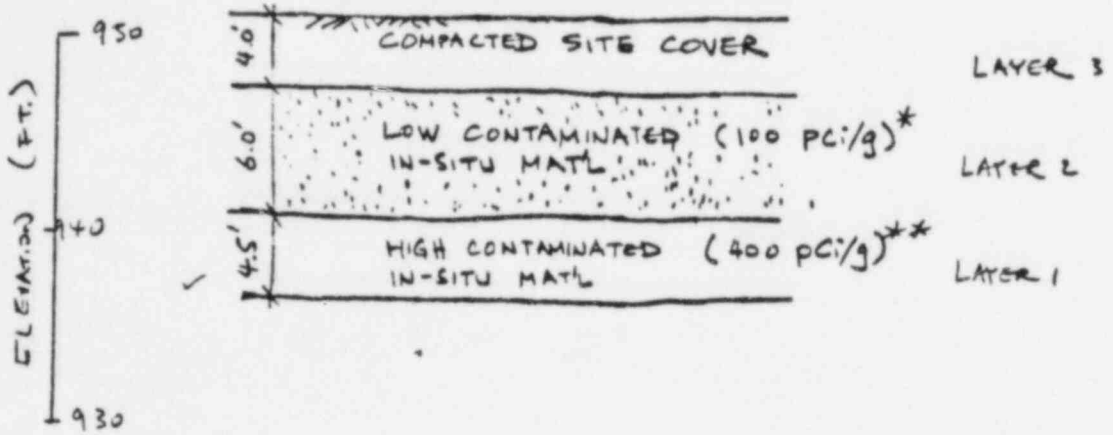
Radium concentration and geometric feature of the contaminated layer were obtained from Source 1. The average existing radium concentration of the contaminated layer, as mentioned in Source 1 - (~~also estimated by Oldham~~) is 400 pCi/g and was used as input to the RAECOM program.

An average representative cross-section of the l

(continued on sheet 5)

(Sh. 2 & 3)

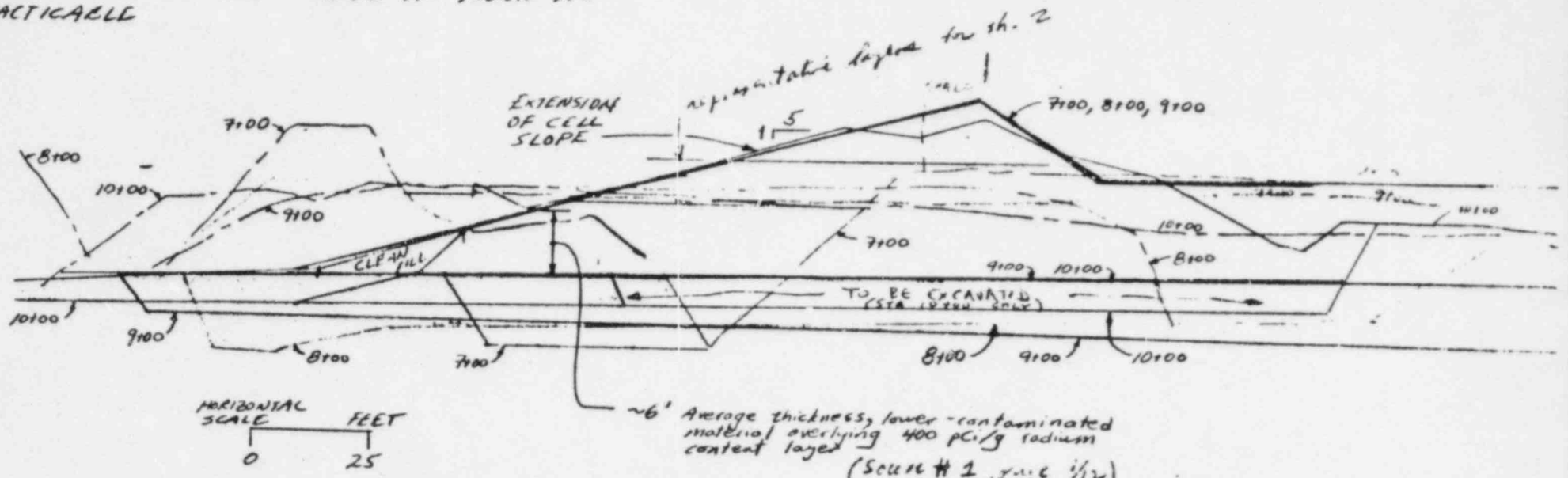
AREAS WITH SOME CLEAN FILL —
REPRESENTATIVE SECTION (FROM SH. 3)



* PROJECTED MAXIMUM RA-226 CONTENT (HIGHEST ALLOWABLE)
** EXISTING RA-226 AVERAGE CONTENT

OF CROSS-SECTIONS FROM VARIOUS STATIONS* TO OBTAIN AVERAGE REPRESENTATIVE SECTION.

*NORMALIZED TO FINISHED GRADE COMMON SLOPE ON EXTENSION OF CELL SLOPE AS MUCH AS PRACTICABLE



(Scale # 1, true size)

Legend

—— Top solid line represents finished grade common. (Clean fill from existing ground to finished grade common, if higher

- - - - Dashed lines represents the existing ground as of 3-1-85 (material in existing ground is assumed to be lowly contaminated, say Ra^{226} concentration of 100 pCi/g) at each of the 4 station 7+00, 8+00, 9+00 & 10+00.

═══ Middle & bottom solid lines with lightly shaded area in-between represent the contaminated layer with a Ra^{226} concentration of 400 pCi/g.

PRT
4/19/85

Ref. Source 1.

UMTRA-CAN
RADON FLUX - AREA B 0/S CELL
4005-200 ECT 3/29/85
FEG 4-1-85

USER INFORMATION FOR INRAEC / RAECOM

The following is ~~an example of~~ the input for INRAEC. (* Indicates a decimal point is required)

HEADING FOR THE RAECO2 RUN-->	UMTRA-CAN: AREA B OS CELL, CHECK FLUX WITH 20 pCi/g Layer 3-29-85	SECTION
NUMBER OF LAYERS, TAILINGS & COVER-->	3	IN = CANFB1 OUT = CANFBOUT
* INITIAL FLUX INTO LAYER 1 (pCi/m2-s)-->	0.0	
* AMBIENT AIR RADON CONCENTRATION (pCi/l)-->	Background 0.18	
LAYER TO BE OPTIMIZED-->	3	
* FLUX LIMIT AT SURFACE (pCi/m2-s)-->	20.0	
* ACCURACY NEEDED (.1 TO .0001)-->	0.001	

LAYER No. N	1	2	3	4	5	6	7
* THICKNESS OF LAYER N (cm)-->	137.	183.	122.				
* DIFFUSION COEFF. OF LAYER N (cm2/s)-->	0.000326	0.00345	0.00671				
* POROSITY OF LAYER N (FRACTION)-->	0.406	0.406	0.361				
* RA-226 CONC. OF LAYER N (pCi/g)-->	400.0	100.0	0.0				
* EMANATING FRACTION OF LAYER N (FRACTION)-->	0.2	0.2	0.0				
* BULK DENSITY OF LAYER N (g/cm3)-->	1.60	1.60	1.73				
* MOISTURE CONTENT OF LAYER N (% DRY WT)-->	22.8	17.7	12.3				

NOTES:
LAYER 2 may be subdivided into 2 layers to acct. for the difference of degree of saturation, which will give a different diffusion coefficient, but is not necessary.
See sh 17, Ecro Calc # 01-709-01 for input parameters.

(A)

soil profile was prepared using sections from source 1. Radiological characteristics and soil parameters of each layer in the profile were obtained from Ref 1, Section F.2.2 and from sheet 17 of IECO Calc. # 01-709-01. Sheet 4 shows input for RAECOM. (It is assumed that the S.G. for in-situ soil is 2.7)

SUMMARY AND CONCLUSIONS - PART I

The computer program, RAECOM (Ref 2), was used for computation. The surface radon flux based on the representative section was found to be 4 pCi/m²/sec, which is less than the EPA criteria of 20 pCi/m²/sec. Therefore, the average radon flux emitted from the present design is acceptable.

The minimum thickness of the backfill required to meet the EPA criteria is found to be 23 cm (9 inches), this condition can be met easily in the area under this study. As mentioned by J. Oldham (per GRT), in cases where the contaminated layer (with Ra226 content about 400 pCi/g) is exposed to site work (such as excavation for placement of design riprap elements), a minimum 3 feet thick of radon barrier material will be placed over the contaminated layer.

AREA B OUTSIDE OF CELL
RADON FLUX

INPUT FILE: CANRN1
OUTPUT HEADING: UNIRA-CAN, AREA B, O/S CELL, FLUX W/ 400 PCI/G LAYER

SUMMARY OF RADON INPUT
HEADING: UNIRA-CAN AREA B, O/S CELL, FLUX W/ 400 PCI/G LAYER, 3-29-85
LAYERS: 3
INITIAL FLUX: 0.000
AMBIENT RN: 0.100
OPTIMIZED LAYER: 0
SURFACE FLUX LIMIT: 0.000
PRECISION: 0.0010

LAYER NO.	THICKNESS CM	DIFFUSION CM2-SEC	POROSITY FRACTION	RA-226 PCI/G	EMANATING FRACTION	BULK DENSITY G/CM3	SOURCE TERM PCI/CM3-SEC	MOISTURE % DRY WT
1	157.0	0.00033	0.406	400.0	0.20	1.60	0.0006621	22.8000
2	183.0	0.00545	0.406	100.0	0.20	1.60	0.0001655	17.7000
3	122.0	0.00871	0.361	0.0	0.00	1.73	0.0000000	12.3000

EXISTING C

By: FBG 3-29-85
ck'd by ECT 3/29/85

UNIRA-CAN AREA B, O/S CELL, FLUX W/ 400 PCI/G LAYER, 3-29-85

********** I N P U T P A R A M E T E R S **********

NUMBER OF LAYERS : 3
RADON FLUX INTO LAYER 1 : 0.00 PCI/M2/SEC
SURFACE RADON CONCENTRATION : 0.100 PCI/LITER
MAKE SOURCE FLUX (JO) FROM LAYER 1 : 35.49 PCI/M2/SEC

LAYER	THICKNESS (CM)	DIFF COEFF (CM2/SEC)	POROSITY	SOURCE (PCI/CM3/SEC)	MOISTURE (DRY WT. PERCENT)
1	157.	3.2000E-04	0.4100	0.5561E-04	22.80
2	183.	3.4500E-03	0.4100	1.0390E-04	17.70
3	122.	8.7100E-03	0.3600	0.0000E+00	12.30

***** R E S U L T S O F R A D O N D I F F U S I O N C A L C U L A T I O N *****

LAYER	THICKNESS (CM)	EXIT FLUX (PCI/M2/SEC)	EXIT CONC. (PCI/LITER)	MIE
1	157.	2.2774E+01	9.9012E+04	0.5445
2	183.	1.0310E+01	5.2541E+04	0.4911
3	122.	3.7350E+00	1.0136E-01	0.5031

Exit flux based on representative section.

INPUT FILE: CANRN1
OUTPUT HEADING: UNIRA-CAN, AREA B, O/S CELL, THICKNESS W/ 400 PCI/G LAYER

SUMMARY OF RADON INPUT
HEADING: UNIRA-CAN AREA B, O/S CELL, FLUX W/ 400 PCI/G LAYER, 3-29-85

LAYER NO.	THICKNESS CM	DIFFUSION CM2-SEC	POROSITY FRACTION	RA-226 PCI/G	EMANATING FRACTION	BULK DENSITY G/CM3	SOURCE TERM PCI/CM3-SEC	MOISTURE % DRY WT
1	137.0	0.00053	0.400	400.0	0.20	1.00	0.0000621	22.0000
2	183.0	0.00545	0.400	100.0	0.20	1.00	0.0001655	11.7000
3	122.0	0.00071	0.301	0.0	0.00	1.75	0.0000000	12.3000

EXISTING (NOT PROJECTED FOR ADDITIONAL RA 226 FROM THORIUM DECAY)

By: FBG 3-29-85
chkd by ECT 3/29/85

UMTRA-GJO AREA B, U/S CELL, FLUX W/ 400 PCI/G LAYER, 3-29-85

********** INPUT PARAMETERS **********

NUMBER OF LAYERS : 3
RADON FLUX INTO LAYER 1 : 0.00 PCI/M2/SEC
SURFACE RADON CONCENTRATION : 0.180 PCI/LITER

LAYER 3 ADJUSTED TO MEET JCRIT : 20.0 +/- 0.100E-02 PCI/M2/SEC

MAKE SOURCE FLUX (JO) FROM LAYER 1 : 33.49 PCI/M2/SEC

LAYER	THICKNESS (CM)	DIFF COEFF (CM2/SEC)	POROSITY	SOURCE (PCI/CM3/SEC)	MOISTURE (DRY WT. PERCENT)
1	137.	5.2600E-04	0.4100	6.5501E-04	22.00
2	183.	5.4500E-03	0.4100	1.0594E-04	11.70
3	122.	6.7100E-03	0.3000	0.0000E+00	12.30

***** RESULTS OF RADON DIFFUSION CALCULATION *****

LAYER	THICKNESS (CM)	EXIT FLUX (PCI/M2/SEC)	EXIT CONC. (PCI/LITER)	MIC
1	137.	2.2144E+01	4.4624E+04	0.3445
2	183.	2.1710E+01	1.7253E+04	0.4911
3	(254)	1.4447E+01	1.0150E-01	0.5031

↑ required thickness of backfill to meet EPA criteria of 20 pCi/m²/sec

PART II - Projected Ra-226 content for 4-Foot Thick Layer

Purpose: Calculate maximum average radon flux from this area. Two subareas are assumed to represent this area, with average layer thickness and material parameters used for each subarea. One subarea has clean fill on top, the other does not (in both areas, bedding, riprap, and select soil will be placed).

Method: 1) Use data in part I above to represent average section with clean fill, but increase Ra-226 content by a factor of 4.5 to account for influence of thorium (Ref. 3)
2) Calculate flux for average section w/o clean fill.
3) Calculate average area-weighted flux

Assumptions:

1) The "low-level contaminated material" referred to in data source No. 1 has a maximum projected radium content of 100 pCi/g over the next 1000 years. (consistent with definition in specification 02060, Rev. 3)(Average is actually less).

2) The material with contamination of 350-450 pCi/g radium content exists at that radium content now, consistent with rough check with some available data below (assuming that data apply to "contaminated material underlying Area B." discussed in data source No. 1)

Radium Content: 400 x 4.5 = 1,800 pCi/g = maximum projected radium content of lower layer.

ROUGH CHECK - TH/RA RATIO & RADIUM CONTENT

Data from Source No. 1 for Thorium/Radium Ratio* (2 pp. in data source No. 1):

HOLE NO.	(SAMPLE) ELEV. FT	TH/RA RATIO	RA CONTENT pCi/g
1	939.88	6.5 ✓ 6.6	440 ✓
4	941.03	1.1	311 ✓
5	939.64	23.1	210 ✓
~~1~~ 11	938.47	2.5	315 ✓ =?
12	938.68	7.1	101 ✓
13	938.98	1.7	870 ✓
8	940.04	2.4	1240 ✓
4B	(None)	0.8	550 ✓
11	Composite #1 - #8	2.0	10
12	Composite #1 - #6	8.4	12
13	Composite #1 - #6	3.7	35
14	Composite #1 - #6	2.2	3.5

Hole No. 11 probably No. 1L (not 1) (source of data is poor in quality) FBG 7-29-85

That is correct. Checked by GRT NGB

$\bar{x}$ = 341.45 ✓
SD = 326.5

AVERAGES*		
$\bar{x}$ =	5.1 ✓	341. ✓ 341.46
s =	6.18	326.5
n =	12	12

*NOTE: Exact location of all samples shown and completeness of data are not available. Averages are used only to check against assumptions used in calculation for general purposes only.

information regarding

This page Superseded by Calc. in Str. 16 NGB

Flux from Area With No Clean Soil Cover

Average thickness of lower-contaminated material overlying layer with 400 pCi/g existing Ra-226 content (see sections on sheet 3): 6 feet (= 183 cm) (From Source, p. 1/12.)

Calculate flux from 400 pCi/g (existing) Ra-226 layer with 6' of lower-contaminated material over it (assume, as above, worst case for lower-contaminated material of 100 pCi/g projected radium content.) Multiply 400 pCi/g by 4.5 as above to get projected maximum Ra-226 content layer.

Flux = 30 pCi/m²-s (see sheet 15)

Flux from Area with Clean Soil Cover

Flux = 4 pCi/m²-s (see sheet 13)

AREA-WEIGHTED AVERAGE

1) See Plan A in attachment. Approximate area of approximate trapezoid + rectangle is

$$\left(\frac{540' + 420'}{2}\right)(130') + (230')(70'/2) = 70{,}450 \text{ ft}^2$$

2) Use distance on extension of cell slope (finished grade common) and normalized sections (sheet 3) to estimate relative areas with and without some clean fill as follows:

a) Total Horizontal Distance = 120'
(along section line)
(From cell, i.e. top of clean fill on finished grade common, to beginning of area where 3 feet minimum clean fill is required)

b) Distance with some clean fill = 70'
(minimum)

c) Distance with no clean fill = 50'

3) Average weighted radon flux =

$$\left(50'\,(30\ pCi/m^2\text{-}s) + 70'(4\ pCi/m^2\text{-}s)\right)\left(\frac{1}{120'}\right) =$$

$$15\ pCi/m^2\text{-}s$$ ✓

Note the following:

a) Worst case for projected radium content of "lower contaminated material" used, i.e., 100 pCi/g Ra-226 content.

b) Area where 3' minimum of clean fill will be required is not considered. From inspection of sections on sheet 3, most of the 400 pCi/g layer will be removed. Also, radon barrier for cell is 3' thick for average projected Ra-226 content of 1404 pCi/g. over 18' of contaminated material. (which results in a flux = 6.5 $pCi/m^2\text{-}s$ approximately) (Ref. 3). Therefore, the flux

where 3' minimum of clean soil will be required is expected to be less than 15 pCi/m^2

CONCLUSION

Based on the above analysis, the average radon flux is not expected to exceed 15 pCi/m^2s and will meet EPA requirements for this portion of the site itself.

AREA B, OUTSIDE OF CELL
RADON FLUX

Sheet 3

FEG 4-1-85

cdl by Oct 4-1-85

INPUT FILE: CANRN1
OUTPUT HEADING: UMTRA-CAN, AREA B O/S CELL, 400 PCI/G LAYER, 4-1-85

SUMMARY OF RADON INPUT
HEADING: UMTRA-CAN, AREA B OUTSIDE CELL, 400 PCI/G LAYER

LAYERS: 3
INITIAL FLUX: 0.000
AMBIENT RN: 0.100
OPTIMIZED LAYER: 0
SURFACE FLUX LIMIT: 0.000
PRECISION: 0.0010

LAYER NO.	THICKNESS CM	DIFFUSION CM2-SEC	POROSITY FRACTION	RA-226 PCI/G	EMANATING FRACTION	BULK DENSITY G/CM3	SOURCE TERM PCI/CM3-SEC	MOISTURE % DRY WT
1	137.0	0.000055	0.400	1000.0	0.20	1.60	0.0029793	22.8000
2	183.0	0.000345	0.400	100.0	0.20	1.60	0.0001655	17.7000
3	122.0	0.000671	0.361	0.0	0.00	1.73	0.0000000	12.3000

UMTRA-CAN, AREA B OUTSIDE CELL, 400 PCI/G LAYER

********** I N P U T P A R A M E T E R S **********

NUMBER OF LAYERS : 3
RADON FLUX INTO LAYER 1 : 0.00 PCI/M2/SEC
SURFACE RADON CONCENTRATION : 0.100 PCI/LITER
BARE SOURCE FLUX (J0) FROM LAYER 1 : 150.7 PCI/M2/SEC

LAYER	THICKNESS (CM)		DIFF COEFF (CM2/SEC)	POROSITY	SOURCE (PCI/CM3/SEC)	MOISTURE (DRY WT. PERCENT)	
#1 #2	319.047	1	137.	3.2000E-04	0.4100	2.9502E-03	22.80
2	183.		5.4500E-03	0.4100	1.0349E-04	17.70	
3	122.		0.7100E-03	0.3600	0.0000E+00	12.30	

***** R E S U L T S O F R A D O N D I F F U S I O N C A L C U L A T I O N *****

LAYER	THICKNESS (CM)	EXIT FLUX (PCI/M2/SEC)	EXIT CONC. (PCI/LITER)	MIL
1	137.	1.1919E+02	2.9359E+03	0.3445
2	183.	1.7022E+01	5.5017E+04	0.4911
3	122.	4.0179E+00	1.0130E-01	0.5051

Sheet 14

AREA B OUTSIDE OF CELL
RADON FLUX

INPUT FILE: UNIRA01
OUTPUT HEADING: UNIRA-CAN, AREA B O/S CELL, 400 PCI/G LAYER, 4-1-85

SUMMARY OF RADCUM INPUT

FBG 4-1-85
dl Ecy 4-1-85

HEADING:	UNIRA-CAN, AREA B OUTSIDE CELL, 400 PCI/G LAYER
LAYERS:	3
INITIAL FLUX:	0.000
AMBIENT RN:	0.100
OPTIMIZED LAYER:	3
SURFACE FLUX LIMIT:	20.000
PRECISION:	
	0.0010

LAYER NO.	THICKNESS CM	DIFFUSION CM2-SEC	POROSITY FRACTION	RA-226 PCI/G	EMANATING FRACTION	BULK DENSITY G/CM3	SOURCE TERM PCI/CM3-SEC	MOISTURE % DRY WT
1	157.0	0.00053	0.400	1000.0	0.20	1.00	0.0029743	22.8000
2	183.0	0.00345	0.400	100.0	0.20	1.00	0.0001655	17.7000
3	122.0	0.00071	0.301	0.0	0.00	1.13	0.0000000	12.3000

↑
91.4 cm = 3'

UNIRA-C ELL, 400 PCI/G LAYER

****** PARAMETERS **********

NUMBER OF LAYERS :	3	
RADON FLUX INTO LAYER 1 :	0.00	PCI/M2/SEC
SURFACE RADON CONCENTRATION :	0.100	PCI/LITER
LAYER 3 ADJUSTED TO MEET JCRIT :	20.0	+/- 0.100E-02 PCI/M2/SEC
BARE SOURCE FLUX (J0) FROM LAYER 1 :	150.7	PCI/M2/SEC

LAYER	THICKNESS (CM)	DIFF COEFF (CM2/SEC)	POROSITY	SOURCE (PCI/CM3/SEC)	MOISTURE (DRY WT. PERCENT)
1	157.	5.2600E-04	0.4100	2.9502E-03	22.80
2	183.	5.4500E-03	0.4100	1.6570E-04	17.70
3	122.	0.7100E-03	0.3000	0.0000E+00	12.30

***** RESULTS OF RADON DIFFUSION CALCULATION *****

LAYER	THICKNESS (CM)	EXIT FLUX (PCI/M2/SEC)	EXIT CONC. (PCI/LITER)	MIL
1	157.	1.1421E+02	2.9541E+03	0.3945
2	183.	6.2499E+01	2.1046E+04	0.4911
3	20.	1.9997E+01	1.0130E-01	0.5051

UMTRA-LAN
AREA B OUTSIDE OF CELL
RADON FLUX

INPUT FILE: LANR01
OUTPUT HEADING: UMTRA-LAN, AREA B O/S CELL, 400 PCI/G LAYER, 4-1-85

FBG 4-1-85
dlf ELT 4-1-85

SUMMARY OF RADCOM INPUT

HEADING:	UMTRA-LAN, AREA B O/S CELL, 400 PCI/G LAYER
LAYERS:	2
INITIAL FLUX:	0.000
AMBIENT RN:	0.100
OPTIMIZED LAYER:	0
SURFACE FLUX LIMIT:	0.000
PRECISION:	0.0010

LAYER NO.	THICKNESS CM	DIFFUSION CM2-SEC	POROSITY FRACTION	RA-226 PCI/G	EMANATING FRACTION	BULK DENSITY G/CM3	SOURCE TERM PCI/CM3-SEC	MOISTURE % DRY WT
1	157.0	0.00055	0.400	1800.0	0.20	1.00	0.0029793	22.8000
2	105.0	0.00545	0.400	100.0	0.20	1.00	0.0001655	17.7000

UMTRA-LAN, AREA B O/S CELL, 400 PCI/G LAYER

********** INPUT PARAMETERS **********

NUMBER OF LAYERS :	2	
RADON FLUX INTO LAYER 1 :	0.00	PCI/M2/SEC
SURFACE RADON CONCENTRATION :	0.100	PCI/LITER
BARE SOURCE FLUX (J0) FROM LAYER 1 :	150.7	PCI/M2/SEC

LAYER	THICKNESS (CM)	DIFF COEFF (CM2/SEC)	POROSITY	SOURCE (PCI/CM3/SEC)	MOISTURE (DRY WT. PERCENT)
1	157.	5.2000E-04	0.4100	2.9502E-03	22.80
2	105.	5.4500E-03	0.4100	1.0390E-04	17.70

***** RESULTS OF RADON DIFFUSION CALCULATION *****

LAYER	THICKNESS (CM)	EXIT FLUX (PCI/M2/SEC)	EXIT CONC. (PCI/LITER)	MIC
1	157.	1.1924E+02	2.9515E+03	0.3445
2	105.	2.9841E+01	8.0397E-02	0.4911

Area-Weighted Average of Radium & Thorium Concentration

Use concentrations, location of contaminated mat'l, & locations of borings from Source No. 1 in basic calc. (Calc. No. 02-200-07). -above.

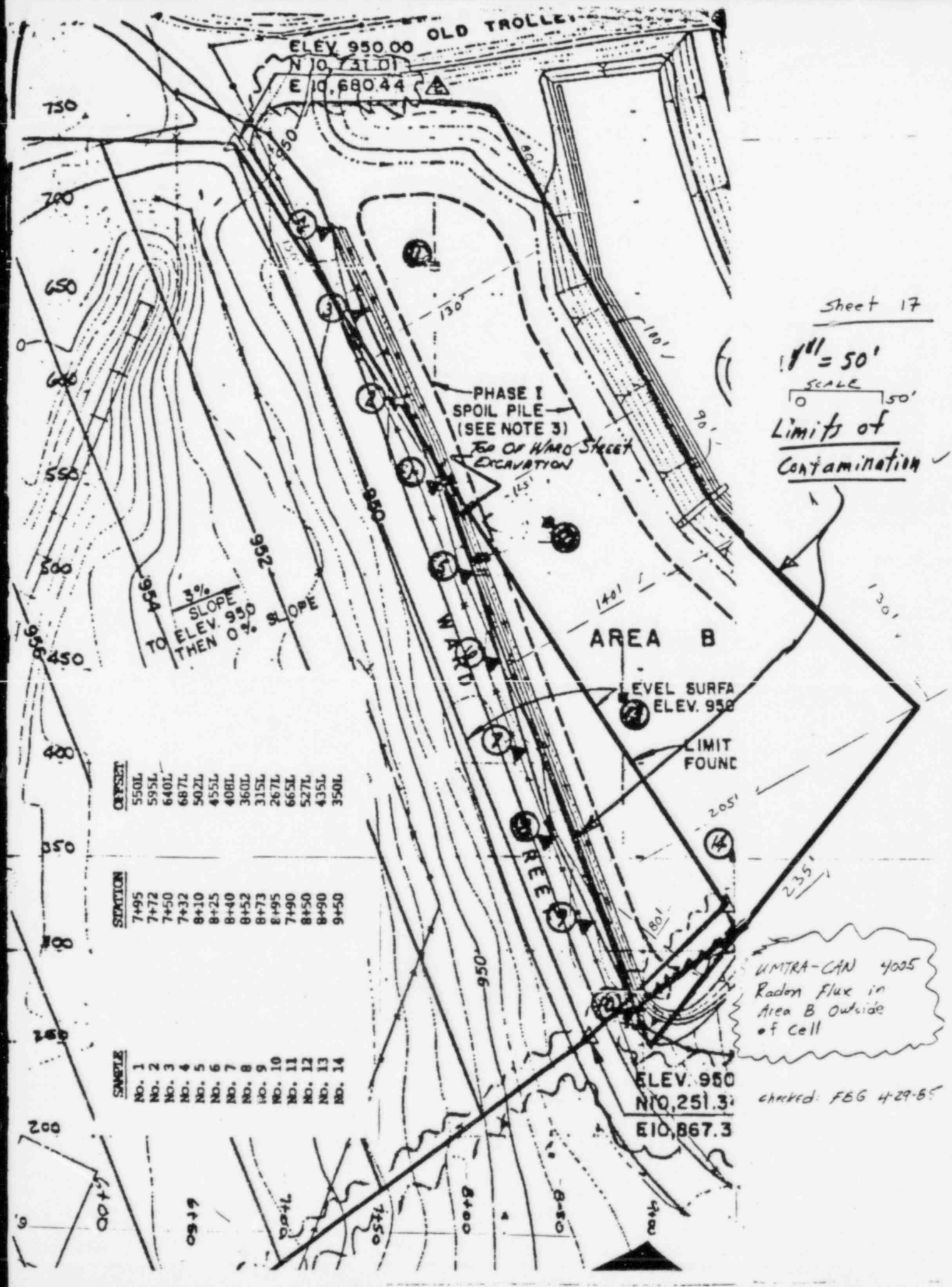
Limits of contamination and locations of borings are shown together on the attached sheet. Borings having samples from the lens are highlighted. They are:

Hole No.	Sample Elev. (ft.)	Ra (pCi/g)	Th/Ra	Area (ft^2)	Weighted (10^4)* Ra (pCi/g)	Th/Ra
1	939.88	440 W	6.5	$\left(\frac{130+125}{2}\right)100$ = 12,750	561	8.29
11	938.47	315 W	2.5		157	1.25
4	941.03	311 W	1.1	$\left(\frac{150+80}{2}\right)130$ = 14,950 [÷3 = 4953]	155	0.55
4B	–	550 W	0.8		274	0.40
5	939.64	210 W	23.1	$\left(\frac{125+140}{2}\right)90$ = 11,925 [÷2 = 5962]	125	13.77
12	938.68	101 W	7.1		60	4.23
8	940.04	1,240 W	2.4	$\left(\frac{140+205}{2}\right)130 + (80)235/2$ = 31,825	1973	3.82
13	938.98	870 W	1.7		1384	2.71
Σ		$\bar{x}$ = 514.6, s = 379	5.67, 7.44	7.145(10^4)	4689	35.02
					656	4.90

Area-weighted averages:

From attached plot (p17), Ra projected = 2.40 × 656 = 1574 pCi/g, < 1800 used in analysis.

*Weighted value = measured value × fraction of area. ΣA = 1.6 acres.

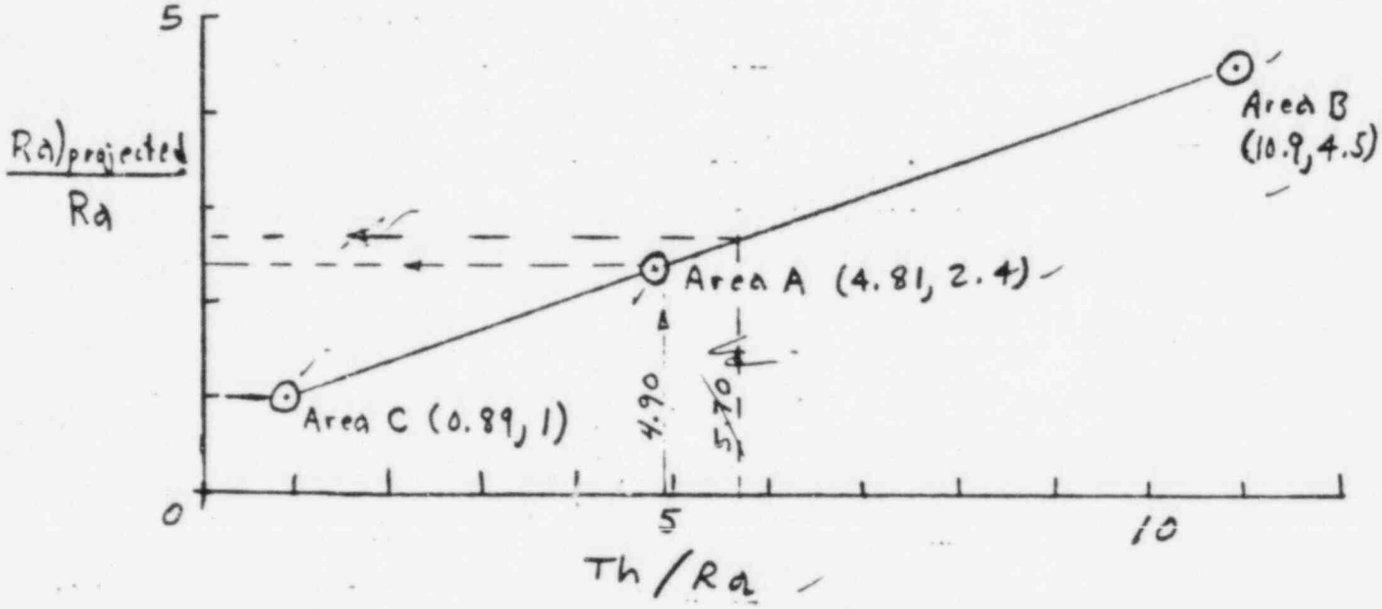


SAMPLE	STATION	OFFSET
No. 1	7+95	550L
No. 2	7+72	595L
No. 3	7+50	640L
No. 4	7+32	687L
No. 5	8+10	502L
No. 6	8+25	455L
No. 7	8+40	408L
No. 8	8+52	360L
No. 9	8+73	315L
No. 10	8+95	267L
No. 11	7+90	665L
No. 12	8+50	527L
No. 13	8+90	435L
No. 14	9+50	350L

From Ref. 3, page 464 get three ratios of Th to Ra.

From page 465 get corresponding factors to multiply current Ra by to get projected Ra.

Plot as follows:



For $Th/Ra = \frac{4.90}{5.1}$, $Ra)_{projected}/Ra \approx \frac{2.4}{2.1}$

For $Ra = \frac{656}{505}$, $Ra)_{projected} = \frac{2.4}{2.1} \times \frac{656}{505} = \frac{1574}{1363}$

This is less than 1,800, the value used in the analysis.

Checker's Note: This analysis assumes that concentrations of Ra and Th used herein represent average or greater-than-average concentrations over the thickness of the contaminated lens at each sample location. This assumption is supported by comparison of the results above with 1) the previous estimate of average Ra concentration of the lens (Ref. 1) and 2) the concentration results for composite samples from recent sampling and testing (Data Source #1).

FEG 4-29-85
HRT 4/29/85

REVIEW COMMENTS of N. G. Banerjee

① The study hinges on the limits of contaminated area provided by the field staff of MKC (Plan A attachment to IOC from Larry Forney to J. Oldham of 6 March 1985); the accuracy of the estimated contaminated area referred above can not be verified from the boring data provided.

② Thorium and Radium contents of Composite Samples from Borings # 11, #12, #13 and #14 are very low compared to that for individual samples from the same borings (Field Data Sheets 1/2 & 2/2). which can not be rationalized without additional explanation. Are these surface Samples?

③ The depths from which the samples are collected are not indicated. I presume, these were worked out from the contour maps and the elevations from which the Samples were collected, in developing the soil profile for cover design.

④ Concluding Comments:

a) Suggest action on item 1 above – See Doc. 4005-CAN-I-02-00545-00 (IOC of 3/27/85 L.F. to File.)

b) Did Some independent calculation before review and approval of the pages referred above

N. Banerjee
5/22/85

For cover thickness = 47 Cm

J_c/J_t = 0.43 from Curve A (Figure 3, Ref. 2)

= 0.80 " Curve B (" ")

Since $a_c/a_t = 0.352$, J_c/J_t values from Curve B is more appropriate to use [Use curve 'B', when $a_t << a_c$]

For actual thickness of radon barrier = 36" ≅ 91.44 Cm

J_c/J_t = 0.20 from Curve A (Figure 3, Ref. 2)

= 0.39 " " B (" ")

Actual flux = $\frac{0.20}{0.43} \times 20 = 9.3$ pCi/m²/sec

or Actual flux = $\frac{0.39}{0.80} \times 20 = 9.75$ pCi/m²/sec.

The conclusion is the choice of Curve A or B in this particular case essentially given the same radon flux

Check Flux for Entire Site if Clean Fill is Not Used Where Fill is Required Above Portions of the Lens Not Encountered During Excavation.

In this case flux = 30 pCi/m²/sec as calculated on Sh. 10, could develope over 71,450 ft² area (Sh. 16). (1.6 Acres) 1.64 ≈ [since 1 acre = 43,560 Sq. Ft]

Flux from the cell would be 20 pCi/m²/sec. if radon barrier thickness = 47 cm (Calc. 02-200-05, Sh. 9). (Included as Attachment-A (Sh. 9, 10 & 11).

This is for measured avg. diffusion coef. = 0.00087 cm²/sec. i.e. from best fit curve for measured values.

To use Radon Attenuation Handbook (Ref. 2),

need a_t & a_c, where $a_i = \rho_i^2 D_i [1-(1-k) m_i]^2$ (Ref. 2, p. 2-4)

$a_t = .466^2 (.00033) [1 - (1-.26) 10^{-2} (1.44) 29.1/.466)]^2$ (Data from Calc. 02-200-05, Sh. 11) (Attachment-A)

[since $m_i = 10^{-2} \cdot \rho M/\rho$] (Ref 2, p 2-4) Ref. 2, p. 2-4

$= .0000716 [1 - 0.65543]^2 = .00000801$ cm²/sec

$a_c = .412^2 (.00087) [1 - (1-.26) 10^{-2} (1.59) 21.2/.412)]^2$

$= .0001476 [1 - .60543]^2 = .00002 30$ cm²/sec

$a_t \approx \frac{1}{2} a_c$ (for cover thickness = 47) → Use Curve A* in Fig. 3, p. 2-5, Ref. 2 → $J_c/J_t = \frac{0.43}{0.8}$ (0.2 ~ 0.4)

Actual thickness of radon barrier = 36" = 91.44 cm → $J_c/J_t = \frac{0.2}{0.4}$

Actual flux = $\frac{0.2}{0.43} \times 20 = \frac{9.3 \approx}{10 \text{ pCi/m}^2/\text{sec}}$ (from cell).

→ see sheet 24 FBG 6-5-85

In this case use of Curve A or B essentially gives the same answer.

UMTRA-CAN 4005
Lens in Area B
Radon Flux

Sheet 21
GRT 5/30/85
FBG 6-6-95

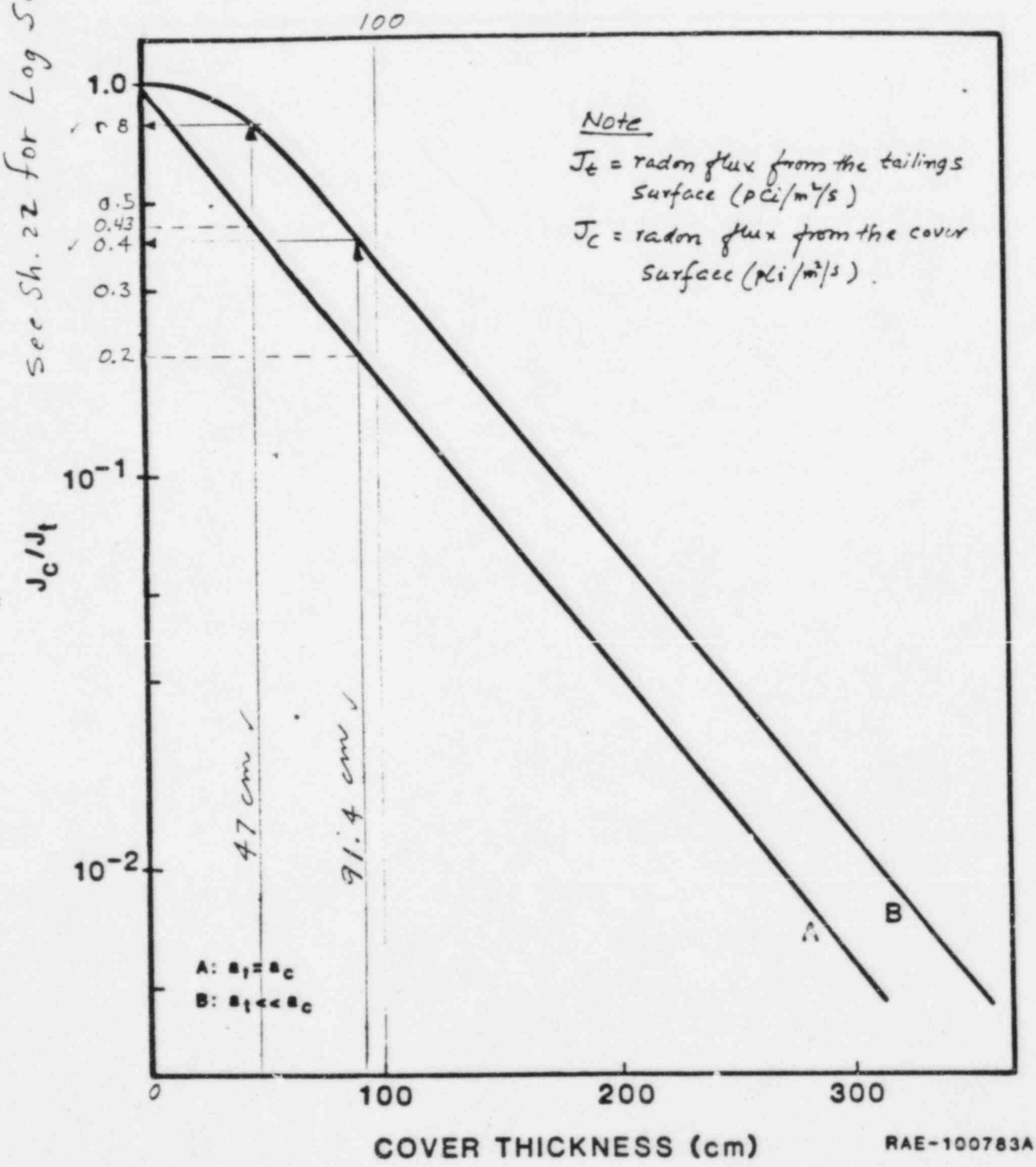


FIGURE 3. COVER SURFACE RADON FLUX FOR VARIOUS THICKNESSESS AND PARAMETERS.

From Ref. 2

Unika Chk 4005
Lens in Area B
Radon Flux

Sheet 22 – Log Scale.*

GRT 5/30/85
FEG 6-6-85

*Used w/ sheet 21.

Flux for remainder of site = 8.6 pCi/m²/sec. (Ref. 1, p. F.2-13). "Attachment - B"

This is before soil loss due to erosion.

Average loss over 200 yrs.* ≈ $\frac{2.0 + 1.0 + 1.4 + 1.\square}{4}$ = 1.55", say 1.6" (Calc. 02-13-RO-14, Sh. 14.)

New thickness = 24 - 1.6 = 22.4" = ~~56.9 cm~~

New flux ≈ $\frac{24}{22.4}$ x 8.6 = 9.2 pCi/m²/sec. {Based on Calc. for cell where doubling thickness, halves flux.

Areas: Cell: 282,000 □' = 6.5 Acres {Calc. 02-200-10, Sh. 3.

Remainder of site: 18.9 - (6.5 - 5.8) - 1.6 = 16.6 Acres. (See Sh. 20 above)

Area of RAP cell, Ref. 1, pg. F.2-12 — 18.8 by Checker (see sheet 24)

Avg. flux for site = $\frac{\overbrace{10(6.5)}^{\text{Cell}} + \overbrace{9.2(16.6)}^{\text{"Remainder"}} + \overbrace{30(1.6)}^{\text{"Lens"}}}{6.5 + 16.6 + 1.6}$

$= \frac{\overbrace{65 + 152.7 + 48}^{265.7}}{24.7} = 10.8$ pCi/m²/sec. (10.6 by Checker (sheet 24))

< 20 pCi/m²/sec.

O.K.

* 200 years used because providing adequate site cover for 1000 years does not appear to be reasonably achievable. (see Calc. 02-13-RO-14, sheet 14) FBG 6-5-85 M.R.J. 6-6-85

Checker's Comments:

1. Compare Flux Obtained Using Curve B (for $a_t \ll a_c$)

With Flux obtained using Curve A (for $a_t = a_c$)

Since $a_t \sim 1/3\ a_c$:

For 47 cm., $J_c/J_t = 0.43$ ✓ (Curve A)

For 91.4 cm (=36"), $J_c/J_t = 0.20$ ✓ (Curve A)

Actual Flux = $\frac{0.2}{0.43} = 9.3$ ✓ pCi/m²/sec

Therefore, flux = 10 pCi/m²/sec is a reasonable value to use for actual flux

2. Area of Disposal Site After Cleanup of Area C for Release of Area C for Unrestricted Use.

Total Area ~ 30 ✓ ac (Ref. 1, p. F.3-2) } (Does Not Consider Clearing of Area C)
Area C ~ 3.1 ✓ ac (Ref. 1, p. F.3-2) } (See Attachment 'C')

"Remainder of Site"* on sheet 23:

Area = 30 (total) − 3.1 (Area C) − 6.5 (cell) − 1.6 (levs-Area B)

= 18.8 ✓ ✓

Average Flux = $\frac{10(6.5) + 9.2(18.8) + 30(1.6)}{6.5 + 18.8 + 1.6}$

= 10.6 pCi/m²/sec ✓ ✓

* Approximate, as several small areas are ignored (e.g., area

CAL NO. 02-200-07

ATTACHMENT C

1/12

SOURCE #1

MORRISON-KNUDSEN COMPANY, INC. (12 pages: 1/12 ~ 12/12)

INTER OFFICE CORRESPONDENCE

DATE March 6, 1985

TO J. Oldham

FROM Larry Farnes LF

LOCATION Albuquerque, NM

LOCATION: Canonsburg, PA

SUBJECT Contaminated Material - Area B

Enclosed is a plan drawing showing the anticipated contaminated material underlying Area B. Also enclosed is some cross-sections thru this area which indicate estimated depth and thickness of contaminated material, depth of low-level contaminated material covering the contaminated material and finish grade line of general fill. On top of the general fill grade would be an additional 9" of bedding, 2'-0 of riprap and 1'-0 of select soil.

Based on our soil samples last fall when doing Ward St., the anticipated range of contamination for the material is from 350 to 450 pCi/gram.

The R.A.P. acknowledges this material in the following references:

1. Article 3.4 - page 12.
2. Article 5.3.1 - page 19.
3. Article B.2 - page B-3.
4. Article B.3 - page B-5.
5. Article D.2 - page D-3.

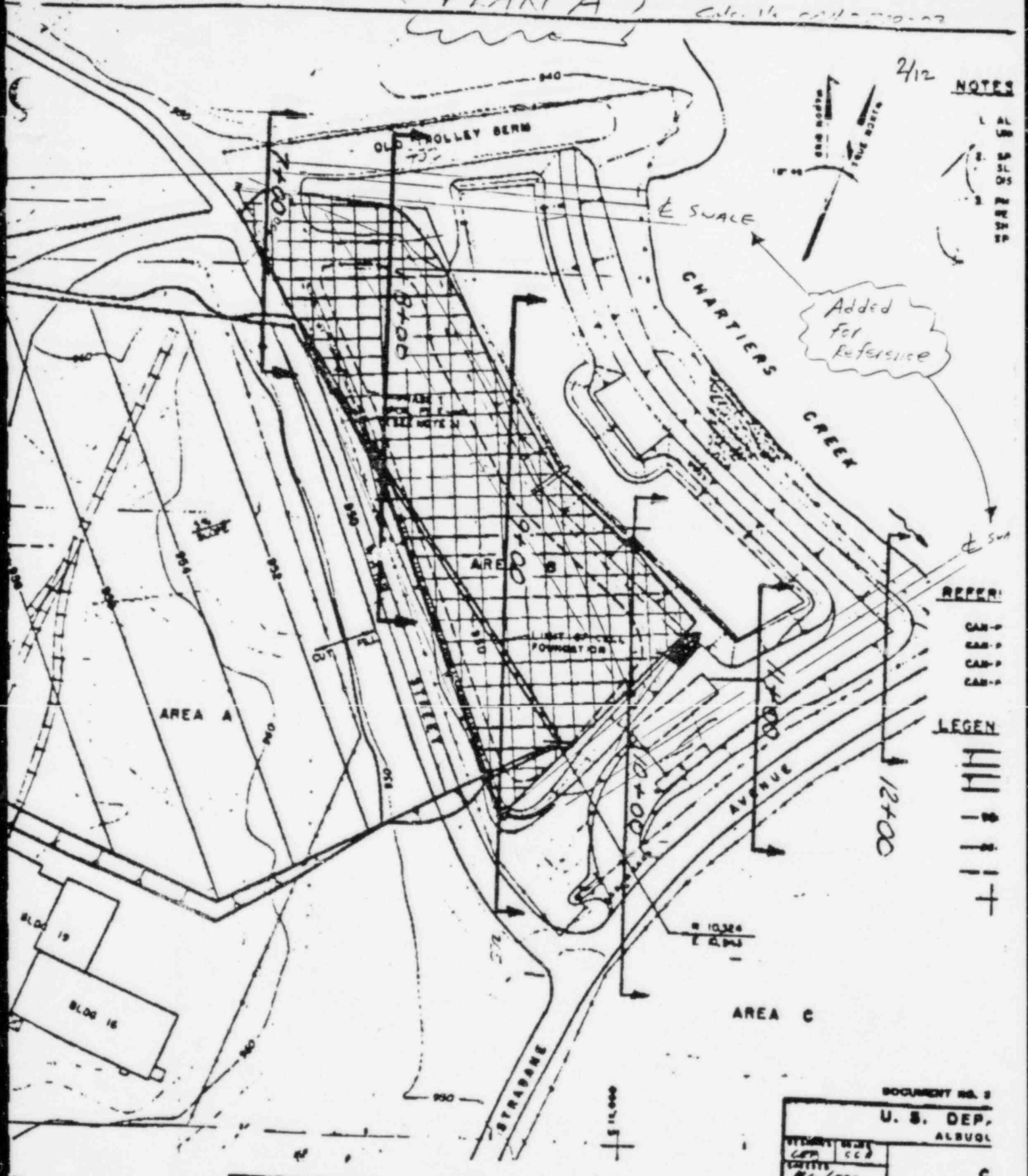
The only deviation appears to be that we feel the material averages 400 pCi/g while the R.A.P. states less than 150 pCi/g.

For this reason we should request clarification from D.O.E. on this issue.

If there are any questions, please call.

LF/db

(PLAN A)


OLD TROLLEY BERM
CHARTIERS CREEK
Added for Reference
AREA A
AREA B
AREA C
TROLLEY
AVENUE
STRADBANE
BLDG 15
BLDG 16
12+00
NOTES
LEGEN
REFER
0 100 150 200
FEET
ISSUED FOR CONSTRUCTION
U. S. DEP
ALBUQ

Calculated by _____ Date 3/6/85

Checked by _____ Date _____

MORRISON-KNUDSEN COMPANY, INC.
QUANTITY SHEET

Project Cornerstone - Area B

Par: —

Sheet _____ of _____

STATION	EXCAVATION E.A.	EXCAVATION D.E.A.	EXCAVATION L.F.	EXCAVATION C.Y.	EMBANKMENT E.A.	EMBANKMENT D.E.A.	EMBANKMENT L.F.	EMBANKMENT C.Y.
6+50	0	300	50	278				
7+00	300	1245	100	2306				
8+00	946	2345	100	4343				
9+00	1400	1720	100	3185				
10+00	320	320	75	444				
10+75	0							
				10556 ±				

Contaminated material

Total C.Y.

Total C.Y.

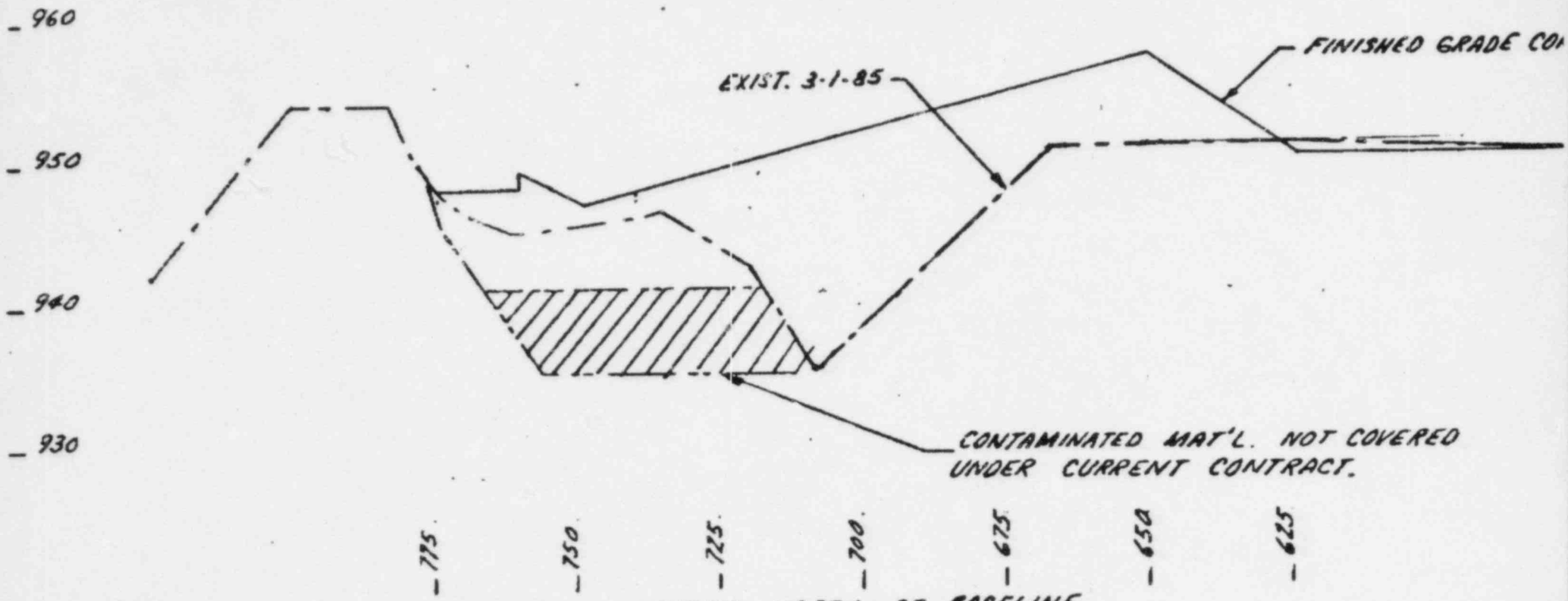
STATION	EXCAVATION E.A.	EXCAVATION D.E.A.	EXCAVATION L.F.	EXCAVATION C.Y.	EMBANKMENT E.A.	EMBANKMENT D.E.A.	EMBANKMENT L.F.	EMBANKMENT C.Y.

Total C.Y.

Total C.Y.

3/12

STATION 7+00



4/12

MORRISON KNUDSEN COMPANY INC

OPERATION Mt. W/ HRC =

ITEM NO SHEET 1 OF 2 PAGE 5/12

JOB 3050 - CLIFF LAP

QUANTITY UNIT EST. BY CO CK'D BY DATE 29 MAR 85

FORM ENG 13 1978 PRINTED IN U.S.A.

LARRY FARIES:

AK. 3 <

Results from Ken Baker / Vail to CHV

EDA Samples -

Sample #1

hole #1 - ✓ el 937.88 - Ra 440 pc/g ± 10
Th - 2280 ± 20 ✓

hole #4 ✓ el 947.03 - Ra 31 pc/g ± 9
Th 3+2 ± 7 ✓

hole #5 ✓ el 937.64 - Ra 210 pc/g ± 7
Th 4850 ± 30

#11 HRS hole 1 ? - ✓ el 938.47 - Ra 315 pc/g ± 9
Th - 790 ± 10 ✓

hole #12 - ✓ el 938.68 - Ra 101 pc/g ± 5
Th - 720 ± 10 ✓

hole #13 - ✓ el 938.98 - Ra 870 pc/g ± 0
Th - 1490 ± 20 ✓

hole #8 el 940.0 ± Ra 1240 pc/g ± 20
Th 2980 ± 20

St. sample #2

hole #4 B el none Ra 560 ± 10
Th 418 ± 8

Composite FAN = Top Mtl =

hole #11 = composite #1-#8 -

Ra = 10 ± 2.

Th = 20 ± 2.

hole #12. Composite #1-#6

Ra = 12 ± 2

Th = 101 ± 4

hole #13 Composite #1-#6

Ra = 35 ± 3

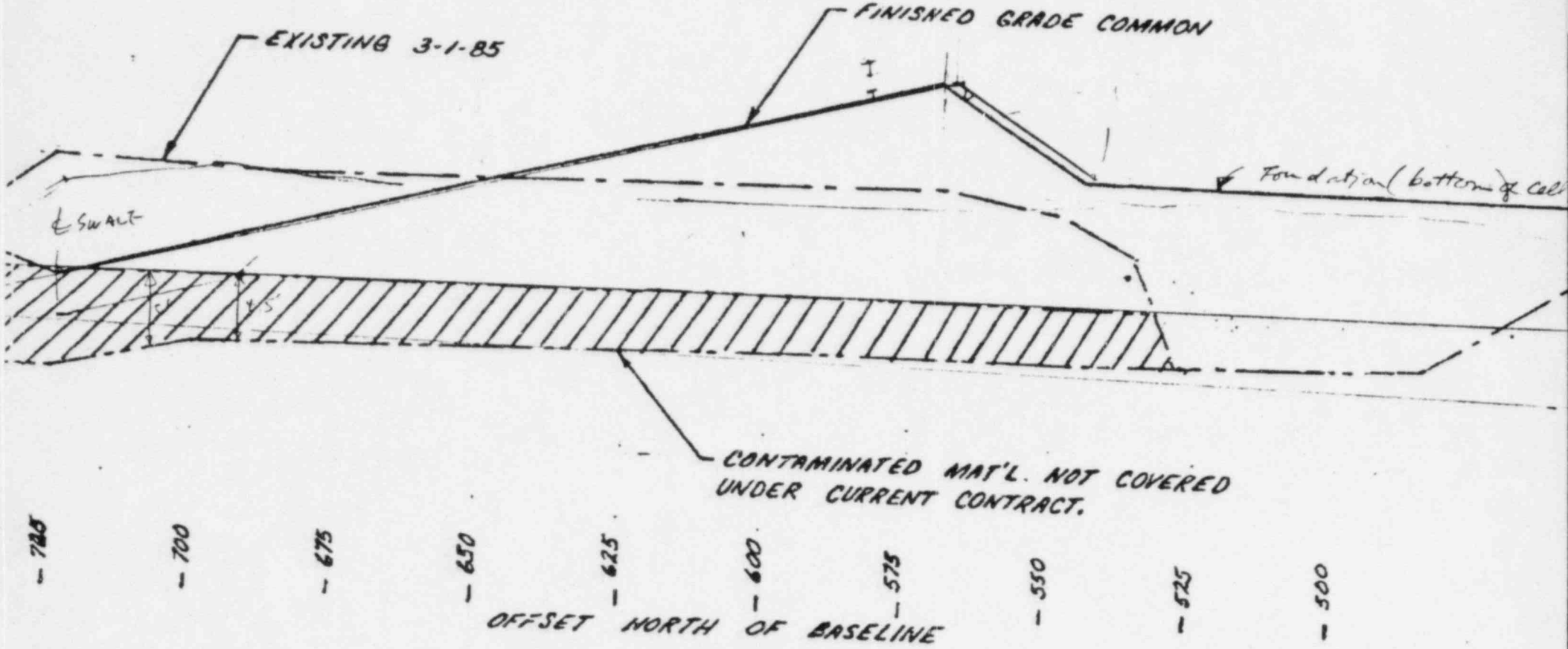
Th = 131 ± 4

hole #14 - Composite #1-#6.

Ra = 3.5

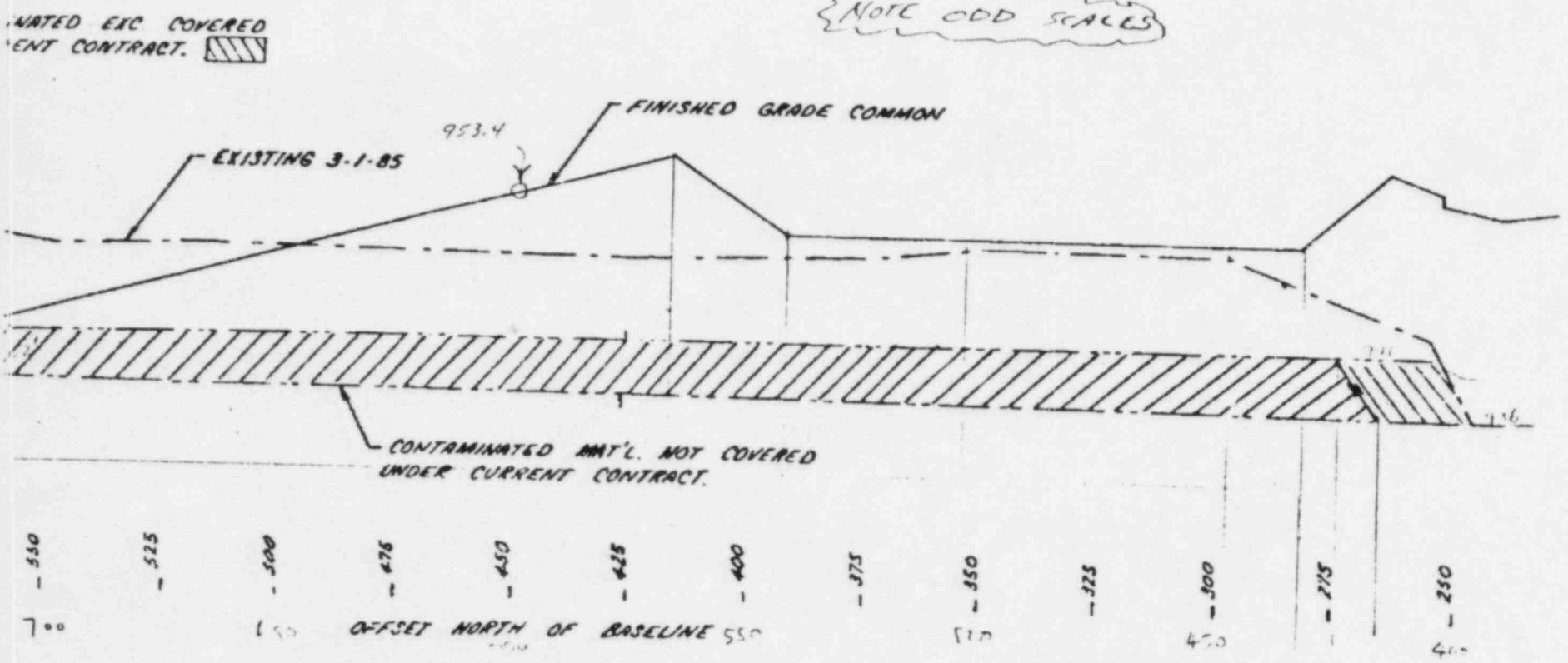
Th = 7.8

STATION 8+00


EXISTING 3-1-85
FINISHED GRADE COMMON
Foundation (bottom of cell
℄ SWALE
CONTAMINATED MAT'L. NOT COVERED UNDER CURRENT CONTRACT.
725
700
675
650
625
600
575
550
525
500
OFFSET NORTH OF BASELINE

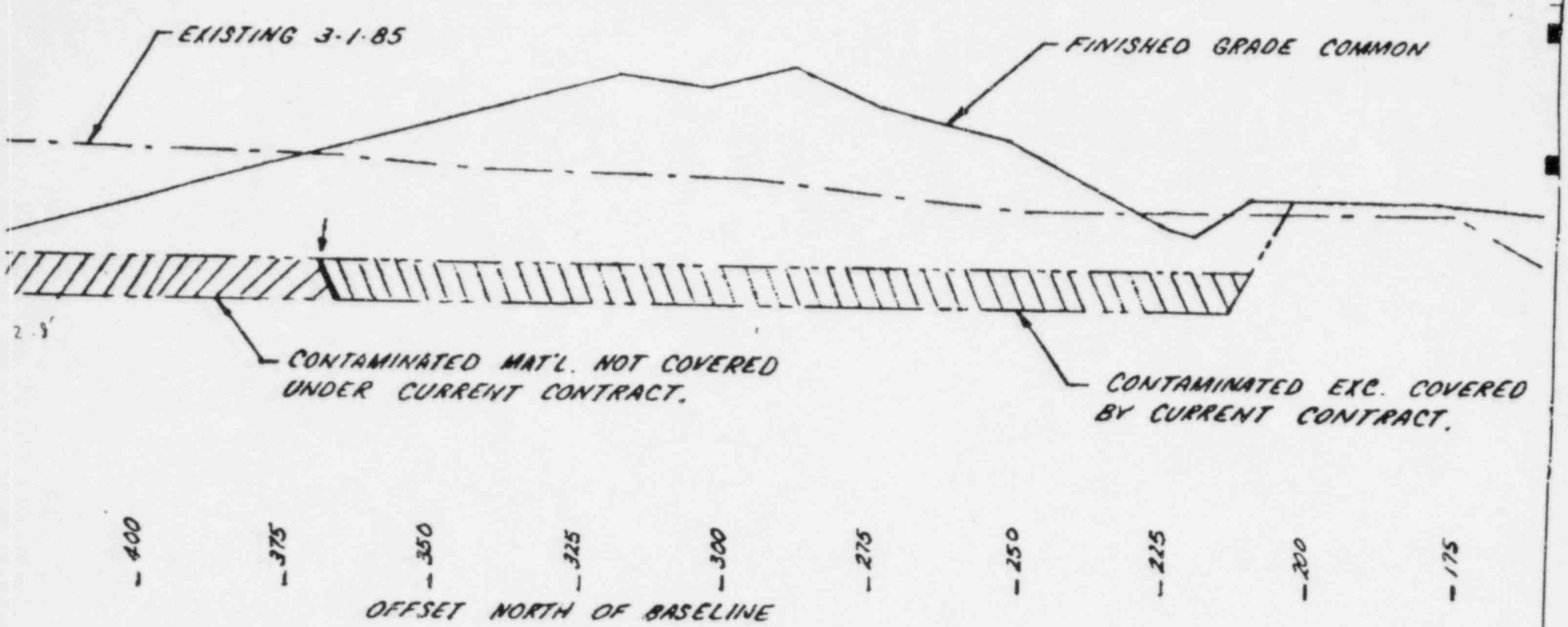
STATION 9+00

NOTE ODD SCALES



put Sta 7+00 on to Str. Base Section to get Max. cut scale

STATION 10+

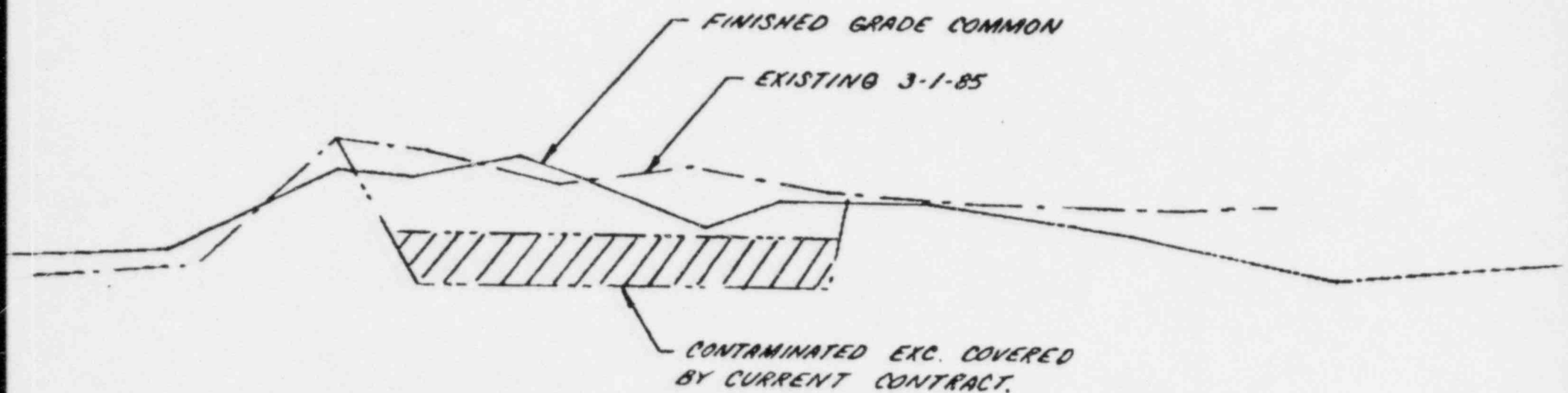


-400 -375 -350 -325 -300 -275 -250 -225 -200 -175

OFFSET NORTH OF BASELINE

9/12

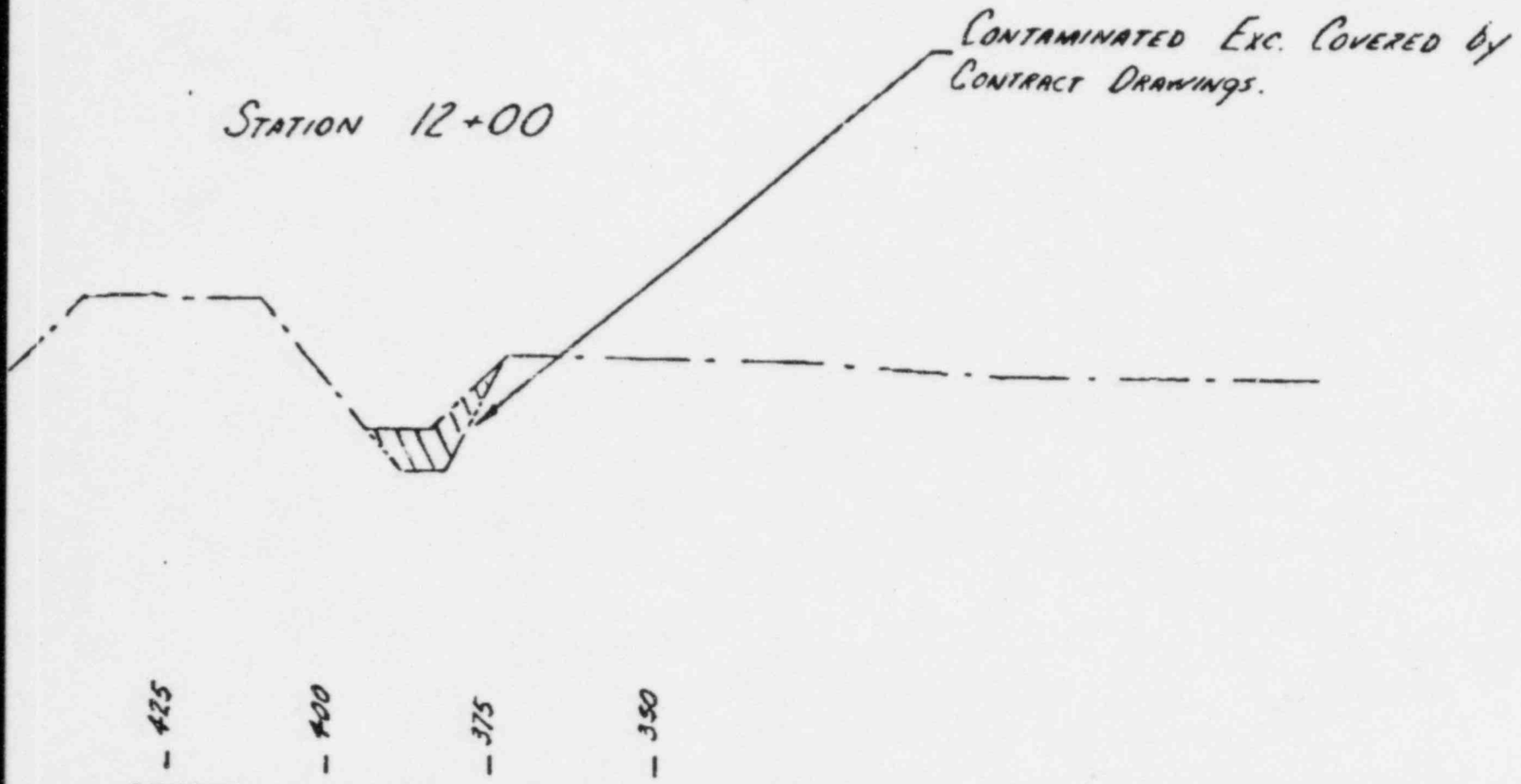
STATION 11+00



-425 -400 -375 -350 -325 -300 -275

OFFSET NORTH OF BASELINE

7/01


CONTAMINATED EXC. COVERED BY CONTRACT DRAWINGS.
STATION 12+00
-425
-400
-375
-350
OFFSET NORTH OF BASELINE

11/12

OLD TROLLE
ELEV. 950.00
N 10,731.01
E 10,680.44
12/12
PHASE I
SPOIL PILE
(SEE NOTE 3)
TOE OF WARD STREET
EXCAVATION
AREA B
LEVEL SURF
ELEV. 95(
LIMIT
FOUN
WARD
REE
3% SLOPE TO ELEV. 950 THEN 0% SLOPE
STATION OFFSET
7+95 550L
7+72 595L
7+50 640L
7+32 687L
8+10 502L
8+25 455L
8+40 408L
8+52 360L
8+73 315L
8+95 267L
7+90 665L
8+50 527L
8+90 435L
9+50 350L

From Calc. No. 02-200-05

Refined Calculation of Diffusion Coef. & Barrier Thickness:

Diffusion Coefficient:

By standard regression analysis best fit 5th order curve to the radon diffusion coefficient measurements on the N. Strabane Township Borrow Area (Data Source 1 on Cover Sheet) is:

$$D = e^{(0.460 - 25.66M + 34.97M^2 + 53.36M^3 - 146.92M^4 + 72.9M^5)}$$

(See plot of this eqn. & best fit 3rd order curve on Sh. 10.)

For $M = 0.82$, $[M^2 = .6724,\ M^3 = .551368,\ M^4 = .4521217,\ M^5 = .3707397]$

$$D = e^{(0.460 - 21.0412 + 23.513828 + 29.420996 - 66.42572 + 27.026924)}$$

$$= e^{-7.045172} = \underline{0.000872 \text{ cm}^2/\text{sec.}}$$

$[\text{Log}_{10} e = 0.43429.\ \text{Log}\, e^{-7.045172} = -3.0596477]$

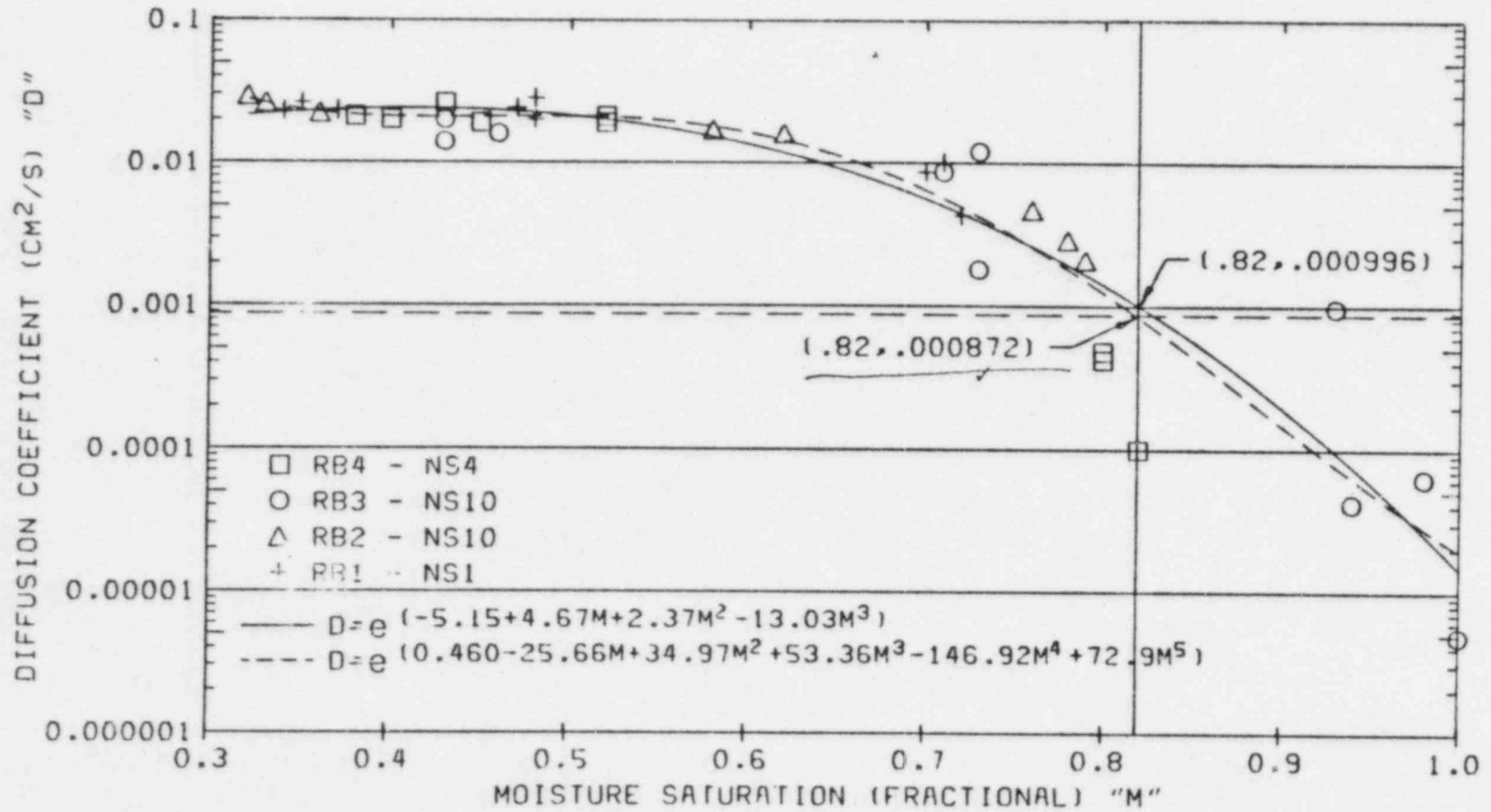
$e^{-7.045172} = 10^{-3.0596477} = 1/10^{3.0596477} = 1/1147.1]$

Barrier Thickness:

Using $D = 0.00087$ cm²/sec. & the input values given on Sh. 3 for the other parameters, an additional RAECOM run was performed (See Sh. 11). The cover thickness required is 47 cm (18.5 inches).

To account for construction accuracy (±0.1') use 21 inches.

CANONSBURG FINAL COVER



Des. ECJ
Chkd. MBE
1-14-95
1-14-95

SHEET 11
ECT 12/27/84

Input chk.d GRT
12/27/84

.?

A

SUMMARY OF RAECOM INPUT

HEADING: ustra-can, sodiFIED DIFFUSION COEFFICIENT 12/27/84
LAYERS: 2
INITIAL FLUX: 0.000
AMBIENT RN: .180 ✓
OPTIMIZED LAYER: 2
SURFACE FLUX LIMIT: 20.000 ✓
PRECISION: .0010

LAYER NO.	THICKNESS CM	DIFFUSION CM2-SEC	POROSITY FRACTION	RA-226 PCI/G	EMANATING FRACTION	BULK DENSITY G/CM3	SOURCE TERM PCI/CM3-SEC	MOISTURE % DRY WT
1	548.6 ✓	.00033	.466	2200.0	.20	1.44	.0028553	29.1000
2	30.0	.00087 ✓	.412	0.0	0.00	1.59 ✓	0.0000000	21.2000 ✓

ustra-can, sodiFIED DIFFUSION COEFFICIENT 12/27/84

********** I N P U T P A R A M E T E R S **********

NUMBER OF LAYERS : 2
RADON FLUX INTO LAYER 1 : 0.00 pCi/m2/sec
SURFACE RADON CONCENTRATION : .180 pCi/liter

LAYER 2 ADJUSTED TO MEET Jcrit : 20.0 +/- .100E-02 pCi/m2/sec

BARE SOURCE FLUX (Jo) FROM LAYER 1 : -166.8 pCi/m2/sec

LAYER	THICKNESS (cm)	DIFF COEFF (cm2/sec)	POROSITY	SOURCE (pCi/cm3/sec)	MOISTURE (dry wt. percent)
1	549.	3.3000E-04	.4700	2.8310E-03	29.10
2	30.	8.7200E-04	.4100	0.0000E+00	21.20

***** R E S U L T S O F R A D O N D I F F U S I O N C A L C U L A T I O N *****

LAYER	THICKNESS (cm)	EXIT FLUX (pCi/m2/sec)	EXIT CONC. (pCi/liter)	MIC
1	549.	1.0357E+02	5.1083E+05	.3444
2	47.	1.9985E+01	7.0283E-02	.3905

Attachment--B
From RAP

IV. CONCLUSIONS

A. Minimum Cover Thickness Required to Meet 20 pCi/m^2sec Standard

Using the data presented in Table F.2.2.2, the RAECO output indicates that 71 cm (28") of the borrow material will attenuate the radon emissions to below the flux limit of 20 pCi/m^2 sec on the encapsulation cell. The remainder of the site will require 13 cm to reduce the flux below 20 pCi/m^2 sec.

It should be noted that this required cover thickness accounts only for attenuation of radon. Additional cover will be required for erosion protection and to control intrusion of man or animals.

B. Post Remedial Action Flux

The radon flux will be further reduced by adding material for erosion control. On the encapsulation cell the cover will consist of 3 feet of compacted clay, 1.5 feet of rock, and 1 foot of topsoil. Taking no credit for the rock cover or topsoil, RAECO gives the final post remedial action flux of 10.4 pCi/m^2sec from the encapsulation cell. The remainder of the site will have a minimum of 2 feet of borrow material for cover with a diffusion coefficient of 0.00671 cm^2/sec. This will result in a flux of 8.6 pCi/m^2sec on the remainder of the site. These two fluxes will result in an average site flux of 9.0 pCi/m^2sec after the remedial action is completed, based on the site weighted average over the 5.8-acre encapsulation cell and 18.9 acres of the remaining area covered on the site.

Attachment - C
From RAP

situated at the intersection of George Street and Strabane Avenue (Figure F.3.1.1). It is bounded on the east by Chartiers Creek, on the west by private property, on the south by George Street and the Consolidated Rail Corporation (ConRail) right-of-way (R.O.W.), and on the north by a right-of-way of the abandoned Washington-Canonsburg Street Railway.

The designated site is located on approximately 18.6 acres of land. It is divided into three separate areas: A, B, and C. Area A covers 11 acres and is bounded by Ward Street, Strabane Avenue, George Street, and the former Georges Pottery Property. Area B covers approximately 4.5 acres and is vacant. It is bounded by Chartiers Creek, Strabane Avenue, Ward Street, and the Washington-Canonsburg Street Railway R.O.W. Area C covers 3.1 acres and is also vacant. It is bounded by Chartiers Creek, Strabane Avenue, and the ConRail R.O.W.

Most of the Canonsburg site was owned by the Canon Development Company which operated it as the Canon Industrial Park from 1962 to 1982. The site was acquired by the Commonwealth of Pennsylvania for the Department of Energy (DOE) in 1982.

It is anticipated that the site will be expanded to encompass the approximately 30 acres between the ConRail R.O.W. and Chartiers Creek. This will add the former Georges Pottery property and the residential properties at the ends of Ward Street and George Street. The proposed finished site is shown in Figure F.3.1.2.

F.3.1.3.2 History of milling operations and processing

The Standard Chemical Company was the first processor to operate at the site, from 1911 to 1922, extracting radium and vanadium from carnotite ore. No further operations were conducted until about 1930 when Vitro Manufacturing Company (now the Vitro Corporation of America) acquired the plant. From 1930 to 1942, Vitro extracted radium and uranium salts from on-site residues and carnotite ore. Beginning in 1942, operations to recover uranium from various ores, concentrates, and scrap were funded by Federal Government contracts.

Liquid wastes were discharged into an open drain that passed under Strabane Avenue and emptied into a swamp now known as Area C, as shown in Figure F.3.1.1. A drainage ditch connected the swamp and Chartiers Creek.

Recovery operations at the Canonsburg site ceased in 1957. The remaining unprocessed residues and contaminated processing wastes remained stored on the site under an Atomic Energy Commission "storage only" license. The real property was sold in 1962 to developers, while Vitro retained title to the uranium-containing materials. Before 1964, an effort was made to decontaminate the immediate plant area, and some contaminated

Enclosure 9 (1p.)

July 17, 1985

SUBJECT: Canonsburg Project - UMTRA
Canonsburg, Washington County

TO: Jim Yusko
Radiation Protection

FROM: Tony Orlando
Bureau of Solid Waste Management

- Under 75.261(c)(4) - "Source, special nuclear, or by-product material as defined by the U. S. Atomic Energy Act, 1954" are excluded from the hazardous waste regulation scheme.

- The proposal of disposing the chrome contaminated soil within the UMTRA cell is acceptable.

- The hazardous waste design standards for disposal cell are more stringent than what is proposed at the Canonsburg UMTRA site, especially for the primary and secondary liners, the subgrade monitoring zone under the cell, etc.

- I would only ask that they include chromium as a parameter in the groundwater monitoring program.

TO/ld

cc: Ray Shuba
Regional File

Rcd 7/22/85