Proposed Plans and Estimated Costs for Tailings Reclamation, Mill Decommissioning and Pond Reclamation at the Uravan Mill - for Surety Purposes

May 30, 1980

1.0 Introduction

The Company presented a draft of its proposed decommissioning and reclamation plan for the Uravan mill to members of the Radiological and Hazardous Waste Division, Colorado Department of Health, on February 27, 1980. The Division's response to the plan, which was contained in a letter to Mr. R. G. Beverly from Mr. A. J. Hazle dated April 1, 1980, stated that it needed to be modified to address a credible worst case. This was defined as:

1.1 "That some further degradation of the Uravan environs by the mill will occur."

1.2 "That removal of all existing and newly generated tailings to final disposal at a new site approximately 20 miles distance from the present mill site will be necessary."

1.3 "That unrestricted use of the decommissioned mill site and/or final tailings disposal site will not be completely achievable."

These conditions were discussed with Mr. Hazle and other members of the Department on April 10, 1980. In that meeting agreement was reached between Union Carbide and the Division that:

1.4 An acceptable approach to tailings reclamation would be stabilization in place after reduction of the slopes of the existing piles to 5 horizontal to 1 vertical. Surplus tailings would be reclaimed in a similar manner in the same area.

1.5 Members of the Department would clarify items 1.1 and 1.3.

This memorandum represents the Company's plans and estimated costs for decommissioning and reclamation of the Uravan mill. This revision incorporates the information from 1.4 and 1.5. The Company will furnish the State Treasurer's office with a letter of credit upon approval of the plan.

The long term surety program, is not addressed in this document as it will be furnished on resolution of the Maybell plan.

2.0 Summary

This document presents a plan and estimated costs for surety purposes for reclamation of the Uravan Tailings Piles, the Club Ranch Ponds, River Ponds, Atkinson Creek Area, Club Mesa Spray Area, and mill decommissioning. The estimated costs for these activities is $20.9 MM. A breakdown of the costs are shown in Table I.

TABLE I

SUMMARY OF RECLAMATION COSTS FOR SURETY PURPOSES

Item	Total Cost $M
Club Ranch Ponds	2508
River Ponds	457
Atkinson Creek Area	740
Club Mesa Spray Area	748
Tailings Pile 2	3634
Tailings Pile 3	1585
New Fill Area	8575
Mill Decommissioning	2680
TOTAL COST	20927

The tailings piles will be reclaimed by reducing the slopes to five horizontal - one vertical and impounding the tailings that cannot be stored under the slope in a new fill area adjacent to Pile 2. The reclaimed areas meet the NRC criteria for above ground long-term impoundment.

The mill decommissiong plan provides for removal of all structures and process area clean-up.

The wastes from the Club Ranch Ponds, River Ponds, Atkinson Creek area, and the Club Mesa Spray Area are reclaimed by impounding in Pile 2 prior to placement of the reclamation cover.

3.0 Calculation of the Reclamation Costs

The reclamation costs presented in this document were estimated using standard engineering unit cost methods. The unit costs used throughout this report are presented below.

Activity	Unit Cost
Excavate, load, or stockpile material	$0.90/cubic yard
Truck haulage less than 10 miles	$1.25/ton
Truck haulage less than 20 miles	$1.50/ton
Grade and fill	$1.00/cubic yard
Rock placement	$1.50/cubic yard
Area stripping	$50/acre

4.0 Decommissioning the Mill

The engineering cost estimate of $2.68 MM for decommissioning the mill are presented in Table II. The activities include the dismantling and removal of all structures and auxillary equipment, salvageable items will be decontaminated and removed from the site. The remaining items will be placed in the tailings piles or fill area prior to reclamation.

5.0 Reclamation of the Club Ranch Ponds, River Ponds, Atkinson Creek Area, and Club Mesa Area

The program for reclamation of these areas calls for:

5.1 The use of heavy equipment to cut out contaminated material, regrade, and backfill.

5.2 The contaminated materials will be placed in the existing tailings pile prior to reclamation, and covered as described in section 6.0.

The individual estimates are presented in Table III.

Table II

Estimated Costs for Decommissioning the Uravan Mill

Item	Description of the work	Cost (1979 M$)
1	Mechanical equipment	1125
2	Storage bins	20
3	Instrumentation	30
4	Process piping and pumps	300
5	Elecrical controls and switch gear	150
6	Plant buildings	325
7	Miscellaneous support facilities	30
8	Break-up and remove concrete	600
9	Cut, regrade, and backfill contaminated process areas	100
	Total cost	2680

Table III

Estimated Costs for the Reclamation of the Club Ranch Ponds, River Ponds, Atkinson Creek Area and the Club Mesa Spray Area

Area	Item No.	Description of the Work	Quantity	Unit Costs ($)	Estimated Costs (M$)
Club Ranch Ponds	1	Excavate and load crystals and contaminated soil 36 acres cut to an average depth of 10 feet	580 M yd^3	0.90/yd^3	520
	2	Haul and dump	1.4 MM tons	1.25/ton	1750
	3	Haul backfill for 1 foot of soil and gravel	58 M yd^3	1.25/ton	180
	4	Grade and fill the area	58 M yd^3	1.00/yd^3	58
		Total Cost			2508
River Ponds	1	Excavate and load contaminated material Ponds 6 and 7 - 115 M yd^3; Ponds 1-5 55 M yd^3	170 M yd^3	0.90/yd^3	150
	2	Haul and dump the material	234 M tons	1.25/ton	290
	3	Haul and dump sand and gravel mix for 1-foot of cover	6.6 M tons	1.25/ton	8
	4	Grade and fill the area	5.2 M yd^3	1.00/yd^3	9
		Total Cost			457

TABLE III (Continued)

Area	Item No.	Description of the Work	Quantity	Unit Costs ($)	Estimated Costs (M$)
Atkinson Creek	1	Excavate and load the contaminated soil and crystals	270 M yd^3	0.90/yd^3	240
	2	Haul and dump the material	380 M tons	1.25/ton	475
	3	Backhaul soil to cover the area to 1 foot	11 M tons	1.25/ton	14
	4	Grade and fill the area	8 M yd^3	1.00/yd^3	8
	5	Revegetate 5 acres @ $345 per acre			3
		Total Cost			740
Club Mesa Spray Area	1	Excavate and load the crystals and contaminated soil Approximately 25 acres to a depth of 10 feet	400 M yd^3	0.90	360
	2	Haul and dump	563 M tons	1.25	700
	3	Grade and fill the area with 1 foot of soil	40 M yd^3	1.00	40
	4	Revegetate 25 acres @ $345/acre			8
		Total Cost			748
		Total Cost for Reclamation			4,453

6.0 Reclamation of the Tailings Piles

6.1 Regulatory Considerations

The Colorado Board of Health adopted regulations for the stabilization of inactive uranium mill tailing piles on December 15, 1966 which became effective January 26, 1967. These regulations were incorporated as Part XI of the Colorado Rules and Regulations Pertaining to Radiation Control, April 1, 1978.

In late 1977 the NRC developed a Branch Position proposing a much different approach to tailings disposal which included a goal after stabilization of background gamma and radon emination rates no higher than two times background. Subsequently the Colorado Department of Health issued the Uranium Mill Licensing Guide in May 1978 incorporating the NRC goals in Section M., Tailings Management Program.

In the August 24, 1979 Federal Register the NRC proposed regulatory changes which included tailings disposal criteria. Hearings have been held on these proposed regulatory changes but to date no actual regulations have been promulgated.

Thus, the only regulations governing inactive tailings currently in effect are those contained in Part XI of the Colorado regulations.

When the NRC eventually issues tailings stabilization regulations, Colorado will no doubt change its regulations. If new regulations require revisions or a reconsideration of the proposal contained herein, Union Carbide will revise and resubmit as required its proposal and will make any required adjustments in its financial surety to cover costs of the revised proposal. Considering approximately another three years use of the existing tailing piles and an additional period to allow the liquid in the pile to drain permitting the use of heavy construction equipment, actual reclamation of the present piles probably will not start for another four to five years. In the meantime, a proposal to meet the basic NRC and State goals is presented, and a commitment is made to revise the proposal and surety as required.

6.2 Reclamation Plan

There will be approximately 10 million tons of tailings impounded in Piles 2 and 3 at shutdown in 1983. The configuration of both piles at that time is shown in Dwg. No. 515057, Revision 0.

The Company's proposal for long term reclamation of Piles 2 and 3 consists of the following elements:

6.2.1 Sufficient time will be allowed so that the phreatic line will drop below the point at which the piles will be cut back to a 5 to 1 slope on reclamation.

6.2.2 The waste material from the Club Ranch, River Ponds, Atkinson Creek storage area, plant area clean-up, and the Club Mesa spray system will be placed in the rear of Pile 2.

6.2.3 The dry tailings above the elevation of the buttress will be cut back and moved to the rear of Pile 2 covering the waste described in 6.2.2.

6.2.4 The slopes of Piles 2 and 3 will be cut back to 5 horizontal - 1 vertical. This will be accomplished by cutting off the rock buttress and pushing the tailings back toward the rear of the piles or moving them into a new lined fill area built to the northwest of Pile 2. Approximately 40% of the tailings can be reclaimed in place.

6.2.5 The rock salvaged from the butress will be stored for use in the final covering.

6.2.6 The reclaimed tailings areas will be covered with 4.5 feet of mancos shale to reduce the radon emination rate to 2 times the background rate and gamma to background. In our case this is more restrictive than 2 $pCi/m^2/sec$ above background figure presented in the GEIS. The cover calculations are attached as Appendix 1.

6.2.7 The final covering will be 2 feet of mine run rock with approximately a 12" top size to protect against erosion. Soil or clay will be dumped into the voids between the rocks in order to provide a 2-foot blanket to protect the clay from drying out. Drawing No. 5-15058 shows a cross section through each of the reclaimed areas.

6.3 Estimated Costs

The estimated costs for reclamation of the piles and the fill area are presented in Table IV.

Table IV

Cost Estimate for Reclaiming Tailings Piles Nos. 2 and 3

Area	Item No.	Description of the Work	Quantities of Material	Unit Cost ($)	Estimated Cost ($M)
Fill	1	Earthwork required for preparation of the area			
		Stripping and leveling the area	44 acres	50/acre	2
		Evaluate and stockpile material	145 M yd^3	0.90/yd^3	131
	2	Excavate and load surplus tailings from piles 2 and 3	1600 M yd^3	0.90/yd^3	1440
	3	Haul tailings from piles 2 and 3 to the fill area	3.6 MM tons	1.25/ton	4500
	4	Excavate and load manchos shale for trucking to the site	320 M yd^3	0.90 yd^3	288
	5	Haul mancos shale to site	540 M tons	1.50 ton	810
	6	Grade the area and compact the shale to 4.5 ft. depth	320 M yd^3	1.75/yd^3	560
	7	Haul rock from the toe berm of Pile 2	260 M tons	1.25	325
	8	Place rock on the top of the shale	260 M tons	1.50	390
	9	Haul and dump the stockpiled earth while placing on the rock to provide for a 1-2 foot layer to protect the clay from drying out	145 M tons	0.90	130
		Total cost for the fill area			8,575

TABLE IV (Continued)

Area	Item No.	Description of the Work	Quantity of Material	Unit Cost ($)	Estimated Cost (M$)
Pile 2	1	Load and haul surplus rock berm not used in fill area to storage	580 M tons	1.25/ton	725
	2	Excavate and load mancos shale	412 M yd^3	0.90/yd^3	370
	3	Haul mancos shale to site	696 M tons	1.50/ton	1044
	4	Grade area to 5 to 1 slope and compact mancos shale to a depth of 4.5"	412 M yd^3	1.75/yd^3	721
	5	Haul and dump a two-foot thick layer of rock	335 M tons	1.25/ton	418
	6	Placement of the rock	183 M yd^3	1.50/yd^3	275
	7	Load, haul and dump approximately 2 feet of soil in the rock fill to act as a moisture barrier	90 M yd^3	0.90	81
		Total for reclamation of Pile 2			3,634

TABLE IV (Continued)

Area	Item No.	Description of the Work	Quantity of Material	Unit Cost ($)	Estimated Cost ($M)
Pile 3	1	Excavate and push rock needed for cover into a stockpile area	95 M yd^3	0.90/yd^3	85
	2	Excavate and load mancos shale	213 M yd^3	0.90/yd^3	192
	3	Haul mancos shale to site	360 M tons	1.50/ton	540
	4	Grade area to 5/1 slope and compact mancos shale	213 M yd^3	1.75/yd^3	373
	5	Haul and dump on a 2-foot thick layer of rock (34 M tons from Pile 2 is required)	174 M tons	1.25/ton	217
	6	Placement of the rock	95 M yd^3	1.50/yd^3	142
	7	Load, haul and dump approximately 2 feet of soil in the two-foot rock layer to act as a moisture layer	40 M yd^3	0.90/yd^3	36
		Total cost for Pile 2			1,585

APPENDIX I

COVER ANALYSES FOR RECLAMATION OF THE URAVAN TAILINGS

DEPTH OF COVER ANALYSIS FOR RECLAMATION (AAI)

Criteria

(a) γ-radiation levels to be reduced to essentially background levels.
(b) Radon emanation to be reduced to less than twice background levels.

These are based on a review of guidelines by Scarano and Linehan, 1978, and are the criteria upon which D & M base their calculations. More recently, the Generic Environmental Impact Statement (GEIS) on Uranium Milling (April 1979) has recommended radon emanation be reduced to 2 $pCi/m^2 \cdot s$ above background.

Data

Radon flux data and Ra-226 concentrations are given in Tables 2.9-8 & 9 of D & M report respectively. Tailings radon flux levels calculated from the average Ra-226 concentration (RA) of 178 pCi/g using either 1.6 x (Ra) Schrager, 1974 in D & M or 0.5 to 1.0 x (Ra) (GEIS) are higher than measured values. It is not apparent whether the drill holes sampled sand and slimes or only one type of material or condition.

Calculation of Radon Emanation

The method outlined in GEIS has been used as a check on the D & M calculations. For a single layer of fill above the tailings:

$$x = \frac{1}{(\lambda P_f / D_f)^{1/2}} \cdot Cn \left(\frac{J_t}{J}\right) \qquad (1)$$

where x = thickness of fill (cm)

λ = decay constant for Ra-222 (2.1×10^{-6} s^{-1})

D_f/P_f = effective diffusion coefficient for fill (cm^2/s)

P_f = porosity of fill

J_t = flux from bare tailings pile ($pCi/m^2 \cdot s$)

J = flux at fill/air interface due to emanation from tailings ($pCi/m^2 \cdot s$).

For an infinitely thick tailings pile (satisfied approximately for thicknesses greater than 3 m)

$$J_t = (Ra)\ P_t\ E(\lambda D_t/P_t)^{1/2} \qquad (2)$$

when (Ra) = (Ra-226 concentration (pCi/gm)

F_t = density of tailings (gm/cm^3)

D_t/P_t = effective diffusion of tailings (cm^2/s)

E - emanation coefficient

The following values have been used

Parameter	Values	Remarks
(Ra)	178 pCi/gm	Average for tailings D & M report
	351 pCi/gm	Maximum for tailings D & M report
F_t	1.6 gm/cm^3	GEIS, Typical value. γD 84.9 to 102.6 lb/ft^3 (1.36 to 1.64 gm/cm^3) D & M Table C-8
E	0.2	GEIS, typical value
λ	2.1×10^{-6} s^{-1}	
D_t/P_t	1×10^{-2} $cm^2 s$	GEIS, typical value (1.02×10^{-2} cm^2/s D & M p 9.5)

Inserting these values in equation (2) yields

J_t average = 82.5 pCi/m^2·s (Ra) 178 pCi/gm

J_t maximum = 162.8 pCi/m^2·s (Ra) 351 pCi/gm.

In the calculation procedure proposed in GEIS, (equation (1)), the contribution of radon from the cover is neglected, since this is considered to be equivalent to the background exhalation.

The most sensitive parameter in (1) is the equivalent diffusion coefficient for the cover. Various values are given in $GEIS_2$ ranging from 6.8×10^{-2} cm^2/s for dry quartz sand through 8×10^{-3} cm^2/s for loams and 6.6×10^{-4} cm^2/s for clay 2.2×10^{-6} cm^2s for mud.

D & M calculations are based on $D_f/P_f = 1.32 \times 10^{-4}$ cm^2/s for Mancos Shale cover based on double the value for montmorillonite clay (see page 9.5 D & M). This would give 6.6×10^{-5} cm^2/s for the latter. A value of 6.6×10^{-4} cm^2/s (note exponent) is generally used for clay cover (GEIS, D & M East Gas Hills EA report for Union Carbide, Table 4). The D & M values for D_f/P_f of 6.6×10^{-5} for montmorillonite clay and 1.32×10^{-4} for mancos shale should be checked for an order of magnitude error. We believe the values should be 6.6×10^{-4} and 1.32×10^{-3} respectively.

For comparative purposes, the following values have been used:

Parameter	Value	Remarks
D_f/P_f	1.0×10^{-2} cm^2/s	Typical for sandy soil (GEIS, D & M)
	1.0×10^{-3} cm^2/s	Clay (GEIS)
	1.32×10^{-3} cm^2/s	Mancos Shale
	(1.32×10^{-4} cm^2/s-D & M)	
	6.6×10^{-4} cm^2/s	Montmorillonite
	(6.6×10^{-5} cm^2/s-D & M)	
J_t	82.5 pCi/m^2·s	Average
	162.8 pCi/m^2·s	Maximum

Parameter	Value	Remarks
J	0.68 $pCi/m^2 \cdot s$	Background at site 6 to give total after cover of 2 x background (D & M report)
	2.00 $pCi/m^2 \cdot s$	Recommended in GEIS

Using these values in Equation (1) gives the results in Tables 1 and 2.

Table 1 is based on criteria that radon emanation be reduced to less than twice background levels, as per Dames & Moore Environmental Report, August 1978.

For all fill types

J_t ($pCi/m^2 \cdot s$)	82.5	(coarse tailings)
	162.8	(slime tailings)
J ($pCi/m^2 \cdot s$)	0.68	(coarse and slime tailings)

TABLE 1 (inches)

	Sand	Clay	Mancos Shale*	Montmorillonite*
Average for Coarse Tailings	130	41	47 (15)	34 (11)
Average for Slime Tailings	149	47	54 (17)	38 (12)

*For comparison, the values in brackets are based on D & M ER using D_f/ρ_f of 1.32×10^{-4} cm^2/s and 6.6×10^{-5} cm^2/s for Mancos shale and Montmorillonite respectively.

Table 2 is based on criteria that radon emanation be reduced to 2 $pCi/^2m \cdot s$ above background, as per the Generic Environmental Impact Statement (GEIS) on Uranium Milling, April 1979.

For all fill types

J_t (pCi/m^2·s)	82.5	(coarse tailings)
	162.8	(slime tailings)
J (pCi/m^2·s)	2.0	(coarse and slime tailings)

TABLE 2 (inches)

	Sand	Clay	Mancos Shale	Montmoril-lonite
Average for coarse tailings	101	32	37	26
Average for Slime Tailings	120	38	43	31

May 30, 1980

MEMORANDUM

Requirements for Sub-Surface Disposal Permit as Presented Under Section 505, Article 8, Title 25, CRS 1973.

Mr. A. J. Hazle, Director of the Division of Radiological and Hazardous Wastes, Colorado Department of Health, requested in a letter dated December 20, 1979 that the Company furnish documentation of its efforts to obtain all permits under Section 505, Title 8, Article 25 of CRS, 1973, as amended. The application of this regulation was reviewed with Mr. Weaver on May 21, 1980. He stated that the current operations at the Uravan mill were exempt from the 505 permit program. However, the permit may be required for the new tailings impoundment.