UNITED STATES

NUCLEAR REGULATORY COMMISSION

REGION IV

URANIUM RECOVERY FIELD OFFICE
BOX 25325
DENVER, COLORADO 80225

DEC 18 1992

Docket No. 40-8084

Rio Algom Mining Corp.
ATTN: Bill Ferdinand, Manager
Radiation Safety, Licensing
and Regulatory Affairs
6305 Waterford Blvd., Suite 325
Oklahoma City, Oklahoma 73118

Dear Mr. Ferdinand:

We have completed our review of your proposed reclamation plan. Our review identified areas where additional information is needed, or where deficiencies in the submittal were noted. These must be satisfactorily addressed prior to determining that the proposed plan meets the requirements of Appendix A to 10 CFR Part 40. Specific comments requiring resolution are enclosed. Please provide your response within 60 days of receipt of this letter.

If you have any questions, please contact Ray Gonzales of my staff on (303) 231-5808.

Sincerely,

Ramon E. Hall
Director

Attachment:
Review Comments

cc:
Bob Pattison, Rio Algom
L. Anderson, RCPD, UT

DF07
1/1

Case No. 040080846600

bcc:
Docket No. 40-8084
PDR/DCS
URFO r/f
LJCallan, RIV
LLUR Branch, LLWM, 5E2
ROGonzales
DLJacoby
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PM:URFO	PM:URFO	DD:URFO	D:URFO:RIV	
ROGonzales/lv	DLJacoby	EFHawkins	REHall	
12/18/92	12/18/92	12/18/92	12/18/92	

REVIEW COMMENTS
RIO ALGOM MINING CORPORATION'S
LISBON MILL RECLAMATION PLAN

I. Surface Water Hydrology and Erosion Protection

Documents Reviewed:

March 4, 1992, RAMC submittal titled, "Design of Runoff-Control Facilities for Final Reclamation," as revised by letters dated March 13, 1992, and November 20, 1992.

1. On page 2-16 of the March 4, 1992 submittal, you state that local boundary shear in a channel can be estimated using Equation 17. This is not correct. In order to determine local boundary shear, the average stone diameter (D_{50}) has to be substituted for k_r in the equation. Also, the entire denominator in the equation has to be squared. Please check and verify that the correct form of the equation was used in your riprap calculations.

2. On page 2-17 of the March 4, 1992 submittal, you state that non-uniform flow factors of 1.5 and 1.25 were used for the large main diversion channels and the smaller tributary channels, respectively. The Corps of Engineers recommends 1.5. Please provide justification for using a smaller flow factor for the tributary channels. Also, we are aware of only one tributary channel as shown on Plate 2 of your March 4, 1992, submittal. If there are other tributary channels, please identify their locations, and provide pertinent information to allow us to evaluate their design.

3. On page 2-19 of your March 4, 1992, submittal, you state that if uniform flow is assumed, γ is equal to 0. This is not correct. γ as you define it on page 2-17 is equal to the unit weight of water which is 62.4 lb/ft^3. Your statement should be corrected to read that if uniform conditions are assumed, the angle λ is equal to zero.

4. On pages 2-23 and L-3 of your March 4, 1992, submittal, you present an equation for determining the Manning's roughness coefficient "n", where $n = 0.0456\ (D_{50}{}^{*}S)^{0.159}$. You state that D_{50} is in feet. This is not correct. The value of D_{50} in this equation should be in inches. Please check your riprap calculations where the incorrect equation was used to assure that the riprap sizes are adequate.

5. On page 3-11 of the March 4, 1992, submittal, you state that use of a flood that occurred in Little Pinto Creek is not valid for estimating the magnitude of potential flood peaks at the site. You suggest that comparison of runoff peaks for watersheds of more similar size closer to the Rio Algom Site would be more appropriate. However, you do not provide such a comparison. If such data are available, they should be used to check the adequacy of the design floods estimated for the site.

   You also state on page 3-11 that one would expect a lower unit-area runoff response at the site than at Little Pinto Creek, because the Little Pinto drainage is steeper and the geology is predominately basalt

and basalt derived soils while at the Lisbon Mill Site the geology is predominantly porous sandstone with sandy and silty soils. Please provide the analyses performed to determine that Little Pinto Creek slopes are steeper than they are at the site together with a copy of any topographic maps or other data used in your analysis. In addition, provide the soils maps or other information used to determine that soils are significantly different.

6. On page 3-21 of your March 4, 1992, submittal, you state that the Diversion Ditch will be incised in bedrock downstream of station 32+20. On page 3-22 you state that the Lower Embankment Spillway will also be excavated in bedrock. Therefore, riprap will not be provided in the channel downstream of station 32+20 nor in the spillway. This may be acceptable if the bedrock is sufficiently resistant to erosion. To ensure this, your specifications will have to include acceptance criteria for determining when the bedrock is sufficiently durable. This is especially important for the spillway, since it is an integral part of the stability of the Lower Impoundment. Your specifications will also have to include testing procedures to ensure that the bedrock is sufficiently resistant to erosion. An acceptable definition and testing procedure is as follows: Erosion resistant bedrock shall be determined by refusal of a power auger drilling vertically, using a carbide steel bit. Tests will be performed in the channel and spillway bottoms on a maximum of 20-foot centers. Erosion resistant rock is natural, undisturbed, intact rock which cannot be readily ripped or loosened by a backhoe during normal excavation.

7. On page 3-22 of your March 4, 1992, submittal, you state that the Lower Embankment Spillway Channel will have a slope of 5 percent from station 0+00 to 4+00. Downstream of station 4+75, you state that the slope will vary from 6 to 10 percent. It is not clear what the slope is between station 4+00 and 4+75. However, Plate 3 which you revised on November 20, 1992, indicates that the slope between station 4+00 and 4+35 is about 25 percent and between station 4+35 and 4+75 it is about 8 percent. Please discuss what effect the steep section will have on the flow regime and stability of the Spillway Channel.

8. On page 3-24 of the March 4, 1992, submittal, you state that flows in the unnamed tributary will not reach the toe of the slope of the lower embankment. Over a period of 1000 years, natural processes may result in the channel meandering toward the pile. You should therefore provide an analysis to verify that over a long period of time, flows in the unnamed tributary will not adversely affect the toe of the slope of the Lower Embankment.

9. On pages 3-27 and 3-28 of your March 4, 1992, submittal, you propose to install a riprap apron at the toe of the Upper Embankment. The apron will be 5 feet wide and 12 inches thick and the riprap will have a median stone diameter (D_{50}) of 2 inches. We have determined that design flows at the toe of the 20 percent embankment outslope will be supercritical. As flows transition onto the much flatter Lower Tailings Impoundment, there will be significant energy dissipation which will be

particularly destabilizing to the individual riprap pieces. There is significant uncertainty in predicting riprap stability where a steep slope transitions onto a much flatter slope. Therefore, the riprap must be conservatively designed, especially since the transition will occur over tailings. An acceptable procedure for determining adequate riprap is to assume that flow will concentrate and form a gully (this is a reasonable assumption that has been verified by field tests performed for the NRC). A flow concentration factor of 3 is acceptable. By assuming that the concentrated flow will result in a triangular shaped gully, you can then estimate flow depth, shear stress, and the required riprap size. The required energy dissipation structure can then be designed using Corps of Engineers or other acceptable procedures.

10. On page 3-29 of your March 4, 1992, submittal, you propose to allow runoff from the undisturbed drainage areas north of the tailings piles to flow onto and over the reclaimed tailings. This design does not meet Criterion 4(a) of 10 CFR Part 40, Appendix A, which requires that upstream rainfall catchment areas be minimized. You should therefore revise your design to divert flows from undisturbed drainage areas away from the reclaimed tailings. If you conclude that it is not feasible to construct diversion channels, you should provide adequate justification to support your conclusion.

11. On page 3-29 of your March 4, 1992, submittal, you propose to install energy dissipation structures where runoff from the undisturbed drainage areas north of the tailings piles will flow onto the reclaimed tailings. The structures will consist of riprap-filled trenches to dissipate the energy of the flowing water. In estimating the dimensions of the trenches and the size of the riprap to be placed in the trenches, you assumed that floods from the undisturbed areas would occur as sheet flow. This assumption is not reasonable, as flows from the undisturbed areas will be concentrated into well defined gullies as shown on Plate 3 of your November 20, 1992, submittal. An acceptable procedure for determining adequate riprap is to determine a peak PMF discharge for the largest drainage area which is area UDD-4. Using this discharge and a cross-section of the largest gully, determine the flow depth, shear stress, and the required riprap size. The required energy dissipation structures can then be designed using Corps of Engineers procedures.

12. In routing the PMF through the Lower Embankment Spillway Channel using HEC1 (see page C-6 of your March 4, 1992, submittal), you assumed a broad crested weir to establish an elevation-discharge rating curve. This assumption may not result in conservative estimates of peak flows, velocities, and flow depths. A more appropriate procedure would be to analyze the spillway using HEC2. By making multiple HEC2 runs with various discharges, a rating curve can be developed. Elevation-discharge values from the curve can then be used as input to HEC1. Please revise your HEC1 analysis by using HEC2 to develop the appropriate elevation-discharge rating curve.

13. On page L-3 of your March 4, 1992, submittal, you state that the following equation, $n = 0.0456\ (D_{50} * S)^{0.159}$, was used to estimate the

Manning roughness coefficient. However, on page L-5, you use the equation, $n = 0.0395\ (D_{50} * S)^{0.167}$. The first of these two equations is the correct one. Please check your calculations and make appropriate revisions if necessary.

14. It is not clear on Plate 3 of your November 20, 1992, submittal, that runoff from the top of the Lower Tailings Impoundment will not run down the face of the embankment. Please provide cross-sections or other drawings showing how the impoundment will be graded to prevent flows from running down the embankment.

15. Riprap must be keyed into in situ bedrock where the Diversion Channel transitions from alluvium to bedrock near station 32+20. Please provide a design including drawings.

16. No information is provided on how riprap will be placed in the Diversion Channels; i.e., how far up the side slopes will the riprap be extended. Please provide drawings showing cross-sectional details for the riprap in the channels. The riprap on the side slopes should provide adequate freeboard.

17. There is no indication that the unnamed tributary to West Coyote Wash will be channeled so that it merges with the Upper Tailings Diversion Channel and the Lower Tailings Diversion Channel (see Plate 4 in your March 4, 1992, submittal). Please provide information and design details that demonstrate that the tributary will be channeled into the two channels.

18. On pages K-10 to K-17 of your March 4, 1992, submittal, you present calculations for the riprap required for the tops of the Tailings Impoundments. It does not appear that you considered flows from the undisturbed drainage areas north of the tailings. In determining contributing drainage areas, you used flow lengths of 1400 feet for the Lower Impoundment and 1700 feet for the Upper Impoundment. Scaling the flow distances from Plate 3 of your March 4, 1992, submittal, we estimated a distance of about 2000 feet for the Lower Impoundment and 2400 feet for the Upper Impoundment. Please revise your riprap calculations to include flood flow contributions from the undisturbed drainage areas.

II. Borrow and Tailings Characterization

Documents Reviewed:

June 16, 1989, RAMC submittal of a June 6, 1989, report titled, "Reclamation Cover Design and Analysis of Tailings at the Lisbon Uranium Mill," as revised by RAMC submittal dated August 16, 1989. This included review of tables summarizing data submitted by RAMC on September 16, 1988.

1. Although the logs for the borrow test pits excavated in March 1989 were submitted on August 16, 1989, we are unable to locate test pits SS-30, SS-34, and SS-35 on Plate 1 of the June 1989 report. In addition, the location of test pits T-11 and T-12 are not given on the logs nor on Plate 1. Please revise Plate 1 to show the locations of these test pits.

2. The laboratory procedure used to determine the diffusion coefficient measurements, RAE-SQAP-3.6, is not a standardized test. We are not familiar with this company's specific procedure for determination of the diffusion coefficient. Therefore, please submit the procedure to support the data. Alternatively, you may use the tests discussed in Regulatory Guide 3.64 to determine the diffusion coefficient.

3. Table 3.1 of the June report provides soil classifications for samples collected during the March 1989 exploration program. To classify fine grained material using the Unified Soil Classification System, it is necessary to have grain size distributions. Gradation test results were not included in the submittal. Please provide this information or clarify the classification procedure.

4. The summary tables of previous testing results located in Appendix A of the June 1989 report, contain numerous sample classifications without accompanying gradations. Please provide the gradation test results or clarify the classification procedure. The table also provides results for Proctor Compaction for both borrow and tailings samples. It appears, however, that the results are from the Modified Proctor test procedure. As these tests produce quite different results, please clarify. The Proctor results should also be reviewed to determine if the relationship defined by the resulting curve is supported. For example, the curve associated with sample T-2 does not define a maximum point since all three specimens appear to have been compacted wet of optimum. Also, after reviewing the data submitted on September 16, 1988, please clarify the procedure that was used to determine the in-place moisture contents. The data sheets for determination of in-place densities were not evident in Appendix F of the September 16, 1988, submittal. Please provide the source of this data.

   After resolution of the above items, please revise the tables in Appendix A accordingly, so that only supported information is provided and results are properly labeled.

III. Radon Attenuation

Documents Reviewed:

June 16, 1989, RAMC submittal of a June 6, 1989 report titled, "Reclamation Cover Design and Analysis of Tailings at the Lisbon Uranium Mill," as revised by RAMC submittal dated August 16, 1989. This included review of tables summarizing data submitted by RAMC on September 16, 1988.

1. Page 3-5 of the June 1989 report indicates that the tailings reach a depth of 50 feet. Therefore, the tailings must be modeled using a minimum depth of 500 centimeters (cm). (It has been determined that a depth of 500 cm represents an infinitely thick tailings source.) If, as indicated on page 3-14, execution errors are encountered when using a depth greater than 50 cm, please contact this office for assistance. We will provide you with a copy of the RADON or RAECOM programs, which can execute for any depth of contaminated materials with the required precision.

2. Radiological characterization of the tailings material was performed only on samples taken from the upper tailings impoundment. Please justify not testing the tailings from the lower impoundment, taking into consideration that different activities were assigned to each material in the modeling.

3. The origins of the parameters that were used to "normalize" the laboratory diffusion coefficient (D) for the tailings are not well defined. Please demonstrate why a density of 1.45 grams/cubic centimeter (g/cm^3) was used to represent the dry bulk density. Please justify why the average of the in-place moistures of the three samples tested was used to normalize the diffusion coefficient rather than the moistures of the test specimens. The normalization procedure recommended by NUREG/CR-3533 uses a ratio of the measured D to a calculated D at the same conditions. Therefore, each of the parameters should be based on the test specimen data. It does not appear that this approach was used. More importantly, the difficulties associated with laboratory testing at or near saturation are very great. Therefore, it is recommended that the testing be performed on specimens remolded at conditions more representative of long-term estimates, or that the diffusion coefficient be estimated using acceptable methodology. Acceptable methods are presented in Regulatory Guide 3.64.

4. The tailings were assigned activity values estimated from average ore grades that were reportedly milled. This estimated activity for the upper tailings, 590.5 picocuries/gram (pCi/g), is substantially less than the average results from the three samples tested in the laboratory, 655 pCi/g. Due to the large discrepancy between the estimated value and the average test value for the upper tailings, it is not considered reasonable to use the estimated values for the upper or lower impoundments. Please revise the radon calculation accordingly.

5. The basis for the selection of the physical parameters used in the modeling (porosity, density, and moisture content), must be provided. You indicate that the selection of 20 percent to represent the long-term moisture content of the tailings was based on the gradation of the tailings, the use of flocculants in the milling process, and the tailings' affinity for water. However, the actual process that was used to reach the estimate was vague. There are methodologies available for calculating the long-term moisture content given in Regulatory Guide 3.64 and NUREG/CR-3533. Please submit the justification for each parameter. It should be noted that equation 16 of NUREG/CR-3533 should be used in lieu of equation 14, as equation 14 contains assumptions that may not be accurate.

6. Determination of acceptable parameters for the cover soils was difficult due to the limited data base and the lack of a commitment to use a specific borrow area(s). Until the concerns listed above are resolved, we consider that only seven samples can be classified from all ten borrows; two silts (ML), three lean clay-silts (CL-ML), and two fat clays (CH). Available compaction data for the borrows are limited to the data obtained in the March 1989 exploration program as the specifications require a percentage of standard Proctor rather than modified Proctor. Of the three standard tests, two were performed on material identified as silt in the logs and one on clay. Please identify the specific borrow(s) you will use and only the test results from that borrow(s) should be considered in the design of the radon attenuation barrier.

   To model the clay layer of the cover, sample SS-36C from Borrow 2 was selected as being representative of the clay materials. The test data sheet for the compaction test on this sample, however, indicated that the material tested was "crushed stone." It is therefore doubtful that this sample is representative of material that meets the specifications. Please provide justification for using this sample to define modeling parameters, or revise the model using parameters that are representative of the material that is to be used. As you consider that a significant portion of the cover material has been placed, actual quality control data may be used for parameter definition.

   To model the silt layer, results from three samples from Borrow 2 and 10 were averaged to define the physical parameters. Once again, the lack of classification information leaves these parameters unsubstantiated. Please provide justification for using these samples to define the silt layer modeling parameters. If quality control data is available, it may be used to define the physical parameters.

   The long-term moisture contents of the silt and clay layers in the cover system were based on the average in-place moisture contents reported for these materials. This is an acceptable method for determining the long-term moisture content of cover soil, if the results are from the borrow that will be used (Borrow 2 and 10) and are from a depth that is not influenced by seasonal variability or from samples close to a water table. The recommended depths are defined in Regulatory Guide 3.64 as

120 to 500 cm. In addition, as indicated in comment No. 4 above, the test procedure for determination of the moisture contents is not clear. Only data from samples that were tested in accordance with ASTM D-2216 or equivalent may be considered. Please review your data and revise the estimate for long-term moisture accordingly or use accepted methodology to estimate the long term moistures.

Please reevaluate and substantiate the parameters used for the cover, and revise the cover depths accordingly.

7. There was no discussion of the suitability of the proposed cover system in the June 1989 report. The effect on the system from freeze/thaw cycles, shrinkage, and animal and vegetation intrusion must be evaluated. The cover system's ability to limit recharge of the tailings must also be addressed. Please provide this information.

IV. Settlement

Documents Reviewed:

June 16, 1989, RAMC submittal of a June 6, 1989, report titled, "Reclamation Cover Design and Analysis of Tailings at the Lisbon Uranium Mill," as revised by RAMC submittal dated August 16, 1989. This included review of tables summarizing data submitted by RAMC on September 16, 1988.

1. The proposed settlement monitoring program did not define a completion event; i.e., 90 percent, that will signify that sufficient settlement has occurred to prevent significant defects in the cover system. Please provide the point which will signify that sufficient settlement has occurred and that the monitoring program can be discontinued.

2. The settlement monitoring plan places the aluminum monitoring plates on top of the clay and silt layers. Normally, the plates are placed on top of the tailings, below the radon attenuation layer. Please justify the placement of the plates above the attenuation layer or modify your plan accordingly.

3. As was indicated to you in our letter dated March 9, 1990, it will be necessary for you to provide a commitment to repair any damage to the cover system if it is placed prior to achieving 90 percent of the expected settlement in the tailings. If the erosion protection material is placed prior to determination that sufficient settlement has taken place, the method that will be used to identify cover defects must be defined. Comparison to the projected settlement amounts will not be acceptable. Please submit the method that will be used to verify that the cover's integrity is intact and a commitment to repair any defects identified.

4. Characterization of the tailings indicate that the tailings are all fine grained. No coarse grained materials; i.e., sands, were reported in the testing program. This is reportedly due to the fine grind produced at the Lisbon mill; 70 percent passing the No. 300 sieve. In addition, when evaluating the long-term moisture content of the tailings, the use of flocculants in the milling process and the tailing's affinity for water were referenced. Therefore, it can be assumed that the settling process due to the dewatering of the tailings will be lengthy.

   The settlement analysis that was submitted indicated that it will take about 14 years to achieve 75 percent of the expected settlement with a 5-foot surcharge. Even though this analysis is not considered acceptable due to the nature of the tailings and the lack of testing, it does provide an estimate of the time necessary to reach an acceptable level of consolidation within the impoundments. You should be aware that the surety instrument will remain in place until the settlement is sufficiently complete and it has been determined that the condition of

the cover is acceptable time. The surety amount will include the cost of removal of r[illegible] cover defects, and replacement of the [illegible]. It may be prud[illegible]der active dewatering techniques to accelerate the process. [illegible]mple, artificial wicks have successfully been used at several [illegible]cations.

V. Construction Specifications

Documents Reviewed:

Section 4 of the March 4, 1992, RAMC submittal as revised by RAMC submittal dated August 8, 1992.

1. The specifications refer only the radon barrier and do not differentiate between the clay layer and the silt layer of the cover. Please revise the appropriate sections of the specifications accordingly.

2. Please specifi[illegible]clude the moisture content as part of the compacti[illegible]s. As the specifications are currently written, it would [illegible] to conclude that after compaction, only the density of mate[illegible] specific requirements.

3. The spec[illegible]cations require that the field compaction be verified once for every 500 cubic yards of material placed. In addition to this requirement, the staff technical position on testing and inspection recommends that the testing be performed twice for each day that 150 cubic yards of material is placed; once per lift, and at least once per shift. Please revise the specifications accordingly or justify the proposed frequency.

4. The specifications require, at a minimum, that classification testing be performed once for each day that 250 cubic yards of material are placed. The staff technical position on testing recommends that, in addition to testing each day that 150 cubic yards are placed, the gradation of each 1000 cubic yards of material placed be tested. Please revise the specifications accordingly or justify the proposed frequency.

5. The specifications do not contain provisions for one-point Proctor testing. The staff technical position on testing recommends that a one point test be performed for each five field compaction tests. Please revise the specifications accordingly or justify not performing this test.

6. Please provide the method of compaction.

7. Please revise the specifications to preclude placement of or on frozen materials.

8. Please indicate the compaction and placement requirements of the mine waste material that will be placed over the tailings. This should include distribution of organics over the fill and reduction of void spaces.

9. The use of the nuclear gauge for field density and moisture determination is acceptable provided that an acceptable correlation is first established for <u>each</u> gauge that is used. Please revise the

specifications to define what will be considered an acceptable correlation between the tests for moisture and density. (See comment No. 7 of our letter dated March 9, 1990.)

10. The retesting of failed areas was not specifically addressed in the specifications. The records must indicate not only that an area passed or failed, but, if it failed when it was retested and whether or not the retest passed, etc. Please provide revised specifications. (See comment No. 8 of our March 9, 1990, letter.)

11. You state that the rock to be used for riprap will have a specific gravity of 2.65 lb/ft^2. Please delete the term lb/ft^2 as specific gravity is a dimensionless number.

12. The specifications require that for each gradation of riprap, rock durability tests including specific gravity, absorption, sodium sulfate soundness and abrasion testing will be performed for the first 30,000 cubic yards (yd^3). For each additional 10,000 yd^3, of a gradation size, the test series will be repeated to ensure suitability. The staff technical position on testing recommends that testing be performed for each type of riprap when approximately one third and two thirds of the total volume of each riprap have been delivered. A final sample should be obtained for each riprap type when the total volume has been delivered. For each type of riprap where the volume is greater that 30,000 yd^3, a test series should be performed for each additional 10,000 yd^3 of riprap delivered. Please revise the specifications accordingly or justify why one test series is sufficient for the first 30,000 yd^3.

13. The specifications require that rock be classified as being poor, fair, or of good quality. It is not clear exactly what is meant by the terms poor, fair, and good. Therefore, you must commit to use rock that meets the scoring criteria in Section 6.2.2 of the staff technical position on erosion protection.

14. The specifications do not contain provisions for assuring that the riprap and filter layers will be placed according to the design thickness. You should therefore develop a grid system for all areas being riprapped, and perform a measurement in each grid area for both the filter and the riprap. Grid spacing should not exceed 200 feet. Please add this requirement to your specifications.