February 24, 2006

Mr. Peter Luthiger
Manager, Radiation Safety and
Environmental Affairs
Rio Algom Mining, LLC
P.O. Box 218
Grants, NM 27020

SUBJECT: AMENDMENT OF SOURCE MATERIALS LICENSE SUA-1473 FOR ALTERNATE CONCENTRATION LIMITS, RIO ALGOM MINING, LLC, AMBROSIA LAKE SITE, MCKINLEY COUNTY, NEW MEXICO, AMENDMENT 56 (TAC L51921)

Dear Mr. Luthiger:

In February 2000 and May 2001, Rio Algom Mining, LLC (RAM) submitted license amendment applications requesting alternate concentration limits (ACLs) for hazardous and nonhazardous constituents at its Ambrosia Lake, McKinley County, New Mexico, uranium mill tailings site. Between February 2000 and January 2005, the U.S. Nuclear Regulatory Commission (NRC) staff reviewed the license applications, which resulted in multiple requests for additional information (RAIs) and RAM responses. The NRC staff issued a draft Environmental Assessment (EA) dated February 16, 2005. Comments were received by the State of New Mexico resulting in the development of nonhazardous ACLs in July 2005. After a series of reviews on the nonhazardous ACLs, NRC staff issued a final EA on January 27, 2006, which addressed agency comments regarding the draft EA.

The NRC staff has documented its review of the submittals in a technical evaluation report (Enclosure 1), in which the staff determined that the proposed ACLs would be protective of human health, safety, and the environment. Approval of the requested modifications required wording changes to License Conditions 34 and 40. The revised license, reissued as Amendment No. 56 to Source Materials License SUA-1473, is enclosed (Enclosure 2).

If you have any questions regarding this letter or the enclosures, please contact Mr. Stephen J. Cohen, at (301) 415-7182 or via e-mail to sjc7@nrc.gov.

In accordance with 10 CFR 2.390 of the NRC's "Rules of Practice," a copy of this letter will be available electronically for public inspection in the NRC Public Document Room or from the Publicly Available Records (PARS) component of NRC's Agencywide Documents Access and Management System (ADAMS). ADAMS is accessible from the NRC Web site at http://www.nrc.gov/NRC/reading-rm/adams.html.

Sincerely,

/RA/

Gary S. Janosko, Chief
Fuel Cycle Facilities Branch
Division of Fuel Cycle Safety
and Safeguards
Office of Nuclear Material Safety
and Safeguards

Docket No.: 40-8905
License No.: SUA-1473

Enclosures: 1. Technical Evaluation Report
2. Amendment No. 56 to License SUA-1473

cc: Gedi Cibas, NMED
Kevin Myers, NMED
Art Kleinrath, DOE - Grand Junction

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TECHNICAL EVALUATION REPORT
ALTERNATE CONCENTRATION LIMITS APPLICATION
RIO ALGOM MINING, LLC
AMBROSIA LAKE URANIUM MILL FACILITY, NEW MEXICO

DATE:

FACILITY: Rio Algom Mining, LLC—Ambrosia Lake Uranium Mill Facility, New Mexico

TECHNICAL REVIEWER: Jill Caverly, Stephen J. Cohen

PROJECT MANAGER: Michael G. Raddatz

1.0 SUMMARY AND CONCLUSIONS

Rio Algom Mining, LLC (RAM), submitted applications for alternate concentration limits (ACLs) as ground water standards in License Condition 34 of Source Materials License SUA–1473 for its Ambrosia Lake, New Mexico, uranium mill tailings site (site). Separate applications were submitted for the uppermost bedrock aquifers (QMC, 2000a) and the alluvial aquifer (QMC, 2001). U.S. Nuclear Regulatory Commission (NRC) staff reviewed these applications, as well as licensee submittals (RAM, 2004, 2003a,b) responding to a request for additional information (NRC, 2003a). A final list of proposed hazardous ACLs was submitted to NRC in October 2003 (RAM, 2003b), supplemented by nonhazardous constituent ACLs in July 2005 (RAM 2005a) and October 2005 (RAM, 2005b). Hazardous contaminants of concern for which ACLs were requested are gross alpha, lead-210, molybdenum, nickel, radium-226 and -228, selenium, thorium-230, and natural uranium, and the nonhazardous constituents for which ACLs were requested are chloride, nitrate, sulfate, and total dissolved solids (TDS).

Based on the NRC staff's review of the ACL requests and supporting documentation, RAM has demonstrated that the contaminants of concern in the ground water will not pose a substantial present or potential hazard to human health and the environment. Human health and environmental protection would be achieved as long as the ACLs are not exceeded and the proposed limits and current contaminant concentrations are as low as reasonably achievable (ALARA), after considering the practicable corrective action alternatives. RAM has supported the proposed ACLs with ground water flow and contaminant transport models that simulate the concentration and migration of contaminants from the point of compliance (POC) to the point of exposure (POE) during the 1,000-year compliance period for each aquifer. While the NRC staff does not concur with all RAM modeling methods and results, independent calculations demonstrate that the ACLs are protective. RAM has proposed an acceptable long-term ground water monitoring plan that NRC has determined would adequately monitor future plume migration and assure that the ACLs would be protective of human health and the environment.

NRC staff has determined that the proposed ACLs are acceptable and in accordance with the requirements of 10 CFR Part 40, Appendix A, Criterion 5B(6), and with the NRC guidance provided in the Standard Review Plan for the Review of a Reclamation Plan for Mill Tailings Sites Under Title II of the Uranium Mill Tailings Radiation Control Act (NRC, 2003b).

Enclosure 1

2.0 BACKGROUND

RAM's Ambrosia Lake facility is located in McKinley County approximately 24 miles due north of Grants, New Mexico, in the Ambrosia Lake valley (see Figure 1). Uranium milling activities started at the site in 1957. The waste management structures are Tailings Impoundments 1 and 2, Decantation Pond 3, and Evaporation Ponds 4 through 10 (see Figure 2). Tailings Impoundments 1 and 2 were built in late 1958, along with Pond 3 at the eastern toe of Tailings Impoundment 1, to accept decanted tailings liquids. Tailings were first produced at the site in November 1958. In 1976, RAM diverted the natural course of the Arroyo del Puerto east of Ponds 4, 5, and 6 and lined Ponds 9 and 10, which were constructed in 1976. The solids fraction was disposed through a slurry transfer system to the tailings impoundments, while the liquids fraction was transferred to the evaporation ponds. Evaporation pond residues from Ponds 3, 4, 5, 6, 7, and 8 were placed in Tailings Impoundments 1 and 2 prior to final reclamation. All the aforementioned tailings impoundments and ponds were unlined.

Seepage from the tailings impoundments and Evaporation Ponds 3 through 6, along with seepage from unrelated mining and milling operations, has saturated and contaminated the alluvium of the Arroyo del Puerto (alluvial aquifer). Seepage from the tailings impoundments and evaporation Ponds 7 and 8 has recharged and contaminated the Tres Hermanos A (TRA) and Tres Hermanos B (TRB) sandstones within the Mancos Formation shale and the Dakota Sandstone, which underlies the Mancos Formation. Consequently, in 1983, RAM entered into an Assurance of Discontinuance (AOD) with the State of New Mexico to minimize the future impact of mill tailings solutions seepage on ground water. The approved AOD remedial action required the construction and maintenance of an interceptor trench (IT-1) and the cessation of discharges to unlined Ponds 4 through 8. These ponds were taken out of service in 1983. In the late 1990s, RAM added interceptor trenches IT-2, -3, and -4 south of Pond 10 to collect seepage potentially missed by IT-1.

In 1986, after the State of New Mexico relinquished its licensing authority over uranium mill activities, NRC reasserted jurisdiction at the site and required that the site begin a ground water detection monitoring program. Data from this program were the basis for the ground water protection standards (GPSs) established for the site by NRC staff. A corrective action program (CAP) for the ground water was developed based on this information. The CAP required pumping and treating ground water to remove certain constituents. RAM has been implementing its CAP since the mid-1980s. Mining and milling operations in the area have had two notable hydrologic effects: creation and maintenance of a saturated zone at the base of the alluvial aquifer and creation of a cone of ground water depression in bedrock aquifers because of drainage in mining features and pumping. Water quality in the alluvium and the units into which the alluvium drains has likely been affected by area mining operations not directly related to the licensee.

3.0 REGULATORY FRAMEWORK

Ground water protection programs for Title II uranium mill tailings sites per 10 CFR Part 40 Appendix A, Criterion 5, must include the following four elements:

1. list of site-specific hazardous constituents per criterion 5B(2);

2. ground water concentration limits (or standards) for these constituents;

3. a compliance location where the concentration limits must be met; and

4. a time period during which compliance is required.

Criterion 5B(5) requires that the concentration limits for individual constituents must not exceed:

1. the Commission-approved background concentration of a constituent in the ground water;

2. the respective value given in Table 5C of Appendix A if the constituent is listed in that table and if the background level of the constituent is below the value listed (corresponds USEPA's maximum concentration limits (MCLs) for drinking water);

3. an ACL established by the Commission.

Criterion 5B(6) of Appendix A states that ACLs can be established on a site-specific basis, provided the following is demonstrated:

1. the constituents will not pose a substantial present or potential hazard to human health or the environment, as long as the ACLs are not exceeded.

2. the ACLs are ALARA, after considering practicable corrective actions.

4.0 LICENSEE'S REQUESTED AMENDMENT

The proposed action is an amendment to NRC license SUA–1473 that will update constituent ground water protection standards to ACLs for the protected aquifers as provided in 10 CFR Part 40, Appendix A, Criterion 5B(6). At the Ambrosia Lake site, four protected aquifers have been identified, the alluvial aquifer and three bedrock aquifers (TRA, TRB, and the Dakota Sandstone). In 2000, 2001, and 2005, the licensee concluded that ground water protection standards for some hazardous and nonhazardous contaminants in the four protected aquifers were not attainable under the current CAP, prompting the need for ACLs. Table 1 presents the requested ACLs.

Table 1
Proposed ACL Concentrations

Contaminant	Alluvial Aquifer	Tres Hermanos B	Tres Hermanos A	Dakota
Molybdenum (mg/L)	176	—	—	—
Nickel (mg/L)	98	6.8	—	6.8
Selenium (mg/L)	49	—	—	—
Gross alpha (pCi/L)	8,402	—	—	—
Radium-226 & -228 (pCi/L)	3,167	218	218	218
Thorium-230 (pCi/L)	13,627	945	945	945
Natural uranium (mg/L)	23	1.6	—	1.6
Lead-210 (pCi/L)	1,274	88	88	88
Chloride (mg/l)	7,110	2,810	1,070	3,200
Nitrate (mg/l)	351	7.7	9.2	22.8
Sulfate (mg/l)	12,000	4,760	2,584	6,480
TDS (mg/l)	26,100	11,700	6,400	14,100

Approving ACLs means that ground water is in compliance; therefore, the CAP would be terminated and site reclamation would be completed subsequently. In addition, a ground water compliance monitoring program would be implemented consisting of POC monitoring, trend, and POE wells for the aquifers at the long-term surveillance and institutional control boundary surrounding the facility.

5.0 <u>TECHNICAL EVALUATION</u>

5.1 ENVIRONMENTAL SETTING

5.1.1 Geology

5.1.1.1 Regional Geology

The site is located north of the Zuni Uplift portion of the San Juan Basin. The basin is characterized by broad areas of relatively flat-lying sedimentary rocks, dipping to the northeast; portions of the basin are covered with alluvium and basalt flows. The site is within the Ambrosia Lake valley, which is formed by the Mesa Montanosa to the west and the San Mateo Mesa to the east. Stratigraphic units of hydrologic significance at the site are, in descending order, the alluvial aquifer, Mancos Formation, TRA and TRB sandstones, Dakota Sandstone, and the Brushy Basin and Westwater Canyon members of the Morrison Formation. The Westwater Canyon Member is the ore-bearing unit in the site vicinity. Units that have been affected by milling activities are the alluvium, TRA and TRB sandstones, and the Dakota Sandstone.

5.1.1.2 Site Geology

The mill site and Tailings Impoundments 1 and 2 are located on the weathered Mancos Formation or on alluvium overlying the Mancos section (see Figure 3). In the vicinity of the RAM site, the Tres Hermanos Sandstone is present as a series of three relatively permeable sand units interbedded with the Mancos Shale. From bottom to top, these three layers are referred to as TRA, TRB, and Tres Hermanos C Sandstone Unit (TRC). Bedrock units impacted by tailings seepage are the Dakota Sandstone that outcrops at Ponds 7 and 8 and the TRB that underlies the saprolite throughout most of Tailings Impoundments 1 and 2.

Most of the seepage from Tailings Impoundments 1 and 2 migrates laterally through the alluvium and shallow saprolite in the direction of the surface slope to the alluvial aquifer, where it enters the interception trench. Seepage that enters the unweathered bedrock beneath Tailings Impoundments 1 and 2 slowly migrates through the TRB to the north and northeast of the site in the general direction of bedrock dip. The dewatering trench located between Pond 7 and Pond 2 has minimized tailings seepage to the TRA that underlies the saprolite and alluvium in the general vicinity of Pond 7.

5.1.2 Surface Water

Prior to mining activity, the Arroyo del Puerto was an ephemeral drainage. Flow in the creek occurred only in response to large rainfall or snowmelt events. Currently, the creek is dry until it reaches the discharge point for treated mine water. During 1999 an average of 9,537 cubic meters/day (m^3/d) (337,000 cubic feet /day (ft^3/d)) of treated mine water was discharged to the Arroyo del Puerto channel. Some water was then diverted from the creek for mine injection. Since January 2000 an average of 3,538 m^3/d (125,000 ft^3/d) of treated mine water has been released to the Arroyo del Puerto channel and no water has been used for mine injection. Water infiltrates from the creek between the mine water discharge point and the Puertocito Creek weir. This infiltration is the primary source of recharge to the alluvial ground water system in the site. Mine discharges are permitted by the State of New Mexico under a National Pollutant Discharge Elimination System (NPDES) permit (Permit No. NM0020532).

5.1.3 Ground Water

5.1.3.1 Alluvial Aquifer

The alluvial aquifer is a saturated zone formed at the base of the alluvium filling the Ambrosia Lake valley in the vicinity of the site; is approximately 60 ft thick (RAM, 2003a, Figure 12; QMC, 2001, Figure 1.3). Figure 4 is a water table map of the alluvial system based on average ground water elevations measured in representative water table wells for the second half of 1999 . Current ground water flow in the alluvial system is generally to the southeast with a gradient of approximately 0.006. A ground water mound has formed in the northern portion of the study area, caused by infiltration from the Arroyo del Puerto bypass channel. North of this mound, ground water flows north toward mine shafts and vent holes located in Section 30. South of the mound ground water flows toward the northern half of trench IT-l, creating a ground water sweep. Ground water seeping from Tailings Impoundment 1 flows east toward trench IT-1. Hydraulic conductivity for the alluvial aquifer ranges from approximately 0.18 meters/day (m/d) (0.6 feet per day (ft/d)) based on pumping tests performed in wells AW-1 and AW-2 to 20 ft/d based on lithologic descriptions in monitoring well logs. Based on the lithology of the alluvium, porosity is estimated to range from 0.15 to 0.25. Specific yield estimates range from 0.10 to 0.20.

Prior to mining in the area, natural sources of recharge to the alluvial system were insufficient to establish saturated conditions. Therefore, natural sources of recharge such as infiltrating overland flow and drainage are insignificant. Principal sources of recharge to the system are as follows:

- RAM discharge of treated mine water into the Arroyo del Puerto bypass channel as part of corrective action program (current primary source)
- surface water runoff
- seepage from RAM Tailings Impoundment 1
- seepage from the Title I Ambrosia Lake Tailings Impoundment located 1.5 mi northeast of the RAM impoundment

Ground water exits the alluvial system at the northern and eastern margins of the study area where vent holes and mine shafts intersect the water table. Alluvial ground water also exits the southern end of study area as underflow beneath the Arroyo del Puerto through a narrow gap in the bedrock. Hydraulic gradients between the alluvial system and subcropping Tres Hermanos units are generally downward, indicating that some ground water is probably moving from the alluvial system into subjacent sandstone units. Results of the hydrologic model as presented by QMC support the suggestion that water levels in the alluvial aquifer on and adjacent to the site are maintained almost entirely by recharge from the RAM pump-and-treat corrective action program activities (QMC, 2001, Appendix C). There is no evidence that the only evaporation ponds in use adjacent to the alluvium—lined Ponds 9 and 10—are sources of seepage into the alluvium.

Ground water in the Ambrosia Lake area is used for irrigation and livestock watering. Neither irrigation nor livestock watering wells are completed in the alluvial aquifer in the vicinity of the tailings impoundments. The alluvial aquifer is not saturated anywhere except near the site and the DOE tailings impoundment and cannot provide sufficient water for use.

5.1.3.2 Bedrock Aquifers

The principal near-surface bedrock hydrogeologic units beneath the site are the TRA, the TRB, and the Dakota Sandstone. The Mancos Formation serves as an aquitard that separates each of these water-bearing units (see Figure 3). Affected ground water in TRA, TRB, and the Dakota sandstones generally flows downdip to the north and northeast beyond the POE boundary, where it is intercepted by numerous vent holes and shafts of the underground mines and by vertical fractures induced by collapse of mine stopes. Ground water infiltrates through these vent holes and shafts to the Westwater Canyon aquifer. An exception is a small portion of TRB in the southwest part of the study area. Interceptor trenches IT-2 and IT-3 intercept water flowing in the TRB to the east from beneath Tailings Impoundment 1 (see Figure 2). A regional cone of depression has formed within bedrock units beneath the site resulting from the dewatering of mines through vent holes and mine shafts (see Figure 5). Bedrock units are recharged where they crop out or are covered by alluvium.

In downhole investigations to determine the flow of water from each of the bedrock units to 30 ventilation holes and shafts, no measurable fluids were observed in the TRC. Two monitoring wells completed in the TRC were also dry. Thus, the TRC does not appear to be affected by tailings seepage from the RAM Ambrosia Lake facility and is not included in the corrective action program. Transmissivity for the TRB is 0.44 square meters/day (m^2/d) (4.7 square feet per day (ft^2/d))(QMC, 2000b). Transmissivity of the Dakota aquifer is 1.21 m^2/d (13 ft^2/d)(QMC, 2000b).

A list provided by the U.S. Geological Survey shows approximately 65 ground water wells within a 25-mile radius of the facility. The closest ground water supply well is completed in the Westwater Canyon Sandstone Member of the Morrison Formation approximately 1.5 miles west of the site. A large reduction in water use and ground water withdrawals has occurred in the Ambrosia Lake area over the past 10 to 15 years because of poor economic conditions as a result of the decline of the uranium industry. The current economic base in the Ambrosia Lake area is reclamation at the site and ranching. With facility reclamation nearing completion, this area would not be likely to experience an increase in ground water use.

5.1.3.3 Background Water Quality

Background values for the site were determined by the calculation of an upper tolerance limit (UTL) for constituent data sets that were either normally or lognormally distributed. In data sets that were not normally or lognormally distributed, the highest observed value was assigned as the UTL. Background concentrations established for hazardous constituents in the alluvium near the site are shown in Table 2.

RAM raises issues with the computation of background water quality data because sources unrelated to site activities have impacted offsite water quality. Such sources include seepage from the DOE facility, mine pumping and discharge, and the runoff and erosion from mine spoils and ore piles. As a result, widespread ambient ground water contamination has occurred that is unrelated to but inseparable from impacts related to milling at the site. Consequently, calculated background values may not be representative of ground water in other parts of the Ambrosia Lake valley outside of mined areas.

Table 2
Background Ground Water Concentrations

Parameter	Background Concentration (UTL)
Gross alpha (pCi/l)	16,726
Lead-210 (pCi/l)	36
Molybdenum (mg/l)	83
Nickel	0.14
Radium-226 & -228 (pCi/l)	196.1
Selenium (mg/l)	3.1
Thorium-230 (pCi/l)	5
Natural uranium (mg/l)	11.1

Source: RAM, 2001

5.1.4 Ecology

By letter dated September 20, 2004, the U.S. Fish and Wildlife Service (FWS) transmitted the Federal list of threatened and endangered species for McKinley County, New Mexico, to NRC staff (FWS, 2004). According to this list, the following threatened and endangered species are found in McKinley County: bald eagle (*Haliaeetus leucocephalus*), black-footed ferret (*Mustela nigripes*), Mexican spotted owl (*Strix occidentalis lucida*) with critical habitat, southwestern willow flycatcher (*Empidonax traillii extimus*), and the Zuni fleabane (*Erigeron rhizomatus*). No habitat for these species has been identified at the site.

5.1.5 Current Remedial Actions

5.1.5.1 Alluvial Aquifer

On June 1, 1986, the State of New Mexico relinquished its licensing authority over uranium milling activities, and the NRC reasserted its regulatory jurisdiction over New Mexico uranium processing facilities and associated byproduct material. As a result of the new regulatory jurisdiction, RAM submitted a ground water detection monitoring plan to the NRC on January 29, 1988. Based on data from this ground water detection monitoring program, NRC staff established ground water protection standards (GPSs) for hazardous constituents in ground water at the POC wells for the TRA, TRB, Dakota, and the alluvial aquifer.

RAM initiated the following corrective actions to mitigate ground water contaminant migration: 1) realigned the Arroyo del Puerto in 1976; 2) discontinued use of all unlined evaporation ponds and removed ponded solutions; and 3) constructed an interceptor trench adjacent to Tailings Impoundment 1. The interceptor trench forms a reverse hydraulic gradient within the alluvial aquifer, so treated minewater infiltrates and flushes the system from the realigned channel towards the interceptor trench, resulting in improved water quality. A total of 3.2 million m^3 (114 million ft^3) of impacted water from Tailings Impoundment 1 and the ground water sweep program have been recovered and removed from the alluvial aquifer via the interceptor trench since 1984. Recovered water, which included storm water runoff that accumulated within the trench, was disposed in lined evaporation ponds.

5.1.5.2 Bedrock Aquifers

As part of the AOD with the New Mexico Water Quality Control Commission, all free tailings solution was removed from unlined Ponds 3 through 8. These ponds and lined Pond 10 were taken out of service in 1983. Also, the interceptor trench located down gradient of Tailings Impoundment 1 was expanded and excavated into bedrock in 1984. Alluvial material was removed down to the underlying Mancos shale or sandstone contact. The completed trench extends approximately 6,200 feet on the down-dip gradient side of Tailings Impoundment 1 along the northern, eastern, and southern toes of Tailings Impoundment 1. Additional corrective actions are described below.

The approved ground water CAP for the Dakota involves continuation of mine water pumping from the Westwater Canyon Member of the Morrison Formation at the Section 30 and Section 30 West mines. The cone of depression caused by mine dewatering intercepts any ground water in the overlying Dakota as a result of drainage into ventilation holes, mine shafts, and fractures induced by mine subsidence. Pumped mine water is treated at the site and discharged pursuant to the NPDES permit for mine water discharge.

The approved ground water CAP for the TRA and TRB also requires continuation of mine water pumping from the Section 30 and Section 30 West mines. The aforementioned cone of depression also intercepts any ground water in the overlying TRA and TRB bedrock units in the same manner as in the Dakota. A dewatering trench was also installed between Ponds 2 and 7 to intercept seepage entering the TRA from these ponds. This dewatering trench is pumped and the produced water is routed to the seepage interceptor trench included in the corrective action plan for the alluvial aquifer. Past corrective actions, including minimizing the amount of free water, use of lined ponds, removal of standing tailings solution, construction and operation of the interceptor trench, and construction of the tailings cover, have reduced seepage of tailings fluid to ground water. Reduced seepage has, in turn, resulted in reduced concentrations of hazardous constituents in ground water at the POC.

5.2 Assessments and Modeling

5.2.1 Alluvial Aquifer

5.2.1.1 Ground Water Flow Model

RAM used MODFLOW to model ground water flow in the alluvial aquifer. The model area includes the saturated extent of alluvium, excluding the area beneath Tailings Impoundment 1 (see QMC, 2000b Figure 1.1). A small portion of TRB adjacent to the southeast corner of Tailings Impoundment 1 was included because ground water collected by trench IT-4 and portions of IT-2 and IT-3 originates from the TRB in that area. Ground water flow directions in that area suggest that this wedge of TRB is in direct communication with the alluvial system. The following hydraulic parameters were used in the model: alluvial aquifer hydraulic conductivity - 1.52 m/d (5 ft/d), TRB hydraulic conductivity - 0.30 m/d (1 ft/d), porosity - 0.2, and specific yield - 0.14. Results of the calibration exercise indicated that estimated and calibrated in and out fluxes differed by approximately 4 percent (QMC, 2000b). Figure 4 presents an alluvial aquifer potentiometric surface map after model calibration.

5.2.1.2 Contaminant Transport Model

Data from the ground water model were used to develop the contaminant transport model. For this purpose, RAM used the SOLUTE code. Model assumptions included a continuous source, a uranium retardation factor of 20, transport distance of 1,220 m (4,000 ft), and simulation time of 100 years. Model output was used to calculate an attenuation factor. ACLs were then calculated by dividing health-risk-based limits by the attenuation factor.

As RAM and NRC staff discussed (RAM, 2003a; Center for Nuclear Waste Repository Analysis (CNWRA), 2003), the use of a relatively simple transport model such as SOLUTE for the alluvial aquifer produces some uncertainty because of, among other factors, potential multiple sources and geochemical heterogeneity. NRC staff suggested such a simple approach would be acceptable if parameters were conservatively chosen. Based on the staff's reviews and independent calculations, RAM concluded that a retardation factor of 20 is sufficiently conservative and a transport distance of 1,220 m (4,000 ft) is appropriate for the distance from proposed POC well S–9 to the POE area at the southeast corner of the site (CNWRA, 2004, Section 4.1).

SOLUTE model results demonstrate that uncertainty in the time required for the alluvial formation to drain could significantly affect the calculated attenuation factor (CNWRA, 2004, Figure 4-1). For example, if alluvium requires 150 years to drain instead of 100 years, the calculated attenuation factor for well S–9 increases by a factor of 20, from 0.001 to 0.02. Therefore, it is important to establish and maintain confidence in the RAM estimate that the alluvium unit will drain within 100 years of cessation of discharges to Arroyo del Puerto. Such confidence can be gained from establishing criteria for the ground water monitoring program to verify the alluvium drains within the timeframe assumed in the transport calculations.

Almost without exception, the requested ACLs exceed any concentrations measured in the vicinity of the RAM and Title I tailings facilities (QMC, 2001; RAM, 2002). In fact, the ACLs even exceed concentrations in process and tailings liquids as reported for molybdenum, nickel, Pb-210, combined radium, Th-230, and natural uranium (QMC, 2001, Table 2.2). Thus, the ACLs are essentially meaningless in terms of reflecting contaminant conditions at the site. Any future observations of contaminant concentrations at the same order of magnitude as these ACLs will undoubtedly trigger concern about the effectiveness of the corrective action program. Nevertheless, the staff concludes that the ACLs are likely to be protective, based on the attenuation argument and the proposed POE locations.

5.2.1.3 Hazard Assessment

The contaminants for which ACLs have been requested are those that the licensee has concluded cannot be expected to conform soon to the ground water protection standards established in the corrective action plan (QMC, 1989; NRC, 2002). Alluvial monitoring data provided in the ACL application demonstrates that constituent trends have decreased slowly during the past 15 years or remained relatively flat. This trend is reinforced when more weight is given to filtered samples (CNWRA, 2003, Section 3.2). In spatial distribution (QMC, 2001, Figures 2.7 to 2.15), the data indicate site-related alluvial contaminants originated chiefly from RAM Tailings Impoundment 1, the site of former unlined Ponds 4, 5, and 6, and the NPDES-compliant discharge in the Arroyo del Puerto bypass channel. RAM remediation and corrective actions have diminished the supply of contaminants to the alluvium through capping impoundments and closure and cleanup of unlined ponds. As NRC staff noted, elevated Ra-226 concentrations in alluvial well 5-08 are not demonstrably derived from the RAM facility (CNWRA, 2003).

RAM addressed the potential for health risks from human exposure to radionuclides by calculating a health-risk-based concentration that would limit the lifetime increase in fatal cancer risk to 1×10^{-4} for ground water consumption at a potential POE location for each individual constituent (QMC, 2001, 2000). This concentration was calculated using the formula

$$I\ (Bq) = R/r$$

where I is the health-risk-based concentration, R is the acceptable lifetime risk of 1×10^{-4} (for an individual constituent), and r is the risk coefficient (EPA, 1999) of that constituent expressed as the probability of cancer mortality rate per unit bequerel (bq) intake of the particular radionuclide in tap water. The health-risk-based concentration (C_{hb}) can then be calculated using the equation

$$C_{hb}\ (pCi/L) = [(I)(CF)]/[(y)(d)(Q)]$$

where CF is the unit conversion factor of 27 pCi/Bq, y is the exposure duration of 30 years, d represents the exposure frequency of 350 days per year, and Q is the 1.11 L/d lifetime combined average intake of tap water from a potentially contaminated source.

In response to an NRC request for additional information (NRC, 2003a), the health-risk-based concentrations were recalculated by the licensee for those constituents known or suspected to cause cancer to approach the lifetime fatal cancer risk of 1×10^{-5} , so the cumulative risk of all constituents remains less than 1×10^{-4} (RAM, 2003a). Gross alpha was evaluated as a constituent of concern using the health-risk-based coefficient of Po-210 as a conservative approach to calculating the gross alpha health-risk-based limit (EPA,1999). Limits for the nonradiological contaminants molybdenum and selenium were taken from EPA (2000) concentrations based on a 1×10^{-6} or lower lifetime cancer risk for drinking contaminated water.

For nickel (which is not considered a carcinogen), the licensee adopted a risk-based limit of 0.1 mg/L on the basis that the chronic effects of long-term nickel ingestion above 0.1 mg/L are reported to be heart and liver damage, dermatitis, and decreased body weight.

It was demonstrated that ground water ingestion was the most likely and risk-limiting pathway (QMC, 2001). RAM calculated health-risk-based concentration limits for the constituents of concern as follows (QMC, 2001, revised in RAM, 2003a):

- molybdenum 0.18 mg/L
- nickel 0.1 mg/L
- selenium 0.05 mg/L
- gross alpha 8.57 pCi/L
- radium-226 & -228 3.23 pCi/L
- thorium-230 13.9 pCi/L
- U-nat 16.4 pCi/L (equivalent at secular equilibrium to 0.025 mg/L)
- lead-210 1.3 pCi/L

Although nonhazardous constituents are generally not considered health risks, RAM used the SOLUTE model to estimate nonhazardous constituent concentrations at the POE. This analysis did not take into account other potential sources. Results of the model indicate that approximate peak POE concentrations based upon the proposed ACLs are as follows:

- chloride 3,900 mg/l
- nitrate 160 mg/l
- sulfate 590 mg/l
- TDS 1,200 mg/l

Concentrations of these constituents are similar to those currently downgradient of the POE. However, the alluvial aquifer is currently dewatering and will continue to do so after deactivating the remediation system. Thus actual pollutant loads and contaminant migration will decrease substantially as the aquifer dewaters.

5.2.1.4 Exposure Assessment

As discussed above, modeled ground water concentrations at the POE for all constituents of interest are all below the calculated human health-risk-based concentrations. This indicates that the proposed health-risk-based concentrations do not pose any present or potential future hazards to human health. Furthermore, future ingestion of ground water originating from the alluvial aquifer is not likely because the aquifer is dewatering, water quality beyond the POE is not sufficient for consumption, and ground water does not emerge as surface water downgradient of the site. No continuous surface water flow will originate from the site after remedial action ceases because current flows in the Arroyo del Puerto are strictly from mine dewatering discharges. Only occasional precipitation events will produce surface water flows. Therefore, no human exposures are expected.

Potential for environmental impacts due to ground water in the site vicinity is expected to be limited due to the lack of permanent surface-water bodies and the low concentrations of hazardous constituents when compared to toxicological benchmarks. Toxicological benchmarks for inorganic constituents are based on no observed adverse effects levels (NOAELs) for representative mammalian and avian wildlife species assuming the animal receives 100 percent of its water from one source. The collection of benchmark values indicated that white-tailed deer are the most sensitive species for which data are available. The benchmark water concentrations protective of white-tailed deer for the three inorganic constituents of interest are as follows:

molybdenum (MoO_4) - 0.60 mg/L
nickel (nickel sulfate hexahydrate) - 171 mg/L
selenium (selenate) - 0.086 mg/L

Proposed human health-risk-based concentrations are all below the NOAEL-based toxicological benchmark values listed above. Therefore, the proposed human health-risk-based concentrations for ground water are considered protective of the environment.

Health risk-based concentrations were compared to benchmarks for radionuclides established for the Rocky Flats Environmental Technology Site. Maximum dose rates are based on findings of an International Atomic Energy Agency report, which states that dose rates of 1 mGy/day or 100 mrad/day will not likely harm animal or plant populations. Considering the aforementioned dose rates, the following benchmark concentrations were calculated for terrestrial animals:

lead-210	170 pCi/l
U-nat	7 mg/L
thorium-230	170 pCi/l
radium-226	250 pCi/l
radium-228	170 pCi/l

No benchmark values are provided for lead-210 and thorium-230; therefore, the benchmark concentration presented for radium-228 was used as a surrogate in the comparison for lead-210 and thorium-230 (QMC, 2000). Calculated health-risk-based concentrations for the radionuclide parameters are below the ecological benchmarks, indicating that the health-risk-based concentrations are protective of the environment.

5.2.2 Bedrock Aquifers

5.2.2.1 Ground Water Modeling

RAM presented the results of previous ground water modeling for the bedrock aquifers in its ACL application (QMC, 2000). Hydraulic properties for the bedrock aquifers are presented in Table 3.

Table 3
Bedrock Aquifers Hydraulic Properties

Aquifer	Hydraulic Conductivity	Transmissivity	Hydraulic Gradient	Ground Water Flow Direction	Ground Water Flow
TRA	NA	NA	NA	north-northeast	NA
TRB	0.8 ft/day	35 gpd/ft	0.042	north-northeast	6 pgm
Dakota	0.4 ft/day	100 gpd/ft	0.037	north-northeast	12.5 gpm

NA = Not Available

Hydraulic data was not available for the TRA because of an insufficient number of wells containing water. Ground water flow in the bedrock units is toward mine shafts and vent holes. These structures drain the bedrock aquifers to the Westwater Canyon aquifer.

5.4.2.2 Contaminant Transport Modeling

For the bedrock aquifers, RAM (2003a) defined the same health-risk-based limits on ground water concentrations as were defined for corresponding contaminants in the alluvium. RAM's proposed ACLs are based on the results of attenuation calculations using a simplified ground water transport model for the Dakota (RAM, 2003b). RAM used the SOLUTE code with the following assumptions: source duration of 22 years, uranium retardation factor of 50, transport distance of 1,189 m (3,900 ft), ground water velocity of 38.1 m/yr (125 ft/yr), and dispersion length of 152.4 m (500 ft). Model output was used to calculate an attenuation factor of 0.0147. Applying this factor to the health-risk-based limits resulted in the new proposed ACLs for all three bedrock units, as shown in Table 1.

The staff concluded that the model retardation factor, ground water velocity, and dispersion length were appropriately chosen, and the model result was verified (CNWRA, 2004, Section 4.2). RAM's current model assumes a pulsed solute source with a duration of 22 years at the same location as POC well 36–06 (RAM, 2003b). In reality, the solute source is located approximately 244 m (800 ft) upgradient from the POC well. However, RAM's approach would underestimate the attenuation factor because it does not account for the fact that the contaminant pulse at the POC is longer in duration than the 22-year source pulse caused by dispersion. Staff found that this approach was inappropriate because it results in ACLs that may not be attenuated to health-risk-based limits at the POE. Previously, RAM calculated an attenuation factor for the Dakota by performing solute transport calculations from the solute source to the POC well and from the solute source to the POE well (QMC, 2000, Section 2.3.2.1). An attenuation factor of 0.16 was then calculated as the ratio of relative solute concentrations between these two well locations. Staff believes this previously used approach is the more appropriate method for estimating attenuation of solutes between two wells located at different distances downstream from a limited-duration source. Using the appropriate approach and the applicable POE location, staff calculated an attenuation factor of 0.12 for the Dakota (CNWRA, 2004, Section 4.2).

At the June 30, 2004, meeting of the NRC and RAM staff and consultants, RAM informed NRC that the institutional control boundary on the west side of the facility was being changed so that the POE for the Dakota aquifer would be located directly north of POC well 36-06 along the road near the boundary between Sections 25 and 30. From Map 1-1 of QMC (2000), staff measured a distance from the Dakota contaminant source area (Ponds 7 and 8) to this POE of approximately 2,591 m (8,500 ft) and performed independent calculations of transport from the source area to the POC (244 m (800 ft)) and POE (2,591 m (8,500 ft)). The ratio of peak solute concentrations for the source-to-POC and the source-to-POE breakthrough curves indicates an attenuation factor of 0.1. However, the peak solute concentration takes nearly 3,000 years to reach the revised POE boundary. During the regulatory period of 1,000 years (NRC, 2003b, Section 4.3.3.2), essentially no solute arrived at the POE location. This analysis indicates that the attenuation factor of 0.0147 used by RAM is not exceeded for a period of at least 1,000 years. Therefore, given the new institutional boundary, the ACLs proposed for the Dakota are acceptable.

A similar modeling approach was used to determine whether the attenuation factor of 0.0147 is appropriate also for the TRA and TRB aquifers. A review of data from RAM's bedrock ACL application (QMC, 2000) indicates that the shortest bedrock aquifer POC-to-POE distance is approximately 1,280 m (4,200 ft) for TRA POC well 31-01 and TRB POC well 31-02 considering the new institutional control boundary. In addition, the distances from source areas to these POC locations are approximately 244 m (800 ft), so that the total POE transport distance is approximately 1,524 m (5,000 ft). Using this POE transport distance in the same model approach as for the Dakota (e.g., retardation factor of 50), the model yields the POE relative concentration history shown by the solid curve in Figure 6. The peak of this breakthrough curve is 0.012, but the value at the end of the regulatory period of 1,000 years (NRC, 2003b, Section 4.3.3.2) is 0.008. The ratio of the 1,000-year value to the peak of the breakthrough curve for the 800-ft transport distance is 0.008/0.08 = 0.1, an attenuation factor nearly seven times higher than the Rio Algom value. TRA and TRB ACLs calculated using this attenuation factor would be a factor of approximately 0.15 smaller than the proposed values.

NRC and RAM staff and their consultants could not agree on the correct technical approach to estimating an attenuation factor for the bedrock aquifers. However, previous model results can be reassessed by using a more realistic retardation factor. The staff concluded that, for the bedrock aquifers, "a pH range of 5 to 7.5 would generally provide confidence that the uranium K_d will be above a value of 12 ml/g and, hence, that R_d will be greater than 100"(CNWRA, 2003, Sections 4.4.1) Ground water monitoring data for TRA POC well 31-01 and TRB POC well 31-02 show recent pH values within this range. Therefore, it is reasonable to use a retardation factor of 100 to model transport along these pathways. Results for the 1,524-m (5,000-ft) source-to-POE pathway indicate that the relative concentration curve peaks at approximately 3,000 years; however, the value at the end of the 1,000-year regulatory period is 0.00012. The curve for the 244-m (800-ft) source-to-POC pathway indicates a peak at 0.04 at approximately 200 years. The resulting POC-to-POE attenuation factor is 0.00012/0.04, or 0.003. This value is lower than the value of 0.0147 used by Rio Algom to set bedrock aquifer ACLs; therefore, staff concludes that the proposed ACLs for the TRA and TRB aquifers are acceptable.

The simplified transport model employed is highly uncertain and suffers from an inability to simulate actual features and processes that could reduce the mass of contaminant along the pathway. Therefore, determining an accurate attenuation factor for the TRA and TRB aquifers is difficult. However, there are mitigating factors in addition to the independent analyses reported here that suggest the RAM value will be protective. First, the TRA and TRB formations have been significantly dewatered within the compliance boundary as a result of decades of drainage into the nearby mineworks (QMC, 2000). While it is technologically possible to obtain ground water from the TRA and TRB aquifers, the potential sustained yield would be minute and not economically feasible for most foreseeable uses. Second, it is expected to take several centuries for the regional water table to recover sufficiently from the decades of dewatering of the mineworks for the TRA and TRB aquifers to resaturate within the compliance area; when this resaturation does occur, it will cause a reversal in the ground water flow direction, which would tend to keep contamination within the compliance boundary and dilute any contaminants remaining.

5.2.2.3 Exposure Assessment

Section 5.2.1.3 regarding calculations of health-risk-based concentrations.

5.2.2.4 Hazard Assessment

Using the health-risk-based concentrations, RAM calculated intakes and risks for various exposure scenarios, regardless of the fact that these scenarios are highly unlikely to occur. Table 4 presents the total intake of radionuclides from all food sources and the risks associated with these intakes.

Table 4
Estimated Radionuclide Uptakes and Risks

Parameter	Intake (pCi/year)	Risk
Lead-210	192	4.9E-06
Radium-226	4,233	3.4E-5
Radium-228	1,059	3.2E-5
Thorium-230	538	1.3E-06
Uranium	1,238	2.5E-06

A review of Table 4 indicates that the total risk from all food intake is on the order of 10E-5, which is below the 10E-4 NRC criterion for cancer risk.

RAM also calculated risks of ground water ingestion of radionuclides, which again is an unlikely scenario. Tables 5 through 7 presents the risks for each bedrock aquifer.

Table 5
Ground Water Ingestion Risks - TRA

Parameter	Ground Water Concentration at POE (pCi/l)	Risk in TRA
Uranium	2.71	1.6E-06
Lead-210	3.80	2.9E-05
Thorium-230	0.41	3.0E-07
Radium-226	1.14	2.6E-06
Radium-228	4.30	3.7E-05

Table 6
Ground Water Ingestion Risks - TRB

Parameter	Ground Water Concentration at POE (pCi/l)	Risk in TRB
Uranium	1.83	1.1E-06
Lead-210	9.90	7.5E-05
Thorium-230	7.70	5.5E-06
Radium-226	3.22	7.4E-06
Radium-228	1.41	1.2E-05

Table 7
Ground Water Ingestion Risks - Dakota

Parameter	Ground Water Concentration at POE (pCi/l)	Risk in Dakota
Uranium	35.20	2.1E-06
Lead-210	9.10	6.9E-05
Thorium-230	1.20	8.6E-07
Radium-226	2.33	5.3E-06
Radium-228	6.20	5.3E-05

RAM has properly assessed potential hazards and exposure pathways relevant to ground water protection at the site. Continuation of the CAP would not result in a significant improvement in protection of human health and the environment. While staff could not reach agreement with RAM on the proper methodology for calculating attenuation factors, independent analyses show that the proposed ACLs for the bedrock aquifers are acceptable if the aquifer attenuates contaminant transport as predicted. That these ACLs will continue to be protective will be verified by the monitoring program.

6.0 CORRECTIVE ACTION ASSESSMENT

6.1 Alluvial Aquifer

RAM stated that the present contaminant levels are ALARA (QMC, 2001). Two alternatives to continuing the corrective action program that were analyzed are (i) completing site reclamation and ending mine water discharge (the basecase) and (ii) enhanced dewatering of Tailings Impoundments 1 and 2 by way of wells drilled into the impoundments. RAM also showed, using reasonable assumptions, that enhanced impoundment dewatering would yield relatively few benefits and would cost an estimated $1.7 million per person-rem averted—far in excess of the value of $2,000 per person-rem in the NRC Draft Regulatory Guide DG–4006 (NRC, 1998). Continuation of the current program for 100 years (the time estimated for complete dewatering of the tailings impoundments) is the most expensive option, costing an estimated $59 million per person-rem averted. The alternatives lead to relatively low reductions in contaminants compared to the basecase (QMC, 2001, Table 3.2), and there is reasonable assurance that, in all cases, attenuation in the alluvium will reduce contaminant concentrations to safe levels.

Staff concludes that continuation of the CAP will not result in a significant improvement in protection of human health and the environment. Cessation of the CAP will allow the alluvial aquifer to return to an unsaturated state so that it will eventually cease to be a potential source of ground water. Because reclamation includes filling in interceptor trenches, seepage from the tailings impoundments would no longer be intercepted and would act once again as a potential contaminant source for the alluvial aquifer. However, (i) impoundment seepage will diminish because of impoundment infiltration barriers, (ii) ground water modeling (QMC, 2001) suggests that this seepage will drain dominantly into the underlying TRB bedrock unit, and (iii) acceptable ACLs will nevertheless be protective for the alluvial ground water that does travel to the POE.

6.2 Bedrock Aquifers

Residual ground water flow in the Dakota near the Section 30 and Section 30 West mines has reached a minimum. According to RAM, in the CAP Annual Report for 1997, the drainage from the Dakota resulting from the mine vent holes and mine shafts has dropped from approximately amount of almost 24,791 m^3/yr (882,353 ft^3/yr) in 1989-1990 to less than 37.8 m^3/yr (1,382 ft^3/yr) by 1997. Likewise, uranium recovery has dropped from 4.08 kg (8.91 lbs) during the 1991-1992 period to essentially zero after 1997. The approved CAP for the Dakota ensures that ground water down dip of the mine vent holes and shafts is not impacted by tailings seepage. However, the approved CAP for the Dakota does not protect ground water in the Dakota in the portions of Sections 36 and 25 located between Ponds 7 and 8 and the mine vent holes. Nevertheless, the availability of ground water in Dakota in this area will continue to diminish due to elimination of Ponds 7 and 8 and dewatering by mine shafts and vent holes in Section 30. The effectiveness of removal of liquids and byproduct material from Ponds 7 and 8 is clearly indicated by the significant decline in the concentration of hazardous constituents at the Dakota POC well 36-06KD. Also, the saturated thickness down gradient from Ponds 7 and 8 has dropped quickly following removal of tailings solution from these ponds.

Since reclamation of the tailings impoundments, the dewatering trench collects little seepage. Likewise, uranium recovery has dropped from 1,000 kg (2,200 lbs) during the 1989-1990 period to about 11.8 kg (25.9 lbs) during the 1996-1997 period. The dewatering trench is effective because the TRA unit, which subcrops in the vicinity of Pond 7, has shown little impact from the site operations. However, with the significant drop in recovery from this dewatering trench following reclamation, it is no longer needed or effective.

Residual ground water flow in the TRA and TRB in the vicinity of the Section 30 and Section 30 West mines has reached a minimum. As reported to the NRC by QMC in the CAP Annual Report for 1997, the drainage from the TRB resulting from the mine vent holes and mine shafts dropped from approximately 3,783 m^3/yr (133,690 ft^3/yr) in 1990 to approximately 416 m^3/yr (14,706 ft^3/yr) by 1997. Likewise, uranium recovery dropped from 0.54 kg/yr (1.2 lb/yr) during the 1991-1992 period to about 0.11 kg (0.24 lb/yr) in the 1996-1997 period.

RAM concluded that the present bedrock aquifer contaminant levels are ALARA (QMC, 2000). Continuation of mine water pumping is not necessary to intercept ground water from the TRA, TRB, and Dakota by the mine shafts and vents. Regional ground water modeling studies suggest it will take hundreds of years for the dewatered formations in the mined region to recover enough for resaturation at POE locations in the TRA and TRB. Although mine water pumping has not dewatered the Dakota at the POE location, removal of tailings fluids and byproduct material from Ponds 7 and 8 has eliminated the contaminant source, and ground water in the Dakota would be protected at the POE if approved ACLs are met at POC wells.

Monitoring well data show that concentrations of constituents associated with mill operations generally have declined in the uppermost bedrock units as a result of source mitigation and ground water corrective action (e.g., QMC, 2000, Figures 2-1 through 2-32, Section 3.2). In approximately the past decade, however, contaminant concentrations, while variable, have stabilized, and no appreciable reductions in contaminant concentrations are occurring in the uppermost bedrock units, despite ongoing ground water corrective action. An evaluation indicated that alternative corrective actions are either unfeasible or would likely achieve only minimal reductions in contaminant concentrations at a cost that would not be justified by the results (QMC, 2000, Sections 3.3 and 3.4). Available information and analyses, therefore, support a conclusion that constituent concentrations for which RAM is seeking ACLs in the uppermost bedrock aquifers are ALARA.

7.0 COMPLIANCE MONITORING

NRC staff is requiring quarterly monitoring for the first 2 years followed by semiannual monitoring until license termination. Table 8 presents the proposed monitoring well network for the site (RAM, 2005b), and Figure 7 presents the monitoring well locations. Table 9 presents the parameters to be analyzed in each aquifer. The well network has been designed to track and assess ground water contamination between the tailings impoundment and the long-term care boundary (see Figure 8) and point of exposure (POE). More frequent monitoring during the beginning of the compliance monitoring program is being required because of the uncertainty of the hydrogeologic and transport models. Contaminated ground water will not emerge as surface water; therefore any exposure must occur through actual ground water use.

Table 8
Ground Water Compliance Monitoring Network[1]

Dakota		TRA		TRB		Alluvium		
POC Well	**Trend Wells**	**POC Well**	**Trend Well**	**POC Well**	**Trend Wells**	**POC Well**	**Trend Wells**	**POE Well**
36-06	30-02	31-01	30-01	36-02	31-67	31-61	32-59	MW-24
	32-45		***33-01***		36-01		31-65	
	30-48KD				31-02		5-08	
	5-02KD				***19-77***		5-73	
	17-01[2]						5-04	
							5-03	

Source: RAM 2005b
1. Note that all wells are compliance wells. GPSs and ACLs are effective for all POC, trend, and POE wells.
2. Bold and italic indicates a background well.

Table 9
Ground water Monitoring Parameters

Dakota	**TRA**	**TRB**	**Alluvium**
pH (s.u.)	pH (s.u.)	pH (s.u.)	pH (s.u.)
Chloride (mg/L)	Chloride (mg/L)	Chloride (mg/L)	Chloride (mg/L)
Sulfate (mg/L)	Sulfate (mg/L)	Sulfate (mg/L)	Sulfate (mg/L)
TDS (mg/L)	TDS (mg/L)	TDS (mg/L)	TDS (mg/L)
Nitrate (mg/L)	Nitrate (mg/L)	Nitrate (mg/L)	Nitrate (mg/L)
Nickel (mg/L)	Lead-210 (pCi/L)	Nickel (mg/L)	Molybdenum (mg/L)
Natural uranium (mg/L)	Radium-226 & -228 (pCi/L)	Natural uranium (mg/L)	Nickel (mg/L)
Lead-210 (pCi/L)	Thorium-230 (pCi/L)	Lead-210 (pCi/L)	Selenium (mg/L)
Radium-226 & -228 (pCi/L)	Cyanide (mg/l)	Radium-226 & -228 (pCi/L)	Natural uranium (mg/L)
Thorium-230 (pCi/L)	Gross alpha (pCi/l)	Thorium-230 (pCi/L)	Lead-210 (pCi/L)
Antimony (mg/l)	Molybdenum (mg/l)	Cyanide (mg/l)	Radium-226 & -228 (pCi/L)
Arsenic (mg/l)	Nickel (mg/L)	Gross alpha (pCi/l)	Thorium-230 (pCi/L)
Beryllium (mg/l)	Selenium (mg/l)	Molybdenum (mg/l)	Gross alpha (pCi/L)
Cadmium (mg/l)	Natural uranium (mg/l)	Selenium (mg/l)	
Cyanide (mg/l)			
Gross alpha (pCi/l)			
Molybdenum (mg/l)			
Lead (mg/l)			
Selenium (mg/l)			

Source: RAM, 2005b

The purpose of this monitoring is to assure that, while RAM remains the licensee, RAM remains in compliance with the ground water standards in the license. Sampling data also allows monitoring of ground water plume movement over time and distance, and assures that ground water contamination does not present an unacceptable risk to human health or the environment in the future. If future data suggests that pollutant concentrations in any compliance well exceed the GPSs or the ACLs, then RAM would be required to implement more frequent monitoring or corrective actions.

8.0 RECOMMENDED LICENSE CHANGES:

The changes are recommended for License Conditions 34, and 40.

34. The licensee shall implement a ground water compliance monitoring program. The monitoring wells presented in Paragraph A of this license condition shall be sampled quarterly for the first two years following approval of the alternate concentration limits contained in Paragraph B of this License Condition. The licensee shall sample the aforementioned monitoring wells semiannually thereafter until license termination. The ground water compliance monitoring program shall consist of the following:

A. Sample Dakota Sandstone wells 17-01, 30-02, ~~30-48,~~ 30-48KD, 32-45, 36-06, and 5-02KD for antimony, arsenic, beryllium, cadmium, chloride, cyanide, gross alpha, lead, lead-210, molybdenum, nickel, nitrate, radium-226 & -228, selenium, sulfate, thorium-230, total dissolved solids, natural uranium, pH, electrical conductivity, and water level.

Sample Tres Hermanos A wells 31-01, 30-01, and 33-01 for chloride, cyanide, gross alpha, lead-210, molybdenum, nickel, nitrate, radium-226 & -228, selenium, sulfate, thorium-230, total dissolved solids, natural uranium, pH, electrical conductivity, and water level.

Sample Tres Hermanos B wells 19-77, 31-02, 31-67, 36-01, and 36-02 for chloride cyanide, gross alpha, lead-210, molybdenum, nickel, nitrate, radium-226 & -228 selenium, thorium-230, sulfate, total dissolved solids, natural uranium, pH, electrical conductivity, and water level.

Sample alluvium wells 5-03, 5-04, 5-08, 5-73, 32-59, 31-61, 31-65, and MW-24, for chloride, gross alpha, lead-210, molybdenum, nickel, nitrate, radium-226 & -228, selenium, sulfate, thorium-230, total dissolved solids, natural uranium, pH, electrical conductivity, and water levels.

B. Comply with the following ground water protection standards at Dakota Sandstone compliance wells 30-02 (old POC), 30-48KD, 5-02KD, 32-45, and 36-06: antimony = 0.05 mg/l; arsenic = 0.1 mg/l, beryllium = 0.01 mg/l; cadmium = 0.01 mg/l; cyanide = 0.04 mg/l; lead = 0.14 mg/l; molybdenum = 0.06 mg/l; selenium = 0.04 mg/l; and gross alpha = 56 pCi/l; Comply with the following alternate concentration limits at the same compliance wells: lead-210 = 88 pCi/l; nickel = 68 mg/l; radium-226 & -228 = 218 pCi/l; natural uranium - 1.6 mg/l; thorium-230 = 945 pCi/l; chloride = 3,200 mg/l; nitrate = 22.8 mg/l; sulfate = 6,480 mg/l; total dissolved solids = 14,100 mg/l. Background is recognized at well 17-01.

Comply with the following ground water protection standards at Tres Hermanos A compliance wells 31-01 (old POC) and 30-01: cyanide = 0.01 mg/l; molybdenum - 0.03 mg/l; nickel = 0.05 mg/l; selenium - 0.03 mg/l; gross alpha = 18.0 pCi/l; and natural uranium - 0.01 mg/l. Comply with the following alternate concentration limits at the same compliance wells: lead-210 = 88 pCi/l; radium-226 & -228 = 218 pCi/l;

thorium-230 = 945 pCi/l; chloride = 1,070 mg/l; nitrate = 9.2 mg/l; sulfate = 2,584 mg/l; total dissolved solids = 6,400 mg/l. Background is recognized as well 33-01.

Comply with the following ground water protection standards at Tres Hermanos B ~~point of~~ compliance wells ~~31-66~~, 31-02, 31-67, 36-01, and 36-02: cyanide = 0.01 mg/l; molybdenum = 0.08 mg/l; selenium = 0.04 mg/l; and gross alpha = 21.0 pCi/l. Comply with the following alternate concentration limits at the same compliance wells: nickel = 6.8 mg/l; radium-226 & -228 = 218 pCi/l; natural uranium = 1.6 mg/l; thorium-230 = 945 pCi/l; lead-210 = 88 pCi/l; chloride = 2,810 mg/l; nitrate = 7.7 mg/l; sulfate = 4,760 mg/l; and total dissolved solids = 11,700 mg/l. Background is recognized as well 19-77.

Comply with the following alternate concentration limits at alluvium ~~point of~~ compliance wells 32-59, 31-61, 31-65, MW-24, 5-08, 5-04, and 5-73: molybdenum = 176 mg/l; nickel = 98 mg/l; selenium = 49 mg/l; gross alpha - 8,402 pCi/l; radium-226 & -228 = 3,167 pCi/l; thorium-230 = 13,627 pCi/l; natural uranium = 23 mg/l; lead-210 = 1,274 pCi/l, chloride = 7,110 mg/l; nitrate = 351 mg/l; sulfate = 12,000 mg/l; total dissolved solids = 26,100 mg/l. Background is recognized as well 5-03.

C. ~~Implement a corrective action program as described in the September 25, 1989, submittal with the objective of returning the concentrations of hazardous constituents to the concentration limits specified in Subsection (B). The program shall, at a minimum, consist of mine dewatering and maintenance and operation of the interceptor trench.~~ [DELETED BY Amendment No. 56]

D. ~~Submit, by August 1 of each year, a review of the corrective action program and its effect on the aquifers.~~ Submit, by February 1 and August 1 of each year ground water monitoring reports to include a minimum of the following: potentiometric surface maps for each aquifer; time vs. concentration plots for all parameters for which ACLs have been issued, hydrographs for the downgradient most trend well or POE well in each aquifer, hydraulic gradient calculations, and tabulated analytical data for each ACL parameter for each well.

E. [DELETED BY Amendment No. 42]

F. If the laboratory results indicate that the concentration of any constituent exceeds its associated ground water protection standard or ACL, the licensee shall collect a second sample within 7 calendar days of becoming aware of the aforementioned exceedance. If the results of this second sample confirm the aforementioned exceedance, the licensee shall increase the monitoring frequency to monthly and submit to NRC staff quarterly reports documenting the exceedance. If the exceedances continue for three consecutive months, the licensee shall submit to NRC staff a ground water corrective action designed to regain compliance with ground water protection standards and ACLs.

[Applicable Amendments: 9, 11, 13, 15, 25, 35, 40, 42, 56]

40. The licensee shall complete site reclamation in accordance with an approved reclamation plan ~~and ground water corrective plan~~, as authorized by License Condition Nos. 37 and 34, respectively, in accordance with the following schedules.

A. To ensure timely compliance with target completion dates established in the Memorandum of Understanding with the Environmental Protection Agency (56 FR 55432, October 25, 1991), the licensee shall complete reclamation to control radon emissions as expeditiously as practicable, considering technological feasibility, in accordance with the following schedule:

(1) Windblown tailings retrieval and placement on the pile - December 31, 1999. Areas inaccessible due to activities authorized by this license will be addressed during final mill decommissioning.

[Applicable Amendments: 38, 43]

(2) Placement of the interim cover to decrease the potential for tailings dispersal and erosion -

For impoundment No. 1 - Completed October 1990
For impoundment No. 2, excluding portions used for approved byproduct material disposal -Completed December 1992

[Applicable Amendment: 44]

(3) Placement of a final radon barrier designed and constructed to limit radon emissions to an average flux of no more than 20 $pCi/m^2/s$ above background -

For impoundment No. 1 - Completed September 1996.
For impoundment No. 2, excluding portions used for approved byproduct material disposal - Completed September 1996.

[Applicable Amendment: 44].

B. Reclamation, to ensure required longevity of the covered tailings and ground water protection, shall be completed as expeditiously as is reasonably achievable, in accordance with the following target dates for completion:

(1) Placement of erosion protection as part of reclamation to comply with Criterion 6 of Appendix A of 10 CFR Part 40 -

For impoundment No. 1 - December 31, 2001

For impoundment No. 2, excluding portions used for approved byproduct material disposal - December 31, 2003

[Applicable Amendment: 45, 49]

(2) ~~Projected completion of groundwater corrective actions to meet performance objectives specified in the groundwater corrective action plan - December 31, 2008~~ Ground water corrective actions - Completed February 21, 2006. [Applicable Amendment No. 56]

C. Any license amendment request to revise the completion dates specified in Section A must demonstrate that compliance was not technologically feasible including inclement weather, (litigation which compels delay to reclamation, or other factors beyond the control of the licensee).

D. Any license amendment request to change the target dates in Section B above, must address added risk to the public health and safety and the environment, with due consideration to the economic costs involved and other factors justifying the request such as delays caused by inclement weather, regulatory delays, litigation, and other factors beyond the control of the licensee.

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