CLUFF LAKE DECOMMISSIONING PROJECT – PLANNNING AND CURRENT STATUS

G. Acott, P. Biol.
R. Pollock, P. Eng.
AREVA/COGEMA Resources Inc.,
P.O. Box 9204
817-45th Street West
Saskatoon, Saskatchewan, Canada S7K 3X5
bob.pollock@cogema.ca

ABSTRACT

The Cluff Lake Project, owned and operated by AREVA/COGEMA Resources Inc., is a uranium mining and milling facility in northern Saskatchewan, which commenced operation in 1980. The decommissioning plan for the Cluff Lake Project received regulatory approval in 2004, following a Comprehensive Study under the Canadian Environmental Assessment Act. The plan involves soil covers for an above-ground tailings area and a waste rock pile, completing the backfilling of an open pit with waste rock and flooding of two other open pits and of two underground mines. A large mill and associated infrastructure will also be demolished and disposed within the backfilled pit. Several alternative methods were considered for the decommissioning of each of the major areas.

Success of the decommissioning will be judged by comparison to objectives established through the environmental assessment process. A comprehensive follow up program has been developed to monitor the key aspects, to demonstrate that the planning assumptions were appropriate and to ensure decommissioning will perform as designed.

This paper summarizes the planning for decommissioning, and describes the current status and subsequent monitoring program.

I. INTRODUCTION

The Cluff Lake Project, owned and operated by AREVA/COGEMA Resources Inc., is a uranium mining and milling facility in northern Saskatchewan, which commenced operation in 1980. Ore reserves at the site have now been depleted and mining was concluded in early 2002. By the time milling operations ceased at the end of 2002, the Cluff Lake Project had produced more than 62 million pounds of uranium concentrate.

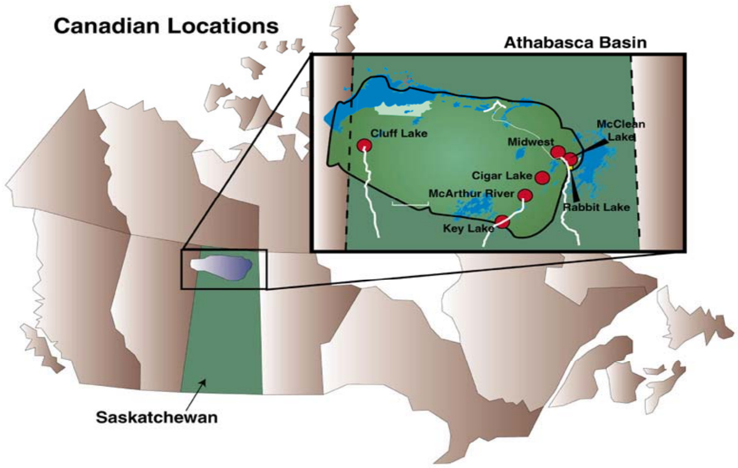

Figure 1: Uranium Mine Locations in Saskatchewan, Canada

This map shows the Athabasca Basin in the extreme northern part of Saskatchewan which hosts the uranium mining activity in the Province.

The Cluff Lake Project is the only uranium mining operation in the western portion of the basin, and is about 75 km south of Lake Athabasca and about 20 km east of the Alberta border.

Planning for decommissioning began in 1998. This activity requires a licence from a federal regulator, the Canadian Nuclear Safety Commission, which triggers the requirement for a federal environmental assessment.

Figure 2: The Comprehensive Study Report and Supporting Documentation

II. PROJECT PLANNING

The Cluff Lake decommissioning plan has been subjected to intensive review and discussion through a five year Comprehensive Study under the Canadian Environmental Assessment Act (CEAA). Key reviewers included:

- Federal Regulatory Agencies including the Canadian Nuclear Safety Commission (CNSC) (the Responsible Authority under CEAA), Environment Canada, Natural Resources Canada, Health Canada, Fisheries and Oceans Canada and the Canadian Environmental Assessment Agency
- Several Provincial Regulatory Agencies co-ordinated by Saskatchewan Environment (SE)
- Community interest groups
- Members of the public

The Comprehensive Study was approved by the Minister of the Environment on April 14, 2004 and the project was referred to the Canadian Nuclear Safety Commission (CNSC) for licensing. The CNSC conducted a two-day hearing on April 29 and June 9, 2004. The latter day was held at La Ronge, Saskatchewan to facilitate participation by northern Saskatchewan stakeholders. The Decommissioning Licence was issued on July 31, 2004. Contractors were mobilized in early August to conduct Phase 1 of the mill demolition and begin the backfilling of the Claude Pit. During the EA approval period, COGEMA were permitted to conduct several clean up and reclamation activities to prepare for final decommissioning.

Decommissioning objectives for a uranium mine and mill site must consider that the waste rock and tailings resulting from the operation, as well as the majority of the waste materials resulting from removing the physical facilities, will be managed on site for the long term. This is a fundamental difference from many other types of nuclear facilities, where all of the physical facilities, and the wastes which have been produced during operations, are removed and disposed elsewhere.

Decommissioning at the Cluff Lake mine and mill site thus means removing structures and primarily disposing of them on site, stabilizing materials such as tailings and waste rock piles, and reclaiming physically disturbed areas such that:

- the environment is safe for non-human biota and human use, and will remain so
- long-term adverse effects are minimized,
- the landscape is stable and self-sustaining, and
- traditional uses such as trapping, hunting and fishing are not restricted.

The plan, which has been accepted through the environmental assessment process, also minimizes constraints on future land use to the extent which it is practical to do so.

III. DECOMMISSIONING PLAN AND CURRENT STATUS

As shown in this long range aerial view (Figure 3), the Cluff Lake site divides naturally into four major areas.

- the tailings management area (TMA) and adjacent borrow area for the till cover are shown in the center of the figure.
- the mill complex is shown just above the TMA.
- the mining area sites are grouped around the east end of Cluff Lake, in the upper right portion of the figure.
- the residential camp area is not in this figure, but is located at the west end of Cluff Lake, to the right of the portion of Cluff Lake shown in this figure.

Figure 3: Overview of the Cluff Lake Site

III.A. Mining Area – D Open Pit

Figure 4 shows the former D mining area in the foreground, and other areas disturbed by mining across the top of the figure. The D area was reclaimed some years ago, but a final radiological survey identified a number of small areas which required further remediation to meet radiological clearance criteria. Placement of a layer of clean till over these areas will require some additional revegetation efforts to stabilize these locations and complete the reclamation of the D mining area.

D Pit was the first orebody mined at Cluff Lake, containing the highest grade uranium ore on the property and significant gold reserves. Mining was completed in 1981 and the pit was flooded in 1983 when the nearby creek overflowed banks during spring thaw.

Extensive monitoring since 1985 has shown the flooded pit to be chemically stratified, with the water quality in the upper 50% of the water column meeting Provincial guidelines for acceptable surface water quality.

Figure 4: D Area Decommissioning

III.B. OP/DP Underground Mine

Figure 5 shows the OP/DP mining area during operations. The OP/DP underground mine has been flooded and the entry backfilled and sealed. The waste rock pile, shown partially removed in the figure, has been fully disposed in Claude pit. As well, much of the mining support infrastructure has been removed.

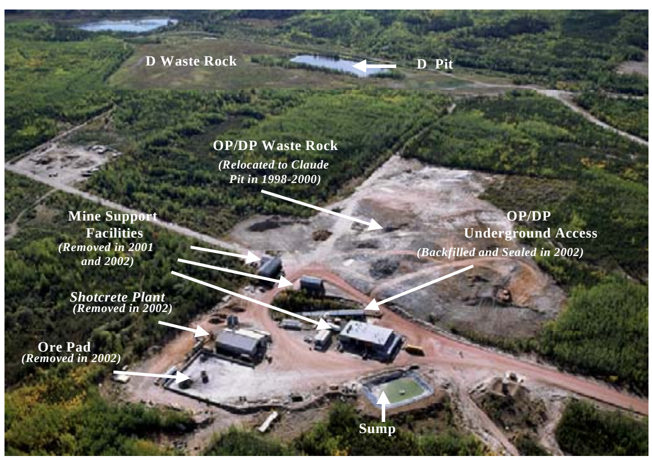

Figure 5: OP/DP Mining Area

Figure 6 shows a more current photo of the OP/DP area with most of the infrastructure removed. Final clean up and re-grading have subsequently been done. Following this activity, we are now preparing a final radiological clearance report for the area, and will submit this to CNSC and SE staff as the vehicle for obtaining approval that clean-up is complete. Once this final closeout step for the area is complete, we will proceed with revegetation as the final decommissioning step.

Areas are evaluated to assess whether they meet radiological clearance criteria through a digitized gamma survey. Figure 7 shows an example of the gamma radiation survey data for the area following the initial phase of clean up on the upper left and following final clean up on the lower right.

Figure 6: OP/DP Area Decommissioning

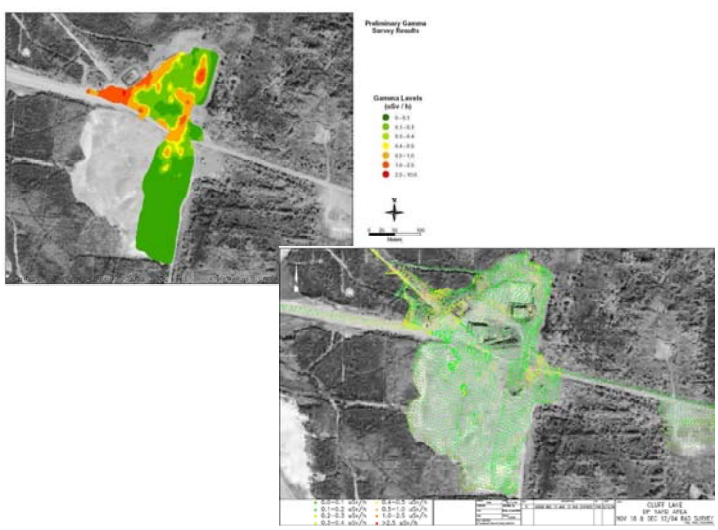

Figure 7: OP/DP Area Gamma Radiation Survey

Both the gamma radiation level and the GPS position are recorded for individual points as the area is systematically traversed, and a standard data processing method used to generate the map. All of the elevated areas, shown in red and orange on the upper left figure, correspond to locations, such as the ore pad or around the fuelling facility where further clean up was to be expected. Clean up was conducted either by removing contaminated surficial soils or by placement of clean till, once the area has been identified by the survey.

Achieving radiological clearance is an iterative process. The area is surveyed, areas requiring further clean up identified and remediated. The area is resurveyed and further work done, if needed, until the criteria are met.

Figure 8: DJ and Claude Mining Areas

III.C. DJ and Claude Mining Areas

Figure 8 shows the DJ mining area in the foreground and the Claude mining area at the top in the background. The DJ underground mine has been closed and some of the mining supporting infrastructure removed.

We plan to decommission the DJN/DJX pits by flooding, however the adjacent DJN pit can be seen to be overfilled with waste rock in this early photo (Figure 9, left side). In late 2004, some of this waste rock was removed to a level 3 m below the final anticipated water level. The end state will be a contiguous DJN/DJX flooded pit.

The DJN waste rock pile (Figure 9, right side) was the dominant contributor to elevated concentrations of sulphate, uranium and nickel in two small streams running through the mining area. The DJN pile was thus relocated to Claude Pit in late 2004.

DJ Area (looking North)

DJN Waste Rock Pile (looking South)

Figure 9: DJ Area Decommissioning

Since completion of mining in 1989, Claude pit (top area of Figure 8) has been approved and used as a repository for various wastes, including waste rock, scrap steel, contaminated materials and demolition wastes.

The initial assessment of Claude pit decommissioning was based on partial backfilling and flooding, however it was evident through source term predictions and contaminant transport modelling, that long-term water quality in the remaining flooded pit would be problematic. As a result, the decommissioning plan is now based on complete backfilling, primarily with the waste rock from the DJN pile. Much of the backfilling was completed in 2004. The task will be completed in 2005 with placement of the remaining (Phase 2) mill demolition waste and rock from the Claude pile. Capping with native till material and revegetating will finalize the Claude pit reclamation.

The Claude waste rock is acid generating and has shown elevated uranium and nickel, as well as reduced pH, in the groundwater wells along the perimeter of the pile. This plume will gradually move towards surface water bodies. To assess the degree of future impact, a detailed regional hydrogeology study was completed of the area and contaminant transport modelling was undertaken, to compare the degree of impact to surface water quality for each of the decommissioning options which were evaluated.

The preferred approach is to reslope to a stable long-term configuration (4H:1V) then place a dry cover over the pile, developed by compacting the final waste rock surface followed by placement of a 1 metre till layer. The compacted waste rock layer is intended to restrict infiltration, as compared to uncompacted waste rock. The till layer provides temporary storage for precipitation and a rooting substrate for a grass/legume cover crop such that transpiration can be maximized. Later invasion of native trees and shrubs will further add to the transpiration capacity after the grass/legume component has stabilized the surface against erosion.

III.D. Mill Complex

Figure 10 shows the mill and supporting facilities during operations. As noted on the figure, some of the redundant supporting facilities were removed earlier. After the stockpiled ore was processed, the mill was mothballed in preparation for final demolition. This involved draining fluids from equipment, removing reagents and disconnecting utilities (electrical, propane, etc).

Figure 10: Mill Complex

Decommissioning the mill area will involve two phases which will be completed in 2004 and 2005. In the first phase, all parts of the mill which are no longer required to support ongoing decommissioning activities have been demolished and disposed in Claude pit. The second phase will complete mill removal.

The mill demolition work is broadly similar to demolition of other comparable size industrial facilities, with special measures as needed to protect workers from residual contamination, and to prevent the spread of contaminants into the environment. Experience during mothballing shows this operation can be conducted safely with the radiological risks significantly reduced from the operating period.

During the summer and early fall of 2004, Phase 1 of the mill demolition was completed (Figure 11). The photos show the removal of the building and infrastructure related to the grinding and leaching circuits.

Figure 11: Mill Area Decommissioning

III.E. Tailings Management Area

The above ground tailings management area (TMA) (Figure 12) was developed in 1980 and has received all tailings produced by the mill over the life of the project. It was established in a topographically-low area by constructing the Main Dam structure which includes a sand/bentonite clay core. Coarse tailings tended to accumulate in the Upper Solids Pond near the point of discharge while finer tailings moved downslope and are predominantly retained in the Lower Solids Pond. Decant water was temporarily retained in the Liquids Pond pending final treatment and release to the environment.

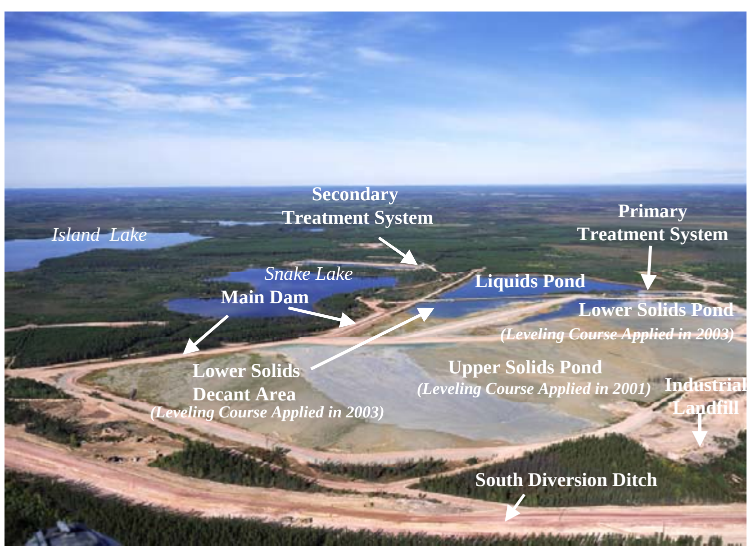

Figure 12: Tailings Management Area

Several decommissioning strategies were considered and were evaluated through hydrogeological and contaminant transport modelling as previously described for the Claude waste rock pile. The primary contaminant of concern from the TMA is Radium-226.

A simple engineered dry cover was the preferred alternative consisting of a minimal layer of 1 metre of native till material over the entire tailings surface area. The till serves to consolidate the tailings resulting in the discharge of excess porewater for treatment and release. Additionally, the till provides a growth substrate for an initial grass/legume cover crop and a storage layer for precipitation in order to maximize the amount of transpiration. Through this method, the amount of infiltration to groundwater is reduced. The till cover also serves to largely eliminate radiological risks.

The initial levelling course of till was placed at the Upper Solids Pond in 2001, and the Lower Solids Pond in 2003. Instrumentation providing pore pressure measurement in the tailings has now demonstrated that consolidation is effectively complete. Final decommissioning of the TMA will involve:

- final grading of the till cover to ensure effective runoff without erosional problems
- backfilling the Liquids Pond
- buttressing the main dam with earth fill, for long term stability
- construction of stormwater management structures
- removal of any remaining buildings and surface infrastructure, and final closeout of the area
- revegetation with commercially available grass and legume species which will quickly establish sod formation to limit erosion and maximize transpiration. Native vegetation will gradually invade the area.

III.F. Site Infrastructure

Various supporting facilities and site infrastructure also have to be dismantled and the disturbed areas reclaimed and revegetated.

Figure 13 shows the Germaine camp. Site activities will be consolidated at the camp, as we complete decommissioning of the mining, mill and TMA areas, and removal of the site infrastructure.

Previous figures have shown the immediate area of disturbance at each major site location. This figure provides a much better perspective of the entire site, and shows the total disturbed area to be relatively small compared to the overall site area.

The camp will be partially decommissioned during the next two years, but sufficient facilities will be retained to support those staff and activities which will be continued during the post-closure monitoring and follow-up program period. In addition to collecting a wide range of data, staff will assess the ongoing success of the revegetation program and perform activities such as applying fertilizer and minor repair of surface erosion which may occur before vegetation is well established. This period of ongoing staff presence on site is estimated to be five years.

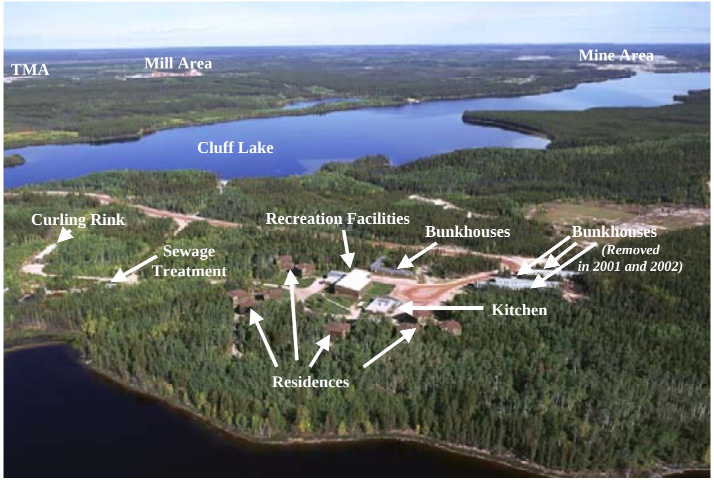

Figure 13: Germaine Camp and Site Overview

IV. HOW WILL WE MEASURE SUCCESS

The Cluff Lake Decommissioning Plan is primarily designed to protect the quality of surface water into the future and to allow traditional use of the site for hunting, trapping and fishing. The regulatory agencies have established the levels of various potential contaminants for protection of aquatic and terrestrial habitat.

Most of the water quality values are those found in the Saskatchewan Surface Water Quality Objectives (SSWQO). Notable exceptions are uranium and molybdenum, for which no SSWQO values exist, and iron.

For uranium, an investigation of the available toxicity studies indicated a proportional dependence on hardness. Therefore, the toxicity data was plotted against hardness and a relationship developed. Employing suitable safety factors, that relationship was determined to be: Uranium criteria = 0.002 X [Hardness]

Further research on uranium toxicity is currently underway using a selection of Northern Saskatchewan aquatic species.

The molybdenum objective for lakes which have not traditionally been impacted by mining operations, was based on an interim Canadian Water Quality Objective of 0.073 mg/L. A value of 0.5 mg/L was accepted for flooded pits and Island Lake, which has received treated effluent through the twenty-two year history of the operation. This value falls below the chronic toxicity response levels documented within the literature.

Iron values are naturally high in the Cluff Lake area. The 95th percentile of monitored values in reference areas within each of the watersheds was selected as a reasonable objective.

Several other factors will also be considered in determining decommissioning success:

- Sediment quality in Island Lake, as determined by monitoring following decommissioning, will be utilized to compare to predicted recovery rates based on modelling. Results will also be compared to various guideline values
- Groundwater will be monitored for water level and quality and compared to modelling estimates
- Amount of infiltration through dry soil covers on the Claude waste rock pile and the TMA will be monitored and compared to predictions
- Assumptions on modelled source terms will be evaluated by direct measurement
- Physical stability of dams, waste rock piles, dry covers and stormwater structures will be evaluated regularly over the initial monitoring period to ensure satisfactory performance
- Adequacy of revegetation on all disturbed areas will be assessed.

In the event that monitored values are substantially different from the modelling predictions or expected performance, the significance of the variations will be assessed. If the result indicates increased risk to human health or the environment, contingency actions and/or further remediation will be assessed and any further necessary actions taken.

The Ecological Risk Assessment was conducted using the predicted values of water and sediment quality in local waterbodies Representative aquatic organisms from various trophic levels (plankton, benthic invertebrates, pelagic and benthic fish) as well as terrestrial organisms, resident in or near water, were assessed for risk from potential radioactive and non-radioactive contaminants. Predicted intakes of the various contaminants were compared to literature-based values of toxicity to sensitive life stages. Risks were identified when the predicted values exceeded the toxicity benchmark.

In summary, the study indicated potential risks to some aquatic species in Island Lake as a result of sediment accumulations of copper, molybdenum and uranium. This is consistent with earlier environmental assessments, as Island Lake has been the immediate downstream receptor for discharged effluent throughout the twenty-two years of operation. The current biological status of Island Lake represents an altered, but functioning, aquatic community which will recover as decommissioning proceeds and effluent discharge is terminated. Modelling indicates the risks will be eliminated within 10 to 50 years of final decommissioning.

For terrestrial animals, the analysis quantified the risk to wildlife from drinking water, foraging for food, and ingesting soil/sediment. Potential risk was identified for muskrat, otter, waterfowl and moose in the Island Lake area from molybdenum, uranium and, to a lesser extent, selenium. As for aquatic species, these risks quickly decrease after decommissioning.

Risks predicted for humans living in the area after decommissioning are not significant.

Monitoring of surface water, groundwater, sediment, benthic invertebrates and fish will continue through decommissioning, similar to the operational period, to ensure that environmental compliance is maintained. It is anticipated that a small site monitoring crew will be resident during at least a five year period following the decommissioning. A ten year observational monitoring program is envisioned thereafter, done on a campaign basis by flying into the site by floatplane or helicopter.

In addition to the regular compliance monitoring program, the Comprehensive Study has required a Follow Up Program to assess the validity of the assumptions used in the planning and ensure the mitigative measures are performing as designed. For Ecological Risk Assessment, this will include a comprehensive inventory of aquatic and terrestrial wildlife at the end of the operational period and additional studies to determine if the predicted risks were appropriate. The Follow Up Program also includes surface and groundwater monitoring to validate the assumptions used in the contaminant transport modelling. In the event that the mitigation is not having the desired effect, COGEMA remains responsible for further action to achieve the decommissioning objectives.

When the monitoring indicates the site is performing effectively, COGEMA expects to file an application for abandonment of its licences. This will require a new Environmental Assessment. If accepted, the surface lease will be concluded, and the Province will become responsible for long term institutional control.

V. CONCLUSION

Figure 14: Cluff Lake Decommissioning

We wish to close with this photograph, which shows at the local and personal scale what we mean by sustainable development and by mining being a temporary use of the land. The local trapper was here before we came, lived on-site through the operational period and will be here after we leave. We wish to leave the site safe for him and those who may follow, and for the plants and animals which are native to the area.