STAKEHOLDER ENGAGEMENT AND ADDITIONAL REMEDIATION OF THE DECOMMISSIONED BEAVERLODGE URANIUM MINE SITE

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ABSTRACT

The Beaverlodge uranium mine and mill were decommissioned by Eldorado Nuclear in the early 1980's. Since 1985 the site has been in "transition phase monitoring". Close-out objectives set at the time of decommissioning and have largely been met; however regulatory agencies and industry struggled to come up with an acceptable and sustainable exit strategy.

Through the development of the Province of Saskatchewan's Institutional Control Program a sustainable exit strategy has become a reality within the province. The Institutional Control Program has provided industry with clear and attainable remediation goals, while ensuring long-term environmental stewardship of remediated industrial sites.

Arguably the greatest challenge facing mine closure projects today becomes one of stakeholder engagement. This paper discusses the site management strategy, as well as the risk assessment and stakeholder engagement tools utilized by Cameco and its consultants in the development of an acceptable path forward plan, as the site is being prepared for transfer to the ICP.

Key words: Institutional Control, Close-out, Stewardship, Closure, Decommissioning

INTRODUCTION

Location

The former Beaverlodge mining and milling properties are located approximately 8 km east of the Northern Settlement of Uranium City located north of Lake Athabasca in the northwest corner of the Province of Saskatchewan (Figure 1). The Beaverlodge/Uranium City area is remote and accessed primarily by aircraft. Uranium City is the only community with road access to the former Beaverlodge properties. In June 2012, the population of permanent residents in Uranium City was estimated to be 89, according to Saskatchewan Ministry of Health (2012).

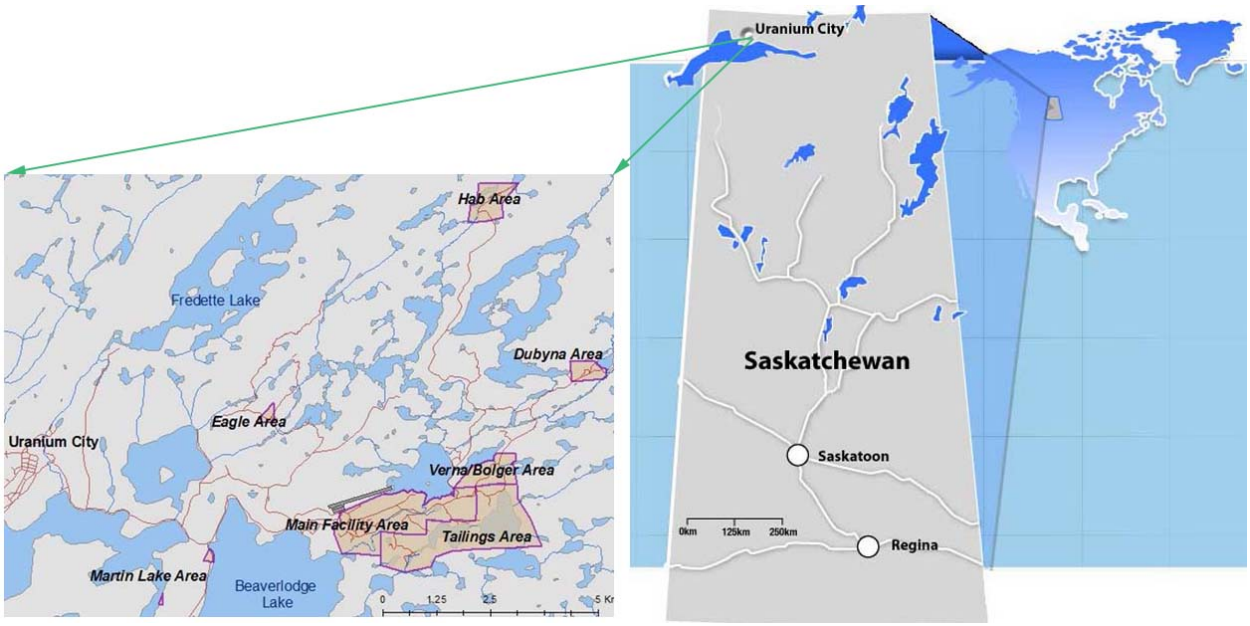

Figure 1 The Beaverlodge site is located north of Lake Athabasca in northern Saskatchewan

Background

As described in MacLaren Plansearch Inc. (1983), uranium-bearing minerals were first discovered in the Beaverlodge area of northern Saskatchewan in 1934. Eldorado Mining and Refining Ltd. (Eldorado), a Crown corporation owned by the Government of Canada, commenced detailed exploration in 1944, leading to start-up of a mine and mill in 1952.

The primary focus of mining activity was north and east of Beaverlodge Lake where three mine shafts led to the development of a significant underground operation. Production from this mine and numerous "satellite mines" continued until 1982.

By modern standards for Saskatchewan uranium deposits, the uranium content of the ore was relatively low. The generally clean nature of the orebody in terms of secondary metal contaminants, as well as its carbonate nature made the waste rock relatively benign. During the initial period of operation, comprehensive environmental protection regulations did not exist. It was not until the mid-1970s, over 20 years after operations began, that a federal Atomic Energy Control Board (AECB) licence was issued and effluent treatment processes were initiated in response to discussions with provincial and federal regulatory authorities.

Current Management Structure

In 1988, the Government of Canada and the Province of Saskatchewan announced their intention to establish an integrated uranium company as the initial step in privatizing their respective uranium investments. Cameco Corporation was created from the merger of the assets of the Saskatchewan Mining Development Corporation and Eldorado.

Under the terms of the asset-transfer agreement, the federal government, through Canada Eldor Inc. (CEI), a subsidiary of the Canada Development and Investment Corporation, retained responsibility for all costs associated with the monitoring and maintenance of the decommissioned Beaverlodge properties, while Cameco retained responsibility for carrying out these activities.

In managing the Beaverlodge site, Cameco has broadly applied the same environmental management approach used at its operating sites. Environmental interactions on the properties are assessed and risks mitigated if warranted.

ORIGINAL DECOMMISSIONING

To meet the conditions of federal and provincial operating permits, Eldorado submitted a Conceptual Reclamation Plan for the main mine and mill facilities to the regulatory agencies in June 1981 (Eldorado 1982). On December 3, 1981, after nearly 30 years of operations, it was announced that the mine and mill operation would be shut down on June 30, 1982. The development of an acceptable and final decommissioning and reclamation plan became priority and was submitted to the regulatory agencies in June 1982. The AECB granted approval for decommissioning and close-out of the Beaverlodge mill and related mining properties on September 1, 1982.

Decommissioning plan approved

The Beaverlodge facility was the first uranium mining and milling operation in Canada subjected to the regulatory approval of a formal decommissioning and reclamation strategy. Each phase of the shutdown, decommissioning and reclamation was subject to detailed discussion between Eldorado and the regulatory agencies, including representatives from the AECB (now the Canadian Nuclear Safety Commission), Environment Canada, Saskatchewan Environment (now Saskatchewan Ministry of Environment), Saskatchewan Labour (now Saskatchewan Ministry of Labour Relations and Workplace Safety), and the federal Ministry of Labour. Regular and detailed inspections were carried out by the various regulatory agencies during all of the decommissioning and reclamation activities.

Eldorado developed an integrated approach to the decommissioning and reclamation of the Beaverlodge mine and mill and associated wastes. A schedule of activities was developed which were to culminate in the transfer of title to the Province of Saskatchewan after satisfactory performance has been demonstrated.

The Eldorado approach to decommissioning and reclamation presented in Eldorado Nuclear Limited (1982) reflected a philosophy directed towards the protection of employees and residents, and the natural environment surrounding the mine and mill site. The Eldorado philosophy and objectives established environmental objectives for the reclamation activities and committed to applying good engineering practices, such as the elimination or minimization of man-made structures in closing out the site.

Close-out criteria were met adjacent to the mill site where Ace Creek flows into Beaverlodge Lake at the time the operation shut down. At the outlet of the Tailing Management Area, it was predicted that uranium concentrations would meet the close-out objectives only in the long term, while radium and total dissolved solids were not expected to meet the close-out objectives in the long-term (~200 years). During the original assessment no significant improvement in the concentrations of these parameters was predicted with any of the reclamation options considered. It was also predicted at the time of decommissioning that changes in Beaverlodge Lake water quality would occur very slowly as a result of the long retention time of the lake.

Transition-phase monitoring and changing expectations

Regulatory-approved site decommissioning and reclamation activities were completed in 1985. Transition-phase monitoring was initiated at that time to verify decommissioning predictions. The majority of the site remains in a transitional monitoring phase, which was initially expected to last for about 10 years following completion of the work.

Despite meeting most of the predicted recovery targets soon after decommissioning was complete the transition phase is now in its 28th year. Failure to bring an end to the transitional monitoring phase can be attributed to many factors, including:

- The length of time between completion of decommissioning activities and final site closure, which still has an uncertain end date;
- Loss of institutional memory with the passage of time;
- Changes of personnel involved with site management and regulation; and,
- Modification or expansion of environmental criteria used to judge the work.

As an example of the latter point, the original decommissioning plan acknowledged that the Beaverlodge area was impacted and was not going to be returned to a pre-mining condition, and was approved by all of the current regulatory agencies or their predecessors. However, since decommissioning the guideline concentration for uranium in the aquatic environment has been reduced by a factor of more than ten from what was targeted at the time of decommissioning. Perhaps more significant has been evolving expectations on acceptable levels of selenium in the aquatic environment. The acceptable concentration of selenium has been reduced by a factor of ten over the last 15 years. When the original close-out objectives were established selenium was not a formal consideration, while today it is arguably the dominant concern.

DEVELOPMENT OF INSTITUTIONAL CONTROL PROGRAM

Another factor that has prevented the Beaverlodge site from moving beyond transition phase monitoring was the lack of a formal and documented program for transferring the properties to the Crown once decommissioning objectives were met. In 2007, after significant consultation with various stakeholders, including the Canadian Nuclear Safety Commission (CNSC), the mining industry, aboriginal organizations and communities in the major mining regions of the province, the Government of

Saskatchewan proclaimed The *Reclaimed Industrial Sites Act* and its associated regulations to establish and enforce the Institutional Control (IC) Program. The IC Program establishes a process for transferring decommissioned mining and milling properties to provincial responsibility, once remediation has been completed and a period of monitoring has shown the properties to be stable.

The two primary components of the program are the IC Registry and two IC funding mechanisms: the "monitoring and maintenance fund" and the "unforeseen events fund" (Saskatchewan Ministry of Energy and Resources 2009). The funds required for the monitoring and maintenance fund are negotiated between the Government of Saskatchewan and the operator, who provides funding for the province to perform long-term monitoring of the site to ensure the site continues to perform as expected. The operator also contributes to an unforeseen events fund as part of a general pool of funds, which is built up as sites are added to the IC Registry and will be available for the province to apply at their discretion to any site not performing as expected.

The IC Program is an innovative approach to assure the long-term care and maintenance of decommissioned and reclaimed industrial sites. The program has provided a goal and focus to decommissioning efforts. Without such a process to transfer properties to Crown control, the incentive to perform additional remediation is difficult to justify. Proponents would likely continue to monitor the current condition in perpetuity. However, with the incentive of returning properties to Crown control, industry will ensure their remediation activities will meet the province's expectations that properties are chemically and physically stable and that unreasonable risks have been mitigated.

Following the development of the IC Program and the transfer of five relatively benign properties into institutional control, attention turned to the remaining licensed properties and what could reasonably be done, if anything, to reduce the residual risk.

REMEDIAL OPTIONS WORKSHOP #1

A Remedial Options Workshop was held in Saskatoon in June of 2009. The overall objective of the workshop was to bring stakeholders into the process of assessing potential options for the additional remediation of the former Eldorado Beaverlodge sites. A total of 41 people participated in the workshop including, representatives from local and regional stakeholders, which included community members and First Nations representatives, government representatives, federal and provincial regulatory agencies (multiple departments), and industry representatives.

The workshop methodology was based on the recognition that decommissioning and reclamation planning is essentially a decision-making process, in that it requires a wide range of options to be compared against a broad set of evaluation criteria. The approach can be summarized in the following steps:

1. Identify all of the methods that are potentially applicable to individual elements of the sites.
2. Create a short list of the most applicable methods and assemble them into example "scenarios" that can be further evaluated against the overall objectives.

3. Identify the evaluation factors that would be used by the assembled stakeholders to assess individual methods and scenarios.
4. Identify the uncertainties that prevent a clear selection of the most appropriate method or scenarios.
5. Scope and prioritize the investigations required to address those uncertainties.

The two-day workshop began with a presentation of a Conceptual Site Model (CSM) to develop a common understanding among all participants. The CSM provided an overview of the site and the general interaction of various environmental components and measured water quality. The presentation also identified the twelve "elements" on the sites that could potentially require further remediation.

- Waste Rock Stability
- Pit Wall Stability
- Mine Water Reaching Surface
- Tailings Area Groundwater
- Waste Water Sludges in Meadow Settling Pond
- Demolition Material in Bolger Pit
- Fookes & Marie Reservoir Subaqueous Tailings
- Fookes & Marie Delta Tailings
- Ace & Fulton Spilled Tailings
- Pistol, Dubyna and Verna Surface Waters
- Ace & Fulton Bay Surface Water
- Beaverlodge Lake sediments

Participants were placed into groups to ensure a broad technical understanding and local knowledge of the sites was being considered. The multi-disciplinary nature of the groups enhanced the divergent thinking process. Participants were asked to collectively brainstorm closure "methods" for the twelve elements and then rank the options to identify which ones they believed were the most worthy of further consideration.

Groups were then asked to develop a hypothetical remediation scenario for the site and identify the factors that they would consider in evaluating a plan for the final remediation of the former Eldorado Beaverlodge sites. All the information was compiled to create the comprehensive list of "evaluation factors", provided in Figure 2.

Groups were then asked to assess whether a preferred option could be identified today and, if not, what critical pieces of information prevented a decision. Based on the results of the group exercises, workshop participants developed a list of the critical information gaps for each area. The list developed for the Ace Creek Watershed is provided in Figure 3.

A high level cost estimate was developed by subject matter experts for each study design. Groups of participants were then asked to prioritize the required studies. Each group was given a "play money" budget that amounted to about one-third of the total costs of all the investigations on the initial list, and asked to select which studies they would fund.

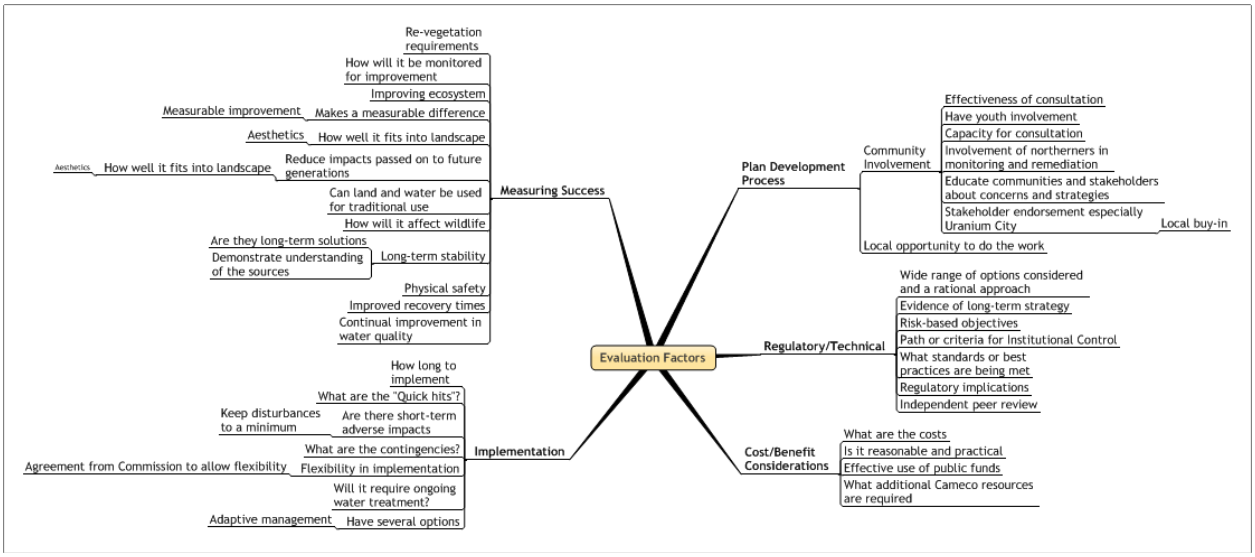

Figure 2 – Evaluation Factors to Consider for Remediation of Beaverlodge

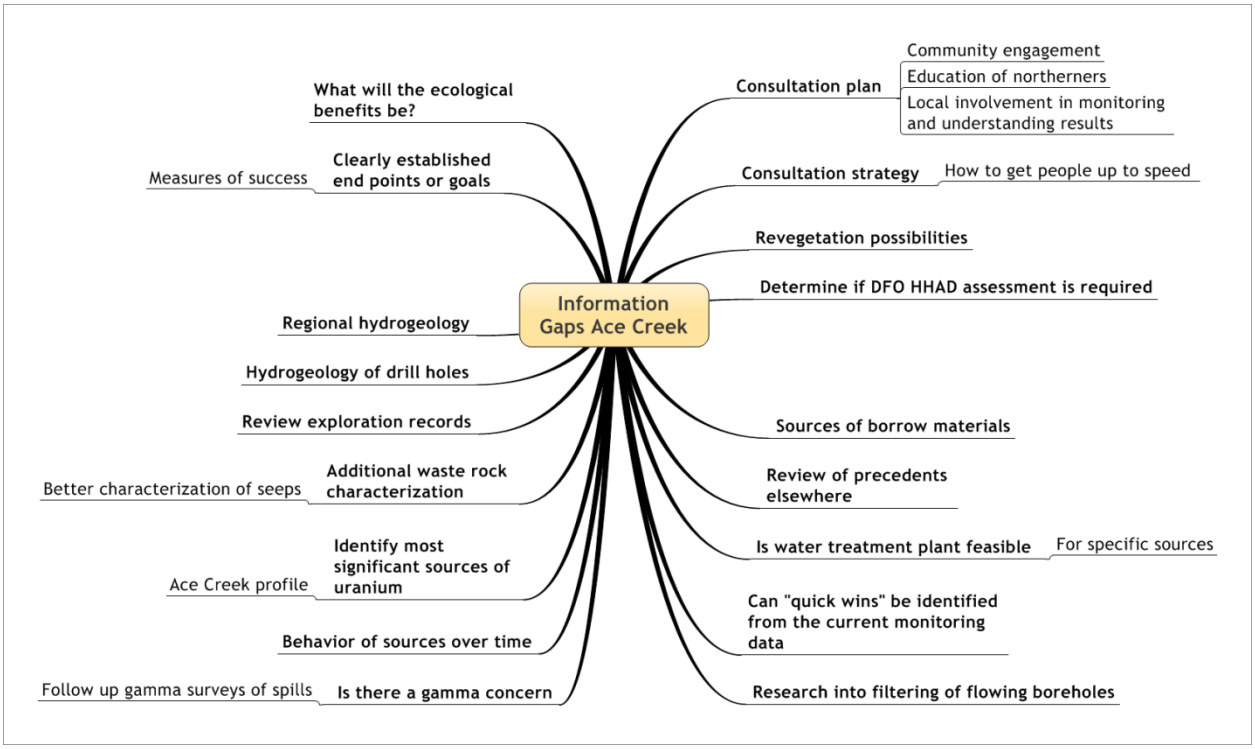

Figure 3 – Information Gaps Preventing Decisions

BEAVERLODGE MANAGEMENT FRAMEWORK

Following the Remedial Options Workshop #1, CNSC, Saskatchewan Ministry of Environment, Environment Canada, Department of Fisheries and Oceans, and Cameco agreed that the ultimate goal of the management of the Beaverlodge properties was to eventually transfer them to the provincial IC Program. Cameco and the regulatory group met over the course of 2009 to develop a Beaverlodge

Management Framework, which established a set of guiding principles to ensure future work performed at the site is with the purpose of ensuring the site is progressing towards the IC program. The management framework has been reviewed with the local and regional stakeholders at every public meeting since it was developed.

The Management Framework recognizes that the Beaverlodge area has been impacted by historical mining operations. It describes the management philosophy, identifies physical boundaries to which the management framework applies, and identifies the minimum requirements for the province to accept properties into the IC Program. The framework references a decision-making process that will guide assessments through to the final endpoint, a critical piece in the management of the Beaverlodge properties. The decision-making process was developed in collaboration with the JRG to ensure there was "buy-in" to the step-wise plan for gathering information, assessing risk and making decisions regarding potential remedial options for the properties. A simplified version of the decision making process is provided in Figure 4.

The Management Framework commits Cameco to maintaining a public outreach program that features proactive stakeholder involvement, including consultation with local communities and aboriginal groups. To meet that commitment there is an opportunity for engagement with stakeholders between each phase of the Management Framework flowchart described in Figure 4.

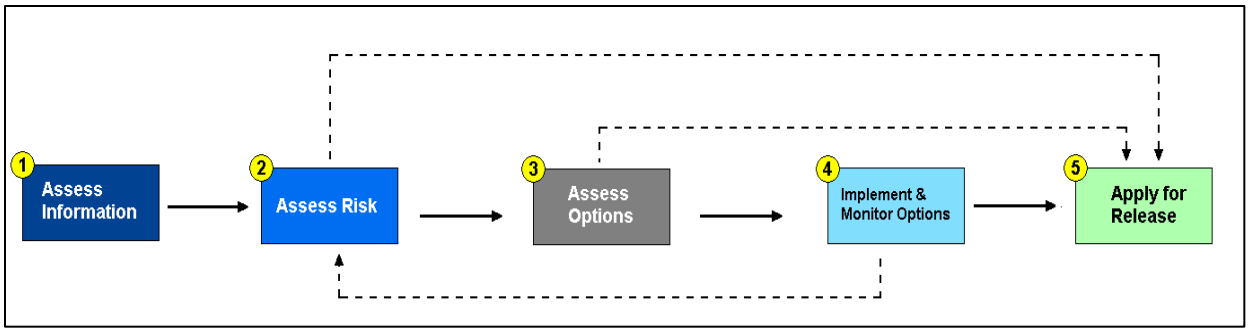

Figure 4 Simplified Beaverlodge management framework flowchart

QUANTITATIVE SITE MODEL DEVELOPMENT

As a result of Remedial Options Workshop #1 Cameco performed over twenty studies between 2009 and 2012 gathering ecologically relevant information to facilitate development of a quantitative site model (QSM) for the properties. The QSM uses contaminant transport and pathways modelling to predict the potential changes in concentrations of contaminants of concern (uranium, radium and selenium) as well as the associated risks to humans and ecological receptors in the Beaverlodge area over the next 150 years. The QSM was developed and tested over a two year period and incorporates all past monitoring data and the results of special studies completed throughout the transition phase monitoring period.

As a management tool the Beaverlodge QSM can be used to simulate a wide variety of potential remedial options, predicting the expected change in environmental conditions following implementation of a

remedial option. This "what if" feature of the model allows for easy and quick prediction of expected contaminant flux reduction by simulating various remedial options, such as:

- Covering the sediments in affected lakes with clay, sand or other cover material.
- Dredging lake sediments for disposal in a secure location.
- Removing waste rock from the shoreline of lake or stream sections.
- Applying a cover on waste rock.
- Isolating or covering exposed tailings spill areas.
- Treating contaminated water.
- Diverting clean flow around a contaminant source.

As the site progresses through the Beaverlodge Management Framework, if additional remediation is warranted, the QSM can be used to establish site specific performance objectives to monitor the success of the remedial activity.

Following the development of the QSM, Cameco and its consultants prepared a document titled "Costing Study – Potential Remedial Options, Former Beaverlodge Mine". The document provided an order of magnitude cost estimate for many of the potential remedial options identified during Remedial Options Workshop #1 and was critical to assessing the benefit and cost of remedial options during Remedial Options Workshop #2.

REMEDIAL OPTIONS WORKSHOP #2

On April 3 and 4, 2012, Cameco Corporation hosted a second workshop in Saskatoon to further evaluate the benefits and costs of potential remedial options for the former Eldorado Mining and Refining Ltd. Beaverlodge mine and mill properties. The 2012 workshop was attended by stakeholder representation mirroring those that attended the 2009 workshop. The specific objectives of the 2012 workshop were to obtain informed, clear and documented feedback about the predicted benefits and estimated costs of a range of remediation options, from a cross-section of stakeholders.

The results of the 2012 workshop were used by Cameco in the development of the Path Forward Plan. This plan describes the activities to be carried out over the next ten years on the Beaverlodge site, in accordance with the Beaverlodge – Management Framework, with the goal of transferring properties to the IC program.

A total of 46 people participated in the two day workshop. Participants included ten individuals representing the northern settlement of Uranium City which is the nearest community to the former Eldorado Beaverlodge properties and six members of the Northern Saskatchewan Environmental Quality Committee (EQC) representing Athabasca Basin and other Northern Saskatchewan communities. Other participants included representatives of the Northern Mine Monitoring Secretariat and various federal and provincial regulatory agencies including the CNSC, Environment Canada, Natural Resources Canada,

Fisheries and Oceans Canada and the Saskatchewan Ministry of Environment, as well as representatives of the Mamawetan Churchill River Regional Health Authority, the Saskatchewan Research Council, CanNorth Environmental Services, Canada Eldor Inc. and Cameco Corporation.

To allow a productive discussion within the time constraints specified, a total of nine options were developed in advance of the workshop. The nine pre-prepared options were chosen to reflect the stakeholder preferences identified in the 2009 workshop and to cover a wide range of potential ideas.
Each of the prepared options was examined prior to the workshop, using the Beaverlodge QSM, to estimate effects on downstream contaminant concentrations (uranium, radium-226 and selenium) and the levels of ecological and human health risk. In each case the changes to environmental conditions, human health and ecological risk over the next 50, 100 and 150 years were assessed in the local (on site) water bodies and major downstream waterbody relevant to the studied option.

The heart of the workshop process was a series of steps that allowed the participants, working as stakeholder groups, to assess the benefits and costs of potential remediation measures. The method differs from conventional cost-benefit analysis in that it does not require all considerations to be converted to a common unit of measurements, such as dollars. That difference has the crucial advantage that it allows stakeholder groups to provide assessments of option "value" that fully reflect their own perspectives. Once those evaluations were completed, the methodology provided an opportunity for dialogue on the various perspectives and differences of opinion.

The first step was a presentation of an option to the workshop participants. In each case, the option was fully described and the estimated cost to complete the remediation work provided. In addition, the predicted changes (if any) to the site and downstream concentrations of contaminants of concern (uranium, radium-226 and selenium) were presented along with corresponding risks to human and ecological receptors in the area. The description also included a summary of any assumptions that were made in modeling the components that comprised each option.

After the presentation of each option, the workshop participants were asked to collectively identify the most pertinent "pros and cons" relative to each option. This part of the agenda allowed for discussion of the option itself as well as any challenges to the assumptions made in the QSM modeling and cost estimates.

Each group was then asked to evaluate the option. To provide consistent feedback, a set of statements were provided as the basis for the evaluations. An example statement was "This option protects the health and safety of local and regional people". Each group was asked to determine whether it "strongly agreed", "agreed", "disagreed" or "strongly disagreed" with each statement.

Once each group had completed its evaluation of an option, the results were reported to the entire workshop and recorded on a projected worksheet. Figure 5 shows an example. This step allowed the level of agreement and disagreement among the groups to be immediately clear. Where there was a significant divergence of opinion on a particular option, the two groups with the differing opinion were asked to explain their reasoning.

Results of the second workshop were very useful to Cameco in developing a Path Forward plan. Despite the varied backgrounds of the workshop participants, the many points of view showed consistent trends. The "do nothing" option was not acceptable to any group, however in general people felt that the large scale remedial options did not improve environmental conditions or reduce ecological or human health risks to a level commensurate with their high cost. There were a few options identified that had relatively low cost and a measureable local benefit, and all groups agreed those should be the focus of further actions.

Objective	Uranium City	EQC	Province	CNSC	Other Federal	Cameco
This option will protect the safety and health of local people	Neutral	Disagree	Neutral	Neutral	Neutral	Neutral
This option will protect fish and animals within the Beaverlodge mine area	Strongly Disagree	Disagree	Neutral	Neutral	Neutral	Agree
This option will improve water quality near the mine area	Disagree	Neutral	Agree	Agree	Agree	Agree
This option will improve recovery times of downstream water bodies	Disagree	Disagree	Agree	Agree	Disagree	Disagree
This option will allow traditional use of land & water in the area	Strongly Disagree	Disagree	Disagree			
This option will present good opportunities for local businesses and workers	Agree	Agree	Agree			Agree
This option will fit into the local landsacpe	Agree	Agree	Agree			Agree
This option's implementation risks and short-term impacts will be acceptable		Disagree	Agree		Disagree	Disagree
This option will be technically feasible		Neutral	Agree	Agree	Agree	Neutral
This option will be reliable over the long term		Agree	Agree	Agree	Agree	Agree
This option meets the standard of good mine closure practice elsewhere		Agree	Neutral	Neutral	Disagree	Neutral
This option will meet applicable provincial and federal regulations		Agree	Neutral	Neutral	Neutral	
This option will allow the site to be handed over to institutional control		Disagree	Neutral	Neutral		
This option will be a good use of public funds	Agree	Disagree	Disagree	Agree	Disagree	Disagree

Figure 5 Example report-back chart from Workshop #2

SUMMARY

The Beaverlodge site was remediated in the 1980's under an approved decommissioning plan that used the best-available technology and industry standards of the day. The plan was approved and monitored by the regulatory agencies at the time, and the site is generally performing as predicted.

Over the now 28 years of “transition-phase”, the decommissioned Beaverlodge properties have been subject to changing expectations resulting largely from the lack of a formal process for determining when decommissioning and reclamation is complete. The recent implementation of an IC Program by the Province of Saskatchewan has brought a clear understanding of what is required to prepare the properties for transfer to the IC Program.

The Beaverlodge Management Framework was developed with the regulatory agencies to ensure that reasonable actions are taken to manage risk prior to proposing transfer to the IC Program. The framework controls the risk of changing expectations and, where remediation is warranted, allows the development of site-specific performance objectives.

Stakeholder workshops were critical in determining investigation priorities and selecting remediation measures. Participants at the first workshop developed a list of information that was required before decisions could be made regarding the feasibility and practicality of implementing additional remediation of the Beaverlodge site. Participants at the second workshop provided clear and informed feedback on remediation options.

The information gathered during the two stakeholder workshops supported the development of a Path Forward plan. The CNSC reviewed the Path Forward plan at a public hearing and subsequently granted Cameco a 10-year licence to perform the remediation required to bring about the final closure of the Beaverlodge site and transfer it into the Province’s IC program.

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